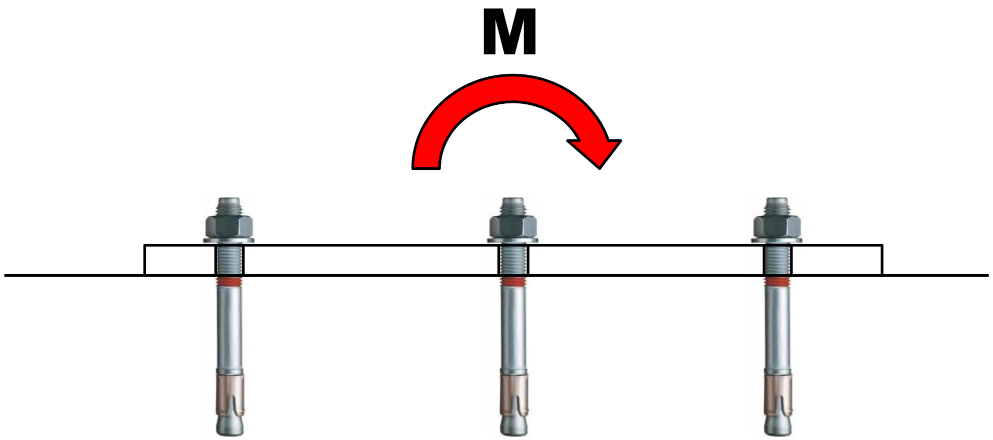
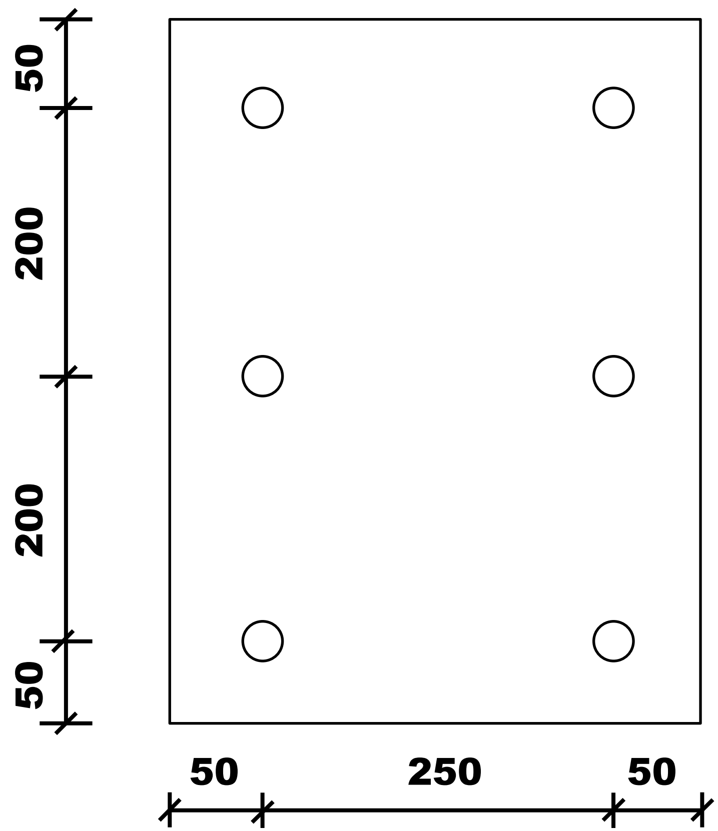
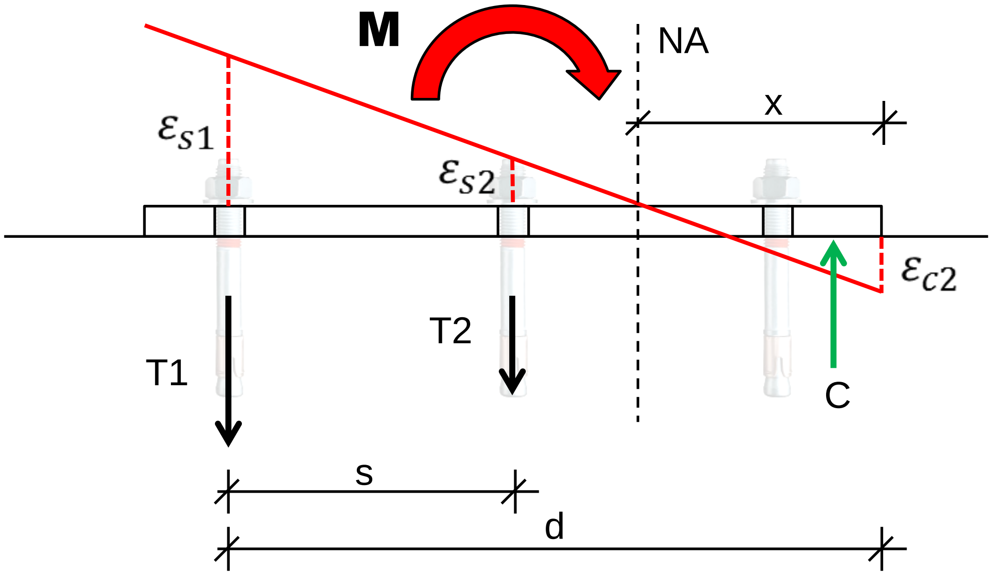
Moment Analysis on 6 or more Nos. Bolts Group





Analysis Assumption:

- **Elasticity theory**
- **Rigid Base Plate (no deformation)**
- **All anchors have equal stiffness**
- **Anchors not transfer the compression**



$$E = \frac{\sigma}{\varepsilon}$$

$$\frac{E_s}{E_c} = m$$

$$\frac{\varepsilon_c}{x} = \frac{\varepsilon_{s1}}{d-x} = \frac{\varepsilon_{s2}}{d-x-s}$$

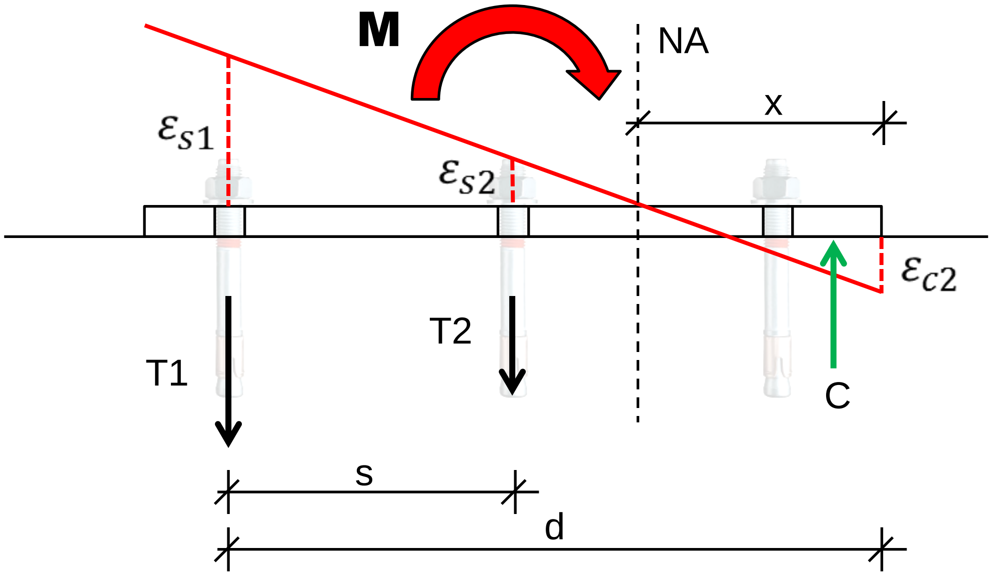
$$T1 = \sigma_{s1}A_s = \varepsilon_{s1}E_sA_s = \frac{\varepsilon_c(d-x)}{x}mE_cA_s$$

$$T2 = \sigma_{s2}A_s = \frac{\varepsilon_c(d-x-s)}{x}mE_cA_s$$

$$C = \frac{\sigma_c x}{2}b = \frac{\varepsilon_c E_c x}{2}b$$

$$\sum F = 0$$

$$C = T1 + T2$$



$$T1 = \sigma_{s1} A_s = \varepsilon_{s1} E_s A_s = \frac{\varepsilon_c (d-x)}{x} m E_c A_s$$

$$T2 = \sigma_{s2} A_s = \frac{\varepsilon_c (d-x-s)}{x} m E_c A_s$$

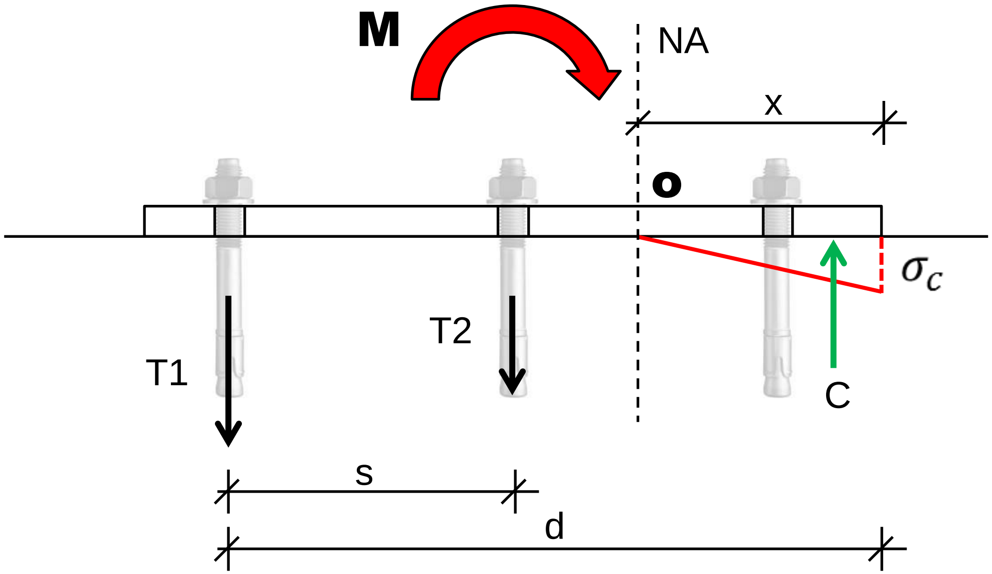
$$C = \frac{\sigma_c x}{2} b = \frac{\varepsilon_c E_c x}{2} b$$

$$\sum F = 0$$

$$C = T1 + T2$$

$$\frac{\varepsilon_c E_c b}{2} x = m E_c A_s \varepsilon_c \left[\frac{(d-x) + (d-x-s)}{x} \right]$$

$$\frac{b}{2} x^2 + 2 m A_s x - m A_s (2d - s) = 0$$



$$T1 = \sigma_{s1}A_s = \varepsilon_{s1}E_sA_s = \frac{\varepsilon_c(d-x)}{x}mE_cA_s$$

$$T2 = \sigma_{s2}A_s = \frac{\varepsilon_c(d-x-s)}{x}mE_cA_s$$

$$C = \frac{\sigma_c x}{2}b = \frac{\varepsilon_c E_c x}{2}b$$

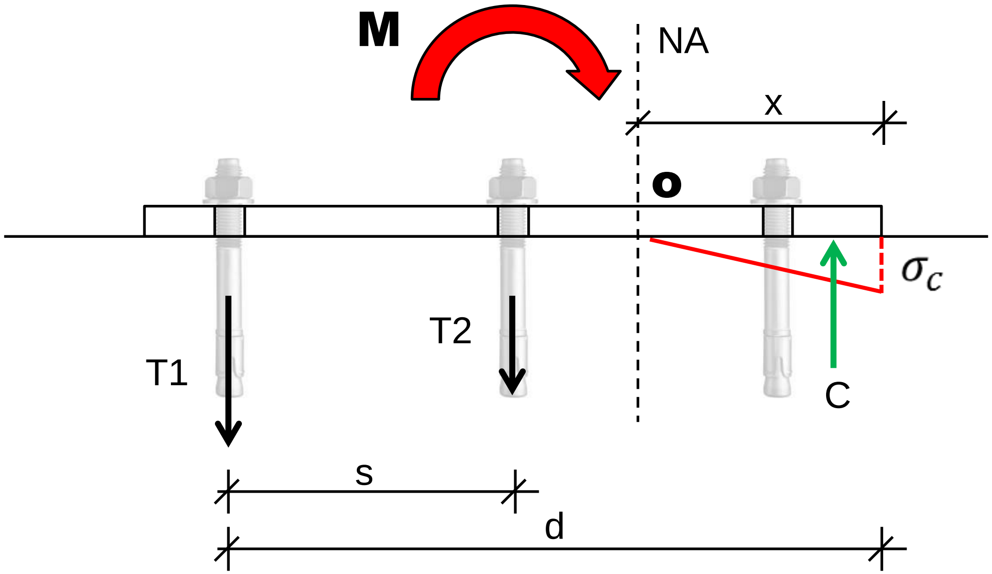
$$T1 = \frac{(d-x)}{x}m\sigma_cA_s$$

$$T2 = \frac{(d-x-s)}{x}m\sigma_cA_s$$

$$\sum M_o = 0$$

$$M = C\frac{2}{3}x + T1(d-x) + T2(d-x-s)$$

$$M = \frac{\sigma_c b}{3}x^2 + m\sigma_cA_s\left[\frac{(d-x)^2+(d-x-s)^2}{x}\right]$$

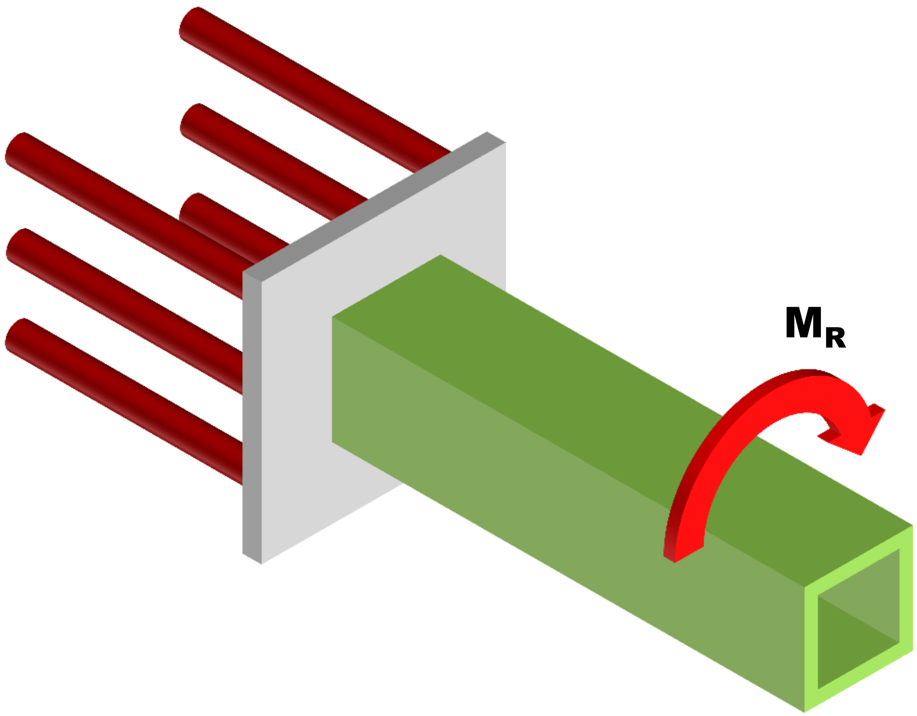


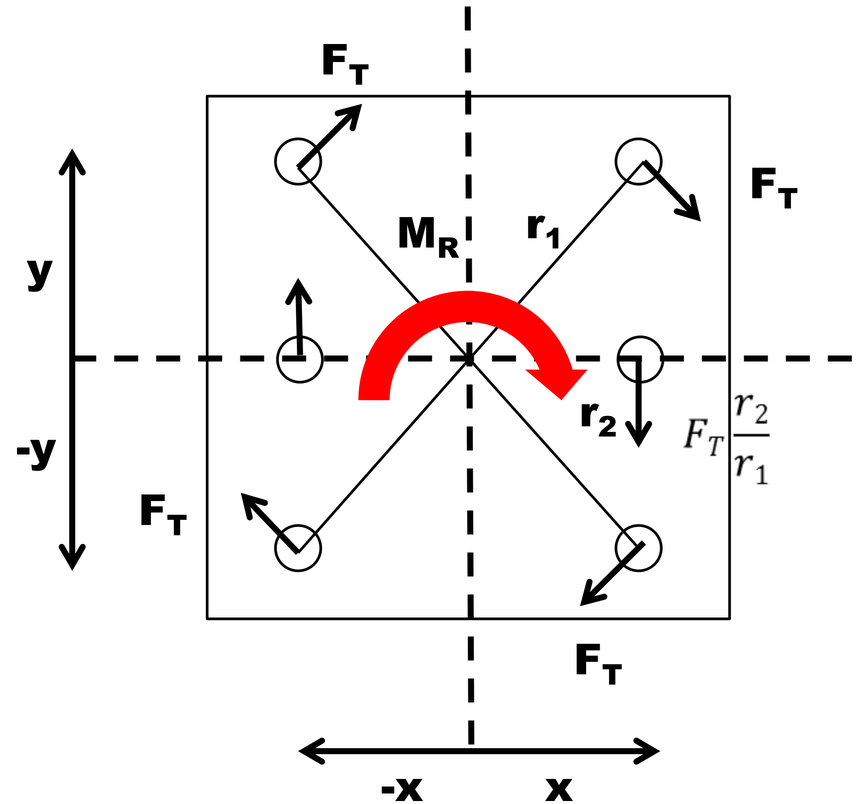
$$\sigma_c = \frac{M}{\frac{b}{3}x^2 + mA_s\left[\frac{(d-x)^2 + (d-x-s)^2}{x}\right]}$$

$$T1 = \frac{(d-x)}{x} m\sigma_c A_s$$

$$T2 = \frac{(d-x-s)}{x} m\sigma_c A_s$$

Torsional Analysis on Bolts Group of Embed

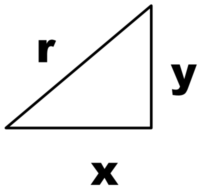




$$M_R = F_T \times r_1 + F_T \frac{r_2}{r_1} r_2 + \cdots$$

$$M_R = \frac{F_T}{r_1} \times (r_1{}^2 + r_2{}^2 + \cdots)$$

$$M_R = \frac{F_T}{r_1} \sum (x^2 + y^2)$$



$$r^2 = x^2 + y^2$$

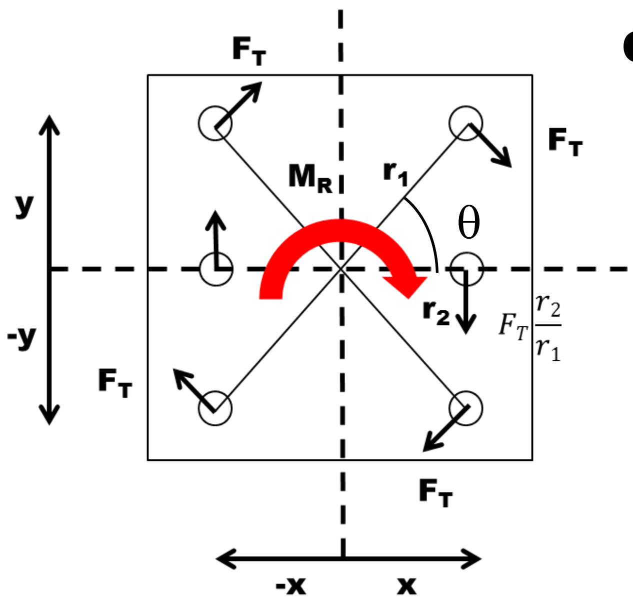
Applied Torsional Moment

Longest distance of the bolt from center of the rotation of the bolt group

$$F_T = \frac{M_R \times r_1}{\boxed{\sum(x^2 + y^2)}}$$

Summation of the coordinate square

Shear Force due to torsional moment



Combined Vertical and Horizontal direct Shear Force

Vertical Shear $$F_{vs} = F_{dvs} + F_T \cos\theta$$

Horizontal Shear $$F_{hs} = F_{dhs} + F_T \sin\theta$$

$$F_{RS} = \sqrt{(F_{dvs} + F_T \cos\theta)^2 + (F_{hs} + F_T \sin\theta)^2}$$