ARCHITECTURAL STRUCTURES I: STATICS AND STRENGTH OF MATERIALS

ENDS 231

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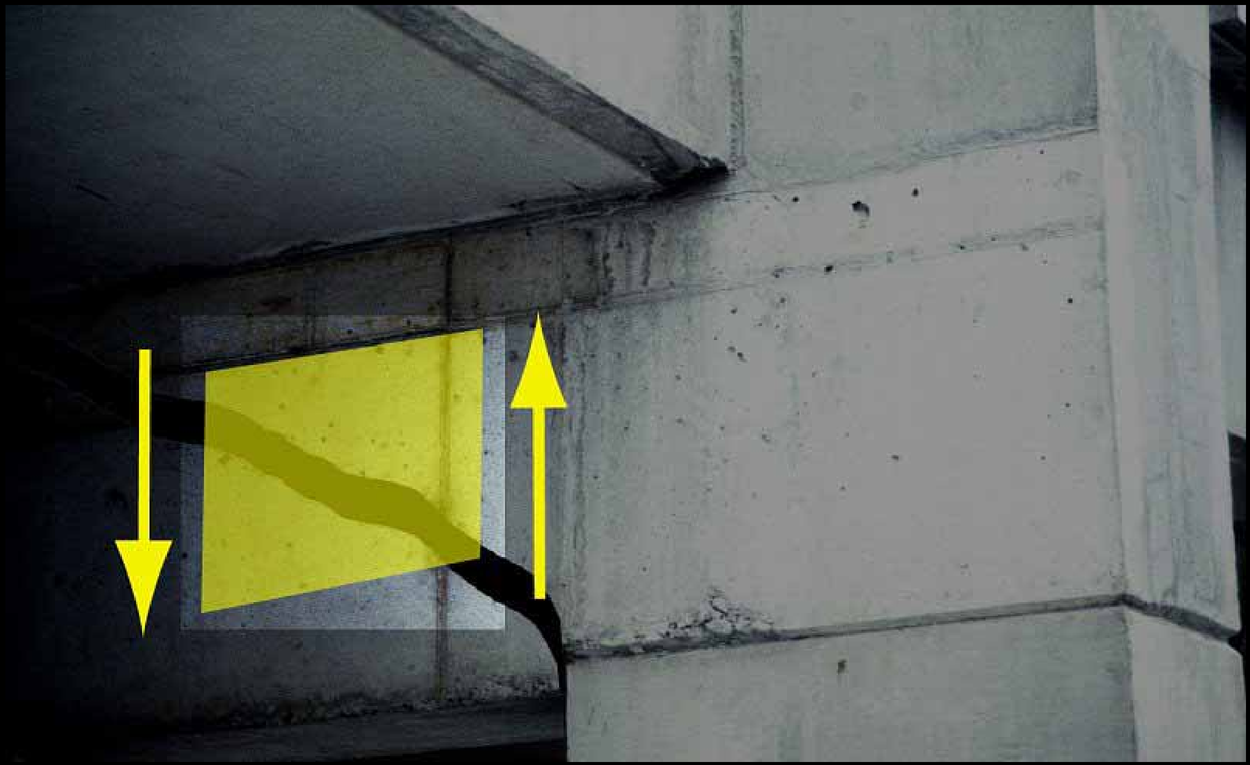
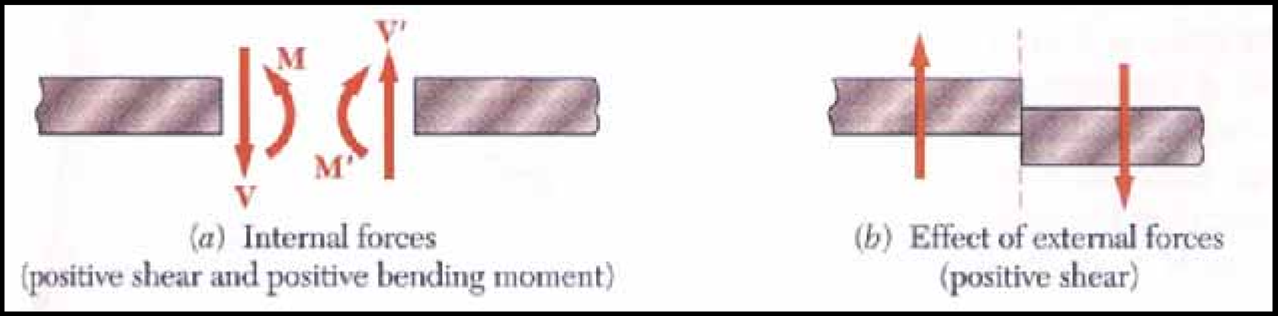
SPRING 2008

lecture
twenty



beams: shear stress

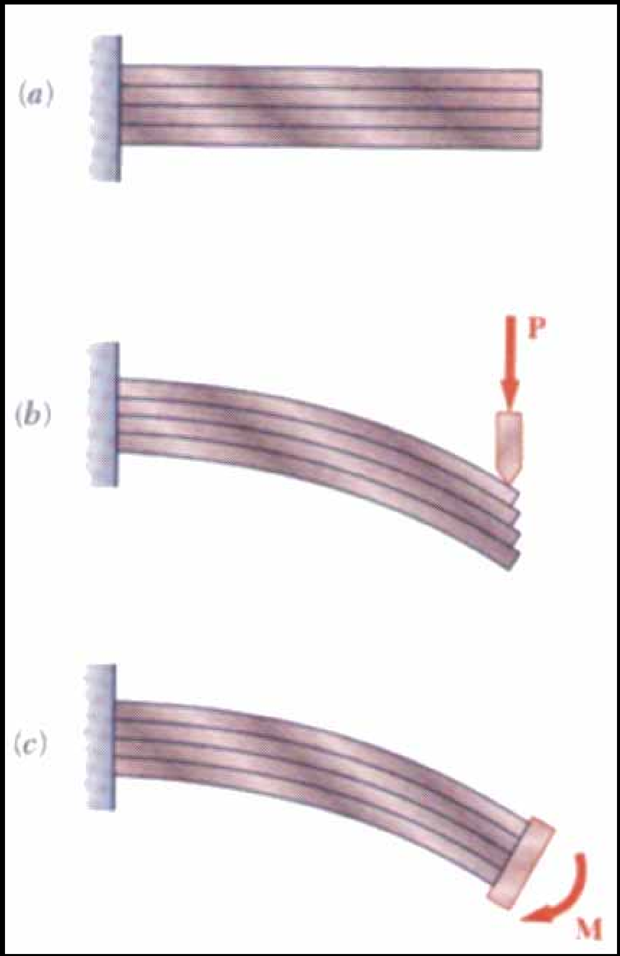
Transverse Loading and Shear



- *perpendicular loading*
- *internal shear*
- *along with bending moment*

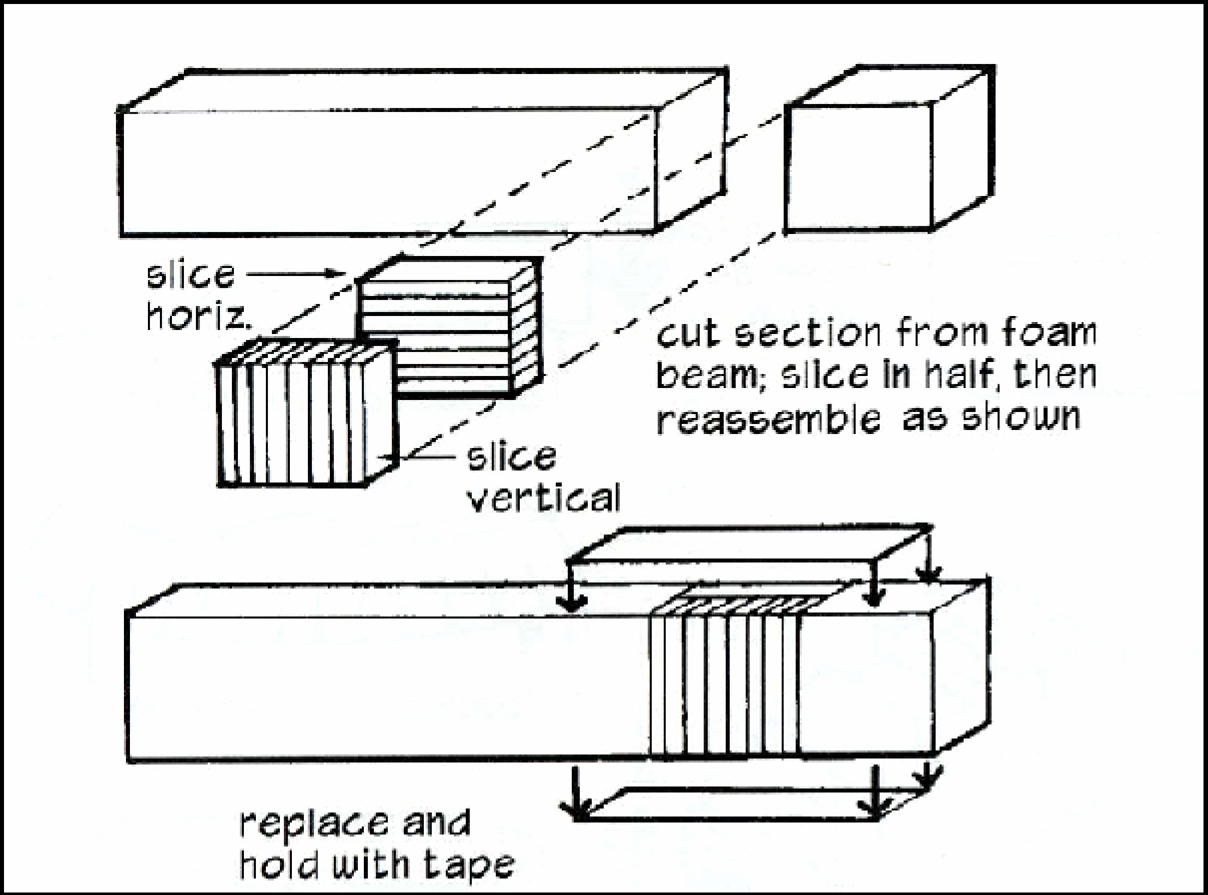
Bending vs. Shear in Design

- *bending stresses dominate*
- *shear stresses exist horizontally with shear*
- *<u>no shear stresses</u> with pure bending*



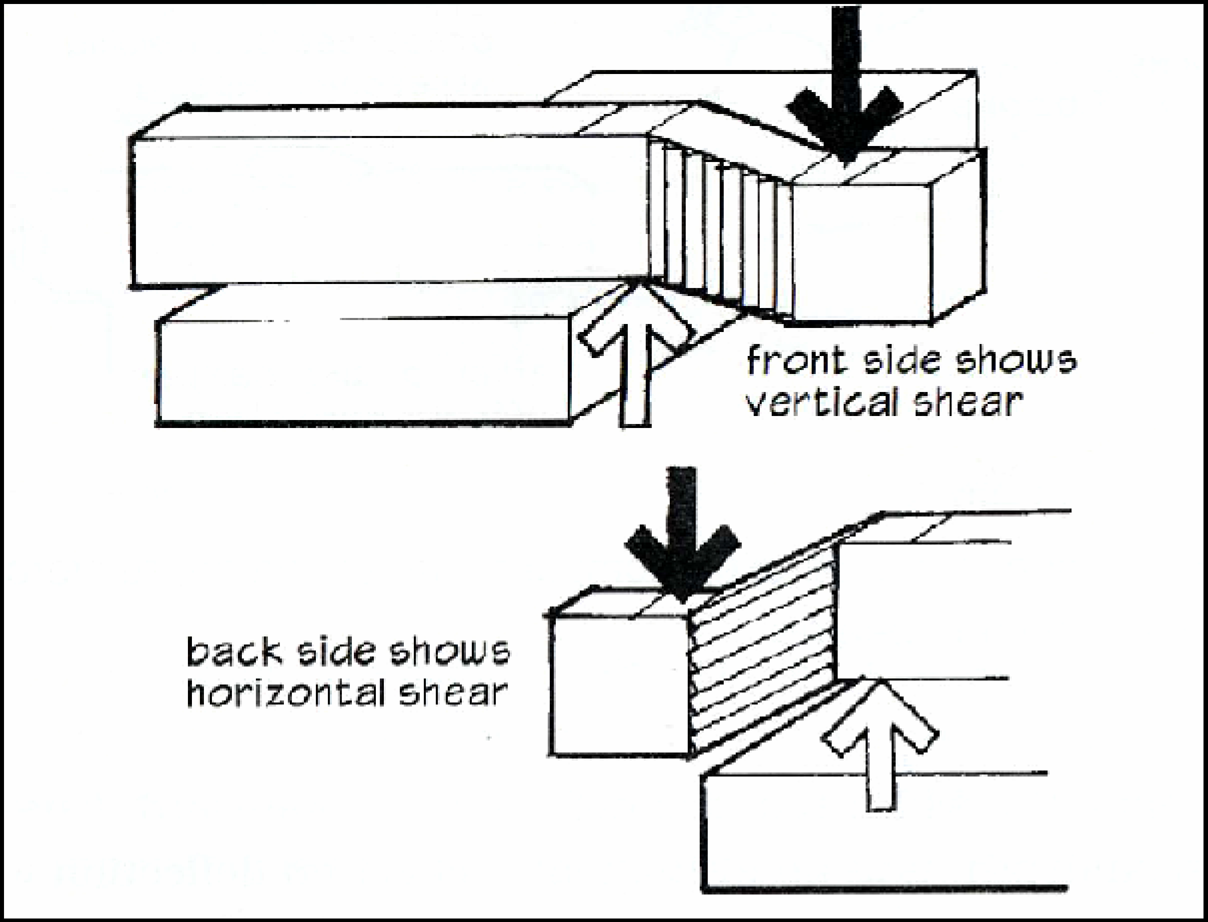
Shear Stresses

- *horizontal & vertical*



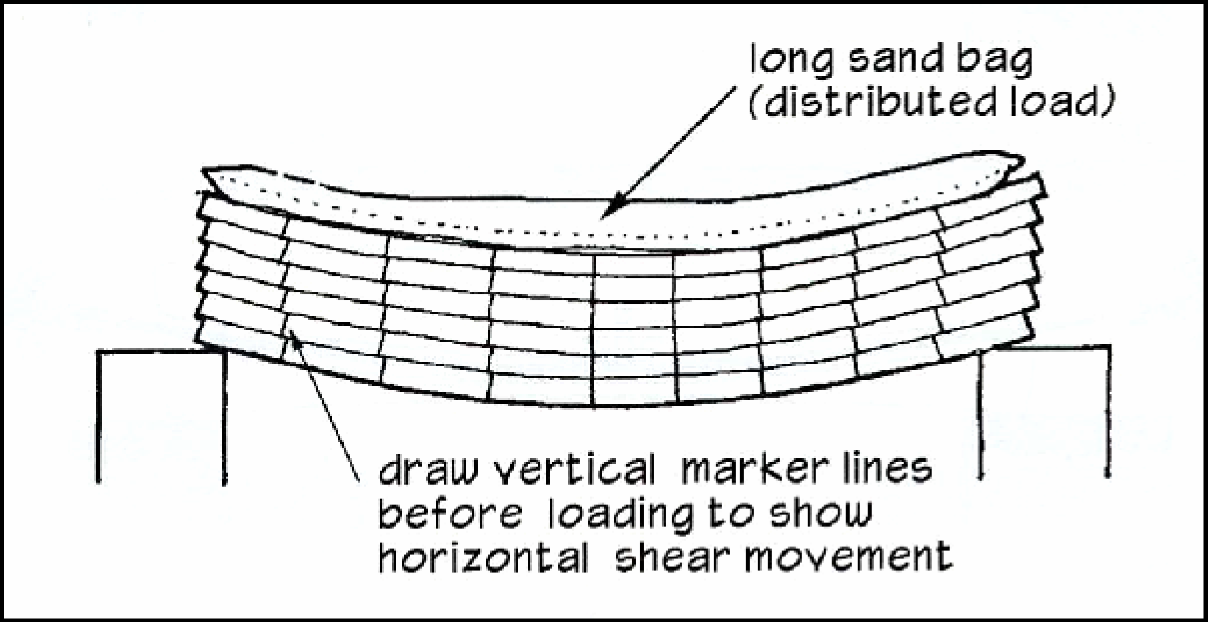
Shear Stresses

- *horizontal & vertical*



Beam Stresses

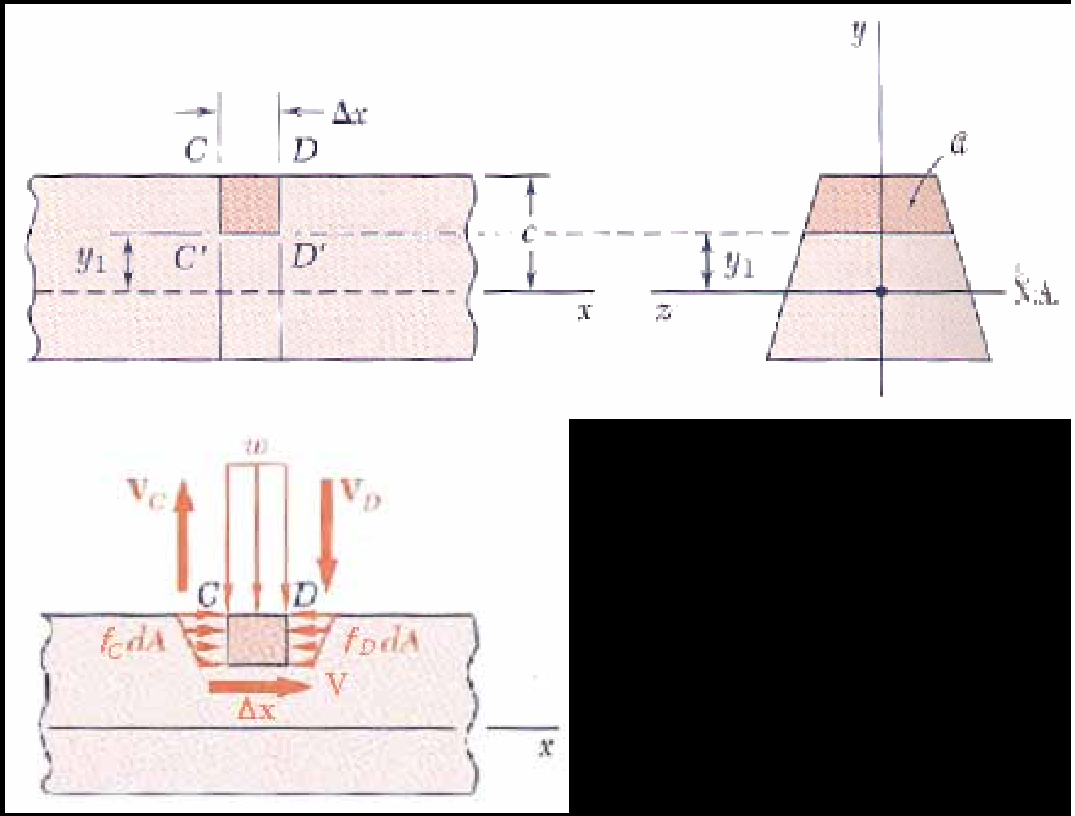
- *horizontal with bending*



Equilibrium

- horizontal force V needed

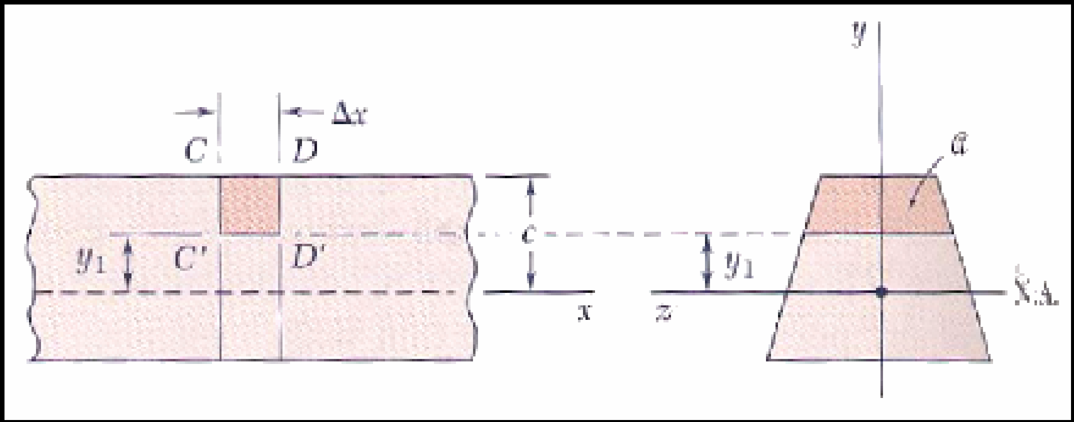
$$V_{longitudinal} = \frac{V_T Q}{I} \Delta x$$



- Q is a moment area

Moment of Area

- *Q is a moment area with respect to the n.a. of area above or below the horizontal*
- *Q_{max} at y=0 (neutral axis)*



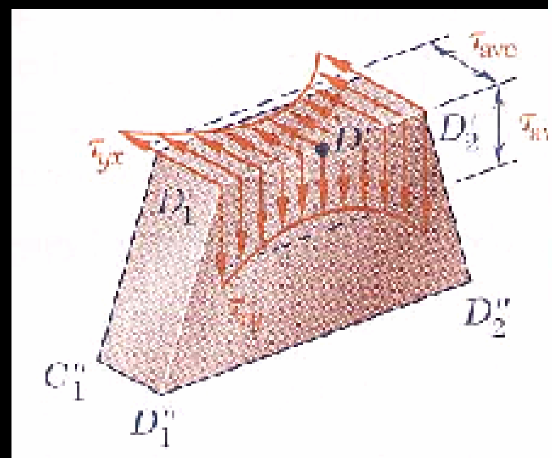
- *q is shear flow:*

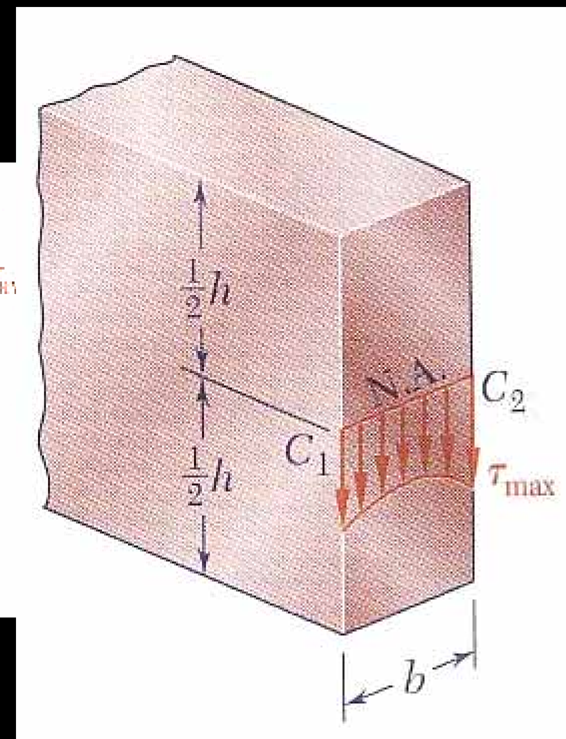
$$q = \frac{V_{longitudinal}}{\Delta x} = \frac{V_T Q}{I}$$

Shearing Stresses

$$f_v = \frac{V}{\Delta A} = \frac{V}{b \cdot \Delta x}$$

$$f_{v-ave} = \frac{VQ}{Ib}$$

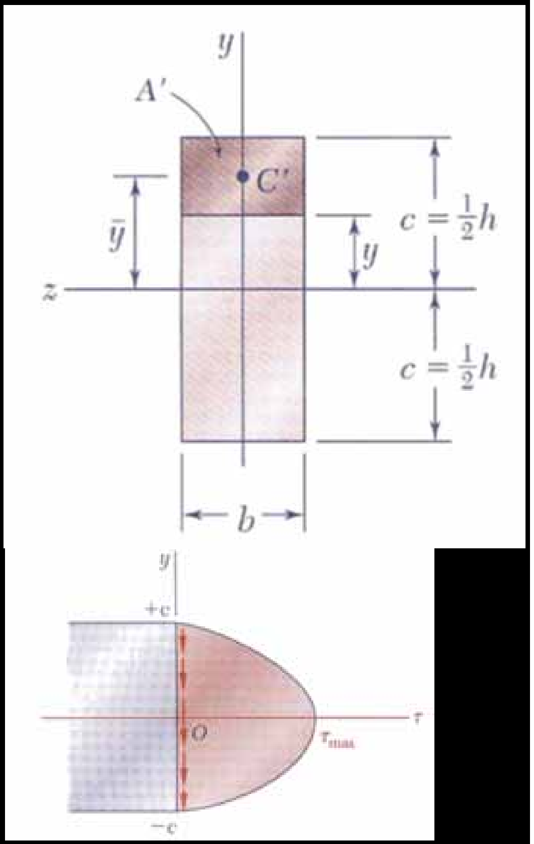




- f_{v-ave} = 0 on the top/bottom
- *b min may not be with Q max*
- *with h/4 $\geq$b, $f_{v\text{-}max} \leq 1.008\, f_{v\text{-}ave}$*

Rectangular Sections

$$I = \frac{bh^3}{12} \qquad Q = A\bar{y} = \frac{bh^2}{8}$$

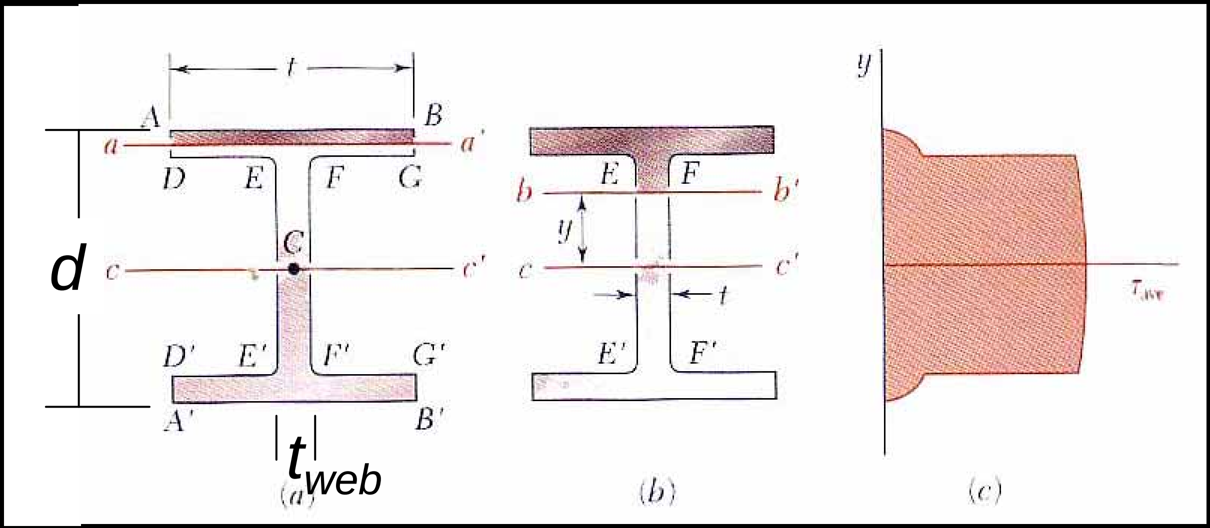


$$f_v = \frac{VQ}{Ib} = \frac{3V}{2A}$$

- $f_{v\text{-}max}$ occurs at n.a.

Steel Beam Webs

- W and S sections
  - b varies



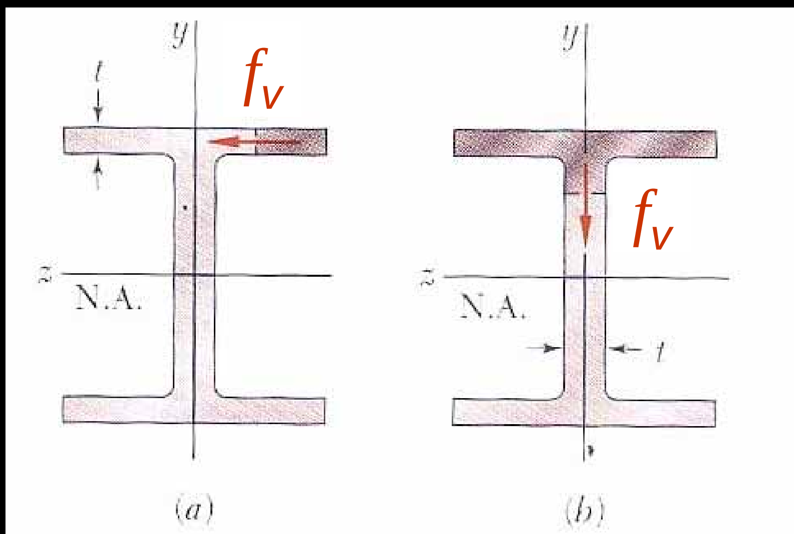
  - stress in flange negligible
  - presume constant stress in web

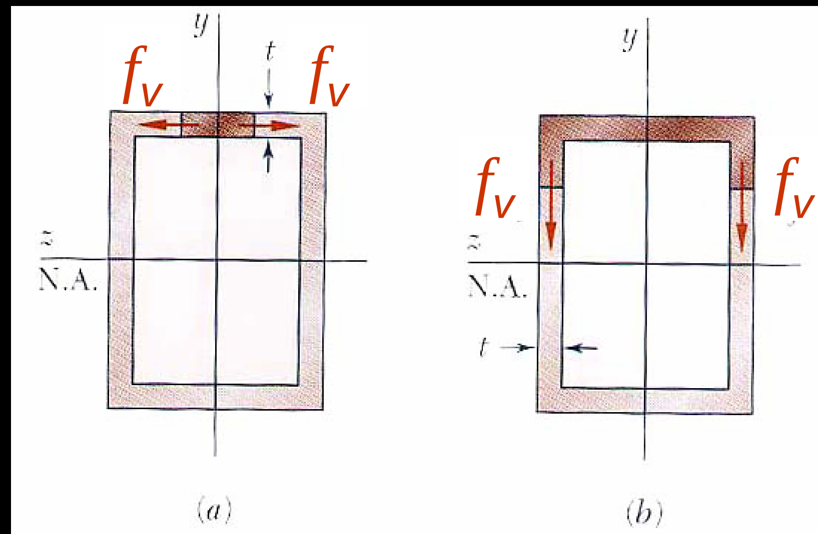
$$f_{v-\max} = \frac{3V}{2A} \approx \frac{V}{A_{web}}$$

Shear Flow

- *loads applied in plane of symmetry*
- *cut made perpendicular*

$$q = \frac{VQ}{I}$$

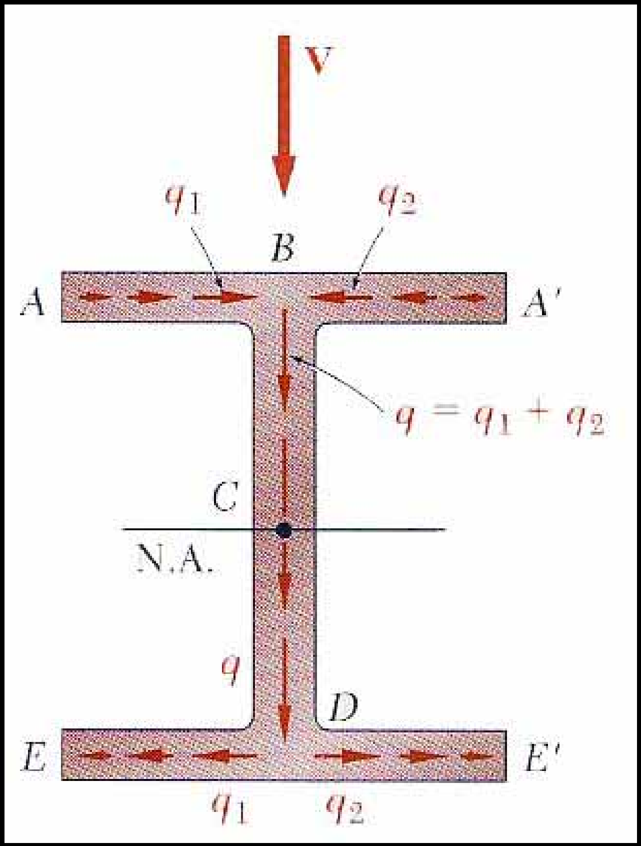




Shear Flow Quantity

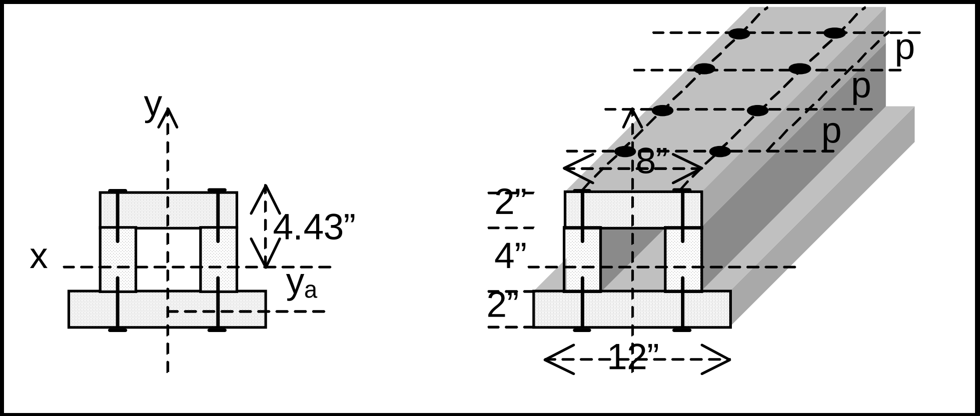
- sketch from Q

$$q = \frac{VQ}{I}$$



Connectors Resisting Shear

- plates with
  - nails
  - rivets
  - bolts
- splices



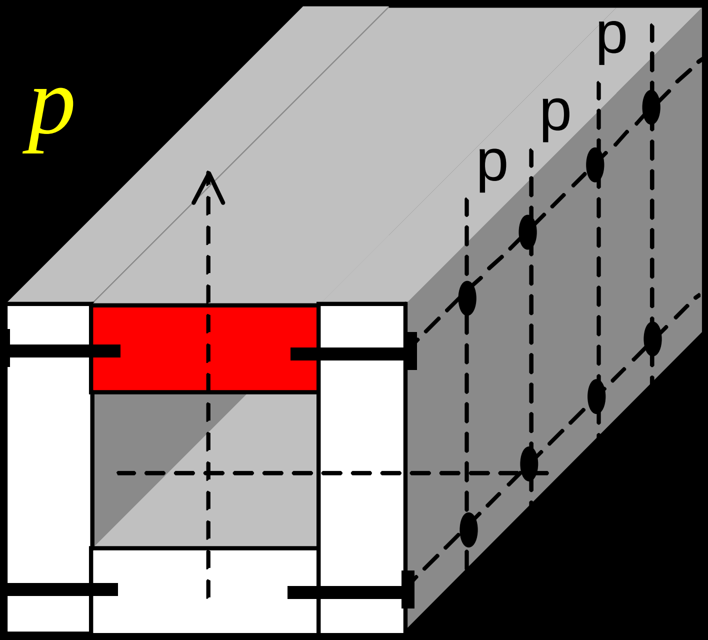
$$\frac{V_{longitudinal}}{p} = \frac{VQ}{I}$$

$$nF_{connector} \geq \frac{VQ_{connected\ area}}{I} \cdot p$$

Vertical Connectors

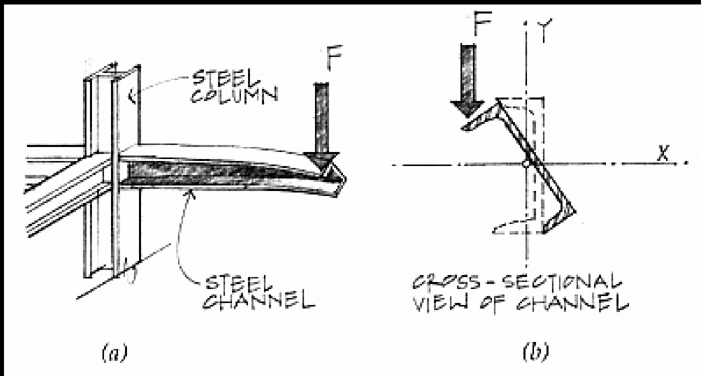
- *isolate an area with vertical interfaces*

$$nF_{connector} \geq \frac{VQ_{connected\ area}}{I} \cdot p$$



Unsymmetrical Shear or Section

- member can bend and twist
  - not symmetric
  - shear not in that plane



- shear center
  - moments balance