ISL Engineering and Land Services

Inspiring sustainable thinking

#503, 4190 Lougheed Hwy., Burnaby, BC V5C 6A8   T: 604.629.2696   F: 604.629.2698

CONFIDENTIAL

August 12, 2014

Our Reference: 31256

Sunshine Coast Regional District
1975 Field Road
Sechelt, BC V0N 3A1

Attention: Sam Adams, Parks Planning Coordinator

Dear Sir:

Reference: Sir Thomas Lipton Park Bridge Load Rating Report

Introduction

We are pleased to submit our report for the Sir Thomas Lipton Park Bridge Load Rating Program. This report will summarize our findings for the three timber pedestrian bridges located in Sir Thomas Lipton Park on Gambier Island: East Creek Bridge, MacDonald Creek Bridge and West Creek Bridge.

On August 6, 2014, ISL submitted the Field Bridge Inspection Forms and Photo Sheets for each of the structures inspected, outlining the various components inspected, their condition ratings and deficiencies.

According to the design drawings, the bridges were designed for pedestrian traffic only (5.0 kPa). At this time, approximately 75% of the lots on the island have been developed, including water and BC Hydro lines. The new development brought vehicular traffic onto these bridges, including sceptic tank trucks, 15-ton excavators, tandem trucks fully loaded with aggregate, and BC Hydro and Telus trucks; these vehicular loads are substantially larger than the designed pedestrian loads. The intent of this Load Rating Program is to report on the load carrying capacities of these bridges for such loading cases. Our findings and results from the structural computation or bridge analysis has been provided in Appendix A for East Creek Bridge and West Creek Bridge, and in Appendix B for MacDonald Creek Bridge.

East Creek Bridge and West Creek Bridge

Steelwork

The East and West Creek Bridges both have a similar structural composition. The steelwork was checked against the CAN/CSA-S6-06 for several vehicular loadings. For these bridges, a 15T excavator, an HS15 truck loading (maximum 53.4kN wheel loading) and an HS20 truck loading (maximum 71.2kN wheel loading) was analyzed and checked for capacity at ultimate limit state. An additional CL625 truck loading (maximum 87.5kN wheel loading) analysis was performed for these crossings as checks against the current loading under the latest bridge code.

The following table reflects the final outcome of the analysis. Any ratio of the Demand/Resistance under 1.0 for Bending and Shear is acceptable under Limit State Analysis. As observed, the loading with the CL625 truck (87.5kN wheel loads) meets the criteria. In short, the structural steelwork is capable of resisting CL625A Design Loads as shown in the following table.

Limit States Summary – Structural Steelwork

Member ID	Combination ID	Bending	Shear Vfy/Vry	Bending or Shear Reserves
18	6 - Pedestrian..	0.1224		
	10 - Dead Loads	0.1221		
	20 - DL + LL	0.3057		
	50 - DL+HS15	0.5424		
	51 - DL+Exc.Cat..	0.3388		
	52 - DL + CL625	0.7080		29.2%
	53 - DL+HS20	0.5424		
28	50 - DL+HS15		0.3911	
	51 - DL+Exc.Cat..		0.2307	
	52 - DL + CL625		0.5297	47.0%
	53 - DL+HS20		0.3911	

Timber Decking

The timber superstructure is the weakest link to the structure. At one time the steel grating performed a function for supporting the pedestrian live load, however the grating has since been replaced by a timber decking system. The system is composed of 102x300 treated timbers supported by the steel girders and a 102x300mm nailer board. The analysis was performed on the decking system and proved to be deficient in shear (Demand/Resistance = 1.45) when the wheel load is allowed to deviate from the top flange of the girder. Any loading off the centerline – in which case the wheel loads would not pass directly over the flanges of the girders – will result in a failure. The historical loading has been successful when the wheel loads were restricted to pass directly over the girders, for which the steelwork would govern.

MacDonald Creek Bridge

Steelwork

The MacDonald Creek Bridge is the longest of the three and was installed on a steep 8% grade. The steelwork was checked against the CAN/CSA-S6-06 for several vehicular loading. For this bridge a 15T excavator, an HS15 truck loading (maximum 53.4kN wheel loading) and an HS20 truck loading (maximum 71.2kN wheel loading) was analyzed and checked for capacity at ultimate limit state. An additional CL625 tuck loading (maximum 87.5kN wheel loading) analysis was performed for this crossing as a check against current loading under the latest bridge code.

The table on the following page reflects the final outcome of the analysis. Any ratio of the Demand/Resistance under 1.0 for Bending and Shear is acceptable under Limit State Analysis. As observed, the loading with the CL625 truck (87.5kN wheel loads) meets the criteria.

The table to follow illustrates that the bending resistance governs over the shear capacity. In short the structural steelwork is capable of resisting CL625A Design Loads as per the requirement of the CAN/CSA-S6-06 code.

Limit States Summary – Structural Steelwork

Memb ID	Combination ID	Bending	Shear Vfy/Vry	Bending or Shear Reserves
21	6 - Pedestrian..	0.1270		
	10 - Dead Loads	0.1490		
	20 - DL + LL	0.3394		
	50 - DL+HS15	0.6099		
	51 - DL+Exc.Cat..	0.4085		
	52 - DL + CL625	0.8607		13.9%
	53 - DL+HS20	0.6099		
29	20 - DL + LL		0.1764	
	50 - DL+HS15		0.3318	
	51 - DL+Exc.Cat..		0.2101	
	52 - DL + CL625		0.5191	48.1%
	53 - DL+HS20		0.3318	

Timber Decking

The timber superstructure is the weakest link to the structure. At one time the steel grating performed a function for supporting the pedestrian live load but since the original design, the grating has been replaced by a timber decking system. The system is composed of 102x300 treated timbers supported by the steel girders and a 102x300mm nailer board.

The analysis was performed on the decking system and proved to be deficient in shear (Demand/Resistance = 1.61) when the wheel load is allowed to deviate from the top flange of the girder. Any loading off the centerline – in which case the wheel loads would not pass directly over the flanges of the girders – will result in a failure. The historical loading has been successful when the wheel loads were restricted to pass directly over the girders, for which the steelwork would govern.

Closing Comments

As such, the vehicular traffic has caused some damage to the East Creek Bridge, MacDonald Creek Bridge and West Creek Bridge, with collision damage and deterioration to the deck, curbs and handrails, and vehicle tread marks on the timber planks. The timber damage is not considered a serious structural defect for pedestrian loads only, but unfortunately the timber system does not meet current standards and code for vehicular loading. Reiterating our previous concern, further use of these bridges by vehicular loading with the existing timber superstructure may result in liabilities and risk to the SCRD. We would also recommend posting a weight restriction at this time limiting passage over the bridges to pedestrian loads only.

The steelwork proved to be adequate for the minimum CL625A vehicular loading of the Canadian Highway Bridge Design Code - CAN/CSA-S6-06. Unfortunately the timber decking system seems to be restricting the load capacity on these bridges. For this reason, we suggest that a properly sized tie and planking timber decking system replace the existing system to upgrade the capacity for a compatible rating between the steelwork and the timber decking. The upgrade would be relatively inexpensive and would allow unrestricted vehicular use to meet the standards for vehicular traffic.

We thank you for the opportunity for this assignment. Please do not hesitate to contact the undersigned should you have any questions.

Yours truly,

ISL Engineering and Land Services Ltd.

K. Poliquin

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
D. R. ESTEY
15517
14/08/12

Karine Poliquin, E.I.T.
Project Engineer

Daniel R. Estey, P.Eng.
Bridge Engineering Manager

Attachments

KP/DRE

Appendix A

Structural Results – East Creek Bridge & West Creek Bridge

#503, 4190 Lougheed Hwy., Burnaby, BC V5C 6A8 T: 604.629.2696 F: 604.629.2698

To:	**Sunshine Coast Regional District**	Date:	**August 11, 2014**
Attention:	**Sam Adams, Parks Planning Coordinator**	Project No:	**31256**
Cc:	**Karine Poliquin, EIT**		
Reference:	**Sir Thomas Lipton Park Bridge Load Rating Report**		
From:	**Daniel Estey, P.Eng.**		

APPENDIX A – East and West Creek Bridges- Structural Results

Project title: Sir Thomas Lipton Park Bridges

Description: East & West Creek Bridges -12.6m

Steel Module Results

Material Properties

ID = **1** | **Type** = Steel

Name = **300W**

F_y = 300 MPa | **E** = 200000 MPa

F_u = 450 MPa | **G** = 78740.2 MPa

ν = 0.27

ρ = 7850 kg/m.3

α = 1.17e-005 1/C

ID = **21** | **Type** = Wood

Name = **Douglas-Fir**

Grade Category = Sawn Lumber - Structural Elements

Standard = CAN/CSA O86-09

Species = Douglas-fir | **Grade** = No. 1 or better

f_t = 5.8 MPa | **E_{05}** = 7000 MPa

f_c = 14 MPa | **E** = 11000 MPa

f_b = 10 MPa | **G** = 2926 MPa

f_v = 1.9 MPa | **ν** = 0.33

f_{cp} = 7 MPa | **ρ** = 490 kg/m.3

α = 4e+011 1/C

Steel Module Results

Section Classification

Section ID = **2** | **Nb Symmetry** = 1

Section Name = **C250x23**

Yield Strength = 300 MPa | **Area** = 2880 mm.2

Geometry

Flange b = 65 mm t = 11.1 mm b/t = 5.8559

Web	h = 231.8 mm	w = 6.1 mm	h/w = 38

Classification - S6-06 cl. 10.9.2

	Class	Ratio (Actual)	Ratio (Maximum)
Pure Compression-Flange	3	5.8559	11.547
Pure Compression-Web	1	38	38.6825
Pure Bending-Flange	3	5.8559	11.547
Pure Bending-Web	1	38	63.5085
Pure Bending (My)-Flange	3	5.8559	11.547
Pure Bending (My)-Web	1	38	38.6825

Section ID = **5** **Nb Symmetry =** 2
Section Name = **WWF400x157**
Yield Strength = 300 MPa **Area =** 19960 mm.2

Geometry

Flange	b = 200 mm	t = 20 mm	b/t = 10
Web	h = 360 mm	w = 11 mm	h/w = 32.7273

Classification - S6-06 cl. 10.9.2

	Class	Ratio (Actual)	Ratio (Maximum)
Pure Compression-Flange	3	10	11.547
Pure Compression-Web	1	32.7273	38.6825
Pure Bending-Flange	3	10	11.547
Pure Bending-Web	1	32.7273	63.5085

Member Classification

Memb ID	Section	Class				Width/Thickness		Cf/Cy	Cf (kN)	Comb ID
		Comp.	Bend. Mx	Bend. My	Comp.-Bend.	Actual	Max.			
18	5 - WWF400x157	3	3	3	3	32.7273	63.5085	0	0	1 - Steel gird..
28	5 - WWF400x157	3	3	3	3	32.7273	63.5085	0	0	1 - Steel gird..

Bending Limit States (1/3)

Memb ID	Section Name	Class Mx	Class My	Comb ID	Critical Moment	Supp Mrx (kN-m)	Supp Mry (kN-m)	Actual Mrx+ (kN-m)	Actual Mrx- (kN-m)
18	WWF400x157	3	3	6 - Pedestrian..	M+	884.784	304.057	884.784	884.784
		3	3	10 - Dead Loads	M+	884.784	304.057	884.784	884.784
		3	3	20 - DL + LL	M+	884.784	304.057	884.784	884.784
		3	3	50 - DL+HS15	M+	884.784	304.057	884.784	884.784
		3	3	51 - DL+Exc.Cat..	M+	884.784	304.057	884.784	884.784
		3	3	52 - DL + CL625	M+	884.784	304.057	884.784	884.784
		3	3	53 - DL+HS20	M+	884.784	304.057	884.784	884.784
28	WWF400x157	3	3	50 - DL+HS15	M+	884.784	304.057	884.784	884.784
		3	3	51 - DL+Exc.Cat..	M+	884.784	304.057	884.784	884.784
		3	3	52 - DL + CL625	M+	884.784	304.057	884.784	884.784
		3	3	53 - DL+HS20	M+	884.784	304.057	884.784	884.784

Bending Limit States (2/3)

Memb ID	Comb ID	Unbraced length (mm)	Lu (mm)	w2	w3/w2	Mfx+ (kN-m)	Mfx- (kN-m)
18	6 - Pedestrian..	1830	7097.9	1		108.301	0

Memb ID	Comb ID	Unbraced length (mm)	Lu (mm)	w2	w3/w2	Mfx+ (kN-m)	Mfx- (kN-m)
	10 - Dead Loads	1830	7097.9	1		108.014	0
	20 - DL + LL	1830	7097.9	1		270.466	0
	50 - DL+HS15	1830	7097.9	1		436.84	0
	51 - DL+Exc.Cat..	1830	7097.9	1		309.148	0
	52 - DL + CL625	1830	7097.9	1		525.557	0
	53 - DL+HS20	1830	7097.9	1		436.84	0
28	50 - DL+HS15	665	7097.9	1		479.94	-88.7044
	51 - DL+Exc.Cat..	665	7097.9	1		299.736	-30.5996
	52 - DL + CL625	665	7097.9	1		626.388	-128.118
	53 - DL+HS20	665	7097.9	1		479.94	-88.7044

Bending Limit States (3/3)

Memb ID	Comb ID	Mfy (kN-m)	ULS M+	ULS M-	Support	Notes
18	6 - Pedestrian..	0	0.1224	0		
	10 - Dead Loads	0	0.1221	0		
	20 - DL + LL	0	0.3057	0		
	50 - DL+HS15	0	0.4937	0		
	51 - DL+Exc.Cat..	0	0.3494	0		
	52 - DL + CL625	0	0.5940	0		
	53 - DL+HS20	0	0.4937	0		
28	50 - DL+HS15	0	0.5424	0.1003		
	51 - DL+Exc.Cat..	0	0.3388	0.0346		
	52 - DL + CL625	0	0.7080	0.1448		
	53 - DL+HS20	0	0.5424	0.1003		

Compression and Bending Limit States (1/2)

Memb ID	Section Name	Class	Comb ID	Cf (kN)	Mfx (kN-m)	Mfy (kN-m)
18	WWF400x157	3	6 - Pedestrian..	0	108.301	0
		3	10 - Dead Loads	0	108.014	0
		3	20 - DL + LL	0	270.466	0
		3	50 - DL+HS15	0	436.84	0
		3	51 - DL+Exc.Cat..	0	309.148	0
		3	52 - DL + CL625	0	525.557	0
		3	53 - DL+HS20	0	436.84	0
28	WWF400x157	3	50 - DL+HS15	0	479.94	0
		3	51 - DL+Exc.Cat..	0	299.736	0
		3	52 - DL + CL625	0	626.388	0
		3	53 - DL+HS20	0	479.94	0

Compression and Bending Limit States (2/2)

Memb ID	Comb ID	w1,x	w1,y	Factor Pex	Factor Pey	ULS Bending	ULS Section	ULS Overall	ULS LTB	Support	Notes
18	6 - Pedestrian..	1	1	1	1	0.1224	0.1224	0.1224	0.1224		
	10 - Dead Loads	1	1	1	1	0.1221	0.1221	0.1221	0.1221		
	20 - DL + LL	1	1	1	1	0.3057	0.3057	0.3057	0.3057		
	50 - DL+HS15	1	1	1	1	0.4937	0.4937	0.4937	0.4937		
	51 - DL+Exc.Cat..	1	1	1	1	0.3494	0.3494	0.3494	0.3494		
	52 - DL + CL625	1	1	1	1	0.5940	0.5940	0.5940	0.5940		
	53 - DL+HS20	1	1	1	1	0.4937	0.4937	0.4937	0.4937		
28	50 - DL+HS15	1	1	1	1	0.5424	0.5424	0.5424	0.5424		
	51 - DL+Exc.Cat..	1	1	1	1	0.3388	0.3388	0.3388	0.3388		

Memb ID	Comb ID	w1,x	w1,y	Factor Pex	Factor Pey	ULS Bending	ULS Section	ULS Overall	ULS LTB	Support	Notes
	52 - DL + CL625	1	1	1	1	0.7080	0.7080	0.7080	0.7080		
	53 - DL+HS20	1	1	1	1	0.5424	0.5424	0.5424	0.5424		

Shear Limit States (1/2)

Memb ID	Section Name	Avy (mm.2)	Avx (mm.2)	Vry (kN)	Vrx (kN)	Comb ID
28	WWF400x157	4400	16000	723.558	2631.12	50 - DL+HS15
		4400	16000	723.558	2631.12	51 - DL+Exc.Cat..
		4400	16000	723.558	2631.12	52 - DL + CL625
		4400	16000	723.558	2631.12	53 - DL+HS20

Shear Limit States (2/2)

Memb ID	Comb ID	Vfy (kN)	Vfx (kN)	ULS Vy	ULS Vx	Notes
28	50 - DL+HS15	282.988	0	0.3911	0	
	51 - DL+Exc.Cat..	166.949	0	0.2307	0	
	52 - DL + CL625	383.303	0	0.5297	0	
	53 - DL+HS20	282.988	0	0.3911	0	

Limit States Summary (1/2)

Memb ID	Section Name	Comb ID	Maximum	Compres	Tension	Bending M+	Bending M-
18	WWF400x157	6 - Pedestrian..	0.1224			0.1224	
		10 - Dead Loads	0.1221			0.1221	
		20 - DL + LL	0.3057			0.3057	
		50 - DL+HS15	0.4937			0.4937	
		51 - DL+Exc.Cat..	0.3494			0.3494	
		52 - DL + CL625	0.5940			0.5940	
		53 - DL+HS20	0.4937			0.4937	
28	WWF400x157	50 - DL+HS15	0.5424			0.5424	0.1003
		51 - DL+Exc.Cat..	0.3388			0.3388	
		52 - DL + CL625	0.7080			0.7080	0.1448
		53 - DL+HS20	0.5424			0.5424	0.1003

Limit States Summary (2/2)

Memb ID	Comb ID	Compres Bending	Tension Bending	Shear Vfx/Vrx	Shear Vfy/Vry	Deflection	Notes
18	6 - Pedestrian..	0.1224	0.1224				
	10 - Dead Loads	0.1221	0.1221				
	20 - DL + LL	0.3057	0.3057				
	50 - DL+HS15	0.4937	0.4937				
	51 - DL+Exc.Cat..	0.3494	0.3494				
	52 - DL + CL625	0.5940	0.5940				
	53 - DL+HS20	0.4937	0.4937				
28	50 - DL+HS15	0.5424	0.5424		0.3911		
	51 - DL+Exc.Cat..	0.3388	0.3388		0.2307		
	52 - DL + CL625	0.7080	0.7080		0.5297		
	53 - DL+HS20	0.5424	0.5424		0.3911		

Steel Code Clauses

PURE COMPRESSION - RESISTANCE

Applied load:

Maximum compressive load anywhere on the member span.

Axial Compression:

[*1] CAN/CSA-S6-06: Clause 10.9.3

PURE BENDING - RESISTANCE

Applied load: Mfx and Mfy

They are selected as the maximum values anywhere on the member span.

Bending - Members with Continuous Laterally Support

[*2] CAN/CSA-S6-06: Cl. 10.10.2.2, 10.10.3.2 and 10.10.4

Bending - Members with Lateral Point Supports

[*2] CAN/CSA-S6-06: Clauses 10.10.2 to 10.10.4

Note:

TBS: Torsional Buckling Support - Weak axis

PTS: Lateral Point Support - Weak axis

AXIAL COMPRESSION AND BENDING

Applied load: Mfx, Mfy and Cf

They are selected as the maximum values anywhere on the member span.

CAN/CSA-S6-06:

[*3] Bending: Clause 10.9.4.4 c)

Mfx/Mrx + Mfy/Mry

Class 1 - I-Shaped Members

[*4] Stability: Clause 10.9.4.4 a), b), c)

All Classes except Class 1 of I shaped members

[*4] Stability: Clause 10.9.4.1 a), b), c)

Supports:

TBS: Lateral Torsional Buckling Support (Weak axis)

PTS: Lateral Point Support (Weak axis)

TENSION AND BENDING

Applied load: Tf and Mf

They are selected as the maximum values anywhere on the member span.

[*5] Axial Tension and Bending: CAN/CSA-S6-06, Clause 10.8.3

Axial Tension: CAN/CSA-S6-06, Clause 10.8.2

SHEAR - RESISTANCE

Shear - Elastic Analysis: Vfx and Vfy

They are selected as the maximum values anywhere on the member span.

[*6] CAN/CSA-S6-06: Clause 10.10.5.1

COMPOSITE SECTIONS - BENDING RESISTANCE

Applied load:

They are selected as the maximum values anywhere on the member span.

Bending - Composite Members

[*7] CAN/CSA-S6-06: Clauses 10.11.5 to 10.11.8

Appendix B

Structural Results – MacDonald Creek Bridge

#503, 4190 Lougheed Hwy., Burnaby, BC V5C 6A8 T: 604.629.2696 F: 604.629.2698

To:	**Sunshine Coast Regional District**	Date:	**August 11, 2014**
Attention:	**Sam Adams, Parks Planning Coordinator**	Project No:	**31256**
Cc:	**Karine Poliquin, EIT**		
Reference:	**Sir Thomas Lipton Park Bridge Load Rating Report**		
From:	**Daniel Estey, P.Eng.**		

APPENDIX B – MacDonald Creek Bridge Structural Results

Project title: Sir Thomas Lipton Park Bridges

Description: MacDonald Creek Bridge No. 1 -22.5 m span on 8% slope

Steel Module Results

Material Properties

ID = **1**
Name = **300W**
F_y = 300 MPa
F_u = 450 MPa

Type = Steel
E = 200000 MPa
G = 78740.2 MPa
ν = 0.27
ρ = 7850 kg/m.3
α = 1.17e-005 1/C

ID = **21**
Name = **Douglas-Fir**
Grade Category = Sawn Lumber - Structural Elements
Standard = CAN/CSA O86-09
Species = Douglas-fir
f_t = 5.8 MPa
f_c = 14 MPa
f_b = 10 MPa
f_v = 1.9 MPa
f_{cp} = 7 MPa

Type = Wood
Grade = No. 1 or better
E_{05} = 7000 MPa
E = 11000 MPa
G = 2926 MPa
ν = 0.33
ρ = 490 kg/m.3
α = 4e+011 1/C

Section Classification

Section ID = **2**
Section Name = **C250x23**
Yield Strength = 300 MPa

Nb Symmetry = 1
Area = 2880 mm.2

Geometry

Flange	b = 65 mm	t = 11.1 mm	b/t = 5.8559

Web	h = 231.8 mm	w = 6.1 mm	h/w = 38

Classification - S6-06 cl. 10.9.2

	Class	Ratio (Actual)	Ratio (Maximum)
Pure Compression-Flange	3	5.8559	11.547
Pure Compression-Web	1	38	38.6825
Pure Bending-Flange	3	5.8559	11.547
Pure Bending-Web	1	38	63.5085
Pure Bending (My)-Flange	3	5.8559	11.547
Pure Bending (My)-Web	1	38	38.6825

Section ID = **4** **Nb Symmetry =** 2

Section Name = **WWF800x279**

Yield Strength = 300 MPa **Area =** 35342 mm.2

Geometry

Flange	b = 250 mm	t = 27.9 mm	b/t = 8.9606
Web	h = 744.2 mm	w = 10 mm	h/w = 74.42

Classification - S6-06 cl. 10.9.2

	Class	Ratio (Actual)	Ratio (Maximum)
Pure Compression-Flange	2	8.9606	9.8150
Pure Compression-Web	4	74.42	38.6825
Pure Bending-Flange	2	8.9606	9.8150
Pure Bending-Web	2	74.42	98.1495

Member Classification

Memb ID	Section	Class				Width/Thickness		Cf/Cy	Cf (kN)	Comb ID
		Comp.	Bend. Mx	Bend. My	Comp.-Bend.	Actual	Max.			
21	4 - WWF800x279	4	2	2	2	74.42	98.1495	0	0	1 - Steel gird..
29	4 - WWF800x279	4	2	2	2	74.42	98.1495	0	0	1 - Steel gird..

Bending Limit States (1/3)

Memb ID	Section Name	Class Mx	Class My	Comb ID	Critical Moment	Supp Mrx (kN-m)	Supp Mry (kN-m)	Actual Mrx+ (kN-m)	Actual Mrx- (kN-m)
21	WWF800x279	2	2	6 - Pedestrian..	M+	3464.29	999.241	3464.29	3464.29
		2	2	10 - Dead Loads	M+	3464.29	999.241	3464.29	3464.29
		2	2	20 - DL + LL	M+	3464.29	999.241	3464.29	3464.29
		2	2	50 - DL+HS15	M+	3464.29	999.241	3464.29	3464.29
		2	2	51 - DL+Exc.Cat..	M+	3464.29	999.241	3464.29	3464.29
		2	2	52 - DL + CL625	M+	3464.29	999.241	3464.29	3464.29
		2	2	53 - DL+HS20	M+	3464.29	999.241	3464.29	3464.29

Bending Limit States (2/3)

Memb ID	Comb ID	Unbraced length (mm)	Lu (mm)	w2	w3/w2	Mfx+ (kN-m)	Mfx- (kN-m)
21	6 - Pedestrian..	1825	7888.86	1		439.865	0
	10 - Dead Loads	1825	7888.86	1		516.134	0
	20 - DL + LL	1825	7888.86	1		1175.93	0
	50 - DL+HS15	1825	7888.86	1		2112.83	0
	51 - DL+Exc.Cat..	1825	7888.86	1		1415.15	0

Memb ID	Comb ID	Unbraced length (mm)	Lu (mm)	w2	w3/w2	Mfx+ (kN-m)	Mfx- (kN-m)
	52 - DL + CL625	1825	7888.86	1		2981.65	0
	53 - DL+HS20	1825	7888.86	1		2112.83	0

Bending Limit States (3/3)

Memb ID	Comb ID	Mfy (kN-m)	ULS M+	ULS M-	Support	Notes
21	6 - Pedestrian..	0	0.1270	0		
	10 - Dead Loads	0	0.1490	0		
	20 - DL + LL	0	0.3394	0		
	50 - DL+HS15	0	0.6099	0		
	51 - DL+Exc.Cat..	0	0.4085	0		
	52 - DL + CL625	0	0.8607	0		
	53 - DL+HS20	0	0.6099	0		

Compression and Bending Limit States (1/2)

Memb ID	Section Name	Class	Comb ID	Cf (kN)	Mfx (kN-m)	Mfy (kN-m)
21	WWF800x279	2	6 - Pedestrian..	0	439.865	0
		2	10 - Dead Loads	0	516.134	0
		2	20 - DL + LL	0	1175.93	0
		2	50 - DL+HS15	0	2112.83	0
		2	51 - DL+Exc.Cat..	0	1415.15	0
		2	52 - DL + CL625	0	2981.65	0
		2	53 - DL+HS20	0	2112.83	0

Compression and Bending Limit States (2/2)

Memb ID	Comb ID	w1,x	w1,y	Factor Pex	Factor Pey	ULS Bending	ULS Section	ULS Overall	ULS LTB	Support	Notes
21	6 - Pedestrian..	1	1	1	1	0.1270	0.1270	0.1270	0.1270		
	10 - Dead Loads	1	1	1	1	0.1490	0.1490	0.1490	0.1490		
	20 - DL + LL	1	1	1	1	0.3394	0.3394	0.3394	0.3394		
	50 - DL+HS15	1	1	1	1	0.6099	0.6099	0.6099	0.6099		
	51 - DL+Exc.Cat..	1	1	1	1	0.4085	0.4085	0.4085	0.4085		
	52 - DL + CL625	1	1	1	1	0.8607	0.8607	0.8607	0.8607		
	53 - DL+HS20	1	1	1	1	0.6099	0.6099	0.6099	0.6099		

Shear Limit States (1/2)

Memb ID	Section Name	Avy (mm.2)	Avx (mm.2)	Vry (kN)	Vrx (kN)	Comb ID
21	WWF800x279	8000	27900	1185.37	4588.02	50 - DL+HS15
		8000	27900	1185.37	4588.02	52 - DL + CL625
		8000	27900	1185.37	4588.02	53 - DL+HS20
29	WWF800x279	8000	27900	1185.37	4588.02	20 - DL + LL
		8000	27900	1185.37	4588.02	50 - DL+HS15
		8000	27900	1185.37	4588.02	51 - DL+Exc.Cat..
		8000	27900	1185.37	4588.02	52 - DL + CL625
		8000	27900	1185.37	4588.02	53 - DL+HS20

Shear Limit States (2/2)

Memb ID	Comb ID	Vfy (kN)	Vfx (kN)	ULS Vy	ULS Vx	Notes
21	50 - DL+HS15	144.738	0	0.1221	0	

Memb ID	Comb ID	Vfy (kN)	Vfx (kN)	ULS Vy	ULS Vx	Notes
	52 - DL + CL625	181.412	0	0.1530	0	
	53 - DL+HS20	144.738	0	0.1221	0	
29	20 - DL + LL	209.132	0	0.1764	0	
	50 - DL+HS15	393.248	0	0.3318	0	
	51 - DL+Exc.Cat..	249.053	0	0.2101	0	
	52 - DL + CL625	615.353	0	0.5191	0	
	53 - DL+HS20	393.248	0	0.3318	0	

Limit States Summary (1/2)

Memb ID	Section Name	Comb ID	Maximum	Compres	Tension	Bending M+	Bending M-
21	WWF800x279	6 - Pedestrian..	0.1270			0.1270	
		10 - Dead Loads	0.1490			0.1490	
		20 - DL + LL	0.3394			0.3394	
		50 - DL+HS15	0.6099			0.6099	
		51 - DL+Exc.Cat..	0.4085			0.4085	
		52 - DL + CL625	0.8607			0.8607	
		53 - DL+HS20	0.6099			0.6099	
29	WWF800x279	20 - DL + LL	0.1764				
		50 - DL+HS15	0.3318				
		51 - DL+Exc.Cat..	0.2101				
		52 - DL + CL625	0.5191				
		53 - DL+HS20	0.3318				

Limit States Summary (2/2)

Memb ID	Comb ID	Compres Bending	Tension Bending	Shear Vfx/Vrx	Shear Vfy/Vry	Deflection	Notes
21	6 - Pedestrian..	0.1270	0.1270				
	10 - Dead Loads	0.1490	0.1490				
	20 - DL + LL	0.3394	0.3394				
	50 - DL+HS15	0.6099	0.6099		0.1221		
	51 - DL+Exc.Cat..	0.4085	0.4085				
	52 - DL + CL625	0.8607	0.8607		0.1530		
	53 - DL+HS20	0.6099	0.6099		0.1221		
29	20 - DL + LL				0.1764		
	50 - DL+HS15				0.3318		
	51 - DL+Exc.Cat..				0.2101		
	52 - DL + CL625				0.5191		
	53 - DL+HS20				0.3318		

Steel Code Clauses

PURE COMPRESSION - RESISTANCE

Applied load:

Maximum compressive load anywhere on the member span.

Axial Compression:

[*1] CAN/CSA-S6-06: Clause 10.9.3

PURE BENDING - RESISTANCE

Applied load: Mfx and Mfy

They are selected as the maximum values anywhere on the member span.

Bending - Members with Continuous Laterally Support

[*2] CAN/CSA-S6-06: Cl. 10.10.2.2, 10.10.3.2 and 10.10.4

Bending - Members with Lateral Point Supports

[*2] CAN/CSA-S6-06: Clauses 10.10.2 to 10.10.4

Note:

TBS: Torsional Buckling Support - Weak axis

PTS: Lateral Point Support - Weak axis

AXIAL COMPRESSION AND BENDING

Applied load: Mfx, Mfy and Cf

They are selected as the maximum values anywhere on the member span.

CAN/CSA-S6-06:

[*3] Bending: Clause 10.9.4.4 c)

Mfx/Mrx + Mfy/Mry

Class 1 - I-Shaped Members

[*4] Stability: Clause 10.9.4.4 a), b), c)

All Classes except Class 1 of I shaped members

[*4] Stability: Clause 10.9.4.1 a), b), c)

Supports:

TBS: Lateral Torsional Buckling Support (Weak axis)

PTS: Lateral Point Support (Weak axis)

TENSION AND BENDING

Applied load: Tf and Mf

They are selected as the maximum values anywhere on the member span.

[*5] Axial Tension and Bending: CAN/CSA-S6-06, Clause 10.8.3

Axial Tension: CAN/CSA-S6-06, Clause 10.8.2

SHEAR - RESISTANCE

Shear - Elastic Analysis: Vfx and Vfy

They are selected as the maximum values anywhere on the member span.

[*6] CAN/CSA-S6-06: Clause 10.10.5.1

COMPOSITE SECTIONS - BENDING RESISTANCE

Applied load:

They are selected as the maximum values anywhere on the member span.

Bending - Composite Members

[*7] CAN/CSA-S6-06: Clauses 10.11.5 to 10.11.8