Homework 2

ME 478 - Finite Element Analysis

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1 Torque on a Wrench

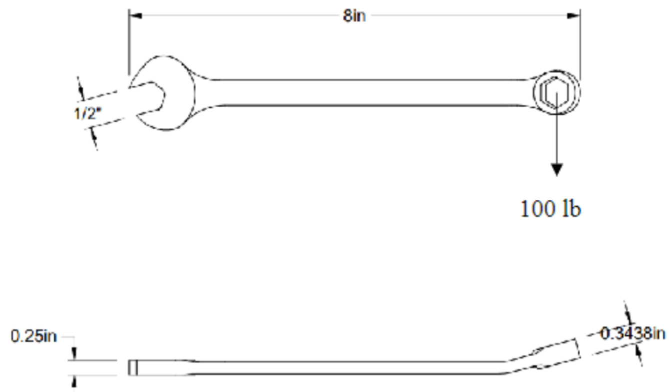


Figure 1. The Engineering Drawing for the wrench design

The wrench design shown in Figure 1 was imported from McMaster. A material with the properties listed in Table 1 was created and assigned to the wrench. The two parallel sides of the wrench profile were fixed, and a 100 lb force was applied on the end. A element size of 0.1 in was used.

Elastic Modulus	30 MPsi
Poisson's Ratio	0.3

Table 1. Wrench Material Properties

After solving the system, we found a maximum principle stress of 86.488 ksi as shown in Figure 2.

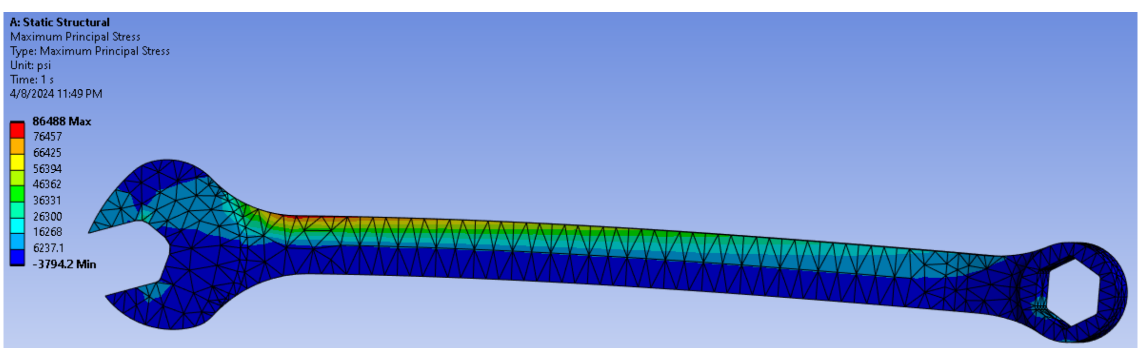


Figure 2. The maximum principle stresses on the wrench

2 Torque on a T-key

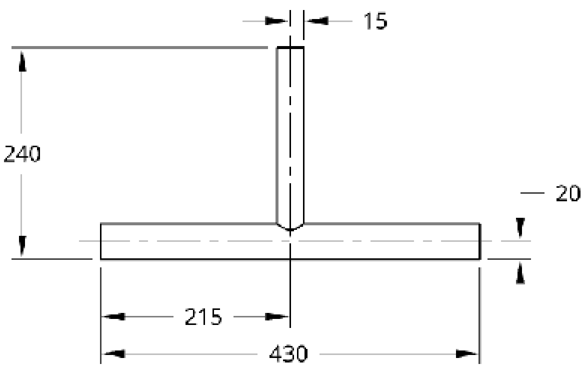


Figure 3. The Engineering Drawing for the T-Key design

The T-key was designed in ANSYS DesignModeler using the drawing shown in Figure 3. A material with the properties listed in Table 2 was created and assigned to the T-key.

Elastic Modulus	205 GPa
Poisson's Ratio	0.3
Yield Strength	250 MPa

Table 2. T-key Material Properties

The end of the smaller diameter pipe was fixed, and opposing forces were applied on the ends of the large diameter pipe to create a force couple as shown in Figure 4. An element size of 5 mm was used.

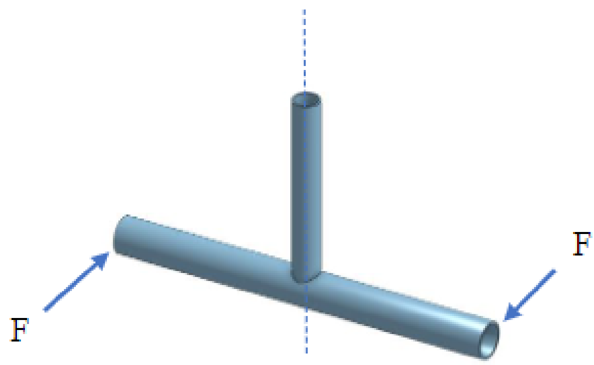
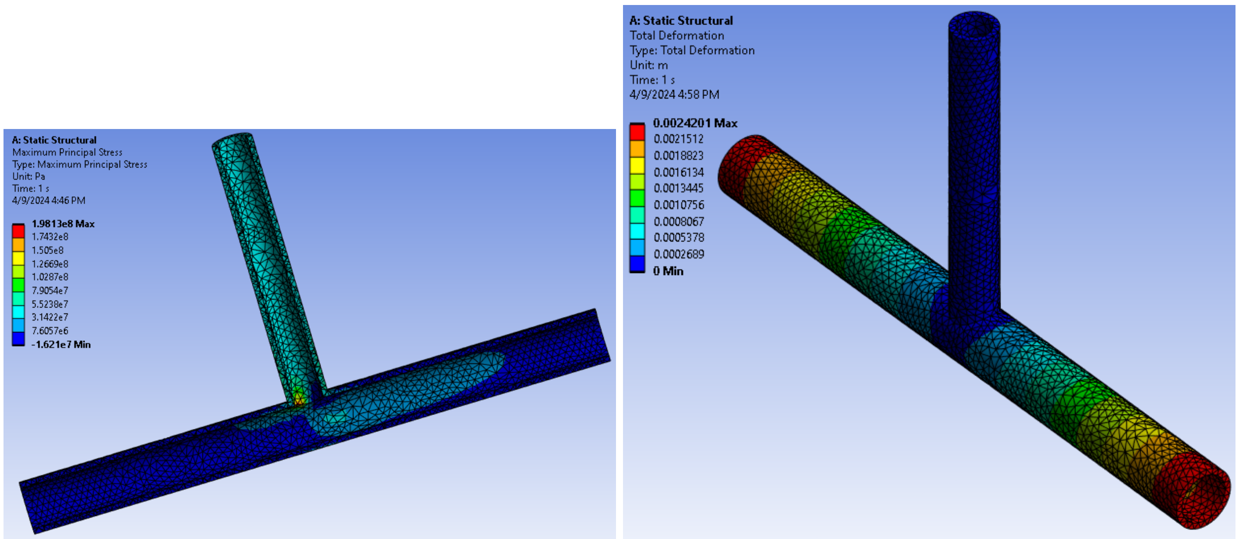


Figure 4. The applied forces on the T-Key

2.1 500 N Applied Force

The applied force was set to 500 N and resulting properties are shown in Figure 5. This created a maximum principle stress of 198.13 MPa on the pipe interface edge. The maximum deformation was 2.42 mm at the edges of the large diameter pipe.



(a) (b)

Figure 5. (a) Maximal. (b).

2.2 Maximum Force

The Von Mises Failure Criterion was used to determine the maximum allowable applied force. A binary search where F $\in$ [500,1000] N was used to approximate the maximum allowable force. The results from the search are listed in Table 3 for brevity.

Force (N)	Von Mises Stress (MPa)	Safety Factor	Failed?
500	172.65	1.448	N
1000	345.3	0.724	Y
750	258.98	0.9655	Y
625	215.82	1.158	N
718.75	248.19	1.007	N
734.38	253.58	0.986	Y
726.56	250.89	0.996	Y
722.66	249.54	1.001	N
724.61	250.21	0.999	Y
723.63	249.85	1.0006	N
723.89	249.96	1.0002	N
724	250	1	Y
723.98	249.99	1.00004	N

Table 3. Binary Search iteration results

An applied force of 723.98 N was determined to be the maximum allowable force. Note that this geometry lacks chamfers or fillets for the pipe interfaces which makes the geometry divergent. For instance, using an element size of 4 mm creates a Von Mises stress of 283.49 MPa, over 30 MPa greater than in the previous simulation.