

The background is a dark blue-grey color, decorated with various geometric shapes and patterns. There are several orange circles of different sizes, some solid and some outlined. There are also white circles, some solid and some outlined. A large orange hexagon is in the top right. A white hexagon is in the top center. A white circle with a dotted pattern is in the top left. A white circle with a dotted pattern is in the bottom right. There are also several white dotted lines and patterns scattered throughout. The title 'STATICS - BRIDGE PROJECT' is centered in white, bold, sans-serif font. Below the title, the names 'Evelyn, Sam, Gui, Katie' are listed in a smaller, white, sans-serif font.

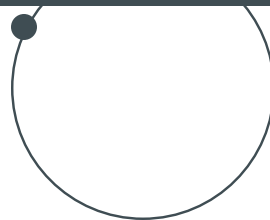
STATICS - BRIDGE PROJECT

Evelyn, Sam, Gui, Katie

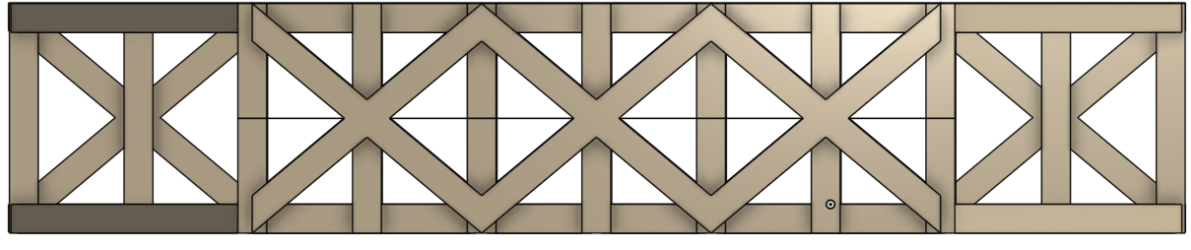


Problem Statement

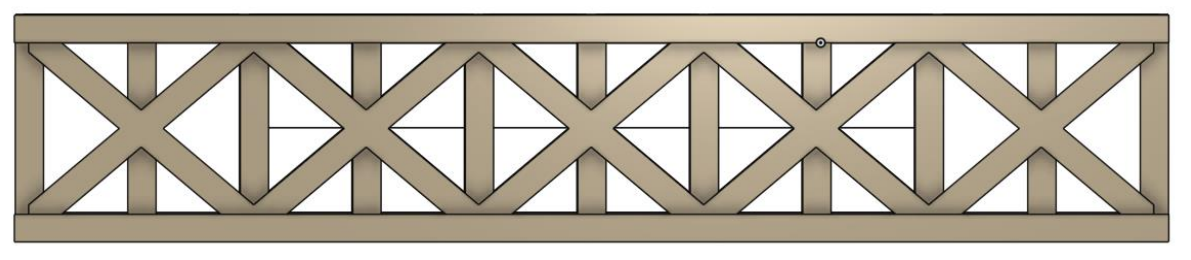
Construct a bridge using light materials, calculate the force in each of the members given a known applied force, and verify stress points through FEA analysis



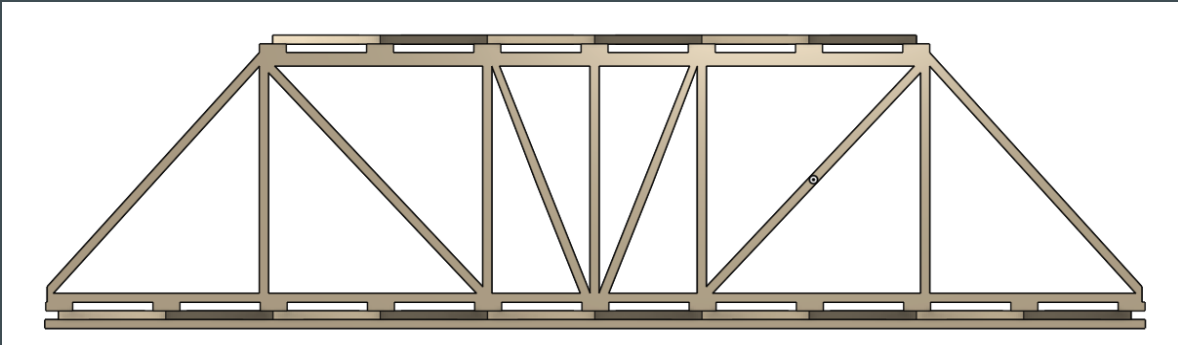
CAD DESIGN



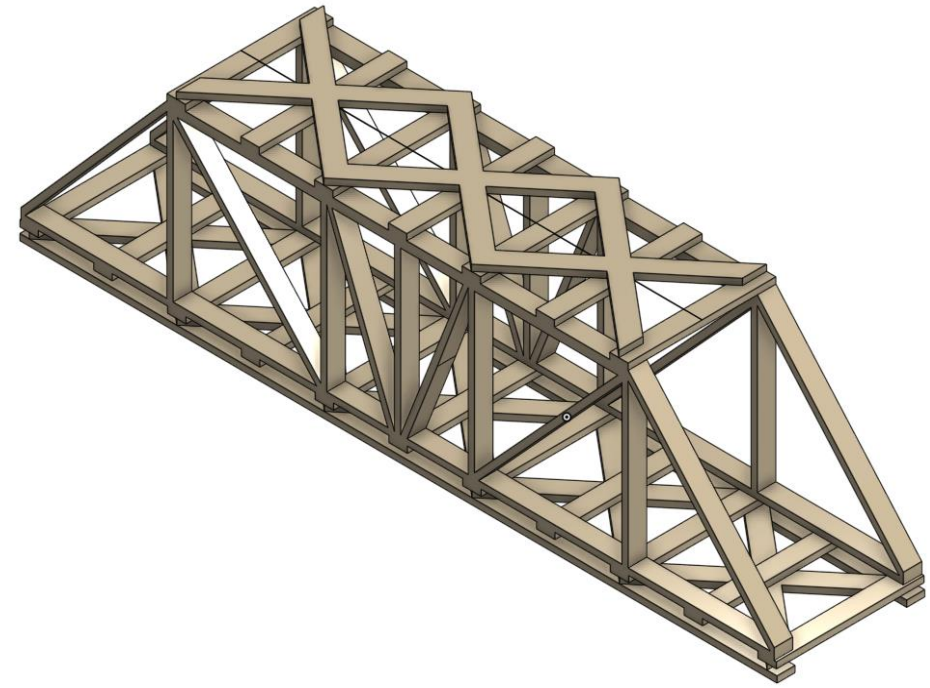
TOP



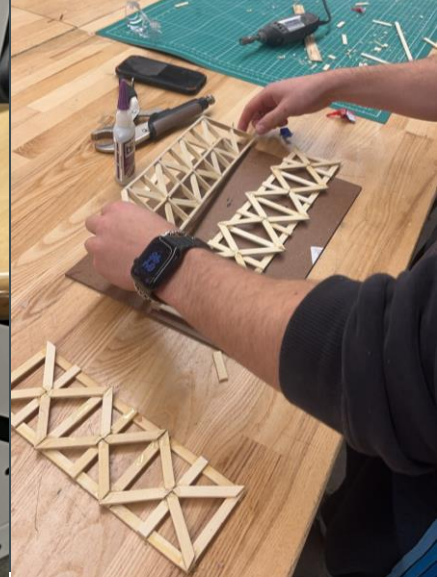
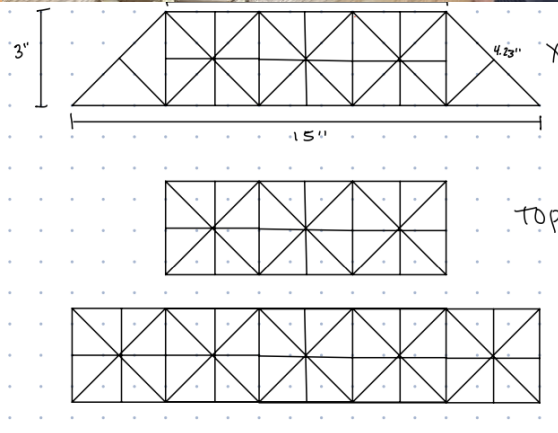
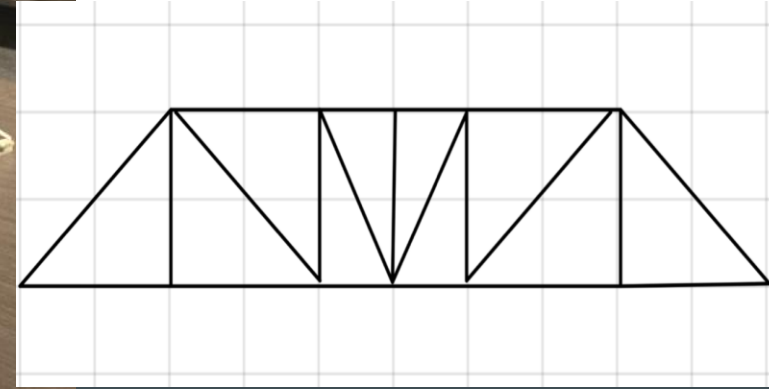
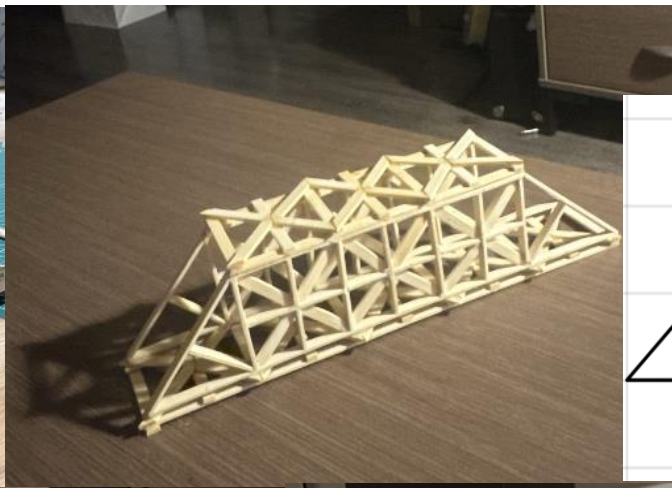
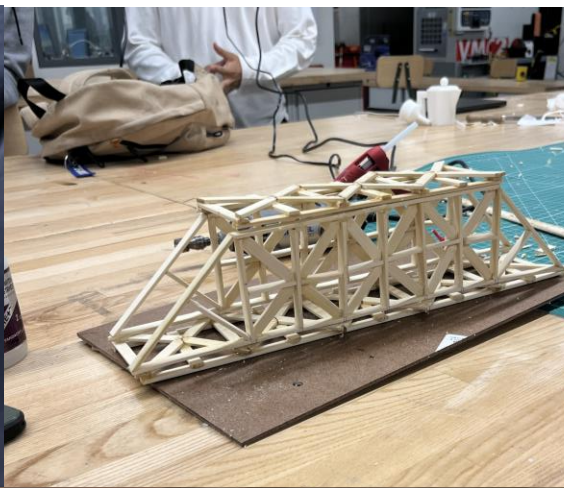
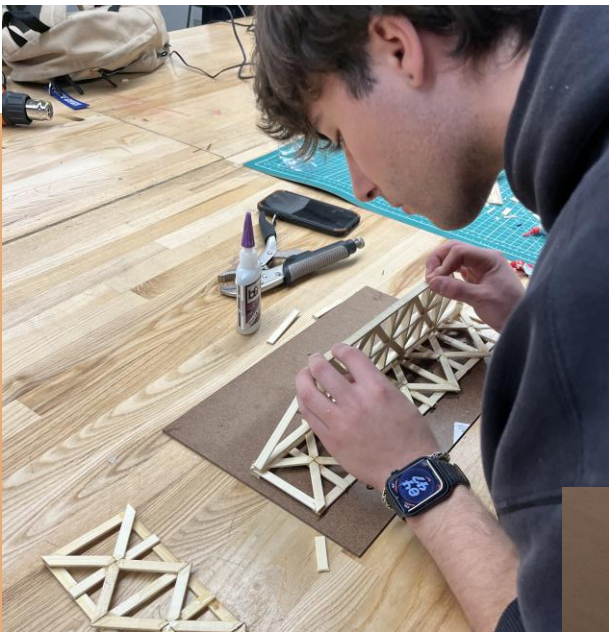
BOTTOM



SIDE

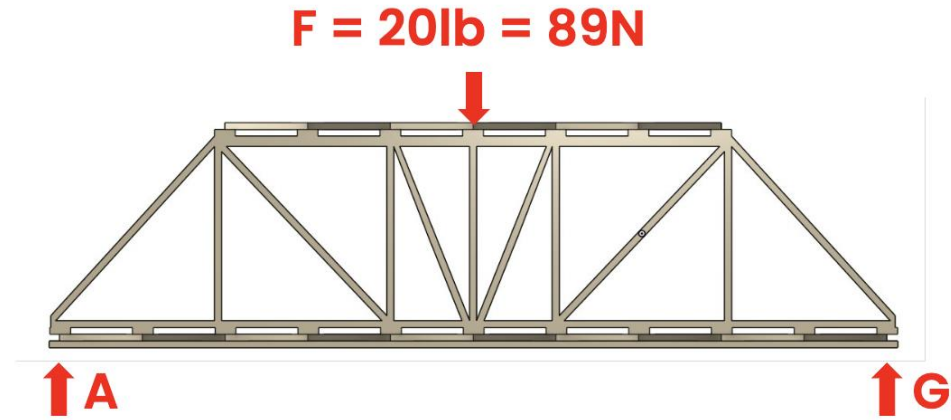


BUILD PROCESS – WHAT WE BUILT



CALCULATIONS

Methodology: Method of Joints



Vertical Force:

$$\sum F_y = 0$$

$$\sum F_y = A_y + G_y - F = 0$$

$$A_y + G_y = 89\text{N}$$

Moment About A:

$$\sum M_A = -(F)(7.5\text{in}) + (G_y)(15\text{in}) = 0$$

$$G_y = \frac{(F)(7.5)}{15} = 89/2 = 44.5\text{N}$$

Force A:

$$A_y + G_y = F$$

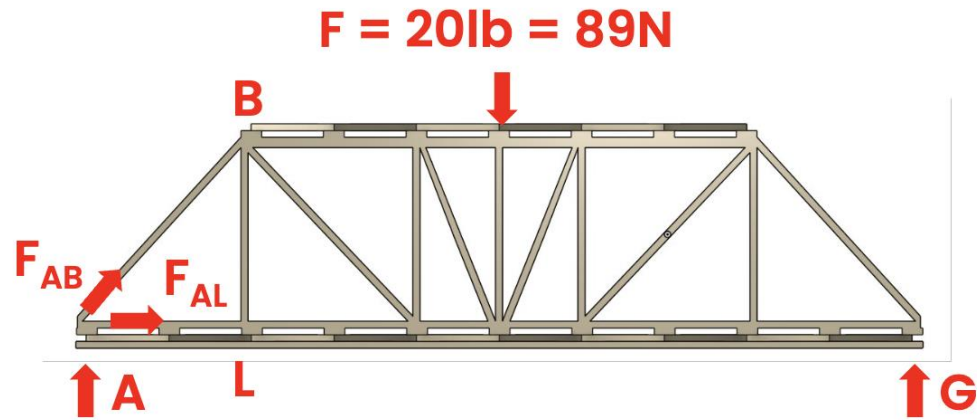
$$A_y = F - G_y = 89 - 44.5 = 44.5$$

Summary:

$$A_y = G_y = 44.5\text{N}$$

CALCULATIONS

Method of Joints: Joint A



$$\sum F_y = 0 = A_y - F_{AB}\sin(45)$$

$$F_{AB} = \frac{A_y}{\sin(45)} = \frac{44.5}{0.7071} = 62.9N, \text{ Tension}$$

$$\sum F_x = 0 = F_{AL} - F_{AB}\cos(45)$$

$$F_{AL} = F_{AB}\cos(45) = (62.9)\cos(45) = 44.5N, \text{ Tension}$$

Calculations

Summary

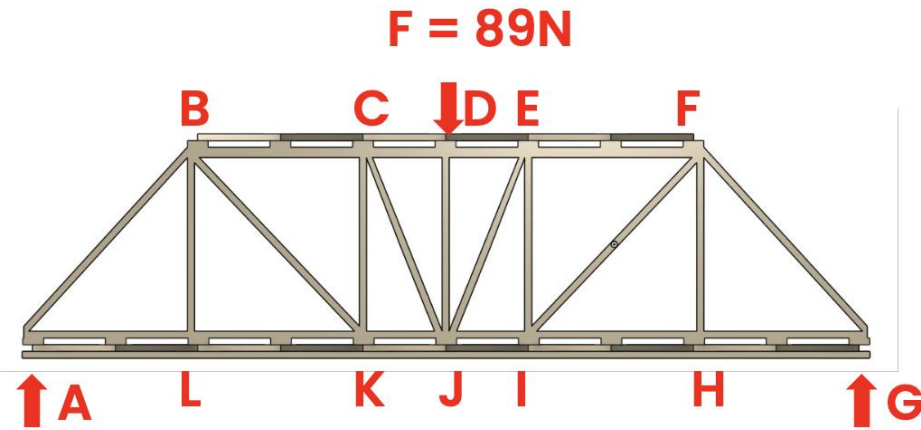


Table 1: Forces in Left-Side Members

Member	Force (N)	Type
A-L	44.5	Tension
A-B	62.9	Tension
B-L	44.5	Compression
L-C	62.9	Tension
C-K	44.5	Compression
K-D	49.8	Tension
D-J	178	Compression
C-D	89.0	Tension
B-C	44.5	Tension
L-K	0.0	Zero-Force
K-J	22.3	Compression

Table 2: Forces in Right-Side Members

Member	Force (N)	Type
H-G	44.5	Tension
F-G	62.9	Tension
F-H	44.5	Compression
I-F	62.9	Tension
E-I	44.5	Compression
D-I	49.8	Tension
D-E	89.0	Tension
E-F	44.5	Tension
I-H	0.0	Zero-Force
J-I	22.3	Compression
J-E	199	Tension

Full Calculations – A

1.1 Reactions A and G

Vertical Force:

$$\begin{aligned}\sum F_y &= 0 \\ \sum F_y &= A_y + G_y - F = 0 \\ A_y + G_y &= 89N\end{aligned}$$

Moment About A:

$$\begin{aligned}\sum M_A &= -(F)(7.5in) + (G_y)(15in) = 0 \\ G_y &= \frac{(F)(7.5)}{15} = 89/2 = 44.5N\end{aligned}$$

Force A:

$$\begin{aligned}A_y + G_y &= F \\ A_y = F - G_y &= 89 - 44.5 = 44.5\end{aligned}$$

Summary:

$$A_y = G_y = 44.5N$$

1.2 Joint A

$$\begin{aligned}\sum F_y &= 0 = A_y - F_{AB}\sin(45) \\ F_{AB} &= \frac{A_y}{\sin(45)} = \frac{44.5}{0.7071} = 62.9N, \text{ Tension}\end{aligned}$$

$$\begin{aligned}\sum F_x &= 0 = F_{AL} - F_{AB}\cos(45) \\ F_{AL} &= F_{AB}\cos(45) = (62.9)\cos(45) = 44.5N, \text{ Tension}\end{aligned}$$

1.3 Joint B

$$\begin{aligned}\sum F_y &= 0 = -F_{AB,y} + F_{BL} = 0 \\ F_{BL} &= F_{AB,y} = 44.5N, \text{ Compression}\end{aligned}$$

$$\begin{aligned}\sum F_x &= 0 = -F_{AB,x} + F_{BC} = 0 \\ F_{BC} &= F_{AB,x} = 44.5N, \text{ Tension}\end{aligned}$$

Full Calculations – B

1.4 Joint L

$$\sum F_y = 0 = -F_{AL} + F_{LC}\sin(45) = 0$$

$$F_{LC} = \frac{F_{AL}}{\sin(45)} = \frac{44.5}{0.7071} = 62.9\text{N, Tension}$$

$$\sum F_x = 0 = -F_{BL} + F_{LK} + F_{LC}\cos(45) = 0$$

$$F_{LK} = F_{BL} - F_{LC}\cos(45) = 0\text{N}$$

1.5 Joint C

$$\sum F_y = 0 = F_{LC} = F_{CK} = 44.5\text{N, Compression}$$

$$\sum F_x = 0 = F_{CD} - F_{BC} - F_{LC} = 0$$

$$F_{CD} = F_{BC} + F_{LC} = 89\text{N, Tension}$$

1.6 Joint K

$$\sum F_y = 0 = -F_{CK} + F_{KD}\sin(\theta)$$

$$\sin(\theta) = \frac{3}{3.354} = 0.8944$$

$$F_{KD} = \frac{F_{CK}}{0.8944} = 49.8\text{N, Tension}$$

$$\sum F_x = 0 = F_{KJ} + F_{KD}\cos(\theta)$$

$$F_{KJ} = -F_{KD}\cos(\theta) = 22.3\text{N, Compression}$$

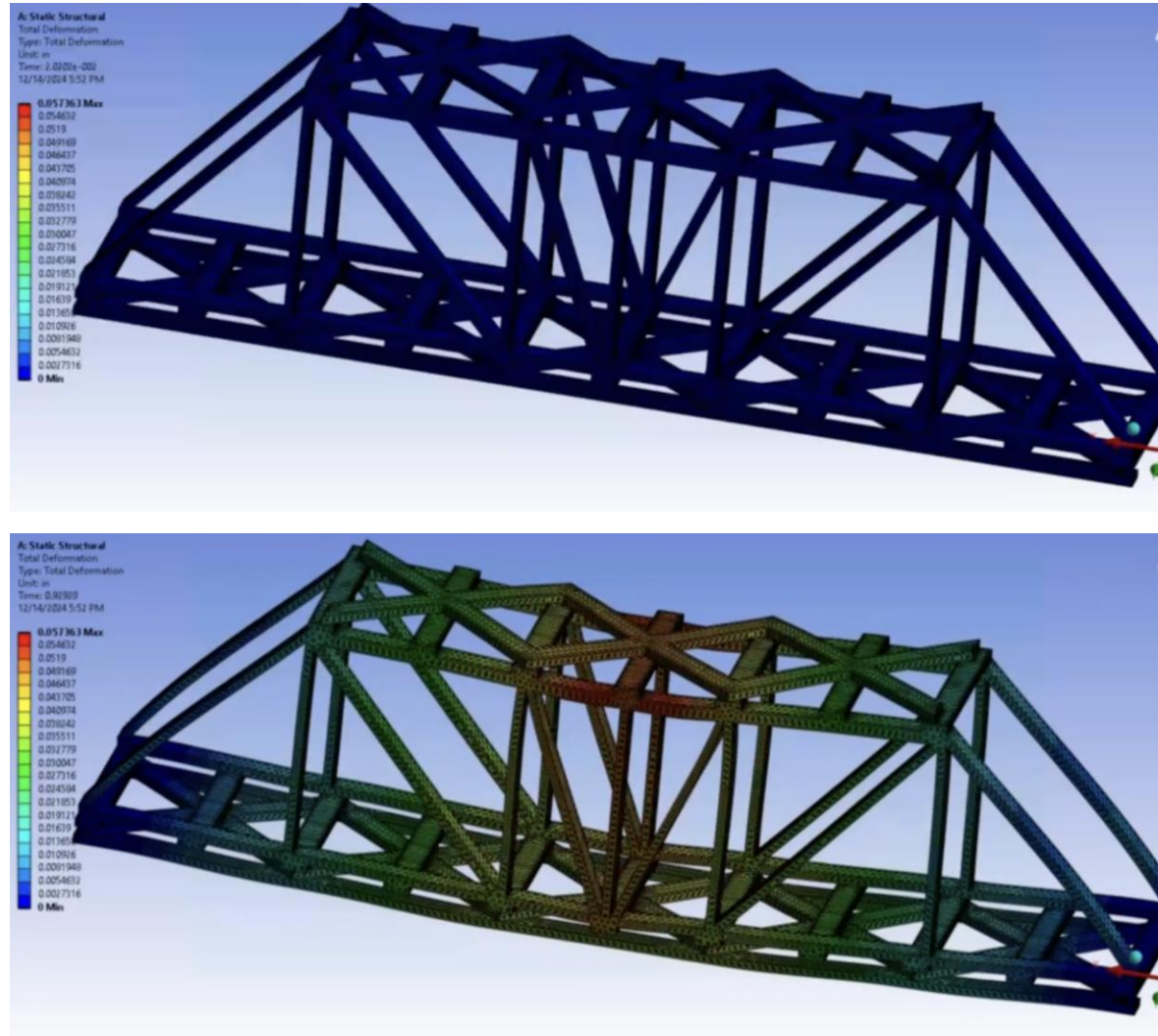
1.7 Joint D

$$\sum F_y = 0 = -F - F_{KD}\sin(\theta) - F_{DI}\sin(\theta) + F_{DJ}$$

$$F_{DJ} = 178\text{N, Compression}$$

$$\sum F_x = 0 = -F_{CD} - (F_{KD}\cos(\theta)) + F_{DE} + (F_{DI}\cos(\theta)) = 0\text{N}$$

CONFIRMATION OF CALCULATIONS: FEA – TOTAL DEFORMATION*



*Given the complexities of glue as joints, the FEA is analogous to loading onto a carved block of wood. The total deformation should be used as general verification of calculations.