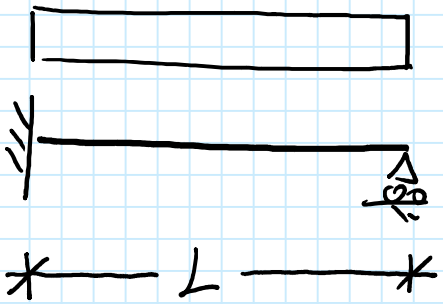
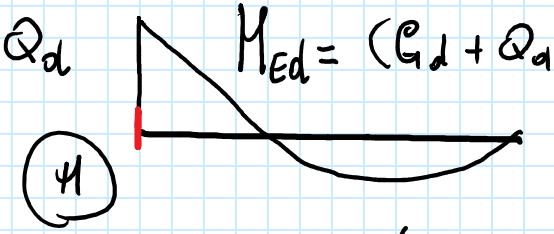
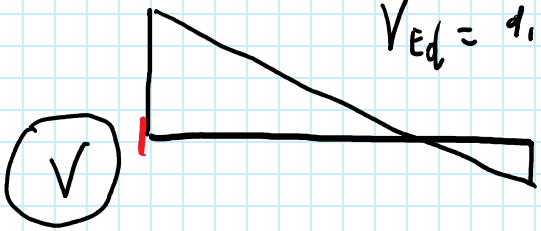
Applicazioni numeriche



$G_d + Q_d$



$M_{Ed} = (G_d + Q_d)\, L^2/8$



$V_{Ed} = 1{,}25\,(G_d + Q_d)\, L/2$

IPE 270

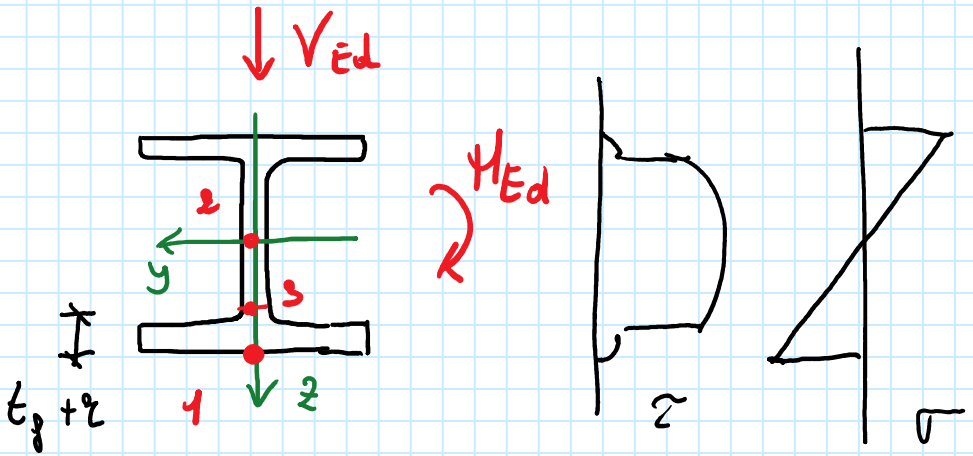
S 235

$M_{Ed} = 45$ kNm

$V_{Ed} = 200$ kN

	G kg/m	h mm	b mm	t_w mm	t_f mm	r mm	A cm^2	h_i mm	d mm	∅	p_{min} mm	p_{max} mm	A_L m^2/m	A_G m^2/t
IPE A 270•	30.7	267	135	5.5	8.7	15	39.15	249.6	219.6	M16	70	72	1.037	33.75
IPE 270	36.1	270	135	6.6	10.2	15	45.95	249.6	219.6	M16	72	72	1.041	28.86

	G kg/m	I_y cm^4	$W_{el.y}$ cm^3	$W_{pl.y}$♦ cm^3	i_y cm	A_{vz} cm^2	I_z cm^4	$W_{el.z}$ cm^3	$W_{pl.z}$♦ cm^3	i_z cm	s_s mm	I_t cm^4	$I_w \times 10^{-3}$ cm^6	S 235	S 355	S 460	S 235	S 355	S 460
IPE A 270	30.7	4917	368.3	412.5	11.21	18.75	358.0	53.03	82.34	3.02	40.47	10.30	59.51	1	1	-	3	4	-
IPE 270	36.1	5790	428.9	484.0	11.23	22.14	419.9	62.20	96.95	3.02	44.57	15.94	70.58	1	1	-	2	3	-



IPE 270

S 235

$M_{Ed} = 75\ kNm$

$V_{Ed} = 200\ kN$

Comportamento elastico

(Classe 3)

1. $\sigma_{max} = \dfrac{M_{Ed}}{I_y}(h/2) = \dfrac{M_{Ed}}{W_{el,y}} = \dfrac{75}{428,9} \times \dfrac{10^3 \times 10^3}{10^3} = 174,9\ MPa$

$\sigma_{max} = 174,9\ MPa \leq \dfrac{f_y}{\gamma_{M0}} = \dfrac{235}{1,05} = 223,8$ OK!

2. $\tau_{max} = \frac{V_2 S_{1/2}}{I_y b} = \frac{200 \times 242}{5790 \times 0{,}66} \times \frac{10^3}{10^2} = 126{,}6 \ MPa$

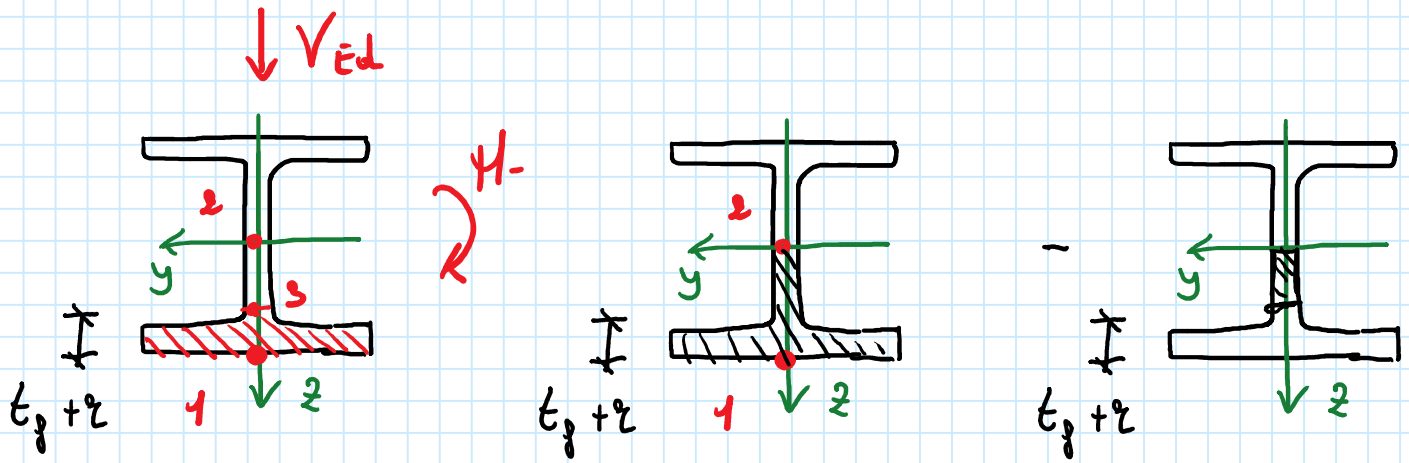
$\tau_{max} = 126{,}6 \ MPa \leq \frac{f_y}{\sqrt{3}\gamma_{M0}} = 129{,}2$ OK!

3. Calcolo σ_3 e τ_3

$\sigma_3 = \frac{M_{Ed}}{I_y} z_3 = \frac{75}{5790} \times 10{,}98 \times \frac{10^3 \times 10^2}{10^3} = 142{,}2 \ MPa$

$z_3 = \frac{h}{2} - (t_f + r) = \frac{270}{2} - (10{,}2 + 15) = 109{,}8 \ mm$

$\tau_3 = \frac{V_{Ed} S_1^3}{I_y b}$



$$S_{1/2} = \frac{W_{pl,y}}{2} \qquad t_w \frac{\left(\frac{h}{2} - t_f - r\right)^2}{2}$$

$$S_y^3 = \frac{W_{pl,y}}{2} - t_w \frac{\left(h/2 - t_f - r\right)^2}{2} = \frac{484}{2} - 6{,}6 \times \frac{(135 - 10{,}2 - 15)^2}{2 \times 10^3}$$

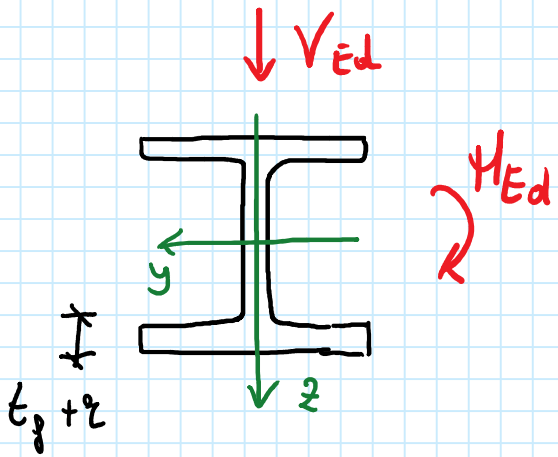
$$= 202.2 \text{ cm}^3$$

$$\tau_3 = \frac{200 \times 202,2}{5790 \times 0,66} \times 10 = 105,8 \text{ MPa}$$

$$\sigma_{id} = \sqrt{\sigma_3^2 + 3\tau_3^2} = \sqrt{142,2^2 + 3 \times 105,8^2} = 231,9 \text{ MPa} \leq \frac{f_y}{\gamma_{M0}} = 223,8 \text{ MPa}$$

$$\sigma_{id} = 231,9 \text{ MPa} \leq \frac{f_y}{\gamma_{M0}} = 223,8 \text{ MPa}$$

NO



IPE 270

S 235

$M_{Ed} = 75 \ kNm$

$V_{Ed} = 200 \ kN$

Comportamento plastico (Classe 1 o 2)

1. $V_{Ed} \leq V_{c,Rd}$

$V_{Ed} = 200 \ KN \leq V_{c,Rd} = 286,1 \ KN$ OK!

2. $\frac{V_{Ed}}{V_{c,Rd}} = \frac{200}{286,1} = 0,699 > 0,5 \Longrightarrow$ La resistenza a flessione è ridotta per effetto del taglio

3. Calcolo $M_{V,Rd}$

$$M_{V,Rd} = \left(W_{pl,y} - \frac{A_w^2 \rho}{4 t_w} \right) \frac{f_y}{\gamma_{M0}} = \left(484 - \frac{16,5^2 \times 0,1585}{4 \times 0,66} \right) \frac{235}{1,05} \times \frac{1}{10^3}$$

$$= 104,7 \text{ kNm}$$

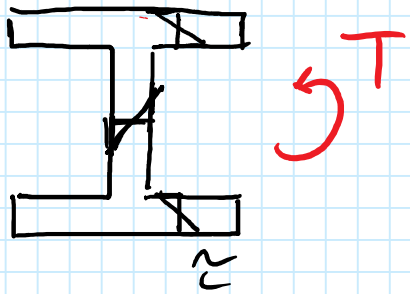
$$\rho = \left(2 \frac{V_{Ed}}{V_{c,Rd}} - 1 \right)^2 = \left(2 \times \frac{200}{286,1} - 1 \right)^2 = 0,1585$$

$$A_w = t_w (h - 2 t_f) = \frac{6,6 \times (270 - 2 \times 10,2)}{10^2} = 16,5 \text{ cm}^2$$

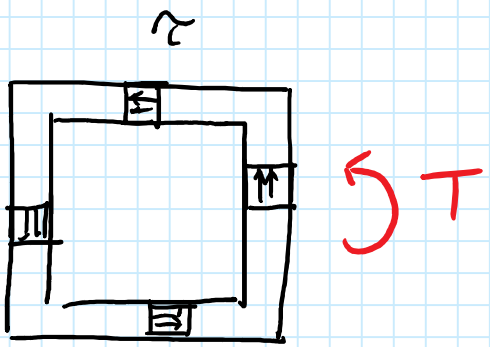
4. $M_{Ed} = 75,0 \text{ kNm} \leq M_{V,Rd} = 104,7 \text{ kNm}$ OK!

Torsione

Torsione primaria → provoca solo τ



... sezioni aperte

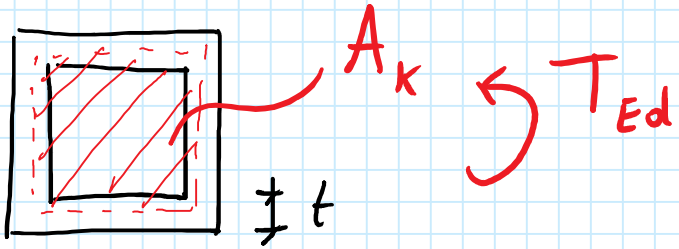


sezioni chiuse

a parità di T

tensioni più piccole

$$\tau = \frac{T}{2 A_k t}$$ formula di Bredt



Sezione a plasticità

↓

SLU

$$\tau = \frac{f_y}{\sqrt{3}\,\gamma_{M0}} = \frac{T_{Rd}}{2 A_k t} \Rightarrow T_{Rd} = 2 A_k t \frac{f_y}{\sqrt{3}\,\gamma_{M0}}$$

$$\begin{cases} T_{Ed} \leq T_{Rd} \\ T_{Rd} = 2 A_k t \dfrac{f_y}{\sqrt{3}\,\gamma_{M0}} \end{cases}$$

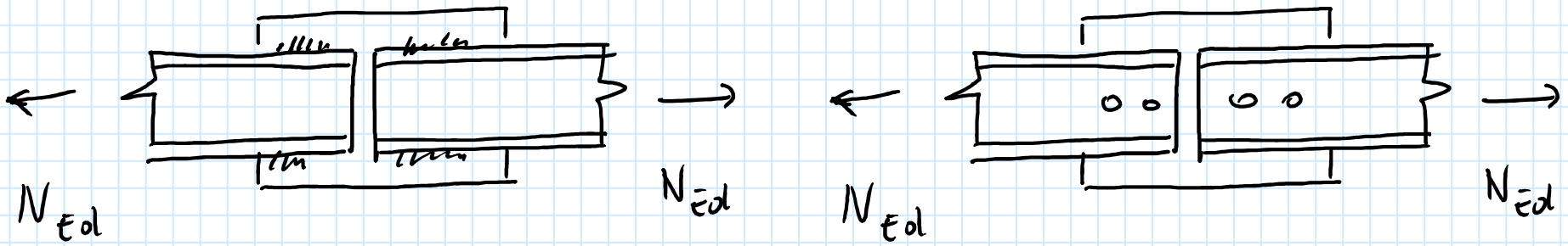
Vale per sezioni chiuse

Classificazione dei collegamenti

1. Tecnologia
   - Collegamenti saldati
   - Collegamenti bullonati

2. Resistenza
   - a parziale ripristino di resistenza
   - a completo ripristino di resistenza

3. Rigidezza
   - Cerniera
   - Semi-rigidi
   - Incastro



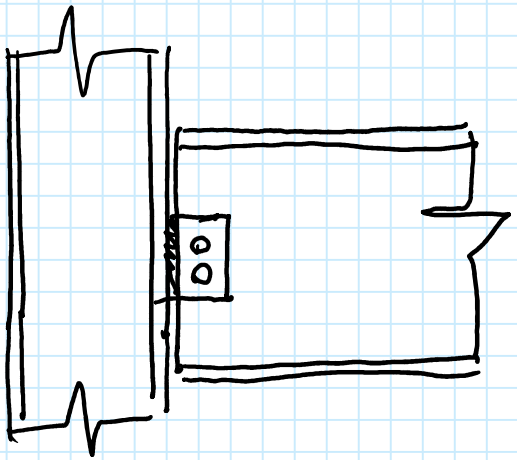
1. Parziale ripristino

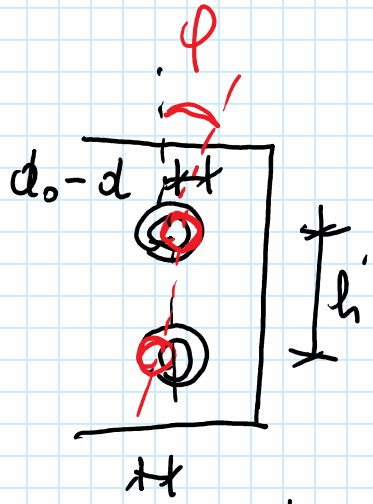
$$R_j \geq N_{Ed}$$

2. Completo ripristino

$R_j \geq N_{pl,Rd}$ del più debole dei profilati collegati

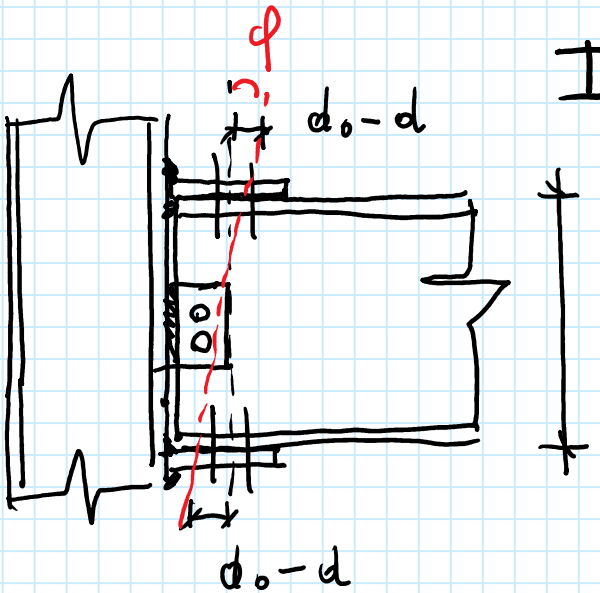
Centrale





$$\varphi = \frac{2(d_0 - d)}{h'}$$

Incastro

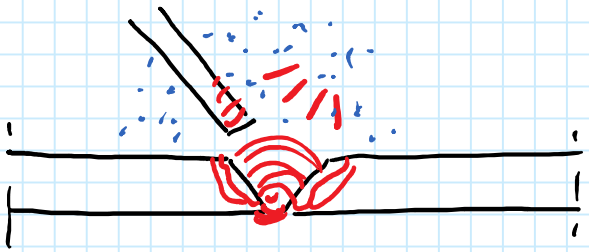


$$\varphi = \frac{2(d_0 - d)}{h}$$

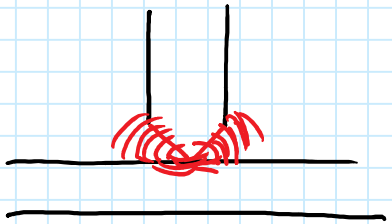
$h \gg h'$

Collegamenti saldati

1. Fonte di calore
2. Metallo d'apporto
3. Protezione del bagno di fusione

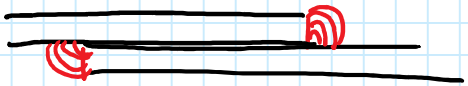


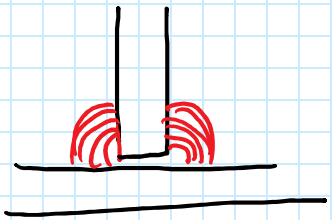
- Saldatura a completa penetrazione



Richiede la preparazione dei lembi: lembi smussati

- Saldatura con lembi d'angolo

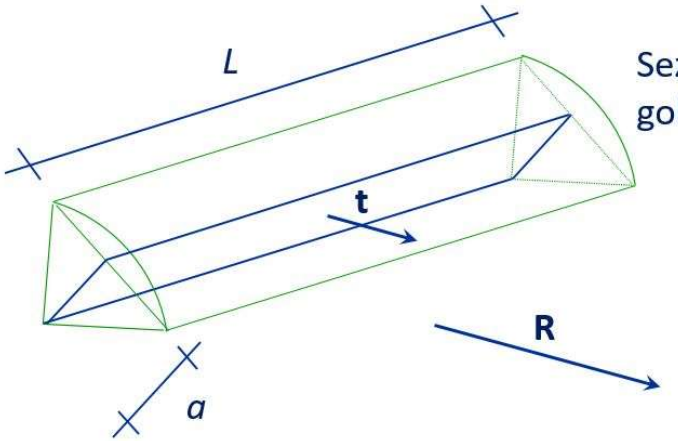




Non richiede lembi smussati

Saldatura

- Manuali
  1. Fiamma ossiacetilenica
  2. Arco elettrico
- Semi-automatiche
- Automatiche



Sezione di gola

R Forza agente sul cordone d'angolo

t Tensione agente sulla sezione di gola

(ha lo stessa direzione di R e modulo pari a $t = R / a\,L$)

$L = L_w$ NTC18

$L = L_w - 2a$ EC3