CAPÍTULO 5

FLAMBAGEM DE COLUNAS (VIGAS)

VIGAS

$$\frac{d^2}{dx^2} v(x) = \frac{M(x)}{EI}$$

$v(x) \rightarrow \varepsilon_x \rightarrow \sigma_x$

PLACAS

$$\frac{\partial^4 w}{\partial x^4} + 2\frac{\partial^4 w}{\partial x^2 \partial y^2} + \frac{\partial^4 w}{\partial y^4} = \frac{p}{D}$$

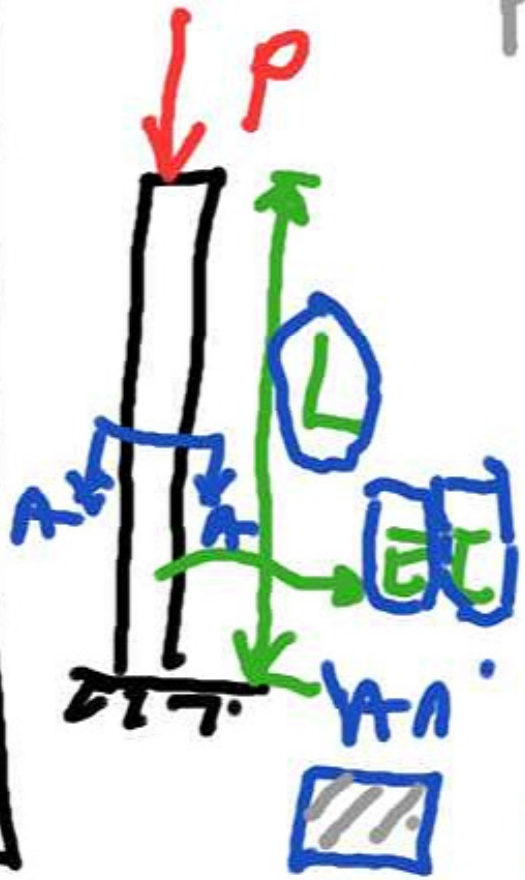
$w(x,y)$

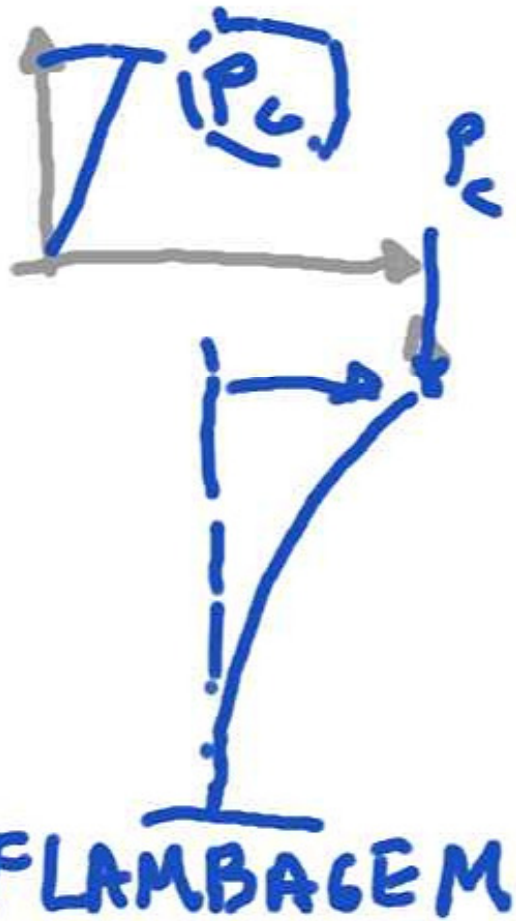
$\Downarrow$

$\varepsilon_x, \varepsilon_y, \gamma_{xy}$

VIGAS - COLUNAS

- COMPRESSÃO -





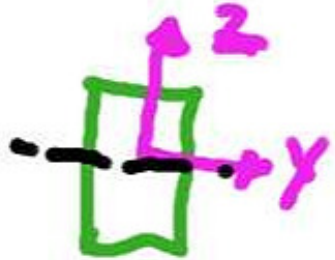
FLAMBAGEM

FLAMBAGEM

$$EI \frac{d^2 v(x)}{dx^2} = -P\,v(x)$$

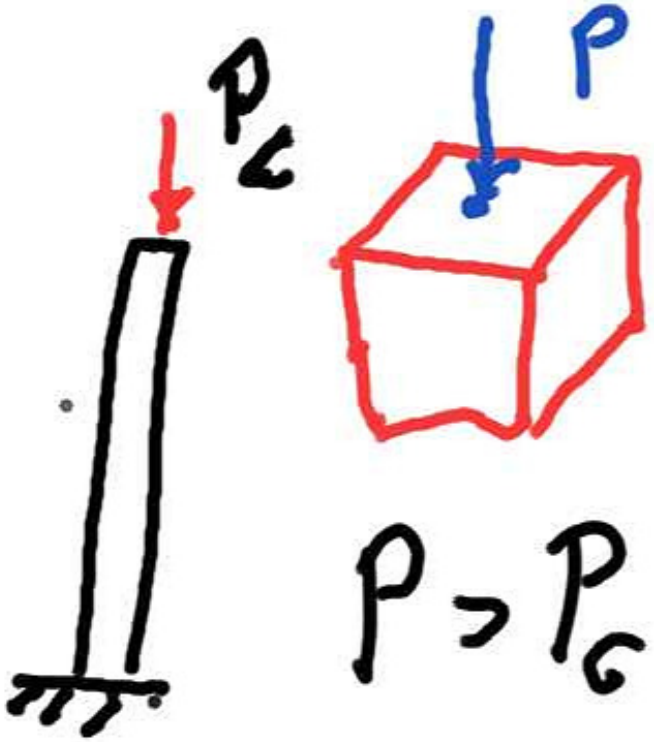
$$M = P\,v(x)$$

CONDIÇÃO CONTORNO



I_y
I_z
$\rightarrow I_{min}$

$$P_c = \pi^2 \frac{E I_{min}}{L^2}$$



$P > P_c$

ESTABILIDADE DO EQUILÍBRIO

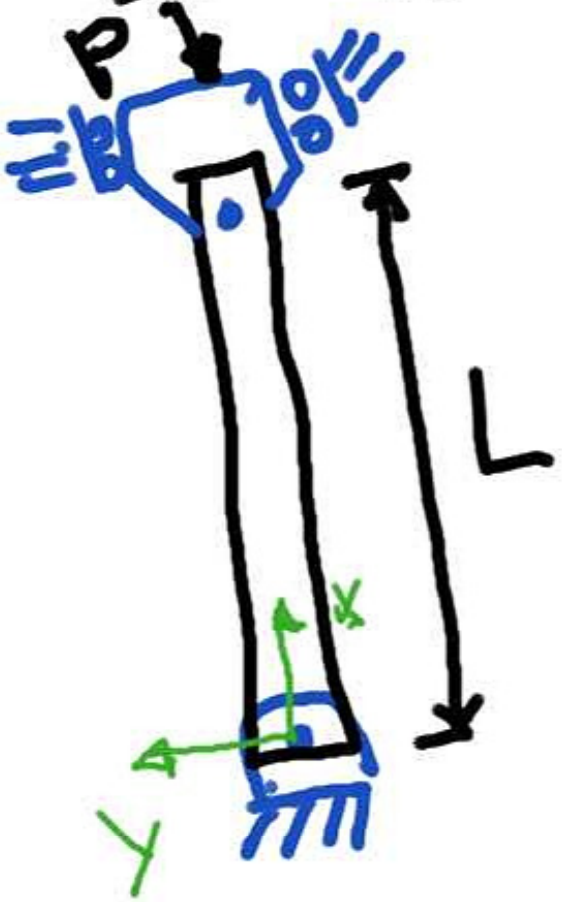
$W = N$

INSTÁVEL

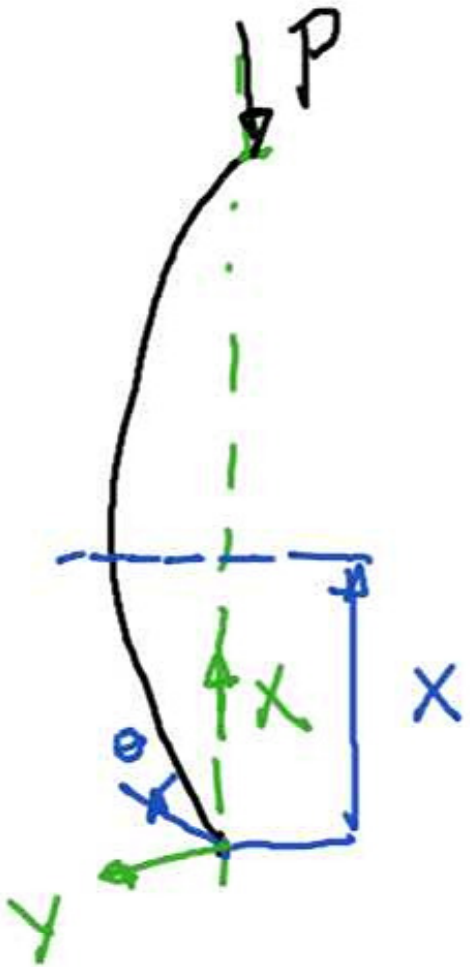
ESTÁVEL

$W = N$

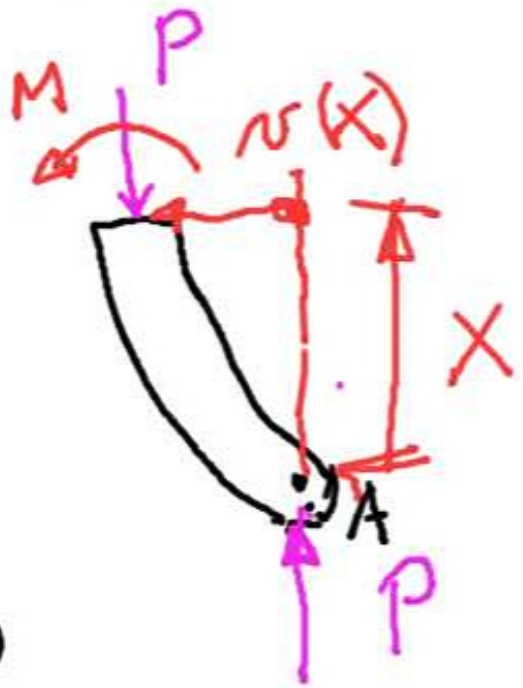
INSTABILIDADE DE COLUNAS



- COLUNA RETA
- MAT. LINEAR-ELÁSTICO
- COLUNA SIMÉTRICA NO PLANO XY
- DEFLEXÃO NO PLANO XY



D . C . L



$$\sum M_A = 0$$

$$M(x) + P\,v(x) = 0$$

$$M(x) = -P\,v(x)$$

· A DEFLEXÃO $v(x)$ É OBTIDA PELA TEORIA DE VIGAS

$$\frac{d^2 v(x)}{dx^2} = \frac{M(x)}{EI} \qquad M(x) = -P v(x)$$

↓

$$EI \frac{d^2 v(x)}{dx^2} + P_{CR} v(x) = 0 \qquad P = P_{CR}$$

$v(x) = ?$

$P_{CR} = ?$

+ C. CONTORNO

$v(x) = 0$

$v(L) = 0$

$$y'' + a y' + a_0 y = 0$$

$$y = e^{\lambda x} \qquad y' = \lambda e^{\lambda x} \qquad y'' = \lambda^2 e^{\lambda x}$$

$$\downarrow$$

$$e^{\lambda x} \neq 0 \quad \left(\lambda^2 + a\lambda + a_0 \right) = 0$$

$$\lambda^2 + a\lambda + a_0 = 0$$

EQ. CARACTER.

$$v'' + \frac{P}{EI} v = 0$$

$$\lambda^2 = \frac{P}{EI}$$

$$v'' + \lambda^2 v = 0$$

$$v(x) = C_1 \sin \lambda x + C_2 \cos \lambda x$$

$$\lambda \quad C_1 \quad C_2 \; \} \; ?$$

$v(L) = 0$ $\quad v(x) = c_1 \sin \lambda x + c_2 \cos \lambda x$

$v(0) = 0$

$\Rightarrow v(0) = c_1 \sin \lambda 0 + c_2 \cos \lambda 0$

$c_2 = 0$

$v(L) = 0 \Rightarrow v(L) = c_1 \sin \lambda L = 0$

$c_1 = 0$ $\quad \sin \lambda L = 0$

$$\sin \lambda L = 0$$

$$\lambda L = n\pi \rightarrow \lambda_n = \frac{n\pi}{L}$$

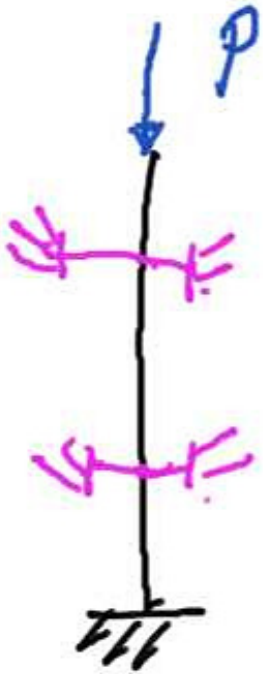
$$\lambda^2 = \frac{P_c}{EI}$$

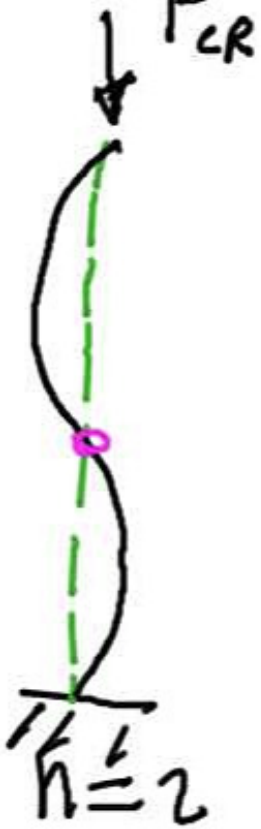
$n = 1, 2, 3, \ldots$

CARGA CRÍTICA EULER

$$P_{CR} = \frac{n^2 \pi^2}{L^2} E I$$

MODOS DE FLAMBAGEM





θ^2

n=1