Project

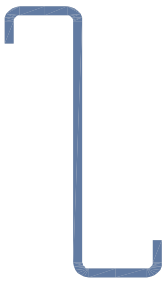
Analysis by InterCAD Kft.
Model: **z_szelemen_X8.axs** 2026. 11. 05. Page 1

STEEL MEMBER DESIGN

Design member **1**
Nodes: **1-2**
Code: **Eurocode-H**
MSZ EN 1993-1-3:2007, MSZ EN 1993-1-5:2012
Material: **S250GD+Z275**
Cross-section: **Lindab Z 150/2.0**
Load case: **Linear, ST1**
Coefficient for seismic forces: **1,00**
Section class: **1** (Plastic design)

Design summary

Design checks				**Result**
Ultimate Limit States				
N-M-V			η_{NMV} = 21,7 %	✔
N-M-Buckl			η_{NMStab} = 78,2 %	✔
Buckling	N_{Ed} = 1,8517·10^{-16} kN	N_{bRd} = 16,87 kN	η_{N_b} = 0 %	✔
Critical moment	M_{cr} = 29199 kNcm			
Lateral-torsional buckling	M_{yEd} = 115,1 kNcm	M_{bRd} = 147,3 kNcm	η_{M_b} = 78,2 %	✔
Bolted connection design			η_{Conn} = 8,5 %	✔
Shear resistance (z)	V_{zEd} = 1,5 kN	V_{zRd} = 40,21 kN	η_{V_z} = 3,7 %	✔
Bending-Concentrated force			η_{MRw} = 142,8 %	✗
Maximum utilization(ULS)			η_{ULS} = 142,8 %	✗
Serviceability Limit States				
Deflection/horizontal displacement			η_{SLS} = 35,7 %	✔





Classification details:

Plate [cm]	$\frac{c}{t}$ [-]	Class [-]
1,7-0,2	8,27	1
3,5-0,2	17,74	1
14,4-0,2	72,24	**1**
4,1-0,2	20,74	1
1,7-0,2	8,27	1

Distortional buckling - Critical stiffener:

$K = 0{,}2318$ kN/cm²

$$\sigma_{cr} = \frac{2 \cdot \sqrt{K \cdot E_s \cdot I_s}}{A_s} = \frac{2 \cdot \sqrt{0{,}2318 \cdot 21000 \cdot 0{,}2509}}{0{,}7208} = 96{,}97 \text{ kN/cm}^2$$

$$\lambda_d = \sqrt{\frac{f_{yb}}{\sigma_{cr}}} = \sqrt{\frac{25}{96{,}97}} = 0{,}5078$$

$\chi_d = 1$

$t_{red} = t \cdot \chi_d = 0{,}2 \cdot 1 = 0{,}2$ cm

$As_{red} = 0{,}7208$ cm²

$$\sigma_{com} = \frac{\chi_d \cdot f_{yb}}{\gamma_{M0}} = \frac{1 \cdot 25}{1} = 25 \text{ kN/cm}^2$$

1. Axial force-Bending-Shear

EN 1993-1-3:2006: 6.1.1, 6.1.10

Critical section: $x = 0{,}500 \cdot L = 0{,}500 \cdot 300 = 150$ cm

No shear reduction is required in the z-direction

No shear reduction is required in the y-direction

$\eta_{NMV} = \eta_{NM} = 21{,}7\%$ ✔

2. Axial Force-Bending-Flexural Buckling

EN 1993-1-3:2024: 8.2.5, 8.2.6

Critical section: $x = 0{,}500 \cdot L = 0{,}500 \cdot 300 = 150$ cm

$$\omega_{xy} = \chi_y + (1 - \chi_y) \cdot sin\frac{x_{s,y} \cdot \pi}{L_{cr,y}} = 1{,}0000 + (1 - 1{,}0000) \cdot sin\frac{150 \cdot \pi}{300} = 1{,}0000$$

$$\omega_{xz} = \chi_z + (1 - \chi_z) \cdot sin\frac{x_{s,z} \cdot \pi}{L_{cr,z}} = 1{,}0000 + (1 - 1{,}0000) \cdot sin\frac{150 \cdot \pi}{300} = 1{,}0000$$

$\omega_{x,LT} = 1{,}0000$

$$\alpha_y = \max\left(0.85 ; \frac{\chi_y}{\omega_{xy}}\right) = \max\left(0.85 ; \frac{1{,}0000}{1{,}0000}\right) = 1{,}0000$$

$\beta_y = \alpha_y = 1{,}0000$

$\delta_y = \alpha_y = 1{,}0000$

$$\alpha_z = \max\left(0.85\,;\,\frac{\chi_z}{\omega_{xz}}\right) = \max\left(0.85\,;\,\frac{1{,}0000}{1{,}0000}\right) = 1{,}0000$$

$$\beta_z = \alpha_z = 1{,}0000$$

$$\delta_z = \alpha_z = 1{,}0000$$

$$\eta_{major} = \left(\left|\frac{\omega_{xy}\cdot N_{Ed_{11}}}{\chi_y\cdot N_{c,Rd}}\right|\right)^{\alpha_y} + \left(\left|\frac{\omega_{x,LT}\cdot\left(M_{y,Ed_{11}} + \Delta M_{y,Ed_{11}}\right)}{\chi_{LT}\cdot M_{cy,Rd}}\right|\right)^{\beta_y} + \left(\left|\frac{M_{z,Ed_{11}} + \Delta M_{z,Ed_{11}}}{M_{cz,Rd}}\right|\right)^{\delta_y} =$$

$$= \left(\left|\frac{1{,}0000\cdot 0}{1{,}0000\cdot 102{,}5}\right|\right)^{1{,}0000} + \left(\left|\frac{1{,}0000\cdot(115{,}1+0)}{1{,}0000\cdot 147{,}3}\right|\right)^{1{,}0000} + \left(\left|\frac{0+0}{681{,}5}\right|\right)^{1{,}0000} = 78{,}2\ \%$$

$$\eta_{minor} = \left(\left|\frac{\omega_{xz}\cdot N_{Ed_{11}}}{\chi_z\cdot N_{c,Rd}}\right|\right)^{\alpha_z} + \left(\left|\frac{\omega_{x,LT}\cdot\left(M_{y,Ed_{11}} + \Delta M_{y,Ed_{11}}\right)}{\chi_{LT}\cdot M_{cy,Rd}}\right|\right)^{\beta_z} + \left(\left|\frac{M_{z,Ed_{11}} + \Delta M_{z,Ed_{11}}}{M_{cz,Rd}}\right|\right)^{\delta_z} =$$

$$= \left(\left|\frac{1{,}0000\cdot 0}{1{,}0000\cdot 102{,}5}\right|\right)^{1{,}0000} + \left(\left|\frac{1{,}0000\cdot(115{,}1+0)}{1{,}0000\cdot 147{,}3}\right|\right)^{1{,}0000} + \left(\left|\frac{0+0}{681{,}5}\right|\right)^{1{,}0000} = 78{,}2\ \%$$

$$\eta_{asym,y} = N_{tot,y} + \left(\left|\frac{M_{y,Ed_{11}} + \Delta M_{y,Ed_{11}}}{M_{cy,Rd}}\right|\right)^{\beta_y} + \left(\left|\frac{M_{z,Ed_{11}} + \Delta M_{z,Ed_{11}}}{M_{cz,Rd}}\right|\right)^{\delta_y} = 0 + \left(\left|\frac{115{,}1+0}{147{,}3}\right|\right)^{1{,}0000} + \left(\left|\frac{0+0}{681{,}5}\right|\right)^{1{,}0000} = 78{,}2\ \%$$

$$\eta_{asym,z} = N_{tot,z} + \left(\left|\frac{M_{y,Ed_{11}} + \Delta M_{y,Ed_{11}}}{M_{cy,Rd}}\right|\right)^{\beta_z} + \left(\left|\frac{M_{z,Ed_{11}} + \Delta M_{z,Ed_{11}}}{M_{cz,Rd}}\right|\right)^{\delta_z} = 0 + \left(\left|\frac{115{,}1+0}{147{,}3}\right|\right)^{1{,}0000} + \left(\left|\frac{0+0}{681{,}5}\right|\right)^{1{,}0000} = 78{,}2\ \%$$

$$\eta_{M_b} = 78{,}2\ \%$$

$$\eta_{NMStab} = \max\left(\eta_{major}\,;\,\eta_{minor}\,;\,\eta_{asym,y}\,;\,\eta_{asym,z}\,;\,\eta_{M_b}\right) = \max\,(78{,}2\,;\,78{,}2\,;\,78{,}2\,;\,78{,}2\,;\,78{,}2) = 78{,}2\ \%$$ ✔

3. Bolted connection design

EN 1993-1-3:2006:

Critical support: $x = 0$ cm

$V_{y,Ed} = 0$ kN

User setting

Design capacities per bolt:

$$F_{v,Rd} = \frac{0.5\cdot f_{ub}\cdot A_{sb}}{\gamma_{M2}} = \frac{0.5\cdot 50\cdot 0{,}58}{1{,}2500} = 11{,}6\ \text{kN}$$

$$F_{t,Rd} = \frac{0.9\cdot f_{ub}\cdot A_{sb}}{\gamma_{M2}} = \frac{0.9\cdot 50\cdot 0{,}58}{1{,}2500} = 20{,}88\ \text{kN}$$

Design of bolts in the web:

$$F_{b,Rd,web} = \frac{2.5 \cdot \alpha_{b,web} \cdot k_{t,web} \cdot f_u \cdot d \cdot t_{web}}{\gamma_{M2}} = \frac{2.5 \cdot 0{,}6667 \cdot 1{,}0000 \cdot 33 \cdot 1 \cdot 0{,}2}{1{,}2500} = 8{,}8 \text{ kN}$$

$$F_{x,web} = \frac{N}{n_{bolts,web} + n_{bolts,fl}} = \frac{1{,}8517 \cdot 10^{-16}}{2+2} = 4{,}6292 \cdot 10^{-17} \text{ kN}$$

$$F_{y,web} = \frac{R_z}{n_{bolts,web}} = \frac{1{,}5}{2} = 0{,}75 \text{ kN}$$

$$F_{Ed,web} = \sqrt{F_{x,web}^2 + F_{y,web}^2} = \sqrt{4{,}6292 \cdot 10^2 + 0{,}75^2} = 0{,}75 \text{ kN}$$

Design of bolts in the flange:

$$F_{b,Rd,fl} = \frac{2.5 \cdot \alpha_{b,fl} \cdot k_{t,fl} \cdot f_u \cdot d \cdot t_{fl}}{\gamma_{M2}} = \frac{2.5 \cdot 0{,}6667 \cdot 1{,}0000 \cdot 33 \cdot 1 \cdot 0{,}2}{1{,}2500} = 8{,}8 \text{ kN}$$

$$F_{x,fl} = \frac{N}{n_{bolts,web} + n_{bolts,fl}} = \frac{1{,}8517 \cdot 10^{-16}}{2+2} = 4{,}6292 \cdot 10^{-17} \text{ kN}$$

$$F_{y,fl} = \frac{V_y}{n_{bolts,fl}} = \frac{0}{2} = 0 \text{ kN}$$

$$F_{Ed,fl} = \sqrt{F_{x,fl}^2 + F_{y,fl}^2} = \sqrt{4{,}6292 \cdot 10^2 + 0^2} = 0 \text{ kN}$$

$$\eta_{Conn} = \max\left(\frac{F_{Ed,web}}{F_{b,Rd,web}} ; \frac{F_{Ed,fl}}{F_{b,Rd,fl}} ; \frac{\max(|V_{z1}| ; |V_{z2}|)}{F_{t,Rd}}\right) = \max\left(\frac{0{,}75}{8{,}8} ; \frac{0}{8{,}8} ; \frac{\max(|(-1{,}5)| ; |0|)}{20{,}88}\right) = 8{,}5\ \% \checkmark$$

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

EN 1993-1-3:2006: 6.1.5

Critical section: $x = 0{,}000 \cdot L = 0{,}000 \cdot 300 = 0$ cm

$V_{y,Ed} = 0$ kN

User setting

5. Combined bending moment and local load or support reaction

EN 1993-1-3:2006: 6.1.11

Critical section: $x = 0{,}500 \cdot L = 0{,}500 \cdot 300 = 150$ cm

$$\eta_{MRw} = \frac{M_{y,Ed_{11}}}{M_{eff,y,Rd}} + \frac{F_{z,Ed_{11}}}{R_{w,Rd}} = \frac{115{,}1}{80{,}59} + \frac{0}{15{,}36} = 142{,}8\ \% \times$$

6. Free flange Axial force-Bending-Lateral torsional buckling

EN 1993-1-3:2006: 10.1.4

Disabled

7. SLS (Serviceability Limit State)

EN 1993-1-1:2005: 7.; EN 1990:2021: 3.4, A1.4

Critical section: $x = 0{,}500 \cdot L = 0{,}500 \cdot 300 = 150$ cm

$e_z = |e_{z,i} + u_z| = |(-0{,}3572) + 0| = 0{,}3572$ cm

$$e_{z,Limit} = \frac{L}{300,0} = \frac{300}{300,0} = 1 \text{ cm}$$

$$\eta_{e_z} = \frac{e_z}{e_{z,Limit}} = \frac{0,3572}{1} = 35,7 \%$$

$$\eta_{SLS} = \max\left(\eta_{e_z}\right) = \max\left(35,7\right) = 35,7 \% \checkmark$$

Partial results

8. Cross-section resistance to axial force:

EN 1993-1-3:2006: 6.1.3

Critical section: $x = 0,000 \cdot L = 0,000 \cdot 300 = 0$ cm

$$N_{c,Rd} = \frac{A_{eff} \cdot f_{yb}}{\gamma_{M0}} = \frac{4,101 \cdot 25}{1,0000} = 102,5 \text{ kN}$$

$$\eta_N = \frac{\left|N_{Ed_1}\right|}{N_{c,Rd}} = \frac{|(-1,8517 \cdot 10^{-16})|}{102,5} = 0 \% \checkmark$$

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

EN 1993-1-3:2006: 6.1.4

Critical section: $x = 0,000 \cdot L = 0,000 \cdot 300 = 0$ cm

$M_{z,Ed} = 0$ kNm

User setting

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

EN 1993-1-3:2006: 6.1.5

Critical section: $x = 0,000 \cdot L = 0,000 \cdot 300 = 0$ cm

$$\lambda_w = 0.346 \cdot \left(\frac{s_w}{t}\right) \cdot \sqrt{\frac{f_{yb}}{E}} = 0.346 \cdot \left(\frac{14,8}{0,2}\right) \cdot \sqrt{\frac{25}{21000}} = 0,8834$$

$f_{bv} = 0.48 \cdot f_{yb} / \lambda_w = 0.48 \cdot 25 / 0,8834 = 13,58$ kN/cm²

$$V_{b,Rd,z} = \frac{\frac{h_w}{\sin(\phi)} \cdot t \cdot f_{bv}}{\gamma_{M0}} = \frac{\frac{14,8}{\sin(90,0000)} \cdot 0,2 \cdot 13,58}{1,0000} = 40,21 \text{ kN}$$

$V_{z,Ed,loc_1} = 1,5$ kN

$$\eta_{V_z} = \frac{V_{z,Ed,loc_1}}{V_{b,Rd,z}} = \frac{1,5}{40,21} = 3,7 \% \checkmark$$

12. Local transverse resistance

EN 1993-1-3:2006: 6.1.7

Critical section: $x = 0,000 \cdot L = 0,000 \cdot 300 = 0$ cm

$$k = \frac{f_{yb}}{22,8} = \frac{25}{22,8} = 1,0965$$

$$k_1 = 1.33 - 0.33 \cdot k = 1.33 - 0.33 \cdot 1,0965 = 0,9682$$

$$k_2 = \min\left(1.15 - 0.15 \cdot \left(\frac{r}{t}\right); 1\right) = \min\left(1.15 - 0.15 \cdot \left(\frac{0}{0,2}\right); 1\right) = 1,0000$$

$$k_3 = 0.7 + 0.3 \cdot \left(\frac{\phi}{90}\right)^2 = 0.7 + 0.3 \cdot \left(\frac{90,0000}{90}\right)^2 = 1,0000$$

$$R_{w,Rd} = \frac{\left(k_1 \cdot k_2 \cdot k_3 \cdot \left(5.92 - \frac{\frac{h}{t}}{132}\right) \cdot \left(1 + 0.01 \cdot \frac{s_s}{t}\right) \cdot t^2 \cdot f_{yb}\right)}{\gamma_{M1}} = \frac{\left(0,9682 \cdot 1,0000 \cdot 1,0000 \cdot \left(5.92 - \frac{\frac{14,8}{0,2}}{132}\right) \cdot \left(1 + 0.01 \cdot \frac{30}{0,2}\right) \cdot 0,2^2 \cdot 25\right)}{1,0000} = 15,36 \text{ kN}$$

$$\eta_F = \frac{F_{Ed}}{R_{w,Rd}} = \frac{1,5}{15,36} = 9,8\ \% \checkmark$$

13. Bending-axial force interaction check

EN 1993-1-3:2006: 6.1.1, 6.1.8, 6.1.9

Critical section: $x = 0,500 \cdot L = 0,500 \cdot 300 = 150$ cm

$$M_{cy,Rd,tens} = \frac{W_{y,ten} \cdot f_{yb}}{\gamma_{M0}} = \frac{21,83 \cdot 25}{1,0000} = 545,8 \text{ kNcm}$$

$$M_{cy,Rd,com} = \frac{W_{y,com} \cdot f_{yb}}{\gamma_{M0}} = \frac{21,19 \cdot 25}{1,0000} = 529,8 \text{ kNcm}$$

$$M_{cz,Rd,tens} = \frac{W_{z,ten} \cdot f_{yb}}{\gamma_{M0}} = \frac{3,211 \cdot 25}{1,0000} = 80,28 \text{ kNcm}$$

$$M_{cz,Rd,com} = \frac{W_{z,com} \cdot f_{yb}}{\gamma_{M0}} = \frac{3,746 \cdot 25}{1,0000} = 93,65 \text{ kNcm}$$

$$\eta_{NM} = \max\left(\frac{M_{y,Ed_{11}}}{M_{cy,Rd,tens}} + \frac{M_{z,Ed_{11}}}{M_{cz,Rd,tens}} - \frac{N_{c,Ed_{11}}}{N_{pl,Rd}}, \frac{N_{c,Ed_{11}}}{N_{pl,Rd}} + \frac{M_{y,Ed_{11}}}{M_{cy,Rd,com}} + \frac{M_{z,Ed_{11}}}{M_{cz,Rd,com}}\right) =$$

$$= \max\left(\frac{(-115,1)}{545,8} + \frac{0}{80,28} - \frac{0}{102,5}, \frac{0}{102,5} + \frac{(-115,1)}{529,8} + \frac{0}{93,65}\right) = 21,7\ \% \checkmark$$

14. Buckling resistance:

EN 1993-1-1:2005: 6.3.1, EN 1993-1-3:2006: 6.2.2

Critical section: $x = 0,500 \cdot L = 0,500 \cdot 300 = 150$ cm

A_b = 4,997 cm²

Normal force is zero along the designed member.

$\rightarrow \chi_y = 1 \quad \chi_z = 1 \quad \chi_{TF} = 1 \rightarrow \chi = 1$

$$N_{b,Rd} = \frac{\chi \cdot A_b \cdot f_y}{\gamma_{M1}} = \frac{1 \cdot 4{,}997 \cdot 25}{1{,}0000} = 16{,}87 \text{ kN}$$

$$\eta_{N_b} = \frac{\left|N_{Ed_{11}}\right|}{N_{b,Rd}} = \frac{|0|}{16{,}87} = 0\ \% \quad (6.46) \checkmark$$

15. Lateral-torsional buckling resistance:

EN 1993-1-1:2005: 6.3.2, EN 1993-1-3:2006: 6.2.4

Critical section: $x = 0{,}500 \cdot L = 0{,}500 \cdot 300 = 150$ cm

M_{cr} Analysis method: AutoMcr

Lateral torsional buckling is not critical. $\rightarrow \chi_{LT} = 1$ (6.57)

$$M_{b,Rd} = \frac{\chi_{LT} \cdot W_y \cdot f_y}{\gamma_{M1}} = \frac{1 \cdot 5{,}892 \cdot 25}{1{,}0000} = 147{,}3 \text{ kNcm} = 1{,}47 \text{ kNm} \quad (6.55)$$

$$\eta_{M_b} = \frac{\left|M_{y,Ed_{11}}\right|}{M_{b,Rd}} = \frac{|(-115{,}1)|}{147{,}3} = 78{,}2\ \% \quad (6.54) \checkmark$$

Lateral supports

Index	Pos. [m]	Rel. pos. [-]	Ecc. [cm]	Ecc. (SF) [cm]	S [kN]
1.	0	0	1,3	8,8	1000,00
2.	3,000	1,000	1,3	0	0

Index	Pos. [m]	Rel. pos. [-]	R_y [kN/m]	R_{xx} [kNm/rad]	R_{zz} [kNm/rad]	R_w [kNm²/(1/m)]	Type
1.	0	0	$1 \cdot 10^{10}$	$1 \cdot 10^{10}$	$1 \cdot 10^{10}$	0	Support from model
2.	3,000	1,000	$1 \cdot 10^{10}$	$1 \cdot 10^{10}$	$1 \cdot 10^{10}$	0	Support from model