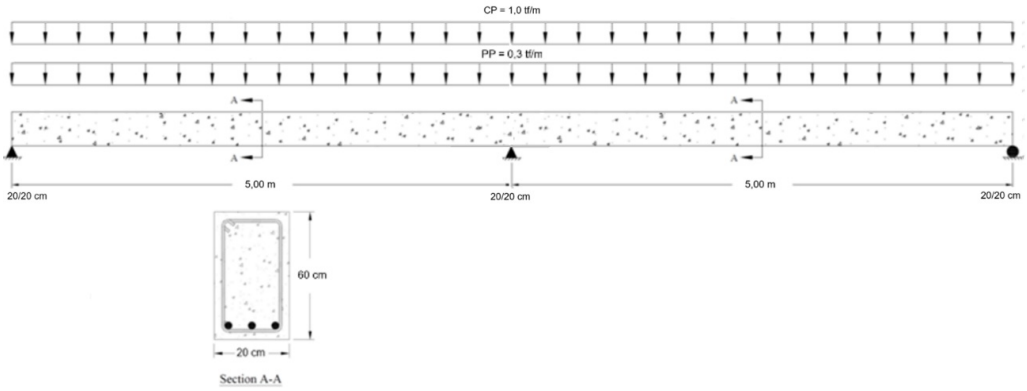
Vigas - Flexão Simples - Viga Continua 2

FLEXÃO SIMPLES

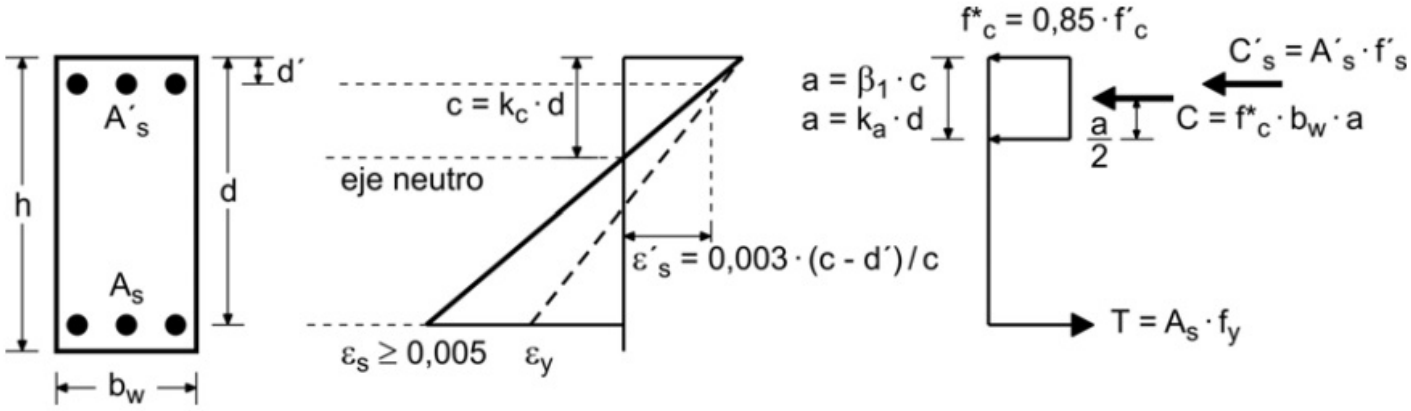
Neste exemplo, será dimensionada a armadura longitudinal e transversal de uma viga submetida a Flexão Simples utilizando como base a Norma Cirsoc-2005, conforme dados abaixo:



Concreto: H-25 / Aço: ADN420

bw: 20 cm / h: 60 cm

TQS:	Software B:	Software C:
Mu+ 31 kN.m	Mu+ 30,3 kN.m	Mu+ 28,3 kN.m
Mu- 56 kN.m	Mu- 55,6 kN.m	Mu- 55,1 kN.m



Flexão+:

$$M_n = \frac{Mu}{\emptyset} = \frac{31{,}00}{0{,}9} = \mathbf{34{,}44\ kN.m}$$

$$d = h - C_c - d_{be} - \frac{d_b}{2} = 60 - 2 - 0{,}6 - 0{,}5 = \mathbf{56{,}90\ cm}$$

$$m_n = \frac{M_n}{0{,}85 \cdot f'_c \cdot b_w \cdot d^2} = \frac{31{,}00}{0{,}85 \cdot 25000 \cdot 0{,}20 \cdot 0{,}569^2} = \mathbf{0{,}025}$$

$$k_a = 1 - (1 - 2 \cdot m_n)^{\frac{1}{2}} = 1 - (1 - 2 \cdot 0{,}025)^{\frac{1}{2}} = \mathbf{0{,}0254}$$

$$\boldsymbol{x = \frac{k_a \cdot d}{0{,}85} = 1{,}70\ cm}$$

$$\boldsymbol{A_s = \frac{k_a \cdot f *_c \cdot b_w \cdot d}{f_y} = \frac{0{,}0254 \cdot 21{,}25 \cdot 20 \cdot 56{,}9}{420} = 1{,}46\ cm^2}$$

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

$$A_{s1,min} = \frac{0{,}25 \cdot \sqrt{f'_c}}{f_y} \cdot b_w \cdot d = \frac{0{,}25 \cdot \sqrt{25}}{420} \cdot 20 \cdot 56{,}9 = 3{,}39\ cm^2$$

$$A_{s2,min} = \frac{1{,}4 \cdot b_w \cdot d}{f_y} = \frac{1{,}4 \cdot 20 \cdot 56{,}9}{420} = 3{,}79\ cm^2$$

$$A_{s,req} = A_s \cdot 1{,}33 = 1{,}95\ cm^2 A_{s,req} = A_s \cdot 1{,}33 = 1{,}95\ cm^2$$

$$\rightarrow\ TQS\ adota\ adicional\ devido\ a\ altura\ da\ viga\ \rightarrow 2{,}56\ cm^2$$

TQS = 2,56 cm2	Software B = 1,87 cm2	Software C = 3,84 cm2

2,56 cm² ≥ 1,95 cm² → OK!!

$$4Ø10\ mm\ \rightarrow 3{,}14\ cm^2$$

øMn (65,69 KN.m) ≥ Mu (31,00 KN.m) → OK!!

Flexão-:

$$\boldsymbol{M_n = \frac{Mu}{Ø} = \frac{56}{0{,}9} = 62{,}22\ kN.m}$$

$$d = h - C_c - d_{be} - \frac{d_b}{2} = 60 - 2 - 0{,}6 - 0{,}6 = \mathbf{56{,}80\ cm}$$

$$m_n = \frac{M_n}{0{,}85 \cdot f'_c \cdot b_w \cdot d^2} = \frac{62{,}22}{0{,}85 \cdot 25000 \cdot 0{,}20 \cdot 0{,}568^2} = \mathbf{0{,}0454}$$

$$k_a = 1 - (1 - 2 \cdot m_n)^{\frac{1}{2}} = 1 - (1 - 2 \cdot 0{,}0454)^{\frac{1}{2}} = \mathbf{0{,}0465}$$

$$\boldsymbol{x = \frac{k_a \cdot d}{0{,}85} = 3{,}10\ cm}$$

$$\boldsymbol{A_s = \frac{k_a \cdot f *_c \cdot b_w \cdot d}{f_y} = \frac{0{,}0465 \cdot 21{,}25 \cdot 20 \cdot 56{,}8}{420} = 2{,}67\ cm^2}$$

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

$$A_{s1,min} = \frac{0{,}25 \cdot \sqrt{f'_c}}{f_y} \cdot b_w \cdot d = \frac{0{,}25 \cdot \sqrt{25}}{420} \cdot 20 \cdot 56{,}8 = 3{,}38\ cm^2$$

$$A_{s2,min} = \frac{1{,}4 \cdot b_w \cdot d}{f_y} = \frac{1{,}4 \cdot 20 \cdot 56{,}8}{420} = 3{,}79\ cm^2$$

$$A_{s,req} = A_s \cdot 1{,}33 = 3{,}56\ cm^2$$

TQS = 3,56 cm2	Software B = 3,54 cm2	Software C = 3,84 cm2

3,56 cm² ≥ 3,56 cm² → OK!!

$4Ø12\ mm \rightarrow 4{,}52\ cm^2$

øMn (93,23 KN.m) ≥ Mu (56,00 KN.m) → OK!!

Cortante:

TQS	Software B	Software C
Vu = 5,61 t	Vu = 5,50 t	Vu = 5,58 t
Vu,design = 4,40 t	Vu,design = 4,47 t	Vu,design = 4,40 t

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

$$V_n = V_c + V_s$$

$$\boldsymbol{V_u = 5{,}61\ t}$$

$$\boldsymbol{V_{u,design} = 4{,}40\ t}$$

$$V_c = \left(1 + \frac{N_u}{14 \cdot A_g}\right)\sqrt{f'_c} \cdot \frac{1}{6} \cdot b_w \cdot d = \left(1 + \frac{0}{14 \cdot 0{,}12}\right)\sqrt{25} \cdot \frac{1}{6} \cdot 2 \cdot 5{,}68 = 9{,}47\ t$$

$$V_{c,lim} = 0{,}3 \cdot \sqrt{f'_c} \cdot bw \cdot d \cdot \sqrt{1 + \frac{0{,}3 \cdot N_u}{A_g}} = 17{,}04\ t$$

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

$$\boldsymbol{V_n = \frac{V_{u,design}}{Ø_{0,75}} = V_c + V_s \rightarrow V_s = 0\ t \rightarrow V_n = 5{,}87\ t}$$

$$V_{s,lim} = \frac{2}{3} \cdot \sqrt{f'_c} \cdot b_w \cdot d = 37{,}87\ t$$

Ø0,75 → øVn ≥ Vu → 4,40 ≥ 4,40 → OK!!

Área de Aço:

$$A_v = \frac{V_s \cdot s}{f_{yt} \cdot d} = \frac{0 \cdot 100}{4{,}2 \cdot 56{,}8} = 0{,}00\ cm^2/m$$

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

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

Espaçamento:

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

$$\boldsymbol{s_1 = \frac{d}{2} = 28{,}4\ cm\ \ ou\ \ s_2 = 400\ mm \rightarrow Adotado{:}28\ cm!}$$

$$\boldsymbol{\emptyset_t = 6\ mm \rightarrow A_v = 2{,}00\ cm^2/m \rightarrow \emptyset 6\ c/\ 28\ cm}$$

Øt = 6 mm → Av = 2,00 cm²/m → ø6 c/ 28 cm

øVn (10,66 t) ≥ Vu (4,40 t) → OK!!