SEZIONE A SEMPLICE ARMATURA

Titolo nota 16/04/2015

$$M = \frac{b\,d^2}{r^2}$$

$r = 0.0157$ m kN μ C25/30

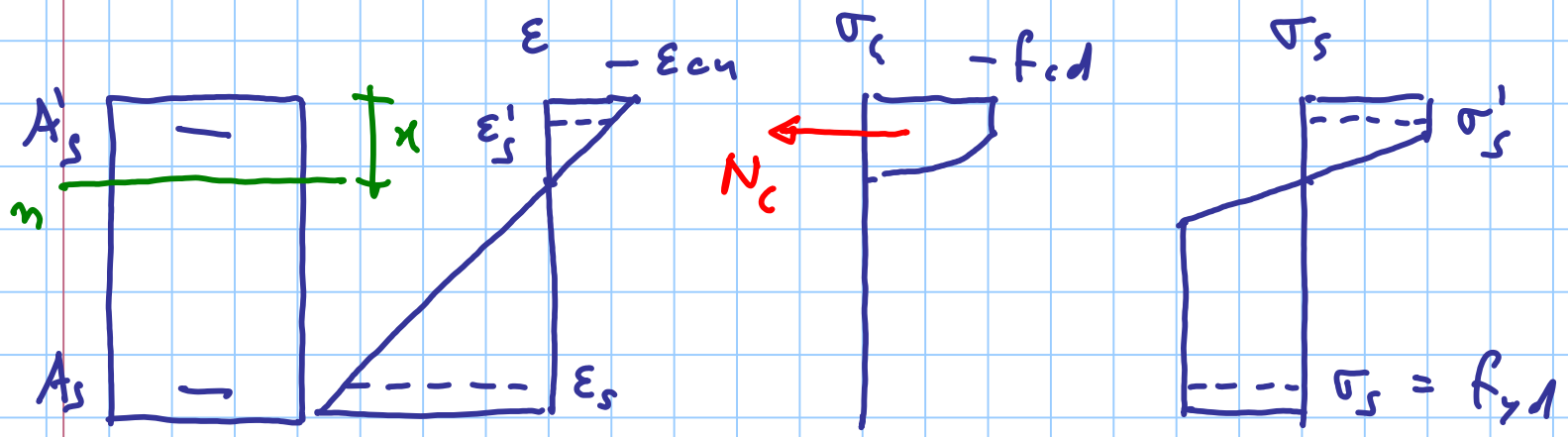
m kN

$$d = r\sqrt{\frac{M}{b}} \qquad b = \frac{M\,r^2}{d^2}$$

$$M = 0.9\,d\,A_s\,f_{yd}$$

$$A_s = \frac{M}{0.9\,d\,f_{yd}}$$

SEZIONE A DOPPIA ARMATURA



$x = 0.25\ d$

ξ

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

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

$\sigma'_s = -f_{yd}$ se $x > 2.27\ c$

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

$\sigma'_s = -s' f_{yd}$

$A'_s = n A_s$

$s' = 1$ armatura snervata

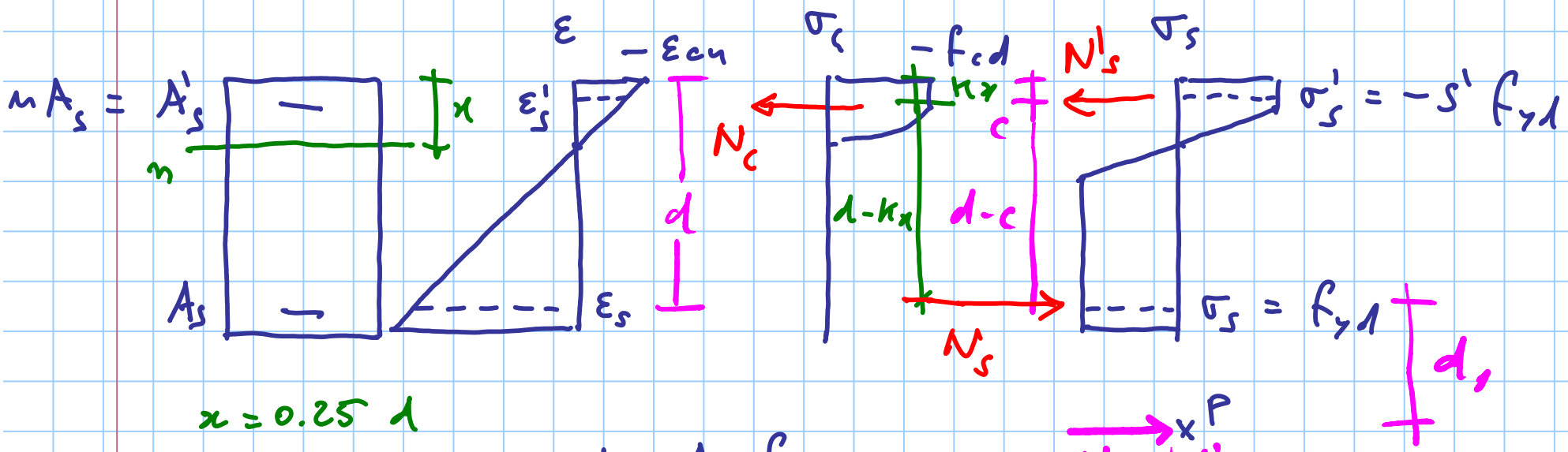
$s' < 1$ " in campo elastico

$$\sigma'_s = -\frac{x-c}{x}\,\varepsilon_{cu}\,E_s \qquad x \text{ in campo elastico}$$

$$\sigma'_s = -\underbrace{\frac{x-c}{x}\,\frac{\varepsilon_{cu}\,E_s}{f_{yd}}}_{s'}\,f_{yd}$$

$$s' = \frac{x-c}{x}\,\frac{\varepsilon_{cu}}{\varepsilon_{yd}} \leq 1$$

$$s' = \mathrm{MIN}\left(\frac{x-c}{x}\,\frac{\varepsilon_{cu}}{\varepsilon_{yd}}\,;\,1\right)$$



$x = 0.25\, d$

$\Rightarrow$

$$N_s = A_s f_{yd}$$

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

eq. r.t. rip. P

$$A_s f_{yd} d_1 = n s' A_s f_{yd} (d - c + d_1)$$

$$(1 - n s') d_1 = n s' (d - c)$$

$$d_1 = \frac{n s' (d - c)}{1 - n s'}$$

$$M_{Ed} = M_{Rd} = N_c \left(d - \kappa x + d_1\right) =$$

$$\boxed{\frac{c}{d} = \gamma}$$

$$= \beta\, b \xi d\, f_{cd} \left(1 - \kappa\xi + \frac{n s' \left(1 - \frac{c}{d}\right)}{1 - n s'}\right) d =$$

$$= \beta \xi f_{cd} \left(1 - \kappa\xi + \frac{n s' (1 - \gamma)}{1 - n s'}\right) b d^2$$

$$M = \frac{b d^2}{z'^2} \qquad \frac{1}{z'^2} = \beta \xi f_{cd} \left(1 - \kappa\xi + \frac{n s' (1 - \gamma)}{1 - n s'}\right)$$

$$\frac{1}{z'^2} = \underbrace{\beta \xi f_d (1 - K\xi)}_{\frac{1}{z^2}} \left[1 + \frac{u s'}{1 - u s'} \frac{1-\gamma}{1 - K\xi} \right]$$

$$(1-\gamma) d = d - c$$

$$(1 - K\xi) d = d - Kx$$

sperso $\quad d - c \simeq d - Kx$

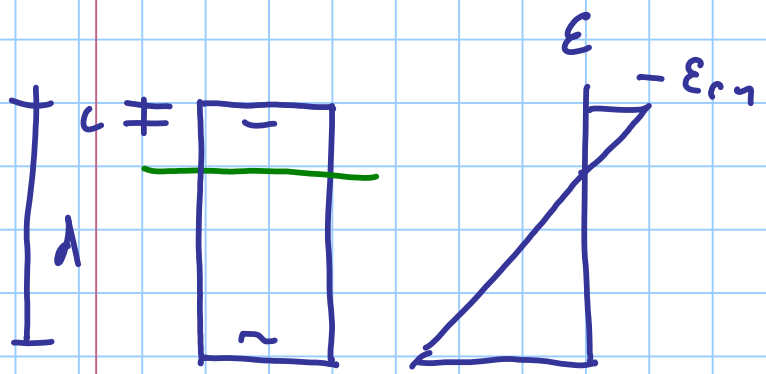
in questo caso $\quad \dfrac{1-\gamma}{1-K\xi} \simeq 1$

e quindi $\quad \dfrac{1}{z'^2} = \dfrac{1}{z^2} \left[1 + \dfrac{u s'}{1 - u s'} \right] = \dfrac{1}{z^2} \dfrac{1}{1 - u s'}$

$$\frac{1}{r'^2} \simeq \frac{1}{r^2}\,\frac{1}{1-m s'} \quad \Rightarrow \quad r' \simeq r\sqrt{1-m s'}$$

$$M = \frac{b\,d^2}{r'^2}$$

$$r' \simeq r\sqrt{1-m s'}$$



$E_s \qquad c = 0.1\ d$

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

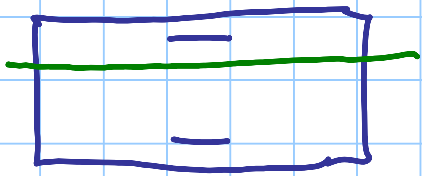
$x = 0.25\ d$
$c = 0.10\ d$
$\Big\} \rightarrow x = 2.5\ c \qquad x > 2.27\ c$

$\downarrow s' = 1$

$T_{1,are}$ dT_2 $c = 0.10\ d$ $s^1 = 1$ C 25/30

u	τ^1
0	0.0197
0.25	0.0171
0.5	0.0139

trave a spessore (ma non esageratamente bassa)



$c \neq$

$c = 0.2\,d$

$x = 0.25\,d$

$c = 0.20\,d$

$x = 1.25\,c \quad < 2.27\,c$

armatura non snervata

$$s' = \frac{x-c}{x}\,\frac{\varepsilon_{cu}}{\varepsilon_{yd}} = \frac{0.05\,d}{0.25\,d}\,\frac{3.5\times 10^{-3}}{1.96\times 10^{-3}} =$$

$= 0.357$

n	r'
0	0.0197
0.25	0.0188
0.5	0.0179
1	0.0158

$\sqrt{1 - s'n}$

$s' = 0.357$

$$A_s = \frac{M}{0.9\, d\, f_{y1}}$$

$$\rho_s = \frac{A_s}{b\, d}$$

$$A_s = \rho_s\, b\, d$$

$$\rho_s\, b\, d = \frac{M}{0.9\, d\, f_{y1}}$$

$$M = \underbrace{0.9\, \rho_s\, f_{y1}}\; b\, d^2$$

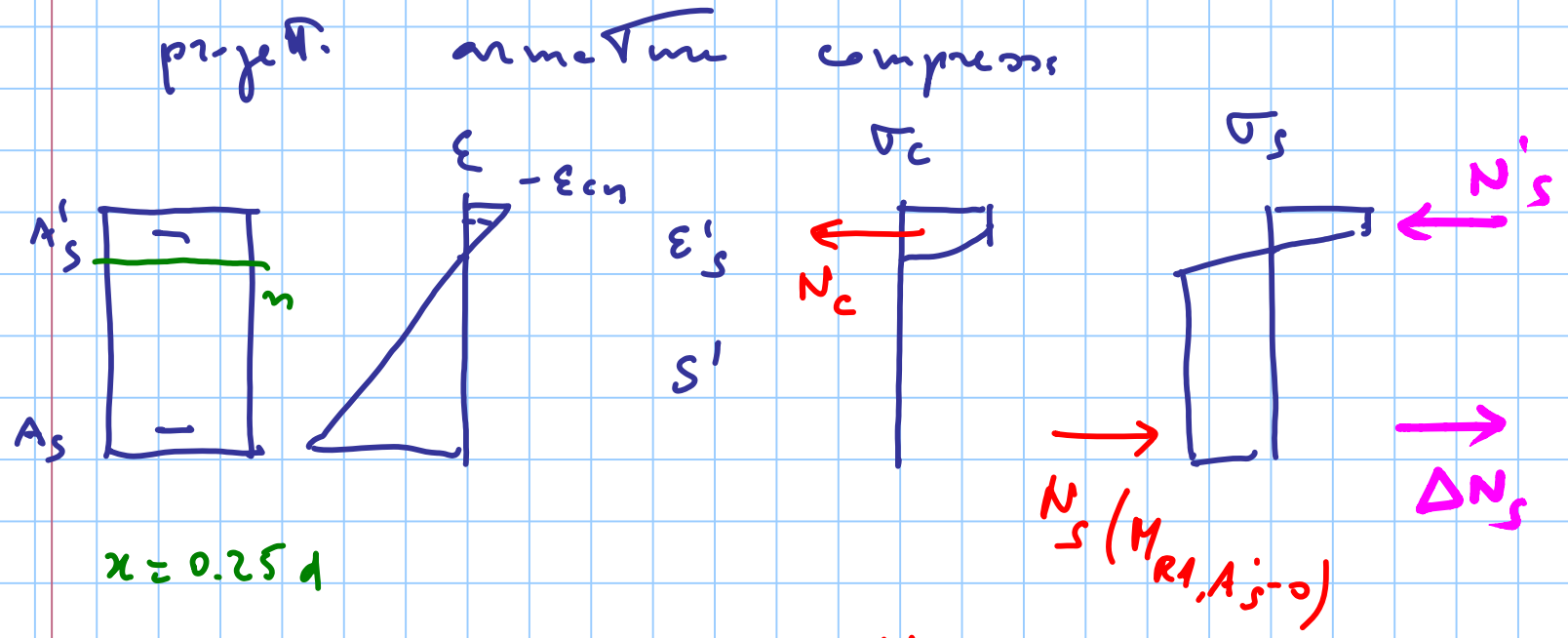
$$M = \frac{b\, d^2}{z_s^2}$$

$$\frac{1}{z_s^2} = 0.9\, \rho_s\, f_{y1}$$

max 0.010
0.015

ρ_s	$\tau_s = \frac{1}{\sqrt{0.9\,\rho_s\,f_{y1}}}$
0.010	0.0169
0.015	0.0140

projet: armature comprese

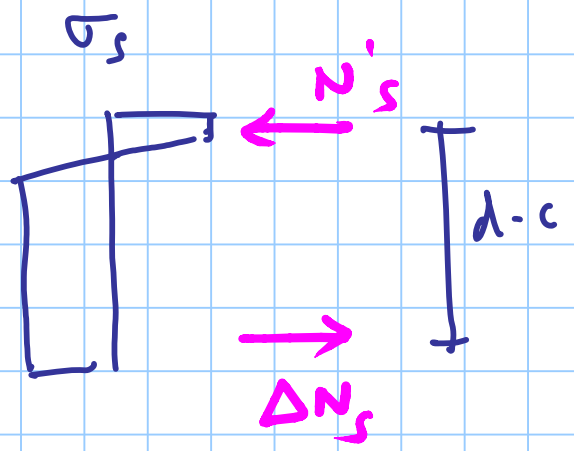


$x = 0.25\,d$

$$M = \frac{b\,d^2}{z^2} = M_{Rd,A'_s=0}$$

$$M_{Ed} \leq M_{Rd,A'_s=0}$$ non serve A'_s

$$M_{Ed} > M_{Rd,A'_s=0}$$ $$\Delta M = M_{Ed} - M_{Rd,A'_s=0}$$



$$\Delta M = \Delta N_s (d-c) = N'_s (d-c)$$

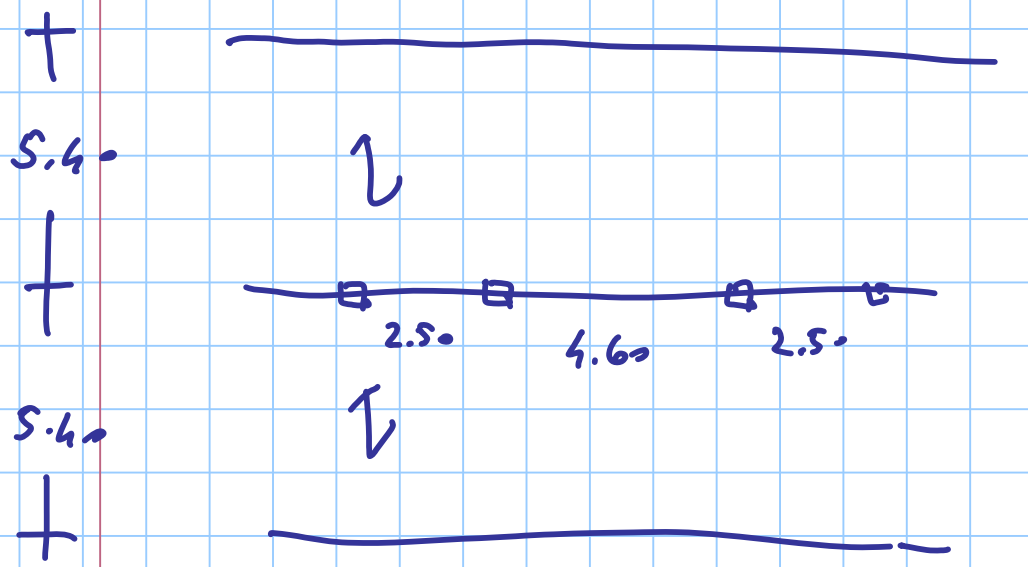
$$\Delta N_s = \frac{\Delta M}{d-c} \qquad \Delta A_s = \frac{\Delta M}{(d-c) f_{yd}}$$

$$A_s = \frac{M_{Rd, A'_s=0}}{0.9\, d\, f_{yd}} + \frac{\Delta M}{(d-c) f_{yd}} \simeq \frac{M_{Rd, A'_s=0} + \Delta M}{0.9\, d\, f_{yd}} = \frac{M_{Ed}}{0.9\, d\, f_{yd}}$$

$$N'_s = \frac{\Delta M}{d - c}$$

$$A'_s = \frac{N'_s}{\sigma'_s} = \frac{\Delta M}{(d-c)\,\sigma'_s} = \frac{\Delta M}{(d-c)\,s'\,f_{y1}}$$

ESEMPI



carichi unitari:

solaio $g_1 + q_1 = 10.0\ kN/m^2$

Trave $g_1 = 4.5\ kN/m$

TRAVE

$g_1 + q_1 = 69.3\ kN/m$

$M_{Ed} = 92.1\ kNm$

$86.1 \times 0.35 = 30.1\ kNm$

$122.2 - 30.1 = 92.1\ kNm$

$$M_{Ed} = 92.1 \ KN\,m$$

$$d = z' \sqrt{\frac{M}{b}} = 0.017 \sqrt{\frac{92.1}{0.30}} = 0.30 \ m$$

$$h = d + c = 0.35 \ m \longrightarrow h = 0.50 \ m = 50 \ cm$$

30×50
$c = 5 \ cm$

$z = 0.0197$ $\quad M_{Rd} = \dfrac{b\,d^2}{z^2} = 156.5 \ KN\,m$

$z = 0.017$ $\quad M_{Rd} = 210.2 \ KN\,m$

$\alpha \quad M_{Ed} = 250 \text{ kNm}$

$$d = z' \sqrt{\frac{M}{b}} = 0.017 \sqrt{\frac{250}{0.3}} = 0.49 \text{ m}$$

$$h = d + c = 0.54 \text{ m} \rightarrow 60 \text{ cm}$$

$$\text{Pr.} \quad d = 0.018 \sqrt{\frac{250}{0.3}} = 0.52 \text{ m} \quad \text{mpn} \quad 60 \text{ cm}$$

$h = 56 \text{ m}$

rel_g. min 30×60

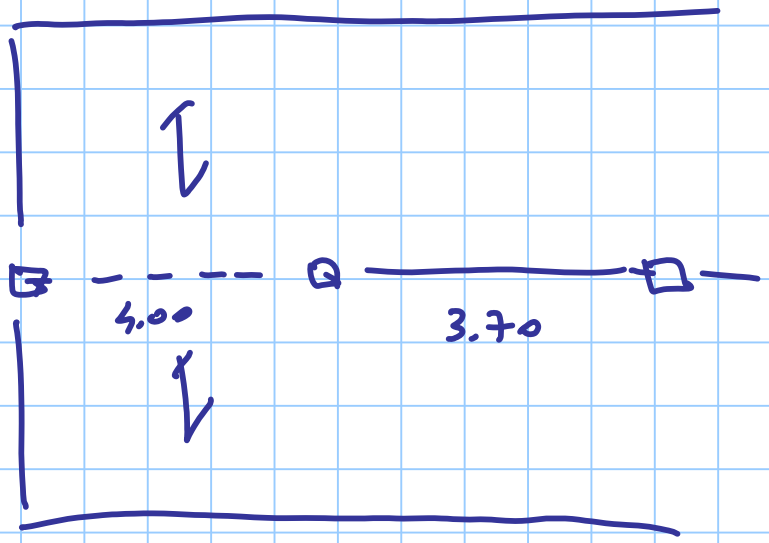
$$A_s = \frac{M}{0.9 \, d \, f_{yd}} = \frac{250 \times 10}{0.9 \times 0.55 \times 391.3} = 13.4 \text{ cm}^2$$

~~Es. 4φ20 + 1φ16~~

$$M_{Rd,A'_s=0} = \frac{b d^2}{z^2} = \frac{0.30 \times 0.55^2}{0.0197^2} = 233.8 \text{ kNm}$$

$$s' = \frac{x-c}{x} \frac{\varepsilon_{cy}}{\varepsilon_{yd}} \leq 1 \qquad s' = 1$$

$$A'_s = \frac{\Delta M}{(d-c)\, s' f_{yd}} = \frac{(250-233.8) \times 10}{0.50 \times 1 \times 391.3} = 0.8 \text{ cm}^2$$

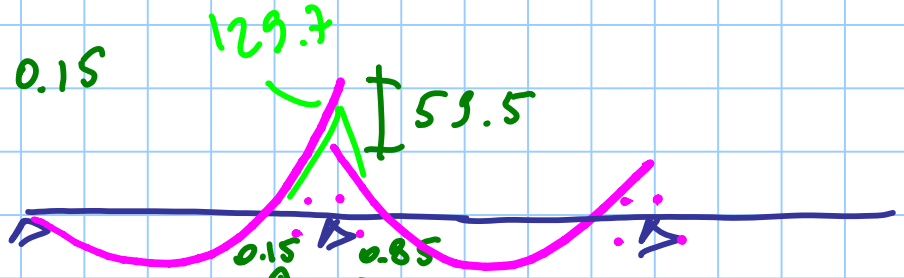


$q = 69.3$ KN/m

	I
30×50	312500 cm⁴
60×26	87880 cm⁴

$I_{em} \simeq 4\ I_{sp}$

$\frac{0.75}{0.75+4.32} = 0.15$



$59.5 \times 0.15 = 8.9$

$138.6 - 8.9 = 129.7$

$ql^2/8$

$ql^2/12$

138.6

79.1

$0.75 = \frac{3 \times 1}{4.00}$

$\frac{4 \times 4}{3.70} = 4.32$

dimensionamento Trave a spessore

$h = 26$ cm

$d = 22$ cm

$c = 4$ cm

$M_{Ed} = 129.7$ kN m

$\tau' = 0.018$

$$b = \frac{M \tau^2}{d^2} = \frac{129.7 \times 0.018^2}{0.22^2} = 0.87 \text{ m}$$

90 x 26 troppo 80 x 26 tirando un po'

ok

sezione 90×26

$$A_s = \frac{M}{0.9\, d\, f_{yd}} = \frac{129.7 \times 10}{0.9 \times 0.22 \times 391.3} = 15.7 \text{ cm}^2$$

$$M_{Rd,A'_s=0} = \frac{b d^2}{\tau^2} = \frac{0.90 \times 0.22^2}{0.0197^2} = 112.2 \text{ kNm}$$

$$x = 0.25\, d = 5.5 \text{ cm}$$

$$s' = \frac{x - c}{x} \frac{\varepsilon_{cu}}{\varepsilon_{yd}} = \frac{1.5}{5.5} \frac{3.5 \times 10^{-3}}{1.96 \times 10^{-3}} = 0.487$$

$$A'_s = \frac{\Delta M}{(d - c)\, s'\, f_{yd}} = \frac{(129.7 - 112.2) \times 10}{0.18 \times 0.487 \times 391.3} = 5.1 \text{ cm}^2$$

se la trave form 80 x 26

$A_s = 15.7 \text{ cm}^2$ come prim.

$$M_{Rd, A'_s=0} = \frac{0.80 \times 0.22^2}{0.0197^2} = 99.7 \text{ kNm}$$

$s' = 0.487$

$$A'_s = \frac{(129.7 - 99.7) \times 10}{0.18 \times 0.487 \times 391.3} = 8.7 \text{ cm}^2$$