- $\frac{d^2 m_x}{dx^2} = \frac{dt_x}{dx}$
- $\frac{d^2 m_x}{dx^2} + \frac{m_\varphi}{R} = -q_z$

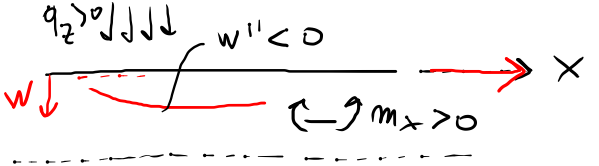
$$-D w^{IV}(x) - \frac{Es}{R^2} w(x) = -q_z$$

$$\boxed{D w^{IV}(x) + \frac{Es}{R^2} w(x) = q_z(x)}$$

"SUOLO ELASTICO": CONTRIBUTO ALLA WINKLER

$$w^{IV}(x) + \frac{Es}{R^2 D} w(x) = \frac{q_z(x)}{D}$$

$$w^{IV}(x) + 4\beta^4 w(x) = \frac{q_z(x)}{D}$$



$$m_x = -D w''(x) \quad ; \quad D = \frac{Es^3 \cdot 1}{12(1-\nu^2)}$$

$$m_\varphi = -\frac{Es}{R} w(x)$$

$$\boxed{M = -EI v''(z)}$$ 15/12/21

PIASTRE INFLESSE

COEFF. RIGIDEZZA PIASTRE

$\star \left(D w''\right)''$

$$\beta = \sqrt[4]{\frac{Es}{4R^2 D}} = \sqrt[4]{\frac{3(1-\nu^2)}{R^2 s^2}} \simeq \frac{1.3}{\sqrt{Rs}}$$ ⊙

$$[\beta] = [L^{-1}] \quad ; \quad \lambda = \frac{2\pi}{\beta} \simeq 4.83\sqrt{Rs}$$ ⊙

β: NUMERO D'ONDA

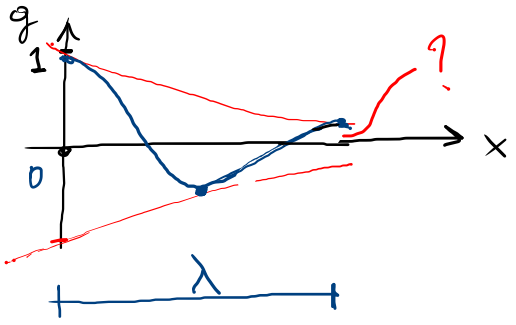
λ: LUNGH. D'ONDA.

INT. PARTIC.

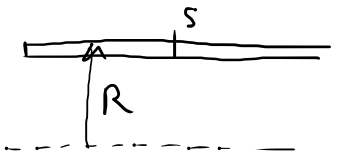
$$w(x) = e^{\beta x}(C_1 \cos\beta x + C_2 \sin\beta x) + e^{-\beta x}(C_3 \cos\beta x + C_4 \sin\beta x) + w_p$$

+ 4 CONDIZ. CONTORNO $(C_1\, C_2\, C_3\, C_4)$

$g(x) = e^{-\beta x}\cos\beta x$; $g(\lambda)$? $\simeq \frac{1}{535}$; $\lambda = \frac{2\pi}{\beta}$

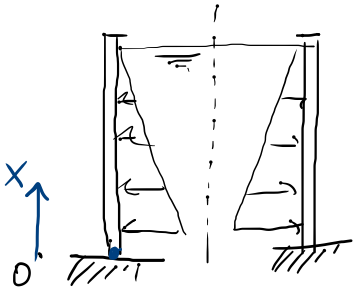


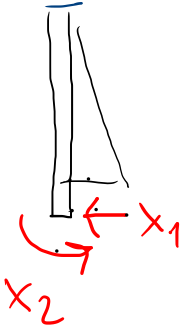
FORTE SMORZAMENTO DEGLI "EFFETTI" ALL'ORIGINE

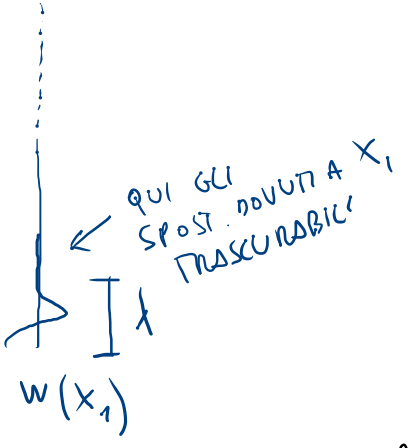


λ? $R = 1$ m, $s = 2$ cm ; $\lambda \simeq 68$ cm

$R = 1$ m, $s = 1$ cm $\quad \lambda \simeq 48$ cm







Se il cilindro è più lungo di 2λ allora gli effetti di bordo NON si trasmettono dall'altra parte.

$$\boxed{w(x) = e^{-\beta x}(C_3\cos\beta x + C_4 \sin\beta x) + w_p}$$

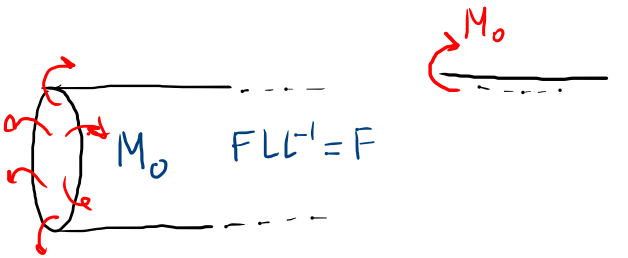
i termini in C_1 e C_2 si eliminano.

$$\begin{cases} \text{EQ. DI CONGR} \\ w(0) = 0 \\ w'(0) = 0 \end{cases}$$

STUDIO DI 2 PROBLEMI FONDAMENTALI

$$\begin{cases} -D w''(0) = 0 \\ -D w'''(0) = +Q_0 \end{cases}$$

$$\begin{cases} C_4 = 0 \\ C_3 = -\dfrac{Q_0}{2\beta^3 D} \end{cases}$$



$$\begin{cases} -D w''(0) = +M_0 \\ -D w'''(0) = 0 \end{cases} \Rightarrow C_3, C_4$$

$$\begin{cases} C_3 = -\dfrac{M_0}{2\beta^2 D} \\ C_4 = +\dfrac{M_0}{2\beta^2 D} \end{cases}$$

$m_x = -D w''(x)$ ↷□↶

$t_x = -D w'''(x)$ ↑□↓

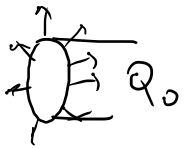
$w(x) = e^{-\beta x}(C_3 c + C_4 s)$

$w'(x) = -\beta e^{-\beta x}(C_3 c + C_4 s) + e^{-\beta x}(C_3 \beta(-s) + C_4 \beta c)$

$w''(x) = \; - \; -$

$w'''(x) =$

COEFFICIENTI ELASTICI DI BORDO



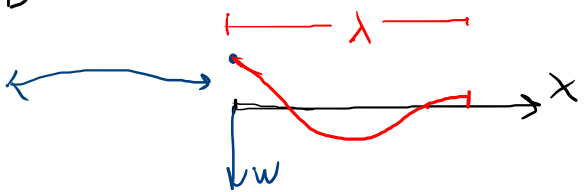
$$w(x) = -\frac{Q_0}{2\beta^3 D} e^{-\beta x} \cos\beta x$$

$$w'(x) = -\frac{Q_0}{2\beta^3 D}(-\beta) e^{-\beta x}\cos\beta x - \frac{Q_0}{2\beta^3 D} e^{-\beta x}(-\beta)\sin\beta x$$

$$= +\frac{Q_0}{2\beta^2 D} e^{-\beta x}(\cos\beta x + \sin\beta x)$$

$$w(0) = -\frac{Q_0}{2\beta^3 D}$$

$$w'(0) = +\frac{Q_0}{2\beta^2 D}$$



COEFF. ELASTICI FORZE APPLICATE

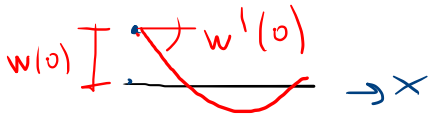
$$\left[\, |w(0)| = \frac{Q_0}{2\beta^3 D} \quad ; \quad |w'(0)| = \frac{Q_0}{2\beta^2 D} \,\right]$$

$$v = \frac{Fl^3}{3EI}$$

$$w(x) = \frac{M_0}{2\beta^2 D} e^{-\beta x} (\sin\beta x - \cos\beta x)$$

$$w'(x) = \frac{1}{\quad} \left[-\beta e^{-\beta x} (\sin\beta x - \cos\beta x) + e^{-\beta x} (\beta \cos\beta x + \beta \sin\beta x) \right]$$

$$= \frac{M_0}{2\beta^2 D} \beta e^{-\beta x} 2\cos\beta x = \frac{M_0}{\beta D} e^{-\beta x} \cos\beta x$$



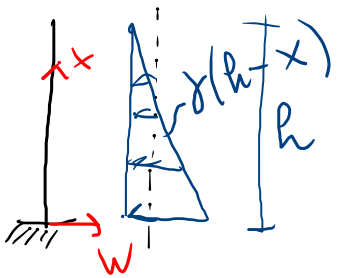
$$w(0) = -\frac{M_0}{2\beta^2 D}$$

$$w'(0) = +\frac{M_0}{\beta D}$$

$$\Rightarrow \boxed{|w(0)| = \frac{M_0}{2\beta^2 D} \qquad |w'(0)| = \frac{M_0}{\beta D}}$$

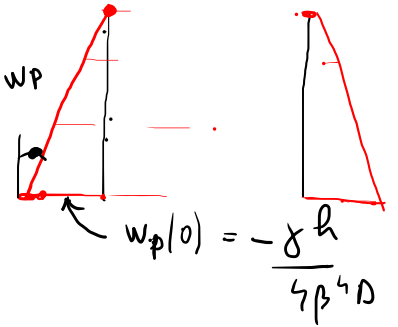
COEFF. ELASTICI MOMENTI APPLICATI

PROBLEMA



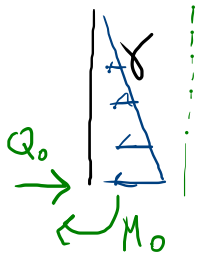
$$q_z(x) = -\gamma(h-x)$$

$$w^{IV}(x) + 4\beta^4 w(x) = -\frac{\gamma(h-x)}{D} \Rightarrow w_p(x) = -\frac{\gamma(h-x)}{4\beta^4 D}$$



$$n_\varphi = -\frac{Es}{R} w(x) \quad \text{IN GENERALE}$$

$$n_\varphi = -\frac{Es}{R} w_p(x) \quad \text{per la SOLUZ. PARTICOLARE}$$



Q_0, M_0 INCOGNITE IPERSTATICHE

$$\begin{cases} w(0) = 0 & \text{EQ DI CONGR.} \\ w'(0) = 0 \end{cases}$$

$$\overset{+}{\mapsto} w: \; -\frac{\gamma h}{4\beta^4 D} + \frac{Q_0}{2\beta^3 D} - \frac{M_0}{2\beta^2 D} = 0$$

$$\overset{+}{\circlearrowright} w': \; \frac{\gamma}{4\beta^4 D} - \frac{Q_0}{2\beta^2 D} + \frac{M_0}{\beta D} = 0$$

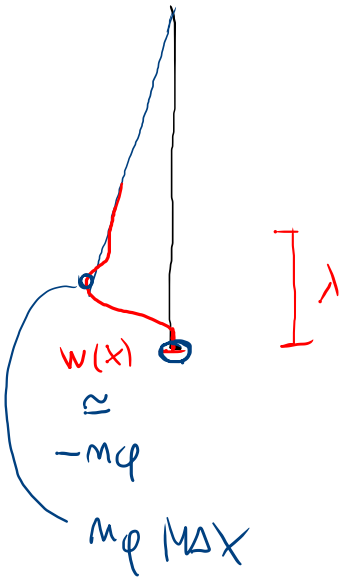
$$\Rightarrow Q_0, M_0 = f(\gamma, h, D, \beta)$$

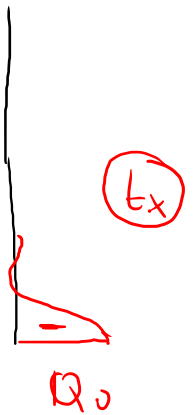
$$w(x) = w_p(x) + \frac{Q_0}{2\beta^3 D} e^{-\beta x}\cos\beta x + \frac{M_0}{2\beta^2 D} e^{-\beta x}(\sin\beta x - \cos\beta x)$$

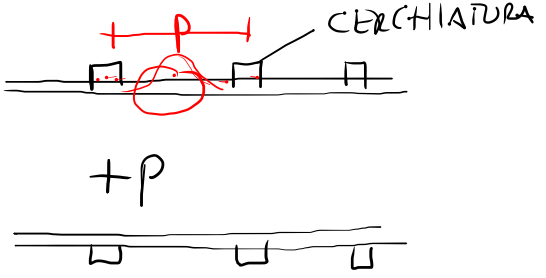
$$\rightarrow \; m_x = -D w''(x)$$

$$t_x = -D w'''(x)$$

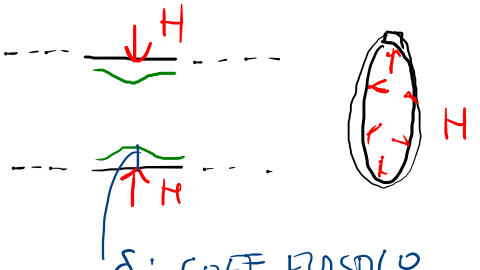
$$n_\varphi = -Es/R \; w(x)$$







CONDOTTA FORZATA



δ : COEFF ELASTICO