Improved Torque Wrench Design

1. Images of CAD model

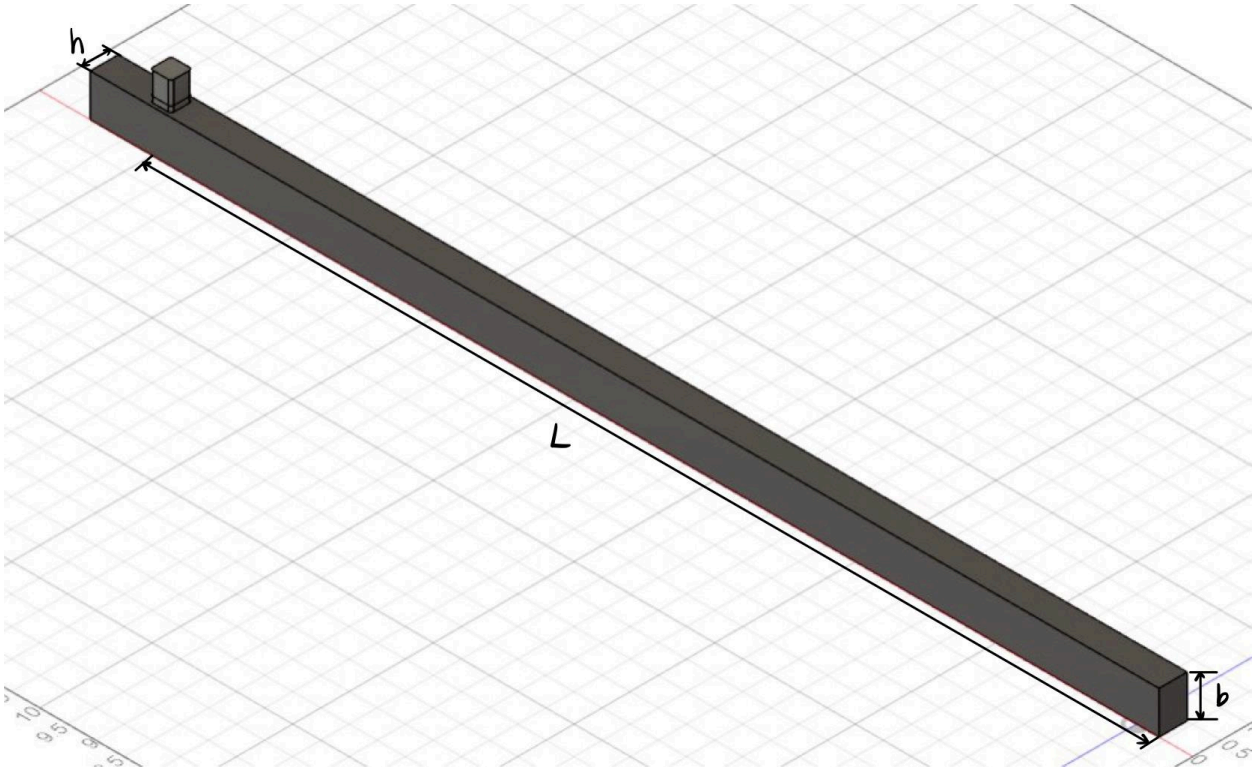

Figure 1.1: dimensions of torque wrench handle; L = 18”, h = 0.5”, b = 0.75”

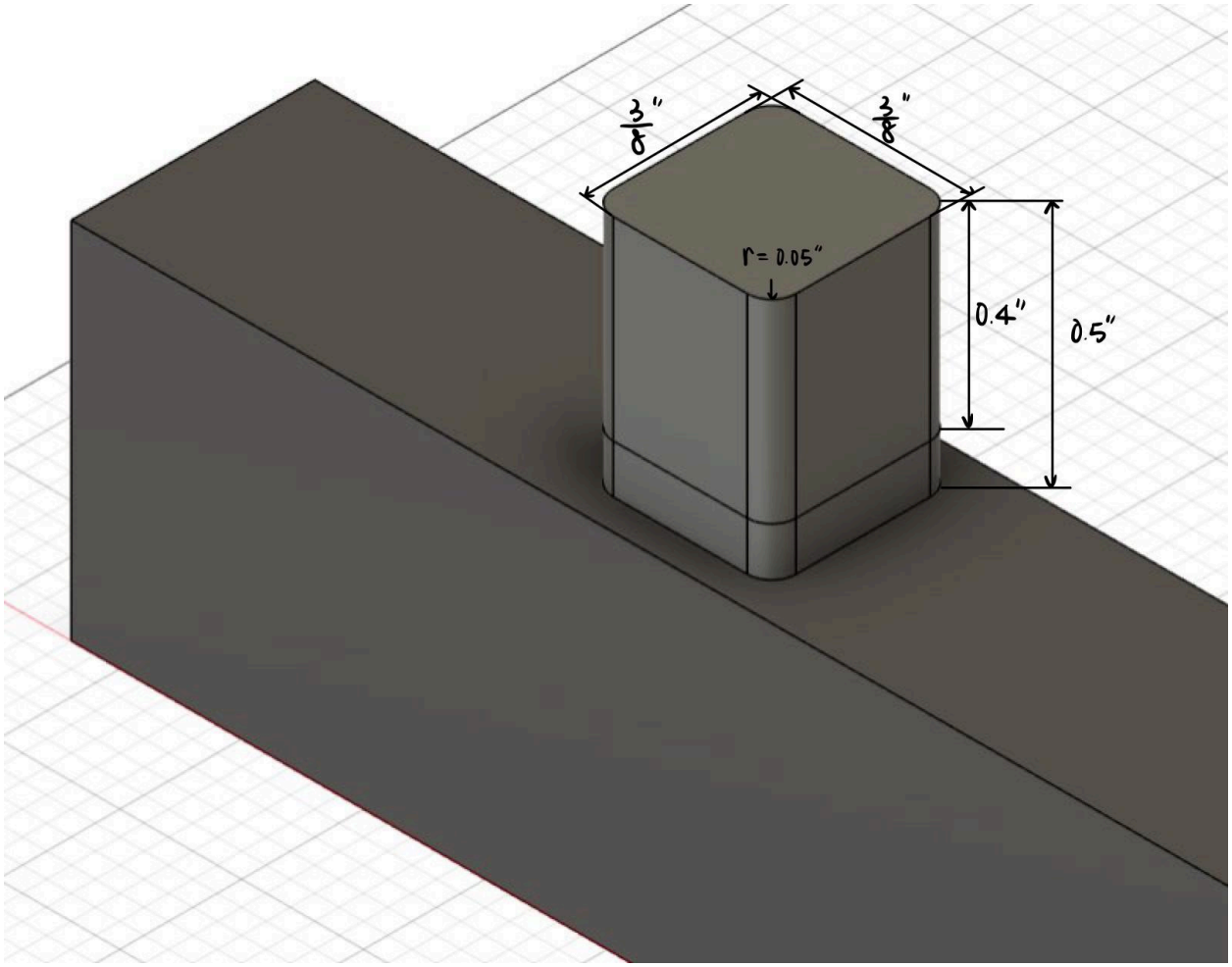

Figure 1.2: dimensions of torque wrench drive

2. Material Selected and Its Mechanical Properties

Material selected: titanium, alpha alloy, Ti-5Al-2.5Sn-0.5Fe, annealed
Mechanical properties:

Young's modulus	16E6 psi
Yield strength	118 ksi
Fracture toughness	88 ksi$\sqrt{in}$
Fracture strength for 10^6 cycles	70 ksi

3. Loads and Boundary Conditions in FEM Model

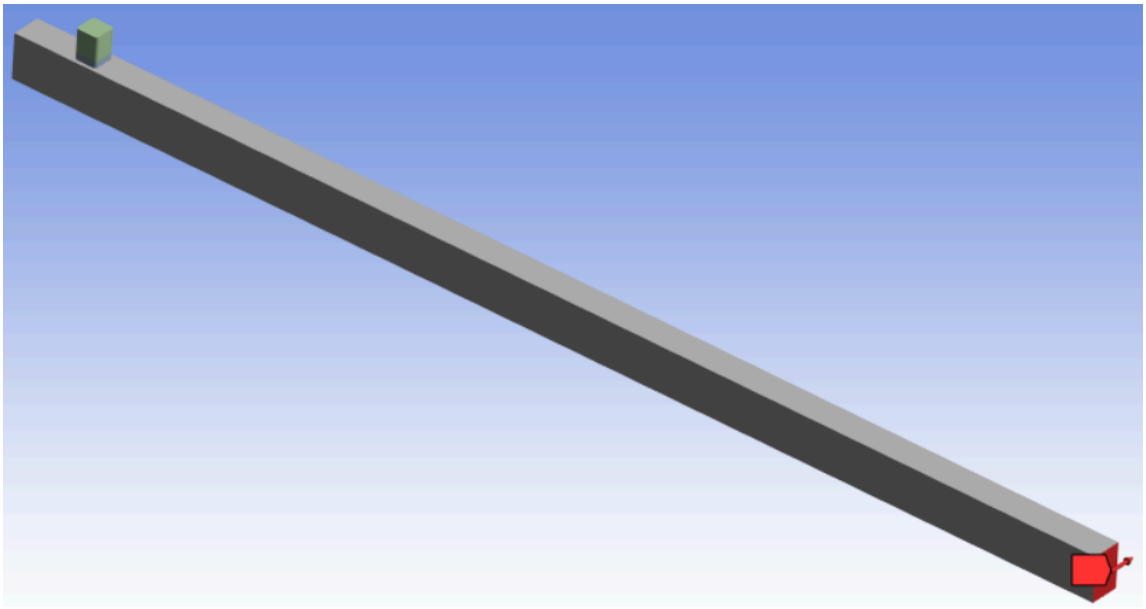

Figure 3.1: bending moment applied on wrench

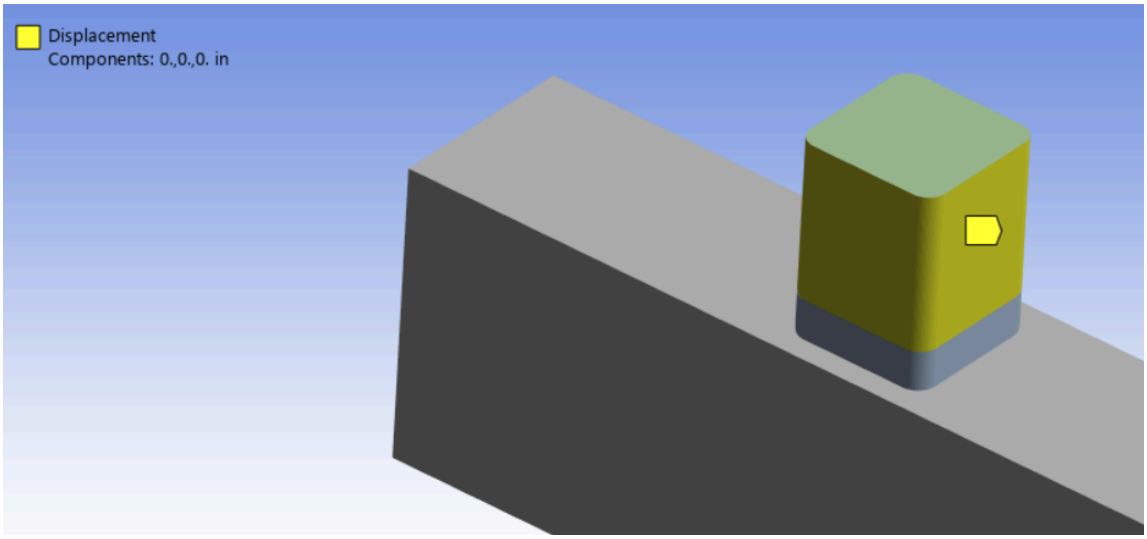

Figure 3.2: drive location fixed in space

4. Normal Strain Contours

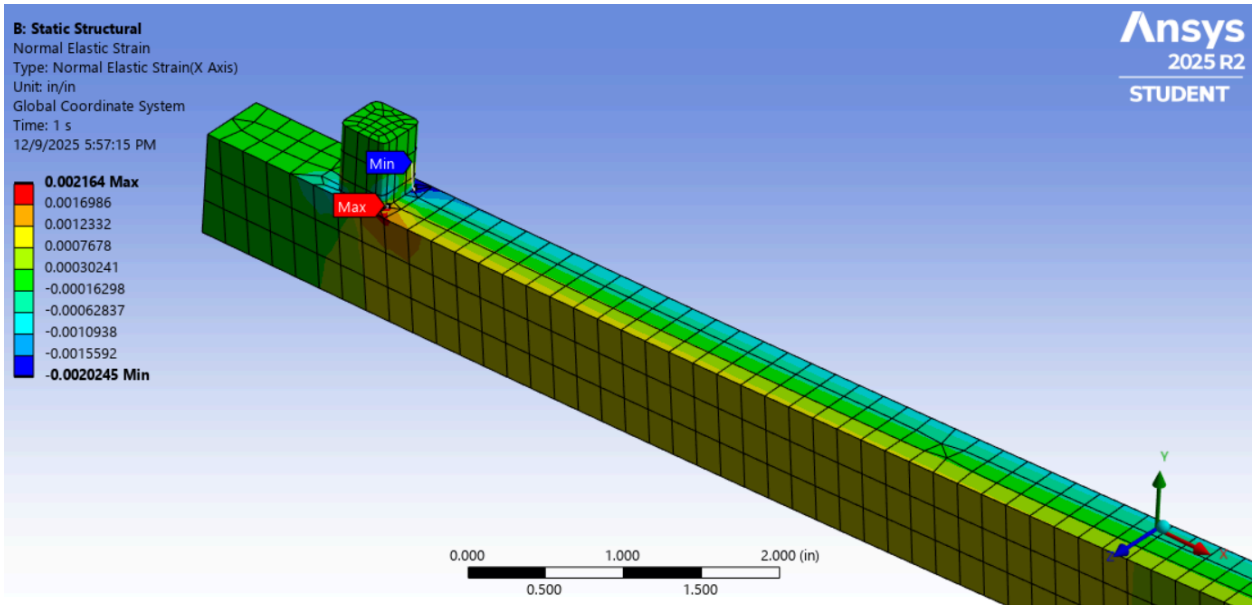

Figure 4.1: normal strain contour of upper half of wrench

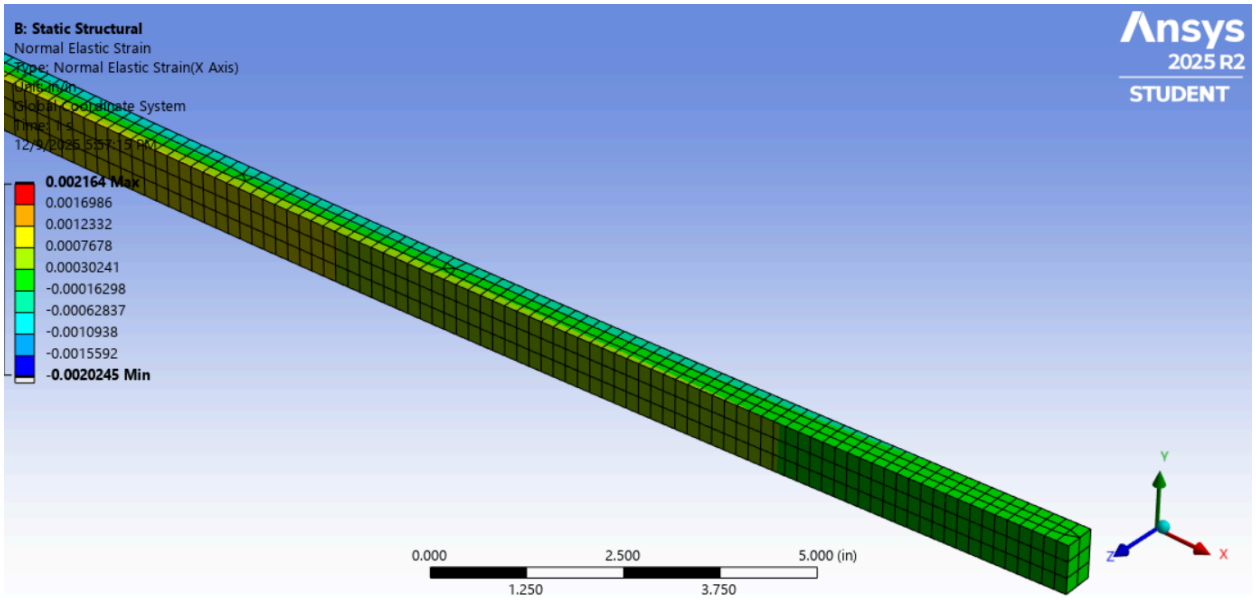

Figure 4.2: normal strain contour of lower half of wrench

5. Maximum Principal Stress Contour Plot

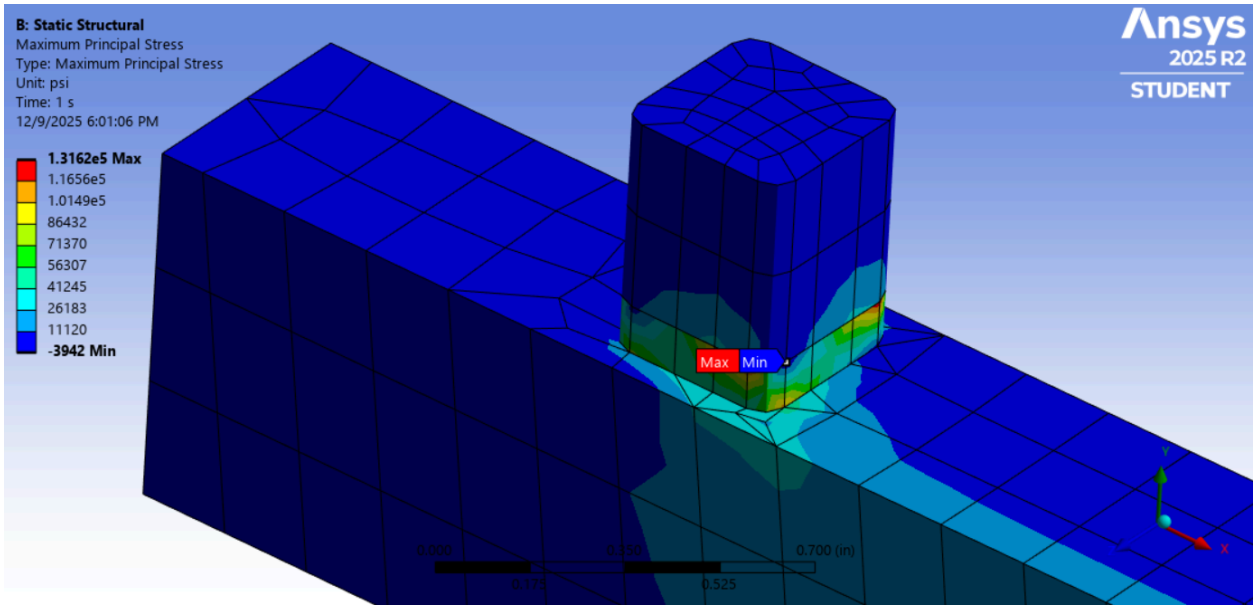

Figure 5.1: maximum principal stress contour plot near the drive

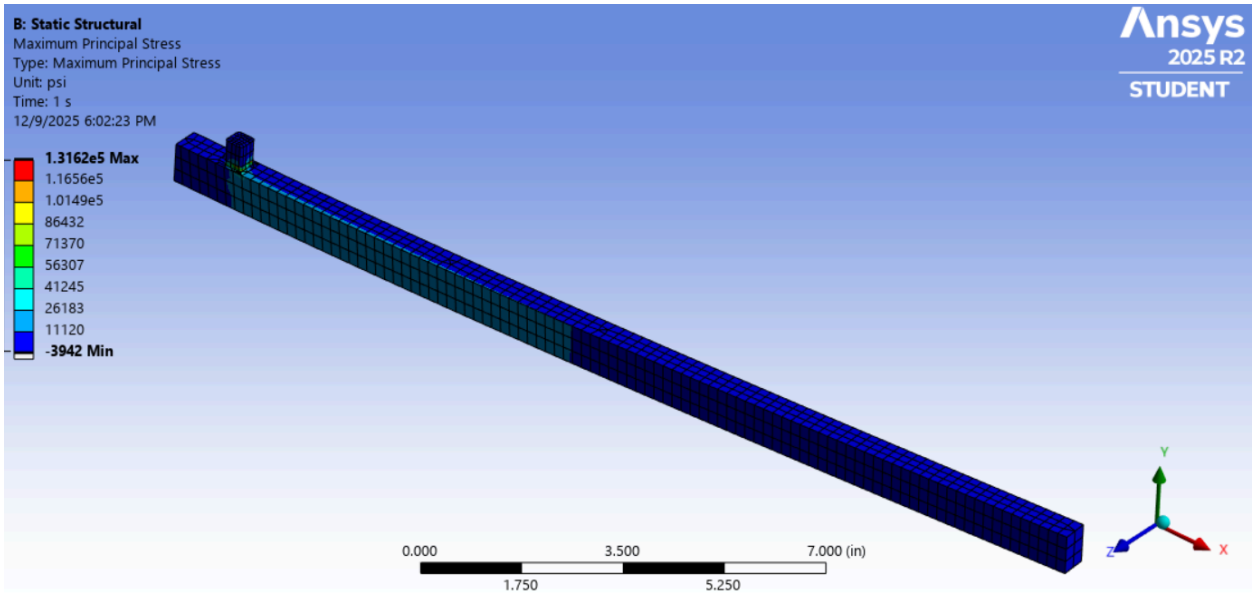

Figure 5.2: maximum principal stress contour plot of entire torque wrench

6. FEM Calculation

Maximum Normal Stress	Overall maximum	68.8 ksi
	Near area where hand calculations are tabulated	19.2 ksi

Load Point Deflection	0.60677 in

Strains at Strain Gauge Location	x-direction	-16.85 in
	Y-direction	0.375 in
	z-direction	0 in

7. Torque Wrench Sensitivity

1.15E-3 in/in = 1.15 mV/V

8. Strain Gauge Selection

Strain Gauge Selected: SGD-3/350-LY11

- https://www.dwyeromega.com/en-us/linear-strain-gages/SGD-LINEAR1-AXIS/p/SGD-3-350-LY11

Specifications of Strain Gauge:

Carrier Length	7 mm
Carrier Width	4 mm
Electrical Connection	Wire Leads
Gauge Type	Linear pattern leads / pads at the end of grid
Grid Length	3.2 mm
Grid Length Range	6 mm
Grid Style	Linear
Grid Width	2.5 mm
Input Voltage	9.5 Vac
Material Construction Option	Steel
Nominal Resistance	350 Ω
Number of Terminals	3
Voltage, Max	9.5 Vrms

Reason for Selection: The SGD-3/350-LY11 strain gauge fits comfortably onto the handle of the torque wrench. The carrier dimensions ensure enough bonding area between the strain gauge and the surface of the torque wrench.