Taglio: formule di verifica a SLU

mercoledì 27 maggio 2026 14:01

$$\boxed{\sigma_c\, b\, \sin^2\vartheta = \sigma_{sw} \frac{A_{sw}}{s} \sin\alpha} \quad (1)$$

$$\boxed{V = \sigma_c\, b\, z \cos\vartheta \sin\vartheta + \sigma_{sw} \frac{A_{sw}}{s} z \cot\alpha \sin\alpha} \quad (2)$$

$$\boxed{V = \sigma_c\, b\, z \frac{\cot\vartheta + \cot\alpha}{1 + \cot^2\vartheta}} \quad (3)$$

PER RICAVARE V_{Rd} DELLE ARMATURE:

DA (1) $\Rightarrow \sigma_c = \sigma_{sw} \frac{A_{sw}}{s} \frac{\sin\alpha}{b \sin^2\vartheta}$ $\Rightarrow$ SOSTITUISCO IN (2)

$$V = \sigma_{sw} \frac{A_{sw}}{s} \frac{\sin\alpha}{\cancel{b} \sin^{\cancel{2}}\vartheta} \cancel{b}\, z \cos\vartheta \cancel{\sin\vartheta} + \sigma_{sw} \frac{A_{sw}}{s} z \cot\alpha \sin\alpha$$

$$\boxed{V = \sigma_{sw} \frac{A_{sw}}{s} z \sin\alpha \left(\cot\vartheta + \cot\alpha\right)} \quad (4)$$

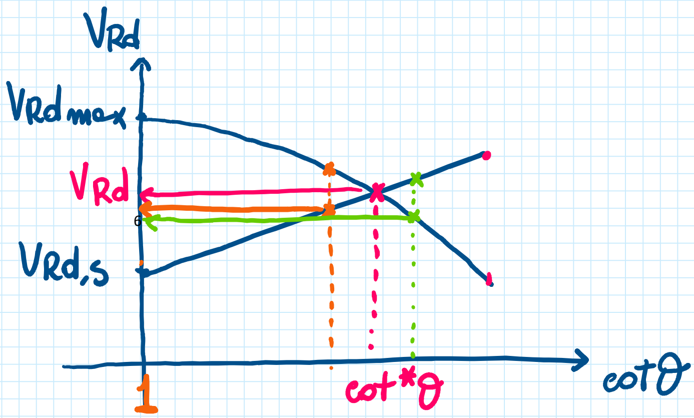
SE $\sigma_{sw} = f_{yd} \Rightarrow V_{Rd,s} = z \frac{A_{sw}}{s} f_{yd} \sin\alpha \left(\cot\vartheta + \cot\alpha\right)$

DA NTC 18: $$\boxed{V_{Rds} = 0.9\, d\, \frac{A_{sw}}{s} f_{yd} \sin\alpha\left(\cot\vartheta + \cot\alpha\right)}$$

NEL CASO DI STAFFE: $\alpha = 90°$

$$\boxed{V_{Rd_{max}} = 0.9\, d\, b\, f'_{cd}\, \alpha \frac{\cot\vartheta}{1+\cot^2\vartheta} \qquad V_{Rd_s} = 0.9\, d\, \frac{A_{sw}}{s}\, f_{yd} \cot\vartheta}$$

PER LA VERIFICA: $V_{Rd} = \text{MIN}\left\{ V_{Rd\,max} ;\ V_{Rd,s} \right\}$



$\cot^*\vartheta \Rightarrow V_{Rd\,max} = V_{Rd,s}$

$$\cancel{0.9\,d}\, b\, f'_{cd}\, \alpha_c \frac{\cancel{\cot\vartheta}}{1+\cot^2\vartheta} = \cancel{0.9\,d}\, \frac{A_{sw}}{s}\, f_{yd}\, \cancel{\cot\vartheta}$$

$$1 + \cot^{*2}\vartheta = \frac{b\, f'_{cd}\, \alpha_c}{\frac{A_{sw}}{s} f_{yd}}$$

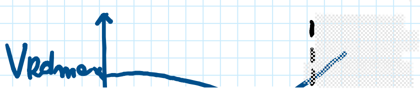
$$\boxed{\cot^*\vartheta = \sqrt{\frac{b\, f'_{cd}\, \alpha_c}{\frac{A_{sw}}{s} f_{yd}} - 1}}$$

DA NTC18 : $1 \le \cot\vartheta \le 2.5$

PER LA VERIFICA:

1) CALCOLO $\cot^*\vartheta$

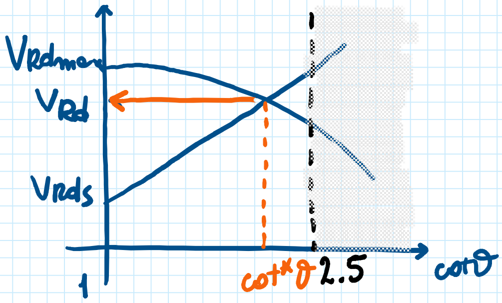
2) ...



2) SE $\cot^*\vartheta \le 2.5$

$$V_{Rd} = V_{Rds}(\cot^*\vartheta) \quad \text{OPPURE}$$

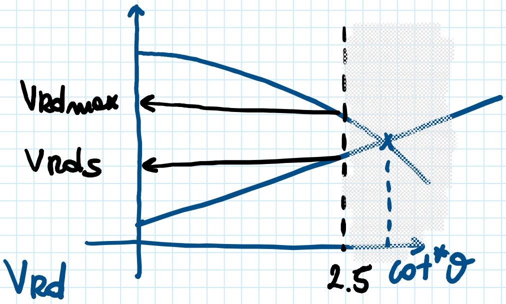
$$V_{Rd} = V_{Rdmax}(\cot^*\vartheta)$$



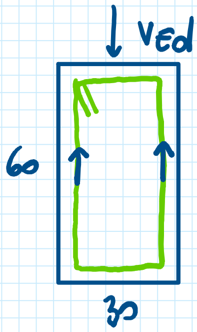
SE $\cot^*\vartheta > 2.5$

$\hookrightarrow \cot\vartheta = 2.5$

$$\left.\begin{array}{l} V_{Rds}(\cot\vartheta = 2.5) \\ V_{Rdmax}(\cot\vartheta = 2.5) \end{array}\right\} \text{MIN} = V_{Rd}$$



ESEMPIO 1



$V_{Ed} = 100$ kN $\qquad$ C 25/30

STAFFE $\phi 8/15$

$c = 5$ cm

1) $$\cot^*\vartheta = \sqrt{\frac{b\, f'_{cd}\, \alpha_c}{\frac{A_{sw}}{s}\, f_{yd}} - 1} = \sqrt{\frac{30 \cdot 7.08}{\frac{1.0}{15} \cdot 391.3} - 1} = \cancel{2.67}\ \ 2.5$$

$$f'_{cd} = 0.5\, f_{cd} = 0.5 \cdot 14.17 = 7.08 \text{ MPa}$$

$$\alpha_c = 1 \quad (N = 0)$$

$$A_{sw} = \pi \frac{\phi^2}{4} \times N_{BRACCI} = \pi \frac{0.8^2}{4} \times 2 = 0.5 \times 2 = 1 \text{ cm}^2$$

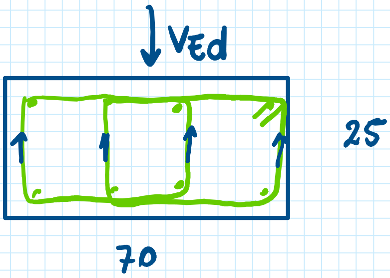
2) $$V_{Rdmax} = 0.9 \cdot 55 \cdot 30 \cdot \frac{0.5 \times 14.17}{10} \cdot \frac{2.5}{1 + 2.5^2} = 362.8 \text{ kN}$$

2) $V_{Rd_{max}} = 0.9 \cdot 55 \cdot 30 \cdot 0.5 \times \frac{14.17}{10} \cdot \frac{2.5}{1 + 2.5^2} = 362.8 \text{ kN}$

$V_{Rd_s} = 0.9 \cdot 55 \cdot \frac{1.0}{15} \cdot 391.3 \times \frac{2.5}{10} = 322.8 \text{ kN}$

$V_{Rd} = 322.8 \text{ kN} > V_{Ed}$ <u>OK!</u>

ESEMPIO 2



$c = 4$ cm $\qquad d = 21$ cm

$\phi 8/10$

$V_{Ed} = 300$ kN

1) $\cot^* \vartheta = \sqrt{\dfrac{b\, f'_{cd}\, \alpha_c}{\frac{A_{sw}}{s} f_{yd}} - 1} = \sqrt{\dfrac{70 \cdot 0.5 \cdot 14.17}{\frac{2.0}{10} \times 391.3} - 1} = 2.3$

$A_{sw} = A_{1\phi 8} \times N_{BR} = 0.5 \times 4 = 2.0$

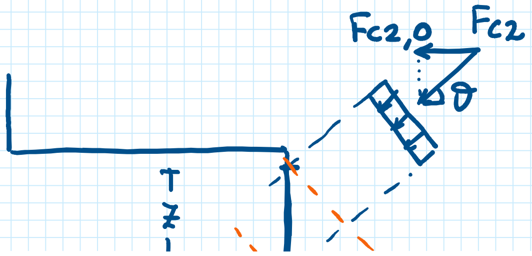
2) $\cot^* \vartheta = 2.3$

4 BRACCI x 0.5 cm²

$V_{Rd_s} = 0.9 \cdot 21 \cdot \frac{2.0}{10} \cdot 391.3 \times \frac{2.3}{10} = 340.2 \text{ kN}$

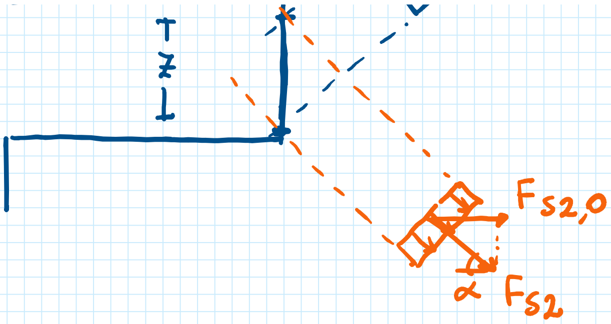
$V_{Rd} = 340.2 > V_{Ed}$ <u>OK!</u>

FERRI DI PARETE



$F_{c2} = \sigma_c\, b\, z \cos\vartheta$

$F_{s2} = \sigma_{sw} \frac{A_{sw}}{s} z \cot\alpha$



EQ. TRASLAZIONE ORIZZONTALE: $F = F_{c2,0} - F_{s2,0}$

$$F = F_{c2} \cos\vartheta - F_{s2} \cdot \cos\alpha$$

RISCRIVO F_{c2} $\left(F_{c2} = \sigma_c\, b\, z \cos\vartheta \right)$:

$$\boxed{V = \sigma_c\, b\, z \frac{\cot\vartheta + \cot\alpha}{1 + \cot^2\vartheta}} \quad (3)$$

$$V = \sigma_c\, b\, z \frac{\cot\vartheta + \cot\alpha}{1 + \cot^2\vartheta} \times \frac{\cos\vartheta}{\cos\vartheta}$$

$$V = F_{c2} \frac{1}{\cos\vartheta} \frac{\cot\vartheta + \cot\alpha}{1 + \cot^2\vartheta} \times \frac{\sin^2\vartheta}{\sin^2\vartheta}$$

$$V = F_{c2} \frac{\sin\vartheta}{\cot\vartheta} \frac{\cot\vartheta + \cot\alpha}{\sin^2\vartheta + \cos^2\vartheta}$$

$$V = F_{c2} \frac{\sin\vartheta}{\cot\vartheta} (\cot\vartheta + \cot\alpha)$$

$$\boxed{F_{c2} = \frac{V \cot\vartheta}{\sin\vartheta (\cot\vartheta + \cot\alpha)}}$$

RISCRIVO F_{s2} $\left(F_{s2} = \sigma_{sw} \frac{A_{sw}}{s} z \cot\alpha \right)$:

$$\boxed{V = \sigma_{sw} \frac{A_{sw}}{s} z \operatorname{sen}\alpha \left(\cot\vartheta + \cot\alpha\right)}$$ (4)

$$V = \sigma_{sw} \frac{A_{sw}}{s} z \operatorname{sen}\alpha \left(\cot\vartheta + \cot\alpha\right) \times \frac{\cot\alpha}{\cot\alpha}$$

$$V = \frac{F_{s2} \operatorname{sen}\alpha}{\cot\alpha} \left(\cot\vartheta + \cot\alpha\right)$$

$$\boxed{F_{s2} = \frac{V \cot\alpha}{\operatorname{sen}\alpha \left(\cot\vartheta + \cot\alpha\right)}}$$

RISCRIVO L'EQ. ALLA TRASLAZ. ORIZZONTALE:

$$F = F_{c2} \cos\vartheta - F_{s2} \cdot \cos\alpha$$

$$F = \frac{V \cot\vartheta \overbrace{\cos\vartheta}^{\cot\vartheta}}{\operatorname{sen}\vartheta \left(\cot\vartheta + \cot\alpha\right)} - \frac{V \cot\alpha \overbrace{\cos\alpha}^{\cot\alpha}}{\operatorname{sen}\alpha \left(\cot\vartheta + \cot\alpha\right)}$$

$$F = \frac{V \cot^2\vartheta}{\left(\cot\vartheta + \cot\alpha\right)} - \frac{V \cot^2\alpha}{\left(\cot\vartheta + \cot\alpha\right)}$$

$$F = \frac{V}{\left(\cot\vartheta + \cot\alpha\right)} \left(\cot^2\vartheta - \cot^2\alpha\right)$$

$$F = \frac{V}{\cancel{\left(\cot\vartheta + \cot\alpha\right)}} \cancel{\left(\cot\vartheta + \cot\alpha\right)} \left(\cot\vartheta - \cot\alpha\right)$$

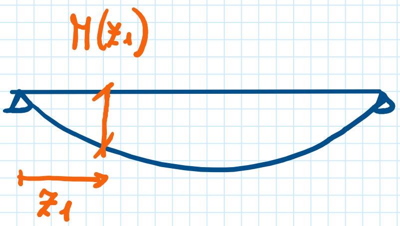
$$\boxed{F = V \left(\cot\vartheta - \cot\alpha\right)}$$

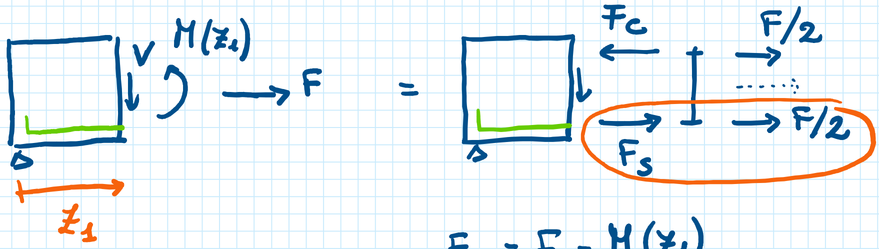
PER PORTARE F : $A_{par} \cdot f_{yd} = F$

$$A_{par} = \frac{V}{f_{yd}} (\cot\vartheta - \cot\alpha)$$

TRASLAZIONE DEL DIAGRAMMA DI M

IN ALTERNATIVA AI FERRI DI PARETE POSSO USARE LA TRASLAZIONE DEL DIAGR. DI M



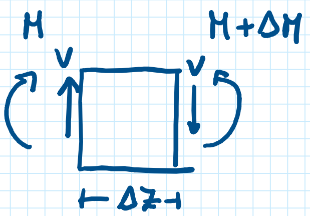


$$F_c = F_s = \frac{M(z_1)}{z}$$

$$F_s' = F_s + \frac{F}{2}$$

$$F_s' = \frac{M(z_1)}{z} + \frac{V(\cot\vartheta - \cot\alpha)}{2}$$

$$\frac{\Delta M}{z}$$



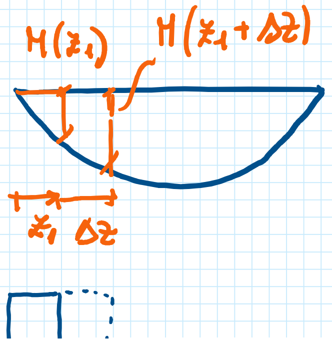
$$\begin{cases} \dfrac{\Delta M}{z} = \dfrac{V}{2}(\cot\vartheta - \cot\alpha) \\ \Delta M = V\Delta z \end{cases} \Rightarrow \frac{\cancel{V}\Delta z}{z} = \frac{\cancel{V}}{2}(\cot\vartheta - \cot\alpha)$$

$$\boxed{\Delta z = \frac{z}{2}(\cot\vartheta - \cot\alpha)}$$

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

$$\cancel{M} + V\Delta z - \cancel{M} - \Delta M = 0$$

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

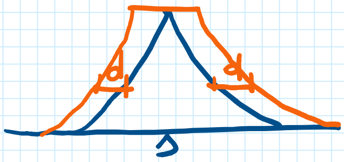


NEL CASO DI STAFFE : $\alpha = 90°$

$$\Delta z = \frac{z}{2} \cot\vartheta$$

($\cot\vartheta = 2$ PER PROGETTARE

$\Delta z = z = 0.9\, d \simeq d$)



PROGETTO A TAGLIO ALLO SLU

PER PORTARE V_{Ed} ⇒ STAFFE A_{sw}/s

⇒ A_{par} OPPURE $\Delta z = \frac{z}{2} \cot\vartheta$

⇒ SEZ. IN CLS

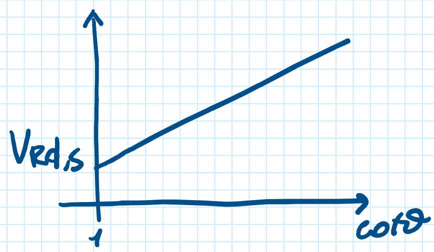
⇒ STAFFE :

$$V_{Ed} = V_{Rds}$$

$$V_{Ed} = 0.9\, d \frac{A_{sw}}{s} f_{yd} \cot\vartheta$$

$$\boxed{\frac{A_{sw}}{s} = \frac{V_{Ed}}{0.9\, d\, f_{yd} \cot\vartheta}}$$

(CONSIGLIO $\cot\vartheta = 2$)



⇒ A_{parz}

OPZIONE 1) $A_{par} = \frac{V}{2} \frac{(\cot\vartheta)}{f_{yd}}$

OPZIONE 2) $\Delta z = \frac{z}{2} \cot\theta$

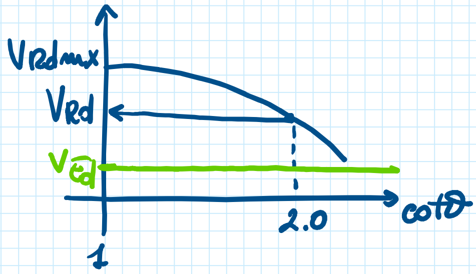
$\Rightarrow$ SEZ. IN CLS

$$V_{Rd_{max}} = 0.9\, d\, b\, f'_{cd}\, \alpha_c \frac{\cot\theta}{1 + \cot^2\theta}$$

CALCOLO: $V_{Rd_{max}} (\cot\theta = 2.0)$

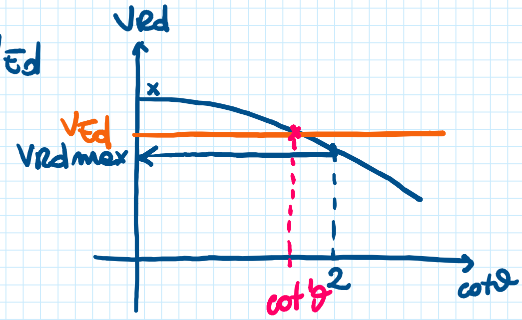
1) $V_{Rd_{max}} (\cot\theta = 2) > V_{Ed}$

POSSO USARE $\forall \cot\theta \leq 2$
PER LE ARMATURE



2) $V_{Rd_{max}} (\cot\theta = 2) < V_{Ed}$

DEVO USARE $\cot'\theta < 2$



$\cot'\theta \Rightarrow V_{Ed} = V_{Rd_{max}}$

$$V_{Ed} = 0.9\, d\, b\, f'_{cd}\, \alpha_c \frac{\cot'\theta}{1 + \cot'\theta^2}$$

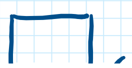
$$V_{Ed} (1 + \cot'\theta^2) = 0.9\, d\, b\, f'_{cd}\, \alpha_c \cot'\theta$$

$$1 + \cot'\theta^2 = \frac{0.9\, d\, b\, f'_{cd}\, \alpha_c \cot'\theta}{V_{Ed}}$$

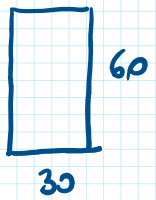
$$\cot'\theta^2 - \frac{0.9\, d\, b\, f'_{cd}}{V_{Ed}} \alpha_c \cot'\theta + 1 = 0$$

$\hookrightarrow \cot'\theta$

ESEMPIO



C 25/30



C 25/30

$c = 5\ cm$

$V_{Ed} = 300\ kN$

1) $V_{Rd\,max}\ (\cot\theta = 2.0)$

$$V_{Rd\,max} = 0.9 \cdot 55 \cdot 30 \cdot \frac{0.5 \times 14.17}{10} \cdot 1 \times \frac{2.0}{1+2.0^2} = 420.8\ kN$$

$\alpha_c = 1\ (N=0)$

$V_{Rd\,max}\ (\cot\theta = 2.0) > V_{Ed} \Rightarrow \forall \cot\theta$ PER LE ARMATURE

2) STAFFE

$$\frac{A_{sw}}{S}_{1m} = \frac{V_{Ed}}{0.9 \cdot d\ f_{yd} \cot\theta} \Rightarrow A_{sw} = \frac{300 \times 1.0 \times 10^3}{0.9 \cdot 55 \cdot 391.3 \cdot 2} = 7.74\ \frac{cm^2}{1m}$$

$\cot\theta = 2$

FISSO · $\phi 8$ $\quad A_{1\phi 8} = 0.5\ cm^2$

· $N_{BRACCI} = 2$

$\}\ A_{sw} = 0.5 \times 2 = 1.0\ cm^2$

$$\frac{N_{STAFFE}}{1m} = \frac{7.74}{1.0} = 7.74\ \frac{STAFFE}{1m}$$

$$S = \frac{100}{7.74} = \cancel{12.9}\ 10\ cm$$

3) ARM. DI PARETE

$$A_{par} = \frac{V}{2}\ \frac{\cot\theta}{f_{yd}} = \frac{300 \cdot 2.0}{2 \cdot 391.3} \times 10 = 7.67\ cm^2$$