1.

Figure 1: Rendering of the CAD model

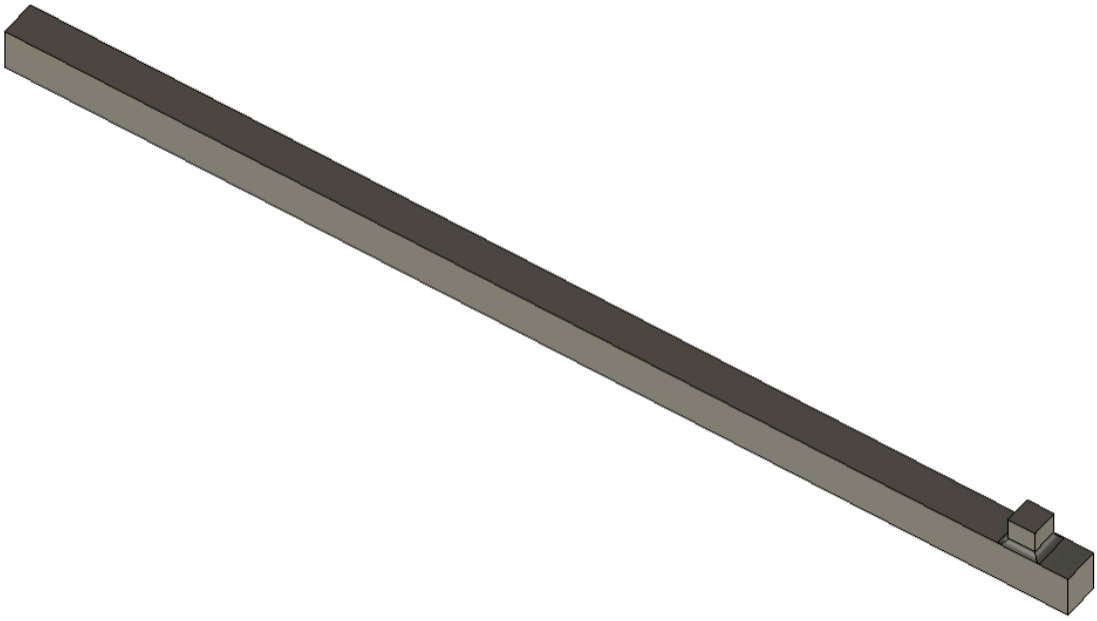


Figure 2: L=14 length of the torque wrench

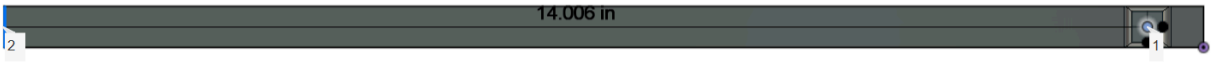


Figure 3: b=0.6 thickness of the torque wrench

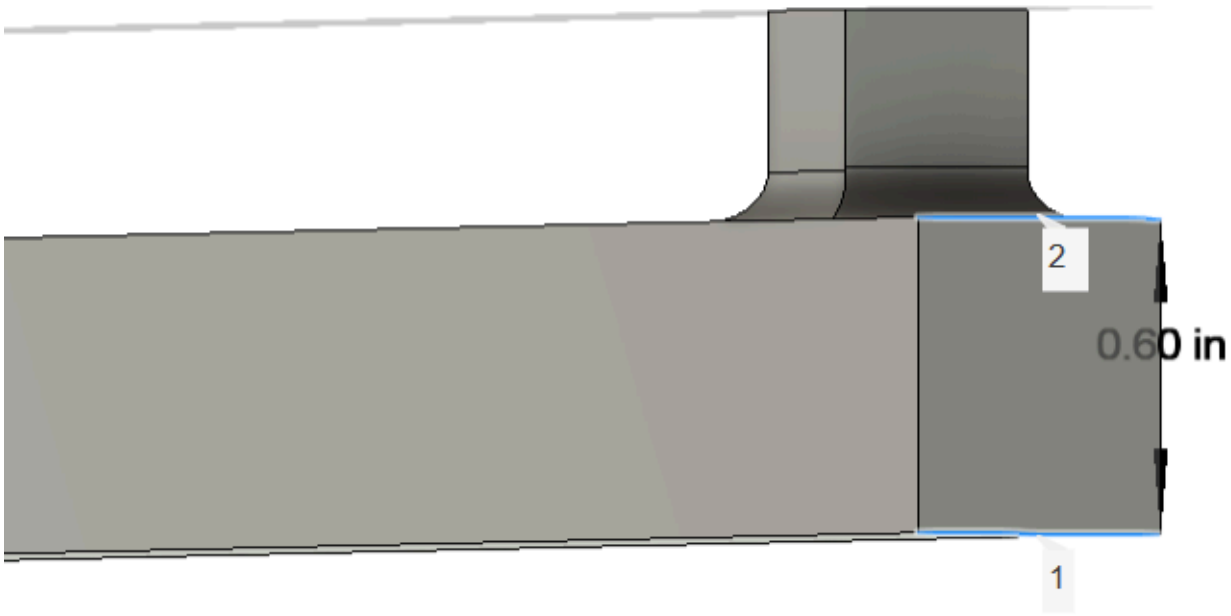


Figure 4: h=0.5 width of the torque wrench

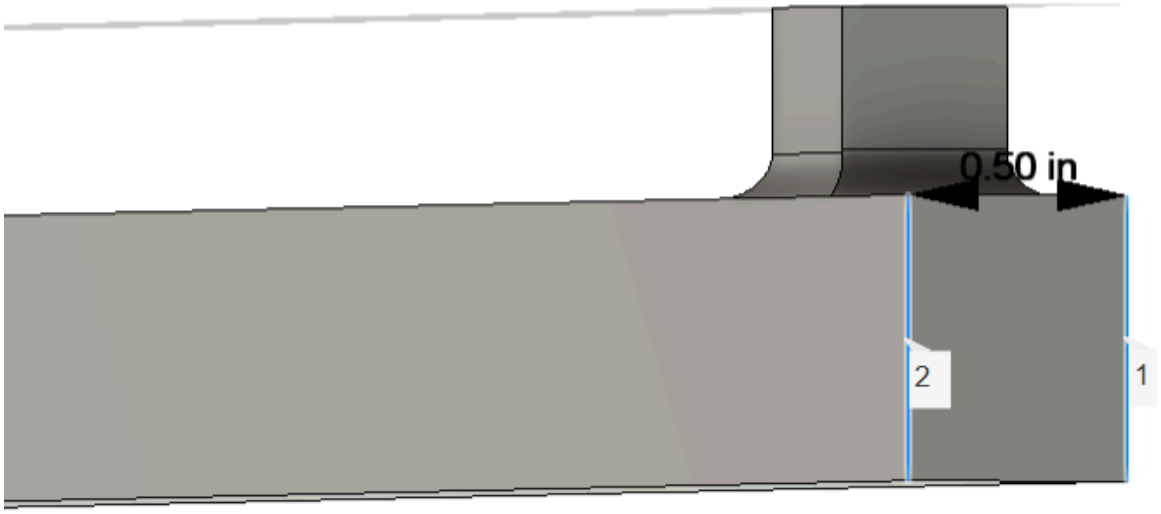
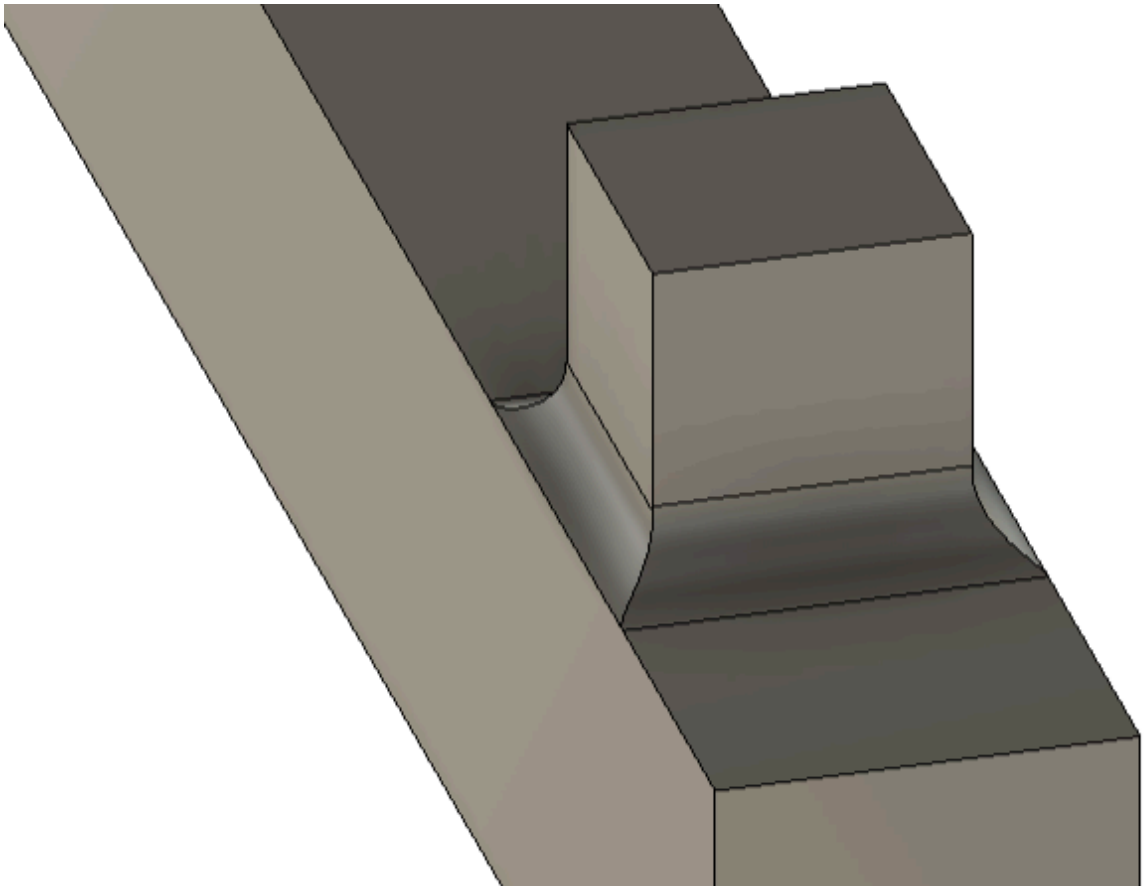


Figure 5: 0.05 filet between the drive and the shaft

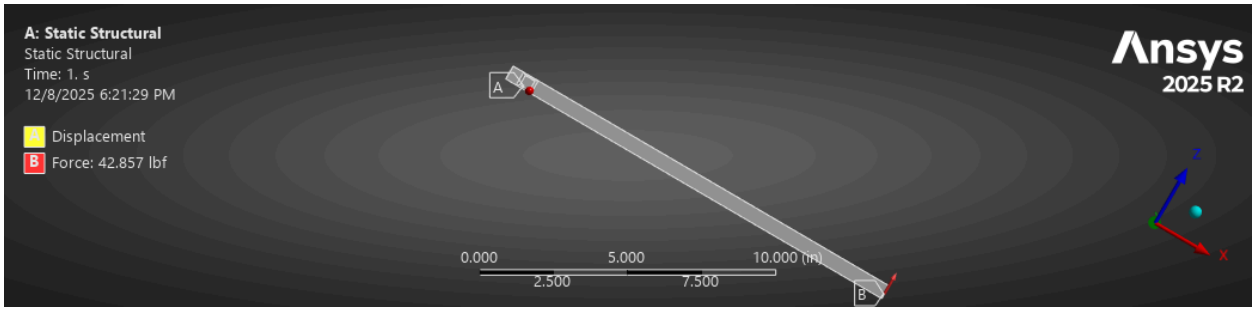


2.

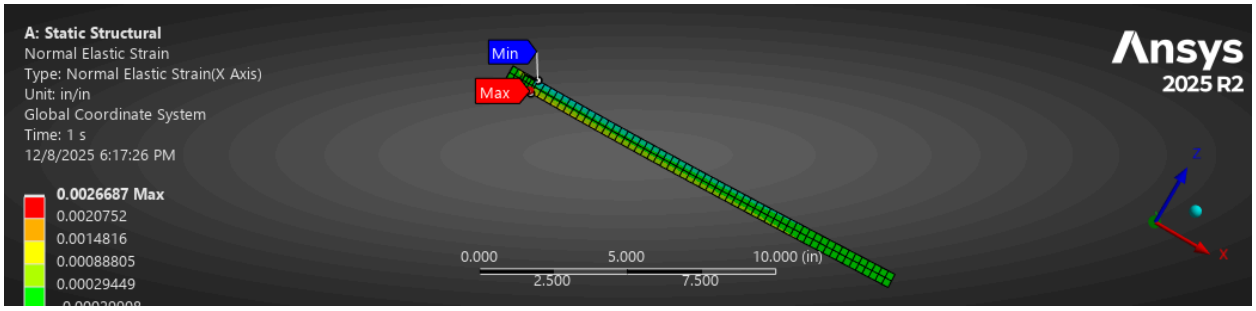
Ti-10V-2Fe-3Al is a premium titanium alloy with high tensile/yield strength, good ductility, good fatigue resistance, and high fracture toughness. In addition to all of these traits, it is significantly lighter per volume than steel. This is common in applications where weight, strength, fatigue, and toughness all matter especially in aerospace or high performance forged components. This material is a strong balance of properties. The material properties from GRANTA are:

- Young's modulus: 17.3×10^6 psi
- Poisson's ratio: 0.32
- Tensile strength: 157×10^3 psi
- Fatigue strength: 91×10^3 psi
- Fracture toughness: 115×10^3 psi$\cdot\sqrt{\text{in}}$

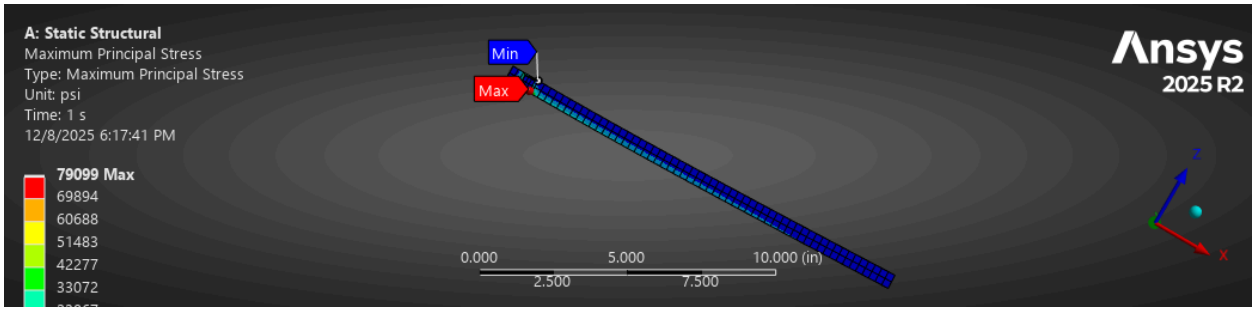
3.



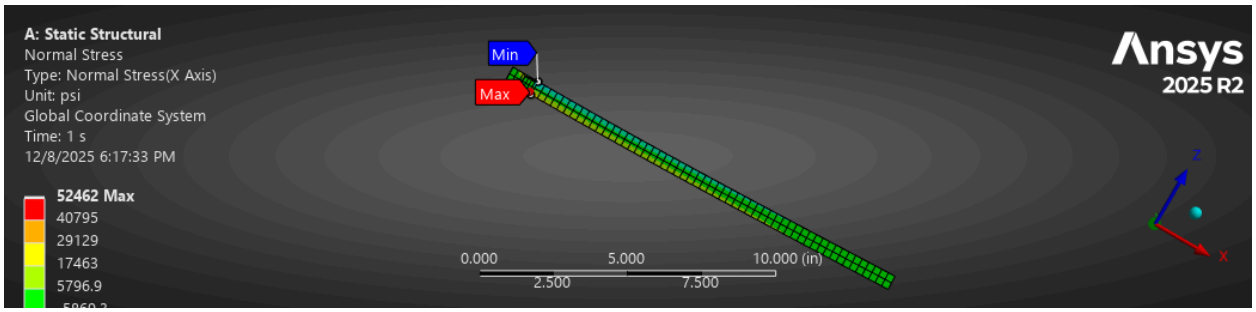
4.

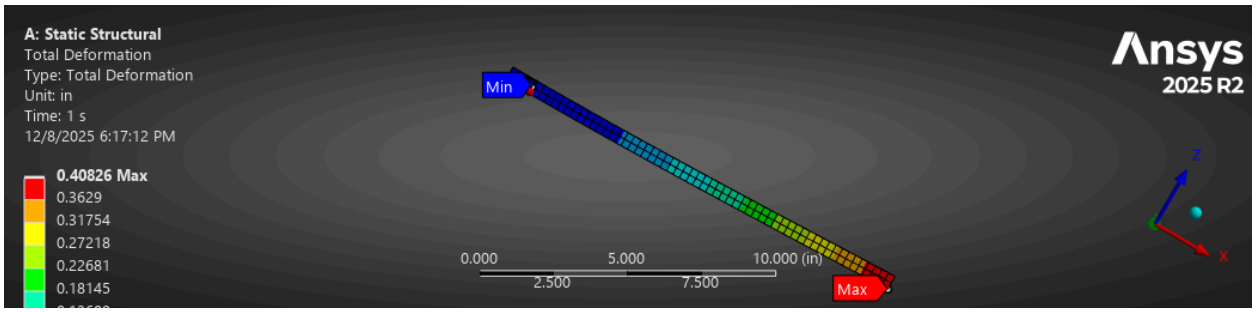

A: Static Structural
Normal Elastic Strain
Type: Normal Elastic Strain(X Axis)
Unit: in/in
Global Coordinate System
Time: 1 s
12/8/2025 6:17:26 PM
0.0026687 Max
0.0020752
0.0014816
0.00088805
0.00029449
Min
Max
0.000
5.000
10.000 (in)
2.500
7.500
Ansys
2025 R2

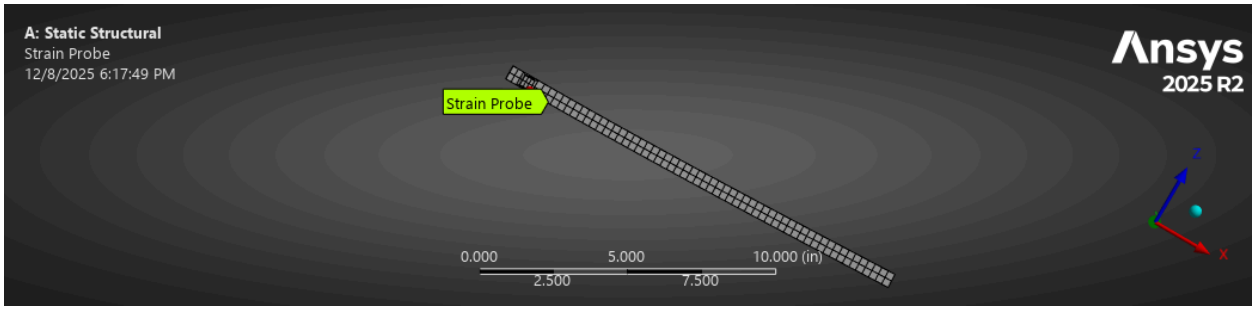
5.


A: Static Structural
Maximum Principal Stress
Type: Maximum Principal Stress
Unit: psi
Time: 1 s
12/8/2025 6:17:41 PM
79099 Max
69894
60688
51483
42277
33072
Min
Max
0.000
5.000
10.000 (in)
2.500
7.500
Ansys
2025 R2

6.


A: Static Structural
Normal Stress
Type: Normal Stress(X Axis)
Unit: psi
Global Coordinate System
Time: 1 s
12/8/2025 6:17:33 PM
52462 Max
40795
29129
17463
5796.9
Min
Max
0.000
5.000
10.000 (in)
2.500
7.500
Ansys
2025 R2


A: Static Structural
Total Deformation
Type: Total Deformation
Unit: in
Time: 1 s
12/8/2025 6:17:12 PM
0.40826 Max
0.3629
0.31754
0.27218
0.22681
0.18145
Min
Max
0.000
5.000
10.000 (in)
2.500
7.500
Ansys
2025 R2



Tabular Data

	Time [s]	Strain Probe (NormX) [in/in]	Strain Probe (NormY) [in/in]	Strain Probe (NormZ) [in/in]	Strain Probe (ShearXY) [in/in]	Strain Probe (ShearYZ) [in/in]	Strain Probe (ShearXZ)
1	1.	1.2887e-003	-3.8641e-004	-3.8694e-004	3.676e-006	6.0167e-007	4.674e-006

7. Torque Wrench Sensitivity: 1.2887

8.

The torque wrench uses a half-bridge strain gauge configuration, incorporating two active gauges in a Wheatstone bridge. Each strain gauge is positioned at a distance c = 1 in from the drive. The selected gauge is the Micro-Measurements CEA-XX-250UWA-120, a uniaxial linear pattern gauge with a 120 Ω nominal resistance and a 0.25 inch gauge length. Its compact package size (0.45 in long and 0.18 in wide) works for our design. It works to be bonded to the handle because of the 0.6 thickness.

```
material = 'Ti-10V-2Fe-3Al'

d = 0.3625

s_max = 2.4000e+04

X_o = 6.5417

X_S = 4.7917

X_K = 9.5501

sn_gauge = 0.0013

output = 0.0013
```