Shear Design for Beams

(One Way Shear)

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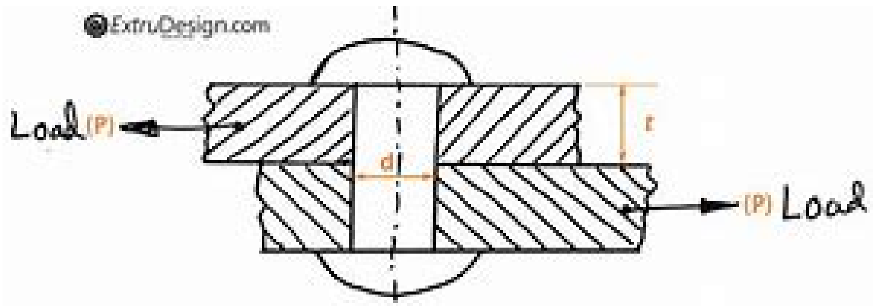
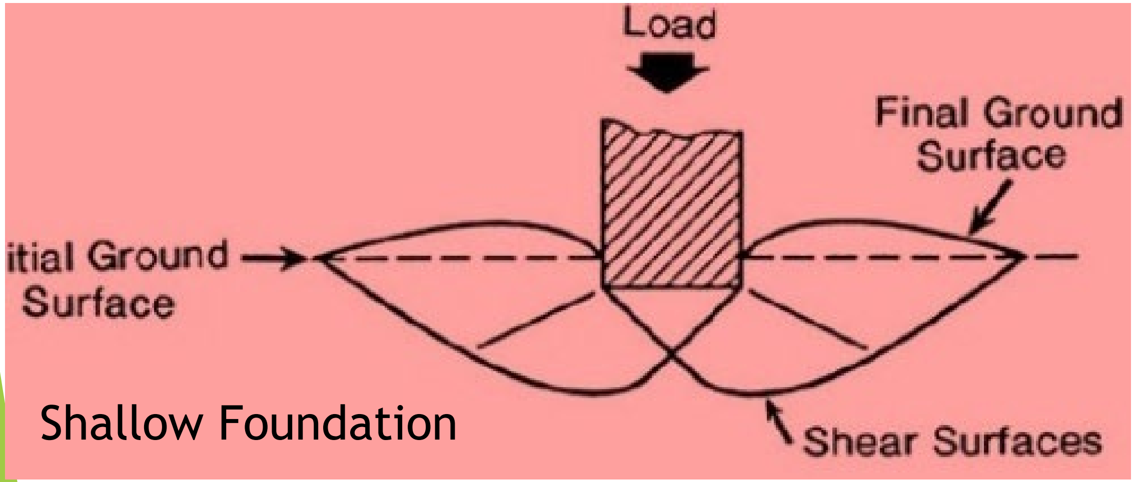
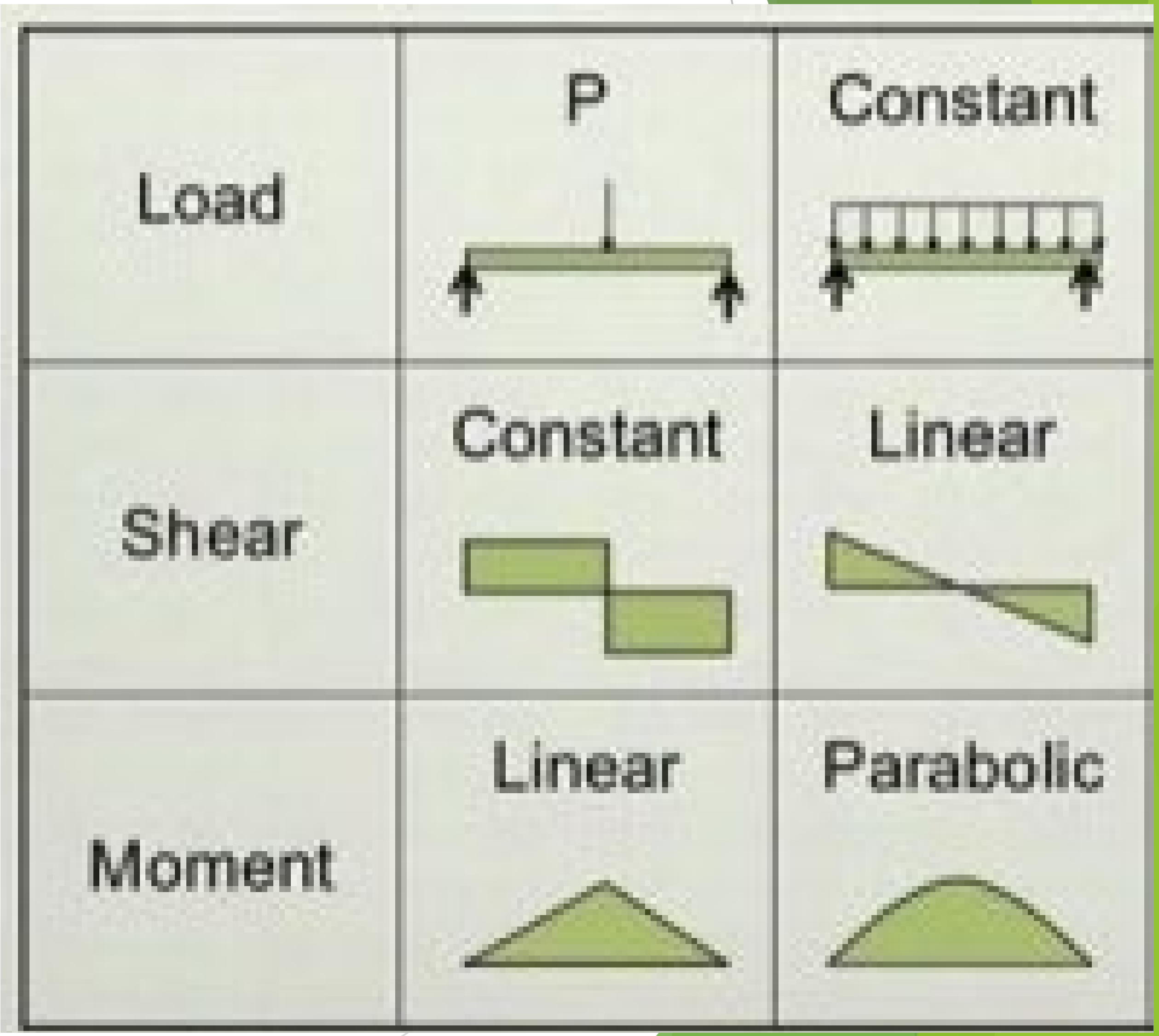
Direct Shear & Shear Force Diagram



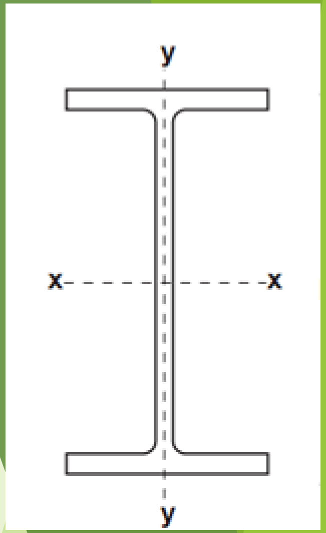
Steel Bolted Connection



Shallow Foundation

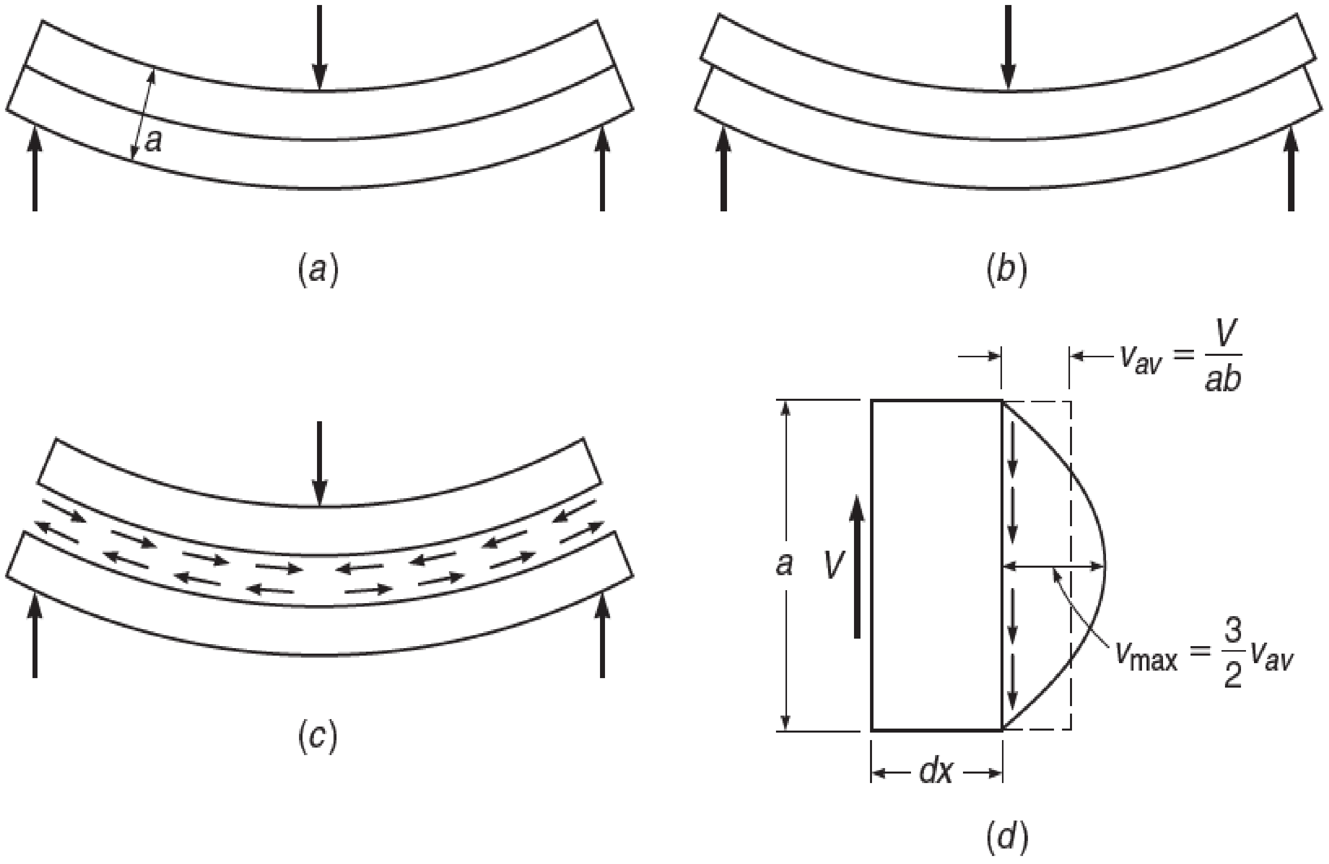


Shear Stress Formulae



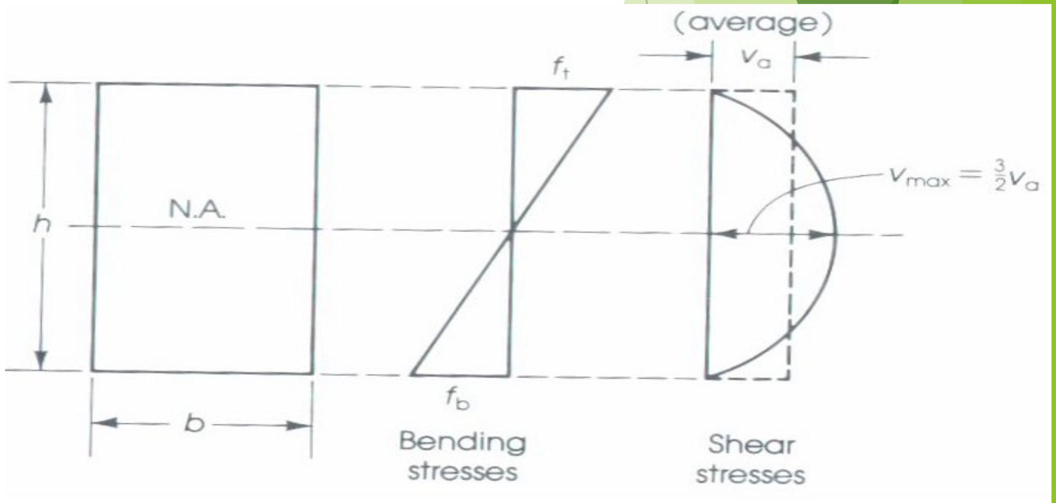
The shear theory is not completely rigorous like flexure theory, because the shear strain is not clearly defined, and there are many variables effect the RC response to shear forces.

The shear stress distribution in any section of the beam is derived from the longitudinal shear force required to satisfy the equilibrium of forces as shown in the figure below:

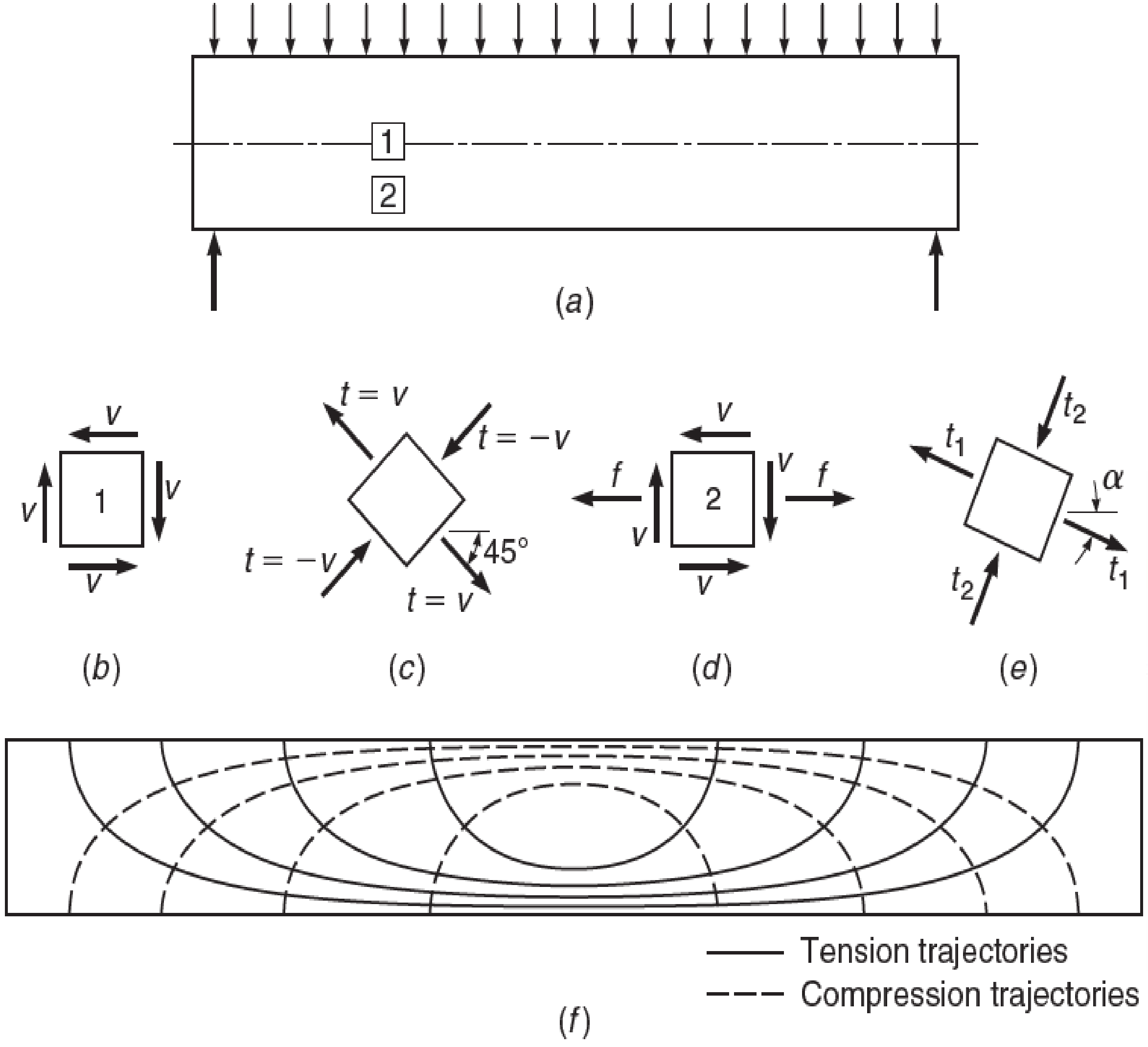


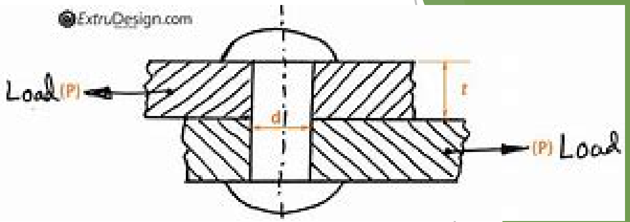
$$\sigma = \frac{M\ y}{E\ I} \qquad (Flexure\ Formulae)$$

$$\tau = \frac{V\ Q}{I\ b} \qquad (Shear\ Formulae)$$



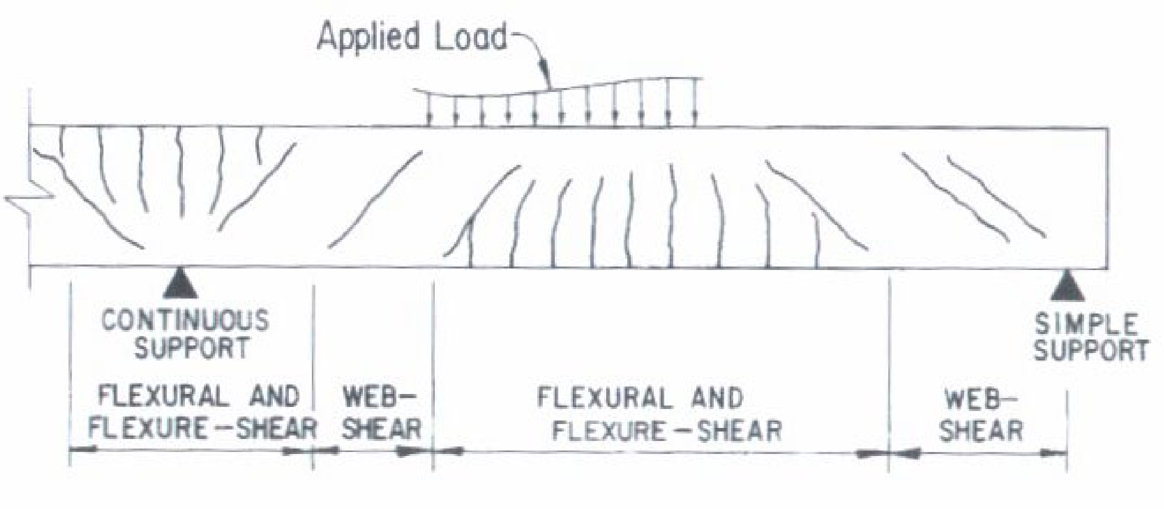
Diagonal Tension



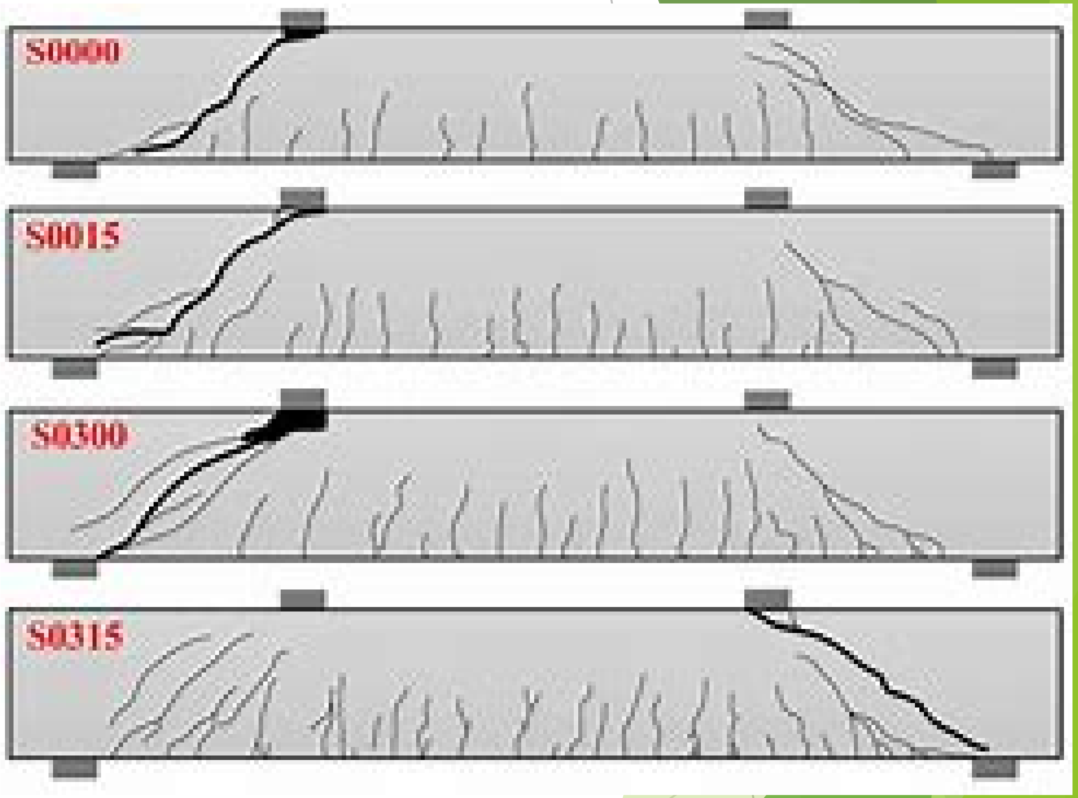


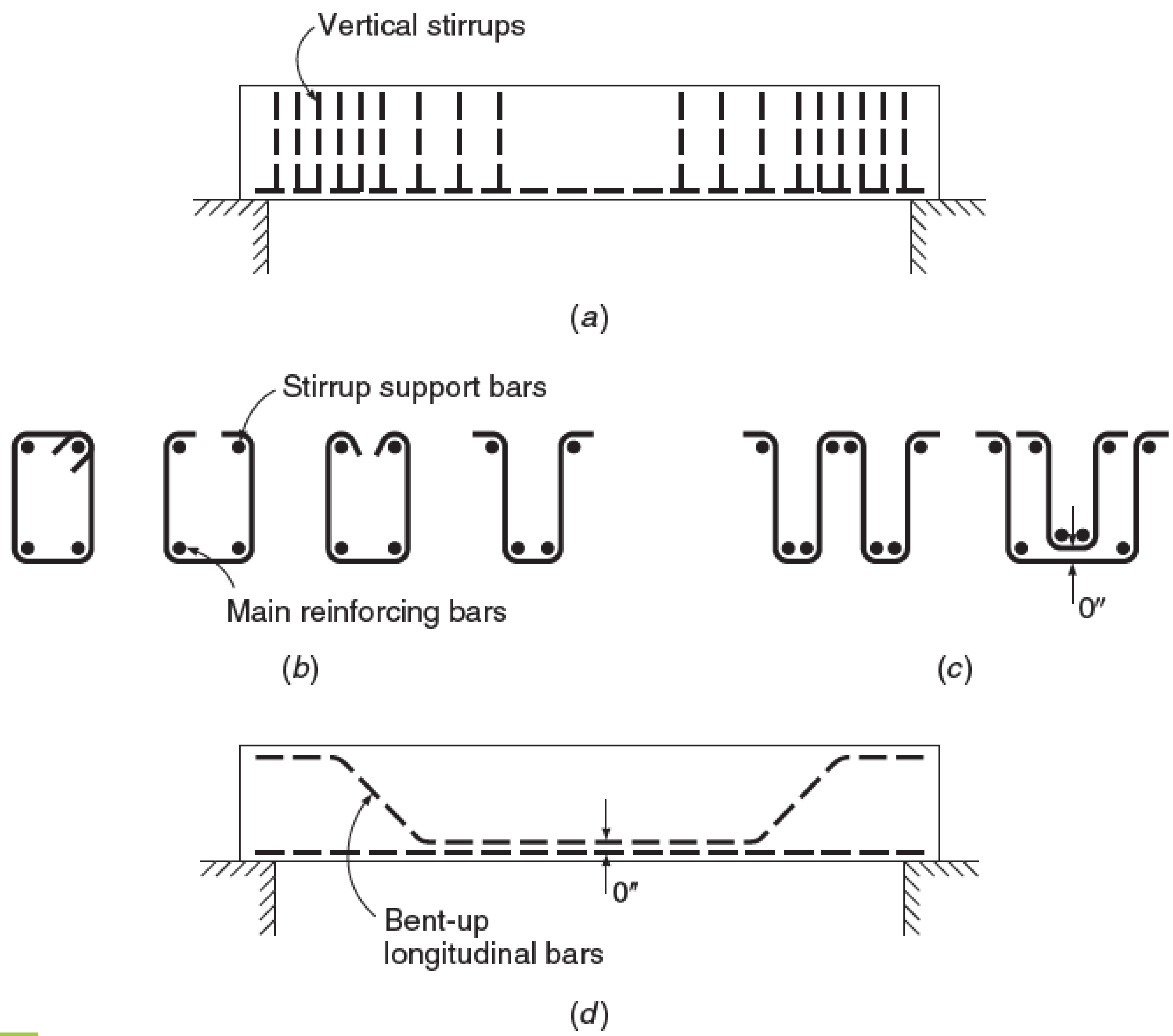
Pure shear is rarely the dominated case in the reinforced concrete members, it is mostly combined with bending moment.

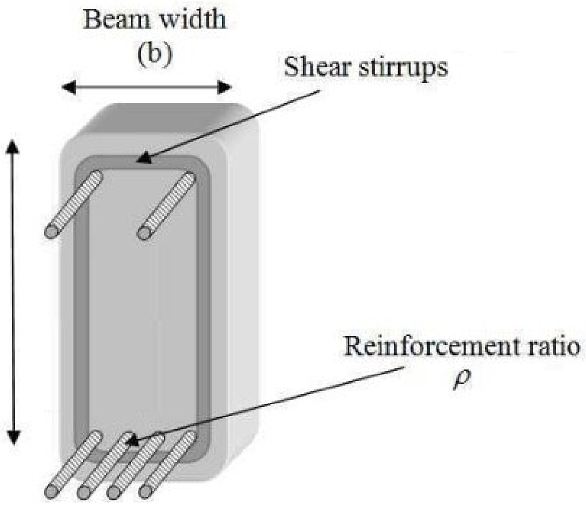
And even when the stress inside the member is pure shear, the failure would be caused by the diagonal tension stress rather than the shear stress.



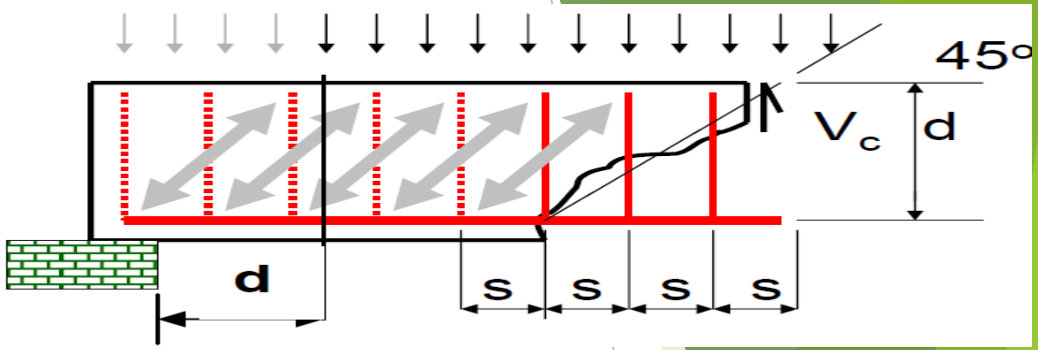
Shear (Diagonal Tension) Cracks and Failure




Vertical stirrups
(a)
Stirrup support bars
Main reinforcing bars
(b)
0″
(c)
0″
Bent-up
longitudinal bars
(d)


Beam width
(b)
Shear stirrups
Reinforcement ratio
ρ

ACI Provisions for Shear



$$V_n \geq \frac{V_u}{\phi}$$

$$V_u = 1.2V_D + 1.6V_L \quad \text{and } \phi = 0.75$$

$$V_n = V_c + V_s$$

$$V_c = 0.17\sqrt{f_c'}\, b_w\, d$$

$$V_s = n\, A_v\, f_{yt}$$

$$n \times s = d$$

n ⟷ s

n: number of stirrups intersect a crack of 45° (no. of stirrups of a distance d)

Av: area of all vertical legs of one stirrup (depends on the stirrup shape)

fyt: yield strength of stirrups steel should be ≤ 420 MPa

$$V_s = A_v\, f_{yt}\, \frac{d}{s}$$

$$s = \frac{A_v\, f_{yt}\, d}{V_s}$$

Thank you…