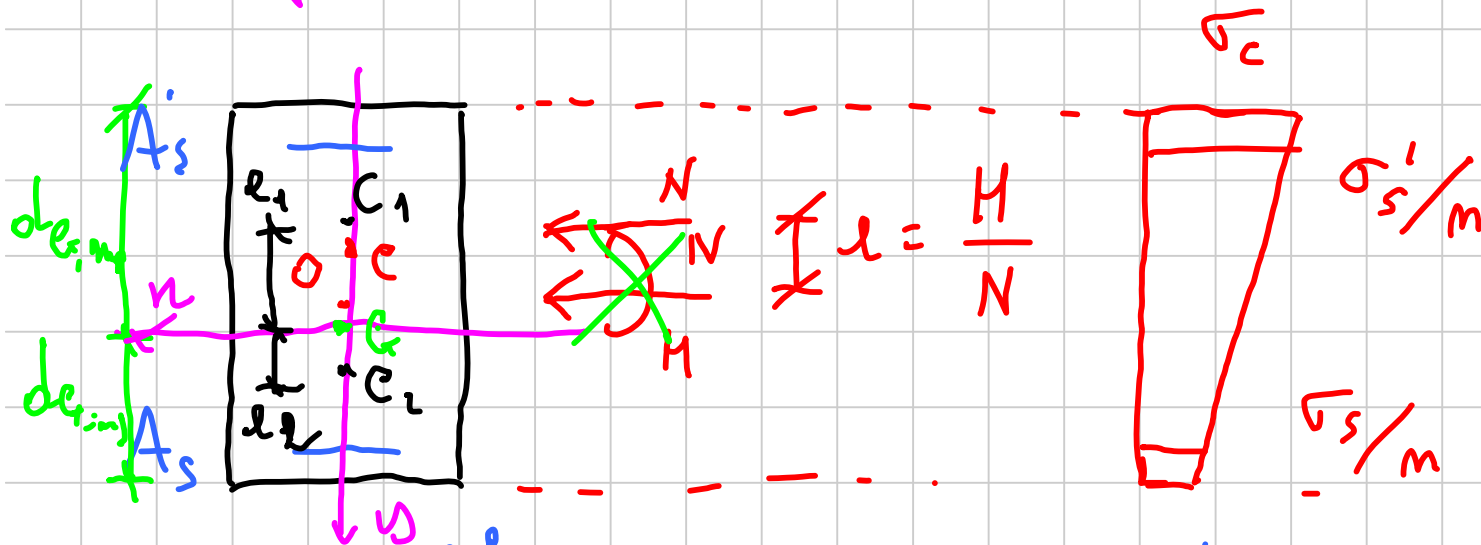


# Punto neutro - piccole eccentricità

Titolo nota

23/04/2015



$$S_{sup} = \frac{bh^2}{2} + mA'_s e + mA_s d$$

$$A = bh + m(A'_s + A_s)$$

$$d_{e,mp} = \frac{S_{sup}}{A}$$

$$d_{e,inf} = h - d_{e,mp}$$

$$e_1 = \frac{I}{A d_{e,inf}}$$

$$e_2 = \frac{I}{A d_{e,up}}$$

$$I = \frac{b d_{e,inf}^3}{3} + \frac{b d_{e,up}^3}{3} + m A'_s (d_{e,up} - e)^2 + m A_s (d_{e,inf} - e)^2$$

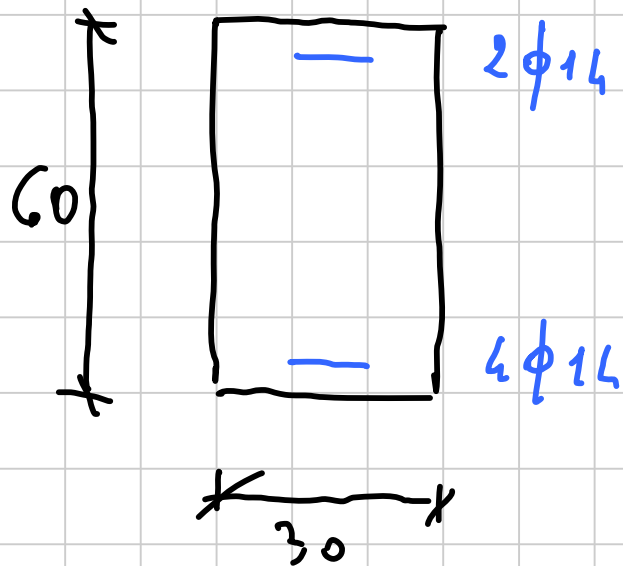
$$e_{c+s} = \frac{M}{N} - \left( \frac{h}{2} - d_{e,inf} \right)$$

$$-e_1 \leq e_{c+s} \leq e_2 \quad \text{piciole eccentricităi}$$

$$\sigma_c = \frac{N}{A} - \frac{N_{e_{ct+s}}}{I} d_{c,mp} \leq 0,6 f_{ck} \quad \text{comb, norm}$$

$$\sigma_{c,ring} = \frac{N}{A} + \frac{N_{e_{ct+s}}}{I} d_{c,ring}$$

$$\sigma'_s = m \left[ \frac{N}{A} - \frac{N_{e_{ct+s}}}{I} (d_{c,mp} - c) \right]$$



$$N = -1000 \text{ KN}$$

$$M = 100 \text{ KNm}$$

C 25/30

B 450 C

$e = 4 \text{ cm}$

$$S_{\text{sup}} = \frac{30 \times 60^2}{2} + 15 \times 3.08 \times 4 + 15 \times 6.16 \times 56 = 59359,2 \text{ cm}^3$$

$$A = 30 \times 60 + 15 (3.08 + 6.16) = 1938,6 \text{ cm}^2$$

$$d_{e, \text{sup}} = \frac{59359,2}{1938,6} = 30,6 \text{ cm}$$

$$d_{\text{avg}} = 60 - 30,6 = 29,4 \text{ cm}$$

$$I = 30 \times \frac{29,4^3}{3} + 30 \times \frac{30,6^3}{3} + 15 \times 3,08 \times (30,6 - 4)^2 \\ + 15 \times 6,16 \times (29,4 - 4)^2 = 632\,950 \text{ cm}^4$$

$$e_1 = \frac{632\,950}{1938,6 \times 29,4} = 11,1 \text{ cm}$$

$$e_2 = \frac{632\,950}{1938,6 \times 30,6} = 10,7 \text{ cm}$$

$$l_{c+s} = \frac{100}{-1000} \times 10^2 - \left( \frac{60}{2} - 29.4 \right) = -10.6 \text{ cm}$$

$$-l_1 = -11.1 < -10.6 < l_2 = 10.7$$

$$\sigma_c = \frac{-1000}{1938.6} \times 10 - \frac{\cancel{1000} \times (\cancel{10.6})}{632950} \times 30.6 \times 10$$

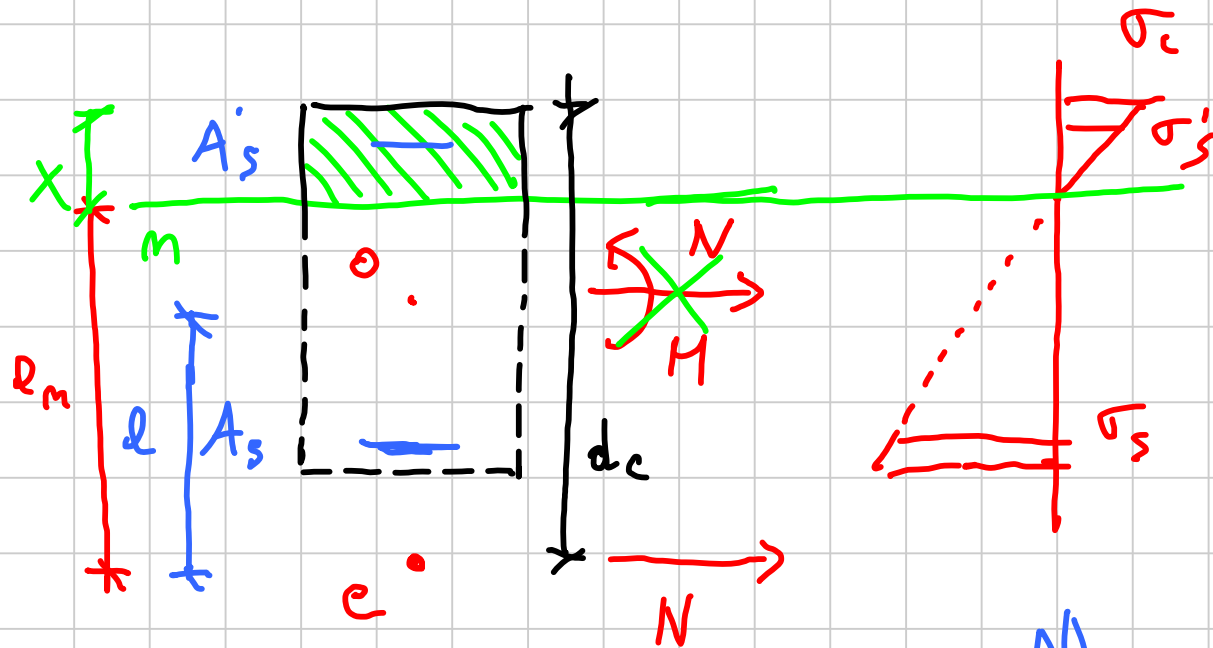
|

$$= -10.3 \text{ MPa}$$

$$\sigma_c = 10.3 \leq 0.6 f_{ck} = 15 \text{ MPa}$$



# Flessione composta con flessione eccentrica (II stadio)



$$e_m = \frac{I_m}{S_m}$$

$$e = \frac{M}{N}$$

$$d_c = \frac{h}{2} + e$$

$$e_m = d_c - x$$

$$S_m = -\frac{bx^2}{2} - mA'_s(x-c) + mA_s(d-x)$$

$$I_m = \frac{bx^3}{3} + mA'_s(x-c)^2 + mA_s(d-x)^2$$

$$I_m = S_m e_m$$

$$\left(-\frac{bx^2}{2} - mA'_s x + mA'_s c + mA_s d - mA_s x\right)(d_c - x) =$$

$$= -\frac{bx^2}{2} d_c + \frac{bx^3}{2} - mA'_s d_c x + mA'_s x^2 + mA'_s c d_c +$$

$$- mA'_s c x + mA_c d d_c - mA_s d x - mA_s d_c x + mA_s x^2$$



$$- \frac{b x^2}{2} d_c + \frac{b x^3}{2} - \underline{\underline{m A'_s d_c x}} + \cancel{\underline{\underline{m A'_s x^2}}} + m A'_s e d_c +$$

$$- \underline{\underline{m A'_s e x}} + m A_c d d_c - \underline{\underline{m A_s d x}} - \underline{\underline{m A_s d_c x}} + \cancel{\underline{\underline{m A_s x^2}}}$$

$$= \frac{b x^3}{3} + \cancel{\underline{\underline{m A'_s x^2}}} + m A'_s e^2 - \underline{\underline{2 m A'_s x e}} + m A_s d^2 +$$

$$\cancel{\underline{\underline{m A_s x^2}}} - \underline{\underline{2 m A_s d x}}$$

$$\cancel{\frac{b x^3}{6}} - \cancel{3} \frac{b d_c x^2}{2} + \frac{6m}{b} [A'_s (e - d_c) + \dot{A}_s (d - d_c)] x$$

$$- \frac{6m}{b} [A'_s (e - d_c) e + A_s (d - d_c) d] = 0$$

$$x^3 - 3d_c x^2 + \frac{6m}{b} [A'_s(c - d_c) + A_s(d - d_c)]x +$$

$$- \frac{6m}{b} [A'_s(c - d_c)c + A_s(d - d_c)d] = 0$$

$$\sigma = \frac{N}{S_m} S$$

$$S_m = -\frac{bx^2}{2} - mA'_s(x - c) + mA_s(d - x) \quad \parallel \Leftarrow$$

$$\sigma = \frac{Ne_m}{I_m} S$$

$$I_m = \frac{bx^3}{3} + mA'_s(x - c)^2 + mA_s(d - c)^2$$

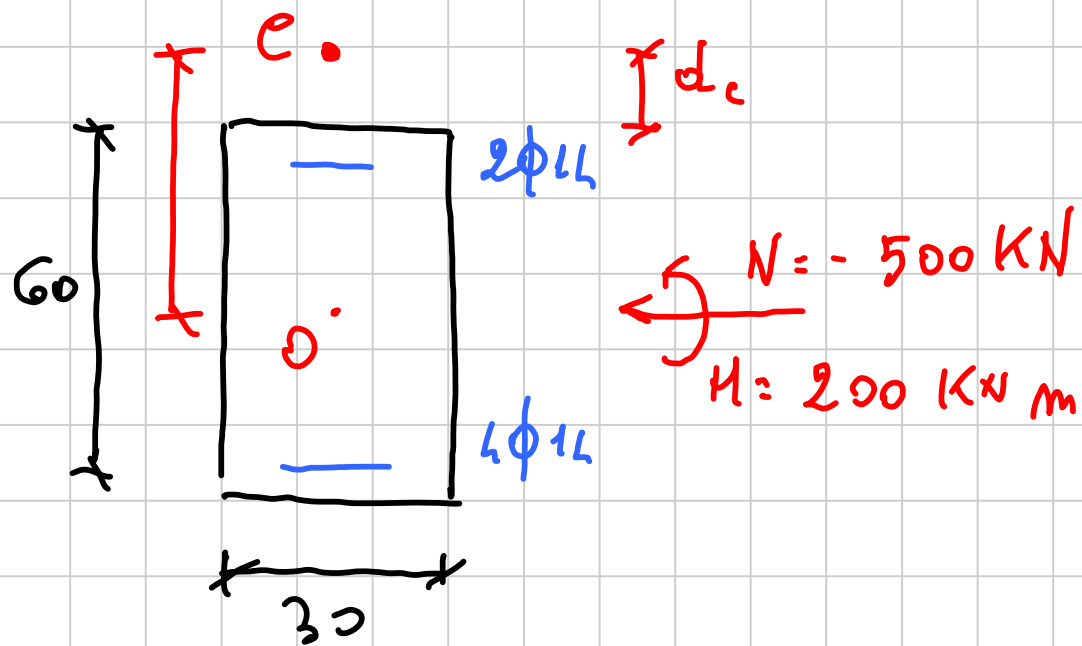
$$\sigma_c = - \frac{N}{S_m} x \leq 0.6 f_{ck}$$

здесь

приним.

$$0.45 f_{ck}$$

$$\sigma_s = m \frac{N}{S_m} (d - x) \leq 0.8 f_{yk}$$



C 25/30

B 450 C

$e = 4 \text{ cm}$

$$e = \frac{M}{N} = \frac{200}{-500} = -0,4 \text{ m} = -40 \text{ mm}$$

$$x^3 - 3d_c x^2 + \frac{6M}{b} [A'_s (c - d_c) + A_s (d - d_c)] x - \frac{6M}{b} [A'_s (c - d_c) c + A_s (d - d_c) d] = 0$$

$$A = 1$$

$$B = -3 \times (-10) = 30 \text{ cm}$$

$$C = \frac{6 \times 15}{30} \times [3.08 \times (4 + 10) + 6.16 \times (56 + 10)] = 1349 \text{ cm}^2$$

$$D = -\frac{6 \times 15}{30} \times [3.08 \times 14 \times 4 + 6.16 \times 66 \times 56] = -68819.5 \text{ cm}^3$$

$$x = 25,2 \text{ cm}$$

$$\sigma = \frac{N}{S_m}$$

$$S_m = - \frac{30 \times 25,2^2}{2} - 15 \times 3,08 \times (25,2 - e) + 15 \times 6,16 \times (56 - 25,2)$$

$$= - 7659 \text{ cm}^2$$

NO

$$\sigma_c = - \frac{500}{-7659} \times 25,2 \times 10 = \underline{16,5 \text{ MPa}} \leq 15 \text{ MPa}$$

$$\sigma_s = 15 \times \frac{500}{-7659} \times (56 - 25,2) \times 10 = 301,6 \text{ MPa} \leq 360 \text{ MPa}$$

Flessione composta - tensioni ammissibili

$$\sigma_c \quad \sigma_s$$

$$\sigma_c \leq \bar{\sigma}_c$$

$$\sigma_s \leq \bar{\sigma}_s$$

$$\sigma_{cm} \leq 0.4 \bar{\sigma}_c$$

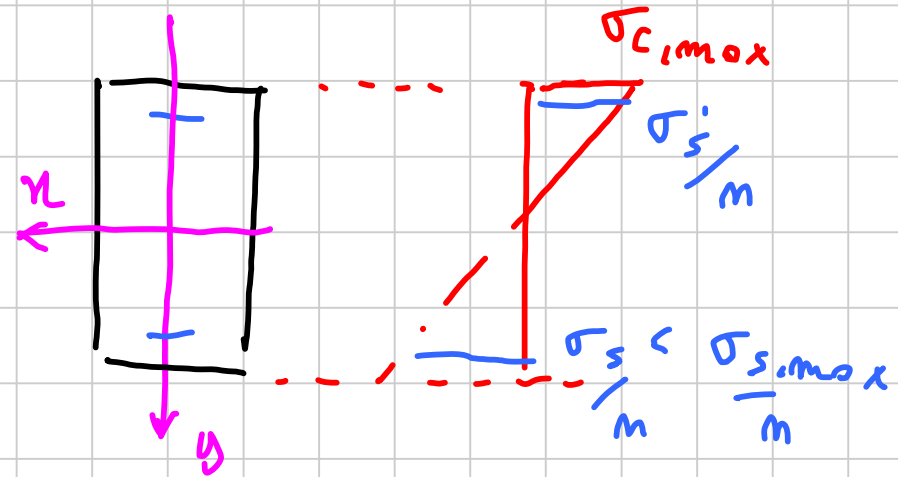
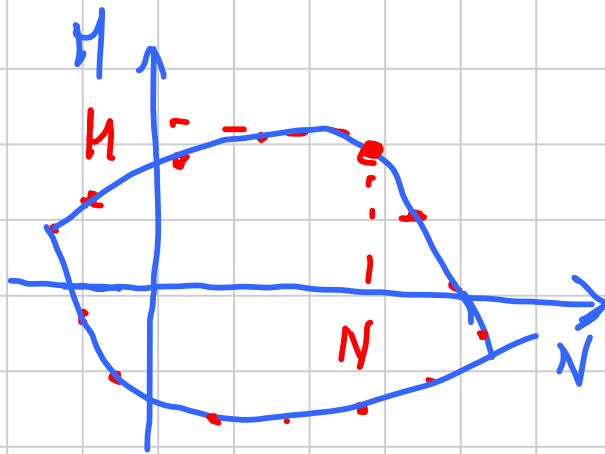
$\sigma_c$  e  $\sigma_s$  come per tensioni uniepis

Estado limite de flexão no exercício 2

$$\sigma_c = \sigma_{c,max}$$

0

$$\sigma_s = \sigma_{s,max}$$



$$N = \int_A \sigma dA$$

$$M = \int_A \sigma y dA$$



# DOMINI H-N e diagrammi limite di tensioni

