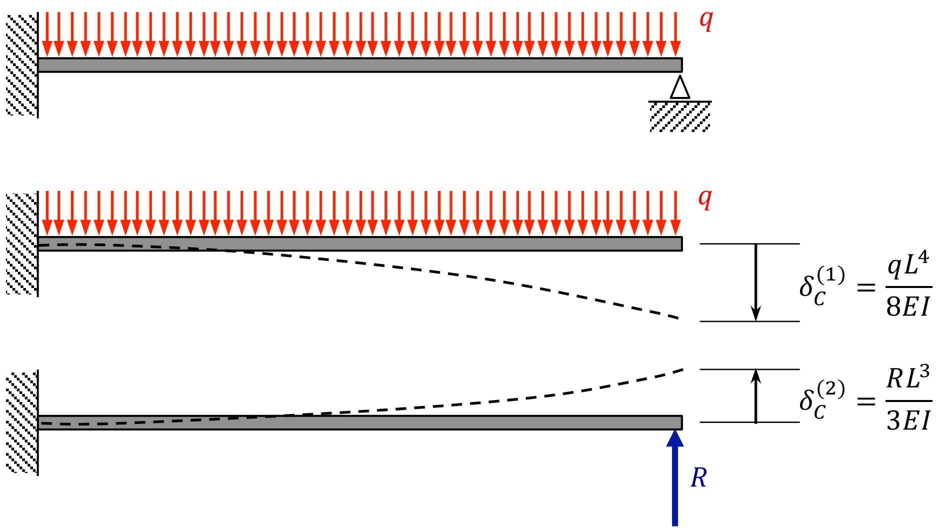
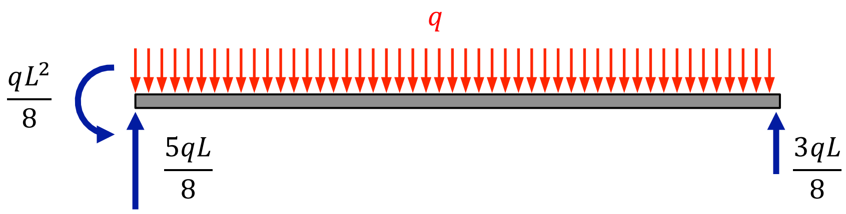
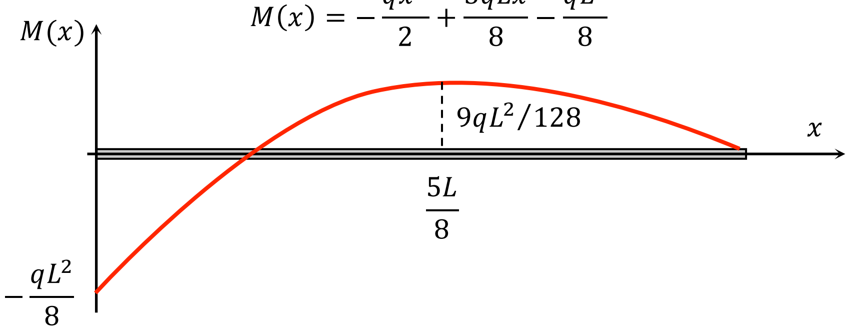
Problema 1.



$$\delta_C^{(1)} = \delta_C^{(2)} \Longrightarrow R = \frac{3qL}{8}$$

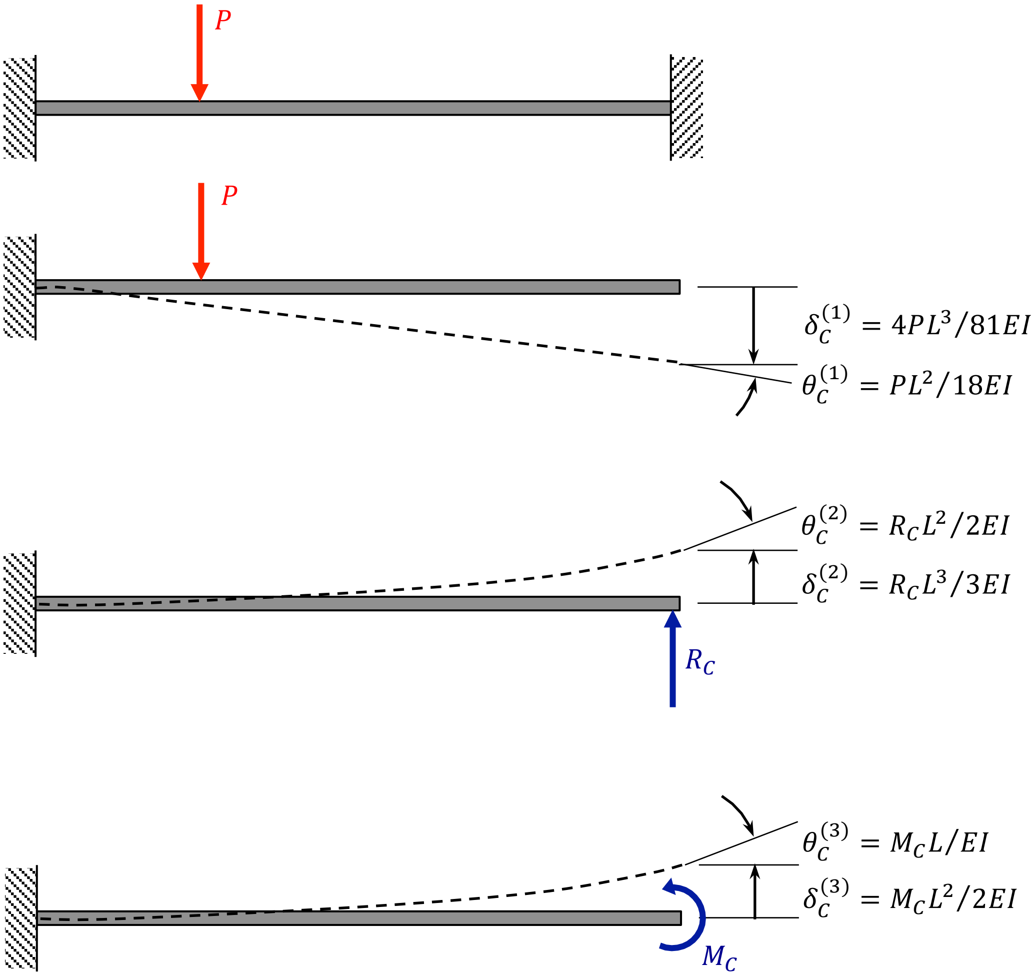


$$M(x) = -\frac{qx^2}{2} + \frac{5qLx}{8} - \frac{qL^2}{8}$$

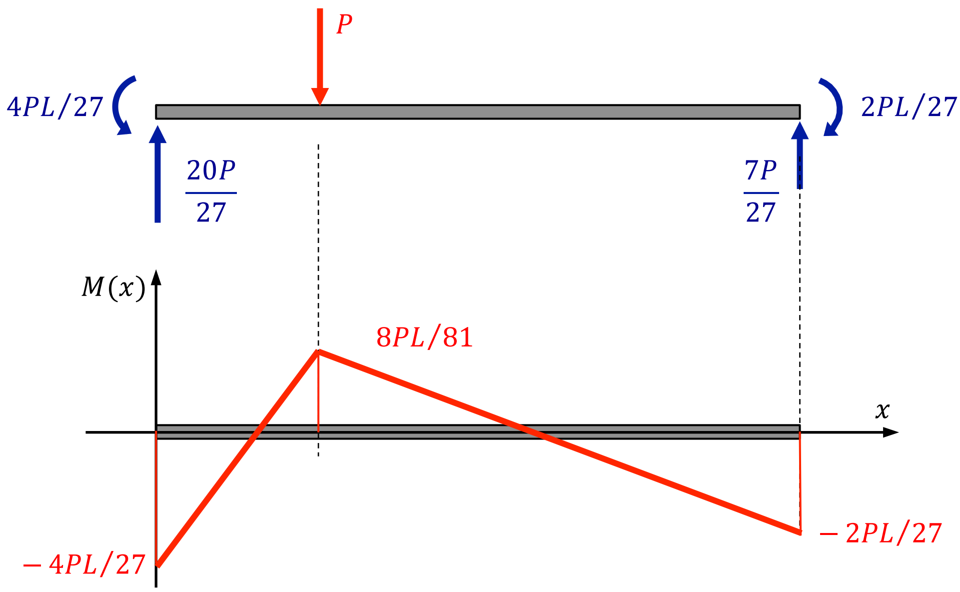


$$\max\{|\sigma_{xx}(x,y)|\} = \frac{h}{2}\frac{\max\{|M(x)|\}}{bh^3/12} = \frac{6}{bh^2}\frac{qL^2}{8} = \frac{3}{4}\frac{qL^2}{bh^2} < S_Y \Longrightarrow q < \frac{4}{3}\left(\frac{S_Y bh^2}{L^2}\right)$$

Problema 2.

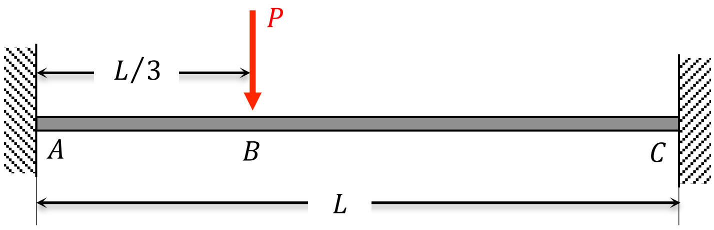


$$\left.\begin{array}{l}
\delta_C^{(1)} - \delta_C^{(2)} - \delta_C^{(3)} = 0 \;\Rightarrow\; \dfrac{4PL^3}{81EI} - \dfrac{R_C L^3}{3EI} - \dfrac{M_C L^2}{2EI} = 0 \;\Rightarrow\; R_C L + \dfrac{3}{2} M_C = \dfrac{4}{27} PL \\[2ex]
\theta_C^{(1)} - \theta_C^{(2)} - \theta_C^{(3)} = 0 \;\Rightarrow\; \dfrac{PL^2}{18EI} - \dfrac{R_C L^2}{2EI} - \dfrac{M_C L}{EI} = 0 \;\Rightarrow\; R_C L + 2M_C = \dfrac{1}{9} PL
\end{array}\right\} \Rightarrow \left\{\begin{array}{l}
R_C = \dfrac{7P}{27} \\[2ex]
M_C = -\dfrac{2PL}{27}
\end{array}\right.$$



$$\max\{|\sigma_{xx}(x,y)|\} = \frac{h}{2}\frac{\max\{|M(x)|\}}{bh^3/12} = \frac{6}{bh^2}\left(\frac{4P_Y L}{27}\right) < S_Y \implies P_Y = \frac{27}{4L}\left(\frac{bh^2 S_Y}{6}\right) = \frac{27}{4}\frac{M_Y}{L}$$

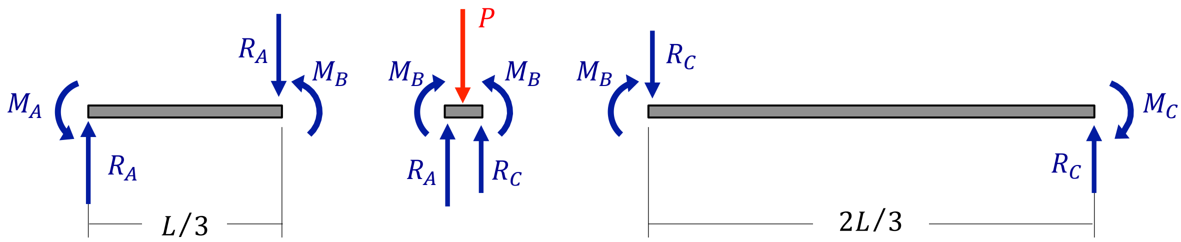
Problema 3.



O colapso plástico ocorre quando forem formadas rótulas plásticas em A, B e C. Nesse caso, os momentos fletores em A, B e C serão:

$$M_A = M_B = M_C = M_L$$

Equilíbrio:



$$M_A + M_B = \frac{R_A L}{3} \qquad R_A + R_C = P \qquad M_B + M_C = \frac{2R_C L}{3}$$

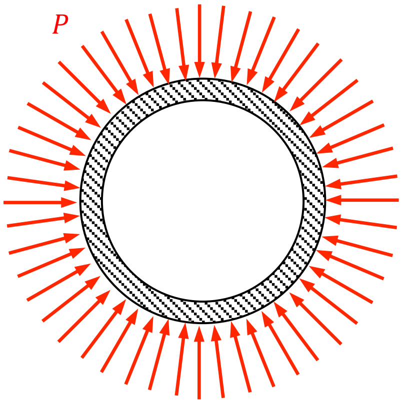
Portanto, quando $P = P_L$

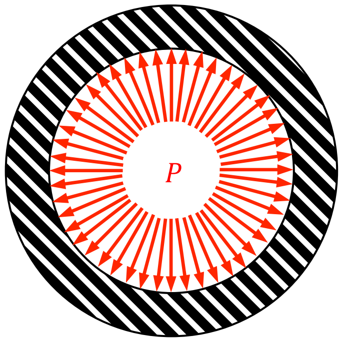
$$\left.\begin{aligned} &M_A = M_B = M_L \implies 2M_L = \frac{R_A L}{3} \\ &R_A + R_C = P_L \\ &M_B = M_C = M_L \implies 2M_L = \frac{2R_c L}{3} \end{aligned}\right\} \implies P_L = 9\frac{M_L}{L} = \frac{27}{2}\frac{M_Y}{L}$$

No Problema 2 obtivemos $P_Y = 27M_Y/4L$, logo

$$P_L = 2P_Y$$

Problema 4.





$$u_r^{(1)}(b_1) = -\frac{(1-v)(b_1^2/a_1^2)b_1 + (1+v)b_1}{E(b_1^2/a_1^2-1)}P = -(9{,}71\times10^{-13})P$$

$$u_r^{(2)}(a_2) = \frac{(1-v)a_2 + (1+v)(b_2^2/a_2)}{E(b_2^2/a_2^2-1)}P = (11{,}3\times10^{-13})P$$

$$b_1 + u_r^{(1)}(b_1) = a_2 + u_r^{(2)}(a_2) \implies [(9{,}71\times10^{-13}) + (11{,}3\times10^{-13})]P = 0{,}105\times10^{-3} \implies P = 50{,}0\ \mathrm{MPa}$$

A tensão radial de contato é $\sigma_{rr} = -50{,}0\ \mathrm{MPa}$