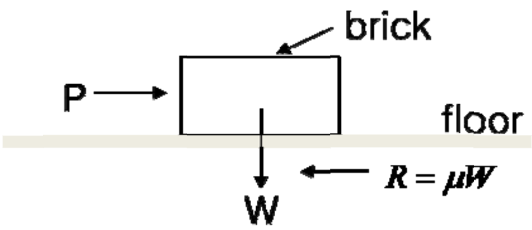
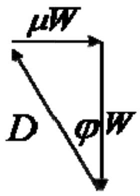
8. Shear in joints

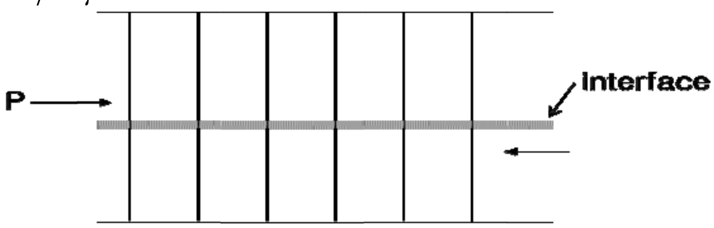
→shear friction theory

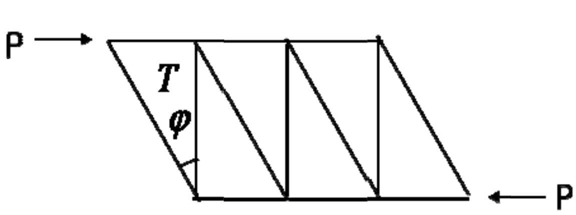


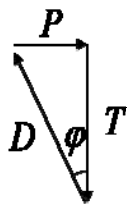
$P \geq R$ → Sliding



$\tan\varphi = \mu$







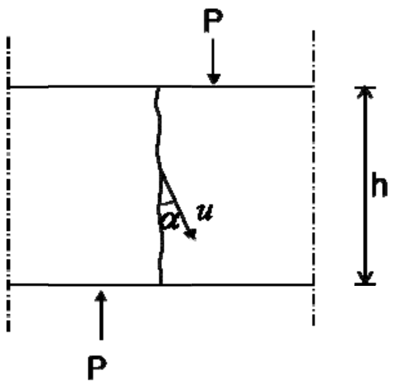
$$T\tan\varphi \geq P \leftrightarrow \mu T \geq P \leftrightarrow \mu A_s f_y \geq P \leftrightarrow A_s \geq \frac{P}{\mu f_y}$$

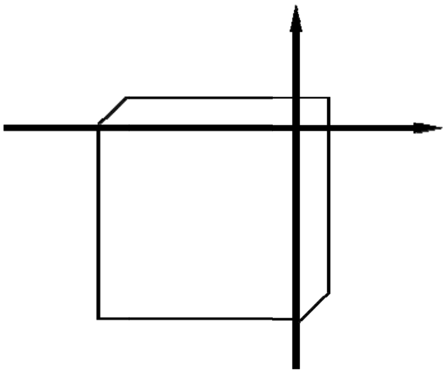
$$D = \frac{T}{\cos\varphi} = \frac{P\cot\varphi}{\cos\varphi}$$

$$\therefore \sigma_c = \frac{P}{\sin\varphi \cdot bt} \leq f$$

8.2 Upper bound solutions

8.2.1 Monolithic concrete





i) $\alpha = 0$

ii) $0 < \alpha < \varphi$

iii) $\alpha = \varphi$

iv) $\varphi < \alpha$

$$\begin{cases} W_E = Pu\cos\alpha \\ D_R = A_s f_y u \sin\alpha \\ D_C = W_l h \end{cases}$$

i) $\alpha = 0$

$$Pu = \frac{1}{2} f_c (1-\sin\alpha) uht$$

$$\tau htu = \frac{1}{2} f_c uht$$

$$\frac{\tau}{f_c} = \frac{1}{2} \quad ①$$

ii) $0 < \alpha < \varphi$

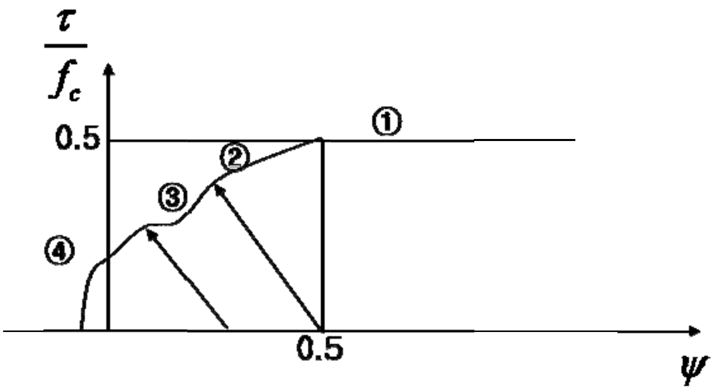
$$\frac{\tau}{f_c} = \sqrt{\psi(1-\psi)} \quad \text{where} \quad \psi = \frac{A_s f_y}{htf_c} \quad ②$$

iii) $\alpha = \varphi$

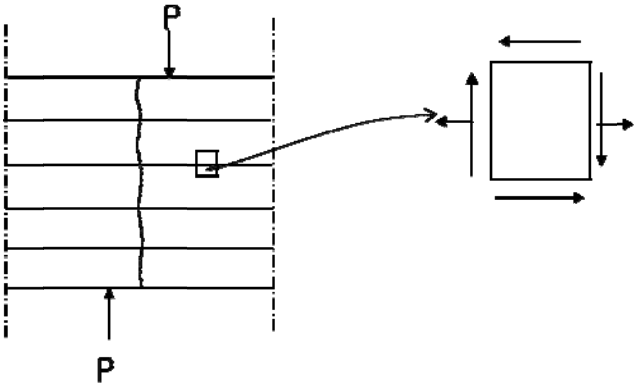
$$\frac{\tau}{f_c} = \frac{1-\sin\varphi}{2\cos\varphi} + \psi\tan\alpha$$

iv) $\varphi < \alpha$

$$\frac{\tau}{f_c} = \sqrt{\left(\psi + \frac{f_t}{f_c}\right)\left[1 - 2\frac{f_t}{f_c}\frac{\sin\varphi}{1-\sin\varphi} - \left(\psi + \frac{f_t}{f_c}\right)\right]}$$

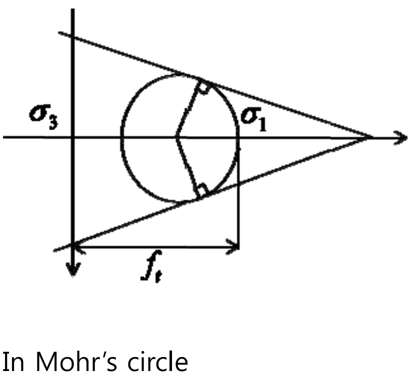


8.3 Lower bound solution



$$\tau = \frac{P}{ht}$$

$$\sigma_x = \frac{T}{ht} = \frac{A_s f_y}{ht}$$



$$k\sigma_1 - \sigma_3 = 2c\sqrt{k}$$

$$\sigma_3 = k\sigma_1 + 2c\sqrt{k}$$

$$\sigma_3 = \frac{1+\sin\varphi}{1-\sin\varphi} f_t - f_c$$

In Mohr's circle

$$\sigma_m = \frac{\sigma_1 + \sigma_3}{2}$$

Radius of $M, C = \frac{\sigma_1 - \sigma_3}{2}$

$$\sigma_m = \frac{f_t}{2} + \frac{f_t}{2}\frac{1+\sin\varphi}{1-\sin\varphi} - \frac{f_c}{2} = \frac{f_t}{1-\sin\varphi} - \frac{f_c}{2}$$

$$R = \frac{f_c}{2} - f_t\frac{\sin\varphi}{1-\sin\varphi}$$

$$\left(\sigma - \sigma_m\right)^2 + \tau^2 = R^2$$

Let $\sigma = \psi f_c$

$$\left(\psi f_c + \frac{f_c}{2} - \frac{f_t}{1-\sin\varphi}\right)^2 + \tau^2 = \left(\frac{f_c}{2} - f_t\frac{\sin\varphi}{1-\sin\varphi}\right)^2$$

$$\left(\frac{\tau}{f_c}\right)^2 = \left(\frac{1}{2} - \frac{f_t}{f_c}\frac{\sin\varphi}{1-\sin\varphi}\right)^2 - \left(\psi + \frac{1}{2} - \frac{f_t}{f_c}\frac{1}{1-\sin\varphi}\right)^2$$