Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

Public Works and Government Services Canada
Ontario Region

PWGSC Project No.: R.013514.030

BURLINGTON LIFT BRIDGE, TOWERS, AND PIERS - STRUCTURAL MODELLING, ANALYSIS AND SURVEYS

PHASE II
RS7: MEMBER CAPACITIES REPORT

FINAL

MMM GROUP

MMM Group Limited
May 2014

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APPENDICES

File: https://www.ecollaboration.mmm.ca/livelinkdav/nodes/23728340/3213009 mb RS7 Report.docx

1. INTRODUCTION

MMM Group Ltd. (MMM) was retained by Public Works and Government Services Canada (PWGSC) to undertake a structural analysis including a 3D model, evaluation of member capacities, and a fatigue review for the Burlington Lift Bridge.

This report presents the results for member capacities as per section RS7 of the terms of reference. Member capacities for the lift span and towers are reported and compared to the demands calculated during the structural analysis and 3D modeling. Capacity to demand ratios (C/D) are reported in a tabular format. All members with capacity to demand ratios less than 1.15 are listed and discussed in this report.

This report should be read in conjunction with a separate report by MMM Group titled **RS6 – 3D Modelling and Structural Analysis Report, May 2014**, which presents the structural analysis and 3D model that provides the demands used for comparison with the member capacities.

A Key Plan showing the location of the structure and a General Arrangement drawing have been provided in Appendix A.

2. EXISTING STRUCTURE

Owned and operated by Public Works and Government Services Canada (PWGSC), the Burlington Lift Bridge is located between the cities of Burlington and Hamilton, Ontario on Eastport Drive spanning the Burlington Canal. The Burlington Canal provides the only navigational opening into the Hamilton Harbour. The majority of traffic crosses the canal via the provincially owned Queen Elizabeth Way (QEW) James N. Allan Skyway; however, the lift bridge provides the only alternate vehicle crossing and is the only crossing available to pedestrians and cyclists. For the purposes of this report, the bridge is considered to run in the north-south direction.

2.1 Structure Description

The Burlington Lift Bridge is a tower-drive steel truss vertical lift bridge designed in 1958 by C.C. Parker and Associates of Hamilton, Ontario and constructed between 1959 and 1960 by the Hamilton Bridge Division of the Bridge and Tank Company of Canada Limited. The bridge originally served both rail and highway traffic in a side-by-side configuration. The railway corridor ran along the eastern half of the structure and the highway corridor ran along the western half of the structure. In 1982 the bridge underwent a major rehabilitation to convert it to a highway traffic only structure through the complete removal of the railway corridor and the addition of two new lanes of traffic. Despite the removal of the railway corridor, the following report shall refer to the east truss as the “railway truss” and the west truss as the “highway truss”.

The bridge is comprised of two 12.60m (41’ - 4”) approach spans, two 9.75m (32’ - 0”) tower spans, and one 112.78m (370’ - 0”) lift span. There is a 2.07m (6’ - 9.5”) wide sidewalk with an aluminum pedestrian hand railing cantilevered from the outside of the highway truss. Two 3.375m wide northbound lanes and two 3.375m wide southbound lanes are provided on the bridge. A steel box beam barrier is located on either side of the roadway. A navigational clearance of approximately 36.58m (120’ - 0”) is provided at high water level.

The substructure is comprised of two concrete tower piers supporting the towers, and two concrete conventional closed abutments at each end of the approach spans.

2.1.1 Lift Span

The lift span is a steel through truss structure that is 15.54m (51’ - 0”) wide from centreline to centreline of the trusses with a vertical lift of 34.12m (111’ - 11”). Each truss is comprised of twelve 9.40m (30’ - 10”) panels which vary in depth from 13.87m (45’ - 6”) at the ends to 16.76m (55’ - 0”) at the midspan.

Truss members (i.e. verticals, diagonals, and top and bottom chords) are comprised of built-up steel sections. Transverse floor beams and longitudinal stringers support an open steel grating deck. The sidewalk deck consists of a thin (50mm) concrete half-filled steel grating.

Portal and sway bracings are provided overhead at panel points.

In the fully closed position (i.e. open to highway traffic), support for the lift span is provided at all four corners from below. Articulation is provided by two fixed supports (bearings) at the south end and two expansion rocker-type supports at the north end. One centring shoe is provided at each end of the lift span.

In any open position (i.e. raised to allow marine traffic), support for the lift span is provided at all four corners by wire ropes attached to lifting girders at the ends of the lift span. The wire ropes then pass over sheaves at the top of each tower and are connected to a counterweight. Guide rollers are also provided at the corners of the lift span and run along tracks on the front columns of the towers.

2.1.2 Towers

There are two steel braced towers at either end of the lift span. Each tower is 15.90m (52’ - 2”) wide from centreline to centreline of the columns, 9.75m (32’ - 0”) long from centreline to centreline of the columns, and is approximately 65m (213’ - 0”) tall.

Tower members (i.e. columns, diagonal bracings, horizontals, etc.) are comprised of built-up steel sections. The roadway passing through the towers is referred to as the “tower span” and is comprised of transverse floor beams and longitudinal stringers supporting a 190mm (7.5”) concrete deck with a 65mm (2.5”) asphalt wearing surface.

There is a 2.47m (8’ - 1”) wide sidewalk with an aluminum pedestrian hand railing cantilevered from the west side of the tower.

Each tower is supported on a concrete tower pier substructure.

At the top of each tower is a machine room which houses the mechanical and electrical equipment necessary to raise and lower the lift span. Wire ropes connected to each end of the lift span pass over the sheaves and are connected to a counterweight (on each tower) which balances the weight of the lift span.

2.1.3 Approach Spans

There are two approach spans at either end of the bridge. Each is 15.90m (52' - 2") wide and 12.60m (41' - 4") in length.

Transverse floor beams and longitudinal stringers support a 190mm (7.5") concrete deck with a 65mm (2.5") asphalt wearing surface. There is a 2.47m (8' - 1") wide sidewalk with an aluminum pedestrian hand railing cantilevered from the west side of the approach spans.

Each approach span is simply supported by the tower piers at one end and a concrete conventional closed abutment at the other. Articulation is provided by fixed bearings at the concrete abutments, and expansion bearings at the tower piers.

3. BACKGROUND FOR EVALUATION

The sections below provide background information regarding the main inputs used for this structural evaluation.

3.1 Member Naming Convention

The member naming convention for evaluation follows the same convention presented in the structural analysis report (RS6-3D Modelling and Structural Analysis Report, May 2014).

3.2 Local Orientation

The orientations for structural members within the spreadsheets correspond with local orientation of the members in the S-Frame model as follows:

- Z corresponds with the vertical plane. For vertical members Z corresponds with the longitudinal direction of the bridge (north-south);
- Y corresponds with the horizontal direction. For vertical members Y corresponds with the transverse direction of the bridge (east-west);
- X always corresponds with the axial direction of the member.

3.3 Built up Section Properties

Section properties calculated for each of the built up members include gross area and moment of inertia in both local z and local y directions. Moments of inertia for all members are calculated based on the gross cross sectional area of the member. Net areas were calculated for the tower members where shop drawings were available.

Section properties for all built up members are calculated about the nodal centre of the member to correspond with the evaluation (S-Frame) computer model. For several members the nodal center corresponds to its geometric centroid (intersection of neutral axes); however, there are some members (truss top chord for example) where the built up member changes section properties by using different plate sizes and/or thicknesses.

At these points of transition the geometric centroid of the member is slightly offset from the nodal centre. Since the S-Frame model uses the nodal centre of the members all of the section properties have been calculated about the nodal centre. It is noted that there is very little difference between the properties calculated about the nodal centre compared to the geometric centroid.

3.4 Material Properties

Gross section properties used in the evaluation for all members were taken from the 1959/1960 fabrication and erection drawings.

Two different grades of steel where used to construct the Burlington Lift Bridge. Regular carbon steel was used commonly throughout the bridge but specific members were constructed using a low alloy high strength steel.

The following table presents the yield and ultimate strengths used in the evaluation for the carbon and low alloy high strength steels.

Table 1: Grade of Steel used for Evaluation

Steel Grade	Yield Strength (Fy)	Ultimate Strength (Fu)	Code Reference
CSA G40.4	230	420	CAN/CSA S6-06 Clause 14.7.4.2
A242	350	480	CAN/CSA S16-09 pp6-5

For the regular carbon steel the historic material properties specified in Clause 14.7.4.2 of the Canadian Highway Bridge Design Code (CHBDC) CSA/CAN S6-06 Supplement No. 3 (March 2013) were used based on the year of construction. Since the CHBDC does not provide historic material properties for low allow steel the values for the A242 steel were obtained from CAN/CSA S16-09.

4. EVALUATION

Capacities of all structural members within the lift span and towers have been evaluated based on the CHBDC; however, the evaluation was limited to the members only and does not include evaluation of the connection and joint capacities. Evaluation of the connection and joint capacities is contemplated to be investigated in Phase III of the project.

4.1 Structural Responses

Evaluation of member capacity was completed for the following structural responses:

- Tension Only
- Compression Only
- Bending Only

For built up members the evaluation for compressive capacity includes a local capacity check for individual components between battens or lattice bars. Bending moments in axial members of the lift span and towers were not included in the evaluation because the flexural demand for these members is extremely low in comparison to the axial demand. Combined bending and axial load cases were reviewed but found to be a non-governing load combination.

4.2 Applicable Sections of CHBDC

Member capacities were determined in accordance with Section 10, Steel Structures, of the Canadian Highway Bridge Design Code (CHBDC) CSA/CAN S6-06 Supplement No. 3 (March 2013).

Specific sub-sections of the CHBDC used for the structural evaluations include 10.5 Design theory and assumptions, 10.8 Tension members, 10.9 Compression members, and 10.10 Beams and girders.

Individual clauses that correspond with the capacity calculations have been listed on the capacity spreadsheets that are included in Appendix D, E, F and G.

4.3 Effective Length Factor (K) for Members in Compression

For all compression members the length of the member was taken as the nodal length between each end nodes (working point to working point). The K factor for compression members was generally taken as 1.0 with two exceptions: laced members were assigned K values larger than 1.0 to account for shear lag while truss members which frame into very large gusset plates were given K values equal to 0.8. The methodology for modifying each of these two K values is presented in the following sections.

4.3.1 K values for Laced Members

For laced members in compression, KL/r was adjusted using the method presented in Stability Design Criteria for Metal Structures (6th Edition, p.94, Ziemian, 2010). When KL/r is equal to or less than 40 a new factor, K', is taken as 1.1K. When KL/r exceeds 40 the new factor K' is a function of KL/r (1.1 at KL/r = 40 down to 1.01 when KL/r = 100).

4.3.2 K values for Compression Members with Large Gusset Plates

Large gusset plates add rigidity to truss members and their connection points. In reality, this rigidity results in the connection acting as neither fully pinned nor fully fixed.

Clause 4.6.2.5 of AASTHO (US Bridge Code) allows K = 0.75 for compression members when both end conditions are bolted, and 'Design of Steel Structures' by (Gaylord et. al 1992) provides what they refer to as a conservative recommendation of K = 0.85, while the previous edition of AASHTO recommended K = 0.80. The Canadian Highway Bridge Design Code does not provide guidance on reduced K factors.

Since the CHBDC does not provide guidance on K values for compression members with large gusset plates, K= 0.8 was chosen for this evaluation to provide a K value that is slightly more conservative than what is currently specified in AASHTO. Reduced K values where applied to correspond with the direction in which the gusset plates provide rigidity and 1.0 for the other axis.

For a member to be assigned a K value of 0.8 a conservative approach was taken in which both ends of the member needed to have large gusset plates. Members that only had large gusset plates at one end were assigned K values of 1.0.

For the entire lift span and towers the only members with reduced K values are diagonal members within the lift span trusses. Appendix B presents a drawing showing the assignment of all members with reduced K values.

4.4 Gross and Net Areas

Many of the built up members have hand holes; accordingly, for members in which shop drawings exist the gross and net areas have been calculated and are used in the evaluation as follows:

- Tensile capacity is calculated using the gross and net areas according to CHBDC clauses 10.8.2(a) and 10.8.2 (b) respectively;
- Compressive capacity is calculated in accordance with CHBDC section 10.9 using the gross area and the yield strength, Fy.

5. MEMBER CAPACITIES

Excel spreadsheets were developed for calculating member capacities and to provide result summaries for member capacities, member demands, and capacity to demand ratios. The spreadsheet flags members that have capacity to demand ratios less than 1.15 and 1.00 respectively.

5.1 Capacity Spreadsheets

For the capacity spreadsheets the user input cells are shaded grey. Primary inputs include:

- Material Properties
- Individual section properties for the built up members
- Orientation and location of individual sections within built up members
- Member length
- Demands (taken from the modelling task RS6 using S-Frame)

A single capacity spreadsheet was produced for each unique built up member within the Burlington Lift Bridge. Since there are several members that have the same built up section each spreadsheet lists the S-Frame end nodes for all of the individual members that consist of the same built up section.

5.2 Summary Spreadsheets for Capacity to Demand

For ease of reference, summary spreadsheets have been provided which lists each member in a tabular format with specific columns for the member name, factored demand, factored capacity, capacity to demand ratio, and a comment line which flags members that have capacity to demand ratios that are less than 1.15 and 1.00 respectively.

6. RESULTS

The results of this evaluation indicate that nearly all of the structural members have capacity to demand ratios that are greater than 1.15.

The lowest capacity to demand ratios for truss members in the lift span are 2.05 and 3.06 for the highway and railway trusses respectively. The lowest capacity to demand ratios for floor beams and stringers within the lift span are 1.77 and 1.15 respectively. For all other members within the lift span, the lowest capacity to demand ratio is 1.31.

Since lift span fabrication drawings are not available to provide the details required to calculate net areas, the results for the lift span members are based on member's gross areas. However, based on the amount of reserve capacity for the lift span members, MMM does not expect that member capacity to demand ratios would drop below 1.15 if net area capacities were calculated based on net areas. Furthermore, a comparison between member capacities calculated in accordance with CHBDC using gross area [Clause 10.8.2(a)] compared to net area [Clause 10.8.2(b)] shows that the net areas must be reduced by more than 35.6% for members with Grade A242 low alloy steel before the net area capacity governs and that the net areas must be reduced by more than 14.2% for members with Grade CSA G40.4 steel before the net area capacity governs.

The lowest capacity to demand ratio for the tower columns is 1.22 corresponding to the lift span in the raised position. The lowest capacity to demand ratio for all built-up girders in the tower, including both floor beams and sheave girders, is 1.25. Tower bracing members have capacity to demand ratios as low as 0.95 as presented and discussed in the following section.

6.1 Members with Capacity to Demand Ratios Less than 1.15

Based on our review of the lift span, towers, and tower span there are two members that have been identified with capacity to demand ratios (C/D) less than 1.15.

Table 2: Capacity to Demand Ratios Less than 1.15

Member	Capacity	Demand	C/D	Load Type	Lift Span
TOWR-SBRC-DIAG	-3,717 kN	-3,914 kN	0.95	Compression	Raised
TOWR-FBRC-MDIA	-4,126 kN	-4,001 kN	1.03	Compression	Raised

The TOWR-SBRC-DIAG C/D ratio of 0.95 is based on the governing case for members in the bottom section of the tower; C/D ratios for the TOWR-SBRC-DIAG members in the middle and upper sections of the towers are 1.43 and 4.07 respectively.

The low capacity to demand ratios reported in Table 2 result from wind loads acting on the Burlington Lift Bridge with the lift span in the raised position. These ultimate limit state demands were calculated using load factors specified in Load Combination ULSV3 as per Clause 13.7.10. of the CHBDC S6-06. As mentioned in the report by MMM Group titled RS6 – 3D Modeling and Structural Analysis, May 2014, the unfactored design wind loading is at least 1.4 times the maximum operating wind velocity of 80 km/h.

The capacity to demand ratios listed in Table 2 are based on demands directly from the 3D model and a capacity calculated using a K value greater than 1.0 as per the equation by Ziemian (2010) that was discussed in Section 4.3.1 of this report. It is MMM's opinion that these two (2) members do not present a concern because the demands to these members would be less than what is predicted by the 3D model and the capacity of these members would be greater than what is determined in our evaluation as discussed below.

In the 3D model each of these diagonal tower braces is receiving superimposed dead loads. While the actual demands to these diagonal braces would include some superimposed dead load, it is noted that the 3D model overestimates the amount of superimposed dead load to each of the diagonal braces. Determining the actual amount of super-imposed dead load that should be applied to each diagonal brace requires detailed information on the erection sequence and other factors that are not available. Accordingly, a conservative approach was taken and the full magnitude of superimposed dead load from the 3D model is reported in Table 2. When the superimposed dead load is removed from these members the demands decrease to -3,646 kN and -3,370 kN respectively for the TOWR-SBRC-DIAG and TOWR-FBRC-MDIA members.

In the member capacity calculations the gusset plates were not assumed to be adequate to justify using a K value of 0.8 for calculating the flexural buckling (compressive) capacity of the diagonal members reported in Table 2. Furthermore, since these diagonal braces are laced members a K value greater than 1.0 was used in the capacity evaluation. This results in a conservative estimate for the compressive capacity of these members. When a K value of 0.8 is used in the evaluation, member capacities increase to -3,822 kN and -4,465 kN respectively for the TOWR-SBRC-DIAG and TOWR-FBRC-MDIA members.

For the purpose of discussion, capacity to demand ratios based on the decreased demands and increased capacities would be C/D = 1.05 for the TOWR-SBRC-DIAG members and C/D = 1.32 for the TOWR-FBRC-MDIA members.

7. DISCUSSION AND RECOMMENDATIONS

This evaluation identified one member (TOWR-FBRC-MDIA) with a capacity to demand ratio less than 1.15 and one member (TOWR-SBRC-DIAG) with a capacity to demand ratio nominally less than 1.0 (as reported in Section 6.1 of this report).

Since the capacity to demand ratio for member TOWR-FBRC-MDIA is greater than 1.0 this member has capacity to carry un-restricted CHBDC loading.

The capacity to demand ratio reported in Table 2 for TOWR-SBRC-DIAG is 0.95. Based on the discussion in Section 6.1, it is anticipated that the actual capacity to demand ratio is more likely to be at capacity (C/D = 1.0) or slightly above capacity (C/D > 1.0). The load case for the 0.95 capacity to demand ratio is with the lift span in the raised position combined with full design wind loads in accordance with the CHBDC. It is noted that the CHBDC design wind loads are based on a wind speed that is at least 1.4 times greater than the maximum allowable operating speed of 80 km/h. Based on this information and the current maximum allowable wind speed for raising the lift span, it is MMM's opinion that the tower side diagonal braces do not require strengthening.

In addition, it should be noted that the 2014 Edition of the CHBDC is intended to reduce the wind load factor to 1.4 from the current 1.5 which will also increase the capacity to demand ratio to a value greater than 1.0.

MMM recommends that Public Works and Government Services Canada consider completing a detailed inspection of the tower side diagonal braces in the bottom section of the towers during the next inspection program for the Burlington Lift Bridge and if section loss due to corrosion is noted, re-evaluation of these members with the reduced area should be completed.

If significant section loss is noted an option for strengthening the tower side diagonal braces is to add additional steel plates to the outer vertical faces of the built up members. The vertical faces of the current diagonal braces consist of plates with dimensions 610mm x 9.5mm. Adding steel plates with dimensions 400mm x 9.5mm to the outside vertical faces of the tower side diagonal braces would increase its capacity by 39%. Since these members are laced, access for bolt installation is available.

8. CONCLUSION

An evaluation of all structural members in the towers, tower span, and lift span of the Burlington Lift Bridge has been completed in accordance with the Canadian Highway Bridge Design Code CAN/CSA S6-06. The evaluation was limited to the members only and did not include evaluation of the connection and joint capacities. Evaluation of the connection and joint capacities is intended to be investigated in Phase III of the project. It should be noted that net area was not used in the capacity calculations for the lift span members due to the information not being available.

With the exception of the two (2) Tower members listed in Table 2, all structural members have calculated capacity to demand ratios that are greater than 1.15 which indicates that factored capacities for individual members are at least 15 percent greater than their respective factored demand (calculated at Ultimate Limit States).

As discussed in Section 7, the tower members which currently have capacity to demand ratios of less than 1.15 are not considered by MMM to require any remedial action due to the following:

- The CHBDC design wind loads are based on a wind speed that is at least 1.4 times greater than the maximum wind speed for raising the bridge (80 km/h);
- The slenderness effects for the semi-rigid end connections are not included in the capacity calculations resulting in a conservative lower bound member capacity;

- The 3D model used to calculate member demands overestimates the amount of superimposed dead load that is applied to each of the diagonal braces; and
- The 2014 Edition of the CHBDC is intended to reduce the wind load factor to 1.4 from the current 1.5 (7% reduction).

As long as the maximum operating wind speed of 80 km/h is maintained, all members within the towers, tower span, and lift span of Burlington Lift Bridge have adequate structural capacity to carry unrestricted CHBDC loading based on their undeteriorated and undamaged state.

It is recommended that PWGSC considers completing a detailed inspection of the Burlington Lift Bridge tower side diagonal braces (TOWR-SBRC-DIAG) in the bottom section of the towers during the next inspection program and if section loss due to corrosion is noted, re-evaluation of these members with the reduced area should be completed.

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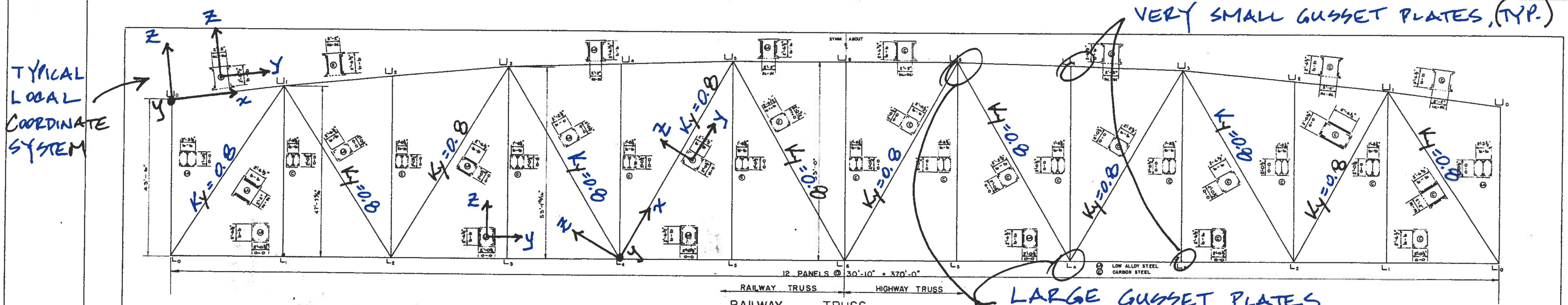
APPENDIX A
KEY PLAN AND GENERAL ARRANGEMENT DRAWING

KEY PLAN

Burlington Lift Bridge, Burlington Ontario

Scale: N.T.S.

APPENDIX B
REDUCED K VALUES FOR COMPRESSION MEMBERS



RAILWAY TRUSS

	BOTTOM CHORDS			TOP CHORDS				DIAGONALS						VERTICALS						
	L_0L_2	L_2L_4	L_4L_6	U_0U_1	U_1U_3	U_3U_5	U_5U_6	L_0U_1	U_1L_2	L_2U_3	U_3L_4	L_4U_5	U_5L_6	U_0L_0	U_1L_1	U_2L_2	U_3L_3	U_4L_4	U_5L_5	U_6L_6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

HIGHWAY TRUSS

	BOTTOM CHORDS			TOP CHORDS				DIAGONALS						VERTICALS						
	L_0L_2	L_2L_4	L_4L_6	U_0U_1	U_1U_3	U_3U_5	U_5U_6	L_0U_1	U_1L_2	L_2U_3	U_3L_4	L_4U_5	U_5L_6	U_0L_0	U_1L_1	U_2L_2	U_3L_3	U_4L_4	U_5L_5	U_6L_6
SECTION USED	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AREA OF SECTION SQ. IN. (GROSS) (NET)	58·5	101·8	101·00		1025 GROSS	1547 GROSS	1581 GROSS													
SECTION MODULUS (CU. IN.)	501 NET	585 NET	649 NET																	
ACTUAL UNIT STRESS KIPS/SQ. IN (DIRECT)	16·50	18·20	24·00		15·20	15·25	[illegible]													
(BENDING)	0·56	0·95	0·76		0·46	0·42	[illegible]													
$f_a/F_a + f_b/F_b$	0·845	1·007	0·917		0·959	0·959	1·00													
MATERIAL	CARBON	CARBON	LOW ALLOY		CARBON															

LIFTING GIRDER

VERTICAL SHEAR (KIPS)	ROPE LOAD	1201
	GIRDER WEIGHT	− 31
	TOTAL	1170
VERTICAL MOMENT (FT.-KIPS)	ROPE LOAD	11002
	GIRDER WEIGHT	− 296
	TOTAL	10706
HORIZONTAL SHEAR TEMPERATURE (KIPS)		7·75
HORIZONTAL MOMENT TEMPERATURE (FT. KIPS)		57·2
WEB REQ'D. SQ. IN.		117
SECTION	WEB	169 x 7/8
	ANGLES	4 Ls 8 x 8 x 3/4
	SIDE PLATES	4 PLs 16 x 1/2
	TOP COVER PLATES	1 PL 24 x 1/2
	BOTTOM COVER PLATES	1 PL 24 x 3/4
	TOP FLANGE ANGLES	2 Ls 4 x 3 x 1/2
	BOTTOM FLANGE ANGLES	2 Ls 4 x 3 x 1/2
NET SECTION MODULUS VERT. BENDING (CU. IN.)		9015
NET SECTION MODULUS HORIZ. BENDING (CU. IN.)		177 (TOP FLG.)
MAXIMUM KIPS/SQ. IN. BENDING STRESS	VERT. MOMENT	14·3
	HORIZ. MOMENT	2·9
	TOTAL	17·2 (TOP)
ALLOWABLE UNIT STRESS (KIPS/SQ. IN.)		15·2 (BOTT.) 18·0 (TOP)
WEB AREA PROVIDED SQ. IN.		148·0
MATERIAL		CARBON

GENERAL NOTES:

1. GENERAL NOTES ON SHEET NO. 2 APPLY HERE.
2. CAMBER. THE LIFT SPAN TRUSSES SHALL BE SO CAMBERED THAT THE STRUCTURE WILL RETAIN ITS GEOMETRIC SHAPE UNDER FULL DEAD LOAD PLUS HALF LIVE LOAD.
3. MATERIAL. MEMBERS FOR WHICH STRUCTURAL LOW-ALLOY STEEL SHALL BE USED ARE DESIGNATED WITH (LA). ALL OTHER MEMBERS ARE STRUCTURAL CARBON STEEL. CONNECTING MATERIALS BETWEEN LOW-ALLOY MEMBERS AND BETWEEN LOW-ALLOY AND CARBON STEEL MEMBERS SHALL BE LOW-ALLOY STEEL, AND ALL OTHER CONNECTING PARTS, LACING AND DIAPHRAGMS SHALL BE CARBON STEEL. ALL RIVETS TO BE CARBON STEEL.
4. RIVETS. 1" Ø RIVETS TO BE USED FOR RAILWAY SIDE MAIN TRUSS. 7/8" Ø RIVETS FOR HIGHWAY SIDE MAIN TRUSS AND ALL FLOOR AND BRACING SYSTEMS, EXCEPT AS NOTED.
5. ALLOWABLE ERECTION STRESSES:
   D.L. + ERECTION LOAD – 1·25 NORMAL UNIT STRESSES.
   D.L. + ERECT. LOAD + 30 P.S.F. WIND – 1·33 NORMAL UNIT STRESSES.
6. SIGN CONVENTIONS:
   + FOR COMPRESSION.
   − FOR TENSION.
7. MOMENT:
   MX-X FOR MOMENT ABOUT HORIZONTAL AXIS.
   MY-Y FOR MOMENT ABOUT VERTICAL AXIS.
8. MINIMUM THICKNESS OF MATERIAL: 3/8" EXCEPT FOR FILLS AND WHERE NOTED OTHERWISE.
9. MINIMUM THICKNESS OF GUSSET PLATES: 1/2" UNLESS NOTED OTHERWISE.

K VALUES FOR MEMBER CAPACITIES

$K_z = 1.0$ FOR ALL MEMBERS

$K_y = 1.0$ EXCEPT AS NOTED ABOVE

W.O. 3213009

M. BOWSER FEB 25, 2014

NO.	REVISIONS	BY	DATE

DEPARTMENT OF PUBLIC WORKS
CANADA
DEVELOPMENT ENGINEERING BRANCH
STRUCTURES DIVISION

C.C. PARKER & ASSOCIATES LTD.
CONSULTING ENGINEERS
HAMILTON ONTARIO

BURLINGTON CANAL LIFT BRIDGE

LIFT SPAN TRUSSES - STRESS SHEET

REGISTERED PROFESSIONAL ENGINEER — CIVIL — I. M. WALLACE — PROVINCE OF ONTARIO

RECOMMENDED DATE 1-12-58 — C.C. PARKER & ASSOC. LTD.
DESIGN D.A.D. CHKD. E.W.A.
DRAWN D.L. CHKD. R.K.C.C.
TRACED W.G. & S.N. CHKD. A.T.
JOB NO. H-538

APPROVED DATE 13/11/58 — CHIEF STRUCTURES DIVISION
APPROVED DATE 14-11-58 — CHIEF ENGINEER

DEPARTMENT PROJECT NO. SD6-4-77

CONTRACT NO. 2

SHEET 3 OF 52

APPENDIX C
CAPACITY TO DEMAND
SUMMARY SHEETS

Member Capacity Summary
Lift Span - Highway Truss
Raised Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-HWYT-L0L2	-8,888	-2,574	3.45		N/A	9,923		N/A		4,021
LIFT-HWYT-L2L4	-15,713		N/A		N/A	17,514	1,446	12.1		8,682
LIFT-HWYT-L4L6	-22,851		N/A		N/A	26,494	2,952	9.0		10,791
LIFT-HWYT-U0U1	-10,517		N/A		N/A	11,455	3,680	3.11		N/A
LIFT-HWYT-U1U3	-14,951	-1,626	9.19		-6,801	16,288		N/A		N/A
LIFT-HWYT-U3U5	-20,867	-3,947	5.29		-10,106	22,730		N/A		N/A
LIFT-HWYT-U5U6	-21,840	-4,722	4.63		-11,084	23,796		N/A		N/A
LIFT-HWYT-L0U1	-27,472	-5,719	4.80		-6,205	32,117		N/A		N/A
LIFT-HWYT-U1L2	-10,258		N/A		N/A	13,959	3,893	3.59		5,360
LIFT-HWYT-L2U3	-7,324	-2,936	2.49		-4,088	10,281		N/A		N/A
LIFT-HWYT-U3L4	-5,694		N/A		N/A	8,116	2,067	3.93		3,256
LIFT-HWYT-L4U5	-6,248	-1,215	5.14		-2,126	8,985		N/A		N/A
LIFT-HWYT-U5L6	-5,392		N/A		-676	7,853	458	17.1		1,579
LIFT-HWYT-U0L0	-19,938		N/A		N/A	29,884	5,158	5.79		5,275
LIFT-HWYT-U1L1	-7,393		N/A		N/A	12,229	536	22.8		1,339
LIFT-HWYT-U2L2	-6,051	-218	27.8		-156	10,391		N/A		N/A
LIFT-HWYT-U3L3	-6,627		N/A		N/A	12,229	550	22.2		1,374
LIFT-HWYT-U4L4	-5,637	-222	25.4		-156	10,391		N/A		N/A
LIFT-HWYT-U5L5	-6,404		N/A		N/A	12,229	534	22.9		1,388
LIFT-HWYT-U6L6	-5,537	-228	24.3		-187	10,391		N/A		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Capacity Summary
Lift Span - Highway Truss
Closed Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-HWYT-L0L2	-8,888		N/A		N/A	9,923	4,123	2.41		4,021
LIFT-HWYT-L2L4	-15,713		N/A		N/A	17,514	7,953	2.20		8,682
LIFT-HWYT-L4L6	-22,851		N/A		N/A	26,494	9,753	2.72		10,791
LIFT-HWYT-U0U1	-10,517	-22	N/A		N/A	11,455	414	27.7		N/A
LIFT-HWYT-U1U3	-14,951	-6,239	2.40		-6,801	16,288		N/A		N/A
LIFT-HWYT-U3U5	-20,867	-9,214	2.26		-10,106	22,730		N/A		N/A
LIFT-HWYT-U5U6	-21,840	-10,068	2.17		-11,084	23,796		N/A		N/A
LIFT-HWYT-L0U1	-27,472	-6,920	3.97		-6,205	32,117		N/A		N/A
LIFT-HWYT-U1L2	-10,258		N/A		N/A	13,959	4,787	2.92		5,360
LIFT-HWYT-L2U3	-7,324	-3,567	2.05		-4,088	10,281		N/A		N/A
LIFT-HWYT-U3L4	-5,694		N/A		N/A	8,116	2,667	3.04		3,256
LIFT-HWYT-L4U5	-6,248	-1,506	4.15		-2,126	8,985		N/A		N/A
LIFT-HWYT-U5L6	-5,392		N/A		-676	7,853	654	12.0		1,579
LIFT-HWYT-U0L0	-19,938	-376	53.0		N/A	29,884		N/A		5,275
LIFT-HWYT-U1L1	-7,393		N/A		N/A	12,229	720	17.0		1,339
LIFT-HWYT-U2L2	-6,051	-302	20.0		-156	10,391		N/A		N/A
LIFT-HWYT-U3L3	-6,627		N/A		N/A	12,229	1,058	11.6		1,374
LIFT-HWYT-U4L4	-5,637	-195	28.9		-156	10,391	89	N/A		N/A
LIFT-HWYT-U5L5	-6,404		N/A		N/A	12,229	906	13.5		1,388
LIFT-HWYT-U6L6	-5,537	-229	24.2		-187	10,391		N/A		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Capacity Summary
Lift Span - Railway Truss
Raised Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-RLYT-L0L2	-13,000	-1,962	6.63		N/A	15,100		N/A		6,249
LIFT-RLYT-L2L4	-25,698		N/A		N/A	29,895	1,484	20.1		13,033
LIFT-RLYT-L4L6	-30,864		N/A		N/A	36,172	2,942	12.3		15,986
LIFT-RLYT-U0U1	-10,517		N/A		N/A	11,455	3,747	3.06		N/A
LIFT-RLYT-U1U3	-20,874	-1,977	10.6		-10,230	22,730		N/A		N/A
LIFT-RLYT-U3U5	-36,612	-4,449	8.23		-15,101	41,025		N/A		N/A
LIFT-RLYT-U5U6	-39,425	-5,130	7.69		-16,400	44,398		N/A		N/A
LIFT-RLYT-L0U1	-39,025	-5,755	6.78		-11,298	48,874		N/A		N/A
LIFT-RLYT-U1L2	-13,411		N/A		N/A	20,484	3,974	5.15		8,100
LIFT-RLYT-L2U3	-11,538	-3,032	3.81		-6,298	18,863		N/A		N/A
LIFT-RLYT-U3L4	-8,694		N/A		N/A	14,435	2,136	6.76		5,137
LIFT-RLYT-L4U5	-7,228	-1,251	5.78		-3,692	10,341		N/A		342
LIFT-RLYT-U5L6	-5,392		N/A		-1,913	7,853	472	16.6		3,149
LIFT-RLYT-U0L0	-19,938		N/A		N/A	29,884	5,153	5.80		5,275
LIFT-RLYT-U1L1	-7,393		N/A		N/A	12,229	492	24.9		2,091
LIFT-RLYT-U2L2	-6,051	-261	23.2		-156	10,391		N/A		N/A
LIFT-RLYT-U3L3	-6,627		N/A		N/A	12,229	551	22.2		2,126
LIFT-RLYT-U4L4	-5,637	-263	21.4		-178	10,391		N/A		N/A
LIFT-RLYT-U5L5	-6,404		N/A		N/A	12,229	537	22.8		2,139
LIFT-RLYT-U6L6	-5,537	-269	20.6		-187	10,391		N/A		N/A

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Member Capacity Summary
Lift Span - Railway Truss
Closed Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-RLYT-L0L2	-13,000		N/A		N/A	15,100	3,980	3.79		6,249
LIFT-RLYT-L2L4	-25,698		N/A		N/A	29,895	8,049	3.71		13,033
LIFT-RLYT-L4L6	-30,864		N/A		N/A	36,172	9,113	3.97		15,986
LIFT-RLYT-U0U1	-10,517	-449	23.4		N/A	11,455	1,139	10.1		N/A
LIFT-RLYT-U1U3	-20,874	-6,763	3.09		-10,230	22,730		N/A		N/A
LIFT-RLYT-U3U5	-36,612	-10,007	3.66		-15,101	41,025		N/A		N/A
LIFT-RLYT-U5U6	-39,425	-10,891	3.62		-16,400	44,398		N/A		N/A
LIFT-RLYT-L0U1	-39,025	-6,741	5.79		-11,298	48,874		N/A		N/A
LIFT-RLYT-U1L2	-13,411		N/A		N/A	20,484	4,872	4.20		8,100
LIFT-RLYT-L2U3	-11,538	-3,601	3.20		-6,298	18,863		N/A		N/A
LIFT-RLYT-U3L4	-8,694		N/A		N/A	14,435	2,649	5.45		5,137
LIFT-RLYT-L4U5	-7,228	-1,567	4.61		-3,692	10,341		N/A		342
LIFT-RLYT-U5L6	-5,392		N/A		-1,913	7,853	644	12.2		3,149
LIFT-RLYT-U0L0	-19,938	-406	49.1		N/A	29,884		N/A		5,275
LIFT-RLYT-U1L1	-7,393		N/A		N/A	12,229	690	17.7		2,091
LIFT-RLYT-U2L2	-6,051	-308	19.6		-156	10,391		N/A		N/A
LIFT-RLYT-U3L3	-6,627		N/A		N/A	12,229	782	15.6		2,126
LIFT-RLYT-U4L4	-5,637	-315	17.9		-178	10,391		N/A		N/A
LIFT-RLYT-U5L5	-6,404		N/A		N/A	12,229	775	15.8		2,139
LIFT-RLYT-U6L6	-5,537	-340	16.3		-187	10,391		N/A		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Capacity Summary
Lift Span - Non-truss Members
Raised Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-TLAT	-960	-688	1.40		-600	2,605	694	3.75		600
LIFT-BLAT	-960	-732	1.31		-544	2,605	857	3.04		544
LIFT-PORT-BSTR	-2,910	-17	N/A		-371	4,154	148	28.1		371
LIFT-PORT-LATD	-497	-71	7.00		N/A	1,398	91	15.4		N/A
LIFT-PORT-LATL	-1,202	-99	12.1		N/A	1,398	92	15.2		N/A
LIFT-PORT-LATT	-1,164	-120	9.70		N/A	1,398	113	12.4		N/A
LIFT-PORT-SWBC	N/A		N/A		-463	1,988	118	16.8		463
LIFT-PORT-SWBV	-1,276	0	N/A		-49	1,398	36	38.8		49
LIFT-SWAY-BSTR	-1,449	-22	65.9		N/A	2,063	69	29.9		N/A
LIFT-SWAY-SWBC	N/A		N/A		N/A	1,988	82	24.2		N/A
LIFT-SWAY-SWBV	-726	-20	36.3		N/A	1,988	17	N/A		N/A
LIFT-SWAY-TSTR	-1,819	-323	5.63		-767	2,036	302	6.74		767
C12X20.7	-627	-12	52.2		N/A	857	13	65.9		N/A
C310X37	-800	-11	72.7		N/A	1,031	12	85.9		N/A
2L3-1/2x3-1/2x3/8	-478	-80	5.98		-258	699	83	8.42		N/A
2L4x4x3/8	-378	-138	2.74		-165	808	75	10.8		165
2L5x5x3/8	-498	-70	7.12		-120	1,018	70	14.5		120
2L6x6x1/2	N/A		N/A		-325	1,617	104	15.5		325

Member Capacity Summary - Lift Span - Bending Only Members

Member ID	Bending					Shear				
	M_r kNm	M_f kNm	M_r/M_f	Comments	M* kNm	V_r kN	V_f kN	V_r/V_f	Comments	V* kN
LIFT-FLBM-END	10,258	315	32.6		N/A	3,172	79	40.2		N/A
LIFT-FLBM-INT	14,295	631	22.7		N/A	3,569	158	22.6		N/A
LIFT-LFGR	25,969	13,779	1.88		N/A	12,046	6,284	1.92		N/A
Lift Span Stringers:										
W24x84 (Original Highway)	802	30	26.7		N/A	859	13	66.1		N/A
W610x125 (1982 Modification)	1,071	30	35.7		N/A	1,397	13	N/A		N/A
Railway Stringers:										
W36x230	3,158	50	63.2		N/A	2,063	22	93.8		N/A

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N/A indicates that the member is not listed in the stress sheets

Member Capacity Summary
Lift Span - Non-truss Members
Closed Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-TLAT	-960	-536	1.79		-600	2,605	538	4.84		600
LIFT-BLAT	-960	-557	1.72		-544	2,605	948	2.75		544
LIFT-PORT-BSTR	-2,910	-40	72.8		-371	4,154	72	57.7		371
LIFT-PORT-LATD	-497	-77	6.46		N/A	1,398	66	21.2		N/A
LIFT-PORT-LATL	-1,202	-77	15.6		N/A	1,398	66	21.2		N/A
LIFT-PORT-LATT	-1,164	-93	12.5		N/A	1,398	82	17.1		N/A
LIFT-PORT-SWBC	N/A	0	N/A		-463	1,988	98	20.3		463
LIFT-PORT-SWBV	-1,276	0	N/A		-49	1,398	45	31.1		49
LIFT-SWAY-BSTR	-1,449	-36	40.3		N/A	2,063	70	29.5		N/A
LIFT-SWAY-SWBC	N/A	0	N/A		N/A	1,988	87	22.8		N/A
LIFT-SWAY-SWBV	-726	-46	15.8		N/A	1,988	23	86.4		N/A
LIFT-SWAY-TSTR	-1,819	-278	6.54		-767	2,036	212	9.61		767
C12X20.7	-627	-137	4.58		N/A	857	644	1.33		N/A
C310X37	-800	-89	8.99		N/A	1,031	618	1.67		N/A
2L3-1/2x3-1/2x3/8	-478	-220	2.17		-258	699	65	10.8		N/A
2L4x4x3/8	-378	-304	1.24		-165	808	143	5.65		165
2L5x5x3/8	-498	-253	1.97		-120	1,018	252	4.04		120
2L6x6x1/2	N/A	0	N/A		-325	1,617	471	3.43		325

Member Capacity Summary - Lift Span - Bending Only Members

Member ID	Bending					Shear				
	M_r kNm	M_f kNm	M_r/M_f	Comments	M* kNm	V_r kN	V_f kN	V_r/V_f	Comments	V* kN
LIFT-FLBM-END	10,258	4,021	2.55		3,002	3,172	1,006	3.15		1,025
LIFT-FLBM-INT	14,295	8,041	1.78		6,493	3,569	2,012	1.77		2,007
LIFT-LFGR	25,969	10,081	2.58		N/A	12,046	4,624	2.61		N/A
Lift Span Stringers:										
W24x84 (Original Highway)	802	695	1.15		317	859	335	2.57		142
W610x125 (1982 Modification)	1,071	695	1.54		231	1,397	335	4.17		129
Railway Stringers:										
W36x230	3,158	68	46.4		1,619	2,063	21	98.3		783

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Member Capacity Summary
Tower - Raised Lift Span

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
TOWR-BBRC-MDIA	-3,529	-1,223	2.89		-547	4,569	658	6.94		547
TOWR-BBRC-RcRc	-12,120	0	N/A		-498	14,200	143	99.3		498
TOWR-BBRC-RdRd	-3,642	-272	13.4		-125	4,149	374	11.1		125
TOWR-BBRC-ReRe	-3,662	0	N/A		-85	4,149	490	8.47		85
TOWR-BBRC-RfRf	-3,662	-509	7.19		-231	4,149	609	6.81		231
TOWR-BBRC-RgRg	-16,282	0	N/A		-81	18,732	329	56.9		81
TOWR-BBRC-UDIA	-3,529	-803	4.40		-520	4,569	452	10.11		520
TOWR-BLAT-FRTL	-345	0	N/A		N/A	1,722	608	2.83		N/A
TOWR-BLAT-HWYL	-458	0	N/A		N/A	2,255	18	N/A		N/A
TOWR-BLAT-RLYL	-693	0	N/A		N/A	2,762	608	4.54		N/A
TOWR-FBRC-CdCe	-47	0	N/A		N/A	1,407	23	61.2		N/A
TOWR-FBRC-FdFd	-4,046	-20	N/A		-796	4,569	601	7.60		396
TOWR-FBRC-FeFe	-4,018	0	N/A		-934	4,569	1,031	4.43		356
TOWR-FBRC-FfFf	-4,606	-1,330	3.46		-1,228	5,207	1,608	3.24		480
TOWR-FBRC-FgFg	-20,236	0	N/A		-947	22,858	584	39.1		423
TOWR-FBRC-MDIA	-4,126	-4,001	1.03	*Cf/Cr < 1.15*	-1,766	5,207	2,371	2.20		1,766
TOWR-FBRC-MdMe	-281	-74	3.80		N/A	1,407	56	25.1		N/A
TOWR-FBRC-UDIA	-3,526	-2,096	1.68		-1,317	4,569	607	7.53		1,317
TOWR-FCOL-BCOL	-68,627	-32,221	2.13		-19,878	76,189	0	N/A		0
TOWR-FCOL-MCOL	-57,560	-24,267	2.37		-17,027	63,328	0	N/A		0
TOWR-FCOL-UCOL	-39,131	-18,420	2.12		-13,838	42,738	0	N/A		0
TOWR-RCOL-BCOL	-22,570	-18,464	1.22		-7,584	24,936	9,109	2.74		2,273
TOWR-RCOL-MCOL	-22,833	-11,008	2.07		-5,520	24,936	4,550	5.48		503
TOWR-RCOL-UCOL	-22,833	-5,703	4.00		-3,745	24,936	0	N/A		0
TOWR-SBRC-DIAG	-3,717	-3,914	0.95	*Cf/Cr < 1.0*	-1,432	4,149	3,328	1.25		1,432
TOWR-SBRC-FgRg	-4,474	0	N/A		-356	5,207	564	9.2		818
TOWR-SBRC-FhRh	-26,305	-717	36.7		0	28,613	1,259	22.7		0
TOWR-SBRC-HORZ	-3,912	0	N/A		-565	4,569	1,065	4.29		805
TOWR-SBRC-SbFc	-4,167	-1,190	3.50		-694	4,179	492	8.49		694
2L3.5x3.5x.375	-569	-387	1.47		N/A	699	403	1.73		N/A
2L4x4x.375	-467	-31	15.1		N/A	808	26	31.1		N/A
2L5x3.5x.375	N/A	0	N/A		N/A	861	104	8.28		N/A
2L5x5x.5	N/A	0	N/A		N/A	1,337	5	N/A		N/A
2L6x6x.375	-590	-294	2.01		N/A	1,337	300	4.46		N/A
C15x33.9	-848	-1	N/A		N/A	1,405	4	N/A		N/A
C380x50	-805	-5	N/A		N/A	1,405	1	N/A		N/A
L4x4x.375	-234	0	N/A		N/A	404	0	N/A		N/A
L5x5x.375	-222	-26	8.54		N/A	509	31	16.4		N/A
L5x5x.5	-267	-9	29.6		N/A	669	9	74.3		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member ID	Bending									
	M_r	M_f	M_r/M_f	Comments	M*	V_r	V_f	V_r/V_f	Comments	V*
	kNm	kNm			kNm	kNm	kNm			kN
TOWR-FLBM-FRNT	8,548	1,560	5.48		2,502	2,887	387	7.46		1,681
TOWR-FLBM-REAR	9,116	3,379	2.70		3,417	3,614	844	4.28		1,855
TOWR-SHVG-G1	10,304	2,241	4.60		2,138	5,094	3,492	1.46		2,851
TOWR-SHVG-G2G3	12,187	2,254	5.41		2,252	5,094	3,498	1.46		2,584
TOWR-SHVG-G4	10,304	2,369	4.35		2,604	5,094	3,560	1.43		3,087
TOWR-SHVG-G6	12,865	999	12.9		423	3,396	235	14.5		138
TOWR-SHVG-G7	100,442	42,238	2.38		38,222	19,473	14,236	1.37		12,566
TOWR-SHVG-G8	20,306	4,819	4.21		6,465	5,341	1,567	3.41		1,922
Tower Span Stringers:										
W27x102 (Original Highway)	1,093	230	4.75		155	1,136	95	12.0		67
W690x152 (1982 Modification)	1,663	230	7.23		362	1,729	95	18.2		71
Approach Span Stringers:										
W33x130 (Original Highway)	1,665	388	4.29		243	1,557	123	12.7		77
W840x193 (1982 Modification)	2,534	388	6.53		362	2,369	123	19.3		116

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Capacity Summary
Tower - Closed Lift Span

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
TOWR-BBRC-MDIA	-3,529	-1,660	2.13		-547	4,569	1,225	3.73		547
TOWR-BBRC-RcRc	-12,120	0	N/A		-498	14,200	99	N/A		498
TOWR-BBRC-RdRd	-3,642	-98	37.2		-125	4,149	16	N/A		125
TOWR-BBRC-ReRe	-3,662	0	N/A		-71	4,149	329	12.6		71
TOWR-BBRC-RfRf	-3,662	0	N/A		-231	4,149	848	4.89		231
TOWR-BBRC-RgRg	-16,282	0	N/A		-81	18,732	226	82.9		81
TOWR-BBRC-UDIA	-3,529	-423	8.3		-520	4,569	72	63.5		520
TOWR-BLAT-FRTL	-345	0	N/A		N/A	1,722	554	3.11		N/A
TOWR-BLAT-HWYL	-458	0	N/A		N/A	2,255	509	4.43		N/A
TOWR-BLAT-RLYL	-693	0	N/A		N/A	2,762	26	N/A		N/A
TOWR-FBRC-CdCe	-47	0	N/A		N/A	1,407	63	22.3		N/A
TOWR-FBRC-FdFd	-4,046	0	N/A		-796	4,569	366	12.5		396
TOWR-FBRC-FeFe	-4,018	0	N/A		-934	4,569	810	5.64		356
TOWR-FBRC-FfFf	-4,606	-1,140	4.04		-1,228	5,207	1,366	3.81		480
TOWR-FBRC-FgFg	-20,236	0	N/A		-947	22,858	459	49.8		423
TOWR-FBRC-MDIA	-4,126	-3,139	1.31		-1,766	5,207	1,777	2.93		1,766
TOWR-FBRC-MdMe	-281	-31	9.06		N/A	1,407	69	20.4		N/A
TOWR-FBRC-UDIA	-3,526	-1,384	2.55		-1,317	4,569	166	27.5		1,317
TOWR-FCOL-BCOL	-68,627	-19,458	3.53		-19,878	76,189	0	N/A		0
TOWR-FCOL-MCOL	-57,560	-16,596	3.47		-17,027	63,328	0	N/A		0
TOWR-FCOL-UCOL	-39,131	-14,547	2.69		-13,838	42,738	0	N/A		0
TOWR-RCOL-BCOL	-22,570	-6,602	3.42		-7,584	24,936	0	N/A		2,289
TOWR-RCOL-MCOL	-22,833	-3,920	5.82		-5,520	24,936	0	N/A		503
TOWR-RCOL-UCOL	-22,833	-2,578	8.9		-3,745	24,936	0	N/A		0
TOWR-SBRC-DIAG	-3,717	-1,589	2.34		-1,432	4,149	919	4.52		1,432
TOWR-SBRC-FgRg	-4,474	0	N/A		-356	5,207	485	10.7		818
TOWR-SBRC-FhRh	-26,305	-72	N/A		0	28,613	568	50.4		0
TOWR-SBRC-HORZ	-3,912	0	N/A		-565	4,569	452	10.1		805
TOWR-SBRC-SbFc	-4,167	-534	7.80		-694	4,179	82	51.0		694
2L3.5x3.5x.375	-569	-110	5.17		N/A	699	127	5.51		N/A
2L4x4x.375	-467	-25	18.7		N/A	808	26	31.1		N/A
2L5x3.5x.375	N/A	0	N/A		N/A	861	35	24.6		N/A
2L5x5x.5	N/A	0	N/A		N/A	1,337	7	N/A		N/A
2L6x6x.375	-590	-118	5.00		N/A	1,337	122	11.0		N/A
C15x33.9	-848	-4	N/A		N/A	1,405	3	N/A		N/A
C380x50	-805	-3	N/A		N/A	1,405	4	N/A		N/A
L4x4x.375	-234	0	N/A		N/A	404	0	N/A		N/A
L5x5x.375	-222	-27	8.22		N/A	509	26	19.6		N/A
L5x5x.5	-267	-13	20.5		N/A	669	13	51.4		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member ID	Bending					Shear				
	M_r kNm	M_f kNm	M_r/M_f	Comments	M* kNm	V_r kN	V_f kN	V_r/V_f	Comments	V* kN
TOWR-FLBM-FRNT	8,548	3,897	2.19		2,502	2,887	1,007	2.87		1,681
TOWR-FLBM-REAR	9,116	7,307	1.25		3,417	3,614	1,891	1.91		1,855
TOWR-SHVG-G1	10,304	1,775	5.80		2,138	5,094	2,750	1.85		2,851
TOWR-SHVG-G2G3	12,187	1,786	6.82		2,252	5,094	2,755	1.85		2,584
TOWR-SHVG-G4	10,304	1,894	5.44		2,604	5,094	2,812	1.81		3,087
TOWR-SHVG-G6	12,865	618	20.8		423	3,396	146	23.3		138
TOWR-SHVG-G7	100,442	33,498	3.00		38,222	19,473	10,610	1.84		12,566
TOWR-SHVG-G8	20,306	4,000	5.08		6,465	5,341	1,274	4.19		1,922
Tower Span Stringers:										
W27x102 (Original Highway)	1,093	921	1.19		541	1,136	423	2.69		276
W690x152 (1982 Modification)	1,663	921	1.81		271	1,729	423	4.09		503
Approach Span Stringers:										
W33x130 (Original Highway)	1,665	1,344	1.24		766	1,557	491	3.17		282
W840x193 (1982 Modification)	2,534	1,344	1.89		860	2,369	491	4.82		307

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

APPENDIX D
LIFT SPAN *HIGHWAY* TRUSS
CAPACITY SPREADSHEETS

Member Capacity Summary
Lift Span - Highway Truss
Raised Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-HWYT-L0L2	-8,888	-2,574	3.45		N/A	9,923		N/A		4,021
LIFT-HWYT-L2L4	-15,713		N/A		N/A	17,514	1,446	12.1		8,682
LIFT-HWYT-L4L6	-22,851		N/A		N/A	26,494	2,952	9.0		10,791
LIFT-HWYT-U0U1	-10,517		N/A		N/A	11,455	3,680	3.11		N/A
LIFT-HWYT-U1U3	-14,951	-1,626	9.19		-6,801	16,288		N/A		N/A
LIFT-HWYT-U3U5	-20,867	-3,947	5.29		-10,106	22,730		N/A		N/A
LIFT-HWYT-U5U6	-21,840	-4,722	4.63		-11,084	23,796		N/A		N/A
LIFT-HWYT-L0U1	-27,472	-5,719	4.80		-6,205	32,117		N/A		N/A
LIFT-HWYT-U1L2	-10,258		N/A		N/A	13,959	3,893	3.59		5,360
LIFT-HWYT-L2U3	-7,324	-2,936	2.49		-4,088	10,281		N/A		N/A
LIFT-HWYT-U3L4	-5,694		N/A		N/A	8,116	2,067	3.93		3,256
LIFT-HWYT-L4U5	-6,248	-1,215	5.14		-2,126	8,985		N/A		N/A
LIFT-HWYT-U5L6	-5,392		N/A		-676	7,853	458	17.1		1,579
LIFT-HWYT-U0L0	-19,938		N/A		N/A	29,884	5,158	5.79		5,275
LIFT-HWYT-U1L1	-7,393		N/A		N/A	12,229	536	22.8		1,339
LIFT-HWYT-U2L2	-6,051	-218	27.8		-156	10,391		N/A		N/A
LIFT-HWYT-U3L3	-6,627		N/A		N/A	12,229	550	22.2		1,374
LIFT-HWYT-U4L4	-5,637	-222	25.4		-156	10,391		N/A		N/A
LIFT-HWYT-U5L5	-6,404		N/A		N/A	12,229	534	22.9		1,388
LIFT-HWYT-U6L6	-5,537	-228	24.3		-187	10,391		N/A		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Capacity Summary
Lift Span - Highway Truss
Closed Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-HWYT-L0L2	-8,888		N/A		N/A	9,923	4,123	2.41		4,021
LIFT-HWYT-L2L4	-15,713		N/A		N/A	17,514	7,953	2.20		8,682
LIFT-HWYT-L4L6	-22,851		N/A		N/A	26,494	9,753	2.72		10,791
LIFT-HWYT-U0U1	-10,517	-22	N/A		N/A	11,455	414	27.7		N/A
LIFT-HWYT-U1U3	-14,951	-6,239	2.40		-6,801	16,288		N/A		N/A
LIFT-HWYT-U3U5	-20,867	-9,214	2.26		-10,106	22,730		N/A		N/A
LIFT-HWYT-U5U6	-21,840	-10,068	2.17		-11,084	23,796		N/A		N/A
LIFT-HWYT-L0U1	-27,472	-6,920	3.97		-6,205	32,117		N/A		N/A
LIFT-HWYT-U1L2	-10,258		N/A		N/A	13,959	4,787	2.92		5,360
LIFT-HWYT-L2U3	-7,324	-3,567	2.05		-4,088	10,281		N/A		N/A
LIFT-HWYT-U3L4	-5,694		N/A		N/A	8,116	2,667	3.04		3,256
LIFT-HWYT-L4U5	-6,248	-1,506	4.15		-2,126	8,985		N/A		N/A
LIFT-HWYT-U5L6	-5,392		N/A		-676	7,853	654	12.0		1,579
LIFT-HWYT-U0L0	-19,938	-376	53.0		N/A	29,884		N/A		5,275
LIFT-HWYT-U1L1	-7,393		N/A		N/A	12,229	720	17.0		1,339
LIFT-HWYT-U2L2	-6,051	-302	20.0		-156	10,391		N/A		N/A
LIFT-HWYT-U3L3	-6,627		N/A		N/A	12,229	1,058	11.6		1,374
LIFT-HWYT-U4L4	-5,637	-195	28.9		-156	10,391	89	N/A		N/A
LIFT-HWYT-U5L5	-6,404		N/A		N/A	12,229	906	13.5		1,388
LIFT-HWYT-U6L6	-5,537	-229	24.2		-187	10,391		N/A		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Location: Lift Span Highway Truss
Member Description: Bottom Chord
Member ID: LIFT-HWYT-L0L2
S-Frame End Nodes: Node 27 to Node 29

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 8x6x1/2	Bot Ls 8x6x1/2
Qty	1	1	2	2	2
y_{dim} (mm)	584	584	11.1	152	152
z_{dim} (mm)	9.5	9.5	762	203	203
I_{y1} ($x10^6mm^4$)	0	0	409	18.40	18.40
I_{z1} ($x10^6mm^4$)	158	158	0	8.96	8.96
A_g (mm^2)	5,548	5,548	8,458	4,350	4,350
y_{bar} (mm)	0	0	306	263	263
z_{bar} (mm)	391	391	0	325	325
I_y ($x10^6mm^4$)	848	848	819	956	956
I_z ($x10^6mm^4$)	158	158	1,584	620	620

A_g = 45,412 mm^2

I_y = 4,426 $x10^6$ mm^4
I_z = 3,139 $x10^6$ mm^4
r_y = 312 mm
r_z = 263 mm

Moment (demand) from original stress sheets: 33 kNm
Moment (demand) from S-Frame model: 116 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-L0L2*

	L_y =	9,398	mm		
	L_z =	9,398	mm		
	K_y =	1.00			
	K_z =	1.00			
	Web h	356	mm		
	Web w	11.1	mm		
	Flange b	280	mm		
	Flange t	9.5	mm		
	n =	1.34			
	Lift Span Raised: C_f =	-2,574	kN		
	Lift Span Lowered: C_f =	0	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			
Cl. 10.9.1.3	Slenderness Ratio =	36	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	32	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	29	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 9,070 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 8,888 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.325$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.386$$

C_r = -8,888 kN Compressive Capacity (Factored)

C_r / C_f = 3.45 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-L0L2*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	4,123	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	9,923	kN	Gross Section
	T_r =	9,923	kN	Tensile Capacity (Factored)
	T_r / T_f =	2.41		

Member Location: Lift Span Highway Truss
Member Description: Bottom Chord
Member ID: LIFT-HWYT-L2L4
S-Frame End Nodes: Node 29 to Node 31

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Web Plates	Web Plates	Top Ls 8x6x1/2	Bot Ls 8x6x1/2
Qty	1	1	2	2	2	2	2
y_{dim} (mm)	533	533	17.5	11.1	12.7	152	152
z_{dim} (mm)	9.5	9.5	762	762	356	203	203
I_{y1} ($x10^6 mm^4$)	0	0	645	409	48	18.40	18.40
I_{z1} ($x10^6 mm^4$)	120	120	0	0	0	8.96	8.96
A_g (mm^2)	5,064	5,064	13,335	8,458	4,521	4,350	4,350
y_{bar} (mm)	0	0	302	288	277	233	233
z_{bar} (mm)	391	391	0	0	0	325	325
I_y ($x10^6 mm^4$)	774	774	1,290	819	95	956	956
I_z ($x10^6 mm^4$)	120	120	2,433	1,403	694	490	490

A_g = 80,156 mm^2

I_y = 5,664 $x10^6$ mm^4
I_z = 5,751 $x10^6$ mm^4
r_y = 266 mm
r_z = 268 mm

Moment (demand) from original stress sheets: 57 kNm
Moment (demand) from S-Frame model: 77 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-L2L4*

	L_y =	9,398	mm			
	L_z =	9,398	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	356	mm			
	Web w	47.7	mm			
	Flange b	229	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	35		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	7		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	24		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 15,713 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 15,730 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.382$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.379$$

C_r = -15,713 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-L2L4*

	Lift Span Raised: T_f =	1,446	kN	
	Lift Span Lowered: T_f =	7,953	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	17,514	kN	Gross Section

T_r = 17,514 kN Tensile Capacity (Factored)

T_r / T_f = 2.20 Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Bottom Chord
Member ID: LIFT-HWYT-L4L6
S-Frame End Nodes: Node 31 to Node 39

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Web Plates	Web Plates	Top Ls 8x6x1/2	Bot Ls 8x6x1/2
Qty	1	1	2	2	2	2	2
y_{dim} (mm)	508	508	17.5	11.1	12.7	152	152
z_{dim} (mm)	9.5	9.5	762	762	356	203	203
I_{y1} ($x10^6 mm^4$)	0	0	645	409	48	18.40	18.40
I_{z1} ($x10^6 mm^4$)	104	104	0	0	0	8.96	8.96
A_g (mm^2)	4,826	4,826	13,335	8,458	4,521	4,350	4,350
y_{bar} (mm)	0	0	302	288	277	233	233
z_{bar} (mm)	391	391	0	0	0	325	325
I_y ($x10^6 mm^4$)	738	738	1,290	819	95	956	956
I_z ($x10^6 mm^4$)	104	104	2,433	1,403	694	490	490

A_g = 79,681 mm^2

I_y = 5,592 $x10^6$ mm^4
I_z = 5,718 $x10^6$ mm^4
r_y = 265 mm
r_z = 268 mm

Moment (demand) from original stress sheets: 57 kNm
Moment (demand) from S-Frame model: 94 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-L4L6*

	L_y =	9,398	mm			
	L_z =	9,398	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	356	mm			
	Web w	60.4	mm			
	Flange b	229	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	35		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	6		<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	24		<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 22,851 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 22,911 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.472$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.467$$

C_r = -22,851 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-L4L6*

	Lift Span Raised: T_f =	2,952	kN	
	Lift Span Lowered: T_f =	9,753	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	26,494	kN	Gross Section
	T_r =	26,494	kN	Tensile Capacity (Factored)
	T_r / T_f =	2.72		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Top Chord
Member ID: LIFT-HWYT-U0U1
S-Frame End Nodes: Node 33 to Node 34

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 4x4x7/16	Bot Ls 4x4x7/16
Qty	1	1	2	2	2
y_{dim} (mm)	965	965	12.7	102	102
z_{dim} (mm)	12.7	12.7	762	102	102
I_{y1} ($x10^6 mm^4$)	0	0	468	2.09	2.09
I_{z1} ($x10^6 mm^4$)	951	951	0	2.09	2.09
A_g (mm^2)	12,256	12,256	9,677	2,140	2,140
y_{bar} (mm)	0	0	336	372	372
z_{bar} (mm)	385	395	8	349	359
I_y ($x10^6 mm^4$)	1,817	1,912	938	527	556
I_z ($x10^6 mm^4$)	951	951	2,185	596	596

A_g =	52,426	mm^2
I_y =	5,749	$x10^6$ mm^4
I_z =	5,280	$x10^6$ mm^4
r_y =	331	mm
r_z =	317	mm

Moment (demand) from original stress sheets: N/A
Moment (demand) from S-Frame model: 64 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-U0U1*

	L_y =	9,482	mm
	L_z =	7,087	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	571	mm
	w	12.7	mm
Flange	b	660	mm
	t	12.7	mm
	n =	1.34	
	Lift Span Raised: C_f =	0	kN
	Lift Span Lowered: C_f =	-22	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =		29	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web	h/w =	45	>	44	*Cl. 10.9.2.1 NOT Satisfied*
	Flanges	b/t =	52	>	44	*Cl. 10.9.2.1 NOT Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 10,517 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 10,677 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.309$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.241$$

C_r =	-10,517	kN	Compressive Capacity (Factored)
C_r / C_f =	478.03		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U0U1*

	Lift Span Raised: T_f =	3,680	kN	
	Lift Span Lowered: T_f =	414	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	11,455	kN	Gross Section
	T_r =	11,455	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.11		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Top Chord
Member ID: LIFT-HWYT-U1U3
S-Frame End Nodes: Node 34 to Node 35

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 4x4x7/16	Bot Ls 8x6x9/16
Qty	1	1	2	2	2
y_{dim} (mm)	965	1,067	17.5	102	152
z_{dim} (mm)	17.5	15.9	762	102	203
I_{y1} ($x10^6 mm^4$)	0	0	645	2.09	20.4
I_{z1} ($x10^6 mm^4$)	1,311	1,610	0	2.09	9.9
A_g (mm^2)	16,888	16,965	13,335	2,140	4,870
y_{bar} (mm)	0	0	339	377	385
z_{bar} (mm)	388	403	8	350	332
I_y ($x10^6 mm^4$)	2,543	2,756	1,292	528	1,114
I_z ($x10^6 mm^4$)	1,311	1,610	3,066	612	1,464

A_g = 74,543 mm^2

I_y = 8,233 $x10^6$ mm^4
I_z = 8,062 $x10^6$ mm^4
r_y = 332 mm
r_z = 329 mm

Moment (demand) from original stress sheets: 53 kNm
Moment (demand) from S-Frame model: 76 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-U1U3*

	L_y =	9,436	mm
	L_z =	9,436	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	571	mm
	w	25.4	mm
Flange	b	660	mm
	t	22.2	mm
	n =	1.34	
	Lift Span Raised: C_f =	-1,626	kN
	Lift Span Lowered: C_f =	-6,239	kN

Cl. 10.5.7 (c) Compression: φ_s = 0.90

Cl. 10.9.1.3	Slenderness Ratio =	29	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	22.48031	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	30	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 14,963 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 14,951 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.306$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.310$$

C_r = -14,951 kN Compressive Capacity (Factored)

C_r / C_f = 2.40 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U1U3*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	16,288	kN	Gross Section
	T_r =	16,288	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Highway Truss
Member Description: Top Chord
Member ID: LIFT-HWYT-U3U5
S-Frame End Nodes: Node 35 to Node 36

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 4x4x7/16	Bot Ls 8x6x3/4
Qty	1	1	2	2	2
y_{dim} (mm)	965	1,067	25.4	102	152
z_{dim} (mm)	25.4	22.2	762	102	203
I_{y1} ($x10^6mm^4$)	1	1	937	2.09	26.4
I_{z1} ($x10^6mm^4$)	1,902	2,247	1	2.09	12.7
A_g (mm^2)	24,511	23,687	19,355	2,140	6,420
y_{bar} (mm)	0	0	343	372	382
z_{bar} (mm)	392	402	8	349	326
I_y ($x10^6mm^4$)	3,768	3,829	1,876	527	1,417
I_z ($x10^6mm^4$)	1,902	2,247	4,556	596	1,899

A_g = 104,028 mm^2

I_y = 11,416 $x10^6$ mm^4
I_z = 11,201 $x10^6$ mm^4
r_y = 331 mm
r_z = 328 mm

Moment (demand) from original stress sheets: 75 kNm
Moment (demand) from S-Frame model: 168 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-U3U5*

	L_y =	9,402	mm	
	L_z =	9,402	mm	
	K_y =	1.00		
	K_z =	1.00		
Web	h	571	mm	
	w	38.1	mm	
Flange	b	660	mm	
	t	22.2	mm	
	n =	1.34		
	Lift Span Raised: C_f =	-3,947	kN	
	Lift Span Lowered: C_f =	-9,214	kN	
Cl. 10.5.7 (c)	Compression: φ_s =	0.90		

Cl. 10.9.1.3	Slenderness Ratio =	29	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	14.98688	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	30	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 20,883 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 20,867 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.306$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.309$$

C_r = -20,867 kN Compressive Capacity (Factored)

C_r / C_f = 2.26 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U3U5*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	22,730	kN	Gross Section
	T_r =	22,730	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Highway Truss
Member Description: Top Chord
Member ID: LIFT-HWYT-U5U6
S-Frame End Nodes: Node 36 to Node 52

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Web Plates	Top Ls 4x4x7/16	Bot Ls 8x6x3/4
Qty	1	1	2	2	2	2
y_{dim} (mm)	965	1,067	12.7	15.9	102	152
z_{dim} (mm)	25.4	22.2	762	762	102	203
I_{y1} ($x10^6mm^4$)	1	1	468	586	2.09	26.4
I_{z1} ($x10^6mm^4$)	1,902	2,247	0	0	2.09	12.7
A_g (mm^2)	24,511	23,687	9,677	12,116	2,140	6,420
y_{bar} (mm)	0	0	336	351	388	398
z_{bar} (mm)	392	402	8	8	349	326
I_y ($x10^6mm^4$)	3,768	3,829	938	1,174	527	1,417
I_z ($x10^6mm^4$)	1,902	2,247	2,185	2,986	649	2,059

A_g =	108,905	mm^2
I_y =	11,653	$x10^6$ mm^4
I_z =	12,028	$x10^6$ mm^4
r_y =	327	mm
r_z =	332	mm

Moment (demand) from original stress sheets: 77 kNm
Moment (demand) from S-Frame model: 176 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results

LIFT-HWYT-U5U6

		L_y =	9,398	mm
		L_z =	9,398	mm
		K_y =	1.00	
		K_z =	1.00	
	Web	h	571	mm
		w	49.0	mm
	Flange	b	660	mm
		t	22.2	mm
		n =	1.34	
		Lift Span Raised: C_f =	-4,722	kN
		Lift Span Lowered: C_f =	-10,068	kN
Cl. 10.5.7 (c)		Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	29	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	12	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	30	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 21,840 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 21,868 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.310$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.305$$

C_r =	-21,840	kN	Compressive Capacity (Factored)
C_r / C_f =	2.17		Capacity over Demand Ratio (C/D)

Tension Results

LIFT-HWYT-U5U6

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	23,796	kN	Gross Section
	T_r =	23,796	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Highway Truss
Member Description: Diagonal
Member ID: LIFT-HWYT-L0U1
S-Frame End Nodes: Node 27 to Node 34

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates	Web Plates	Top Ls 4x4x3/4	Bot Ls 8x6x3/4
Qty	1	1	4	2	2	2
y_{dim} (mm)	965	1,067	19.1	19.1	102	152
z_{dim} (mm)	25.4	25.4	762	457	102	203
I_{y1} ($x10^6 mm^4$)	1	1	702	152	3.24	26.40
I_{z1} ($x10^6 mm^4$)	1,902	2,571	0	0	3.24	12.70
A_g (mm^2)	24,511	27,102	14,516	8,706	3,530	6,420
y_{bar} (mm)	0	0	351	379	402	409
z_{bar} (mm)	392	408	8	43	347	330
I_y ($x10^6 mm^4$)	3,768	4,513	2,813	335	857	1,451
I_z ($x10^6 mm^4$)	1,902	2,571	7,155	2,502	1,147	2,173

A_g = 146,989 mm^2

I_y = 13,737 $x10^6$ mm^4
I_z = 17,451 $x10^6$ mm^4
r_y = 306 mm
r_z = 345 mm

Moment (demand) from original stress sheets: 2034 kNm*
Moment (demand) from S-Frame model: 446 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for this member due to loads from portal bracing

Compression Results *LIFT-HWYT-L0U1*

	L_y =	17,297	mm	
	L_z =	11,810	mm	
	K_y =	0.80		
	K_z =	1.00		
Web	h	762	mm	
	w	57.1	mm	
Flange	b	663	mm	
	t	25.4	mm	
	n =	1.34		
	Lift Span Raised: C_f =	-5,719	kN	
	Lift Span Lowered: C_f =	-6,920	kN	
Cl. 10.5.7 (c)	Compression: φ_s =	0.90		

Cl. 10.9.1.3	Slenderness Ratio =	57	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	13	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	26	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 27,472 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 28,936 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.489$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.370$$

C_r =	-27,472	kN	Compressive Capacity (Factored)
C_r / C_f =	3.97		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-L0U1*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	32,117	kN	Gross Section
	T_r =	32,117	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Highway Truss
Member Description: Diagonal
Member ID: LIFT-HWYT-U1L2
S-Frame End Nodes: Node 34 to Node 29

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates		Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	2		2	2
y_{dim} (mm)	559	559	25.4		102	102
z_{dim} (mm)	15.9	15.9	762		102	102
I_{y1} ($x10^6mm^4$)	0	0	937		1.84	1.84
I_{z1} ($x10^6mm^4$)	231	231	1		1.84	1.84
A_g (mm^2)	8,888	8,888	19,355		1,850	1,850
y_{bar} (mm)	0	0	297		255	255
z_{bar} (mm)	391	391	0		358	358
I_y ($x10^6mm^4$)	1,359	1,359	1,873	0	478	478
I_z ($x10^6mm^4$)	231	231	3,417	0	244	244

A_g = 63,886 mm^2

I_y = 5,547 $x10^6$ mm^4
I_z = 4,368 $x10^6$ mm^4
r_y = 295 mm
r_z = 261 mm

Moment (demand) from original stress sheets: 98 kNm
Moment (demand) from S-Frame model: 178 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-U1L2*

	L_y =	17,297	mm
	L_z =	17,297	mm
	K_y =	0.80	
	K_z =	1.00	
Web	h	558	mm
	w	22.2	mm
Flange	b	365	mm
	t	9.5	mm
	n =	1.34	
	Lift Span Raised: C_f =	0	kN
	Lift Span Lowered: C_f =	0	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	66	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	25	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	38	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 11,823 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 10,258 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.507$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.714$$

C_r =	-10,258	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U1L2*

	Lift Span Raised: T_f =	3,893	kN	
	Lift Span Lowered: T_f =	4,787	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	13,959	kN	Gross Section
	T_r =	13,959	kN	Tensile Capacity (Factored)
	T_r / T_f =	2.92		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Diagonal
Member ID: LIFT-HWYT-L2U3
S-Frame End Nodes: Node 29 to Node 35

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	2	2	2
y_{dim} (mm)	559	559	19.1	102	102
z_{dim} (mm)	9.5	9.5	762	102	102
I_{y1} ($x10^6mm^4$)	0	0	702	1.84	1.84
I_{z1} ($x10^6mm^4$)	138	138	0	1.84	1.84
A_g (mm^2)	5,311	5,311	14,516	1,850	1,850
y_{bar} (mm)	0	0	300	262	262
z_{bar} (mm)	391	391	0	358	358
I_y ($x10^6mm^4$)	812	812	1,405	478	478
I_z ($x10^6mm^4$)	138	138	2,614	258	258

A_g = 47,053 mm^2

I_y = 3,984 $x10^6$ mm^4
I_z = 3,406 $x10^6$ mm^4
r_y = 291 mm
r_z = 269 mm

Moment (demand) from original stress sheets: 88 kNm
Moment (demand) from S-Frame model: 158 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-L2U3*

	L_y =	18,732	mm			
	L_z =	18,732	mm			
	K_y =	0.80				
	K_z =	1.00				
	Web h	558	mm			
	Web w	25.4	mm			
	Flange b	365	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-2,936	kN			
	Lift Span Lowered: C_f =	-3,567	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	70		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	22		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	38		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 8,463 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 7,324 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.556$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.752$$

C_r = -7,324 kN Compressive Capacity (Factored)

C_r / C_f = 2.05 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-L2U3*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	10,281	kN	Gross Section
	T_r =	10,281	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Highway Truss
Member Description: Diagonal
Member ID: LIFT-HWYT-U3L4
S-Frame End Nodes: Node 35 to Node 31

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	2	2	2
y_{dim} (mm)	572	572	14.3	102	102
z_{dim} (mm)	9.5	9.5	660	102	102
I_{y1} ($x10^6mm^4$)	0	0	343	1.84	1.84
I_{z1} ($x10^6mm^4$)	148	148	0	1.84	1.84
A_g (mm^2)	5,434	5,434	9,438	1,850	1,850
y_{bar} (mm)	0	0	303	267	267
z_{bar} (mm)	342	342	0	308	308
I_y ($x10^6mm^4$)	636	636	685	355	355
I_z ($x10^6mm^4$)	148	148	1,733	267	267

A_g = 37,144 mm^2

I_y = 2,666 $x10^6$ mm^4
I_z = 2,565 $x10^6$ mm^4
r_y = 268 mm
r_z = 263 mm

Moment (demand) from original stress sheets: 69 kNm
Moment (demand) from S-Frame model: 134 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-U3L4*

	L_y =	18,732.0	mm		
	L_z =	18,732	mm		
	K_y =	0.80			
	K_z =	1.00			
	Web h	456	mm		
	Web w	19.1	mm		
	Flange b	368	mm		
	Flange t	9.5	mm		
	n =	1.34			
	Lift Span Raised: C_f =	0	kN		
	Lift Span Lowered: C_f =	0	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			
Cl. 10.9.1.3	Slenderness Ratio =	71	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	24	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	39	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 6,476 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 5,694 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.604$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.770$$

C_r =	-5,694	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U3L4*

	Lift Span Raised: T_f =	2,067	kN	
	Lift Span Lowered: T_f =	2,667	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	8,116	kN	Gross Section
	T_r =	8,116	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.04		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Diagonal
Member ID: LIFT-HWYT-L4U5
S-Frame End Nodes: Node 31 to Node 36

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates		Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	2		2	2
y_{dim} (mm)	559	559	17.5		102	102
z_{dim} (mm)	9.5	9.5	660		102	102
I_{y1} ($x10^6mm^4$)	0	0	419		1.84	1.84
I_{z1} ($x10^6mm^4$)	138	138	0		1.84	1.84
A_g (mm^2)	5,311	5,311	11,550		1,850	1,850
y_{bar} (mm)	0	0	302		265	265
z_{bar} (mm)	342	342	0		308	308
I_y ($x10^6mm^4$)	621	621	839		355	355
I_z ($x10^6mm^4$)	138	138	2,107		264	264

A_g = 41,121 mm^2

I_y = 2,790 $x10^6$ mm^4
I_z = 2,911 $x10^6$ mm^4
r_y = 260 mm
r_z = 266 mm

Moment (demand) from original stress sheets: 77 kNm
Moment (demand) from S-Frame model: 149 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-L4U5*

	L_y =	19,219	mm
	L_z =	19,219	mm
	K_y =	0.80	
	K_z =	1.00	
Web	h	456	mm
	w	22.2	mm
Flange	b	355	mm
	t	9.5	mm
	n =	1.34	
	Lift Span Raised: C_f =	-1,215	kN
	Lift Span Lowered: C_f =	-1,506	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	74	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	21	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	37	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 7,003 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 6,248 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.637$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.780$$

C_r = -6,248 kN Compressive Capacity (Factored)

C_r / C_f = 4.15 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-L4U5*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	8,985	kN	Gross Section

T_r = 8,985 kN Tensile Capacity (Factored)

T_r / T_f = N/A

Member Location: Lift Span Highway Truss
Member Description: Diagonal
Member ID: LIFT-HWYT-U5L6
S-Frame End Nodes: Node 36 to Node 39

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates		Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	2		2	2
y_{dim} (mm)	584	584	14.3		102	102
z_{dim} (mm)	9.5	9.5	610		102	102
I_{y1} ($x10^6mm^4$)	0	0	270		1.84	1.84
I_{z1} ($x10^6mm^4$)	158	158	0		1.84	1.84
A_g (mm^2)	5,548	5,548	8,723		1,850	1,850
y_{bar} (mm)	0	0	303		267	267
z_{bar} (mm)	316	316	0		282	282
I_y ($x10^6mm^4$)	554	554	541		298	298
I_z ($x10^6mm^4$)	158	158	1,602		267	267

A_g = 35,942 mm^2

I_y = 2,245 $x10^6$ mm^4
I_z = 2,452 $x10^6$ mm^4
r_y = 250 mm
r_z = 261 mm

Moment (demand) from original stress sheets: 69 kNm
Moment (demand) from S-Frame model: 136 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-HWYT-U5L6*

	L_y =	19,219	mm
	L_z =	19,219	mm
	K_y =	0.80	
	K_z =	1.00	
Web	h	406	mm
	w	14.3	mm
Flange	b	380	mm
	t	9.5	mm
	n =	1.34	
	Lift Span Raised: C_f =	0	kN
	Lift Span Lowered: C_f =	0	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	77	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	28	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 6,001 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 5,392 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.664$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.794$$

C_r =	-5,392	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U5L6*

	Lift Span Raised: T_f =	458	kN	
	Lift Span Lowered: T_f =	654	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	7,853	kN	Gross Section
	T_r =	7,853	kN	Tensile Capacity (Factored)
	T_r / T_f =	12.01		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Vertical
Member ID: LIFT-HWYT-U0L0
S-Frame End Nodes: Node 33 to Node 27

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Centre Webs	Outer Webs	Outer Ls 4x4x3/4	Inner Ls 5x5x3/4
Qty	1	1	1	2	2	4	4
y_{dim} (mm)	686	686	22.2	19.1	12.7	102	127
z_{dim} (mm)	12.7	12.7	584	330	584	102	127
I_{y1} ($x10^6 mm^4$)	342	342	1	0	0	3.24	6.6
I_{z1} ($x10^6 mm^4$)	0	0	368	57	211	3.24	6.6
A_g (mm^2)	8,712	8,712	12,965	6,287	7,417	3,530	4,490
y_{bar} (mm)	304	304	0	0	0	264	258
z_{bar} (mm)	0	0	0	21	355	317	69
I_y ($x10^6 mm^4$)	342	342	1	6	1,870	1,432	112
I_z ($x10^6 mm^4$)	805	805	368	114	422	997	1,222

A_g =	89,876	mm^2
I_y =	4,103	$x10^6$ mm^4
I_z =	4,734	$x10^6$ mm^4
r_y =	214	mm
r_z =	229	mm

Moment (demand) from original stress sheets: 1024 kNm*
Moment (demand) from S-Frame model: 26 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-HWYT-U0L0*

	L_y =	13,259	mm			
	L_z =	13,259	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	380	mm			
	Web w	12.7	mm			
	Flange b	380	mm			
	Flange t	12.7	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	-376	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	62		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	30		<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	30		<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 19,938 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 20,969 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.826$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.769$$

C_r = -19,938 kN Compressive Capacity (Factored)

C_r / C_f = 53.03 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U0L0*

	Lift Span Raised: T_f =	5,158	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	29,884	kN	Gross Section
	T_r =	29,884	kN	Tensile Capacity (Factored)
	T_r / T_f =	5.79		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Vertical
Member ID: LIFT-HWYT-U1L1
S-Frame End Nodes: Node 34 to Node 28

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x1/2	Inner Ls 5x5x5/8
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	12.7	12.7	584	584	102	127
I_{y1} ($x10^6 mm^4$)	128	128	0	0	2.34	5.7
I_{z1} ($x10^6 mm^4$)	0	0	211	158	2.34	5.7
A_g (mm^2)	6,287	6,287	7,417	5,548	2,430	3,790
y_{bar} (mm)	303	303	0	0	267	259
z_{bar} (mm)	0	0	0	263	227	44
I_y ($x10^6 mm^4$)	128	128	0	768	510	52
I_z ($x10^6 mm^4$)	577	577	211	315	702	1,040

A_g = 55,966 mm^2

I_y = 1,587 $x10^6\ mm^4$
I_z = 3,423 $x10^6\ mm^4$
r_y = 168 mm
r_z = 247 mm

Moment (demand) from original stress sheets: 535 kNm*
Moment (demand) from S-Frame model: 56 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-HWYT-U1L1*

		L_y =	14,521	mm
		L_z =	9,566	mm
		K_y =	1.00	
		K_z =	1.00	
	Web	h	380	mm
		w	9.5	mm
	Flange	b	380	mm
		t	9.5	mm
		n =	1.34	
		Lift Span Raised: C_f =	0	kN
		Lift Span Lowered: C_f =	0	kN
Cl. 10.5.7 (c)		Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =		86	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web	h/w =	40	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges	b/t =	40	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 7,393 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 10,817 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.931$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.418$$

C_r = -7,393 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U1L1*

	Lift Span Raised: T_f =	536	kN	
	Lift Span Lowered: T_f =	720	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	12,229	kN	Gross Section
	T_r =	12,229	kN	Tensile Capacity (Factored)
	T_r / T_f =	16.98		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Vertical
Member ID: LIFT-HWYT-U2L2
S-Frame End Nodes: Node 37 to Node 29

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x3/8	Inner Ls 5x5x1/2
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	9.5	9.5	584	584	102	127
I_{y1} ($x10^6 mm^4$)	96	96	0	0	1.84	4.7
I_{z1} ($x10^6 mm^4$)	0	0	211	158	1.84	4.7
A_g (mm^2)	4,703	4,703	7,417	5,548	1,850	3,060
y_{bar} (mm)	305	305	0	0	271	264
z_{bar} (mm)	0	0	0	263	228	42
I_y ($x10^6 mm^4$)	96	96	0	768	392	40
I_z ($x10^6 mm^4$)	437	437	211	315	551	872

A_g =	47,558	mm^2
I_y =	1,392	$x10^6$ mm^4
I_z =	2,824	$x10^6$ mm^4
r_y =	171	mm
r_z =	244	mm

Moment (demand) from original stress sheets: 535 kNm*
Moment (demand) from S-Frame model: 75 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-HWYT-U2L2*

	L_y =	15,362	mm			
	L_z =	9,566	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	380	mm			
	Web w	9.5	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-218	kN			
	Lift Span Lowered: C_f =	-302	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	90		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	40		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 6,051 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 9,168 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.969$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.424$$

C_r = -6,051 kN Compressive Capacity (Factored)

C_r / C_f = 20.04 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U2L2*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	10,391	kN	Gross Section
	T_r =	10,391	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Highway Truss
Member Description: Vertical
Member ID: LIFT-HWYT-U3L3
S-Frame End Nodes: Node 35 to Node 30

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x1/2	Inner Ls 5x5x5/8
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	12.7	12.7	584	584	102	127
I_{y1} ($x10^6 mm^4$)	128	128	0	0	2.34	5.7
I_{z1} ($x10^6 mm^4$)	0	0	211	158	2.34	5.7
A_g (mm^2)	6,287	6,287	7,417	5,548	2,430	3,790
y_{bar} (mm)	303	303	0	0	267	259
z_{bar} (mm)	0	0	0	263	227	44
I_y ($x10^6 mm^4$)	128	128	0	768	510	52
I_z ($x10^6 mm^4$)	577	577	211	315	702	1,040

A_g = 55,966 mm^2

I_y = 1,587 $x10^6$ mm^4
I_z = 3,423 $x10^6$ mm^4
r_y = 168 mm
r_z = 247 mm

Moment (demand) from original stress sheets: 535 kNm*
Moment (demand) from S-Frame model: 86 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-HWYT-U3L3*

	L_y =	16,239	mm
	L_z =	9,566	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	380	mm
	w	9.5	mm
Flange	b	380	mm
	t	9.5	mm
	n =	1.34	
	Lift Span Raised: C_f =	0	kN
	Lift Span Lowered: C_f =	0	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	96	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	40	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 6,627 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 10,817 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.041$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.418$$

C_r = -6,627 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U3L3*

	Lift Span Raised: T_f =	550	kN	
	Lift Span Lowered: T_f =	1,058	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	12,229	kN	Gross Section
	T_r =	12,229	kN	Tensile Capacity (Factored)
	T_r / T_f =	11.56		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Vertical
Member ID: LIFT-HWYT-U4L4
S-Frame End Nodes: Node 38 to Node 31

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x3/8	Inner Ls 5x5x1/2
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	9.5	9.5	584	584	102	127
I_{y1} ($x10^6 mm^4$)	96	96	0	0	1.84	4.7
I_{z1} ($x10^6 mm^4$)	0	0	211	158	1.84	4.7
A_g (mm^2)	4,703	4,703	7,417	5,548	1,850	3,060
y_{bar} (mm)	305	305	0	0	271	264
z_{bar} (mm)	0	0	0	263	228	42
I_y ($x10^6 mm^4$)	96	96	0	768	392	40
I_z ($x10^6 mm^4$)	437	437	211	315	551	872

A_g = 47,558 mm^2

I_y = 1,392 $x10^6$ mm^4
I_z = 2,824 $x10^6$ mm^4
r_y = 171 mm
r_z = 244 mm

Moment (demand) from original stress sheets: 535 kNm*
Moment (demand) from S-Frame model: 90 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-HWYT-U4L4*

	L_y =	16,484	mm			
	L_z =	9,566	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	380	mm			
	Web w	9.5	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-222	kN			
	Lift Span Lowered: C_f =	-195	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	96		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	40		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r\,(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 5,637 kN *Governs*

Cl. 10.9.3.1 $C_{r\,(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 9,168 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.040$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.424$$

C_r =	-5,637	kN	Compressive Capacity (Factored)
C_r / C_f =	25.39		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U4L4*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	89	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	10,391	kN	Gross Section
	T_r =	10,391	kN	Tensile Capacity (Factored)
	T_r / T_f =	116.76		

Member Location: Lift Span Highway Truss
Member Description: Vertical
Member ID: LIFT-HWYT-U5L5
S-Frame End Nodes: Node 36 to Node 32

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x1/2	Inner Ls 5x5x5/8
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	12.7	12.7	584	584	102	127
I_{y1} ($x10^6 mm^4$)	128	128	0	0	2.34	5.7
I_{z1} ($x10^6 mm^4$)	0	0	211	158	2.34	5.7
A_g (mm^2)	6,287	6,287	7,417	5,548	2,430	3,790
y_{bar} (mm)	303	303	0	0	267	259
z_{bar} (mm)	0	0	0	263	227	44
I_y ($x10^6 mm^4$)	128	128	0	768	510	52
I_z ($x10^6 mm^4$)	577	577	211	315	702	1,040

A_g =	55,966	mm^2
I_y =	1,587	$x10^6$ mm^4
I_z =	3,423	$x10^6$ mm^4
r_y =	168	mm
r_z =	247	mm

Moment (demand) from original stress sheets: 535 kNm*
Moment (demand) from S-Frame model: 94 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-HWYT-U5L5*

	L_y =	16,764	mm			
	L_z =	9,566	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	380	mm			
	Web w	9.5	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	100		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	40		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 6,404 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 10,817 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.075$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.418$$

C_r =	-6,404	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U5L5*

	Lift Span Raised: T_f =	534	kN	
	Lift Span Lowered: T_f =	906	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	12,229	kN	Gross Section
	T_r =	12,229	kN	Tensile Capacity (Factored)
	T_r / T_f =	13.50		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Highway Truss
Member Description: Vertical
Member ID: LIFT-HWYT-U6L6
S-Frame End Nodes: Node 52 to Node 39

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x3/8	Inner Ls 5x5x1/2
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	9.5	9.5	584	584	102	127
I_{y1} ($x10^6 mm^4$)	96	96	0	0	1.84	4.7
I_{z1} ($x10^6 mm^4$)	0	0	211	158	1.84	4.7
A_g (mm^2)	4,703	4,703	7,417	5,548	1,850	3,060
y_{bar} (mm)	305	305	0	0	271	264
z_{bar} (mm)	0	0	0	263	228	42
I_y ($x10^6 mm^4$)	96	96	0	768	392	40
I_z ($x10^6 mm^4$)	437	437	211	315	551	872

A_g = 47,558 mm^2

I_y = 1,392 $x10^6$ mm^4
I_z = 2,824 $x10^6$ mm^4
r_y = 171 mm
r_z = 244 mm

Moment (demand) from original stress sheets: 535 kNm*
Moment (demand) from S-Frame model: 94 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-HWYT-U6L6*

	L_y =	16,764	mm			
	L_z =	9,566	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	380	mm			
	Web w	9.5	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-228	kN			
	Lift Span Lowered: C_f =	-229	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	98		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	40		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 5,537 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 9,168 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.058$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.424$$

C_r = -5,537 kN Compressive Capacity (Factored)

C_r / C_f = 24.18 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-HWYT-U6L6*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	10,391	kN	Gross Section
	T_r =	10,391	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

APPENDIX E
LIFT SPAN *RAILWAY* TRUSS
CAPACITY SPREADSHEETS

Member Capacity Summary
Lift Span - Railway Truss
Raised Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-RLYT-L0L2	-13,000	-1,962	6.63		N/A	15,100		N/A		6,249
LIFT-RLYT-L2L4	-25,698		N/A		N/A	29,895	1,484	20.1		13,033
LIFT-RLYT-L4L6	-30,864		N/A		N/A	36,172	2,942	12.3		15,986
LIFT-RLYT-U0U1	-10,517		N/A		N/A	11,455	3,747	3.06		N/A
LIFT-RLYT-U1U3	-20,874	-1,977	10.6		-10,230	22,730		N/A		N/A
LIFT-RLYT-U3U5	-36,612	-4,449	8.23		-15,101	41,025		N/A		N/A
LIFT-RLYT-U5U6	-39,425	-5,130	7.69		-16,400	44,398		N/A		N/A
LIFT-RLYT-L0U1	-39,025	-5,755	6.78		-11,298	48,874		N/A		N/A
LIFT-RLYT-U1L2	-13,411		N/A		N/A	20,484	3,974	5.15		8,100
LIFT-RLYT-L2U3	-11,538	-3,032	3.81		-6,298	18,863		N/A		N/A
LIFT-RLYT-U3L4	-8,694		N/A		N/A	14,435	2,136	6.76		5,137
LIFT-RLYT-L4U5	-7,228	-1,251	5.78		-3,692	10,341		N/A		342
LIFT-RLYT-U5L6	-5,392		N/A		-1,913	7,853	472	16.6		3,149
LIFT-RLYT-U0L0	-19,938		N/A		N/A	29,884	5,153	5.80		5,275
LIFT-RLYT-U1L1	-7,393		N/A		N/A	12,229	492	24.9		2,091
LIFT-RLYT-U2L2	-6,051	-261	23.2		-156	10,391		N/A		N/A
LIFT-RLYT-U3L3	-6,627		N/A		N/A	12,229	551	22.2		2,126
LIFT-RLYT-U4L4	-5,637	-263	21.4		-178	10,391		N/A		N/A
LIFT-RLYT-U5L5	-6,404		N/A		N/A	12,229	537	22.8		2,139
LIFT-RLYT-U6L6	-5,537	-269	20.6		-187	10,391		N/A		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Capacity Summary
Lift Span - Railway Truss
Closed Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-RLYT-L0L2	-13,000		N/A		N/A	15,100	3,980	3.79		6,249
LIFT-RLYT-L2L4	-25,698		N/A		N/A	29,895	8,049	3.71		13,033
LIFT-RLYT-L4L6	-30,864		N/A		N/A	36,172	9,113	3.97		15,986
LIFT-RLYT-U0U1	-10,517	-449	23.4		N/A	11,455	1,139	10.1		N/A
LIFT-RLYT-U1U3	-20,874	-6,763	3.09		-10,230	22,730		N/A		N/A
LIFT-RLYT-U3U5	-36,612	-10,007	3.66		-15,101	41,025		N/A		N/A
LIFT-RLYT-U5U6	-39,425	-10,891	3.62		-16,400	44,398		N/A		N/A
LIFT-RLYT-L0U1	-39,025	-6,741	5.79		-11,298	48,874		N/A		N/A
LIFT-RLYT-U1L2	-13,411		N/A		N/A	20,484	4,872	4.20		8,100
LIFT-RLYT-L2U3	-11,538	-3,601	3.20		-6,298	18,863		N/A		N/A
LIFT-RLYT-U3L4	-8,694		N/A		N/A	14,435	2,649	5.45		5,137
LIFT-RLYT-L4U5	-7,228	-1,567	4.61		-3,692	10,341		N/A		342
LIFT-RLYT-U5L6	-5,392		N/A		-1,913	7,853	644	12.2		3,149
LIFT-RLYT-U0L0	-19,938	-406	49.1		N/A	29,884		N/A		5,275
LIFT-RLYT-U1L1	-7,393		N/A		N/A	12,229	690	17.7		2,091
LIFT-RLYT-U2L2	-6,051	-308	19.6		-156	10,391		N/A		N/A
LIFT-RLYT-U3L3	-6,627		N/A		N/A	12,229	782	15.6		2,126
LIFT-RLYT-U4L4	-5,637	-315	17.9		-178	10,391		N/A		N/A
LIFT-RLYT-U5L5	-6,404		N/A		N/A	12,229	775	15.8		2,139
LIFT-RLYT-U6L6	-5,537	-340	16.3		-187	10,391		N/A		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Location: Lift Span Railway Truss
Member Description: Bottom Chord
Member ID: LIFT-RLYT-L0L2
S-Frame End Nodes: Node 1 to Node 3

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 8x6x1/2	Bot Ls 8x6x1/2
Qty	1	1	2	2	2
y_{dim} (mm)	584	584	11.1	152	152
z_{dim} (mm)	9.5	9.5	762	203	203
I_{y1} ($x10^6mm^4$)	0	0	409	18.40	18.40
I_{z1} ($x10^6mm^4$)	158	158	0	8.96	8.96
A_g (mm^2)	5,548	5,548	8,458	4,350	4,350
y_{bar} (mm)	0	0	306	263	263
z_{bar} (mm)	391	391	0	325	325
I_y ($x10^6mm^4$)	848	848	819	956	956
I_z ($x10^6mm^4$)	158	158	1,584	620	620

A_g = 45,412 mm^2

I_y = 4,426 $x10^6$ mm^4

I_z = 3,139 $x10^6$ mm^4

r_y = 312 mm

r_z = 263 mm

Moment (demand) from original stress sheets: 33 kNm

Moment (demand) from S-Frame model: 112 kNm

Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-RLYT-L0L2*

	L_y =	9,398	mm
	L_z =	9,398	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	356	mm
	w	11.1	mm
Flange	b	280	mm
	t	9.5	mm
	n =	1.34	
	Lift Span Raised: C_f =	-1,962	kN
	Lift Span Lowered: C_f =	0	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	36	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	32	<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	29	<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 13,448 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 13,000 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.401$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.476$$

C_r =	-13,000	kN	Compressive Capacity (Factored)
C_r / C_f =	6.63		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-L0L2*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	3,980	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	15,100	kN	Gross Section
	T_r =	15,100	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.79		

Member Location: Lift Span Railway Truss
Member Description: Bottom Chord
Member ID: LIFT-RLYT-L2L4
S-Frame End Nodes: Node 3 to Node 5

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Web Plates	Top Ls 8x6x1/2	Bot Ls 8x6x1/2
Qty	1	1	4	2	2	2
y_{dim} (mm)	533	533	17.5	12.7	152	152
z_{dim} (mm)	9.5	9.5	762	356	203	203
I_{y1} ($x10^6mm^4$)	0	0	645	48	18.40	18.40
I_{z1} ($x10^6mm^4$)	120	120	0	0	8.96	8.96
A_g (mm^2)	5,064	5,064	13,335	4,521	4,350	4,350
y_{bar} (mm)	0	0	294	270	239	239
z_{bar} (mm)	391	391	0	0	325	325
I_y ($x10^6mm^4$)	774	774	2,581	95	956	956
I_z ($x10^6mm^4$)	120	120	4,612	659	515	515

A_g =	89,909	mm^2
I_y =	6,136	$x10^6$ mm^4
I_z =	6,541	$x10^6$ mm^4
r_y =	261	mm
r_z =	270	mm

Moment (demand) from original stress sheets: 62 kNm
Moment (demand) from S-Frame model: 82 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-RLYT-L2L4*

	L_y =	9,398	mm			
	L_z =	9,398	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	356	mm			
	Web w	47.7	mm			
	Flange b	229	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	36		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	7		<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	24		<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 25,698 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 25,892 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.479$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.464$$

C_r =	-25,698	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-L2L4*

	Lift Span Raised: T_f =	1,484	kN	
	Lift Span Lowered: T_f =	8,049	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	29,895	kN	Gross Section
	T_r =	29,895	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.71		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Bottom Chord
Member ID: LIFT-RLYT-L4L6
S-Frame End Nodes: Node 5 to Node 13

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Web Plates	Web Plates	Top Ls 8x6x1/2	Bot Ls 8x6x1/2
Qty	1	1	4	2	2	2	2
y_{dim} (mm)	508	508	17.5	12.7	12.7	152	152
z_{dim} (mm)	9.5	9.5	762	762	356	203	203
I_{y1} ($x10^6mm^4$)	0	0	645	468	48	18.40	18.40
I_{z1} ($x10^6mm^4$)	104	104	0	0	0	8.96	8.96
A_g (mm^2)	4,826	4,826	13,335	9,677	4,521	4,350	4,350
y_{bar} (mm)	0	0	294	270	257	226	226
z_{bar} (mm)	391	391	0	0	0	325	325
I_y ($x10^6mm^4$)	738	738	2,581	937	95	956	956
I_z ($x10^6mm^4$)	104	104	4,612	1,411	597	462	462

A_g = 108,789 mm^2

I_y = 7,000 $x10^6$ mm^4
I_z = 7,753 $x10^6$ mm^4
r_y = 254 mm
r_z = 267 mm

Moment (demand) from original stress sheets: 76 kNm
Moment (demand) from S-Frame model: 115 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-RLYT-L4L6*

	L_y =	9,398	mm		
	L_z =	9,398	mm		
	K_y =	1.00			
	K_z =	1.00			
	Web h	356	mm		
	Web w	60.4	mm		
	Flange b	229	mm		
	Flange t	9.5	mm		
	n =	1.34			
	Lift Span Raised: C_f =	0	kN		
	Lift Span Lowered: C_f =	0	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			
Cl. 10.9.1.3	Slenderness Ratio =	37	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	6	<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	24	<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 30,864 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 31,255 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.493$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.469$$

C_r =	-30,864	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-L4L6*

	Lift Span Raised: T_f =	2,942	kN	
	Lift Span Lowered: T_f =	9,113	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	36,172	kN	Gross Section
	T_r =	36,172	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.97		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Top Chord
Member ID: LIFT-RLYT-U0U1
S-Frame End Nodes: Node 7 to Node 8

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 4x4x7/16	Bot Ls 4x4x7/16
Qty	1	1	2	2	2
y_{dim} (mm)	965	965	12.7	102	102
z_{dim} (mm)	12.7	12.7	762	102	102
I_{y1} ($x10^6 mm^4$)	0	0	468	2.09	2.09
I_{z1} ($x10^6 mm^4$)	951	951	0	2.09	2.09
A_g (mm^2)	12,256	12,256	9,677	2,140	2,140
y_{bar} (mm)	0	0	336	372	372
z_{bar} (mm)	385	395	8	349	359
I_y ($x10^6 mm^4$)	1,817	1,912	938	527	556
I_z ($x10^6 mm^4$)	951	951	2,185	596	596

A_g = 52,426 mm^2

I_y = 5,749 $x10^6$ mm^4
I_z = 5,280 $x10^6$ mm^4
r_y = 331 mm
r_z = 317 mm

Moment (demand) from original stress sheets: N/A
Moment (demand) from S-Frame model: 64 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results

LIFT-RLYT-U0U1

	L_y =	9,482	mm			
	L_z =	7,087	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	571	mm			
	Web w	12.7	mm			
	Flange b	660	mm			
	Flange t	12.7	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	-449	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	29		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	45		>	44	*Cl. 10.9.2.1 NOT Satisfied*
	Flanges b/t =	52		>	44	*Cl. 10.9.2.1 NOT Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 10,517 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 10,677 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.309$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.241$$

C_r =	-10,517	kN	Compressive Capacity (Factored)
C_r / C_f =	23.42		Capacity over Demand Ratio (C/D)

Tension Results

LIFT-RLYT-U0U1

	Lift Span Raised: T_f =	3,747	kN	
	Lift Span Lowered: T_f =	1,139	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	11,455	kN	Gross Section
	T_r =	11,455	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.06		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Top Chord
Member ID: LIFT-RLYT-U1U3
S-Frame End Nodes: Node 8 to Node 9

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 4x4x7/16	Bot Ls 8x6x3/4
Qty	1	1	4	2	2
y_{dim} (mm)	965	1,067	12.7	102	152
z_{dim} (mm)	25.4	22.2	762	102	203
I_{y1} ($x10^6mm^4$)	1	1	468	2.09	26.4
I_{z1} ($x10^6mm^4$)	1,902	2,247	0	2.09	12.7
A_g (mm^2)	24,511	23,687	9,677	2,140	6,420
y_{bar} (mm)	0	0	343	386	396
z_{bar} (mm)	392	402	8	349	330
I_y ($x10^6mm^4$)	3,768	3,829	1,876	527	1,450
I_z ($x10^6mm^4$)	1,902	2,247	4,555	641	2,035

A_g = 104,028 mm^2

I_y = 11,449 $x10^6$ mm^4
I_z = 11,380 $x10^6$ mm^4
r_y = 332 mm
r_z = 331 mm

Moment (demand) from original stress sheets: 73 kNm
Moment (demand) from S-Frame model: 102 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-RLYT-U1U3*

	L_y =	9,436	mm
	L_z =	9,436	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	571	mm
	w	25.4	mm
Flange	b	660	mm
	t	22.2	mm
	n =	1.34	
	Lift Span Raised: C_f =	-1,977	kN
	Lift Span Lowered: C_f =	-6,763	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	29	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	22.48031	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	30	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 20,879 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 20,874 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.307$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.308$$

C_r =	-20,874	kN	Compressive Capacity (Factored)
C_r / C_f =	3.09		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-U1U3*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	22,730	kN	Gross Section
	T_r =	22,730	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Railway Truss
Member Description: Top Chord
Member ID: LIFT-RLYT-U3U5
S-Frame End Nodes: Node 9 to Node 10

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 4x4x7/16	Bot Ls 8x6x3/4
Qty	1	1	4	2	2
y_{dim} (mm)	965	1,067	19.1	102	152
z_{dim} (mm)	25.4	22.2	762	102	203
I_{y1} ($x10^6mm^4$)	1	1	702	2.09	26.4
I_{z1} ($x10^6mm^4$)	1,902	2,247	0	2.09	12.7
A_g (mm^2)	24,511	23,687	14,516	2,140	6,420
y_{bar} (mm)	0	0	349	398	408
z_{bar} (mm)	392	402	8	349	326
I_y ($x10^6mm^4$)	3,768	3,829	2,813	527	1,417
I_z ($x10^6mm^4$)	1,902	2,247	7,074	682	2,162

A_g = 123,383 mm^2

I_y = 12,354 $x10^6$ mm^4
I_z = 14,067 $x10^6$ mm^4
r_y = 316 mm
r_z = 338 mm

Moment (demand) from original stress sheets: 85 kNm
Moment (demand) from S-Frame model: 183 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results

LIFT-RLYT-U3U5

	L_y =	9,402	mm			
	L_z =	9,402	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	571	mm			
	Web w	38.1	mm			
	Flange b	660	mm			
	Flange t	22.2	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-4,449	kN			
	Lift Span Lowered: C_f =	-10,007	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	30		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	14.98688		<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	30		<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 36,612 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 36,951 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.396$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.371$$

C_r = -36,612 kN Compressive Capacity (Factored)

C_r / C_f = 3.66 Capacity over Demand Ratio (C/D)

Tension Results

LIFT-RLYT-U3U5

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	41,025	kN	Gross Section

T_r = 41,025 kN Tensile Capacity (Factored)

T_r / T_f = N/A

Member Location: Lift Span Railway Truss
Member Description: Top Chord
Member ID: LIFT-RLYT-U5U6
S-Frame End Nodes: Node 10 to Node 26

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Web Plates	Top Ls 4x4x7/16	Bot Ls 8x6x3/4
Qty	1	1	4	2	2	2
y_{dim} (mm)	965	1,067	19.1	11.1	102	152
z_{dim} (mm)	25.4	22.2	762	457	102	203
I_{y1} ($x10^6 mm^4$)	1	1	702	88	2.09	26.4
I_{z1} ($x10^6 mm^4$)	1,902	2,247	0	0	2.09	12.7
A_g (mm^2)	24,511	23,687	14,516	5,073	2,140	6,420
y_{bar} (mm)	0	0	349	374	398	408
z_{bar} (mm)	392	402	8	42	349	326
I_y ($x10^6 mm^4$)	3,768	3,829	2,813	194	527	1,417
I_z ($x10^6 mm^4$)	1,902	2,247	7,074	1,419	682	2,163

A_g = 133,528 mm^2

I_y = 12,549 $x10^6$ mm^4
I_z = 15,488 $x10^6$ mm^4
r_y = 307 mm
r_z = 341 mm

Moment (demand) from original stress sheets: 95 kNm
Moment (demand) from S-Frame model: 201 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-RLYT-U5U6*

	L_y =	9,398	mm
	L_z =	9,398	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	571	mm
	w	49.0	mm
Flange	b	660	mm
	t	22.2	mm
	n =	1.34	
	Lift Span Raised: C_f =	-5,130	kN
	Lift Span Lowered: C_f =	-10,891	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	31	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	12	<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	30	<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 39,425 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 40,036 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.408$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.367$$

C_r = -39,425 kN Compressive Capacity (Factored)

C_r / C_f = 3.62 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-U5U6*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	44,398	kN	Gross Section
	T_r =	44,398	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Railway Truss
Member Description: Diagonal
Member ID: LIFT-RLYT-L0U1
S-Frame End Nodes: Node 1 to Node 8

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*(CAN/CSA-S16-09 PP6-5)*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates	Web Plates	Top Ls 4x4x3/4	Bot Ls 8x6x3/4
Qty	1	1	4	2	2	2
y_{dim} (mm)	965	1,067	19.1	19.1	102	152
z_{dim} (mm)	25.4	25.4	762	457	102	203
I_{y1} ($x10^6 mm^4$)	1	1	702	152	3.24	26.40
I_{z1} ($x10^6 mm^4$)	1,902	2,571	0	0	3.24	12.70
A_g (mm^2)	24,511	27,102	14,516	8,706	3,530	6,420
y_{bar} (mm)	0	0	351	379	402	409
z_{bar} (mm)	392	408	8	43	347	330
I_y ($x10^6 mm^4$)	3,768	4,513	2,813	335	857	1,451
I_z ($x10^6 mm^4$)	1,902	2,571	7,155	2,502	1,147	2,173

A_g = 146,989 mm^2

I_y = 13,737 $x10^6$ mm^4
I_z = 17,451 $x10^6$ mm^4
r_y = 306 mm
r_z = 345 mm

Moment (demand) from original stress sheets: 152 kNm
Moment (demand) from S-Frame model: 446 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-RLYT-L0U1*

	L_y =	17,297	mm
	L_z =	11,810	mm
	K_y =	0.80	
	K_z =	1.00	
Web	h	762	mm
	w	57.1	mm
Flange	b	663	mm
	t	25.4	mm
	n =	1.34	
	Lift Span Raised: C_f =	-5,755	kN
	Lift Span Lowered: C_f =	-6,741	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	57	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	13	<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	26	<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 39,025 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 42,484 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.603$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.456$$

C_r = -39,025 kN Compressive Capacity (Factored)

C_r / C_f = 5.79 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-L0U1*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	48,874	kN	Gross Section
	T_r =	48,874	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Railway Truss
Member Description: Diagonal
Member ID: LIFT-RLYT-U1L2
S-Frame End Nodes: Node 8 to Node 3

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	2	2	2	2
y_{dim} (mm)	559	559	15.9	12.7	102	102
z_{dim} (mm)	9.5	9.5	762	762	102	102
I_{y1} ($x10^6mm^4$)	0	0	586	468	1.84	1.84
I_{z1} ($x10^6mm^4$)	138	138	0	0	1.84	1.84
A_g (mm^2)	5,311	5,311	12,116	9,677	1,850	1,850
y_{bar} (mm)	0	0	289	303	252	252
z_{bar} (mm)	391	391	0	0	358	358
I_y ($x10^6mm^4$)	812	812	1,172	937	478	478
I_z ($x10^6mm^4$)	138	138	2,024	1,777	239	239

A_g = 61,607 mm^2

I_y = 4,689 $x10^6$ mm^4
I_z = 4,555 $x10^6$ mm^4
r_y = 276 mm
r_z = 272 mm

Moment (demand) from original stress sheets: 106 kNm
Moment (demand) from S-Frame model: 173 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results

LIFT-RLYT-U1L2

	L_y =	17,297	mm			
	L_z =	17,297	mm			
	K_y =	0.80				
	K_z =	1.00				
	Web h	558	mm			
	Web w	22.2	mm			
	Flange b	365	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	64		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	25		<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	38		>	36	*Cl. 10.9.2.1 NOT Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 15,607 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 13,411 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.668$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.847$$

C_r = -13,411 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results

LIFT-RLYT-U1L2

	Lift Span Raised: T_f =	3,974	kN	
	Lift Span Lowered: T_f =	4,872	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	20,484	kN	Gross Section

T_r = 20,484 kN Tensile Capacity (Factored)

T_r / T_f = 4.20 Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Diagonal
Member ID: LIFT-RLYT-L2U3
S-Frame End Nodes: Node 3 to Node 9

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates		Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	4		2	2
y_{dim} (mm)	559	559	12.7		102	102
z_{dim} (mm)	9.5	9.5	762		102	102
I_{y1} ($x10^6mm^4$)	0	0	468		1.84	1.84
I_{z1} ($x10^6mm^4$)	138	138	0		1.84	1.84
A_g (mm^2)	5,311	5,311	9,677		1,850	1,850
y_{bar} (mm)	0	0	297		255	255
z_{bar} (mm)	391	391	0		358	358
I_y ($x10^6mm^4$)	812	812	1,873	0	478	478
I_z ($x10^6mm^4$)	138	138	3,415	0	244	244

A_g = 56,731 mm^2

I_y = 4,453 $x10^6$ mm^4
I_z = 4,180 $x10^6$ mm^4
r_y = 280 mm
r_z = 271 mm

Moment (demand) from original stress sheets: 106 kNm
Moment (demand) from S-Frame model: 181 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results

	L_y =	18,732	mm	
	L_z =	18,732	mm	
	K_y =	0.80		
	K_z =	1.00		
Web	h	558	mm	
	w	25.4	mm	
Flange	b	365	mm	
	t	9.5	mm	
	n =	1.34		
	Lift Span Raised: C_f =	-3,032	kN	
	Lift Span Lowered: C_f =	-3,601	kN	
Cl. 10.5.7 (c)	Compression: φ_s =	0.90		

Cl. 10.9.1.3	Slenderness Ratio =	69	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	22	<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	38	>	36	*Cl. 10.9.2.1 NOT Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 13,881 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 11,538 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.712$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.919$$

C_r =	-11,538	kN	Compressive Capacity (Factored)
C_r / C_f =	3.20		Capacity over Demand Ratio (C/D)

Tension Results

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	18,863	kN	Gross Section
	T_r =	18,863	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Railway Truss
Member Description: Diagonal
Member ID: LIFT-RLYT-U3L4
S-Frame End Nodes: Node 9 to Node 5

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	2	2	2
y_{dim} (mm)	572	572	19.1	102	102
z_{dim} (mm)	9.5	9.5	660	102	102
I_{y1} ($x10^6 mm^4$)	0	0	456	1.84	1.84
I_{z1} ($x10^6 mm^4$)	148	148	0	1.84	1.84
A_g (mm^2)	5,434	5,434	12,573	1,850	1,850
y_{bar} (mm)	0	0	301	262	262
z_{bar} (mm)	342	342	0	308	308
I_y ($x10^6 mm^4$)	636	636	913	355	355
I_z ($x10^6 mm^4$)	148	148	2,279	258	258

A_g = 43,414 mm^2

I_y = 2,893 $x10^6$ mm^4
I_z = 3,091 $x10^6$ mm^4
r_y = 258 mm
r_z = 267 mm

Moment (demand) from original stress sheets: 81 kNm
Moment (demand) from S-Frame model: 149 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results

LIFT-RLYT-U3L4

	L_y =	18,732.0	mm		
	L_z =	18,732	mm		
	K_y =	0.80			
	K_z =	1.00			
	Web h	456	mm		
	Web w	19.1	mm		
	Flange b	368	mm		
	Flange t	9.5	mm		
	n =	1.34			
	Lift Span Raised: C_f =	0	kN		
	Lift Span Lowered: C_f =	0	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			
Cl. 10.9.1.3	Slenderness Ratio =	73	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	24	<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	39	>	36	*Cl. 10.9.2.1 NOT Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 10,097 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 8,694 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.773$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.935$$

C_r = -8,694 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results

LIFT-RLYT-U3L4

	Lift Span Raised: T_f =	2,136	kN	
	Lift Span Lowered: T_f =	2,649	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	14,435	kN	Gross Section
	T_r =	14,435	kN	Tensile Capacity (Factored)
	T_r / T_f =	5.45		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Diagonal
Member ID: LIFT-RLYT-L4U5
S-Frame End Nodes: Node 5 to Node 10

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	2	2	2
y_{dim} (mm)	559	559	22.2	102	102
z_{dim} (mm)	9.5	9.5	660	102	102
I_{y1} ($x10^6 mm^4$)	0	0	532	1.84	1.84
I_{z1} ($x10^6 mm^4$)	138	138	1	1.84	1.84
A_g (mm^2)	5,311	5,311	14,652	1,850	1,850
y_{bar} (mm)	0	0	299	259	259
z_{bar} (mm)	342	342	0	308	308
I_y ($x10^6 mm^4$)	621	621	1,064	355	355
I_z ($x10^6 mm^4$)	138	138	2,621	252	252

A_g = 47,325 mm^2

I_y = 3,015 $x10^6$ mm^4
I_z = 3,401 $x10^6$ mm^4
r_y = 252 mm
r_z = 268 mm

Moment (demand) from original stress sheets: 91 kNm
Moment (demand) from S-Frame model: 164 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results *LIFT-RLYT-L4U5*

	L_y =	19,219	mm			
	L_z =	19,219	mm			
	K_y =	0.80				
	K_z =	1.00				
	Web h	456	mm			
	Web w	22.2	mm			
	Flange b	355	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-1,251	kN			
	Lift Span Lowered: C_f =	-1,567	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	76		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	21		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	37		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 7,940 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 7,228 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.657$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.774$$

C_r = -7,228 kN Compressive Capacity (Factored)

C_r / C_f = 4.61 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-L4U5*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	10,341	kN	Gross Section
	T_r =	10,341	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Railway Truss
Member Description: Diagonal
Member ID: LIFT-RLYT-U5L6
S-Frame End Nodes: Node 10 to Node 13

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty	1	1	2	2	2
y_{dim} (mm)	584	584	14.3	102	102
z_{dim} (mm)	9.5	9.5	610	102	102
I_{y1} ($x10^6 mm^4$)	0	0	270	1.84	1.84
I_{z1} ($x10^6 mm^4$)	158	158	0	1.84	1.84
A_g (mm^2)	5,548	5,548	8,723	1,850	1,850
y_{bar} (mm)	0	0	303	267	267
z_{bar} (mm)	316	316	0	282	282
I_y ($x10^6 mm^4$)	554	554	541	298	298
I_z ($x10^6 mm^4$)	158	158	1,602	267	267

A_g = 35,942 mm^2

I_y = 2,245 $x10^6$ mm^4
I_z = 2,452 $x10^6$ mm^4
r_y = 250 mm
r_z = 261 mm

Moment (demand) from original stress sheets: 69 kNm
Moment (demand) from S-Frame model: 136 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

Compression Results

LIFT-RLYT-U5L6

	L_y =	19,219	mm			
	L_z =	19,219	mm			
	K_y =	0.80				
	K_z =	1.00				
	Web h	406	mm			
	Web w	14.3	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	77		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	28		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 6,001 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 5,392 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.664$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.794$$

C_r =	-5,392	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results

LIFT-RLYT-U5L6

	Lift Span Raised: T_f =	472	kN	
	Lift Span Lowered: T_f =	644	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	7,853	kN	Gross Section
	T_r =	7,853	kN	Tensile Capacity (Factored)
	T_r / T_f =	12.19		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Vertical
Member ID: LIFT-RLYT-U0L0
S-Frame End Nodes: Node 1 to Node 7

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Centre Webs	Outer Webs	Outer Ls 4x4x3/4	Inner Ls 5x5x3/4
Qty	1	1	1	2	2	4	4
y_{dim} (mm)	686	686	22.2	19.1	12.7	102	127
z_{dim} (mm)	12.7	12.7	584	330	584	102	127
I_{y1} ($x10^6 mm^4$)	342	342	1	0	0	3.24	6.6
I_{z1} ($x10^6 mm^4$)	0	0	368	57	211	3.24	6.6
A_g (mm^2)	8,712	8,712	12,965	6,287	7,417	3,530	4,490
y_{bar} (mm)	304	304	0	0	0	264	258
z_{bar} (mm)	0	0	0	21	355	317	69
I_y ($x10^6 mm^4$)	342	342	1	6	1,870	1,432	112
I_z ($x10^6 mm^4$)	805	805	368	114	422	997	1,222

A_g = 89,876 mm^2

I_y = 4,103 $x10^6$ mm^4
I_z = 4,734 $x10^6$ mm^4
r_y = 214 mm
r_z = 229 mm

Moment (demand) from original stress sheets: 1024 kNm*
Moment (demand) from S-Frame model: 26 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-RLYT-U0L0*

	L_y =	13,259	mm
	L_z =	13,259	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	380	mm
	w	12.7	mm
Flange	b	380	mm
	t	12.7	mm
	n =	1.34	

	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	-406	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	62		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	30		<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	30		<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 19,938 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 20,969 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.826$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.769$$

C_r = -19,938 kN Compressive Capacity (Factored)

C_r / C_f = 49.11 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-U0L0*

	Lift Span Raised: T_f =	5,153	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	29,884	kN	Gross Section
	T_r =	29,884	kN	Tensile Capacity (Factored)
	T_r / T_f =	5.80		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Vertical
Member ID: LIFT-RLYT-U1L1
S-Frame End Nodes: Node 2 to Node 8

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x1/2	Inner Ls 5x5x5/8
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	12.7	12.7	584	584	102	127
I_{y1} ($x10^6mm^4$)	128	128	0	0	2.34	5.7
I_{z1} ($x10^6mm^4$)	0	0	211	158	2.34	5.7
A_g (mm^2)	6,287	6,287	7,417	5,548	2,430	3,790
y_{bar} (mm)	303	303	0	0	267	259
z_{bar} (mm)	0	0	0	263	227	44
I_y ($x10^6mm^4$)	128	128	0	768	510	52
I_z ($x10^6mm^4$)	577	577	211	315	702	1,040

A_g = 55,966 mm^2

I_y = 1,587 $x10^6$ mm^4
I_z = 3,423 $x10^6$ mm^4
r_y = 168 mm
r_z = 247 mm

Moment (demand) from original stress sheets: 648 kNm*
Moment (demand) from S-Frame model: 56 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-RLYT-U1L1*

	L_y =	14,521	mm			
	L_z =	9,566	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	380	mm			
	Web w	9.5	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	86		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	40		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 7,393 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 10,817 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.931$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.418$$

C_r =	-7,393	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-U1L1*

	Lift Span Raised: T_f =	492	kN	
	Lift Span Lowered: T_f =	690	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	12,229	kN	Gross Section
	T_r =	12,229	kN	Tensile Capacity (Factored)
	T_r / T_f =	17.72		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Vertical
Member ID: LIFT-RLYT-U2L2
S-Frame End Nodes: Node 3 to Node 11

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x3/8	Inner Ls 5x5x1/2
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	9.5	9.5	584	584	102	127
I_{y1} ($x10^6mm^4$)	96	96	0	0	1.84	4.7
I_{z1} ($x10^6mm^4$)	0	0	211	158	1.84	4.7
A_g (mm^2)	4,703	4,703	7,417	5,548	1,850	3,060
y_{bar} (mm)	305	305	0	0	271	264
z_{bar} (mm)	0	0	0	263	228	42
I_y ($x10^6mm^4$)	96	96	0	768	392	40
I_z ($x10^6mm^4$)	437	437	211	315	551	872

A_g =	47,558	mm^2
I_y =	1,392	$x10^6$ mm^4
I_z =	2,824	$x10^6$ mm^4
r_y =	171	mm
r_z =	244	mm

Moment (demand) from original stress sheets: 648 kNm*
Moment (demand) from S-Frame model: 75 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesement of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-RLYT-U2L2*

	L_y =	15,362	mm		
	L_z =	9,566	mm		
	K_y =	1.00			
	K_z =	1.00			
	Web h	380	mm		
	Web w	9.5	mm		
	Flange b	380	mm		
	Flange t	9.5	mm		
	n =	1.34			
	Lift Span Raised: C_f =	-261	kN		
	Lift Span Lowered: C_f =	-308	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			

Cl. 10.9.1.3	Slenderness Ratio =	90	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	40	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 6,051 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 9,168 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.969$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.424$$

C_r = -6,051 kN Compressive Capacity (Factored)

C_r / C_f = 19.65 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-U2L2*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	10,391	kN	Gross Section
	T_r =	10,391	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Railway Truss
Member Description: Vertical
Member ID: LIFT-RLYT-U3L3
S-Frame End Nodes: Node 4 to Node 9

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x1/2	Inner Ls 5x5x5/8
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	12.7	12.7	584	584	102	127
I_{y1} ($x10^6 mm^4$)	128	128	0	0	2.34	5.7
I_{z1} ($x10^6 mm^4$)	0	0	211	158	2.34	5.7
A_g (mm^2)	6,287	6,287	7,417	5,548	2,430	3,790
y_{bar} (mm)	303	303	0	0	267	259
z_{bar} (mm)	0	0	0	263	227	44
I_y ($x10^6 mm^4$)	128	128	0	768	510	52
I_z ($x10^6 mm^4$)	577	577	211	315	702	1,040

A_g =	55,966	mm^2
I_y =	1,587	$x10^6$ mm^4
I_z =	3,423	$x10^6$ mm^4
r_y =	168	mm
r_z =	247	mm

Moment (demand) from original stress sheets: 648 kNm*
Moment (demand) from S-Frame model: 86 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-RLYT-U3L3*

	L_y =	16,239	mm			
	L_z =	9,566	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	380	mm			
	Web w	9.5	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	96		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	40		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 6,627 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 10,817 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.041$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.418$$

C_r = -6,627 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-U3L3*

	Lift Span Raised: T_f =	551	kN	
	Lift Span Lowered: T_f =	782	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	12,229	kN	Gross Section
	T_r =	12,229	kN	Tensile Capacity (Factored)
	T_r / T_f =	15.64		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Vertical
Member ID: LIFT-RLYT-U4L4
S-Frame End Nodes: Node 5 to Node 12

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x3/8	Inner Ls 5x5x1/2
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	9.5	9.5	584	584	102	127
I_{y1} ($x10^6 mm^4$)	96	96	0	0	1.84	4.7
I_{z1} ($x10^6 mm^4$)	0	0	211	158	1.84	4.7
A_g (mm^2)	4,703	4,703	7,417	5,548	1,850	3,060
y_{bar} (mm)	305	305	0	0	271	264
z_{bar} (mm)	0	0	0	263	228	42
I_y ($x10^6 mm^4$)	96	96	0	768	392	40
I_z ($x10^6 mm^4$)	437	437	211	315	551	872

A_g =	47,558	mm^2
I_y =	1,392	$x10^6$ mm^4
I_z =	2,824	$x10^6$ mm^4
r_y =	171	mm
r_z =	244	mm

Moment (demand) from original stress sheets: 648 kNm*
Moment (demand) from S-Frame model: 90 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-RLYT-U4L4*

	L_y =	16,484	mm			
	L_z =	9,566	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	380	mm			
	Web w	9.5	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-263	kN			
	Lift Span Lowered: C_f =	-315	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	96		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	40		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 5,637 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 9,168 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.040$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.424$$

C_r =	-5,637	kN	Compressive Capacity (Factored)
C_r / C_f =	17.90		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-U4L4*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	10,391	kN	Gross Section
	T_r =	10,391	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Lift Span Railway Truss
Member Description: Vertical
Member ID: LIFT-RLYT-U5L5
S-Frame End Nodes: Node 6 to Node 10

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x1/2	Inner Ls 5x5x5/8
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	12.7	12.7	584	584	102	127
I_{y1} ($x10^6 mm^4$)	128	128	0	0	2.34	5.7
I_{z1} ($x10^6 mm^4$)	0	0	211	158	2.34	5.7
A_g (mm^2)	6,287	6,287	7,417	5,548	2,430	3,790
y_{bar} (mm)	303	303	0	0	267	259
z_{bar} (mm)	0	0	0	263	227	44
I_y ($x10^6 mm^4$)	128	128	0	768	510	52
I_z ($x10^6 mm^4$)	577	577	211	315	702	1,040

A_g = 55,966 mm^2

I_y = 1,587 $x10^6$ mm^4
I_z = 3,423 $x10^6$ mm^4
r_y = 168 mm
r_z = 247 mm

Moment (demand) from original stress sheets: 648 kNm*
Moment (demand) from S-Frame model: 94 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-RLYT-U5L5*

	L_y =	16,764	mm
	L_z =	9,566	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	380	mm
	w	9.5	mm
Flange	b	380	mm
	t	9.5	mm
	n =	1.34	
	Lift Span Raised: C_f =	0	kN
	Lift Span Lowered: C_f =	-340	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	100	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	40	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 6,404 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 10,817 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.075$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.418$$

C_r = -6,404 kN Compressive Capacity (Factored)

C_r / C_f = 18.83 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-U5L5*

	Lift Span Raised: T_f =	537	kN	
	Lift Span Lowered: T_f =	775	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	12,229	kN	Gross Section
	T_r =	12,229	kN	Tensile Capacity (Factored)
	T_r / T_f =	15.78		Capacity over Demand Ratio (C/D)

Member Location: Lift Span Railway Truss
Member Description: Vertical
Member ID: LIFT-RLYT-U6L6
S-Frame End Nodes: Node 13 to Node 26

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge (centreline of truss)
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Centre Web	Outer Webs	Outer Ls 4x4x3/8	Inner Ls 5x5x1/2
Qty	1	1	1	2	4	4
y_{dim} (mm)	495	495	12.7	9.5	102	127
z_{dim} (mm)	9.5	9.5	584	584	102	127
I_{y1} ($x10^6mm^4$)	96	96	0	0	1.84	4.7
I_{z1} ($x10^6mm^4$)	0	0	211	158	1.84	4.7
A_g (mm^2)	4,703	4,703	7,417	5,548	1,850	3,060
y_{bar} (mm)	305	305	0	0	271	264
z_{bar} (mm)	0	0	0	263	228	42
I_y ($x10^6mm^4$)	96	96	0	768	392	40
I_z ($x10^6mm^4$)	437	437	211	315	551	872

A_g =	47,558	mm^2
I_y =	1,392	$x10^6$ mm^4
I_z =	2,824	$x10^6$ mm^4
r_y =	171	mm
r_z =	244	mm

Moment (demand) from original stress sheets: 648 kNm*
Moment (demand) from S-Frame model: 94 kNm
Due to the small magnitude of this moment, the moment from the continuity of the chord member has been neglected in the assesment of member capacity

* The original stress sheets report relatively large moments for all vertical truss members due to loads from sway bracing

Compression Results *LIFT-RLYT-U6L6*

	L_y =	16,764	mm			
	L_z =	9,566	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	380	mm			
	Web w	9.5	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-269	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	98		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	40		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 5,537 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 9,168 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.058$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.424$$

C_r =	-5,537	kN	Compressive Capacity (Factored)
C_r / C_f =	20.58		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-RLYT-U6L6*

	Lift Span Raised: T_f =	0	kN	
	Lift Span Lowered: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	10,391	kN	Gross Section
	T_r =	10,391	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

APPENDIX F
LIFT SPAN GENERAL MEMBERS
CAPACITY SPREADSHEETS

Member Capacity Summary
Lift Span - Non-truss Members
Raised Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-TLAT	-960	-688	1.40		-600	2,605	694	3.75		600
LIFT-BLAT	-960	-732	1.31		-544	2,605	857	3.04		544
LIFT-PORT-BSTR	-2,910	-17	N/A		-371	4,154	148	28.1		371
LIFT-PORT-LATD	-497	-71	7.00		N/A	1,398	91	15.4		N/A
LIFT-PORT-LATL	-1,202	-99	12.1		N/A	1,398	92	15.2		N/A
LIFT-PORT-LATT	-1,164	-120	9.70		N/A	1,398	113	12.4		N/A
LIFT-PORT-SWBC	N/A		N/A		-463	1,988	118	16.8		463
LIFT-PORT-SWBV	-1,276	0	N/A		-49	1,398	36	38.8		49
LIFT-SWAY-BSTR	-1,449	-22	65.9		N/A	2,063	69	29.9		N/A
LIFT-SWAY-SWBC	N/A		N/A		N/A	1,988	82	24.2		N/A
LIFT-SWAY-SWBV	-726	-20	36.3		N/A	1,988	17	N/A		N/A
LIFT-SWAY-TSTR	-1,819	-323	5.63		-767	2,036	302	6.74		767
C12X20.7	-627	-12	52.2		N/A	857	13	65.9		N/A
C310X37	-800	-11	72.7		N/A	1,031	12	85.9		N/A
2L3-1/2x3-1/2x3/8	-478	-80	5.98		-258	699	83	8.42		N/A
2L4x4x3/8	-378	-138	2.74		-165	808	75	10.8		165
2L5x5x3/8	-498	-70	7.12		-120	1,018	70	14.5		120
2L6x6x1/2	N/A		N/A		-325	1,617	104	15.5		325

Member Capacity Summary - Lift Span - Bending Only Members

Member ID	Bending					Shear				
	M_r kNm	M_f kNm	M_r/M_f	Comments	M* kNm	V_r kN	V_f kN	V_r/V_f	Comments	V* kN
LIFT-FLBM-END	10,258	315	32.6		N/A	3,172	79	40.2		N/A
LIFT-FLBM-INT	14,295	631	22.7		N/A	3,569	158	22.6		N/A
LIFT-LFGR	25,969	13,779	1.88		N/A	12,046	6,284	1.92		N/A
Lift Span Stringers:										
W24x84 (Original Highway)	802	30	26.7		N/A	859	13	66.1		N/A
W610x125 (1982 Modification)	1,071	30	35.7		N/A	1,397	13	N/A		N/A
Railway Stringers:										
W36x230	3,158	50	63.2		N/A	2,063	22	93.8		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Capacity Summary
Lift Span - Non-truss Members
Closed Position

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
LIFT-TLAT	-960	-536	1.79		-600	2,605	538	4.84		600
LIFT-BLAT	-960	-557	1.72		-544	2,605	948	2.75		544
LIFT-PORT-BSTR	-2,910	-40	72.8		-371	4,154	72	57.7		371
LIFT-PORT-LATD	-497	-77	6.46		N/A	1,398	66	21.2		N/A
LIFT-PORT-LATL	-1,202	-77	15.6		N/A	1,398	66	21.2		N/A
LIFT-PORT-LATT	-1,164	-93	12.5		N/A	1,398	82	17.1		N/A
LIFT-PORT-SWBC	N/A	0	N/A		-463	1,988	98	20.3		463
LIFT-PORT-SWBV	-1,276	0	N/A		-49	1,398	45	31.1		49
LIFT-SWAY-BSTR	-1,449	-36	40.3		N/A	2,063	70	29.5		N/A
LIFT-SWAY-SWBC	N/A	0	N/A		N/A	1,988	87	22.8		N/A
LIFT-SWAY-SWBV	-726	-46	15.8		N/A	1,988	23	86.4		N/A
LIFT-SWAY-TSTR	-1,819	-278	6.54		-767	2,036	212	9.61		767
C12X20.7	-627	-137	4.58		N/A	857	644	1.33		N/A
C310X37	-800	-89	8.99		N/A	1,031	618	1.67		N/A
2L3-1/2x3-1/2x3/8	-478	-220	2.17		-258	699	65	10.8		N/A
2L4x4x3/8	-378	-304	1.24		-165	808	143	5.65		165
2L5x5x3/8	-498	-253	1.97		-120	1,018	252	4.04		120
2L6x6x1/2	N/A	0	N/A		-325	1,617	471	3.43		325

Member Capacity Summary - Lift Span - Bending Only Members

Member ID	Bending					Shear				
	M_r kNm	M_f kNm	M_r/M_f	Comments	M* kNm	V_r kN	V_f kN	V_r/V_f	Comments	V* kN
LIFT-FLBM-END	10,258	4,021	2.55		3,002	3,172	1,006	3.15		1,025
LIFT-FLBM-INT	14,295	8,041	1.78		6,493	3,569	2,012	1.77		2,007
LIFT-LFGR	25,969	10,081	2.58		N/A	12,046	4,624	2.61		N/A
Lift Span Stringers:										
W24x84 (Original Highway)	802	695	1.15		317	859	335	2.57		142
W610x125 (1982 Modification)	1,071	695	1.54		231	1,397	335	4.17		129
Railway Stringers:										
W36x230	3,158	68	46.4		1,619	2,063	21	98.3		783

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Location: Lift Span
Member Description: End Floorbeam
Member ID: LIFT-FLBM-END
S-Frame End Nodes: Node 1 to Node 27, Node 14 to Node 40

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plate	Top Ls 8x8x3/4	Bot Ls 8x8x3/4
Qty	1	1	1	2	2
y_{dim} (mm)	508	508	12.7	203	203
z_{dim} (mm)	12.7	12.7	1,981	203	203
I_{y1} ($x10^6 mm^4$)	0	0	8,228	29.0	29.0
I_{z1} ($x10^6 mm^4$)	139	139	0	29.0	29.0
A_g (mm^2)	6,452	6,452	25,159	7,390	7,390
y_{bar} (mm)	0	0	0	64	64
z_{bar} (mm)	1,003	1,003	0	939	939
I_y ($x10^6 mm^4$)	6,490	6,490	8,228	13,090	13,090
I_z ($x10^6 mm^4$)	139	139	0	119	119

A_g =	67,622	mm^2	Z_y =	53.159	$x10^6$ mm^3
			Z_z =	3.531	$x10^6$ mm^3
I_y =	47,388	$x10^6$ mm^4	S_y =	46.949	$x10^6$ mm^3
I_z =	515	$x10^6$ mm^4	S_z =	2.027	$x10^6$ mm^3
r_y =	837	mm	J =	1,032	$x10^3$ mm^4
r_z =	87	mm			

Bending Results *LIFT-FLBM-END*

Cl. 10.5.7 (a)

Flexure: φ_s =		0.95	
Web	h	1,588	mm
	w	12.7	mm
Flange	b	229	mm
	t	32.0	mm
Lift Span Raised: M_f =		475	kNm
Lift Span Closed: M_f =		-3,454	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members

M_{max} =	3,454	kNm
M_a =	509	kNm
M_b =	1,474	kNm
M_c =	531	kNm
L =	1,295	mm

Cl. 10.9.2.1 Determining Class of Section

Web	h/w =	125.0	<	125.3	*Class 3*
Flanges	b/t =	7	<	35	*Class 2 or better*

==> Overall Class: 3

Cl. 10.10.2.2 Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 11,615 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3 Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p\left[1-\frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ N/A kNm

$M_p = Z_y F_y =$ 12,226 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{{M_{max}}^2+4{M_a}^2+7{M_b}^2+4{M_c}^2}} \leq 2.5 =$$ 2.50

Cl. 10.10.3.2 Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 10,258 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28 M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 10,798 kNm

M_r = 10,258 kNm Moment Capacity (Factored)

==> Result: Lift Span Closed: M_r / M_f = 2.97 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 21.60 Capacity over Demand Ratio (C/D)

Shear Results *LIFT-FLBM-END*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,295 mm (spacing of transverse stiffeners)

h = 1,981 mm (clear depth of web between flanges)

a/h = 0.65 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 16.5 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 16.5

F_{cr} = 132.7 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.7 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 3,172 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 3.15 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 40.15

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.39 *< 1.0* *==> Satisfied*

Member Location: Lift Span
Member Description: Intermediate Floorbeam
Member ID: LIFT-FLBM-INT
S-Frame End Nodes: Node 2 to Node 28, Node 3 to Node 29, Node 4 to Node 30, Node 5 to Node 31, Node 6 to Node 32, Node 13 to Node 39, Node 19 to Node 45, Node 18 to Node 44, Node 17 to Node 43, Node 16 to Node 42, Node 15 to Node 41

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plate	Top Ls 8x8x7/8	Bot Ls 8x8x7/8
Qty	1	1	1	2	2
y_{dim} (mm)	508	508	14.3	203	203
z_{dim} (mm)	19.1	19.1	1,981	203	203
I_{y1} ($x10^6mm^4$)	0	0	9,259	33.0	33.0
I_{z1} ($x10^6mm^4$)	208	209	0	33.0	33.0
A_g (mm^2)	9,677	9,703	28,306	8,520	8,520
y_{bar} (mm)	0	0	0	65	65
z_{bar} (mm)	1,003	1,003	0	938	938
I_y ($x10^6mm^4$)	9,736	9,761	9,259	15,059	15,059
I_z ($x10^6mm^4$)	208	209	0	138	138

A_g =	81,767	mm^2	Z_y =	65.426	$x10^6$ mm^3
			Z_z =	4.673	$x10^6$ mm^3
I_y =	58,873	$x10^6$ mm^4	S_y =	58.144	$x10^6$ mm^3
I_z =	693	$x10^6$ mm^4	S_z =	2.728	$x10^6$ mm^3
r_y =	849	mm	J =	2,832	$x10^3$ mm^4
r_z =	92	mm			

Bending Results *LIFT-FLBM-INT*

Cl. 10.5.7 (a)

Flexure:	φ_s =	0.95	
Web	h	1,588	mm
	w	14.3	mm
Flange	b	229	mm
	t	32.0	mm
Lift Span Raised:	M_f =	1,133	kNm
Lift Span Closed:	M_f =	8,041	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members			
	M_{max} =	8,041	kNm
	M_a =	4,583	kNm
	M_b =	5,899	kNm
	M_c =	4,089	kNm
	L =	1,295	mm

Cl. 10.9.2.1 Determining Class of Section

Web	h/w =	111.0	<	112.1	*Class 2 or better*
Flanges	b/t =	7	<	35	*Class 2 or better*

==> Overall Class: 2

Cl. 10.10.2.2 Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 14,295 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3 Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p\left[1 - \frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ N/A kNm

$M_p = Z_y F_y =$ 15,048 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{M_{max}^2 + 4M_a^2 + 7M_b^2 + 4M_c^2}} \leq 2.5 =$$ 1.50

Cl. 10.10.3.2 Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 12,704 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y\left[1 - \frac{0.28M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 13,373 kNm

M_r = 14,295 kNm Moment Capacity (Factored)

==> Result: Lift Span Closed: M_r / M_f = 1.78 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 12.62 Capacity over Demand Ratio (C/D)

Shear Results *LIFT-FLBM-INT*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,295 mm (spacing of transverse stiffeners)

h = 1,981 mm (clear depth of web between flanges)

a/h = 0.65 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 16.5 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 16.5

F_{cr} = 132.7 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.7 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 3,569 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 1.77 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 22.59

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.67 *< 1.0* *==> Satisfied*

Member Location: Lift Span
Member Description: Lifting Girder
Member ID: LIFT-LFGR
S-Frame End Nodes: Node 7 to Node 33, Node 20 to Node 46

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for the lift girder have been calculated about the neutral axis of the built up plate girder

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plate	B. Cover Plate	Web Plate	Top Ls 8x8x3/4	Bot Ls 8x8x3/4	Top Web Plates	Bot Web Plates	Top Ls 4x3x1/2	Bot Ls 4x3x1/2
Qty	1	1	1	2	2	2	2	2	2
y_{dim} (mm)	914	660	22.2	203	203	12.7	12.7	102	102
z_{dim} (mm)	12.7	19.1	4,299	203	203	406	406	76	76
I_{y1} ($x10^6 mm^4$)	0	0	147,146	29.0	29.0	71	71	1.0	1.0
I_{z1} ($x10^6 mm^4$)	809	457	4	29.0	29.0	0	0	2.1	2.1
A_g (mm^2)	11,613	12,581	95,544	7,390	7,390	5,161	5,161	2,100	2,100
y_{bar} (mm)	0	0	0	82	82	17	17	413	286
z_{bar} (mm)	2,168	2,145	13	2,104	2,079	1,959	1,934	2,141	2,145
I_y ($x10^6 mm^4$)	54,583	57,884	147,162	65,486	63,941	39,757	38,752	19,254	19,326
I_z ($x10^6 mm^4$)	809	457	4	156	156	3	3	721	348

A_g =	178,343	mm^2	Z_y =	274.859	$x10^6\ mm^3$	d_1 =	4,315	mm
			Z_z =	10.441	$x10^6\ mm^3$	I_{zc} =	457,230	$x10^3\ mm^4$
I_y =	506,146	$x10^6\ mm^4$	S_y =	232.780	$x10^6\ mm^3$	β_y =	-2,547	
I_z =	2,658	$x10^6\ mm^4$	S_z =	5.814	$x10^6\ mm^3$	B_1 =	-10.12	
r_y =	1,685	mm	J =	17,878	$x10^3\ mm^4$	B_2 =	129.1	
r_z =	122	mm	c_w =	5,439	$x10^{12}\ mm^6$			

Bending Results *LIFT-LFGR*

Cl. 10.5.7 (a)

Flexure: φ_s =		0.95	
Web	h	3,487	mm
	w	22.2	mm
Flange	b	254	mm
	t	19.1	mm
Lift Span Raised: M_f =		13,779	kNm
Lift Span Closed: M_f =		10,081	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members	M_{max} =	13,779	kNm
	M_a =	2,398	kNm
	M_b =	3,602	kNm
	M_c =	3,536	kNm
	L =	7,773	mm

Cl. 10.9.2.1 Determining Class of Section

Web	h/w =	156.9	>	125.3	*Exceeds Class 3 Limits*
Flanges	b/t =	13	<	35	*Class 2 or better*

==> Overall Class: 4

Cl. 10.10.2.2 Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 60,057 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3 Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p \left[1 - \frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm

$$M_u = \frac{\omega_2 \pi}{L}\left[\sqrt{E_s I_z G_s J}\left[B_1 + \sqrt{1 + B_2 + B_1^2}\right]\right] =$$ 27,336 kNm

$M_p = Z_y F_y =$ 63,218 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{M_{max}^2 + 4M_a^2 + 7M_b^2 + 4M_c^2}} \leq 2.5 =$$ 2.50

Cl. 10.10.3.2 Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 50,863 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28 M_y}{M_u}\right] \leq \varphi_s M_y$ = 26,415 kNm

(b) $M_r = \phi_s M_u$ = 25,969 kNm ***<== Governs***

$M_y = S_y F_y$ = 53,539 kNm

M_r = 25,969 kNm Moment Capacity (Factored)

==> Result: Lift Span Closed: M_r / M_f = 2.58 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 1.88 Capacity over Demand Ratio (C/D)

Shear Results *LIFT-LFGR*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 2,184 mm (spacing of transverse stiffeners)

h = 4,299 mm (clear depth of web between flanges)

a/h = 0.51 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 24.7 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 24.7

F_{cr} = 132.7 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.7 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 12,046 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 2.61 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 1.92

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.62 *< 1.0* *==> Satisfied*

Member Location: Lift Span
Member Description: Stringers
Member ID: W24x84
S-Frame End Nodes: 143-227, 227-167, 167-239, 239-179, 179-251, 251-191, 191-263, 263-203, 203-275, 275-215, 215-287, 287-144, 145-228, 228-168, 168-240, 240-180, 180-252, 252-192, 192-264, 264-204, 204-276, 276-216, 216-288
288-146, 147-229, 229-169, 169-241, 241-181, 181-253, 253-193, 193-265, 265-205, 205-277, 277-217, 217-289, 289-148
149-230, 230-170, 170-242, 242-182, 182-254, 254-194, 194-266, 266-206, 206-278, 278-218, 218-290, 290-150, 151-231
231-171, 171-243, 243-183, 183-255, 255-195, 195-267, 267-207, 207-279, 279-219, 219-291, 291-152, 153-232, 232-172
172-244, 244-184, 184-256, 256-196, 196-268, 268-208, 208-280, 280-220, 220-292, 292-154, 155-233, 233-173, 173-245
245-185, 185-257, 257-197, 197-269, 269-209, 209-281, 281-221, 221-293, 293-156, 157-234, 234-174, 174-246, 246-186
186-258, 258-198, 198-270, 270-210, 210-282, 282-222, 222-294, 294-158, 159-235, 235-175, 175-247, 247-187, 187-259
259-199, 199-271, 271-211, 211-283, 283-223, 223-295, 295-160, 161-236, 236-176, 176-248, 248-188, 188-260, 260-200
200-272, 272-212, 212-284, 284-224, 224-296, 296-162, 163-237, 237-177, 177-249, 249-189, 189-261, 261-201, 201-273
273-213, 213-285, 285-225, 225-297, 297-164, 165-238, 238-178, 178-250, 250-190, 190-262, 262-202, 202-274, 274-214
214-286, 286-226, 226-298, 298-166

Member orientation (local axis): z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	0
Qty	1
y_{dim} (mm)	229
z_{dim} (mm)	612.0
I_{y1} ($x10^6 mm^4$)	985
I_{z1} ($x10^6 mm^4$)	39
A_g (mm^2)	15,900
y_{bar} (mm)	0
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	985
I_z ($x10^6 mm^4$)	39

A_g =	15,900 mm^2	Z_y =	3.670	$x10^6$ mm^3
		Z_z =	0.535	$x10^6$ mm^3
I_y =	985 $x10^6$ mm^4	S_y =	3.219	$x10^6$ mm^3
I_z =	39 $x10^6$ mm^4	S_z =	0.343	$x10^6$ mm^3
r_y =	249 mm	J =	1,540	$x10^3$ mm^4
r_z =	50 mm	C_w =	3450	$x10^9$ mm^6

Bending Results *W24x84*

Cl. 10.5.7 (a)

Flexure:	φ_s =	0.95	
Web	h	573	mm
	w	11.9	mm
Flange	b	229	mm
	t	19.6	mm
Lift Span Raised:	M_f =	41	kNm
Lift Span Closed:	M_f =	695	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members

M_{max} =	695	kNm
M_a =	500	kNm
M_b =	671	kNm
M_c =	531	kNm
L =	3,150	mm

Cl. 10.9.2.1 Determining Class of Section

Web	h/w =	48.1	<	112.1	*Class 2 or better*
Flanges	b/t =	12	<	35	*Class 2 or better*

==> Overall Class: 2

Cl. 10.10.2.2 Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 802 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3 Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p \left[1 - \frac{0.28 M_p}{M_u}\right] \leq \varphi_s M_p =$ 802 kNm ***<== Governs***

(b) $M_r = \phi_s M_u =$ 2,760 kNm

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ 2,906 kNm

$M_p = Z_y F_y =$ 844 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{{M_{max}}^2 + 4{M_a}^2 + 7{M_b}^2 + 4{M_c}^2}} \leq 2.5 =$$ 1.16

Cl. 10.10.3.2 Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 703 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y\left[1 - \frac{0.28M_y}{M_u}\right] \leq \varphi_s M_y$ = 703 kNm

(b) $M_r = \phi_s M_u$ = 2,760 kNm

$M_y = S_y F_y$ = 740 kNm

==> Result: M_r = 802 kNm Moment Capacity (Factored)

Lift Span Closed: M_r / M_f = 1.15 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 19.6 Capacity over Demand Ratio (C/D)

Shear Results *W24x84*

Cl 10.10.5.1 k_v = 5.34 *Assume web is unstiffened (i.e. a=0)*

F_{cr} = 133 MPa

F_t = 0 MPa

$F_s = F_{cr} + F_t$ = 133 MPa

$V_r = \phi_s A_w F_s$ = 859 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 2.57 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 66.10

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.81 *< 1.0* *==> Satisfied*

Member Location: Lift Span
Member Description: Railway Stringers
Member ID: W36x230
S-Frame End Nodes: Node 894 to Node 817, Node 896 to Node 825, Node 841 to Node 900, Node 849 to Node 899, Node 809 to Node 894, Node 803 to Node 895, Node 895 to Node 811, Node 817 to Node 896, Node 825 to Node 897, Node 897 to Node 849, Node 899 to Node 841, Node 898 to Node 835

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	W36x230
Qty	1
y_{dim} (mm)	419
z_{dim} (mm)	911.9
I_{y1} ($x10^6 mm^4$)	6,243
I_{z1} ($x10^6 mm^4$)	391
A_g (mm^2)	43,613
y_{bar} (mm)	0
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	6,243
I_z ($x10^6 mm^4$)	391

A_g =	43,613	mm^2	Z_y =	15.453	$x10^6$ mm^3
			Z_z =	2.884	$x10^6$ mm^3
I_y =	6,243	$x10^6$ mm^4	S_y =	13.694	$x10^6$ mm^3
I_z =	391	$x10^6$ mm^4	S_z =	1.867	$x10^6$ mm^3
r_y =	378	mm	J =	11,904	$x10^3$ mm^4
r_z =	95	mm	C_w =	75727.11	$x10^9$ mm^6

Bending Results *W36x230*

Cl. 10.5.7 (a)

Flexure: φ_s =		0.95	
Web	h	848	mm
	w	19.3	mm
Flange	b	419	mm
	t	32.0	mm
Lift Span Raised: M_f =		50	kNm
Lift Span Closed: M_f =		68	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members	M_{max} =	50	kNm
	M_a =	40	kNm
	M_b =	50	kNm
	M_c =	39	kNm
	L =	9,398	mm

Cl. 10.9.2.1

Determining Class of Section

Web	h/w =	43.9	<	112.1	*Class 2 or better*
Flanges	b/t =	13	<	35	*Class 2 or better*

==> Overall Class: 2

Cl. 10.10.2.2

Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 3,376 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3

Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p \left[1 - \frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ 3,158 kNm ***<== Governs***

(b) $M_r = \phi_s M_u =$ 5,061 kNm

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ 5,327 kNm

$M_p = Z_y F_y =$ 3,554 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{M_{max}^2 + 4M_a^2 + 7M_b^2 + 4M_c^2}} \leq 2.5 =$$ 1.12

Cl. 10.10.3.2

Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 2,992 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28M_y}{M_u}\right] \leq \varphi_s M_y =$ 2871 kNm

(b) $M_r = \phi_s M_u =$ 5,061 kNm

$M_y = S_y F_y =$ 3,150 kNm

==> Result:	M_r =	3,158 kNm	Moment Capacity (Factored)
	Lift Span Closed: M_r / M_f =	46.43	Capacity over Demand Ratio (C/D)
	Lift Span Raised: M_r / M_f =	62.59	Capacity over Demand Ratio (C/D)

Shear Results *W36x230*

Cl 10.10.5.1 k_v = 5.34 *Assume web is unstiffened (i.e. a=0)*

F_{cr} = 133 MPa

F_t = 0 MPa

$F_s = F_{cr} + F_t =$ 133 MPa

$V_r = \phi_s A_w F_s =$ 2063 kN Shear Capacity (Factored)

==> Result:	Lift Span Closed: V_r / V_f =	98.26	Capacity over Demand Ratio (C/D)
	Lift Span Raised: V_r / V_f =	93.79	

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.02 *< 1.0* *==> Satisfied*

Member Location: Lift Span
Member Description: Top Lateral
Member ID: LIFT-TLAT
S-Frame End Nodes: Node 33 to Node 122, Node 122 to Node 7, Node 34 to Node 101, Node 101 to Node 8, Node 37 to Node 103, Node 103 to Node 11, Node 35 to Node 105, Node 105 to Node 9, Node 38 to Node 107, Node 107 to Node 12, Node 36 to Node 109, Node 109 to Node 10, Node 49 to Node 109, Node 109 to Node 23, Node 51 to Node 111, Node 111 to Node 25, Node 48 to Node 113, Node 113 to Node 22, Node 50 to Node 115, Node 115 to Node 24, Node 47 to Node 117, Node 117 to Node 21, Node 46 to Node 126, Node 126 to Node 20

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 7x4x7/16
Qty	4
y_{dim} (mm)	178
z_{dim} (mm)	102
I_{y1} ($x10^6 mm^4$)	2.45
I_{z1} ($x10^6 mm^4$)	9.88
A_g (mm^2)	2,980
y_{bar} (mm)	74
z_{bar} (mm)	365
I_y ($x10^6 mm^4$)	1,598
I_z ($x10^6 mm^4$)	105

A_g =	11,920	mm^2
I_y =	1,598	$x10^6$ mm^4
I_z =	105	$x10^6$ mm^4
r_y =	366	mm
r_z =	94	mm

Local Check for Capacity of Single Angle Between Battens

r =	22.3	mm
L =	775	mm
A_g =	2,980	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.376$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$: -585 kN

Capacity of single angle does not govern built up member capacity

Compression Results *LIFT-TLAT*

	L_y =	12,196	mm			
	L_z =	12,196	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.01	
	Web	N/A				
	Flange b	167	mm			
	Flange t	11.1	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-688	kN			
	Lift Span Lowered: C_f =	-536	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	130	<	160		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	15	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 2,324 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 960 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.396$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.416$$

C_r = -960 kN Compressive Capacity (Factored)

C_r / C_f = 1.40 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-TLAT*

	Lift Span Raised: T_f =	694	kN	
	Lift Span Lowered: T_f =	538	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	2,605	kN	Gross Section
	T_r =	2,605	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.75		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Bottom Lateral
Member ID: LIFT-BLAT
S-Frame End Nodes: Node 127 to Node 27, Node 1 to Node 127, Node 129 to Node 31, Node 5 to Node 129, Node 131 to Node 42, Node 16 to Node 131, Node 29 to Node 128, Node 3 to Node 128, Node 39 to Node 130, Node 13 to Node 130, Node 130 to Node 44, Node 130 to Node 18, Node 132 to Node 40, Node 132 to Node 14, Node 127 to Node 29, Node 128 to Node 5, Node 129 to Node 39, Node 131 to Node 18, Node 42 to Node 132, Node 132 to Node 16, Node 131 to Node 44, Node 13 to Node 129, Node 31 to Node 128, Node 3 to Node 127

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 7x4x7/16
Qty	4
y_{dim} (mm)	178
z_{dim} (mm)	102
I_{y1} ($x10^6 mm^4$)	2.45
I_{z1} ($x10^6 mm^4$)	9.88
A_g (mm^2)	2,980
y_{bar} (mm)	74
z_{bar} (mm)	374
I_y ($x10^6 mm^4$)	1,677
I_z ($x10^6 mm^4$)	105

A_g =	11,920	mm^2
I_y =	1,677	$x10^6$ mm^4
I_z =	105	$x10^6$ mm^4
r_y =	375	mm
r_z =	94	mm

Local Check for Capacity of Single Angle Between Battens

r =	22.3	mm
L =	775	mm
A_g =	2,980	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.376$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -585 kN

Capacity of single angle does not govern built up member capacity

Compression Results *LIFT-BLAT*

	L_y =	12,196	mm			
	L_z =	12,196	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.01	
	Web	N/A				
	Flange b	167	mm			
	Flange t	11.1	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-732	kN			
	Lift Span Lowered: C_f =	-557	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	130	<	160		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	15	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 2,333 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 960 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.386$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.416$$

C_r =	-960	kN	Compressive Capacity (Factored)
C_r / C_f =	1.31		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-BLAT*

	Lift Span Raised: T_f =	857	kN	
	Lift Span Lowered: T_f =	948	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	2,605	kN	Gross Section
	T_r =	2,605	kN	Tensile Capacity (Factored)
	T_r / T_f =	2.75		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Portal Frame Bottom Strut
Member ID: LIFT-PORT-BSTR
S-Frame End Nodes: Node 134 to Node 133, Node 137 to Node 136

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 4x4x3/8	Web Plates
Qty	4	2
y_{dim} (mm)	102	10
z_{dim} (mm)	102	609.6
I_{y1} ($x10^6 mm^4$)	1.84	180
I_{z1} ($x10^6 mm^4$)	1.84	0
A_g (mm^2)	1,850	5,806
		5,806
y_{bar} (mm)	358	392
z_{bar} (mm)	282	0
I_y ($x10^6 mm^4$)	596	360
I_z ($x10^6 mm^4$)	958	1,786

A_g =	19,013	mm^2
I_y =	956	$x10^6\ mm^4$
I_z =	2,743	$x10^6\ mm^4$
r_y =	224	mm
r_z =	380	mm

Local Check for Capacity of Single Angle Between Battens

r =	20.0	mm
L =	622	mm
A_g =	4,753	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.336$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$: -946 kN

Capacity of single angle does not govern built up member capacity

Compression Results *LIFT-PORT-BSTR*

	L_y =	15,545	mm			
	L_z =	7,772	mm			
	K_y =	1.00		K'_y =	1.03	
	K_z =	1.00		K'_z =	1.10	
	Web h	406	mm			
	Web w	10	mm			
	Flange b	102	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-17	kN			
	Lift Span Lowered: C_f =	-40	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	69	<	160		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	42.6	<	44		*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	11	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 2,910 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,871 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.771$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.243$$

C_r = -2,910 kN Compressive Capacity (Factored)

C_r / C_f = 72.75 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-PORT-BSTR*

	Lift Span Raised: T_f =	148	kN	
	Lift Span Lowered: T_f =	72	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,154	kN	Gross Section
	T_r =	4,154	kN	Tensile Capacity (Factored)
	T_r / T_f =	28.07		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Portal Frame Top Lateral Diagonal
Member ID: LIFT-PORT-LATD
S-Frame End Nodes: Node 855 to Node 858, Node 859 to Node 855

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 3.5x3.5x3/8
Qty	4
y_{dim} (mm)	89
z_{dim} (mm)	89
I_{y1} ($x10^6 mm^4$)	1.19
I_{z1} ($x10^6 mm^4$)	1.19
A_g (mm^2)	1,600
y_{bar} (mm)	38
z_{bar} (mm)	362
I_y ($x10^6 mm^4$)	842
I_z ($x10^6 mm^4$)	14

A_g =	6,400	mm^2
I_y =	842	$x10^6\ mm^4$
I_z =	14	$x10^6\ mm^4$
r_y =	363	mm
r_z =	47	mm

Local Check for Capacity of Single Angle Between Battens

r =	17.4	mm
L =	775	mm
A_g =	1,600	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.479$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = -300 kN

Capacity of single angle does not govern built up member capacity

Compression Results *LIFT-PORT-LATD*

	L_y =	6,283	mm			
	L_z =	6,283	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.01	
	Web	N/A				
	Flange b	89	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-71	kN			
	Lift Span Lowered: C_f =	-77	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	133	<	160		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	9	<	44		*Cl. 10.9.2.1 Satisfied*
Cl. 10.9.3.1	$C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ =	1,311	kN			
Cl. 10.9.3.1	$C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ =	497	kN	*Governs*		

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.206$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.452$$

C_r =	-497	kN	Compressive Capacity (Factored)
C_r / C_f =	6.46		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-PORT-LATD*

	Lift Span Raised: T_f =	91	kN	
	Lift Span Lowered: T_f =	66	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,398	kN	Gross Section
	T_r =	1,398	kN	Tensile Capacity (Factored)
	T_r / T_f =	15.37		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Portal Frame Top Longitudinal Member
Member ID: LIFT-PORT-LATL
S-Frame End Nodes: Node 122 to Node 850, Node 853 to Node 850, Node 850 to Node 854, Node 855 to Node 126

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 3.5x3.5x3/8
Qty	4
y_{dim} (mm)	89
z_{dim} (mm)	89
I_{y1} ($\times10^6 mm^4$)	1.19
I_{z1} ($\times10^6 mm^4$)	1.19
A_g (mm^2)	1,600
y_{bar} (mm)	279
z_{bar} (mm)	362
I_y ($\times10^6 mm^4$)	842
I_z ($\times10^6 mm^4$)	503

A_g =	6,400	mm^2
I_y =	842	$\times10^6$ mm^4
I_z =	503	$\times10^6$ mm^4
r_y =	363	mm
r_z =	280	mm

Local Check for Capacity of Single Angle Between Battens

r =	17.4	mm
L =	775	mm
A_g =	1,600	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.479$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -300 kN

Capacity of single angle governs built up member capacity

Compression Results *LIFT-PORT-LATL*

	L_y =	9,482	mm			
	L_z =	9,482	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.10	
	Web	N/A				
	Flange b	89	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-99	kN			
	Lift Span Lowered: C_f =	-77	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	34	<	160		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	9	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,283 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,245 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.310$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.401$$

C_r = -1,202 kN Compressive Capacity (Factored)

C_r / C_f = 12.14 Capacity over Demand Ratio (C/D)

Tension Results *LIFT-PORT-LATL*

	Lift Span Raised: T_f =	92	kN	
	Lift Span Lowered: T_f =	66	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,398	kN	Gross Section
	T_r =	1,398	kN	Tensile Capacity (Factored)
	T_r / T_f =	15.20		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Portal Frame Top Transverse Member
Member ID: LIFT-PORT-LATT
S-Frame End Nodes: Node 851 to Node 853, Node 854 to Node 852, Node 858 to Node 856, Node 857 to Node 859

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y = 230 MPa *CSA S6-06 Cl. 14.7.4.2*
F_u = 420 MPa *CSA S6-06 Cl. 14.7.4.2*
E_s = 200,000 MPa
G_s = 77,000 MPa

Built Up Section Properties

	Angles 3.5x3.5x3/8
Qty	4
y_{dim} (mm)	89
z_{dim} (mm)	89
I_{y1} ($x10^6mm^4$)	1.19
I_{z1} ($x10^6mm^4$)	1.19
A_g (mm^2)	1,600
y_{bar} (mm)	32
z_{bar} (mm)	362
I_y ($x10^6mm^4$)	842
I_z ($x10^6mm^4$)	11

A_g = 6,400 mm^2

I_y = 842 $x10^6$ mm^4
I_z = 11 $x10^6$ mm^4
r_y = 363 mm
r_z = 42 mm

Local Check for Capacity of Single Angle Between Battens

r = 17.4 mm
L = 775 mm
A_g = 1,600 mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.479$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -300 kN

Capacity of single angle does not govern built up member capacity

Compression Results

LIFT-PORT-LATT

	L_y =	1,964	mm			
	L_z =	1,964	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.07	
	Web	N/A				
	Flange b	89	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-120	kN			
	Lift Span Lowered: C_f =	-93	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	47	<	160		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	9	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,324 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,164 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.064$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.537$$

C_r = -1,164 kN Compressive Capacity (Factored)

C_r / C_f = 9.70 Capacity over Demand Ratio (C/D)

Tension Results

LIFT-PORT-LATT

	Lift Span Raised: T_f =	113	kN	
	Lift Span Lowered: T_f =	82	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,398	kN	Gross Section
	T_r =	1,398	kN	Tensile Capacity (Factored)
	T_r / T_f =	12.38		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Portal Frame Sway Bracing
Member ID: LIFT-PORT-SWBC
S-Frame End Nodes: Node 34 to Node 135, Node 135 to Node 8, Node 21 to Node 138, Node 138 to Node 47, Node 133 to Node 139, Node 139 to Node 122, Node 122 to Node 140, Node 140 to Node 134, Node 141 to Node 136, Node 126 to Node 141, Node 142 to Node 126, Node 137 to Node 142

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Tee Section WT4x24
Qty	2
y_{dim} (mm)	206
z_{dim} (mm)	108
I_{y1} ($x10^6 mm^4$)	2.85
I_{z1} ($x10^6 mm^4$)	12.70
A_g (mm^2)	4,548
y_{bar} (mm)	0
z_{bar} (mm)	368
I_y ($x10^6 mm^4$)	1,235
I_z ($x10^6 mm^4$)	25

A_g =	9,097	mm^2
I_y =	1,235	$x10^6$ mm^4
I_z =	25	$x10^6$ mm^4
r_y =	368	mm
r_z =	53	mm

Local Check for Capacity of Tee Between Battens

r =	25.0	mm
L =	533	mm
A_g =	4,548	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.230$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -928 kN

Capacity of single tee does not govern built up member capacity

Compression Results *LIFT-PORT-SWBC*

	L_y =	4,757	mm			
	L_z =	9,514	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.00	
	Web h	108	mm			
	Web w	10	mm			
	Flange b	89	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	180	>	160		*Cl. 10.9.1.3 NOT Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	10.6	<	44		*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	9	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.153$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.953$$

C_r = N/A kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *LIFT-PORT-SWBC*

	Lift Span Raised: T_f =	118	kN	
	Lift Span Lowered: T_f =	98	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,988	kN	Gross Section
	T_r =	1,988	kN	Tensile Capacity (Factored)
	T_r / T_f =	16.84		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Portal Frame Vertical Bracing
Member ID: LIFT-PORT-SWBV
S-Frame End Nodes: Node 122 to Node 135, Node 138 to Node 126

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 3.5x3.5x3/8
Qty	4
y_{dim} (mm)	89
z_{dim} (mm)	89
I_{y1} ($x10^6 mm^4$)	1.19
I_{z1} ($x10^6 mm^4$)	1.19
A_g (mm^2)	1,600
y_{bar} (mm)	279
z_{bar} (mm)	362
I_y ($x10^6 mm^4$)	842
I_z ($x10^6 mm^4$)	503

A_g =	6,400	mm^2
I_y =	842	$x10^6$ mm^4
I_z =	503	$x10^6$ mm^4
r_y =	363	mm
r_z =	280	mm

Local Check for Capacity of Single Angle Between Battens

r =	17.4	mm
L =	533	mm
A_g =	1,600	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.330$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = -319 kN

Capacity of single angle governs built up member capacity

Compression Results *LIFT-PORT-SWBV*

	L_y =	5,487	mm			
	L_z =	5,487	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.10	
	Web	N/A				
	Flange b	89	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	20	<	160		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	9	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,315 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,305 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.180$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.232$$

C_r =	-1,276	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-PORT-SWBV*

	Lift Span Raised: T_f =	36	kN	
	Lift Span Lowered: T_f =	45	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,398	kN	Gross Section
	T_r =	1,398	kN	Tensile Capacity (Factored)
	T_r / T_f =	31.08		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Sway Frame Bottom Strut
Member ID: LIFT-SWAY-BSTR
S-Frame End Nodes: Node 119 to Node 120, Node 53 to Node 54, Node 80 to Node 81, Node 82 to Node 83, Node 84 to Node 85, Node 86 to Node 87, Node 88 to Node 89, Node 90 to Node 91, Node 92 to Node 93, Node 77 to Node 78, Node 123 to Node 124,

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Channels 12x25
Qty	2
y_{dim} (mm)	77
z_{dim} (mm)	305
I_{y1} ($x10^6 mm^4$)	59.90
I_{z1} ($x10^6 mm^4$)	1.85
A_g (mm^2)	4,720
y_{bar} (mm)	250
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	120
I_z ($x10^6 mm^4$)	592

A_g =	9,440	mm^2
I_y =	120	$x10^6$ mm^4
I_z =	592	$x10^6$ mm^4
r_y =	113	mm
r_z =	250	mm

Local Check for Capacity of Single Channel Between Battens

r =	19.8	mm
L =	533	mm
A_g =	4,720	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.291$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = -951 kN

Capacity of single channel does not govern built up member capacity

Compression Results *LIFT-SWAY-BSTR*

	L_y =	7,772	mm			
	L_z =	15,545	mm			
	K_y =	1.00		K'_y =	1.03	
	K_z =	1.00		K'_z =	1.04	
	Web h	280	mm			
	Web w	10	mm			
	Flange b	67	mm			
	Flange t	12.7	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-22	kN			
	Lift Span Lowered: C_f =	-36	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	69	<	160	*Cl. 10.9.1.3 Satisfied*	
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	28.5	<	44	*Cl. 10.9.2.1 Satisfied*	
	Flanges b/t =	5	<	44	*Cl. 10.9.2.1 Satisfied*	

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,449 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,538 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.768$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.696$$

C_r =	-1,449	kN	Compressive Capacity (Factored)
C_r / C_f =	40.25		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-SWAY-BSTR*

	Lift Span Raised: T_f =	69	kN	
	Lift Span Lowered: T_f =	70	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	2,063	kN	Gross Section
	T_r =	2,063	kN	Tensile Capacity (Factored)
	T_r / T_f =	29.47		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Sway Frame Cross Sway Bracing
Member ID: LIFT-SWAY-SWBC

S-Frame End Nodes: Node 54 to Node 101, Node 101 to Node 53, Node 81 to Node 103, Node 103 to Node 80, Node 83 to Node 105, Node 105 to Node 82, Node 85 to Node 107, Node 107 to Node 84, Node 87 to Node 109, Node 109 to Node 86, Node 89 to Node 111, Node 111 to Node 88, Node 91 to Node 113, Node 113 to Node 90, Node 93 to Node 115, Node 115 to Node 92, Node 78 to Node 117, Node 117 to Node 77, Node 37 to Node 876, Node 876 to Node 102, Node 102 to Node 877, Node 877 to Node 11, Node 35 to Node 878, Node 878 to Node 104, Node 104 to Node 879, Node 879 to Node 9, Node 38 to Node 880, Node 880 to Node 106, Node 106 to Node 881, Node 881 to Node 12, Node 36 to Node 882, Node 882 to Node 108, Node 108 to Node 883, Node 883 to Node 10, Node 52 to Node 884, Node 884 to Node 110, Node 110 to Node 885, Node 885 to Node 26, Node 49 to Node 886, Node 886 to Node 112, Node 112 to Node 887, Node 887 to Node 23, Node 51 to Node 888, Node 888 to Node 114, Node 114 to Node 889, Node 889 to Node 25, Node 48 to Node 890, Node 890 to Node 116, Node 116 to Node 891, Node 891 to Node 22, Node 50 to Node 892, Node 892 to Node 118, Node 118 to Node 893, Node 893 to Node 24

Member orientation (local axis): z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Built Up Section Properties

	Tee Section WT4x24
Qty	2
y_{dim} (mm)	206
z_{dim} (mm)	108
I_{y1} ($x10^6mm^4$)	2.85
I_{z1} ($x10^6mm^4$)	12.70
A_g (mm^2)	4,548
y_{bar} (mm)	0
z_{bar} (mm)	247
I_y ($x10^6mm^4$)	560
I_z ($x10^6mm^4$)	25

A_g =	9,097	mm^2
I_y =	560	$x10^6$ mm^4
I_z =	25	$x10^6$ mm^4
r_y =	248	mm
r_z =	53	mm

Local Check for Capacity of Single Tee Between Battens

r =	25.0	mm
L =	533	mm
A_g =	4,548	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.230$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -928 kN

Capacity of single angle does not govern built up member capacity

Compression Results *LIFT-SWAY-SWBC*

	L_y =	5,203	mm			
	L_z =	10,405	mm			
	K_y =	1.00			K'_y =	1.10
	K_z =	1.00			K'_z =	1.00
Web	h	108	mm			
	w	10	mm			
Flange	b	89	mm			
	t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	0	kN			
	Lift Span Lowered: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				

Cl. 10.9.1.3	Slenderness Ratio =	197	>	160	*Cl. 10.9.1.3 NOT Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	10.6	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	9	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.249$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 2.134$$

C_r =	N/A	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-SWAY-SWBC*

	Lift Span Raised: T_f =	82	kN	
	Lift Span Lowered: T_f =	87	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,988	kN	Gross Section
	T_r =	1,988	kN	Tensile Capacity (Factored)
	T_r / T_f =	22.85		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Sway Frame Vertical Bracing
Member ID: LIFT-SWAY-SWBV
S-Frame End Nodes: Node 121 to Node 122, Node 125 to Node 126, Node 101 to Node 102, Node 103 to Node 104, Node 105 to Node 106, Node 107 to Node 108, Node 109 to Node 110, Node 111 to Node 112, Node 113 to Node 114, Node 115 to Node 116, Node 117 to Node 118

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Tee Section WT4x24
Qty	2
y_{dim} (mm)	206
z_{dim} (mm)	108
I_{y1} ($x10^6mm^4$)	2.85
I_{z1} ($x10^6mm^4$)	12.70
A_g (mm^2)	4,548
y_{bar} (mm)	0
z_{bar} (mm)	247
I_y ($x10^6mm^4$)	561
I_z ($x10^6mm^4$)	25

A_g =	9,097	mm^2
I_y =	561	$x10^6$ mm^4
I_z =	25	$x10^6$ mm^4
r_y =	248	mm
r_z =	53	mm

Local Check for Capacity of Single Tee Between Battens

r =	25.0	mm
L =	533	mm
A_g =	4,548	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.230$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$: -928 kN

Capacity of single angle does not govern built up member capacity

Compression Results

LIFT-SWAY-SWBV

	L_y =	6,918	mm				
	L_z =	6,918	mm				
	K_y =	1.00			K'_y =	1.10	
	K_z =	1.00			K'_z =	1.01	
Web	h	108	mm				
	w	10	mm				
Flange	b	89	mm				
	t	9.5	mm				
	n =	1.34					
	Lift Span Raised: C_f =	-20	kN				
	Lift Span Lowered: C_f =	-46	kN				
Cl. 10.5.7 (c)	Compression: φ_s =	0.90					
Cl. 10.9.1.3	Slenderness Ratio =	131		<	160		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits						
	Web h/w =	10.6		<	44		*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	9		<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 1,814 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 726 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.331$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.426$$

C_r =	-726	kN	Compressive Capacity (Factored)
C_r / C_f =	15.78		Capacity over Demand Ratio (C/D)

Tension Results

LIFT-SWAY-SWBV

	Lift Span Raised: T_f =	17	kN	
	Lift Span Lowered: T_f =	23	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,988	kN	Gross Section
	T_r =	1,988	kN	Tensile Capacity (Factored)
	T_r / T_f =	86.42		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Sway Frame Top Strut
Member ID: LIFT-SWAY-TSTR
S-Frame End Nodes: Node 8 to Node 34, Node 11 to Node 37, Node 9 to Node 35, Node 12 to Node 38, Node 10 to Node 36, Node 26 to Node 52, Node 23 to Node 49, Node 25 to Node 51, Node 22 to Node 48, Node 24 to Node 50, Node 21 to Node 47

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 5x5x3/8
Qty	4
y_{dim} (mm)	127
z_{dim} (mm)	127
I_{y1} ($x10^6 mm^4$)	3.64
I_{z1} ($x10^6 mm^4$)	3.64
A_g (mm^2)	2,330
y_{bar} (mm)	231
z_{bar} (mm)	352
I_y ($x10^6 mm^4$)	1,170
I_z ($x10^6 mm^4$)	514

A_g =	9,320	mm^2
I_y =	1,170	$x10^6$ mm^4
I_z =	514	$x10^6$ mm^4
r_y =	354	mm
r_z =	235	mm

Local Check for Capacity of Single Angle Between Battens

r =	25.1	mm
L =	775	mm
A_g =	2,330	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.333$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$: -464 kN

Capacity of single angle does not govern built up member capacity

Compression Results *LIFT-SWAY-TSTR*

	L_y =	7,773	mm			
	L_z =	7,773	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.10	
	Web	N/A				
	Flange b	127	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-323	kN			
	Lift Span Lowered: C_f =	-278	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	33	<	160		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	13	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,891 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,819 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.261$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.393$$

C_r =	-1,819	kN	Compressive Capacity (Factored)
C_r / C_f =	5.63		Capacity over Demand Ratio (C/D)

Tension Results *LIFT-SWAY-TSTR*

	Lift Span Raised: T_f =	302	kN	
	Lift Span Lowered: T_f =	212	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	2,036	kN	Gross Section
	T_r =	2,036	kN	Tensile Capacity (Factored)
	T_r / T_f =	6.74		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Diaphragms (Original on highway side)
Member ID: C12X20.7

S-Frame End Nodes: 311-313, 313-315, 315-317, 317-319, 319-321, 321-300, 312-314, 314-316, 316-318, 318-320, 320-322, 322-302, 335-337, 337-339, 339-341, 341-343, 343-345, 345-324, 336-338, 338-340, 340-342, 342-344, 344-346 346-326, 359-361, 361-363, 363-365, 365-367, 367-369, 369-348, 360-362, 362-364, 364-366, 366-368, 368-370, 370-350 383-385, 385-387, 387-389, 389-391, 391-393, 393-372, 384-386, 386-388, 388-390, 390-392, 392-394, 394-374, 407-409 409-411, 411-413, 413-415, 415-417, 417-396, 408-410, 410-412, 412-414, 414-416, 416-418, 418-398, 431-433, 433-435 435-437, 437-439, 439-441, 441-420, 432-434, 434-436, 436-438, 438-440, 440-442, 442-422, 455-457, 457-459, 459-461 461-463, 463-465, 465-444, 456-458, 458-460, 460-462, 462-464, 464-466, 466-446, 479-481, 481-483, 483-485, 485-487 487-489, 489-468, 480-482, 482-484, 484-486, 486-488, 488-490, 490-470, 503-505, 505-507, 507-509, 509-511, 511-513 513-492, 504-506, 506-508, 508-510, 510-512, 512-514, 514-494, 527-529, 529-531, 531-533, 533-535, 535-537, 537-516 528-530, 530-532, 532-534, 534-536, 536-538, 538-518, 551-553, 553-555, 555-557, 557-559, 559-561, 561-540, 552-554 554-556, 556-558, 558-560, 560-562, 562-542, 575-577, 577-579, 579-581, 581-583, 583-585, 585-564, 576-578, 578-580 580-582, 582-584, 584-586, 586-566

Member orientation (local axis): z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description).

Built Up Section Properties

	Channel 12x20.7
Qty	1
y_{dim} (mm)	74
z_{dim} (mm)	305
I_{y1} ($x10^6mm^4$)	53.50
I_{z1} ($x10^6mm^4$)	1.59
A_g (mm^2)	3,920
y_{bar} (mm)	0
z_{bar} (mm)	0
I_y ($x10^6mm^4$)	54
I_z ($x10^6mm^4$)	2

A_g = 3,920 mm^2

I_y = 54 $x10^6$ mm^4
I_z = 2 $x10^6$ mm^4
r_y = 117 mm
r_z = 20.1 mm

Compression Results *C12X20.7*

	L_y =	1,295	mm			
	L_z =	1,295	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.04	
	Web	N/A				
	Flange b	74	mm			
	t	12.7	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-12	kN			
	Lift Span Lowered: C_f =	-137	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	64	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	6	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 809 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 627 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.132$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.719$$

C_r =	-627	kN	Compressive Capacity (Factored)
C_r / C_f =	4.58		Capacity over Demand Ratio (C/D)

Tension Results *C12X20.7*

	Lift Span Raised: T_f =	13	kN	
	Lift Span Lowered: T_f =	644	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	857	kN	Gross Section
	T_r =	857	kN	Tensile Capacity (Factored)
	T_r / T_f =	1.33		Capacity over Demand Ratio (C/D)

Member Location: Approach and Tower Spans
Member Description: Diaphragms (Original on highway side)
Member ID: C310X37

S-Frame End Nodes: 299-303, 303-305, 305-307, 307-309, 309-311, 301-304, 304-306, 306-308, 308-310, 310-312, 323-327, 327-329, 329-331, 331-333, 333-335, 325-328, 328-330, 330-332, 332-334, 334-336, 347-351, 351-353, 353-355, 355-357, 357-359, 349-352, 352-354, 354-356, 356-358, 358-360, 371-375, 375-377, 377-379, 379-381, 381-383, 373-376, 376-378, 378-380, 380-382, 382-384, 395-399, 399-401, 401-403, 403-405, 405-407, 397-400, 400-402, 402-404, 404-406, 406-408, 419-423, 423-425, 425-427, 427-429, 429-431, 421-424, 424-426, 426-428, 428-430, 430-432, 443-447, 447-449, 449-451, 451-453, 453-455, 445-448, 448-450, 450-452, 452-454, 454-456, 467-471, 471-473, 473-475, 475-477, 477-479, 469-472, 472-474, 474-476, 476-478, 478-480, 491-495, 495-497, 497-499, 499-501, 501-503, 493-496, 496-498, 498-500, 500-502, 502-504, 515-519, 519-521, 521-523, 523-525, 525-527, 517-520, 520-522, 522-524, 524-526, 526-528, 539-543, 543-545, 545-547, 547-549, 549-551, 541-544, 544-546, 546-548, 548-550, 550-552, 563-567, 567-569, 569-571, 571-573, 573-575, 565-568, 568-570, 570-572, 572-574, 574-576,

Member orientation (local axis): *z always corresponds with the vertical plane*
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Built Up Section Properties

	Channel 310x37
Qty	1
y_{dim} (mm)	77
z_{dim} (mm)	305
I_{y1} ($x10^6 mm^4$)	59.90
I_{z1} ($x10^6 mm^4$)	1.85
A_g (mm^2)	4,720
y_{bar} (mm)	0
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	60
I_z ($x10^6 mm^4$)	2

A_g = 4,720 mm^2

I_y = 60 $x10^6$ mm^4
I_z = 2 $x10^6$ mm^4
r_y = 113 mm
r_z = 19.8 mm

Compression Results *C310X37*

	L_y =	1,130	mm		
	L_z =	1,130	mm		
	K_y =	1.00		K'_y =	1.10
	K_z =	1.00		K'_z =	1.05
	Web	N/A			
	Flange b	77	mm		
	Flange t	12.7	mm		
	n =	1.34			
	Lift Span Raised: C_f =	-12	kN		
	Lift Span Lowered: C_f =	-89	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			

Cl. 10.9.1.3	Slenderness Ratio =	57	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Flanges b/t =	6	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 975 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 800 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.119$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.644$$

C_r =	-800	kN	Compressive Capacity (Factored)
C_r / C_f =	8.99		Capacity over Demand Ratio (C/D)

Tension Results *C310X37*

	Lift Span Raised: T_f =	12	kN	
	Lift Span Lowered: T_f =	618	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,031	kN	Gross Section
	T_r =	1,031	kN	Tensile Capacity (Factored)
	T_r / T_f =	1.67		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Traction Bracing Ends
Member ID: 2L3-1/2x3-1/2x3/8
S-Frame End Nodes: Node 798 to Node 799, Node 794 to Node 800, Node 806 to Node 807, Node 802 to Node 808, Node 814 to Node 815, Node 810 to Node 816, Node 822 to Node 823, Node 818 to Node 824, Node 830 to Node 831, Node 826 to Node 832, Node 838 to Node 839, Node 834 to Node 840, Node 846 to Node 847, Node 842 to Node 848

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 3-1/2x3-1/2x3/8
Qty	2
y_{dim} (mm)	89
z_{dim} (mm)	89
I_{y1} ($x10^6 mm^4$)	1.19
I_{z1} ($x10^6 mm^4$)	1.19
A_g (mm^2)	1,600
y_{bar} (mm)	38
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	2
I_z ($x10^6 mm^4$)	7

A_g =	3,200	mm^2
I_y =	2.380	$x10^6$ mm^4
I_z =	7.099	$x10^6$ mm^4
r_y =	27	mm
r_z =	47	mm

Local Check for Capacity of Single Angle

r =	17.4	mm
L =	600	mm
A_g =	1,600	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.371$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = -315 kN

Capacity of single angle does not govern built up member capacity

Compression Results *2L3-1/2x3-1/2x3/8*

	L_y =	1,961 mm				
	L_z =	1,961 mm				
	K_y =	1.00		K'_y =	1.03	
	K_z =	1.00		K'_z =	1.08	
	Web	N/A				
	Flange b	89 mm				
	t	9.5 mm				
	n =	1.34				
	Lift Span Raised: C_f =	-80 kN				
	Lift Span Lowered: C_f =	-220 kN				
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	72	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	9	<	44		*Cl. 10.9.2.1 Satisfied*
Cl. 10.9.3.1	$C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ =	478 kN		*Governs*		
Cl. 10.9.3.1	$C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ =	599 kN				

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.798$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.487$$

C_r =	-478	kN	Compressive Capacity (Factored)
C_r / C_f =	2.17		Capacity over Demand Ratio (C/D)

Tension Results *2L3-1/2x3-1/2x3/8*

	Lift Span Raised: T_f =	83	kN	
	Lift Span Lowered: T_f =	65	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	699	kN	Gross Section
	T_r =	699	kN	Tensile Capacity (Factored)
	T_r / T_f =	8.42		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Traction Bracing End Diagonals and End Longitudinal Member
Member ID: 2L4x4x3/8
S-Frame End Nodes: Node 794 to Node 795, Node 797 to Node 798, Node 794 to Node 801, Node 802 to Node 803, Node 805 to Node 806, Node 802 to Node 809, Node 810 to Node 811, Node 813 to Node 814, Node 810 to Node 817, Node 818 to Node 819, Node 821 to Node 822, Node 818 to Node 825, Node 826 to Node 827, Node 829 to Node 830, Node 826 to Node 833, Node 834 to Node 835, Node 837 to Node 838, Node 834 to Node 841, Node 842 to Node 843, Node 845 to Node 846, Node 842 to Node 849

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 4x4x3/8
Qty	2
y_{dim} (mm)	102
z_{dim} (mm)	102
I_{y1} ($x10^6mm^4$)	1.84
I_{z1} ($x10^6mm^4$)	1.84
A_g (mm^2)	1,850
y_{bar} (mm)	42
z_{bar} (mm)	0
I_y ($x10^6mm^4$)	4
I_z ($x10^6mm^4$)	10

A_g =	3,700	mm^2
I_y =	3.680	$x10^6$ mm^4
I_z =	10.114	$x10^6$ mm^4
r_y =	32	mm
r_z =	52	mm

Local Check for Capacity of Single Angle

r =	20.0	mm
L =	1,000	mm
A_g =	1,850	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.539$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = -336 kN

Capacity of single angle does not govern built up member capacity

Compression Results *2L4x4x3/8*

	L_y =	3,418	mm			
	L_z =	3,418	mm			
	K_y =	1.00		K'_y =	1.01	
	K_z =	1.00		K'_z =	1.03	
	Web	N/A				
	Flange b	102	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Raised: C_f =	-138	kN			
	Lift Span Lowered: C_f =	-304	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	108	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	11	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 378 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 586 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.185$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.730$$

C_r =	-378	kN	Compressive Capacity (Factored)
C_r / C_f =	1.24		Capacity over Demand Ratio (C/D)

Tension Results *2L4x4x3/8*

	Lift Span Raised: T_f =	75	kN	
	Lift Span Lowered: T_f =	143	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	808	kN	Gross Section
	T_r =	808	kN	Tensile Capacity (Factored)
	T_r / T_f =	5.65		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Traction Bracing Interior Diagonals
Member ID: 2L5x5x3/8
S-Frame End Nodes: Node 795 to Node 796, Node 796 to Node 797, Node 803 to Node 804, Node 804 to Node 805, Node 811 to Node 812, Node 812 to Node 813, Node 819 to Node 820, Node 820 to Node 821, Node 827 to Node 828, Node 828 to Node 829, Node 835 to Node 836, Node 836 Node 837, Node 843 to Node 844, Node 844 to Node 845

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 5x5x3/8
Qty	2
y_{dim} (mm)	127
z_{dim} (mm)	127
I_{y1} ($x10^6mm^4$)	3.64
I_{z1} ($x10^6mm^4$)	3.64
A_g (mm^2)	2,330
y_{bar} (mm)	48
z_{bar} (mm)	0
I_y ($x10^6mm^4$)	7
I_z ($x10^6mm^4$)	18

A_g =	4,660	mm^2
I_y =	7.280	$x10^6$ mm^4
I_z =	18.017	$x10^6$ mm^4
r_y =	40	mm
r_z =	62	mm

Local Check for Capacity of Single Angle

r =	25.1	mm
L =	1,000	mm
A_g =	2,330	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.429$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -448 kN

Capacity of single angle does not govern built up member capacity

Compression Results *2L5x5x3/8*

	L_y =	4,121	mm		
	L_z =	4,121	mm		
	K_y =	1.00		K'_y =	1.01
	K_z =	1.00		K'_z =	1.03
	Web	N/A			
	Flange b	127	mm		
	t	9.5	mm		
	n =	1.34			
	Lift Span Raised: C_f =	-70	kN		
	Lift Span Lowered: C_f =	-253	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			

Cl. 10.9.1.3	Slenderness Ratio =	104	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Flanges b/t =	13	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 498 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 733 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.141$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.739$$

C_r = -498 kN Compressive Capacity (Factored)

C_r / C_f = 1.97 Capacity over Demand Ratio (C/D)

Tension Results *2L5x5x3/8*

	Lift Span Raised: T_f =	70	kN	
	Lift Span Lowered: T_f =	252	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,018	kN	Gross Section
	T_r =	1,018	kN	Tensile Capacity (Factored)
	T_r / T_f =	4.04		Capacity over Demand Ratio (C/D)

Member Location: Lift Span
Member Description: Lift Span Traction Bracing Transverse Member
Member ID: 2L6x6x1/2
S-Frame End Nodes: Node 798 to Node 794, Node 806 to Node 802, Node 814 to Node 810, Node 822 to Node 818, Node 846 to Node 842, Node 838 to Node 834, Node 830 to Node 826

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles L6x6x1/2
Qty	2
y_{dim} (mm)	152
z_{dim} (mm)	152
I_{y1} ($x10^6 mm^4$)	8.22
I_{z1} ($x10^6 mm^4$)	8.22
A_g (mm^2)	3,700
y_{bar} (mm)	55
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	16
I_z ($x10^6 mm^4$)	39

A_g =	7,400	mm^2
I_y =	16.440	$x10^6$ mm^4
I_z =	39.152	$x10^6$ mm^4
r_y =	47	mm
r_z =	73	mm

Local Check for Capacity of Single Angle

r =	30.0	mm
L =	5,791	mm
A_g =	3,700	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 2.086$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = -160 kN

Capacity of single angle does not govern built up member capacity

Compression Results *2L6x6x1/2*

	L_y =	5,791	mm		
	L_z =	11,582	mm		
	K_y =	1.00		K'_y =	1.01
	K_z =	1.00		K'_z =	1.01
	Web	N/A			
	Flange b	152	mm		
	Flange t	12.7	mm		
	n =	1.34			
	Lift Span Raised: C_f =	0	kN		
	Lift Span Lowered: C_f =	0	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			

Cl. 10.9.1.3 Slenderness Ratio = 159 > 120 *Cl. 10.9.1.3 NOT Satisfied*

Cl. 10.9.2.1 Width to Thickness Limits

Flanges b/t = 12 < 44 *Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.339$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.729$$

C_r = N/A kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *2L6x6x1/2*

	Lift Span Raised: T_f =	104	kN	
	Lift Span Lowered: T_f =	471	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,617	kN	Gross Section
	T_r =	1,617	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.43		Capacity over Demand Ratio (C/D)

APPENDIX G
TOWER
CAPACITY SPREADSHEETS

Member Capacity Summary
Tower - Raised Lift Span

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
TOWR-BBRC-MDIA	-3,529	-1,223	2.89		-547	4,569	658	6.94		547
TOWR-BBRC-RcRc	-12,120	0	N/A		-498	14,200	143	99.3		498
TOWR-BBRC-RdRd	-3,642	-272	13.4		-125	4,149	374	11.1		125
TOWR-BBRC-ReRe	-3,662	0	N/A		-85	4,149	490	8.47		85
TOWR-BBRC-RfRf	-3,662	-509	7.19		-231	4,149	609	6.81		231
TOWR-BBRC-RgRg	-16,282	0	N/A		-81	18,732	329	56.9		81
TOWR-BBRC-UDIA	-3,529	-803	4.40		-520	4,569	452	10.11		520
TOWR-BLAT-FRTL	-345	0	N/A		N/A	1,722	608	2.83		N/A
TOWR-BLAT-HWYL	-458	0	N/A		N/A	2,255	18	N/A		N/A
TOWR-BLAT-RLYL	-693	0	N/A		N/A	2,762	608	4.54		N/A
TOWR-FBRC-CdCe	-47	0	N/A		N/A	1,407	23	61.2		N/A
TOWR-FBRC-FdFd	-4,046	-20	N/A		-796	4,569	601	7.60		396
TOWR-FBRC-FeFe	-4,018	0	N/A		-934	4,569	1,031	4.43		356
TOWR-FBRC-FfFf	-4,606	-1,330	3.46		-1,228	5,207	1,608	3.24		480
TOWR-FBRC-FgFg	-20,236	0	N/A		-947	22,858	584	39.1		423
TOWR-FBRC-MDIA	-4,126	-4,001	1.03	*Cf/Cr < 1.15*	-1,766	5,207	2,371	2.20		1,766
TOWR-FBRC-MdMe	-281	-74	3.80		N/A	1,407	56	25.1		N/A
TOWR-FBRC-UDIA	-3,526	-2,096	1.68		-1,317	4,569	607	7.53		1,317
TOWR-FCOL-BCOL	-68,627	-32,221	2.13		-19,878	76,189	0	N/A		0
TOWR-FCOL-MCOL	-57,560	-24,267	2.37		-17,027	63,328	0	N/A		0
TOWR-FCOL-UCOL	-39,131	-18,420	2.12		-13,838	42,738	0	N/A		0
TOWR-RCOL-BCOL	-22,570	-18,464	1.22		-7,584	24,936	9,109	2.74		2,273
TOWR-RCOL-MCOL	-22,833	-11,008	2.07		-5,520	24,936	4,550	5.48		503
TOWR-RCOL-UCOL	-22,833	-5,703	4.00		-3,745	24,936	0	N/A		0
TOWR-SBRC-DIAG	-3,717	-3,914	0.95	*Cf/Cr < 1.0*	-1,432	4,149	3,328	1.25		1,432
TOWR-SBRC-FgRg	-4,474	0	N/A		-356	5,207	564	9.2		818
TOWR-SBRC-FhRh	-26,305	-717	36.7		0	28,613	1,259	22.7		0
TOWR-SBRC-HORZ	-3,912	0	N/A		-565	4,569	1,065	4.29		805
TOWR-SBRC-SbFc	-4,167	-1,190	3.50		-694	4,179	492	8.49		694
2L3.5x3.5x.375	-569	-387	1.47		N/A	699	403	1.73		N/A
2L4x4x.375	-467	-31	15.1		N/A	808	26	31.1		N/A
2L5x3.5x.375	N/A	0	N/A		N/A	861	104	8.28		N/A
2L5x5x.5	N/A	0	N/A		N/A	1,337	5	N/A		N/A
2L6x6x.375	-590	-294	2.01		N/A	1,337	300	4.46		N/A
C15x33.9	-848	-1	N/A		N/A	1,405	4	N/A		N/A
C380x50	-805	-5	N/A		N/A	1,405	1	N/A		N/A
L4x4x.375	-234	0	N/A		N/A	404	0	N/A		N/A
L5x5x.375	-222	-26	8.54		N/A	509	31	16.4		N/A
L5x5x.5	-267	-9	29.6		N/A	669	9	74.3		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member ID	Bending									
	M_r	M_f	M_r/M_f	Comments	M*	V_r	V_f	V_r/V_f	Comments	V*
	kNm	kNm			kNm	kNm	kNm			kN
TOWR-FLBM-FRNT	8,548	1,560	5.48		2,502	2,887	387	7.46		1,681
TOWR-FLBM-REAR	9,116	3,379	2.70		3,417	3,614	844	4.28		1,855
TOWR-SHVG-G1	10,304	2,241	4.60		2,138	5,094	3,492	1.46		2,851
TOWR-SHVG-G2G3	12,187	2,254	5.41		2,252	5,094	3,498	1.46		2,584
TOWR-SHVG-G4	10,304	2,369	4.35		2,604	5,094	3,560	1.43		3,087
TOWR-SHVG-G6	12,865	999	12.9		423	3,396	235	14.5		138
TOWR-SHVG-G7	100,442	42,238	2.38		38,222	19,473	14,236	1.37		12,566
TOWR-SHVG-G8	20,306	4,819	4.21		6,465	5,341	1,567	3.41		1,922
Tower Span Stringers:										
W27x102 (Original Highway)	1,093	230	4.75		155	1,136	95	12.0		67
W690x152 (1982 Modification)	1,663	230	7.23		362	1,729	95	18.2		71
Approach Span Stringers:										
W33x130 (Original Highway)	1,665	388	4.29		243	1,557	123	12.7		77
W840x193 (1982 Modification)	2,534	388	6.53		362	2,369	123	19.3		116

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Capacity Summary
Tower - Closed Lift Span

Member ID	Compression					Tension				
	C_r kN	C_f kN	C_r/C_f	Comments	C* kN	T_r kN	T_f kN	T_r/T_f	Comments	T* kN
TOWR-BBRC-MDIA	-3,529	-1,660	2.13		-547	4,569	1,225	3.73		547
TOWR-BBRC-RcRc	-12,120	0	N/A		-498	14,200	99	N/A		498
TOWR-BBRC-RdRd	-3,642	-98	37.2		-125	4,149	16	N/A		125
TOWR-BBRC-ReRe	-3,662	0	N/A		-71	4,149	329	12.6		71
TOWR-BBRC-RfRf	-3,662	0	N/A		-231	4,149	848	4.89		231
TOWR-BBRC-RgRg	-16,282	0	N/A		-81	18,732	226	82.9		81
TOWR-BBRC-UDIA	-3,529	-423	8.3		-520	4,569	72	63.5		520
TOWR-BLAT-FRTL	-345	0	N/A		N/A	1,722	554	3.11		N/A
TOWR-BLAT-HWYL	-458	0	N/A		N/A	2,255	509	4.43		N/A
TOWR-BLAT-RLYL	-693	0	N/A		N/A	2,762	26	N/A		N/A
TOWR-FBRC-CdCe	-47	0	N/A		N/A	1,407	63	22.3		N/A
TOWR-FBRC-FdFd	-4,046	0	N/A		-796	4,569	366	12.5		396
TOWR-FBRC-FeFe	-4,018	0	N/A		-934	4,569	810	5.64		356
TOWR-FBRC-FfFf	-4,606	-1,140	4.04		-1,228	5,207	1,366	3.81		480
TOWR-FBRC-FgFg	-20,236	0	N/A		-947	22,858	459	49.8		423
TOWR-FBRC-MDIA	-4,126	-3,139	1.31		-1,766	5,207	1,777	2.93		1,766
TOWR-FBRC-MdMe	-281	-31	9.06		N/A	1,407	69	20.4		N/A
TOWR-FBRC-UDIA	-3,526	-1,384	2.55		-1,317	4,569	166	27.5		1,317
TOWR-FCOL-BCOL	-68,627	-19,458	3.53		-19,878	76,189	0	N/A		0
TOWR-FCOL-MCOL	-57,560	-16,596	3.47		-17,027	63,328	0	N/A		0
TOWR-FCOL-UCOL	-39,131	-14,547	2.69		-13,838	42,738	0	N/A		0
TOWR-RCOL-BCOL	-22,570	-6,602	3.42		-7,584	24,936	0	N/A		2,289
TOWR-RCOL-MCOL	-22,833	-3,920	5.82		-5,520	24,936	0	N/A		503
TOWR-RCOL-UCOL	-22,833	-2,578	8.9		-3,745	24,936	0	N/A		0
TOWR-SBRC-DIAG	-3,717	-1,589	2.34		-1,432	4,149	919	4.52		1,432
TOWR-SBRC-FgRg	-4,474	0	N/A		-356	5,207	485	10.7		818
TOWR-SBRC-FhRh	-26,305	-72	N/A		0	28,613	568	50.4		0
TOWR-SBRC-HORZ	-3,912	0	N/A		-565	4,569	452	10.1		805
TOWR-SBRC-SbFc	-4,167	-534	7.80		-694	4,179	82	51.0		694
2L3.5x3.5x.375	-569	-110	5.17		N/A	699	127	5.51		N/A
2L4x4x.375	-467	-25	18.7		N/A	808	26	31.1		N/A
2L5x3.5x.375	N/A	0	N/A		N/A	861	35	24.6		N/A
2L5x5x.5	N/A	0	N/A		N/A	1,337	7	N/A		N/A
2L6x6x.375	-590	-118	5.00		N/A	1,337	122	11.0		N/A
C15x33.9	-848	-4	N/A		N/A	1,405	3	N/A		N/A
C380x50	-805	-3	N/A		N/A	1,405	4	N/A		N/A
L4x4x.375	-234	0	N/A		N/A	404	0	N/A		N/A
L5x5x.375	-222	-27	8.22		N/A	509	26	19.6		N/A
L5x5x.5	-267	-13	20.5		N/A	669	13	51.4		N/A

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member ID	Bending					Shear				
	M_r kNm	M_f kNm	M_r/M_f	Comments	M* kNm	V_r kN	V_f kN	V_r/V_f	Comments	V* kN
TOWR-FLBM-FRNT	8,548	3,897	2.19		2,502	2,887	1,007	2.87		1,681
TOWR-FLBM-REAR	9,116	7,307	1.25		3,417	3,614	1,891	1.91		1,855
TOWR-SHVG-G1	10,304	1,775	5.80		2,138	5,094	2,750	1.85		2,851
TOWR-SHVG-G2G3	12,187	1,786	6.82		2,252	5,094	2,755	1.85		2,584
TOWR-SHVG-G4	10,304	1,894	5.44		2,604	5,094	2,812	1.81		3,087
TOWR-SHVG-G6	12,865	618	20.8		423	3,396	146	23.3		138
TOWR-SHVG-G7	100,442	33,498	3.00		38,222	19,473	10,610	1.84		12,566
TOWR-SHVG-G8	20,306	4,000	5.08		6,465	5,341	1,274	4.19		1,922
Tower Span Stringers:										
W27x102 (Original Highway)	1,093	921	1.19		541	1,136	423	2.69		276
W690x152 (1982 Modification)	1,663	921	1.81		271	1,729	423	4.09		503
Approach Span Stringers:										
W33x130 (Original Highway)	1,665	1,344	1.24		766	1,557	491	3.17		282
W840x193 (1982 Modification)	2,534	1,344	1.89		860	2,369	491	4.82		307

* Total load listed on the stress sheet from the original design drawings;
N/A indicates that the member is not listed in the stress sheets

Member Location: Tower
Member Description: Rear Diagonal Brace in Mid Section
Member ID: TOWR-BBRC-MDIA
S-Frame End Nodes: Node 619 to Node 598, Node 605 to Node 619, Node 619 to Node 606, Node 597 to Node 619
Node 964 to Node 955, Node 946 to Node 964, Node 964 to Node 947, Node 954 to Node 964

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y = 230 MPa *CSA S6-06 Cl. 14.7.4.2*
F_u = 420 MPa *CSA S6-06 Cl. 14.7.4.2*
E_s = 200,000 MPa
G_s = 77,000 MPa

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 6x4x3/8	Bot Ls 6x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	102	102
z_{dim} (mm)			610	152	152
I_{y1} ($x10^6mm^4$)	0	0	180	2.06	2.06
I_{z1} ($x10^6mm^4$)	0	0	0	5.58	5.58
A_g (mm^2)	0	0	5,795	2,330	2,330
y_{bar} (mm)			421	367	367
z_{bar} (mm)			0	287	287
I_y ($x10^6mm^4$)	0	0	359	388	388
I_z ($x10^6mm^4$)	0	0	2,054	639	639

A_g = 20,910 mm^2
A_n = 19,703 mm^2
I_y = 1,135 $x10^6$ mm^4
I_z = 3,332 $x10^6$ mm^4
r_y = 233 mm
r_z = 399 mm

Compression Results *TOWR-BBRC-MDIA*

	L_y =	11,837	mm			
	L_z =	23,674	mm			
	K_y =	1.00			K'$_y$ =	1.10
	K_z =	1.00			K'$_z$ =	1.01
Web	h	404	mm			
	w	9.5	mm			
Flange	b	N/A	mm			
	t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-1,660	kN			
	Lift Span Raised: C_f =	-1,223	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	59	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	43	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,647 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,529 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.603$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.649$$

C_r =	-3,529	kN	Compressive Capacity (Factored)
C_r / C_f =	2.13		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BBRC-MDIA*

	Lift Span Closed: T_f =	1,225	kN	
	Lift Span Raised: T_f =	658	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,569	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	6,682	kN	Net Section
	T_r =	4,569	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.73		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Rear Horizontal Brace, Top of Top Section
Member ID: TOWR-BBRC-RcRc
S-Frame End Nodes: Node 613 to Node 614, Node 962 to Node 963

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 6x6x3/4	Bot Ls 6x6x3/4
Qty	1	1	2	2	2
y_{dim} (mm)	813	813	12.7	152	152
z_{dim} (mm)	12.7	12.7	889	152	152
I_{y1} ($x10^6 mm^4$)	0	0	744	11.60	11.60
I_{z1} ($x10^6 mm^4$)	569	569	0	11.60	11.60
A_g (mm^2)	10,325	10,325	11,290	5,440	5,440
y_{bar} (mm)	0	0	413	362	362
z_{bar} (mm)	451	451	0	400	400
I_y ($x10^6 mm^4$)	2,100	2,100	1,487	1,764	1,764
I_z ($x10^6 mm^4$)	569	569	3,852	1,449	1,449

A_g =	64,991	mm^2
A_n =	60,486	mm^2
I_y =	9,216	$x10^6$ mm^4
I_z =	7,887	$x10^6$ mm^4
r_y =	377	mm
r_z =	348	mm

Compression Results *TOWR-BBRC-RcRc*

	L_y =	15,904	mm			
	L_z =	15,904	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	585	mm			
	Web w	12.7	mm			
	Flange b	509	mm			
	Flange t	12.7	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	46		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	46		>	44	*Cl. 10.9.2.1 NOT Satisfied*
	Flanges b/t =	40		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 12,347 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 12,120 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.456$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.493$$

C_r =	-12,120	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BBRC-RcRc*

	Lift Span Closed: T_f =	99	kN	
	Lift Span Raised: T_f =	143	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	14,200	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	20,514	kN	Net Section
	T_r =	14,200	kN	Tensile Capacity (Factored)
	T_r / T_f =	99.30		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Rear Horizontal Brace, Middle of Top Section
Member ID: TOWR-BBRC-RdRd
S-Frame End Nodes: Node 609 to Node 610, Node 958 to Node 959

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	102	102
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6mm^4$)	0	0	180	1.84	1.84
I_{z1} ($x10^6mm^4$)	0	0	0	1.84	1.84
A_g (mm^2)	0	0	5,795	1,850	1,850
y_{bar} (mm)			418	384	384
z_{bar} (mm)			0	282	282
I_y ($x10^6mm^4$)	0	0	359	298	298
I_z ($x10^6mm^4$)	0	0	2,025	549	549

A_g =	18,990	mm^2
A_n =	15,213	mm^2
I_y =	955	$x10^6$ mm^4
I_z =	3,124	$x10^6$ mm^4
r_y =	224	mm
r_z =	406	mm

Compression Results *TOWR-BBRC-RdRd*

	L_y =	7,950	mm			
	L_z =	15,900	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.03	
Web	h	404	mm			
	w	9.5	mm			
Flange	b	N/A	mm			
	t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-98	kN			
	Lift Span Raised: C_f =	-272	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	39	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	43	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,665 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,642 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.421$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.436$$

C_r =	-3,642	kN	Compressive Capacity (Factored)
C_r / C_f =	13.39		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BBRC-RdRd*

	Lift Span Closed: T_f =	16	kN	
	Lift Span Raised: T_f =	374	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,149	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	5,159	kN	Net Section
	T_r =	4,149	kN	Tensile Capacity (Factored)
	T_r / T_f =	11.09		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Rear Horizontal Brace, Top of Middle Section
Member ID: TOWR-BBRC-ReRe
S-Frame End Nodes: Node 605 to Node 606, Node 954 to Node 955

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	102	102
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6 mm^4$)	0	0	180	1.84	1.84
I_{z1} ($x10^6 mm^4$)	0	0	0	1.84	1.84
A_g (mm^2)	0	0	5,795	1,850	1,850
y_{bar} (mm)			418	384	384
z_{bar} (mm)			0	282	282
I_y ($x10^6 mm^4$)	0	0	359	298	298
I_z ($x10^6 mm^4$)	0	0	2,025	549	549

A_g =	18,990	mm^2
A_n =	15,213	mm^2
I_y =	955	$x10^6\ mm^4$
I_z =	3,124	$x10^6\ mm^4$
r_y =	224	mm
r_z =	406	mm

Compression Results *TOWR-BBRC-ReRe*

	L_y =	7,950	mm			
	L_z =	15,900	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	406	mm			
	Web w	9.5	mm			
	Flange b	N/A	mm			
	Flange t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	39		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	43		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,721 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,662 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.383$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.423$$

C_r =	-3,662	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BBRC-ReRe*

	Lift Span Closed: T_f =	329	kN	
	Lift Span Raised: T_f =	490	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,149	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	5,159	kN	Net Section
	T_r =	4,149	kN	Tensile Capacity (Factored)
	T_r / T_f =	8.47		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Rear Horizontal Brace, Middle of Middle Section
Member ID: TOWR-BBRC-RfRf
S-Frame End Nodes: Node 601 to Node 602, Node 950 to Node 951

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	102	102
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6 mm^4$)	0	0	180	1.84	1.84
I_{z1} ($x10^6 mm^4$)	0	0	0	1.84	1.84
A_g (mm^2)	0	0	5,795	1,850	1,850
y_{bar} (mm)			418	384	384
z_{bar} (mm)			0	282	282
I_y ($x10^6 mm^4$)	0	0	359	298	298
I_z ($x10^6 mm^4$)	0	0	2,025	549	549

A_g =	18,990	mm^2
A_n =	15,213	mm^2
I_y =	955	$x10^6$ mm^4
I_z =	3,124	$x10^6$ mm^4
r_y =	224	mm
r_z =	406	mm

Compression Results *TOWR-BBRC-RfRf*

		L_y =	7,950	mm
		L_z =	15,900	mm
		K_y =	1.00	
		K_z =	1.00	
	Web	h	406	mm
		w	9.5	mm
	Flange	b	N/A	mm
		t	N/A	mm
		n =	1.34	
	Lift Span Closed:	C_f =	0	kN
	Lift Span Raised:	C_f =	-509	kN
Cl. 10.5.7 (c)	Compression:	φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	39	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	43	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,721 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,662 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.383$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.423$$

C_r =	-3,662	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BBRC-RfRf*

	Lift Span Closed: T_f =	848	kN	
	Lift Span Raised: T_f =	609	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,149	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	5,159	kN	Net Section
	T_r =	4,149	kN	Tensile Capacity (Factored)
	T_r / T_f =	4.89		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Rear Horizontal Brace, Top of Lower Section
Member ID: TOWR-BBRC-RgRg
S-Frame End Nodes: Node 597 to Node 598, Node 946 to Node 947

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 7x4x3/4	Bot Ls 7x4x3/4
Qty	1	1	2	2	2
y_{dim} (mm)	813	813	12.7	102	102
z_{dim} (mm)	12.7	12.7	1,778	178	178
I_{y1} ($x10^6mm^4$)	0	0	5,949	3.82	3.82
I_{z1} ($x10^6mm^4$)	569	569	0	15.80	15.80
A_g (mm^2)	10,325	10,325	22,581	4,980	4,980
y_{bar} (mm)	0	0	419	387	387
z_{bar} (mm)	901	901	0	832	832
I_y ($x10^6mm^4$)	8,382	8,382	11,897	6,902	6,902
I_z ($x10^6mm^4$)	569	569	7,929	1,523	1,523

A_g =	85,731	mm^2
A_n =	72,176	mm^2
I_y =	42,466	$x10^6$ mm^4
I_z =	12,113	$x10^6$ mm^4
r_y =	704	mm
r_z =	376	mm

Compression Results *TOWR-BBRC-RgRg*

	L_y =	7,950	mm		
	L_z =	15,900	mm		
	K_y =	1.00			
	K_z =	1.00			
	Web h	1,422	mm		
	Web w	12.7	mm		
	Flange b	609	mm		
	Flange t	12.7	mm		
	n =	1.34			
	Lift Span Closed: C_f =	0	kN		
	Lift Span Raised: C_f =	0	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			
Cl. 10.9.1.3	Slenderness Ratio =	42	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	112	>	44	*Cl. 10.9.2.1 NOT Satisfied*
	Flanges b/t =	48	>	44	*Cl. 10.9.2.1 NOT Satisfied*

Cl. 10.9.3.1 $C_{r\,(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 17,699 kN

Cl. 10.9.3.1 $C_{r\,(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 16,282 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.122$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.457$$

C_r =	-16,282	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BBRC-RgRg*

	Lift Span Closed: T_f =	226	kN	
	Lift Span Raised: T_f =	329	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	18,732	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	24,478	kN	Net Section
	T_r =	18,732	kN	Tensile Capacity (Factored)
	T_r / T_f =	56.94		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Rear Diagonal Braces in Upper Section
Member ID: TOWR-BBRC-UDIA
S-Frame End Nodes: Node 605 to Node 620, Node 620 to Node 614, Node 613 to Node 620, Node 620 to Node 606, Node 965 to Node 963, Node 962 to Node 965, Node 965 to Node 955, Node 954 to Node 965

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 6x4x3/8	Bot Ls 6x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	102	102
z_{dim} (mm)			610	152	152
I_{y1} ($x10^6mm^4$)	0	0	180	2.06	2.06
I_{z1} ($x10^6mm^4$)	0	0	0	5.58	5.58
A_g (mm^2)	0	0	5,795	2,330	2,330
y_{bar} (mm)			421	367	367
z_{bar} (mm)			0	287	287
I_y ($x10^6mm^4$)	0	0	359	388	388
I_z ($x10^6mm^4$)	0	0	2,054	639	639

A_g =	20,910	mm^2
A_n =	17,133	mm^2
I_y =	1,135	$x10^6$ mm^4
I_z =	3,332	$x10^6$ mm^4
r_y =	233	mm
r_z =	399	mm

Compression Results *TOWR-BBRC-UDIA*

	L_y =	11,837	mm			
	L_z =	23,674	mm			
	K_y =	1.00			K'_y =	1.10
	K_z =	1.00			K'_z =	1.01
Web	h	404	mm			
	w	9.5	mm			
Flange	b	N/A	mm			
	t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-423	kN			
	Lift Span Raised: C_f =	-803	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	59	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	43	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 3,647 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 3,529 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.603$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.649$$

C_r =	-3,529	kN	Compressive Capacity (Factored)
C_r / C_f =	4.40		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BBRC-UDIA*

	Lift Span Closed: T_f =	72	kN	
	Lift Span Raised: T_f =	452	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,569	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	5,811	kN	Net Section
	T_r =	4,569	kN	Tensile Capacity (Factored)
	T_r / T_f =	10.11		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Front lateral bracing under deck level within the tower span
Member ID: TOWR-BLAT-FRTL
S-Frame End Nodes: Node 744 to Node 591, Node 744 to Node 592, Node 1071 to Node 940, Node 1071 to Node 941

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Ls 5x3.5x3/8	Bot Ls 5x3.5x3/8
Qty	2	2
y_{dim} (mm)	89	89
z_{dim} (mm)	127	127
I_{y1} ($x10^6 mm^4$)	1.33	1.33
I_{z1} ($x10^6 mm^4$)	3.24	3.24
A_g (mm^2)	1,970	1,970
y_{bar} (mm)	35	35
z_{bar} (mm)	356	356
I_y ($x10^6 mm^4$)	502	502
I_z ($x10^6 mm^4$)	11	11

A_g =	7,880	mm^2
A_n =	6,927	mm^2
I_y =	1,004	$x10^6$ mm^4
I_z =	23	$x10^6$ mm^4
r_y =	357	mm
r_z =	54	mm

Compression Results *TOWR-BLAT-FRTL*

	L_y =	9,327	mm			
	L_z =	9,327	mm			
	K_y =	1.00			K'_y =	1.00
	K_z =	1.00			K'_z =	1.10
	Web h		mm			
	Web w		mm			
	Flange b		mm			
	Flange t		mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	174	>	120	*Cl. 10.9.1.3 NOT Satisfied*	

Cl. 10.9.2.1 Width to Thickness Limits

Web h/w = N/A

Flanges b/t = N/A

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,591 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 345 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.282$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 2.067$$

C_r = -345 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BLAT-FRTL*

	Lift Span Closed: T_f =	554	kN	
	Lift Span Raised: T_f =	608	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,722	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	2,349	kN	Net Section
	T_r =	1,722	kN	Tensile Capacity (Factored)
	T_r / T_f =	2.83		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Rear lateral bracing on the highway side under deck level within the tower span
Member ID: TOWR-BLAT-HWYL
S-Frame End Nodes: Node 593 to Node 744, Node 942 to Node 1071

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Ls 5x3.5x1/2	Bot Ls 5x3.5x1/2
Qty	2	2
y_{dim} (mm)	89	89
z_{dim} (mm)	127	127
I_{y1} ($x10^6 mm^4$)	1.68	1.68
I_{z1} ($x10^6 mm^4$)	4.16	4.16
A_g (mm^2)	2,580	2,580
y_{bar} (mm)	36	36
z_{bar} (mm)	357	357
I_y ($x10^6 mm^4$)	661	661
I_z ($x10^6 mm^4$)	15	15

A_g =	10,320	mm^2
A_n =	9,050	mm^2
I_y =	1,322	$x10^6$ mm^4
I_z =	30	$x10^6$ mm^4
r_y =	358	mm
r_z =	54	mm

Compression Results *TOWR-BLAT-HWYL*

	L_y =	9,327	mm			
	L_z =	9,327	mm			
	K_y =	1.00			K'_y =	1.00
	K_z =	1.00			K'_z =	1.10
Web	h		mm			
	w		mm			
Flange	b		mm			
	t		mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				

Cl. 10.9.1.3 Slenderness Ratio = 173 > 120 *Cl. 10.9.1.3 NOT Satisfied*

Cl. 10.9.2.1 Width to Thickness Limits
Web h/w = N/A
Flanges b/t = N/A

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 2,084 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 458 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.282$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 2.054$$

C_r = -458 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BLAT-HWYL*

	Lift Span Closed: T_f =	509	kN	
	Lift Span Raised: T_f =	18	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	2,255	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	3,069	kN	Net Section
	T_r =	2,255	kN	Tensile Capacity (Factored)
	T_r / T_f =	4.43		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Rear lateral bracing on the railway side under deck level within the tower span
Member ID: TOWR-BLAT-RLYL
S-Frame End Nodes: Node 594 to Node 744, Node 943 to Node 1071

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Ls 8x6x1/2	Bot Ls 5x3.5x3/8
Qty	2	2
y_{dim} (mm)	152	89
z_{dim} (mm)	203	127
I_{y1} ($x10^6 mm^4$)	18.40	3.24
I_{z1} ($x10^6 mm^4$)	8.96	1.33
A_g (mm^2)	4,350	1,970
y_{bar} (mm)	50	35
z_{bar} (mm)	334	356
I_y ($x10^6 mm^4$)	1,007	506
I_z ($x10^6 mm^4$)	40	7

A_g =	12,640	mm^2
A_n =	11,529	mm^2
I_y =	1,513	$x10^6$ mm^4
I_z =	47	$x10^6$ mm^4
r_y =	346	mm
r_z =	61	mm

Compression Results *TOWR-BLAT-RLYL*

	L_y =	9,327	mm				
	L_z =	9,327	mm				
	K_y =	1.00		K'_y =	1.00		
	K_z =	1.00		K'_z =	1.10		
	Web h		mm				
	Web w		mm				
	Flange b		mm				
	Flange t		mm				
	n =	1.34					
	Lift Span Closed: C_f =	0	kN				
	Lift Span Raised: C_f =	0	kN				
Cl. 10.5.7 (c)	Compression: φ_s =	0.90					
Cl. 10.9.1.3	Slenderness Ratio =	153	>	120		*Cl. 10.9.1.3 NOT Satisfied*	

Cl. 10.9.2.1 Width to Thickness Limits

Web h/w = N/A

Flanges b/t = N/A

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 2,547 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 693 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.292$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.813$$

C_r = -693 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *TOWR-BLAT-RLYL*

	Lift Span Closed: T_f =	26	kN	
	Lift Span Raised: T_f =	608	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	2,762	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	3,910	kN	Net Section
	T_r =	2,762	kN	Tensile Capacity (Factored)
	T_r / T_f =	4.54		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Front and rear vertical member in lower section
Member ID: TOWR-FBRC-CdCe
S-Frame End Nodes: Node 623 to Node 625, Node 624 to Node 626, Node 968 to Node 970, Node 969 to Node 971

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	All Ls 4x3x3/8
Qty	4
y_{dim} (mm)	102
z_{dim} (mm)	76
I_{y1} ($x10^6 mm^4$)	1.67
I_{z1} ($x10^6 mm^4$)	0.80
A_g (mm^2)	1,610
y_{bar} (mm)	45
z_{bar} (mm)	406
I_y ($x10^6 mm^4$)	1,068
I_z ($x10^6 mm^4$)	16

A_g =	6,440	mm^2
A_n =	5,490	mm^2
I_y =	1,068	$x10^6$ mm^4
I_z =	16	$x10^6$ mm^4
r_y =	407	mm
r_z =	50	mm

Compression Results *TOWR-FBRC-CdCe*

	L_y =	11,837	mm			
	L_z =	23,674	mm			
	K_y =	1.00			K'_y =	1.00
	K_z =	1.00			K'_z =	1.04
Web	h	404	mm			
	w	9.5	mm			
Flange	b	N/A	mm			
	t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				

Cl. 10.9.1.3	Slenderness Ratio =	471	>	120	*Cl. 10.9.1.3 NOT Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	43	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,290 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 47 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.314$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 5.310$$

C_r =	-47	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-FBRC-CdCe*

	Lift Span Closed: T_f =	63	kN	
	Lift Span Raised: T_f =	23	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,407	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	1,862	kN	Net Section
	T_r =	1,407	kN	Tensile Capacity (Factored)
	T_r / T_f =	22.34		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Front Horizontal Brace, Middle of Top Section
Member ID: TOWR-FBRC-FdFd
S-Frame End Nodes: Node 608 to Node 607, Node 957 to Node 956

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 6x4x3/8	Bot Ls 6x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	152	152
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6mm^4$)	0	0	180	5.58	5.58
I_{z1} ($x10^6mm^4$)	0	0	0	2.06	2.06
A_g (mm^2)	0	0	5,795	2,330	2,330
y_{bar} (mm)			450	396	396
z_{bar} (mm)			0	287	287
I_y ($x10^6mm^4$)	0	0	359	395	395
I_z ($x10^6mm^4$)	0	0	2,347	735	735

A_g =	20,910	mm^2
A_n =	17,133	mm^2
I_y =	1,149	$x10^6$ mm^4
I_z =	3,817	$x10^6$ mm^4
r_y =	234	mm
r_z =	427	mm

Compression Results *TOWR-FBRC-FdFd*

	L_y =	7,950 mm				
	L_z =	15,900 mm				
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.03	
	Web h	404 mm				
	Web w	9.5 mm				
	Flange b	N/A mm				
	Flange t	N/A mm				
	n =	1.34				
	Lift Span Closed: C_f =	0 kN				
	Lift Span Raised: C_f =	-20 kN				
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	37	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	43	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,066 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,046 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.403$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.415$$

C_r = -4,046 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *TOWR-FBRC-FdFd*

	Lift Span Closed: T_f =	366 kN	
	Lift Span Raised: T_f =	601 kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95	
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,569 kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	5,811 kN	Net Section
	T_r =	4,569 kN	Tensile Capacity (Factored)
	T_r / T_f =	7.60	Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Front Horizontal Brace, Top of middle Section
Member ID: TOWR-FBRC-FeFe
S-Frame End Nodes: Node 604 to Node 603, Node 953 to Node 952

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 6x4x3/8	Bot Ls 6x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	152	152
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6mm^4$)	0	0	180	5.58	5.58
I_{z1} ($x10^6mm^4$)	0	0	0	2.06	2.06
A_g (mm^2)	0	0	5,795	2,330	2,330
y_{bar} (mm)			421	397	397
z_{bar} (mm)			0	286	286
I_y ($x10^6mm^4$)	0	0	359	392	392
I_z ($x10^6mm^4$)	0	0	2,054	739	739

A_g =	20,910	mm^2
A_n =	17,133	mm^2
I_y =	1,144	$x10^6$ mm^4
I_z =	3,531	$x10^6$ mm^4
r_y =	234	mm
r_z =	411	mm

Compression Results *TOWR-FBRC-FeFe*

	L_y =	7,950	mm			
	L_z =	15,900	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.03	
	Web h	404	mm			
	Web w	9.5	mm			
	Flange b	N/A	mm			
	Flange t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	39	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	43	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,065 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,018 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.404$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.431$$

C_r =	-4,018	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-FBRC-FeFe*

	Lift Span Closed: T_f =	810	kN	
	Lift Span Raised: T_f =	1,031	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,569	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	5,811	kN	Net Section
	T_r =	4,569	kN	Tensile Capacity (Factored)
	T_r / T_f =	4.43		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Front Horizontal Brace, Middle of Middle Section
Member ID: TOWR-FBRC-FfFf
S-Frame End Nodes: Node 600 to Node 599, Node 949 to Node 948

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 6x4x1/2	Bot Ls 6x4x1/2
Qty			2	2	2
y_{dim} (mm)			9.5	152	152
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6 mm^4$)	0	0	180	7.20	7.20
I_{z1} ($x10^6 mm^4$)	0	0	0	2.64	2.64
A_g (mm^2)	0	0	5,795	3,060	3,060
y_{bar} (mm)			450	399	399
z_{bar} (mm)			0	286	286
I_y ($x10^6 mm^4$)	0	0	359	515	515
I_z ($x10^6 mm^4$)	0	0	2,347	980	980

A_g =	23,830	mm^2
A_n =	19,703	mm^2
I_y =	1,389	$x10^6$ mm^4
I_z =	4,306	$x10^6$ mm^4
r_y =	241	mm
r_z =	425	mm

Compression Results *TOWR-FBRC-FfFf*

		L_y =	7,950	mm		
		L_z =	15,900	mm		
		K_y =	1.00		K'_y =	1.10
		K_z =	1.00		K'_z =	1.03
	Web	h	406	mm		
		w	9.5	mm		
	Flange	b	N/A	mm		
		t	N/A	mm		
		n =	1.34			
		Lift Span Closed: C_f =	-1,140	kN		
		Lift Span Raised: C_f =	-1,330	kN		
Cl. 10.5.7 (c)		Compression: φ_s =	0.90			

Cl. 10.9.1.3	Slenderness Ratio =	37	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	43	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,655 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,606 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.391$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.417$$

C_r =	-4,606	kN	Compressive Capacity (Factored)
C_r / C_f =	3.46		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-FBRC-FfFf*

	Lift Span Closed: T_f =	1,366	kN	
	Lift Span Raised: T_f =	1,608	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	5,207	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	6,682	kN	Net Section
	T_r =	5,207	kN	Tensile Capacity (Factored)
	T_r / T_f =	3.24		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Front Horizontal Brace, Top of Lower Section
Member ID: TOWR-FBRC-FgFg
S-Frame End Nodes: Node 596 to Node 595, Node 945 to Node 944

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plates	Top Ls 8x8x3/4	Bot Ls 8x8x3/4
Qty	1	1	2	2	2
y_{dim} (mm)	940	940	12.7	203	203
z_{dim} (mm)	15.9	15.9	1,778	203	203
I_{y1} ($x10^6mm^4$)	0	0	5,949	29.00	29.00
I_{z1} ($x10^6mm^4$)	1,101	1,101	0	29.00	29.00
A_g (mm^2)	14,946	14,946	22,581	7,390	7,390
y_{bar} (mm)	0	0	480	416	416
z_{bar} (mm)	903	903	0	837	837
I_y ($x10^6mm^4$)	12,187	12,187	11,897	10,412	10,412
I_z ($x10^6mm^4$)	1,101	1,101	10,406	2,616	2,616

A_g =	104,613	mm^2
A_n =	98,760	mm^2
I_y =	57,097	$x10^6$ mm^4
I_z =	17,838	$x10^6$ mm^4
r_y =	739	mm
r_z =	413	mm

Compression Results *TOWR-FBRC-FgFg*

	L_y =	7,950	mm			
	L_z =	15,900	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	1,372	mm			
	Web w	12.7	mm			
	Flange b	534	mm			
	Flange t	15.9	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	39	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	108	>	44		*Cl. 10.9.2.1 NOT Satisfied*
	Flanges b/t =	34	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 21,605 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 20,236 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.116$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.416$$

C_r = -20,236 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *TOWR-FBRC-FgFg*

	Lift Span Closed: T_f =	459	kN	
	Lift Span Raised: T_f =	584	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	22,858	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	33,494	kN	Net Section
	T_r =	22,858	kN	Tensile Capacity (Factored)
	T_r / T_f =	39.14		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Front Diagonal Brace in Mid Section
Member ID: TOWR-FBRC-MDIA
S-Frame End Nodes: Node 623 to Node 595, Node 604 to Node 623, Node 623 to Node 603, Node 596 to Node 623
Node 968 to Node 944, Node 953 to Node 968, Node 968 to Node 952, Node 945 to Node 968

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 6x4x1/2	Bot Ls 6x4x1/2
Qty			2	2	2
y_{dim} (mm)			9.5	152	152
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6mm^4$)	0	0	180	7.20	7.20
I_{z1} ($x10^6mm^4$)	0	0	0	2.64	2.64
A_g (mm^2)	0	0	5,795	3,060	3,060
y_{bar} (mm)			450	394	394
z_{bar} (mm)			0	286	286
I_y ($x10^6mm^4$)	0	0	359	515	515
I_z ($x10^6mm^4$)	0	0	2,347	955	955

A_g =	23,830	mm^2
A_n =	19,703	mm^2
I_y =	1,389	$x10^6$ mm^4
I_z =	4,258	$x10^6$ mm^4
r_y =	241	mm
r_z =	423	mm

Compression Results *TOWR-FBRC-MDIA*

	L_y =	11,837	mm			
	L_z =	23,674	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.02	
	Web h	406	mm			
	Web w	9.5	mm			
	Flange b	N/A	mm			
	Flange t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-3,139	kN			
	Lift Span Raised: C_f =	-4,001	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	56	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	43	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,215 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,126 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.582$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.614$$

C_r =	-4,126	kN	Compressive Capacity (Factored)
C_r / C_f =	1.03	*	Capacity over Demand Ratio (C/D)
			**** C/D is less than 1.15***

Tension Results *TOWR-FBRC-MDIA*

	Lift Span Closed: T_f =	1,777	kN	
	Lift Span Raised: T_f =	2,371	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	5,207	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	6,682	kN	Net Section
	T_r =	5,207	kN	Tensile Capacity (Factored)
	T_r / T_f =	2.20		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Front and rear vertical member in middle section
Member ID: TOWR-FBRC-MdMe
S-Frame End Nodes: Node 619 to Node 621, Node 620 to Node 622, Node 964 to Node 966, Node 965 to Node 967

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	All Ls 4x3x3/8
Qty	4
y_{dim} (mm)	102
z_{dim} (mm)	76
I_{y1} ($x10^6mm^4$)	1.67
I_{z1} ($x10^6mm^4$)	0.80
A_g (mm^2)	1,610
y_{bar} (mm)	45
z_{bar} (mm)	406
I_y ($x10^6mm^4$)	1,068
I_z ($x10^6mm^4$)	16

A_g =	6,440	mm^2
A_n =	5,490	mm^2
I_y =	1,068	$x10^6$ mm^4
I_z =	16	$x10^6$ mm^4
r_y =	407	mm
r_z =	50	mm

Compression Results *TOWR-FBRC-MdMe*

	L_y =	8,770	mm			
	L_z =	8,770	mm			
	K_y =	1.00		K'_y =	1.00	
	K_z =	1.00		K'_z =	1.10	
	Web h		mm			
	Web w		mm			
	Flange b		mm			
	Flange t		mm			
	n =	1.34				
	Lift Span Closed: C_f =	-31	kN			
	Lift Span Raised: C_f =	-74	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	175	>	120		*Cl. 10.9.1.3 NOT Satisfied*

Cl. 10.9.2.1 Width to Thickness Limits

Web h/w = N/A

Flanges b/t = N/A

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,313 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 281 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.233$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 2.074$$

C_r = -281 kN Compressive Capacity (Factored)

C_r / C_f = 3.80 Capacity over Demand Ratio (C/D)

Tension Results *TOWR-FBRC-MdMe*

	Lift Span Closed: T_f =	69	kN	
	Lift Span Raised: T_f =	56	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,407	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	1,862	kN	Net Section
	T_r =	1,407	kN	Tensile Capacity (Factored)
	T_r / T_f =	20.39		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Front Diagonal Brace in Upper Section
Member ID: TOWR-FBRC-UDIA
S-Frame End Nodes: Node 604 to Node 624, Node 624 to Node 611, Node 612 to Node 624, Node 624 to Node 603
Node 953 to Node 969, Node 969 to Node 960, Node 961 to Node 969, Node 969 to Node 952

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 6x4x3/8	Bot Ls 6x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	152	152
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6 mm^4$)	0	0	180	5.58	5.58
I_{z1} ($x10^6 mm^4$)	0	0	0	2.06	2.06
A_g (mm^2)	0	0	5,795	2,330	2,330
y_{bar} (mm)			421	367	367
z_{bar} (mm)			0	286	286
I_y ($x10^6 mm^4$)	0	0	359	392	392
I_z ($x10^6 mm^4$)	0	0	2,054	632	632

A_g =	20,910	mm^2
A_n =	17,133	mm^2
I_y =	1,144	$x10^6$ mm^4
I_z =	3,318	$x10^6$ mm^4
r_y =	234	mm
r_z =	398	mm

Compression Results *TOWR-FBRC-UDIA*

	L_y =	11,837	mm			
	L_z =	23,674	mm			
	K_y =	1.00		K'_y =	1.10	
	K_z =	1.00		K'_z =	1.01	
Web	h	406	mm			
	w	9.5	mm			
Flange	b	N/A	mm			
	t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-1,384	kN			
	Lift Span Raised: C_f =	-2,096	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	59	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	43	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,653 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,526 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.601$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.651$$

C_r =	-3,526	kN	Compressive Capacity (Factored)
C_r / C_f =	1.68		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-FBRC-UDIA*

	Lift Span Closed: T_f =	166	kN	
	Lift Span Raised: T_f =	607	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,569	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	5,811	kN	Net Section
	T_r =	4,569	kN	Tensile Capacity (Factored)
	T_r / T_f =	7.53		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Bottom section of front column
Member ID: TOWR-FCOL-BCOL
S-Frame End Nodes: Node 588 to Node 789, Node 587 to Node 788, Node 937 to Node 1091, Node 936 to Node 1090

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Web Plates	Web Plates	Web Plates	Inner L's 8x8x1	Outer L's 8x8x1
Qty	1	1	2	2	2	4	4
y_{dim} (mm)	1,219	737	25.4	25.4	25.4	203	203
z_{dim} (mm)	22.2	22.2	914	711	508	203	203
I_{y1} ($x10^6mm^4$)	1	1	1,616	761	277	36.90	36.90
I_{z1} ($x10^6mm^4$)	3,351	741	1	1	1	36.90	36.90
A_g (mm^2)	27,062	16,361	23,216	18,059	12,903	9,670	9,670
y_{bar} (mm)	0	0	362	388	413	315	473
z_{bar} (mm)	475	475	0	105	0	404	404
I_y ($x10^6mm^4$)	6,107	3,692	3,232	1,920	555	6,461	6,461
I_z ($x10^6mm^4$)	3,351	741	6,087	5,439	4,403	3,986	8,801

A_g =	229,140	mm^2
A_n =	215,667	mm^2
I_y =	28,428	$x10^6$ mm^4
I_z =	32,808	$x10^6$ mm^4
r_y =	352	mm
r_z =	378	mm

Compression Results *TOWR-FCOL-BCOL*

	L_y =	9,804	mm
	L_z =	9,804	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	914	mm
	w	76.0	mm
Flange	b	331	mm
	t	22.2	mm
	n =	1.34	
	Lift Span Closed: C_f =	-19,458	kN
	Lift Span Raised: C_f =	-32,221	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	28	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	12	<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	15	<	36	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 68,627 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 69,218 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.371$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.345$$

C_r = -68,627 kN Compressive Capacity (Factored)

C_r / C_f = 2.13 Capacity over Demand Ratio (C/D)

Tension Results *TOWR-FCOL-BCOL*

	Lift Span Closed: T_f =	0	kN	
	Lift Span Raised: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	76,189	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	83,593	kN	Net Section
	T_r =	76,189	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Tower
Member Description: Middle section of front column
Member ID: TOWR-FCOL-MCOL
S-Frame End Nodes: Node 789 to Node 793, Node 788 to Node 792, Node 1091 to Node 1095, Node 1090 to Node 1094

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Web Plates	Web Plates	Web Plates	Inner L's 8x8x1	Outer L's 8x8x1
Qty	1	1	2	2	2	2	2
y_{dim} (mm)	1,219	737	25.4	25.4	25.4	203	203
z_{dim} (mm)	22.2	22.2	914	711	508	203	203
I_{y1} ($x10^6 mm^4$)	1	1	1,616	761	277	36.90	36.90
I_{z1} ($x10^6 mm^4$)	3,351	741	1	1	1	36.90	36.90
A_g (mm^2)	27,062	16,361	23,216	18,059	12,903	9,670	9,670
y_{bar} (mm)	0	0	362	388	413	315	460
z_{bar} (mm)	475	475	0	105	0	404	404
I_y ($x10^6 mm^4$)	6,107	3,692	3,232	1,920	555	3,230	3,230
I_z ($x10^6 mm^4$)	3,351	741	6,087	5,439	4,403	1,993	4,166

A_g =	190,460	mm^2
A_n =	176,984	mm^2
I_y =	21,967	$x10^6$ mm^4
I_z =	26,180	$x10^6$ mm^4
r_y =	340	mm
r_z =	371	mm

Compression Results *TOWR-FCOL-MCOL*

	L_y =	8,763	mm
	L_z =	8,763	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	914	mm
	w	76.0	mm
Flange	b	1,117	mm
	t	22.2	mm
	n =	1.34	
	Lift Span Closed: C_f =	-16,596	kN
	Lift Span Raised: C_f =	-24,267	kN

Cl. 10.5.7 (c)	Compression: φ_s =	0.90			
Cl. 10.9.1.3	Slenderness Ratio =	26	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	12	<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	50	>	36	*Cl. 10.9.2.1 NOT Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 57,560 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 58,051 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.344$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.315$$

C_r =	-57,560	kN	Compressive Capacity (Factored)
C_r / C_f =	2.37		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-FCOL-MCOL*

	Lift Span Closed: T_f =	0	kN	
	Lift Span Raised: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	63,328	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	68,599	kN	Net Section
	T_r =	63,328	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Tower
Member Description: Upper section of front column
Member ID: TOWR-FCOL-UCOL
S-Frame End Nodes: Node 638 to Node 642, Node 637 to Node 641, Node 983 to Node 987, Node 982 to Node 986, Node 793 to Node 638, Node 792 to Node 637, Node 1095 to Node 983, Node 1094 to Node 982

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Web Plates	Inner L's 8x8x1	Outer L's 8x8x1
Qty	1	1	2	2	2
y_{dim} (mm)	1,219	737	25.4	203	203
z_{dim} (mm)	22.2	22.2	914	203	203
I_{y1} ($x10^6 mm^4$)	1	1	1,616	36.90	36.90
I_{z1} ($x10^6 mm^4$)	3,351	741	1	36.90	36.90
A_g (mm^2)	27,062	16,361	23,216	9,670	9,670
y_{bar} (mm)	0	0	387	315	460
z_{bar} (mm)	475	475	0	404	404
I_y ($x10^6 mm^4$)	6,107	3,692	3,232	3,230	3,230
I_z ($x10^6 mm^4$)	3,351	741	6,956	1,993	4,166

A_g =	128,534	mm^2
A_n =	115,052	mm^2
I_y =	19,492	$x10^6\ mm^4$
I_z =	17,207	$x10^6\ mm^4$
r_y =	389	mm
r_z =	366	mm

Compression Results — *TOWR-FCOL-UCOL*

	L_y =	8,763	mm
	L_z =	8,763	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h		mm
	w	25.4	mm
Flange	b	1,117	mm
	t	22.2	mm
	n =	1.34	
	Lift Span Closed: C_f =	-14,547	kN
	Lift Span Raised: C_f =	-18,420	kN

Cl. 10.5.7 (c)	Compression: φ_s =	0.90			
Cl. 10.9.1.3	Slenderness Ratio =	24	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	0	<	36	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	50	>	36	*Cl. 10.9.2.1 NOT Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 39,333 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 39,131 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.300$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.319$$

C_r =	-39,131	kN	Compressive Capacity (Factored)
C_r / C_f =	2.12		Capacity over Demand Ratio (C/D)

Tension Results — *TOWR-FCOL-UCOL*

	Lift Span Closed: T_f =	0	kN	
	Lift Span Raised: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	42,738	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	44,594	kN	Net Section
	T_r =	42,738	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Tower
Member Description: Bottom section of rear column
Member ID: TOWR-RCOL-BCOL
S-Frame End Nodes: Node 589 to Node 786, Node 590 to Node 787, Node 938 to Node 1088, Node 939 to Node 1089

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Inner Cover	Web Plates	All L's 8x6x1
Qty	1	1	2	2	4
y_{dim} (mm)	25.4	25.4	737	406	203
z_{dim} (mm)	813	813	12.7	25.4	153
I_{y1} ($x10^6 mm^4$)	1,137	1,137	0	1	16.00
I_{z1} ($x10^6 mm^4$)	1	1	424	142	33.50
A_g (mm^2)	20,650	20,650	9,360	10,312	8,370
y_{bar} (mm)	387	387	368	0	333
z_{bar} (mm)	0	0	0	425	345
I_y ($x10^6 mm^4$)	1,137	1,137	0	3,726	4,049
I_z ($x10^6 mm^4$)	3,094	3,094	3,382	283	3,847

A_g =	114,125	mm^2
A_n =	96,061	mm^2
I_y =	10,051	$x10^6$ mm^4
I_z =	13,700	$x10^6$ mm^4
r_y =	297	mm
r_z =	346	mm

Compression Results *TOWR-RCOL-BCOL*

	L_y =	9,804	mm
	L_z =	9,804	mm
	K_y =	1.00	
	K_z =	1.00	
Web	h	737	mm
	w	50.0	mm
Flange	b	509	mm
	t	25.4	mm
	n =	1.34	
	Lift Span Closed: C_f =	-6,602	kN
	Lift Span Raised: C_f =	-18,464	kN
Cl. 10.5.7 (c)	Compression: φ_s =	0.90	

Cl. 10.9.1.3	Slenderness Ratio =	33	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	15	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	20	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 22,570 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 22,915 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.357$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.305$$

C_r = -22,570 kN Compressive Capacity (Factored)

C_r / C_f = 1.22 Capacity over Demand Ratio (C/D)

Tension Results *TOWR-RCOL-BCOL*

	Lift Span Closed: T_f =	0	kN	
	Lift Span Raised: T_f =	9,109	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	24,936	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	32,579	kN	Net Section
	T_r =	24,936	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Tower
Member Description: Middle section of rear column
Member ID: TOWR-RCOL-MCOL
S-Frame End Nodes: Node 786 to Node 790, Node 787 to Node 791, Node 1088 to Node 1092, Node 1089 to Node 1093

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Inner Cover	Web Plates	All L's 8x6x1
Qty	1	1	2	2	4
y_{dim} (mm)	25.4	25.4	737	406	203
z_{dim} (mm)	813	813	12.7	25.4	153
I_{y1} ($x10^6 mm^4$)	1,137	1,137	0	1	16.00
I_{z1} ($x10^6 mm^4$)	1	1	424	142	33.50
A_g (mm^2)	20,650	20,650	9,360	10,312	8,370
y_{bar} (mm)	387	387	368	0	333
z_{bar} (mm)	0	0	0	425	345
I_y ($x10^6 mm^4$)	1,137	1,137	0	3,726	4,049
I_z ($x10^6 mm^4$)	3,094	3,094	3,382	283	3,847

A_g =	114,125	mm^2
A_n =	96,061	mm^2
I_y =	10,051	$x10^6$ mm^4
I_z =	13,700	$x10^6$ mm^4
r_y =	297	mm
r_z =	346	mm

Compression Results *TOWR-RCOL-MCOL*

		L_y =	8,763	mm		
		L_z =	8,763	mm		
		K_y =	1.00			
		K_z =	1.00			
	Web	h	331	mm		
		w	12.7	mm		
	Flange	b	509	mm		
		t	25.4	mm		
		n =	1.34			
		Lift Span Closed: C_f =	-3,920	kN		
		Lift Span Raised: C_f =	-11,008	kN		
Cl. 10.5.7 (c)		Compression: φ_s =	0.90			
Cl. 10.9.1.3		Slenderness Ratio =	30	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web	h/w =	26	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges	b/t =	20	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 22,833 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 23,095 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.319$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.273$$

C_r =	-22,833	kN	Compressive Capacity (Factored)
C_r / C_f =	2.07		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-RCOL-MCOL*

	Lift Span Closed: T_f =	0	kN	
	Lift Span Raised: T_f =	4,550	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	24,936	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	32,579	kN	Net Section
	T_r =	24,936	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Tower
Member Description: Upper section of rear column
Member ID: TOWR-RCOL-UCOL
S-Frame End Nodes: Node 639 to Node 643, Node 640 to Node 644, Node 984 to Node 988, Node 985 to Node 989, Node 790 to Node 639, Node 791 to Node 640, Node 1092 to Node 984, Node 1093 to Node 985

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Inner Cover	Web Plates	All L's 8x6x1
Qty	1	1	2	2	4
y_{dim} (mm)	25.4	25.4	737	406	203
z_{dim} (mm)	813	813	12.7	25.4	153
I_{y1} ($x10^6mm^4$)	1,137	1,137	0	1	16.00
I_{z1} ($x10^6mm^4$)	1	1	424	142	33.50
A_g (mm^2)	20,650	20,650	9,360	10,312	8,370
y_{bar} (mm)	387	387	368	0	333
z_{bar} (mm)	0	0	0	425	345
I_y ($x10^6mm^4$)	1,137	1,137	0	3,726	4,049
I_z ($x10^6mm^4$)	3,094	3,094	3,382	283	3,847

A_g =	114,125	mm^2
A_n =	96,061	mm^2
I_y =	10,051	$x10^6$ mm^4
I_z =	13,700	$x10^6$ mm^4
r_y =	297	mm
r_z =	346	mm

Compression Results *TOWR-RCOL-UCOL*

	L_y =	8,763	mm			
	L_z =	8,763	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	331	mm			
	Web w	12.7	mm			
	Flange b	509	mm			
	Flange t	25.4	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-2,578	kN			
	Lift Span Raised: C_f =	-5,703	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	30		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	26		<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	20		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 22,833 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 23,095 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.319$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.273$$

C_r =	-22,833	kN	Compressive Capacity (Factored)
C_r / C_f =	4.00		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-RCOL-UCOL*

	Lift Span Closed: T_f =	0	kN	
	Lift Span Raised: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	24,936	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	32,579	kN	Net Section
	T_r =	24,936	kN	Tensile Capacity (Factored)

T_r / T_f = #DIV/0! **#DIV/0!**

#DIV/0!

Member Location: Tower
Member Description: Side bracing diagonals
Member ID: TOWR-SBRC-DIAG
S-Frame End Nodes: 609-612, 605-608, 601-604, 597-600, 593-596, 610-611, 606-607, 602-603, 598-599, 594-595, 961-958, 957-954, 953-950, 949-946, 945-942, 960-959, 956-955, 952-951, 948-947, 944-943, 598-627, 627-591, 629-59
606-629, 631-607, 614-631, 628-595, 602-628, 630-603, 610-630, 597-632, 632-592, 634-600, 605-634, 636-608, 613-63
633-596, 601-633, 635-604, 609-635, 972-947, 940-972, 948-974, 974-955, 956-976, 976-963, 944-973, 973-951, 952-97
975-959, 977-946, 941-977, 949-979, 979-954, 957-981, 981-962, 945-978, 978-950, 953-980, 980-958

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 4x4x3/8	Bot Ls 4x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	102	102
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6mm^4$)	0	0	180	1.84	1.84
I_{z1} ($x10^6mm^4$)	0	0	0	1.84	1.84
A_g (mm^2)	0	0	5,795	1,850	1,850
y_{bar} (mm)			395	362	362
z_{bar} (mm)			0	282	282
I_y ($x10^6mm^4$)	0	0	359	298	298
I_z ($x10^6mm^4$)	0	0	1,808	489	489

A_g =	18,990	mm^2
A_n =	15,213	mm^2
I_y =	955	$x10^6$ mm^4
I_z =	2,786	$x10^6$ mm^4
r_y =	224	mm
r_z =	383	mm

Compression Results

TOWR-SBRC-DIAG

	L_y =	6,558	mm			
	L_z =	13,116	mm			
	K_y =	1.00			K'_y =	1.10
	K_z =	1.00			K'_z =	1.04
Web	h	406	mm			
	w	9.5	mm			
Flange	b	N/A	mm			
	t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-1,589	kN			
	Lift Span Raised: C_f =	-3,914	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	34	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	43	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,767 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,717 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.347$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.386$$

C_r =	-3,717	kN	Compressive Capacity (Factored)
C_r / C_f =	0.95	*	Capacity over Demand Ratio (C/D)
			C/D is less than 1 !!!

Tension Results

TOWR-SBRC-DIAG

	Lift Span Closed: T_f =	919	kN	
	Lift Span Raised: T_f =	3,328	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,149	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	5,159	kN	Net Section
	T_r =	4,149	kN	Tensile Capacity (Factored)
	T_r / T_f =	1.25		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Side brace - horizontal bottom section
Member ID: TOWR-SBRC-FgRg
S-Frame End Nodes: Node 597 to Node 596, Node 598 to Node 595, Node 945 to Node 946, Node 944 to Node 947

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 6x4x1/2	Bot Ls 6x4x1/2
Qty			2	2	2
y_{dim} (mm)			9.5	152	152
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6mm^4$)	0	0	180	7.20	7.20
I_{z1} ($x10^6mm^4$)	0	0	0	2.64	2.64
A_g (mm^2)	0	0	5,795	3,060	3,060
y_{bar} (mm)			395	341	341
z_{bar} (mm)			0	286	286
I_y ($x10^6mm^4$)	0	0	359	515	515
I_z ($x10^6mm^4$)	0	0	1,808	717	717

A_g =	23,830	mm^2
A_n =	21,003	mm^2
I_y =	1,389	$x10^6$ mm^4
I_z =	3,242	$x10^6$ mm^4
r_y =	241	mm
r_z =	369	mm

Compression Results

TOWR-SBRC-FgRg

	L_y =	9,754	mm			
	L_z =	9,754	mm			
	K_y =	1.00			K'_y =	1.10
	K_z =	1.00			K'_z =	1.09
Web	h	406	mm			
	w	9.5	mm			
Flange	b	N/A	mm			
	t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			

Cl. 10.5.7 (c) Compression: φ_s = 0.90

Cl. 10.9.1.3 Slenderness Ratio = 40 < 120 *Cl. 10.9.1.3 Satisfied*

Cl. 10.9.2.1 Width to Thickness Limits
Web h/w = 43 < 44 *Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r\,(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,474 kN *Governs*

Cl. 10.9.3.1 $C_{r\,(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,778 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.480$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.311$$

C_r = -4,474 kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results

TOWR-SBRC-FgRg

	Lift Span Closed: T_f =	485	kN	
	Lift Span Raised: T_f =	564	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	5,207	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	7,123	kN	Net Section
	T_r =	5,207	kN	Tensile Capacity (Factored)
	T_r / T_f =	9.23		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Side bracing - lower horizontal
Member ID: TOWR-SBRC-FhRh
S-Frame End Nodes: Node 593 to Node 592, Node 594 to Node 591, Node 941 to Node 942, Node 940 to Node 943

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Cover Plate	Cover Plate	Web Plates	All L's 8x6x1
Qty	1	1	2	4
y_{dim} (mm)	762	762	19.0	152
z_{dim} (mm)	19.0	19.0	1,803	203
I_{y1} ($x10^6mm^4$)	0	0	9,280	33.50
I_{z1} ($x10^6mm^4$)	701	701	1	16.00
A_g (mm^2)	14,478	14,478	34,257	8,370
y_{bar} (mm)	0	0	390	339
z_{bar} (mm)	911	911	0	835
I_y ($x10^6mm^4$)	12,016	12,016	18,560	23,477
I_z ($x10^6mm^4$)	701	701	10,423	3,912

A_g =	130,950	mm^2
A_n =	107,222	mm^2
I_y =	66,070	$x10^6$ mm^4
I_z =	15,736	$x10^6$ mm^4
r_y =	710	mm
r_z =	347	mm

Compression Results *TOWR-SBRC-FhRh*

	L_y =	9,754	mm			
	L_z =	9,754	mm			
	K_y =	1.00				
	K_z =	1.00				
	Web h	1,599	mm			
	Web w	19.0	mm			
	Flange b	558	mm			
	Flange t	19.0	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-72	kN			
	Lift Span Raised: C_f =	-717	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	28		<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Web h/w =	84		>	44	*Cl. 10.9.2.1 NOT Satisfied*
	Flanges b/t =	29		<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 26,986 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 26,305 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.148$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.304$$

C_r = -26,305 kN Compressive Capacity (Factored)

C_r / C_f = 36.69 Capacity over Demand Ratio (C/D)

Tension Results *TOWR-SBRC-FhRh*

	Lift Span Closed: T_f =	568	kN	
	Lift Span Raised: T_f =	1,259	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	28,613	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	36,364	kN	Net Section
	T_r =	28,613	kN	Tensile Capacity (Factored)
	T_r / T_f =	22.73		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Side bracing - typical horizontal member
Member ID: TOWR-SBRC-HORZ
S-Frame End Nodes: Node 601 to Node 600, Node 602 to Node 599, Node 605 to Node 604, Node 606 to Node 603, Node 609 to Node 608, Node 610 to Node 607, Node 613 to Node 612, Node 614 to Node 611, Node 949 to Node 950, Node 948 to Node 951, Node 953 to Node 954, Node 952 to node 955, Node 957 to Node 958, Node 956 to Node 959, Node 961 to Node 962, Node 960 to Node 963

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 6x4x3/8	Bot Ls 6x4x3/8
Qty			2	2	2
y_{dim} (mm)			9.5	102	102
z_{dim} (mm)			610	152	152
I_{y1} ($\times10^6 mm^4$)	0	0	180	2.06	2.06
I_{z1} ($\times10^6 mm^4$)	0	0	0	5.58	5.58
A_g (mm^2)	0	0	5,795	2,330	2,330
y_{bar} (mm)			451	422	422
z_{bar} (mm)			0	256	256
I_y ($\times10^6 mm^4$)	0	0	359	310	310
I_z ($\times10^6 mm^4$)	0	0	2,358	841	841

A_g =	20,910	mm^2
A_n =	17,132	mm^2
I_y =	978	$\times10^6$ mm^4
I_z =	4,040	$\times10^6$ mm^4
r_y =	216	mm
r_z =	440	mm

Compression Results *TOWR-SBRC-HORZ*

	L_y =	9,754	mm			
	L_z =	9,754	mm			
	K_y =	1.00			K'_y =	1.10
	K_z =	1.00			K'_z =	1.07
	Web h	406	mm			
	Web w	9.5	mm			
	Flange b	380	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				

Cl. 10.9.1.3	Slenderness Ratio =	45	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	43	<	44	*Cl. 10.9.2.1 Satisfied*
	Flanges b/t =	40	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 3,912 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,260 kN

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.487$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.240$$

C_r =	-3,912	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-SBRC-HORZ*

	Lift Span Closed: T_f =	452	kN	
	Lift Span Raised: T_f =	1,065	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,569	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	5,810	kN	Net Section
	T_r =	4,569	kN	Tensile Capacity (Factored)
	T_r / T_f =	4.29		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Side bracing - top diagonal bracing that frames into girder
Member ID: TOWR-SBRC-SbFc
S-Frame End Nodes: Node 614 to Node 645, Node 645 to Node 611, Node 613 to Node 646, Node 646 to Node 612
Node 990 to Node 963, Node 960 to Node 990, Node 991 to Node 962, Node 961 to Node 991

Member orientation (local axis):
z always corresponds with the vertical plane or longitudinal direction of the bridge
y always corresponds to the horizontal plane or transverse direction of the bridge
Section properties for all built up members are calculated about the nodal centre of the member (refer to Section 3.3 of the report for a full description)

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Top Lattice	Bottom Lattice	Web Plates	Top Ls 4x4x1/2	Bot Ls 4x4x1/2
Qty			2	2	2
y_{dim} (mm)			9.5	102	102
z_{dim} (mm)			610	102	102
I_{y1} ($x10^6 mm^4$)	0	0	180	2.34	2.34
I_{z1} ($x10^6 mm^4$)	0	0	0	2.34	2.34
A_g (mm^2)	0	0	5,795	2,430	2,430
y_{bar} (mm)			395	362	362
z_{bar} (mm)			0	282	282
I_y ($x10^6 mm^4$)	0	0	359	391	391
I_z ($x10^6 mm^4$)	0	0	1,808	642	642

A_g =	21,310	mm^2
A_n =	12,323	mm^2
I_y =	1,142	$x10^6$ mm^4
I_z =	3,092	$x10^6$ mm^4
r_y =	231	mm
r_z =	381	mm

Compression Results *TOWR-SBRC-SbFc*

	L_y =	6,558	mm			
	L_z =	13,116	mm			
	K_y =	1.00			K'_y =	1.10
	K_z =	1.00			K'_z =	1.05
Web	h	406	mm			
	w	9.5	mm			
Flange	b	N/A	mm			
	t	N/A	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-534	kN			
	Lift Span Raised: C_f =	-1,190	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				

Cl. 10.9.1.3	Slenderness Ratio =	34	<	120	*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits				
	Web h/w =	43	<	44	*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,242 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 4,167 kN *Governs*

$$\lambda_y = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.336$$

$$\lambda_z = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.389$$

C_r =	-4,167	kN	Compressive Capacity (Factored)
C_r / C_f =	3.50		Capacity over Demand Ratio (C/D)

Tension Results *TOWR-SBRC-SbFc*

	Lift Span Closed: T_f =	82	kN	
	Lift Span Raised: T_f =	492	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	4,656	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	4,179	kN	Net Section
	T_r =	4,179	kN	Tensile Capacity (Factored)
	T_r / T_f =	8.49		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Tower span front floor beam
Member ID: TOWR-FLBM-FRNT
S-Frame End Nodes: Node 591 to Node 592, Node 940 to Node 941

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plate	Top Ls 8x8x1/2	Bot Ls 8x8x1/2
Qty	1	1	1	2	2
y_{dim} (mm)	508	508	12.7	203	203
z_{dim} (mm)	12.7	12.7	1,803	203	203
I_{y1} ($x10^6 mm^4$)	0	0	6,203	20.2	20.2
I_{z1} ($x10^6 mm^4$)	139	139	0	20.2	20.2
A_g (mm^2)	6,452	6,452	22,898	4,990	4,990
A_n (mm^2)	6,452	6,452	22,898	4,990	4,990
y_{bar} (mm)	0	0	0	62	62
z_{bar} (mm)	914	914	0	852	852
I_y ($x10^6 mm^4$)	5,390	5,390	6,203	7,285	7,285
I_z ($x10^6 mm^4$)	139	139	0	79	79

A_g =	55,761	mm^2	Z_y =	39.121	$x10^6$ mm^3
A_n =	55,761	mm^2	Z_z =	2.876	$x10^6$ mm^3
I_y =	31,552	$x10^6$ mm^4	S_y =	34.283	$x10^6$ mm^3
I_z =	435	$x10^6$ mm^4	S_z =	1.714	$x10^6$ mm^3
r_y =	752	mm	J =	1,001	$x10^3$ mm^4
r_z =	88	mm			

Cl. 10.5.7 (a)

	Flexure: φ_s =	0.95	
Web	h	1,397	mm
	w	12.7	mm
Flange	b	235	mm
	t	25.4	mm
Lift Span Closed: M_f =		3,897	kNm
Lift Span Raised: M_f =		1,560	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members	M_{max} =	N/A	kNm
	M_a =		kNm
	M_b =		kNm
	M_c =		kNm
	L =		mm

V_f = 1,007 kN

V_f = 387 kN

Cl. 10.9.2.1 Determining Class of Section

Web	h/w =	110.0	<	112.1	*Class 2 or better*
Flanges	b/t =	9	<	35	*Class 2 or better*

==> Overall Class: 2

Cl. 10.10.2.2 Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 8,548 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3 Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p\left[1 - \frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ N/A kNm

$M_p = Z_y F_y =$ 8,998 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{M_{max}{}^2 + 4M_a{}^2 + 7M_b{}^2 + 4M_c{}^2}} \leq 2.5 =$$ N/A

Cl. 10.10.3.2 Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 7,491 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28 M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 7,885 kNm

M_r = 8,548 kNm Moment Capacity (Factored)

==> Result: Lift Span Closed: M_r / M_f = 2.19 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 5.48 Capacity over Demand Ratio (C/D)

Shear Results *TOWR-FLBM-FRNT*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,219 mm (spacing of transverse stiffeners)

h = 1,803 mm (clear depth of web between flanges)

a/h = 0.68 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 15.7 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 15.7

F_{cr} = 132.7 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.7 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 2,887 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 2.87 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 7.46

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.49 *< 1.0* *==> Satisfied*

Member Location: Tower
Member Description: Tower span rear floor beam
Member ID: TOWR-FLBM-REAR
S-Frame End Nodes: Node 594 to Node 593, Node 943 to Node 942

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plate	Top Ls 8x8x1/2	Bot Ls 8x8x1/2
Qty	1	1	1	2	2
y_{dim} (mm)	508	508	15.9	203	203
z_{dim} (mm)	12.7	12.7	1,803	203	203
I_{y1} ($x10^6mm^4$)	0	0	7,766	20.2	20.2
I_{z1} ($x10^6mm^4$)	139	139	1	20.2	20.2
A_g (mm^2)	6,452	6,452	28,668	4,990	4,990
A_n (mm^2)	6,452	6,452	28,668	4,990	4,990
y_{bar} (mm)	0	0	0	64	64
z_{bar} (mm)	914	914	0	852	852
I_y ($x10^6mm^4$)	5,390	5,390	7,766	7,285	7,285
I_z ($x10^6mm^4$)	139	139	1	81	81

A_g =	61,531	mm^2	Z_y =	41.721	$x10^6$ mm^3
A_n =	61,531	mm^2	Z_z =	2.916	$x10^6$ mm^3
I_y =	33,115	$x10^6$ mm^4	S_y =	35.981	$x10^6$ mm^3
I_z =	441	$x10^6$ mm^4	S_z =	1.735	$x10^6$ mm^3
r_y =	734	mm	J =	1,298	$x10^3$ mm^4
r_z =	85	mm			

Bending Results *TOWR-FLBM-REAR*

Cl. 10.5.7 (a)

	Flexure: φ_s =	0.95		
Web	h	1,397	mm	
	w	15.9	mm	
Flange	b	235	mm	
	t	25.4	mm	
Lift Span Closed: M_f =		7,307	kNm	V_f = 1,891 kN
Lift Span Raised: M_f =		3,379	kNm	V_f = 844 kN

Factored Moments for Calculating Capacity of Laterally Unbraced Members			
	M_{max} =	N/A	kNm
	M_a =		kNm
	M_b =		kNm
	M_c =		kNm
	L =		mm

Cl. 10.9.2.1 Determining Class of Section

Web	h/w =	87.9	<	112.1	*Class 2 or better*
Flanges	b/t =	9	<	35	*Class 2 or better*

==> Overall Class: 2

Cl. 10.10.2.2 Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 9,116 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3 Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p\left[1 - \frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} = \text{N/A kNm}$$

$M_p = Z_y F_y =$ 9,596 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{{M_{max}}^2 + 4{M_a}^2 + 7{M_b}^2 + 4{M_c}^2}} \leq 2.5 = \text{N/A}$$

Cl. 10.10.3.2 Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 7,862 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28 M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 8,276 kNm

==> Result: M_r = 9,116 kNm Moment Capacity (Factored)

Lift Span Closed: M_r / M_f = 1.25 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 2.70 Capacity over Demand Ratio (C/D)

Shear Results *TOWR-FLBM-REAR*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,219 mm (spacing of transverse stiffeners)

h = 1,803 mm (clear depth of web between flanges)

a/h = 0.68 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 15.7 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 15.7

F_{cr} = 132.7 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.7 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 3,614 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 1.91 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 4.28

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.82 *< 1.0* *==> Satisfied*

Member Location: Tower
Member Description: Top of Tower - Outer Longitudinal Sheave Girder
Member ID: TOWR-SHVG-G1
S-Frame End Nodes: Node 647 to Node 648, Node 901 to Node 902, Node 992 to Node 993, Node 1108 to Node 1109

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plate	Top Ls 8x6x3/4	Bot Ls 8x6x3/4
Qty			1	2	2
y_{dim} (mm)			19.1	152	152
z_{dim} (mm)			2,121	203	203
I_{y1} ($x10^6mm^4$)	0	0	15,147	26.4	26.4
I_{z1} ($x10^6mm^4$)	0	0	1	12.7	12.7
A_g (mm^2)	0	0	40,405	6,420	6,420
A_n (mm^2)	0	0	40,405	6,420	6,420
y_{bar} (mm)			0	50	50
z_{bar} (mm)			0	1,002	1,002
I_y ($x10^6mm^4$)	0	0	15,147	12,944	12,944
I_z ($x10^6mm^4$)	0	0	1	58	58

A_g = 66,085 mm^2		Z_y =	47.156	$x10^6$ mm^3
A_n = 66,085 mm^2		Z_z =	1.284	$x10^6$ mm^3
I_y = 41,036 $x10^6$ mm^4		S_y =	38.477	$x10^6$ mm^3
I_z = 116 $x10^6$ mm^4		S_z =	0.720	$x10^6$ mm^3
r_y = 788 mm		J =	1,222	$x10^3$ mm^4
r_z = 42 mm				

Bending Results

TOWR-SHVG-G1

Cl. 10.5.7 (a)

Flexure: φ_s =		0.95	
Web	h	1,715	mm
	w	19.1	mm
Flange	b	152	mm
	t	19.1	mm
Lift Span Closed: M_f =		1,775	kNm
Lift Span Raised: M_f =		2,241	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members	M_{max} =	N/A	kNm
	M_a =		kNm
	M_b =		kNm
	M_c =		kNm
	L =	9,754	mm

V_f = 2,750 kN

V_f = 3,492 kN

Cl. 10.9.2.1

Determining Class of Section

Web	h/w =	90.0	<	112.1	*Class 2 or better*
Flanges	b/t =	8	<	35	*Class 2 or better*

==> Overall Class: 2

Cl. 10.10.2.2

Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 10,304 kNm — *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3

Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p \left[1 - \frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm N/A

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ N/A kNm

$M_p = Z_y F_y =$ 10,846 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{{M_{max}}^2 + 4{M_a}^2 + 7{M_b}^2 + 4{M_c}^2}} \leq 2.5 =$$ N/A

Cl. 10.10.3.2

Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 8,407 kNm — *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28 M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 8,850 kNm

M_r = 10,304 kNm Moment Capacity (Factored)

==> Result: Lift Span Closed: M_r / M_f = 5.80 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 4.60 Capacity over Demand Ratio (C/D)

Shear Results *TOWR-SHVG-G1*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,727 mm (spacing of transverse stiffeners)

h = 2,121 mm (clear depth of web between flanges)

a/h = 0.81 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 12.1 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 12.1

F_{cr} = 132.7 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.7 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 5,094 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 1.85 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 1.46

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.37 *< 1.0* *==> Satisfied*

Member Location: Tower
Member Description: Top of Tower - Longitudinal Sheave Girders
Member ID: TOWR-SHVG-G2G3
S-Frame End Nodes: Node 649 to Node 650, Node 951 Node 952, Node 905 to Node 906, Node 903 to Node 904, Node 994 to Node 995, Node 996 to Node 997, Node 1112 to Node 1113, Node 1110 to Node 1111

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plate	Top Ls 8x8x7/8	Bot Ls 8x8x7/8
Qty			1	2	2
y_{dim} (mm)			19.1	203	203
z_{dim} (mm)			2,121	203	203
I_{y1} ($x10^6 mm^4$)	0	0	15,147	33.0	33.0
I_{z1} ($x10^6 mm^4$)	0	0	1	33.0	33.0
A_g (mm^2)	0	0	40,405	8,520	8,520
A_n (mm^2)	0	0	40,405	8,520	8,520
y_{bar} (mm)			0	69	69
z_{bar} (mm)			0	1,008	1,008
I_y ($x10^6 mm^4$)	0	0	15,147	17,380	17,380
I_z ($x10^6 mm^4$)	0	0	1	147	147

A_g =	74,485	mm^2	Z_y =	55.777	$x10^6$ mm^3
A_n =	74,485	mm^2	Z_z =	2.352	$x10^6$ mm^3
I_y =	49,907	$x10^6$ mm^4	S_y =	46.795	$x10^6$ mm^3
I_z =	295	$x10^6$ mm^4	S_z =	1.390	$x10^6$ mm^3
r_y =	819	mm	J =	1,222	$x10^3$ mm^4
r_z =	63	mm			

Cl. 10.5.7 (a)

Flexure:	φ_s =	0.95		
Web	h	1,715	mm	
	w	19.1	mm	
Flange	b	152	mm	
	t	22.2	mm	
Lift Span Closed:	M_f =	1,786	kNm	V_f = 2,755 kN
Lift Span Raised:	M_f =	2,254	kNm	V_f = 3,498 kN

Factored Moments for Calculating Capacity of Laterally Unbraced Members			
	M_{max} =	N/A	kNm
	M_a =		kNm
	M_b =		kNm
	M_c =		kNm
	L =		mm

Cl. 10.9.2.1 Determining Class of Section

Web	h/w =	90.0	<	112.1	*Class 2 or better*
Flanges	b/t =	7	<	35	*Class 2 or better*

==> Overall Class: 2

Cl. 10.10.2.2 Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 12,187 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3 Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p\left[1 - \frac{0.28M_p}{M_u}\right] \le \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ N/A kNm

$M_p = Z_y F_y =$ 12,829 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{{M_{max}}^2 + 4{M_a}^2 + 7{M_b}^2 + 4{M_c}^2}} \le 2.5 =$$ N/A

Cl. 10.10.3.2 Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 10,225 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 10,763 kNm

M_r = 12,187 kNm Moment Capacity (Factored)

==> Result: Lift Span Closed: M_r / M_f = 6.82 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 5.41 Capacity over Demand Ratio (C/D)

Shear Results *TOWR-SHVG-G2G3*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,727 mm (spacing of transverse stiffeners)

h = 2,121 mm (clear depth of web between flanges)

a/h = 0.81 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 12.1 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 12.1

F_{cr} = 132.7 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.7 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 5,094 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 1.81 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 1.43

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.36 *< 1.0* *==> Satisfied*

Member Location: Tower
Member Description: Top of Tower - Longitudinal Sheave Girder
Member ID: TOWR-SHVG-G4
S-Frame End Nodes: Node 653 to Node 654, Node 907 to Node 908, Node 998 to Node 999, Node 1114 to Node 1115

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plate	Top Ls 8x6x3/4	Bot Ls 8x6x3/4
Qty			1	2	2
y_{dim} (mm)			19.1	152	152
z_{dim} (mm)			2,121	203	203
I_{y1} ($x10^6 mm^4$)	0	0	15,147	26.4	26.4
I_{z1} ($x10^6 mm^4$)	0	0	1	12.7	12.7
A_g (mm^2)	0	0	40,405	6,420	6,420
A_n (mm^2)	0	0	40,405	6,420	6,420
y_{bar} (mm)			0	50	50
z_{bar} (mm)			0	1,002	1,002
I_y ($x10^6 mm^4$)	0	0	15,147	12,944	12,944
I_z ($x10^6 mm^4$)	0	0	1	58	58

A_g =	66,085	mm^2	Z_y =	47.156	$x10^6$ mm^3
A_n =	66,085	mm^2	Z_z =	1.284	$x10^6$ mm^3
I_y =	41,036	$x10^6$ mm^4	S_y =	38.477	$x10^6$ mm^3
I_z =	116	$x10^6$ mm^4	S_z =	0.720	$x10^6$ mm^3
r_y =	788	mm	J =	1,222	$x10^3$ mm^4
r_z =	42	mm			

Cl. 10.5.7 (a)

	Flexure: φ_s =	0.95	
Web	h	1,715	mm
	w	19.1	mm
Flange	b	152	mm
	t	19.1	mm
Lift Span Closed: M_f =		1,894	kNm
Lift Span Raised: M_f =		2,369	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members

M_{max} =	N/A	kNm
M_a =		kNm
M_b =		kNm
M_c =		kNm
L =	9,754	mm

V_f = 2,812 kN

V_f = 3,560 kN

Cl. 10.9.2.1

Determining Class of Section

Web	h/w =	90.0	<	112.1	*Class 2 or better*
Flanges	b/t =	8	<	35	*Class 2 or better*

==> Overall Class: 2

Cl. 10.10.2.2

Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 10,304 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3

Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p\left[1 - \frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm N/A

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ N/A kNm

$M_p = Z_y F_y =$ 10,846 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{M_{max}^2 + 4M_a^2 + 7M_b^2 + 4M_c^2}} \leq 2.5 =$$ N/A

Cl. 10.10.3.2

Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 8,407 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28 M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 8,850 kNm

M_r = 10,304 kNm Moment Capacity (Factored)

==> Result: Lift Span Closed: M_r / M_f = 5.44 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 4.35 Capacity over Demand Ratio (C/D)

Shear Results *TOWR-SHVG-G4*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,727 mm (spacing of transverse stiffeners)

h = 2,121 mm (clear depth of web between flanges)

a/h = 0.81 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 12.1 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 12.1

F_{cr} = 132.7 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.7 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 5,094 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 1.81 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 1.43

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.38 *< 1.0* *==> Satisfied*

Member Location: Tower
Member Description: Top of Tower - Longitudinal Fascia Girders
Member ID: TOWR-SHVG-G6
S-Frame End Nodes: Node 638 to Node 639, Node 637 to Node 640, Node 983 to Node 984, Node 982 to Node 985

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plate	Top Ls 6x6x1/2	Bot Ls 6x6x1/2
Qty			2	4	4
y_{dim} (mm)			12.7	152	152
z_{dim} (mm)			2,121	152	152
I_{y1} ($x10^6 mm^4$)	0	0	10,098	8.2	8.2
I_{z1} ($x10^6 mm^4$)	0	0	0	8.2	8.2
A_g (mm^2)	0	0	26,937	3,700	3,700
A_n (mm^2)	0	0	26,937	3,700	3,700
y_{bar} (mm)			0	49	49
z_{bar} (mm)			0	1,024	1,024
I_y ($x10^6 mm^4$)	0	0	20,196	15,552	15,552
I_z ($x10^6 mm^4$)	0	0	1	68	68

A_g =	83,473	mm^2	Z_y =	58.877	$x10^6$ mm^3
A_n =	83,473	mm^2	Z_z =	1.450	$x10^6$ mm^3
I_y =	51,300	$x10^6$ mm^4	S_y =	48.101	$x10^6$ mm^3
I_z =	138	$x10^6$ mm^4	S_z =	0.869	$x10^6$ mm^3
r_y =	784	mm	J =	2,896	$x10^3$ mm^4
r_z =	41	mm			

Bending Results *TOWR-SHVG-G6*

Cl. 10.5.7 (a)

Flexure:	φ_s =	0.95	
Web	h	1,715	mm
	w	19.1	mm
Flange	b	152	mm
	t	19.1	mm
Lift Span Closed:	M_f =	618	kNm
Lift Span Raised:	M_f =	999	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members	M_{max} =	N/A	kNm
	M_a =		kNm
	M_b =		kNm
	M_c =		kNm
	L =	9,754	mm

V_f = 146 kN
V_f = 235 kN

Cl. 10.9.2.1 Determining Class of Section

Web	h/w =	90.0	<	112.1	*Class 2 or better*
Flanges	b/t =	8	<	35	*Class 2 or better*

==> Overall Class: 2

Cl. 10.10.2.2 Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 12,865 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3 Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p\left[1-\frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm N/A

$$M_u = \frac{\omega_2\pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ N/A kNm

$M_p = Z_y F_y =$ 13,542 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{M_{max}^2+4M_a^2+7M_b^2+4M_c^2}} \leq 2.5 =$$ N/A

Cl. 10.10.3.2 Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 10,510 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y\left[1 - \frac{0.28M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 11,063 kNm

==> Result: M_r = 12,865 kNm Moment Capacity (Factored)

Lift Span Closed: M_r / M_f = 20.82 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 12.88 Capacity over Demand Ratio (C/D)

Shear Results *TOWR-SHVG-G6*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,829 mm (spacing of transverse stiffeners)

h = 2,121 mm (clear depth of web between flanges)

a/h = 0.86 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 11.2 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 11.2

F_{cr} = 132.7 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.7 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 3,396 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 23.26 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 14.45

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.05 *< 1.0* *==> Satisfied*

Member Location:	Tower
Member Description:	Top of Tower - Front Transverse Sheave Girder
Member ID:	TOWR-SHVG-G7
S-Frame End Nodes:	Node 637 to Node 638, Node 982 to Node 983

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	350	MPa	*Low Alloy Steel A242*
F_u =	480	MPa	*CAN/CSA-S16-09 PP6-5*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	B. Cover Plates	Web Plate	Top Ls 8x8x1	Bot Ls 8x8x1	Bot Fl. Ls 7x4x1/2	B. Flange Plates	Filler Plates
Qty	2	1	1	1	2	2	4	2	4
y_{dim} (mm)	660	873	483	22.2	203	203	102	12.7	9.5
z_{dim} (mm)	22.2	15.9	15.9	4,572	203	203	178	381	305
I_{y1} ($x10^6 mm^4$)	1	0	0	176,803	36.9	36.9	11.1	59	22
I_{z1} ($x10^6 mm^4$)	532	882	149	4	36.9	36.9	2.8	0	0
A_g (mm^2)	14,652	13,881	7,680	101,498	9,670	9,670	3,390	4,839	2,898
A_n (mm^2)	14,652	13,881	7,680	101,498	9,670	9,670	3,390	4,839	2,898
y_{bar} (mm)	0	74	0	0	80	80	413	443	16
z_{bar} (mm)	2,314	2,300	2,316	0	2,232	2,232	2,316	2,316	2,139
I_y ($x10^6 mm^4$)	156,912	73,429	41,193	176,803	96,422	96,422	72,778	52,025	53,118
I_z ($x10^6 mm^4$)	1,064	958	149	4	198	198	2,324	1,899	3

A_g =	225,870	mm^2	Z_y =	302.081	$x10^6\ mm^3$
A_n =	225,870	mm^2	Z_z =	10.959	$x10^6\ mm^3$
I_y =	819,104	$x10^6\ mm^4$	S_y =	357.375	$x10^6\ mm^3$
I_z =	6,796	$x10^6\ mm^4$	S_z =	31.743	$x10^6\ mm^3$
r_y =	1,904	mm	J =	7,745	$x10^3\ mm^4$
r_z =	173	mm			

Cl. 10.5.7 (a)

Flexure:	φ_s =	0.95		
Web	h	4,044	mm	
	w	22.2	mm	
Flange	b	330	mm	
	t	25.4	mm	
Lift Span Closed:	M_f =	33,498	kNm	V_f = 10,610 kN
Lift Span Raised:	M_f =	42,238	kNm	V_f = 14,236 kN

Factored Moments for Calculating Capacity of Laterally Unbraced Members			
	M_{max} =	N/A	kNm
	M_a =		kNm
	M_b =		kNm
	M_c =		kNm
	L =	9,754	mm

Cl. 10.9.2.1

Determining Class of Section

Web	h/w =	182	>	102	*Exceeds Class 3 Limits*
Flanges	b/t =	13	<	28	*Class 2 or better*

==> Overall Class: 4

Cl. 10.10.2.2

Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 100,442 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3

Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p \left[1 - \frac{0.28 M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm N/A

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ N/A kNm

$M_p = Z_y F_y =$ 105,729 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{{M_{max}}^2 + 4{M_a}^2 + 7{M_b}^2 + 4{M_c}^2}} \leq 2.5 =$$ N/A

Cl. 10.10.3.2

Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 118,827 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 125,081 kNm

==> Result: M_r = 100,442 kNm Moment Capacity (Factored)

Lift Span Closed: M_r / M_f = 3.00 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 2.38 Capacity over Demand Ratio (C/D)

Shear Results *TOWR-SHVG-G7*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,359 mm (spacing of transverse stiffeners)

h = 4,572 mm (clear depth of web between flanges)

a/h = 0.30 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 64.4 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 64.4

F_{cr} = 202.0 MPa

F_t = 0 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 202.0 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 19,473 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 1.84 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 1.37

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.49 *< 1.0* *==> Satisfied*

Member Location: Tower
Member Description: Top of Tower - Rear Transverse Sheave Girder
Member ID: TOWR-SHVG-G8
S-Frame End Nodes: Node 640 to Node 639, Node 985 to Node 984

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	T. Cover Plates	B. Cover Plates	Web Plate	Top Ls 8x6x5/8	Bot Ls 8x6x5/8
Qty	1	1	1	2	2
y_{dim} (mm)	508	508	12.7	203	203
z_{dim} (mm)	12.7	12.7	3,353	152	152
I_{y1} ($x10^6mm^4$)	0	0	39,895	22.5	22.5
I_{z1} ($x10^6mm^4$)	139	139	1	10.9	10.9
A_g (mm^2)	6,452	6,452	42,583	5,390	5,390
A_n (mm^2)	6,452	6,452	42,583	5,390	5,390
y_{bar} (mm)	0	0	0	71	71
z_{bar} (mm)	1,689	1,689	0	1,644	1,644
I_y ($x10^6mm^4$)	18,405	18,405	39,895	29,180	29,180
I_z ($x10^6mm^4$)	139	139	1	76	76

A_g =	77,046	mm^2	Z_y =	92.933	$x10^6$ mm^3
A_n =	77,046	mm^2	Z_z =	3.169	$x10^6$ mm^3
I_y =	135,066	$x10^6$ mm^4	S_y =	80.277	$x10^6$ mm^3
I_z =	430	$x10^6$ mm^4	S_z =	2.056	$x10^6$ mm^3
r_y =	1,324	mm	J =	1,266	$x10^3$ mm^4
r_z =	75	mm			

Bending Results *TOWR-SHVG-G8*

Cl. 10.5.7 (a)

Flexure:	φ_s =	0.95	
Web	h	2,350	mm
	w	12.7	mm
Flange	b	254	mm
	t	28.6	mm
Lift Span Closed:	M_f =	4,000	kNm
Lift Span Raised:	M_f =	4,819	kNm

Factored Moments for Calculating Capacity of Laterally Unbraced Members			
	M_{max} =	N/A	kNm
	M_a =		kNm
	M_b =		kNm
	M_c =		kNm
	L =	9,754	mm

V_f = 1,274 kN

V_f = 1,567 kN

Cl. 10.9.2.1 Determining Class of Section

Web	h/w =	185	>	125	*Exceeds Class 3 Limits*
Flanges	b/t =	9	<	35	*Class 2 or better*

==> Overall Class: 4

Cl. 10.10.2.2 Class 1 and Class 2 Sections - Laterally Supported

$M_r = \phi_s Z_y F_y =$ 20,306 kNm *Moment resistance for laterally supported Class 1 or Class 2 sections*

Cl. 10.10.2.3 Class 1 and Class 2 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_p\left[1 - \frac{0.28M_p}{M_u}\right] \leq \varphi_s M_p =$ N/A kNm

(b) $M_r = \phi_s M_u =$ N/A kNm N/A

$$M_u = \frac{\omega_2 \pi}{L}\sqrt{E_s I_z G_s J + \left[\frac{\pi E_s}{L}\right]^2 I_z C_w} =$$ N/A kNm

$M_p = Z_y F_y =$ 21,375 kNm

$$\omega_2 = \frac{4M_{max}}{\sqrt{{M_{max}}^2 + 4{M_a}^2 + 7{M_b}^2 + 4{M_c}^2}} \leq 2.5 =$$ N/A

Cl. 10.10.3.2 Class 3 Sections - Laterally Supported

$M_r = \phi_s S_y F_y =$ 17,540 kNm *Moment resistance for laterally supported Class 3 sections*

Cl. 10.10.3.3 Class 3 Sections - Laterally Unbraced Members

(a) $M_r = 1.15\varphi_s M_y \left[1 - \frac{0.28 M_y}{M_u}\right] \leq \varphi_s M_y$ = N/A kNm

(b) $M_r = \phi_s M_u$ = N/A kNm

$M_y = S_y F_y$ = 18,464 kNm

==> Result: M_r = 20,306 kNm Moment Capacity (Factored)

Lift Span Closed: M_r / M_f = 5.08 Capacity over Demand Ratio (C/D)

Lift Span Raised: M_r / M_f = 4.21 Capacity over Demand Ratio (C/D)

Shear Results *TOWR-SHVG-G8*

Cl. 10.5.7 (b) Flexure: φ_s = 0.95

a = 1,562 mm (spacing of transverse stiffeners)

h = 3,353 mm (clear depth of web between flanges)

a/h = 0.47 < 1

Cl 10.10.5.1 $k_v = 4 + \frac{5.34}{(\frac{a}{h})^2}$ = 28.6 $k_v = 5.34 + \frac{4}{(\frac{a}{h})^2}$ = N/A

k_v = 28.6

F_{cr} = 127.1 MPa

F_t = 4.9 MPa

Cl 10.10.5.1 $F_s = F_{cr} + F_t$ = 132.0 MPa

Cl 10.10.5.1 $V_r = \phi_s A_w F_s$ = 5,341 kN Shear Capacity (Factored)

==> Result: Lift Span Closed: V_r / V_f = 4.19 Capacity over Demand Ratio (C/D)

Lift Span Raised: V_r / V_f = 3.41

Cl 10.10.5.2 $0.727\frac{M_f}{M_r} + 0.455\frac{V_f}{V_r} < 1.0$ Check shear/moment interaction

= 0.25 *< 1.0* *==> Satisfied*

Member Location: Tower

Member Description: Sheave Girder Bracing

Member ID: 2L3.5x3.5x.375

S-Frame End Nodes: Node 756 to Node 639, Node 775 to Node 776, Node 775 to Node 638, Node 779 to Node 780, Node 751 to Node 779, Node 785 to Node 653, Node 780 to Node 785, Node 917 to Node 918, Node 918 to Node 923, Node 923 to Node 907, Node 913 to Node 922, Node 909 to Node 917, Node 924 to Node 925, Node 925 to Node 914, Node 913 to Node 914, Node 925 to Node 926, Node 909 to Node 925, Node 924 to Node 640, Node 1185 to Node 1186, Node 1186 to Node 984, Node 1190 to Node 1191, Node 1190 to Node 983, Node 1194 to Node 1195, Node 1185 to Node 1194, Node 1200 to Node 998, Node 1195 to Node 1200, Node 1209 to Node 1210, Node 1210 to Node 1215, Node 1215 to Node 1114, Node 1205 to Node 1214, Node 1201 to Node 1209, Node 1216 to Node 1217, Node 1217 to Node 1206, Node 1205 to Node 1206, Node 1217 to Node 1218, Node 1201 to Node 1217, Node 1216 to Node 985, Node 751 to Node 756

Member orientation (local axis):

z always corresponds with the vertical plane

y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 3.5x3.5x3/8
Qty	2
y_{dim} (mm)	89
z_{dim} (mm)	89
I_{y1} ($x10^6mm^4$)	1.19
I_{z1} ($x10^6mm^4$)	1.19
A_g (mm^2)	1,600
A_n (mm^2)	1,600
y_{bar} (mm)	38
z_{bar} (mm)	0
I_y ($x10^6mm^4$)	2
I_z ($x10^6mm^4$)	7

A_g =	3,200	mm^2
A_n =	3,200	mm^2
I_y =	2.380	$x10^6$ mm^4
I_z =	7.099	$x10^6$ mm^4
r_y =	27	mm
r_z =	47	mm

Local Check for Capacity of Single Angle

r =	27.3	mm
L =	1,372	mm
A_g =	1,600	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.542$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = -290 kN

Capacity of single angle does not govern built up member capacity

Compression Results *2L3.5x3.5x.375*

	L_y =	1,372	mm			
	L_z =	1,372	mm			
	K_y =	1.00		K'_y =	1.06	
	K_z =	1.00		K'_z =	1.10	
	Web	N/A				
	Flange b	89	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-110	kN			
	Lift Span Raised: C_f =	-387	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	50	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	9	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 569 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 635 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.574$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.346$$

C_r = -569 kN Compressive Capacity (Factored)

C_r / C_f = 1.47 Capacity over Demand Ratio (C/D)

Tension Results *2L3.5x3.5x.375*

	Lift Span Closed: T_f =	127	kN	
	Lift Span Raised: T_f =	403	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	699	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	1,085	kN	Net Section
	T_r =	699	kN	Tensile Capacity (Factored)
	T_r / T_f =	1.73		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Tower Traction Bracing
Member ID: 2L4x4x.375
S-Frame End Nodes: Node 860 to Node 865, Node 868 to Node 864, Node 862 to Node 866, Node 869 to Node 867, Node 1099 to Node 1096, Node 1098 to Node 1102, Node 1100 to Node 1097, Node 1101 to Node 1103,

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 4x4x3/8
Qty	2
y_{dim} (mm)	102
z_{dim} (mm)	102
I_{y1} ($x10^6mm^4$)	1.84
I_{z1} ($x10^6mm^4$)	1.84
A_g (mm^2)	1,850
A_n (mm^2)	1,850
y_{bar} (mm)	42
z_{bar} (mm)	0
I_y ($x10^6mm^4$)	4
I_z ($x10^6mm^4$)	10

A_g =	3,700	mm^2
A_n =	3,700	mm^2
I_y =	3.680	$x10^6$ mm^4
I_z =	10.114	$x10^6$ mm^4
r_y =	32	mm
r_z =	52	mm

Local Check for Capacity of Single Angle

r =	31.5	mm
L =	2,802	mm
A_g =	1,850	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.960$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -237 kN

Capacity of single angle does not govern built up member capacity

Compression Results *2L4x4x.375*

	L_y =	2,802	mm			
	L_z =	2,802	mm			
	K_y =	1.00		K'_y =	1.02	
	K_z =	1.00		K'_z =	1.05	
	Web	N/A				
	Flange b	102	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-25	kN			
	Lift Span Raised: C_f =	-31	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	89	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	11	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 467 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 643 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.977$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.608$$

C_r = -467 kN Compressive Capacity (Factored)

C_r / C_f = 15.07 Capacity over Demand Ratio (C/D)

Tension Results *2L4x4x.375*

	Lift Span Closed: T_f =	26	kN	
	Lift Span Raised: T_f =	26	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	808	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	1,255	kN	Net Section
	T_r =	808	kN	Tensile Capacity (Factored)
	T_r / T_f =	31.09		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Sheave Girder Bracing
Member ID: 2L5x3.5x.375
S-Frame End Nodes: Node 1216 to Node 1227, Node 1227 to Node 1185, Node 1201 to Node 1227, Node 924 to Node 935, Node 935 to Node 751, Node 909 to Node 935

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 5x3.5x3/8
Qty	2
y_{dim} (mm)	127
z_{dim} (mm)	89
I_{y1} ($x10^6mm^4$)	1.33
I_{z1} ($x10^6mm^4$)	3.24
A_g (mm^2)	1,970
A_n (mm^2)	1,970
y_{bar} (mm)	53
z_{bar} (mm)	0
I_y ($x10^6mm^4$)	3
I_z ($x10^6mm^4$)	18

A_g =	3,940	mm^2
A_n =	3,940	mm^2
I_y =	2.660	$x10^6$ mm^4
I_z =	17.547	$x10^6$ mm^4
r_y =	26	mm
r_z =	67	mm

Local Check for Capacity of Single Angle

r =	27.3	mm
L =	3,340	mm
A_g =	1,970	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.321$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$: -175 kN

Capacity of single angle does not govern built up member capacity

Compression Results *2L5x3.5x.375*

	L_y =	3,340	mm			
	L_z =	3,340	mm			
	K_y =	1.00		K'_y =	1.01	
	K_z =	1.00		K'_z =	1.06	
	Web	N/A				
	Flange b	127	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	129	>	120		*Cl. 10.9.1.3 NOT Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	13	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.400$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.572$$

C_r = N/A kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *2L5x3.5x.375*

	Lift Span Closed: T_f =	35	kN	
	Lift Span Raised: T_f =	104	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	861	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	1,336	kN	Net Section
	T_r =	861	kN	Tensile Capacity (Factored)
	T_r / T_f =	8.28		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Tower Traction Bracing
Member ID: 2L5x5x.5
S-Frame End Nodes: Node 866 to Node 867, Node 1101 to Node 1100

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 5x5x1/2
Qty	2
y_{dim} (mm)	127
z_{dim} (mm)	127
I_{y1} ($x10^6 mm^4$)	4.68
I_{z1} ($x10^6 mm^4$)	4.68
A_g (mm^2)	3,060
A_n (mm^2)	3,060
y_{bar} (mm)	50
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	9
I_z ($x10^6 mm^4$)	25

A_g =	6,120	mm^2
A_n =	6,120	mm^2
I_y =	9.360	$x10^6\ mm^4$
I_z =	24.660	$x10^6\ mm^4$
r_y =	39	mm
r_z =	63	mm

Local Check for Capacity of Single Angle

r =	27.3	mm
L =	3,383	mm
A_g =	3,060	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.337$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -267 kN

Capacity of single angle does not govern built up member capacity

Compression Results *2L5x5x.5*

	L_y =	6,765	mm			
	L_z =	3,383	mm			
	K_y =	1.00		K'_y =	1.01	
	K_z =	1.00		K'_z =	1.05	
	Web	N/A				
	Flange b	127	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	173	>	120		*Cl. 10.9.1.3 NOT Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	13	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = N/A kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.877$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.605$$

C_r = N/A kN Compressive Capacity (Factored)

C_r / C_f = N/A Capacity over Demand Ratio (C/D)

Tension Results *2L5x5x.5*

	Lift Span Closed: T_f =	7	kN	
	Lift Span Raised: T_f =	5	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,337	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	2,076	kN	Net Section
	T_r =	1,337	kN	Tensile Capacity (Factored)
	T_r / T_f =	191.03		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Sheave Girder Bracing
Member ID: 2L6x6x.375
S-Frame End Nodes: Node 655 to Node 656, Node 1189 to Node 1185, Node 1189 to Node 998, Node 1189 o Node 1201, Node 1189 to Node 1114, Node 1183 to Node 1184, Node 774 to Node 751, Node 774 to Node 653, Node 774 to Node 909, Node 774 to Node 907

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 6x6x3/8
Qty	2
y_{dim} (mm)	152
z_{dim} (mm)	152
I_{y1} ($x10^6 mm^4$)	4.68
I_{z1} ($x10^6 mm^4$)	4.68
A_g (mm^2)	3,060
A_n (mm^2)	3,060
y_{bar} (mm)	50
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	9
I_z ($x10^6 mm^4$)	25

A_g =	6,120	mm^2
A_n =	6,120	mm^2
I_y =	9.360	$x10^6$ mm^4
I_z =	24.660	$x10^6$ mm^4
r_y =	39	mm
r_z =	63	mm

Local Check for Capacity of Single Angle

r =	27.3	mm
L =	2,223	mm
A_g =	3,060	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.879$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -425 kN

Capacity of single angle does not govern built up member capacity

Compression Results *2L6x6x.375*

	L_y =	4,447	mm			
	L_z =	4,447	mm			
	K_y =	1.00		K'_y =	1.01	
	K_z =	1.00		K'_z =	1.03	
	Web	N/A				
	Flange b	127	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-118	kN			
	Lift Span Raised: C_f =	-294	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	114	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	13	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 590 kN *Governs*

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 931 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.242$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.779$$

C_r = -590 kN Compressive Capacity (Factored)

C_r / C_f = 2.01 Capacity over Demand Ratio (C/D)

Tension Results *2L6x6x.375*

	Lift Span Closed: T_f =	122	kN	
	Lift Span Raised: T_f =	300	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,337	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	2,076	kN	Net Section
	T_r =	1,337	kN	Tensile Capacity (Factored)
	T_r / T_f =	4.46		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Tower Traction Bracing
Member ID: L4x4x.375
S-Frame End Nodes: Node 871 to Node 873, Node 1107 to Node 1105

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 4x4x3/8
Qty	1
y_{dim} (mm)	102
z_{dim} (mm)	102
I_{y1} ($x10^6 mm^4$)	1.84
I_{z1} ($x10^6 mm^4$)	1.84
A_g (mm^2)	1,850
A_n (mm^2)	1,850
y_{bar} (mm)	0
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	2
I_z ($x10^6 mm^4$)	2

A_g =	1,850	mm^2
A_n =	1,850	mm^2
I_y =	1.840	$x10^6$ mm^4
I_z =	1.840	$x10^6$ mm^4
r_y =	32	mm
r_z =	32	mm

Local Check for Capacity of Single Angle

r =	31.5	mm
L =	2,802	mm
A_g =	1,850	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.960$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = -237 kN

Capacity of single angle does not govern built up member capacity

Compression Results *L4x4x.375*

	L_y =	2,802	mm			
	L_z =	2,802	mm			
	K_y =	1.00		K'_y =	1.02	
	K_z =	1.00		K'_z =	1.02	
	Web	N/A				
	Flange b	102	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Closed: C_f =	0	kN			
	Lift Span Raised: C_f =	0	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	89	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	11	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 234 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 234 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.977$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.977$$

C_r =	-234	kN	Compressive Capacity (Factored)
C_r / C_f =	N/A		Capacity over Demand Ratio (C/D)

Tension Results *L4x4x.375*

	Lift Span Closed: T_f =	0	kN	
	Lift Span Raised: T_f =	0	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	404	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	627	kN	Net Section
	T_r =	404	kN	Tensile Capacity (Factored)
	T_r / T_f =	N/A		

Member Location: Tower
Member Description: Tower Traction Bracing
Member ID: L5x5x3/8
S-Frame End Nodes: Node 865 to Node 862, Node 868 to Node 869, Node 866 to Node 870, Node 872 to Node 867, Node 1097 to Node 1099, Node 1103 to Node 1102, Node 1104 to Node 1100, Node 1101 to Node 1106

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 5x5x3/8
Qty	1
y_{dim} (mm)	127
z_{dim} (mm)	127
I_{y1} ($x10^6 mm^4$)	3.64
I_{z1} ($x10^6 mm^4$)	3.64
A_g (mm^2)	2,330
A_n (mm^2)	2,330
y_{bar} (mm)	0
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	4
I_z ($x10^6 mm^4$)	4

A_g =	2,330	mm^2
A_n =	2,330	mm^2
I_y =	3.640	$x10^6$ mm^4
I_z =	3.640	$x10^6$ mm^4
r_y =	40	mm
r_z =	40	mm

Local Check for Capacity of Single Angle

r =	27.3	mm
L =	3,168	mm
A_g =	2,330	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.253$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$: -222 kN

Capacity of single angle does not govern built up member capacity

Compression Results *L5x5x3/8*

	L_y =	3,168	mm			
	L_z =	3,168	mm			
	K_y =	1.00		K'_y =	1.02	
	K_z =	1.00		K'_z =	1.02	
	Web	N/A				
	Flange b	127	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-27	kN			
	Lift Span Raised: C_f =	-26	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	80	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	13	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 322 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$ = 322 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.885$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.885$$

C_r =	-222	kN	Compressive Capacity (Factored)
C_r / C_f =	8.22		Capacity over Demand Ratio (C/D)

Tension Results *L5x5x3/8*

	Lift Span Closed: T_f =	26	kN	
	Lift Span Raised: T_f =	31	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	509	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	790	kN	Net Section
	T_r =	509	kN	Tensile Capacity (Factored)
	T_r / T_f =	16.42		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Tower Traction Bracing
Member ID: L5x5x1/2
S-Frame End Nodes: Node 871 to Node 872, Node 871 to Node 870, Node 1106 to Node 1105, Node 1104 to 1105

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Angles 5x5x1/2
Qty	1
y_{dim} (mm)	127
z_{dim} (mm)	127
	4.68
I_{z1} ($x10^6 mm^4$)	4.68
A_g (mm^2)	3,060
A_n (mm^2)	3,060
y_{bar} (mm)	0
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	5
I_z ($x10^6 mm^4$)	5

A_g =	3,060	mm^2
A_n =	3,060	mm^2
I_y =	4.680	$x10^6$ mm^4
I_z =	4.680	$x10^6$ mm^4
r_y =	39	mm
r_z =	39	mm

Local Check for Capacity of Single Angle

r =	27.3	mm
L =	3,388	mm
A_g =	3,060	mm^2

$$\lambda = \frac{KL}{r}\sqrt{\frac{F_y}{\pi^2 E_s}} = 1.340$$

Cl. 10.9.3.1 $C_r = \phi_s A F_y (1 + \lambda^{2n})^{-1/n}$: -267 kN

Capacity of single angle does not govern built up member capacity

Compression Results *L5x5x1/2*

	L_y =	3,388	mm			
	L_z =	3,388	mm			
	K_y =	1.00		K'_y =	1.02	
	K_z =	1.00		K'_z =	1.02	
	Web	N/A				
	Flange b	127	mm			
	Flange t	9.5	mm			
	n =	1.34				
	Lift Span Closed: C_f =	-27	kN			
	Lift Span Raised: C_f =	-26	kN			
Cl. 10.5.7 (c)	Compression: φ_s =	0.90				
Cl. 10.9.1.3	Slenderness Ratio =	87	<	120		*Cl. 10.9.1.3 Satisfied*
Cl. 10.9.2.1	Width to Thickness Limits					
	Flanges b/t =	13	<	44		*Cl. 10.9.2.1 Satisfied*

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 395 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 395 kN

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.954$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.954$$

C_r =	-267	kN	Compressive Capacity (Factored)
C_r / C_f =	9.87		Capacity over Demand Ratio (C/D)

Tension Results *L5x5x1/2*

	Lift Span Closed: T_f =	26	kN	
	Lift Span Raised: T_f =	31	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	669	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	1,038	kN	Net Section
	T_r =	669	kN	Tensile Capacity (Factored)
	T_r / T_f =	21.57		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Tower and Approach Span Diaphragms (Original Hwy Side)
Member ID: C15x33.9
S-Frame End Nodes: 704-706, 705-707, 706-708, 707-709, 708-710, 709-711, 710-712, 711-713, 1031-1033, 1032-1034, 1033-1035, 1034-1036, 1035-1037, 1036-1038, 1037-1039, 1038-1040, 675-677, 677-679, 679-681, 681-683, 720-726, 722-727, 724-728, 726-729, 727-730, 728-731, 729-732, 730-733, 731-734, 732-735, 733-736, 734-737, 1004-1002, 1006-1004, 1008-1006, 1010-1008, 1053-1047, 1054-1049, 1055-1051, 1056-1053, 1057-1054, 1058-1055, 1059-1056, 1060-1057, 1061-1058, 1062-1059, 1063-1060, 1064-1061

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Channel C15x33.9
Qty	1
y_{dim} (mm)	86
z_{dim} (mm)	381
I_{y1} ($x10^6 mm^4$)	131
I_{z1} ($x10^6 mm^4$)	3.39
A_g (mm^2)	6,430
A_n (mm^2)	6,430
y_{bar} (mm)	0
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	131
I_z ($x10^6 mm^4$)	3

A_g =	6,430	mm^2
A_n =	6,430	mm^2
I_y =	131	$x10^6$ mm^4
I_z =	3.4	$x10^6$ mm^4
r_y =	143	mm
r_z =	23	mm

Compression Results *C15x33.9*

	L_y =	1,943	mm		
	L_z =	1,943	mm		
	K_y =	1.00		K'_y =	1.10
	K_z =	1.00		K'_z =	1.02
	Web	N/A			
	Flange	N/A			
	n =	1.34			
	Lift Span Closed: C_f =	-4	kN		
	Lift Span Raised: C_f =	-1	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			

Cl. 10.9.1.3	Slenderness Ratio =	85	<	120	*Cl. 10.9.1.3 Satisfied*

Cl. 10.9.2.1 Width to Thickness Limits

N/A

Cl. 10.9.3.1	$C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ =	1,324	kN	
Cl. 10.9.3.1	$C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ =	848	kN	*Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.162$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.932$$

C_r =	-848	kN	Compressive Capacity (Factored)
C_r / C_f =	212.06		Capacity over Demand Ratio (C/D)

Tension Results *C15x33.9*

	Lift Span Closed: T_f =	3	kN	
	Lift Span Raised: T_f =	4	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,405	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	2,181	kN	Net Section
	T_r =	1,405	kN	Tensile Capacity (Factored)
	T_r / T_f =	351.24		Capacity over Demand Ratio (C/D)

Member Location: Tower
Member Description: Tower and Approach Span Diaphragms (1982 Rly Side)
Member ID: C380x50
S-Frame End Nodes: 712-714, 713-715, 714-716, 715-717, 716-718, 717-719, 1039-1041, 1040-1042, 1041-1043, 1042-1044, 1043-1045, 1044-1046, 683-685, 685-687, 687-698, 735-738, 736-739, 737-740, 738-741, 741-721, 739-742, 742-723, 740-743, 743-725, 1012-1010, 1014-1012, 1025-1014, 1065-1062, 1066-1063, 1067-1064, 1068-1065, 1048-1068, 1069-1066, 1050-1069, 1070-1067, 1052-1070

Member orientation (local axis):
z always corresponds with the vertical plane
y always corresponds to the horizontal plane

Material Properties

F_y =	230	MPa	*CSA S6-06 Cl. 14.7.4.2*
F_u =	420	MPa	*CSA S6-06 Cl. 14.7.4.2*
E_s =	200,000	MPa	
G_s =	77,000	MPa	

Built Up Section Properties

	Channel C380x50
Qty	1
y_{dim} (mm)	86
z_{dim} (mm)	381
I_{y1} ($x10^6 mm^4$)	131
I_{z1} ($x10^6 mm^4$)	3.39
A_g (mm^2)	6,430
A_n (mm^2)	6,430
y_{bar} (mm)	0
z_{bar} (mm)	0
I_y ($x10^6 mm^4$)	131
I_z ($x10^6 mm^4$)	3

A_g =	6,430	mm^2
A_n =	6,430	mm^2
I_y =	131.000	$x10^6$ mm^4
I_z =	3.390	$x10^6$ mm^4
r_y =	143	mm
r_z =	23	mm

Compression Results *C380x50*

	L_y =	2,057	mm		
	L_z =	2,057	mm		
	K_y =	1.00		K'_y =	1.10
	K_z =	1.00		K'_z =	1.02
	Web	N/A			
	Flange	N/A			
	n =	1.34			
	Lift Span Closed: C_f =	-3	kN		
	Lift Span Raised: C_f =	-5	kN		
Cl. 10.5.7 (c)	Compression: φ_s =	0.90			

Cl. 10.9.1.3 Slenderness Ratio = 90 < 120 *Cl. 10.9.1.3 Satisfied*

Cl. 10.9.2.1 Width to Thickness Limits

N/A

Cl. 10.9.3.1 $C_{r(y)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 1,322 kN

Cl. 10.9.3.1 $C_{r(z)} = \phi_s A F_y (1+\lambda^{2n})^{-1/n}$ = 805 kN *Governs*

$$\lambda_y = \frac{K'_y L_y}{r_y}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.171$$

$$\lambda_z = \frac{K'_z L_z}{r_z}\sqrt{\frac{F_y}{\pi^2 E_s}} = 0.985$$

C_r =	-805	kN	Compressive Capacity (Factored)
C_r / C_f =	161.10		Capacity over Demand Ratio (C/D)

Tension Results *C380x50*

	Lift Span Closed: T_f =	4	kN	
	Lift Span Raised: T_f =	1	kN	
Cl. 10.5.7 (d)	tension: φ_s =	0.95		
Cl. 10.8.2 (a)	$T_r = \varphi_s A_g F_y$ =	1,405	kN	Gross Section
Cl. 10.8.2 (b)	$T_r = 0.85\varphi_s A_n F_u$ =	2,181	kN	Net Section
	T_r =	1,405	kN	Tensile Capacity (Factored)
	T_r / T_f =	351.24		Capacity over Demand Ratio (C/D)