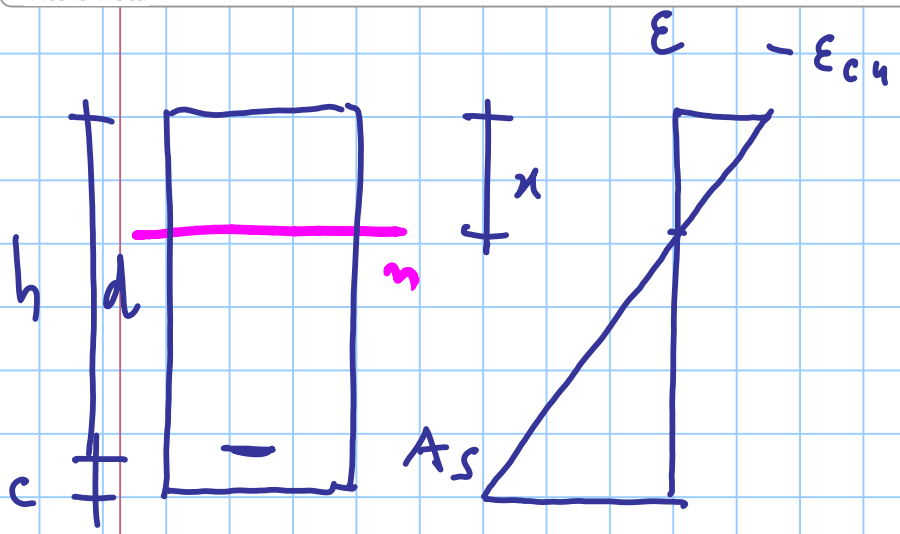
VERIFICA FLESSIONE SLV

Titolo nota 03/04/2014



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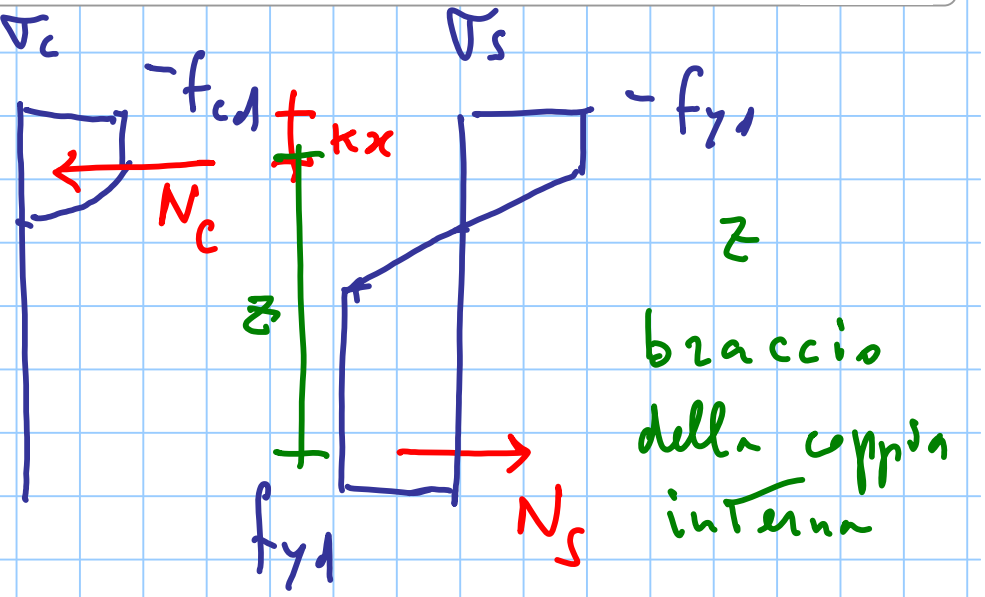


per Trovare x

$$N_c = -\beta b x f_{cd}$$

$$N_s = \sigma_s A_s$$

$$N = \int \sigma \, dA = \int_{cls} \sigma_c \, dA_c + \int_{acc} \sigma_s \, dA_s$$

$$-\beta b x f_{cd} + A_s f_{yd} = 0$$

$$x = \frac{A_s f_{yd}}{\beta b f_{cd}}$$

$$M_{Rd} = \int \sigma_y \, dA \qquad M_{Rd} = N_s \; z$$

$$z = d - k x$$

$A_s = 4.62\ cm^2$

$d = 56\ cm$

$M_{Ed} = 100\ kN_m$

C25/30 $\quad f_{cd} = 14.17\ MPa$

B450c $\quad f_{yd} = 391.3\ MPa$

$$x = \frac{A_s f_{yd}}{\beta b f_{cd}} = \frac{4.62 \times 391.3}{0.81 \times 30 \times 14.17} =$$

$$= 5.25\ cm$$

$$z = d - kx = 56 - 0.416 \times 5.25 =$$

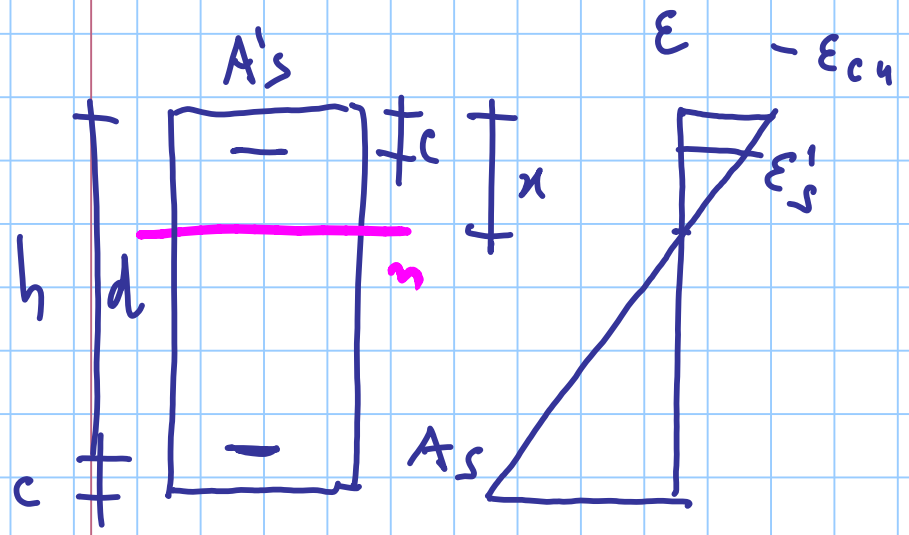
$$= 53.8\ cm$$

$$M_{Rd} = A_s f_{yd} z = \frac{4.62 \times 391.3 \times 53.8}{1000} =$$

$$= 97.3\ kN\,m$$

$$N_c = \frac{14.17 \times 30 \times 5.25 \times 0.81}{10} = 180.77 \text{ kN}$$

$$N_s = A_s f_{yd} = \frac{4.62 \times 391.3}{10} = 180.78 \text{ kN}$$



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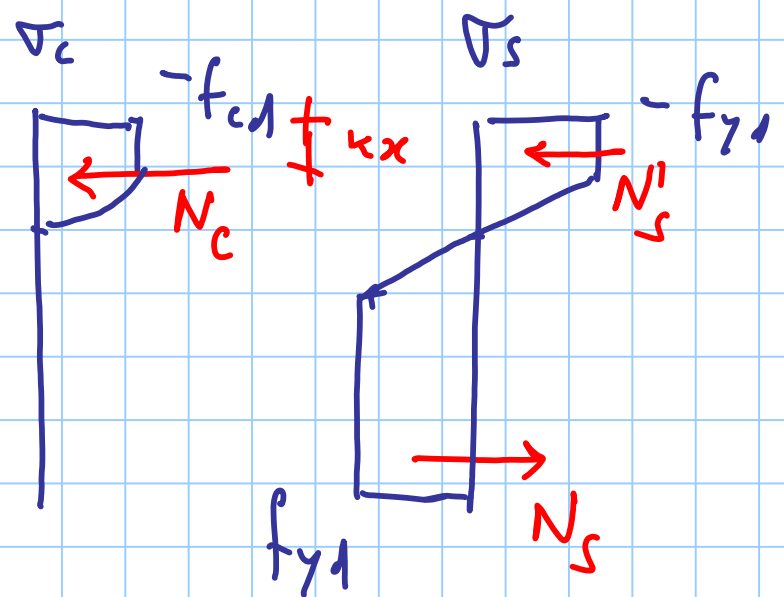


$$N'_s = A'_s \sigma'_s \qquad \frac{\varepsilon'_s}{-\varepsilon_{cu}} = \frac{x-c}{x}$$

$$\varepsilon'_s = -\varepsilon_{cu}\frac{x-c}{x}$$

$x \quad \varepsilon_{yd} > \varepsilon'_s > -\varepsilon_{yd} \qquad \sigma'_s = E_s \varepsilon'_s$

$x \quad \varepsilon'_s \leq -\varepsilon_{yd} \qquad \sigma'_s = -f_{yd}$

armatura compressa snervata x

$$-\varepsilon_{cu}\frac{x-c}{x} \leq -\varepsilon_{yd}$$

$$-\varepsilon_{cu}x + \varepsilon_{cu}c \leq -\varepsilon_{yd}x$$

$$\varepsilon_{cu}\cdot c \leq (\varepsilon_{cu}-\varepsilon_{yd})x$$

$$x \geq 2.26\ c$$

$$x \geq \frac{\varepsilon_{cu}}{\varepsilon_{cu}-\varepsilon_{yd}}c$$

$\varepsilon_{cu} = 3.5\times10^{-3}$

$\varepsilon_{yd} = 1.95\times10^{-3}$

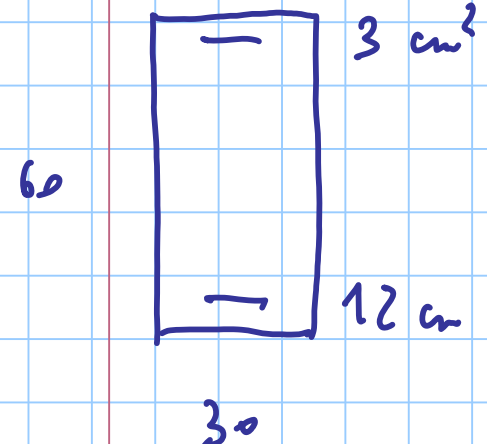
$\varepsilon_{cu} = 3.5\times10^{-3}$

Se l'armatura compressa è snervata

$$N'_s = -A'_s f_{yd}$$

$$N = 0 \rightarrow \quad -\beta b x f_{cd} + A_s f_{yd} - A'_s f_{yd} = 0$$

$$x = \frac{(A_s - A'_s) f_{yd}}{\beta b f_{cd}}$$



$$x = \frac{(12-3)\,391.3}{0.81 \times 30 \times 14.17} = 10.23 \text{ cm}$$

$Kx = 0.416 \times 10.23$

$= 4.26$ cm

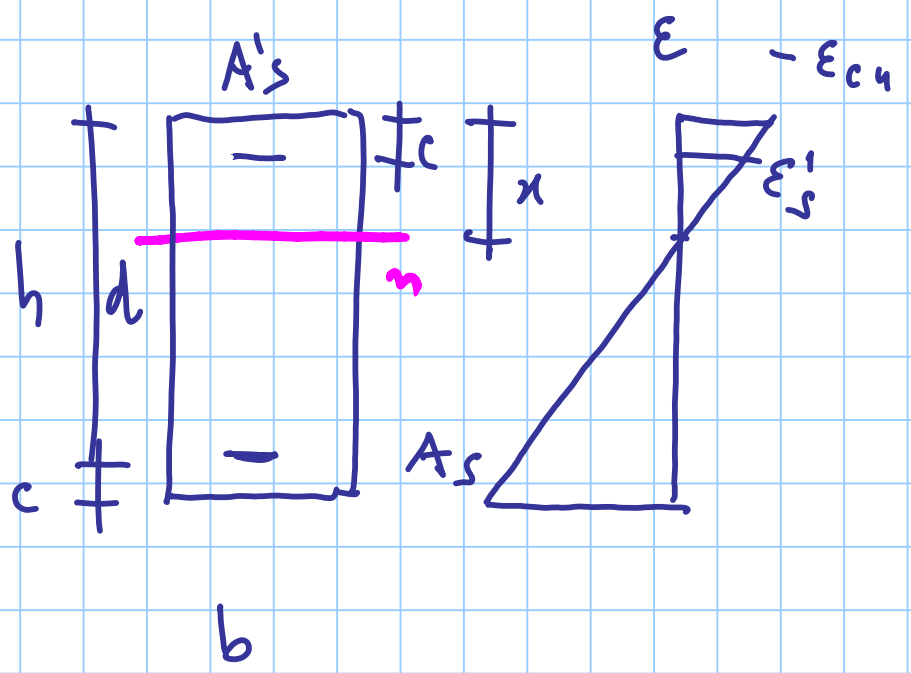
A'_s è ancora ?

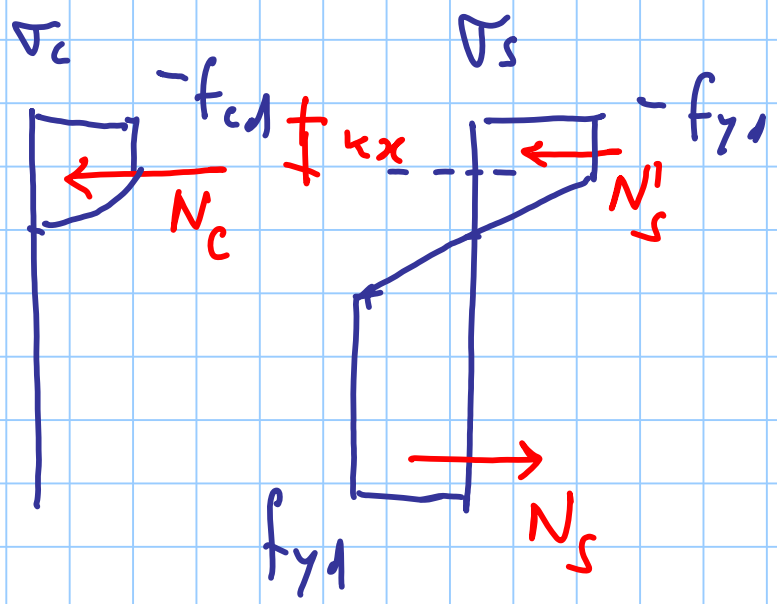
$$\frac{x}{c} = \frac{10.23}{4} = 2.56 > 2.26 \quad SI$$

$$M_{Rd} = A_s f_{yd}(d - Kx) + A'_s f_{yd}(Kx - c) =$$

$$= \left[12 \times 391.3 \times (56 - 4.26) + 3 \times 391.3\,(4.26 - 4)\right] \times 10^{-3} =$$

243.0 0.3 $= 243.3$ kNm





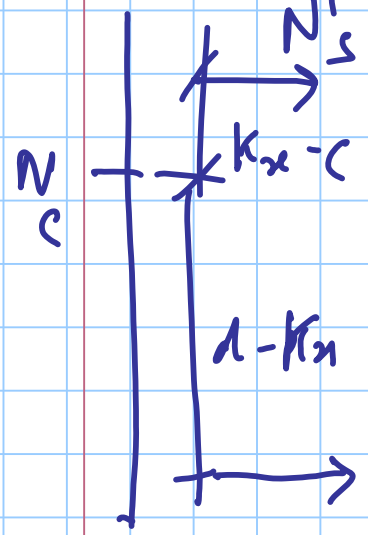
M posso calcolarlo rispetto a qualsiasi punto

lo faccio rispetto a N_c

$$M_{Rd} = A_s f_{yd} (d - Kx) + A'_s f_{yd} (Kx - c)$$

se A'_s aumenta

$$\mu = \frac{A'_s}{A_s}$$



col segno

$$N'_s = A'_s \sigma'_s = -s' \mu A_s f_{yd}$$

$$\frac{\sigma'_s}{-f_{yd}} = s' \quad (s' = 1 \text{ se snerv.})$$

$$N_s = A_s \sigma_s = s A_s f_{yd}$$

$$\frac{\sigma_s}{f_{yd}} = s \quad (s = 1)$$

$$M_{Rd} = \underbrace{s}_{=1} A_s f_{yd} (d - \kappa x) + s' m A_s f_{yd} (\kappa x - c)$$

$$= A_s f_{yd} (d - \kappa x) \left[1 + s' m \frac{\kappa x - c}{d - \kappa x} \right]$$

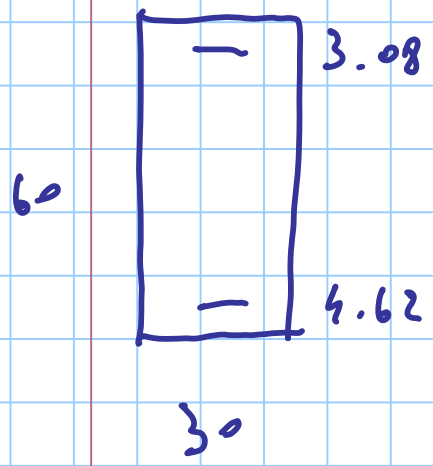
se l'armatura compressa non è snervata

$$N = 0 \rightarrow \quad -\beta b x f_{cd} + A_s f_{yd} + A'_s \sigma'_s = 0$$

$$\sigma'_s = E_s \varepsilon'_s \qquad \varepsilon'_s = -\varepsilon_{cu} \frac{x - c}{x}$$

$$-\beta b x f_{cd} + A_s f_{yd} - A'_s E_s \varepsilon_{cu} \frac{x - c}{x} = 0$$

equazione di 2° grado



$x \; A'_s = 0 \qquad x = 5.25$

$$-\beta b f_{cd} = -344.3$$

$$A_s f_{yd} = 1807.8$$

$$A'_s E_s \varepsilon_{cd} = 2156$$

$$-344.3 x + 1807.8 - 2156 \frac{x-4}{x} = 0$$

$$-344.3 x^2 + 1807.8 x - 2156 x + 8624 = 0$$

$$-348.2 x$$

$$x^2 + 1.011\,x - 25.05 = 0$$

$$x = -\frac{1.011}{2} \pm \sqrt{\left(\frac{1.011}{2}\right)^2 + 25.05}$$

$$-0.506 + \underbrace{\sqrt{0.506^2 + 25.05}}_{5.03} = 4.525 \text{ m}$$

$x = 4.525\ cm$

$$\varepsilon'_s = -\varepsilon_{cu}\frac{x-c}{x} = -3.5\times10^{-3}\ \frac{4.525-4}{4.525} = -0.406\times10^{-3}$$

$\sigma'_s = -81.2\ MPa$ NON SNERVATA

$$N_s = A_s f_{yd} = 4.62\times391.3\times10^{-1} = 180.8\ kN$$

$$N'_s = A'_s \sigma'_s = 3.08\times(-81.2)\times10^{-1} = -25.0\ kN$$

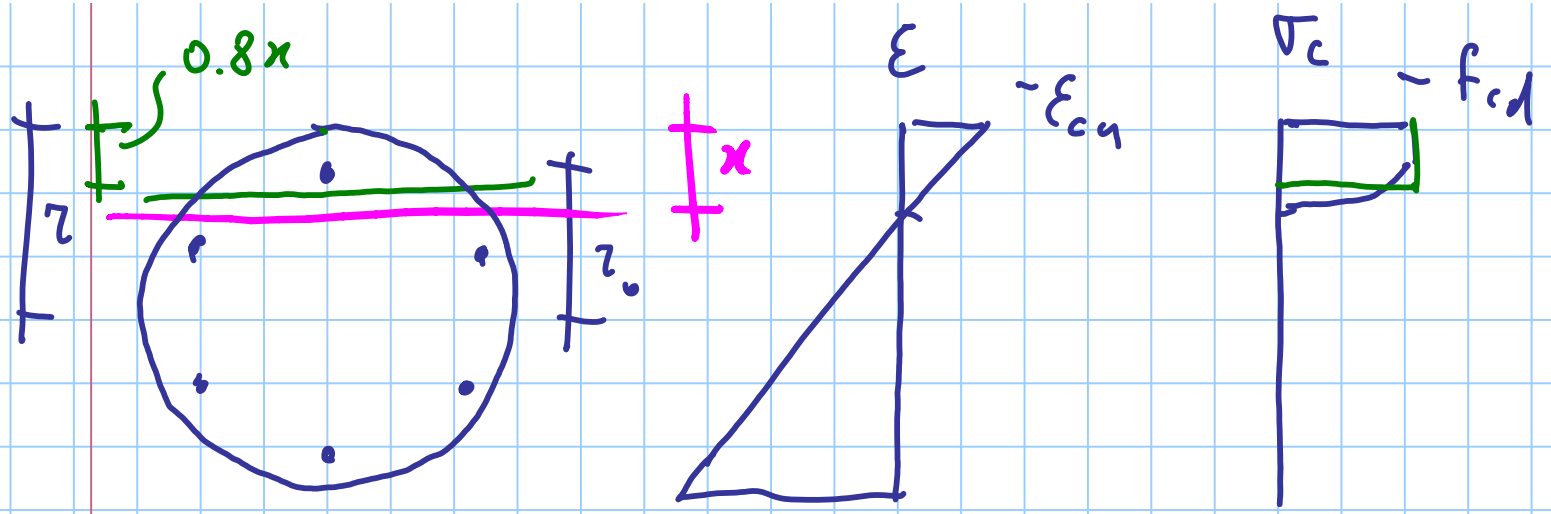
$$N_c = -\beta b x f_{cd} = -0.81\times30\times4.525\times14.17\times10^{-1} = -155.8\ kN$$

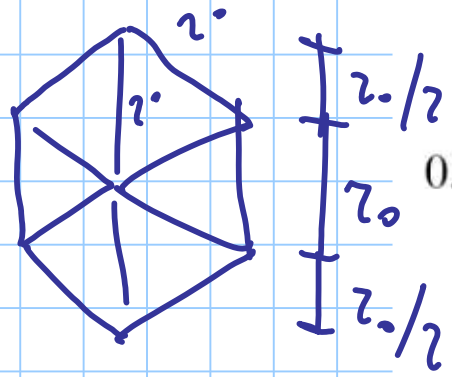
OK $N_s + N'_s + N_c \geq P$ $\quad kx = 1.882$

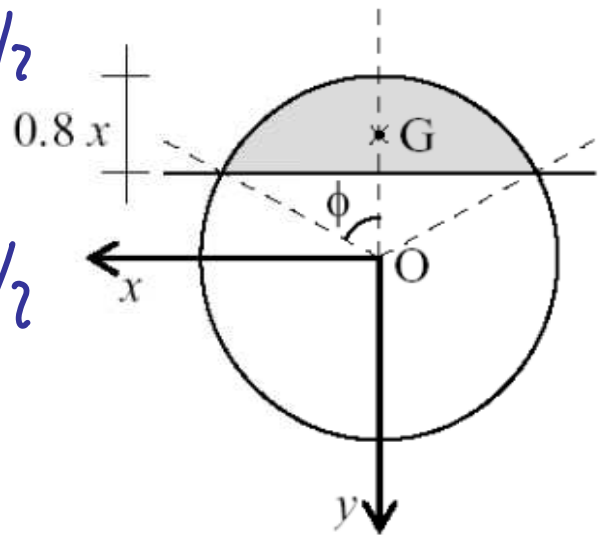
$$M_{Rd} = A_s f_{y1} (d - kx) - A'_s \sigma'_s (kx - c) =$$

$$= \left[4.62 \times 391.3 \left(56 - 1.882 \right) + 3.08 \times 81.2 \left(1.882 - 4 \right) \right] \times 10^{-3}$$

$$97.8 \qquad - 0.5 \qquad = 97.3 \ kNm$$





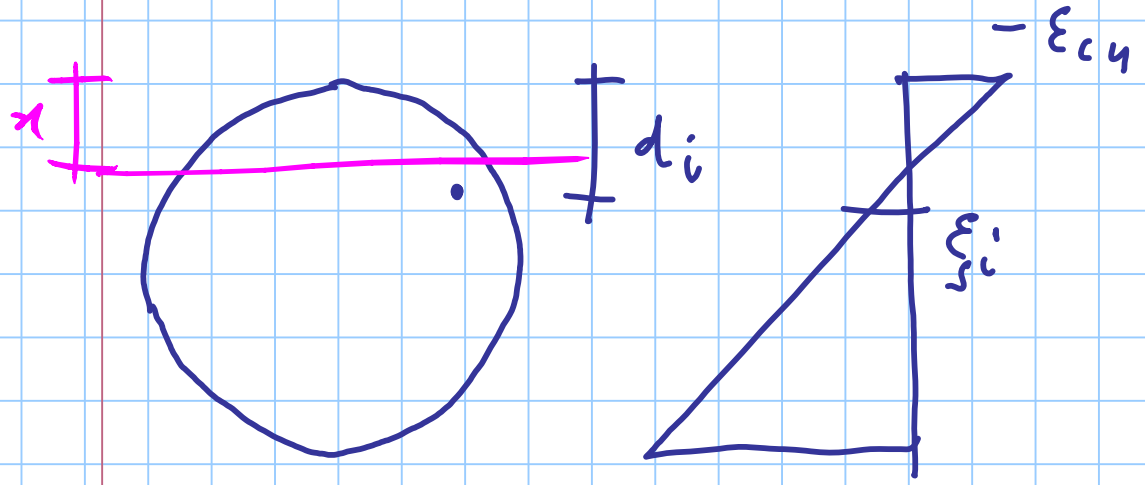


$$\phi = \arccos\frac{r - 0.8\,x}{r}$$

$$A = \frac{r^2}{2}(2\,\phi - \sin 2\phi)$$

$$d_{OG} = \frac{2}{3}\frac{r^3 \sin^3\phi}{A}$$

assign x



$$\frac{\varepsilon_{si}}{\varepsilon_{cu}} = \frac{d_i - x}{x}$$

$$A_{si} \rightarrow \varepsilon_{si} = \varepsilon_{cu} \frac{d_i - x}{x} \rightarrow \sigma_{si}$$

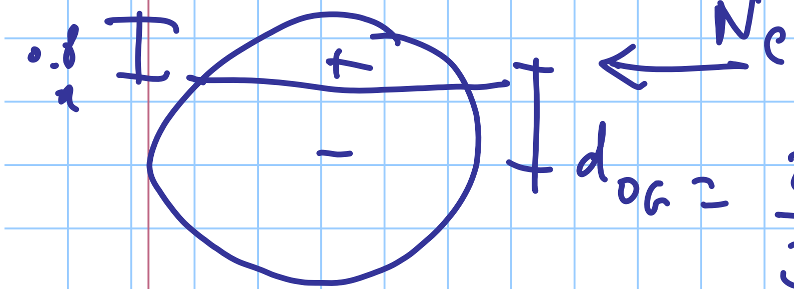
$$N_{si} = A_{si}\ \sigma_{si}$$

$$N_c = -A_c f_{cd}$$

$$A_c = \frac{r^2}{2}\left(2\phi - \sin 2\phi\right)$$

$$\phi = \arccos \frac{r - 0.8x}{r}$$

$N_c = 0 \rightarrow x$



$$d_{OG} = \frac{2}{3} \frac{r^3 \sin^3\phi}{A_c}$$

calcolo M eff. di N_c N_s : (rispetto ad O)