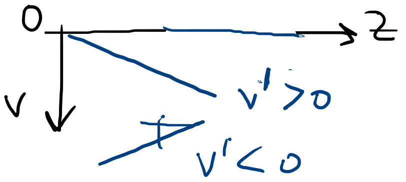
... (LINEA ELASTICA IV ORDINE)

5/10/22

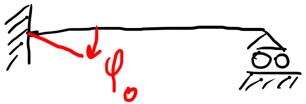
$$\boxed{EI\, v^{IV} = q}$$

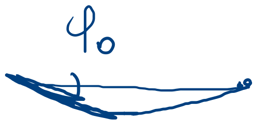


$v' = -\varphi \quad (\varphi + \circlearrowleft)$

$v'(L) = -\varphi_0$

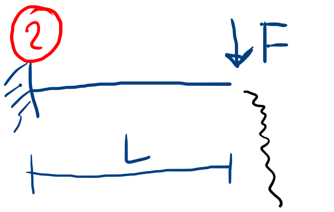
CEDIMENTI ANELASTICI



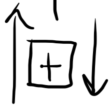


$EI\, v^{IV} = 0$

$$\begin{cases} v(0) = 0 \\ v'(0) = \varphi_0 \\ v(L) = 0 \\ v''(L) = 0 \end{cases} \Rightarrow \text{RISOLUZ.}$$



$T = +F$

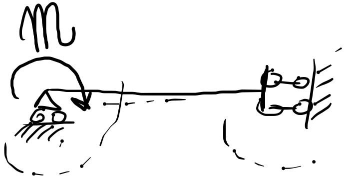


$M = -EIv''$

$T = -EIv'''$

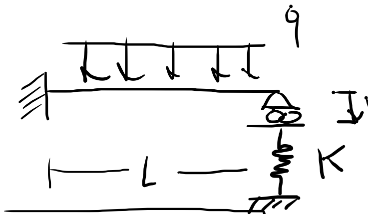
$EIv'''' = 0$

$$\begin{cases} v(0) = 0 \\ v'(0) = 0 \\ v''(L) = 0 \\ v'''(L) = -\dfrac{F}{EI} \end{cases}$$



$\boxed{v'''' = 0}$

$$\begin{cases} v(0) = 0 \\ v''(0) = -\dfrac{m}{EI} \\ v'(L) = 0 \\ v'''(L) = 0 \end{cases}$$



$Iv(L) > 0$

$\boxed{EIv'''' = 0}$

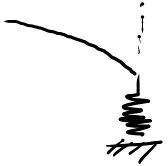
$$\begin{cases} v(0) = v'(0) = 0 \\ v'''(L) = \dfrac{K}{EI} v(L) \\ v''(L) = 0 \end{cases}$$

$EIv'''(L) = -T$

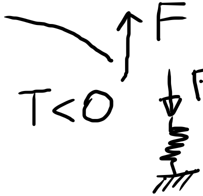
$= F$

$EIv'''(L) = Kv(L)$

VINCOLO CEDEVOLE ELASTICO



$v(L) > 0$



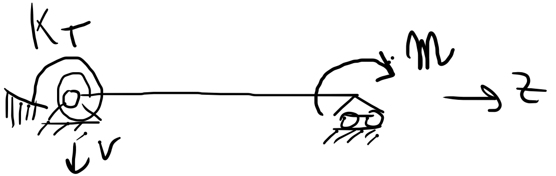
$T < 0$

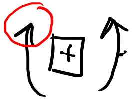
$F = Kv(L)$

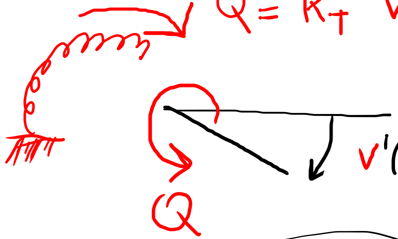
$K \to \infty$ $\quad$ $v(L) = \dfrac{EI}{K} v'''(L) \to 0$

$K \to 0$, $v'''(L) \to 0$

1 V. IPERST.







$Q = K_T\, v'(0)$

$v'(0) > 0$

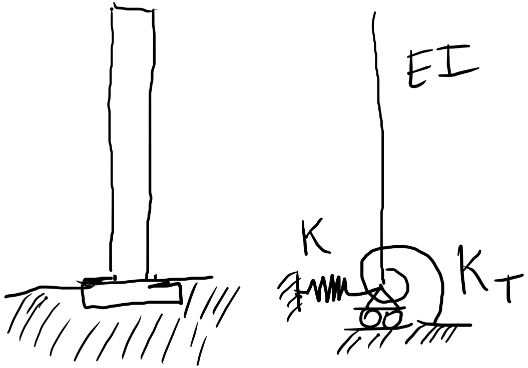
$EI\, v''''(z) = 0$

$-EI\, v''(L) = M(L) = -m$

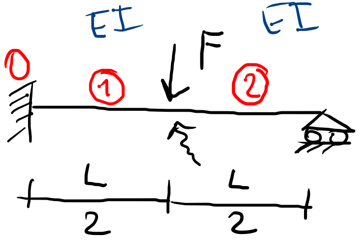
$$\begin{cases} v''(L) = \dfrac{m}{EI} \\ v(L) = 0 \\ v''(0) = \dfrac{K_T}{EI}\, v'(0) \\ v(0) = 0 \end{cases}$$

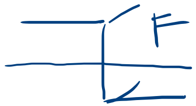
$M(0) = -Q = -EI\, v''(0)$

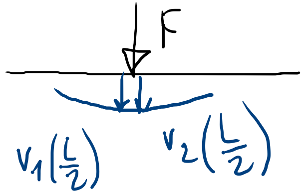
$[K_T] = [FL] \sim kNm$

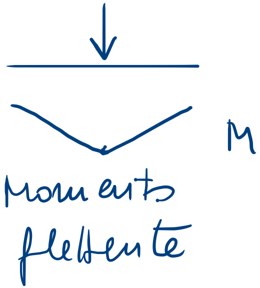


CARICHI CONCENTRATI IN CAMPATA





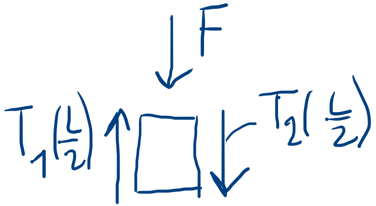




(1) $z \in \left[0, \frac{L}{2}\right[$ $\quad v_1''''(z) = 0$

(2) $z \in \left]\frac{L}{2}, L\right]$ $\quad v_2''''(z) = 0$

} 8 costanti (c. limiti + c. raccordo)



$$T_2\left(\frac{L}{2}\right) + F - T_1\left(\frac{L}{2}\right) = 0$$

$v_1(0) = 0$

$v_1'(0) = 0$

$v_2(L) = 0$

$v_2''(L) = 0$

$v_1\left(\frac{L}{2}^-\right) = v_2\left(\frac{L}{2}^+\right)$

$v_1'\left(\frac{L^-}{2}\right) = v_2'\left(\frac{L}{2}^+\right)$

} CINEMATICHE

STATICHE

$$\boxed{-EI\, v_2'''\left(\frac{L}{2}\right) + F + EI\, v_1'''\left(\frac{L}{2}\right) = 0}$$

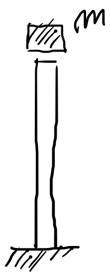
EQ. SALTO DEL TAGLIO

$$EI\, v_1''\left(\frac{L^-}{2}\right) = EI\, v_2''\left(\frac{L}{2}^+\right)$$

PRINCIPIO DI STAZIONARIETA' DELL'ENERGIA POTENZIALE

DALLA MECCANICA DEI SISTEMI DISCRETI SAPPIAMO CHE ATTRAVERSO LA STAZIONARIETA' DELL'ENERGIA POTENZIALE TOTALE SI OTTENGONO LE CONFIGURAZIONI DI EQUILIBRIO.

$$\Pi(\underline{u}) = \frac{1}{2}\int_B \underset{\sim}{\sigma} \cdot \underset{\sim}{\varepsilon}\, dV - \underbrace{\left\{ \int_B \underline{b} \cdot \underline{u}\, dV + \int_{\partial B} \underline{p} \cdot \underline{u}\, dS \right\}}_{\text{POTENZIALE DEI CARICHI}}$$



$\underline{u}$: CAMPO DI SPOST. IN B

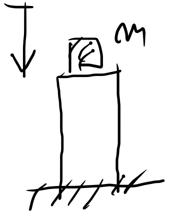
$\underset{\sim}{\sigma} = \mathbb{C}\, \underset{\sim}{\varepsilon}$

$\underset{\sim}{\varepsilon} = \frac{1}{2}\left(\nabla \underline{u} + \nabla \underline{u}^T\right)$

APPLICO UNA 'VARIAZIONE' DELLO SPOST. $\delta \underline{u}$

($\delta \underline{u}$ SIMILE A UNO SPOST. VIRTUALE)

EQUIL. : $\underline{u}^*$



$$\Pi(\underline{u}+\delta\underline{u}) = \frac{1}{2}\int_B \mathbb{C}(\underset{\sim}{\varepsilon}+\delta\underset{\sim}{\varepsilon})\cdot(\underset{\sim}{\varepsilon}+\delta\underset{\sim}{\varepsilon})\,dV - \int_B \underline{b}\cdot(\underline{u}+\delta\underline{u})\,dV - \int_{\partial B} \underline{p}\cdot(\underline{u}+\delta\underline{u})\,dS$$

$$\delta\underset{\sim}{\varepsilon} = \frac{1}{2}\left(\nabla\delta\underline{u}+\nabla\delta\underline{u}^T\right)$$

$$\Pi(\underline{u})+\delta\Pi = \frac{1}{2}\int \underbrace{\mathbb{C}\,\underset{\sim}{\varepsilon}}_{\underset{\sim}{\sigma}}\cdot\underset{\sim}{\varepsilon} + 2\,\mathbb{C}\,\underset{\sim}{\varepsilon}\cdot\delta\underset{\sim}{\varepsilon} + \underbrace{\mathbb{C}\,\delta\underset{\sim}{\varepsilon}}_{\delta\underset{\sim}{\sigma}}\cdot\delta\underset{\sim}{\varepsilon} - \int \underline{b}\cdot\underline{u} - \int \underline{b}\cdot\delta\underline{u} - \int \underline{p}\cdot\underline{u} - \int \underline{p}\cdot\delta\underline{u}$$

$$\delta\Pi = \underbrace{\frac{1}{2}\int \mathbb{C}\,\underset{\sim}{\varepsilon}\cdot\delta\underset{\sim}{\varepsilon} - \int \underline{b}\cdot\delta\underline{u} - \int \underline{p}\cdot\delta\underline{u}}_{\delta\Pi^{(1)}} + \underbrace{\frac{1}{2}\int_B \mathbb{C}\,\delta\underset{\sim}{\varepsilon}\cdot\delta\underset{\sim}{\varepsilon}}_{\delta\Pi^{(2)}}$$

FORMA QUADRATICA DEF. POSITIVA >0

STAZIONARIETÀ $\Pi(\underline{u}) \Rightarrow \boxed{\delta\Pi^{(1)} = 0}$

$$\delta\Pi^{(1)} = \int_B \underset{\sim}{\sigma}\cdot\delta\underset{\sim}{\varepsilon} - \int_B \underline{b}\cdot\delta\underline{u} - \int_{\partial B} \underline{p}\cdot\delta\underline{u} = 0$$

$$\boxed{\int_B \underset{\sim}{\sigma}\cdot\delta\underset{\sim}{\varepsilon} = \int \underline{b}\cdot\delta\underline{u} + \int \underline{p}\cdot\delta\underline{u}}$$

PLV $\Rightarrow \underset{\sim}{\sigma}$ è IN EQUIL. CON $\underline{p}, \underline{b}$

$$\Rightarrow \begin{cases} (B) & \operatorname{div}\underset{\sim}{\sigma} + \underline{b} = \underline{0} \\ (\partial B) & \underset{\sim}{\sigma}\,\underline{m} = \underline{p} \end{cases}$$

$\delta\Pi^{(1)} = 0 \Rightarrow$ CONDIZ. DI EQUILIBRIO DEL SISTEMA $(\underline{u}^*)$

$\delta\Pi^{(2)} > 0 \Rightarrow$ LA CONFIG. DI EQUILIBRIO $(\underline{u}^*)$ È UN MINIMO DELL'ENERGIA