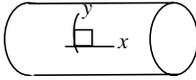# Problem Set #5   1.050 Solid Mechanics
Fall 2004
(Due Friday, 15 October)

Problem 5.1

A closed can of soda is under pressure equivalent to that in an automobile tire. We measured the wall thickness in lab on Thursday to be 0.0025 inches. Estimate the axial stress σ_a and the hoop stress σ_θ? acting at a point in this closed, thin cylindrical shell, away from the ends. C

Construct a Mohr's circle for this state of stress with components with respect to the xy axis shown. $(\sigma_x = \sigma_a; \ \sigma_y = \sigma_\theta)$.

Determine the rotation of axis at the point which would bring you to planes of maximum shear stress. What is the magnitude of the maximum shear stress component at the point.

Problem 5.2

A *rigid* beam is pinned supported at its left end and at midspan and the right end by two springs, each of stiffness k (force/displacement). The beam supports a weight P at mid span.
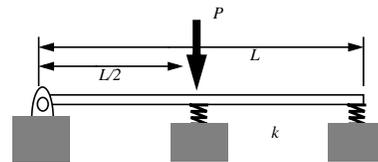
i) Construct a compatibility condition, relating the displacements of the springs to the rotation of the rigid beam.

ii) Draw an isolation of the rigid beam and write out the consequences of force and moment equilibrium

iii) Using the force/deformation relations for the linear springs, express equilibrium in terms of the angle of rotation of the beam.

iv) Solve for the rotation, then for the forces of reaction at the three support points.

v) Sketch the shear force and bending moment diagram.

Problem 5.3

The figure shows one of the eight ribs of the umbrellas, the unfurling of which we have studied in Class Exercise #7, the results of which have been posted on our MIT server (at two places under the heading of "Class Exercises"). We now want to finish our analysis and pick a size, a spring constant, for the spring connecting the "pins" C and D.

Set up a spread sheet, the final column of which computes the (nondimensional) value of the force P (as *P/kb*), the spring change-in-length, call it D, and the position of pin D relative to the top pin as functions of the angle θ.

Plot P/kb versus θ

In this use the following values for lengths (which I have estimated).

   $a = 5.50$ in. $b = 5.25$ in. $c = 2.50$ in.   and $d = 3.50$ in.

Take the initial value for theta to be 20° , $\theta_0 = 20$. deg. and increment by 2 to 5 degrees

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