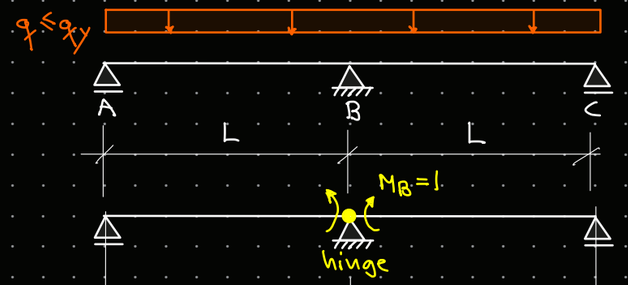
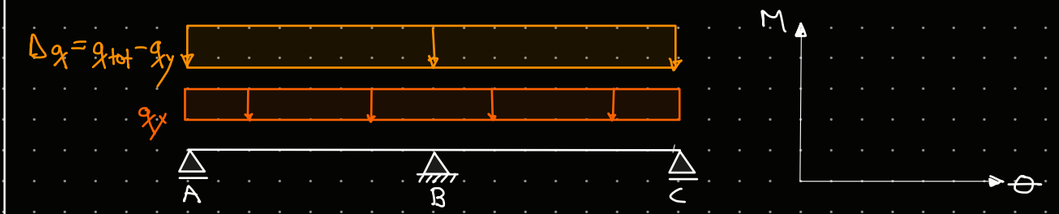
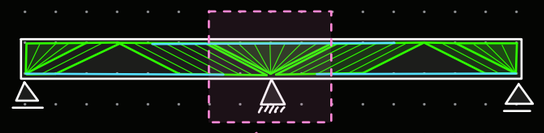
Rotation demand





Plastic hinge length ↔ Tension chord force profile $F_{sup}(x)$

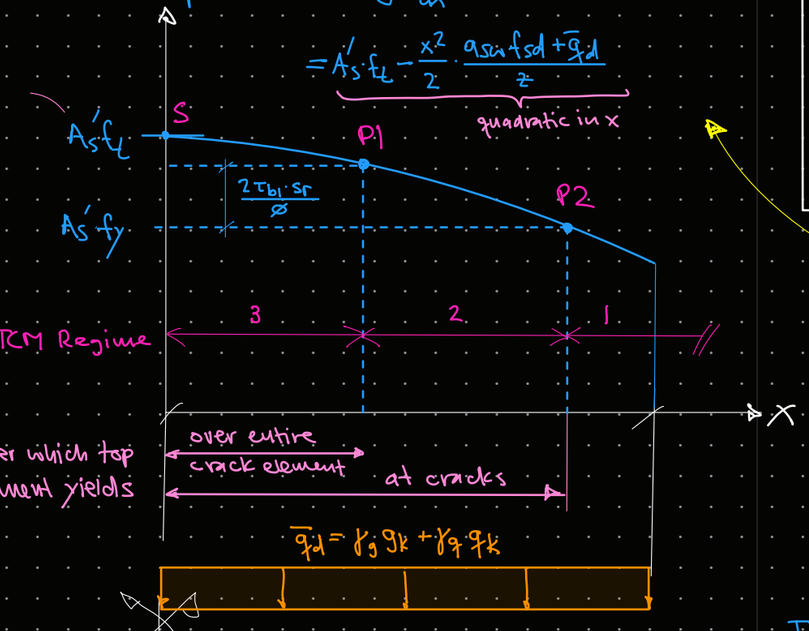


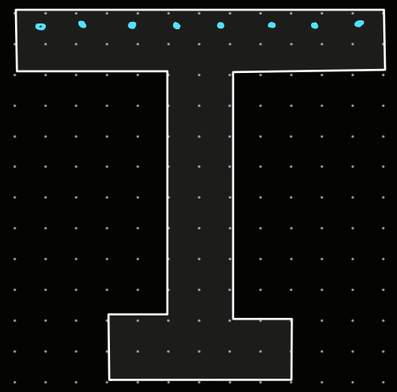
fan region = detailed study

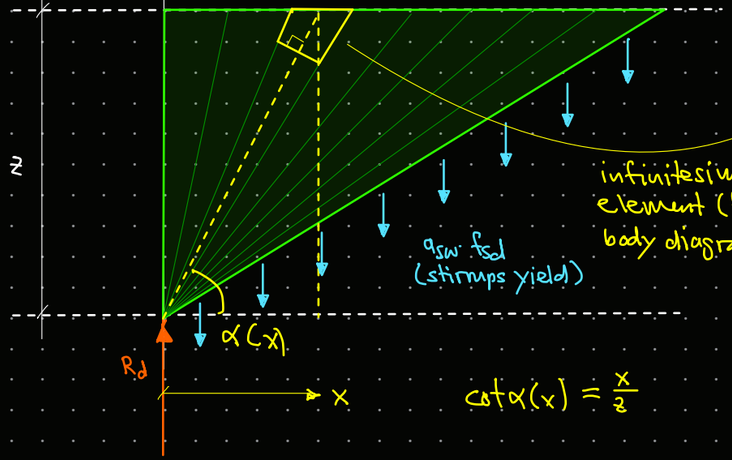
assumption: steel rupture governing

$$F_{sup}(x) = A_s' f_t + \int \frac{dF_{sup}}{dx}\,dx$$

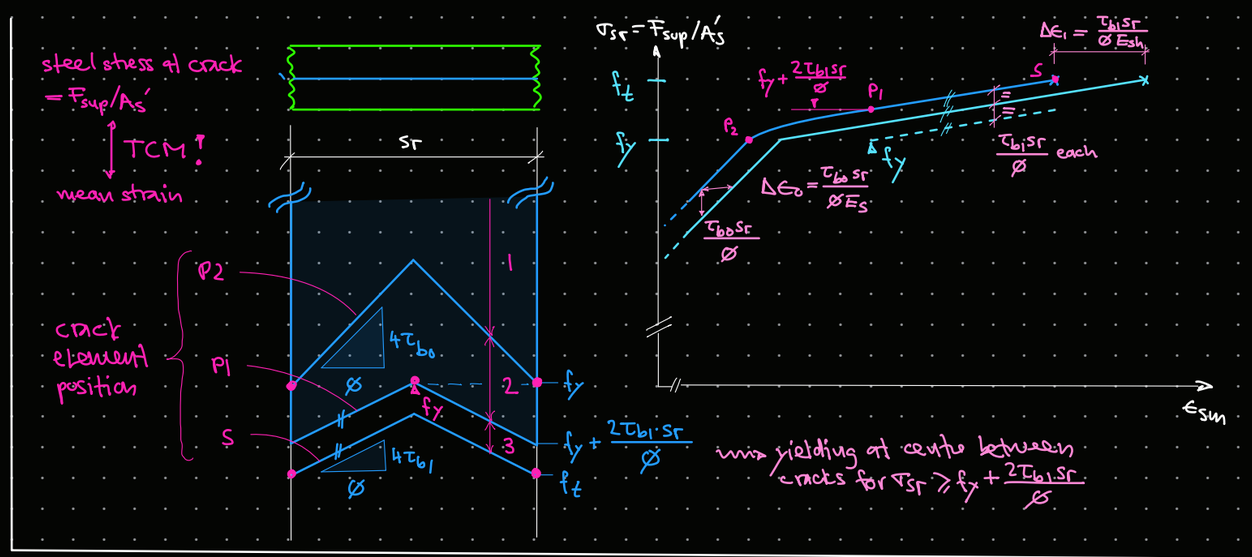
$$= \underbrace{A_s' f_t - \frac{x^2}{2}\cdot\frac{a_{sw} f_{sd} + \bar{q}_d}{z}}_{\text{quadratic in } x}$$







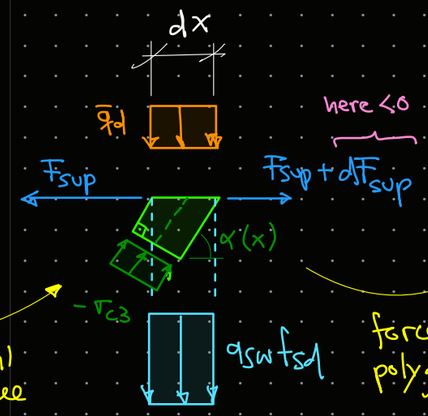
$$\cot\alpha(x) = \frac{x}{z}$$



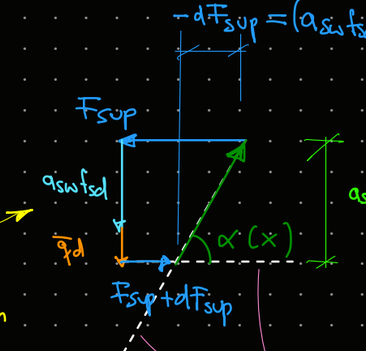
min yielding at centre between cracks for $\sigma_{sr} \geq f_y + \frac{2\tau_{b1}\cdot sr}{\varnothing}$

integrate (with $F_{sup}(0) = A_s f_t$)

$$\frac{dF_{sup}}{dx} = (a_{sw}\cdot f_{sd} + \bar{q}_d)\cdot\cot\alpha = \underbrace{(a_{sw}\cdot f_{sd} + \bar{q}_d)\cdot\frac{x}{z}}_{\text{linear in } x}$$

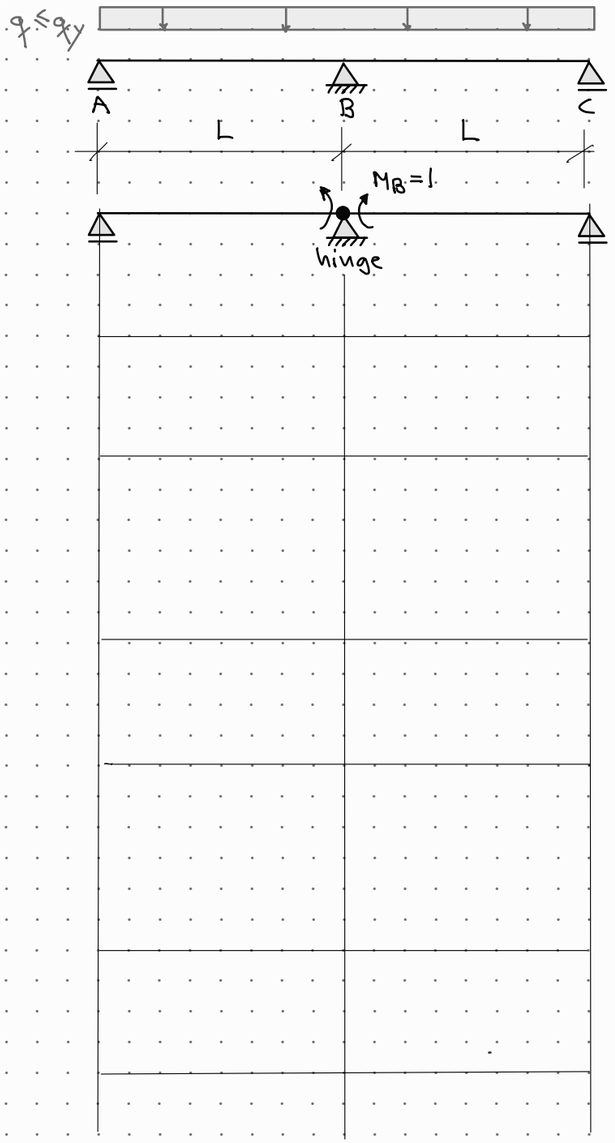


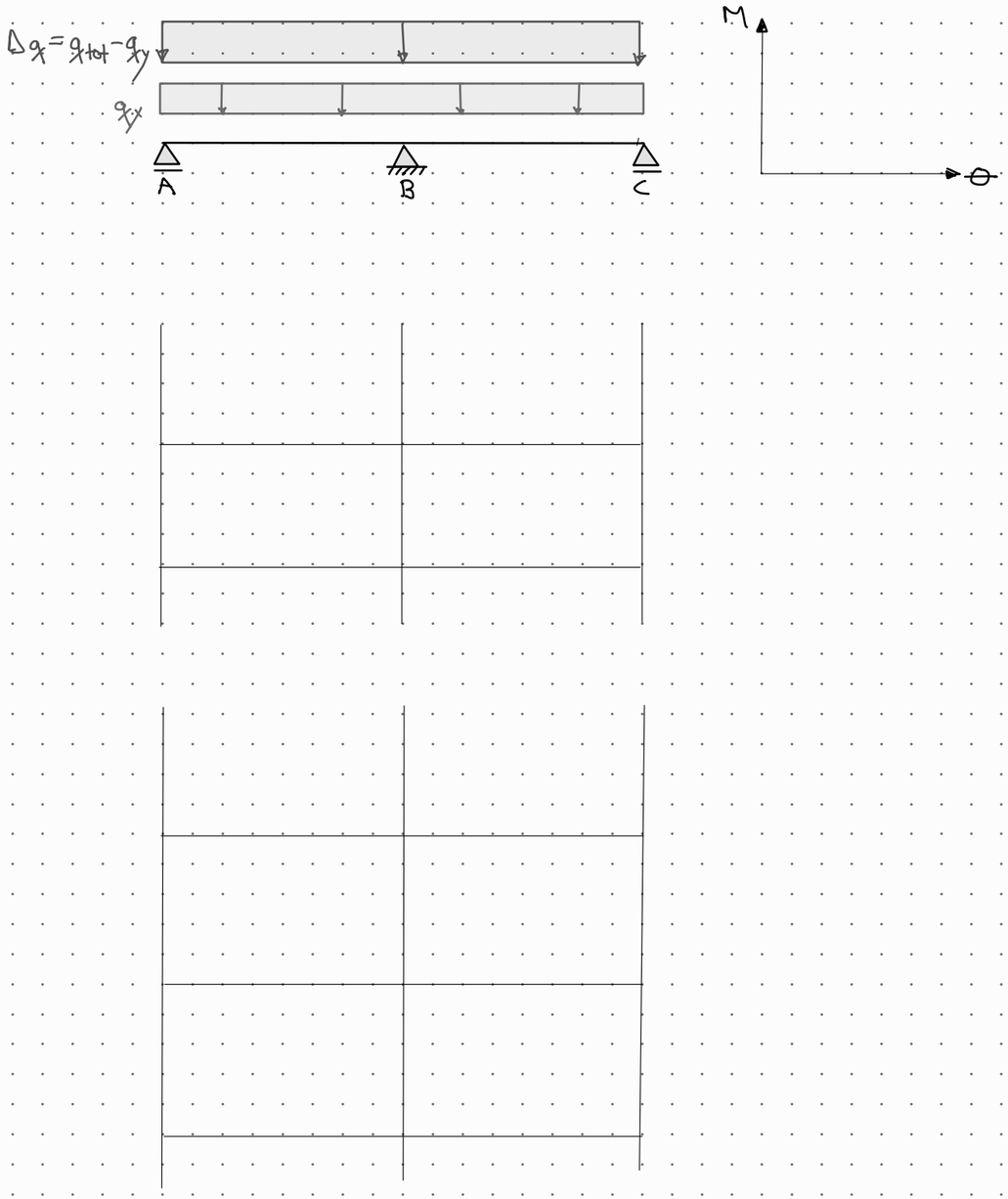
force polygon



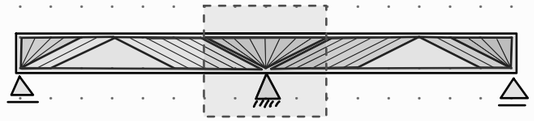
known directions → Force polygon must be closed = equilibrium

Rotation demand





Plastic hinge length ↔ Tension chord force profile $F_{sup}(x)$



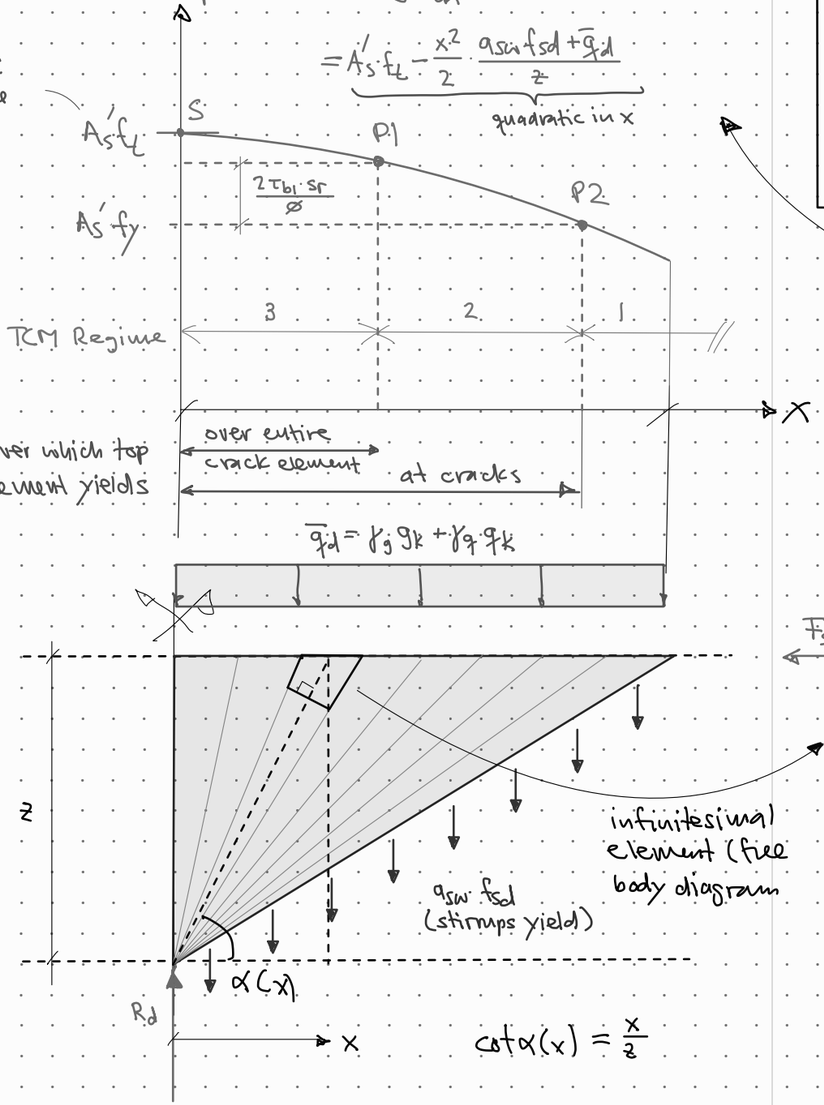
fan region = detailed study

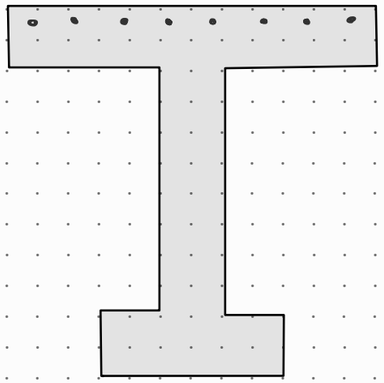
$$F_{sup}(x) = A_s' f_t + \int \frac{dF_{sup}}{dx} dx$$

$$= A_s' f_t - \frac{x^2}{2} \frac{a_{sw} f_{sd} + \bar{q}_d}{z}$$

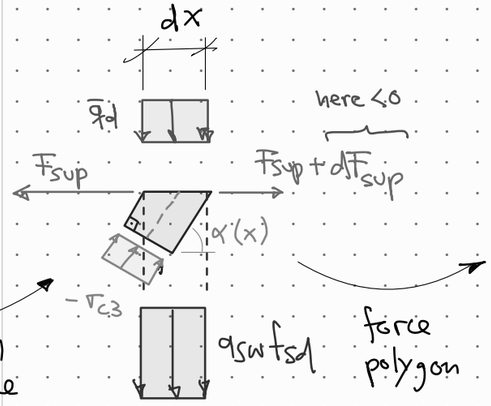
quadratic in x

assumption: steel rupture governing





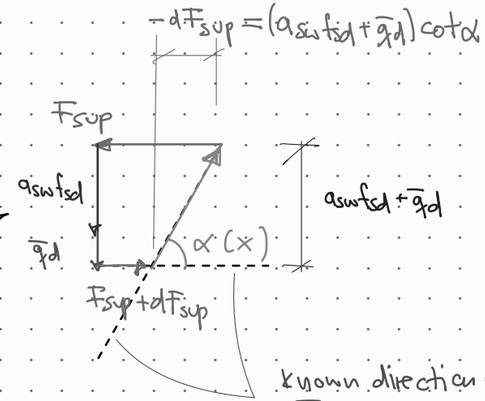
infinitesimal element (free body diagram)



integrate (with $F_{sup}(0) = A_s f_t$)

$$\frac{dF_{sup}}{dx} = (a_{sw} \cdot f_{sd} + \bar{q}_d) \cdot \cot\alpha = \underbrace{(a_{sw} \cdot f_{sd} + \bar{q}_d) \cdot \frac{x}{z}}_{\text{linear in } x}$$

force polygon

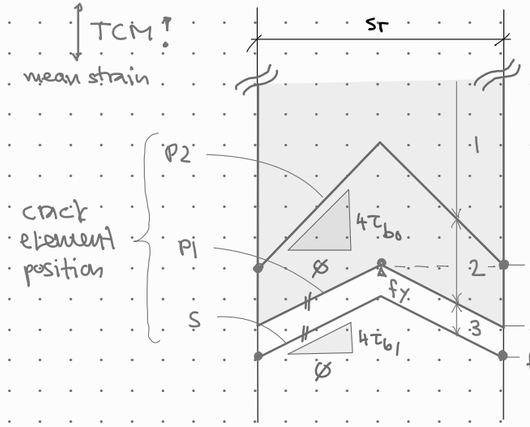


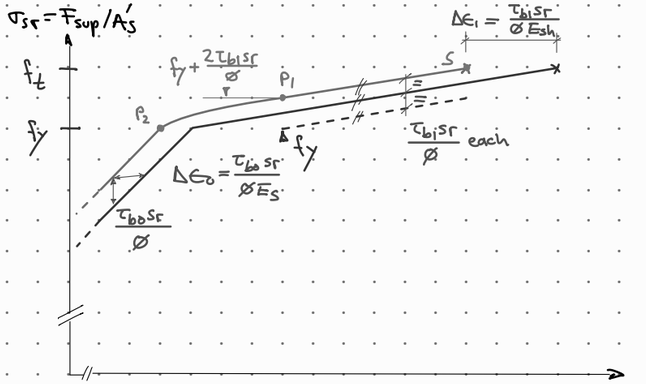
known directions → Force polygon must be closed = equilibrium

steel stress at crack $= F_{sup}/A_s'$

TCM ?

mean strain





min yielding at centre between cracks for $\sigma_{sr} \geq f_y + \frac{2\tau_{b1} \cdot sr}{\varnothing}$