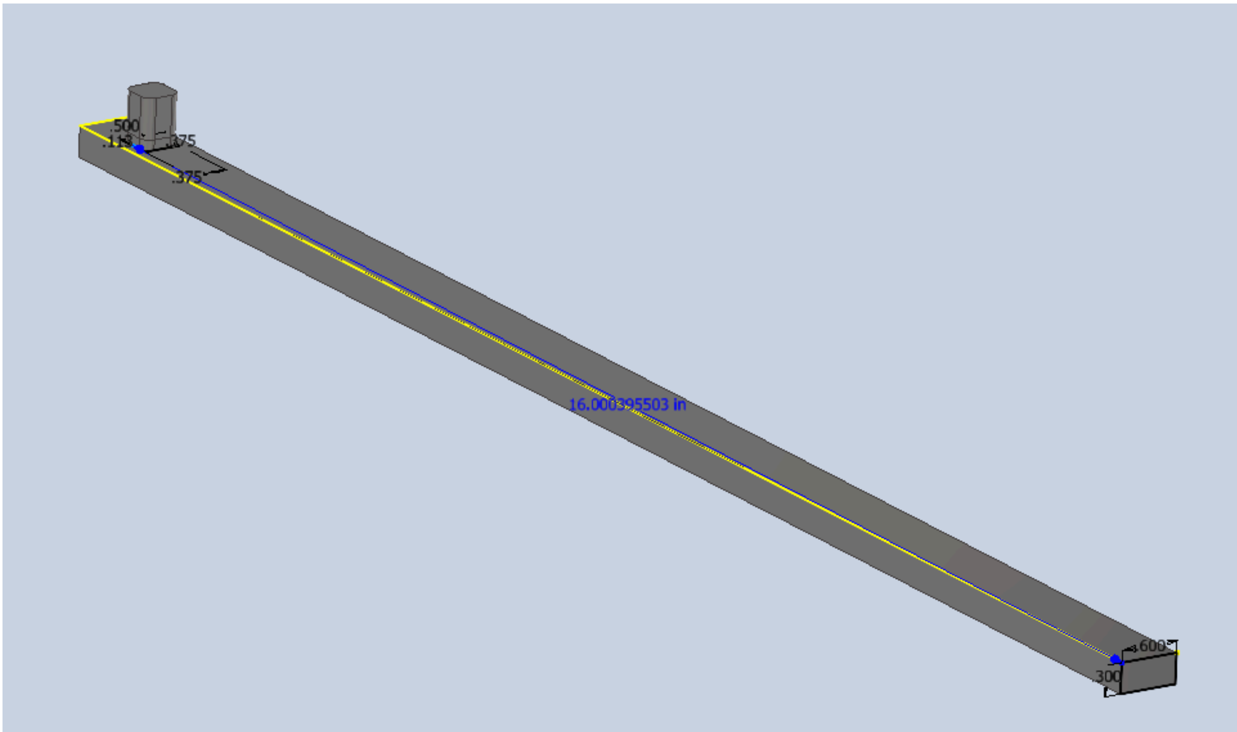
MAE 3270 Final Assignment
Portfolio

Cameron Harvey

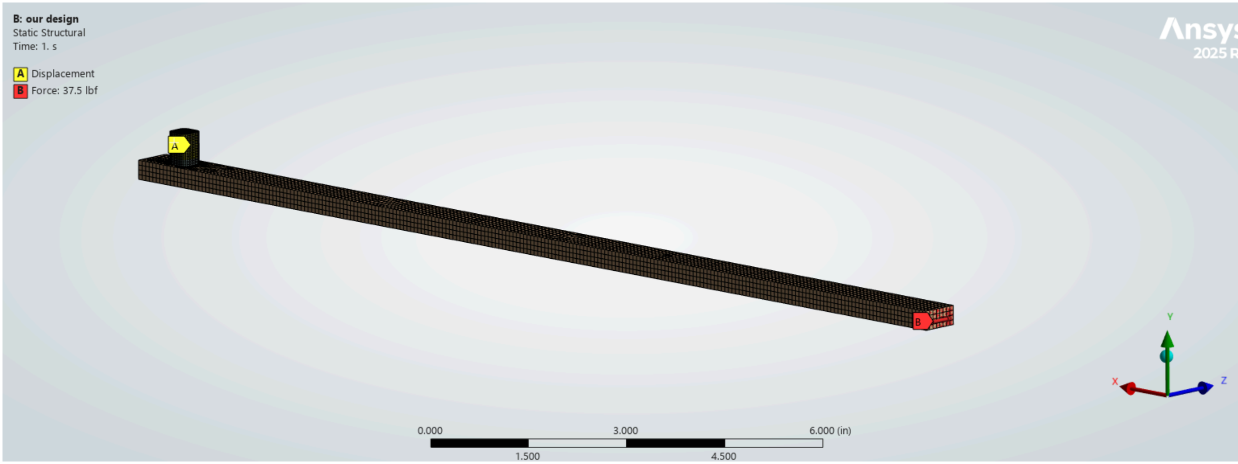
1. Picture of CAD Model (with relevant dimensions included in image and below)



   1.1. Dimension of Torque Wrench Arm - 0.3” x 0.6” x 16.0”
   1.2. Dimension of Drive - 0.375” x 0.375” x 0.5”

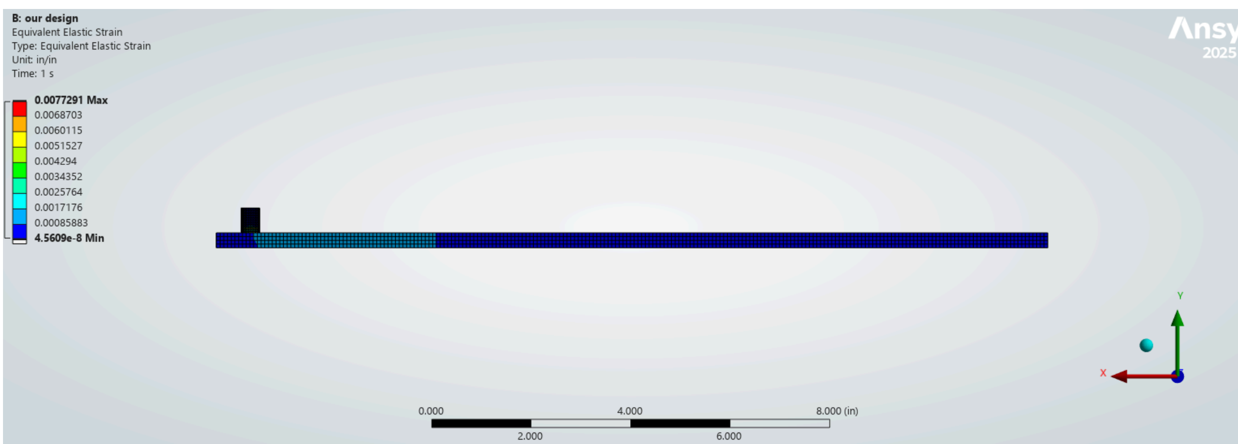
2. Material Choice
   2.1. We chose to use AISI 4330V Low Alloy Steel (quenched and tempered), for its number of material properties. This material tends to deform rather than crack (more ductile), so we didn’t have to worry about brittle failure. It had a lower Young’s Modulus ($E = 29.75 \cdot 10^6 psi$) compared to some other steels (helping us achieve the desired strain). The yield strength was still high enough, to ensure we maintained our factor of safety from yielding ($\sigma_y = 195\ ksi$). Its K_{IC} and fatigue strength was also suitable ($K_{IC} = 90.95\ ksi\sqrt{in}$, Fatigue Strength $= 110 \cdot 10^3 psi$).

3. ANSYS Set Up



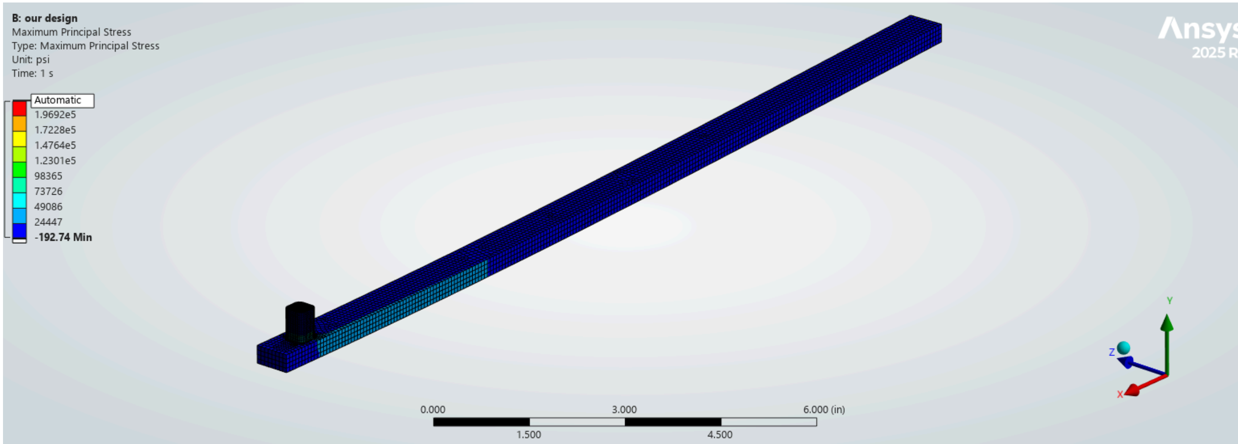
3.1. As seen in the image, we make an unnecessary large (high node) mesh. We apply zero displacement constraint around the entire 0.4’’ part of the wall of the drive. Finally, we calculated the force at the end of the arm to be 37.5 lbf (given the moment and arm length) and applied it on the end face of the arm in the z direction (proper direction given the CAD Model/ANSYS setup).

4. ANSYS Normal Strain Contours (in Strain Gauge Direction)



4.1. It's a little difficult to see, due to our mesh, but along the bar, we can see an increase in strain going right from the drive, but eventually fading away as we get around 4 inches to the right of the drive. If we changed our strain range, we probably could’ve gotten more resolution in the region of interest.

5. ANSYS Maximum Principal Stress Contours



5.1. Similar to the previous results, it is a little hard to see, but if we look at the arm, we can see a similar contour plot as with normal strain (which makes sense, given the relation between the two).

6. Results from FEM

6.1. By examining the results, we found the maximum normal stress of 77.36 ksi to occur on the drive, which is much higher than our calculated value, most likely due to stress concentrations. On the bar, however, we found our max normal stress to be 32.5 ksi, which is very close to our calculated value of 33.3 ksi. Looking then at the strain in the strain gauge region, we found it to be roughly 1053 $\mu\varepsilon$, which again is extremely close to our calculated value of 1050 $\mu\varepsilon$. Finally, we found maximum deflection at the load point to be 0.3722", which is somewhat close to our estimated value of 0.32".

7. Torque Wrench Sensitivity

7.1. With a half-bridge strain gauge we can just take our strain at the strain gauge (in $\mu\varepsilon$) and multiply it by 1000 to get our sensitivity reading in mV/V. This leaves us with a strain of 1.053 mV/V

8. Strain Gauge Selection

8.1. When selecting a strain gauge, you want it to both fit the part and be able to read the range of strain well. So I chose the SGD-7/1000-LY41. It has a D of 0.22" so it will fit on the part, and is also temperature compensation for steel (which is the material of this torque wrench). It's also larger in the axial direction, when compared to others, which should offer a better reading. The full dimensions are A= 0.276", B=0.142", C=0.465", D=0.220". An image (with a key) is included below.

PRECISION STRAIN GAGE
PRECISION LINEAR PATTERN FOR STATIC AND DYNAMIC APPLICATIONS

To Order

GAGE PATTERN Leads not shown	MODEL NO. Pkg of 10	NOM. RESIS-TANCE (Ω)	DIMENSIONS mm (inch)† GRID A	GRID B	CARRIER C	CARRIER D	MAX V* (Vrms)	TERMINATION	TEMP COMP	TERM PAD
Shown actual size 11.4 mm	SGD-6/120-LY11	120	6.50 (0.256)	3.10 (0.122)	11.40 (0.449)	5.10 (0.201)	9	Ribbon Leads	ST	BTP-4
	SGD-6/120-LY13	120	Linear pattern, medium size 120 Ω				12	Ribbon Leads	AL	
	SGD-6/120-LY41	120					9	Solder Pads	ST	
	SGD-6/120-LY43	120					12	Solder Pads	AL	
Shown actual size 11.4 mm	SGD-7/350-LY11	350	6.50 (0.256)	3.10 (0.122)	11.40 (0.449)	5.10 (0.201)	15	Ribbon Leads	ST	BTP-5
	SGD-7/350-LY13	350	Linear pattern, medium size 350 Ω				20	Ribbon Leads	AL	
	SGD-7/350-LY41	350					15	Solder Pads	ST	
	SGD-7/350-LY43	350					20	Solder Pads	AL	
Shown actual size 11.8 mm	SGD-7/1000-LY11	1000	7.00 (0.276)	3.60 (0.142)	11.80 (0.465)	5.60 (0.220)	27	Ribbon Leads	ST	BTP-5
	SGD-7/1000-LY13	1000	Medium size, higher resistance, reduced heat genaration 1000 Ω				37	Ribbon Leads	AL	
	SGD-7/1000-LY41	1000					27	Solder Pads	ST	
	SGD-7/1000-LY43	1000					37	Solder Pads	AL	
Shown actual size 17.7 mm	SGD-10/120-LY11	120	10.00 (0.394)	4.90 (0.193)	17.70 (0.697)	8.00 (0.315)	14	Ribbon Leads	ST	BTP-5
	SGD-10/120-LY13	120	Linear pattern, Large size 120 Ω				19	Ribbon Leads	AL	
	SGD-10/120-LY41	120					14	Solder Pads	ST	
	SGD-10/120-LY43	120					19	Solder Pads	AL	

DISCOUNT SCHEDULE

1 to 10 pkgs.	Net
11 to 24 pkgs.	5%
25 to 49 pkgs.	10%
50 and up and OEM	Consult Factory

** Maximum permitted bridge energizing voltage (Vrms).*
***Note:** For strain gage accessories visit us online.*
***Ordering Example: SGD-6/120-LY13,** 6.5 mm grid, 120 Ω nominal-resistance strain gage.*

NOTE
ST = Steel
AL = Aluminum

BONDABLE TERMINAL PADS

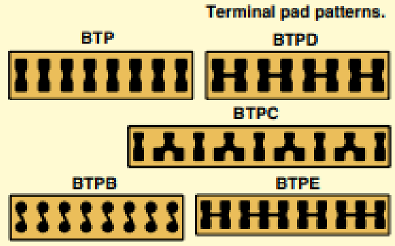
When installing strain gages with ribbon leads or solder pads, use Bondable Terminal Pads (BTP) between the strain gage and the wires to your instrumentation.

The Bondable Terminal Pads provide a large easy to use soldering area and provide strain relief between the strain gage and the heavy instrument wires.

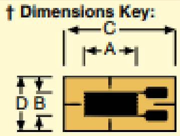
Using Bondable Terminal Pads is simple. Use the same adhesive and bonding procedure on the Bondable Terminal Pads as you use on the strain gage.

OMEGA offers BTPs in several sizes and wiring configurations to fit most all strain gage applications.

Terminal pad patterns.



† Dimensions Key:



GRID
A: Active gage length
B: Active gage width
CARRIER
C: Matrix length
D: Matrix width

STRAIN GAGES
E