SE2_E16-06

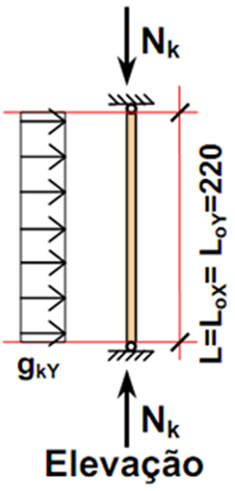
Verificar a condição de segurança da peça sujeita a flexocompressão indicada nas figuras.

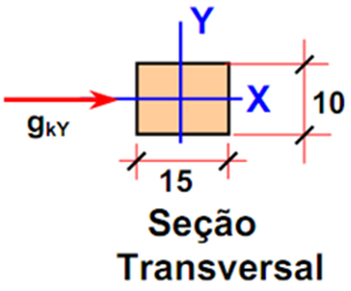
Dados:
- ELU Combinação Normal;
- Conífera C-25 , 2a categoria;
- Classe 1 de umidade;
- ELUti : Carregamento de longa duração;

$NGk := 4\ kN$ (permanente)

$NQk := 8\ kN$ (variável)

$gyk := 3\ \frac{kN}{m}$ (permanente)





Propriedades da Madeira:

$fc0k := 25\ MPa$ $fv0k := 5\ MPa$ $Ec0m := 8,5\ GPa$

$kmod3 := 0,8$ Conífera

$kmod2 := 1,0$ Ambiente Classe 2

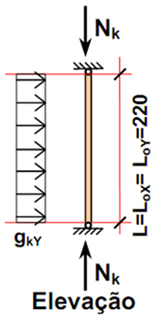
$kmod1 := 0,7$ Carregamentos de Longa Duração

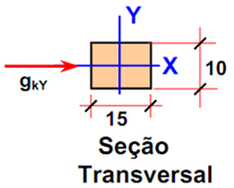
$kmod := kmod1 \cdot kmod2 \cdot kmod3 = 0,56$

$fc0d := kmod \cdot \frac{fc0k}{1,4} = 1\ \frac{kN}{cm^2}$ $Ec0ef := kmod \cdot Ec0m = 476\ \frac{kN}{cm^2}$

$fv0d := kmod \cdot \frac{fv0k}{1,8} = 0,1556\ \frac{kN}{cm^2}$

Combinações de Ações (ELU):





$L := 220\ cm$ $Lox := L = 220\ cm$

$NGk := 4\ kN$ (permanente) $\gamma g := 1,4$

$NQk := 8\ kN$ (variável) $\gamma q := 1,4$

$gyk := 3\ \frac{kN}{m}$ (permanente)

Combinações de Ações de Esforços Axiais:

$Nsd := \gamma g \cdot NGk + \gamma q \cdot NQk = 16,8\ kN$

Combinações de Efeitos de Momentos Fletores de 1a Ordem:

$Msdy1 := \frac{\gamma g \cdot gyk \cdot L^2}{8} = 254,1\ kN\ cm$

Verificação de Resistência - Flexocompressão Reta:

$$\left(\frac{\sigma_{Nc,d}}{f_{c0,d}}\right)^2 + \frac{\sigma_{Md}}{f_{c0,d}} \leq 1$$

$b := 15\ cm \qquad h := 10\ cm$

$Ag := b \cdot h = 150\ cm^2 \qquad Iy := \frac{h \cdot b^3}{12} = 2812,5\ cm^4$

$Wy := \frac{Iy}{\frac{b}{2}} = 375\ cm^3 \qquad Wy := \frac{h \cdot b^2}{6} = 375\ cm^3$

$\sigma Ncd := \frac{Nsd}{Ag} = 0,112\ \frac{kN}{cm^2} \qquad \sigma Myd1 := \frac{Msdy1}{Wy} = 0,6776\ \frac{kN}{cm^2}$

$Eq_verif := \left(\frac{\sigma Ncd}{fc0d}\right)^2 + \frac{\sigma Myd1}{fc0d} = 0,69014 \quad < 1 \quad$ OK ! Verifica !

Análise da Geometria do Problema:

$Ix := \frac{b \cdot h^3}{12} = 1250\ cm^4 \qquad Iy = 2812,5\ cm^4$

$rx := \sqrt{\frac{Ix}{Ag}} = 2,8868\ cm \qquad ry := \sqrt{\frac{Iy}{Ag}} = 4,3301\ cm$

$Lox := L = 220\ cm \qquad Loy := L = 220\ cm$

$\lambda x := \frac{Lox}{rx} = 76,21 \qquad \lambda y := \frac{Loy}{ry} = 50,8068$

* Para ambos eixos principais de inércia, a peça é MEDIANAMENTE ESBELTA

Verificação de Estabilidade do Eixo Y:

Peças Medianamente Esbeltas ($40 < \lambda \leq 80$):

$e_a = \frac{L_0}{300} \geq \frac{h}{30} \qquad e_i = \frac{M_{1d}}{N_{Sd}} \geq \frac{h}{30}$

$e_1 = e_i + e_a$

$F_E = \frac{\pi^2 \cdot E_{c0,ef} \cdot I}{L_0^2}$

$M_{Sd} = N_{Sd} \cdot e_1 \cdot \left(\frac{F_E}{F_E - N_{Sd}}\right)$

$\sigma_{Nsd} = \frac{N_{Sd}}{A}$

$\sigma_{Msd} = \frac{M_{Sd}}{I} \cdot y = \frac{M_{Sd}}{W}$

$\frac{\sigma_{Nsd}}{f_{c0d}} + \frac{\sigma_{Msd}}{f_{c0d}} \leq 1$

$hy := b = 15\ cm \qquad FEy := \frac{\pi^2 \cdot Ec0ef \cdot Iy}{Loy^2} = 272,99\ kN$

$eay := \text{if}\ \frac{Loy}{300} \geq \frac{hy}{30} = 0,73333\ cm$

$\frac{Loy}{300}$

else

$\frac{hy}{30}$

$Msdy1 = 254,1\ kN\ cm$

$eiy := \text{if}\ \frac{Msdy1}{Nsd} \geq \frac{hy}{30} = 15,125\ cm$

$\frac{Msdy1}{Nsd}$

else

$\frac{hy}{30}$

$e1y := eay + eiy = 15,858\ cm$

$\frac{FEy}{FEy - Nsd} = 1,0656 \qquad Msdy_final := Nsd \cdot e1y \cdot \left(\frac{FEy}{FEy - Nsd}\right) = 283,89\ kN\ cm$

$\sigma Nsd := \frac{Nsd}{Ag} = 0,112 \ \frac{kN}{cm^2}$ $\sigma Msdy_final := \frac{Msdy_final}{Wy} = 0,75704 \ \frac{kN}{cm^2}$

$\frac{\sigma_{Nsd}}{f_{c0d}} + \frac{\sigma_{Msd}}{f_{c0d}} \leq 1$ $Verif_EstY := \frac{\sigma Nsd}{fc0d} + \frac{\sigma Msdy_final}{fc0d} = 0,86904$ < 1 OK ! Verifica !

Verificação de Estabilidade do Eixo X:

Peças Medianamente Esbeltas ($40 < \lambda \leq 80$):

$hx := h = 10 \ cm$ $FEx := \frac{\pi^2 \cdot Ec0ef \cdot Ix}{Lox^2} = 121,3309 \ kN$

$e_a = \frac{L_0}{300} \geq \frac{h}{30}$ $e_i = \frac{M_{1d}}{N_{Sd}} \geq \frac{h}{30}$

$e_1 = e_i + e_a$

$eax := \text{if} \ \frac{Lox}{300} \geq \frac{hx}{30} = 0,7333 \ cm$

$\frac{Lox}{300}$

else

$\frac{hx}{30}$

$F_E = \frac{\pi^2 \cdot E_{c0,ef} \cdot I}{L_0^2}$

$M_{Sd} = N_{Sd} \cdot e_1 \cdot \left(\frac{F_E}{F_E - N_{Sd}}\right)$

$\sigma_{Nsd} = \frac{N_{Sd}}{A}$ $Msdx1 := 0$

$\sigma_{Msd} = \frac{M_{Sd}}{I} \cdot y = \frac{M_{Sd}}{W}$

$eix := \text{if} \ \frac{Msdx1}{Nsd} \geq \frac{hx}{30} = 0,3333 \ cm$

$\frac{Msdx1}{Nsd}$

else

$\frac{hx}{30}$

$\frac{\sigma_{Nsd}}{f_{c0d}} + \frac{\sigma_{Msd}}{f_{c0d}} \leq 1$

$Wx := \frac{b \cdot h^2}{6} = 250 \ cm^3$ $e1x := eax + eix = 1,0667 \ cm$

$\frac{FEx}{FEx - Nsd} = 1,1607$ $Msdx_final := Nsd \cdot e1x \cdot \left(\frac{FEx}{FEx - Nsd}\right) = 20,8001 \ kN \ cm$

$\sigma Nsd := \frac{Nsd}{Ag} = 0,112 \ \frac{kN}{cm^2}$ $\sigma Msdx_final := \frac{Msdx_final}{Wx} = 0,0832 \ \frac{kN}{cm^2}$

$\frac{\sigma_{Nsd}}{f_{c0d}} + \frac{\sigma_{Msd}}{f_{c0d}} \leq 1$ $Verif_EstX := \frac{\sigma Nsd}{fc0d} + \frac{\sigma Msdx_final}{fc0d} = 0,1952$ < 1 OK ! Verifica !
