JOHNS HOPKINS
WHITING SCHOOL of ENGINEERING

Department of Civil & Systems Engineering

ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS

Student Steel Bridge Competition

Bridge Design

Goal: Design welded truss components to lower our member count and simplify construction while promoting sustainability.

Sustainability in Manufacturing: This year, we fully manufactured the bridge in-house using both raw materials and recycled material from previous years. The cutting and welding of members directly from analysis improved material efficiency, reduced the emissions associated with outsourced fabrication and transportation, and promotes long-term sustainability by developing manufacturing skills within the team for future projects.

Solutions: This year, we addressed the cantilevered end of the stringer through calculations, cuts, and welds to comply with this year's rules. Mini trusses as a bottom chord and steel pipe over-truss as the top chord take the bulk of forces, while thoughtful connection locations ensure reduced complexity and constructability.

The color scheme of our bridge is inspired by the desert flour o'clock (*Mirabilis multiflora)* and *Salvia greggii,* two plants found in El Paso area. This design choice ties the bridge to the natural environment that shaped the project context.

Limit States:

Member Type	Limit States Checked
Over-truss	Compression, Tension, Stability checks
Lower Chord	Compression, Tension, Shear
Lateral Bracing	Bending

Connection Design: The connection tabs on the stringers are interchangeable, allowing for efficient construction. The upper truss members are detailed with thin tabs to ease alignment and simplify bolts connections at joints where multiple members meet.

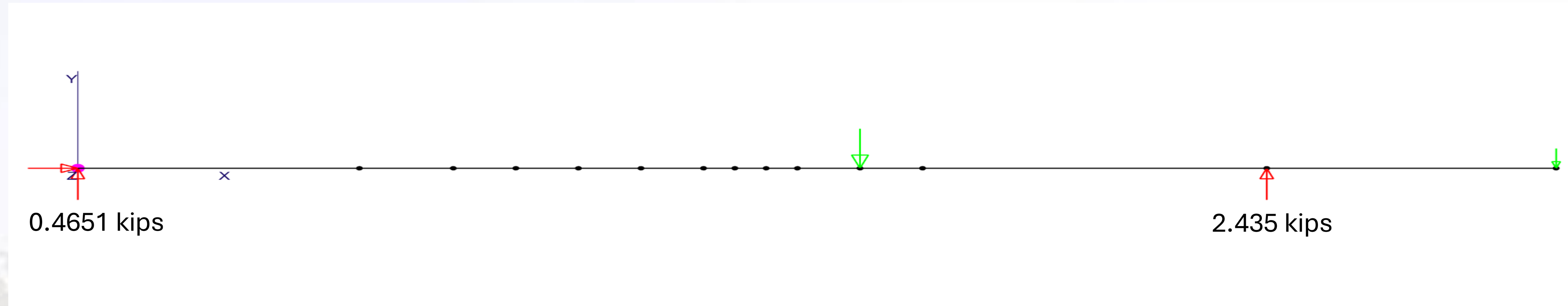

Fig.1. Free body diagram of one bridge stringer for the 11th load case

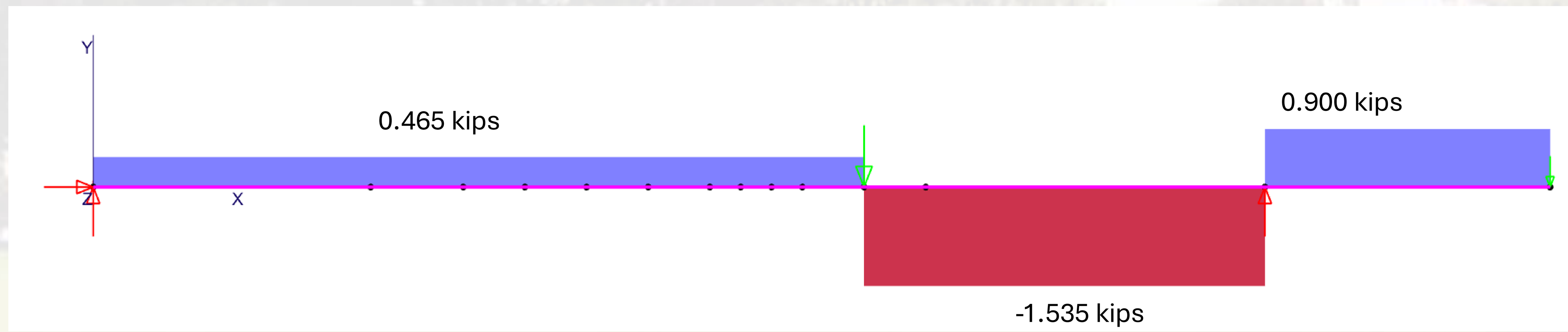

Fig. 2. Shear diagram of one bridge stringer for the 11th load case

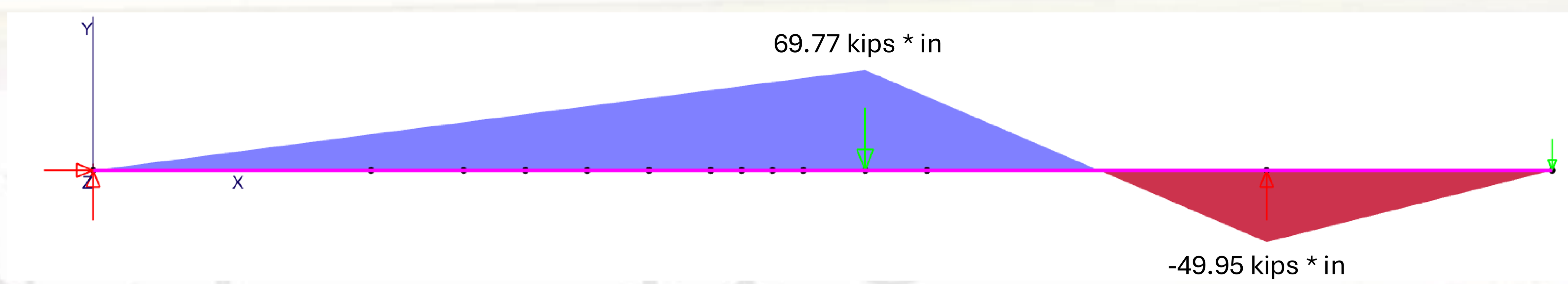

Fig. 3. Moment diagram of one bridge stringer for the 11th load case

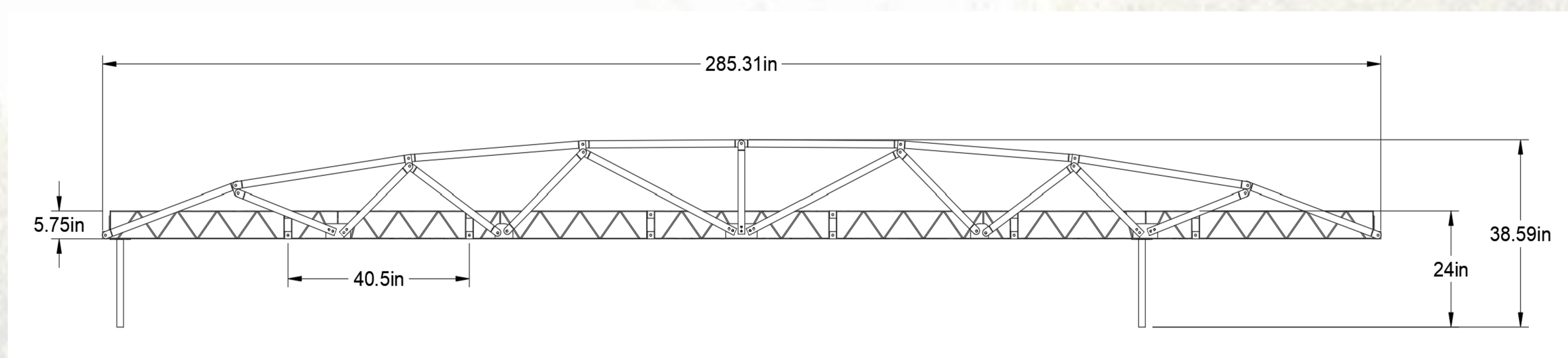

Fig. 4. Dimensioned elevation view drawing of the bridge

Analysis in MASTAN2

We reviewed all possible load conditions to verify that the bridge would not fail and that deflection limits would be met. Using a MASTAN2 beam model, we were able to determine maximum shear and moment forces to size the truss depth. After this, we used a 3D MASTAN2 model with distributed vertical and lateral loading conditions; the resulting axial forces were used to size the individual members. The results of the eleventh vertical load test are shown in Figs. 1-3.

We analyzed the longest over-truss member for its most critical load state, 2.767 kips in compression according to our MASTAN model.

$$Pcr = \frac{(\pi^2 EI)}{(KL)^2} = \frac{\pi^2 \times 29000\ ksi\ x\ 0.199\ in^4}{(1.0\ x\ 39\ in)^2} =$$

$$= 38.2\ kips > 2.767\ kips$$

ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS MARYLAND SECTION

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