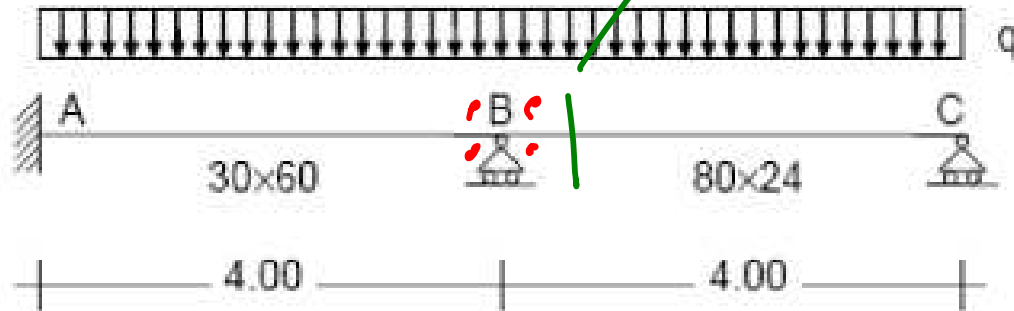


$$\frac{69120}{540000 + 69120} = 0.113$$



COMPITO

$$\frac{4EI}{l}$$

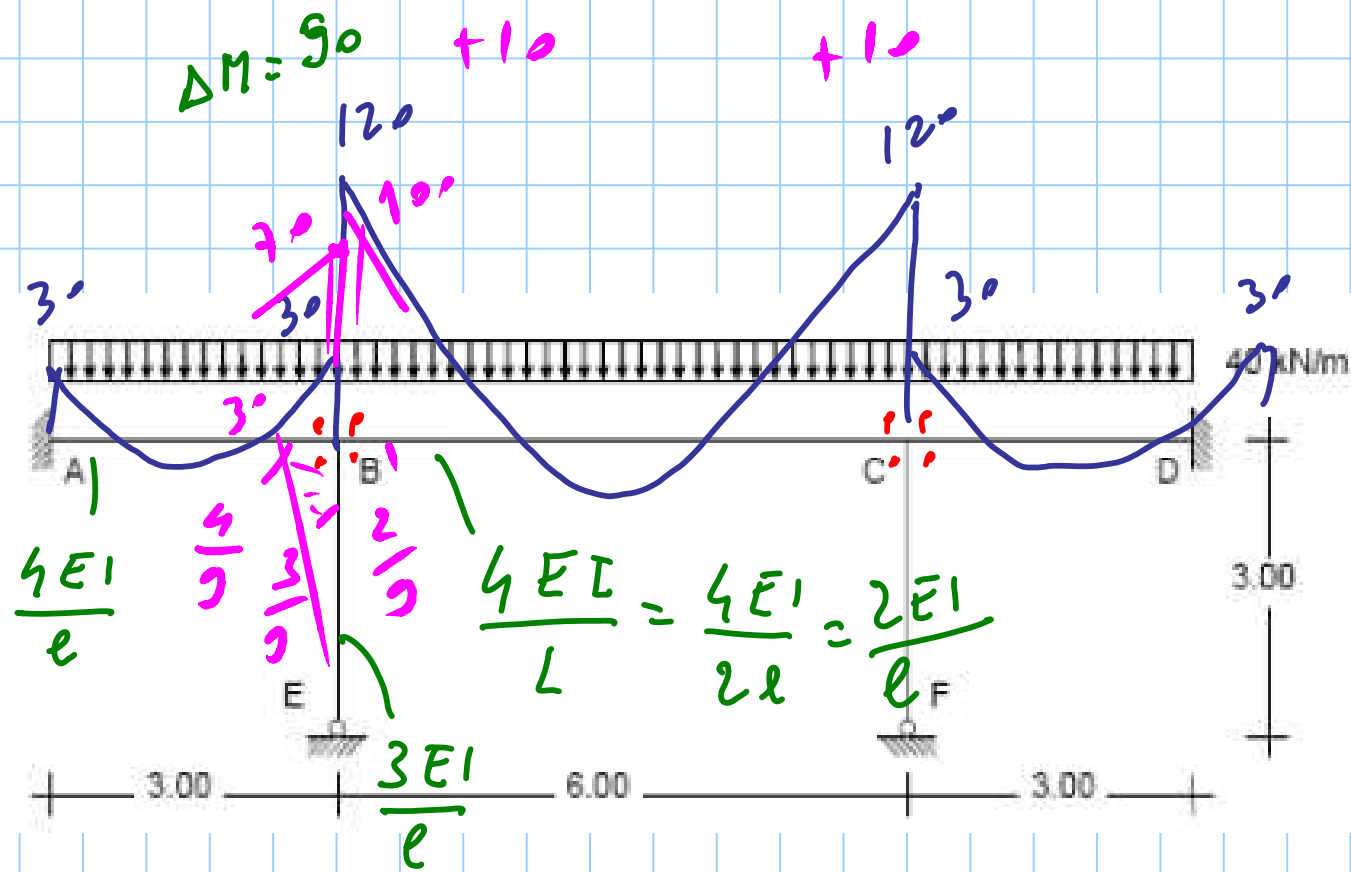
$$\frac{3EI}{l}$$

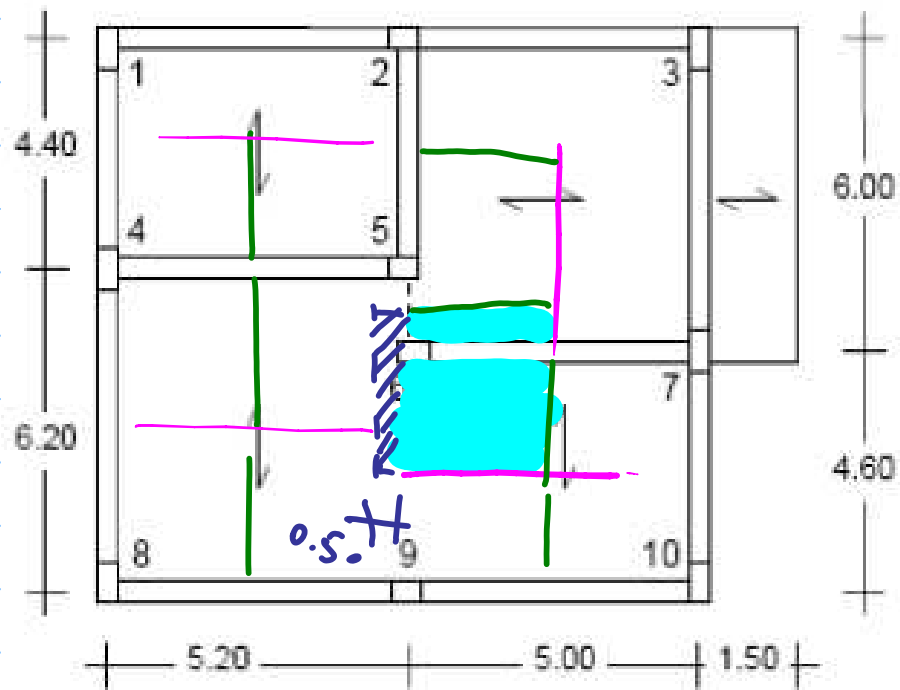
$$I = \frac{30 \times 60^3}{12} =$$

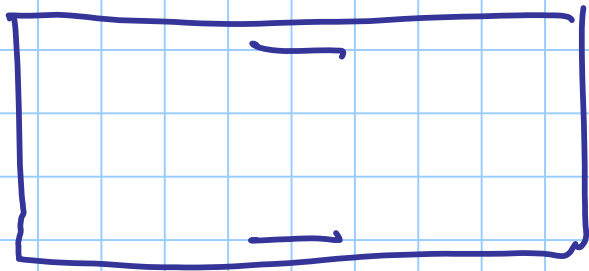
$$\frac{80 \times 24^3}{12} =$$

$$540000 \text{ cm}^4 \times \frac{4}{4.00}$$

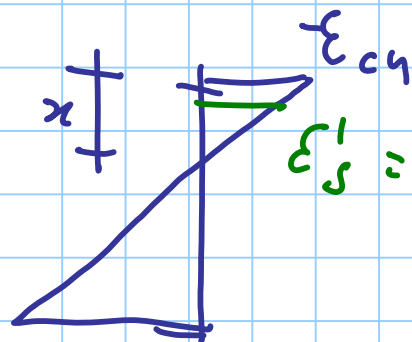
$$> 92160 \text{ cm}^4 \times \frac{3}{4.00} = 69120$$





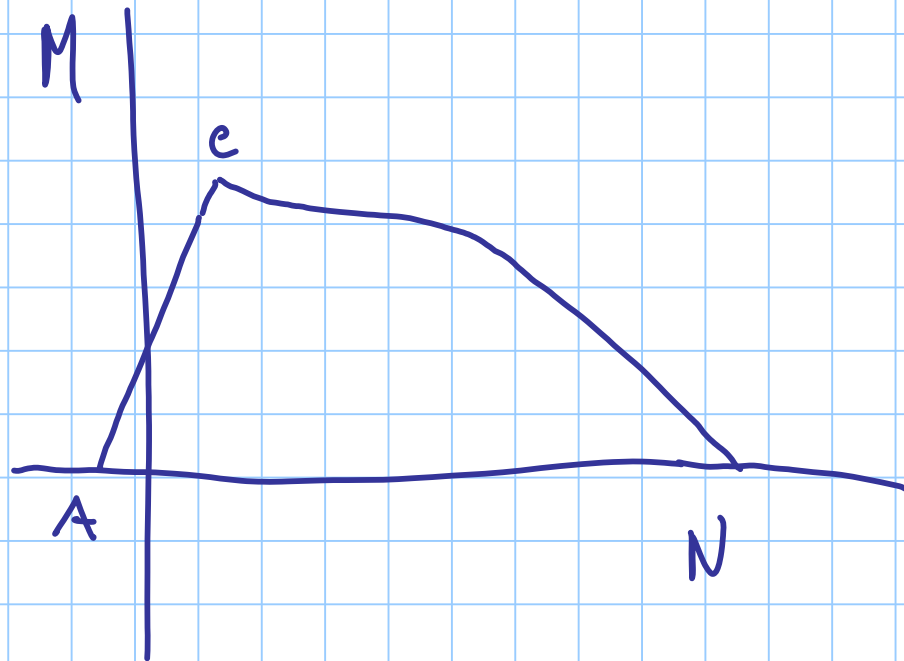


$$x = 0.25d$$

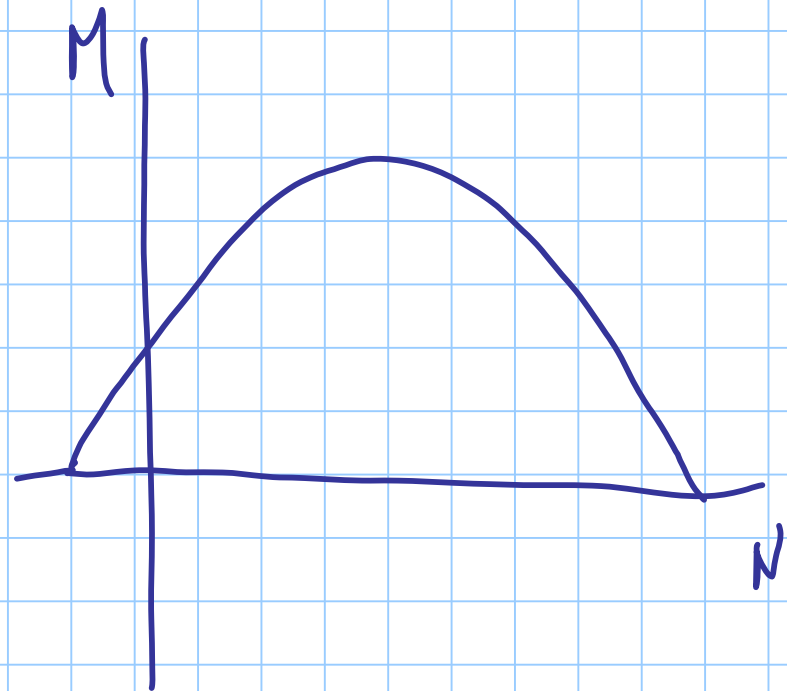


$$\epsilon'_s = \frac{x - c}{x} \epsilon_{cy}$$

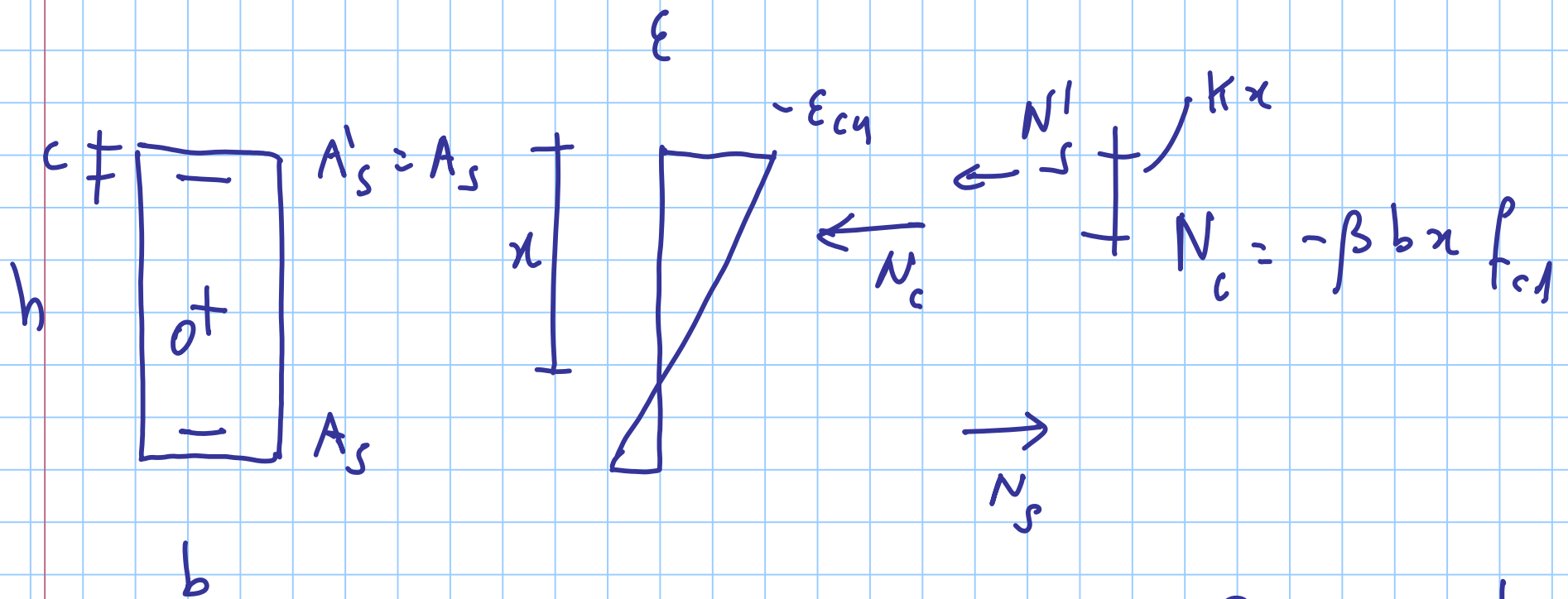
# PRESSOFLESSIONE



2° STADIO



3° STADIO



$$N = -\beta b x f_{cd} \rightarrow x = \frac{-N}{\beta b f_{cd}}$$

$$M = -N \left( \frac{h}{2} - kx \right)$$

$$0 \leq x \leq h$$

$$\beta = 0.81$$

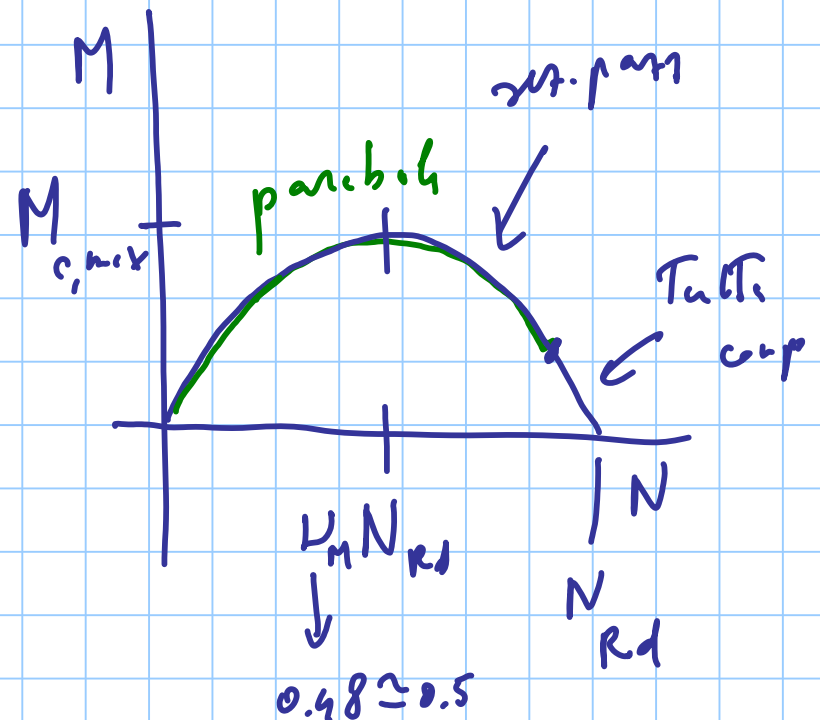
$$k = 0.416$$

$$M = -N \left( \frac{h}{2} + \frac{K}{\beta b f_{cd}} N \right)$$

$$\frac{dM}{dN} = -\frac{h}{2} - 2N \frac{K}{\beta b f_{cd}}$$

$$\frac{dM}{dN} = 0 \quad \text{pm} \quad 2N \frac{K}{\beta b f_{cd}} = \frac{h}{2}$$

$$N_{M R_d} = N = \frac{\beta b h f_{cd}}{4K} = \left( \frac{\beta}{4K} \right) N_{R_d}$$



$$0.487 \approx 0.5$$

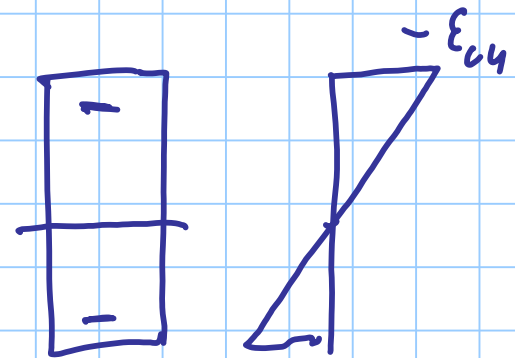
$$M_{z, \max} + \frac{\beta b h f_{cd}}{4K} \left( \frac{h}{2} - \frac{\cancel{K}}{\cancel{\beta} \cancel{f_{cd}}} \frac{\cancel{\beta} \cancel{b} h \cancel{f_{cd}}}{4\cancel{K}} \right)$$

$$= \frac{\beta b h^2 f_{cd}}{16K} = \left( \frac{\beta}{16K} \right) b h^2 f_{cd}$$

$$0.122 \simeq 0.12$$

$$\begin{cases} N = -\beta b x f_{cd} \\ N = \frac{\beta}{4K} N_{rd} \end{cases}$$

$$\Rightarrow x \simeq 0.6 h$$





$$\sigma_s = f_{yd}$$

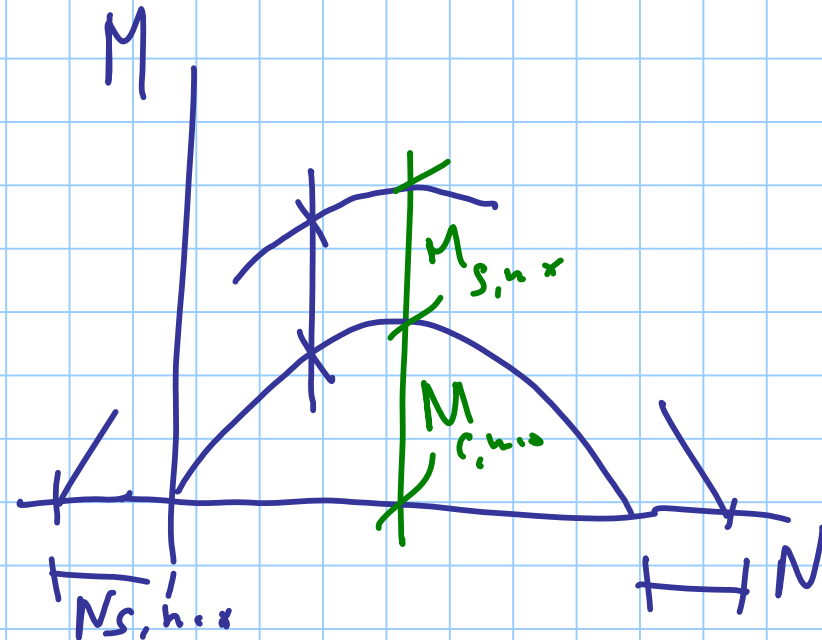
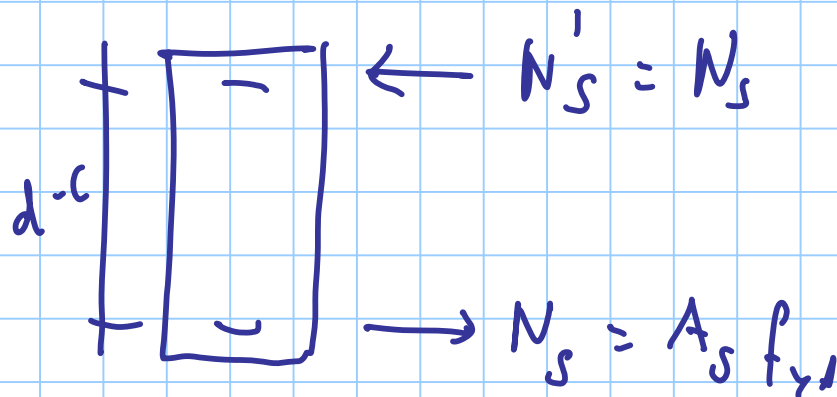
$$\sigma_s' = -f_{yd}$$

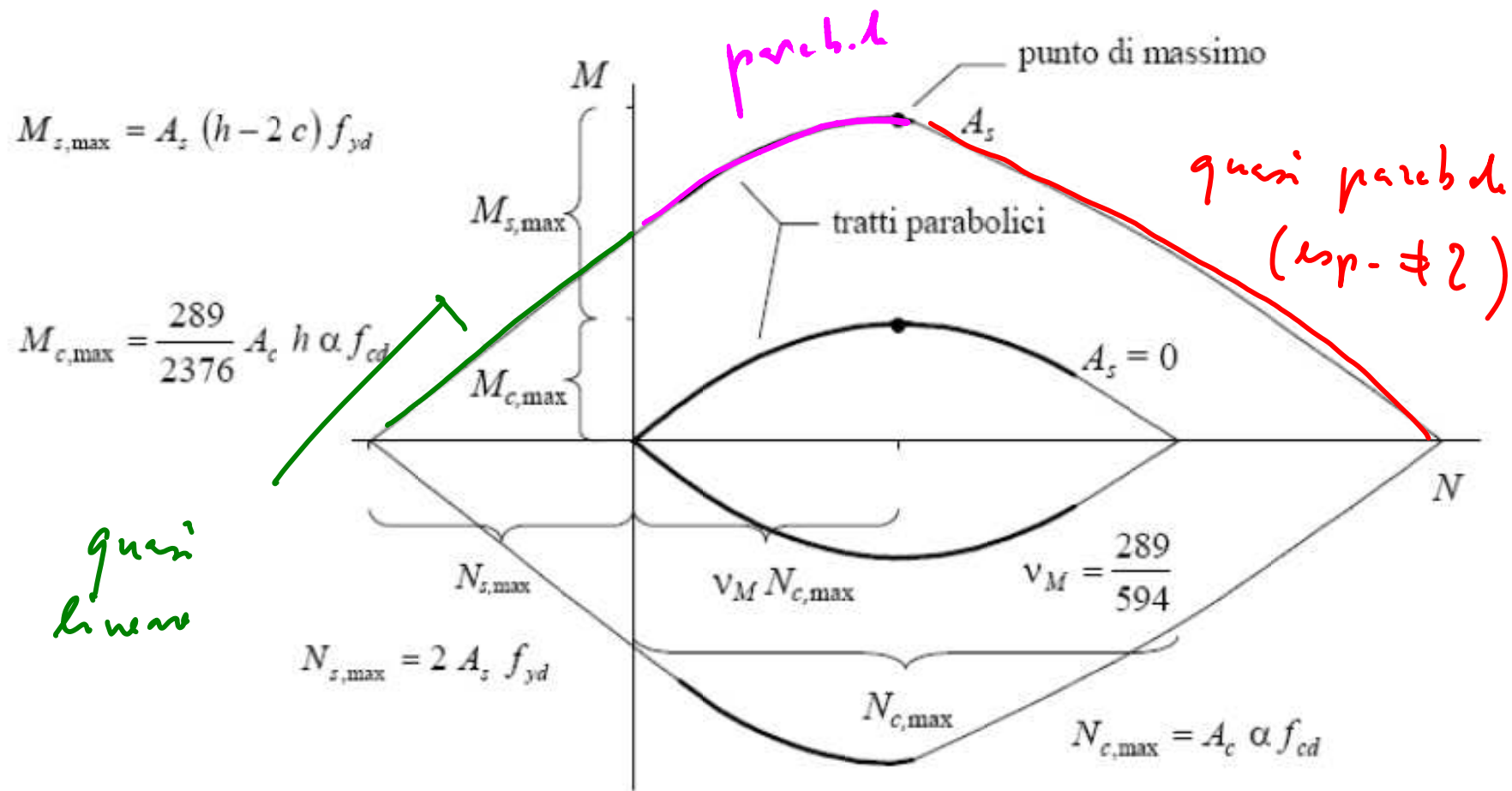
per la armatura

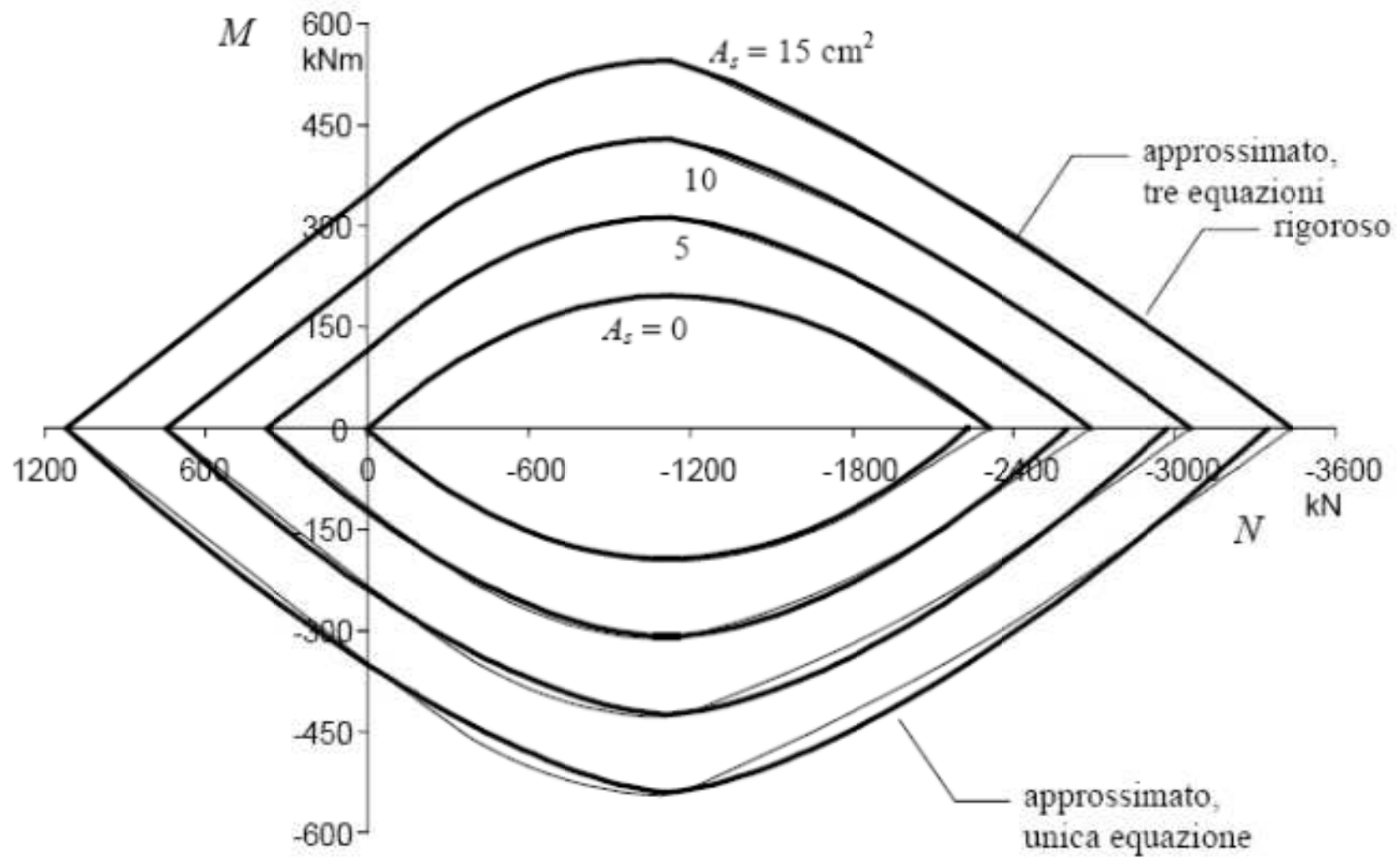
$$N \geq 0$$

$$M_{s, \max} = A_s f_{yd} (h - 2c)$$

$$N_{s, \max} = 2A_s f_{yd}$$







$$M_{Rd} = (M_{c,\max} + M_{s,\max}) \left[ 1 - \left| \frac{N_{Rd} + v_M N_{c,\max}}{v_M N_{c,\max} + N_{s,\max}} \right|^m \right]$$

con 
$$m = 1 + \frac{v_M N_{c,\max}}{v_M N_{c,\max} + N_{s,\max}}$$

$$N_{c,\max} = A_c f_{cd}$$

$$v_M = \frac{289}{594}$$

$$M_{c,\max} = \frac{289}{2376} A_c h f_{cd}$$

$$N_{s,\max} = 2 A_s f_{yd}$$

$$M_{s,\max} = A_s (h - 2c) f_{yd}$$

Esempio

$$b = 40 \text{ cm}$$

$$h = 60 \text{ cm}$$

$$c = 4 \text{ cm}$$

$$A_s = A'_s = 6 \text{ cm}^2$$

$$f_{cd} = 14.2 \text{ MPa}$$

$$f_{yd} = 391.3 \text{ MPa}$$

$$N_{c,max} = b h f_{cd} = 3408 \text{ kN}$$

$$M_{c,max} \approx 0.12 b h^2 f_{cd} = 245 \text{ kNm}$$

$$N_{s,max} = 2 A_s f_{yd} = 470 \text{ kN}$$

$$M_{s,max} = A_s (h - 2c) f_{yd} = 122 \text{ kNm}$$

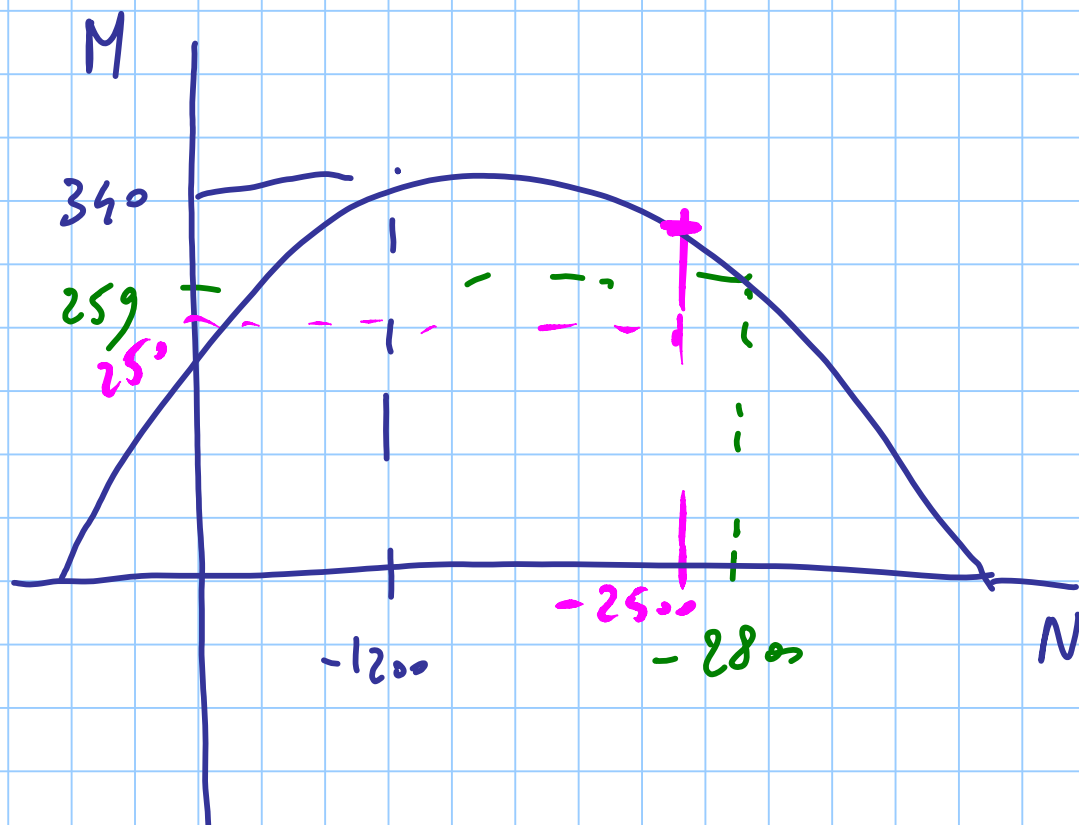
$$m = 1 + \frac{0.5 \times 3408}{0.5 \times 3408 + 470} = 1.784$$

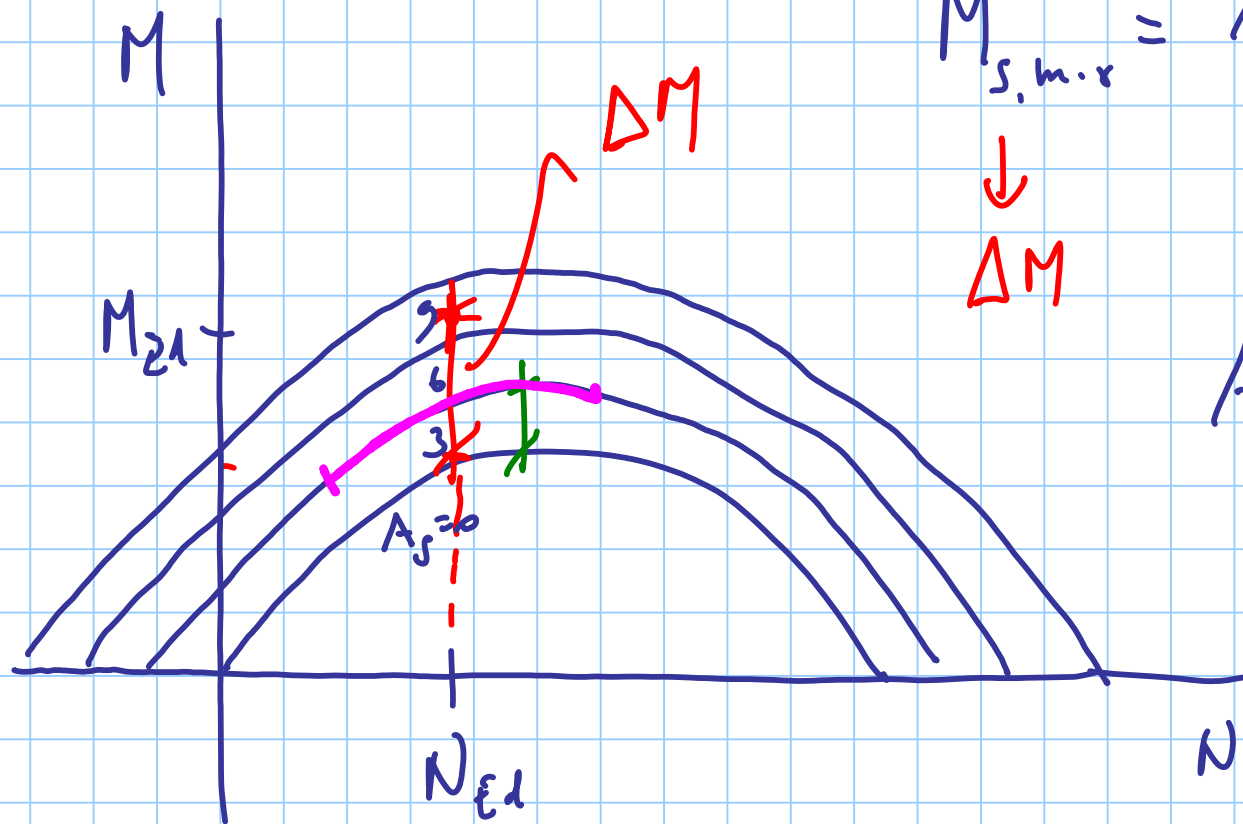
$$N_{Ed} = N_{Rd} = -1200 \text{ KN}$$

$$M_{Rd} = (245 + 122) \left[ 1 - \left( \frac{-1200 + 0.5 \times 3408}{0.5 \times 3408 + 470} \right)^{1.785} \right] = 340 \text{ KNm}$$

$$N'_{Ed} = N_{Rd} = -2800 \text{ KN}$$

$$M_{Rd} = (245 + 122) \left[ 1 - \left( \frac{-2800 + 0.5 \times 3408}{0.5 \times 3408 + 470} \right)^{1.785} \right] = 259 \text{ KNm}$$





$$M_{s.m.r} = A_s (h - 2c) f_{y1}$$

↓  
 $\Delta M$

$$A_s = \frac{\Delta M}{(h - 2c) f_{y1}}$$



Esempio:

40 x 60

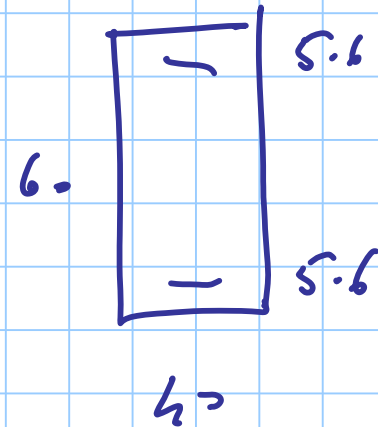
$$N_{Ed} = -2000 \text{ kN}$$

$$M_{Ed} = 350 \text{ kNm}$$

$$M_{c(N)} = M_{c, \max} \left[ 1 - \left( \frac{N_{Ed} + 0.5 N_{c, \max}}{0.5 N_{c, \max}} \right)^2 \right]$$
$$245 \left[ 1 - \left( \frac{-2000 + 0.5 \times 3408}{0.5 \times 3408} \right)^2 \right] = 237 \text{ kNm}$$

$$\Delta M = 350 - 237 = 113 \text{ kNm}$$

$$A_s = \frac{113 \times 10}{0.52 \times 391.3} = 5.6 \text{ cm}^2$$



TA  $\leftrightarrow$  SLU  
VERDE ROSA

