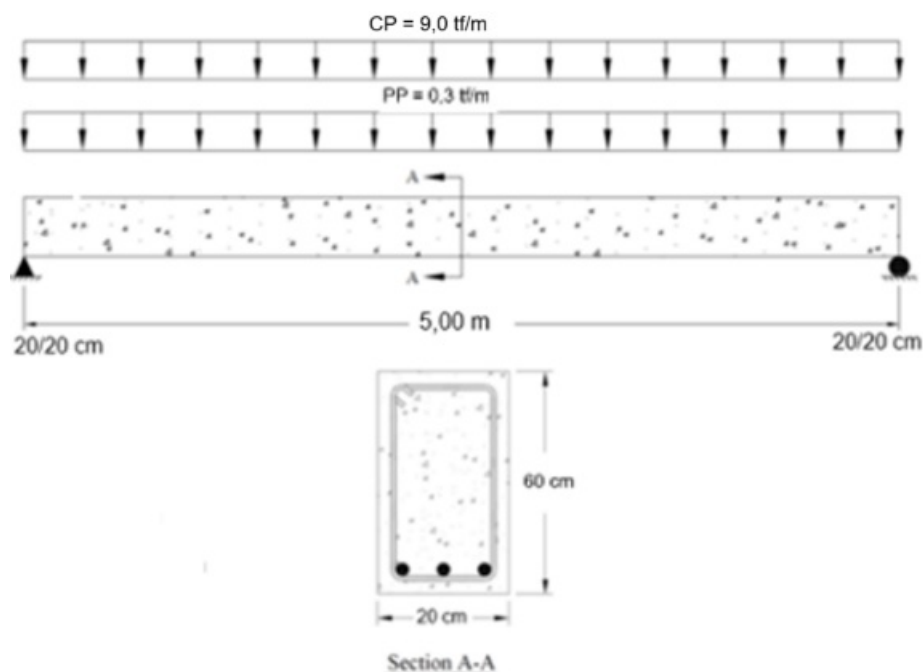


Vigas - Flexão Simples 5

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:

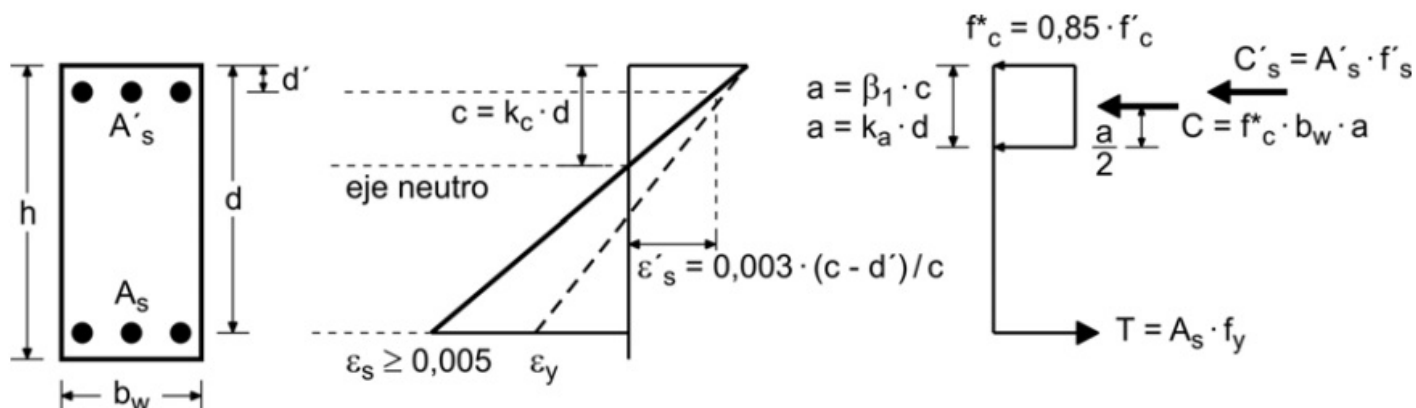


Concreto: H-25 / Aço: ADN420

bw: 20 cm / h: 60 cm

Mu:

TQS = 373,00 kN.m	Software B = 383,7 kN.m	Software C = 373,3 kN.m
-------------------	-------------------------	-------------------------



Flexão:

$$M_n = \frac{Mu}{\phi} = \frac{373,00}{0,9} = 414,44 \text{ kN.m}$$

$$d = h - C_c - d_{be} - \frac{d_b}{2} = 60 - 2 - 0,8 - 1 = 56,20 \text{ cm}$$

$$m_n = \frac{M_n}{0,85 \cdot f'_c \cdot b_w \cdot d^2} = \frac{414,44}{0,85 \cdot 25000 \cdot 0,20 \cdot 0,562^2} = 0,3087 \quad k_{a,max} = 0,375 \cdot \beta_1 = 0,319$$

$$k_a = 1 - (1 - 2 \cdot m_n)^{\frac{1}{2}} = 1 - (1 - 2 \cdot 0,3087)^{\frac{1}{2}} = 0,3815 \rightarrow k_a > k_{a,max}$$

$$x = 0,375 \cdot d = 21 \text{ cm}$$

$$M_c = f_{*c} \cdot b_w \cdot d^2 \cdot k_{a,max} \cdot \left(1 - \frac{k_{a,max}}{2}\right) = 21250 \cdot 0,2 \cdot 0,562^2 \cdot 0,319 \cdot \left(1 - \frac{0,319}{2}\right) = 359,91 \text{ kN.m}$$

$$\Delta M_n = M_n - M_c = 414,44 - 359,91 = 54,53 \text{ kN.m}$$

$$A'_s = \frac{\Delta M_n}{f'_s \cdot (d - d')} = \frac{54,53}{420 \cdot (0,562 - 0,033)} = 2,45 \text{ cm}^2$$

$$A_s = \frac{k_a \cdot f_{*c} \cdot b_w \cdot d}{f_y} + \frac{A'_s \cdot f'_s}{f_y} = \frac{0,319 \cdot 21,25 \cdot 200 \cdot 56,2}{420} + \frac{2,45 \cdot 420}{420} = 18,14 + 2,45 = 20,59 \text{ cm}^2$$

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

$$A_{s1,min} = \frac{0,25 \cdot \sqrt{f'_c}}{f_y} \cdot b_w \cdot d = \frac{0,25 \cdot \sqrt{25}}{420} \cdot 20 \cdot 56,2 = 3,35 \text{ cm}^2$$

$$A_{s2,min} = \frac{1,4 \cdot b_w \cdot d}{f_y} = \frac{1,4 \cdot 20 \cdot 56,2}{420} = 3,75 \text{ cm}^2$$

$$A_{s,req} = A_s \cdot 1,33 = 27,44 \text{ cm}^2 \quad A_{s,req} = A_s \cdot 1,33 = 27,44 \text{ cm}^2$$

TQS	Software B	Software C
As = 20,59 cm ²	As = 24,15 cm ²	As = 22,73 cm ²
A's = 2,45 cm ²	A's = 0,0 cm ²	A's = 2,04 cm ²

$$20,59 \text{ cm}^2 \geq 3,75 \text{ cm}^2 \rightarrow \text{OK!!}$$

$$3\emptyset 20 \text{ mm} \rightarrow 21,99 \text{ cm}^2$$

$$\phi M_n (376,83 \text{ KN.m}) \geq M_u (373,00 \text{ KN.m}) \rightarrow \text{OK!!}$$

Cortante:

TQS	Software B	Software C
Vu = 32,59 t	Vu = 31,25 t	Vu = 32,53 t
Vu,design = 23,90 t	Vu,design = 23,85 t	Vu,design = 23,70 t

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

$$V_n = V_c + V_s$$

$$V_u = 32,59 \text{ t}$$

$$V_{u,design} = 23,90 \text{ t}$$

$$V_c = \left(1 + \frac{N_u}{14 \cdot A_g}\right) \sqrt{f'_c} \cdot \frac{1}{6} \cdot b_w \cdot d = \left(1 + \frac{0}{14 \cdot 0,12}\right) \sqrt{25} \cdot \frac{1}{6} \cdot 2 \cdot 5,62 = 9,37 \text{ t}$$

$$V_{c,lim} = 0,3 \cdot \sqrt{f'_c} \cdot b_w \cdot d \cdot \sqrt{1 + \frac{0,3 \cdot N_u}{A_g}} = 16,86 \text{ t}$$

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

$$V_n = \frac{V_{u,design}}{\phi_{0,75}} = V_c + V_s \rightarrow V_s = 22,50 \text{ t} \rightarrow V_n = 31,87 \text{ t}$$

$$V_{s,lim} = \frac{2}{3} \cdot \sqrt{f'_c} \cdot b_w \cdot d = 37,47 \text{ t}$$

$$\phi_{0,75} \rightarrow \phi V_n \geq V_u \rightarrow 23,90 \geq 23,90 \rightarrow OK!!$$

Área de Aço:

$$A_v = \frac{V_s \cdot s}{f_{yt} \cdot d} = \frac{22,50 \cdot 100}{4,2 \cdot 56,2} = 9,53 \text{ cm}^2/\text{m}$$

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

$$A_v \geq A_{v,min} \rightarrow 9,53 \geq 1,55 \rightarrow A_v!!$$

Espaçamento:

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

$$s_1 = \frac{d}{2} = 28,1 \text{ cm ou } s_2 = 400 \text{ mm} \rightarrow \text{Adotado: } 10 \text{ cm!}$$

$$\phi_t = 8 \text{ mm} \rightarrow A_v = 10,0 \text{ cm}^2/\text{m} \rightarrow \phi 8 \text{ c/ } 10 \text{ cm}$$

$$\phi_t = 8 \text{ mm} \rightarrow A_v = 10,00 \text{ cm}^2/\text{m} \rightarrow \phi 8 \text{ c/ } 10 \text{ cm}$$

$$\phi V_n (24,73 \text{ t}) \geq V_u (23,90 \text{ t}) \rightarrow OK!!$$