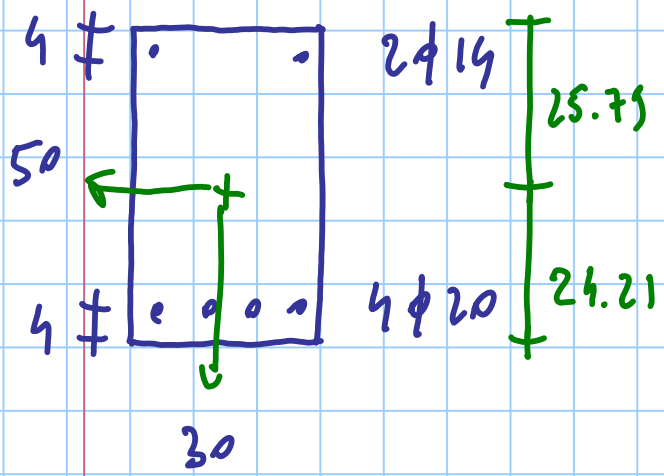
Titolo nota 09/04/2015



1° modello di comportamento

$I = 355298\ cm^4$

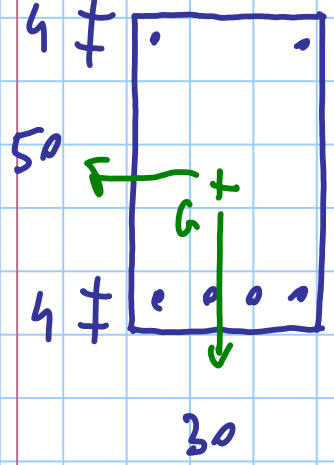
$M = 20\ kNm \qquad \sigma_c = 1.36\ MPa$

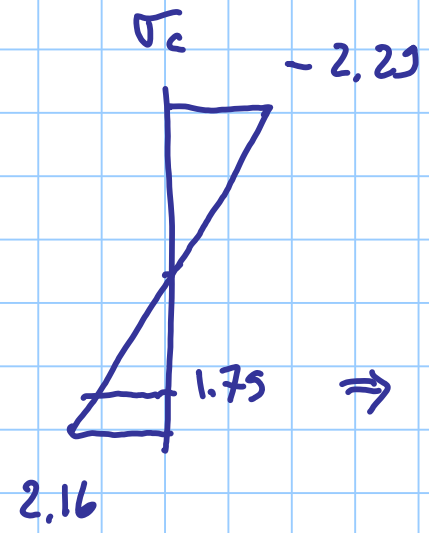
$M = 31.6\ kNm \qquad \sigma_c = 2.16\ MPa \rightarrow$ fessurazione

$M = 31.6\ kNm$

$$\sigma_s = n \frac{M}{I} y = 6.35 \times \frac{31.6 \times 10^6}{355298 \times 10^4} \times 20.21 \times 10^1 = 11.4\ MPa$$

$$\sigma_{c,sup} = \frac{316 \times 10^6}{355298 \times 10^4} \times (-25.75) = -2.29\ MPa$$

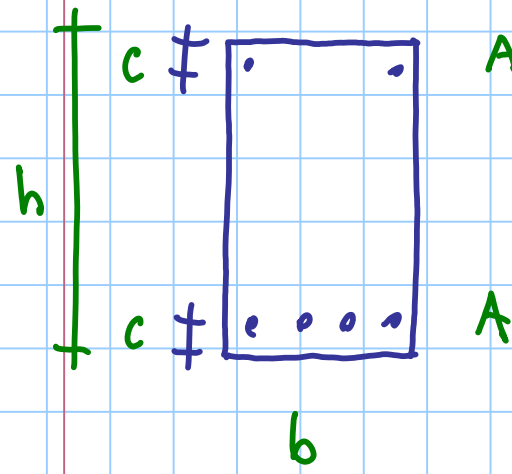




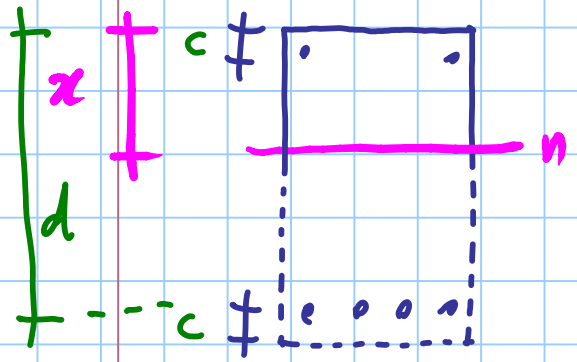
$\Rightarrow \sigma_s = 6.35 \times 1.75 = 11.4$

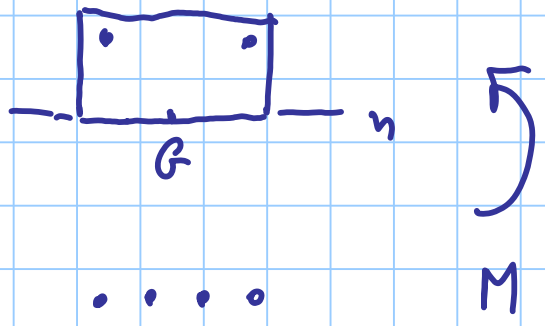
2° modello di comportamento

CLS non reagisce a trazione



d = altezza utile





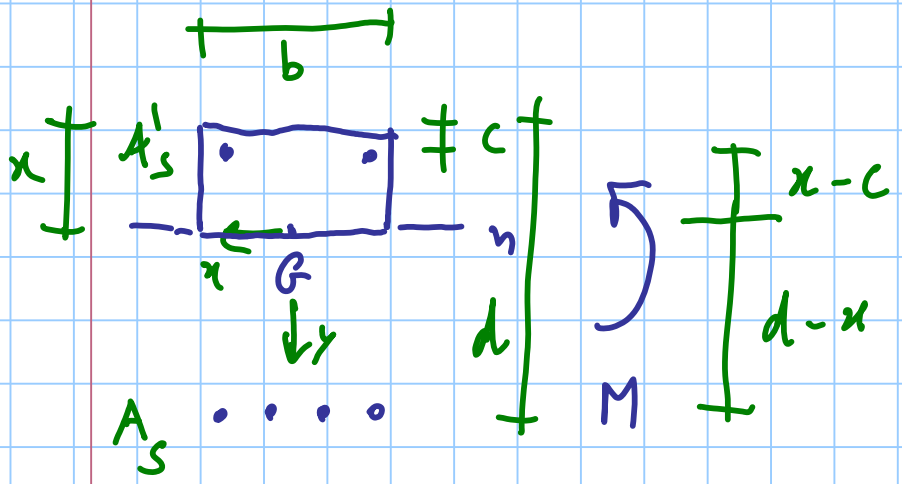
momento statico S_n rispetto all'asse neutro

↓

n è baricentrico

↓

$S_n = 0$



$$S_n = -\frac{b x^2}{2} - n A'_s (x-c) + n A_s (d-x) = 0$$

$$\frac{b x^2}{2} + n A'_s x - n A'_s c - n A_s d + n A_s x = 0$$

$$\frac{b}{2} x^2 + n (A_s + A'_s) x - n (A_s d + A'_s c) = 0$$

$$\frac{b}{2n\left(A_s+A'_s\right)}x^2 + x - \frac{A_s d + A'_s c}{A_s + A'_s} = 0$$

$$x = \frac{-1 + \sqrt{1 + \cancel{2}\,\frac{b}{\cancel{2}n\left(A_s+A'_s\right)}\,\frac{A_s d + A'_s c}{A_s + A'_s}}}{\cancel{2}\cdot\frac{b}{\cancel{2}n\left(A_s+A'_s\right)}}$$

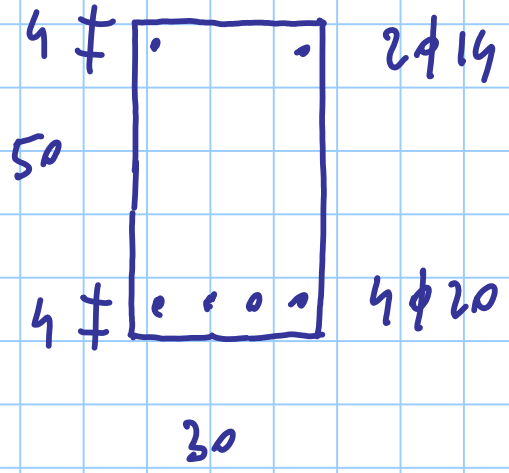
$$x = \frac{n(A_s + A'_s)}{b}\left[-1 + \sqrt{1 + \frac{2b(A_s d + A'_s c)}{n(A_s + A'_s)^2}}\right]$$

$$\psi = \frac{n(A_s + A'_s)}{b d}$$

$$d_{G.S} = \frac{A_s d + A'_s c}{A_s + A'_s}$$

distanza baricentro armature b.i.d sup.

$$x = \psi d\left[-1 + \sqrt{1 + \frac{2 d_{G.S}}{\psi d}}\right]$$



$b = 30\ cm$

$h = 50\ cm$

$c = 4\ cm$

$d = 46\ cm$

$A_s = 12.56\ cm^2$

$A'_s = 3.08\ cm^2$

$n = 6.35$

[app. $n = 15$]

$$\psi = \frac{6.35\left(12.56 + 3.08\right)}{30 \times 46} = 0.07197$$

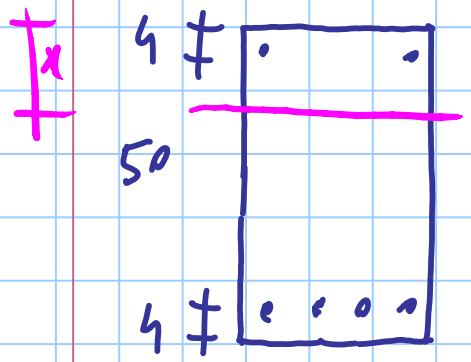
$\psi d = 3.31\ cm$

$$d_{G,S} = \frac{12.56 \times 46 + 3.08 \times 4}{12.56 + 3.08} = 37.73\ cm$$

$$x = \psi d \left[-1 + \sqrt{1 + \frac{2\, d_{f.s}}{\psi d}} \right] =$$

$$= 0.07197 \times 46 \left[-1 + \sqrt{1 + \frac{2 \times 37.73}{0.07197 \times 46}} \right] =$$

$$= 3.31 \left[-1 + \sqrt{1 + 22.80} \right] = 12.84 \text{ cm}$$

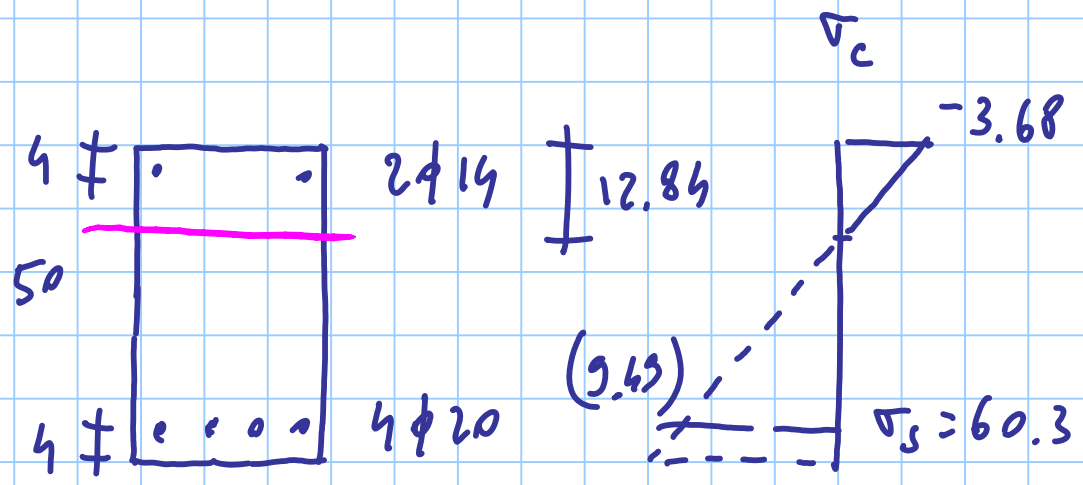


$x = 12.84$ cm

$$I_n = \frac{b\,x^3}{3} + n\,A'_s\,(x-c)^2 + n\,A_s\,(d-x)^2$$

$$I_n = \frac{30 \times 12.84^3}{3} + 6.35 \times 3.08 \times 8.84^2 + 6.35 \times 12.56 \times 33.16^2 =$$

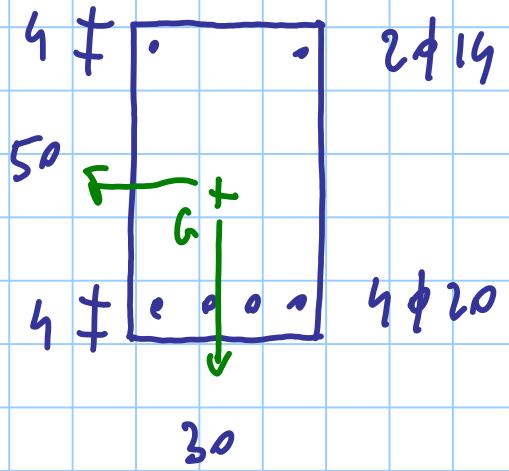
$$= 110\,396 \text{ cm}^4$$

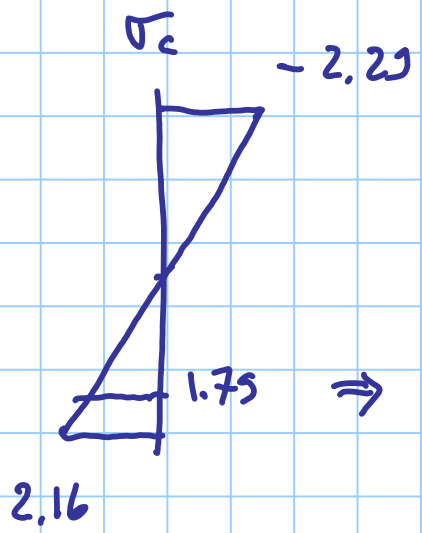


$M = 31.6\ kN\,m$

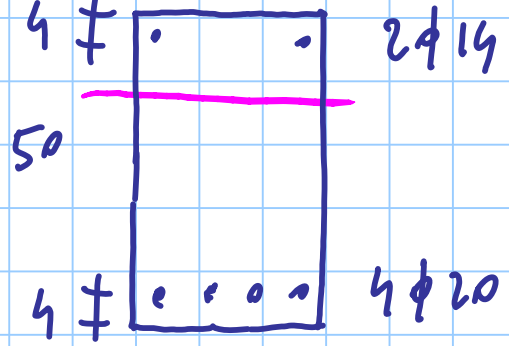
$$\sigma_{c,sup} = \frac{M}{I}\,y = \frac{31.6 \times 10^{6}}{110396 \times 10^{4}} \times \left(-12.84 \times 10^{1}\right) = -3.68\ MPa$$

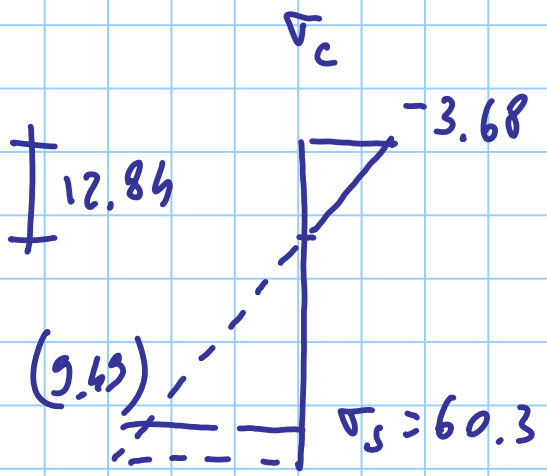
$$\sigma_{s,inf} = n\,\frac{M}{I}\,y = 6.35 \times \frac{31.6 \times 10^{6}}{110396 \times 10^{4}} \times \left(33.16 \times 10^{1}\right) = 60.3\ MPa$$





$\Rightarrow \sigma_s = 6.35 \times 1.75 = 11.4$





$n = 6.35$

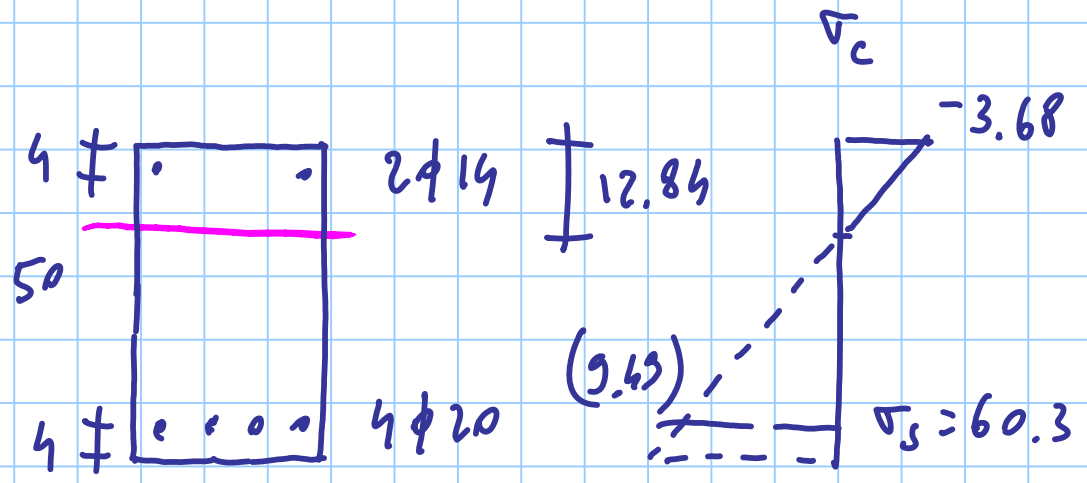
con $n = 15$ $\quad x = 17.70$ cm

$$I_n = 215011 \text{ cm}^4$$

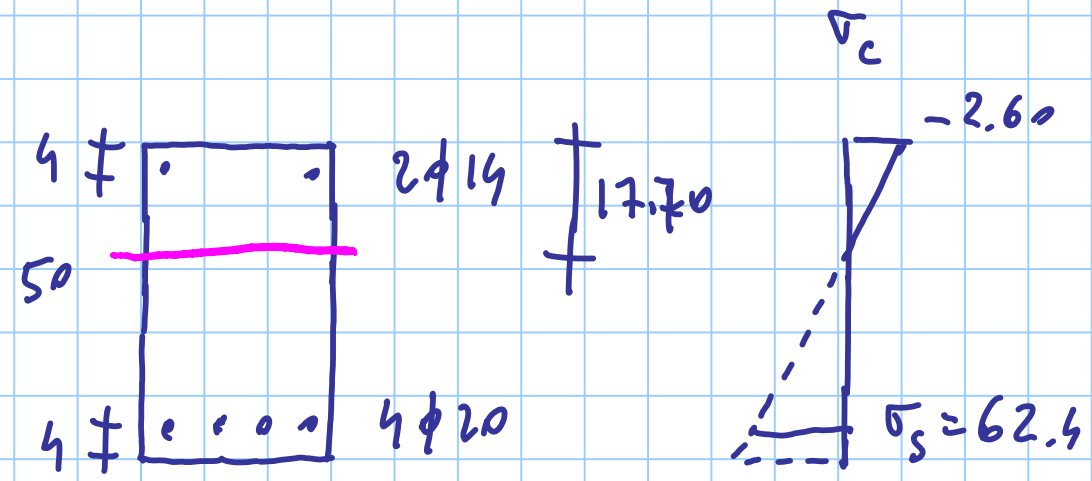
per $M = 31.6$ KNm

$$\sigma_{c,mp} = \frac{31.6 \times 10^6}{215011 \times 10^4} \times (-17.70 \times 10) = -2.60 \text{ MPa}$$

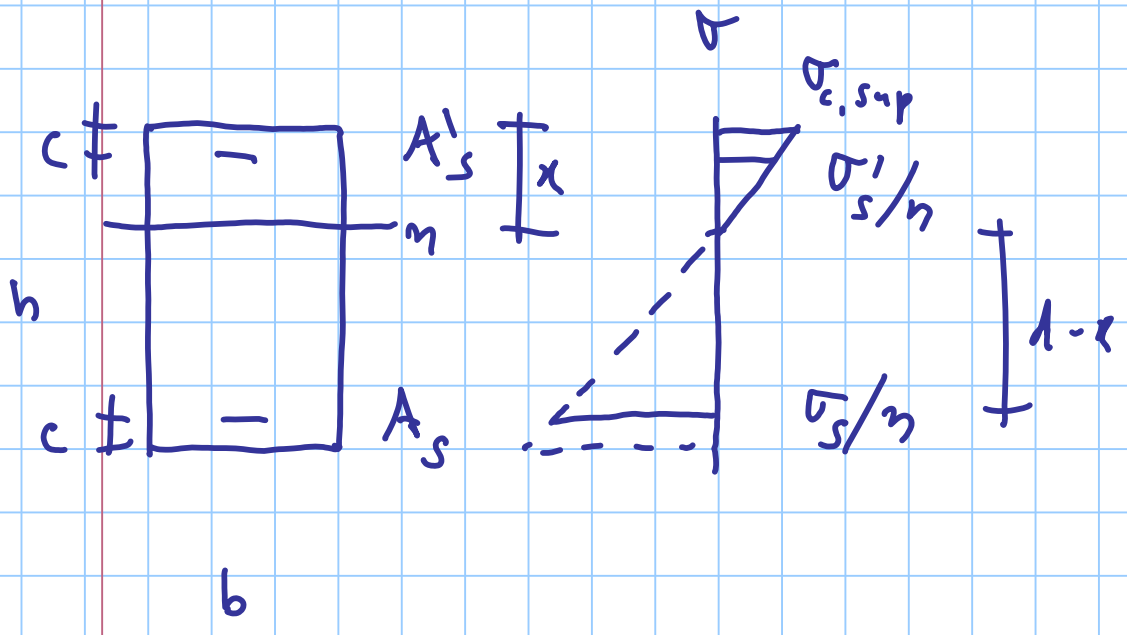
$$\sigma_{s,inf} = n \frac{M}{I} y = 15 \times \frac{31.6 \times 10^6}{215011 \times 10^4} \times 28.3 \times 10 = 62.39 \text{ MPa}$$


4 ϕ
2 ϕ 14
12.84
50
4 ϕ
4 ϕ 20
σc
-3.68
(9.45)
σs = 60.3

$n = 6.35$


4 ϕ
2 ϕ 14
17.70
50
4 ϕ
4 ϕ 20
σc
-2.60
σs = 62.4

$n = 15$



$$N = \int \sigma \, dA = 0$$

$$\frac{\sigma'_s/n}{x-c} = \frac{\sigma_{c,sup}}{x} \Rightarrow \sigma'_s = n \frac{x-c}{x} \sigma_{c,sup}$$

$$\frac{\sigma_s/n}{1-x} = \frac{\sigma_{c,sup}}{x} \Rightarrow \sigma_s = -n \frac{1-x}{x} \sigma_{c,sup}$$

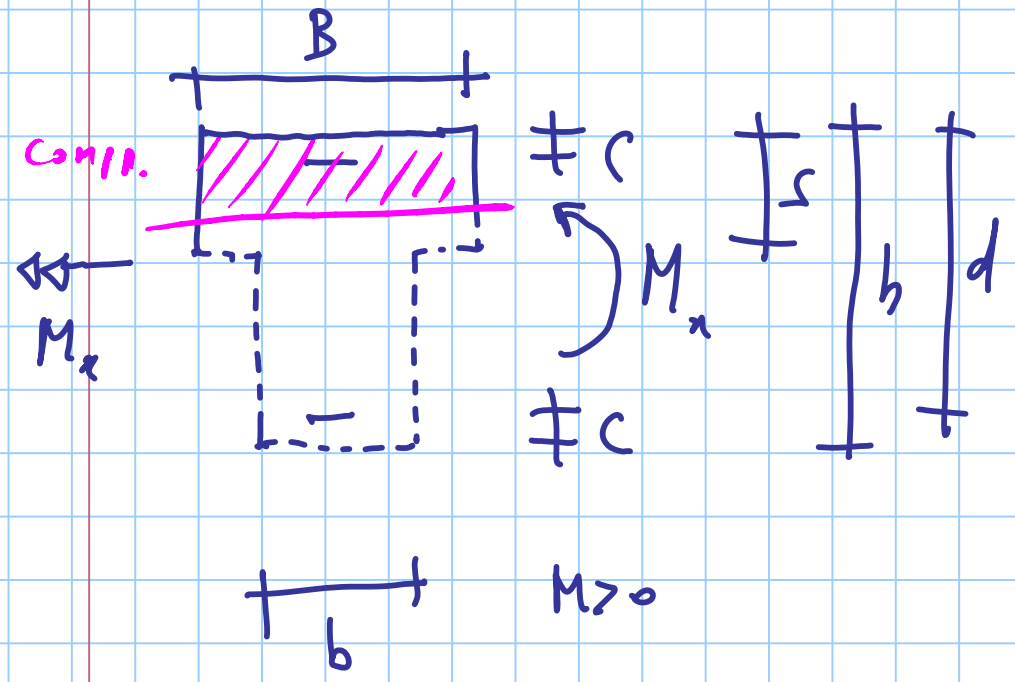
$$N = \int_{cls} \sigma \, dA + \sigma_s A_s + \sigma'_s A'_s$$

$$N = b x \frac{\sigma_{c,max}}{2} - n \frac{d-x}{x} \sigma_{c,max} A_s + n \frac{x-c}{x} \sigma_{c,max} A'_s = 0$$

$$\frac{b x^2}{2} - n A_s (d-x) + n A'_s (x-c) = 0$$

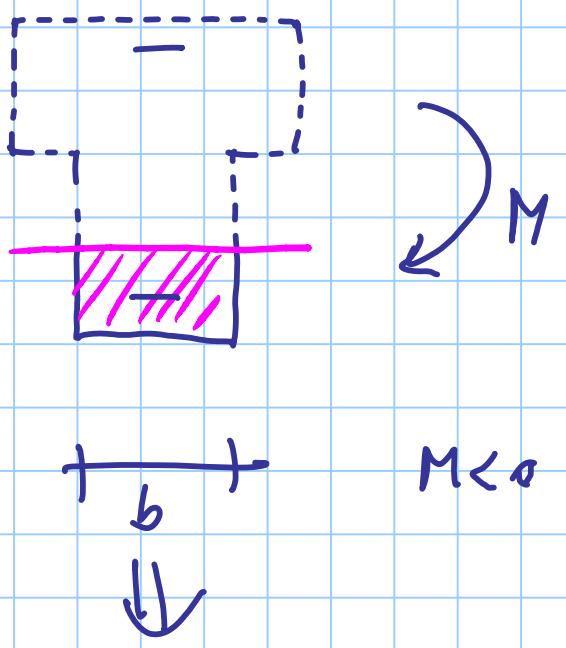
COME PRIMA DI $S_n = 0$

SEZIONE A T



$M > 0$

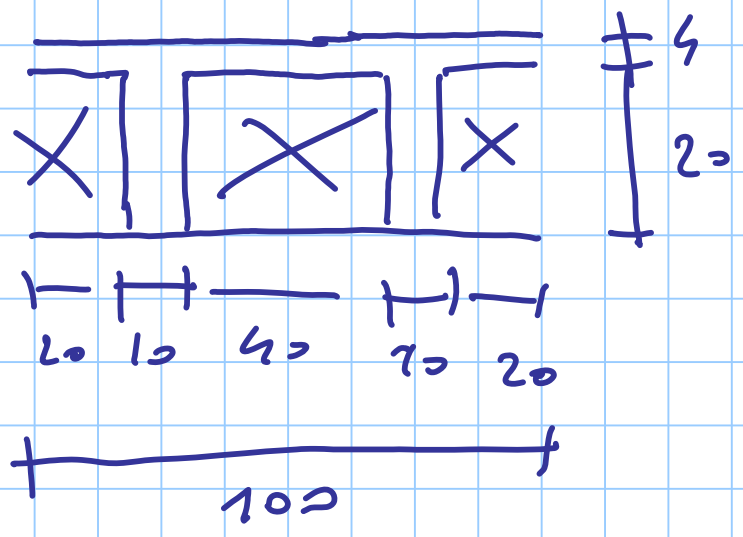
sezione rettangolare con larghezza B



$M < 0$

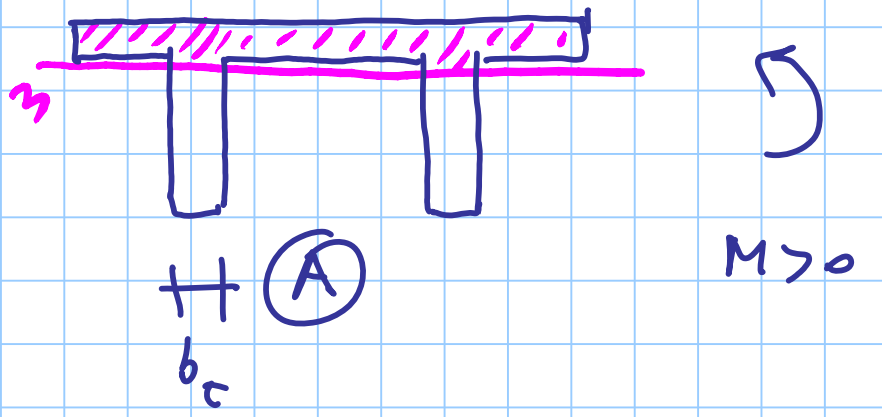
sezione rettangolare con larghezza b

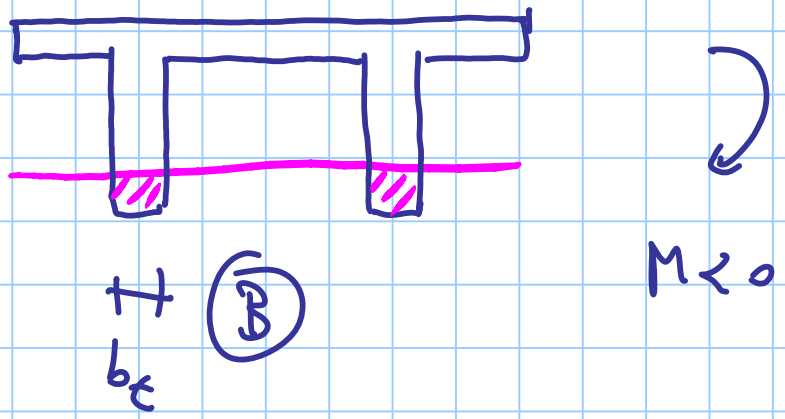
Solaio

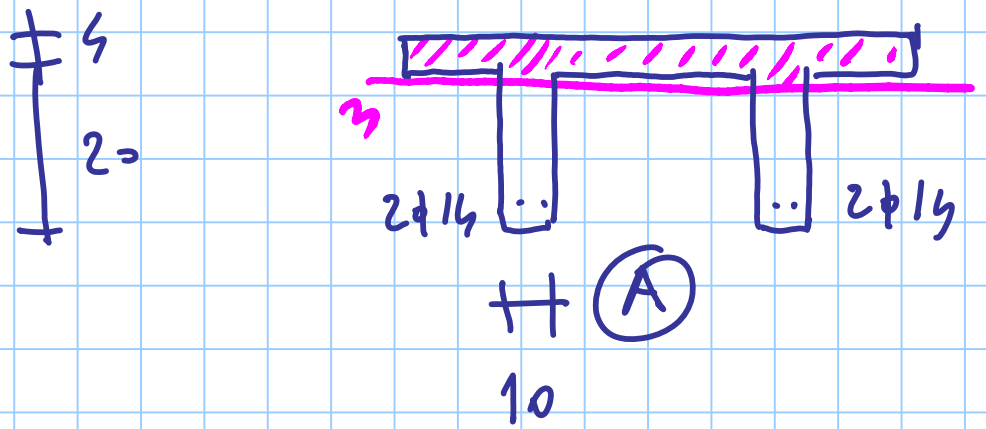


(A) sezione a T
(ma quasi rettangolare
con larghezza 100)

(B) sezione rettang. larga
con larghezza $2 b_c$







$h = 24$ cm

$d = 21$ cm

ipotizzo $b = 100$ e calcolo x

$A_s = 6.16$ cm^2 $\qquad A'_s = 0$ $\qquad c = 3$ cm

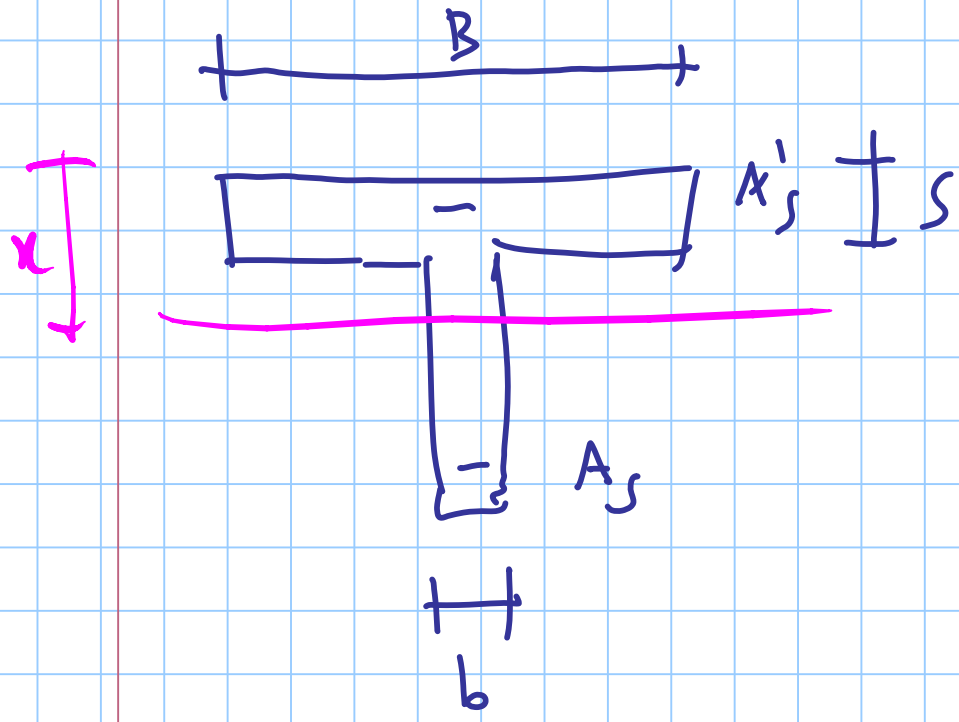
$$\psi = \frac{n(A_s + A'_s)}{b\,d} = \frac{15 \times 6.16}{100 \times 21} = 0.044$$

$d_{G,S} = d$

$$x = \psi d \left[-1 + \sqrt{1 + \frac{2 \, d \, \varepsilon_s}{\psi \, d}} \right] =$$

$$= 0.044 \times 21 \left[-1 + \sqrt{1 + \frac{2}{0.044}} \right] =$$

$$= 0.924 \left[-1 + \sqrt{1 + 45.45} \right] = 5.37 \text{ cm} > 4 \text{ cm}$$



$B = 100$ cm

$b = 20$ cm

$s = 4$ cm

$d = 21$ cm

$c = 3$ cm

$$S_h = -\left[\frac{B\,x^2}{2} - (B-b)\frac{(x-s)^2}{2}\right] - n\,A'_s\,(x-c) + n\,A_s\,(d-x)$$

$$-50x^2 + 40(x-4)^2 + 15 \times 6.16 \times (21-x) = 0$$

$$-50x^2 + 40x^2 - 320x + 640 + 1940.4 - 92.4x = 0$$

$$-10x^2 - 412.4x + 2580.4 = 0$$

$$x^2 + 41.24x - 258.04 = 0$$

$$x = -\frac{41.24}{2} + \sqrt{\left(\frac{41.24}{2}\right)^2 + 258.04} =$$

$$-20.62 + 26.14 = 5.52 \text{ cm}$$

$$I_n = \frac{B x^3}{3} - (B-b)\frac{(x-s)^3}{3} + n A'_s (x-c)^2 + n A_s (1-x)^2$$

$5606,6 \quad - \quad 61.6 \qquad - \; - \; -$

$\Downarrow$

poi si calcola $\quad \sigma = \frac{M}{J} y$

per serie generiche

essere in grado di calcolare S_n in funzione di x

$S_n = 0$ equazione "complicata"

- usare "ricerca obiettivo" di Excel

x	S_n

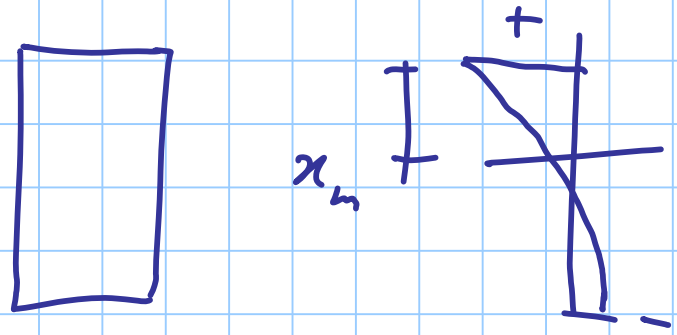
- procedimenti iterativi

assegno x_1 e quindi la sezione reagente

calcolo la posizione del baricentro $x_2 = \frac{S}{A}$

ripeto con x_2

- metodo del dimezzamento



$x_1 = 0 \quad S_n(x_1)$

$x_2 = b \quad S_n(x_2)$

$x_m = \frac{x_1 + x_2}{2} \quad S_n(x_m)$