FLESSIONE

Titolo nota 09/04/2014

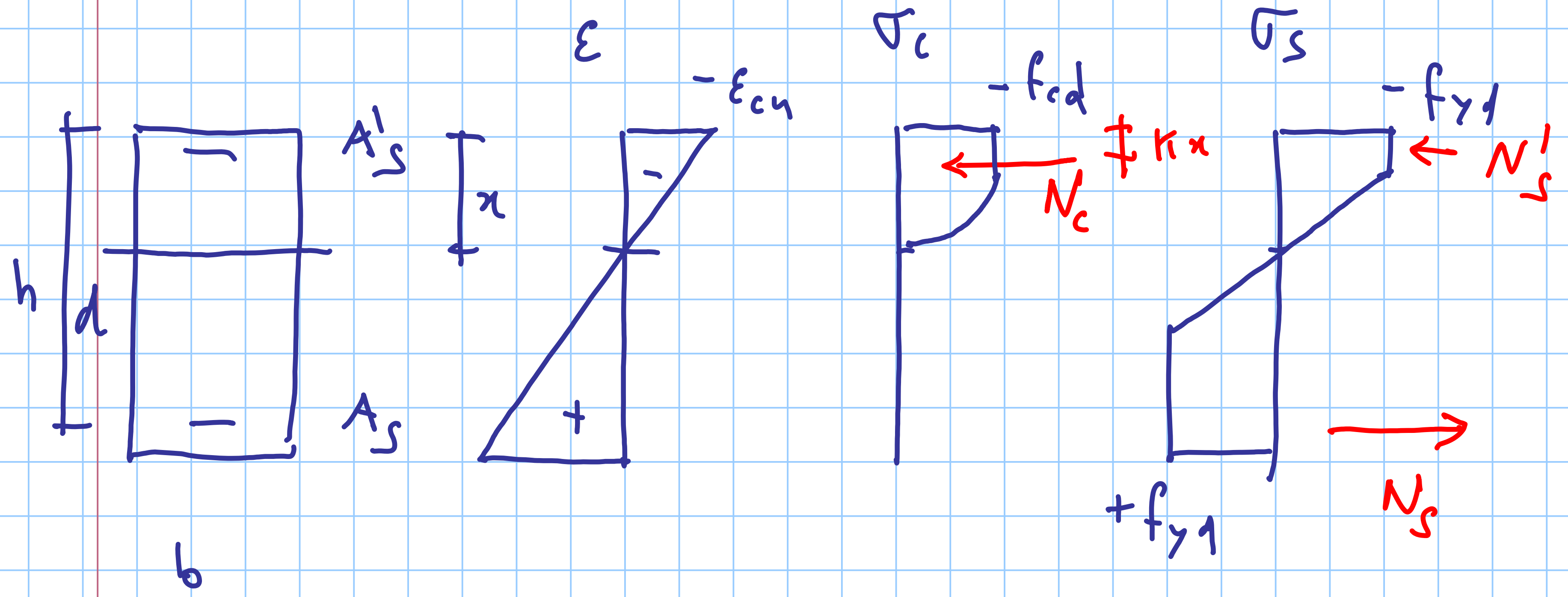
VERIFICA SLU

assegnato SEZIONE ARMATURA

M_{Ed}

procedimento: calcolo x (dalla condizione $N = 0$)

M_{Rd} (da equilibrio rotaz.)

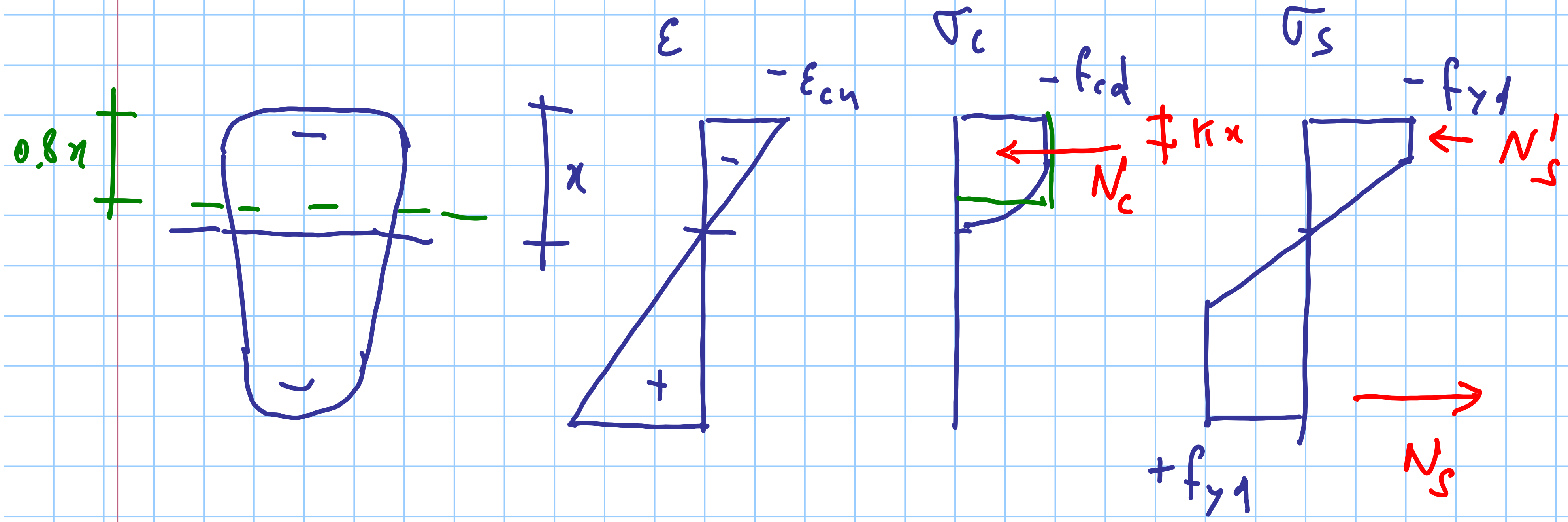


$$N_c = -\beta \, A_c \, f_{cd} = -\beta \, b \, x \, f_{cd}$$

area compressa

$\beta \to 0.81$

$$N_s = A_s \, \sigma_s \qquad\qquad N_s' = A_s' \, \sigma_s'$$

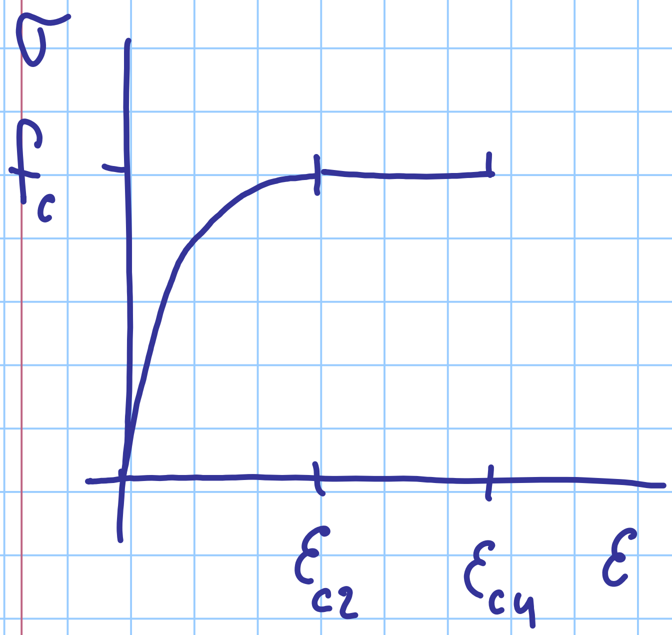

0.8x
x
ε
−εcu
σc
−fcd
k1x
Nc
σs
−fyd
N's
Ns
+fyd

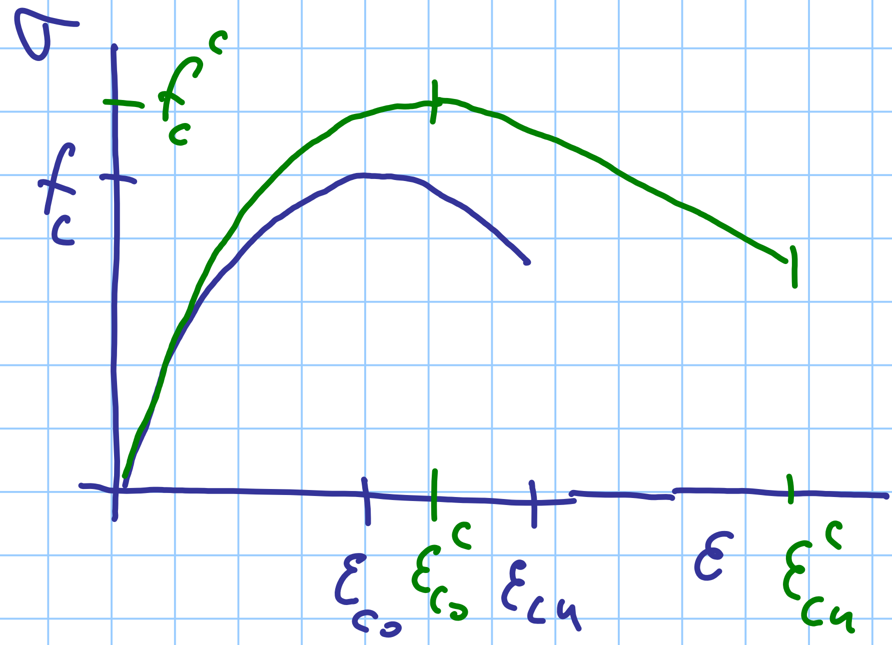
$$N_c = -\beta\, b\, x\, f_{cd}$$

$$N_s = A_s\, f_{yd}$$

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

$$M_{Rd} = A_s\,(d - \kappa\, x)$$





convenzionale

usato per verifiche SLU

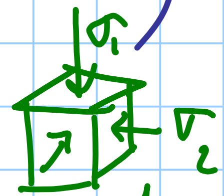
$$\varepsilon_{c2} = 2\times10^{-3}$$

$$\varepsilon_{cu} = 3,5\times10^{-3}$$

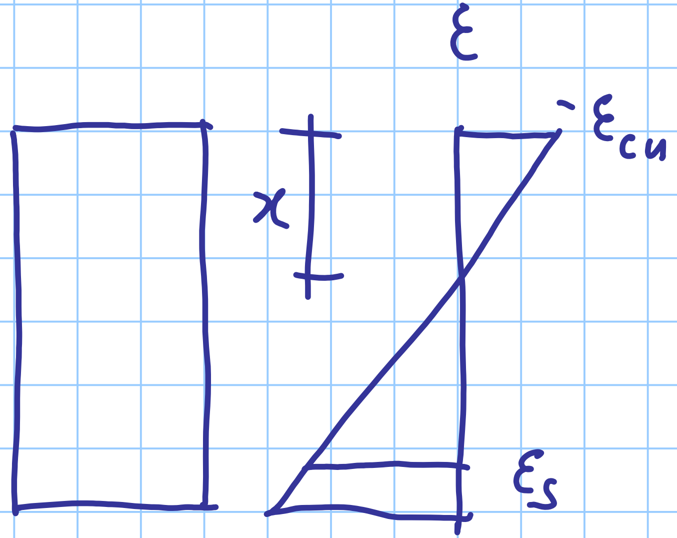
sperimentale

(o una approssimazione)

CLS confinato

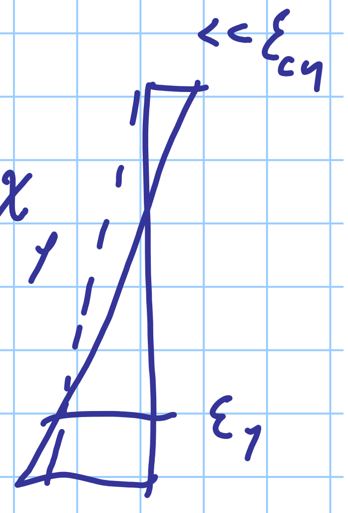


dovuta a staffe



$\frac{\varepsilon_y}{d} \leftarrow \chi_y$

snerv. x $\varepsilon_s = \varepsilon_y$

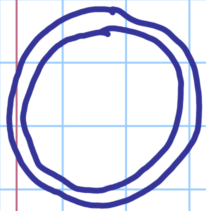


$\frac{1}{r} = \chi$ curvatura = pendenza del diag. di ε

$$\frac{1}{r_u} = \chi_u = \frac{\varepsilon_{cu}}{x}$$

$$\frac{\chi_u}{\chi_y} = \frac{\varepsilon_{cu}/x}{\varepsilon_y/d} = \frac{\varepsilon_{cu}/\varepsilon_y}{x/d}$$

CONFINAMENTO dovuto alle staffe

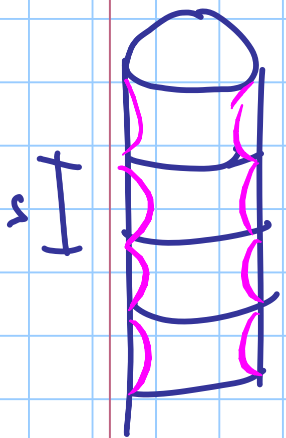


$$\sigma_{c,trasv} = \sigma_2 = 0.5\, \omega_{st}\, f_c$$

r_0

$$\omega_{st} = \frac{2 A_{st}}{s\, r_0}\, \frac{f_y}{f_c}$$

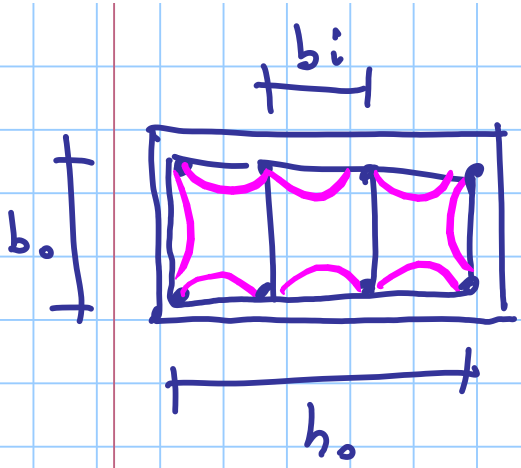
$$\alpha = \left(1 - \frac{s}{3 d_0}\right)^2$$



α efficacia

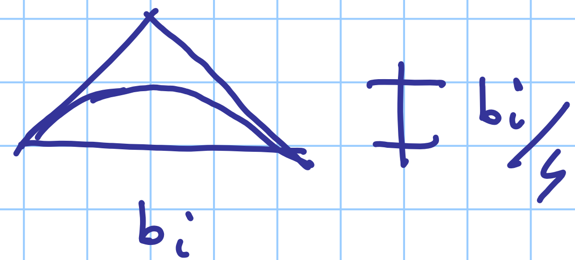
$$\frac{\text{Volume ben confinato}}{\text{Volume Tot}}$$

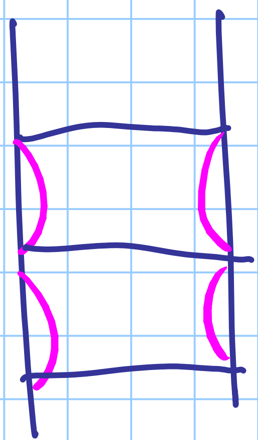
$$\sigma_2 = 0.5\, \alpha\, \omega_{st}\, f_c$$



$$\omega_{st} = \frac{A_{st}\, l_{TOT}}{s\, b_0\, h_0}\,\frac{f_y}{f_c}$$

$$\alpha_n = 1 - \frac{\sum b_i^2}{6\, b_0\, h_0}$$

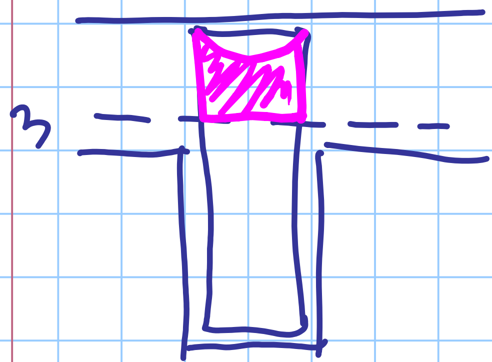


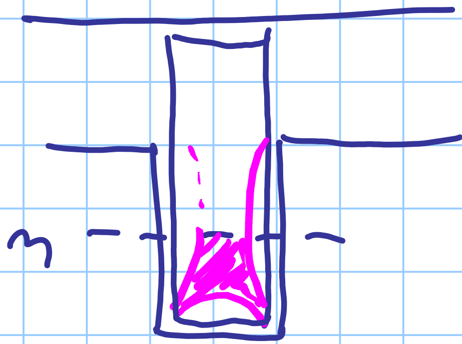


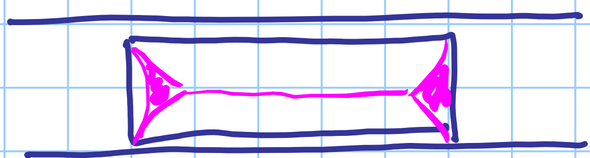
$$\alpha = \alpha_n\, \alpha_s$$

$$\alpha_s = \left(1 - \frac{s}{3\, b_0}\right)\left(1 - \frac{s}{3\, h_0}\right)$$

$$\sigma_2 = 0{,}5\, \alpha\, \omega_{st}\, f_c$$

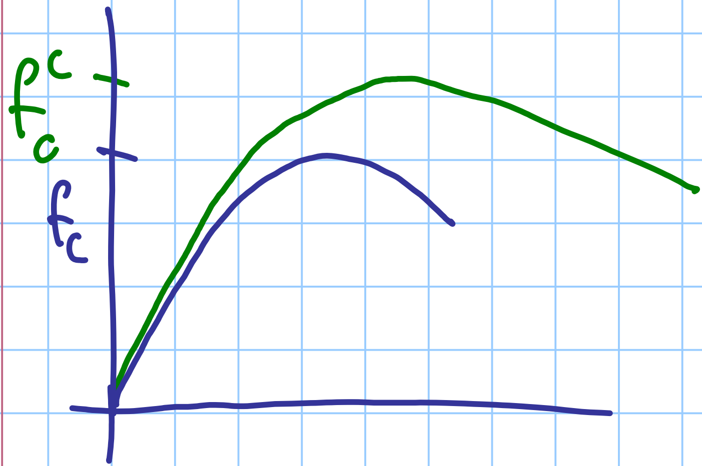






non confinato

CALCESTRUZZO CONFINATO



$$f_c^c = f_c + 5.0\ \sigma_2$$

per $\sigma_2 \le 0{,}05\ f_c$

$$f_c^c = 1{,}125\ f_c + 2.5\ \sigma_2$$

$$\varepsilon_u^c = \varepsilon_u + 0.14\ \omega_{st}$$

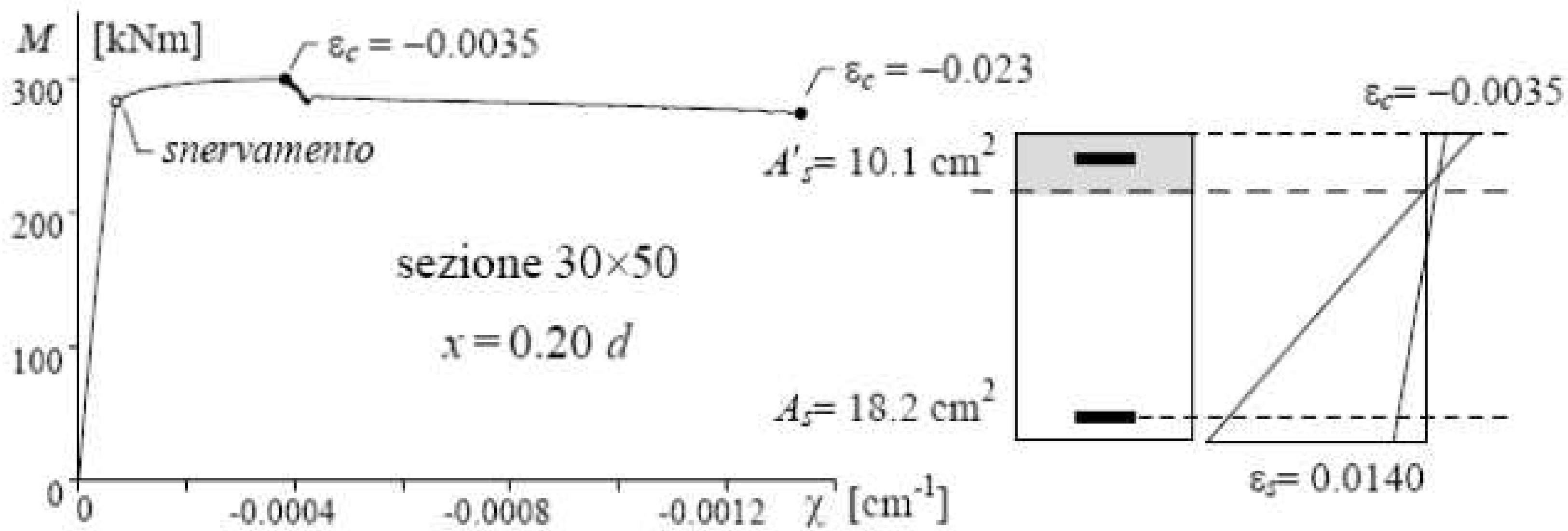
$$f_c^c = K\ f_c$$

$$\varepsilon_{co}^c = K^2\ \varepsilon_{co}$$

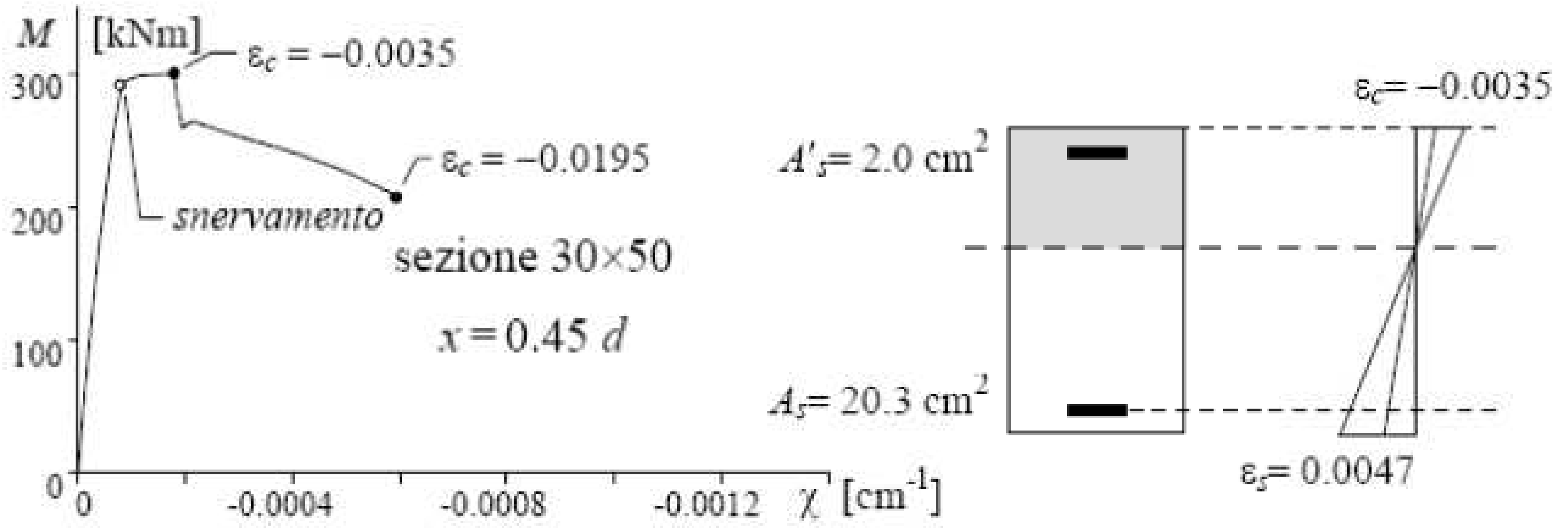
DUTTILITA'

a parità di resistenze

in funzione di A_s e A'_s



$A_s = 18.2 \text{ cm}^2$ $\quad$ $A'_s = 10.1 \text{ cm}^2$



$A_s = 20.3\ cm^2$ $\qquad$ $A'_s = 2{,}0\ cm^2$

per avere una buona duttilità $\frac{x}{d}$ deve essere piccolo

ASSUMO $\frac{x}{d} = 0.25$

PROGETTO SLU

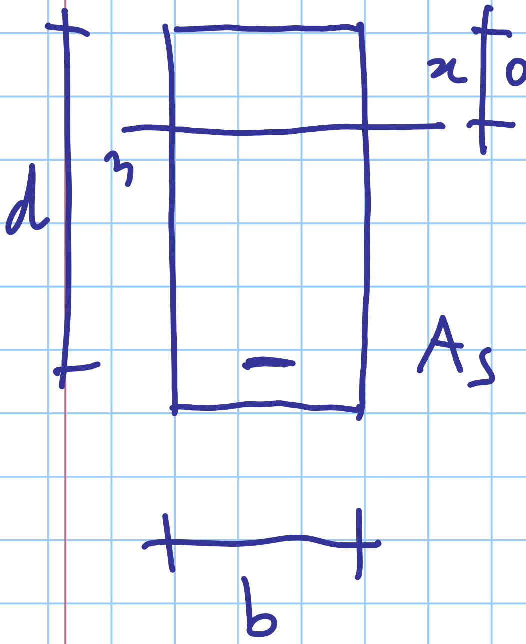
assegnato : $M_{Ed} \rightarrow M_{Rd}$ necessario

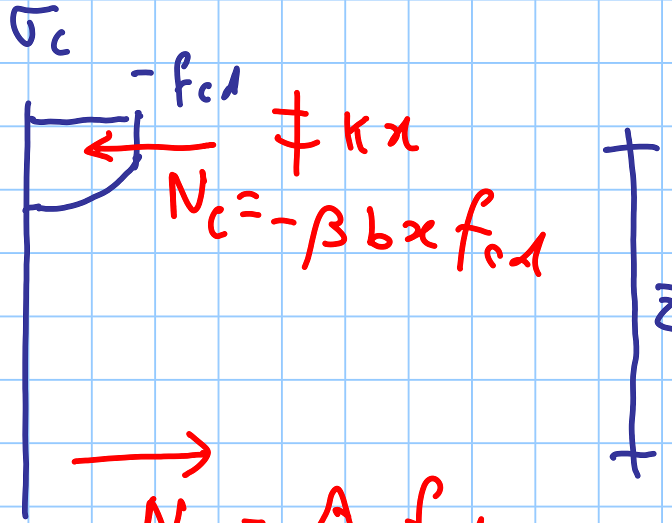
determinare : sezione e armatura

procedimento : assegno x $\left(\text{o meglio } \frac{x}{d} \right)$

$\hookrightarrow$ trovare b d A_s A_s'

SEZIONE RETTANGOLARE, semplice armatura





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

$$N_s = A_s f_{yd}$$

$$z = d - \kappa x = d(1-\kappa\xi)$$

$$M_{Rd} = N_s\, d(1-\kappa\xi)$$

$$M_{Rd} = N_c\, d(1-\kappa\xi)$$

$$\xi = \frac{x}{d}$$

progetto della sezione

$$M_{Rd} = N_c \, d\,(1-K\xi) = \overbrace{\beta\, b\, \xi\, d\, f_{cd}}^{N_c}\, d\,(1-K\xi)$$

$$M_{Rd} = \beta\,\xi\,(1-K\xi)\, f_{cd} \cdot b\, d^2$$

$$M_{Rd} = \frac{b\, d^2}{r^2} \qquad r = \frac{1}{\sqrt{\beta\,\xi\,(1-K\xi)\, f_{cd}}}$$

UNITA' DI MISURA per la formula

KN e m

Cls C25/30

$f_{cd} = 14.17$ MPa =

= 14170 KPa

$$r = \frac{1}{\sqrt{0,81 \times 0.25 (1 - 0.416 \times 0.25)\, 14170}} = 0.0197$$

$$M_{Rd} = \frac{b\,d^2}{r^2}$$ VERIFICA

30x50 c=4

$$M_{Rd} = \frac{0.30 \times 0.46^2}{0.0197^2} = 163.6 \text{ KNm}$$

$$d = r\sqrt{\frac{M_{Ed}}{b}}$$ PROGETTO (Trave emergente)

$$M_{Ed} = 300 \text{ KNm}$$

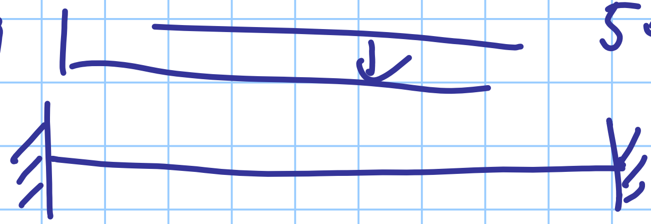
$$d = 0{,}0197 \sqrt{\frac{300}{0.30}} = 0.63 \text{ m} = 63 \text{ cm}$$

$$h = d + c \geq 67 \text{ cm} \qquad 30 \times 70$$

$$b = \frac{M_{Ed} r^2}{d^2}$$

PROGETTO (Trave a spessore)

q



50 KN/m

$h = 26$ cm

$d = 22$ cm

$l = 6.00$ m

$M_{est} = \frac{q l^2}{12} = 150$ KNm $\rightarrow$ $b = \frac{150 \times 0.0197^2}{0.22^2} = 1.20$ m

$M_{mezz} = 75$ KNm $\rightarrow$ $b = 0.60$ m

PROGETTO ARMATURA

$$M_{Rd} = N_s \, d \underbrace{(1-k\xi)}_{\simeq 0.9} \simeq A_s \, f_{yd} \, 0.9 \, d$$

$$A_s = \frac{M_{Ed}}{0.9 \, d \, f_{yd}} = \frac{150 \times 10}{0.9 \times 0.22 \times 391.3} \, cm^2 = 19.4 \, cm^2$$

Trave a spessore $d = 0.22$ m