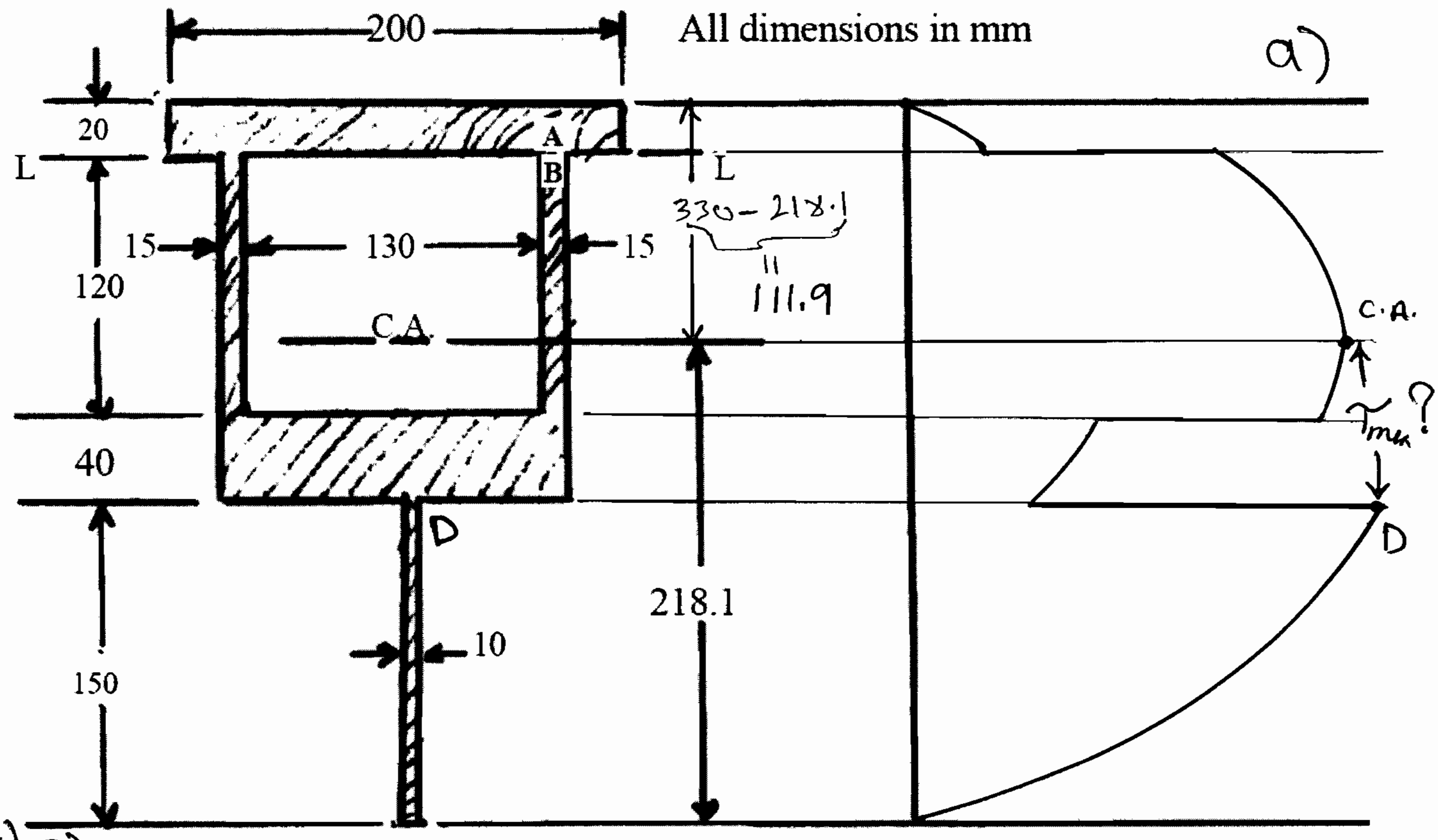
The vertical shear force in a beam, with the cross-section shown below, is 500 kN.

a) *Qualitatively* (without numbers), **draw the vertical shear stress distribution** (τ) on the cross section in the provided space.

b) Determine the **shear stresses** at points A and B (just above and just below line LL).

c) Determine the **value and location of the maximum shear stress.**

The Centroidal Axis **(C.A.)** ***is located as shown on the cross section and*** $\mathbf{I_{C.A.} = 9.884(10)^7\ mm^4}$.

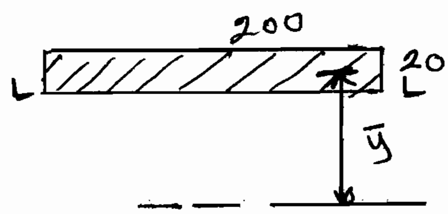


τ Distribution

(pts.) a)

③ τ-distribution as shown ⇗

② b) $Q_{LL} = A\bar{y} = 200(20)(111.9-10)$
$= 407,600 \text{ mm}^3$



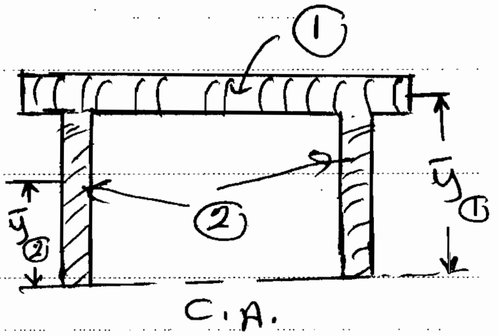
② $q_{LL} = \dfrac{VQ}{I} = \dfrac{500(10^3)(407\,600)}{9.884(10^7)}$

$= 2061.92 \text{ N/mm}$

① $\tau_A = \dfrac{q_{LL}}{t_A} = \dfrac{2061.92}{200} \Rightarrow$ $\boxed{\tau_A = 10.31 \text{ MPa}}$

① $\tau_B = \dfrac{q_{LL}}{t_B} = \dfrac{2061.92}{15+15} \Rightarrow$ $\boxed{\tau_B = 68.73 \text{ MPa}}$

c) τ_{max} is at the C.A. or at D as shown on the τ-dist. above. Thus we need to check both locations.



@ C.A.: Take the upper area as it easier.

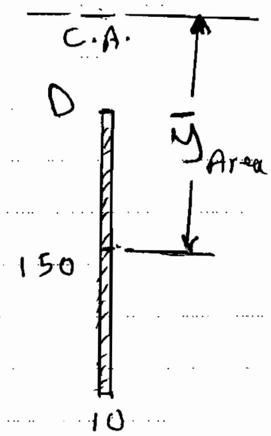
We divide it into two areas ① and ②

$$Q_{C.A.} = Q_{①} + Q_{②} = 407{,}600 + 2(15)(111.9-20)\left(\frac{111.9-20}{2}\right)$$

$$= 407{,}600 + 126{,}684 = 534{,}284 \text{ mm}^3$$

⑤ $$\tau_{C.A.} = \frac{VQ}{It} = \frac{500(10)^3(534{,}284)}{9.884(10)^7(15+15)} \Rightarrow \tau_{C.A.} = 90.09 \text{ MPa}$$

@ D : It is easier to take the lower area as shown ⟹



$$Q_D = A\bar{y} = 10(150)\left(218.1 - \frac{150}{2}\right) = 214{,}650 \text{ mm}^3$$

$$\tau_D = \frac{500(10)^3(214{,}650)}{9.884(10)^7(10)}$$

④ $$= 108.6 \text{ MPa}$$

① Thus $\boxed{\tau_{max} = 108.6 \text{ MPa @ D shown}}$

① units