Progetto a flessione semplice

giovedì 18 aprile 2024 08:02

SEZIONE SEMPLICE ARMATURA

SEZ. CLS $\Rightarrow$ $M = \frac{b d^2}{z^2} = M_{Ed}$ $\begin{cases} b \\ d \end{cases}$

$z = 0.0197$ (c 25/30)

ARMATURA $\Rightarrow$ $A_s = \frac{M_{Ed}}{0.9\, d\, f_{yd}}$

SEZIONE A DOPPIA ARMATURA

SEZ. CLS: $M = \frac{b d^2}{z'^2} = M_{Ed}$ $\begin{cases} b \\ d \end{cases}$

$z' = z\, K = z \sqrt{1 - \mu_s'}$

$z' < z$

ARM. TESA: $A_s = \frac{M_{Ed}}{0.9\, d\, f_{yd}}$

PROG. ARMATURA COMPRESSA

1) $M_{Ed} = \frac{b d^2}{z'^2}$ $\begin{cases} b \\ d \end{cases}$ T.E. $d = z' \sqrt{\frac{M_{Ed}}{b}} \Rightarrow d + c = h$ $\Downarrow$ **b x H**

$z' = f(\mu)$

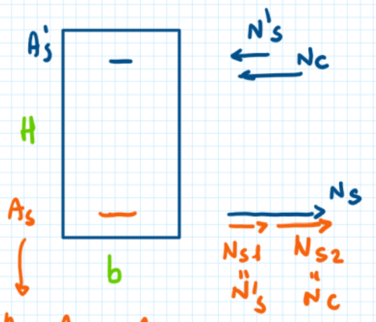
2) $M_{Rd\,A_s'=0} = \frac{b d^2}{z^2}$ $d = H - c$

└ (0.0197 c25/30)

se $M_{Rd\,A_s'=0} > M_{Ed}$ $\Rightarrow$ A_s' NON NECESSARIA

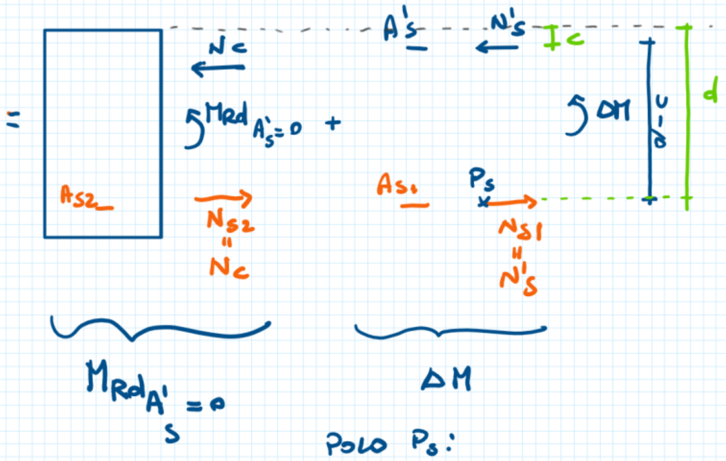
se $M_{Rd\,A_s'=0} < M_{Ed}$ $\Rightarrow$ A_s' È NECESSARIA

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



$$A_s = A_{s1} + A_{s2}$$

$$N_s = N_{s1} + N_{s2}$$



Polo P_s:

$$N'_s = A'_s \sigma'_s = A'_s(-s' f_{yd})$$

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

$$\Delta M = +A'_s s' f_{yd} (d - c)$$

$$A'_s = \frac{\Delta M}{s' f_{yd} (d - c)}$$

$$s' = \frac{\xi - \gamma}{\xi} \frac{\varepsilon_{cu}}{\varepsilon_{yd}} \leq 1$$

ATTENZIONE A z':

$$\rho = \frac{A_s}{bd}$$

$$\rho_{MAX} = 1\% \ (\div 1.5\%)$$

$$\begin{cases} A_s = \dfrac{M_{Ed}}{0.9\, d\, f_{yd}} \\ \rho_{MAX} = \dfrac{A_s}{bd} \end{cases} \Rightarrow \rho_{MAX} = \frac{1}{bd} \frac{M_{Ed}}{0.9\, d\, f_{yd}}$$

$$M_{Ed} = bd^2 (\rho_{MAX}\, 0.9\, f_{yd})$$

$$M_{Ed} = \frac{bd^2}{r_s^2} \qquad \frac{1}{r_s^2}$$

$$r_s = \frac{1}{\sqrt{\rho_{MAX} \times 0.9 \times f_{yd} \times 10^3}} = 0.0167 \quad (0.017)$$

$\rho_{MAX} = 0.1$

CONSIGLIO DI PROG:

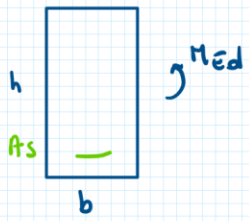
ORIENTATIVAMENTE $\mu = 0.25$ ⇒ TR. EMERG.: $\xi' = 0.017 \div 0.018$

TR. SPESS.: $\xi' = 0.019 \div 0.018$

Progetto a flessione di sezioni in c.a. allo Stato Limite Ultimo

Calcestruzzo:		f_{ck} =	25.0	MPa	f_{cd} =	14.17	MPa	
Acciaio:		f_{yk} =	450.0	MPa	f_{yd} =	391.3	MPa	
					ξ = x/d =	0.2500		
	γ =		0.05	0.10	0.15	0.20	0.25	
	s' =		1.0000	1.0000	0.7156	0.3578	0.0000	
u =	0.00	r =			0.0197			
u =	0.10	r' =	0.0187	0.0187	0.0190	0.0194	0.0197	
u =	0.20	r' =	0.0175	0.0176	0.0183	0.0191	0.0197	
u =	0.30	r' =	0.0164	0.0165	0.0176	0.0187	0.0197	
u =	0.40	r' =	0.0151	0.0153	0.0168	0.0184	0.0197	
u =	0.50	r' =	0.0137	0.0139	0.0160	0.0181	0.0197	

ESEMPIO 1



$M_{Ed} = 250$ kNm

$b = 30$ cm

$c = 5$ cm

C 25/30

1) PROG. CLS

$$M_{Ed} = \frac{b d^2}{z^2} \Rightarrow d = z\sqrt{\frac{M_{Ed}}{b}} = 0.0197\sqrt{\frac{250}{0.30}} = 0.57 \text{ m}$$

$z = 0.0197$ (C 25/30)

$h = 57 + 5 = 62$ cm ⇒ 30 x 70

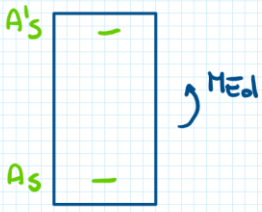
2) PROG. A_s

$$A_s = \frac{M_{Ed}}{0.9\ d\ f_{yd}} = \frac{250 \times 10}{0.9 \times 0.65 \times 391.3} = 10.92 \text{ cm}^2$$

$d = 70 - 5 = 65$ cm

$3\phi 20 + 1\phi 16 = 10.96$ cm² OK!

ESEMPIO 2



$M_{Ed} = 250$ kNm

$b = 30$ cm

$c = 5$ cm

1) PROG. SEZ IN CLS:

$$\frac{bd^2}{\zeta'^2} = M_{Ed} \quad \Rightarrow \quad d = \zeta' \sqrt{\frac{M_{Ed}}{b}} = 0.017 \sqrt{\frac{250}{0.3}} = 0.49 \text{ m}$$

$h = 49 + 5 = 54$ cm $\Rightarrow$ 30 x 60

$\zeta' = ?$ $\quad \mu = 0.25$ $\quad \gamma \simeq 0.1$

Calcestruzzo:	f_{ck} = 25.0 MPa			f_{cd} = 14.17 MPa	
Acciaio:	f_{yk} = 450.0 MPa			f_{yd} = 391.3 MPa	
				$\xi = x/d$ = 0.2500	
γ =	0.05	0.10	0.15	0.20	0.25
s' =	1.0000	1.0000	0.7156	0.3578	0.0000
u = 0.00	r =			0.0197	
u = 0.10	r' =	0.0187	0.0187	0.0190	0.0194	0.0197
u = 0.20	r' =	0.0175	0.0176	0.0183	0.0191	0.0197
u = 0.30	r' =	0.0164	0.0165	0.0176	0.0187	0.0197
u = 0.40	r' =	0.0151	0.0153	0.0168	0.0184	0.0197

$\Rightarrow \zeta' = 0.017$

2) PROG. A_S

$$A_S = \frac{M_{Ed}}{0.9\, d\, f_{yd}} = \frac{250 \times 10}{0.9 \times 0.55 \times 391.3} = 12.9 \text{ cm}^2$$

$d = 60 - 5 = 55$

$\Downarrow$

$4\phi 20 + 1\phi 14 = 14.1 \text{ cm}^2$

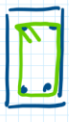
3) PROG. A'_S

$$M_{Rd\,A'_S=0} = \frac{0.3 \times 0.55^2}{0.0197^2} = 233.8 \text{ kNm}$$

$\Delta M = 250 - 233.8 = 16.2$ kNm

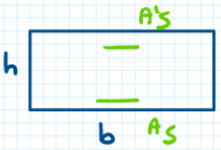
$$A'_S = \frac{\Delta M}{s'\, f_{yd}\, (d-c)} = \frac{16.2 \times 10}{391.3\,(0.55 - 0.05)} = 0.76 \text{ cm}^2$$

$\hookrightarrow 2\phi 14$



$$s' = \frac{\xi - \gamma}{\xi} \frac{\varepsilon_{cu}}{\varepsilon_{yd}} = \frac{0.25 - 5/55}{0.25} \frac{0.0035}{0.00196} = 1.14 \quad (1.0)$$

ESEMPIO 3



$M_{Ed} = 100$ kNm

$c = 4.0$ cm

$h_{SOL} = 25$ cm

$h = 25$ cm $\Rightarrow d = 25 - 4 = 21$ cm

$\gamma = \frac{c}{d} = \frac{4}{21} = 0.19$

1) PROG. SEZ IN CLS

$$M_{Ed} = \frac{b\,d^2}{\zeta'^2} \Rightarrow b = \frac{M_{Ed}\,\zeta'^2}{d^2} = 100 \times \frac{0.0181^2}{0.21^2} = 0.74\ m \Rightarrow 80 \times 25$$

ζ' :

Calcestruzzo:			f_{ck} =	25.0	MPa	f_{cd} = 14.17	MPa
Acciaio:			f_{yk} =	450.0	MPa	f_{yd} = 391.3	MPa
						ξ = x/d = 0.2500	

		γ =	0.05	0.10	0.15	0.20	0.25
		s' =	1.0000	1.0000	0.7156	0.3578	0.0000
u =	0.00	r =			0.0197		
u =	0.10	r' =	0.0187	0.0187	0.0190	0.0194	0.0197
u =	0.20	r' =	0.0175	0.0176	0.0183	0.0191	0.0197
u =	0.30	r' =	0.0164	0.0165	0.0176	0.0187	0.0197
u =	0.40	r' =	0.0151	0.0153	0.0168	0.0184	0.0197
u =	0.50	r' =	0.0137	0.0139	0.0160	0.0181	0.0197

$\zeta' = 0.0181$

2) PROG. A_S

$$A_S = \frac{M_{Ed}}{0.9\ d\ f_{yd}} = \frac{100 \times 10}{0.9 \times 0.21 \times 391.3} = 13.52\ cm^2$$

$\downarrow$

$4\phi 20 + 1\phi 14$

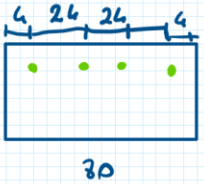
3) PROG. A'_S

$$M_{Rd}\Big|_{A'_S = 0} = 0.80 \times \frac{0.21^2}{0.0197^2} = 90.9\ kNm$$

$\Delta M = 100 - 90.9 = 9.1$ kNm

$$A'_S = \frac{9.1 \times 10}{0.42 \times 391.3 \times (0.21 - 0.04)} = 3.26\ cm^2 \Rightarrow 3\phi 14$$

$4\phi 14$



$$\varepsilon' = \frac{\xi - \gamma}{\xi}\,\frac{\varepsilon_{cu}}{\varepsilon_{yd}} = \frac{0.25 - 4/21}{0.25}\,\frac{0.0035}{0.00197} = 0.42$$