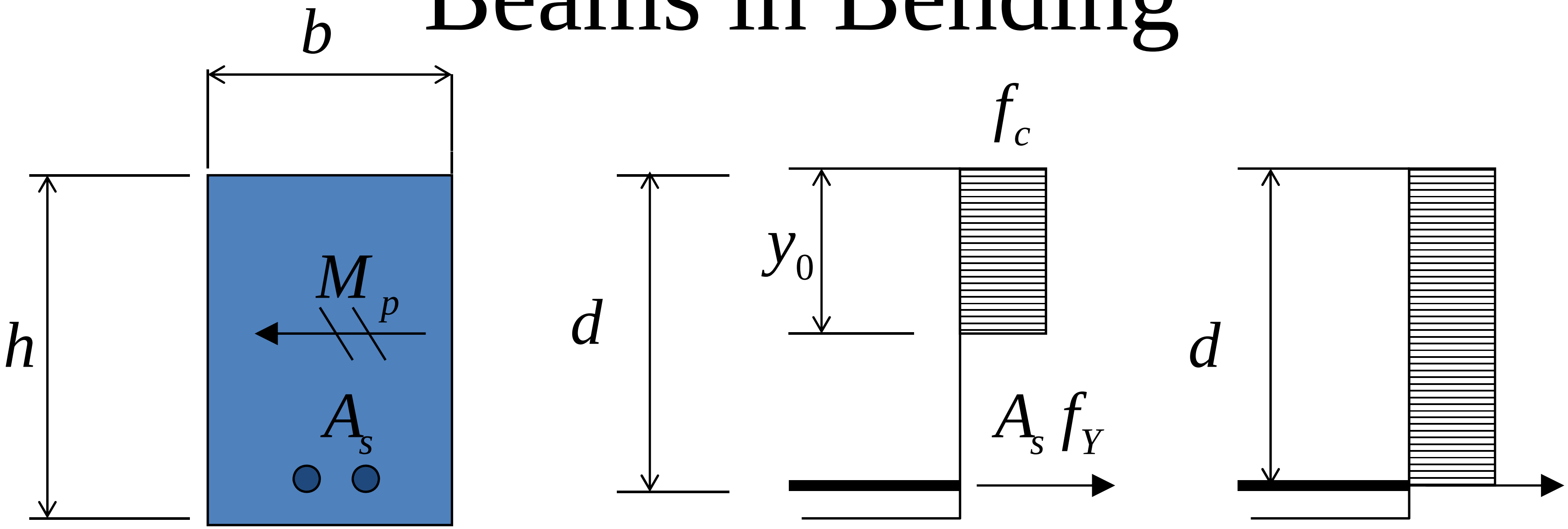
Chap. 5 Beams

- Beams in Bending
- Beams in Shear

- Transverse reinforcement
- Without transverse reinforcement
- Effective Concrete Compressive Strength
- Arch Actions
- Design
- With Normal Forces

- Beams in Torsion

Beams in Bending



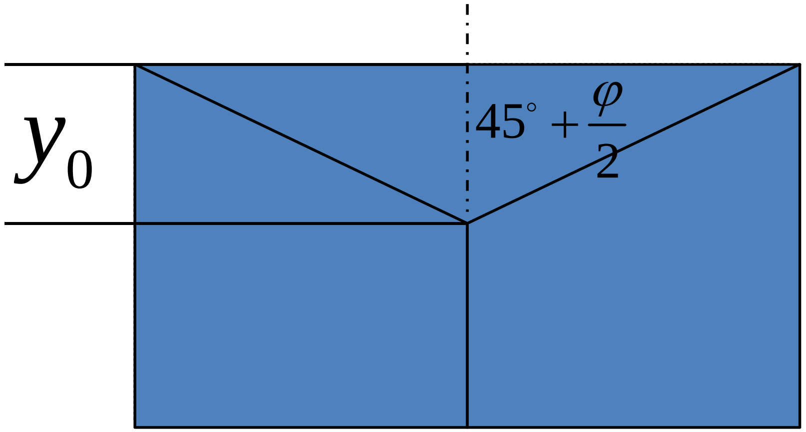
$$A_s f_Y = y_0 b f_c$$

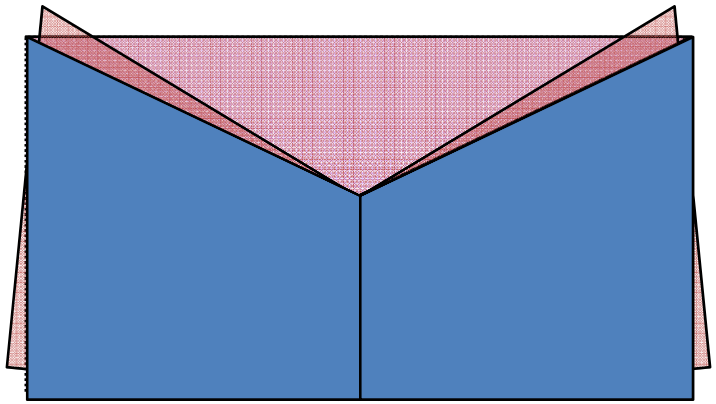
$$\frac{y_0}{d} = \Phi$$

$$M_p = \left(1 - \frac{1}{2}\Phi\right)\Phi b d^2 f_c$$

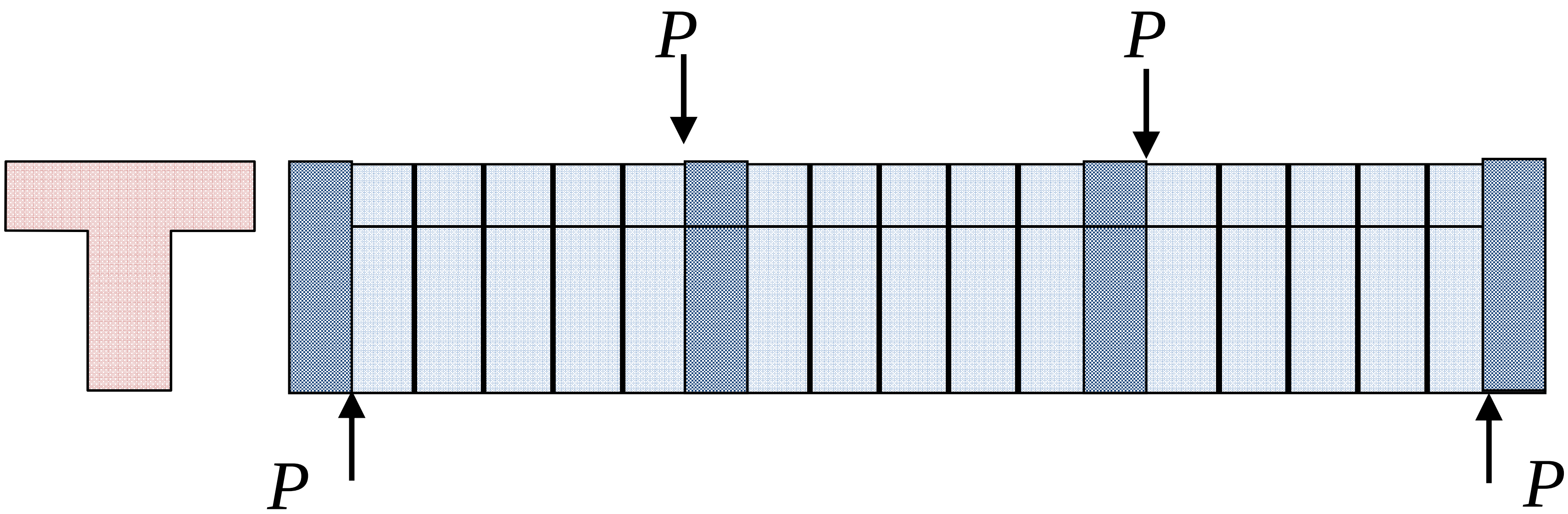
$$M_p = b d^2 f_c$$

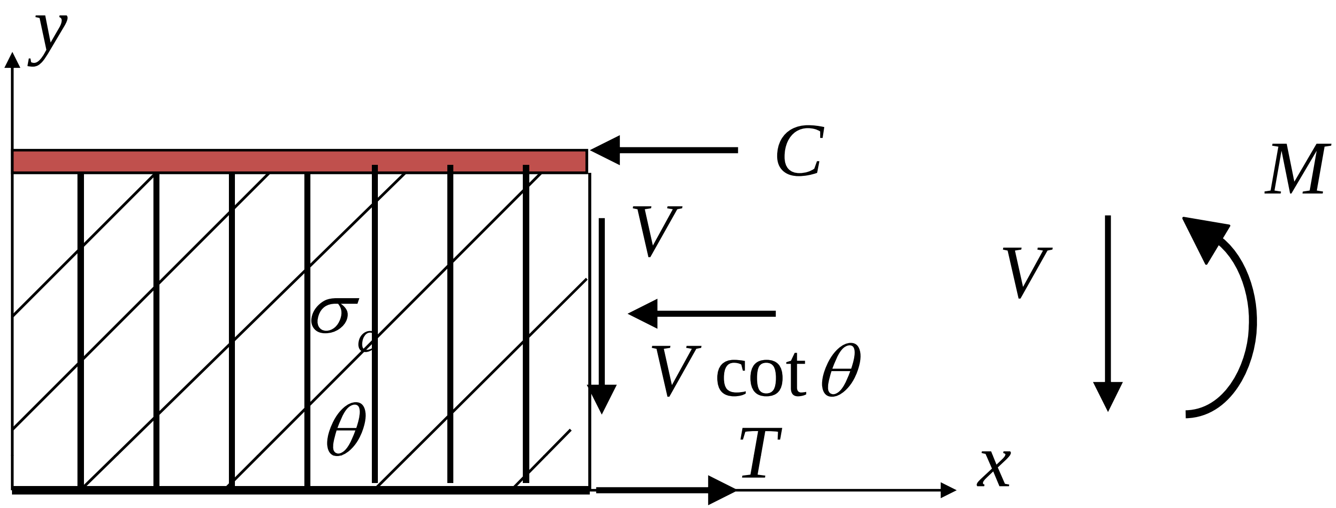
Failure Mechanism in Bending



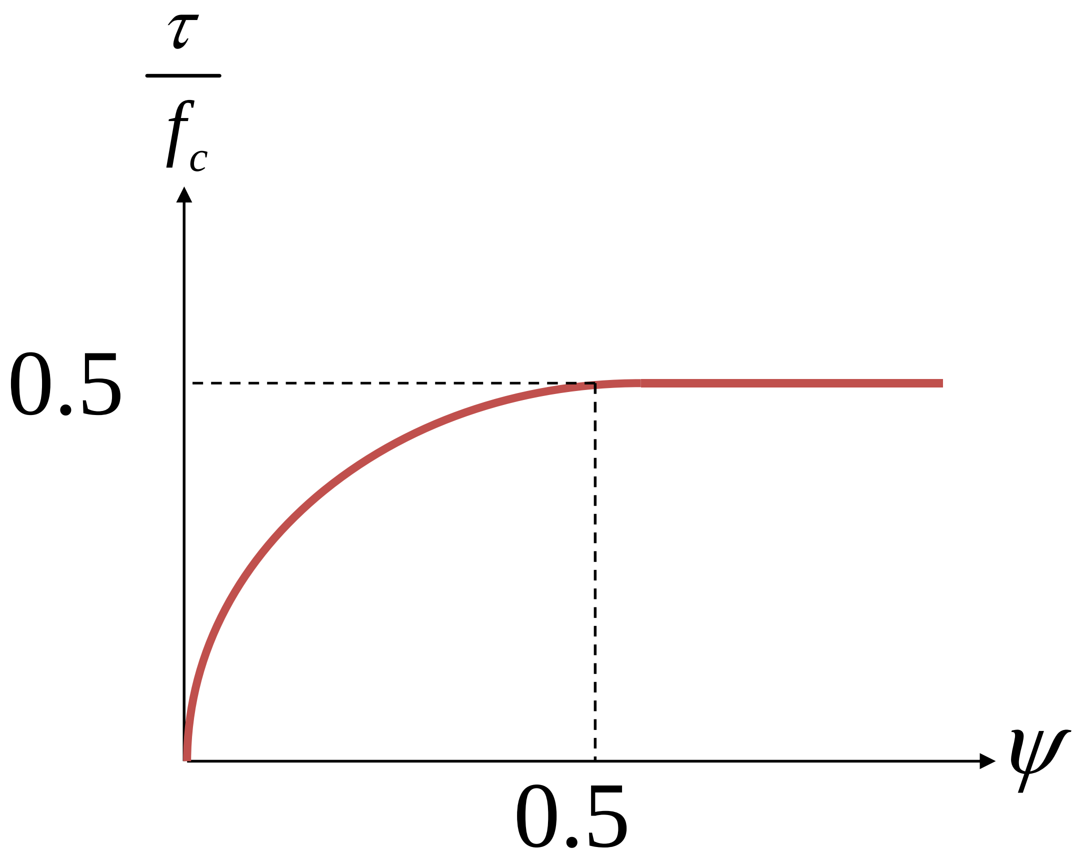


Beams in Shear



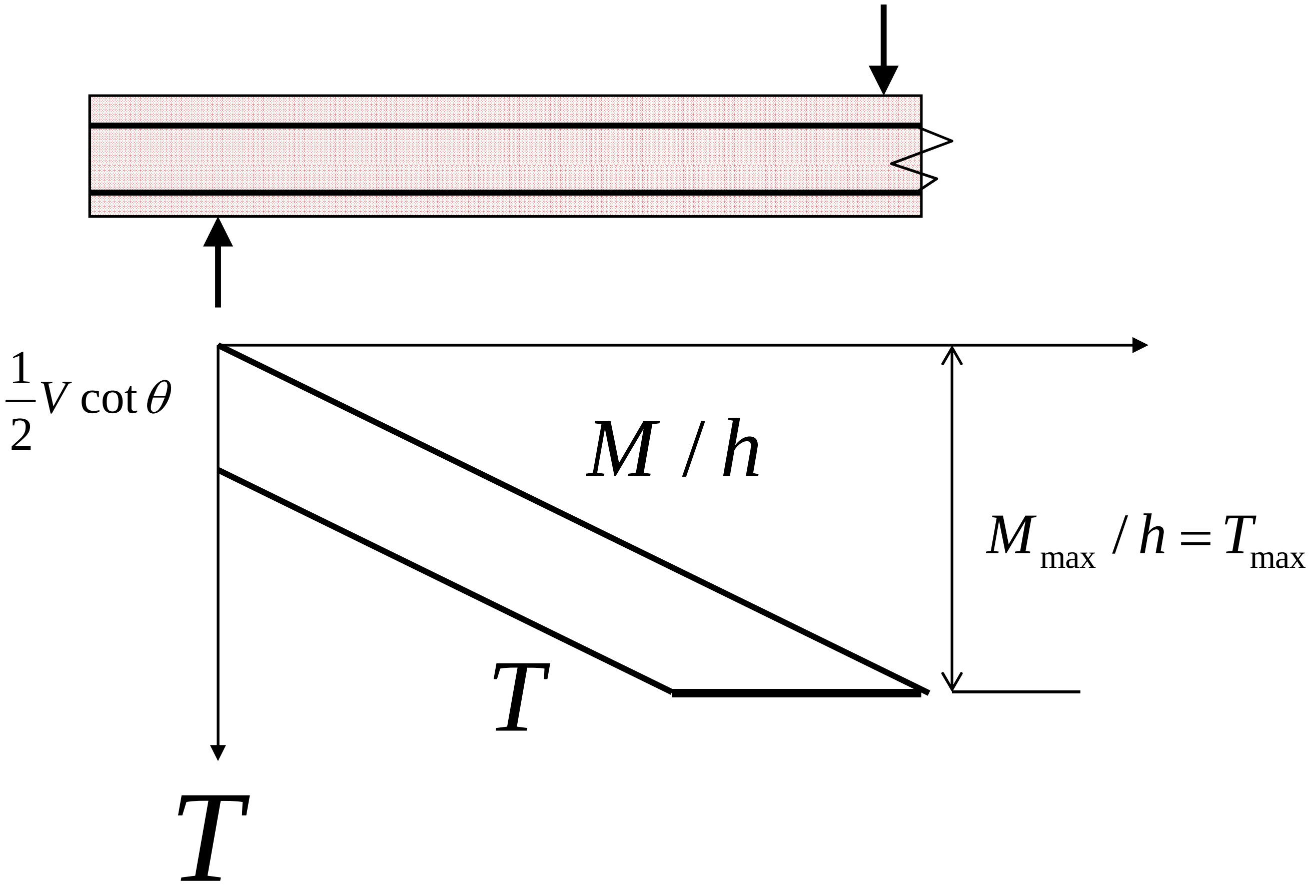


Lower Bound Solution

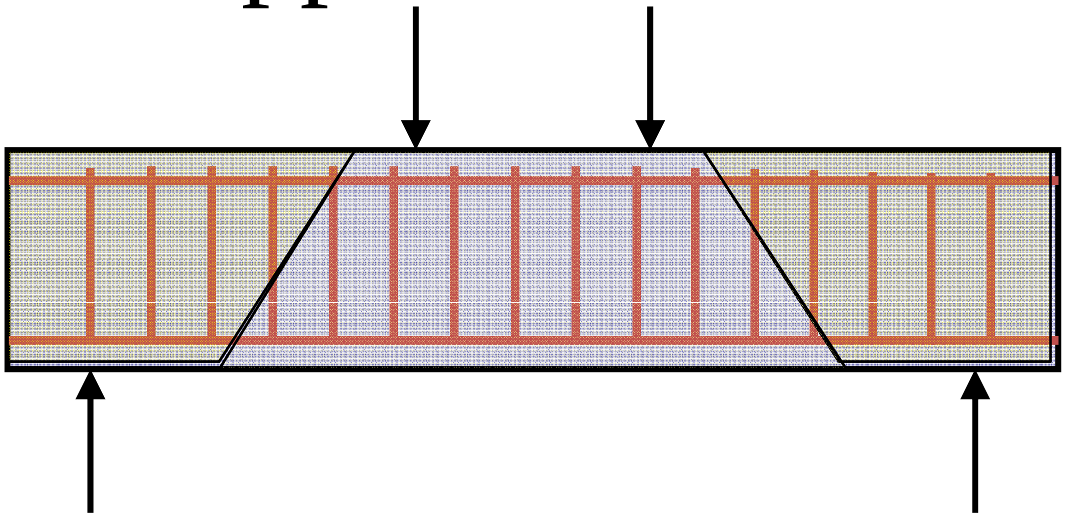


$$\frac{\tau}{f_c} = \begin{cases} \sqrt{\psi(1-\psi)} \\ \dfrac{1}{2} \end{cases}$$

Shift in Tension Force in Stringer



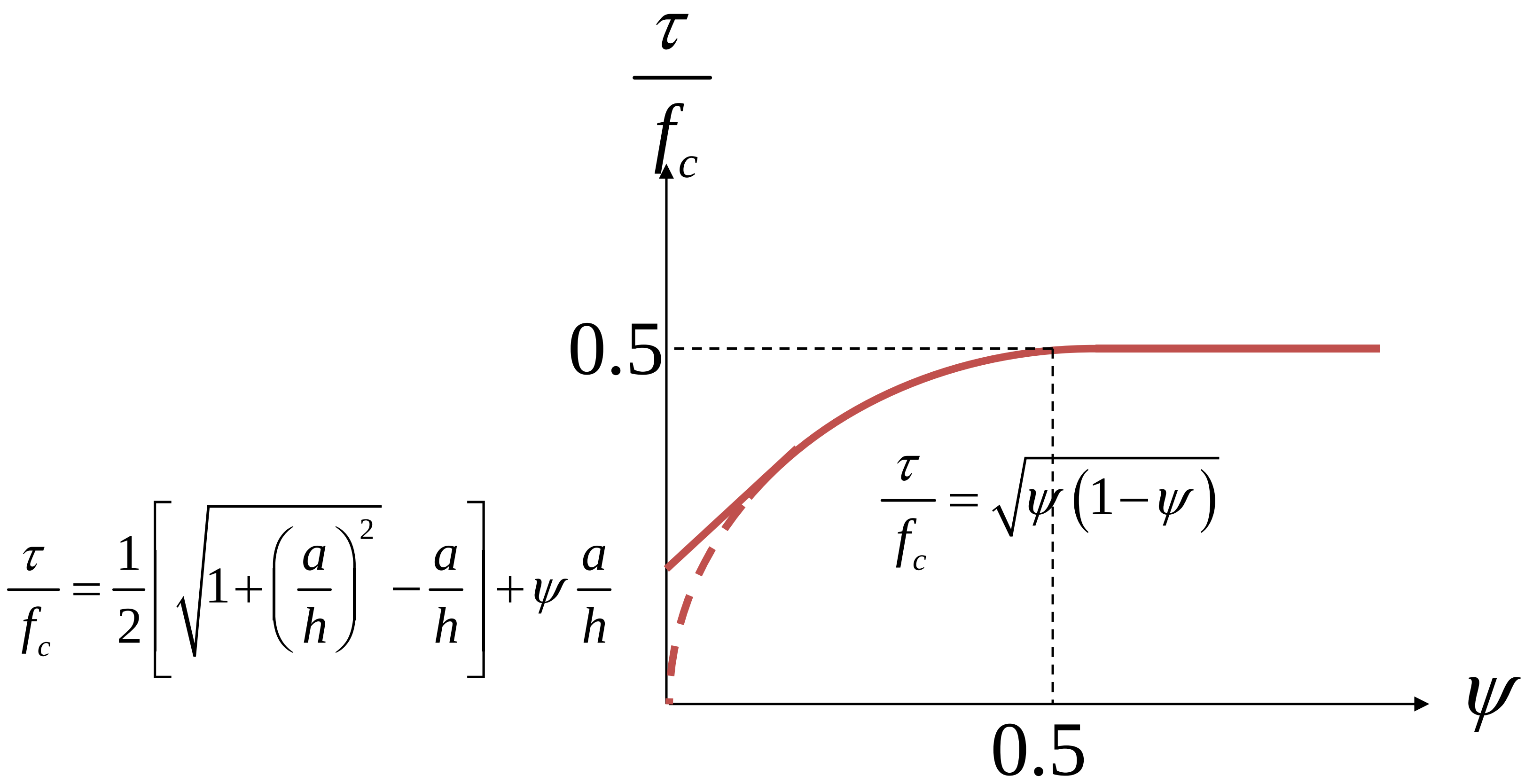
Upper Bound Solution



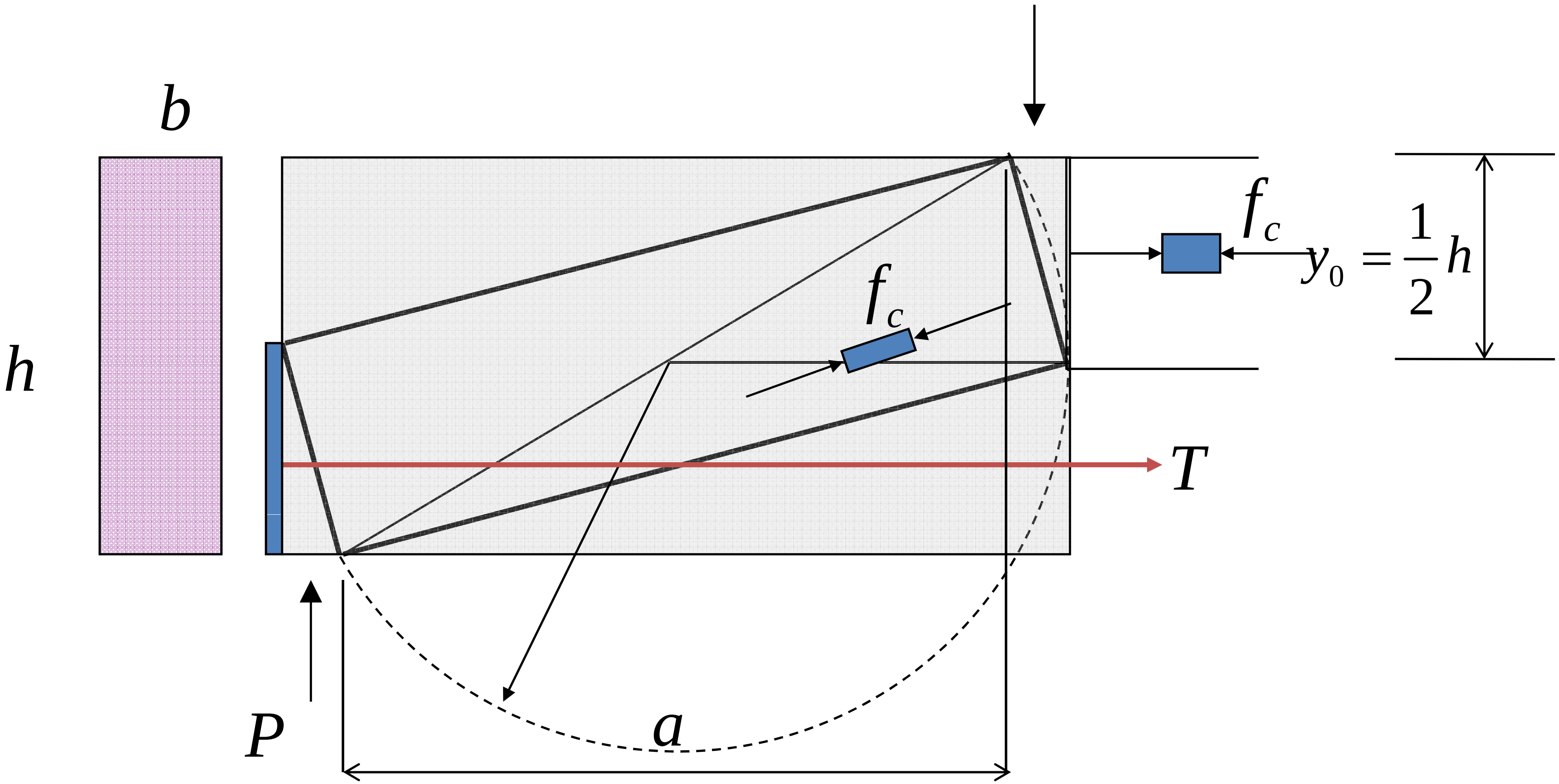
$$\beta = 2\theta \qquad \tan\theta = \sqrt{\frac{\psi}{1-\psi}}$$

$$\frac{\tau}{f_c} = \frac{1}{2}\left[\sqrt{1+\left(\frac{a}{h}\right)^2} - \frac{a}{h}\right] + \psi\frac{a}{h}$$

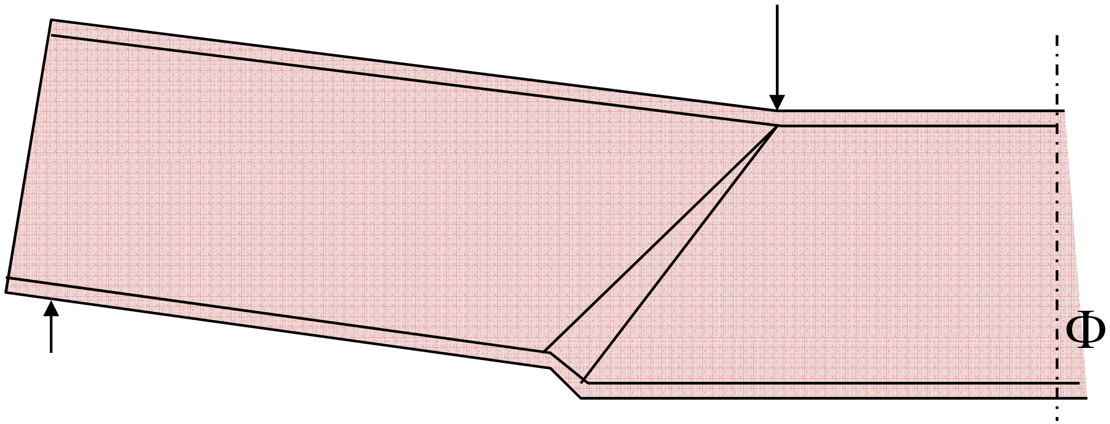
Upper Bound Solutions



Shear Capacity without Shear Reinforcement



Influence of Longitudinal Reinforcement on Shear Capacity



$$\Phi = \frac{A_{sl}\, f_{Yl}}{bhf_c}$$

$$T_Y = \frac{Pa}{h} + \frac{1}{2} P \cot\theta$$

$$\tau = \frac{P}{bh} = r f_{Yw} \cot\theta$$

$$\frac{\tau}{f_c} = \psi \left[\sqrt{\frac{2\Phi}{\psi} + \left(\frac{a}{h}\right)^2} - \frac{a}{h} \right]$$