

1.

Figure 1: Rendering of the CAD model

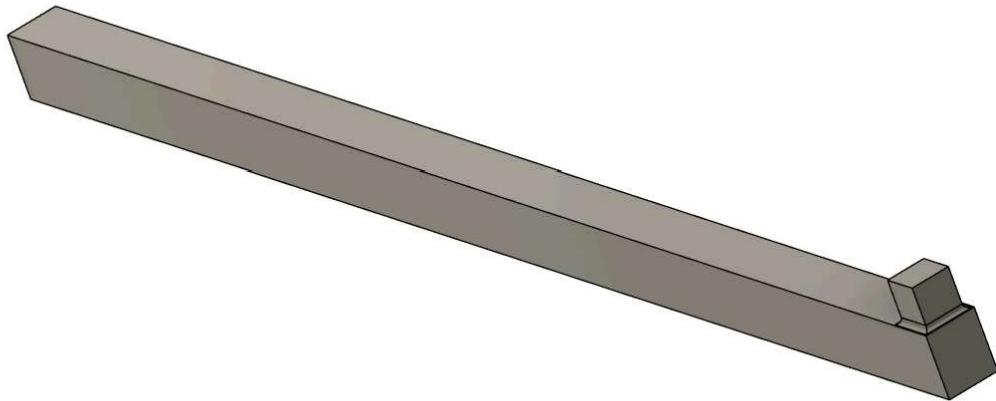
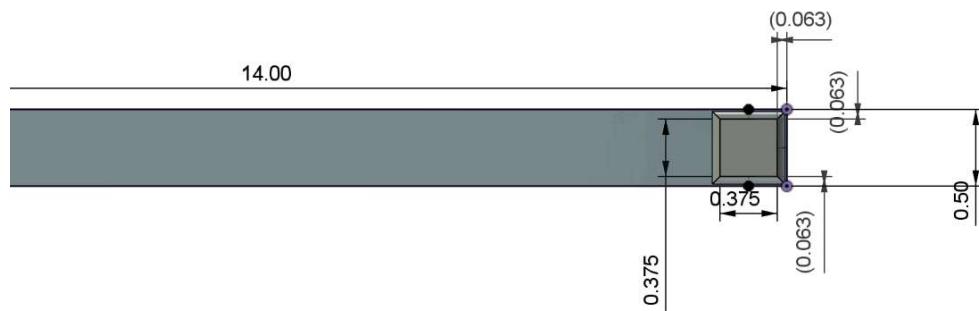


Figure 2: Key Dimensions



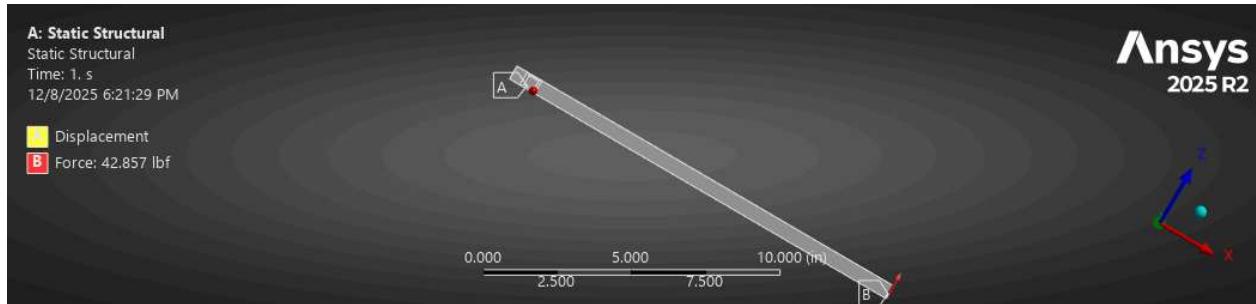
2.

Ti-10V-2Fe-3Al is a titanium alloy with strong mechanical properties, including high strength, good ductility, solid fatigue resistance, and good fracture toughness. It also weighs much less than steel, which is why it's commonly used in aerospace and other applications where keeping weight down while maintaining strength is important. Overall, it offers a good balance of properties for lightweight structural parts. The material properties used for this analysis come from the GRANTA database:

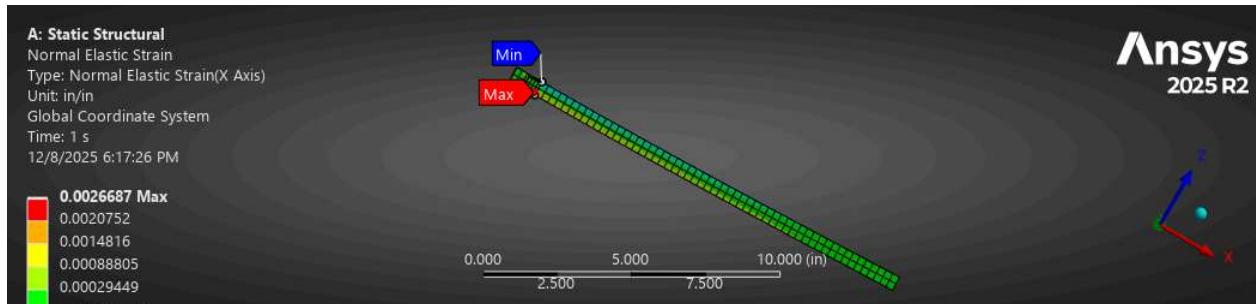
- Young's modulus: 17.3×10^6 psi

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

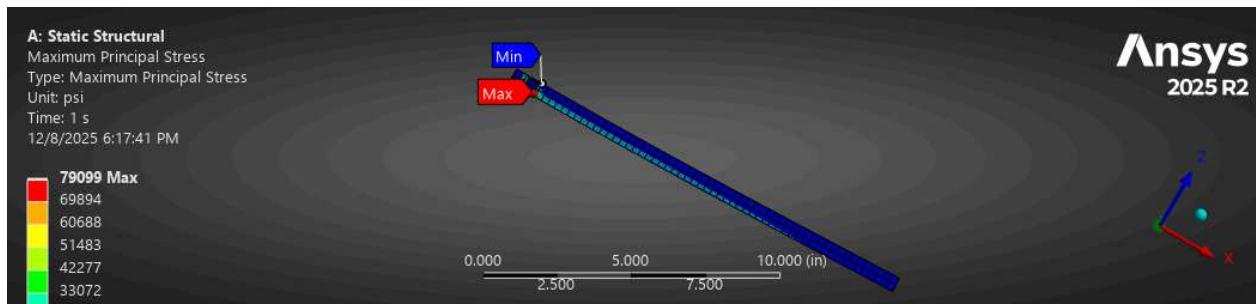
3.



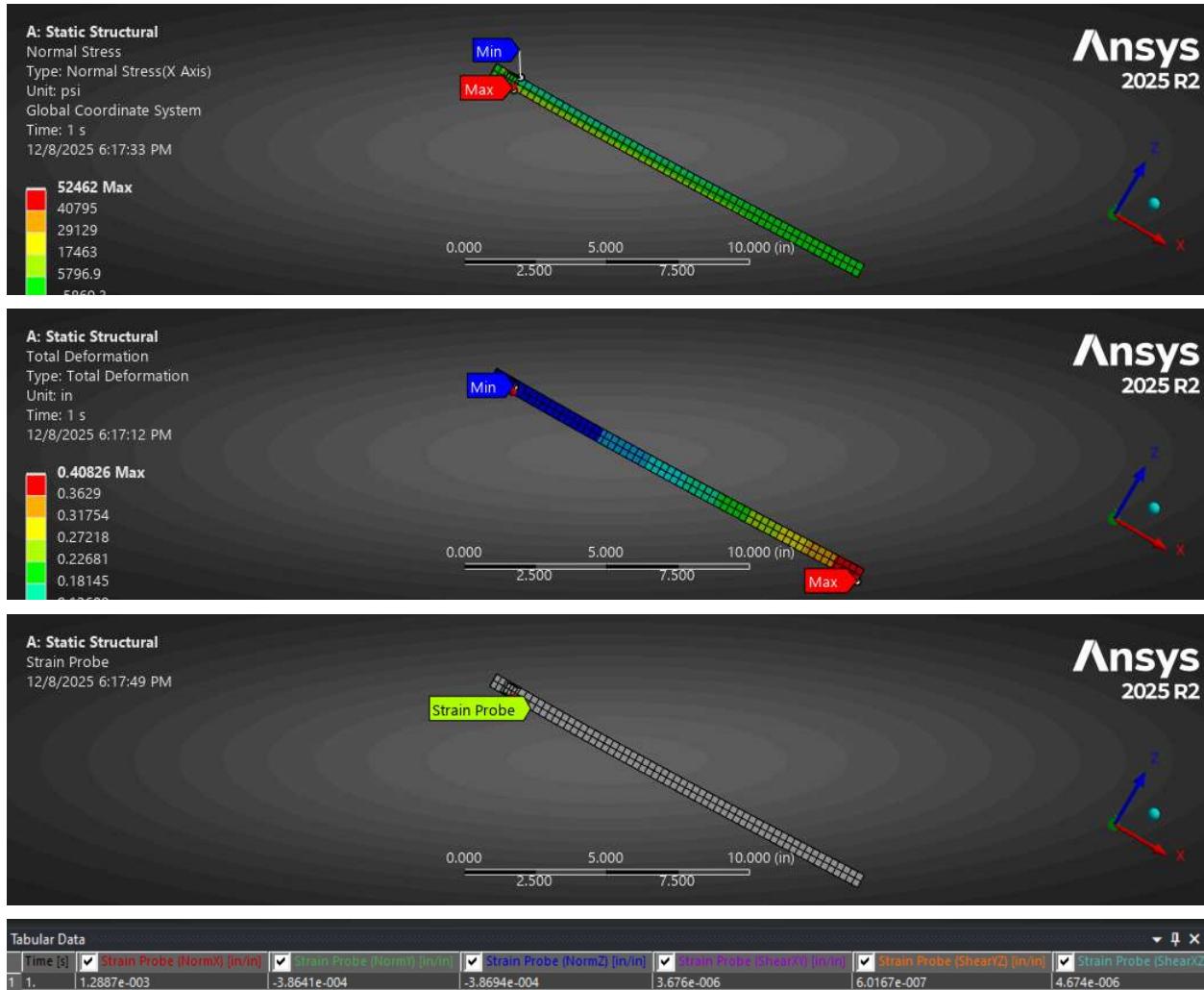
4.



5.



6.



7. Torque Wrench Sensitivity: 1.2887

8.

The torque wrench uses a half-bridge setup with two active strain gauges in a Wheatstone bridge. The gauges are placed 1 inch from the drive. We selected the Micro-Measurements CEA-XX-250UWA-120 strain gauge, which is a uniaxial gauge with a $120\ \Omega$ resistance and a 0.25 inch gauge length. Its small size (0.45 in by 0.18 in) fits well on the handle, and it can be easily bonded since the handle thickness is 0.6 inches.

```
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
```