Forsgren Associates has completed the temporary ramp deflection and capacity calculations for the Calumet Reactor Bigge (Job #13Q-9199) Rev 1 Truck Configuration. Per our scope of work, we have determined the deflections and moment and shear capacities for the 52-foot long Bigge Jump Bridge (Almas International drawing with the identifier “Old Bridge Reinforced 1988”), as well as for the 60-foot Barge Ramp (BR60-2 and BR60-3).

52-Foot Jump Bridge:

This jump bridge is 8 feet wide, 52 feet long, with a center of bearing to center of bearing length of 48 feet, based on drawings provided by Bigge. Two jump bridges will be used to span across the following structures, each carrying half of the truck load:

- Bridge Key 18525; US-95, 11.7 Miles North of Moscow
- Bridge Key 18705; US-95, 0.1 Mile South of Cocolalla

Please see Appendix A for the following supporting information:

- Bridge Site Drawings
- 52’ Jump Bridge Drawings
- Calculations

A model of the temporary jump bridge was developed in LARSA 4D to determine the deflections and loading. The ramp was modeled as a simple span beam constructed of A36 steel. Using the LARSA Section Composer tool, the ramp was modeled using the dimensions of the plates and a tee-shaped element made from half of a W27x146 as shown on the plans provided by Bigge. The web depth varies from 0 inch at the beginning of the ramp to 12 3/8 inches at full depth. One support was assumed as a pinned condition with rotation fixed about the vertical and longitudinal axis, and all translation fixed. The other support was similarly supported, but allowed to move in the longitudinal direction. The jump bridge was assumed to act as a single composite unit, and the
capacities of the various welds and connections within the unit were not analyzed as part of this scope.

Since two jump bridges will be utilized for crossing the structures, each jump bridge will carry half of the transport vehicle load. The transport vehicle was modeled as a series of moving point loads representing the individual axle loads, and placed along the centerline of the jump bridge. The spacing and values of the loads are based on the truck configuration provided by Bigge.

Based on the results of the model, the service dead plus live load deflection is 2.02 inches. The plans of the 52-foot jump bridge indicate approximately 1.625 inches thickness of steel plates at each bearing location. A 1-inch thick by 4-foot wide steel plate will be placed beneath each bearing to provide a total of 2.625 inches of clearance between the jump bridge and the roadway surface.

The maximum shears and moments in the ramp bridge are as shown in the table below.

<table>
<thead>
<tr>
<th>Load Condition</th>
<th>Service Shear (kips)</th>
<th>Service Moment (k-ft)</th>
<th>Load Factor</th>
<th>Factored Shear (kips)</th>
<th>Factored Moment (k-ft)</th>
</tr>
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<tbody>
<tr>
<td>Live Load + Impact</td>
<td>85.17</td>
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<td>Total</td>
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<td>1826.36</td>
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Shear and moment capacities of the jump bridge were determined at several sections, based on how the geometry and cross sections change along the length of the structure. Shear capacities were determined at two sections near the end of the jump bridge; the face of the support with additional web members, as well as at the location just beyond where the additional web members end. Moment capacities were calculated at these two locations, as well as near the ramp top angle point, and at the midspan of the structure.

In all cases, the shear and moment capacities exceed the factored loads applied at the various locations. The bridge is adequate to meet the strength demands of the proposed loading.

**60-Foot Barge Ramp:**

This jump bridge is 6'-4" wide and 60 feet long, with an assumed center of bearing to center of bearing length of 59.5 feet, based on drawings provided by Bigge. Three adjacent jump bridges will be used to span across the following structure:

- Bridge Key 19080; SH 200B over Strong Creek; in East Hope
Please see Appendix B for the following supporting information:

- Bridge Site Drawings
- 60’ Barge Ramp Drawings
- Calculations

Very little information about the existing bridge over Strong Creek is available. Field measurements were obtained on June 26, 2014, and used to prepare the drawings. Calculating the capacities against the surcharge loading to the abutment walls, wing walls, and the extended beam seat walls at the widened portion of the bridge is impractical due to the number of unknowns. The proposed approach limits the amount of influence of the surcharge load on the various walls by maintaining a minimum distance of one-half the estimated height of the walls to any load point, in accordance with ITD policy. As shown on the Jump Bridge Plan in Appendix B, the shaded areas next to the walls indicate the limits where loading is to be avoided. Generally speaking, the jump bridge supports are to be a minimum of 5 feet from the abutment walls, 4 feet from the wing walls, and 2 feet from the extended beam seat walls. In order to meet these criteria, the 60-foot ramp bridges are required at this site.

A model of the temporary ramp bridge was developed in LARSA 4D to determine the deflections and loading. The ramp was modeled as a simple span beam constructed of A992 Grade 50 steel. Using the LARSA Section Composer tool, the ramp was modeled using the dimensions of the adjacent W24x104 beam elements as shown on the plans provided by Bigge. The beam webs are cut at the ramp sections, and the structure depth varies from 10 inch at the beginning of the ramp to 24.06 inches at full depth. One support was assumed as a pinned condition with rotation fixed about the vertical and longitudinal axis, and all translation fixed. The other support was similarly supported, but allowed to move in the longitudinal direction. The adjacent beams are welded together with butt welds in a stitch pattern along the edges of the flanges. The jump bridge was assumed to act as a single composite unit, and the capacities of the flange welds were not analyzed as part of this scope.

In order for the jump bridges to provide the necessary width for the transport vehicle, three jump bridges will be placed side by side over the Strong Creek structure. Based on the geometry of the layout, the two outside jump bridges will carry the majority of the transport vehicle loading. Because of this, the model of the jump bridge is assumed to carry half of the transport vehicle load. The transport vehicle was modeled as a series of moving point load pairs representing the tandem wheel loads, and placed along the centerline of the jump bridge. The spacing and values of the loads are based on the truck configuration provided by Bigge.

Based on the results of the model, the service dead plus live load deflection is 2.26 inches. The jump bridge will be elevated so that 3-inches clear exists from the bottom of the jump bridge to the roadway surface.
The maximum shears and moments in the ramp bridge are as shown in the table below.

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<th>Service Shear (kips)</th>
<th>Service Moment (k-ft)</th>
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<th>Factored Shear (kips)</th>
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Shear and moment capacities of the jump bridge were determined at several sections, based on how the geometry and cross sections change along the length of the structure. Shear capacities were determined at the ends of the jump bridge. Moment capacities were calculated at the end and midspan of the jump bridge.

In all cases, the shear and moment capacities exceed the factored loads applied at the locations. The bridge is adequate to meet the strength demands of the proposed loading.

For both jump bridge configurations, at each of the three locations, we recommend that the ends of the bridges be supported on wide, stiff plates to better distribute the reaction loads to the underlying soil, and to limit the bridge from sinking into the supporting pavement and soil. We recommend supporting the jump bridges on 1-inch thick steel plates, with plan dimensions equaling the width of the jump bridge in the transverse direction and four feet longitudinally. This will approximately equal the maximum pressure allowed to be exerted by a dual wheel load onto the pavement.
Appendix A (52-Foot Jump Bridge):

Bridge Site Drawings
52’ Jump Bridge Drawings
Calculations
TEMPORARY JUMP BRIDGE CALCULATIONS

52' STEEL JUMP BRIDGE

ITD PERMIT ASSISTANCE – BIGGE CRANE

Prepared By:
Jason Wolfe, P.E., S.E.

Checked By:
Chris Atkinson, EIT
Barrie Jo Moss, EIT

FORSgren
Associates Inc.
Max Deflection ~ 2\frac{1}{32}"

- Recommend shimming/elevating jump bridge so that 2\frac{5}{16} clear between deck & jump bridge
### Section C Critical Shear (Section A)

From UABS:
- $A = 152.82 \text{ in}^2$
- $I_{xx} = 192.94 \text{ in}^4$
- $I_{yy} = 133246.8 \text{ in}^4$
- $J = 442.06 \text{ in}^4$
- $S_x = 109.42 \text{ in}^3$
- $S_y = 2776.04 \text{ in}^3$
- $R_x = 1.124''$
- $R_y = 29.53''$

Shear Area: 

$$
\text{Shear Area} = \left(1.125 + 0.25\right) (0.5)(8) + \left(1.125 + 0.975\right) (0.605) \text{ in}^2 = 10.582 \text{ in}^2
$$

Shear Capacity: 

$$
\phi V_n = 0.9 \left(228.6 \text{ k} \right) = 205.7 \text{ k} > V_n = 163.0 \text{ k} \therefore \text{ OK}
$$

Moment Capacity: 

$$
\phi M_n = 0.9 \left(328.26 \text{ k} \cdot \text{in} \right) = 294.43 \text{ k} \cdot \text{in} > M_n = 163.4 \text{ k} \cdot \text{in} \therefore \text{ OK}
$$
SECTION B

FROM LARSA:  
\[ A = 158.21 \text{ in}^2 \]
\[ I_x = 164.3, 40 \text{ in}^4 \]
\[ J_y = 137.933.2 \text{ in}^4 \]
\[ J = 71.46 \text{ in}^4 \]
\[ S_x = 394.23 \text{ in}^3 \]
\[ S_y = 2873.61 \text{ in}^3 \]
\[ R_x = 3.223'' \]
\[ R_y = 29.572'' \]

SHEAR AREA:  
\[ (5.625 + 0.975)(0.605) = 15.97 \text{ in}^2 \]

SHEAR CAPACITY:  
\[ 0.60(36 \text{ ksi})(15.97 \text{ in}^2) = 345 \text{ k} \]

\[ \phi V_h = 0.9(345 \text{ k}) = 310.5 \text{ k} \]

\[ V_o = 159.1 \text{ k} \]

OK

MOMENT CAPACITY:  
\[ 36 \text{ ksi}(394.23 \text{ in}^3) = 14192.3 \text{ in}^4 \]

\[ \phi M_y = 0.5(1182.7) = 591.4 \text{ k} \text{ in} \]

\[ M_y = \frac{1182.7 \text{ k in}}{3.5437''} \]

\[ \bar{y}_1 = \frac{4(3.5437)(0.605)(3.5437) + 96(0.625)(3.5437 + 0.625)}{4(3.5437)(0.605) + 96(0.625)} \]

\[ \bar{y}_1 = 3.5955'' \]

\[ \bar{y}_2 = \frac{4(2.0813)(0.605)(2.0813) + 4(14)(0.975)(2.0563 - 0.975)}{4(2.0813)(0.605) + 4(14)(0.975) + 4(14)(0.625)} \]

\[ \bar{y}_2 = 2.7507'' \]

\[ a = \bar{y}_1 + \bar{y}_2 = 6.3462'' \]

\[ Z = \frac{(158.121)(6.3462)}{2} = 502.01 \]

\[ M_p = F_y Z = (36 \text{ ksi})(502.01 \text{ in}^3) = 18072.5 \text{ k in} = 1506 \text{ k ft} \]

\[ \phi M_n = 0.9(1506 \text{ k ft}) = 1355.4 \text{ k ft} \]

\[ \phi M > 1064.4 \text{ k ft} > M_n > 706.1 \text{ k ft} \]

OK
**SECTION C**

**From LARSA:**

- **A:** 174.5475
- **Jzz:** 6807.237

\[ h = \frac{12.375}{4(0.605)} = 5.11 \text{ ft} \]

\[ L_b = 48' \]

\[ L_p = 1.76 \sqrt{\frac{E}{F_y}} = 1.76 \sqrt{29,000 \div 36} = 1470.55' \]

**FROM LARSA**

\[ L_e < L_p \Rightarrow M_{y_0} = M_p \]

\[ \gamma_1 = (36 \text{ ksi}) (856.1592 \text{ in}^2) = 30821.73 \text{ k} \cdot \text{in} \]

\[ M_y = 2568.5 \text{ k} \cdot \text{ft} \]

\[ \gamma_1 = \frac{4(7.326)(0.605)(7.326) + 96(0.625)(7.326 + 0.625)}{4(7.326)(0.605) + 96(0.625)} \]

\[ \gamma_1 = 6.732'' \]

\[ \gamma_2 = \frac{4(5.049)(0.605)(5.049) + 4(14)(0.975)(6.025 - 0.725) + 4(12)(0.625)(6.025 + 0.625)}{4(5.049)(0.605) + 4(14)(0.975) + 4(12)(0.625)} \]

\[ \gamma_2 = 5.404'' \]

\[ a = \gamma_1 + \gamma_2 = 12.136'' \]

\[ Z_x = \frac{(A)}{2} a = \frac{(174.5475)(12.136'')}{2} = 1059.178 \text{ k} \cdot \text{in}^2 \]

\[ M_p = F_y Z_x = (36 \text{ ksi})(1059.178 \text{ k} \cdot \text{in}) = 38130.4 \text{ k} \cdot \text{in} \]

\[ = 3177.5 \text{ k} \cdot \text{ft} \]

\[ \phi M_0 = 0.9 (3177.5 \text{ k} \cdot \text{ft}) = 2859.75 \text{ k} \cdot \text{ft} \]

\[ \phi M_y = 2311.65 \text{ k} \cdot \text{ft} \]

\[ M_o = 1277.2 \text{ k} \cdot \text{ft} \]
### SECTION D

**From**
- $A = 235.7975 \, \text{in}^2$
- $S_2 = 10.179.44 \, \text{in}^3$
- $I_2 = 7.474''$
- $J = 8714.225 \, \text{in}^4$
- $S_1 = 1256.876 \, \text{in}^3$
- $R_y = 29.318''$

**Calculations**

- $h = \frac{12.375}{4(0.665)}$
- $L_b = 48' = 576''$
- $L_p = 1.76 \sqrt{E} / f_y = 1.76(29.318) \sqrt{29000} / 26$
- $= 146.95''$
- $= 121'$. $M_n = M_p$

- $M_y = 36 \, \text{ksi}(1256.876 \, \text{in}^3)$
- $= 45.247.5 \, \text{in} \cdot \text{lb}$
- $= 3770.60 \, \text{in} \cdot \text{lb}$

- $\phi M_y = 3393.5 \, \text{kt} \cdot \text{in}$

- $\bar{y}_1 = \frac{4(0.605)(5.876)^2}{2} + 96(0.625)(5.876+0.625/2)$
- $= 4(0.605)(5.876) + 96(0.625)$

- $\bar{y}_1 = 6.068''$

- $\bar{y}_2 = \frac{4(0.605)(6.455^2)}{2} + 4(14)(0.775)(7.474-0.425) / 7.474^2 + 2(33)(0.625)(7.474+0.425)$

- $\bar{y}_2 = 6.756''$

- $\alpha = \bar{y}_1 + \bar{y}_2 = 12.823''$

- $Z_x = \left( \frac{\alpha}{2} \right) (A) = \frac{235.7975 (12.823)}{2} = 1511.87 \, \text{in}^3$

- $M_p = F_y Z_x = 36 \, \text{ksi}(1511.87 \, \text{in}^3) = 54427.4 \, \text{k-in}$

- $\phi M_n = 0.6(4535.60) = 2721.3 \, \text{k-ft}$

- $\phi M_y = 3393.5 \, \text{k-ft}$

- $M_0 = 1826.5 \, \text{k-ft}$
\[ \begin{align*}
\Delta_b & = \frac{5.835}{384.64} = 0.0154 \text{ in} \\
\Delta_l & = \frac{0.363}{48.00} = 0.0076 \text{ in} \\
\Delta_u & = \frac{P_d}{24.00} = 0.021 \text{ in} \\
\Delta_u & = \frac{27.16}{24.00} = 0.008 \text{ in} \\
\Delta_u & = \frac{27.16(5.833^2)}{24(29000)(10179.49)} = 0.002 \text{ in} \\
M_d & = \frac{(0.63)^2(14.74^2)}{8} = 198.72 \text{ k-ft} \\
M_{L1} & = \frac{(27.16)(14.74)}{7} = 426.97 \text{ k-ft} \\
M_{L2} & = 27.16(14.74) = 405.15 \text{ k-ft} \\
M_{L3} & = 27.16(5.833) = 158.92 \text{ k-ft} \\
V_d & = \frac{(0.63)(14.74)}{2} = 16.56 \text{ k} \\
V_L & = \frac{(27.16)(6)}{2} = 81.48 \text{ k} \\
\end{align*} \]
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Tuesday, July 29, 2014

Forsgren Associates

415 S. 4th St.
Boise, ID 83702
Tel: 208-342-3144
Fax: 208-383-0819
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### Section Shapes (in)

**Center Section**

- Member +2
- Member +1
- Member +3
- Member +4
- Member +5

---

Tuesday, July 29, 2014
Appendix B (60-Foot Barge Ramp):

Bridge Site Drawings
60' Barge Ramp Drawings
Calculations
BRIDGE SECTION

CONCRETE GIRDER AT ABUTMENT
60 FT BARGE RAMP — BR60-2 & BR60-3

2 REQUIRED AS SHOWN

APPROX. WEIGHT EACH = 37,250 LBS.

APPROVED FOR CONSTRUCTION
GENERAL ARRANGEMENT
60 FT BARGE RAMP - BR60-2 AND BR60-3

APPROVED FOR CONSTRUCTION
CUT DETAIL

1. Initial Cut Detail
2. Final Shape Detail

DETAIL

BEAM
- AS92 MATERIAL

BEAM
- AS92 MATERIAL

NOTCHES IN TOP & BOT. FLANGES OF ITEM ONLY

CHAM. A/B/F.

FINISHED SHAPE

1' - 4 1/2" Top
7' - 0" Top
1' - 4 3/4" Bottom
8½" Top

NOTE:

FINAL SHAPE DETAIL

APPROVED FOR CONSTRUCTION

BEAM FABRICATION DETAILS
60 FT BARGE RAMP - BR60-2 AND BR60-3
TEMPORARY JUMP BRIDGE CALCULATIONS

60' BARGE RAMP BRIDGE

ITD PERMIT ASSISTANCE – BIGGE CRANE

Prepared By:
Jason Wolfe, P.E., S.E.

Checked By:
Chris Atkinson, EIT
Barrie Jo Moss, EIT

FORSgren
Associates Inc.
### Owner-Project
**Bridge - Calumet Reactor**

### Feature
Capacity calls for 60' Jump Bridge

#### 60' Ramp Moment Capacity (Midspan)

\[ M_y = F_y S_x \]

\[ S_x = 1534.78 \text{ in}^3 \quad \text{(Midspan)} \]

\[ M_y = (50 \times 6)(1534.78 \text{ in}^3) = 76,739 \text{ in-lbs} \]

\[ = 6395 \text{ k-ft} \]

\[ \phi M_y = 0.9(6395) = 5755 \text{ k-ft} \]

#### Zx:

\[ Z_x = \left( \frac{A}{2} \right) x \]

\[ Z_x = \left( \frac{30.6}{2} \right)(18.88") \]

\[ = 288.86 \text{ in}^2 \quad \text{(for I)} \]

\[ M_y = F_y Z_x \]

\[ = 50 \times 6 \times (1733.18 \text{ in}^3) \]

\[ = 86659.2 \text{ k-in} \]

\[ = 7221.6 \text{ k-ft} \]

\[ \frac{Z_x}{S_x} = \frac{1733.18}{1534.78} = 1.13 < 1.5 \text{ ok} \]

---

**Reference:**
- AISC LRFD Manual 2nd Ed.
- AASHTO LRFD
\[ \frac{h}{f_w} = \frac{2.40W - 2(0.75)}{6(0.5)} = \frac{22.56}{3} = 7.52 \]

Determine if acts as beam or plate girders per AISC:

- If \( \frac{h}{f_w} > \lambda_r \Rightarrow \text{Plate girders, use APP 6} \)
- \( \leq \lambda_r \Rightarrow \text{Beam, use Ch. F & APP 5} \)

\[ \frac{h}{f_w} < \lambda_r = 3.76 \sqrt{E/f_y} \text{ Compact} = 90.5 \checkmark \]
\[ \leq \lambda_r = 5.77 \sqrt{E/f_y} \text{ Non-compact} = 137.3 \checkmark \]

Acts as beam - use AISC Ch. F
MIDSPAN BEAM TO ACT AS BOX SECTION

\[ L_p = \frac{0.13 f_y E}{M_p} \]

\[ = \frac{0.13(21.97\text{ in})(29,000\text{ ksi})}{86659.2 \text{ in}^2} \]

\[ = 2474.5\text{ in} \]

\[ = 206.2' \]

\[ L_b < L_p \]

\[ \phi M_n = \phi M_p \]

\[ M_r = F_y S_x = (50\text{ ksi})(1529.78\text{ in}^3) \]

\[ = 76739\text{ k-in} \]

\[ L_y = \frac{2 f_y E}{M_r} \]

\[ = \frac{2(21.97\text{ in})(29,000)}{76739} \]

\[ = 42991.5\text{ in} \]

\[ = 3582.6' \]

\[ \phi M_n = 0.9(7221.6\text{ k-ft}) = 6499\text{ k-ft} \]

Max Moment \[ M_o = 2721.24\text{ k-ft} \]
### Moment Capacity @ End

\[ M_y = F_y S_x \]
\[ S_x = 522.7 \text{ in}^3 \text{ (end)} \]

From LRFD:
\[ M_y = (50 \text{ kfs}) (522.7 \text{ in}^3) = 26135 \text{ k-in} \]
\[ = 2177.9 \text{ k-ft} \]

\[ Z_x = \left( \frac{A}{2} \right) (a) \]
\[ = \frac{141.42 \text{ in}^2}{2} (8.35 \text{ in}) \]
\[ = 590.43 \text{ in}^3 \]

\[ M_p = F_y Z_x = (50 \text{ kfs}) (590.43 \text{ in}^3) \]
\[ M_p = 29521.425 \text{ k-in} \]
\[ = 24601.1 \text{ k-ft} \]

\[ \frac{Z_x}{S_x} = \frac{590.43}{522.7} = 1.13 < 1.5 \]

\[ \bar{y} = \left( \frac{15.3 \text{ in}^3 (9.44'' - 0.5'') (7.03'') (703 \text{ k-ft})}{2} \right) \]
\[ = 15.3 \text{ in}^2 (0.5'') (7.03'') \]
\[ \bar{y} = 11.207'' \]
\[ \bar{y} = (11.207'' - 7.03'') = 4.177'' \]
\[ a = 2 (4.177'') = 8.35'' \]
\[ A = 30.6 \text{ in}^2 - 14.06'' (0.5'') \]
\[ A = 23.57 \text{ in}^2 (6) = 141.42 \text{ in}^2 \]
<table>
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<tr>
<th>FEATURE</th>
<th>ACTS AS BEAM ((&lt;3.76\text{ ft}))</th>
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<tbody>
<tr>
<td>( h = \frac{15''-2(0.75)}{6(0.5'')} = \frac{8.5}{3} = 2.83 )</td>
<td></td>
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**Consider Beam to act as box section**

\[
L_p = \frac{0.13 \cdot \frac{V_k \cdot E}{M_p}}{\sqrt{J/A}} \quad \text{(AISC LRFD)}
\]

\[
= \frac{0.13 \cdot (22.03)(29,000)}{29521.425} \quad \text{from L-466A}
\]

\[
= 0.13 \cdot \frac{(22.03)(29,000)}{29521.425} \quad \text{(191.42 ft)}
\]

\[
L_p = 2796.5 \text{ ft}
\]

\[
= 233'
\]

\[
L_4 < L_p \quad \therefore \phi M_n = \phi M_p
\]

\[
\phi M_p = 0.9(2400.1 \text{ k.-ft}) = 2160 \text{ k.-ft}
\]
<table>
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<tr>
<th>FEATURE</th>
<th>60' JUMP BRIDGE CAPACITY</th>
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<td>SHEAR CAPACITY @ END</td>
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| \[ A < 2.95 \sqrt{\frac{E}{F_y}} = 2.95 \sqrt{\frac{25000}{50}} = 59 \]  
  (AISC LUFD 312) |
| \[ V_n = 0.16 F_y A_w \]  
  \[ A_w = 6(10^\prime)(0.5^\prime) = 30 \text{ in}^2 \] |
| \[ V_n = 0.16(50 \text{ ksi})(30 \text{ in}^2) = 900 \text{ k} \] |
| \[ \phi V_n = 0.9(900 \text{ k}) = 810 \text{ k} \] |
| MAX FACTORED SHEAR = 810 k FROM LARSA |

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<td>MAX DEFORMATION (SERVICE) = 2.26 in FROM LARSA</td>
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RECOMMEND SHIMMING/ELEVATING JUMP BRIDGE 
SO THAT 3" CLEAR BETWEEN DECK & JUMP BRIDGE
Owner-Project: Cantor

By: 
Date: 7/25/14
Project No.:

Check by: 
Date: 7/29/14
Sheet:

**Feature**

Gun Check on \( \Delta, M, V \) - 60' Jump Between

\( \Delta_D = \frac{5 \times 0.029 \times 59.5^2}{384 \times E I} \times \frac{7.57(29,000)(18463.41)}{} \)

\( \Delta_D = 0.33'' \)

\( \Delta_L = \frac{P \times L}{4 \times E I} = \frac{27,155 (59.5')}{48 \times E I} \times 0.385'' \)

\( \Delta_L = \frac{P \times L}{24 \times E I} = \frac{27,155 (59.5')^2}{24 \times E I} \times 0.673'' \)

\( \Delta_L = \frac{27,155 (11.583')}{24 \times E I} (3(59.5')^2 - 4(11.583')^2) = 0.427'' \)

\( \Delta_L = \frac{27,155 (2.5')}{24 \times E I} (3(59.5')^2 - 4(2.5')^2) = 0.097'' \)

**Larsa Values in Green**

Total \( \Delta_L = 1.582'' \)

\( \Delta_D = 0.33'' \)

Combined \( \Delta = 1.913'' \)

\( M_D = \frac{0.029 \times 59.5^2}{8} = 278.35 \text{k-ft} \)

\( M_L = \frac{P \times L}{4} = \frac{27,155 (59.5')}{4} = 803.93 \text{k-ft} \)

\( M_L = \frac{P \times L}{24} = \frac{27,155 (20.667)}{24} = 561.20 \text{k-ft} \)

\( M_L = \frac{27,155 (11.583')}{24} = 314.54 \text{k-ft} \)

\( M_L = \frac{27,155 (2.5')}{24} = 67.89 \text{k-ft} \)

\( V_D = \frac{wL}{2} = 0.029 (59.5') = 18.71 \text{k} \)

\( V_L = \frac{7(27,155)}{2} = 95.04 \text{k} \)

\( V_D = 18.71 \text{k} \)

\( V_L = 95.04 \text{k} \)

\( V_T = 113.76 \text{k} \)

\( M_L = 1347.56 \text{k-ft} \)

\( M_D = 278.35 \text{k-ft} \)

\( M_T = 1625.91 \text{k-ft} \)

\( V_D = 18.71 \text{k} \)

\( V_L = 95.04 \text{k} \)

\( V_T = 113.76 \text{k} \)
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### Shear Area Factor Y:
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### Shear Area Factor Z:
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Tuesday, July 29, 2014

Forsgren Associates

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Fax: 208-383-0819