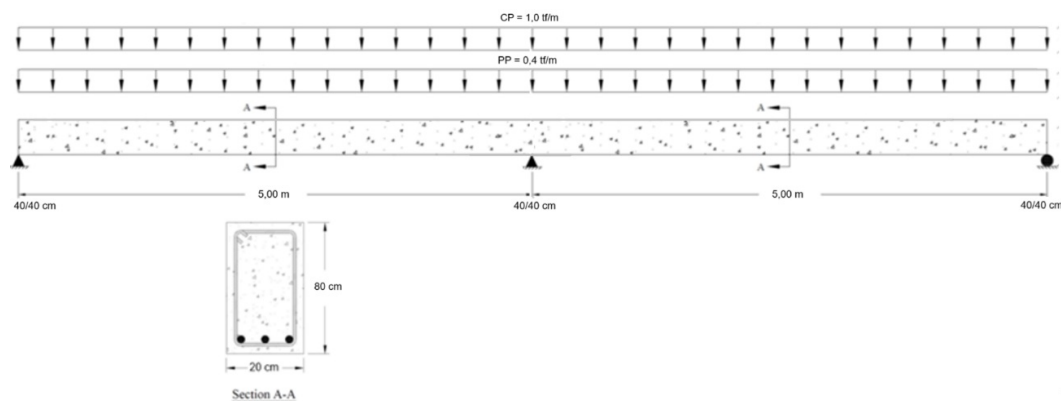


Vigas - Flexão Simples - Viga Continua 5

FLEXÃO SIMPLES

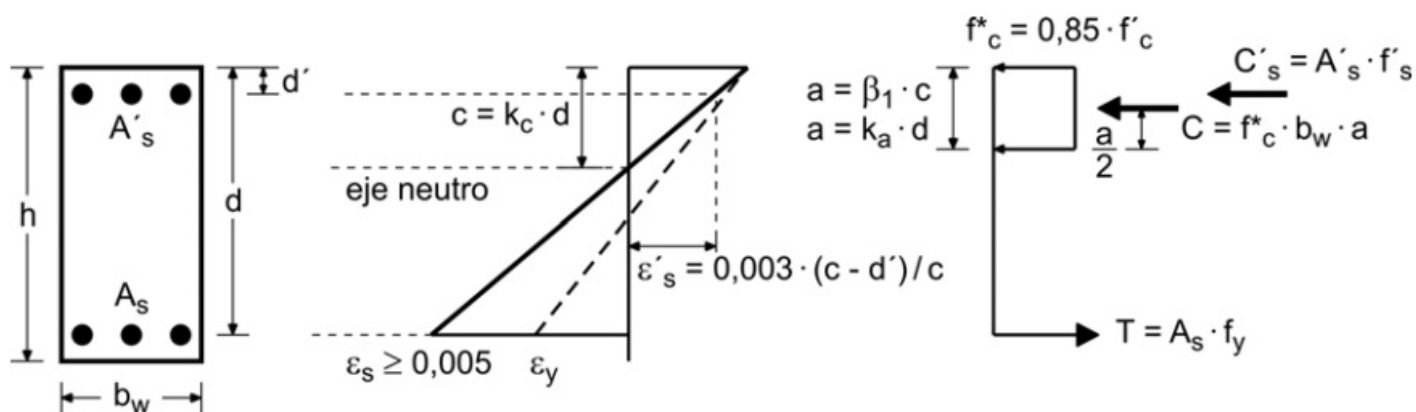
Neste exemplo, será dimensionada a armadura longitudinal e transversal de uma viga submetida a Flexão Simples utilizando como base a Norma Cirsoc-2005, conforme dados abaixo:



Concreto: H-25 / Aço: ADN420

bw: 20 cm / h: 80 cm

TQS:	Software B:	Software C:
Mu+ 29 kN.m	Mu+ 27 kN.m	Mu+ 30,5 kN.m
Mu- 55 kN.m	Mu- 54,9 kN.m	Mu- 54,3 kN.m



Flexão+:

$$M_n = \frac{M_u}{\phi} = \frac{29,00}{0,9} = 32,22 \text{ kN.m}$$

$$d = h - C_c - d_{be} - \frac{d_b}{2} = 80 - 2 - 0,6 - 0,6 = 76,8 \text{ cm}$$

$$m_n = \frac{M_n}{0,85 \cdot f'_c \cdot b_w \cdot d^2} = \frac{32,22}{0,85 \cdot 25000 \cdot 0,20 \cdot 0,768^2} = \mathbf{0,0129}$$

$$k_a = 1 - (1 - 2 \cdot m_n)^{\frac{1}{2}} = 1 - (1 - 2 \cdot 0,0129)^{\frac{1}{2}} = \mathbf{0,0129}$$

$$x = \frac{k_a \cdot d}{0,85} = \mathbf{1,17 \text{ cm}}$$

$$A_s = \frac{k_a \cdot f'_c \cdot b_w \cdot d}{f_y} = \frac{0,0129 \cdot 21,25 \cdot 20 \cdot 76,8}{420} = \mathbf{1,00 \text{ cm}^2}$$

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

$$A_{s1,min} = \frac{0,25 \cdot \sqrt{f'_c}}{f_y} \cdot b_w \cdot d = \frac{0,25 \cdot \sqrt{25}}{420} \cdot 20 \cdot 76,8 = 4,57 \text{ cm}^2$$

$$A_{s2,min} = \frac{1,4 \cdot b_w \cdot d}{f_y} = \frac{1,4 \cdot 20 \cdot 76,8}{420} = 5,12 \text{ cm}^2$$

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

→ TQS adota adicional devido a altura da viga → $3,36 \text{ cm}^2$

TQS = $3,36 \text{ cm}^2$	Software B = $1,23 \text{ cm}^2$	Software C = $5,17 \text{ cm}^2$
---------------------------	----------------------------------	----------------------------------

$$3,39 \text{ cm}^2 \geq 3,36 \text{ cm}^2 \rightarrow \text{OK!!}$$

$$3\emptyset 12 \text{ mm} \rightarrow 3,39 \text{ cm}^2$$

$$\emptyset M_n (96,23 \text{ KN.m}) \geq M_u (29,00 \text{ KN.m}) \rightarrow \text{OK!!}$$

Flexão:-

$$M_n = \frac{M_u}{\phi} = \frac{55}{0,9} = \mathbf{61,11 \text{ kN.m}}$$

$$d = h - C_c - d_{be} - \frac{d_b}{2} = 80 - 2 - 0,6 - 0,5 = \mathbf{76,90 \text{ cm}}$$

$$m_n = \frac{M_n}{0,85 \cdot f'_c \cdot b_w \cdot d^2} = \frac{61,11}{0,85 \cdot 25000 \cdot 0,20 \cdot 0,769^2} = \mathbf{0,0243}$$

$$k_a = 1 - (1 - 2 \cdot m_n)^{\frac{1}{2}} = 1 - (1 - 2 \cdot 0,0243)^{\frac{1}{2}} = \mathbf{0,0246}$$

$$x = \frac{k_a \cdot d}{0,85} = \mathbf{2,23 \text{ cm}}$$

$$A_s = \frac{k_a \cdot f'_c \cdot b_w \cdot d}{f_y} = \frac{0,0246 \cdot 21,25 \cdot 20 \cdot 76,9}{420} = \mathbf{1,92 \text{ cm}^2}$$

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

$$A_{s1,min} = \frac{0,25 \cdot \sqrt{f'_c}}{f_y} \cdot b_w \cdot d = \frac{0,25 \cdot \sqrt{25}}{420} \cdot 20 \cdot 76,9 = 4,58 \text{ cm}^2$$

$$A_{s2,min} = \frac{1,4 \cdot b_w \cdot d}{f_y} = \frac{1,4 \cdot 20 \cdot 76,9}{420} = 5,13 \text{ cm}^2$$

$$A_{s,req} = A_s \cdot 1,33 = 2,56 \text{ cm}^2 \quad A_{s,req} = A_s \cdot 1,33 = 2,56 \text{ cm}^2$$

TQS = 2,56 cm ²	Software B = 2,51 cm ²	Software C = 5,17 cm ²
----------------------------	-----------------------------------	-----------------------------------

$$3,14 \text{ cm}^2 \geq 2,56 \text{ cm}^2 \rightarrow \text{OK!!}$$

$$4\phi 10 \text{ mm} \rightarrow 3,14 \text{ cm}^2$$

$$\phi M_n (89,31 \text{ KN.m}) \geq M_u (55,00 \text{ KN.m}) \rightarrow \text{OK!!}$$

Cortante:

TQS	Software B	Software C
Vu = 5,73 t	Vu = 5,48 t	Vu = 5,70 t
Vu,design = 3,83 t	Vu,design = 3,98 t	Vu,design = 3,80 t

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

$$V_n = V_c + V_s$$

$$V_u = 5,73 \text{ t}$$

$$V_{u,design} = 3,83 \text{ t}$$

$$V_c = \left(1 + \frac{N_u}{14 \cdot A_g}\right) \sqrt{f'_c} \cdot \frac{1}{6} \cdot b_w \cdot d = \left(1 + \frac{0}{14 \cdot 0,12}\right) \sqrt{25} \cdot \frac{1}{6} \cdot 2 \cdot 7,68 = 12,80 \text{ t}$$

$$V_{c,lim} = 0,3 \cdot \sqrt{f'_c} \cdot b_w \cdot d \cdot \sqrt{1 + \frac{0,3 \cdot N_u}{A_g}} = 23,04 \text{ t}$$

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

$$V_n = \frac{V_{u,design}}{\phi_{0,75}} = V_c + V_s \rightarrow V_s = 0 \text{ t} \rightarrow V_n = 5,11 \text{ t}$$

$$V_{s,lim} = \frac{2}{3} \cdot \sqrt{f'_c} \cdot b_w \cdot d = 51,20 \text{ t}$$

$$\phi 0,75 \rightarrow \phi V_n \geq V_u \rightarrow 3,83 \geq 3,83 \rightarrow \text{OK!!}$$

Área de Aço:

$$A_v = \frac{V_s \cdot s}{f_{yt} \cdot d} = \frac{0 \cdot 100}{4,2 \cdot 56,6} = 0,00 \text{ cm}^2/\text{m}$$

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

$$A_v \geq A_{v,min} \rightarrow 0,00 \leq 1,55 \rightarrow \text{Adotado } A_{v,min}!!$$

Espaçamento:

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

$$s_1 = \frac{d}{2} = 38,4 \text{ cm ou } s_2 = 400 \text{ mm} \rightarrow \text{Adotado: } 35 \text{ cm!}$$

$$\phi_t = 6 \text{ mm} \rightarrow A_v = 1,60 \text{ cm}^2/\text{m} \rightarrow \phi 6 \text{ c/ } 35 \text{ cm}$$

$$\phi_t = 6 \text{ mm} \rightarrow A_v = 1,60 \text{ cm}^2/\text{m} \rightarrow \phi 6 \text{ c/ } 35 \text{ cm}$$

$$\phi V_n (13,50 \text{ t}) \geq V_u (3,83 \text{ t}) \rightarrow \text{OK!!}$$