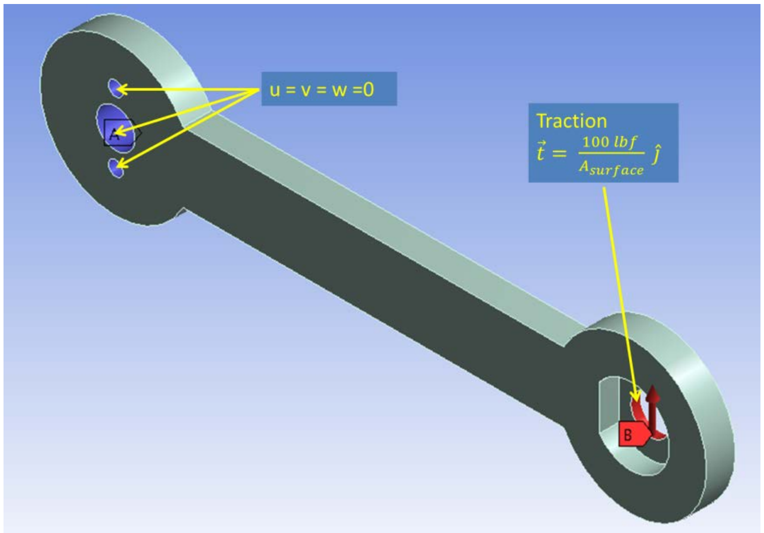
Bike Crank in ANSYS: Exercise

Learning Goals

Practice:

- Solving a 3D FEA problem using ANSYS
- Verifying 3D FEA results by comparing with hand calculations

Problem Specification



Before attempting this problem, go through the bike crank tutorial at:

https://confluence.cornell.edu/x/gA0eDg

Geometry

Parasolid file of geometry can be downloaded from the Crank Exercises page: https://confluence.cornell.edu/x/kA0eDg

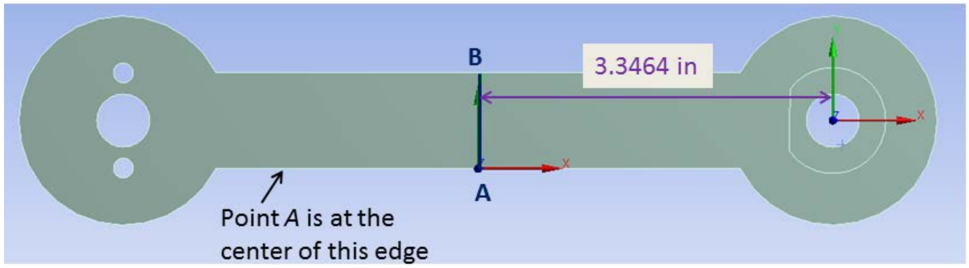
Material: Al 6061 T6

Boundary Conditions

Displacement constraints and non-zero traction to be applied are indicated in the accompanying figure. All other boundaries are free surfaces and have zero traction.

1. Pre-Analysis

a. What is the mathematical model (governing equations + boundary conditions + any additional relations) that needs to be solved using ANSYS? What are the assumptions in the mathematical model?
b. Briefly outline the strategy ANSYS uses to solve this mathematical model and calculate the displacement and stress distributions. Focus on the big picture (as discussed in the ANSYS lectures) and describe it at a level that a sophomore in statics would be able to understand.
c. Perform hand calculations using beam theory to predict the following:
    - Bending stress σ_x along the line AB shown in the figure.



Plot this σ_x vs. y variation in MATLAB or Excel. You'll be adding the corresponding ANSYS result to this plot later.

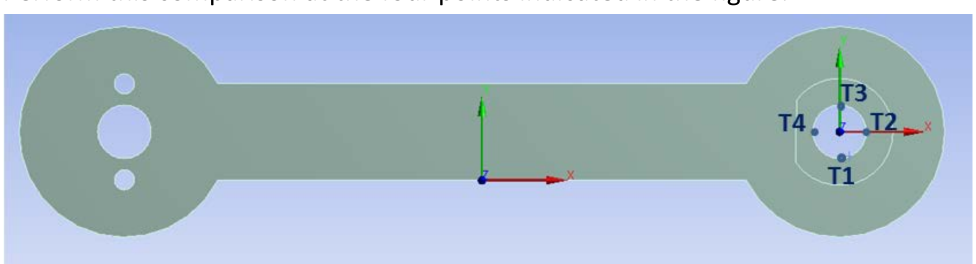
- Repeat the above calculation and plot for the strain ϵ_x.

2. Numerical Results from ANSYS

Obtain the FEM solution using ANSYS on two meshes. The finer mesh should contain at least twice as many nodes as your original mesh. Use your judgment in setting mesh sizings.

Present the following plots/results:

a. **Coarse and fine meshes.** Indicate the number of nodes in each mesh.
b. **Deformed shape obtained on the two meshes**. Black-and-white printout is fine for all plots. Include undeformed wireframe in both plots. Is the displacement field reasonably independent of the mesh?
c. **σ_x contours obtained on the two meshes**. Is σ_x reasonably independent of the mesh, particularly in regions of stress concentration near the fixed holes?
d. **Check whether the applied traction matches the appropriate component of the stress.** Perform this comparison at the four points indicated in the figure.



e. **Extract σ_x along the line AB**. Add the ANSYS result for the two meshes to the prior plot (from part 1.c) of σ_x vs. y variation along line AA. How well do the ANSYS results compare with beam bending theory?
f. **Repeat the above for strain ϵ_x along the line AB**. Note that ANSYS reports *engineering* shear strain (which is two times the tensor shear strain).