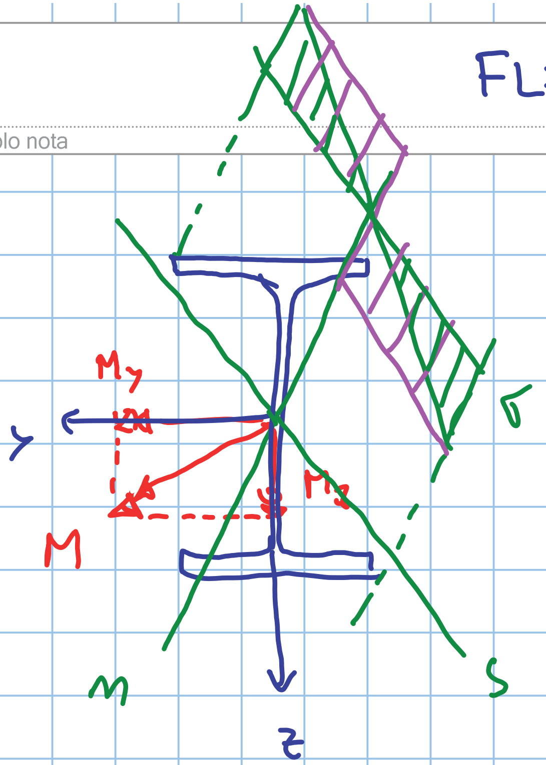
FLESSIONE SEMPLICE DEVIATA

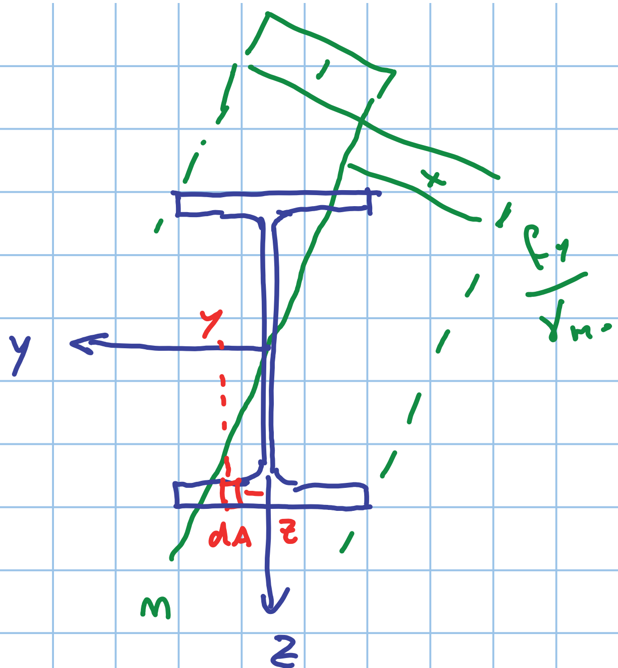


in generale n non è perpendicolare a s

MODELLO LINEARE → asse neutro baricentrico

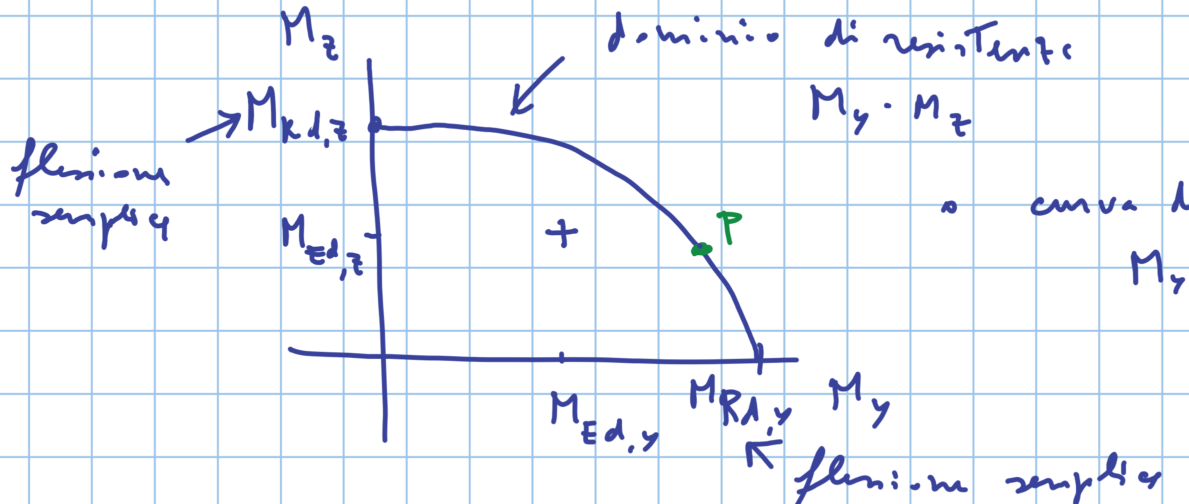
MODELLO ELASTICO - PERF. PLASTICO

→ asse neutro divide la sezione in due parti di area uguale



$$M_y = \int \sigma z \, dA = \frac{f_y}{\gamma_{M0}} \int_{tens} z \, dA - \frac{f_y}{\gamma_{M0}} \int_{comp} z \, dA$$

$$M_z = -\int \sigma y \, dA = -\frac{f_y}{\gamma_{M0}} \int_{tens} y \, dA + \frac{f_y}{\gamma_{M0}} \int_{comp} y \, dA$$



dominio di resistenza $M_y \cdot M_z$

o curva di interazione $M_y - M_z$

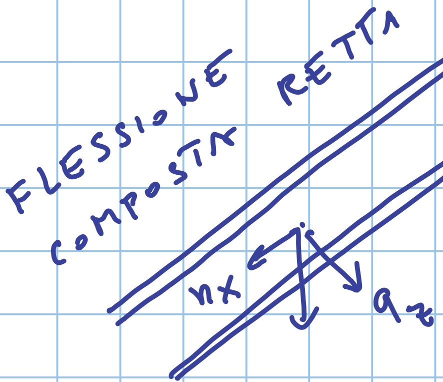
assegno un n

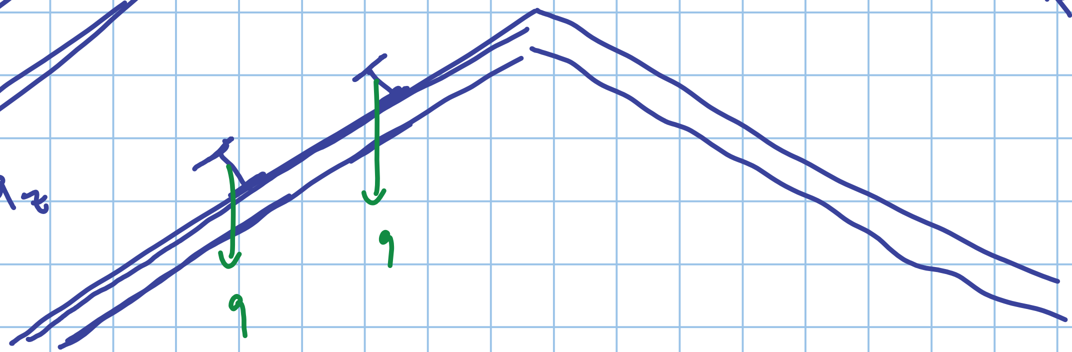
trovo un punto P

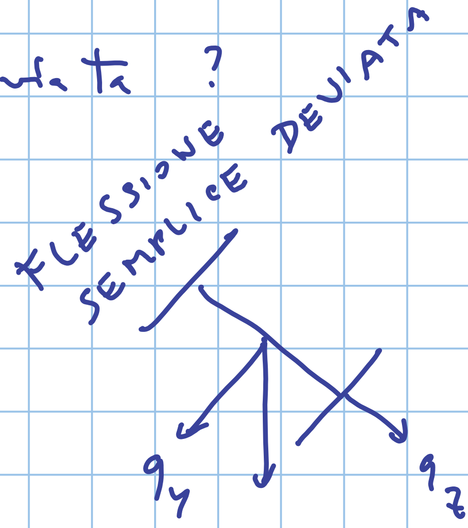
$M_{Rd,y} - M_{Rd,z}$

corrispondente

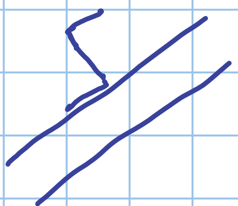
confronto tra momenti flettenti sollecitanti e resistenti quando abbiamo flessione semplice deviata ?





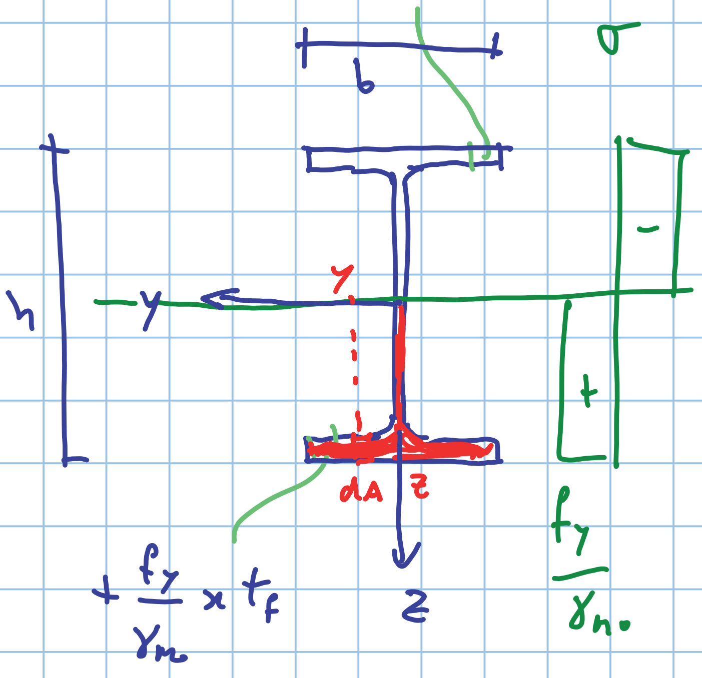


queste travi hanno un carico verticale non parallelo all'anima → flessione deviata

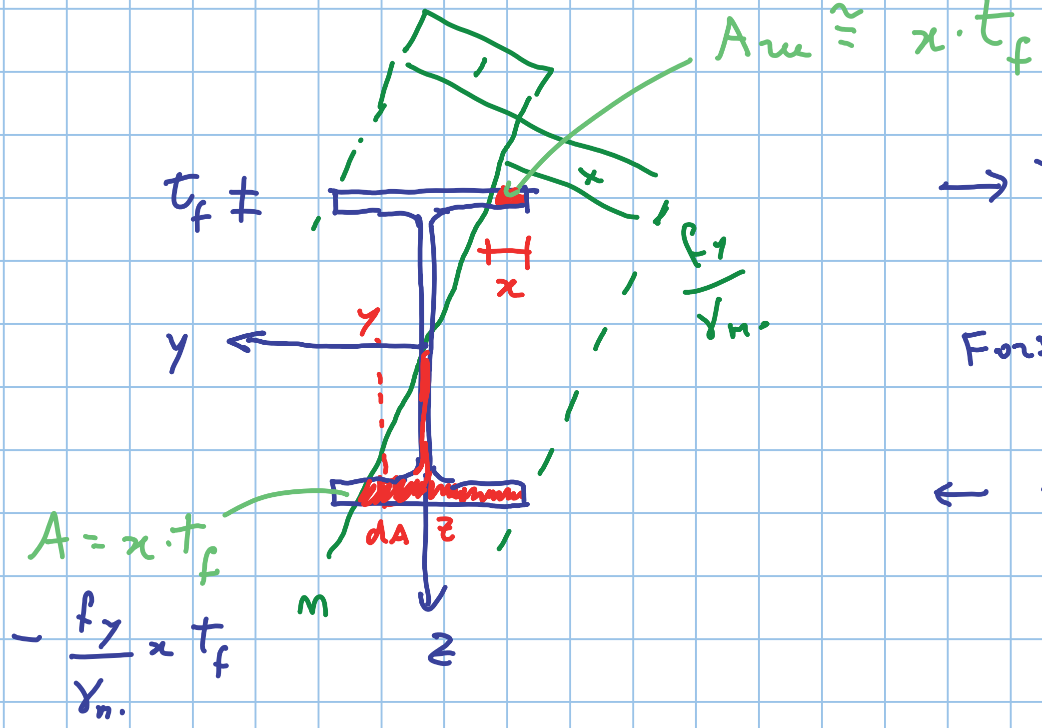


alternativa profilo a Z (piegato a freddo)

$$\int \sigma \, dA = -\frac{f_y}{\gamma_{M0}} \cdot x \cdot t_f$$



$$+\frac{f_y}{\gamma_{M0}} \cdot x \cdot T_f$$



$\rightarrow \; +2 \frac{f_y}{\gamma_{M0}} x \, t_f$

Forze $\perp$ al piano yz

$\leftarrow \; -2 \frac{f_y}{\gamma_{M0}} x \, t_f$

in rosso: parte tesa

$$M_y = M_{Rd,y}$$

$$M_z = 0$$

$$M_y = M_{Rd,y} - 2 \frac{f_y}{\gamma_{M0}} x \, t_f \, (h - t_f)$$

$$M_z = 0 + 2 \frac{f_y}{\gamma_{M0}} x \, t_f \, (b - x)$$

$$M_y = M_{Rd,y} - 2\frac{f_y}{\gamma_{M0}}\, x\, t_f\, (h - t_f)$$

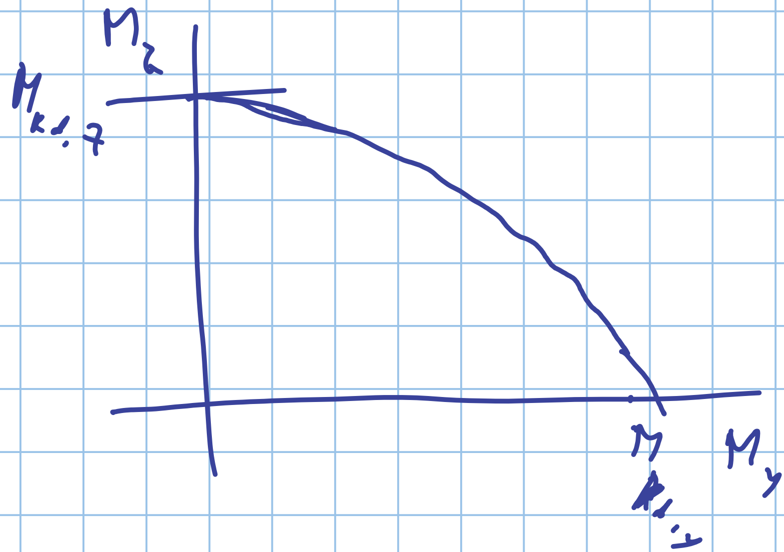
$$0 \le x \le \frac{b}{2}$$

$$M_z = 0 + 2\frac{f_y}{\gamma_{M0}}\, x\, t_f\, (b - x)$$

per $x = \frac{b}{2}$

$$M = 0$$

$$M_z = M_{Rd,z}$$



Normativa (classi 1 e 2)

$$\left(\frac{M_{y,Ed}}{M_{y,Rd}}\right)^2 + \left|\frac{M_{z,Ed}}{M_{z,Rd}}\right| \le 1$$

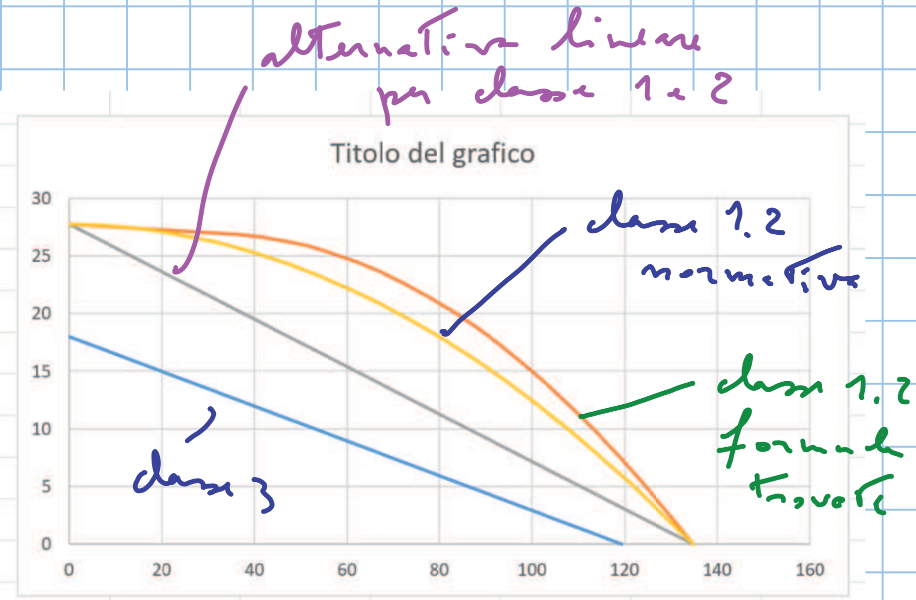
profilo di classe 3

modello lineare

$$\sigma = \frac{M_y}{I_y} z - \frac{M_z}{I_z} y$$

$$\sigma_{max} = \left| \frac{M_y}{W_{el,y}} \right| + \left| \frac{M_z}{W_{el,z}} \right| \leq \frac{f_y}{\gamma_{M0}}$$

$$\left| \frac{M_y}{M_{y,Rd}} \right| + \left| \frac{M_z}{M_{z,Rd}} \right| \leq 1$$

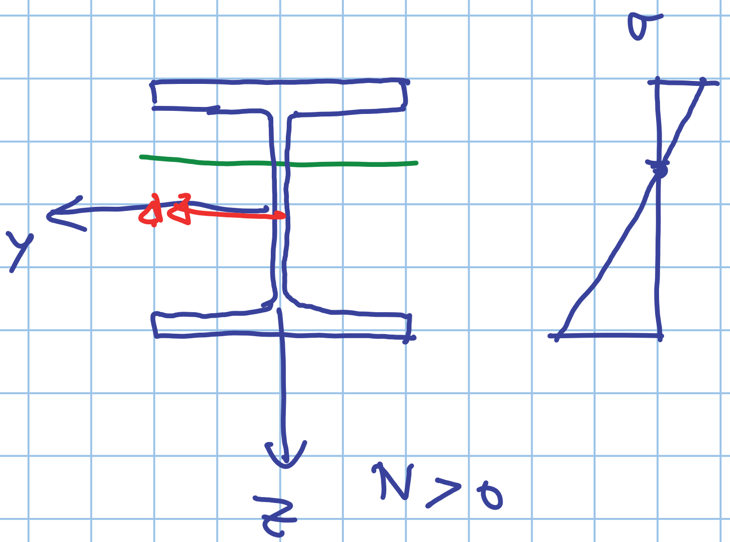


FLESSIONE COMPOSTA RETTA

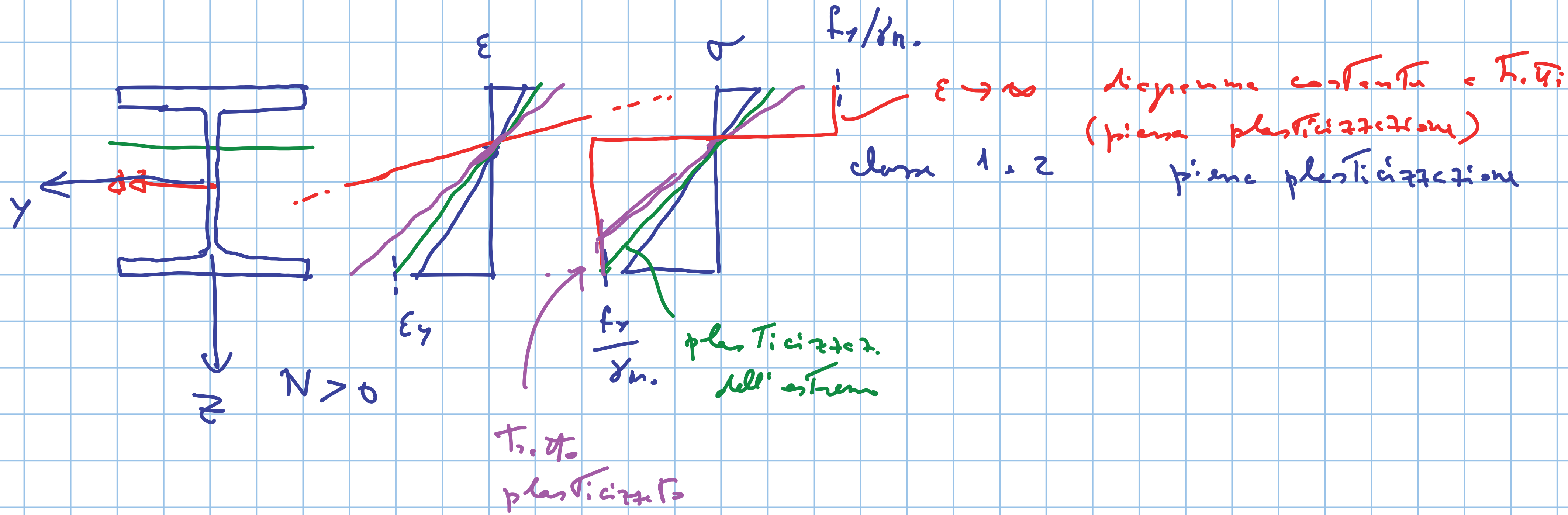
$$\sigma = \frac{N}{A} + \frac{M_y}{I_y} z$$

classe 3 $\qquad |\sigma_{max}| \le \frac{f_y}{\gamma_{M0}}$

classe 1, 2 $\qquad$ piena plasticizzazione



$N > 0$

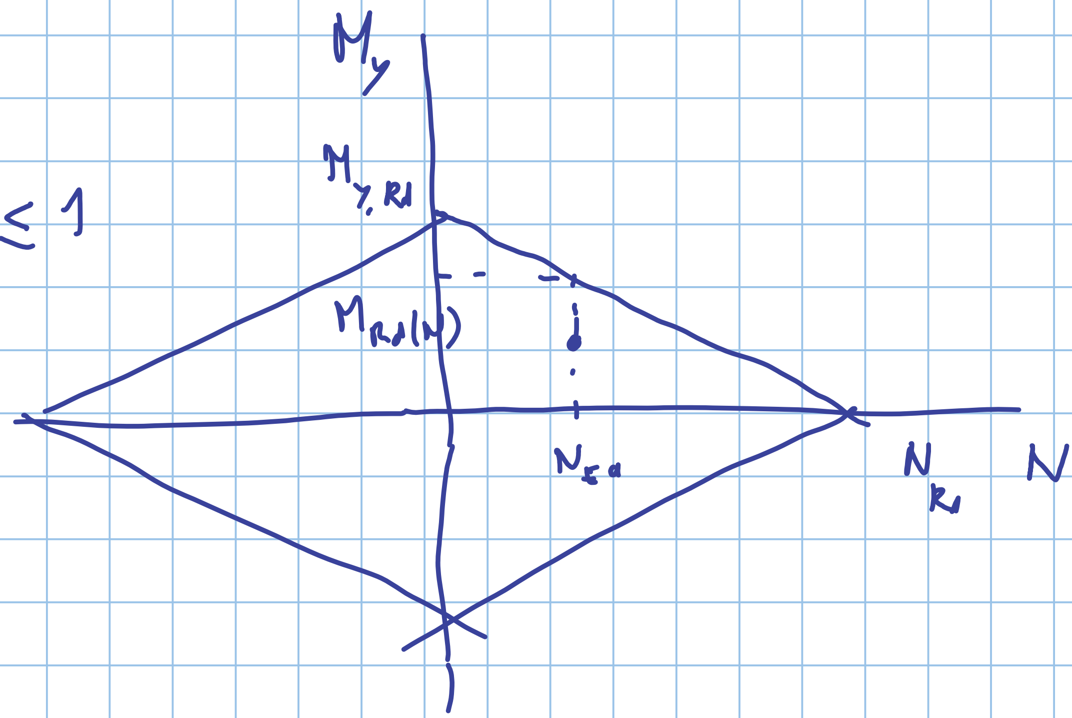


ε
σ
f_y/γ_{M_0}
y
z
$N > 0$
ε_y
$\frac{f_y}{\gamma_{M_0}}$
plasticizzaz. dell'estremo
tratto plasticizzato
$\varepsilon \to \infty$
diagramma costante a tratti
(piena plasticizzazione)
classe 1 e 2
piena plasticizzazione

classe 3 comportamento lineare

$$\sigma_{max} = \left| \frac{N}{A} \right| + \left| \frac{M_y}{W_y} \right| \leq \frac{f_y}{\gamma_{M0}}$$

$$\left| \frac{N_{Ed}}{N_{Rd}} \right| + \left| \frac{M_{y,Ed}}{M_{y,Rd}} \right| \leq 1$$



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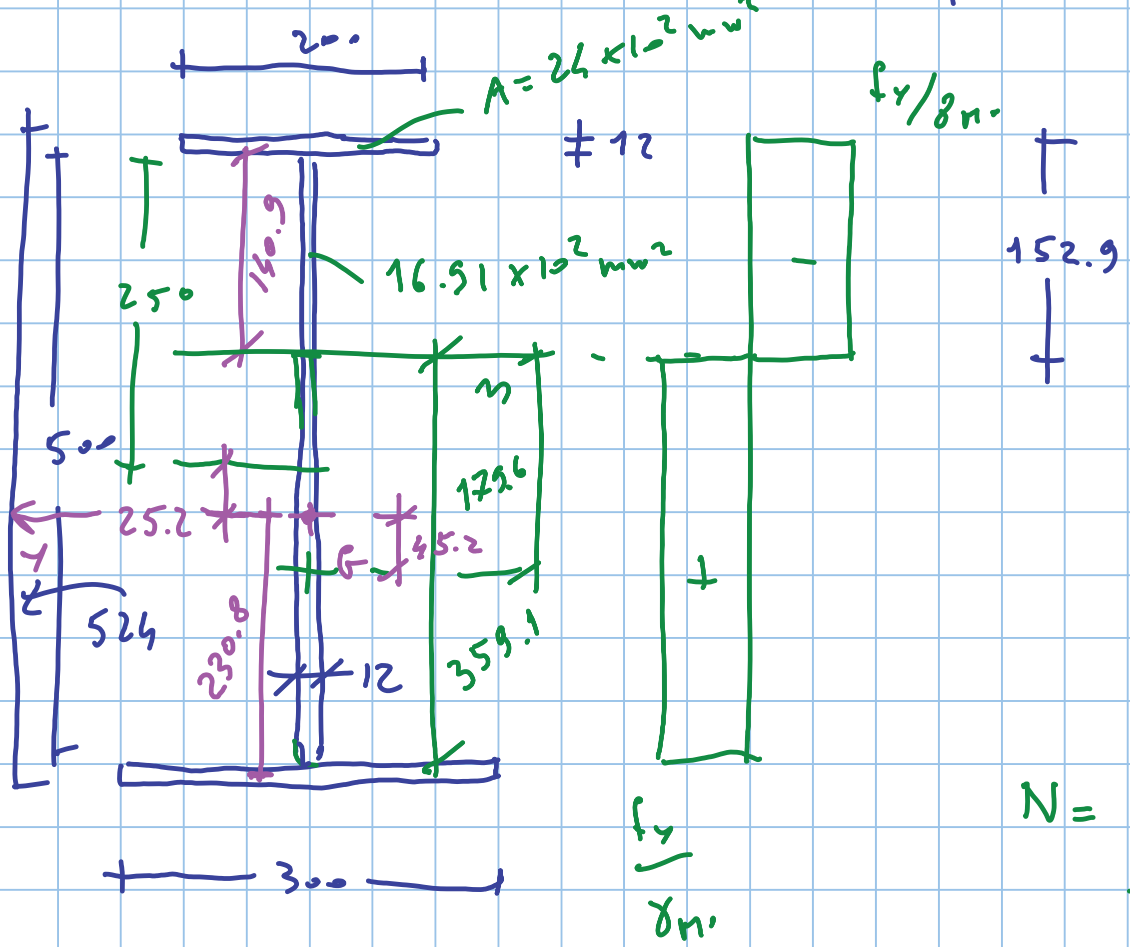
classe 1 e 2

piena plasticizzazione



$$N_{Ed} = 1000\ kN$$

$$M_{Ed} = 250\ kNm$$

considero $N = 1000\ kN$

e trovo il corrispondente $M_{Rd(N)}$

$$N = \int \sigma\, dA = \int_{ten} \sigma\, dA + \int_{comp} \sigma\, dA =$$

$$= \frac{f_y}{\gamma_{M0}} A_{ten} - \frac{f_y}{\gamma_{M0}} A_{comp}$$

$$N = (A_{ten} - A_{comp}) \frac{f_y}{\gamma_{M0}}$$

$$N = (A_{tens} - A_{comp}) \frac{f_y}{\gamma_{M0}}$$

$$\Delta A = A_{tens} - A_{comp} = \frac{N_{Ed}\,\gamma_{M0}}{f_y} = \frac{1000 \times 10^3 \times 1.05}{275} = 38.18 \times 10^2 \text{ mm}^2$$

$$A_{TOT} = 120 \times 10^2 \text{ mm}^2$$

$$A_{tens} = A_{comp} + \Delta A$$

$$A_{TOT} = A_{tens} + A_{comp} = 2A_{comp} + \Delta A$$

$$A_{comp} = \frac{A_{TOT} - \Delta A}{2} = \frac{120 - 38.18}{2} \times 10^2 = 40.91 \times 10^2 \text{ mm}^2$$

$$M_y = \int \sigma z \, dA = \int_{A_{Tens}} \sigma z \, dA + \int_{A_{compr}} \sigma z \, dA = \frac{f_y}{\gamma_{M0}} \int_{A_{Tens}} z \, dA - \frac{f_y}{\gamma_{M0}} \int_{A_{com}} z \, dA =$$

$$= \left(S_{A_{tens}} - S_{A_{com}} \right) \frac{f_y}{\gamma_{M0}} = 2 \, S_{A_{tens}} \frac{f_y}{\gamma_{M0}}$$

$$S_{A_{tens}} + S_{A_c} = S_A = 0$$

$$M_{y,Rd} = 2 \times 1025.7 \times 10^3 \times \frac{275}{1.05} \times 10^{-6} = 537.3 \ \text{KNm}$$

$$S_{A_{com}} = - S_{A_{tens}}$$

$$S_{A_t} = \underbrace{300 \times 12}_{\text{Ala inf}} \times 230.8 + \underbrace{359.1 \times 12}_{\text{parte di anima tesa}} \times 45.2 = 1025.7 \times 10^3 \ \text{mm}^3$$