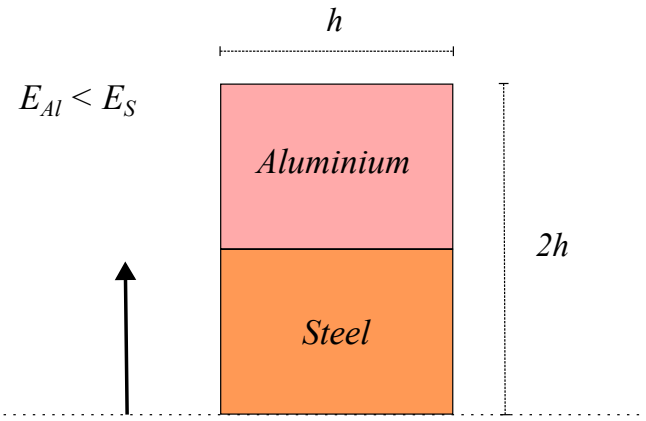
Tutorial 9: Uniform beam bending

APL 104 - 2024 (Solid Mechanics)

Q1. Think of a composite beam having a rectangular cross-section such that one-half of the cross-section (having a square shape) is aluminium while the other half is steel. When such a beam is bent, where will the neutral axis lie in the cross-section (calculated from the bottom line of the cross-section)?

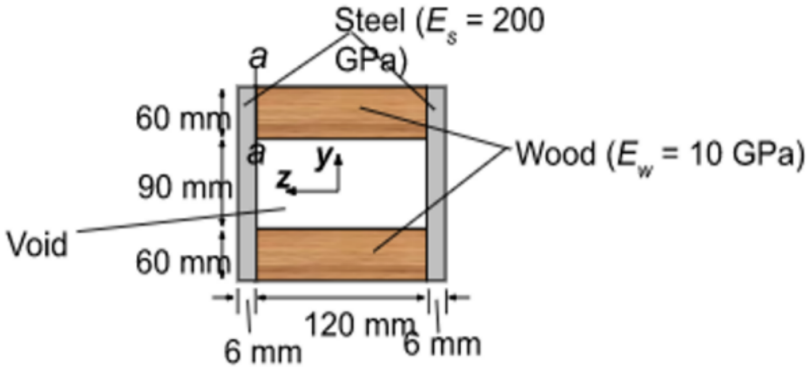


Q2. A beam of composite cross-section is subjected to bending moment $M_z = 30$kN. Find:

(a) The curvature $\kappa = \frac{1}{R}$ induced in the beam

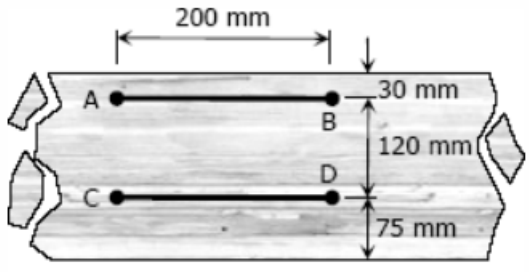
(b) Maximum bending stress in wood

(c) Maximum bending stress in steel

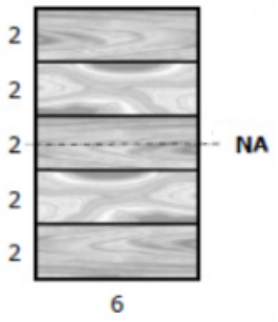


Q3. A flat steel bar, 1 inch wide by 0.25 inch thick and 40 inch long, is bent by couples applied at the ends so that the midpoint deflection is 1 inch. Compute the stress in the bar and the magnitude of the applied couples. Use $E = 200$GPa.

Q4. In a laboratory test of a beam loaded by end couples, the longitudinal fibers at layer AB in the figure below are found to increase 60×10^{-3}mm whereas those at CD decrease $100\times10^{-3}mm$ in the 200mm-gauge length. Using $E=70GPa$, determine the flexural stress in the top and bottom fibers.



Q5. A laminated beam is composed of five planks, each 6 in. by 2 in. glued together to form a section 6 in. wide by 10 in. high.



The allowable shear stress in the glue is 90 psi, the allowable shear stress in the wood is 120 psi, and the allowable flexural stress in the wood is 1200 psi. Determine the maximum uniformly distributed load that can be carried by a simply supported beam on a 6ft simple span.

Q6. For an I-beam, assume the beam is subjected to tranverse load

(a) Obtain an expression for variation in shear stress τ_{xy} within its cross-section. You can use the formula $\tau_{xy}=\dfrac{VQ(y)}{I_{zz}T(y)}$.

(b) Using the expression above, draw a graph depicting qualitative variation in shear stress within the cross-section.

(c) Where is the shear stress maximum? Find the ration of maximum shear stress to average shear stress in the cross-section.