Topics

1- Shear stress evaluation.

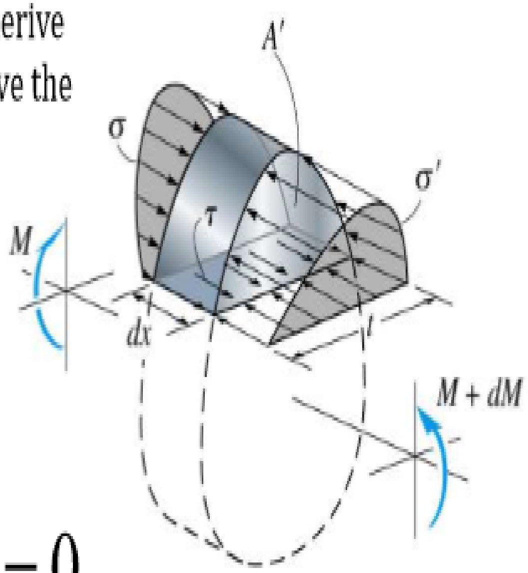
2- Nominal shear value for a beam.

Prepared by Eng.Maged Kamel.

DERIVATION OF SHEAR FORMULA

Consider the section shown in figure. To derive the formula for shear stress , we first derive the formula for shear force.

$$\overleftarrow{+}\sum F_x = 0$$



Three-dimensional view

$$\int_{A'} \sigma' dA - \int_{A'} \sigma dA - \tau(t\,dx) = 0$$

$$\int_{A'} \left(\frac{M+dM}{I}\right) y\,dA - \int_{A'} \left(\frac{M}{I}\right) y\,dA - \tau(t\,dx) = 0$$

$$\tau = \frac{1}{It}\left(\frac{dM}{dx}\right)\int_{A'} \underbrace{y\,dA}_{= Q}$$

Recall, dM/dx = V

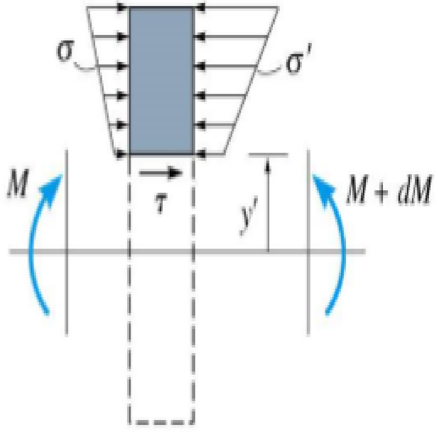
$$\tau = \frac{VQ}{It}$$

Internal Shear (lb)

First Moment of area (in^3) at point of interest

Moment of inertia of entire cross section (in^4)

Thickness of cross-section at point of interest (in)



Profile view

Where ,

$$Q = \bar{y}' \cdot A'$$

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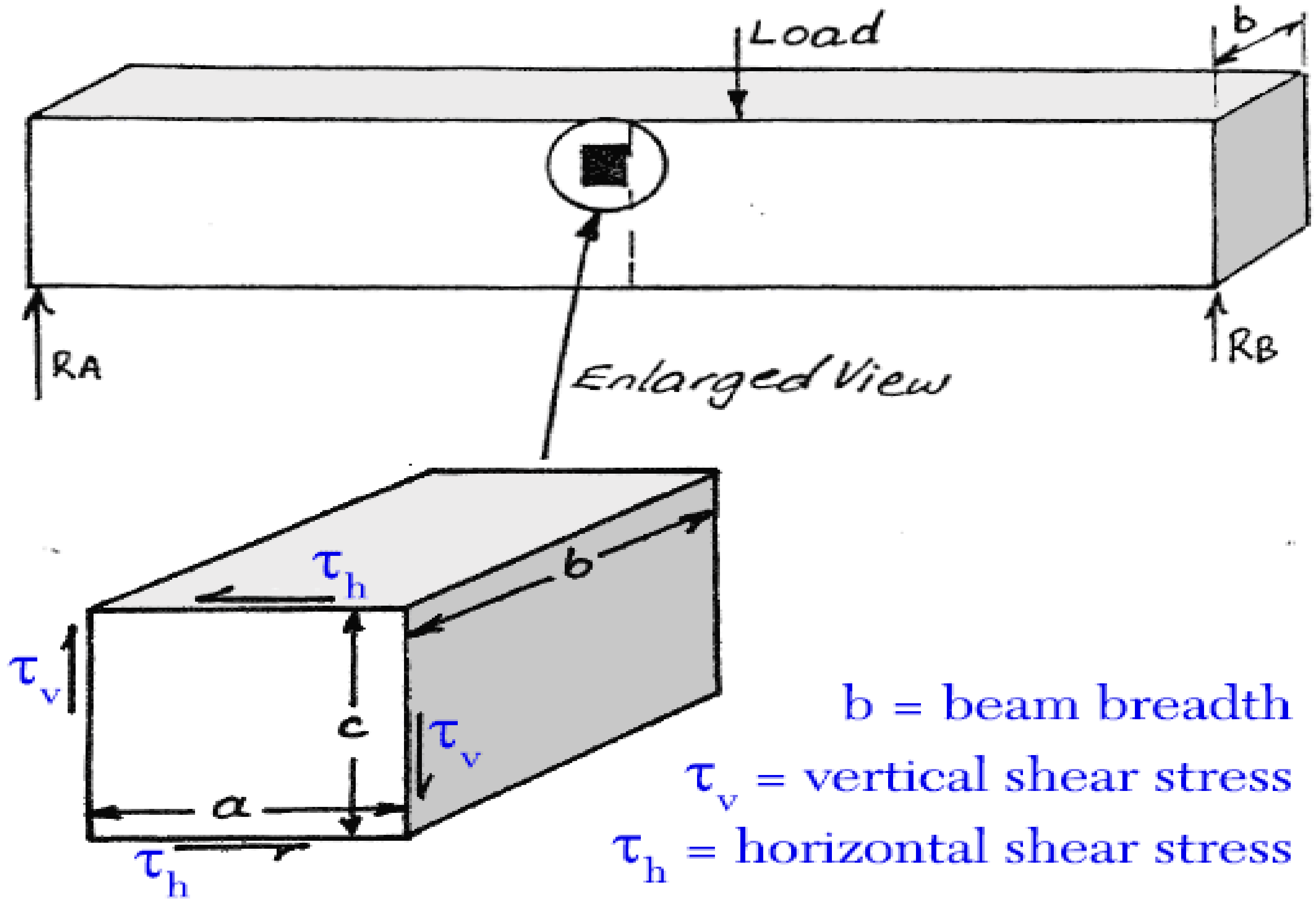
Relationship Between Vertical And Horizontal Shear Stress

http://www.learneasy.info



Horizontal shear stress $\tau_h = \tau_v$

The transverse and longitudinal shear forces produce stresses called the vertical and horizontal shear stresses. These stresses are shown acting on a small part of the beam in the figure above.
At any particular point in the beam the horizontal shear stress is equal to the vertical shear stress.

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Proof $\tau_v = \tau_h$

Proof

To prove $\tau_v = \tau_h$

Force acting on a horizontal surface = τ_h x (ab)

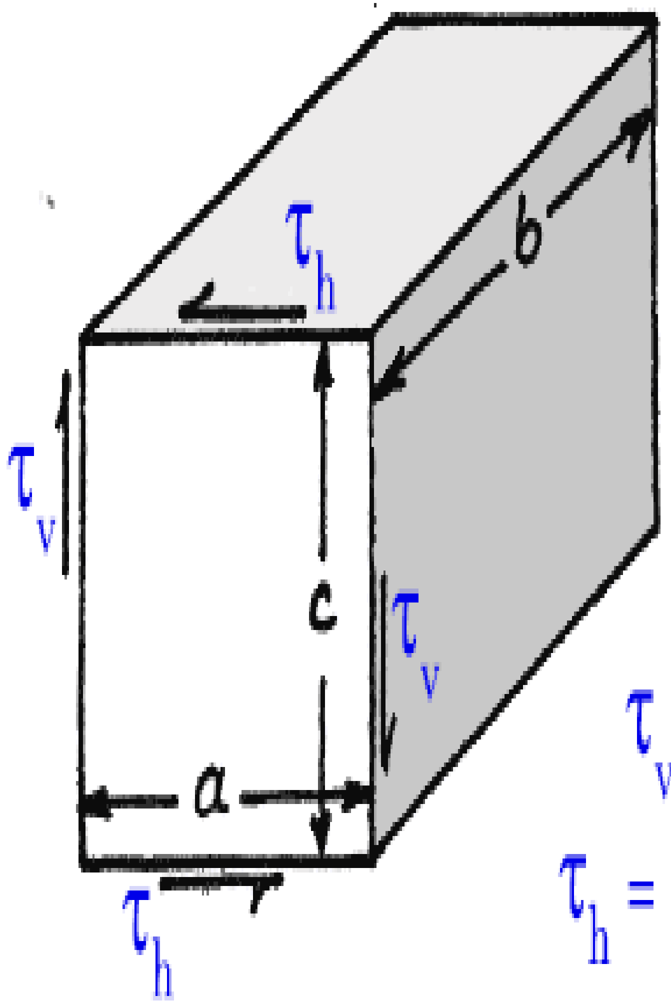
Force acting on a vertical surface = τ_v x (cb)

Taking moments about anywhere on the front face of the element (e.g. the centre of it);

τ_h (ab)c = τ_v (cb) a

So $\tau_v = \tau_h$

(Note: This works even if the element is a rectangular rather than a square prism)



b = beam breadth

τ_v = vertical shear stress

τ_h = horizontal shear stress