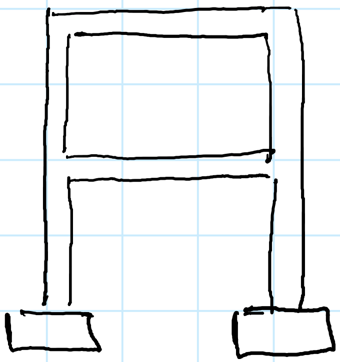
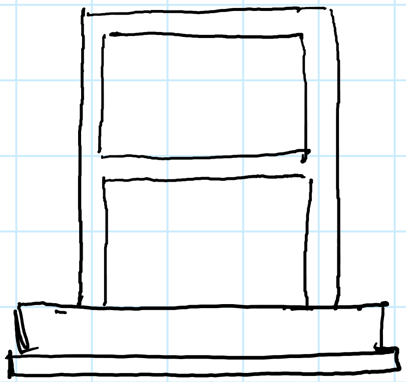
CLASSIFICAZIONE FONDAZIONI

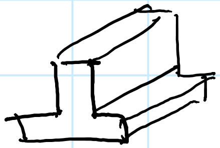
FONDAZIONI DIRETTE
- PLINTI ISOLATI
- TRAVE ROVESCIA
- RETICOLO DI TRAVI
- PLATEA NERVATA

FONDAZIONI PROFONDE — FONDAZIONI SU PALI

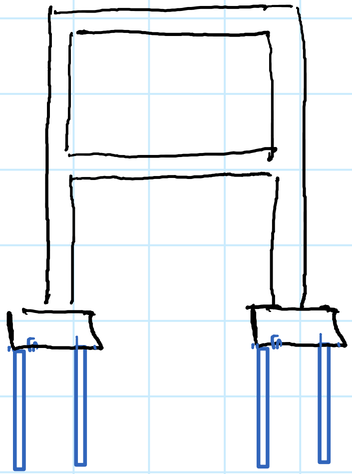


PLINTI





TRAVE ROVESCIA



PLINTI SU PALI

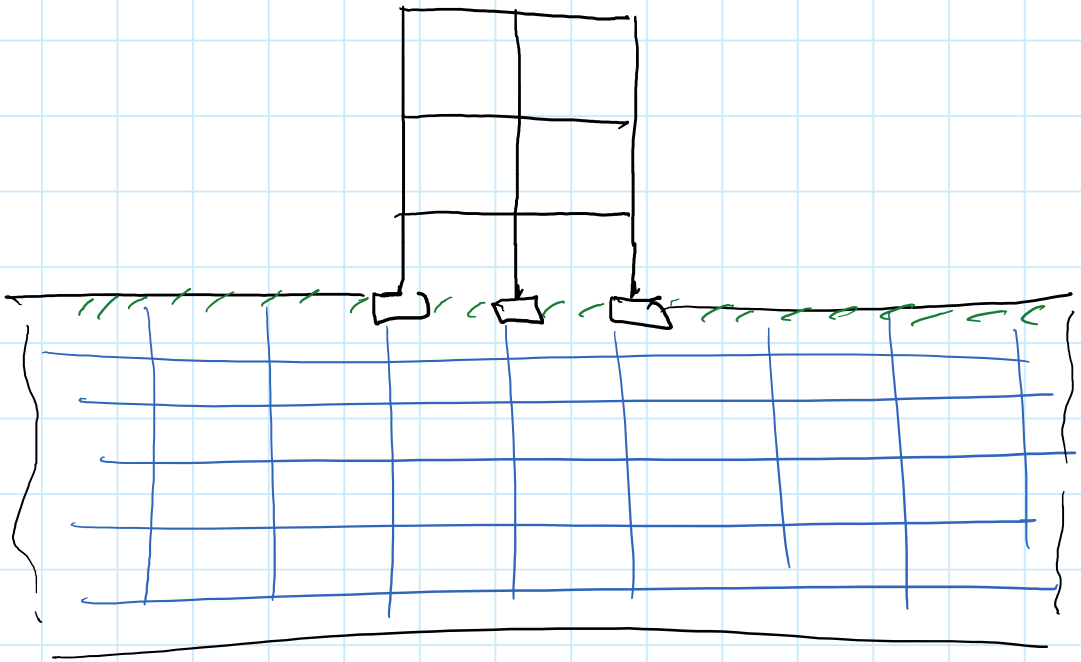
ASPETTI COINVOLTI

1. CALCOLO DELLA CAPACITÀ PORTANTE E DEI CEDIMENTI (GEOTECNICA)

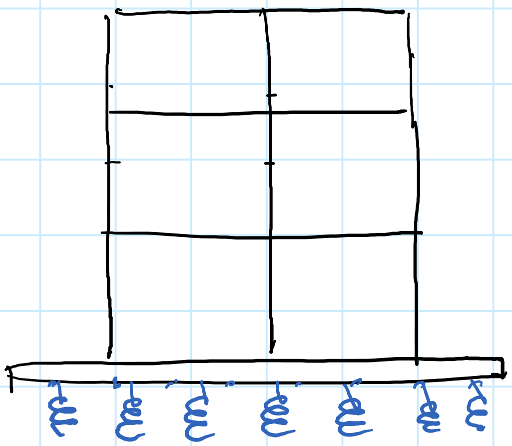
2. PROGETTO SEZIONE CLS E ARMATURE (STRUTTURALE)

3. INTERAZIONE TERRENO - STRUTTURA

POSSIBILI MODELLI

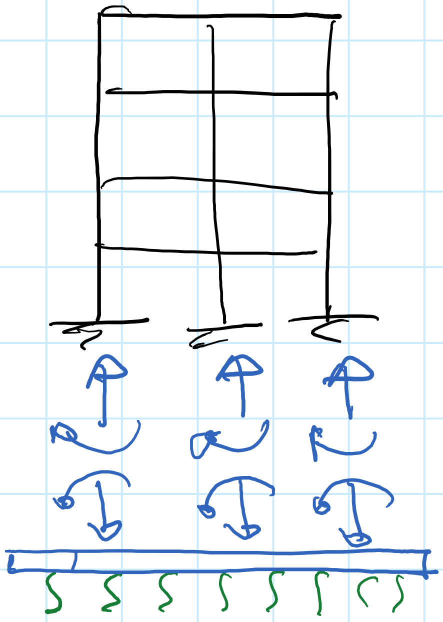


MODELLO AGLI ELEMENTI FINITI DEL TERRENO



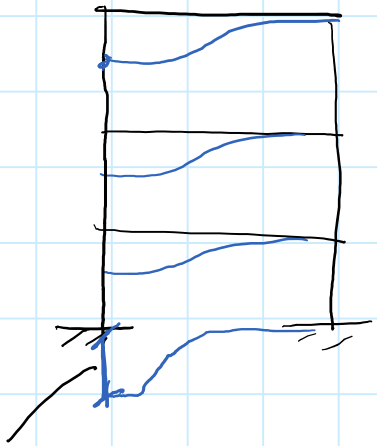
MODELLO SEMPLIFICATO DI SUOLO ALLA WINKLER

SEMPLIFICAZIONE PER FONDAZIONE RIGIDA



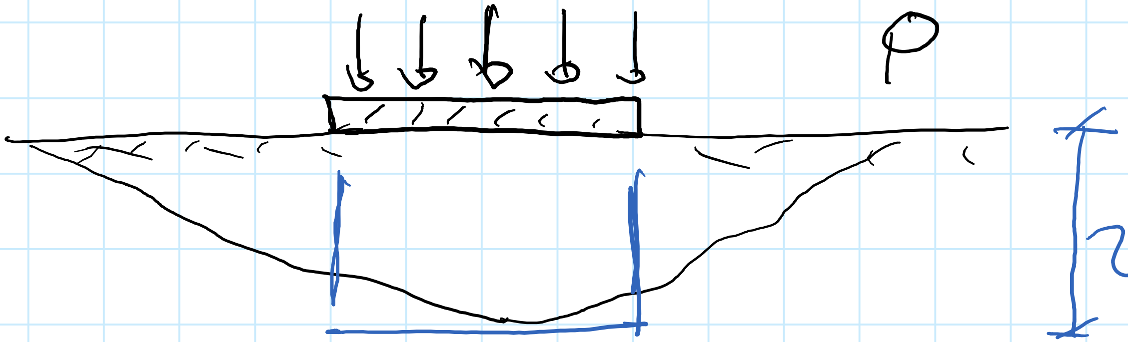
SUOLO ALLA WINKLER

N.B. SE LA FONDAZIONE NON È SUFFICIENTEMENTE RIGIDA



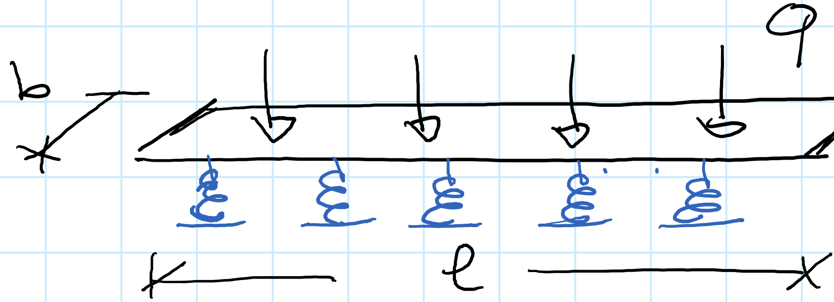
CEDIMENTO DIFFERENZIALE

TRAVE ALLA WINKLER (SUOLO ELASTICO)

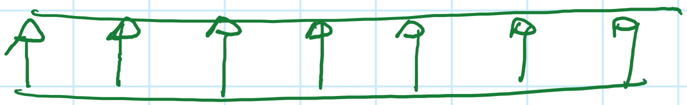


$$\frac{p}{v} = K \quad \left[\frac{F}{L^3}\right]$$

COSTANTE DI SOTTOFONDO



$$q = p \cdot b \rightarrow K = \frac{q}{v\,b}$$



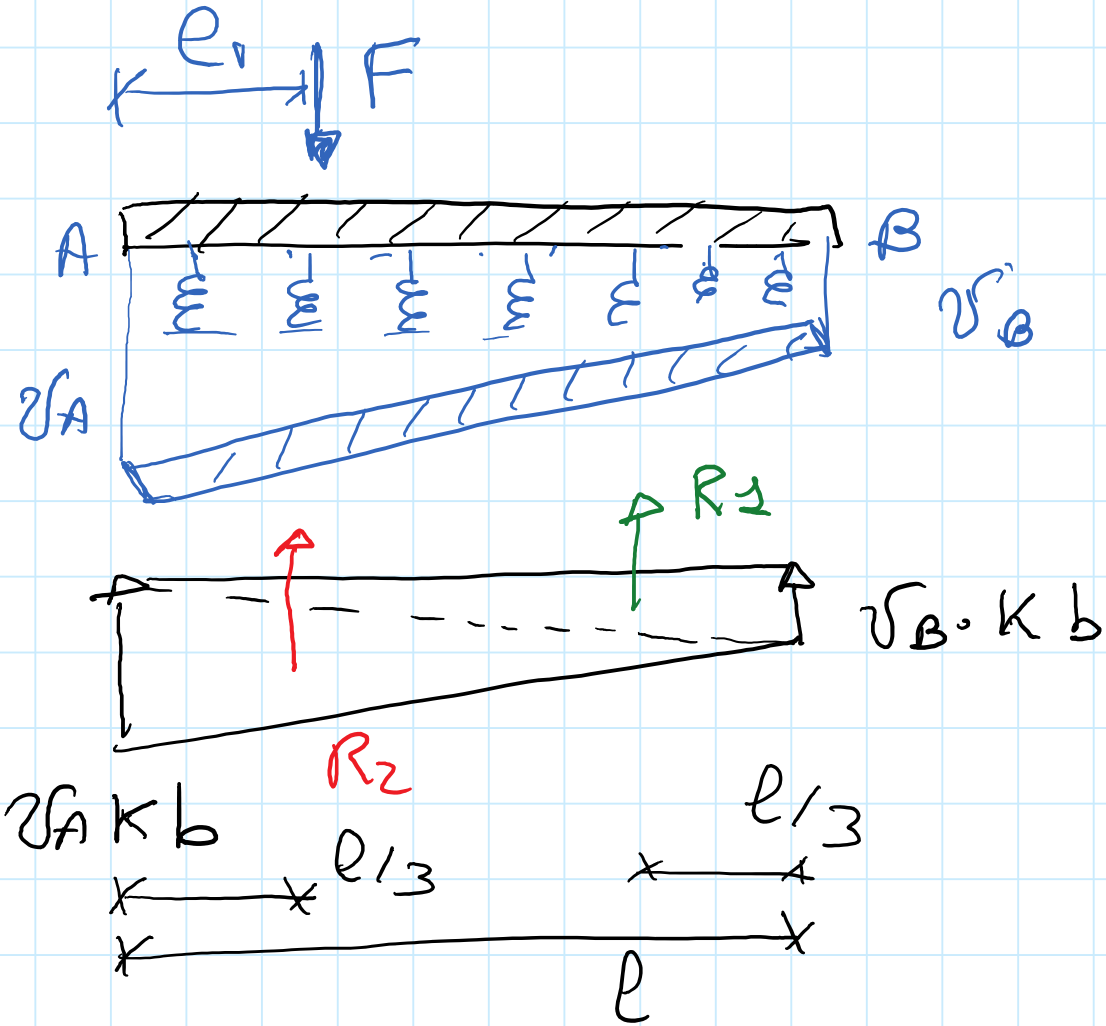
$r = K \cdot v\,b$ (REAZIONE TERRENO)

TRAVE RIGIDA SU SUOLO ELASTICO

TRAVE ELASTICA SU SUOLO ELASTICO

TRAVE RIGIDA SU SUOLO ELASTICO

UTILE SOLO PER STIMA CEDIMENTI.



2 GRADI DI LIBERTÀ

$$R_1 = v_B K b \, l \, \frac{1}{2}$$

$$R_2 = v_A K b \, l \, \frac{1}{2}$$

IMPONGO DUE CONDIZ. DI EQUILIBRIO

1. $F = R_1 + R_2$

2. $F \cdot l_1 = R_2 \frac{l}{3} + R_1 \frac{2}{3} l$

$$\begin{cases} F = R_1 + R_2 \\ F \cdot \ell_1 = R_2 \dfrac{\ell}{3} + R_1 \dfrac{2}{3}\ell \end{cases} \longrightarrow \begin{cases} R_1 = F - R_2 & (1) \\ F\ell_1 = R_2 \cdot \dfrac{\ell}{3} + (F - R_2)\dfrac{2}{3}\ell & (A) \end{cases}$$

$$(A) \quad F \cdot \ell_1 = R_2 \cdot \frac{\ell}{3} + \frac{2}{3}F\ell - \frac{2}{3}R_2\ell$$

$$\frac{1}{3}R_2\ell = \frac{2}{3}F\ell - F\ell_1 \longrightarrow R_2 = \frac{3}{\ell}F\left(\frac{2}{3}\ell - \ell_1\right)$$

$$\sigma_A K b \cdot \frac{\ell}{2} = \frac{3F}{\ell}\left(\frac{2}{3}\ell - \ell_1\right) \longrightarrow \sigma_A = \frac{6F}{Kb\ell^2}\left(\frac{2}{3}\ell - \ell_1\right)$$

$$(1) \quad R_1 = F - \frac{3}{\ell}F\left(\frac{2}{3}\ell - \ell_1\right) = -F + \frac{3}{\ell}F\ell_1 \Longrightarrow$$

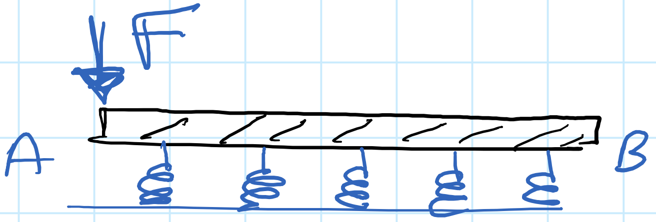
$$\sigma_B K \ell b \frac{1}{2} = -F + \frac{3}{\ell}F\ell_1 \longrightarrow \sigma_B = \frac{2F}{Kb\ell^2}\left(-\ell + 3\ell_1\right)$$

SE $-\ell + 3\ell_1 < 0$, CIOÈ $\ell_1 < \frac{1}{3}\ell \Rightarrow v_B < 0$

(UNA PARTE DEL TERRENO SAREBBE SOGGETTA A TRAZIONE)

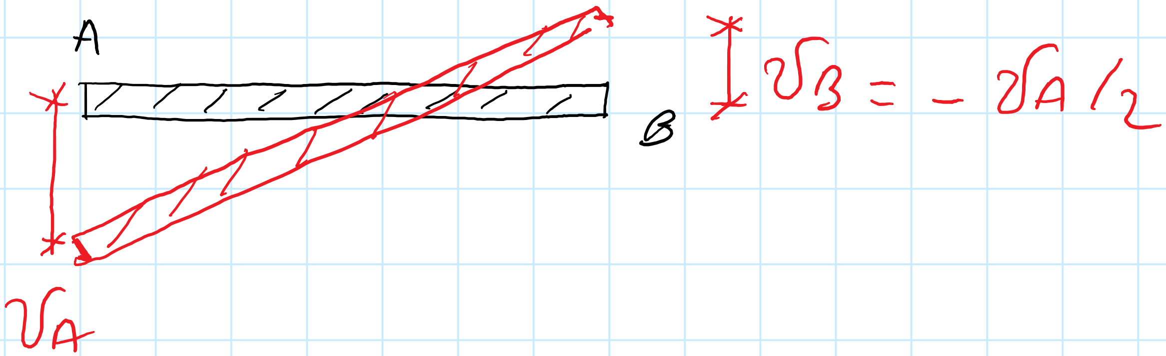
CASO PARTICOLARE

$\ell_1 = 0 \Rightarrow$

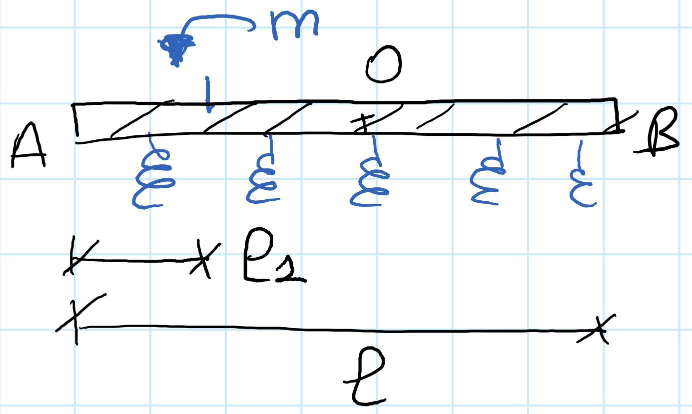


$$v_B = -\frac{2F}{Kb\ell}$$

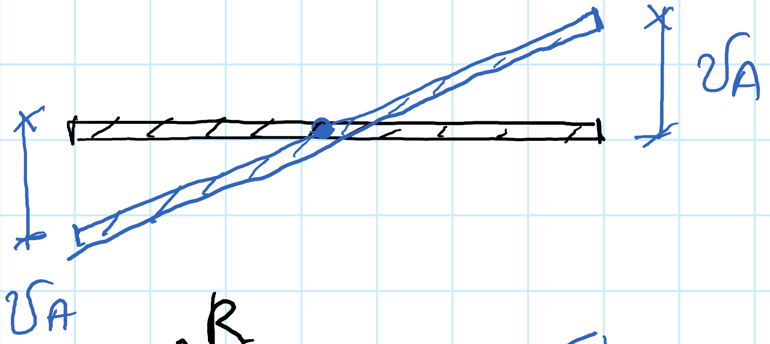
$$v_A = \frac{4F}{Kb\ell}$$



ESEMPIO 2



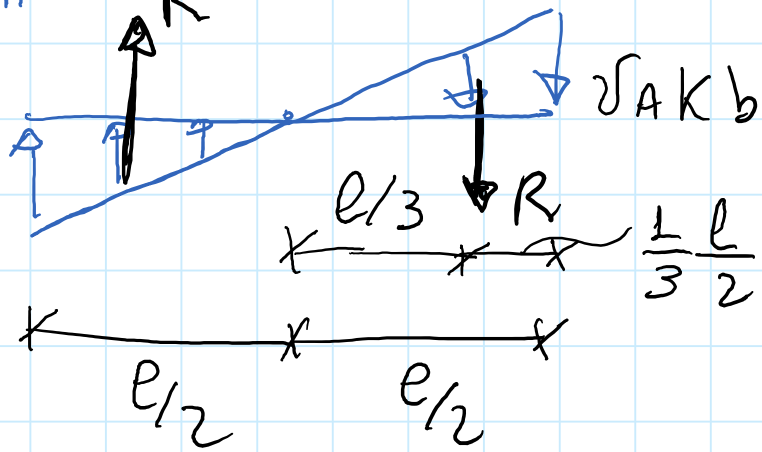
PER AVERE EQ. ALLA TRASLAZIONE $v\left(\frac{l}{2}\right) = 0$



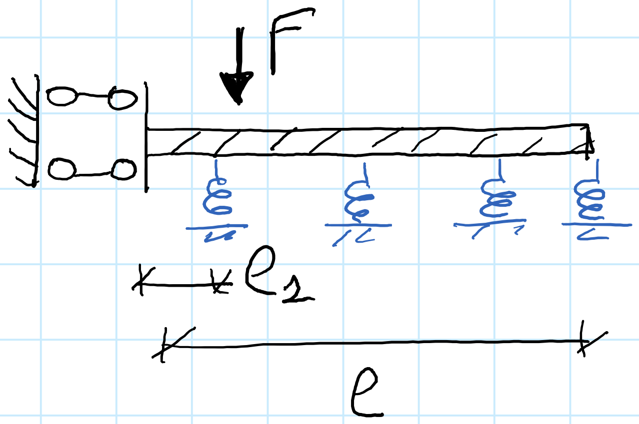
$$R \cdot \frac{2}{3} l = m$$

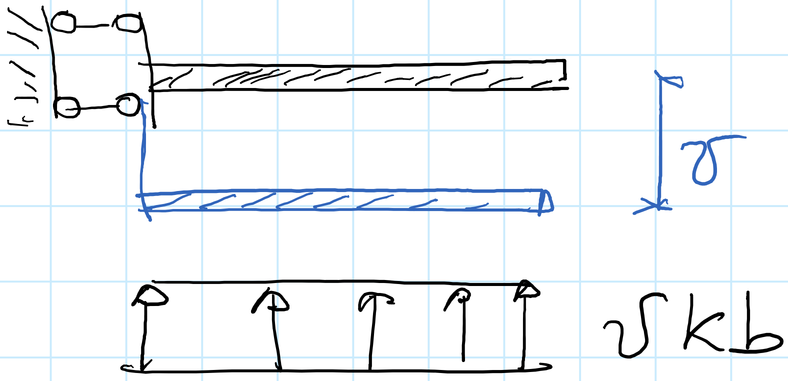
$$v_A k b \cdot \frac{l}{2} \cdot \frac{1}{\cancel{2}} \cdot \frac{\cancel{2}}{3} l = m$$

$$v_A = \frac{6m}{k b l^2}$$



ESEMPIO 3

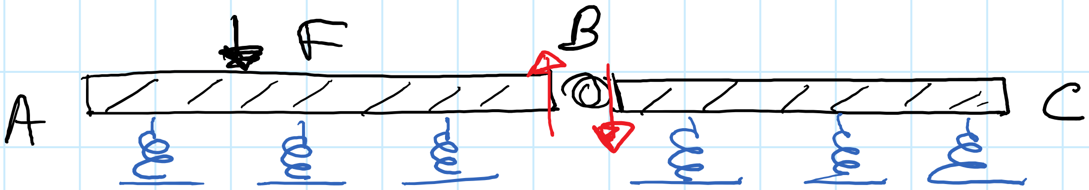


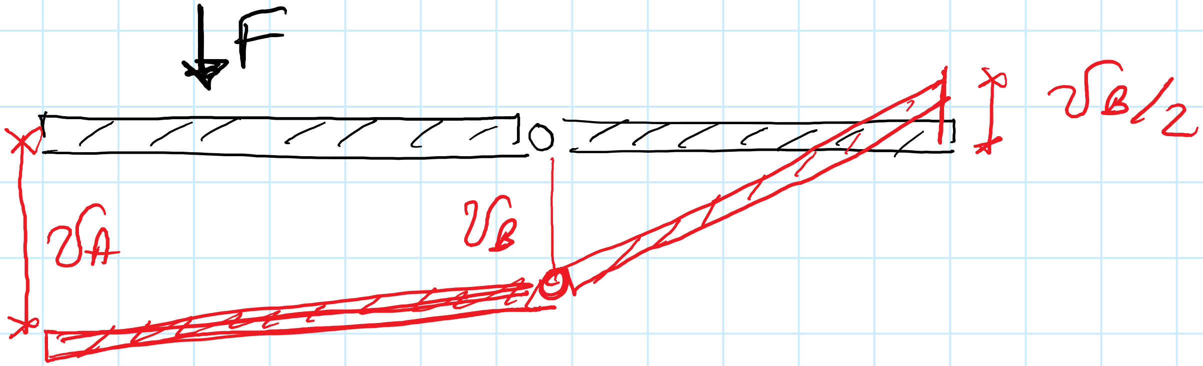


EQ. TRASLAZIONE $\quad F = kb \cdot v\ell \rightarrow v = \dfrac{F}{kb\ell}$

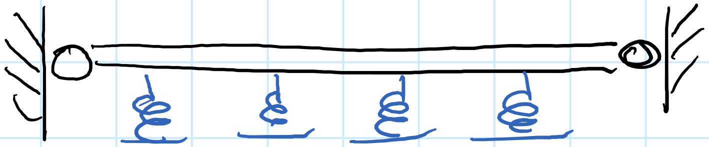
DA EQ. ROTAZIONE TROVO LA REAZIONE DEL VINCOLO

ESEMPIO 4



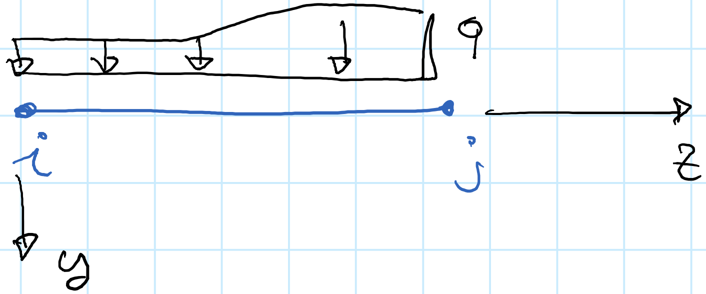


ESEMPIO 5



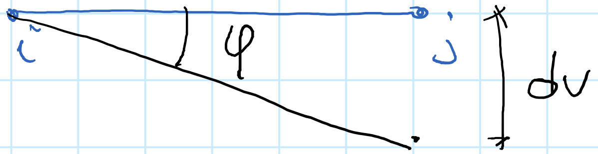
IL METODO È APPLICABILE SOLO A TRAVI CHE SAREBBERO LABILI IN ASSENZA DI SUOLO

TRAVE ELASTICA SU SUOLO ELASTICO



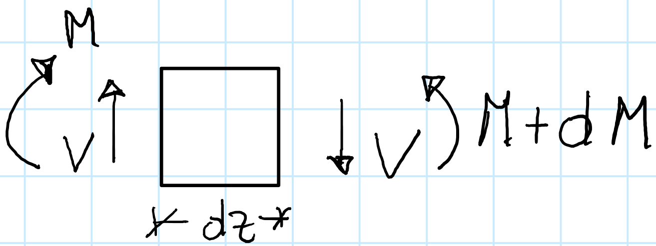
$v > 0$ se $\downarrow$

$\varphi > 0$ se $\circlearrowright$



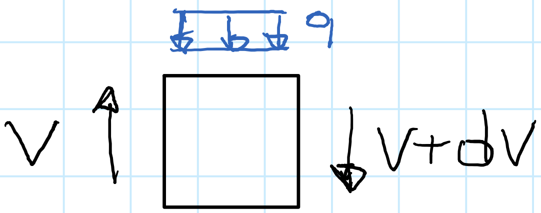
$$\varphi = -\frac{dv}{dz}$$

$$\chi = \frac{d\varphi}{dz} = -\frac{d^2 v}{dz^2} \rightarrow \chi = \frac{M}{EI} \Rightarrow M = -EI\frac{d^2 v}{dz^2}$$



$$\cancel{M} + V\,dz = \cancel{M} + dM \Rightarrow$$

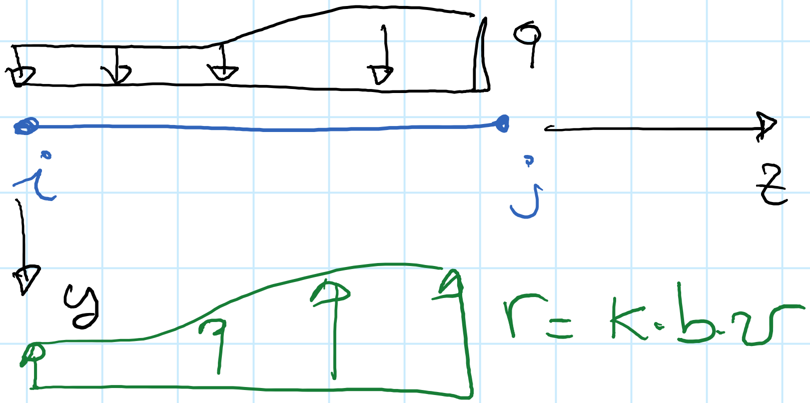
$$V = \frac{dM}{dz} = -EI\frac{d^3 v}{dz^3}$$



$$\cancel{V} - q\,dz = \cancel{V} + dV \rightarrow q = -\frac{dV}{dz} = EI\frac{d^4 v}{dz^4}$$

EQUAZIONE DELLA LINEA ELASTICA IN ASSENZA DI SUOLO $\rightarrow$ $EIv^{IV} = q$

IN PRESENZA DI SUOLO



NASCE UN CARICO REATTIVO CHE SI OPPONE AGLI SPOSTAMENTI

$$EIv^{IV} = q - vkb$$

$$\cancel{EI}v^{IV} + \frac{kbv}{EI} = \frac{q}{EI}$$

POSTO $\lambda^4 = \dfrac{kb}{4EI}$ $\rightarrow$ $\boxed{v^{IV} + 4\lambda^4 \cdot v = \dfrac{q}{EI}}$

SOLUZIONE DELL' EQ. OMOGENEA ASSOCIATA

$v^{IV} + 4\lambda^4 v = 0$ LA SOLUZIONE È DEL TIPO

$$v = C_1 e^{\lambda z} \operatorname{sen}\lambda z + C_2 e^{\lambda z} \cos\lambda z + C_3 e^{-\lambda z} \operatorname{sen}\lambda z + C_4 e^{-\lambda z} \cos\lambda z$$

VERIFICA PER IL 1° TERMINE

$$v = e^{\lambda z} \operatorname{sen}\lambda z$$

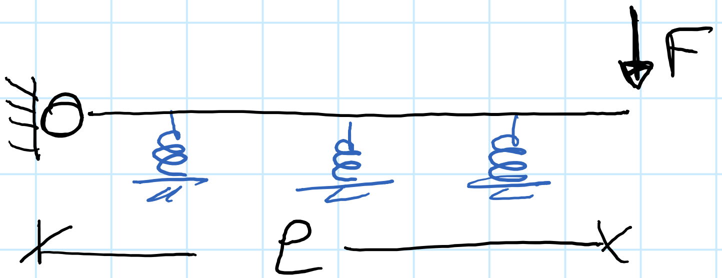
$$v' = \lambda e^{\lambda z} \operatorname{sen}\lambda z + \lambda e^{\lambda z} \cos\lambda z = \lambda e^{\lambda z} (\operatorname{sen}\lambda z + \cos\lambda z)$$

$$v'' = \lambda^2 e^{\lambda z} (\operatorname{sen}\lambda z + \cos\lambda z) + \lambda^2 e^{\lambda z} (\cos\lambda z - \operatorname{sen}\lambda z)$$
$$= 2\lambda^2 e^{\lambda z} \cos\lambda z$$

$$v''' = 2\lambda^3 e^{\lambda z} \cos\lambda z - 2\lambda^3 e^{\lambda z} \operatorname{sen}\lambda z = 2\lambda^3 e^{\lambda z} (\cos\lambda z - \operatorname{sen}\lambda z)$$

$$v^{IV} = 2\lambda^4 e^{\lambda z} (\cos\lambda z - \operatorname{sen}\lambda z) + 2\lambda^4 e^{\lambda z} (-\operatorname{sen}\lambda z - \cos\lambda z)$$
$$= -4\lambda^4 e^{\lambda z} \operatorname{sen}\lambda z$$

ESEMPIO 1



CONDIZIONI DA IMPORRE PER DETERMINARE LE 4 COSTANTI

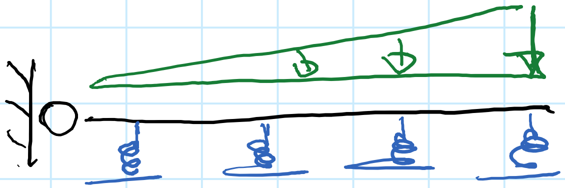
$$v(0) = 0$$

$$M(0) = 0 \rightarrow -EIv''(0) = 0$$

$$V(l) = F \rightarrow -EIv'''(l) = F$$

$$M(l) = 0 \rightarrow -EIv''(l) = 0$$

SOLUZIONI PARTICOLARI



$$q = q_0 \frac{z}{\ell}$$

$$v^{IV} + 4\lambda^4 v = \frac{q_0 z}{\ell EI}$$

ALLA SOLUZIONE GENERALE $v = C_1 e^{\lambda z} \sin\lambda z + \dots - C_4 e^{-\lambda z} \cos\lambda z$

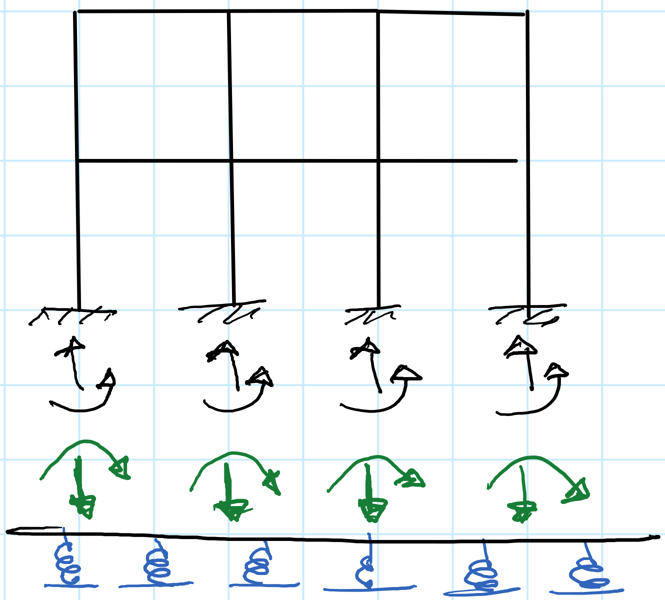
SI AGGIUNGE LA SOLUZIONE PARTICOLARE

$$v = Az + B \rightarrow v^{IV} = 0 \rightarrow 4\lambda^4 \cdot (Az + B) = \frac{q_0 \, z}{\ell EI} \quad \forall z$$

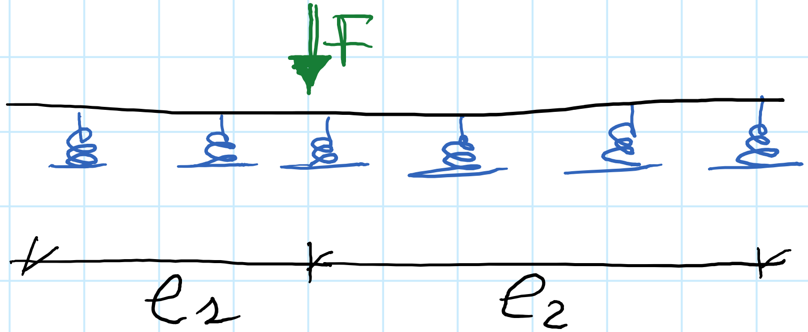
SE $z = 0 \rightarrow B = 0 \rightarrow$

$$4\lambda^4 \cdot A \cancel{z} = \frac{q_0 \cancel{z}}{\ell EI} \rightarrow A = \frac{q_0}{4\lambda^4 \ell EI}$$

CASO DI PARTICOLARE INTERESSE



STUDIO IL CASO GENERICO

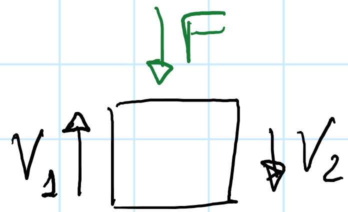


CONDIZIONI AL 1° ESTREMO

$$M_1(0) = 0;\ V_1(0) = 0$$

CONDIZIONI NEI PUNTI DI APPLICAZIONE DELLE FORZE

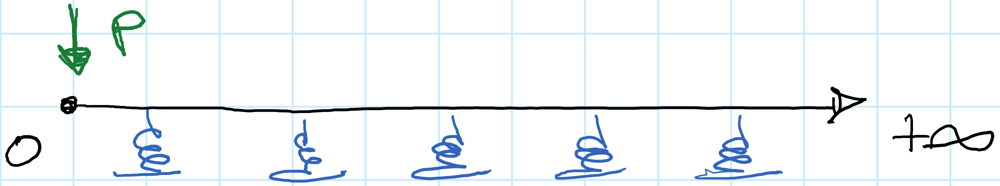
$$\begin{cases} v_1(l_1) = v_2(0) \\ \varphi_1(l_1) = \varphi_2(0) \\ M_1(l_1) = M_2(0) \\ V_1(l_1) - F = V_2(0) \end{cases}$$



CONDIZIONI AL 2° ESTREMO

$$M_2(l_2) = 0;\ V_2(l_2) = 0$$

TRAVE DI LUNGHEZZA INFINITA CON FORZA AD UN ESTREMO



$$v = C_1 e^{\lambda z} \operatorname{sen} \lambda z + C_2 e^{\lambda z} \cos \lambda z + C_3 e^{-\lambda z} \operatorname{sen} \lambda z + C_4 e^{-\lambda z} \cos \lambda z$$

se $z \to \infty \Rightarrow v \to 0$ $\qquad e^{-\lambda z} \to 0$

$e^{\lambda z} \to \infty \Rightarrow C_1 = C_2 = 0$

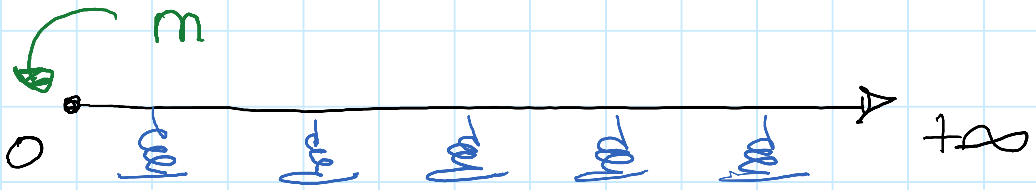
$$\Rightarrow v = C_3 e^{-\lambda z} \operatorname{sen} \lambda z + C_4 e^{\lambda z} \cos \lambda z$$

ALTRE CONDIZIONI : $M(0) = 0$

$\bar{V}(0) = -P$

$\rightarrow$ SI OTTIENE SOLUZIONE SEMPLICE IN FORMA CHIUSA

TRAVE DI LUNGHEZZA INFINITA CON COPPIA AD UN ESTREMO



$$v = C_1 e^{\lambda z} \operatorname{sen} \lambda z + C_2 e^{\lambda z} \cos \lambda z + C_3 e^{-\lambda z} \operatorname{sen} \lambda z + C_4 e^{-\lambda z} \cos \lambda z$$

se $z \to \infty \Rightarrow v \to 0$ $\quad e^{-\lambda z} \to 0$

$e^{\lambda z} \to \infty \Rightarrow C_1 = C_2 = 0$

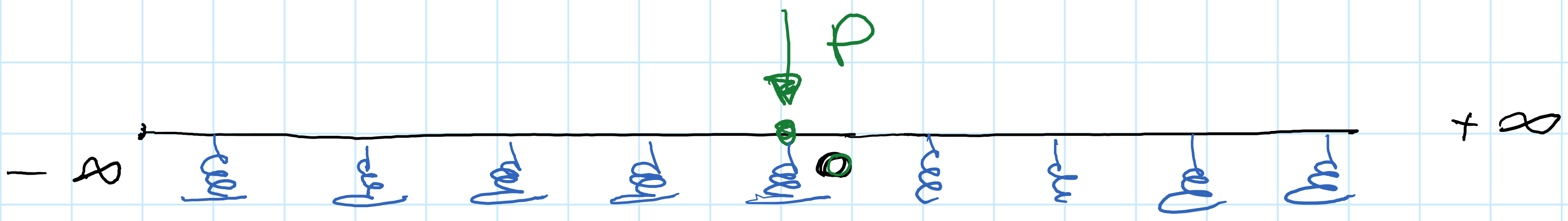
$$\Rightarrow v = C_3 e^{-\lambda z} \operatorname{sen} \lambda z + C_4 e^{\lambda z} \cos \lambda z$$

ALTRE CONDIZIONI : $M(0) = -m$

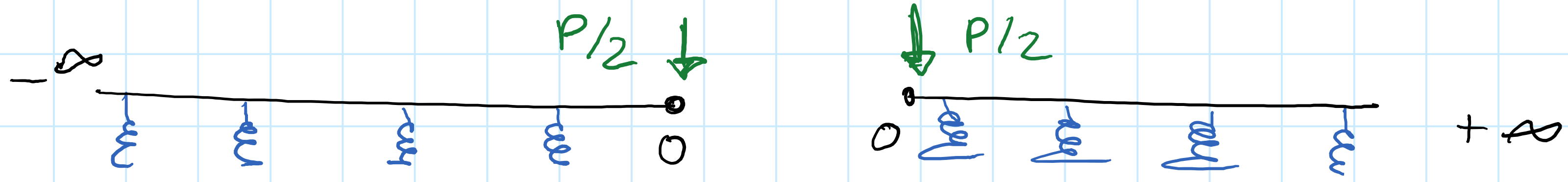
$\bar{V}(0) = 0$

$\rightarrow$ SI OTTIENE SOLUZIONE SEMPLICE IN FORMA CHIUSA

TRAVE DI LUNGHEZZA INFINITA CON FORZA IN O



SCOMPONGO IL PROBLEMA IN 2 :



NEL TRATTO 2 $\Rightarrow$ $v(z \to \infty) = 0$ $\rightarrow$ $C_1 = C_2 = 0$

$\varphi(0) = 0$ (PER LA SIMMETRIA)

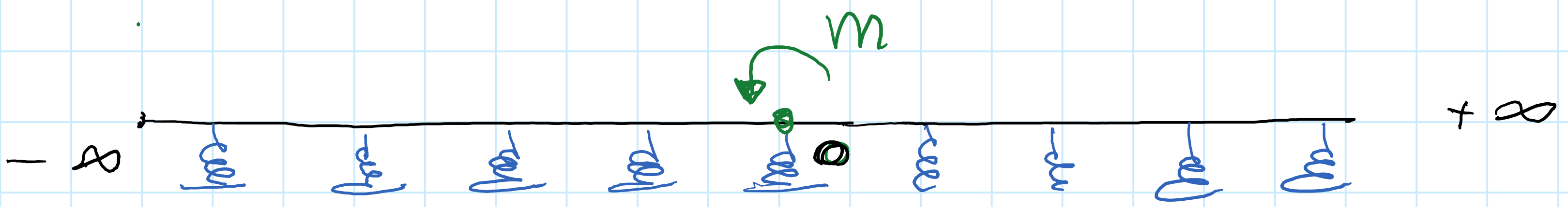
$V(0) = -P/2$

NEL TRATTO 1 $\rightarrow$ $v(z \to -\infty) = 0$ $\rightarrow$ $C_3 = C_4 = 0$

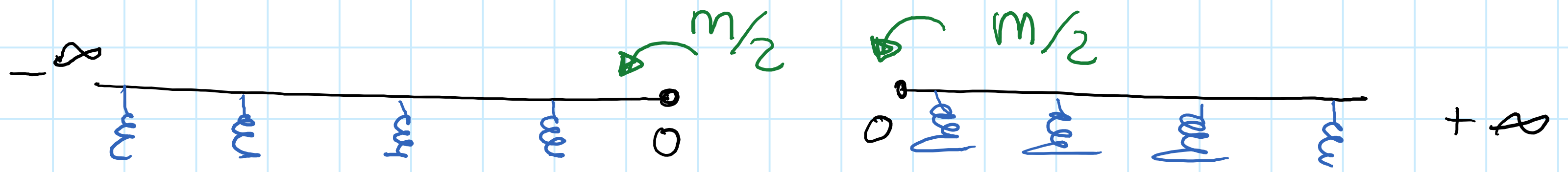
$\varphi(0) = 0$

$V(0) = P/2$

TRAVE DI LUNGHEZZA INFINITA CON COPPIA IN O



SCOMPONGO IL PROBLEMA IN 2:



NEL TRATTO 2 $\Rightarrow$ $v(z \to \infty) = 0 \rightarrow C_1 = C_2 = 0$

$$v(0) = 0$$

$$M(0) = -m/2$$

NEL TRATTO 1 $\rightarrow$ $v(z \to -\infty) = 0 \rightarrow C_3 = C_4 = 0$

$$v(0) = 0$$

$$M(0) = m/2$$

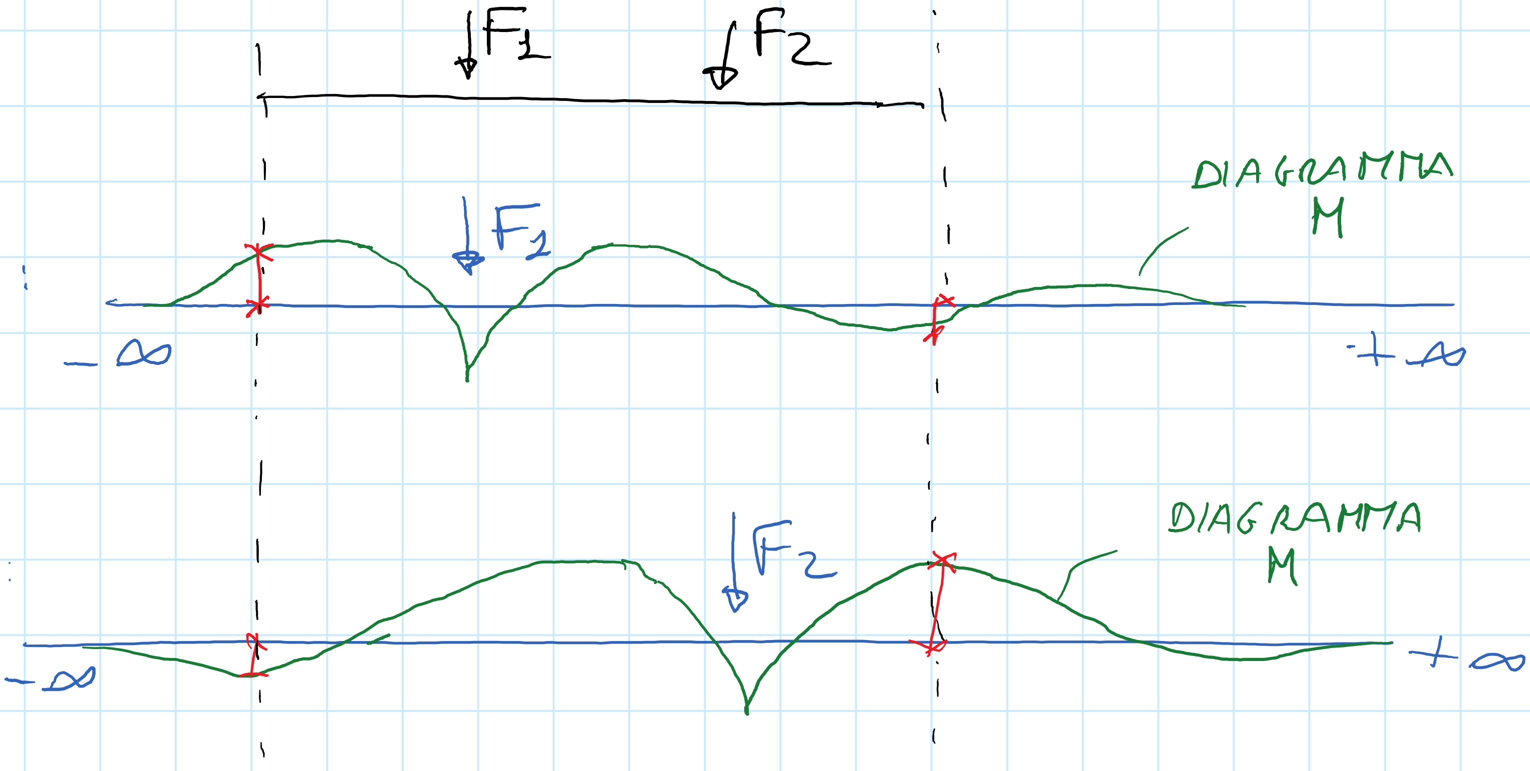
TRAVE DI LUNGHEZZA FINITA RISOLTA CON SOVRAPPOSIZIONE EFFETTI

1. RISOLVO :

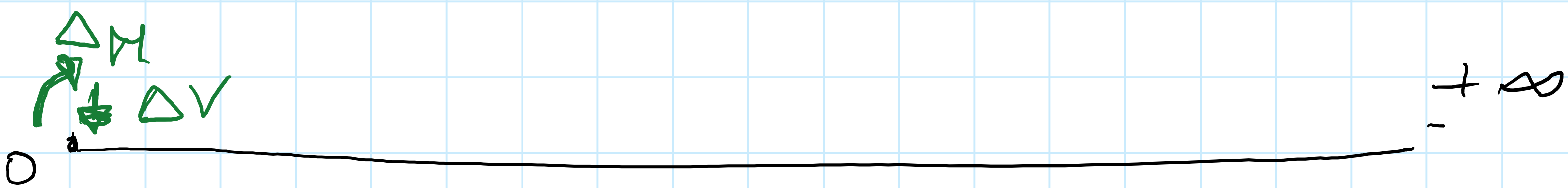
↓

DIAGRAMMA M, V

2. RISOLVO :



⇒ SOMMANDO GLI EFFETTI TROVO AGLI ESTREMI DELLA TRAVE DI LUNGHEZZA FINITA $M, V \neq 0$ ⇒



CORREGGO APPLICANDO COPPIE E FORZE AI 2 ESTREMI