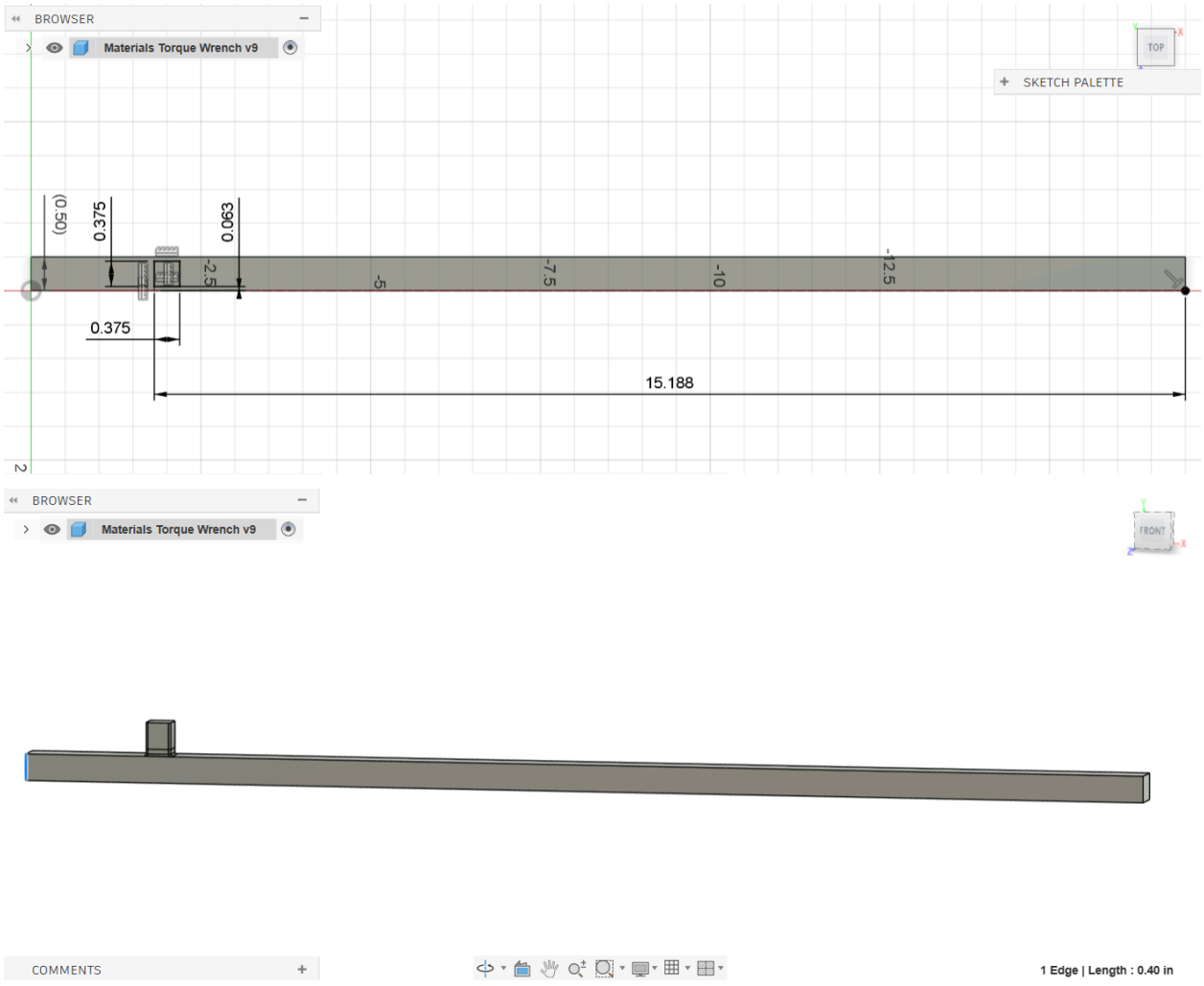
MAE 3270 System Dynamics

Fall 2025
Final Homework Torque Wrench Design

By:
Mia Paz

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



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

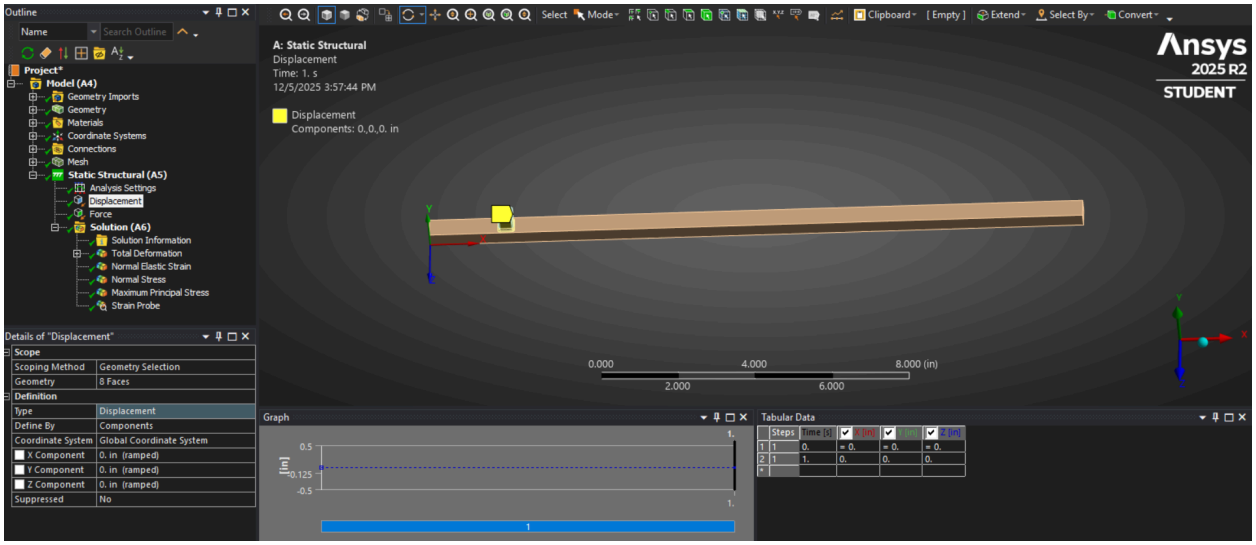
Low-alloy steel was chose as the material, which contains a small percentage of alloying elements. This allows for the material to have improved mechanical properties compared to regular carbon steel, such as a high yield strength, fatigue strength, and fracture toughness.

Properties:

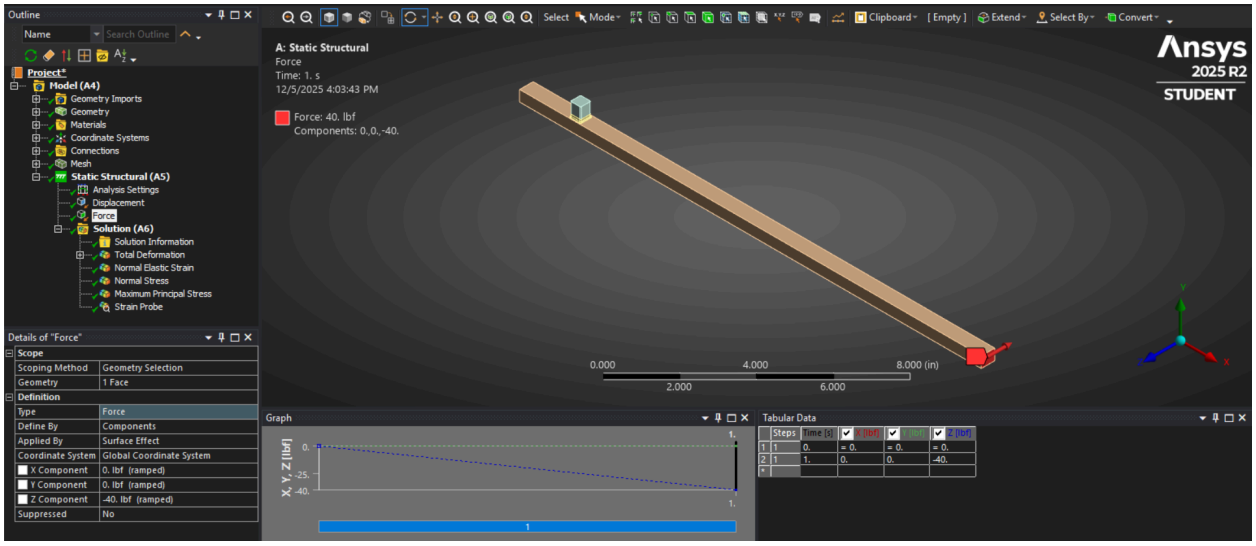
- Young's Modulus: 30.5e6 psi
- Poisson's Ratio: 0.29
- Tensile strength: 232e3 psi
- KIC: 96.5e3 psi sqrt(in)
- Fatigue strength: 94.4e3 for 10^6 cycles

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

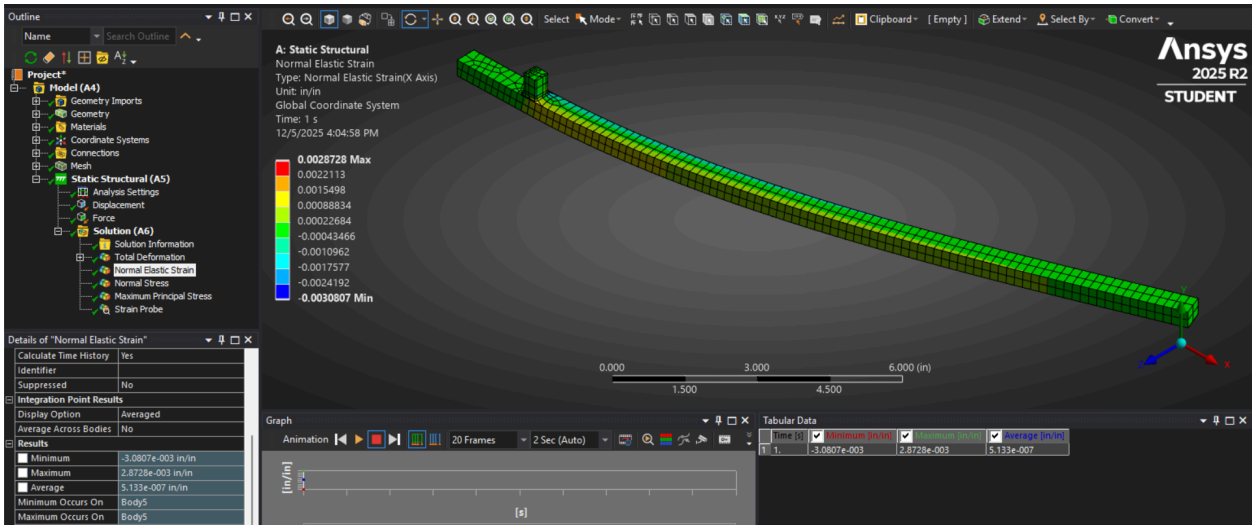
Boundary Conditions:



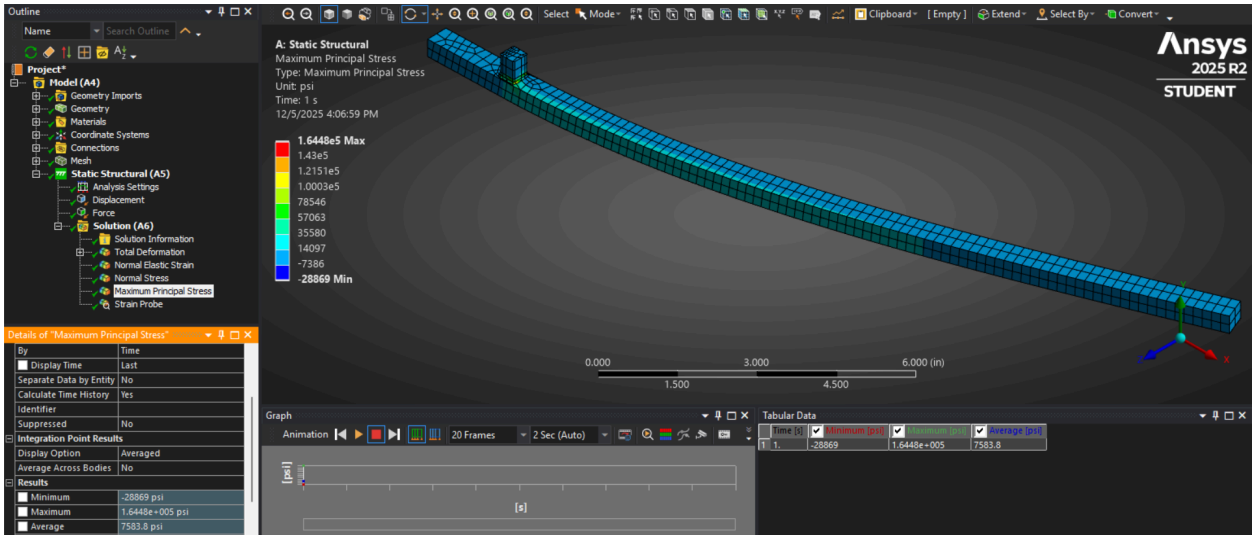
Applied Load:



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

   My hand calculations were pretty close to the FEM calculations. Our design's FEM produced a maximum normal stress of about 35 ksi, a load point deflection of 0.38808 inches, and a strain at the strain gauge location of 1090 microstrain. This almost matches our hand calculations, which produced a maximum normal stress of about 33.6 ksi, a load point deflection of 0.3541 inches, and a strain at the strain gauge location of 1101.6 microstrain. The small discrepancies are to be expected, with the hand calculations outputting higher values since they don't account for the fillets or the boundary condition of the clamping on the drive in our design.

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

   Using the strain at the center of the strain gauge from the FEM, we found the torque wrench sensitivity to be 10.9 mV/V.

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

Additional Features 1	Transducer quality
Carrier Length	9.2 mm
Carrier Width	6 mm
Commodity Code	9026.20.0000
DepthValue	8.1
ECCN	EAR99
Electrical Connection	Wire Leads
Grid Length	1.5 mm
Grid Style	Wide Linear Pattern, Dual Grid
Grid Width	4.8 mm
GrossWeightValue	0.15
HeightUoM	IN
HeightValue	0.6

https://www.dwyeromega.com/en-us/uniaxial-half-bridge-strain-gauges-with-transducer-quality/SGT-Half-Bridge-Uniaxial/p/SGT-1LH-1000-TY11