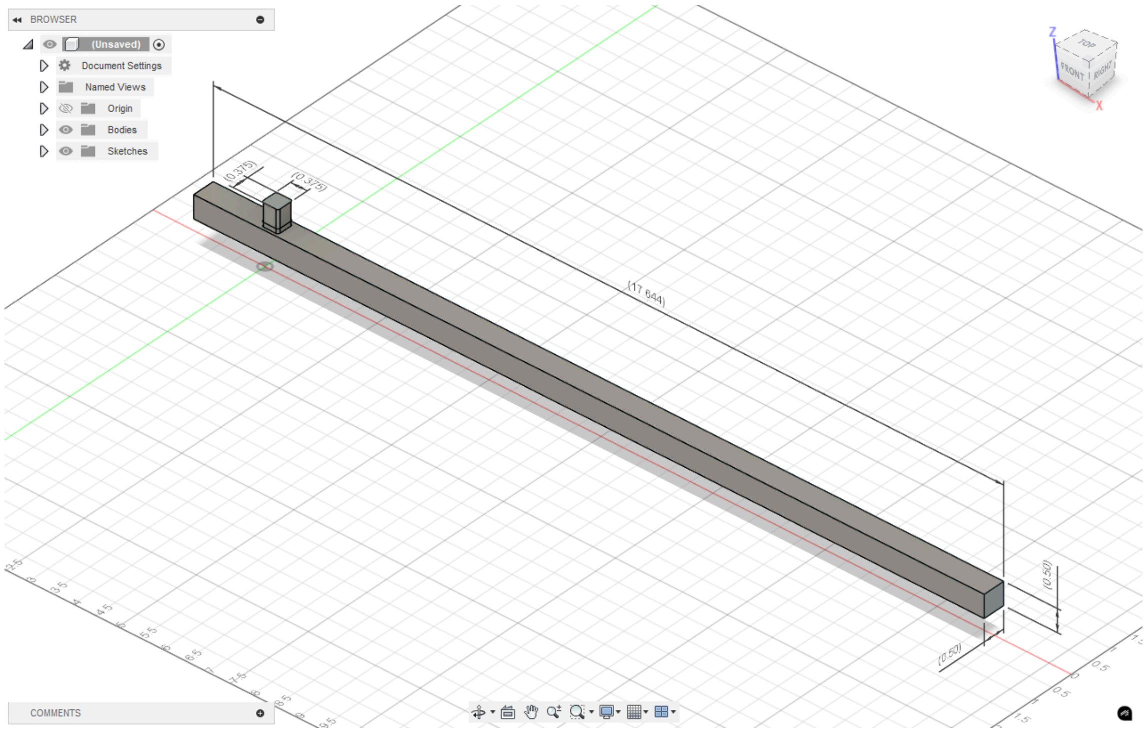
# Torque Wrench Material Design

## 1. CAD model and key dimensions




## 2. Material used and its relevant mechanical properties

The material assigned to this torque wrench is Ti-6Al-4V:

Young’s modulus: 16.1e6 psi

Poisson’s ratio: 0.35

Tensile strength: 148e3 psi

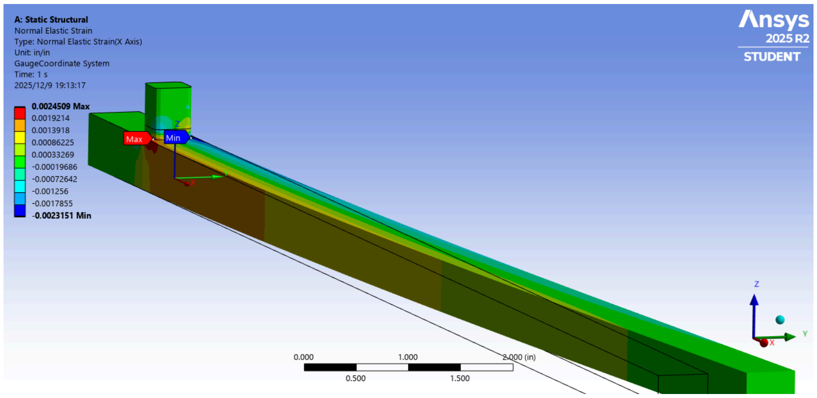
Fracture toughness: 74.6e3 psi

Fatigue strength: 90e3 psi

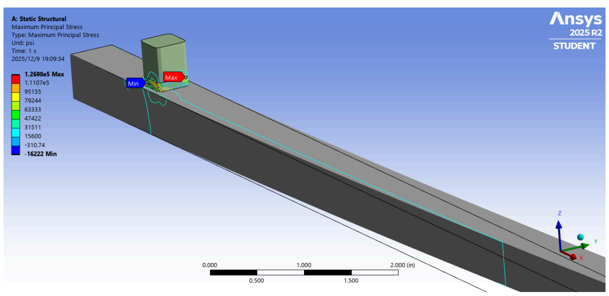
## 3. Diagram communicating how loads and boundary conditions were applied to your FEM model.

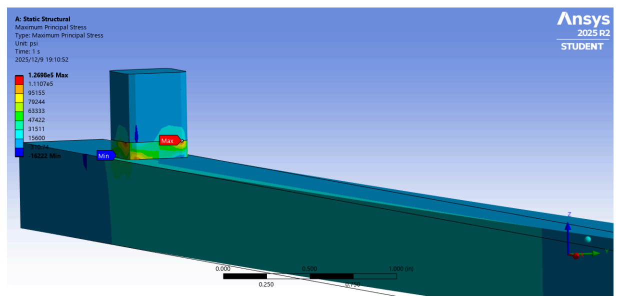
| | x | y | z |
|---|---|---|---|
| Constraints (at head) | 0 | 0 | 0 |
| Forces (at grip) | | M/L=600lbf/16in | |

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



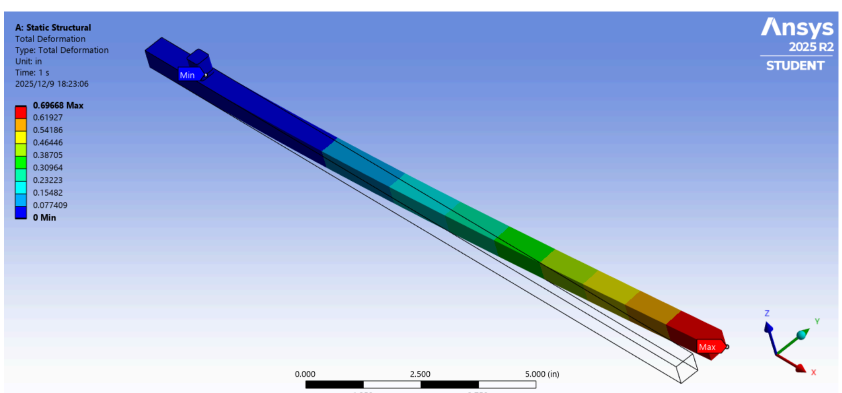

### 5. Contour plot of maximum principal stress from FEM



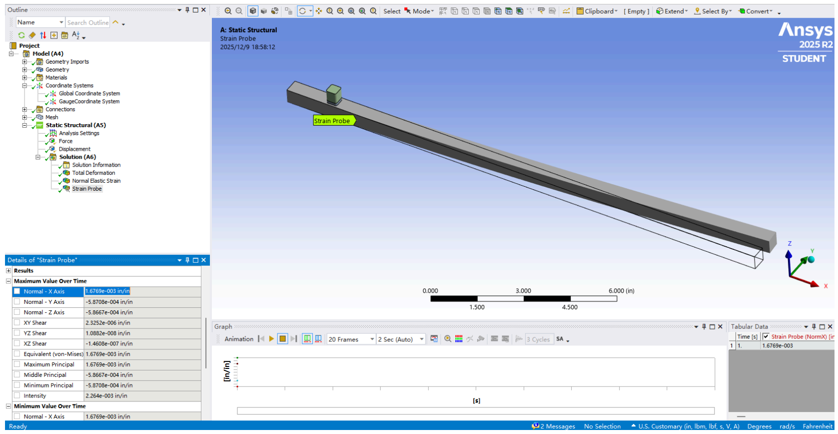




Isolines Contour bands

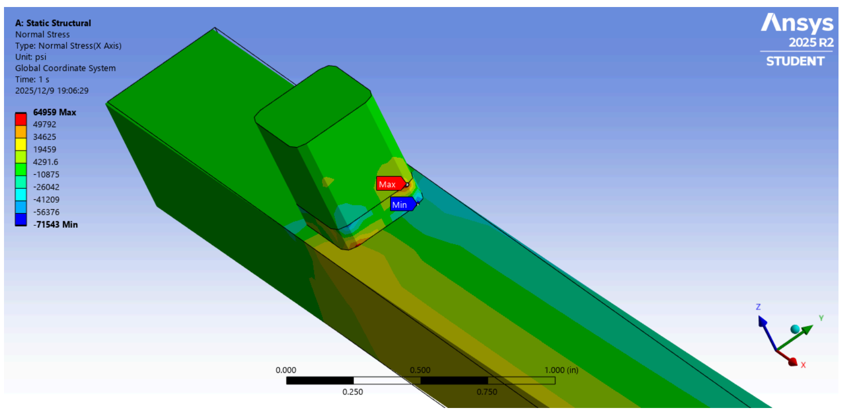
### 6. Summarize results from FEM calculation showing maximum normal stress (anywhere), load point deflection, strains at the strain gauge locations




The FEM calculated total deformation is 0.697in, while the MATLAB calculated deformation is 0.611in, which are pretty close.




The FEM calculated normal strain at the gauge location is 1.677e03, which is exactly the same as the MATLAB output.



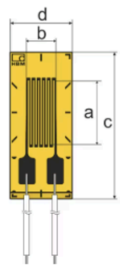

The FEM calculated normal stress is 6.496e4 psi, while that calculated in MATLAB is 2.880e4 psi. One contributing factor of such a large difference between the calculated results is because the MATLAB hand calculation uses simple beam theory (assuming a prismatic beam and gives only the nominal bending stress); the FEM model, however, has 3-D geometry, including the transition where the drive meets the handle. The geometric changes create stress concentrations, so the peak stress from FEM is higher than the average stress predicted by beam theory.

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

Torque wrench sensitivity is positively correlated with output, which is equal to output=k*strain/2=2* 1.6769mV/V /2 = 1.6769

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

The selected strain gauge model is CLY41-3/120ZE, which would fit with the strain measurement purpose of our model. The dimensions also fit with the torque wrench beam.




**CLY41-3/120ZE**

## Strain gauge 3/120ZE LY41

Strain gage series Y
Geometry: linear
Measuring grid material: constantan
Carrier foil: polyimide
1 measuring grid
Measuring grid covered
50 mm fluoropolymer-insulated wires
Temp. response: ferr. steel (10.8 ppm/K)
Nominal resistance: 120 ohms
Measuring grid length: 3 mm
Contents per package: 10 pcs.

| | |
|---|---|
| Measuring grid length | 3 mm |
| Measuring grid width | 1.2 mm |
| Carrier length | 8 mm |
| Carrier width | 5 mm |