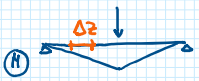
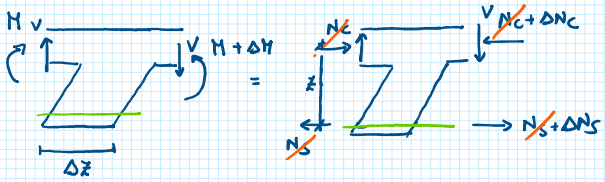
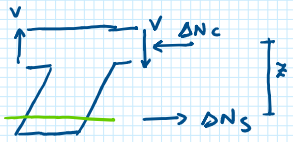
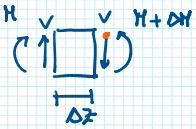
V_{Rd} DENTE







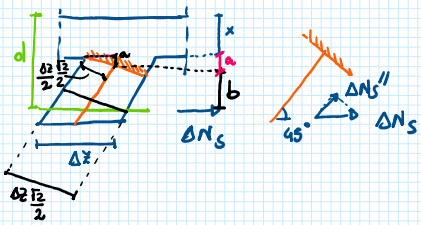


$$\begin{cases} \Delta N_S = \dfrac{\Delta M}{z} \\ \Delta M = V\,\Delta z \end{cases} \Rightarrow \Delta N_S = V\dfrac{\Delta z}{z}$$

$$M + V\Delta z - (M+\Delta M) = 0$$

$$M + V\Delta z - M - \Delta M = 0$$

$$\Delta M = V\Delta z$$



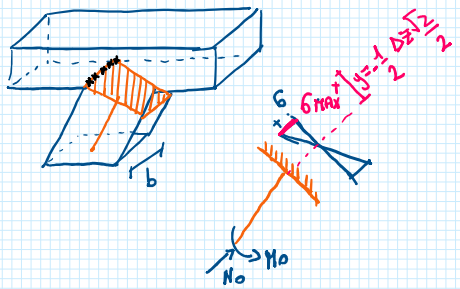
$$\Delta N_S'' = N_0 \Rightarrow N_0 = -\Delta N_S \frac{\sqrt{2}}{2}$$

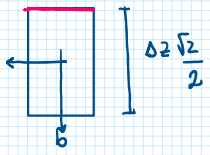
$$N_0 = -V\frac{\Delta z}{z}\frac{\sqrt{2}}{2}$$

$$M_0 = -\Delta N_S\, b = -V\frac{\Delta z}{z}\left(d - x - \frac{\Delta z}{4}\right)$$

$$b = d - x - a = d - x - \frac{\Delta z}{4}$$

$$a = \Delta z\frac{\sqrt{2}}{2}\frac{1}{2}\frac{\sqrt{2}}{2} = \frac{\Delta z}{4}$$





$$\sigma_{MAX}^{+} = f_{ctf_d} = 1.2\, f_{ctd}$$

$$\sigma = \frac{N}{A} + \frac{M}{I}y \Rightarrow \sigma_{MAX}^{+}: \quad N = N_0 = -V\frac{\Delta z}{z}\frac{\sqrt{2}}{2}$$

$$M = M_0 = -V\frac{\Delta z}{z}\left(d - x - \frac{\Delta z}{4}\right)$$

$$A = b\,\Delta z\frac{\sqrt{2}}{2}$$

$$y = -\frac{1}{2}\Delta z\frac{\sqrt{2}}{2}$$

$$I = \frac{b}{12}\left(\Delta z\frac{\sqrt{2}}{2}\right)^3$$

$$I = \frac{b\,\Delta z^2\,(\sqrt{2})^3}{\cdots}$$

$$I = \frac{b}{12}\left(\Delta z^3 + \frac{\Delta z}{2}\right)$$

$$\frac{I}{y} = \frac{\frac{b}{12}\Delta z^3 \left(\frac{\Delta z}{2}\right)^3}{-\frac{1}{2}\Delta z \frac{\Delta z}{2}} = -\frac{b}{12}\Delta z^2$$

$$\sigma_{MAX}^{+} = \frac{-V\frac{\Delta z}{z}\frac{\Delta z}{2}}{b\,\Delta z\frac{\Delta z}{2}} + \frac{+V\frac{\Delta z}{z}\left(d - x - \frac{\Delta z}{4}\right)}{-\frac{b}{12}\Delta z^2}$$

$$\sigma_{MAX}^{+} = -\frac{V}{bz} + \frac{12V}{bz}\,\frac{\left(d - x - \frac{\Delta z}{4}\right)}{\Delta z}$$

SPERIMENTALMENTE: $x \cong 0.2\,d$, $\Delta z \cong d$ $\Rightarrow \left(d - x - \frac{\Delta z}{4}\right) = d - 0.2d - 0.25d = 0.55\,d$

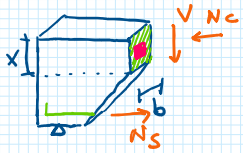
$$\sigma_{MAX}^{+} = -\frac{V}{bz} + \frac{12V}{bz}\,\frac{0.55\,d}{d}$$

$$\sigma_{MAX}^{+} = \frac{V}{bz}\left(-1 + 12 \cdot 0.55\right) = 5.6\,\frac{V}{bz}$$

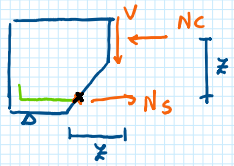
$$\sigma_{MAX}^{+} = 1.2\,f_{ctd} \Rightarrow V_{Rd\,DENTE} = \frac{1.2}{5.6} f_{ctd}\, b\, z \quad (z \approx 0.9\,d)$$

$$\boxed{V_{Rd\,DENTE} = 0.193\, b\, d\, f_{ctd}}$$

V_{Rd} DORSO



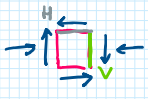
$V \Rightarrow \tau = \frac{V}{bx}$ $\quad N_c \Rightarrow \sigma_c = \frac{N_c}{bx}$



$-Vz + N_c z = 0 \Rightarrow N_c = V$

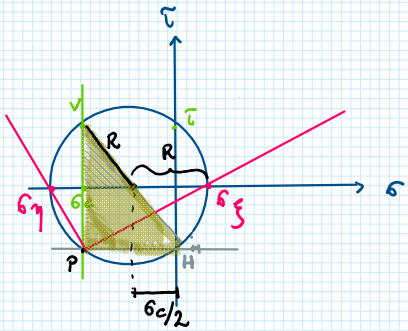
$\Downarrow$

$\sigma_c = \tau = \frac{V}{bx}$



$V\left(\sigma_c^{-};\ \tau^{+}\right)$

$H\left(0;\ \tau^{-}\right)$



DEVO RICAVARE: $\sigma_3 = R - \frac{\sigma_c}{2}$

$$R = \sqrt{\tau^2 + \left(\frac{\sigma_c}{2}\right)^2} = \sqrt{\left(\frac{V}{bx}\right)^2 + \left(\frac{1}{2}\frac{V}{bx}\right)^2}$$

$$= \frac{V}{bx}\sqrt{1+\frac{1}{4}} = \sqrt{1.25}\ \frac{V}{bx}$$

$$\sigma_\xi = \frac{V}{bx}\sqrt{1.25} - \frac{1}{2}\frac{V}{bx}$$

$$\sigma_\xi = \frac{V}{bx}\left(\sqrt{1.25} - 0.5\right) = 0.618\,\frac{V}{bx}$$

SE $\sigma_\xi = f_{ctd} \Rightarrow V_{Rd\,DORSO} = \frac{1}{0.618} f_{ctd}\, bx = 1.618\, f_{ctd}\, bx$

$$\boxed{V_{Rd\,DORSO} = 1.618\, bx\, f_{ctd}}$$

$$V_{Rd} = MIN \begin{cases} V_{Rd\,DENTE} \\ V_{Rd\,DORSO} \end{cases}$$

Se $V_{Rd\,DORSO} < V_{Rd\,DENTE}$

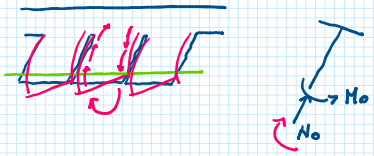
$$1.618\, bx\, f_{ctd} < 0.193\, bd\, f_{ctd}$$

$$x < \frac{0.193}{1.618}\, d$$

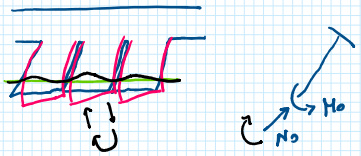
$$x < 0.12\, d$$

ALTRI CONTRIBUTI DI RESISTENZA

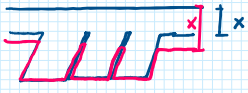
1) INGRANAMENTO DEGLI INERTI



2) EFFETTO SPINOTTO



3) PRESENZA DI N



DA NORMATIVA:

$$V_{Rd_c} = \left[0.18\,\frac{k\sqrt[3]{100\,\rho_l f_{cm}}}{\gamma_c}\,MPa + 0.15\,\sigma_{cp}\right] b_w d \geq \left[0.035\,\sqrt{k^3 f_{cm}}\,MPa + 0.15\,\sigma_{cp}\right] b_w d$$

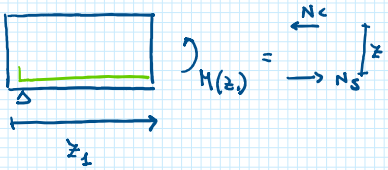
$$k = 1 + \sqrt{\frac{200}{d}} \leq 2 \qquad [mm]$$ INGR. INERTI

$$\rho_l = \frac{A_s}{b_w d} \leq 0.02$$ EFFETTO SPINOTTO

$$\sigma_{cp} = \frac{N}{A} \leq 0.2 f_{cd}$$ EFFETTO DI N

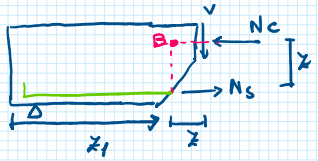
(N POSITIVO SE DI COMPRESSIONE)

OSSERVAZIONE



$$N_s = \frac{M(z_1)}{z}$$

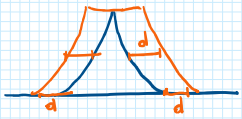
$$A_s = \frac{N_s}{f_{yd}} = \frac{M(z_1)}{z f_{yd}} = \frac{M(z_1)}{0.9\,d\,f_{yd}}$$



$$-V z + N_s z = M(z_1)$$

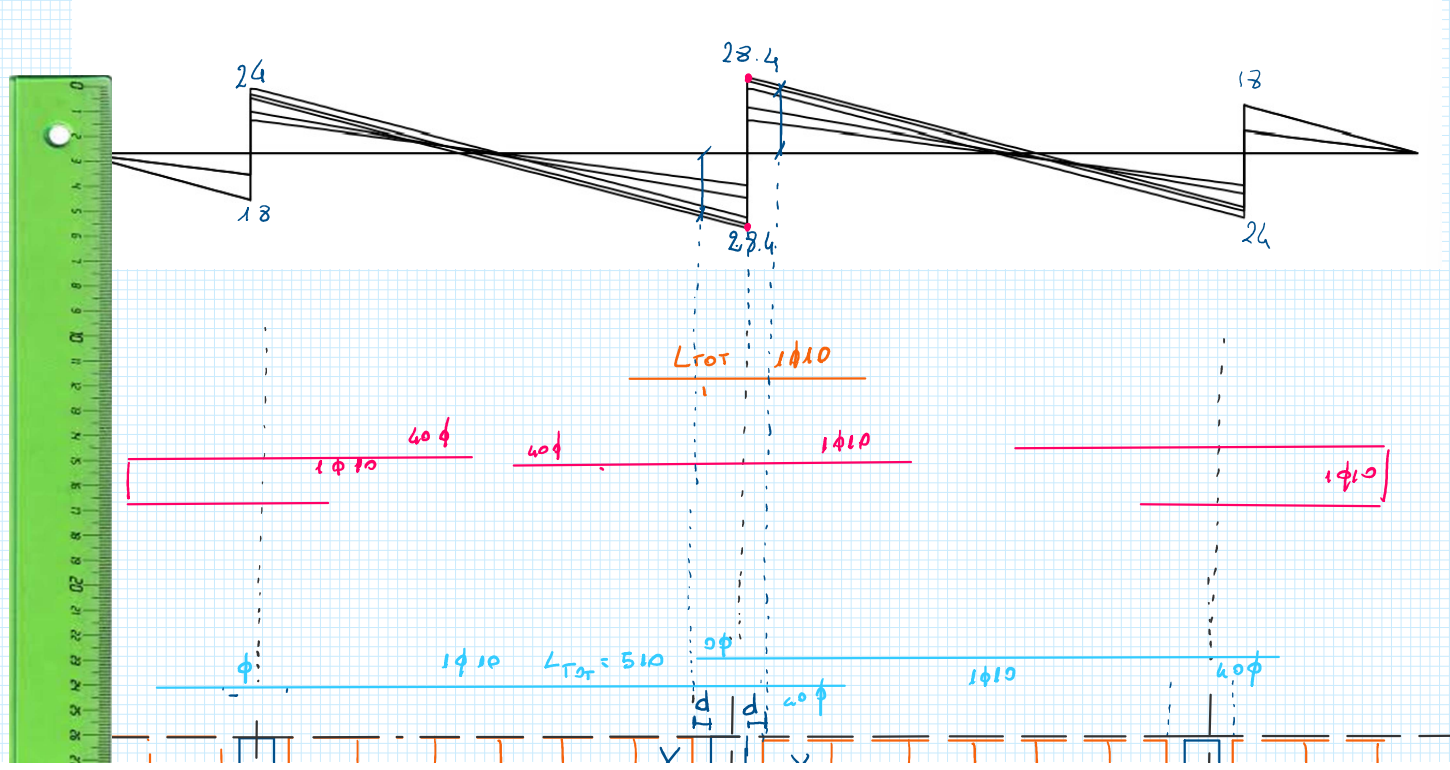
$$N_s = \frac{M(z_1) + Vz}{z} \qquad M(z_1 + z)$$

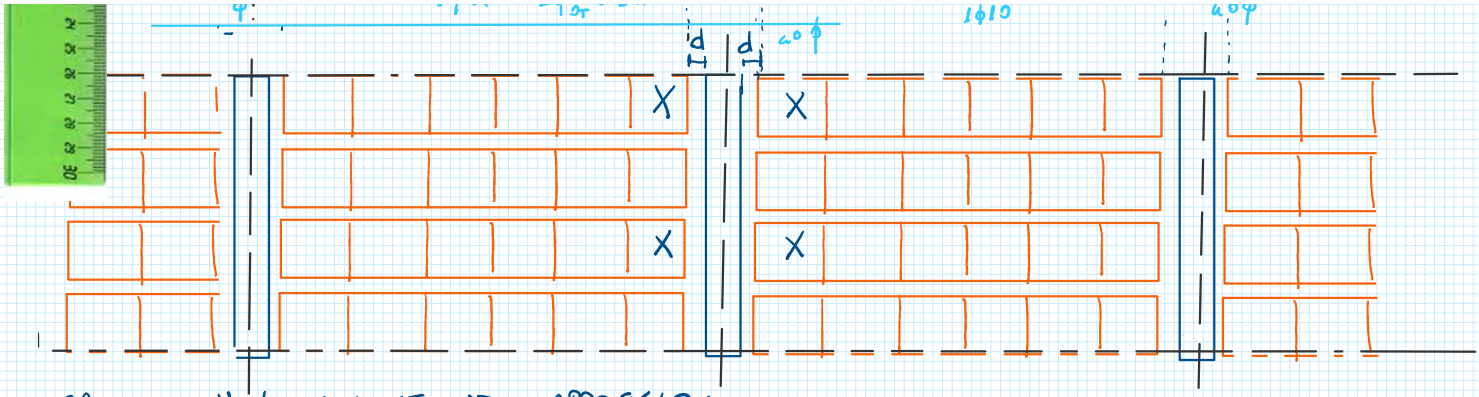
$$N_s = \frac{M(z_1 + z)}{z}$$



ESEMPIO => PROG: VERIFICA A TAGLIO DEL SOLAIO

1 cm = 10 kN





CALCOLO $V_{Rd\,c}$ SUL SECONDO APPOGGIO:

$$V_{Rd\,c} = \left[0.18 \left(k \sqrt[3]{100 \rho_l \rho_{cw}}\right)^{MPa} + 0.15 \sigma_{cp}\right] b_w d$$

$$k = 1 + \sqrt{\frac{200}{d}} = 1 + \sqrt{\frac{200}{200}} = 2 \quad (\leq 2)$$

$d = 23 - 3 = 20\ cm = 200\ mm$

$$\rho_l = \frac{A_s}{b_w d} = \frac{(2 \times 0.78) \times 3^{N.TRAVETTI}}{3 \times 8 \times 20} = 0.00975$$

$$\sigma_{cp} = \frac{N}{A} \leq 0.2 f_{cd} = 0$$

$$V_{Rd\,c} = \left[0.18 \cdot 2 \cdot \frac{\sqrt[3]{100 \cdot 0.00975 \cdot 25}}{1.5}\right] \frac{24 \cdot 20}{10} = 33.4\ kN > V_{Ed\ 2^\circ APP}\ \checkmark$$

POICHÉ HO ARM. TESA, NON SERVE CALCOLARE IL SECONDO TERMINE

CALCOLO $V_{Rd\,c}$ SUL PRIMO APP.:

$$k = 1 + \sqrt{\frac{200}{d}} = 1 + \sqrt{\frac{200}{200}} = 2 \quad (\leq 2)$$

$d = 23 - 3 = 20\ cm = 200\ mm$

$$\rho_l = \frac{A_s}{b_w d} = \frac{(1 \times 0.78) \times 3^{N.TRAVETTI}}{3 \times 8 \times 20} = 0.00488$$

$$\sigma_{cp} = \frac{N}{A} \leq 0.2 f_{cd} = 0$$

$$V_{Rd\,c} = \left[0.18 \cdot 2 \cdot \frac{\sqrt[3]{100 \cdot 0.00488 \cdot 25}}{1.5}\right] \frac{24 \cdot 20}{10} = 26.52\ kN$$

DA CONFRONTARE CON V_{Ed} DEL PRIMO APPOGGIO

SE $V_{Rd\,c} < V_{Ed}$ => FASCIA SEMIPIENA => $b_w = 3 \times 8 + 25 + \frac{25}{2}$ (3TR/1m)

$b_w = 2 \times 10 + 40$ (2TR/1m)