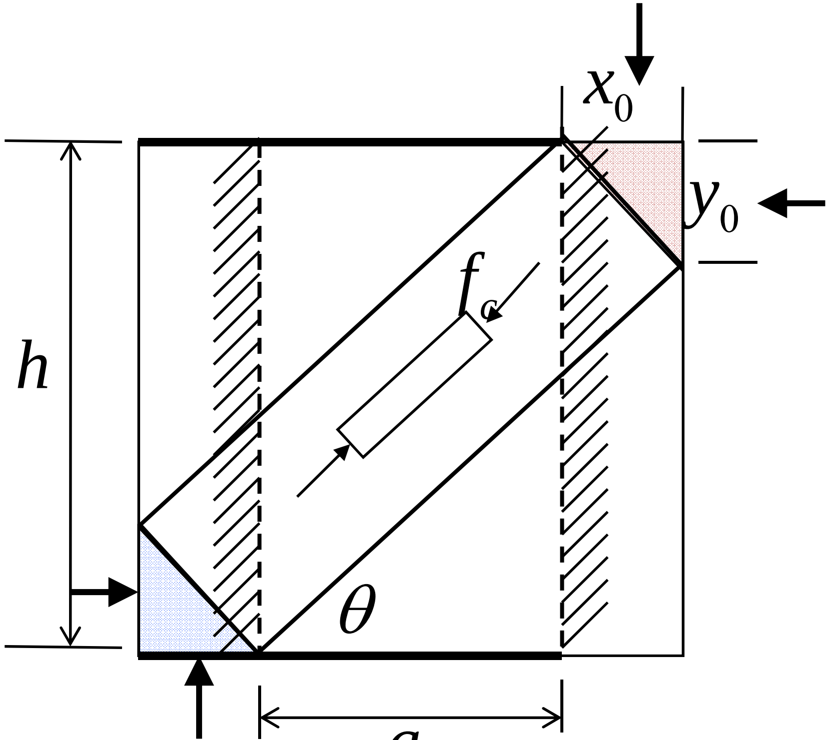
Strut and Tie Models

- Strut
- Strut and Tie Systems
- Fans

- Non-concentric fans
- Concentric fans
- Fans with Bond

Single Strut



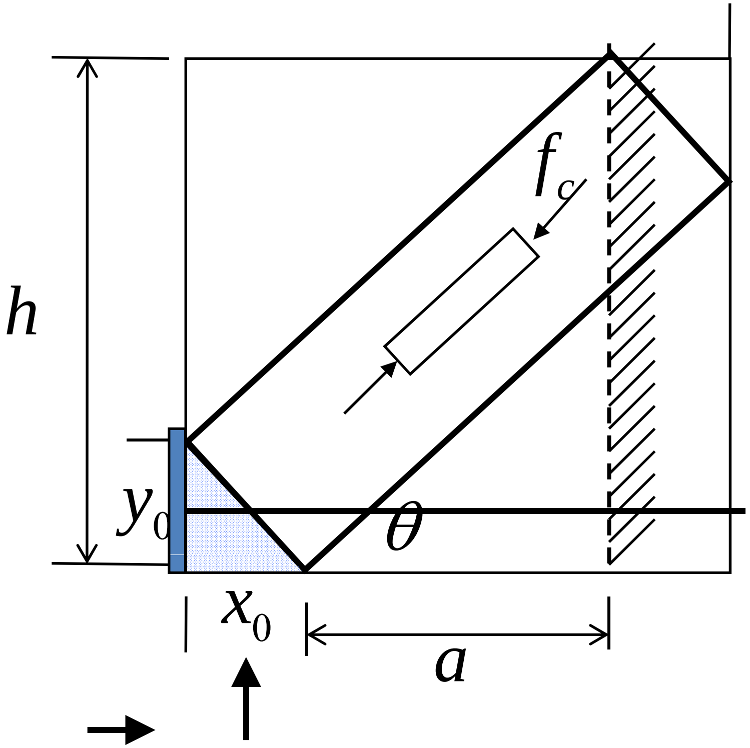
$$\tan\theta = \frac{x_0}{y_0} = \frac{h - y_0}{a + x_0}$$

$$\frac{x_0}{h} = \frac{1}{2}\left[\sqrt{1 + \left(\frac{a}{h}\right)^2} - \frac{a}{h}\right]$$

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

$$\frac{x}{h} = \frac{1}{2}\left[\sqrt{4\frac{y_0}{h}\left(1 - \frac{y_0}{h}\right) + \left(\frac{a}{h}\right)^2} - \frac{a}{h}\right]$$

Single Strut



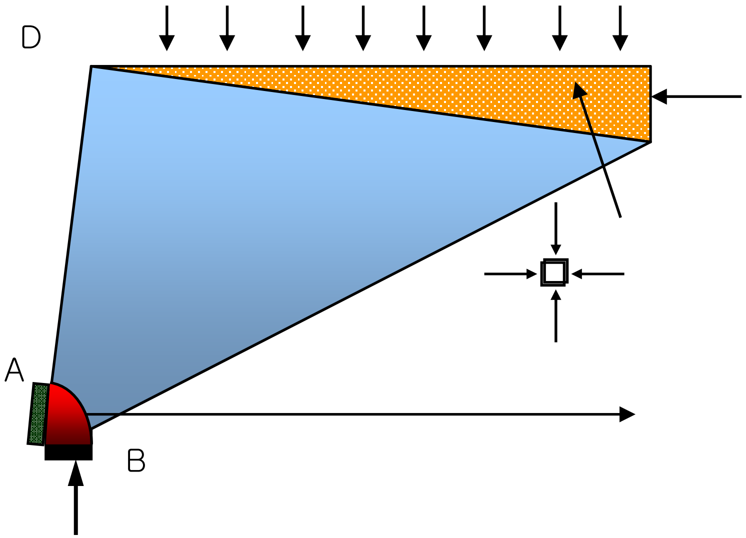
$$A_s f_Y = y_0 t f_c$$

$$\Phi = \frac{A_s f_Y}{t h f_c} = \frac{y_0}{h} \le \frac{1}{2}$$

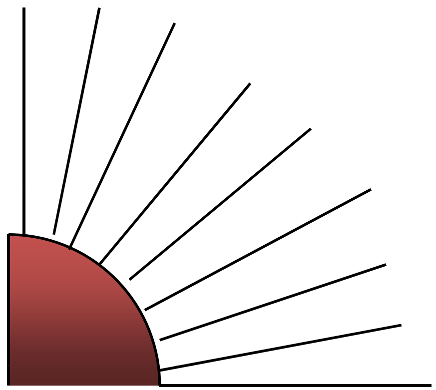
$$\frac{\tau}{f_c} = \frac{P}{t h f_c} = \frac{x_0}{h} = \frac{1}{2}\left[\sqrt{4\Phi\left(1-\Phi\right)+\left(\frac{a}{h}\right)^2} - \frac{a}{h}\right]$$

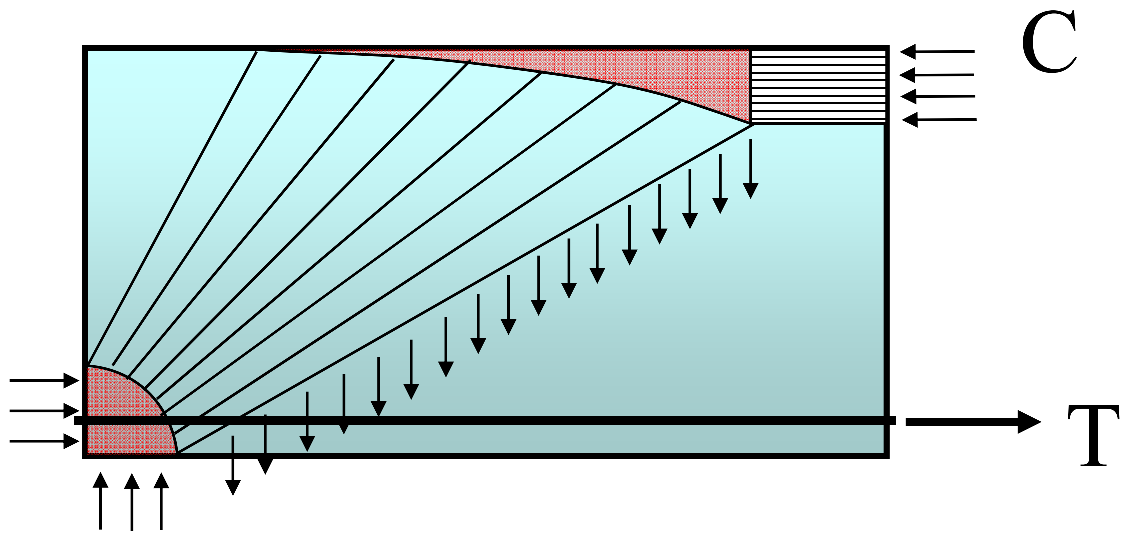
Fan-shaped stress fields

- Non-concentric fan
- Uniform Normal stress type
- Uniform Shear stress type

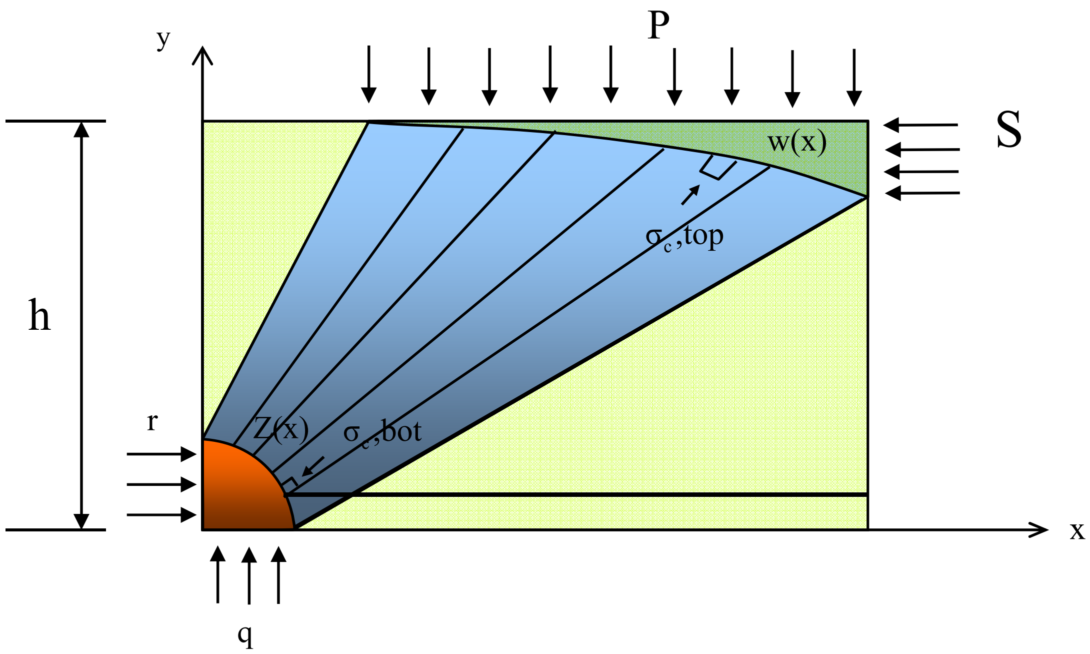


- Concentric Fan



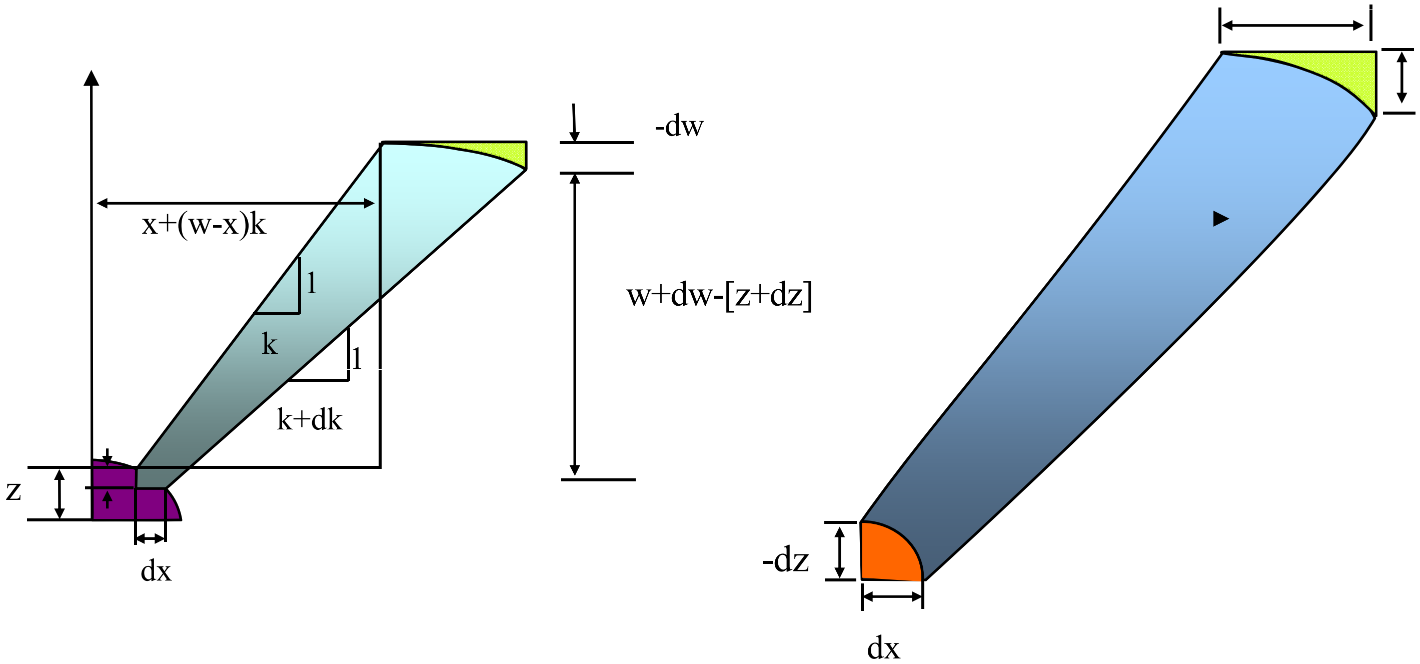


Boundary Stress on
Non-concentric fan-shaped stress field

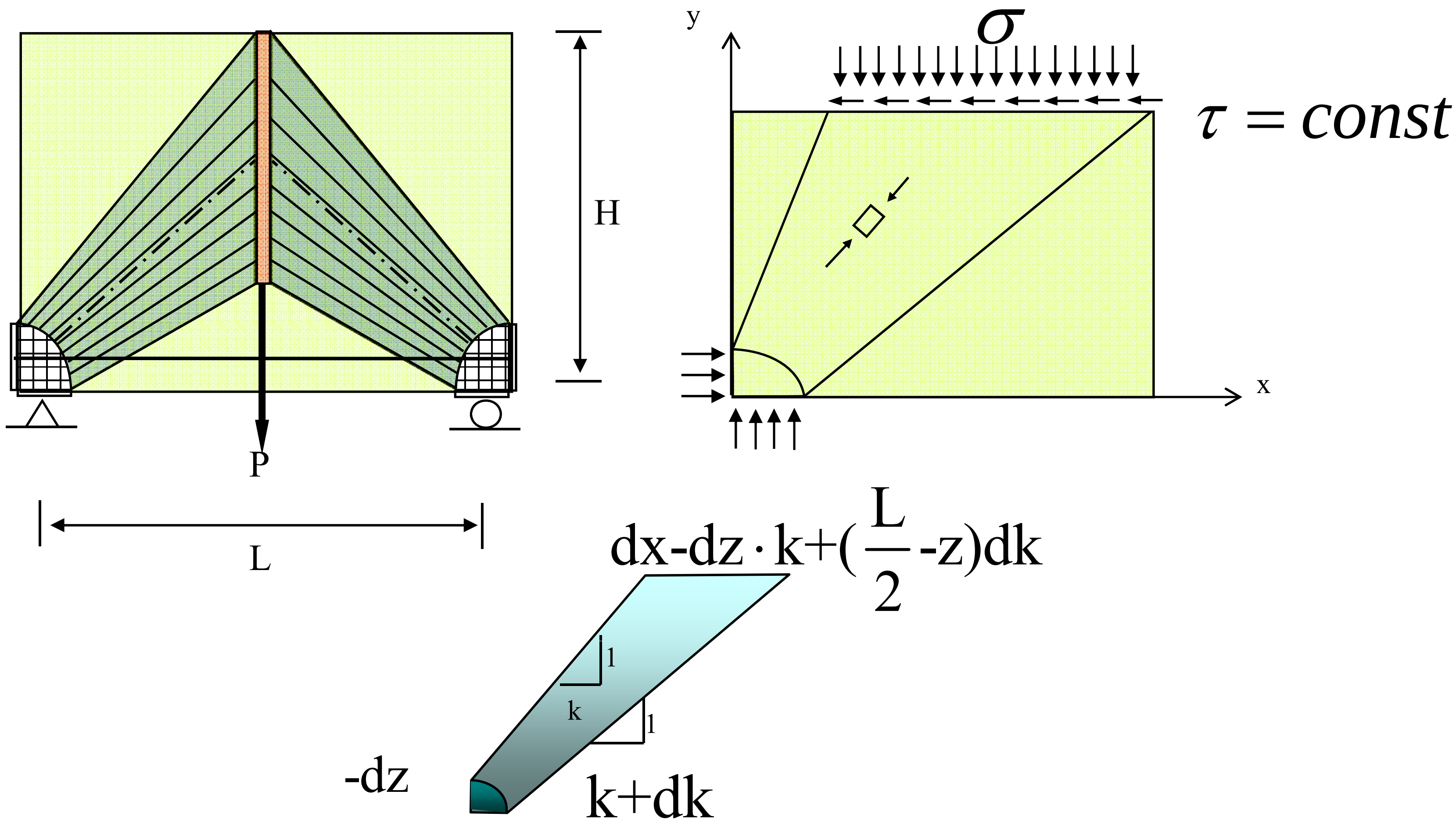


Uniform normal stress on boundary of Non-concentric fan-shaped stress field

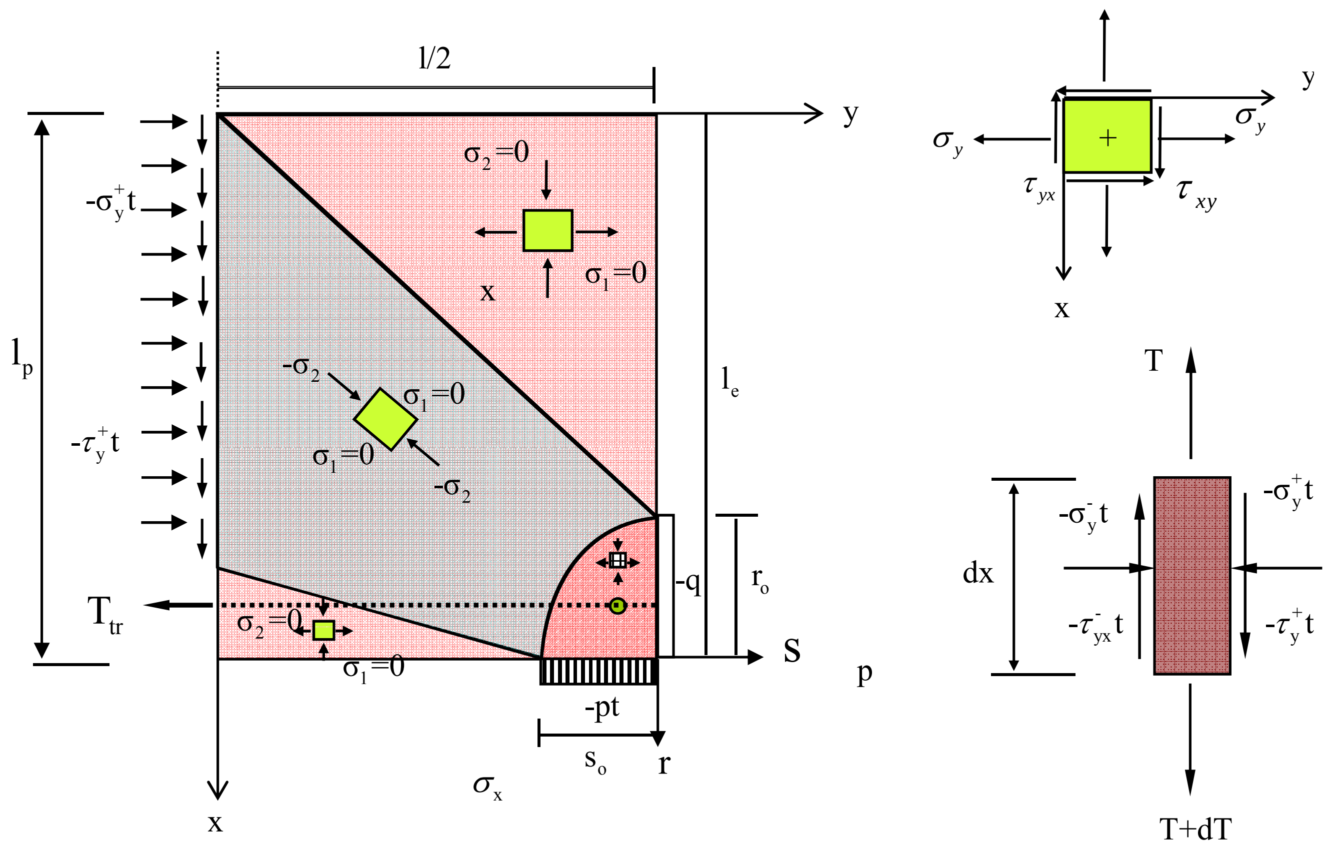
$$d\square = dx + (dw - dz)k + (w - z)dk$$



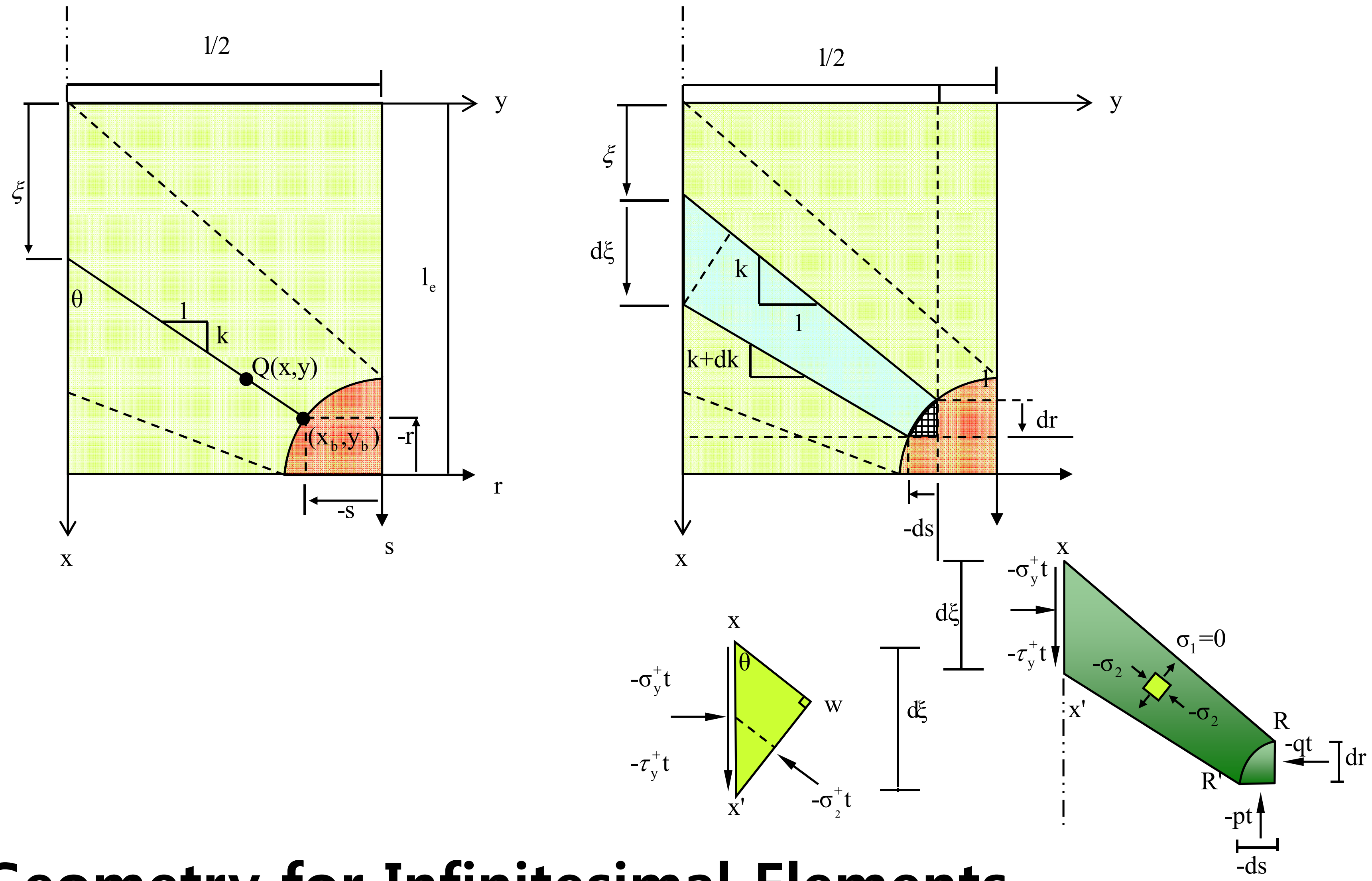
Geometry for Infinitesimal Elements of Non-concentric Fan-shaped stress field (Unifo
Normal stress type)



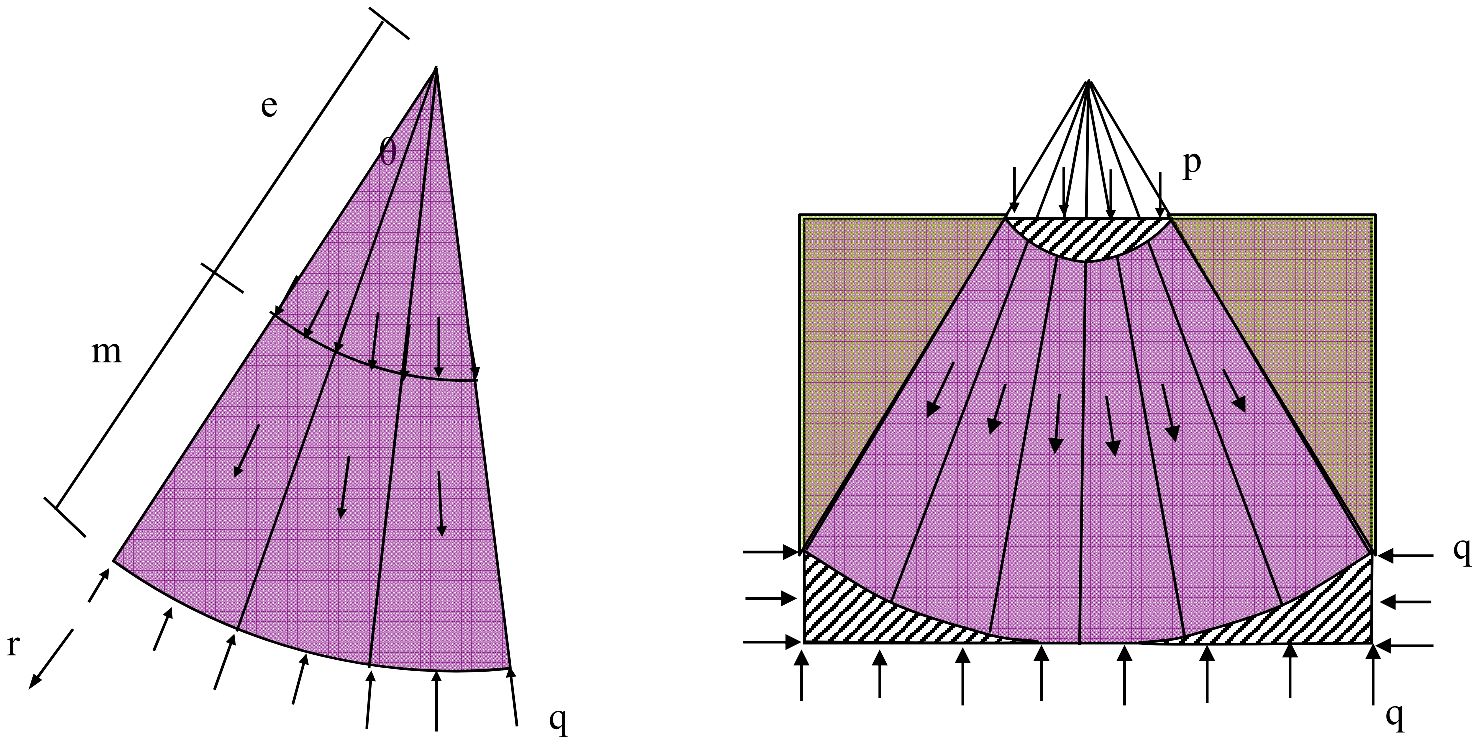
Uniform shear stress on boundary of Non-concentric fan-shaped stress field



l/2
y
$-\sigma_y^+t$
$\sigma_2=0$
x
$\sigma_1=0$
l_p
$-\sigma_2$
$\sigma_1=0$
$-\tau_y^+t$
$\sigma_1=0$
$-\sigma_2$
l_e
T_{tr}
$\sigma_2=0$
$\sigma_1=0$
-q
r_o
S
p
-pt
s_o
r
σ_x
x
y
σ_y
σ_y
τ_{yx}
τ_{xy}
x
T
$-\sigma_y^-t$
$-\sigma_y^+t$
dx
$-\tau_{yx}^-t$
$-\tau_y^+t$
T+dT



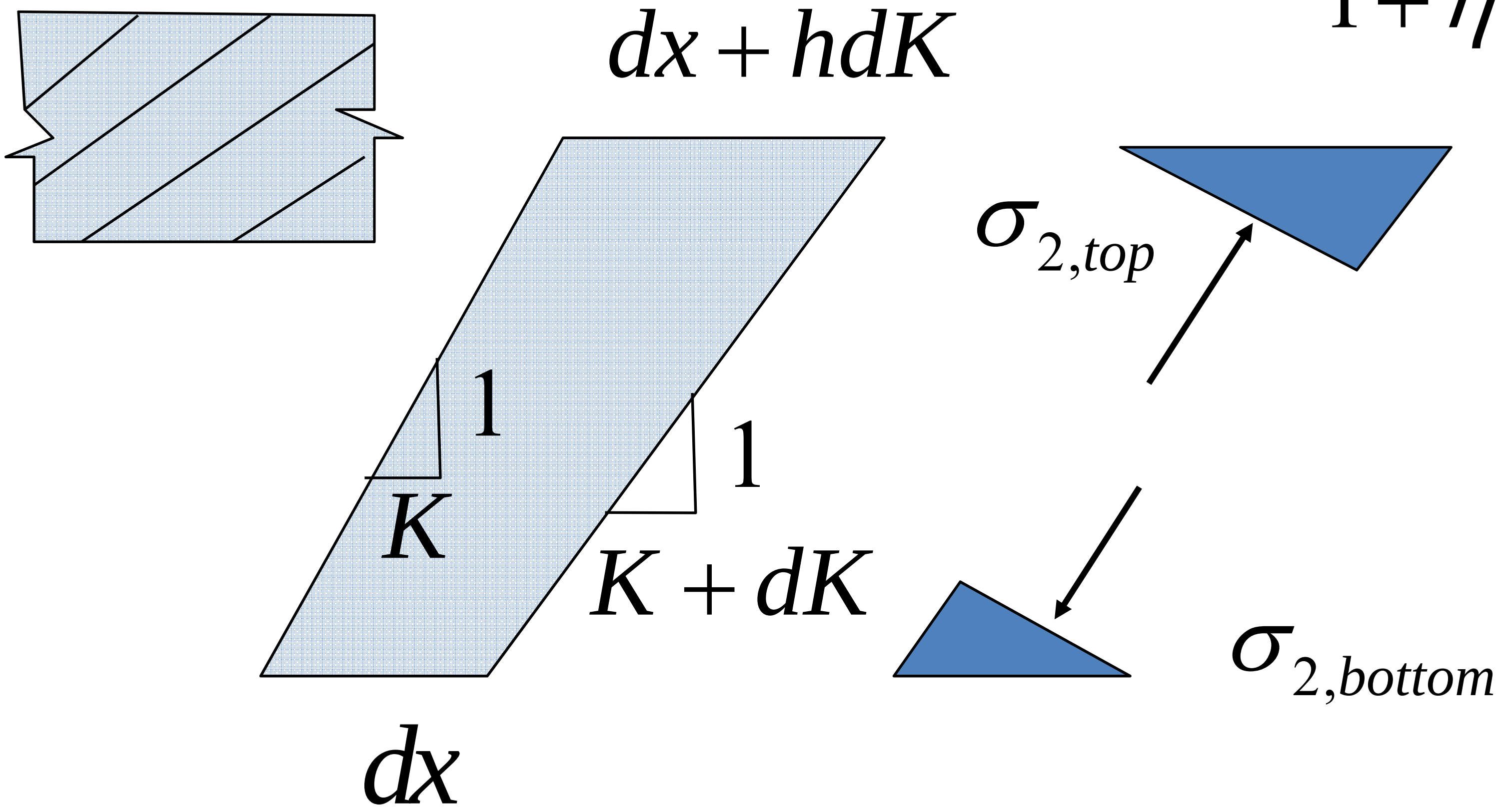
Geometry for Infinitesimal Elements of Non-concentric Fan-shaped stress field (Unifor Shear stress type)



Concentric Fan-shaped stress field

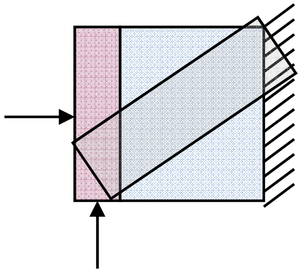
dx

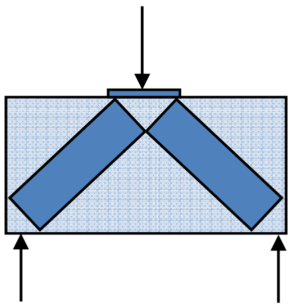
$$\sigma_{2,top} = \frac{\sigma_{2,bottom}}{1+\eta\frac{dK}{dx}}$$

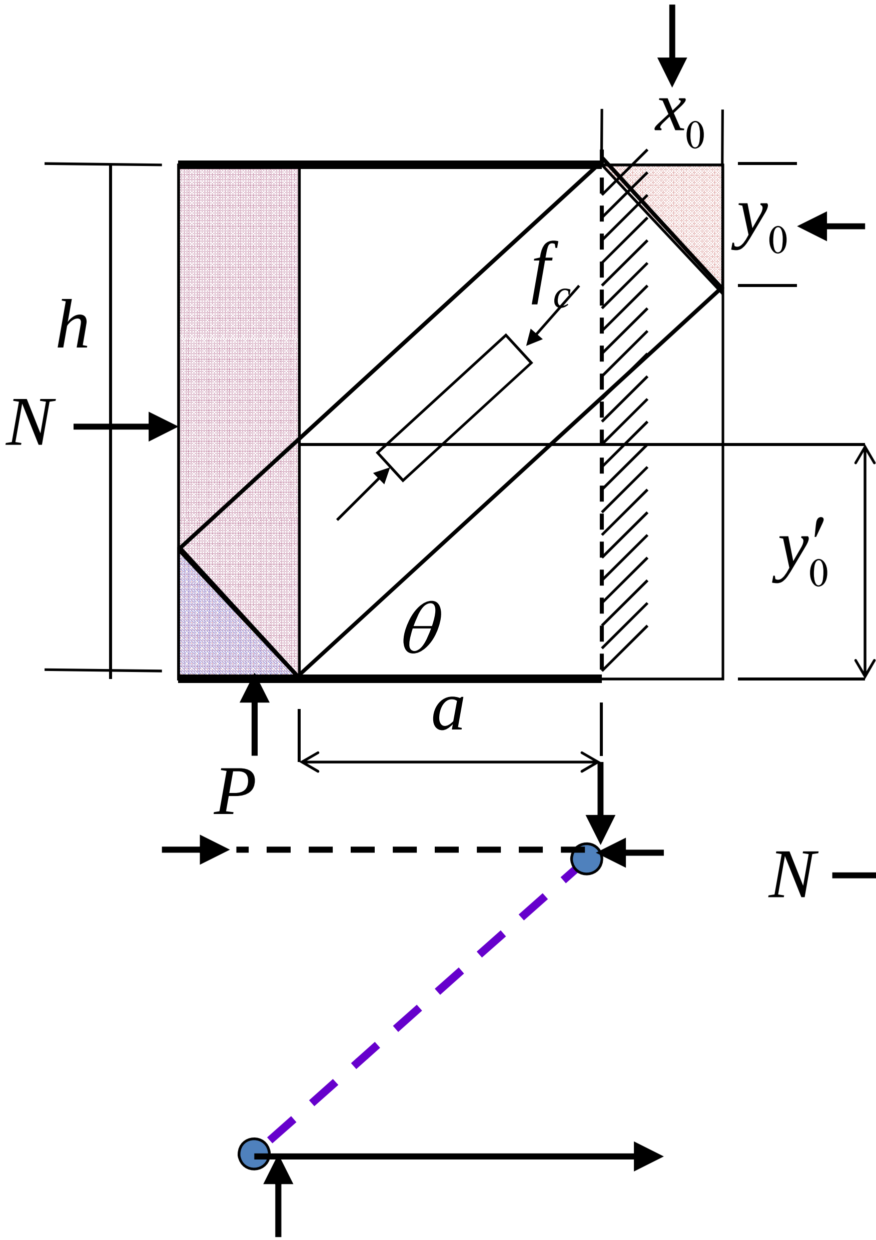


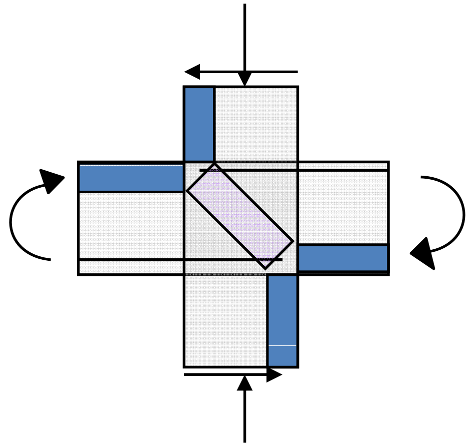
Stress State in Diagonal Compression Stress Fields

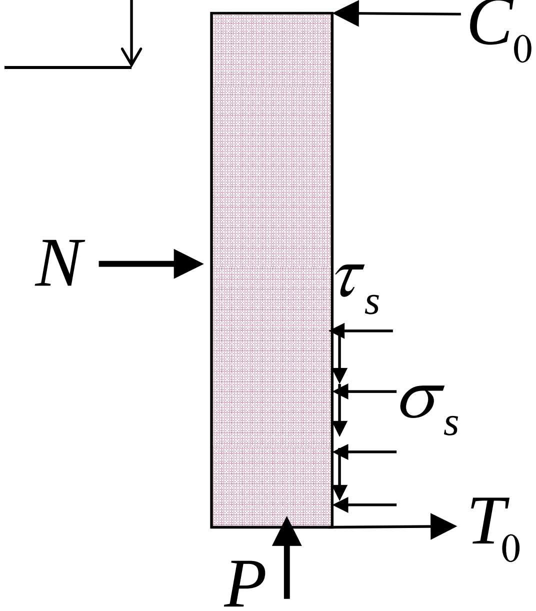
Single Strut action



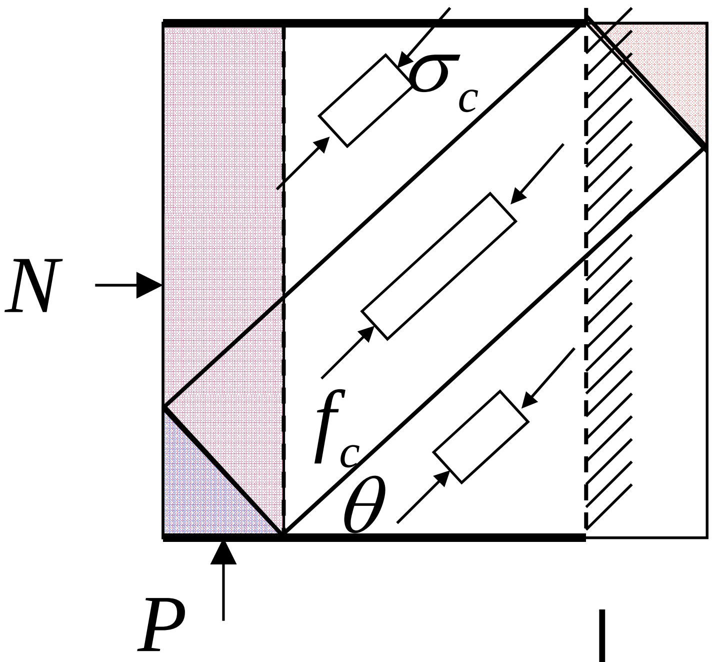


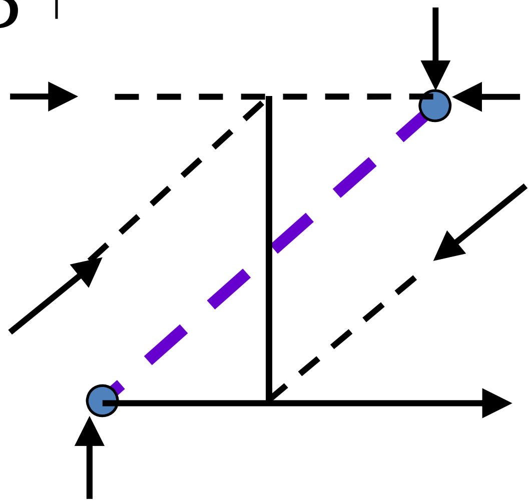


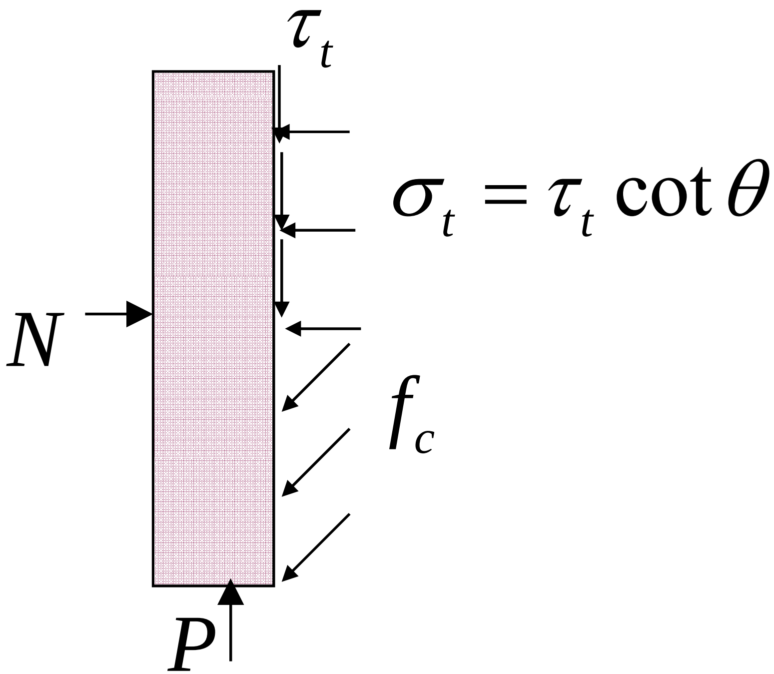




Strut with Diagonal Compression Field



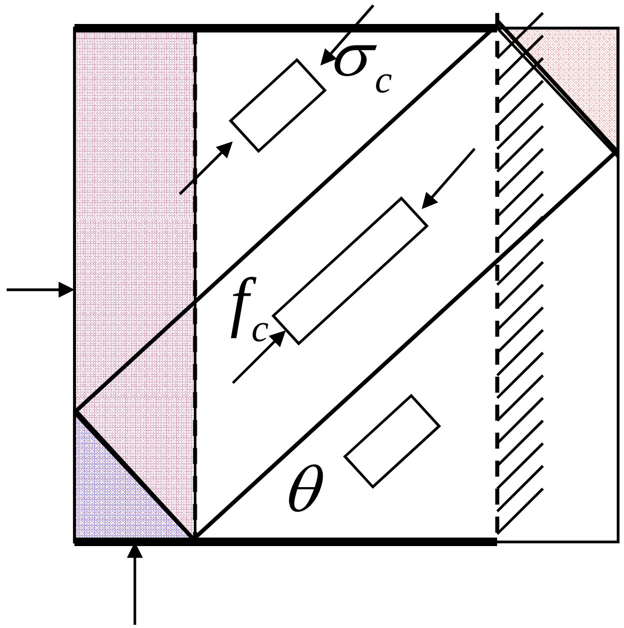


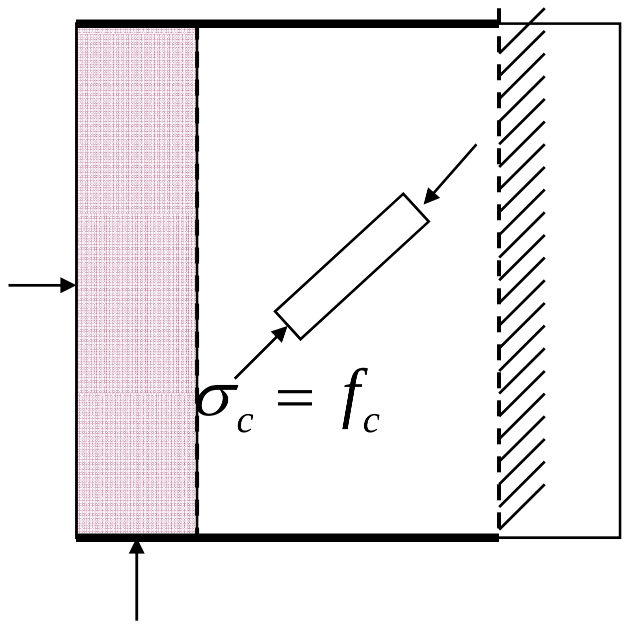


$$P_s = \frac{1}{2} t h f_c \left[\sqrt{1 + \left(\frac{a}{h} \right)^2} - \frac{a}{h} \right]$$

$$\tau_t = \frac{P - P_s}{t\left(h - y_0'\right)}$$

Diagonal Compression Field

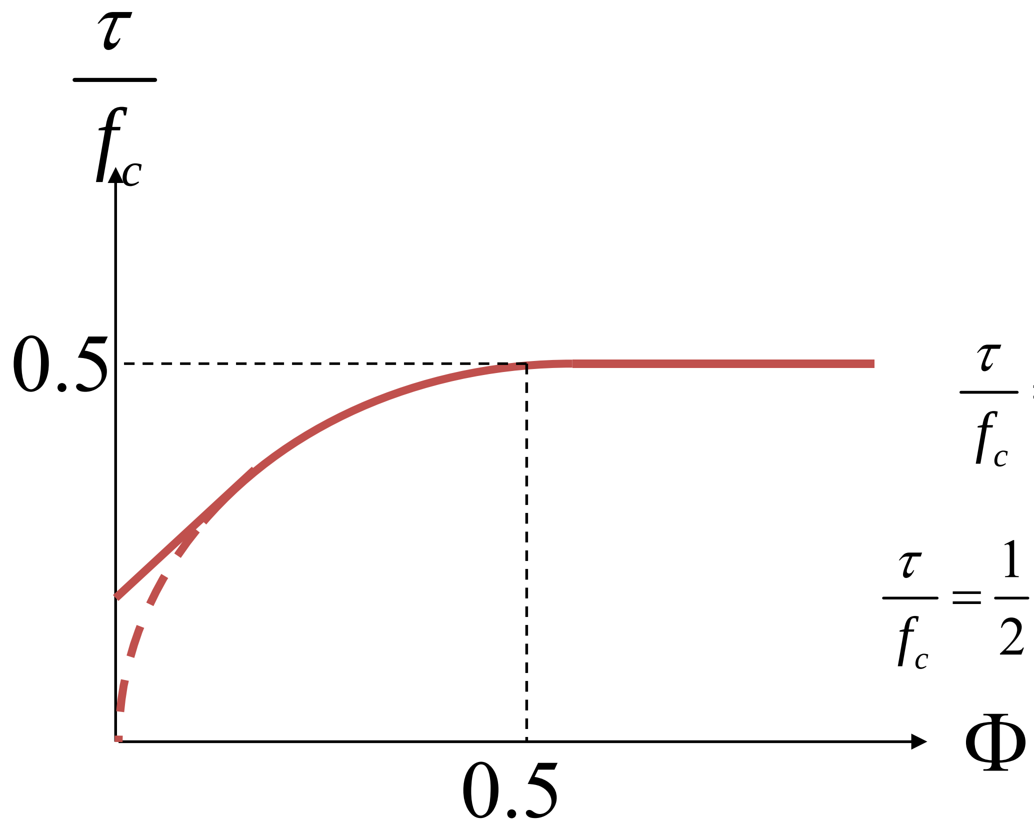




$$\sin 2\theta = \frac{2\tau}{f_c} \qquad r f_{Yy} = \tau \tan\theta$$

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

Maximum Shear Strength



$$\frac{\tau}{f_c} = \sqrt{\Phi_y \left(1 - \Phi_y\right)}$$

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

Strut with Fan-Shaped Stress Field