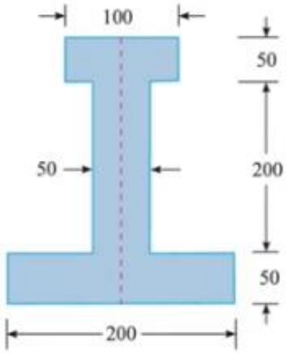
UNIT-III UNSYMMETRICAL SECTIONS

EXAMPLE 15.2. *Figure 15.2 shows a rolled steel beam of an unsymmetrical I-section.*



$\sigma_{b_{max}} = 40$ Mpa

$= 40 \times 10^6$ N/m²

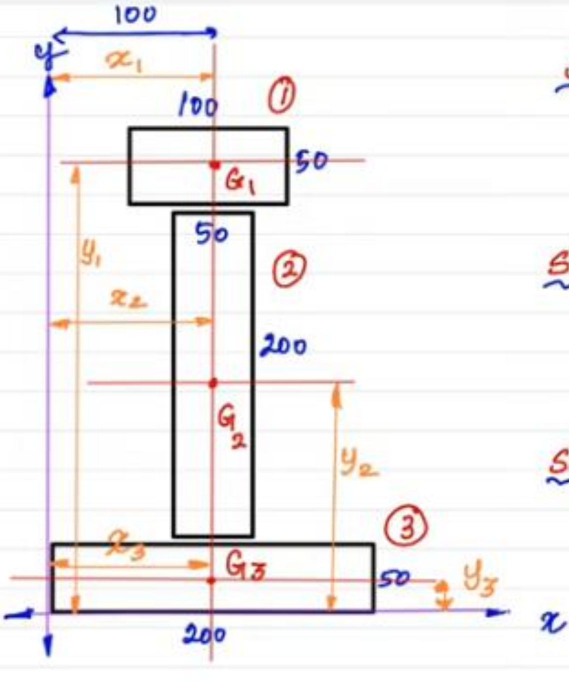
$= 40 \times 10^6 \times \frac{N}{10^6 mm^2}$

$\sigma_{b_{max}} = 40$ N/mm²

Fig. 15.2

If the maximum bending stress in the beam section is not to exceed 40 MPa, find the moment, which the beam can resist.

Formula : $\sigma_b = \frac{M_b \cdot y}{I}$; y - distance b/w centroid and extreme fibre.



Shape 1 :

$x_1 = 100$ mm

$y_1 = 50 + 200 + \frac{50}{2} = 275$ mm

$A_1 = 100 \times 50 = 5000$ mm²

$b_1 \times d_1$

Shape 2 :

$x_2 = 100$ mm

$y_2 = 50 + 200/2 = 150$ mm

$A_2 = b_2 \times d_2 = 50 \times 200$

$= 10000$ mm²

Shape 3 :

$x_1 = 100$ mm

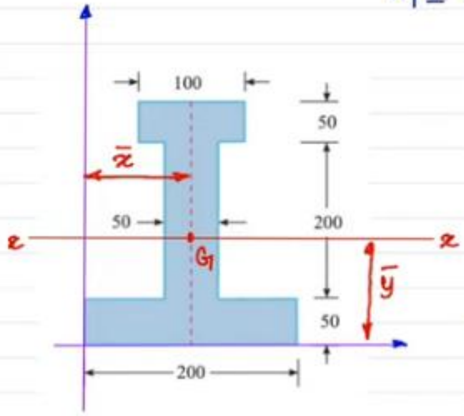
$y_1 = 50/2 = 25$ mm

$A_3 = b_3 \times d_3 = 200 \times 50$

$A_3 = 10000$ mm²

Centroid; $G(\bar{x}, \bar{y})$, $\bar{x} = 200/2 = 100$ mm

$$\bar{y} = \frac{y_1 A_1 \pm y_2 A_2 \pm y_3 A_3}{A_1 \pm A_2 \pm A_3}$$



$$\bar{y} = \frac{275 \times 5000 + 150 \times 10000 + 25 \times 10000}{(5000 + 10000 + 10000)}$$

$\bar{y} = 125$ mm

$G(100, 125)$ mm

Moment of inertia, about x-x axis.

$$I_{xx} = I_G + Ah^2 \; ; \quad h = (\bar{y} \sim y)$$

$$I_{xx} = I_1 \pm I_2 \pm I_3$$

$h_1 = (\bar{y} \sim y_1) = (125 \text{ mm} \sim 275 \text{mm}) = 150$ mm

$h_2 = (\bar{y} \sim y_2) = (125 \text{mm} \sim 150 \text{mm}) = 25$ mm

$h_3 = (\bar{y} \sim y_3) = (125 \text{ mm} \sim 25 \text{mm}) = 100$ mm

$$I_{xx} = \left\{ \frac{b_1 d_1^3}{12} + A_1 h_1^2 \right\} + \left\{ \frac{b_2 d_2^3}{12} + A_2 h_2^2 \right\} + \left\{ \frac{b_3 d_3^3}{12} + A_3 h_3^2 \right\}$$

$$\Rightarrow \left\{ \frac{100 \times 50^3}{12} + 5000 \times 150^2 \right\} + \left\{ \frac{50 \times 200^3}{12} + 10000 \times 25^2 \right\} + \left\{ \frac{200 \times 50^3}{12} + 10000 \times 100^2 \right\}$$

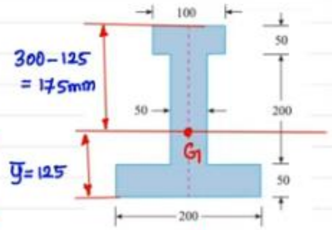
$= 255.2 \times 10^6$ mm^4.

Bending stress; $\sigma_{max} = \dfrac{M_b \cdot y_{max}}{I}$

$\sigma_{max} = 40 \text{ Mpa} = 40 \text{ N/mm}^2$

$I = 255.2 \text{ mm}^4$

$y_{max} = 175 \text{ mm}$



$\sigma = \dfrac{M_b \; y}{I}$

$40 \text{ N/mm}^2 = \dfrac{M_b \times 175 \text{ mm}}{255.2 \times 10^6 \text{ mm}^4}$

$M_b = \dfrac{40 \times 255.2 \times 10^6}{175} = 58.7 \times 10^6 \text{ N.mm}$ //