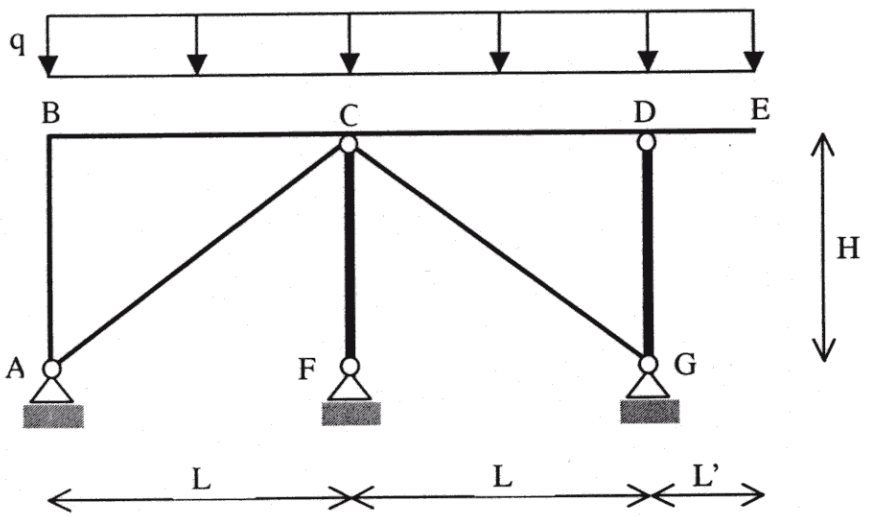
Corso di Laurea in Ingegneria Civile

Prova scritta di Scienza delle Costruzioni II

Ferrara, 28/10/2002



L = 4 m

L' = 1,5 m

H = 3 m

q = 2000 Kg/m

σ_{samm}=2400 Kg/cm^2

A1) Progettare mediante profilati HEB il telaio ABCDE in Figura trascurando le deformazioni assiali delle bielle verticali e di controventamento. Disegnare i diagrammi dell'azione interna (M, N, T).

A2) Verificare lo stato tensionale nella sezione maggiormente sollecitata a flessione.

B) Risolvere il telaio tenendo conto della deformazione assiale della biella tesa (Area A=10 cm^2).

C) Calcolare lo spostamento orizzontale del punto E.

D) Tenere conto della deformazione assiale dei pilastri CF e DG realizzati con profili HEB 100.

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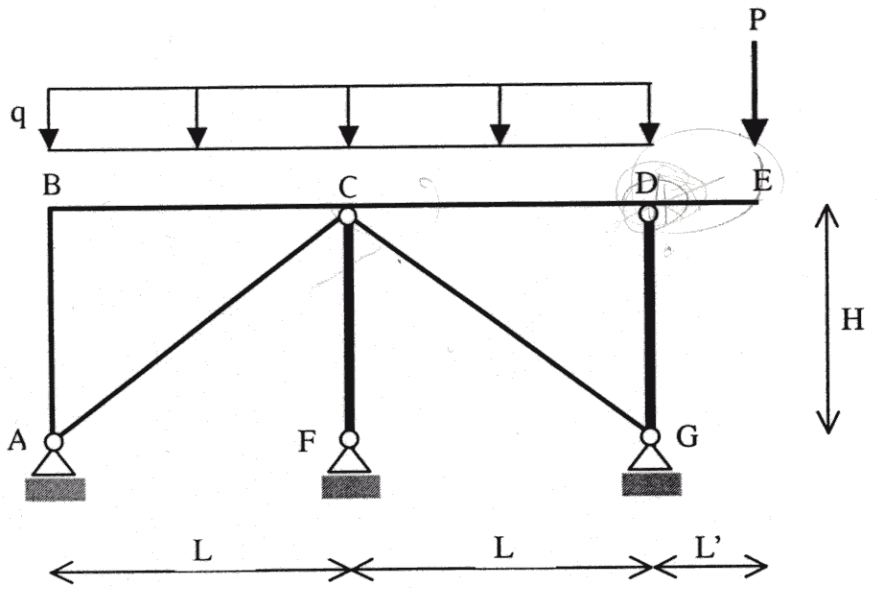

L = 4 m

L' = 1,5 m

H = 3 m

q = 3000 Kg/m

P=3000 Kg

σ_{samm}=2400 Kg/cm^2

A1) Progettare mediante profilati HEB il telaio ABCDE in Figura trascurando le deformazioni assiali delle bielle verticali e di controventamento. Disegnare i diagrammi dell'azione interna (M, N, T).

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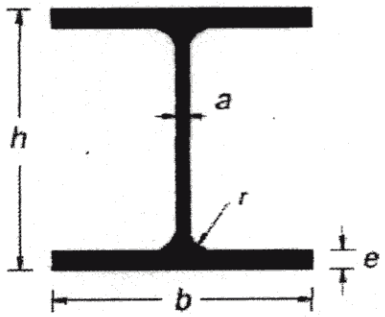
Prova B

www.oppo.it

Profilati metallici

0101

Travi HEB ad ali larghe parallele - serie normale UNI 5397-78

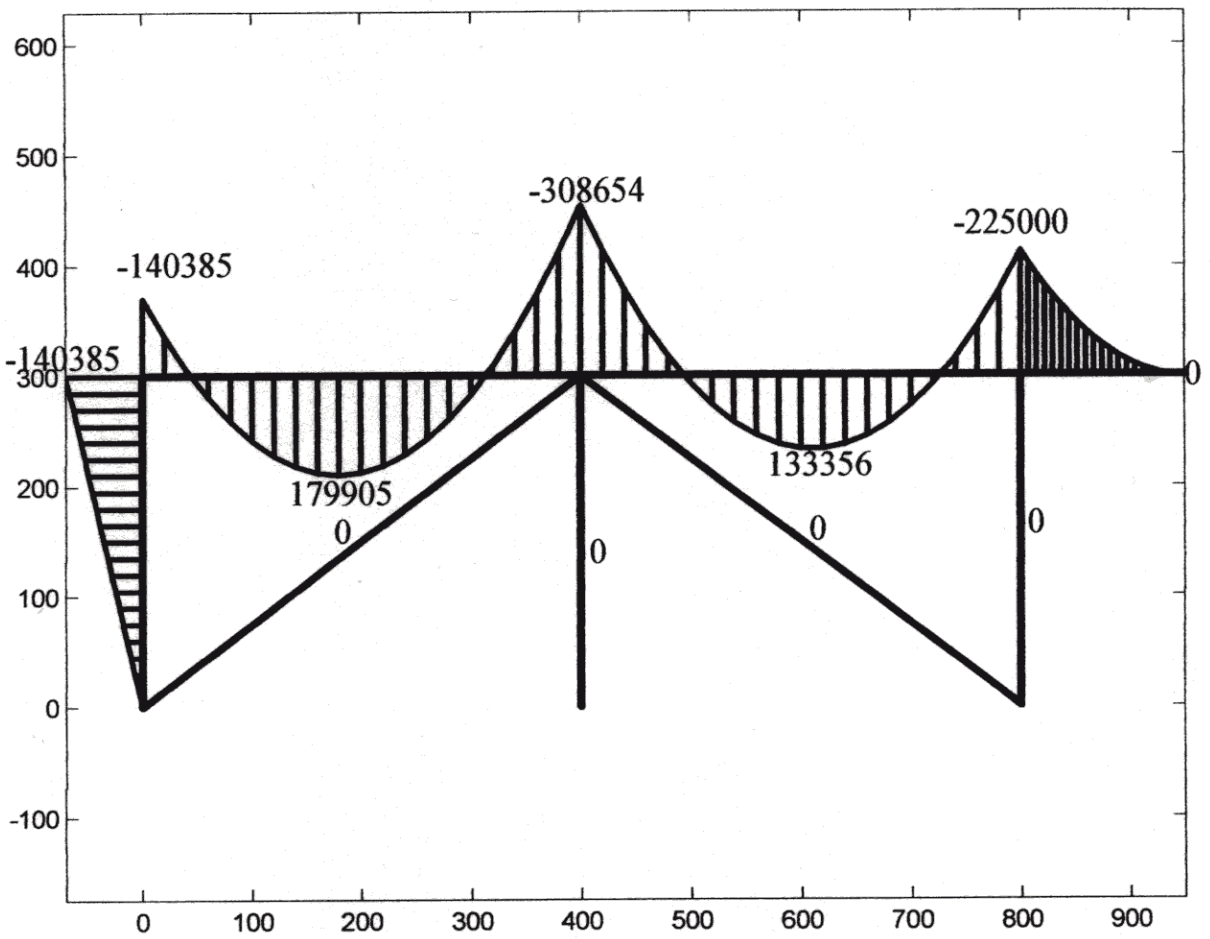


Download
profilati_heb.dwg

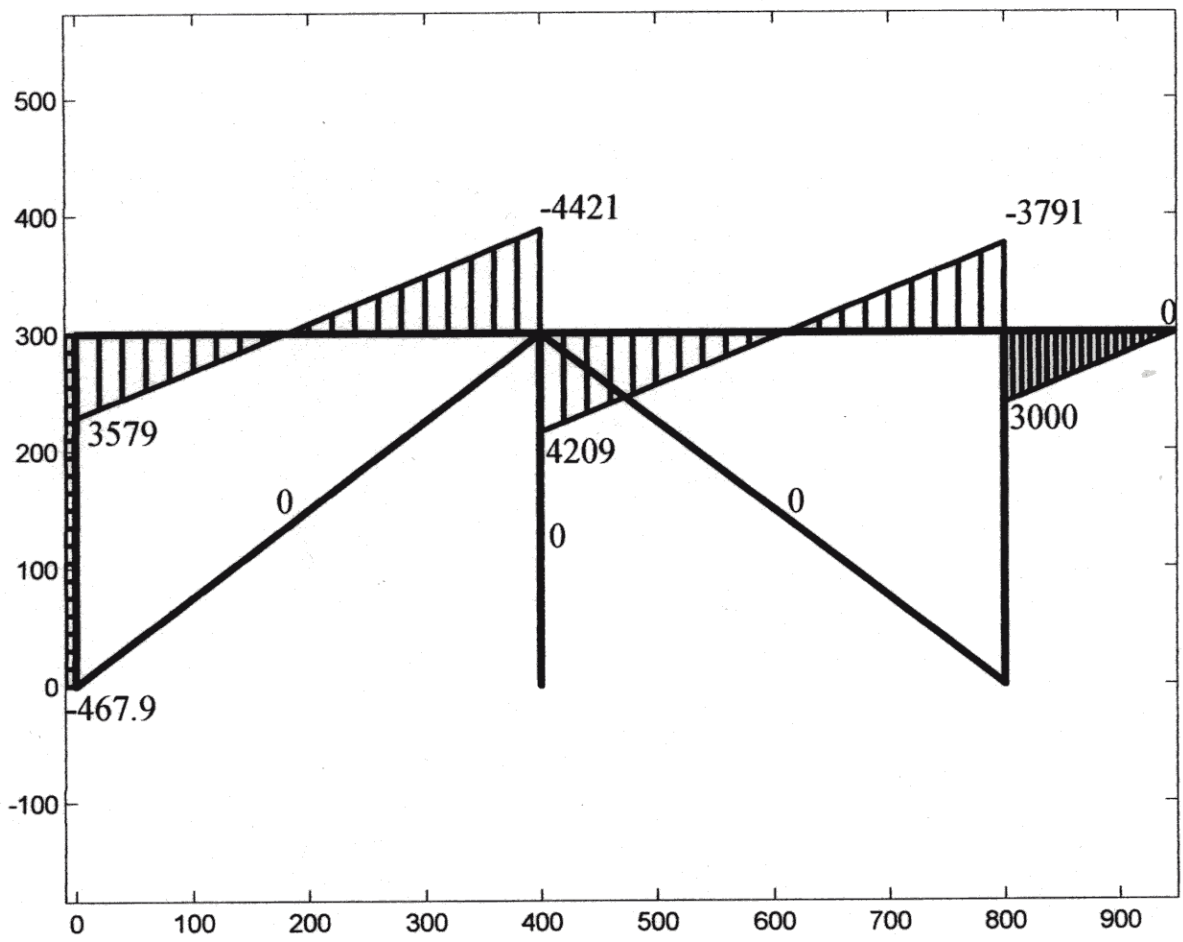
Sigla HEB	b mm	h mm	a mm	e mm	r mm	Peso kg/m	Sezione cm2	Momenti di inerzia Jx cm4	Momenti di inerzia Jy cm4	Moduli di resistenza Wx cm3	Moduli di resistenza Wy cm3	Raggi di inerzia ix cm	Raggi di inerzia iy cm
100	100	100	6,0	10,0	12	20,4	26,04	449,5	167,3	89,91	33,45	4,16	2,53
120	120	120	6,5	11,0	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

Argomenti correlati

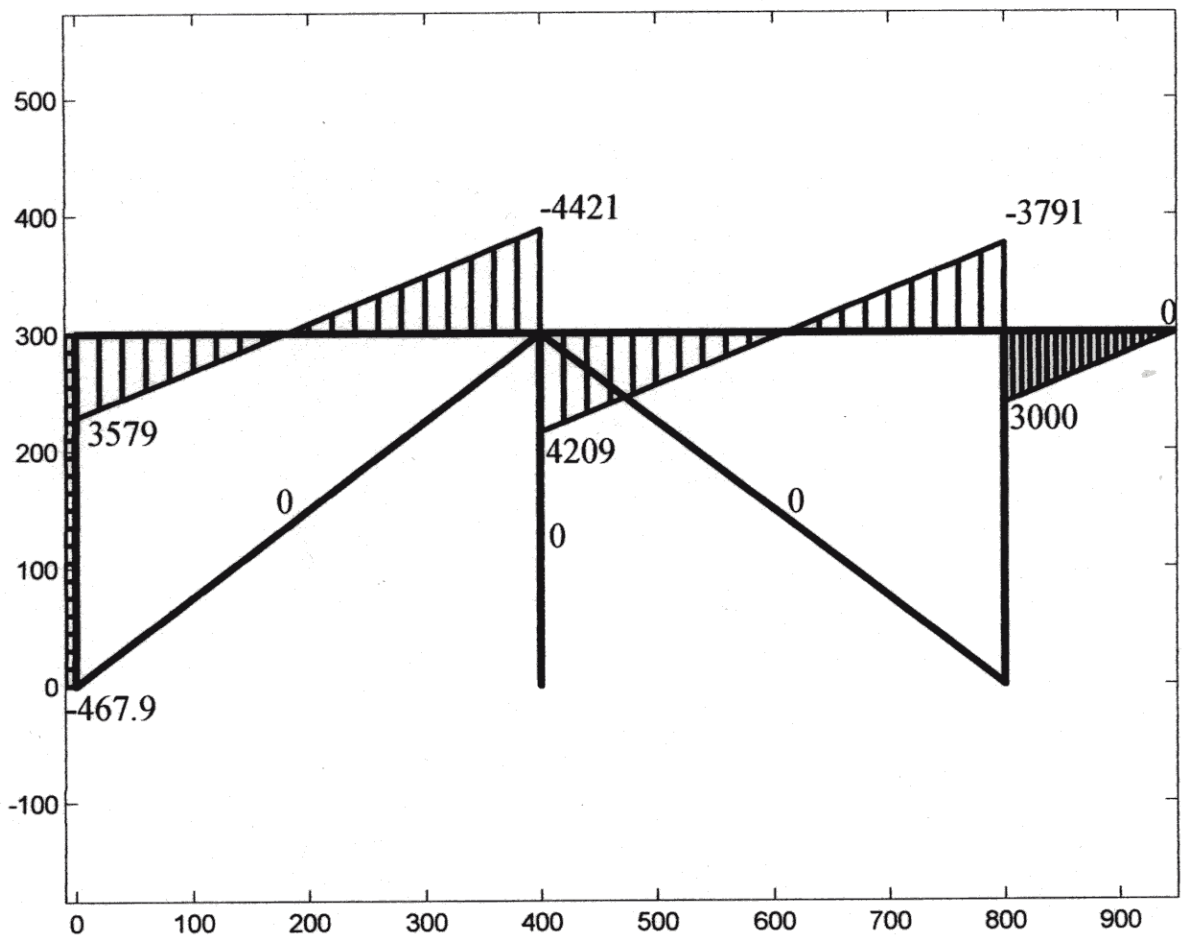
- Profilati metallici



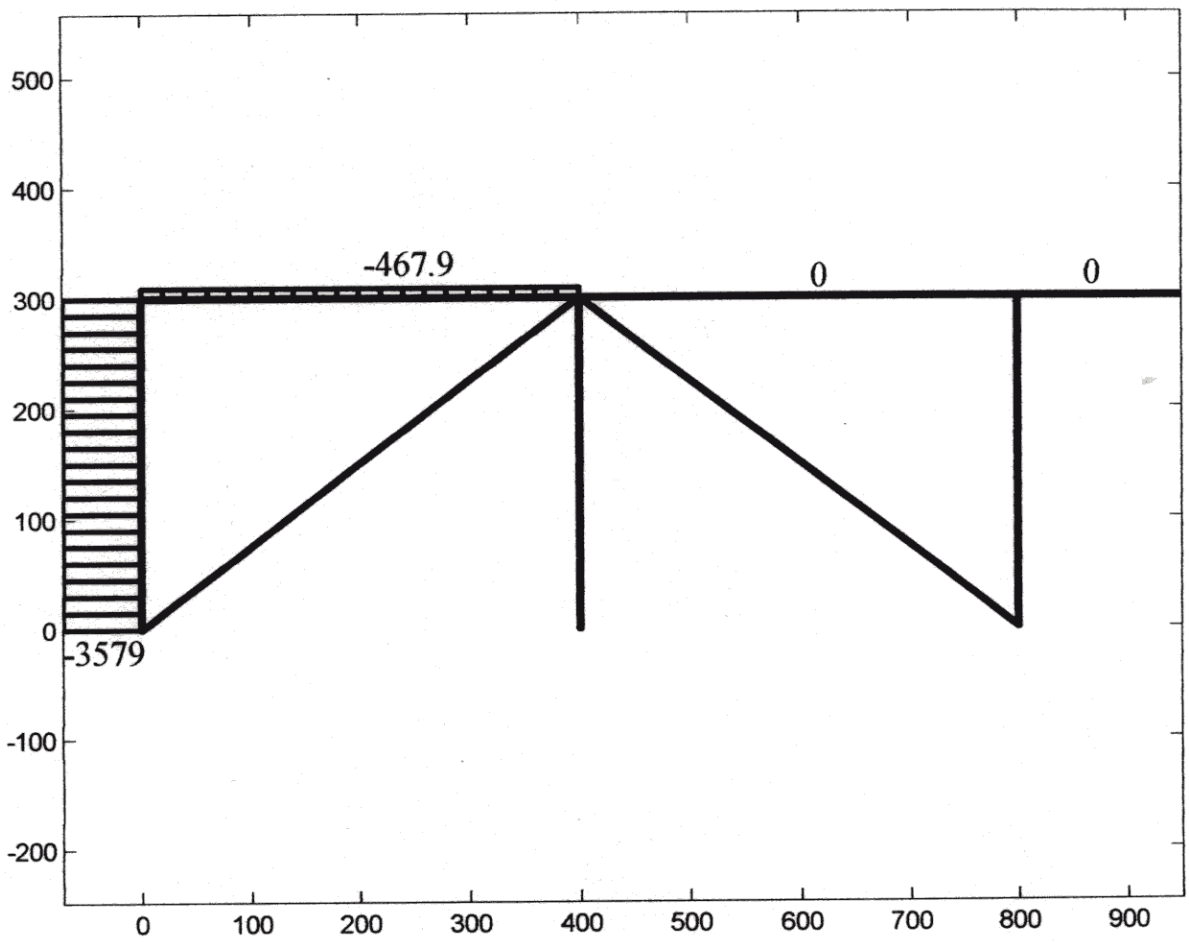
PROVA A Pto A [M [kg. cm]]



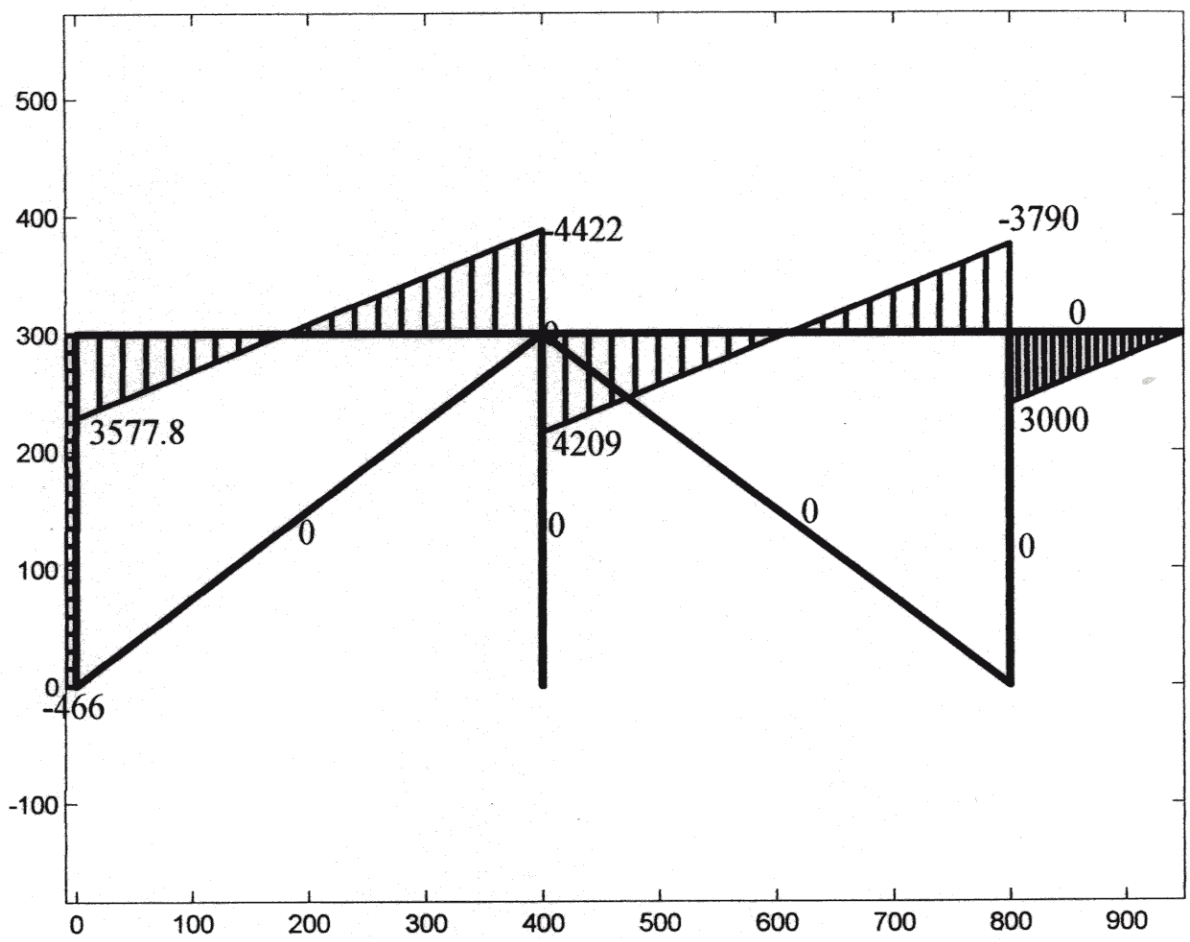
PROVA A Pto A (T [kg])



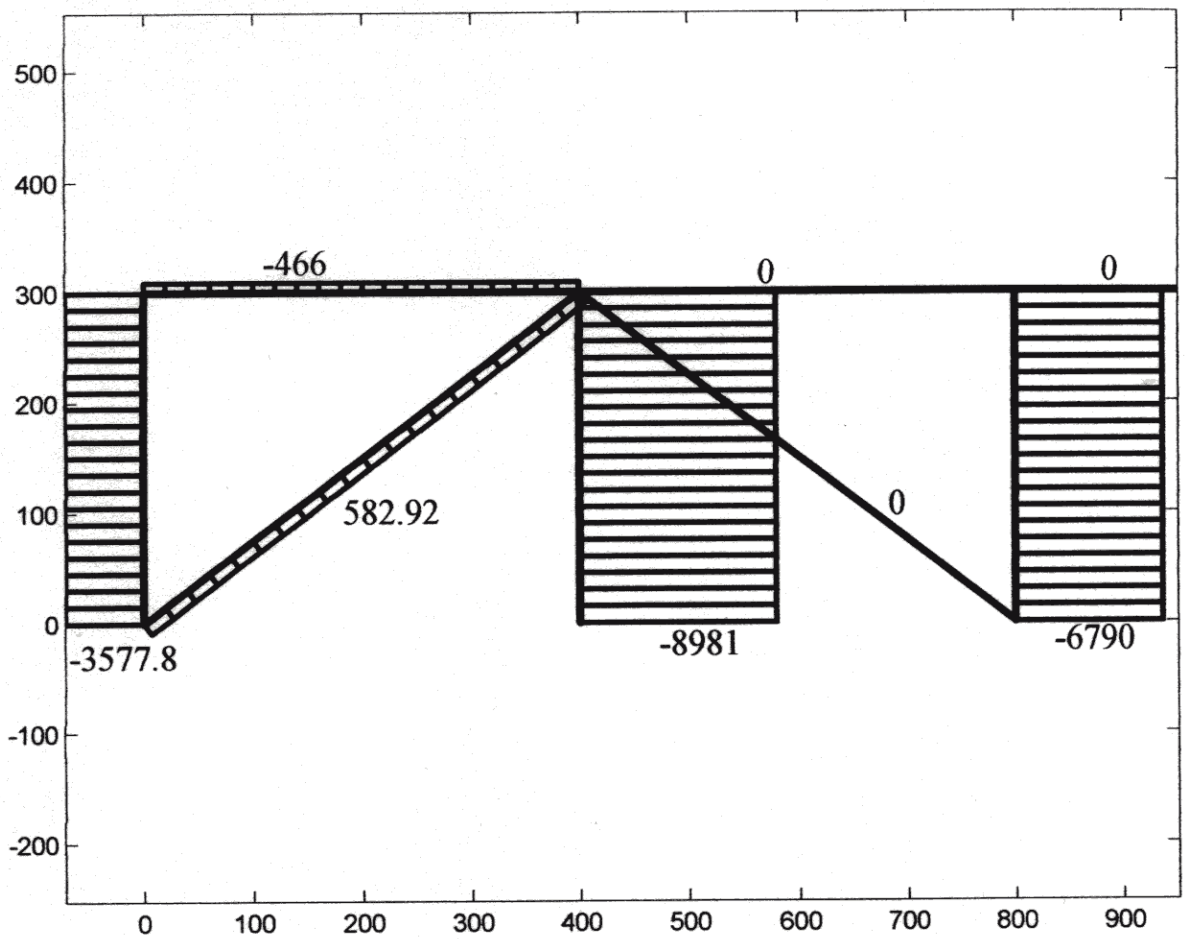
PROVA A Pto A (T [kg])



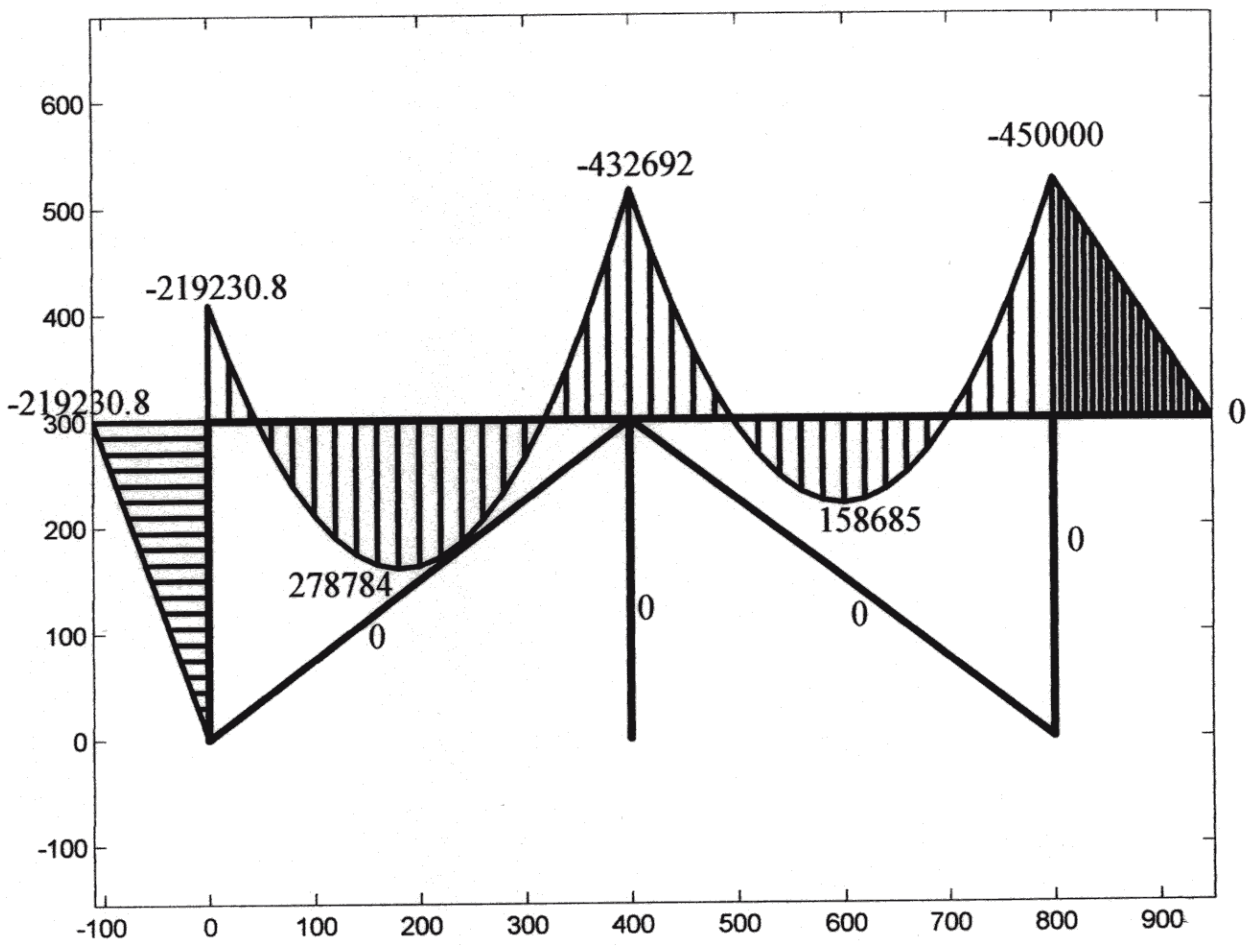
PROVA A Pto A (N [kg])



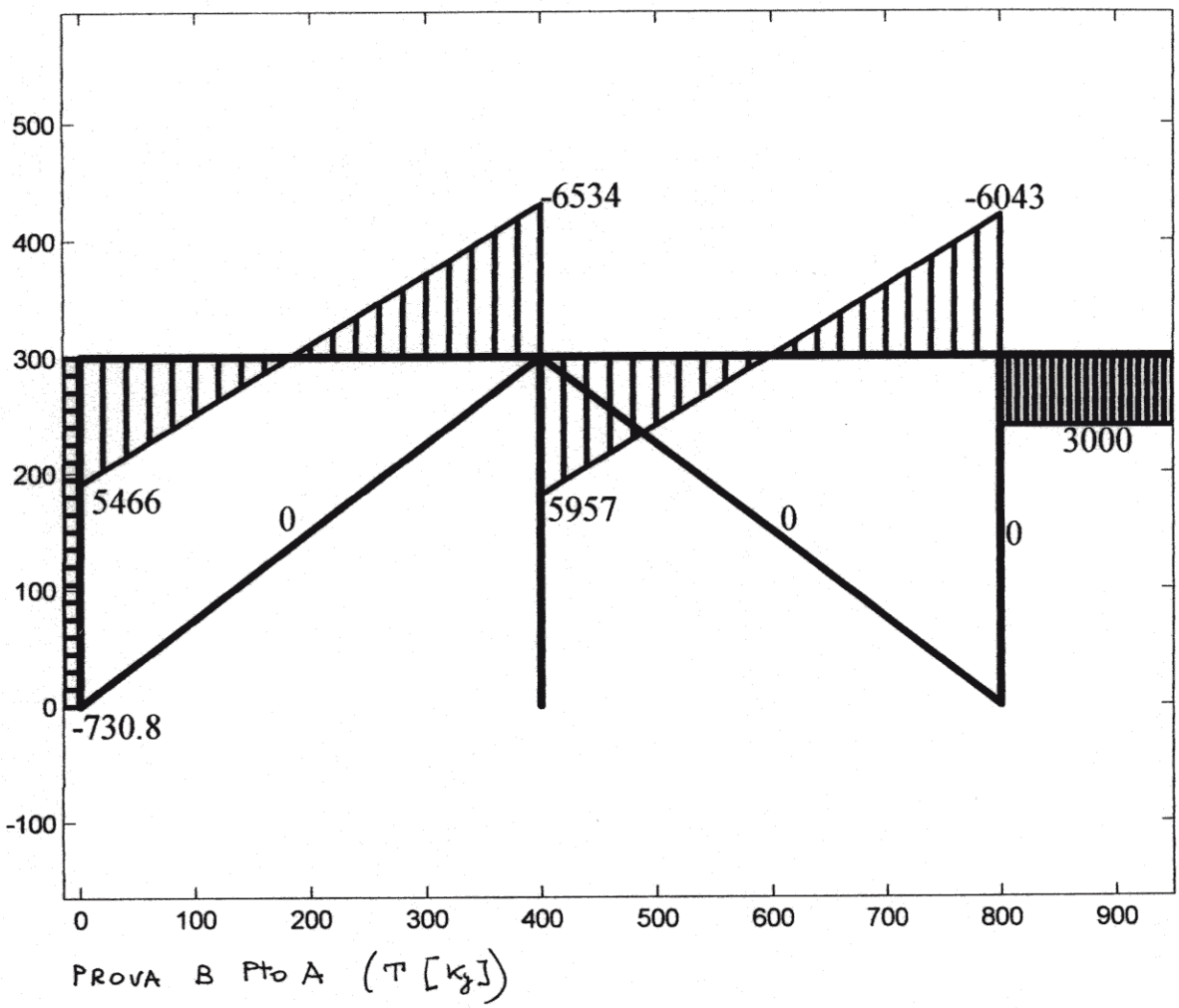
PROVA A PTO B (T [kg])



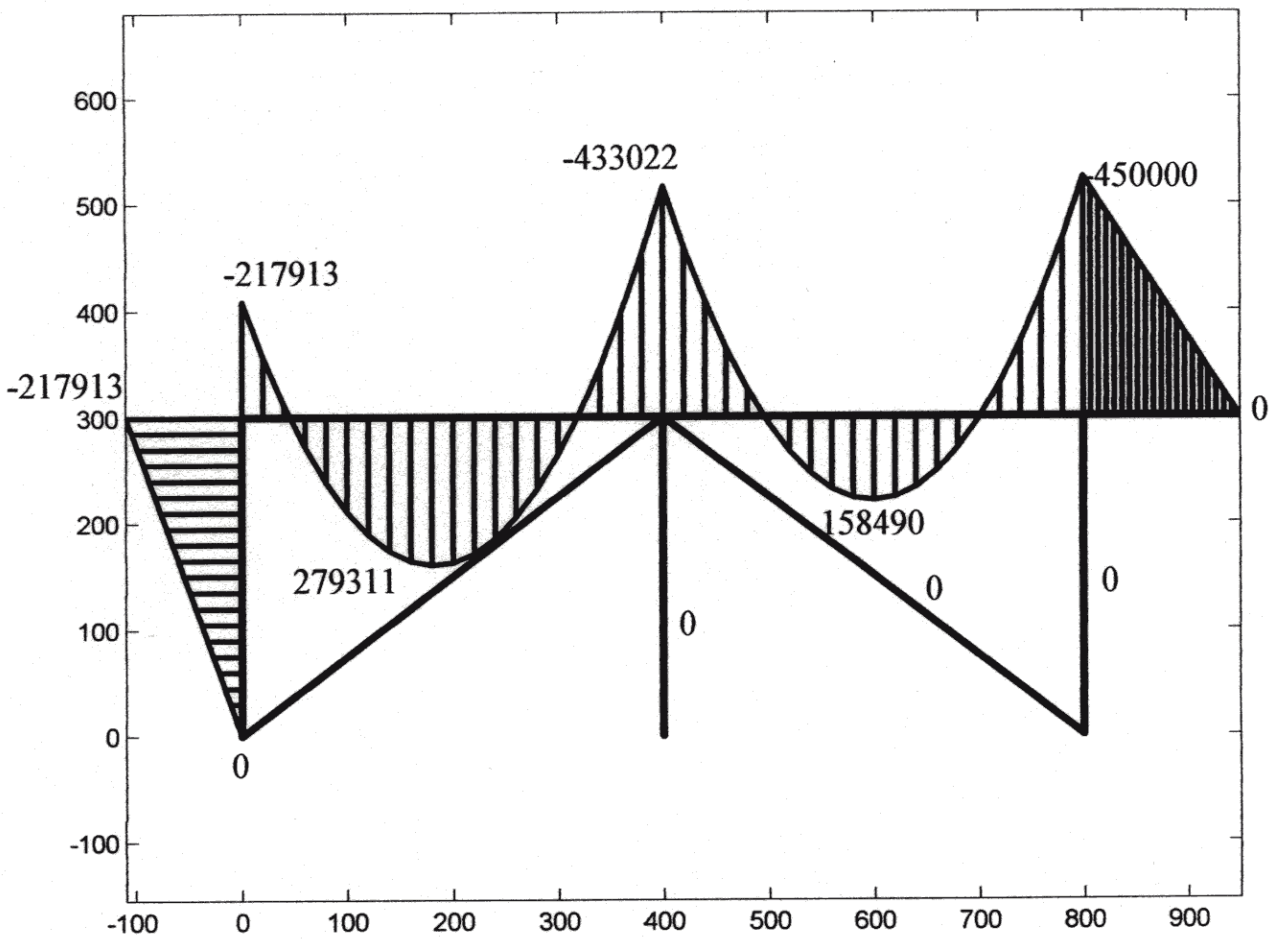
PROVA A Pto B (N [kg])



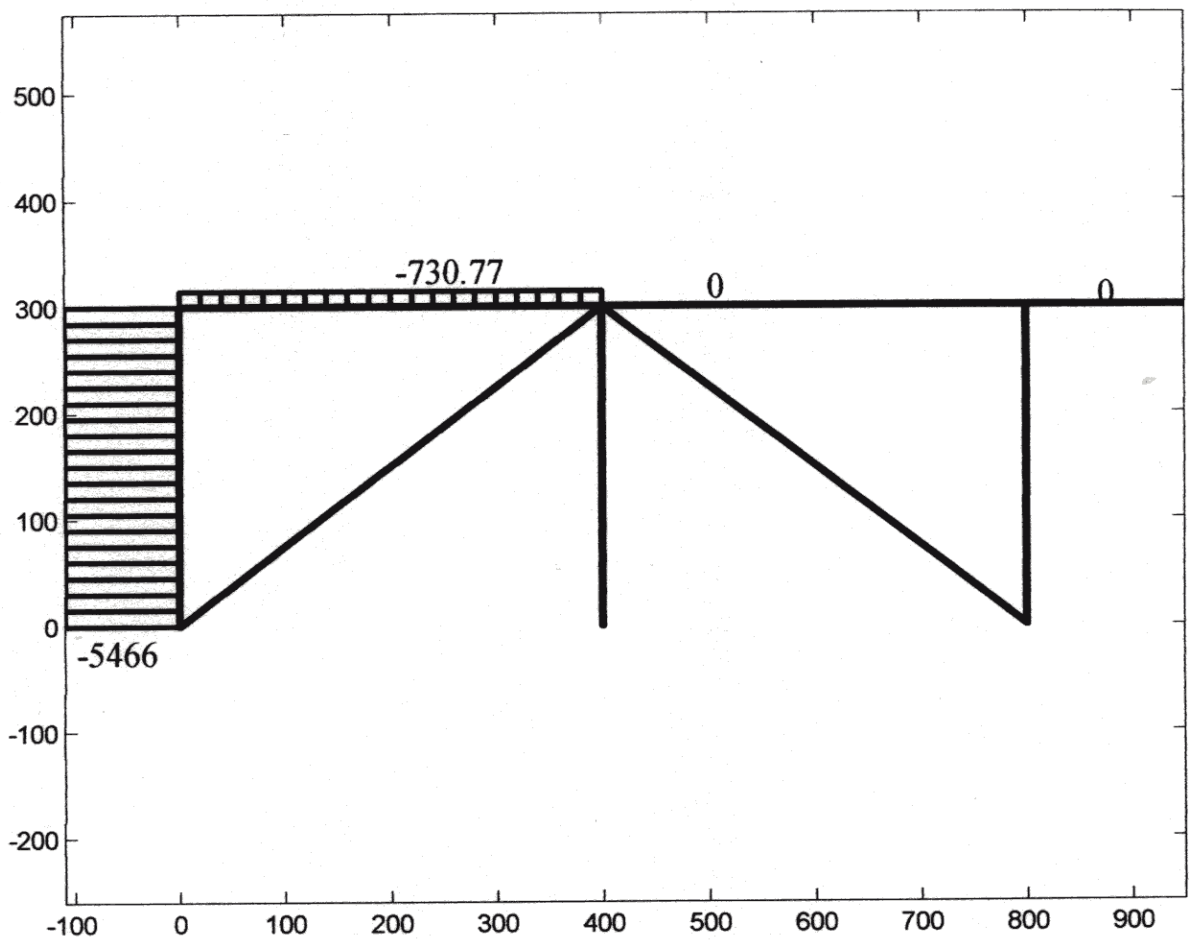
PROVA B PtoA (M [Kg cm])



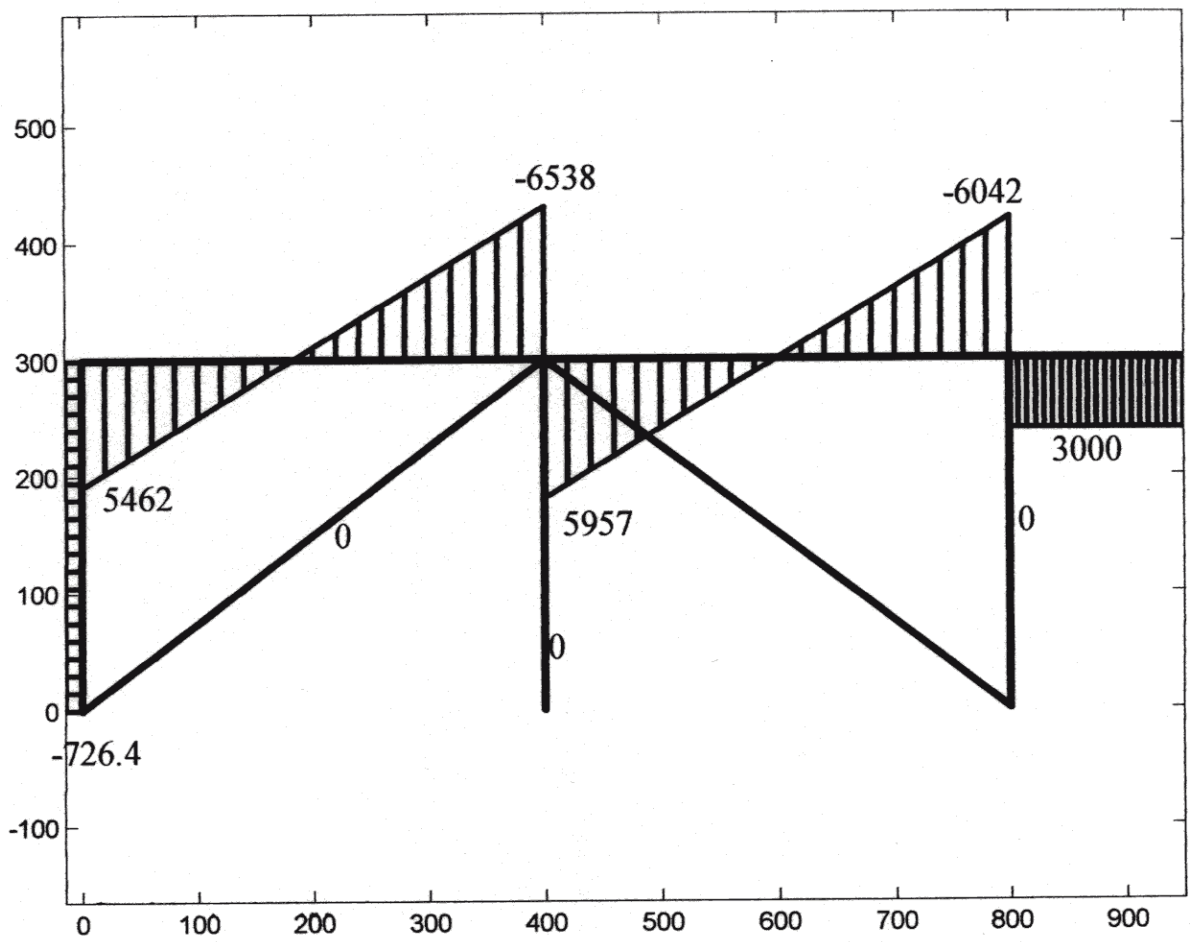
PROVA B Pto A (T [kg])



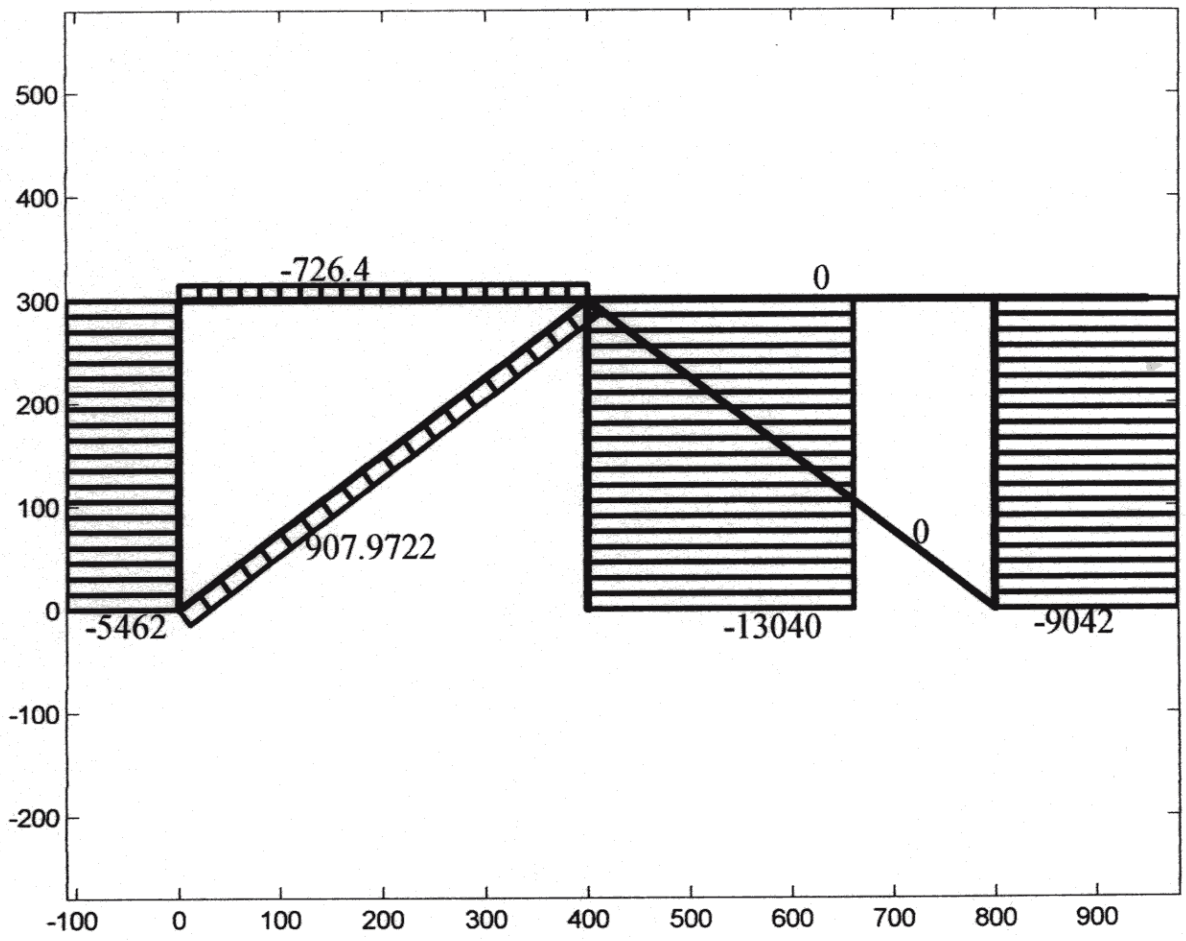
PROVA B Pto B (M [Kg. cm])



PROVA B Pto A (N [kg])



PROVA B pto B (T [Kg])

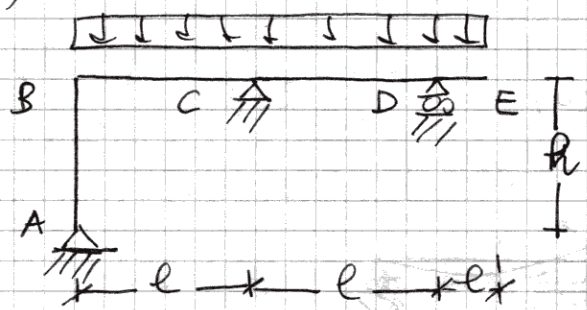


PROVA B Pto B (N [Kg])

Compito di SdC II 28/10/02 I

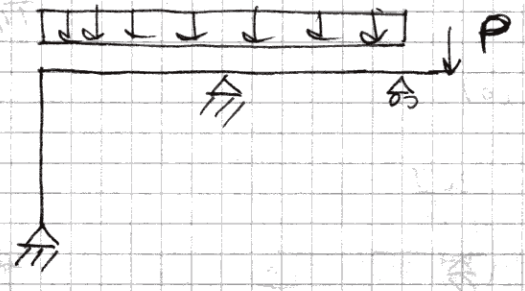
Metodo degli spostamenti

4)



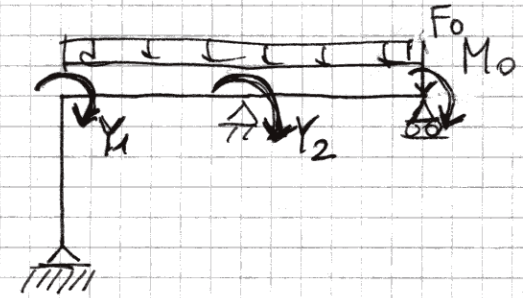
prova (A)

$q = 2000$ kg/m
$l = 4$ m ; $h = 3$ m
$l' = 1,5$ m



prova (B)

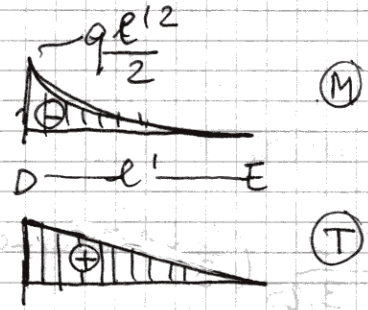
$q = 3000$ kg/m
$l = 4$ m ; $h = 3$ m
$l' = 1,5$ m
$P = 3000$ kg

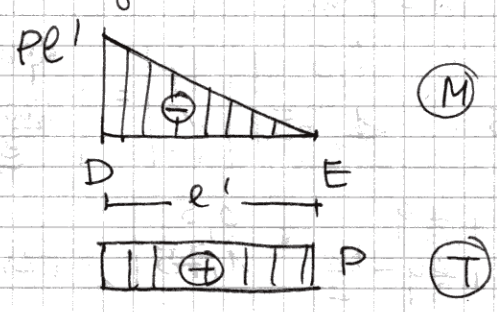


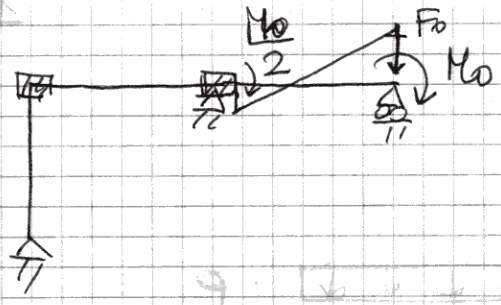
dove $M_o = \begin{cases} \frac{q l'^2}{2} = 2250 \text{ kgm} & \text{prova (A)} \\ Pl' = 4500 \text{ kgm} & \text{prova (B)} \end{cases}$

$F_o = \begin{cases} ql' = 3000 \text{ kg} & \text{(A)} \\ P = 3000 \text{ kg} & \text{(B)} \end{cases}$

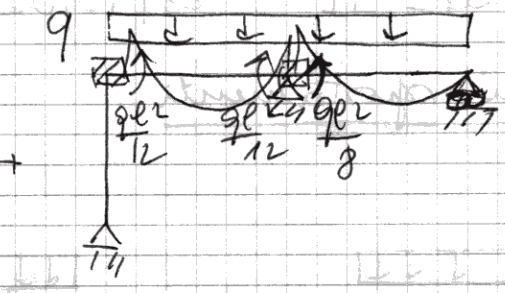
000// la mensola DE è un tratto ISOSTATICO di cui conosco il momento ed il taglio







(o)



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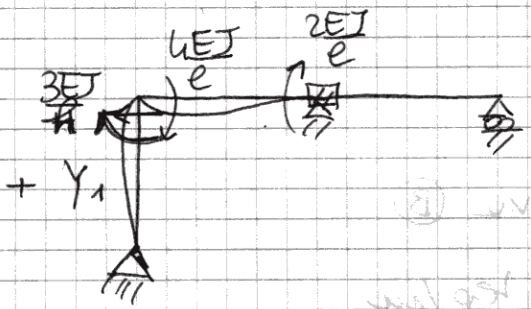
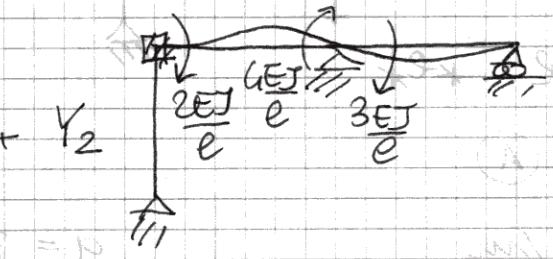




$$k_{10} = -\frac{ql^2}{12}$$

$$k_{20} = \frac{ql^2}{12} - \frac{ql^2}{8} + \frac{M_0}{2} = -\frac{ql^2}{24} + \frac{M_0}{2}$$

$$k_{11} = \frac{3EJ}{h} + \frac{4EJ}{e}$$

$$k_{12} = k_{21} = \frac{2EJ}{e}$$

$$k_{22} = \frac{7EJ}{e}$$

$$EJ \begin{vmatrix} \frac{4}{e} + \frac{3}{h} & \frac{2}{e} \\ \frac{2}{e} & \frac{7}{e} \end{vmatrix} \begin{vmatrix} Y_1 \\ Y_2 \end{vmatrix} = \begin{vmatrix} ql^2/12 \\ \frac{ql^2}{24} - \frac{M_0}{2} \end{vmatrix}$$

$l = 4\,m$; $h = 3\,m$

$$EJ \begin{vmatrix} 2 & 0{,}5 \\ 0{,}5 & 1{,}75 \end{vmatrix} \begin{vmatrix} Y_1 \\ Y_2 \end{vmatrix} = \begin{vmatrix} q \cdot 4/3 \\ \frac{q \cdot 3}{3} - \frac{M_0}{2} \end{vmatrix}$$

$$EJ\,Y_1 = \begin{vmatrix} \frac{4}{3}q & 0{,}5 \\ \frac{3}{3}q - \frac{M_0}{2} & 1{,}75 \end{vmatrix} / (2 \times 1{,}75 - 0{,}5^2) = \frac{1}{3{,}25}\left(\frac{4}{3} \times 1{,}75q - 0{,}5\left(\frac{3q}{3} - \frac{M_0}{2}\right)\right)$$

$$= \frac{1}{3{,}25}\left(2{,}333q - 0{,}338q + \frac{M_0}{4}\right) = \frac{1}{3{,}25}\left(2q + \frac{M_0}{4}\right)$$

$$EJY_2 = \begin{vmatrix} 2 & \frac{4}{3}q \\ 0{,}5 & \frac{2}{3}q - \frac{M_0}{2} \end{vmatrix} \cdot \frac{1}{3{,}25} = \left(\frac{4}{3}q - M_0 - 0{,}5 \cdot \frac{4}{3}q\right)\frac{1}{3{,}25} = \text{III}$$

$$= \left(\frac{2}{3}q - M_0\right)\frac{1}{3{,}25}$$

$$\begin{cases} EJY_1 = \frac{1}{3{,}25}\left(2q + \frac{M_0}{4}\right) \\ EJY_2 = \frac{1}{3{,}25}\left(\frac{2}{3}q - M_0\right) \end{cases}$$

Prova (A) $q = 2000$ kg/m, $M_0 = 2250$ kg m $\Rightarrow$ $EJY_1 = 1403{,}84$ kg m^2, $EJY_2 = -282{,}05$ kg m^2

Prova (B) $q = 3000$ kg/m, $M_0 = 4500$ kg m $\rightarrow$ $EJY_1 = 2.192{,}307$ kg m^2, $EJY_2 = -769{,}23$ kg m^2

$$M_{BA} = -\frac{3EJ}{\ell}Y_1$$

$$M_{DC} = M_0$$

$$M_{BC} = -\frac{q\ell^2}{12} + \frac{4EJ}{\ell}Y_1 + \frac{2EJ}{\ell}Y_2$$

$$M_{CB} = -\frac{q\ell^2}{12} - \frac{2EJ}{\ell}Y_1 - \frac{4EJ}{\ell}Y_2$$

$$M_{CD} = -\frac{q\ell^2}{8} + \frac{M_0}{2} + \frac{3EJ}{\ell}Y_2$$

prova (A)

$M_{BA} = 1403{,}84$ kg m

$M_{DC} = -2250$ kg m

$M_{BC} = -1403{,}84$ kg m

$M_{CB} = -3085{,}84$ kg m

$M_{CD} = -3086$ kg m

$M_{max} = M_C = -3086$ kg m

prova (B)

$M_{BA} = 2192{,}31$ kg m

$M_{DC} = 4500$ kg m

$M_{BC} = 2192{,}31$ kg m

$M_{CB} = 4326{,}92$ kg m

$M_{CD} = 4326{,}92$ kg m

$M_{max} = M_{CD} = 4327$ kg m

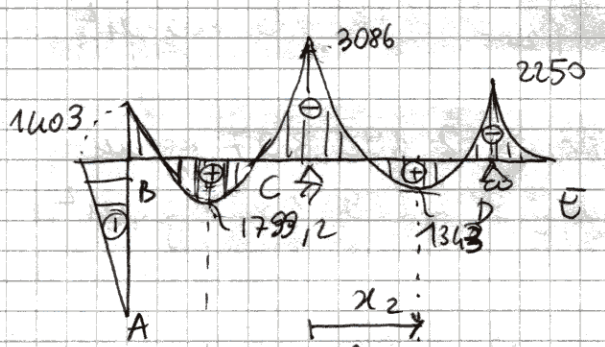
PROGETTO

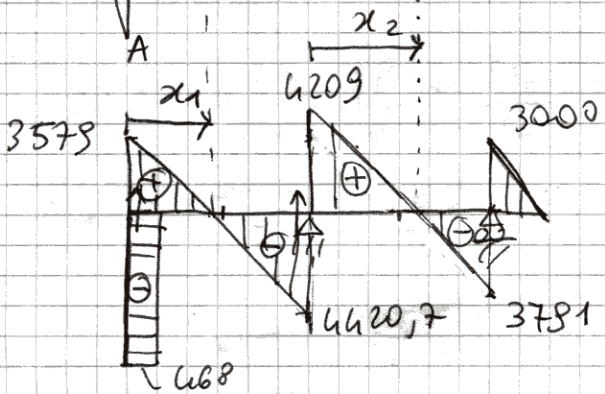
$$W \geq \frac{M_{max}}{\sigma_{adm}} = \begin{cases} 128{,}6\ cm^3 & \text{caso (A)} \\ 187{,}5\ cm^3 & \text{caso (B)} \end{cases}$$

HEB 120 caso (A)

HEB 140 caso (B)

DIAGRAMMI DELLE AZIONI INTERNE (caso (A))

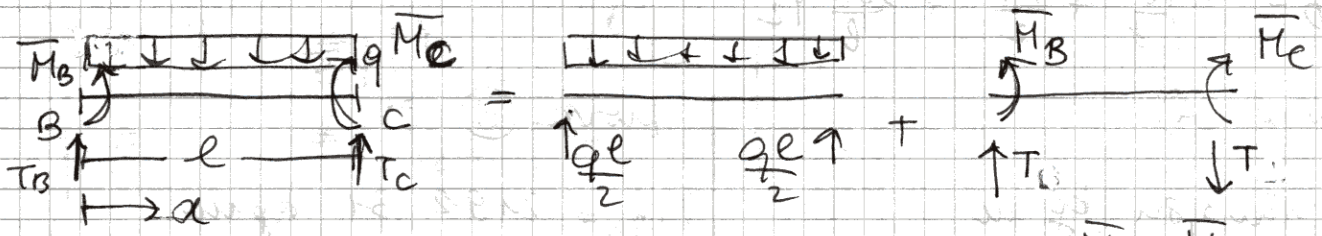




$$x_1 = \frac{3579 \cdot \ell}{(3579+4420{,}7)} = 1{,}78\ m$$

$$x_2 = \frac{4209}{(4209+3791)}\ \ell = 2{,}10\ m$$

Oss// Come trovare il taglio dati i momenti ai nodi?



$$T = \frac{\overline{M}_B - \overline{M}_C}{\ell}$$

$$T_B = \frac{q\ell}{2} + \frac{\overline{M}_B - \overline{M}_C}{\ell}$$

$$T_C = -\frac{q\ell}{2} + \frac{\overline{M}_B - \overline{M}_C}{\ell}$$

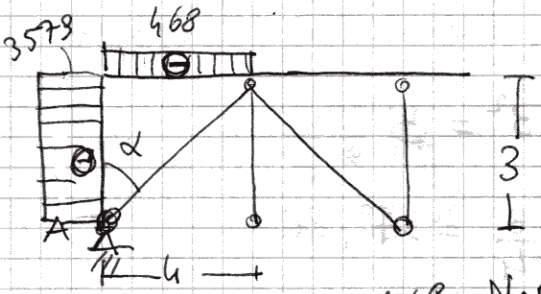
$$M(x) = T_B x - q\frac{x^2}{2} - \overline{M}_B$$

caso (A)

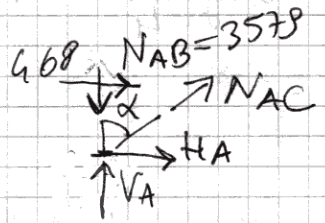
$M(x = 1{,}78\,m) = 3579 \cdot 1{,}78 - q\frac{1{,}78^2}{2} - 1403 = 1799{,}2\ kgm$

$M(x = 2{,}1\,m) = 4209 \cdot 2{,}1 - q\frac{2{,}1^2}{2} - 3086 = 1342{,}9\ kgm$

Diagramma dello sforzo normale (N)



$\alpha = \operatorname{arctg}\frac{4}{3} = 53°\ 13'$



modo A:

$$\begin{cases} -N_{AB} + N_{AC}\cos\alpha + V_A = 0 \\ 468 + N_{AC}\sin\alpha + H_A = 0 \end{cases}$$

3 incognite, 2 equazioni non risolvo determinare N_{AC}

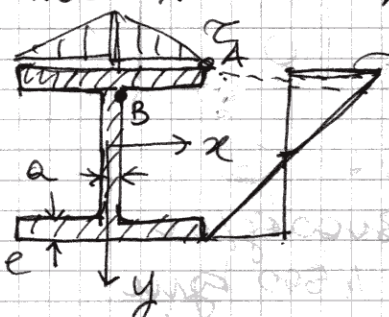
VERIFICA A FLESSIONE

sezione più sollecitata caso (A)

$M_{CB} = 3086\ kgm = 308600\ kgcm$

$T_{CB} = 4420{,}7$

HEB 120 : $W_x = 144{,}1\ cm^3$; $J_x = 864{,}4\ cm^4$



$\sigma_{33} = \frac{M_{CB}}{W}$

$\tau = \frac{TS}{bI}$

$h = 120\ mm$ $\sigma_B = 2141{,}5\ kg/cm^2$

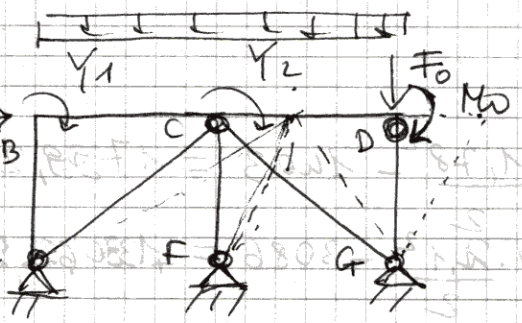
$a = 6{,}5\ mm$

$e = 11\ mm$

$\tau(B) = \frac{2(1{,}1 \times 6) \times 6 \cdot 4420{,}7}{0{,}65 \cdot 864{,}4} = 103{,}8\ kg/cm^2$

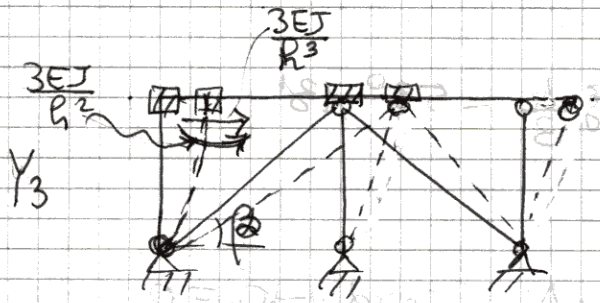
$\sigma_{id} = \sqrt{\sigma_B^2 + 3\tau_B^2} = 2150\ \frac{kg}{cm^2} < \sigma_{adm} = 2400\ kg/cm^2$

B)



se Y_3 è come assunto in figura, la bielletta è AC

I sottosistemi (0), (1), (2) sono identici a quelli del caso (A).



(3)

$$l_b = \sqrt{4^2+3^2} = 5$$

$$\beta = \operatorname{atg}\frac{3}{4} \simeq 37°$$

$$k_{30} = 0$$

$$k_{33} = \frac{3EJ}{h^3} + \frac{EA}{l_b}\cos^2\beta = \frac{3EJ}{9\cdot 3} + \frac{EA}{5}\cos^2\beta$$

$$k_{13} = -\frac{3EJ}{h^2} = -\frac{EJ}{3}$$

$$\begin{vmatrix} EJ2 & 0{,}5EJ & -0{,}333EJ \\ 0{,}5EJ & 1{,}75EJ & 0 \\ -0{,}333EJ & 0 & \frac{EJ}{9} + EA\underbrace{\frac{\cos^2\beta}{5}}_{=0{,}128} \end{vmatrix} \begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \end{vmatrix} = \begin{vmatrix} \frac{4}{3}q \\ \frac{2}{3}q - \frac{M_0}{2} \\ 0 \end{vmatrix}$$

PROVA (A)

$q = 2000$ kg/m
$M_0 = 2.250$ kgm
$J = 864{,}4$ cm^4
$A = 10$ cm^2
$\mu = \frac{A}{J} = 1{,}156\,8\cdot 10^{-2}$ cm^{-2}
$= 115{,}68$ m^{-2}
$EJ\,Y_1 = 1409{,}48$ kgm^2
$EJ\,Y_2 = -283{,}63$ kgm^2
$EJ\,Y_3 = 31{,}46$ kgm^3

PROVA (B)

$q = 3000$ kg/m
$M_0 = 4500$ kgm
$J = 1509$ cm^4
$A = 10$ cm^2
$\mu = \frac{A}{J} = 6{,}627\cdot 10^{-3}$ cm^{-2}
$= 66{,}27$ m^{-2}
$EJ\,Y_1 = 2201{,}11$ kgcm^2
$EJ\,Y_2 = -771{,}74$ kgcm^2
$EJ\,Y_3 = 49{,}13$ kgcm^3

di brevi risolvendo:

$$EJ \begin{vmatrix} 2 & 0,5 & -0,333 \\ 0,5 & 1,75 & 0 \\ -0,333 & 0 & 0,111 + \mu\, 0,128 \end{vmatrix} \cdot \begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \end{vmatrix} = \begin{vmatrix} \frac{1}{3}9 \\ \frac{2}{3}9 - \frac{M_0}{2} \\ 0 \end{vmatrix}$$

$$\mu = \frac{A}{J}$$

Controllo equilibrio ai nodi, nodo (A)

$$M_{BA} = -\frac{3EJ}{h^2} Y_1 + \frac{3EJ}{h^2} Y_3 = -1409,48 + \frac{43,13}{3}$$

$$1389 \ \text{kg m}$$

$$M_{BC} = -\frac{ql^2}{12} + \frac{4EJ}{l} Y_1 + \frac{2EJ}{l} Y_2 = -2000 \cdot \frac{4}{3} + 1409,48 - 104,873$$

$$= 1389,01 \ \text{kg m}$$

etc....

c) Calcolare lo spostamento orizzontale del punto E

nodo (A)

$$u_E = \frac{EJ Y_3}{EJ} = \frac{31,46 \cdot 10^6 \ \text{kg cm}^3}{2 \cdot 1 \cdot 10^6 \frac{\text{kg}}{\text{cm}^2} \cdot 864,4 \ \text{cm}^4} = 0,0173 \ \text{cm}$$

nodo (B)

$$u_E = \frac{EJ Y_3}{EJ} = \frac{43,13 \ \text{kg cm}^3}{2 \cdot 1 \cdot 10^6 \frac{\text{kg}}{\text{cm}^2} \cdot 1503 \ \text{cm}^4} = 0,0155 \ \text{cm}$$