$$\begin{cases} b := 300\ \text{mm} \\ h := 300\ \text{mm} \end{cases}$$

+ le trazioni

$$N_{Ed} := (-400)\ \text{kN}$$

$$\begin{bmatrix} A_s := \begin{bmatrix} A_{arm}([\text{"3Φ16"}]) \\ A_{arm}([\text{"2Φ16"}]) \\ A_{arm}([\text{"3Φ16"}]) \end{bmatrix} & c := \begin{bmatrix} 40 \\ 150 \\ 260 \end{bmatrix} \text{mm} \end{bmatrix}$$

$$\begin{cases} \gamma_c := 1,5 \\ \gamma_s := 1,15 \end{cases}$$

$$\begin{cases} f_{ck} := 25\ \text{MPa} \\ \alpha_{cc} := 0,85 \\ \varepsilon_{cu} := -0,0035 \\ \varepsilon_{c2} := -0,002 \end{cases}$$

$$\begin{cases} f_{yk} := 450\ \text{MPa} \\ E_s := 206\ \text{GPa} \\ \varepsilon_{su} := 0,0675 \end{cases}$$

$$f_{cd} := \frac{\alpha_{cc} \cdot f_{ck}}{\gamma_c} = 14,17\ \text{MPa} \qquad f_{yd} := \frac{f_{yk}}{\gamma_s} = 391,3\ \text{MPa} \qquad \varepsilon_{sy} := \frac{f_{yd}}{E_s} = 0,0019$$

$$\sigma_s(\varepsilon\#) := \begin{cases} E_s \cdot \varepsilon\# & \text{if} \quad |\varepsilon\#| < \varepsilon_{sy} \\ \text{sign}(\varepsilon\#) \cdot f_{yd} & \text{otherwise} \end{cases}$$

$$\chi_{max,stimato} := 2 \cdot \frac{f_{yd}}{E_s \cdot (\max(c) - \min(c))} = 0,0173 \cdot \frac{1}{\text{m}}$$

$$n := 20$$

$$\Delta := \frac{\chi_{max,stimato}}{n}$$

$$\sigma_c(\varepsilon\#) := \begin{cases} (-f_{cd}) \cdot \left(2 \cdot \frac{\varepsilon\#}{\varepsilon_{c2}} - \left(\frac{\varepsilon\#}{\varepsilon_{c2}}\right)^2\right) & \text{if} \quad (\varepsilon\# > \varepsilon_{c2}) \wedge (\varepsilon\# \le 0) \\ -f_{cd} & \text{if} \quad \varepsilon\# \le \varepsilon_{c2} \\ 0 & \text{otherwise} \end{cases}$$

deformazione in ordinata y per curvatura χ

$$\varepsilon(\chi\#; y\#) := \chi\# \cdot y\#$$

equilibrio traslazione

$$f(x) := \left(b\ \text{mm} \cdot \int_0^{\frac{x}{\text{mm}}} \sigma_c(\varepsilon(-\chi; y\ \text{mm}))\, \text{d}y\right) - (x > h) \cdot \left(b\ \text{mm} \cdot \int_0^{\frac{x-h}{\text{mm}}} \sigma_c(\varepsilon(-\chi; y\ \text{mm}))\, \text{d}y\right) + \sum_{k=1}^{\text{rows}(A_s)} A_{s_k} \cdot \sigma_s\left(\varepsilon\left(\chi; c_k - x\right)\right) - N_{Ed}$$

equilibrio rotazione

$$M_R := \left((-b)\ \text{mm} \cdot \int_0^{\frac{x_n}{\text{mm}}} \sigma_c(\varepsilon(-\chi; y\ \text{mm})) \cdot \left(y\ \text{mm} + \frac{h}{2} - x_n\right) \text{d}y - (x_n > h) \cdot \left((-b)\ \text{mm} \cdot \int_0^{\frac{x_n-h}{\text{mm}}} \sigma_c(\varepsilon(-\chi; y\ \text{mm})) \cdot \left(y\ \text{mm} + \frac{h}{2} - x_n\right) \text{d}y\right)\right) - \sum_{k=1}^{\text{rows}(A_s)} A_{s_k} \cdot \sigma_s\left(\varepsilon\left(\chi; c_k - x_n\right)\right) \cdot \left(\frac{h}{2} - c_k\right)$$

$t_0 := \text{time}(0)$

$flag := 0$
$j := 0$
while $flag = 0$
  $j := j + 1$
  if $j = 1$
    $\chi_{a_j} := \Delta$
  else
    $\chi_{a_j} := \chi_{a_{j-1}} + \Delta$
  $\chi := \chi_{a_j}$
  $Part := \text{if } j = 1$
    $10 \cdot h$
  else
    $1{,}1 \cdot X_{neutro_{j-1}}$
  $x_n := \text{solve}\left(\frac{f(x \text{ mm})}{\text{N}}; x; 10^{-4}; \frac{Part}{\text{mm}}\right) \text{mm}$
  $NN_j := f(x_n)$
  if $|NN_j| > 0{,}1 \text{ N}$
    $Msg1 := \text{concat}(\text{"fallita all'iterazione "}; \text{num2str}(j))$
  else
    $Msg1 := \text{concat}(\text{"verificata all'iterazione "}; \text{num2str}(j))$
  $M_{Rd_j} := M_R$
  $X_{neutro_j} := x_n$
  $\varepsilon_{c_j} := -\chi \cdot x_n$
  $\varepsilon_{s2_j} := \chi \cdot (\min(c) - x_n)$
  $\varepsilon_{s1_j} := \chi \cdot (\max(c) - x_n)$
  if $\varepsilon_{c_j} \le \varepsilon_{cu}$
    $Msg2 := \text{"rottura lato calcestruzzo"}$
    $flag := 1$
  else
    $Msg2 := \text{"calcestruzzo integro"}$
  if $\varepsilon_{s1_j} \ge \varepsilon_{su}$
    $Msg3 := \text{"rottura lato acciaio teso"}$
    $flag := 1$
  else
    $Msg3 := \text{"acciaio integro"}$

$\text{time}(0) - t_0 = 226{,}6 \text{ s}$

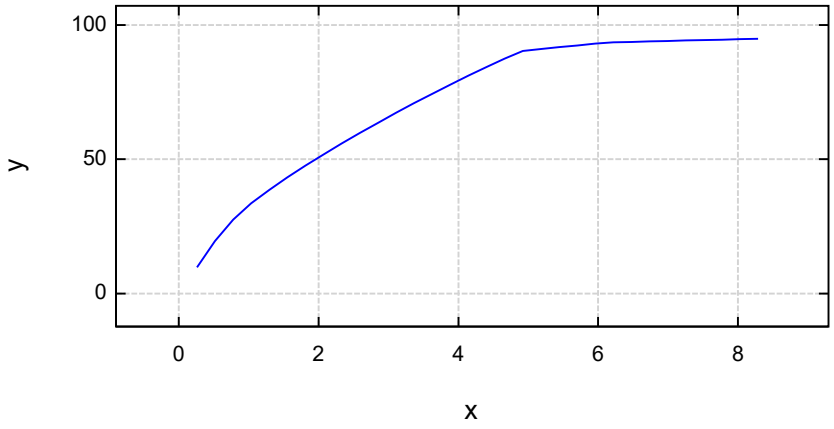
$Msg1 = \text{"verificata all'iterazione 32"}$

$Msg2 = \text{"rottura lato calcestruzzo"}$

$Msg3 = \text{"acciaio integro"}$

$M_{Rd_j} = 94,8616 \text{ kN m}$

$\chi_{a_j} = 0,0276 \cdot \frac{1}{\text{m}}$



Pilastro P01 (Diagramma Momento-Curavatura)

$N_d = -400\,kN$

$b = 300\,mm \qquad h = 300\,mm$

$\begin{pmatrix} A_s\,[mm^2] \\ pos.\ arm.\,[mm] \end{pmatrix} = \begin{pmatrix} 603 & 402 & 603 \\ 40 & 150 & 260 \end{pmatrix}$

$R_{ck} = 30\,MPa \qquad \gamma_c = 1.5 \qquad \varepsilon_{c0} \times 1000 = -2 \qquad \varepsilon_{cu} \times 1000 = -3.5$

$f_{yk} = 450\,MPa \qquad \gamma_s = 1.15 \qquad \varepsilon_{su} \times 1000 = 67.5 \qquad E_s = 206\,GPa$

primo snervamento relativo al calcestruzzo

rottura lato calcestruzzzo

$(1/r)_y = 1.3622 \times 10^{-5}\,rad/mm \qquad (1/r)_u = 2.7025 \times 10^{-5}\,rad/mm \qquad M_u = 94.161\,kN \cdot m$

$(1/r)_{y,effet} = 1.6054 \times 10^{-5}\,rad/mm \qquad M_{y,effet} = 80.286\,kN \cdot m \qquad \mu_{1/r} = 1.6834$