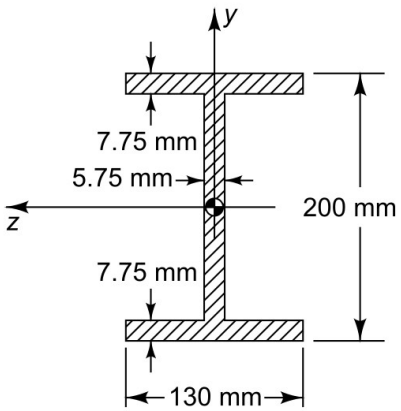
ME231: Tutorial – VI

November 17, 2020

Q.1: A steel cantilever beam 6 m long, whose cross section is shown, is loaded by a 5-kN load. Find the maximum bending stress and maximum shear stress in the beam.

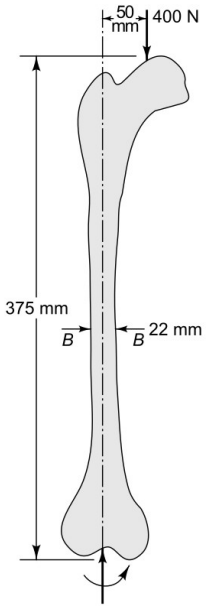


Q.2: A rough sketch of a human femur subjected to a vertical load of 400 N is shown.

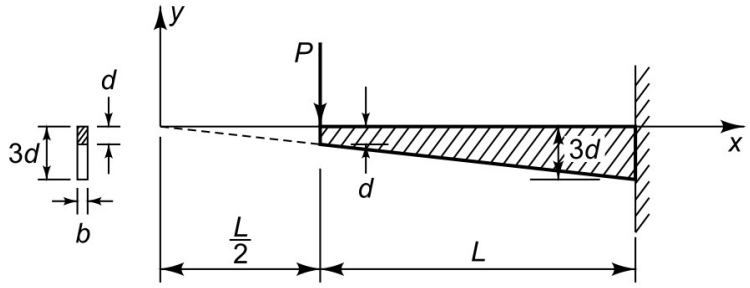
(a) Determine the distribution of stress across the section BB assuming that the circular section is solid bone.

(b) Same as (a), except that this time assume that the inner half of the bone radius consists of "spongy" bone. Assume that the "spongy" bone does not carry appreciable stress.

(c) What is the percentage increase in the maximum stress of distribution (b) compared with the maximum stress of distribution (a)?



Q.3: A cantilever beam of width b and length L has a depth which tapers uniformly from d at the tip to $3d$ at the wall. It is loaded by a force P at the tip, as shown. Find the location and magnitude of the maximum bending stress.



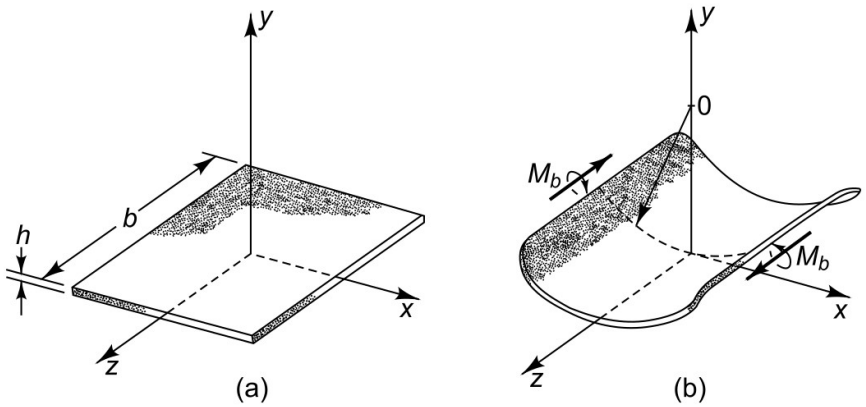
Q:4: A plate is a "beam" in which the thickness is very small compared to the width, as shown in part (a) of the figure. It is observed experimentally that, when a plate is bent by the application of moments to the ends, the central part forms a cylindrical surface and the anticlastic curvature is restricted to the vicinity of the edges, as shown in part (b) of the figure. (Bend a piece of cardboard to verify this behavior.) Proceeding from this observed geometric behavior, develop the following relation for the curvature of the central cylindrical portion:

$$\frac{d\phi}{ds} = \frac{1}{\rho} = \frac{12(1-\nu^2)M}{Eh^3}$$

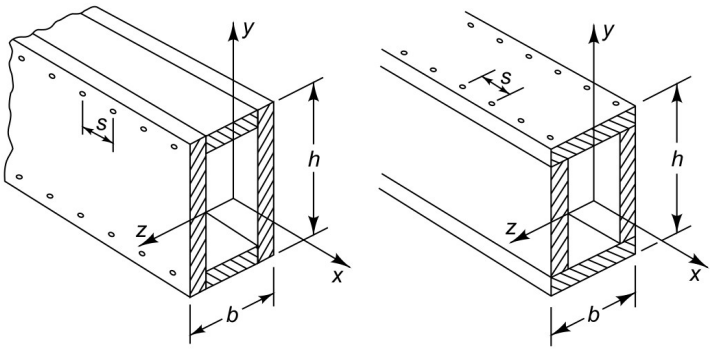
where M is the bending moment per unit width of plate in the central portion. Show also that in the central cylindrical portion the bending stress σ_x is given by

$$\sigma_x = \frac{12M_y}{h^3}$$

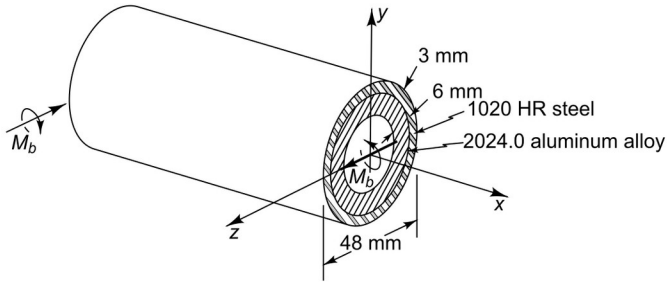
Hint: Think if the plate can be considered as a beam in xy-plane with plane strain approximation.



Q.5: Two designs have been suggested for building a box beam by nailing together four pieces of wood of equal thickness. The dimensions b and h and the spacing s are equal in both designs. If the beam is to carry loading in the xy-plane, is one design better than the other?



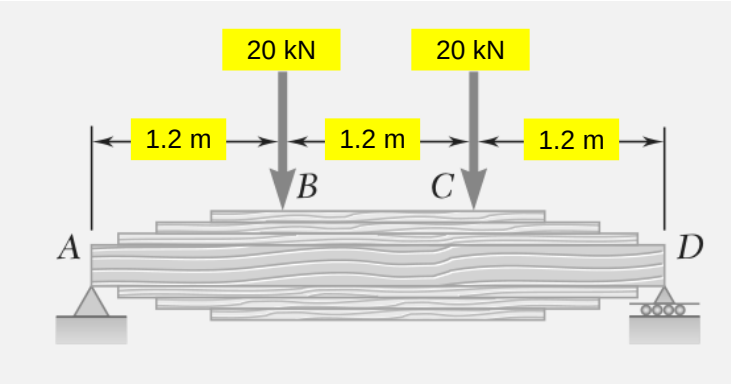
Q.6: A 1020 HR steel pipe in a chemical plant is lined with 2024-0 aluminum alloy for corrosion resistance. When the pipe is installed in the piping system, what is the maximum bending moment it can withstand without exceeding the yield stress of either the steel or the aluminum alloy?



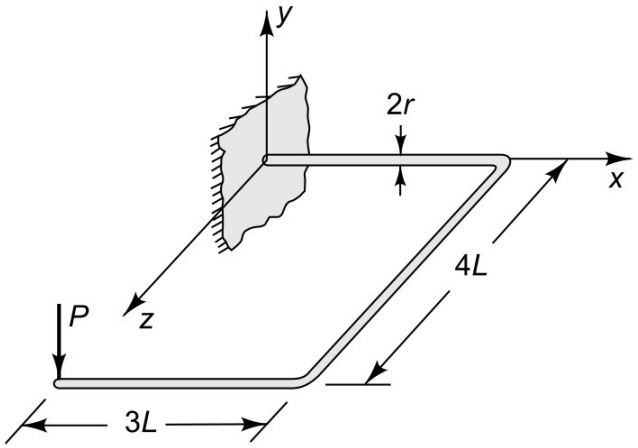
Q.7: A 3.6 m long beam made of a timber with an allowable normal stress of 16 MPa and an allowable shearing stress of 3 MPa is to carry two 20 kN loads located at its third points. It can be shown that a beam of uniform rectangular cross section, 100 mm wide and 115 mm deep, would satisfy the allowable shearing stress requirement. Since such a beam would not satisfy the allowable normal stress requirement, it will be reinforced by gluing planks of the same timber, 100 mm wide and 31 mm thick, to the top and bottom of the beam in symmetric manner. Determine

(a) the required number of pairs of planks,

(b) the length of the planks in each pair that will yield the most economical design.



Q.8: A circular rod of radius r is bent into the shape of a U to form the structure of figure. The material in the rod has a yield stress Y in simple tension. We wish to determine the load P that will cause yielding to begin at some point in the structure.



*** END ***