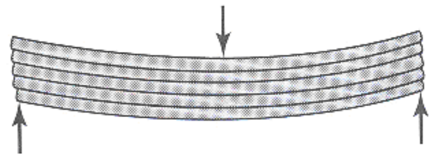
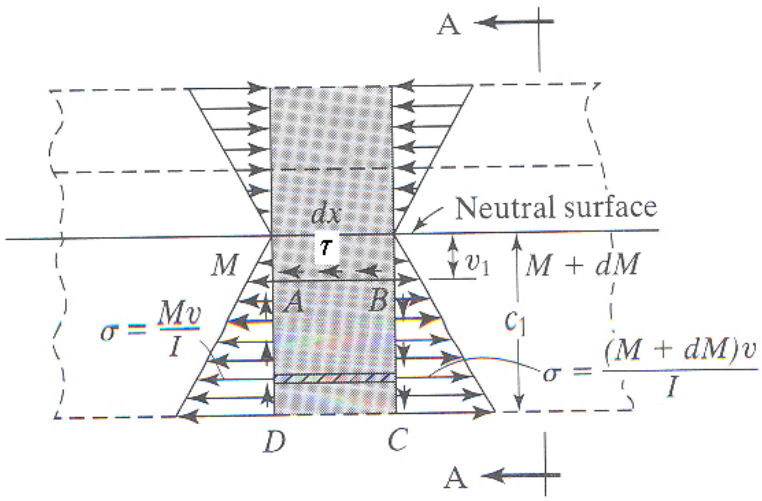
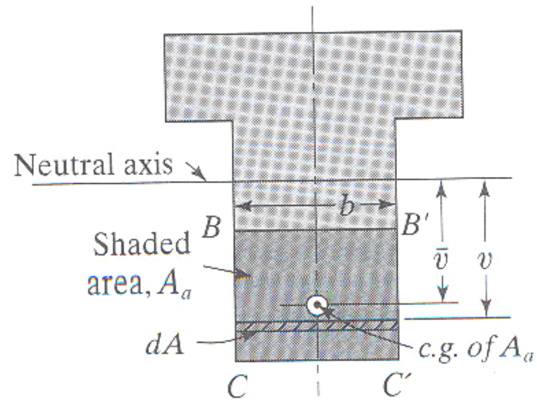
TRANSVERSE SHEAR STRESS



(a) Sliding of laminated strips under transverse shear loads



(b) Side view of beam



(c) Section A–A

The equilibrium equation for horizontal forces for $ABCD$ is then

$$\tau b\, dx + \int_{v_1}^{c_1} \frac{M v\, dA}{I} = \int_{v_1}^{c_1} \frac{(M + dM) v\, dA}{I}$$

$$\tau = \frac{1}{b} \int_{v_1}^{c_1} \frac{dM}{dx} \frac{v\, dA}{I} = \frac{V}{Ib} \int_{v_1}^{c_1} v\, dA$$

$$\tau = \frac{V}{Ib} \bar{v} A_a = \frac{VQ}{Ib}$$

When finding transverse shear stress (τ) for a composite section, the following formula can be used:

$$\tau = \frac{V}{Ib} \sum \bar{v} A_a = \frac{V}{Ib} \left(\bar{v}_1 A_{a1} + \bar{v}_2 A_{a2} \ldots \right)$$

EXAMPLE 1-12

Problem Statement: Find the transverse shear in the material 3 in. from the top surface for the beam of Fig. 1-21 (a).

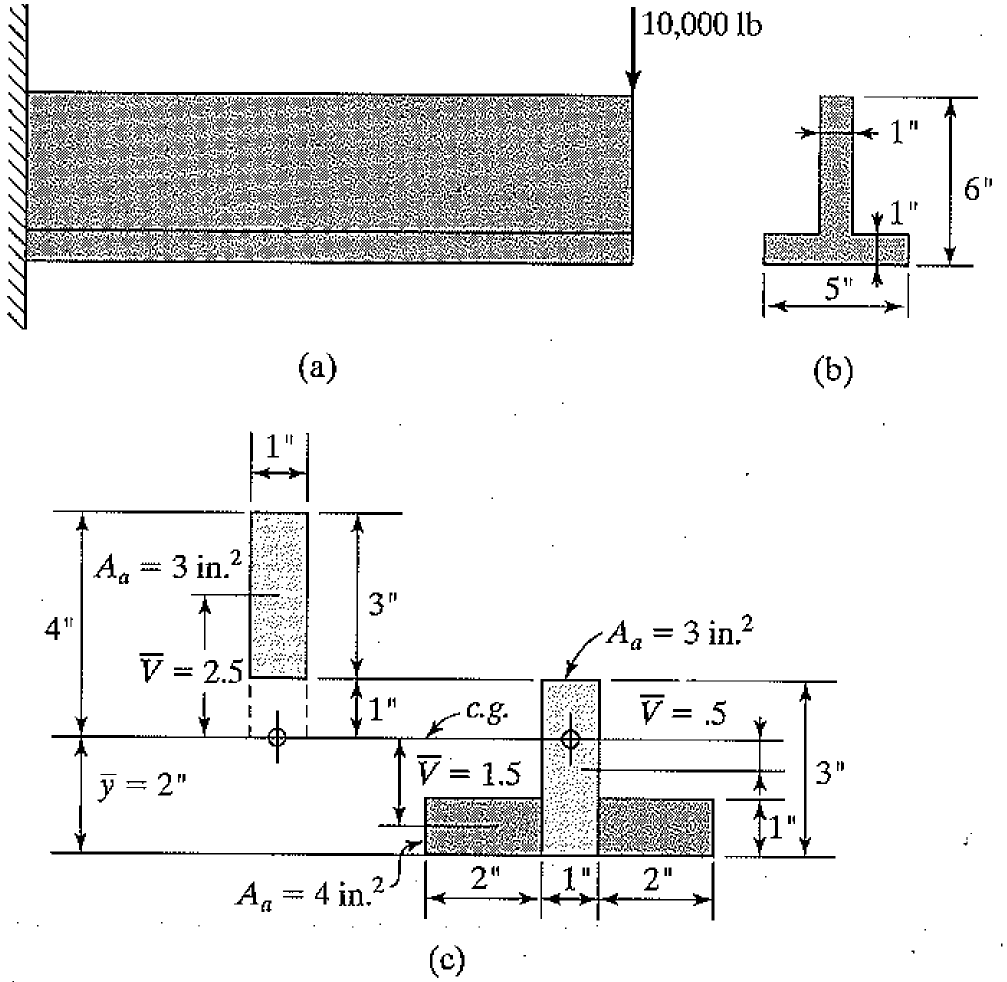


Figure 1-21 Examples 1-3, 1-6, and 1-12

Referring to Fig. 1-21(c), it is seen for a location 3 in. from the top that $\bar{v}$ = 2.5 in. and A_a = 3 in.^{2}. Substitution in Eq. (25) gives

$$\tau = \frac{10{,}000}{33.33 \times 1} \times 2.5 \times 3 = 2250 \text{ psi}$$

It is of course immaterial whether A_a is taken above or below the location at which the stress is desired. Equation (26) gives

$$\tau = \frac{10{,}000}{33.33 \times 1}(1.5 \times 4 + 0.5 \times 3) = 2250 \text{ psi}$$

Max. Transverse shear stress, τ_{max} always occurs at NA (because Q is max at NA)

Max Transverse shear stresses (τ_{max}):

Solid rectangular cross-section	$\tau_{max} = \frac{3}{2}\frac{V}{A}$	A = area of the cross-section = b.d
Solid circular cross-section	$\tau_{max} = \frac{4}{3}\frac{V}{A}$	A = area of the cross-section = $\frac{\pi}{4}d^2$
Circular cross section with thin wall*	$\tau_{max} = 2\frac{V}{A}$	A = area of the cross-section $= \frac{\pi}{4}\left(d_o^2 - d_i^2\right)$
I cross-section	$\tau_{max} = \frac{V}{A}$	A = t.d t= thickness of the web, and d= total depth of the I-beam