ANSYS - Pressure Vessel

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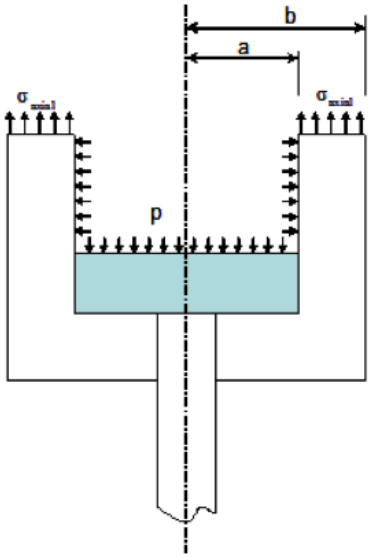
Hoop, Axial and Radial Stresses in Thick-Walled Pressure Vessels

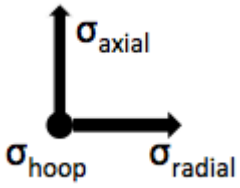
Created using ANYS 14.0

Problem Specification

Consider the following pressurized thick-walled hydraulic cylinder. The following figure shows a section through the mid-plane.



Stress directions in cylindrical coordinates:



$_{hoop}$ is in the circumferential direction (out of the plane here)

a = inner radius = 1.5 in

b = outer radius = 2 in

Assume the cylinders are 18 inches long and the vessel is pressurized to 1000 psi. Here, we will be interested in finding the hoop, axial and radial stresses at the mid-length of the cylinders (@ 9 inches), to neglect the local effects of the end caps.

Compare the finite element results obtained from axisymmetric analysis to those calculated with the theoretical formulae for both thin-wall and thick-wall approximations.

Note: For this problem, the material choice will not affect the stresses; it will only affect the displacements and strains.

Learning Goals

The purpose of this tutorial is to showcase, in a relatively simple situation, where thin-wall pressure vessel theory is no longer as valid as it is in the limit of large radius-to-thickness ratios. The point is that inadequate theory should not be used for validation purposes in the limit that the physical assumptions on which the theory is based break down. In this problem, this happens gradually as the vessel walls become thicker. This tutorial is meant to highlight where it is relatively straightforward to apply axisymmetric FEA and resolve a solution correctly that disprove analytical treatment with simple formulae derived for thin-walled vessels.

Go to Step 1 - Pre-Analysis & Start-Up

Go to all ANSYS Learning Modules