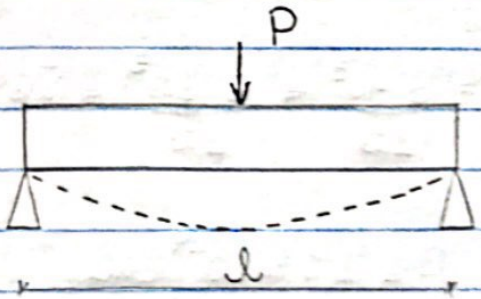
Aula 9
Mecânica Geral

→ cálculo de flecha em vigas

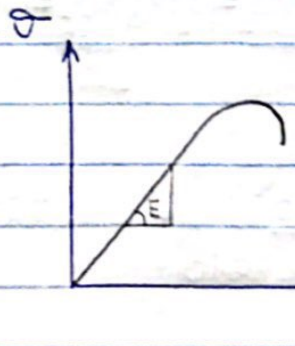
↝ flecha: deslocamento vertical provocado por um carregamento.




$$f = \frac{P \cdot l^3}{48 \cdot E \cdot I}$$

Onde: P - carga → força aplicada
l - comprimento da viga
E - módulo elástico
I - inércia

• Lei de Hooke

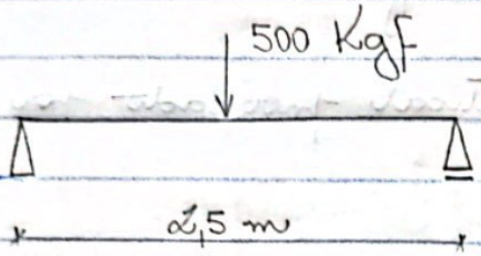


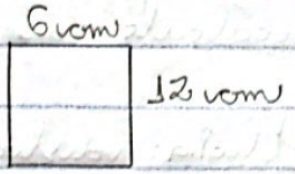

$$\sigma = E \cdot \varepsilon$$

$$E = \frac{\sigma}{\varepsilon}$$ → regime elástico

↝ equação da flecha: { tipo de carregamento / tipo de apoio }

Ex. 1: Considere a viga representada na figura e calcule a flecha correspondente ao carregamento indicado.



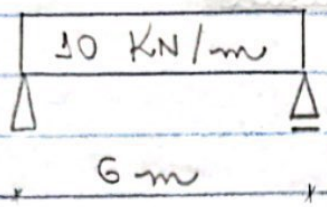




$E_{mad} = 25.000\ KN/cm^2$

$$f = \frac{P.l^3}{48.E.I} \qquad I = \frac{b.h^3}{12} = \frac{6.12^3}{12} = 864\ cm^4$$

$$f = \frac{500 \cdot 250^3}{48 \cdot 25000 \cdot 864} \rightarrow f = 1,2 \times 10^{-4}\ cm$$

Ex. 2:





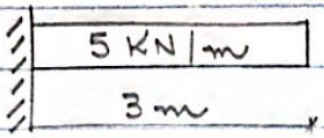
$E_{aço} = 20.500\ KN/cm^2$

$$I = \frac{b.h^3}{12} - \frac{b.h^3}{12} = \frac{12.25^3}{12} - \frac{9.22^3}{12} = 7610\ cm^4$$

$$f = \frac{5.P.l^4}{384.E.I} = \frac{5.0,1.600^4}{384.20500.7610} = 1,08\ cm$$

Ex. 3:

$E = 20\,500\ KN/cm^2$



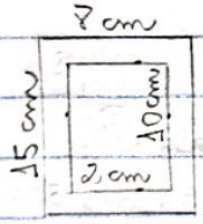

$$f = \frac{P \cdot l^4}{8 \cdot E \cdot I}$$

a)


$$I = \frac{b \cdot h^3}{12} = \frac{8 \cdot 15^3}{12} = 2250\ cm^4$$

$$f = \frac{0{,}05 \cdot 300^4}{8 \cdot 20500 \cdot 2250} = 1{,}10\ cm$$

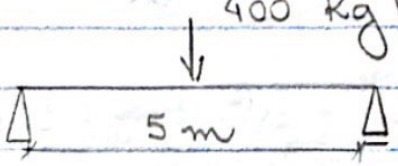
b)




$$I = \frac{8 \cdot 15^3}{12} - \frac{2 \cdot 10^3}{12} = 2083{,}33\ cm$$

$$f = \frac{0{,}05 \cdot 300^4}{8 \cdot 20500 \cdot 2083{,}33} = 1{,}19\ cm$$

Ex. 4:




$E = 25000\ MPa$

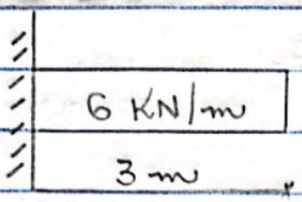
a) idem 3.a

$$f = \frac{400 \cdot 500^3}{48 \cdot 250000 \cdot 2250} = 1{,}85\ cm$$

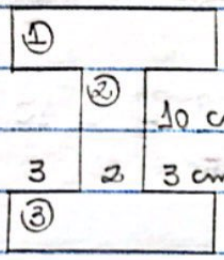
b) idem 3.b.

$$f = \frac{400 \cdot 500^3}{48 \cdot 250000 \cdot 2083,33} = 2 \text{ cm}$$

Ex. 5:




$E = 20500 \text{ KN/cm}^2$




| Fig | A | x | y | xA | yA |
|---|---|---|---|---|---|
| 1 | 20 | 4 | 13,75 | 80 | 275 |
| 2 | 20 | 4 | 7,5 | 80 | 150 |
| 3 | 20 | 4 | 1,25 | 80 | 25 |
| Σ | 60 | | | 240 | 450 |

$$\bar{x} = \frac{240}{60} = 4 \text{ cm} \qquad \bar{y} = \frac{450}{60} = 7,6 \text{ cm}$$

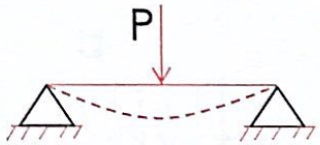
$$I_x = \frac{b \cdot h^3}{12} + A (y - \bar{y})^2$$

$$I_{x1} + I_{x2} + I_{x3} = 1750 \text{ cm}^4$$

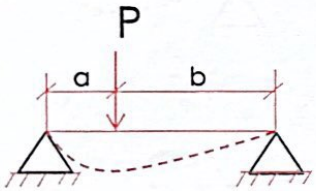
$$f = \frac{0,06 \cdot 300^4}{8 \cdot 20500 \cdot 1750} = 1,70 \text{ cm}$$

# Barras Flexionadas:

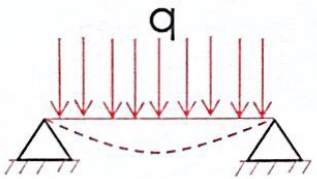
Fórmulas de Flexão e flechas em barras simples



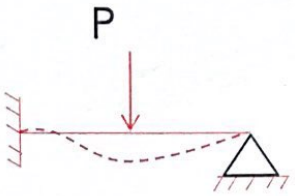

$$Mmax = \frac{P.L}{4} \qquad y = \frac{P.L^3}{48.E.I}$$




$$Mmax = \frac{P.a.b}{L} \qquad y = \frac{P.a^2.b^2}{3.E.I}$$




$$Mmax = \frac{q.L^2}{8} \qquad y = \frac{5.q.L^4}{384.E.I}$$




$$Mmax = \frac{3.P.L}{16} \qquad y = \frac{7.P.L^3}{768.E.I}$$

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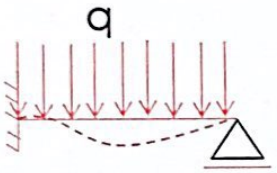
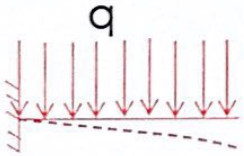
# Barras Flexionadas:

Fórmulas de Flexão e flechas em barras simples

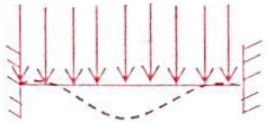



$$Mmax = \frac{q.L^2}{8} \qquad y = \frac{q.L^4}{185.E.I}$$


$$Mmax = P.L \qquad y = \frac{P.L^3}{3.E.I}$$




$$Mmax = \frac{P.L^2}{2} \qquad y = \frac{P.L^4}{8.E.I}$$



$$Mmax = \frac{P.L^2}{12} \qquad y = \frac{q.L^4}{384.E.I}$$

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