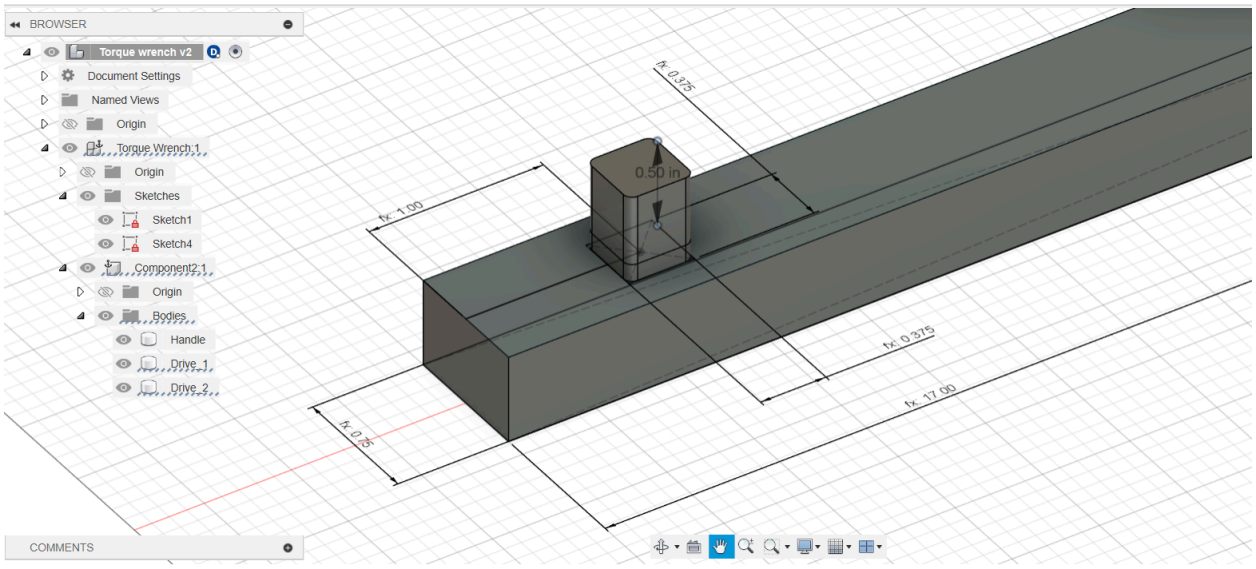
MAE 3270

Fall 2025
Final HW / Course Project
Part II: Design for Portfolio

By:
Katherine Ruelan, David Almeida

Summary:
Design a torque wrench of given dimensions that can satisfy factors of safety requirements for brittle fracture, crack propagation, and cyclic loading.

CAD model of torque wrench from Fusion 360:



Material selected for torque wrench:

Titanium, beta alloy, Ti-12Mo-6Zr-2Fe

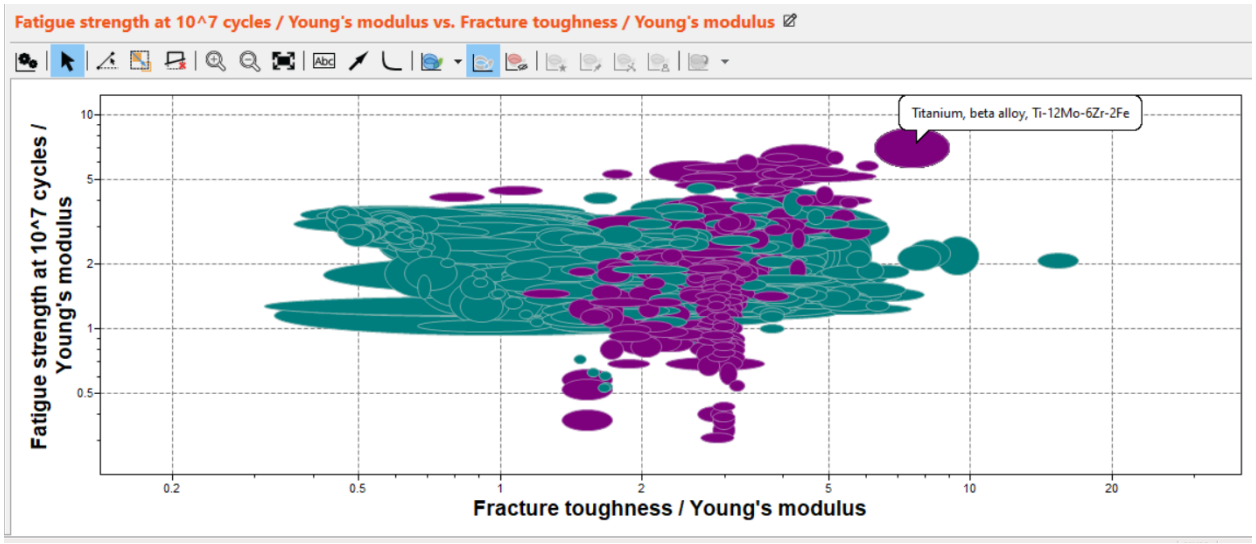
E = 9.16 - 13.1 E6 psi

ν = 0.31 - 0.35

σ_y = 130 - 157 E3 psi

Fatigue strength at 10E7 cycles = 69.2 - 86.8 E3 psi

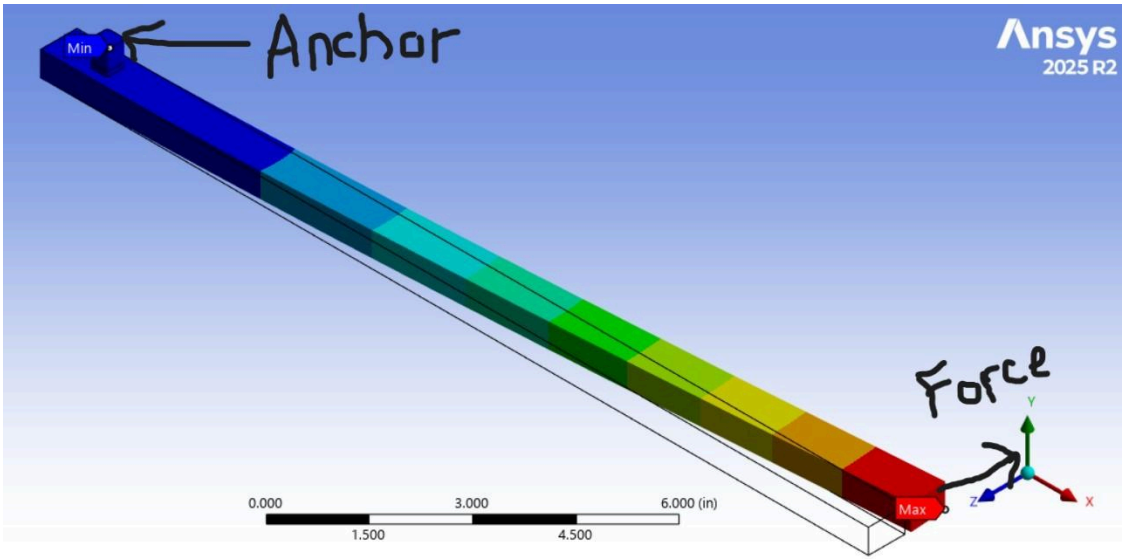
K_{IC} = 80.1 - 83.7 E3 psi·in$^{1/2}$



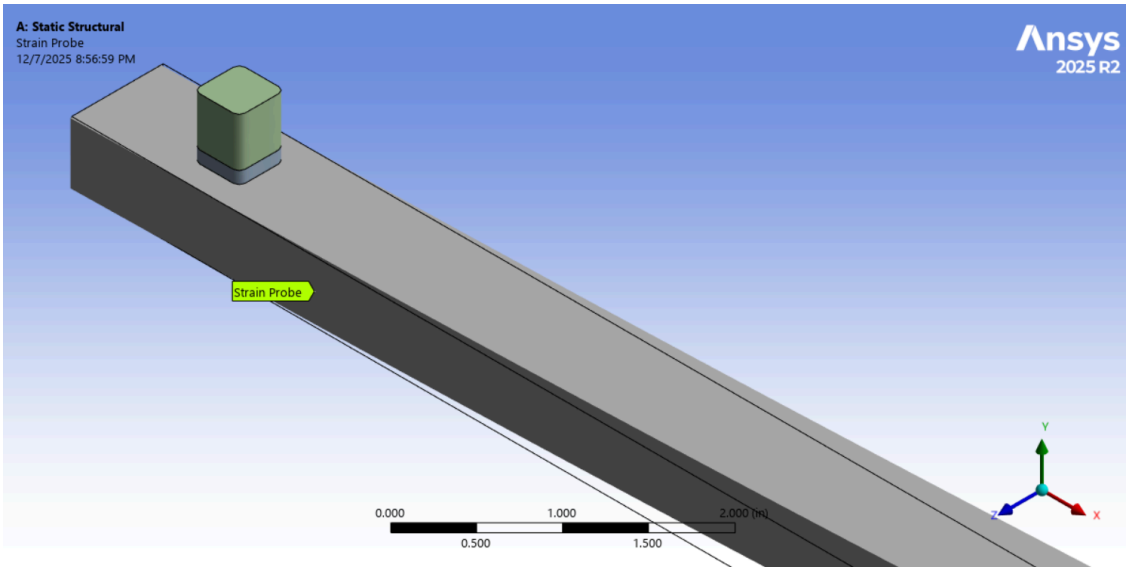
Above shows how this alloy of Titanium compares to other alloys of Titanium as well as alloys of Steel and Aluminum.

Loads and Boundary Conditions, and strain gauge location:

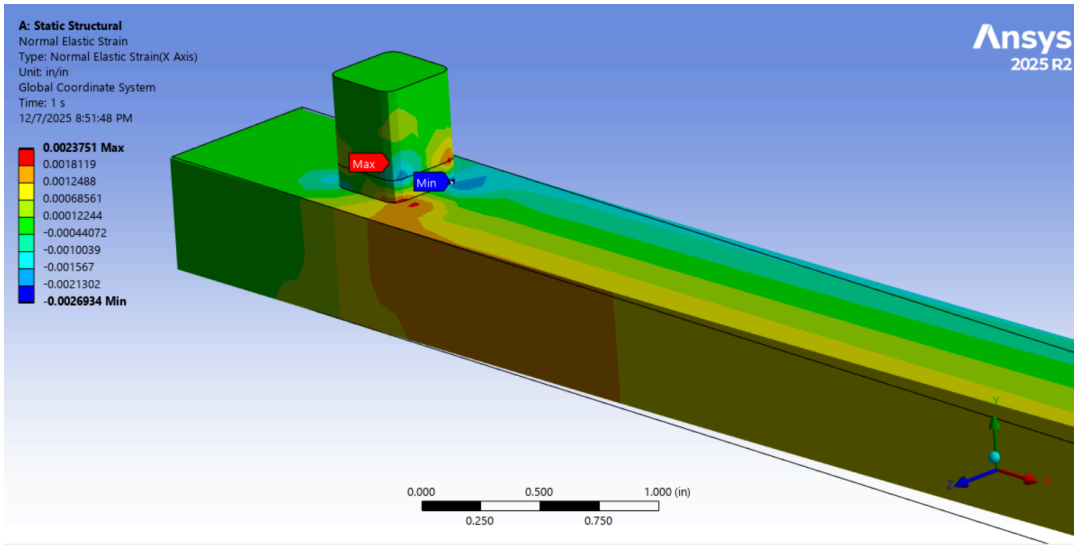
As indicated in the picture below, the tip of the body of the drive was chosen to be the stationary anchor in Ansys. The face of the tip of the handle was chosen to be where the force is applied and thus the maximum deflection.



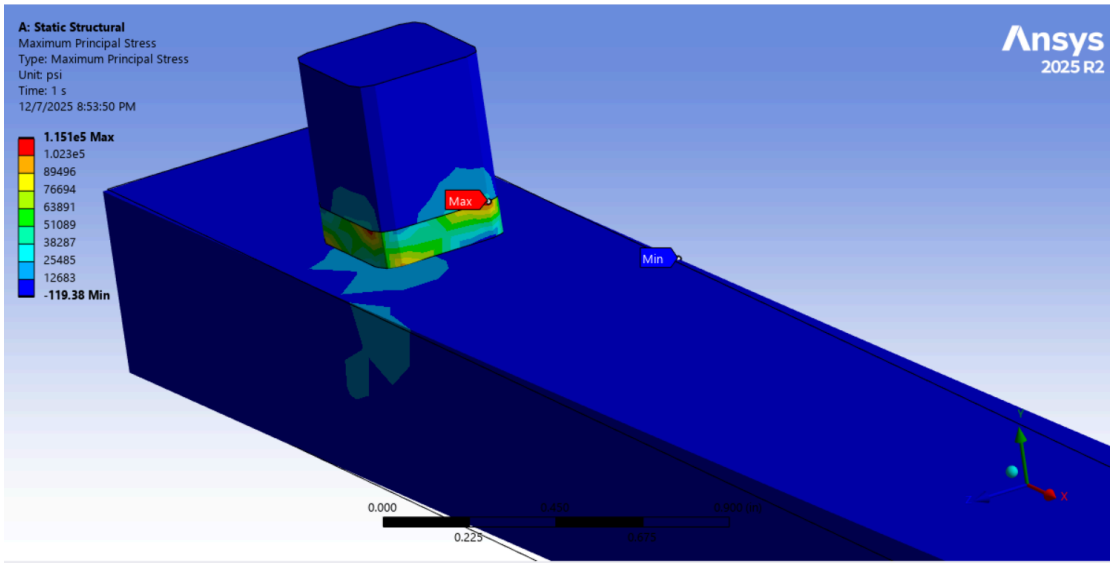
Below is an image showing the location of the strain gauge:



Normal Strain Contours:



Maximum Principal Stress Contours:



Summary of numerical results of FEM:

$\sigma_{Max,\ Normal}$: 52,714 psi

ε_{Gage}: 1308.4 μ strains

$Deflection_{Max}$: 0.48383 in

Torque Wrench Sensitivity in mV/V using strain from FEM analysis: 1.3084 mV/V

Strain Gauge Selected: SGT-2LH/350-TY11

We chose a half bridge strain gauge design with a width of 0.158 in and a length of 0.563 in.

Portfolio submission format:

```
---
layout: project
title: Design a Torque Wrench, by David Almeida and Kate Ruelan
description: Using given specifications, chose a material that satisfies
all of the factor of safety, and performance requirements, and model on
Ansys
technologies: [Autodesk Fusion, Ansys, Matlab]
image: /assets/images/Normal-strain-contours.png
---

The torque design on CAD is shown below:
/assets/images/CAD-model-of-torque-wrench-from-Fusion-360.png

Material selected for torque wrench:
Titanium, beta alloy, Ti-12Mo-6Zr-2Fe
E = 9.16 - 13.1 E6 psi
 = 0.31 - 0.35
y = 130 - 157 E3 psi
Fatigue strength at 10E7 cycles = 69.2 - 86.8 E3 psi
KIC = 80.1 - 83.7 E3 psiin1/2

/assets/images/Screenshot-Granta_software.png
Above shows how this alloy of Titanium compares to other alloys of
Titanium as well as alloys of Steel and Aluminum.

Loads and Boundary Conditions, and strain gauge location:
As indicated in the picture below, the tip of the body of the drive was
chosen to be the stationary anchor in Ansys. The face of the tip of the
handle was chosen to be where the force is applied and thus the maximum
deflection.
/assets/images/boundary-conditions-diagram.jpg
Below is an image showing the location of the strain gauge:
/assets/images/strain-gauge-location-on-torque-wrench.png

Normal Strain Contours:
/assets/images/Normal-strain-contours.png

Maximum Principal Stress Contours:
```

principal-stress-contours.png

Summary of numerical results of FEM:
Max, Normal : 52,714 psi
Gage: 1308.4 strains
DeflectionMax: 0.48383 in

Torque Wrench Sensitivity in mV/V using strain from FEM analysis: 1.3084 mV/V
Strain Gauge Selected: SGT-2LH/350-TY11 We chose a half bridge strain gauge design with a width of 0.158 in and a length of 0.563 in.