

## Work: Example Model

Author:

Model: SteelFrame. axs

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### STEEL MEMBER DESIGN

Design member **60**Nodes: **13-14**Code: **Eurocode**

EN 1993-1-1:2005 + AC:2009, EN 1993-1-5:2006

Material: **S 355**Cross-section: **HE 200 B**Load case: **Linear, Envelope (Default)**Coefficient for seismic forces: **1,0**

#### 1. Axial force-Bending-Shear

EN 1993-1-1: 6.2.1, 6.2.8, 6.2.9

Critical combination: **Co #2**Section class: **1** (Plastic design)Critical section:  $x = 1,00 \cdot L = 1,00 \cdot 365,76 = 365,76$  cm

$$N_{Ed_{11}} = -85,29 \text{ kN} \quad V_{y,Ed_{11}} = 0 \text{ kN} \quad V_{z,Ed_{11}} = -44,44 \text{ kN} \quad M_{y,Ed_{11}} = -11334,32 \text{ kNm} = -113,34 \text{ kNm} \quad M_{z,Ed_{11}} = -1,07 \text{ kNm} = -0,01 \text{ kNm}$$

$$\eta_{NMV_{pl}} = \max(\eta_N; \eta_{M_{y,pl}}; \eta_{M_{z,pl}}; \eta_{V_z}; \eta_{V_y}) = \max(3,1; 51,5; 0; 11,2; 0) = 51,5 \% \quad \text{passed}$$

#### 2. Axial Force-Bending-Flexural Buckling

EN 1993-1-1: 6.3.3, Annex B: Method 2

Critical combination: **Co #2**Section class: **1** (Plastic design)Critical section:  $x = 1,00 \cdot L = 1,00 \cdot 365,76 = 365,76$  cm

$$C_{my} = \max(0,2 + 0,8 \cdot \alpha_{my}, 0,4) = \max(0,2 + 0,8 \cdot 0,246, 0,4) = 0,4 \geq 0,4 \quad \text{Table B.3}$$

$$C_{mz} = \max(0,2 + 0,8 \cdot \alpha_{mz}, 0,4) = \max(0,2 + 0,8 \cdot 0,5, 0,4) = 0,6 \geq 0,4 \quad \text{Table B.3}$$

$$f_{yy} = \min(\lambda_y^* - 0,2; 0,8) = \min(0,56 - 0,2; 0,8) = 0,36$$

$$f_{zz} = \min(2 \cdot \lambda_z^* - 0,6; 1,4) = \min(2 \cdot 0,95 - 0,6; 1,4) = 1,29$$

$$k_{yy} = C_{my} \cdot \left( 1 + f_{yy} \cdot \frac{\left| N_{Ed_{11}} \right|}{\chi_y \cdot N_{pl,Rd}} \right) = 0,4 \cdot \left( 1 + 0,36 \cdot \frac{|(-85,29)|}{0,86 \cdot 2771,84} \right) = 0,405$$

$$k_{zy} = 0,6 \cdot k_{yy} = 0,6 \cdot 0,405 = 0,243 \quad \text{Table Annex B.1}$$

$$k_{yz} = 0,6 \cdot k_{zz} = 0,6 \cdot 0,642 = 0,385$$

$$k_{zz} = C_{mz} \cdot \left( 1 + f_{zz} \cdot \frac{\left| N_{Ed_{11}} \right|}{\chi_z \cdot N_{pl,Rd}} \right) = 0,6 \cdot \left( 1 + 1,29 \cdot \frac{|(-85,29)|}{0,57 \cdot 2771,84} \right) = 0,642 \quad \text{Table Annex B.1}$$

$$\chi_y = \min \left( \frac{1}{\phi_y + \sqrt{\phi_y^2 - \lambda_y^*}^2}; 1 \right) = 0,86 \quad (6.49)$$

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$$\chi_z = \min \left( \frac{1}{\phi_z + \sqrt{\phi_z^2 - \lambda_z^*}^2}; 1 \right) = 0,57 \quad (6.49)$$

$$\eta_{NMBuckl_1} = \frac{\left| N_{Ed_{11}} \right|}{\frac{\chi_y \cdot N_{pl,Rd}}{\gamma_{M1}}} + k_{yy} \cdot \frac{\left| M_{y,Ed_{11}} \right|}{\frac{M_{pl,Rd,y}}{\gamma_{M1}}} + k_{yz} \cdot \frac{\left| M_{z,Ed_{11}} \right|}{\frac{M_{pl,Rd,z}}{\gamma_{M1}}} = \frac{|(-85,29)|}{0,86 \cdot 2771,84} + 0,405 \cdot \frac{|(-11334,32)|}{22010,89} + 0,385 \cdot \frac{|(-1,07)|}{10772,21} = 24,5 \% \quad (6.61)$$

$$\eta_{NMBuckl_2} = \frac{\left| N_{Ed_{11}} \right|}{\frac{\chi_z \cdot N_{pl,Rd}}{\gamma_{M1}}} + k_{zy} \cdot \frac{\left| M_{y,Ed_{11}} \right|}{\frac{M_{pl,Rd,y}}{\gamma_{M1}}} + k_{zz} \cdot \frac{\left| M_{z,Ed_{11}} \right|}{\frac{M_{pl,Rd,z}}{\gamma_{M1}}} = \frac{|(-85,29)|}{0,57 \cdot 2771,84} + 0,243 \cdot \frac{|(-11334,32)|}{22010,89} + 0,642 \cdot \frac{|(-1,07)|}{10772,21} = 17,9 \% \quad (6.62)$$

$$\eta_{NMBuckl} = 24,5 \% \quad \text{passed}$$

### 3. Axial force-Bending-Lateral torsional buckling

EN 1993-1-1: 6.3.3, Annex B: Method 2

Critical combination: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 1,00 \cdot L = 1,00 \cdot 365,76 = 365,76$  cm

$$C_{my} = \max(0,2 + 0,8 \cdot \alpha_{my}, 0,4) = \max(0,2 + 0,8 \cdot 0,246, 0,4) = 0,4 \geq 0,4 \quad \text{Table B.3}$$

$$C_{mz} = \max(0,2 + 0,8 \cdot \alpha_{mz}, 0,4) = \max(0,2 + 0,8 \cdot 0,5, 0,4) = 0,6 \geq 0,4 \quad \text{Table B.3}$$

$$C_{mLT} = \max(0,2 + 0,8 \cdot \alpha_{mLT}, 0,4) = \max(0,2 + 0,8 \cdot 0,246, 0,4) = 0,4 \geq 0,4 \quad \text{Table B.3}$$

$$f_{yy} = \min(\lambda_y^* - 0,2; 0,8) = \min(0,56 - 0,2; 0,8) = 0,36$$

$$f_{zy} = \min \left( \frac{0,1}{C_{mLT} - 0,25}; \frac{0,1 \cdot \lambda_z^*}{C_{mLT} - 0,25} \right) = \min \left( \frac{0,1}{0,4 - 0,25}; \frac{0,1 \cdot 0,95}{0,4 - 0,25} \right) = 0,63$$

$$f_{zz} = \min(2 \cdot \lambda_z^* - 0,6; 1,4) = \min(2 \cdot 0,95 - 0,6; 1,4) = 1,29$$

$$k_{yy} = C_{my} \cdot \left( 1 + f_{yy} \cdot \frac{\left| N_{Ed_{11}} \right|}{\frac{\chi_y \cdot N_{pl,Rd}}{\gamma_{M1}}} \right) = 0,4 \cdot \left( 1 + 0,36 \cdot \frac{|(-85,29)|}{0,86 \cdot 2771,84} \right) = 0,405$$

$$k_{zy} = 1 - f_{zy} \cdot \frac{\left| N_{Ed_{11}} \right|}{\frac{\chi_z \cdot N_{pl,Rd}}{\gamma_{M1}}} = 1 - 0,63 \cdot \frac{|(-85,29)|}{0,57 \cdot 2771,84} = 0,966 \quad \text{Table Annex B.1, B.2}$$

$$k_{yz} = 0,6 \cdot k_{zz} = 0,6 \cdot 0,642 = 0,385$$

$$k_{zz} = C_{mz} \cdot \left( 1 + f_{zz} \cdot \frac{\left| N_{Ed_{11}} \right|}{\frac{\chi_z \cdot N_{pl,Rd}}{\gamma_{M1}}} \right) = 0,6 \cdot \left( 1 + 1,29 \cdot \frac{|(-85,29)|}{0,57 \cdot 2771,84} \right) = 0,642 \quad \text{Table Annex B.1, B.2}$$

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$$\chi_y = \min \left( \frac{1}{\phi_y + \sqrt{\phi_y^2 - \lambda_y^2}} ; 1 \right) = 0,86 \quad (6.49)$$

$$\chi_z = \min \left( \frac{1}{\phi_z + \sqrt{\phi_z^2 - \lambda_z^2}} ; 1 \right) = 0,57 \quad (6.49)$$

$$\chi_{LT} = \min \left( \frac{1}{\phi_{LT} + \sqrt{\phi_{LT}^2 - \beta \cdot \lambda_{LT}^2}} ; 1 \right) = 0,95 \quad (6.56)$$

$$\eta_{NMLTBuckl_1} = \frac{\left| N_{Ed,11} \right|}{\frac{\chi_y \cdot N_{pl,Rd}}{\gamma_{M1}}} + k_{yy} \cdot \frac{\left| M_{y,Ed,11} \right|}{\frac{\chi_{LT} \cdot M_{pl,Rd,y}}{\gamma_{M1}}} + k_{yz} \cdot \frac{\left| M_{z,Ed,11} \right|}{\frac{M_{pl,Rd,z}}{\gamma_{M1}}} = \frac{|(-85,29)|}{0,86 \cdot 2771,84} + 0,405 \cdot \frac{|(-11334,32)|}{0,95 \cdot 22010,89} + 0,385 \cdot \frac{|(-1,07)|}{10772,21} = 25,4$$

% (6.61)

$$\eta_{NMLTBuckl_2} = \frac{\left| N_{Ed,11} \right|}{\frac{\chi_z \cdot N_{pl,Rd}}{\gamma_{M1}}} + k_{zy} \cdot \frac{\left| M_{y,Ed,11} \right|}{\frac{\chi_{LT} \cdot M_{pl,Rd,y}}{\gamma_{M1}}} + k_{zz} \cdot \frac{\left| M_{z,Ed,11} \right|}{\frac{M_{pl,Rd,z}}{\gamma_{M1}}} = \frac{|(-85,29)|}{0,57 \cdot 2771,84} + 0,966 \cdot \frac{|(-11334,32)|}{0,95 \cdot 22010,89} + 0,642 \cdot \frac{|(-1,07)|}{10772,21} = 57,5$$

% (6.62)

$\eta_{NMLTBuckl} = 57,5 \%$  passed

### 4. Cross-section resistance to shear (y):

EN 1993-1-1: 6.2.6

Critical combination: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 0,00 \cdot L = 0,00 \cdot 365,76 = 0 \text{ cm}$

$$A_{V,y} = 2 \cdot b \cdot t_f = 60,00 \text{ cm}^2$$

$$V_{pl,Rd,y} = \frac{A_{V,y} \cdot f_y}{\sqrt{3} \cdot \gamma_{M0}} = \frac{60,00 \cdot 35,50}{\sqrt{3} \cdot 1} = 1229,76 \text{ kN} \quad (6.18)$$

$$\eta_{V_y} = \frac{\left| V_{y,Ed,1} \right|}{V_{pl,Rd,y}} = \frac{|0|}{1229,76} = 0 \% \quad (6.17) \quad \text{passed}$$

### 5. Shear web buckling resistance:

EN 1993-1-5: 5.1, 5.2, 5.3, 5.5, Annex A: A.3

Critical combination: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 0,00 \cdot L = 0,00 \cdot 365,76 = 0 \text{ cm}$

$$a_{max} = 3,66$$

$$\eta_w = 1,2 \quad 5.2 (2) \text{ NOTE 2}$$

$$h_w = h - 2 \cdot t_f = 20,00 - 2 \cdot 1,50 = 17,00 \text{ cm}$$

No stiffener  $\rightarrow k_t = 5,34$  (A.5)

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$$\frac{h_w}{t_w} \leq \frac{31 \cdot \varepsilon \cdot \sqrt{k_\tau}}{\eta_w} \rightarrow V_{b,Rd} = V_{pl,Rd,z} = 398,24 = 398,24 \text{ kN} \quad (5.1 (2))$$

$$\eta_{V_w} = \frac{|V_{z,Ed_1}|}{V_{b,Rd}} = \frac{|(-53,58)|}{398,24} = 13,5 \% \quad (5.10) \quad \text{passed}$$

### 6. Web shear-Bending-Axial force

EN 1993-1-1: 6.2.9; EN 1993-1-5: 7.1

Critical combination: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 1,00 \cdot L = 1,00 \cdot 365,76 = 365,76 \text{ cm}$

$$M_{f,Rd} = b \cdot t_f \cdot f_y \cdot (h - t_f) = 20,00 \cdot 1,50 \cdot 35,50 \cdot (20,00 - 1,50) = 19702,50 \text{ kNm} = 197,03 \text{ kNm}$$

$$\left| M_{y,Ed_{11}} \right| \leq M_{f,Rd} \rightarrow \eta_{V_w,MN} = \frac{\left| M_{y,Ed_{11}} \right|}{M_{pl,Rd,y}} = \frac{|(-11334,32)|}{22010,89} = 51,5 \% \quad (7.1) \quad \text{passed}$$

### 7. SLS (Serviceability Limit State)

EN 1993-1-1: 7., EN 1990: 3.4, A1.4.

Critical combination : Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 0,70 \cdot L = 0,70 \cdot 365,76 = 256,03 \text{ cm}$

$$w_x = |w_{x,i} - w_{x,0}| = |(-0,59) - 0| = 0,59 \text{ cm}$$

$$w_{x,Limit} = \frac{H_{SLS}}{250,0} = \frac{365,76}{250,0} = 1,46 \text{ cm}$$

$$\eta_{w_x} = \frac{w_x}{w_{x,Limit}} = \frac{0,59}{1,46} = 40,4 \%$$

$$w_y = |w_{y,i} - w_{y,0}| = |0,04 - 0| = 0,04 \text{ cm}$$

$$w_{y,Limit} = \frac{H_{SLS}}{250,0} = \frac{365,76}{250,0} = 1,46 \text{ cm}$$

$$\eta_{w_y} = \frac{w_y}{w_{y,Limit}} = \frac{0,04}{1,46} = 3,0 \%$$

$$\eta_{SLS} = \max(\eta_{w_x}; \eta_{w_y}) = \max(40,4; 3,0) = 40,4 \% \quad \text{passed}$$

### Partial results

### 8. Cross-section resistance to axial force:

EN 1993-1-1: 6.2.4

Critical combination: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 0,00 \cdot L = 0,00 \cdot 365,76 = 0 \text{ cm}$

$$N_{pl,Rd} = \frac{A \cdot f_y}{\gamma_{M0}} = \frac{78,08 \cdot 35,50}{1} = 2771,84 \text{ kN} \quad (6.10)$$

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$$\eta_N = \frac{\left| N_{Ed_1} \right|}{N_{pl,Rd}} = \frac{\left| (-87,71) \right|}{2771,84} = 3,2 \% \quad (6.9) \quad \text{passed}$$

### 9. Cross-section resistance to bending (yy):

EN 1993-1-1: 6.2.5

Critical combination: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 0,95 \cdot L = 0,95 \cdot 365,76 = 347,47 \text{ cm}$

$$M_{pl,Rd,y} = \frac{W_{pl,y} \cdot f_y}{\gamma_{M0}} = \frac{620,02 \cdot 35,50}{1} = 22010,89 \text{ kNm} = 220,11 \text{ kNm} \quad (6.13)$$

$$\eta_{M_{y,pl}} = \frac{\left| M_{y,Ed_9} \right|}{M_{pl,Rd,y}} = \frac{\left| (-10517,43) \right|}{22010,89} = 47,8 \% \quad (6.12) \quad \text{passed}$$

### 10. Cross-section resistance to bending (zz):

EN 1993-1-1: 6.2.5

Critical combination: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 1,00 \cdot L = 1,00 \cdot 365,76 = 365,76 \text{ cm}$

$$M_{pl,Rd,z} = \frac{W_{pl,z} \cdot f_y}{\gamma_{M0}} = \frac{303,44 \cdot 35,50}{1} = 10772,21 \text{ kNm} = 107,72 \text{ kNm} \quad (6.13)$$

$$\eta_{M_{z,pl}} = \frac{\left| M_{z,Ed_{11}} \right|}{M_{pl,Rd,z}} = \frac{\left| (-1,07) \right|}{10772,21} = 0 \% \quad (6.12) \quad \text{passed}$$

### 11. Cross-section resistance to shear (z):

EN 1993-1-1: 6.2.6

Critical combination: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 0,00 \cdot L = 0,00 \cdot 365,76 = 0 \text{ cm}$

$$A_{V,z} = A - 2 \cdot b \cdot t_f + (t_w + 2 \cdot r) \cdot t_f = 19,43 \text{ cm}^2$$

$$V_{pl,Rd,z} = \frac{A_{V,z} \cdot f_y}{\sqrt{3} \cdot \gamma_{M0}} = \frac{19,43 \cdot 35,50}{\sqrt{3} \cdot 1} = 398,24 \text{ kN} \quad (6.18)$$

$$\eta_V_z = \frac{\left| V_{z,Ed_1} \right|}{V_{pl,Rd,z}} = \frac{\left| (-53,58) \right|}{398,24} = 13,5 \% \quad (6.17) \quad \text{passed}$$

### 12. Bending-shear interaction check

EN 1993-1-1: 6.2.1, 6.2.8, 6.2.9

Critical combination for N-M-V strength interaction: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 1,00 \cdot L = 1,00 \cdot 365,76 = 365,76 \text{ cm}$

$V_{z,Ed_{11}} = -44,44 \text{ kN} \leq V_{pl,Rd,z}/2 = 199,12 \text{ kN} \rightarrow$  The effect of shear force on moment resistance is negligible. 6.2.8 (2)

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$V_{y,Ed_{11}} = 0 \text{ kN} \leq V_{pl,Rd,y}/2 = 614,88 \text{ kN} \rightarrow \text{The effect of shear force on moment resistance is negligible. } \text{6.2.8 (2)}$

### 13. Bending-axial force interaction check

EN 1993-1-1: 6.2.1, 6.2.8, 6.2.9

Critical combination for N-M-V strength interaction: **Co #2**Section class: **1** (Plastic design)Critical section:  $x = 1,00 \cdot L = 1,00 \cdot 365,76 = 365,76 \text{ cm}$ 

$$n = \frac{|N_{Ed_{11}}|}{N_{pl,Rd}} = \frac{85,29}{2771,84} = 3,1 \% \leq 25\%$$

$$|N_{Ed_{11}}| = 85,29 \text{ kN} \leq N_{Rd,w}/2 = \frac{h_w \cdot t_w \cdot f_y}{2 \cdot \gamma_{M0}} = \frac{17,00 \cdot 0,90 \cdot 35,50}{2 \cdot 1} = 271,57 \text{ kN}$$

$$M_{N,y,Rd} = M_{y,V,Rd} = 22010,89 = 22010,89 \text{ kNm} = 220,11 \text{ kNm}$$

$$M_{N,z,Rd} = M_{z,V,Rd} = 10772,21 = 10772,21 \text{ kNm} = 107,72 \text{ kNm}$$

$$\eta_{MN,1} = \frac{M_{y,Ed_{11}}}{M_{N,y,Rd}} = \frac{(-11334,32)}{22010,89} = 51,5 \%$$

$$\eta_{MN,2} = \frac{M_{z,Ed_{11}}}{M_{N,z,Rd}} = \frac{(-1,07)}{10772,21} = 0 \%$$

$$\alpha_{MN} = 2$$

$$\beta_{MN} = \max(5 \cdot n/100; 1) = \max(5 \cdot 3,1/100; 1) = 1$$

$$\eta_{MN,3} = \left( \frac{M_{y,Ed_{11}}}{M_{N,y,Rd}} \right)^{\alpha_{MN}} + \left( \frac{M_{z,Ed_{11}}}{M_{N,z,Rd}} \right)^{\beta_{MN}} = \left( \frac{(-11334,32)}{22010,89} \right)^2 + \left( \frac{(-1,07)}{10772,21} \right)^1 = 26,5 \% \quad (6.41)$$

$$\eta_{MN} = \max(\eta_{MN,1}; \eta_{MN,2}; \eta_{MN,3}; \eta_N) = \max(51,5; 0; 26,5; 3,1) = 51,5 \% \quad \text{passed}$$

### 14. Buckling resistance:

EN 1993-1-1: 6.3.1

Critical combination for N-M-Buckling interaction: **Co #2**Section class: **1** (Plastic design)Critical section:  $x = 1,00 \cdot L = 1,00 \cdot 365,76 = 365,76 \text{ cm}$ 

$$K_y = 1$$

$$K_z = 1$$

$$L_{cr,y} = K_y \cdot L = 1 \cdot 365,76 = 365,76 \text{ cm}$$

$$L_{cr,z} = K_z \cdot L = 1 \cdot 365,76 = 365,76 \text{ cm}$$

Buckling curve about the y axis:  $b$  Table 6.2 $\rightarrow \alpha_y = 0,34$  Table 6.1Buckling curve about the z axis:  $c$  Table 6.2 $\rightarrow \alpha_z = 0,49$  Table 6.1

$$\lambda_y^* = \sqrt{\frac{A \cdot f_y}{N_{cr,y}}} = \sqrt{\frac{78,08 \cdot 35,50}{8824,86}} = 0,56 \quad (6.50)$$

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$$\lambda_z^* = \sqrt{\frac{A \cdot f_y}{N_{cr,z}}} = \sqrt{\frac{78,08 \cdot 35,50}{3103,75}} = 0,95 \quad (6.50)$$

$$\phi_y = \frac{1 + \alpha_y \cdot (\lambda_y^* - 0,2) + \lambda_y^{*2}}{2} = \frac{1 + 0,34 \cdot (0,56 - 0,2) + 0,56^2}{2} = 0,7183$$

$$\phi_z = \frac{1 + \alpha_z \cdot (\lambda_z^* - 0,2) + \lambda_z^{*2}}{2} = \frac{1 + 0,49 \cdot (0,95 - 0,2) + 0,95^2}{2} = 1,1291$$

$$\chi_y = \min \left( \frac{1}{\phi_y + \sqrt{\phi_y^2 - \lambda_y^{*2}}} ; 1 \right) = \min \left( \frac{1}{0,7183 + \sqrt{0,7183^2 - 0,56^2}} ; 1 \right) = 0,86 \quad (6.49)$$

$$\chi_z = \min \left( \frac{1}{\phi_z + \sqrt{\phi_z^2 - \lambda_z^{*2}}} ; 1 \right) = \min \left( \frac{1}{1,1291 + \sqrt{1,1291^2 - 0,95^2}} ; 1 \right) = 0,57 \quad (6.49)$$

$$\chi = \min(\chi_y; \chi_z) = \min(0,86; 0,57) = 0,57 \leq 1,0$$

$$N_{b,Rd} = \frac{\chi \cdot A \cdot f_y}{\gamma_{M1}} = \frac{0,57 \cdot 78,08 \cdot 35,50}{1} = 1586,73 \text{ kN} \quad (6.47)$$

$$\eta_{N_b} = \frac{|N_{Ed,11}|}{N_{b,Rd}} = \frac{|(-85,29)|}{1586,73} = 5,4 \% \quad (6.46) \quad \text{passed}$$

### 15. Lateral-torsional buckling resistance:

EN 1993-1-1: 6.3.2

Critical combination for N-M-LTBuckling interaction: Co #2

Section class: 1 (Plastic design)

Critical section:  $x = 1,00 \cdot L = 1,00 \cdot 365,76 = 365,76 \text{ cm}$  $M_{cr}$  Analysis method: AutoMcr

$$M_{cr} = 83792,95 \text{ kNm} = 837,93 \text{ kNm}$$

$$\lambda_{LT} = \sqrt{\frac{W_y \cdot f_y}{M_{cr}}} = \sqrt{\frac{620,02 \cdot 35,50}{83792,95}} = 0,51$$

Buckling curve: b Table 6.5

 $\rightarrow \alpha_{LT} = 0,34$  Table 6.3

$$\phi_{LT} = \frac{1 + \alpha_{LT} \cdot (\lambda_{LT} - \lambda_{LT,0}) + \beta \cdot \lambda_{LT}^2}{2} = \frac{1 + 0,34 \cdot (0,51 - 0,4) + 0,75 \cdot 0,51^2}{2} = 0,62$$

$$\chi_{LT} = \min \left( \frac{1}{\phi_{LT} + \sqrt{\phi_{LT}^2 - \beta \cdot \lambda_{LT}^2}} ; 1 \right) = \min \left( \frac{1}{0,62 + \sqrt{0,62^2 - 0,75 \cdot 0,51^2}} ; 1 \right) = 0,95 \quad (6.57)$$

$$M_{b,Rd} = \frac{\chi_{LT} \cdot W_y \cdot f_y}{\gamma_{M1}} = \frac{0,95 \cdot 620,02 \cdot 35,50}{1} = 21020,31 \text{ kNm} = 210,20 \text{ kNm} \quad (6.55)$$

$$\eta_{M_b} = \frac{|M_{y,Ed,11}|}{M_{b,Rd}} = \frac{|(-11334,32)|}{21020,31} = 53,9 \% \quad (6.54) \quad \text{passed}$$

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**Lateral supports**

Index	Pos. [m]	Rel. pos. [-]	Ecc. [cm]	$R_y$ [kN/m]	$R_{xx}$ [kNm/rad]	$R_{zz}$ [kNm/rad]	$R_w$ [kNm <sup>2</sup> /(1/m)]	Type
1.	0	0	0	$1 \cdot 10^{10}$	0	0	0	Support from model
2.	1,500	0,410	0	$1 \cdot 10^{10}$	0	0	0	Additional support
3.	3,658	1,000	0	0	$1,44 \cdot 10^3$	0	0	Connecting element (IPE 360: a=3,05 m; (14-17); EI/a=)