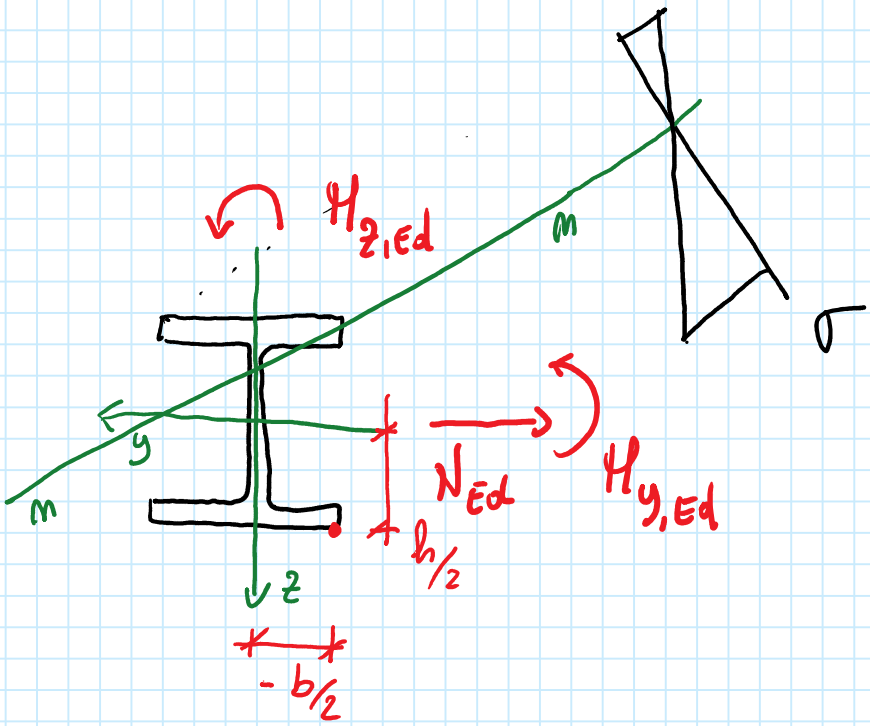
Flessione composta deviata

Sezioni di classe 3



Verifica in termini di tensione

$$\sigma = \frac{N_{Ed}}{A} + \frac{M_{y,Ed}}{I_y} z - \frac{M_{z,Ed}}{I_z} y$$

$$\sigma_{max} = \frac{N_{Ed}}{A} + \frac{M_{y,Ed}}{I_y}(h/2) + \frac{M_{z,Ed}}{I_z}(b/2) \leq f_y / \gamma_{M0}$$

$$\sigma_{max} = \frac{|N_{Ed}|}{A} + \frac{|M_{Ed,y}|}{W_{el,y}} + \frac{|M_{Ed,z}|}{W_{el,z}} \leq \frac{f_y}{\gamma_{M0}}$$

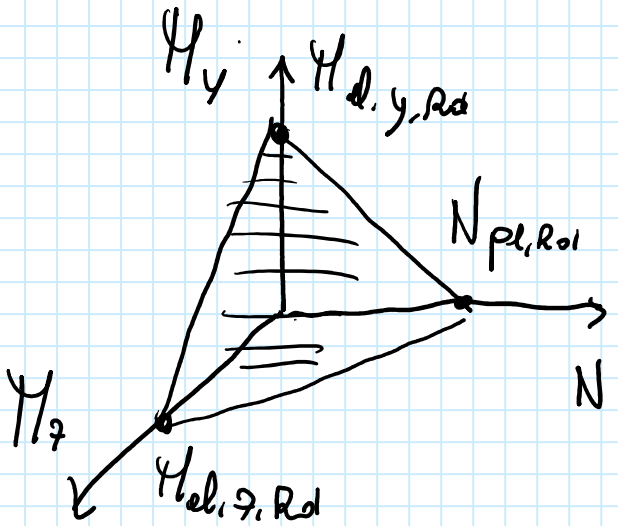
Dominio $M_y - M_z - N$

$$\frac{|N_{Ed}|}{A} + \frac{|M_{Ed,y}|}{W_{el,y}} + \frac{|M_{Ed,z}|}{W_{el,z}} \leq \frac{f_y}{\gamma_{M0}}$$

$$\frac{|N_{Ed}|}{A f_y/\gamma_{M0}} + \frac{|M_{Ed,y}|}{W_{el,y} f_y/\gamma_{M0}} + \frac{|M_{Ed,z}|}{W_{el,z} f_y/\gamma_{M0}} \leq 1$$

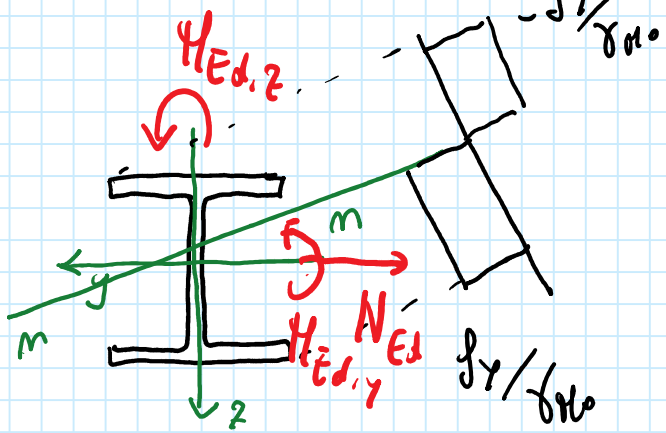
$N_{pl,Rd}$ $\quad$ $M_{el,y,Rd}$ $\quad$ $M_{el,z,Rd}$

$$\frac{|N_{Ed}|}{N_{pl,Rd}} + \frac{|M_{Ed,y}|}{M_{el,y,Rd}} + \frac{|M_{Ed,z}|}{M_{el,z,Rd}} \leq 1$$



Sezioni di classe 1 e 2

Si può costruire un dominio ma non è pieno... 3 punti non bastano

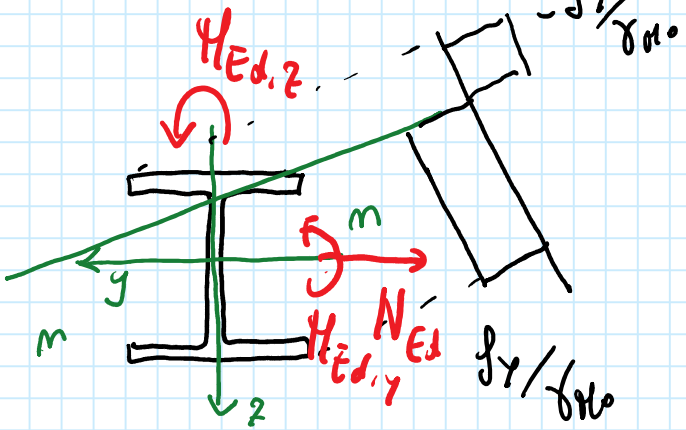


$$N_{Ed} = \int_A \sigma \, dA$$

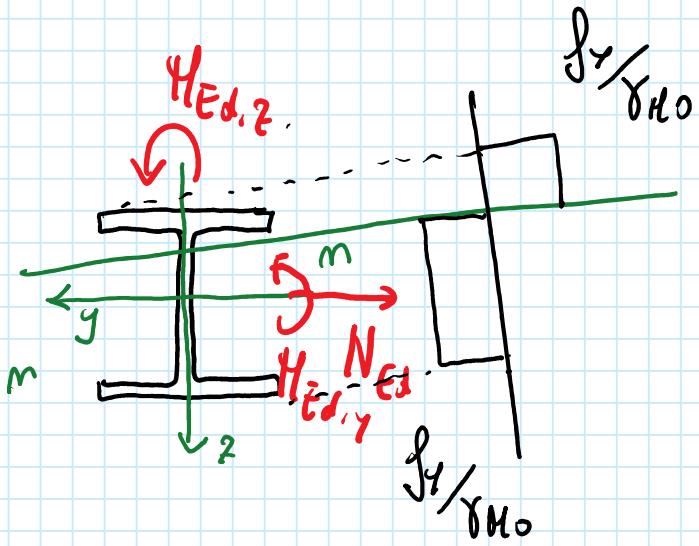
$$M_{Ed,y} = \int_A \sigma \, z \, dA$$

$$M_{Ed,z} = -\int_A \sigma \, y \, dA$$

$\Rightarrow$ Ottengo un punto del dominio. $(N_{Ed}, M_{Ed,y}, M_{Ed,z})$

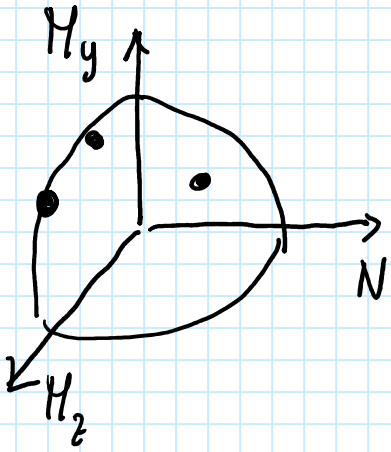


Faccio variare la posizione dell'asse neutro e ottengo altri punti.



Cambio l'inclinazione dell'asse neutro e ripeto il procedimento determinando una nuova serie di punti facendo variare la posizione dell'asse neutro.

Infine, collego i punti ottenuti ottenendo una superficie che definisce il dominio $M_y - M_z, N$.



La NTC18 e l'EC3 forniscono domini approssimati ma in forme analitiche

Dominio (analitico) delle NTC18 per sezioni a doppio T di classe 1 e 2

$$\left(\frac{|M_{y,Ed}|}{M_{pl,N,y,Rd}}\right)^2 + \left(\frac{|M_{z,Ed}|}{M_{pl,N,z,Rd}}\right)^{5n} \leq 1 \qquad n \geq 0,2$$

$$\frac{|M_{y,Ed}|}{M_{pl,N,y,Rd}} + \frac{|M_{z,Ed}|}{M_{pl,N,z,Rd}} \leq 1 \qquad n < 0,2$$

$$n = \frac{N_{Ed}}{N_{pl,Rd}}$$

Per sezioni diverse da quelle a doppio T

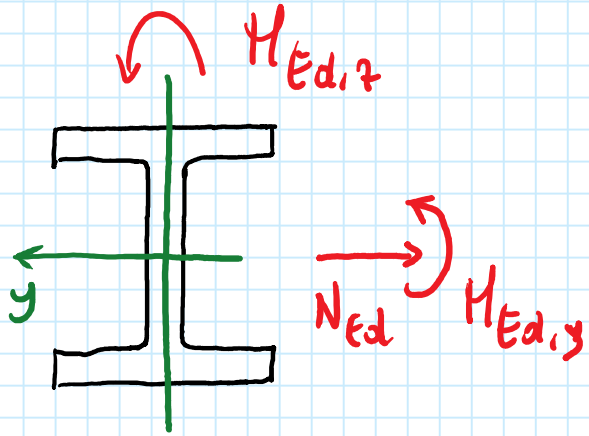
$$\frac{|M_{Ed,y}|}{M_{pl,N,y,Rd}} + \frac{|M_{Ed,z}|}{M_{pl,N,z,Rd}} \leq 1$$

indipendentemente dal valore di $n = \frac{N_{Ed}}{N_{pl,Rd}}$

Nel caso di flessione semplice deviata

$$\frac{|M_{Ed,y}|}{M_{pl,y,Rd}} + \frac{|M_{Ed,z}|}{M_{pl,z,Rd}} \leq 1$$

per qualunque tipo di sezione.



HEB 260

S 235

Classe 3

$N_{Ed} = 500\ KN$

$M_{Ed,y} = M_{Ed,z} = 50\ KNm$

$$\frac{|N_{Ed}|}{N_{pl,Rd}} + \frac{|M_{Ed,y}|}{M_{el,y,Rd}} + \frac{|M_{Ed,z}|}{M_{el,z,Rd}} \leq 1$$

$$N_{pl,Rd} = 1181{,}4 \times \frac{235}{1{,}05} \times \frac{1}{10} = 2649{,}9\ KN$$

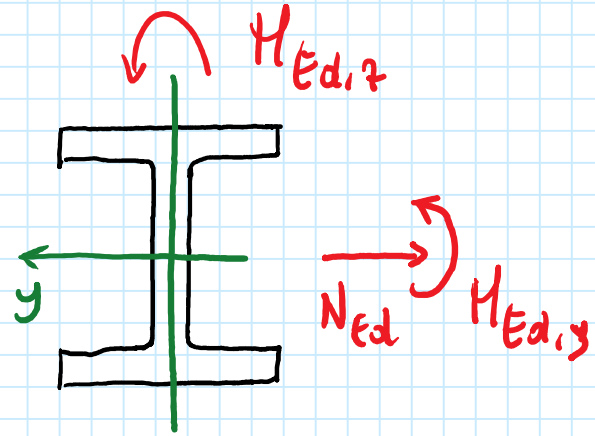
$$M_{el,y,Rd} = 1148 \times \frac{235}{1{,}05} \times \frac{1}{10^3} = 256{,}9\ KNm$$

$$M_{el,z,Rd} = 395 \times \frac{235}{1{,}05} \times \frac{1}{10^3} = 88{,}4\ KNm$$

$$\frac{500}{2649,9} + \frac{50}{256,9} + \frac{50}{88,4} \leq 1$$

OK!

$$0,1884 + 0,1946 + 0,5656 = 0,9489$$



HEB 260

S 235

Classe 1 o 2

$N_{Ed} = 500\ KN$

$M_{Ed,y} = M_{Ed,z} = 50\ KN/m$

1. Individuo le formule di verifica

$n : \frac{500}{2649,9} = 0,188 < 0,2$

$$\frac{M_{Ed,y}}{M_{pl,N,y,Rd}} + \frac{M_{Ed,z}}{M_{pl,N,z,Rd}} \leq 1$$

2. Calcolo $M_{pl,N,y,Rd}$

$n \leq 0,5\ a$

$$a = \frac{118,4 - 2 \times 260 \times 14,5/100}{118,4} = 0,234$$

$n = 0,188 < 0,5 \times 0,234 = 0,117$ NO

$$M_{pl,N,y,Rd} = M_{pl,y,Rd} \frac{1-n}{1-0,5a} = 283 \times \frac{235}{1,05} \times \frac{1-0,188}{1-0,117} \times \frac{1}{10^3}$$

$= 263,4\ KNm$

3. Calcolo $M_{pl,N,z,Rd}$

$n \leq a$

$n = 0,188 < 0,234$ SI

$$M_{pl,N,z,Rd} = M_{pl,z,Rd} = 602,2 \times \frac{235}{1,05} \times \frac{1}{10^3} = 134,8 \text{ kNm}$$

4. Eseguo le verifiche

$$\frac{M_{Ed,y}}{M_{pl,N,y,Rd}} + \frac{M_{Ed,z}}{M_{pl,N,z,Rd}} = \frac{50}{263,4} + \frac{50}{134,8} = 0,560 < 1$$

OK!