Sir John A. Macdonald Parkway Bridge O/P LRT Extension to QUE (SN015940)

MH NO. 2140670

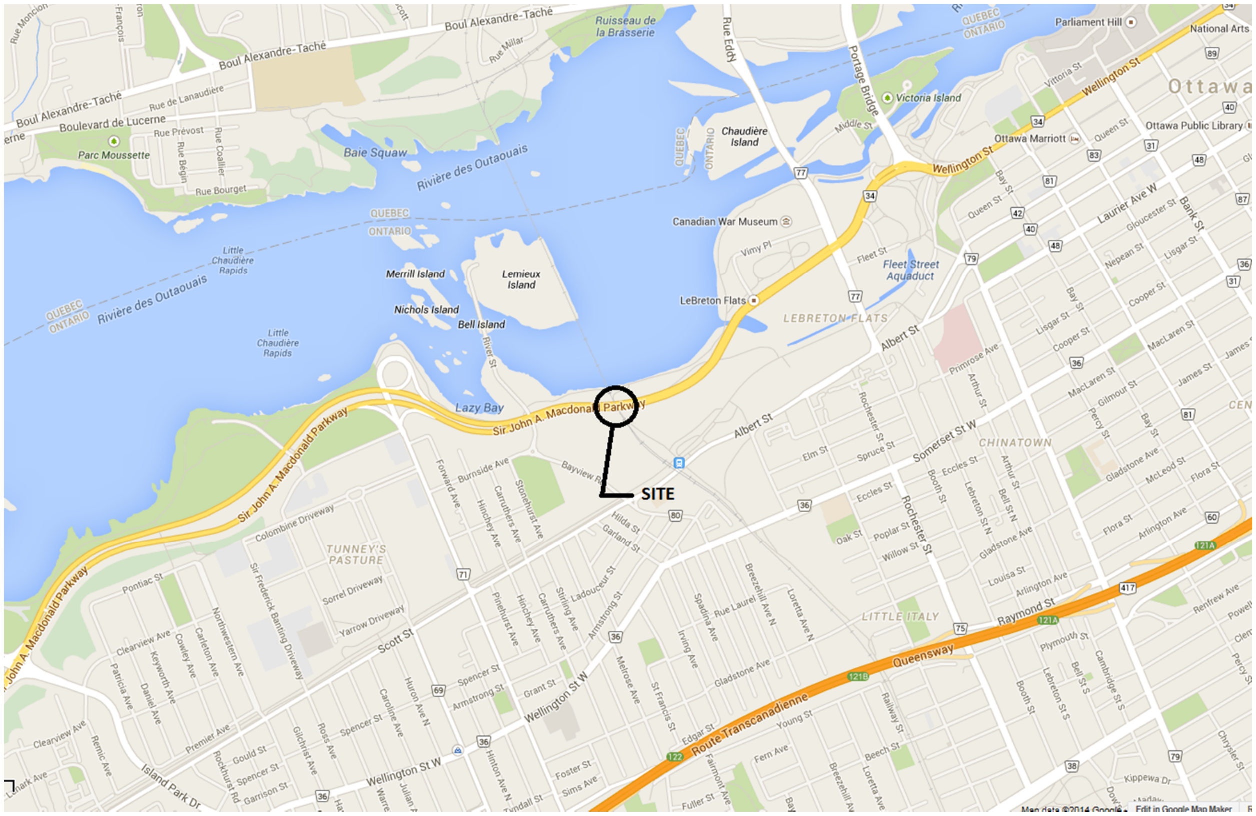
Contract No. ISD14-7114

STRUCTURE NO. 015940

STRUCTURE EVALUATION REPORT

January 2015

MORRISON HERSHFIELD


SITE
Rivière des Outaouais
Baie Squaw
Parc Moussette
Boul Alexandre-Taché
Boulevard de Lucerne
Chaudière Island
Victoria Island
Portage Bridge
Rue Eddy
Canadian War Museum
LeBreton Flats
LEBRETON FLATS
Fleet Street Aquaduct
Parliament Hill
National Arts
Ottawa
Ottawa Marriott
Ottawa Public Library
Wellington St
Merrill Island
Lemieux Island
Nichols Island
Bell Island
Little Chaudière Rapids
Lazy Bay
Sir John A. Macdonald Parkway
Albert St
Somerset St W
CHINATOWN
LITTLE ITALY
TUNNEY'S PASTURE
Scott St
Wellington St W
Queensway
Route Transcanadienne
Raymond St
Laurier Ave W
Bank St
Rochester St
Bayview Rd
Island Park Dr

Key Plan

Appendix A – Bridge Design Drawings
Appendix B – Site Photos
Appendix C – Vehicle Load Information
Appendix D – Structural Analysis Calculations

2 SITE INFORMATION

Structure Name:	Sir John A. Macdonald Parkway Bridge		
Site Number:	015940		
Highway Above:	Sir John A. Macdonald parkway	Below:	Ottawa Light Rail Transit/Bike Path
Type of Structure:	Reinforced Concrete Rigid Frame		
Number of Spans:	3	Span Lengths (m):	12.2, 17.1, 12.2
Overall Structure Width (m):	24.08	Year Built:	1966
Direction of Structure:	West to East		
Party Members:	Joseph Ostrowski Hui Liu		
Dates of Inspection:	October 24, 2014		
Temperature:	18°C	Weather:	Sunny
Year Last Rehabilitated:	2006		

3 INTRODUCTION

3.1 Background

Morrison Hershfield Limited was retained by the City of Ottawa to carry out the Structural Evaluation of the Sir John A. Macdonald (SJAM) Parkway Bridge O/P LRT Extension to QUE (SN015940) as part of the SJAM Bridges (SN015940 & SN016470) and CCR Aqueduct Bridge (SN015120) Structural Evaluation assignment.

As a result of Ottawa Light Rail Transit's (OLRT'S) west portal and track alignment, there is a plan to route OC Transpo buses onto the SJAM Parkway, between Parkdale Avenue and Preston Street extension, for a period of 3 years. This report evaluates the capacity of the LRT Extension Overpass structure (SN015940) to carry OC Transpo buses and provides recommendations for necessary remedial work.

3.2 General Description and History of Structure

The Sir John A. Macdonald LRT Extension Overpass (SN015940) is located on the SJAM Parkway, about 0.317km east of Slidell Street. Built in 1966, the structure is a reinforced rigid concrete frame with an overall span of 43.79m and an overall width of 24.08m. The bridge is curved and skewed 18.8° to the highway alignment. Minor rehabilitations were carried out in 1980-1981, 1984, 1987, and 2006. Deficient railings have been temporarily corrected with temporary concrete barriers. Trucks and buses are restricted from travel over this section of the SJAM Parkway.

4 METHODOLOGY OF INSPECTION/ANALYSIS

The inspection of the structure was carried out in accordance with the 2008 Ontario Structure Inspection Manual (OSIM).

The inspection was carried out by Hui Liu, P. Eng., on October 24, 2014 under the direction of Joseph Ostrowski, P. Eng. The weather condition at the time of inspection was sunny with a temperature of 18°C.

Inspection was conducted of the visible, accessible portions of the structure above grade.

The structural evaluation was completed in accordance with CAN/CSA-S6-06, Canadian Highway Bridge Design Code (CHBDC). The analysis was based on sizes of the structural components of the bridge as identified in the original construction drawings and as measured on site.

5 SUMMARY OF SIGNIFICANT STRUCTURAL FINDINGS

The structure is generally in fair condition, with significant deterioration noted in the abutments and bearings. This section summarizes the most significant findings of the visual inspection. Detailed descriptions are provided in the individual component subsections. Site photographs of the structure and components are included in Appendix B.

5.1 Concrete Bridge Deck

The bridge deck is a structural component of the 3-span rigid frame structure. The deck varies in thickness and is slightly curved in plan geometry. The top surface of the bridge deck was not visible due to the asphalt pavement.

The bridge deck soffit is generally in good condition with evidence of some minor surface patch repairs. No delamination or significant deterioration is apparent. Several transverse cracks in the centre span soffit (Photo 3) and hairline cracks under the west bound lane located in the middle of the span were noted. These were identified as being a normal condition for reinforced concrete and were not identified as structural defects. Some slightly wider continuous cracks under the east bound lane were noted and were also not considered as a structural defect.

5.2 Abutments

The west abutment is in fair to poor condition with varying degrees of deterioration. Localized areas of medium to severe spalling and water/rust stains beneath the expansion joint were noted (Photo 5 – 8).

The east abutment is in poor condition. Two substantial delamination areas were noted: one in the top middle of the abutment, the horizontal length measured as 1.3m; the other at the northeast corner, which had been previously patched. There are also localized spalls and corroded reinforcing steel of the top of the abutment wall beneath the leaking expansion joint.

5.3 Wingwalls

The exposed parts of wingwalls are in fair condition.

5.4 Bearings

The west abutment bearings are corroded. The bearings consist of a top steel plate, bottom steel plate, and Lubrite plate between the top and bottom plates. The corrosion condition varies from light to severe (Photo 7, 8).

The east abutment bearings are generally in worse condition than the west abutment bearings. Light to medium corrosion was noted on all bearings.

5.5 Legs

The two reinforced concrete legs are in good condition. The exposed surfaces appear to have been coated with concrete sealant. No significant deficiencies were noted.

5.6 Concrete Sidewalks and Median

The concrete sidewalks and median are in fair condition. Light scaling and narrow to medium width cracks were noted on the surface of the sidewalks and median.

5.7 Curbs

The sidewalks and median curbs are generally in fair to poor condition with localized spalling in the curbs and wide cracks on the south curb.

5.8 Railings

The steel HSS section railing and post traffic barrier system on the bridge are generally in fair condition. Severe corrosion was noted at the ends of railings; the portions over the bridge deck were well maintained. The existing railing system does not meet current CHBDC requirements.

5.9 Barriers

Temporary Concrete Barriers (TCBs) were installed on both sides of the bridge immediately behind the curb face and in front of the steel railings. The TCBs are not anchored to the deck but are offset approximately 1.2 m from the edge of the deck. The TCBs are generally in good condition, no instability issue was noted.

5.10 Asphalt

The asphalt wearing surfaces in the west bound lane and east bound lane are in fair to poor condition. Large cracks, asphalt raveling and potholes coincide with the expansion joints at either end of the bridge. Severe longitudinal cracks and light to medium transverse cracks were noted near the approach slab. The west bound lane exhibits light wheel track rutting.

5.11 Foundations

The foundations were not accessible during the time of inspection. No visible evidence of geotechnical instability was observed.

5.12 Embankments

Both the west and east embankments are in good condition. The embankments have been well protected with grouted laid stone.

5.13 Approaches

There are separate approach slabs for the eastbound and westbound lanes. Significant settlement was noted on all approach slabs; 25mm to 50mm was measured at the ends of the concrete apron/sidewalks (Photo 13). The settlement has also caused cracks in the asphalt wearing surface.

5.14 Expansion Joints

Paved over expansion joints at the abutments are continuous across the bridge. The expansion joint assemblies are not visible. There are no concrete end dams. The asphalt pavement is distressed at the joints (parallel cracking, potholes) and the joints are leaking.

6 STRUCTURAL EVALUATION

The structural evaluation for the SJAM Parkway Bridge O/P LRT Extention (SN015940) was carried out based on the current condition of the structure. The dimensions of the structural components were taken from original design drawings and site measurements. Structural evaluation calculations can be found in Appendix D.

6.1 Reference Material

The following information was obtained and used in carrying out the analysis:

1. Original design drawings, M. M. Dillon & Company Limited Consulting Engineers, 15 December 1965.
2. Condition Inspection Report, NCC, 23 June 1995.
3. SJAM Parkway Rehabilitation Drawings, Genivar, January 2005.
4. Asset Information Management Tool Report, NCC, September 9, 2014.
5. Canadian Highway Bridge Design Code, CAN/CSA-S6-06
6. Structural Manual, MTO

6.2 Load Carrying Capacity

6.2.1 Method of Evaluation

The bridge is a 3-span skewed (18.8 degrees) reinforced concrete rigid frame structure. The centre span is 18.03m long (at deck level, measured along the centreline of the median) and is supported by 2 inclined concrete legs. The end spans are each 12.88m long (at deck level, measured along the centerline of the median). The abutment end of each end span is supported on sliding bearings. The deck varies in thickness and the overall width is 24.08m (measured perpendicular to the centreline of the median); the width of the bridge deck is 21m.

No cracking, deformation, stresses, or vibrations detrimental to the structural integrity are expected or evident in the structure. In accordance with the CHBDC, only ultimate limit states are considered for the bridge evaluation. Due to the skew and curvature, the simplified method of analysis is not valid

for this bridge configuration. Therefore, the structure was modeled in three dimensions and analyzed by the finite element method using SAP2000.

6.2.2 Loading

The ULS1 load combination was evaluated considering for the following 7 cases:

Case 1: Fully loaded buses in all 4 lanes.
Case 2: Unladen buses in all 4 lanes.
Case 3: Fully loaded buses in median lanes only.
Case 4: Unladen buses in median lanes only.
Case 5: Fully loaded buses in curb lanes only.
Case 6: Unladen buses in curb lanes only.
Case 7: Fully loaded buses in both west bound lanes and unladen buses in both east bound lanes.

The existing temporary concrete barrier along either side of the bridge was included as a superimposed dead load for all load cases.

The bus configuration and loadings (provided by OC Transpo) follow:

Type A: New Flyer INVERO
Two axles, distance of axles 7.17m, maximum axle weight 88.63kN, total unladen weight of vehicle 133.44kN, total loaded weight of 192.9kN.

Type B: New Flyer Articulated D60LFR
Three axles, distance of outmost axles 13.48m, maximum axle weight 101.80kN, total unladen weight of vehicle 202.68kN, total loaded weight of 302.9kN.

Type C: Orion VII Hybrid
Two axles, distance of axles 7.22m, maximum axle weight 97.61kN, total unladen weight of vehicle 142.7kN, total loaded weight of 192.96kN.

Type D: Alexander Dennis Double Decker ENVIRO 500
Three axles, distance of outmost axles 8.0m, maximum axle weight 78.1kN, total unladen weight of vehicle 178.5kN, total loaded weight of 242.0kN.

The Type D bus represents the most critical loading. This bus loading was taken as a moving load in the structural analysis. All the following conclusions are based on Type D bus.

6.2.3 Results of Evaluation

The structural evaluation reveals that the critical component for all load cases is the leg portion of the deck/pier leg haunch. The load capacity of this component was determined by considering beam/column interaction.

The factored moments and resistances for the critical portion of the deck/leg haunch under the most severe (Type D bus) loading follow:

Load Cases (Type D buses)		Critical Structural Element: Leg (Pier) Location: at bottom of haunch		
		M_f (kNm/m)	M_r (kNm/m)	M_r/M_f
Case 1	Fully loaded buses in all 4 lanes	251.9	209.1	0.83
Case 2	Unladen buses in all 4 lanes	203.8	218.9	1.07
Case 3	Fully loaded buses in 2 median lanes	217.5	215	0.99
Case 4	Unladen buses in 2 median lanes	210.5	219.5	1.04
Case 5	Fully loaded buses in 2 curb lanes	223.4	218.4	0.98
Case 6	Unladen buses in 2 curb lanes	208.1	221.1	1.06
Case 7	Fully loaded buses in both west bound lanes and unladen buses in both east bound lanes	236.6	212.1	0.90

Table 1: Load Carrying Capacity of All Load Cases

The results of this enhanced structural evaluation indicate that:

a) The bridge has sufficient structural capacity to carry unladen buses in all 4 lanes;
b) The bridge is marginally overstressed by fully loaded buses in the 2 median lanes OR in the 2 curb lanes; and
c) The bridge is substantially overstressed by fully loaded buses in adjacent lanes (i.e. 2 westbound lanes) and by fully loaded buses in all 4 lanes.

6.3 Traffic Barrier Evaluation

The traffic barriers on the bridge consist of a permanent HSS railing system augmented by temporary concrete barriers (TCBs) located 1.2m from either edge of the bridge.

The required level of protection, assuming an AADT of approximately 26,000 (based on turning movement counts at Vimy Place Intersection), is PL-2.

The existing railing configuration does not match any of the current crash-tested barrier requirements required by the CHBDC. However the existing TCB, located more than 1.0m (deflection distance) from the edge, provides adequate traffic protection.

7 RECOMMENDATIONS

7.1 Remedial Work Needed to Accommodate OC Transpo Buses

1. No remedial work is required to accommodate unladen buses (load cases 2, 4 and 6).
2. Restrict fully loaded buses to 1 lane only in opposing directions (load cases 3 and 5).
3. Strengthening is required for fully loaded buses in adjacent lanes (load case 7) and for fully loaded buses in all 4 lanes (load case 1). Fibre reinforced polymer (FRP) externally bonded reinforcement applied to the concave face of the deck/leg haunch could provide sufficient strengthening at modest cost with minimal disruption and minimal impact on the appearance of the bridge.

Note: Removing the temporary concrete barriers (TCB) to reduce the dead load would not be sufficient to prevent overstress (for load cases 1 and 7). Furthermore, the cost of installing a new PL-2 railing system is greater than the cost of FRP reinforcement.

7.2 General Rehabilitation to Extend the Bridge Service Life

1. Remove existing TCBs, railing system, sidewalks and bridge deck cantilevers. Reconstruct concrete sidewalk and bridge cantilever to accommodate new PL2 steel railing.
2. Miscellaneous concrete repair.
3. Replace bridge bearings.
4. Replace expansion joint assemblies with strip seal type assemblies or eliminate expansion joints by means of semi-integral abutment conversion.

8 CLOSURE

We trust that this report is sufficient for your immediate requirements. Please contact us if there are any questions or concerns regarding the evaluation or recommendations contained herein.

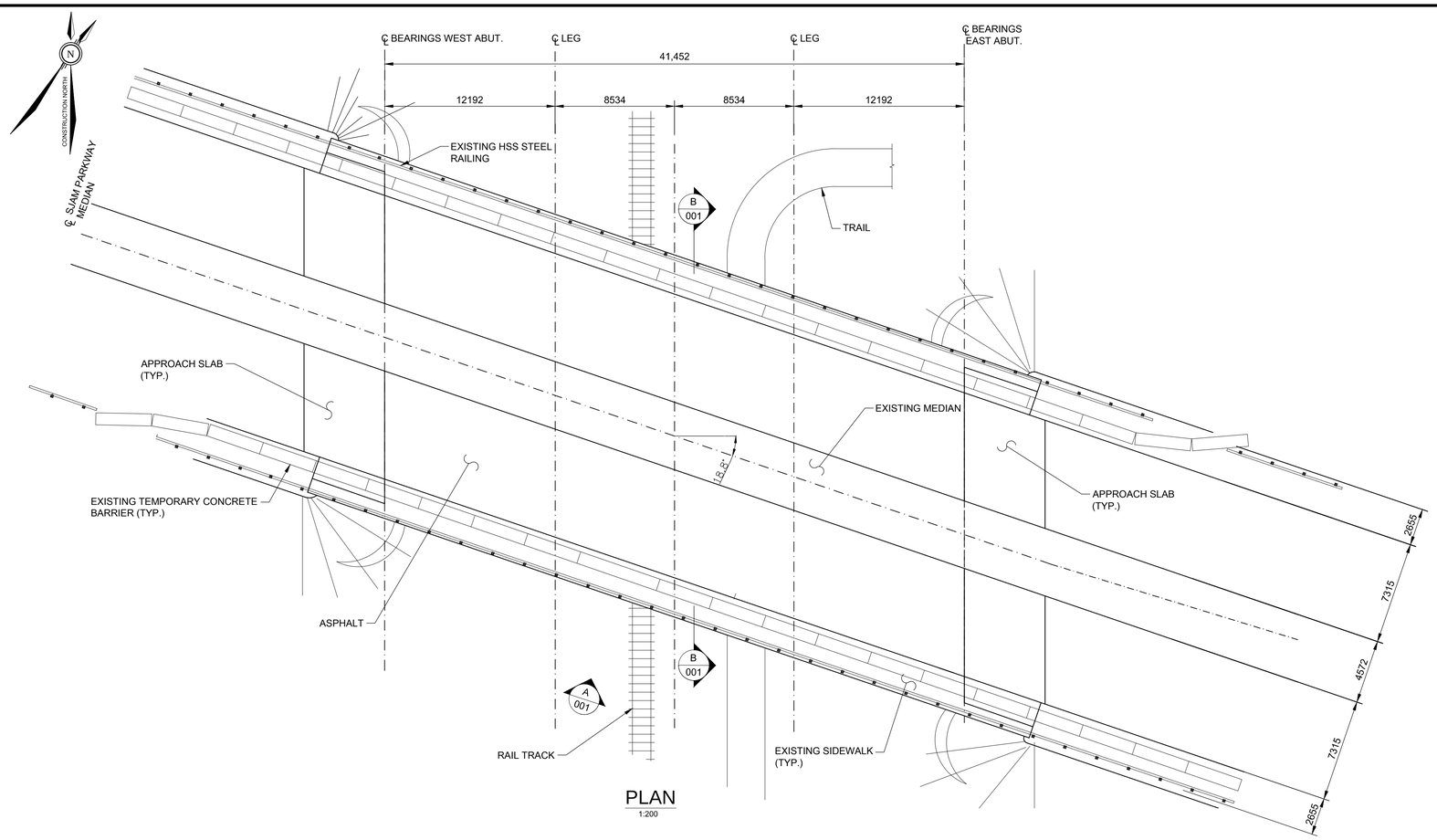
Sincerely,

Hui Liu, P.Eng.
Structural Engineer
Morrison Hershfield Limited

Joe Ostrowski, P.Eng.
Project Manager
Morrison Hershfield Limited

APPENDIX A

Bridge Design Drawings



PLAN
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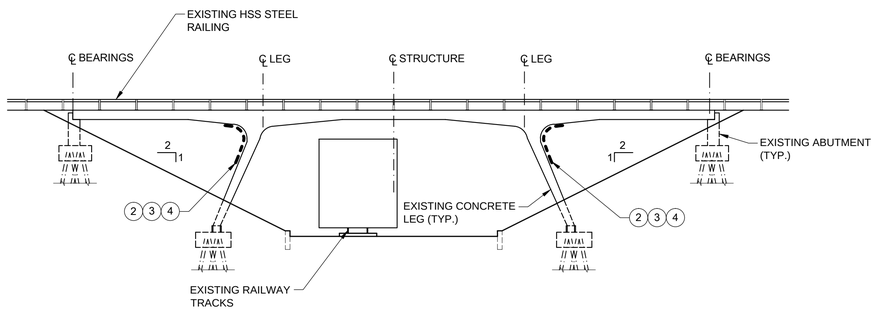

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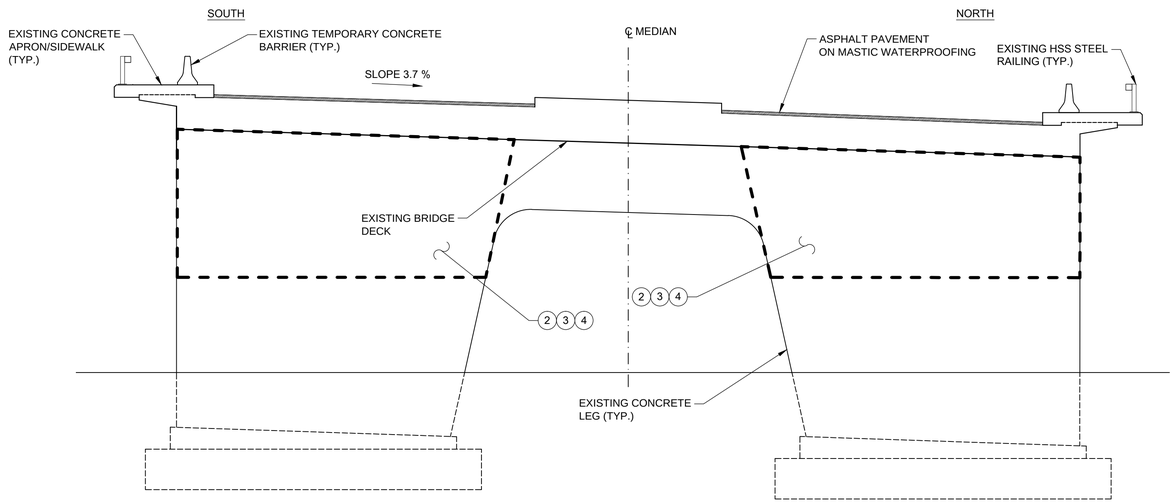

SECTION B 001
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SJAM PARKWAY BRIDGE O/P LRT EXTENSION TO QUE (SN015940)

GENERAL ARRANGEMENT

MORRISON HERSHFIELD

Ottawa

Contract No.	Dwg. No.
ISD14-7114	001

Sheet 1 of 1

Asset No. ——

Asset Group ——

Des.	Chk'd.
HL	JBE
Dwn.	Chk'd.
GK	HL

Utility Circ. No. ——

Index No. ——

Const. Inspector ——

Scale: AS NOTED

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)

NOTES:

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER APPLICABLE CONTRACT DRAWINGS. INFORMATION SHOWN ON THIS DRAWING HAS BEEN EXTRACTED FROM ORIGINAL DESIGN DRAWINGS, M.M. DILLON & COMPANY DEC. 15. 1965. AND SUPPLEMENTED BY FIELD INVESTIGATIONS.

SCOPE OF WORK INCLUDES BUT IS NOT LIMITED TO:

1. TRAFFIC CONTROL
2. PREPARE CONCRETE SURFACE TO RECEIVE FRP REINFORCEMENT
3. APPLY FRP REINFORCEMENT
4. APPLY TOP COAT TO FRP REINFORCEMENT

APPENDIX B

Site Photos

Photo 1: North elevation of the bridge

Photo 2: Top of bridge

Photo 3: Light cracks in the soffit of bridge deck

Photo 4: Soffit of bridge deck

Photo 5: Delamination in the east abutment

Photo 6: Delamination in the east abutment

Photo 7: Spalling and leaking in west abutment

Photo 8: Severe corrosion in bearing

Photo 9: Sidewalks

Photo 10: Cracks in curb

Photo 11: Railing and post

Photo 12: Severe cracks in asphalt at expansion joint

Photo 13: Settlement of approach slab

Photo 14: Expansion joint

Photo 15: Underside of the bridge

Photo 16: Underside of the bridge

APPENDIX C

Vehicle Load Information

OC Transpo Transit Fleet - Bus Axle Loads

Bus Type	New Flyer INVERO	New Flyer Articulated D60LFR	Orion VII Hybrid	Alexander Dennis Double Decker ENVIRO 500
platform	40 - ft	60 - ft	40 - ft	40 - ft
front axle weight	9880 lb (4481 Kg)	9220 lb (4182 Kg)	9940 lb (4509 Kg)	11023 lb (5000 Kg)
# of wheels-front	2	2	2	2
centre axle weight	N/A	13020 lb (5906 Kg)	N/A	17218 lb (7810 Kg)
# of wheels-centre	N/A	4	N/A	4
rear axle weight	19540 lb (8863 Kg)	22440 lb (10180 Kg)	21520 lb (9761 Kg)	11111 lb (5040 Kg)
# of wheels-rear	4	4	4	2
unladen weight	29420 lb (13344 Kg)	44680 lb (20268 Kg)	31460 lb (14270 Kg)	39352 lb (17850 Kg)
front axle GAWR	14780 lb (6700 Kg)	14770 (6700 Kg)	6704 Kg	7100 Kg
centre axle GAWR	N/A	24250 lb (11000 Kg)	N/A	10000 Kg
rear axle GAWR	27760 lb (12590 Kg)	27760 lb (12590 Kg)	12592 Kg	7100 Kg
number of buses	326	359	177	75
Notes	GAWR as per the OEM stamp.	GAWR as per the OEM stamp.	GAWR as per the OEM stamp.	1) GAWR as per the OEM stamp. 2) Centre axle is drive axle and rear axle is auxiliary axle.

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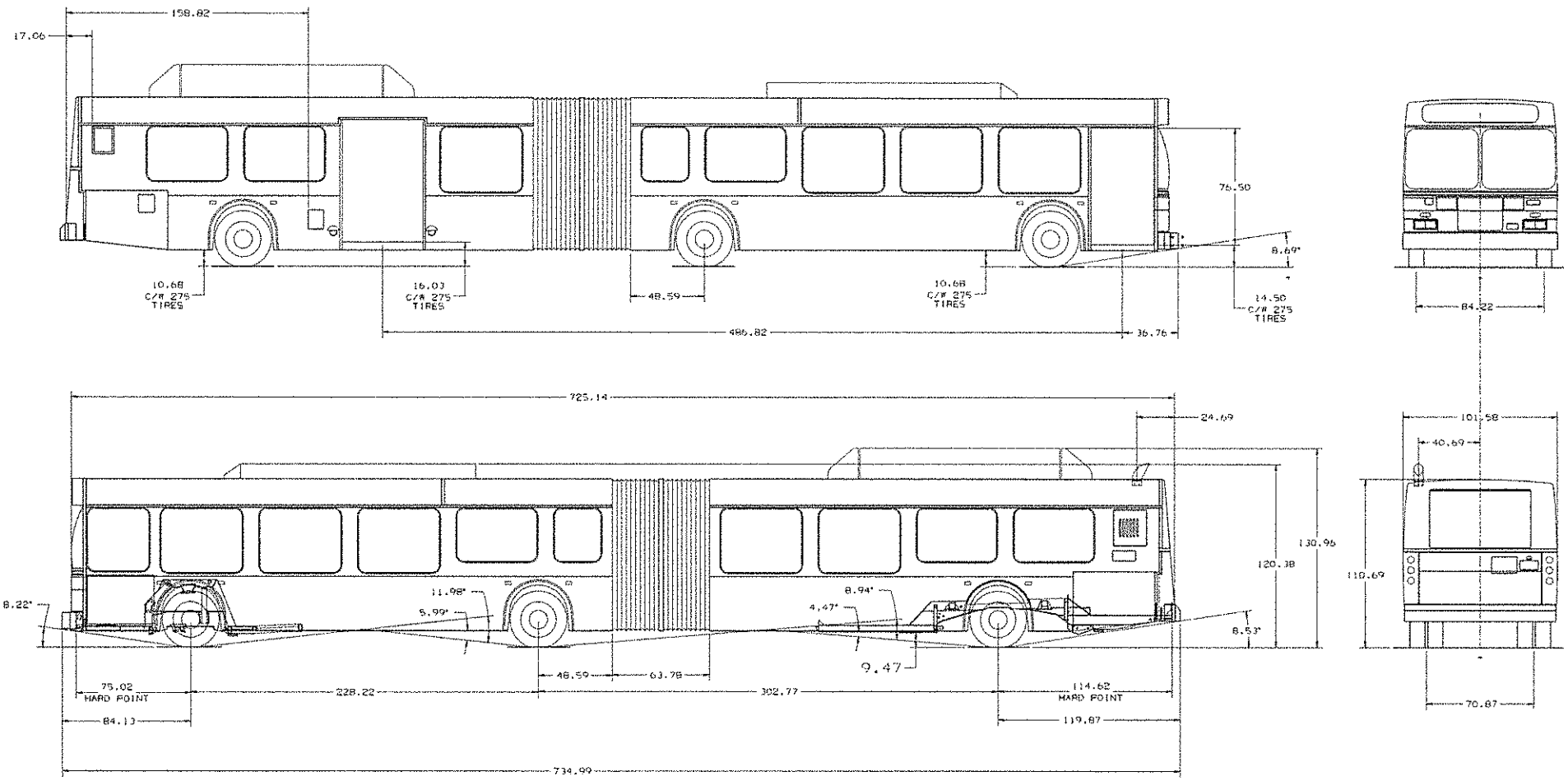

ADD 0.62 ±.25 INCHES TO ALL VERTICAL DIMENSIONS
AND .65° TO ALL ANGLES
WHEN USING 305 TIRES

SYM	REVISION	DRAWN	CHK'D	ENG'R	RELEASE	DATE

NOTICE! THIS DRAWING IS A FACSIMILE OF THE ELECTRONIC MASTER. ALL REVISIONS MUST BE INCORPORATED ELECTRONICALLY. MANUAL REVISION IS NOT ALLOWED.

MATERIAL	-
FINISH	
TREATMENT	
UNSPEC'D TOLS.	.X ± .12 / .XX ± .06 / .XXX ± .03 / ANGLES ± 1° / HOLE DIA. BEND RADII, HOLE TO TUBE BENDS & LENGTH HOLES C TO D, D TO E, HOLES DE CL. PLUS
METRIC	.X ± 3 / .XX ± 1.5 / .XXX ± 0.8 / 0.4 / 0.8 / 1° / 5:1 / 5:1 / 1%
DRAWN	
CHK'D	
ENG'R	
DO NOT SCALE DRAWING IN 1:1 ARE IN mm	
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SHEET 1 OF 3	

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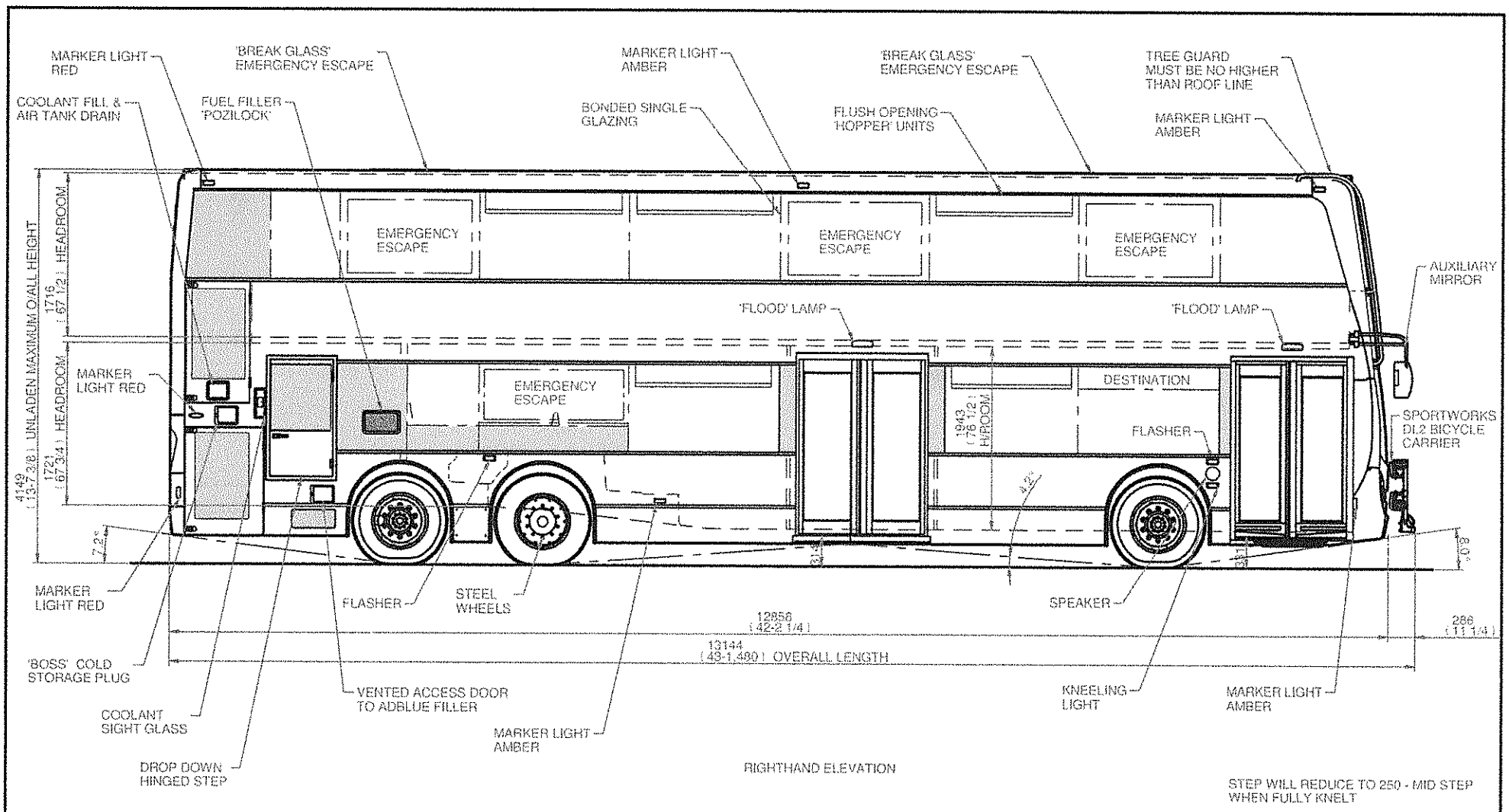


ALEXANDER DENNIS

Form No EN-059

Rev	Date	Description	Name

Title :

ENVIRO 500 12.8 METRE LOW HEIGHT LHD BODY

DENNIS E500 CHASSIS - CUMMINS EPA10 ENGINE, COMPLETE WITH ALLISON B500R TRANSMISSION

REF : 'OC TRANSPO' OTTAWA

Drawn : Alex. D

Date : 27-01-12

Enq ; 2011/0406/EDD

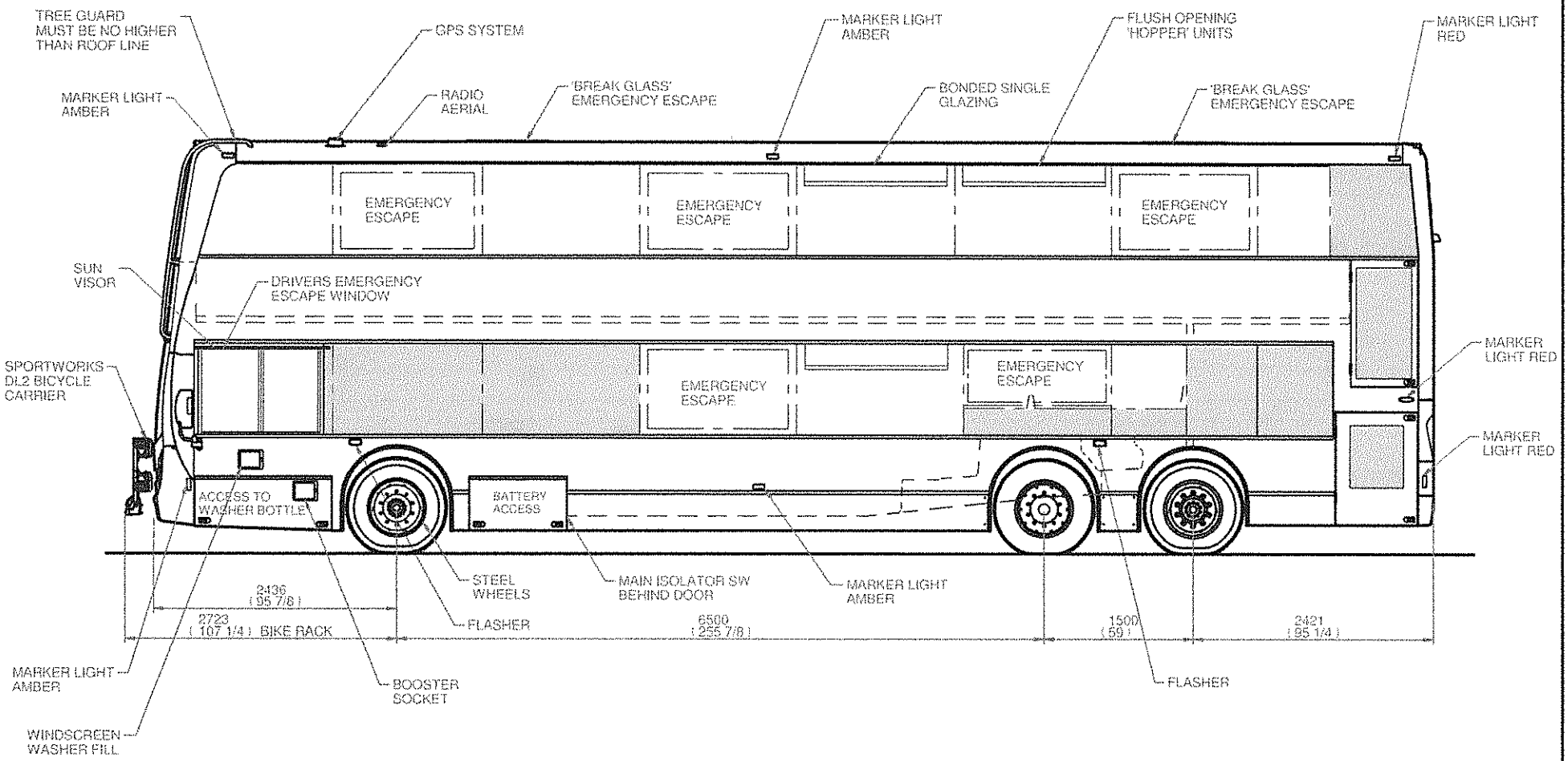
Seat Type : American Seating Vision Seat

Alexander Dennis Ltd
91 Glasgow Road
Falkirk FK1 4JB
T- 01324 621672 F- 01324 621746

Iss No : 00

Page No : 1

Drg No : B503GA



LEFTHAND ELEVATION

ALEXANDER DENNIS

Form No EN-059

Rev	Date	Description	Name

Title :
ENVIRO 500 12.8 METRE LOW HEIGHT LHD BODY
DENNIS E500 CHASSIS - CUMMINS EPA10 ENGINE, COMPLETE WITH ALLISON B500R TRANSMISSION
REF : 'OC TRANSPO' OTTAWA

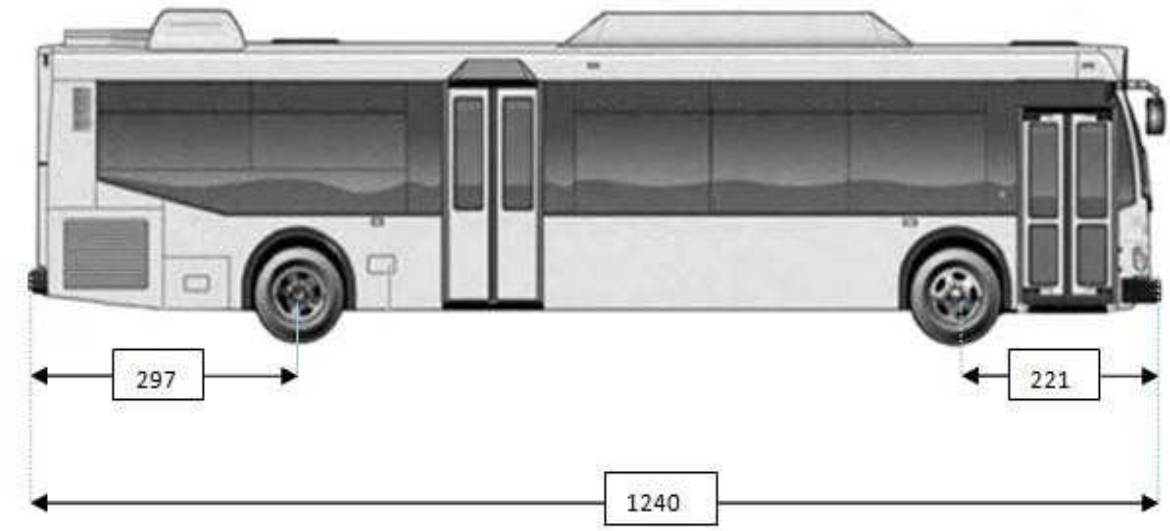
Drawn : Alex. D
Date : 27-01-12
Enq : 2011/0406/EDD

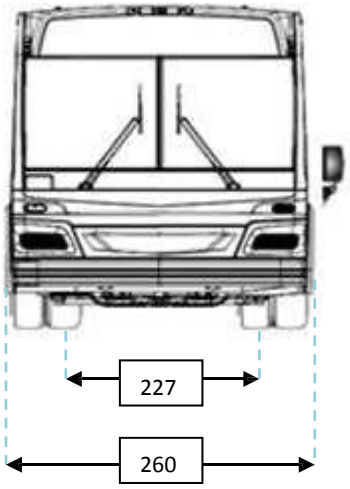
Seat Type : American Seating Vision Seat

Alexander Dennis Ltd
91 Glasgow Road
Falkirk FK1 4JB
T- 01324 621672 F- 01324 621746

Iss No : 00
Page No : 2
Drg No : B503GA

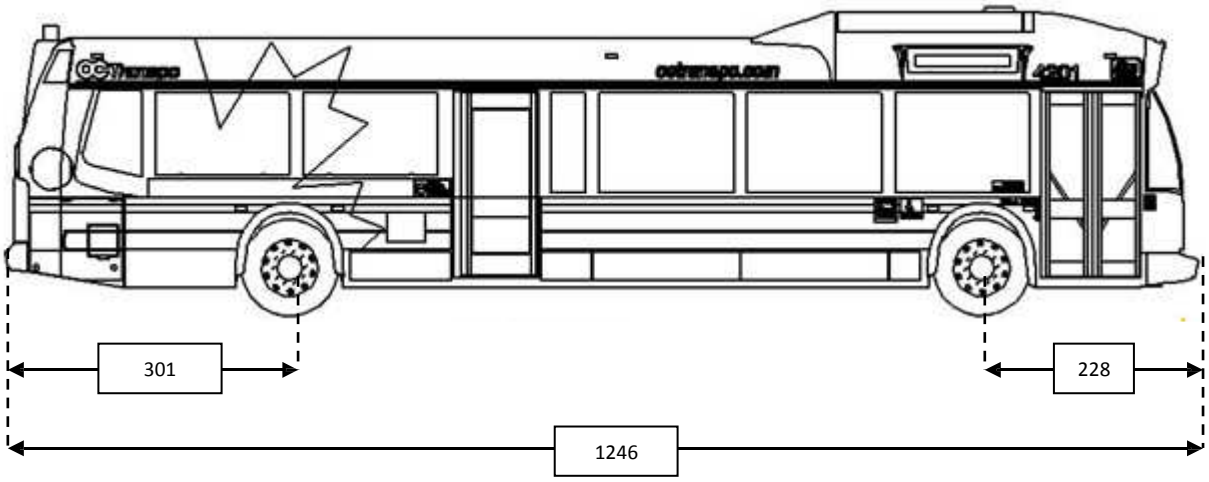
Orion VII Diesel-Electric Hybrid Bus

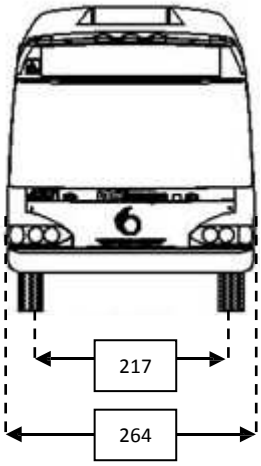




Dimensions are in cm

New Flyer INVERO





Dimensions are in cm

APPENDIX D

Structural Analysis Calculations

CPR Overhead

Structural Analysis Parameters

System Behaviour : S3

Element Behaviour : E3

Inspection Level : INSP3

} ⇒ $\beta = 2.5$ (CHBDC Table 14.5)

$\alpha_D = 1.05$ — D_1 Table 14.7

1.1 — D_2

$\alpha_L = 1.35$ Table 14.8

Dynamic Load Allowance : 0.3 CHBDC 3.8.4.5.3

Moving Load :

Double Decker Bus Load

Material Strength :

Concrete : 4000 psi (27 MPa)

Reinforcing Steel : 275 MPa (Built in 1966)

OC Transpo Transit Fleet - Bus Axle Loads

Bus Type	platform	front axle weight	# of wheels-front	centre axle weight	# of wheels-centre	rear axle weight	# of wheels-rear	Unladen Weight	Front Axle GAWR	Centre Axle GAWR	Rear Axle GAWR	Number of buses	Notes
New Flyer INVERO	40-ft	9880 lb (4481 Kg)	2	N/A	N/A	19540 lb (8863 Kg)	4	29420 lb (13344 Kg)	14780 lb (6700 Kg)	N/A	27760 lb (12590 Kg)	326	GAWR as per the OEM stamp.
New Flyer articulated D60LFR	60-ft	9220 lb (4182 Kg)	2	13020 lb (5906 Kg)	4	22440 lb (10180 Kg)	4	44680 lb (20268 Kg)	14770 (6700 Kg)	24250 lb (11000 Kg)	27760 lb (12590 Kg)	359	GAWR as per the OEM stamp.
Orion VII hybrid	40-ft	9940 lb (4509 Kg)	2	N/A	N/A	21520 lb (9761 Kg)	4	31460 lb (14270 Kg)	6704 Kg	N/A	12592 Kg	177	GAWR as per the OEM stamp.
Alexander Dennis double decker ENVIRO 500	40-ft	11023 lb (5000 Kg)	2	17218 lb (7810 Kg)	4	11111 lb (5040 Kg)	2	39352 lb (17850 Kg)	7100 Kg	10000 Kg	7100 Kg	75	1) GAWR as per the OEM stamp. 2) Centre axle is drive axle and rear axle is auxiliary axle.

Dead :

Median : 33.36 kN/m

Sidewalk : 1.99 kN/m

Asphalt : 0.99 kN/m^2

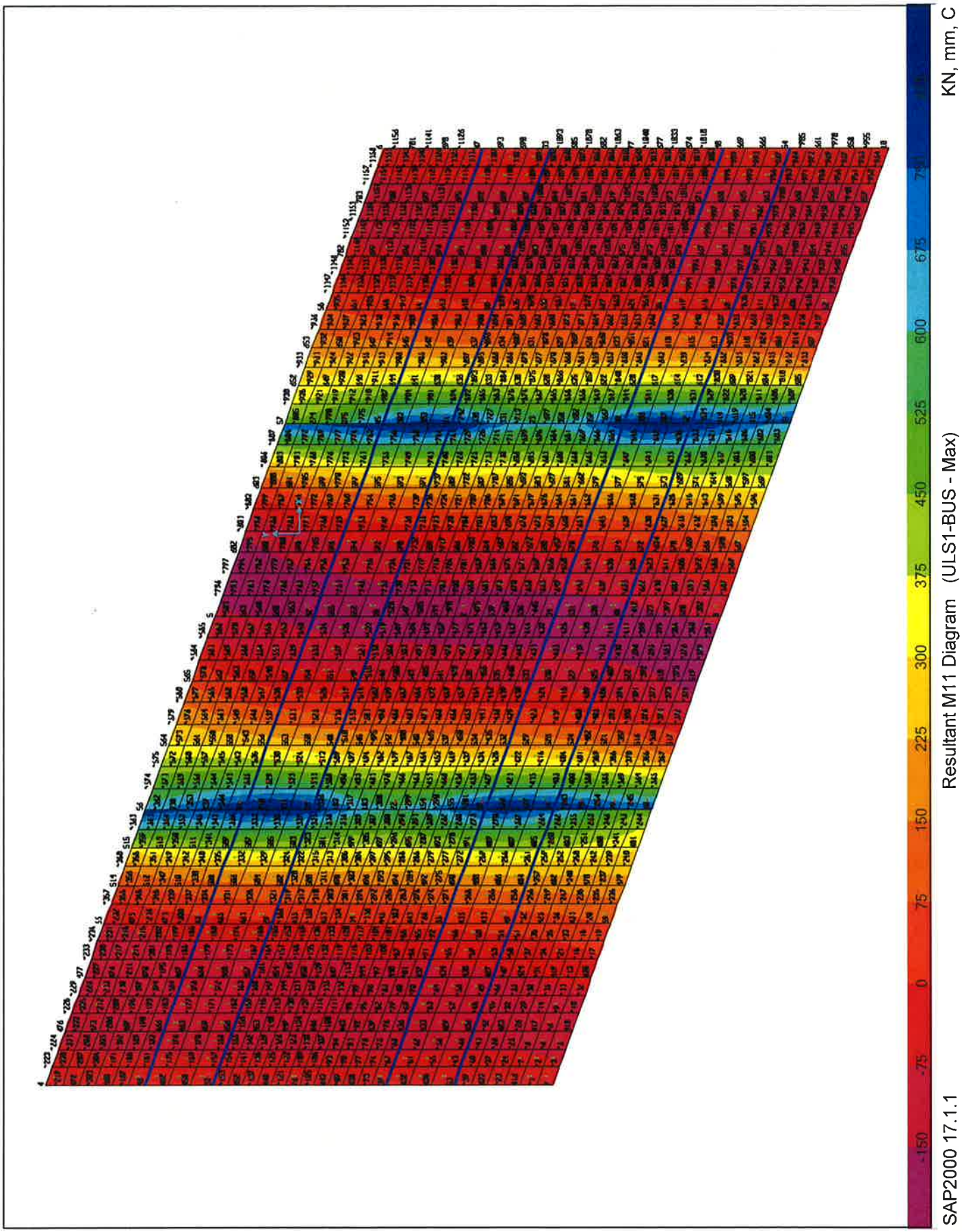
Rail : 0.4 kN/m

TCB : 11.76 kN/m (Each side)

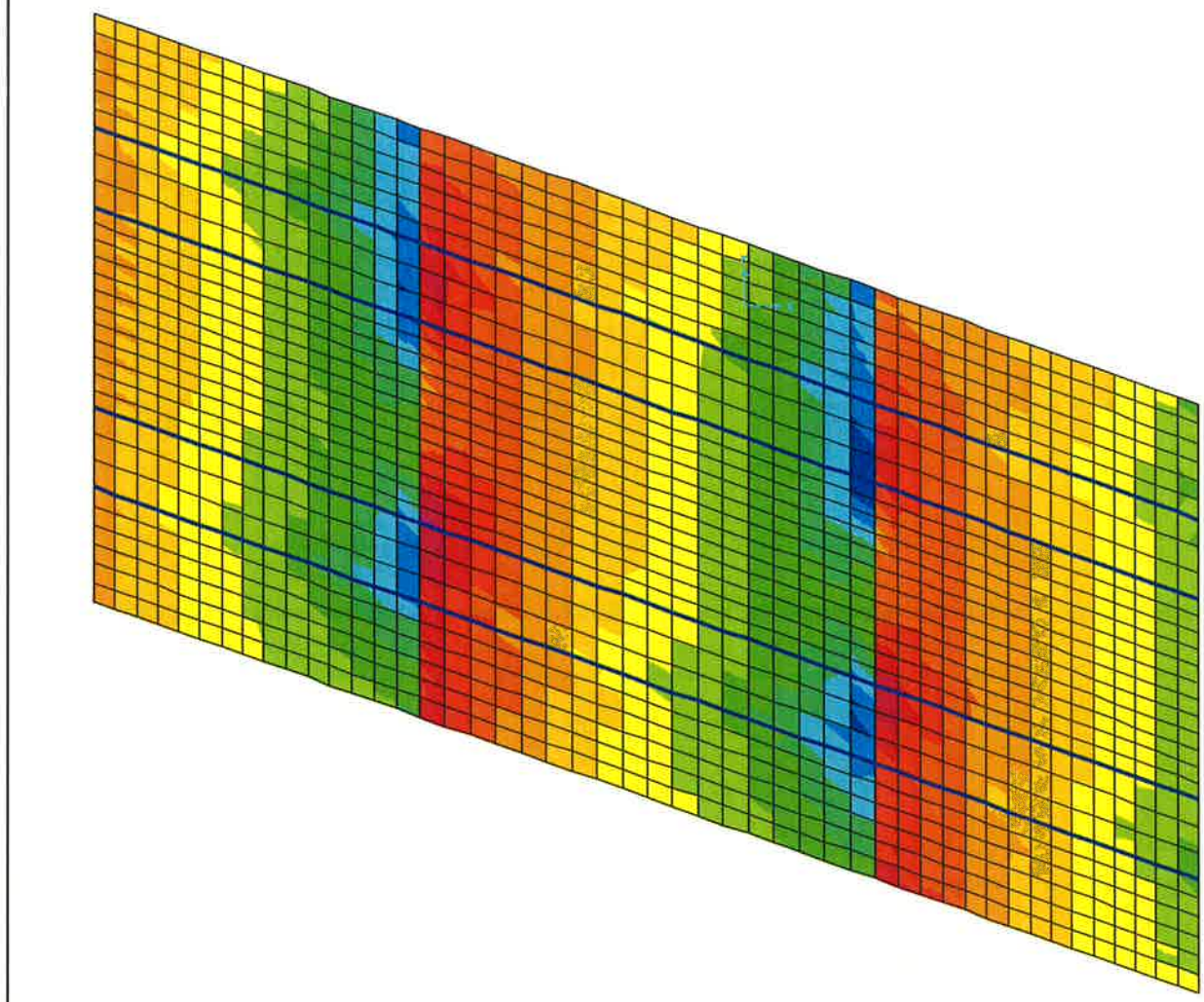
JAN 2 8 2015

Hui Lin

2


1/26/2015
SN015940 shell.sdb
KN, mm, C
Resultant M11 Diagram (ULS1-BUS - Max)
SAP2000 17.1.1
-150
-75
0
75
150
225
300
375
450
525
600
675
750

Hui Lin



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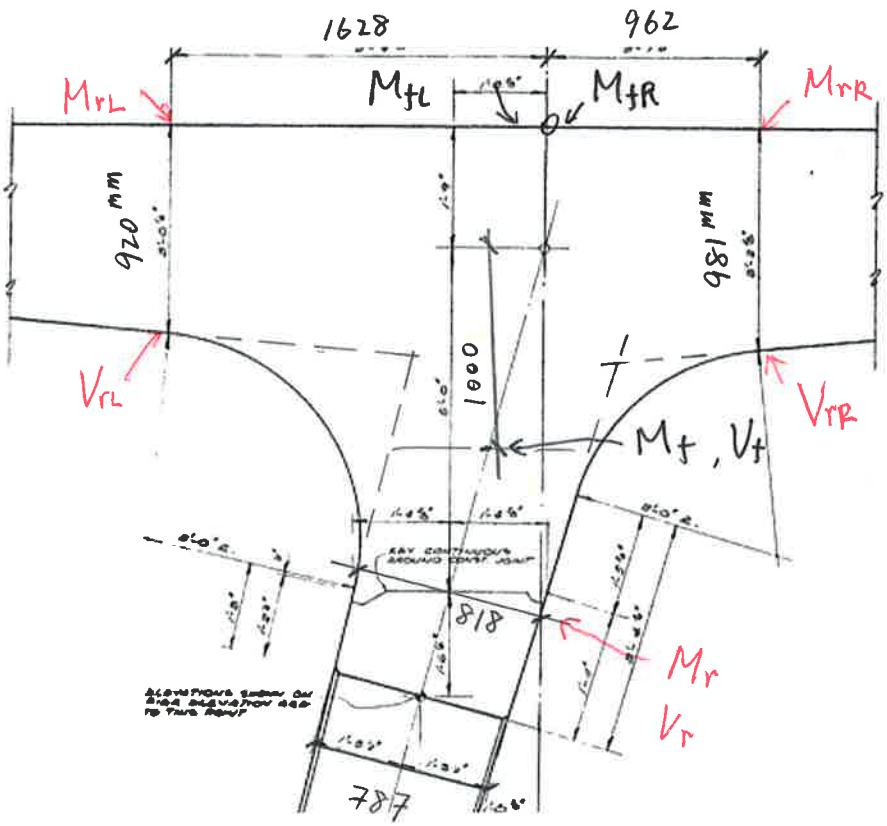
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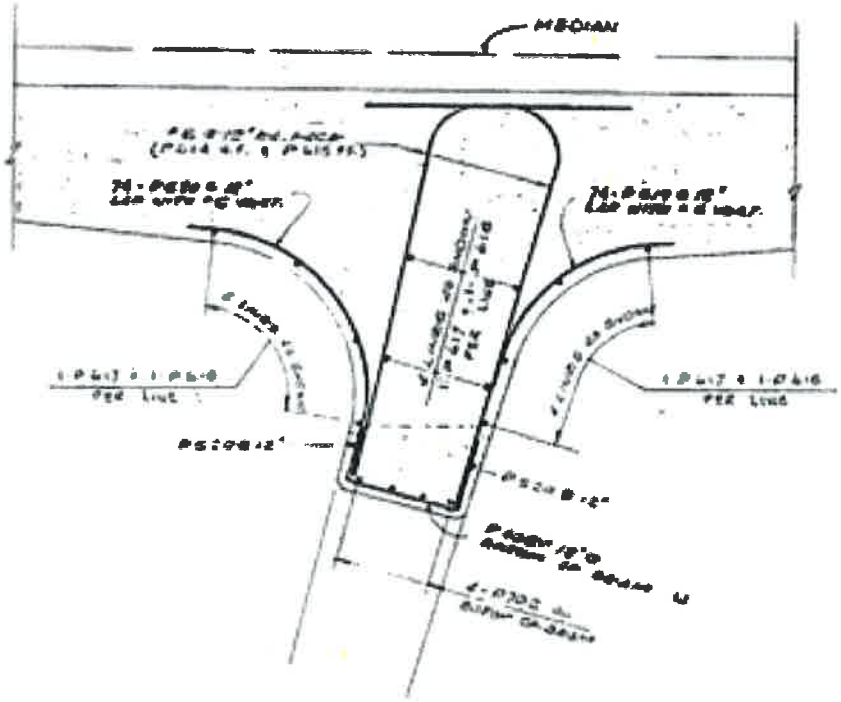
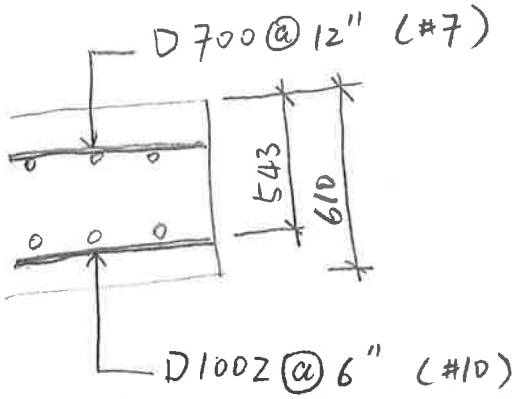
962
M_{rL}
M_{fL}
M_{fR}
M_{rR}
920 mm
981 mm
1000
V_{rL}
V_{rR}
M_f, V_f
818
M_r
V_r
787

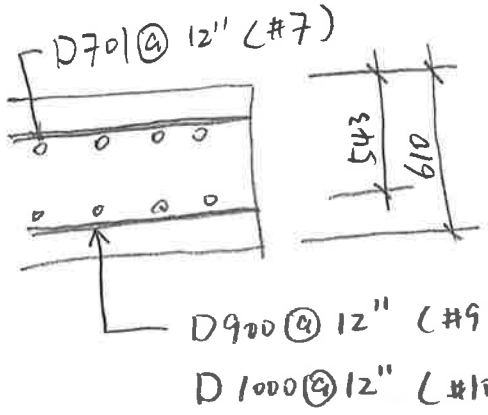

MEDIAN

Hui Lin

Mid-span in End span of Bridge



Mid-span in centre span of Bridge



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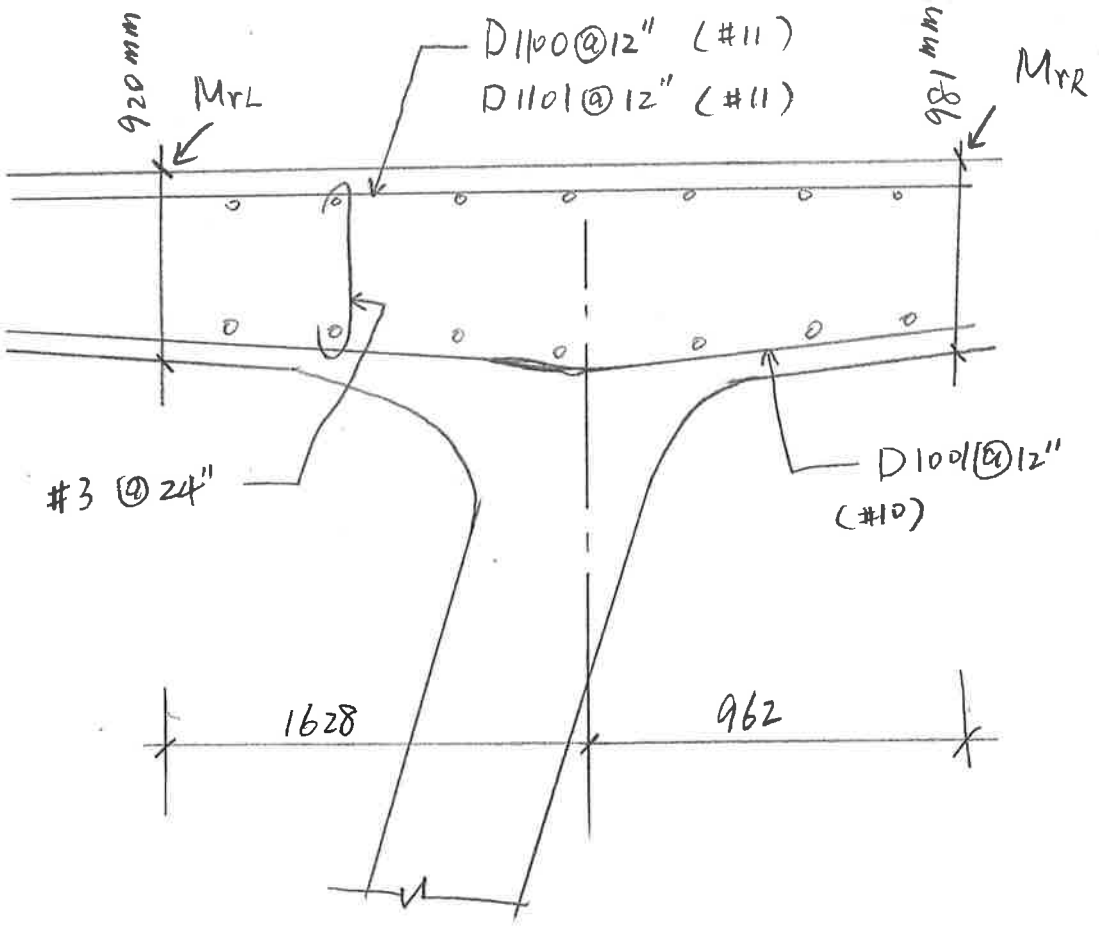

Concrete Beam Shear Resistance (CHBDC 2006) Vc, Vs, Vp, Vr					
	Rmark	Symbols	Data	Unit	Notes
Section		h	610	mm	Overall thickness
		d	543	mm	Effective depth (distance from extrem compression fibre to centroid of tensile force)
		d_v	489	mm	0.72h - taken as the greater; 0.9d - taken as the greater
		b_v	1000	mm	Effective web width, taken as minimum web witdth whin the depth dv
V_c		ϕ_c	0.75		Resistance factor for concrete
		f_c'	27	Mpa	Concrete strength
	Automatic	f_{cr}	2.078460969	Mpa	Not be greater than 3.2MPa; 0.4Vfc' - nomal-density concrete
		β	0.18		1) β = 0.18 -with tansverse reinforcement; 2)β = 0.18 -without tansverse reinforcement, <3dv; 3) β = 230/(1000+dv) without transverse reinforcement, but having max. size of coarse aggregate not less than 20mm (CHBDC 8.9.3.6)
	Automatic	V_c	**343024.0022**	N	Vc = 2.5*β*ϕc*fcr*bv*dv, (CHBDC 8.9.3.4)
V_s		Θ	42	°	Θ = 42° , non-prestressed, not subjected to axial tension, fy≤400MPa, fc'≤ 60MPa; Angle of inclination of the principal diagonal compressive stresses to the longitudinal axis of beam
	Automatic	Radians	0.733038286	rad	Convert Dgrees to Radians
		ϕ_s	0.9		Resistance factor for rebars
		f_y	230	Mpa	Specified yield strength of rebars
		A_v	116	mm^2	Area of transverse shear reinforcement perpendicular to the axis of beam within a distance of s
	Automatic	cotΘ	1.110612515		cosΘ/sinΘ
		s	610	mm	Spacing of stirups
	Automatic	V_s	**21378.14024**	N	Vs = ϕs*fy*Av*dv*cotΘ/s (CHBDC 8.9.3.5)
V_s - with inclination		Θ	42	°	Θ = 42° , non-prestressed, not subjected to axial tension, fy≤400MPa, fc'≤ 60MPa; Angle of inclination of the principal diagonal compressive stresses to the longitudinal axis of beam
	Automatic	Radians	0.733038286	rad	Convert Dgrees to Radians
		ϕ_s	0.95		Resistance factor for rebars
		f_y	1620	Mpa	Specified yield strength of rebars
		A_v	0	mm^2	Area of transverse shear reinforcement perpendicular to the axis of beam within a distance of s
	Automatic	cotΘ	1.110612515		cosΘ/sinΘ
		s	610	mm	Spacing of stirups
		α	90	°	Transverse reinforcement inclined at an angle to the longitudinal axis
	Automatic	Radians	1.570796327	rad	Convert Degrees to Radians
	Automatic	cotα	6.12574E-17		cosα/sinα
	Automatic	sinα	1		
	Automatic	V_s	**0**	N	Vs = ϕs*fy*Av*dv*(cotΘ + cotα)*sinα/s Trans verse reinforcement inclined at an angle to the longitudinal axis, and in the direction that will intersec diagonal cracks caused by the shear (CHBDC 8.9.3.5)
V_r	Automatic	Limit of (V_c + V_s)	2475562.5	N	Vc + Vs shall not exceed 0.25*ϕc*fc'*bv*dv
	Φp = 0.95	V_p	0	N	Component in the direction of the applied shear of all of the effective prestressing forces crossing the critical section factored by ϕp (taken as positive if resisting the applied shear)
	Sum up	**V_r**	**364402.1424**	N	Vr = Vc +Vs+Vp

Min. Av, Vf limit requiring transverse reinforcement					
		V_f (limit)	152455.1121	N	Rigions requiring transverse reinforcement. Vf is greater than (0.2*ϕc*fcr*bv*dv+0.5ϕp*Vp) and T_f is greater than 0.25 Tcr
		A_v(min.)	826.8659942	mm^2	Min. amount of transverse reinforcement: A_v is not less than 0.15*fcr(bv*s/fy)

SLAB V_r = 364.4 kN/m

AT BEARINGS

JAN 29 2015

HL

Concrete Beam Shear Resistance (CHBDC 2006) Vc, Vs, Vp, Vr					
	Rmark	Symbols	Data	Unit	Notes
Section		h	981	mm	Overall thickness
		d	912	mm	Effective depth (distance from extrem compression fibre to centroid of tensile force)
		d_v	821	mm	0.72h - taken as the greater; 0.9d - taken as the greater
		b_v	1000	mm	Effective web width, taken as minimum web witdth whin the depth dv
V_c		ϕ_c	0.75		Resistance factor for concrete
		f_c'	27	Mpa	Concrete strength
	Automatic	f_{cr}	2.078460969	Mpa	Not be greater than 3.2MPa; 0.4Vfc' - nomal-density concrete
		β	0.18		1) β = 0.18 -with tansverse reinforcement; 2)β = 0.18 -without tansverse reinforcement, <3dv; 3) β = 230/(1000+dv) without transverse reinforcement, but having max. size of coarse aggregate not less than 20mm (CHBDC 8.9.3.6)
	Automatic	V_c	**575915.5538**	N	Vc = 2.5*β*ϕc*fcr*bv*dv, (CHBDC 8.9.3.4)
V_s		Θ	42	°	Θ = 42° , non-prestressed, not subjected to axial tension, fy≤400MPa, fc'≤ 60MPa; Angle of inclination of the principal diagonal compressive stresses to the longitudinal axis of beam
	Automatic	Radians	0.733038286	rad	Convert Dgrees to Radians
		ϕ_s	0.9		Resistance factor for rebars
		f_y	230	Mpa	Specified yield strength of rebars
		A_v	116	mm^2	Area of transverse shear reinforcement perpendicular to the axis of beam within a distance of s
	Automatic	cotΘ	1.110612515		cosΘ/sinΘ
		s	610	mm	Spacing of stirups
	Automatic	V_s	**35892.54221**	N	Vs = ϕs*fy*Av*dv*cotΘ/s (CHBDC 8.9.3.5)
V_s - with inclination		Θ	42	°	Θ = 42° , non-prestressed, not subjected to axial tension, fy≤400MPa, fc'≤ 60MPa; Angle of inclination of the principal diagonal compressive stresses to the longitudinal axis of beam
	Automatic	Radians	0.733038286	rad	Convert Dgrees to Radians
		ϕ_s	0.95		Resistance factor for rebars
		f_y	1620	Mpa	Specified yield strength of rebars
		A_v	0	mm^2	Area of transverse shear reinforcement perpendicular to the axis of beam within a distance of s
	Automatic	cotΘ	1.110612515		cosΘ/sinΘ
		s	610	mm	Spacing of stirups
		α	90	°	Transverse reinforcement inclined at an angle to the longitudinal axis
	Automatic	Radians	1.570796327	rad	Convert Degrees to Radians
	Automatic	cotα	6.12574E-17		cosα/sinα
	Automatic	sinα	1		
	Automatic	V_s	**0**	N	Vs = ϕs*fy*Av*dv*(cotΘ + cotα)*sinα/s Trans verse reinforcement inclined at an angle to the longitudinal axis, and in the direction that will intersec diagonal cracks caused by the shear (CHBDC 8.9.3.5)
V_r	Automatic	Limit of (V_c + V_s)	4156312.5	N	Vc + Vs shall not exceed 0.25*ϕc*fc'*bv*dv
	Φp = 0.95	V_p	0	N	Component in the direction of the applied shear of all of the effective prestressing forces crossing the critical section factored by ϕp (taken as positive if resisting the applied shear)
	Sum up	**V_r**	**611808.096**	N	Vr = Vc +Vs+Vp

Min. Av, Vf limit requiring transverse reinforcement					
		V_f (limit)	255962.4683	N	Rigions requiring transverse reinforcement. Vf is greater than (0.2*ϕc*fcr*bv*dv+0.5ϕp*Vp) and T_f is greater than 0.25 Tcr
		A_v(min.)	826.8659942	mm^2	Min. amount of transverse reinforcement: A_v is not less than 0.15*fcr(bv*s/fy)

SLAB V_r = 611.8 KN

AT PIER - CENTRE SPAN

JAN 2 9 2015

HL

Concrete Beam Shear Resistance (CHBDC 2006) Vc, Vs, Vp, Vr					
	Rmark	Symbols	Data	Unit	Notes
Section		h	920	mm	Overall thickness
		d	851	mm	Effective depth (distance from extrem compression fibre to centroid of tensile force)
		d_v	766	mm	0.72h - taken as the greater; 0.9d - taken as the greater
		b_v	1000	mm	Effective web width, taken as minimum web witdth whin the depth dv
V_c		ϕ_c	0.75		Resistance factor for concrete
		f_c'	27	Mpa	Concrete strength
	Automatic	f_{cr}	2.078460969	Mpa	Not be greater than 3.2MPa; 0.4Vfc' - nomal-density concrete
		β	0.18		1) β = 0.18 -with tansverse reinforcement; 2)β = 0.18 -without tansverse reinforcement, <3dv; 3) β = 230/(1000+dv) without transverse reinforcement, but having max. size of coarse aggregate not less than 20mm (CHBDC 8.9.3.6)
	Automatic	V_c	**537334.122**	N	Vc = 2.5*β*ϕc*fcr*bv*dv, (CHBDC 8.9.3.4)
V_s		Θ	42	°	Θ = 42° , non-prestressed, not subjected to axial tension, fy≤400MPa, fc'≤ 60MPa; Angle of inclination of the principal diagonal compressive stresses to the longitudinal axis of beam
	Automatic	Radians	0.733038286	rad	Convert Dgrees to Radians
		ϕ_s	0.9		Resistance factor for rebars
		f_y	230	Mpa	Specified yield strength of rebars
		A_v	116	mm^2	Area of transverse shear reinforcement perpendicular to the axis of beam within a distance of s
	Automatic	cotΘ	1.110612515		cosΘ/sinΘ
		s	610	mm	Spacing of stirups
	Automatic	V_s	**33488.04791**	N	Vs = ϕs*fy*Av*dv*cotΘ/s (CHBDC 8.9.3.5)
V_s - with inclination		Θ	42	°	Θ = 42° , non-prestressed, not subjected to axial tension, fy≤400MPa, fc'≤ 60MPa; Angle of inclination of the principal diagonal compressive stresses to the longitudinal axis of beam
	Automatic	Radians	0.733038286	rad	Convert Dgrees to Radians
		ϕ_s	0.95		Resistance factor for rebars
		f_y	1620	Mpa	Specified yield strength of rebars
		A_v	0	mm^2	Area of transverse shear reinforcement perpendicular to the axis of beam within a distance of s
	Automatic	cotΘ	1.110612515		cosΘ/sinΘ
		s	610	mm	Spacing of stirups
		α	90	°	Transverse reinforcement inclined at an angle to the longitudinal axis
	Automatic	Radians	1.570796327	rad	Convert Degrees to Radians
	Automatic	cotα	6.12574E-17		cosα/sinα
	Automatic	sinα	1		
	Automatic	V_s	**0**	N	Vs = ϕs*fy*Av*dv*(cotΘ + cotα)*sinα/s Trans verse reinforcement inclined at an angle to the longitudinal axis, and in the direction that will intersec diagonal cracks caused by the shear (CHBDC 8.9.3.5)
V_r	Automatic	Limit of (V_c + V_s)	3877875	N	Vc + Vs shall not exceed 0.25*ϕc*fc'*bv*dv
	Φp = 0.95	V_p	0	N	Component in the direction of the applied shear of all of the effective prestressing forces crossing the critical section factored by ϕp (taken as positive if resisting the applied shear)
	Sum up	V_r	**570822.1699**	N	Vr = Vc +Vs+Vp

Min. Av, Vf limit requiring transverse reinforcement					
		V_f (limit)	238815.1653	N	Rigions requiring transverse reinforcement. Vf is greater than (0.2*ϕc*fcr*bv*dv+0.5ϕp*Vp) and T_r is greater than 0.25 Tcr
		A_v(min.)	826.8659942	mm^2	Min. amount of transverse reinforcement: A_v is not less than 0.15*fcr(bv*s/fy)

SLAB V_r = 570.8 KN

AT PIER – END SPAN

JAN 2 9 2015

HL

Concrete Beam Moment Resistance (CHBDC 2006)				
Remark	Symbols	Data	Unit	Notes
	b	1000	mm	Total width of flange (including web)
	b_w	1000	mm	Web width, when neutral axil is located in flange, b_w should be taen as b (C8.8.4.1)
	hf	0	mm	thickness of flange
	f_c'	27	Mpa	Concrete strength
Automatic	α1	0.8095		α1=0.85-0.0015*fc' ≥ 0.67 (CHBDC 8.8.3)
Automatic	β1	0.9025		β1=0.97-0.0025*fc' ≥ 0.67 (CHBDC 8.8.3)
Automatic	c	61.32714185	mm	$c = (Ts-C_{c1})/\alpha1*\beta1*\phi c*fc'*b_w$, Distance from extrem compression fibre to neutral axis
Automatic	a	55.34774552	mm	a = β1*c , Equivalent rectangular compression zone height
	ϕ_c	0.75		Resistance factor for concrete
	C_{c1}	0	N	$C_{c1} = \alpha1*\phi c*fc'*hf*(b-bw)$ Amount of compression in flange (C8.8.3)
Automatic	C_{c2}	907281	N	$C_{c2} = \alpha1*\phi c*fc'*a*b_w$ Amount of compression in web (C8.8.3)
	A_s	4383	mm^2	Area of rebars on the flexural tension side
	f_y	230	Mpa	Yield strength of tensile rebar
	ϕ_s	0.9		Resistance factor of reinforcing steel
Automatic	T_s	907281	N	$T_s = \phi s*fy*A_s$ Amount of tension in reinforcing steel
	d	610	mm	Height of beam
	d_s	543	mm	Distance from centroid of rebars to extrem compression fibre of concrete beam
Automatic	M_r	**467545604**	N-mm	Moment resistance, $Mr = Ts*(ds-a/2) - C_{c1}*(hf/2-a/2)$ (C8.8.4.1)

Limit for Min. & Max. Reinforcement				
	M_r(min.)			Min. Reinforcement: Factored M_r is at least 1.2*Mcr. $M_{cr} = fcr*I/y$ (CHBDC 8.8.4.3)
	c/d (max.)			Max. Reinforcement: c/d not exceeding 0.5, (CHBDC 8.8.4.5)

SLAB $M_r = 467.5$ kNm/m

M10 - SPAN IN CENTRE SPAN

JAN 2 9 2015

HL

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Concrete Beam Moment Resistance (CHBDC 2006)				
Remark	Symbols	Data	Unit	Notes
	b	1000	mm	Total width of flange (including web)
	b_w	1000	mm	Web width, when neutral axil is located in flange, b_w should be taen as b (C8.8.4.1)
	hf	0	mm	thickness of flange
	f_c'	27	Mpa	Concrete strength
Automatic	α1	0.8095		α1=0.85-0.0015*fc' ≥ 0.67 (CHBDC 8.8.3)
Automatic	β1	0.9025		β1=0.97-0.0025*fc' ≥ 0.67 (CHBDC 8.8.3)
Automatic	c	68.58901423	mm	$c = (Ts-C_{c1})/\alpha1*\beta1*\phi c*fc'*b_w$, Distance from extrem compression fibre to neutral axis
Automatic	a	61.90158534	mm	a = β1*c , Equivalent rectangular compression zone height
	ϕ_c	0.75		Resistance factor for concrete
	C_{c1}	0	N	$C_{c1} = \alpha1*\phi c*fc'*hf*(b-bw)$ Amount of compression in flange (C8.8.3)
Automatic	C_{c2}	1014714	N	$C_{c2} = \alpha1*\phi c*fc'*a*b_w$ Amount of compression in web (C8.8.3)
	A_s	4902	mm^2	Area of rebars on the flexural tension side
	f_y	230	Mpa	Yield strength of tensile rebar
	ϕ_s	0.9		Resistance factor of reinforcing steel
Automatic	T_s	1014714	N	$T_s = \phi s*fy*A_s$ Amount of tension in reinforcing steel
	d	610	mm	Height of beam
	d_s	543	mm	Distance from centroid of rebars to extrem compression fibre of concrete beam
Automatic	M_r	**519583499**	N-mm	Moment resistance, $Mr = Ts*(ds-a/2) - C_{c1}*(hf/2-a/2)$ (C8.8.4.1)

Limit for Min. & Max. Reinforcement				
	M_r(min.)			Min. Reinforcement: Factored M_r is at least 1.2*Mcr. $M_{cr} = fcr*I/y$ (CHBDC 8.8.4.3)
	c/d (max.)			Max. Reinforcement: c/d not exceeding 0.5, (CHBDC 8.8.4.5)

SLAB M_r = 519.6 kNm /m

MID-SPAN IN END SPAN

JAN 2 9 2015

HL

Concrete Beam Moment Resistance (CHBDC 2006)				
Remark	Symbols	Data	Unit	Notes
	b	1000	mm	Total width of flange (including web)
	b_w	1000	mm	Web width, when neutral axil is located in flange, b_w should be taen as b (C8.8.4.1)
	hf	0	mm	thickness of flange
	f_c'	27	Mpa	Concrete strength
Automatic	α1	0.8095		α1=0.85-0.0015*fc' ≥ 0.67 (CHBDC 8.8.3)
Automatic	β1	0.9025		β1=0.97-0.0025*fc' ≥ 0.67 (CHBDC 8.8.3)
Automatic	c	84.53994777	mm	$c = (Ts-C_{c1})/\alpha1*\beta1*\phi c*fc'*b_w$, Distance from extrem compression fibre to neutral axis
Automatic	a	76.29730286	mm	a = β1*c, Equivalent rectangular compression zone height
	ϕ_c	0.75		Resistance factor for concrete
	C_{c1}	0	N	$C_{c1} = \alpha1*\phi c*fc'*hf*(b-bw)$ Amount of compression in flange (C8.8.3)
Automatic	C_{c2}	1250694	N	$C_{c2} = \alpha1*\phi c*fc'*a*b_w$ Amount of compression in web (C8.8.3)
	A_s	6042	mm^2	Area of rebars on the flexural tension side
	f_y	230	Mpa	Yield strength of tensile rebar
	ϕ_s	0.9		Resistance factor of reinforcing steel
Automatic	T_s	1250694	N	$T_s = \phi s*fy*A_s$ Amount of tension in reinforcing steel
	d	981	mm	Height of beam
	d_s	912	mm	Distance from centroid of rebars to extrem compression fibre of concrete beam
Automatic	M_r	**1092920639**	N-mm	Moment resistance, $Mr = Ts*(ds-a/2) - C_{c1}*(hf/2-a/2)$ (C8.8.4.1)

Limit for Min. & Max. Reinforcement				
	M_r(min.)			Min. Reinforcement: Factored M_r is at least 1.2*Mcr. $M_{cr} = fcr*I/y$ (CHBDC 8.8.4.3)
	c/d (max.)			Max. Reinforcement: c/d not exceeding 0.5, (CHBDC 8.8.4.5)

SLAB M_{rR} = 1092.9 kN-m/m

JAN 2 9 2015

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Concrete Beam Moment Resistance (CHBDC 2006)				
Remark	Symbols	Data	Unit	Notes
	b	1000	mm	Total width of flange (including web)
	b_w	1000	mm	Web width, when neutral axil is located in flange, b_w should be taen as b (C8.8.4.1)
	hf	0	mm	thickness of flange
	f_c'	27	Mpa	Concrete strength
Automatic	α1	0.8095		α1=0.85-0.0015*fc' ≥ 0.67 (CHBDC 8.8.3)
Automatic	β1	0.9025		β1=0.97-0.0025*fc' ≥ 0.67 (CHBDC 8.8.3)
Automatic	c	84.53994777	mm	$c = (Ts-C_{c1})/\alpha1*\beta1*\phi c*fc'*b_w$, Distance from extrem compression fibre to neutral axis
Automatic	a	76.29730286	mm	a = β1*c, Equivalent rectangular compression zone height
	ϕ_c	0.75		Resistance factor for concrete
	C_{c1}	0	N	$C_{c1} = \alpha1*\phi c*fc'*hf*(b-bw)$ Amount of compression in flange (C8.8.3)
Automatic	C_{c2}	1250694	N	$C_{c2} = \alpha1*\phi c*fc'*a*b_w$ Amount of compression in web (C8.8.3)
	A_s	6042	mm^2	Area of rebars on the flexural tension side
	f_y	230	Mpa	Yield strength of tensile rebar
	ϕ_s	0.9		Resistance factor of reinforcing steel
Automatic	T_s	1250694	N	$T_s = \phi s*fy*A_s$ Amount of tension in reinforcing steel
	d	920	mm	Height of beam
	d_s	851	mm	Distance from centroid of rebars to extrem compression fibre of concrete beam
Automatic	M_r	**1016628305**	N-mm	Moment resistance, $Mr = Ts*(ds-a/2) - C_{c1}*(hf/2-a/2)$ (C8.8.4.1)

Limit for Min. & Max. Reinforcement				
	M_r(min.)			Min. Reinforcement: Factored M_r is at least 1.2*Mcr. $M_{cr} = fcr*I/y$ (CHBDC 8.8.4.3)
	c/d (max.)			Max. Reinforcement: c/d not exceeding 0.5, (CHBDC 8.8.4.5)

SLAB M_{rL}^{-} = 1016.6 kNm/m

JAN 2 9 2015

HL

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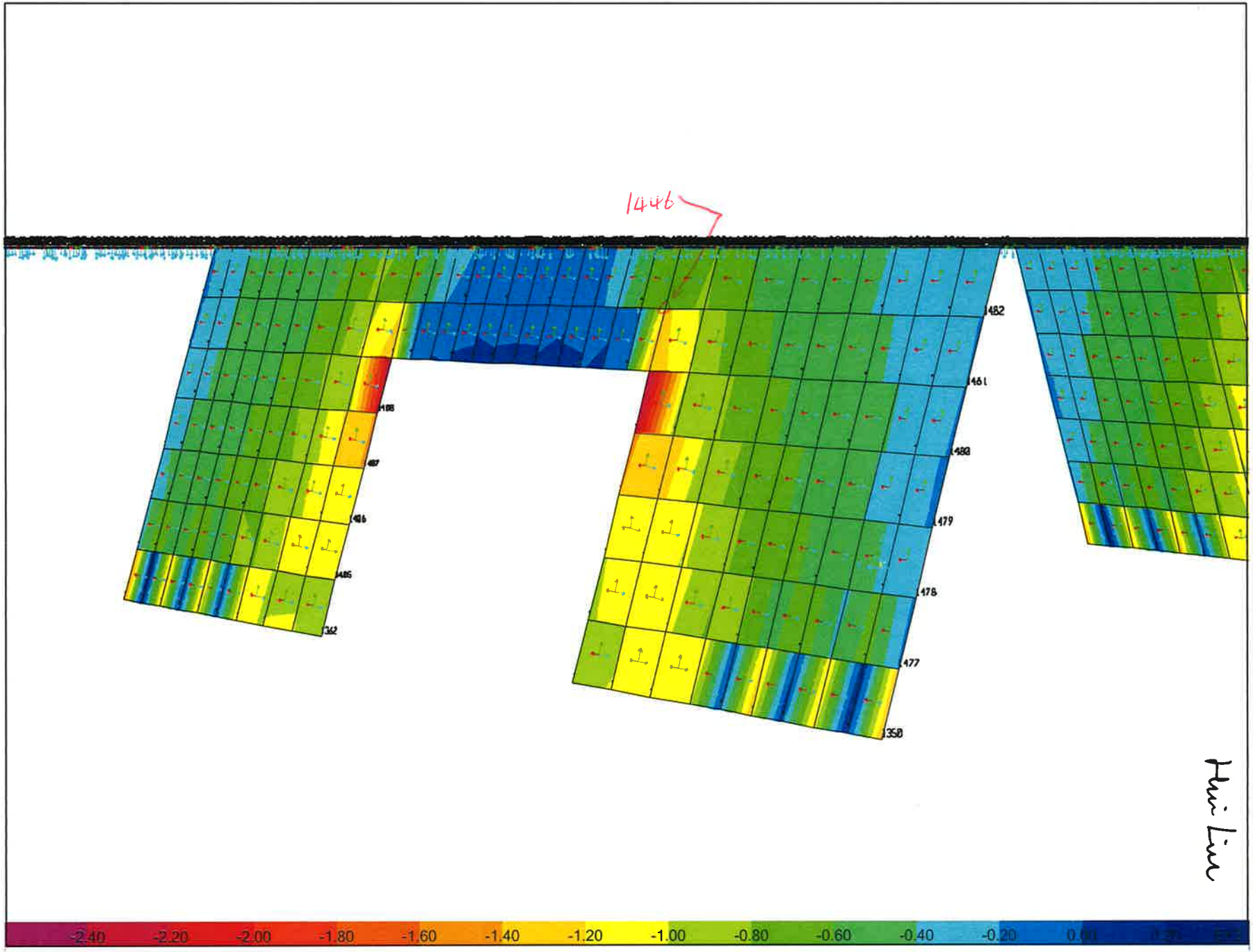

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15

SN015940 shell.sdb JAN 2 8 2015 1/7/2015

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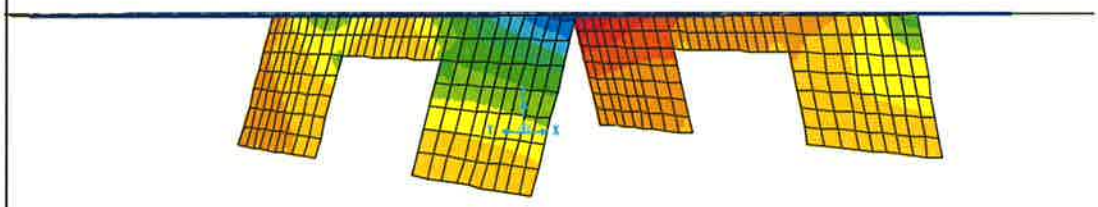

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SAP2000 17.1.1 Resultant M22 Diagram (ULS1-BUS - Max) KN, mm, C

JAN 2 8 2015

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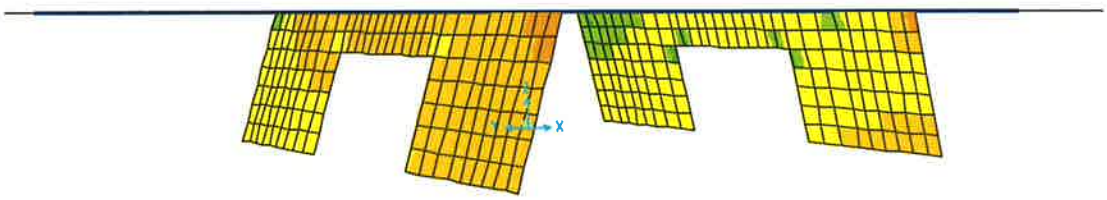

V_y N M_y M_z V_z

TABLE: Element Forces - Area Shells												
Area	Joint	OutputCase	CaseType	StepType	F11	F22	F12	M11	M22	M12	V13	V23
Text	Text	Text	Text	Text	KN/m	KN/m	KN/m	KN-m/m	KN-m/m	KN-m/m	KN/m	KN/m
1483	1445	ULS1-FULL BUS	Combination	Max	-488.99	-1331.66	-217.36	8.1296	150.4464	47.0868	13.62	37.9
1483	1446	ULS1-FULL BUS	Combination	Max	-41.14	-1256.33	-264.83	26.0705	99.6541	37.1928	13.74	39.35
1483	1452	ULS1-FULL BUS	Combination	Max	15.26	-970.29	-185.93	27.5783	151.4098	22.4283	14.28	3.71
1483	1451	ULS1-FULL BUS	Combination	Max	-437.22	-1046.23	-138.45	5.1387	165.724	33.7071	15.19	2.27
1483	1445	ULS1-FULL BUS	Combination	Min	-610.46	-1536.89	-263.76	-6.4648	-7.2453	-6.7728	0.76	-15.9
1483	1446	ULS1-FULL BUS	Combination	Min	-98.32	-1453.44	-323.12	-0.8854	9.083	-11.6903	4.59	-15.72
1483	1452	ULS1-FULL BUS	Combination	Min	-35.51	-1141.24	-236.66	4.8412	16.1301	-10.5317	5.34	-12.06
1483	1451	ULS1-FULL BUS	Combination	Min	-539.8	-1222.5	-176.76	-3.5	3.3948	-6.0735	0.31	-12.23
1518	1475	ULS1-FULL BUS	Combination	Max	-8.54	-355.91	135.26	18.3604	174.694	-6.4421	1.57	-30.07
1518	1476	ULS1-FULL BUS	Combination	Max	-32.83	-357.85	147.02	38.971	226.6246	-12.0458	-5.38	-30.18
1518	~1212	ULS1-FULL BUS	Combination	Max	-22.7	-320.01	49.64	18.8827	234.0264	-12.5496	-5.03	-33.28
1518	~1211	ULS1-FULL BUS	Combination	Max	2.35	-318.06	38.66	8.4081	181.4777	-6.5266	1.92	-33.16
1518	1475	ULS1-FULL BUS	Combination	Min	-17.35	-440.66	110.03	6.982	46.7159	-16.6737	-7.02	-52.14
1518	1476	ULS1-FULL BUS	Combination	Min	-43.66	-444.05	118.55	15.7959	79.0584	-24.2906	-21.05	-52.7
1518	~1212	ULS1-FULL BUS	Combination	Min	-37.62	-412.38	23	7.8075	87.85	-26.5081	-20.62	-53.37
1518	~1211	ULS1-FULL BUS	Combination	Min	-12.13	-409.4	14.94	3.8608	52.1185	-18.4236	-6.58	-52.82
1518	~1211	ULS1-FULL BUS	Combination	Max	-34.36	-327.83	16.35	9.2991	181.6248	-6.4264	-0.34	-33.41
1518	~1212	ULS1-FULL BUS	Combination	Max	-0.63	-320.29	22.61	30.1408	235.7871	-12.7236	-19.53	-33.88
1518	1482	ULS1-FULL BUS	Combination	Max	25.27	-190.47	89.78	-2.7254	251.5914	-12.6014	-18.7	-39.81
1518	1481	ULS1-FULL BUS	Combination	Max	-7.3	-197.86	83.61	-0.4085	184.8029	-5.4486	0.49	-39.35
1518	~1211	ULS1-FULL BUS	Combination	Min	-38.81	-419.58	-1.19	4.068	52.2338	-18.8744	-4.69	-51.41
1518	~1212	ULS1-FULL BUS	Combination	Min	-5.41	-411.73	1.02	15.5227	89.3967	-28.7182	-36.49	-52.02
1518	1482	ULS1-FULL BUS	Combination	Min	19.34	-299.24	76.13	-3.0488	98.8364	-29.5437	-35.03	-64.11
1518	1481	ULS1-FULL BUS	Combination	Min	-16.23	-307.28	73.47	-1.1577	55.6485	-18.2135	-3.23	-63.5

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Summary	
Status	Unacceptable
Maximum	1.000
V & T Util	0.278
N vs M Util	1.205

Section Name	Consultant
Concrete Section	Morrison Hershfield

Canadian Building Standards

CSA Standard A23.3-04, "Design of Concrete Structures"

CSA Standard A23.1-04, "Concrete Materials and Methods of Concrete Construction"

Design Aids, Manuals, and Handbooks

"Concrete Design Handbook", Cement Association of Canada, 3rd Edition, 2006

"Prestressed Concrete Structures", Collins and Mitchell, Prentice Hall Inc., 1991 (MCFT)

Section Dimensions

Rectangular Column
b = 1000 mm
h = 818 mm

Quantities (approx.)

Concrete = 1959 kg/m
Steel = 24.5 kg/m
Primary = 14.1 kg/m
Secondary = 10.3 kg/m

Material Properties

fc' = 27 MPa
fy (vert) = 230.0 MPa
fy (ties) = 230.0 MPa
Wc = 2400 kg/m3
Ws = 7850 kg/m3
Poisson's Ratio = 0.2
hagg = 20 mm
Es = 200000 MPa
Ec = 28165 MPa
Gc = 11735 MPa
fr = 3.12 MPa

Gross Properties

Zbar = 0 mm
Ybar = 0 mm
Ag = 818000 mm2
Ig (y-y) = 45612xE6 mm4
Ig (z-z) = 68167xE6 mm4
Ashear (Y) = 681667 mm2
Ashear (Z) = 681667 mm2
Jg = 92327xE6 mm4

Effective Properties

Ae = 818000 mm2
Ie (y-y) = 45612xE6 mm4
Ie (z-z) = 68167xE6 mm4
Ase (Y) = 681667 mm2
Ase (Z) = 681667 mm2
Je = 92327xE6 mm4

Vertical Bars

1000 x 818 Column
6-20M Vert
As = 1800 mm2
Rho = 0.22 %
Tangential Splice

Ties

10M Ties @ 305 mm
Legs (Z-Direction) = 3
Legs (Y-Direction) = 2

Miscellaneous

Clear Cover = 50 mm

Factored Input Loads

Load Case/Combo	N (kN)	T (kNm)	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Comment
1	-1256.3	0.0	39.4	99.7	-4.1	37.2	
2	-1453.4	0.0	-15.7	9.1	-98.3	-11.7	
3	-190.5	0.0	-39.8	251.6	25.3	-12.1	
4	-299.2	0.0	-64.1	98.8	19.3	-18.2	
5	-1453.4	0.0	-15.7	9.1	-98.3	-11.7	** Alt. Min. Moment - LC# 2

Factored Design Loads (with Minimum Moments):

Load Case/Combo	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Mres (kNm)	Theta
1	39.4	99.7	-4.1	37.2	106.4	160°
2	-15.7	9.1	-98.3	-65.4	66.0	262°
3	-39.8	251.6	25.3	-12.1	251.9	183°
4	-64.1	98.8	19.3	-18.2	100.5	190°
5	-15.7	57.5	-98.3	-11.7	58.6	192°

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N vs M Results			Axial Utilization	Moment Utilization	
GLC	#3		Nf = -190.5 kN	Mf = 251.9 kNm	Mn = 236.6 kNm
Status	Unacceptable	Message 1	Nr (max) = -9557.9 kN	Mr = 209.1 kNm	Mp = 275.1 kNm
Utilization	1.205		Utilization = 0.020	Utilization = 1.205	
Maximum	1.000				
Theta	183°				

Shear and Torsion Utilization		Shear Z-Direction	Shear Y-Direction	Torsion
GLC	2	bw = 1000 mm	bw = 818 mm	Tcr = 236.2 kNm
Nf	-1453.4 kN	dv = 683 mm	dv = 720 mm	Tf = 0.0 kNm < 0.25 Tcr
Vfz / Vrz	0.031	As (Tens) = 867 mm2	As (Tens) = 1177 mm2	Ignore Torsional Effects
Vfy / Vry	0.247	Av = 300 mm2	Av = 200 mm2	
Status	Acceptable	Lambda = 1.00	Lambda = 1.00	
Utilization	0.278	Mf (y-y) = 9.1 kNm	Mf (z-z) = -65.4 kNm	
Maximum	1.000	Vfz = 15.7 kN	Vfy = 98.3 kN	
Method	Simplified	Vsz = 187.6 kN	Vsy = 131.8 kN	
		Vcz = 315.3 kN	Vcy = 266.0 kN	
		Vrz = 503.0 kN	Vry = 397.8 kN	
		Beta = 0.137	Beta = 0.134	
		Theta = 35.0°	Theta = 35.0°	

Tie Spacing for Shear/Torsion		Maximum Shear Stress	
Spacing	305.0 mm	Stress	0.168 MPa
Maximum	818.0 mm	Maximum	4.388 MPa
Status	Acceptable	Status	Acceptable

Tie Spacing		Tie Diameter	
S	305 mm	Diam.	11.3 mm
S (max)	312 mm	Diam. (min)	5.9 mm
Status	Acceptable	Status	Acceptable

Vertical Steel Area		Status	As/Ag
As	1800 mm2	Message 35	0.22 %
As (min)	8180 mm2	Warning	1.00 %
As (max)	32720 mm2	Acceptable	4.00 %

Vertical Bar Splice Type	
Tangential Splice	
Status	Acceptable

Vertical Bar Spacing		Vertical Bar Diameter		Minimum Number of Vertical Bars	
Ny	3 Specified	db (vert)	19.5 mm	#Bars	6 Specified
Ny (max)	13.4 Allowed	db (min)	16.0 mm	#Bars	4 Required
Nz	2 Specified	Status	Acceptable	Status	Acceptable
Nz (max)	10.8 Allowed				
Status	Acceptable				

Vertical Reinforcing			Horizontal Reinforcing		
fy (min)	300.0 MPa		fy (min)	300.0 MPa	
fy (vert)	230.0 MPa		fy (horz)	230.0 MPa	
fy (max)	500.0 MPa		fy (max)	500.0 MPa	
Status	Warning	Message 17	Status	Warning	Message 18

Concrete Strength		Concrete Density	
fc' (min)	20.0 MPa	Wc (min)	1500.0 kg/m3

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fc'	27.0 MPa	Wc	2400.0 kg/m3
fc' (max)	80.0 MPa	Wc (max)	2500.0 kg/m3
Status	Acceptable	Status	Acceptable

Canadian Reinforcing Bars

Index	Bar Designation	Diameter (mm)	Area (mm2)
1	10M	11.3	100.0
2	15M	16.0	200.0
3	20M	19.5	300.0
4	25M	25.2	500.0
5	30M	29.9	700.0
6	35M	35.7	1000.0
7	45M	43.7	1500.0
8	55M	56.4	2500.0

List of Messages

Message 1	Unacceptable	Axial Load and Moment Utilization equals or exceeds Maximum. Clauses 10.1, 10.10, or 14.2.2 of A23.3
Message 17	Warning	fy of Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 18	Warning	fy of Shear Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 35	Warning	Area of Vertical Steel provided does not meet the Minimum. Clause 10.10.5 or 10.9.1 of A23.3

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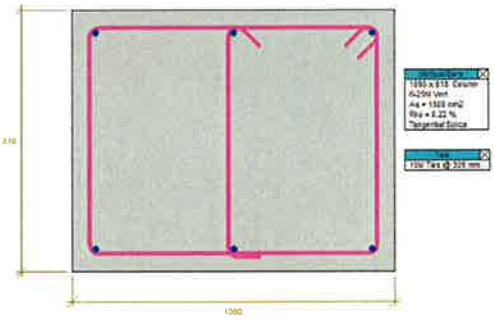

Morrison Hershfield
admin
Ph: 555-1234 Fax: 555-4321

#100 - 1234 Anywhere Place
AnyCity, AnyState
AnyCountry

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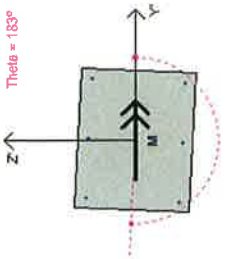

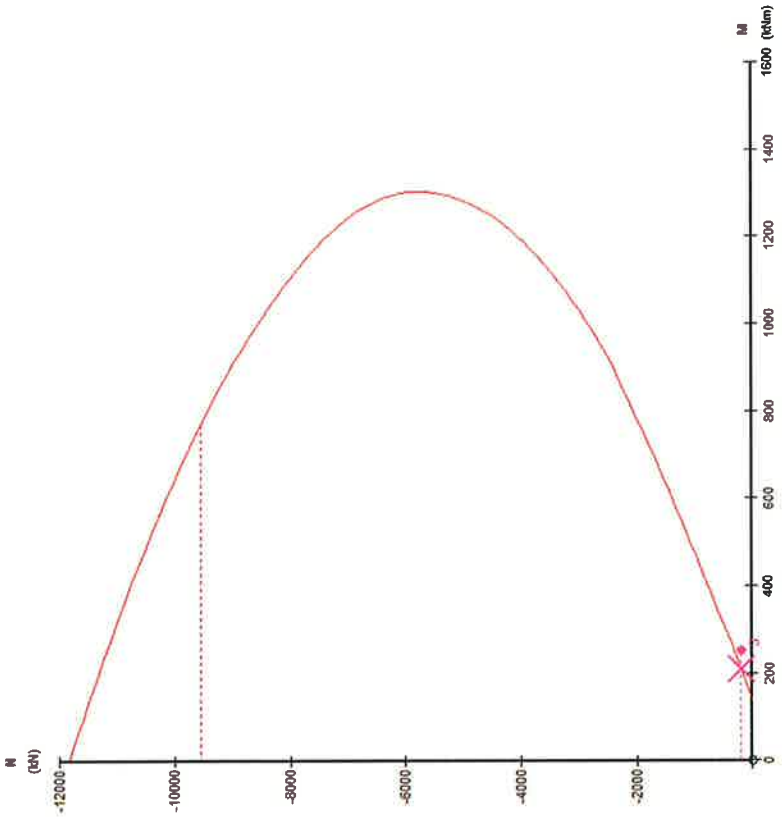

Concrete Section
1000 mm x 618 mm Column
6-20M Vert
Ag = 618000 mm2
As = 1800 mm
Rho = 0.22 %
fc' = 27 MPa
fy (vert) = 230.0 MPa

V_y N M_y M_z V_z

TABLE: Element Forces - Area Shells

Area	AreaElem	Joint	OutputCase	CaseType	StepType	F11	F22	F12	M11	M22	M12	V13	V23
Text	Text	Text	Text	Text	Text	KN/m	KN/m	KN/m	KN-m/m	KN-m/m	KN-m/m	KN/m	KN/m
1483	1483	1445	ULS1-BUS	Combination	Max	-506.3	-1338.14	-224.21	4.5763	112.0197	34.6097	10.09	24.62
1483	1483	1446	ULS1-BUS	Combination	Max	-52.92	-1262.08	-272.09	20.7004	77.7418	26.0485	10.78	25.76
1483	1483	1452	ULS1-BUS	Combination	Max	5.93	-974.12	-194.89	22.3865	117.7597	14.9717	11.45	-0.52
1483	1483	1451	ULS1-BUS	Combination	Max	-449.49	-1050.26	-146.97	3.3065	124.8248	24.6321	11.23	-1.65
1483	1483	1445	ULS1-BUS	Combination	Min	-576.91	-1468.87	-252.43	-2.6512	33.7829	7.4015	4.42	-2.47
1483	1483	1446	ULS1-BUS	Combination	Min	-87.2	-1386.46	-308.03	7.5801	33.1139	0.9577	7.39	-1.96
1483	1483	1452	ULS1-BUS	Combination	Min	-23.53	-1066.31	-224.76	12.2342	52.2854	-2.0753	8.2	-8.45
1483	1483	1451	ULS1-BUS	Combination	Min	-510.69	-1147.54	-168.71	-0.6249	45.6552	4.4738	4.48	-8.96
1518	1518-1	1475	ULS1-BUS	Combination	Max	-12.05	-365.42	126.32	14.2908	136.9198	-8.7898	-1.02	-34.87
1518	1518-1	1476	ULS1-BUS	Combination	Max	-34.62	-367.62	137.34	31.2694	181.4645	-14.5009	-9.64	-35.12
1518	1518-1	~1212	ULS1-BUS	Combination	Max	-26.94	-334.18	42.37	14.9542	188.2617	-15.4752	-9.29	-37.24
1518	1518-1	~1211	ULS1-BUS	Combination	Max	-4.43	-331.95	31.95	6.4861	142.7798	-9.3492	-0.66	-37
1518	1518-1	1475	ULS1-BUS	Combination	Min	-16	-393.06	119.06	9.7447	78.6858	-12.8004	-4.84	-44.29
1518	1518-1	1476	ULS1-BUS	Combination	Min	-39.61	-395.53	128.24	21.3285	115.1491	-19.2954	-16.69	-44.74
1518	1518-1	~1212	ULS1-BUS	Combination	Min	-33.51	-362.41	34.32	10.2974	122.8348	-21.0375	-16.3	-45.62
1518	1518-1	~1211	ULS1-BUS	Combination	Min	-9.79	-359.94	25.11	4.7807	84.1261	-14.1386	-4.45	-45.17
1518	1518-2	~1211	ULS1-BUS	Combination	Max	-34.72	-341.63	11.47	7.1705	142.9093	-9.3722	-1.47	-36.74
1518	1518-2	~1212	ULS1-BUS	Combination	Max	-1.34	-333.98	16.48	24.7924	189.8672	-16.2489	-23.18	-37.23
1518	1518-2	1482	ULS1-BUS	Combination	Max	22.65	-214.56	83.21	-2.7696	203.0965	-16.3917	-22.23	-44.54
1518	1518-2	1481	ULS1-BUS	Combination	Max	-11.02	-222.18	77.89	-0.5893	145.803	-8.5218	-0.51	-44.06
1518	1518-2	~1211	ULS1-BUS	Combination	Min	-37.24	-369.68	6.19	5.1605	84.2517	-14.451	-3.18	-44.14
1518	1518-2	~1212	ULS1-BUS	Combination	Min	-2.81	-362.29	9.81	18.6625	124.3746	-22.7414	-30.41	-44.69
1518	1518-2	1482	ULS1-BUS	Combination	Min	20.01	-249.59	78.97	-2.8934	134.939	-23.3425	-29.18	-54.63
1518	1518-2	1481	ULS1-BUS	Combination	Min	-14.24	-257.07	75.17	-0.995	87.3968	-13.7721	-1.95	-54.08

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Summary	
Status	Warning
Maximum	1.000
V & T Util	0.223
N vs M Util	0.931

Section Name	Consultant
Concrete Section	Morrison Hershfield

Canadian Building Standards

CSA Standard A23.3-04, "Design of Concrete Structures"
CSA Standard A23.1-04, "Concrete Materials and Methods of Concrete Construction"

Design Aids, Manuals, and Handbooks

"Concrete Design Handbook", Cement Association of Canada, 3rd Edition, 2006
"Prestressed Concrete Structures", Collins and Mitchell, Prentice Hall Inc., 1991 (MCFT)

Section Dimensions
Rectangular Column
b = 1000 mm
h = 818 mm

Quantities (approx.)
Concrete = 1959 kg/m
Steel = 24.5 kg/m
Primary = 14.1 kg/m
Secondary = 10.3 kg/m

Material Properties
fc' = 27 MPa
fy (vert) = 230.0 MPa
fy (ties) = 230.0 MPa
Wc = 2400 kg/m3
Ws = 7850 kg/m3
Poisson's Ratio = 0.2
hagg = 20 mm
Es = 200000 MPa
Ec = 28165 MPa
Gc = 11735 MPa
fr = 3.12 MPa

Gross Properties
Zbar = 0 mm
Ybar = 0 mm
Ag = 818000 mm2
Ig (y-y) = 45612xE6 mm4
Ig (z-z) = 68167xE6 mm4
Ashear (Y) = 681667 mm2
Ashear (Z) = 681667 mm2
Jg = 92327xE6 mm4

Effective Properties
Ae = 818000 mm2
Ie (y-y) = 45612xE6 mm4
Ie (z-z) = 68167xE6 mm4
Ase (Y) = 681667 mm2
Ase (Z) = 681667 mm2
Je = 92327xE6 mm4

Vertical Bars
1000 x 818 Column
6-20M Vert
As = 1800 mm2
Rho = 0.22 %
Tangential Splice

Ties
10M Ties @ 305 mm
Legs (Z-Direction) = 3
Legs (Y-Direction) = 2

Miscellaneous
Clear Cover = 50 mm

Factored Input Loads

Load Case/Combo	N (kN)	T (kNm)	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Comment
1	-1262.1	0.0	25.8	77.7	-52.9	26.0	
2	-1386.5	0.0	-2.0	33.1	-87.2	1.0	
3	-214.6	0.0	-44.5	203.1	22.7	-16.4	
4	-249.6	0.0	-54.6	134.9	20.0	-23.3	
5	-1386.5	0.0	-2.0	33.1	-87.2	1.0	** Alt. Min. Moment - LC# 2

Factored Design Loads (with Minimum Moments):

Load Case/Combo	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Mres (kNm)	Theta
1	25.8	77.7	-52.9	26.0	82.0	161°
2	-2.0	54.8	-87.2	1.0	54.8	179°
3	-44.5	203.1	22.7	-16.4	203.8	185°
4	-54.6	134.9	20.0	-23.3	136.9	190°
5	-2.0	33.1	-87.2	62.4	70.6	118°

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N vs M Results		Axial Utilization	Moment Utilization	
GLC	#3	Nf = -214.6 kN	Mf = 203.8 kNm	Mn = 246.0 kNm
Status	Acceptable	Nr (max) = -9557.9 kN	Mr = 218.9 kNm	Mp = 284.3 kNm
Utilization	0.931	Utilization = 0.022	Utilization = 0.931	
Maximum	1.000			
Theta	185°			

Shear and Torsion Utilization		Shear Z-Direction	Shear Y-Direction	Torsion
GLC	2	bw = 1000 mm	bw = 818 mm	Tcr = 236.2 kNm
Nf	-1386.5 kN	dv = 678 mm	dv = 720 mm	Tf = 0.0 kNm < 0.25 Tcr
Vfz / Vrz	0.004	As (Tens) = 884 mm2	As (Tens) = 1189 mm2	Ignore Torsional Effects
Vfy / Vry	0.219	Av = 300 mm2	Av = 200 mm2	
Status	Acceptable	Lambda = 1.00	Lambda = 1.00	
Utilization	0.223	Mf (y-y) = 54.8 kNm	Mf (z-z) = 1.0 kNm	
Maximum	1.000	Vfz = 2.0 kN	Vfy = 87.2 kN	
Method	Simplified	Vsz = 186.1 kN	Vsy = 131.8 kN	
		Vcz = 313.8 kN	Vcy = 266.0 kN	
		Vrz = 499.9 kN	Vry = 397.8 kN	
		Beta = 0.137	Beta = 0.134	
		Theta = 35.0°	Theta = 35.0°	

Tie Spacing for Shear/Torsion		Maximum Shear Stress	
Spacing	305.0 mm	Stress	0.148 MPa
Maximum	818.0 mm	Maximum	4.388 MPa
Status	Acceptable	Status	Acceptable

Tie Spacing		Tie Diameter	
S	305 mm	Diam.	11.3 mm
S (max)	312 mm	Diam. (min)	5.9 mm
Status	Acceptable	Status	Acceptable

Vertical Steel Area		Status	As/Ag
As	1800 mm2	Message 35	0.22 %
As (min)	8180 mm2	Warning	1.00 %
As (max)	32720 mm2	Acceptable	4.00 %

Vertical Bar Splice Type
Tangential Splice
Status: Acceptable

Vertical Bar Spacing		Vertical Bar Diameter		Minimum Number of Vertical Bars	
Ny	3 Specified	db (vert)	19.5 mm	#Bars	6 Specified
Ny (max)	13.4 Allowed	db (min)	16.0 mm	#Bars	4 Required
Nz	2 Specified	Status	Acceptable	Status	Acceptable
Nz (max)	10.8 Allowed				
Status	Acceptable				

Vertical Reinforcing			Horizontal Reinforcing		
fy (min)	300.0 MPa		fy (min)	300.0 MPa	
fy (vert)	230.0 MPa		fy (horz)	230.0 MPa	
fy (max)	500.0 MPa		fy (max)	500.0 MPa	
Status	Warning	Message 17	Status	Warning	Message 18

Concrete Strength		Concrete Density	
fc' (min)	20.0 MPa	Wc (min)	1500.0 kg/m3

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fc'	27.0 MPa	Wc	2400.0 kg/m3
fc' (max)	80.0 MPa	Wc (max)	2500.0 kg/m3
Status	Acceptable	Status	Acceptable

Canadian Reinforcing Bars

Index	Bar Designation	Diameter (mm)	Area (mm2)
1	10M	11.3	100.0
2	15M	16.0	200.0
3	20M	19.5	300.0
4	25M	25.2	500.0
5	30M	29.9	700.0
6	35M	35.7	1000.0
7	45M	43.7	1500.0
8	55M	56.4	2500.0

List of Messages

Message 17	Warning	fy of Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 18	Warning	fy of Shear Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 35	Warning	Area of Vertical Steel provided does not meet the Minimum. Clause 10.10.5 or 10.9.1 of A23.3

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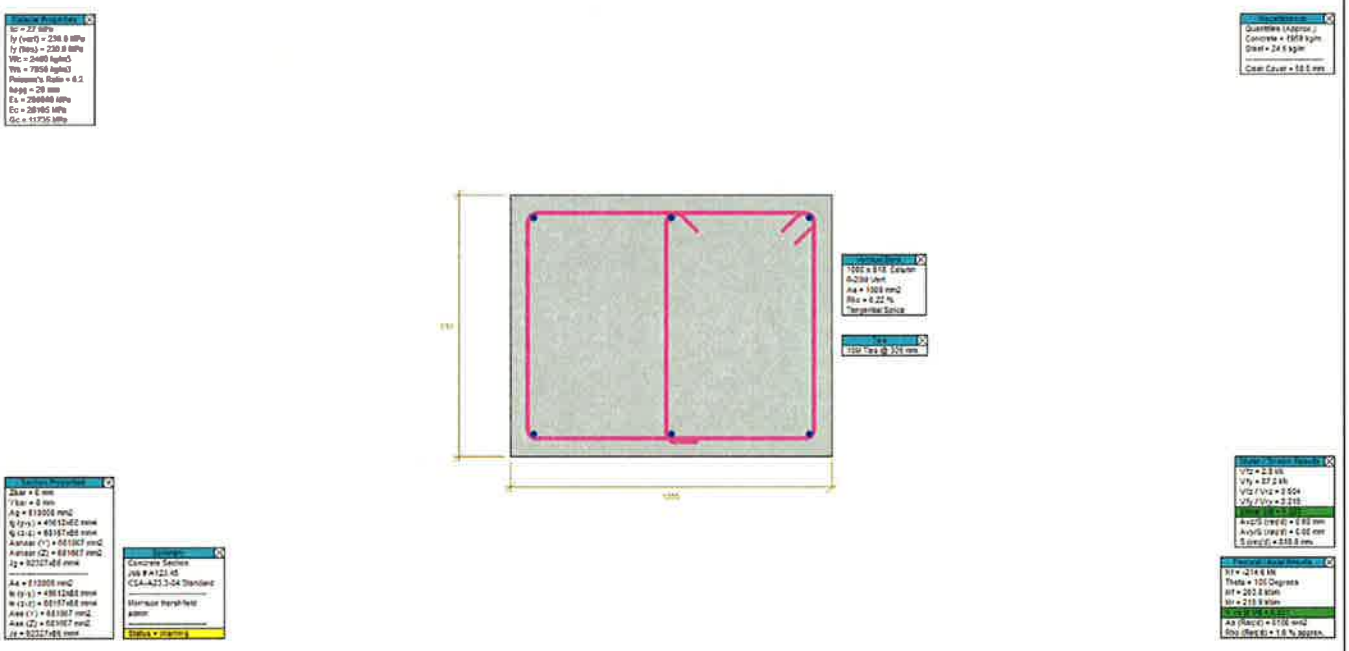
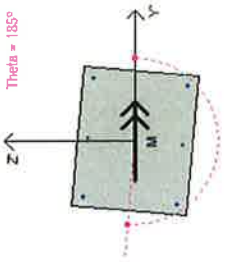
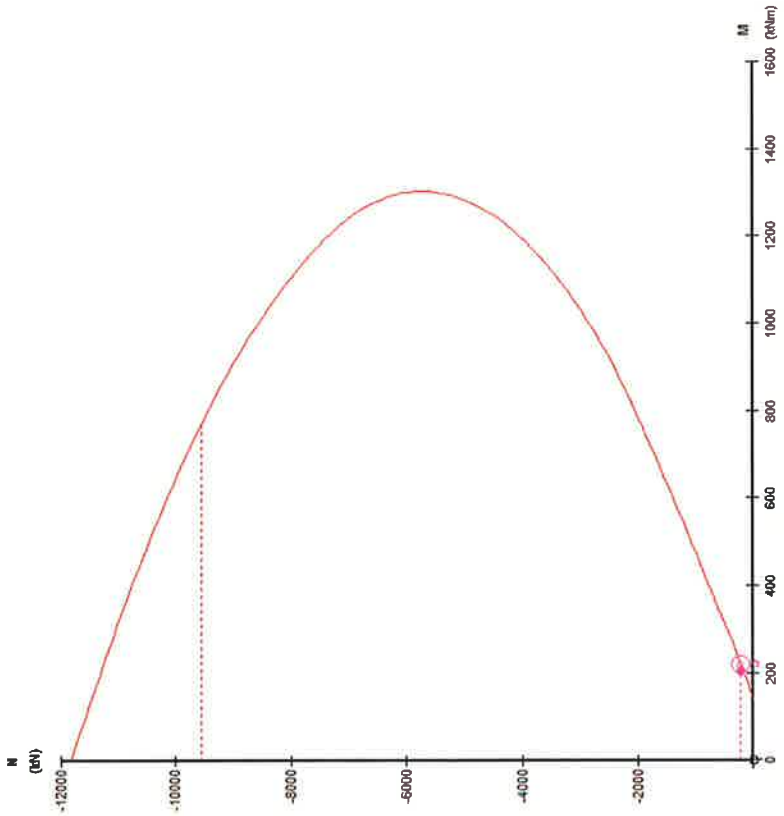


Morrison Hershfield
admin
Ph: 555-1234 Fax: 555-4321

#100 - 1234 Anywhere Place
AnyCity, AnyState
AnyCountry





Concrete Section
1000 mm x 818 mm Column
5-20M Vert
Ag = 818000 mm2
As = 1600 mm
Rho = 0.22 %
fc' = 27 MPa
fy (Vert) = 230.0 MPa

TABLE: Element Forces - Area Shells													
Area	AreaElem	Joint	OutputCase	CaseType	StepType	F11	F22	F12	M11	M22	M12	V13	V23
Text	Text	Text	Text	Text	Text	KN/m	KN/m	KN/m	KN-m/m	KN-m/m	KN-m/m	KN/m	KN/m
1483	1483	1445	ULS1 FULL BUS- 2 LANES	Combination	Max	-501.99	-1336.2	-223.73	6.1273	125.1251	38.9578	11.15	28.83
1483	1483	1446	ULS1 FULL BUS- 2 LANES	Combination	Max	-47.14	-1260.34	-271.63	22.8031	85.4929	29.856	11.64	30.07
1483	1483	1452	ULS1 FULL BUS- 2 LANES	Combination	Max	12	-973.09	-194.42	24.3428	129.4089	17.4903	12.3	0.72
1483	1483	1451	ULS1 FULL BUS- 2 LANES	Combination	Max	-445.54	-1049.07	-146.46	4.1358	138.6062	27.8285	12.44	-0.51
1483	1483	1445	ULS1 FULL BUS- 2 LANES	Combination	Min	-596.64	-1512.15	-261.64	-3.5587	19.9672	2.3986	3.52	-7.58
1483	1483	1446	ULS1 FULL BUS- 2 LANES	Combination	Min	-92.87	-1427.66	-319.89	5.1443	25.4689	-3.8442	7.1	-7.19
1483	1483	1452	ULS1 FULL BUS- 2 LANES	Combination	Min	-27.25	-1097.02	-234.49	10.6773	41.3482	-5.3789	7.95	-9.96
1483	1483	1451	ULS1 FULL BUS- 2 LANES	Combination	Min	-527.6	-1179.92	-175.69	-1.1171	32.2002	0.7432	3.36	-10.36
1518	1518-1	1475	ULS1 FULL BUS- 2 LANES	Combination	Max	-11.67	-361.32	127.51	15.3103	148.3756	-8.2921	-0.47	-33.67
1518	1518-1	1476	ULS1 FULL BUS- 2 LANES	Combination	Max	-33.86	-363.4	138.93	33.3728	194.7614	-13.9165	-8.65	-33.88
1518	1518-1	~1212	ULS1 FULL BUS- 2 LANES	Combination	Max	-25.44	-327.76	42.89	15.9366	201.4826	-14.7916	-8.3	-36.2
1518	1518-1	~1211	ULS1 FULL BUS- 2 LANES	Combination	Max	-3.31	-325.63	32.27	6.8727	154.3952	-8.7418	-0.12	-35.98
1518	1518-1	1475	ULS1 FULL BUS- 2 LANES	Combination	Min	-16.97	-398.4	117.84	9.1957	70.057	-13.6828	-5.6	-46.33
1518	1518-1	1476	ULS1 FULL BUS- 2 LANES	Combination	Min	-40.56	-400.86	126.78	20.0051	105.6115	-20.3552	-18.13	-46.83
1518	1518-1	~1212	ULS1 FULL BUS- 2 LANES	Combination	Min	-34.21	-365.64	32.16	9.6719	113.5223	-22.2697	-17.74	-47.47
1518	1518-1	~1211	ULS1 FULL BUS- 2 LANES	Combination	Min	-10.48	-363.19	23.17	4.589	75.513	-15.1841	-5.21	-46.97
1518	1518-2	~1211	ULS1 FULL BUS- 2 LANES	Combination	Max	-34.61	-335.41	11.64	7.6179	154.5274	-8.7181	-1.25	-35.84
1518	1518-2	~1212	ULS1 FULL BUS- 2 LANES	Combination	Max	-1.23	-327.69	16.72	26.125	203.1169	-15.433	-22.25	-36.33
1518	1518-2	1482	ULS1 FULL BUS- 2 LANES	Combination	Max	23.49	-204.56	83.88	-2.758	216.9371	-15.5053	-21.33	-43.28
1518	1518-2	1481	ULS1 FULL BUS- 2 LANES	Combination	Max	-10.3	-212.24	78.38	-0.513	157.4245	-7.8353	-0.33	-42.81
1518	1518-2	~1211	ULS1 FULL BUS- 2 LANES	Combination	Min	-38.01	-373.04	4.61	4.9192	75.64	-15.5506	-3.56	-45.8
1518	1518-2	~1212	ULS1 FULL BUS- 2 LANES	Combination	Min	-3.21	-365.67	7.83	17.8807	115.07	-24.1666	-31.97	-46.36
1518	1518-2	1482	ULS1 FULL BUS- 2 LANES	Combination	Min	19.95	-251.76	78.22	-2.9231	125.3181	-24.8571	-30.68	-56.85
1518	1518-2	1481	ULS1 FULL BUS- 2 LANES	Combination	Min	-14.59	-259.26	74.74	-1.0585	78.8759	-14.8981	-2.27	-56.29

Fully Laden Double Decker — 2 Lanes

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Fully laden Double Decker — 2 Median Lanes

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File Name: G:\sconcrete-15940\wall.SCO

Section Name	Consultant
Concrete Section	Morrison Hershfield

Summary

Status	Borderline
Maximum	1.000
V & T Util	0.248
N vs M Util	1.012

Canadian Building Standards

CSA Standard A23.3-04, "Design of Concrete Structures"
CSA Standard A23.1-04, "Concrete Materials and Methods of Concrete Construction"

Design Aids, Manuals, and Handbooks

"Concrete Design Handbook", Cement Association of Canada, 3rd Edition, 2006
"Prestressed Concrete Structures", Collins and Mitchell, Prentice Hall Inc., 1991 (MCFT)

Section Dimensions
Rectangular Column
b = 1000 mm
h = 818 mm

Quantities (approx.)
Concrete = 1959 kg/m
Steel = 24.5 kg/m
Primary = 14.1 kg/m
Secondary = 10.3 kg/m

Material Properties
fc' = 27 MPa
fy (vert) = 230.0 MPa
fy (ties) = 230.0 MPa
Wc = 2400 kg/m3
Ws = 7850 kg/m3
Poisson's Ratio = 0.2
hagg = 20 mm
Es = 200000 MPa
Ec = 28165 MPa
Gc = 11735 MPa
fr = 3.12 MPa

Gross Properties
Zbar = 0 mm
Ybar = 0 mm
Ag = 818000 mm2
Ig (y-y) = 45612xE6 mm4
Ig (z-z) = 68167xE6 mm4
Ashear (Y) = 681667 mm2
Ashear (Z) = 681667 mm2
Jg = 92327xE6 mm4

Effective Properties
Ae = 818000 mm2
Ie (y-y) = 45612xE6 mm4
Ie (z-z) = 68167xE6 mm4
Ase (Y) = 681667 mm2
Ase (Z) = 681667 mm2
Je = 92327xE6 mm4

Vertical Bars
1000 x 818 Column
6-20M Vert
As = 1800 mm2
Rho = 0.22 %
Tangential Splice

Ties
10M Ties @ 305 mm
Legs (Z-Direction) = 3
Legs (Y-Direction) = 2

Miscellaneous
Clear Cover = 50 mm

Factored Input Loads

Load Case/Combo	N (kN)	T (kNm)	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Comment
1	-1260.3	0.0	30.1	85.5	-47.1	29.9	
2	-1427.7	0.0	-7.2	25.5	-92.9	-3.8	
3	-204.6	0.0	-43.3	216.9	23.5	-15.5	
4	-251.8	0.0	-56.9	125.3	20.0	-24.9	
5	-1427.7	0.0	-7.2	25.5	-92.9	-3.8	** Alt. Min. Moment - LC# 2

Factored Design Loads (with Minimum Moments):

Load Case/Combo	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Mres (kNm)	Theta
1	30.1	85.5	-47.1	29.9	90.6	161°
2	-7.2	56.4	-92.9	-3.8	56.6	184°
3	-43.3	216.9	23.5	-15.5	217.5	184°
4	-56.9	125.3	20.0	-24.9	127.8	191°
5	-7.2	25.5	-92.9	-64.2	69.1	248°

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N vs M Results			Axial Utilization	Moment Utilization	
GLC	#3		Nf = -204.6 kN	Mf = 217.5 kNm	Mn = 242.0 kNm
Status	Borderline	Message 1	Nr (max) = -9557.9 kN	Mr = 215.0 kNm	Mp = 280.5 kNm
Utilization	1.012		Utilization = 0.021	Utilization = 1.012	
Maximum	1.000				
Theta	184°				

Shear and Torsion Utilization		Shear Z-Direction	Shear Y-Direction	Torsion
GLC	2	bw = 1000 mm	bw = 818 mm	Tcr = 236.2 kNm
Nf	-1427.7 kN	dv = 681 mm	dv = 720 mm	Tf = 0.0 kNm < 0.25 Tcr
Vfz / Vrz	0.014	As (Tens) = 873 mm2	As (Tens) = 1181 mm2	Ignore Torsional Effects
Vfy / Vry	0.233	Av = 300 mm2	Av = 200 mm2	
Status	Acceptable	Lambda = 1.00	Lambda = 1.00	
Utilization	0.248	Mf (y-y) = 56.4 kNm	Mf (z-z) = -3.8 kNm	
Maximum	1.000	Vfz = 7.2 kN	Vfy = 92.9 kN	
Method	Simplified	Vsz = 187.1 kN	Vsy = 131.8 kN	
		Vcz = 314.8 kN	Vcy = 266.0 kN	
		Vrz = 502.0 kN	Vry = 397.8 kN	
		Beta = 0.137	Beta = 0.134	
		Theta = 35.0°	Theta = 35.0°	

Tie Spacing for Shear/Torsion		Maximum Shear Stress	
Spacing	305.0 mm	Stress	0.158 MPa
Maximum	818.0 mm	Maximum	4.388 MPa
Status	Acceptable	Status	Acceptable

Tie Spacing		Tie Diameter	
S	305 mm	Diam.	11.3 mm
S (max)	312 mm	Diam. (min)	5.9 mm
Status	Acceptable	Status	Acceptable

Vertical Steel Area		Status	As/Ag
As	1800 mm2	Message 35	0.22 %
As (min)	8180 mm2	Warning	1.00 %
As (max)	32720 mm2	Acceptable	4.00 %

Vertical Bar Splice Type	
Tangential Splice	
Status	Acceptable

Vertical Bar Spacing		Vertical Bar Diameter		Minimum Number of Vertical Bars	
Ny	3 Specified	db (vert)	19.5 mm	#Bars	6 Specified
Ny (max)	13.4 Allowed	db (min)	16.0 mm	#Bars	4 Required
Nz	2 Specified	Status	Acceptable	Status	Acceptable
Nz (max)	10.8 Allowed				
Status	Acceptable				

Vertical Reinforcing			Horizontal Reinforcing		
fy (min)	300.0 MPa		fy (min)	300.0 MPa	
fy (vert)	230.0 MPa		fy (horz)	230.0 MPa	
fy (max)	500.0 MPa		fy (max)	500.0 MPa	
Status	Warning	Message 17	Status	Warning	Message 18

Concrete Strength		Concrete Density	
fc' (min)	20.0 MPa	Wc (min)	1500.0 kg/m3

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fc'	27.0 MPa	Wc	2400.0 kg/m3
fc' (max)	80.0 MPa	Wc (max)	2500.0 kg/m3
Status	Acceptable	Status	Acceptable

Canadian Reinforcing Bars

Index	Bar Designation	Diameter (mm)	Area (mm2)
1	10M	11.3	100.0
2	15M	16.0	200.0
3	20M	19.5	300.0
4	25M	25.2	500.0
5	30M	29.9	700.0
6	35M	35.7	1000.0
7	45M	43.7	1500.0
8	55M	56.4	2500.0

List of Messages

Message 1	Borderline	Axial Load and Moment Utilization equals or exceeds Maximum. Clauses 10.1, 10.10, or 14.2.2 of A23.3
Message 17	Warning	fy of Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 18	Warning	fy of Shear Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 35	Warning	Area of Vertical Steel provided does not meet the Minimum. Clause 10.10.5 or 10.9.1 of A23.3

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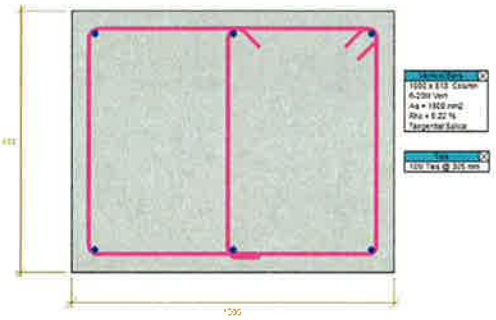

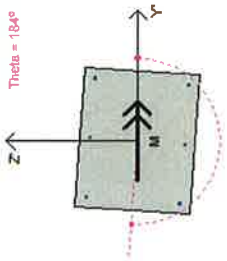

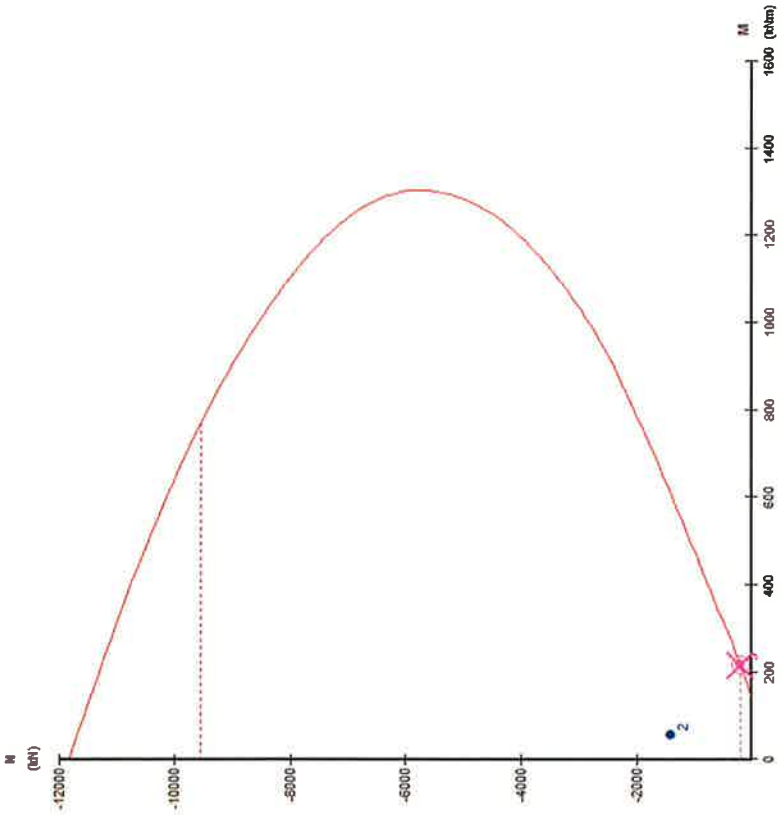

Concrete Section
1000 mm x 618 mm Column
6-20M Vert
Ag = 618000 mm2
As = 1800 mm
Rho = 0.22 %
f'c = 27 MPa
fy (vert) = 230.0 MPa

M = 2375 kNm
N = -11670 kN

TABLE: Element Forces - Area Shells													
Area	AreaElem	Joint	OutputCase	CaseType	StepType	F11	F22	F12	M11	M22	M12	V13	V23
Text	Text	Text	Text	Text	Text	KN/m	KN/m	KN/m	KN-m/m	KN-m/m	KN-m/m	KN/m	KN/m
1483	1483	1445	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-506.3	-1338.14	-224.21	4.5763	112.0197	34.6097	10.09	24.62
1483	1483	1446	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-52.92	-1262.08	-272.09	20.7004	77.7418	26.0485	10.78	25.76
1483	1483	1452	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	5.93	-974.12	-194.89	22.3865	117.7597	14.9717	11.45	-0.52
1483	1483	1451	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-449.49	-1050.26	-146.97	3.3065	124.8248	24.6321	11.23	-1.65
1483	1483	1445	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-576.91	-1468.87	-252.43	-2.6512	33.7829	7.4015	4.42	-2.47
1483	1483	1446	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-87.2	-1386.46	-308.03	7.5801	33.1139	0.9577	7.39	-1.96
1483	1483	1452	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-23.53	-1066.31	-224.76	12.2342	52.2854	-2.0753	8.2	-8.45
1483	1483	1451	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-510.69	-1147.54	-168.71	-0.6249	45.6552	4.4738	4.48	-8.96
1518	1518-1	1475	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-12.05	-365.42	126.32	14.2908	136.9198	-8.7898	-1.02	-34.87
1518	1518-1	1476	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-34.62	-367.62	137.34	31.2694	181.4645	-14.5009	-9.64	-35.12
1518	1518-1	~1212	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-26.94	-334.18	42.37	14.9542	188.2617	-15.4752	-9.29	-37.24
1518	1518-1	~1211	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-4.43	-331.95	31.95	6.4861	142.7798	-9.3492	-0.66	-37
1518	1518-1	1475	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-16	-393.06	119.06	9.7447	78.6858	-12.8004	-4.84	-44.29
1518	1518-1	1476	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-39.61	-395.53	128.24	21.3285	115.1491	-19.2954	-16.69	-44.74
1518	1518-1	~1212	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-33.51	-362.41	34.32	10.2974	122.8348	-21.0375	-16.3	-45.62
1518	1518-1	~1211	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-9.79	-359.94	25.11	4.7807	84.1261	-14.1386	-4.45	-45.17
1518	1518-2	~1211	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-34.72	-341.63	11.47	7.1705	142.9093	-9.3722	-1.47	-36.74
1518	1518-2	~1212	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-1.34	-333.98	16.48	24.7924	189.8672	-16.2489	-23.18	-37.23
1518	1518-2	1482	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	22.65	-214.56	83.21	-2.7696	203.0965	-16.3917	-22.23	-44.54
1518	1518-2	1481	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Max	-11.02	-222.18	77.89	-0.5893	145.803	-8.5218	-0.51	-44.06
1518	1518-2	~1211	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-37.24	-369.68	6.19	5.1605	84.2517	-14.451	-3.18	-44.14
1518	1518-2	~1212	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-2.81	-362.29	9.81	18.6625	124.3746	-22.7414	-30.41	-44.69
1518	1518-2	1482	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	20.01	-249.59	78.97	-2.8934	134.939	-23.3425	-29.18	-54.63
1518	1518-2	1481	ULS1-2 LANES UNLADEN DOUBLE DECKER	Combination	Min	-14.24	-257.07	75.17	-0.995	87.3968	-13.7721	-1.95	-54.08

Unladen Double Decker – 2 Lanes

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Unladen Double Decker — 2 Median Lanes

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Section Name	**Consultant**
Concrete Section	Morrison Hershfield

Summary

Status	Warning
Maximum	1.000
V & T Util	0.221
N vs M Util	0.959

Canadian Building Standards

CSA Standard A23.3-04, "Design of Concrete Structures"
CSA Standard A23.1-04, "Concrete Materials and Methods of Concrete Construction"

Design Aids, Manuals, and Handbooks

"Concrete Design Handbook", Cement Association of Canada, 3rd Edition, 2006
"Prestressed Concrete Structures", Collins and Mitchell, Prentice Hall Inc., 1991 (MCFT)

Section Dimensions
Rectangular Column
b = 1000 mm
h = 818 mm

Quantities (approx.)
Concrete = 1959 kg/m
Steel = 24.5 kg/m
Primary = 14.1 kg/m
Secondary = 10.3 kg/m

Material Properties
fc' = 27 MPa
fy (vert) = 230.0 MPa
fy (ties) = 230.0 MPa
Wc = 2400 kg/m3
Ws = 7850 kg/m3
Poisson's Ratio = 0.2
hagg = 20 mm
Es = 200000 MPa
Ec = 28165 MPa
Gc = 11735 MPa
fr = 3.12 MPa

Gross Properties
Zbar = 0 mm
Ybar = 0 mm
Ag = 818000 mm2
Ig (y-y) = 45612xE6 mm4
Ig (z-z) = 68167xE6 mm4
Ashear (Y) = 681667 mm2
Ashear (Z) = 681667 mm2
Jg = 92327xE6 mm4

Effective Properties
Ae = 818000 mm2
Ie (y-y) = 45612xE6 mm4
Ie (z-z) = 68167xE6 mm4
Ase (Y) = 681667 mm2
Ase (Z) = 681667 mm2
Je = 92327xE6 mm4

Vertical Bars
1000 x 818 Column
6-20M Vert
As = 1800 mm2
Rho = 0.22 %
Tangential Splice

Ties
10M Ties @ 305 mm
Legs (Z-Direction) = 3
Legs (Y-Direction) = 2

Miscellaneous
Clear Cover = 50 mm

Factored Input Loads

Load Case/Combo	N (kN)	T (kNm)	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Comment
1	-1262.2	0.0	25.8	77.1	-63.8	25.7	
2	-1345.0	0.0	-0.6	32.5	-87.4	2.4	
3	-216.9	0.0	-43.8	209.9	22.8	-15.5	
4	-283.2	0.0	-57.1	129.1	19.8	-24.8	
5	-1345.0	0.0	-0.6	32.5	-87.4	2.4	** Alt. Min. Moment - LC# 2

Factored Design Loads (with Minimum Moments):

Load Case/Combo	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Mres (kNm)	Theta
1	25.8	77.1	-63.8	25.7	81.3	162°
2	-0.6	53.2	-87.4	2.4	53.2	177°
3	-43.8	209.9	22.8	-15.5	210.5	184°
4	-57.1	129.1	19.8	-24.8	131.5	191°
5	-0.6	32.5	-87.4	60.5	68.7	118°

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N vs M Results		Axial Utilization	Moment Utilization	
GLC	#3	Nf = -216.9 kN	Mf = 210.5 kNm	Mn = 246.6 kNm
Status	Acceptable	Nr (max) = -9557.9 kN	Mr = 219.5 kNm	Mp = 285.0 kNm
Utilization	0.959	Utilization = 0.023	Utilization = 0.959	
Maximum	1.000			
Theta	184°			

Shear and Torsion Utilization		Shear Z-Direction	Shear Y-Direction	Torsion
GLC	2	bw = 1000 mm	bw = 818 mm	Tcr = 236.2 kNm
Nf	-1345.0 kN	dv = 674 mm	dv = 720 mm	Tf = 0.0 kNm < 0.25 Tcr
Vfz / Vrz	0.001	As (Tens) = 896 mm2	As (Tens) = 1197 mm2	Ignore Torsional Effects
Vfy / Vry	0.220	Av = 300 mm2	Av = 200 mm2	
Status	Acceptable	Lambda = 1.00	Lambda = 1.00	
Utilization	0.221	Mf (y-y) = 53.2 kNm	Mf (z-z) = 2.4 kNm	
Maximum	1.000	Vfz = 0.6 kN	Vfy = 87.4 kN	
Method	Simplified	Vsz = 185.0 kN	Vsy = 131.8 kN	
		Vcz = 312.7 kN	Vcy = 266.0 kN	
		Vrz = 497.7 kN	Vry = 397.8 kN	
		Beta = 0.137	Beta = 0.134	
		Theta = 35.0°	Theta = 35.0°	

Tie Spacing for Shear/Torsion		Maximum Shear Stress	
Spacing	305.0 mm	Stress	0.148 MPa
Maximum	818.0 mm	Maximum	4.388 MPa
Status	Acceptable	Status	Acceptable

Tie Spacing		Tie Diameter	
S	305 mm	Diam.	11.3 mm
S (max)	312 mm	Diam. (min)	5.9 mm
Status	Acceptable	Status	Acceptable

Vertical Steel Area		Status	As/Ag
As	1800 mm2	Message 35	0.22 %
As (min)	8180 mm2	Warning	1.00 %
As (max)	32720 mm2	Acceptable	4.00 %

Vertical Bar Splice Type	
Tangential Splice	
Status	Acceptable

Vertical Bar Spacing		Vertical Bar Diameter		Minimum Number of Vertical Bars	
Ny	3 Specified	db (vert)	19.5 mm	#Bars	6 Specified
Ny (max)	13.4 Allowed	db (min)	16.0 mm	#Bars	4 Required
Nz	2 Specified	Status	Acceptable	Status	Acceptable
Nz (max)	10.8 Allowed				
Status	Acceptable				

Vertical Reinforcing			Horizontal Reinforcing		
fy (min)	300.0 MPa		fy (min)	300.0 MPa	
fy (vert)	230.0 MPa		fy (horz)	230.0 MPa	
fy (max)	500.0 MPa		fy (max)	500.0 MPa	
Status	Warning	Message 17	Status	Warning	Message 18

Concrete Strength		Concrete Density	
fc' (min)	20.0 MPa	Wc (min)	1500.0 kg/m3

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fc'	27.0 MPa	Wc	2400.0 kg/m3
fc' (max)	80.0 MPa	Wc (max)	2500.0 kg/m3
Status	Acceptable	Status	Acceptable

Canadian Reinforcing Bars

Index	Bar Designation	Diameter (mm)	Area (mm2)
1	10M	11.3	100.0
2	15M	16.0	200.0
3	20M	19.5	300.0
4	25M	25.2	500.0
5	30M	29.9	700.0
6	35M	35.7	1000.0
7	45M	43.7	1500.0
8	55M	56.4	2500.0

List of Messages

Message 17	Warning	fy of Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 18	Warning	fy of Shear Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 35	Warning	Area of Vertical Steel provided does not meet the Minimum. Clause 10.10.5 or 10.9.1 of A23.3

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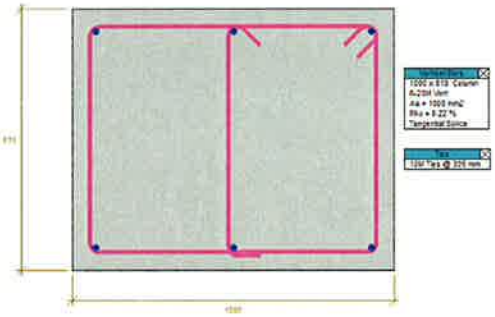

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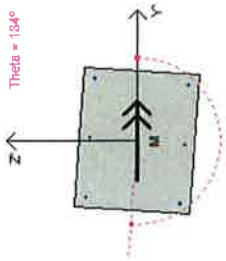

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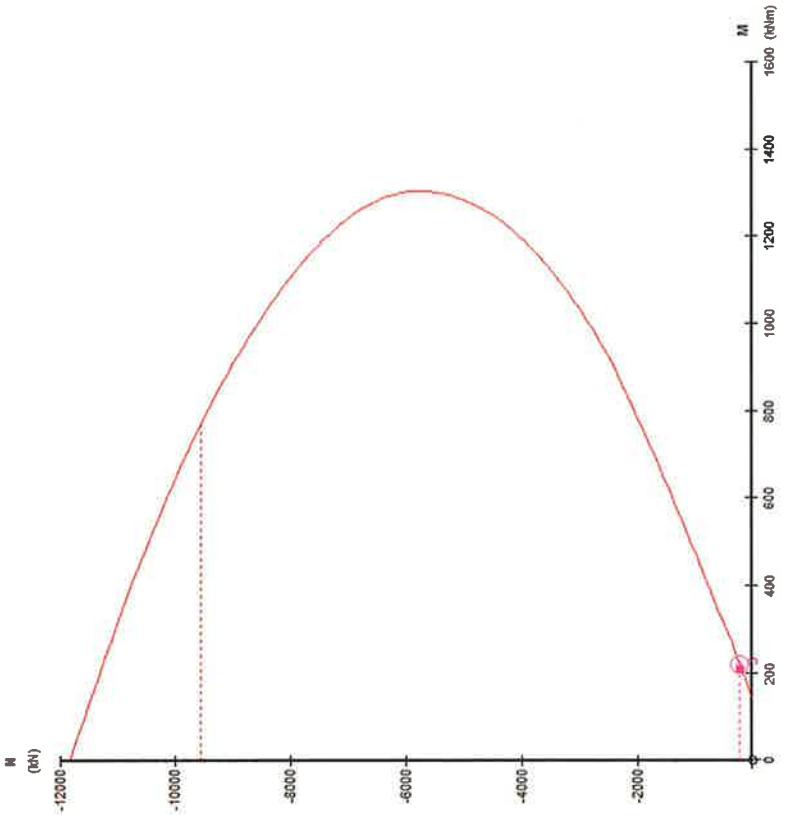

Concrete Section
1000 mm x 818 mm Column
6-20M Vert
Ag = 818000 mm2
As = 1800 mm
Rho = 0.22 %
fc' = 27 MPa
fy (vert) = 230.0 MPa

V_y N M_y M_z V_z

TABLE: Element Forces - Area Shells

Area	AreaElem	Joint	OutputCase	CaseType	StepType	F11	F22	F12	M11	M22	M12	V13	V23
Text	Text	Text	Text	Text	Text	KN/m	KN/m	KN/m	KN-m/m	KN-m/m	KN-m/m	KN/m	KN/m
1483	1483	1445	ULS1-2 full decker curb lanes	Combination	Max	-500.89	-1335.93	-217.48	4.2043	121.4292	37.3892	11.38	28.85
1483	1483	1446	ULS1-2 full decker curb lanes	Combination	Max	-60.65	-1260.18	-264.83	21.1834	82.239	28.7539	10.97	30.07
1483	1483	1452	ULS1-2 full decker curb lanes	Combination	Max	-5.69	-973.17	-185.93	23.0887	125.443	16.8569	12	1.14
1483	1483	1451	ULS1-2 full decker curb lanes	Combination	Max	-448.42	-1049.27	-138.69	3.0839	135.2702	26.5514	12.62	-0.07224
1483	1483	1445	ULS1-2 full decker curb lanes	Combination	Min	-550.19	-1423.85	-238.66	-4.7299	23.8405	4.7004	2.48	-3.9
1483	1483	1446	ULS1-2 full decker curb lanes	Combination	Min	-82.25	-1344.44	-289.36	5.3292	25.8144	-0.3955	5.07	-3.47
1483	1483	1452	ULS1-2 full decker curb lanes	Combination	Min	-25.27	-1054.65	-207.95	8.0388	39.5727	-2.651	5.7	-8.45
1483	1483	1451	ULS1-2 full decker curb lanes	Combination	Min	-489.31	-1133.4	-157.19	-2.7701	32.9672	2.4902	2.56	-8.87
1518	1518-1	1475	ULS1-2 full decker curb lanes	Combination	Max	-9.5	-365.81	133.53	16.3214	150.3896	-7.2951	0.62	-32.38
1518	1518-1	1476	ULS1-2 full decker curb lanes	Combination	Max	-34.69	-368.03	144.26	34.7095	198.7042	-13.1417	-7.2	-32.54
1518	1518-1	~1212	ULS1-2 full decker curb lanes	Combination	Max	-26.26	-335.64	49.49	16.9845	206.5043	-13.8022	-6.84	-35.33
1518	1518-1	~1211	ULS1-2 full decker curb lanes	Combination	Max	-0.46	-333.46	38.66	7.6171	156.9454	-7.5747	0.98	-35.16
1518	1518-1	1475	ULS1-2 full decker curb lanes	Combination	Min	-14.61	-427.88	113.16	7.8703	64.1649	-14.9409	-5.29	-48.09
1518	1518-1	1476	ULS1-2 full decker curb lanes	Combination	Min	-41.62	-431.36	122.37	18.2807	98.1262	-22.1957	-17.88	-48.55
1518	1518-1	~1212	ULS1-2 full decker curb lanes	Combination	Min	-36.58	-406.61	27.87	9.0096	106.5235	-24.0973	-17.45	-49.78
1518	1518-1	~1211	ULS1-2 full decker curb lanes	Combination	Min	-10.67	-403.55	19.24	4.2001	69.5085	-16.3946	-4.86	-49.32
1518	1518-2	~1211	ULS1-2 full decker curb lanes	Combination	Max	-34.61	-342.96	16.35	8.3988	157.0892	-7.5834	-0.67	-35.19
1518	1518-2	~1212	ULS1-2 full decker curb lanes	Combination	Max	-0.77	-335.68	22.61	27.5706	208.22	-14.2042	-21.34	-35.66
1518	1518-2	1482	ULS1-2 full decker curb lanes	Combination	Max	23.38	-213.91	88.98	-2.7529	222.9413	-14.2245	-20.44	-42.29
1518	1518-2	1481	ULS1-2 full decker curb lanes	Combination	Max	-9.1	-221.05	83.07	-0.5933	160.336	-6.6702	0.23	-41.82
1518	1518-2	~1211	ULS1-2 full decker curb lanes	Combination	Min	-36.76	-413.39	2.37	4.4989	69.6168	-16.7554	-3.94	-48.16
1518	1518-2	~1212	ULS1-2 full decker curb lanes	Combination	Min	-4.41	-405.43	5.41	17.0202	108.0507	-25.9599	-33.43	-48.73
1518	1518-2	1482	ULS1-2 full decker curb lanes	Combination	Min	19.44	-296.85	78.03	-2.9938	118.1611	-26.6286	-32.08	-59.82
1518	1518-2	1481	ULS1-2 full decker curb lanes	Combination	Min	-15.61	-304.87	74.53	-1.011	72.8289	-16.0193	-2.58	-59.25

Fully Laden Double Decker — 2 Curb Lanes

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S-CONCRETE 11.00.31 (c) S-FRAME Software Inc.

File Name: G:\sconcrete-15940\wall.SCO

Summary	
Status	Borderline
Maximum	1.000
V & T Util	0.214
N vs M Util	1.023

Section Name
Concrete Section

Consultant
Morrison Hershfield

Canadian Building Standards
CSA Standard A23.3-04, "Design of Concrete Structures"
CSA Standard A23.1-04, "Concrete Materials and Methods of Concrete Construction"

Design Aids, Manuals, and Handbooks
"Concrete Design Handbook", Cement Association of Canada, 3rd Edition, 2006
"Prestressed Concrete Structures", Collins and Mitchell, Prentice Hall Inc., 1991 (MCFT)

Section Dimensions
Rectangular Column
b = 1000 mm
h = 818 mm

Quantities (approx.)
Concrete = 1959 kg/m
Steel = 24.5 kg/m
Primary = 14.1 kg/m
Secondary = 10.3 kg/m

Material Properties
fc' = 27 MPa
fy (vert) = 230.0 MPa
fy (ties) = 230.0 MPa
Wc = 2400 kg/m3
Ws = 7850 kg/m3
Poisson's Ratio = 0.2
hagg = 20 mm
Es = 200000 MPa
Ec = 28165 MPa
Gc = 11735 MPa
fr = 3.12 MPa

Gross Properties
Zbar = 0 mm
Ybar = 0 mm
Ag = 818000 mm2
Ig (y-y) = 45612xE6 mm4
Ig (z-z) = 68167xE6 mm4
Ashear (Y) = 681667 mm2
Ashear (Z) = 681667 mm2
Jg = 92327xE6 mm4

Effective Properties
Ae = 818000 mm2
Ie (y-y) = 45612xE6 mm4
Ie (z-z) = 68167xE6 mm4
Ase (Y) = 681667 mm2
Ase (Z) = 681667 mm2
Je = 92327xE6 mm4

Vertical Bars
1000 x 818 Column
6-20M Vert
As = 1800 mm2
Rho = 0.22 %
Tangential Splice

Ties
10M Ties @ 305 mm
Legs (Z-Direction) = 3
Legs (Y-Direction) = 2

Miscellaneous
Clear Cover = 50 mm

Factored Input Loads

Load Case/Combo	N (kN)	T (kNm)	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Comment
1	-1260.2	0.0	30.1	82.2	-60.7	28.8	
2	-1344.4	0.0	-3.5	25.8	-82.3	-0.4	
3	-213.9	0.0	-42.3	222.9	23.4	-14.2	
4	-296.9	0.0	-59.8	118.2	19.4	-26.6	
5	-1344.4	0.0	-3.5	25.8	-82.3	-0.4	** Alt. Min. Moment - LC# 2

Factored Design Loads (with Minimum Moments):

Load Case/Combo	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Mres (kNm)	Theta
1	30.1	82.2	-60.7	28.8	87.1	161°
2	-3.5	53.2	-82.3	-0.4	53.2	180°
3	-42.3	222.9	23.4	-14.2	223.4	184°
4	-59.8	118.2	19.4	-26.6	121.1	193°
5	-3.5	25.8	-82.3	-60.5	65.8	247°

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N vs M Results			Axial Utilization	Moment Utilization	
GLC	#3		Nf = -213.9 kN	Mf = 223.4 kNm	Mn = 245.5 kNm
Status	Borderline	Message 1	Nr (max) = -9557.9 kN	Mr = 218.4 kNm	Mp = 283.9 kNm
Utilization	1.023		Utilization = 0.022	Utilization = 1.023	
Maximum	1.000				
Theta	184°				

Shear and Torsion Utilization		Shear Z-Direction	Shear Y-Direction	Torsion
GLC	2	bw = 1000 mm	bw = 818 mm	Tcr = 236.2 kNm
Nf	-1344.4 kN	dv = 674 mm	dv = 720 mm	Tf = 0.0 kNm < 0.25 Tcr
Vfz / Vrz	0.007	As (Tens) = 896 mm2	As (Tens) = 1197 mm2	Ignore Torsional Effects
Vfy / Vry	0.207	Av = 300 mm2	Av = 200 mm2	
Status	Acceptable	Lambda = 1.00	Lambda = 1.00	
Utilization	0.214	Mf (y-y) = 53.2 kNm	Mf (z-z) = -0.4 kNm	
Maximum	1.000	Vfz = 3.5 kN	Vfy = 82.3 kN	
Method	Simplified	Vsz = 185.0 kN	Vsy = 131.8 kN	
		Vcz = 312.7 kN	Vcy = 266.0 kN	
		Vrz = 497.7 kN	Vry = 397.8 kN	
		Beta = 0.137	Beta = 0.134	
		Theta = 35.0°	Theta = 35.0°	

Tie Spacing for Shear/Torsion		Maximum Shear Stress	
Spacing	305.0 mm	Stress	0.140 MPa
Maximum	818.0 mm	Maximum	4.388 MPa
Status	Acceptable	Status	Acceptable

Tie Spacing		Tie Diameter	
S	305 mm	Diam.	11.3 mm
S (max)	312 mm	Diam. (min)	5.9 mm
Status	Acceptable	Status	Acceptable

Vertical Steel Area		Status	As/Ag
As	1800 mm2	Message 35	0.22 %
As (min)	8180 mm2	Warning	1.00 %
As (max)	32720 mm2	Acceptable	4.00 %

Vertical Bar Splice Type	
Tangential Splice	
Status	Acceptable

Vertical Bar Spacing		Vertical Bar Diameter		Minimum Number of Vertical Bars	
Ny	3 Specified	db (vert)	19.5 mm	#Bars	6 Specified
Ny (max)	13.4 Allowed	db (min)	16.0 mm	#Bars	4 Required
Nz	2 Specified	Status	Acceptable	Status	Acceptable
Nz (max)	10.8 Allowed				
Status	Acceptable				

Vertical Reinforcing			Horizontal Reinforcing		
fy (min)	300.0 MPa		fy (min)	300.0 MPa	
fy (vert)	230.0 MPa		fy (horz)	230.0 MPa	
fy (max)	500.0 MPa		fy (max)	500.0 MPa	
Status	Warning	Message 17	Status	Warning	Message 18

Concrete Strength		Concrete Density	
fc' (min)	20.0 MPa	Wc (min)	1500.0 kg/m3

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fc'	27.0 MPa	Wc	2400.0 kg/m3
fc' (max)	80.0 MPa	Wc (max)	2500.0 kg/m3
Status	Acceptable	Status	Acceptable

Canadian Reinforcing Bars

Index	Bar Designation	Diameter (mm)	Area (mm2)
1	10M	11.3	100.0
2	15M	16.0	200.0
3	20M	19.5	300.0
4	25M	25.2	500.0
5	30M	29.9	700.0
6	35M	35.7	1000.0
7	45M	43.7	1500.0
8	55M	56.4	2500.0

List of Messages

Message 1	Borderline	Axial Load and Moment Utilization equals or exceeds Maximum. Clauses 10.1, 10.10, or 14.2.2 of A23.3
Message 17	Warning	fy of Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 18	Warning	fy of Shear Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 35	Warning	Area of Vertical Steel provided does not meet the Minimum. Clause 10.10.5 or 10.9.1 of A23.3

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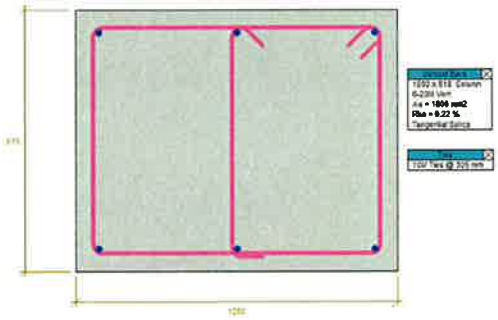

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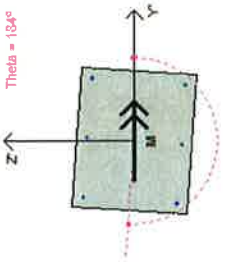

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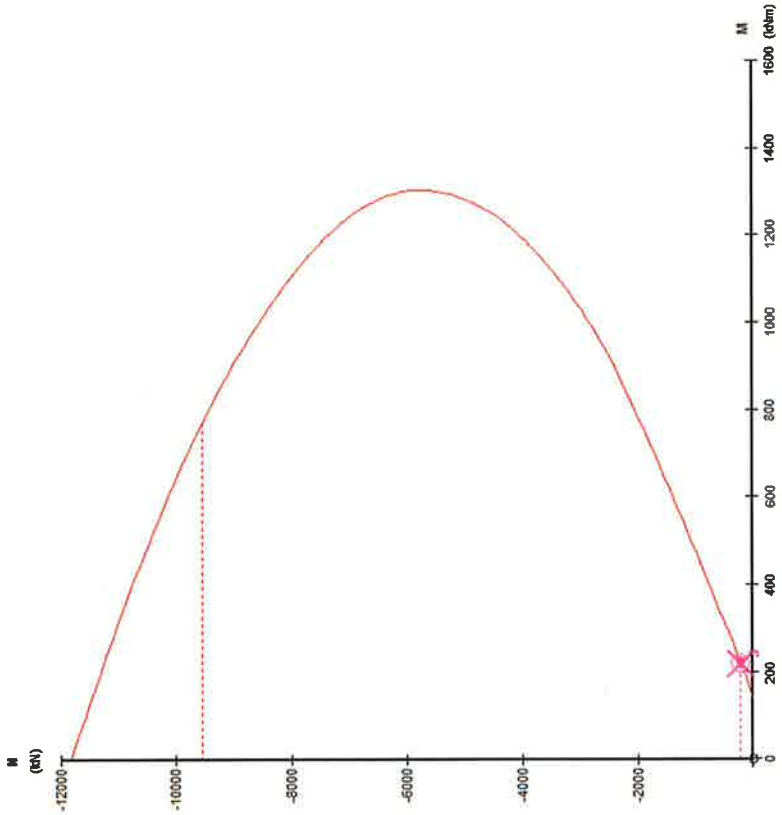

Concrete Section
1000 mm x 818 mm Column
6-20M Vert
Ag = 818000 mm2
As = 1800 mm
Rho = 0.22 %
fc' = 27 MPa
fy (vert) = 230.0 MPa

V_y N M_y M_z V_z

TABLE: Element Forces - Area Shells

Area	AreaElem	Joint	OutputCase	CaseType	StepType	F11	F22	F12	M11	M22	M12	V13	V23
Text	Text	Text	Text	Text	Text	KN/m	KN/m	KN/m	KN-m/m	KN-m/m	KN-m/m	KN/m	KN/m
1483	1483	1445	uls1- 2 unladen curb lanes	Combination	Max	-505.44	-1337.94	-219.5	3.1584	109.3156	33.45	10.26	24.64
1483	1483	1446	uls1- 2 unladen curb lanes	Combination	Max	-63.15	-1261.97	-266.97	19.504	75.3456	25.2357	10.28	25.76
1483	1483	1452	uls1- 2 unladen curb lanes	Combination	Max	-7.44	-974.18	-188.51	21.4586	114.8451	14.5042	11.22	-0.21
1483	1483	1451	uls1- 2 unladen curb lanes	Combination	Max	-451.63	-1050.41	-141.11	2.5245	122.3661	23.6915	11.36	-1.32
1483	1483	1445	uls1- 2 unladen curb lanes	Combination	Min	-542.32	-1403.61	-235.38	-3.5231	36.7158	9.1354	3.65	0.31
1483	1483	1446	uls1- 2 unladen curb lanes	Combination	Min	-79.29	-1324.9	-285.37	7.6793	33.3459	3.5705	5.86	0.84
1483	1483	1452	uls1- 2 unladen curb lanes	Combination	Min	-22.04	-1034.92	-205.02	10.2529	50.9626	0.0056	6.51	-7.32
1483	1483	1451	uls1- 2 unladen curb lanes	Combination	Min	-482.17	-1113.1	-154.99	-1.8556	46.2584	5.7904	3.89	-7.85
1518	1518-1	1475	uls1- 2 unladen curb lanes	Combination	Max	-10.45	-368.74	130.81	15.0403	138.4035	-8.0377	-0.2	-33.9
1518	1518-1	1476	uls1- 2 unladen curb lanes	Combination	Max	-35.24	-371.03	141.31	32.2642	184.3543	-13.9178	-8.55	-34.1
1518	1518-1	~1212	uls1- 2 unladen curb lanes	Combination	Max	-27.6	-339.97	47.29	15.7346	191.9552	-14.7239	-8.19	-36.58
1518	1518-1	~1211	uls1- 2 unladen curb lanes	Combination	Max	-2.36	-337.7	36.71	7.0376	144.6625	-8.467	0.16	-36.37
1518	1518-1	1475	uls1- 2 unladen curb lanes	Combination	Min	-14.25	-414.86	115.66	8.7444	74.2737	-13.7332	-4.6	-45.6
1518	1518-1	1476	uls1- 2 unladen curb lanes	Combination	Min	-40.38	-418.09	125.06	20.0311	109.5465	-20.6616	-16.49	-46.02
1518	1518-1	~1212	uls1- 2 unladen curb lanes	Combination	Min	-35.29	-392.85	31.23	9.7939	117.589	-22.3936	-16.08	-47.34
1518	1518-1	~1211	uls1- 2 unladen curb lanes	Combination	Min	-9.94	-389.93	22.3	4.492	79.6291	-15.0367	-4.19	-46.91
1518	1518-2	~1211	uls1- 2 unladen curb lanes	Combination	Max	-34.72	-347.18	14.98	7.7498	144.8006	-8.5147	-1.03	-36.24
1518	1518-2	~1212	uls1- 2 unladen curb lanes	Combination	Max	-1	-339.86	20.87	25.8687	193.621	-15.3164	-22.5	-36.72
1518	1518-2	1482	uls1- 2 unladen curb lanes	Combination	Max	22.55	-221.27	87.02	-2.7655	207.5192	-15.421	-21.55	-43.79
1518	1518-2	1481	uls1- 2 unladen curb lanes	Combination	Max	-10.17	-228.48	81.38	-0.6493	147.9546	-7.6422	-0.0874	-43.31
1518	1518-2	~1211	uls1- 2 unladen curb lanes	Combination	Min	-36.31	-399.66	4.58	4.844	79.7407	-15.3457	-3.46	-45.89
1518	1518-2	~1212	uls1- 2 unladen curb lanes	Combination	Min	-3.71	-391.83	8.09	18.0154	119.1145	-24.072	-31.5	-46.45
1518	1518-2	1482	uls1- 2 unladen curb lanes	Combination	Min	19.63	-283.15	78.84	-2.9461	129.5809	-24.6618	-30.22	-56.84
1518	1518-2	1481	uls1- 2 unladen curb lanes	Combination	Min	-15	-291.02	75	-0.96	82.8674	-14.6045	-2.18	-56.28

Unladen Double Decker — 2 Curb Lanes

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File Name: G:\sconcrete-15940\wall.SCO

Summary	
Status	Warning
Maximum	1.000
V & T Util	0.211
N vs M Util	0.941

Section Name
Concrete Section

Consultant
Morrison Hershfield

Canadian Building Standards
CSA Standard A23.3-04, "Design of Concrete Structures"
CSA Standard A23.1-04, "Concrete Materials and Methods of Concrete Construction"

Design Aids, Manuals, and Handbooks
"Concrete Design Handbook", Cement Association of Canada, 3rd Edition, 2006
"Prestressed Concrete Structures", Collins and Mitchell, Prentice Hall Inc., 1991 (MCFT)

Section Dimensions
Rectangular Column
b = 1000 mm
h = 818 mm

Quantities (approx.)
Concrete = 1959 kg/m
Steel = 24.5 kg/m
Primary = 14.1 kg/m
Secondary = 10.3 kg/m

Material Properties
fc' = 27 MPa
fy (vert) = 230.0 MPa
fy (ties) = 230.0 MPa
Wc = 2400 kg/m3
Ws = 7850 kg/m3
Poisson's Ratio = 0.2
hagg = 20 mm
Es = 200000 MPa
Ec = 28165 MPa
Gc = 11735 MPa
fr = 3.12 MPa

Gross Properties
Zbar = 0 mm
Ybar = 0 mm
Ag = 818000 mm2
Ig (y-y) = 45612xE6 mm4
Ig (z-z) = 68167xE6 mm4
Ashear (Y) = 681667 mm2
Ashear (Z) = 681667 mm2
Jg = 92327xE6 mm4

Effective Properties
Ae = 818000 mm2
Ie (y-y) = 45612xE6 mm4
Ie (z-z) = 68167xE6 mm4
Ase (Y) = 681667 mm2
Ase (Z) = 681667 mm2
Je = 92327xE6 mm4

Vertical Bars
1000 x 818 Column
6-20M Vert
As = 1800 mm2
Rho = 0.22 %
Tangential Splice

Ties
10M Ties @ 305 mm
Legs (Z-Direction) = 3
Legs (Y-Direction) = 2

Miscellaneous
Clear Cover = 50 mm

Factored Input Loads

Load Case/Combo	N (kN)	T (kNm)	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Comment
1	-1262.0	0.0	25.8	75.3	-63.2	25.2	
2	-1324.9	0.0	0.8	33.3	-79.3	3.6	
3	-221.3	0.0	-43.8	207.5	22.6	-15.4	
4	-283.2	0.0	-56.8	129.6	19.3	-24.7	
5	-1324.9	0.0	0.8	33.3	-79.3	3.6	** Alt. Min. Moment - LC# 2

Factored Design Loads (with Minimum Moments):

Load Case/Combo	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Mres (kNm)	Theta
1	25.8	75.3	-63.2	25.2	79.4	161°
2	0.8	52.4	-79.3	3.6	52.5	176°
3	-43.8	207.5	22.6	-15.4	208.1	184°
4	-56.8	129.6	19.3	-24.7	131.9	191°
5	0.8	33.3	-79.3	59.6	68.3	119°

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N vs M Results		Axial Utilization	Moment Utilization	
GLC	#3	Nf = -221.3 kN	Mf = 208.1 kNm	Mn = 248.2 kNm
Status	Acceptable	Nr (max) = -9557.9 kN	Mr = 221.1 kNm	Mp = 286.6 kNm
Utilization	0.941	Utilization = 0.023	Utilization = 0.941	
Maximum	1.000			
Theta	184°			

Shear and Torsion Utilization		Shear Z-Direction	Shear Y-Direction	Torsion
GLC	1	bw = 1000 mm	bw = 818 mm	Tcr = 236.2 kNm
Nf	-1262.0 kN	dv = 664 mm	dv = 720 mm	Tf = 0.0 kNm < 0.25 Tcr
Vfz / Vrz	0.052	As (Tens) = 924 mm2	As (Tens) = 1216 mm2	Ignore Torsional Effects
Vfy / Vry	0.159	Av = 300 mm2	Av = 200 mm2	
Status	Acceptable	Lambda = 1.00	Lambda = 1.00	
Utilization	0.211	Mf (y-y) = 75.3 kNm	Mf (z-z) = 25.2 kNm	
Maximum	1.000	Vfz = 25.8 kN	Vfy = 63.2 kN	
Method	Simplified	Vsz = 182.4 kN	Vsy = 131.8 kN	
		Vcz = 310.1 kN	Vcy = 266.0 kN	
		Vrz = 492.5 kN	Vry = 397.8 kN	
		Beta = 0.138	Beta = 0.134	
		Theta = 35.0°	Theta = 35.0°	

Tie Spacing for Shear/Torsion		Maximum Shear Stress	
Spacing	305.0 mm	Stress	0.135 MPa
Maximum	818.0 mm	Maximum	4.388 MPa
Status	Acceptable	Status	Acceptable

Tie Spacing		Tie Diameter	
S	305 mm	Diam.	11.3 mm
S (max)	312 mm	Diam. (min)	5.9 mm
Status	Acceptable	Status	Acceptable

Vertical Steel Area		Status	As/Ag
As	1800 mm2	Message 35	0.22 %
As (min)	8180 mm2	Warning	1.00 %
As (max)	32720 mm2	Acceptable	4.00 %

Vertical Bar Splice Type	
Tangential Splice	
Status	Acceptable

Vertical Bar Spacing		Vertical Bar Diameter		Minimum Number of Vertical Bars	
Ny	3 Specified	db (vert)	19.5 mm	#Bars	6 Specified
Ny (max)	13.4 Allowed	db (min)	16.0 mm	#Bars	4 Required
Nz	2 Specified	Status	Acceptable	Status	Acceptable
Nz (max)	10.8 Allowed				
Status	Acceptable				

Vertical Reinforcing			Horizontal Reinforcing		
fy (min)	300.0 MPa		fy (min)	300.0 MPa	
fy (vert)	230.0 MPa		fy (horz)	230.0 MPa	
fy (max)	500.0 MPa		fy (max)	500.0 MPa	
Status	Warning	Message 17	Status	Warning	Message 18

Concrete Strength		Concrete Density	
fc' (min)	20.0 MPa	Wc (min)	1500.0 kg/m3

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fc'	27.0 MPa	Wc	2400.0 kg/m3
fc' (max)	80.0 MPa	Wc (max)	2500.0 kg/m3
Status	Acceptable	Status	Acceptable

Canadian Reinforcing Bars

Index	Bar Designation	Diameter (mm)	Area (mm2)
1	10M	11.3	100.0
2	15M	16.0	200.0
3	20M	19.5	300.0
4	25M	25.2	500.0
5	30M	29.9	700.0
6	35M	35.7	1000.0
7	45M	43.7	1500.0
8	55M	56.4	2500.0

List of Messages

Message 17	Warning	fy of Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 18	Warning	fy of Shear Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 35	Warning	Area of Vertical Steel provided does not meet the Minimum. Clause 10.10.5 or 10.9.1 of A23.3

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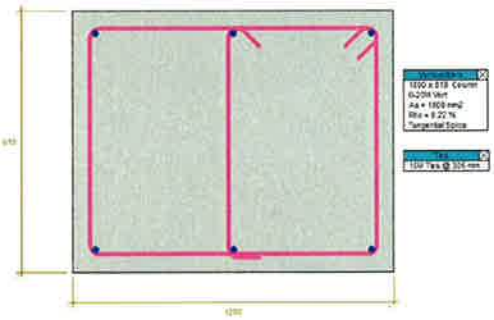

Morrison Hershfield
admin
Ph: 555-1234 Fax: 555-4321

#100 - 1234 Anywhere Place
AnyCity, AnyState
AnyCountry

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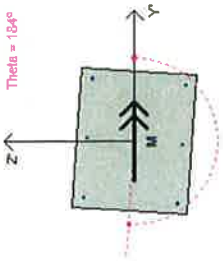

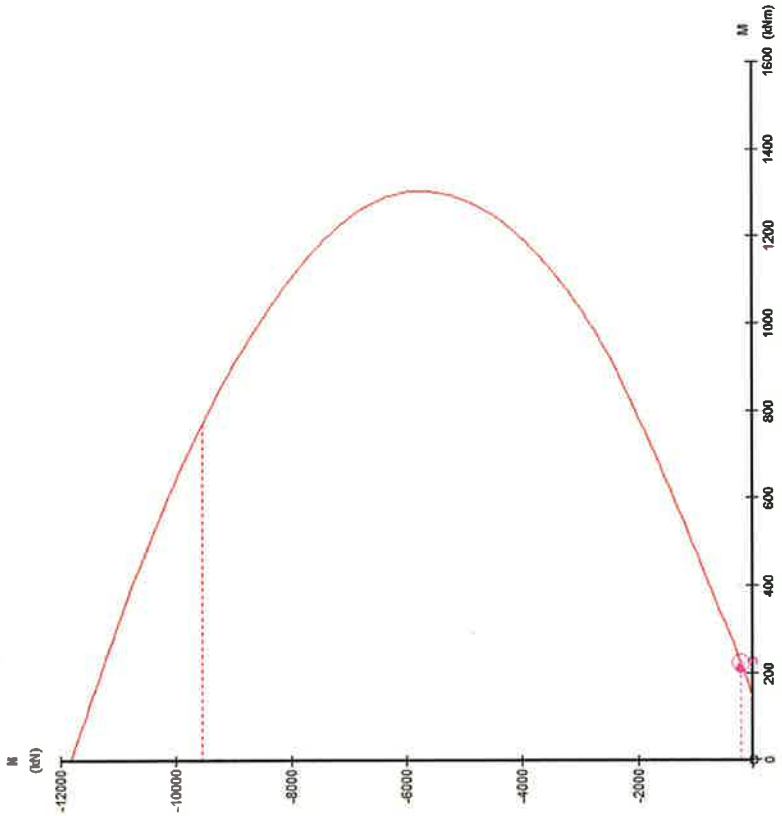

Concrete Section
1000 mm x 818 mm Column
6-20M Vert
Ag = 818000 mm2
As = 1800 mm
Rho = 0.22 %
f'c = 27 MPa
fy (vert) = 230.0 MPa

V_y N M_y M_z V_z

TABLE: Element Forces - Area Shells													
Area	AreaElem	Joint	OutputCase	CaseType	StepType	F11	F22	F12	M11	M22	M12	V13	V23
Text	Text	Text	Text	Text	Text	KN/m	KN/m	KN/m	KN-m/m	KN-m/m	KN-m/m	KN/m	KN/m
1483	1483	1445	ULS1 CASE7	Combination	Max	-495.72	-1333.07	-219.05	7.6387	140.408	44.2031	12.58	35.03
1483	1483	1446	ULS1 CASE7	Combination	Max	-49.37	-1257.47	-266.42	24.3493	93.2041	35.004	12.19	36.41
1483	1483	1452	ULS1 CASE7	Combination	Max	7.17	-970.51	-187.86	25.8894	141.5044	21.1344	12.98	2.73
1483	1483	1451	ULS1 CASE7	Combination	Max	-442.51	-1046.55	-140.48	4.6568	154.223	31.6698	14.05	1.36
1483	1483	1445	ULS1 CASE7	Combination	Min	-605.25	-1506.06	-258.58	-6.0835	5.5673	-2.3436	1.67	-12.17
1483	1483	1446	ULS1 CASE7	Combination	Min	-97.36	-1421.38	-313.65	2.6708	17.268	-7.8133	5.09	-11.91
1483	1483	1452	ULS1 CASE7	Combination	Min	-33.84	-1105.25	-228.63	7.4629	27.8639	-7.9434	5.9	-11.05
1483	1483	1451	ULS1 CASE7	Combination	Min	-535.52	-1186.46	-172.79	-2.9339	16.8063	-2.767	1.38	-11.31
1518	1518-1	1475	ULS1 CASE7	Combination	Max	-9.91	-358.29	132.6	16.9802	162.9241	-6.995	0.8	-31.34
1518	1518-1	1476	ULS1 CASE7	Combination	Max	-33.47	-360.3	144.06	36.4861	212.3935	-12.5954	-6.6	-31.49
1518	1518-1	~1212	ULS1 CASE7	Combination	Max	-24.28	-324.47	48.16	17.6339	219.5783	-13.2428	-6.25	-34.28
1518	1518-1	~1211	ULS1 CASE7	Combination	Max	-0.26	-322.47	37.16	7.7163	169.3832	-7.2334	1.15	-34.13
1518	1518-1	1475	ULS1 CASE7	Combination	Min	-16.88	-422.03	113.55	7.6649	56.2189	-15.3361	-6.3	-49.59
1518	1518-1	1476	ULS1 CASE7	Combination	Min	-42.24	-425.06	122.39	17.3137	89.5696	-22.5142	-19.63	-50.11
1518	1518-1	~1212	ULS1 CASE7	Combination	Min	-36.54	-394.3	27.03	8.4875	97.9721	-24.6265	-19.2	-50.81
1518	1518-1	~1211	ULS1 CASE7	Combination	Min	-11.51	-391.48	18.56	4.0448	61.5788	-17.0063	-5.88	-50.28
1518	1518-2	~1211	ULS1 CASE7	Combination	Max	-34.5	-332.18	15.28	8.53	169.5234	-7.1801	-0.62	-34.22
1518	1518-2	~1212	ULS1 CASE7	Combination	Max	-0.84	-324.63	21.26	28.4222	221.2824	-13.6059	-20.5	-34.69
1518	1518-2	1482	ULS1 CASE7	Combination	Max	24.33	-198.86	87.88	-2.7282	236.2601	-13.571	-19.64	-41.01
1518	1518-2	1481	ULS1 CASE7	Combination	Max	-8.68	-206.3	81.86	-0.4743	172.587	-6.2511	0.25	-40.55
1518	1518-2	~1211	ULS1 CASE7	Combination	Min	-38.08	-401.41	1.49	4.3098	61.6958	-17.4377	-4.17	-48.93
1518	1518-2	~1212	ULS1 CASE7	Combination	Min	-4.39	-393.7	4.22	16.3504	99.5042	-26.7358	-34.55	-49.52
1518	1518-2	1482	ULS1 CASE7	Combination	Min	19.42	-282.16	77.2	-3.0016	109.2248	-27.5242	-33.15	-60.99
1518	1518-2	1481	ULS1 CASE7	Combination	Min	-15.64	-290	74.13	-1.1221	64.9933	-16.7758	-2.78	-60.4

2 Fully Laden Double Deckers in 2 WBLs

2 UnLaden Double Deckers in 2 EBLs

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File Name: G:\sconcrete-15940\wall.SCO

Summary

Status	Unacceptable
Maximum	1.000
V & T Util	0.268
N vs M Util	1.116

Section Name Concrete Section

Consultant Morrison Hershfield

Canadian Building Standards

CSA Standard A23.3-04, "Design of Concrete Structures"

CSA Standard A23.1-04, "Concrete Materials and Methods of Concrete Construction"

Design Aids, Manuals, and Handbooks

"Concrete Design Handbook", Cement Association of Canada, 3rd Edition, 2006

"Prestressed Concrete Structures", Collins and Mitchell, Prentice Hall Inc., 1991 (MCFT)

Section Dimensions

Rectangular Column
b = 1000 mm
h = 818 mm

Quantities (approx.)

Concrete = 1959 kg/m
Steel = 24.5 kg/m
Primary = 14.1 kg/m
Secondary = 10.3 kg/m

Material Properties

fc' = 27 MPa
fy (vert) = 230.0 MPa
fy (ties) = 230.0 MPa
Wc = 2400 kg/m3
Ws = 7850 kg/m3
Poisson's Ratio = 0.2
hagg = 20 mm
Es = 200000 MPa
Ec = 28165 MPa
Gc = 11735 MPa
fr = 3.12 MPa

Gross Properties

Zbar = 0 mm
Ybar = 0 mm
Ag = 818000 mm2
Ig (y-y) = 45612xE6 mm4
Ig (z-z) = 68167xE6 mm4
Ashear (Y) = 681667 mm2
Ashear (Z) = 681667 mm2
Jg = 92327xE6 mm4

Effective Properties

Ae = 818000 mm2
Ie (y-y) = 45612xE6 mm4
Ie (z-z) = 68167xE6 mm4
Ase (Y) = 681667 mm2
Ase (Z) = 681667 mm2
Je = 92327xE6 mm4

Vertical Bars

1000 x 818 Column
6-20M Vert
As = 1800 mm2
Rho = 0.22 %
Tangential Splice

Ties

10M Ties @ 305 mm
Legs (Z-Direction) = 3
Legs (Y-Direction) = 2

Miscellaneous

Clear Cover = 50 mm

Factored Input Loads

Load Case/Combo	N (kN)	T (kNm)	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Comment
1	-1257.5	0.0	36.4	93.2	-49.4	35.0	
2	-1421.4	0.0	-11.9	17.3	-97.4	-7.8	
3	-198.9	0.0	-41.0	236.3	24.3	-13.6	
4	-282.2	0.0	-61.0	109.2	19.4	-27.5	
5	-1421.4	0.0	-11.9	17.3	-97.4	-7.8	** Alt. Min. Moment - LC# 2

Factored Design Loads (with Minimum Moments):

Load Case/Combo	Vz (kN)	My (kNm)	Vy (kN)	Mz (kNm)	Mres (kNm)	Theta
1	36.4	93.2	-49.4	35.0	99.6	159°
2	-11.9	56.2	-97.4	-7.8	56.7	188°
3	-41.0	236.3	24.3	-13.6	236.6	183°
4	-61.0	109.2	19.4	-27.5	112.6	194°
5	-11.9	17.3	-97.4	-64.0	66.3	255°

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N vs M Results			Axial Utilization	Moment Utilization	
GLC	#3		Nf = -198.9 kN	Mf = 236.6 kNm	Mn = 239.7 kNm
Status	Unacceptable	Message 1	Nr (max) = -9557.9 kN	Mr = 212.1 kNm	Mp = 278.2 kNm
Utilization	1.116		Utilization = 0.021	Utilization = 1.116	
Maximum	1.000				
Theta	183°				

Shear and Torsion Utilization		Shear Z-Direction	Shear Y-Direction	Torsion
GLC	2	bw = 1000 mm	bw = 818 mm	Tcr = 236.2 kNm
Nf	-1421.4 kN	dv = 681 mm	dv = 720 mm	Tf = 0.0 kNm < 0.25 Tcr
Vfz / Vrz	0.024	As (Tens) = 874 mm2	As (Tens) = 1182 mm2	Ignore Torsional Effects
Vfy / Vry	0.245	Av = 300 mm2	Av = 200 mm2	
Status	Acceptable	Lambda = 1.00	Lambda = 1.00	
Utilization	0.268	Mf (y-y) = 56.2 kNm	Mf (z-z) = -7.8 kNm	
Maximum	1.000	Vfz = 11.9 kN	Vfy = 97.4 kN	
Method	Simplified	Vsz = 187.0 kN	Vsy = 131.8 kN	
		Vcz = 314.7 kN	Vcy = 266.0 kN	
		Vrz = 501.7 kN	Vry = 397.8 kN	
		Beta = 0.137	Beta = 0.134	
		Theta = 35.0°	Theta = 35.0°	

Tie Spacing for Shear/Torsion		Maximum Shear Stress	
Spacing	305.0 mm	Stress	0.166 MPa
Maximum	818.0 mm	Maximum	4.388 MPa
Status	Acceptable	Status	Acceptable

Tie Spacing		Tie Diameter	
S	305 mm	Diam.	11.3 mm
S (max)	312 mm	Diam. (min)	5.9 mm
Status	Acceptable	Status	Acceptable

Vertical Steel Area		Status	As/Ag
As	1800 mm2	Message 35	0.22 %
As (min)	8180 mm2	Warning	1.00 %
As (max)	32720 mm2	Acceptable	4.00 %

Vertical Bar Splice Type	
Tangential Splice	
Status	Acceptable

Vertical Bar Spacing		Vertical Bar Diameter		Minimum Number of Vertical Bars	
Ny	3 Specified	db (vert)	19.5 mm	#Bars	6 Specified
Ny (max)	13.4 Allowed	db (min)	16.0 mm	#Bars	4 Required
Nz	2 Specified	Status	Acceptable	Status	Acceptable
Nz (max)	10.8 Allowed				
Status	Acceptable				

Vertical Reinforcing			Horizontal Reinforcing		
fy (min)	300.0 MPa		fy (min)	300.0 MPa	
fy (vert)	230.0 MPa		fy (horz)	230.0 MPa	
fy (max)	500.0 MPa		fy (max)	500.0 MPa	
Status	Warning	Message 17	Status	Warning	Message 18

Concrete Strength		Concrete Density	
fc' (min)	20.0 MPa	Wc (min)	1500.0 kg/m3

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fc'	27.0 MPa	Wc	2400.0 kg/m3
fc' (max)	80.0 MPa	Wc (max)	2500.0 kg/m3
Status	Acceptable	Status	Acceptable

Canadian Reinforcing Bars

Index	Bar Designation	Diameter (mm)	Area (mm2)
1	10M	11.3	100.0
2	15M	16.0	200.0
3	20M	19.5	300.0
4	25M	25.2	500.0
5	30M	29.9	700.0
6	35M	35.7	1000.0
7	45M	43.7	1500.0
8	55M	56.4	2500.0

List of Messages

Message 1	Unacceptable	Axial Load and Moment Utilization equals or exceeds Maximum. Clauses 10.1, 10.10, or 14.2.2 of A23.3
Message 17	Warning	fy of Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 18	Warning	fy of Shear Reinforcing is not within an Acceptable range. Clause 8.5.1 of A23.3, 300 <= fy <= 500 MPa
Message 35	Warning	Area of Vertical Steel provided does not meet the Minimum. Clause 10.10.5 or 10.9.1 of A23.3

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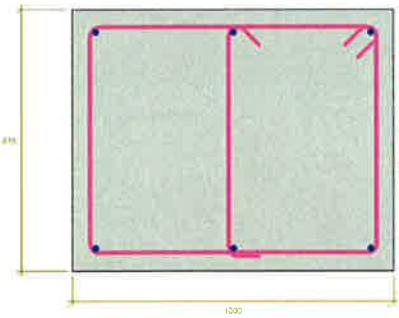

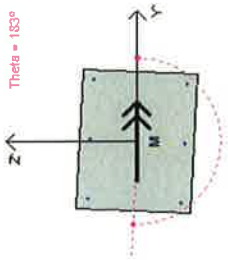

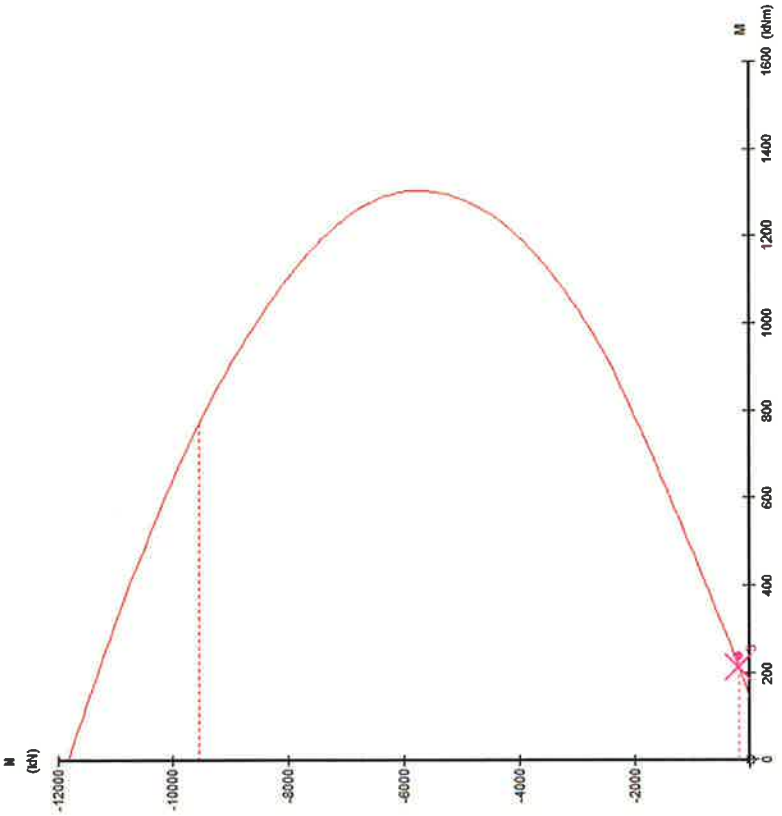

Concrete Section
1000 mm x 818 mm Column
8-20M Vert
Ag = 818000 mm2
As = 1800 mm
Rho = 0.22 %
fc' = 27 MPa
fy (vert) = 230.0 MPa

Summary											
Load Cases		Slab							Leg (Pier)		Load Carrying Capacity
		Negative M_f at pier (kNm/m)		M_f at mid-span in centre span (kNm/m)	M_f at mid-span in end span (kNm/m)	V_f at bearings (kN/m)	V_f at pier (kN/m)		M_r/M_f at bottom of haunch (kNm/m)	V_r/V_f at bottom of haunch (kN/m)	
		End side (M_{fl})	Centre side (M_{fr})				End side (V_{fl})	Centre side (V_{fr})			
Case 1	Fully laden Double Decker in 4 lanes	830	932	276.8	218	168	342	432	209.1/251.9	397.8/98.3	Not Capable
Case 2	Unladen Double Decker in 4 lanes	789	883	232.6	177	157	318	386	218.9/203.8	397.8/87.2	Capable
Case3	Fully laden Double Decker in 2 median lanes	769	895	240.5	179	141	392	427	215.0/217.5	397.8/92.9	Capable
Case 4	Unladen Double Decker in 2 median lanes	746	869	232.6	177	134	329	405	219.5/210.5	397.8/87.4	Capable
Case 5	Fully laden Double Decker in 2 curb lanes	Similar as case 3	Similar as case 3	Similar as case 3	Similar as case 3	Similar as case 3	Similar as case 3	Similar as case 3	218.4/223.4	397.8/82.3	Conditionaly Capable
Case 6	Unladen Double Decker in 2 curb lanes	Similar as case 4	Similar as case 4	Similar as case 4	Similar as case 4	Similar as case 4	Similar as case 4	Similar as case 4	221.1/208.1	397.8/63.2	Capable
Case 7	Fully loaded buses in both west bound lanes and unladen buses in both east bound lanes	Between case 1 & case 2	Between case 1 & case 2	Between case 1 & case 2	Between case 1 & case 2	Between case 1 & case 2	Between case 1 & case 2	Between case 1 & case 2	212.1/236.6	397.8/97.4	Not Capable
	Resistance (M_r)	1016.6	1092.9	467.5	519.6	364.4	570.8	611.8			