Project

Analysis by MIGUEL A.R. NEVADO

AxisVM X7 R2g · Registered to MIGUEL A.R. NEVADO

Z119 BGGM - ANÁLISIS DE JÁCENA-PARED VOLADA - losa añadida.axs

Report

TIMBER MEMBER DESIGN

Design member **1**
Nodes: **2737-2738**
Code: **Eurocode**
EN 1995-1-1:2004 + A1:2008
Material: **GL 24c**
Service class: **2**
Cross-section: **O 195**
Load case: **ROTURA**
Load-duration class: **Short term**

1. Axial force

EN 1995-1-1: 6.1.2, 6.1.4

Critical section: $x = 0{,}00 \cdot L = 0{,}00 \cdot 7243 = 0$ mm

$$\sigma_{c,0,d} = \frac{|N_x|}{A_x} = \frac{|(-1{,}4528 \cdot 10^5)|}{2{,}9859 \cdot 10^4} = 4{,}9 \text{ N/mm}^2$$

$$f_{c,0,d} = \frac{k_{mod} \cdot f_{c,0,k}}{\gamma_M} = \frac{0{,}90 \cdot 22}{1{,}25} = 15 \text{ N/mm}^2$$

$$\eta_N = \frac{\sigma_{c,0,d}}{f_{c,0,d}} = \frac{4{,}9}{15} = 31{,}4\ \% \quad (6.2)$$ **passed**

2. Bending (y)

EN 1995-1-1: 6.1.6

Critical section: $x = 1{,}00 \cdot L = 1{,}00 \cdot 7243 = 7243$ mm

$$\sigma_{m,y,d} = \frac{|M_y|}{W_y} = \frac{|(-1{,}3783 \cdot 10^6)|}{7{,}2766 \cdot 10^5} = 1{,}9 \text{ N/mm}^2$$

$$k_{h,y} = \min\left(\left(\frac{600}{h}\right)^{0.1}; 1.1\right) = \min\left(\left(\frac{600}{195}\right)^{0.1}; 1.1\right) = 1{,}1 \quad (3.2)$$

$$f_{m,y,d} = \frac{k_{mod} \cdot k_{h,y} \cdot f_{m,k}}{\gamma_M} = \frac{0{,}90 \cdot 1{,}1 \cdot 24}{1{,}25} = 19 \text{ N/mm}^2$$

$$\eta_{M_y} = \frac{\sigma_{m,y,d}}{f_{m,y,d}} = \frac{1{,}9}{19} = 10{,}0\ \%$$ **passed**

3. Bending (z)

EN 1995-1-1: 6.1.6

Critical section: $x = 0{,}00 \cdot L = 0{,}00 \cdot 7243 = 0$ mm

$$\sigma_{m,z,d} = \frac{|M_z|}{W_z} = \frac{|0|}{7{,}2766 \cdot 10^5} = 0 \text{ N/mm}^2$$

$$k_{h,z} = \min\left(\left(\frac{600}{b}\right)^{0.1}; 1.1\right) = \min\left(\left(\frac{600}{195}\right)^{0.1}; 1.1\right) = 1{,}1 \quad (3.2)$$

$$f_{m,z,d} = \frac{k_{mod} \cdot k_{h,z} \cdot f_{m,k}}{\gamma_M} = \frac{0{,}90 \cdot 1{,}1 \cdot 24}{1{,}25} = 19 \text{ N/mm}^2$$

$$\eta_{M_z} = \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{0}{19} = 0\ \%$$ **passed**

4. Shear(y)

EN 1995-1-1: 6.1.7

Critical section: $x = 0{,}00 \cdot L = 0{,}00 \cdot 7243 = 0$ mm

$k_{cr} = 0{,}67$ (6.13a)

$$\tau_{V_y,d} = \frac{|V_y| \cdot 16}{3 \cdot \pi \cdot b^2} = \frac{|0| \cdot 16}{3 \cdot \pi \cdot 195^2} = 0\ \text{N/mm}^2$$

$$f_{v,y,d} = \frac{k_{mod} \cdot f_{v,y,k}}{\gamma_M} = \frac{0{,}90 \cdot 3{,}5}{1{,}25} = 2{,}5\ \text{N/mm}^2$$

$$\eta_{V_y} = \frac{\tau_{V_y,d}}{f_{v,y,d}} = \frac{0}{2{,}5} = 0\ \%$$ (6.13) **passed**

5. Shear(z)

EN 1995-1-1: 6.1.7

Critical section: $x = 0{,}00 \cdot L = 0{,}00 \cdot 7243 = 0$ mm

$k_{cr} = 0{,}67$ (6.13a)

$$\tau_{V_z,d} = \frac{|V_z| \cdot 16}{3 \cdot \pi \cdot b^2} = \frac{|(-299)| \cdot 16}{3 \cdot \pi \cdot 195^2} = 0{,}013\ \text{N/mm}^2$$

$$f_{v,z,d} = \frac{k_{mod} \cdot f_{v,z,k}}{\gamma_M} = \frac{0{,}90 \cdot 3{,}5}{1{,}25} = 2{,}5\ \text{N/mm}^2$$

$$\eta_{V_z} = \frac{\tau_{V_z,d}}{f_{v,z,d}} = \frac{0{,}013}{2{,}5} = 0{,}5\ \%$$ (6.13) **passed**

6. Torsion

EN 1995-1-1: 6.1.8

Critical section: $x = 0{,}00 \cdot L = 0{,}00 \cdot 7243 = 0$ mm

$$\tau_{tor,d} = \frac{2 \cdot |M_x|}{\pi \cdot (h/2)^3} = \frac{2 \cdot |0|}{\pi \cdot (195/2)^3} = 0\ \text{N/mm}^2$$

$$f_{v,d} = \frac{k_{mod} \cdot f_{v,k}}{\gamma_M} = \frac{0{,}90 \cdot 3{,}5}{1{,}25} = 2{,}5\ \text{N/mm}^2$$

$k_{shape} = 1{,}2$ (6.15)

$$\eta_{M_x} = \frac{\tau_{tor,d}}{k_{shape} \cdot f_{v,d}} = \frac{0}{1{,}2 \cdot 2{,}5} = 0\ \%$$ (6.14) **passed**

INTERACTION CHECK

7. Axial Force-Bending

EN 1995-1-1: 6.3.2, 6.2.4

Critical section: $x = 1{,}00 \cdot L = 1{,}00 \cdot 7243 = 7243$ mm

$$\eta_1 = \left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + \frac{|\sigma_{m,y,d}|}{f_{m,y,d}} + k_m \cdot \frac{|\sigma_{m,z,d}|}{f_{m,z,d}} = \left(\frac{4{,}8}{15}\right)^2 + \frac{|1{,}9|}{19} + 1 \cdot \frac{|0|}{19} = 19{,}7\ \%$$ (6.19)

$$\eta_2 = \left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + k_m \cdot \frac{|\sigma_{m,y,d}|}{f_{m,y,d}} + \frac{|\sigma_{m,z,d}|}{f_{m,z,d}} = \left(\frac{4,8}{15}\right)^2 + 1 \cdot \frac{|1,9|}{19} + \frac{|0|}{19} = 19,7\ \% \quad (6.20)$$

$\eta_{N,M} = \max(\eta_1 ; \eta_2) = \max(19,7 ; 19,7) = 19,7\ \%$ **passed**

8. Compression-Bending-Buckling

EN 1995-1-1: 6.3.2

Critical section: $x = 1,00 \cdot L = 1,00 \cdot 7243 = 7243$ mm

$$\lambda_y = \frac{K_{yy} \cdot L_{tot}}{i_{s,y}} = \frac{0,70 \cdot 7243}{49} = 104$$

$$\lambda_z = \frac{K_{zz} \cdot L_{tot}}{i_{s,z}} = \frac{0,70 \cdot 7243}{49} = 104$$

$$\lambda_{rel,y} = \frac{\lambda_y}{\pi} \cdot \sqrt{\frac{f_{c,0,k}}{E_{0.05}}} = \frac{104}{\pi} \cdot \sqrt{\frac{22}{9100}} = 1,6 \quad (6.21)$$

$$\lambda_{rel,z} = \frac{\lambda_z}{\pi} \cdot \sqrt{\frac{f_{c,0,k}}{E_{0.05}}} = \frac{104}{\pi} \cdot \sqrt{\frac{22}{9100}} = 1,6 \quad (6.22)$$

$$k_y = 0.5 \cdot \left(1 + \beta_c \cdot (\lambda_{rel,y} - 0.3) + \lambda_{rel,y}^2\right) = 0.5 \cdot (1 + 0,10 \cdot (1,6 - 0.3) + 1,6^2) = 1,86 \quad (6.27)$$

$$k_z = 0.5 \cdot \left(1 + \beta_c \cdot (\lambda_{rel,z} - 0.3) + \lambda_{rel,z}^2\right) = 0.5 \cdot (1 + 0,10 \cdot (1,6 - 0.3) + 1,6^2) = 1,86 \quad (6.28)$$

$$k_{c,y} = \min\left(\frac{1}{k_y + \sqrt{k_y^2 - \lambda_{rel,y}^2}} ; 1\right) = \min\left(\frac{1}{1,86 + \sqrt{1,86^2 - 1,6^2}} ; 1\right) = 0,36 \quad (6.25)$$

$$k_{c,z} = \min\left(\frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} ; 1\right) = \min\left(\frac{1}{1,86 + \sqrt{1,86^2 - 1,6^2}} ; 1\right) = 0,36 \quad (6.26)$$

$$\eta_1 = \frac{|\sigma_{c,0,d}|}{k_{c,y} \cdot f_{c,0,d}} + \frac{|\sigma_{m,y,d}|}{f_{m,y,d}} + k_m \cdot \frac{|\sigma_{m,z,d}|}{f_{m,z,d}} = \frac{|4,8|}{0,36 \cdot 15} + \frac{|1,9|}{19} + 1 \cdot \frac{|0|}{19} = 97,1\ \% \quad (6.23)$$

$$\eta_2 = \frac{|\sigma_{c,0,d}|}{k_{c,z} \cdot f_{c,0,d}} + k_m \cdot \frac{|\sigma_{m,y,d}|}{f_{m,y,d}} + \frac{|\sigma_{m,z,d}|}{f_{m,z,d}} = \frac{|4,8|}{0,36 \cdot 15} + 1 \cdot \frac{|1,9|}{19} + \frac{|0|}{19} = 97,1\ \% \quad (6.24)$$

$\eta_{N,M,Buck} = \max(\eta_1 ; \eta_2) = \max(97,1 ; 97,1) = 97,1\ \%$ **passed**

9. Axial force-Bending-Lateral torsional buckling

EN 1995-1-1: 6.3.3

Critical section: $x = 0,75 \cdot L = 0,75 \cdot 7243 = 5432$ mm

$dL = 2 \cdot h_{max} = 2 \cdot 195_{max} = 390$ mm

$$\sigma_{m,crit} = \frac{\pi \cdot \sqrt{E_{0.05} \cdot I_z \cdot G_{0.05} \cdot I_x}}{(K_{LT} \cdot L_{tot} + dL) \cdot W_y} = \frac{\pi \cdot \sqrt{9100 \cdot 7,0947 \cdot 10^7 \cdot 546 \cdot 1,4195 \cdot 10^8}}{(1,00 \cdot 7243 + 390) \cdot 7,2766 \cdot 10^5} = 127\ \text{N/mm}^2 \quad (6.31)$$

$$\lambda_{rel,m} = \sqrt{\frac{f_{m,k}}{\sigma_{m,crit}}} = \sqrt{\frac{24}{127}} = 0,44 \quad (6.30)$$

$k_{crit} = 1,00 \quad (6.34)$

$$\eta_1 = \frac{\sigma_{c,0,d}}{k_{c,z} \cdot f_{c,0,d}} + \left(\frac{|\sigma_{m,y,d}|}{k_{crit} \cdot f_{m,y,d}}\right)^2 = \frac{4,8}{0,36 \cdot 15} + \left(\frac{|1,6|}{1,00 \cdot 19}\right)^2 = 88,0\ \% \quad (6.35)$$

$$\eta_2 = \frac{|\sigma_{m,y,d}|}{k_{crit} \cdot f_{m,y,d}} = \frac{|1,6|}{1,00 \cdot 19} = 8,5\ \% \quad (6.33)$$

$\eta_{N,M,LTB} = \max(\eta_1 ; \eta_2) = 88,0\ \%$ **passed**

10. Shear-Torsion

DIN EN 1995-1-1/NA:2010-12 NCI NA.6.1.9 (no EN 1995-1-1 formula)

Critical section: $x = 0,00 \cdot L = 0,00 \cdot 7243 = 0$ mm

At Point A (middle pont of the b side); $\tau_{V_z,d} = 0$

$$\tau_{V_y,d} = \frac{|V_y| \cdot 16}{3 \cdot \pi \cdot (h)^2} = \frac{|0| \cdot 16}{3 \cdot \pi \cdot (195)^2} = 0\ \text{N/mm}^2$$

$$\eta_A = \frac{|\tau_{tor,d}|}{k_{shape} \cdot f_{v,d}} + \left(\frac{\tau_{V_y,d}}{f_{v,y,d}}\right)^2 = \frac{|0|}{1,2 \cdot 2,5} + \left(\frac{0}{2,5}\right)^2 = 0\ \% \quad (NA.55)$$

At Point B (middle pont of the h side); $\tau_{V_y,d} = 0$

$$\tau_{tor,d} = \frac{2 \cdot |M_x|}{\pi \cdot (h/2)^3} = \frac{2 \cdot |0|}{\pi \cdot (195/2)^3} = 0\ \text{N/mm}^2$$

$$\tau_{V_z,d} = \frac{|V_z| \cdot 16}{3 \cdot \pi \cdot (h)^2} = \frac{|(-299)| \cdot 16}{3 \cdot \pi \cdot (195)^2} = 0\ \text{N/mm}^2$$

$$\eta_B = \frac{|\tau_{tor,d}|}{k_{shape} \cdot f_{v,d}} + \left(\frac{\tau_{V_z,d}}{f_{v,z,d}}\right)^2 = \frac{|0|}{1,2 \cdot 2,5} + \left(\frac{0}{2,5}\right)^2 = 0\ \% \quad (NA.55)$$

At Point A (middle pont of the b side); $\tau_{tor,d,O} = 0$

$$\eta_O = \left(\frac{\tau_{V_y,d}}{f_{v,y,d}}\right)^2 + \left(\frac{\tau_{V_z,d}}{f_{v,z,d}}\right)^2 = \left(\frac{0}{2,5}\right)^2 + \left(\frac{0}{2,5}\right)^2 = 0\ \% \quad (NA.55)$$

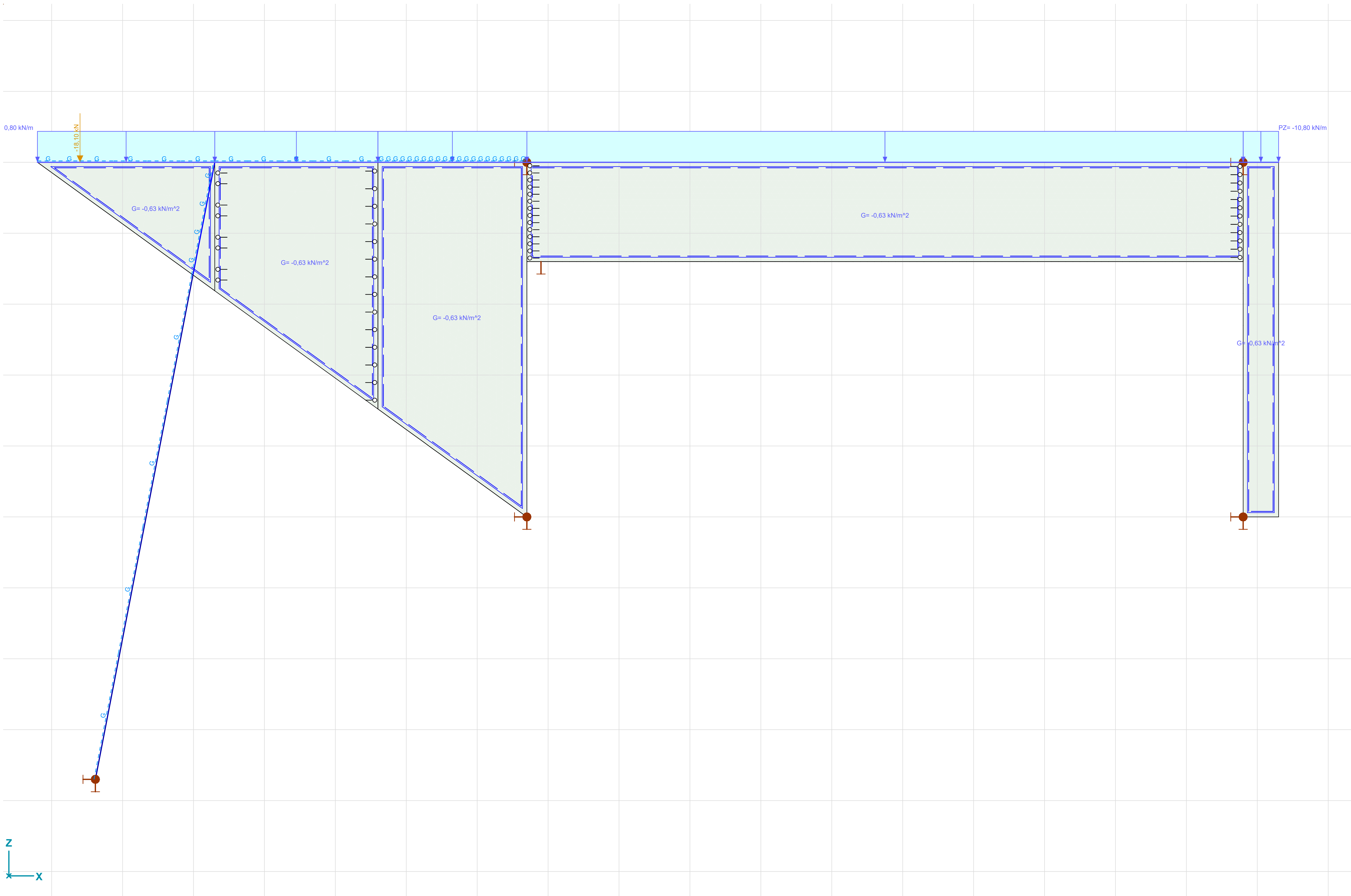
$\eta_{V_y,V_z,M_x} = \max\left(\eta_A ; \eta_B ; \eta_O ; \eta_{V_y} ; \eta_{V_z}\right) = \max(0 ; 0 ; 0 ; 0 ; 0,5) = 0,5\ \%$ **passed**

11. Apex zone tensile stress perpendicular to the axis

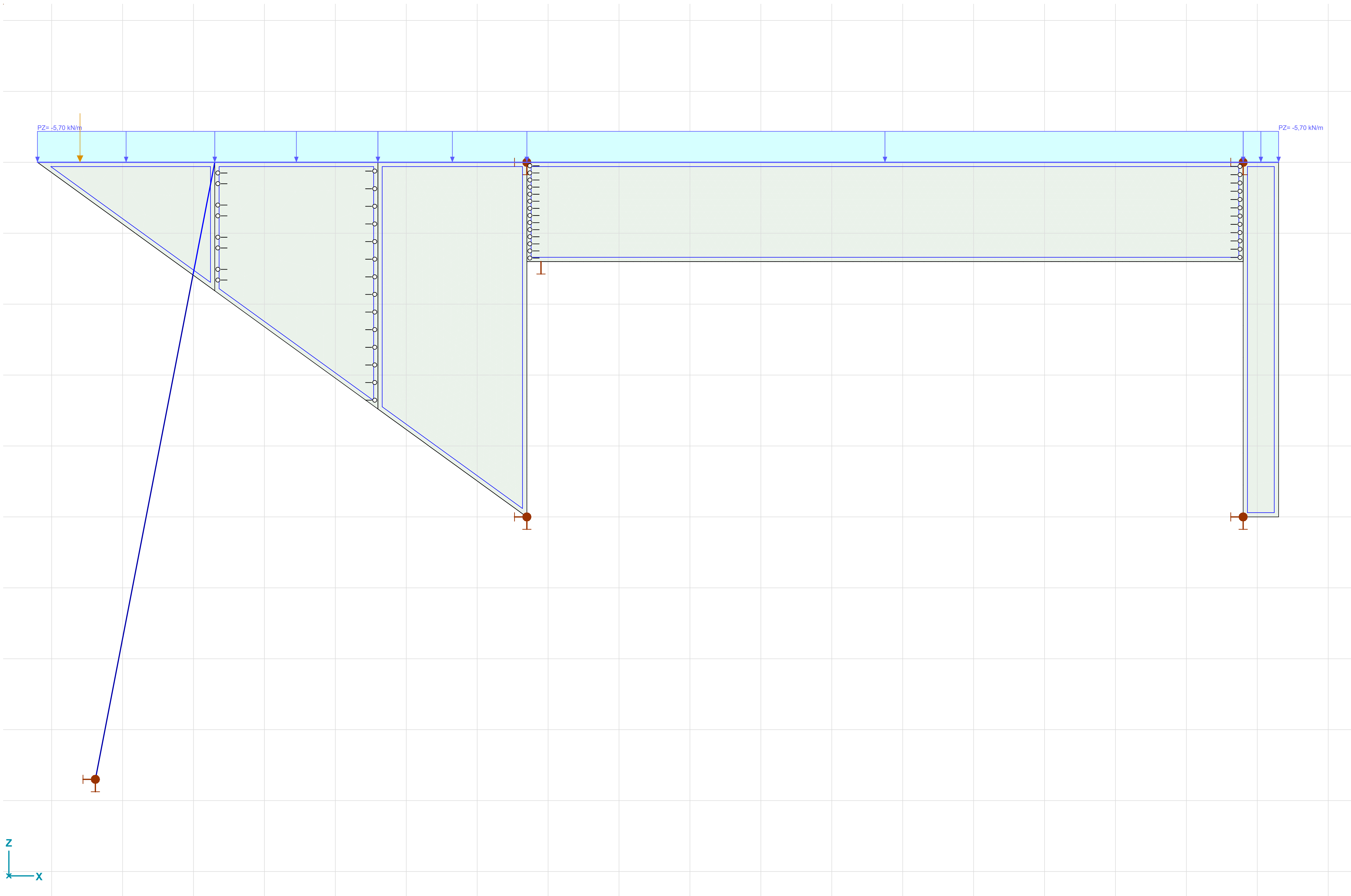
EN 1995-1-1: 6.4.3

Critical section: $x = 0,00 \cdot L = 0,00 \cdot 7243 = 0$ mm

$\eta_{Apex} = 0\ \%$ (6.53) **passed**

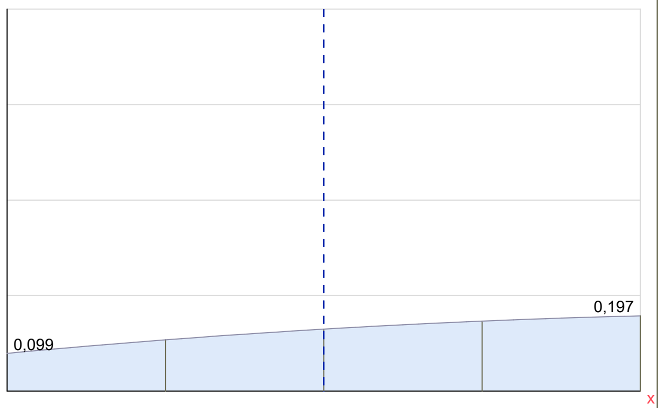


PERMANENTE, Front view

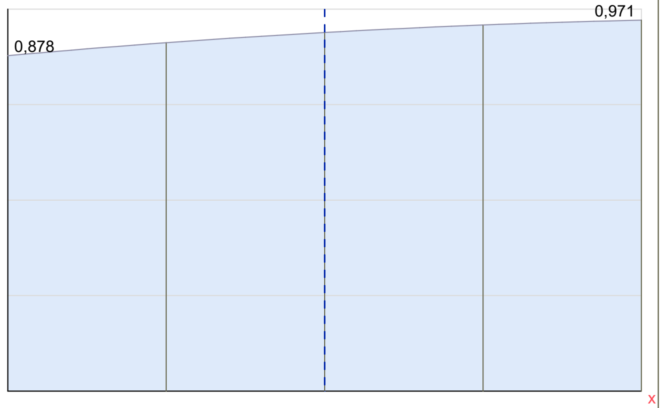


USO, Front view

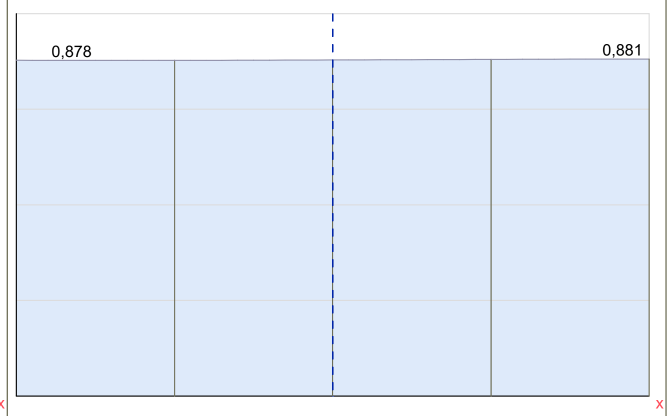
N-M
(EN 6.2.3, 6.2.4)

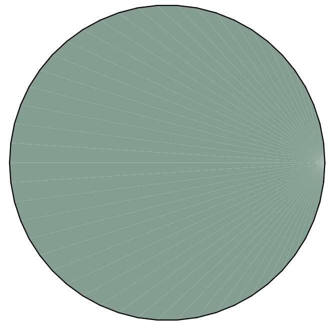


N-M-Buckl
(EN 6.3.2)



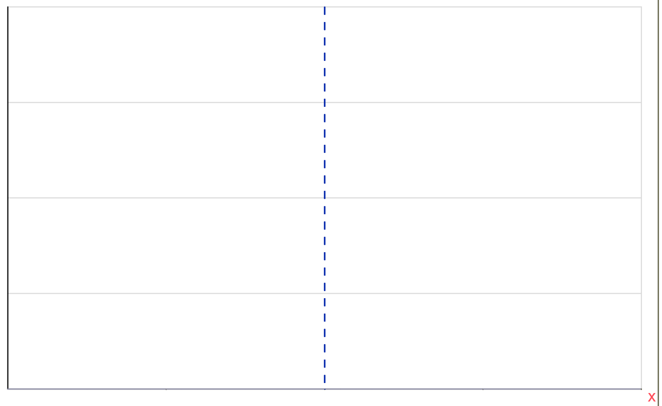
N-M-LTBuckl
(EN 6.3.3)





Vy-Vz-Tx
(EN 6.1.7, 6.1.8)

My-Vz
(EN 6.4.3)



Linear - ROTURA

x[m]	=	3,622
N-M	=	0,162
N-M-Buckl	=	0,939
N-M-LTBuckl	=	0,879
Vy-Vz-Tx	=	0,003
My-Vz	=	0
st90d [N/mm^2]	=	0

Utilization

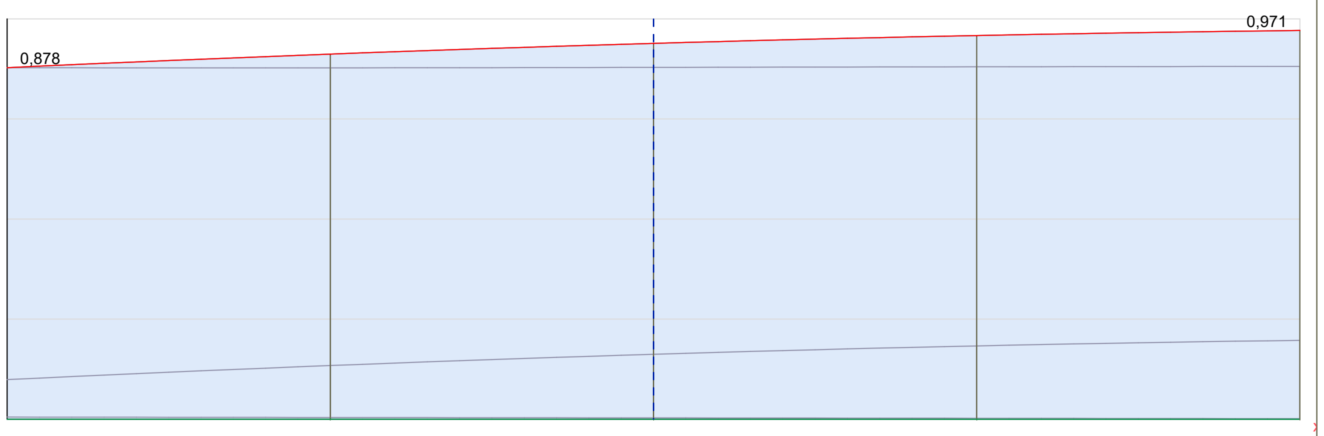
Maximum Utilization	=	0,939
ULS	=	0,939
SLS	=	0

Material	GL 24c
Timber type	GLULAM
	Class 2
Cross-section	O 195
Ax [mm^2]	29858,68
Ix [mm^4]	1,4195E+8
Iy [mm^4]	7,0947E+7
Iz [mm^4]	7,0947E+7

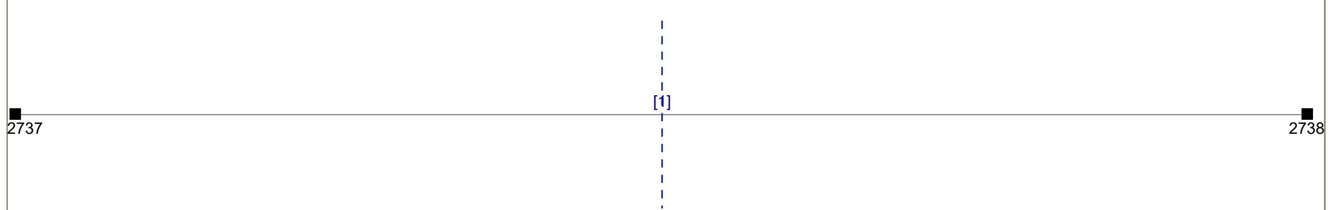
Buckling coefficients

K_{yy}	0,700
K_{zz}	0,700
K_{LT}	1,000
Z_a	0,500

Utilization

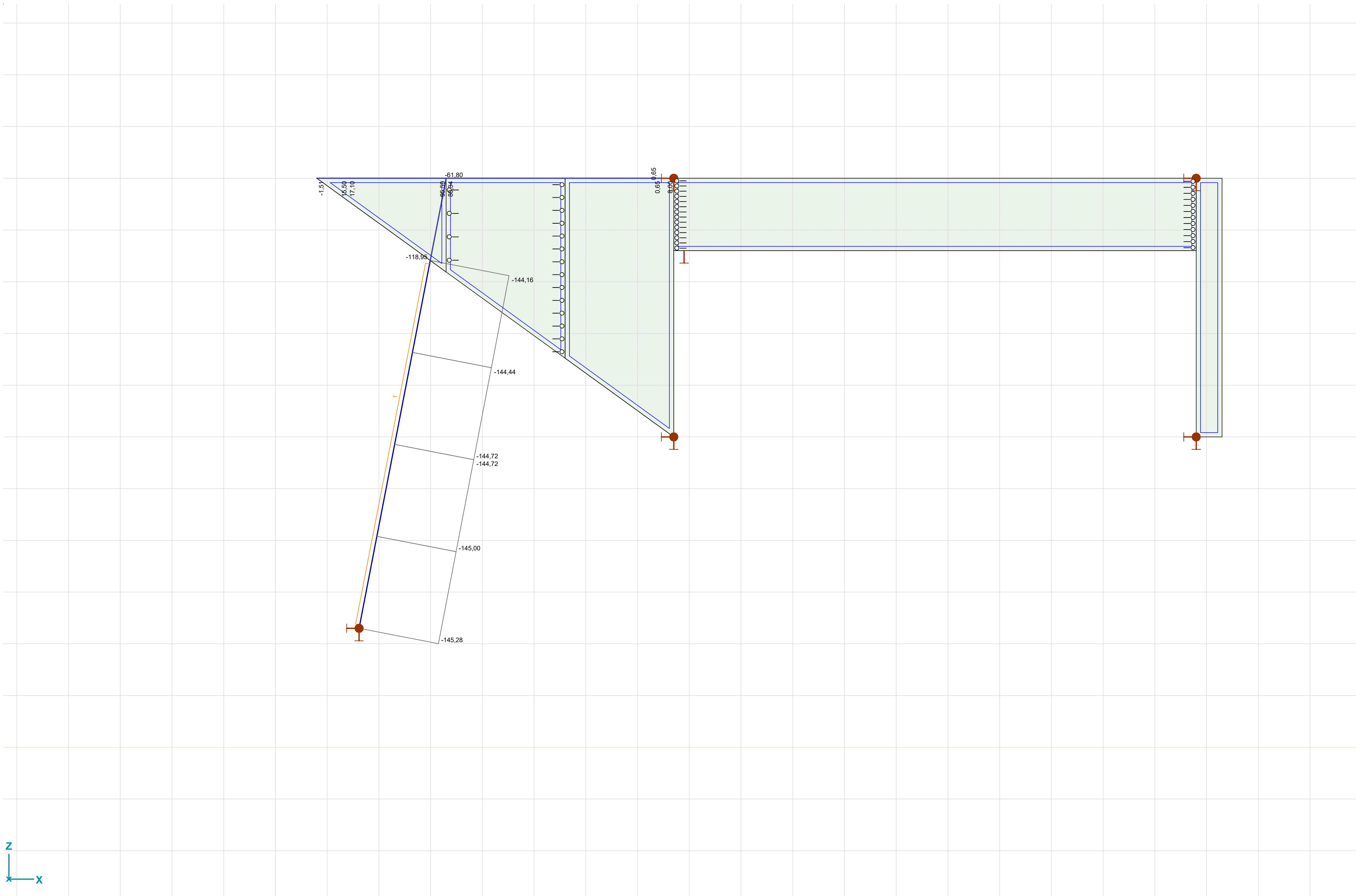


Timber design member 1
x [m] = 3,622 m

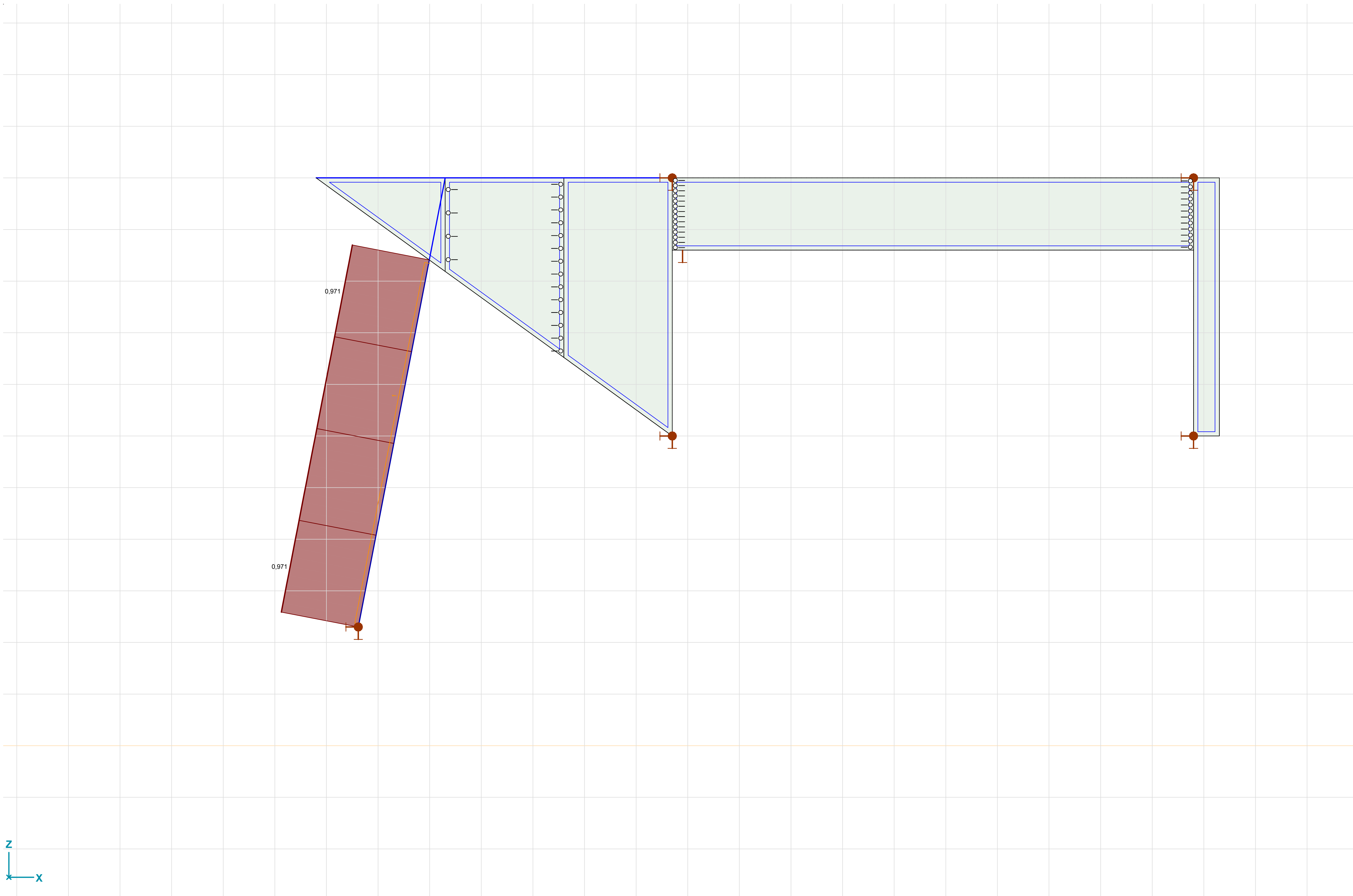


Total length: 7,243 m

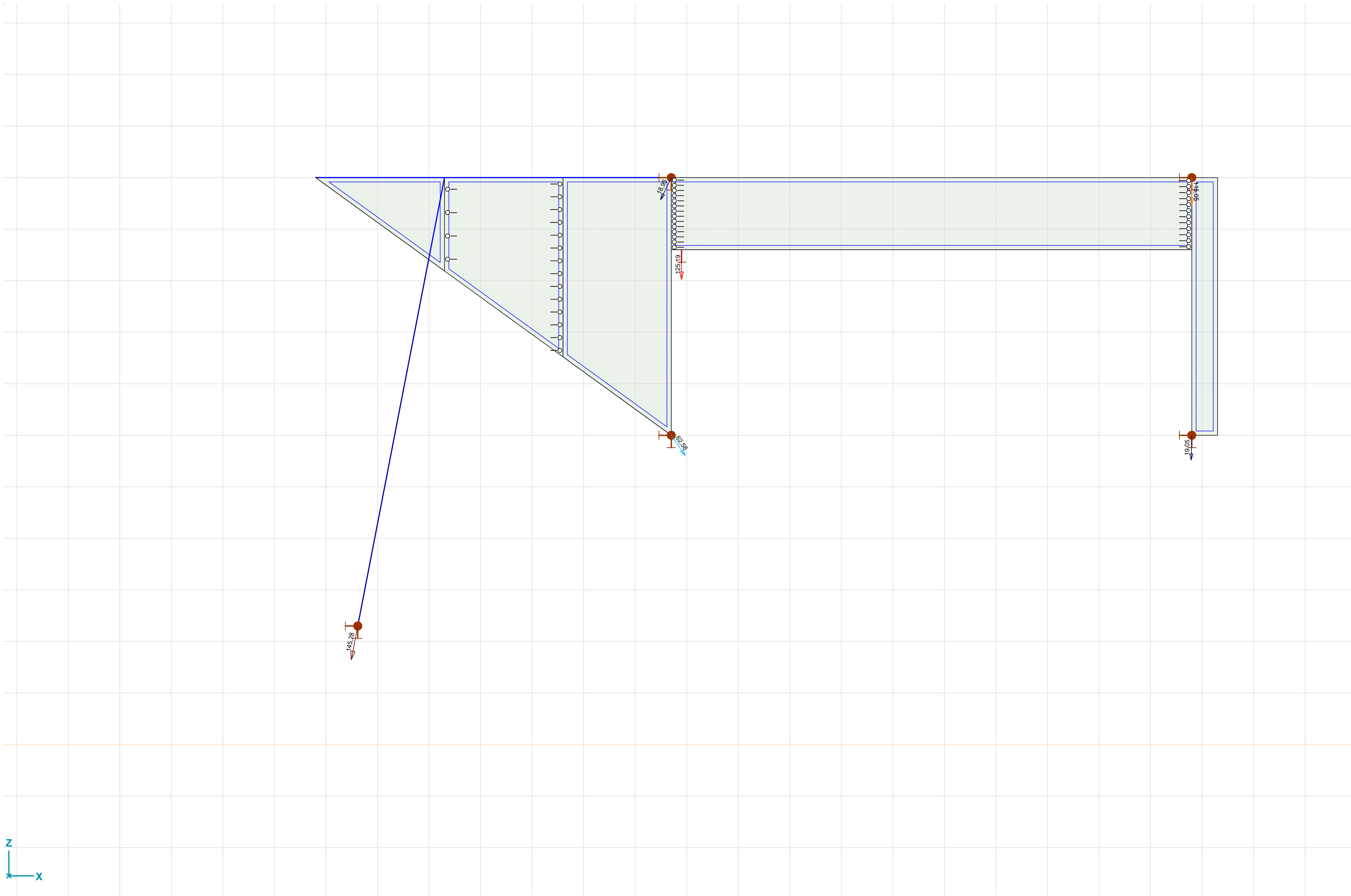
[StI], Linear, ROTURA (ULS), Utilization, Timber design member 1, [Pos.: 3,622m;]



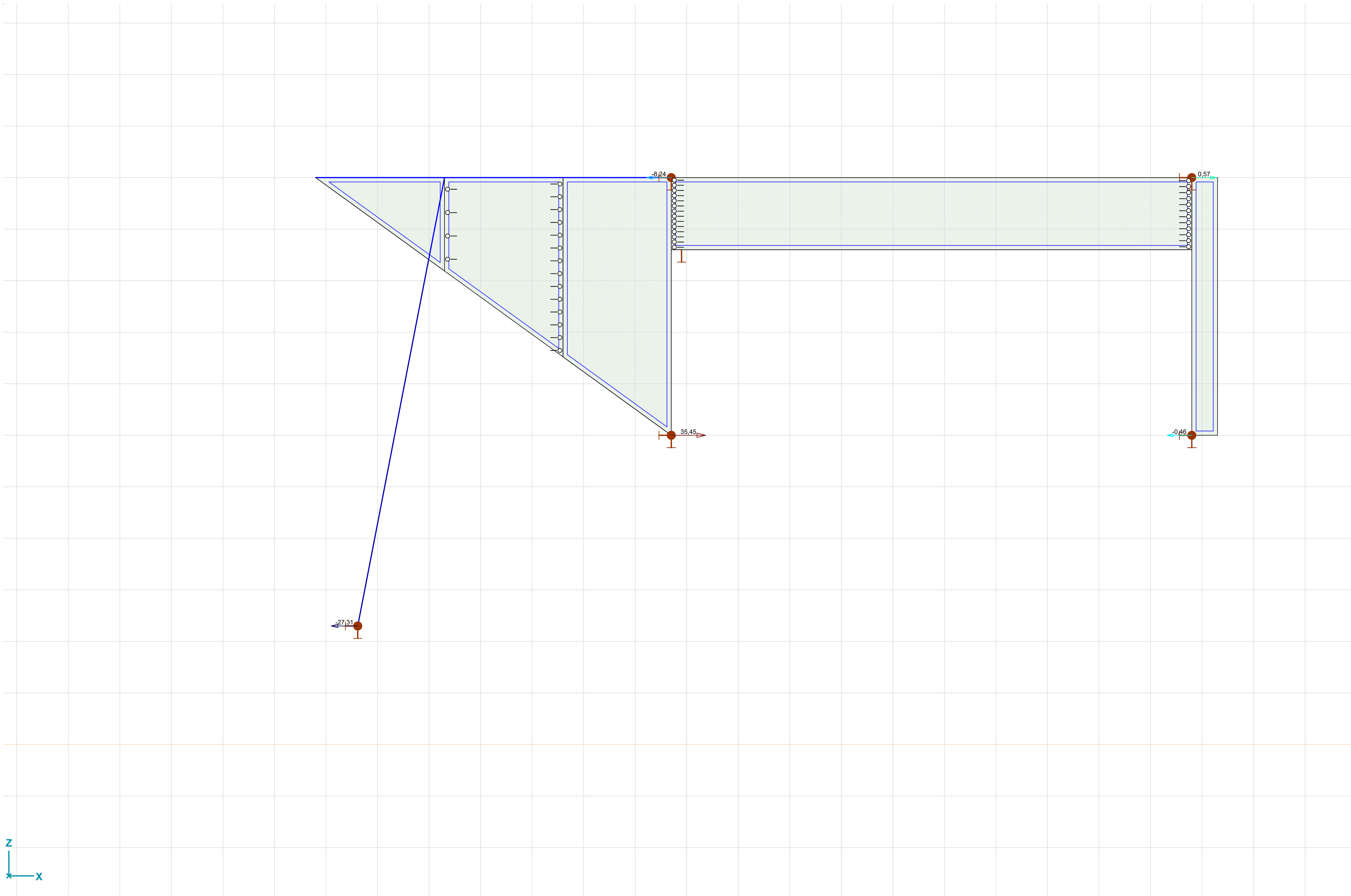
[Tm], Linear, ROTURA (ULS), Nx, Diagram, Front view



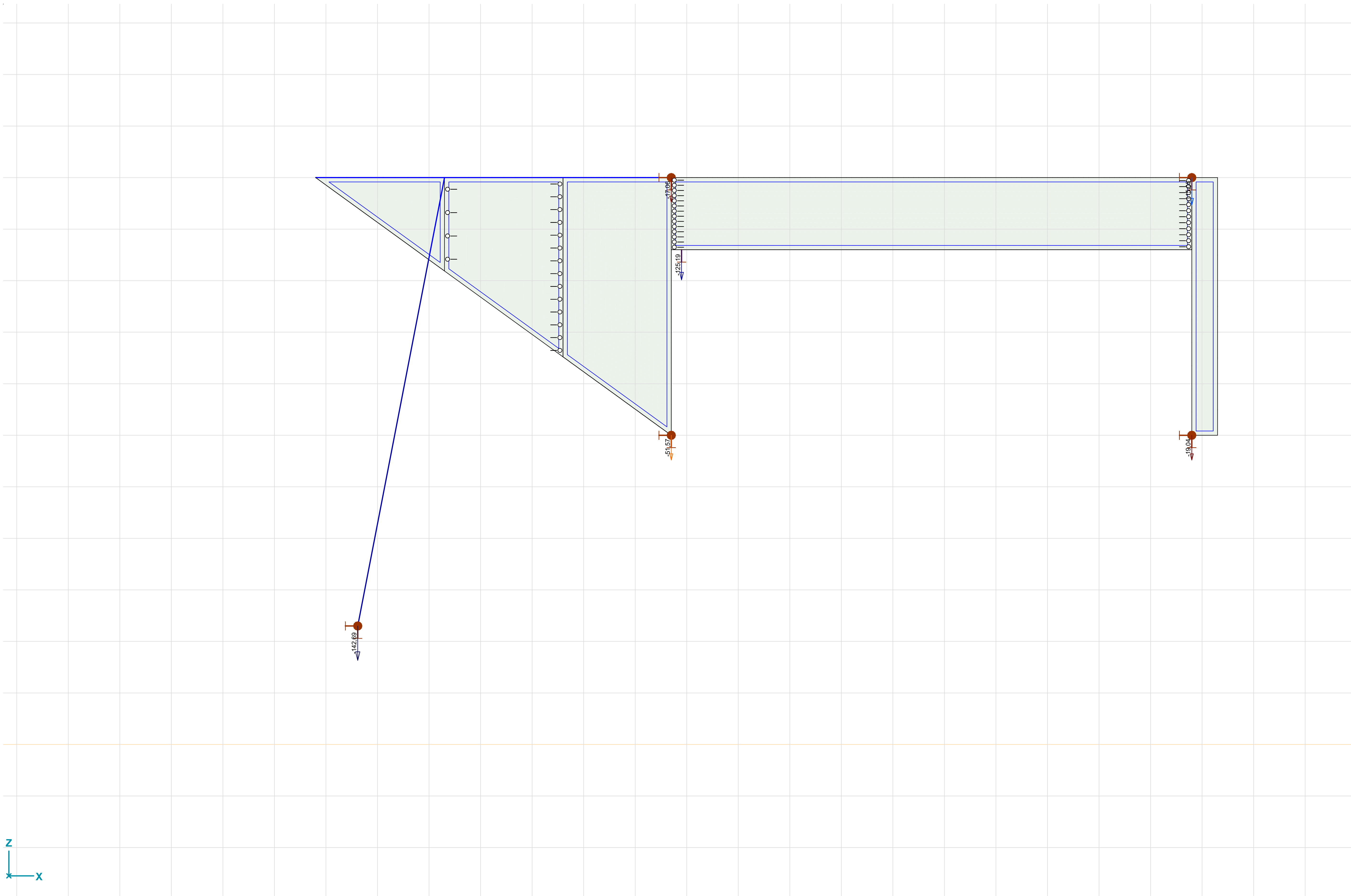
[Tml], Linear, ROTURA (ULS), Utilization, Filled diagram, Front view



[I], Linear, ROTURA (ULS), Rr (nodal supp.), Diagram, Front view



[I], Linear, ROTURA (ULS), Rx (nodal supp.), Diagram, Front view



[I], Linear, ROTURA (ULS), Rz (nodal supp.), Diagram, Front view