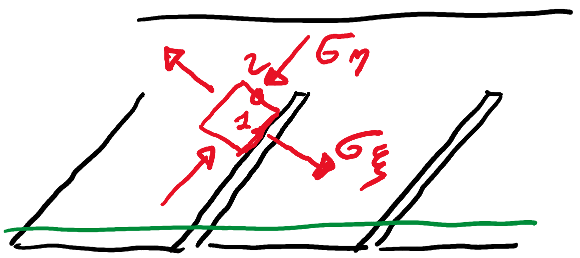
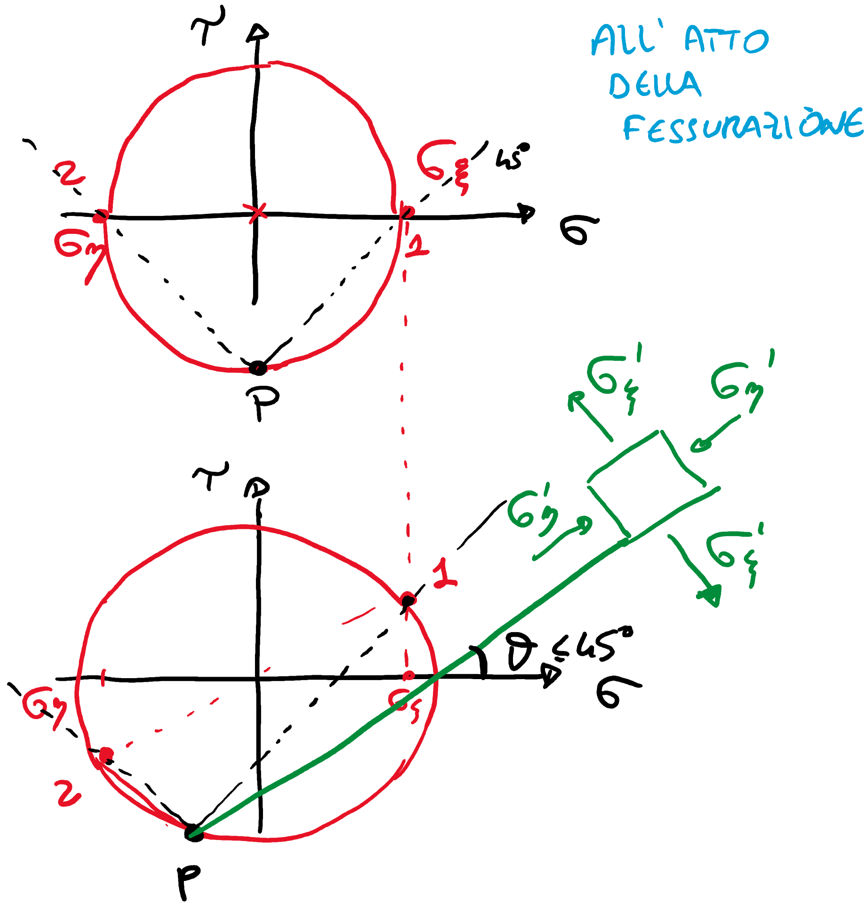
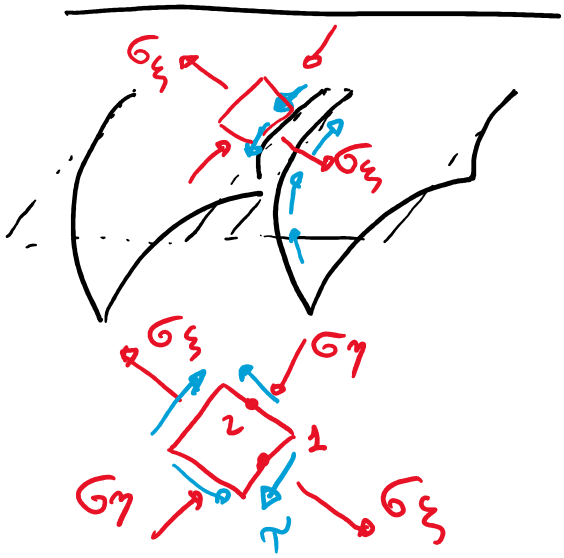
CONSIDERAZIONI STATO TENSIONALE

giovedì 4 giugno 2020 13:53





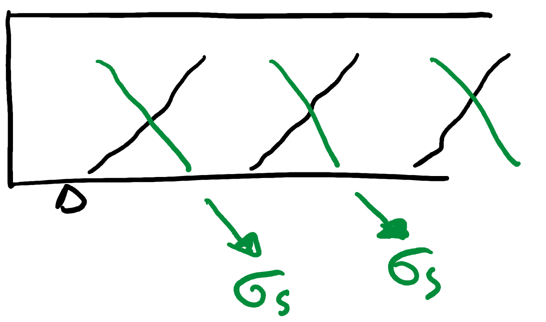
DOPO LA FESSURAZIONE



IL FLUSSO DI TENSIONI DI COMPRESSIONE È INCLINATO DI UN ANGOLO $\theta \leq 45°$

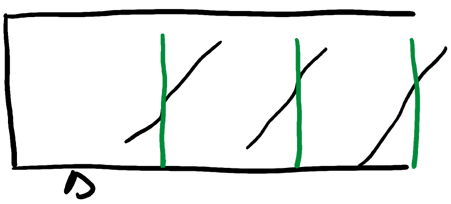
POSSIBILI DISPOSIZIONI ARMATURA A TAGLIO

giovedì 4 giugno 2020 14:10



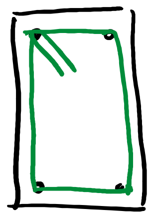
ARMATURA CON BARRE SAGOMATE

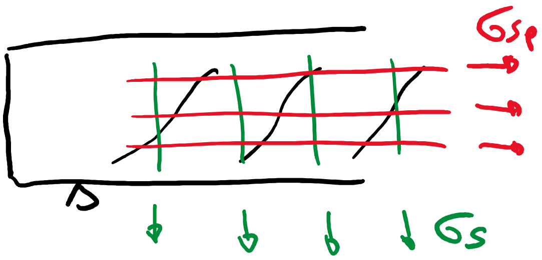
(NEL PASSATO)



STAFFE

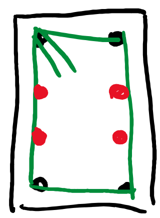
(NORD ITALIA)





STAFFE + ARMATURA DI PARETE

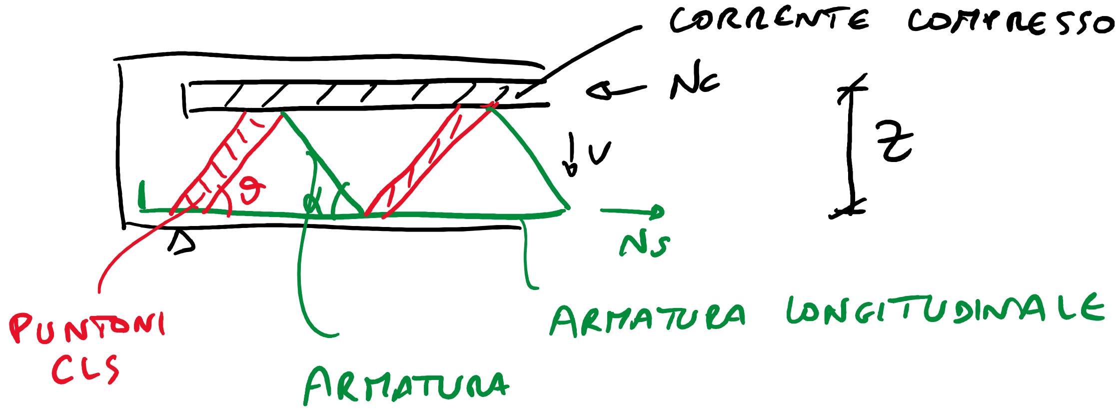
(SUD ITALIA)



POSSIBILI MODELLI

giovedì 4 giugno 2020 14:14

1. TRALICCIO AD INCLINAZIONE VARIABILE DEL PUNTONE



α=90° SE USO STAFFE

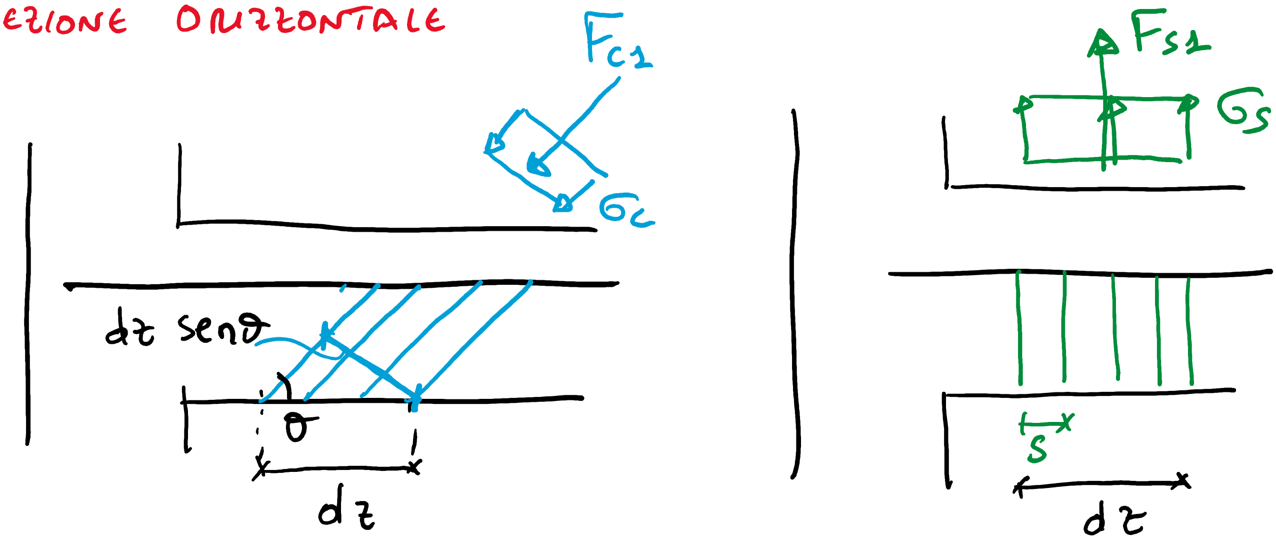
2. CAMPI DI TENSIONE

- FLUSSI DI TENSIONE NEL CLS INCLINATI DI ϑ
- FLUSSO DI TENSIONI NELLE ARMATURE
- CARATTERISTICHE DELLA SOLLECITAZIONE AGENTI

MODELLO CON CAMPI DI TENSIONE - STAFFE

giovedì 4 giugno 2020 14:18

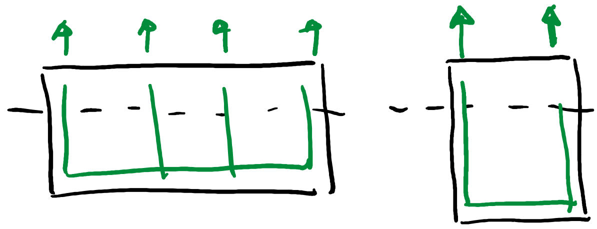
SEZIONE ORIZZONTALE



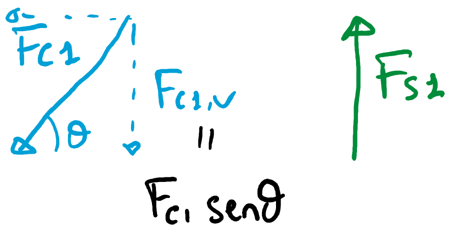
$$F_{c1} = \sigma_c\, b \cdot dz \,\mathrm{sen}\,\theta \qquad F_{s1} = \sigma_s \cdot n_b A_{st} \frac{dz}{s}$$

s = PASSO STAFFA

$$n_{STAFFE} = \frac{dz}{s}$$



EQUILIBRIO TRASLAZIONE VERTICALE



$$F_{c1,V} = F_{s1}$$

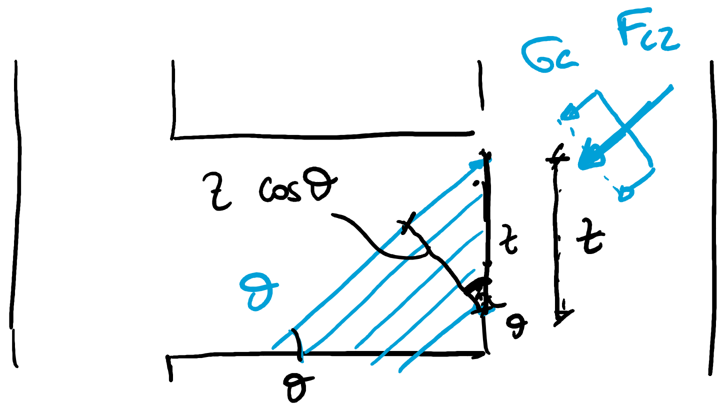
$F_{c1,O}$ = FORZA SCORRIMENTO

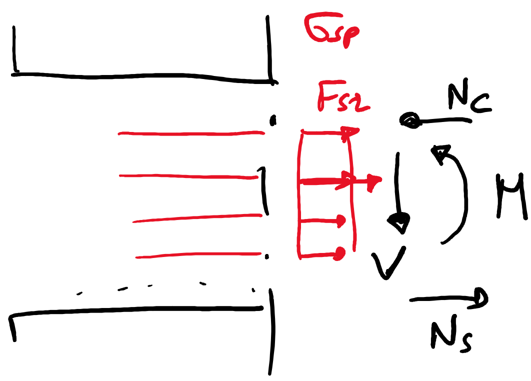
$$\sigma_c \cdot b\, dz\, \mathrm{sen}^2\theta = \sigma_s \cdot n_b \frac{A_{st}}{s} \cdot dz \quad \rightarrow$$

$$\boxed{\sigma_c = \sigma_s \cdot \frac{n_b A_{st}}{b s} \frac{1}{\mathrm{sen}^2\theta}} \qquad (1)$$

SEZIONE VERTICALE

giovedì 4 giugno 2020 14:28

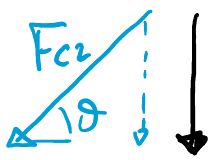




$$F_{cz} = \sigma_c \, b \, z \cos\theta$$

$$F_{sz} = A_{sp} \cdot \sigma_{sp}$$

A_{sp} ↑ AREA ARMATURA DI PARETE



$$\rightarrow \quad F_{cz,v} = V$$

$$F_{czv} = F_{cz} \cdot \operatorname{sen}\theta$$

(2)

$$\boxed{\sigma_c \cdot b \cdot z \frac{\cos\theta}{\operatorname{sen}\theta} \cdot \operatorname{sen}^2\theta = V} \rightarrow$$

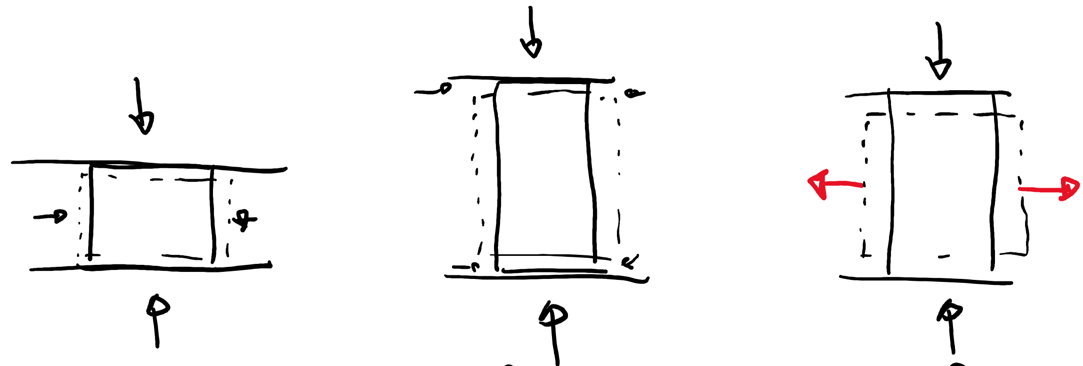
$$\frac{\cos\theta}{\operatorname{sen}\theta} = \operatorname{cotg}\theta \qquad \operatorname{sen}^2\theta = \frac{1}{1+\operatorname{cotg}^2\theta}$$

$$V = \sigma_c \cdot bz \, \frac{\operatorname{cotg}\theta}{1+\operatorname{cotg}^2\theta}$$

CRISI NEL CLS $\rightarrow \sigma_c = \nu f_{cd}$ $\qquad \nu = 0{,}5$

ν = COEFF. RIDUTTIVO DELLA RESISTENZA A COMPRESSIONE PER LA PRESENZA DI TRAZIONE IN DIREZIONE ORTOGONALE

ESEMPIO



$$V_{Rcd} = \nu f_{cd} \cdot b z \cdot \frac{\cot g\,\theta}{1 + \cot g^2\theta}$$

SOSTITUENDO ① ⇒ ②

$$\underbrace{\sigma_s \cdot \frac{n A_{st}}{\cancel{b} s}}_{\sigma_c} \frac{1}{\cancel{\operatorname{sen}^2\theta}} \cdot \cancel{b} z \cot g\,\theta \cdot \cancel{\operatorname{sen}^2\theta} = V$$

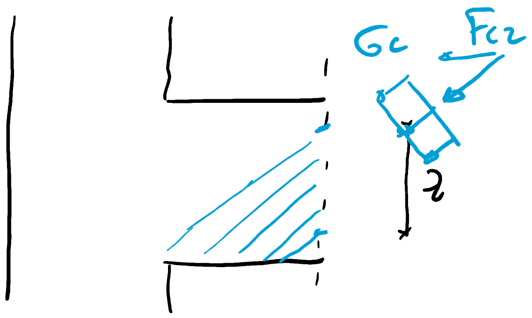
$$\sigma_s \cdot \frac{n_b A_{st}}{s} \cdot z \cot g\,\theta = V$$

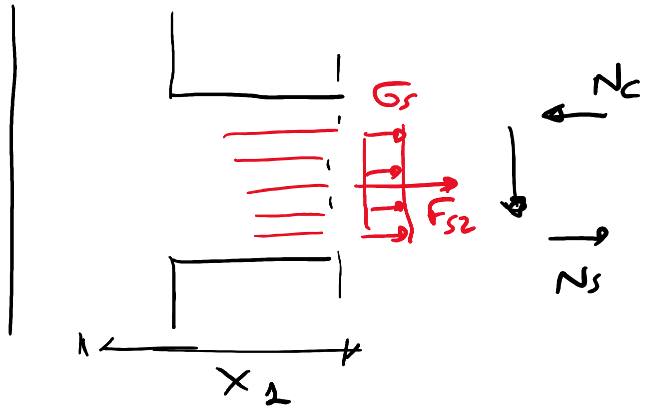
CRISI NELLE ARMATURE SE $\sigma_s = f_{yd}$ →

$$V_{Rsd} = \frac{n_b A_{st}}{s} \cdot z f_{yd} \cot g\,\theta$$

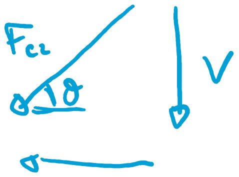
EQUILIBRIO - DIREZIONE ORIZZONTALE

giovedì 4 giugno 2020 14:42





SE VOGLIO CHE $N_c = N_s \Rightarrow F_{cz,0} = F_{sz}$

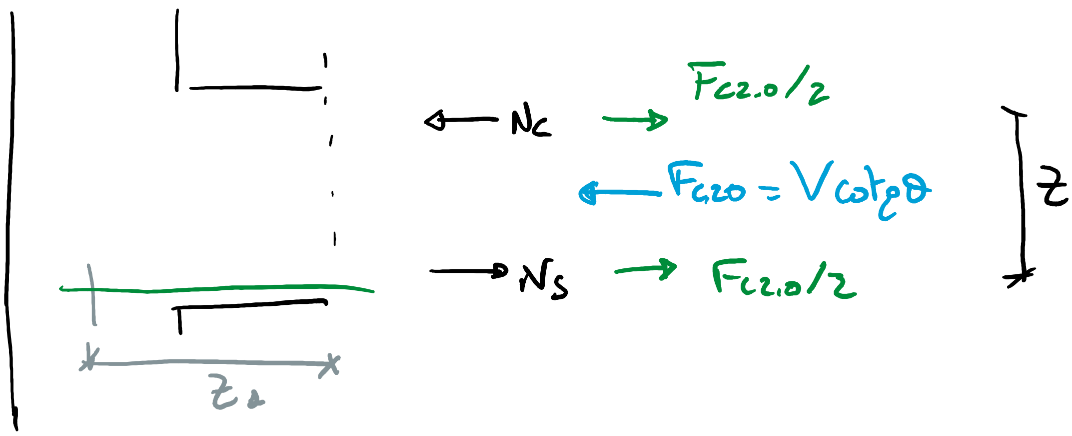


$F_{cz,0} = V \cot\theta$

$$V \cot\theta = \sigma_s \cdot A_{sp}$$

$$A_{sp} = \frac{V \cdot \cot\theta}{f_{yd}}$$

SE NON METTO ARMATURA DI PARETE $F_{sz} = 0$



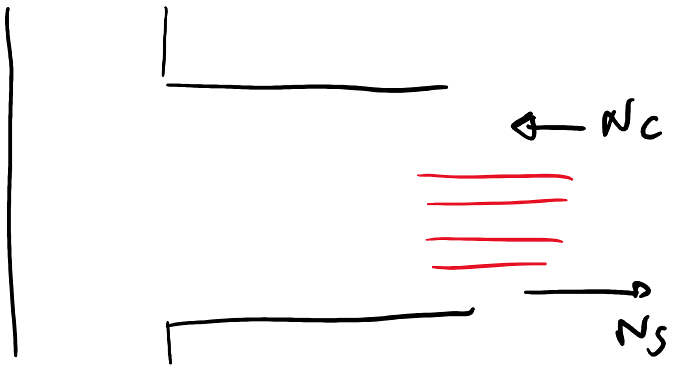
$$N'_s = N_s + \frac{V}{2}\cot\theta = \frac{M(z_1)}{z} + \frac{V}{2}\cot\theta \cdot \frac{z}{z}$$

$$\Rightarrow N_s' = \frac{1}{z}\left[M(z_1) + \underbrace{\frac{V\cot g\theta}{2}\cdot z}\right]$$

$$\Delta M = V \cdot \frac{z}{2}\cot g\theta$$

$\Rightarrow N_s'$ TRASLAZIONE DEL DIAGRAMMA DEI MOMENTI DI $\frac{z}{2}\cot g\theta$

SOLUZIONE ALTERNATIVA



$\rightarrow F_{c2,0}/2$

$\rightarrow F_{c2,0}/2 = V\cdot\frac{\cot g\theta}{2}$

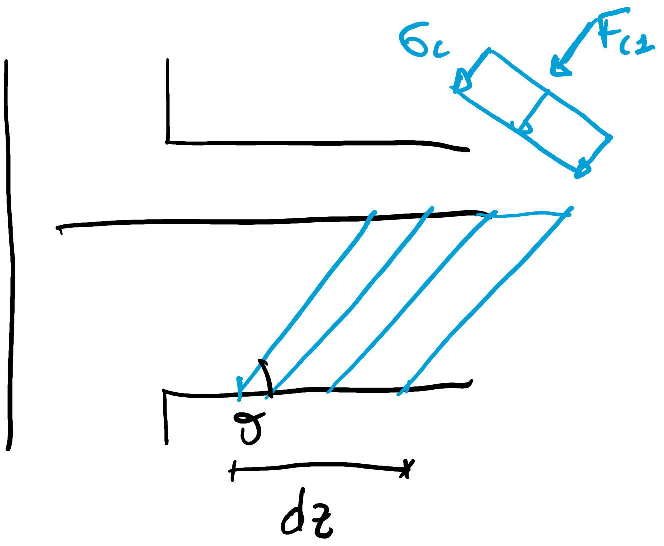
$$A_p = \frac{V\cot g\,\theta}{2\,f_{yd}}$$

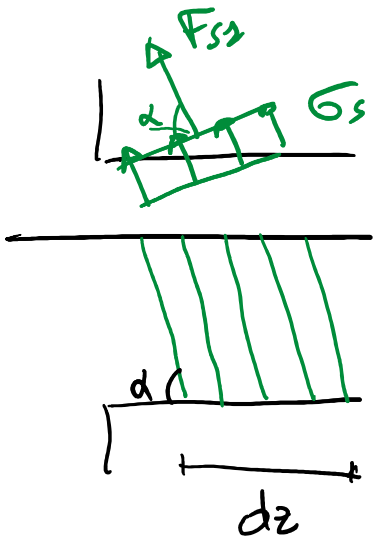
$\Rightarrow$ POSSO EVITARE TRASLAZIONE DIAGRAMMA MOMENTI

MODELLO PER ARMATURA CON SAGOMATI

giovedì 4 giugno 2020 14:52

SEZIONE ORIZZONTALE



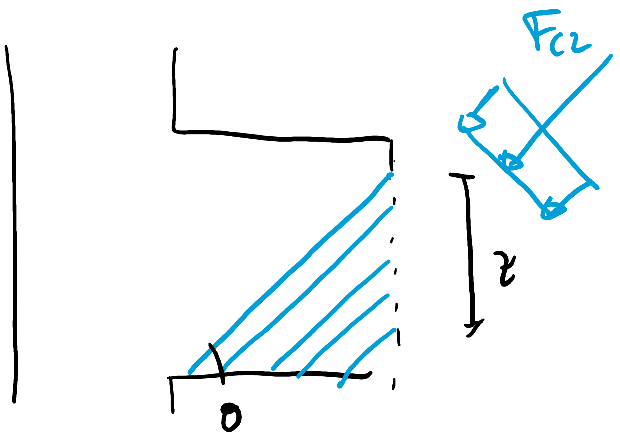


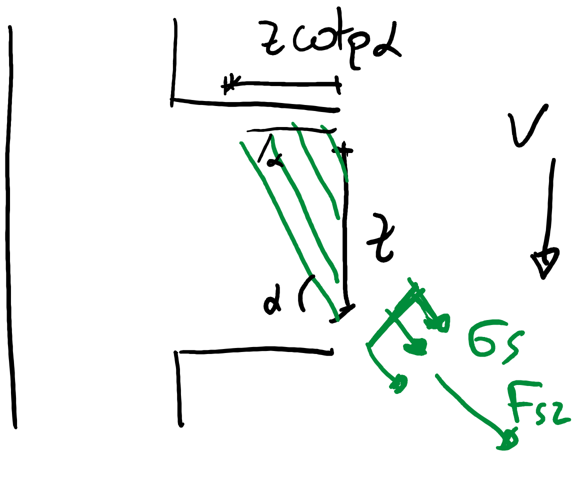
$$F_{s1} = A_{sw} \cdot \frac{dz}{s} \sigma_s$$

EQ. TRASLAZ. VERTICALE

$$F_{c1,V} = F_{s1,V} \Rightarrow \operatorname{sen}\alpha$$

SEZ. VERTICALE





$$F_{c2,V} + F_{s2,V} = V$$

$$F_{s2} = \frac{A_w}{s} z \cot g\,\alpha$$

INDICAZIONI DI NORMATIVA

RESISTENZA DI PROGETTO PER IL CLS

$$V_{Rcd} = \nu f_{cd} \cdot \alpha_c \cdot b \underbrace{0{,}9d}_{z} \frac{\cot\theta + \cot\alpha}{1+\cot^2\theta}$$

CON $\nu = 0.5$

$1 \le \cot\theta \le 2{,}5$

SE $\alpha = 90°$ (STAFFE) $\Rightarrow \cot\alpha = 0$

α_c TIENE CONTO DI EVENTUALE N_{Ed}

$$\alpha_c = \begin{cases} 1 & \text{SE } \sigma_c = 0 \\ 1 + \frac{\sigma_c}{f_{cd}} & \text{SE } \sigma_c \le 0.25 f_{cd} \\ 1.25 & \text{SE } 0.25 \le \sigma_c \le 0.5 f_{cd} \\ 2{,}5\left(1 - \frac{\sigma_c}{f_{cd}}\right) & \text{SE } 0.5 f_{cd} \le \sigma_c \le f_{cd} \end{cases}$$

RESISTENZA DI PROGETTO DELLE ARMATURE

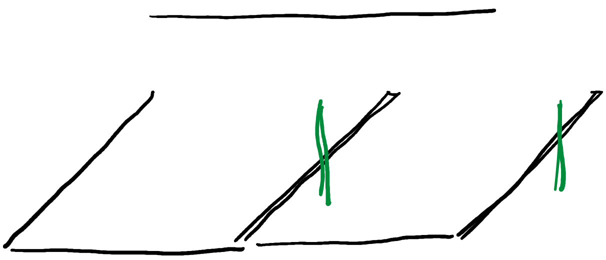
$$V_{Rsd} = \frac{A_{sw}}{s} \cdot f_{yd} \cdot 0{,}9d \left(\cot\theta + \cot\alpha\right) \operatorname{sen}\alpha$$

SE USO STAFFE $\Rightarrow$ $\frac{A_{sw}}{s} = \frac{n_b A_{st}}{s}$

$\alpha = 90°$ $\rightarrow$ $\cot\alpha = 0$, $\operatorname{sen}\alpha = 1$

VALORI $\cot g\theta$

giovedì 4 giugno 2020 15:05



NELLA SITUAZIONE INIZIALE $\cot g\theta = 1$ $(\theta = 45°)$

$$V_{Rcd} = \nu f_{cd}\, \alpha_c\, b\, z \frac{\cot g\theta}{1+\cot g^2\theta}$$

→ DECRESCE AL CRESCERE DI $\cot g\theta$

$$V_{Rsd} = n_b \frac{A_{st}}{s}\, z\, f_{yd} \cot g\theta$$

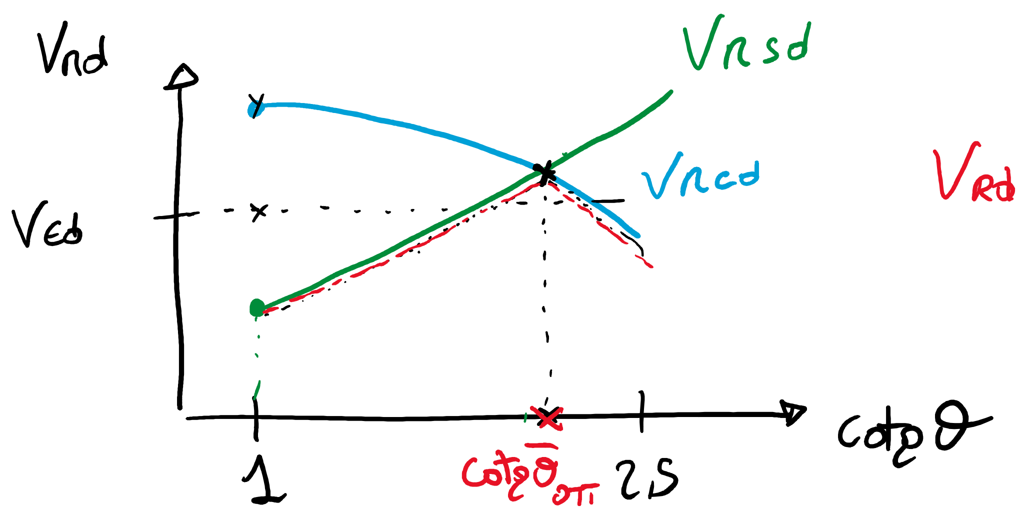
⇒ CRESCE CON $\cot g\theta$

SE $V_{Ed} > V_{Rcd}$ $(\cot g\theta = 1)$ ⇒ SI SCHIACCIA IL PUNTONE DI CLS

SE $V_{Ed} < V_{Rcd}$ $(\cot g\theta = 1)$ E $V_{Ed} > V_{Rsd}$ ⇒ SI SNERVANO LE ARMATURE

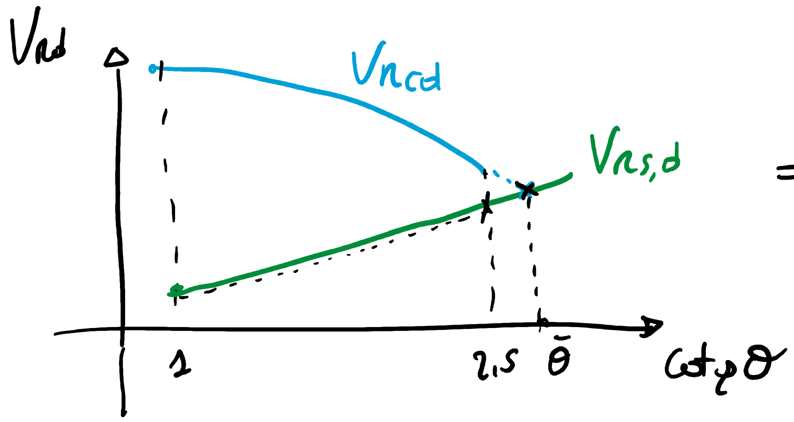
⇒ NASCONO SCORRIMENTI LUNGO LE LESIONI → NASCONO τ PER INGRANAMENTO INERTI ⇒ θ SI RIDUCE → $\cot g\theta$ CRESCE

⇒ V_{Rsd} AUMENTA



$V_{Rd} = \min(V_{Rsd}, V_{Rcd})$

NELLA VERIFICA CERCO $\cot\bar{\theta}_{OTT}$: $V_{Rcd} = V_{Rsd}$



$\Rightarrow$

SE $\cot\bar{\theta}_{OTT} > 2,5$ $\Longrightarrow$ $V_{Rd} = V_{Rsd}\ (\cot\theta = 2,5)$

LA VERIFICA È SODDISFATTA SE $V_{Ed} \leq V_{Rd}$

VALORE DI $\cot\bar{\theta}$ OTT $\quad V_{Rcd} = V_{Rsd}$

$$b \not{z} \cdot \nu f_{cd} \alpha_c \cdot \frac{\cot\theta}{1+\cot^2\theta} = \frac{n_b A_{st}}{s} \cdot \not{z} f_{yd} \not{\cot\theta}$$

$$1 + \cot^2\theta = \frac{\nu f_{cd} \alpha_c \cdot b}{\frac{n_b A_{st}}{s} \cdot f_{yd}} \rightarrow$$

$$\cot^2\theta = \frac{\nu f_{cd} \alpha_c b s}{n_b A_{st} f_{yd}} - 1 \Rightarrow$$

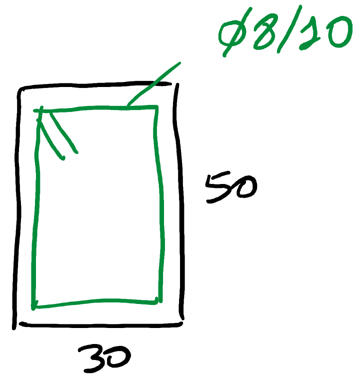
$$\cot\theta_{OTT} = \sqrt{\frac{\nu f_{cd} \alpha_c b s}{n_b A_{st} f_{yd}} - 1}$$

ESEMPIO

giovedì 4 giugno 2020 15:24

TRAVE 30 x 50 $\quad \phi 8 / 10$

$V_{Ed} = 320$ KN



C 25/30

B450 C

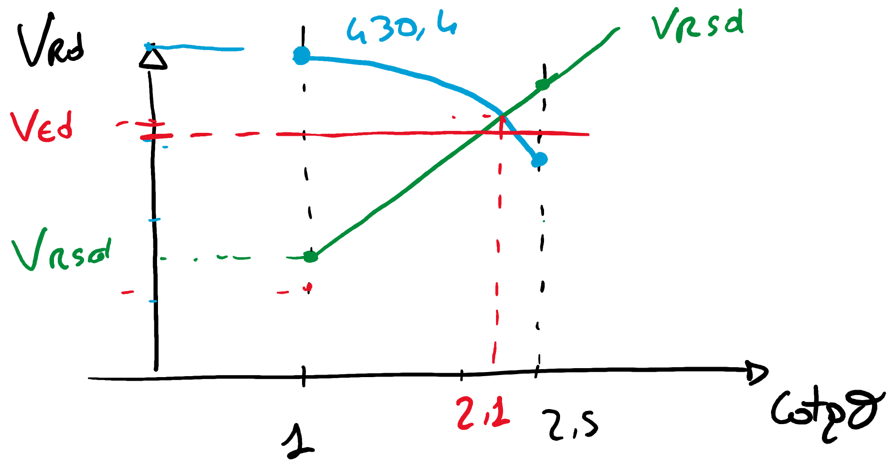
c = 5 cm $\rightarrow$ d = 45 cm

$$V_{Rcd} = \frac{1}{10} 0{,}5 \times 14.17 \text{ MPa} \cdot 30 \cdot 0{,}9 \times 45 \text{ cm}^2 \times \frac{\cot\theta}{1+\cot^2\theta}$$

νf_{cd} $\qquad b \cdot \quad z$

$$= 860.83 \cdot \frac{\cot\theta}{1+\cot^2\theta}$$

se $\cot\theta = 1 \rightarrow V_{Rcd} = 860.83 \, \frac{1}{2} = 430{,}4$ KN



$$V_{Rsd}(\cot\theta = 1) = \frac{2 \times A_{\phi 8}}{10 \text{ cm}} \times 0{,}9 \times 45 \text{ cm} \times 391{,}3 \frac{N}{mm^2} \times \cot\theta$$

$$= \frac{2 \times 0{,}5 \text{ cm}^2}{10 \text{ cm}} \times 0{,}9 \times 45 \text{ cm} \times 391{,}3 \frac{N}{mm^2} \, \frac{1}{10}$$

$V_{Rsd}(\cot\theta = 1) = 158,5\ kN$

se $\cot\theta = 2,5$ $\quad V_{Rs,d} = 158,5 \times 2,5 = 396,25\ kN$

$$V_{Rcd} = 860,83 \times \frac{2,5}{1+2,5^2} = 296,84\ kN$$

CERCO $$\cot\bar{\theta}_{OTT} = \sqrt{\frac{0,5 \times 14,17\ MPa \times 30\ cm \times 10\ cm}{2 \times 0,5\ cm^2 \times 391,3\ MPa} - 1}$$

$$= 2,10$$

$V_{Rsd} = 158,5 \times 2,1 = 332,85\ kN$ $> 320\ kN$

$\Rightarrow$ VERIFICATA

PROGETTO

giovedì 4 giugno 2020 15:39

- b, h SONO NOTI PERCHÉ PROGETTO A FLESSIONE
- V_{Ed}

TROVARE → ARMATURA A TAGLIO

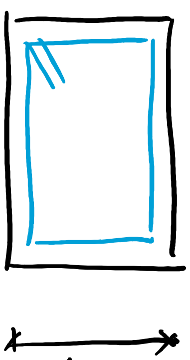
MINIMI DI ARMATURA : NTC

[1] $\frac{n_b A_{st}}{s} \geq 0.15\, b_w \frac{cm^2}{m}$ b_w in cm

[2] $s \leq 0.8\, d$ (VINCOLANTE SOLO PER TRAVI A SPESSORE MOLTO BASSE)

[3] $s \leq 33\, cm$

TRAVE EMERGENTE



$b_w = 30\, cm$

$n_b = 2$

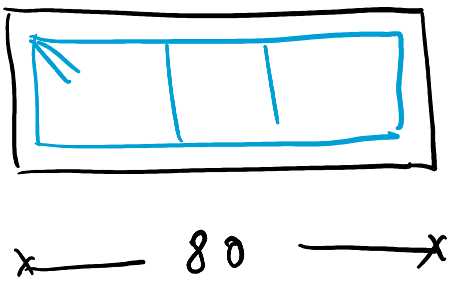
$A_{\phi 8} = 0,5\, cm^2$

$$\frac{2 \times 0,5\, cm^2}{s} \geq 0,15 \times 30\, \frac{cm^2}{m}$$

$$s \leq \frac{2 \times 0,5}{0,15 \times 30} = 0,22\, m$$

$\Rightarrow \phi 8/20$

TRAVE A SPESSORE



$n_b = 4$

$A_{\phi 8} = 0,5\ cm$

$b_w = 80\ cm$

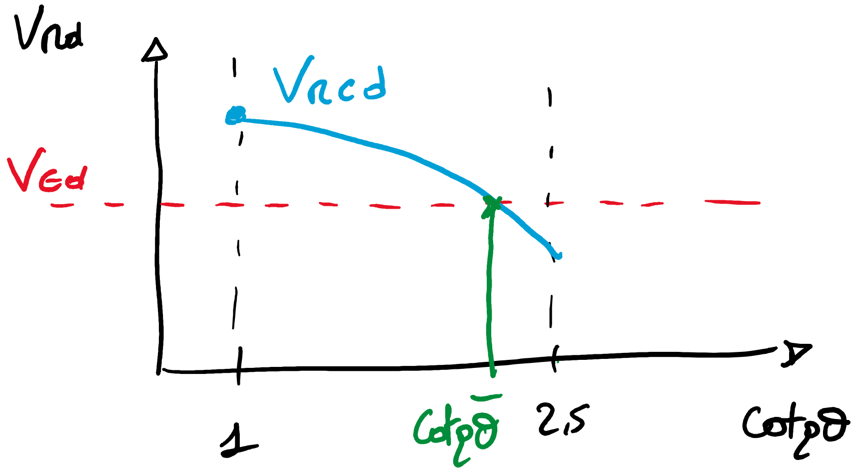
$$\frac{4 \times 0,5\ cm^2}{S} \geq 0,15 \times 80\ cm^2/m$$

$$S \leq \frac{2\ cm^2}{0,15 \times 80\ cm^2}\ m = 0.16 \Rightarrow \phi 8/15$$

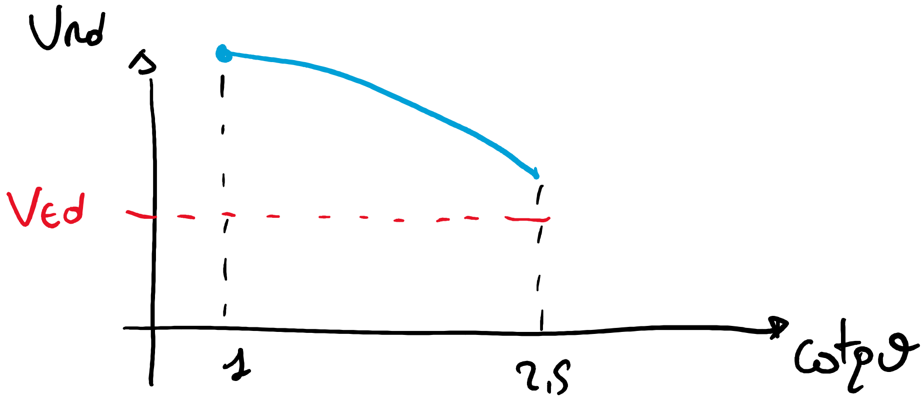
4 BRACCI

ARMATURA A TAGLIO NECESSARIA

giovedì 4 giugno 2020 15:47



SEZ CLS È NOTA
↓
CONOSCO V_{Rcd}
↓
CONFRONTO V_{Rcd} CON V_{Ed}



Se $V_{Ed} < V_{Rcd}$ PER TUTTI I VALORI DI $\cot\theta$ ⇒

$$V_{Rsd} = n_b \frac{A_{st}}{s} \cdot z f_{yd} \cot\theta \implies$$

$$n_b \frac{A_{st}}{s} = \frac{V_{Ed}}{z f_{yd} \cot\theta}$$

⇒ $\frac{A_{st}}{s}$ NECESSARIA SI RIDUCE AL CRESCERE DI $\cot\theta$

POTREI PROGETTARE STAFFE CON $\cot\theta = 2.5$ → CONSIGLIO $\cot\theta = 2$

MOTIVO 1: NON HO VANTAGGI AD AUMENTARE TROPPO $\cot\theta$ PERCHÉ DEVO COMUNQUE DISPORRE ARMATURA MINIMA

MOTIVO 2: $A_{s,PARETE} = \frac{V}{2} \frac{\cot\theta}{f_{yd}}$

o

TRASLAZIONE DIAGRAMMA MOMENTI $= \frac{z}{2} \cot\theta$

} CRESCONO CON $\cot\theta$

se V_{Ed} INTERSECA V_{Rcd} ⇒

CERCO max $\overline{\cot\theta}$ PER CUI $V_{Rcd} \geq V_{Ed}$

$$b z \alpha_c \nu f_{cd} \cdot \frac{\cot\theta}{1+\cot^2\theta} = V_{Ed} \Rightarrow$$

$$1 + \cot^2\theta = \frac{b z \alpha \nu f_{cd} \cot\theta}{V_{Ed}} \Rightarrow$$

$$\cot^2\theta - \frac{b z \alpha \nu f_{cd}}{V_{Ed}} \cdot \cot\theta + 1 = 0 \Rightarrow$$

$$\overline{\cot\theta} = \frac{b z \alpha \nu f_{cd}}{2 V_{Ed}} \pm \sqrt{\left(\frac{b z \alpha \nu f_{cd}}{2 V_{Ed}}\right)^2 - 1}$$

PRENDO SOLO SOLUZIONE CON +

⇒ PROGETTO STAFFE ⇒ $\frac{n_b A_{st}}{s} \geq \frac{V_{Ed}}{f_{yd}\, z \cot\bar{\theta}}$