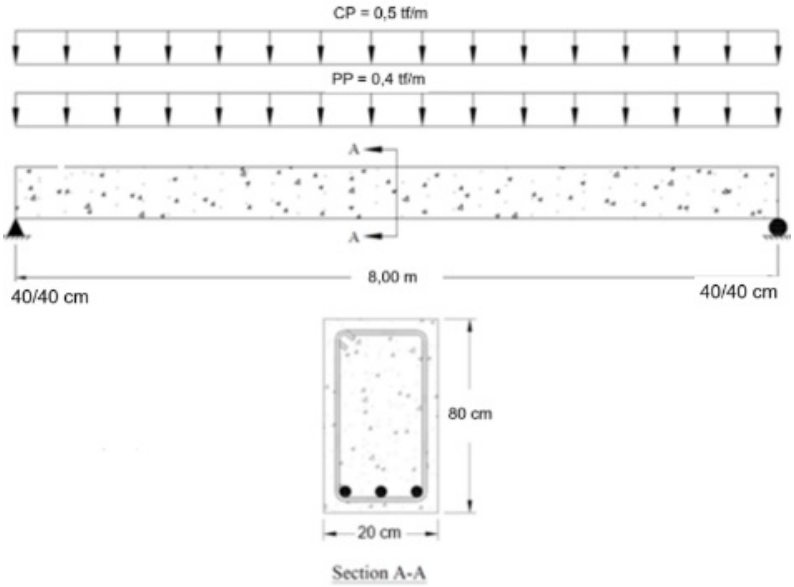
Vigas - Flexão Simples 5

FLEXÃO SIMPLES

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

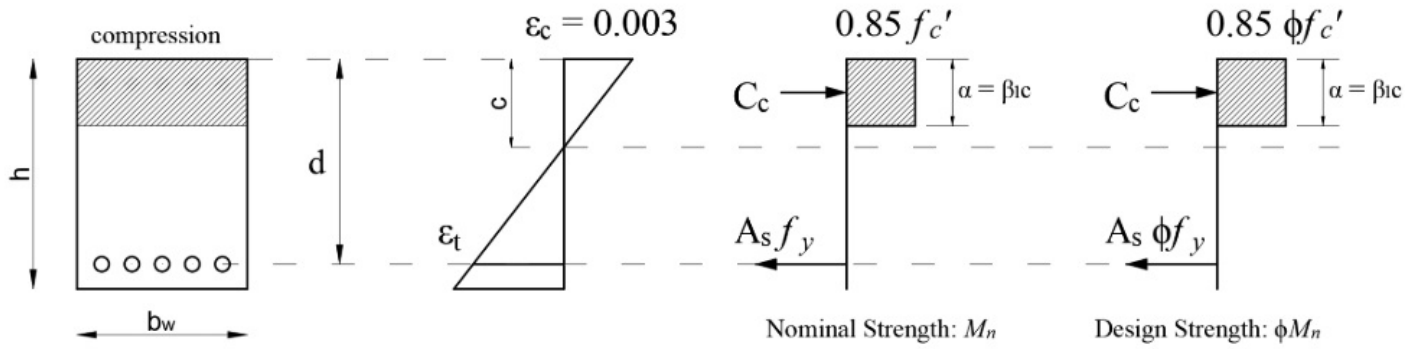


Concreto - C25 (4000 psi) / Aço – ADN420 (60 ksi)

bw: 8 in / h: 31,50 in

Mu:

TQS = 531 kip.in	**Software B = 538,08 kip.in**	**Software C = 550,47 kip.in**



Flexão:

$$M_n = \frac{Mu}{\emptyset} = \frac{531}{0,9} = 611,63\ \boldsymbol{kip.in}$$

$$d = h - C_c - d_{be} - \frac{d_b}{2} = 31,50 - 1,57 - 0,375 - 0,1875 = \mathbf{29,37\ in}$$

$$R_n = \frac{M_{n,req}}{b_w \cdot d^2} = \frac{611{,}63}{8 \cdot 29{,}37^2} = 0{,}085\ ksi = 85{,}48\ \boldsymbol{psi}$$

$$\rho = \left(0{,}85 \cdot \frac{f'_c}{f_y}\right) \cdot [1 - \sqrt{1 - \left(\frac{2 \cdot R_n}{0{,}85 \cdot f'_c}\right)} = (0{,}85 \cdot \frac{4}{60}) \cdot (1 - \sqrt{1 - \left(\frac{2 \cdot 0{,}085}{0{,}85 \cdot 4}\right)}) = \mathbf{0{,}0014}$$

$$\boldsymbol{A_s} = \rho \cdot b_w \cdot d = 0{,}0014 \cdot 8 \cdot 29{,}37 = \mathbf{0{,}34\ in^2}$$

As,min (ACI 318-19 – 9.6.1.2)

$$\left(\frac{3 \cdot \sqrt{f'_c}}{f_y}\right) \cdot b_w \cdot d = \left(\frac{3 \cdot \sqrt{4000}}{60000}\right) \cdot 8 \cdot 29{,}37 = \mathbf{0{,}74\ in^2}$$

$$\left(\frac{200}{f_y}\right) \cdot b_w \cdot d = \left(\frac{200}{60000}\right) \cdot 8 \cdot 29{,}37 = \mathbf{0{,}78\ in^2}$$

$$A_{s,req} = A_s \cdot 1{,}33 = 0{,}45\ in^2 \rightarrow TQS\ adota\ adicional\ devido\ a\ altura\ da\ viga \rightarrow 0{,}55\ in^2$$

$$\boldsymbol{A_{s,min}} = \mathbf{0{,}55\ in^2}$$

TQS = 0,55 in2	**Software B = 0,47 in2**	**Software C = 0,80 in2**

0,55 in2 ≥ 0,55 in2 → OK!

$5\#3 \rightarrow 0{,}55\ in2$

øMn (848,78 kip.in) ≥ Mu (531,00 kip.in) → OK!!

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

$$\alpha = \frac{A_s \cdot f_y}{0{,}85 \cdot f'_c \cdot b_w} = \frac{0{,}34 \cdot 60}{0{,}85 \cdot 4 \cdot 8} = 0{,}75\ in$$

Linha Neutra: $\boldsymbol{c} = \frac{\alpha}{\beta_1} = \frac{0{,}75}{0{,}85} = 0{,}88\ \boldsymbol{inc} = \frac{\alpha}{\beta_1} = \frac{0{,}75}{0{,}85} = 0{,}88\ \boldsymbol{in}$

$$\varepsilon_t = 0{,}003 \cdot \left(\frac{d - c}{c}\right) = 0{,}003 \cdot \left(\frac{29{,}37 - 0{,}88}{0{,}88}\right) = \mathbf{0{,}097}$$

0,097 ≥ 0,005 → OK! Tension Controlled! → ø 0,90 OK!

Cortante:

TQS	Software B	Software C
Vu = 10,93 kips	Vu = 10,36 kips	Vu = 11,03 kips
Vu,design = 8,31 kips	Vu,design = 8,32 kips	Vu,design = 8,38 kips

$$V_n = V_c + V_s$$

$$\boldsymbol{V_u = 10,93\ kips}$$

$$\boldsymbol{V_{u,design} = 8,31\ kips}$$

$$V_c = 2 \cdot \lambda \cdot \sqrt{f'_c} \cdot b_w \cdot d = 2 \cdot 1 \cdot \sqrt{4000} \cdot 8 \cdot 29,37 = 29,72\ \boldsymbol{kips}$$

$$\boldsymbol{V_n = \frac{V_{u,design}}{\emptyset_{0,75}} = V_c + V_s \quad \rightarrow \quad V_s = 0\ kips \quad \rightarrow \quad V_n = 11,08\ kips}$$

$$V_{s,lim} = 8 \cdot \sqrt{f'_c} \cdot b_w \cdot d = 8 \cdot \sqrt{4000} \cdot 8 \cdot 29,37 = \boldsymbol{118,89\ kips}$$

Vs ≤ Vs,lim OK!

Ø0,75 → øVn ≥ Vu → 8,31 ≥ 8,31 → OK!!

Área de Aço:

$$A_v = \frac{V_s \cdot s}{f_{yt} \cdot d} = \frac{A_v}{s} = \frac{0}{60 \cdot 29,37} = 0,0\ in^2$$

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

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

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

Espaçamento:

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

$$\boldsymbol{s_1 = \frac{d}{2} = 14,7\ in\ \ ou\ \ s_2 = 24\ in \rightarrow 14,9\ in! \rightarrow 10\ in!!}$$

$$\emptyset_t = \#3 \ \rightarrow \#3 \ @ \ 10 \ in$$

øVn (51,37 kips) ≥ Vu (8,31 kips)