24-650 Applied Finite Element Analysis
Assignment 8

submitted by

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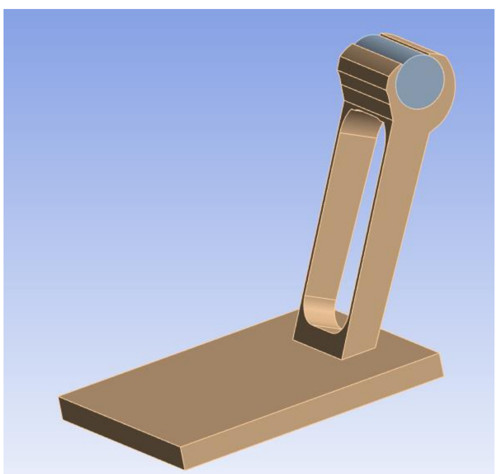
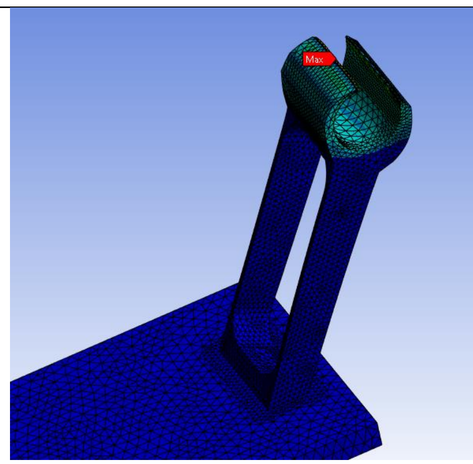
Objective

The goal of this assignment is to design a bracket for minimum mass and minimum fatigue damage
The results are:

	 (Max Stress Indicated)	Mass (kg):**6.137** L (mm): **428** W (mm): **250** Peak σ_{eq} (MPa): **5.3837** Fatigue Damage: **0.00364** Max Deform (mm): **0.001525**

Assumptions and Loading Conditions

1) The load (Fx = 26,000 N) is fully reversible and is applied 25,000 times to the cylindrical surface.
2) The load is transferred through the to-be-designed bracket to a support plate of length L, width W, and a fixed thickness of 25 mm.
3) This is a single-part design.
4) Material properties is indicated below:

Property	Value	Unit
Material Field Variables	Table	
Density	2700	kg m^-3
Isotropic Elasticity		
Derive from	Young's Modulus...	
Young's Modulus	71	GPa
Poisson's Ratio	0.31	
Bulk Modulus	6.2281E+10	Pa
Shear Modulus	2.7099E+10	Pa
S-N Curve	Tabular	

Table of Properties Row 13: S-N Curve		
	A	B
1	Cycles	Alternating Stress (MPa)
2	1000	105
3	1600	68.2
4	6500	42.2
5	5E+05	21.4
6	1.8E+06	17.2
7	1.07E+07	14.1

Figure 1. Material Properties.

Boundary Conditions

The boundary conditions of support on bottom of the bracket are indicated below.

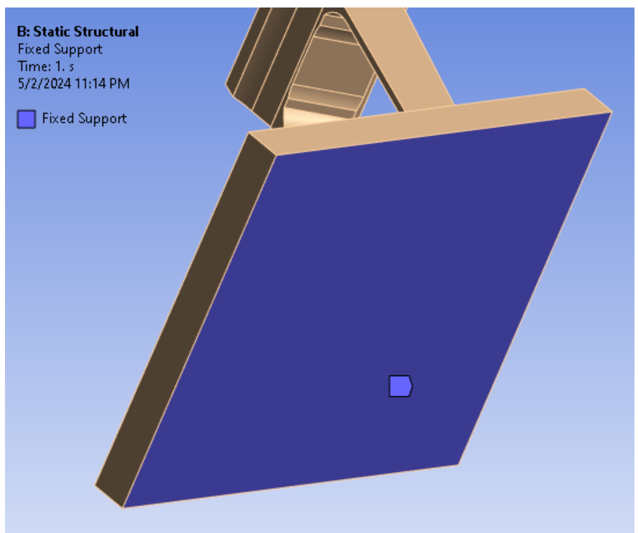


Figure 3. Fixed Support BC

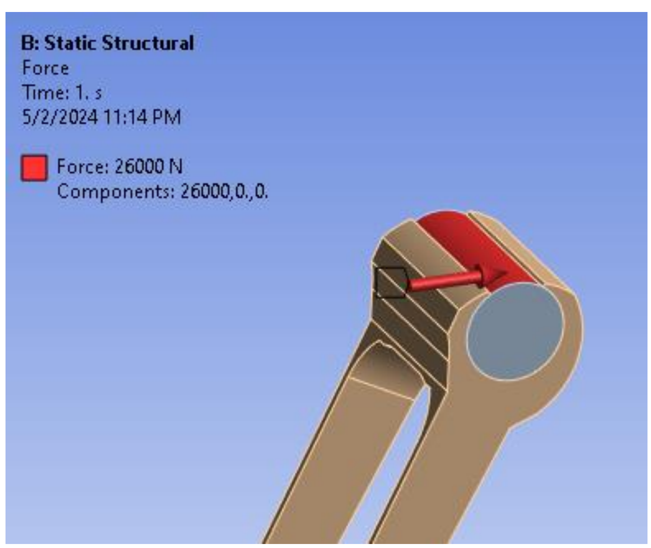
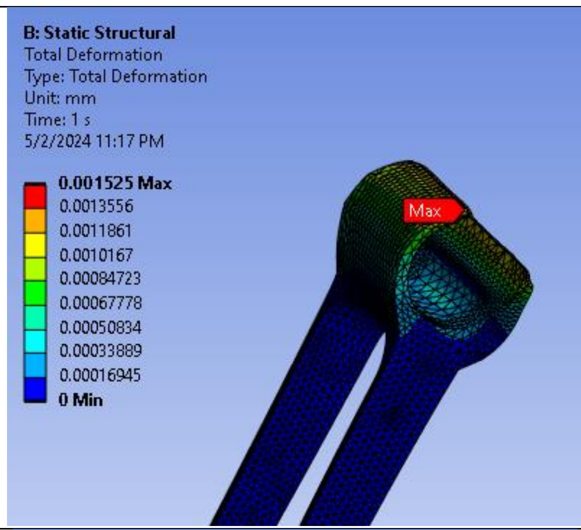
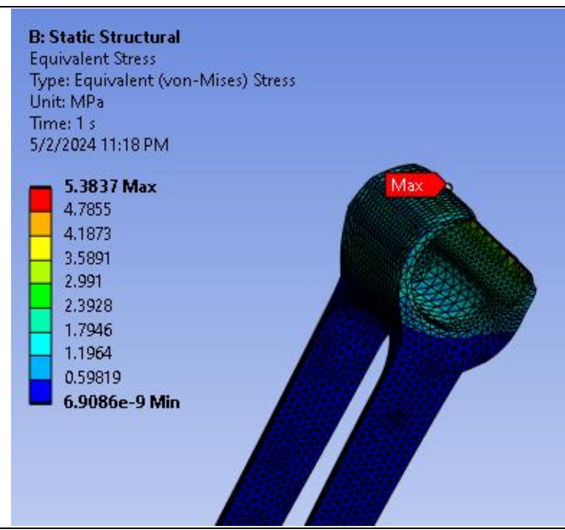


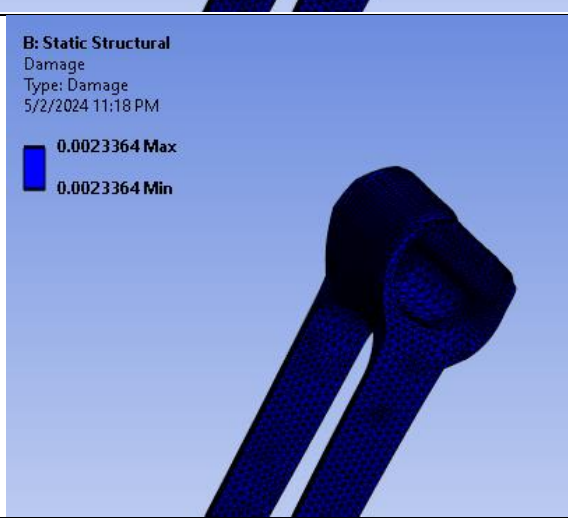
Figure 4. Force BC

Figure 5. Frictionless BC

Results (Static Structural)







Mesh Convergence Study for Stress

Element Size	Refinement	Stress (MPa)
0.28	0	11.451
0.2	0	6.324
0.2	1	5.752
0.1	0	5.346
0.1	**1**	**5.384**

Final Adapted Value

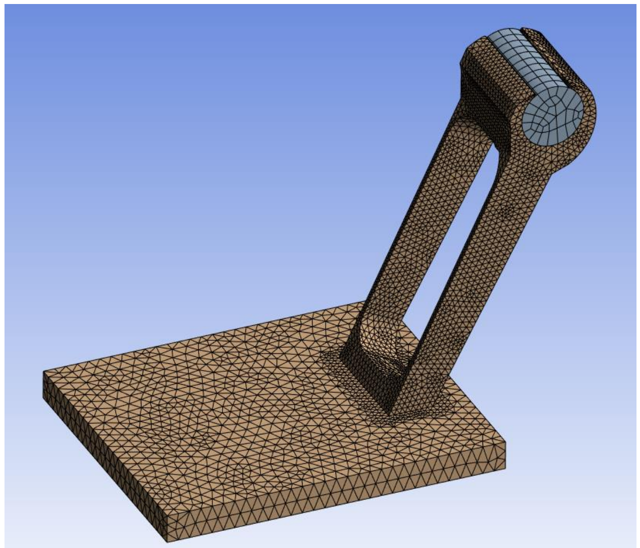
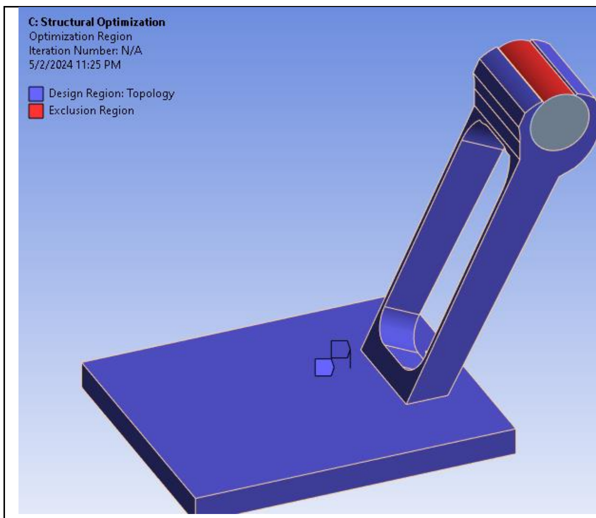
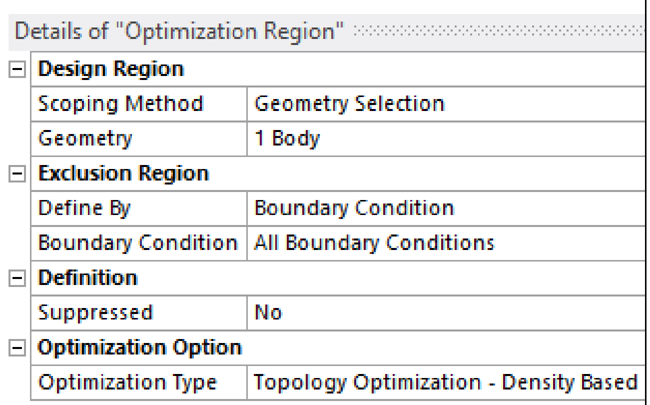


Figure 6. Final mesh generation with refinement around the bracket.

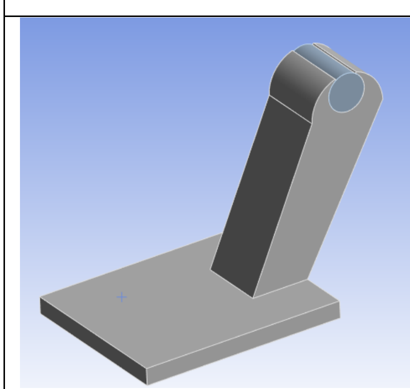
Results (Topology Optimization)

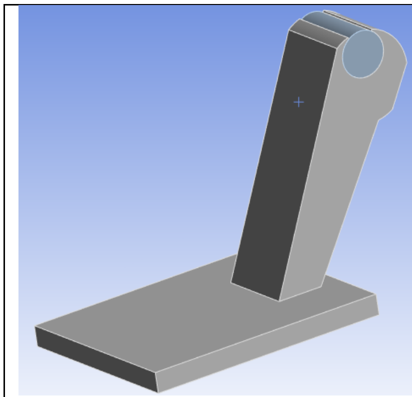
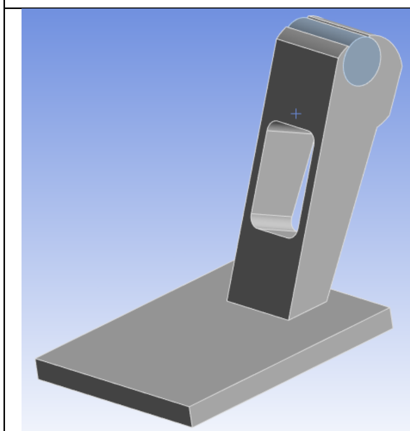
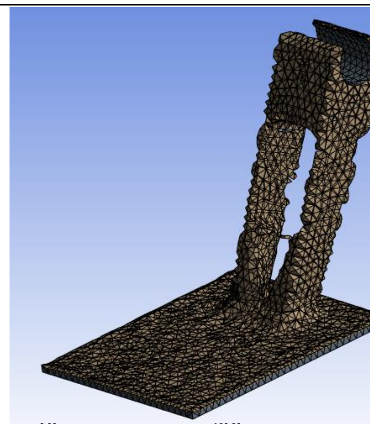
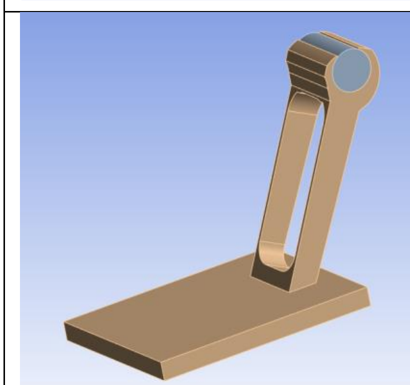
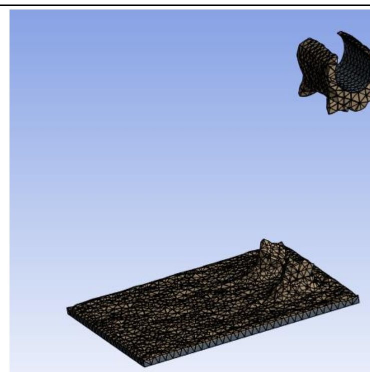




Details of "Optimization Region"

Design Region	
Scoping Method	Geometry Selection
Geometry	1 Body
Exclusion Region	
Define By	Boundary Condition
Boundary Condition	All Boundary Conditions
Definition	
Suppressed	No
Optimization Option	
Optimization Type	Topology Optimization - Density Based

Model	Topology Result	Properties
		Mass (kg): **12.17** L (mm): **428** W (mm): **250** Peak σ_{eq} (MPa): **4.6179** Fatigue Damage: **0.00234** Max Deform (mm): **0.00137**

		Mass (kg): **10.38** L (mm): **428** W (mm): **250** Peak σ_{eq} (MPa): **4.7041** Fatigue Damage: **0.00234** Max Deform (mm): **0.00141**
		Mass (kg): **8.7354** L (mm): **428** W (mm): **250** Peak σ_{eq} (MPa): **4.7027** Fatigue Damage: **0.00234** Max Deform (mm): **0.00140**
		Mass (kg):**6.137** L (mm): **428** W (mm): **250** Peak σ_{eq} (MPa): **5.3837** Fatigue Damage: **0.00364** Max Deform (mm): **0.001525**

Conclusion

For this project, we employed a structural optimization tool to streamline the geometry, eliminating superfluous elements and enhancing the design's strength and efficiency. Based on the table in the results-topology optimization section, one can conclude that the intuitive design often contains massive redundancy which can cost waste of material and increasing structural weight. By applying topology optimization, it facilitated the enhancement of the design's potency and resulted in overall cost savings.