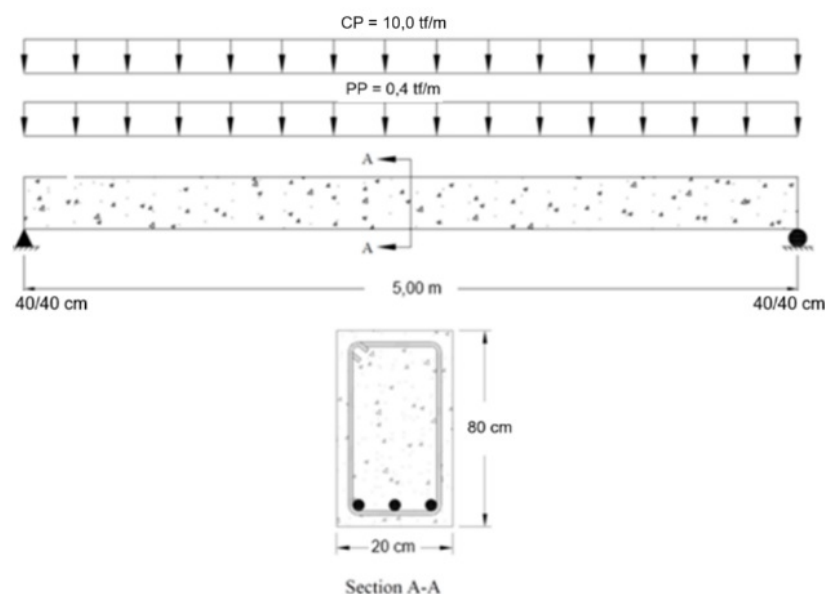


## Vigas - Flexão Simples 10

### FLEXÃO SIMPLES

Neste exemplo, será dimensionada a armadura longitudinal e transversal de uma viga submetida a Flexão Simples utilizando como base a Norma Cirsoc-2005, conforme dados abaixo:

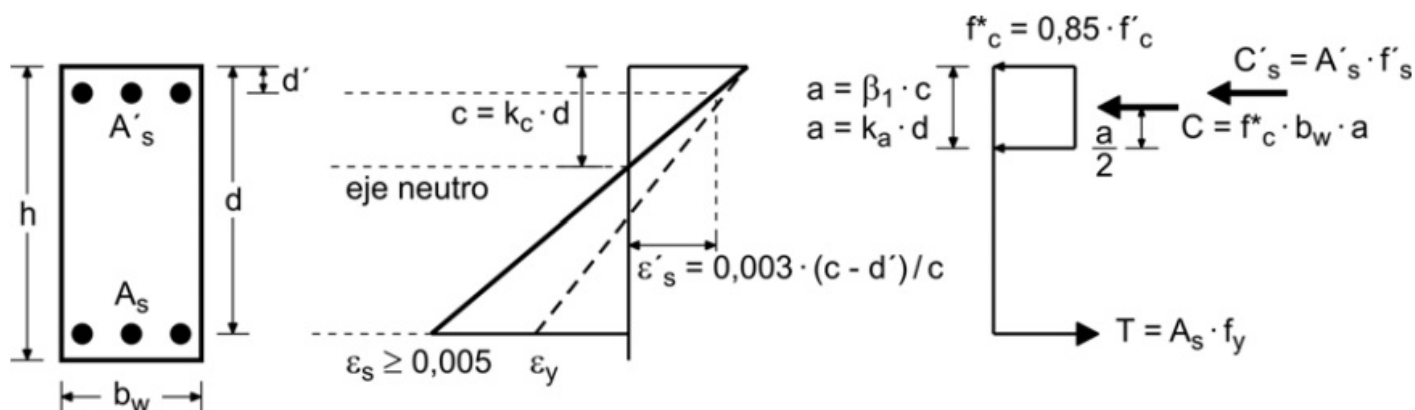


Concreto: H-25 / Aço: ADN420

bw: 20 cm / h: 80 cm

Mu:

|                  |                         |                         |
|------------------|-------------------------|-------------------------|
| TQS = 306,0 kN.m | Software B = 310,8 kN.m | Software C = 307,4 kN.m |
|------------------|-------------------------|-------------------------|



Flexão:

$$M_n = \frac{Mu}{\phi} = \frac{306,00}{0,9} = 340,00 \text{ kN.m}$$

$$d = h - C_c - d_{be} - \frac{d_b}{2} = 80 - 2 - 0,8 - 0,8 = 76,40 \text{ cm}$$

$$m_n = \frac{M_n}{0,85 \cdot f'_c \cdot b_w \cdot d^2} = \frac{340,00}{0,85 \cdot 25000 \cdot 0,20 \cdot 0,764^2} = \mathbf{0,1371}$$

$$k_a = 1 - (1 - 2 \cdot m_n)^{\frac{1}{2}} = 1 - (1 - 2 \cdot 0,1371)^{\frac{1}{2}} = \mathbf{0,1480}$$

$$x = \frac{k_a \cdot d}{0,85} = \mathbf{13,30 \text{ cm}}$$

$$A_s = \frac{k_a \cdot f'_c \cdot b_w \cdot d}{f_y} = \frac{0,1480 \cdot 21,25 \cdot 20 \cdot 76,4}{420} = \mathbf{11,44 \text{ cm}^2}$$

$$A_s \geq A_{s,min}$$

$$A_{s1,min} = \frac{0,25 \cdot \sqrt{f'_c}}{f_y} \cdot b_w \cdot d = \frac{0,25 \cdot \sqrt{25}}{420} \cdot 20 \cdot 76,4 = 4,55 \text{ cm}^2$$

$$A_{s2,min} = \frac{1,4 \cdot b_w \cdot d}{f_y} = \frac{1,4 \cdot 20 \cdot 76,4}{420} = 5,09 \text{ cm}^2$$

$$A_{s,req} = A_s \cdot 1,33 = 15,26 \text{ cm}^2$$

|                 |                        |                        |
|-----------------|------------------------|------------------------|
| TQS = 11,44 cm2 | Software B = 11,89 cm2 | Software C = 10,26 cm2 |
|-----------------|------------------------|------------------------|

$$11,44 \text{ cm}^2 \geq 5,09 \text{ cm}^2 \rightarrow \text{OK!!}$$

$$6\emptyset 16 \text{ mm} \rightarrow 12,06 \text{ cm}^2$$

$$\emptyset \text{Mn (321,12 KN.m)} \geq \text{Mu (306,00 KN.m)} \rightarrow \text{OK!!}$$

### Cortante:

| TQS                 | Software B          | Software C          |
|---------------------|---------------------|---------------------|
| Vu = 36,45 t        | Vu = 33,49 t        | Vu = 36,35 t        |
| Vu,design = 22,36 t | Vu,design = 22,31 t | Vu,design = 22,10 t |

$$\beta_w = \frac{A_s}{b_w \cdot d}$$

$$V_n = V_c + V_s$$

$$V_u = 36,45 \text{ t}$$

$$V_{u,design} = 22,36 \text{ t}$$

$$V_c = \left(1 + \frac{N_u}{14 \cdot A_g}\right) \sqrt{f'_c} \cdot \frac{1}{6} \cdot b_w \cdot d = \left(1 + \frac{0}{14 \cdot 0,12}\right) \sqrt{25} \cdot \frac{1}{6} \cdot 2 \cdot 7,64 = 12,73 \text{ t}$$

$$V_{c,lim} = 0,3 \cdot \sqrt{f'_c} \cdot b_w \cdot d \cdot \sqrt{1 + \frac{0,3 \cdot N_u}{A_g}} = 22,92 \text{ t}$$

$$V_c \leq V_{c,lim} \rightarrow OK!!$$

$$V_n = \frac{V_{u,design}}{\phi_{0,75}} = V_c + V_s \rightarrow V_s = 17,08 \text{ t} \rightarrow V_n = 29,81 \text{ t}$$

$$V_{s,lim} = \frac{2}{3} \cdot \sqrt{f'_c} \cdot b_w \cdot d = 50,93 \text{ t}$$

$$\phi_{0,75} \rightarrow \phi V_n \geq V_u \rightarrow 22,36 \geq 22,36 \rightarrow OK!!$$

### Área de Aço:

$$A_v = \frac{V_s \cdot s}{f_{yt} \cdot d} = \frac{17,08 \cdot 100}{4,2 \cdot 76,4} = 5,32 \text{ cm}^2/\text{m}$$

$$A_{v,min} = \frac{1}{16} \cdot \sqrt{f'_c} \cdot \frac{b_w \cdot s}{f_{yt}} \geq 0,33 \cdot \frac{b_w \cdot s}{f_{yt}} = 1,55 \text{ cm}^2/\text{m}$$

$$A_v \geq A_{v,min} \rightarrow 5,32 \geq 1,55 \rightarrow A_v!!$$

Espaçamento:

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

$$s_1 = \frac{d}{2} = 38,2 \text{ cm ou } s_2 = 400 \text{ mm} \rightarrow \text{Adotado: } 18 \text{ cm!}$$

$$\phi_t = 8 \text{ mm} \rightarrow A_v = 5,56 \text{ cm}^2/\text{m} \rightarrow \phi 8 \text{ c/ } 18 \text{ cm}$$

$$\phi_t = 8 \text{ mm} \rightarrow A_v = 5,56 \text{ cm}^2/\text{m} \rightarrow \phi 8 \text{ c/ } 18 \text{ cm}$$

$$\phi V_n (22,93 \text{ t}) \geq V_u (22,36 \text{ t}) \rightarrow OK!!$$