DEPARTMENT OF CIVIL ENGINEERING, IIT BOMBAY

CE 221 Solid Mechanics: QUIZ 2

Note: **Assume suitable data if not given.**

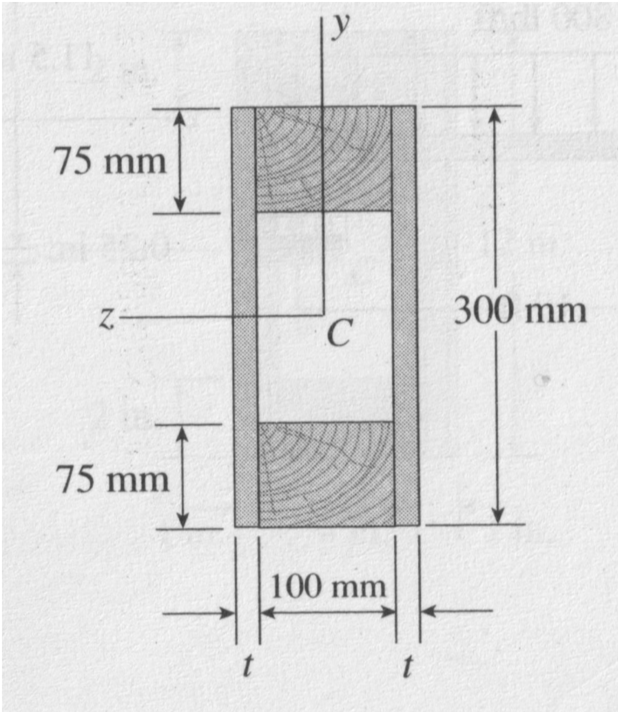
16/10/2014 Total Marks:10 Duration: 50 mins Instructors S. Banerjee/N.K.Chandiramani

Problem 1 (5 marks):

A simply supported beam of span length **3.2m** carries a uniform load of intensity **48kN/m**. The cross-section of the beam is a hollow box with wood flanges and steel side plates, as shown in the figure. The wood flanges are **75mm** X **100mm** in cross-section, and the steel plates are **300mm** deep.

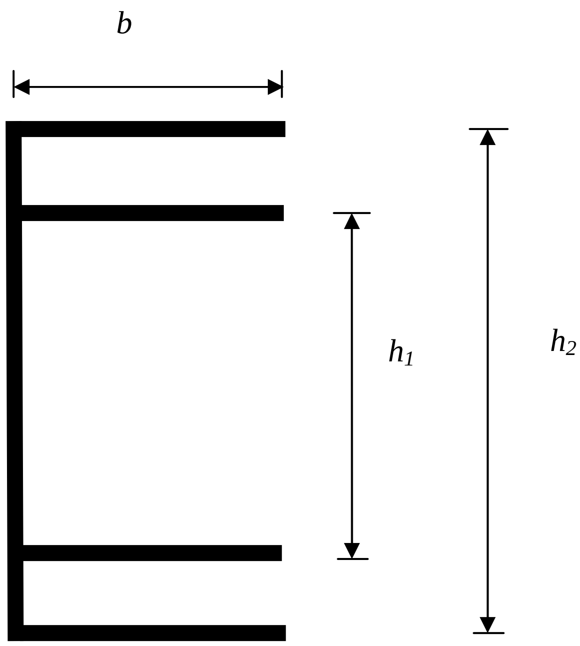
What is the required thickness ***t*** of the steel plates if the allowable stresses (in both tension and compression) are **120MPa** for the steel and **6.5 MPa** for the wood?

Assume that the moduli of elasticity for the steel and wood are **210GPa** and **10GPa**, respectively, and disregard the weight of the beam.



Problem 2 (5 marks):

The thin-walled cross-section channel beam, with double flanges and constant thickness (***t***) throughout the section, is shown in the figure. The cross-section is symmetric about the horizontal axis. Calculate the distance of the shear center from the centerline of the web. All dimensions shown are centerline-to-centerline. Use ***b*=100mm, *h*$_2$=250mm, *h*$_1$=200mm, *t*=5mm**



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P1 $M_{max} = \frac{wL^2}{8}$; $n = \frac{E_S}{E_W} = 21$; $w = 48\,\frac{N}{mm}$, $L = 3200\,mm$

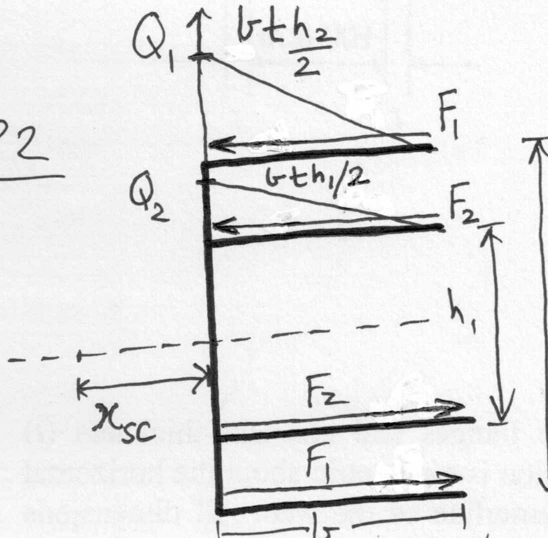
$$I_{tranformed} = \frac{2(300)^3(nt)}{12} + 2\left(\frac{(100)(75)^3}{12} + (100)(75)\left(\frac{3}{4}\cdot 150\right)^2\right)$$

$$\because \frac{120}{6.5} = \frac{(\sigma_{all})_s}{(\sigma_{all})_w} < n \Rightarrow \text{steel is critical (governing)}$$

$$(\sigma_{max})_s = 120 = n\,\frac{M_{max}(150)}{I} \rightarrow \text{solve for } t$$

$$\boxed{t = 14.98\,mm}$$

P2



$$F_1 = \int \tau_1 t\,ds = \int q_1\,ds = \int \frac{1 \cdot Q_1}{I}\,ds$$

$$= \frac{\frac{1}{2} b \cdot b t \frac{h_2}{2}}{I}$$

$$F_2 = \frac{\frac{1}{2} b \cdot b t \frac{h_1}{2}}{I}$$

$$I = \frac{t h_2^3}{12} + 4\underbrace{\frac{b t^3}{12}}_{\simeq 0\ (\because t \text{ small, thin walled})} + 2\left(bt\frac{h_2^2}{4} + bt\frac{h_1^2}{4}\right)$$

$$\Sigma M = 0 \Rightarrow 1 \cdot x_{sc} = F_1 h_2 + F_2 h_1$$

$$= \frac{1}{2}\,\frac{b^2 t}{I}\left(\frac{h_2^2 + h_1^2}{2}\right)$$

$$= \frac{b^2(h_2^2 + h_1^2)}{\frac{h_2^3}{3} + 2b(h_2^2 + h_1^2)}$$

$b = 100$, $h_1 = 200$, $h_2 = 250$ $\Rightarrow$ $\boxed{x_{sc} = 39.87\,mm}$