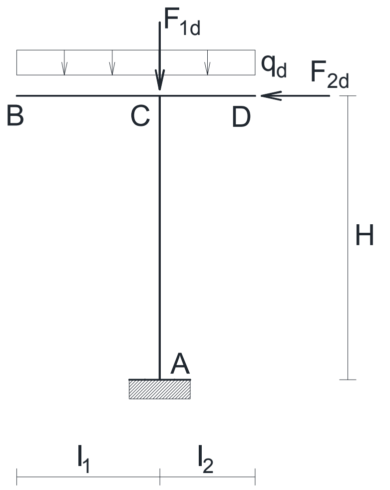
Acciaio: flessione, taglio e instabilità dell'equilibrio



Data la struttura rappresentata in figura, avente le seguenti dimensioni:

$l_1 := 1.5 \cdot m \quad l_2 := 1 \cdot m \quad H := 2.8 \cdot m$

e soggetta ai seguenti carichi:

distribuito $q_d := 90 \cdot \frac{kN}{m}$

concentrato $F_{1d} := 75 \cdot kN$

concentrato $F_{2d} := 35 \cdot kN$

è realizzata in acciaio con acciaio $f_{yk} := 420 \cdot MPa$

Verificare il pilastro AC rispetto agli effetti dell'instabilità dell'equilibrio.

$\gamma_{M0} := 1.05 \qquad f_{yd} := \frac{f_{yk}}{\gamma_{M0}} = 400 \cdot MPa$

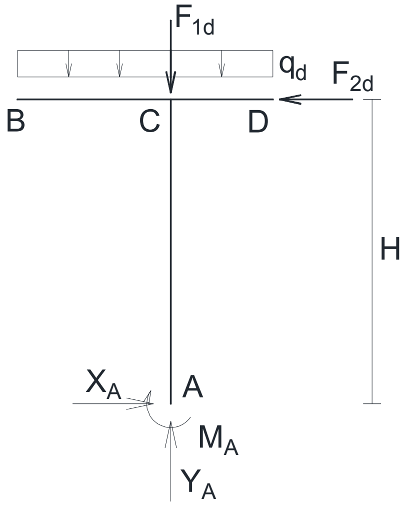
$E_s := 200000 \cdot MPa \qquad$ Pilastro AC : HEB 140

Calcolo delle reazioni vincolari e delle sollecitazioni

$X_A := F_{2d} \qquad X_A = 35 \cdot kN$

$Y_A := \left[q_d \cdot (l_1 + l_2)\right] + F_{1d} \qquad Y_A = 300 \cdot kN$

$M_A := q_d \cdot (l_1 + l_2) \cdot \left[l_1 - \frac{(l_1 + l_2)}{2}\right] + F_{2d} \cdot H \qquad M_A = 154.25 \cdot kN \cdot m$



Sforzo normale:

$N_{AC} := -Y_A$ $\qquad N_{AC} = -300 \cdot kN$

$N_{BC} := 0$

$N_{CD} := -F_{2d}$ $\qquad N_{CD} = -35 \cdot kN$

Taglio:

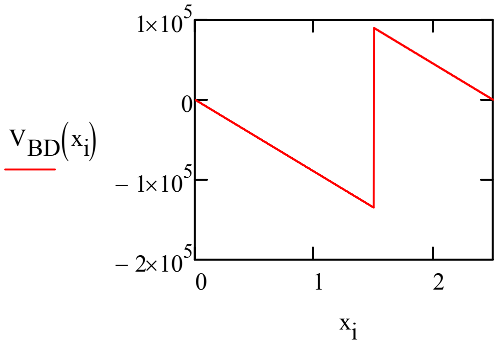
$V_{AC} := -X_A$ $\qquad V_{AC} = -35 \cdot kN$

$V_{BD}(x) := \mathrm{if}\left(x < l_1, -q_d \cdot x, Y_A - F_{1d} - q_d \cdot x\right)$

$V_B := V_{BD}(0) = 0 \cdot kN$ $\qquad V_{Cs} := V_{BD}\left(l_1 \cdot 0.9999999\right) = -135 \cdot kN$

$V_{Cd} := V_{BD}\left(l_1 \cdot 1.0000001\right) = 90 \cdot kN$ $\qquad V_D := V_{BD}\left(l_1 + l_2\right) = 0 \cdot kN$

$i := 0..500 \qquad x_i := \frac{\left(l_1 + l_2\right)}{500} \cdot i$



Momento flettente:

$M_{AC}(y) := M_A - X_A \cdot y$

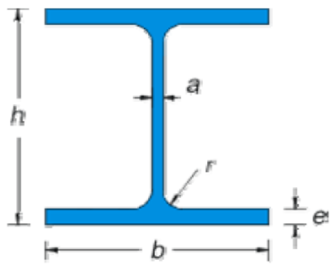
$M_{AC}(0) = 154.25 \cdot kN \cdot m$ $\qquad$ $M_{AC}(H) = 56.25 \cdot kN \cdot m$

$$M_{BD}(x) := \text{if}\left[x \le l_1, -q_d \cdot \frac{x^2}{2}, M_{BD}(l_1) + M_{AC}(H) + V_{Cd} \cdot (x - l_1) - q_d \cdot \frac{(x - l_1)^2}{2}\right]$$

$M_{BD}(0) = 0 \cdot kN \cdot m$ $\quad M_C := M_{BD}(l_1) = -101.25 \cdot kN \cdot m$ $\quad M_D := M_{BD}(l_1 + l_2) = -1.35 \times 10^{-5} \cdot kN \cdot$ı

$M_{Cdx} := M_{BD}(l_1 \cdot 1.00000001) = -45 \cdot kN \cdot m$

Progetto e verifica del pilastro



Download
profilati_heb.dwq

Sigla HEB	b mm	h mm	a mm	e mm	r mm	Peso kg/m	Sezione cm2	Momenti di inerzia		Moduli di resistenza		Raggi di inerzia	
								Jx cm4	Jy cm4	Wx cm3	Wy cm3	ix cm	iy cm
100	100	100	6,0	10,0	12	20,4	26,04	449,5	167,3	89,91	33,45	4,16	2,53
120	120	120	6,5	11,0	12	26,7	34,01	864,4	317,5	144,1	52,92	5,04	3,06
140	140	140	7,0	12,0	12	33,7	42,96	1.509	549,7	215,6	78,52	5,93	3,58
160	160	160	8,0	13,0	15	42,6	54,25	2.492	889,2	311,5	111,2	6,78	4,05
180	180	180	8,5	14,0	15	51,2	65,25	3.831	1.363	425,7	151,4	7,66	4,57
200	200	200	9,0	15,0	18	61,3	78,08	5.696	2.003	569,6	200,3	8,54	5,07
220	220	220	9,5	16,0	18	71,5	91,04	8.091	2.843	735,5	258,5	9,43	5,59
240	240	240	10,0	17,0	21	83,2	106,0	11.260	3.923	938,3	326,9	10,31	6,08
260	260	260	10,0	17,5	24	93,0	118,4	14.920	5.135	1.148	395,0	11,22	6,58
280	280	280	10,5	18,0	24	103,0	131,4	19.270	6.595	1.376	471,0	12,11	7,09
300	300	300	11,0	19,0	27	117,0	149,1	25.170	8.563	1.678	570,9	12,99	7,58
320	300	320	11,5	20,5	27	127,0	161,3	30.820	9.239	1.926	615,9	13,82	7,57
340	300	340	12,0	21,5	27	134,0	170,9	36.660	9.690	2.156	646,0	14,65	7,53
360	300	360	12,5	22,5	27	142,0	180,6	43.190	10.140	2.400	676,1	15,46	7,49
400	300	400	13,5	24,0	27	155,0	197,8	57.680	10.820	2.884	721,3	17,08	7,40
450	300	450	14,0	26,0	27	171,0	218,0	79.890	11.720	3.551	781,4	19,14	7,33
500	300	500	14,5	28,0	27	187,0	238,6	107.200	12.620	4.287	841,6	21,19	7,27
550	300	550	15,0	29,0	27	199,0	254,1	136.700	13.080	4.971	871,8	23,20	7,17
600	300	600	15,5	30,0	27	212,0	270,0	171.000	13.530	5.701	902,0	25,17	7,08
650	300	650	16,0	31,0	27	225,0	286,3	210.600	13.980	6.480	932,3	27,12	6,99
700	300	700	17,0	32,0	27	241,0	306,4	256.900	14.440	7.340	962,7	28,96	6,87
800	300	800	17,5	33,0	30	262,0	334,2	359.100	14.900	8.977	993,6	32,78	6,68
900	300	900	18,5	35,0	30	291,0	371,3	494.100	15.820	10.980	1.054	36,48	6,53
1000	300	1000	19,0	36,0	30	314,0	400,0	644.700	16.280	12.890	1.085	40,15	6,38

Dimensionamento pilastro

Caratteristiche geometriche della sezione scelta

HEB140 $A_{pil} := 42.96 \cdot cm^2$ $i_x := 5.93 \cdot cm$ $i_y := 3.58 \cdot cm$ $J_x := 1509cm^4$ $W_x := 549.7cm^3$

Verifica di instabilità a pressoflessione

$$M_{eqED} := \left| 0.6 \cdot M_{AC}(0) - 0.4 M_{AC}(H) \right|$$

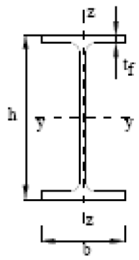
$$M_{eqED} = 70.05 \cdot kN \cdot m \quad > \quad 0.4 \cdot M_{AC}(0) = 61.7 \cdot kN \cdot m$$

$\beta_x := 2 \qquad l_{ix} := \beta_x \cdot H \qquad \lambda_x := \frac{l_{ix}}{i_x}$

$\beta_y := 0.8 \qquad l_{iy} := \beta_y \cdot H \qquad \lambda_y := \frac{l_{iy}}{i_y}$

$\lambda_x = 94.435 \qquad \lambda_y = 62.57 \qquad \lambda_{cr} := \pi \cdot \sqrt{\frac{E_s}{f_{yk}}} \qquad \lambda_{cr} = 68.555$

$\lambda n_x := \frac{\lambda_x}{\lambda_{cr}} \qquad \lambda n_y := \frac{\lambda_y}{\lambda_{cr}} \qquad \lambda n_x = 1.378 \qquad \lambda n_y = 0.913$

					S420	
Sezioni laminate		$h/b > 1,2$	$t_f \leq 40$ mm	y-y z-z	a b	a_0 a_0
		$h/b > 1,2$	40 mm < $t_f \leq 100$ mm	y-y z-z	b c	a a
		$h/b \leq 1,2$	$t_f \leq 100$ mm	y-y z-z	b c	a a
		$h/b \leq 1,2$	$t_f > 100$ mm	y-y z-z	d d	c c

a_0	a	b	c	d
0,13	0,21	0,34	0,49	0,76

86

$\alpha x := 0.34 \qquad \alpha y := 0.49$

$\Phi_x := 0.5 \cdot \left[1 + \alpha x \cdot \left(\lambda n_x - 0.2\right) + \lambda n_x^{\,2}\right] \qquad \Phi_x = 1.649$

$\Phi_y := 0.5 \cdot \left[1 + \alpha y \cdot \left(\lambda n_y - 0.2\right) + \lambda n_y^{\,2}\right] \qquad \Phi_y = 1.091$

$\chi_x := \frac{1}{\Phi_x + \sqrt{\Phi_x^{\,2} - \lambda n_x^{\,2}}} \qquad \chi_x = 0.391$

$\chi_y := \frac{1}{\Phi_y + \sqrt{\Phi_y^{\,2} - \lambda n_y^{\,2}}} \qquad \chi_y = 0.592$

$\chi_{min} := \min(\chi_x, \chi_y)$ $\chi_{min} = 0.391$

$$N_{Cx} := \frac{\pi^2 \cdot E_s \cdot J_x}{l_{ix}^2}$$ $N_{Cx} = 949.824 \cdot kN$

$$\frac{|N_{AC}|}{\chi_{min} \cdot A_{pil} \cdot f_{yd}} + \frac{|M_{eqED}|}{f_{yd} \cdot W_x \cdot \left(1 - \frac{N_{AC}}{N_{Cx}}\right)} = 0.688$$

La sezione è verificata