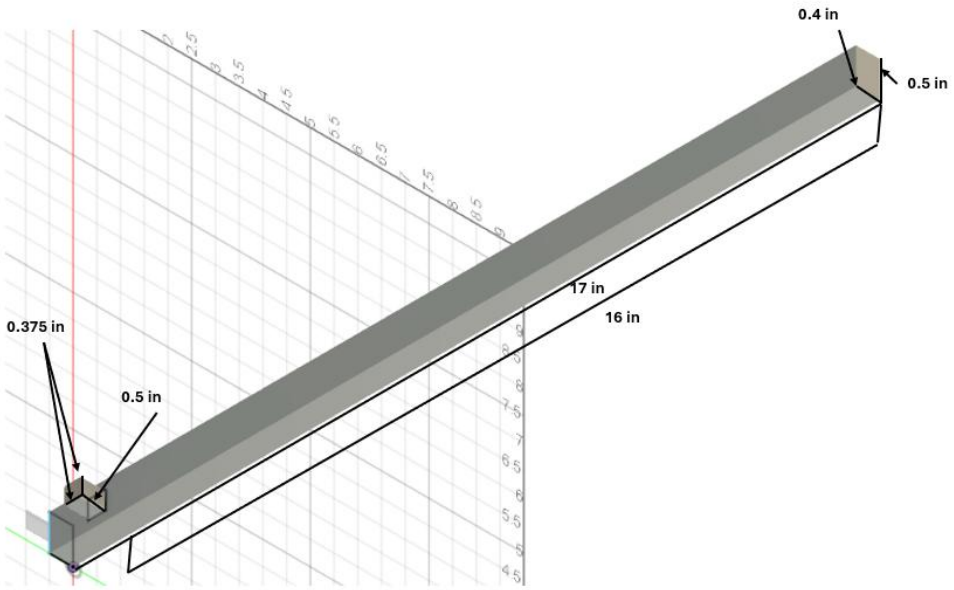
MAE 3270, Fall 2025, Last HW, Design Project, Due Dec 8
Rahul Barpanda

1 What to include in your HW and portfolio

1.1 Your Design, Upload to portfolio

1.1.1 Results

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



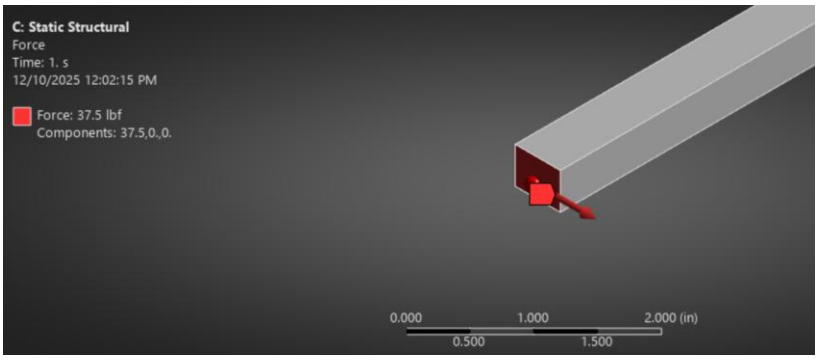
2. Describe material used and its relevant mechanical properties.

Ti-6Al-4V (Grade 5). This was used because it was able to meet all three safety factors and sensitivity criteria. It had the highest allowable stress-to-modulus ratio among the three options.

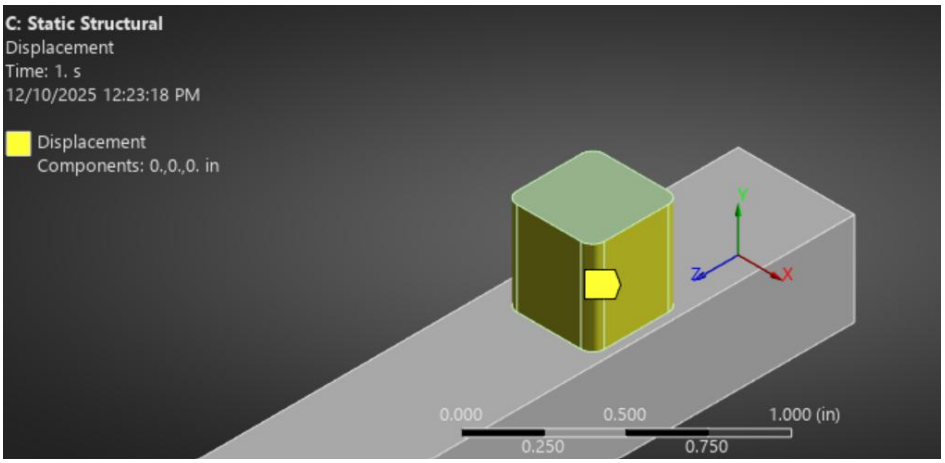
The material properties are as follows:

- *Young's Modulus = $16.5*10^6$ psi*
- *Poisson's Ratio = 0.34*
- *Ultimate Tensile Strength = $1.6*10^5$ psi*
- *Fracture Toughness = $5*10^4$ psi*$in^{1/2}$*
- *Fatigue strength = $9*10^4$ psi*

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

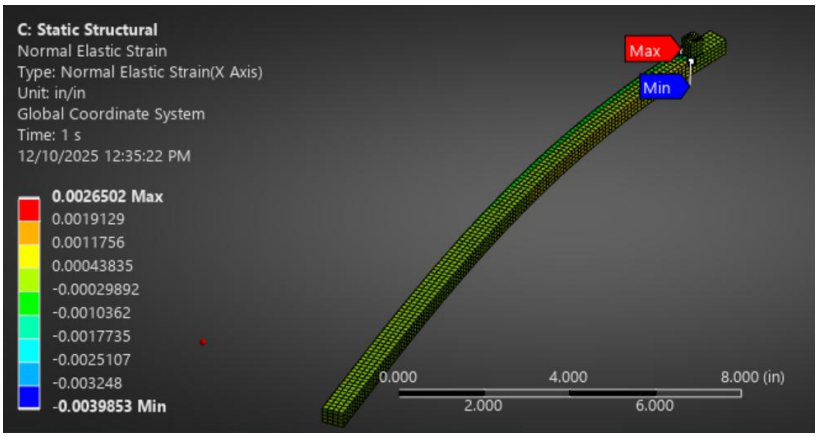


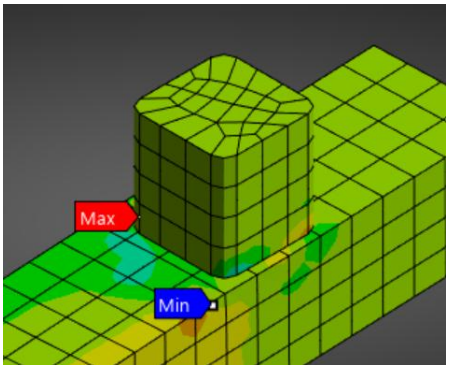
Applied force of 37.5 lbs in +x direction at the end of the wrench

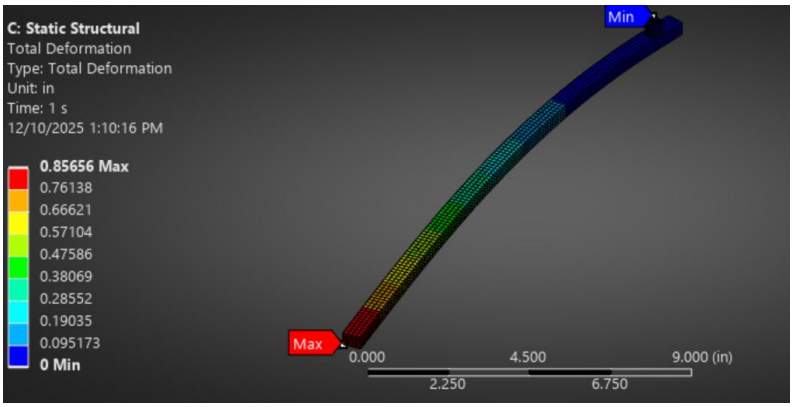


Fixed pivot, hence, displacement is defined to be 0 inches in all directions

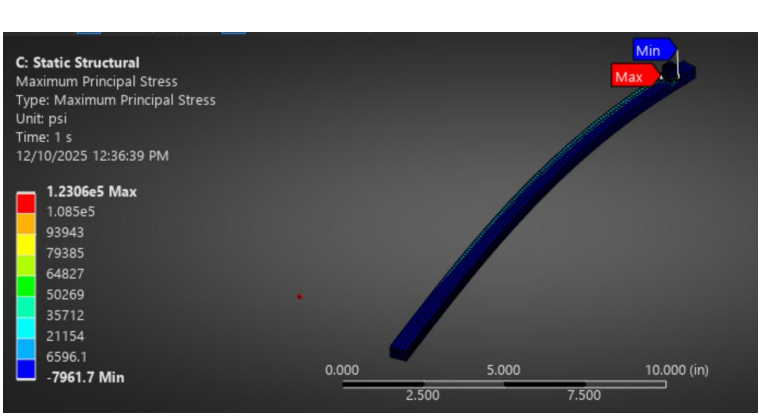
4. Normal strain contours (in the strain gauge direction) from FEM

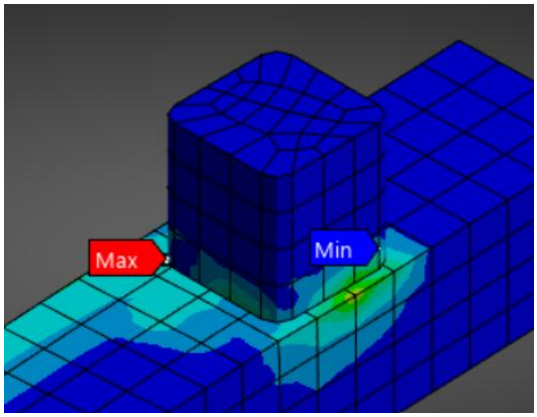






5. Contour plot of maximum principal stress from FEM





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

Max Normal Stress	Load Point Deflection
$1.2306*10^5$	.85656 in

Tabular Data

	Time [s]	Strain Probe (NormX) [in/in]	Strain Probe (NormY) [in/in]	Strain Probe (NormZ) [in/in]	Strain Probe (ShearXY) [in/in]	Strain Probe (ShearYZ) [in/in]	Strain Probe (ShearXZ) [in/in]
1	1.	6.9543e-004	6.9535e-004	-2.0453e-003	1.3846e-007	-1.3741e-006	1.5573e-006

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

$2.0453*10^{-3}*10^3 = 2.0453$ mV/V. This satisfies the condition that it needs to be greater than 1 mV/V. Compared to the hand calculations for this condition, the drop is expected because it utilizes the simplified beam theory (does not consider the presence of fillets, etc).

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

Vishay Micromeasurements C2A Series Strain Gauge 125 LR

125LR 	0.125 [3.18] Each Section	0.245 [6.22] Complete Pattern	0.070 [1.78] Each Section	0.415 [10.54] Complete Pattern	C2A-XX-125LR-120 C2A-XX-125LR-350	120 ±0.6% 350 ±0.6%
	General-purpose 45° rectangular single-plane rosette.					

https://www.vishay-measurements.ca/pdf/strain/C2A_Series.pdf