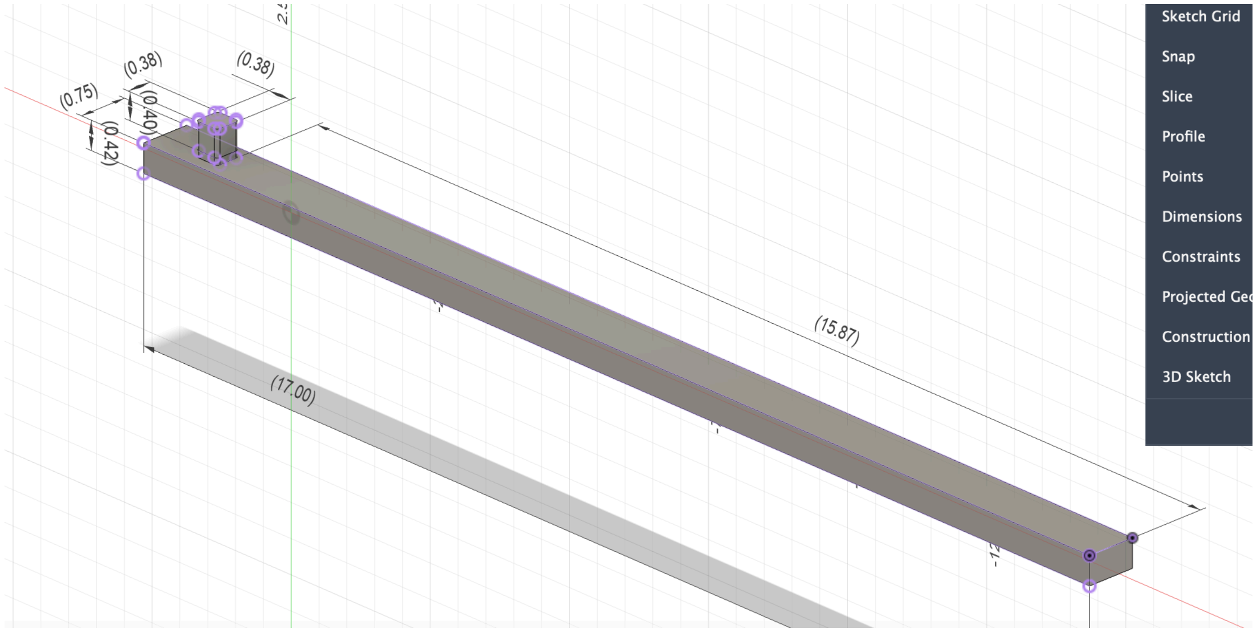
Torque Wrench Design

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



3.2 Describe material used and its relevant mechanical properties.

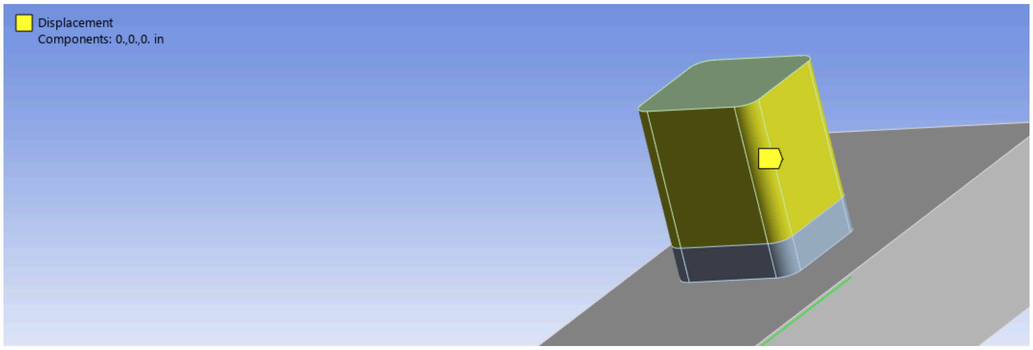
Aluminum 7075-T6 (properties from Granta)

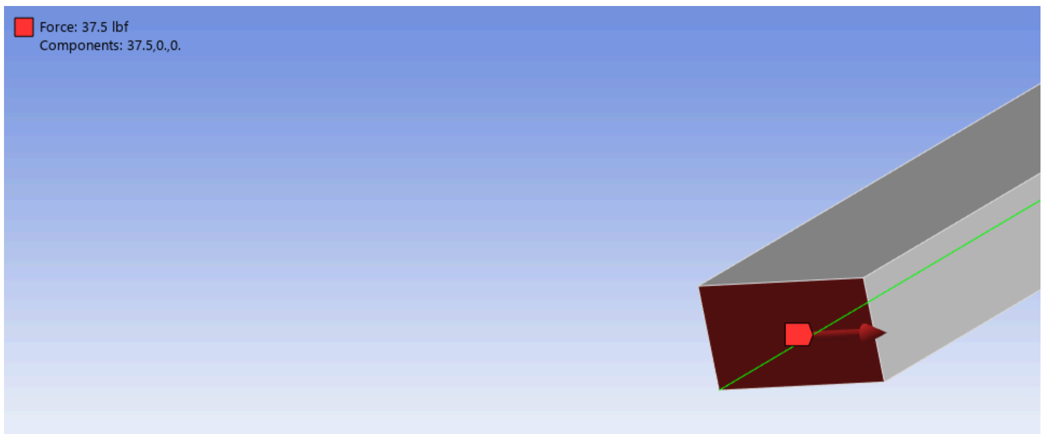
We choose this material because it is a very strong and lightweight alloy. It has strength similar to some steel but is a lot lighter.

→Young's Modulus: $1.1\ x\ 10^{7}$psi

→Poisson's Ratio: 0.33

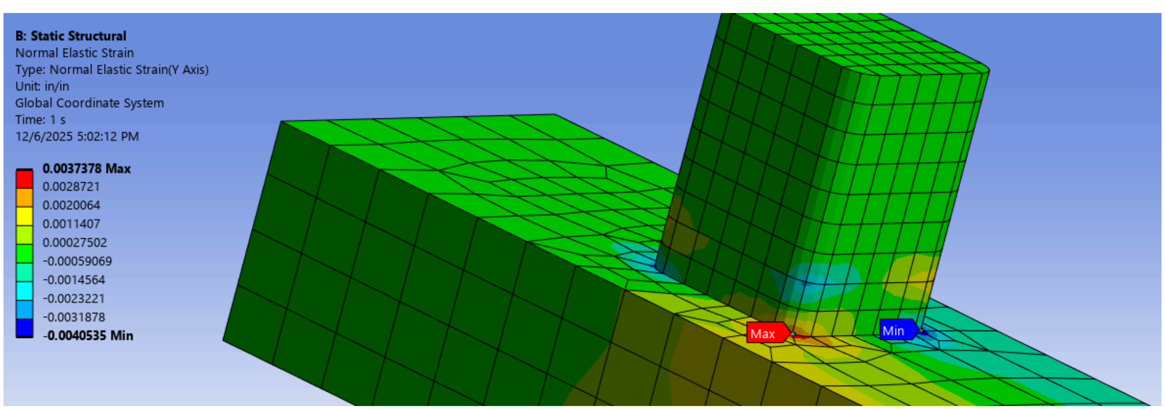
3.3 Diagram communicating how loads and boundary conditions were applied to your FEM model.



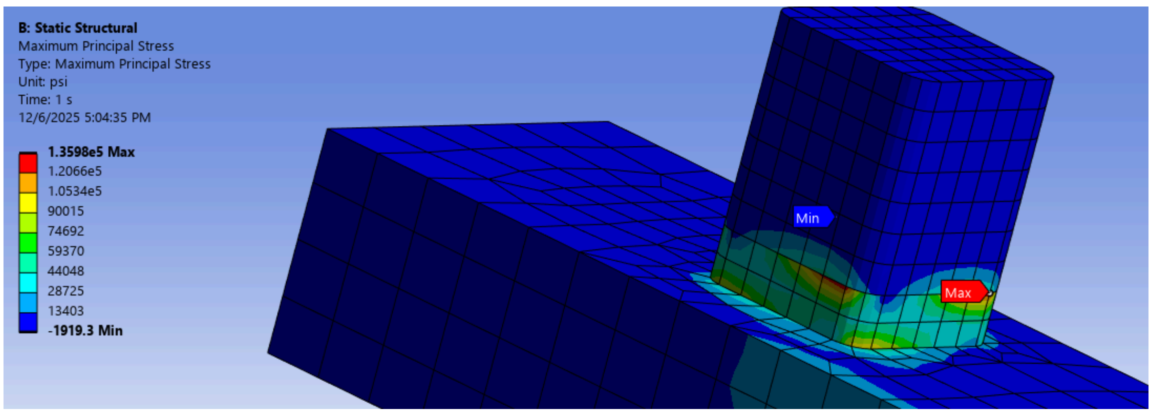


Boundary condition is set at the drive to restrict its movement while the force is being put at the face at the end of the torque wrench at 37.5 lbf, which is the result of 600lbf / 16 inch.

3.4 Normal strain contours (in the strain gauge direction) from FEM



3.5 Contour plot of maximum principal stress from FEM



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

Maximum normal stress: 55442 psi

Load point deflection: 0.44955 inch

Strains at strain gauge location:

Results	
Normal - X Axis	-4.2857e-004 in/in
Normal - Y Axis	1.2987e-003 in/in
Normal - Z Axis	-4.2862e-004 in/in
XY Shear	-6.7846e-007 in/in
YZ Shear	-4.9403e-007 in/in
XZ Shear	7.0875e-008 in/in
Equivalent (von-Mises)	1.2987e-003 in/in
Maximum Principal	1.2987e-003 in/in
Middle Principal	-4.2855e-004 in/in
Minimum Principal	-4.2864e-004 in/in
Intensity	1.7274e-003 in/in

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

We would use the Equivalent(von-Mises) strain value: $\varepsilon_{FEM} =$

$1.2987\ x\ 10^{-3}\ in/in$

Now Calculate for $\frac{V_{out}}{V_{in}}$:

$\frac{V_{out}}{V_{in}} = GF\varepsilon_{FEM} x(bridge\ factor)$ = 2 x 1.2987 x 10^{-3}x0.5 = 1.2987 x 10^{-3}

Finally, calculate for sensitivity:

$$S = \frac{1.2987\ x\ 10^{-3}}{600} = 2.2\ x\ 10^{-3} mV/V$$

or

1.3 mV/V at 600 in-lbf

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

Our selected strain gauge locates at 15 inches from the edge of the handle bar and 1 inch apart from the top block, according to the homework guidance. It is a single strain with 0 degrees of tilt along the side of the handle bar in Y-Z plane.