ME 478 FINITE ELEMENT ANALYSIS

Project #2

Consider a thin plate loaded in tension with a hole through it (Figure 1). The plate has a length l = 1.0 meters, width w = 0.4 meters, thickness t = 0.01 meters, and a central hole with diameter d = 0.2 meters. The plate is made of steel with an *elastic modulus* E = 200 GPa and *Poisson's ratio* v = 0.29. A tensile loading is applied in the x-direction as a pressure p = 1.0 N/m^2 along the vertical edges of the plate. The goal of this project is to determine the *stress concentration factor* K_t as a function of d/w. You will compare your results with published results. As a savvy FEM engineer, you should be on the lookout for conditions of symmetry that you can exploit when building your model.

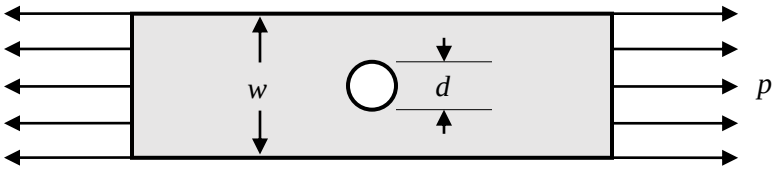

Figure 1. Thin plate with central hole.

Results

In your report, be sure to include the following:

1. What does the deformed shape, the stress in the x-direction (σ_x), and the von Mises stress look like?

2. The heat map for the von Mises stress in part 1 should be smooth and continuous across the elements. If your result shows otherwise, the solution is not convergent. Fix these 'rough' results by refining the mesh with more elements (mesh refinement). What is the effect of mesh refinement on the results for your model? Show a graph of maximum von Mises stress at the hole versus the number of elements in the model.

3. After completing the mesh refinement, compare your maximum value for σ_x against the expected maximum σ_x for a plate with a hole using the relationship for the stress concentration factor K_t. Specifically,

$$\sigma_{x,max} = K_t \, p \, w / (w - d) \tag{1}$$

$$K_t = 3 - 3.14 \, (d/w) + 3.667 \, (d/w)^2 - 1.527 \, (d/w)^3 \tag{2}$$

4. For the round hole, determine the stress concentration factor K_t as a function of d/w by redoing your model with different values for the diameter of the hole. Make a graph comparing K_t vs. d/w from your results and from equation (2).