CE 222— FINITE ELEMENT METHODS

PROBLEM SET #8

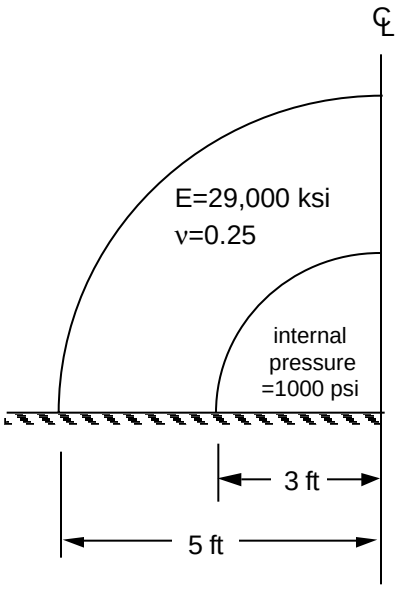
Problem 1

Perform an axisymmetric finite element analysis of the hemispherical pressure vessel. Use a 3 by 3 mesh of 9–node axisymmetric elements. Use the `polar` coordinate system for the `block` command to define the circular geometry. Include the unit weight of the steel material (490 lb/ft^3) as a body force downward in the vertical direction.

With separate calculations, compute the equivalent nodal forces due to the internal pressure using the isoparametric transformation for the normal vector and radius of the loaded surface. Assemble the equivalent nodal loads for the analysis.

Plot the stress components along the centerline and the support line. Plot the contours of minimum and maximum principal stress.

Repeat the analysis of the vessel with an outside radius reduced to 4 ft. What is the effect on the stress distribution?



Problem 2

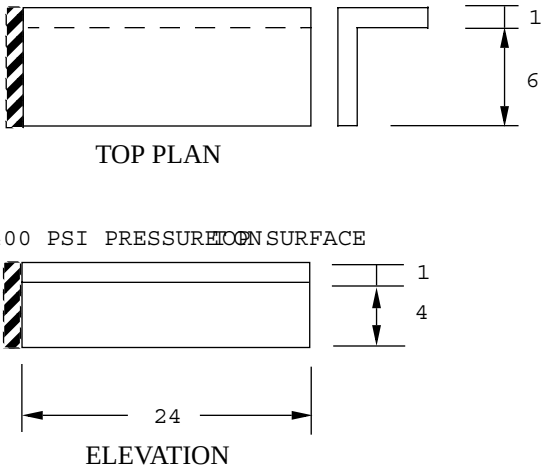
A structural steel bracket is welded from two plates 1 in. thick. and cantilevered from a support. Assume the support restrains all displacement components at the fixed end. The top surface (24”x7”) is supporting a distributed load of 400 psi.

Perform a 3D finite element analysis of the bracket with 8-node brick elements. Use two elements through the thickness of the plates.

(a) Determine the displacement at the tip. Compare the displacement from the finite element solution with elementary beam bending theory.

(b) Plot the maximum and minimum principal stress distributions. How significant are the through thickness stresses in the plates?

(c) Compute the first three vibration frequencies and mode shapes (`subpace`). Plot the mode shapes.



Note: With the distributed version of FEAP, the `block` command may not generate the 3D mesh correctly. It can be fixed by defining node 27 for each block at the geometric center of the block.

Problem 3

For the quadrilateral element below, compute the 2x2 submatrix of the (consistent) mass matrix for node 4 using numerical integration. The material has density ρ. The nodal coordinates of the element are given in parentheses.