ASSIGNMENT 8 – Topology Optimization of Bracket with Fatigue

Referring to the design space shown in Figure 1 (**A8Geom.scdoc**), your task is to design a bracket for minimum mass and minimum fatigue damage that fits in and adheres to the given design space with the indicated reversible load and made of A6 aluminum alloy. It is important and necessary that you use topology optimization (TO) as a tool for devising your design. The load (F_x = 26,000 N) is fully reversible and is applied 25,000 times to the cylindrical surface. 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. The support plate is part of the bracket and is fully supported (fixed) on its bottom surface. In other words, this is a single-part design.

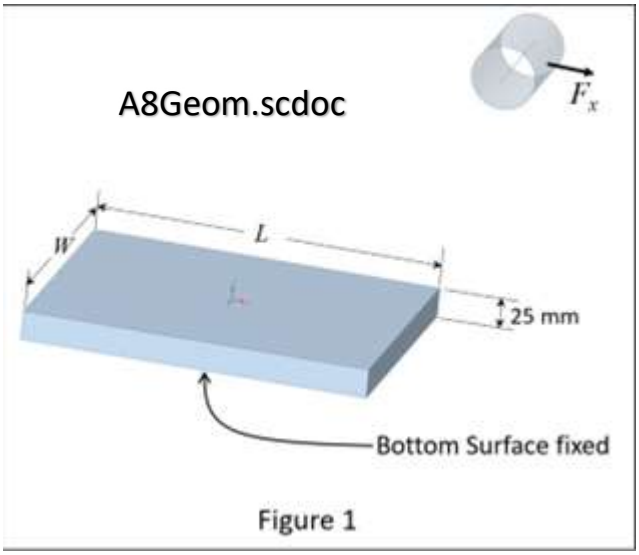


Figure 1

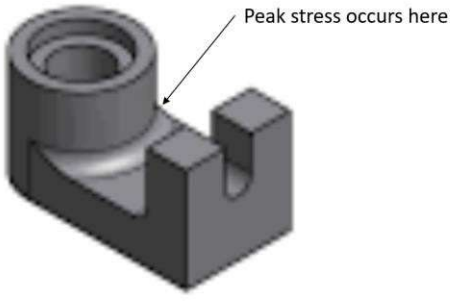
For A6 aluminum alloy use E = 71 GPa, ν = 0.31, ρ = 2700 kg/m^3 and the following S-N fatigue strength versus life cycles data: 105 MPa at 1000 cycles, 68.2 MPa at 1600 cycles, 42.2 MPa at 6500 cycles, 21.4 MPa at 500,000 cycles, 17.2 MPa at 1,800,000 cycles, and 14.1 MPa at 10,700,000 cycles.

A good design with adequate structural integrity is achieved when:

a) Mass is minimized as much as possible.
b) Fatigue damage is less than 1 and minimized as much as possible.
c) The total deformation under load F (= 26,000 N or -26,000 N) is less than 1 mm.

Referring to Figure 2, in your report show and describe your final design, the total mass of the bracket, the length and width of the support plate portion of the bracket, the peak equivalent stress and where it occurs, fatigue damage, and the maximum deformation.

Mass (kg)	***
L (mm)	***
W (mm)	***
peak σ_{eq} (MPa)	***
Fatigue Damage	***
Max Deformation (mm)	***



My Final Design

Figure 2

Assumptions and Additional Guidance

1. For this assignment, it is important to use T.O. as a tool that suggests designs and various design modifications. Use it a little or a lot. It is your decision. Create your final design using conventional CAD tools in your favorite CAD system. Assume the bracket will be made by conventional manufacturing processes (e.g., forging, casting, machining) and NOT by 3D printing.
2. Since fatigue damage is based on peak stresses, accurate and converged stresses are expected.
3. Ignore all stresses where the support plate is fixed.
4. Do not change the size and shape of the cylindrical surface. Do not change the center of mass of the support plate nor its thickness of 25 mm. In other words, adjust L and W in a way the maintains the plate's center of mass.
5. Any introduction of sharp concave corners or other stress singularities will result in a 10-point deduction.
6. Fatigue data: The stress life (S-N) fatigue properties are shown in Figure 3 in semi log scale form; i.e., life is log, and stress amplitude is linear. In *Engineering Data*, add a *S-N Curve* in the *Life* folder for the A6 material. Be sure to select *Semi-Log* for the Interpolation of the S-N data. In *Mechanical*, add the *Fatigue Tool* with a *Damage* result to your solution and insert *25,000 Design Life Cycles*. As mentioned above the load is fully reversible and mean stress effects should not be included in the damage calculation.

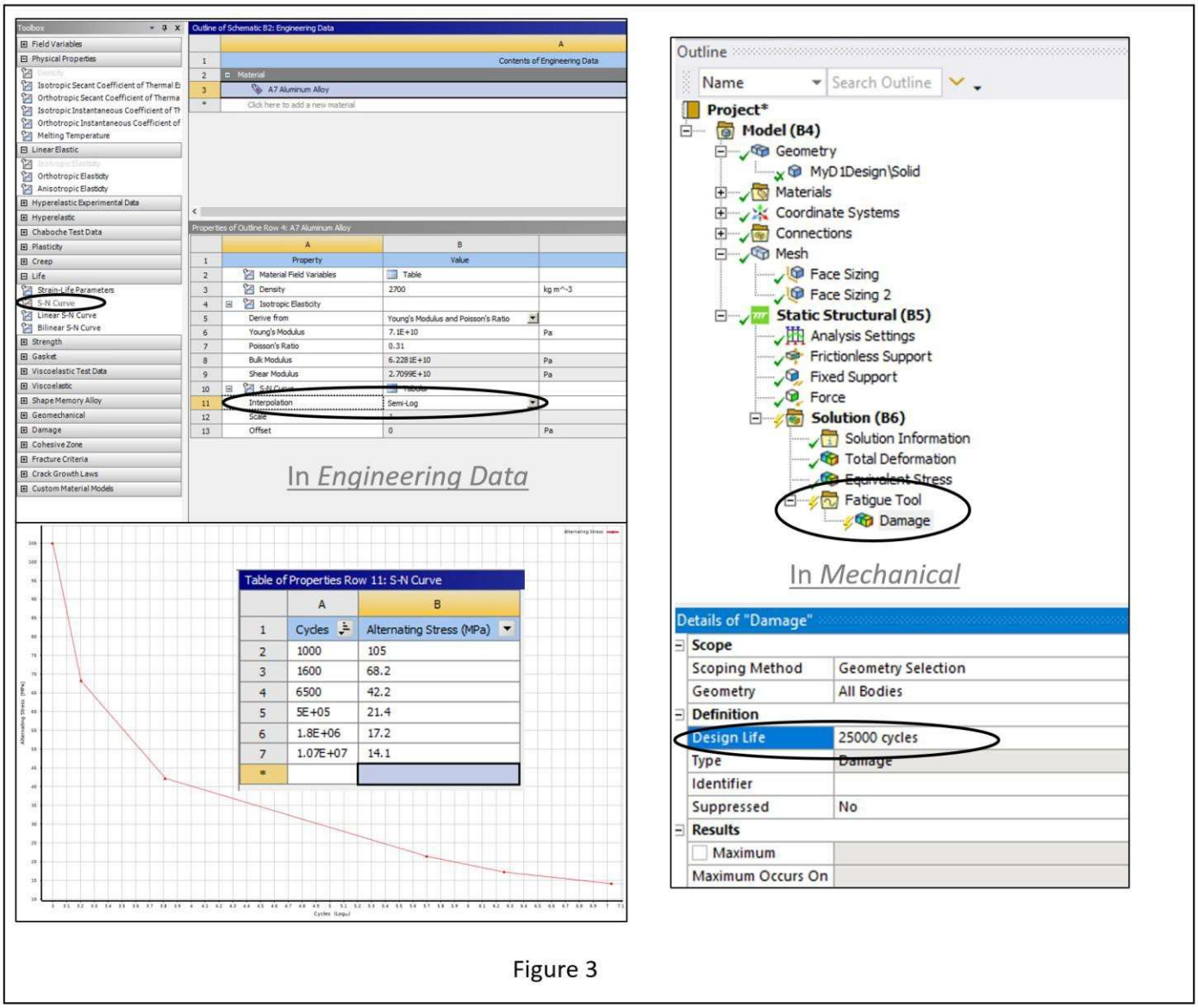


Figure 3