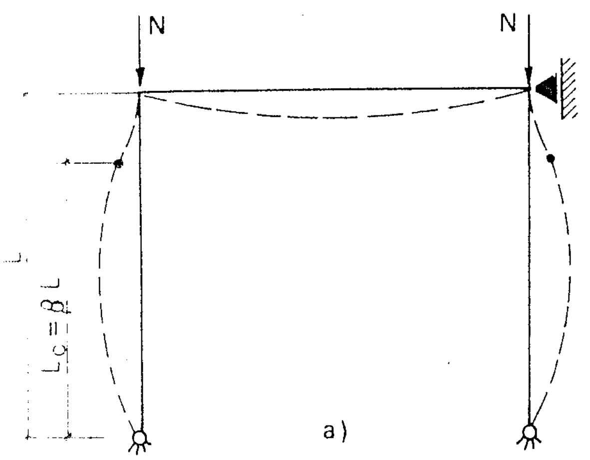
Paragrafi del “Ballio” a cui dedicare la dovuta attenzione

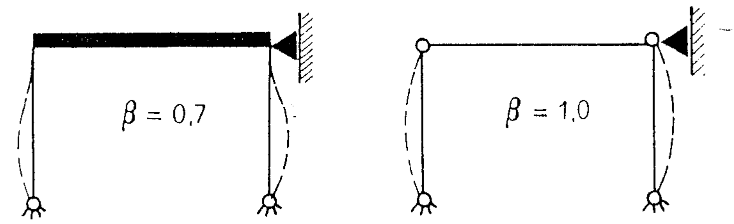
1.5.4. Aste nei telai

Le lunghezze di libera inflessione $L_c = \beta L$ può essere definita come la lunghezza dell'asta incernierata che ha lo stesso carico critico o come la distanza fra due punti di flesso della deformata critica.

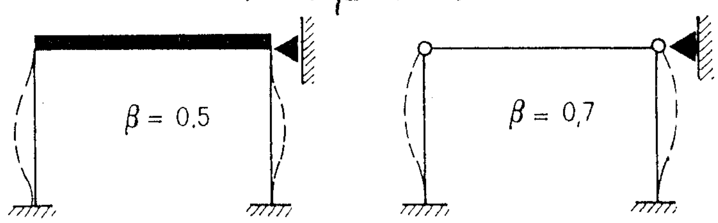
Per telai a nodi fissi la variabilità di β è contenuta:

$0.7 \le \beta \le 1$



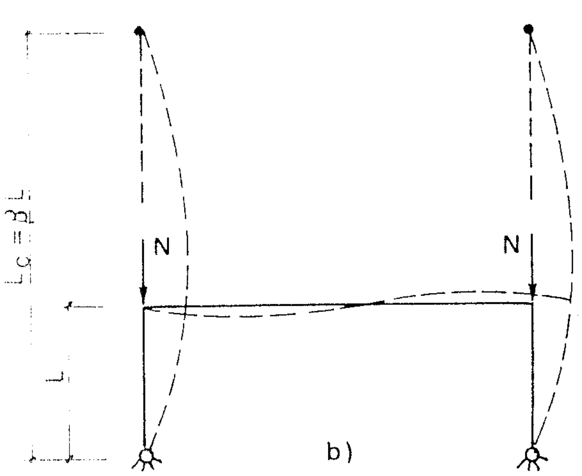


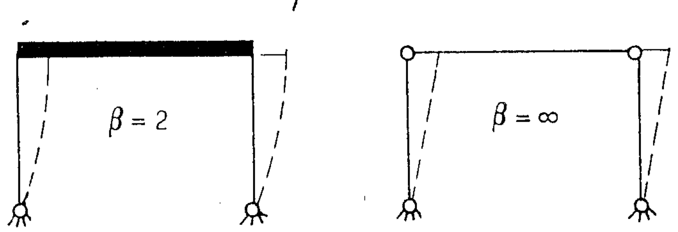
$0.5 \le \beta \le 0.7$



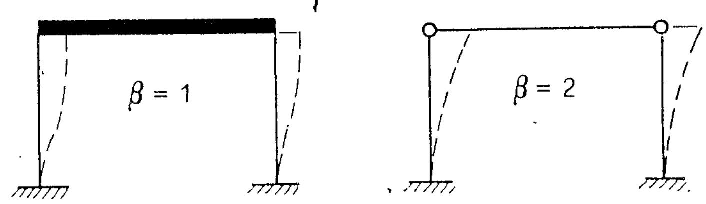
Per telai a nodi spostabili la variabilità è molto più grande

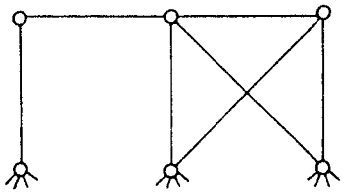
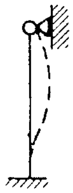
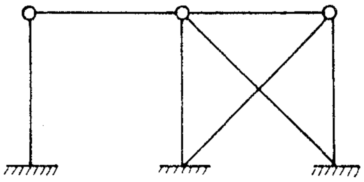
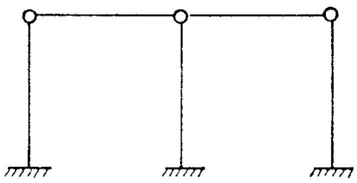
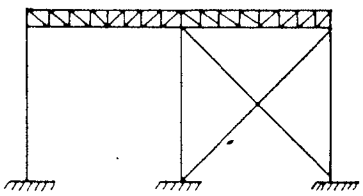
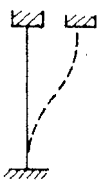
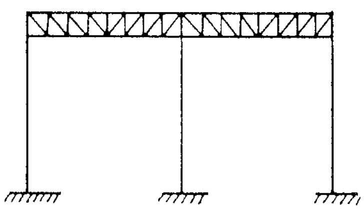
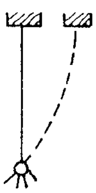
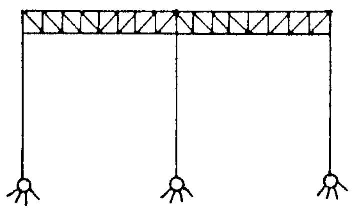
$2 \le \beta \le \infty$





$1 \le \beta \le 2$



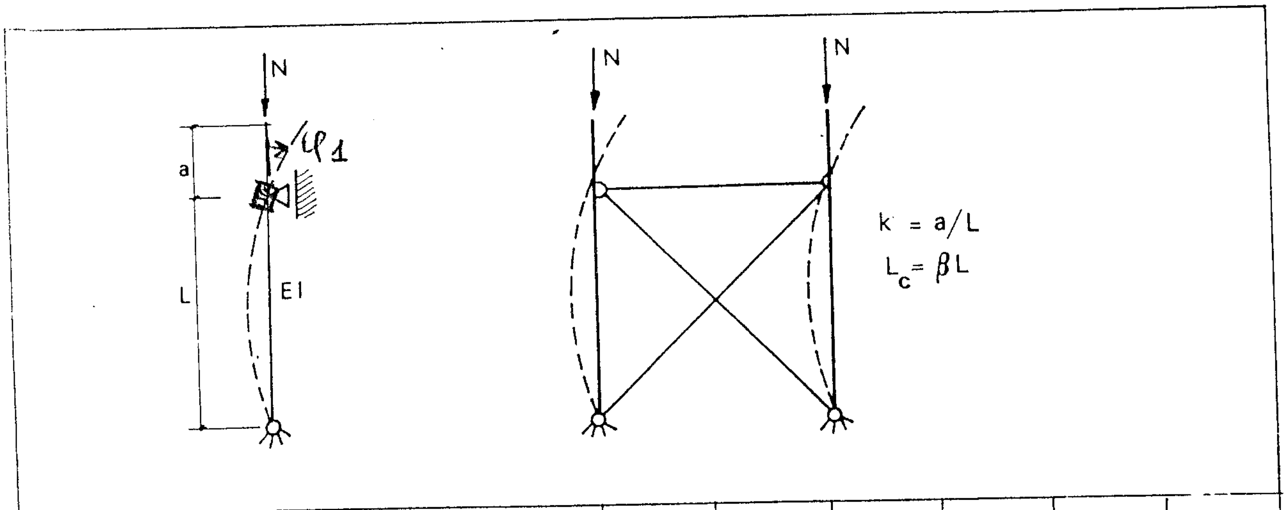
CASO	ESEMPIO	β teorico	CNR 10011
		1,0	1.0
		0,7	0.8
		2,0	2.0
		0,5	0.7
		1,0	1.2
		2,0	2.1

Per tener conto di non perfetta fissità rotazionale aumentare β del 10 ÷ 20 % (come CNR)

1.2. Aste con vincoli intermedi

Usare metodo delle forze o delle deformazioni.
L'equazione di stabilità si ottiene annullando il determinante dei coefficienti.

Es. (v. Caironi pag. 61)



k	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
β	1.0	1.11	1.24	1.40	1.56	1.74	1.93	2.16	2.31	2.50	2.70

Metodo deformazioni

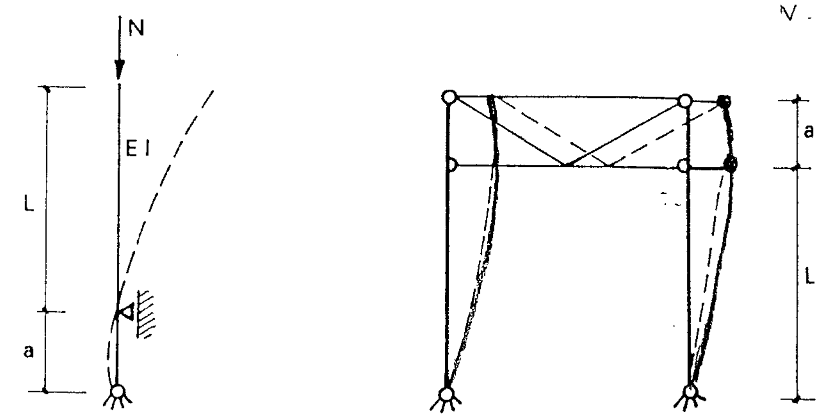
$$M_{11}\varphi_1 = 0 \qquad M_{11} = \frac{3EI}{L}\frac{1}{I_1} - \frac{EI}{a}\alpha a \, tg\, \alpha a$$

$$\Delta = M_{11} = \frac{3EI}{L}\frac{1}{I_1(\alpha L)} - \frac{EI}{kL} k\alpha L \, tg(k\alpha L) = 0$$

$$\frac{3}{I_1} = \alpha L \, tg(k\alpha L)$$

Ad esempio per $K = 1$ l'equazione è soddisfatta da $\alpha L = 1.166 \rightarrow \beta = \frac{\pi}{\alpha L} = 2.7$

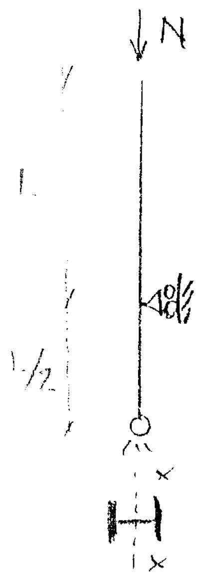
v. Caironi pag. 61



$k = a/L$

$L_c = \beta L$

k	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
β	2	2.07	2.13	2.20	2.27	2.34	2.41	2.48	2.55	2.62	2.70



Esempio numerico

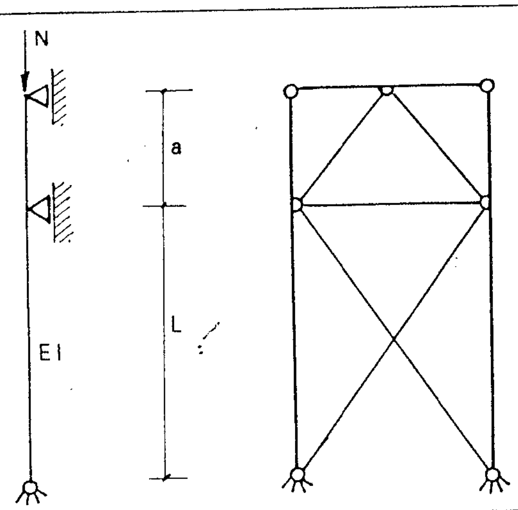
Acciaio Fe 430 $\quad L = 400$ cm

HE 200 A $\quad i_x = 8.28$ cm $\quad A = 53.8\ cm^2$

$\frac{h}{b} < 1.2 \rightarrow$ curva c

$K = 0.5 \rightarrow \beta = 2.34 \rightarrow L_c = 400 \times 2.34 = 936$

$\lambda = \frac{L_c}{i_x} = 113 \rightarrow \omega = 2.57$

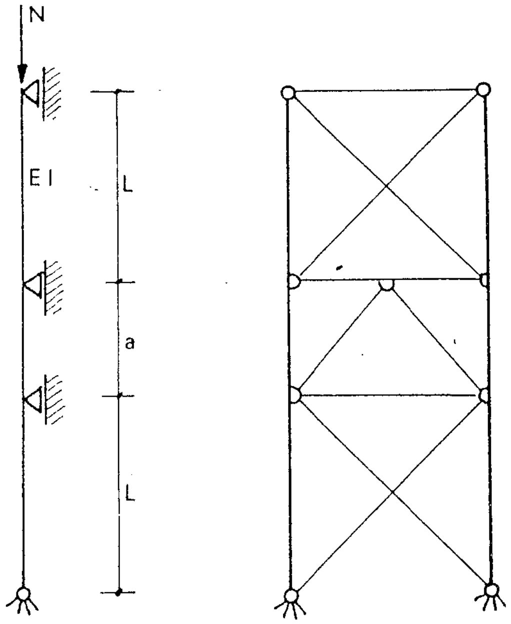


$k = a/L$

$L_c = \beta L$

k	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
β	0.70	0.72	0.74	0.77	0.79	0.81	0.84	0.87	0.91	0.95	1.0

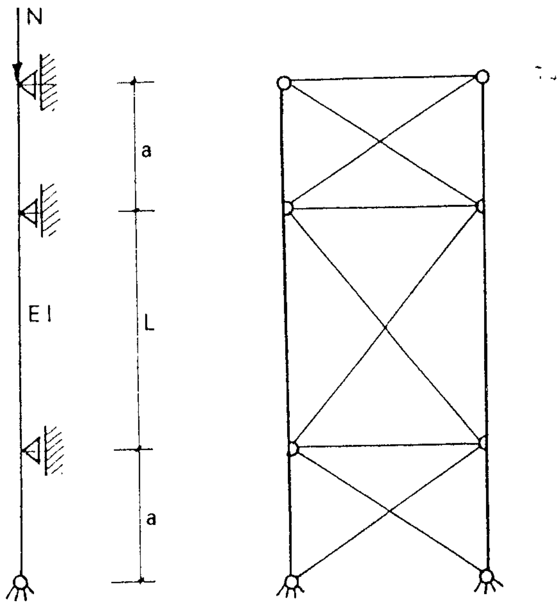
V. Caironi pag. 27



$k = a/L$

$L_c = \beta L$

k	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
β	0.7	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.0



$k = a \quad L$

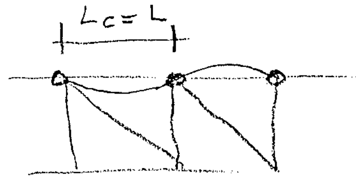
$L_c = \beta L$

k	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
β	0.5	0.53	0.57	0.61	0.65	0.70	0.75	0.81	0.87	0.93	1.0

1.3. Aste nelle travature reticolari

CNR 10011 par. 7.2.2.1.2.

Aste di corrente

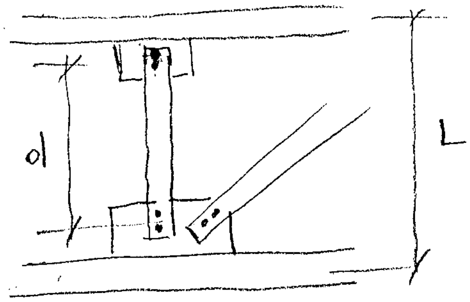


$\beta = 1$

Aste di parete

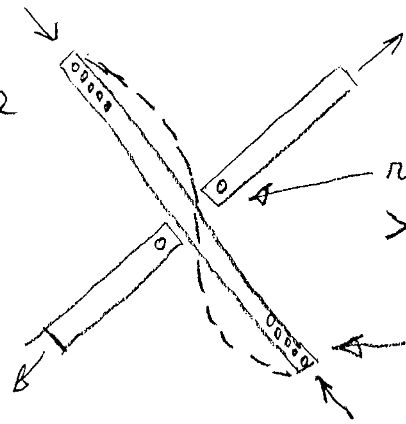
$L_c = d \geq 0{,}8\,L$

(EC3 0,9 L
par. 5.8.2 (3))



Incrocio asta tesa con compressa

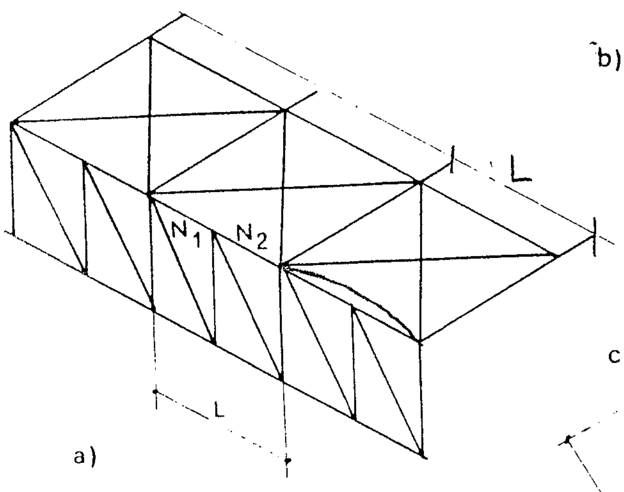
$\beta = 0.5$



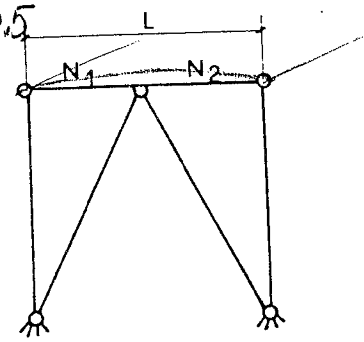
resistenza attacco $> \frac{1}{5}$ resistenza attacco asta compressa

N variabile

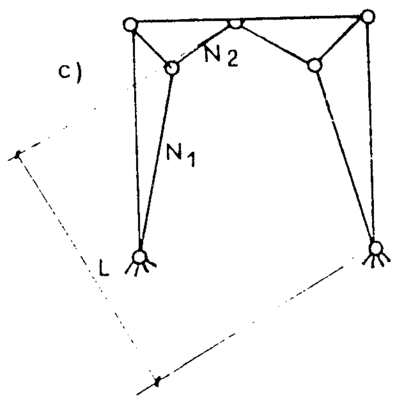
$N_1 > N_2 \qquad \beta = 0{,}75 + 0{,}25\,\dfrac{N_2}{N_1} \geq 0{,}5$



a)



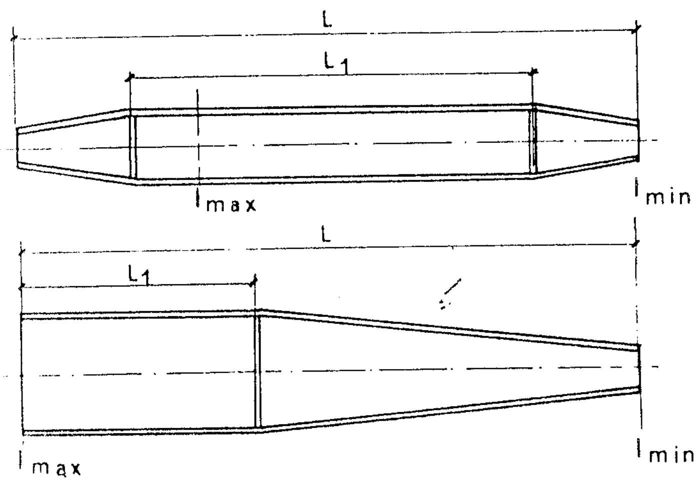
b)



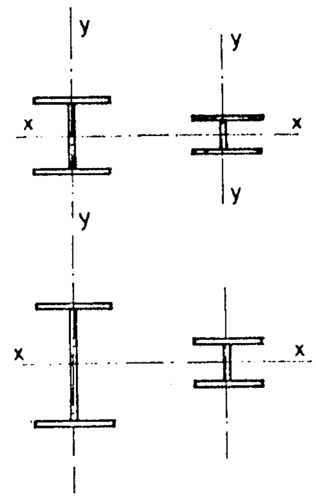
c)

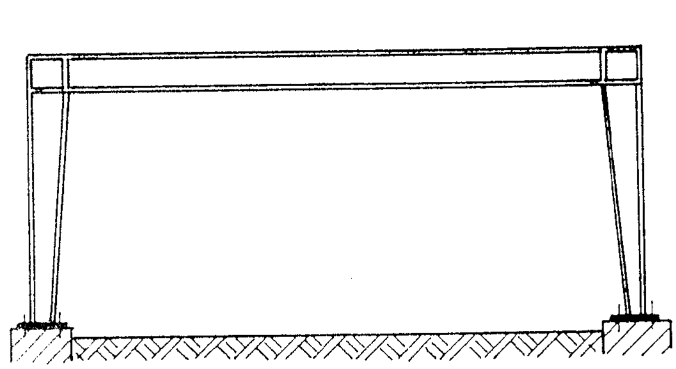
Aste a geometria variabile

variabili gradualmente "Tapered columns"

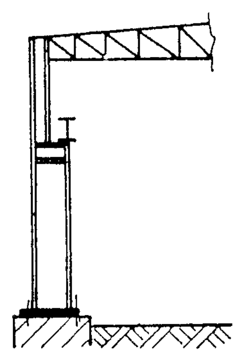


variabili a tronchi "stepped columns"



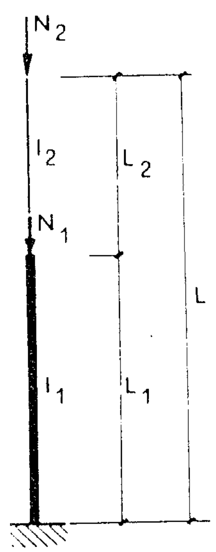


c)

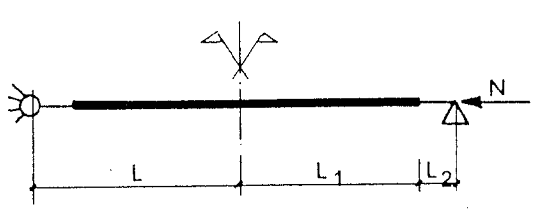


d)

Esistono formule approssimate per il calcolo di I_{eq} - Si può fare un calcolo elastico esatto (v. Caironi pag. 62)

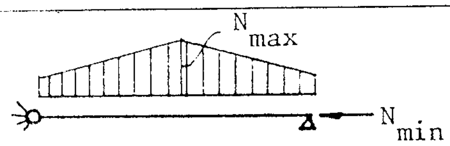
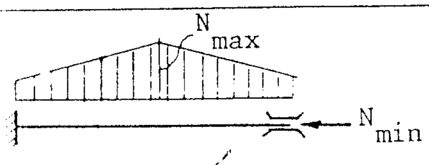
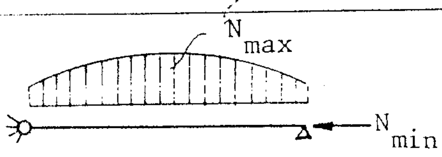


a)



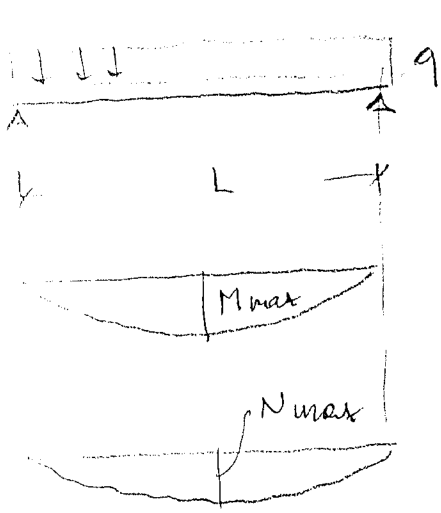
b)

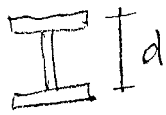
N variabile

	$\beta = \sqrt{(1+2.18\eta)/3.18}$	$\eta = \frac{N_{min}}{N_{max}}$
	$\beta = \sqrt{(1+0.93\eta)/7.72}$	
	$\beta = \sqrt{(1+1.09\eta)/2.09}$	

È il caso del corrente compresso di una trave da verificare a svergolamento col metodo dell'asta isolata.

Esempio

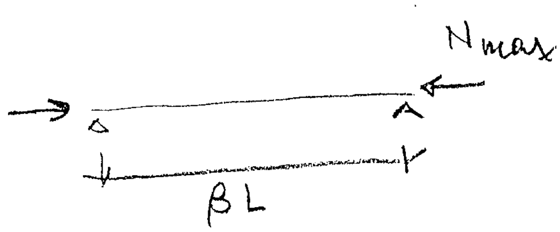




$$M_{max} = \frac{qL^2}{8}$$

$$N_{max} = \frac{M_{max}}{d}$$

Verificare l'ala compressa



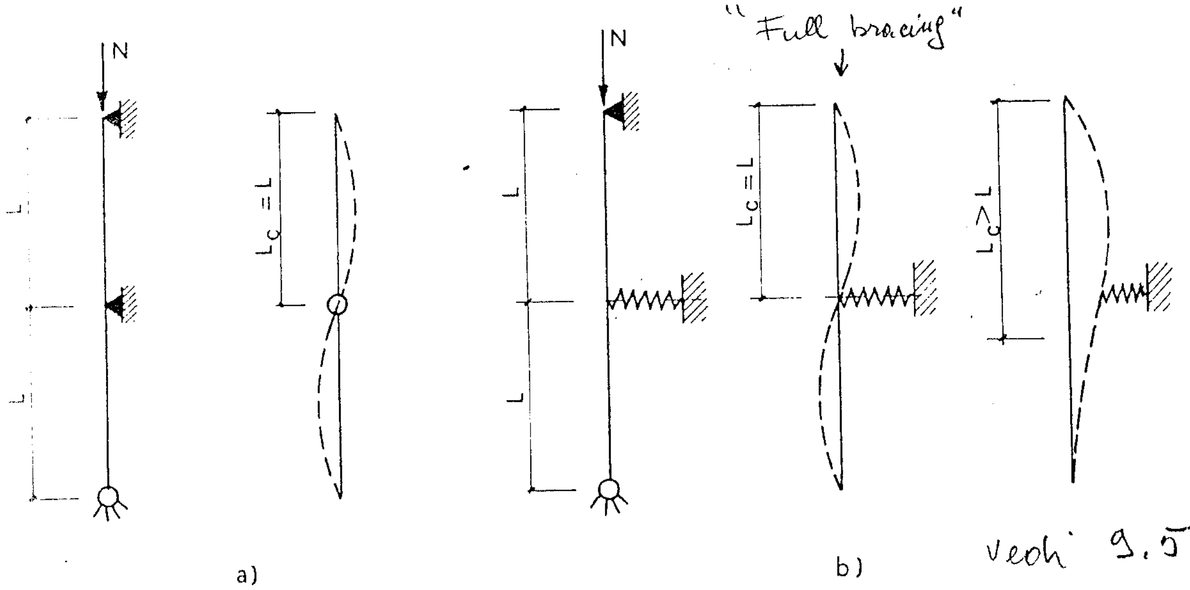
con $\beta = \sqrt{(1+1.09\times 0)/2.09}$

$\beta = 0{,}692$.

In alternativa usare $L_c = L$ con $N = \frac{\overline{M}}{d}$

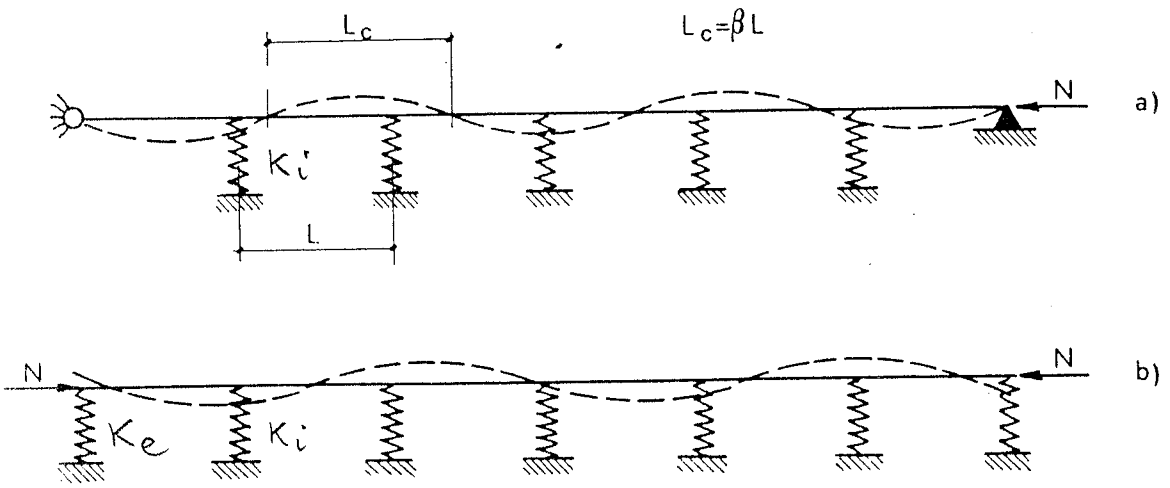
9.5.3. Aste con vincoli elastici

9.5.3.1. Aste compresse



vedi 9.5.

Nel caso di numerosi vincoli elastici (trave su suolo elastico):



Il problema è già stato illustrato per il caso di "full bracing" cioè quando si voglia che $L_c = L$.

Si aveva, per asta idealmente rettilinea:

$$K \geq K_{id} = 4\,\frac{N_e}{L} \qquad \text{con} \qquad N_e = \frac{\pi^2 E I}{L^2}$$

spesso però non è necessario avere una lunghezza di libera inflessione $L_c = L$. In tal caso si avrà un carico critico $N_{cr} = \pi^2 EI/L_c^2 < N_e$ -

Le rigidezza richiesta in tale caso è (Engesser):

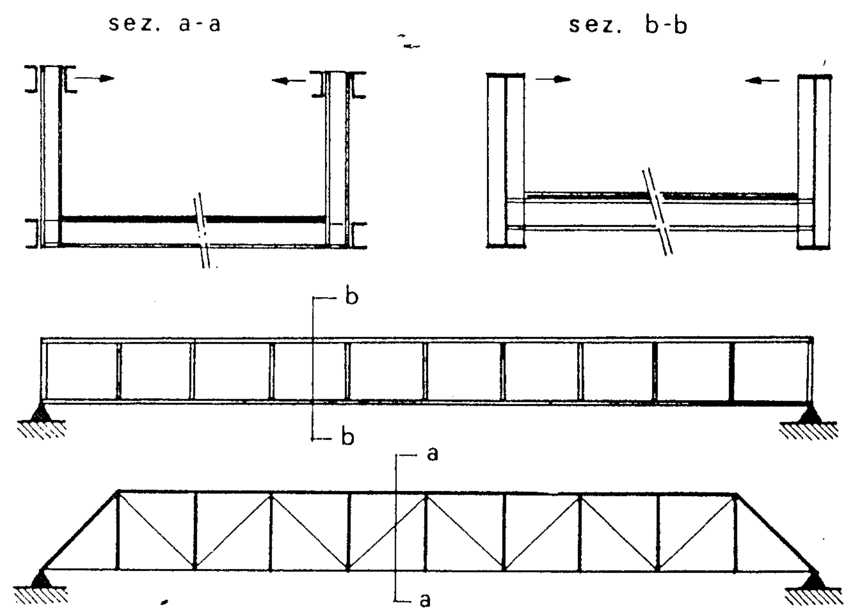
$$K \geq K_{id} = \frac{\pi^2}{4\beta^2}\,\frac{N_{cr}}{L} \simeq \frac{2{,}5}{\beta^2}\,\frac{N_{cr}}{L}\,;\ \left(\beta = L_c/L > 1.2\right)$$

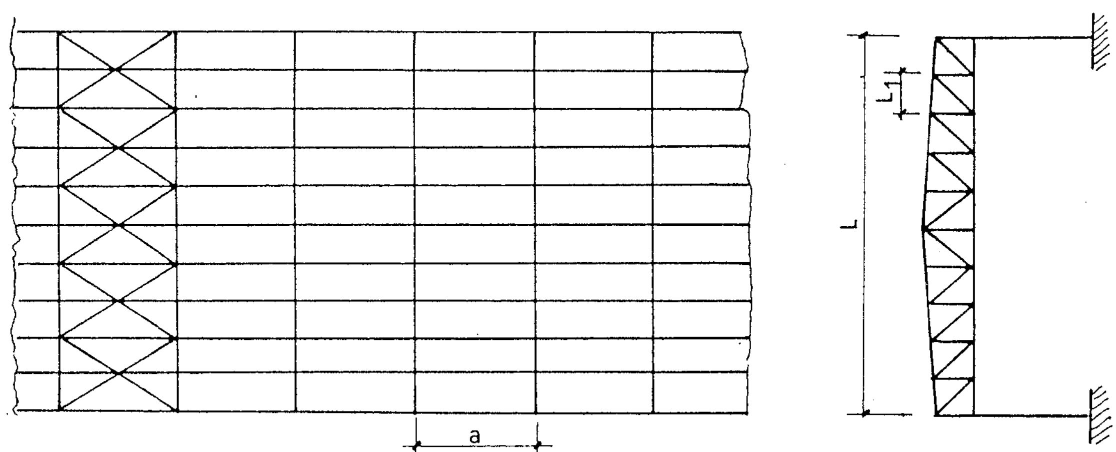
È la formula fornita dalle CNR 10011 al par. 7.2.7.1:

Per vincoli di estremità elastici (fig. b) il valore di Kid va aumentato con un coefficiente η-

Esempi :

b)





c)