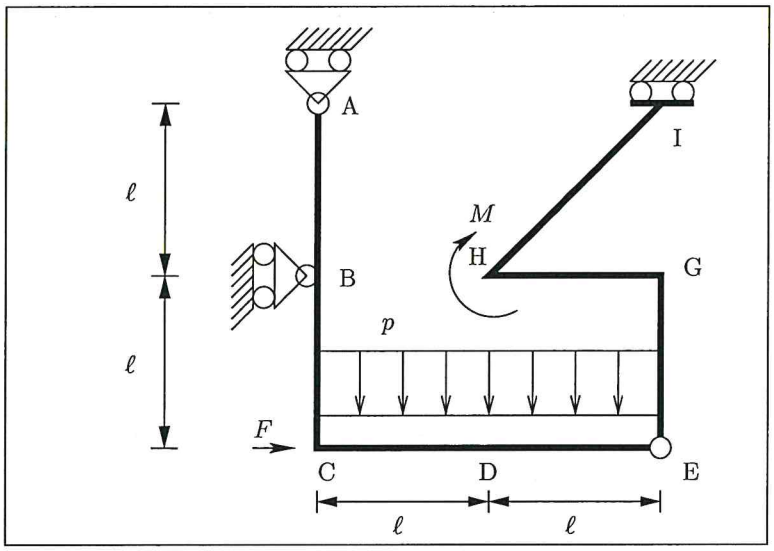
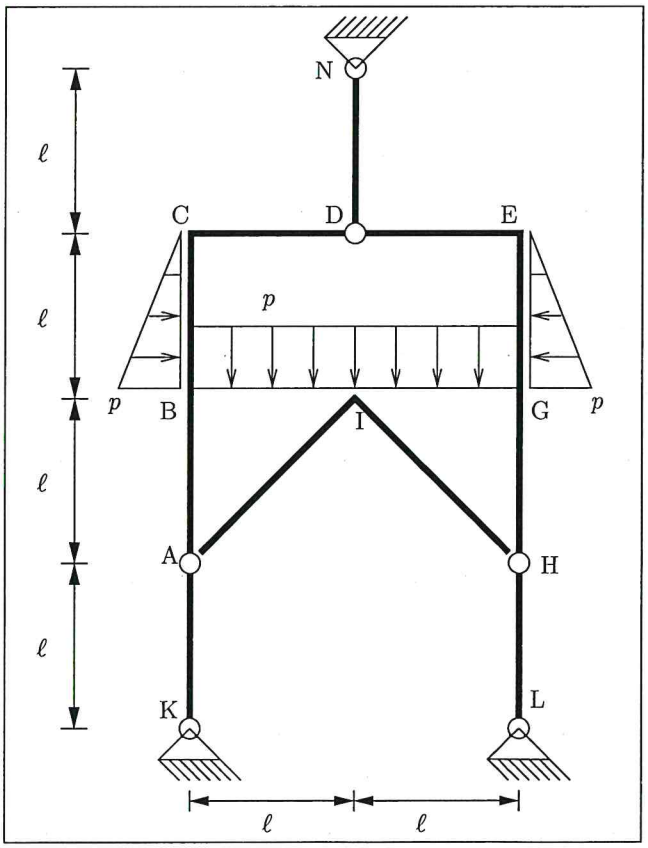
Statica - Ingegneria Civile e Ambientale - Prof. Daniele Zulli

APPELLO DEL 10/2/2025 - DURATA 3 ORE

Esercizio 1: Scrivere e diagrammare le leggi di variazione delle caratteristiche di sollecitazione per la struttura in figura, nel caso in cui sia $F = p\ell$ e $M = p\ell^2$. Calcolare la rotazione della sezione in G, noto EI e per $EA \to +\infty$.



Esercizio 2: Diagrammare le caratteristiche di sollecitazione per la struttura in figura nel caso in cui sia $EA = \frac{EI}{\ell^2}$ nei tratti AK, HL e DN, mentre $EA \to +\infty$ altrove.



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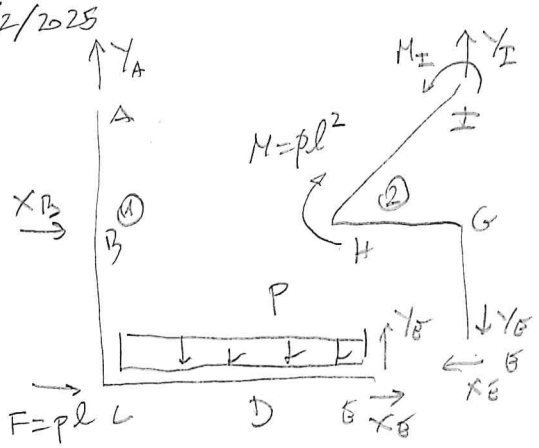


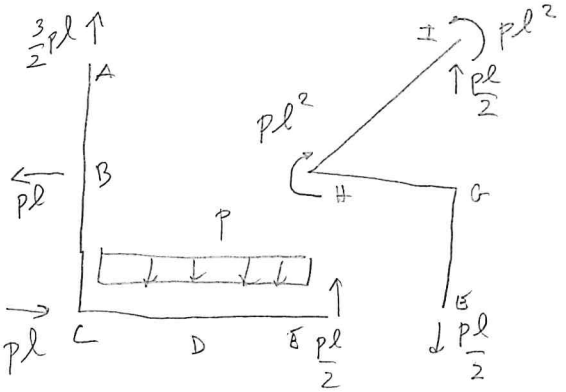
$\sum_{②} F_x = 0 \quad X_G = 0; \quad \sum_{②} M_I = 0 \;,\; M_I - pl^2 - X_G 2l = 0,\; M_I = pl^2$

$\sum_{①} M_B = 0 \;,\; pl^2 - 2pl^2 + 2Y_E l + X_G l = 0 \;,\; Y_E = \frac{pl}{2}$

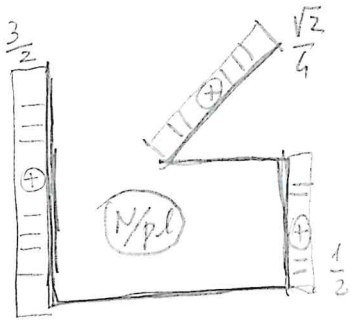
$\sum_{①} F_y = 0 \;,\; Y_A + Y_E - 2pl = 0 \;,\; Y_A = \frac{3}{2}pl$

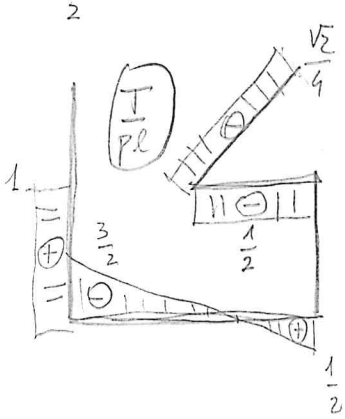
$\sum_{①} F_x = 0 \;,\; X_B + pl + X_G = 0 \;,\; X_B = -pl$

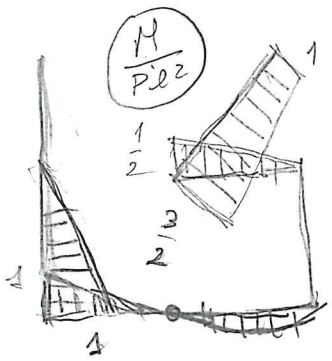
$\sum_{②} F_y = 0 \;,\; Y_I = Y_G = \frac{pl}{2}$



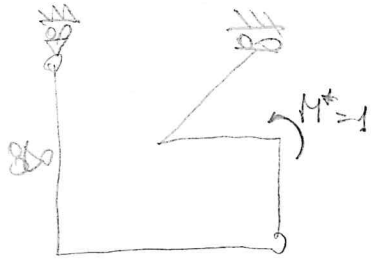
TRAVE	LUNG.	N	T	M
AB	l	$\frac{3}{2}pl$	0	0
BC	l	$\frac{3}{2}pl$	pl	$-plx$
CE	$2l$	0	$-\frac{3}{2}pl+px$	$-pl^2+\frac{3}{2}plx-\frac{px^2}{2}$
EG	l	$\frac{pl}{2}$	0	0
IH	$l\sqrt{2}$	$pl\frac{\sqrt{2}}{4}$	$pl\frac{\sqrt{2}}{4}$	$-pl^2-pl\frac{\sqrt{2}}{4}x$
HG	l	0	$-\frac{pl}{2}$	$-\frac{pl^2}{2}+\frac{pl}{2}x$

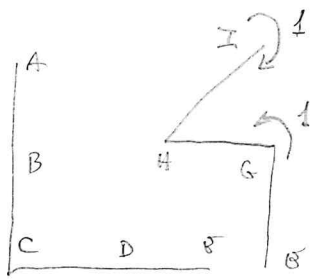






Probl. virt.





$M^*_{IH}(x) = 1$

$M^*_{HG}(x) = 1$

$M^*(x) \equiv 0$ altrove

$$\varphi_G = \frac{1}{EI}\int_D M(x)M^*(x)\,dx = \frac{1}{EI}\left[\int_0^{l\sqrt{2}}\left(-pl^2 - pl\frac{\sqrt{2}}{4}x\right)dx + \int_0^{l}\left(-\frac{pl^2}{2}+\frac{pl}{2}x\right)dx\right] = -\frac{1+5\sqrt{2}}{4}\frac{pl^3}{EI}$$

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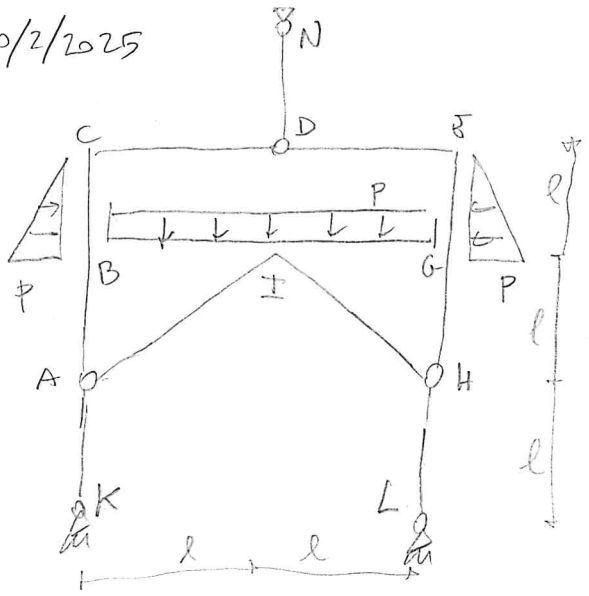
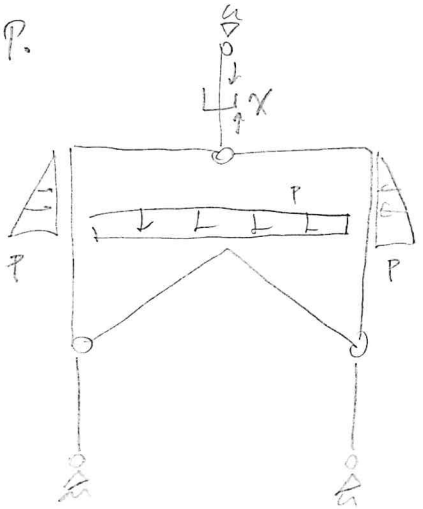
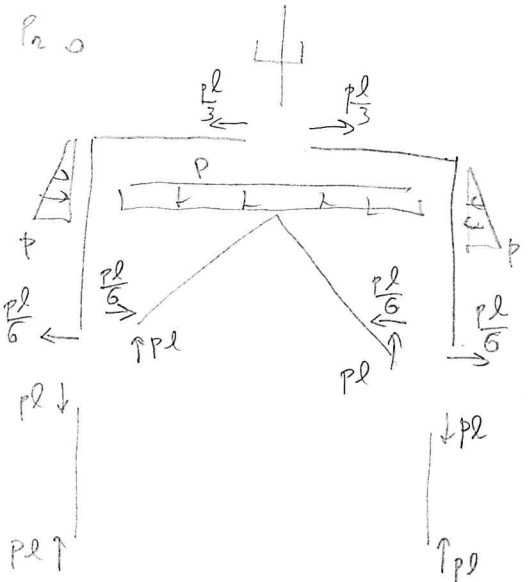


Anello a 3 cerniere ipostatico per vincoli interni. ADH vincolato a terra con 3 bielle verticali. La labilità orizzontale è risolta dalla simmetria di geometria e carichi.
La struttura è 1 volta iperstatica

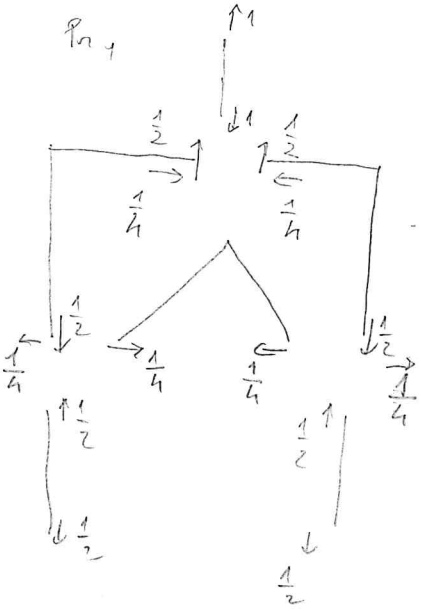
S.P.



P_{x0}



P_{x1}



TRAVE	LUNG	N_0	M_0	N_1	M_1
AK	l	$-pl$	0	$\frac{1}{2}$	0
DN	l	0	0	1	0
AB	l	–	$\frac{pl}{6}x$	–	$\frac{x}{4}$
BC	l	–	$\frac{pl^2}{6}+\frac{pl}{6}x-\frac{p}{l}(l-x)\frac{x^2}{2}-\frac{p}{l}\frac{x^3}{3}$	–	$\frac{1}{4}(l+x)$
DC	l	–	0	–	$-\frac{x}{2}$
AI	$l\sqrt{2}$	–	$\frac{5}{6}\frac{\sqrt{2}}{2}plx-p\frac{x^2}{4}$	–	$-\frac{\sqrt{2}}{8}x$

$$\eta_{11}=\frac{1}{EA}\left[\int_{DN}N_1^2\,dx+2\int_{AK}N_1^2\,dx\right]+\frac{2}{EI}\left[\int_D M_1^2\,dx\right]=\frac{48+\sqrt{2}}{24}\frac{l^3}{EI}$$

$$\eta_{10}=\frac{1}{EA}\left[\int_{DN}N_1N_0\,dx+2\int_{AK}N_1N_0\,dx\right]+\frac{2}{EI}\int_D M_1M_0\,dx=$$

$$=-\frac{11(58+5\sqrt{2})}{720}\frac{pl^4}{EI}$$

$$\eta_{11}X_1+\eta_{10}=0 \Rightarrow X_1=-\frac{\eta_{10}}{\eta_{11}}=\beta pl,\quad \beta=\frac{11(1387+91\sqrt{2})}{34530}\simeq 0{,}483$$