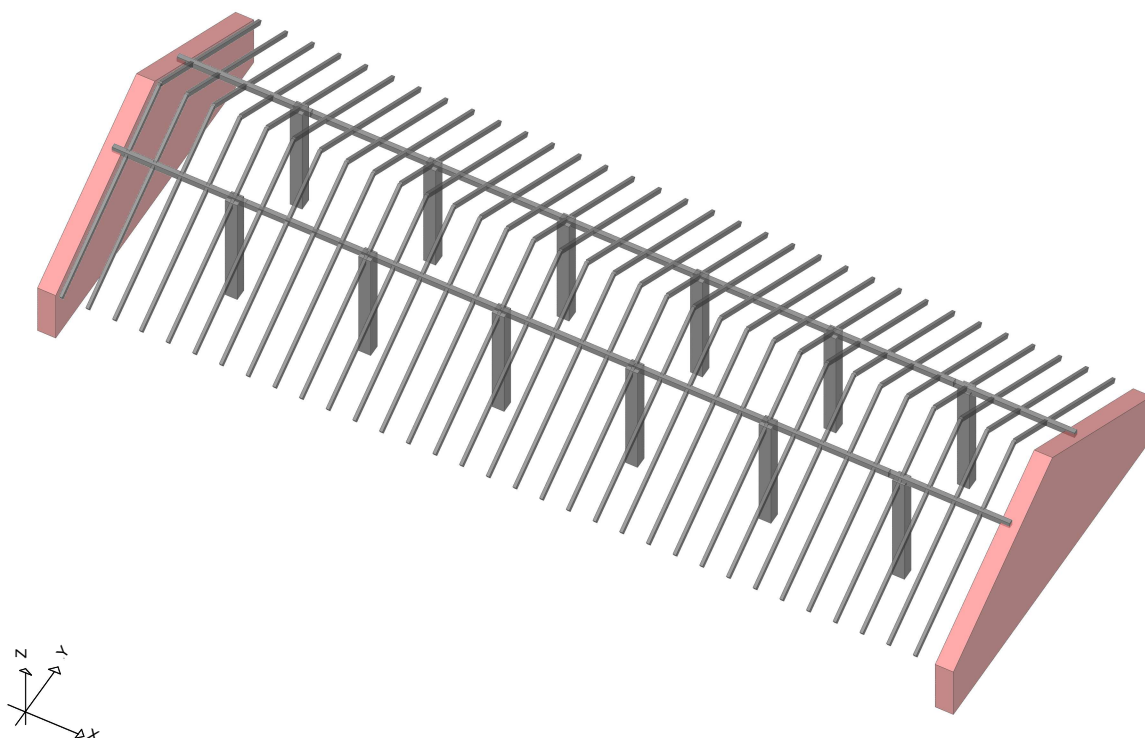


Statická analýza

SO-03 Skladová hala č. 3

Posúdenie možnosti osadenia FVE na strechu dreveného krovu

Vypracoval: Ing. Tomáš Keresztesi



Input data - Structure

Level scheme

Name	z [m]	h [m]
Stredove vāznice	4.20	4.20

Name	z [m]	h [m]
	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	MB Standard	1.000e+6	0.15	15.00	6.000e-6	5.000e+6	0.15
2	C 20/25	3.050e+7	0.20	25.00	1.000e-5	3.050e+7	0.20
3	Holz-Nadelhplz-Masives	1.000e+7	0.20	5.00	1.000e-5	1.000e+7	0.20

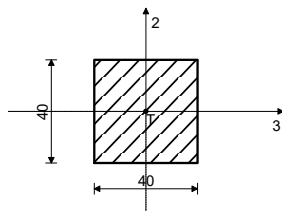
Slab sets

No	t[m]	e[m]	Material	Analysis type	Orthotropy	E2[kN/m ²]	G[kN/m ²]	α
<1>	0.600	0.300	1	Masonry	Isotropy			

Beam sets

Set: 1 Section: b/d=40/40, Approx. eccentricity, Stlp

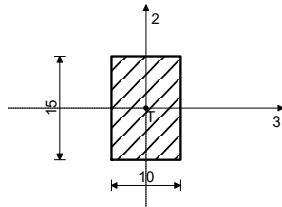
Mat.	A1	A2	A3	I1	I2	I3
2 - C 20/25	1.600e-1	1.333e-1	1.333e-1	3.605e-3	2.133e-3	2.133e-3



[cm]

Set: 2 Section: b/d=10/15, Approx. eccentricity, Krokva

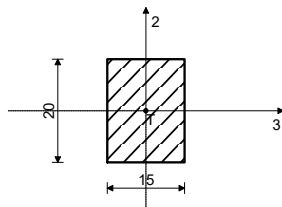
Mat.	A1	A2	A3	I1	I2	I3
3 - Holz-Nadelhpl...	1.500e-2	1.250e-2	1.250e-2	2.935e-5	1.250e-5	2.812e-5



[cm]

Set: 3 Section: b/d=15/20, Approx. eccentricity, Vāznica

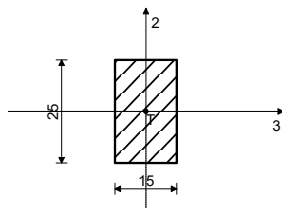
Mat.	A1	A2	A3	I1	I2	I3
3 - Holz-Nadelhpl...	3.000e-2	2.500e-2	2.500e-2	1.215e-4	5.625e-5	1.000e-4
ST: EA1 x 1, EA2 x 1, EA3 x 1, EI1 x 0.1, EI2 x 1, EI3 x 1, γ x 1;						
SE: EA1 x 1, EA2 x 1, EA3 x 1, EI1 x 1, EI2 x 1, EI3 x 1, γ x 1;						



[cm]

Set: 4 Section: b/d=15/25, Approx. eccentricity, Zosilnena vāznica

Mat.	A1	A2	A3	I1	I2	I3
3 - Holz-Nadelhpl...	3.750e-2	3.125e-2	3.125e-2	1.761e-4	7.031e-5	1.953e-4
ST: EA1 x 1, EA2 x 1, EA3 x 1, EI1 x 0.1, EI2 x 1, EI3 x 1, γ x 1;						
SE: EA1 x 1, EA2 x 1, EA3 x 1, EI1 x 1, EI2 x 1, EI3 x 1, γ x 1;						



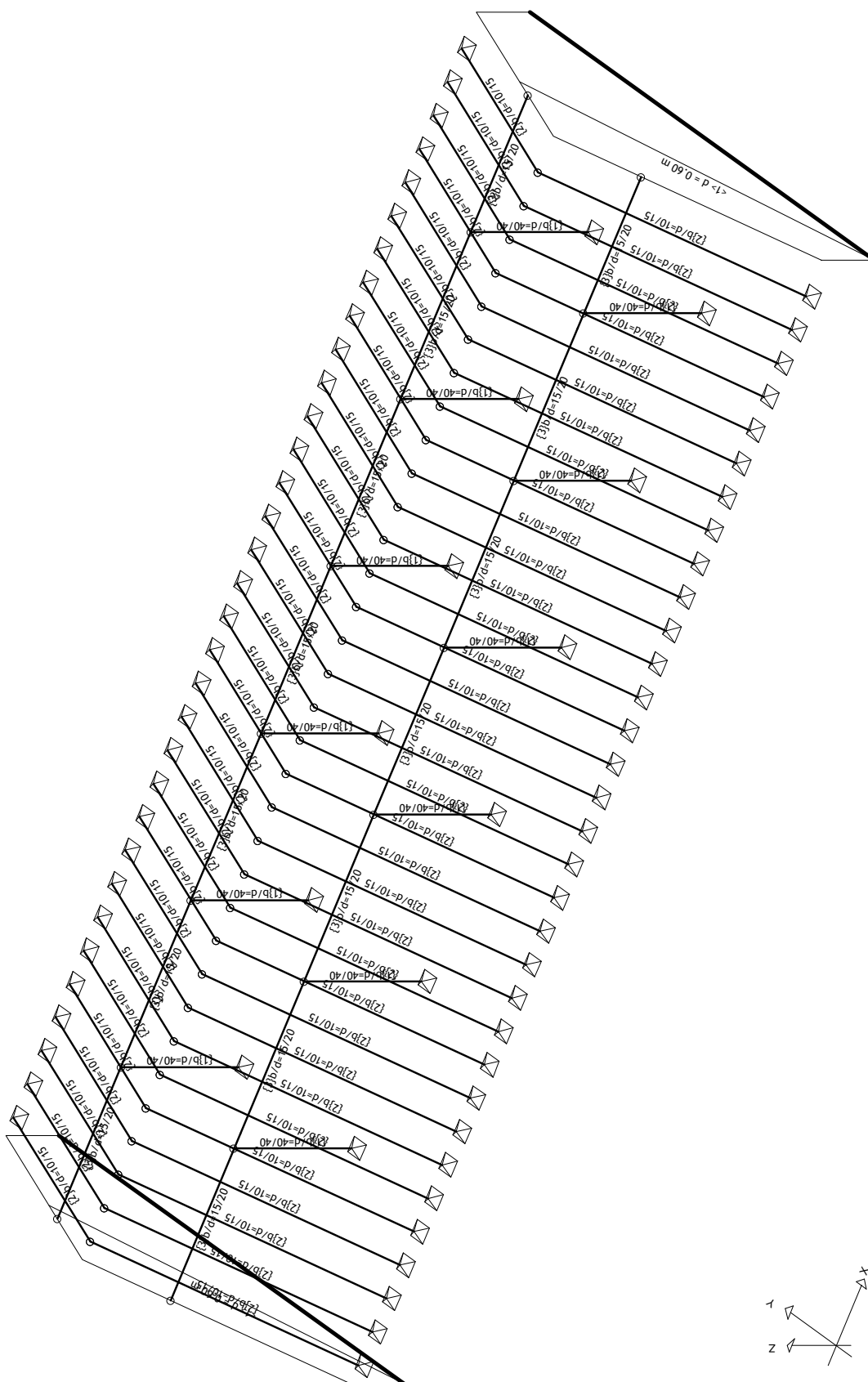
[cm]

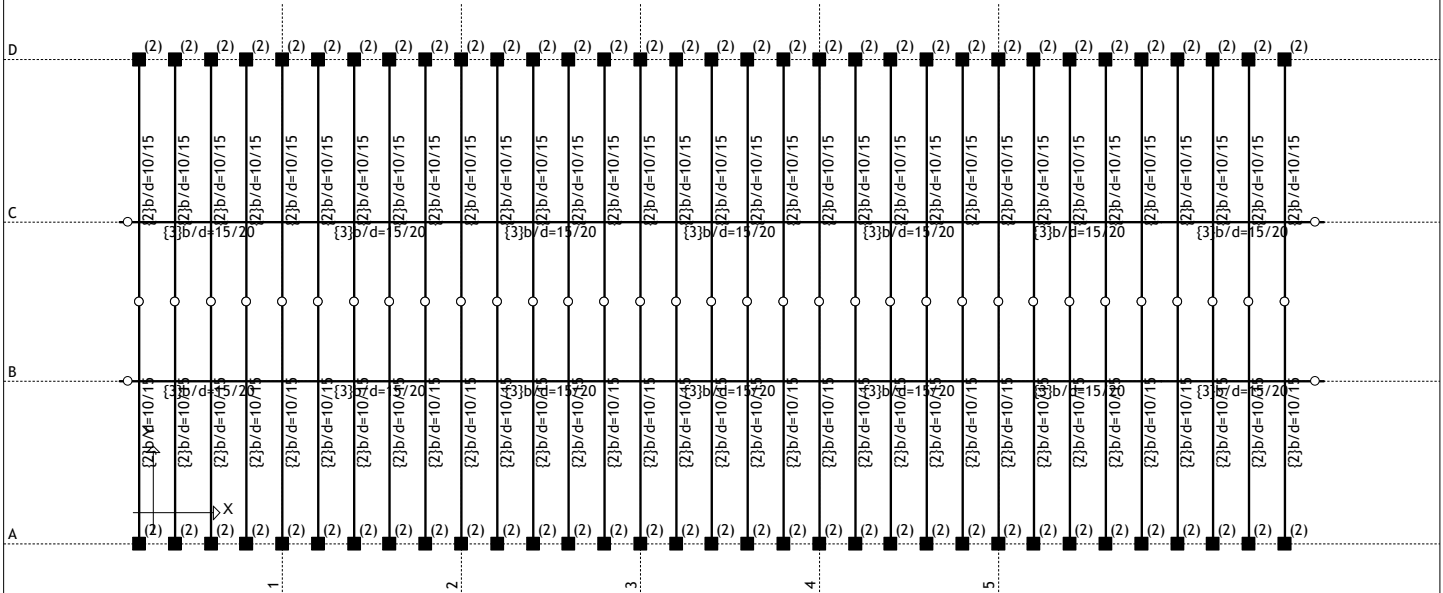
Linear support sets

Set	K,R1	K,R2	K,R3	K,M1	Soil [m]
1	1.000e+5	1.000e+7	1.000e+3		

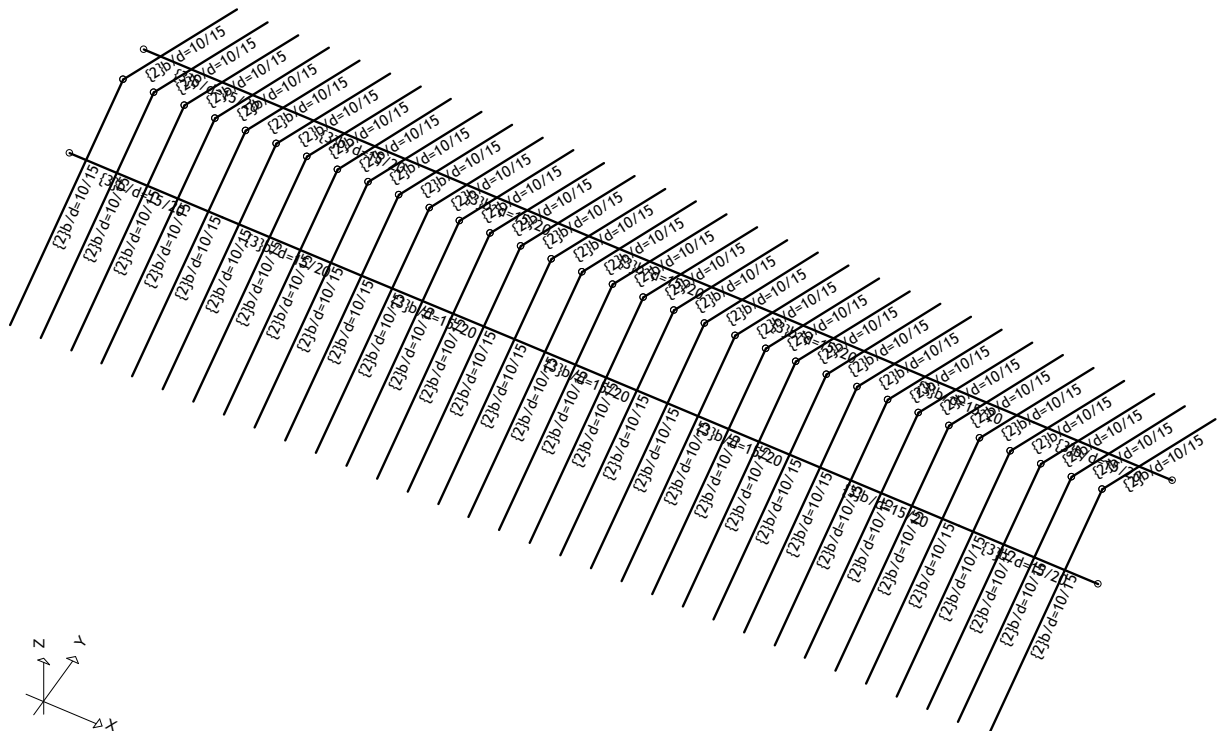
Point support sets

Set	K,R1	K,R2	K,R3	K,M1	K,M2	K,M3
1	1.000e+10	1.000e+10	1.000e+10	1.000e+10	1.000e+10	
2			1.000e+10			

Input data - Structure

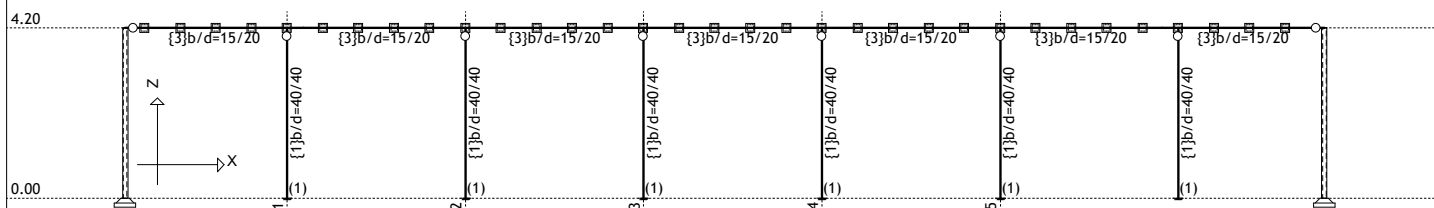
Input data - Structure

View: Strecha - Group: Sypka

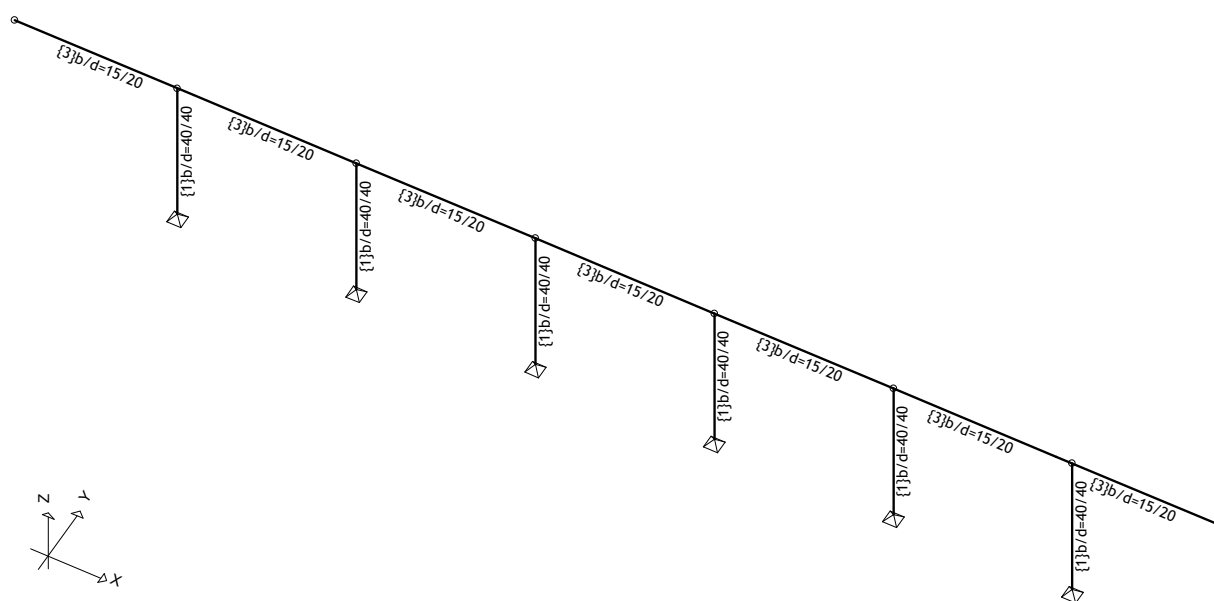


View: Strecha (Group: Sypka)

Input data - Structure



Frame: H 2 - Group: Sypka

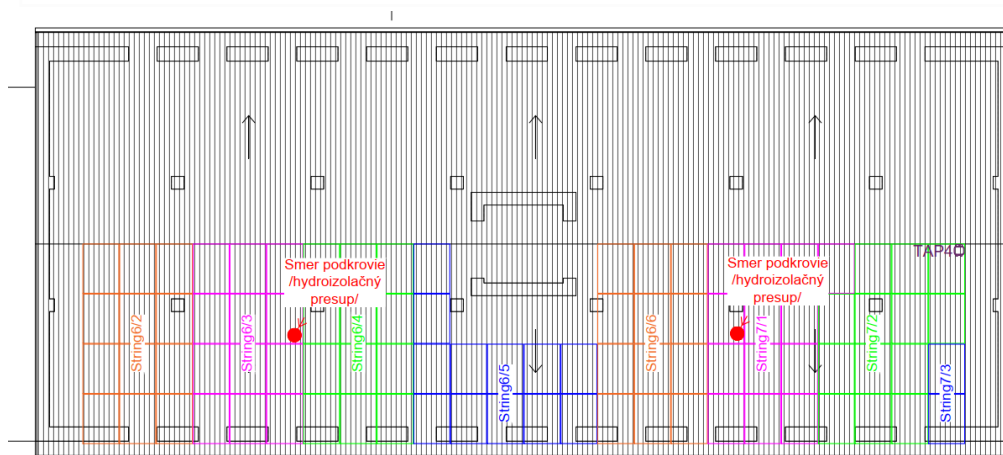


Frame: H 2 (Group: Sypka)

Input data - Load

Stále zaťaženia podľa STN EN 1991-1

- Vlastná tiaž nosnej konštrukcie je spočítaná výpočtovým programom
- Stále zaťaženie pôsobiace na strechu tvorí tiaž plechovej krytiny a plnoplošného dreveného záklopu hr. 25 mm, ktorá bola uvažovaná ako hodnota 0,20 kN/m²
- Novou zložkou stáleho zaťaženia je tiaž fotovoltaických panelov: prírastok 0,20 kN/m²

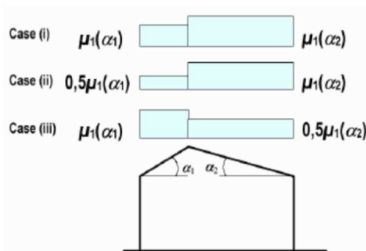


Obr.: Schéma rozmiestnenia panelov na streche objektu (podľa projektu FBB Electric)

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

Vstupné údaje:

Sklon strechy: 30 ° (α_1) 30 ° (α_2)
 Expozícia: normálna (C_e)
 Snehová oblasť: 1
 Nadmorská výška miesta stavby: 125 m.n.m. (A)



Výpočet:

Charakteristické zaťaženie snehom s pôsobiace na strechu:

$$s_k := \mu_1 \cdot C_e \cdot C_t \cdot s_k$$

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)

$$a = 0.454$$

$$A = 125$$

$$b = 970$$

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

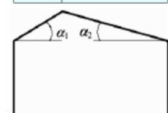
$$s_k = 0.58 \quad \text{kN/m}^2$$

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

$$s_{I\mu_1\alpha_1} := \mu_{1\alpha_1} \cdot C_e \cdot C_t \cdot s_k = 0.466 \quad \text{kN/m}^2 \quad s_{I\mu_1\alpha_2} := \mu_{1\alpha_2} \cdot C_e \cdot C_t \cdot s_k = 0.466 \quad \text{kN/m}^2$$

$$s_{II\mu_1\alpha_1} := 0.5\mu_{1\alpha_1} \cdot C_e \cdot C_t \cdot s_k = 0.233 \quad \text{kN/m}^2 \quad s_{II\mu_1\alpha_2} := \mu_{1\alpha_2} \cdot C_e \cdot C_t \cdot s_k = 0.233 \quad \text{kN/m}^2$$

$$s_{III\mu_1\alpha_1} := \mu_{1\alpha_1} \cdot C_e \cdot C_t \cdot s_k = 0.466 \quad \text{kN/m}^2 \quad s_{III\mu_1\alpha_2} := 0.5\mu_{1\alpha_2} \cdot C_e \cdot C_t \cdot s_k = 0.233 \quad \text{kN/m}^2$$



Input data - Load**Governing load - EC2 (EN 1992-1-1:2004)**LFK für GebäudeLoad Case

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

08. [PT] I+1.50×II
09. [PT] 1.35×I
10. [PT] I+II+0.60×III
11. [PT] I+0.50×II+III
12. [PT] I+III
13. [PT] I+II
14. [PT] I

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
02. [PT] 1.35×I+0.75×II+1.50×III
03. [PT] I+1.50×II+0.90×III
04. [PT] I+0.75×II+1.50×III
05. [PT] 1.35×I+1.50×III
06. [PT] 1.35×I+1.50×II
07. [PT] I+1.50×III

Combinations for fissure and deflection calculation

(characteristic combinations - long-term)

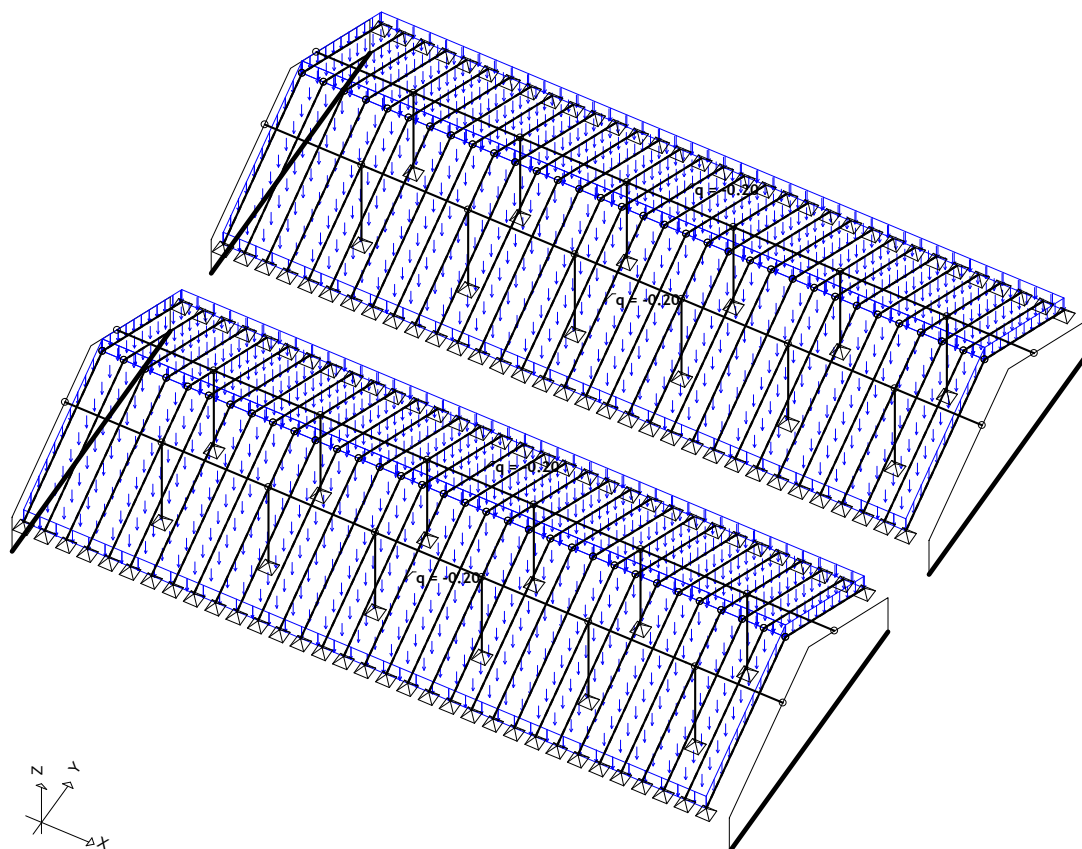
1. I
2. I
3. I
4. I
5. I

(characteristic combinations - short-term)

1. II+0.60×III
2. 0.50×II+III
3. III
4. II
5. ---

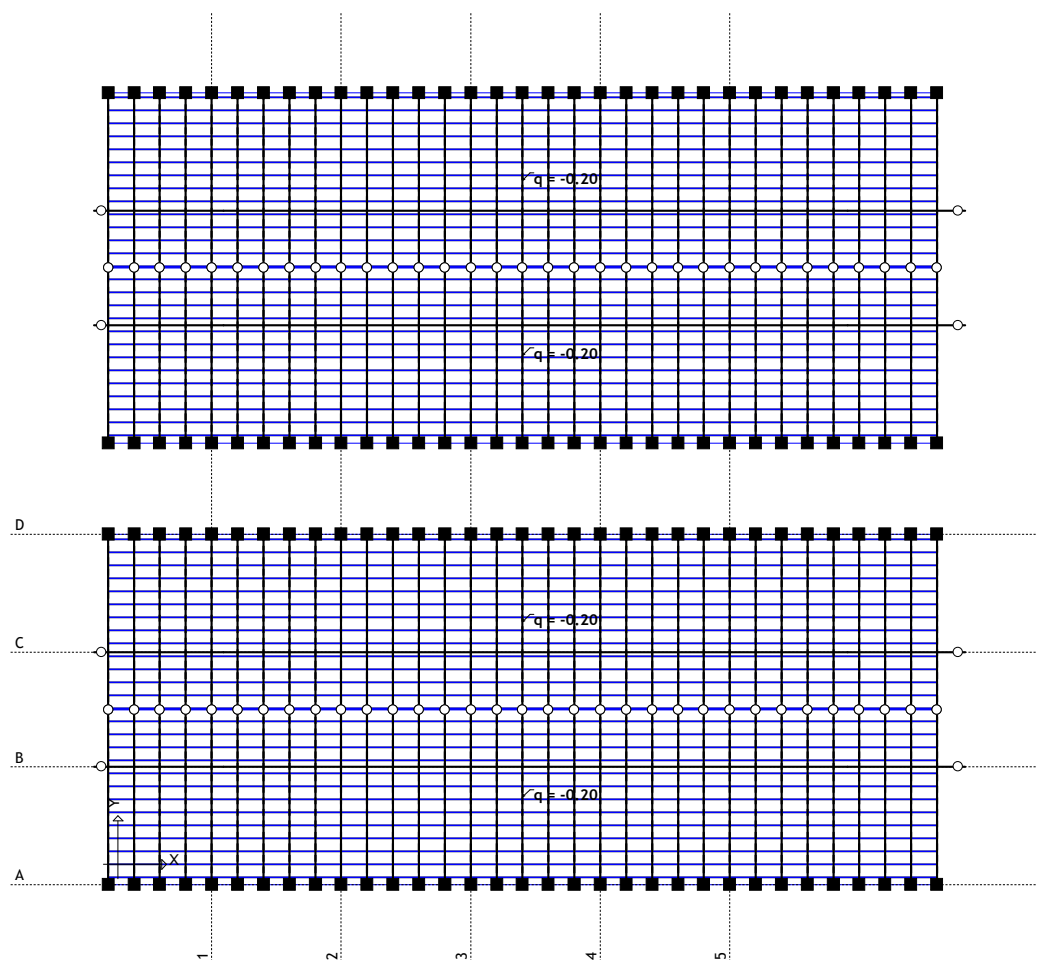
Input data - Load

Load 1: vl. + st. (g)



Isometric

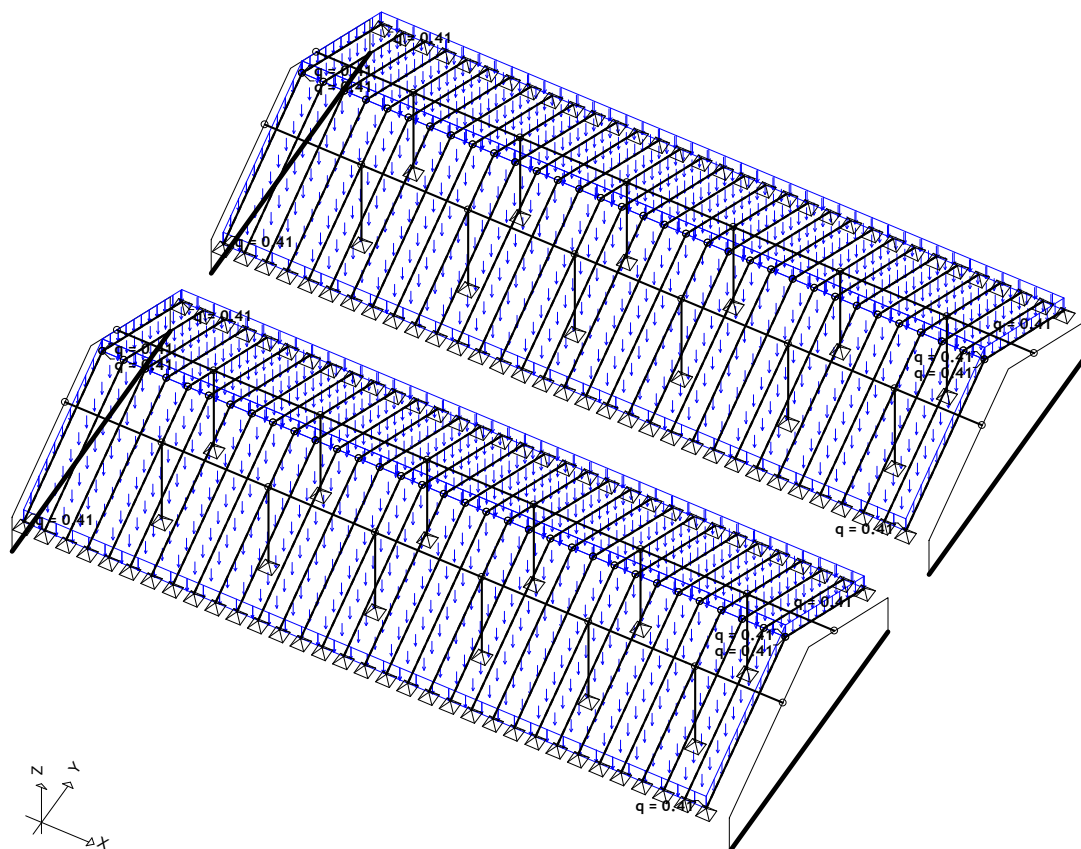
Load 1: vl. + st. (g)



View: Strecha sycky

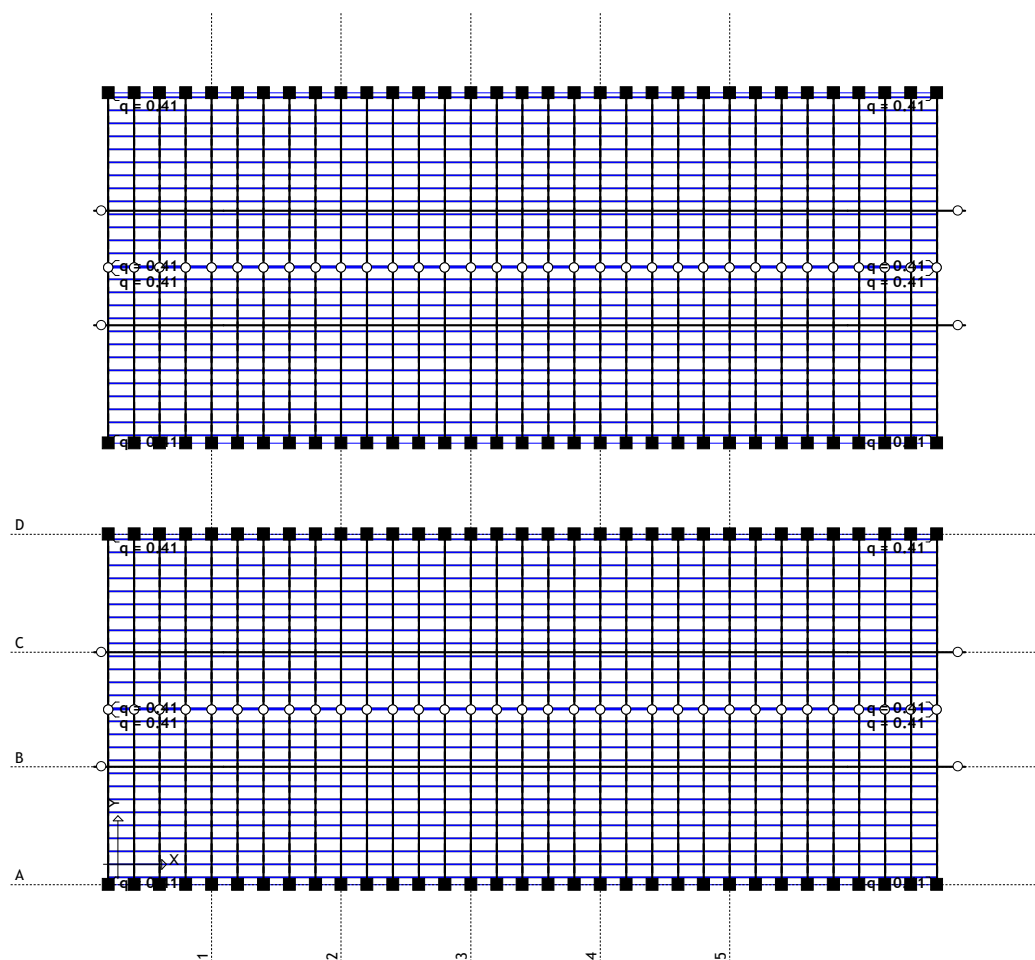
Input data - Load

Load 2: sn.



Isometric

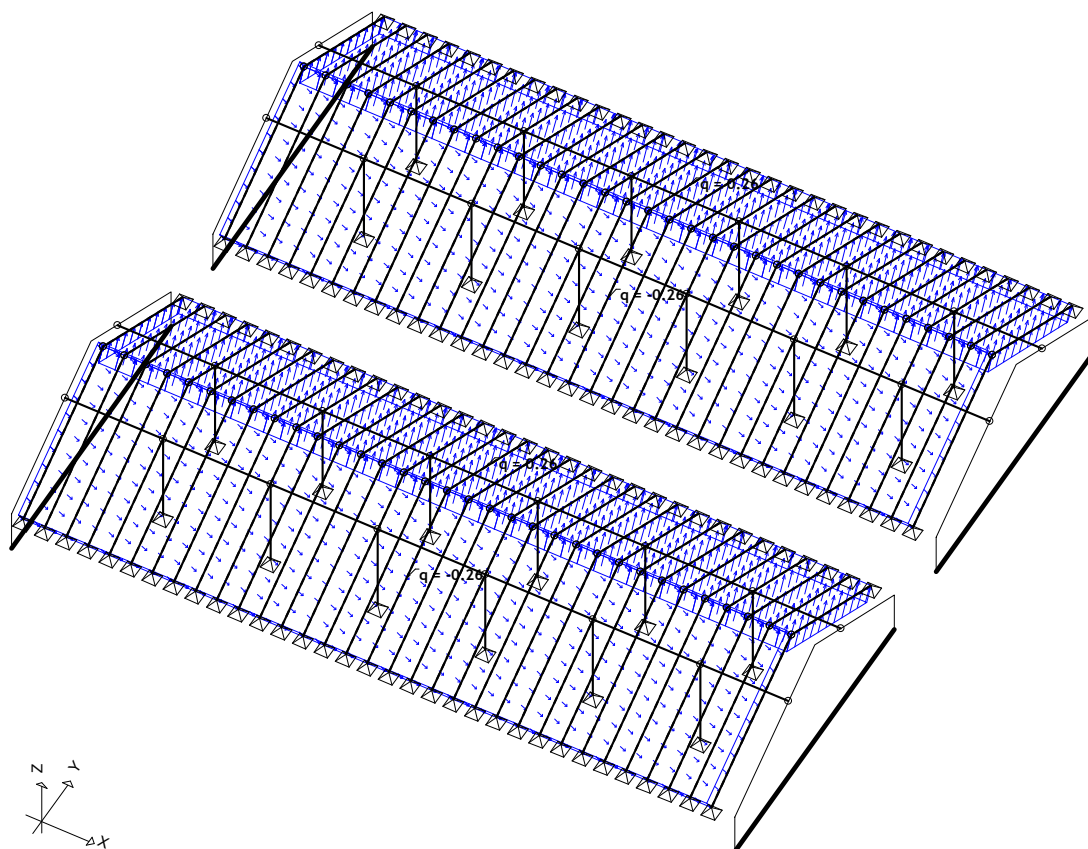
Load 2: sn.



View: Strecha sycky

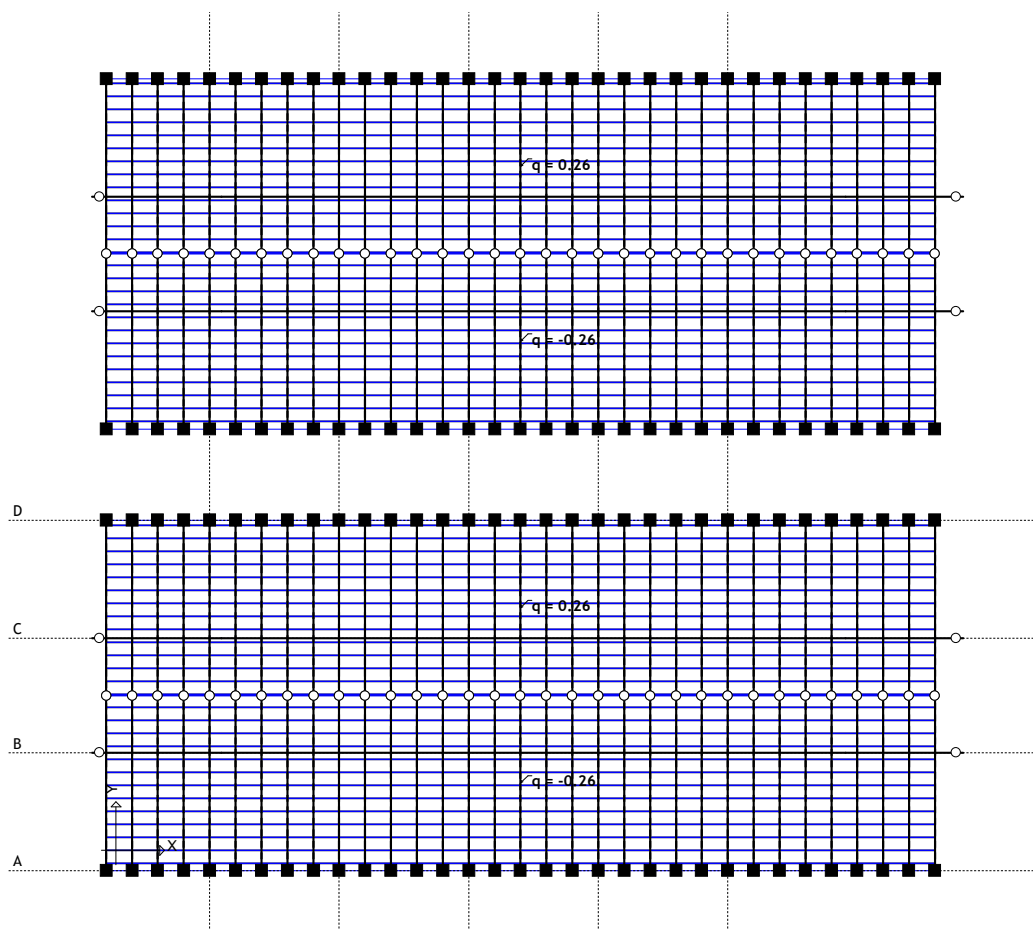
Input data - Load

Load 3: w.x



Isometric

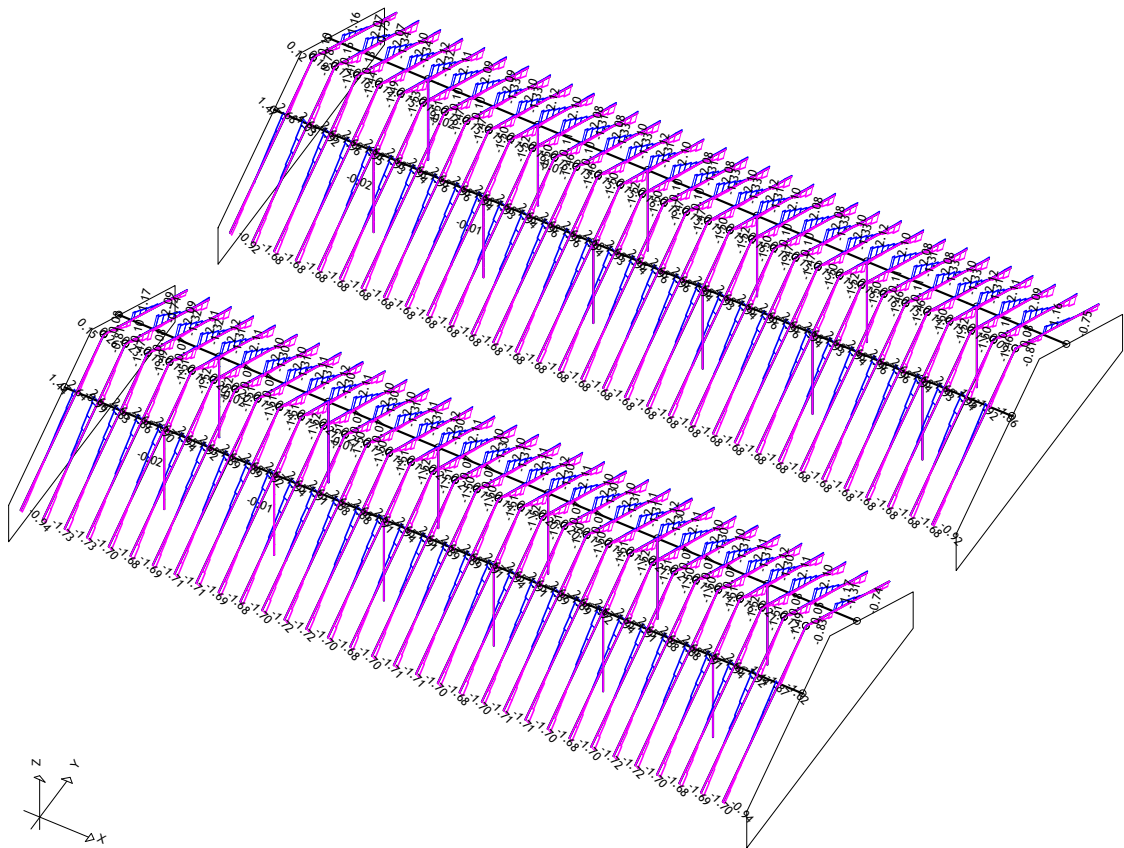
Load 3: w.x



View: Strecha sypky

Krokvý

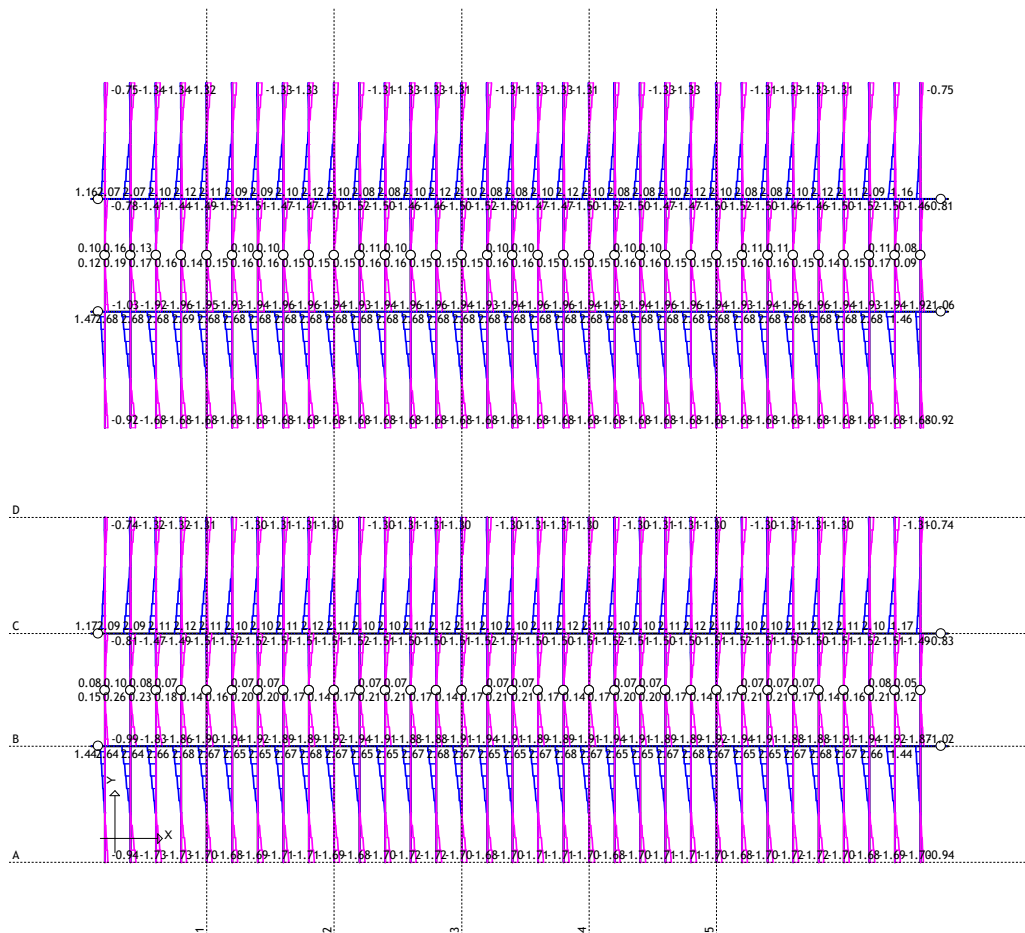
Load 18: [ULS] 4-12



Isometric

Beam Results: max V2= 2.69 / min V2= -1.96 kN

Load 18: [ULS] 4-12

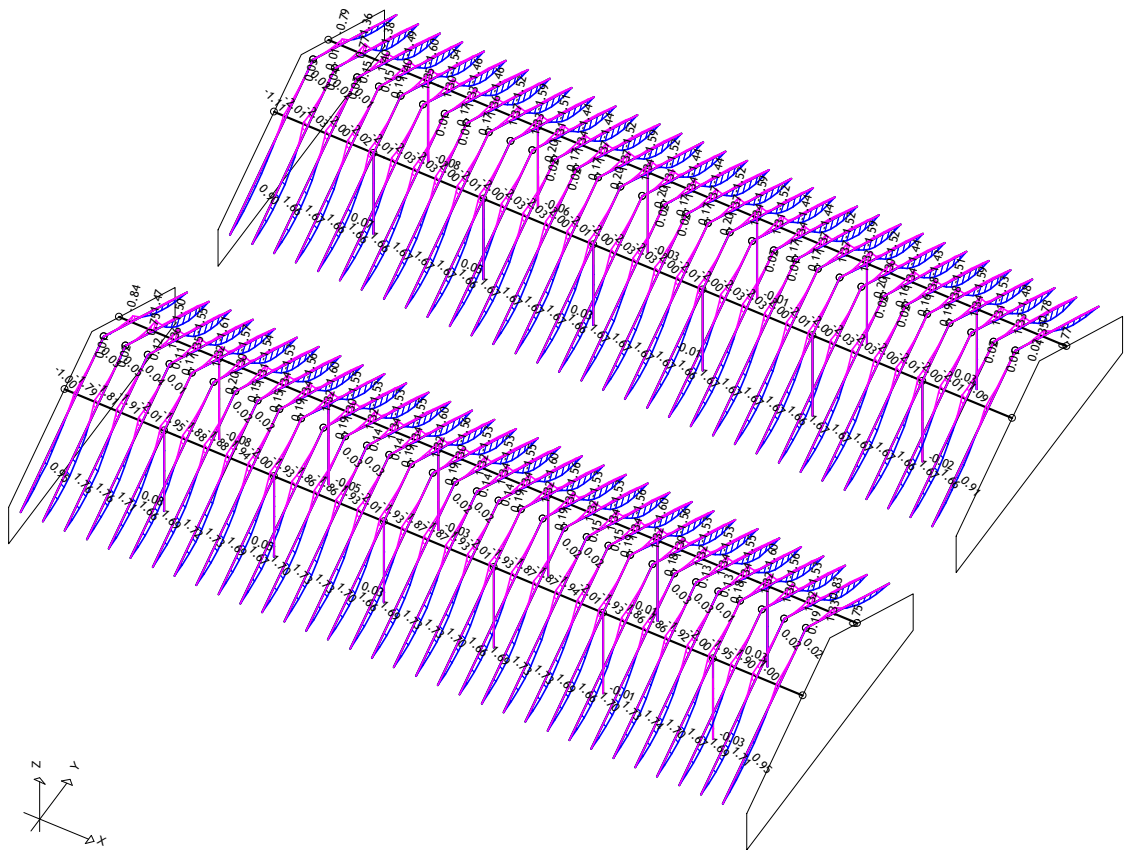


View: Strecha sycky

Beam Results: max V2= 2.69 / min V2= -1.96 kN

Krokvý

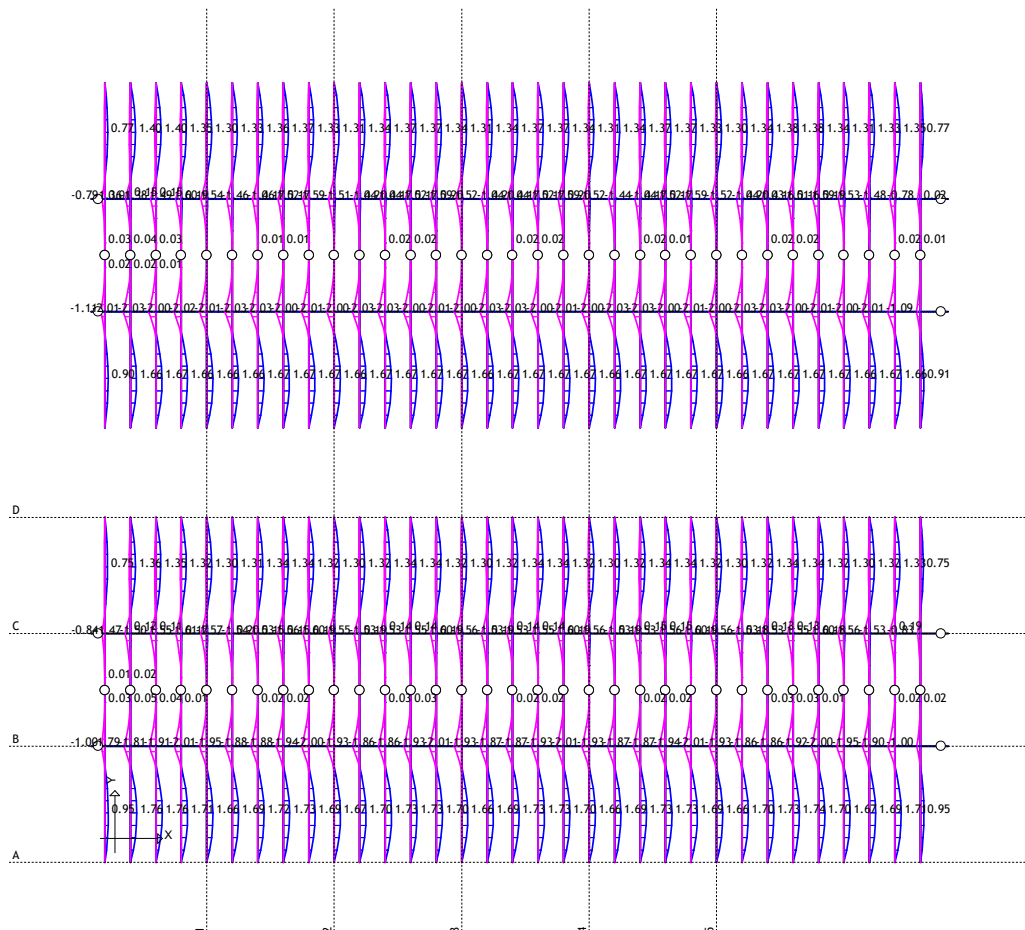
Load 18: [ULS] 4-12



Isometric

Beam Results: max M3= 1.76 / min M3= -2.03 kNm

Load 18: [ULS] 4-12

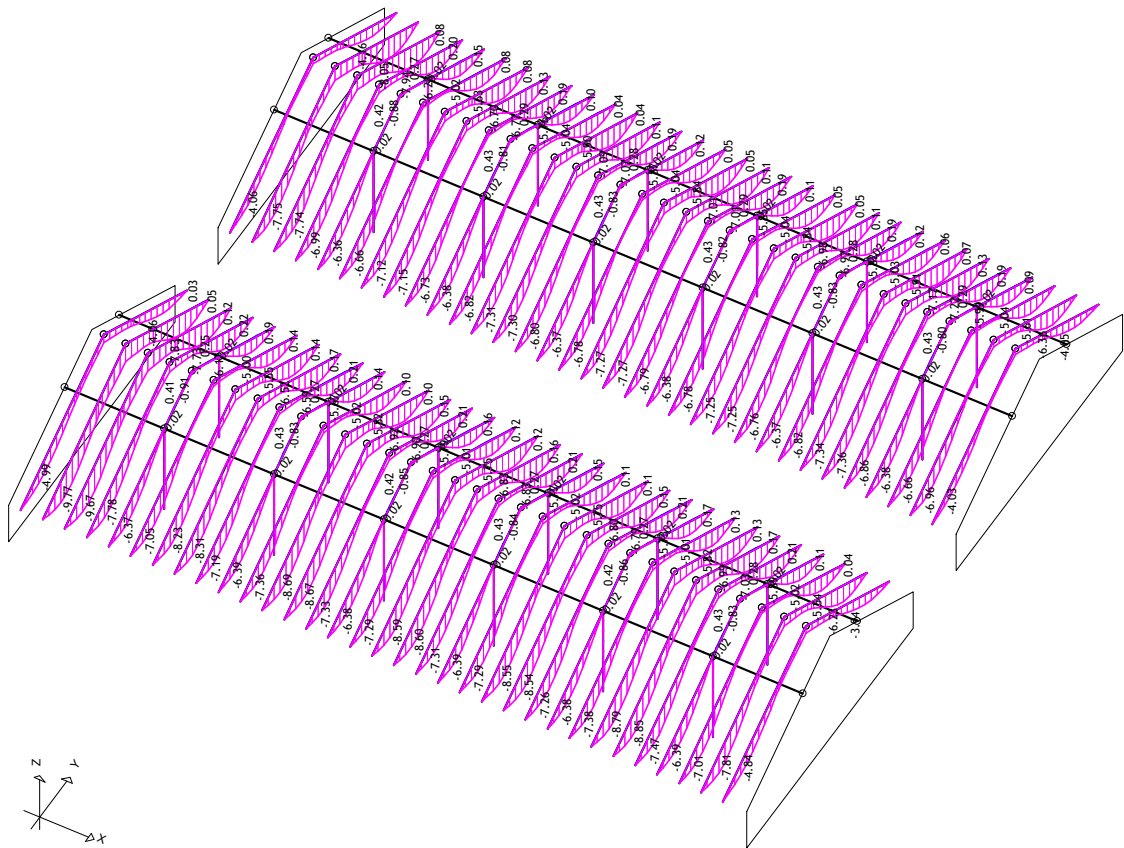


View: Strecha sycky

Beam Results: max M3= 1.76 / min M3= -2.03 kNm

Krokvý

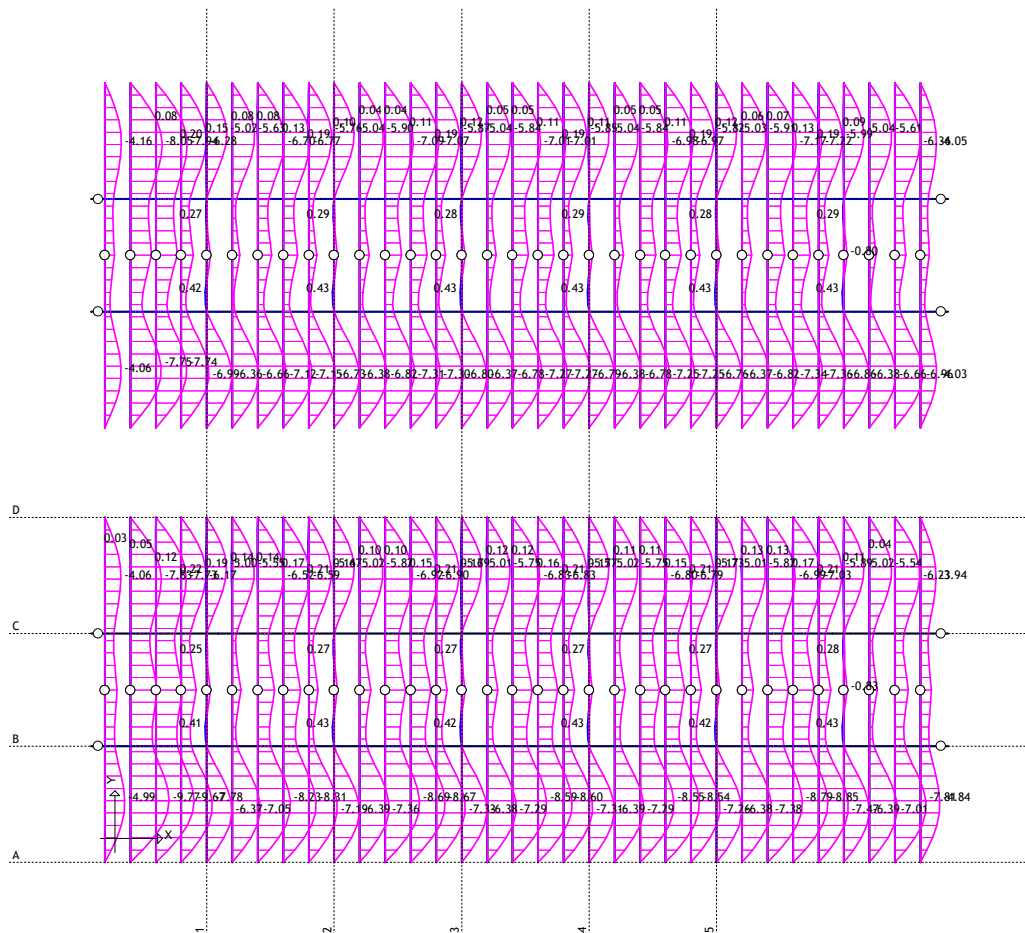
Load 19: [SLS] 13-17



Isometric

Beam Results: max Zd= 0.43 / min Zd= -9.77 m / 1000

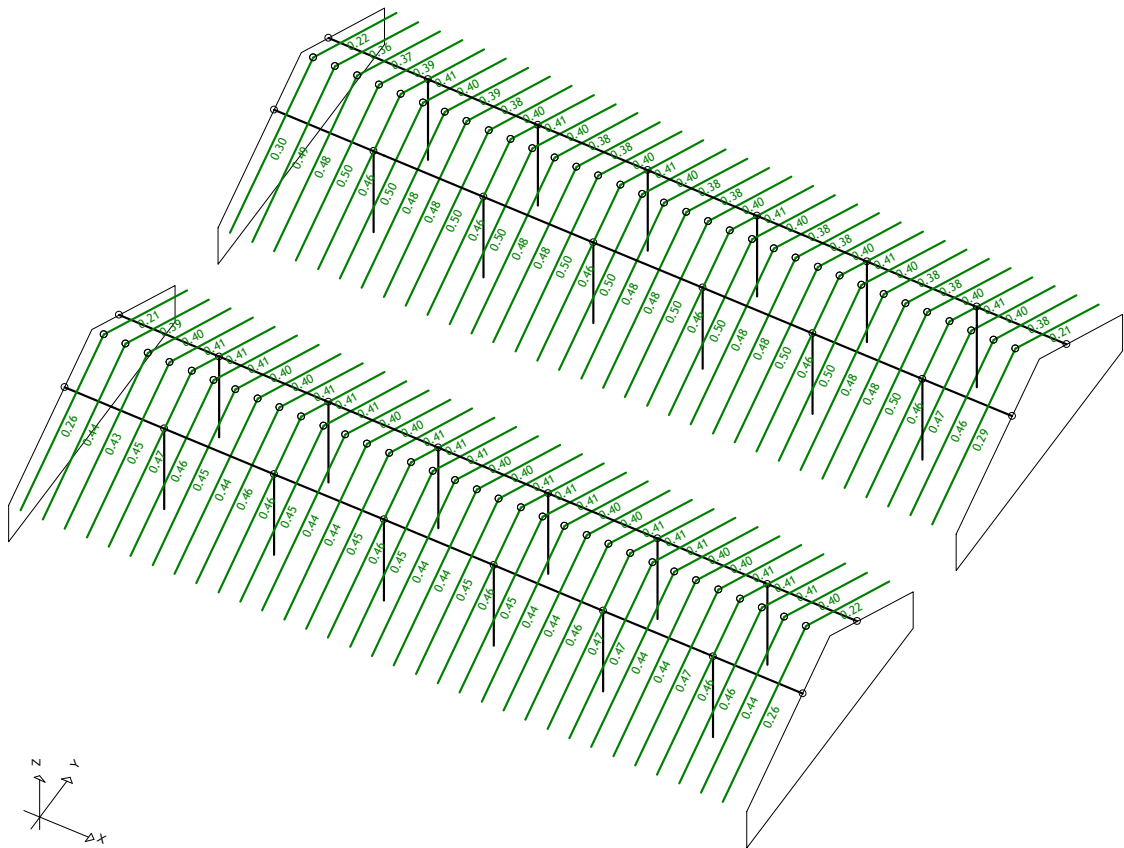
Load 19: [SLS] 13-17



View: Strecha sycky

Beam Results: max Zd= 0.43 / min Zd= -9.77 m / 1000

Krokvý

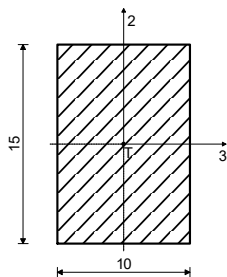


Isometric
Stability control

Posúdenie krokvy priťaženej panelmi FVE

BEAM 501-659

Solid timber - softwood - C24
Service class 3
EUROCODE (EN 1995-1-1)



[cm]

UTILISATION FACTORS FOR ALL LOAD CASE COMBINATIONS

4. $\gamma=0.47$	6. $\gamma=0.44$	9. $\gamma=0.43$
5. $\gamma=0.40$	11. $\gamma=0.39$	7. $\gamma=0.36$
13. $\gamma=0.33$	16. $\gamma=0.30$	14. $\gamma=0.28$
8. $\gamma=0.28$	10. $\gamma=0.24$	12. $\gamma=0.22$
15. $\gamma=0.20$	17. $\gamma=0.16$	

AXIAL STRESSES CONTROL

(load 4, at 461.4 cm from the start of the member)

The axial force design value	Ned = -1.241 kN
Transversal Force in Axis 2 Direction	V2ed = -1.958 kN
Transversal Force in Axis 3 Direction	V3ed = 0.000 kN
Bending Moment around Axis 2	M2ed = 0.000 kNm
Bending Moment around Axis 3	M3ed = 2.028 kNm

STRESS CONTROL - COMPRESSION AND BENDING

Load type: basic - short-term

Rectification Coefficient

Partial factor for material properties

Kmod =	0.700
γ_m =	1.300

Depth factor - axis 2

Kh_2 = 1.084

Depth factor - axis 3

Kh_3 = 1.000

Factor considering re-distribution of bending stresses

km = 0.700

Characteristic compressive strength

fc,0,k = 21.000 MPa

Design compressive strength

fc,0,d = 11.308 MPa

Characteristic bending strength

fm,k = 24.000 MPa

Design bending strength - axis 2

fm,2,d = 14.015 MPa

Design bending strength about axis 3

fm,3,d = 12.923 MPa

Relative slenderness

 $\lambda_{rel,2}$ = 0.587

Relative slenderness

 $\lambda_{rel,3}$ = 2.688

Design compressive stress

 $\sigma_{c,0,d}$ = 0.083 MPa

Section modulus

W3 = 375.00 cm³

Axial Stress Bending around Axis 3

 $\sigma_{m3,d}$ = 5.408 MPa

$$\sigma_{m3,d} \leq f_{m,3,d} (5.408 \leq 12.923)$$

Section utilization is 41.9%

COMPRESSION AND BENDING - BIG SLENDERNESS

Deviation from straightness factor

 β_c = 0.200

Coefficient

k3 = 4.351

Coefficient

k2 = 0.701

Coefficient

kc,3 = 0.129

Coefficient

kc,2 = 0.922

$$(\sigma_{c,0,d} / (k_{c,2} \times f_{c,0,d})) + k_m \times (\sigma_{m3,d} / f_{m,3,d}) + \sigma_{m2,d} / f_{m,2,d} \leq 1 (0.301 \leq 1)$$

Section utilization is 30.1%

$$(\sigma_{c,0,d} / (k_{c,3} \times f_{c,0,d})) + \sigma_{m3,d} / f_{m,3,d} + k_m \times (\sigma_{m2,d} / f_{m,2,d}) \leq 1 (0.475 \leq 1)$$

Section utilization is 47.5%

STABILITY CONTROL

Load type: basic - short-term

Rectification Coefficient

Kmod = 0.700

Partial factor for material properties

 γ_m = 1.300

Length between lateral restr.points

lef = 100.00 cm

Krokvy

fifth percentile value of the modulus E parallel to the grain

E0.05 = 7400.0 MPa

fifth percentile value of shear modulus parallel to grain

G0.05 = 460.00 MPa

Torsional section modulus

Itor = 2909.5 cm⁴

Moment of inertia

I2 = 1250.0 cm⁴

Section modulus

W3 = 375.00 cm³

Critical bending stress

 $\sigma_{m,crit} = 294.77$ MPa

Relative buckling slenderness

 $\lambda_{rel} = 0.285$

Coefficient

 $k_{krit} = 1.000$

Axial Stress Bending around Axis 3

 $\sigma_{m3,d} = 5.408$ MPa $\sigma_{m3,d} \leq k_{krit} \times \sigma_{m3,d} (5.408 \leq 12.923)$

Section utilization is 41.9%

SHEAR STRESSES CONTROL

(load 4, at 461.4 cm from the start of the member)

Transversal Force in Axis 2 Direction

V2ed = 2.682 kN

STRESS CONTROL – SHEAR

Load type: basic - short-term

Rectification Coefficient

 $K_{mod} = 0.700$

Partial factor for material properties

 $\gamma_m = 1.300$

Characteristic shear strength

 $f_{v,k} = 4.000$ MPa

Design shear strength

 $f_{v,d} = 2.154$ MPa

Cross Section Surface

 $A = 150.00$ cm²

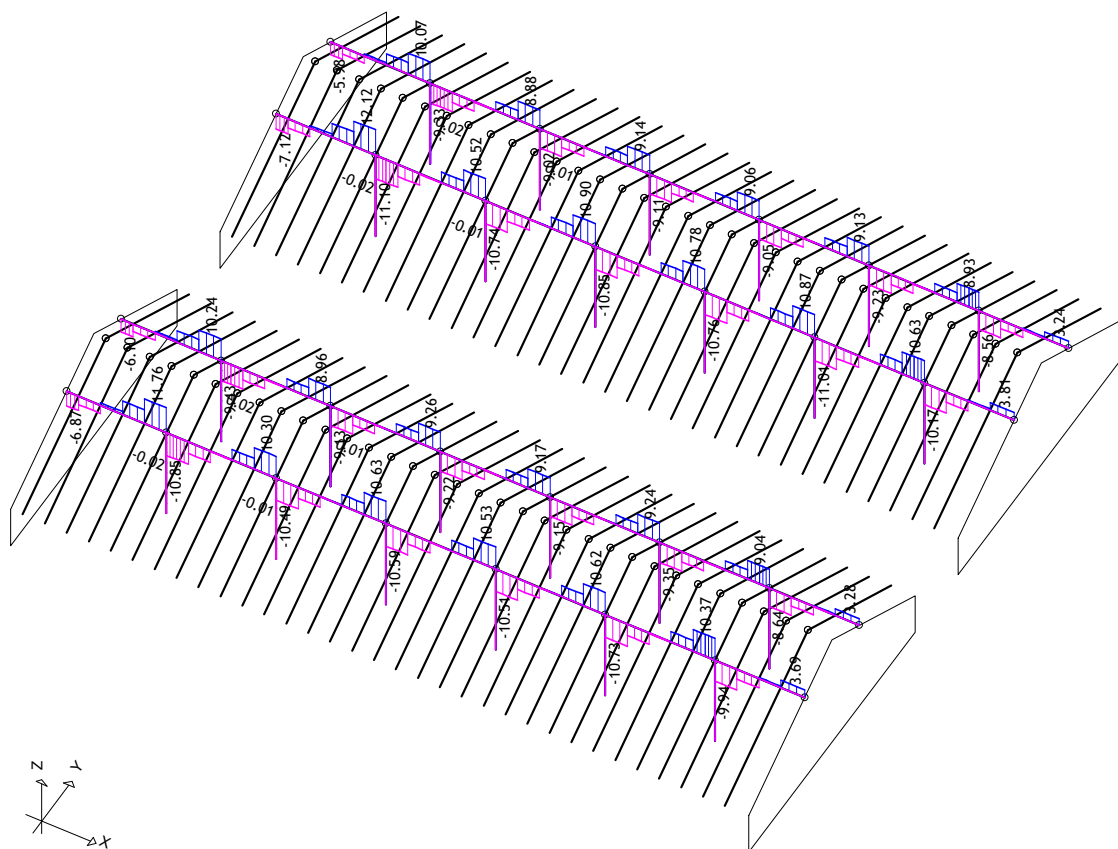
Actual Shear Stress(Axis 2)

 $\tau_{2,d} = 0.268$ MPa $\tau_{2,d} \leq f_{v,d} (0.268 \leq 2.154)$

Section utilization is 12.4%

Vážnice

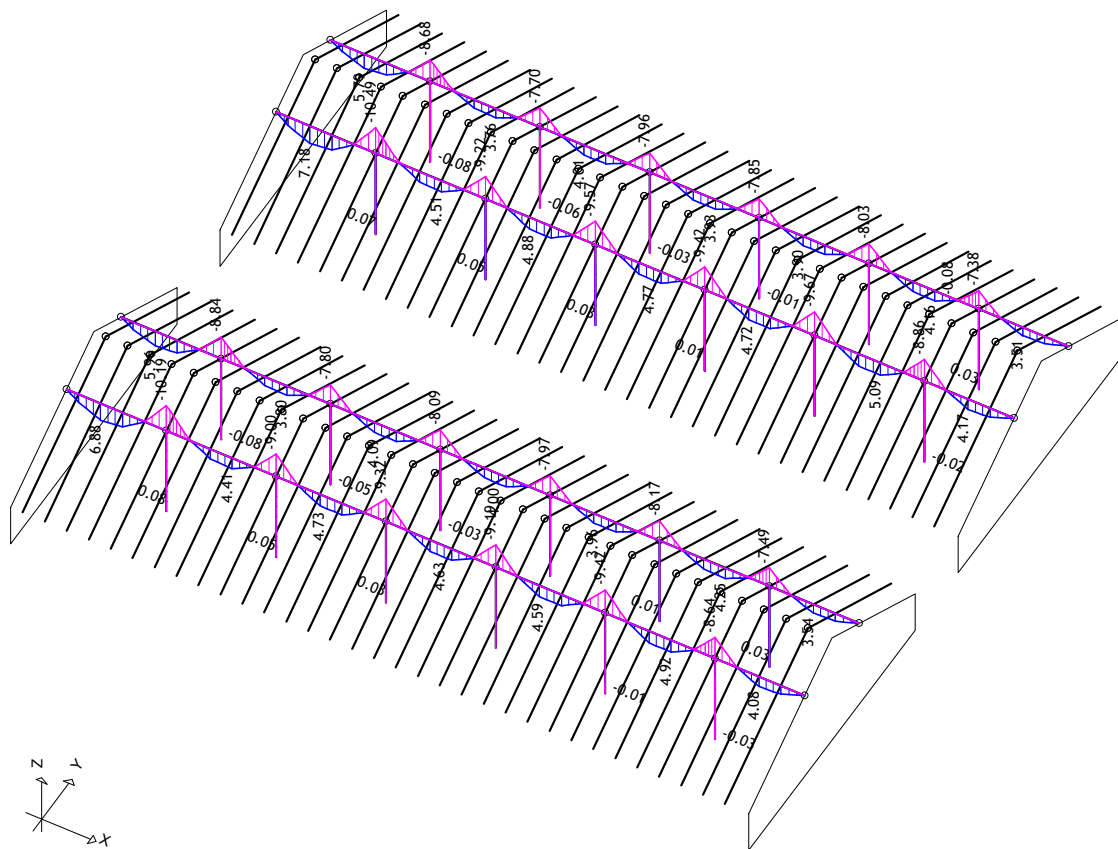
Load 18: [ULS] 4-12



Isometric

Beam Results: max V2= 12.12 / min V2= -11.10 kN

Load 18: [ULS] 4-12

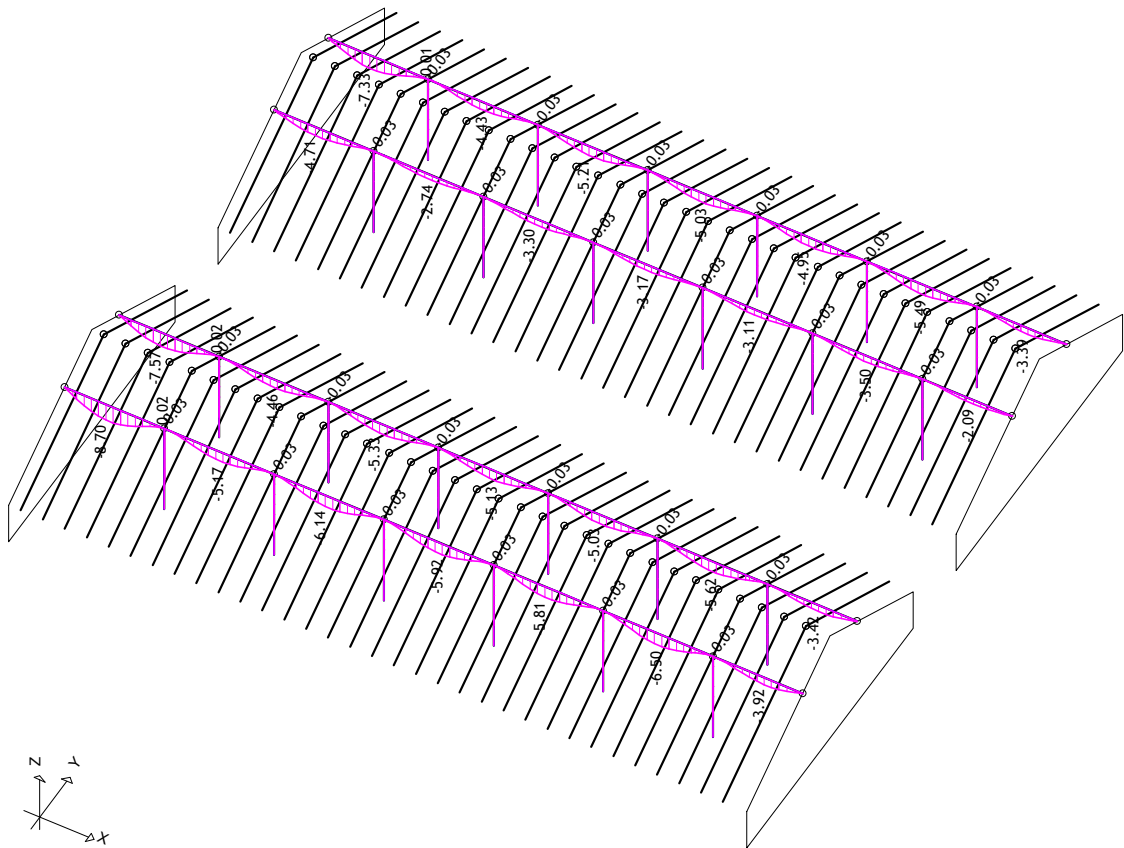


Isometric

Beam Results: max M3= 7.18 / min M3= -10.49 kNm

Vážnice

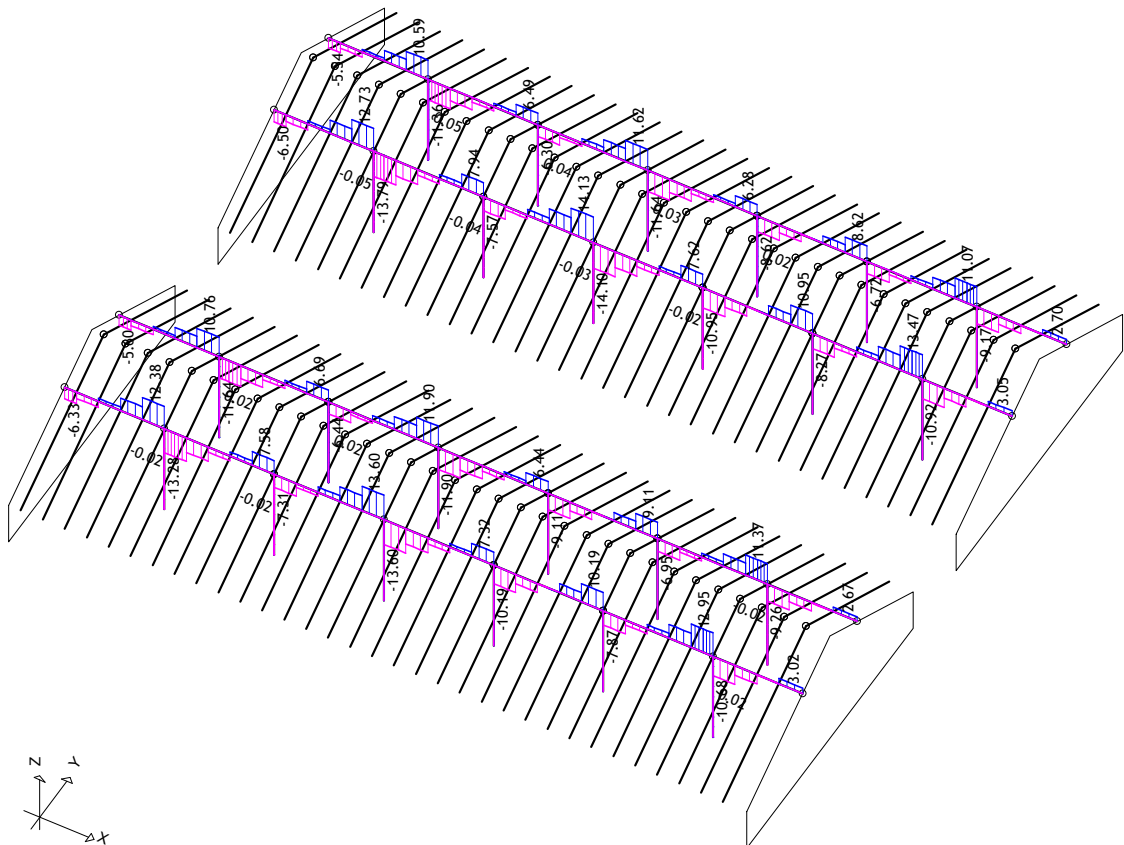
Load 18: [ULS] 4-12



Isometric

Beam Results: max Zd= 0.02 / min Zd= -8.70 m / 1000

Load 18: [ULS] 4-12

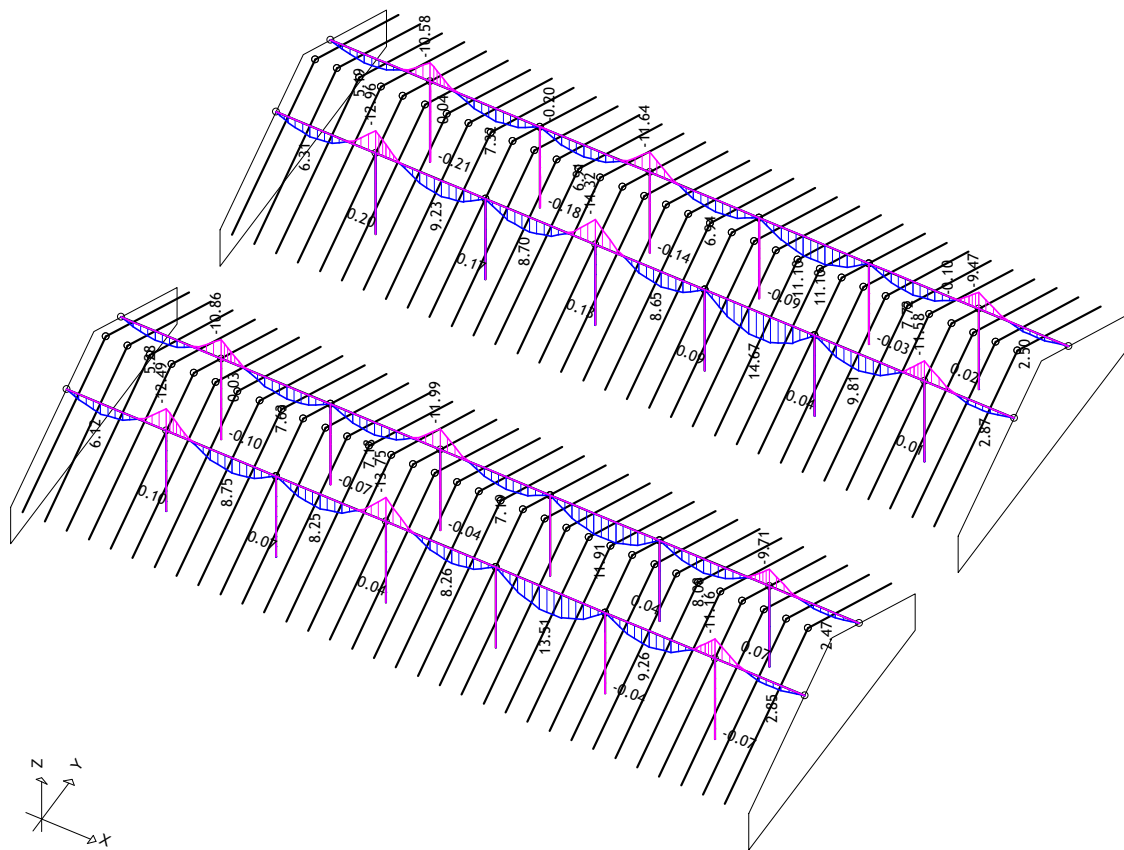


Isometric

Beam Results: max V2= 14.13 / min V2= -14.10 kN

Vážnice

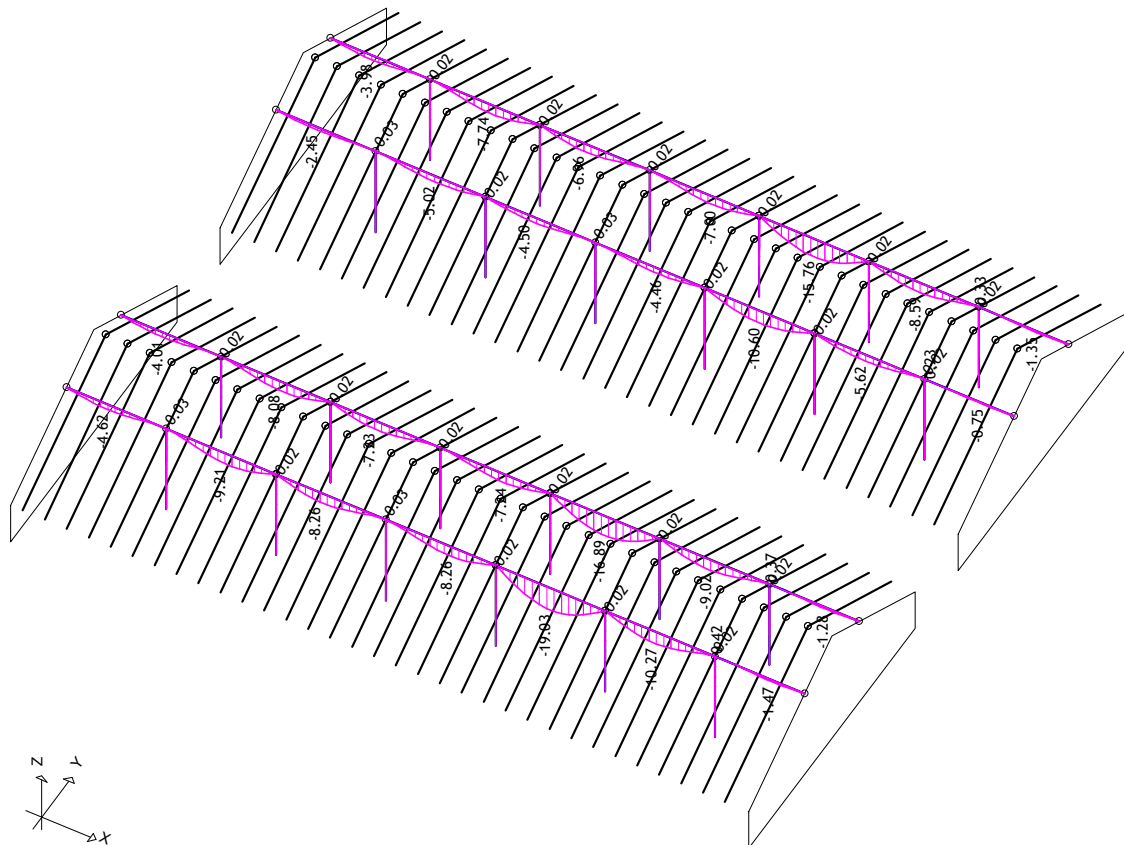
Load 18: [ULS] 4-12



Isometric

Beam Results: max M3= 14.67 / min M3= -14.33 kNm

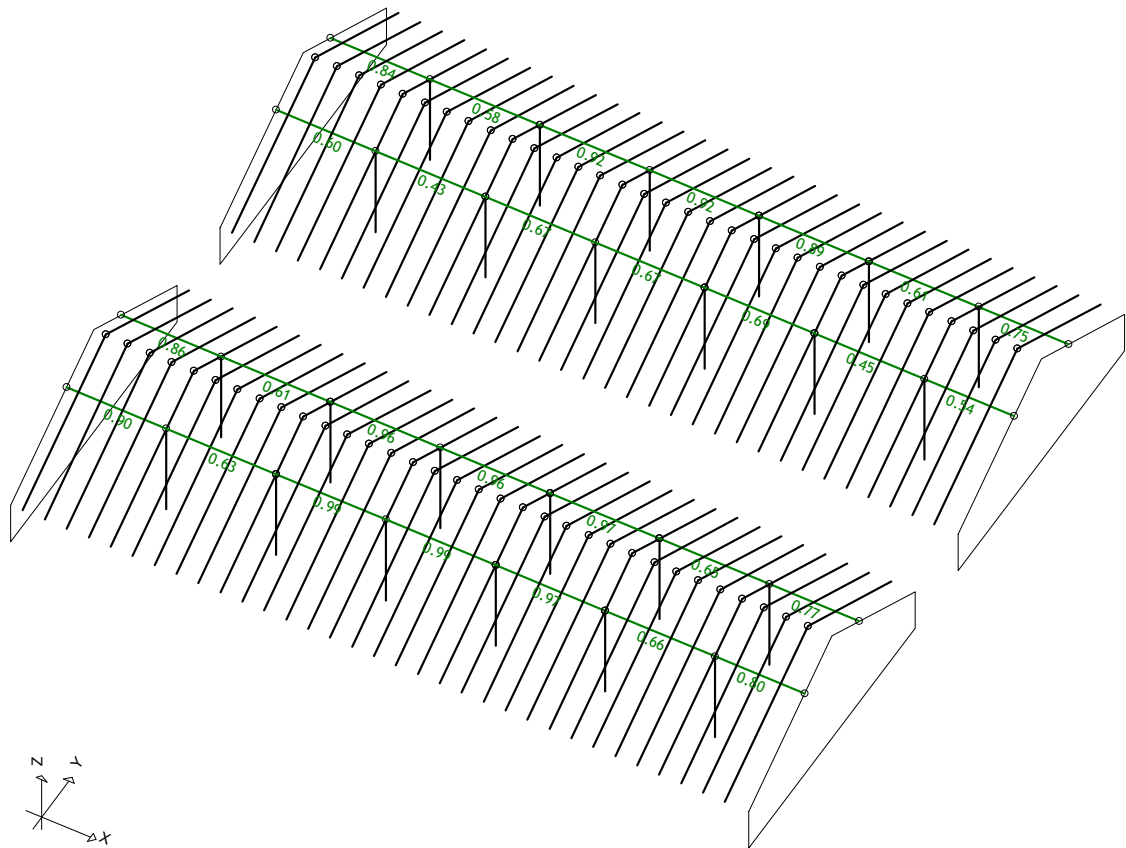
Load 19: [SLS] 13-17



Isometric

Beam Results: max Zd= 0.42 / min Zd= -19.03 m / 1000

Vážnice

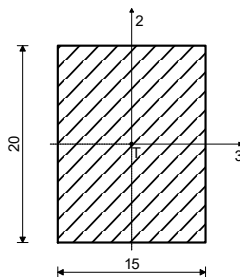


Isometric
Stability control

Posúdenie vážnice nepriťaženej panelmi FVE

BEAM 232-310

Solid timber - softwood - C27
Service class 3
EUROCODE (EN 1995-1-1)



[cm]

UTILISATION FACTORS FOR ALL LOAD CASE COMBINATIONS

4. $\gamma=0.99$	9. $\gamma=0.96$	5. $\gamma=0.92$
6. $\gamma=0.91$	11. $\gamma=0.85$	7. $\gamma=0.84$
8. $\gamma=0.70$	13. $\gamma=0.68$	16. $\gamma=0.67$
14. $\gamma=0.64$	10. $\gamma=0.62$	12. $\gamma=0.51$
15. $\gamma=0.49$	17. $\gamma=0.38$	

AXIAL AND SHEAR STRESSES CONTROL
(load 4, at the beginning of the member)

The axial force design value	Ned ≈ 0.000 kN
Transversal Force in Axis 2 Direction	V2ed = -13.605 kN
Transversal Force in Axis 3 Direction	V3ed = 0.826 kN
Torsion Moment	M1ed = -0.022 kNm
Bending Moment around Axis 2	M2ed = 0.700 kNm
Bending Moment around Axis 3	M3ed = 13.751 kNm

STRESS CONTROL – BENDING

Load type: basic - short-term
Rectification Coefficient

Kmod = 0.700

Partial factor for material properties

ym = 1.300

Depth factor - axis 2

Kh_2 = 1.000

Depth factor - axis 3

Kh_3 = 1.000

Factor considering re-distribution of bending stresses

km = 0.700

Characteristic bending strength

fm,k = 27.000 MPa

Design bending strength

fm,d = 14.538 MPa

Section modulus

W2 = 750.00 cm³

Axial Stress Bending around Axis 2

σm2,d = 0.934 MPa

Section modulus

W3 = 1000.0 cm³

Axial Stress Bending around Axis 3

σm3,d = 13.751 MPa

$$km \times (\sigma_{m3,d} / f_{m,3,d}) + \sigma_{m2,d} / f_{m,2,d} \leq 1 \quad (0.726 \leq 1)$$

Section utilization is 72.6%

$$\sigma_{m3,d} / f_{m,3,d} + km \times (\sigma_{m2,d} / f_{m,2,d}) \leq 1 \quad (0.991 \leq 1)$$

Section utilization is 99.1%

STRESS CONTROL – SHEAR

Load type: basic - short-term

Rectification Coefficient

Kmod = 0.700

Partial factor for material properties

ym = 1.300

Characteristic shear strength

fv,k = 4.000 MPa

Design shear strength

fv,d = 2.154 MPa

Cross Section Surface

A = 300.00 cm²

Actual Shear Stress(Axis 2)

τ2,d = 0.680 MPa

Actual Shear Stress(Axis 3)

τ3,d = 0.041 MPa

Influence Superposition from Transversal Force

(2) τ2,d / fv,d = 0.316

(3)

(3) τ3,d / fv,d = 0.019

$$(2)^2 + (3)^2 \leq 1 \quad (0.106 \leq 1)$$

Section utilization is 10.6%

STRESS CONTROL – TORSION

Characteristic shear strength

fv,k = 4.000 MPa

Design shear strength

fv,d = 2.154 MPa

Coefficient

kshape = 1.200

Vážnice

Torsion section modulus	Wt = 1009.5 cm ³	Partial factor for material properties	γ _m = 1.300
Actual Shear Stress	τ _{tor,d} = 0.022 MPa	Length between lateral restr.points	l _{ef} = 100.00 cm
τ_{tor,d} ≤ k_{shape} × f_{v,d} (0.022 ≤ 2.585)		fifth percentile value of the modulus E parallel to the grain	E _{0.05} = 8000.0 MPa
Section utilization is 0.9%		fifth percentile value of shear modulus parallel to grain	G _{0.05} = 500.00 MPa
Influence Superposition from Transversal Force and Torsion Moment		Torsional section modulus	I _{tor} = 12081 cm ⁴
(1)	τ _{tor,d} / (k _{shape} × f _{v,d}) = 0.009	Moment of inertia	I ₂ = 5625.0 cm ⁴
(2)	τ _{2,d} / f _{v,d} = 0.316	Section modulus	W ₃ = 1000.0 cm ³
(3)	τ _{3,d} / f _{v,d} = 0.019	Critical bending stress	σ _{m,crit} = 517.95 MPa
(1) + (2)² + (3)² ≤ 1 (0.109 ≤ 1)		Relative buckling slenderness	λ _{rel} = 0.228
Section utilization is 10.9%		Coefficient	k _{krit} = 1.000
STABILITY CONTROL		Axial Stress Bending around Axis 3	σ _{m3,d} = 13.751 MPa
Load type: basic - short-term		σ_{m3,d} ≤ k_{krit} × f_{m3,d} (13.751 ≤ 14.538)	
Rectification Coefficient		K _{mod} = 0.700	
		Section utilization is 94.6%	

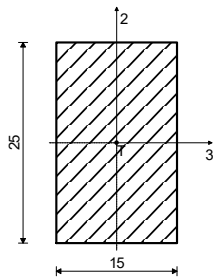
Posúdenie zosilnenej vážnice priťaženej panelmi FVE

BEAM 503-596

Solid timber - softwood - C27

Service class 3

EUROCODE (EN 1995-1-1)



[cm]

UTILISATION FACTORS FOR ALL LOAD CASE COMBINATIONS

4. γ=0.67	9. γ=0.65	5. γ=0.63
6. γ=0.61	7. γ=0.58	11. γ=0.58
8. γ=0.49	13. γ=0.46	16. γ=0.45
14. γ=0.44	10. γ=0.44	12. γ=0.35
15. γ=0.34	17. γ=0.26	

AXIAL AND SHEAR STRESSES CONTROL
(load 4, at the beginning of the member)

The axial force design value	N _{ed} = -0.124 kN
Transversal Force in Axis 2 Direction	V _{2ed} = -14.102 kN
Transversal Force in Axis 3 Direction	V _{3ed} = 0.910 kN
Torsion Moment	M _{1ed} = -0.040 kNm
Bending Moment around Axis 2	M _{2ed} = 0.682 kNm
Bending Moment around Axis 3	M _{3ed} = 14.324 kNm

STRESS CONTROL - COMPRESSION AND BENDING

Load type: basic - short-term

Rectification Coefficient

Partial factor for material properties

Depth factor - axis 2

Depth factor - axis 3

Factor considering re-distribution of bending stresses

Characteristic compressive strength	f _{c,0,k} = 22.000 MPa
Design compressive strength	f _{c,0,d} = 11.846 MPa
Characteristic bending strength	f _{m,k} = 27.000 MPa
Design bending strength	f _{m,d} = 14.538 MPa
Relative slenderness	λ _{rel,2} = 0.385
Relative slenderness	λ _{rel,3} = 0.231
Design compressive stress	σ _{c,0,d} = 0.003 MPa
Section modulus	W ₂ = 937.50 cm ³
Axial Stress Bending around Axis 2	σ _{m2,d} = 0.727 MPa

$$\sigma_{m2,d} \leq f_{m,d} \quad (0.727 \leq 14.538)$$

Section utilization is 5.0%

Section modulus	W ₃ = 1562.5 cm ³
Axial Stress Bending around Axis 3	σ _{m3,d} = 9.167 MPa

$$\sigma_{m3,d} \leq f_{m,d} \quad (9.167 \leq 14.538)$$

Section utilization is 63.1%

COMPRESSION AND BENDING - BIG SLENDERNESS

Deviation from straightness factor

Coefficient

β_c = 0.200k₃ = 0.520

Coefficient	k ₂ = 0.583
Coefficient	k _{c,3} = 1.015
Coefficient	k _{c,2} = 0.980

$$(\sigma_{c,0,d} / (k_{c,2} \times f_{c,0,d})) + k_m \times (\sigma_{m3,d} / f_{m,d}) + \sigma_{m2,d} / f_{m,d} \leq 1 \quad (0.492 \leq 1)$$

Section utilization is 49.2%

$$(\sigma_{c,0,d} / (k_{c,3} \times f_{c,0,d})) + \sigma_{m3,d} / f_{m,d} + k_m \times (\sigma_{m2,d} / f_{m,d}) \leq 1 \quad (0.666 \leq 1)$$

Section utilization is 66.6%

STRESS CONTROL – SHEAR

Load type: basic - short-term

Rectification Coefficient

Partial factor for material properties

Characteristic shear strength

Design shear strength

Cross Section Surface

Actual Shear Stress(Axis 2)

Actual Shear Stress(Axis 3)

Influence Superposition from Transversal Force

(2)

(3)

K _{mod} = 0.700
γ _m = 1.300
f _{v,k} = 4.000 MPa
f _{v,d} = 2.154 MPa
A = 375.00 cm ²
τ _{2,d} = 0.564 MPa
τ _{3,d} = 0.036 MPa
τ _{2,d} / f _{v,d} = 0.262
τ _{3,d} / f _{v,d} = 0.017

$$(2)^2 + (3)^2 \leq 1 \quad (0.073 \leq 1)$$

Section utilization is 7.3%

STRESS CONTROL – TORSION

Characteristic shear strength

Design shear strength

Coefficient

Torsion section modulus

Actual Shear Stress

f _{v,k} = 4.000 MPa
f _{v,d} = 2.154 MPa
k _{shape} = 1.250
W _t = 1327.5 cm ³
τ _{tor,d} = 0.030 MPa

$$\tau_{tor,d} \leq k_{shape} \times f_{v,d} \quad (0.030 \leq 2.692)$$

Section utilization is 1.1%

Influence Superposition from Transversal Force and Torsion Moment

(1)

(2)

(3)

τ _{tor,d} / (k _{shape} × f _{v,d}) = 0.011
τ _{2,d} / f _{v,d} = 0.262
τ _{3,d} / f _{v,d} = 0.017

$$(1) + (2)^2 + (3)^2 \leq 1 \quad (0.080 \leq 1)$$

Section utilization is 8.0%

STABILITY CONTROL

Load type: basic - short-term

Rectification Coefficient

Partial factor for material properties

Length between lateral restr.points

fifth percentile value of the modulus E parallel to the grain

fifth percentile value of shear modulus parallel to grain

E _{0.05} = 8000.0 MPa
G _{0.05} = 500.00 MPa
I _{tor} = 17447 cm ⁴
I ₂ = 7031.2 cm ⁴
W ₃ = 1562.5 cm ³
σ _{m,crit} = 445.39 MPa
λ _{rel} = 0.246
k _{krit} = 1.000
σ _{m3,d} = 9.167 MPa

Väznice

$\sigma_{m,3,d} \leq k_{krit} \times f_{m,3,d}$ (9.167 ≤ 14.538)

Section utilization is 63.1%

Záver

Záver:

Konštrukcia strechy je podmiennečne spôsobilá na osadenie fotovoltaiických panelov.

Je nutné zosilniť stredovú väznicu na tej strane strechy, kde budú osadené panely FVE - vid' obrázok nižšie.

Zosilnená stredová väznica na strane osadenia FVE

