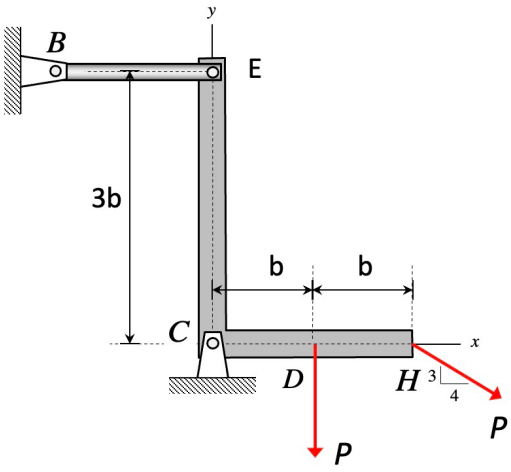
Quiz No. 10 ***Name*** SOLUTION

ME 270 – Summer 2024 - Prague



Given: Member BE has a cross-sectional area of A and is made of a material having a Young's modulus of E and a yield strength of σ_Y. Loads of P and P act at locations D and H, respectively, on member ECH.

Find: For this problem:

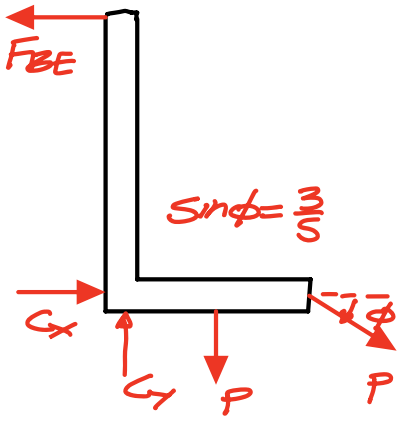
a) Determine the axial stress and strain in rod BE.

b) Has the material in rod BE failed due to yielding? If not, what is the factor of safety for this loading against yielding?

For this problem, use the following parameters: E = 200 GPa, σ_Y = 250 MPa, P = 150 kN and A = 220 mm^2.

NOTE: In your work, you must show the four steps of analysis: 1) FBDs, 2) equilibrium, 3) solvability, and 4) solve.

1. FBD: member ECH



2. Equilibrium:

(1) $\Sigma M_C = F_{BE}(3b) - P(b) - (P\sin\phi)(2b) = 0$

(2) $\Sigma F_x = -F_{BE} + C_x + P\cos\phi = 0$

(3) $\Sigma F_y = C_y - P\sin\phi = 0$

3. Solvability: 3 equations / 3 unknowns

4. Solve

(1) $\Rightarrow F_{BE} = \frac{1}{3}P(1+2\sin\phi) = \frac{11}{15}P$

(a) $\sigma_{BE} = \frac{F_{BE}}{A} = \frac{(\frac{11}{15})(150)(10^3)N}{(220\,mm^2)(\frac{m}{1000mm})^2} = 0.5\times10^9\,Pa$

$\varepsilon_{BE} = \frac{\sigma_{BE}}{E} = \frac{0.5\times10^9\,Pa}{200\times10^9\,Pa} = 0.0025$

(b) $FS = \frac{\sigma_Y}{\sigma_{BE}} = \frac{250\times10^6\,Pa}{0.5\times10^9\,Pa} = 0.5 < 1$ (failed)