APPENDIX B - BRIDGE INSPECTION REPORTS

- 2017 Bridge Inspection Report
- 2018 Load Capacity Evaluation Report

The Regional Municipality of Niagara

2017 Municipal Bridge Appraisal - Rehabilitation/Replacement

Structure Name	St. Paul West CNR Bridge
ID Number	081215
Classification	☑ Bridge ☐ Culvert ☑ Structure ☐ Municipal
Location	081 St. Paul Street West, 0.50 km E of 072 Louth Street

Load Posting	15, 30, 40	**Span Lengths**	16.8 m
		Board Order / Agreement	☑
Structure Type	SOSG		
Yr Constructed	1910		
Yr Rehabilitated	N/A		
Inspection Date	10-Nov-17	**Current AADT**	7950
Previous Inpsection	21-Aug-15	**Date AADT**	1992
Next Inspection:	2019	**Previous ID Number**	

Effects of Deterioration

There are load posting signs at the east and west approaches. The east approach load posting sign is situated behind a tree, restricting visibility for trucks. The approaches to the structure are steep and there is poor visibility over the structure. The asphalt roadway on the approaches is in fair condition with areas of wide transverse cracking and isolated areas of alligator cracking and settlement. The asphalt roadway over the structure is in poor condition with wide transverse and longitudinal cracks throughout the deck and severe potholes with exposed portions of the concrete bridge deck. The sidewalks on the approaches have settled and are uneven. Voids under the sidewalks on the approaches have been filled with concrete grout. There are areas of severe concrete disintegration along the curbs. The sidewalks over the bridge are in poor condition. The north sidewalk is sloping off the structure to the north and the south sidewalk is sloping off the structure to the south. There are longitudinal cracks in the north and south sidewalks indicating rotation of both sidewalks. Asphalt and concrete patch repairs have been completed on sections of the south sidewalk. However, there are light to medium delaminations and spalls on the south sidewalk. As a result of the settlement on the approaches, there are steep sidewalks connecting the bridge sidewalk to the approach sidewalk which may limit pedestrian accessibility over the bridge. The steel pedestrian railings over the bridge are in poor condition and are leaning outwards. The connections at the base of the pedestrian rail posts are deformed due to crevice corrosion and several of the connections are loose. The through-plate girders above the bridge deck are in poor condition. There is severe corrosion and section loss of the through-plate girders along the sidewalks and curbs. There is an area of severe corrosion and web perforation (approx. 600mm long and up to 25mm wide) at the curb line of the south girder of the west span near the west column. Other areas along the curb line indicate severe corrosion of the web. However, the full extent of deterioration is not visible. Several of the stiffeners are perforated at the sidewalk level. There is severe crevice corrosion between the built-up plates that has warped the plates and caused several rivets to fail. The east end of the south through-plate girder has rotated to the west. The connection between the top of the north west column and the west span north through-plate girder is beginning to separate (25mm) and has caused several rivets to fail. These rivets have been replaced with bolts. The longitudinal through-plate girders below the bridge deck are in poor condition with areas of severe corrosion and significant loss of cross-sectional area and loss of rivet heads at the abutments. There is severe section loss and perforations through the bottom flange next to all the bearings. The transverse 'I' beam girders of the bridge deck have been filled with concrete. Only the bottom flanges could be inspected. The bottom flanges of the transverse deck beams are generally in fair condition, with areas of severe corrosion at the connections with the through-plate girders. The steel piers are generally in fair condition. There are areas of severe corrosion at the gusset plates at the bases of the columns. The gusset plates connecting the lateral cross bracing have buckled likely due to deformation from severe crevice corrosion. The abutment walls and wingwalls are in poor condition with areas of severe cracking and concrete disintegration. At the east abutment there is a wide vertical crack with severe spalling next to the south girder. There is a void in the roadway and ballast wall at this location. At the west abutment a temporary support has been installed under the second transverse girder from the west. Concrete patch repairs have been completed next to the temporary support. There is severe leakage through the bridge deck as evident on the abutment walls. The bridge deck soffit is in very poor condition with extensive areas of severe spalling with exposed corroding reinforcing steel, delaminations, and leakage.

Recommendation

We recommend completing an updated load capacity evaluation (LCE) NOW. Based on the poor roadway geometry and the level of deterioration throughout the structure, we recommend scheduling the structure for replacement NOW. We recommend inspecting the structure every six months for further evidence of deterioration and loss of load carrying capacity.
Notify Rail Company that the bridge is their responsibility.

Recommended Rehabilitation

RSL - Replace Bridge same location of other Components — LCE - Load Capacity Evaluation

Priority Rating	NOW	**Implementation Ranking**	High		
Estimated Total Cost	$9,010,000.00	**General Overall Condition**	Poor	**BCI**	42

Structure Name St. Paul West CNR Bridge

ID Number 081215

Classification ☑ Bridge ☐ Culvert ☑ Structure ☐ Municipal

Location 081 St. Paul Street West, 0.50 km E of 072 Louth Street

Recommended Rehabilitation

RSL - Replace Bridge same location of other Components LCE - Load Capacity Evaluation

Engineering Cost

Engineering		$1,000,000.00
LCE		$10,000.00
	Sub Total	$1,010,000.00

Construction Cost

RSL		$8,000,000.00
		$0.00
		$0.00
		$0.00
		$0.00
	Sub Total	$8,000,000.00
	Total	$9,010,000.00

St. Paul West CNR Bridge

081215

Photograph No. 1: 0530: South elevation

Photograph No. 2: 0465: Very severe concrete spalling on bridge deck soffit.

St. Paul West CNR Bridge

081215

Photograph No. 3: 0430: Perforation in the through-plate girder web

Photograph No. 4: 0541: Section loss of the bottom flange of the through plate girder at the south east bearing

LOAD CAPACITY EVALUATION OF
ST. PAUL STREET WEST CNR BRIDGE
(STRUCTURE NO. 081215)
IN THE CITY OF ST. CATHARINES
MILE 11.68 GRIMSBY SUBDIVISION

November 2018

ELLIS Engineering Inc.
214 Martindale Road, Suite 201
St. Catharines, Ontario, L2S 0B2
Phone: (905) 934-9049
www.ellis.on.ca

THE REGIONAL MUNICIPALITY OF NIAGARA

LOAD CAPACITY EVALUATION OF
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November 23, 2018

The Regional Municipality of Niagara
1815 Sir Isaac Brock Way
Thorold, Ontario
L2V 4T7

Attention: **Mr. Frank Tassone, C.E.T.**
Associate Director, Transportation Engineering

Reference: **Load Capacity Evaluation (LCE) for the St. Paul Street West CNR Bridge, Region Structure No. 081215, Mile 11.68 Grimsby Subdivision. Our File No.: 848.**

We are pleased to submit a copy of the load capacity evaluation for the St. Paul Street West CNR Bridge (Structure No. 081215), conducted in accordance with the Canadian Highway Bridge Design Code (CHBDC CAN/CSA-S6-14). The report reviews the present condition of the existing three-span concrete slab on steel girder bridge.

The primary task was to determine the load carrying capacity of the structure, in view of posting a revised load limit. To accomplish this task, work included a visual inspection of the bridge to confirm structural dimensions and the effects of deterioration, and a structural analysis using load factors for evaluation. The conclusive results of the inspection and load capacity evaluation (LCE) are included in this report.

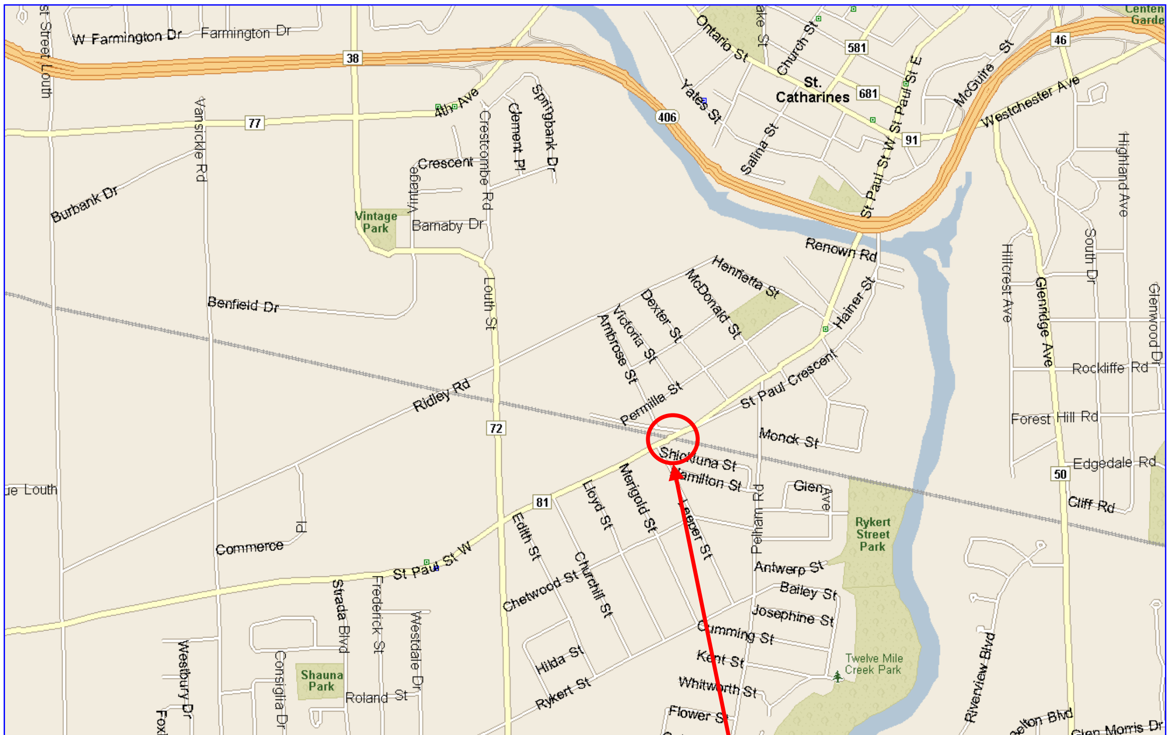
We thank you for giving us the opportunity to provide our services for this project. Should you have any questions concerning the report, please contact the undersigned.

Yours truly,
ELLIS Engineering Inc.

Duane VanGeest, P.Eng.
ELLIS Engineering Inc.

Darryl Bakker, E.I.T.
ELLIS Engineering Inc.

SITE LOCATION – KEY PLAN



St. Paul Street West CNR Bridge
Structure No. 081215
Mile 11.68 Grimsby Subdivision

EXECUTIVE SUMMARY

The St. Paul Street West CNR Bridge, constructed circa 1922, is a two lane, three-span concrete slab on steel girder structure. The structure crosses over the CNR rail tracks at Mile 11.68 Grimsby Subdivision. The bridge is located in the City of St. Catharines, on St. Paul Street West between Great Western Street and Shickluna Street.

The existing bridge is in poor condition and has a triple load limit posting of 15, 30, and 40 tonnes. There is also a posted speed warning sign of 20km/hr at the bridge as the approach roadways are very steep, limiting the sight lines over the bridge.

A visual inspection of the structure was completed on September 11, 2018 to verify the bridge geometry and dimensions on the existing drawings, to determine the effects of deterioration, and to identify components with poor service performance.

A load capacity evaluation was conducted in accordance with the Canadian Highway Bridge Design Code. The load capacity evaluation results in a triple load posting of 16, 26, and 38 tonnes. As the findings of the structural analysis are similar to the current load posting, we recommend maintaining the current load posting of 15, 30, and 40 tonnes.

There are no immediate concerns with fatigue-prone areas on the bridge.

Due to severe deterioration and section loss, we recommend inspecting the structure for further deterioration and displacements every six months until the structure is replaced. The structural steel shall be checked for any increase in section loss or perforations, particularly at the bottom flanges and the webs of the main girders. If further deterioration is found, an updated load capacity evaluation may be required.

We agree with the 2017 inspection report that, due to the deteriorated state of the bridge and poor roadway geometry, the structure should be replaced NOW.

1. INTRODUCTION

1.1 Brief Description of the Bridge

The existing concrete slab on steel girder structure was built circa 1922. The three-span, two lane bridge spans over the CNR rail tracks at Mile 11.68 Grimsby Subdivision. The bridge is located on St. Paul Street West between Great Western Street and Shickluna Street in the City of St. Catharines.

The existing bridge is 13.9m wide and 41.5m long with span lengths of 14.8m, 17.4m, and 9.3m. The superstructure consists of two longitudinal steel through-plate girders, supporting transverse steel stringers, a reinforced concrete deck, and two reinforced concrete sidewalks. The transverse steel stringers are encased in concrete. The substructure consists of concrete abutments and structural steel piers. The bridge has a skew of approximately 51°.

As per the 1977 rehabilitation drawings, work was done on the structure including:

- Full depth replacement of portions of the reinforced concrete bridge deck;
- Replacement of concrete on portions of the transverse stringers;
- Replacement of both reinforced concrete sidewalks;
- Repairs to the north end of the east abutment;
- Waterproofing and asphalt paving;
- Removal of stairs and construction of a new reinforced concrete retaining wall at the northwest corner.

In 2015, a temporary support was installed at the west abutment to support one of the transverse stringers, where there was an area of severe concrete deterioration.

A portion of the original 1922 construction drawings and the 1977 rehabilitation drawings were available, and are included in Appendix ‘D’. There are no available drawings of the main girders and there is evidence that the girders may have been salvaged from a previous structure.

Currently, the structure is posted with a triple load limit of 15, 30, and 40 tonnes on both approaches. This posting was installed between 2011 and 2013. This posting is based on a load capacity evaluation completed by CNR. However, CNR has not provided this report to the Niagara Region.

There is a 20km/h posted warning speed at the bridge as the approaches have steep grades (7.3% and 7.74%) which limit visibility.

There is a board order for this structure, outlining the agreements between the railway company and the local municipalities.

2. INSPECTION

2.1 Verification of Bridge Drawings

It appears that the structure was generally constructed as per the original 1922 drawings and rehabilitated as per the 1977 rehabilitation drawings. Drawings of the main girders were not available, and the girders were therefore measured on site. There are conflicting details on the original drawings for the steel overhang supports. The dimensions of the steel supports were measured on site. The configuration of the pier cross-bracing is different from what is shown on the drawings. The true cross-bracing configuration was measured and used in the analysis.

2.2 Effects of Deterioration

We have reviewed the "2017 Municipal Bridge Appraisal, Rehabilitation/Replacement Needs" report (2017, ELLIS Engineering Inc.). According to the report, the bridge is in poor condition. The inspection report recommended that the structure be replaced NOW.

We completed a visual inspection of the structure on September 11, 2018 to quantify the extent of deterioration and areas of structural concern. Several structural components could not be fully inspected due to limited access over the railway and due to concrete encasement. Photographs showing the effects of deterioration throughout the structure are included in Appendix 'A'.

<u>Roadway and Sidewalks</u>

The approaches to the structure are steep and there is poor visibility over the structure. The asphalt roadway on the approaches is in fair condition with areas of wide transverse cracking and isolated areas of alligator cracking and settlement. The asphalt roadway over the structure is in poor condition with wide transverse and longitudinal cracks throughout the deck and severe potholes with exposed portions of the concrete bridge deck.

The sidewalks on the approaches have settled and are uneven. There are areas of severe concrete disintegration along the curbs. The sidewalks over the bridge are in poor condition. The north sidewalk is sloping off the structure to the north and the south sidewalk is sloping off the structure to the south. There are longitudinal cracks in the north and south sidewalks indicating rotation of both sidewalks. Asphalt and concrete patch repairs have been completed on sections of the south sidewalk. However, there are light to medium delaminations and spalls on the south sidewalk. As a result of the settlement on the approaches, there are steep sidewalks connecting the bridge sidewalk to the approach sidewalk which may limit pedestrian accessibility over the bridge.

The steel pedestrian railings over the bridge are in poor condition and are leaning outwards. The connections at the base of the pedestrian rail posts are deformed due to crevice corrosion and several of the connections are loose.

Steel Through-Plate Girders

The main steel through-plate girders above the bridge deck are in poor condition. There is severe corrosion and section loss of the webs along the sidewalks and curbs. There is an area of severe corrosion and web perforation (approximately 600mm long and up to 25mm wide) at the curb line of the south girder of the west span near the west column. Several of the stiffeners are perforated at the sidewalk level. There is severe crevice corrosion between the built-up flange plates that has warped the plates and caused several rivets to fail. The east end of the south through-plate girder has rotated to the west.

The connection between the top of the northwest pier column and the west span north through-plate girder is beginning to separate (25mm) and has caused several rivets to fail. These rivets have been replaced with bolts.

The longitudinal through-plate girders below the bridge deck are in poor condition with areas of severe corrosion and significant loss of cross-sectional area and loss of rivet heads at the abutments. There is severe section loss and perforations through the bottom flange next to all the bearings.

Transverse Stringers

The transverse 'I' beam stringers of the bridge deck have been filled with concrete. Only the bottom flanges could be inspected. The bottom flanges of the transverse stringers are generally in fair condition, with areas of severe corrosion at the connections with the through-plate girders.

Substructure

The steel piers are generally in fair condition. There are areas of severe corrosion at the gusset plates at the bases of the columns. The gusset plates connecting the lateral cross bracing have buckled likely due to deformation from severe crevice corrosion.

The abutment walls and wingwalls are in poor condition with areas of severe cracking and concrete disintegration. At the east abutment there is a wide vertical crack with severe spalling next to the south girder. There is a void in the roadway and ballast wall at this location.

At the west abutment a temporary support has been installed under the second transverse stringer from the west. Concrete patch repairs have been completed next to the temporary support.

Bridge Deck Soffit

The bridge deck soffit is in very poor condition with extensive areas of severe spalling with exposed corroding reinforcing steel, delaminations, and leakage. There is severe leakage through the bridge deck as evident on the abutment walls.

3. LOAD CAPACITY EVALUATION

3.1 Structural Evaluation

The load capacity evaluation was conducted in accordance with the Canadian Highway Bridge Design Code (CHBDC, CAN/CSA-S6-14). The unbraced lengths of the main girders were evaluated considering U-Frame action described in the British Standard BS 5400-3 “Steel, concrete and composite bridges.”

The structural analysis was performed utilizing hand calculations and S-FRAME, a structural finite element analysis program. The live load capacity factors and the load limit postings were then calculated based on the results of the analysis.

S-CALC, a section properties calculator program, was used to determine the section properties of the structural steel members. A report of the section properties is included in Appendix ‘C’.

The remaining fatigue life evaluation was performed utilizing hand calculations from the CHBDC. The following AADT values were used for the evaluation: 7950 (1992), 9300 (2013), and 9200 (2016). For the evaluation, the ADTT was 10% of the AADT for all years of the structure’s life.

3.1.1 Material Properties

The following material properties were used for the load capacity evaluation:

<u>Structural Steel</u>

- Bridge Constructed Prior to 1905 (CHBDC Table 14.1) (Used for main girders)
  - Specified Yield Strength of Original Structural Steel, F_y = 180 MPa
  - Specified Ultimate Strength of Original Structural Steel, F_u = 360 MPa

- Bridge Constructed Between 1905 and 1932 (CHBDC Table 14.1) (Used for remaining steel)
  - Specified Yield Strength of Original Structural Steel, F_y = 210 MPa
  - Specified Ultimate Strength of Original Structural Steel, F_u = 420 MPa

<u>Concrete</u>

- Specified Compressive Strength of Reinforced Concrete Deck = 20 MPa (CHBDC Clause 14.7.4.3)

<u>Reinforcing Steel</u>

- Specified Yield Strength of Deck Reinforcing Steel = 230 MPa (CHBDC Table 14.2, bridge constructed circa 1922)

3.1.2 Loads

The transitory (live) loads used were Level 1 Evaluation Loads (CL1-625-ONT Truck), Level 2 Evaluation Loads (CL2-625-ONT Truck) and Level 3 Evaluation Loads (CL3-625-ONT Truck) for a Class 'A' Highway.

The following dead loads are applicable:

- Bridge deck concrete (200mm thick);
- Structural steel self-weight;
- Asphalt (90mm thickness).

3.1.3 Finite Element Analysis

Several finite element models of the bridge were developed in S-FRAME for analysis. In general, two types of S-FRAME models were generated. The first type was a beam model, where each member was modelled as a beam. The second type was a mesh model, where the longitudinal main girders, stringers, and concrete deck were modelled with shell elements.

A screenshot of the south side of the beam model is shown in Figure 1.

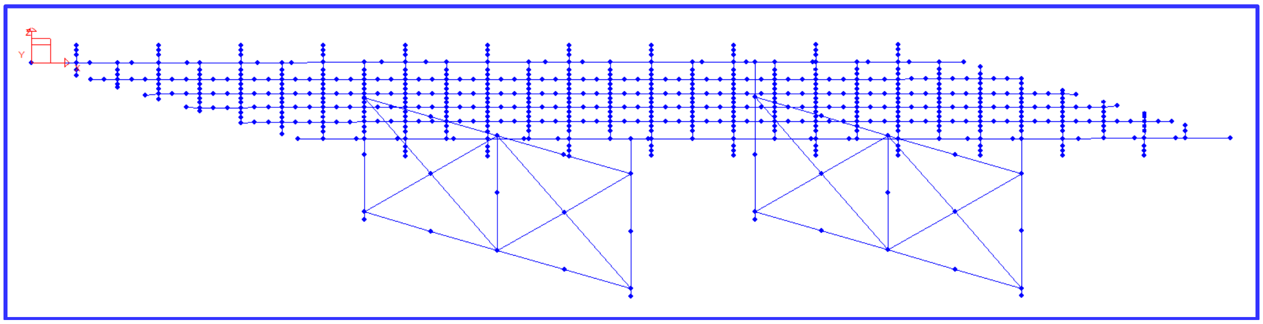


Figure 1: Finite Element Beam Model

A screenshot of the south side of the mesh model is shown in Figure 2.

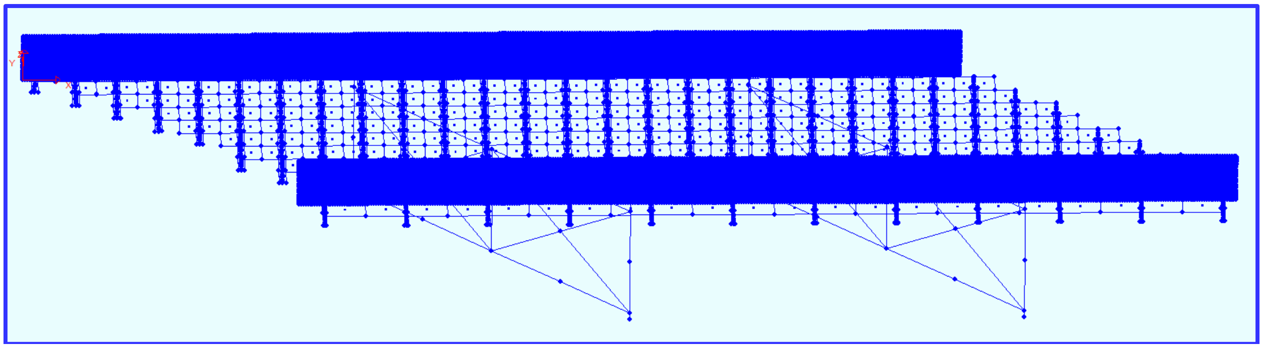


Figure 2: Finite Element Mesh Model

Additional screenshots of the S-FRAME finite element models are included in Appendix 'B'.

With the beam model, various end conditions of the main girders were investigated (pinned and fixed). It was also assumed that the compression flanges of the main girders were laterally restrained by U-frame behaviour of the web stiffeners and transverse stringers (British Standard – Steel, concrete and composite bridges - BS 5400-3).

The mesh model was used to analyze the stresses in the girders at critical locations and to confirm the results of the beam model. The mesh model was also used to investigate the effects of web perforations on the stresses within the girders.

The girders and transverse stringers were analyzed for maximum bending moment and shear. The pier columns were analyzed for axial compression and bending moment. The concrete deck was analyzed for punching shear.

A section loss of 20% was assumed for all structural steel elements to represent the effects of deterioration.

3.2 Structural Capacity

The live load capacity factors, summarized in Table 1, were determined using the properties of the deteriorated members as measured on site (September 2018).

The live load capacity factors for the deteriorated structural elements at Evaluation Level 1 are included in Table 1.

Table 1: Live Load Capacity Factors, F, at Evaluation Level 1

Member	Live Load Capacity Factor, F	Governing Load Effect
Main Girder, East Span	2.69	Bending Moment
Main Girder, Centre Span	2.72	Shear
Main Girder, West Span	**0.62**	Bending Moment
Stringers	1.88	Bending Moment
Sidewalk Overhangs	>>1	Bending Moment
Deck	1.98	Punching Shear
Piers	1.92	Axial Compression

The live load capacity factor for the main girders at the west span governs with a value of 0.62 at Evaluation Level 1. The same location governs for Evaluation Level 2 and Evaluation Level 3, with live load capacity factors of 0.61 and 0.69, respectively.

The live load capacity factors are sensitive to the effective length of the main girders, as the girder moment capacity is governed by lateral torsional buckling. U-frame behaviour of the main girders was assumed in order to obtain effective lengths that are representative for each span.

The structural steel girders were checked with the properties of steel fabricated prior to 1905 and of steel fabricated between 1905 and 1932. The different steel properties produce the same live load capacity factor at the critical location for the governing member (Main Girder, West Span).

From the finite element beam model, the location of the governing bending moment was found in the west span near the west abutment. This location was investigated further with the finite element mesh model, where the stresses in the webs and flanges were further analyzed.

From the results of this analysis, it was determined that there is a high stress concentration at the bottom of the main girder web near the west abutment from combined dead loads and live loads. However, the stresses at this location were determined to be less than the yield strength of the steel. The stresses at this location are shown in Figure 3.

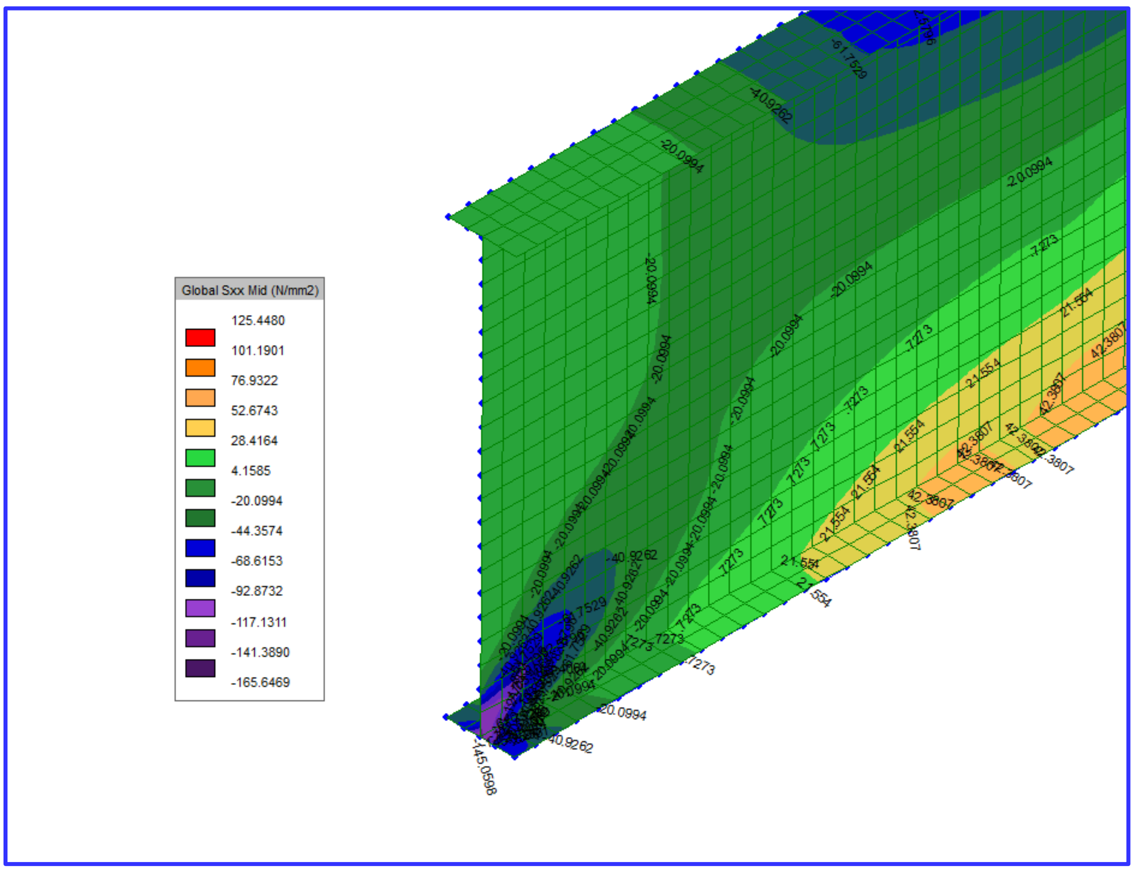


Figure 3: ULS Stresses in South Girder at West Abutment

The finite element mesh model confirmed the results of the finite element beam model. By modelling and analyzing the web perforations in the finite element mesh model, it was determined that there is no significant reduction in the structural capacity of the girders at the locations of the web perforations. However, any significant increase in the size or number of perforations may require re-analysis of the girders.

The riveted connections of the girders to the pier columns were analyzed for live load capacity. It was determined that the rivets at the top of the connection do not have sufficient structural capacity to carry live loads. This confirms the observations from the site inspection, where the top rivets of the northwest column have failed and the west span north through-plate girder is beginning to separate (Appendix 'A', Photograph 3). The failed rivets at this location have been replaced with bolts.

Due to the deterioration of the structure, the governing live load capacity factor is 0.62 and the following triple load limit posting is required:

- Level 3 – 16 tonnes. (Single Unit Vehicles)
- Level 2 – 26 tonnes. (Two Unit Vehicles - Tractor-trailer, Semi-trailer or Single Unit Vehicle-trailer)
- Level 1 – 38 tonnes. (Vehicle Trains - Tractor with more than one trailer)

The current load posting of 15, 30, and 40 tonnes is similar to the results from this load capacity evaluation.

The concrete deck was analyzed for punching shear in accordance with the bridge code. No immediate concerns were found for live load punching through the deck. However, with the severe spalling of the underside of the concrete deck, continued deterioration may result in small holes developing in the deck.

3.3 Remaining Fatigue Life

An evaluation of the remaining fatigue life was completed on areas of the bridge with fatigue-prone details. These areas include the riveted connections of the built-up steel plate girders and the riveted connections between the stringers and the girders.

From the evaluation, it was determined that the riveted connections between the stringers and the girders are the most critical for fatigue. The remaining fatigue life of these connections is approximately 20-30 years. However, this greatly exceeds the expected residual life of the bridge.

4. CONCLUSION & RECOMMENDATIONS

The results of our analysis conclude that the main girders are the most over-utilized members with governing live load capacity factors of 0.62, 0.61, and 0.69 at Evaluation Level 1, Evaluation Level 2, and Evaluation Level 3, respectively.

The load capacity evaluation results in a triple load posting of 16, 26, and 38 tonnes. As the findings of the structural analysis are similar to the current load posting, we recommend maintaining the current load posting of 15, 30, and 40 tonnes.

There are no immediate concerns with fatigue-prone areas on the bridge.

Due to severe deterioration and section loss, we recommend inspecting the structure for further deterioration and displacements every six months until the structure is replaced. The structural steel shall be checked for any increase in section loss or perforations, particularly at the bottom flanges and the webs of the main girders. The concrete deck shall be inspected for punch holes. If further deterioration is found, an updated load capacity evaluation may be required.

We agree with the 2017 inspection report that, due to the deteriorated state of the bridge and poor roadway geometry, the structure should be replaced NOW.

THE REGIONAL MUNICIPALITY OF NIAGARA

LOAD CAPACITY EVALUATION OF
ST. PAUL STREET WEST CNR BRIDGE
(STRUCTURE NO. 081215)
IN THE CITY OF ST. CATHARINES
MILE 11.68 GRIMSBY SUBDIVISION

APPENDIX ‘A’

Photographs (No. 1-6)

Photograph 1 – East end of the north through-plate girder

Photograph 2 – Perforations through the web of the south through-plate girder

Photograph 3 – Failed rivets and separation of girder at northwest pier column

Photograph 4 – Underside of structure looking southwest

Photograph 5 – Severe corrosion on underside of main girder bottom flanges

Photograph 6 – Deterioration in concrete bridge deck soffit (typical)

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LOAD CAPACITY EVALUATION OF
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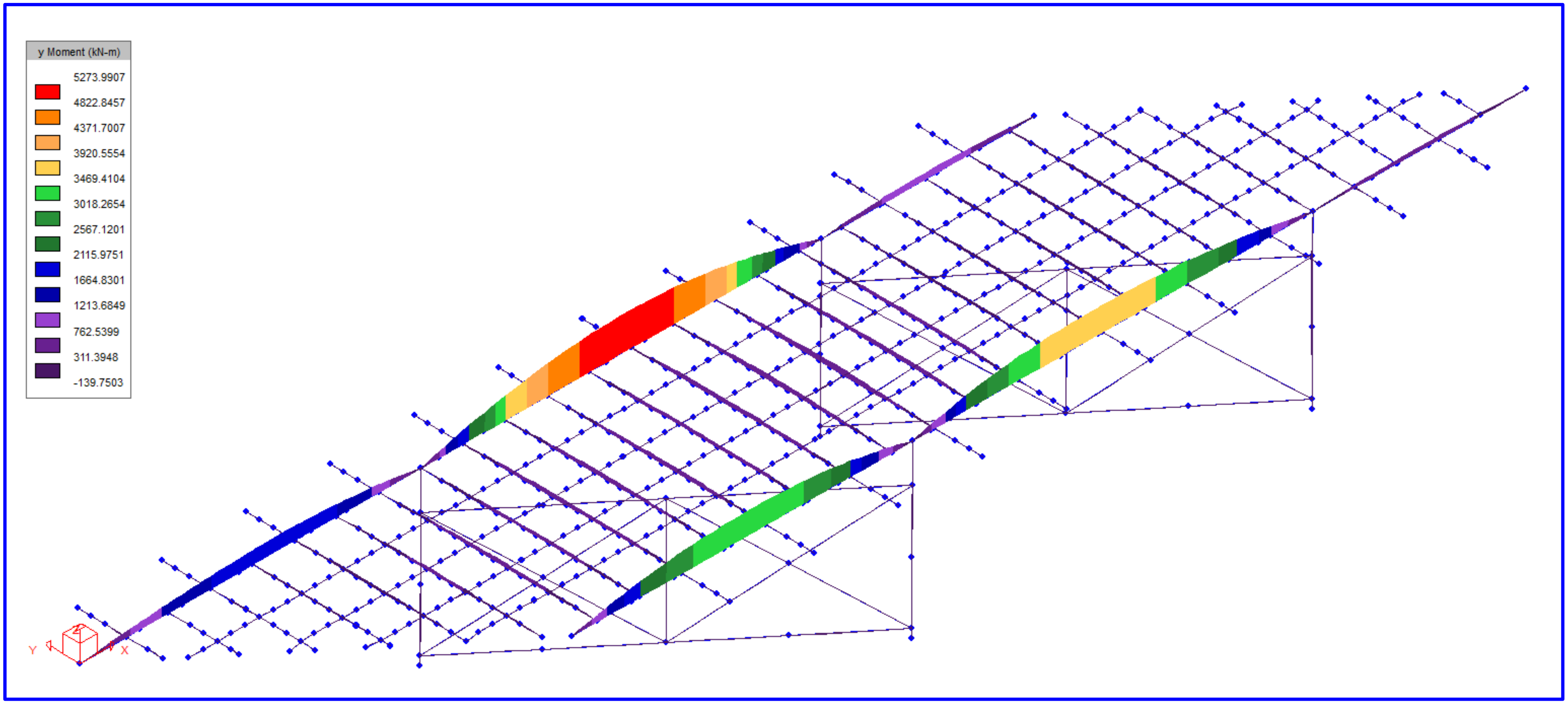
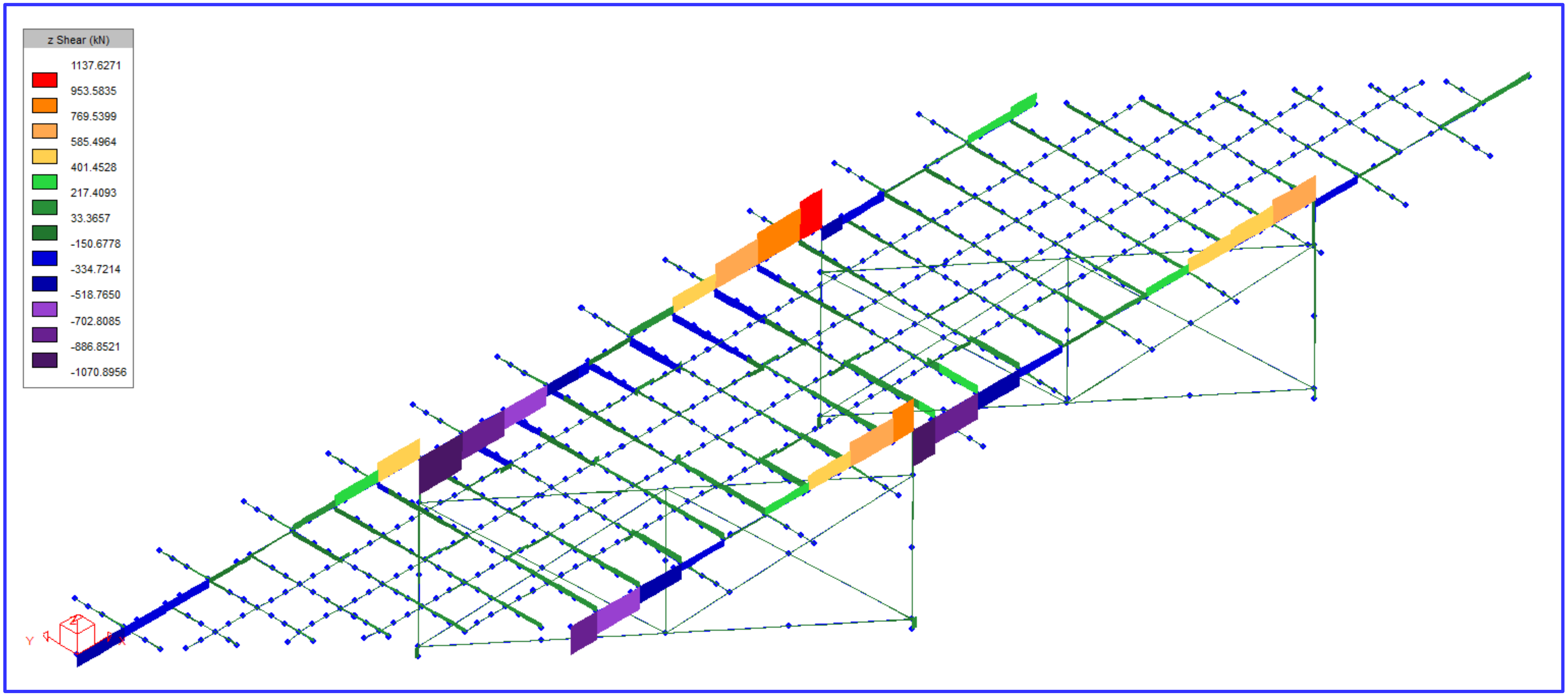
APPENDIX 'B'

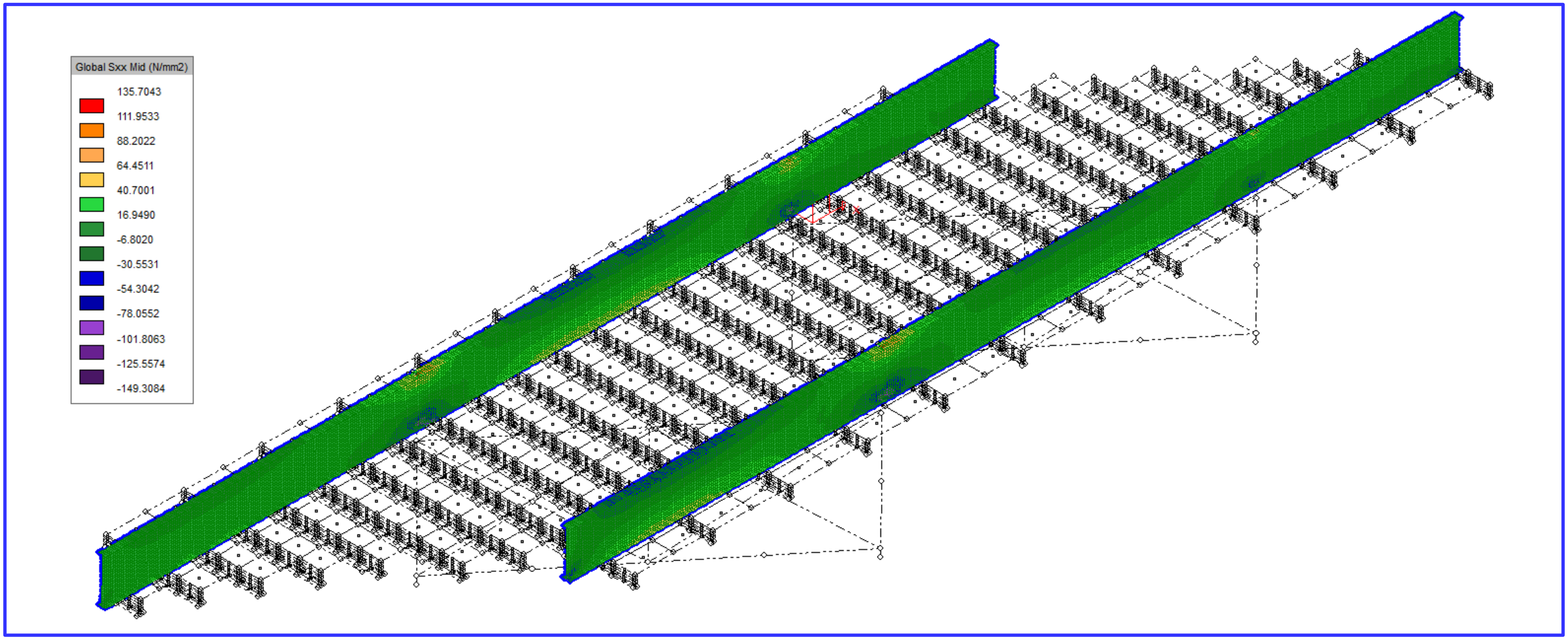
S-FRAME Finite Element Model Screenshots



Screenshot 1 – ULS Total Bending Moments on Finite Element Beam Model



Screenshot 2 – ULS Total Shear on Finite Element Beam Model



Screenshot 3 – SLS Stresses on Main Girders in the Finite Element Mesh Model

THE REGIONAL MUNICIPALITY OF NIAGARA

LOAD CAPACITY EVALUATION OF
ST. PAUL STREET WEST CNR BRIDGE
(STRUCTURE NO. 081215)
IN THE CITY OF ST. CATHARINES
MILE 11.68 GRIMSBY SUBDIVISION

APPENDIX 'C'

Structural Steel Section Properties Report

St. Paul Street West CNR Bridge LCE

Section Properties

Load Capacity Evaluation

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Table Of Contents

Checked By: DV

Sections - 1

ID	Name	Geometric Perimeter (mm)	Geometric Area (A) (mm^2)	Geometric Mass (kg/m)	Geometric Elastic Neutral Axis Centroid Offset (Bottom Left Corner) X (mm)
1	Stringer (26"x150lb/ft)	2,507.996	2.8332e+4	1.5443e+9	152.4
4	Overhang (20"x65lb/ft)	1,600.2	1.2161e+4	6.6286e+8	76.2
5	Pier Column (14.5"x130.5lb/ft)	2,141.22	2.4761e+4	1.3497e+9	179.832
6	Pier Diagonal (2-L6"x4"x3/8")	1,004.644	4,737.8938	2.5825e+8	114.3039
7	Pier Strut (2-C12"x25lb/ft)	1,776.9288	9,596.5305	5.2308e+8	114.3039
11	Main Girder (15" x 1 Plate)	8,270.388	4.9355e+4	2.6902e+9	190.5
12	Main Girder (15" x 2 Plates)	9,832.488	5.6613e+4	3.0858e+9	190.5
13	Main Girder (15" x 3 Plates)	1.1395e+4	6.3871e+4	3.4814e+9	190.5
14	Main Girder (15" x 4 Plates)	1.2957e+4	7.1129e+4	3.8770e+9	190.5
15	Main Girder (13" x 1 Plate)	7,355.988	4.0151e+4	2.1885e+9	165.1
16	Main Girder (13" x 2 Plates)	8,714.888	4.6441e+4	2.5314e+9	165.1
17	Main Girder (13" x 3 Plates)	1.0074e+4	5.2732e+4	2.8743e+9	165.1
18	Main Girder (13" x 4 Plates)	1.1433e+4	5.9022e+4	3.2171e+9	165.1
19	Main Girder (13" x 5 Plates)	1.2792e+4	6.5312e+4	3.5600e+9	165.1

Sections - 2

Geometric Elastic Neutral Axis Centroid Offset (Bottom Left Corner) Y (mm)	Geometric Elastic Neutral Axis Moment of Inertia X (Ix) (mm^4)	Geometric Elastic Neutral Axis Moment of Inertia Y (Iy) (mm^4)	Geometric Elastic Neutral Axis Product Of Inertia (Ixy) (mm^4)	Geometric Elastic Neutral Axis Radius of Gyration X (Rx) (mm)
330.2	2.1461e+9	1.4535e+8	0	275.2266
254	4.7825e+8	1.2135e+7	0	198.3095
184.15	6.1057e+8	2.0939e+8	0	157.0298
103.7292	1.1320e+7	4.2985e+7	0	48.8792
152.4	1.2288e+8	9.1910e+7	0	113.1557
1,076.325	3.4384e+10	1.5723e+8	0	834.6719
1,085.85	4.2867e+10	2.4502e+8	0	870.1726
1,095.375	5.1500e+10	3.3282e+8	0	897.9526
1,104.9	6.0285e+10	4.2062e+8	0	920.6207
1,076.325	2.4904e+10	8.2948e+7	0	787.5657
1,085.85	3.2256e+10	1.4010e+8	0	833.3976
1,095.375	3.9738e+10	1.9726e+8	0	868.0937
1,104.9	4.7351e+10	2.5441e+8	0	895.6909
1,114.425	5.5097e+10	3.1156e+8	0	918.471

Sections - 3

Geometric Elastic Neutral Axis Radius of Gyration Y (Ry) (mm)	Geometric Elastic Neutral Axis Section Modulus Bottom X (Sx) (mm^3)	Geometric Elastic Neutral Axis Section Modulus X (Sx) (mm^3)	Geometric Elastic Neutral Axis Section Modulus Y (Sy) (mm^3)	Principal Theta (deg)	Principal Moment of Inertia Major (mm^4)	Principal Moment of Inertia Minor (mm^4)
71.6266		6.4994e+6	9.5375e+5	0	2.1771e+9	1.3094e+8
31.5886		1.8829e+6	1.5925e+5	0	4.8991e+8	1.0700e+7
91.9579		3.3156e+6	1.1643e+6	0	6.1979e+8	2.0316e+8
95.2497	1.0913e+5	2.3258e+5	3.7605e+5	-90	4.2985e+7	1.1320e+7
97.8643		8.0627e+5	8.0408e+5	0	1.2288e+8	9.1910e+7

Checked By: DV

Sections - 3

Geometric Elastic Neutral Axis Radius of Gyration Y (Ry) (mm)	Geometric Elastic Neutral Axis Section Modulus Bottom X (Sx) (mm^3)	Geometric Elastic Neutral Axis Section Modulus X (Sx) (mm^3)	Geometric Elastic Neutral Axis Section Modulus Y (Sy) (mm^3)	Principal Theta (deg)	Principal Moment of Inertia Major (mm^4)	Principal Moment of Inertia Minor (mm^4)
56.4412		3.1946e+7	8.2533e+5	0	3.4384e+10	1.5723e+8
65.788		3.9478e+7	1.2862e+6	0	4.2867e+10	2.4502e+8
72.1864		4.7016e+7	1.7471e+6	0	5.1500e+10	3.3282e+8
76.8994		5.4561e+7	2.2080e+6	0	6.0285e+10	4.2062e+8
45.4522		2.3138e+7	5.0241e+5	0	2.4904e+10	8.2948e+7
54.9249		2.9706e+7	8.4859e+5	0	3.2256e+10	1.4010e+8
61.1616		3.6278e+7	1.1948e+6	0	3.9738e+10	1.9726e+8
65.6538		4.2856e+7	1.5409e+6	0	4.7351e+10	2.5441e+8
69.0678		4.9440e+7	1.8871e+6	0	5.5097e+10	3.1156e+8

Sections - 4

Principal Radius of Gyration Major (Rxp) (mm)	Principal Radius of Gyration Minor (Ryp) (mm)	Principal Section Modulus Major Bottom (Sx) (mm^3)	Principal Section Modulus Major Top (Sx) (mm^3)	Principal Section Modulus Minor Left (Sy) (mm^3)	Principal Section Modulus Minor Right (Sy) (mm^3)
275.263	67.5054	6.5933e+6	6.5933e+6	8.5917e+5	8.5917e+5
198.7342	29.3695	1.9288e+6	1.9288e+6	1.4041e+5	1.4041e+5
156.9147	89.8373	3.3657e+6	3.3657e+6	1.1297e+6	1.1297e+6
95.2497	48.8792	3.7605e+5	3.7605e+5	2.3258e+5	1.0913e+5
113.1557	97.8643	8.0627e+5	8.0627e+5	8.0408e+5	8.0408e+5
834.6719	56.4412	3.1946e+7	3.1946e+7	8.2533e+5	8.2533e+5
870.1726	65.788	3.9478e+7	3.9478e+7	1.2862e+6	1.2862e+6
897.9526	72.1864	4.7016e+7	4.7016e+7	1.7471e+6	1.7471e+6
920.6207	76.8994	5.4561e+7	5.4561e+7	2.2080e+6	2.2080e+6
787.5657	45.4522	2.3138e+7	2.3138e+7	5.0241e+5	5.0241e+5
833.3976	54.9249	2.9706e+7	2.9706e+7	8.4859e+5	8.4859e+5
868.0937	61.1616	3.6278e+7	3.6278e+7	1.1948e+6	1.1948e+6
895.6909	65.6538	4.2856e+7	4.2856e+7	1.5409e+6	1.5409e+6
918.471	69.0678	4.9440e+7	4.9440e+7	1.8871e+6	1.8871e+6

Sections - 5

Principal Plastic Section Modulus X (Zx) (mm^3)	Principal Plastic Section Modulus Y (Zy) (mm^3)	Plastic Centroid Offset (Elastic Neutral Axis) X (mm)	Plastic Centroid Offset (Elastic Neutral Axis) Y (mm)
7.4491e+6	1.3818e+6	0	0
2.2645e+6	2.4088e+5	0	0
3.7946e+6	1.7402e+6	0	0
4.2926e+5	1.9687e+5	0	20.628
9.8144e+5	9.1510e+5	0	0
3.7595e+7	1.5102e+6	0	0
4.5442e+7	2.2015e+6	0	0
5.3358e+7	2.8928e+6	0	0
6.1342e+7	3.5841e+6	0	0
2.8268e+7	9.1628e+5	0	0
3.5068e+7	1.4355e+6	0	0

Checked By: DV

Sections - 5			
Principal Plastic Section Modulus X (Zx) (mm^3)	Principal Plastic Section Modulus Y (Zy) (mm^3)	Plastic Centroid Offset (Elastic Neutral Axis) X (mm)	Plastic Centroid Offset (Elastic Neutral Axis) Y (mm)
4.1928e+7	1.9548e+6	0	0
4.8848e+7	2.4741e+6	0	0
5.5829e+7	2.9933e+6	0	0

Sections - 6					
Plastic Section Modulus X (Zx) (mm^3)	Plastic Section Modulus Y (Zy) (mm^3)	Polar Source	Polar Moment of Inertia (mm^4)	Polar Radius of Gyration (mm)	Shear Center Centroid Offset (Elastic Neutral Axis) X (Xo) (mm)
7.3372e+6	1.4670e+6	Polygon	2.3081e+9	283.4196	0
2.2112e+6	2.5614e+5	Polygon	5.0061e+8	200.8926	0
3.7331e+6	1.7682e+6	Polygon	8.2294e+8	180.812	0
1.9687e+5	4.2926e+5	Polygon	5.4304e+7	107.0592	
9.8144e+5	9.1510e+5	Polygon	2.1479e+8	149.6049	
3.7595e+7	1.5102e+6	Polygon	3.4542e+10	836.5781	
4.5442e+7	2.2015e+6	Polygon	4.3112e+10	872.656	
5.3358e+7	2.8928e+6	Polygon	5.1833e+10	900.8495	
6.1342e+7	3.5841e+6	Polygon	6.0705e+10	923.8268	
2.8268e+7	9.1628e+5	Polygon	2.4987e+10	788.8762	
3.5068e+7	1.4355e+6	Polygon	3.2396e+10	835.2056	
4.1928e+7	1.9548e+6	Polygon	3.9935e+10	870.2456	
4.8848e+7	2.4741e+6	Polygon	4.7606e+10	898.0939	
5.5829e+7	2.9933e+6	Polygon	5.5408e+10	921.0642	

Sections - 7					
Shear Center Centroid Offset (Elastic Neutral Axis) Y (Yo) (mm)	Shear Area Area X (Asx) (mm^2)	Shear Area Area Y (Asy) (mm^2)	Torsional Constant Torsional Constant (J) (mm^4)	Stress Points Source	Stress Points Top Left X (mm)
0	1.5624e+4	1.0568e+4	6.3815e+6	Closed Form Solution	-152.4
0	5,190.3122	6,451.6	1.1211e+6	Closed Form Solution	-76.2
0	1.6177e+4	6,267.7294	5.0326e+6	Closed Form Solution	-179.832
	1,935.48	2,903.22	1.4084e+5	Closed Form Solution	-39.9063
	3,943.347	5,992.2461	3.8429e+5	Closed Form Solution	-39.9063
	3.6371e+4	3.6371e+4	2.4652e+6	Closed Form Solution	-220.6625
	4.2419e+4	4.2419e+4	2.6812e+6	Closed Form Solution	-220.6625
	4.8468e+4	4.8468e+4	2.8972e+6	Closed Form Solution	-220.6625
	5.4516e+4	5.4516e+4	3.1133e+6	Closed Form Solution	-220.6625
	3.0645e+4	3.1855e+4	1.7768e+6	Closed Form Solution	-195.2625
	3.5887e+4	3.7097e+4	1.9636e+6	Closed Form Solution	-195.2625
	4.1129e+4	4.2339e+4	2.1503e+6	Closed Form Solution	-195.2625
	4.6371e+4	4.7581e+4	2.3371e+6	Closed Form Solution	-195.2625
	5.1613e+4	5.2822e+4	2.5239e+6	Closed Form Solution	-195.2625

Checked By: DV

Sections - 8							
Stress Points Top Left Y (mm)	Stress Points Top Right X (mm)	Stress Points Top Right Y (mm)	Stress Points Bottom Left X (mm)	Stress Points Bottom Left Y (mm)	Stress Points Bottom Right X (mm)	Stress Points Bottom Right Y (mm)	Reference Axis Properties Elastic Centroid Offset X (mm)
330.2	152.4	330.2	-152.4	-330.2	152.4	-330.2	0
254	76.2	254	-76.2	-254	76.2	-254	0
184.15	179.832	184.15	-179.832	-184.15	179.832	-184.15	0
-113.7959	188.7015	-113.7959	-39.9063	-266.1959	188.7015	-266.1959	74.3976
-113.7959	188.7015	-113.7959	-39.9063	-418.5959	188.7015	-418.5959	74.3976
879.475	160.3375	879.475	-220.6625	-1,273.175	160.3375	-1,273.175	-30.1625
889	160.3375	889	-220.6625	-1,282.7	160.3375	-1,282.7	-30.1625
898.525	160.3375	898.525	-220.6625	-1,292.225	160.3375	-1,292.225	-30.1625
908.05	160.3375	908.05	-220.6625	-1,301.75	160.3375	-1,301.75	-30.1625
879.475	134.9375	879.475	-195.2625	-1,273.175	134.9375	-1,273.175	-30.1625
889	134.9375	889	-195.2625	-1,282.7	134.9375	-1,282.7	-30.1625
898.525	134.9375	898.525	-195.2625	-1,292.225	134.9375	-1,292.225	-30.1625
908.05	134.9375	908.05	-195.2625	-1,301.75	134.9375	-1,301.75	-30.1625
917.575	134.9375	917.575	-195.2625	-1,311.275	134.9375	-1,311.275	-30.1625

Sections - 9				
Reference Axis Properties Elastic Centroid Offset Y (mm)	Reference Axis Properties Moment of Inertia X (Ix) (mm^4)	Reference Axis Properties Moment of Inertia Y (Iy) (mm^4)	Reference Axis Properties Radius of Gyration X (Rx) (mm)	Reference Axis Properties Radius of Gyration Y (Ry) (mm)
0	2.1461e+9	1.4535e+8	275.2266	71.6266
0	4.7825e+8	1.2135e+7	198.3095	31.5886
0	6.1057e+8	2.0939e+8	157.0298	91.9579
-162.4667	1.3638e+8	6.9209e+7	169.6603	120.8615
-266.1959	8.0289e+8	1.4503e+8	289.2481	122.9326
-196.85	3.6297e+10	2.0213e+8	857.5705	63.9952
-196.85	4.5061e+10	2.9653e+8	892.1605	72.3729
-196.85	5.3975e+10	3.9093e+8	919.2762	78.2346
-196.85	6.3041e+10	4.8533e+8	941.431	82.6032
-196.85	2.6460e+10	1.1948e+8	811.7941	54.5498
-196.85	3.4056e+10	1.8235e+8	856.3303	62.662
-196.85	4.1781e+10	2.4523e+8	890.1329	68.1947
-196.85	4.9638e+10	3.0811e+8	917.0671	72.2509
-196.85	5.7628e+10	3.7098e+8	939.329	75.3667

Sections - 10				
Analysis Factors Area	Analysis Factors Mass	Analysis Factors Moment of Inertia	Analysis Factors Shear Area	Analysis Factors Torsional Constant
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1

Checked By: DV

Sections - 10				
Analysis Factors Area	Analysis Factors Mass	Analysis Factors Moment of Inertia	Analysis Factors Shear Area	Analysis Factors Torsional Constant
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1

Checked By: DV

Materials - 1							
ID	Name	Youngs Modulus (MPa)	Shear Modulus (MPa)	Poisson's Ratio	Density (kg/m^3)	Strength (MPa)	Thermal Expansion Coeff. (/C*1.0E+6)
1	Steel	2.00e+5	75,842.33	0.318	7,849.047	344.738	11.7
2	Concrete	26,889.553	11,031.612	0.219	2,402.77	29.992	10.08
3	Timber	5,791.596	361.975	7	368.425	4.482	11.7
4	Iron	68,947.573	27,579.029	0.25	7,368.493	129.966	12
5	Aluminum	68,947.573	26,200.078	0.316	2,723.139	413.685	21.96

Materials - 2	
Max Aggregate Size (mm)	Cost ($/m^3)
	0.00
25.4	0.00
	0.00
	0.00
	0.00

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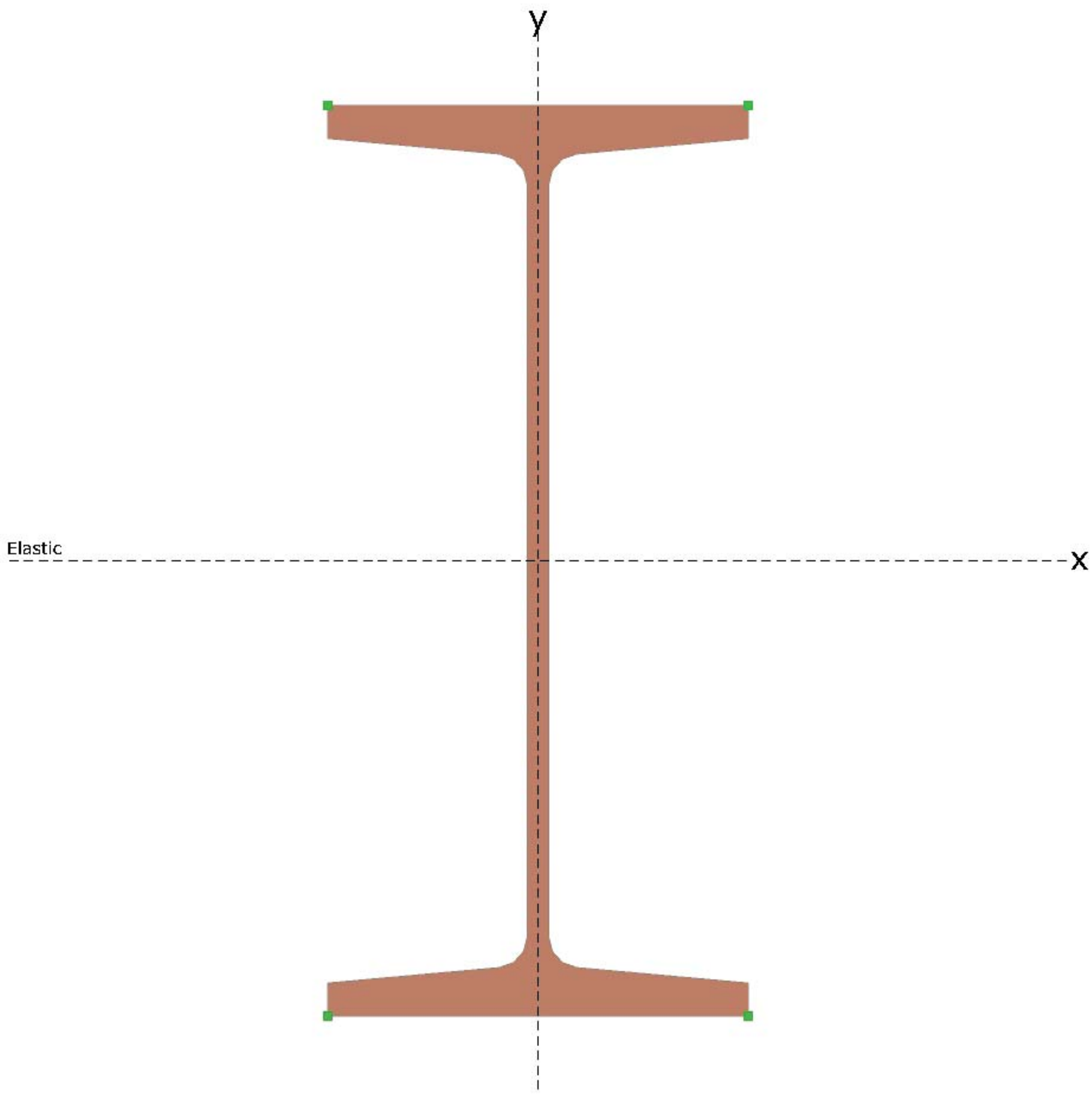

Stringer (26"x150lb/ft)

Checked By: DV

Summary		
Name	I-beam, Sloped Flange	
Material	Steel	
Area (A)	2.8332e+4	mm^2
Moment of Inertia		
X (Ix)	2.1461e+9	mm^4
Y (Iy)	1.4535e+8	mm^4
Theta	0	deg
Torsional Constant (J)	6.3815e+6	mm^4

Dimensions		
Width	304.8	mm
Depth	660.4	mm
Web Thickness	16.002	mm
Flange		
Slope	0.09	
Thickness	30.755	mm
Min Thickness	24.257	mm
Max Thickness	37.253	mm
Fillets		
Type	Fillet	
Radius X	20.32	mm
Radius Y	12.7	mm

Geometric Properties		
Perimeter	2,507.996	mm
Area (A)	2.8332e+4	mm^2
Mass	1.5443e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	152.4	mm
Y	330.2	mm
Moment of Inertia		
X (Ix)	2.1461e+9	mm^4
Y (Iy)	1.4535e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	275.2266	mm
Y (Ry)	71.6266	mm
Section Modulus		
Bottom X (Sx)	6.4994e+6	mm^3
X (Sx)	6.4994e+6	mm^3
Left Y (Sy)	9.5375e+5	mm^3
Y (Sy)	9.5375e+5	mm^3

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	2.1771e+9	mm^4
Minor	1.3094e+8	mm^4
Radius of Gyration		
Major (Rxp)	275.263	mm
Minor (Ryp)	67.5054	mm
Section Modulus		
Major Bottom (Sx)	6.5933e+6	mm^3
Major Top (Sx)	6.5933e+6	mm^3
Minor Left (Sy)	8.5917e+5	mm^3
Minor Right (Sy)	8.5917e+5	mm^3
Plastic Section Modulus		
X (Zx)	7.4491e+6	mm^3
Y (Zy)	1.3818e+6	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	7.3372e+6	mm^3
Y (Zy)	1.4670e+6	mm^3

Shear Area Properties		
Area		
X (Asx)	1.5624e+4	mm^2
Y (Asy)	1.0568e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		

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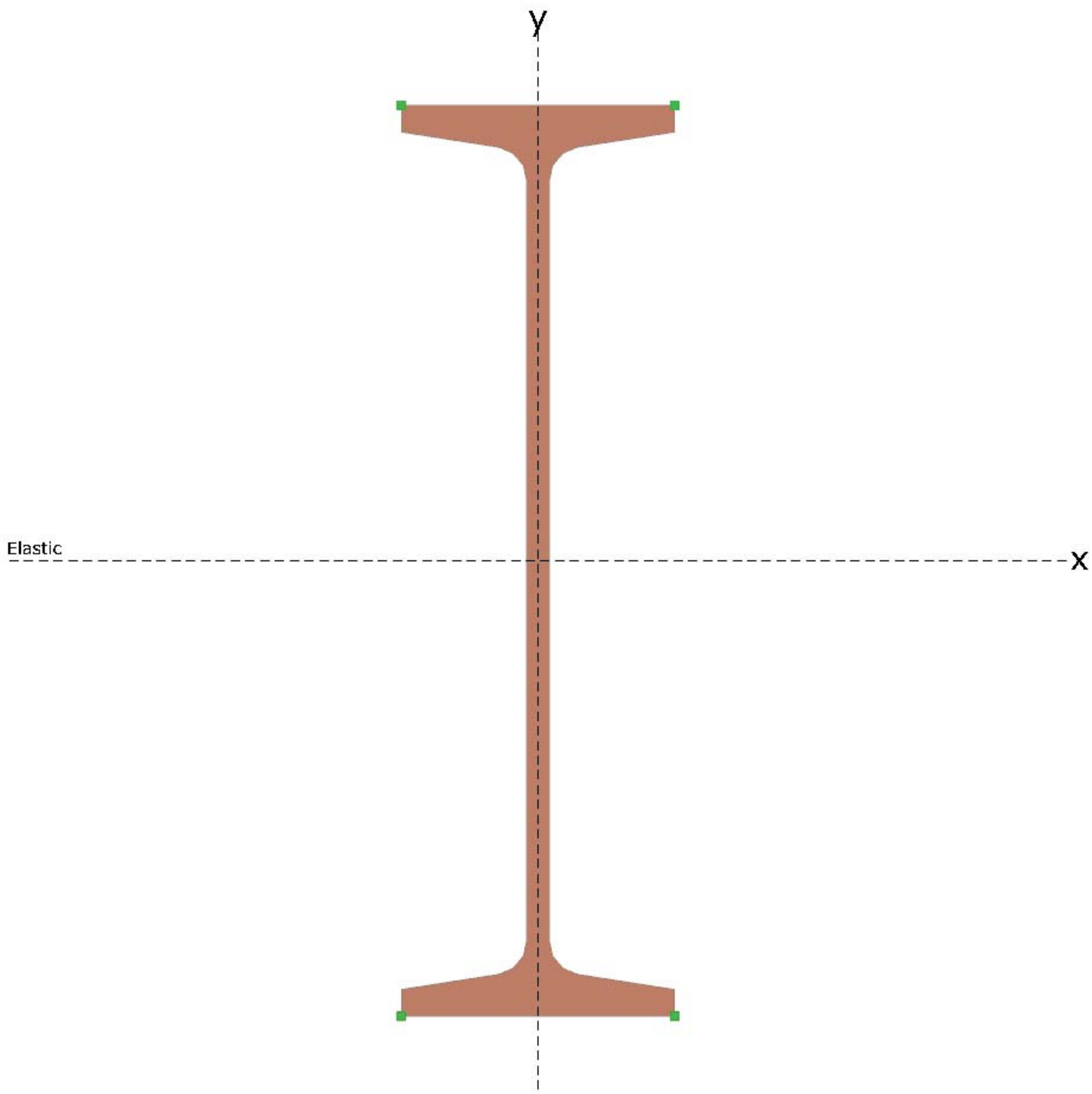
Shear Center Properties		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	6.3815e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Overhang (20"x65lb/ft)

Checked By: DV

Summary		
Name	I-beam, Sloped Flange	
Material	Steel	
Area (A)	1.2161e+4	mm^2
Moment of Inertia		
X (Ix)	4.7825e+8	mm^4
Y (Iy)	1.2135e+7	mm^4
Theta	0	deg
Torsional Constant (J)	1.1211e+6	mm^4

Dimensions		
Width	152.4	mm
Depth	508	mm
Web Thickness	12.7	mm
Flange		
Slope	0.156	
Thickness	20.434	mm
Min Thickness	14.986	mm
Max Thickness	25.883	mm
Fillets		
Type	Fillet	
Radius X	16.002	mm
Radius Y	12.7	mm

Geometric Properties		
Perimeter	1,600.2	mm
Area (A)	1.2161e+4	mm^2
Mass	6.6286e+8	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	76.2	mm
Y	254	mm
Moment of Inertia		
X (Ix)	4.7825e+8	mm^4
Y (Iy)	1.2135e+7	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	198.3095	mm
Y (Ry)	31.5886	mm
Section Modulus		
Bottom X (Sx)	1.8829e+6	mm^3
X (Sx)	1.8829e+6	mm^3
Left Y (Sy)	1.5925e+5	mm^3
Y (Sy)	1.5925e+5	mm^3

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	4.8991e+8	mm^4
Minor	1.0700e+7	mm^4
Radius of Gyration		
Major (Rxp)	198.7342	mm
Minor (Ryp)	29.3695	mm
Section Modulus		
Major Bottom (Sx)	1.9288e+6	mm^3
Major Top (Sx)	1.9288e+6	mm^3
Minor Left (Sy)	1.4041e+5	mm^3
Minor Right (Sy)	1.4041e+5	mm^3
Plastic Section Modulus		
X (Zx)	2.2645e+6	mm^3
Y (Zy)	2.4088e+5	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	2.2112e+6	mm^3
Y (Zy)	2.5614e+5	mm^3

Shear Area Properties		
Area		
X (Asx)	5,190.3122	mm^2
Y (Asy)	6,451.6	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		

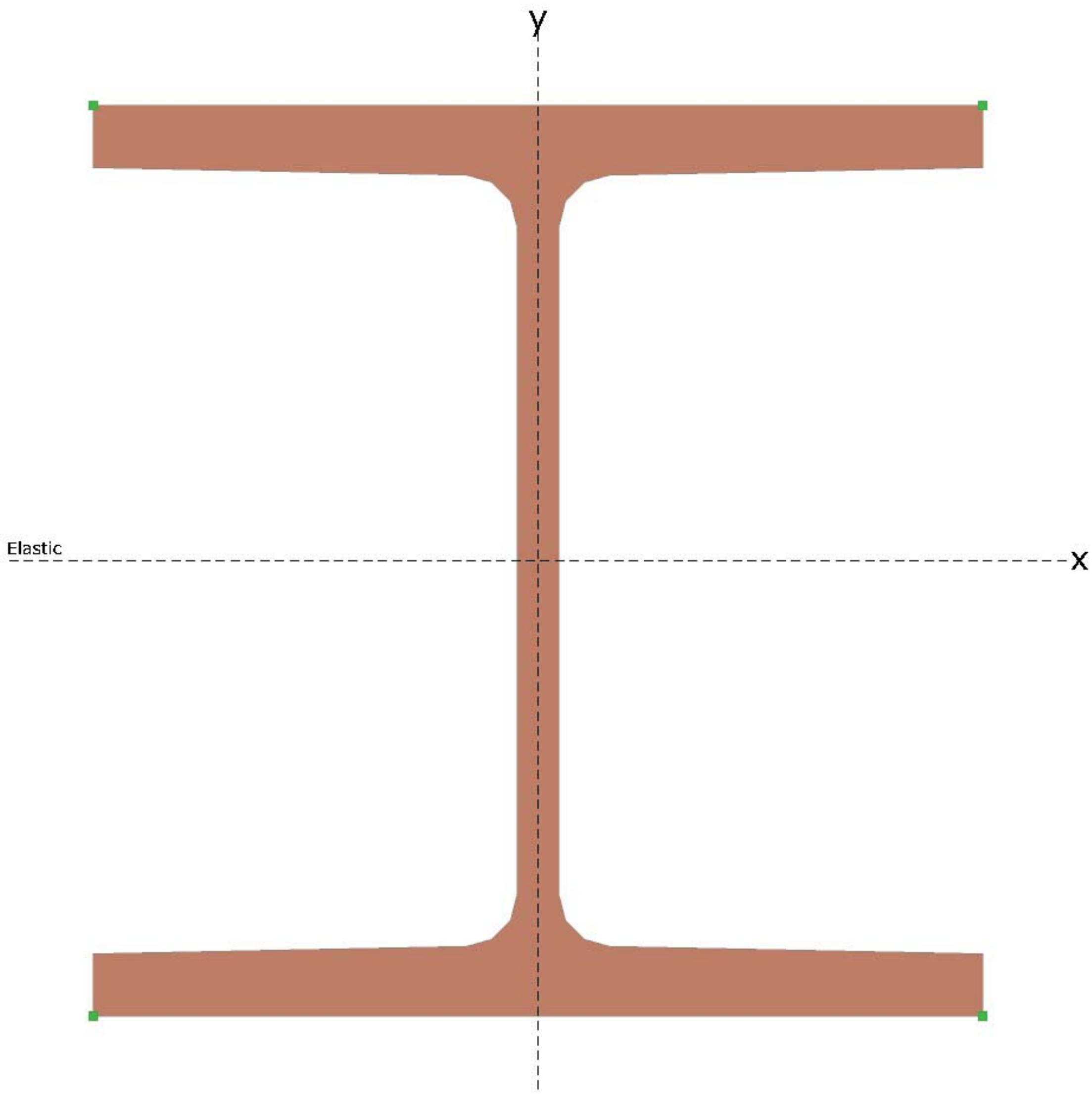
Checked By: DV

Shear Center Properties		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	1.1211e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Pier Column (14.5"x130.5lb/ft)

Checked By: DV

Summary		
Name	I-beam, Sloped Flange	
Material	Steel	
Area (A)	2.4761e+4	mm^2
Moment of Inertia		
X (Ix)	6.1057e+8	mm^4
Y (Iy)	2.0939e+8	mm^4
Theta	0	deg
Torsional Constant (J)	5.0326e+6	mm^4

Geometric Properties		
Perimeter	2,141.22	mm
Area (A)	2.4761e+4	mm^2
Mass	1.3497e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	179.832	mm
Y	184.15	mm
Moment of Inertia		
X (Ix)	6.1057e+8	mm^4
Y (Iy)	2.0939e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	157.0298	mm
Y (Ry)	91.9579	mm
Section Modulus		
Bottom X (Sx)	3.3156e+6	mm^3
X (Sx)	3.3156e+6	mm^3
Left Y (Sy)	1.1643e+6	mm^3
Y (Sy)	1.1643e+6	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	3.7331e+6	mm^3
Y (Zy)	1.7682e+6	mm^3

Dimensions		
Width	359.664	mm
Depth	368.3	mm
Web Thickness	17.018	mm
Flange		
Slope	0.02	
Thickness	26.986	mm
Min Thickness	25.273	mm
Max Thickness	28.699	mm
Fillets		
Type	Fillet	
Radius X	20.32	mm
Radius Y	12.7	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	6.1979e+8	mm^4
Minor	2.0316e+8	mm^4
Radius of Gyration		
Major (Rxp)	156.9147	mm
Minor (Ryp)	89.8373	mm
Section Modulus		
Major Bottom (Sx)	3.3657e+6	mm^3
Major Top (Sx)	3.3657e+6	mm^3
Minor Left (Sy)	1.1297e+6	mm^3
Minor Right (Sy)	1.1297e+6	mm^3
Plastic Section Modulus		
X (Zx)	3.7946e+6	mm^3
Y (Zy)	1.7402e+6	mm^3

Shear Area Properties		
Area		
X (Asx)	1.6177e+4	mm^2
Y (Asy)	6,267.7294	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		

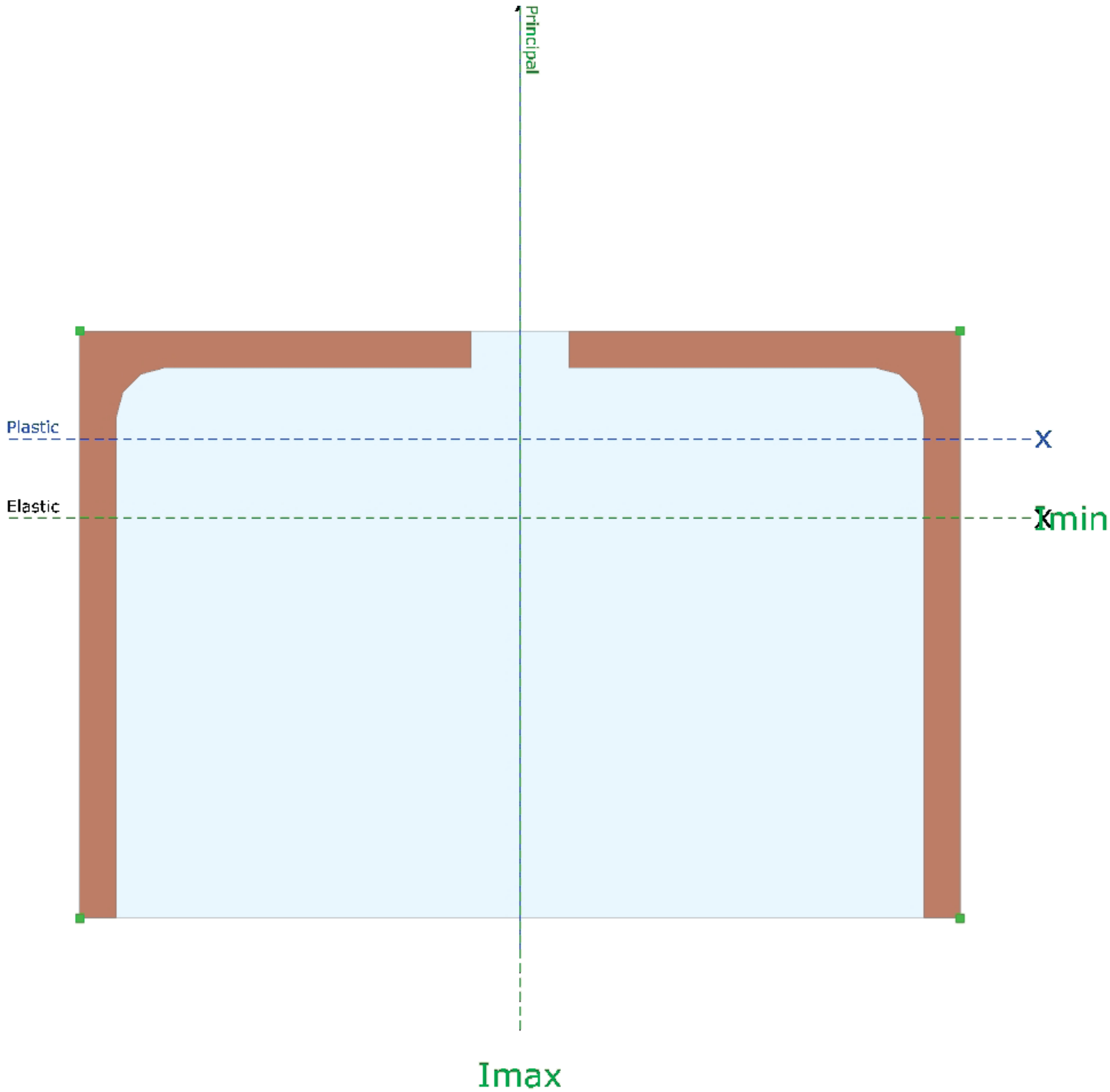
Checked By: DV

Shear Center Properties		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	5.0326e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Pier Diagonal (2-L6"x4"x3/8")

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	4,737.8938	mm^2
Moment of Inertia		
X (Ix)	1.1320e+7	mm^4
Y (Iy)	4.2985e+7	mm^4
Theta	-90	deg
Torsional Constant (J)	1.4084e+5	mm^4

Geometric Properties		
Perimeter	1,004.644	mm
Area (A)	4,737.8938	mm^2
Mass	2.5825e+8	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	114.3039	mm
Y	103.7292	mm
Moment of Inertia		
X (Ix)	1.1320e+7	mm^4
Y (Iy)	4.2985e+7	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	48.8792	mm
Y (Ry)	95.2497	mm
Section Modulus		
Bottom X (Sx)	1.0913e+5	mm^3
Top X (Sx)	2.3258e+5	mm^3
Left Y (Sy)	3.7605e+5	mm^3
Y (Sy)	3.7605e+5	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	20.628	mm
Section Modulus		
X (Zx)	1.9687e+5	mm^3
Y (Zy)	4.2926e+5	mm^3

Dimensions		
Width	228.608	mm
Depth	152.4	mm

Principal Properties		
Theta	-90	deg
Moment of Inertia		
Major	4.2985e+7	mm^4
Minor	1.1320e+7	mm^4
Radius of Gyration		
Major (Rxp)	95.2497	mm
Minor (Ryp)	48.8792	mm
Section Modulus		
Major Bottom (Sx)	3.7605e+5	mm^3
Major Top (Sx)	3.7605e+5	mm^3
Minor Left (Sy)	2.3258e+5	mm^3
Minor Right (Sy)	1.0913e+5	mm^3
Plastic Section Modulus		
X (Zx)	4.2926e+5	mm^3
Y (Zy)	1.9687e+5	mm^3

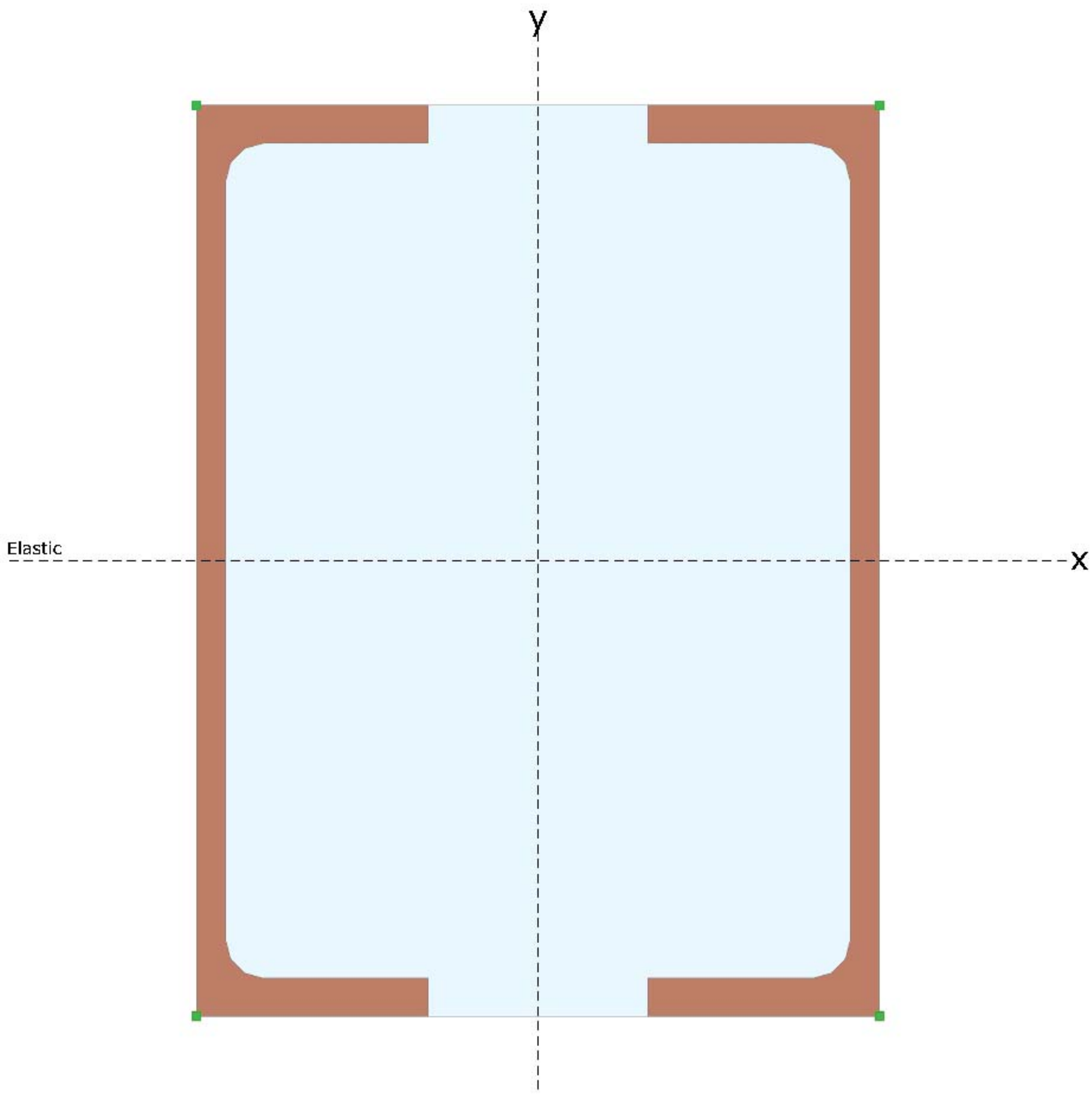
Shear Area Properties		
Area		
X (Asx)	1,935.48	mm^2
Y (Asy)	2,903.22	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	1.4084e+5	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Pier Strut (2-C12"x25lb/ft)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	9,596.5305	mm^2
Moment of Inertia		
X (Ix)	1.2288e+8	mm^4
Y (Iy)	9.1910e+7	mm^4
Theta	0	deg
Torsional Constant (J)	3.8429e+5	mm^4

Geometric Properties		
Perimeter	1,776.9288	mm
Area (A)	9,596.5305	mm^2
Mass	5.2308e+8	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	114.3039	mm
Y	152.4	mm
Moment of Inertia		
X (Ix)	1.2288e+8	mm^4
Y (Iy)	9.1910e+7	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	113.1557	mm
Y (Ry)	97.8643	mm
Section Modulus		
Bottom X (Sx)	8.0627e+5	mm^3
X (Sx)	8.0627e+5	mm^3
Left Y (Sy)	8.0408e+5	mm^3
Y (Sy)	8.0408e+5	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	9.8144e+5	mm^3
Y (Zy)	9.1510e+5	mm^3

Dimensions		
Width	228.608	mm
Depth	304.8	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	1.2288e+8	mm^4
Minor	9.1910e+7	mm^4
Radius of Gyration		
Major (Rxp)	113.1557	mm
Minor (Ryp)	97.8643	mm
Section Modulus		
Major Bottom (Sx)	8.0627e+5	mm^3
Major Top (Sx)	8.0627e+5	mm^3
Minor Left (Sy)	8.0408e+5	mm^3
Minor Right (Sy)	8.0408e+5	mm^3
Plastic Section Modulus		
X (Zx)	9.8144e+5	mm^3
Y (Zy)	9.1510e+5	mm^3

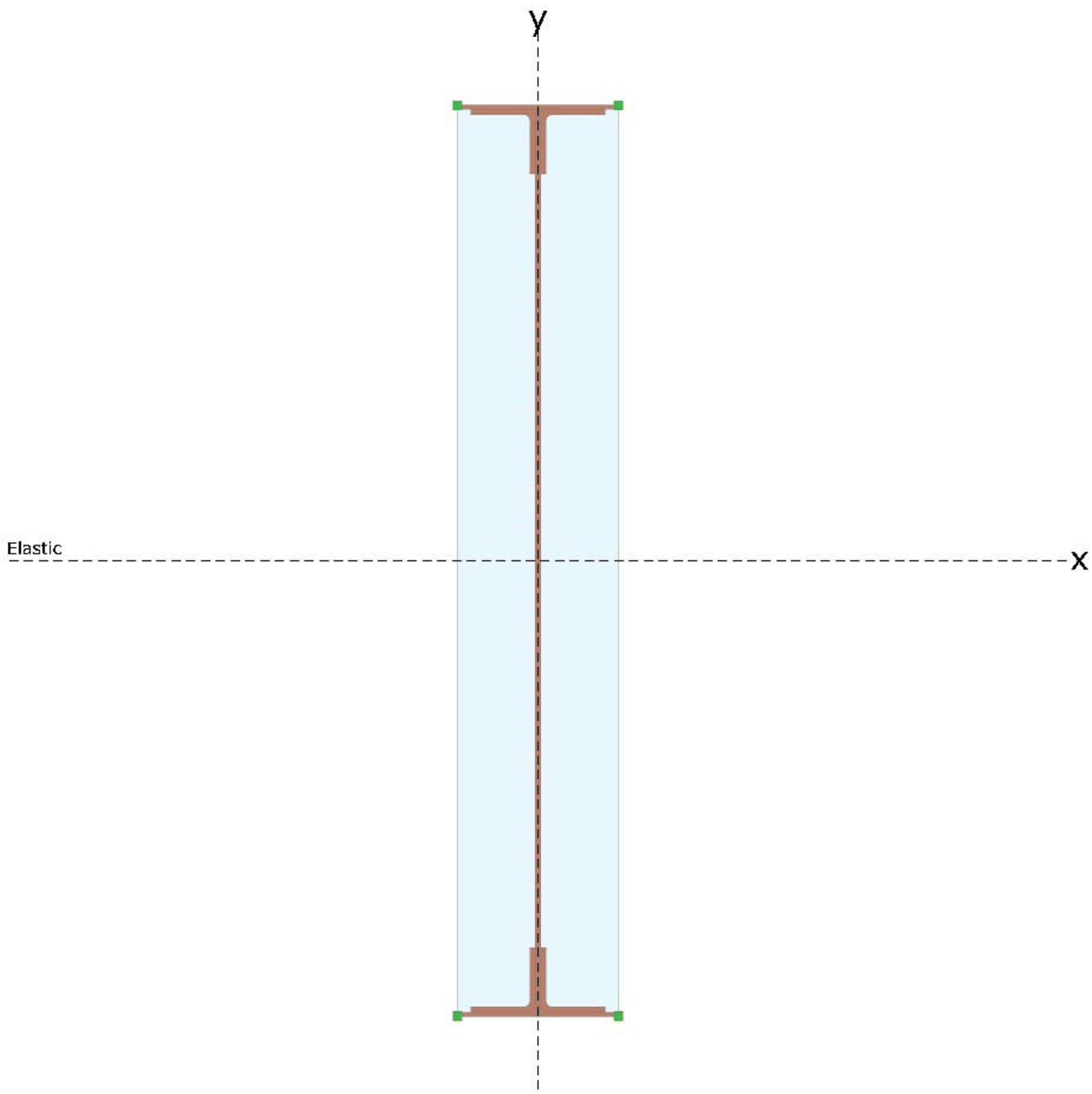
Shear Area Properties		
Area		
X (Asx)	3,943.347	mm^2
Y (Asy)	5,992.2461	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	3.8429e+5	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Main Girder (15" x 1 Plate)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	4.9355e+4	mm^2
Moment of Inertia		
X (Ix)	3.4384e+10	mm^4
Y (Iy)	1.5723e+8	mm^4
Theta	0	deg
Torsional Constant (J)	2.4652e+6	mm^4

Geometric Properties		
Perimeter	8,270.388	mm
Area (A)	4.9355e+4	mm^2
Mass	2.6902e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X		mm
	1,076.325	mm
Moment of Inertia		
X (Ix)	3.4384e+10	mm^4
Y (Iy)	1.5723e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	834.6719	mm
Y (Ry)	56.4412	mm
Section Modulus		
Bottom X (Sx)	3.1946e+7	mm^3
X (Sx)	3.1946e+7	mm^3
Left Y (Sy)	8.2533e+5	mm^3
Y (Sy)	8.2533e+5	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	3.7595e+7	mm^3
Y (Zy)	1.5102e+6	mm^3

Dimensions		
Width	381	mm
Depth	2,152.65	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	3.4384e+10	mm^4
Minor	1.5723e+8	mm^4
Radius of Gyration		
Major (Rxp)	834.6719	mm
Minor (Ryp)	56.4412	mm
Section Modulus		
Major Bottom (Sx)	3.1946e+7	mm^3
Major Top (Sx)	3.1946e+7	mm^3
Minor Left (Sy)	8.2533e+5	mm^3
Minor Right (Sy)	8.2533e+5	mm^3
Plastic Section Modulus		
X (Zx)	3.7595e+7	mm^3
Y (Zy)	1.5102e+6	mm^3

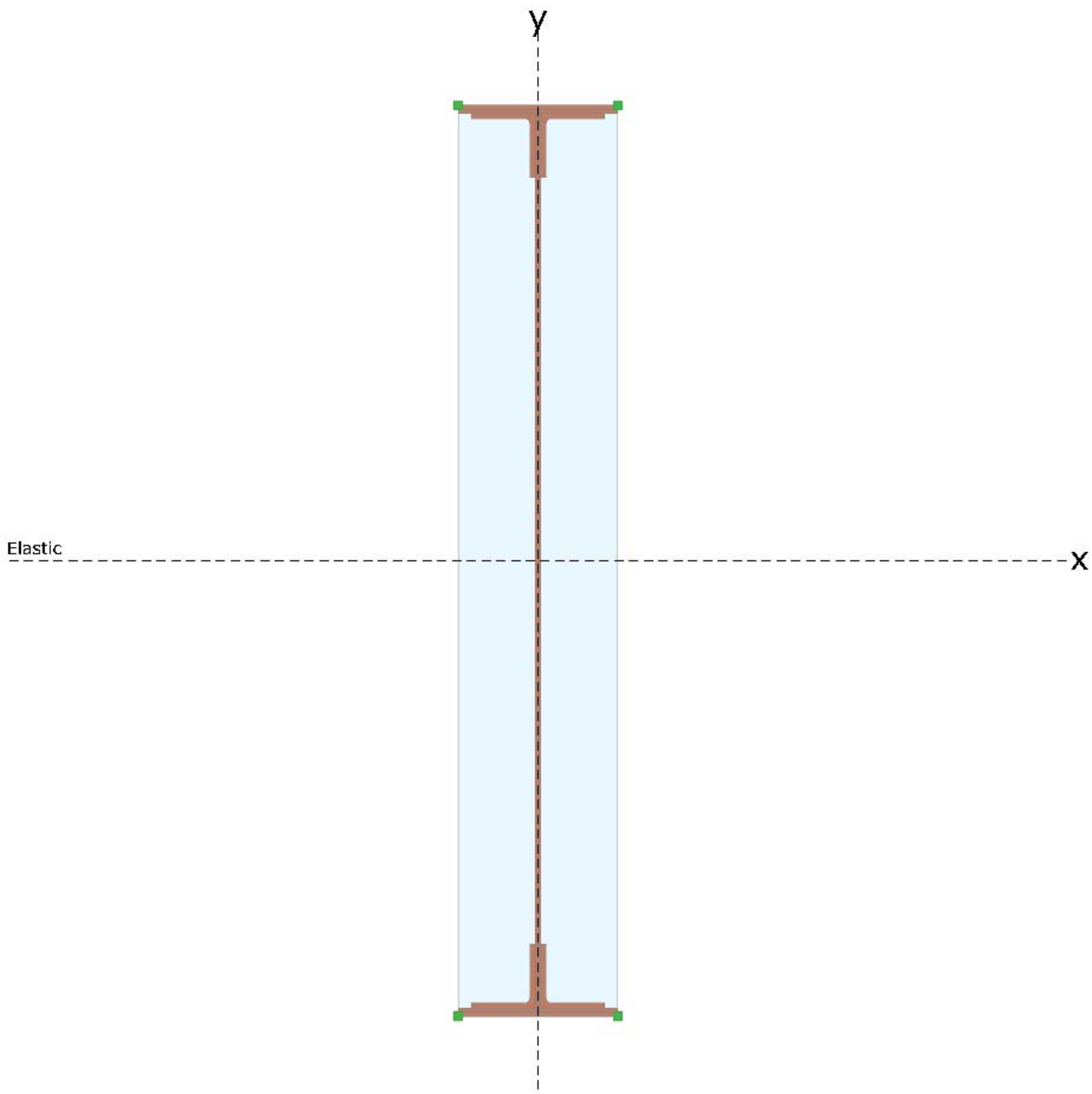
Shear Area Properties		
Area		
X (Asx)	3.6371e+4	mm^2
Y (Asy)	3.6371e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	2.4652e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Main Girder (15" x 2 Plates)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	5.6613e+4	mm^2
Moment of Inertia		
X (Ix)	4.2867e+10	mm^4
Y (Iy)	2.4502e+8	mm^4
Theta	0	deg
Torsional Constant (J)	2.6812e+6	mm^4

Geometric Properties		
Perimeter	9,832.488	mm
Area (A)	5.6613e+4	mm^2
Mass	3.0858e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	190.5	mm
Y	1,085.85	mm
Moment of Inertia		
X (Ix)	4.2867e+10	mm^4
Y (Iy)	2.4502e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	870.1726	mm
Y (Ry)	65.788	mm
Section Modulus		
Bottom X (Sx)	3.9478e+7	mm^3
X (Sx)	3.9478e+7	mm^3
Left Y (Sy)	1.2862e+6	mm^3
Y (Sy)	1.2862e+6	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	4.5442e+7	mm^3
Y (Zy)	2.2015e+6	mm^3

Dimensions		
Width	381	mm
Depth	2,171.7	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	4.2867e+10	mm^4
Minor	2.4502e+8	mm^4
Radius of Gyration		
Major (Rxp)	870.1726	mm
Minor (Ryp)	65.788	mm
Section Modulus		
Major Bottom (Sx)	3.9478e+7	mm^3
Major Top (Sx)	3.9478e+7	mm^3
Minor Left (Sy)	1.2862e+6	mm^3
Minor Right (Sy)	1.2862e+6	mm^3
Plastic Section Modulus		
X (Zx)	4.5442e+7	mm^3
Y (Zy)	2.2015e+6	mm^3

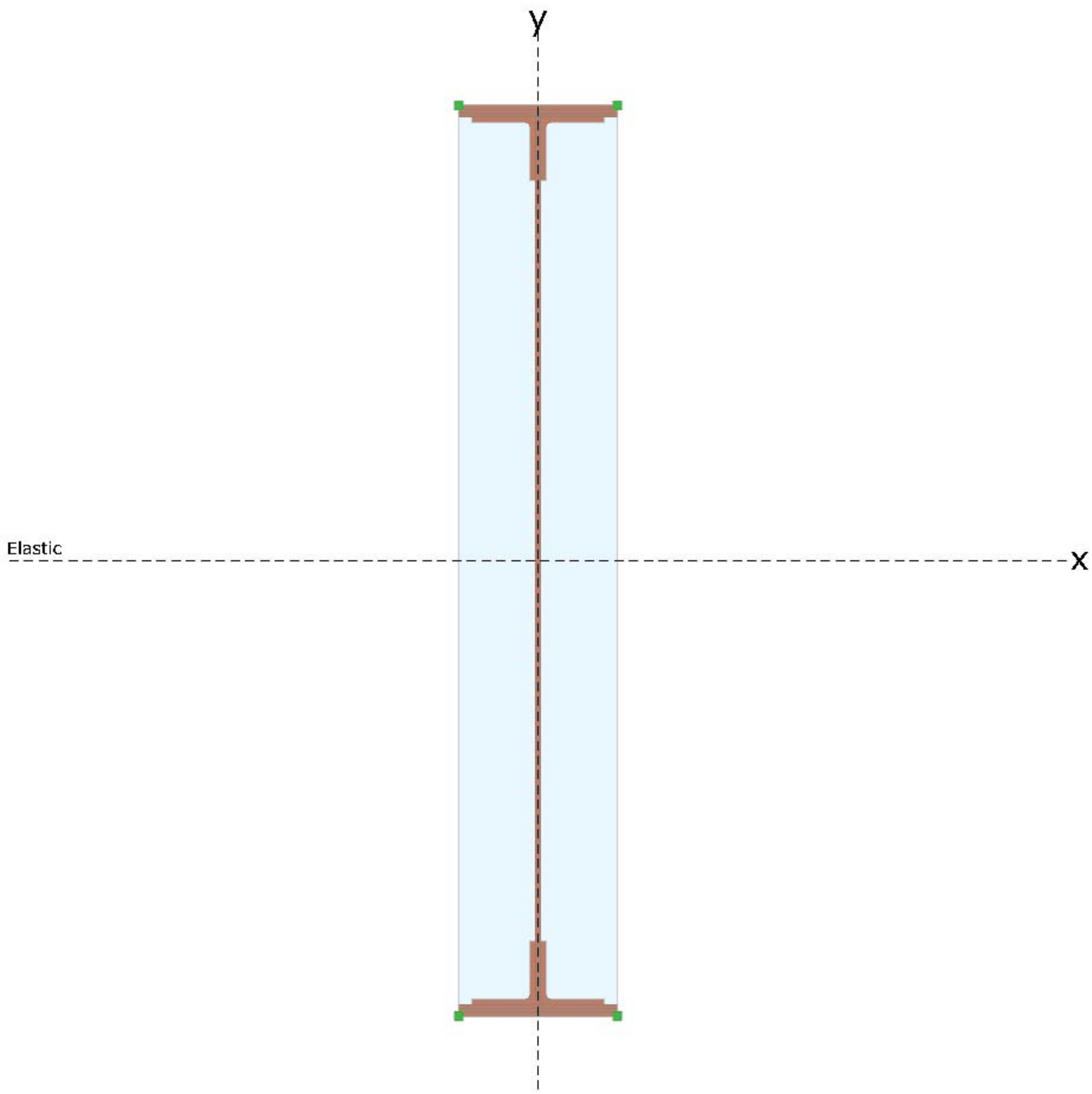
Shear Area Properties		
Area		
X (Asx)	4.2419e+4	mm^2
Y (Asy)	4.2419e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	2.6812e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Main Girder (15" x 3 Plates)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	6.3871e+4	mm^2
Moment of Inertia		
X (Ix)	5.1500e+10	mm^4
Y (Iy)	3.3282e+8	mm^4
Theta	0	deg
Torsional Constant (J)	2.8972e+6	mm^4

Geometric Properties		
Perimeter	1.1395e+4	mm
Area (A)	6.3871e+4	mm^2
Mass	3.4814e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	190.5	mm
Y	1,095.375	mm
Moment of Inertia		
X (Ix)	5.1500e+10	mm^4
Y (Iy)	3.3282e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	897.9526	mm
Y (Ry)	72.1864	mm
Section Modulus		
Bottom X (Sx)	4.7016e+7	mm^3
X (Sx)	4.7016e+7	mm^3
Left Y (Sy)	1.7471e+6	mm^3
Y (Sy)	1.7471e+6	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	5.3358e+7	mm^3
Y (Zy)	2.8928e+6	mm^3

Dimensions		
Width	381	mm
Depth	2,190.75	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	5.1500e+10	mm^4
Minor	3.3282e+8	mm^4
Radius of Gyration		
Major (Rxp)	897.9526	mm
Minor (Ryp)	72.1864	mm
Section Modulus		
Major Bottom (Sx)	4.7016e+7	mm^3
Major Top (Sx)	4.7016e+7	mm^3
Minor Left (Sy)	1.7471e+6	mm^3
Minor Right (Sy)	1.7471e+6	mm^3
Plastic Section Modulus		
X (Zx)	5.3358e+7	mm^3
Y (Zy)	2.8928e+6	mm^3

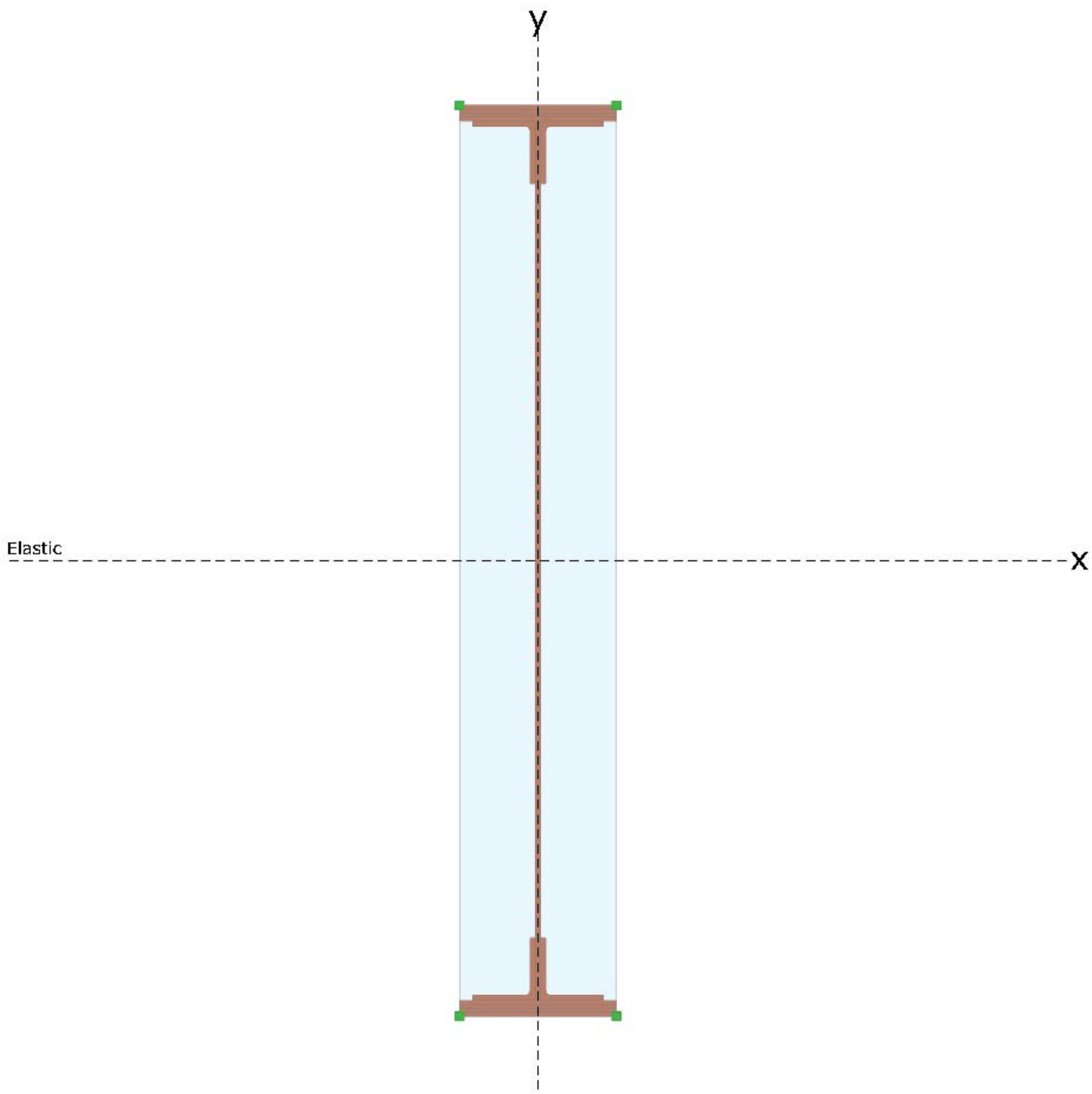
Shear Area Properties		
Area		
X (Asx)	4.8468e+4	mm^2
Y (Asy)	4.8468e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	2.8972e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Main Girder (15" x 4 Plates)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	7.1129e+4	mm^2
Moment of Inertia		
X (Ix)	6.0285e+10	mm^4
Y (Iy)	4.2062e+8	mm^4
Theta	0	deg
Torsional Constant (J)	3.1133e+6	mm^4

Geometric Properties		
Perimeter	1.2957e+4	mm
Area (A)	7.1129e+4	mm^2
Mass	3.8770e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	190.5	mm
Y	1,104.9	mm
Moment of Inertia		
X (Ix)	6.0285e+10	mm^4
Y (Iy)	4.2062e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	920.6207	mm
Y (Ry)	76.8994	mm
Section Modulus		
Bottom X (Sx)	5.4561e+7	mm^3
X (Sx)	5.4561e+7	mm^3
Left Y (Sy)	2.2080e+6	mm^3
Y (Sy)	2.2080e+6	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	6.1342e+7	mm^3
Y (Zy)	3.5841e+6	mm^3

Dimensions		
Width	381	mm
Depth	2,209.8	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	6.0285e+10	mm^4
Minor	4.2062e+8	mm^4
Radius of Gyration		
Major (Rxp)	920.6207	mm
Minor (Ryp)	76.8994	mm
Section Modulus		
Major Bottom (Sx)	5.4561e+7	mm^3
Major Top (Sx)	5.4561e+7	mm^3
Minor Left (Sy)	2.2080e+6	mm^3
Minor Right (Sy)	2.2080e+6	mm^3
Plastic Section Modulus		
X (Zx)	6.1342e+7	mm^3
Y (Zy)	3.5841e+6	mm^3

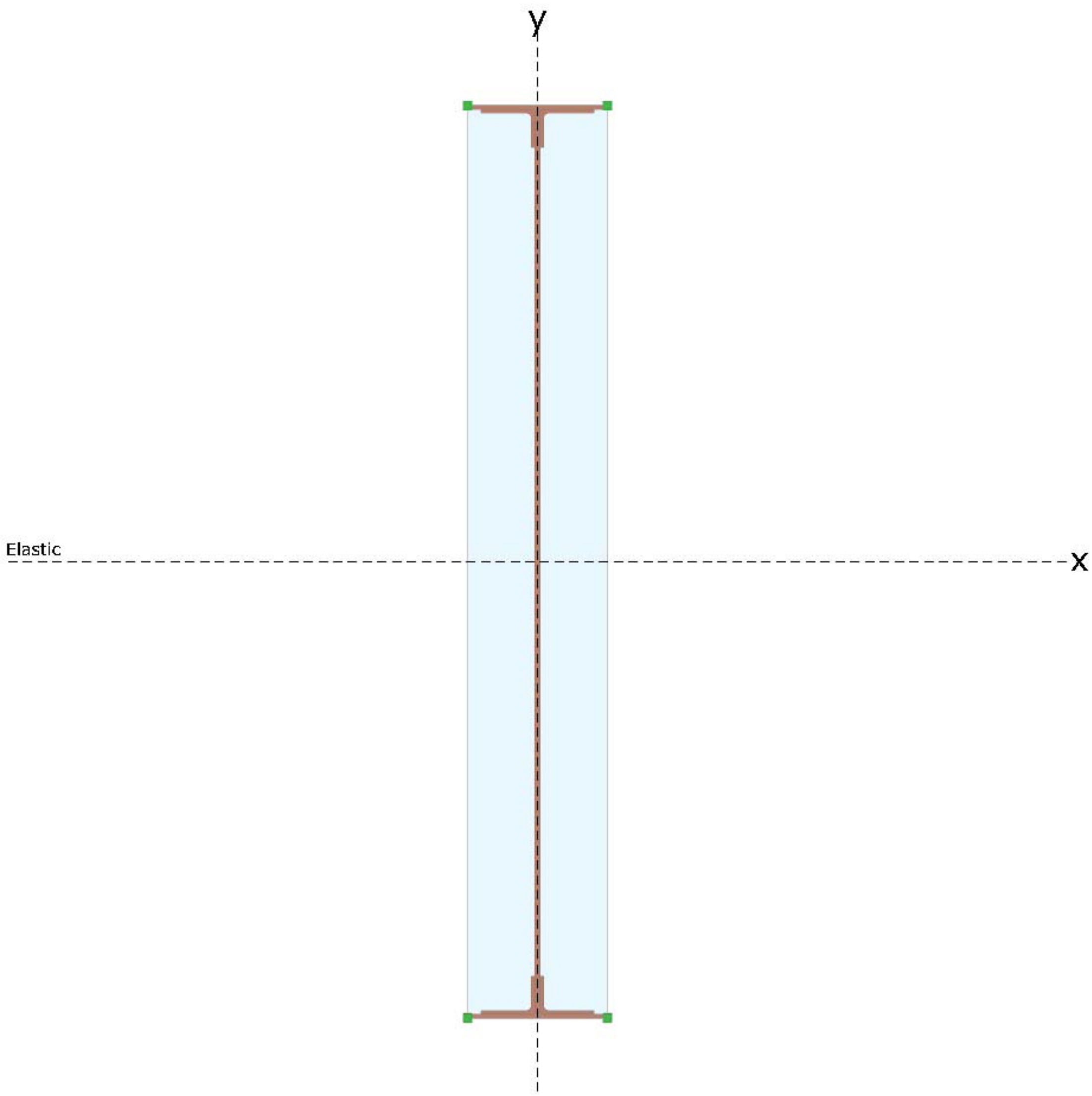
Shear Area Properties		
Area		
X (Asx)	5.4516e+4	mm^2
Y (Asy)	5.4516e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	3.1133e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Main Girder (13" x 1 Plate)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	4.0151e+4	mm^2
Moment of Inertia		
X (Ix)	2.4904e+10	mm^4
Y (Iy)	8.2948e+7	mm^4
Theta	0	deg
Torsional Constant (J)	1.7768e+6	mm^4

Geometric Properties		
Perimeter	7,355.988	mm
Area (A)	4.0151e+4	mm^2
Mass	2.1885e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	165.1	mm
Y	1,076.325	mm
Moment of Inertia		
X (Ix)	2.4904e+10	mm^4
Y (Iy)	8.2948e+7	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	787.5657	mm
Y (Ry)	45.4522	mm
Section Modulus		
Bottom X (Sx)	2.3138e+7	mm^3
X (Sx)	2.3138e+7	mm^3
Left Y (Sy)	5.0241e+5	mm^3
Y (Sy)	5.0241e+5	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	2.8268e+7	mm^3
Y (Zy)	9.1628e+5	mm^3

Dimensions		
Width	330.2	mm
Depth	2,152.65	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	2.4904e+10	mm^4
Minor	8.2948e+7	mm^4
Radius of Gyration		
Major (Rxp)	787.5657	mm
Minor (Ryp)	45.4522	mm
Section Modulus		
Major Bottom (Sx)	2.3138e+7	mm^3
Major Top (Sx)	2.3138e+7	mm^3
Minor Left (Sy)	5.0241e+5	mm^3
Minor Right (Sy)	5.0241e+5	mm^3
Plastic Section Modulus		
X (Zx)	2.8268e+7	mm^3
Y (Zy)	9.1628e+5	mm^3

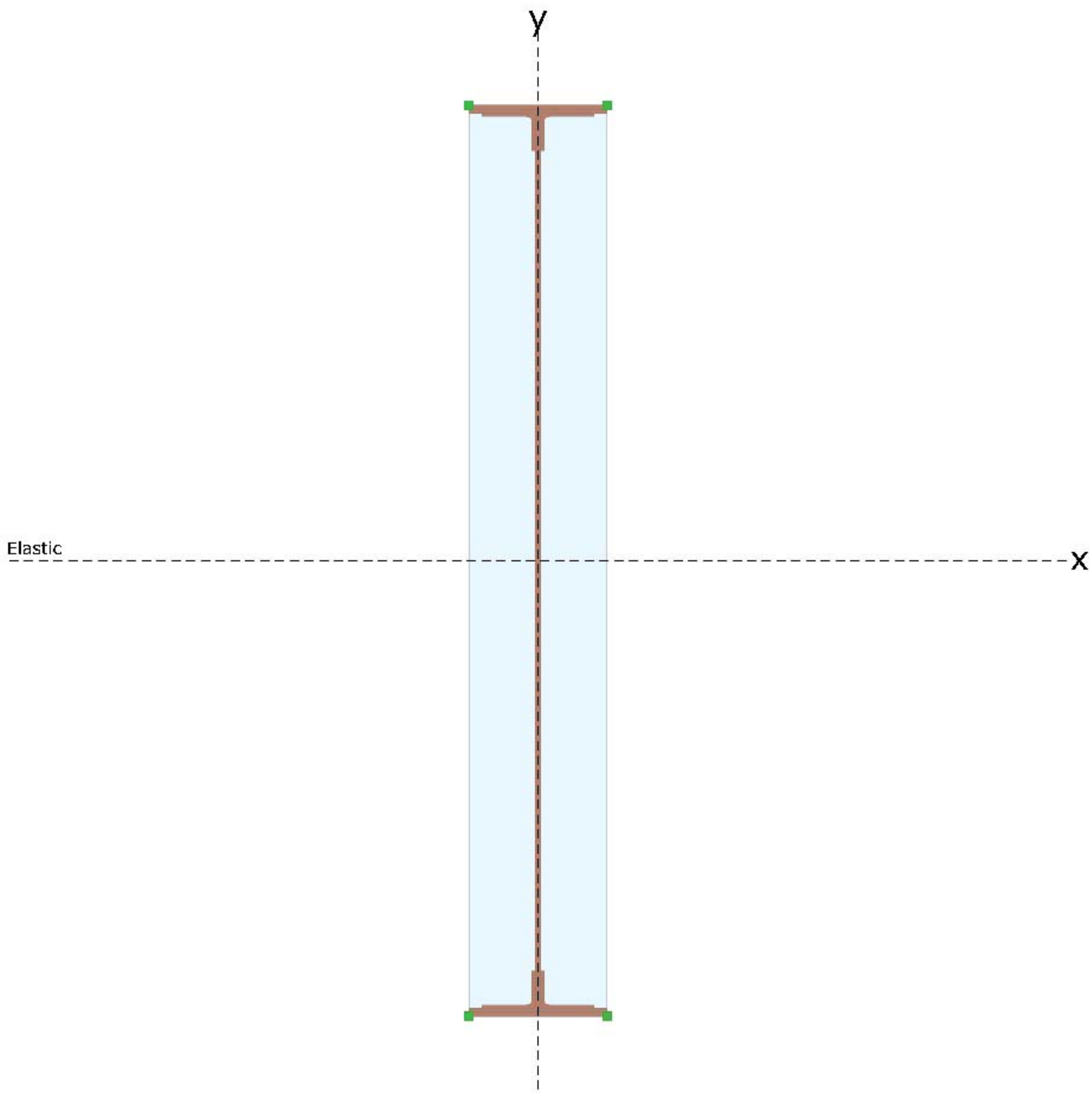
Shear Area Properties		
Area		
X (Asx)	3.0645e+4	mm^2
Y (Asy)	3.1855e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	1.7768e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Main Girder (13" x 2 Plates)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	4.6441e+4	mm^2
Moment of Inertia		
X (Ix)	3.2256e+10	mm^4
Y (Iy)	1.4010e+8	mm^4
Theta	0	deg
Torsional Constant (J)	1.9636e+6	mm^4

Geometric Properties		
Perimeter	8,714.888	mm
Area (A)	4.6441e+4	mm^2
Mass	2.5314e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	165.1	mm
Y	1,085.85	mm
Moment of Inertia		
X (Ix)	3.2256e+10	mm^4
Y (Iy)	1.4010e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	833.3976	mm
Y (Ry)	54.9249	mm
Section Modulus		
Bottom X (Sx)	2.9706e+7	mm^3
X (Sx)	2.9706e+7	mm^3
Left Y (Sy)	8.4859e+5	mm^3
Y (Sy)	8.4859e+5	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	3.5068e+7	mm^3
Y (Zy)	1.4355e+6	mm^3

Dimensions		
Width	330.2	mm
Depth	2,171.7	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	3.2256e+10	mm^4
Minor	1.4010e+8	mm^4
Radius of Gyration		
Major (Rxp)	833.3976	mm
Minor (Ryp)	54.9249	mm
Section Modulus		
Major Bottom (Sx)	2.9706e+7	mm^3
Major Top (Sx)	2.9706e+7	mm^3
Minor Left (Sy)	8.4859e+5	mm^3
Minor Right (Sy)	8.4859e+5	mm^3
Plastic Section Modulus		
X (Zx)	3.5068e+7	mm^3
Y (Zy)	1.4355e+6	mm^3

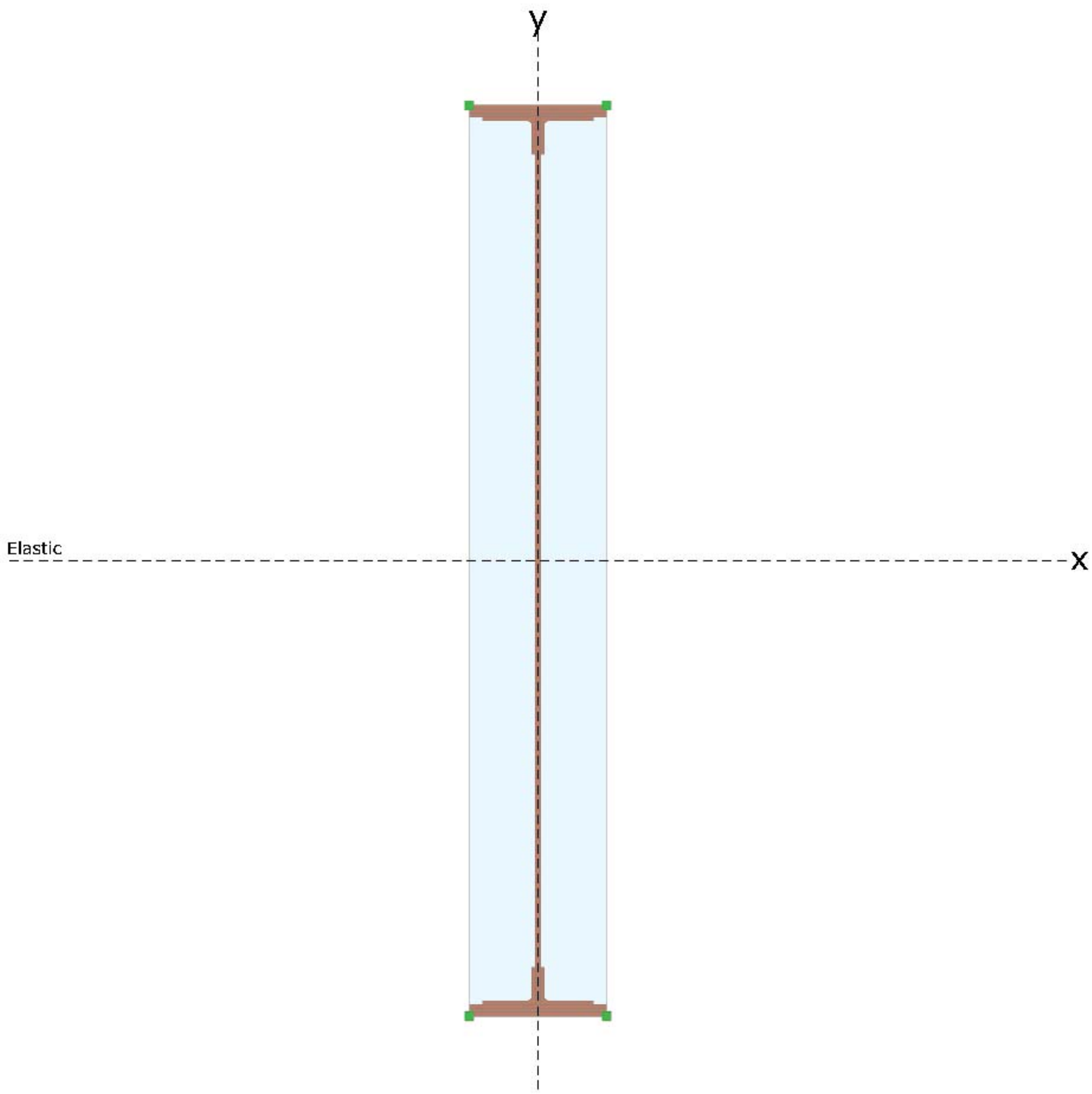
Shear Area Properties		
Area		
X (Asx)	3.5887e+4	mm^2
Y (Asy)	3.7097e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	1.9636e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Main Girder (13" x 3 Plates)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	5.2732e+4	mm^2
Moment of Inertia		
X (Ix)	3.9738e+10	mm^4
Y (Iy)	1.9726e+8	mm^4
Theta	0	deg
Torsional Constant (J)	2.1503e+6	mm^4

Geometric Properties		
Perimeter	1.0074e+4	mm
Area (A)	5.2732e+4	mm^2
Mass	2.8743e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	165.1	mm
Y	1,095.375	mm
Moment of Inertia		
X (Ix)	3.9738e+10	mm^4
Y (Iy)	1.9726e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	868.0937	mm
Y (Ry)	61.1616	mm
Section Modulus		
Bottom X (Sx)	3.6278e+7	mm^3
X (Sx)	3.6278e+7	mm^3
Left Y (Sy)	1.1948e+6	mm^3
Y (Sy)	1.1948e+6	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	4.1928e+7	mm^3
Y (Zy)	1.9548e+6	mm^3

Dimensions		
Width	330.2	mm
Depth	2,190.75	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	3.9738e+10	mm^4
Minor	1.9726e+8	mm^4
Radius of Gyration		
Major (Rxp)	868.0937	mm
Minor (Ryp)	61.1616	mm
Section Modulus		
Major Bottom (Sx)	3.6278e+7	mm^3
Major Top (Sx)	3.6278e+7	mm^3
Minor Left (Sy)	1.1948e+6	mm^3
Minor Right (Sy)	1.1948e+6	mm^3
Plastic Section Modulus		
X (Zx)	4.1928e+7	mm^3
Y (Zy)	1.9548e+6	mm^3

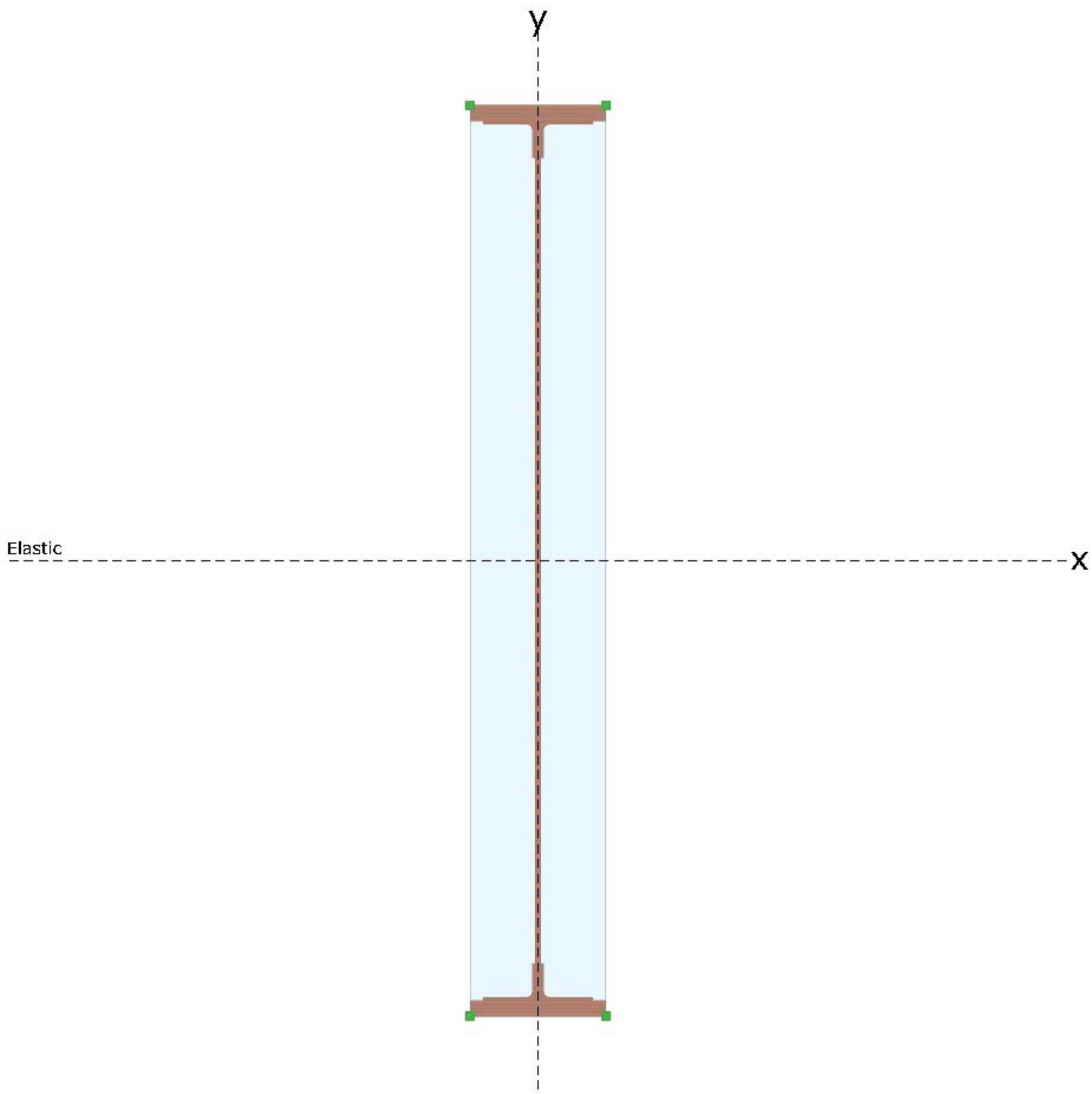
Shear Area Properties		
Area		
X (Asx)	4.1129e+4	mm^2
Y (Asy)	4.2339e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	2.1503e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Main Girder (13" x 4 Plates)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	5.9022e+4	mm^2
Moment of Inertia		
X (Ix)	4.7351e+10	mm^4
Y (Iy)	2.5441e+8	mm^4
Theta	0	deg
Torsional Constant (J)	2.3371e+6	mm^4

Geometric Properties		
Perimeter	1.1433e+4	mm
Area (A)	5.9022e+4	mm^2
Mass	3.2171e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	165.1	mm
Y	1,104.9	mm
Moment of Inertia		
X (Ix)	4.7351e+10	mm^4
Y (Iy)	2.5441e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	895.6909	mm
Y (Ry)	65.6538	mm
Section Modulus		
Bottom X (Sx)	4.2856e+7	mm^3
X (Sx)	4.2856e+7	mm^3
Left Y (Sy)	1.5409e+6	mm^3
Y (Sy)	1.5409e+6	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	4.8848e+7	mm^3
Y (Zy)	2.4741e+6	mm^3

Dimensions		
Width	330.2	mm
Depth	2,209.8	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	4.7351e+10	mm^4
Minor	2.5441e+8	mm^4
Radius of Gyration		
Major (Rxp)	895.6909	mm
Minor (Ryp)	65.6538	mm
Section Modulus		
Major Bottom (Sx)	4.2856e+7	mm^3
Major Top (Sx)	4.2856e+7	mm^3
Minor Left (Sy)	1.5409e+6	mm^3
Minor Right (Sy)	1.5409e+6	mm^3
Plastic Section Modulus		
X (Zx)	4.8848e+7	mm^3
Y (Zy)	2.4741e+6	mm^3

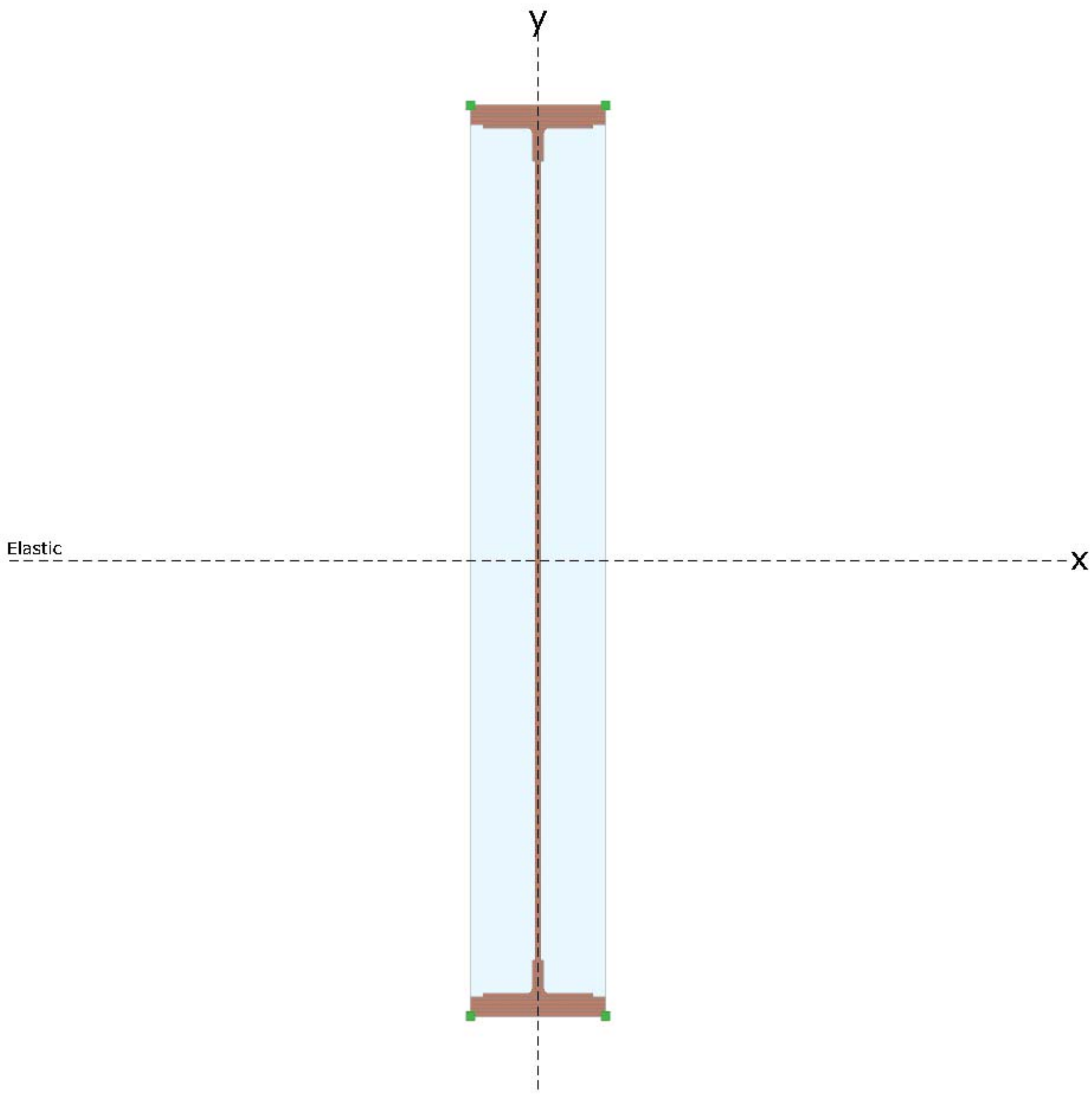
Shear Area Properties		
Area		
X (Asx)	4.6371e+4	mm^2
Y (Asy)	4.7581e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	2.3371e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

Checked By: DV



Main Girder (13" x 5 Plates)

Checked By: DV

Summary		
Name	Compound	
Reference Material	Steel	
Area (A)	6.5312e+4	mm^2
Moment of Inertia		
X (Ix)	5.5097e+10	mm^4
Y (Iy)	3.1156e+8	mm^4
Theta	0	deg
Torsional Constant (J)	2.5239e+6	mm^4

Geometric Properties		
Perimeter	1.2792e+4	mm
Area (A)	6.5312e+4	mm^2
Mass	3.5600e+9	kg/m
Elastic Neutral Axis		
Centroid Offset (Bottom Left Corner)		
X	165.1	mm
Y	1,114.425	mm
Moment of Inertia		
X (Ix)	5.5097e+10	mm^4
Y (Iy)	3.1156e+8	mm^4
Product Of Inertia (Ixy)	0	mm^4
Radius of Gyration		
X (Rx)	918.471	mm
Y (Ry)	69.0678	mm
Section Modulus		
Bottom X (Sx)	4.9440e+7	mm^3
X (Sx)	4.9440e+7	mm^3
Left Y (Sy)	1.8871e+6	mm^3
Y (Sy)	1.8871e+6	mm^3

Plastic Properties		
Centroid Offset (Elastic Neutral Axis)		
X	0	mm
Y	0	mm
Section Modulus		
X (Zx)	5.5829e+7	mm^3
Y (Zy)	2.9933e+6	mm^3

Dimensions		
Width	330.2	mm
Depth	2,228.85	mm

Principal Properties		
Theta	0	deg
Moment of Inertia		
Major	5.5097e+10	mm^4
Minor	3.1156e+8	mm^4
Radius of Gyration		
Major (Rxp)	918.471	mm
Minor (Ryp)	69.0678	mm
Section Modulus		
Major Bottom (Sx)	4.9440e+7	mm^3
Major Top (Sx)	4.9440e+7	mm^3
Minor Left (Sy)	1.8871e+6	mm^3
Minor Right (Sy)	1.8871e+6	mm^3
Plastic Section Modulus		
X (Zx)	5.5829e+7	mm^3
Y (Zy)	2.9933e+6	mm^3

Shear Area Properties		
Area		
X (Asx)	5.1613e+4	mm^2
Y (Asy)	5.2822e+4	mm^2

Shear Center Properties		
Centroid Offset (Elastic Neutral Axis)		
X (Xo)	0	mm
Y (Yo)	0	mm
Center Offset (Principal Axis)		
X (Xop)	0	mm
Y (Yop)	0	mm

Torsional Constant		
Torsional Constant (J)	2.5239e+6	mm^4

Warping Constant		
Warping Constant (Cw)	0	mm^6

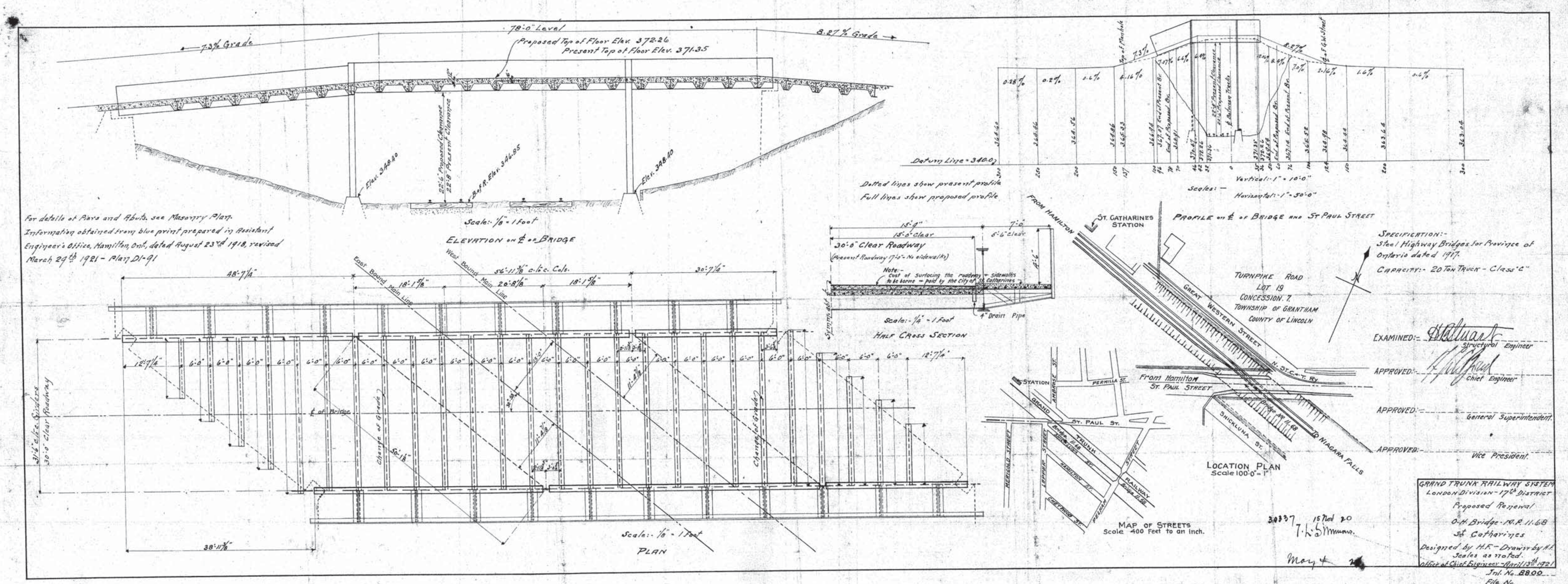
THE REGIONAL MUNICIPALITY OF NIAGARA

LOAD CAPACITY EVALUATION OF
ST. PAUL STREET WEST CNR BRIDGE
(STRUCTURE NO. 081215)
IN THE CITY OF ST. CATHARINES
MILE 11.68 GRIMSBY SUBDIVISION

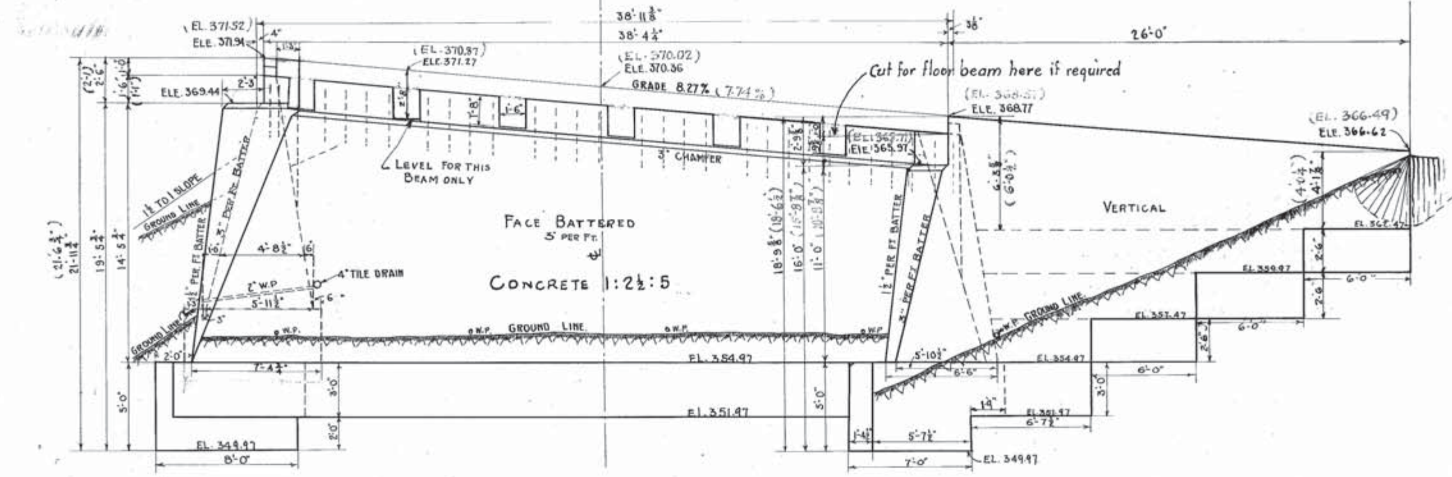
<u>APPENDIX 'D'</u>

1922 Original Construction Drawings (13 Pages)

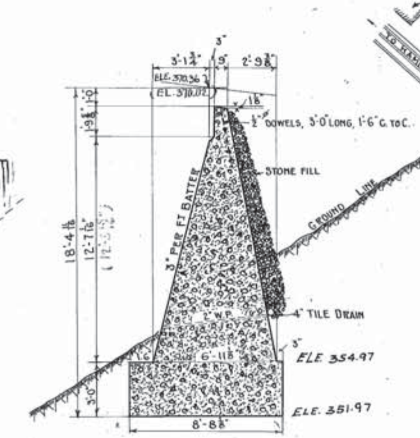
1977 Rehabilitation Drawings (5 Pages)



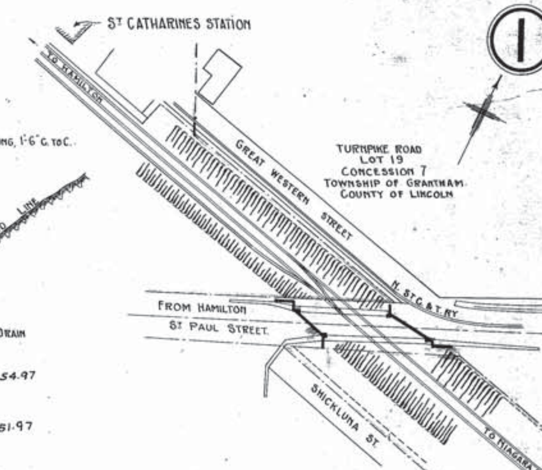
78'-0" Level
7.3% Grade
8.27% Grade
Proposed Top of Floor Elev. 372.26
Present Top of Floor Elev. 371.35
22'-6" Proposed Clearance
22'-8" Present Clearance
Elev. 348.80
B. of R. Elev. 346.85
Scale:- 1/8" = 1 Foot
ELEVATION on ℄ of BRIDGE
For details of Piers and Abuts. see Masonry Plan.
Information obtained from blue print prepared in Assistant Engineer's Office, Hamilton, Ont., dated August 23rd 1918, revised March 29th 1921 - Plan D1-91
Datum Line = 340.0
Dotted lines show present profile
Full lines show proposed profile
Scales:- Vertical - 1" = 10'-0" Horizontal - 1" = 50'-0"
PROFILE on ℄ of BRIDGE and ST PAUL STREET
30'-0" Clear Roadway
(Present Roadway 17'-5" - No sidewalks)
Note:- Cost of surfacing the roadway & sidewalks to be borne & paid by the City of St. Catharines
4" Drain Pipe
Scale:- 1/4" = 1 Foot
HALF CROSS SECTION
East Bound Main Line
West Bound Main Line
56'-11 3/8" c. to c. Cols.
Change of Grade
℄ of Bridge
31'-6" c. to c. Girders
30'-0" Clear Roadway
Scale:- 1/8" = 1 Foot
PLAN
FROM HAMILTON
ST. CATHARINES STATION
TURNPIKE ROAD
LOT 19
CONCESSION 7
TOWNSHIP OF GRANTHAM
COUNTY OF LINCOLN
GREAT WESTERN STREET
N. ST. C. & T. RY.
From Hamilton
ST. PAUL STREET
SHICKLUNA ST.
TO NIAGARA FALLS
LOCATION PLAN
Scale 100'-0" = 1"
STATION
PERMILLA ST.
ST. PAUL ST.
GRAND TRUNK RAILWAY
MAP OF STREETS
Scale 400 feet to an inch.
SPECIFICATION:- Steel Highway Bridges for Province of Ontario dated 1917.
CAPACITY:- 20 Ton Truck - Class "C"
EXAMINED:- Structural Engineer
APPROVED:- Chief Engineer
APPROVED:- General Superintendent
APPROVED:- Vice President
GRAND TRUNK RAILWAY SYSTEM
LONDON DIVISION - 17th DISTRICT
Proposed Renewal
O.H. Bridge - M.P. 11.68
St. Catharines
Designed by H.R. - Drawn by H.R.
Scales as noted.
Office of Chief Engineer - April 13th 1921
Inl. No. 8800
File No.



— SIDE ELEVATION —



— CROSS SECTION ON ℄ —
(ON SQUARE)



— LOCATION PLAN —
SCALE 100'-0"=1"

NOTES

Foundations:- reported "Good" (G.A.M.) but no details given, loading therefore limited to 2½ tons per sq. ft. uniformly distributed, footings to be carried down deeper if necessary, to reach firm ground.

Setting out work:-

Check carefully all lines and levels with steel plan, insofar as they affect the latter.

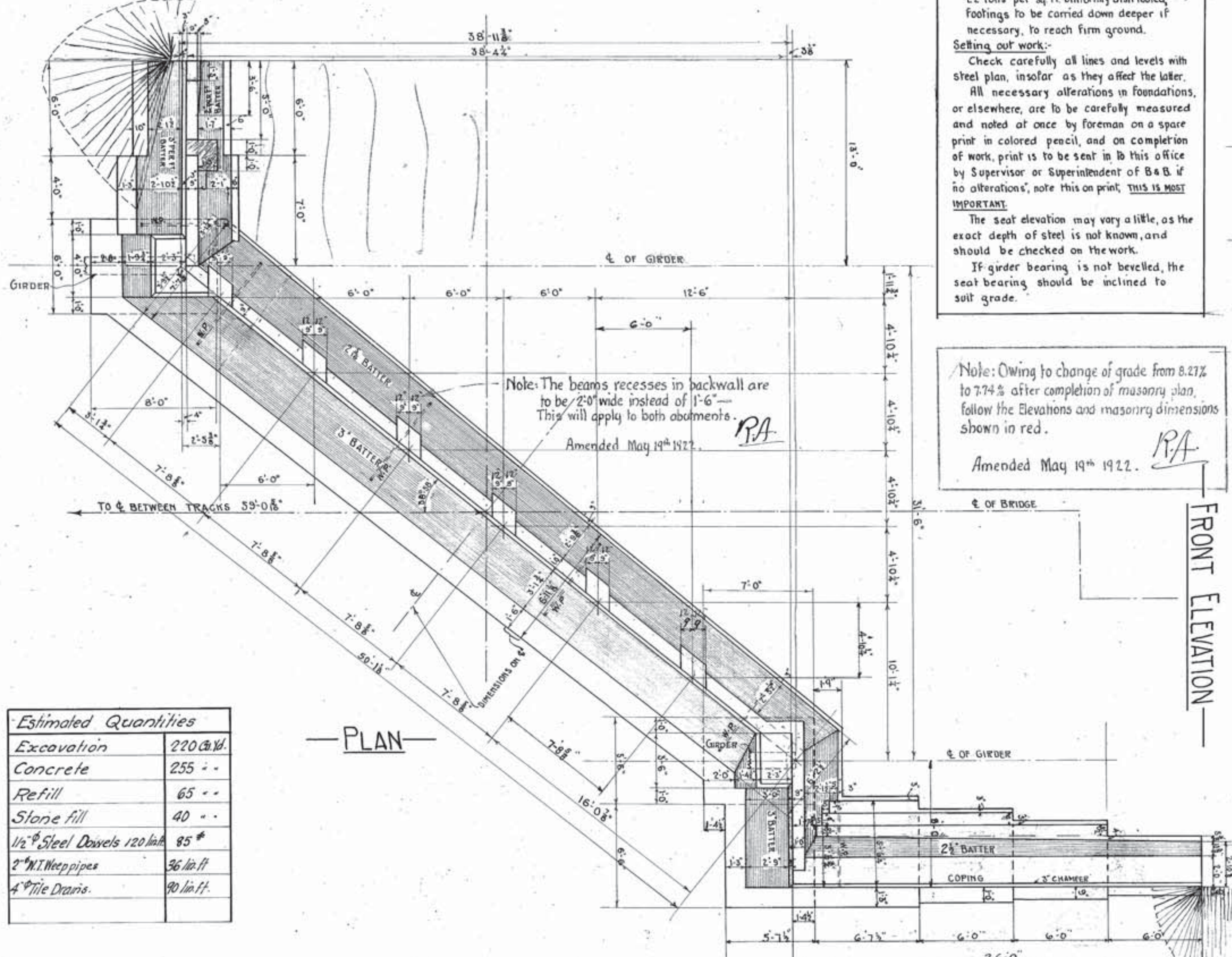
All necessary alterations in foundations, or elsewhere, are to be carefully measured and noted at once by foreman on a spare print in colored pencil, and on completion of work, print is to be sent in to this office by Supervisor or Superintendent of B&B. if "no alterations", note this on print, THIS IS MOST IMPORTANT.

The seat elevation may vary a little, as the exact depth of steel is not known, and should be checked on the work.

If girder bearing is not bevelled, the seat bearing should be inclined to suit grade.

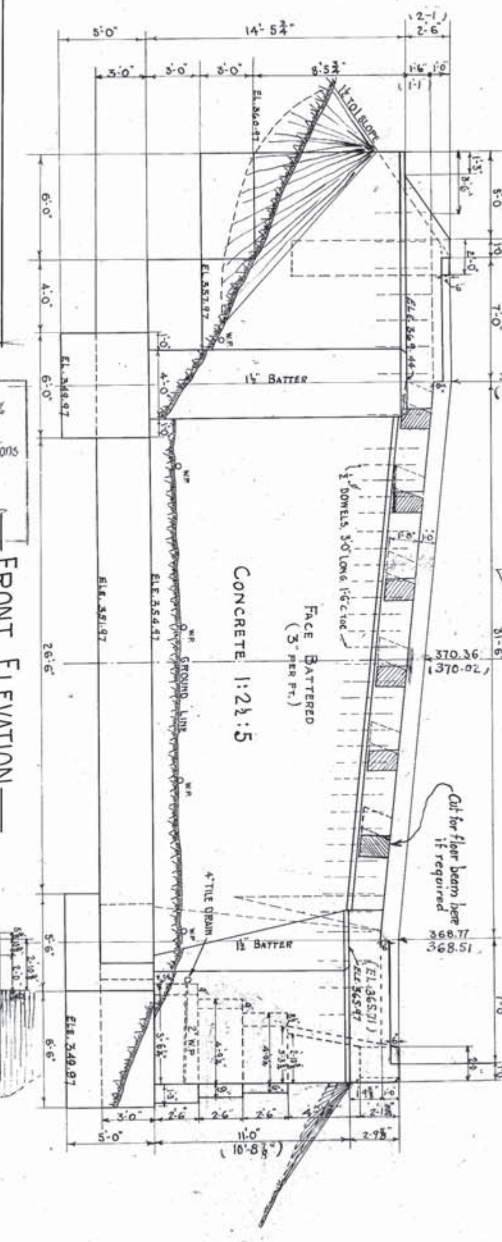
Note: Owing to change of grade from 8.27% to 7.74% after completion of masonry plan, follow the Elevations and masonry dimensions shown in red.

Amended May 19th 1922. R.A.



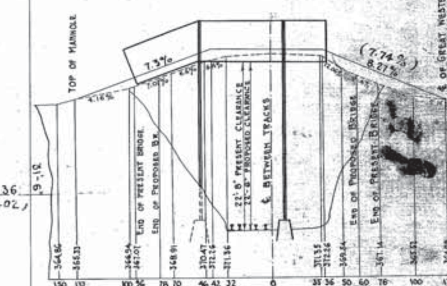
— PLAN —

Estimated Quantities	
Excavation	220 Cu. Yd.
Concrete	255 " "
Refill	65 " "
Stone fill	40 " "
1½" ⌀ Steel Dowels 120 lin. ft.	85 #
2" ⌀ W.I. Weepipes	36 lin. ft.
4" ⌀ Tile Drains	90 lin. ft.



— FRONT ELEVATION —

— MAP OF STREETS —
SCALE 400'-0"=1"



— PROFILE ON ℄ OF BRIDGE & ST. PAUL ST —
SCALES:- VERTICAL:- 1" = 10.0"; HORIZONTAL:- 1" = 50.0"

EXAMINED R. Armour — MASONRY ENGINEER.

APPROVED [signature] — CHIEF ENGINEER.

APPROVED — GENERAL SUPERINTENDENT

APPROVED — VICE PRESIDENT.

AMENDED NOV. 18TH 1921

GRAND TRUNK RAILWAY SYSTEM.

— LONDON DIVISION — 17TH DISTRICT —

— OVERHEAD BRIDGE M.P. 11.68 —

— ST. CATHARINES —

— NORTH ABUTMENT —

— SCALE ¼" = 1'-0" —

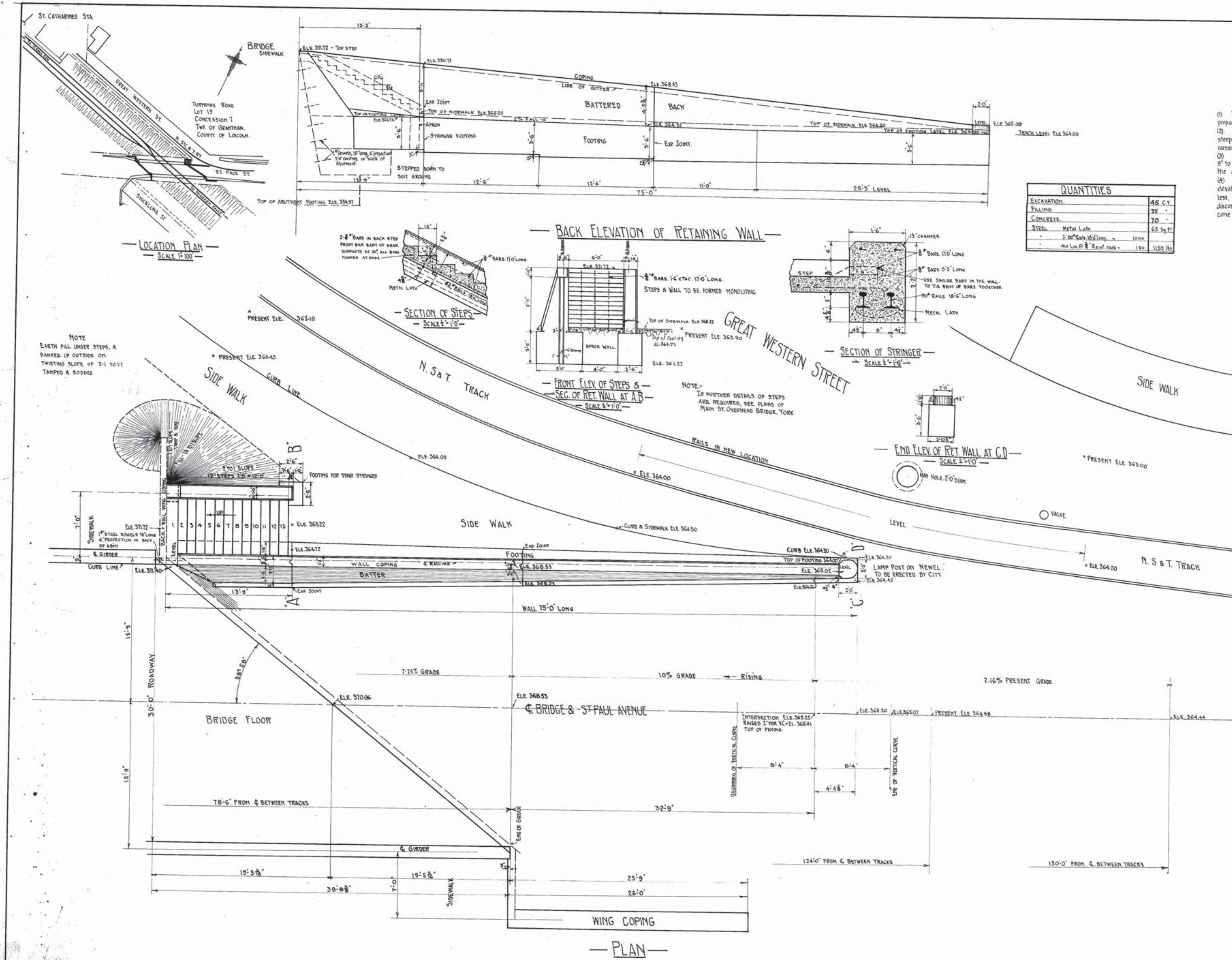
OFFICE OF CHIEF ENG'R. MONTREAL JULY 21

FILE Nº [illegible]

JTR. Nº 8698

484-35

Drawn by S.L.
Traced by L.G. Checked for Steel by H.F.



— Notes —

(1). This plan is based on rather incomplete data, and has been prepared without as much time for study as might be desired.
(2). The grade of St Paul Street approach has been made a little steeper at the bottom (10%) so as to avoid the necessity of raising the street railway tracks much.
(3). If there is no objection to raising the street railway say 9" to 12", the regular grade (7.74%) may be retained throughout, the curb of the retaining wall to conform.
(4). The length, depth of footings etc. of retaining wall, grade elevations of roadway and electric railway may be varied, more or less, according to judgement, and it is advised that details be discussed with City Engineer, and agreed upon, especially as regards curve adjustment, track elevations and street grades.

Quantities			
Excavation			45 C.Y.
Filling			75 "
Concrete			70 "
Steel	Metal Lath		65 Sq.Ft.
"	2-80# Rails 18'6" long =	1000	
"	410 Lin. Ft 3/8" Reinf. rods =	150	1150 lbs

Approved. ______________________ General Sup't G.T.R.

Approved. ______________________ City Engr. St Catharines

Examined. R. Amos [signature] Masonry Engineer.

Approved. [signature] Chief Engineer.

Approved. ______________________ General Superin'dt

Approved. ______________________ Vice President.

Grand Trunk Railway System.

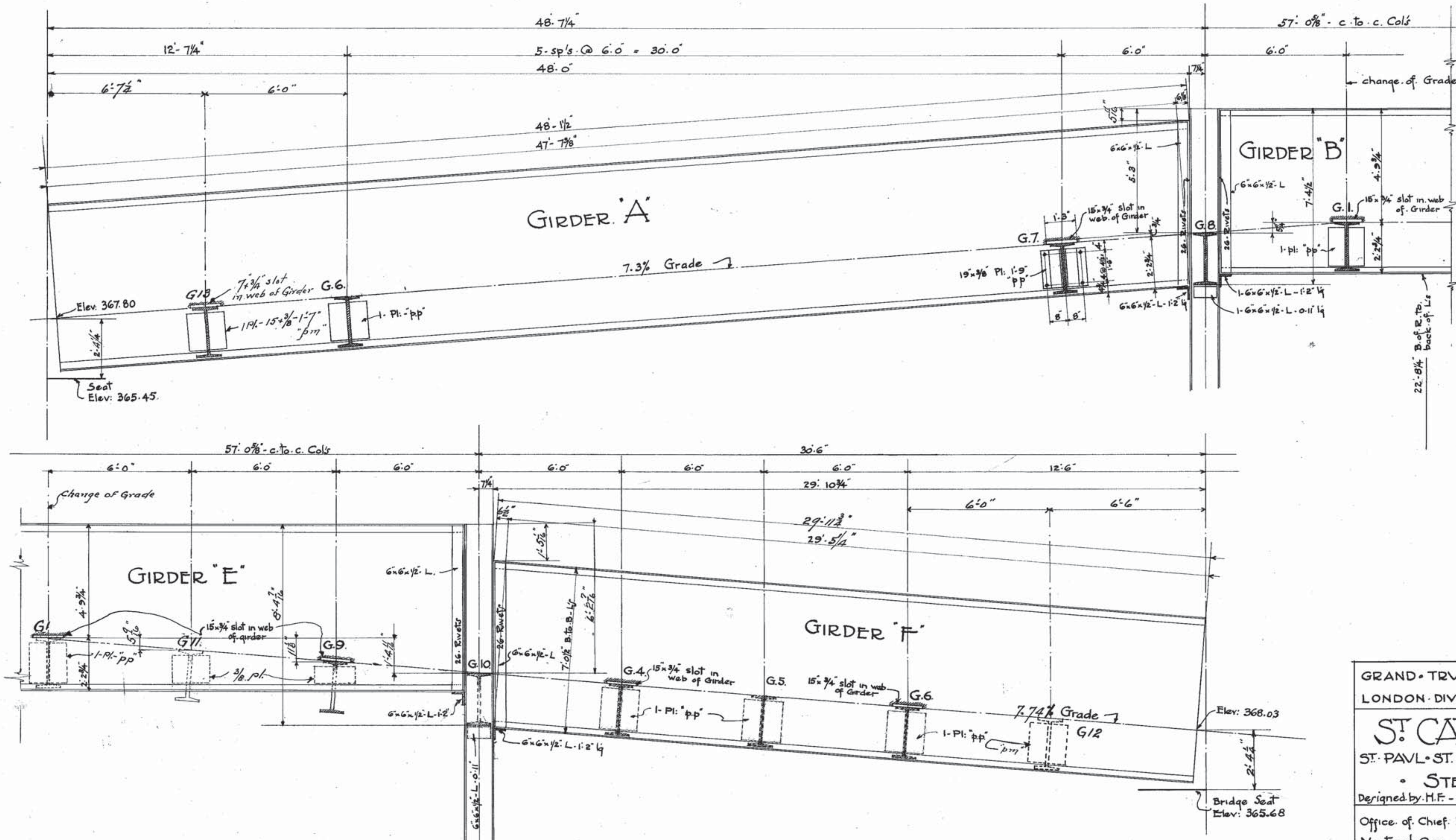
— London Division — 17th District —
— Overhead Bridge — M.P. 11.68 —
St Paul Avenue St Catharines —
— Retaining Wall and Steps —
— North Approach —
— Scale 1/4" = 1'-0" —

Office of Chief Engine. Montreal Aug. 21st 1922

L.G.

File No. [struck out]
Jurnl. No. 9435

484-35



GRAND • TRUNK • RAILWAY • SYSTEM
LONDON • DIVISION ••• 17TH DISTRICT

ST. CATHERINES

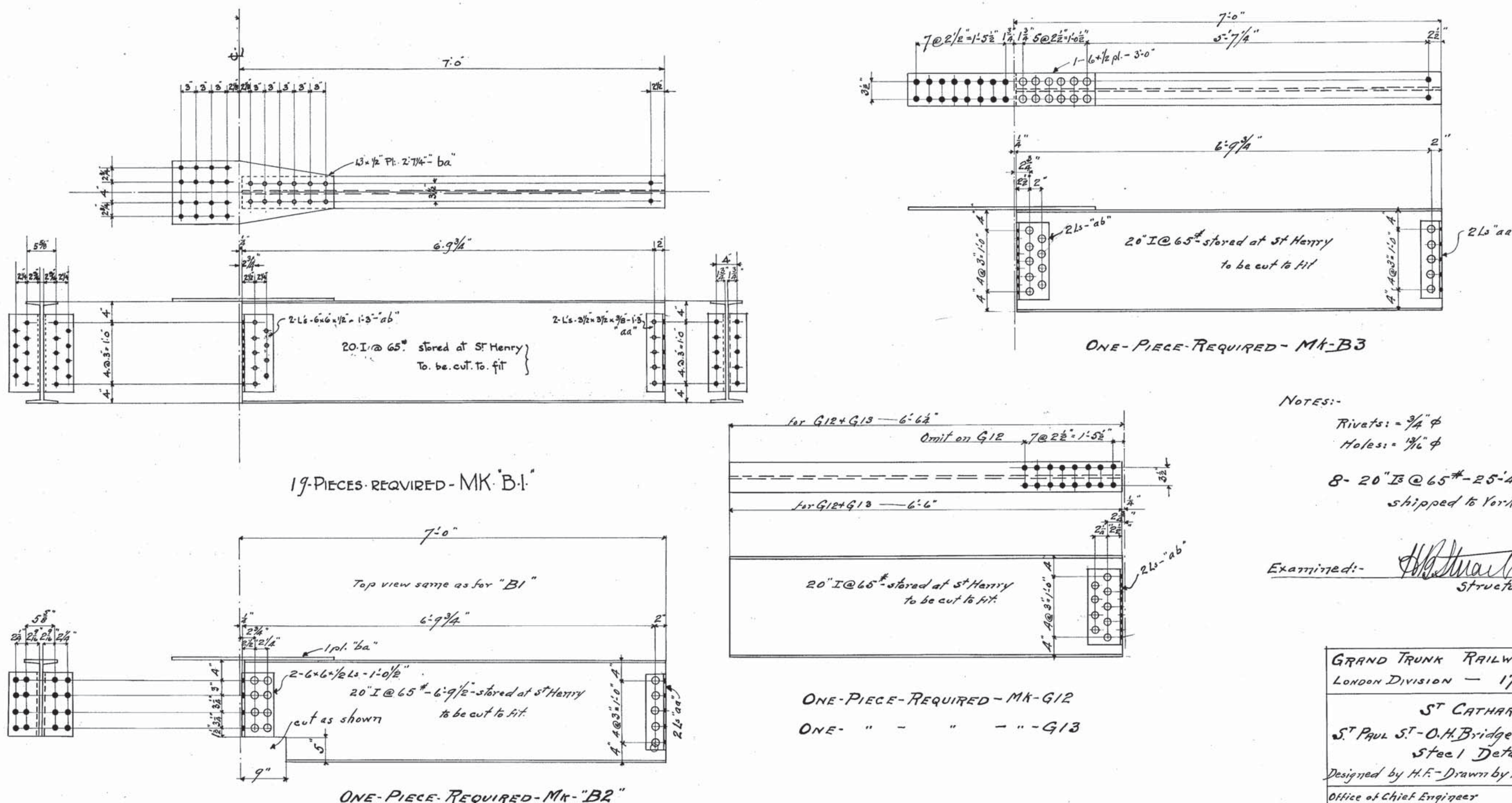
ST. PAUL-ST. O.H. BRIDGE -- MILE 11.68.

• STEEL • DETAILS •

Designed by H.F. - Drawn by L.M.W. Scale ⅜" to 1'-0"

Office of Chief Engineer — Jnl. No 8902

Montreal Que: August 1921. — File No 484-35



NOTES:-

Rivets: = ¾" ⌀

Holes: = 13/16" ⌀

8 - 20" I's @ 65# - 25'-4" to be shipped to York, Ont.

Examined:- H.B. Stuart
Structural Engineer.

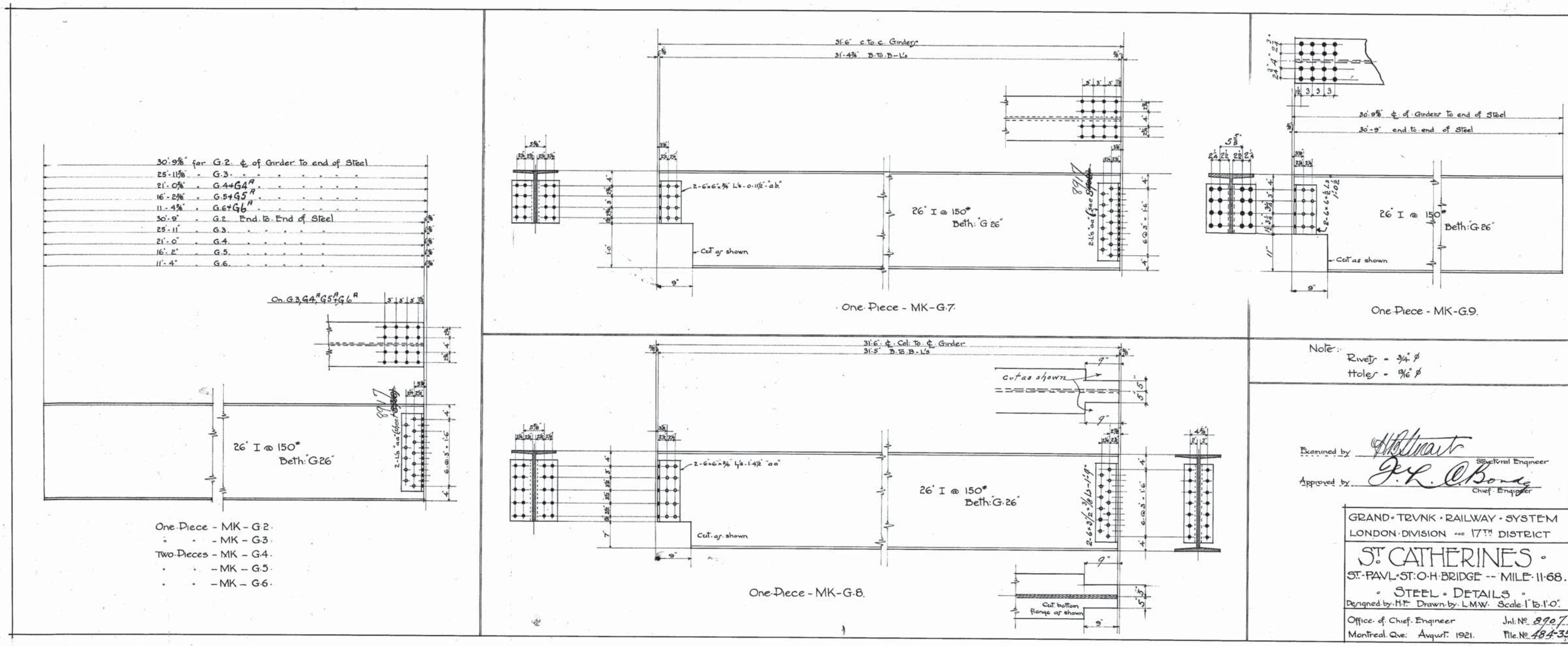
GRAND TRUNK RAILWAY SYSTEM
LONDON DIVISION — 17th DISTRICT

ST CATHARINES
St Paul St - O.H. Bridge - Mile 11.68
Steel Details

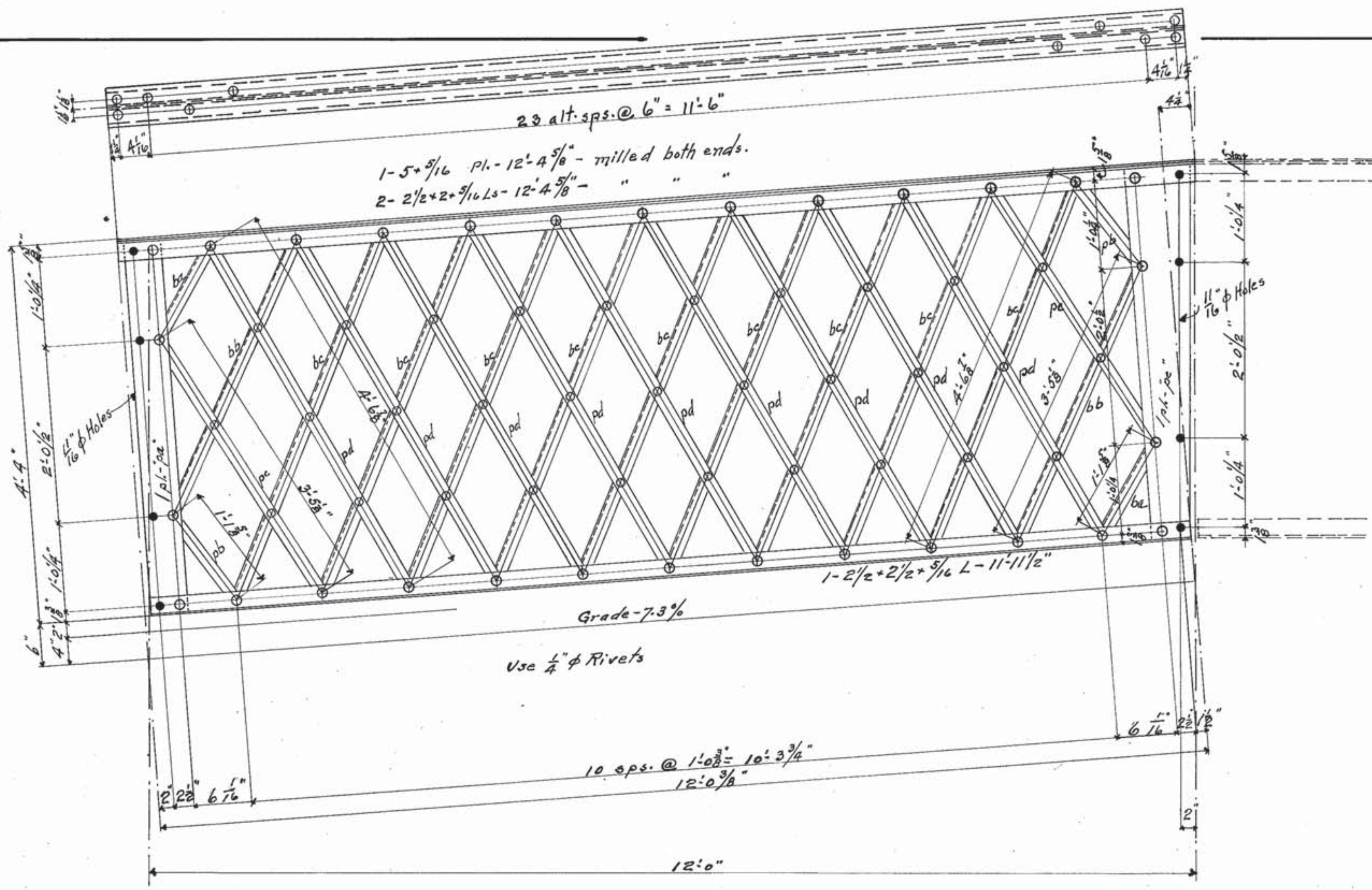
Designed by H.F. - Drawn by H.F. - Scale: 1" = 1 foot

Office of Chief Engineer — Jnl. No. 8904

Montreal - August 20th 1921 — File No. 484-35

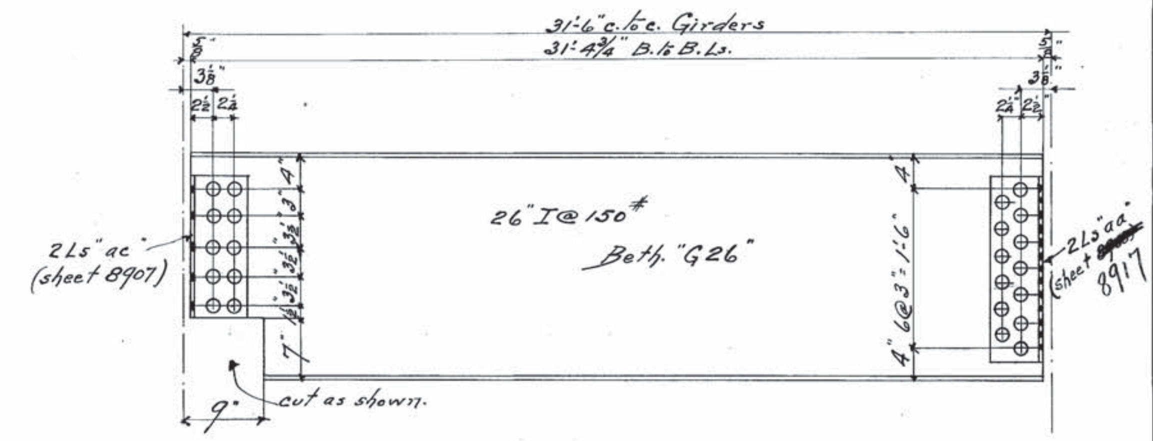


30'-9⅝" for G.2. ℄ of Girder to end of Steel
25'-11⅝" G.3.
21'-0⅝" G.4+G4A
16'-2⅝" G.5+G5A
11'-4⅝" G.6+G6A
30'-9" G.2. End to End of Steel
25'-11" G.3.
21'-0" G.4.
16'-2" G.5.
11'-4" G.6.
On G3, G4A, G5A+G6A
26" I @ 150#
Beth: G.26"
One Piece - MK - G.2.
" - MK - G.3.
Two Pieces - MK - G.4.
" - MK - G.5.
" - MK - G.6.
31'-6" c. to c. Girders
31'-4⅜" B. to B. - L's
2-6x6x¾" L's - 0-11½" "ab"
26" I @ 150#
Beth: G.26"
Cut as shown
One Piece - MK - G.7.
30'-9⅝" ℄ of Girders to end of Steel
30'-9" end to end of Steel
26" I @ 150#
Beth: G.26"
Cut as shown
One Piece - MK - G.9.
31'-6" ℄ Col. to ℄ Girder
31'-5" B. to B. - L's
Cut as shown
2-6x6x¾" L's - 1-4½" "aa"
26" I @ 150#
Beth: G.26"
Cut as shown
Cut bottom flange as shown
One Piece - MK - G.8.
Note:
Rivets - ¾" ϕ
Holes - 13/16" ϕ
Examined by
Structural Engineer
Approved by
Chief Engineer
GRAND TRUNK RAILWAY SYSTEM
LONDON DIVISION — 17TH DISTRICT
ST. CATHERINES
ST. PAUL ST. O.H. BRIDGE -- MILE 11.68.
STEEL DETAILS
Designed by H.F. Drawn by L.M.W. Scale 1" to 1'-0".
Office of Chief Engineer
Montreal, Que. August 1921.
Jnl. No. 8907
File No. 484-35



1-5×5/16 Pl. - 4'-3/8" - "pa"
2-1 1/2×1/4 pls. - 1'-2 5/8" - "pb"
2-1 1/2×1/4 pls. - 3'-6 1/8" - "pc"
9-1 1/2×1/4 pls. - 4'-7 7/8" - "pd"
2-1 1/2×1 1/2×1/4 Ls - 1'-2 5/8" - "ba"
2-1 1/2×1 1/2×1/4 Ls - 3'-6 1/8" - "bb"
9-1 1/2×1 1/2×1/4 Ls - 4'-7 7/8" - "bc"
1-9 3/4×5/16 pl. - 4'-3/8" - "pe" (cut as shown)

One - Panel - Required - Mkd. - "F1"



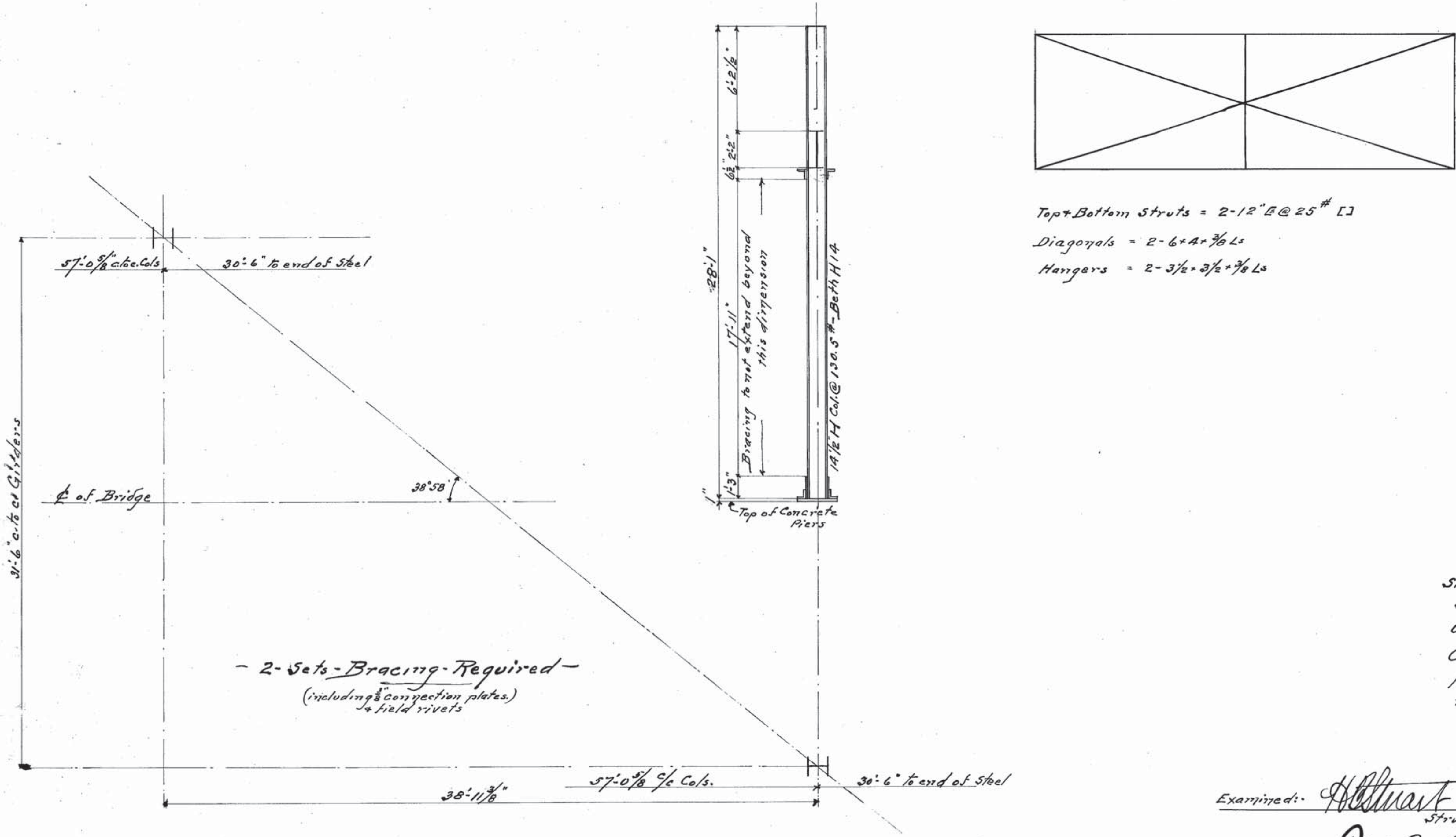
One - Piece - Required - Mk - G11

Notes:-
Rivets = 3/4" φ except on "F1" = 1/4" φ
Holes = 13/16" φ " " " = 11/16" φ

Examined:- H. Stuart
Structural Engineer

Approved:- J. L. C. Bond
Chief Engineer

GRAND - TRUNK - RAILWAY - SYSTEM
LONDON DIVISION - 17th DISTRICT
ST CATHARINES
ST PAUL ST. - O - H - BRIDGE - MILE 11.68
STEEL DETAILS
Designed by H. - Drawn by H. F. - Scale 1" = 1'-0"
Office of Chief Engineer - Jnl. No 8909
Montreal - August 23rd 1921 - File No. 484-35



Top + Bottom Struts = 2-12" [@ 25# [ ]

Diagonals = 2-6 × 4 × 3/8 Ls

Hangers = 2-3 1/2 × 3 1/2 × 3/8 Ls

SPECIFICATIONS:-
Steel Highway Bridges for Province of Ontario dated 1917

CAPACITY:- 20 TON Truck - Class "C"

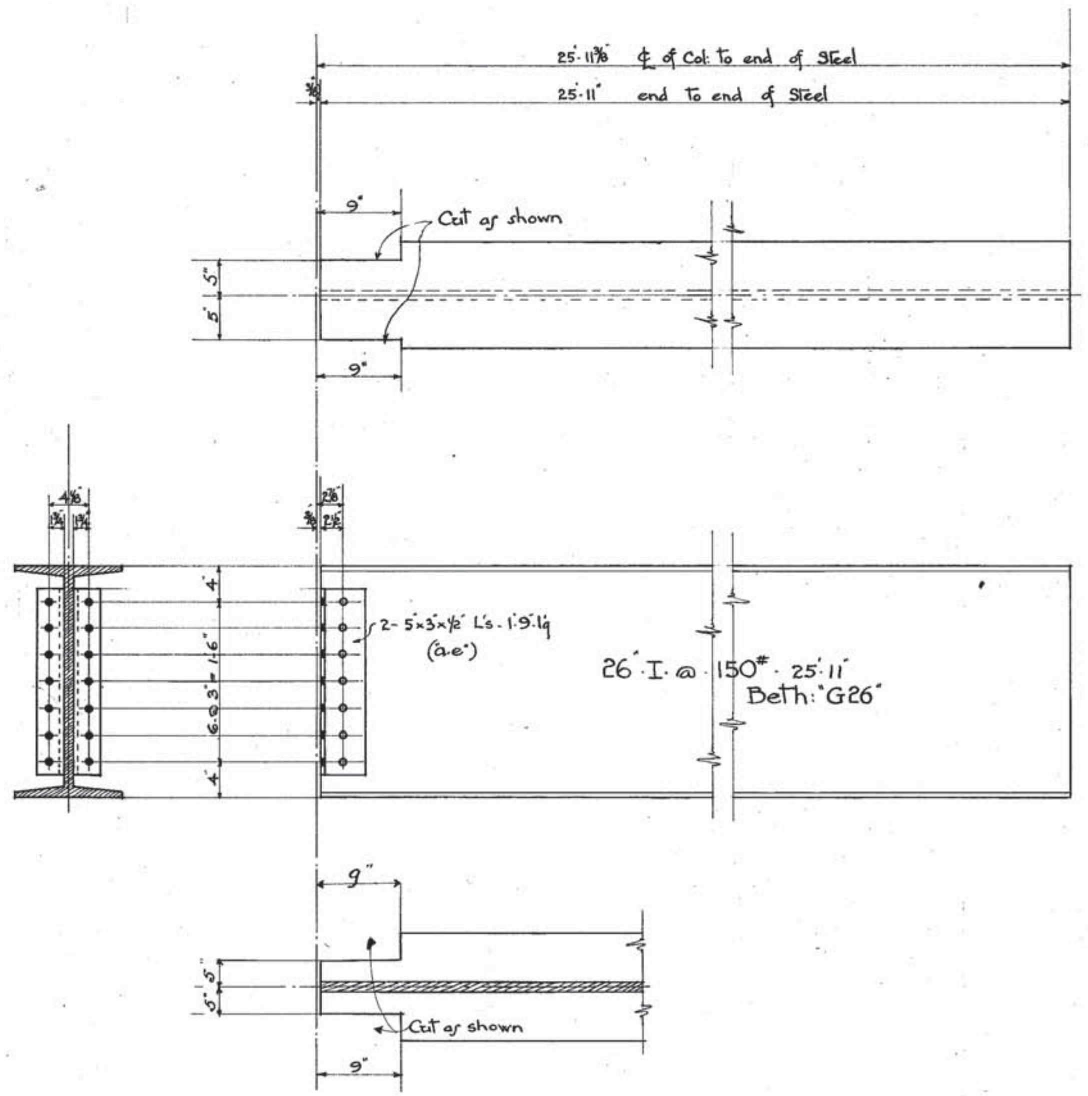
Material to receive one coat of shop paint #400 Dominion Paint Works - Walkerville - Ont.

Examined:- H. Stuart
Structural Engineer

Approved:- J. L. C. Bond
Chief Engineer

GRAND TRUNK RAILWAY SYSTEM
LONDON DIVISION - 17th DISTRICT
Proposed Renewal
O.H. Bridge - M.P. 11.68
St Catharines
Bracing between Columns
Office of Chief Engineer - 8-27-21

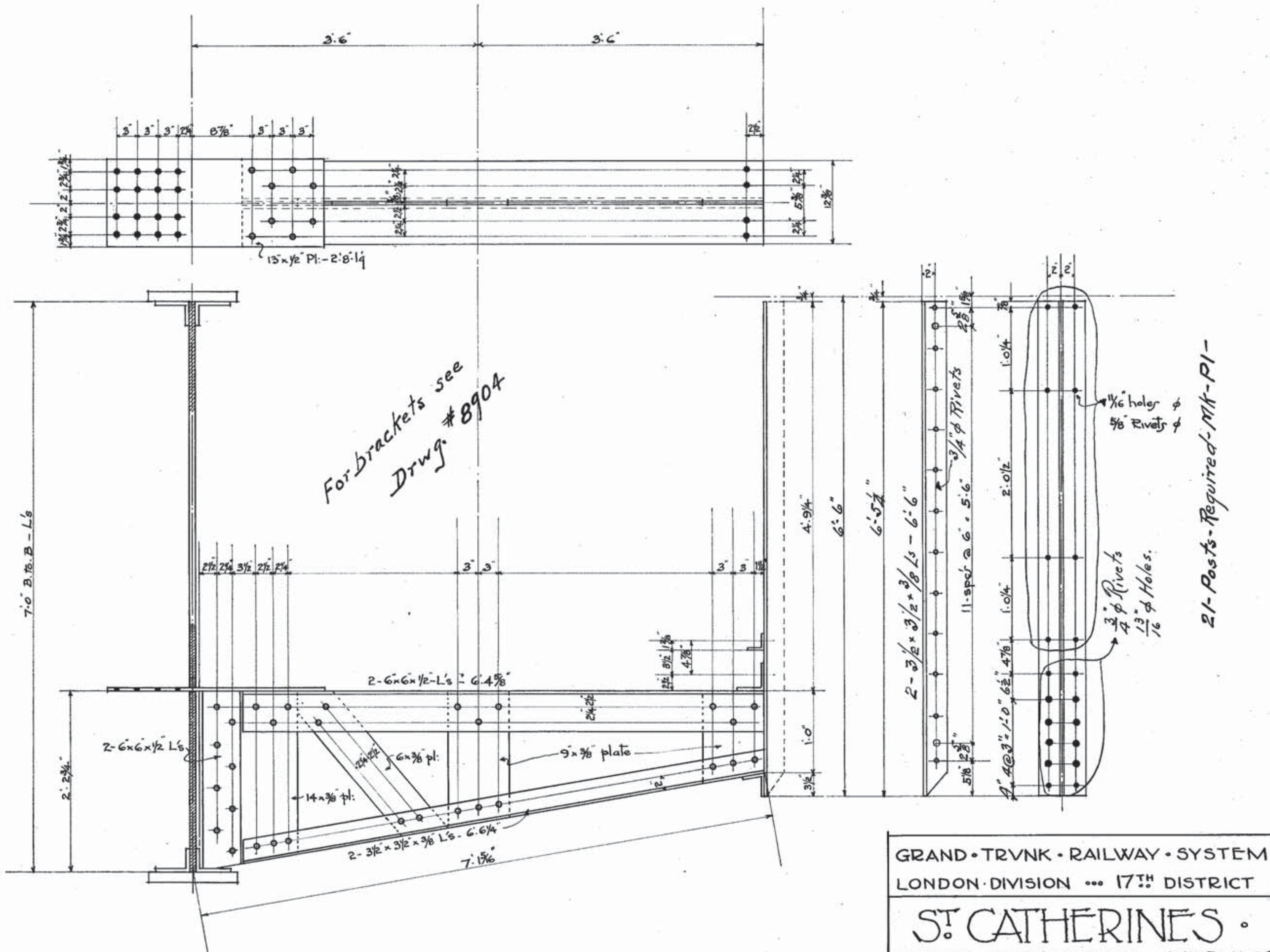
Jnl. No. 8913
File No. 484-35



One Piece Required- MK-"G10"

Note: Rivets = 3/4" ϕ

Holes - 13/16" ϕ



Examined by H.B. Stuart
Structural Engineer

Approved by J. L. C. Bond
Chief Engineer.

GRAND • TRUNK • RAILWAY • SYSTEM

LONDON • DIVISION ••• 17TH DISTRICT

ST CATHERINES •

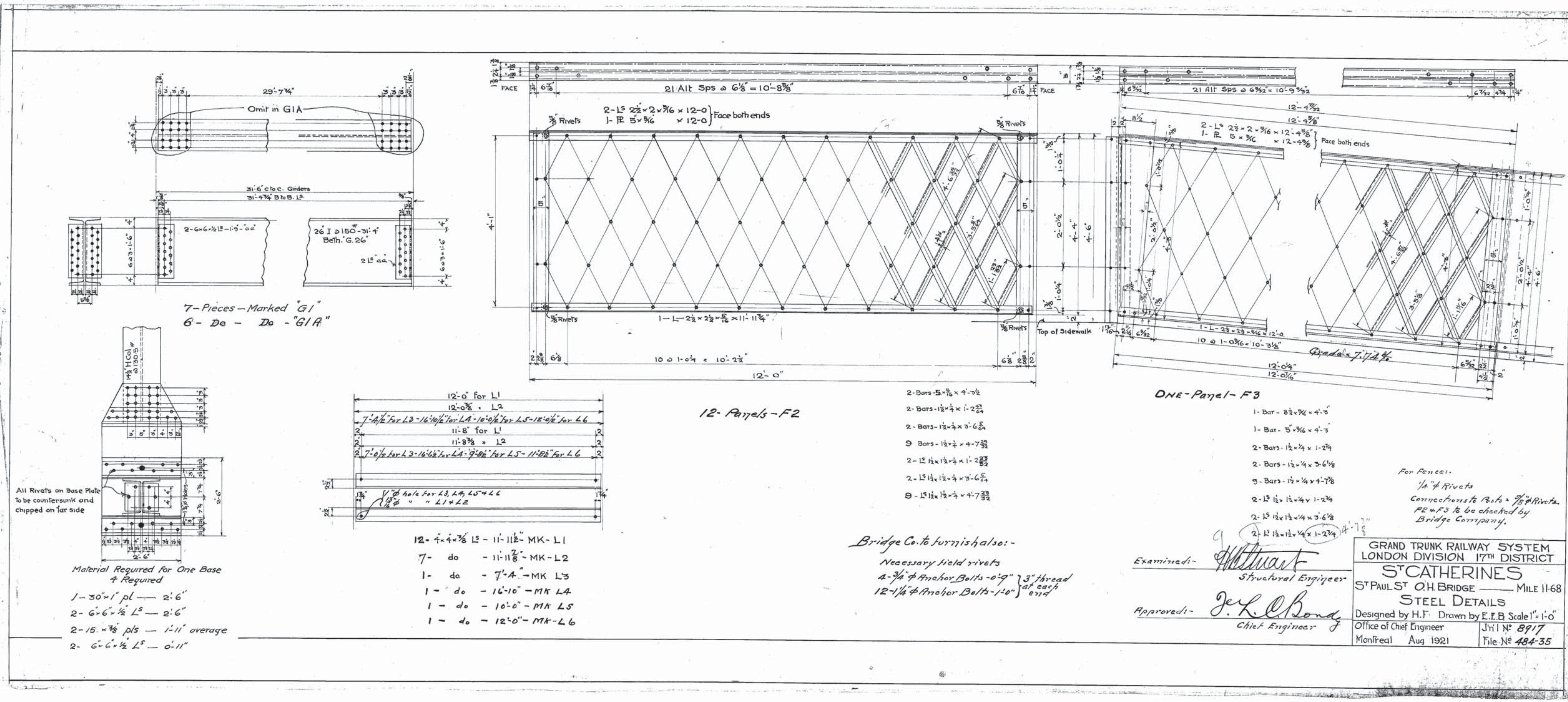
ST-PAUL • ST • O • H • BRIDGE -- MILE • 11 • 68.

• STEEL • DETAILS •

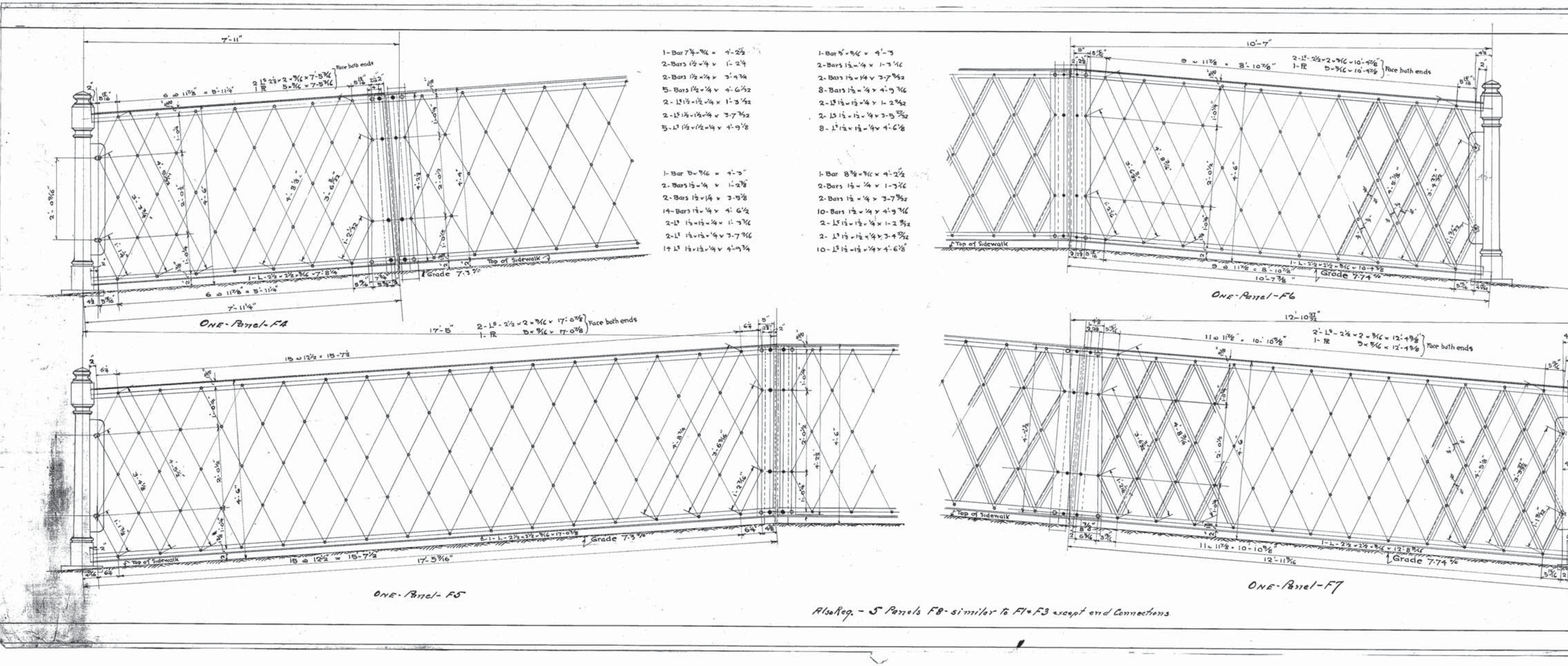
Designed by H.F. Drawn by L.M.W. Scale 1" to 1'-0"

Office of Chief Engineer — Jnl: No 8914

Montreal Que. August 1921. — File No 484-35



29'-7¾"
Omit in G1A
31'-6" c to c. Girders
31'-4¾" B to B. L's
2-6×6×½ L's-1'-9" "aa"
26" I @ 150#-31'-4" Beth. G.26"
2 L's "aa"
7-Pieces-Marked "G1"
6- Do - Do -"G1A"
All Rivets on Base Plate to be countersunk and chipped on far side
Material Required for One Base
4 Required
1-30"×1" pl — 2'-6"
2- 6"×6"×½" L's — 2'-6"
2-15×⅜" p/s — 1'-11" average
2- 6"×6"×½" L's — 0'-11"
12'-0" for L1
12'-0⅜" " L2
7'-4½" for L3-16'-10½" for L4-10'-0½" for L5-12'-0½" for L6
11'-8" for L1
11'-8⅜" " L2
7'-0½" for L3-16'-6½" for L4-9'-8½" for L5-11'-8½" for L6
12- 4"×4"×⅜" L's - 11'-11½" MK-L1
7- do - 11'-11⅞" MK-L2
1- do - 7'-4" MK L3
1- do - 16'-10" MK L4
1- do - 10'-0" MK L5
1- do - 12'-0" MK L6
21 Alt Sps @ 6⅛" = 10'-8⅝"
2-L's 2½"×2"×5/16 × 12-0
1- Pl. 5×5/16 × 12-0
Face both ends
⅝" Rivets
1-L-2½×2½×5/16×11'-11¾"
Top of Sidewalk
10 @ 1-0¼ = 10'-2½"
12'-0"
12- Panels-F2
2-Bars-5×5/16×4'-3½
2-Bars-1½×¼×1-2 31/64
2-Bars-1½×¼×3-6 5/64
9 Bars-1½×¼×4-7 23/32
2-L's 1½×1½×¼×1-2 23/32
2-L's 1½×1½×¼×3-6 5/64
9-L's 1½×1½×¼×4-7 23/32
21 Alt Sps @ 6 3/32 = 10'-9 5/32
2-L's 2½×2×5/16 × 12'-4⅜"
1- Pl. 5×5/16 × 12-4⅜
Face both ends
1-L-2½×2½×5/16×12-0
10 @ 1-0 9/16 = 10'-5⅝"
Grade 7.714%
12'-0¼"
12'-0 9/16"
One-Panel-F3
1-Bar- 8½×5/16×4'-5"
1-Bar- 5"×5/16×4'-3"
2-Bars-1½×¼×1-2¾
2-Bars-1½×¼×3-6⅛
9-Bars-1½×¼×4-7⅞
2-L's 1½×1½×¼×1-2¾
2-L's 1½×1½×¼×3-6⅛
2-L's 1½×1½×¼×1-2¾ 4'-7⅞"
For Fence:-
¼" ⌀ Rivets
Connections to Posts = ⅝" ⌀ Rivets
F2 & F3 to be checked by Bridge Company.
Bridge Co. to furnish also:-
Necessary field rivets
4-⅞" ⌀ Anchor Bolts-0'-9"
12-1¼" ⌀ Anchor Bolts-1'-0"
3" thread at each end
Examined:- H. Stuart
Structural Engineer
Approved:- Jas. L. C. Bond
Chief Engineer
GRAND TRUNK RAILWAY SYSTEM
LONDON DIVISION 17TH DISTRICT
ST CATHERINES
ST PAUL ST O.H. BRIDGE — MILE 11.68
STEEL DETAILS
Designed by H.F. Drawn by E.E.B. Scale 1" = 1'-0"
Office of Chief Engineer
Montreal Aug 1921
Jn'l No 8917
File No 484-35



Examined:- H. Stuart
Structural Engineer

Approved:- J. L. D. Bonds
Chief Engineer

Note:-
¾" ϕ Rivets
Connections to Posts - ⅝" ϕ Rivets.
F4-F5-F6-F7 + F8 to be checked by Bridge Co.

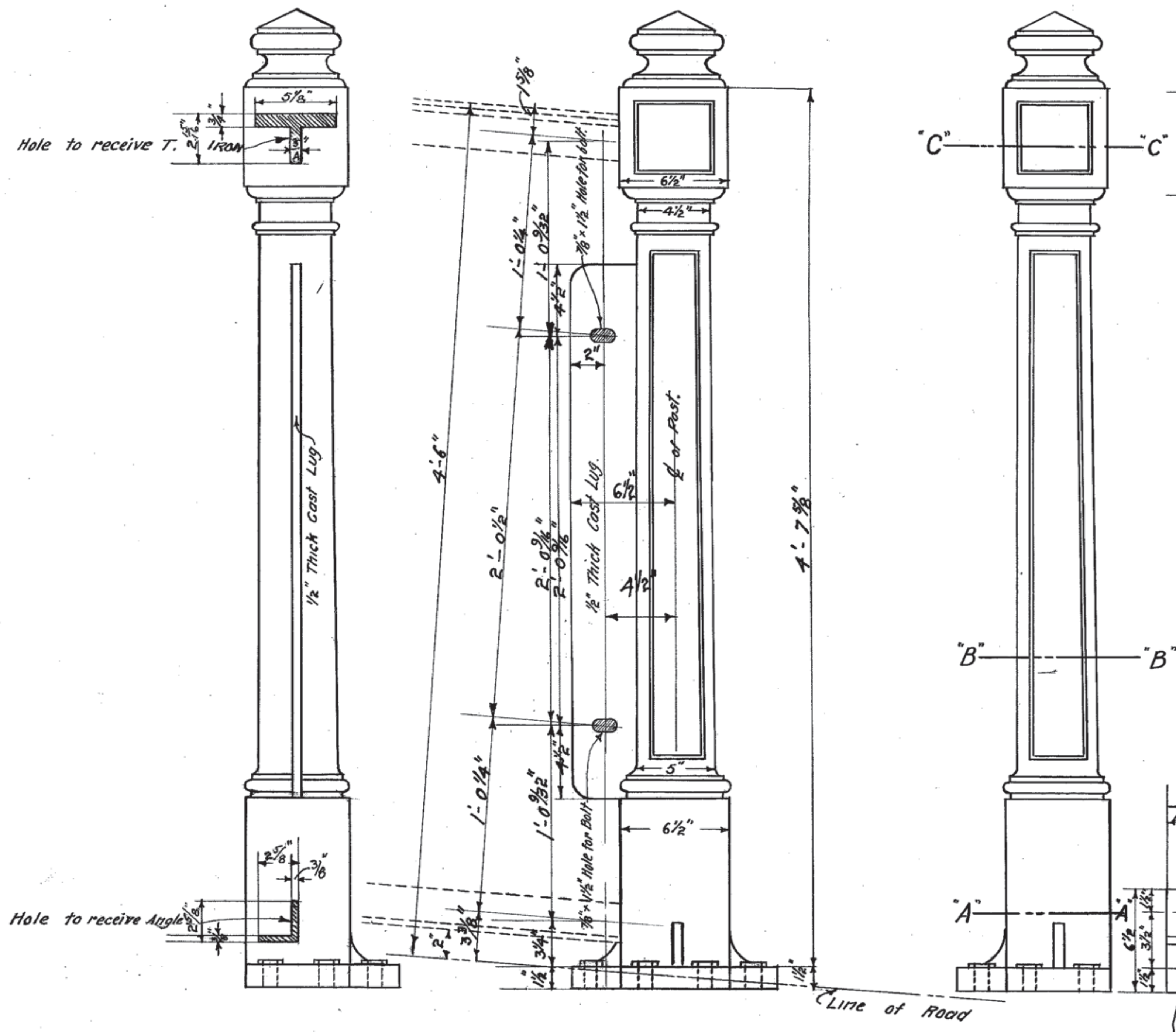
GRAND TRUNK RAILWAY SYSTEM
LONDON DIVISION 17 DISTRICT

ST CATHERINES
ST PAUL ST O.H. BRIDGE MILE 11-68
STEEL DETAILS

Designed by H.F Drawn by E.E.B
Scale 1" = 1'-0"

Office of Chief Engineer Montreal Aug 1921	J'n'l No 8918 — File No 484-35

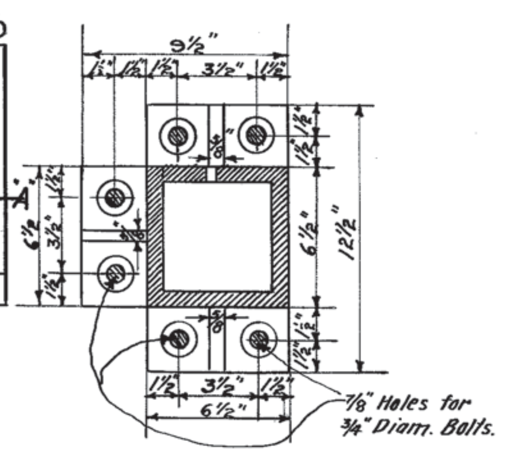
8918



ELEVATIONS

SECTION "C"-"C"

SECTION "B"-"B"



SECTION "A"-"A"

2 RIGHT HAND Posts Req. As Shown
2 LEFT " " "

NOTE:-
All castings must be tough Gray Iron free from cold shuts or injourious blow holes, true to form and thickness, and of a workman like finish.
Sample pieces 1" Inch Square cast from same heat of metal in sand moulds shall be capable of sustaining on a Clear span of 12 inches a central load of 2400 pounds when tested in the Rough Bar

EXAMINED:- H. B. Stuart
Structural Engineer

APPROVED:- J. L. C. Bondy
Chief Engineer

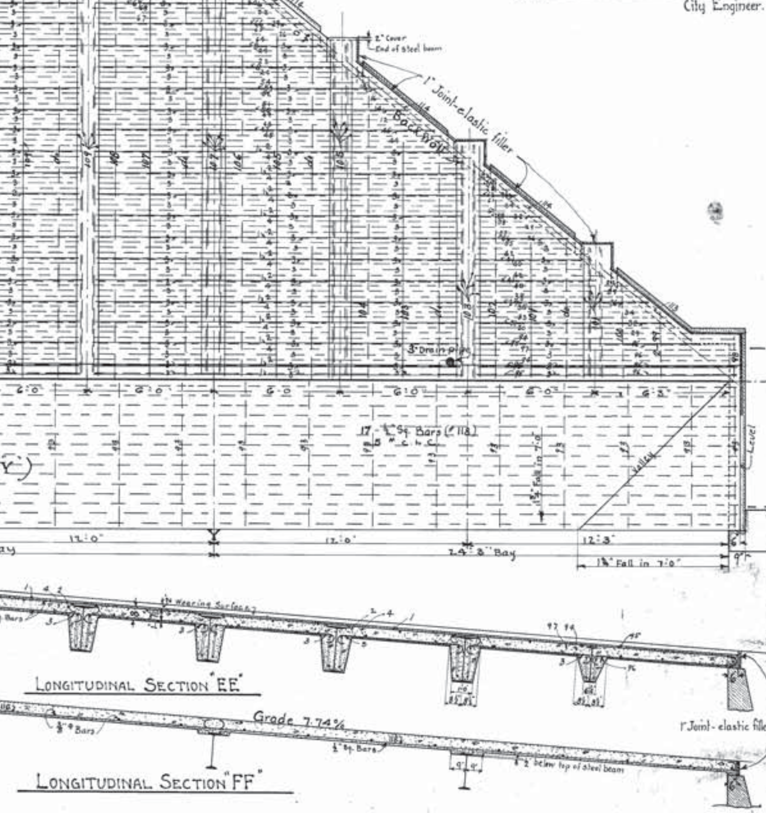
GRAND TRUNK RAILWAY SYSTEM
LONDON DIVISION 17TH DISTRICT.

ST CATHERINES
ST PAUL ST O.H. BRIDGE MILE 11·68
DETAIL OF CAST IRON NEWEL POSTS
Scale 2"=1'-0"

Office of Chief Engineer
Montreal. April 29th 1922

Journal No 9222
File No 484-35

J.A.S.



MARKS	Nº	SIZE	WEIGHT	MARKS	Nº	SIZE	WEIGHT
*1-115	233	½" Sq. Bars 20'6" lg.	4060#	*38-69-71	6	½" Sq. Bars 10'9" lg.	55
2-4	401	" 22'3" "	7584	39	7	" 2'10" "	17
3-78-74-100	1391	" 7'0" "	8276	44-42	16	" 9'1" "	124
5-45	4	" 20'8" "	70	41	7	" 8'6" "	51
6-7	3	" 22'1" "	56	44-75	7	" 6'3" "	37
8-95	9	" 14'6" "	111	45-86	3	" 20'1" "	51
9-48	4	" 19'5" "	66	46	6	" 5'2" "	26
10	5	" 7'11" "	34	47	3	" 18'4" "	47
11	2	" 17'9" "	30	53	2	" 15'11" "	27
12-78	6	" 5'0" "	26	55	2	" 7'2" "	12
13-49	4	" 18'10" "	64	56-57-92	5	" 6'6" "	28
14-79-80	7	" 4'4" "	26	72	2	" 9'7" "	16
15-51	4	" 18'2" "	62	76-77	2	" 5'9" "	10
16	5	" 3'8" "	16	81	1	" 3'10" "	3
17	2	" 16'5" "	28	83	1	" 19'0" "	16
18-82	6	" 3'3" "	17	84	1	" 13'0" "	11
19-52	4	" 17'7" "	60	85	1	" 12'4" "	10
20-50-54	6	" 17'0" "	87	87	1	" 4'2" "	4
21-94-97	5	" 15'5" "	65	90-91	2	" 6'0" "	10
22	13	" 2'6" "	28	96	4	" 7'9" "	26
23-24	18	" 15'8" "	173	116	120	" 26'0" "	2652
25-64	3	" 13'10" "	35	117	13	" 24'0" "	306
26-58	8	" 5'11" "	40	118	17	" 26'3" "	379
27-30-61	3	" 12'8" "	34	119	32	" 18'0" "	490
28-65	3	" 13'2" "	34	Extra	20	" 30'0" "	510
29-59-60-89	12	" 5'5" "	54			Total	26500#
31	2	" 11'5" "	19				
32-61-88	10	" 4'8" "	40	98	1	⅝" Round Bars 8'6" lg.	1
33-66-68	6	" 12'0" "	61	99	2	" 5'3" "	2
34-62-63	11	" 4'0" "	37	100	2	" 4'9" "	4
35-70	4	" 11'8" "	38	101	14	" 6'3" "	33
36	7	" 3'5" "	20	102	2	" 9'6" "	7
37	2	10'2" "	17	103	16	" 11'3" "	68
				104	2	" 14'6" "	11
				105	16	" 16'0" "	96
				106	2	" 19'3" "	14
				107	16	" 20'9" "	125
				108	2	" 24'0" "	18
				109	16	" 25'6" "	153
				110-111	322	" 16'6" "	1998
				112	3	" 2'0" "	2
				113	2	" 5'6" "	4
				114	10	" 7'6" "	28
				93	94	" 6'9" "	236
				Extra	10	" 30'0"	113
							2913#
						Total Steel -	29219#
				Iron Wire	Gauge #14		200
				Concrete		– Slab (1:2:4)	205 C.Y.
				"		Wearing Surf. & curb (1:1½:3)	32 "

③

SPECIFICATION – ONTARIO CONCRETE HIGHWAY BRIDGES.
LOADING – ROADWAY – 20 TON ROLLER.
SIDEWALK – 100# PER SQUARE FOOT.
UNIT STRESSES – CONCRETE – COMPRES. 650# PER SQ. INCH
SHEAR – 60# " "
(PLAIN BARS) BOND – 60# " "
STEEL – TENSION – 16000# " "
(G.T.R. SPECIFICATION FOR SLABS)

CONCRETE – SLAB 1:2:4
DO – WEARING SURFACE – 1:1½:3

Notes:– The net computed thickness of Roadway slab is exclusive of 2" wearing surface of 1:1½:3 fine Concrete – Coarse aggregate ⅜" hard "pea stone" or screened gravel, – which is to be applied to the fresh surface of the slab before it has begun to set.

Steel Bars. – All bending to be done cold.
All steel must be clean and free from loose scales.
All bars are to be straight and true, portions bent up to be in same plane. –
Steel should be properly spaced, braced and supported, so that placing of concrete will not disturb it.

Concrete. – If placing of concrete in the slab is not continuous, care must be taken to stop the concrete with a vertical face at either the centre of the span or at the centre of bearing.

Approved ____ Ontario Highway Board.

Approved ____ City Engineer.

Note:– Any suitable gully, – City of St. Catherines pattern, – will be accepted.

DETAIL – CAST IRON GULLEY
SCALE – 4" = 1'0"

Examined R. Armour – Masonry Engineer
Approved [signature] – Chief Engineer
Approved ____ General Superintendent
Approved ____ Vice President.

GRAND TRUNK RAILWAY SYSTEM
LONDON DIVISION – 17TH DISTRICT
OVERHEAD BRIDGE – M.P. 11.68
ST. PAUL STR. – ST. CATHERINES
REINFORCED CONCRETE FLOOR PLAN
SCALE – ⅜" = 1'0"
OFFICE OF CHIEF ENGINEER – MONTREAL – JUNE – 1922

Tool Nº 9271
File Nº

49.

A531 St. Cath

REGIONAL MUNICIPALITY OF NIAGARA

PUBLIC WORKS DEPARTMENT

REPAIRS TO STRUCTURE No. 71

St. Paul Street Over CNR

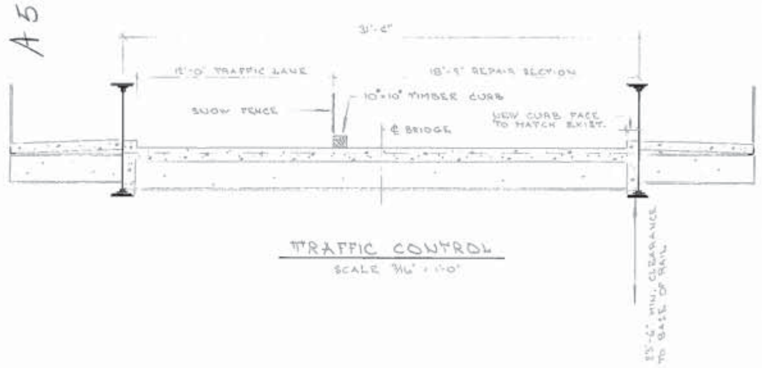
– Key Plan –

C.H. EIDT P. ENG.
DIRECTOR OF ENGINEERING

J.E. CAMPBELL
REGIONAL CHAIRMAN

CONTRACT NO. RN. 77 – 15

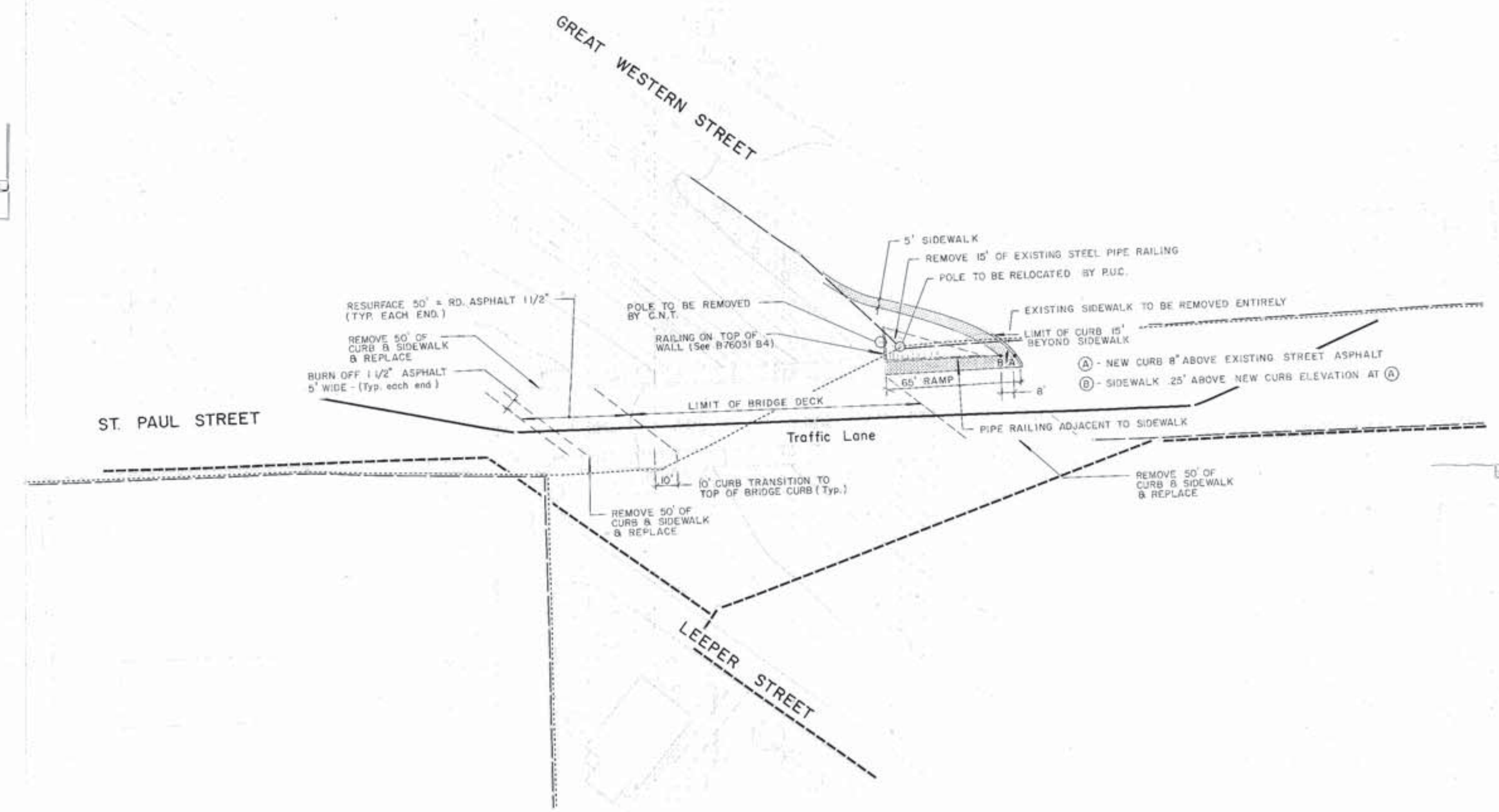
A531

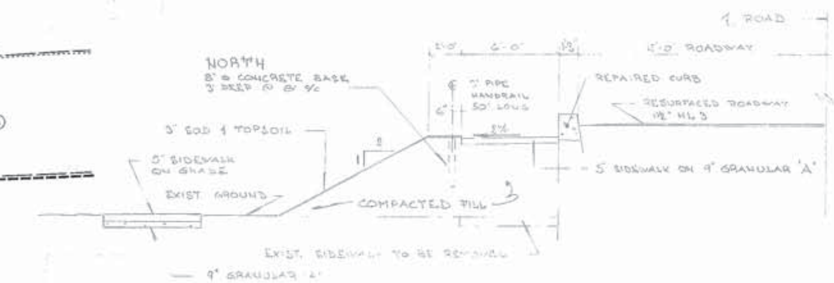


TRAFFIC CONTROL
SCALE 3/16" = 1'-0"

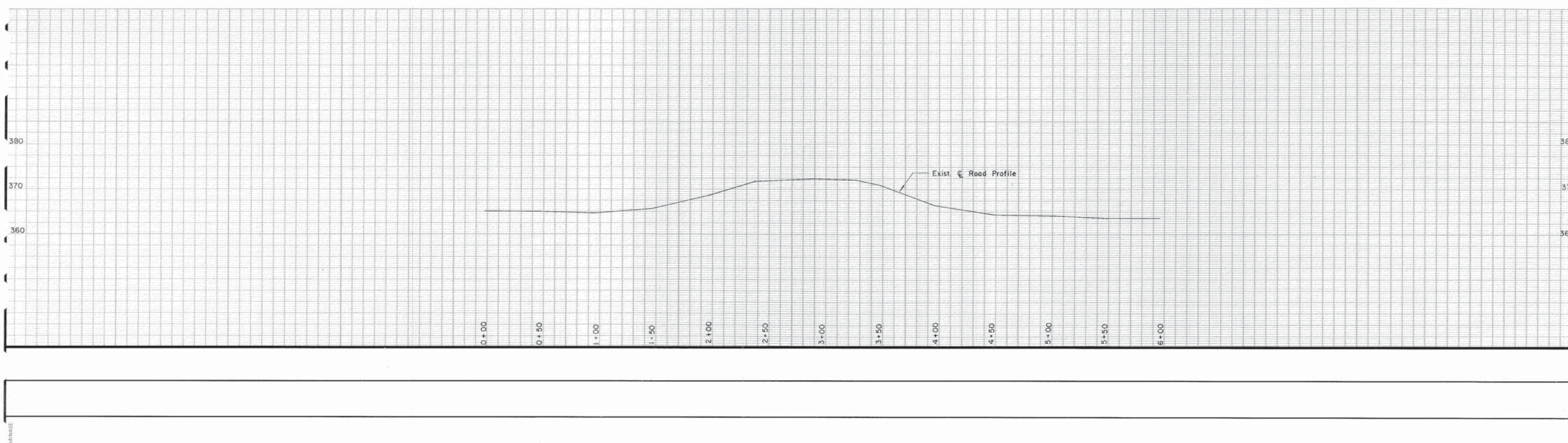
LEGEND

- O/H Primary (4000V)
- O/H Secondary (120/240V)
- Bell Canada
- 10" x 10" Timber Curb





SECTION IN VICINITY OF 3+50
SCALE 3/16" = 1'-0"



NOTES

1. MINIMUM CONCRETE STRENGTH AT 28 DAYS SHALL BE:
   Deck = 4000 psi
   Sidewalk = "
   Retaining Wall = "
2. REINFORCING STEEL SHALL BE HARD GRADE AND HIGH BOND WITH A MINIMUM YIELD STRENGTH OF 50000 psi.
3. CLEAR COVER TO REINFORCING STEEL SHALL BE:
   1" top of deck slab
   1 1/2" bottom of deck & sidewalk & top of sidewalk
   2" cover to retaining walls exposed to earth
   3" cover to concrete poured against earth
4. ALL CONSTRUCTION JOINTS SHALL BE APPROVED BY THE ENGINEER.
5. ALL EXPOSED CORNERS SHALL BE CHAMFERED 1" x 1" UNLESS OTHERWISE NOTED.
6. APPROVED ADMIXTURES SUPPLIED BY THE CONTRACTOR SHALL BE ADDED TO ALL CONCRETE.

APPROVED

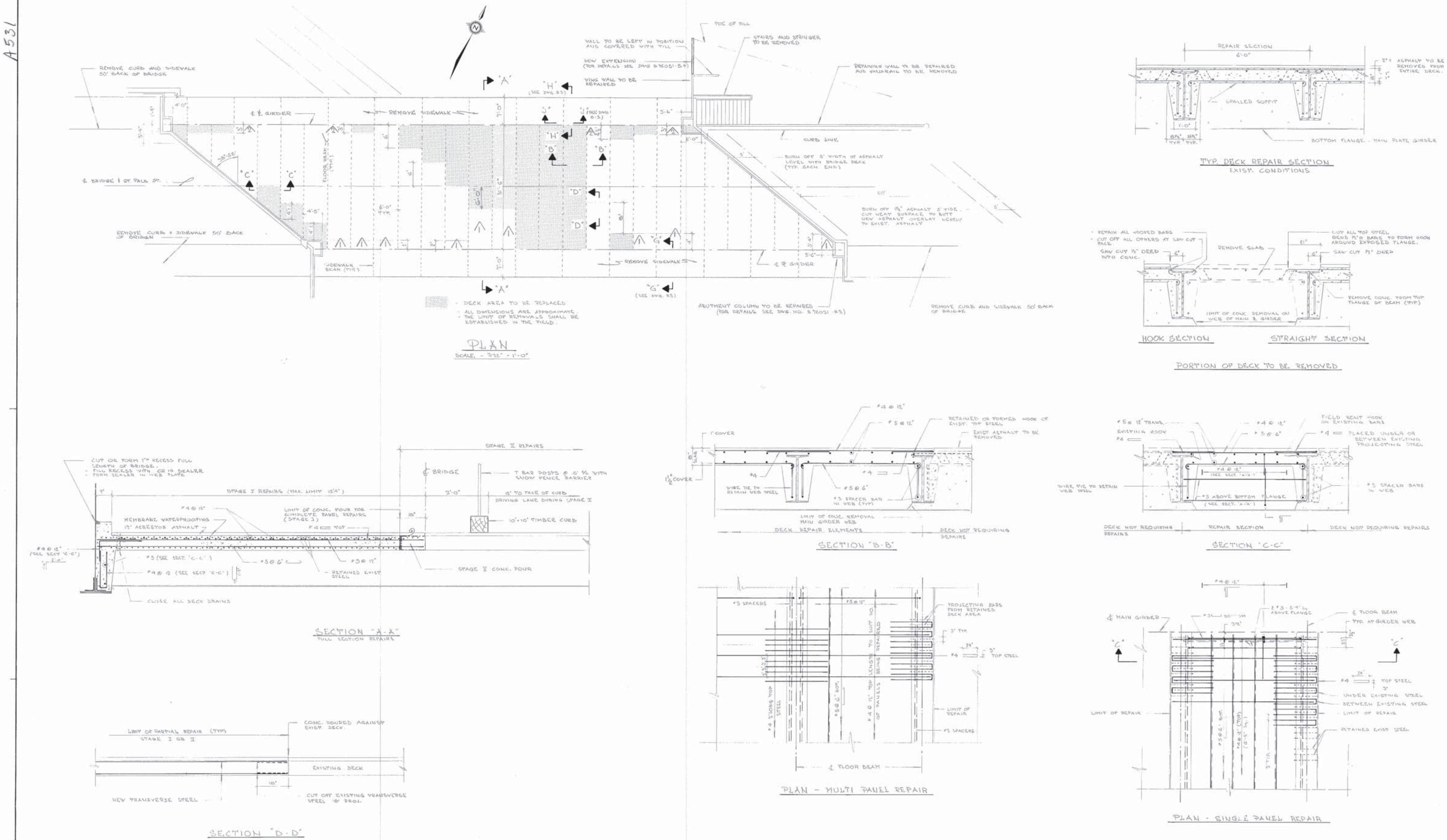
NO.	REVISION	DATE	INITIAL

RH Read-Harris Engineering
160 Duncan Mill Rd. Don Mills
Approved — Consultants

REGIONAL MUNICIPALITY OF NIAGARA
Structure No. 71
St. Paul Street West over CNR
SITE PLAN

HORIZ. 1" = 40' or SCALE AS SHOWN	VERT. SCALE 1" = 10'	Cont. No. 77-15	DATE MARCH/77
DRAWN BY J.S.	CHECKED BY P.E.S.	DWG. No.	B76031 - B1

A531



No.	TITLE	DATE	REVISIONS	BY
2		SEPT.10/77	AS CONSTRUCTED DETAIL	
1		AUG. 11/77	DELETE DECK REPAIRS	

Read-Harris Engineering
160 Duncan Mill Rd. Don Mills

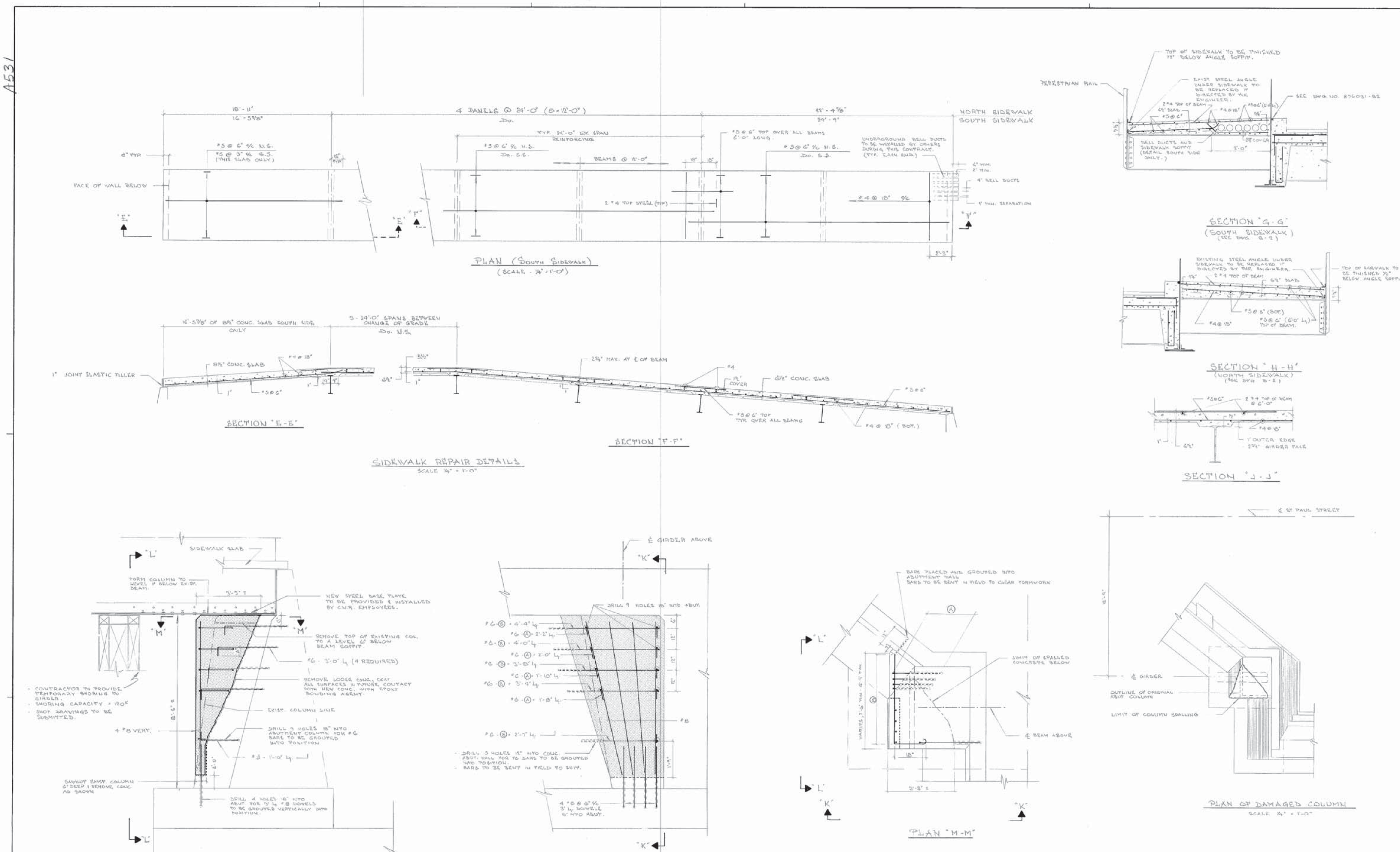
Approved — Consultants

REGIONAL MUNICIPALITY OF NIAGARA

Structure No. 71
St. Paul Street West over CNR
DECK REPAIR DETAILS

DRAWN BY: J.S. | DESIGNED BY: P.E.S. | CHECKED BY: P.E.S. | Cont. No. 77-15

SCALE: 1/2" = 1'-0" or AS SHOWN | DATE: MARCH 1977 | DWG. No. B76031 - B2



No.	TITLE	DATE	REVISIONS	BY

Read-Harris Engineering
160 Duncan Mill Rd. Don Mills

Approved

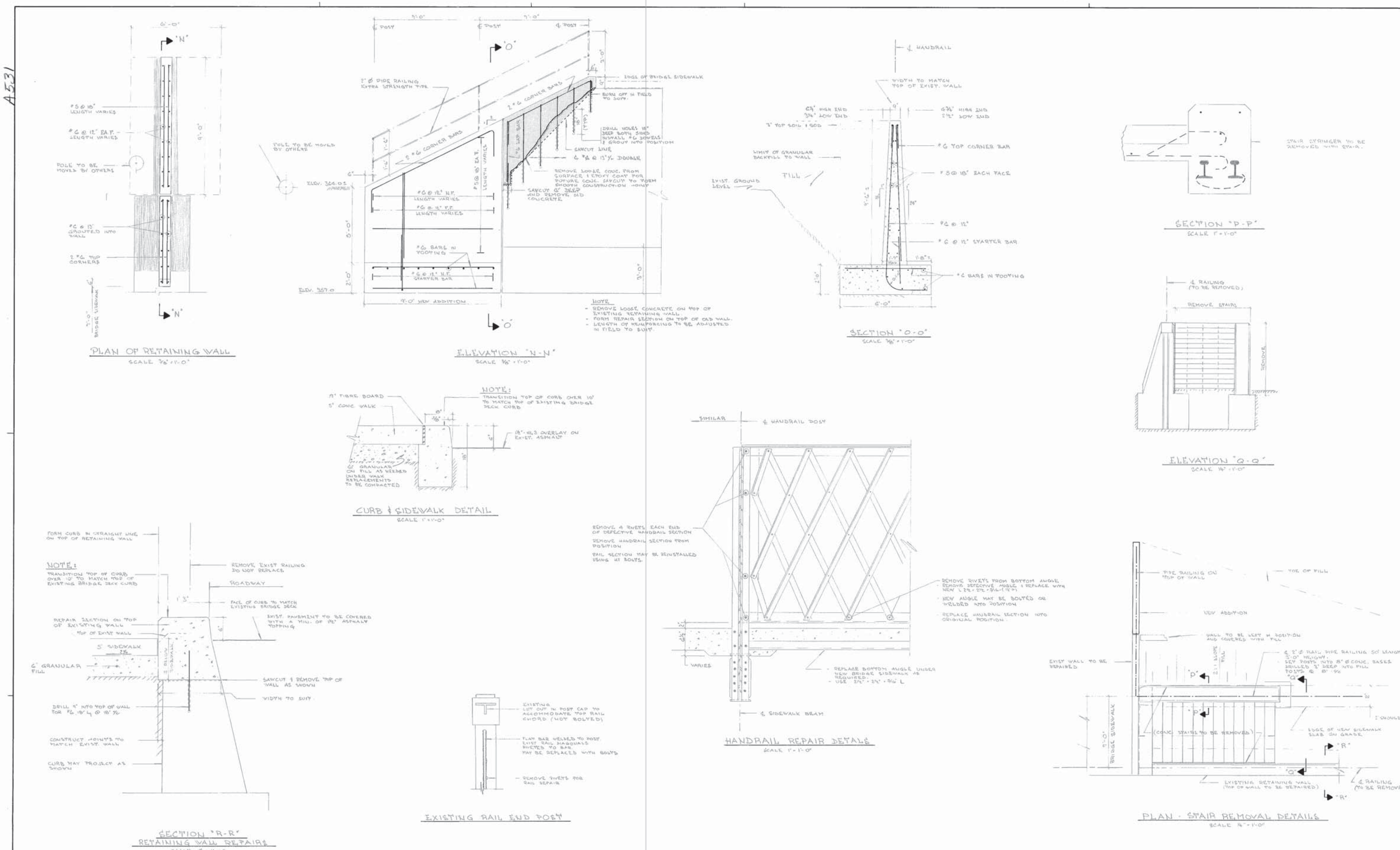
REGIONAL MUNICIPALITY OF NIAGARA

Structure No. 71
St. Paul Street West over CNR
SIDEWALK & ABUTMENT COLUMN REPAIRS

DRAWN BY: J.S. | DESIGNED BY: P.E.S. | CHECKED BY: P.E.S. | Cont. No. 77-15

SCALE: 1/2" = 1'-0" or AS SHOWN | DWG. No. B76031 - B3

DATE: MARCH 1977



No.	TITLE	DATE	REVISIONS	BY

Read-Harris Engineering
160 Duncan Mill Rd. Don Mills
Approved — Consultants

REGIONAL MUNICIPALITY OF NIAGARA
Structure No. 71
St. Paul Street West over CNR
RETAINING WALL & HANDRAIL REPAIRS

DRAWN BY: J.S. DESIGNED BY: P.E.S. CHECKED BY: P.E.S. Cont. No. 77-15
SCALE: AS SHOWN
DATE: MARCH 1977
DWG. No. B76031 - B4