American Society of Civil Engineers Steel Bridge – Truss-worthy

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Introduction

The American Society of Civil Engineers (ASCE) and American Institute of Steel Construction (AISC) Steel Bridge Competition is a yearly nation-wide competition challenging students to determine how to fabricate, construct, and erect a scale model steel bridge under timed construction conditions. The Steel Bridge Competition encourages students to extend their classroom knowledge a practical, hands-on design and construction that fosters creativity and fosters innovation.

2024 Problem Statement

Lincoln Parish Park located in Ruston, Louisiana, renowned for its extensive amenities, such as mountain bike trails, scenic pavilions, campground, and Hoogland Lake which allows for fishing, kayaking and canoeing, is considering the addition of a new a disc golf course. This new disc golf course utilizes the existing lakes and ponds to create a more challenging obstacle for players. To create a non-invasive, planned river obstacle, a bridge must be erected of steel per the parks request.

2024 Rules for Fabricating and Construction

- A bridge should only be constructed of only members, loose bolts and loose nuts
- Each member shall not exceed 3'-6" x 6" x4"
- The bridge is to have two stringers, each contiguous that range from 20' to 21' long
- The bridge shall not be wider than 5'-0" at any point'
- The tops of the stringers shall be more more than 1'-11" and no less than 1'-7" above the ground
- The vertical clearance at all points above the ground and river shall be no less than 5"
- The bridge is not to touch the river or ground outside the footings
- Building must take place in 30 minutes
- A vertical load test will commence with a total load of 2500 lbs
- A lateral load test will measure the sway of the bridge under 50 lbs

Design and Fabrication

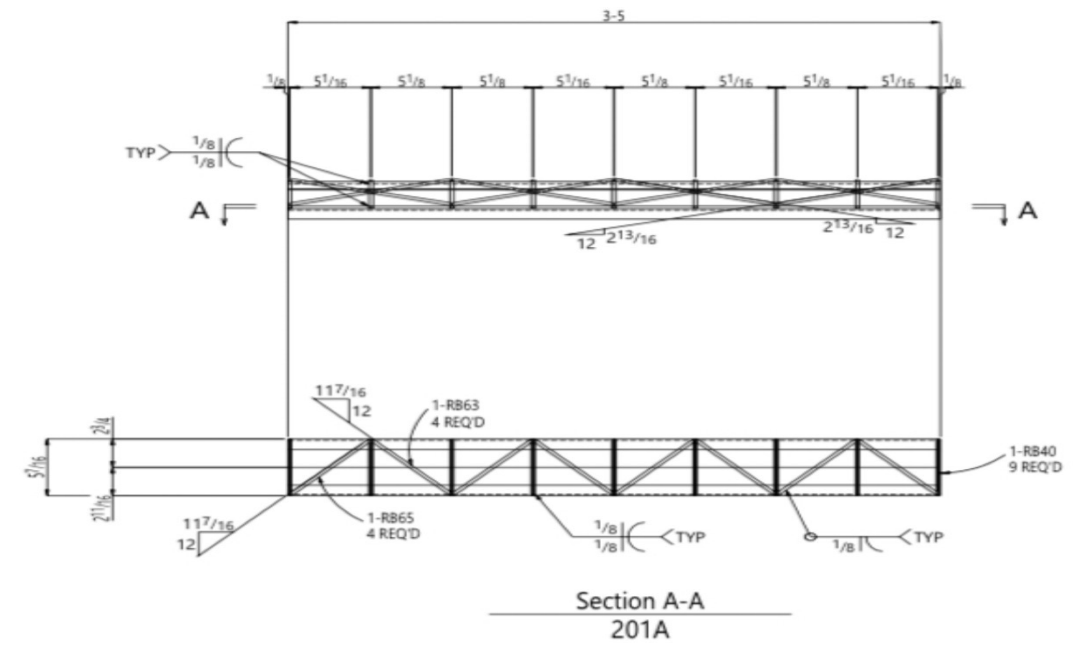
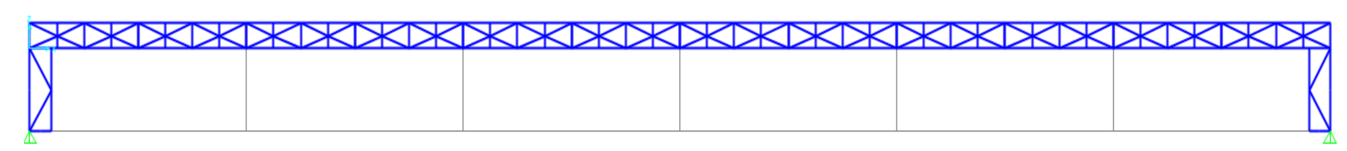
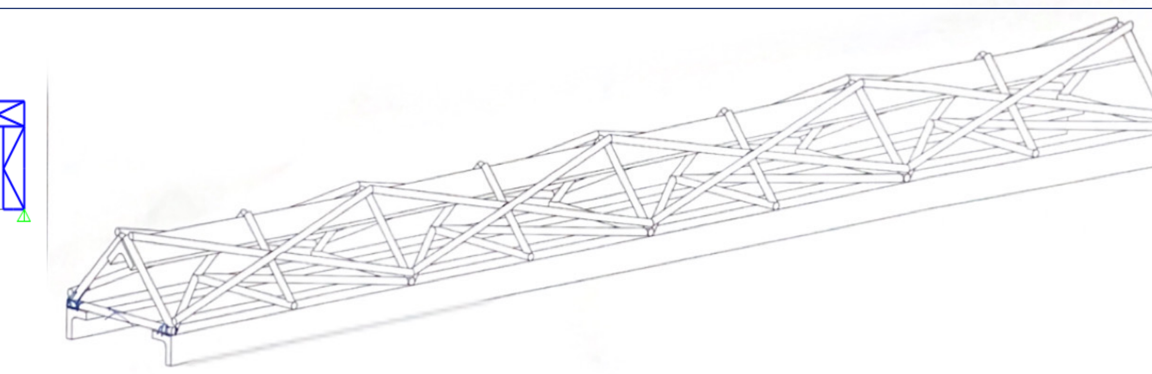


Figure 1



The bridge consists of two contiguous stringers. The 2D side view is shown above. The gray line represents an individual member from the bridge that is 3'-5". (6) individual members make up the span of the bridge to meet the length requirements and minimize construction time. The dimensions of a single member are shown in figure 1. A height of 1'-9" was chosen due to the deflection from the self weight of the bridge.



The isometric view of an individual member is shown above. A triangular truss was constructed due to their inherent stability and strength to weight ratio. Triangular cross sectioned stringers have a high moment of inertia, which allows for resistance to bending and torsional forces, making them ideal for supporting loads over long spans.

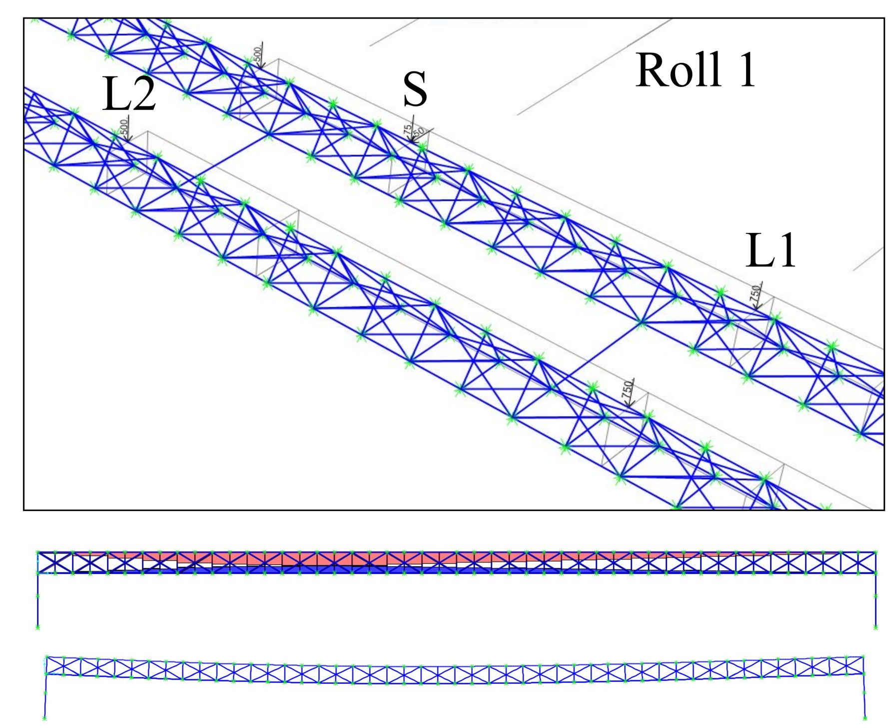
Structural Analysis

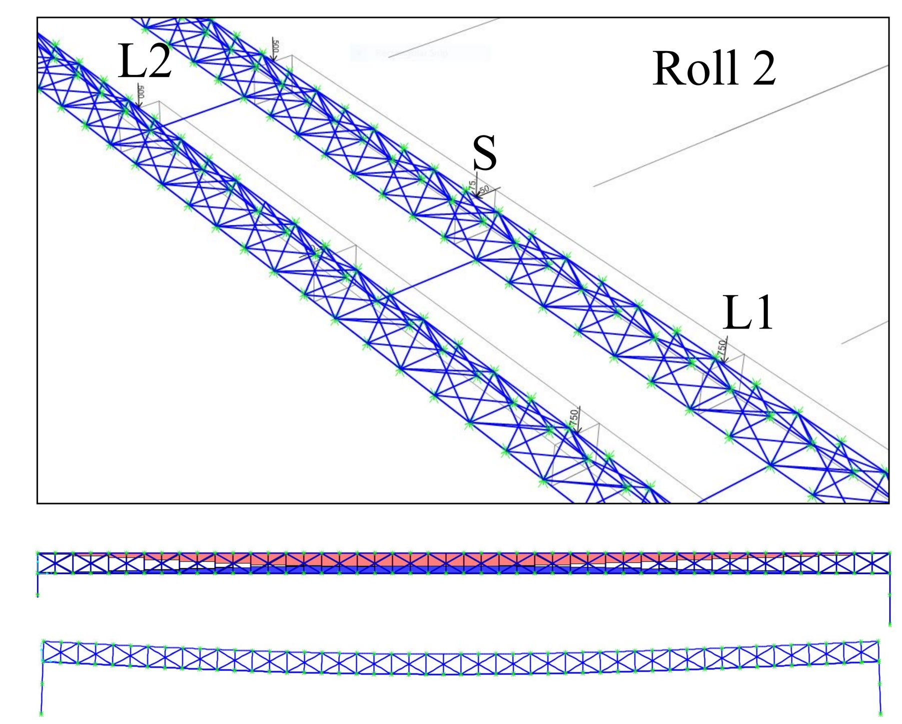
Before timed construction, the head judge rolls a die to determine the location of the decking units along the bridge for the lateral and vertical load tests. The possible results of the roll are found in table 1. Using SAP2000, our model was tested against each possible case.

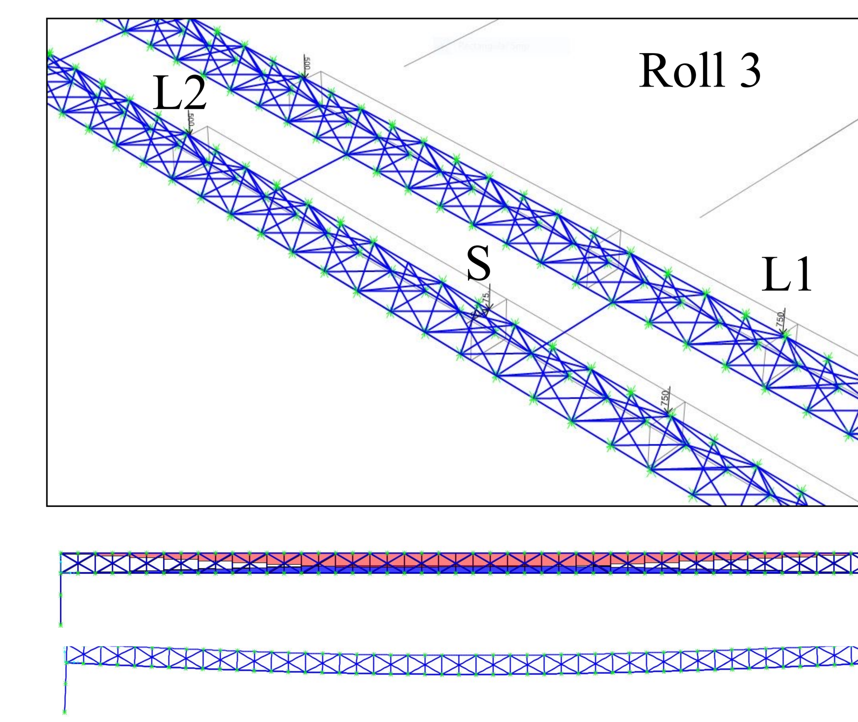
Table 1 – Load Cases

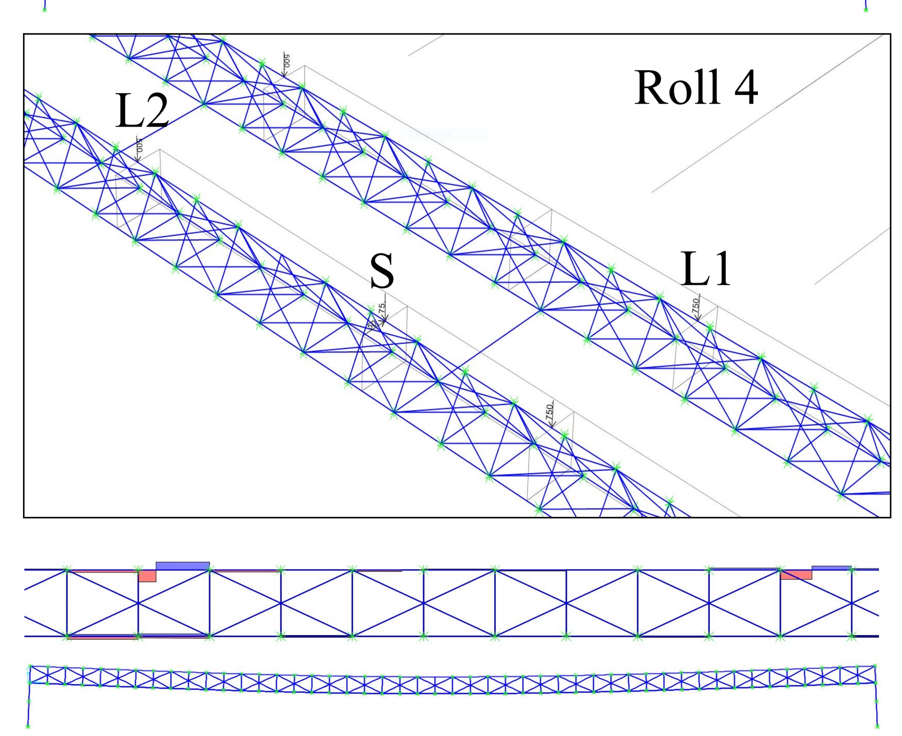
Roll	L1	L2	S
1	4'-6"	9'-0"	7'-6"
2	6'-0"	12'-0"	9'-0"
3	7'-0"	13'-0"	9'-0"
4	7'-6"	11'-6"	9'-0"
5	8'-6"	12'-6"	10'-6"
6	10'-0"	14'-0"	10'-6"

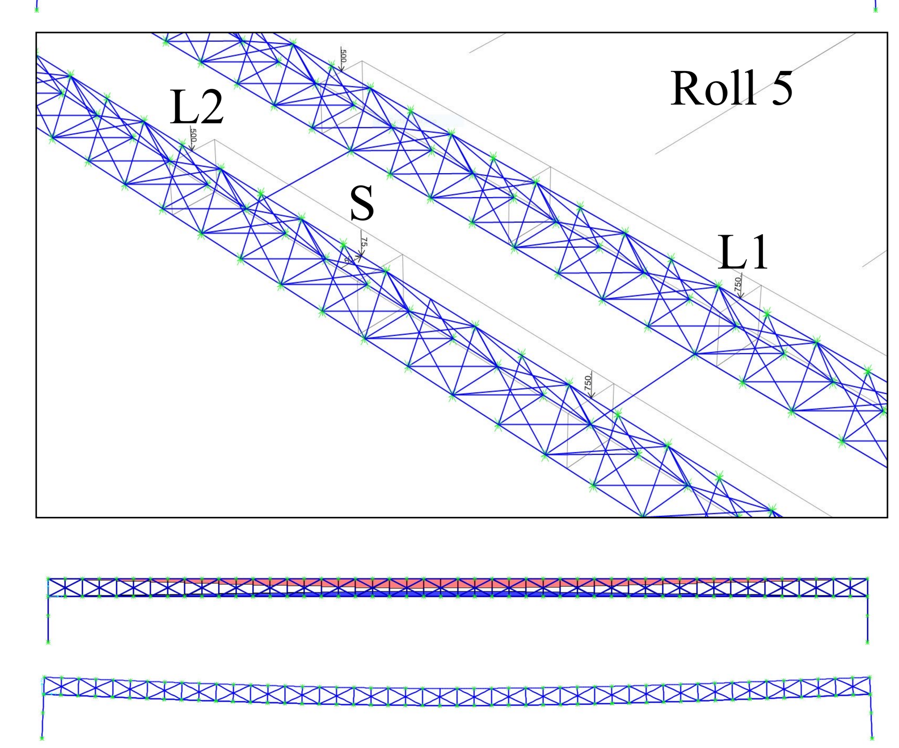
L1,L2- dimensions for positioning decking units for vertical load test
S- dimensions for positioning decking units for lateral load test

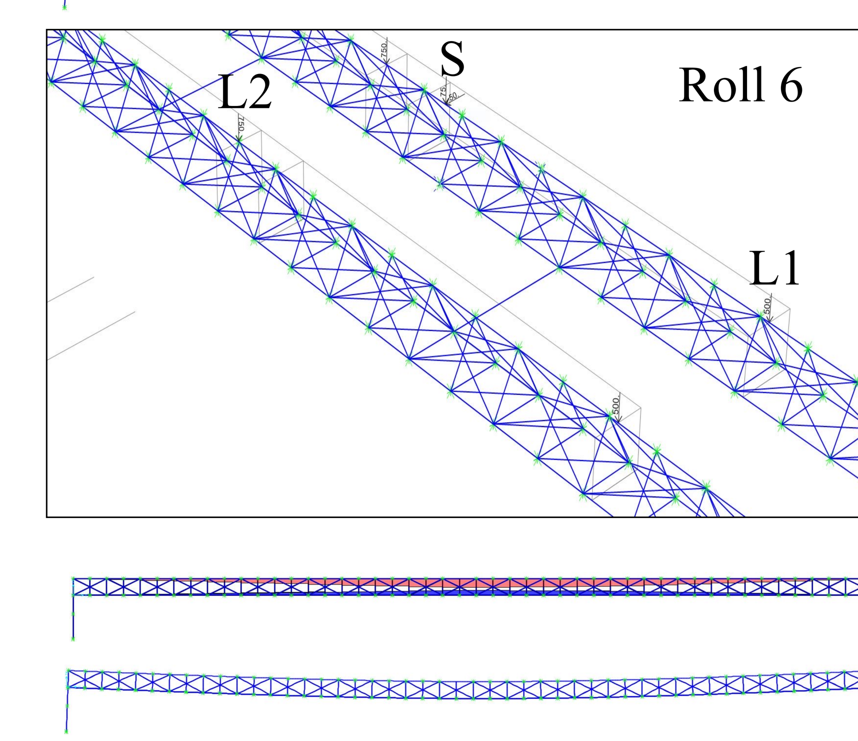






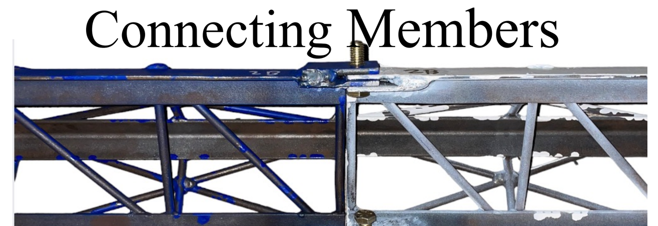






Construction Methods

Connecting Members

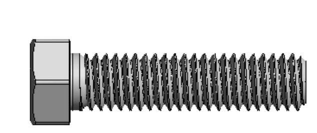


To connect each member along the span, a series of female and male connection points were welded to the members. This created a sequence of finger joints which allows the ability to join members quickly and securely. These finger joints allowed the shear force to be distributed across the bolt and joint interface to prevent tear out.

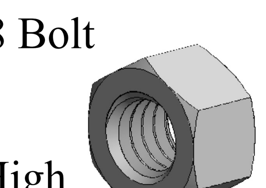
Optimal Bolt Dimension

$$R_n = F_m A_b$$

The formula above represents the nominal strength for fasteners and threaded parts where R_n is the maximum load that a fastener can carry before failure, F_m is the nominal strength and A_b is the area of the bolt. According to SAP2000, $F_m = 54\ ksi$ and $R_n = 16.57\ K$, meaning $A_b = 0.307''$.



3/8"-16, 1 1/2", fully threaded Grade 8 Bolt



3/8"-16, High Strength Grade 8 Hex Nut

Bridge Bracing

X-bracing, intermediate bracing and lateral bracing. X-bracing enhances overall stiffness of the bridge, ensuring it can withstand horizontal forces without excessive deformation. The intermediate bracing runs horizontally between members to help support and stabilize. Lateral bracing was used to help prevent sway of the bridge deck

Final Bridge

Acknowledgements

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References

Steel Construction Manual. American Institute of Steel Construction, 2023.