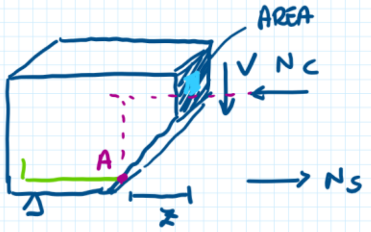
Taglio: modello a pettine

giovedì 29 maggio 2025 08:01

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

$$\boxed{V_{Rd,\,DORSO}}$$



$A = b\,x$

$\tau = \frac{V}{b\,x} \qquad \sigma = \frac{N_c}{b\,x}$

EQ. ALLA ROTAZ. RISPETTO "A":

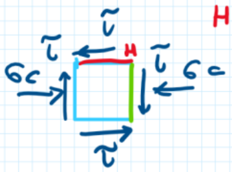
$N_c\, z - V z = 0 \Rightarrow N_c = V$

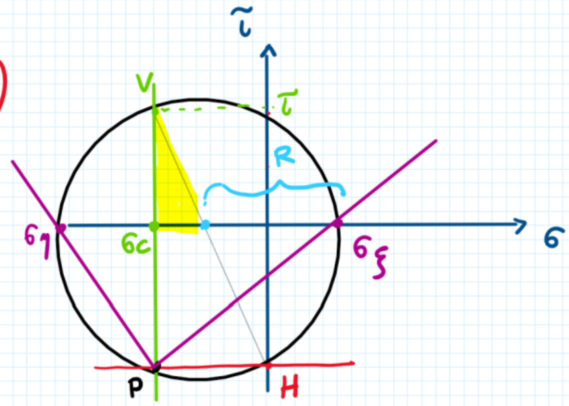
$\Downarrow$

$\sigma = \tau$

$V(\sigma_c ; \tau)$

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





$$\sigma_\xi = R - \frac{\sigma_c}{2}$$

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

$$\sigma_\xi = \sqrt{\left(\frac{V}{bx}\right)^2 + \left(\frac{1}{2}\frac{V}{bx}\right)^2} - \frac{1}{2}\frac{V}{bx}$$

$$\sigma_\xi = \frac{V}{bx}\left[\sqrt{1 + \frac{1}{4}} - \frac{1}{2}\right]$$

$$\sigma_\xi = \frac{V}{bx}\, 0.618$$

$$V_{Rd_{DORSO}} \Rightarrow \sigma_\xi = f_{ctd}$$

$$f_{ctd} = \frac{V}{bx}\, 0.618$$

$$V_{Rd,DORSO} = \frac{1}{0.618}\, b\, x\, f_{ctd}$$

$$\boxed{V_{Rd,DORSO} = 1.6\, b\, x\, f_{ctd}}$$

$$\left.\begin{array}{l} V_{Rd,DENTE} = 0.194\, b\, d\, f_{ctd} \\ V_{Rd,DORSO} = 1.6\, b\, x\, f_{ctd} \end{array}\right\} \text{MIN} = V_{Rd}$$

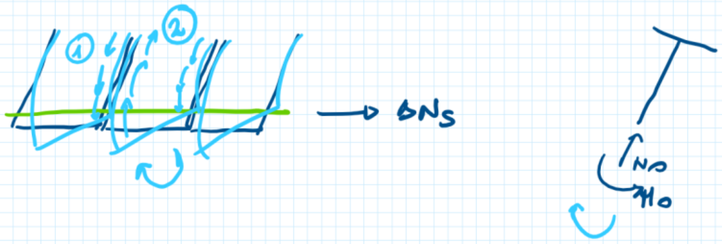
SE AVVIENE PRIMA LA ROTTURA DEL DORSO: $V_{Rd_{DORSO}} < V_{Rd_{DENTE}}$

$$1.6\, \cancel{b}\, x\, \cancel{f_{ctd}} < 0.194\, \cancel{b}\, d\, \cancel{f_{ctd}}$$

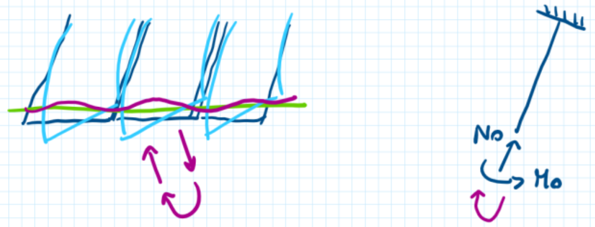
$$\boxed{x < \frac{0.194}{1.6}\, d = 0.12\, d}$$

FENOMENI RESISTENTI AGGIUNTIVI :

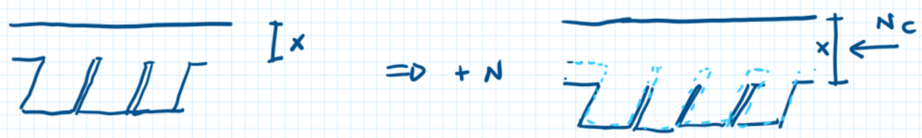
1) INGRANAMENTO DEGLI INERTI



2) EFFETTO SPINOTTO (BIETTA)



3) PRESENZA DI N DI COMPRESSIONE



DA NORMATIVA:

$$V_{Rd_c} = \Bigg[\underbrace{\frac{0.18\,k\,\sqrt[3]{100\,\rho_e\,f_{ck}}}{\gamma_c}}_{\text{EFF. INGR. + EFF. SPINOTTO}} + \underbrace{0.15\,\sigma_{cp}}_{N}\Bigg] b_w\,d \geq \Big[\underbrace{0.035\sqrt{k^3 f_{ck}}}_{\text{EFF. INGRANAMENTO}} + \underbrace{0.15\,\sigma_{cp}}_{N}\Big] b_w\,d$$

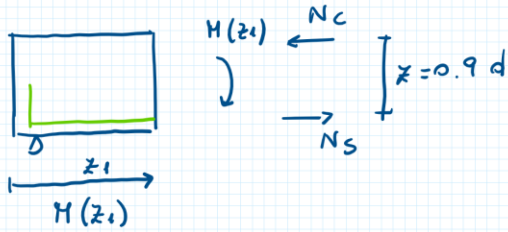
f_{ck} [MPa]

$$k = 1 + \sqrt{\frac{200}{d}} \leq 2.0 \qquad d\,[mm]$$

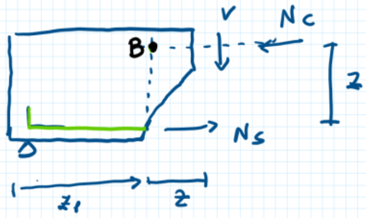
$$\rho_e = \frac{A_s}{b_w d}$$

$$\sigma_{cp} = \frac{N}{A_c} \leq 0.2\,f_{cd} \qquad (N \text{ POSITIVO DI COMPRESSIONE})$$

OSSERVA :

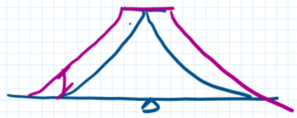


$$A_s = \frac{N_s}{f_{yd}} = \frac{M(z_1)}{z\, f_{yd}} = \frac{M(z_1)}{0.9\, d\, f_{yd}}$$

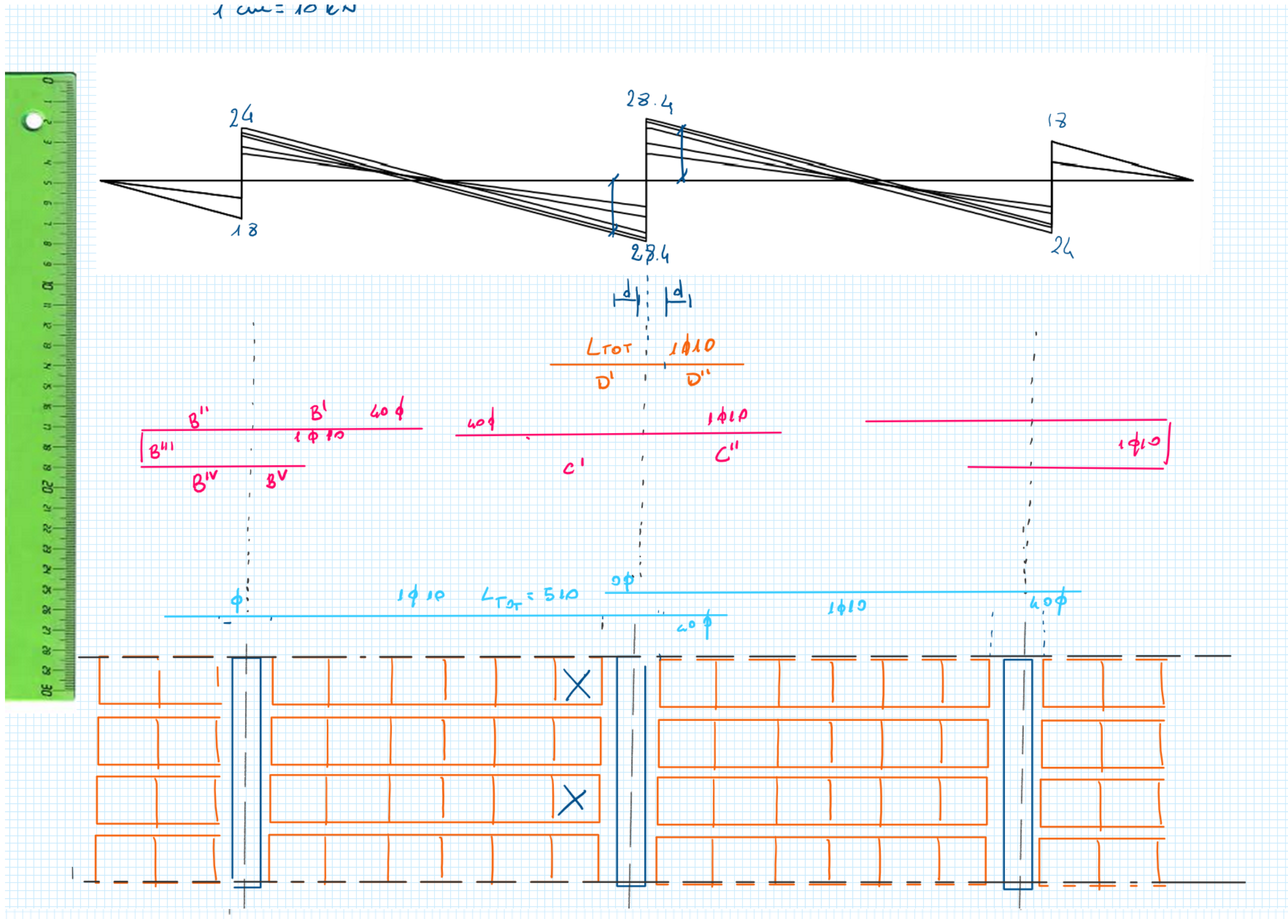


$$-Vz + N_s z = M(z_1)$$

$$N_s = \frac{M(z_1) + \overbrace{Vz}^{\Delta M}}{z} = \frac{M(z_1 + z)}{z}$$



1 cm = 10 kN



$$V_{Rd_c} = \left[0.18\, k \frac{\sqrt[3]{100\, \rho_\ell\, f_{ck}}}{\gamma_c} + 0.15\, \sigma_{cp} \right] b_w\, d$$

$$k = 1 + \sqrt{\frac{200}{d}} = 1 + \sqrt{\frac{200}{200}} = 2 \leq 2 \quad \text{ok!}$$

$d = 23 - 3 = 20$ cm

$$\rho_\ell = \frac{A_s}{b_w\, d} = \frac{(2 \times 0.79) \times 3}{(3 \times 8) \times 20} = 0.0098 < 0.02$$

n TRAVETTI / 1 m

$$\sigma_{cp} = \frac{N}{A} = 0$$

$$V_{Rd_c} = \left[\underbrace{0.18 \times 2 \times \frac{\sqrt[3]{100 \times 0.0098 \times 25}}{1.5}}_{\text{MPa}} \right] \frac{(3 \times 8) \times 20}{10} = 33.5 \text{ kN}$$

$$\frac{\text{kN}}{\cancel{\text{mm}^2}} \qquad \frac{\cancel{\text{cm}^2} \times 10^2}{10^3}$$

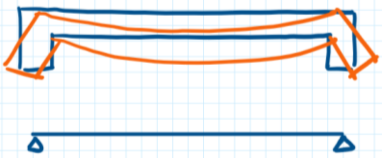
Se $V_{Ed} > V_{Rd_c}$ ⇒ FASCIA SEMIPIENA ⇒ $b_w = 3 \times 8 + b_{PIGN} + \frac{b_{PIGNI}}{2}$

$b_w = 2 \times 10 + b_{PIGN}$

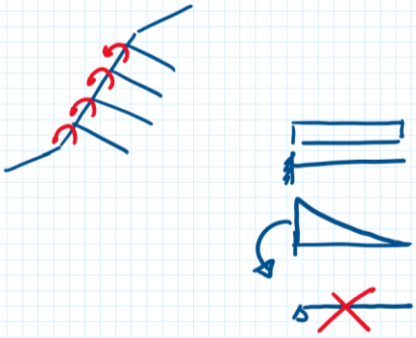
Torsione

giovedì 29 maggio 2025 09:40

TORSIONE PER CONGRUENZA



TORSIONE PER EQUILIBRIO

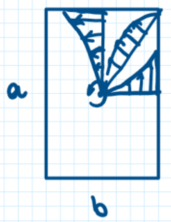


$\Downarrow$

DA VERIFICARE

SW

SEZ. OMOGENEA



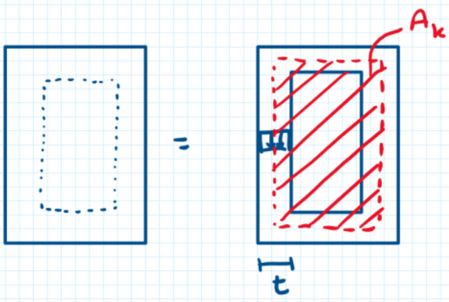
$$\tau_{MAX} = \frac{T}{a\,b^2}\,\psi \qquad (a > b)$$

$$\psi = 3 + \frac{2.6}{0.45 + \frac{a}{b}}$$

$a \to \infty \;:\; \psi \to 3$

$a \to b \;:\; \psi \to 3 + \frac{2.6}{0.45 + 1} = 4.8$

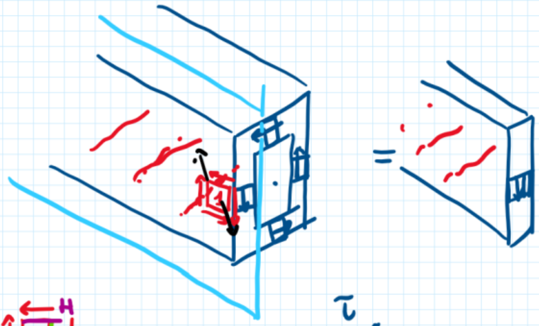
SEZ. IN CLS. SOGGETTA A TORSIONE



$$\tau = \frac{T}{2\,A_k\,t}$$ FORMULA DI BREDT

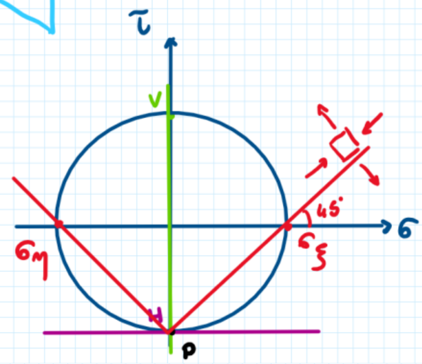
$$t = MAX \begin{cases} 2c \\ \frac{A}{u} = \frac{\text{AREA SEZ. RETT.}}{\text{PERIM. SEZ. RETT.}} \end{cases}$$

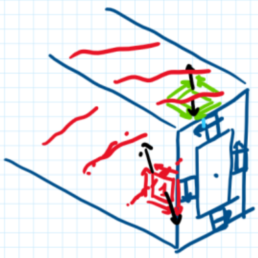
STUDIO DELLO STATO TENSIONALE DOVUTO A T :



$V(0; \tau^+)$

$H(0; \tau^-)$





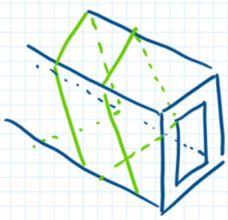
 $\Rightarrow$ σ_η e σ_ξ a 45°

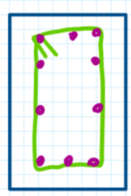
IN PRESENZA DI T $\Rightarrow$ LESIONI A 45° A SPIRALE

↳ ARMATURE A TORSIONE

1) ARMATURE A SPIRALE

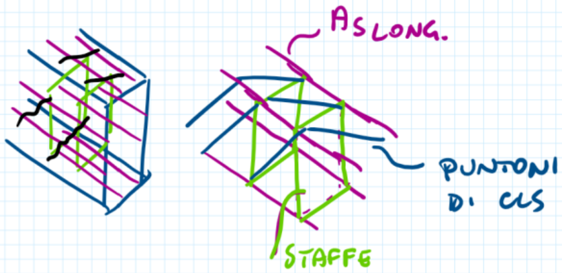
2) STAFFE + ARM. LONGITUDINALI



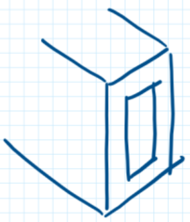


MODELLI DI CALCOLO:

1) TRALICCIO MORSCH



2) CAMPI DI TENSIONE ⇐ STUDIEREMO QUESTO



CAMPI DI TENSIONI ⇒ σ_c
$\sigma_{s,st}$
$\sigma_{s,lon}$

COME AVVIENE IL PASSAGGIO ALLO SLU?

IN GENERE LE ARMATURE RAGGIUNGONO LO SNERVAMENTO

POSSO CONTINUARE A FAR CRESCERE T....

... PUNTONI DI CLS SI INFLETTONO ...

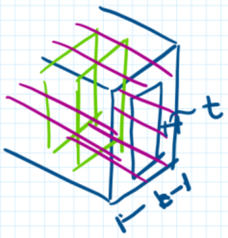
... NASCONO NUOVE TENSIONI τ SULLE FACCE

DI SCORRIMENTO TRA PUNTONI ...

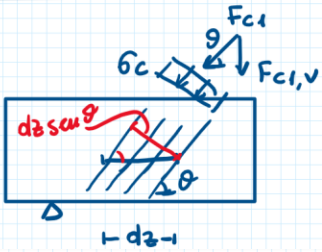
... NUOVO STATO TENSIONALE CON σ_ξ e σ_η

INCLINATE DI $\vartheta < 45°$

CAMPI DI TENSIONE

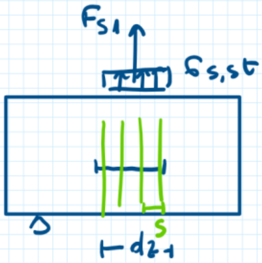


SEZ. ORIZZONTALE



$$F_{c1} = \sigma_c \, t \, dz \, \operatorname{sen}\vartheta$$

$$F_{c1,v} = F_{c1} \times \operatorname{sen}\vartheta = \sigma_c \, t \, dz \, \operatorname{sen}^2\vartheta$$



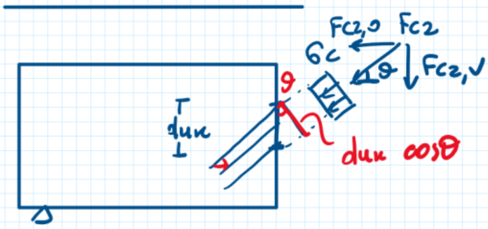
$$F_{s1} = \sigma_{s,st} \, A_{s,st} \, \frac{dz}{s}$$

EQUILIBRIO TRASLAZ. VERTICALE: $F_{c1,v} = F_{s1}$

$$\sigma_c t \, \cancel{dz} \, \operatorname{sen}^2\vartheta = \sigma_{s,st} \, A_{s,st} \, \frac{\cancel{dz}}{s}$$

$$\boxed{\sigma_c t \operatorname{sen}^2\vartheta = \sigma_{s,st} \frac{A_{s,st}}{s}} \quad 1$$

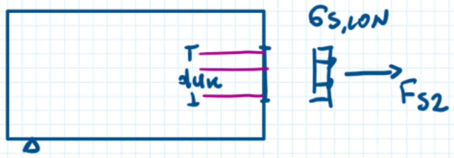
SEZ. VERTICALE



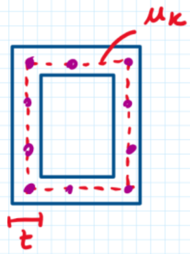
$$F_{c2} = \sigma_c \, t \, du_x \cos\vartheta$$

$$F_{c2o} = F_{c2} \times \cos\vartheta = \sigma_c \, t \, du_x \cos^2\vartheta$$

$$F_{c2v} = F_{c2} \times \operatorname{sen}\vartheta = \sigma_c \, t \, du_x \cos\vartheta \operatorname{sen}\vartheta$$



$$F_{s2} = \sigma_{s,lon} \cdot \frac{A_{s\,lon}}{u_k}\, du_k$$



$$\frac{A_{s\,lon}}{u_k} = \frac{x}{du_k}$$

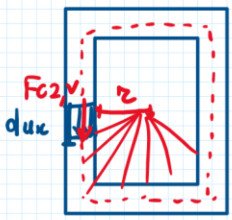
$$x = A_{s\,lon}\frac{du_k}{u_k}$$

EQUILIBRIO ALLA TRASLAZ. ORIZZ.: $F_{c2,o} = F_{s2}$

$$\sigma_c\, t\, \cancel{du_k} \cos^2\vartheta = \sigma_{s\,lon}\frac{A_{s\,lon}}{u_k}\cancel{du_k}$$

$$\boxed{\sigma_c\, t \cos^2\vartheta = \sigma_{s,lon}\frac{A_{s,lon}}{u_k}} \quad 2$$

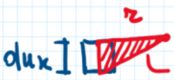
EQUILIBRIO ALLA ROTAZIONE:



$$dT = F_{c2,v} \cdot r$$

$$T = \int F_{c2,v} \cdot r = \int \sigma_c\, t\, du_k \cos\vartheta \operatorname{sen}\vartheta\, r =$$

$$= \sigma_c\, t \operatorname{sen}\vartheta \cos\vartheta \underbrace{\int r\, du_k}_{2A_k}$$



$$\frac{r\,du_k}{2} \times 2 = r\,du_k$$

$$= \sigma_c\, t \operatorname{sen}\vartheta \cos\vartheta\, 2A_k$$

$$\boxed{T = \sigma_c\, t \operatorname{sen}\vartheta \cos\vartheta\, 2A_k} \quad 3$$

LA RESISTENZA A T DELLA SEZ IN CLS: T_{Rdmax}

3

$$T = \sigma_c\, t \operatorname{sen}\vartheta \cos\vartheta\, 2A_k \qquad T_{Rdmax} \Rightarrow \sigma_c = f'_{cd} = \nu f_{cd} = 0.5 f_{cd}$$

$$T_{Rdmax} = 2A_k\, t\, f'_{cd} \operatorname{sen}\vartheta \cos\vartheta \times \frac{\operatorname{sen}\vartheta}{\operatorname{sen}\vartheta}$$

$$T_{Rd\,max} = 2 A_k\, t\, f'_{cd}\, \cot\vartheta \,\frac{\sin^2\vartheta}{\sin^2\vartheta + \cos^2\vartheta}$$

$$T_{Rd\,max} = 2 A_k\, t\, f'_{cd}\, \frac{\cot\vartheta\, \cancel{\sin^2\vartheta}}{\cancel{\sin^2\vartheta}\,(1 + \cot^2\vartheta)}$$

$$\boxed{T_{Rd\,max} = 2 A_k\, t\, f'_{cd}\, \frac{\cot\vartheta}{1 + \cot^2\vartheta}}$$

T_{Rd} DELLA SEZ. IN CLS