2007-20601

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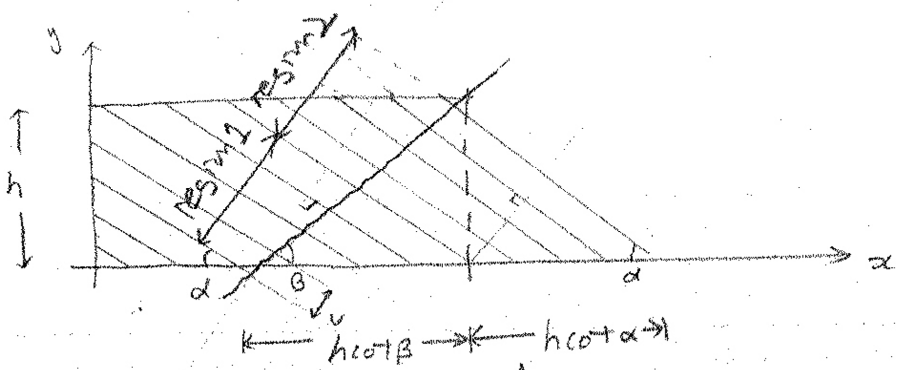
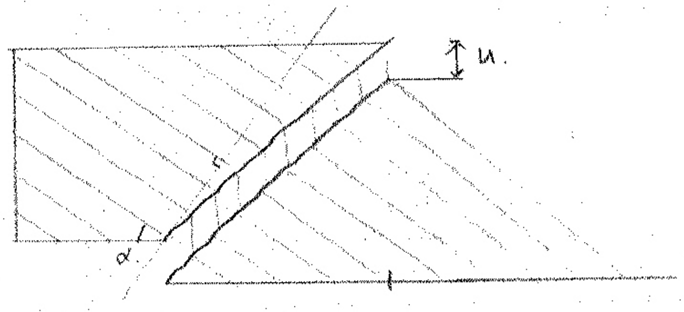
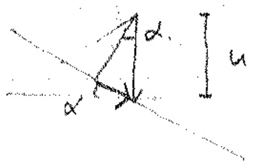
Maximum Shear Capacity, Inclined Reinforcement Using Upper Bound Solution.



reinforcement ratio $r = \dfrac{A_s}{cb}$



- Strain direction due to displacement u



$u \cdot \sin\alpha$

- Plane stress, modified coulomb material

$$W_e = \frac{1}{2} f_c u b \cdot (1 - \sin\alpha)$$

$$P_u = \frac{1}{2} f_c \cdot b(1-\cos\beta)\frac{h}{\sin\beta} u$$

$$+ r f_y b \cdot h\cot\beta \cdot \sin\alpha \cdot u \cdot \sin\alpha \qquad \text{(region 1)}$$

$$+ r f_y \cdot b \cdot h\cot\alpha \cdot \sin\alpha \cdot u \cdot \sin\alpha \qquad \text{(region 2)}$$

$$\frac{\tau}{f_c} = \frac{P}{bhf_c} = \frac{1}{2}(1-\cos\beta)\frac{1}{\sin\beta} + \psi\cot\beta \cdot \sin^2\alpha + \psi\cot\alpha \cdot \sin^2\alpha \qquad — ①$$

To minimize ① with respect to β

$$\frac{d}{d\beta}\left(\frac{\tau}{f_c}\right) = \psi\left[-1-\cot^2\beta\right]\cdot\sin^2\alpha + \frac{1}{2} - \frac{\frac{1}{2}-\frac{1}{2}\cdot\cos\beta}{\sin^2\beta}\cdot\cos\beta = 0$$

$$\tan\beta = \frac{2\sqrt{\psi - \psi^2\sin^2\alpha}}{-2\psi\sin^2\alpha + 1} \times \sin\alpha \qquad — ②$$

$$\tan\beta = \frac{B}{A}, \quad A^2 + B^2 = 1 \Rightarrow \sin\beta = 2\sqrt{\psi - \psi^2\sin^2\alpha} \cdot \sin\alpha \qquad — ③$$

Substitute ②, ③ into ①

$$\frac{\tau}{f_c} = \sqrt{\psi\sin^2\alpha\,(1-\psi\sin^2\alpha)} + \psi\cos\alpha \cdot \sin\alpha$$

- relation btw θ, β

from lower bound,

$$\tan\theta = \sqrt{\frac{\eta_1 \sin^2\alpha}{1-\eta_1 \sin^2\alpha}}$$

$$\tan 2\theta = \frac{2\tan\theta}{1-\tan^2\theta} = \frac{2\sqrt{\dfrac{\eta_1\cdot\sin^2\theta}{1-\eta_1\cdot\sin^2\theta}}}{1-\dfrac{\eta_1\cdot\sin^2\theta}{1-\eta_1\cdot\sin^2\theta}}$$

$$= \frac{2\sqrt{\eta_1\cdot\sin^2\theta\,(1-\eta_1\sin^2\theta)}}{1-2\eta_1\cdot\sin^2\theta} = \tan\beta \quad (2)$$

$\Rightarrow$ $\beta = 2\theta$ //