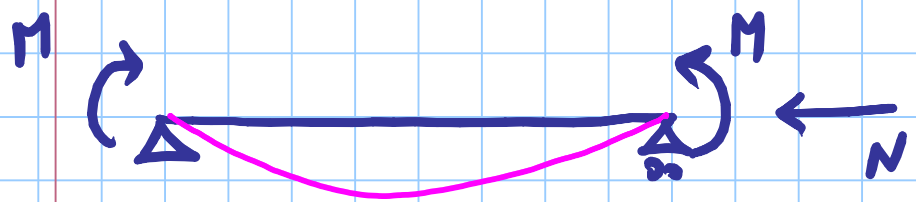
Titolo nota 03/12/2013



$$\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_{min}\cdot f_{yk}\cdot A}+\frac{M_{yeq,Ed}\cdot\gamma_{M1}}{f_{yk}\cdot W_y\cdot\left(1-\frac{N_{Ed}}{N_{cr,y}}\right)}+\frac{M_{zeq,Ed}\cdot\gamma_{M1}}{f_{yk}\cdot W_z\cdot\left(1-\frac{N_{Ed}}{N_{cr,z}}\right)}\leq 1$$

metodo A circolare

$\gamma_{M0} = \gamma_{M1}$

$$\chi_{min}\frac{f_y A}{\gamma_{M1}} = N_{b,Rd} \qquad \frac{f_y W_y}{\gamma_{M1}} = M_{y,Rd}$$

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

esempio IPE 160 (anche se non molto buone per presso-flessione)

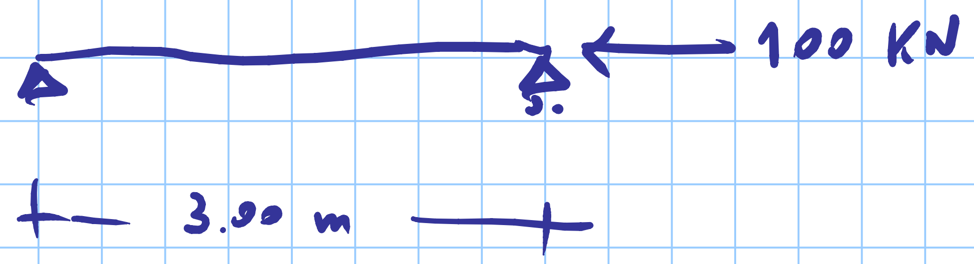
S 275

$A = 20.1 \times 10^2 \ mm^2$

$W_{pl,y} = 123.9 \times 10^3 \ mm^3$ $i_y = 65.8 \ mm$

$W_{pl,z} = 26.10 \times 10^3 \ mm^3$ $i_z = 18.4 \ mm$

$I_y = 869.3 \times 10^4 \ mm^4$



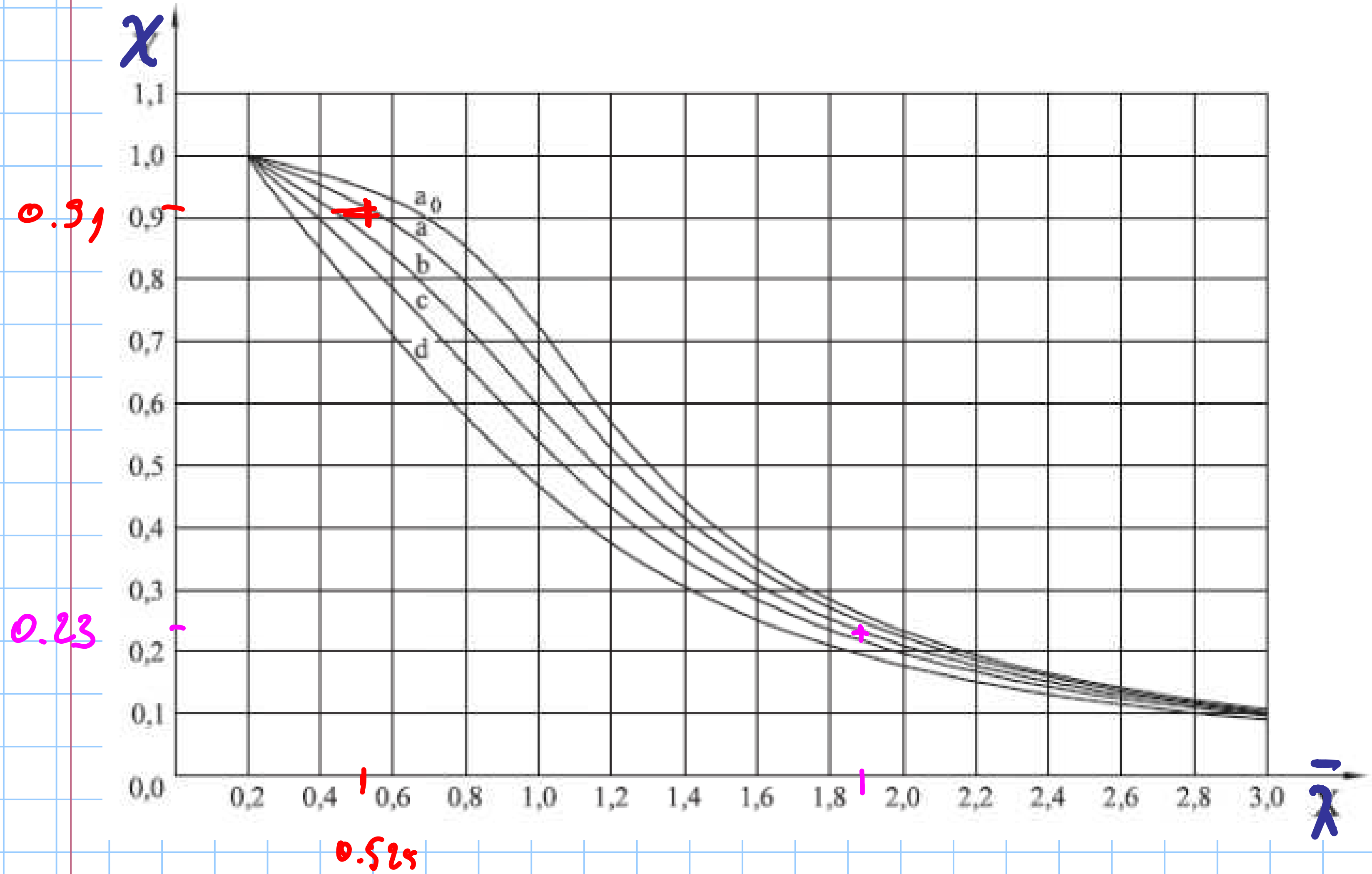
$$N_{Rd} = A \frac{f_y}{\gamma_{M0}} = 20.1 \times 10^2 \times \frac{275}{1.05} = 526.4 \text{ KN}$$

$$M_{y,Rd} = W_{pl,y} \frac{f_y}{\gamma_{M0}} = 123.9 \times 10^3 \times \frac{275}{1.05} = 32.45 \text{ KNm}$$

$$M_{z,Rd} = W_{pl,z} \frac{f_y}{\gamma_{M0}} = 26.1 \times 10^3 \times \frac{275}{1.05} = 6.84 \text{ KNm}$$

$$\lambda_y = \frac{3000}{65.8} = 45.6 \qquad \lambda_z = \frac{3000}{18.4} = 163.0$$

$$\lambda_1 = \pi \sqrt{\frac{E}{f_y}} = 86.8 \qquad \bar{\lambda} = \bar{\lambda}_z = 1.89 \quad \text{curve b}$$



χ
1,1
1,0
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
0.91
0.23
a_0
a
b
c
d
0,2
0,4
0,6
0,8
1,0
1,2
1,4
1,6
1,8
2,0
2,2
2,4
2,6
2,8
3,0
$\bar{\lambda}$
0.525

$N_{b,Rd} = 0.23\, N_{Rd} = 121.1$ KN

Verifica con $N_{Ed} = 100$ KN $\qquad M_{y,Ed} = 15$ KNm

$$N_{cr,y} = \frac{\pi^2 E I_y}{l_0^2} = \frac{3.14^2 \times 210\,000 \times 869.3 \times \cancel{10^4}}{3\cancel{000}^2} \times \cancel{10^{-3}} =$$

$= 2002$ KN

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

$$\underbrace{\frac{100.0}{121.1}}_{0.826} + \underbrace{\underbrace{\frac{15.0}{32.45}}_{0.462}\cdot\frac{1}{\underbrace{\left(1-\frac{100}{2002}\right)}_{0.95}}}_{0.486} \leq 1$$

$$1.312 \not\leq 1$$

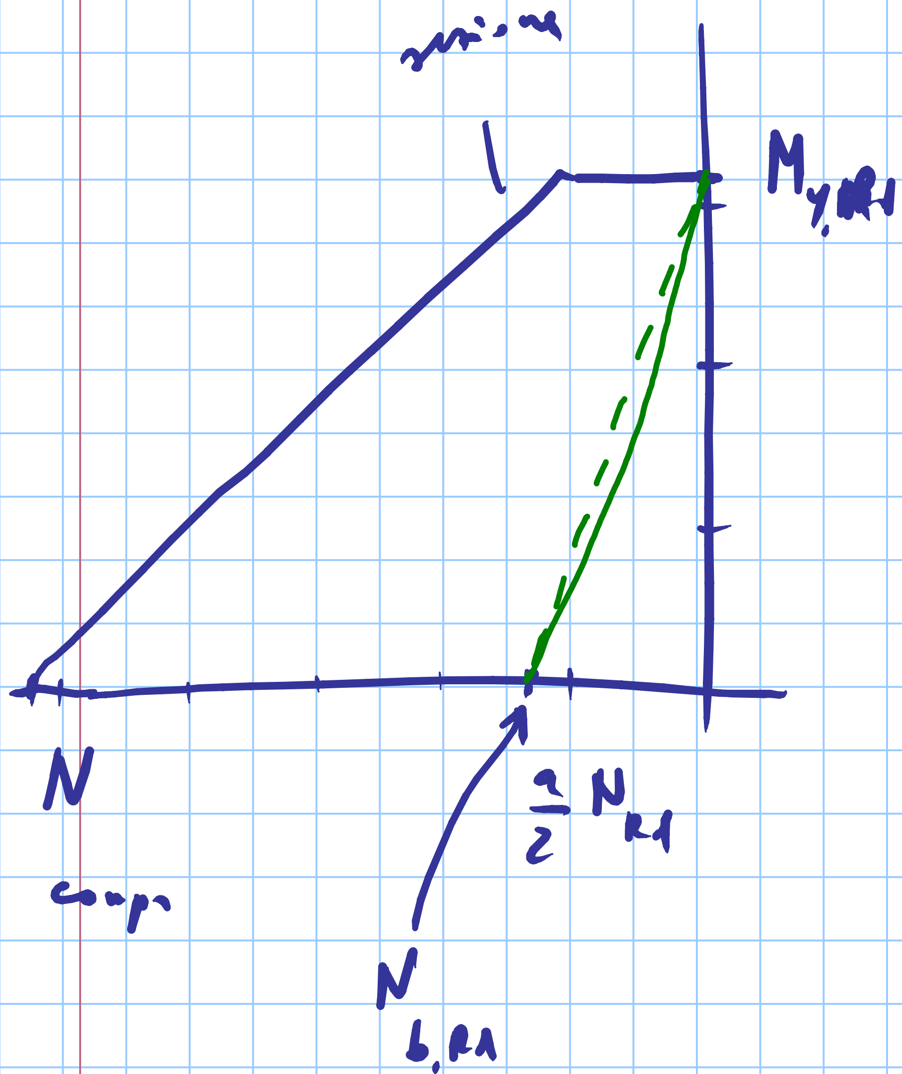
NON VERIFICATA

$$a = \frac{A - 2\,b\,t_f}{A} = \frac{2010 - 2 \times 82 \times 7.4}{2010} = 0.396$$

$b = 82\ mm$

$t_f = 7.4\ mm$

$A = 20.1 \times 10^2\ mm^2$



$M_{y,Rd}$
N
comp
$\frac{a}{2} N_{Rd}$
$N_{b,Rd}$

METODO B circolare ; EC3

$$\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_y\cdot A\cdot f_{yk}}+k_{yy}\cdot\frac{M_{y,Ed}\cdot\gamma_{M1}}{\chi_{LT}\cdot W_y\cdot f_{yk}}+k_{yz}\cdot\frac{M_{z,Ed}\cdot\gamma_{M1}}{W_z\cdot f_{yk}}\le 1$$

$$\frac{N_{Ed}\cdot\gamma_{M1}}{\chi_z\cdot A\cdot f_{yk}}+k_{zy}\cdot\frac{M_{y,Ed}\cdot\gamma_{M1}}{\chi_{LT}\cdot W_y\cdot f_{yk}}+k_{zz}\cdot\frac{M_{z,Ed}\cdot\gamma_{M1}}{W_z\cdot f_{yk}}\le 1$$

$$\frac{N_{Ed}}{N_{y,b,Rd}}+K_{yy}\frac{M_{y,Ed}}{M_{y,Rd}}+K_{yz}\frac{M_{z,Ed}}{M_{z,Rd}}\le 1$$

$$\frac{N_{Ed}}{N_{z,b,Rd}}+K_{zy}\frac{M_{y,Ed}}{M_{y,Rd}}+K_{zz}\frac{M_{z,Ed}}{M_{z,Rd}}\le 1$$

k	Tipi di sezione	Sezioni di classe 3 e 4 (proprietà delle sezioni calcolate in campo elastico)	[illegible] (proprietà delle sezioni calcolate in campo plastico)
k_{yy}	I, H, Sezioni cave	$\alpha_{my} \cdot \left(1+0,6 \cdot \bar{\lambda}_y \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right) \le \alpha_{my} \cdot \left(1+0,6 \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right)$	$\alpha_{my} \cdot \left(1+\left(\bar{\lambda}_y - 0,2\right) \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right) \le \alpha_{my} \cdot \left(1+0,8 \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right)$
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	$\alpha_{mz} \cdot \left(1+0,6 \cdot \bar{\lambda}_y \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right) \le \alpha_{mz} \cdot \left(1+0,6 \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right)$	$\alpha_{mz} \cdot \left(1+\left(2\bar{\lambda}_y - 0,6\right) \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right) \le \alpha_{mz} \cdot \left(1+1,4 \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right)$
	Sezioni cave		$\alpha_{mz} \cdot \left(1+\left(\bar{\lambda}_y - 0,2\right) \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right) \le \alpha_{mz} \cdot \left(1+0,8 \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right)$

Per pressoflessione retta, $M_{y,Ed} \neq 0$, $k_{zy} = 0$ ($M_{z,Ed}=0$).

consideriamo $M_{z,Ed} = 0$ $\Longrightarrow$ $K_{zy} = 0$

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

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

$$K_{yy} = \underbrace{\alpha_{my}}_{1 \text{ x } M = \text{cnt}} \cdot \left(1 + \left(\bar{\lambda}_y - 0,2\right) \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right) \leq \alpha_{my} \cdot \left(1 + 0,8 \cdot \frac{N_{Ed} \cdot \gamma_{M1}}{\chi_y \cdot A \cdot f_{yk}}\right)$$

$$K_{yy} = 1 + (\bar{\lambda}_y - 0.2) \frac{N_{Ed}}{N_{y,b,Rd}}$$

ma non maggiore di $1 + 0.8 \dfrac{N_{Ed}}{N_{y,b,Rd}}$

Nell'esempio di prima

$\lambda_y = 45.6 \qquad \bar{\lambda}_y = 0.525 \qquad \chi_y = 0.91$

$N_{y,b,Rd} = 0.91 \times 526.4 = 479.0 \ KN$

$N_{z,b,Rd} = 121.1 \ KN$

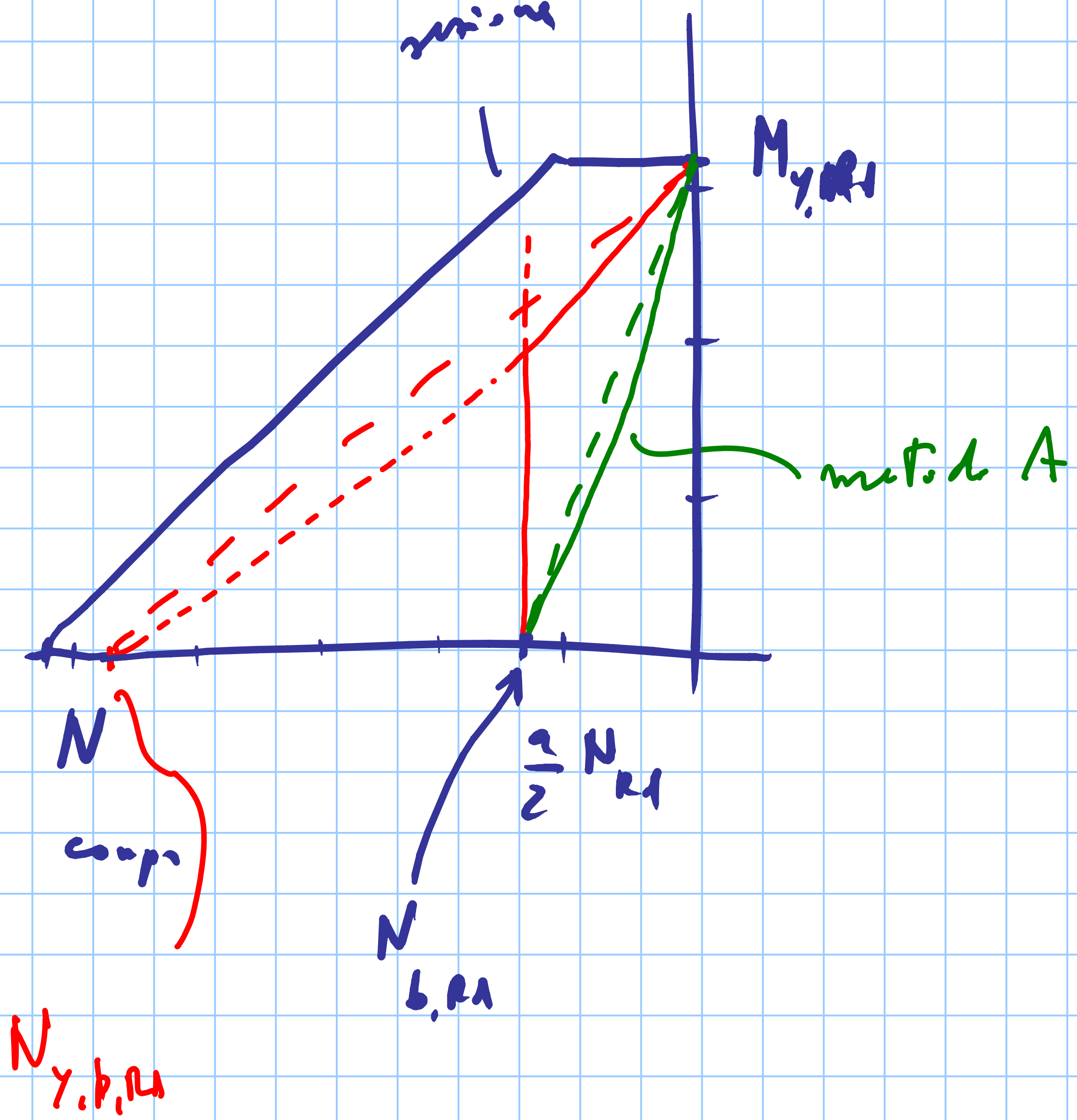
$$K_{yy} = 1 + (\bar{\lambda}_y - 0.2) \frac{N_{Ed}}{N_{y,b,Rd}} = 1 + (0.525 - 0.2) \frac{100.0}{479.0} =$$

$$= 1{,}068$$

Verifica

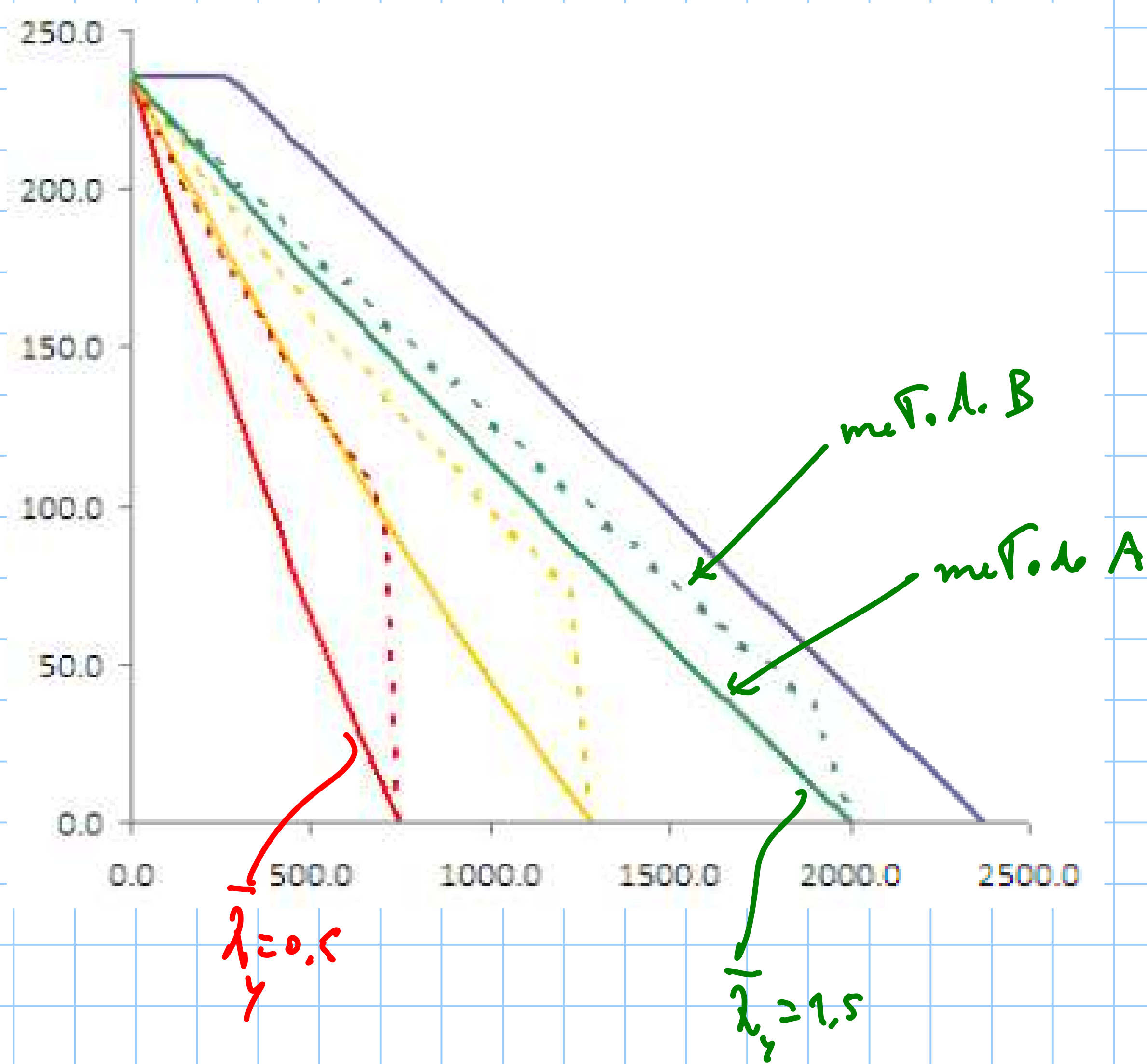
$$\frac{N_{Ed}}{N_{y,b,Rd}} + K_{yy} \frac{M_{y,Ed}}{M_{y,Rd}} \leq 1 \Rightarrow \overset{0.209}{\frac{100.0}{479.0}} + \underbrace{1.07 \overset{0.462}{\frac{15}{32.45}}}_{0.495} \leq 1 \quad \text{ok}$$

$$\frac{N_{Ed}}{N_{z,b,Rd}} \leq 1 \qquad \frac{100.0}{121.1} \leq 1$$

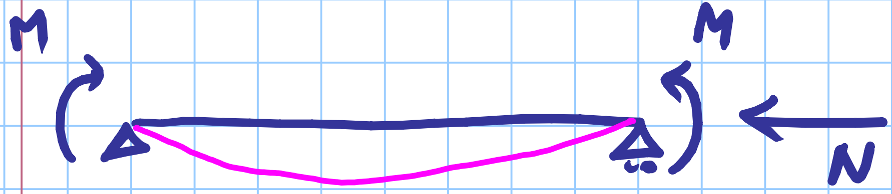


$M_{y,Rd}$
metodo A
N
compr
$\frac{a}{2} N_{Rd}$
$N_{b,Rd}$
$N_{y,b,Rd}$

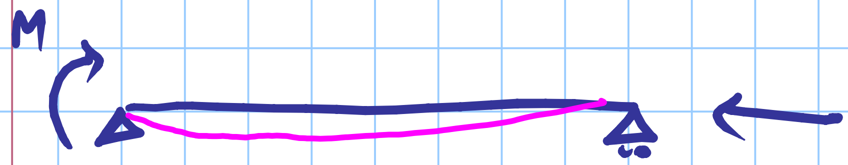
HE B 240

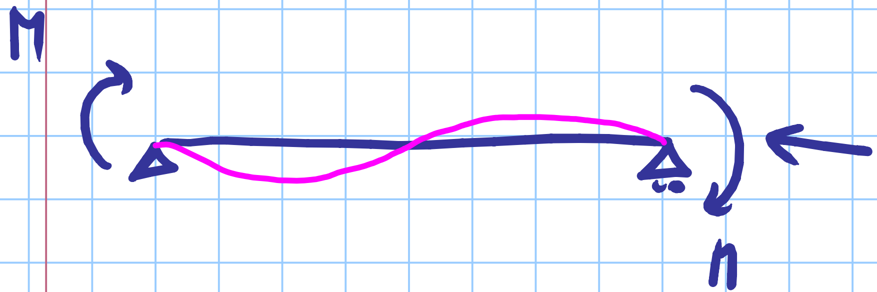


250.0
200.0
150.0
100.0
50.0
0.0
0.0
500.0
1000.0
1500.0
2000.0
2500.0
met. d. B
met. d. A
$\bar{\lambda}_y = 0,5$
$\bar{\lambda}_y = 1,5$



la deformata spinge verso l'instabilità





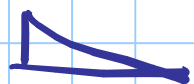
la deformata aiuta

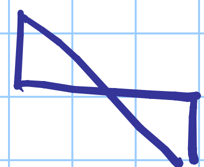
METODO A

$$M_{eq,Ed} = 0,6 \cdot M_a - 0,4 \cdot M_b \geq 0,4 \cdot M_a$$

$$|M_a| > |M_b|$$

$M_b = -M_A$  $M_{eq} = M_a$

$M_b = 0$  $M_{eq} = 0.6\ M_A$

$M_b = M_a$  $M_{eq} = 0.6\ M_a$

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

$$M_{eq,y,Ed} = \text{coeff.}\ M_{Ed}$$