Problem 1 (35 points)

A tubular post of square cross section supports a horizontal platform.

The tube has outer dimension \( b = 6 \) in. and wall thickness \( t = 0.5 \) in. The platform has dimensions 6.75 in. \( \times \) 24.0 in. and supports a uniformly distributed load of 20 psi acting over its upper surface. The resultant of this distributed load is a vertical force \( P_1 \):

\[ P_1 = (20 \text{ psi})(6.75 \text{ in.} \times 24.0 \text{ in.}) = 3240 \text{ lb} \]

This force acts at the midpoint of the platform, which is at distance \( d = 9 \) in. from the longitudinal axis of the post. A second load \( P_2 = 800 \) lb acts horizontally on the post at height \( h = 52 \) in. above the base.

Determine the principal stresses and maximum shear stresses at points \( A \) and \( B \) at the base of the post due to the loads \( P_1 \) and \( P_2 \) combined.

Solution:
Problem 2 (25 points) Find the reactions $R_A, M_A, \text{ and } R_B$ due to the load $P$. Assume that the bar has inertia $I$ and Young’s modulus $E$. Do you get the expected reactions in the limit $k \to 0$. You may use the information given on the right.

\[ y = \frac{P}{6EI} \left( x^3 - 3Lx^2 \right) \]

Solution:
Problem 3 (15 points) The plastic tube with outer diameter 120 mm, and thickness 5 mm, carries the 550-N load in addition to an internal pressure of 2 MPa. Find the maximum shear, principal stresses and principal planes in the tube at
(a) Element K
(b) Element H

Continue your work on reverse side
Problem 4 (15 points): A car of mass $m$ and velocity $v$ strikes a stopper bar whose one end (closest to the car) is free and the other is rigidly mounted to wall. If the diameter of the circular bar is $d$ and its length is $L$, find the velocity of the car at which the bar will first buckle.

Solution:
Problem 5 (10 points)

A steel rod of diameter 15 mm is held snugly (but without any initial stresses) between rigid walls by the arrangement shown in the figure.

Calculate the temperature drop $\Delta T$ (degrees Celsius) at which the average shear stress in the 12-mm diameter bolt becomes 45 MPa. (For the steel rod, use $\alpha = 12 \times 10^{-6}$°C and $E = 200$ GPa.)

Solution: