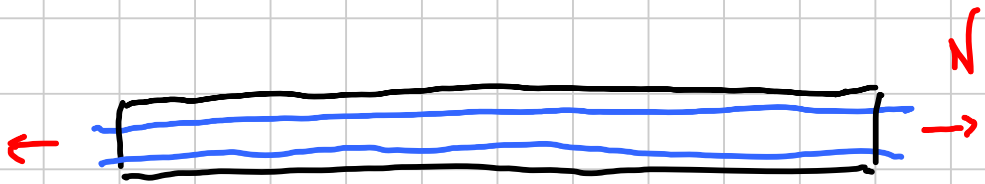
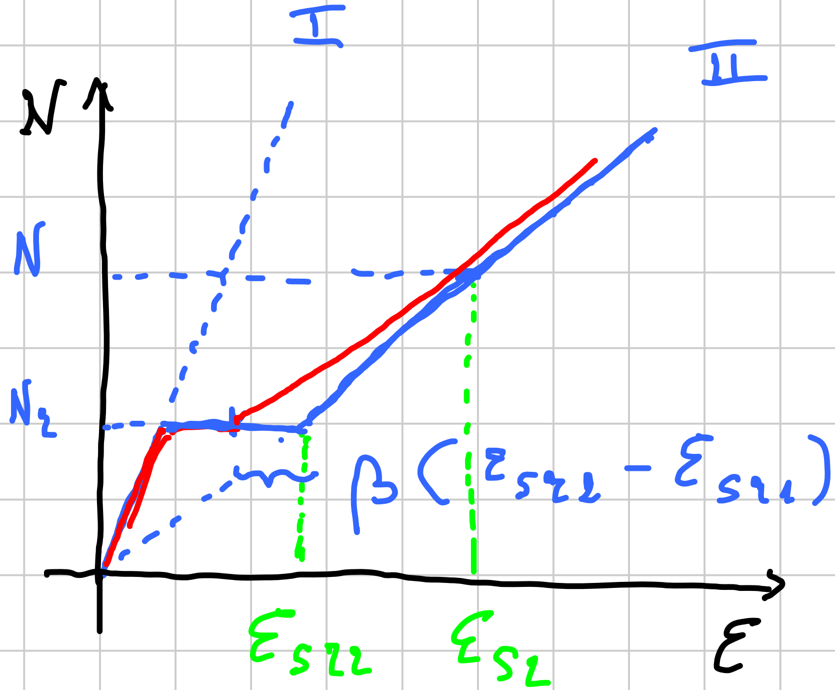
VERIFICA DEGLI SPOSTAMENTI

Titolo nota 26/05/2015

$$f(Q+Q) \leq \frac{1}{250} L$$

$$f(Q) \leq \frac{1}{500} L$$





I

$$\varepsilon_{s1} = \varepsilon_c = \frac{N}{E_c(A_c + n A_s)} = \frac{N}{E_c A_c + E_s A_s}$$

II

$$\varepsilon_{s2} = \frac{N}{E_s A_s}$$

$$\varepsilon_{sr} = \varepsilon_{sr2} - \beta\left(\varepsilon_{sr2} - \varepsilon_{sr1}\right) \quad \text{für} \quad N = N_2$$

$$\varepsilon_{s} = \varepsilon_{s2} - \beta\left(\varepsilon_{sr2} - \varepsilon_{sr1}\right)\frac{N_2}{N} \quad \text{für} \quad N > N_2$$

$$\frac{\varepsilon_{s2}}{N} = \frac{\varepsilon_{sr2}}{N_2} \Rightarrow \varepsilon_{sr2} = \varepsilon_{s2}\frac{N_2}{N} \; ; \; \varepsilon_{sr1} = \varepsilon_{s1}\frac{N_2}{N}$$

$$\varepsilon_{s} = \varepsilon_{s2} - \beta\left(\varepsilon_{s2} - \varepsilon_{s1}\right)\left(\frac{N_2}{N}\right)^2$$

$$\varepsilon_{s} = \varepsilon_{s2}\underbrace{\left[1 - \beta\left(\frac{N_2}{N}\right)^2\right]}_{\xi} + \varepsilon_{s1}\beta\left(\frac{N_2}{N}\right)^2$$

$$\zeta = 1 - \beta \left(\frac{N_r}{N} \right)^2$$

tirante

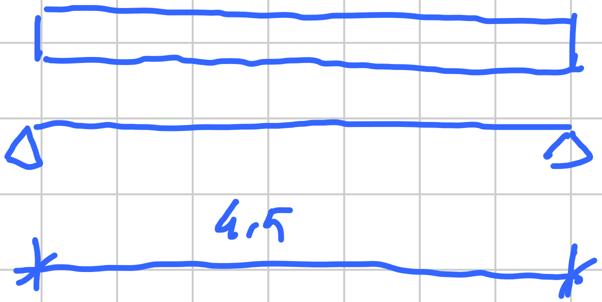
$$\varepsilon_s = \zeta \, \varepsilon_{s2} + (1 - \zeta) \, \varepsilon_{s1}$$

$$\zeta = 1 - \beta \left(\frac{M_r}{M} \right)^2$$

trave

$$\chi = \zeta \, \chi_2 + (1 - \zeta) \, \chi_1$$

$$f = \zeta \, f_2 + (1 - \zeta) \, f_1$$



$G_k = 20\ KN/m$

$Q_k = 15\ KN/m$

$$M_{Ed} = \frac{48{,}5 \times 4.5^2}{8} = 123\ KNm$$

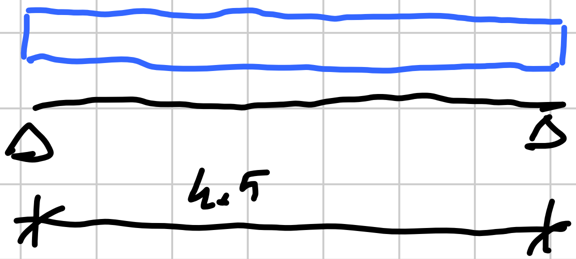
$G_d + Q_d = 1{,}3 \times 20 + 1.5 \times 15 = 48.5\ KN/m$

$$b = \frac{r'^2 M_{Ed}}{d^2} = \frac{0{,}018^2 \times 123}{0{,}22^2} = 82\ cm$$

90×26 $h = 26\ cm$

$$A_s = \frac{123 \times 10}{0{,}9 \times 0{,}22 \times 391{,}3} = 15.87\ cm^2$$

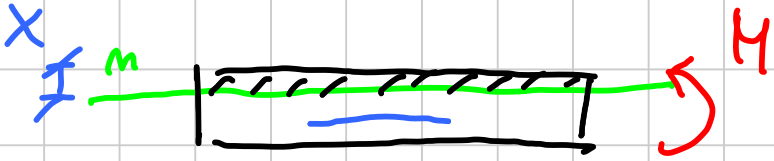
$5\phi 20 + 1\phi 14$ $A_s = 17.2\ cm^2$



$$G_k + \psi_2 Q_k = 20 + 0{,}3 \times 15 = 24{,}5 \ \mathrm{KN/m}$$

$$f_2 = \frac{5}{384} \frac{Q L^4}{E_c I_2}$$

$$E_c = \frac{E_{cm}}{1 + \underbrace{\phi}_{2,5}} = \frac{31500}{3{,}5} = 9000 \ \mathrm{MPa}$$



$$+\frac{B x^2}{2} - m A_s (d - x) = 0$$

$$\frac{B}{2} x^2 + m A_s x - m A_s d$$

$$45 x^2 + 258 x - 5676 = 0$$

$$x = \frac{-258 + \sqrt{258^2 + 4 \times 45 \times 5676}}{90} = 8,7$$

$$I_2 = \frac{B x^3}{3} + n A_s (d-x)^2 = \frac{90 \times 8{,}7^3}{3} + 15 \times 17{,}2 \times (22 - 8{,}7)^2$$

$$= 65400 \text{ cm}^4$$

$$f_2 = \frac{5}{384} \frac{Q L^4}{E_c I_2} = \frac{5}{384} \times \frac{24{,}5 \times 4{,}5^4}{9000 \times 65400} \times \frac{10^{\cancel{12}\,8}}{\cancel{10^4}} = 22 \text{ mm}$$

$$f_{lim} = \frac{1}{250} L = \frac{4500}{25} = 18 \text{ mm}$$

$$f_1 = \frac{5}{384} \frac{Q L^2}{E_c I_1}$$

$$S_0 = \frac{B h^2}{2} + m A_s d = \frac{90 \times 26^2}{2} + 15 \times 17{,}2 \times 22 =$$

$$= 36096 \text{ cm}^3$$

$$A = B h + m A_s = 90 \times 26 + 15 \times 17{,}2 = 2598 \text{ cm}^2$$

$$d_{G,sup} = \frac{S_0}{A} = \frac{36096}{2598} = 13{,}9 \text{ cm}$$

$$d_{G,inf} = 12{,}1 \text{ cm}$$

$$I_1 = \frac{B d_{e_{sup}}^3}{3} + \frac{B d_{e_{inf}}^3}{3} + n A_s (d_{e_{inf}} - c)^2$$

$$= \frac{90 \times 13{,}9^3}{3} + \frac{90 \times 12.1^3}{3} + 15 \times 17{,}2 \times (12{,}1 - 4)^2$$

$$= 150642 \text{ cm}^4$$

$$f_1 = \frac{5}{384} \frac{Q L^2}{E_c I_1} = \frac{5}{384} \times \frac{24{,}5 \times 4{,}5^4 \times 10^8}{9000 \times 150642} = 9{,}6 \text{ mm}$$

$$\zeta = 1 - \beta \left(\frac{M_r}{M} \right)^2$$

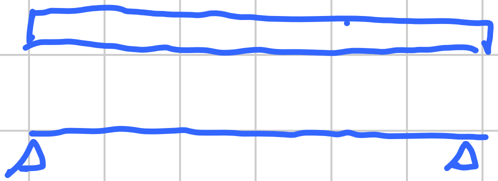
$$\beta = \begin{cases} 1 & \text{carichi breve durata} \\ 0,5 & \text{= lunga durata} \end{cases}$$

$$M_r = \frac{I_1}{d_{G,inf}} f_{cfm}$$

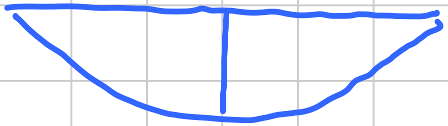
$f_{ctm} = 2.56$ MPa

$f_{cfm} = 1,2 \times 2,56 = 3,07$ MPa

$$= \frac{150642}{12.1} \times \frac{3.07}{10^3} = 38,2 \text{ KNm}$$



24,5 KN/m



$$M_{max} = \frac{24,5 \times 4,5^2}{8} = 62 \text{ KNm}$$

$$M = \frac{2}{3} M_{max} = \frac{2}{3} \times 62 = 41,3 \text{ KNm}$$

$$\zeta = 1 - 0,5 \left(\frac{38,2}{41,3} \right)^2 = 0,57$$

$$f = \xi f_2 + (1 - \xi) f_1$$

$$= 0{,}57 \times 22 + (1 - 0{,}57) \times 9{,}6 = 16{,}7 \text{ mm} < 18 \text{ mm}$$

OK !

$$f_2 = \frac{5}{384} \frac{Q L^4}{E_c I_2}$$

$$M_{max} = \frac{Q L^2}{8} \Longrightarrow Q = \frac{8 M_{max}}{L^2}$$

$$f_2 = \frac{5}{384} \frac{L^{\cancel{4}\,2}}{E_c I_2} \frac{8 M_{max}}{\cancel{L^2}} = \frac{40}{384} \frac{M_{max} L^2}{E_c I_2}$$

$$\sigma_s = n \frac{M_{max}}{I_2} (d - x) \Longrightarrow M_{max} = \frac{\sigma_s I_2}{n d (1 - \xi)}$$

$$f_2 = \frac{10}{384} \frac{L^2}{E_c \cancel{I_2}} \frac{\sigma_s \cancel{I_2}}{m\, d\, (1-\xi)}$$

$$\frac{f_2}{L} = \frac{10}{384} \frac{\sigma_s}{m E_c (1-\xi)} \frac{L^{\cancel{2}}}{d} \leq \left(\frac{f_2}{L}\right)_{lim}$$

$$\frac{L}{d} \leq \frac{384}{10} \frac{m\, E_c (1-\xi)}{\sigma_s} \left(\frac{f_2}{L}\right)_{lim}$$

$$\lambda \leq K\left[11 + \frac{0{,}0015 \cdot f_{ck}}{\rho + \rho'}\right] \cdot \left[\frac{500 A_{s,eff.}}{f_{yk} A_{s,calc.}}\right] \qquad \text{(C4.1.13)}$$

$$\lambda = \frac{L}{h}$$

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

$$\rho' = \frac{A_s'}{b\,d}$$

Tabella C4.1.I *Valori di K e snellezze limite per elementi inflessi in c.a. in assenza di compressione assiale*

Sistema strutturale	K	Calcestruzzo molto sollecitato ρ=1,5%	Calcestruzzo poco sollecitato ρ=0,5%
Travi semplicemente appoggiate, piastre incernierate mono o bidirezionali	1,0	14	20
Campate terminali di travi continue o piastre continue monodirezionali o bidirezionali continue sul lato maggiore	1,3	18	26
Campate intermedie di travi continue o piastre continue mono o bidirezionali	1,5	20	30
Piastre non nervate sostenute da pilastri (snellezza relativa alla luce maggiore)	1,2	17	24

$$\rho = \frac{17,2}{90 \times 22} = 0.009 = 0,9\%$$

$$\left(\frac{L}{h}\right)_{lim} = 1\left[11 + \frac{0.0015 \times 25}{0.009}\right]\left(\frac{500 \times 17,2}{450 \times 15,81}\right) = 18,2$$

$$\frac{L}{h} = \frac{450}{26} = 17.3 < 18.2$$

OK!