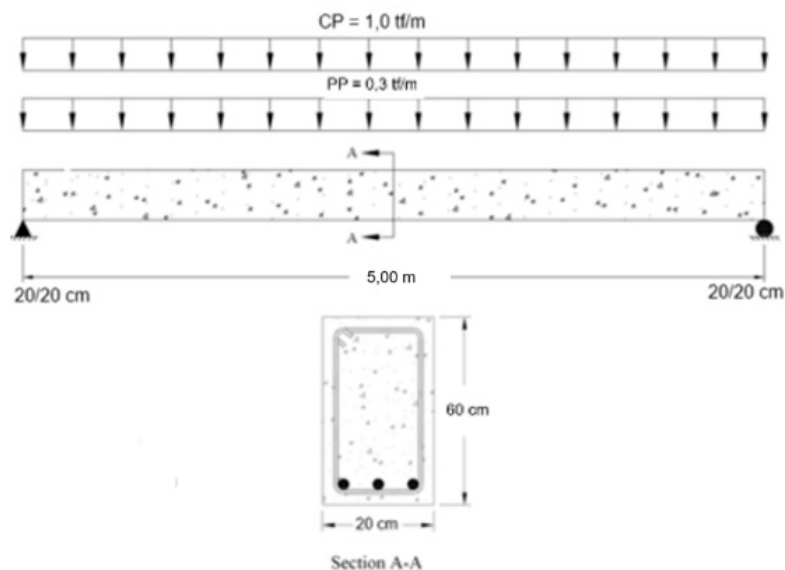


## Vigas - Flexão Simples 2

### FLEXÃO SIMPLES

Neste exemplo, será dimensionada a armadura longitudinal e transversal de uma viga submetida a Flexão Simples utilizando como base a Norma ACI318-19, conforme dados abaixo:

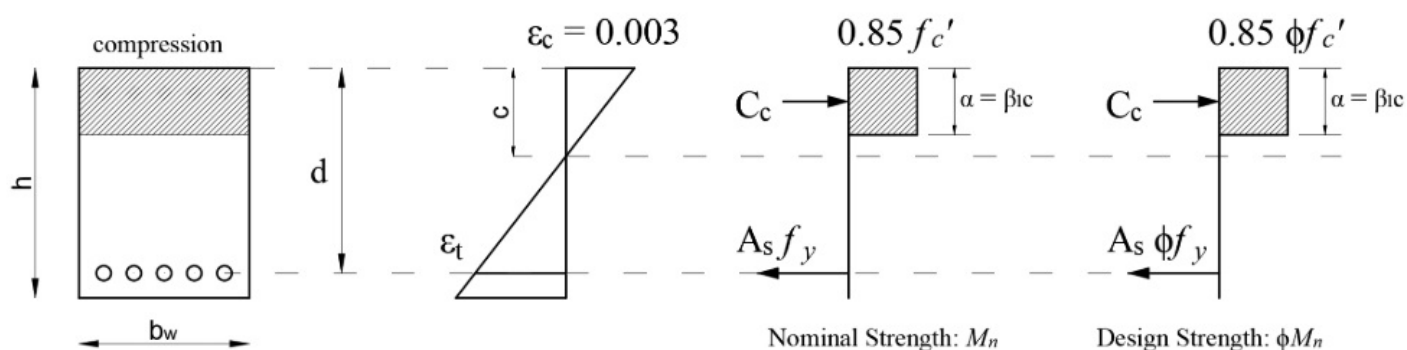


Concreto - C25 (4000 psi) / Aço – ADN420 (60 ksi)

bw: 8 in / h: 24 in

Mu:

|                     |                            |                            |
|---------------------|----------------------------|----------------------------|
| TQS = 460,25 kip.in | Software B = 474,41 kip.in | Software C = 460,25 kip.in |
|---------------------|----------------------------|----------------------------|



Flexão:

$$M_n = \frac{M_u}{\phi} = \frac{460,25}{0,9} = 511,33 \text{ kip.in}$$

$$d = h - C_c - d_{be} - \frac{d_b}{2} = 24 - 1,57 - 0,375 - 0,3125 = 21,75 \text{ in}$$

$$R_n = \frac{M_{n,req}}{b_w \cdot d^2} = \frac{511,33}{8 \cdot 21,75^2} = 0,135 \text{ ksi} = 135,14 \text{ psi}$$

$$\rho = \left(0,85 \cdot \frac{f'_c}{f_y}\right) \cdot \left[1 - \sqrt{1 - \left(\frac{2 \cdot R_n}{0,85 \cdot f'_c}\right)}\right] = \left(0,85 \cdot \frac{4}{60}\right) \cdot \left(1 - \sqrt{1 - \left(\frac{2 \cdot 0,135}{0,85 \cdot 4}\right)}\right) = 0,0023$$

$$A_s = \rho \cdot b_w \cdot d = 0,0023 \cdot 8 \cdot 21,75 = 0,40 \text{ in}^2$$

As,min (ACI 318-19 – 9.6.1.2)

$$\left(\frac{3 \cdot \sqrt{f'_c}}{f_y}\right) \cdot b_w \cdot d = \left(\frac{3 \cdot \sqrt{4000}}{60000}\right) \cdot 8 \cdot 21,75 = 0,55 \text{ in}^2$$

$$\left(\frac{200}{f_y}\right) \cdot b_w \cdot d = \left(\frac{200}{60000}\right) \cdot 8 \cdot 21,75 = 0,58 \text{ in}^2$$

$$A_{s,min} = 0,58 \text{ in}^2$$

|                |                       |                       |
|----------------|-----------------------|-----------------------|
| TQS = 0,58 in2 | Software B = 0,52 in2 | Software C = 0,60 in2 |
|----------------|-----------------------|-----------------------|

0,60 in2 ≥ 0,58 in2 → OK!

3#4 → 0,60 in2

øMn (702,46 kip.in) ≥ Mu (460,25 kip.in) → OK!!

Verificação do fator de redução (ACI318-19 – 21.2.2)

$$\alpha = \frac{A_s \cdot f_y}{0,85 \cdot f'_c \cdot b_w} = \frac{0,6 \cdot 60}{0,85 \cdot 4 \cdot 8} = 0,85 \text{ in}$$

$$\text{Linha Neutra: } c = \frac{\alpha}{\beta_1} = \frac{0,85}{0,85} = 1,00 \text{ in}$$

$$\varepsilon_t = 0,003 \cdot \left(\frac{d - c}{c}\right) = 0,003 \cdot \left(\frac{21,75 - 1,00}{1,00}\right) = 0,06$$

0,06 ≥ 0,005 → OK! Tension Controlled! → ø 0,90 OK!

Cortante:

|     |            |            |
|-----|------------|------------|
| TQS | Software B | Software C |
|-----|------------|------------|

|                              |                              |                              |
|------------------------------|------------------------------|------------------------------|
| <b>Vu = 10,05 kips</b>       | <b>Vu = 9,64 kips</b>        | <b>Vu = 9,99 kips</b>        |
| <b>Vu,design = 7,41 kips</b> | <b>Vu,design = 7,34 kips</b> | <b>Vu,design = 7,28 kips</b> |

$$V_n = V_c + V_s$$

$$V_u = 10,05 \text{ kips}$$

$$V_{u,design} = 7,41 \text{ kips}$$

$$V_c = 2 \cdot \lambda \cdot \sqrt{f'_c} \cdot b_w \cdot d = 2 \cdot 1 \cdot \sqrt{4000} \cdot 8 \cdot 21,75 = 22,01 \text{ kips}$$

$$V_n = \frac{V_{u,design}}{\phi_{0,75}} = V_c + V_s \rightarrow V_s = 0 \text{ kips} \rightarrow V_n = 9,88 \text{ kips}$$

$$V_{s,lim} = 8 \cdot \sqrt{f'_c} \cdot b_w \cdot d = 8 \cdot \sqrt{4000} \cdot 8 \cdot 21,75 = 88,03 \text{ kips}$$

$V_s \leq V_{s,lim}$  OK!

$$\phi_{0,75} \rightarrow \phi V_n \geq V_u \rightarrow 7,41 \geq 7,41 \rightarrow \text{OK!!}$$

### Área de Aço:

$$A_v = \frac{V_s \cdot s}{f_{yt} \cdot d} = \frac{A_v}{s} = \frac{0}{60 \cdot 21,75} = 0,0 \text{ in}^2$$

$$\frac{A_{v,min}}{s} = \frac{0,75 \cdot \sqrt{f'_c} \cdot b_w}{f_{yt}} = 0,0063 \text{ in}^2$$

$$\frac{A_{v,min}}{s} = \frac{50 \cdot b_w}{f_{yt}} = 0,0067 \text{ in}^2$$

$$A_v \geq A_{v,min} \rightarrow 0,00 \leq 0,0067 \rightarrow A_{v,min}!!$$

### Espaçamento:

$$s \leq s_{max} \rightarrow s_{max} = \text{menor valor entre } s_1 \text{ e } s_2$$

$$s_1 = \frac{d}{2} = 10,88 \text{ in ou } s_2 = 24 \text{ in} \rightarrow 10,88 \text{ in!} \rightarrow 10 \text{ in!!}$$

$$\phi_t = \#3 \rightarrow \#3 @ 10 \text{ in}$$

$$\phi V_n (23,89 \text{ kips}) \geq V_u (7,41 \text{ kips})$$

