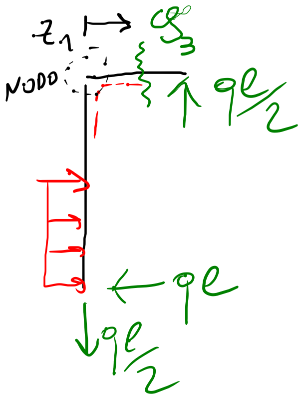
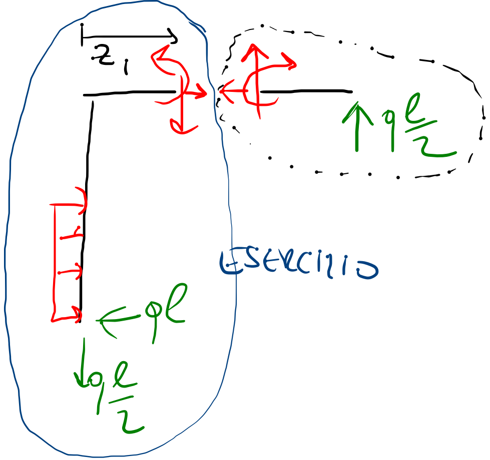
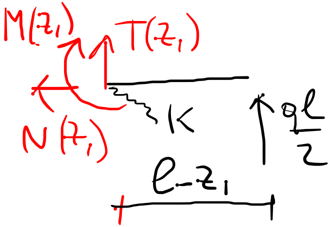
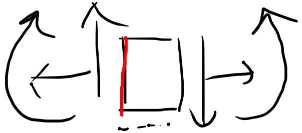
20/04/23





ESERCIZIO





EQUILIBRIO

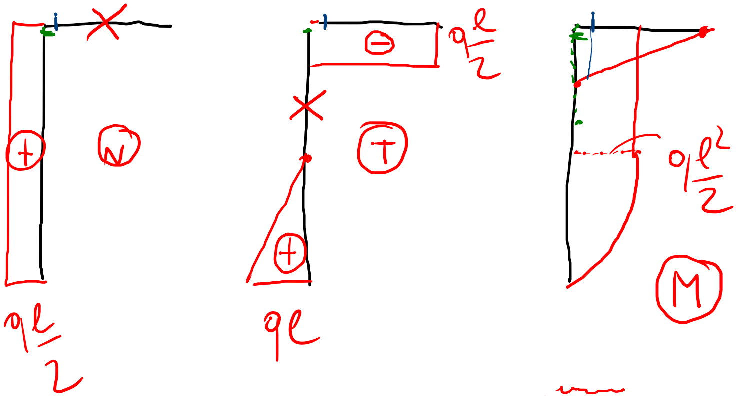
$+\rightarrow \; : \; -N(z_1)=0$

$+\uparrow \; : \; +T(z_1)+q\frac{\ell}{2}=0$

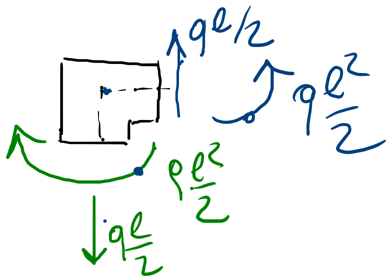
$+\circlearrowleft K \; : \; -M(z_1)+q\frac{\ell}{2}(\ell-z_1)=0 \; ; \quad M(z_1)=q\frac{\ell}{2}(\ell-z_1)$

$N(z_1)=0$

$T(z_1)=-q\frac{\ell}{2}$



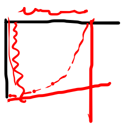
EQUILIBRIO DEL NODO



EQUIL. VERT: OK

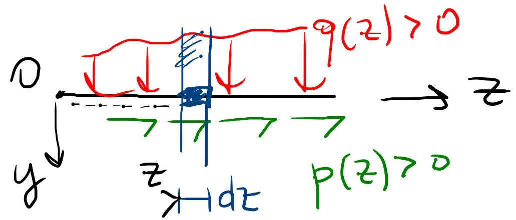
" ORIZZ: OK

EQUIL. ROTAZ: OK

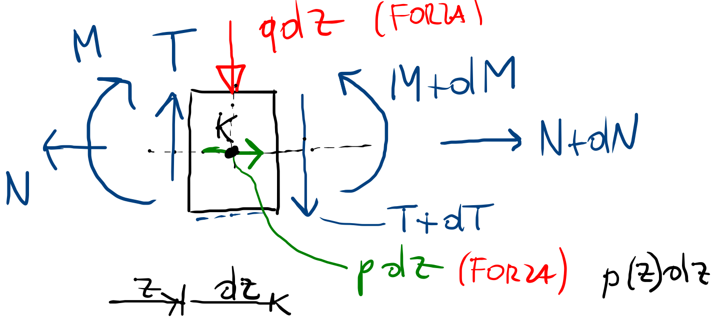


RIBALTAMENTO INTERNO DEL DIAGR. M

EQ. DI EQUILIBRIO PUNTUALE DELLE TRAVI RETTILINEE (EQ. INDEFINITE DI EQUILIBRIO)



$[p, q] = \left[\frac{F}{L}\right]$



EQUILIBRIO DEL CONCIO INFINITESIMO

$\xrightarrow{+}$: $\cancel{-N} + p\,dz \cancel{+N} + dN = 0 \Rightarrow dN = -p\,dz \Rightarrow$

$+\uparrow$: $\cancel{+T} - q\,dz - (\cancel{T} + dT) = 0 \Rightarrow dT = -q\,dz \Rightarrow$

$$\boxed{\begin{aligned} \frac{dN(z)}{dz} &= -p(z) \\ \frac{dT(z)}{dz} &= -q(z) \end{aligned}}$$

EQ. EQUIL. PUNTUALE (O INDEFINITE)

$K\circlearrowright^{+}$: $\cancel{-M} - T\frac{dz}{2} - (T + dT)\frac{dz}{2} + \cancel{M} + dM = 0 \Rightarrow -T\frac{dz}{2} - T\frac{dz}{2} - dT\frac{dz}{2} + dM = 0$

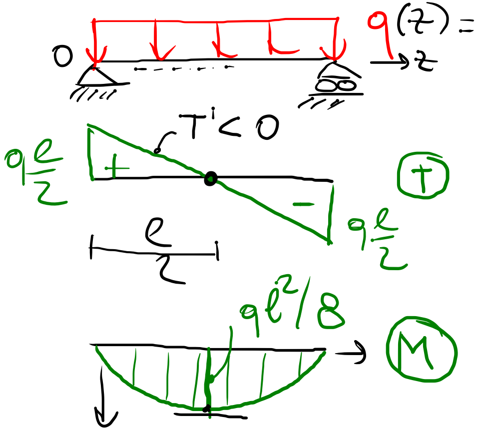
$$\underbrace{-T\,dz}_{\text{I ORDINE}} \; \underbrace{-dT\frac{dz}{2}}_{\text{II ORDINE}} \; \underbrace{+dM}_{\text{I ORDINE}} = 0 \Rightarrow \frac{dM}{dz} = T \Rightarrow \boxed{\frac{dM(z)}{dz} = T(z)}$$

SIGNIFICATO FISICO DELLE EQ. EQUIL. PUNTUALE

$$\frac{dN}{dz} = -p$$

$$\frac{dT}{dz} = -q$$

$$\frac{dM}{dz} = T$$



$T(z) = q\frac{\ell}{2} - qz \; ; \; \frac{dT}{dz} = -q$ OK

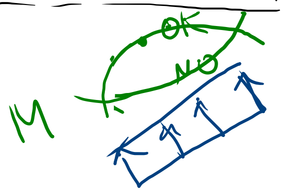
$M(z) = q\frac{\ell}{2}z - q\frac{z^2}{2} \; ; \; \frac{dM}{dz} = q\frac{\ell}{2} - 2\frac{qz}{2}$ OK

$= q\frac{\ell}{2} - qz = T(z)$

$\frac{dM}{dz} = 0 \Rightarrow$ MASSIMI / MINIMI } PTI STAZIONARIETÀ

$\Downarrow$

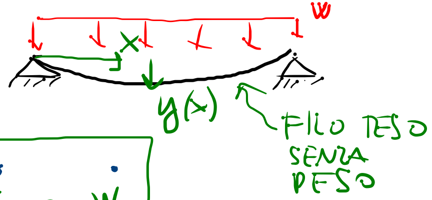
$T = 0$



$$\frac{d^2M}{dz^2} = \frac{dT}{dz} = -q$$

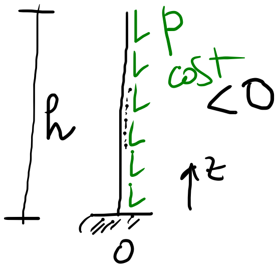
$$\frac{d^2M(z)}{dz^2} = -q(z)$$

ANALOGIA

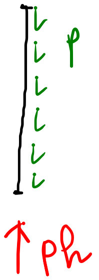


$$\boxed{\frac{d^2y}{dx^2} = -w}$$

ESERCIZIO DI INTEGRAZ. DELL' EQ $\frac{dN}{dz} = -p$



? CALCOLARE $N(z)$ INTEGRANDO $\frac{dN}{dz} = -p$

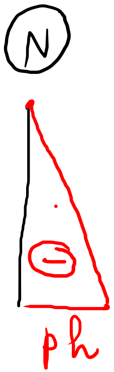


SCL.

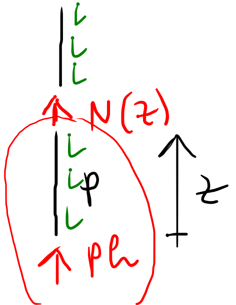
$(p<0)$

$$\begin{cases} \frac{dN}{dz} = p \\ N(0) = -ph \end{cases} \Rightarrow N(z) = pz + C \Rightarrow \boxed{N(z) = pz - ph}$$

$$C = -ph$$



DET. DI $N(z)$ CON IL METODO DELLA SEZIONE

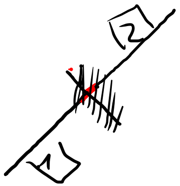


$$+\uparrow: \; +ph - pz + N(z) = 0$$

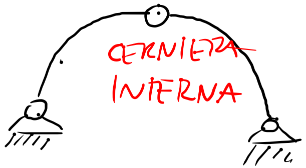
$$N(z) = pz - ph$$

VINCOLI INTERNI

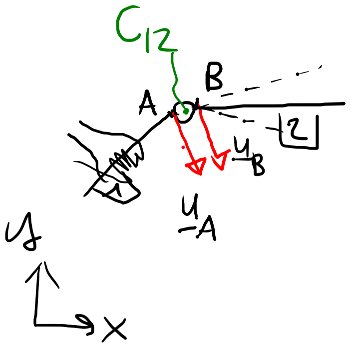
$v=3$: INCASTRO INTERNO



VINCOLO CHE ANNULLA TUTTI I G.D.L. RELATIVI DEL CORPO $\boxed{2}$ RISPETTO A $\boxed{1}$



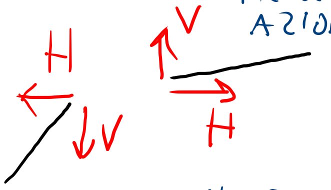
$v=2$: CERNIERA INTERNA



$\underline{u}_A = \underline{u}_B$ EQ DI VINCOLO $\begin{cases} u_{Ax} = u_{Bx} \\ u_{Ay} = u_{By} \end{cases}$

ROTAZIONI RELATIVE LIBERE.

CINEMATICA



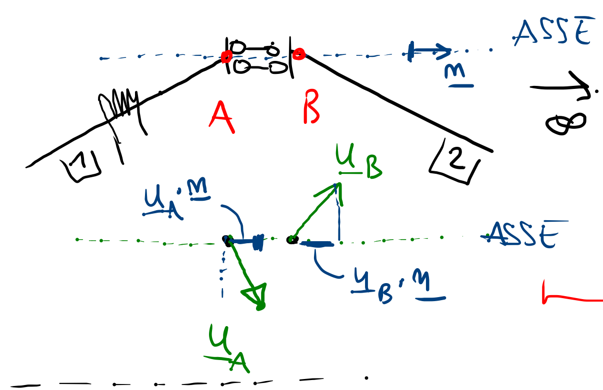
OPPOSTE PER IL PRINCIPIO DI AZIONE-REAZ.

REAZ. VINCOLARI INTERNE : 2 INCOGNITE V, H

STATICA

IL PUNTO CERNIERA È SEDE DI UN C.I.R. RELATIVO TRA I CORPI $\boxed{1}$ e $\boxed{2}$: C_{12}

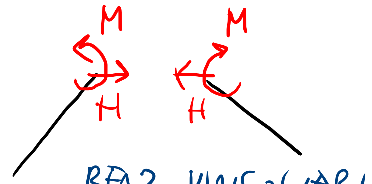
$\nu = 2$: DOPPIO PENDOLO INTERNO (PATTINO INTERNO)



$\rightarrow$ ∞ CIRREL C_{12}

$$\left.\begin{aligned} \underline{u}_A \cdot \underline{m} &= \underline{u}_B \cdot \underline{m} \\ \theta_1 &= \theta_2 \end{aligned}\right\} \text{EQ. DI VINCOLO}$$

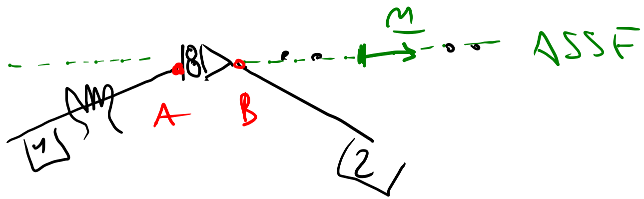
CINEMATICA



REAZ. VINCOLARI

STATICA

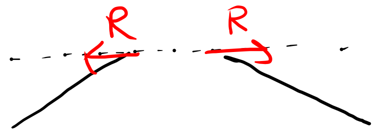
$\nu = 1$: CARRELLO (BIELLA, PENDOLO) INTERNO



$$\underline{u}_A \cdot \underline{m} = \underline{u}_B \cdot \underline{m}$$

EQ. DI VINCOLO

CINEMATICA



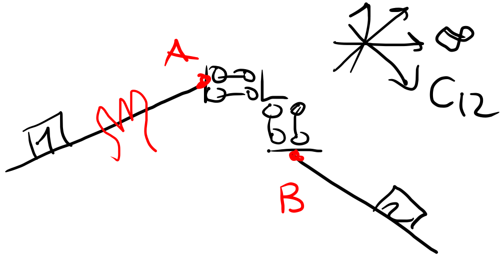
1 REAZ. VINCOLARE

STATICA

(NOTA: ROT. RELATIVE LIBERE: $\theta_1 \neq \theta_2$)

C_{12}: UN PUNTO DELL'ASSE

$v=1$: DOPPIO-DOPPIO PENDOLO INTERNO

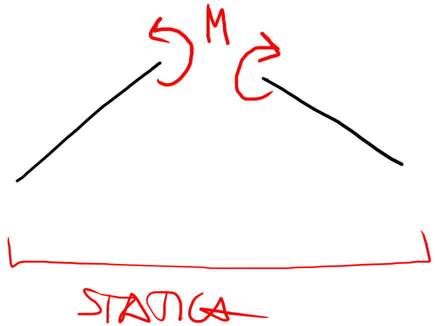


$\theta_1 = \theta_2$ EQ. DI VINCOLO

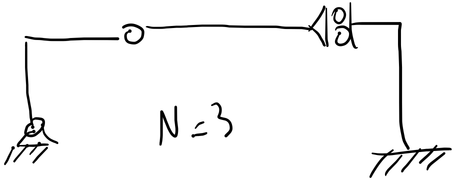
$C_{12} \in$ RETTA IMPROPRIA

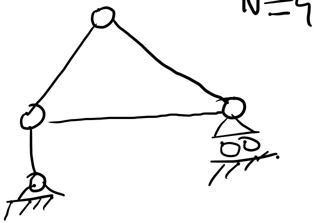
(NOTA: IL CORPO $\boxed{2}$ PUÒ TRASLARE LIBERAMENTE RISPETTO A $\boxed{1}$)

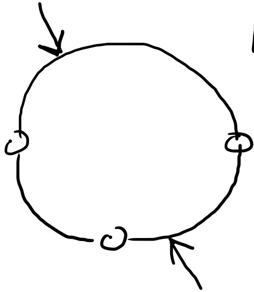
CINEMATICA



OSSERVAZ. CON I VINCOLI INTERNI POSSO COSTRUIRE STRUTTURE FORMATE DA N CORPI RIGIDI







N=3, SOLO VINCOLI INTERNI

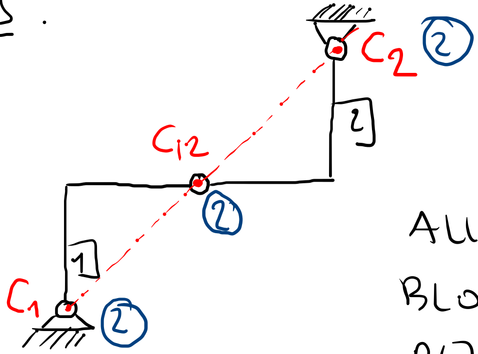
CARICHI EQUILIBRATI

Lo STUDIO della cinematica di 2 C.R. mutuamente vincolati coinvolge 3 CENTRI IST. DI ROTAZIONE (3 C.I.R.): C_1, C_2, C_{12}

PROPRIETÀ: CONDIZ. NECESSARIA affinché avvenga un moto relativo tra 2 C.R. è che i C.I.R. C_1 e C_2 siano allineati con C_{12}.

$$C_1 \Leftrightarrow C_{12} \Leftrightarrow C_2$$

ES.



L'ALLINEAM DEI CENTRI NON PERMETTE ALLE 3 CERNIERE DI BLOCCARE TUTTI I GDL DEL SISTEMA

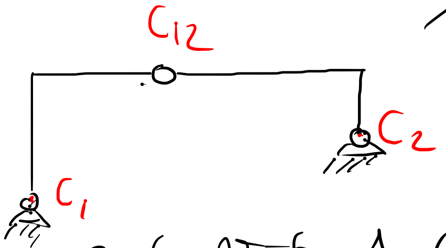
$\Rightarrow s=5$

$g = 2 \cdot 3 = 6$

$v = 6$

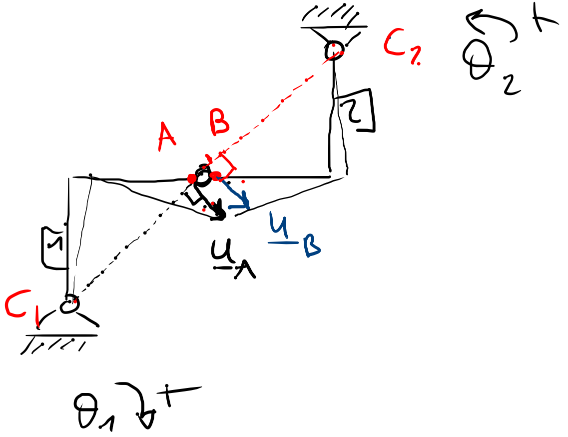
VINCOLI INEFFICACI

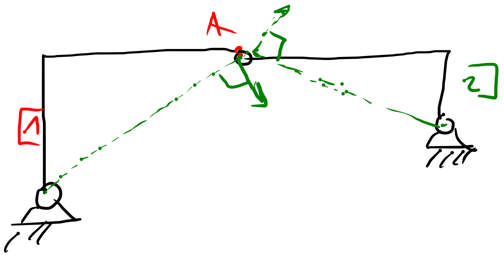
$\cancel{C_1 \Leftrightarrow C_{12} \Leftrightarrow C_2}$



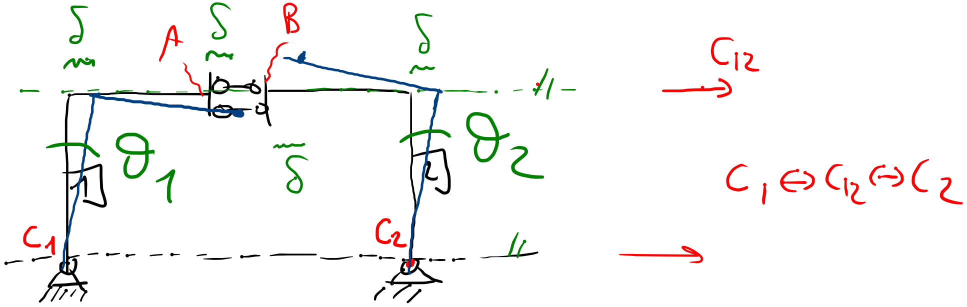
$g=6,\ v=6,\ s=6$

ISOSTATICA

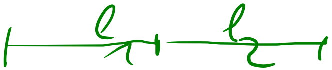




L'ALLINEAM. DELLE 3 CERNIERE GARANTISCE CHE I PUNTI A e B SI POSSONO SPOSTARE COMPATIBILMENTE CON I VINCOLI DEL SISTEMA

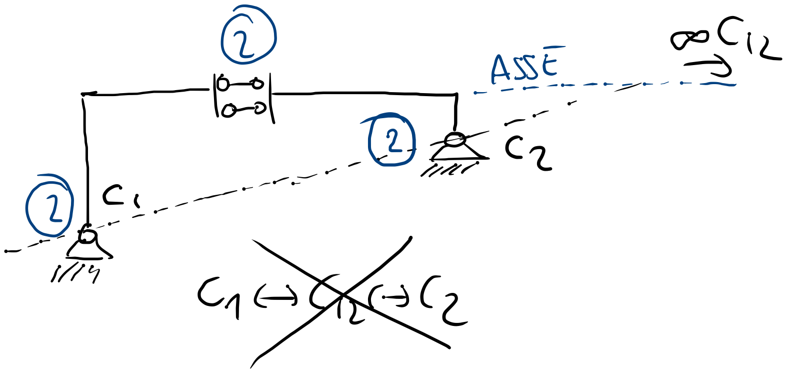


$\theta_1 = \theta_2$



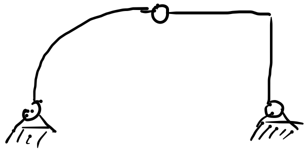
CINEMATISMO
(STR. LABILE)

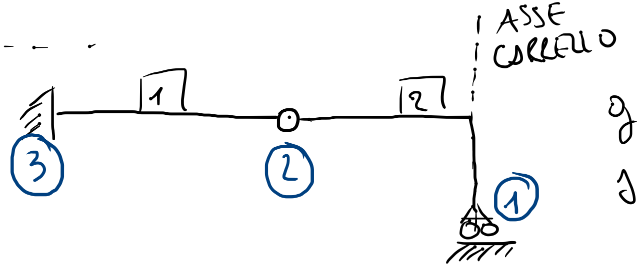
$g=6, \; v=6, \; s=5$



STR ISOSTATICA.

ESEMPI DI STR ISOSTATICHE



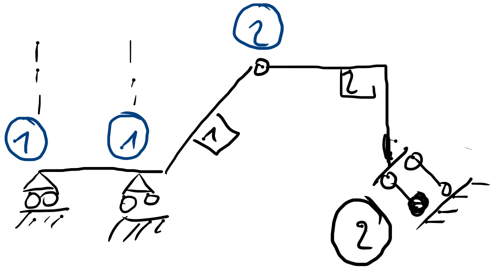


$g = 6$, $v = 6$

$\ell = 6$

ARCO A 3 CERNIERE

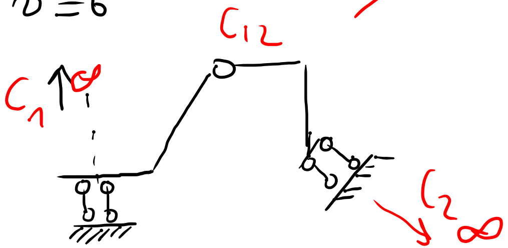
(CERNIERE NON ALLINEATE)



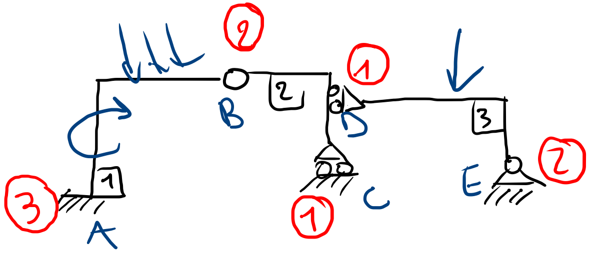
$g = 6$, $v = 6$

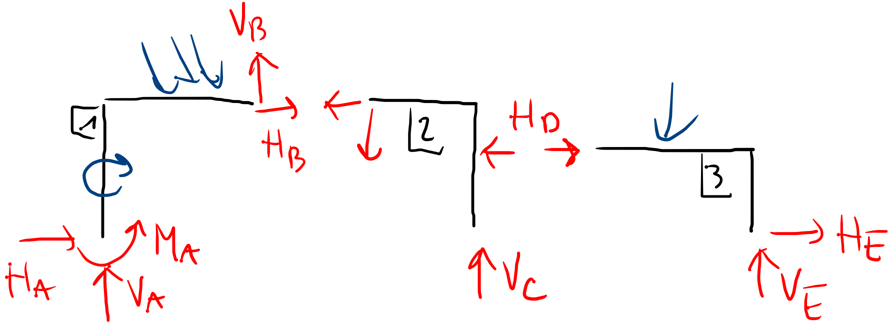
$\ell = 6$ $C_1 \uparrow \infty$

$\cancel{C_1 \leftrightarrow C_{12} \leftrightarrow C_2}$



METODO GENERALE DI ANALISI STATICA DELLE STR. ARTICOLATE





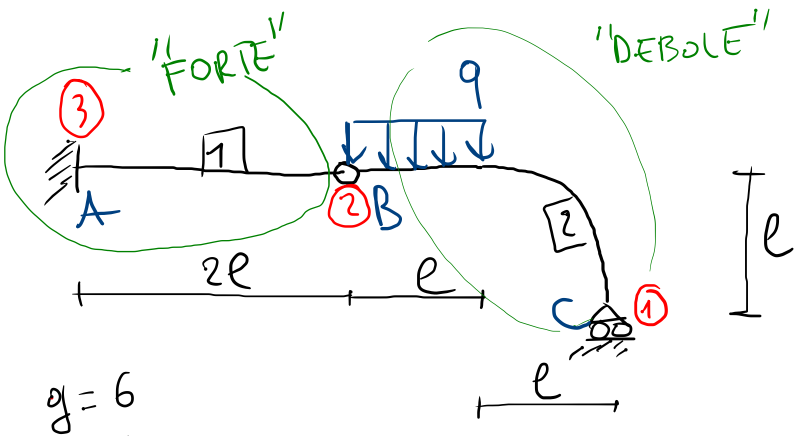
$g = 9,\quad v = 9,\quad s = 9$ (ISOST.)

QUANTE INCOGNITE STATICHE
CI SONO? 9!

SISTEMA DI
(9) g EQ.
IN
(9) v INCOGN.

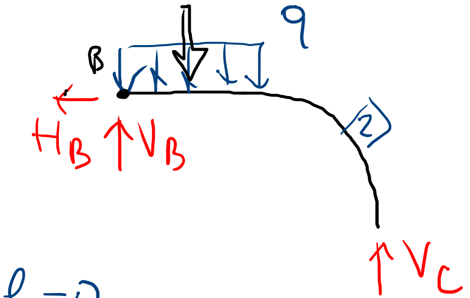
$$\begin{cases} \overset{+}{\rightarrow} \ \boxed{1} \\ +\uparrow \ \boxed{1} \\ \circlearrowleft A \ \boxed{1} \\ \overset{+}{\rightarrow} \ \boxed{2} \\ \uparrow + \ \boxed{2} \\ \circlearrowleft B \ \boxed{2} \\ \overset{+}{\rightarrow} \ \boxed{3} \\ +\uparrow \ \boxed{3} \\ \circlearrowleft E \ \boxed{3} \end{cases}$$

ES: STUDIO DI UNA STR ISOSTATICA "A STRUTTURA GERARCHICA"



$g = 6$
$v = 6$
$s = 6$
ISOST.

1) RISOLVO PRIMA LA STR $\boxed{2}$, INFATTI NOTO CHE LE INCOGNITE CHE INSISTONO SU $\boxed{2}$ SONO SOLO 3.



$\xrightarrow{+}$: $-H_B = 0$

$+\uparrow$: $V_B + V_C - q\ell = 0$

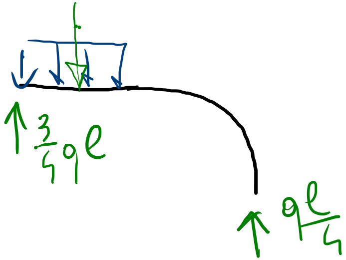
$+\circlearrowleft B$: $-q\ell\frac{\ell}{2} + V_C 2\ell = 0$

$V_C = +q\frac{\ell}{4}$

$V_B = \frac{3}{4}q\ell$

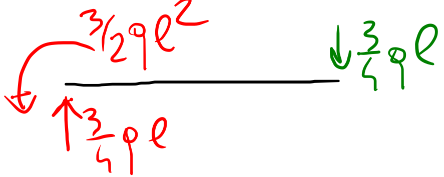
$H_B = 0$

$\Leftarrow$

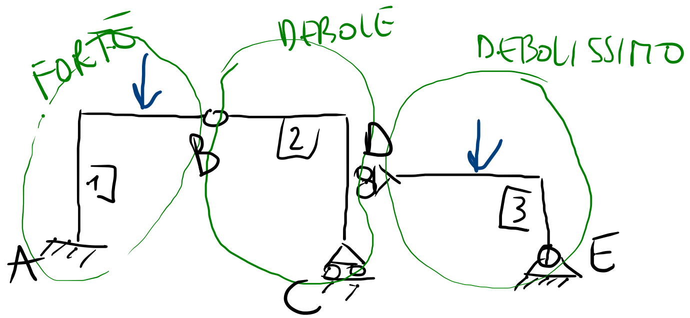


2)

RISOLVO LA STR $\boxed{1}$ "FORTE"



$\boxed{\text{ES}}$: STRUTT. CON 2 ORDINI DI GERARCHIA

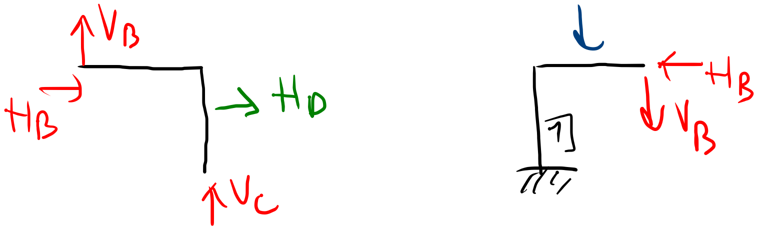


1) RISOLVO $\boxed{3}$ (3 EQ. IN 3 INCOGNITE)

e applico le reaz. opposte in D a $\boxed{2}$

2) RISOLVO $\boxed{2}$ (3 EQ. IN 3 INCOGNITE)

e applico le reaz. opposte in B a $\boxed{1}$



3) RISOLVO $\boxed{1}$

3 EQ. IN 3 INCOGNITE