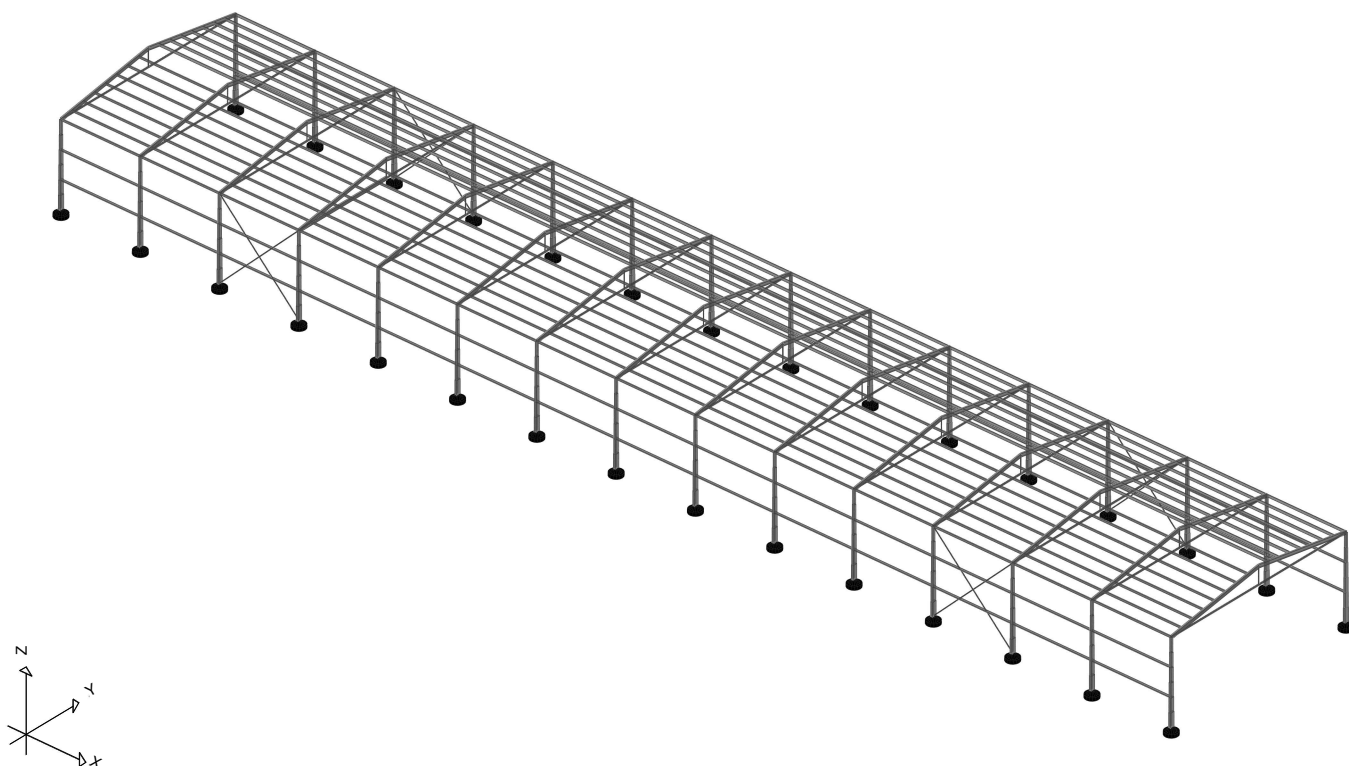


Statická analýza

SO-01 Výrobná hala

Posúdenie možnosti osadenia FVE na strechu ocelejovej haly

Vypracoval: Ing. Tomáš Keresztesi



Input data - Structure

Level scheme

Name	z [m]	h [m]
Hreben	7.25	7.25

Name	z [m]	h [m]
+0	0.00	

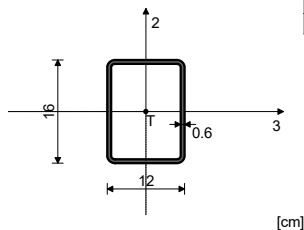
Table of materials

No	Material name	E[kN/m ²]	μ	γ [kN/m ³]	α [1/C]	Em[kN/m ²]	μ m
1	Stahl	2.100e+8	0.30	78.50	1.000e-5	2.100e+8	0.30

Beam sets

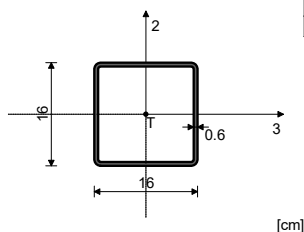
Set: 1 Section: □ 160x120x6, Approx. eccentricity, Stlp

Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	3.123e-3	1.920e-3	1.440e-3	1.410e-5	7.183e-6	1.121e-5



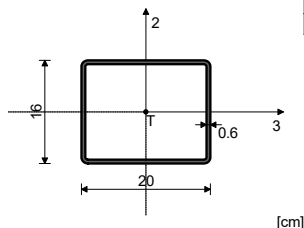
Set: 2 Section: □ 160x160x6, Approx. eccentricity, Stlp

Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	3.624e-3	1.920e-3	1.920e-3	2.227e-5	1.418e-5	1.418e-5



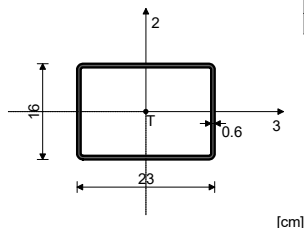
Set: 3 Section: □ 160x200x6, Approx. eccentricity, Stlp

Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	4.104e-3	1.920e-3	2.400e-3	3.123e-5	2.400e-5	1.701e-5



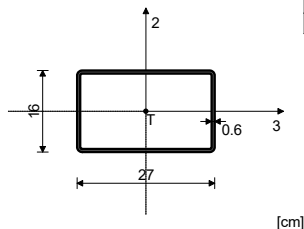
Set: 4 Section: □ 160x230x6, Approx. eccentricity, Stlp

Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	4.464e-3	1.920e-3	2.760e-3	3.829e-5	3.349e-5	1.916e-5



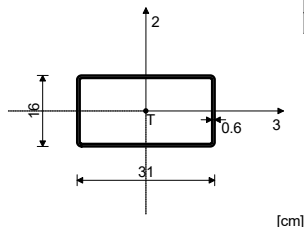
Set: 5 Section: □ 160x270x6, Approx. eccentricity, Stlp

Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	4.944e-3	1.920e-3	3.240e-3	4.804e-5	4.931e-5	2.200e-5



Set: 6 Section: □ 160x310x6, Approx. eccentricity, Stlp

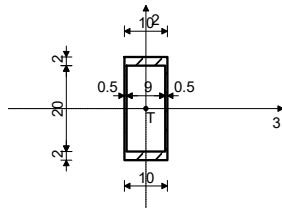
Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	5.424e-3	1.920e-3	3.720e-3	5.808e-5	6.908e-5	2.485e-5



Input data - Structure

Set: 7 Section: [100/240, Approx. eccentricity, Stlp

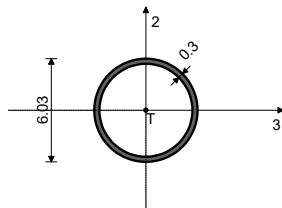
Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	6.000e-3	2.353e-3	3.792e-3	1.792e-5	7.850e-6	5.520e-5



[cm]

Set: 8 Section: D= 60.3x3, Approx. eccentricity, Vzpera

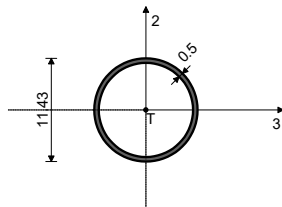
Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	5.400e-4	2.699e-4	2.699e-4	4.443e-7	2.222e-7	2.222e-7



[cm]

Set: 9 Section: D= 114.3x5, Approx. eccentricity, Tiahlo

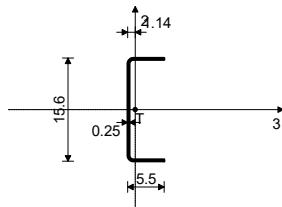
Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	1.717e-3	8.580e-4	8.580e-4	5.136e-6	2.569e-6	2.569e-6



[cm]

Set: 10 Section: [150x55x2.5, Approx. eccentricity, Vážnica

Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	6.369e-4	3.900e-4	2.750e-4	1.346e-9	1.766e-7	2.241e-6



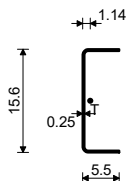
[cm]

Set: 11 Section: 2x[150x55x2.5, Approx. eccentricity, Vážnica

Mat.	A1	A2	A3	I1	I2	I3
1 - Stahl	1.274e-3	7.800e-4	5.500e-4	2.692e-9	5.216e-7	4.483e-6



No	Section	$\Delta 3$ [cm]	$\Delta 2$ [cm]	α	Mat.
1	[150x55x2.5	1.15	0.00	0.00	1
2	[150x55x2.5	-1.15	0.00	3.14	1



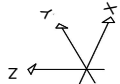
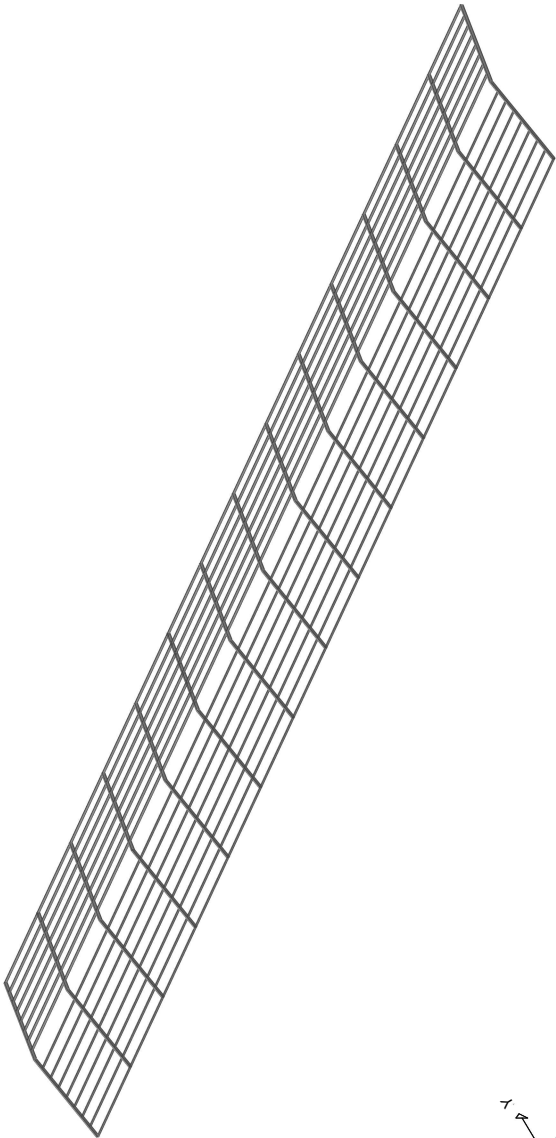
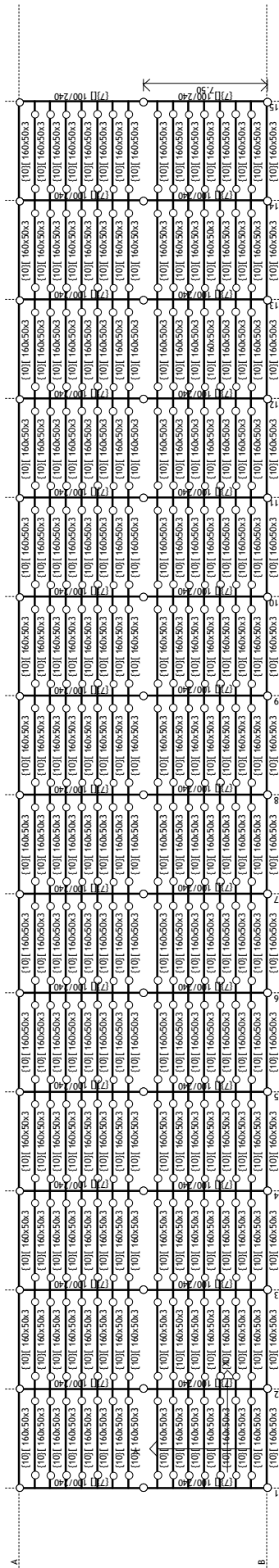
[cm]

[150x55x2.5

Point support sets

Set	K,R1	K,R2	K,R3	K,M1	K,M2	K,M3
2	1.000e+10	1.000e+10	1.000e+10	1.000e+10		

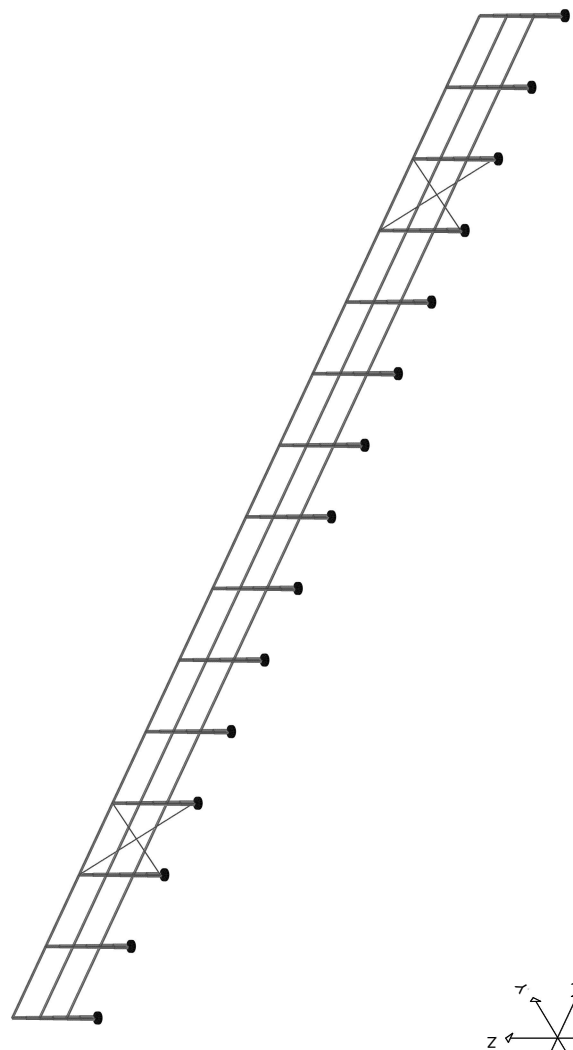
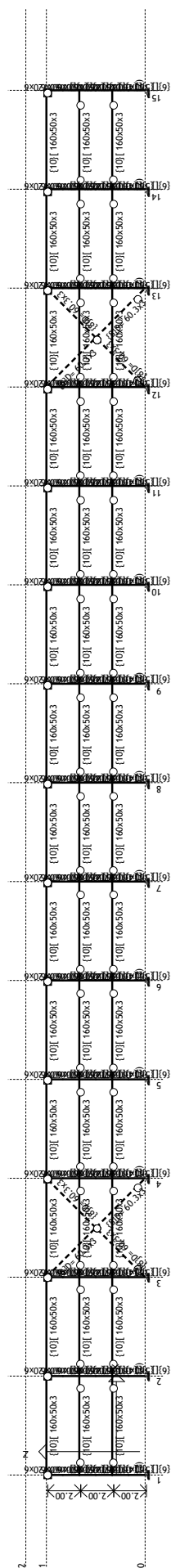
Input data - Structure



View: Strecha - Group: Hala SO.01

View: Strecha (Group: Hala SO.01)

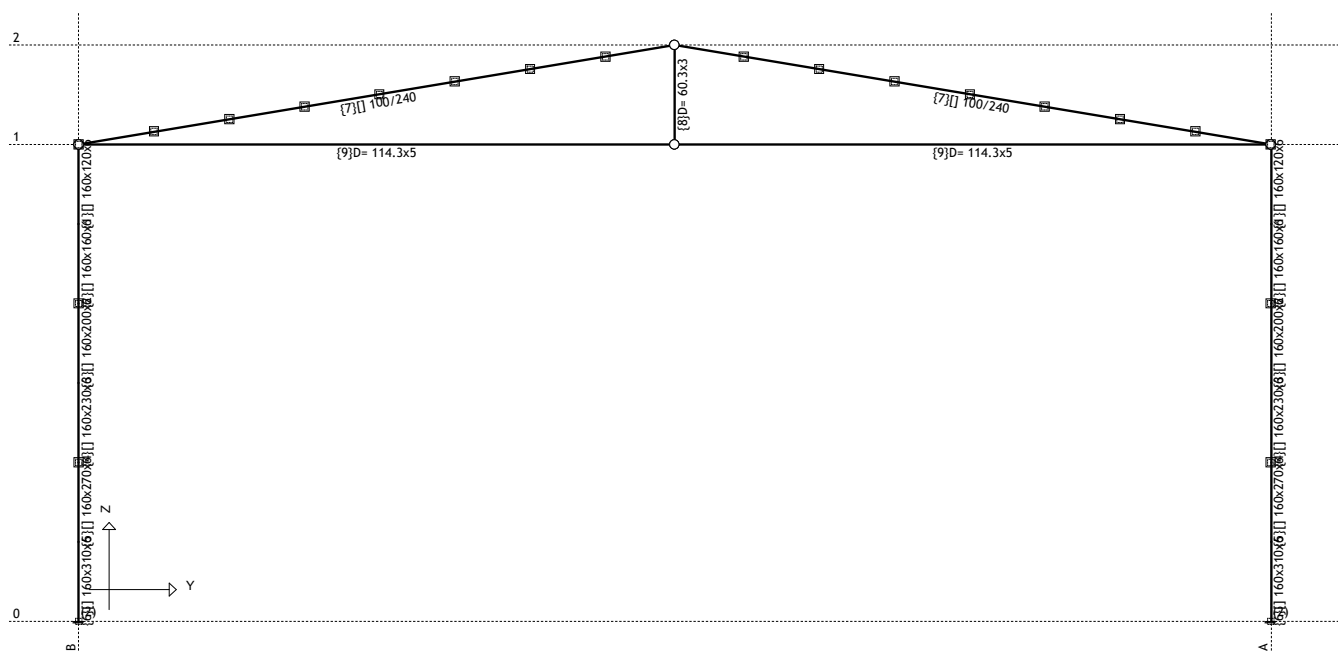
Input data - Structure



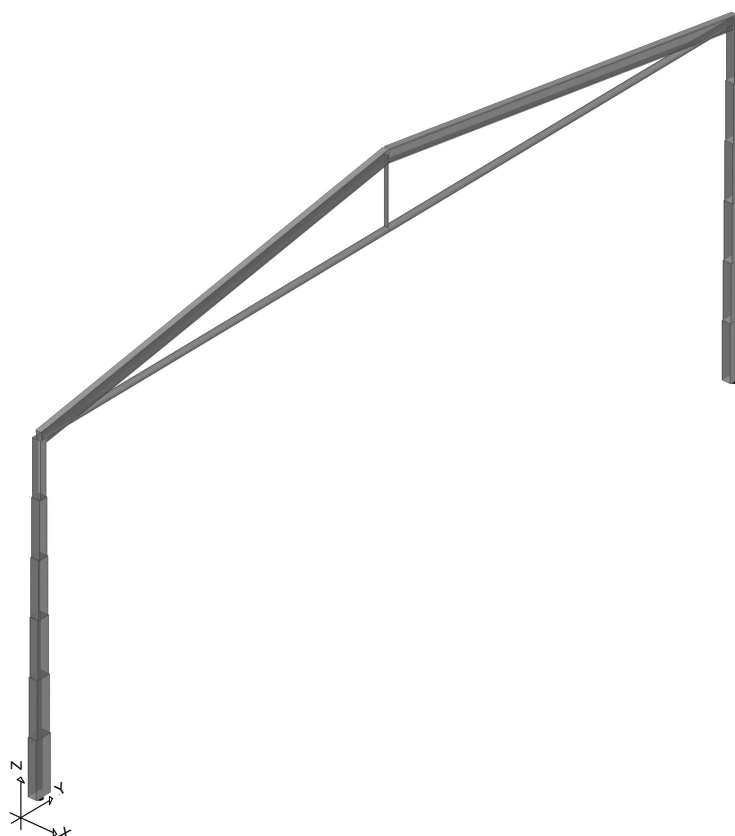
Frame: H 1 - Group: Hala SO.01

Frame: H 1 (Group: Hala SO.01)

Input data - Structure



Frame: V_3 - Group: Hala SO.01

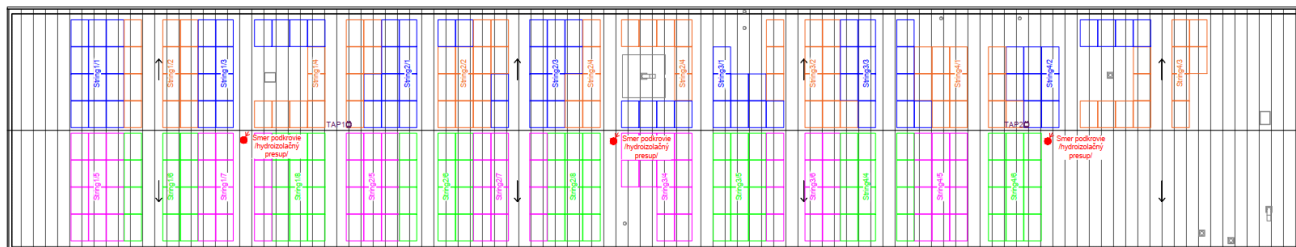


Frame: V_3 (Group: Hala SO.01)

Input data - Load

Stále zaťaženia podľa STN EN 1991-1

- Vlastná tiaž nosnej konštrukcie je spočítaná výpočtovým programom
- Stále zaťaženie pôsobiace na konštrukciu tvorí tiaž sendvičových panelov (strešných a stenových), ktorá bola uvažovaná ako hodnota 0,14 kN/m²
- Novou zložkou stáleho zaťaženia je tiaž fotovoltaických panelov: prírastok 0,20 kN/m²

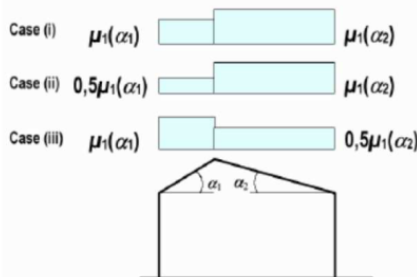


Obr.: Schéma rozmiestnenia panelov na streche objektu (podľa projektu FBB Electric)

Zaťaženie sedlovej strechy snehom - podľa STN EN 1991-1-3

Vstupné údaje:

Sklon strechy: 10 ° (α 1) 10 ° (α 2)
 Expozícia: normálna (Ce)
 Snehová oblasť: 1
 Nadmorská výška miesta stavby: 125 m.n.m (A)



Výpočet:

Charakteristické zaťaženie snehom s pôsobiace na strechu:

$$s_{sk} := \mu_1 \cdot C_e \cdot C_t \cdot s_k$$

μ - tvarový súčiniteľ zaťaženia snehom (STN EN 1991-1-3)

$$\mu_{1\alpha 1} = 0.80 \quad \mu_{1\alpha 2} = 0.80$$

C_e - súčiniteľ podmienok expozície (STN EN 1991-1-3)

$$C_e = 1.00$$

C_t - teplotný súčiniteľ (STN EN 1991-1-3)

$$C_t = 1.00$$

s_k - charakteristická hodnota zaťaženia snehom na povrchu zeme (kN/m²) (STN EN 1991-1-3)

$$a = 0.454$$

$$A = 125$$

$$b = 970$$

$$s_k := a + \frac{A}{b}$$

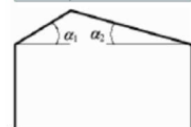
$$s_k = 0.58 \quad \text{kN/m}^2$$

Charakteristické zaťaženie snehom s pôsobiace na strechu: $s_{sk} := \mu_1 \cdot C_e \cdot C_t \cdot s_k$

$$s_{I\mu 1\alpha 1} := \mu_{1\alpha 1} \cdot C_e \cdot C_t \cdot s_k \quad 0.466 \quad \text{kN/m}^2 \quad s_{I\mu 1\alpha 2} := \mu_{1\alpha 2} \cdot C_e \cdot C_t \cdot s_k \quad 0.466 \quad \text{kN/m}^2$$

$$s_{II\mu 1\alpha 1} := 0.5\mu_{1\alpha 1} \cdot C_e \cdot C_t \cdot s_k \quad 0.233 \quad \text{kN/m}^2 \quad s_{II\mu 1\alpha 2} := \mu_{1\alpha 2} \cdot C_e \cdot C_t \cdot s_k \quad 0.233 \quad \text{kN/m}^2$$

$$s_{III\mu 1\alpha 1} := \mu_{1\alpha 1} \cdot C_e \cdot C_t \cdot s_k \quad 0.466 \quad \text{kN/m}^2 \quad s_{III\mu 1\alpha 2} := 0.5\mu_{1\alpha 2} \cdot C_e \cdot C_t \cdot s_k \quad 0.233 \quad \text{kN/m}^2$$



Input data - Load

Input data - Load

Governing load - EC2 (EN 1992-1-1:2004)

LFK für Gebäude

Load Case

- I st + vl (g) - <Permanent>(long-term)
 II sn - <Snow - <= 1000 m>(short-term)
 III w.x - <Wind> (+/-)(short-term)
 IV w.y - <Wind> (+/-)(short-term)

Partial factors for materials

[PT] Persistent and Transient: $\gamma_C = 1.50$, $\gamma_S = 1.15$ [SE] Seismic combinations: $\gamma_C = 1.50$, $\gamma_S = 1.15$ [AC] Accidental: $\gamma_C = 1.20$, $\gamma_S = 1.00$

User-defined load combinations

01. [PT] 1.35×I+1.50×II-0.90×III-0.90×IV
02. [PT] 1.35×I+1.50×II-0.90×III+0.90×IV
03. [PT] 1.35×I+1.50×II+0.90×III-0.90×IV
04. [PT] 1.35×I+1.50×II+0.90×III+0.90×IV
05. [PT] 1.35×I+0.75×II-1.50×III-0.90×IV
06. [PT] 1.35×I+0.75×II-1.50×III+0.90×IV
07. [PT] 1.35×I+0.75×II-0.90×III-1.50×IV
08. [PT] 1.35×I+0.75×II-0.90×III+1.50×IV
09. [PT] 1.35×I+0.75×II+0.90×III-1.50×IV
10. [PT] 1.35×I+0.75×II+0.90×III+1.50×IV
11. [PT] 1.35×I+0.75×II+1.50×III-0.90×IV
12. [PT] 1.35×I+0.75×II+1.50×III+0.90×IV
13. [PT] I+1.50×II-0.90×III-0.90×IV
14. [PT] I+1.50×II-0.90×III+0.90×IV
15. [PT] I+1.50×II+0.90×III-0.90×IV
16. [PT] I+1.50×II+0.90×III+0.90×IV
17. [PT] I+0.75×II-1.50×III-0.90×IV
18. [PT] I+0.75×II-1.50×III+0.90×IV
19. [PT] I+0.75×II-0.90×III-1.50×IV
20. [PT] I+0.75×II-0.90×III+1.50×IV
21. [PT] I+0.75×II+0.90×III-1.50×IV
22. [PT] I+0.75×II+0.90×III+1.50×IV
23. [PT] I+0.75×II+1.50×III-0.90×IV
24. [PT] I+0.75×II+1.50×III+0.90×IV
25. [PT] 1.35×I-1.50×III-0.90×IV
26. [PT] 1.35×I-1.50×III+0.90×IV
27. [PT] 1.35×I-0.90×III-1.50×IV
28. [PT] 1.35×I-0.90×III+1.50×IV
29. [PT] 1.35×I+0.90×III-1.50×IV
30. [PT] 1.35×I+0.90×III+1.50×IV
31. [PT] 1.35×I+1.50×III-0.90×IV
32. [PT] 1.35×I+1.50×III+0.90×IV
33. [PT] 1.35×I+1.50×II-0.90×III
34. [PT] 1.35×I+1.50×II-0.90×IV
35. [PT] 1.35×I+1.50×II+0.90×IV
36. [PT] 1.35×I+1.50×II+0.90×III
37. [PT] 1.35×I+0.75×II-1.50×III
38. [PT] 1.35×I+0.75×II-1.50×IV
39. [PT] 1.35×I+0.75×II+1.50×IV
40. [PT] 1.35×I+0.75×II+1.50×III
41. [PT] I-1.50×III-0.90×IV
42. [PT] I-1.50×III+0.90×IV
43. [PT] I-0.90×III-1.50×IV
44. [PT] I-0.90×III+1.50×IV
45. [PT] I+0.90×III-1.50×IV
46. [PT] I+0.90×III+1.50×IV
47. [PT] I+1.50×III-0.90×IV
48. [PT] I+1.50×III+0.90×IV
49. [PT] I+1.50×II-0.90×III

50. [PT] I+1.50×II-0.90×IV
51. [PT] I+1.50×II+0.90×IV
52. [PT] I+1.50×II+0.90×III
53. [PT] I+0.75×II-1.50×III
54. [PT] I+0.75×II-1.50×IV
55. [PT] I+0.75×II+1.50×IV
56. [PT] I+0.75×II+1.50×III
57. [PT] 1.35×I-1.50×III
58. [PT] 1.35×I-1.50×IV
59. [PT] 1.35×I+1.50×IV
60. [PT] 1.35×I+1.50×III
61. [PT] 1.35×I+1.50×II
62. [PT] I-1.50×III
63. [PT] I-1.50×IV
64. [PT] I+1.50×IV
65. [PT] I+1.50×III
66. [PT] I+1.50×II
67. [PT] 1.35×I
68. [PT] I+II-0.60×III
69. [PT] I+II-0.60×IV
70. [PT] I+II+0.60×IV
71. [PT] I+II+0.60×III
72. [PT] I+0.50×II-III
73. [PT] I+0.50×II-IV
74. [PT] I+0.50×II+IV
75. [PT] I+0.50×II+III
76. [PT] I-III
77. [PT] I-IV
78. [PT] I+IV
79. [PT] I+III
80. [PT] I+II
81. [PT] I

Combinations for fissure and deflection calculation (characteristic combinations - long-term)

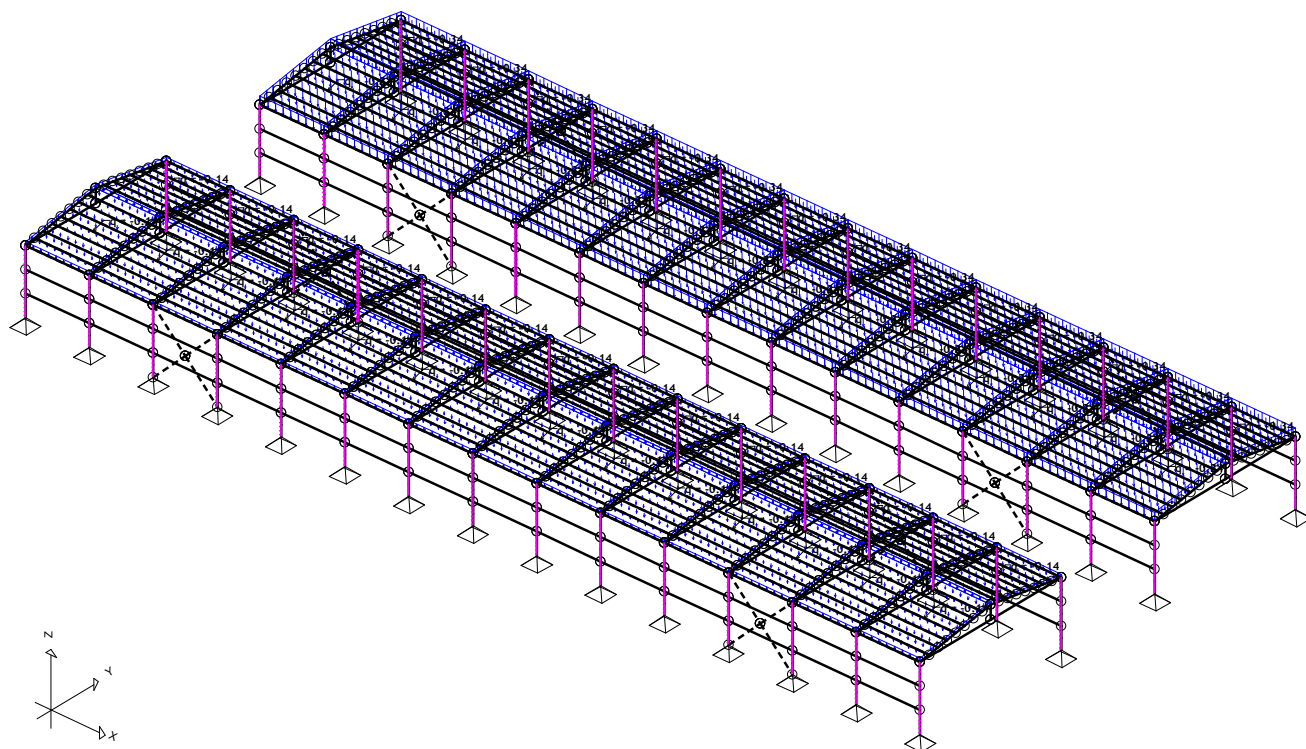
01. I
02. I
03. I
04. I
05. I
06. I
07. I
08. I
09. I
10. I
11. I
12. I
13. I
14. I

(characteristic combinations - short-term)

01. II-0.60×III
02. II-0.60×IV
03. II+0.60×IV
04. II+0.60×III
05. 0.50×II-III
06. 0.50×II-IV
07. 0.50×II+IV
08. 0.50×II+III
09. -III
10. -IV
11. IV
12. III
13. II
14. ---

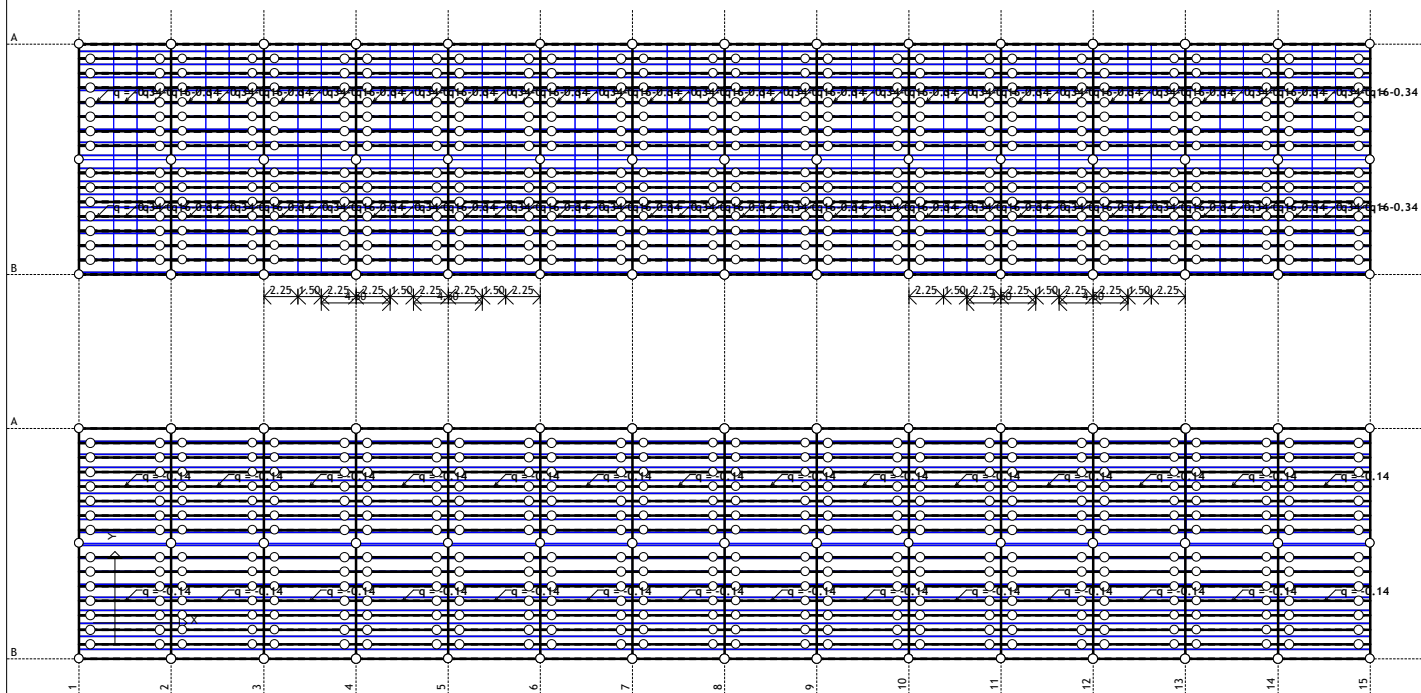
Input data - Load

Load 1: st + vl (g)



Isometric

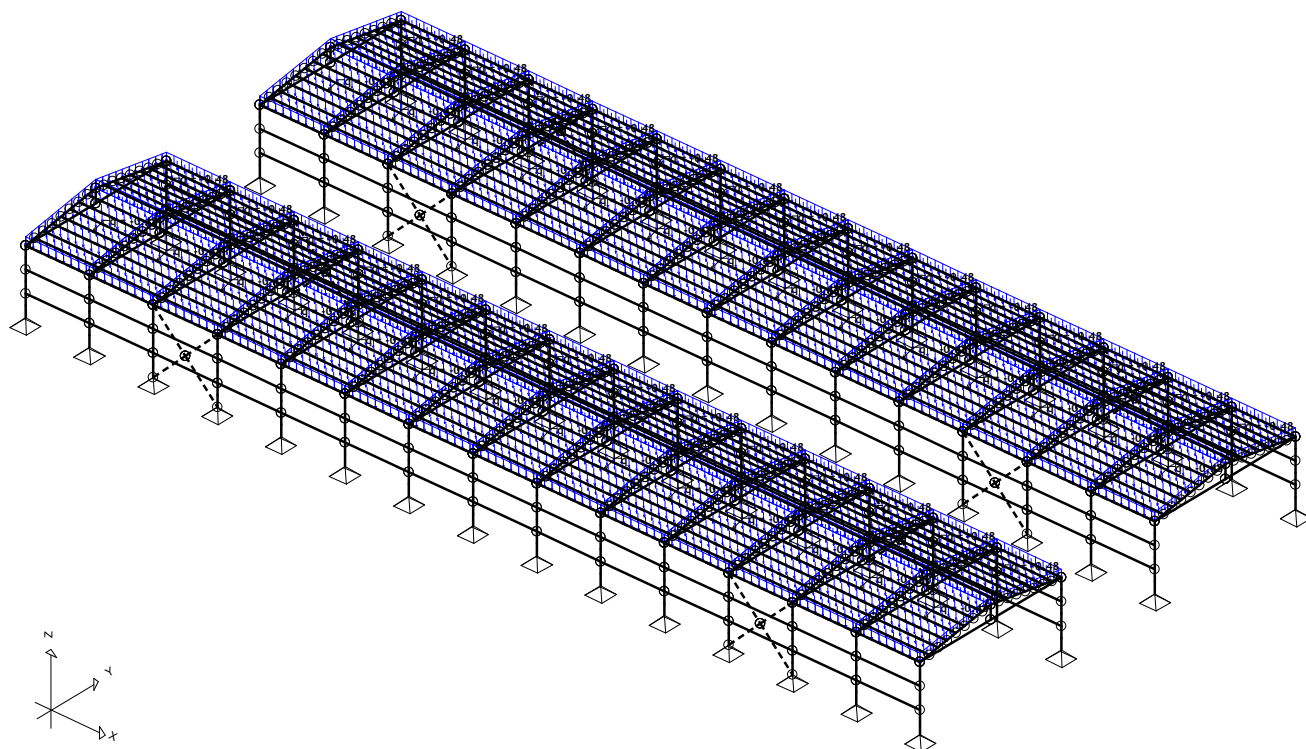
Load 1: st + vl (g)



View: Strecha

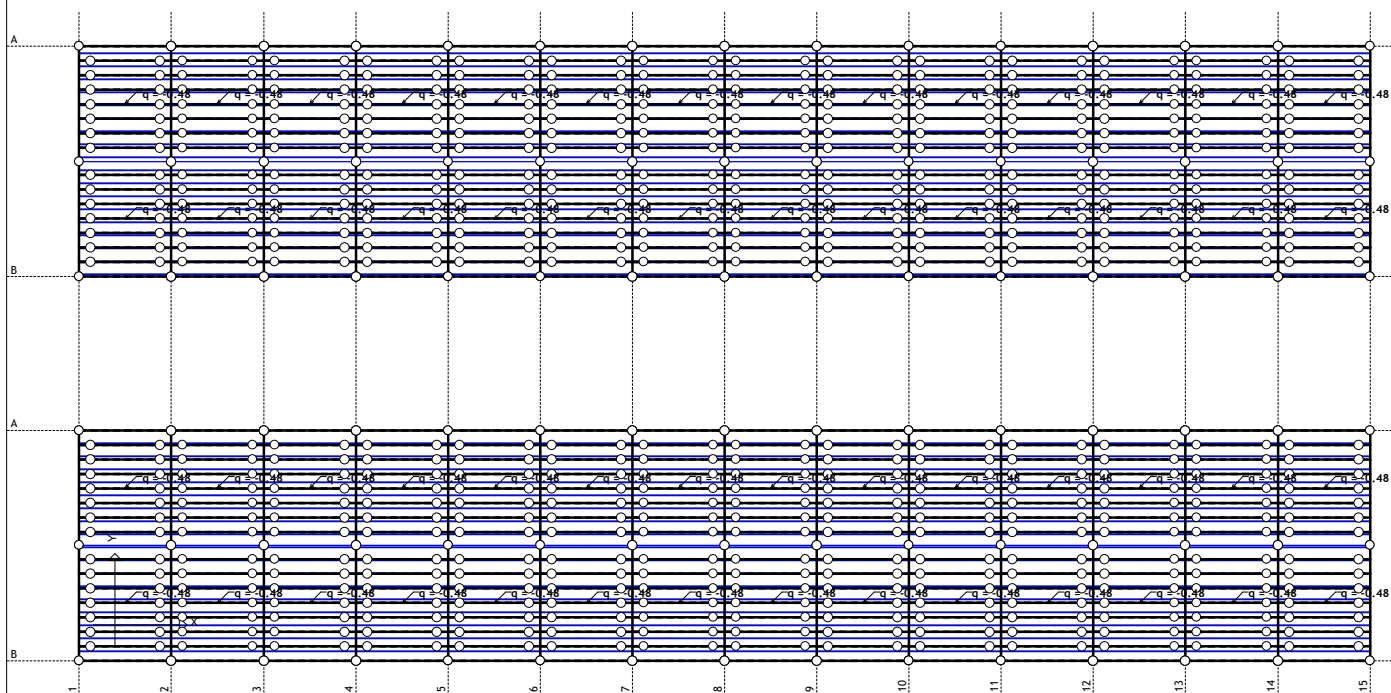
Input data - Load

Load 2: sn



Isometric

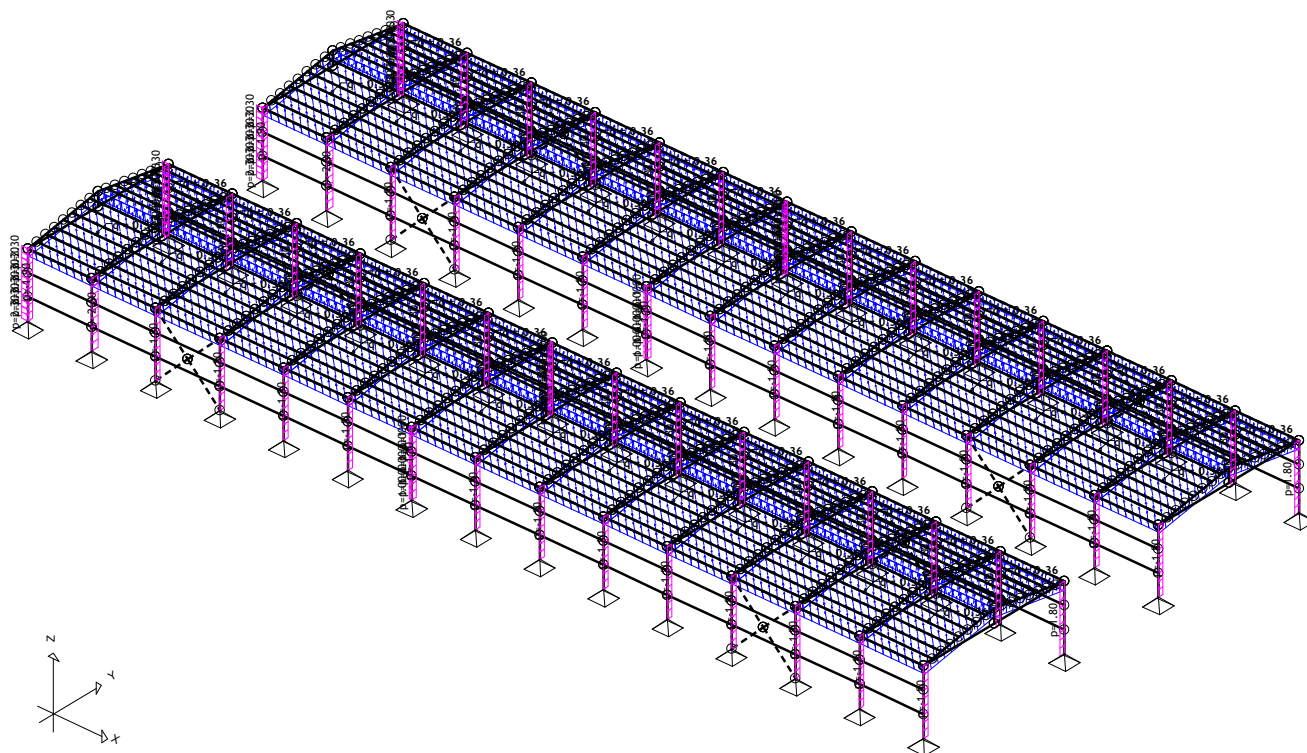
Load 2: sn



View: Strecha

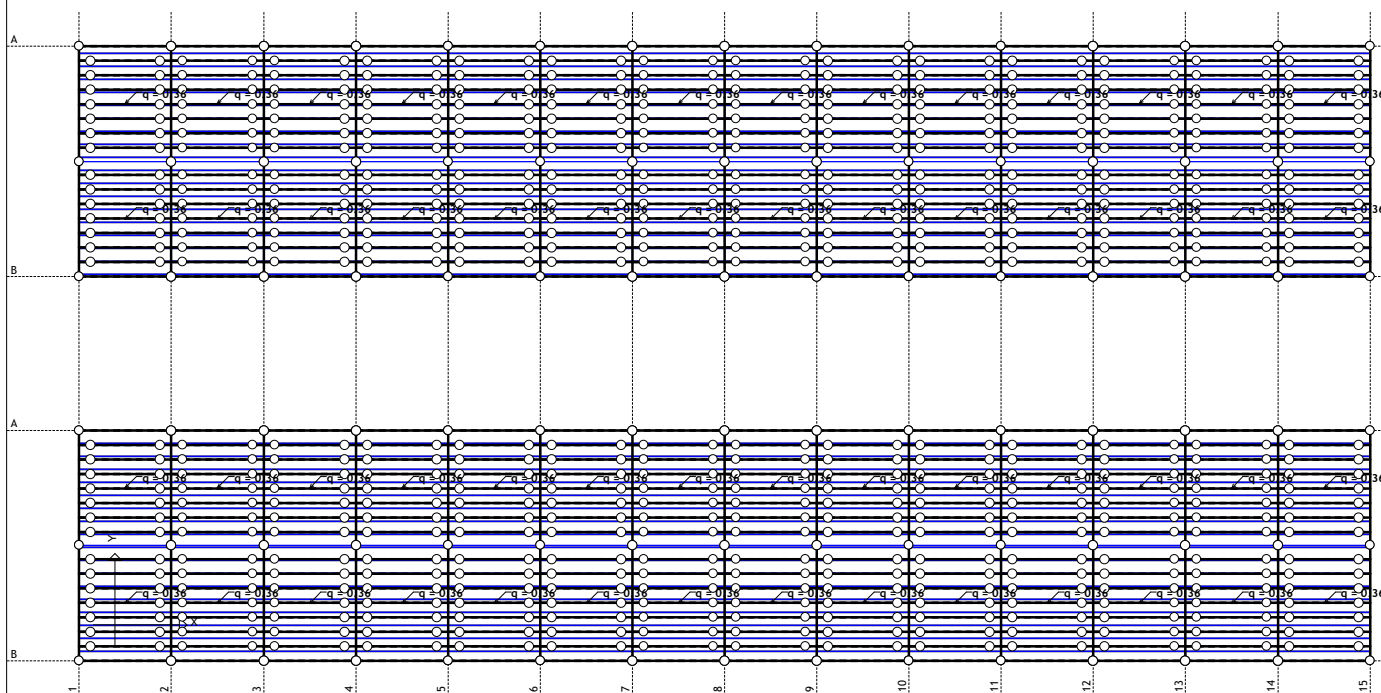
Input data - Load

Load 3: w.x



Isometric

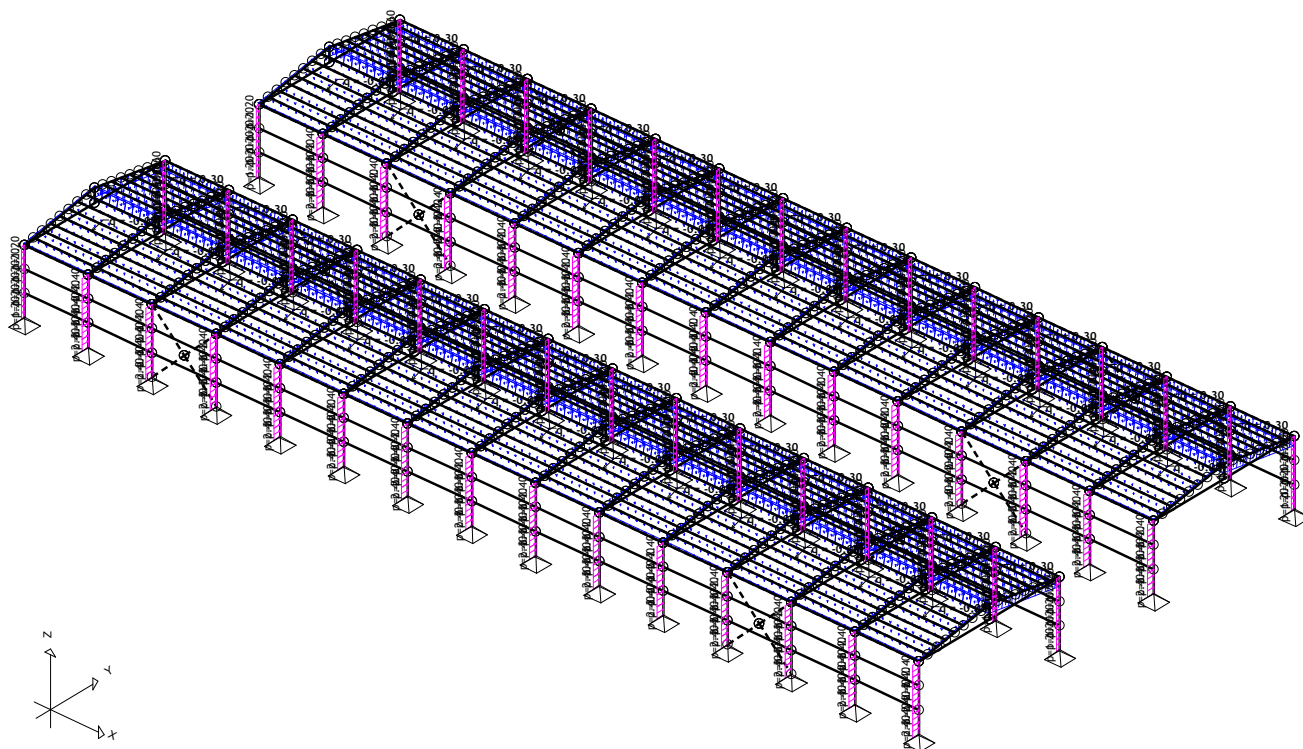
Load 3: w.x



View: Strecha

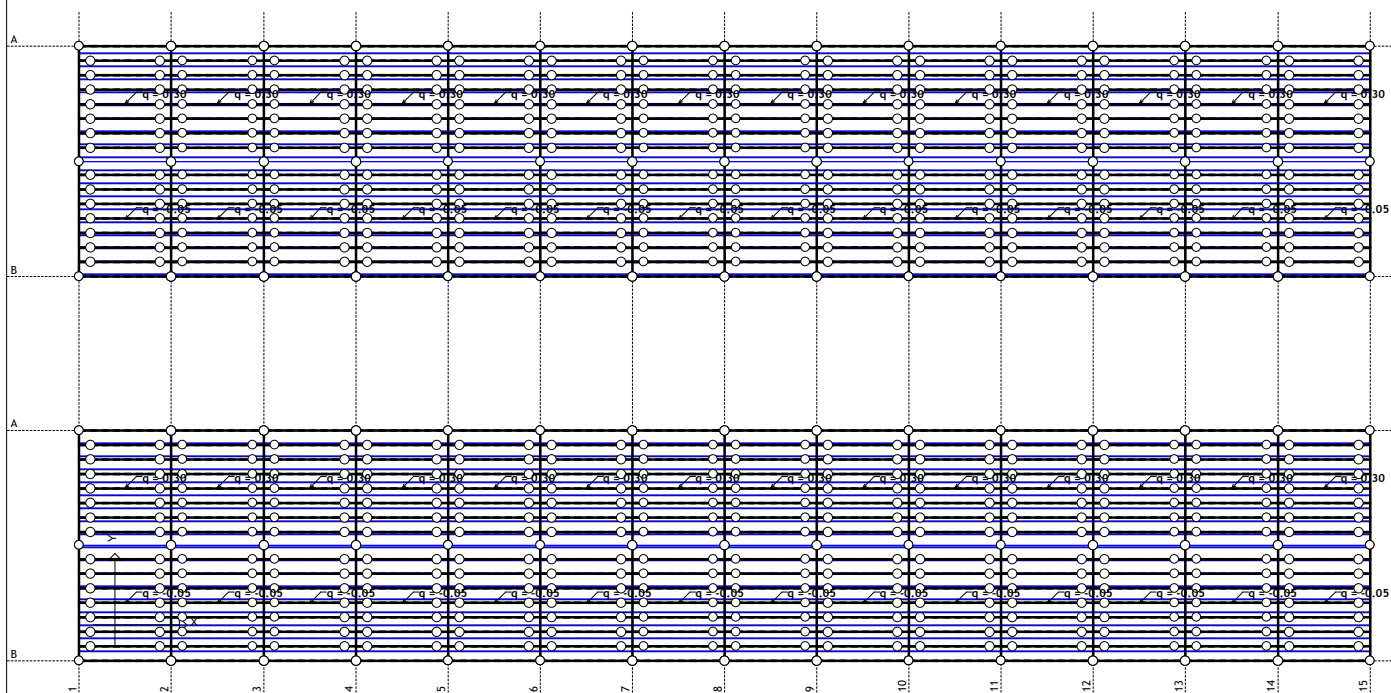
Input data - Load

Load 4: w.y



Isometric

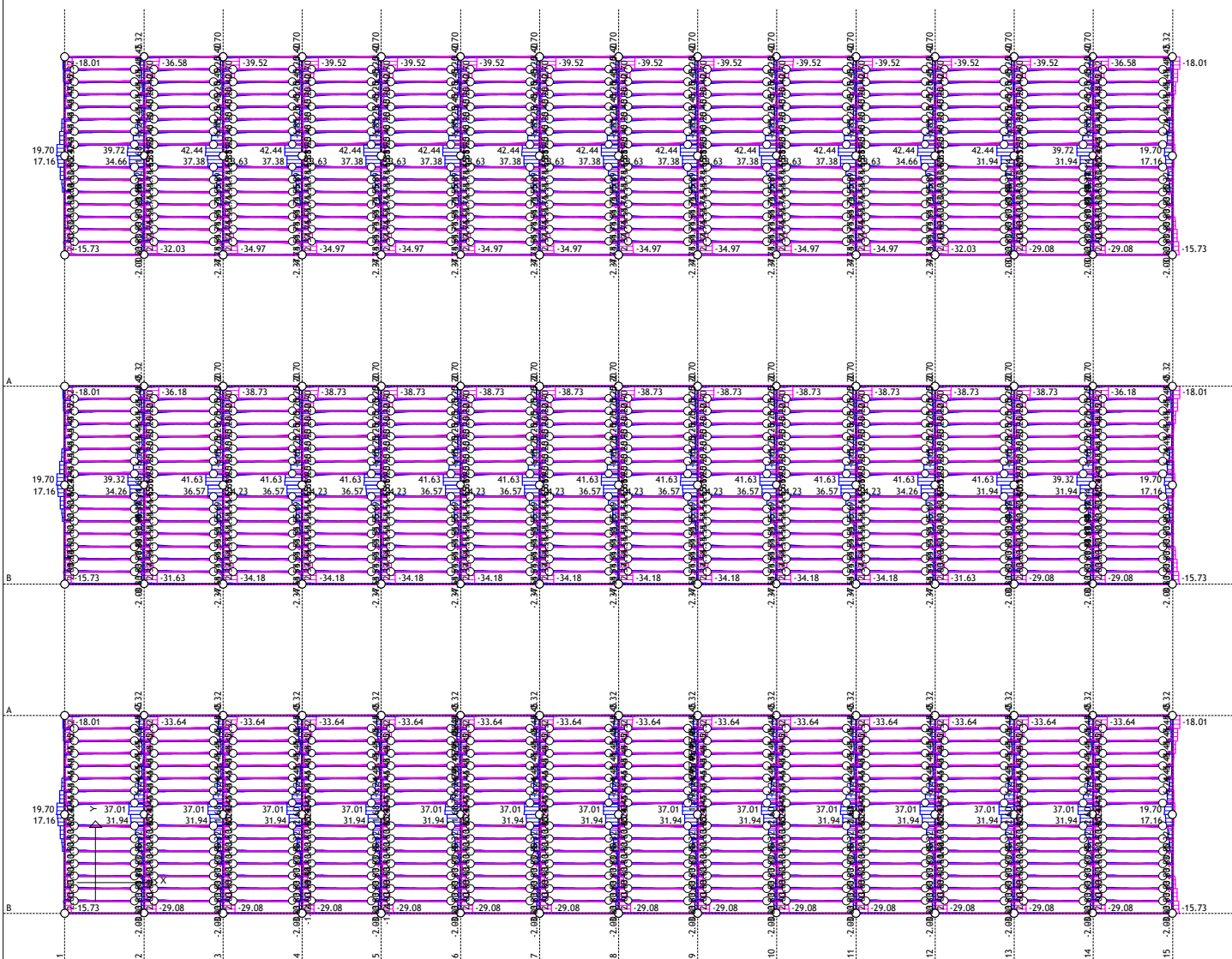
Load 4: w.y



View: Strecha

Strecha

Load 86: [ULS] 5-71

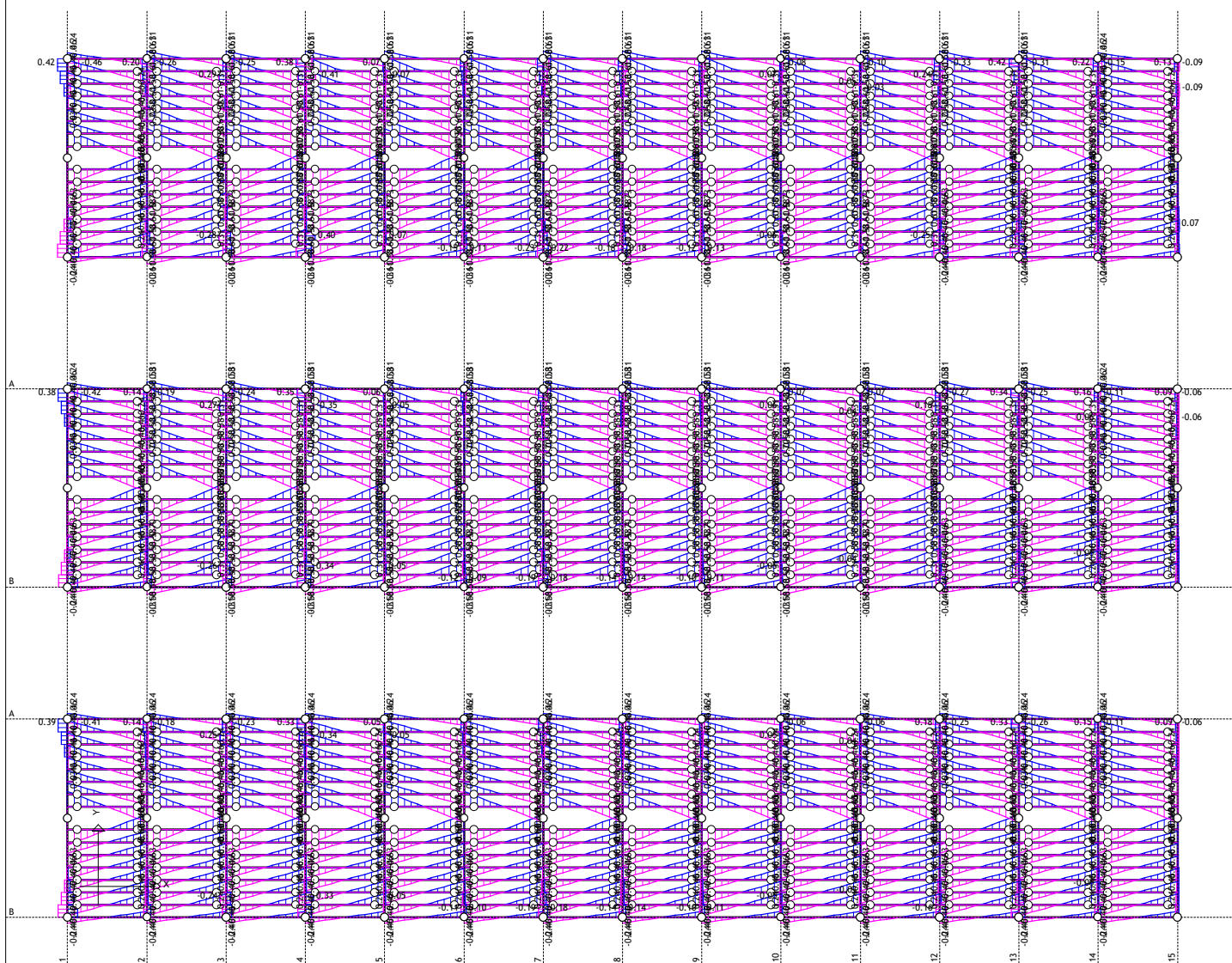


View: Strecha - cela

Beam Results: max V2= 42.44 / min V2= -39.52 kN

Strecha

Load 86: [ULS] 5-71

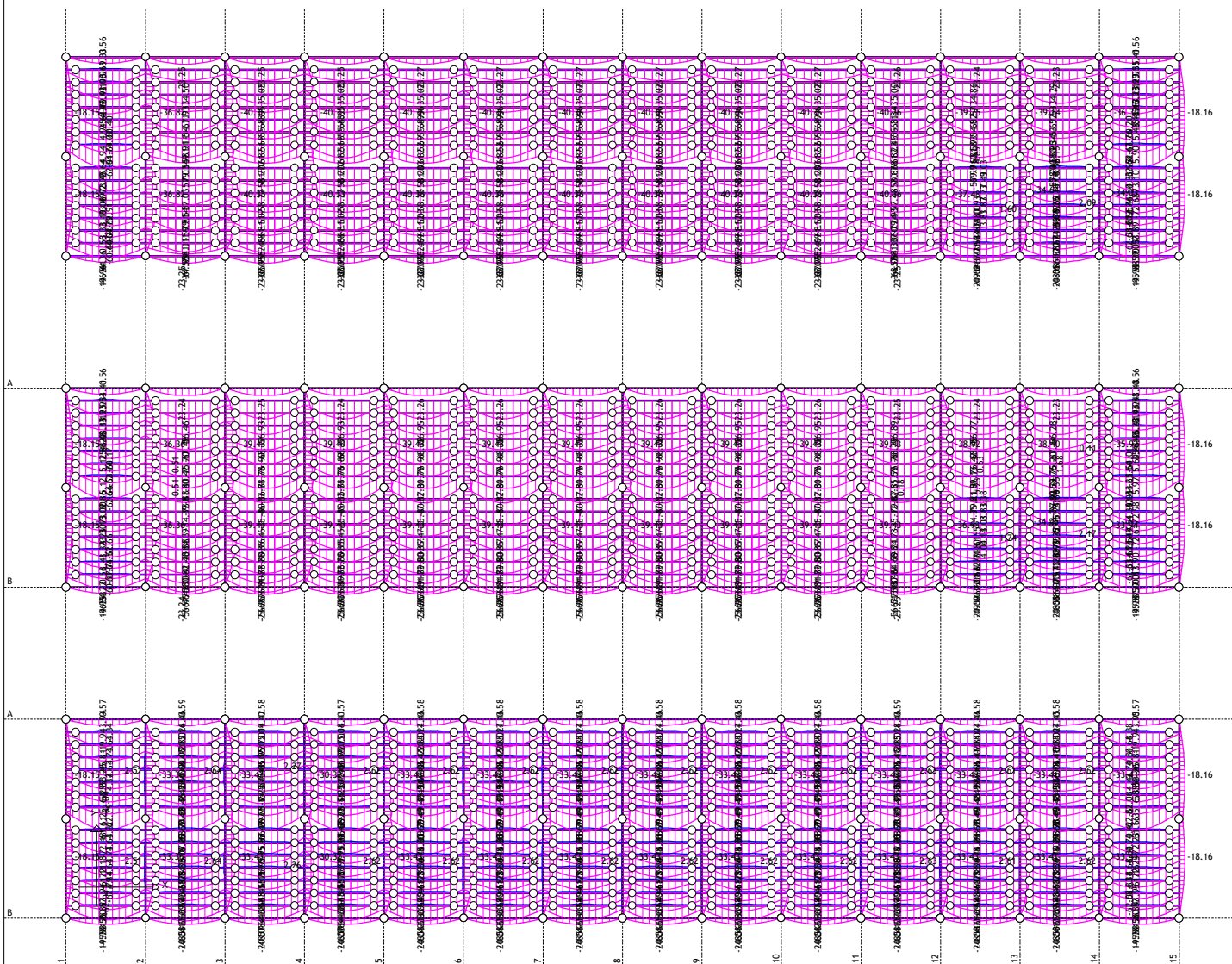


View: Strecha - cela

Beam Results: max V3= 0.73 / min V3= -0.73 kN

Strecha

Load 88: [SLS] 72-85

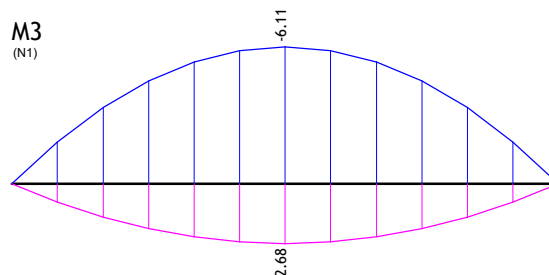
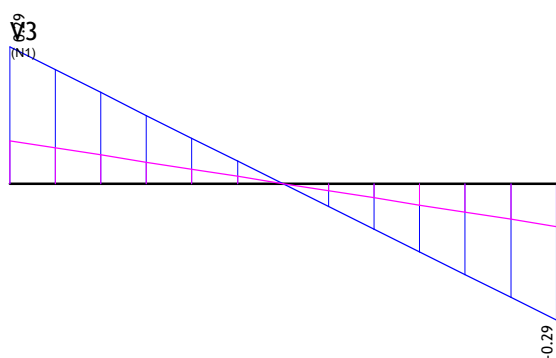
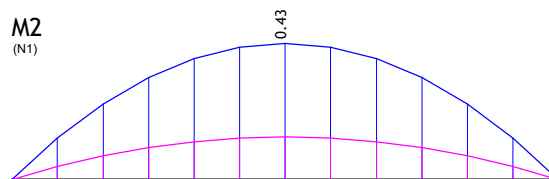
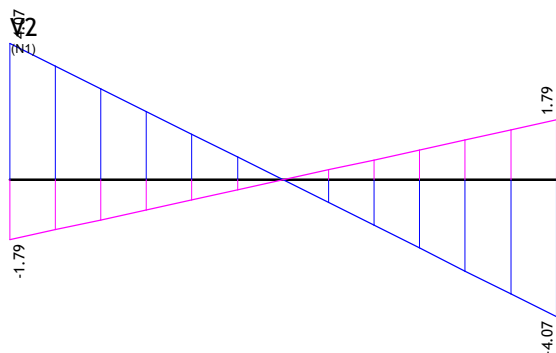


View: Strecha - cela

Beam Results: max Zd= 7.50 / min Zd= -85.47 m / 1000

Strecha

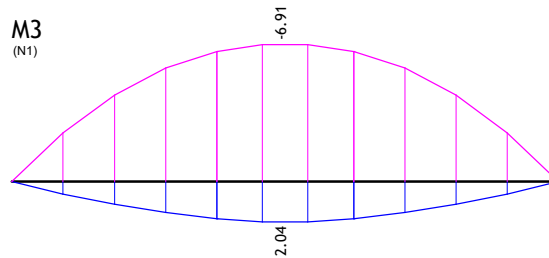
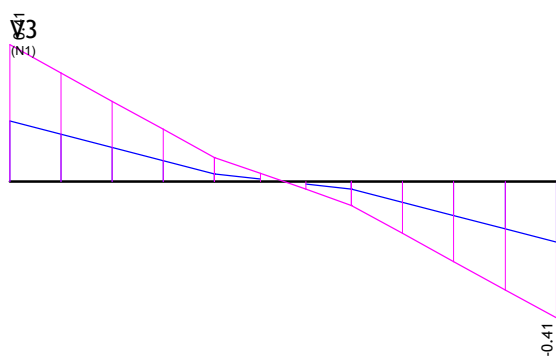
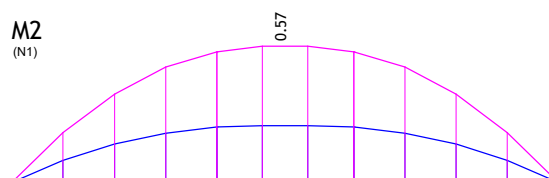
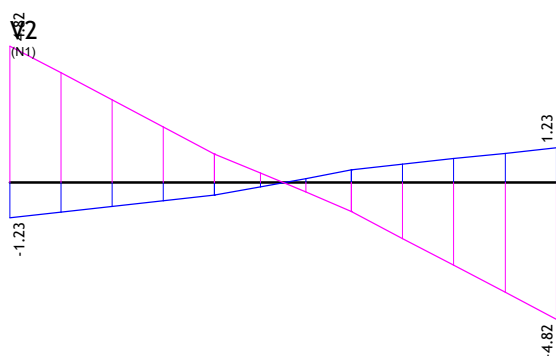
Load 86: [ULS] 5-71



Beam Results: (679-770)

V2 [kN], V3 [kN], M2 [kNm], M3 [kNm]

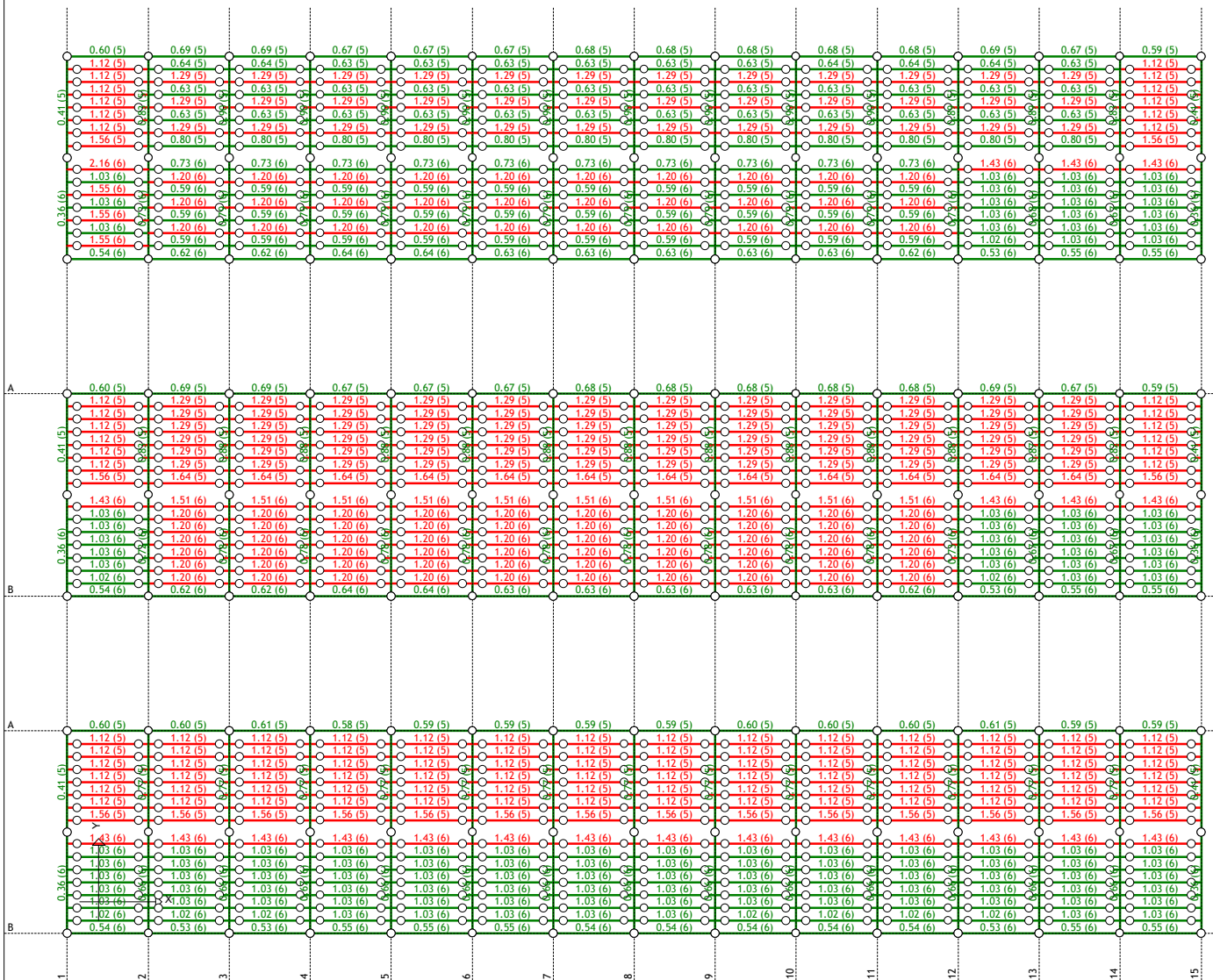
Load 86: [ULS] 5-71



Beam Results: (1011-1076)

V2 [kN], V3 [kN], M2 [kNm], M3 [kNm]

Strecha



View: Strecha - cela
Stress control

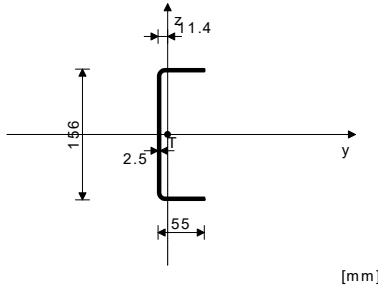
Strecha

Posúdenie existujúcej strešnej väznice bez FVE

BEAM 564-473

CROSS-SECTION: [150x55x2.5 [S 355] [Set: 10]
EUROCODE 3 (EN 1993-1-1:2005)

CROSS-SECTION PROPERTIES



Ax =	6.369 cm ²
Ay =	2.750 cm ²
Az =	3.900 cm ²
Ix =	0.135 cm ⁴
Iy =	224.13 cm ⁴
Iz =	17.658 cm ⁴
Wy =	28.735 cm ³
Wz =	4.050 cm ³
Wy,pl =	35.357 cm ³
Wz,pl =	7.091 cm ³
γM0 =	1.000
γM1 =	1.000
γM2 =	1.250
Anet/A =	1.000

(fy = 35.5 kN/cm², fu = 49.0 kN/cm²)

UTILISATION FACTORS FOR ALL LOAD CASE COMBINATIONS

5. γ=1.61	17. γ=1.54	9. γ=1.40
11. γ=1.37	37. γ=1.34	21. γ=1.32
23. γ=1.29	38. γ=1.28	53. γ=1.27
54. γ=1.22	41. γ=1.17	57. γ=1.09
42. γ=1.09	6. γ=1.07	65. γ=1.04
58. γ=1.01	18. γ=1.00	70. γ=0.96
29. γ=0.96	31. γ=0.93	10. γ=0.92
72. γ=0.92	45. γ=0.88	73. γ=0.88
39. γ=0.87	22. γ=0.85	47. γ=0.85
7. γ=0.81	76. γ=0.80	55. γ=0.79
61. γ=0.75	19. γ=0.75	77. γ=0.75
84. γ=0.71	40. γ=0.70	62. γ=0.68
66. γ=0.67	56. γ=0.65	13. γ=0.60
74. γ=0.60	8. γ=0.60	67. γ=0.59
12. γ=0.58	25. γ=0.55	20. γ=0.54
30. γ=0.53	80. γ=0.52	24. γ=0.51
75. γ=0.48	81. γ=0.47	52. γ=0.45
46. γ=0.45	36. γ=0.43	50. γ=0.42
15. γ=0.42	34. γ=0.41	43. γ=0.37
16. γ=0.37	28. γ=0.36	27. γ=0.36
14. γ=0.36	26. γ=0.35	44. γ=0.32
33. γ=0.32	59. γ=0.30	69. γ=0.28
71. γ=0.28	68. γ=0.27	78. γ=0.27
60. γ=0.27	49. γ=0.26	63. γ=0.24
64. γ=0.23	79. γ=0.23	85. γ=0.21
32. γ=0.20	83. γ=0.16	82. γ=0.16
35. γ=0.13	48. γ=0.13	51. γ=0.12

MEMBER SUBJECT TO AXIAL COMPRESSION AND BENDING (load 5, at 300.0 cm from the start of the member)

The axial force design value	N _{Ed} =	-0.054 kN
The bending mom.design value(y-y)	M _{Ed,y} =	-6.675 kNm
The bending mom.design value(z-z)	M _{Ed,z} =	-0.685 kNm
System length	L =	600.00 cm

5.5 CLASSIFICATION OF CROSS-SECTIONS

Class 4 cross-sections
bottom flange 55.0mm X 2.5mm [81.7%] 18.3%

6.2 RESISTANCE OF CROSS-SECTIONS

6.2.4 Compression

Effective area of cross section	A _{eff} =	6.274 cm ²
The design compression resistance	N _{c,Rd} =	222.73 kN

Requirement 6.9: N_{Ed} ≤ N_{c,Rd} (0.05 ≤ 222.73)

6.2.5 Bending about the y-y axis

Effective section modulus	W _{y,eff} =	27.153 cm ³
The design moment resistance	M _{c,Rd} =	9.639 kNm

Requirement 6.12: M_{Ed,y} ≤ M_{c,Rd,y} (6.68 ≤ 9.64)

6.2.5 Bending about the z-z axis

Effective section modulus	W _{z,eff} =	3.359 cm ³
The design moment resistance	M _{c,Rd} =	1.192 kNm

Requirement 6.12: M_{Ed,z} ≤ M_{c,Rd,z} (0.68 ≤ 1.19)

6.2.9 Bending and axial force

Requirement 6.43: (1.27 ≤ 1)

The criteria is not satisfied.

6.3 BUCKLING RESISTANCE OF MEMBERS

6.3.1.1 Buckling resistance

Buckling length y-y	I _y =	600.00 cm
Relative slenderness y-y	λ _y =	1.314
Buckling curve for axis y-y: C	α =	0.490
Elastic critical force	N _{cr,y} =	129.04 kN
The reduction factor	χ _y =	0.383

The design buckling resistance

Requirement 6.46: N_{Ed} ≤ N_{b,Rd,y} (0.05 ≤ 85.32)

N_{b,Rd,y} = 85.315 kN

Buckling length z-z

I_z = 198.00 cm

Relative slenderness z-z

λ_z = 1.545

Buckling curve for axis z-z: C

α = 0.490

The reduction factor

χ_z = 0.301

The design buckling resistance

N_{b,Rd,z} = 66.931 kN

Requirement 6.46: N_{Ed} ≤ N_{b,Rd,z} (0.05 ≤ 66.93)

6.3.2.1 Buckling resistance

Coefficient

C1 = 0.972

Coefficient

C2 = 0.304

Coefficient

C3 = 0.980

The eff.length fact.for later.restr.

k = 0.330

The eff.length fact.for tors.restr.

kw = 1.000

Coordinate

zg = 0.000 cm

Coordinate

zj = 0.000 cm

Length between lateral restr.points

L = 200.00 cm

The warping constant

Iw = 797.28 cm⁶

The elast.crit.mom.(lt buck.)

Mcr = 20.352 kNm

Appropriate section modulus

Wy = 27.153 cm³

The imperfection factor

αLT = 0.760

The non-dimensional slenderness

λLT = 0.688

The reduction factor (6.3.2.2.)

χLT = 0.651

The design buckling resistance

Mb,Rd = 6.274 kNm

Requirement 6.54: M_{Ed,y} ≤ Mb,Rd (6.68 ≤ 6.27)

The criteria is not satisfied.

6.3.3 Uniform members in bending and axial compression

Values of interaction factors obtained from Annex B

(alternative method 2)

The equiv.unif.mom.fact.flex.buck.

Cmy = 0.950

The equiv.unif.mom.fact.flex.buck.

Cmz = 0.950

The equiv.unif.mom.fact.flex.buck.

CmLT = 0.950

Interaction factors

kyy = 0.950

Interaction factors

kyy = 0.950

Interaction factors

kzy = 1.000

Interaction factors

kzz = 0.950

The reduction factor

χy = 0.383

N_{Ed} / (χy N_{Rk} / γM1)

0.001

kyy * (M_{yEd} + ΔM_{yEd}) / ...

1.011

kzy * (M_{zEd} + ΔM_{zEd}) / ...

0.546

Requirement 6.61: (1.56 ≤ 1)

The criteria is not satisfied.

The reduction factor

χz = 0.301

N_{Ed} / (χz N_{Rk} / γM1)

0.001

kzy * (M_{yEd} + ΔM_{yEd}) / ...

1.064

kzz * (M_{zEd} + ΔM_{zEd}) / ...

0.546

Requirement 6.62: (1.61 ≤ 1)

The criteria is not satisfied.

Check of the shear resistance

(load 5, at the beginning of the member)

The axial force design value	N _{Ed} =	-0.054 kN
The shear force design value(y-y)	V _{Ed,y} =	0.457 kN
The shear force design value(z-z)	V _{Ed,z} =	4.450 kN
System length	L =	600.00 cm

6.2 RESISTANCE OF CROSS-SECTIONS

6.2.6 Shear

Design shear resistance	V _{pl,Rd,z} =	79.934 kN
Design shear resistance	V _{c,Rd,z} =	79.934 kN

Requirement 6.17: V_{Ed,z} ≤ V_{c,Rd,z} (4.45 ≤ 79.93)

Design shear resistance

V_{pl,Rd,y} = 56.364 kN

Design shear resistance

V_{c,Rd,y} = 56.364 kN

Requirement 6.17: V_{Ed,y} ≤ V_{c,Rd,y} (0.46 ≤ 56.36)

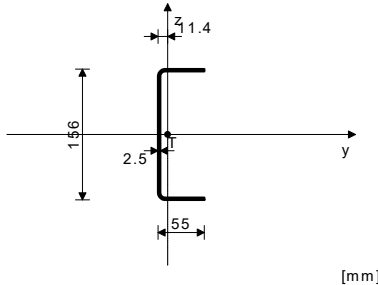
Strecha

Posúdenie existujúcej strešnej väznice s FVE

BEAM 1006-927

CROSS-SECTION: [150x55x2.5 [S 355] [Set: 10]
EUROCODE 3 (EN 1993-1-1:2005)

CROSS-SECTION PROPERTIES



Ax =	6.369 cm ²
Ay =	2.750 cm ²
Az =	3.900 cm ²
Ix =	0.135 cm ⁴
Iy =	224.13 cm ⁴
Iz =	17.658 cm ⁴
Wy =	28.735 cm ³
Wz =	4.050 cm ³
Wy,pl =	35.357 cm ³
Wz,pl =	7.091 cm ³
γM0 =	1.000
γM1 =	1.000
γM2 =	1.250
Anet/A =	1.000

(fy = 35.5 kN/cm², fu = 49.0 kN/cm²)

UTILISATION FACTORS FOR ALL LOAD CASE COMBINATIONS

5. γ=1.81	17. γ=1.69	9. γ=1.62
11. γ=1.59	37. γ=1.54	21. γ=1.48
38. γ=1.48	23. γ=1.45	53. γ=1.42
41. γ=1.38	42. γ=1.36	42. γ=1.30
6. γ=1.27	57. γ=1.25	65. γ=1.24
29. γ=1.20	31. γ=1.17	58. γ=1.17
18. γ=1.15	10. γ=1.12	70. γ=1.11
39. γ=1.07	72. γ=1.06	45. γ=1.06
47. γ=1.03	73. γ=1.02	22. γ=1.00
61. γ=0.98	7. γ=0.97	76. γ=0.96
55. γ=0.94	62. γ=0.91	77. γ=0.90
19. γ=0.87	40. γ=0.87	84. γ=0.86
66. γ=0.84	12. γ=0.79	67. γ=0.77
56. γ=0.77	8. γ=0.76	13. γ=0.75
74. γ=0.75	30. γ=0.75	80. γ=0.69
20. γ=0.66	25. γ=0.66	24. γ=0.66
81. γ=0.64	46. γ=0.62	75. γ=0.61
15. γ=0.59	43. γ=0.58	71. γ=0.49
27. γ=0.49	44. γ=0.48	33. γ=0.48
59. γ=0.46	78. γ=0.42	32. γ=0.41
14. γ=0.40	16. γ=0.39	52. γ=0.39
60. γ=0.38	49. γ=0.38	28. γ=0.38
26. γ=0.36	50. γ=0.36	85. γ=0.36
36. γ=0.35	79. γ=0.35	34. γ=0.34
35. γ=0.29	48. γ=0.28	64. γ=0.25
69. γ=0.24	68. γ=0.22	63. γ=0.22
51. γ=0.19	82. γ=0.17	83. γ=0.17

MEMBER SUBJECT TO AXIAL COMPRESSION AND BENDING (load 5, at 289.3 cm from the start of the member)

The axial force design value	N _{Ed} =	-0.037 kN
The shear force design value(y-y)	V _{Ed,y} =	0.016 kN
The shear force design value(z-z)	V _{Ed,z} =	0.159 kN
The bending mom.design value(y-y)	M _{Ed,y} =	-7.470 kNm
The bending mom.design value(z-z)	M _{Ed,z} =	-0.820 kNm
System length	L =	600.00 cm

5.5 CLASSIFICATION OF CROSS-SECTIONS

Class 4 cross-sections
bottom flange 55.0mm X 2.5mm [84.2%] 15.8%

6.2 RESISTANCE OF CROSS-SECTIONS

6.2.4 Compression

Effective area of cross section

A_{eff} = 6.307 cm²

The design compression resistance

N_{c,Rd} = 223.91 kN

Requirement 6.9: N_{Ed} ≤ N_{c,Rd} (0.04 ≤ 223.91)

6.2.5 Bending about the y-y axis

Effective section modulus

W_{y,eff} = 27.557 cm³

The design moment resistance

M_{c,Rd} = 9.783 kNm

Requirement 6.12: M_{Ed,y} ≤ M_{c,Rd,y} (7.47 ≤ 9.78)

6.2.5 Bending about the z-z axis

Effective section modulus

W_{z,eff} = 3.466 cm³

The design moment resistance

M_{c,Rd} = 1.230 kNm

Requirement 6.12: M_{Ed,z} ≤ M_{c,Rd,z} (0.82 ≤ 1.23)

6.2.6 Shear

Design shear resistance

V_{pl,Rd,z} = 79.934 kN

Design shear resistance

V_{c,Rd,z} = 79.934 kN

Requirement 6.17: V_{Ed,z} ≤ V_{c,Rd,z} (0.16 ≤ 79.93)

Design shear resistance

V_{pl,Rd,y} = 56.364 kN

Design shear resistance

V_{c,Rd,y} = 56.364 kN

Requirement 6.17: V_{Ed,y} ≤ V_{c,Rd,y} (0.02 ≤ 56.36)

6.2.10 Bending, shear and axial force

No reduction need be made in the resistance moment

Requirement: V_{Ed,z} ≤ 50%V_{pl,Rd,z}; V_{Ed,y} ≤ 50%V_{pl,Rd,y}

6.2.9 Bending and axial force

Requirement 6.43: (1.43 ≤ 1)

The criteria is not satisfied.

6.3 BUCKLING RESISTANCE OF MEMBERS

6.3.1.1 Buckling resistance

Buckling length y-y

l_y = 600.00 cm

Relative slenderness y-y

λ_y = 1.317

Buckling curve for axis y-y: C

α = 0.490

Elastic critical force

N_{cr,y} = 129.04 kN

The reduction factor

χ_y = 0.382

The design buckling resistance

N_{b,Rd,y} = 85.445 kN

Requirement 6.46: N_{Ed} ≤ N_{b,Rd,y} (0.04 ≤ 85.45)

Buckling length z-z

l_z = 198.00 cm

Relative slenderness z-z

λ_z = 1.549

Buckling curve for axis z-z: C

α = 0.490

The reduction factor

χ_z = 0.299

The design buckling resistance

N_{b,Rd,z} = 67.007 kN

Requirement 6.46: N_{Ed} ≤ N_{b,Rd,z} (0.04 ≤ 67.01)

6.3.2.1 Buckling resistance

Coefficient

C1 = 0.972

Coefficient

C2 = 0.304

Coefficient

C3 = 0.980

The eff.length fact.for later.restr.

k = 0.330

The eff.length fact.for tors.restr.

kw = 1.000

Coordinate

zg = 0.000 cm

Coordinate

zj = 0.000 cm

Length between lateral restr.points

L = 200.00 cm

The warping constant

Iw = 797.28 cm⁶

The elast.crit.mom.(I-t buck.)

M_{cr} = 20.352 kNm

Appropriate section modulus

W_y = 27.557 cm³

The imperfection factor

αLT = 0.760

The non-dimensional slenderness

λLT = 0.693

The reduction factor (6.3.2.2.)

χLT = 0.648

The design buckling resistance

M_{b,Rd} = 6.335 kNm

Requirement 6.54: M_{Ed,y} ≤ M_{b,Rd} (7.47 ≤ 6.33)

The criteria is not satisfied.

6.3.3 Uniform members in bending and axial compression

Values of interaction factors obtained from Annex B

(alternative method 2)

The equiv.unif.mom.fact.flex.buck.

C_{my} = 0.950

The equiv.unif.mom.fact.flex.buck.

C_{mz} = 0.950

The equiv.unif.mom.fact.flex.buck.

C_{mLT} = 0.950

Interaction factors

k_{yy} = 0.950

Interaction factors

k_{yz} = 0.950

Interaction factors

k_{zy} = 1.000

Interaction factors

k_{zz} = 0.950

The reduction factor

χ_y = 0.382

N_{Ed} / (χ_y N_{Rk} / γM1)

0.000

k_{yy} * (M_{yEd} + ΔM_{yEd}) / ...

1.121

k_{yz} * (M_{zEd} + ΔM_{zEd}) / ...

0.634

Requirement 6.61: (1.75 ≤ 1)

The criteria is not satisfied.

The reduction factor

χ_z = 0.299

N_{Ed} / (χ_z N_{Rk} / γM1)

0.001

k_{zy} * (M_{yEd} + ΔM_{yEd}) / ...

1.179

k_{zz} * (M_{zEd} + ΔM_{zEd}) / ...

0.634

Requirement 6.62: (1.81 ≤ 1)

The criteria is not satisfied.

Check of the shear resistance

(load 5, at the beginning of the member)

The axial force design value	N _{Ed} =	-0.037 kN
The shear force design value(y-y)	V _{Ed,y} =	0.581 kN
The shear force design value(z-z)	V _{Ed,z} =	5.198 kN
System length	L =	600.00 cm

6.2 RESISTANCE OF CROSS-SECTIONS

6.2.6 Shear

Design shear resistance

V_{pl,Rd,z} = 79.934 kN

Design shear resistance

V_{c,Rd,z} = 79.934 kN

Requirement 6.17: V_{Ed,z} ≤ V_{c,Rd,z} (5.20 ≤ 79.93)

Design shear resistance

V_{pl,Rd,y} = 56.364 kN

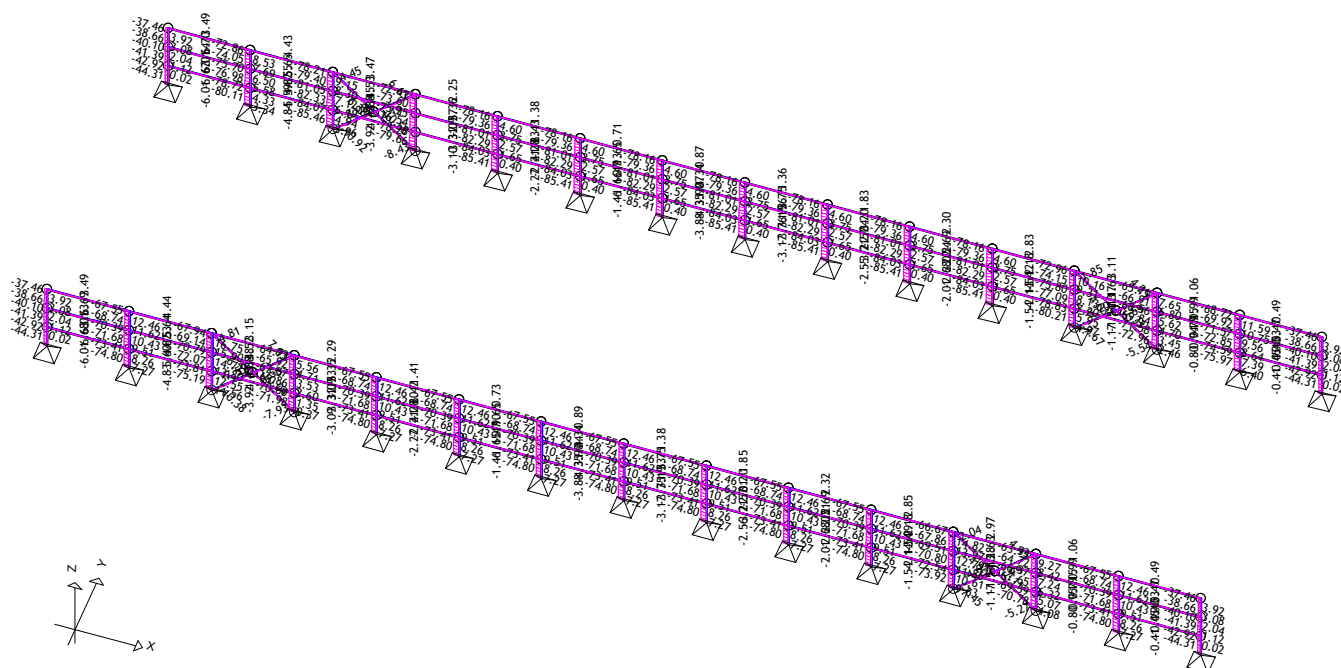
Design shear resistance

V_{c,Rd,y} = 56.364 kN

Requirement 6.17: V_{Ed,y} ≤ V_{c,Rd,y} (0.58 ≤ 56.36)

Rám H1

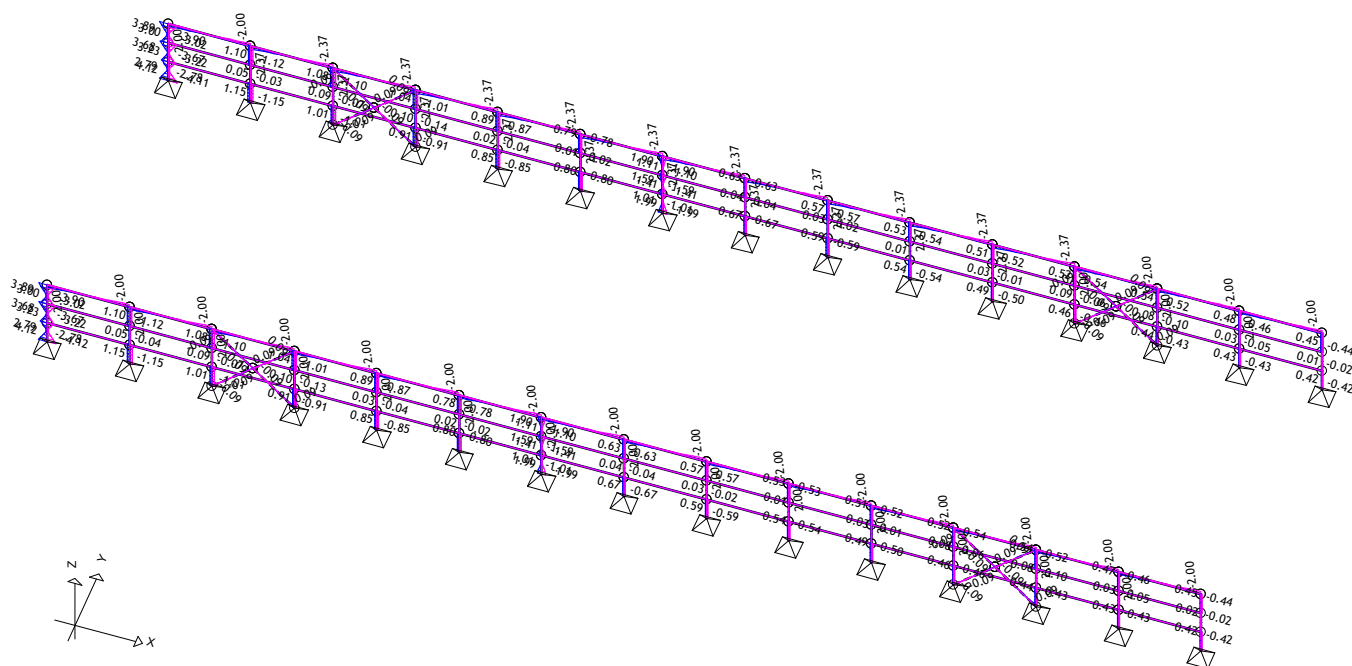
Load 86: [ULS] 5-71



Group: H1

Beam Results: max N1= 16.75 / min N1= -85.46 kN

Load 86: [ULS] 5-71

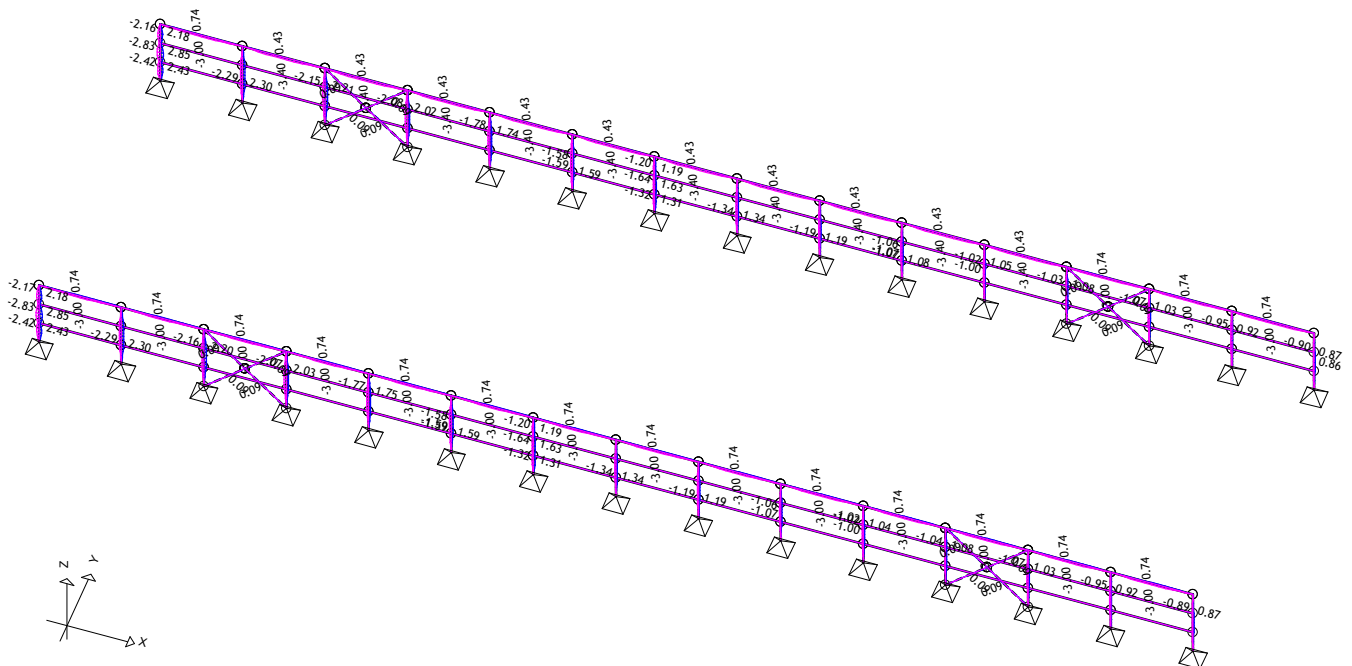


Group: H1

Beam Results: max V2= 4.12 / min V2= -4.12 kN

Rám H1

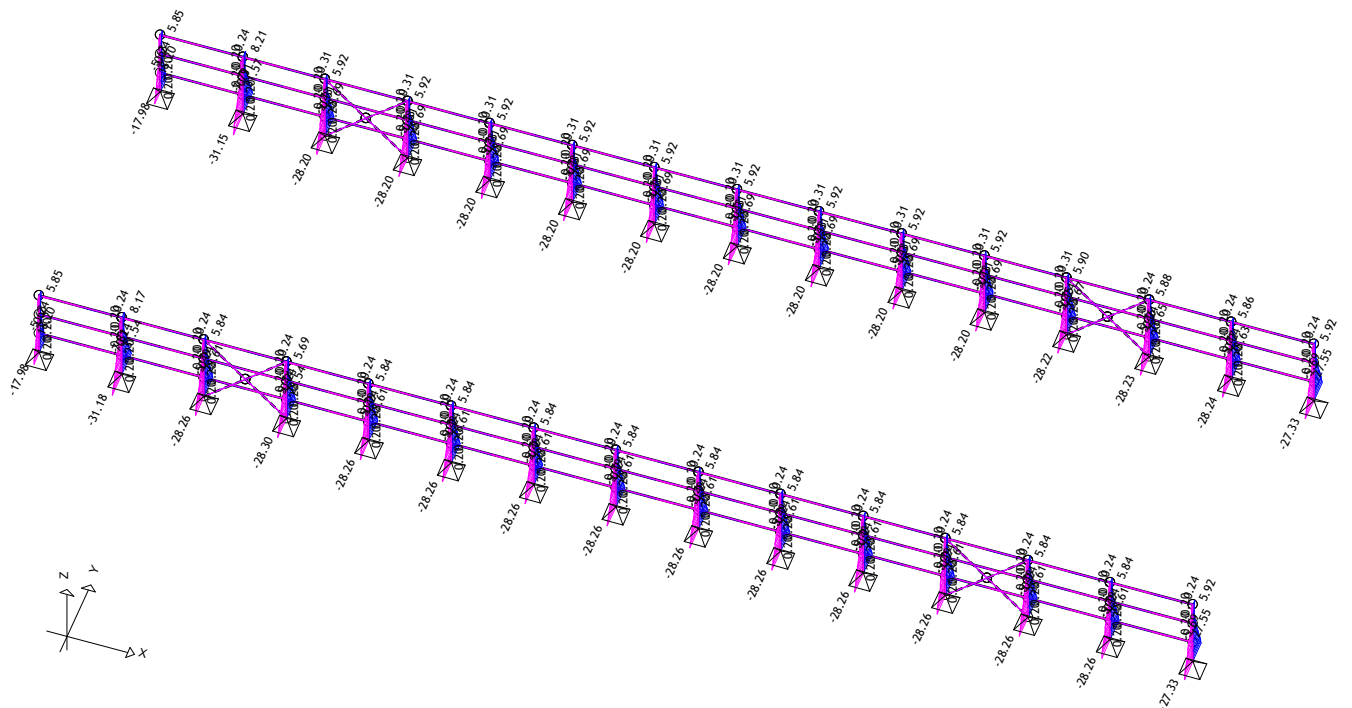
Load 86: [ULS] 5-71



Group: H1

Beam Results: max M3= 2.85 / min M3= -3.40 kNm

Load 86: [ULS] 5-71

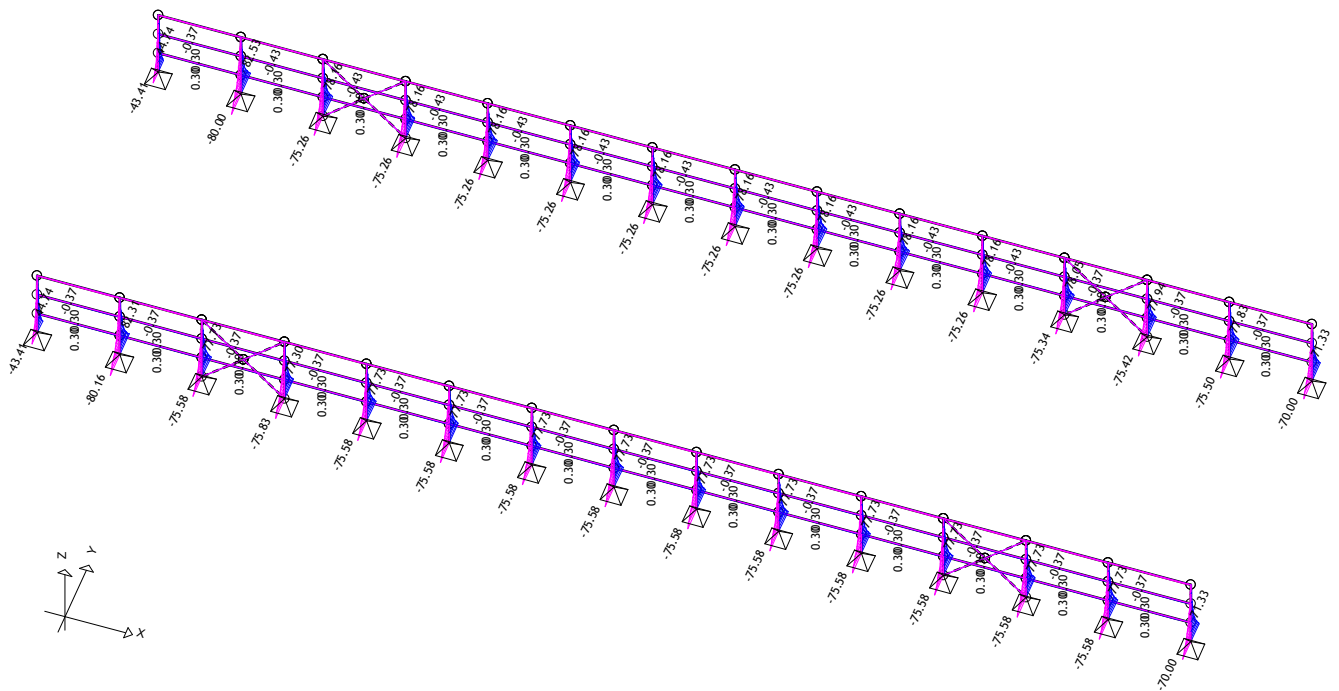


Group: H1

Beam Results: max V3= 31.57 / min V3= -31.18 kN

Rám H1

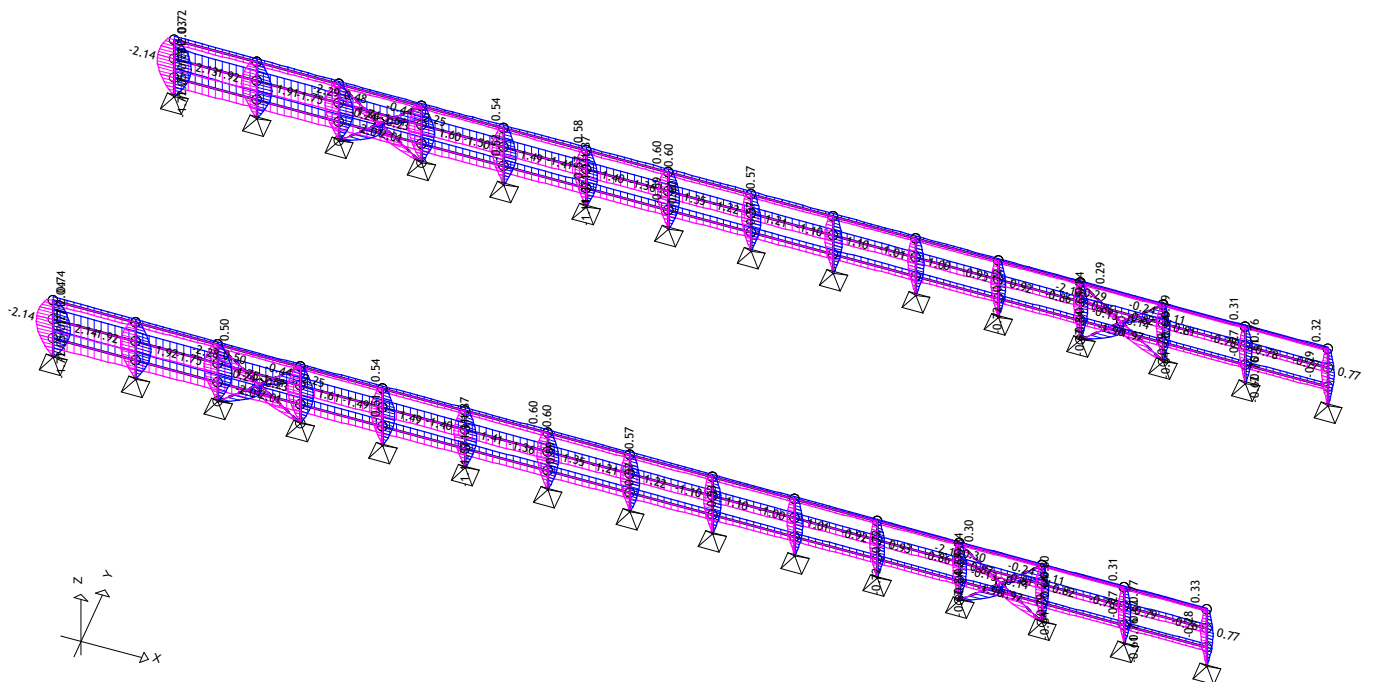
Load 86: [ULS] 5-71



Group: H1

Beam Results: max M2= 82.53 / min M2= -80.16 kNm

Load 87: [ULS_fasada] 76-79

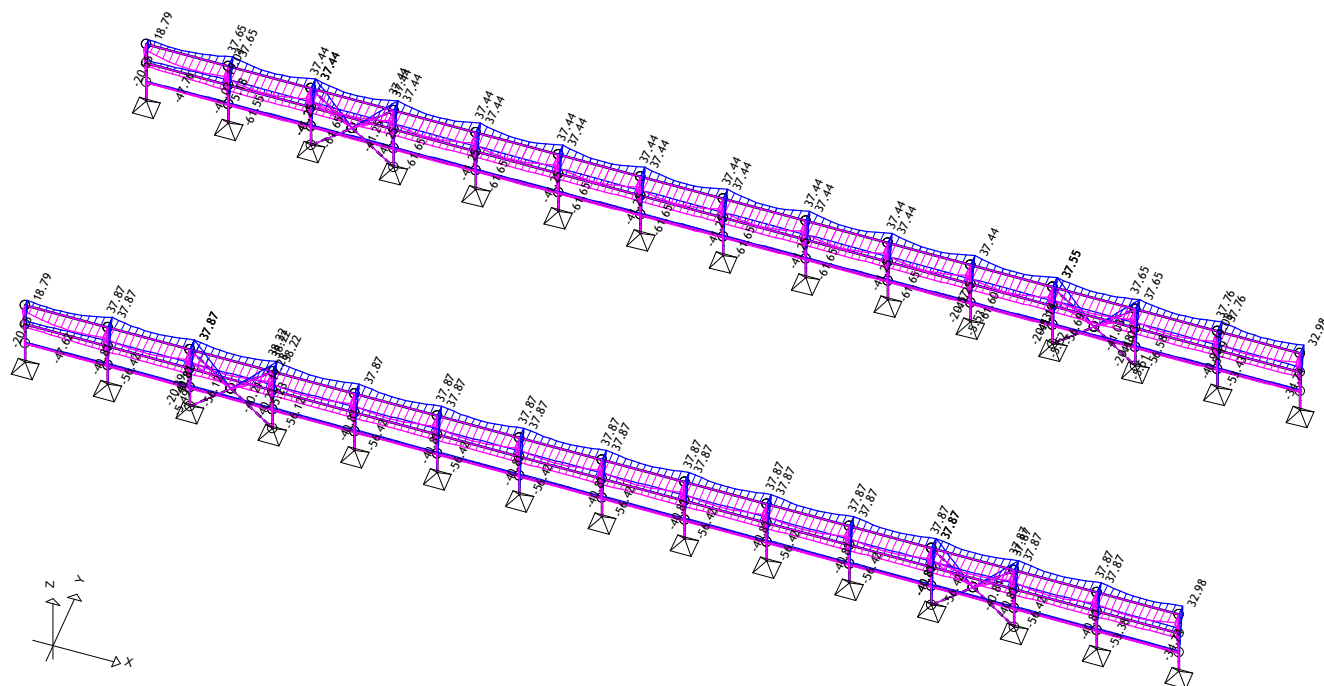


Group: H1

Beam Results: max Xd= 2.25 / min Xd= -2.29 m / 1000

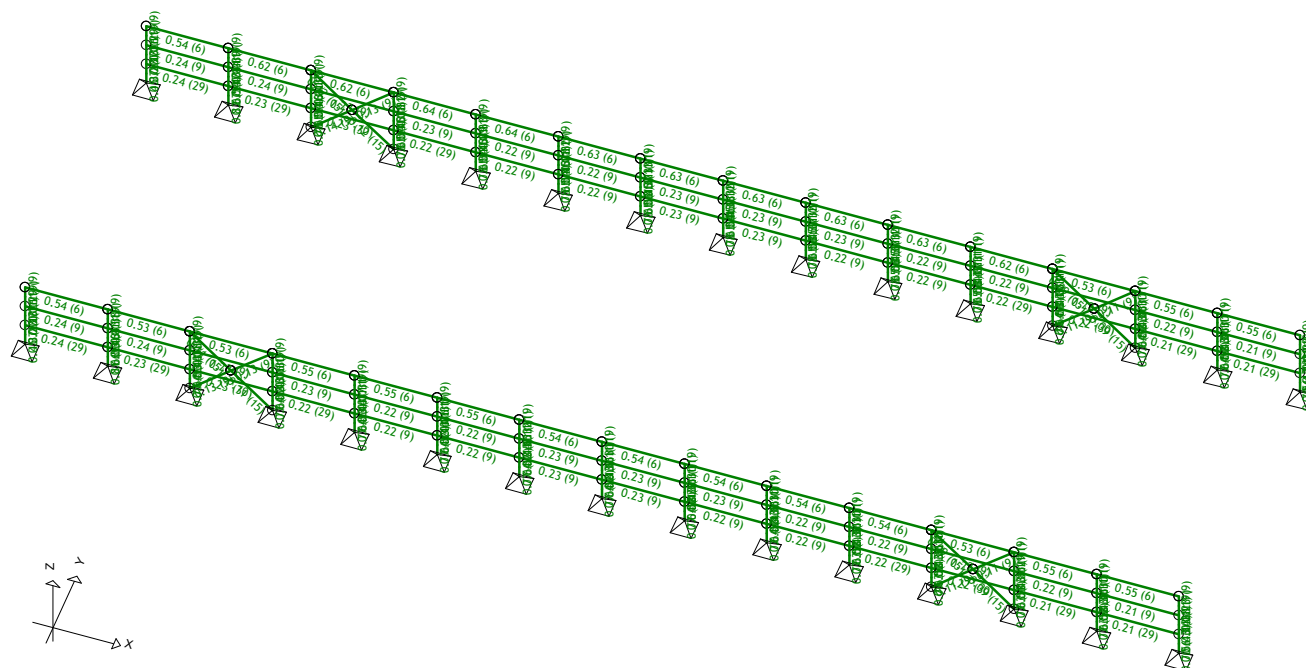
Rám H1

Load 87: [ULS_fasada] 76-79



Group: H1

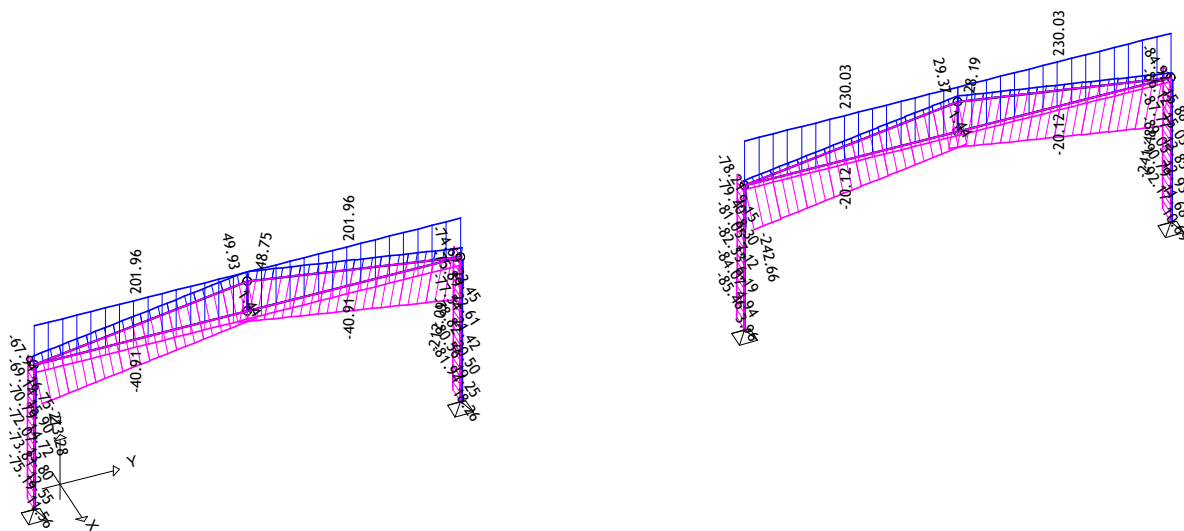
Beam Results: max Yd= 38.22 / min Yd= -61.65 m / 1000

Rám H1

Group: H1
Stress control

Rám V3

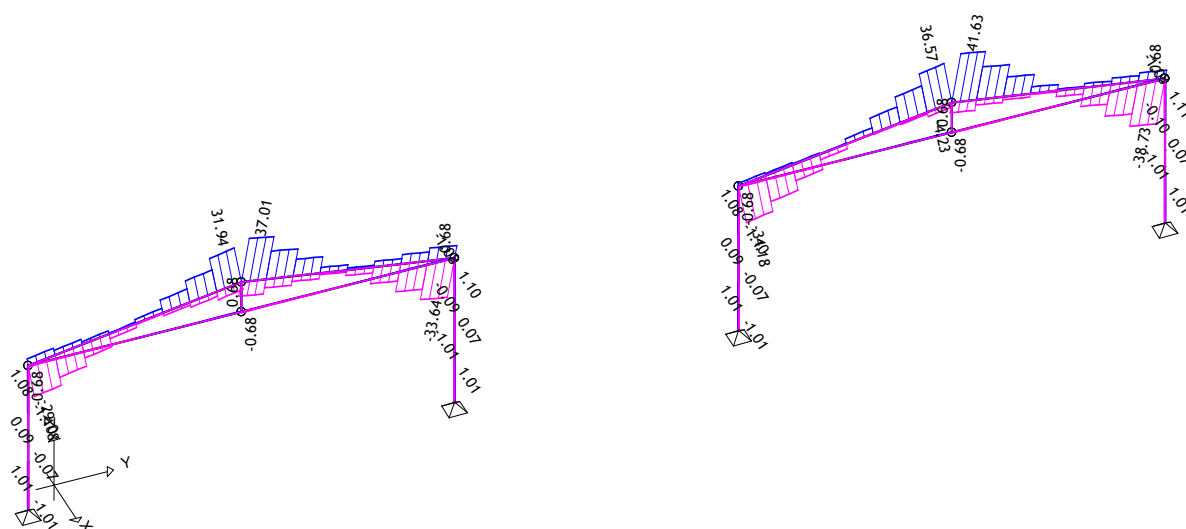
Load 86: [ULS] 5-71



Frame: V_3 (Group: Hala)

Beam Results: max N1= 230.03 / min N1= -242.66 kN

Load 86: [ULS] 5-71

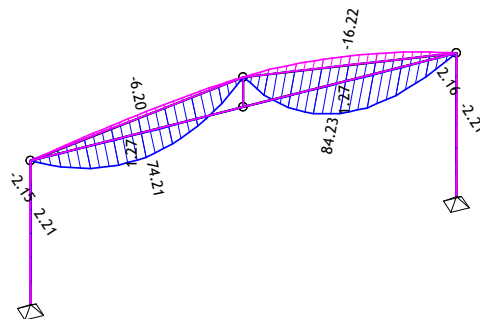
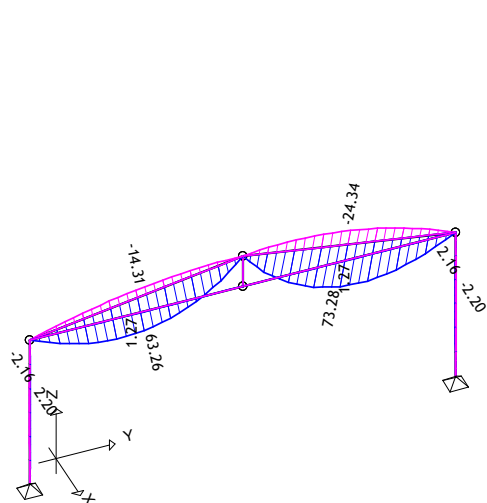


Frame: V_3 (Group: Hala)

Beam Results: max V2= 41.63 / min V2= -38.73 kN

Rám V3

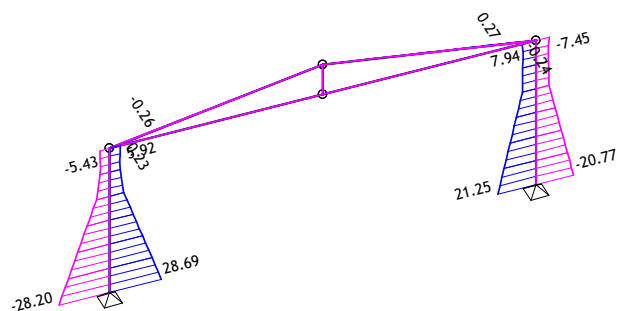
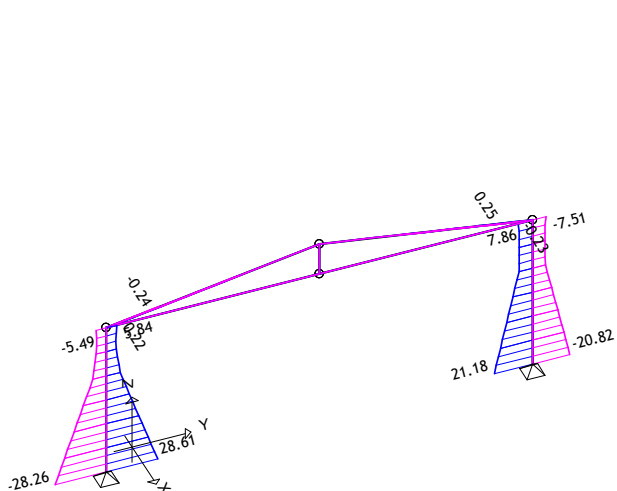
Load 86: [ULS] 5-71



Frame: V_3 (Group: Hala)

Beam Results: max M3= 84.23 / min M3= -24.34 kNm

Load 86: [ULS] 5-71

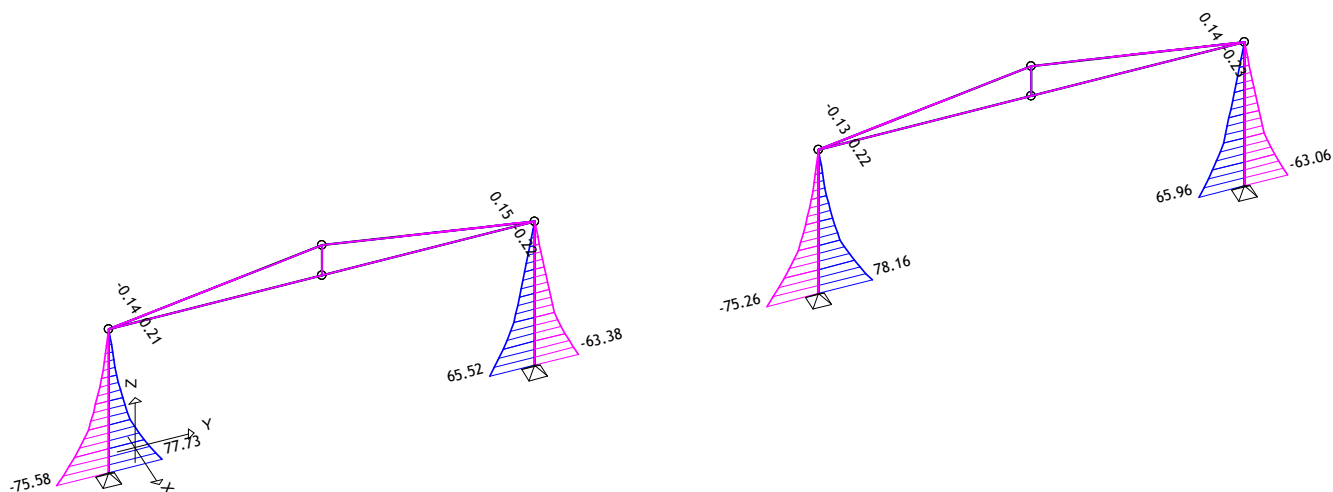


Frame: V_3 (Group: Hala)

Beam Results: max V3= 28.69 / min V3= -28.26 kN

Rám V3

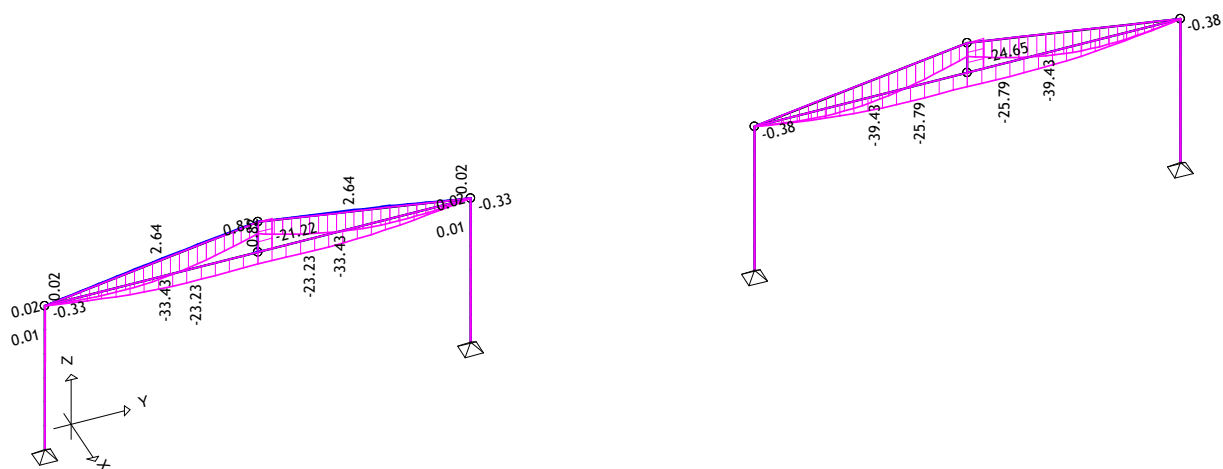
Load 86: [ULS] 5-71



Frame: V_3 (Group: Hala)

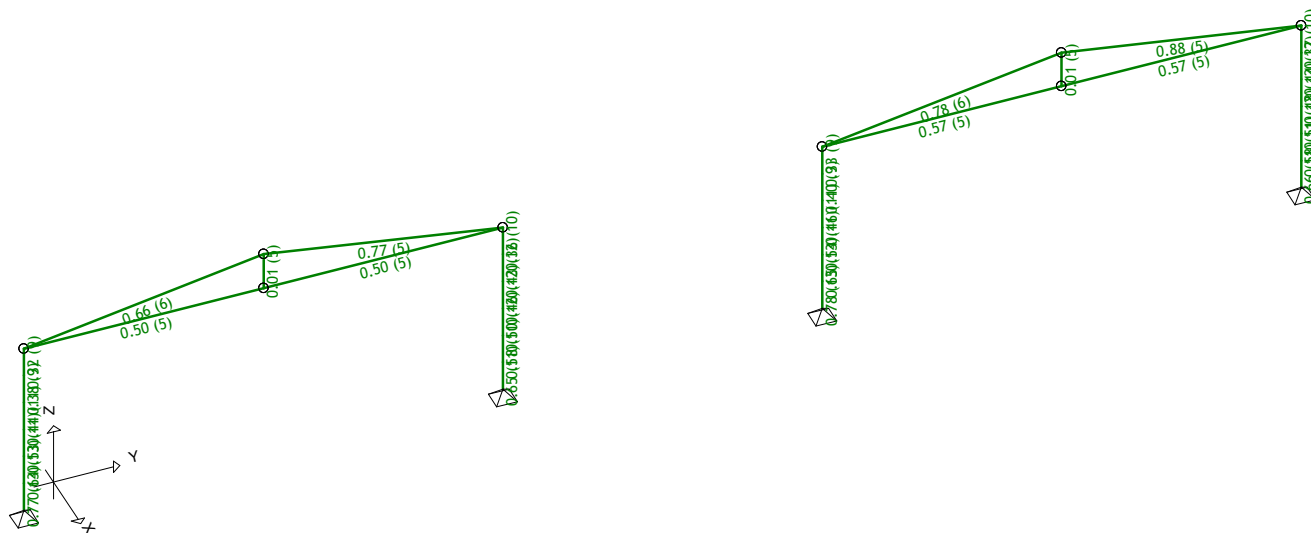
Beam Results: max M2= 78.16 / min M2= -75.58 kNm

Load 88: [SLS] 72-85



Frame: V_3 (Group: Hala)

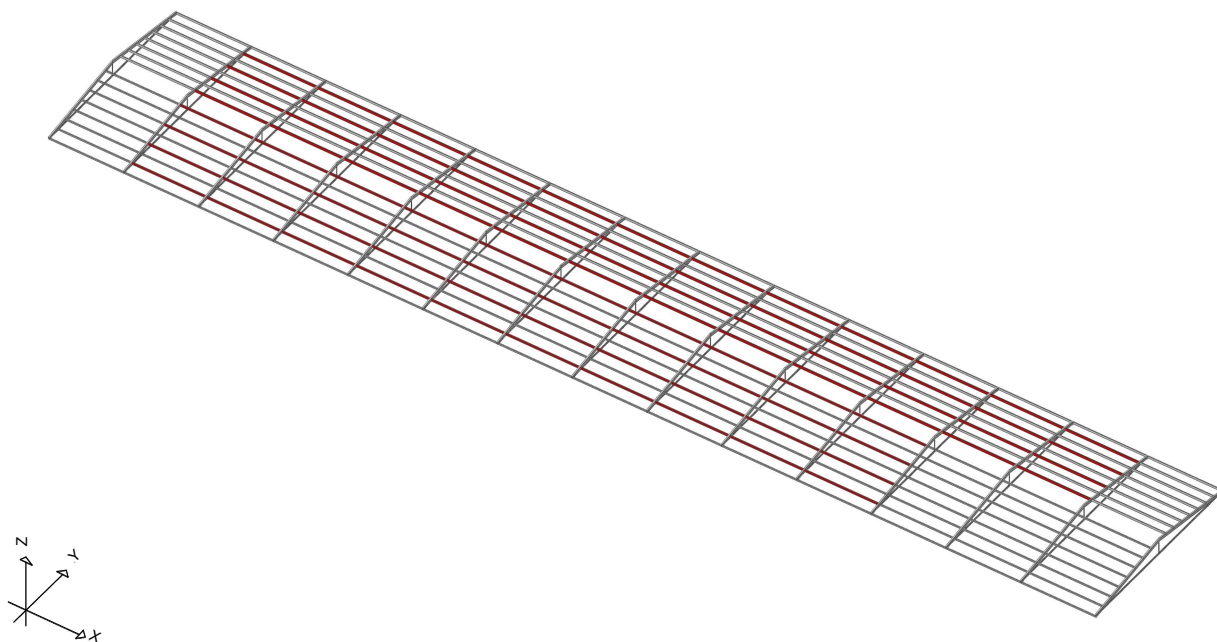
Beam Results: max Zd= 2.64 / min Zd= -39.43 mm / 1000

Rám V3

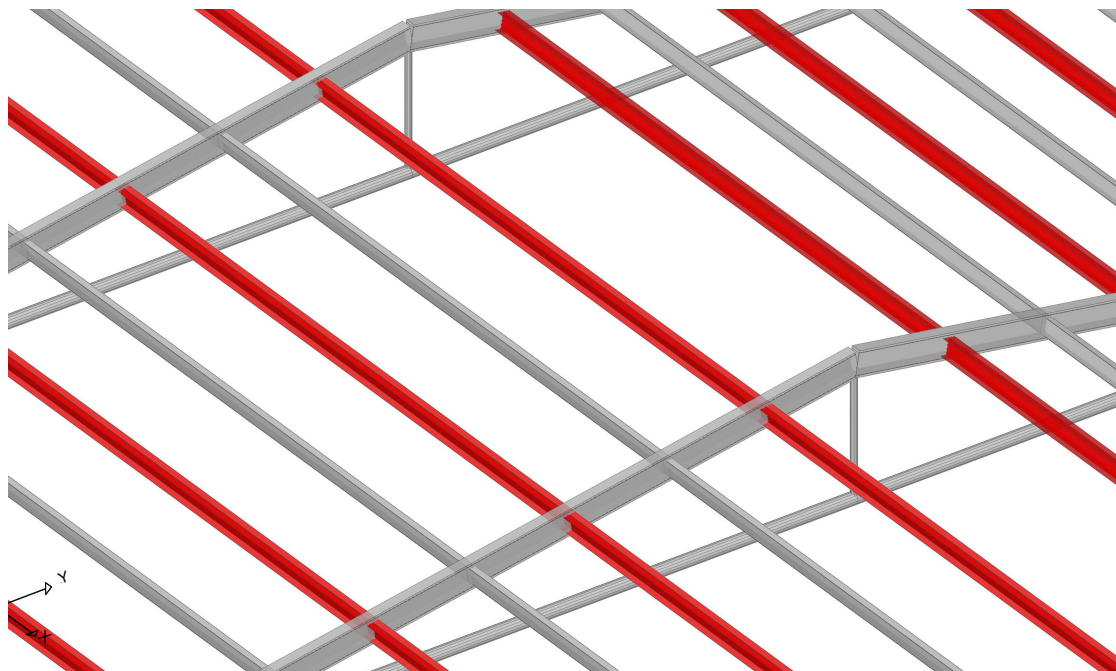
Frame: V_3 (Group: Hala)
Stress control

Záver

Axonometria doplnených strešných väzníc

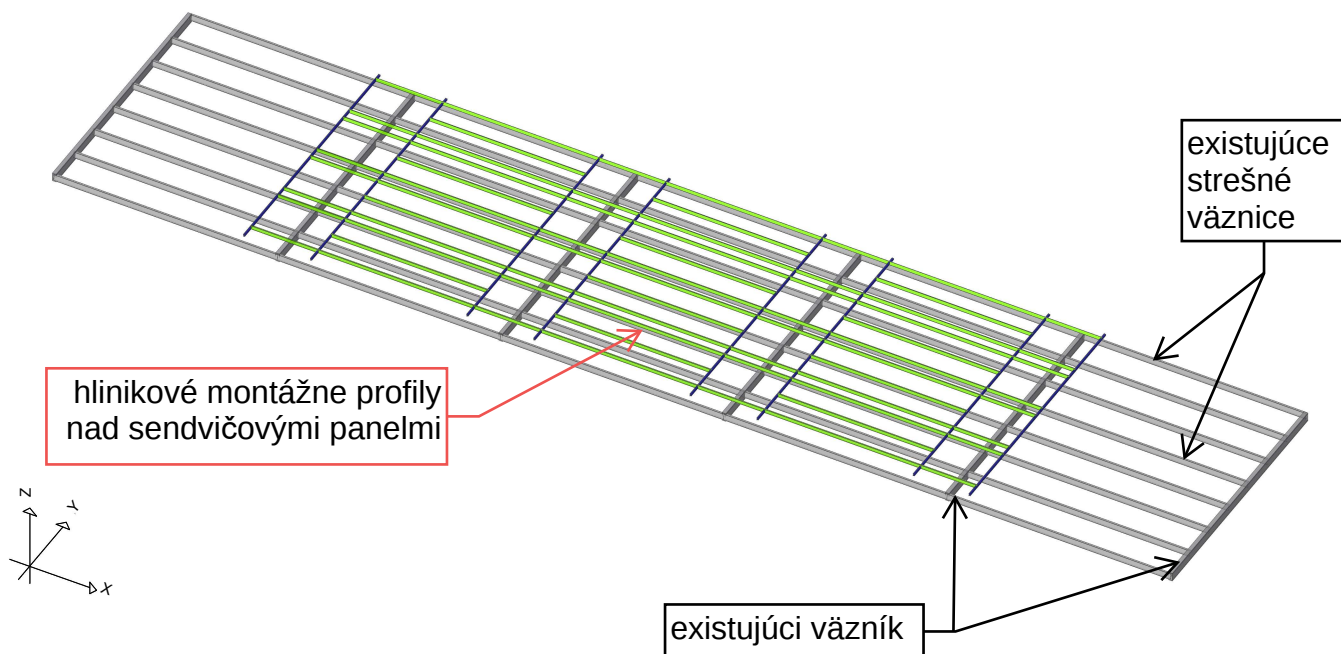


Axonometria doplnených strešných väzníc

**Záver:****Konštrukcia strechy je spôsobilá na osadenie fotovoltaických panelov.**

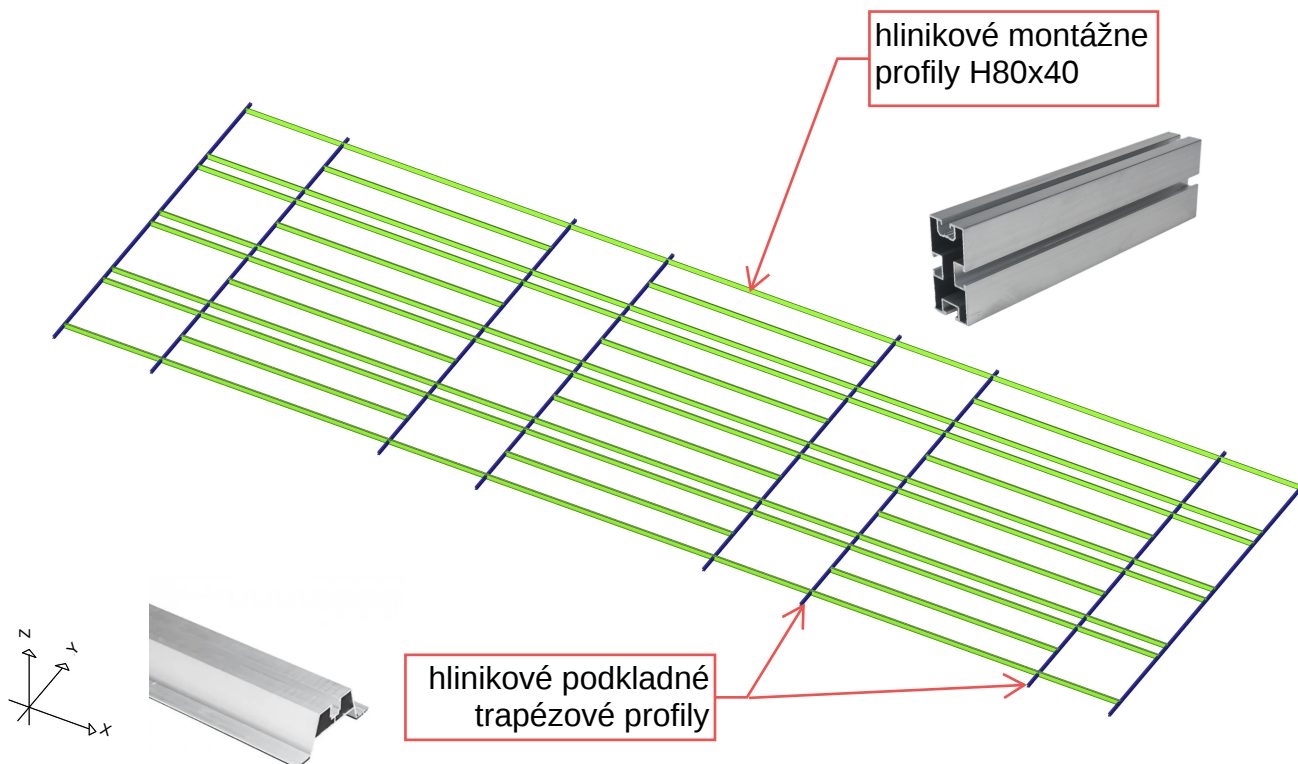
Nadstrešná hliníková konštrukcia

Beam	
7. []	100/240 (Väzník)
10. []	150x55x2.5 (Väznica)
14. H	80x40x1.5 (Mont. H profil)
15. Q	40x1.5 (Mont. trap. profil)



Numerical data set
Beam (7,10,14,15)

Beam	
14. H	80x40x1.5 (Mont. H profil)
15. Q	40x1.5 (Mont. trap. profil)



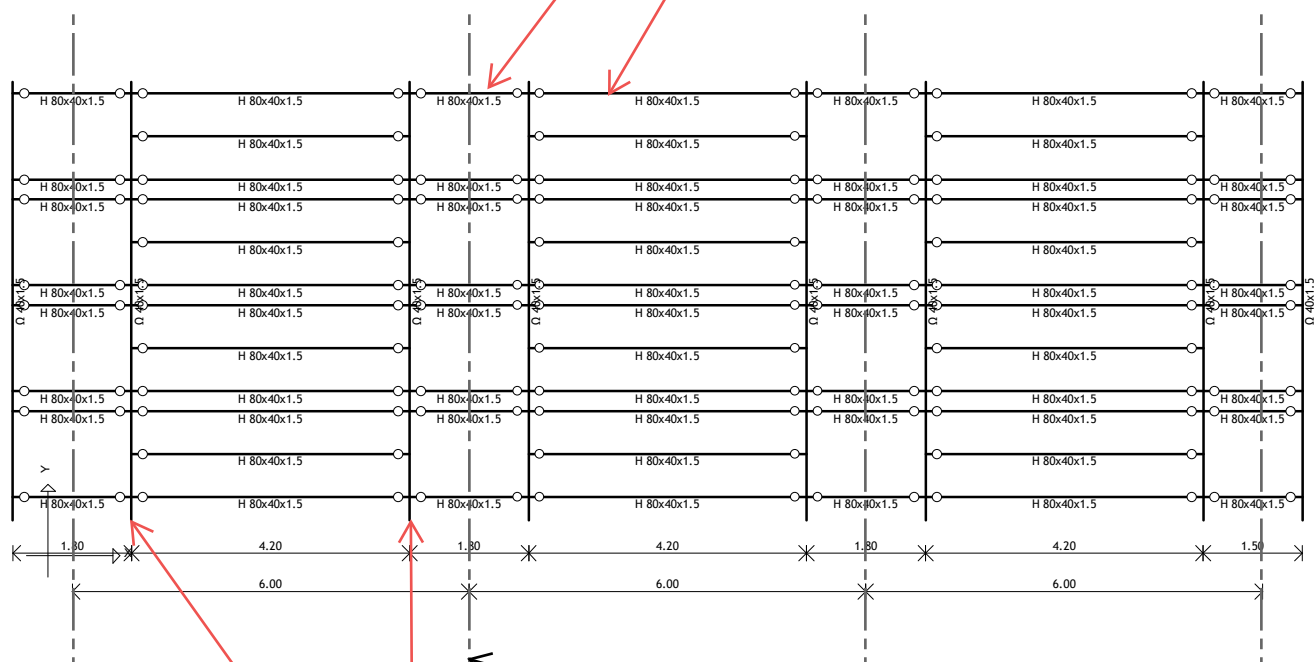
Numerical data set
Beam (14,15)

Nadstrešná hliníková konštrukcia



hliníkové montážne profily H80x40
nad väzníkom 2ks pod FV panel
L= 1,8 m

hliníkové montážne profily H80x40
nad väzníkom 3ks pod FV panel
L= 4,2 m



osi existujúcich
väzníkov

hliníkové podkladné
trapézové profily
uložené 90 + 90cm
od osi väzníkov

