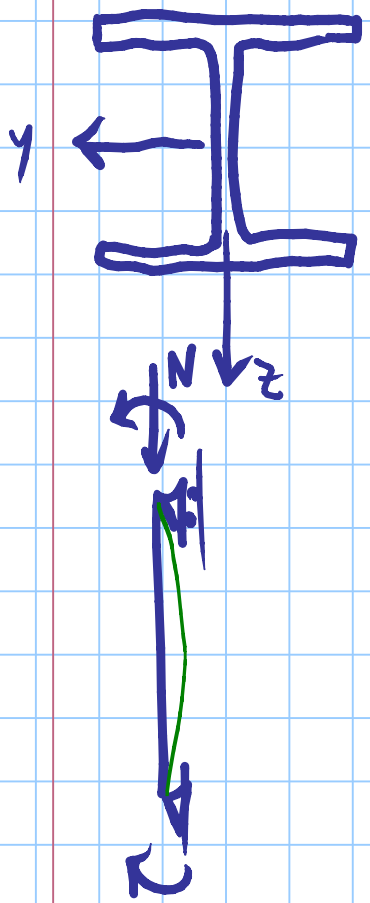
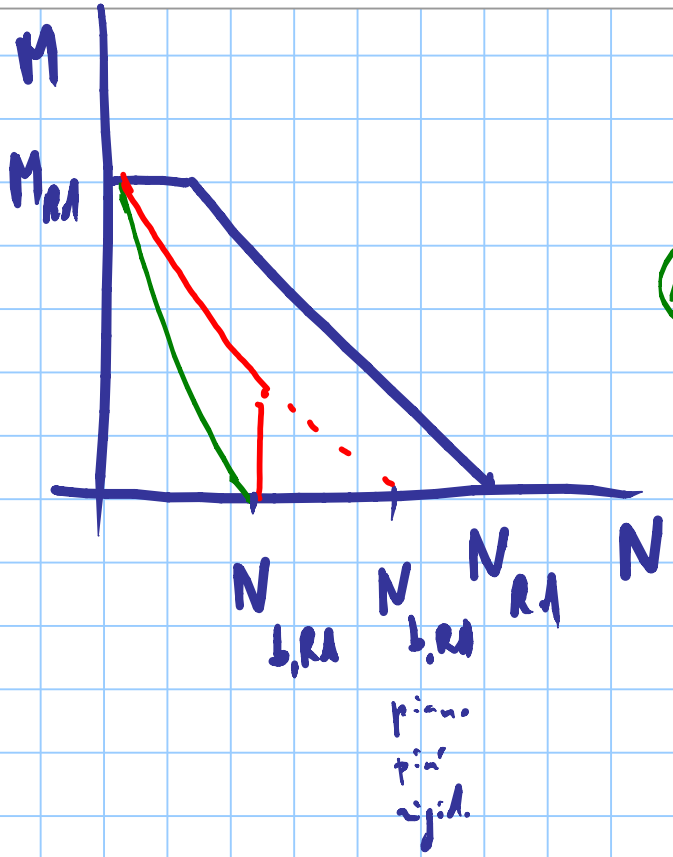
Titolo nota 08/01/2013



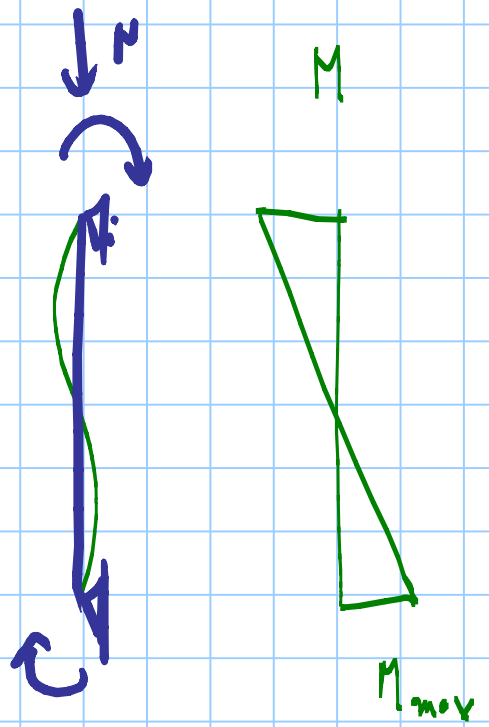


$$N_{b,Rd} < N_{Rd}$$

(A)
$$\frac{N_{Ed}}{N_{b,Rd}} + \frac{M_{y,Ed}}{M_{Rd}\left(1 - \frac{N_{Ed}}{N_u}\right)} \leq 1$$

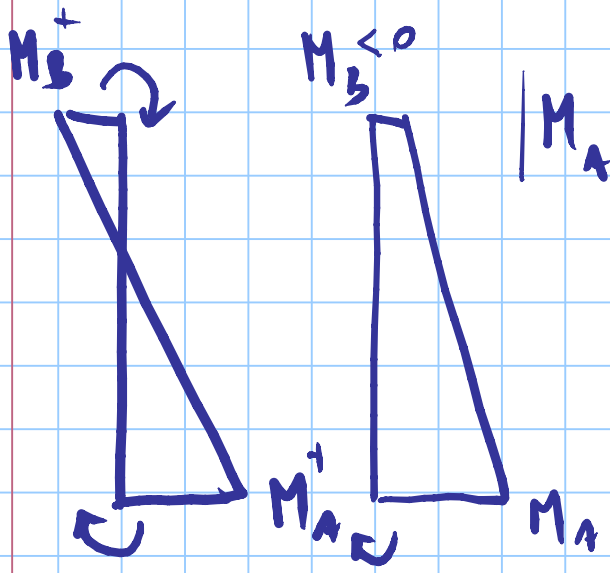
(B)
$$\frac{N_{Ed}}{N_{y,b,Rd}} + \frac{K_{yy}\, M_{y,Ed}}{M_{Rd}} \leq 1$$

$$\frac{N_{Ed}}{N_{z,b,Rd}} \leq 1$$



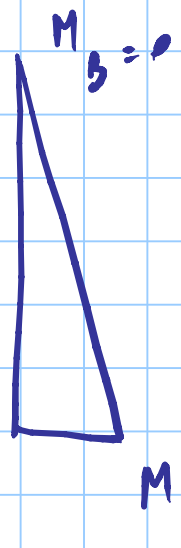
$$M_{ed} \leq M_{max}$$

M c.t.l. A

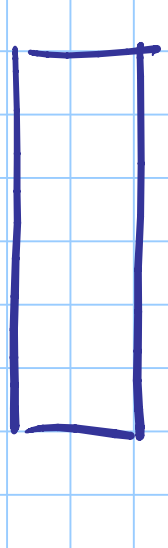


$$|M_A| > |M_B|$$

$$M_{ed} = 0.6\,M_A - 0.4\,M_B \geq 0.4\,M_A$$



$$M_{sd} = 0.6\ M_A$$

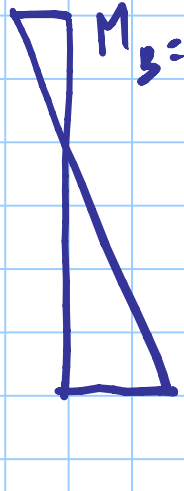


$$M_{sd} = 0.6 M_A - 0.4 M_B =$$

$$= M_A$$

$$\downarrow$$

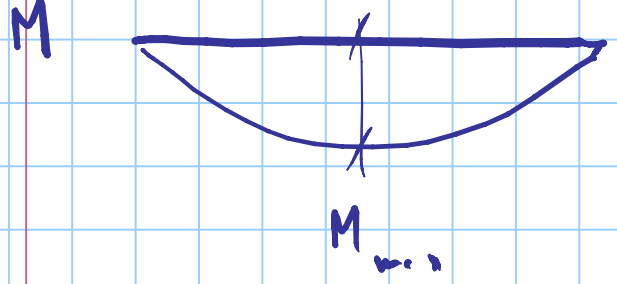
$$-M_A$$



$$M_{sd} = 0.6\ M_A - 0.4\ M_B = 0.4\ M_A$$

$$\downarrow$$

$$0.5 M_A$$

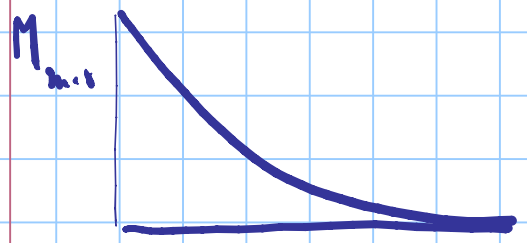


$$M_{eq} = 1.3\, M_m$$

$$0.75\, M_{max} \leq M_{eq} \leq M_{max}$$

$$M_m = \frac{2}{3} M_{max}$$

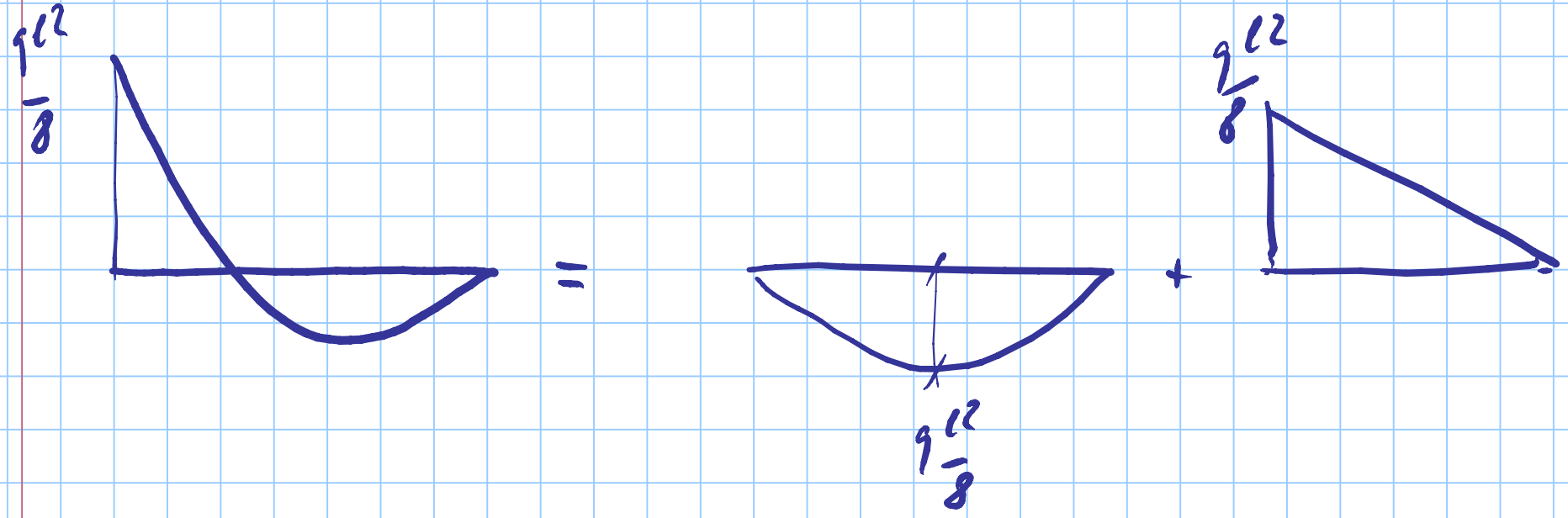
$$M_{eq} = 1.3 \times \frac{2}{3} M_{max} = 0.867\, M_{max}$$



$$M_m = \frac{1}{3} M_{max}$$

0.75

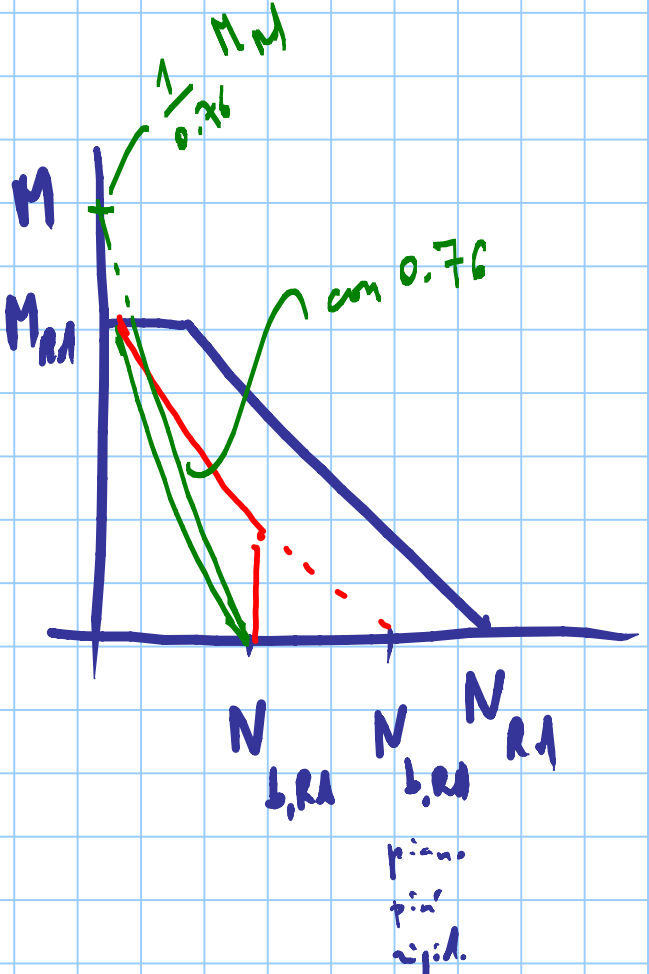
$$M_{eq} = 1.3 \times \frac{1}{3} M_{max} = 0.433\, M_{max}$$



$$M_m = \frac{2}{3}\,\frac{ql^2}{8}$$

$$M_m = -\frac{1}{2}\,\frac{ql^2}{8}$$

$$M_m = \frac{1}{6}\,\frac{ql^2}{8}$$

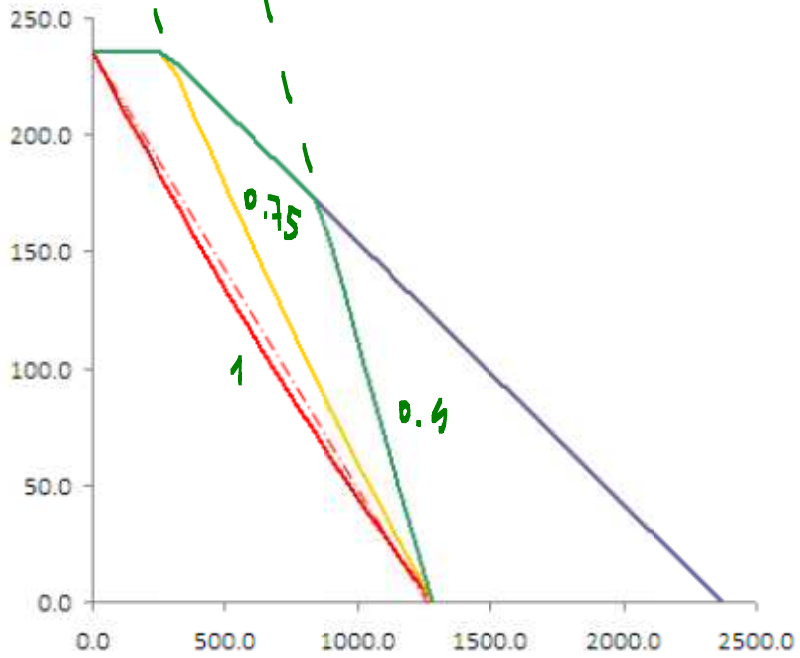


$0.76\, M_{max}$

(A) $\dfrac{N_{Ed}}{N_{b,Rd}} + \dfrac{M_{y,Ed,eq}}{M_{Rd}\left(1 - \dfrac{N_{Ed}}{N_u}\right)} \leq 1$

per $N = 0$ $\qquad \dfrac{0.76\, M_{max}}{M_{Rd}} \leq 1$

$M_{Ed} \leq \dfrac{1}{0.76} M_{Rd} = 1.32\, M_{Rd}$


250.0
200.0
150.0
100.0
50.0
0.0
0.0
500.0
1000.0
1500.0
2000.0
2500.0
0.75
1
0.5

metodo A

m.T.d. B

k	Tipi di sezione	Sezioni di classe 3 e 4 (proprietà delle sezioni calcolate in campo elastico)	Sezioni di classe 1 e 2 (proprietà delle sezioni calcolate in campo elastico)
k_{yy}	I, H, Sezioni cave	$\alpha_{my}\cdot\left(1+0,6\cdot\bar{\lambda}_y\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)\le\alpha_{my}\cdot\left(1+0,6\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)$	$\alpha_{my}\cdot\left(1+(\bar{\lambda}_y-0,2)\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)\le\alpha_{my}\cdot\left(1+0,8\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)$
k_{yz}	I, H, Sezioni cave	k_{zz}	$0,6\cdot k_{zz}$
k_{zy}	I, H, Sezioni cave	$0,8\cdot k_{yy}$	$0,6\cdot k_{yy}$
k_{zz}	I, H	$\alpha_{mz}\cdot\left(1+0,6\cdot\bar{\lambda}_y\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)\le\alpha_{mz}\cdot\left(1+0,6\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)$	$\alpha_{mz}\cdot\left(1+(2\bar{\lambda}_y-0,6)\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)\le\alpha_{mz}\cdot\left(1+1,4\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)$
	Sezioni cave		$\alpha_{mz}\cdot\left(1+(\bar{\lambda}_y-0,2)\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)\le\alpha_{mz}\cdot\left(1+0,8\cdot\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}\right)$
Per pressoflessione retta $M_{y,Ed}\neq 0$, , $k_{zy}=0$ ($M_{z,Ed}=0$)			

$$K_{yy}=\alpha_{my}\left[1+(\bar{\lambda}-0.2)\frac{N_{Ed}}{N_{y,b,Rd}}\right]\le\alpha_{my}\left[1+0.8\frac{N_{Ed}}{N_{y,1,Rd}}\right]$$

circolare NTC 08

EC3

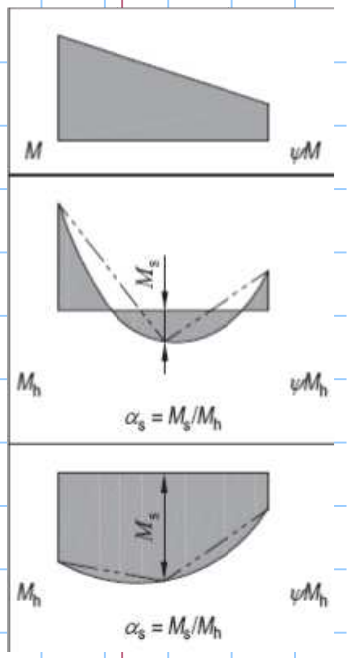


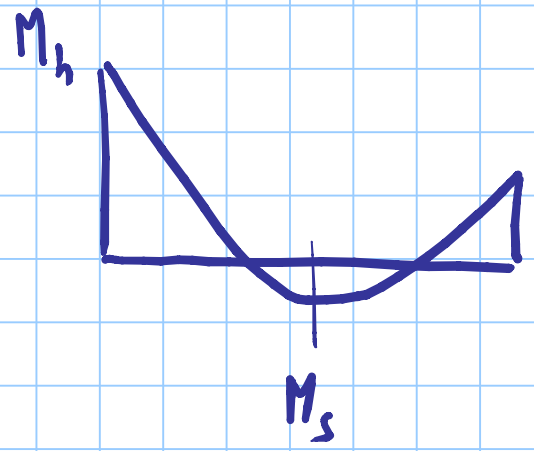
Diagramma del momento	Intervallo		Coefficienti α_{my}, α_{mz}, α_{mLT}	
			Carico uniforme	Carico concentrato
M_h … ψM_h	$-1 \le \psi \le 1$		$0,6+0,4\psi \ge 0,4$	
M_h … ψM_h, M_s; $\lvert M_h \rvert > \lvert M_s \rvert$; $\alpha_s = M_s/M_h$	$0 \le \alpha_s \le 1$	$-1 \le \psi \le 1$	$0,2+0,8\alpha_s \ge 0,4$	$0,2+0,8\alpha_s \ge 0,4$
	$-1 \le \alpha_s < 0$	$0 \le \psi \le 1$	$0,1-0,8\alpha_s \ge 0,4$	$-0,8\alpha_s \ge 0,4$
		$-1 \le \psi \le 0$	$0,1(1-\psi)-0,8\alpha_s \ge 0,4$	$0,2(-\psi)-0,8\alpha_s \ge 0,4$
M_h … ψM_h, M_s; $\lvert M_s \rvert > \lvert M_h \rvert$; $\alpha_h = M_h/M_s$	$0 \le \alpha_h \le 1$	$-1 \le \psi \le 1$	$0,95+0,05\alpha_h$	$0,90+0,10\alpha_h$
	$-1 \le \alpha_h < 0$	$0 \le \psi \le 1$	$0,95+0,05\alpha_h$	$0,90+0,10\alpha_h$
		$-1 \le \psi \le 0$	$0,95+0,05\alpha_h(1+2\psi)$	$0,90+0,10\alpha_h(1+2\psi)$

M_s è il momento in mezzeria

$\psi > 0$ se M_B e M_A hanno il stesso segno come conv. coll.

$|M_h| > |M_s|$

$\alpha_s > 0$

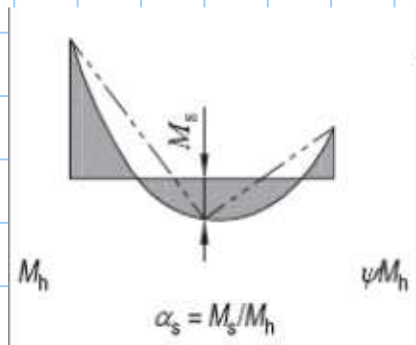


$$\alpha_s = \frac{M_s}{M_h}$$

$0 < \alpha_s < 1$

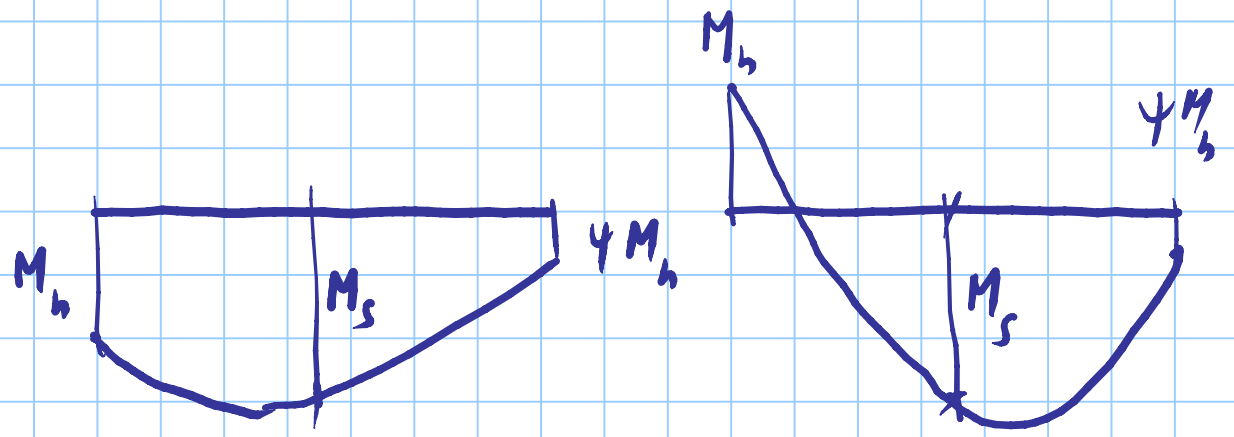
$\alpha_s < 0$

$-1 < \alpha_s < 0$



$0 \le \alpha_s \le 1$	$-1 \le \psi \le 1$	$0{,}2 + 0{,}8\ \alpha_s \ge 0{,}4$	$0{,}2 + 0{,}8\ \alpha_s \ge 0{,}4$
$-1 \le \alpha_s < 0$	$0 \le \psi \le 1$	$0{,}1 - 0{,}8\ \alpha_s \ge 0{,}4$	$-\ 0{,}8\ \alpha_s \ge 0{,}4$
	$-1 \le \psi < 0$	$0{,}1(1 - \psi) - 0{,}8\ \alpha_s \ge 0{,}4$	$0{,}2\ (-\psi) - 0{,}8\ \alpha_s \ge 0{,}4$

$$|M_s| > |M_h|$$

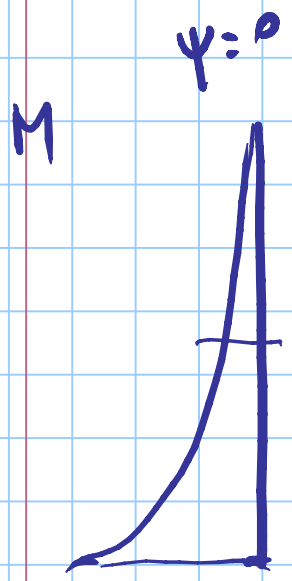


$$\alpha_h = \frac{M_h}{M_s}$$

$\alpha_h > 0$

$\alpha_h < 0$

 $\alpha_s = M_s/M_h$	$0 \le \alpha_h \le 1$	$-1 \le \psi \le 1$	$0{,}95 + 0{,}05\ \alpha_h$	$0{,}90 + 0{,}10\ \alpha_h$
	$-1 \le \alpha_h < 0$	$0 \le \psi \le 1$	$0{,}95 + 0{,}05\ \alpha_h$	$0{,}90 + 0{,}10\ \alpha_h$
		$-1 \le \psi < 0$	$0{,}95 + 0{,}05\ \alpha_h\ (1 + 2\ \psi)$	$0{,}90 + 0{,}10\ \alpha_h\ (1 + 2\ \psi)$



$M_s = \frac{1}{4}\frac{ql^2}{2}$

$M_h = \frac{ql^2}{2}$

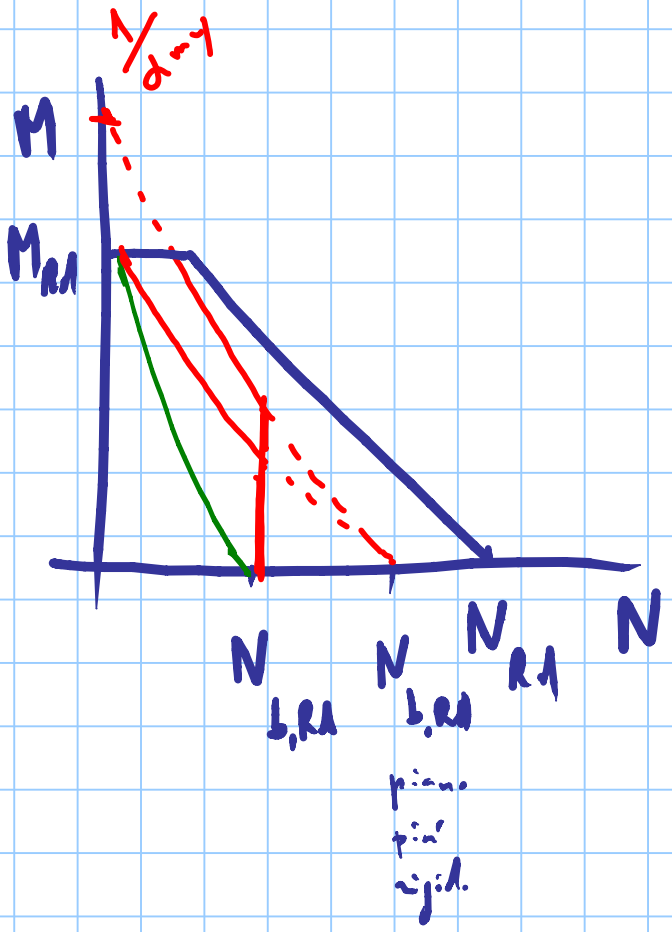
$M_s < M_h$

$\alpha_s = 0.25$

Diagramma del momento	Intervallo		Coefficienti α_{my}, α_{mz}, α_{mLT}	
			Carico uniforme	Carico concentrato
M_h … ψM_h	$-1 \le \psi \le 1$		$0,6+0,4\psi \ge 0,4$	
M_h … ψM_h, M_s; $\alpha_s = M_s/M_h$	$0 \le \alpha_s \le 1$	$-1 \le \psi \le 1$	$0,2+0,8\alpha_s \ge 0,4$	$0,2+0,8\alpha_s \ge 0,4$
	$-1 \le \alpha_s < 0$	$0 \le \psi \le 1$	$0,1-0,8\alpha_s \ge 0,4$	$-0,8\alpha_s \ge 0,4$
		$-1 \le \psi \le 0$	$0,1(1-\psi)-0,8\alpha_s \ge 0,4$	$0,2(-\psi)-0,8\alpha_s \ge 0,4$
M_h … ψM_h, M_s; $\alpha_h = M_h/M_s$	$0 \le \alpha_h \le 1$	$-1 \le \psi \le 1$	$0,95+0,05\alpha_h$	$0,90+0,10\alpha_h$
	$-1 \le \alpha_h < 0$	$0 \le \psi \le 1$	$0,95+0,05\alpha_h$	$0,90+0,10\alpha_h$
		$-1 \le \psi \le 0$	$0,95+0,05\alpha_h(1+2\psi)$	$0,90+0,10\alpha_h(1+2\psi)$

$\alpha_{my} = 0.2 + 0.8\,\alpha_s \ge 0.4$

$\alpha_{my} = 0.4$



$N = 0$

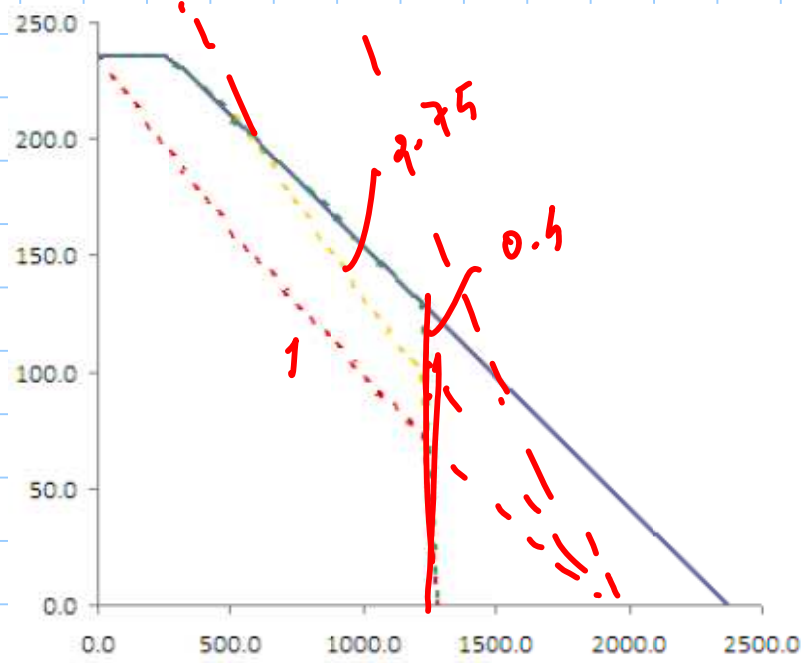
$$\frac{k_{yy} \overset{\alpha_{cr,y}}{\overbrace{\Uparrow}} M_{y,Ed}}{M_{y,Rd}} \leq 1$$

$$M_{y,Ed} \leq \frac{1}{\alpha_{cr,y}} M_{y,Rd}$$

$$\alpha_{cr,y} = 0.75$$

(B) $$\frac{N_{Ed}}{N_{y,b,Rd}} + \frac{k_{yy} M_{y,Ed}}{M_{y,Rd}} \leq 1$$

$$\frac{N_{Ed}}{N_{z,b,Rd}} \leq 1$$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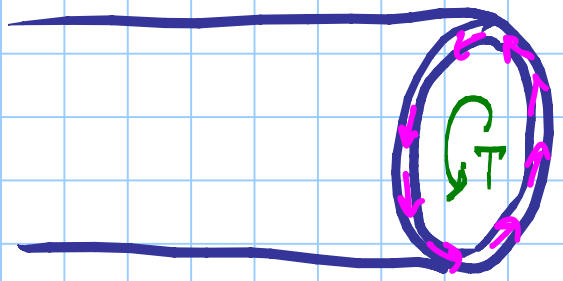
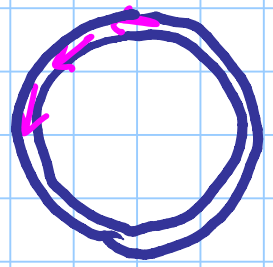
200.0
150.0
100.0
50.0
0.0
0.0
500.0
1000.0
1500.0
2000.0
2500.0
2.75
0.4
1

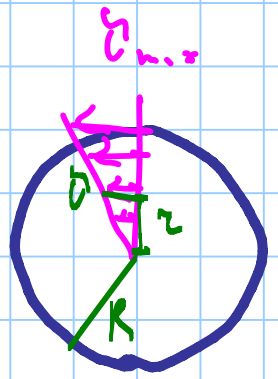
$N_{b,Rc}$

TORSIONE

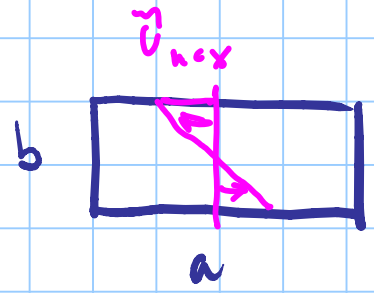




$$\tau_{cmt} = \frac{T\,r}{I_p}$$



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

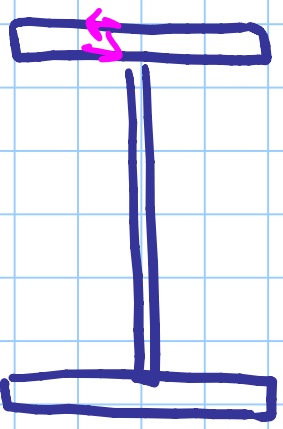


$$\tau = \psi \frac{T}{a b^2}$$

$a > b$

$$\tau = 3 \frac{T}{a t^2} = \frac{T t}{I_T}$$

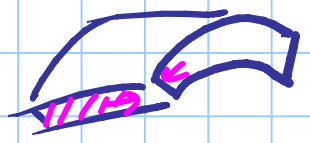
$a >> t$ $\quad \psi = 3$ $\quad I_T = \frac{1}{3} a t^3$



$$I_T = \frac{1}{3} \sum a_i t_i^3$$

$$\tau_{max} = \frac{T t}{I_T}$$

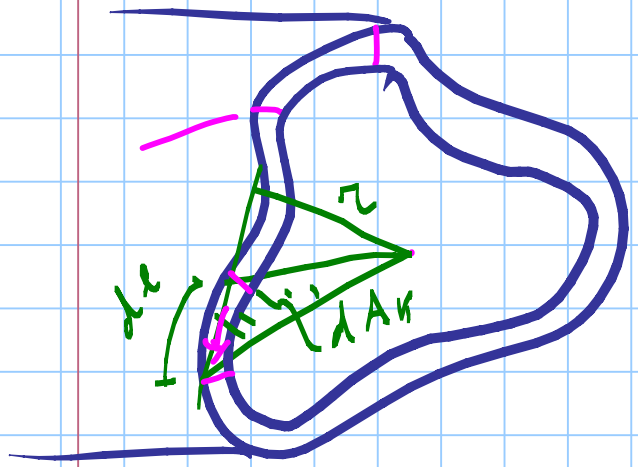
$F = \tau \cdot 1 \cdot t$



$\tau t = const$

BREDT

$$\tau = \frac{T}{2 t A_K}$$



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

$$\int \tau t \, 2AA_K$$

$$\tau t 2A_n = T$$

DE SAINT VENANT

Torsione

primaria

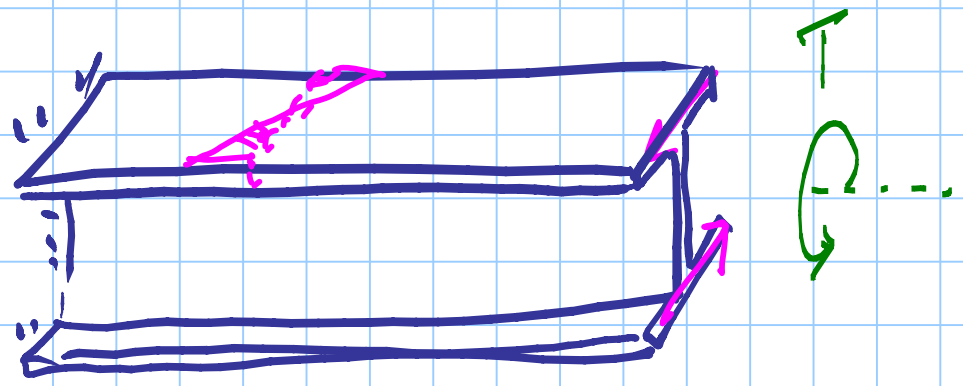
VLASOV

torsione per
elementi aperti molto sottili

secondaria

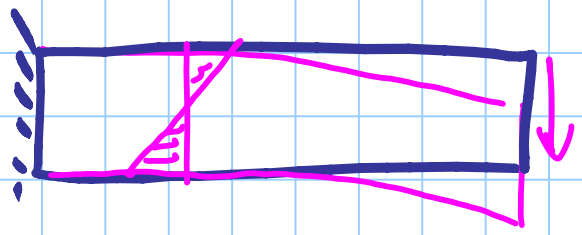
INCASTRO

c'è $M \rightarrow \sigma$



T

σ



nmd

M