Titolo nota 18/12/2014

$$M_u = \frac{\pi^2 E I_z}{l_0^2} \frac{h - t_f}{2} =$$

$$= \frac{\pi^2 E I_z}{l_0^2} \sqrt{\frac{I_w}{I_z}}$$

Trascurando rig. tors.

$$M_u = \frac{\pi^2 E I_z}{l_0^2} \sqrt{\frac{I_w}{I_z} + \frac{l_0^2}{\pi^2} \frac{G I_t}{E I_z}}$$

tenendo conto di $G I_t$

$$M_{cr} = \underbrace{\frac{\pi}{l_0}\sqrt{E I_z \, G I_t}}_{18.168 \text{ KNm}} \; \underbrace{\sqrt{\underbrace{\frac{\pi^2}{l_0^2}\,\frac{E I_\omega}{G I_t}}_{0.0947} + 1}}_{1.046}$$

IPE 200 $\quad L = 7.10$ m

$I_z = 142.4 \times 10^4 \text{ mm}^4 \qquad E = 210\,000$ MPa

$I_t = 6.98 \times 10^4 \text{ mm}^4 \qquad G = 80\,770$ MPa

$I_\omega = 12.99 \times 10^9 \text{ mm}^6 \qquad M_{cr} = 19.0$ KNm

$$\frac{\pi}{l}\sqrt{E I_z \, G I_t} =$$

$$\frac{3.14}{7100}\sqrt{2.1\times10^5 \cdot 142.4\times10^4 \times 8.077\times10^4 \times 6.98\times10^5} =$$

$$\sqrt{1685{,}9\times10^{18}}$$

$$0.018168\times10^9 \qquad 41.06\times10^9$$

$$18.168\times10^6 \ Nmm = 18.168 \ KNm$$

HE 180 A

$I_z = 924.6 \times 10^4 \ mm^4$

$I_t = 14.80 \times 10^4 \ mm^4$

$I_w = 60.21 \times 10^9 \ mm^6$

$W_{pl} = 324.9 \times 10^3 \ mm^3$

$M_{cr} = 74.06$ KNm

152.35×10^9

$\downarrow$

67.41 KNm

0.207

S275

$M_{Rd} = 85.1$ KNm

$$\bar{\lambda}_{LT} = \sqrt{\frac{W_{pl,y} \; f_y}{M_{cr}}} = \sqrt{\frac{89.35}{74.06}} = 1.098$$

$$\phi_{LT} = 0.5 \left[1 + \alpha_{LT} \left(\bar{\lambda}_{LT} - 0.2 \right) + \bar{\lambda}_{LT}^{2} \right]$$ in general

$$= 0.5 \left[1 + \alpha_{LT} \left(\bar{\lambda}_{LT} - \bar{\lambda}_{LT0} \right) + \beta \, \bar{\lambda}_{LT}^{2} \right]$$ profile laminat.

$\bar{\lambda}_{LT0} \downarrow 0.4$ $\quad \beta \downarrow 0.75$

	curv.
$\frac{h}{b} \leq 2$	a
> 2	b

α_{LT} : $a \to 0.21$ $\quad b \to 0.34$

$$\chi_{LT} = \frac{1}{\phi_{LT} + \sqrt{\phi_{LT}^2 - \bar{\lambda}_{LT}^2}} \leq 1 \quad \text{in generale}$$

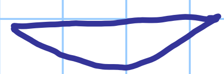
$$\frac{1}{\phi_{LT} + \sqrt{\phi_{LT}^2 - \underbrace{\beta}_{0.75} \bar{\lambda}_{LT}^2}} \leq 1 \quad \text{profili laminati}$$

$$\leq \frac{1}{\bar{\lambda}_{LT}^2}$$

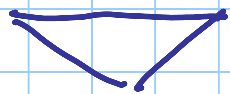
se M varia

$$M_{cr} = C_2 \frac{\pi}{L} \sqrt{E I_z G I_t} \sqrt{1 + \frac{\pi^2}{L^2} \frac{E I_w}{G I_t}}$$

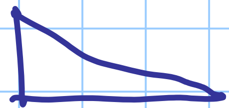
$C_2 > 1$



$C_2 = 1.132$



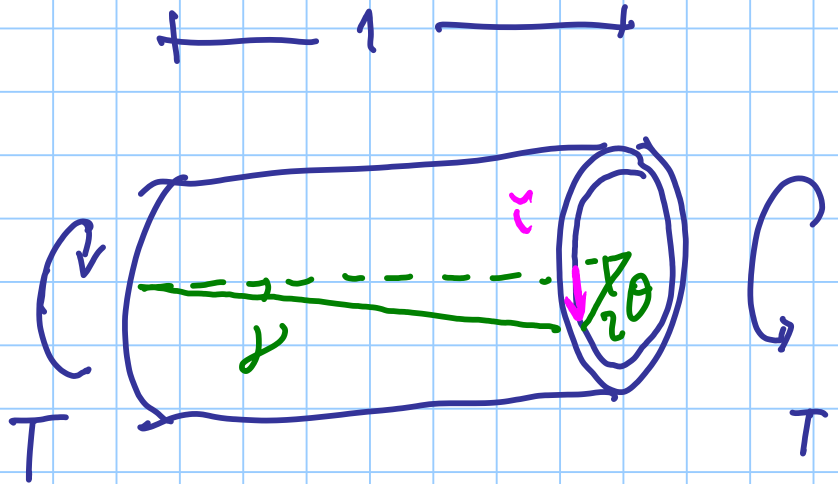
$C_2 = 1.365$



$C_2 = 1.879$

$$\chi_{LT,mod} = \frac{\chi_{LT}}{f}$$

$$f = 1 - 0.5(1 - k_c)\left[1 - 2(\bar{\lambda}_{LT} - 0.8)^2\right] \leq 1$$

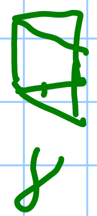


θ = angolo di rotazione unitaria

$$\gamma \cdot 1 = \theta \cdot r$$

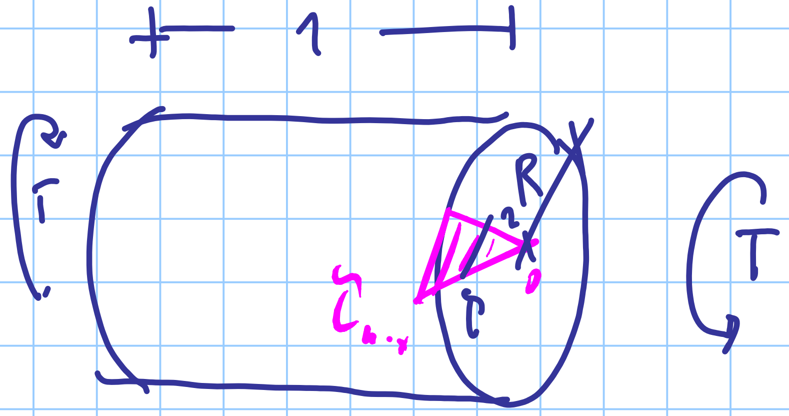
$$\theta = \frac{\gamma}{r}$$

$$\tau = G\gamma$$



$$T = \int \tau \, dA \, r = \int \frac{\tau}{r} \cdot r^2 \, dA = \frac{\tau}{r} I_t$$

momento d'inerzia polare

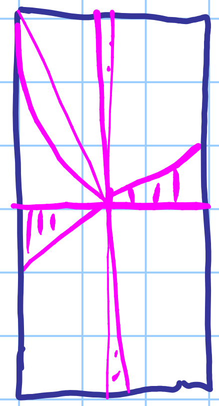


$$\tau = \tau_{max} \frac{r}{R}$$

$$T = \frac{\tau_{max}}{R} I_t$$

$$\tau_{max} = \frac{T\,R}{I_t}$$

$a \geq b$

a  τ_{max}

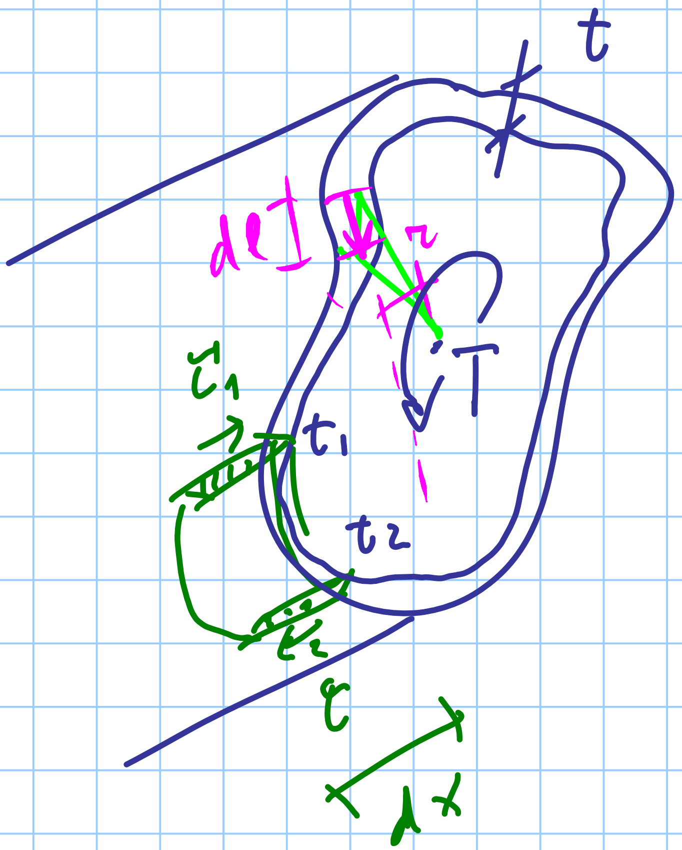
b

$$\tau_{max} = \psi \frac{T}{a b^2} \Rightarrow T = \frac{a b^2}{\psi} \tau_{max}$$

$$\psi = 3 + \frac{1.8}{a/b}$$

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

$a \gg b \qquad \psi \to 3$



$$\tau_1 \cdot t_1\, dx = \tau_2 \cdot t_2\, dx$$

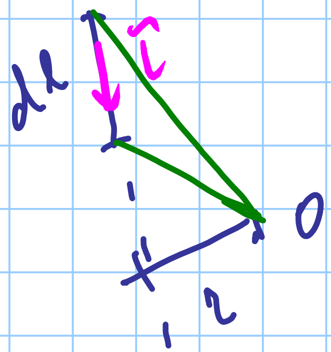
$$\tau\, t = \text{cost}$$

BREDT

$$T \int \tau\, dA \cdot r$$

$$T = \int \tau\, t\, dl \cdot r$$

$\tau \; t \; dl \; r$



$$dA = \frac{dl \cdot r}{2}$$

$$dl \cdot r = 2\,dA$$

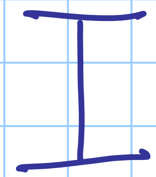
$$T = \int \tau t \cdot 2\,dA = \tau \, t \, 2 A_K$$

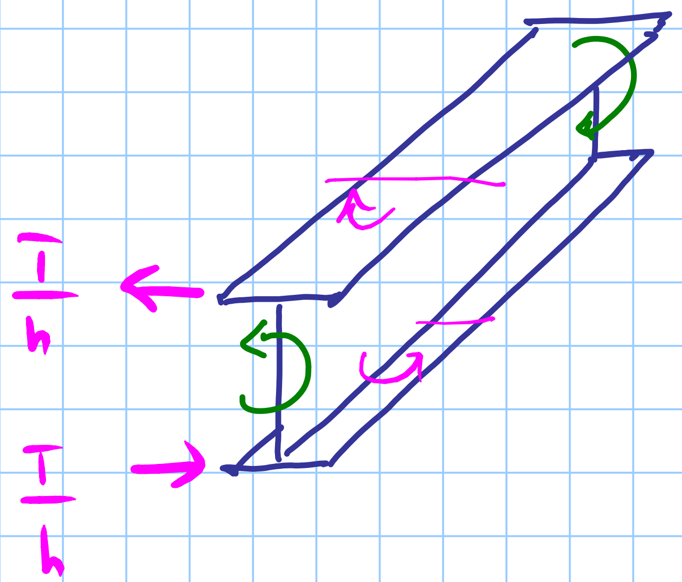
$$\tau_{max} = \frac{T}{2 A t_{min}}$$

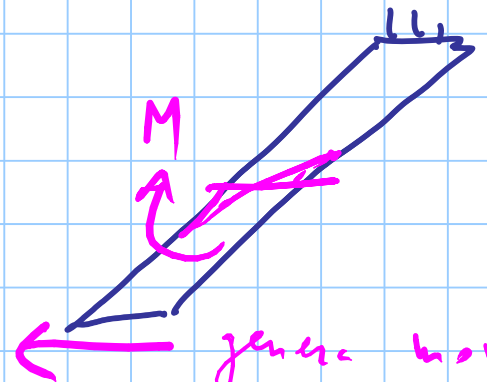
resistenza a torsione profili chiusi

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

e i profili aperti ?







genera momento flettente quindi σ

BIMOMENTO $= M \cdot h$ (VLASOV)

TEORIA DI DE SAINT VENANT

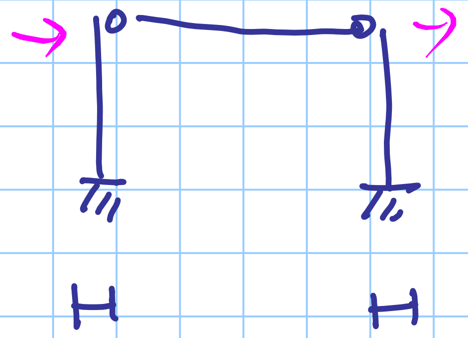
torsione primaria   sezioni compatte

TEORIA DI VLASOV $t \rightarrow 0$

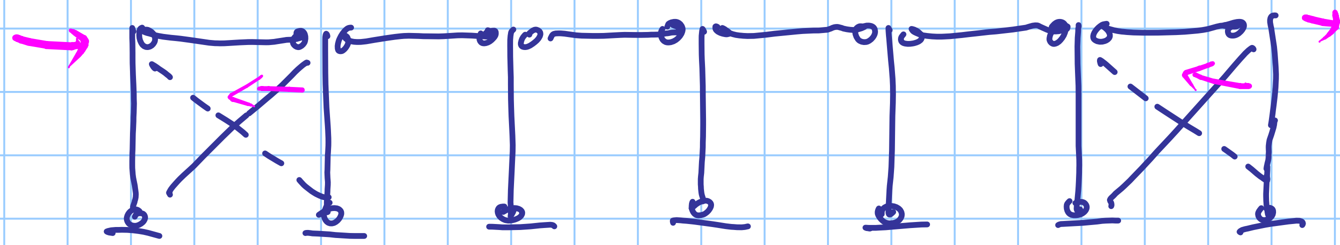
torsione secondaria

PROGETTO

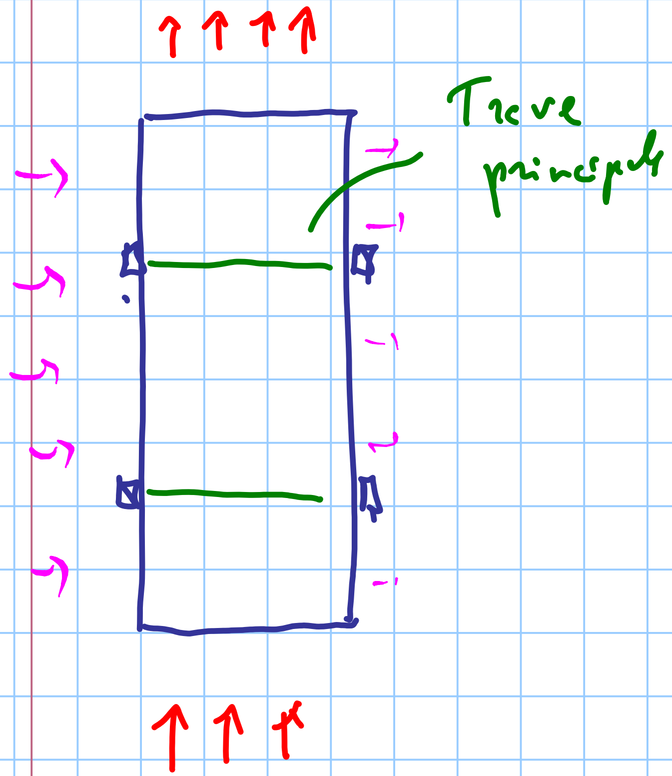
CAPANNONE

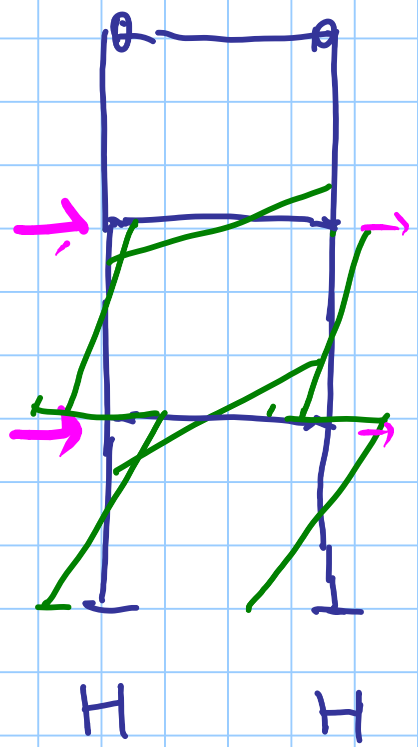


$$\delta \leq \frac{1}{150} H$$



SCALE

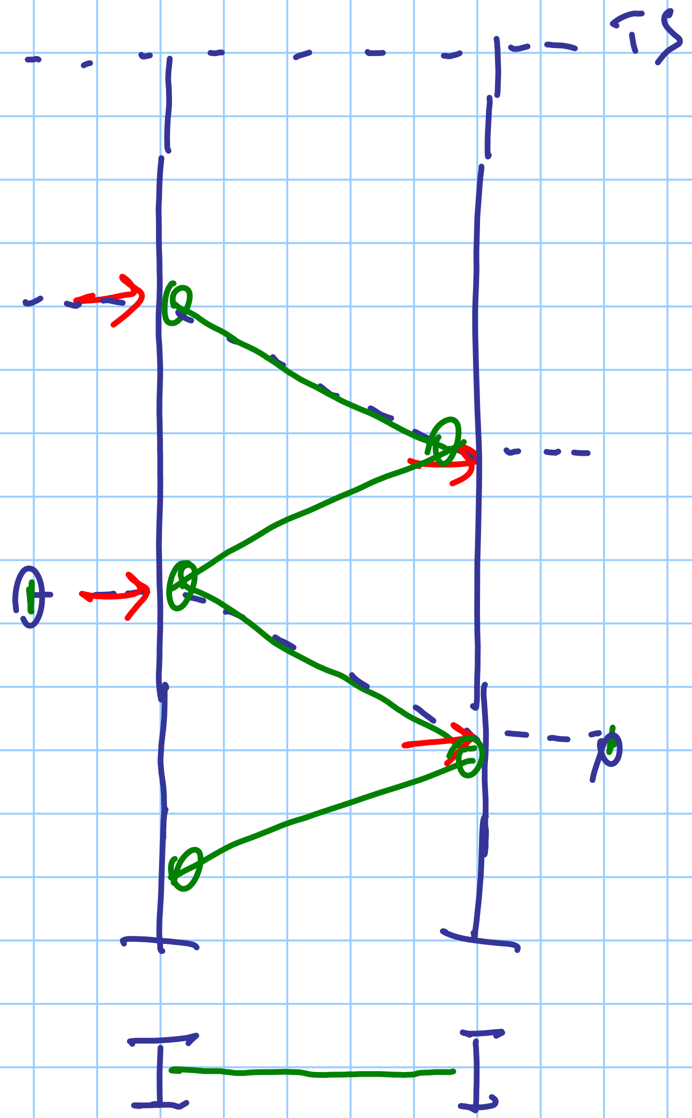


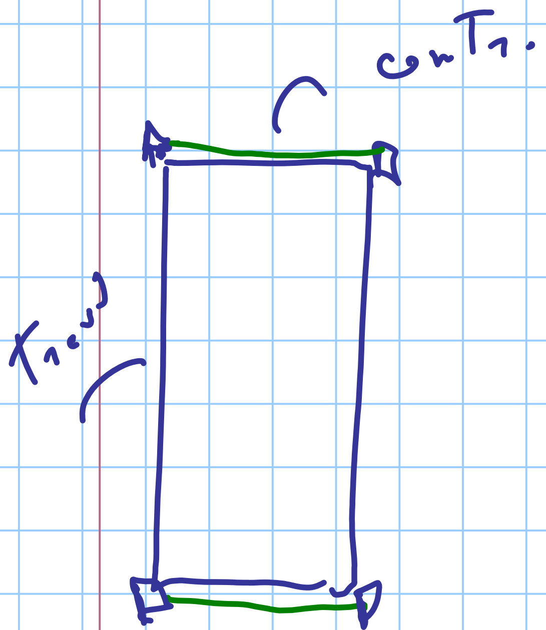


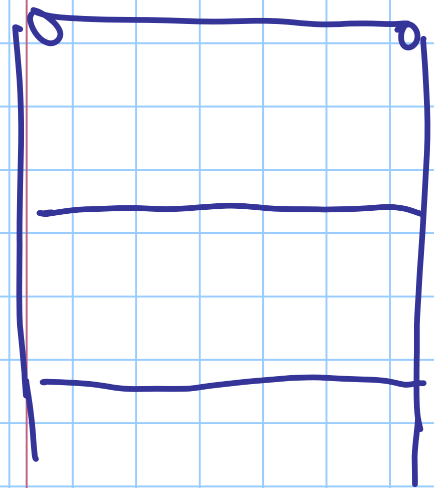
$$\Delta = \frac{H}{500}$$

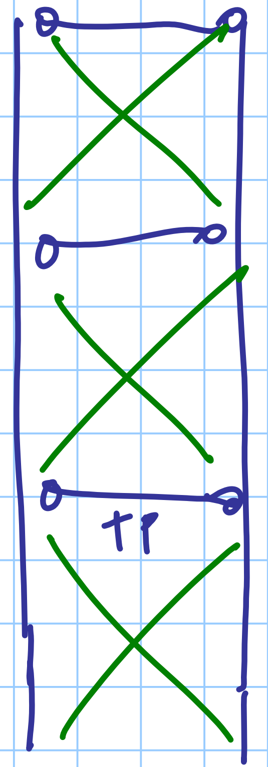
$$\delta = \frac{h}{300}$$

Tip 4, 5, 6





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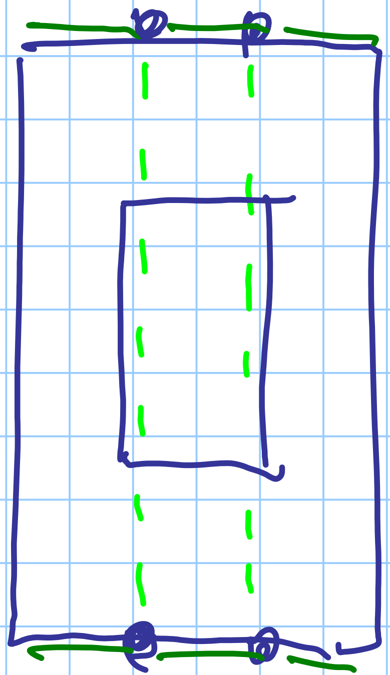

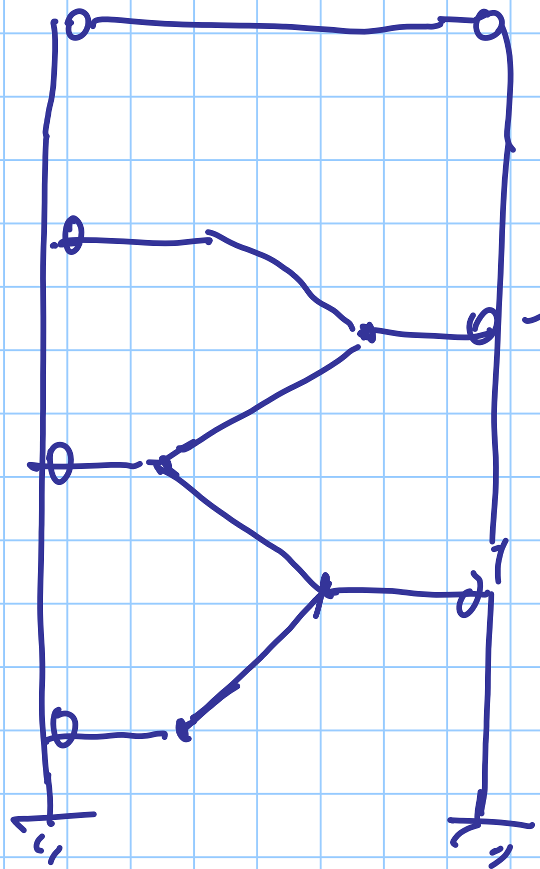

? cerniera,
incastro

forse
meglio incastro