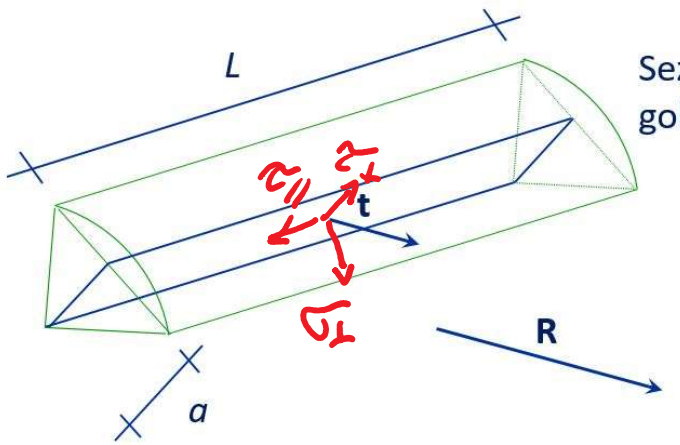
Verifica del cordone d'angolo



R	Forza agente sul cordone d'angolo
t	Tensione agente sulla sezione di gola
	(ha lo stessa direzione di R e modulo pari a $t = R / a\,L$)

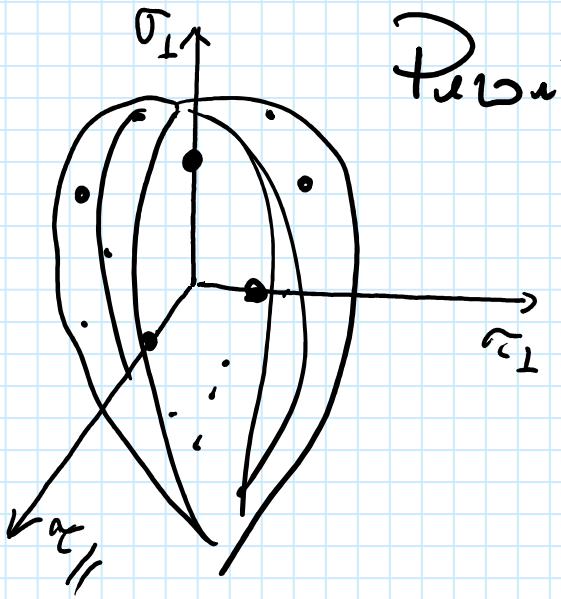
Le sezioni da verificare sono le sezioni di gola:

1. Si valuta la tensione

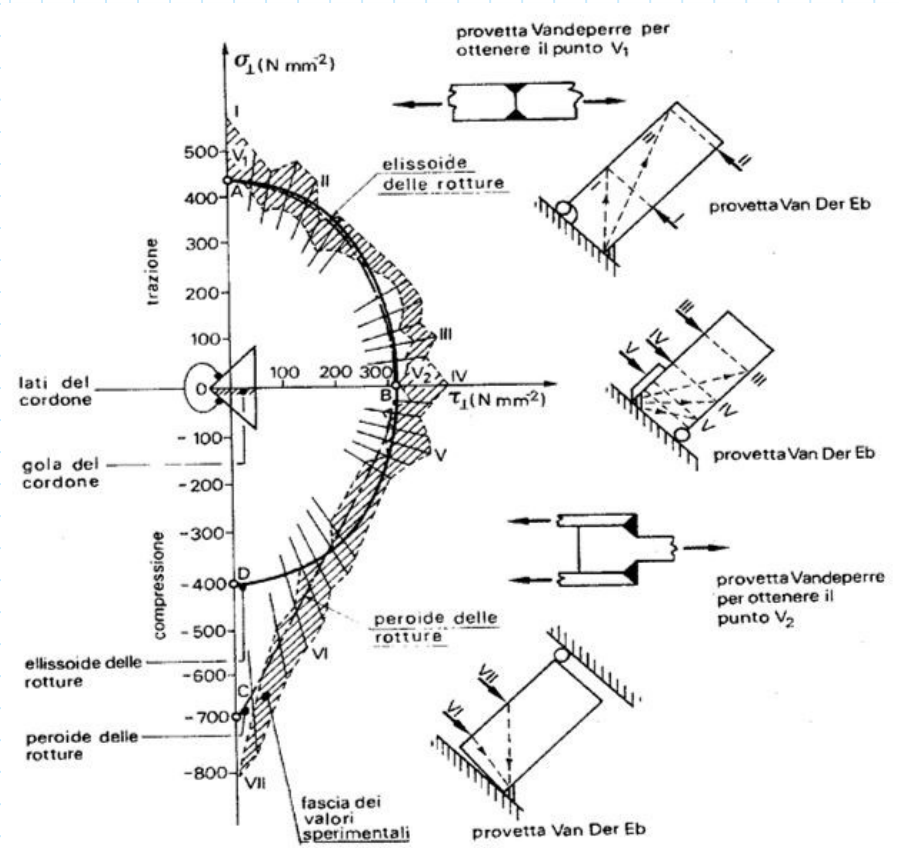
$$t = \frac{R}{a\,L}$$

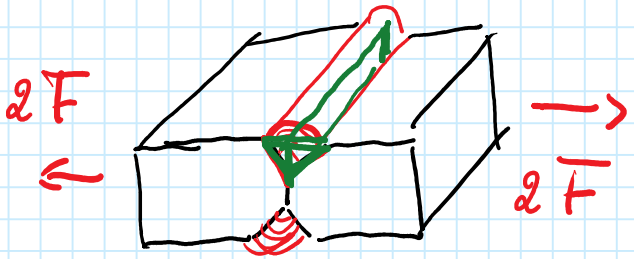
2. Si valutano le componenti $\sigma_\perp$, $\tau_{//}$ e $\tau_\perp$

Si costruisce il dominio di resistenza del cordone d'angolo per punti. Il generico punto si ottiene generando una terna di tensioni $\sigma_\perp$, $\tau_{//}$ e $\tau_\perp$ e facendole crescere fino alla rottura del cordone.



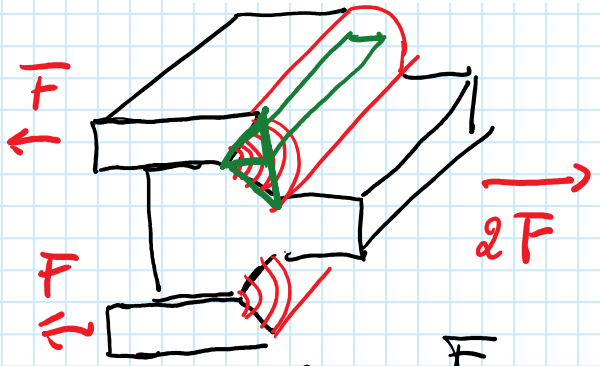
Peroide





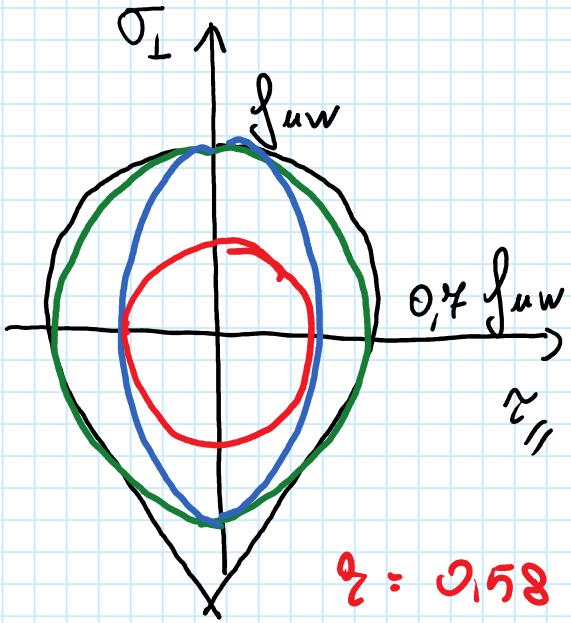
$$\sigma_\perp = \frac{F}{aL} \qquad F_{rd} \rightarrow f_{wv}$$

$$\tau_{//} = \tau_\perp = 0$$

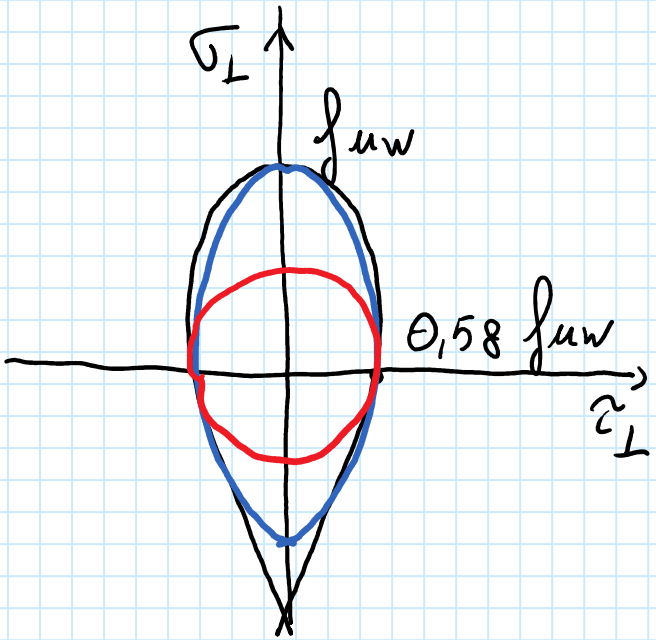


$$\tau_\perp = \frac{F}{aL} \qquad F_{rd} \rightarrow 0{,}58\, f_{wv}$$

$$\sigma_\perp = \tau_{//} = 0$$



$\tau = 0{,}58\, f_{uw}$



Esistono tre diversi domini, rappresentabili in forma analitica, per approssimare (a favore di sicurezza) il periodo:

1. l'ellissoide (con 3 semi-assi diversi)
2. l'ellissoide di rotazione
3. la sfera

L'ellissoide

$$\left(\frac{\sigma_\perp}{f_{uw}}\right)^2 + \left(\frac{\tau_{//}}{0{,}4\, f_{uw}}\right)^2 + \left(\frac{\tau_\perp}{0{,}58 f_{uw}}\right)^2 \leq 1$$

$$\frac{1}{0{,}4} = \sqrt{2} \qquad \frac{1}{0{,}58} = \sqrt{3}$$

$$\frac{\sigma_\perp^2}{f_{uw}^2} + 2\frac{\tau_{//}^2}{f_{uw}^2} + 3\frac{\tau_\perp^2}{f_{uw}^2} \leq 1$$

$$\boxed{\sigma_{id} = \sqrt{\sigma_\perp^2 + 2\tau_{//}^2 + 3\tau_\perp^2} \leq f_{uw}}$$

L'ellissoide di rotazione

$$\left(\frac{\sigma_\perp}{f_{uw}}\right)^2 + \left(\frac{\tau_{//}}{0{,}58 f_{uw}}\right)^2 + \left(\frac{\tau_\perp}{0{,}58 f_{uw}}\right)^2 \leq 1$$

$$\frac{\sigma_\perp^2}{f_{uw}^2} + \frac{3\,\tau_{//}^2}{f_{uw}^2} + \frac{3\,\tau_\perp}{f_{uw}^2} \leq 1$$

$$\sqrt{\sigma_\perp^2 + 3\tau_{//}^2 + 3\tau_\perp^2} \leq f_{uw}$$

$$\boxed{\sigma_{id} = \sqrt{\sigma_\perp^2 + 3\tau^2} \leq f_{uw}}$$

Adottato da:

NTC 18

EC3

Le sfere

$$\left(\frac{\sigma_\perp}{0{,}58 f_{uw}}\right)^2 + \left(\frac{\tau_{//}}{0{,}58 f_{uw}}\right)^2 + \left(\frac{\tau_\perp}{0{,}58 f_{uw}}\right)^2 \leq 1$$

$$\frac{3\sigma_\perp^2}{f_{uw}^2} + \frac{3\tau_{//}^2}{f_{uw}^2} + \frac{3\tau_\perp^2}{f_{uw}^2} \leq 1$$

$$\sqrt{\sigma_\perp^2 + \tau_{//}^2 + \tau_\perp^2} \leq \frac{f_{uw}}{\sqrt{3}}$$

$$t = \frac{R}{\alpha L} \leq \frac{f_{uw}}{\sqrt{3}}$$

Adottato da:

NTC 18

EC3

Ma quanto vale la resistenza unitaria di calcolo f_{uw}?

$$f_{uw} = \frac{f_u}{\beta_w \gamma_{M2}}$$

β_w $\begin{cases} 0{,}8 & S235 \\ 0{,}85 & S275 \\ 0{,}9 & S355 \end{cases}$

β_w considera che il calcolo è un mix tra materiale base e metallo d'apporto (di norma di migliore qualità)

f_{uw} è la resistenza meccanica per portare la $\sigma_\perp$

Ellissoide di tensioni, formule di normative

$$\sigma_{id} = \sqrt{\sigma_\perp^2 + 3\tau^2} \leq \frac{f_u}{\beta_w \gamma_{M2}}$$

f_u = tensione di rottura dei pezzi saldati (materiale base)

$$\beta_w = \begin{cases} 0{,}80 & S235 \\ 0{,}85 & S275 \\ 0{,}90 & S355 \end{cases}$$

Inoltre $\sigma_\perp \leq 0{,}9 \dfrac{f_u}{\gamma_{M2}}$

Dominio sferico, formule di normativa

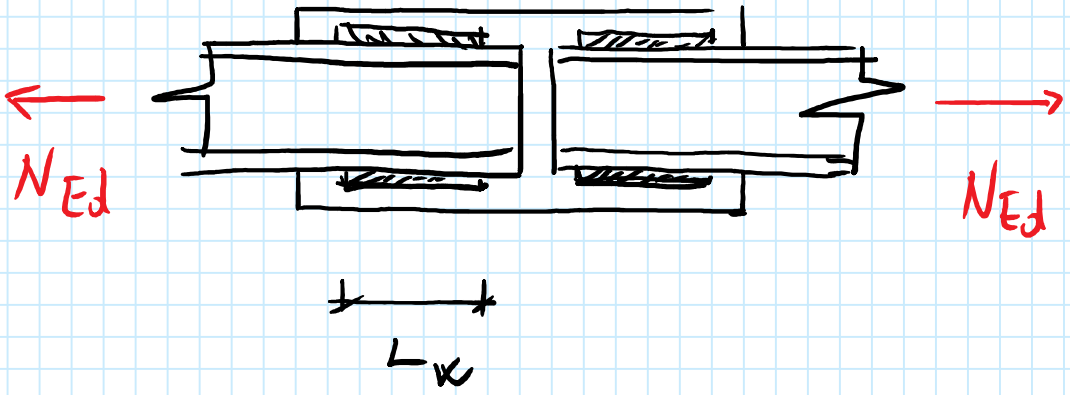
$$\tau = \frac{R}{a_w L} \leq f_{vw,d}$$

$$f_{vw,d} = \frac{f_u}{\sqrt{3}\,\beta_w\,\gamma_{M2}}$$

f_u = tensione di rottura dei pezzi saldati (materiale base)

β_w =

0,80	S235
0,85	S275
0,90	S355



2 UPN 80 , S 235

$L_w = 150$ mm

$a = 5$ mm

$N_{Ed} = 200$ kN

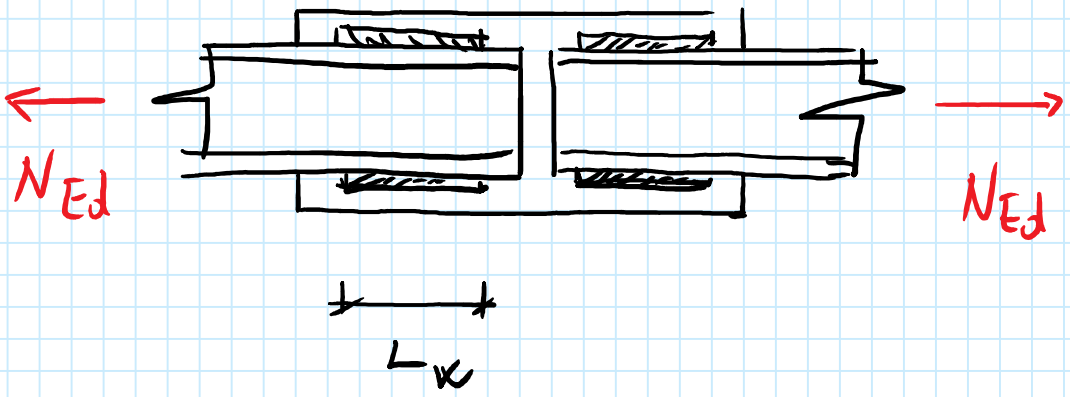
Per avere ripristino di resistenza

$$F_{w,Ed} = \frac{N_{Ed}}{4} = \frac{200}{4} = 50 \text{ kN}$$

$$t = \frac{F_{w,Ed}}{a \cdot L} = \frac{50 \times 10^3}{5 \cdot \times 150} = 66{,}7 \text{ MPa}$$

$t \leq f_{v,w,d}$ OK!

$$f_{v,w,d} = \frac{f_u}{\sqrt{3}\, \beta_w \gamma_{M_2}} = \frac{360}{\sqrt{3} \times 0{,}8 \times 1{,}25} = 207{,}8 \text{ MPa}$$



2 UPN 80 , S 235

$L_w = 150$ mm

$a = 5$ mm

$N_{Ed} = 200$ KN

Completo ripristino di resistenza

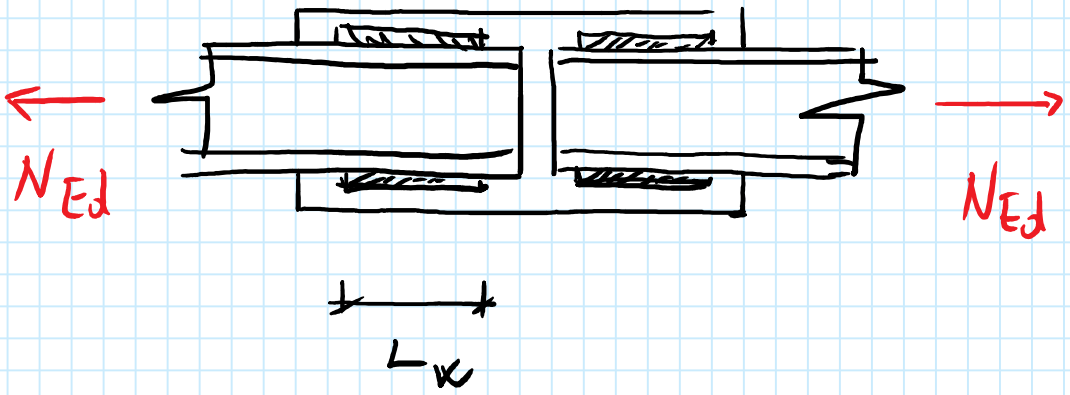
$$N_{pl,Rd} = \frac{A f_y}{\gamma_{M0}} = 22 \times \frac{235}{1,05} \times \frac{1}{10} = 492,4 \text{ KN}$$

$$F_{w,Ed} = \frac{N_{pl,Rd}}{4} = \frac{492,4}{4} = 123,1 \text{ KN}$$

$$t = \frac{123,1}{5 \times 150} \times 10^3 = 164,1 \text{ MPa}$$

$t \leq f_{v,w,d}$ OK!

$$f_{v,w,d} = \frac{f_u}{\sqrt{3}\, \beta_w \gamma_{M2}} = \frac{360}{\sqrt{3} \times 0,8 \times 1,25} = 207,8 \text{ MPa}$$



1 UPN 80 , S 235

$L_w = 150$ mm

$a = 5$ mm

$N_{Ed} = 200$ kN

Completo ripristino di resistenza

Verifica con ellissoide

$$F_{w,Ed} = \frac{N_{pl,Rd}}{4} = 123,1 \text{ kN}$$

$$\sigma_\perp = 0 \qquad \tau = \frac{F_{w,Ed}}{a\,L} = \frac{123,1}{5 \times 150} \times 10^3 = 164,1 \text{ MPa}$$

$$\sigma_{id} = \sqrt{\sigma_\perp^2 + 3\tau^2} = \sqrt{0^2 + 3 \times 164,1^2} = 284,3 \text{ MPa} \leq \frac{f_u}{\beta_w \gamma_{M2}} = \frac{360}{0,80 \times 1,25} = 360 \text{ MPa}$$

$\sigma_{id} \leq \frac{f_u}{\beta_w \gamma_{M2}}$ OK!