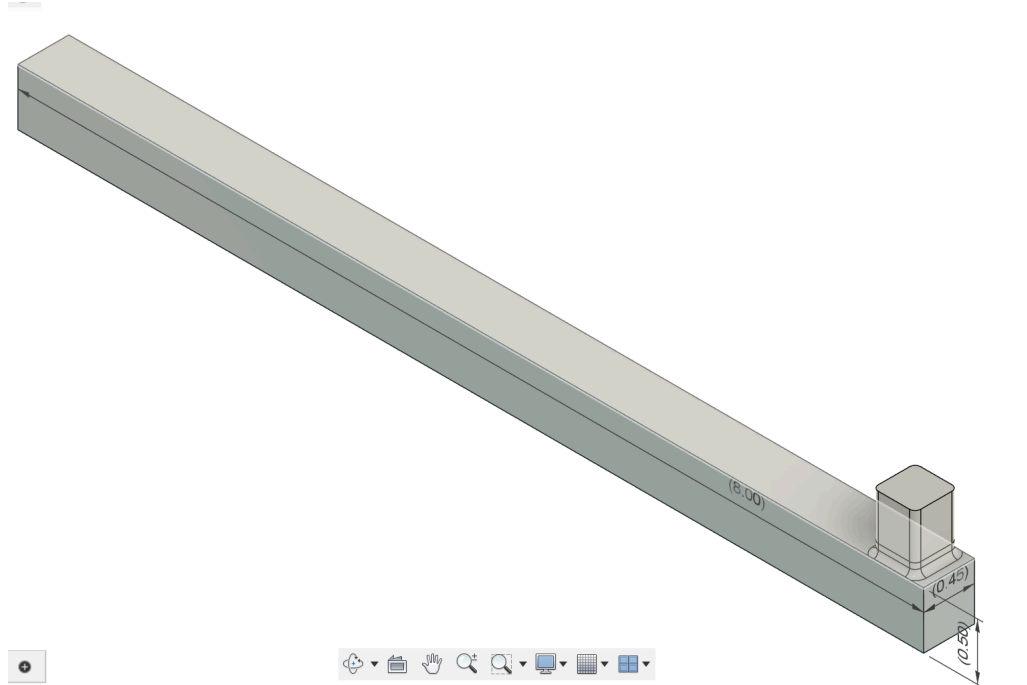


**1. Image(s) of CAD model. Must show all key dimensions.**



**2. Describe the material used and its relevant mechanical properties.**

Material: Titanium Ti-6Al-4V (Grade 5), Annealed

Subcategory: Alpha/Beta Titanium Alloy; Metal; Nonferrous Metal; Titanium Alloy

Material properties:

Young's modulus: 16.1E6

Poisson's ratio: 0.35

Tensile strength: 148E3

Fracture toughness: 74.6E3

Fatigue strength: 90E3

--- inputs ---

b,h = 0.450 , 0.500 in

c = 1.00 in

--- results ---

sigma (ksi) = 32.00

strain (ue) = 1739

tip defl (in) = 0.1696

SF\_yield = 4.62

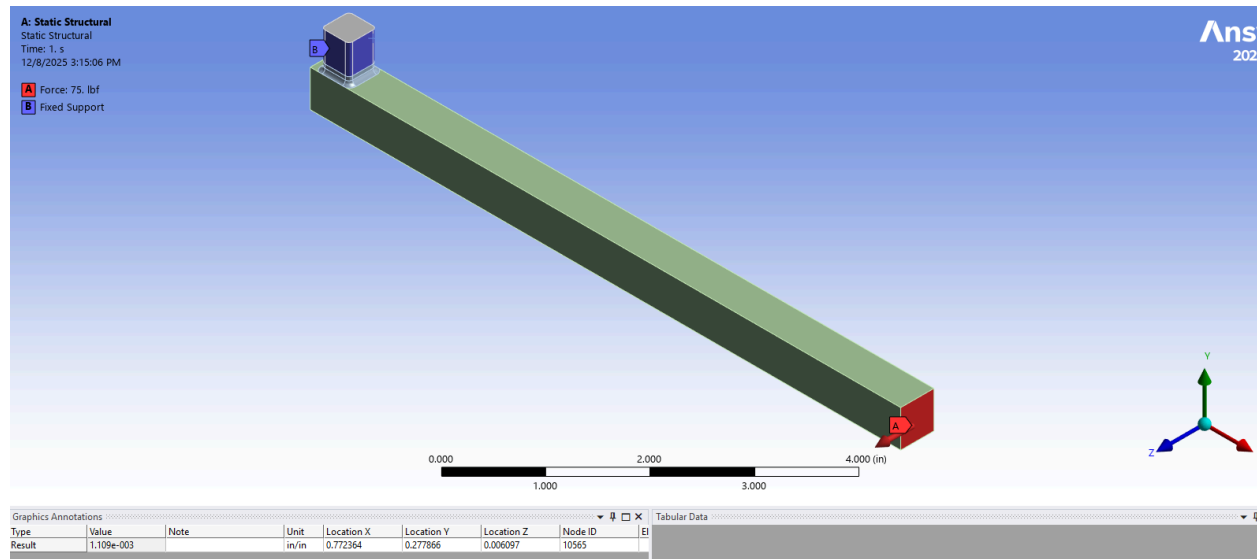
SF\_K = 5.87

SF\_fatigue = 2.81

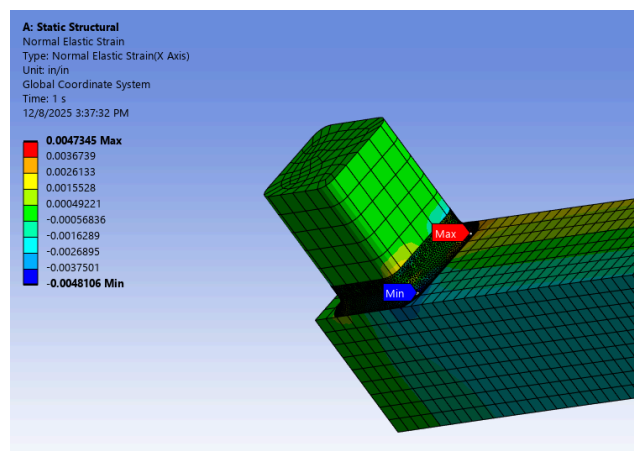
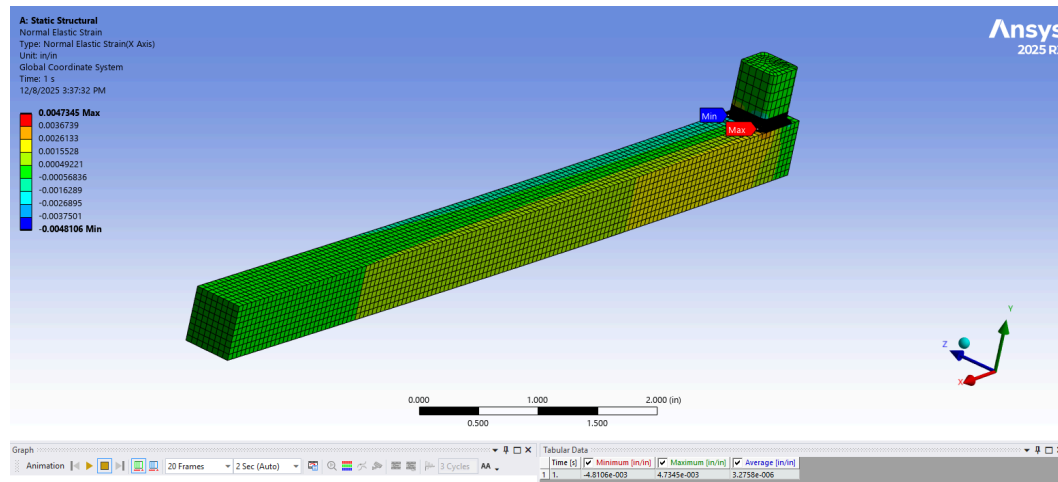
output (mV/V) = 1.739

sens (mV/V per in-lbf) = 0.00290

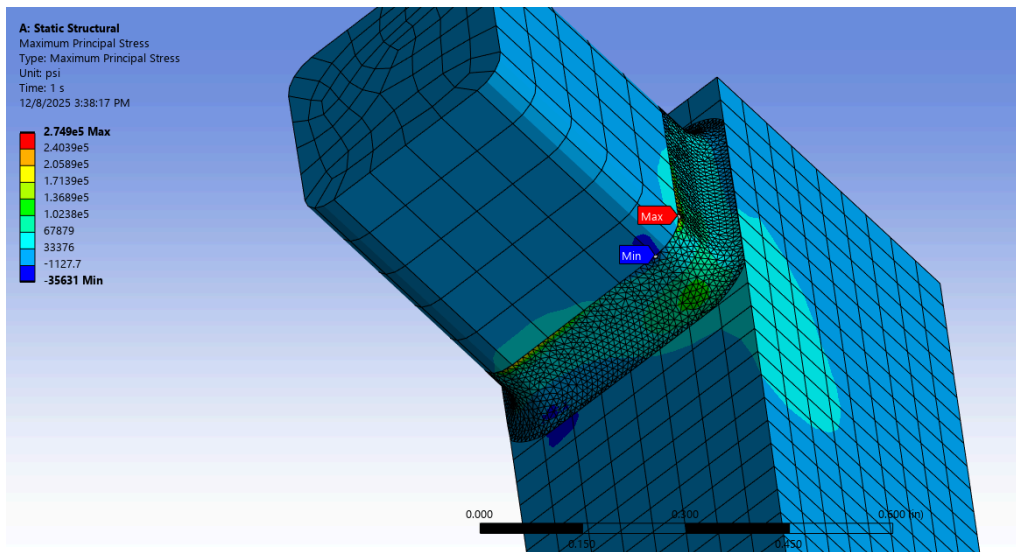
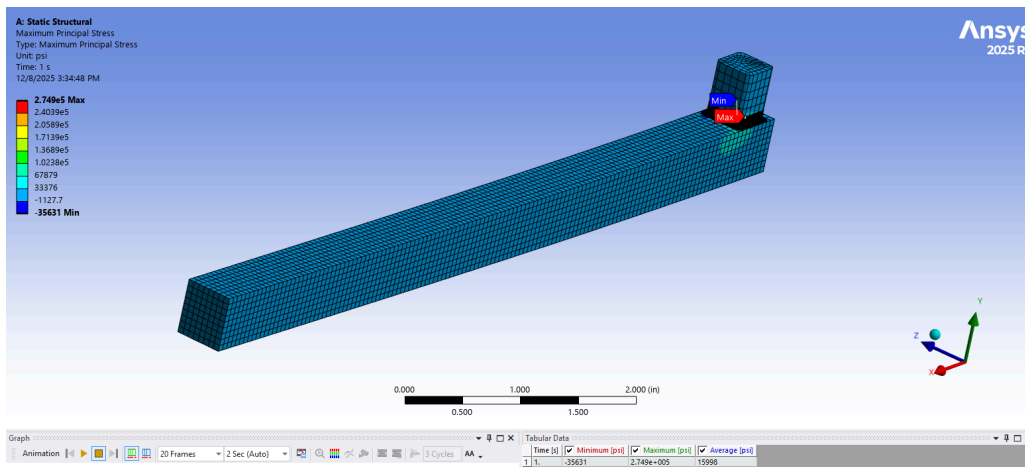
### 3. Diagram communicating how loads and boundary conditions were applied to your FEM model.



### 4. Normal strain contours (in the strain gauge direction) from FEM

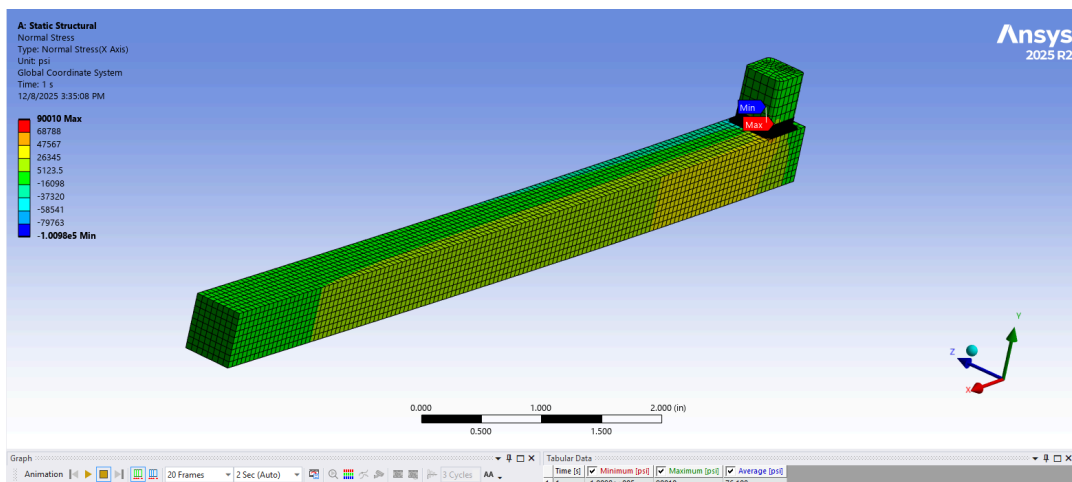


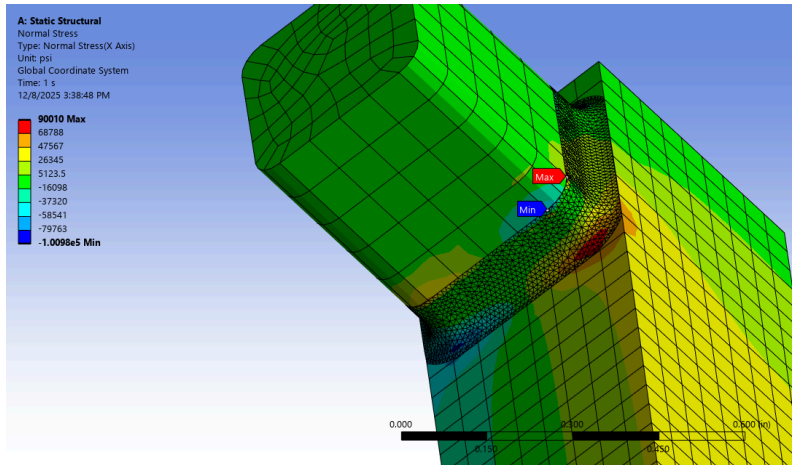
## 5. Contour plot of maximum principal stress from FEM



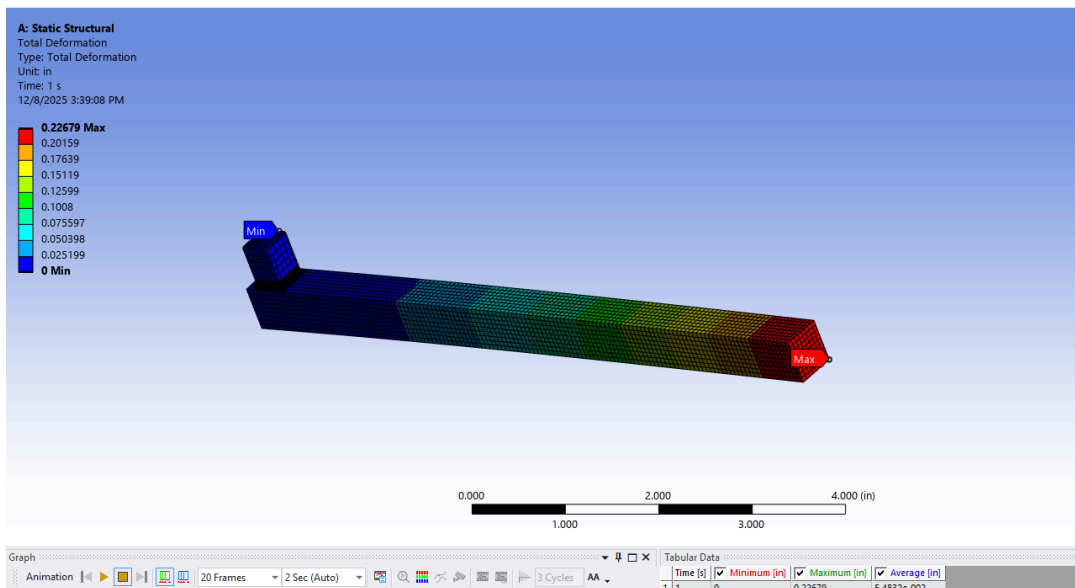
## 6. Summarize results from FEM calculation showing maximum normal stress (anywhere), load point deflection, strains at the strain gauge locations

Normal stress: Max= 90010 psi Min=-100980 psi

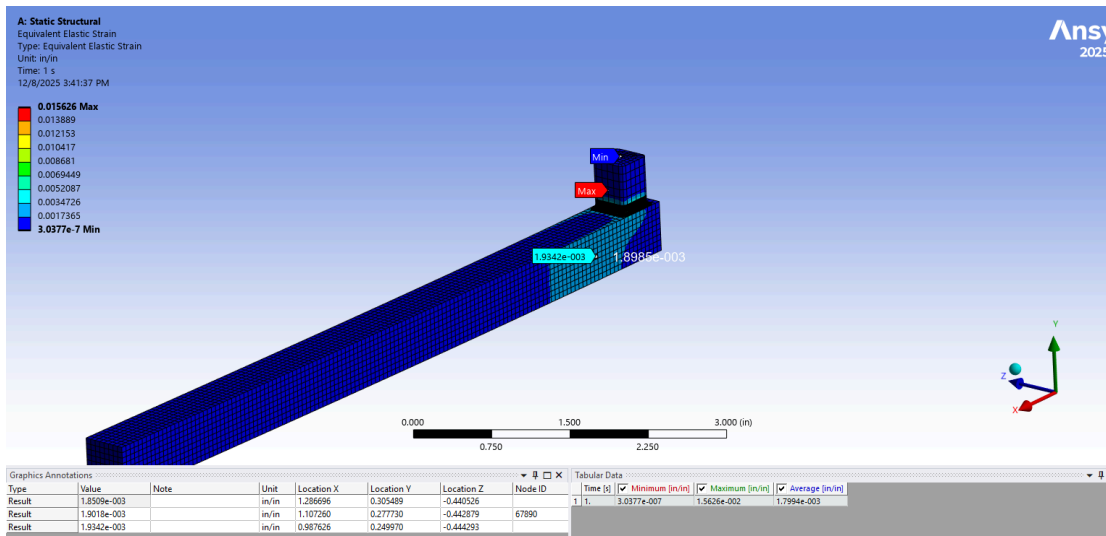




Tip deformation: 0.22679in



Strain at strain gauge: 1934microstrain



### 7. Torque wrench sensitivity in mV/V using strains from the FEM analysis

Torque wrench sensitivity is directly correlated with outputs:

$$\text{Output} = k \cdot \text{strain} / 2 = 2 \cdot 1.934 / 2 = \mathbf{1.934 \text{ mV/V}}$$

**8. Strain gauge selected (give type and dimensions). Note that design must physically have enough space to bond the gauges.**



For this design, a single-element linear metal-foil strain gauge is selected so it can be aligned with the principal bending strain on the wrench arm and still comfortably fit on the machined flat.

- Type: 350  $\Omega$  constantan foil, single axial element
- Gauge length: ~3 mm
- Grid width: ~2 mm
- Overall backing footprint: about 5 mm  $\times$  3–4 mm

This size is small enough to bond fully on the available flat area of the torque wrench handle, while still long enough to average the local strain field and give a stable, repeatable signal.