LABORATORY EXPERIMENT 1
Stress Transformations and Pressure Vessels

PreLab Questions:
1. What direction experiences the largest normal stress for a pressurized cylindrical vessel and why?
2. What raw data is experimentally measured using a strain gauge and how is it converted into strain?

I. Introduction

Pressure vessels are typically cylinders with sealed ends designed to withstand large changes in internal pressure without failing catastrophically. An example of a well-designed pressure vessel is a metal (aluminum or stainless steel) beverage can, which is pressurized to maintain carbonation of the beverage. In this experiment, you will learn how to measure strains quantitatively during internal and external deformation of such pressure vessels, and to calculate from these strains the principal stresses of the cylindrical pressure vessel. Other examples of pressure vessels are given below :

Figures of pressure vessels removed due to copyright restrictions.

liquified natural gas tanker

Alaska pipelines

submarines

II. Objectives

The objectives of this experiment are to:
1. Instrument a pressure vessel with strain gages.
2. Measure strain as a function of internal loading (pressurization) for both aluminum and steel beverage cans, and estimate the critical internal pressure for each can type.
3. Use Mohr's circle to resolve stresses calculated for an angle relative to the principal stress directions onto the principle stress axes.
4. Compare the principal stress states from analytical formulations of stress as a function of pressure and geometry $\sigma(P, r, t)$ and stress as a function of mechanical properties and strain $\sigma(E, \varepsilon)$.
5. Measure the force-displacement response and critical buckling load of unpressurized vessels under external loading (uniaxial compression).
6. Compare the experimental and theoretical buckling loads for a pressure vessel that is not infinitely long compared to its diameter.