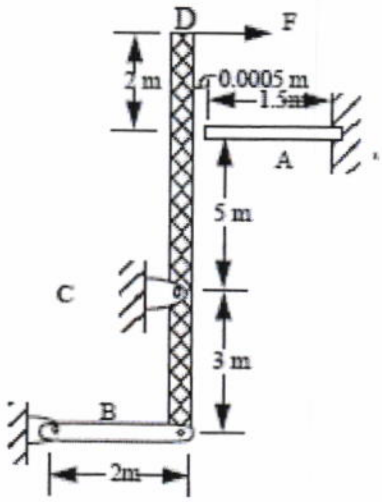
University Of Technology
Building and Construction Eng. Dept.
Final Exam – First Attempt – 2013/2014

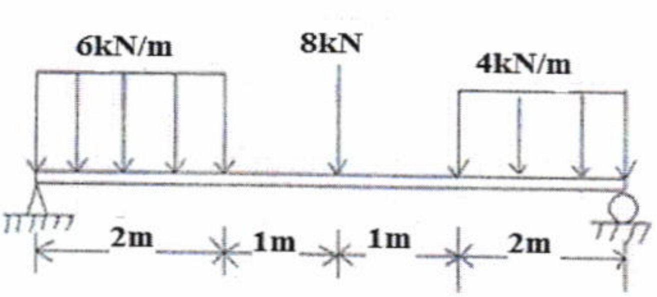
Subject : Strength of Materials. **Date: 28/ 05/ 2014**
Class : Second Year. **Time : 3 Hours**

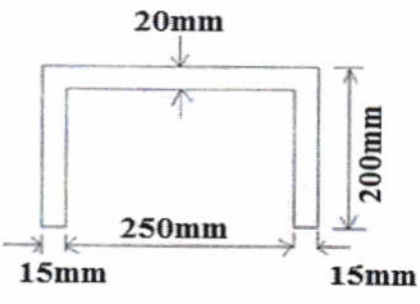
<u>**Note**</u>: Answer <u>**FOUR**</u> questions only.

Q1: Bar A and bar B have a cross-sectional area of 400 mm2and a modulus of elasticity E = 200 GPa. A gap exists between bar A and the rigid bar before the force F is applied. Point D is seen to move by 0.00091 m. Determine: (a) the applied force F and (b) the axial stress in bar B.



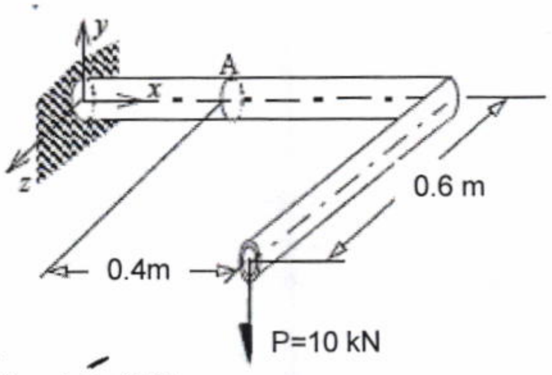
Q2: The simply supported beam with a cross section as shown in the figure was loaded as shown, determine the following.
(a)Draw the Shear force and Bending moment diagrams.
(b)The maximum tensile and compressive bending stresses.





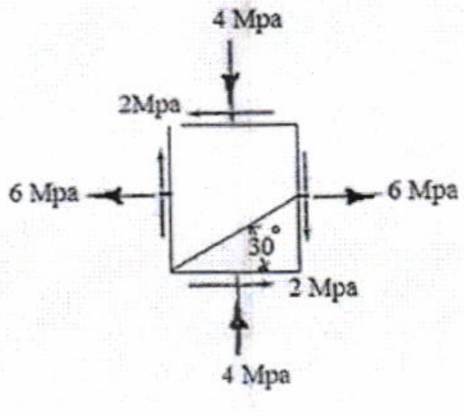
Beam cross section

Q3: A pipe with an outside diameter of 100mm and wall thickness of 10 mm is loaded as shown. Determine the normal and shearing stresses at point A. Point A is on the surface of the pipe at the top.

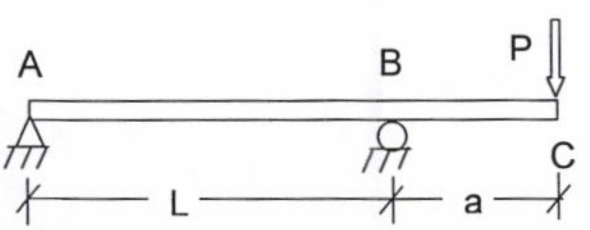


For a circle $I=J/2=\pi R^4/4$
For a semicircle $A=\pi R^2/2$ and $\bar{Y}=4R/3\pi$

Q4: The stresses shown on the element as figure, Find (by using Mohr's circle or by equations):
(a)The values of σ_α and τ_α if $\alpha=30^\circ$
(b) Determine the stresses and its directions on principal plane.
(c) Determine the stresses and its directions on maximum shear plane.



Q5: Using the moment area method, find the slope and the deflection at point (C) of the beam shown. EI=constant.



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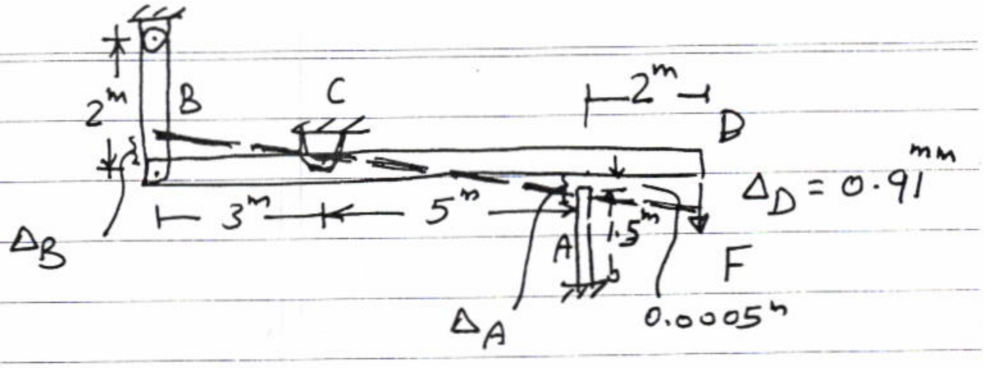
Q1



$$\frac{0.91}{7000} = \frac{\Delta_B}{3000} \Rightarrow \Delta_B = 0.39^{mm}$$

$$\delta_B = \Delta_B = \frac{PL}{AE} \Rightarrow 0.39 = \frac{P_B\,(2000)}{(400)(200000)}$$

$$P_B = 15.6^{KN}$$

stress at B $\sigma_B = \frac{15600}{400} = 39\ MPa\ (N/mm^2)$

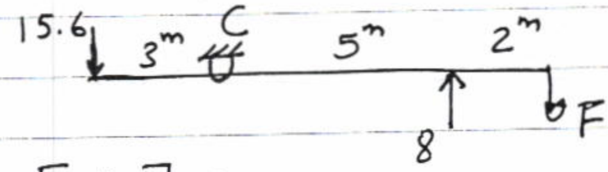
$$\frac{0.91}{7000} = \frac{\Delta_A}{5000} \Rightarrow \Delta_A = 0.65$$

$$\delta_A = 0.65 - 0.5 = 0.15^{mm}$$

$$\delta_A = \frac{PL}{AE} \Rightarrow 0.15 = \frac{P_A * 1500}{400 * 200000}$$

$$P_A = 8000^N = 8^{KN}$$

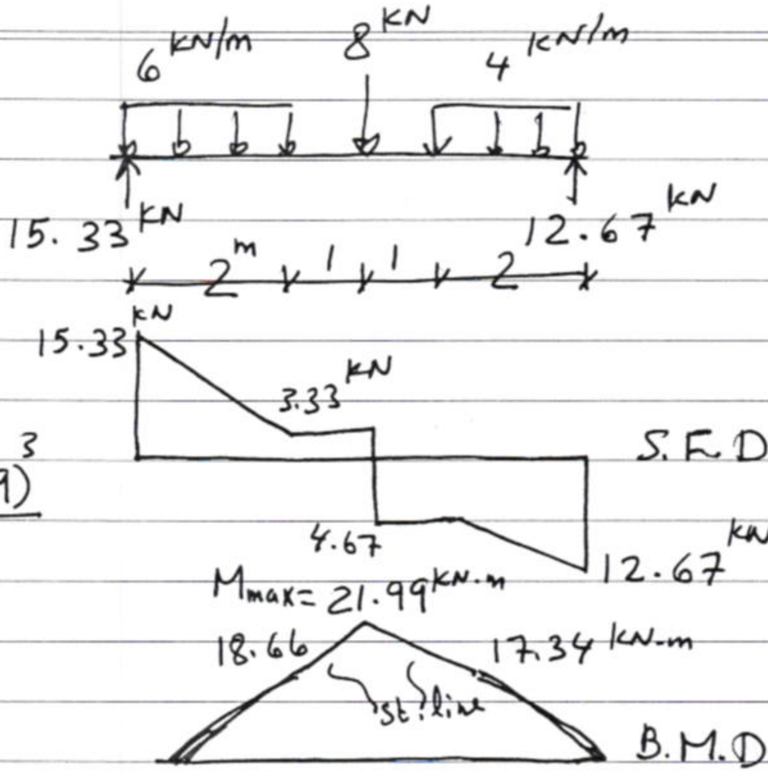
$\Sigma M_C = 0$ +↻



$$-15.6(3) - 8(5) + F * 7 = 0$$

$$F = \frac{86.8}{7} = 12.4^{KN.}$$

Q_2



$$\bar{y} = \frac{(280*20)(10) + 2(180*15)(110)}{280*20 + 2(180*15)}$$

$$\bar{y} = 59.09 \text{ mm}$$

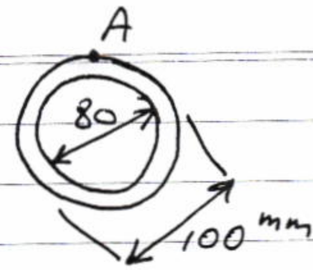
$$I = \frac{280(59.09)^3}{3} - \frac{250(39.09)^3}{3} + 2\left(\frac{15(140.91)^3}{3}\right)$$

$$I = 42.25 * 10^6 \text{ mm}$$

$$\sigma_{comp} = \frac{MC}{I} = \frac{21.99 * \cancel{10^6}(59.09)}{42.25 * \cancel{10^6}} = 30.74 \text{ MPa}$$

$$\sigma_{ten} = \frac{MC}{I} = \frac{21.99 * \cancel{10^6}(140.91)}{42.25 * \cancel{10^6}} = 73.33 \text{ MPa}.$$

Q_3: Torque $= 10^{kN} * 0.6^{m} = 6^{kN.m}$



Shear Force $= 10^{kN}$

Bending Moment $= 10^{kN} * 0.4^{m} = 4^{kN.m}$

$$I = \frac{\pi[(50)^4 - (40)^4]}{4} = 2.898 * 10^6 \ mm^4$$

$$J = I/2 = 1.449 * 10^6 \ mm^4$$

Bending Stress $(\sigma) = \frac{MC}{I}$

$$= \frac{(4*10^6)(50)}{2.898*10^6} = 69 \ MPa.$$

Shearing Stress due to Shearing Force:

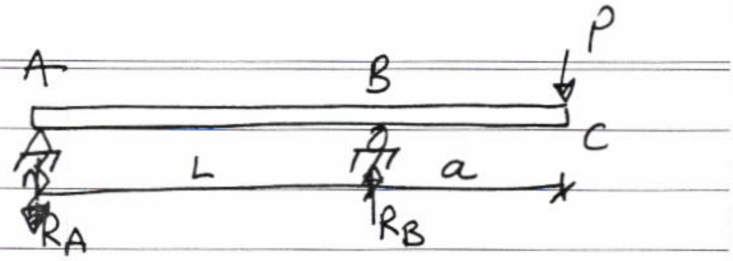
$$\tau = \frac{VQ}{Ib} = \frac{10*10^3 \ (\bar{A}\bar{y})}{1.449*10^6 (20)} = zero.$$

$(\bar{A}\bar{y})$ = zero (on the surface of pipe)

Shearing stress due to torque:

$$\tau = \frac{TR}{J} = \frac{(6*\cancel{10^6})(50)}{1.449*\cancel{10^6}} = 207 \ MPa.$$

Q5:



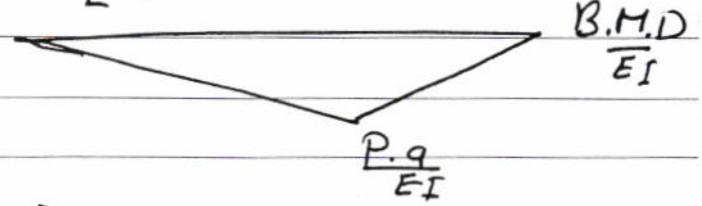
$\Sigma M_A = 0$ +↻

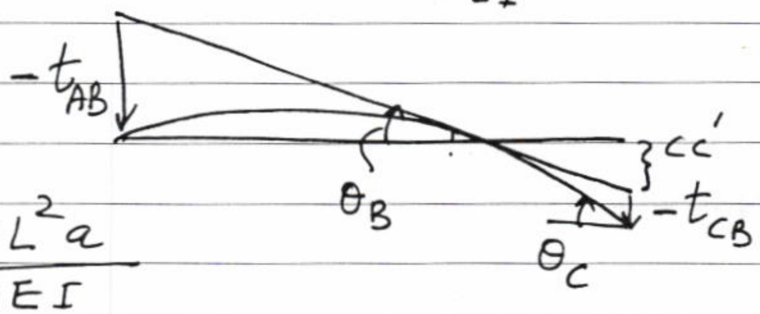
$P(L+a) - R_B(L) = 0$

$\Rightarrow R_B = \frac{P(L+a)}{L} = P(1 + \frac{a}{L})$

$\Sigma M_B = 0$ +↻

$\Rightarrow R_A = -\frac{Pa}{L}$





$t_{AB} = \frac{1}{2} \frac{P.a}{EI} \cdot L(\frac{2}{3}L) = \frac{PL^2a}{3EI}$

$\frac{cc'}{a} = \frac{t_{AB}}{L} \Rightarrow cc' = \frac{Pa^2L}{3EI}$

$t_{CB} = \frac{1}{2} \frac{P.a}{EI} \cdot a(\frac{2}{3}a) = \frac{Pa^3}{3EI}$

$\therefore y_c = cc' + t_{CB} = \frac{Pa^2L}{3EI} + \frac{Pa^3}{3EI} = \frac{Pa^2}{3EI}(L+a)$

$\theta_B = \frac{t_{AB}}{L} = \frac{PL^2a}{3EI} \cdot \frac{1}{L} = \frac{PLa}{3EI}$

$\theta_C = \theta_B + \Delta\theta_{CB}$

$\Delta\theta_{CB} = \frac{1}{2} \frac{P.a}{EI} \cdot a = \frac{Pa^2}{2EI}$

$\theta_C = \frac{PLa}{3EI} + \frac{Pa^2}{2EI}$