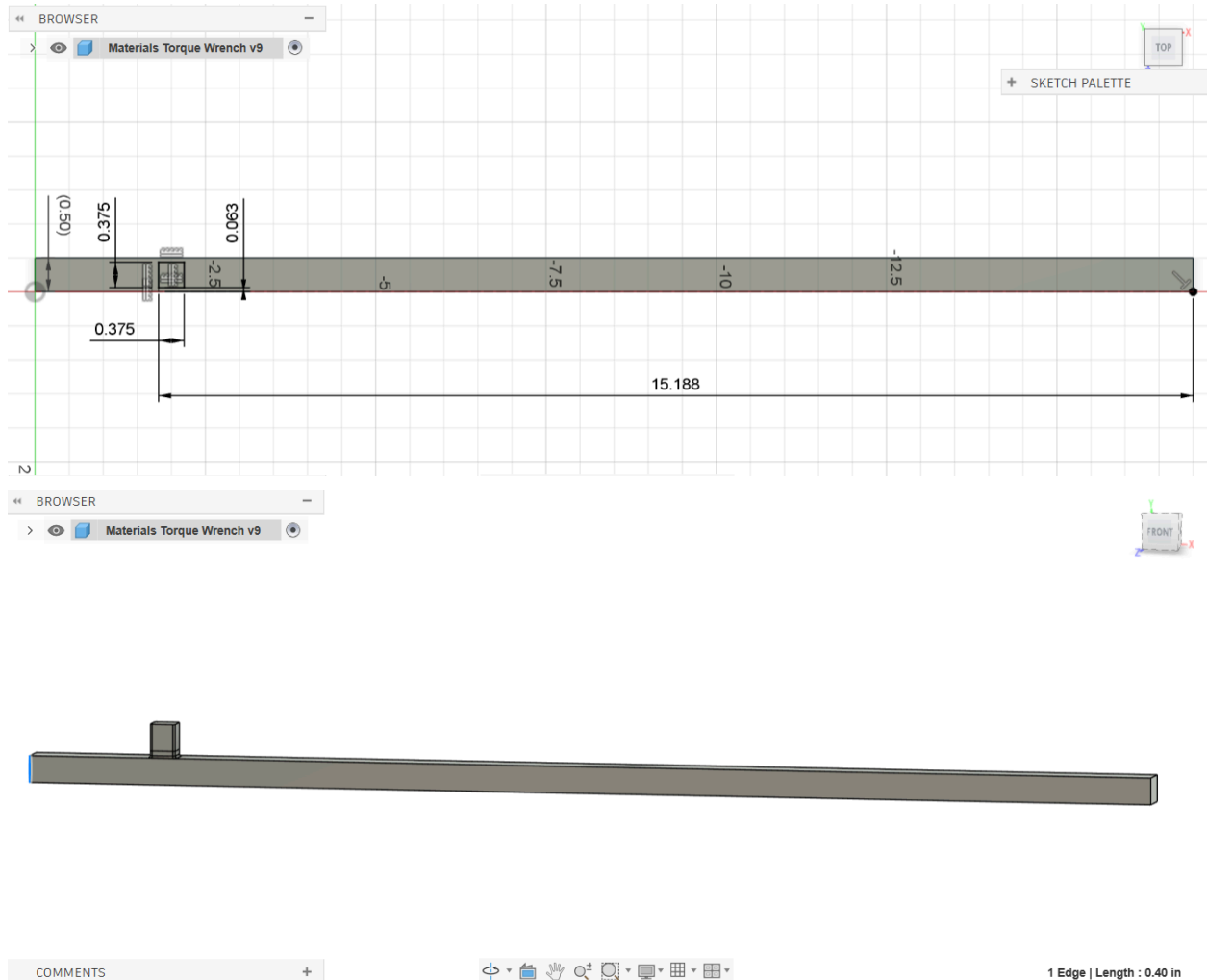


## Part 2– Our Design

### 1. CAD Images



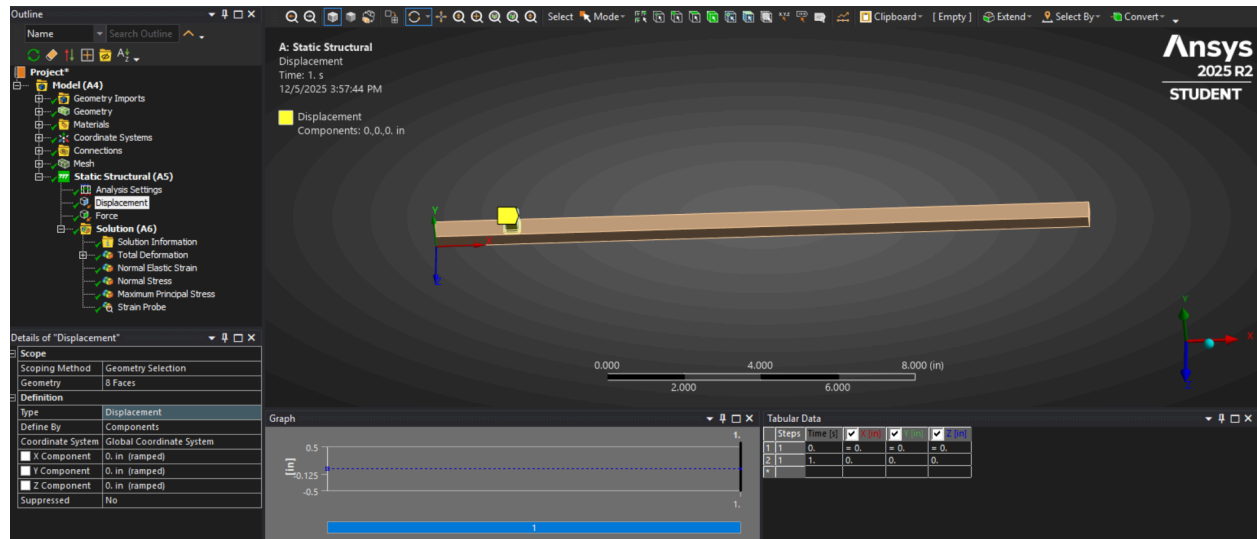
2. We used low-alloy steel for our material, which contains a small percentage of alloying elements. This allows for the material to have improved mechanical properties compared to regular carbon steel, such as a high yield strength, fatigue strength, and fracture toughness.

#### Properties:

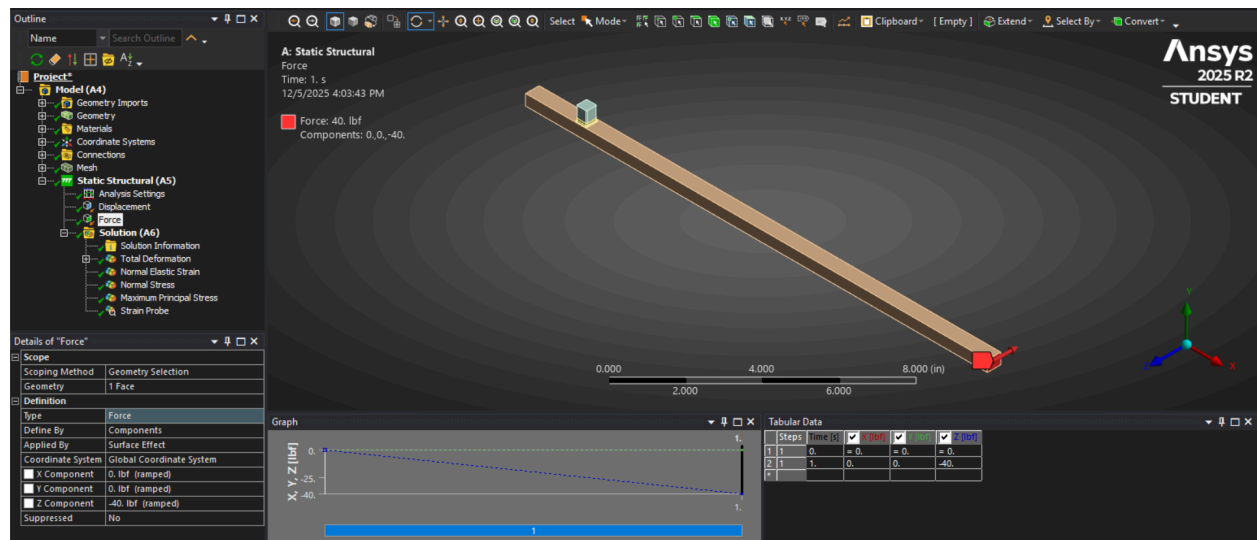
- Young's Modulus: 30.5e6 psi
- Poisson's Ratio: 0.29
- Tensile strength: 232e3 psi
- KIC: 96.5e3 psi sqrt(in)
- Fatigue strength: 94.4e3 for  $10^6$  cycles

### 3.

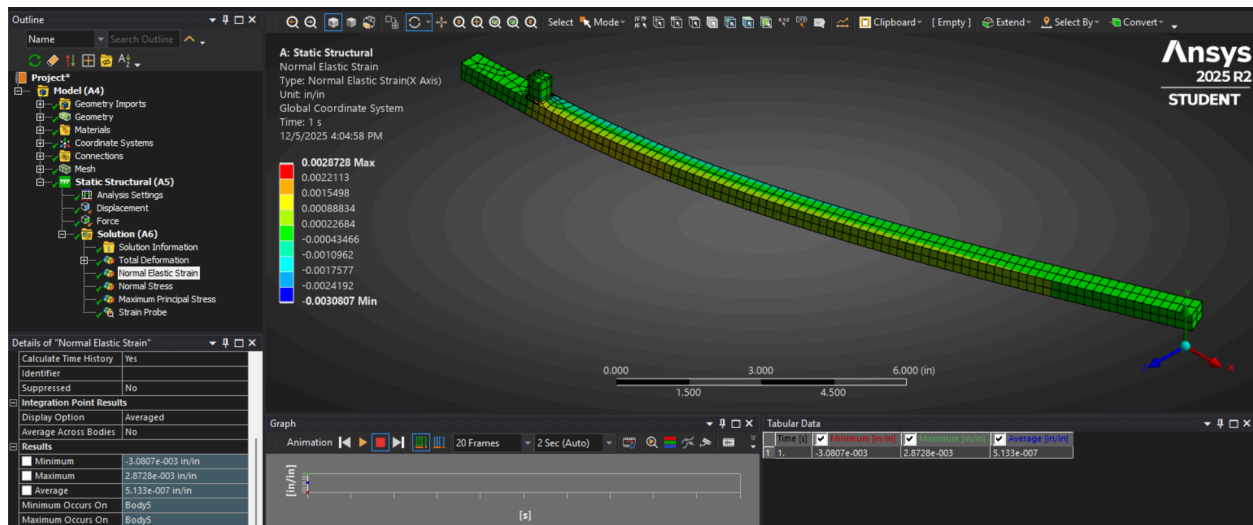
#### Boundary Conditions:



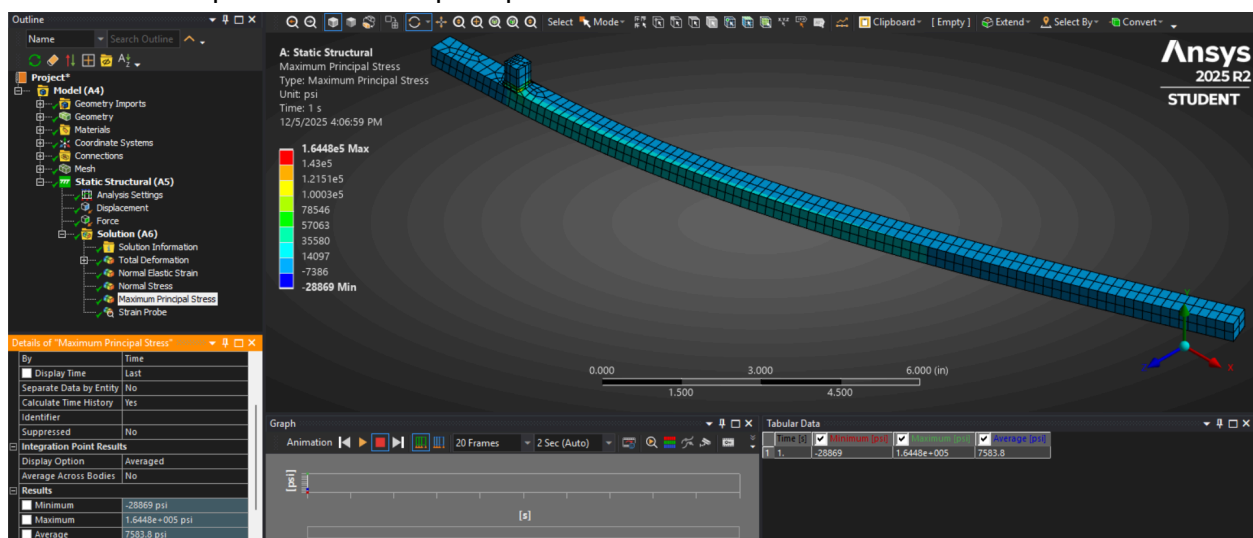
Applied Load:



#### 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

Our 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 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>