AM16-AB-B1b

Problema A

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restart

$L := 2.5$:
$H := 1.5$:
$b := 44.45$:
$t := 4.760$:
$Ag := 4.0$:
$ec := 13.9$:
$d := 16.0$:
$Lc := 40.00$:
$fy := 25.0$:
$fu := 40.0$:
$E := 20000.0$:

$L_cm := 100 \cdot L$:
$H_cm := 100 \cdot H$:
$b_cm := b \cdot 0.1$:
$t_cm := t \cdot 0.1$:
$ec_cm := ec \cdot 0.1$:
$d_cm := d \cdot 0.1$:
$\gamma a1 := 1.1$:
$\gamma a2 := 1.35$:

Verificação ESB:

$$Rtd_ESB_1cant := \frac{Ag \cdot fy}{\gamma a1}$$

$$90.90909091 \quad \textbf{(1)}$$

Verificação RSL:

$$d_pad := d_cm + 0.35$$

$$1.95 \quad \textbf{(2)}$$

$$An1 := Ag - d_pad \cdot t_cm$$

$$3.071800 \quad \textbf{(3)}$$

$$lc := 0.1 \cdot Lc$$

$$4.000 \quad \textbf{(4)}$$

$$Ct := 1 - \frac{ec_cm}{lc}$$

$$0.6525000000 \quad \textbf{(5)}$$

if $Ct > 0.90$ **then** $Ct := 0.90$ **end if**
if $Ct < 0.60$ **then** $Ct := 0.60$ **end if**

$$Ae1 := Ct \cdot An1$$

$$2.004349500 \quad \textbf{(6)}$$

$$Rtd_RSL_1cant := \frac{Ae1 \cdot fu}{\gamma a2}$$

59.38813333 **(7)**

Verificação de Cisalhamento de Bloco:

$$\mathrm{Agv1} := (2.2 \cdot \mathrm{d_cm} + \mathrm{lc}) \cdot t_cm$$

3.5795200 **(8)**

$$Anv1 := Agv1 - 1.5 * d_pad * t_cm$$

2.1872200 **(9)**

$$Ant1 := (0.5 \cdot b_cm - 0.5 \cdot d_pad) \cdot t_cm$$

0.59381000 **(10)**

$$Rtd1 := \frac{1}{\gamma a2} \cdot (0.6 \cdot fu \cdot Anv1 + fu \cdot Ant1)$$

56.47828148 **(11)**

$$Rtd2 := \frac{1}{\gamma a2} \cdot (0.6 \cdot fy \cdot Agv1 + fu \cdot Ant1)$$

57.36681481 **(12)**

$$Rtd_CIS_1cant := \min(Rtd1, Rtd2)$$

56.47828148 **(13)**

Relação NAB com a carga P:

$$hAB := \sqrt{(0.5 \cdot L_cm)^2 + H_cm^2}$$

195.2562419 **(14)**

$$cos\alpha := \frac{H_cm}{hAB}$$

0.7682212796 **(15)**

$$sen\alpha := \frac{L_cm}{hAB}$$

1.280368799 **(16)**

$$ESB := 2 \cdot Rtd_ESB_1cant$$

181.8181818 **(17)**

$$RSL := 2 \cdot Rtd_RSL_1cant$$

118.7762667 **(18)**

$$CIS := 2 \cdot Rtd_CIS_1cant$$

112.9565630 **(19)**

$$NAC := \min(ESB, RSL, CIS)$$

112.9565630 **(20)**

$$\mathrm{P} := 2 \cdot \mathrm{NAC} \cdot cos\alpha$$

173.5512707 **(21)**

$$P_ESB := \mathrm{ESB} \cdot cos\alpha$$

139.6765963 **(22)**

Problema B

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restart

$L := 4.0$:
$H := 4.0$:
$bf := 250.0$:
$tf := 9.50$:
$hw := 325.0$:
$tw := 6.5$:
$q1 := 3.0$:
$P := 120.0$:
$fy := 25.0$:
$E := 20000.0$:

$L_cm := 100 \cdot L$:
$H_cm := 100 \cdot H$:
$bf_cm := bf \cdot 0.1$:
$tf_cm := tf \cdot 0.1$:
$hw_cm := hw \cdot 0.1$:
$tw_cm := tw \cdot 0.1$:

$\gamma a1 := 1.1$:
$\gamma a2 := 1.35$:

$\gamma perm := 1.25$:
$\gamma acid := 1.50$:

Combinação de Açoes:

$qsd := \gamma perm \cdot q1 + \gamma acid \cdot q2$:
$Psd := \gamma perm \cdot P$:

print("[", *qsd*, "] kN/m +", *Psd*, "kN")

"[", $1.50\ q2 + 3.750$, "] kN/m +", 150.000, "kN" **(23)**

Propriedades Geométricas:

$Ag := 2 \cdot bf_cm \cdot tf_cm + hw_cm \cdot tw_cm$

68.62500 **(24)**

$$Iy := \frac{hw_cm \cdot tw_cm^3}{12} + 2 \cdot \left(\frac{tf_cm \cdot bf_cm^3}{12} \right)$$

2474.702109 **(25)**

$$Ix := \frac{tw_cm \cdot hw_cm^3}{12} + 2 \cdot \left(\frac{bf_cm \cdot tf_cm^3}{12} + (bf_cm \cdot tf_cm) \cdot \left(\frac{hw_cm}{2} + \frac{tf_cm}{2} \right)^2 \right)$$

$$15149.97969 \quad (26)$$

$$rx := \sqrt{\frac{Ix}{Ag}}$$

$$14.85815370 \quad (27)$$

$$ry := \sqrt{\frac{Iy}{Ag}}$$

$$6.005100575 \quad (28)$$

$$Ky := 1.0$$

$$1.0 \quad (29)$$

$$Ly := H_cm$$

$$400.0 \quad (30)$$

$$\lambda y := \frac{Ky \cdot Ly}{ry}$$

$$66.61004175 \quad (31)$$

$$\mathrm{d_cm} := \mathrm{hw_cm} + 2 \cdot \mathrm{tf_cm}$$

$$34.400 \quad (32)$$

$$Wx := \frac{Ix}{0.5 \cdot d_cm}$$

$$880.8127726 \quad (33)$$

$$Wy := \frac{Iy}{0.5 \cdot bf_cm}$$

$$197.9761687 \quad (34)$$

$$Zx := 2 \cdot \left((bf_cm \cdot tf_cm) \cdot \left(\frac{hw_cm}{2} + \frac{tf_cm}{2} \right) + \left(\frac{hw_cm}{2} \cdot tw_cm \right) \cdot \left(\frac{hw_cm}{4} \right) \right)$$

$$966.0781250 \quad (35)$$

if $\lambda y < 200$ **then** $print(\text{"Esbeltez Adequada} < 200\text{"})$ **else** $print(\text{"Esbeltez Inadequada} > 200\text{"})$ **end if**

Verificação de Flambagem Local Elemento AA - Coluna BC:

$$\mathrm{bt_alma} := \frac{hw}{tw}$$

$$50.00000000 \quad (36)$$

$$bt_lim_alma := 1.49 \cdot \sqrt{\frac{E}{fy}}$$

$$42.14356416 \quad (37)$$

if $bt_alma < bt_lim_alma$ **then**
$Qa := 1$:
$print(\text{"Qa="}, Qa)$;

else

$$bef := \min\left(1.92 \cdot tw_cm \cdot \sqrt{\frac{E}{fy}} \cdot \left(1 - \frac{0.34}{\mathrm{bt_alma}} \cdot \sqrt{\frac{E}{fy}} \right), hw \right) :$$

$Aef := Ag - (hw_cm - bef) \cdot tw_cm$:

$Qa := \frac{Aef}{Ag}$:

print("bef=", bef, "cm");

print("Aef=", Aef, "cm2");

print("Qa=", Qa);

end if:

"bef=", 28.50965052, "cm"

"Aef=", 66.03127284, "cm2"

"Qa=", 0.9622043401 **(38)**

Verificação de Flambagem Local Elemento AL - Coluna BC:

$$\text{bt_mesa} := \frac{0.5 \cdot bf}{tf}$$

13.15789474 **(39)**

$$kc := \frac{4}{\sqrt{\frac{hw}{tw}}}$$

0.5656854248 **(40)**

if $kc > 0.76$ **then** $kc := 0.76$ **end if**

if $kc < 0.35$ **then** $kc := 0.35$ **end if**

$$bt_lim_mesa := 0.64 \cdot \sqrt{\frac{E}{\left(\frac{fy}{kc}\right)}}$$

13.61483749 **(41)**

$$bt_lim_elast_mesa := 1.17 \cdot \sqrt{\frac{E}{\left(\frac{fy}{kc}\right)}}$$

24.88962479 **(42)**

if $bt_mesa < bt_lim_mesa$ **then**

$Qs := 1$:

print("Qs=", Qs);

elif $bt_mesa < bt_lim_elast_mesa$ **then**

$Qs := 1.415 - 0.65 \cdot bt_mesa \cdot \sqrt{\frac{fy}{kc \cdot E}}$:

print("Qs=", Qs);

else

$$Qs := \frac{0.90 \cdot E \cdot kc}{fy \cdot (bt_mesa)^2} :$$
$print(\text{"Qs="}, Qs);$
end if:

"Qs=", 1 **(43)**

$$Q := Qa \cdot Qs$$

0.9622043401 **(44)**

Verificação de Flambagem Global - Coluna BC:

$$\lambda 0y := \lambda y \cdot \sqrt{\frac{Q \cdot fy}{\pi^2 \cdot E}}$$

0.7353235838 **(45)**

if $\lambda 0y \leq 1.5$ **then** $Xy := 0.658^{\lambda 0y^2}$ **else** $Xy := \frac{0.877}{\lambda 0y^2}$ **end if**:

$print(\text{"Xy="}, Xy)$

"Xy=", 0.7974704515 **(46)**

$$Ncrdy := \frac{Q \cdot Xy \cdot Ag \cdot fy}{\gamma a1} :$$
$print(\text{"Ncrdy="}, Ncrdy, \text{"kN"})$

"Ncrdy=", 1196.772476, "kN" **(47)**

Verificação de Momento Fletor - Viga AB:

$$Mrdx_kNm := \frac{Zx \cdot fy}{\gamma a1 \cdot 100.0}$$

219.5632102 **(48)**

Máximos q2:

$$Ncsd := \gamma perm \cdot P + \frac{(\gamma perm \cdot q1 + \gamma acid \cdot q2) \cdot L}{2}$$

$157.5000000 + 3.000000000\ q2$ **(49)**

$$q2_coluna := solve(Ncsd - Ncrdy = 0, q2)$$

346.4241587 **(50)**

$$Msd := \frac{(\gamma perm \cdot q1 + \gamma acid \cdot q2) \cdot L^2}{8}$$

$3.000000000\ q2 + 7.500000000$ **(51)**

$$q2_viga := solve(Msd - Mrdx_kNm = 0,\ q2)$$

$$70.68773673 \qquad \textbf{(52)}$$