# MOST ČEZ SAVO

STATIČNA ANALIZA

**Računal:**
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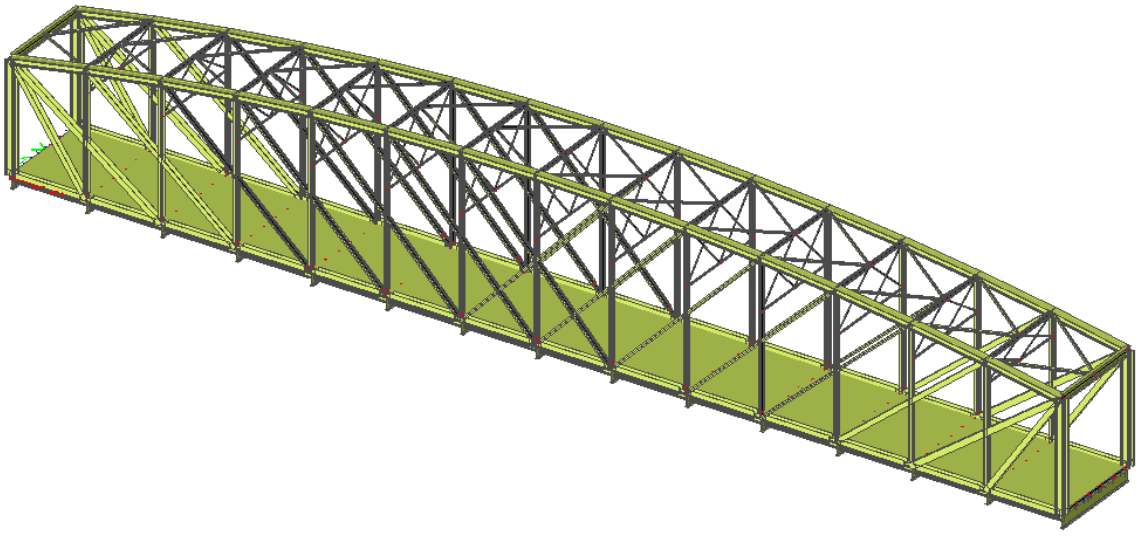
## 1. ZASNOVA KONSTRUKCIJE

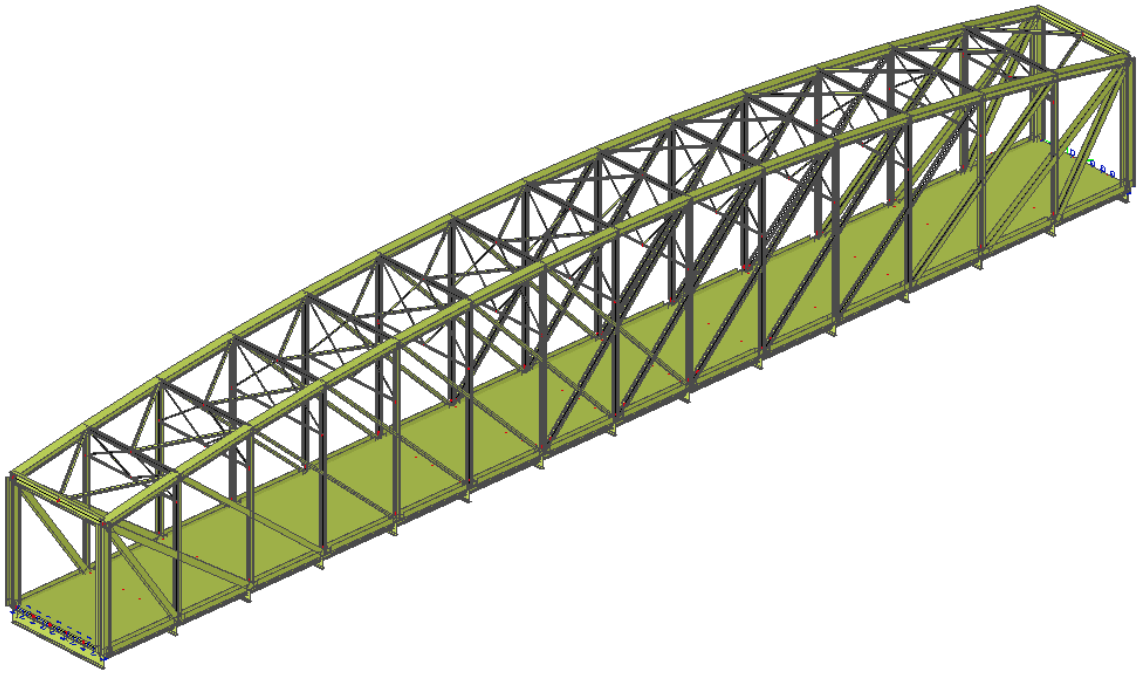
Objekt most čez Savo je sestavljen iz dveh jeklenih nosilcev, ter sovprežno voziščno konstrukcijo. Vsak nosilec je tlorisnih dimenzij cca. 57,26x5,4m torej je celoten most dolžine cca. 114,52m. Zasnovan je kot kovičeno prostorsko paličje zgrajeno leta 1907. V zgodovini objekta je bil le ta večkrat saniran, nazadnje leta 1996. Izvedena je bila računska analiza za oceno varnosti, saj je objekt v zelo slabem stanju.

Predpostavljena kvaliteta materiala je S235 za jekleno konstrukcijo, ter C35/45 za AB ploščo in armaturo B500.

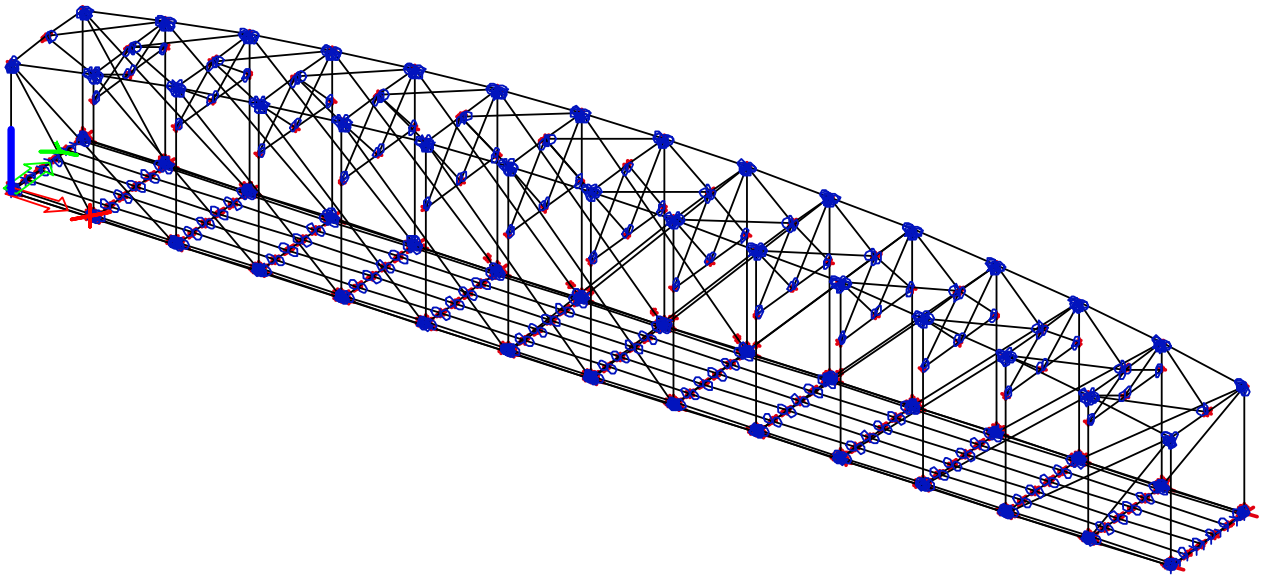
Analiza konstrukcije je bila izvedena na prostorskem paličju, z sovprežno ploščo.

Renderiran prikaz modela:





Model konstrukcije s prikazanimi sprostitvami v elementih (členki):



Pri statičnem izračunu je bila upoštevana lastna teža, ter ostali stalni ter spremenljivi vplivi.

Izvrednotene obtežne kombinacije za posamezne obtežne primere (lastna teža, stalna obtežba, spremenljiva obtežba, veter, promet…) ter dokazi varnosti na mejna stanja določamo skladno s standardi EUROCODE.

Račun je bil izveden z računalniškim programom SCIA Engineer 2009.

# 2. VPLIVI NA OBJEKT

## LASTNA IN STALNA:

### a. Lastna teža konstrukcije :

Za vse konstrukcijske elemente je lastna teža v izračunu upoštevana avtomatsko (računalniški program SCIA Enginer 2009) s prostorninski težo armiranega betona $\gamma_{betona} = 25.0kN\cdot m^{-3}$.

### b. Stalna obtežba vozišče konstrucije:

- asfalt 6cm $d_{as.g} = 6cm$ $g_{as}(d_{as.g}) = 1.50\cdot kN\cdot m^{-2}$
- HI $q_{hi} = 0.16\cdot kN\cdot m^{-2}$

$$q_{st} := q_{hi} + (g_{as}(d_{as.g})) = 1.66\cdot kPa$$

## VPLIV PROMETA:

Na mostu je za prometno obtežbo upoštevano vozilo skladno z SIST EN 1991-1-1, 6.3.3 (prometne in parkirne površine za srednje težka vozila). Za izračun ni upoštevano vozilo iz modela LM1 (osna obtežl $Q_{ki}$ = 300kN), ki ga standard SIST EN 1991-2 predvideva, saj bo na tem objektu omejen promet. Omejitev obtežbe na mostu dosežemo z omejitvijo pred mostom.

Vozišče širine 5.4m razdelim na 1 namišljen pas širine $w_1 = 3m$

in preostali del širine $w_{ostalo} = 2.4m$

$\alpha_{Q1} = 1$ prilagoditveni faktor

$\alpha_{q1} = 1$ prilagoditveni faktor

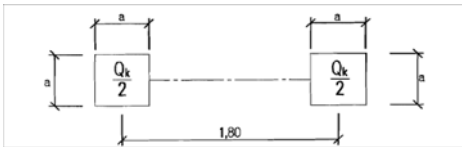
Navpična obtežba

- dinamični faktor

$\phi = 1$ za kolesa s pnevmatikami (po SIST EN 1991-1-1, 6.3.2.3 (3))

- koncentrirani osni pritisk

$Q_{1k} = 100kN$ => dve točkovni sili po $\frac{\phi\cdot Q_{1k}}{2} = 50\cdot kN$




- porazdeljena obtežba

$q_{1k} = 2.5kN\cdot m^{-2}$ na 1 pasu

$q_{rk} = 2.5kN\cdot m^{-2}$ na preostalem pasu

Vodoravna obtežba

- zavorne sile in pospeševalne sile

$L_{krova} = 57.26m$ dolžina mosta

$Q_{lk} = 0.6\cdot\alpha_{Q1}\cdot 2\cdot Q_{1k} + 0.1\cdot\alpha_{q1}\cdot q_{1k}\cdot w_1\cdot L_{krova}$ $Q_{lk} = 162.94\cdot kN$

omejitev $180\alpha_{Q1}\cdot kN \le Q_{lk} \le 900kN$

## VPLIV VETERA:

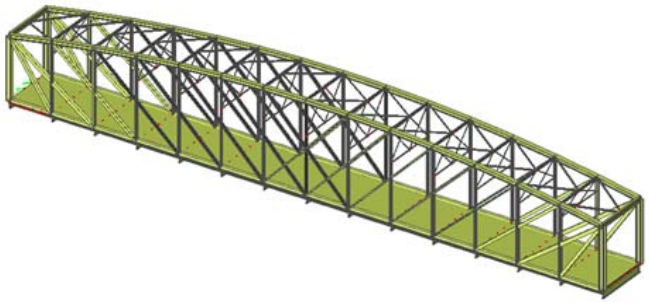
- osnovna hitrost vetra: $v_b = 25m \cdot s^{-1}$ Cona 1

- osnovna (referenčni) tlak vetra: $q_{ref} = 0.5 \cdot \rho_z \cdot v_b^2$ $q_{ref} = 0.39 \cdot kN \cdot m^{-2}$

- kategorija terena

***ktg I***
***ktg II***

- višina objekta $Z_h = 7.5m$



$b = 5.4m$

$d_{tot} = 8.8m$ (glej 8.3.1)

$L_{razpon} = 57.26m$

- koeficient izpostavljenosti $C_e(Z_h) = 2.60$

### Sila vetra

- dinamična metoda ni potrebna => $C_s C_d = 1.0$

#### a.) brez prometa

- koeficient sile brez upoštevanja vitkosti

$\frac{b}{d_{tot}} = 0.61$ => slika 8.3 odčitamo $c_{f.x} = 2.36$ (za normalne mostove se lahko vzame $c_{fx}$=1.3 ali odčita iz slike)

- referenčna površina brez prometne obtežbe (glej 8.3.1(4)) $d = d_{tot} = 8.8m$

$A_{ref.x} = d + 0.6m$ $A_{ref.x} = 9.4m$

- faktor obtežbe vetra (standard prikazuje dva možna izračuna $C_1$ in $C_2$ - glej 8.3.2, izberem manjšega - $C_1$, ker je bolj natančen izračun, kot pa $C_2$ iz preglednice - bolj konservativna vrednost)

$C_1 = C_e(Z_h) \cdot c_{f.x} = 6.14$

$C_2 = 6.6$ glej preglednico 8.2 $C_{min} = \min(C_1, C_2) = 6.14$

Sila vetra v smeri X (prečna smer)

$F_{w.x} = q_{ref} \cdot C_{min} \cdot A_{ref.x}$ $F_{w.x} = 22.56 \cdot kN \cdot m^{-1}$

Sila vetra v smeri Y (vzdolžna smer)

$F_{w.y} = 0.25 \cdot F_{w.x}$ $F_{w.y} = 5.64 \cdot kN \cdot m^{-1}$

#### b.) z prometom

Pri kombinaciji vetra z prometom se upošteva manjša izmed vrednosti: - $F_w^*$, $v_b$ = 23m/s
- $\Psi_0 * F_{wk}$

**1.) maksimalna sila vetra** $v_{b.p1} = 23m \cdot s^{-1}$

$b_{p1} = b = 5.4\,m$ $d_{tot.p1} = d_{tot} + 2m = 10.8\,m$ višina na kateri se upošteva vpliv vetra je višina preklade povečana za 2.0m

- osnovna (referenčni) tlak vetra: $q_{ref.p1} = 0.5 \cdot \rho_z \cdot v_{b.p1}^2$ $q_{ref.p1} = 0.33 \cdot kN \cdot m^{-2}$

- koeficient sile brez upoštevanja vitkosti

$\frac{b_{p1}}{d_{tot.p1}} = 0.5$ => slika 8.3 odčitamo $c_{f.x.p1} = 2.4$ (za normalne mostove se lahko vzame $c_{fx}$=1.3 ali odčita iz slike)

- referenčna površina pri $V_b$ = 23m/s $d = d_{tot} = 8.8\,m$

$A_{ref.x.p1} = d + 2m$ $A_{ref.x.p1} = 10.8\,m$

- faktor obtežbe vetra (standard prikazuje dva možna izračuna $C_1$ in $C_2$ - glej 8.3.2, izberem manjšega - $C_1$, ker je bolj natančen izračun, kot pa $C_2$ iz preglednice - bolj konservativna vrednost)

$C_{1.p1} = C_e(Z_h) \cdot c_{f.x.p1} = 6.24$

$C_{2.p1} = 6.7$ glej preglednico 8.2 $C_{min.p1} = \min(C_{1.p1}, C_{2.p1}) = 6.24$

Sila vetra v smeri X (prečna smer)

$F_{w.x.p1} = q_{ref.p1} \cdot C_{min.p1} \cdot A_{ref.x.p1}$ $F_{w.x.p1} = 22.27 \cdot kN \cdot m^{-1}$

Sila vetra v smeri Y (vzdolžna smer)

$F_{w.y.p1} = 0.25 \cdot F_{w.x.p1}$ $F_{w.y.p1} = 5.57 \cdot kN \cdot m^{-1}$

**2.) vpliv vetra na vozila z upoštevanjem faktorja** $\psi_0 = 0.6$

$b_{p2} = b = 5.4\,m$ $d_{tot.p2} = d_{tot} + 3.5m = 12.3\,m$ višina na kateri se upošteva vpliv vetra je višina preklade povečana za 3.5m - višina tovornjaka

- koeficient sile brez upoštevanja vitkosti

$\frac{b_{p2}}{d_{tot.p2}} = 0.44$ => slika 8.3 odčitamo $c_{f.x.p2} = 2.4$ (za normalne mostove se lahko vzame $c_{fx}$=1.3 ali odčita iz slike)

- referenčna površina z prometno obtežbo $d = d_{tot} = 8.8\,m$

$A_{ref.x.p2} = d + 3.5m$ $A_{ref.x.p2} = 12.3\,m$

- faktor obtežbe vetra (standard prikazuje dva možna izračuna $C_1$ in $C_2$ - glej 8.3.2, izberem manjšega - $C_1$, ker je bolj natančen izračun, kot pa $C_2$ iz preglednice - bolj konservativna vrednost)

$C_{1.p2} = C_e(Z_h) \cdot c_{f.x.p2} = 6.24$

$C_{2.p2} = 6.7$ glej preglednico 8.2 $C_{min.p2} = \min(C_{1.p2}, C_{2.p2}) = 6.24$

Sila vetra v smeri X (prečna smer)

$F_{w.x.p2} = q_{ref} \cdot C_{min.p2} \cdot A_{ref.x.p2} \cdot \psi_0$ $F_{w.x.p2} = 17.98 \cdot kN \cdot m^{-1}$

Sila vetra v smeri Y (vzdolžna smer)

$F_{w.y.p2} = 0.25 \cdot F_{w.x.p2}$ $F_{w.y.p2} = 4.49 \cdot kN \cdot m^{-1}$

Merodajna obtežba vetra za kombinacijo z prometom

Sila vetra v smeri X (prečna smer)

$F_{w.x.p} = \min\left(F_{w.x.p1}, F_{w.x.p2}\right)$ $F_{w.x.p} = 17.98 \cdot kN \cdot m^{-1}$

Sila vetra v smeri Y (vzdolžna smer)

$F_{w.y.p} = \min\left(F_{w.y.p1}, F_{w.y.p2}\right)$ $F_{w.y.p} = 4.49 \cdot kN \cdot m^{-1}$ => $\frac{F_{w.y.p}}{w_1} = 1.5 \cdot kN \cdot m^{-2}$

## VPLIV TEMPERATURE

$T_{max} = 40\ ^0C$
$T_{min} = -25\ ^0C$ max in min temperaturi iz kart najnižjih in najvišjih temperatur (nacionalni dodatek k SIST EN 1991-1-5)

$T_0 = 20\ ^0C$ referenčna temperatura (če ni podatka se poda $T_0$=10$^0$C - dodatek A)

Za tip mostu 2, sta dejanski temperaturi na mostu sledeči (slika 6.1)

$T_{e.max} = T_{max} + 5$ $T_{e.max} = 45\ ^0C$

$T_{e.min} = T_{min} + 5$ $T_{e.min} = -20\ ^0C$

Enakomerni vpliv temerature

$\Delta T_{N.CON} = T_{e.min} - T_0$ $\Delta T_{N.CON} = -40\ ^0C$ osni skrček

$\Delta T_{N.EXP} = T_{e.max} - T_0$ $\Delta T_{N.EXP} = 25\ ^0C$ osni raztezek

Nenakomerni vpliv temerature

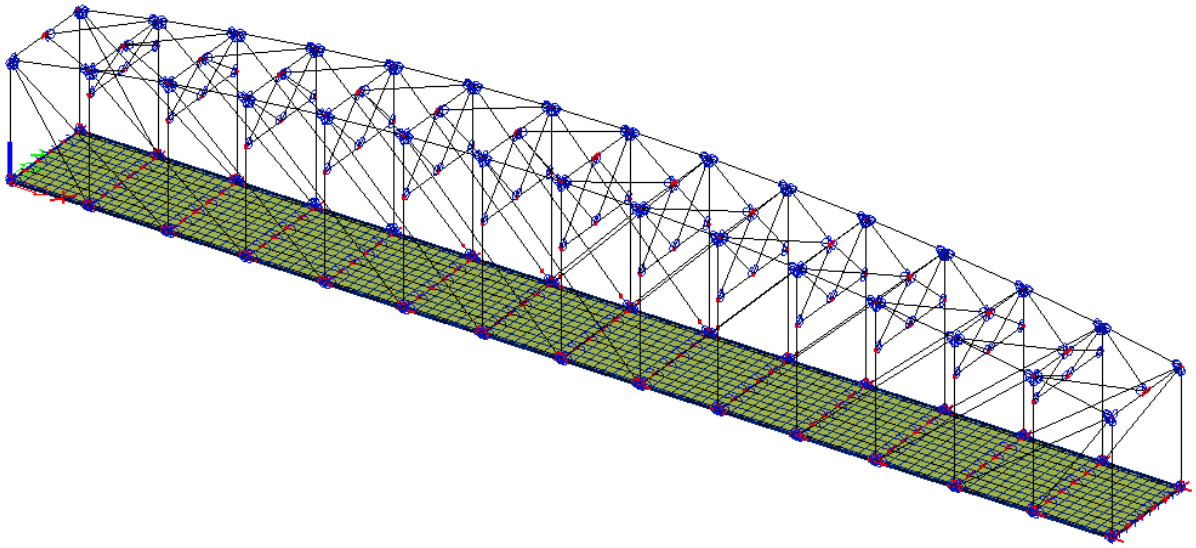
$\Delta T_{Met} = 15\ ^0C$ .....Zgornji rob prekladne konstrukcije toplejši od spodnjega.

$\Delta T_{Mcol} = 18\ ^0C$ .....Spodnji rob prekladne konstrukcije toplejši od spodnjega.

## 3. ANALIZA KONSTRUKCIJE

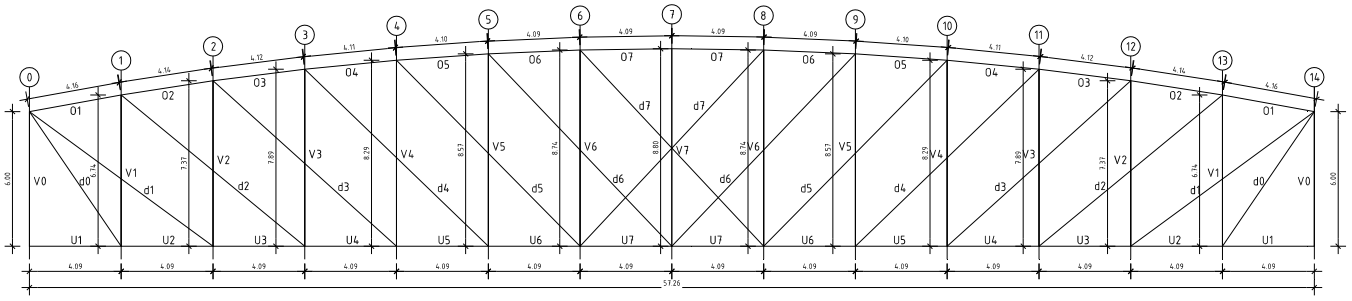
Analiza je opravljena na prostorskem modelu, sestavljenem iz linijskih in ploskovnih elementov. Podpiranje konstrukcije je modelirano kot toge podpore sten ter stebrov v tla. Sestavljeni so bili trije modeli (dva za obstoječe stanje – vsak nosilec posebej, ter eden za novo sanirano stanje).

Računski model konstrukcije:

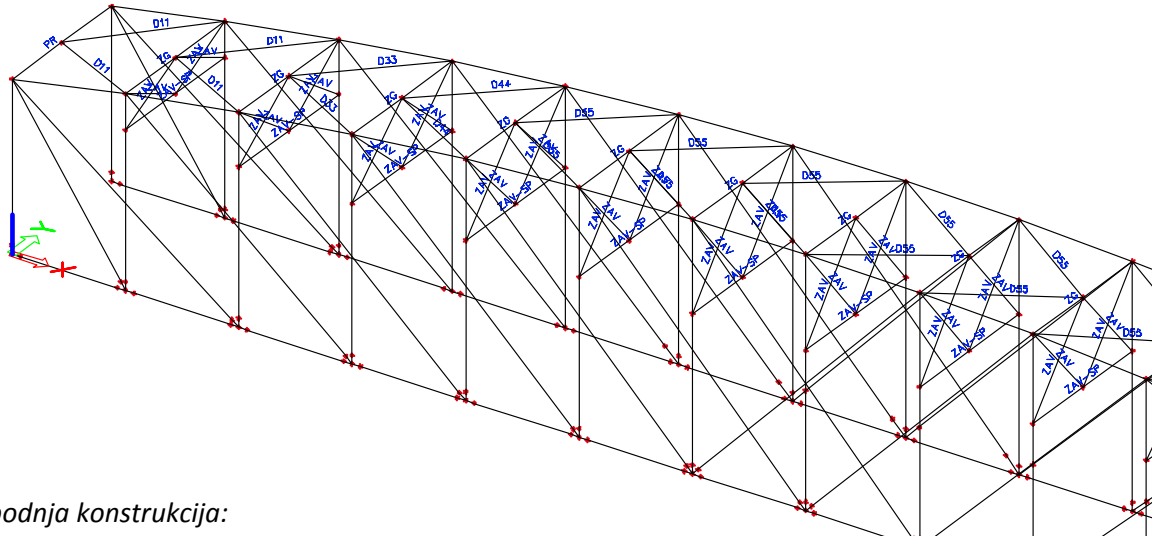


**Uporabljeni prečni prerezi:**

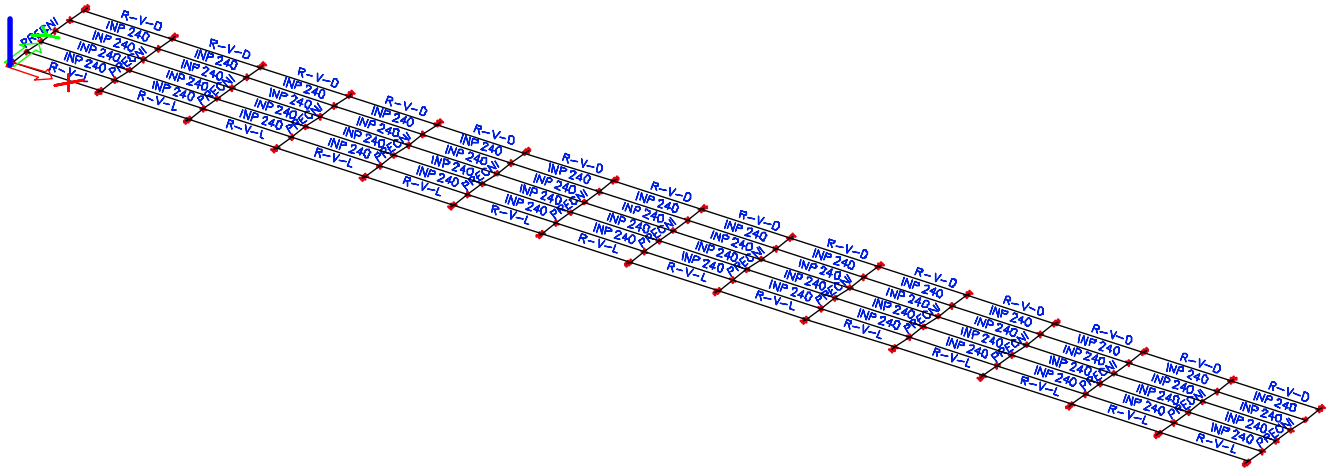
*Vertikale, diagonale, spodnji pas, zgornji pas:*

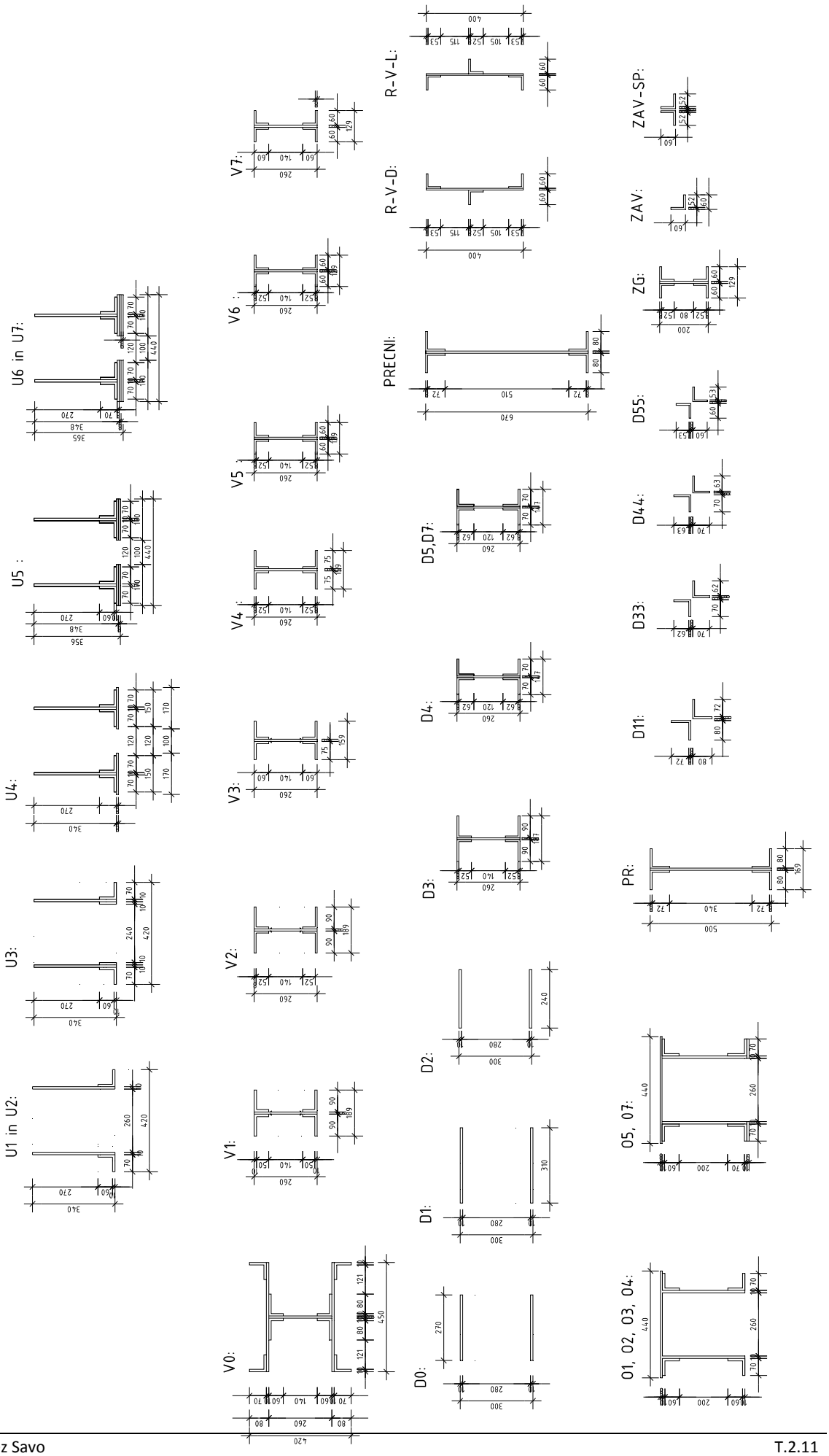


*Zavetrovanje:*



*Spodnja konstrukcija:*




U6 in U7:
U5 :
U4:
U3:
U1 in U2:
V7:
V6 :
V5 :
V4 :
V3:
V2:
V1:
V0:
R-V-L:
R-V-D:
PRECNI:
D5,D7:
D4:
D3:
D2:
D1:
D0:
ZAV-SP:
ZAV:
ZG:
D55:
D44:
D33:
D11:
PR:
05, 07:
01, 02, 03, 04:

## 3.1. Analiza konstrukcije v MSN

### 3.1.1. Notranje sile v elementih:

V vertikalah, diagonalah, spodnjem pasu ter zavetrovanju prikazujemo samo osne sile, ker je sistem zastavljen kot prostorsko paličje.

**Stalno in začasno projektno stanje**

S1.) $\gamma_G$×lastna t.+ $\gamma_G$×stalne obt + $\gamma_Q$×promet + 0.60×$\gamma_Q$×temp. spr.+ 0.2×$\gamma_Q$×veter

S2.) $\gamma_G$×lastna t.+ $\gamma_G$×stalne obt + $\gamma_Q$× temp. spr.+ 0.75×$\gamma_Q$× promet + 0.2×$\gamma_Q$×veter

S3.) $\gamma_G$×lastna t.+ $\gamma_G$×stalne obt + $\gamma_Q$× zavorne sile + 0.75×$\gamma_Q$× promet + 0.2×$\gamma_Q$×veter

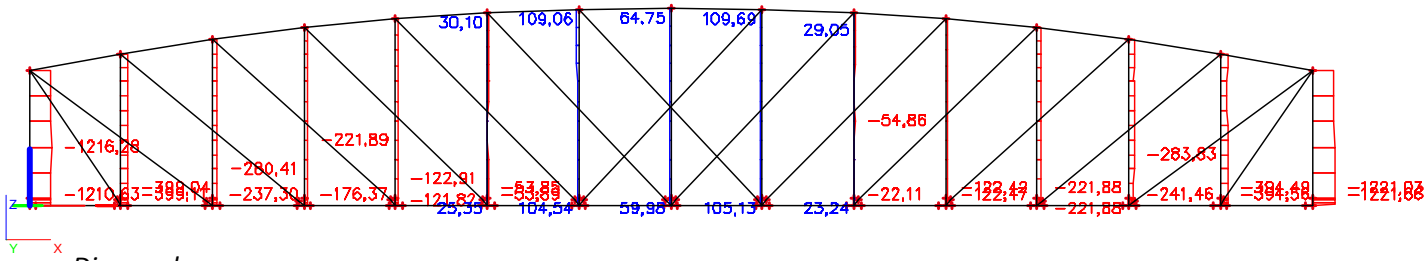
S4.) $\gamma_G$×lastna t.+ $\gamma_G$×stalne obt + $\gamma_Q$× veter + 0.75×$\gamma_Q$× promet

*stalni vplivi:* $\gamma_{G.sup}$= 1.35, $\gamma_{G.inf}$= 1.0, $\gamma_P$= 1.0

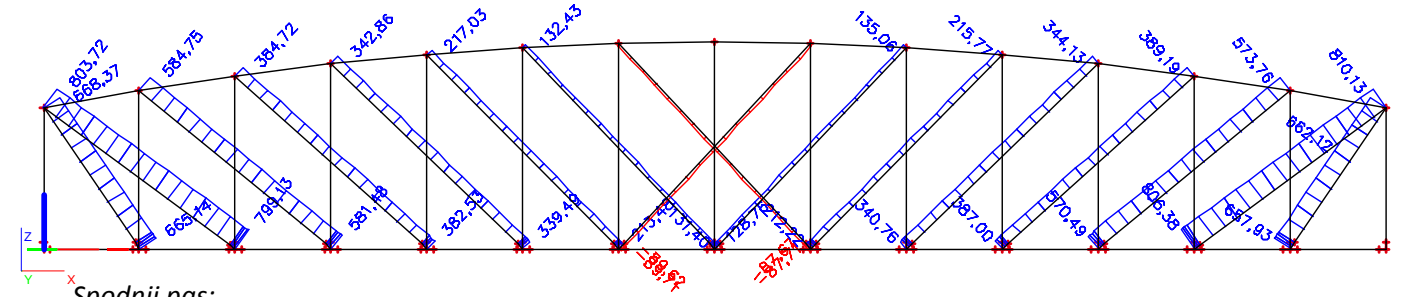
*spremenljivi vplivi:* $\gamma_{Q.sup}$= 1.5, $\gamma_{Q.inf}$= 0.0

**OP.: Notranje sile prikazujemo samo za en nosilec, saj sta nosilca enaka! Prav tako ni bistvenih razlik med notranjimi silami obstoječega in saniranega stanja!**

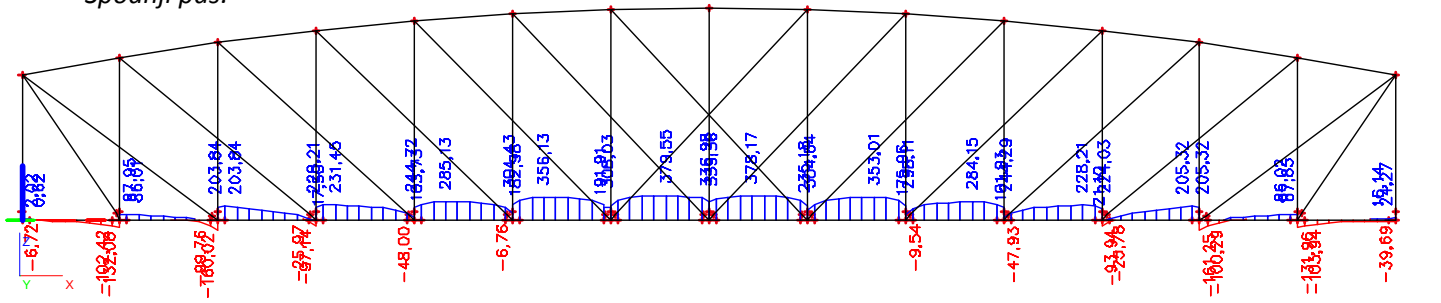
*Vertikale:*



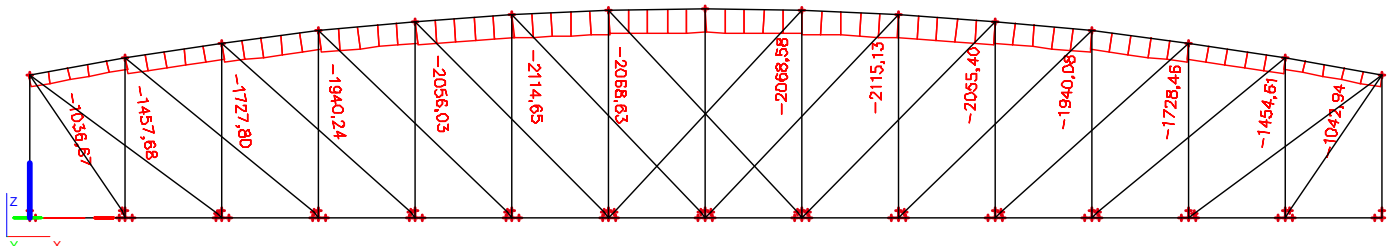

*Diagonale:*



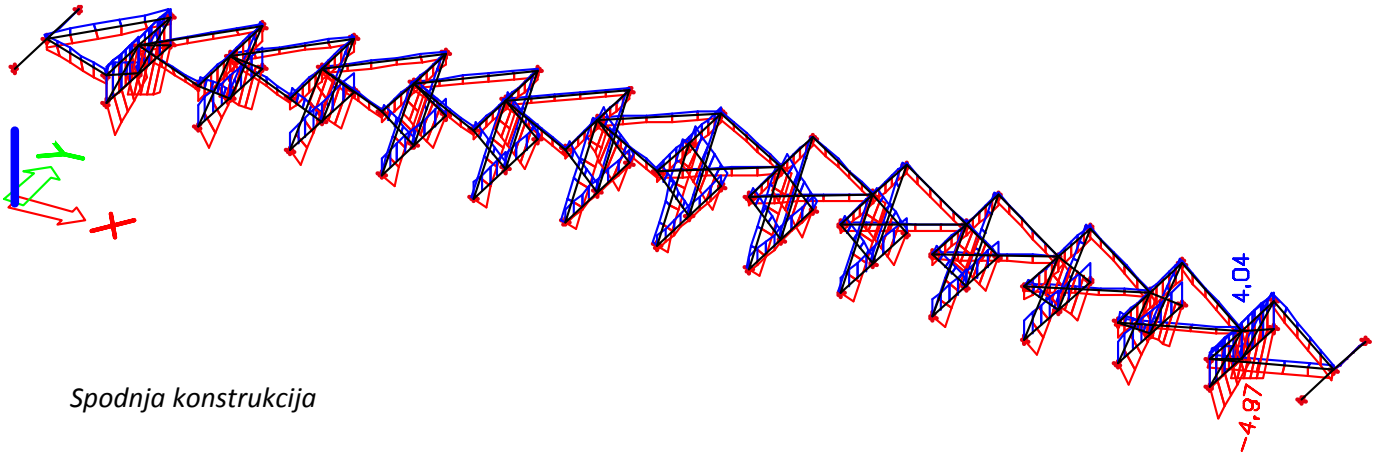

*Spodnji pas:*



*Zgornji pas:*

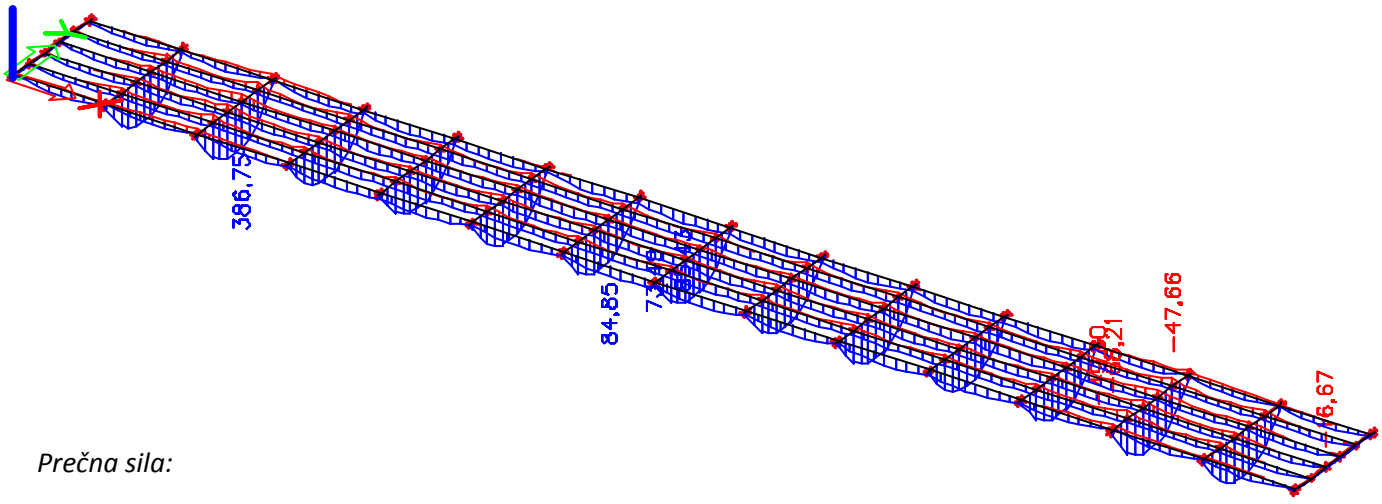



*Zavetrovanje:*

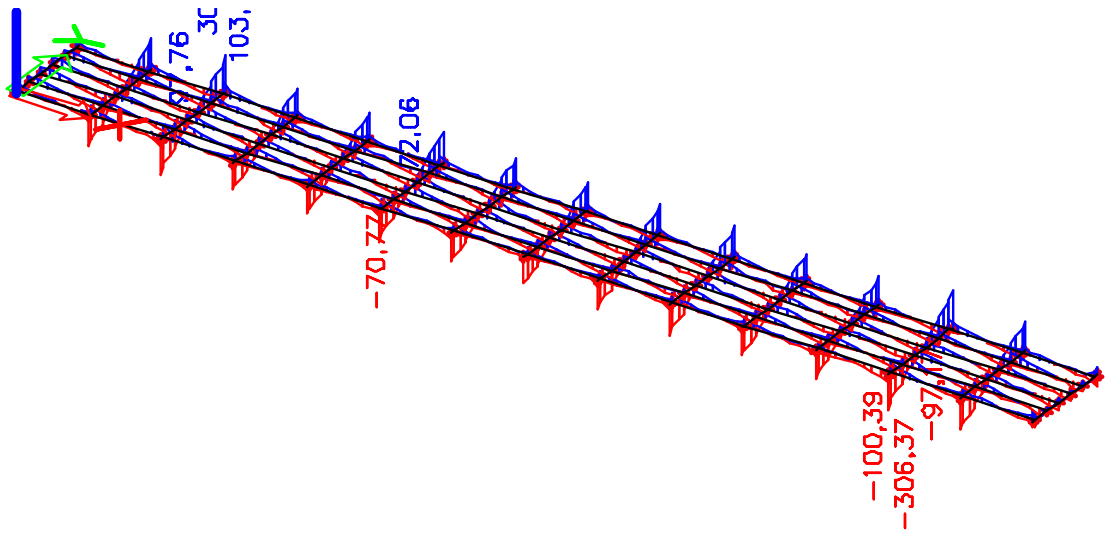



*Spodnja konstrukcija*

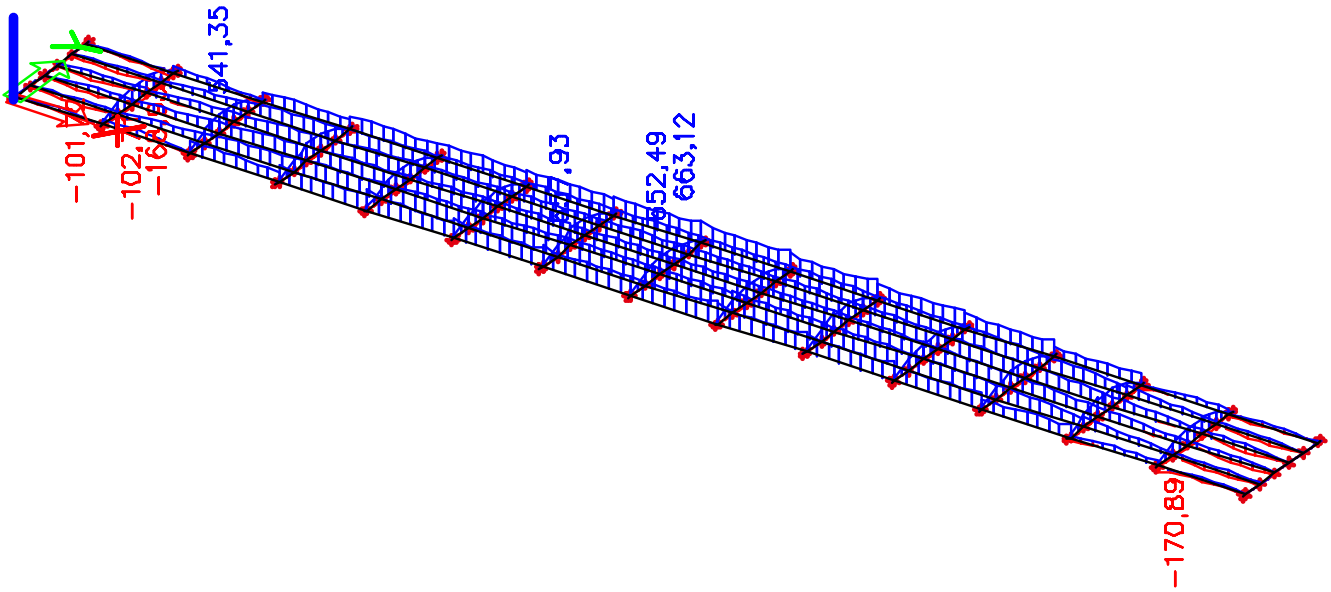
*Momenti:*




*Prečna sila:*



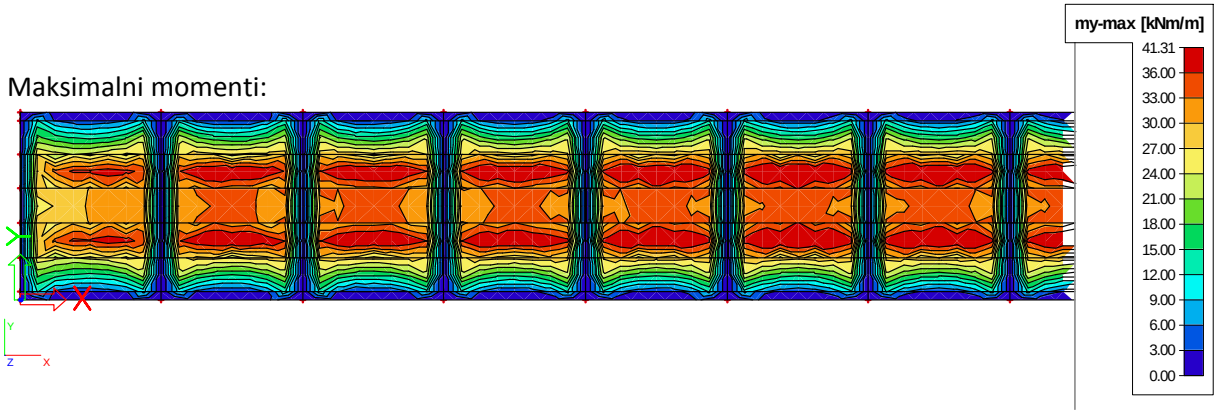
*Osna sila:*



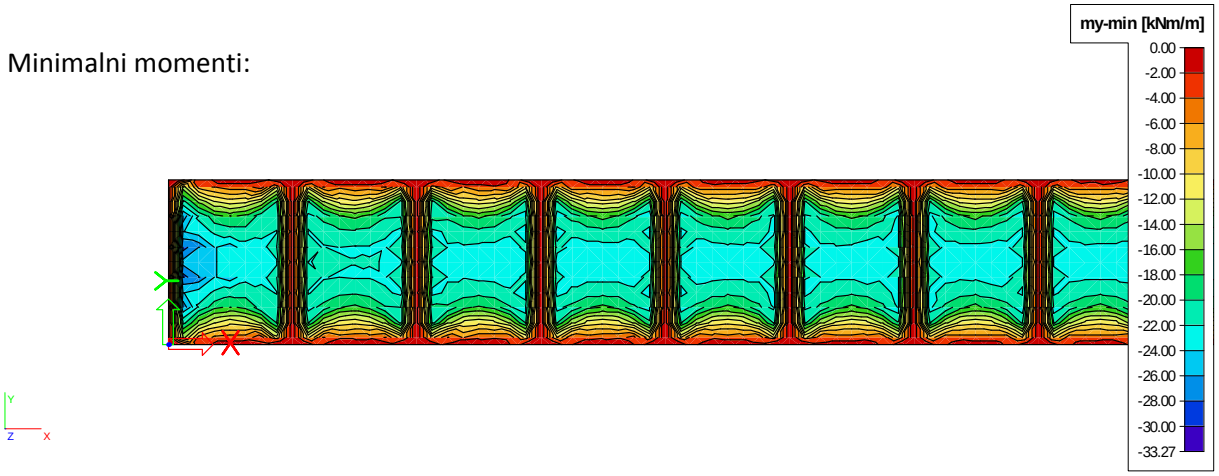

*Momenti v AB plošči :*

**OP.: Plošča je nosilna le v krajši smeri, zato prikazujemo le te momente! Prikazujemo le polovico mostu, ker sta konstrukcija ter obtežba simetrični.**

Maksimalni momenti:



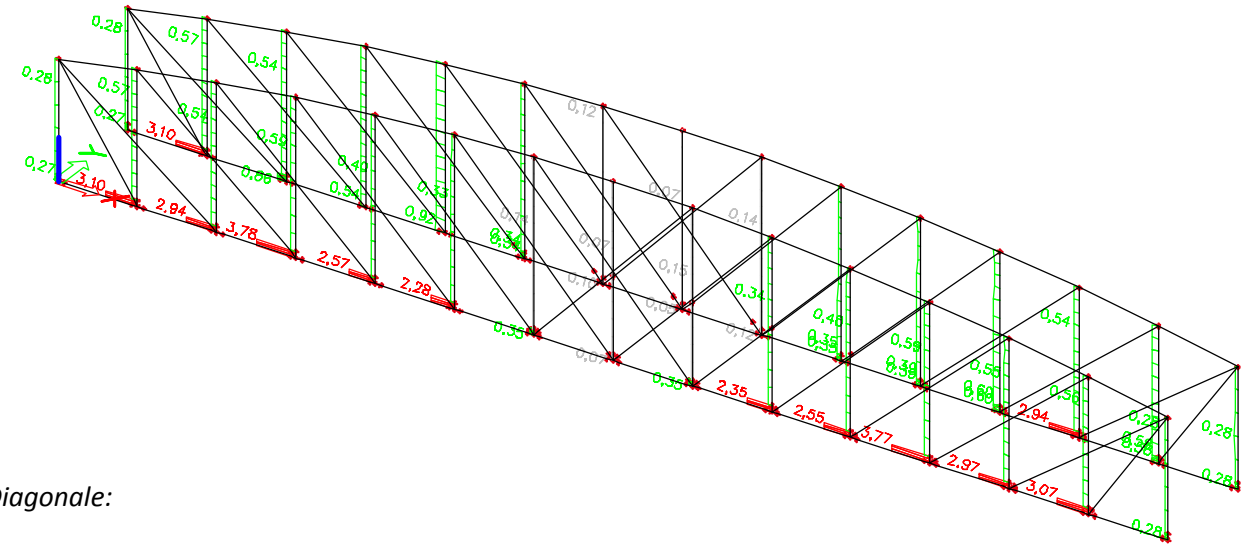

Minimalni momenti:



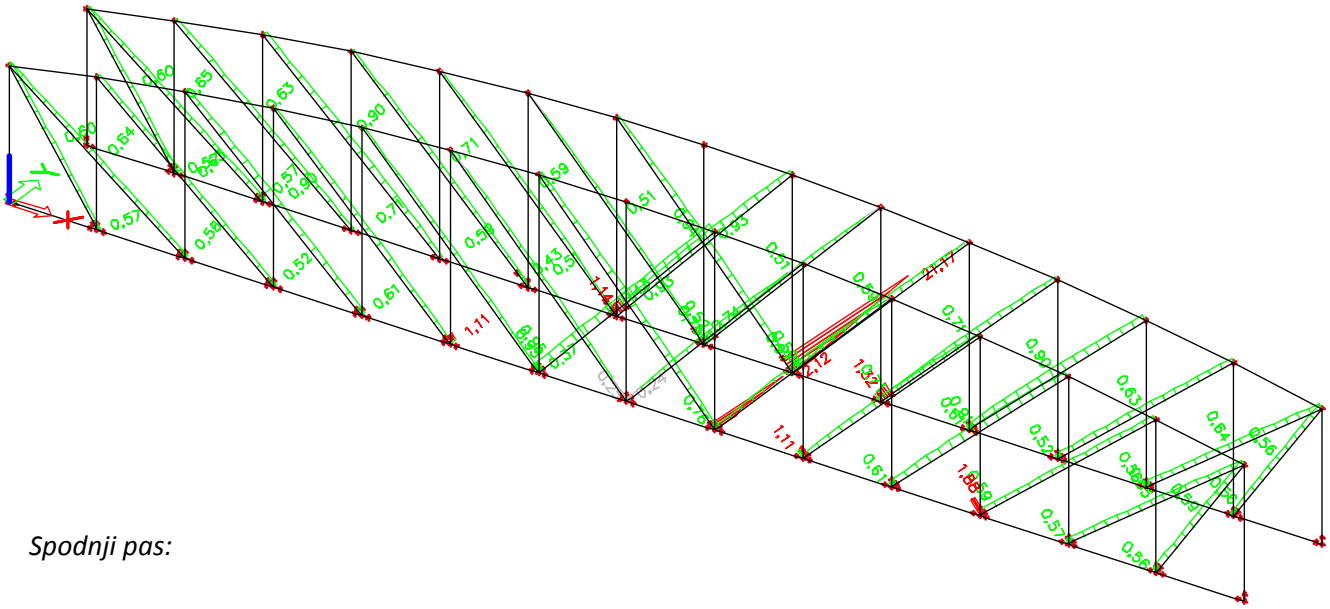
### 3.1.2. Kontrola nosilnosti in stabilnosti OBSTOJEČEGA STANJA

***Kontrola nosilnosti in stabilnosti oz. izkoriščenost elementov v NOSILCU 1:***

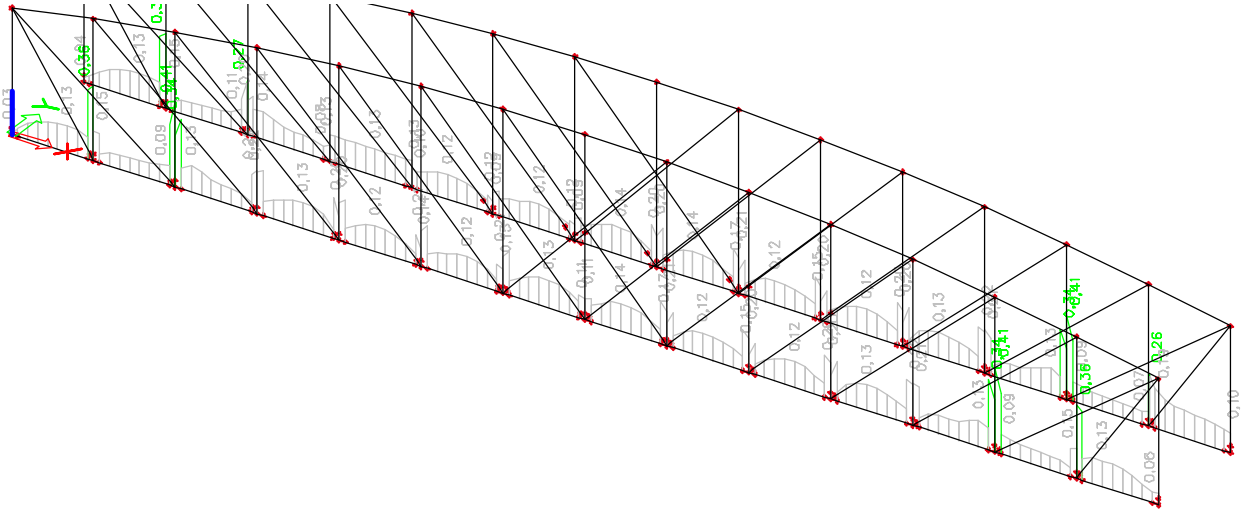
*Vertikale:*



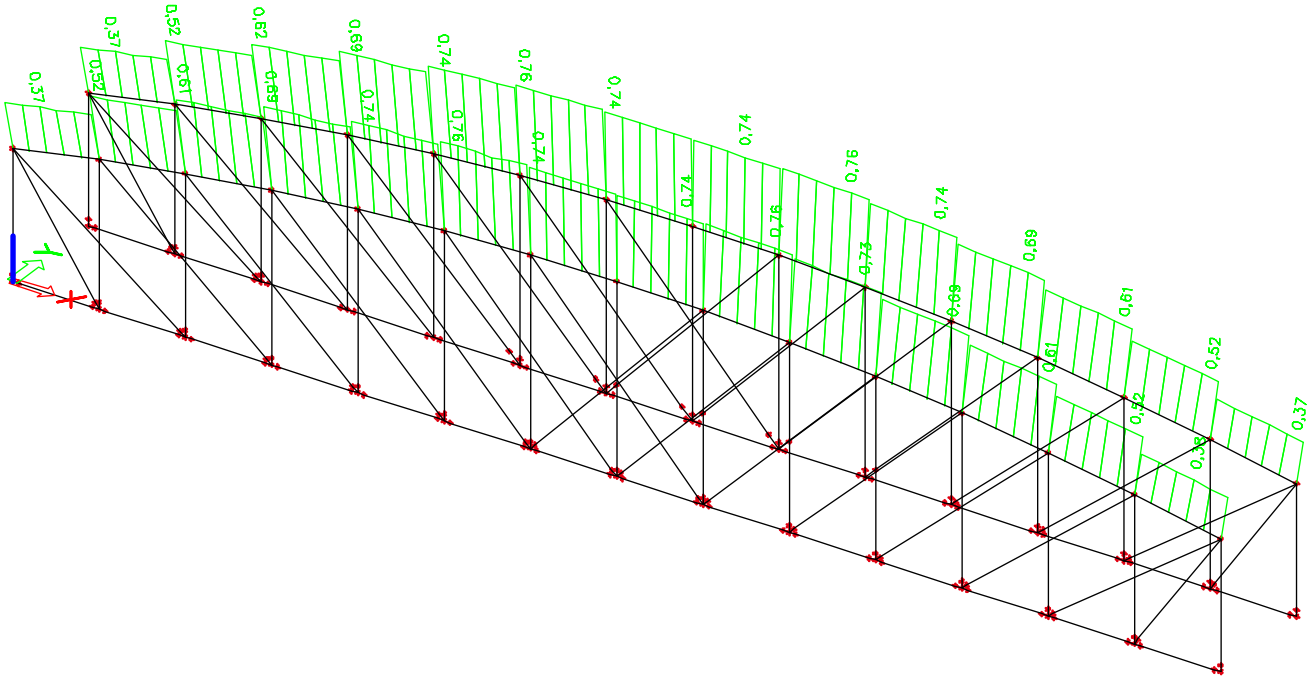
*Diagonale:*



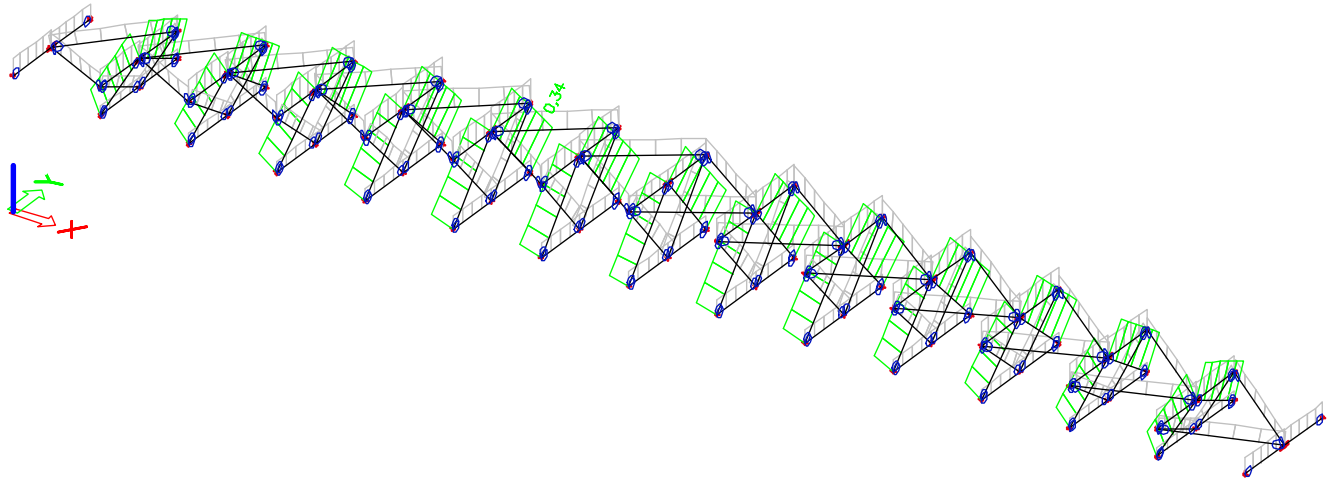
*Spodnji pas:*



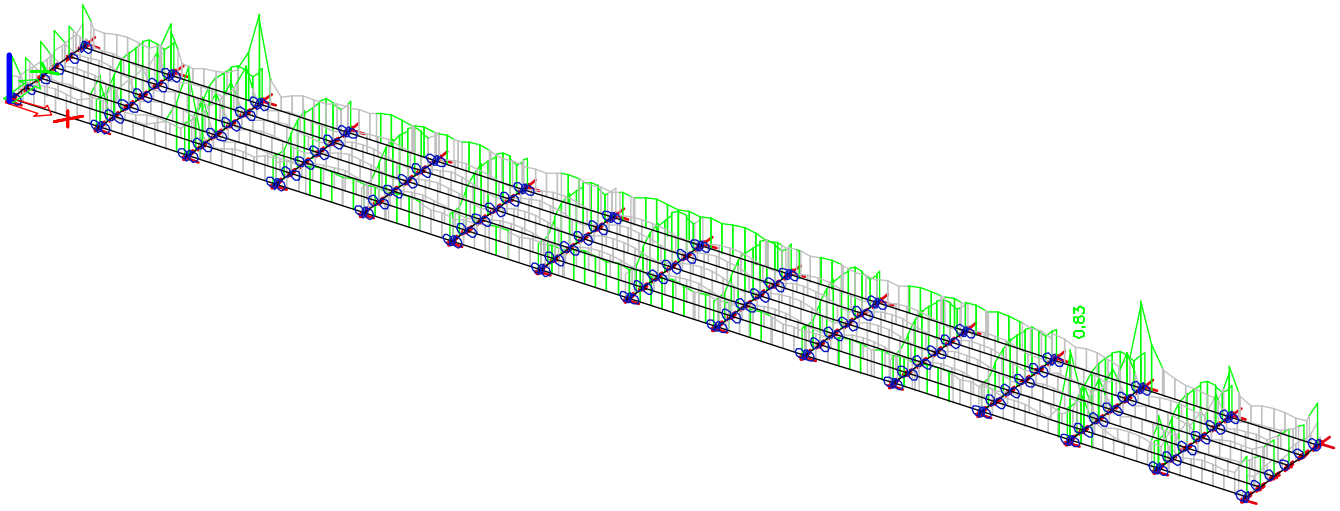
*Zgornji pas:*




*Zavetrovanje:*



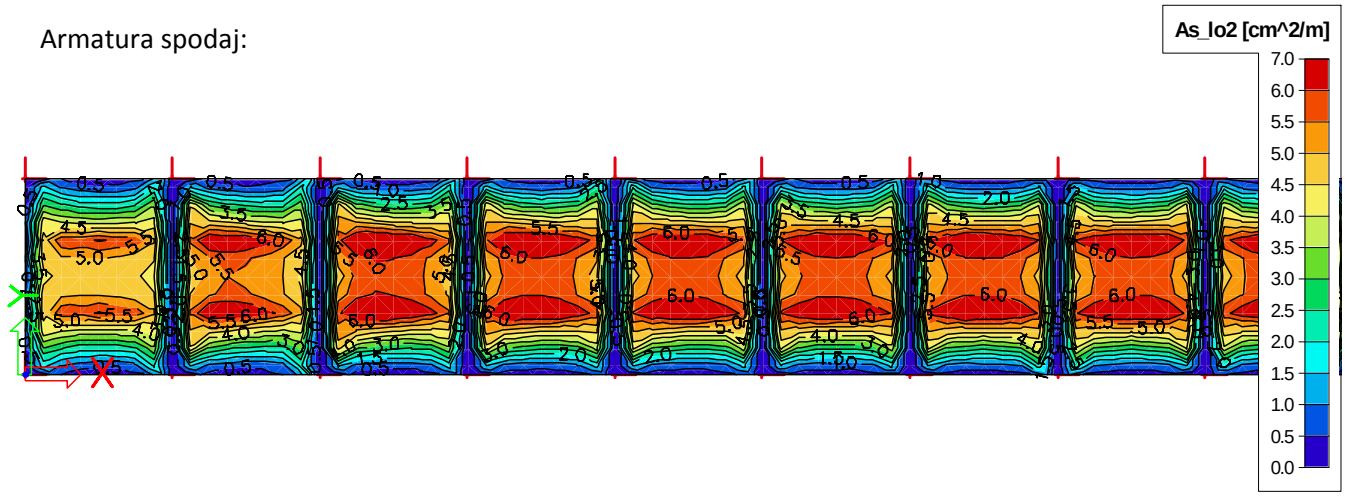

*Spodnja konstrukcija:*



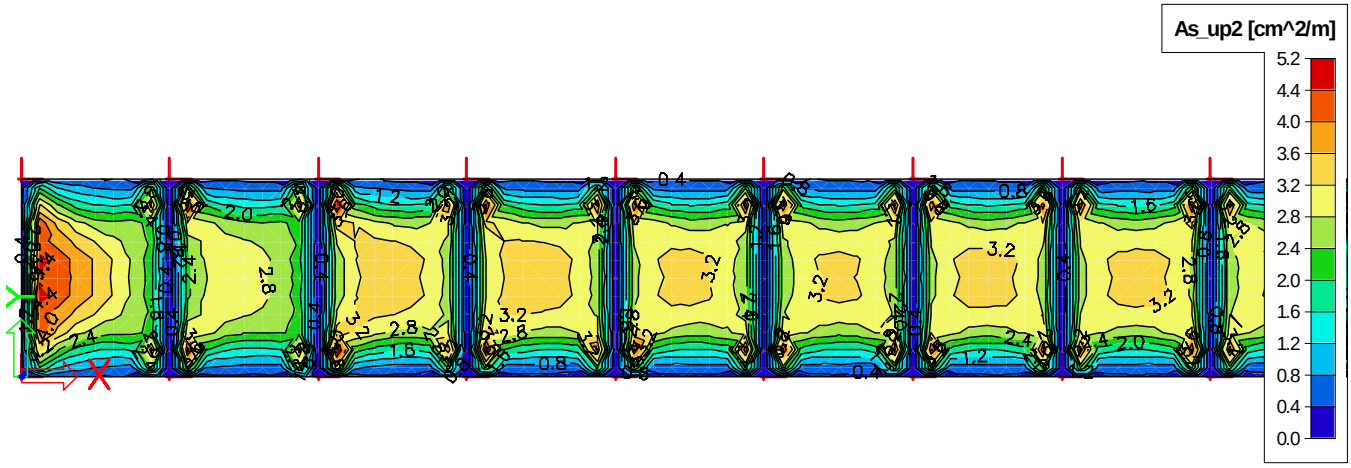
*Računsko potrebna armatura v plošči:*

Prikazujemo samo armaturo v krajši smeri plošče (enostransko nosilna plošča) za polovico mostu, saj je konstrukcija in obtežba simetrična. V nenosilni smeri je potreba po armaturi 20% potrebne armature v nosilni smeri.

Armatura spodaj:

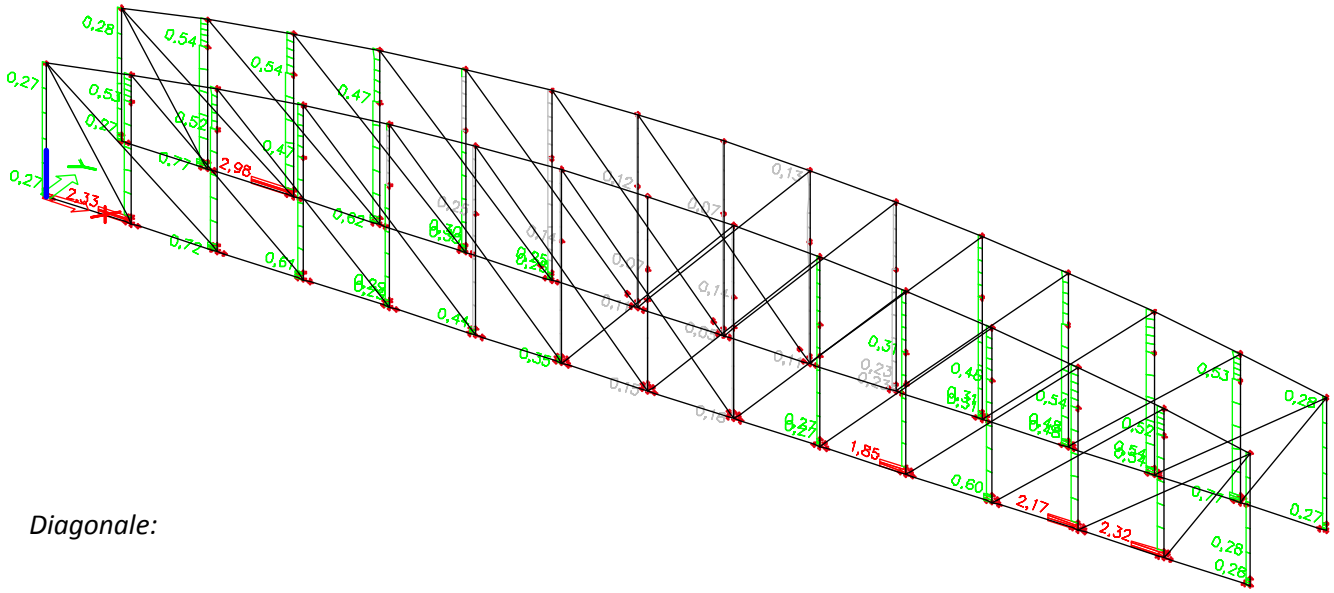



Armatura zgoraj:

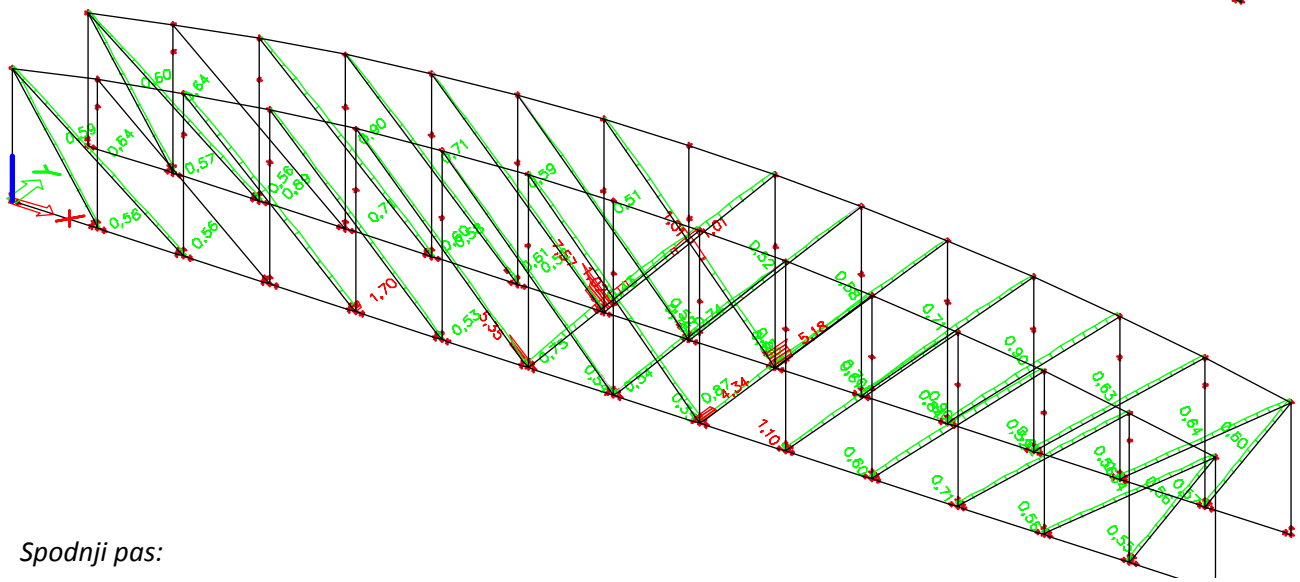


## *Kontrola nosilnosti in stabilnosti oz. izkoriščenost elementov v NOSILCU 2:*

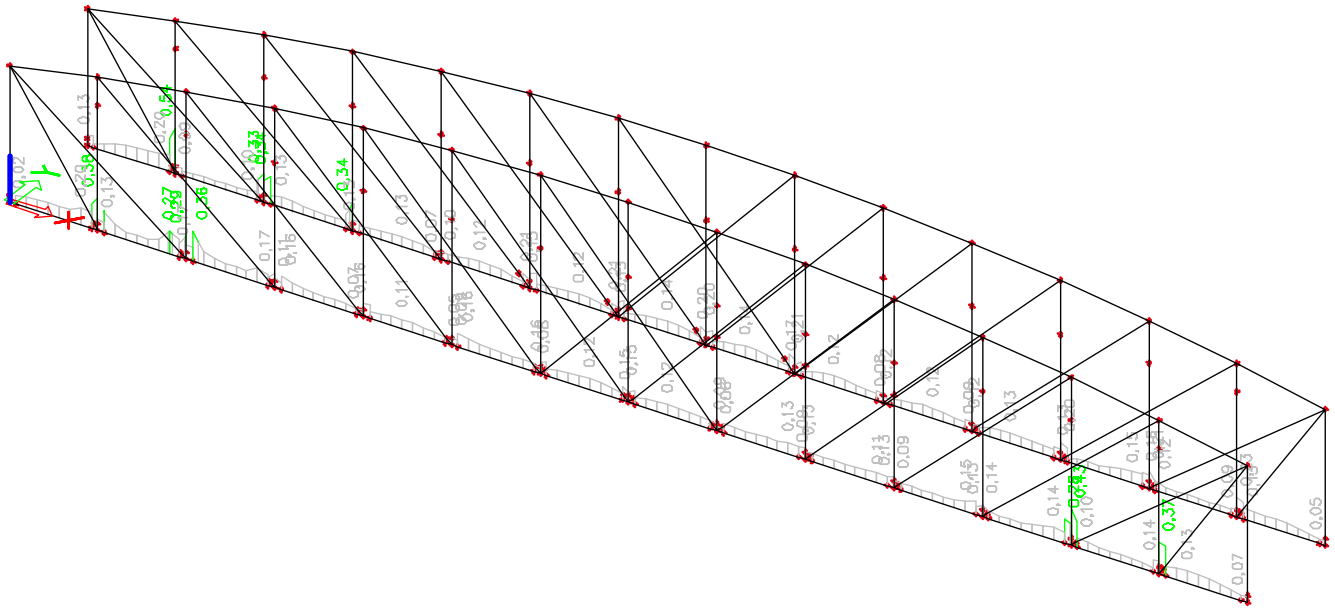
*Vertikale:*



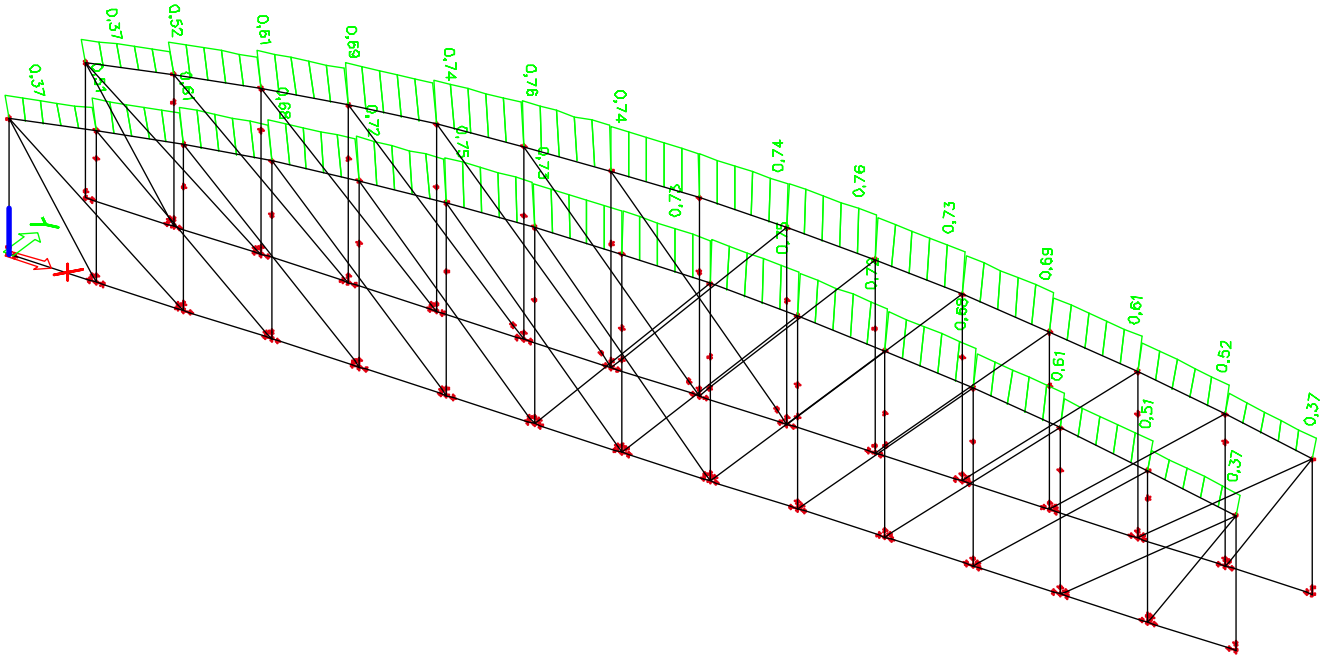
*Diagonale:*



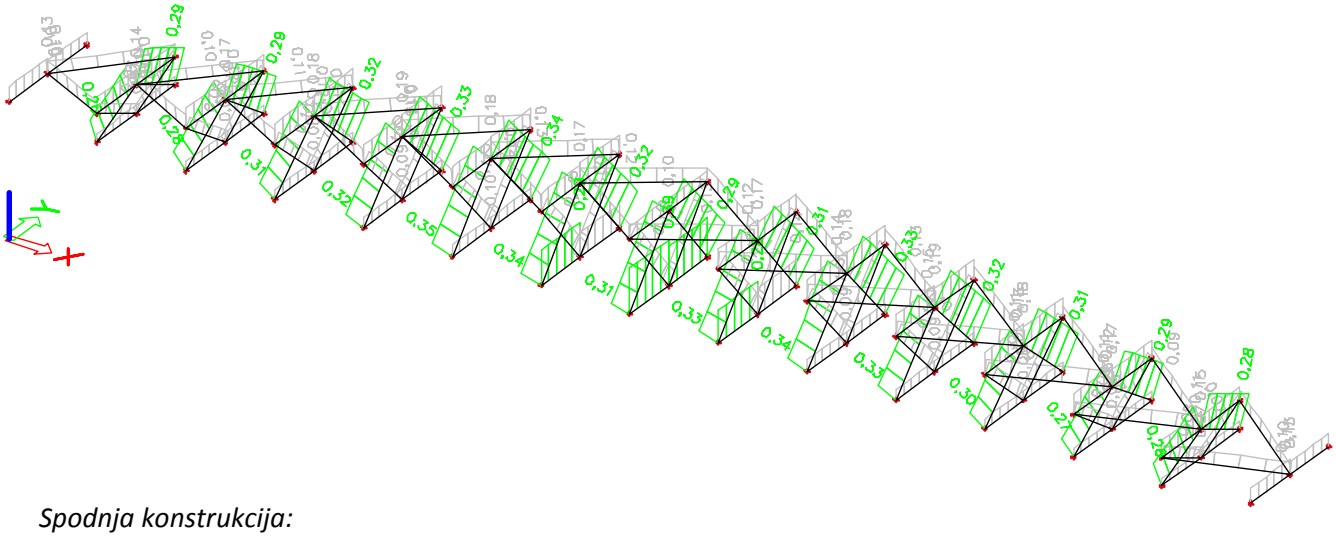
*Spodnji pas:*



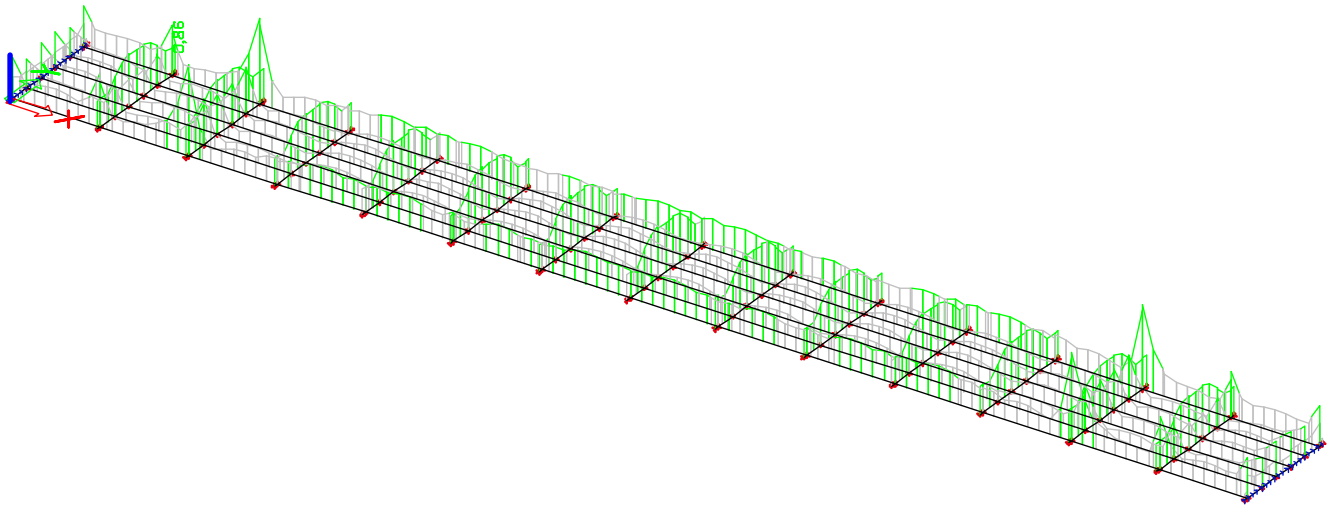
*Zgornji pas:*



*Zavetrovanje:*



*Spodnja konstrukcija:*



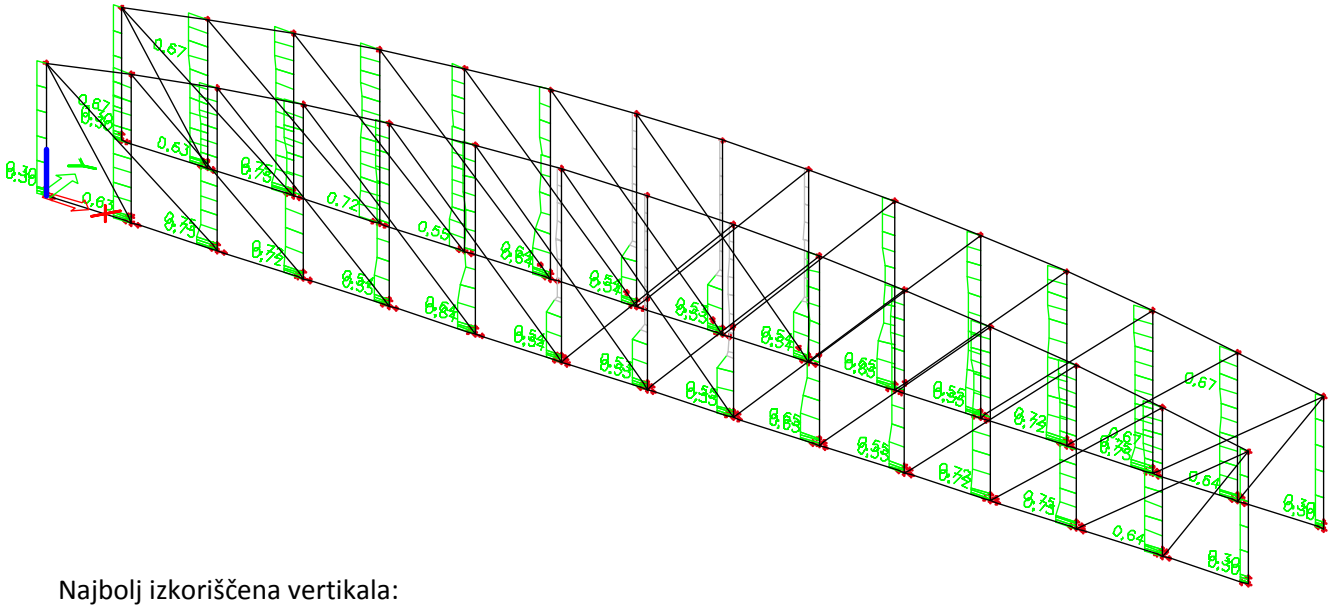
*Računsko potrebna armatura v plošči:*

Sovprežna plošča izkazuje enake potrebe po armaturi kot pri nosilcu 1, zato rezultatov ne prikazujemo (glej *Računsko potrebna armatura v plošči* - NOSILEC 1)!

### 3.1.1. Kontrola nosilnosti in stabilnosti za SANIRANO STANJE

**OP.: Kontrole mejnih stanj prikazujemo le za en nosilce, saj sta po sanaciji enaka!**

*Vertikale:*



Najbolj izkoriščena vertikala:

**EC3 : EN 1993 Code Check**

| | | | | |
|---|---|---|---|---|
| **Member B806** | **General cross-section** | **S 235** | **MSN-66/1** | **0.75** |

| NEd [kN] | Vy,Ed [kN] | Vz,Ed [kN] | TEd [kNm] | My,Ed [kNm] | Mz,Ed [kNm] |
|---|---|---|---|---|---|
| -200.43 | -0.00 | -3.18 | 0.00 | 12.72 | -0.00 |

**The critical check is on position 0.00 m**

| Buckling parameters | yy | zz | |
|---|---|---|---|
| type | sway | non-sway | |
| Slenderness | 38.03 | 98.67 | |
| Reduced slenderness | 0.40 | 1.05 | |
| Buckling curve | c | c | |
| Imperfection | 0.49 | 0.49 | |
| Reduction factor | 0.89 | 0.51 | |
| Length | 7.37 | 7.37 | m |
| Buckling factor | 0.60 | 0.60 | |
| Buckling length | 4.42 | 4.42 | m |
| Critical Euler load | 6511.42 | 967.44 | kN |

| LTB | | |
|---|---|---|
| LTB length | 7.37 | m |
| k | 1.00 | |
| kw | 1.00 | |
| C1 | 1.81 | |

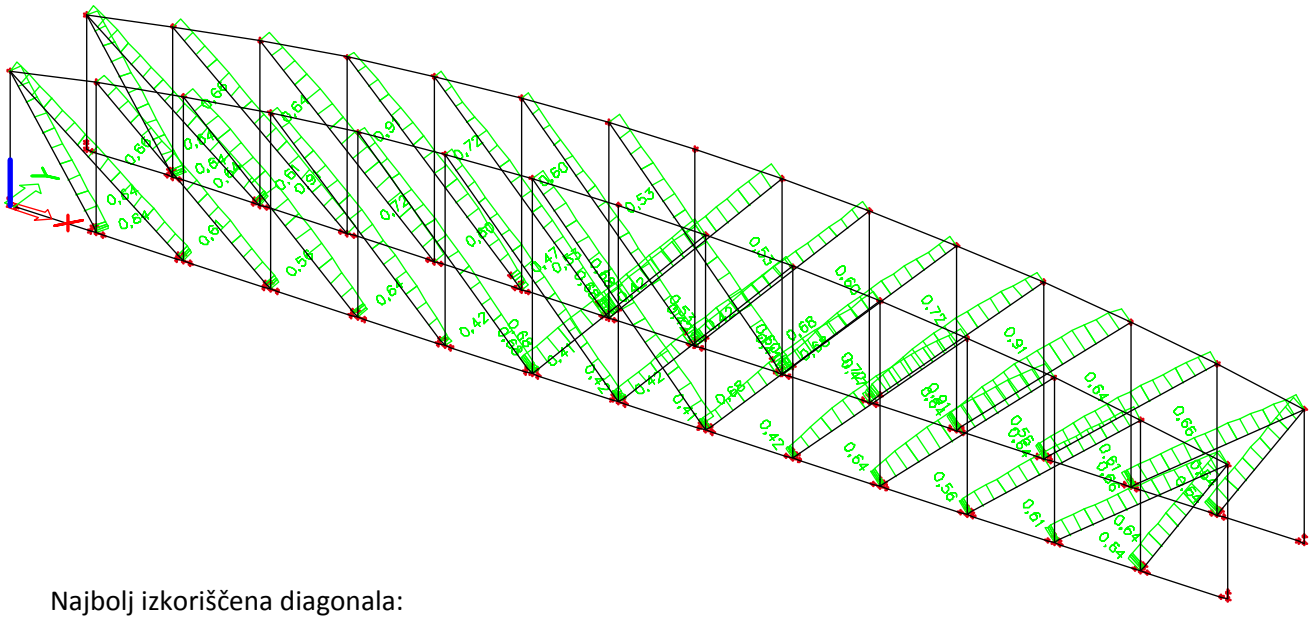
| | | |
|---|---|---|
| C2 | 0.20 | |
| C3 | 2.64 | |

load in center of gravity

| SECTION CHECK | |
|---|---|
| Compression check | 0.19 < 1 |
| Shear check (Vy) | 0.00 < 1 |
| Shear check (Vz) | 0.01 < 1 |
| Bending moment check (My) | 0.11 < 1 |
| M | 0.30 < 1 |

| STABILITY CHECK | |
|---|---|
| Buckling | 0.37 < 1 |
| Torsional-flexural buckling | 0.39 < 1 |
| LTB | 0.33 < 1 |
| Compression + Moment | 0.62 < 1 |
| Compression + Moment | 0.75 < 1 |

*Diagonale:*



Najbolj izkoriščena diagonala:

**EC3 : EN 1993 Code Check**

| | | | | |
|---|---|---|---|---|
| **Member B850** | **General cross-section** | **S 235** | **MSN-67/2** | **0.91** |

| Basic data EC3 : EN 1993 | |
|---|---|
| partial safety factor Gamma M0 for resistance of cross-sections | 1.00 |
| partial safety factor Gamma M1 for resistance to instability | 1.00 |
| partial safety factor Gamma M2 for resistance of net sections | 1.25 |

| Material data | | |
|---|---|---|
| yield strength fy | 23.50 | kN/cm^2 |
| tension strength fu | 36.00 | kN/cm^2 |
| fabrication | rolled | |

**SECTION CHECK**

**The critical check is on position 5.71 m**

| Internal forces | | |
|---|---|---|
| NEd | 394.86 | kN |
| Vy,Ed | -0.05 | kN |
| Vz,Ed | -0.39 | kN |
| TEd | -0.00 | kNm |
| My,Ed | -0.81 | kNm |
| Mz,Ed | 3.44 | kNm |

**Normal force check**

according to article EN 1993-1-1 : 6.2.3. and formula EN 1993-1-1 : (6.5)

| Table of values | | |
|---|---|---|
| Nt.Rd | 691.84 | kN |
| unity check | 0.57 | |

**Shear check (Vy)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| Table of values | | |
|---|---|---|
| Vc,Rd | 399.43 | kN |
| unity check | 0.00 | |

**Shear check (Vz)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| Table of values | | |
|---|---|---|
| Vc,Rd | 399.43 | kN |
| unity check | 0.00 | |

**Bending moment check (My)**

according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)

Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 76.08 | kNm |
| unity check | 0.01 | |

**Bending moment check (Mz)**

according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)

Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 10.34 | kNm |
| unity check | 0.33 | |

**Combined bending, axial force and shear force check**

according to article EN 1993-1-1 : 6.2 and formula EN 1993-1-1: (6.1)

Section classification is 3.

| Table of values | | |
|---|---|---|
| sigma N | -13.41 | kN/cm^2 |
| sigma Myy | -0.25 | kN/cm^2 |
| sigma Mzz | -7.82 | kN/cm^2 |
| Tau y | -0.00 | kN/cm^2 |
| Tau z | -0.00 | kN/cm^2 |

| | | |
|---|---|---|
| Tau t | -0.00 | kN/cm^2 |

ro 0.00 place 7
unity check 0.91
Element satisfies the section check !

**STABILITY CHECK**

| **Buckling parameters** | yy | zz | |
|---|---|---|---|
| type | sway | non-sway | |
| Slenderness | 46.05 | 178.72 | |
| Reduced slenderness | 0.49 | 1.90 | |
| Buckling curve | c | c | |
| Imperfection | 0.49 | 0.49 | |
| Reduction factor | 0.85 | 0.21 | |
| Length | 11.01 | 11.01 | m |
| Buckling factor | 0.50 | 0.50 | |
| Buckling length | 5.51 | 5.51 | m |
| Critical Euler load | 2877.72 | 191.03 | kN |

**LTB check**

according to article EN 1993-1-1 : 6.3.2.1. and formula EN 1993-1-1 : (6.54)

| **Table of values** | | |
|---|---|---|
| Mb.Rd | 76.08 | kNm |
| Wy | 323732.35 | mm^3 |
| reduction | 1.00 | |
| imperfection | 0.76 | |
| reduced slenderness | 2.41 | |
| method for LTB curve | Art. 6.3.2.2. | |
| Mcr | 13.11 | kNm |
| unity check | 0.01 | |

| **LTB** | | |
|---|---|---|
| LTB length | 11.01 | m |
| k | 1.00 | |
| kw | 1.00 | |
| C1 | 2.32 | |
| C2 | 0.07 | |
| C3 | 0.85 | |

load in center of gravity

**Compression and bending check**

according to article EN 1993-1-1 : 6.3.3. and formula EN 1993-1-1 : (6.61) (6.62)

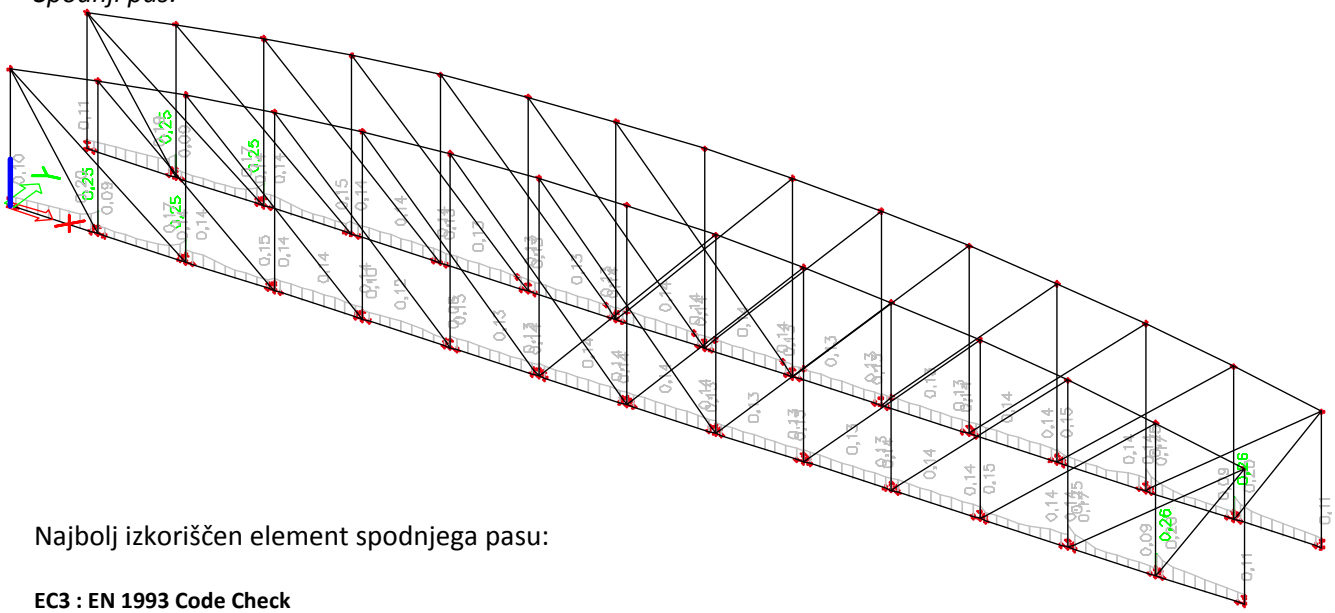
Interaction Method 1

| **Table of values** | | |
|---|---|---|
| kyy | 1.000 | |
| kyz | 1.000 | |
| kzy | 1.000 | |
| kzz | 1.000 | |
| Delta My | 0.00 | kNm |
| Delta Mz | 0.00 | kNm |
| A | 2944.00 | mm^2 |
| Wy | 323732.35 | mm^3 |
| Wz | 43996.56 | mm^3 |
| NRk | 691.84 | kN |
| My,Rk | 76.08 | kNm |
| Mz,Rk | 10.34 | kNm |
| My,Ed | 2.87 | kNm |

| | | |
|---|---|---|
| Mz,Ed | 3.44 | kNm |
| Interaction Method 1 | | |
| Mcr0 | 13.11 | kNm |
| reduced slenderness 0 | 2.41 | |
| Cmy,0 | 1.000 | |
| Cmz,0 | 1.000 | |
| Cmy | 1.000 | |
| Cmz | 1.000 | |
| CmLT | 1.000 | |
| muy | 1.000 | |
| muz | 1.000 | |
| wy | 1.083 | |
| wz | 1.500 | |
| npl | 0.000 | |
| aLT | 0.999 | |
| bLT | 0.021 | |
| cLT | 0.112 | |
| dLT | 0.003 | |
| eLT | 0.011 | |
| Cyy | 0.998 | |
| Cyz | 0.944 | |
| Czy | 1.000 | |
| Czz | 0.995 | |

unity check = 0.00 + 0.04 + 0.33 = 0.37
unity check = 0.00 + 0.04 + 0.33 = 0.37
Element satisfies the stability check !

*Spodnji pas:*



Najbolj izkoriščen element spodnjega pasu:

**EC3 : EN 1993 Code Check**

| | | | | |
|---|---|---|---|---|
| **Member B271** | **General cross-section** | **S 235** | **MSN-103/3** | **0.81** |

| **Basic data EC3 : EN 1993** | |
|---|---|
| partial safety factor Gamma M0 for resistance of cross-sections | 1.00 |
| partial safety factor Gamma M1 for resistance to instability | 1.00 |
| partial safety factor Gamma M2 for resistance of net sections | 1.25 |

| Material data | | |
|---|---|---|
| yield strength fy | 23.50 | kN/cm^2 |
| tension strength fu | 36.00 | kN/cm^2 |
| fabrication | rolled | |

**SECTION CHECK**
**The critical check is on position 0.00 m**

| Internal forces | | |
|---|---|---|
| NEd | -146.99 | kN |
| Vy,Ed | 3.30 | kN |
| Vz,Ed | -9.92 | kN |
| TEd | 0.01 | kNm |
| My,Ed | 2.40 | kNm |
| Mz,Ed | -0.06 | kNm |

Warning: Torsion is not taken into account for this cross-section!

**Compression check**
according to article EN 1993-1-1 : 6.2.4 and formula EN 1993-1-1 : (6.9)
Section classification is 3.

| Table of values | | |
|---|---|---|
| Nc.Rd | 1240.33 | kN |
| unity check | 0.12 | |

**Shear check (Vy)**
according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| Table of values | | |
|---|---|---|
| Vc,Rd | 716.10 | kN |
| unity check | 0.00 | |

**Shear check (Vz)**
according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| Table of values | | |
|---|---|---|
| Vc,Rd | 716.10 | kN |
| unity check | 0.01 | |

**Bending moment check (My)**
according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)
Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 106.11 | kNm |
| unity check | 0.02 | |

**Bending moment check (Mz)**
according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)
Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 6.80 | kNm |
| unity check | 0.01 | |

**Combined bending, axial force and shear force check**
according to article EN 1993-1-1 : 6.2 and formula EN 1993-1-1: (6.1)
Section classification is 3.

| Table of values | | |
|---|---|---|
| sigma N | 2.78 | kN/cm^2 |
| sigma Myy | 0.52 | kN/cm^2 |
| sigma Mzz | 0.02 | kN/cm^2 |
| Tau y | 0.01 | kN/cm^2 |
| Tau z | -0.00 | kN/cm^2 |
| Tau t | 0.00 | kN/cm^2 |

ro 0.00 place 7
unity check 0.14
Element satisfies the section check !
**STABILITY CHECK**

| Buckling parameters | yy | zz | |
|---|---|---|---|
| type | sway | non-sway | |
| Slenderness | 31.17 | 214.73 | |
| Reduced slenderness | 0.33 | 2.29 | |
| Buckling curve | c | c | |
| Imperfection | 0.49 | 0.49 | |
| Reduction factor | 0.93 | 0.16 | |
| Length | 4.09 | 4.09 | m |
| Buckling factor | 1.00 | 1.00 | |
| Buckling length | 4.09 | 4.09 | m |
| Critical Euler load | 11256.33 | 237.24 | kN |

Warning: slenderness 214.73 is larger then 200.00 !
**Buckling check**
according to article EN 1993-1-1 : 6.3.1.1. and formula EN 1993-1-1 : (6.46)

| Table of values | | |
|---|---|---|
| Nb.Rd | 192.64 | kN |
| unity check | 0.76 | |

**Torsional-flexural buckling check**
according to article EN 1993-1-1 : 6.3.1.1. and formula EN 1993-1-1 : (6.46)

| Table of values | | |
|---|---|---|
| Nb.Rd | 192.64 | kN |
| Reduced slenderness | 2.29 | |
| Reduction factor | 0.16 | |
| sigma,cr,T | 18.59 | kN/cm^2 |
| sigma,cr,TF | 4.49 | kN/cm^2 |
| Torsional buckling length | 4.09 | m |
| unity check | 0.76 | |

**LTB check**
according to article EN 1993-1-1 : 6.3.2.1. and formula EN 1993-1-1 : (6.54)

| Table of values | | |
|---|---|---|
| Mb.Rd | 106.11 | kNm |
| Wy | 451533.38 | mm^3 |
| reduction | 1.00 | |
| imperfection | 0.76 | |
| reduced slenderness | 0.18 | |
| method for LTB curve | Art. 6.3.2.2. | |
| Mcr | 3197.97 | kNm |

| | | |
|---|---|---|
| unity check | 0.02 | |

| LTB | | |
|---|---|---|
| LTB length | 0.08 | m |
| k | 1.00 | |
| kw | 1.00 | |
| C1 | 1.11 | |
| C2 | 0.00 | |
| C3 | 1.00 | |

load in center of gravity

**Compression and bending check**

according to article EN 1993-1-1 : 6.3.3. and formula EN 1993-1-1 : (6.61) (6.62)

Interaction Method 1

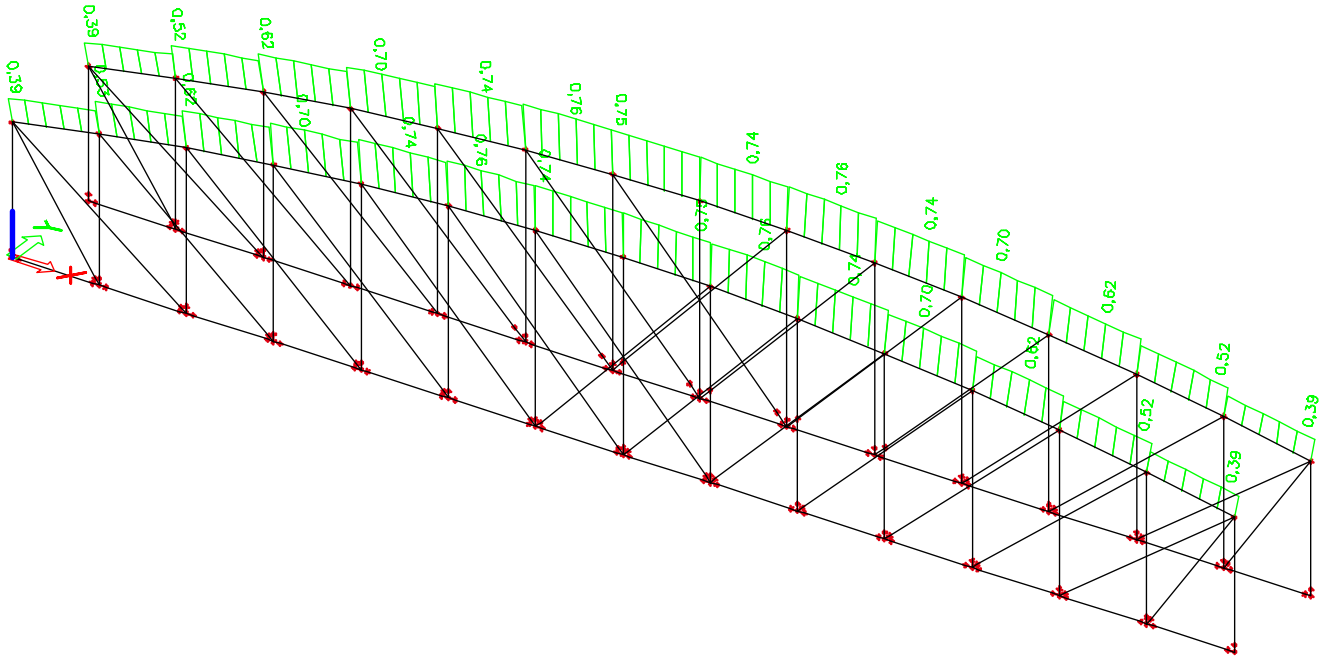
| Table of values | | |
|---|---|---|
| kyy | 1.637 | |
| kyz | 1.449 | |
| kzy | 0.690 | |
| kzz | 0.610 | |
| Delta My | 0.00 | kNm |
| Delta Mz | 0.00 | kNm |
| A | 5278.00 | mm^2 |
| Wy | 451533.38 | mm^3 |
| Wz | 28951.66 | mm^3 |
| NRk | 1240.33 | kN |
| My,Rk | 106.11 | kNm |
| Mz,Rk | 6.80 | kNm |
| My,Ed | 5.72 | kNm |
| Mz,Ed | 0.13 | kNm |
| Interaction Method 1 | | |
| Mcr0 | 3197.97 | kNm |
| reduced slenderness 0 | 0.18 | |
| Cmy,0 | 0.955 | |
| Cmz,0 | 0.552 | |
| Cmy | 0.973 | |
| Cmz | 0.552 | |
| CmLT | 1.661 | |
| muy | 0.999 | |
| muz | 0.421 | |
| wy | 1.290 | |
| wz | 1.500 | |
| npl | 0.119 | |
| aLT | 0.998 | |
| bLT | 0.000 | |
| cLT | 0.000 | |
| dLT | 0.000 | |
| eLT | 0.000 | |
| Cyy | 0.775 | |
| Cyz | 0.944 | |
| Czy | 0.431 | |
| Czz | 0.974 | |

unity check = 0.13 + 0.09 + 0.03 = 0.24

unity check = 0.76 + 0.04 + 0.01 = 0.81

Element satisfies the stability check !

*Zgornji pas:*



Najbolj izkoriščen element zgornjega pasu:

**EC3 : EN 1993 Code Check**

| | | | | |
|---|---|---|---|---|
| **Member B828** | **General cross-section** | **S 235** | **MSN-64/4** | **0.76** |

| **Basic data EC3 : EN 1993** | |
|---|---|
| partial safety factor Gamma M0 for resistance of cross-sections | 1.00 |
| partial safety factor Gamma M1 for resistance to instability | 1.00 |
| partial safety factor Gamma M2 for resistance of net sections | 1.25 |

| **Material data** | | |
|---|---|---|
| yield strength fy | 23.50 | kN/cm^2 |
| tension strength fu | 36.00 | kN/cm^2 |
| fabrication | rolled | |

**SECTION CHECK**

**The critical check is on position 2.46 m**

Axis definition :

- local y- axis in this code check is referring to the local z axis in Scia Engineer
- local z- axis in this code check is referring to the local y axis in Scia Engineer

| **Internal forces** | | |
|---|---|---|
| NEd | -2121.22 | kN |
| Vy,Ed | -0.66 | kN |
| Vz,Ed | 0.56 | kN |
| TEd | 0.00 | kNm |
| My,Ed | 0.18 | kNm |
| Mz,Ed | -3.24 | kNm |

Warning: Torsion is not taken into account for this cross-section!

**Compression check**

according to article EN 1993-1-1 : 6.2.4 and formula EN 1993-1-1 : (6.9)

Section classification is 3.

| **Table of values** | | |
|---|---|---|
| Nc.Rd | 3647.20 | kN |
| unity check | 0.58 | |

**Shear check (Vy)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| **Table of values** | | |
|---|---|---|
| Vc,Rd | 2105.71 | kN |
| unity check | 0.00 | |

**Shear check (Vz)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| **Table of values** | | |
|---|---|---|
| Vc,Rd | 2105.71 | kN |
| unity check | 0.00 | |

**Bending moment check (My)**

according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)

Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 339.84 | kNm |
| unity check | 0.00 | |

**Bending moment check (Mz)**
according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)
Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 297.24 | kNm |
| unity check | 0.01 | |

**Combined bending, axial force and shear force check**
according to article EN 1993-1-1 : 6.2 and formula EN 1993-1-1: (6.1)
Section classification is 3.

| Table of values | | |
|---|---|---|
| sigma N | 13.67 | kN/cm^2 |
| sigma Myy | 0.01 | kN/cm^2 |
| sigma Mzz | 0.17 | kN/cm^2 |
| Tau y | -0.00 | kN/cm^2 |
| Tau z | 0.00 | kN/cm^2 |
| Tau t | 0.00 | kN/cm^2 |

ro 0.00 place 1
unity check 0.59
Element satisfies the section check !
**STABILITY CHECK**

| Buckling parameters | yy | zz | |
|---|---|---|---|
| type | non-sway | sway | |
| Slenderness | 28.59 | 30.73 | |
| Reduced slenderness | 0.30 | 0.33 | |
| Buckling curve | b | b | |
| Imperfection | 0.34 | 0.34 | |
| Reduction factor | 0.96 | 0.95 | |
| Length | 4.09 | 4.09 | m |
| Buckling factor | 1.00 | 1.00 | |
| Buckling length | 4.09 | 4.09 | m |
| Critical Euler load | 39349.21 | 34070.32 | kN |

**Buckling check**
according to article EN 1993-1-1 : 6.3.1.1. and formula EN 1993-1-1 : (6.46)

| Table of values | | |
|---|---|---|
| Nb.Rd | 3479.62 | kN |
| unity check | 0.61 | |

**Torsional-flexural buckling check**
according to article EN 1993-1-1 : 6.3.1.1. and formula EN 1993-1-1 : (6.46)

| Table of values | | |
|---|---|---|
| Nb.Rd | 2842.02 | kN |
| Reduced slenderness | 0.71 | |
| Reduction factor | 0.78 | |
| sigma,cr,T | 46.90 | kN/cm^2 |
| sigma,cr,TF | 219.53 | kN/cm^2 |
| Torsional buckling length | 4.09 | m |

| | | |
|---|---|---|
| unity check | 0.75 | |

**LTB check**

according to article EN 1993-1-1 : 6.3.2.1. and formula EN 1993-1-1 : (6.54)

| Table of values | | |
|---|---|---|
| Mb.Rd | 339.84 | kNm |
| Wy | 1446133.33 | mm^3 |
| reduction | 1.00 | |
| imperfection | 0.76 | |
| reduced slenderness | 0.33 | |
| method for LTB curve | Art. 6.3.2.2. | |
| Mcr | 3079.63 | kNm |
| unity check | 0.00 | |

| LTB | | |
|---|---|---|
| LTB length | 4.09 | m |
| k | 1.00 | |
| kw | 1.00 | |
| C1 | 2.64 | |
| C2 | 0.02 | |
| C3 | 0.68 | |

load in center of gravity

**Compression and bending check**

according to article EN 1993-1-1 : 6.3.3. and formula EN 1993-1-1 : (6.61) (6.62)

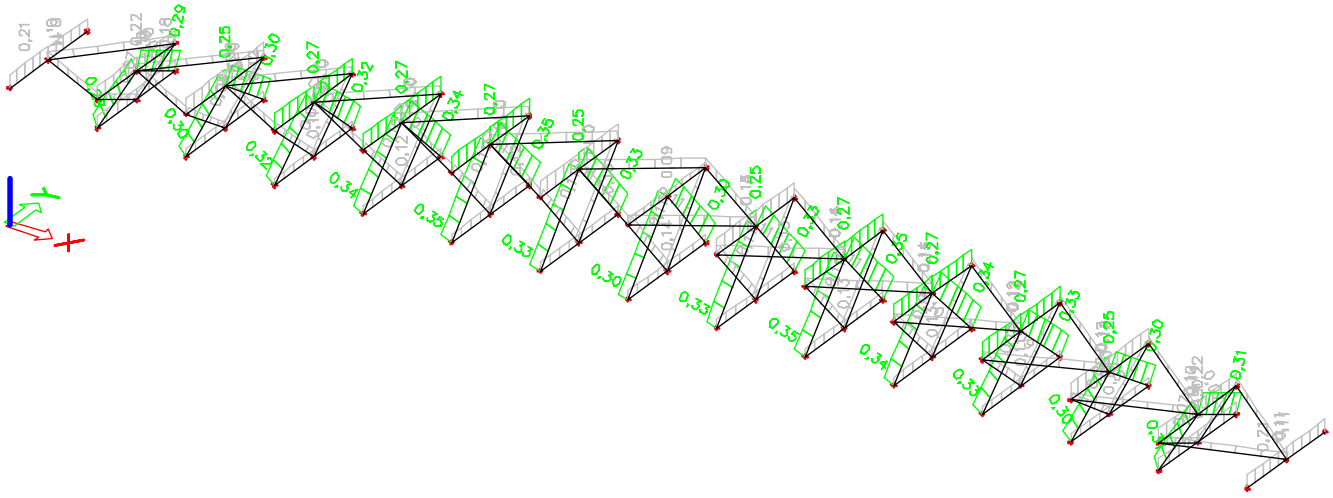
Interaction Method 1

| Table of values | | |
|---|---|---|
| kyy | 1.133 | |
| kyz | 1.066 | |
| kzy | 1.132 | |
| kzz | 1.065 | |
| Delta My | 0.00 | kNm |
| Delta Mz | 0.00 | kNm |
| A | 15520.00 | mm^2 |
| Wy | 1446133.33 | mm^3 |
| Wz | 1264840.88 | mm^3 |
| NRk | 3647.20 | kN |
| My,Rk | 339.84 | kNm |
| Mz,Rk | 297.24 | kNm |
| My,Ed | 1.26 | kNm |
| Mz,Ed | 3.24 | kNm |
| Interaction Method 1 | | |
| Mcr0 | 3079.63 | kNm |
| reduced slenderness 0 | 0.33 | |
| Cmy,0 | 0.957 | |
| Cmz,0 | 1.002 | |
| Cmy | 0.960 | |
| Cmz | 1.002 | |
| CmLT | 1.119 | |
| muy | 0.998 | |
| muz | 0.997 | |
| wy | 1.482 | |
| wz | 1.450 | |
| npl | 0.582 | |
| aLT | 0.989 | |
| bLT | 0.000 | |

| | | |
|---|---|---|
| cLT | 0.001 | |
| dLT | 0.000 | |
| eLT | 0.013 | |
| Cyy | 1.440 | |
| Cyz | 1.462 | |
| Czy | 1.506 | |
| Czz | 1.392 | |

unity check = 0.60 + 0.00 + 0.01 = 0.62
unity check = 0.75 + 0.00 + 0.01 = 0.76
Element satisfies the stability check !

*Zavetrovanje:*



Najbolj izkoriščen element zavetrovanja:

**EC3 : EN 1993 Code Check**

| | | | | |
|---|---|---|---|---|
| **Member B180** | **General cross-section** | **S 235** | **MSN-85/6** | **0.35** |

| **Basic data EC3 : EN 1993** | |
|---|---|
| partial safety factor Gamma M0 for resistance of cross-sections | 1.00 |
| partial safety factor Gamma M1 for resistance to instability | 1.00 |
| partial safety factor Gamma M2 for resistance of net sections | 1.25 |

| **Material data** | | |
|---|---|---|
| yield strength fy | 23.50 | kN/cm^2 |
| tension strength fu | 36.00 | kN/cm^2 |
| fabrication | rolled | |

**SECTION CHECK**

**The critical check is on position 0.00 m**

| **Internal forces** | | |
|---|---|---|
| NEd | -3.41 | kN |
| Vy,Ed | 0.11 | kN |
| Vz,Ed | 0.07 | kN |
| TEd | -0.00 | kNm |
| My,Ed | 0.07 | kNm |
| Mz,Ed | -0.07 | kNm |

**Compression check**

according to article EN 1993-1-1 : 6.2.4 and formula EN 1993-1-1 : (6.9)

Section classification is 3.

| **Table of values** | | |
|---|---|---|
| Nc.Rd | 210.56 | kN |
| unity check | 0.02 | |

**Shear check (Vy)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| **Table of values** | | |
|---|---|---|
| Vc,Rd | 121.57 | kN |
| unity check | 0.00 | |

**Shear check (Vz)**
according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| Table of values | | |
|---|---|---|
| Vc,Rd | 121.57 | kN |
| unity check | 0.00 | |

**Bending moment check (My)**
according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)
Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 2.61 | kNm |
| unity check | 0.03 | |

**Bending moment check (Mz)**
according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)
Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 1.14 | kNm |
| unity check | 0.06 | |

**Combined bending, axial force and shear force check**
according to article EN 1993-1-1 : 6.2 and formula EN 1993-1-1: (6.1)
Section classification is 3.

| Table of values | | |
|---|---|---|
| sigma N | 0.38 | kN/cm^2 |
| sigma Myy | -0.00 | kN/cm^2 |
| sigma Mzz | 1.48 | kN/cm^2 |
| Tau y | 0.00 | kN/cm^2 |
| Tau z | 0.01 | kN/cm^2 |
| Tau t | -0.00 | kN/cm^2 |

ro 0.00 place 4
unity check 0.08
Element satisfies the section check !
**STABILITY CHECK**

| Buckling parameters | yy | zz | |
|---|---|---|---|
| type | sway | non-sway | |
| Slenderness | 178.41 | 348.95 | |
| Reduced slenderness | 1.90 | 3.72 | |
| Buckling curve | b | b | |
| Imperfection | 0.34 | 0.34 | |
| Reduction factor | 0.23 | 0.07 | |
| Length | 4.09 | 4.09 | m |
| Buckling factor | 1.00 | 1.00 | |
| Buckling length | 4.09 | 4.09 | m |
| Critical Euler load | 58.34 | 15.25 | kN |

Warning: slenderness 348.95 is larger then 200.00 !
**Buckling check**
according to article EN 1993-1-1 : 6.3.1.1. and formula EN 1993-1-1 : (6.46)

| Table of values | | |
|---|---|---|

| | | |
|---|---|---|
| Nb.Rd | 13.96 | kN |
| unity check | 0.24 | |

**Torsional-flexural buckling check**
according to article EN 1993-1-1 : 6.3.1.1. and formula EN 1993-1-1 : (6.46)

| Table of values | | |
|---|---|---|
| Nb.Rd | 13.96 | kN |
| Reduced slenderness | 3.72 | |
| Reduction factor | 0.07 | |
| sigma,cr,T | 450.53 | kN/cm^2 |
| sigma,cr,TF | 1.70 | kN/cm^2 |
| Torsional buckling length | 4.09 | m |
| unity check | 0.24 | |

**LTB check**
according to article EN 1993-1-1 : 6.3.2.1. and formula EN 1993-1-1 : (6.54)

| Table of values | | |
|---|---|---|
| Mb.Rd | 2.61 | kNm |
| Wy | 11094.47 | mm^3 |
| reduction | 1.00 | |
| imperfection | 0.76 | |
| reduced slenderness | 0.64 | |
| method for LTB curve | Art. 6.3.2.2. | |
| Mcr | 6.39 | kNm |
| unity check | 0.03 | |

| LTB | | |
|---|---|---|
| LTB length | 4.09 | m |
| k | 1.00 | |
| kw | 1.00 | |
| C1 | 1.58 | |
| C2 | 0.25 | |
| C3 | 2.64 | |

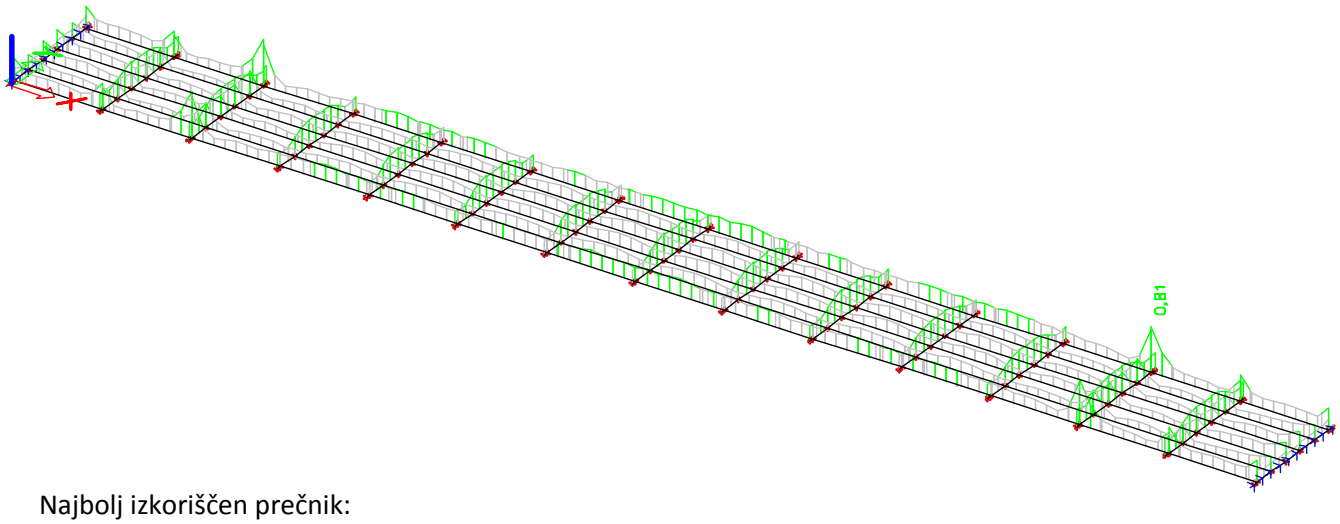
load in center of gravity
**Compression and bending check**
according to article EN 1993-1-1 : 6.3.3. and formula EN 1993-1-1 : (6.61) (6.62)
Interaction Method 1

| Table of values | | |
|---|---|---|
| kyy | 1.110 | |
| kyz | 1.232 | |
| kzy | 0.916 | |
| kzz | 1.018 | |
| Delta My | 0.00 | kNm |
| Delta Mz | 0.00 | kNm |
| A | 896.00 | mm^2 |
| Wy | 11094.47 | mm^3 |
| Wz | 4852.78 | mm^3 |
| NRk | 210.56 | kN |
| My,Rk | 2.61 | kNm |
| Mz,Rk | 1.14 | kNm |
| My,Ed | 0.13 | kNm |
| Mz,Ed | 0.07 | kNm |
| Interaction Method 1 | | |
| Mcr0 | 6.39 | kNm |

| | | |
|---|---|---|
| reduced slenderness 0 | 0.64 | |
| Cmy,0 | 1.032 | |
| Cmz,0 | 1.003 | |
| Cmy | 1.012 | |
| Cmz | 1.003 | |
| CmLT | 1.081 | |
| muy | 0.954 | |
| muz | 0.788 | |
| wy | 1.500 | |
| wz | 1.500 | |
| npl | 0.016 | |
| aLT | 0.930 | |
| bLT | 0.000 | |
| cLT | 0.001 | |
| dLT | 0.000 | |
| eLT | 0.000 | |
| Cyy | 0.861 | |
| Cyz | 0.809 | |
| Czy | 0.805 | |
| Czz | 0.864 | |

unity check = 0.07 + 0.05 + 0.08 = 0.20
unity check = 0.24 + 0.04 + 0.06 = 0.35
Element satisfies the stability check !

*Spodnja konstrukcija:*




Najbolj izkoriščen prečnik:

**EC3 : EN 1993 Code Check**

| | | | | |
|---|---|---|---|---|
| **Member B231** | **General cross-section** | **S 235** | **MSN-67/2** | **0.50** |

| **Basic data EC3 : EN 1993** | |
|---|---|
| partial safety factor Gamma M0 for resistance of cross-sections | 1.00 |
| partial safety factor Gamma M1 for resistance to instability | 1.00 |
| partial safety factor Gamma M2 for resistance of net sections | 1.25 |

| **Material data** | | |
|---|---|---|
| yield strength fy | 23.50 | kN/cm^2 |
| tension strength fu | 36.00 | kN/cm^2 |

| | | |
|---|---|---|
| fabrication | rolled | |

**SECTION CHECK**

**The critical check is on position 2.20 m**

| Internal forces | | |
|---|---|---|
| NEd | 644.00 | kN |
| Vy,Ed | 2.44 | kN |
| Vz,Ed | 9.96 | kN |
| TEd | 0.00 | kNm |
| My,Ed | 111.76 | kNm |
| Mz,Ed | 0.47 | kNm |

Warning: Torsion is not taken into account for this cross-section!

**Normal force check**

according to article EN 1993-1-1 : 6.2.3. and formula EN 1993-1-1 : (6.5)

| Table of values | | |
|---|---|---|
| Nt.Rd | 2560.09 | kN |
| unity check | 0.25 | |

**Shear check (Vy)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| Table of values | | |
|---|---|---|
| Vc,Rd | 1478.07 | kN |
| unity check | 0.00 | |

**Shear check (Vz)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| Table of values | | |
|---|---|---|
| Vc,Rd | 1478.07 | kN |
| unity check | 0.01 | |

**Bending moment check (My)**

according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)

Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 492.56 | kNm |
| unity check | 0.23 | |

**Bending moment check (Mz)**

according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)

Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 18.51 | kNm |
| unity check | 0.03 | |

**Combined bending, axial force and shear force check**

according to article EN 1993-1-1 : 6.2 and formula EN 1993-1-1: (6.1)

Section classification is 3.

| Table of values | | |
|---|---|---|

| | | |
|---|---|---|
| sigma N | -5.91 | kN/cm^2 |
| sigma Myy | -5.33 | kN/cm^2 |
| sigma Mzz | -0.60 | kN/cm^2 |
| Tau y | 0.00 | kN/cm^2 |
| Tau z | 0.00 | kN/cm^2 |
| Tau t | 0.00 | kN/cm^2 |

ro 0.00 place 13
unity check 0.50
Element satisfies the section check !

**STABILITY CHECK**

| **Buckling parameters** | yy | zz | |
|---|---|---|---|
| type | sway | non-sway | |
| Slenderness | 21.27 | 40.46 | |
| Reduced slenderness | 0.23 | 0.43 | |
| Buckling curve | b | c | |
| Imperfection | 0.34 | 0.49 | |
| Reduction factor | 0.99 | 0.88 | |
| Length | 5.40 | 1.00 | m |
| Buckling factor | 1.00 | 1.00 | |
| Buckling length | 5.40 | 1.00 | m |
| Critical Euler load | 49907.88 | 13791.67 | kN |

**LTB check**
according to article EN 1993-1-1 : 6.3.2.1. and formula EN 1993-1-1 : (6.54)

| **Table of values** | | |
|---|---|---|
| Mb.Rd | 492.56 | kNm |
| Wy | 2096007.21 | mm^3 |
| reduction | 1.00 | |
| imperfection | 0.76 | |
| reduced slenderness | 0.11 | |
| method for LTB curve | Art. 6.3.2.2. | |
| Mcr | 37368.65 | kNm |
| unity check | 0.23 | |

| **LTB** | | |
|---|---|---|
| LTB length | 0.02 | m |
| k | 1.00 | |
| kw | 1.00 | |
| C1 | 1.14 | |
| C2 | 0.03 | |
| C3 | 1.00 | |

load in center of gravity

**Compression and bending check**
according to article EN 1993-1-1 : 6.3.3. and formula EN 1993-1-1 : (6.61) (6.62)
Interaction Method 1

| **Table of values** | | |
|---|---|---|
| kyy | 1.000 | |
| kyz | 1.000 | |
| kzy | 1.000 | |
| kzz | 1.000 | |
| Delta My | 0.00 | kNm |
| Delta Mz | 0.00 | kNm |
| A | 10894.00 | mm^2 |
| Wy | 2096007.21 | mm^3 |

| | | |
|---|---|---|
| Wz | 78748.26 | mm^3 |
| NRk | 2560.09 | kN |
| My,Rk | 492.56 | kNm |
| Mz,Rk | 18.51 | kNm |
| My,Ed | 111.76 | kNm |
| Mz,Ed | 0.65 | kNm |
| Interaction Method 1 | | |
| Mcr0 | 37368.65 | kNm |
| reduced slenderness 0 | 0.11 | |
| Cmy,0 | 1.000 | |
| Cmz,0 | 1.000 | |
| Cmy | 1.000 | |
| Cmz | 1.000 | |
| CmLT | 1.000 | |
| muy | 1.000 | |
| muz | 1.000 | |
| wy | 1.206 | |
| wz | 1.500 | |
| npl | 0.000 | |
| aLT | 0.999 | |
| bLT | 0.000 | |
| cLT | 0.005 | |
| dLT | 0.006 | |
| eLT | 0.273 | |
| Cyy | 1.000 | |
| Cyz | 0.998 | |
| Czy | 0.999 | |
| Czz | 0.864 | |

unity check = 0.00 + 0.23 + 0.03 = 0.26
unity check = 0.00 + 0.23 + 0.03 = 0.26
Element satisfies the stability check !

Najbolj izkoriščen glavni vzdolžni nosilec:

**EC3 : EN 1993 Code Check**

| | | | | |
|---|---|---|---|---|
| **Member B271** | **General cross-section** | **S 235** | **MSN-103/3** | **0.81** |

| **Basic data EC3 : EN 1993** | |
|---|---|
| partial safety factor Gamma M0 for resistance of cross-sections | 1.00 |
| partial safety factor Gamma M1 for resistance to instability | 1.00 |
| partial safety factor Gamma M2 for resistance of net sections | 1.25 |

| **Material data** | | |
|---|---|---|
| yield strength fy | 23.50 | kN/cm^2 |
| tension strength fu | 36.00 | kN/cm^2 |
| fabrication | rolled | |

**SECTION CHECK**

**The critical check is on position 0.00 m**

| **Internal forces** | | |
|---|---|---|
| NEd | -146.99 | kN |
| Vy,Ed | 3.30 | kN |
| Vz,Ed | -9.92 | kN |
| TEd | 0.01 | kNm |
| My,Ed | 2.40 | kNm |
| Mz,Ed | -0.06 | kNm |

Warning: Torsion is not taken into account for this cross-section!

**Compression check**

according to article EN 1993-1-1 : 6.2.4 and formula EN 1993-1-1 : (6.9)
Section classification is 3.

| **Table of values** | | |
|---|---|---|
| Nc.Rd | 1240.33 | kN |
| unity check | 0.12 | |

**Shear check (Vy)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| **Table of values** | | |
|---|---|---|
| Vc,Rd | 716.10 | kN |
| unity check | 0.00 | |

**Shear check (Vz)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| **Table of values** | | |
|---|---|---|
| Vc,Rd | 716.10 | kN |
| unity check | 0.01 | |

**Bending moment check (My)**

according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)
Section classification is 3.

| **Table of values** | | |
|---|---|---|
| Mc,Rd | 106.11 | kNm |

| | | |
|---|---|---|
| unity check | 0.02 | |

**Bending moment check (Mz)**
according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)
Section classification is 3.

| Table of values | | |
|---|---|---|
| Mc,Rd | 6.80 | kNm |
| unity check | 0.01 | |

**Combined bending, axial force and shear force check**
according to article EN 1993-1-1 : 6.2 and formula EN 1993-1-1: (6.1)
Section classification is 3.

| Table of values | | |
|---|---|---|
| sigma N | 2.78 | kN/cm^2 |
| sigma Myy | 0.52 | kN/cm^2 |
| sigma Mzz | 0.02 | kN/cm^2 |
| Tau y | 0.01 | kN/cm^2 |
| Tau z | -0.00 | kN/cm^2 |
| Tau t | 0.00 | kN/cm^2 |

ro 0.00 place 7
unity check 0.14
Element satisfies the section check !
**STABILITY CHECK**

| Buckling parameters | yy | zz | |
|---|---|---|---|
| type | sway | non-sway | |
| Slenderness | 31.17 | 214.73 | |
| Reduced slenderness | 0.33 | 2.29 | |
| Buckling curve | c | c | |
| Imperfection | 0.49 | 0.49 | |
| Reduction factor | 0.93 | 0.16 | |
| Length | 4.09 | 4.09 | m |
| Buckling factor | 1.00 | 1.00 | |
| Buckling length | 4.09 | 4.09 | m |
| Critical Euler load | 11256.33 | 237.24 | kN |

Warning: slenderness 214.73 is larger then 200.00 !
**Buckling check**
according to article EN 1993-1-1 : 6.3.1.1. and formula EN 1993-1-1 : (6.46)

| Table of values | | |
|---|---|---|
| Nb.Rd | 192.64 | kN |
| unity check | 0.76 | |

**Torsional-flexural buckling check**
according to article EN 1993-1-1 : 6.3.1.1. and formula EN 1993-1-1 : (6.46)

| Table of values | | |
|---|---|---|
| Nb.Rd | 192.64 | kN |
| Reduced slenderness | 2.29 | |
| Reduction factor | 0.16 | |
| sigma,cr,T | 18.59 | kN/cm^2 |
| sigma,cr,TF | 4.49 | kN/cm^2 |
| Torsional buckling length | 4.09 | m |
| unity check | 0.76 | |

**LTB check**

according to article EN 1993-1-1 : 6.3.2.1. and formula EN 1993-1-1 : (6.54)

| Table of values | | |
|---|---|---|
| Mb.Rd | 106.11 | kNm |
| Wy | 451533.38 | mm^3 |
| reduction | 1.00 | |
| imperfection | 0.76 | |
| reduced slenderness | 0.18 | |
| method for LTB curve | Art. 6.3.2.2. | |
| Mcr | 3197.97 | kNm |
| unity check | 0.02 | |

| LTB | | |
|---|---|---|
| LTB length | 0.08 | m |
| k | 1.00 | |
| kw | 1.00 | |
| C1 | 1.11 | |
| C2 | 0.00 | |
| C3 | 1.00 | |

load in center of gravity

**Compression and bending check**

according to article EN 1993-1-1 : 6.3.3. and formula EN 1993-1-1 : (6.61) (6.62)

Interaction Method 1

| Table of values | | |
|---|---|---|
| kyy | 1.637 | |
| kyz | 1.449 | |
| kzy | 0.690 | |
| kzz | 0.610 | |
| Delta My | 0.00 | kNm |
| Delta Mz | 0.00 | kNm |
| A | 5278.00 | mm^2 |
| Wy | 451533.38 | mm^3 |
| Wz | 28951.66 | mm^3 |
| NRk | 1240.33 | kN |
| My,Rk | 106.11 | kNm |
| Mz,Rk | 6.80 | kNm |
| My,Ed | 5.72 | kNm |
| Mz,Ed | 0.13 | kNm |
| Interaction Method 1 | | |
| Mcr0 | 3197.97 | kNm |
| reduced slenderness 0 | 0.18 | |
| Cmy,0 | 0.955 | |
| Cmz,0 | 0.552 | |
| Cmy | 0.973 | |
| Cmz | 0.552 | |
| CmLT | 1.661 | |
| muy | 0.999 | |
| muz | 0.421 | |
| wy | 1.290 | |
| wz | 1.500 | |
| npl | 0.119 | |
| aLT | 0.998 | |
| bLT | 0.000 | |
| cLT | 0.000 | |

| | | |
|---|---|---|
| dLT | 0.000 | |
| eLT | 0.000 | |
| Cyy | 0.775 | |
| Cyz | 0.944 | |
| Czy | 0.431 | |
| Czz | 0.974 | |

unity check = 0.13 + 0.09 + 0.03 = 0.24
unity check = 0.76 + 0.04 + 0.01 = 0.81
Element satisfies the stability check !

Najbolj izkoriščen sekundarni vzdolžni nosilec (INP 240):

**EC3 : EN 1993 Code Check**

| | | | | |
|---|---|---|---|---|
| **Member B275** | **INP240** | **S 235** | **MSN-145/5** | **0.43** |

| **Basic data EC3 : EN 1993** | |
|---|---|
| partial safety factor Gamma M0 for resistance of cross-sections | 1.00 |
| partial safety factor Gamma M1 for resistance to instability | 1.00 |
| partial safety factor Gamma M2 for resistance of net sections | 1.25 |

| **Material data** | | |
|---|---|---|
| yield strength fy | 23.50 | kN/cm^2 |
| tension strength fu | 36.00 | kN/cm^2 |
| fabrication | rolled | |

**SECTION CHECK**

Width-to-thickness ratio for internal compression parts (EN 1993-1-1 : Tab.5.2. sheet 1).
ratio 22.57 on position 0.00 m

| **ratio** | | |
|---|---|---|
| maximum ratio | 1 | 33.00 |
| maximum ratio | 2 | 38.00 |
| maximum ratio | 3 | 42.25 |

==> Class cross-section 1

Width-to-thickness ratio for outstand flanges (EN 1993-1-1 : Tab.5.2. sheet 2).
ratio 3.05 on position 0.00 m

| **ratio** | | |
|---|---|---|
| maximum ratio | 1 | 9.00 |
| maximum ratio | 2 | 10.00 |
| maximum ratio | 3 | 13.89 |

==> Class cross-section 1

**The critical check is on position 0.00 m**

| **Internal forces** | | |
|---|---|---|
| NEd | -87.52 | kN |
| Vy,Ed | 1.86 | kN |
| Vz,Ed | -10.33 | kN |
| TEd | 0.01 | kNm |
| My,Ed | 0.07 | kNm |
| Mz,Ed | -0.12 | kNm |

Warning: Torsion is not taken into account for this cross-section!

**Compression check**

according to article EN 1993-1-1 : 6.2.4 and formula EN 1993-1-1 : (6.9)
Section classification is 1.

| **Table of values** | | |
|---|---|---|
| Nc.Rd | 1083.35 | kN |
| unity check | 0.08 | |

**Shear check (Vy)**

according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| Table of values | | |
|---|---|---|
| Vc,Rd | 373.10 | kN |
| unity check | 0.00 | |

**Shear check (Vz)**
according to article EN 1993-1-1 : 6.2.6. and formula EN 1993-1-1 : (6.17)

| Table of values | | |
|---|---|---|
| Vc,Rd | 302.84 | kN |
| unity check | 0.03 | |

**Bending moment check (My)**
according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)
Section classification is 1.

| Table of values | | |
|---|---|---|
| Mc,Rd | 96.82 | kNm |
| unity check | 0.00 | |

**Bending moment check (Mz)**
according to article EN 1993-1-1 : 6.2.5. and formula EN 1993-1-1 : (6.12)
Section classification is 1.

| Table of values | | |
|---|---|---|
| Mc,Rd | 16.45 | kNm |
| unity check | 0.01 | |

**Combined bending, axial force and shear force check**
according to article EN 1993-1-1 : 6.2.9.1. and formula EN 1993-1-1 : (6.41)
Section classification is 1.

| Table of values | | |
|---|---|---|
| MNVy.Rd | 96.82 | kNm |
| MNVz.Rd | 16.45 | kNm |

alfa 2.00 beta 1.00
unity check 0.01
Element satisfies the section check !
**STABILITY CHECK**

| Buckling parameters | yy | zz | |
|---|---|---|---|
| type | sway | non-sway | |
| Slenderness | 42.60 | 186.80 | |
| Reduced slenderness | 0.45 | 1.99 | |
| Buckling curve | a | b | |
| Imperfection | 0.21 | 0.34 | |
| Reduction factor | 0.94 | 0.21 | |
| Length | 4.09 | 4.09 | m |
| Buckling factor | 1.00 | 1.00 | |
| Buckling length | 4.09 | 4.09 | m |
| Critical Euler load | 5265.76 | 273.82 | kN |

**Buckling check**
according to article EN 1993-1-1 : 6.3.1.1. and formula EN 1993-1-1 : (6.46)

| Table of values | | |
|---|---|---|
| Nb.Rd | 229.14 | kN |
| unity check | 0.38 | |

**LTB check**

according to article EN 1993-1-1 : 6.3.2.1. and formula EN 1993-1-1 : (6.54)

| Table of values | | |
|---|---|---|
| Mb.Rd | 96.82 | kNm |
| Wy | 412000.00 | mm^3 |
| reduction | 1.00 | |
| imperfection | 0.34 | |
| reduced slenderness | 0.03 | |
| method for LTB curve | Art. 6.3.2.2. | |
| Mcr | 98009.85 | kNm |
| unity check | 0.00 | |

| LTB | | |
|---|---|---|
| LTB length | 0.08 | m |
| k | 1.00 | |
| kw | 1.00 | |
| C1 | 1.15 | |
| C2 | 0.46 | |
| C3 | 0.53 | |

load in center of gravity

**Compression and bending check**

according to article EN 1993-1-1 : 6.3.3. and formula EN 1993-1-1 : (6.61) (6.62)

Interaction Method 1

| Table of values | | |
|---|---|---|
| kyy | 1.364 | |
| kyz | 0.824 | |
| kzy | 0.708 | |
| kzz | 0.863 | |
| Delta My | 0.00 | kNm |
| Delta Mz | 0.00 | kNm |
| A | 4610.00 | mm^2 |
| Wy | 412000.00 | mm^3 |
| Wz | 70000.00 | mm^3 |
| NRk | 1083.35 | kN |
| My,Rk | 96.82 | kNm |
| Mz,Rk | 16.45 | kNm |
| My,Ed | 5.32 | kNm |
| Mz,Ed | 0.21 | kNm |
| Interaction Method 1 | | |
| Mcr0 | 84899.18 | kNm |
| reduced slenderness 0 | 0.03 | |
| Cmy,0 | 1.002 | |
| Cmz,0 | 0.753 | |
| Cmy | 1.001 | |
| Cmz | 0.753 | |
| CmLT | 1.231 | |
| muy | 0.999 | |
| muz | 0.730 | |
| wy | 1.164 | |
| wz | 1.500 | |
| npl | 0.081 | |
| aLT | 0.994 | |
| bLT | 0.000 | |
| cLT | 0.000 | |

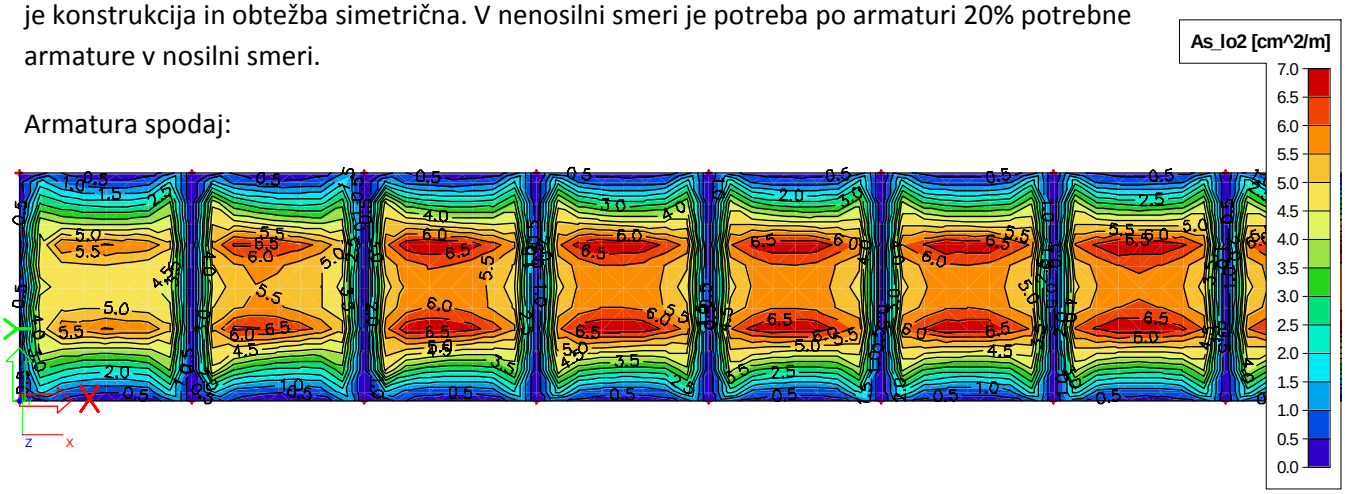
| | | |
|---|---|---|
| dLT | 0.000 | |
| eLT | 0.000 | |
| Cyy | 0.918 | |
| Cyz | 0.914 | |
| Czy | 0.682 | |
| Czz | 0.936 | |

unity check = 0.09 + 0.07 + 0.01 = 0.17
unity check = 0.38 + 0.04 + 0.01 = 0.43
Element satisfies the stability check !

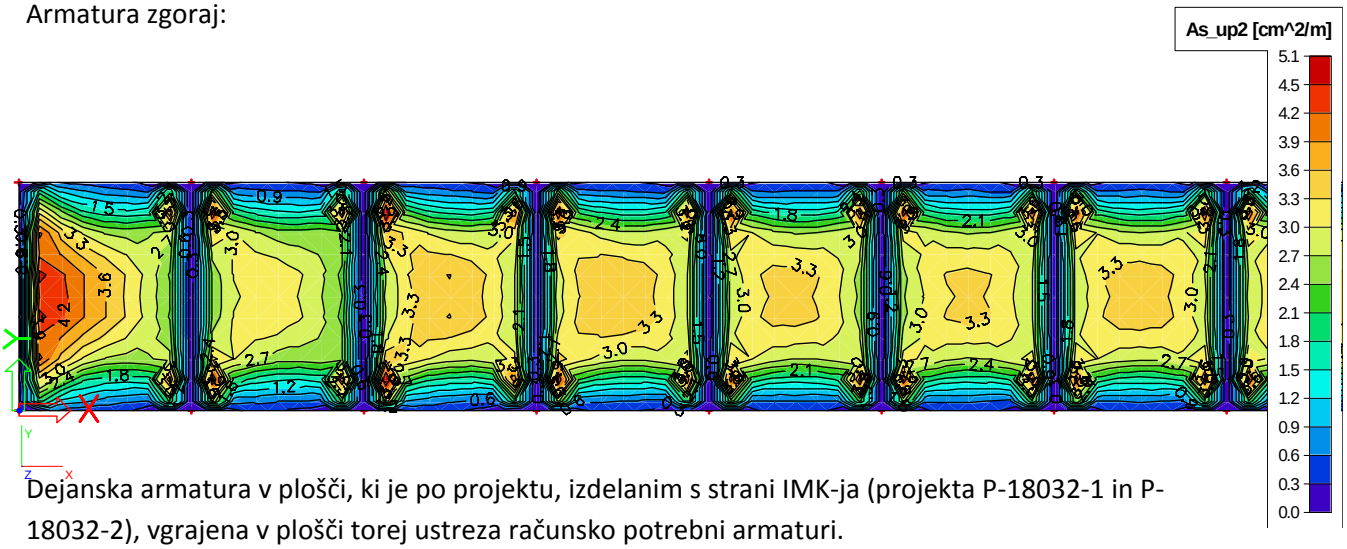
*Računsko potrebna armatura v plošči:*

Prikazujemo samo armaturo v krajši smeri plošče (enostransko nosilna plošča) za polovico mostu, saj je konstrukcija in obtežba simetrična. V nenosilni smeri je potreba po armaturi 20% potrebne armature v nosilni smeri.

Armatura spodaj:




Armatura zgoraj:




Dejanska armatura v plošči, ki je po projektu, izdelanim s strani IMK-ja (projekta P-18032-1 in P-18032-2), vgrajena v plošči torej ustreza računsko potrebni armaturi.

## 3.2. Analiza konstrukcije v MSU

**OP.: Kontrole v mejnem stanju uporabnosti preverjamo le za SANIRANO STANJE.**

**Redka obtežna kombinacija**

R1.) lastna teža + stalne obtežbe + promet + 0.2×veter

R2.) lastna teža + stalne obtežbe + temperaturne spremembe + 0.75×promet + 0.2×veter

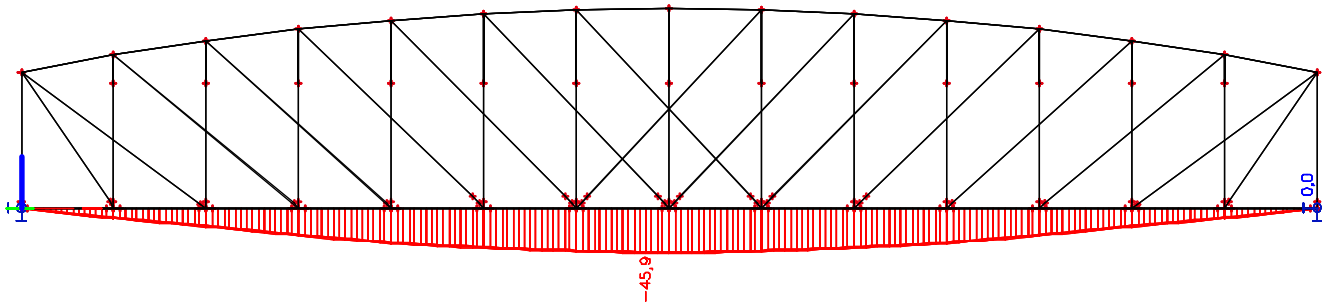
R3.) lastna teža + stalne obtežbe + zavorne sile + 0.75×promet + 0.2×veter

**Pogosta obtežna kombinacija**

PO1.) lastna teža + stalne obtežbe + 0.75×promet + 0.6×temperaturne spremembe

PO2.) lastna teža + stalne obtežbe + 0.6×temperaturne spremembe

### 3.2.1. Kontrola povesov




$u_{z,dej}$ = 45,9 mm < $u_{z,dovoljeni}$ = L/300 = 57260 mm/300 = 191 mm

Dejanski povesi so manjši od dovoljenih!

## 4. STATIČNA PREVERBA ZVAROV V SKLOPU SANACIJE

### -Kontrola zvarov pri sanaciji Diagonal:

| Member | $F_L$ [kN] | $V_L$ [kN] | $F_{II}$ [kN] | Mx [kNm] | My [kNm] | Mz [kNm] | $v_{II} = \tau_{II}$ [kN/cm2] | $v_L = \tau_L$ [kN/cm2] | $n = \sigma_L$ [kN/cm2] | Interakcija [kN/cm2] | | $f_{v,w,d}$ [kN/cm2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPOJ 1 | 0,00 | 0,00 | 390,00 | 0,00 | 0,00 | 0,00 | 8,13 | 0,00 | 0,00 | 8,13 | < | 12,47 |

| | | | |
|---|---|---|---|
| Max | 8,13 | < | 20,78 |

| | | |
|---|---|---|
| št. daljših zvarov: | 2 | |
| št. krajših zvarov: | 0 | |
| t = | 6 | mm |
| a = | 3 | mm |
| $l_{z,daljši}$ = | 800 | mm |
| $l_{z,krajši}$ = | 1 | mm |
| $f_u$ = | 360 | N/mm$^2$ |
| $\beta_w$ = | 0,8 | |
| $\beta_{w,l}$ = | 0,6 | |
| $W_{z,zv-daljši}$ = | 640,00 | cm$^3$ |
| $W_{y,zv-daljši}$ = | 9,60 | cm$^3$ |
| $\gamma_{M2}$ = | 1,25 | |
| $I_{z,zv-daljši}$ = | 25600,00 | cm$^4$ |
| $I_{y,zv-daljši}$ = | 0,48 | cm$^4$ |

### -Kontrola zvarov pri sanaciji Diagonal:

| Member | $F_L$ [kN] | $V_L$ [kN] | $F_{II}$ [kN] | Mx [kNm] | My [kNm] | Mz [kNm] | $v_{II} = \tau_{II}$ [kN/cm2] | $v_L = \tau_L$ [kN/cm2] | $n = \sigma_L$ [kN/cm2] | Interakcija [kN/cm2] | | $f_{v,w,d}$ [kN/cm2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPOJ 1 | 0,00 | 0,00 | 400,00 | 0,00 | 0,00 | 0,00 | 16,67 | 0,00 | 0,00 | 16,67 | < | 20,78 |

| | | | |
|---|---|---|---|
| Max | 16,67 | < | 20,78 |

| | | |
|---|---|---|
| št. daljših zvarov: | 4 | |
| št. krajših zvarov: | 0 | |
| t = | 6 | mm |
| a = | 3 | mm |
| $l_{z,daljši}$ = | 200 | mm |
| $l_{z,krajši}$ = | 1 | mm |
| $f_u$ = | 360 | N/mm$^2$ |
| $\beta_w$ = | 0,8 | |
| $\beta_{w,l}$ = | 1 | |
| $W_{z,zv-daljši}$ = | 80,00 | cm$^3$ |
| $W_{y,zv-daljši}$ = | 4,80 | cm$^3$ |
| $\gamma_{M2}$ = | 1,25 | |
| $I_{z,zv-daljši}$ = | 800,00 | cm$^4$ |
| $I_{y,zv-daljši}$ = | 0,24 | cm$^4$ |

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V1,V13 - DIAGONALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 14$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 70$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 10$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

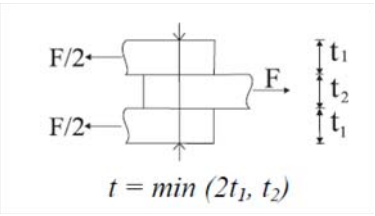
### 4. Obtežba v elementu:

$Fvsde := 670$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 47.857$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 47.857$ kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

○ robna zakovica

○ notranja zakovica

$\alpha_d = 1.4$ $k_1 = 3.151$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 1$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 302.543$ kN $Fvsd = 47.857$ kN < $Fbrd = 302.543$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V2,V12 - DIAGONALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 20$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 10$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

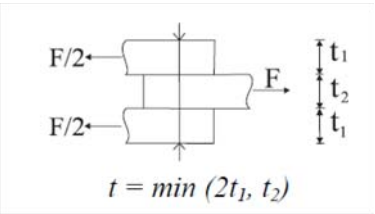
### 4. Obtežba v elementu:

$Fvsde := 811$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 40.55$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 40.55$kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 323.474$ kN $Fvsd = 40.55$kN < $Fbrd = 323.474$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V3,V11 - DIAGONALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 18$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 10$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

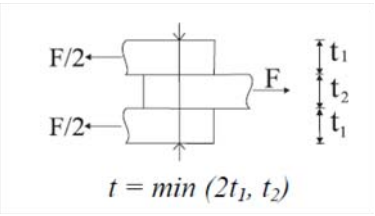
### 4. Obtežba v elementu:

$Fvsde := 590$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 32.778$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 32.778$ kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 323.474$ kN $Fvsd = 32.778$ kN < $Fbrd = 323.474$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V4,V10 - DIAGONALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 12$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

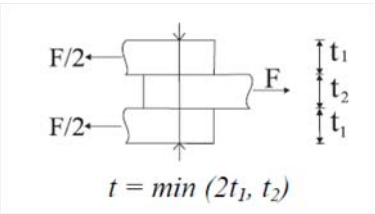
### 4. Obtežba v elementu:

$Fvsde := 390$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 32.5$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 32.5$ kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 32.5$ kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V5,V9 - DIAGONALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 10$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

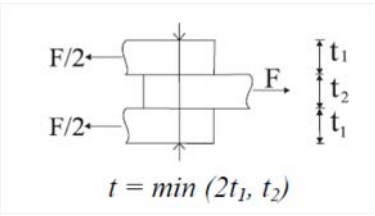
### 4. Obtežba v elementu:

$Fvsde := 350$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 35$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 35$ kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

◉ robna zakovica

○ notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 35$ kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V6,V8 - DIAGONALA D5

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 10$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

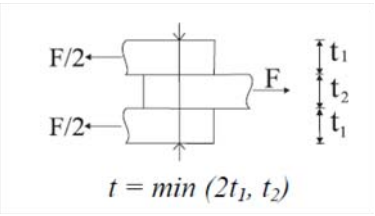
### 4. Obtežba v elementu:

$Fvsde := 218$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 21.8$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 21.8$ kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 21.8$ kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V7 - DIAGONALA D6

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 10$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

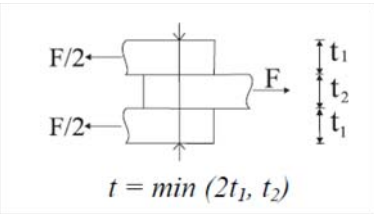
### 4. Obtežba v elementu:

$Fvsde := 136$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 13.6$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 13.6$ kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 13.6$ kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V6,V8 - DIAGONALA D7

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 20$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

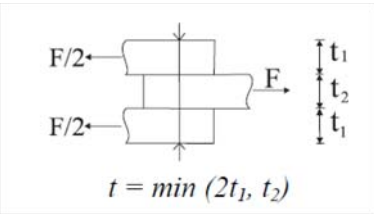
### 4. Obtežba v elementu:

$Fvsde := 100$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 5$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 5$ kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 5$ kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V1,V13 - VERTIKALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 12$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 10$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

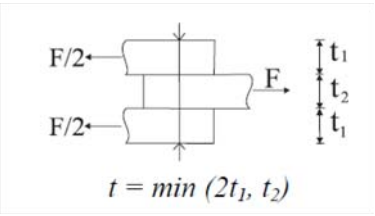
### 4. Obtežba v elementu:

$Fvsde := 405$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 33.75$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 33.75$kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 323.474$ kN $Fvsd = 33.75$kN < $Fbrd = 323.474$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V2,V12 - VERTIKALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 12$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

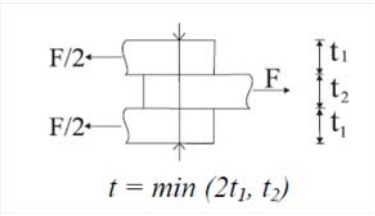
### 4. Obtežba v elementu:

$Fvsde := 285$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 23.75$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 23.75$kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

◉ robna zakovica

○ notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 23.75$kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V3,V11 - VERTIKALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 12$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 9$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

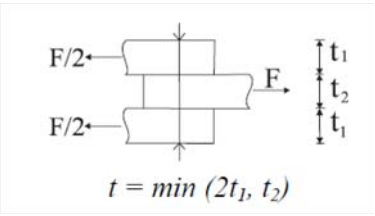
### 4. Obtežba v elementu:

$Fvsde := 226$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 18.833$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 18.833$ kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

◉ robna zakovica

○ notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 291.127$ kN $Fvsd = 18.833$ kN < $Fbrd = 291.127$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V4,V10 - VERTIKALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 12$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

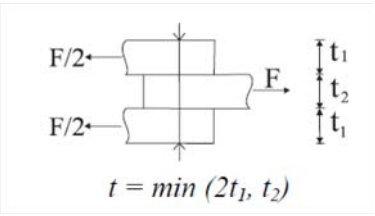
### 4. Obtežba v elementu:

$Fvsde := 123$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 10.25$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 10.25$kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 10.25$kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V5,V9 - VERTIKALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 12$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

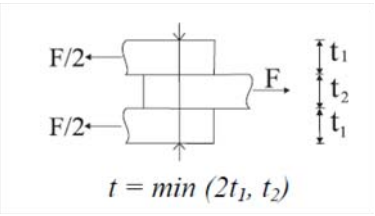
### 4. Obtežba v elementu:

$Fvsde := 55$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 4.583$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 4.583$kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

◉ robna zakovica

○ notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 4.583$kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V6,V9 - VERTIKALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 12$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

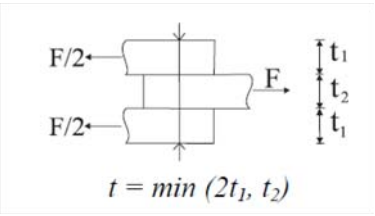
### 4. Obtežba v elementu:

$Fvsde := 112$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 9.333$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 9.333$kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 9.333$kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"

## STATIČNA PREVERBA STIKA: -VOZLIŠČE V7 - VERTIKALA

### 1. Materiali:

pločevina: S235 / S275 $f_y = 23.5$ kN/cm² $f_u = 36$ kN/cm²

zakovice: $fur := 40$ kN/cm²

### 2. Zakovice:

$d := 30$ mm ..... zunanji premer zakovice

$n := 12$ ..... število zakovic $dn := \frac{d}{1.5} = 20$ mm ..... notranji premer zakovice

$do := dn + (2 \cdot 0.005 \cdot dn) = 20.2$ mm ..... premer luknje

$Ao := \frac{do^2 \cdot \pi}{4 \cdot 100} = 3.205$ cm² .... presek luknje

$An := \frac{dn^2 \cdot 3.14}{4 \cdot 100} = 3.14$ cm² .... presek zakovice

$e1 := 45$ mm ..... oddaljenost od roba $e2 := 45$ mm ..... oddaljenost od roba

$p1 := 100$ mm ..... medsebojna oddaljenost $p2 := 100$ mm ..... medsebojna oddaljenost

### 3. Element:

$t := 8$ mm ..... debeline pločevine $nr := 1$ ..... število strižnih ravnin

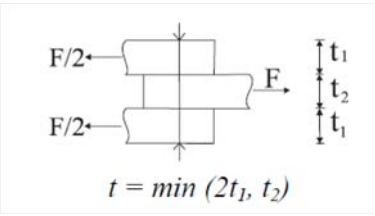
### 4. Obtežba v elementu:

$Fvsde := 65$ kN ..... Projektna sila v elementu

$Fvsd := \frac{Fvsde}{n} = 5.417$ kN ..... Projektna sila v zakovici

$Fvrd := \frac{0.6 \cdot fur \cdot Ao}{\gamma m2} = 61.531$ kN ..... Projektna strižna odpornost zakovice

### 5. Kontrole:




**Projektna nosilnost zakovice na prestrig:**

$Fvsd = 5.417$kN < $nr \cdot Fvrd = 61.531$ kN

**Projektna nosilnost zakovice na bočni pritisk:**

(•) robna zakovica

( ) notranja zakovica

$\alpha_d = 0.743$ $k_1 = 4.538$ $\alpha_b := \min\left(\alpha_d, \frac{fur}{f_u}, 1\right) = 0.743$

$Fbrd := \frac{k_1 \cdot \alpha_b \cdot fur \cdot d \cdot t}{\gamma m2 \cdot 100} = 258.779$ kN $Fvsd = 5.417$kN < $Fbrd = 258.779$ kN

Kontrole = "so OK"