Projekt čelične konstrukcije stadiona Višnjik

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Sažetak:

Prema podlogama arhitektonskog rješenja, izrađen je projekt čelične konstrukcije stadiona Višnjik u Zadru. Arhitektonskim podlogama zadana je tlocrtna, uzdužna i poprečna dispozicija kao i oblik konstruktivnih elemenata. Na temelju zadanih gabarita napravljen je proračunski model na kojem je izvršeno dimenzioniranje svih konstruktivnih elemenata. Za odabrane elemente konstrukcije izvršen je proračun spojeva te su napravljeni građevinski nacrti i iskaz materijala. Svi proračuni konstrukcije izvedeni su prema normama Eurocode-a.

Ključne riječi:

čelična konstrukcija, stadion, priključci, nacrti

Steel construction project for Višnjik stadium

Abstract:

Steel construction project for Višnjik stadium in Zadar was made according to the drawings of architectural solution. The arcitectural drawings defined ground, longitudinal and transverse plans, as well as the type of construction elements. Structure model was made based on given dimensions, which was used for dimensioning all construction elements. Calculation of joints, construction design and bill of material were made for selected elements of the construction. All calculations related to the construction were carried out under the Eurocode norms.

Keywords:

steel construction, stadium, joints, drawings

SVEUČILIŠTE U SPLITU
FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE

STUDIJ:	**DIPLOMSKI SVEUČILIŠNI STUDIJ GRAĐEVINARSTVA**
KANDIDAT:	Monika Ćosić
BROJ INDEKSA:	685
KATEDRA:	**Katedra za metalne i drvene konstrukcije**
PREDMET:	Metalne konstrukcije

ZADATAK ZA DIPLOMSKI RAD

Tema: Projekt čelične konstrukcije stadiona Višnjik

Opis zadatka: Na temelju zadanih arhitektonskih podloga potrebno je napraviti proračun čelične konstrukcije stadiona Višnjik smještenog na području Zadra. Projekt treba sadržavati proračunski model konstrukcije pomoću kojeg će se izvršiti dimenzioniranje konstruktivnih elemenata u skladu s HRN EN 1993, HRN EN 1994 i HRN EN 1992.
Također je potrebno proračunati spojeve te izraditit pripadajuće nacrte.

U Splitu, ožujak 2019.

Voditelj Diplomskog rada:

Prof. dr. sc. Ivica Boko

Predsjednik Povjerenstva
za završne i diplomske ispite:
Doc. dr. sc. Ivo Andrić

SADRŽAJ:

1. TEHNIČKI OPIS

1.1. Opis konstrukcije

Predmet ovog projekta je čelična konstrukcija stadiona Višnjik smještenog na području Zadra. Obuhvat se nalazi unutar Športskog centra „Višnjik“ koji je pozicioniran između Poluotoka (stare gradske jezgre) na jugu i stambenog naselja Bili Brig na sjeveroistoku. Odabrani obuhvat je kat. čestica 3838/1 koja je u vlasništvu Republike Hrvatske. Zona obuhvata 9,61 ha. Kompleks ŠC „Višnjik“ omeđen je sa sjeverozapadne strane Ulicom Edvina Androvića, s juga Ulicom Domovinskog rata, s jugoistoka Splitskom ulicom i sa sjeverne strane Ulicom Slavka Perovića. Pristup glavnom parkingu je s ulice Slavka Perovića, dok su omogućeni kolni ulazi sa sve četiri strane kompleksa.

Objekt se funkcionalno sastoji od dva dijela, nogometnog i atletskog stadiona međusobno povezanih natkrivenim trijemom i garažom u prizemlju. Objekt je planiran kao višeetažna konstrukcija sa višenamjenskim sadržajem. U podzemnoj etaži su smješene garaže, prostori namjenjeni igračima, službenim osobama, prostorija za održavanje stadiona te skladište. U nadzemnim etažama se nalaze uredi, smještajne jedinice, kuglana, teretana, fitness prostor i caffe bar.

Vertikalnu nosivu konstrukciju čine armirano betonski i čelični stupovi oblika poprečnog presjeka „I“. Krovna konstrukcija se sastoji od čeličnih rešetkastih nosača oslonjenih na čelične i armirano betonske stupove. Rešetkasti nosači su izrađeni od šupljih čeličnih profila kvadratnog poprečnog presjeka. Međukatne konstrukcije su armirano betonske ploče. Tribine su izrađene od armiranog betona.
Temelji su armirano betonski, izvedeni kao temelji samci, kvadratnog tlocrtnog oblika. Iznad temelja je postavljena temeljna armirano betonska ploča.
Odvodnja je rješena padovima krova.

Ukupna širina objekta je 160 m, dok duljina iznosi 198 m. Ukupna površina krovne plohe je 18563,7 m^2, a visina objekta je 18,5 m.

1.2. O proračunu konstrukcije

Proračun konstrukcije napravljen je uz pomoć programskog paketa SCIA Engineer 19.0. Proračun reznih sila, te dimenzioniranje konstruktivnih elemenata provedeno je korištenjem programa SCIA Engineer 19.0. Spojevi su izračunati uz pomoć programa IDEA StatiCa, dok je za grafički dio projekta korišten AutoCAD 2018.

Proračun reznih sila izvršen je po linearnoj teoriji elastičnosti prvog reda. Proračunom su obuhvaćena sva djelovanja na konstrukciju, a to su: vlastita težina, dodatno stalno opterećenje, pokretno opterećenje, opterećenje snijegom, vjetarom, djelovanje temperature i potres.

S obzirom na lokaciju objekta napravljena je analiza opterećenja koja obuhvaća djelovanje snijega i vjetra. Objekt se nalazi na području Zadra, te prema karti snijega za Republiku Hrvatsku ova građevina spada u 1. područje – priobalje i otoci, što određuje karakterističnu vrijednost opterećenja snijegom na tlu. U obzir je uzeta i nadmorska visina na kojoj se nalazi objekt. Za opterećenje vjetrom odabrana je zona III, kategorija zemljišta 0, te je u obzir uzeta visina objekta i njegova zaštičenost.

Budući da je vjetar dominantno opterećenje za ovakav tip objekta, posvećena mu je velika pažnja. Konstrukcija je otvorenog tipa pa je promatrano tlačno i podtlačno djelovanje vjetra. U proračunskom modelu opterećenje vjetrom je prikazano kao površinsko opterećenje na krovnim panelima.

Za svaki element konstrukcije određena je mjerodavna kombinacija opterećenja za provjeru krajnjeg graničnog stanja i graničnog stanja uporabivosti. Za svako granično stanje napravljene su posebne kombinacije uz poštivanje parcijalnih faktora sigurnosti prema EN 1991.

Rezultati uključuju rezne sile i pomake određenih djelova konstrukcije. Rezne sile su dane u jedinicama kN za poprečne i uzdužne sile, kNm za momente, te u mm za pomake konstrukcije. U obzir su uzete sve mjerodavne kombinacije opterećenja , te je svaki element dimenzioniran sukladno njegovim reznim silama.

1.3. Materijal za izradu konstrukcije

Materijal za izradu glavne nosive konstrukcije, kao i stupova je čelik S355.
Konstruktivni elementi će međusobno bit vezani vijčanim i zavarenim spojevima. Vijci korišteni za izvedbu ove konstrukcije su: M12, M16, M22, M24, M27 i M36, svi kvalitete 5.6. Spojevi i nastavci elemenata konstrukcije uključuju dodatne ploče i ukrute, također iste kvalitete čelika.

Za betonski dio konstrukcije predviđen je beton klase C40/50. Temelji su armirano betosnki, klasa betona C25/30, armatura B500B.

1.4. Opis montaže konstrukcije

Izvedba konstrukcije je montažna. Svi elementi konstrukcije predgotovljeni stižu na gradilište te se međusobno vežu vijcima.

Nulta faza montaže, nakon izvedenih svih predhodno potrebnih radova, je montaža stupova. Stup se pridržaje dizalicom dok se ne postigne vertikalnost pomoću dvostrukih vijaka. Nakon provjere vertikalnosti, vrši se ispunjenje prostora između spojne i betonske ploče ekspandirajućim mortom.

Nakon toga se na stupove veže bočna sekundarna konstrukcija, glavni i sekundarni rešetkasti nosači.

Svi elementi konstrukcije se dovoze na gradilište duljine do 15 m zbog transporta. Na gradilištu se spajaju u veće segmente i takvi podižu dizalicom na predviđenu poziciju te vijčano i zavarima spajaju na ostatak konstrukcije.

1.5. Primjenjeni propisi

Proračun i dimenzioniranje svih elemenata čelične konstrukcije provedeni su u skladu sa EUROCODE-om 3, a analiza djelovanja na konstrukciju napravljena je u skladu sa EUROCODE-om 1. Posebno je proveden proračun zavarenih spojeva prema EN 1993, dio 1-8.

1.6. Antikorozivna zaštita

Kod čelika pod korozijom se podrazumijeva oksidacija željeza pri djelovanju vlage i raznih nečistoća. Agensi koji ubrzavaju hrđanje su zagađena atmosfera, industrijsko područje zagađeno sumporom, sol itd.

Zaštita čeličnih konstrukcija od hrđanja vrši se:

- premazima

- cinkom

- metalizacijom

- uporabom specijalnih čelika

- katodnom zaštitom

Zaštita premazima obavlja se u svrhu sprječavanja kontakta kisika i vlage sa čelikom. Premazivanje se obično vrši bojanjem u dva sloja: osnovni premaz i zaštitni premaz. Osnovni premaz neposredno štiti čelik, a potrebno je da bude izrađen od tvari koje nisu štetne po ljudsko zdravlje. Zaštitni sloj služi za zaštitu osnovnog premaza.

Prerano propadanje konstrukcije najčešće nastaje uslijed loših detalja u konstrukciji (nepristupačna mjesta za bojenje, mjesta gdje se zadržava voda, oštri bridovi gdje se ne može nanijeti zahtjevana debljina premaza i i sl.) koje treba nastojati izbjegavati.

Sistem zaštite bojom sastoji se iz:

- pripreme površine – trajnost premaza ovisi o prionjivosti boje za metalnu površinu, što ovisi o čistoći površine prije bojanja. Čiščenje se vrši četkama, pjeskarenjem, plamenikom ili kemijskim sredstvima.

- nanošenje boje – bojenje se vrši četkom, valjkom ili prskanjem. Treba paziti na ograničenja za pojedine boje. Broj slojeva premaza obično se sastoji od dva, a specifično od četiri ili više slojeva. Novi premaz može se vršiti tek kada je predhodni potpuno suh. Debljini premaza potrebno je posvetiti posebnu pažnju. Općenito, deblji premaz povećava trajnost zaštite. Ukupna debljina suhih premaza treba se kretati između 0,1 – 0,4 mm.

Dobro izvedeni premazi traju:

- do 30 godina u zatvorenoj prostoriji

- do 20 godina kod konstrukcija zaštićenih od kiše

- do 10 godina u prirodi

- 2 do 3 godine u zagađenom okolišu

Zaštita pocinčavanjem podrazumijeva vrste zaštite koje se ostvaruju nanošenjem prevlake cinka. Mase i debljine prevlaka cinka za pojedine elemente određene su prema Pravilniku o tehničkim mjerama i uvjetima za zaštitu čeličnih konstrukcija od korozije i ne mogu biti manje od 500g/m2 elementa debljine 5 mm. Sve čelične konstrukcije prethodno treba odmastiti, očistiti razblaženom otopinom klorovodične kiseline te isprati hladnom vodom. Neposredno prije pocinčavanja čelična konstrukcija se stavlja u taljevinu ili otopinu za flusiranje.

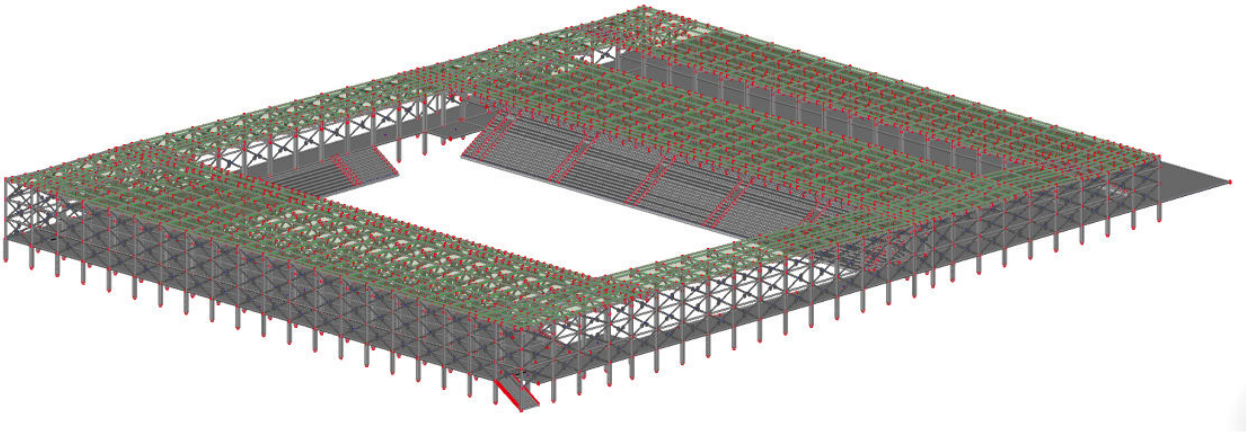
Toplo pocinčavanje se izvodi stavljanjem tekućine u rastopljeni cink. Cink mora biti kvaliteta Zn 97,5 do Zn 99,5 prema HRN EN ISO 14713:2001. Prevlaka cinka dobivena toplim postupkom mora biti homogena i mora prekrivati osnovicu. Prevlaka cinka mora čvrsto prianjati za čeličnu površinu i ne smije se ljuštiti niti pucati pri uporabi. Prije montaže potrebno je izvršiti kontrolu prevlake cinka prema HRN C.A1. 558, odnosno mase prevlake cinka prema HRN A6.021.

1.7. Protupožarna zaštita

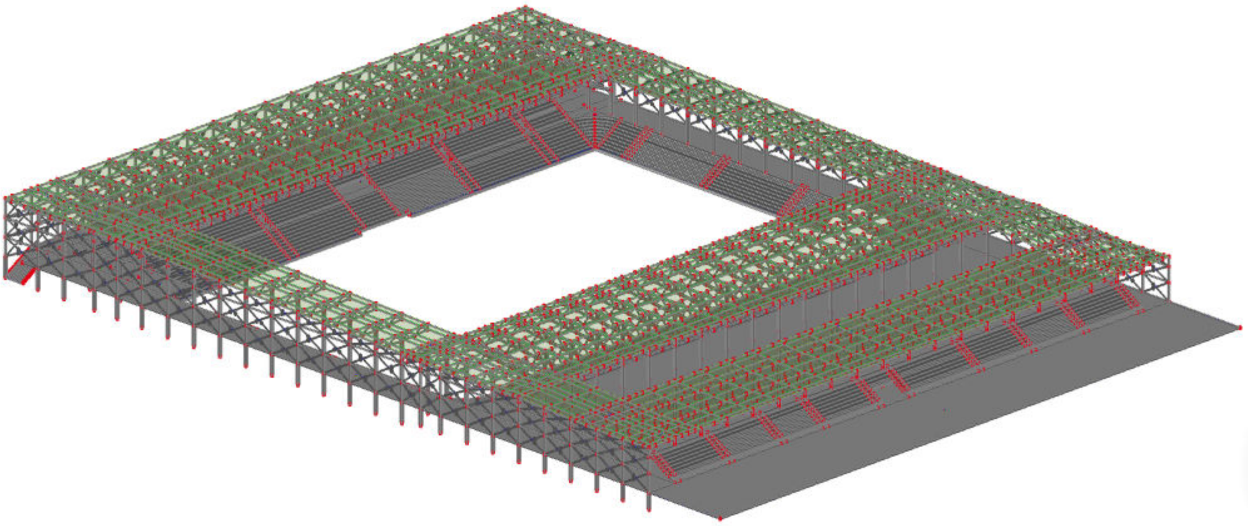
Pri izvedbi osigurat će se provedba svih propisa o zaštiti od požara. Pristup i intervencija vatrogasnog vozila omogućit će se sa zapadne strane parcele. Zahtijevana vatrootpornost elemenata čelične konstrukcije je F30. Osiguranje vatrootpornosti osiguravamo specijalnim ekspandirajućim premazima.

2. NUMERIČKI MODEL KONSTRUKCIJE

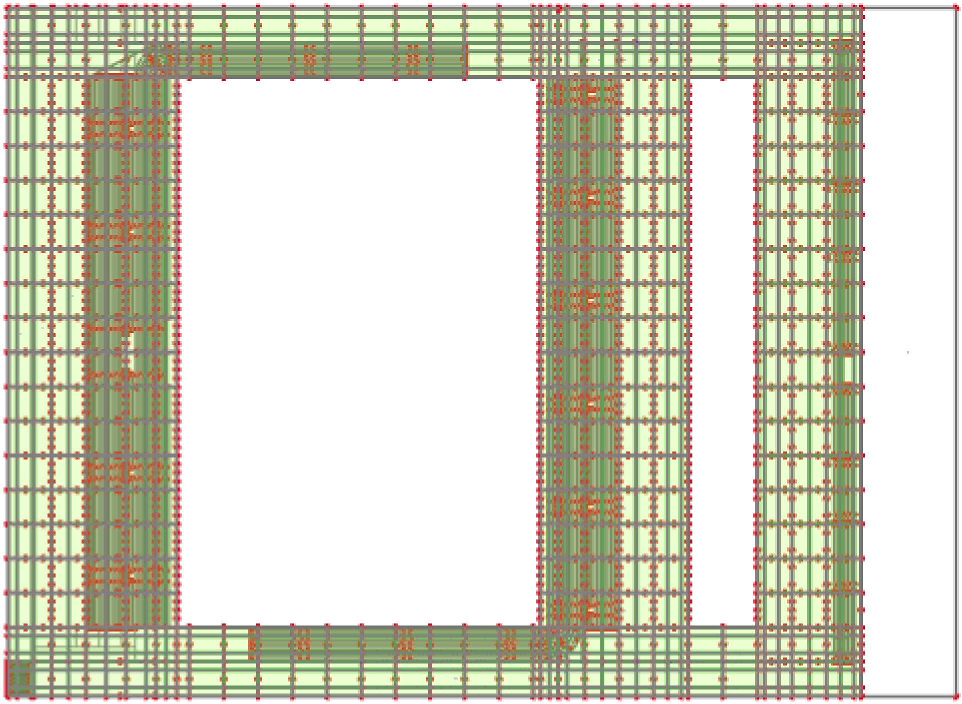
Numerički 3D render modela konstrukcije je izrađen u programu Scia Engineer 2019.



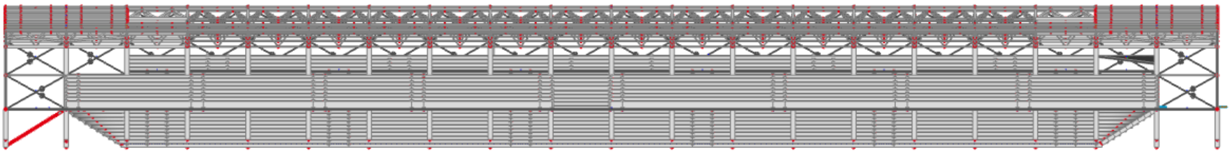
Slika 2.1. *Izmometrijski prikaz 3D modela*



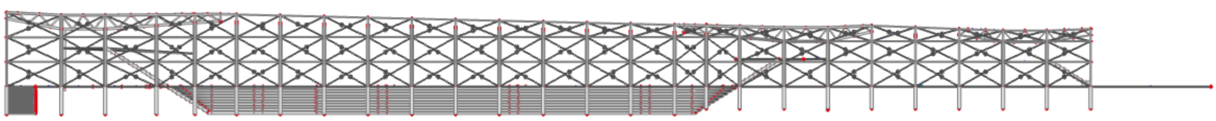
Slika 2.2. *Izmometrijski prikaz 3D modela*



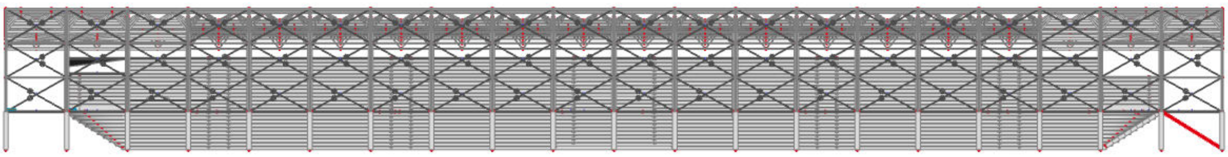
Slika 2.3. *Tlocrtni prikaz modela*



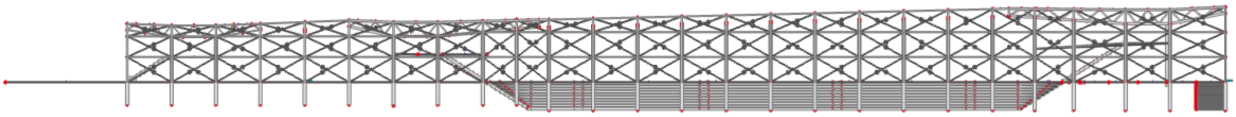
Slika 2.4. *Prikaz istočnog pročelja*



Slika 2.5. *Prikaz južnog pročelja*



Slika 2.6. *Prikaz zapadnog pročelja*



Slika 2.7. *Prikaz sjevernog pročelja*

3. ANALIZA OPTEREĆENJA

3.1. Stalno opterećenje

Stalno opterećenje uključeno je kroz numerički model.

3.2. Dodatno stalno opterećenje

pozicija 300 - krov

- sendvič paneli (aluminij) 0,25 kN/m^2
- instalacije 0,20 kN/m^2

Ukupno dodatno stalno opterećenje: g_{300}=0,45 kN/m^2

a) pozicija 200

- završna obrada poda 0,24 kN/m^2
- AB estrih 1,25 kN/m^2
- hidroizolacija 0,10 kN/m^2

Ukupno dodatno stalno opterećenje: g_{200}=1,59 kN/m^2

b) pozicija 100

- završna obrada poda 0,24 kN/m^2
- AB estrih 1,25 kN/m^2
- hidroizolacija 0,10 kN/m^2

Ukupno dodatno stalno opterećenje: g_{100}=1,59 kN/m^2

c) stubište

- završna obrada gazišta – kamena ploča 0,56 kN/m^2
- cementni namaz 0,20 kN/m^2

Ukupno dodatno stalno opterećenje: $g_{stubište}$=0,76 kN/m^2

d) tribine

- završna obrada poda 0,24 kN/m^2
- cementni namaz 0,20 kN/m^2
- oprema 0,20 kN/m^2

Ukupno dodatno stalno opterećenje: $g_{tribine}$=0,64 kN/m^2

3.3. Promjenjivo (pokretno) opterećenje

a) pozicija 300 – krov

Za pokretno opterećenje na krovu uzima se opterećenje snijegom i vjetrom koje je obrađeno u zasebnim stavkama.

b) Pozicija 200,100 i tribine

Kategorija	Prostor	EC1 q_k (kN/m^2)	Q_k (kN)
A	- sobe	2.0	2.0
	- stubišta	3.0	2.0
	- balkoni	4.0	2.0
B	- uredski prostori	3.0	2.0
C	C_1 – prostorije sa stolovima u školama, kavanama, restoranima, blagovaonicama, knjižnicama, recepcijama	3.0	4.0
	C_2 – prostorije s nepomičnim stolcima u crkvama, kazalištima ili kinima, sobe za sastanke, dvorane za predavanja, čekaonice	4.0	4.0
	C_3 – prostorije bez prepreka za kretanje ljudi u muzejima, izložbenim prostorima, pristupi u javnim i administrativnim zgradama, hotelima i sl.	5.0	4.0
	C_4 – športske prostorije i prostori za igru npr. plesne dvorane, gimnastičke dvorane, pozornice i sl.	5.0	7.0
	C_5 – prostorije za velika okupljanja ljudi, zgrade za javne priredbe, koncertne dvorane, športske dvorane s gledalištem, terase.	5.0	4.0
D	D_1 – prostorije u trgovinama	5.0	4.0
	D_2 – prostorije u robnim kućama i trgovinama na veliko, papirnicama	5.0	7.0
E	E - skladišta uključujući knjižnice	6.0	7.0

Slika 3.1. *Vrijednosti korisnog djelovanja u zgradama*

- stubišta – 3.0 kN/m^2

- uredski prostori – 3.0 kN/m^2

- prostori sa stolovima u školama, kavanama, restoranima, blagovaonicama, knjižnicama, recepcijama – 3.0 kN/m^2

- prostorije za velika okupljanja ljudi, zgrade za javne priredbe, koncertne dvorane, športske dvorane s gledalištem, terase – 5.0 kN/m^2

3.4. Opterećenje snijegom

Opterećenje snijegom na krovu

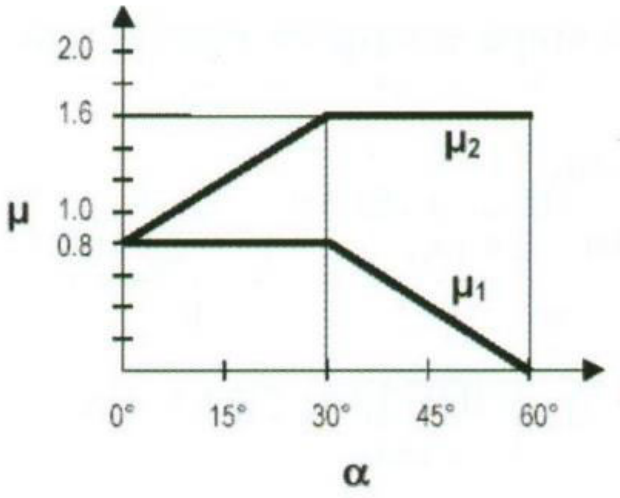
$s = \mu_1 \cdot C_e \cdot C_t \cdot s_k$

μ_1 - koeficijent oblika opterećenja snijegom

C_e - koeficijent izloženosti (obično se usvaja vrijednost 1,0)

C_t - toplinski koeficijent (obično se usvaja vrijednost 1,0)

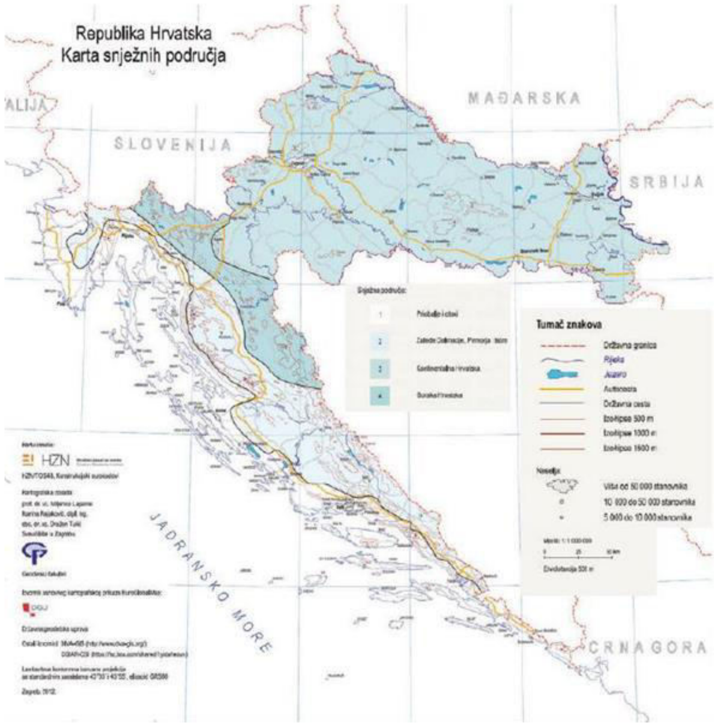
s_k - karakteristična vrijednost opterećenja snijegom na tlu



Slika 3.2. *Koeficijenti oblika opterećenja snijegom*

- za krov nagiba $\alpha \leq 2,8°$ očitana je vrijednost $\mu_1 = 0,8$

Prema karti snijega za Republiku Hrvatsku ova građevina spada u 1. područje – priobalje i otoci, te je prema nadmorskoj visini očitana vrijednost s_k (karakteristična vrijednost opterećenja snijegom na tlu) $\Rightarrow s_k = 0,5$ kN/m^2



Slika 3.3. *Karta snijega za Republiku Hrvatsku*

Nadmorska visina do [m]	1. područje – priobalje i otoci [kN/m²]	2. područje – zaleđe Dalmacije, Primorja i Istre [kN/m²]	3. područje – kontinentalna Hrvatska [kN/m²]	4. područje – gorska Hrvatska [kN/m²]
100	0,50	0,75	1,00	1,25
200	0,50	0,75	1,25	1,50
300	0,50	0,75	1,50	1,75
400	0,50	1,00	1,75	2,00
500	0,50	1,25	2,00	2,50
600	0,50	1,50	2,25	3,00
700	0,50	2,00	2,50	3,50
800	0,50	2,50	2,75	4,00
900	1,00	3,00	3,00	4,50
1 000	2,00	4,00	3,50	5,00
1 100	3,00	5,00	4,00	5,50
1 200	4,00	6,00	4,50	6,00
1 300	5,00	7,00		7,00
1 400	6,00	8,00		8,00
1 500		9,00		9,00
1 600		10,00		10,00
1 700		11,00		11,00
1 800		12,00		

Tablica 3.1. *Karakteristične vrijednosti opterećenja snijegom za pojedina područja i nadmorske visine*

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

μ_1 - koeficijent oblika $\Rightarrow \mu_1 = 0,8$

C_e - koeficijent izloženosti $\Rightarrow C_e = 1,0$

C_t - toplinski koeficijent $\Rightarrow C_t = 1,0$

s_k - karakteristična vrijednost opterećenja snijegom na tlu

$s = 0,8 \cdot 1,0 \cdot 1,0 \cdot 0,5 = 0,4\ kN / m^2$

3.5. Opterećenje vjetrom

Osnovni pritisak vjetra računa se prema izrazu:

$$q_b = \frac{1}{2} \cdot \rho \cdot v_b^2 \left[kN / m^2 \right]$$

gdje je:

q_b - osnovni pritisak vjetra

v_b – osnovna brzina vjetra

ρ – gustoća zraka (ρ=1,25 kg/m^3)

Osnovna brzina vjetra v_b dana je izrazom:

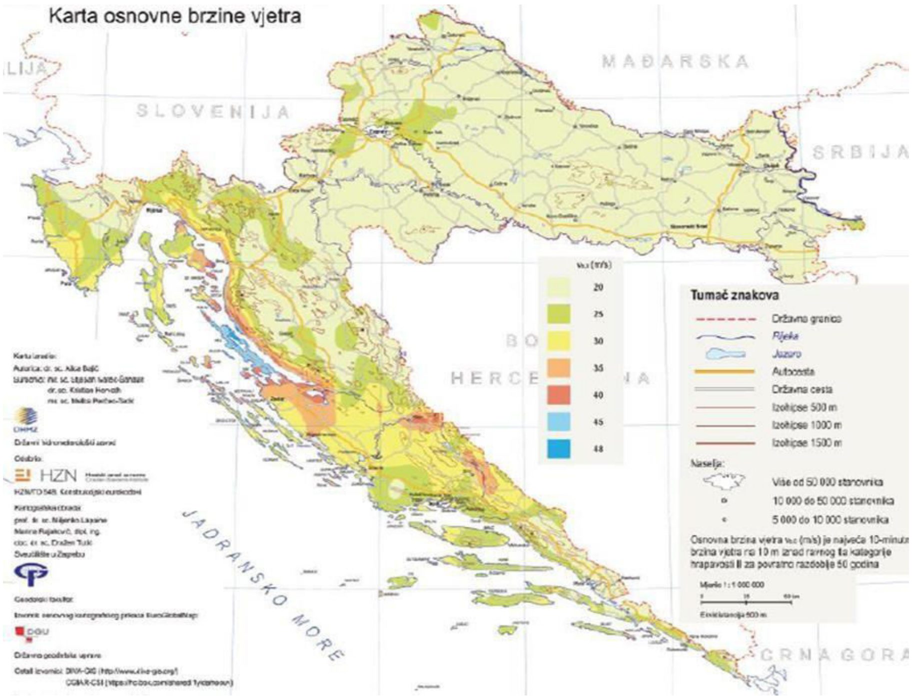
$$v_b = c_{dir} \cdot c_{season} \cdot v_{b0}$$

gdje je:

v_{b0} – fundamentalna vrijednost osnovne brzine vjetra; očitava se iz karte

c_{dir} – koeficijent smjera vjetra (obično se uzima vrijednost 1,0)

c_{season} – koeficijent ovisan o godišnjem dobu (obično se uzima vrijednost 1,0)



Slika 3.4. *Karta osnovnih brzina vjetra za Republiku Hrvatsku*

Osnovni pritisak vjetra:

$v_b = 30,0$ (m/s) – očitano za područje Zadra

$c_{dir} = c_{season} = 1,0$

$$v_b = c_{dir} \cdot c_{season} \cdot v_{b0}$$

$$v_b = 1,0 \cdot 1,0 \cdot 30$$

$$v_b = 30[m/s]$$

$$q_b = \frac{1}{2} \cdot \rho \cdot v_b^2 \left[kN/m^2\right]$$

$$q_b = \frac{1}{2} \cdot 1,25 \cdot 30^2$$

$$q_b = 562,5\left[N/m^2\right] = 0,5625\left[kN/m^2\right]$$

Nakon dobivenih vrijednosti v_b i v_{b0}, definira se srednja brzina vjetra $v_m(z)$ iznad terena:

$$v_m(z) = v_b \cdot c_r(z) \cdot c_0(z)[m/s]$$

gdje je:

$c_r(z)$ – faktor hrapavosti terena

$c_0(z)$ – faktor orografije ili opisivanje brežuljaka ili gora (obično se uzima 1,0)

Faktor hrapavosti $c_r(z)$ određuje se prema:

$$c_r(z) = k_r \cdot \ln\left(\frac{z}{z_0}\right) \quad \text{za} \quad z_{min} \le z \le z_{max}$$

$$c_r(z) = c_r(z_{\min}) \quad \text{za } z \le z_{min}$$

gdje je:

z_0 – duljina hrapavosti

k_r – faktor terena ovisan o duljini hrapavosti

z_{min} – minimalna visina hrapavosti

z_{max} – maksimalna visina hrapavosti (usvaja se vrijednost 200m)

Faktor terena k_r se određuje prema izrazu:

$$k_r = 0{,}19 \cdot \left(\frac{z_0}{z_{0,II}}\right)^{0{,}07}$$

gdje je:

z_0 – duljina hrapavosti

k_r – faktor terena ovisan o duljini hrapavosti

$z_{0,II}$ – duljina hrapavosti za kategoriju terena II – (prema tablici iznosi 0,05)

Vrijednosti z_0 i z_{min} za pojedinu kategoriju terena očitavaju se iz sljedeće tablice:

Kategorija terena		z_0 [m]	z_{min} [m]
0	More ili priobalna područja izložena otvorenom moru	0,003	1
I	Jezera ili ravna i horizontalno položena područja sa zanemarivom vegetacijom i bez prepreka	0,01	1
II	Područja s niskom vegetacijom, npr. travom, i izoliranim preprekama (drveće, zgrade) s razmakom najmanje 20 visina prepreke	0,05	2
III	Područja sa stalnim pokrovom od vegetacije ili zgrade ili područja s izoliranim preprekama s razmakom najviše 20 visina prepreke (npr. sela, predgrađa, stalna šuma)	0,3	5
IV	Područja s najmanje 15 % površine pokrivene zgradama čija prosječna visina premašuje 15 m	1,0	10

Tablica 3.2. *Vrijednosti z_0 i z_{min} za različite kategorije terena*

$$k_r = 0,19 \cdot \left(\frac{z_0}{z_{0,II}} \right)^{0,07}$$

$$k_r = 0,19 \cdot \left(\frac{0,003}{0,05} \right)^{0,07} = 0,156$$

$$c_r(z) = k_r \cdot \ln\left(\frac{z}{z_0} \right) \text{ za } z_{min} \leq z \leq z_{max}$$

$$c_r(z) = 0,156 \cdot \ln\left(\frac{18,50}{0,003} \right)$$

$$c_r(z) = 1,361$$

$$c_0(z) = 1,0$$

$$v_m(z) = v_b \cdot c_r(z) \cdot c_0(z)\left[m/s\right]$$

$$v_m(18,5) = 30 \cdot 1,361 \cdot 1,0 = 40,83\left[m/s\right]$$

Intenzitet turbulencije $I_v(z)$ računa se prema izrazu:

$$I_{v(z)} = \frac{k_I}{c_{o(z)} \cdot \ln\left(\frac{z}{z_0} \right)}$$

gdje je:

k_I – faktor turbulencije (obično se uzima vrijednost 1,0, ukoliko nije drugačije definirano Nacionalnim dodatkom)

$$I_{v(z)} = \frac{1,0}{1,0 \cdot \ln\left(\frac{18,50}{0,003} \right)}$$

$$I_{v(z)} = 0,115$$

Pritisak brzine vjetra pri udaru $q_p(z)$ se računa prema sljedećem izrazu:

$$q_{p(z)} = c_e(z) \cdot q_b = \left[1 + 7I_v(z)\right] \cdot \frac{1}{2} \cdot \rho \cdot v_m^{\,2}(z)$$

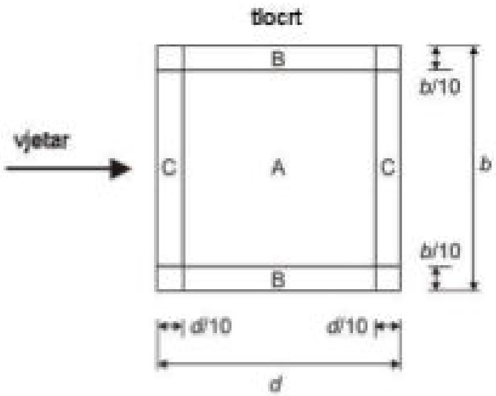
gdje je:

$c_e(z)$ – faktor izloženosti i odnosi se na pritisak te ovisi o visini iznad terena z i kategoriji terena

$$q_{p(z)} = [1 + 7 \cdot 0{,}115] \cdot \frac{1}{2} \cdot 1{,}25 \cdot 40{,}83^2 \cdot 10^{-3}$$

$$q_{p(18,5)} = 1{,}88 \left[kN/m^2 \right]$$

Proračun koeficijenta pritiska za jednostrešnu nadstrešnicu:



Slika 3.5. *Zone djelovanja vjetra*

Nagib krova α	Zapriječenost φ	Koeficijenti sveukupne sile c_f	Područje A	Područje B	Područje C
0°	Najveća vrijednost, svi φ	+ 0,2	+ 0,5	+ 1,8	+ 1,1
	Najmanja vrijednost, φ=0	– 0,5	– 0,6	– 1,3	– 1,4
	Najmanja vrijednost, φ = 1	– 1,3	– 1,5	– 1,8	– 2,2

Tablica 3.3. *Vrijednosti koeficijenata pritiska vjetra*

Napomena: uzete su maksimalne vrijednosti koeficijenata pritiska vjetra

Rezultirajuće djelovanje tlaka po zonama:

$$w_e = q_p \cdot c_{p,net} \left[kN / m^2 \right]$$

PODRUČJE	$q_p(kN/m^2)$	$c_{p,net}$	$w_e(kN/m^2)$
A	1,88	-1.5	-2.82
B	1,88	-1.8	-3.38
C	1,88	-2.2	-4.14

Tablica 3.4. *Rezultirajuće djelovanje tlaka po zonama*

Rezultirajuće djelovanje podtlaka po zonama:

$$w_i = q_p \cdot c_{p,net} \left[kN / m^2 \right]$$

PODRUČJE	$q_p(kN/m^2)$	$c_{p,net}$	$w_i(kN/m^2)$
A	1,88	+0,5	+0.94
B	1,88	+1.8	+3.38
C	1,88	+1,1	+2.07

Tablica 3.5. *Rezultirajuće djelovanje podtlaka po zonama*

Trenje po krovu od djelovanja vjetra

Sila trenja od djelovanja vjetra računa se prema formuli:

$$F_{fr} = c_{fr} \cdot q_p(z) \cdot A_{fr}$$

gdje je:

c_{fr} - koeficijent trenja (određuje se prema tablici 2.6.)

$q_p(z)$ – pritisak brzine vjetra pri udaru

A_{fr} - površina usporedno sa smjerom vjetra

A_{fr} = 18676,86 m^2

Površina	Koeficijent trenja c_{fr}
Glatka (npr. čelik, glatki beton)	0,01
Gruba (npr. grubi beton, katranske ploče)	0,02
Vrlo gruba (npr. valovite, rebraste i naborane površine)	0,04

Tablica 3.6. *Koeficijent trenja c_{fr} za zidove, parapete i krovne površine*

$$F_{fr} = 0,04 \cdot 1,88 \cdot 18676,86$$

$$F_{fr} = 1404,5 kN$$

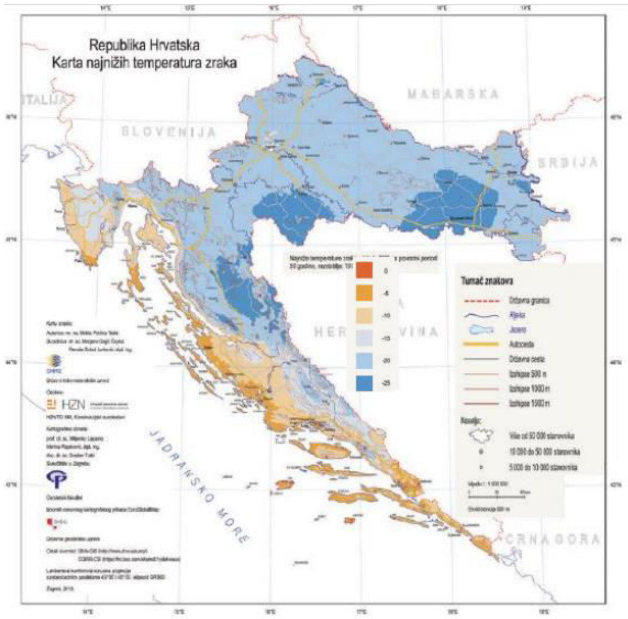
$$f_{tr} = \frac{F_{fr}}{A_{krova}} \left(kN / m^2 \right)$$

$$f_{tr} = \frac{1404,50}{18676,86}$$

$$f_{tr} = 0,0752 \left(kN / m^2 \right)$$

3.6. Djelovanje temeprature

Slika 3.6 *Karta najviših temperatura zraka u RH*



Slika 3.7 *Karta najnižih temperatura zraka u RH*

Za područje Zadra očitane su vrijednosti:
Najviše temperature zraka: T_{max} = 40 °C
Najniže temperature zraka: T_{min} = -5 °C

Pretpostavlja se djelovanje jednolike temperaturne promjene u svim presjecima.
Pretpostavljena temperatura pri montaži konstrukcije: T = 15 °C

Maksimalna pozitivna temperaturna promjena: T_{max} = 40 °C-15 °C = 25 °C
Maksimalna negativna temperaturna promjena: T_{min} = -5 °C-15 °C = -20 °C

3.7. Potres

Potresne sile proračunate su postupkom spektralne analize prema EC-8. Građevina je smještena u VIII potresnoj zoni prema važećoj seizmičkoj karti. Računsko projektno ubrzanje tla je a = 0.20 g.

Građevina je temeljena na nanosima vrlo zbijenog pijeska,šljunka ili vrlo krute gline debljine najmanje nekoliko desetaka metara, sa svojstvom postupnoga povećanja mehaničkih svojstava s dubina, što odgovara klasi tla B.

Proračun je izvršen za faktor ponašanja q=3

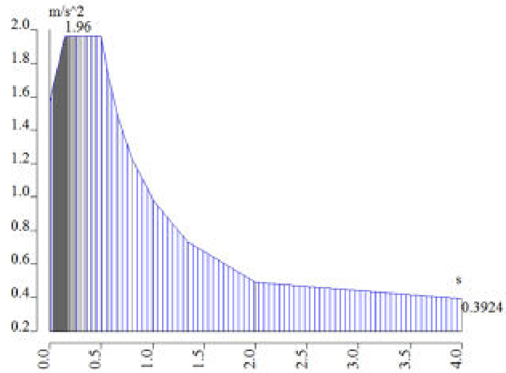
Koeficijenti za proračun ordinata spektra odgovora

Faktor važnosti ψ=1.2 (građevine čija je potresna otpornost važna sa stajališta posljedica vezanih za rušenje, npr.škole, dvorane za skupove, kulturne institucije)

Faktor ponašanja q=3.0

Tlo klase "A": S=1.2, T_B=0.15 s, T_C=0.5 s, T_D=2.0 s

Računsko ubrzanje tla a = 0.20 g (VIII seizmička zona)

Naziv	**Način crtanja spektra**	**Informacija o seizmičkom djelovanju**	**Grafički prikaz**
Projektni spektar za proračun seizmičkog djelovanja (za smjer x i y)	Uz pomoć perioda	Tip propisa – Eurocode 8 Tip tla - B Djelovanje - Horizontalno Tip spektra - tip 1 Koeficijent akceleracije. ag - 0,2 ag proračunska akceleracija – 1,961 beta - 0,2 q – faktor ponašanja – 3.0 (za smjer x i y)	

Tablica 3.7. *Prikaz osnovnih informacija o proračunskom spektru*

-S_x-potresno opterećenje u smjeru x (zadan spektar odgovora za smjer x + 30% spektra odgovora za smjer y)

-S_y-potresno opterećenje u smjeru y (zadan spektar odgovora za smjer y + 30% spektra odgovora za smjer x)

Nakon provedene modalne analize vidljivo je da potres neće imati značajan utjecaj na konstrukciju.

4. KOMBINACIJE DJELOVANJA

4.1. Granično stanje nosivosti

(1) $1,35 \cdot (g + \Delta g) + 1,5 \cdot s$

(2) $1,35 \cdot (g + \Delta g) + 1,5 \cdot w_{pritisak}$

(3) $1,35 \cdot (g + \Delta g) + 1,80 \cdot q$

(4) $1,35 \cdot (g + \Delta g) + 0,9 \cdot (1,50s + 1,5w_{pritisak} + 1,8q)$

(5) $1,35 \cdot (g + \Delta g) + 0,9 \cdot (1,50s + 1,5w_{pritisak} + 1,8q + 1,5w_{trenje})$

(6) $1,35 \cdot (g + \Delta g) + 1,5w_{trenje}$

(7) $1,35 \cdot (g + \Delta g) + 0,9 \cdot (1,5w_{pritisak} + 1,8q + 1,5w_{trenje} + 1,5T_{\max})$

(8) $1,35 \cdot (g + \Delta g) + 0,9 \cdot (1,5s + 1,5w_{pritisak} + 1,8q + 1,5w_{trenje} + 1,5T_{\min})$

(9) $1,0 \cdot (g + \Delta g) + 1,5w_{odizanje}$

(10) $1,0 \cdot (g + \Delta g) + 1,5 \cdot 0,9(w_{odizanje} + T_{\min})$

(11) $1,0 \cdot (g + \Delta g) + 1,5 \cdot 0,9(w_{odizanje} + T_{\min} + w_{trenje})$

(12) $1,0 \cdot (g + \Delta g) + 0,5 \cdot q + 1,0 \cdot S_x$

(13) $1,0 \cdot (g + \Delta g) + 0,5 \cdot q + 1,0 \cdot S_y$

4.2. Granično stanje uporabivosti

Kombinacije za GSU su iste kao za GSN, s tim da su primjenjeni adekvatni koeficijenti za kombinacije djelovanja prema EN 1991.

- Parcijalni faktor za promjenjivo (pokretno) opterećenje – 1,5 × 1,2 =1,8 (nije vršena kombinacija opterećenja, tj. postavljanje pokretnog opterećenja u najkritičnije položaje, već je pokretno opterećenje uvećano za 20%)

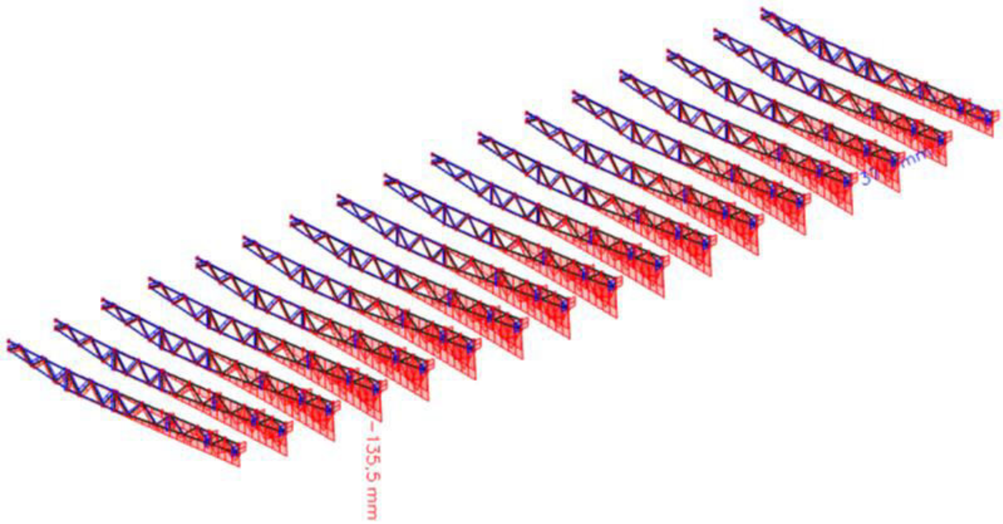
- Parcijalni faktor za djelovanje više promjenjivih opterećenja je – 0,9 × 1,5 = 1,35

5. DIMENZIONIRANJE ELEMENATA KONSTRUKCIJE

5.1. Pomaci konstrukcije

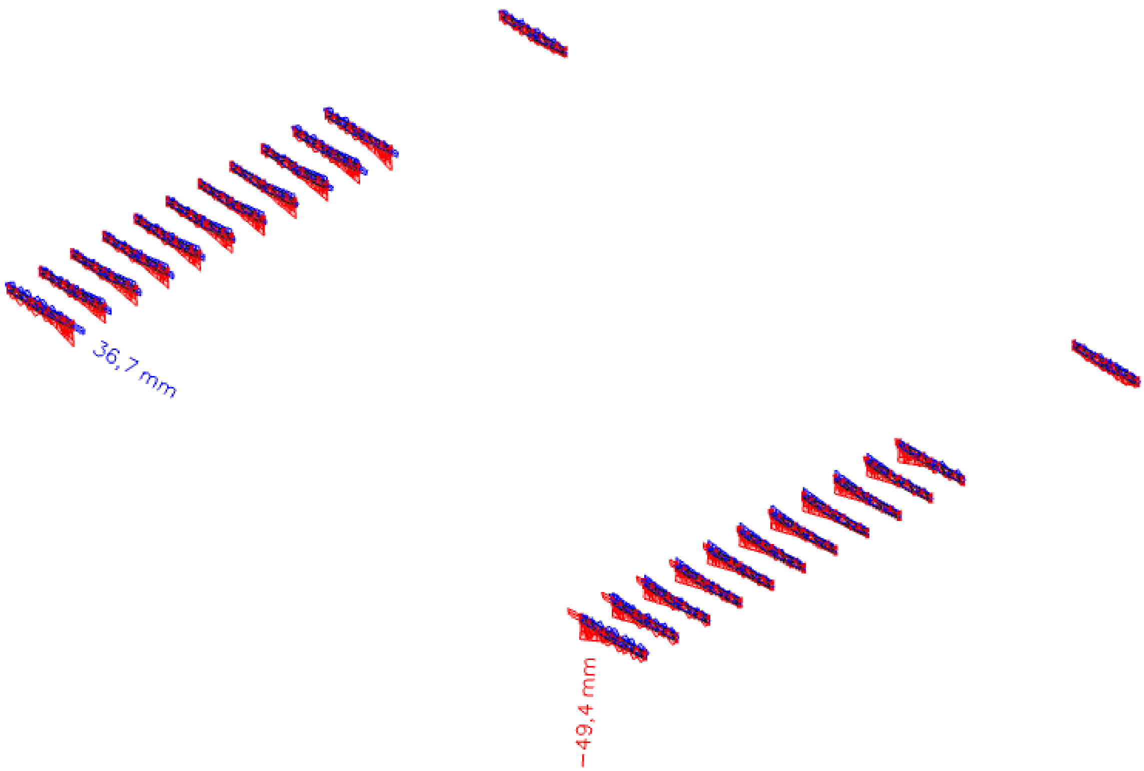
Vertikalni progib krovne rešetkaste konstrukcije:

- rešetka R1



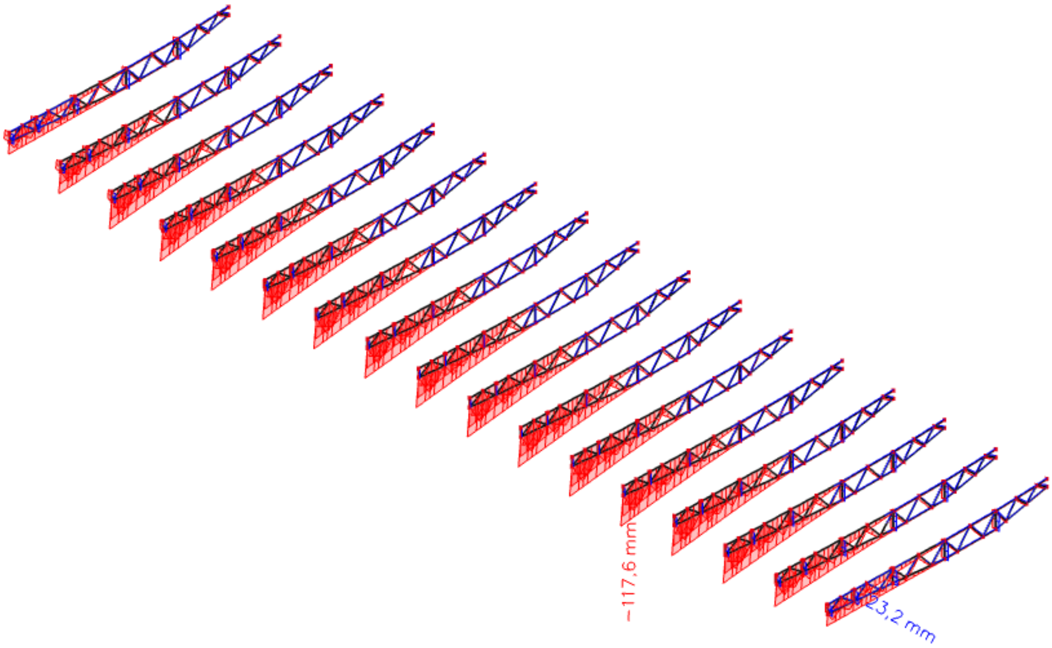
Slika 5.1. *Vertikalni progib rešetke R1*

-rešetka R2



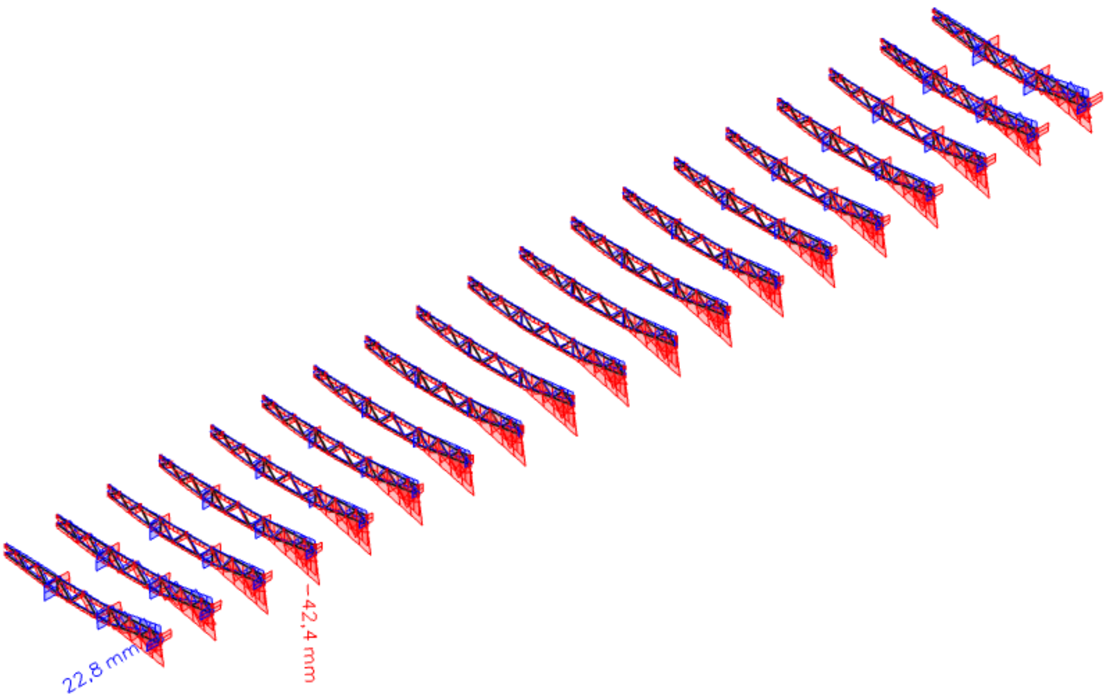
Slika 5.2. *Vertikalni progib rešetke R2*

-rešetka R3



Slika 5.3. *Vertikalni progib rešetke R3*

- rešetka R4



Slika 5.4. *Vertikalni progib rešetke R4*

- rešetka R1:

Dopušteni vertikalni pomak:

$$u_{z,dop} = \frac{\mathrm{l}}{150} = \frac{21{,}061 \cdot 1000}{150} = 140{,}41\ mm$$

$u_z = 135{,}5\ \text{mm} < u_{z,dop} = 140{,}41\ mm$; zadovoljava

- rešetka R2:

Dopušteni vertikalni pomak:

$$u_{z,dop} = \frac{\mathrm{l}}{150} = \frac{8{,}0 \cdot 1000}{150} = 53{,}33\ mm$$

$u_z = 49{,}4\ \text{mm} < u_{z,dop} = 53{,}33\ mm$; zadovoljava

- rešetka R3:

Dopušteni vertikalni pomak:

$$u_{z,dop} = \frac{\mathrm{l}}{150} = \frac{18{,}276 \cdot 1000}{150} = 121{,}84\ mm$$

$u_z = 117{,}6\ \text{mm} < u_{z,dop} = 121{,}84\ mm$; zadovoljava

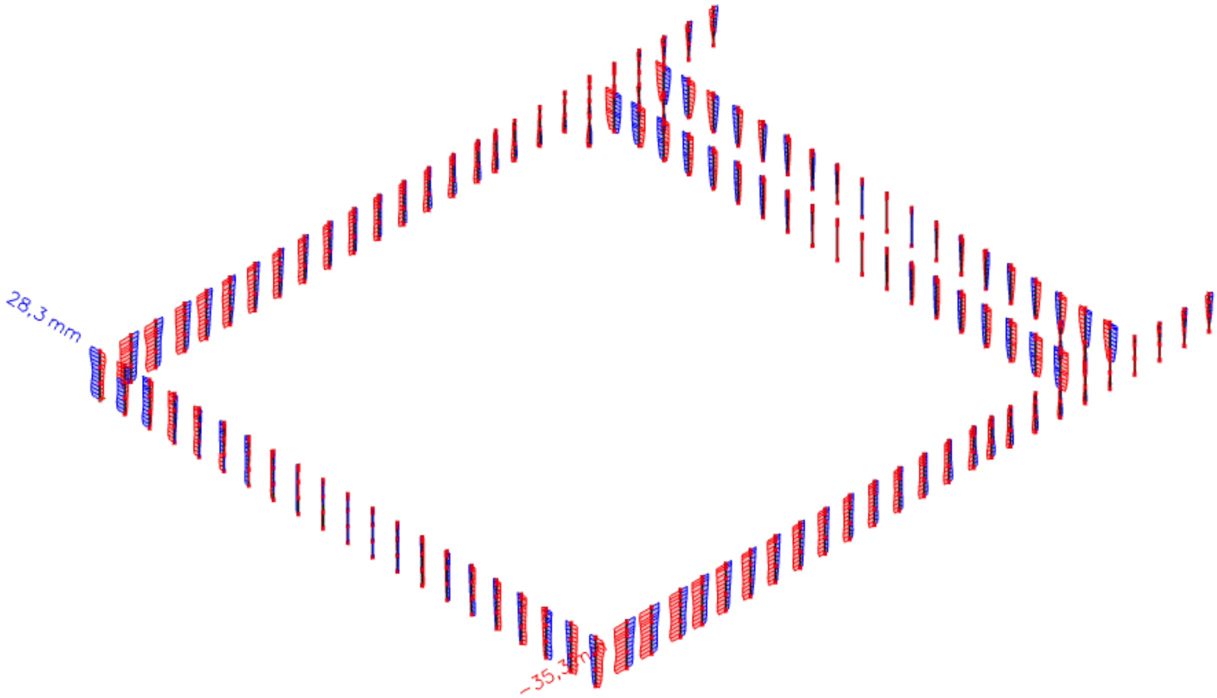
- rešetka R4:

Dopušteni vertikalni pomak:

$$u_{z,dop} = \frac{\mathrm{l}}{150} = \frac{8{,}006 \cdot 1000}{150} = 53{,}37\ mm$$

$u_z = 42{,}4\ \text{mm} < u_{z,dop} = 53{,}37\ mm$; zadovoljava

Horizontalni pomak stupova:



Slika 5.5. *Horizontalni pomaci stupova*

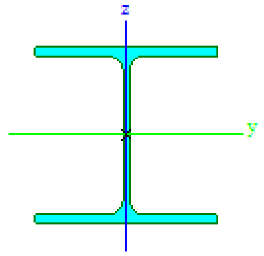
Dopušteni horizontalni pomak pomak:

$$u_{y,dop} = \frac{l}{150} = \frac{13,5 \cdot 1000}{150} = 90,0\ mm$$

$u_y = 35,3\ \text{mm} < u_{y,dop} = 90,0\ mm$;   zadovoljava

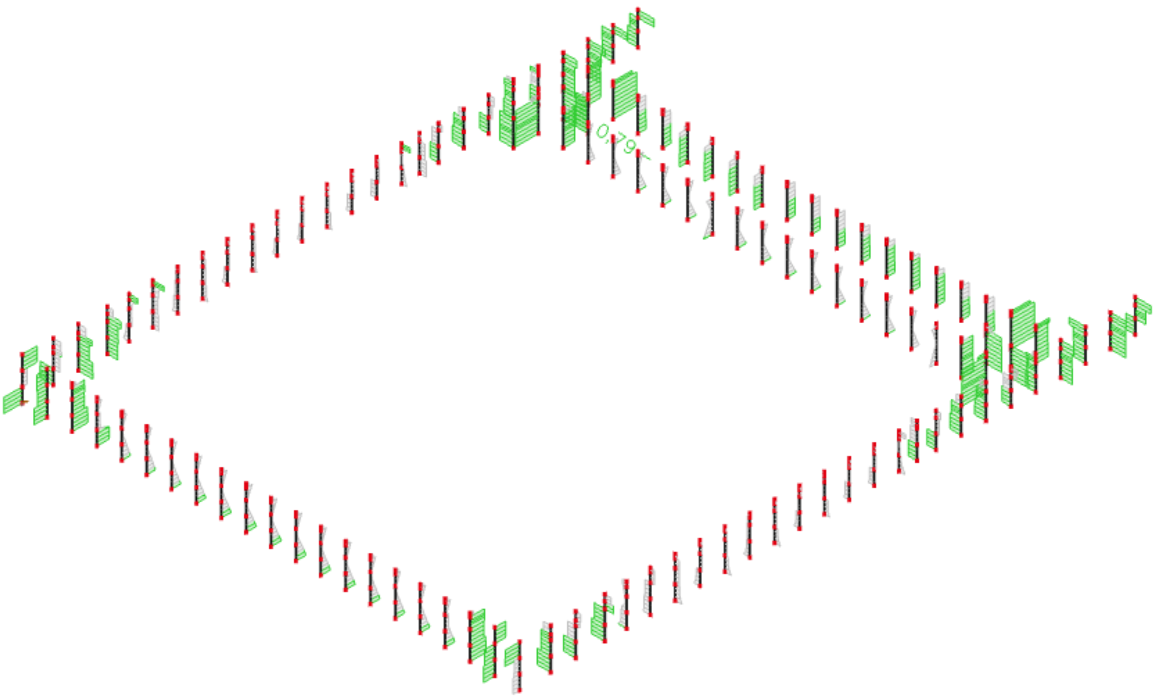
5.2. Dimenzioniranje stupa pozicije S1

Name	S1
Type	HEA280
Source description	Profil Arbed / Structural shapes / Edition Octobre 1995
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	b
Flexural buckling z-z	c
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m²]	9,7300e-03	
A y, z [m²]	7,0049e-03	2,3104e-03
I y, z [m⁴]	1,3700e-04	4,7600e-05
I w [m⁶], t [m⁴]	7,8537e-07	6,2100e-07
W_{el} y, z [m³]	1,0100e-03	3,4000e-04
W_{pl} y, z [m³]	1,1125e-03	5,1667e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	140	135
α [deg]	0,00	
A L, D [m²/m]	1,6000e+00	1,6026e+00
M_{ply} +, - [Nm]	3,95e+05	3,95e+05
M_{plz} +, - [Nm]	1,84e+05	1,84e+05

Tablica 5.1. *Karakteristike poprečnog presjeka stupa pozicije S1*



Slika 5.6. *Prikaz iskoristivosti stupa pozicije S1*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = S1 - HEA280

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp11975	9,000 / 9,000 m	HEA280	S 355	GSN	0,79 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 9,000 m

Internal forces	Calculated	Unit
N_{Ed}	-484,74	kN
$V_{y,Ed}$	-2,76	kN
$V_{z,Ed}$	0,31	kN
T_{Ed}	0,00	kNm
$M_{y,Ed}$	-6,28	kNm
$M_{z,Ed}$	-13,92	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	112	13	6,391e+04	9,666e+04	0,66	0,46	1,00	8,62	7,32	8,14	11,61	3
3	SO	112	13	4,754e+04	1,480e+04	0,31	0,89	1,00	8,62	7,32	8,14	16,10	3
4	I	196	8	5,433e+04	4,533e+04	0,83		1,00	24,50	22,78	27,66	32,80	2
5	SO	112	13	3,574e+04	2,995e+03	0,08	1,36	1,00	8,62	7,32	8,14	19,95	3
7	SO	112	13	5,211e+04	8,485e+04	0,61	0,47	1,00	8,62	7,32	8,14	11,68	3

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 3

Semi-Comp+ properties		
Material coefficient ε	0,81	
Flange class 2 slenderness limit $\beta_{2,y,f}$	8,14	
Flange class 3 slenderness limit $\beta_{3,y,f}$	11,39	
Web class 2 slenderness limit $\beta_{2,y,w}$	67,53	
Web class 3 slenderness limit $\beta_{3,y,w}$	100,89	
Flange class 2 slenderness limit $\beta_{2,z,f}$	8,14	
Flange class 3 slenderness limit $\beta_{3,z,f}$	13,02	
Web slenderness ratio c/t_w	24,50	
Flange slenderness ratio c/t_f	8,62	
Reference slenderness ratio $c/t_{ref,y}$	0,15	
Reference slenderness ratio $c/t_{ref,z}$	0,10	
Interpolated section modulus $W_{3,y}$	1,0974e-03	m³
Interpolated section modulus $W_{3,z}$	4,9932e-04	m³

Note: The resistance for this semi-compact section has been calculated according to Semi-Comp+.

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	9,7300e-03	m²
$N_{c,Rd}$	3454,15	kN
Unity check	0,14	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,y}$	1,0974e-03	m^3
$M_{3,y,Rd}$	389,58	kNm
Unity check	0,02	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,z}$	4,9932e-04	m^3
$M_{3,z,Rd}$	177,26	kNm
Unity check	0,08	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	7,5360e-03	m^2
$V_{pl,y,Rd}$	1544,57	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	3,1780e-03	m^2
$V_{pl,z,Rd}$	651,36	kN
Unity check	0,00	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	2	
τ_{Ed}	0,0	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,3,y,Rd}$	334,91	kNm
α	2,00	
$M_{N,3,z,Rd}$	173,77	kNm
β	1,00	

Unity check (6.41) = 0,00 + 0,08 = 0,08 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 9,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	112	13	6,391e+04	9,666e+04	0,66	0,46	1,00	8,62	7,32	8,14	11,61	3
3	SO	112	13	4,754e+04	1,480e+04	0,31	0,89	1,00	8,62	7,32	8,14	16,10	3
4	I	196	8	5,433e+04	4,533e+04	0,83		1,00	24,50	22,78	27,66	32,80	2
5	SO	112	13	3,574e+04	2,995e+03	0,08	1,36	1,00	8,62	7,32	8,14	19,95	3
7	SO	112	13	5,211e+04	8,485e+04	0,61	0,47	1,00	8,62	7,32	8,14	11,68	3

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 3

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	9,000	10,800	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	9,000	10,800	m
Critical Euler load N_{cr}	3505,65	845,84	kN
Slenderness λ	75,85	154,41	
Relative slenderness λ_{rel}	0,99	2,02	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	b	c	
Imperfection α	0,34	0,49	
Reduction factor χ	0,60	0,19	

Interaction method 1 parameters		
Maximum relative deflection δ_y	-3,3	mm
Equivalent moment factor $C_{mz,0}$	0,54	
Factor μ_y	0,94	
Factor μ_z	0,48	
Factor ε_y	0,12	
Factor a_{LT}	1,00	
Critical moment for uniform bending $M_{cr,0}$	232,87	kNm
Relative slenderness $\lambda_{rel,0}$	1,29	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,17	
Equivalent moment factor C_{my}	0,97	
Equivalent moment factor C_{mz}	0,54	
Equivalent moment factor C_{mLT}	1,53	
Factor b_{LT}	0,00	
Factor c_{LT}	0,01	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,09	
Factor w_z	1,47	
Factor n_{pl}	0,14	
Maximum relative slenderness $\lambda_{rel,max}$	2,02	
Factor C_{yy}	0,92	
Factor C_{yz}	0,96	
Factor C_{zy}	0,60	
Factor C_{zz}	1,00	

Unity check (6.61) = 0,23 + 0,03 + 0,07 = 0,33 -
Unity check (6.62) = 0,73 + 0,01 + 0,05 = 0,79 -

Shear Buckling check
According to EN 1993-1-5 article 5 & 7.1 and formula (5.10) & (7.1)

Shear Buckling parameters		
Buckling field length a	9,000	m
Web	unstiffened	
Web height h_w	244	mm
Web thickness t	8	mm
Material coefficient ε	0,81	
Shear correction factor η	1,20	

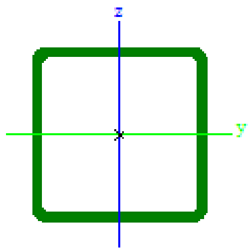
Shear Buckling verification	
Web slenderness h_w/t	30,50
Web slenderness limit	48,82

Note: The web slenderness is such that Shear Buckling effects may be ignored according to EN 1993-1-5 article 5.1(2).

The member satisfies the stability check.

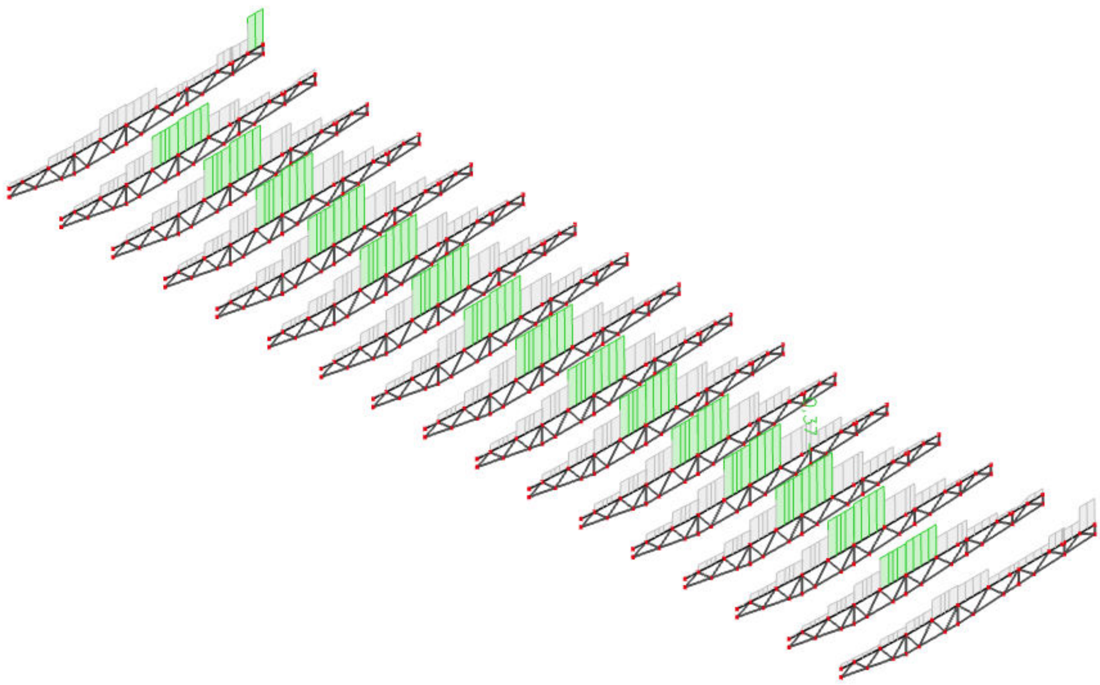
5.3. Dimenzioniranje gornjeg pojasa rešetke pozicije R1

Name	R1-GP
Type	SHS400/400/20.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m²]	3,0000e-02	
A y, z [m²]	1,4981e-02	1,4981e-02
I y, z [m⁴]	7,1540e-04	7,1540e-04
I w [m⁶], t [m⁴]	1,7067e-05	1,1250e-03
W_{el} y, z [m³]	3,5770e-03	3,5770e-03
W_{pl} y, z [m³]	4,2470e-03	4,2470e-03
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	200	200
α [deg]	0,00	
A L, D [m²/m]	1,5500e+00	2,9538e+00
M_{ply} +, - [Nm]	1,51e+06	1,51e+06
M_{plz} +, - [Nm]	1,51e+06	1,51e+06

Tablica 5.2. *Karakteristike poprečnog presjeka gornjeg pojasa rešetke pozicije R1*



Slika 5.6. *Prikaz iskoristivosti gornjeg pojasa rešetke pozicije R1*

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,5000e-02	m^2
$V_{pl,z,Rd}$	3074,39	kN
Unity check	0,03	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,2	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	1236,11	kNm
α	1,97	
$M_{N,z,Rd}$	1236,11	kNm
β	1,97	

Unity check (6.41) = 0,06 + 0,00 = 0,06 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 18,721 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	340	20	1,303e+03	-9,754e+03	-7,49		0,12	17,00	248,64	286,62	1171,81	1
3	I	340	20	-1,002e+04	-3,416e+03								
5	I	340	20	-2,377e+03	8,680e+03	-0,27		0,79	17,00	30,90	37,07	55,41	1
7	I	340	20	8,942e+03	2,341e+03	0,26		1,00	17,00	22,78	27,66	41,56	1

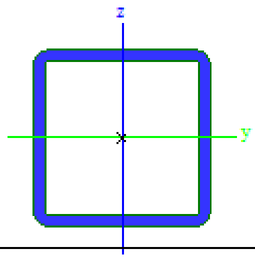
Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

The member satisfies the stability check.

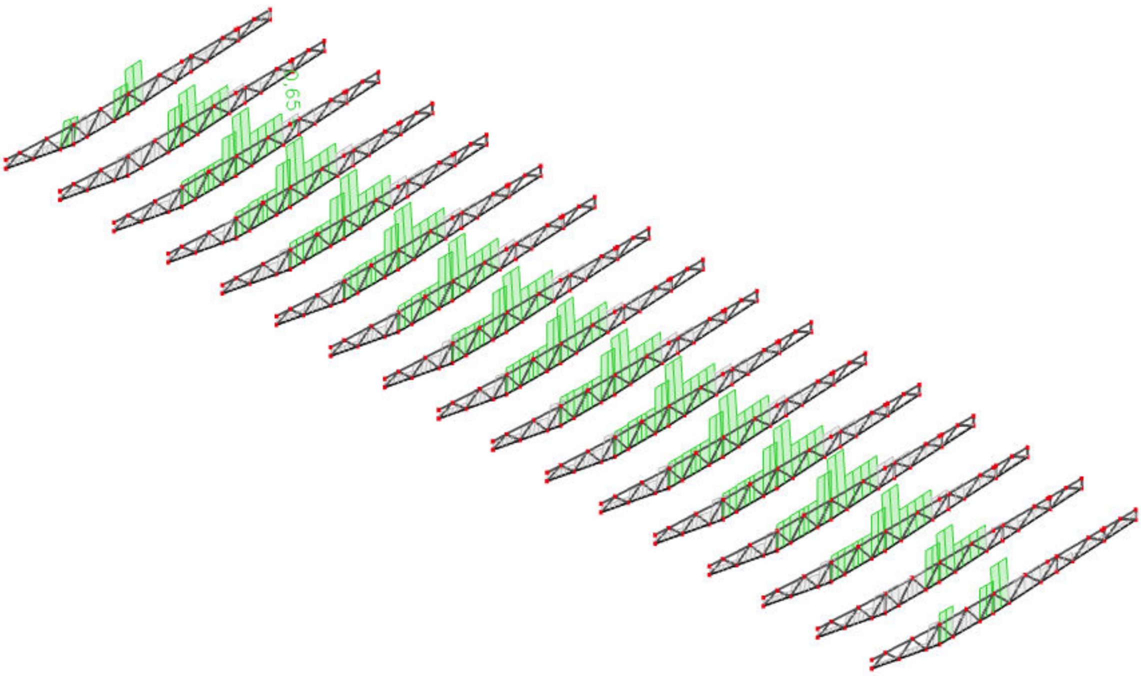
5.4. Dimenzioniranje donjeg pojasa rešetke pozicije R1

Name	R1-DP
Type	SHS400/400/25.0
Source description	Corus Advance Sections
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	3,5900e-02	
A y, z [m^2]	1,8204e-02	1,8204e-02
I y, z [m^4]	8,2200e-04	8,2200e-04
I w [m^6], t [m^4]	2,1333e-05	1,3600e-03
W_{el} y, z [m^3]	4,1100e-03	4,1100e-03
W_{pl} y, z [m^3]	5,0693e-03	5,0693e-03
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	200	200
α [deg]	0,00	
A L, D [m^2/m]	1,5100e+00	2,9138e+00
M_{ply} +, - [Nm]	1,80e+06	1,80e+06
M_{plz} +, - [Nm]	1,80e+06	1,80e+06

Tablica 5.3. *Karakteristike poprečnog presjeka donjeg pojasa rešetke pozicije R1*



Slika 5.7. *Prikaz iskoristivosti donjeg pojasa rešetke pozicije R1*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R1-DP - SHS400/400/25.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp143	21,110 / 21,110 m	SHS400/400/25.0	S 355	GSN	0,65 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 21,110 m

Internal forces	Calculated	Unit
N_{Ed}	-4313,11	kN
$V_{y,Ed}$	-4,75	kN
$V_{z,Ed}$	-344,13	kN
T_{Ed}	-0,78	kNm
$M_{y,Ed}$	-749,92	kNm
$M_{z,Ed}$	-24,77	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	325	25	2,902e+05	2,806e+05	0,97		1,00	13,00	22,78	27,66	31,27	1
3	I	325	25	2,576e+05	-3,178e+04	-0,12		0,89	13,00	26,31	31,78	50,67	1
5	I	325	25	-5,331e+04	-4,375e+04								
7	I	325	25	-2,076e+04	2,686e+05	-0,08		0,93	13,00	24,97	30,22	49,37	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	3,5900e-02	m²
$N_{c,Rd}$	12744,50	kN
Unity check	0,34	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	5,0693e-03	m³
$M_{pl,y,Rd}$	1799,60	kNm
Unity check	0,42	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	5,0693e-03	m³
$M_{pl,z,Rd}$	1799,60	kNm
Unity check	0,01	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,7950e-02	m²
$V_{pl,y,Rd}$	3679,02	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,7950e-02	m^2
$V_{pl,z,Rd}$	3679,02	kN
Unity check	0,09	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,1	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	1529,20	kNm
α	1,91	
$M_{N,z,Rd}$	1529,20	kNm
β	1,91	

Unity check (6.41) = 0,26 + 0,00 = 0,26 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 21,110 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	325	25	2,902e+05	2,806e+05	0,97		1,00	13,00	22,78	27,66	31,27	1
3	I	325	25	2,576e+05	-3,178e+04	-0,12		0,89	13,00	26,31	31,78	50,67	1
5	I	325	25	-5,331e+04	-4,375e+04								
7	I	325	25	-2,076e+04	2,686e+05	-0,08		0,93	13,00	24,97	30,22	49,37	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	2,346	9,382	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	2,346	9,382	m
Critical Euler load N_{cr}	309674,37	19354,65	kN
Slenderness λ	15,50	62,00	
Relative slenderness λ_{rel}	0,20	0,81	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	1,00	0,79	
Buckling resistance $N_{b,Rd}$	12736,51	10056,52	kN

Flexural Buckling verification		
Cross-section area A	3,5900e-02	m^2
Buckling resistance $N_{b,Rd}$	10056,52	kN
Unity check	0,43	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	3,5900e-02	m²
Plastic section modulus $W_{pl,y}$	5,0693e-03	m³
Plastic section modulus $W_{pl,z}$	5,0693e-03	m³
Design compression force N_{Ed}	4313,11	kN
Design bending moment (maximum) $M_{y,Ed}$	-749,92	kNm
Design bending moment (maximum) $M_{z,Ed}$	-24,77	kNm
Characteristic compression resistance N_{Rk}	12744,50	kN
Characteristic moment resistance $M_{y,Rk}$	1799,60	kNm
Characteristic moment resistance $M_{z,Rk}$	1799,60	kNm
Reduction factor χ_y	1,00	
Reduction factor χ_z	0,79	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,74	
Interaction factor k_{yz}	0,66	
Interaction factor k_{zy}	0,44	
Interaction factor k_{zz}	0,97	

Maximum moment $M_{y,Ed}$ is derived from beam pp143 position 21,110 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp143 position 21,110 m.

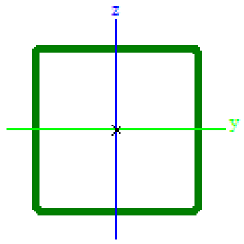
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	309674,37	kN
Critical Euler load $N_{cr,z}$	19354,65	kN
Elastic critical load $N_{cr,T}$	2409677,53	kN
Plastic section modulus $W_{pl,y}$	5,0693e-03	m³
Elastic section modulus $W_{el,y}$	4,1100e-03	m³
Plastic section modulus $W_{pl,z}$	5,0693e-03	m³
Elastic section modulus $W_{el,z}$	4,1100e-03	m³
Second moment of area I_y	8,2200e-04	m⁴
Second moment of area I_z	8,2200e-04	m⁴
Torsional constant I_t	1,3600e-03	m⁴
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	-0,06	
Equivalent moment factor $C_{my,0}$	0,77	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	-24,77	kNm
Maximum relative deflection δ_y	0,4	mm
Equivalent moment factor $C_{mz,0}$	0,84	
Factor μ_y	1,00	
Factor μ_z	0,94	
Factor ε_y	1,52	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	46214,24	kNm
Relative slenderness $\lambda_{rel,0}$	0,20	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,35	
Equivalent moment factor C_{my}	0,77	
Equivalent moment factor C_{mz}	0,84	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,23	
Factor w_z	1,23	
Factor n_{pl}	0,34	
Maximum relative slenderness $\lambda_{rel,max}$	0,81	
Factor C_{yy}	1,07	
Factor C_{yz}	0,98	
Factor C_{zy}	1,00	
Factor C_{zz}	1,05	

Unity check (6.61) = 0,34 + 0,31 + 0,01 = 0,65 -
Unity check (6.62) = 0,43 + 0,18 + 0,01 = 0,63 -

The member satisfies the stability check.

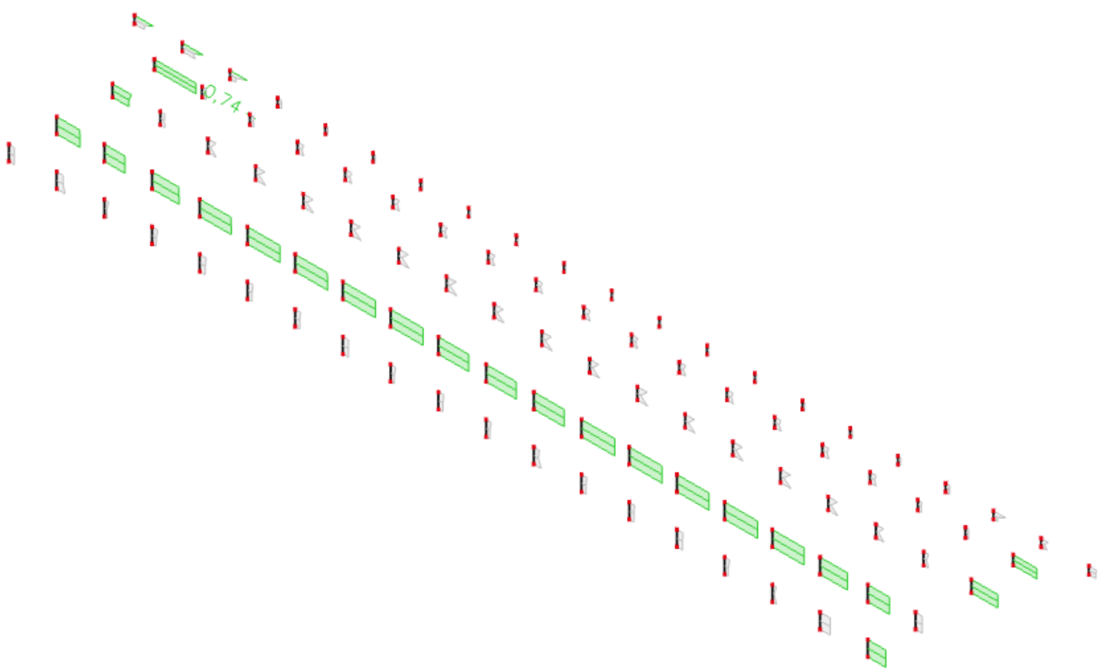
5.5. Dimenzioniranje vertikale rešetke pozicije R1

Name	R1-V
Type	SHS250/250/8.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m^2]	7,6800e-03	
A y, z [m^2]	3,8370e-03	3,8370e-03
I y, z [m^4]	7,4550e-05	7,4550e-05
I w [m^6], t [m^4]	6,5104e-07	1,1530e-04
W_{el} y, z [m^3]	5,9600e-04	5,9600e-04
W_{pl} y, z [m^3]	6,9400e-04	6,9400e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	125	125
α [deg]	0,00	
A L, D [m^2/m]	9,7900e-01	1,9015e+00
M_{ply} +, - [Nm]	2,46e+05	2,46e+05
M_{plz} +, - [Nm]	2,46e+05	2,46e+05

Tablica 5.4. *Karakteristike poprečnog presjeka vertikale rešetke pozicije R1*



Slika 5.8. *Prikaz iskoristivosti vertikala rešetke pozicije R1*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R1-V - SHS250/250/8.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp8971	1,527 / 1,527 m	SHS250/250/8.0	S 355	GSN	0,74 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmax

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 1,527 m

Internal forces	Calculated	Unit
N_{Ed}	-402,36	kN
$V_{y,Ed}$	-116,62	kN
$V_{z,Ed}$	61,10	kN
T_{Ed}	7,09	kNm
$M_{y,Ed}$	71,02	kNm
$M_{z,Ed}$	-24,35	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	226	8	-2,595e+04	-9,977e+04								
3	I	226	8	-9,476e+04	1,206e+05	-0,79		0,56	28,25	49,30	57,59	81,31	1
5	I	226	8	1,308e+05	2,046e+05	0,64		1,00	28,25	22,78	27,66	35,34	3
7	I	226	8	1,996e+05	-1,571e+04	-0,08		0,93	28,25	25,01	30,27	49,41	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 3

Semi-Comp+ properties		
Material coefficient ε	0,81	
Flange class 2 slenderness limit $\beta_{2,y,f}$	27,66	
Flange class 3 slenderness limit $\beta_{3,y,f}$	30,92	
Web class 2 slenderness limit $\beta_{2,y,w}$	67,53	
Web class 3 slenderness limit $\beta_{3,y,w}$	100,89	
Web class 2 slenderness limit $\beta_{2,z,w}$	27,66	
Web class 3 slenderness limit $\beta_{3,z,w}$	30,92	
Web slenderness ratio c/t_w	28,25	
Flange slenderness ratio c/t_f	28,25	
Reference slenderness ratio $c/t_{ref,y}$	0,18	
Reference slenderness ratio $c/t_{ref,z}$	0,18	
Interpolated section modulus $W_{3,y}$	6,7632e-04	m³
Interpolated section modulus $W_{3,z}$	6,7632e-04	m³

Note: The resistance for this semi-compact section has been calculated according to Semi-Comp+.

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	7,6800e-03	m²
$N_{c,Rd}$	2726,40	kN
Unity check	0,15	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,y}$	6,7632e-04	m³
$M_{3,y,Rd}$	240,09	kNm
Unity check	0,30	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,z}$	6,7632e-04	m^3
$M_{3,z,Rd}$	240,09	kNm
Unity check	0,10	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	3,8400e-03	m^2
$V_{pl,y,Rd}$	787,04	kN
Unity check	0,15	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	3,8400e-03	m^2
$V_{pl,z,Rd}$	787,04	kN
Unity check	0,08	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	7,6	MPa
τ_{Rd}	205,0	MPa
Unity check	0,04	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,3,y,Rd}$	204,66	kNm
α	1,70	
$M_{N,3,z,Rd}$	204,66	kNm
β	1,70	

Unity check (6.41) = 0,17 + 0,03 = 0,19 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 0,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	226	8	-1,446e+05	3,216e+05	-0,45		0,69	28,25	36,70	43,65	62,22	1
3	I	226	8	3,357e+05	2,681e+05	0,80		1,00	28,25	22,78	27,66	33,24	3
5	I	226	8	2,492e+05	-2,170e+05	-0,87		0,53	28,25	52,86	61,43	88,15	1
7	I	226	8	-2,312e+05	-1,635e+05								

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 3

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	1,527	1,527	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	1,527	1,527	m
Critical Euler load N_{cr}	66229,52	66229,52	kN
Slenderness λ	15,50	15,50	
Relative slenderness λ_{rel}	0,20	0,20	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	

Note: The slenderness or compression force is such that Flexural Buckling effects may be ignored according to EN 1993-1-1 article 6.3.1.2(4).

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	7,6800e-03	m^2
Interpolated section modulus $W_{3,y}$	6,7632e-04	m^3
Interpolated section modulus $W_{3,z}$	6,7632e-04	m^3
Design compression force N_{Ed}	402,36	kN
Design bending moment (maximum) $M_{y,Ed}$	71,02	kNm
Design bending moment (maximum) $M_{z,Ed}$	153,77	kNm
Characteristic compression resistance N_{Rk}	2726,40	kN
Characteristic moment resistance $M_{y,Rk}$	240,09	kNm
Characteristic moment resistance $M_{z,Rk}$	240,09	kNm
Reduction factor χ_y	1,00	
Reduction factor χ_z	1,00	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,70	
Interaction factor k_{yz}	0,44	
Interaction factor k_{zy}	0,42	
Interaction factor k_{zz}	0,73	

Maximum moment $M_{y,Ed}$ is derived from beam pp8971 position 1,527 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp8971 position 0,000 m.

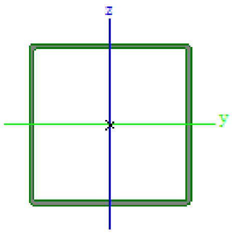
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	66229,52	kN
Critical Euler load $N_{cr,z}$	66229,52	kN
Elastic critical load $N_{cr,T}$	509479,74	kN
Interpolated section modulus $W_{3,y}$	6,7632e-04	m^3
Elastic section modulus $W_{el,y}$	5,9600e-04	m^3
Interpolated section modulus $W_{3,z}$	6,7632e-04	m^3
Elastic section modulus $W_{el,z}$	5,9600e-04	m^3
Second moment of area I_y	7,4550e-05	m^4
Second moment of area I_z	7,4550e-05	m^4
Torsional constant I_t	1,1530e-04	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	-0,31	
Equivalent moment factor $C_{my,0}$	0,72	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,16	
Equivalent moment factor $C_{mz,0}$	0,76	
Factor μ_y	1,00	
Factor μ_z	1,00	
Factor ε_y	2,27	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	25594,55	kNm
Relative slenderness $\lambda_{rel,0}$	0,10	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,29	
Equivalent moment factor C_{my}	0,72	
Equivalent moment factor C_{mz}	0,76	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,13	
Factor w_z	1,13	
Factor n_{pl}	0,15	
Maximum relative slenderness $\lambda_{rel,max}$	0,20	
Factor C_{yy}	1,04	
Factor C_{yz}	1,04	
Factor C_{zy}	1,04	
Factor C_{zz}	1,04	

Unity check (6.61) = 0,15 + 0,21 + 0,28 = 0,64 -
Unity check (6.62) = 0,15 + 0,12 + 0,47 = 0,74 -

The member satisfies the stability check.

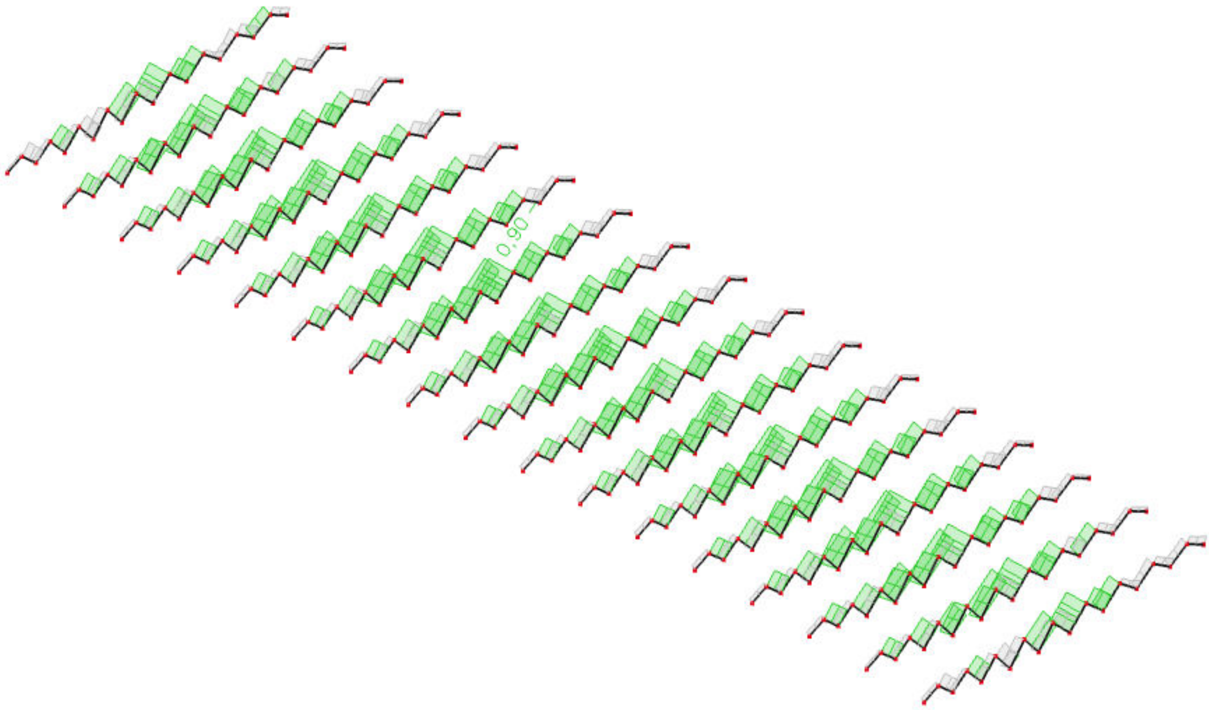
5.6. Dimenzioniranje ispune rešetke pozicije R1

Name	R1-I
Type	SHS250/250/6.3
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	roled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m^2]	6,1000e-03	
A y, z [m^2]	3,0489e-03	3,0489e-03
I y, z [m^4]	6,0140e-05	6,0140e-05
I w [m^6], t [m^4]	5,1270e-07	9,2380e-05
W_{el} y, z [m^3]	4,8100e-04	4,8100e-04
W_{pl} y, z [m^3]	5,5600e-04	5,5600e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	125	125
α [deg]	0,00	
A L, D [m^2/m]	9,8400e-01	1,9224e+00
M_{ply} +, - [Nm]	1,97e+05	1,97e+05
M_{plz} +, - [Nm]	1,97e+05	1,97e+05

Tablica 5.5. *Karakteristike poprečnog presjeka vertikale rešetke pozicije R1*



Slika 5.9. *Prikaz iskoristivosti ispune rešetke pozicije R1*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R1-I - SHS250/250/6.3

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp219	3,202 / 3,202 m	SHS250/250/6.3	S 355	GSN	0,90 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 3,202 m

Internal forces	Calculated	Unit
N_{Ed}	-1307,12	kN
$V_{y,Ed}$	1,90	kN
$V_{z,Ed}$	18,09	kN
T_{Ed}	-0,28	kNm
$M_{y,Ed}$	28,94	kNm
$M_{z,Ed}$	4,12	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	231	6	1,478e+05	1,636e+05	0,90		1,00	36,68	22,78	27,66	31,99	4
3	I	231	6	1,671e+05	2,783e+05	0,60		1,00	36,68	22,78	27,66	35,89	4
5	I	231	6	2,809e+05	2,651e+05	0,94		1,00	36,68	22,78	27,66	31,53	4
7	I	231	6	2,616e+05	1,504e+05	0,57		1,00	36,68	22,78	27,66	36,27	4

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Effective section N-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	231	3,550e+05	3,550e+05	1,00	4,00	0,79	0,91	210	105	105
3	I	231	3,550e+05	3,550e+05	1,00	4,00	0,79	0,91	210	105	105
5	I	231	3,550e+05	3,550e+05	1,00	4,00	0,79	0,91	210	105	105
7	I	231	3,550e+05	3,550e+05	1,00	4,00	0,79	0,91	210	105	105

Effective section My+
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	231	-3,399e+05	-3,399e+05							
3	I	231	3,370e+05	-3,219e+05	-0,96	22,74	0,33	1,00	118	47	71
5	I	231	3,550e+05	3,550e+05	1,00	4,00	0,79	0,91	210	105	105
7	I	231	3,370e+05	-3,219e+05	-0,96	22,74	0,33	1,00	118	47	71

Effective section Mz+
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	231	3,370e+05	-3,219e+05	-0,96	22,74	0,33	1,00	118	47	71
3	I	231	3,550e+05	3,550e+05	1,00	4,00	0,79	0,91	210	105	105
5	I	231	3,370e+05	-3,219e+05	-0,96	22,74	0,33	1,00	118	47	71
7	I	231	-3,399e+05	-3,399e+05							

Effective properties						
Effective area	A_{eff}	5,5781e-03	m²			
Effective second moment of area	$I_{eff,y}$	5,8162e-05	m⁴	$I_{eff,z}$	5,8162e-05	m⁴
Effective section modulus	$W_{eff,y}$	4,5562e-04	m³	$W_{eff,z}$	4,5562e-04	m³
Shift of the centroid	$e_{N,y}$	0	mm	$e_{N,z}$	0	mm

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A_{eff}	5,5781e-03	m²
$N_{c,Rd}$	1980,22	kN
Unity check	0,66	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,y,min}$	4,5562e-04	m³
$M_{c,y,Rd}$	161,74	kNm
Unity check	0,18	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,z,min}$	4,5562e-04	m³
$M_{c,z,Rd}$	161,74	kNm
Unity check	0,03	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	3,0500e-03	m²
$V_{pl,y,Rd}$	625,13	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	3,0500e-03	m²
$V_{pl,z,Rd}$	625,13	kN
Unity check	0,03	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,4	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.3 and formula (6.43)

Effective properties		
A_{eff}	5,5781e-03	m²
$e_{N,y}$	0	mm
$e_{N,z}$	0	mm
$W_{eff,y}$	4,5562e-04	m³
$W_{eff,z}$	4,5562e-04	m³

Normal stresses		
$\sigma_{N,Ed}$	234,3	MPa
$\sigma_{My,Ed}$	63,5	MPa
$\sigma_{Mz,Ed}$	9,0	MPa
$\sigma_{tot,Ed}$	306,9	MPa
Unity check	0,86	-

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 3,202 m

Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	231	6	1,478e+05	1,636e+05	0,90		1,00	36,68	22,78	27,66	31,99	4
3	I	231	6	1,671e+05	2,783e+05	0,60		1,00	36,68	22,78	27,66	35,89	4
5	I	231	6	2,809e+05	2,651e+05	0,94		1,00	36,68	22,78	27,66	31,53	4
7	I	231	6	2,616e+05	1,504e+05	0,57		1,00	36,68	22,78	27,66	36,27	4

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	3,202	3,202	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	3,202	3,202	m
Critical Euler load N_{cr}	12160,70	12160,70	kN
Slenderness λ	32,24	32,24	
Relative slenderness λ_{rel}	0,40	0,40	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,95	0,95	
Buckling resistance $N_{b,Rd}$	1884,88	1884,88	kN

Flexural Buckling verification		
Cross-section effective area A_{eff}	5,5781e-03	m²
Buckling resistance $N_{b,Rd}$	1884,88	kN
Unity check	0,69	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section effective area A_{eff}	5,5781e-03	m²
Effective section modulus $W_{eff,y}$	4,5562e-04	m³
Effective section modulus $W_{eff,z}$	4,5562e-04	m³
Design compression force N_{Ed}	1307,12	kN
Design bending moment (maximum) $M_{y,Ed}$	-31,02	kNm
Design bending moment (maximum) $M_{z,Ed}$	4,12	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance N_{Rk}	1980,22	kN
Characteristic moment resistance $M_{y,Rk}$	161,74	kNm
Characteristic moment resistance $M_{z,Rk}$	161,74	kNm
Reduction factor χ_y	0,95	
Reduction factor χ_z	0,95	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,00	
Interaction factor k_{yz}	0,73	
Interaction factor k_{zy}	1,00	
Interaction factor k_{zz}	0,73	

Maximum moment $M_{y,Ed}$ is derived from beam pp219 position 0,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp219 position 3,202 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	12160,70	kN
Critical Euler load $N_{cr,z}$	12160,70	kN
Elastic critical load $N_{cr,T}$	383665,65	kN
Effective section modulus $W_{eff,y}$	4,5562e-04	m³
Second moment of area I_y	6,0140e-05	m⁴
Second moment of area I_z	6,0140e-05	m⁴
Torsional constant I_t	9,2380e-05	m⁴
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-31,02	kNm
Maximum relative deflection δ_z	0,1	mm

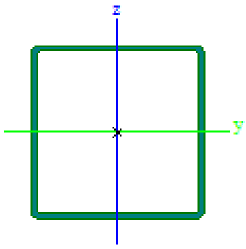
Interaction method 1 parameters		
Equivalent moment factor $C_{my,0}$	0,90	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,48	
Equivalent moment factor $C_{mz,0}$	0,66	
Factor μ_y	0,99	
Factor μ_z	0,99	
Factor ε_y	0,29	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	9591,52	kNm
Relative slenderness $\lambda_{rel,0}$	0,13	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,31	
Equivalent moment factor C_{my}	0,90	
Equivalent moment factor C_{mz}	0,66	
Equivalent moment factor C_{mLT}	1,00	

Unity check (6.61) = 0,69 + 0,19 + 0,02 = 0,90 -
Unity check (6.62) = 0,69 + 0,19 + 0,02 = 0,90 -

The member satisfies the stability check.

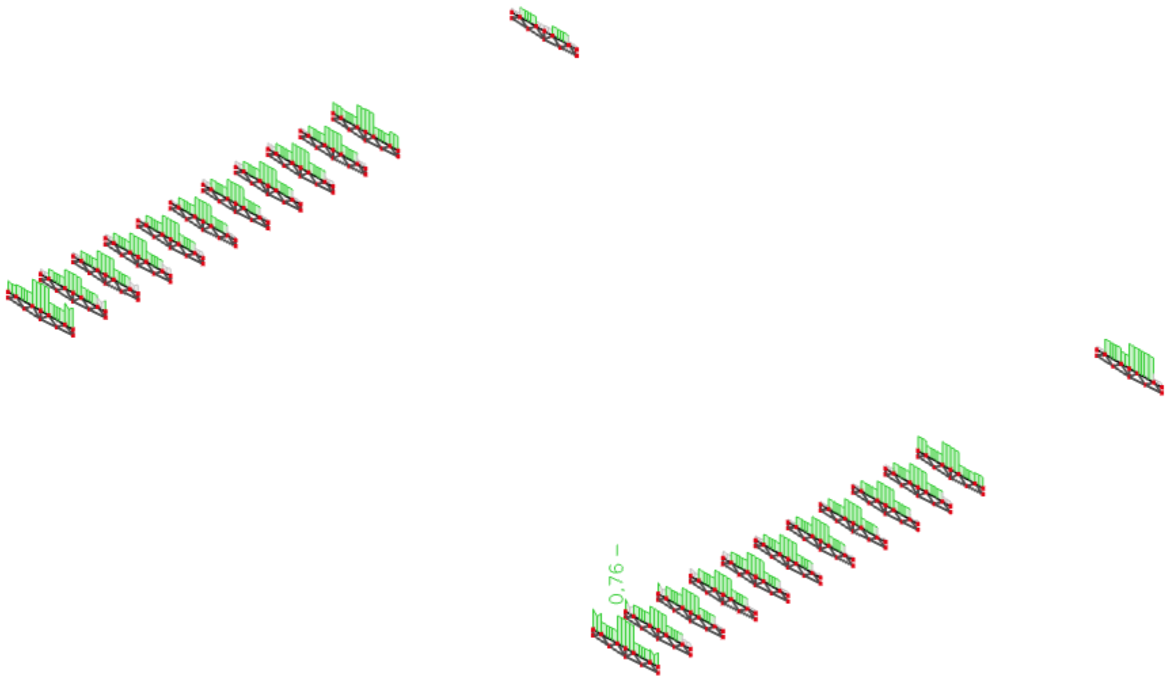
5.7. Dimenzioniranje gornjeg pojasa rešetke pozicije R2

Name	R2-GP
Type	SHS200/200/6.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	roled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	4,6200e-03	
A y, z [m^2]	2,3083e-03	2,3083e-03
I y, z [m^4]	2,8830e-05	2,8830e-05
I w [m^6], t [m^4]	1,6000e-07	4,4490e-05
W_{el} y, z [m^3]	2,8800e-04	2,8800e-04
W_{pl} y, z [m^3]	3,3500e-04	3,3500e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	100	100
α [deg]	0,00	
A L, D [m^2/m]	7,8500e-01	1,5261e+00
M_{ply} +, - [Nm]	1,19e+05	1,19e+05
M_{plz} +, - [Nm]	1,19e+05	1,19e+05

Tablica 5.6. *Karakteristike poprečnog presjeka gornjeg pojasa rešetke pozicije R2*



Slika 5.10. *Prikaz iskoristivosti gornjeg pojasa rešetke pozicije R2*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R2-GP - SHS200/200/6.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp670	0,000 / 8,000 m	SHS200/200/6.0	S 355	GSN	0,76 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
N_{Ed}	1241,94	kN
$V_{y,Ed}$	11,08	kN
$V_{z,Ed}$	11,60	kN
T_{Ed}	-3,72	kNm
$M_{y,Ed}$	-17,21	kNm
$M_{z,Ed}$	-9,10	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	182	6	-1,824e+05	-2,398e+05								
3	I	182	6	-2,453e+05	-3,539e+05								
5	I	182	6	-3,556e+05	-2,981e+05								
7	I	182	6	-2,927e+05	-1,840e+05								

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Tension check
According to EN 1993-1-1 article 6.2.3 and formula (6.5)

A	4,6200e-03	m²
$N_{pl,Rd}$	1640,10	kN
$N_{u,Rd}$	1629,94	kN
$N_{t,Rd}$	1629,94	kN
Unity check	0,76	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	3,3500e-04	m³
$M_{pl,y,Rd}$	118,92	kNm
Unity check	0,14	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	3,3500e-04	m³
$M_{pl,z,Rd}$	118,92	kNm
Unity check	0,08	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	2,3100e-03	m²
$V_{pl,y,Rd}$	473,46	kN
Unity check	0,02	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	2,3100e-03	m^2
$V_{pl,z,Rd}$	473,46	kN
Unity check	0,02	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	8,2	MPa
τ_{Rd}	205,0	MPa
Unity check	0,04	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	38,00	kNm
α	4,72	
$M_{N,z,Rd}$	38,00	kNm
β	4,72	

Unity check (6.41) = 0,02 + 0,00 = 0,03 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 6,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	182	6	8,408e+04	2,787e+04	0,33		1,00	30,33	22,78	27,66	40,26	3
3	I	182	6	2,258e+04	-8,171e+04	-3,62		0,22	30,33	135,30	155,97	443,28	1
5	I	182	6	-8,330e+04	-2,709e+04								
7	I	182	6	-2,180e+04	8,250e+04	-0,26		0,79	30,33	30,60	36,72	55,08	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 3

Semi-Comp+ properties		
Material coefficient ε	0,81	
Flange class 2 slenderness limit $\beta_{2,y,f}$	27,66	
Flange class 3 slenderness limit $\beta_{3,y,f}$	30,92	
Web class 2 slenderness limit $\beta_{2,y,w}$	67,53	
Web class 3 slenderness limit $\beta_{3,y,w}$	100,89	
Web class 2 slenderness limit $\beta_{2,z,w}$	27,66	
Web class 3 slenderness limit $\beta_{3,z,w}$	30,92	
Web slenderness ratio c/t_w	30,33	
Flange slenderness ratio c/t_f	30,33	
Reference slenderness ratio $c/t_{ref,y}$	0,82	
Reference slenderness ratio $c/t_{ref,z}$	0,82	
Interpolated section modulus $W_{3,y}$	2,9644e-04	m^3
Interpolated section modulus $W_{3,z}$	2,9644e-04	m^3

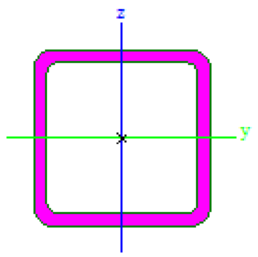
Note: The resistance for this semi-compact section has been calculated according to Semi-Comp+.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

The member satisfies the stability check.

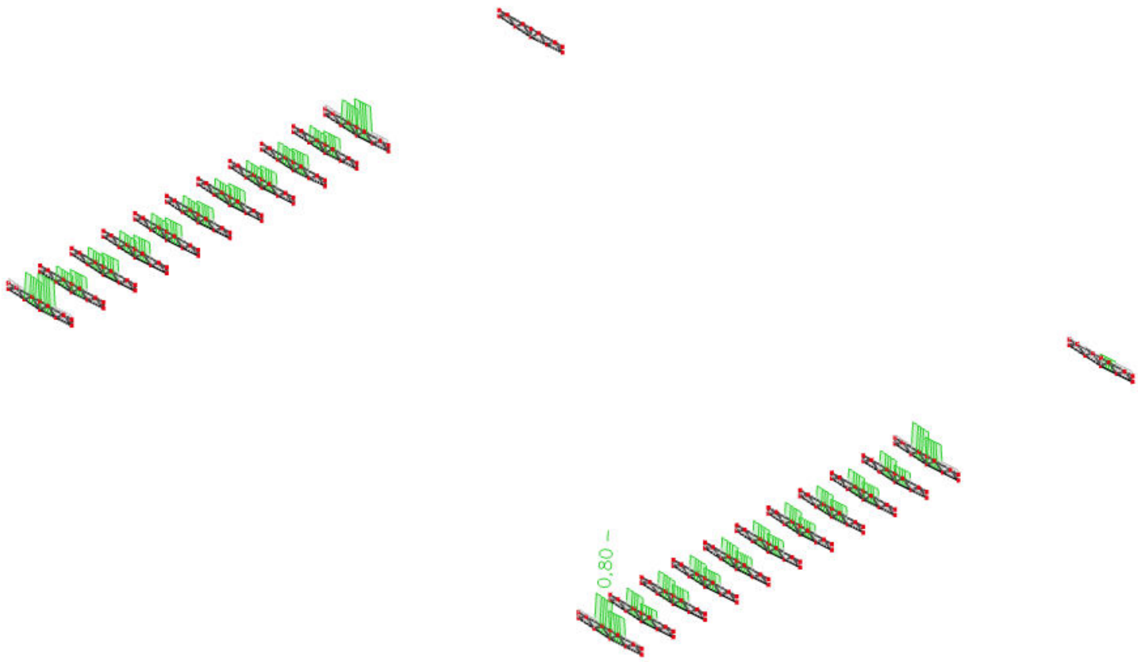
5.8. Dimenzioniranje donjeg pojasa rešetke pozicije R2

Name	R2-DP
Type	SHS200/200/14.2
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m²]	1,0300e-02	
A y, z [m²]	5,1665e-03	5,1665e-03
I y, z [m⁴]	5,8720e-05	5,8720e-05
I w [m⁶], t [m⁴]	3,7867e-07	9,4170e-05
W_{el} y, z [m³]	5,8700e-04	5,8700e-04
W_{pl} y, z [m³]	7,1400e-04	7,1400e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	100	100
α [deg]	0,00	
A L, D [m²/m]	7,6300e-01	1,4252e+00
M_{ply} +, - [Nm]	2,53e+05	2,53e+05
M_{plz} +, - [Nm]	2,53e+05	2,53e+05

Tablica 5.7. *Karakteristike poprečnog presjeka donjeg pojasa rešetke pozicije R2*



Slika 5.11. *Prikaz iskoristivosti donjeg pojasa rešetke pozicije R2*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R2-DP - SHS200/200/14.2

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp671	8,019 / 8,019 m	SHS200/200/14.2	S 355	GSN	0,80 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 8,019 m

Internal forces	Calculated	Unit
N_{Ed}	-872,29	kN
$V_{y,Ed}$	2,20	kN
$V_{z,Ed}$	-27,34	kN
T_{Ed}	8,62	kNm
$M_{y,Ed}$	-81,89	kNm
$M_{z,Ed}$	0,86	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	157	14	2,128e+05	2,151e+05	0,99		1,00	11,08	22,78	27,66	31,03	1
3	I	157	14	1,955e+05	-2,401e+04	-0,12		0,89	11,08	26,30	31,76	50,65	1
5	I	157	14	-4,403e+04	-4,635e+04								
7	I	157	14	-2,675e+04	1,928e+05	-0,14		0,88	11,08	26,77	32,31	51,12	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	1,0300e-02	m²
$N_{c,Rd}$	3656,50	kN
Unity check	0,24	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	7,1400e-04	m³
$M_{pl,y,Rd}$	253,47	kNm
Unity check	0,32	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	7,1400e-04	m³
$M_{pl,z,Rd}$	253,47	kNm
Unity check	0,00	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	5,1500e-03	m²
$V_{pl,y,Rd}$	1055,54	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	5,1500e-03	m^2
$V_{pl,z,Rd}$	1055,54	kN
Unity check	0,03	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	8,8	MPa
τ_{Rd}	205,0	MPa
Unity check	0,04	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	248,80	kNm
α	1,77	
$M_{N,z,Rd}$	248,80	kNm
β	1,77	

Unity check (6.41) = 0,14 + 0,00 = 0,14 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 8,019 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	157	14	2,128e+05	2,151e+05	0,99		1,00	11,08	22,78	27,66	31,03	1
3	I	157	14	1,955e+05	-2,401e+04	-0,12		0,89	11,08	26,30	31,76	50,65	1
5	I	157	14	-4,403e+04	-4,635e+04								
7	I	157	14	-2,675e+04	1,928e+05	-0,14		0,88	11,08	26,77	32,31	51,12	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	4,009	8,019	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	4,009	8,019	m
Critical Euler load N_{cr}	7570,72	1892,68	kN
Slenderness λ	53,10	106,20	
Relative slenderness λ_{rel}	0,69	1,39	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,85	0,42	
Buckling resistance $N_{b,Rd}$	3108,35	1546,16	kN

Flexural Buckling verification		
Cross-section area A	1,0300e-02	m^2
Buckling resistance $N_{b,Rd}$	1546,16	kN
Unity check	0,56	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	1,0300e-02	m^2
Plastic section modulus $W_{pl,y}$	7,1400e-04	m^3
Plastic section modulus $W_{pl,z}$	7,1400e-04	m^3
Design compression force N_{Ed}	872,29	kN
Design bending moment (maximum) $M_{y,Ed}$	-81,89	kNm
Design bending moment (maximum) $M_{z,Ed}$	-5,01	kNm
Characteristic compression resistance N_{Rk}	3656,50	kN
Characteristic moment resistance $M_{y,Rk}$	253,47	kNm
Characteristic moment resistance $M_{z,Rk}$	253,47	kNm
Reduction factor χ_y	0,85	
Reduction factor χ_z	0,42	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,15	
Interaction factor k_{yz}	1,13	
Interaction factor k_{zy}	0,67	
Interaction factor k_{zz}	1,03	

Maximum moment $M_{y,Ed}$ is derived from beam pp671 position 8,019 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp671 position 5,346 m.

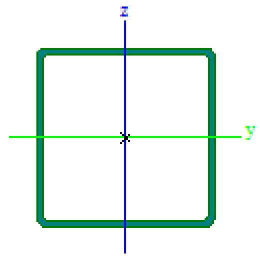
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	7570,72	kN
Critical Euler load $N_{cr,z}$	1892,68	kN
Elastic critical load $N_{cr,T}$	668153,19	kN
Plastic section modulus $W_{pl,y}$	7,1400e-04	m^3
Elastic section modulus $W_{el,y}$	5,8700e-04	m^3
Plastic section modulus $W_{pl,z}$	7,1400e-04	m^3
Elastic section modulus $W_{el,z}$	5,8700e-04	m^3
Second moment of area I_y	5,8720e-05	m^4
Second moment of area I_z	5,8720e-05	m^4
Torsional constant I_t	9,4170e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-81,89	kNm
Maximum relative deflection δ_z	5,1	mm
Equivalent moment factor $C_{my,0}$	0,94	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	-5,01	kNm
Maximum relative deflection δ_y	1,5	mm
Equivalent moment factor $C_{mz,0}$	0,80	
Factor μ_y	0,98	
Factor μ_z	0,67	
Factor ε_y	1,65	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	3797,22	kNm
Relative slenderness $\lambda_{rel,0}$	0,26	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,31	
Equivalent moment factor C_{my}	0,94	
Equivalent moment factor C_{mz}	0,80	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,22	
Factor w_z	1,22	
Factor n_{pl}	0,24	
Maximum relative slenderness $\lambda_{rel,max}$	1,39	
Factor C_{yy}	0,90	
Factor C_{yz}	0,77	
Factor C_{zy}	0,64	
Factor C_{zz}	0,96	

Unity check (6.61) = 0,28 + 0,37 + 0,02 = 0,67 -
Unity check (6.62) = 0,56 + 0,21 + 0,02 = 0,80 -

The member satisfies the stability check.

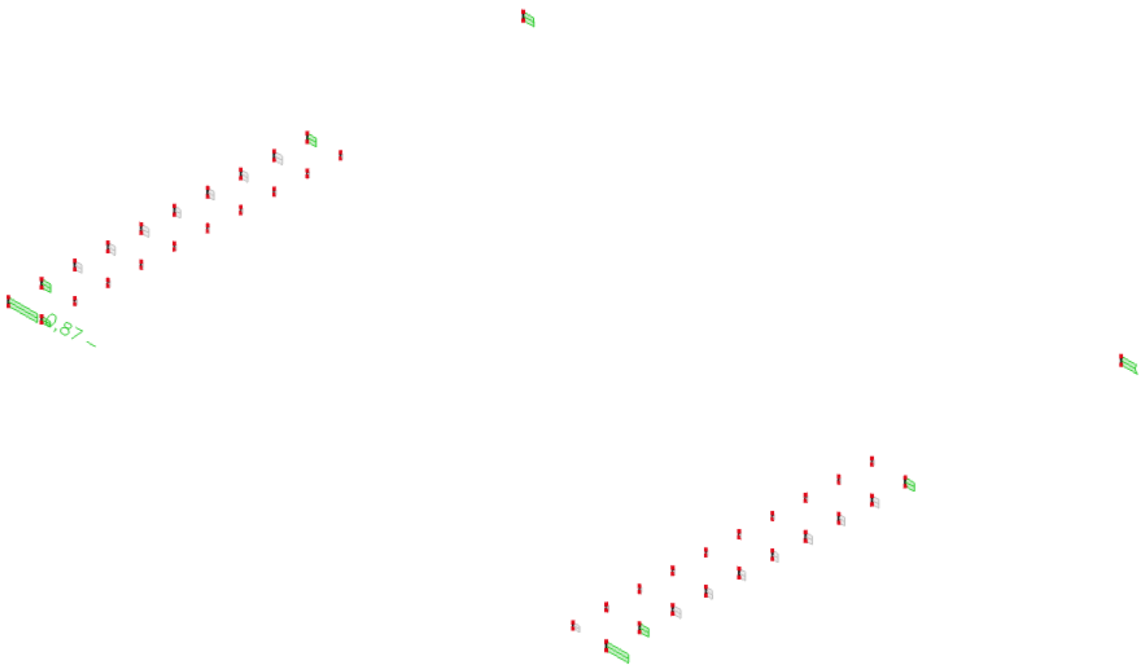
5.9. Dimenzioniranje vertikale rešetke pozicije R2

Name	R2-V
Type	SHS180/180/6.3
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m^2]	4,3300e-03	
A y, z [m^2]	2,1669e-03	2,1669e-03
I y, z [m^4]	2,1680e-05	2,1680e-05
I w [m^6], t [m^4]	9,9202e-08	3,3610e-05
W_{el} y, z [m^3]	2,4100e-04	2,4100e-04
W_{pl} y, z [m^3]	2,8100e-04	2,8100e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	90	90
α [deg]	0,00	
A L, D [m^2/m]	7,0400e-01	1,3624e+00
M_{ply} +, - [Nm]	9,98e+04	9,98e+04
M_{plz} +, - [Nm]	9,98e+04	9,98e+04

Tablica 5.8. *Karakteristike poprečnog presjeka vertikale rešetke pozicije R2*



Slika 5.12. *Prikaz iskoristivosti vertikale rešetke pozicije R2*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R2-V - SHS180/180/6.3

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp509	1,800 / 1,800 m	SHS180/180/6.3	S 355	GSN	0,87 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 1,800 m

Internal forces	Calculated	Unit
N_{Ed}	-323,98	kN
$V_{y,Ed}$	26,27	kN
$V_{z,Ed}$	20,70	kN
T_{Ed}	1,22	kNm
$M_{y,Ed}$	26,78	kNm
$M_{z,Ed}$	-19,12	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	161	6	3,851e+04	-1,036e+05	-2,69		0,27	25,57	108,07	124,59	305,26	1
3	I	161	6	-1,013e+05	9,765e+04	-1,04		0,49	25,57	59,69	68,81	104,73	1
5	I	161	6	1,110e+05	2,531e+05	0,44		1,00	25,57	22,78	27,66	38,40	2
7	I	161	6	2,508e+05	5,184e+04	0,21		1,00	25,57	22,78	27,66	42,66	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 2

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	4,3300e-03	m²
$N_{c,Rd}$	1537,15	kN
Unity check	0,21	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	2,8100e-04	m³
$M_{pl,y,Rd}$	99,75	kNm
Unity check	0,27	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	2,8100e-04	m³
$M_{pl,z,Rd}$	99,75	kNm
Unity check	0,19	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	2,1650e-03	m²
$V_{pl,y,Rd}$	443,74	kN
Unity check	0,06	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	2,1650e-03	m^2
$V_{pl,z,Rd}$	443,74	kN
Unity check	0,05	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	3,2	MPa
τ_{Rd}	205,0	MPa
Unity check	0,02	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	99,75	kNm
α	1,75	
$M_{N,z,Rd}$	99,75	kNm
β	1,75	

Unity check (6.41) = 0,10 + 0,06 = 0,16 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 0,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	161	6	3,634e+05	-1,302e+05	-0,36		0,74	25,57	33,62	40,17	58,48	1
3	I	161	6	-1,525e+05	-2,305e+05								
5	I	161	6	-2,142e+05	2,793e+05	-0,77		0,57	25,57	48,53	56,75	79,92	1
7	I	161	6	3,017e+05	3,796e+05	0,79		1,00	25,57	22,78	27,66	33,29	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 2

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	1,800	1,800	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	1,800	1,800	m
Critical Euler load N_{cr}	13868,62	13868,62	kN
Slenderness λ	25,44	25,44	
Relative slenderness λ_{rel}	0,33	0,33	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	

Note: The slenderness or compression force is such that Flexural Buckling effects may be ignored according to EN 1993-1-1 article 6.3.1.2(4).

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	4,3300e-03	m²
Plastic section modulus $W_{pl,y}$	2,8100e-04	m³
Plastic section modulus $W_{pl,z}$	2,8100e-04	m³
Design compression force N_{Ed}	323,98	kN
Design bending moment (maximum) $M_{y,Ed}$	26,78	kNm
Design bending moment (maximum) $M_{z,Ed}$	-66,41	kNm
Characteristic compression resistance N_{Rk}	1537,15	kN

Bending and axial compression check parameters		
Characteristic moment resistance $M_{y,Rk}$	99,75	kNm
Characteristic moment resistance $M_{z,Rk}$	99,75	kNm
Reduction factor χ_y	1,00	
Reduction factor χ_z	1,00	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,68	
Interaction factor k_{yz}	0,50	
Interaction factor k_{zy}	0,41	
Interaction factor k_{zz}	0,83	

Maximum moment $M_{y,Ed}$ is derived from beam pp509 position 1,800 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp509 position 0,000 m.

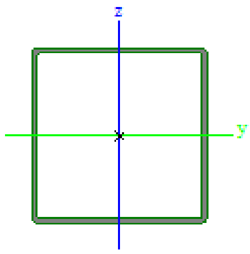
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	13868,62	kN
Critical Euler load $N_{cr,z}$	13868,62	kN
Elastic critical load $N_{cr,T}$	277426,90	kN
Plastic section modulus $W_{pl,y}$	2,8100e-04	m^3
Elastic section modulus $W_{el,y}$	2,4100e-04	m^3
Plastic section modulus $W_{pl,z}$	2,8100e-04	m^3
Elastic section modulus $W_{el,z}$	2,4100e-04	m^3
Second moment of area I_y	2,1680e-05	m^4
Second moment of area I_z	2,1680e-05	m^4
Torsional constant I_t	3,3610e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	-0,39	
Equivalent moment factor $C_{my,0}$	0,70	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	0,29	
Equivalent moment factor $C_{mz,0}$	0,85	
Factor μ_y	1,00	
Factor μ_z	1,00	
Factor ε_y	1,48	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	6207,14	kNm
Relative slenderness $\lambda_{rel,0}$	0,13	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,30	
Equivalent moment factor C_{my}	0,70	
Equivalent moment factor C_{mz}	0,85	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,17	
Factor w_z	1,17	
Factor n_{pl}	0,21	
Maximum relative slenderness $\lambda_{rel,max}$	0,33	
Factor C_{yy}	1,06	
Factor C_{yz}	1,05	
Factor C_{zy}	1,06	
Factor C_{zz}	1,05	

Unity check (6.61) = 0,21 + 0,18 + 0,33 = 0,72 -
Unity check (6.62) = 0,21 + 0,11 + 0,55 = 0,87 -

The member satisfies the stability check.

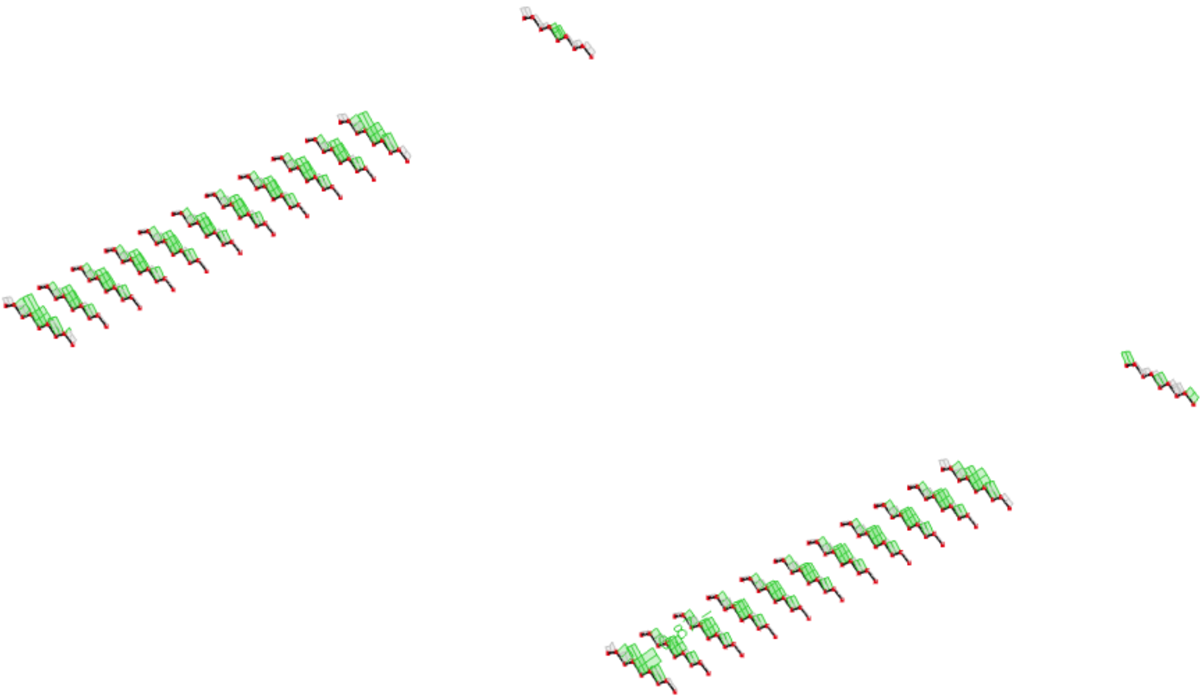
5.10. Dimenzioniranje ispune rešetke pozicije R2

Name	R1-I
Type	SHS250/250/6.3
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	roled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	6,1000e-03	
A y, z [m^2]	3,0489e-03	3,0489e-03
I y, z [m^4]	6,0140e-05	6,0140e-05
I w [m^6], t [m^4]	5,1270e-07	9,2380e-05
W_{el} y, z [m^3]	4,8100e-04	4,8100e-04
W_{pl} y, z [m^3]	5,5600e-04	5,5600e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	125	125
α [deg]	0,00	
A L, D [m^2/m]	9,8400e-01	1,9224e+00
M_{ply} +, - [Nm]	1,97e+05	1,97e+05
M_{plz} +, - [Nm]	1,97e+05	1,97e+05

Tablica 5.9. *Karakteristike poprečnog presjeka ispune rešetke pozicije R2*



Slika 5.13. *Prikaz iskoristivosti ispune rešetke pozicije R2*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R2-I - SHS180/180/6.3

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp679	2,691 / 2,691 m	SHS180/180/6.3	S 355	GSN	0,87 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 2,691 m

Internal forces	Calculated	Unit
N_{Ed}	-559,38	kN
$V_{y,Ed}$	2,41	kN
$V_{z,Ed}$	-19,86	kN
T_{Ed}	5,20	kNm
$M_{y,Ed}$	-40,68	kNm
$M_{z,Ed}$	-7,18	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	161	6	3,187e+05	2,654e+05	0,83		1,00	25,57	22,78	27,66	32,83	2
3	I	161	6	2,514e+05	-5,090e+04	-0,20		0,83	25,57	28,68	34,52	53,05	1
5	I	161	6	-6,064e+04	-7,243e+03								
7	I	161	6	6,668e+03	3,090e+05	0,02		1,00	25,57	22,78	27,66	46,81	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 2

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	4,3300e-03	m²
$N_{c,Rd}$	1537,15	kN
Unity check	0,36	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	2,8100e-04	m³
$M_{pl,y,Rd}$	99,75	kNm
Unity check	0,41	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	2,8100e-04	m³
$M_{pl,z,Rd}$	99,75	kNm
Unity check	0,07	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	2,1650e-03	m²
$V_{pl,y,Rd}$	443,74	kN
Unity check	0,01	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	2,1650e-03	m^2
$V_{pl,z,Rd}$	443,74	kN
Unity check	0,04	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	13,7	MPa
τ_{Rd}	205,0	MPa
Unity check	0,07	-

Combined Shear and Torsion check for V_y and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.28)

$V_{pl,T,y,Rd}$	414,13	kN
Unity check	0,01	-

Combined Shear and Torsion check for V_z and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.28)

$V_{pl,T,z,Rd}$	414,13	kN
Unity check	0,05	-

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	83,28	kNm
α	1,95	
$M_{N,z,Rd}$	83,28	kNm
β	1,95	

Unity check (6.41) = 0,25 + 0,01 = 0,26 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 2,691 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	161	6	3,187e+05	2,654e+05	0,83		1,00	25,57	22,78	27,66	32,83	2
3	I	161	6	2,514e+05	-5,090e+04	-0,20		0,83	25,57	28,68	34,52	53,05	1
5	I	161	6	-6,064e+04	-7,243e+03								
7	I	161	6	6,668e+03	3,090e+05	0,02		1,00	25,57	22,78	27,66	46,81	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 2

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	2,691	2,691	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	2,691	2,691	m
Critical Euler load N_{cr}	6206,40	6206,40	kN
Slenderness λ	38,03	38,03	
Relative slenderness λ_{rel}	0,50	0,50	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,92	0,92	
Buckling resistance $N_{b,Rd}$	1421,86	1421,86	kN

Flexural Buckling verification		
Cross-section area A	4,3300e-03	m^2
Buckling resistance $N_{b,Rd}$	1421,86	kN
Unity check	0,39	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.

This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	4,3300e-03	m^2
Plastic section modulus $W_{pl,y}$	2,8100e-04	m^3
Plastic section modulus $W_{pl,z}$	2,8100e-04	m^3
Design compression force N_{Ed}	559,38	kN
Design bending moment (maximum) $M_{y,Ed}$	-40,68	kNm
Design bending moment (maximum) $M_{z,Ed}$	-13,66	kNm
Characteristic compression resistance N_{Rk}	1537,15	kN
Characteristic moment resistance $M_{y,Rk}$	99,75	kNm
Characteristic moment resistance $M_{z,Rk}$	99,75	kNm
Reduction factor χ_y	0,92	
Reduction factor χ_z	0,92	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,97	
Interaction factor k_{yz}	0,57	
Interaction factor k_{zy}	0,60	
Interaction factor k_{zz}	0,92	

Maximum moment $M_{y,Ed}$ is derived from beam pp679 position 2,691 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp679 position 0,000 m.

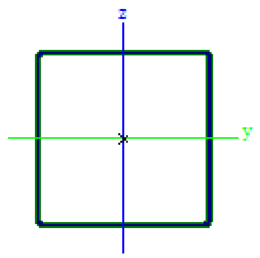
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	6206,40	kN
Critical Euler load $N_{cr,z}$	6206,40	kN
Elastic critical load $N_{cr,T}$	273925,71	kN
Plastic section modulus $W_{pl,y}$	2,8100e-04	m^3
Elastic section modulus $W_{el,y}$	2,4100e-04	m^3
Plastic section modulus $W_{pl,z}$	2,8100e-04	m^3
Elastic section modulus $W_{el,z}$	2,4100e-04	m^3
Second moment of area I_y	2,1680e-05	m^4
Second moment of area I_z	2,1680e-05	m^4
Torsional constant I_t	3,3610e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-40,68	kNm
Maximum relative deflection δ_z	2,8	mm
Equivalent moment factor $C_{my,0}$	0,95	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	0,53	
Equivalent moment factor $C_{mz,0}$	0,91	
Factor μ_y	0,99	
Factor μ_z	0,99	
Factor ε_y	1,31	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	4126,07	kNm
Relative slenderness $\lambda_{rel,0}$	0,16	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,28	
Equivalent moment factor C_{my}	0,95	
Equivalent moment factor C_{mz}	0,91	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,17	
Factor w_z	1,17	
Factor n_{pl}	0,36	
Maximum relative slenderness $\lambda_{rel,max}$	0,50	
Factor C_{yy}	1,07	
Factor C_{yz}	1,04	
Factor C_{zy}	1,03	
Factor C_{zz}	1,07	

Unity check (6.61) = 0,39 + 0,40 + 0,08 = 0,87 -
Unity check (6.62) = 0,39 + 0,25 + 0,13 = 0,77 -

The member satisfies the stability check.

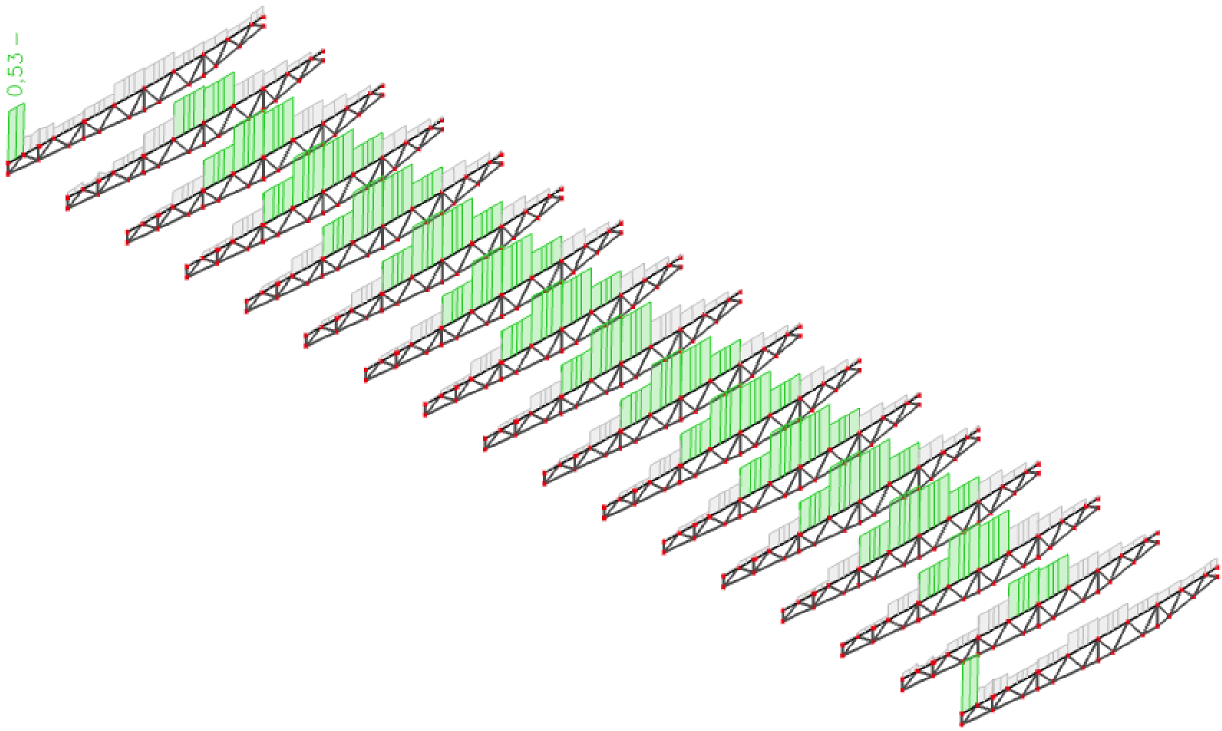
5.11. Dimenzioniranje gornjeg pojasa rešetke pozicije R3

Name	R3-GP
Type	SHS400/400/10.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	1,5500e-02	
A y, z [m^2]	7,7454e-03	7,7454e-03
I y, z [m^4]	3,9130e-04	3,9130e-04
I w [m^6], t [m^4]	8,5333e-06	6,0090e-04
W_{el} y, z [m^3]	1,9560e-03	1,9560e-03
W_{pl} y, z [m^3]	2,2600e-03	2,2600e-03
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	200	200
α [deg]	0,00	
A L, D [m^2/m]	1,5700e+00	3,0769e+00
M_{ply} +, - [Nm]	8,02e+05	8,02e+05
M_{plz} +, - [Nm]	8,02e+05	8,02e+05

Tablica 5.10. *Karakteristike poprečnog presjeka gornjeg pojasa rešetke pozicije R3*



Slika 5.14. *Prikaz iskoristivosti gornjeg pojasa rešetke pozicije R3*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R3-GP - SHS400/400/10.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp834	2,031 / 18,276 m	SHS400/400/10.0	S 355	GSN	0,53 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmax

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 2,031 m

Internal forces	Calculated	Unit
N_{Ed}	-707,54	kN
$V_{y,Ed}$	-22,37	kN
$V_{z,Ed}$	-109,58	kN
T_{Ed}	-0,85	kNm
$M_{y,Ed}$	4,51	kNm
$M_{z,Ed}$	-47,99	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	370	10	6,611e+04	2,073e+04	0,31		1,00	37,00	22,78	27,66	40,58	3
3	I	370	10	1,962e+04	2,389e+04	0,82		1,00	37,00	22,78	27,66	32,96	4
5	I	370	10	2,523e+04	7,061e+04	0,36		1,00	37,00	22,78	27,66	39,79	3
7	I	370	10	7,172e+04	6,746e+04	0,94		1,00	37,00	22,78	27,66	31,57	4

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Effective section N-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	370	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	335	168	168
3	I	370	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	335	168	168
5	I	370	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	335	168	168
7	I	370	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	335	168	168

Effective section My+
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	370	-3,390e+05	-3,390e+05							
3	I	370	3,372e+05	-3,212e+05	-0,95	22,68	0,34	1,00	189	76	114
5	I	370	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	335	168	168
7	I	370	3,372e+05	-3,212e+05	-0,95	22,68	0,34	1,00	189	76	114

Effective section Mz-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	370	3,372e+05	-3,212e+05	-0,95	22,68	0,34	1,00	189	76	114
3	I	370	-3,390e+05	-3,390e+05							
5	I	370	3,372e+05	-3,212e+05	-0,95	22,68	0,34	1,00	189	76	114
7	I	370	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	335	168	168

Effective properties						
Effective area	A_{eff}	1,4098e-02	m²			
Effective second moment of area	$I_{eff,y}$	3,7770e-04	m⁴	$I_{eff,z}$	3,7770e-04	m⁴
Effective section modulus	$W_{eff,y}$	1,8470e-03	m³	$W_{eff,z}$	1,8470e-03	m³
Shift of the centroid	$e_{N,y}$	0	mm	$e_{N,z}$	0	mm

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A_{eff}	1,4098e-02	m²
$N_{c,Rd}$	5004,83	kN
Unity check	0,14	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,y,min}$	1,8470e-03	m³
$M_{c,y,Rd}$	655,70	kNm
Unity check	0,01	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,z,min}$	1,8470e-03	m³
$M_{c,z,Rd}$	655,70	kNm
Unity check	0,07	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	7,7500e-03	m²
$V_{pl,y,Rd}$	1588,43	kN
Unity check	0,01	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	7,7500e-03	m²
$V_{pl,z,Rd}$	1588,43	kN
Unity check	0,07	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,3	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.3 and formula (6.43)

Effective properties		
A_{eff}	1,4098e-02	m²
$e_{N,y}$	0	mm
$e_{N,z}$	0	mm
$W_{eff,y}$	1,8470e-03	m³
$W_{eff,z}$	1,8470e-03	m³

Normal stresses		
$\sigma_{N,Ed}$	50,2	MPa
$\sigma_{My,Ed}$	2,4	MPa
$\sigma_{Mz,Ed}$	26,0	MPa
$\sigma_{tot,Ed}$	78,6	MPa
Unity check	0,22	-

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 0,000 m

Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	370	10	-5,950e+04	-6,193e+04								
3	I	370	10	-5,654e+04	1,453e+05	-0,39		0,72	37,00	34,64	41,33	59,69	2
5	I	370	10	1,508e+05	1,532e+05	0,98		1,00	37,00	22,78	27,66	31,09	4
7	I	370	10	1,479e+05	-5,398e+04	-0,37		0,73	37,00	33,84	40,43	58,74	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	2,031	2,031	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	2,031	2,031	m
Critical Euler load N_{cr}	196685,99	196685,99	kN
Slenderness λ	12,78	12,78	
Relative slenderness λ_{rel}	0,16	0,16	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	

Note: The slenderness or compression force is such that Flexural Buckling effects may be ignored according to EN 1993-1-1 article 6.3.1.2(4).

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section effective area A_{eff}	1,4098e-02	m²
Effective section modulus $W_{eff,y}$	1,8470e-03	m³
Effective section modulus $W_{eff,z}$	1,8470e-03	m³
Design compression force N_{Ed}	707,54	kN
Design bending moment (maximum) $M_{y,Ed}$	213,42	kNm
Design bending moment (maximum) $M_{z,Ed}$	-47,99	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance N_{Rk}	5004,83	kN
Characteristic moment resistance $M_{y,Rk}$	655,70	kNm
Characteristic moment resistance $M_{z,Rk}$	655,70	kNm
Reduction factor χ_y	1,00	
Reduction factor χ_z	1,00	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,00	
Interaction factor k_{yz}	0,80	
Interaction factor k_{zy}	1,00	
Interaction factor k_{zz}	0,80	

Maximum moment $M_{y,Ed}$ is derived from beam pp834 position 0,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp834 position 2,031 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	196685,99	kN
Critical Euler load $N_{cr,z}$	196685,99	kN
Elastic critical load $N_{cr,T}$	1046210,19	kN
Effective section modulus $W_{eff,y}$	1,8470e-03	m³
Second moment of area I_y	3,9130e-04	m⁴
Second moment of area I_z	3,9130e-04	m⁴
Torsional constant I_t	6,0090e-04	m⁴
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	213,42	kNm
Maximum relative deflection δ_z	-0,7	mm
Equivalent moment factor $C_{my,0}$	1,00	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	0,05	
Equivalent moment factor $C_{mz,0}$	0,80	
Factor μ_y	1,00	
Factor μ_z	1,00	

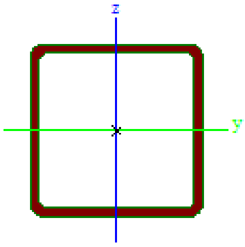
Interaction method 1 parameters		
Factor ε_y	2,30	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	101929,58	kNm
Relative slenderness $\lambda_{rel,0}$	0,08	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,26	
Equivalent moment factor C_{my}	1,00	
Equivalent moment factor C_{mz}	0,80	
Equivalent moment factor C_{mLT}	1,00	

Unity check (6.61) = 0,14 + 0,33 + 0,06 = 0,53 -
Unity check (6.62) = 0,14 + 0,33 + 0,06 = 0,53 -

The member satisfies the stability check.

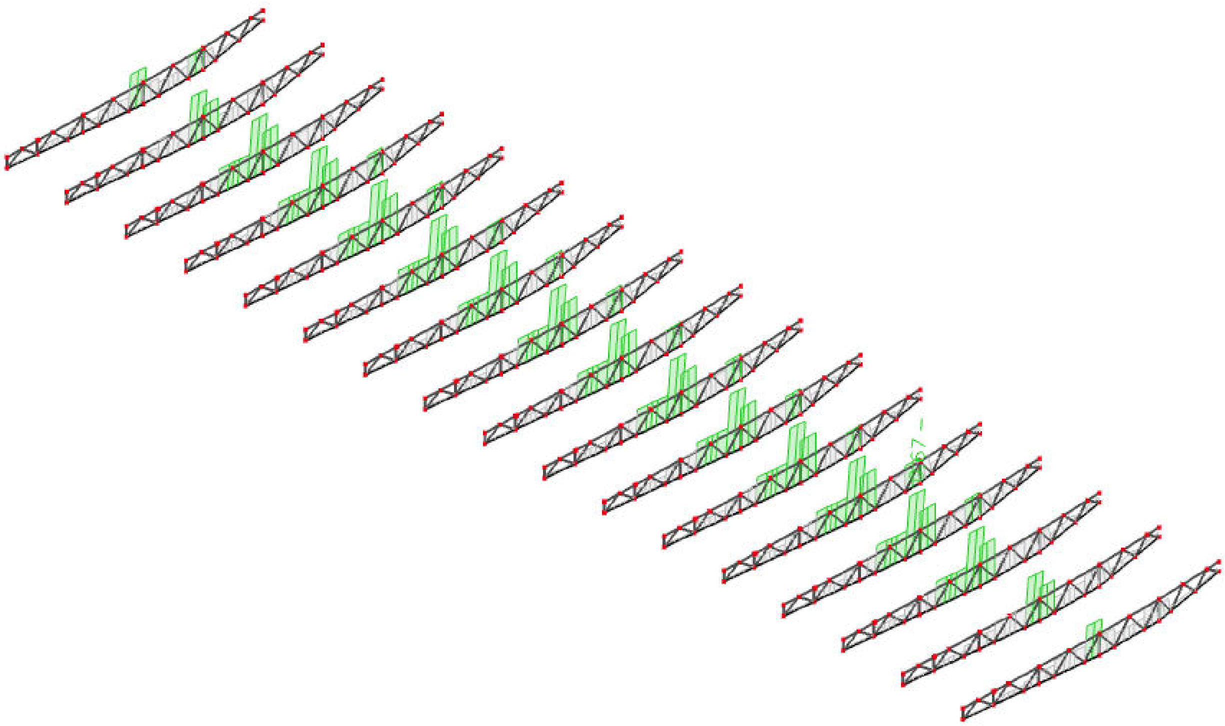
5.12. Dimenzioniranje donjeg pojasa rešetke pozicije R3

Name	R3-DP
Type	SHS400/400/20.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	3,0000e-02	
A y, z [m^2]	1,4981e-02	1,4981e-02
I y, z [m^4]	7,1540e-04	7,1540e-04
I w [m^6], t [m^4]	1,7067e-05	1,1250e-03
W_{el} y, z [m^3]	3,5770e-03	3,5770e-03
W_{pl} y, z [m^3]	4,2470e-03	4,2470e-03
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	200	200
α [deg]	0,00	
A L, D [m^2/m]	1,5500e+00	2,9538e+00
M_{ply} +, - [Nm]	1,51e+06	1,51e+06
M_{plz} +, - [Nm]	1,51e+06	1,51e+06

Tablica 5.11. *Karakteristike poprečnog presjeka donjeg pojasa rešetke pozicije R3*



Slika 5.15. *Prikaz iskoristivosti donjeg pojasa rešetke pozicije R3*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R3-DP - SHS400/400/20.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp1609	18,349 / 18,349 m	SHS400/400/20.0	S 355	GSN	0,67 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 18,349 m

Internal forces	Calculated	Unit
N_{Ed}	-2981,75	kN
$V_{y,Ed}$	-5,54	kN
$V_{z,Ed}$	-393,33	kN
T_{Ed}	-5,30	kNm
$M_{y,Ed}$	-765,57	kNm
$M_{z,Ed}$	-27,65	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	340	20	3,094e+05	2,963e+05	0,96		1,00	17,00	22,78	27,66	31,38	1
3	I	340	20	2,741e+05	-8,981e+04	-0,33		0,75	17,00	32,62	39,04	57,33	1
5	I	340	20	-1,104e+05	-9,729e+04								
7	I	340	20	-7,511e+04	2,888e+05	-0,26		0,79	17,00	30,47	36,57	54,94	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	3,0000e-02	m²
$N_{c,Rd}$	10650,00	kN
Unity check	0,28	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	4,2470e-03	m³
$M_{pl,y,Rd}$	1507,68	kNm
Unity check	0,51	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	4,2470e-03	m³
$M_{pl,z,Rd}$	1507,68	kNm
Unity check	0,02	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,5000e-02	m²
$V_{pl,y,Rd}$	3074,39	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,5000e-02	m^2
$V_{pl,z,Rd}$	3074,39	kN
Unity check	0,13	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,9	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	1415,96	kNm
α	1,82	
$M_{N,z,Rd}$	1415,96	kNm
β	1,82	

Unity check (6.41) = 0,33 + 0,00 = 0,33 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 18,349 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	340	20	3,094e+05	2,963e+05	0,96		1,00	17,00	22,78	27,66	31,38	1
3	I	340	20	2,741e+05	-8,981e+04	-0,33		0,75	17,00	32,62	39,04	57,33	1
5	I	340	20	-1,104e+05	-9,729e+04								
7	I	340	20	-7,511e+04	2,888e+05	-0,26		0,79	17,00	30,47	36,57	54,94	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	2,039	8,155	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	2,039	8,155	m
Critical Euler load N_{cr}	356723,68	22295,23	kN
Slenderness λ	13,20	52,81	
Relative slenderness λ_{rel}	0,17	0,69	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	1,00	0,85	
Buckling resistance $N_{b,Rd}$	10650,00	9072,28	kN

Flexural Buckling verification		
Cross-section area A	3,0000e-02	m^2
Buckling resistance $N_{b,Rd}$	9072,28	kN
Unity check	0,33	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	3,0000e-02	m^2
Plastic section modulus $W_{pl,y}$	4,2470e-03	m^3
Plastic section modulus $W_{pl,z}$	4,2470e-03	m^3
Design compression force N_{Ed}	2981,75	kN
Design bending moment (maximum) $M_{y,Ed}$	-765,57	kNm
Design bending moment (maximum) $M_{z,Ed}$	-27,65	kNm
Characteristic compression resistance N_{Rk}	10650,00	kN
Characteristic moment resistance $M_{y,Rk}$	1507,68	kNm
Characteristic moment resistance $M_{z,Rk}$	1507,68	kNm
Reduction factor χ_y	1,00	
Reduction factor χ_z	0,85	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,75	
Interaction factor k_{yz}	0,64	
Interaction factor k_{zy}	0,46	
Interaction factor k_{zz}	0,99	

Maximum moment $M_{y,Ed}$ is derived from beam pp1609 position 18,349 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp1609 position 18,349 m.

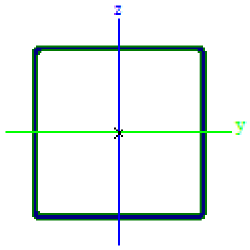
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	356723,68	kN
Critical Euler load $N_{cr,z}$	22295,23	kN
Elastic critical load $N_{cr,T}$	1916353,00	kN
Plastic section modulus $W_{pl,y}$	4,2470e-03	m^3
Elastic section modulus $W_{el,y}$	3,5770e-03	m^3
Plastic section modulus $W_{pl,z}$	4,2470e-03	m^3
Elastic section modulus $W_{el,z}$	3,5770e-03	m^3
Second moment of area I_y	7,1540e-04	m^4
Second moment of area I_z	7,1540e-04	m^4
Torsional constant I_t	1,1250e-03	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	-0,04	
Equivalent moment factor $C_{my,0}$	0,78	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	-27,65	kNm
Maximum relative deflection δ_y	0,4	mm
Equivalent moment factor $C_{mz,0}$	0,91	
Factor μ_y	1,00	
Factor μ_z	0,98	
Factor ε_y	2,15	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	45141,14	kNm
Relative slenderness $\lambda_{rel,0}$	0,18	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,36	
Equivalent moment factor C_{my}	0,78	
Equivalent moment factor C_{mz}	0,91	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,19	
Factor w_z	1,19	
Factor n_{pl}	0,28	
Maximum relative slenderness $\lambda_{rel,max}$	0,69	
Factor C_{yy}	1,05	
Factor C_{yz}	0,98	
Factor C_{zy}	1,01	
Factor C_{zz}	1,04	

Unity check (6.61) = 0,28 + 0,38 + 0,01 = 0,67 -
Unity check (6.62) = 0,33 + 0,23 + 0,02 = 0,58 -

The member satisfies the stability check.

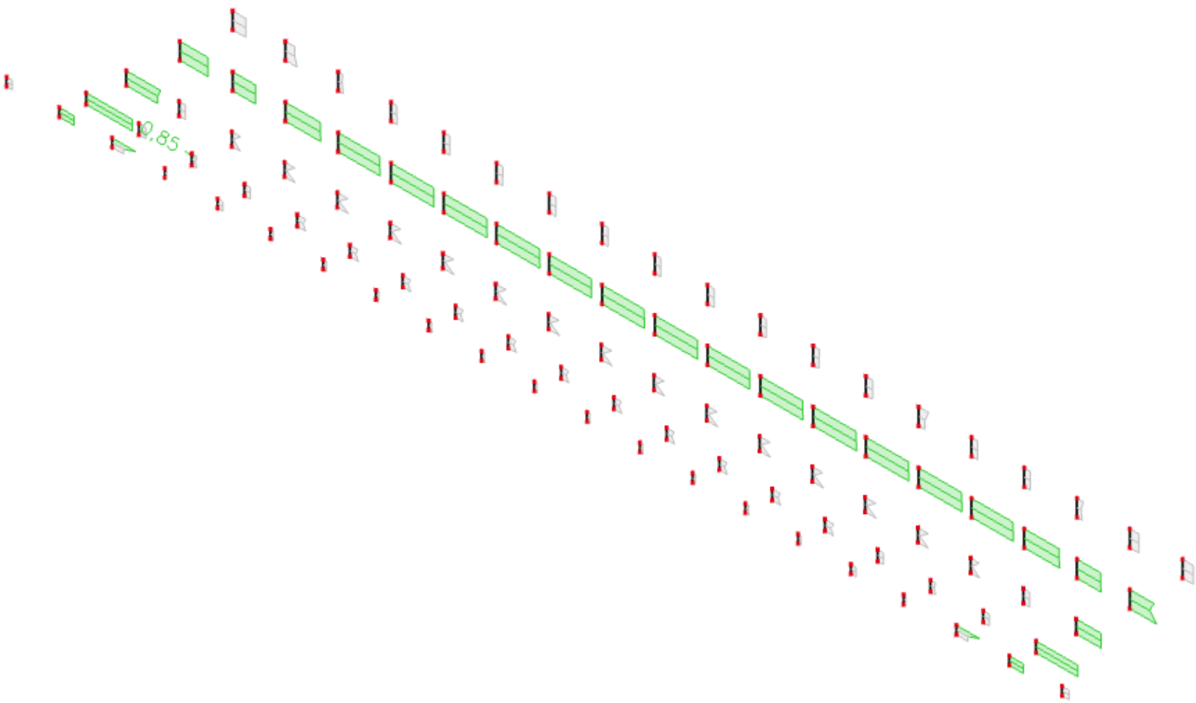
5.13. Dimenzioniranje vertikale rešetke pozicije R3

Name	R3-V
Type	SHS180/180/5.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m²]	3,4700e-03	
A y, z [m²]	1,7363e-03	1,7363e-03
I y, z [m⁴]	1,7650e-05	1,7650e-05
I w [m⁶], t [m⁴]	7,8732e-08	2,7180e-05
W_{el} y, z [m³]	1,9600e-04	1,9600e-04
W_{pl} y, z [m³]	2,2700e-04	2,2700e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	90	90
α [deg]	0,00	
A L, D [m²/m]	7,0700e-01	1,3784e+00
M_{ply} +, - [Nm]	8,07e+04	8,07e+04
M_{plz} +, - [Nm]	8,07e+04	8,07e+04

Tablica 5.12. *Karakteristike poprečnog presjeka vertikale rešetke pozicije R3*



Slika 5.16. *Prikaz iskoristivosti vertikale rešetke pozicije R3*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R3-V - SHS180/180/5.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp9153	1,528 / 1,528 m	SHS180/180/5.0	S 355	GSN	0,85 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmax

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 1,528 m

Internal forces	Calculated	Unit
N_{Ed}	-308,71	kN
$V_{y,Ed}$	32,91	kN
$V_{z,Ed}$	15,11	kN
T_{Ed}	1,24	kNm
$M_{y,Ed}$	14,92	kNm
$M_{z,Ed}$	10,18	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	165	5	-3,263e+04	6,251e+04	-0,52		0,66	33,00	39,22	46,49	65,52	1
3	I	165	5	6,962e+04	2,091e+05	0,33		1,00	33,00	22,78	27,66	40,23	3
5	I	165	5	2,104e+05	1,153e+05	0,55		1,00	33,00	22,78	27,66	36,67	3
7	I	165	5	1,082e+05	-3,129e+04	-0,29		0,78	33,00	31,39	37,63	55,95	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 3

Semi-Comp+ properties		
Material coefficient ε	0,81	
Flange class 2 slenderness limit $\beta_{2,y,f}$	27,66	
Flange class 3 slenderness limit $\beta_{3,y,f}$	30,92	
Web class 2 slenderness limit $\beta_{2,y,w}$	67,53	
Web class 3 slenderness limit $\beta_{3,y,w}$	100,89	
Web class 2 slenderness limit $\beta_{2,z,w}$	27,66	
Web class 3 slenderness limit $\beta_{3,z,w}$	30,92	
Web slenderness ratio c/t_w	33,00	
Flange slenderness ratio c/t_f	33,00	
Reference slenderness ratio $c/t_{ref,y}$	1,00	
Reference slenderness ratio $c/t_{ref,z}$	1,00	
Interpolated section modulus $W_{3,y}$	1,9600e-04	m³
Interpolated section modulus $W_{3,z}$	1,9600e-04	m³

Note: The resistance for this semi-compact section has been calculated according to Semi-Comp+.

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	3,4700e-03	m²
$N_{c,Rd}$	1231,85	kN
Unity check	0,25	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,y}$	1,9600e-04	m³
$M_{3,y,Rd}$	69,58	kNm
Unity check	0,21	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,z}$	1,9600e-04	m^3
$M_{3,z,Rd}$	69,58	kNm
Unity check	0,15	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,7350e-03	m^2
$V_{pl,y,Rd}$	355,60	kN
Unity check	0,09	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,7350e-03	m^2
$V_{pl,z,Rd}$	355,60	kN
Unity check	0,04	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	4,0	MPa
τ_{Rd}	205,0	MPa
Unity check	0,02	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,3,y,Rd}$	52,14	kNm
α	1,79	
$M_{N,3,z,Rd}$	52,14	kNm
β	1,79	

Unity check (6.41) = 0,11 + 0,05 = 0,16 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 0,764 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	165	5	1,420e+05	2,180e+03	0,02		1,00	33,00	22,78	27,66	46,96	3
3	I	165	5	-1,102e+03	3,042e+04	-0,04		0,97	33,00	23,80	28,85	48,28	3
5	I	165	5	3,562e+04	1,754e+05	0,20		1,00	33,00	22,78	27,66	42,74	3
7	I	165	5	1,787e+05	1,472e+05	0,82		1,00	33,00	22,78	27,66	32,93	4

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Effective section N-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	165	3,550e+05	3,550e+05	1,00	4,00	0,71	0,97	160	80	80
3	I	165	3,550e+05	3,550e+05	1,00	4,00	0,71	0,97	160	80	80
5	I	165	3,550e+05	3,550e+05	1,00	4,00	0,71	0,97	160	80	80
7	I	165	3,550e+05	3,550e+05	1,00	4,00	0,71	0,97	160	80	80

Effective section My+
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	165	-3,498e+05	-3,498e+05							
3	I	165	3,349e+05	-3,296e+05	-0,98	23,48	0,29	1,00	83	33	50
5	I	165	3,550e+05	3,550e+05	1,00	4,00	0,71	0,97	160	80	80
7	I	165	3,349e+05	-3,296e+05	-0,98	23,48	0,29	1,00	83	33	50

Effective section Mz+
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	165	3,349e+05	-3,296e+05	-0,98	23,48	0,29	1,00	83	33	50
3	I	165	3,550e+05	3,550e+05	1,00	4,00	0,71	0,97	160	80	80
5	I	165	3,349e+05	-3,296e+05	-0,98	23,48	0,29	1,00	83	33	50
7	I	165	-3,498e+05	-3,498e+05							

Effective properties						
Effective area	A_{eff}	3,3706e-03	m²			
Effective second moment of area	$I_{eff,y}$	1,7455e-05	m⁴	$I_{eff,z}$	1,7455e-05	m⁴
Effective section modulus	$W_{eff,y}$	1,9255e-04	m³	$W_{eff,z}$	1,9255e-04	m³
Shift of the centroid	$e_{N,y}$	0	mm	$e_{N,z}$	0	mm

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	1,528	1,528	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	1,528	1,528	m
Critical Euler load N_{cr}	15672,68	15672,68	kN
Slenderness λ	21,42	21,42	
Relative slenderness λ_{rel}	0,28	0,28	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	

Note: The slenderness or compression force is such that Flexural Buckling effects may be ignored according to EN 1993-1-1 article 6.3.1.2(4).

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section effective area A_{eff}	3,3706e-03	m²
Effective section modulus $W_{eff,y}$	1,9255e-04	m³
Effective section modulus $W_{eff,z}$	1,9255e-04	m³
Design compression force N_{Ed}	308,71	kN
Design bending moment (maximum) $M_{y,Ed}$	14,92	kNm
Design bending moment (maximum) $M_{z,Ed}$	-40,09	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance N_{Rk}	1196,56	kN
Characteristic moment resistance $M_{y,Rk}$	68,36	kNm
Characteristic moment resistance $M_{z,Rk}$	68,36	kNm
Reduction factor χ_y	1,00	
Reduction factor χ_z	1,00	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,68	
Interaction factor k_{yz}	0,75	
Interaction factor k_{zy}	0,68	
Interaction factor k_{zz}	0,75	

Maximum moment $M_{y,Ed}$ is derived from beam pp9153 position 1,528 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp9153 position 0,000 m.

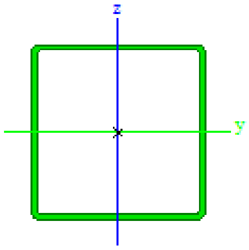
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	15672,68	kN
Critical Euler load $N_{cr,z}$	15672,68	kN
Elastic critical load $N_{cr,T}$	222671,71	kN
Effective section modulus $W_{eff,y}$	1,9255e-04	m^3
Second moment of area I_y	1,7650e-05	m^4
Second moment of area I_z	1,7650e-05	m^4
Torsional constant I_t	2,7180e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	-0,55	
Equivalent moment factor $C_{my,0}$	0,67	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,25	
Equivalent moment factor $C_{mz,0}$	0,73	
Factor μ_y	1,00	
Factor μ_z	1,00	
Factor ε_y	0,85	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	5958,36	kNm
Relative slenderness $\lambda_{rel,0}$	0,11	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,31	
Equivalent moment factor C_{my}	0,67	
Equivalent moment factor C_{mz}	0,73	
Equivalent moment factor C_{mLT}	1,00	

Unity check (6.61) = 0,26 + 0,15 + 0,44 = 0,85 -
Unity check (6.62) = 0,26 + 0,15 + 0,44 = 0,85 -

The member satisfies the stability check.

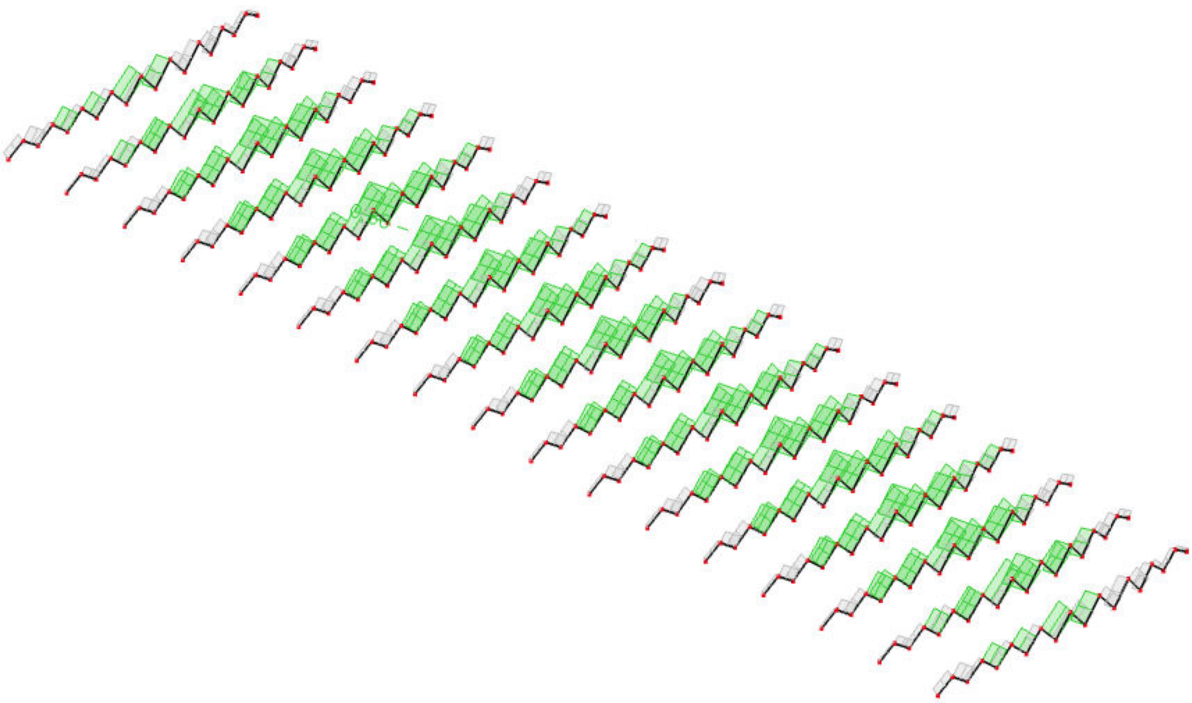
5.14. Dimenzioniranje ispune rešetke pozicije R3

Name	R3-I
Type	SHS200/200/6.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	4,6200e-03	
A y, z [m^2]	2,3083e-03	2,3083e-03
I y, z [m^4]	2,8830e-05	2,8830e-05
I w [m^6], t [m^4]	1,6000e-07	4,4490e-05
W_{el} y, z [m^3]	2,8800e-04	2,8800e-04
W_{pl} y, z [m^3]	3,3500e-04	3,3500e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	100	100
α [deg]	0,00	
A L, D [m^2/m]	7,8500e-01	1,5261e+00
M_{ply} +, - [Nm]	1,19e+05	1,19e+05
M_{plz} +, - [Nm]	1,19e+05	1,19e+05

Tablica 5.13. *Karakteristike poprečnog presjeka ispune rešetke pozicije R3*



Slika 5.17. *Prikaz iskoristivosti ispune rešetke pozicije R3*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R3-I - SHS200/200/6.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp1398	0,000 / 3,202 m	SHS200/200/6.0	S 355	GSN	0,80 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
N_{Ed}	-999,75	kN
$V_{y,Ed}$	-0,24	kN
$V_{z,Ed}$	-8,04	kN
T_{Ed}	0,19	kNm
$M_{y,Ed}$	13,34	kNm
$M_{z,Ed}$	0,56	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	182	6	1,699e+05	1,734e+05	0,98		1,00	30,33	22,78	27,66	31,14	3
3	I	182	6	1,763e+05	2,605e+05	0,68		1,00	30,33	22,78	27,66	34,82	3
5	I	182	6	2,632e+05	2,597e+05	0,99		1,00	30,33	22,78	27,66	31,06	3
7	I	182	6	2,568e+05	1,725e+05	0,67		1,00	30,33	22,78	27,66	34,89	3

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 3

Semi-Comp+ properties		
Material coefficient ε	0,81	
Flange class 2 slenderness limit $\beta_{2,y,f}$	27,66	
Flange class 3 slenderness limit $\beta_{3,y,f}$	30,92	
Web class 2 slenderness limit $\beta_{2,y,w}$	67,53	
Web class 3 slenderness limit $\beta_{3,y,w}$	100,89	
Web class 2 slenderness limit $\beta_{2,z,w}$	27,66	
Web class 3 slenderness limit $\beta_{3,z,w}$	30,92	
Web slenderness ratio c/t_w	30,33	
Flange slenderness ratio c/t_f	30,33	
Reference slenderness ratio $c/t_{ref,y}$	0,82	
Reference slenderness ratio $c/t_{ref,z}$	0,82	
Interpolated section modulus $W_{3,y}$	2,9644e-04	m³
Interpolated section modulus $W_{3,z}$	2,9644e-04	m³

Note: The resistance for this semi-compact section has been calculated according to Semi-Comp+.

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	4,6200e-03	m²
$N_{c,Rd}$	1640,10	kN
Unity check	0,61	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,y}$	2,9644e-04	m³
$M_{3,y,Rd}$	105,23	kNm
Unity check	0,13	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,z}$	2,9644e-04	m^3
$M_{3,z,Rd}$	105,23	kNm
Unity check	0,01	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	2,3100e-03	m^2
$V_{pl,y,Rd}$	473,46	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	2,3100e-03	m^2
$V_{pl,z,Rd}$	473,46	kN
Unity check	0,02	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,4	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,3,y,Rd}$	41,09	kNm
α	2,86	
$M_{N,3,z,Rd}$	41,09	kNm
β	2,86	

Unity check (6.41) = 0,04 + 0,00 = 0,04 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 3,202 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	182	6	2,638e+05	2,626e+05	1,00		1,00	30,33	22,78	27,66	30,97	3
3	I	182	6	2,596e+05	1,716e+05	0,66		1,00	30,33	22,78	27,66	35,04	3
5	I	182	6	1,687e+05	1,700e+05	0,99		1,00	30,33	22,78	27,66	31,00	3
7	I	182	6	1,729e+05	2,610e+05	0,66		1,00	30,33	22,78	27,66	35,02	3

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 3

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	3,202	3,202	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	3,202	3,202	m
Critical Euler load N_{cr}	5829,61	5829,61	kN
Slenderness λ	40,53	40,53	
Relative slenderness λ_{rel}	0,53	0,53	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,91	0,91	
Buckling resistance $N_{b,Rd}$	1499,97	1499,97	kN

Flexural Buckling verification		
Cross-section area A	4,6200e-03	m^2
Buckling resistance $N_{b,Rd}$	1499,97	kN
Unity check	0,67	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	4,6200e-03	m^2
Interpolated section modulus $W_{3,y}$	2,9644e-04	m^3
Interpolated section modulus $W_{3,z}$	2,9644e-04	m^3
Design compression force N_{Ed}	999,75	kN
Design bending moment (maximum) $M_{y,Ed}$	-13,95	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,56	kNm
Characteristic compression resistance N_{Rk}	1640,10	kN
Characteristic moment resistance $M_{y,Rk}$	105,23	kNm
Characteristic moment resistance $M_{z,Rk}$	105,23	kNm
Reduction factor χ_y	0,91	
Reduction factor χ_z	0,91	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,96	
Interaction factor k_{yz}	0,48	
Interaction factor k_{zy}	0,59	
Interaction factor k_{zz}	0,78	

Maximum moment $M_{y,Ed}$ is derived from beam pp1398 position 3,202 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp1398 position 0,000 m.

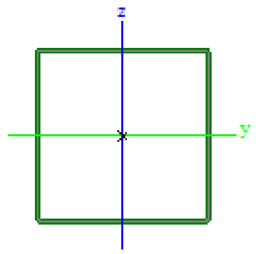
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	5829,61	kN
Critical Euler load $N_{cr,z}$	5829,61	kN
Elastic critical load $N_{cr,T}$	290514,84	kN
Interpolated section modulus $W_{3,y}$	2,9644e-04	m^3
Elastic section modulus $W_{el,y}$	2,8800e-04	m^3
Interpolated section modulus $W_{3,z}$	2,9644e-04	m^3
Elastic section modulus $W_{el,z}$	2,8800e-04	m^3
Second moment of area I_y	2,8830e-05	m^4
Second moment of area I_z	2,8830e-05	m^4
Torsional constant I_t	4,4490e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-13,95	kNm
Maximum relative deflection δ_z	0,0	mm
Equivalent moment factor $C_{my,0}$	0,83	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,36	
Equivalent moment factor $C_{mz,0}$	0,67	
Factor μ_y	0,98	
Factor μ_z	0,98	
Factor ε_y	0,22	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	4597,49	kNm
Relative slenderness $\lambda_{rel,0}$	0,15	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,31	
Equivalent moment factor C_{my}	0,83	
Equivalent moment factor C_{mz}	0,67	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,03	
Factor w_z	1,03	
Factor n_{pl}	0,61	
Maximum relative slenderness $\lambda_{rel,max}$	0,53	
Factor C_{yy}	1,02	
Factor C_{yz}	1,01	
Factor C_{zy}	0,99	
Factor C_{zz}	1,03	

Unity check (6.61) = 0,67 + 0,13 + 0,00 = 0,80 -
Unity check (6.62) = 0,67 + 0,08 + 0,00 = 0,75 -

The member satisfies the stability check.

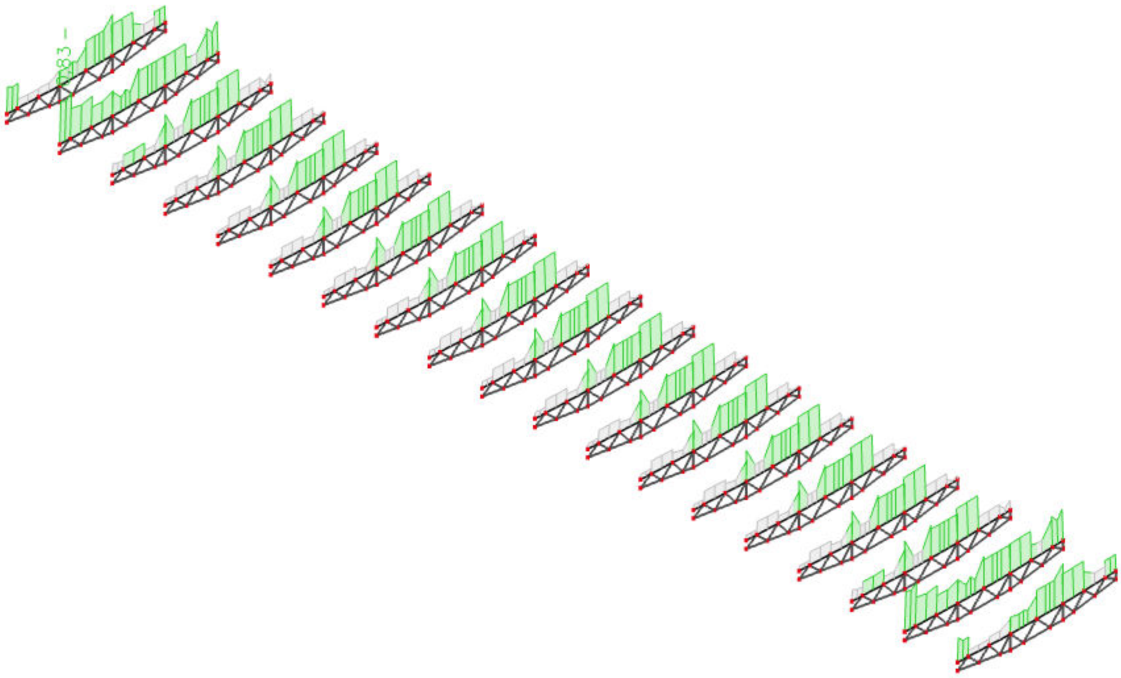
5.15. Dimenzioniranje gornjeg pojasa rešetke pozicije R4

Name	R4-GP
Type	SHS200/200/4.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	3,1300e-03	
A y, z [m^2]	1,5593e-03	1,5593e-03
I y, z [m^4]	2,0000e-05	2,0000e-05
I w [m^6], t [m^4]	1,0667e-07	3,0410e-05
W_{el} y, z [m^3]	2,0000e-04	2,0000e-04
W_{pl} y, z [m^3]	2,2875e-04	2,2875e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	100	100
α [deg]	0,00	
A L, D [m^2/m]	7,8965e-01	1,5508e+00
M_{ply} +, - [Nm]	8,12e+04	8,12e+04
M_{plz} +, - [Nm]	8,12e+04	8,12e+04

Tablica 5.14. *Karakteristike poprečnog presjeka gornjeg pojasa rešetke pozicije R4*



Slika 5.18. *Prikaz iskoristivosti gornjeg pojasa rešetke pozicije R4*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R4-GP - SHS200/200/4.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp886	1,601 / 8,006 m	SHS200/200/4.0	S 355	GSN	0,83 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmax

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 1,601 m

Internal forces	Calculated	Unit
N_{Ed}	-410,96	kN
$V_{y,Ed}$	-21,74	kN
$V_{z,Ed}$	1,24	kN
T_{Ed}	-8,44	kNm
$M_{y,Ed}$	4,44	kNm
$M_{z,Ed}$	-17,03	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	188	4	1,904e+05	2,951e+04	0,16		1,00	47,00	22,78	27,66	43,74	4
3	I	188	4	2,698e+04	6,886e+04	0,39		1,00	47,00	22,78	27,66	39,19	4
5	I	188	4	7,318e+04	2,340e+05	0,31		1,00	47,00	22,78	27,66	40,60	4
7	I	188	4	2,366e+05	1,947e+05	0,82		1,00	47,00	22,78	27,66	32,94	4

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Effective section N-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	188	3,550e+05	3,550e+05	1,00	4,00	1,02	0,77	145	72	72
3	I	188	3,550e+05	3,550e+05	1,00	4,00	1,02	0,77	145	72	72
5	I	188	3,550e+05	3,550e+05	1,00	4,00	1,02	0,77	145	72	72
7	I	188	3,550e+05	3,550e+05	1,00	4,00	1,02	0,77	145	72	72

Effective section My+
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	188	-3,157e+05	-3,157e+05							
3	I	188	3,413e+05	-3,020e+05	-0,88	21,03	0,44	1,00	100	40	60
5	I	188	3,550e+05	3,550e+05	1,00	4,00	1,02	0,77	145	72	72
7	I	188	3,413e+05	-3,020e+05	-0,88	21,03	0,44	1,00	100	40	60

Effective section Mz-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m^2]	σ_2 [kN/m^2]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	188	3,413e+05	-3,020e+05	-0,88	21,03	0,44	1,00	100	40	60
3	I	188	-3,157e+05	-3,157e+05							
5	I	188	3,413e+05	-3,020e+05	-0,88	21,03	0,44	1,00	100	40	60
7	I	188	3,550e+05	3,550e+05	1,00	4,00	1,02	0,77	145	72	72

Effective properties						
Effective area	A_{eff}	2,4286e-03	m^2			
Effective second moment of area	$I_{eff,y}$	1,8155e-05	m^4	$I_{eff,z}$	1,8155e-05	m^4
Effective section modulus	$W_{eff,y}$	1,7170e-04	m^3	$W_{eff,z}$	1,7170e-04	m^3
Shift of the centroid	$e_{N,y}$	0	mm	$e_{N,z}$	0	mm

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A_{eff}	2,4286e-03	m^2
$N_{c,Rd}$	862,16	kN
Unity check	0,48	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,y,min}$	1,7170e-04	m^3
$M_{c,y,Rd}$	60,95	kNm
Unity check	0,07	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,z,min}$	1,7170e-04	m^3
$M_{c,z,Rd}$	60,95	kNm
Unity check	0,28	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,5650e-03	m^2
$V_{pl,y,Rd}$	320,76	kN
Unity check	0,07	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,5650e-03	m^2
$V_{pl,z,Rd}$	320,76	kN
Unity check	0,00	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	27,5	MPa
τ_{Rd}	205,0	MPa
Unity check	0,13	-

Combined Shear and Torsion check for V_y and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.28)

$V_{pl,T,y,Rd}$	277,80	kN
Unity check	0,08	-

Combined Shear and Torsion check for V_z and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.28)

$V_{pl,T,z,Rd}$	277,80	kN
Unity check	0,00	-

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.3 and formula (6.43)

Effective properties		
A_{eff}	2,4286e-03	m^2
$e_{N,y}$	0	mm
$e_{N,z}$	0	mm
$W_{eff,y}$	1,7170e-04	m^3
$W_{eff,z}$	1,7170e-04	m^3

Normal stresses		
$\sigma_{N,Ed}$	169,2	MPa
$\sigma_{My,Ed}$	25,8	MPa
$\sigma_{Mz,Ed}$	99,2	MPa
$\sigma_{tot,Ed}$	294,3	MPa
Unity check	0,83	-

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 1,601 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	188	4	1,904e+05	2,951e+04	0,16		1,00	47,00	22,78	27,66	43,74	4
3	I	188	4	2,698e+04	6,886e+04	0,39		1,00	47,00	22,78	27,66	39,19	4
5	I	188	4	7,318e+04	2,340e+05	0,31		1,00	47,00	22,78	27,66	40,60	4
7	I	188	4	2,366e+05	1,947e+05	0,82		1,00	47,00	22,78	27,66	32,94	4

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	1,601	1,601	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	1,601	1,601	m
Critical Euler load N_{cr}	16169,58	16169,58	kN
Slenderness λ	20,03	20,03	
Relative slenderness λ_{rel}	0,23	0,23	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	

Note: The slenderness or compression force is such that Flexural Buckling effects may be ignored according to EN 1993-1-1 article 6.3.1.2(4).

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section effective area A_{eff}	2,4286e-03	m²
Effective section modulus $W_{eff,y}$	1,7170e-04	m³
Effective section modulus $W_{eff,z}$	1,7170e-04	m³
Design compression force N_{Ed}	410,96	kN
Design bending moment (maximum) $M_{y,Ed}$	4,44	kNm
Design bending moment (maximum) $M_{z,Ed}$	17,77	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance N_{Rk}	862,16	kN
Characteristic moment resistance $M_{y,Rk}$	60,95	kNm
Characteristic moment resistance $M_{z,Rk}$	60,95	kNm
Reduction factor χ_y	1,00	
Reduction factor χ_z	1,00	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,02	
Interaction factor k_{yz}	0,59	
Interaction factor k_{zy}	1,02	
Interaction factor k_{zz}	0,59	

Maximum moment $M_{y,Ed}$ is derived from beam pp886 position 1,601 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp886 position 0,000 m.

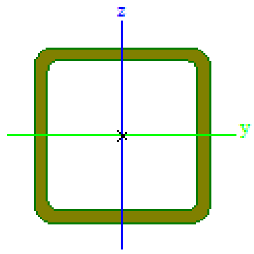
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	16169,58	kN
Critical Euler load $N_{cr,z}$	16169,58	kN
Elastic critical load $N_{cr,T}$	198945,15	kN
Effective section modulus $W_{eff,y}$	1,7170e-04	m^3
Second moment of area I_y	2,0000e-05	m^4
Second moment of area I_z	2,0000e-05	m^4
Torsional constant I_t	3,0410e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	4,44	kNm
Maximum relative deflection δ_z	-0,2	mm
Equivalent moment factor $C_{my,0}$	0,99	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,96	
Equivalent moment factor $C_{mz,0}$	0,58	
Factor μ_y	1,00	
Factor μ_z	1,00	
Factor ε_y	0,15	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	6411,71	kNm
Relative slenderness $\lambda_{rel,0}$	0,10	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,24	
Equivalent moment factor C_{my}	0,99	
Equivalent moment factor C_{mz}	0,58	
Equivalent moment factor C_{mLT}	1,00	

Unity check (6.61) = 0,48 + 0,07 + 0,17 = 0,72 -
Unity check (6.62) = 0,48 + 0,07 + 0,17 = 0,72 -

The member satisfies the stability check.

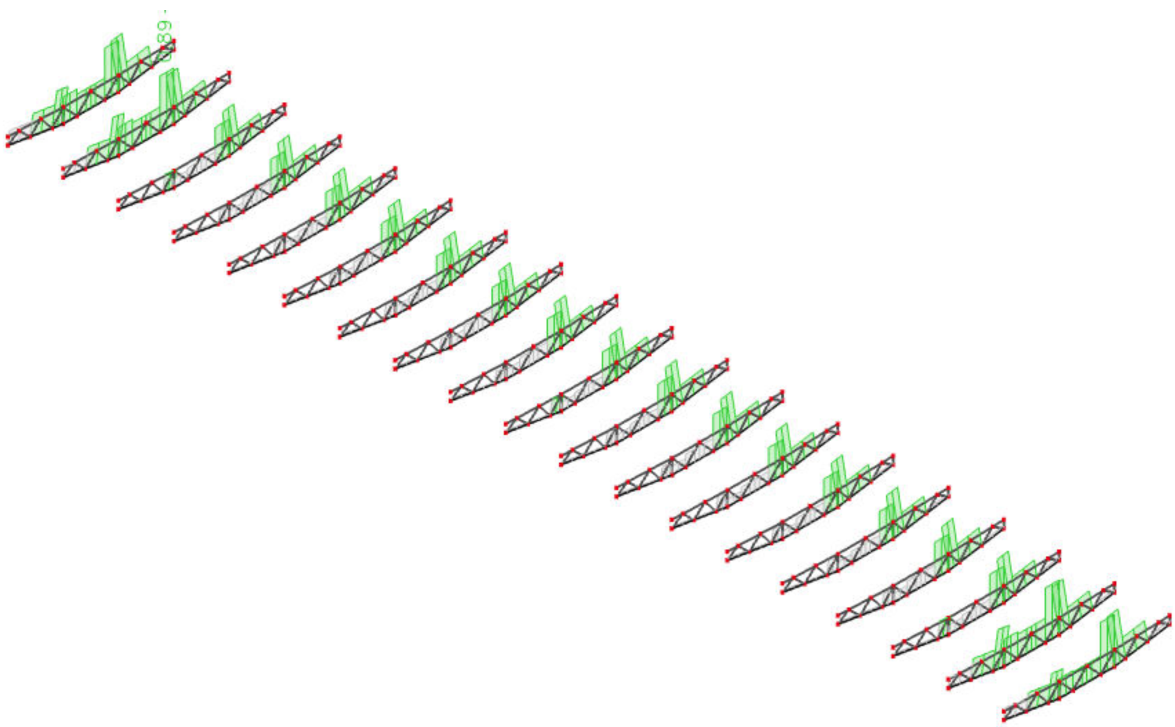
5.16. Dimenzioniranje donjeg pojasa rešetke pozicije R4

Name	R4-DP
Type	SHS200/200/14.2
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m²]	1,0300e-02	
A y, z [m²]	5,1665e-03	5,1665e-03
I y, z [m⁴]	5,8720e-05	5,8720e-05
I w [m⁶], t [m⁴]	3,7867e-07	9,4170e-05
W_{el} y, z [m³]	5,8700e-04	5,8700e-04
W_{pl} y, z [m³]	7,1400e-04	7,1400e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	100	100
α [deg]	0,00	
A L, D [m²/m]	7,6300e-01	1,4252e+00
M_{ply} +, - [Nm]	2,53e+05	2,53e+05
M_{plz} +, - [Nm]	2,53e+05	2,53e+05

Tablica 5.15. *Karakteristike poprečnog presjeka donjeg pojasa rešetke pozicije R4*



Slika 5.19. *Prikaz iskoristivosti donjeg pojasa rešetke pozicije R4*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R4-DP - SHS200/200/14.2

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp899	8,000 / 8,000 m	SHS200/200/14.2	S 355	GSN	0,89 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmax

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 8,000 m

Internal forces	Calculated	Unit
N_{Ed}	-1139,19	kN
$V_{y,Ed}$	1,18	kN
$V_{z,Ed}$	-66,34	kN
T_{Ed}	0,23	kNm
$M_{y,Ed}$	-107,75	kNm
$M_{z,Ed}$	4,96	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	157	14	2,741e+05	2,874e+05	0,95		1,00	11,08	22,78	27,66	31,42	1
3	I	157	14	2,625e+05	-2,638e+04	-0,10		0,91	11,08	25,64	31,00	50,02	1
5	I	157	14	-5,364e+04	-6,693e+04								
7	I	157	14	-4,207e+04	2,468e+05	-0,17		0,85	11,08	27,71	33,40	52,06	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	1,0300e-02	m²
$N_{c,Rd}$	3656,50	kN
Unity check	0,31	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	7,1400e-04	m³
$M_{pl,y,Rd}$	253,47	kNm
Unity check	0,43	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	7,1400e-04	m³
$M_{pl,z,Rd}$	253,47	kNm
Unity check	0,02	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	5,1500e-03	m²
$V_{pl,y,Rd}$	1055,54	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	5,1500e-03	m^2
$V_{pl,z,Rd}$	1055,54	kN
Unity check	0,06	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,2	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	224,95	kNm
α	1,86	
$M_{N,z,Rd}$	224,95	kNm
β	1,86	

Unity check (6.41) = 0,25 + 0,00 = 0,25 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 8,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	157	14	2,741e+05	2,874e+05	0,95		1,00	11,08	22,78	27,66	31,42	1
3	I	157	14	2,625e+05	-2,638e+04	-0,10		0,91	11,08	25,64	31,00	50,02	1
5	I	157	14	-5,364e+04	-6,693e+04								
7	I	157	14	-4,207e+04	2,468e+05	-0,17		0,85	11,08	27,71	33,40	52,06	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	2,000	8,000	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	2,000	8,000	m
Critical Euler load N_{cr}	30426,02	1901,63	kN
Slenderness λ	26,49	105,95	
Relative slenderness λ_{rel}	0,35	1,39	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,97	0,42	
Buckling resistance $N_{b,Rd}$	3533,37	1552,11	kN

Flexural Buckling verification		
Cross-section area A	1,0300e-02	m^2
Buckling resistance $N_{b,Rd}$	1552,11	kN
Unity check	0,73	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	1,0300e-02	m^2
Plastic section modulus $W_{pl,y}$	7,1400e-04	m^3
Plastic section modulus $W_{pl,z}$	7,1400e-04	m^3
Design compression force N_{Ed}	1139,19	kN
Design bending moment (maximum) $M_{y,Ed}$	-107,75	kNm
Design bending moment (maximum) $M_{z,Ed}$	-5,26	kNm
Characteristic compression resistance N_{Rk}	3656,50	kN
Characteristic moment resistance $M_{y,Rk}$	253,47	kNm
Characteristic moment resistance $M_{z,Rk}$	253,47	kNm
Reduction factor χ_y	0,97	
Reduction factor χ_z	0,42	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,79	
Interaction factor k_{yz}	0,82	
Interaction factor k_{zy}	0,32	
Interaction factor k_{zz}	0,66	

Maximum moment $M_{y,Ed}$ is derived from beam pp899 position 8,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp899 position 0,000 m.

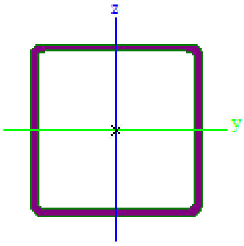
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	30426,02	kN
Critical Euler load $N_{cr,z}$	1901,63	kN
Elastic critical load $N_{cr,T}$	668158,25	kN
Plastic section modulus $W_{pl,y}$	7,1400e-04	m^3
Elastic section modulus $W_{el,y}$	5,8700e-04	m^3
Plastic section modulus $W_{pl,z}$	7,1400e-04	m^3
Elastic section modulus $W_{el,z}$	5,8700e-04	m^3
Second moment of area I_y	5,8720e-05	m^4
Second moment of area I_z	5,8720e-05	m^4
Torsional constant I_t	9,4170e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	-0,21	
Equivalent moment factor $C_{my,0}$	0,74	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	-5,26	kNm
Maximum relative deflection δ_y	-0,6	mm
Equivalent moment factor $C_{mz,0}$	0,52	
Factor μ_y	1,00	
Factor μ_z	0,54	
Factor ε_y	1,66	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	3806,20	kNm
Relative slenderness $\lambda_{rel,0}$	0,26	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,21	
Equivalent moment factor C_{my}	0,74	
Equivalent moment factor C_{mz}	0,52	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,22	
Factor w_z	1,22	
Factor n_{pl}	0,31	
Maximum relative slenderness $\lambda_{rel,max}$	1,39	
Factor C_{yy}	0,97	
Factor C_{yz}	0,95	
Factor C_{zy}	0,76	
Factor C_{zz}	1,05	

Unity check (6.61) = 0,32 + 0,33 + 0,02 = 0,67 -
Unity check (6.62) = 0,73 + 0,14 + 0,01 = 0,89 -

The member satisfies the stability check.

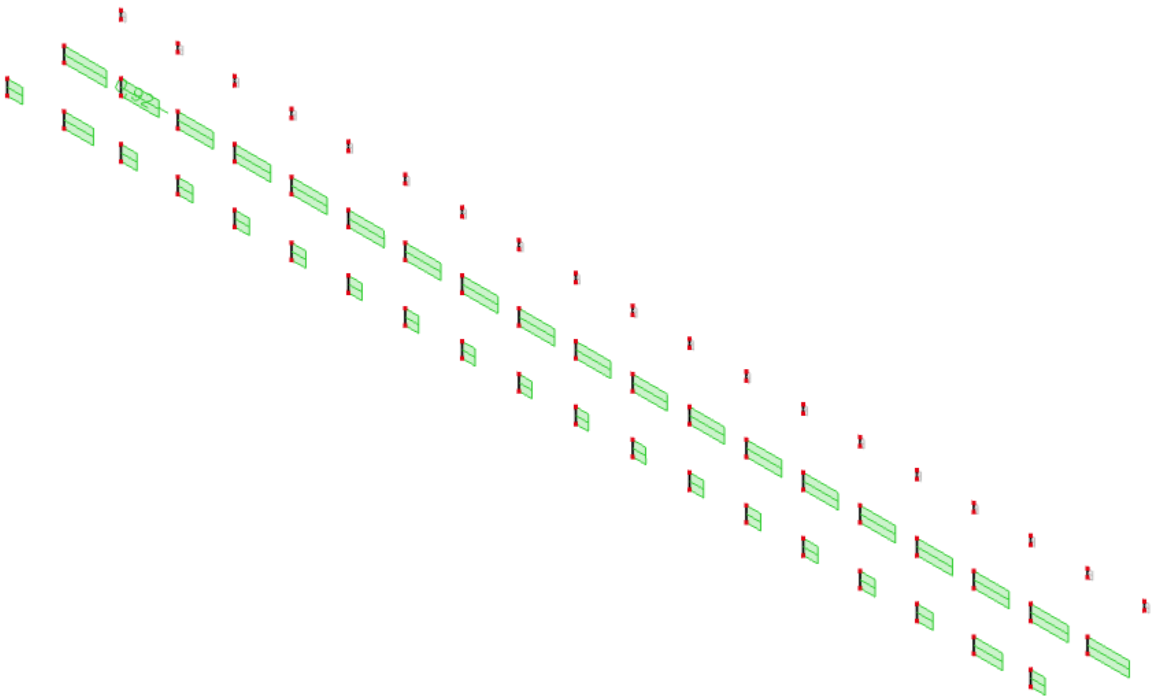
5.17. Dimenzioniranje vertikale rešetke pozicije R4

Name	R4-V
Type	SHS140/140/6.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m^2]	3,1800e-03	
A y, z [m^2]	1,5883e-03	1,5883e-03
I y, z [m^4]	9,4400e-06	9,4400e-06
I w [m^6], t [m^4]	2,6891e-08	1,4750e-05
W_{el} y, z [m^3]	1,3500e-04	1,3500e-04
W_{pl} y, z [m^3]	1,5900e-04	1,5900e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	70	70
α [deg]	0,00	
A L, D [m^2/m]	5,4500e-01	1,0461e+00
M_{ply} +, - [Nm]	5,64e+04	5,64e+04
M_{plz} +, - [Nm]	5,64e+04	5,64e+04

Tablica 5.16. *Karakteristike poprečnog presjeka vertikale rešetke pozicije R4*



Slika 5.20. *Prikaz iskoristivosti vertikale rešetke pozicije R4*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R4-V - SHS140/140/6.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp847	2,100 / 2,100 m	SHS140/140/6.0	S 355	GSN	0,92 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 2,100 m

Internal forces	Calculated	Unit
N_{Ed}	-601,34	kN
$V_{y,Ed}$	14,85	kN
$V_{z,Ed}$	-6,34	kN
T_{Ed}	-0,07	kNm
$M_{y,Ed}$	-13,17	kNm
$M_{z,Ed}$	20,68	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	122	6	1,491e+05	4,163e+05	0,36		1,00	20,33	22,78	27,66	39,78	1
3	I	122	6	4,211e+05	2,510e+05	0,60		1,00	20,33	22,78	27,66	35,96	1
5	I	122	6	2,295e+05	-3,778e+04	-0,16		0,86	20,33	27,54	33,20	51,89	1
7	I	122	6	-4,256e+04	1,276e+05	-0,33		0,75	20,33	32,81	39,26	57,55	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	3,1800e-03	m²
$N_{c,Rd}$	1128,90	kN
Unity check	0,53	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	1,5900e-04	m³
$M_{pl,y,Rd}$	56,44	kNm
Unity check	0,23	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	1,5900e-04	m³
$M_{pl,z,Rd}$	56,44	kNm
Unity check	0,37	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,5900e-03	m²
$V_{pl,y,Rd}$	325,89	kN
Unity check	0,05	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,5900e-03	m^2
$V_{pl,z,Rd}$	325,89	kN
Unity check	0,02	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,3	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	34,52	kNm
α	2,44	
$M_{N,z,Rd}$	34,52	kNm
β	2,44	

Unity check (6.41) = 0,09 + 0,29 = 0,38 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 2,100 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	122	6	1,491e+05	4,163e+05	0,36		1,00	20,33	22,78	27,66	39,78	1
3	I	122	6	4,211e+05	2,510e+05	0,60		1,00	20,33	22,78	27,66	35,96	1
5	I	122	6	2,295e+05	-3,778e+04	-0,16		0,86	20,33	27,54	33,20	51,89	1
7	I	122	6	-4,256e+04	1,276e+05	-0,33		0,75	20,33	32,81	39,26	57,55	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	2,100	2,100	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	2,100	2,100	m
Critical Euler load N_{cr}	4436,62	4436,62	kN
Slenderness λ	38,54	38,54	
Relative slenderness λ_{rel}	0,50	0,50	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,92	0,92	
Buckling resistance $N_{b,Rd}$	1041,85	1041,85	kN

Flexural Buckling verification		
Cross-section area A	3,1800e-03	m^2
Buckling resistance $N_{b,Rd}$	1041,85	kN
Unity check	0,58	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	3,1800e-03	m^2
Plastic section modulus $W_{pl,y}$	1,5900e-04	m^3
Plastic section modulus $W_{pl,z}$	1,5900e-04	m^3
Design compression force N_{Ed}	601,34	kN
Design bending moment (maximum) $M_{y,Ed}$	-13,17	kNm
Design bending moment (maximum) $M_{z,Ed}$	20,68	kNm
Characteristic compression resistance N_{Rk}	1128,90	kN
Characteristic moment resistance $M_{y,Rk}$	56,44	kNm
Characteristic moment resistance $M_{z,Rk}$	56,44	kNm
Reduction factor χ_y	0,92	
Reduction factor χ_z	0,92	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,78	
Interaction factor k_{yz}	0,39	
Interaction factor k_{zy}	0,48	
Interaction factor k_{zz}	0,64	

Maximum moment $M_{y,Ed}$ is derived from beam pp847 position 2,100 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp847 position 2,100 m.

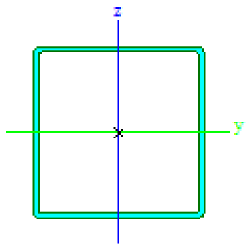
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	4436,62	kN
Critical Euler load $N_{cr,z}$	4436,62	kN
Elastic critical load $N_{cr,T}$	202789,76	kN
Plastic section modulus $W_{pl,y}$	1,5900e-04	m^3
Elastic section modulus $W_{el,y}$	1,3500e-04	m^3
Plastic section modulus $W_{pl,z}$	1,5900e-04	m^3
Elastic section modulus $W_{el,z}$	1,3500e-04	m^3
Second moment of area I_y	9,4400e-06	m^4
Second moment of area I_z	9,4400e-06	m^4
Torsional constant I_t	1,4750e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	-0,01	
Equivalent moment factor $C_{my,0}$	0,77	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,51	
Equivalent moment factor $C_{mz,0}$	0,64	
Factor μ_y	0,99	
Factor μ_z	0,99	
Factor ε_y	0,52	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	2311,20	kNm
Relative slenderness $\lambda_{rel,0}$	0,16	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,26	
Equivalent moment factor C_{my}	0,77	
Equivalent moment factor C_{mz}	0,64	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,18	
Factor w_z	1,18	
Factor n_{pl}	0,53	
Maximum relative slenderness $\lambda_{rel,max}$	0,50	
Factor C_{yy}	1,13	
Factor C_{yz}	1,13	
Factor C_{zy}	1,10	
Factor C_{zz}	1,15	

Unity check (6.61) = 0,58 + 0,18 + 0,14 = 0,90 -
Unity check (6.62) = 0,58 + 0,11 + 0,23 = 0,92 -

The member satisfies the stability check.

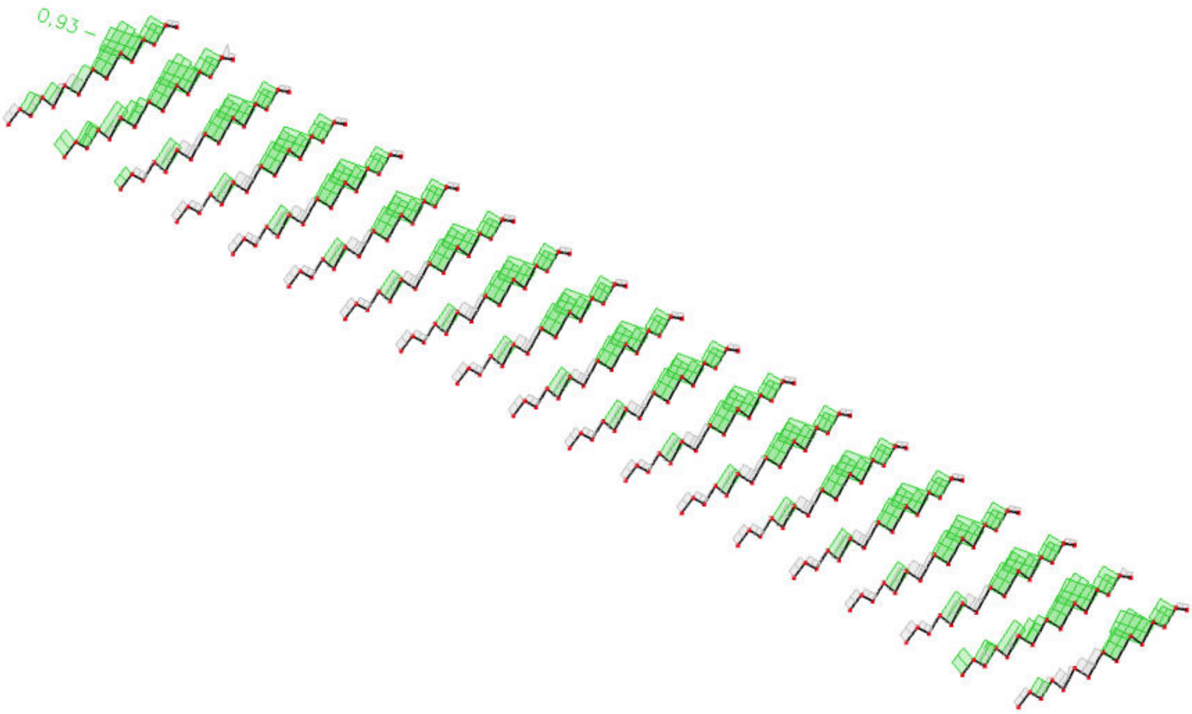
5.18. Dimenzioniranje ispune rešetke pozicije R4

Name	R4-I
Type	SHS140/140/4.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	roled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	2,1760e-03	
A y, z [m^2]	1,0793e-03	1,0793e-03
I y, z [m^4]	6,7060e-06	6,7060e-06
I w [m^6], t [m^4]	1,7927e-08	1,0190e-05
W_{el} y, z [m^3]	9,5800e-05	9,5800e-05
W_{pl} y, z [m^3]	1,0976e-04	1,0976e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	70	70
α [deg]	0,00	
A L, D [m^2/m]	5,4965e-01	1,0708e+00
M_{ply} +, - [Nm]	3,90e+04	3,90e+04
M_{plz} +, - [Nm]	3,90e+04	3,90e+04

Tablica 5.17. *Karakteristike poprečnog presjeka ispune rešetke pozicije R4*



Slika 5.21. *Prikaz iskoristivosti ispune rešetke pozicije R4*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R4-I - SHS140/140/4.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp882	0,000 / 2,530 m	SHS140/140/4.0	S 355	GSN	0,93 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
N_{Ed}	-457,62	kN
$V_{y,Ed}$	-1,49	kN
$V_{z,Ed}$	-3,04	kN
T_{Ed}	0,92	kNm
$M_{y,Ed}$	5,09	kNm
$M_{z,Ed}$	3,41	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	128	4	1,269e+05	1,927e+05	0,66		1,00	32,00	22,78	27,66	35,07	3
3	I	128	4	1,978e+05	2,961e+05	0,67		1,00	32,00	22,78	27,66	34,94	3
5	I	128	4	2,971e+05	2,313e+05	0,78		1,00	32,00	22,78	27,66	33,49	3
7	I	128	4	2,261e+05	1,279e+05	0,57		1,00	32,00	22,78	27,66	36,41	3

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 3

Semi-Comp+ properties		
Material coefficient ε	0,81	
Flange class 2 slenderness limit $\beta_{2,y,f}$	27,66	
Flange class 3 slenderness limit $\beta_{3,y,f}$	30,92	
Web class 2 slenderness limit $\beta_{2,y,w}$	67,53	
Web class 3 slenderness limit $\beta_{3,y,w}$	100,89	
Web class 2 slenderness limit $\beta_{2,z,w}$	27,66	
Web class 3 slenderness limit $\beta_{3,z,w}$	30,92	
Web slenderness ratio c/t_w	32,00	
Flange slenderness ratio c/t_f	32,00	
Reference slenderness ratio $c/t_{ref,y}$	1,00	
Reference slenderness ratio $c/t_{ref,z}$	1,00	
Interpolated section modulus $W_{3,y}$	9,5800e-05	m³
Interpolated section modulus $W_{3,z}$	9,5800e-05	m³

Note: The resistance for this semi-compact section has been calculated according to Semi-Comp+.

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	2,1760e-03	m²
$N_{c,Rd}$	772,48	kN
Unity check	0,59	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,y}$	9,5800e-05	m³
$M_{3,y,Rd}$	34,01	kNm
Unity check	0,15	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,z}$	9,5800e-05	m^3
$M_{3,z,Rd}$	34,01	kNm
Unity check	0,10	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,0880e-03	m^2
$V_{pl,y,Rd}$	223,00	kN
Unity check	0,01	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,0880e-03	m^2
$V_{pl,z,Rd}$	223,00	kN
Unity check	0,01	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	6,2	MPa
τ_{Rd}	205,0	MPa
Unity check	0,03	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,3,y,Rd}$	13,86	kNm
α	2,75	
$M_{N,3,z,Rd}$	13,86	kNm
β	2,75	

Unity check (6.41) = 0,06 + 0,02 = 0,08 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 2,530 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	128	4	2,468e+05	2,396e+05	0,97		1,00	32,00	22,78	27,66	31,23	4
3	I	128	4	2,375e+05	1,783e+05	0,75		1,00	32,00	22,78	27,66	33,84	3
5	I	128	4	1,767e+05	1,839e+05	0,96		1,00	32,00	22,78	27,66	31,34	4
7	I	128	4	1,860e+05	2,452e+05	0,76		1,00	32,00	22,78	27,66	33,74	3

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Effective section N-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	128	3,550e+05	3,550e+05	1,00	4,00	0,69	0,99	126	63	63
3	I	128	3,550e+05	3,550e+05	1,00	4,00	0,69	0,99	126	63	63
5	I	128	3,550e+05	3,550e+05	1,00	4,00	0,69	0,99	126	63	63
7	I	128	3,550e+05	3,550e+05	1,00	4,00	0,69	0,99	126	63	63

Effective section My+
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	128	-3,525e+05	-3,525e+05							
3	I	128	3,342e+05	-3,317e+05	-0,99	23,69	0,28	1,00	64	26	39
5	I	128	3,550e+05	3,550e+05	1,00	4,00	0,69	0,99	126	63	63
7	I	128	3,342e+05	-3,317e+05	-0,99	23,69	0,28	1,00	64	26	39

Effective section Mz+
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	128	3,342e+05	-3,317e+05	-0,99	23,69	0,28	1,00	64	26	39
3	I	128	3,550e+05	3,550e+05	1,00	4,00	0,69	0,99	126	63	63
5	I	128	3,342e+05	-3,317e+05	-0,99	23,69	0,28	1,00	64	26	39
7	I	128	-3,525e+05	-3,525e+05							

Effective properties						
Effective area	A_{eff}	2,1287e-03	m²			
Effective second moment of area	$I_{eff,y}$	6,5909e-06	m⁴	$I_{eff,z}$	6,5909e-06	m⁴
Effective section modulus	$W_{eff,y}$	9,3838e-05	m³	$W_{eff,z}$	9,3838e-05	m³
Shift of the centroid	$e_{N,y}$	0	mm	$e_{N,z}$	0	mm

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	2,530	2,530	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	2,530	2,530	m
Critical Euler load N_{cr}	2171,17	2171,17	kN
Slenderness λ	45,58	45,58	
Relative slenderness λ_{rel}	0,59	0,59	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,89	0,89	
Buckling resistance $N_{b,Rd}$	675,41	675,41	kN

Flexural Buckling verification		
Cross-section effective area A_{eff}	2,1287e-03	m²
Buckling resistance $N_{b,Rd}$	675,41	kN
Unity check	0,68	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section effective area A_{eff}	2,1287e-03	m²
Effective section modulus $W_{eff,y}$	9,3838e-05	m³
Effective section modulus $W_{eff,z}$	9,3838e-05	m³
Design compression force N_{Ed}	457,62	kN
Design bending moment (maximum) $M_{y,Ed}$	5,09	kNm
Design bending moment (maximum) $M_{z,Ed}$	3,41	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance N_{Rk}	755,69	kN
Characteristic moment resistance $M_{y,Rk}$	33,31	kNm
Characteristic moment resistance $M_{z,Rk}$	33,31	kNm
Reduction factor χ_y	0,89	
Reduction factor χ_z	0,89	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,04	
Interaction factor k_{yz}	0,90	
Interaction factor k_{zy}	1,04	
Interaction factor k_{zz}	0,90	

Maximum moment $M_{y,Ed}$ is derived from beam pp882 position 0,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp882 position 0,000 m.

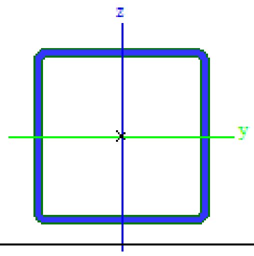
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	2171,17	kN
Critical Euler load $N_{cr,z}$	2171,17	kN
Elastic critical load $N_{cr,T}$	134473,74	kN
Effective section modulus $W_{eff,y}$	9,3838e-05	m^3
Second moment of area I_y	6,7060e-06	m^4
Second moment of area I_z	6,7060e-06	m^4
Torsional constant I_t	1,0190e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	5,09	kNm
Maximum relative deflection δ_z	-0,6	mm
Equivalent moment factor $C_{my,0}$	0,85	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,11	
Equivalent moment factor $C_{mz,0}$	0,73	
Factor μ_y	0,97	
Factor μ_z	0,97	
Factor ε_y	0,25	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	1341,48	kNm
Relative slenderness $\lambda_{rel,0}$	0,16	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,29	
Equivalent moment factor C_{my}	0,85	
Equivalent moment factor C_{mz}	0,73	
Equivalent moment factor C_{mLT}	1,00	

Unity check (6.61) = 0,68 + 0,16 + 0,09 = 0,93 -
Unity check (6.62) = 0,68 + 0,16 + 0,09 = 0,93 -

The member satisfies the stability check.

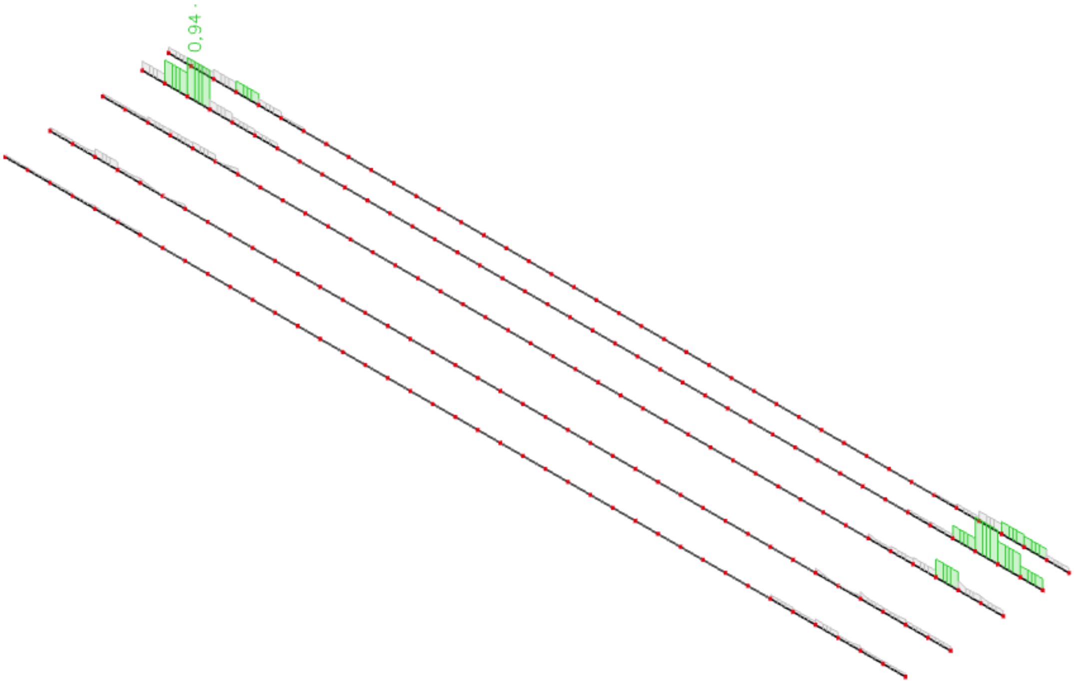
5.19. Dimenzioniranje donjeg pojasa rešetke pozicije R5 (segment 1)

Name	R5-DP1
Type	SHS350/350/16.0
Source description	Corus Advance Sections
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m²]	2,1100e-02	
A y, z [m²]	1,0464e-02	1,0464e-02
I y, z [m⁴]	3,8900e-04	3,8900e-04
I w [m⁶], t [m⁴]	7,0029e-06	6,1000e-04
W_{el} y, z [m³]	2,2300e-03	2,2300e-03
W_{pl} y, z [m³]	2,6028e-03	2,6028e-03
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	175	175
α [deg]	0,00	
A L, D [m²/m]	1,3600e+00	2,6168e+00
M_{ply} +, - [Nm]	9,24e+05	9,24e+05
M_{plz} +, - [Nm]	9,24e+05	9,24e+05

Tablica 5.18. *Karakteristike poprečnog presjeka donjeg pojasa rešetke pozicije R5 (segment 1)*



Slika 5.22. *Prikaz iskoristivosti donjeg pojasa rešetke pozicije R5 (segment 1)*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R5-DP1 - SHS350/350/16.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp9002	8,000 / 8,000 m	SHS350/350/16.0	S 355	GSN	0,94 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 8,000 m

Internal forces	Calculated	Unit
N_{Ed}	-1572,40	kN
$V_{y,Ed}$	9,32	kN
$V_{z,Ed}$	-121,00	kN
T_{Ed}	6,78	kNm
$M_{y,Ed}$	-420,79	kNm
$M_{z,Ed}$	41,65	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	302	16	2,411e+05	2,738e+05	0,88		1,00	18,87	22,78	27,66	32,25	1
3	I	302	16	2,580e+05	-7,171e+04	-0,28		0,78	18,87	31,03	37,22	55,55	1
5	I	302	16	-9,090e+04	-1,235e+05								
7	I	302	16	-1,078e+05	2,219e+05	-0,49		0,67	18,87	37,94	45,05	63,82	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	2,1100e-02	m²
$N_{c,Rd}$	7490,50	kN
Unity check	0,21	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	2,6028e-03	m³
$M_{pl,y,Rd}$	923,99	kNm
Unity check	0,46	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	2,6028e-03	m³
$M_{pl,z,Rd}$	923,99	kNm
Unity check	0,05	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,0550e-02	m²
$V_{pl,y,Rd}$	2162,32	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,0550e-02	m^2
$V_{pl,z,Rd}$	2162,32	kN
Unity check	0,06	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	1,9	MPa
τ_{Rd}	205,0	MPa
Unity check	0,01	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	923,99	kNm
α	1,75	
$M_{N,z,Rd}$	923,99	kNm
β	1,75	

Unity check (6.41) = 0,25 + 0,00 = 0,26 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 8,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	302	16	2,411e+05	2,738e+05	0,88		1,00	18,87	22,78	27,66	32,25	1
3	I	302	16	2,580e+05	-7,171e+04	-0,28		0,78	18,87	31,03	37,22	55,55	1
5	I	302	16	-9,090e+04	-1,235e+05								
7	I	302	16	-1,078e+05	2,219e+05	-0,49		0,67	18,87	37,94	45,05	63,82	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	4,000	16,000	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	4,000	16,000	m
Critical Euler load N_{cr}	50390,50	3149,41	kN
Slenderness λ	29,46	117,84	
Relative slenderness λ_{rel}	0,39	1,54	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,96	0,36	
Buckling resistance $N_{b,Rd}$	7165,03	2660,45	kN

Flexural Buckling verification		
Cross-section area A	2,1100e-02	m^2
Buckling resistance $N_{b,Rd}$	2660,45	kN
Unity check	0,59	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	2,1100e-02	m^2
Plastic section modulus $W_{pl,y}$	2,6028e-03	m^3
Plastic section modulus $W_{pl,z}$	2,6028e-03	m^3
Design compression force N_{Ed}	1572,40	kN
Design bending moment (maximum) $M_{y,Ed}$	-420,79	kNm
Design bending moment (maximum) $M_{z,Ed}$	41,65	kNm
Characteristic compression resistance N_{Rk}	7490,50	kN
Characteristic moment resistance $M_{y,Rk}$	923,99	kNm
Characteristic moment resistance $M_{z,Rk}$	923,99	kNm
Reduction factor χ_y	0,96	
Reduction factor χ_z	0,36	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,15	
Interaction factor k_{yz}	0,95	
Interaction factor k_{zy}	0,68	
Interaction factor k_{zz}	0,81	

Maximum moment $M_{y,Ed}$ is derived from beam pp9002 position 8,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp9002 position 8,000 m.

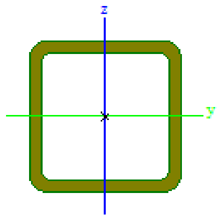
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	50390,50	kN
Critical Euler load $N_{cr,z}$	3149,41	kN
Elastic critical load $N_{cr,T}$	1337759,73	kN
Plastic section modulus $W_{pl,y}$	2,6028e-03	m^3
Elastic section modulus $W_{el,y}$	2,2300e-03	m^3
Plastic section modulus $W_{pl,z}$	2,6028e-03	m^3
Elastic section modulus $W_{el,z}$	2,2300e-03	m^3
Second moment of area I_y	3,8900e-04	m^4
Second moment of area I_z	3,8900e-04	m^4
Torsional constant I_t	6,1000e-04	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-420,79	kNm
Maximum relative deflection δ_z	4,6	mm
Equivalent moment factor $C_{my,0}$	0,99	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	41,65	kNm
Maximum relative deflection δ_y	-4,2	mm
Equivalent moment factor $C_{mz,0}$	0,66	
Factor μ_y	1,00	
Factor μ_z	0,61	
Factor ε_y	2,53	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	12463,84	kNm
Relative slenderness $\lambda_{rel,0}$	0,27	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,20	
Equivalent moment factor C_{my}	0,99	
Equivalent moment factor C_{mz}	0,66	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,17	
Factor w_z	1,17	
Factor n_{pl}	0,21	
Maximum relative slenderness $\lambda_{rel,max}$	1,54	
Factor C_{yy}	0,89	
Factor C_{yz}	0,83	
Factor C_{zy}	0,55	
Factor C_{zz}	0,99	

Unity check (6.61) = 0,22 + 0,52 + 0,04 = 0,78 -
Unity check (6.62) = 0,59 + 0,31 + 0,04 = 0,94 -

The member satisfies the stability check.

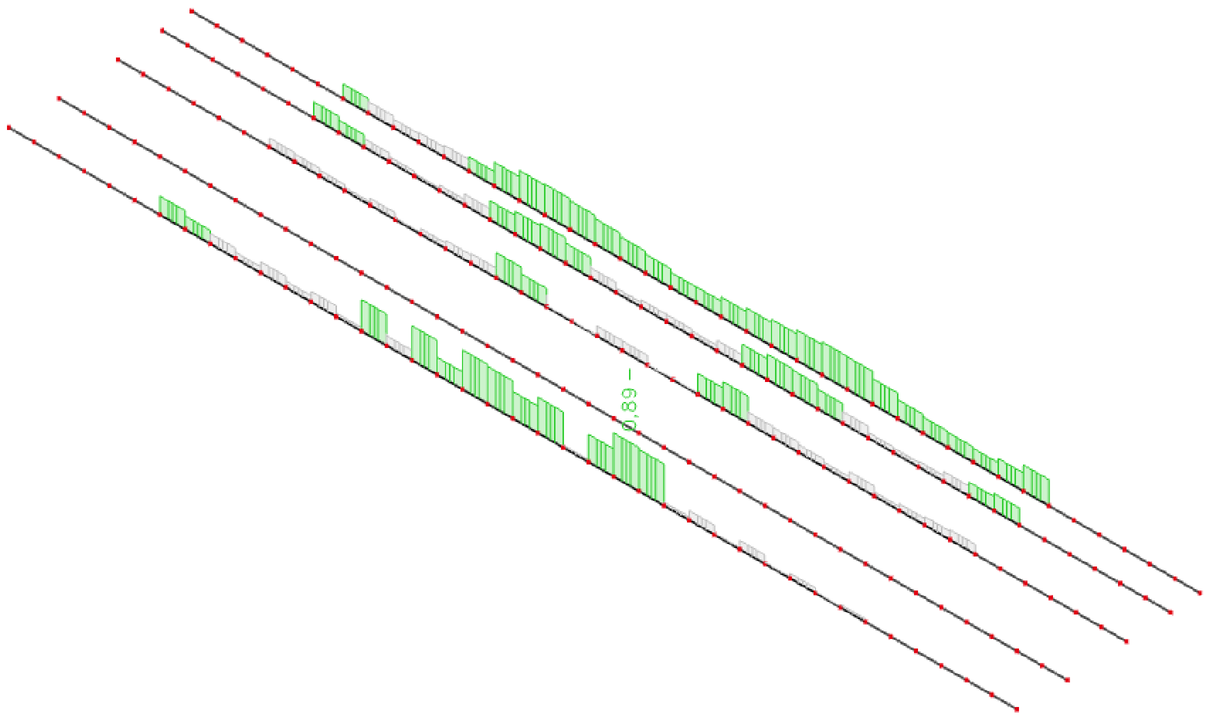
5.20. Dimenzioniranje donjeg pojasa rešetke pozicije R5 (segment 2)

Name	R5-DP2
Type	SHS80/80/6.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	roled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m²]	1,7400e-03	
A y, z [m²]	8,6833e-04	8,6833e-04
I y, z [m⁴]	1,5600e-06	1,5600e-06
I w [m⁶], t [m⁴]	1,6384e-09	2,5200e-06
W_{el} y, z [m³]	3,9100e-05	3,9100e-05
W_{pl} y, z [m³]	4,7800e-05	4,7800e-05
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	40	40
α [deg]	0,00	
A L, D [m²/m]	3,0500e-01	5,6613e-01
M_{ply} +, - [Nm]	1,69e+04	1,69e+04
M_{plz} +, - [Nm]	1,69e+04	1,69e+04

Tablica 5.19. *Karakteristike poprečnog presjeka donjeg pojasa rešetke pozicije R5 (segment 2)*



Slika 5.23. *Prikaz iskoristivosti donjeg pojasa rešetke pozicije R5 (segment 2)*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R5-DP2 - SHS80/80/6.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp7742	4,000 / 8,000 m	SHS80/80/6.0	S 355	GSN	0,89 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmax

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 4,000 m

Internal forces	Calculated	Unit
N_{Ed}	-42,13	kN
$V_{y,Ed}$	-0,02	kN
$V_{z,Ed}$	0,44	kN
T_{Ed}	0,00	kNm
$M_{y,Ed}$	-0,27	kNm
$M_{z,Ed}$	0,07	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	62	6	2,938e+04	3,207e+04	0,92		1,00	10,33	22,78	27,66	31,85	1
3	I	62	6	3,128e+04	2,044e+04	0,65		1,00	10,33	22,78	27,66	35,15	1
5	I	62	6	1,913e+04	1,643e+04	0,86		1,00	10,33	22,78	27,66	32,51	1
7	I	62	6	1,722e+04	2,806e+04	0,61		1,00	10,33	22,78	27,66	35,71	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	1,7400e-03	m²
$N_{c,Rd}$	617,70	kN
Unity check	0,07	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	4,7800e-05	m³
$M_{pl,y,Rd}$	16,97	kNm
Unity check	0,02	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	4,7800e-05	m³
$M_{pl,z,Rd}$	16,97	kNm
Unity check	0,00	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,7000e-04	m²
$V_{pl,y,Rd}$	178,31	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,7000e-04	m²
$V_{pl,z,Rd}$	178,31	kN
Unity check	0,00	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,0	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	16,97	kNm
α	1,67	
$M_{N,z,Rd}$	16,97	kNm
β	1,67	

Unity check (6.41) = 0,00 + 0,00 = 0,00 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 0,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	62	6	3,653e+04	3,337e+04	0,91		1,00	10,33	22,78	27,66	31,87	1
3	I	62	6	3,114e+04	1,124e+04	0,36		1,00	10,33	22,78	27,66	39,72	1
5	I	62	6	9,625e+03	1,279e+04	0,75		1,00	10,33	22,78	27,66	33,82	1
7	I	62	6	1,502e+04	3,491e+04	0,43		1,00	10,33	22,78	27,66	38,54	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	4,000	8,000	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	4,000	8,000	m
Critical Euler load N_{cr}	202,08	50,52	kN
Slenderness λ	133,59	267,18	
Relative slenderness λ_{rel}	1,75	3,50	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,28	0,08	
Buckling resistance $N_{b,Rd}$	175,92	47,60	kN

Flexural Buckling verification		
Cross-section area A	1,7400e-03	m²
Buckling resistance $N_{b,Rd}$	47,60	kN
Unity check	0,89	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	1,7400e-03	m^2
Plastic section modulus $W_{pl,y}$	4,7800e-05	m^3
Plastic section modulus $W_{pl,z}$	4,7800e-05	m^3
Design compression force N_{Ed}	42,13	kN
Design bending moment (maximum) $M_{y,Ed}$	-0,27	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0,08	kNm
Characteristic compression resistance N_{Rk}	617,70	kN
Characteristic moment resistance $M_{y,Rk}$	16,97	kNm
Characteristic moment resistance $M_{z,Rk}$	16,97	kNm
Reduction factor χ_y	0,28	
Reduction factor χ_z	0,08	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,26	
Interaction factor k_{yz}	2,13	
Interaction factor k_{zy}	0,27	
Interaction factor k_{zz}	0,61	

Maximum moment $M_{y,Ed}$ is derived from beam pp7742 position 4,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp7742 position 0,000 m.

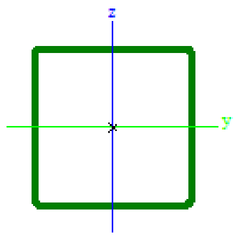
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	202,08	kN
Critical Euler load $N_{cr,z}$	50,52	kN
Elastic critical load $N_{cr,T}$	113541,42	kN
Plastic section modulus $W_{pl,y}$	4,7800e-05	m^3
Elastic section modulus $W_{el,y}$	3,9100e-05	m^3
Plastic section modulus $W_{pl,z}$	4,7800e-05	m^3
Elastic section modulus $W_{el,z}$	3,9100e-05	m^3
Second moment of area I_y	1,5600e-06	m^4
Second moment of area I_z	1,5600e-06	m^4
Torsional constant I_t	2,5200e-06	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-0,27	kNm
Maximum relative deflection δ_z	-1,2	mm
Equivalent moment factor $C_{my,0}$	0,97	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	-0,08	kNm
Maximum relative deflection δ_y	-0,7	mm
Equivalent moment factor $C_{mz,0}$	0,53	
Factor μ_y	0,84	
Factor μ_z	0,18	
Factor ε_y	0,29	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	101,42	kNm
Relative slenderness $\lambda_{rel,0}$	0,41	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,21	
Equivalent moment factor C_{my}	0,97	
Equivalent moment factor C_{mz}	0,53	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,22	
Factor w_z	1,22	
Factor n_{pl}	0,07	
Maximum relative slenderness $\lambda_{rel,max}$	3,50	
Factor C_{yy}	0,82	
Factor C_{yz}	0,76	
Factor C_{zy}	0,49	
Factor C_{zz}	0,94	

Unity check (6.61) = 0,24 + 0,02 + 0,01 = 0,27 -
Unity check (6.62) = 0,89 + 0,00 + 0,00 = 0,89 -

The member satisfies the stability check.

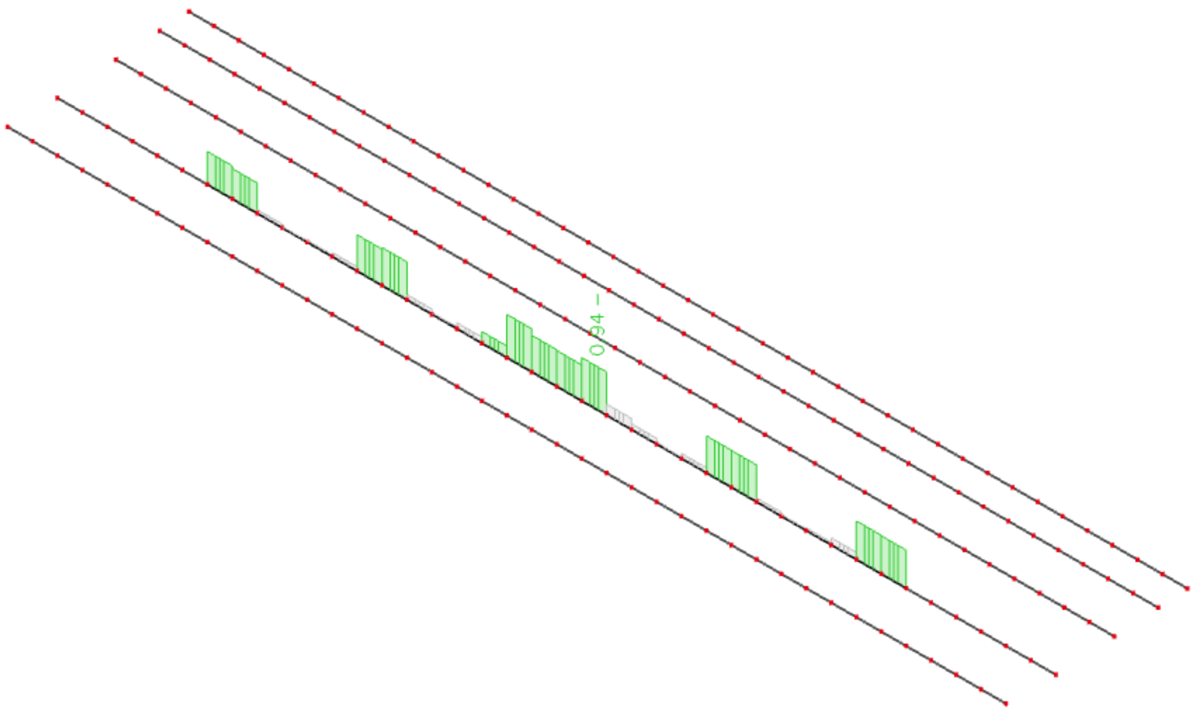
5.21. Dimenzioniranje donjeg pojasa rešetke pozicije R5 (segment 3)

Name	R5-DP3
Type	SHS150/150/5.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m^2]	2,8700e-03	
A y, z [m^2]	1,4363e-03	1,4363e-03
I y, z [m^4]	1,0020e-05	1,0020e-05
I w [m^6], t [m^4]	3,1641e-08	1,5500e-05
W_{el} y, z [m^3]	1,3400e-04	1,3400e-04
W_{pl} y, z [m^3]	1,5600e-04	1,5600e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	75	75
α [deg]	0,00	
A L, D [m^2/m]	5,8700e-01	1,1384e+00
M_{ply} +, - [Nm]	5,53e+04	5,53e+04
M_{plz} +, - [Nm]	5,53e+04	5,53e+04

Tablica 5.20. *Karakteristike poprečnog presjeka donjeg pojasa rešetke pozicije R5 (segment 3)*



Slika 5.24. *Prikaz iskoristivosti donjeg pojasa rešetke pozicije R5 (segment 3)*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R5-DP3 - SHS150/150/5.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp7724	0,000 / 8,000 m	SHS150/150/5.0	S 355	GSN	0,94 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmax

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
N_{Ed}	-258,84	kN
$V_{y,Ed}$	0,15	kN
$V_{z,Ed}$	1,81	kN
T_{Ed}	-0,15	kNm
$M_{y,Ed}$	-3,75	kNm
$M_{z,Ed}$	-0,42	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	135	5	1,200e+05	1,144e+05	0,95		1,00	27,00	22,78	27,66	31,43	2
3	I	135	5	1,123e+05	6,181e+04	0,55		1,00	27,00	22,78	27,66	36,63	2
5	I	135	5	6,015e+04	6,579e+04	0,91		1,00	27,00	22,78	27,66	31,86	2
7	I	135	5	6,787e+04	1,184e+05	0,57		1,00	27,00	22,78	27,66	36,29	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 2

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	2,8700e-03	m²
$N_{c,Rd}$	1018,85	kN
Unity check	0,25	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	1,5600e-04	m³
$M_{pl,y,Rd}$	55,38	kNm
Unity check	0,07	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	1,5600e-04	m³
$M_{pl,z,Rd}$	55,38	kNm
Unity check	0,01	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,4350e-03	m²
$V_{pl,y,Rd}$	294,12	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,4350e-03	m²
$V_{pl,z,Rd}$	294,12	kN
Unity check	0,01	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,7	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	54,26	kNm
α	1,79	
$M_{N,z,Rd}$	54,26	kNm
β	1,79	

Unity check (6.41) = 0,01 + 0,00 = 0,01 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 0,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	135	5	1,200e+05	1,144e+05	0,95		1,00	27,00	22,78	27,66	31,43	2
3	I	135	5	1,123e+05	6,181e+04	0,55		1,00	27,00	22,78	27,66	36,63	2
5	I	135	5	6,015e+04	6,579e+04	0,91		1,00	27,00	22,78	27,66	31,86	2
7	I	135	5	6,787e+04	1,184e+05	0,57		1,00	27,00	22,78	27,66	36,29	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 2

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	4,000	8,000	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	4,000	8,000	m
Critical Euler load N_{cr}	1297,98	324,49	kN
Slenderness λ	67,70	135,39	
Relative slenderness λ_{rel}	0,89	1,77	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,74	0,28	
Buckling resistance $N_{b,Rd}$	757,11	283,25	kN

Flexural Buckling verification		
Cross-section area A	2,8700e-03	m²
Buckling resistance $N_{b,Rd}$	283,25	kN
Unity check	0,91	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	2,8700e-03	m^2
Plastic section modulus $W_{pl,y}$	1,5600e-04	m^3
Plastic section modulus $W_{pl,z}$	1,5600e-04	m^3
Design compression force N_{Ed}	258,84	kN
Design bending moment (maximum) $M_{y,Ed}$	-3,75	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0,42	kNm
Characteristic compression resistance N_{Rk}	1018,85	kN
Characteristic moment resistance $M_{y,Rk}$	55,38	kNm
Characteristic moment resistance $M_{z,Rk}$	55,38	kNm
Reduction factor χ_y	0,74	
Reduction factor χ_z	0,28	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,16	
Interaction factor k_{yz}	0,88	
Interaction factor k_{zy}	0,33	
Interaction factor k_{zz}	0,38	

Maximum moment $M_{y,Ed}$ is derived from beam pp7724 position 0,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp7724 position 0,000 m.

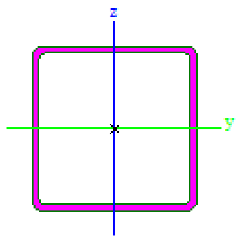
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	1297,98	kN
Critical Euler load $N_{cr,z}$	324,49	kN
Elastic critical load $N_{cr,T}$	179439,12	kN
Plastic section modulus $W_{pl,y}$	1,5600e-04	m^3
Elastic section modulus $W_{el,y}$	1,3400e-04	m^3
Plastic section modulus $W_{pl,z}$	1,5600e-04	m^3
Elastic section modulus $W_{el,z}$	1,3400e-04	m^3
Second moment of area I_y	1,0020e-05	m^4
Second moment of area I_z	1,0020e-05	m^4
Torsional constant I_t	1,5500e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-3,75	kNm
Maximum relative deflection δ_z	0,9	mm
Equivalent moment factor $C_{my,0}$	0,87	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	-0,42	kNm
Maximum relative deflection δ_y	-0,2	mm
Equivalent moment factor $C_{mz,0}$	0,32	
Factor μ_y	0,94	
Factor μ_z	0,26	
Factor ε_y	0,31	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	637,63	kNm
Relative slenderness $\lambda_{rel,0}$	0,29	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,27	
Equivalent moment factor C_{my}	0,87	
Equivalent moment factor C_{mz}	0,32	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,16	
Factor w_z	1,16	
Factor n_{pl}	0,25	
Maximum relative slenderness $\lambda_{rel,max}$	1,77	
Factor C_{yy}	0,87	
Factor C_{yz}	1,00	
Factor C_{zy}	0,52	
Factor C_{zz}	1,06	

Unity check (6.61) = 0,34 + 0,08 + 0,01 = 0,43 -
Unity check (6.62) = 0,91 + 0,02 + 0,00 = 0,94 -

The member satisfies the stability check.

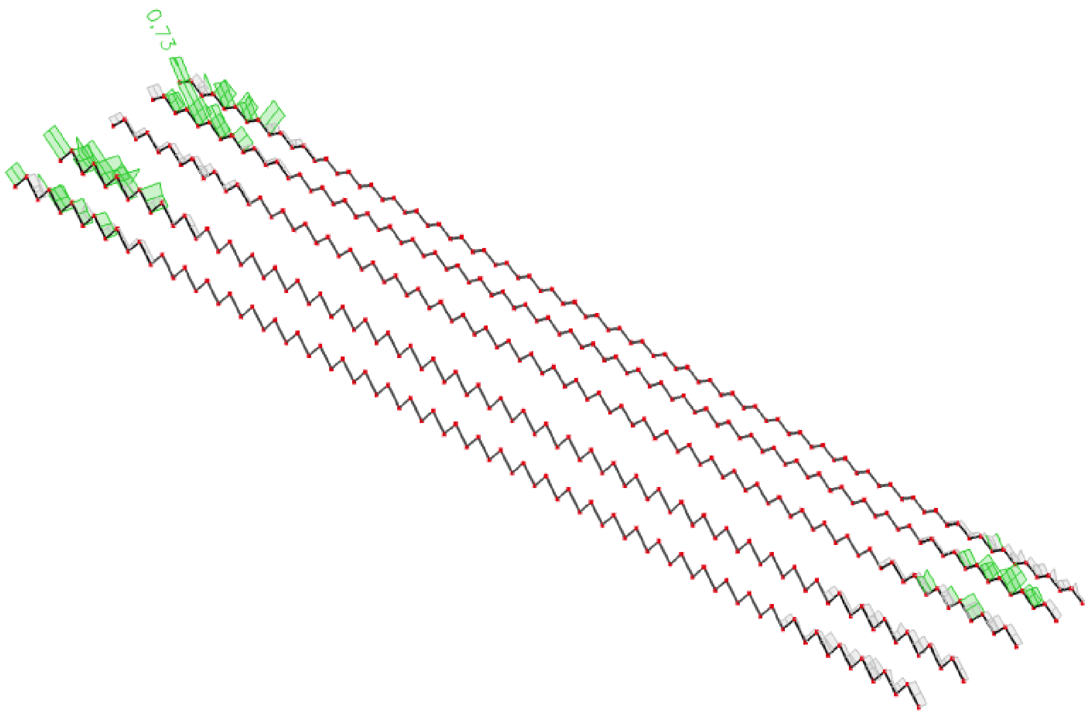
5.22. Dimenzioniranje ispune rešetke pozicije R5 (segment 1)

Name	R5-I1
Type	SHS200/200/8.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	6,0800e-03	
A y, z [m^2]	3,0370e-03	3,0370e-03
I y, z [m^4]	3,7090e-05	3,7090e-05
I w [m^6], t [m^4]	2,1333e-07	5,7780e-05
W_{el} y, z [m^3]	3,7100e-04	3,7100e-04
W_{pl} y, z [m^3]	4,3600e-04	4,3600e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	100	100
α [deg]	0,00	
A L, D [m^2/m]	7,7900e-01	1,5015e+00
M_{ply} +, - [Nm]	1,55e+05	1,55e+05
M_{plz} +, - [Nm]	1,55e+05	1,55e+05

Tablica 5.21. *Karakteristike poprečnog presjeka ispune rešetke pozicije R5 (segment 1)*



Slika 5.25. *Prikaz iskoristivosti ispune rešetke pozicije R5 (segment 1)*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R5-I1 - SHS200/200/8.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp9087	2,517 / 2,517 m	SHS200/200/8.0	S 355	GSN	0,73 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 2,517 m

Internal forces	Calculated	Unit
N_{Ed}	-725,09	kN
$V_{y,Ed}$	-5,06	kN
$V_{z,Ed}$	-28,92	kN
T_{Ed}	4,40	kNm
$M_{y,Ed}$	-58,20	kNm
$M_{z,Ed}$	-7,73	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	176	8	2,884e+05	2,517e+05	0,87		1,00	22,00	22,78	27,66	32,34	1
3	I	176	8	2,375e+05	-3,875e+04	-0,16		0,86	22,00	27,50	33,15	51,84	1
5	I	176	8	-4,964e+04	-1,297e+04								
7	I	176	8	1,251e+03	2,775e+05	0,00		1,00	22,00	22,78	27,66	47,23	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	6,0800e-03	m²
$N_{c,Rd}$	2158,40	kN
Unity check	0,34	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	4,3600e-04	m³
$M_{pl,y,Rd}$	154,78	kNm
Unity check	0,38	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	4,3600e-04	m³
$M_{pl,z,Rd}$	154,78	kNm
Unity check	0,05	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	3,0400e-03	m²
$V_{pl,y,Rd}$	623,08	kN
Unity check	0,01	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	3,0400e-03	m^2
$V_{pl,z,Rd}$	623,08	kN
Unity check	0,05	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	7,5	MPa
τ_{Rd}	205,0	MPa
Unity check	0,04	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	134,68	kNm
α	1,90	
$M_{N,z,Rd}$	134,68	kNm
β	1,90	

Unity check (6.41) = 0,20 + 0,00 = 0,21 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 2,517 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	176	8	2,884e+05	2,517e+05	0,87		1,00	22,00	22,78	27,66	32,34	1
3	I	176	8	2,375e+05	-3,875e+04	-0,16		0,86	22,00	27,50	33,15	51,84	1
5	I	176	8	-4,964e+04	-1,297e+04								
7	I	176	8	1,251e+03	2,775e+05	0,00		1,00	22,00	22,78	27,66	47,23	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	2,517	2,517	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	2,517	2,517	m
Critical Euler load N_{cr}	12138,53	12138,53	kN
Slenderness λ	32,22	32,22	
Relative slenderness λ_{rel}	0,42	0,42	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,95	0,95	
Buckling resistance $N_{b,Rd}$	2043,98	2043,98	kN

Flexural Buckling verification		
Cross-section area A	6,0800e-03	m^2
Buckling resistance $N_{b,Rd}$	2043,98	kN
Unity check	0,35	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	6,0800e-03	m^2
Plastic section modulus $W_{pl,y}$	4,3600e-04	m^3
Plastic section modulus $W_{pl,z}$	4,3600e-04	m^3
Design compression force N_{Ed}	725,09	kN
Design bending moment (maximum) $M_{y,Ed}$	-58,20	kNm
Design bending moment (maximum) $M_{z,Ed}$	-7,73	kNm
Characteristic compression resistance N_{Rk}	2158,40	kN
Characteristic moment resistance $M_{y,Rk}$	154,78	kNm
Characteristic moment resistance $M_{z,Rk}$	154,78	kNm
Reduction factor χ_y	0,95	
Reduction factor χ_z	0,95	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,96	
Interaction factor k_{yz}	0,37	
Interaction factor k_{zy}	0,58	
Interaction factor k_{zz}	0,61	

Maximum moment $M_{y,Ed}$ is derived from beam pp9087 position 2,517 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp9087 position 2,517 m.

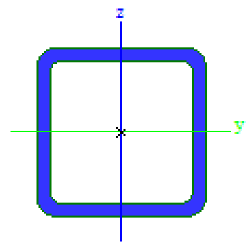
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	12138,53	kN
Critical Euler load $N_{cr,z}$	12138,53	kN
Elastic critical load $N_{cr,T}$	388230,23	kN
Plastic section modulus $W_{pl,y}$	4,3600e-04	m^3
Elastic section modulus $W_{el,y}$	3,7100e-04	m^3
Plastic section modulus $W_{pl,z}$	4,3600e-04	m^3
Elastic section modulus $W_{el,z}$	3,7100e-04	m^3
Second moment of area I_y	3,7090e-05	m^4
Second moment of area I_z	3,7090e-05	m^4
Torsional constant I_t	5,7780e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-58,20	kNm
Maximum relative deflection δ_z	2,3	mm
Equivalent moment factor $C_{my,0}$	0,97	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,65	
Equivalent moment factor $C_{mz,0}$	0,63	
Factor μ_y	1,00	
Factor μ_z	1,00	
Factor ε_y	1,32	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	7582,62	kNm
Relative slenderness $\lambda_{rel,0}$	0,14	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,28	
Equivalent moment factor C_{my}	0,97	
Equivalent moment factor C_{mz}	0,63	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,18	
Factor w_z	1,18	
Factor n_{pl}	0,34	
Maximum relative slenderness $\lambda_{rel,max}$	0,42	
Factor C_{yy}	1,07	
Factor C_{yz}	1,09	
Factor C_{zy}	1,06	
Factor C_{zz}	1,10	

Unity check (6.61) = 0,35 + 0,36 + 0,02 = 0,73 -
Unity check (6.62) = 0,35 + 0,22 + 0,03 = 0,60 -

The member satisfies the stability check.

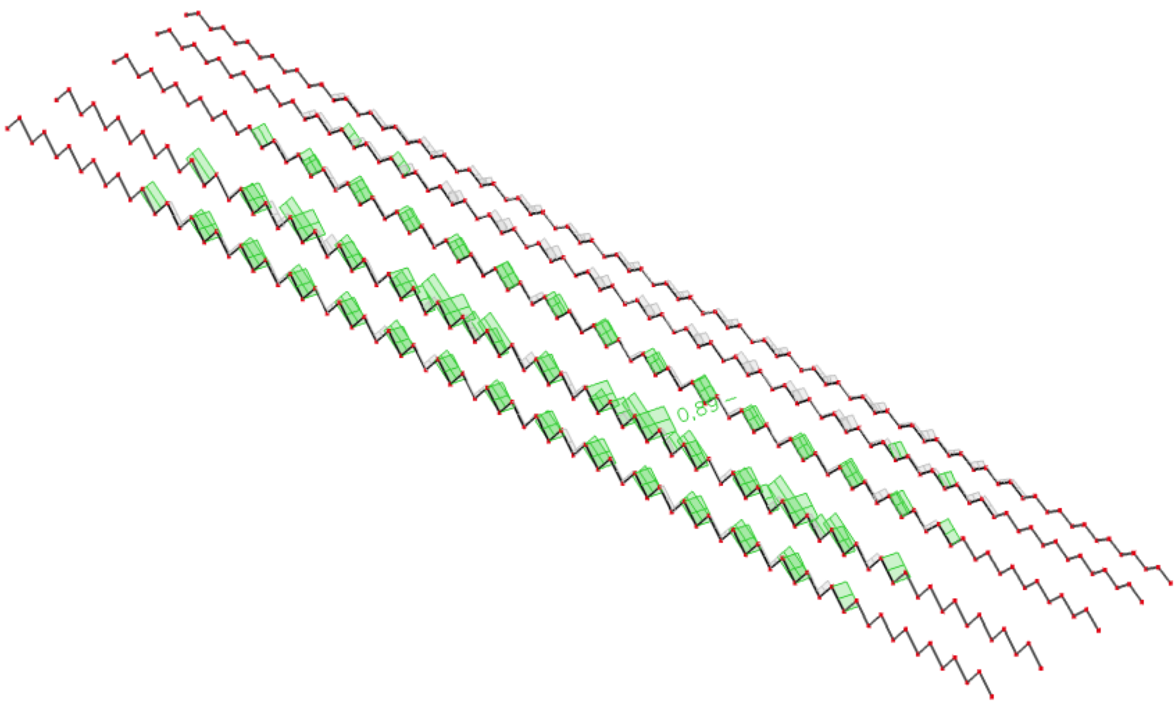
5.23. Dimenzioniranje ispune rešetke pozicije R5 (segment 2)

Name	R5-I2
Type	SHS80/80/6.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m^2]	1,7400e-03	
A y, z [m^2]	8,6833e-04	8,6833e-04
I y, z [m^4]	1,5600e-06	1,5600e-06
I w [m^6], t [m^4]	1,6384e-09	2,5200e-06
W_{el} y, z [m^3]	3,9100e-05	3,9100e-05
W_{pl} y, z [m^3]	4,7800e-05	4,7800e-05
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	40	40
α [deg]	0,00	
A L, D [m^2/m]	3,0500e-01	5,6613e-01
M_{ply} +, - [Nm]	1,69e+04	1,69e+04
M_{plz} +, - [Nm]	1,69e+04	1,69e+04

Tablica 5.22. *Karakteristike poprečnog presjeka ispune rešetke pozicije R5 (segment 2)*



Slika 5.26. *Prikaz iskoristivosti ispune rešetke pozicije R5 (segment 2)*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R5-I2 - SHS80/80/6.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp7799	0,000 / 3,202 m	SHS80/80/6.0	S 355	GSN	0,89 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
N_{Ed}	-220,58	kN
$V_{y,Ed}$	0,25	kN
$V_{z,Ed}$	-0,08	kN
T_{Ed}	-0,01	kNm
$M_{y,Ed}$	0,17	kNm
$M_{z,Ed}$	-0,57	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	62	6	1,343e+05	1,118e+05	0,83		1,00	10,33	22,78	27,66	32,83	1
3	I	62	6	1,103e+05	1,168e+05	0,94		1,00	10,33	22,78	27,66	31,53	1
5	I	62	6	1,196e+05	1,421e+05	0,84		1,00	10,33	22,78	27,66	32,72	1
7	I	62	6	1,437e+05	1,371e+05	0,95		1,00	10,33	22,78	27,66	31,41	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	1,7400e-03	m²
$N_{c,Rd}$	617,70	kN
Unity check	0,36	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	4,7800e-05	m³
$M_{pl,y,Rd}$	16,97	kNm
Unity check	0,01	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	4,7800e-05	m³
$M_{pl,z,Rd}$	16,97	kNm
Unity check	0,03	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,7000e-04	m²
$V_{pl,y,Rd}$	178,31	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,7000e-04	m²
$V_{pl,z,Rd}$	178,31	kN
Unity check	0,00	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,1	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	14,06	kNm
α	1,94	
$M_{N,z,Rd}$	14,06	kNm
β	1,94	

Unity check (6.41) = 0,00 + 0,00 = 0,00 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 3,202 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	62	6	1,377e+05	1,468e+05	0,94		1,00	10,33	22,78	27,66	31,60	1
3	I	62	6	1,451e+05	1,192e+05	0,82		1,00	10,33	22,78	27,66	32,97	1
5	I	62	6	1,158e+05	1,066e+05	0,92		1,00	10,33	22,78	27,66	31,79	1
7	I	62	6	1,083e+05	1,343e+05	0,81		1,00	10,33	22,78	27,66	33,14	1

Student version

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	3,202	3,202	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	3,202	3,202	m
Critical Euler load N_{cr}	315,44	315,44	kN
Slenderness λ	106,92	106,92	
Relative slenderness λ_{rel}	1,40	1,40	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,42	0,42	
Buckling resistance $N_{b,Rd}$	258,33	258,33	kN

Flexural Buckling verification		
Cross-section area A	1,7400e-03	m²
Buckling resistance $N_{b,Rd}$	258,33	kN
Unity check	0,85	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Student version

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	1,7400e-03	m^2
Plastic section modulus $W_{pl,y}$	4,7800e-05	m^3
Plastic section modulus $W_{pl,z}$	4,7800e-05	m^3
Design compression force N_{Ed}	220,58	kN
Design bending moment (maximum) $M_{y,Ed}$	-0,66	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0,57	kNm
Characteristic compression resistance N_{Rk}	617,70	kN
Characteristic moment resistance $M_{y,Rk}$	16,97	kNm
Characteristic moment resistance $M_{z,Rk}$	16,97	kNm
Reduction factor χ_y	0,42	
Reduction factor χ_z	0,42	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,60	
Interaction factor k_{yz}	0,47	
Interaction factor k_{zy}	0,40	
Interaction factor k_{zz}	0,69	

Maximum moment $M_{y,Ed}$ is derived from beam pp7799 position 3,202 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp7799 position 0,000 m.

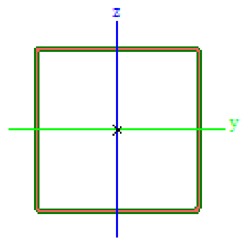
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	315,44	kN
Critical Euler load $N_{cr,z}$	315,44	kN
Elastic critical load $N_{cr,T}$	113696,60	kN
Plastic section modulus $W_{pl,y}$	4,7800e-05	m^3
Elastic section modulus $W_{el,y}$	3,9100e-05	m^3
Plastic section modulus $W_{pl,z}$	4,7800e-05	m^3
Elastic section modulus $W_{el,z}$	3,9100e-05	m^3
Second moment of area I_y	1,5600e-06	m^4
Second moment of area I_z	1,5600e-06	m^4
Torsional constant I_t	2,5200e-06	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-0,66	kNm
Maximum relative deflection δ_z	0,5	mm
Equivalent moment factor $C_{my,0}$	0,46	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,40	
Equivalent moment factor $C_{mz,0}$	0,52	
Factor μ_y	0,43	
Factor μ_z	0,43	
Factor ε_y	0,13	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	253,59	kNm
Relative slenderness $\lambda_{rel,0}$	0,26	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,24	
Equivalent moment factor C_{my}	0,46	
Equivalent moment factor C_{mz}	0,52	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,22	
Factor w_z	1,22	
Factor n_{pl}	0,36	
Maximum relative slenderness $\lambda_{rel,max}$	1,40	
Factor C_{yy}	1,08	
Factor C_{yz}	0,94	
Factor C_{zy}	0,99	
Factor C_{zz}	1,06	

Unity check (6.61) = 0,85 + 0,02 + 0,02 = 0,89 -
Unity check (6.62) = 0,85 + 0,02 + 0,02 = 0,89 -

The member satisfies the stability check.

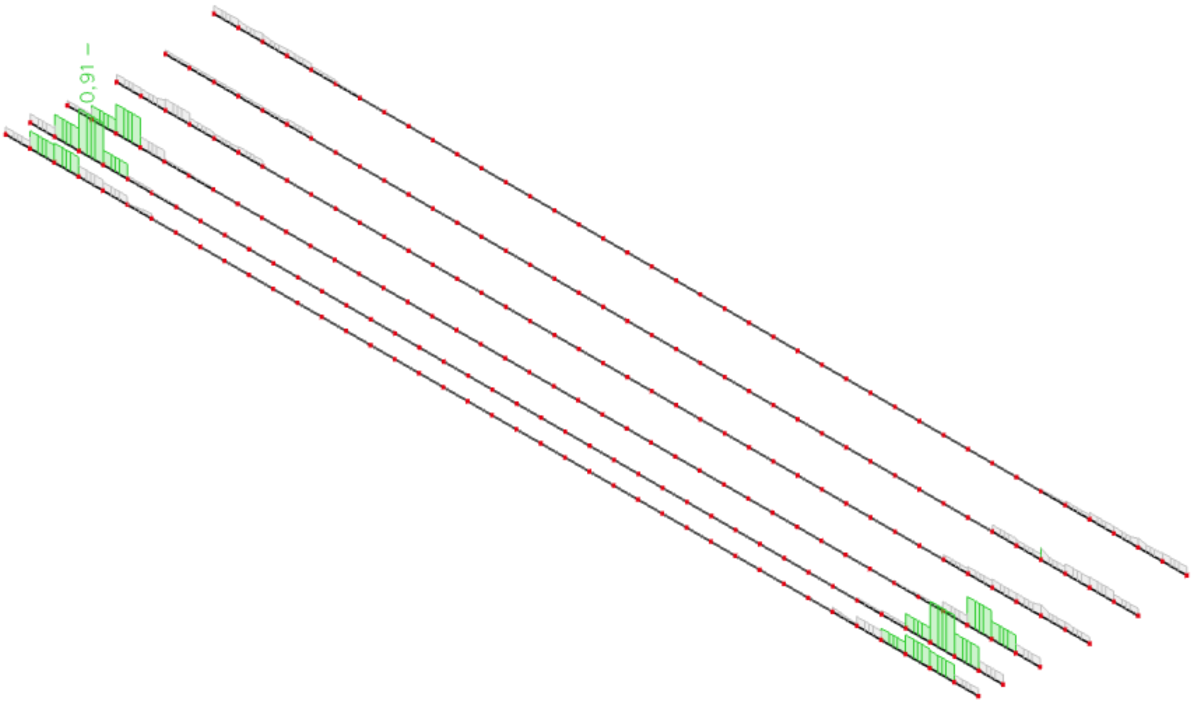
5.23. Dimenzioniranje donjeg pojasa rešetke pozicije R6 (segment 1)

Name	R6-DP1
Type	SHS350/350/8.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m^2]	1,0900e-02	
A y, z [m^2]	5,4370e-03	5,4370e-03
I y, z [m^4]	2,1130e-04	2,1130e-04
I w [m^6], t [m^4]	3,5015e-06	3,2380e-04
W_{el} y, z [m^3]	1,2070e-03	1,2070e-03
W_{pl} y, z [m^3]	1,3920e-03	1,3920e-03
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	175	175
α [deg]	0,00	
A L, D [m^2/m]	1,3800e+00	2,7015e+00
M_{ply} +, - [Nm]	4,94e+05	4,94e+05
M_{plz} +, - [Nm]	4,94e+05	4,94e+05

Tablica 5.23. *Karakteristike poprečnog presjeka donjeg pojasa rešetke pozicije R6 (segment 1)*



Slika 5.27. *Prikaz iskoristivosti donjeg pojasa rešetke pozicije R6 (segment 1)*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R6-DP1 - SHS350/350/8.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp9151	0,000 / 8,000 m	SHS350/350/8.0	S 355	GSN	0,91 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
N_{Ed}	-695,99	kN
$V_{y,Ed}$	6,35	kN
$V_{z,Ed}$	54,14	kN
T_{Ed}	-7,70	kNm
$M_{y,Ed}$	-188,97	kNm
$M_{z,Ed}$	-25,75	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	326	8	2,368e+05	1,971e+05	0,83		1,00	40,75	22,78	27,66	32,83	4
3	I	326	8	1,889e+05	-1,026e+05	-0,54		0,65	40,75	39,98	47,33	66,56	2
5	I	326	8	-1,088e+05	-6,908e+04								
7	I	326	8	-6,095e+04	2,306e+05	-0,26		0,79	40,75	30,60	36,72	55,08	3

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Effective section N-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	326	3,550e+05	3,550e+05	1,00	4,00	0,88	0,85	277	139	139
3	I	326	3,550e+05	3,550e+05	1,00	4,00	0,88	0,85	277	139	139
5	I	326	3,550e+05	3,550e+05	1,00	4,00	0,88	0,85	277	139	139
7	I	326	3,550e+05	3,550e+05	1,00	4,00	0,88	0,85	277	139	139

Effective section My-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	326	3,550e+05	3,550e+05	1,00	4,00	0,88	0,85	277	139	139
3	I	326	3,390e+05	-3,136e+05	-0,93	22,00	0,38	1,00	169	68	102
5	I	326	-3,297e+05	-3,297e+05							
7	I	326	3,390e+05	-3,136e+05	-0,93	22,00	0,38	1,00	169	68	102

Effective section Mz-
Effective width calculation
According to EN 1993-1-5 article 4.4

Id	Type	b_p [mm]	σ_1 [kN/m^2]	σ_2 [kN/m^2]	ψ [-]	k_σ [-]	λ_p [-]	ρ [-]	b_e [mm]	b_{e1} [mm]	b_{e2} [mm]
1	I	326	3,390e+05	-3,136e+05	-0,93	22,00	0,38	1,00	169	68	102
3	I	326	-3,297e+05	-3,297e+05							
5	I	326	3,390e+05	-3,136e+05	-0,93	22,00	0,38	1,00	169	68	102
7	I	326	3,550e+05	3,550e+05	1,00	4,00	0,88	0,85	277	139	139

Effective properties						
Effective area	A_{eff}	9,3220e-03	m^2			
Effective second moment of area	$I_{eff,y}$	1,9950e-04	m^4	$I_{eff,z}$	1,9950e-04	m^4
Effective section modulus	$W_{eff,y}$	1,1002e-03	m^3	$W_{eff,z}$	1,1002e-03	m^3
Shift of the centroid	$e_{N,y}$	0	mm	$e_{N,z}$	0	mm

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A_{eff}	9,3220e-03	m^2
$N_{c,Rd}$	3309,29	kN
Unity check	0,21	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,y,min}$	1,1002e-03	m^3
$M_{c,y,Rd}$	390,57	kNm
Unity check	0,48	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,z,min}$	1,1002e-03	m^3
$M_{c,z,Rd}$	390,57	kNm
Unity check	0,07	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	5,4500e-03	m^2
$V_{pl,y,Rd}$	1117,03	kN
Unity check	0,01	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	5,4500e-03	m^2
$V_{pl,z,Rd}$	1117,03	kN
Unity check	0,05	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	4,1	MPa
τ_{Rd}	205,0	MPa
Unity check	0,02	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.3 and formula (6.43)

Effective properties		
A_{eff}	9,3220e-03	m^2
$e_{N,y}$	0	mm
$e_{N,z}$	0	mm
$W_{eff,y}$	1,1002e-03	m^3
$W_{eff,z}$	1,1002e-03	m^3

Normal stresses		
$\sigma_{N,Ed}$	74,7	MPa
$\sigma_{My,Ed}$	171,8	MPa
$\sigma_{Mz,Ed}$	23,4	MPa
$\sigma_{tot,Ed}$	269,8	MPa
Unity check	0,76	-

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 0,000 m

Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	326	8	2,368e+05	1,971e+05	0,83		1,00	40,75	22,78	27,66	32,83	4
3	I	326	8	1,889e+05	-1,026e+05	-0,54		0,65	40,75	39,98	47,33	66,56	2
5	I	326	8	-1,088e+05	-6,908e+04								
7	I	326	8	-6,095e+04	2,306e+05	-0,26		0,79	40,75	30,60	36,72	55,08	3

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 4

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	4,000	16,000	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	4,000	16,000	m
Critical Euler load N_{cr}	27371,50	1710,72	kN
Slenderness λ	28,73	114,92	
Relative slenderness λ_{rel}	0,35	1,39	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,97	0,42	
Buckling resistance $N_{b,Rd}$	3197,01	1397,86	kN

Flexural Buckling verification		
Cross-section effective area A_{eff}	9,3220e-03	m²
Buckling resistance $N_{b,Rd}$	1397,86	kN
Unity check	0,50	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section effective area A_{eff}	9,3220e-03	m²
Effective section modulus $W_{eff,y}$	1,1002e-03	m³
Effective section modulus $W_{eff,z}$	1,1002e-03	m³
Design compression force N_{Ed}	695,99	kN
Design bending moment (maximum) $M_{y,Ed}$	-188,97	kNm
Design bending moment (maximum) $M_{z,Ed}$	-25,75	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance N_{Rk}	3309,29	kN
Characteristic moment resistance $M_{y,Rk}$	390,57	kNm
Characteristic moment resistance $M_{z,Rk}$	390,57	kNm
Reduction factor χ_y	0,97	
Reduction factor χ_z	0,42	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,01	
Interaction factor k_{yz}	1,38	
Interaction factor k_{zy}	0,73	
Interaction factor k_{zz}	0,99	

Maximum moment $M_{y,Ed}$ is derived from beam pp9151 position 0,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp9151 position 0,000 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	27371,50	kN
Critical Euler load $N_{cr,z}$	1710,72	kN
Elastic critical load $N_{cr,T}$	675289,96	kN
Effective section modulus $W_{eff,y}$	1,1002e-03	m³
Second moment of area I_y	2,1130e-04	m⁴
Second moment of area I_z	2,1130e-04	m⁴
Torsional constant I_t	3,2380e-04	m⁴
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-188,97	kNm
Maximum relative deflection δ_z	3,8	mm

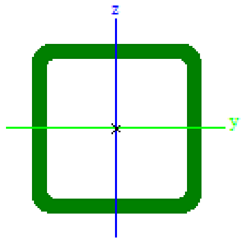
Interaction method 1 parameters		
Equivalent moment factor $C_{my,0}$	0,99	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	-25,75	kNm
Maximum relative deflection δ_y	8,4	mm
Equivalent moment factor $C_{mz,0}$	0,82	
Factor μ_y	1,00	
Factor μ_z	0,72	
Factor ε_y	2,30	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	6692,46	kNm
Relative slenderness $\lambda_{rel,0}$	0,24	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,20	
Equivalent moment factor C_{my}	0,99	
Equivalent moment factor C_{mz}	0,82	
Equivalent moment factor C_{mLT}	1,00	

Unity check (6.61) = 0,22 + 0,49 + 0,09 = 0,80 -
Unity check (6.62) = 0,50 + 0,35 + 0,07 = 0,91 -

The member satisfies the stability check.

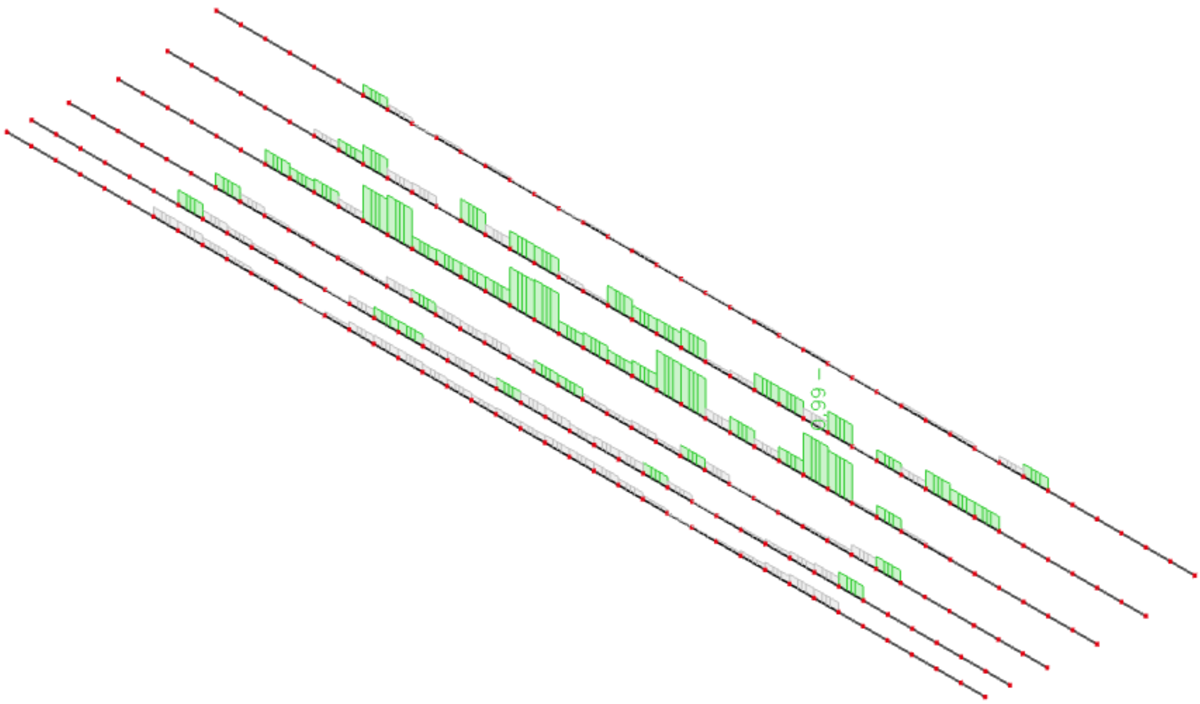
5.24. Dimenzioniranje donjeg pojasa rešetke pozicije R6 (segment 2)

Name	R6-DP2
Type	SHS80/80/6.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m^2]	1,7400e-03	
A y, z [m^2]	8,6833e-04	8,6833e-04
I y, z [m^4]	1,5600e-06	1,5600e-06
I w [m^6], t [m^4]	1,6384e-09	2,5200e-06
W_{el} y, z [m^3]	3,9100e-05	3,9100e-05
W_{pl} y, z [m^3]	4,7800e-05	4,7800e-05
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	40	40
α [deg]	0,00	
A L, D [m^2/m]	3,0500e-01	5,6613e-01
M_{ply} +, - [Nm]	1,69e+04	1,69e+04
M_{plz} +, - [Nm]	1,69e+04	1,69e+04

Tablica 5.24. *Karakteristike poprečnog presjeka donjeg pojasa rešetke pozicije R6 (segment 2)*



Slika 5.28. *Prikaz iskoristivosti donjeg pojasa rešetke pozicije R6 (segment 2)*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R6-DP2 - SHS80/80/6.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp8265	4,000 / 8,000 m	SHS80/80/6.0	S 355	GSN	0,99 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 4,000 m

Internal forces	Calculated	Unit
N_{Ed}	-46,97	kN
$V_{y,Ed}$	0,03	kN
$V_{z,Ed}$	0,22	kN
T_{Ed}	-0,04	kNm
$M_{y,Ed}$	0,01	kNm
$M_{z,Ed}$	-0,04	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	62	6	2,775e+04	2,606e+04	0,94		1,00	10,33	22,78	27,66	31,58	1
3	I	62	6	2,592e+04	2,615e+04	0,99		1,00	10,33	22,78	27,66	31,01	1
5	I	62	6	2,633e+04	2,802e+04	0,94		1,00	10,33	22,78	27,66	31,58	1
7	I	62	6	2,816e+04	2,793e+04	0,99		1,00	10,33	22,78	27,66	31,00	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	1,7400e-03	m²
$N_{c,Rd}$	617,70	kN
Unity check	0,08	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	4,7800e-05	m³
$M_{pl,y,Rd}$	16,97	kNm
Unity check	0,00	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	4,7800e-05	m³
$M_{pl,z,Rd}$	16,97	kNm
Unity check	0,00	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,7000e-04	m²
$V_{pl,y,Rd}$	178,31	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,7000e-04	m²
$V_{pl,z,Rd}$	178,31	kN
Unity check	0,00	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,6	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	16,97	kNm
α	1,67	
$M_{N,z,Rd}$	16,97	kNm
β	1,67	

Unity check (6.41) = 0,00 + 0,00 = 0,00 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 8,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	62	6	3,880e+04	4,224e+04	0,92		1,00	10,33	22,78	27,66	31,82	1
3	I	62	6	4,039e+04	1,780e+04	0,44		1,00	10,33	22,78	27,66	38,36	1
5	I	62	6	1,528e+04	1,184e+04	0,77		1,00	10,33	22,78	27,66	33,54	1
7	I	62	6	1,369e+04	3,628e+04	0,38		1,00	10,33	22,78	27,66	39,44	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	4,000	8,000	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	4,000	8,000	m
Critical Euler load N_{cr}	202,08	50,52	kN
Slenderness λ	133,59	267,18	
Relative slenderness λ_{rel}	1,75	3,50	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,28	0,08	
Buckling resistance $N_{b,Rd}$	175,92	47,60	kN

Flexural Buckling verification		
Cross-section area A	1,7400e-03	m²
Buckling resistance $N_{b,Rd}$	47,60	kN
Unity check	0,99	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	1,7400e-03	m^2
Plastic section modulus $W_{pl,y}$	4,7800e-05	m^3
Plastic section modulus $W_{pl,z}$	4,7800e-05	m^3
Design compression force N_{Ed}	46,97	kN
Design bending moment (maximum) $M_{y,Ed}$	-0,57	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,09	kNm
Characteristic compression resistance N_{Rk}	617,70	kN
Characteristic moment resistance $M_{y,Rk}$	16,97	kNm
Characteristic moment resistance $M_{z,Rk}$	16,97	kNm
Reduction factor χ_y	0,28	
Reduction factor χ_z	0,08	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,03	
Interaction factor k_{yz}	1,09	
Interaction factor k_{zy}	0,09	
Interaction factor k_{zz}	0,16	

Maximum moment $M_{y,Ed}$ is derived from beam pp8265 position 8,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp8265 position 8,000 m.

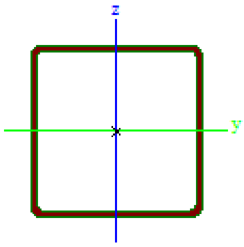
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	202,08	kN
Critical Euler load $N_{cr,z}$	50,52	kN
Elastic critical load $N_{cr,T}$	113541,42	kN
Plastic section modulus $W_{pl,y}$	4,7800e-05	m^3
Elastic section modulus $W_{el,y}$	3,9100e-05	m^3
Plastic section modulus $W_{pl,z}$	4,7800e-05	m^3
Elastic section modulus $W_{el,z}$	3,9100e-05	m^3
Second moment of area I_y	1,5600e-06	m^4
Second moment of area I_z	1,5600e-06	m^4
Torsional constant I_t	2,5200e-06	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-0,57	kNm
Maximum relative deflection δ_z	-0,2	mm
Equivalent moment factor $C_{my,0}$	0,79	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	0,09	kNm
Maximum relative deflection δ_y	0,2	mm
Equivalent moment factor $C_{mz,0}$	0,16	
Factor μ_y	0,82	
Factor μ_z	0,08	
Factor ε_y	0,54	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	101,42	kNm
Relative slenderness $\lambda_{rel,0}$	0,41	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,22	
Equivalent moment factor C_{my}	0,79	
Equivalent moment factor C_{mz}	0,16	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,22	
Factor w_z	1,22	
Factor n_{pl}	0,08	
Maximum relative slenderness $\lambda_{rel,max}$	3,50	
Factor C_{yy}	0,82	
Factor C_{yz}	1,01	
Factor C_{zy}	0,49	
Factor C_{zz}	1,03	

Unity check (6.61) = 0,27 + 0,03 + 0,01 = 0,31 -
Unity check (6.62) = 0,99 + 0,00 + 0,00 = 0,99 -

The member satisfies the stability check.

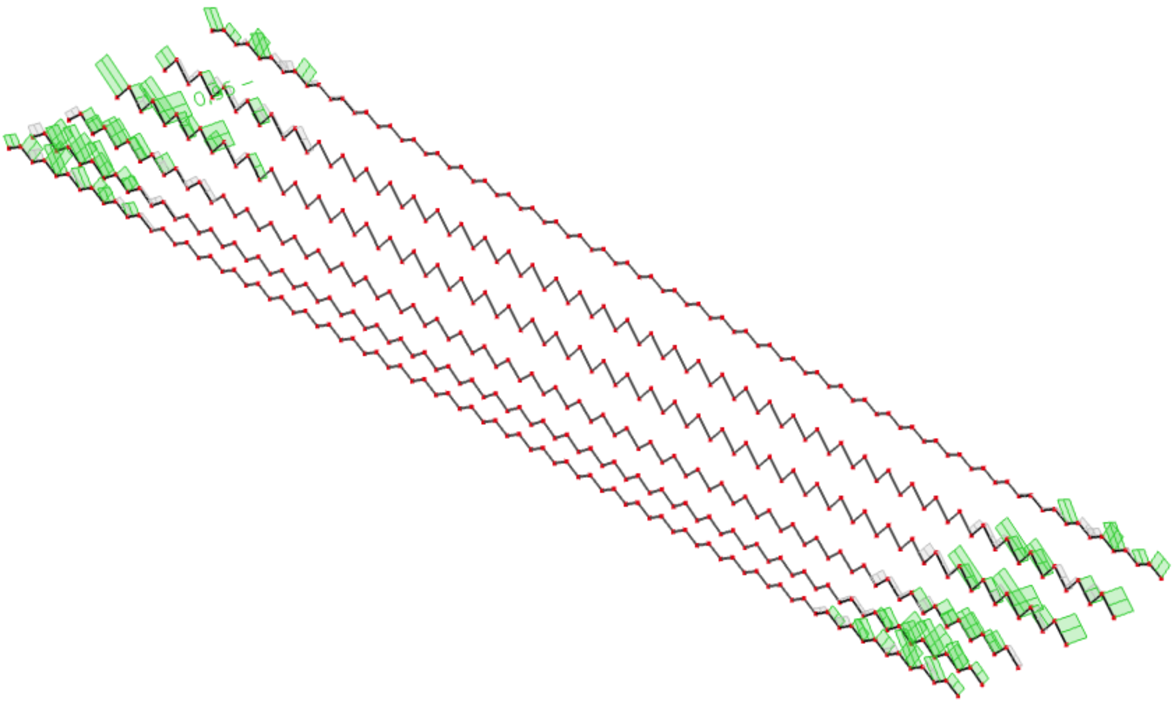
5.25. Dimenzioniranje ispune rešetke pozicije R6 (segment 1)

Name	R6-I1
Type	SHS110/110/4.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m²]	1,6800e-03	
A y, z [m²]	8,3926e-04	8,3926e-04
I y, z [m⁴]	3,1300e-06	3,1300e-06
I w [m⁶], t [m⁴]	5,3684e-09	4,8500e-06
W_{el} y, z [m³]	5,6800e-05	5,6800e-05
W_{pl} y, z [m³]	6,6460e-05	6,6460e-05
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	55	55
α [deg]	0,00	
A L, D [m²/m]	4,2965e-01	8,3075e-01
M_{ply} +, - [Nm]	2,36e+04	2,36e+04
M_{plz} +, - [Nm]	2,36e+04	2,36e+04

Tablica 5.25. *Karakteristike poprečnog presjeka ispune rešetke pozicije R6 (segment 1)*



Slika 5.29. *Prikaz iskoristivosti ispune rešetke pozicije R6 (segment 1)*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R6-I1 - SHS110/110/4.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp8309	3,202 / 3,202 m	SHS110/110/4.0	S 355	GSN	0,95 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 3,202 m

Internal forces	Calculated	Unit
N_{Ed}	-288,73	kN
$V_{y,Ed}$	4,01	kN
$V_{z,Ed}$	0,03	kN
T_{Ed}	0,68	kNm
$M_{y,Ed}$	-0,19	kNm
$M_{z,Ed}$	4,98	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	98	4	9,730e+04	2,533e+05	0,38		1,00	24,50	22,78	27,66	39,32	2
3	I	98	4	2,594e+05	2,533e+05	0,98		1,00	24,50	22,78	27,66	31,17	2
5	I	98	4	2,467e+05	9,070e+04	0,37		1,00	24,50	22,78	27,66	39,61	2
7	I	98	4	8,458e+04	9,069e+04	0,93		1,00	24,50	22,78	27,66	31,66	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 2

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	1,6800e-03	m²
$N_{c,Rd}$	596,40	kN
Unity check	0,48	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	6,6460e-05	m³
$M_{pl,y,Rd}$	23,59	kNm
Unity check	0,01	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	6,6460e-05	m³
$M_{pl,z,Rd}$	23,59	kNm
Unity check	0,21	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,4000e-04	m²
$V_{pl,y,Rd}$	172,17	kN
Unity check	0,02	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,4000e-04	m²
$V_{pl,z,Rd}$	172,17	kN
Unity check	0,00	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	7,5	MPa
τ_{Rd}	205,0	MPa
Unity check	0,04	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	15,98	kNm
α	2,26	
$M_{N,z,Rd}$	15,98	kNm
β	2,26	

Unity check (6.41) = 0,00 + 0,07 = 0,07 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 0,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	98	4	3,093e+05	6,315e+04	0,20		1,00	24,50	22,78	27,66	42,71	2
3	I	98	4	5,201e+04	2,524e+04	0,49		1,00	24,50	22,78	27,66	37,64	2
5	I	98	4	3,420e+04	2,803e+05	0,12		1,00	24,50	22,78	27,66	44,46	2
7	I	98	4	2,914e+05	3,182e+05	0,92		1,00	24,50	22,78	27,66	31,85	2

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 2

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	3,202	3,202	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	3,202	3,202	m
Critical Euler load N_{cr}	632,91	632,91	kN
Slenderness λ	74,17	74,17	
Relative slenderness λ_{rel}	0,97	0,97	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,69	0,69	
Buckling resistance $N_{b,Rd}$	409,12	409,12	kN

Flexural Buckling verification		
Cross-section area A	1,6800e-03	m²
Buckling resistance $N_{b,Rd}$	409,12	kN
Unity check	0,71	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	1,6800e-03	m^2
Plastic section modulus $W_{pl,y}$	6,6460e-05	m^3
Plastic section modulus $W_{pl,z}$	6,6460e-05	m^3
Design compression force N_{Ed}	288,73	kN
Design bending moment (maximum) $M_{y,Ed}$	-0,85	kNm
Design bending moment (maximum) $M_{z,Ed}$	-7,85	kNm
Characteristic compression resistance N_{Rk}	596,40	kN
Characteristic moment resistance $M_{y,Rk}$	23,59	kNm
Characteristic moment resistance $M_{z,Rk}$	23,59	kNm
Reduction factor χ_y	0,69	
Reduction factor χ_z	0,69	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,16	
Interaction factor k_{yz}	0,42	
Interaction factor k_{zy}	0,85	
Interaction factor k_{zz}	0,65	

Maximum moment $M_{y,Ed}$ is derived from beam pp8309 position 0,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp8309 position 0,000 m.

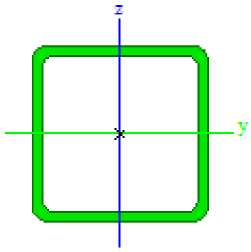
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	632,91	kN
Critical Euler load $N_{cr,z}$	632,91	kN
Elastic critical load $N_{cr,T}$	105420,35	kN
Plastic section modulus $W_{pl,y}$	6,6460e-05	m^3
Elastic section modulus $W_{el,y}$	5,6800e-05	m^3
Plastic section modulus $W_{pl,z}$	6,6460e-05	m^3
Elastic section modulus $W_{el,z}$	5,6800e-05	m^3
Second moment of area I_y	3,1300e-06	m^4
Second moment of area I_z	3,1300e-06	m^4
Torsional constant I_t	4,8500e-06	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-0,85	kNm
Maximum relative deflection δ_z	0,8	mm
Equivalent moment factor $C_{my,0}$	0,81	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,63	
Equivalent moment factor $C_{mz,0}$	0,50	
Factor μ_y	0,79	
Factor μ_z	0,79	
Factor ε_y	0,09	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	498,61	kNm
Relative slenderness $\lambda_{rel,0}$	0,22	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,24	
Equivalent moment factor C_{my}	0,81	
Equivalent moment factor C_{mz}	0,50	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,17	
Factor w_z	1,17	
Factor n_{pl}	0,48	
Maximum relative slenderness $\lambda_{rel,max}$	0,97	
Factor C_{yy}	1,02	
Factor C_{yz}	1,04	
Factor C_{zy}	0,84	
Factor C_{zz}	1,11	

Unity check (6.61) = 0,71 + 0,04 + 0,14 = 0,89 -
Unity check (6.62) = 0,71 + 0,03 + 0,22 = 0,95 -

The member satisfies the stability check.

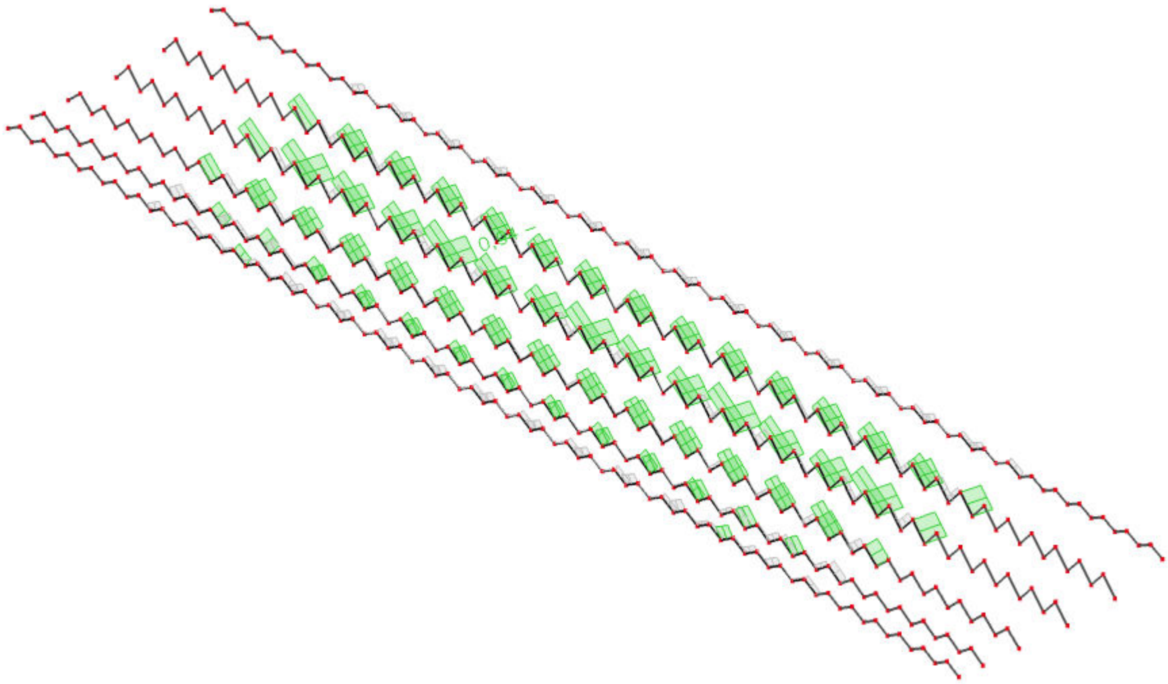
5.26. Dimenzioniranje ispune rešetke pozicije R6 (segment 2)

Name	R6-I2
Type	SHS70/70/4.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m²]	1,0400e-03	
A y, z [m²]	5,1926e-04	5,1926e-04
I y, z [m⁴]	7,4700e-07	7,4700e-07
I w [m⁶], t [m⁴]	5,6023e-10	1,1800e-06
W_{el} y, z [m³]	2,1300e-05	2,1300e-05
W_{pl} y, z [m³]	2,5500e-05	2,5500e-05
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	35	35
α [deg]	0,00	
A L, D [m²/m]	2,7000e-01	5,1075e-01
M_{ply} +, - [Nm]	9,06e+03	9,06e+03
M_{plz} +, - [Nm]	9,06e+03	9,06e+03

Tablica 5.26. *Karakteristike poprečnog presjeka ispune rešetke pozicije R6 (segment 2)*



Slika 5.30. *Prikaz iskoristivosti ispune rešetke pozicije R6 (segment 2)*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = R6-I2 - SHS70/70/4.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp8357	3,202 / 3,202 m	SHS70/70/4.0	S 355	GSN	0,94 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 3,202 m

Internal forces	Calculated	Unit
N_{Ed}	-117,68	kN
$V_{y,Ed}$	-0,11	kN
$V_{z,Ed}$	-0,13	kN
T_{Ed}	0,01	kNm
$M_{y,Ed}$	-0,15	kNm
$M_{z,Ed}$	-0,21	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	58	4	1,280e+05	1,115e+05	0,87		1,00	14,50	22,78	27,66	32,37	1
3	I	58	4	1,096e+05	9,820e+04	0,90		1,00	14,50	22,78	27,66	32,07	1
5	I	58	4	9,856e+04	1,151e+05	0,86		1,00	14,50	22,78	27,66	32,54	1
7	I	58	4	1,170e+05	1,284e+05	0,91		1,00	14,50	22,78	27,66	31,90	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	1,0400e-03	m²
$N_{c,Rd}$	369,20	kN
Unity check	0,32	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	2,5500e-05	m³
$M_{pl,y,Rd}$	9,05	kNm
Unity check	0,02	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	2,5500e-05	m³
$M_{pl,z,Rd}$	9,05	kNm
Unity check	0,02	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	5,2000e-04	m²
$V_{pl,y,Rd}$	106,58	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	5,2000e-04	m²
$V_{pl,z,Rd}$	106,58	kN
Unity check	0,00	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,4	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	8,02	kNm
α	1,88	
$M_{N,z,Rd}$	8,02	kNm
β	1,88	

Unity check (6.41) = 0,00 + 0,00 = 0,00 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 3,202 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	58	4	1,280e+05	1,115e+05	0,87		1,00	14,50	22,78	27,66	32,37	1
3	I	58	4	1,096e+05	9,820e+04	0,90		1,00	14,50	22,78	27,66	32,07	1
5	I	58	4	9,856e+04	1,151e+05	0,86		1,00	14,50	22,78	27,66	32,54	1
7	I	58	4	1,170e+05	1,284e+05	0,91		1,00	14,50	22,78	27,66	31,90	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	3,202	3,202	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	3,202	3,202	m
Critical Euler load N_{cr}	151,05	151,05	kN
Slenderness λ	119,46	119,46	
Relative slenderness λ_{rel}	1,56	1,56	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,35	0,35	
Buckling resistance $N_{b,Rd}$	128,08	128,08	kN

Flexural Buckling verification		
Cross-section area A	1,0400e-03	m²
Buckling resistance $N_{b,Rd}$	128,08	kN
Unity check	0,92	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	1,0400e-03	m^2
Plastic section modulus $W_{pl,y}$	2,5500e-05	m^3
Plastic section modulus $W_{pl,z}$	2,5500e-05	m^3
Design compression force N_{Ed}	117,68	kN
Design bending moment (maximum) $M_{y,Ed}$	-0,15	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0,21	kNm
Characteristic compression resistance N_{Rk}	369,20	kN
Characteristic moment resistance $M_{y,Rk}$	9,05	kNm
Characteristic moment resistance $M_{z,Rk}$	9,05	kNm
Reduction factor χ_y	0,35	
Reduction factor χ_z	0,35	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,60	
Interaction factor k_{yz}	0,32	
Interaction factor k_{zy}	0,40	
Interaction factor k_{zz}	0,50	

Maximum moment $M_{y,Ed}$ is derived from beam pp8357 position 3,202 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp8357 position 3,202 m.

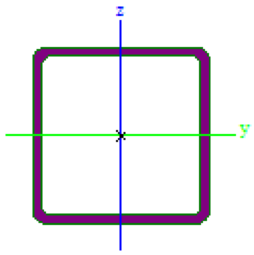
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	151,05	kN
Critical Euler load $N_{cr,z}$	151,05	kN
Elastic critical load $N_{cr,T}$	66424,24	kN
Plastic section modulus $W_{pl,y}$	2,5500e-05	m^3
Elastic section modulus $W_{el,y}$	2,1300e-05	m^3
Plastic section modulus $W_{pl,z}$	2,5500e-05	m^3
Elastic section modulus $W_{el,z}$	2,1300e-05	m^3
Second moment of area I_y	7,4700e-07	m^4
Second moment of area I_z	7,4700e-07	m^4
Torsional constant I_t	1,1800e-06	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-0,15	kNm
Maximum relative deflection δ_z	0,3	mm
Equivalent moment factor $C_{my,0}$	0,46	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,62	
Equivalent moment factor $C_{mz,0}$	0,39	
Factor μ_y	0,30	
Factor μ_z	0,30	
Factor ε_y	0,06	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	120,05	kNm
Relative slenderness $\lambda_{rel,0}$	0,27	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,22	
Equivalent moment factor C_{my}	0,46	
Equivalent moment factor C_{mz}	0,39	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,20	
Factor w_z	1,20	
Factor n_{pl}	0,32	
Maximum relative slenderness $\lambda_{rel,max}$	1,56	
Factor C_{yy}	1,05	
Factor C_{yz}	0,99	
Factor C_{zy}	0,94	
Factor C_{zz}	1,07	

Unity check (6.61) = 0,92 + 0,01 + 0,01 = 0,94 -
Unity check (6.62) = 0,92 + 0,01 + 0,01 = 0,94 -

The member satisfies the stability check.

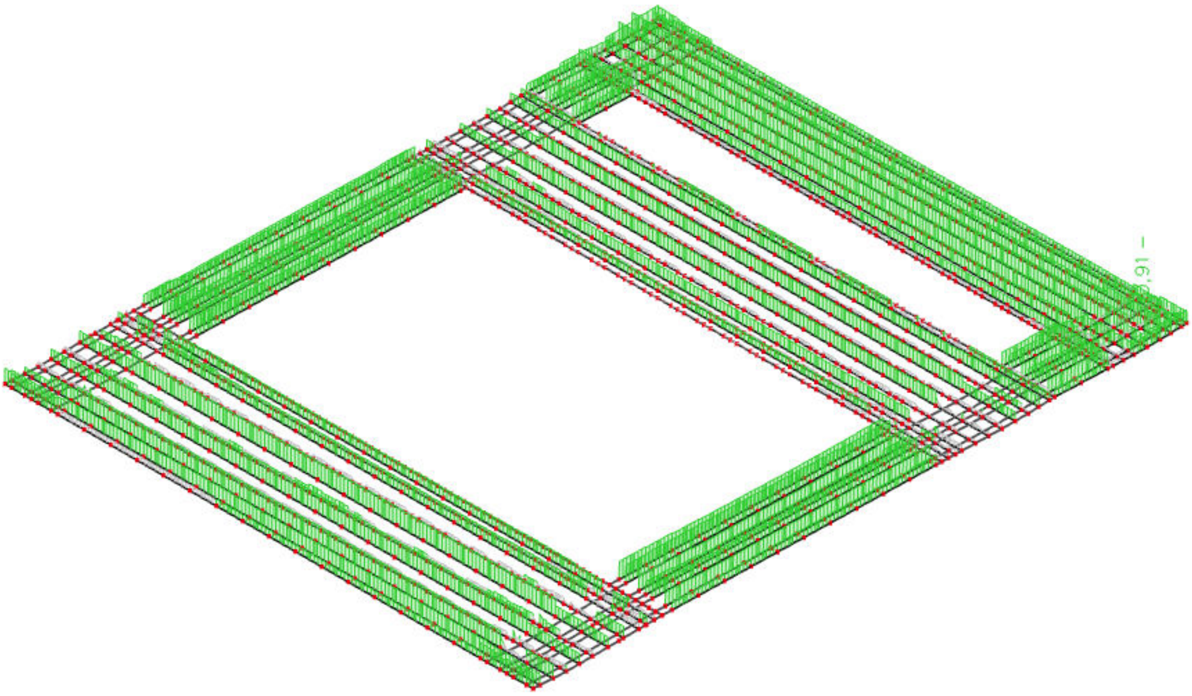
5.27. Dimenzioniranje krovne podrožnice pozicije KP1

Name	KP1
Type	SHS200/200/10.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	x



A [m²]	7,4900e-03	
A y, z [m²]	3,7454e-03	3,7454e-03
I y, z [m⁴]	4,4710e-05	4,4710e-05
I w [m⁶], t [m⁴]	2,6667e-07	7,0310e-05
W_{el} y, z [m³]	4,4700e-04	4,4700e-04
W_{pl} y, z [m³]	5,3100e-04	5,3100e-04
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	100	100
α [deg]	0,00	
A L, D [m²/m]	7,7400e-01	1,4769e+00
M_{ply} +, - [Nm]	1,88e+05	1,88e+05
M_{plz} +, - [Nm]	1,88e+05	1,88e+05

Tablica 5.27. *Karakteristike poprečnog presjeka krovne podrožnice pozicije KP1*



Slika 5.30. *Prikaz iskoristivosti krovne podrožnie pozicije KP1*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = KP1 - SHS200/200/10.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp2090	**8,000 / 8,000 m**	**SHS200/200/10.0**	**S 355**	**GSN**	**0,91 -**

Combination key
GSN / 1.35*vlastita težina + 1.35*dodatno stalno opterećenje + 1.50*vjetar pritisak

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 8,000 m

Internal forces	Calculated	Unit
N_{Ed}	-19,07	kN
$V_{y,Ed}$	14,19	kN
$V_{z,Ed}$	-107,77	kN
T_{Ed}	-2,94	kNm
$M_{y,Ed}$	-164,28	kNm
$M_{z,Ed}$	14,56	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	170	10	3,240e+05	3,793e+05	0,85		1,00	17,00	22,78	27,66	32,57	1
3	I	170	10	3,459e+05	-2,789e+05	-0,81		0,55	17,00	50,13	58,49	82,84	1
5	I	170	10	-3,189e+05	-3,743e+05								
7	I	170	10	-3,408e+05	2,840e+05	-1,20		0,45	17,00	64,44	74,28	121,58	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	7,4900e-03	m²
$N_{c,Rd}$	2658,95	kN
Unity check	0,01	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	5,3100e-04	m³
$M_{pl,y,Rd}$	188,50	kNm
Unity check	0,87	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	5,3100e-04	m³
$M_{pl,z,Rd}$	188,50	kNm
Unity check	0,08	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	3,7450e-03	m²
$V_{pl,y,Rd}$	767,57	kN
Unity check	0,02	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	3,7450e-03	m²
$V_{pl,z,Rd}$	767,57	kN
Unity check	0,14	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	4,1	MPa
τ_{Rd}	205,0	MPa
Unity check	0,02	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	188,50	kNm
α	1,66	
$M_{N,z,Rd}$	188,50	kNm
β	1,66	

Unity check (6.41) = 0,80 + 0,01 = 0,81 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 8,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	170	10	3,240e+05	3,793e+05	0,85		1,00	17,00	22,78	27,66	32,57	1
3	I	170	10	3,459e+05	-2,789e+05	-0,81		0,55	17,00	50,13	58,49	82,84	1
5	I	170	10	-3,189e+05	-3,743e+05								
7	I	170	10	-3,408e+05	2,840e+05	-1,20		0,45	17,00	64,44	74,28	121,58	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	8,000	2,000	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	8,000	2,000	m
Critical Euler load N_{cr}	1447,92	23166,68	kN
Slenderness λ	103,54	25,89	
Relative slenderness λ_{rel}	1,36	0,34	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	

Note: The slenderness or compression force is such that Flexural Buckling effects may be ignored according to EN 1993-1-1 article 6.3.1.2(4).

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	7,4900e-03	m²
Plastic section modulus $W_{pl,y}$	5,3100e-04	m³
Plastic section modulus $W_{pl,z}$	5,3100e-04	m³
Design compression force N_{Ed}	19,07	kN
Design bending moment (maximum) $M_{y,Ed}$	-164,28	kNm
Design bending moment (maximum) $M_{z,Ed}$	14,56	kNm
Characteristic compression resistance N_{Rk}	2658,95	kN

Bending and axial compression check parameters		
Characteristic moment resistance $M_{y,Rk}$	188,50	kNm
Characteristic moment resistance $M_{z,Rk}$	188,50	kNm
Reduction factor χ_y	1,00	
Reduction factor χ_z	1,00	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	1,01	
Interaction factor k_{yz}	0,35	
Interaction factor k_{zy}	0,61	
Interaction factor k_{zz}	0,59	

Maximum moment $M_{y,Ed}$ is derived from beam pp2090 position 8,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp2090 position 8,000 m.

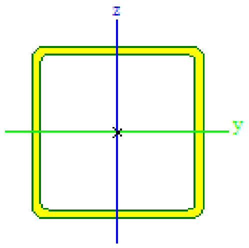
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	1447,92	kN
Critical Euler load $N_{cr,z}$	23166,68	kN
Elastic critical load $N_{cr,T}$	487248,63	kN
Plastic section modulus $W_{pl,y}$	5,3100e-04	m^3
Elastic section modulus $W_{el,y}$	4,4700e-04	m^3
Plastic section modulus $W_{pl,z}$	5,3100e-04	m^3
Elastic section modulus $W_{el,z}$	4,4700e-04	m^3
Second moment of area I_y	4,4710e-05	m^4
Second moment of area I_z	4,4710e-05	m^4
Torsional constant I_t	7,0310e-05	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-164,28	kNm
Maximum relative deflection δ_z	-50,7	mm
Equivalent moment factor $C_{my,0}$	0,99	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,97	
Equivalent moment factor $C_{mz,0}$	0,59	
Factor μ_y	1,00	
Factor μ_z	1,00	
Factor ε_y	144,35	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	11608,70	kNm
Relative slenderness $\lambda_{rel,0}$	0,13	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,29	
Equivalent moment factor C_{my}	0,99	
Equivalent moment factor C_{mz}	0,59	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,19	
Factor w_z	1,19	
Factor n_{pl}	0,01	
Maximum relative slenderness $\lambda_{rel,max}$	1,36	
Factor C_{yy}	1,00	
Factor C_{yz}	1,00	
Factor C_{zy}	0,99	
Factor C_{zz}	1,00	

Unity check (6.61) = 0,01 + 0,88 + 0,03 = 0,91 -
Unity check (6.62) = 0,01 + 0,53 + 0,05 = 0,58 -

The member satisfies the stability check.

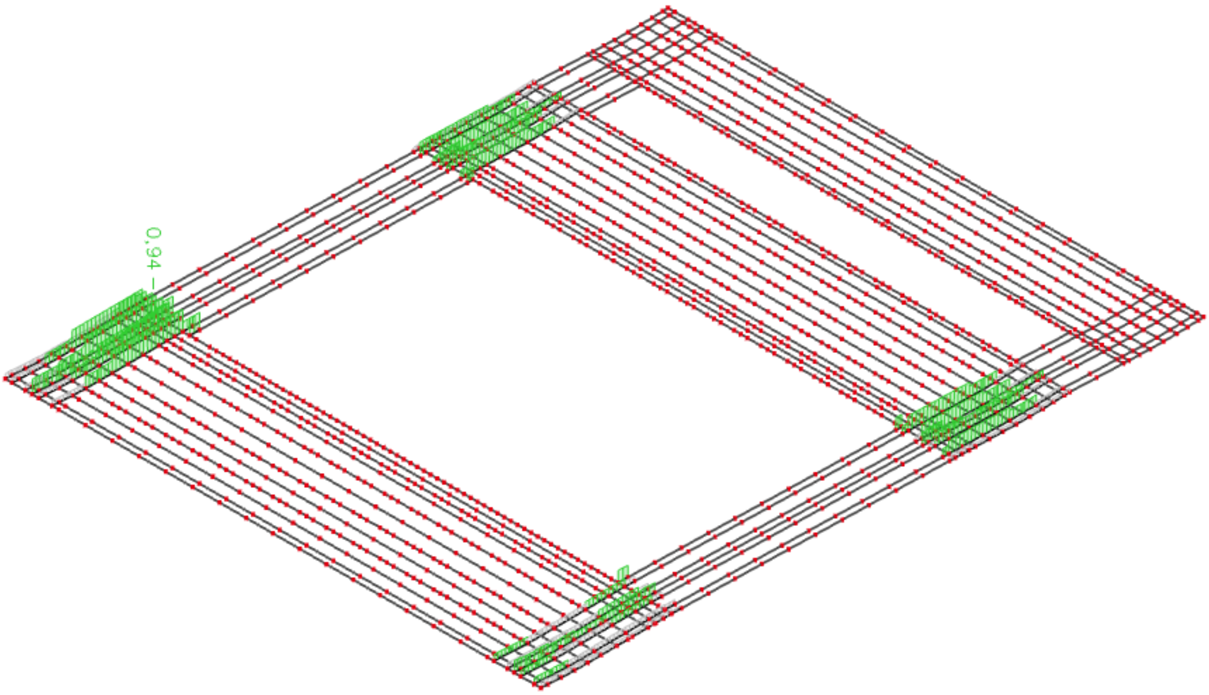
5.28. Dimenzioniranje krovne podrožnice pozicije KP2

Name	KP2
Type	SHS300/300/14.2
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	roled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m^2]	1,6000e-02	
A y, z [m^2]	8,0065e-03	8,0065e-03
I y, z [m^4]	2,1640e-04	2,1640e-04
I w [m^6], t [m^4]	2,8755e-06	3,3940e-04
W_{el} y, z [m^3]	1,4420e-03	1,4420e-03
W_{pl} y, z [m^3]	1,7080e-03	1,7080e-03
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	150	150
α [deg]	0,00	
A L, D [m^2/m]	1,1600e+00	2,2252e+00
M_{ply} +, - [Nm]	6,06e+05	6,06e+05
M_{plz} +, - [Nm]	6,06e+05	6,06e+05

Tablica 5.28. *Karakteristike poprečnog presjeka krovne podrožnice pozicije KP2*



Slika 5.31. *Prikaz iskoristivosti krovne podrožnie pozicije KP2*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = KP2 - SHS300/300/14.2

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp7250	21,061 / 21,061 m	SHS300/300/14.2	S 355	GSN	0,94 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*snijeg + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmin

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 21,061 m

Internal forces	Calculated	Unit
N_{Ed}	186,80	kN
$V_{y,Ed}$	-17,67	kN
$V_{z,Ed}$	158,62	kN
T_{Ed}	-1,04	kNm
$M_{y,Ed}$	568,64	kNm
$M_{z,Ed}$	-19,62	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	257	14	-3,756e+05	-3,989e+05								
3	I	257	14	-3,629e+05	3,137e+05	-1,16		0,46	18,13	63,18	72,83	117,04	1
5	I	257	14	3,523e+05	3,756e+05	0,94		1,00	18,13	22,78	27,66	31,60	1
7	I	257	14	3,396e+05	-3,370e+05	-0,99		0,50	18,13	58,23	67,16	100,17	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Tension check
According to EN 1993-1-1 article 6.2.3 and formula (6.5)

A	1,6000e-02	m²
$N_{pl,Rd}$	5680,00	kN
$N_{u,Rd}$	5644,80	kN
$N_{t,Rd}$	5644,80	kN
Unity check	0,03	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	1,7080e-03	m³
$M_{pl,y,Rd}$	606,34	kNm
Unity check	0,94	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	1,7080e-03	m³
$M_{pl,z,Rd}$	606,34	kNm
Unity check	0,03	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,0000e-03	m²
$V_{pl,y,Rd}$	1639,67	kN
Unity check	0,01	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	8,0000e-03	m^2
$V_{pl,z,Rd}$	1639,67	kN
Unity check	0,10	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,4	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	606,34	kNm
α	1,66	
$M_{N,z,Rd}$	606,34	kNm
β	1,66	

Unity check (6.41) = 0,90 + 0,00 = 0,90 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 21,061 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	257	14	-3,756e+05	-3,989e+05								
3	I	257	14	-3,629e+05	3,137e+05	-1,16		0,46	18,13	63,18	72,83	117,04	1
5	I	257	14	3,523e+05	3,756e+05	0,94		1,00	18,13	22,78	27,66	31,60	1
7	I	257	14	3,396e+05	-3,370e+05	-0,99		0,50	18,13	58,23	67,16	100,17	1

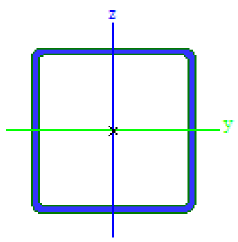
Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

The member satisfies the stability check.

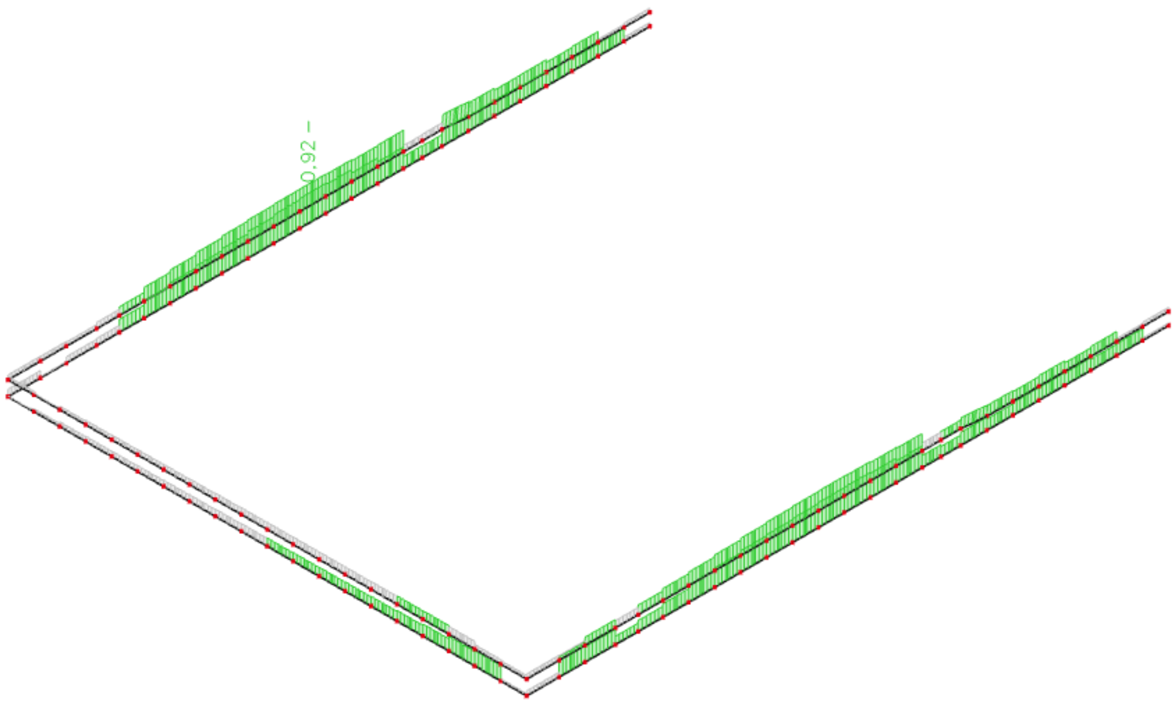
5.29. Dimenzioniranje bočne podrožnice pozicije BP

Name	BP
Type	SHS120/120/5.0
Source description	British Standard / BS 5950 part 1 : 1990 & EN 10210-2
Item material	S 355
Fabrication	rolled
Flexural buckling y-y	a
Flexural buckling z-z	a
Lateral torsional buckling	Default
Use 2D FEM analysis	×



A [m^2]	2,2700e-03	
A y, z [m^2]	1,1363e-03	1,1363e-03
I y, z [m^4]	4,9800e-06	4,9800e-06
I w [m^6], t [m^4]	1,0368e-08	7,7700e-06
W_{el} y, z [m^3]	8,3000e-05	8,3000e-05
W_{pl} y, z [m^3]	9,7600e-05	9,7600e-05
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	60	60
α [deg]	0,00	
A L, D [m^2/m]	4,6700e-01	8,9844e-01
M_{ply} +, - [Nm]	3,46e+04	3,46e+04
M_{plz} +, - [Nm]	3,46e+04	3,46e+04

Tablica 5.29. *Karakteristike poprečnog presjeka bočne podrožnice pozicije BP*



Slika 5.32. *Prikaz iskoristivosti bočne podrožnice BP*

EC-EN 1993 Steel check ULS

Linear calculation
Class: GSN
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = BP - SHS120/120/5.0

EN 1993-1-1 Code Check
National annex: Standard EN

Member pp12607	0,000 / 8,000 m	SHS120/120/5.0	S 355	GSN	0,92 -

Combination key
GSN / 1.35*vlastita težina + 1.62*korisno opterećenje + 1.35*dodatno stalno opterećenje + 1.35*vjetar pritisak + 1.35*trenje po krovu + 1.35*Tmax

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	355,0	MPa
Ultimate strength f_u	490,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
N_{Ed}	-131,29	kN
$V_{y,Ed}$	-0,01	kN
$V_{z,Ed}$	0,79	kN
T_{Ed}	0,02	kNm
$M_{y,Ed}$	-0,68	kNm
$M_{z,Ed}$	0,08	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	105	5	6,482e+04	6,642e+04	0,98		1,00	21,00	22,78	27,66	31,18	1
3	I	105	5	6,581e+04	5,146e+04	0,78		1,00	21,00	22,78	27,66	33,45	1
5	I	105	5	5,070e+04	4,910e+04	0,97		1,00	21,00	22,78	27,66	31,26	1
7	I	105	5	4,971e+04	6,406e+04	0,78		1,00	21,00	22,78	27,66	33,52	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	2,2700e-03	m²
$N_{c,Rd}$	805,85	kN
Unity check	0,16	-

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	9,7600e-05	m³
$M_{pl,y,Rd}$	34,65	kNm
Unity check	0,02	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	9,7600e-05	m³
$M_{pl,z,Rd}$	34,65	kNm
Unity check	0,00	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,1350e-03	m²
$V_{pl,y,Rd}$	232,63	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,1350e-03	m^2
$V_{pl,z,Rd}$	232,63	kN
Unity check	0,00	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,2	MPa
τ_{Rd}	205,0	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{N,y,Rd}$	34,65	kNm
α	1,71	
$M_{N,z,Rd}$	34,65	kNm
β	1,71	

Unity check (6.41) = 0,00 + 0,00 = 0,00 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 8,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	105	5	7,923e+04	7,986e+04	0,99		1,00	21,00	22,78	27,66	31,00	1
3	I	105	5	7,800e+04	3,821e+04	0,49		1,00	21,00	22,78	27,66	37,57	1
5	I	105	5	3,629e+04	3,566e+04	0,98		1,00	21,00	22,78	27,66	31,10	1
7	I	105	5	3,752e+04	7,731e+04	0,49		1,00	21,00	22,78	27,66	37,64	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Flexural Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	8,000	8,000	m
Buckling factor k	1,00	1,00	
Buckling length l_{cr}	8,000	8,000	m
Critical Euler load N_{cr}	161,28	161,28	kN
Slenderness λ	170,80	170,80	
Relative slenderness λ_{rel}	2,24	2,24	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	a	
Imperfection α	0,21	0,21	
Reduction factor χ	0,18	0,18	
Buckling resistance $N_{b,Rd}$	146,02	146,02	kN

Flexural Buckling verification		
Cross-section area A	2,2700e-03	m^2
Buckling resistance $N_{b,Rd}$	146,02	kN
Unity check	0,90	-

Torsional(-Flexural) Buckling check
According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)
Note: The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1
Note: The cross-section concerns an RHS section with 'h / b < 10 / $\lambda_{rel,z}$'.
This section is thus not susceptible to Lateral Torsional Buckling.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	2,2700e-03	m^2
Plastic section modulus $W_{pl,y}$	9,7600e-05	m^3
Plastic section modulus $W_{pl,z}$	9,7600e-05	m^3
Design compression force N_{Ed}	131,29	kN
Design bending moment (maximum) $M_{y,Ed}$	-1,89	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,08	kNm
Characteristic compression resistance N_{Rk}	805,85	kN
Characteristic moment resistance $M_{y,Rk}$	34,65	kNm
Characteristic moment resistance $M_{z,Rk}$	34,65	kNm
Reduction factor χ_y	0,18	
Reduction factor χ_z	0,18	
Reduction factor χ_{LT}	1,00	
Interaction factor k_{yy}	0,40	
Interaction factor k_{yz}	1,23	
Interaction factor k_{zy}	0,26	
Interaction factor k_{zz}	1,23	

Maximum moment $M_{y,Ed}$ is derived from beam pp12607 position 8,000 m.
Maximum moment $M_{z,Ed}$ is derived from beam pp12607 position 0,000 m.

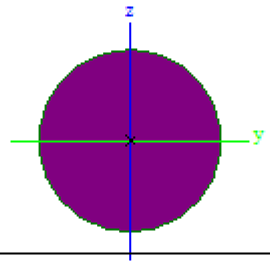
Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	161,28	kN
Critical Euler load $N_{cr,z}$	161,28	kN
Elastic critical load $N_{cr,T}$	143108,61	kN
Plastic section modulus $W_{pl,y}$	9,7600e-05	m^3
Elastic section modulus $W_{el,y}$	8,3000e-05	m^3
Plastic section modulus $W_{pl,z}$	9,7600e-05	m^3
Elastic section modulus $W_{el,z}$	8,3000e-05	m^3
Second moment of area I_y	4,9800e-06	m^4
Second moment of area I_z	4,9800e-06	m^4
Torsional constant I_t	7,7700e-06	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-1,89	kNm
Maximum relative deflection δ_z	-2,4	mm
Equivalent moment factor $C_{my,0}$	0,35	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	0,39	
Equivalent moment factor $C_{mz,0}$	0,89	
Factor μ_y	0,22	
Factor μ_z	0,22	
Factor ε_y	0,39	
Factor a_{LT}	0,00	
Critical moment for uniform bending $M_{cr,0}$	318,22	kNm
Relative slenderness $\lambda_{rel,0}$	0,33	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,25	
Equivalent moment factor C_{my}	0,35	
Equivalent moment factor C_{mz}	0,89	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,00	
Factor d_{LT}	0,00	
Factor e_{LT}	0,00	
Factor w_y	1,18	
Factor w_z	1,18	
Factor n_{pl}	0,16	
Maximum relative slenderness $\lambda_{rel,max}$	2,24	
Factor C_{yy}	1,02	
Factor C_{yz}	0,51	
Factor C_{zy}	0,95	
Factor C_{zz}	0,85	

Unity check (6.61) = 0,90 + 0,02 + 0,00 = 0,92 -
Unity check (6.62) = 0,90 + 0,01 + 0,00 = 0,92 -

The member satisfies the stability check.

5.30. Dimenzioniranje bočnog sprega pozicije BS

Name	KP4
Type	RD27
Source description	Stahl im Hochbau / 14.Auflage Band I / Teil 1
Item material	S 355
Fabrication	roled
Flexural buckling y-y	c
Flexural buckling z-z	c
Lateral torsional buckling	Default
Use 2D FEM analysis	✓



A [m²]	5,7226e-04	
A y, z [m²]	5,1431e-04	5,1431e-04
I y, z [m⁴]	2,5540e-08	2,5540e-08
I w [m⁶], t [m⁴]	3,1923e-26	5,2251e-08
W_{el} y, z [m³]	1,8919e-06	1,8919e-06
W_{pl} y, z [m³]	3,2288e-06	3,2288e-06
d y, z [mm]	0	0
c YUCS, ZUCS [mm]	14	14
α [deg]	0,00	
A L, D [m²/m]	8,4599e-02	8,4819e-02
M_{ply} +, - [Nm]	1,16e+03	1,16e+03
M_{plz} +, - [Nm]	1,16e+03	1,16e+03

Tablica 5.30. *Karakteristike poprečnog presjeka bočnog sprega pozicije BS*

Dimenzioniranje elementa

$$N_{c,Rd} = N_{pl,Rd} = \frac{A \cdot f_y}{\gamma_{M_0}} = \frac{5{,}72 \cdot 35{,}5}{1{,}25} = 162{,}45(kN)$$

Uvjet nosivosti:

$$N_{c,Rd} > N_{Ed}$$

$$162{,}45\ (\mathrm{kN}) \geq 158{,}06(kN)$$

uvjet zadovoljen

6. SPOJEVI

6.1. Spoj stupa s pločom

Steel connection

Name	spoj stupa s pločom
Node	N1510
Connection type	Frame bolted
Connection geometry	Column base
Calculation type	Internal forces
Lc/Combi	GSN7

Connected beams

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
pp12790	S1 - HEA280	S 355	4,500	N1510	N10202	beam (80)

Parts of connection

Bolts

M24 - 5.6 (ISO 4014, ISO 4032, ISO 7089)			
Name		Bolt pattern	4 bolts/row
Internal bolts distance [mm]	110	External bolts distance [mm]	80
Length [mm]	820	Reference	Bottom of the beam
1.Location [mm]	330	2.Location [mm]	
5.Location [mm]	-60	6.Location [mm]	

End-plate

EP1			
Material	S 355	Left extension [mm]	80
Thickness[mm]	25	Right extension [mm]	80
Input	Top/Bottom/Left/Right	Total width [mm]	440
Top extension [mm]	100	Total height [mm]	470
Bottom extension [mm]	100		

Connection analysis: Side [pp12790]

According to EN 1993-1-8
National annex: Standard EN

Partial safety factors	
Gamma M0	1.00
Gamma M1	1.00
Gamma M2	1.25
Gamma M3	1.25
Gamma c	1.50

1. Internal forces

GSN7		
NEd	-200.40	kN
Vz,Ed	37.94	kN
My,Ed	-145.93	kNm

Left side in Tension, Right side in Compression.

...::STRONG-AXIS CALCULATION::..

2. T-stub in compression
According to EN 1993-1-8 Article 6.2.5

Bearing width data		
α	1.50	-
βj	0.60	-
fcd	26.67	MPa
fj	24.00	MPa
c	55.51	mm

3. Design moment resistance Mj,y,Rd
3.1. Design resistance of basic components
3.1.1. Column flange and web in compression - Right side
According to EN 1993-1-8 Article 6.2.6.7

Fc,fb,Rd data		
Section class	3	
Mc,Rd	358.55	kNm
hb-tfb	257.00	mm
Fc,fb,Rd	1395.14	kN

3.1.2. Concrete in compression under the right column flange
According to EN 1993-1-8 Article 6.2.6.9

Fc,pl,Rd data		
beff	124.02	mm
leff	391.02	mm
Aeff	48496.50	mm^2
Fc,pl,Rd	1163.92	kN

3.1.3. Design tension resistance of anchor row
(effective lengths in mm, resistance in kN)

Ft,Rd data		
fub	500.00	MPa
As	353.00	mm^2
k2	0.90	-
Beta	0.85	-
Ft,Rd	108.02	kN
Lb	261.75	mm

Note: The bolt-rows are numbered starting from the bolt-row farthest from the centre of compression as given by EN 1993-1-8 Article 6.2.7.2 (1).

Note: The effective lengths and resistances of bolt-rows are calculated considering 4 bolts per row.

Note: The Alternative method for FT,1,Rd according to EN 1993-1-8 Article 6.2.4, Table 6.2 is used.

3.1.4. Base plate under the left column flange
According to EN 1993-1-8 Article 6.2.6.11, 6.2.6.8
(effective lengths in mm, resistance in kN)

row	m2U	m2L	limit	near flange U	near flange L	Classification
1	-	-	-	-	-	Bolt-row outside of beam

row	p (p1+p2)	e	ex	m	mx	n	λ1U	λ2U	αU	λ1L	λ2L	αL
1	0.00+0.00	85.00	40.00	-	50.95	40.00	-	-	-	-	-	-

row	leff,cp,i	leff,nc,i
1	255.03	220.00

For individual anchor row:

row	leff,1	leff,2	Lb*	Prying forces	FT,1,Rd	FT,2,Rd	FT,3,Rd	Ft,ep,Rd,i
1	220.00	220.00	119.79	X	479.03	479.03	432.07	432.07

row	beff,t,wb	Ft,wb,Rd,i
1	-	-

3.1.4.1. Base plate in bending under the left column flange

row	Ft,pl,Rd,i	Ft,pl,Rd,g	Ft,pl,Rd,r
1	432.07	-	432.07

Ft,pl,Rd = 432.07 kN

3.1.4.2. Column web in tension under the left column flange

row	Ft,wc,Rd,i	Ft,wc,Rd,g	Ft,wc,Rd,r
1	-	-	-

3.2. Determination of Mj,y,Rd
According to EN 1993-1-8 Article 6.2.8.3 Table 6.7

Mj,Rd data		
FT,l,Rd	432.07	kN
zT,l	195.00	mm
FC,r,Rd	1163.92	kN
zC,r	128.50	mm
z	323.50	mm
e	-728.21	mm

Mj,y,Rd = 169.72 kNm

4. Design shear resistance VRd

Vz,Rd data		
Vz,Rd	395.36	kN
Fv,Rd	49.42	kN
e1,ep	40.00	mm
p1	390.00	mm
Alfa_d plate	0.51	
Alfa_b plate	0.51	
Fb,ep,Rd	301.54	kN
Alfa_b (6.2) plate	0.35	
F1,vb,Rd	84.72	kN
F2,vb,Rd	49.42	kN

5. Stiffness calculation

5.1. Design rotational stiffness
According to EN 1993-1-8 Article 6.3.4
Bolt-rows under the left column flange

row	k15[mm]	k16[mm]	keff[mm]
1	11.05	2.16	1.81

Sj data		
kT,l	1.81	mm
zT,l	195.00	mm
kC,r	21.15	mm
zC,r	128.50	mm
z	323.50	mm
ek	103.06	mm
e	-728.21	mm
Sj,ini	42.58	MNm/rad
mu	1.99	
Sj	21.42	MNm/rad

5.2. Stiffness classification
According to EN 1993-1-8 Article 5.2.2.5 (2)

Stiffness data		
frame type	braced	
E	210000.00	MPa
Ic	137000000.00	mm^4
Lc	4500.14	mm
λ0,rel	0.50	-

System RIGID

5.3. Ductility classification
In the endplate we have the following :
t > 0.53 sqrt(fub/fy) d
This results in a non-ductile classification for ductility : class 3.

6. Design Calculations.
6.1. Anchorage length
According to EN 1992-1-1 Article 8.4

Anchorage data		
fctd	1.64	MPa
good bond condition	no	-
μ1	0.70	-
μ2	1.00	-
fbd	2.58	MPa
Ft,bolt	108.02	kN
As,prov	353.00	mm^2
As,req	360.06	mm^2
σ,sd	306.00	MPa
lb,rqd	711.91	mm
bar shape	Straight	-
α1	1.00	-
lbd	711.91	mm

Anchorage data - straight		
d	24.00	mm
lbd,c	555.50	mm

Anchorage data		
lbd	711.91	mm
lbd,c	555.50	mm
lb,min	240.00	mm
lbd	711.91	mm

6.2. Calculation weldsize
6.2.1. Calculation af

data		
Mj,y,Rd	69.75	kNm
α	1.40	
h	257.00	mm
FRd	379.98	kN
Nt,Rd	1292.20	kN
fu	490.00	MPa
β_w	0.90	
minimum af	7.49	mm
af	8.00	mm

6.2.2. Calculation aw

data		
M	69.75	kNm
N	200.40	kN
V	37.94	kN
fu	490.00	MPa
β_w	0.90	
a1	8.00	mm
a3	8.00	mm
l1	280.00	mm
l2	183.00	mm
l3	112.00	mm
A	8430.00	mm^2
I	136013670.50	mm^4
minimum aw (a2)	4.61	mm
aw	5.00	mm

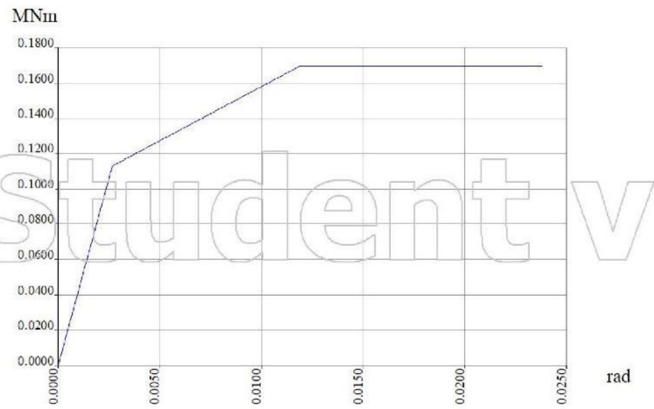
...::RESULTS::...

7. Unity checks

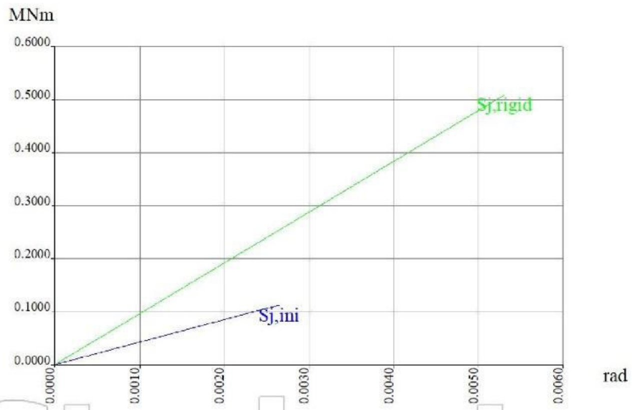
Unity checks	
My,Ed/Mj,y,Rd	0.86
Vz,Ed/Vz,Rd	0.10

The connection satisfies.

Moment-rotation diagram: Side [pp12790] - Strong axis



Stiffness classification: Side [pp12790] - Strong axis



6.2. Montažni nastavak donjeg pojasa

Project:	**Montažni nastavak donjeg pojasa**
Project no:	
Author:	

Project data

Project name	Montažni nastavak donjeg pojasa
Project number	
Author	
Description	
Date	22.6.2019.
Design code	EN

Material

Steel	S 355

Project: Montažni nastavak donjeg pojasa
Project no:
Author:

Project item Con N102

Design

Name	Con N102
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
pp47	8 - SHS400/400/25.0	90,0	-3,9	0,0	0	0	0	Position
pp48	10 - SHS400/400/25.0	-90,0	3,9	0,0	0	0	0	Position

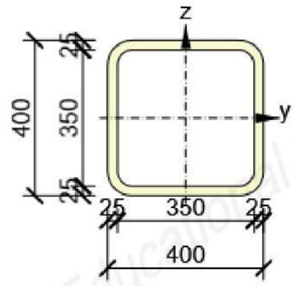
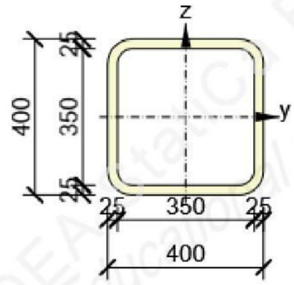
Cross-sections

Name	Material
8 - SHS400/400/25.0	S 355
10 - SHS400/400/25.0	S 355

Project: **Montažni nastavak donjeg pojasa**
Project no:
Author:

IDEA StatiCa® Calculate yesterday's estimates

Cross-sections

Name	Material	Drawing
8 - SHS400/400/25.0	S 355	
10 - SHS400/400/25.0	S 355	

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M22 5.6	M22 5.6	22	500,0	380

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE	pp47	342,8	-46,9	38,4	-57,9	39,7	-70,6
	pp48	342,8	-46,9	-38,4	-57,9	39,7	70,6

Check

Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	0,3 < 5%	OK
Bolts	95,0 < 100%	OK
Welds	98,4 < 100%	OK
Buckling	Not calculated	

Project:	**Montažni nastavak donjeg pojasa**
Project no:	
Author:	

Plates

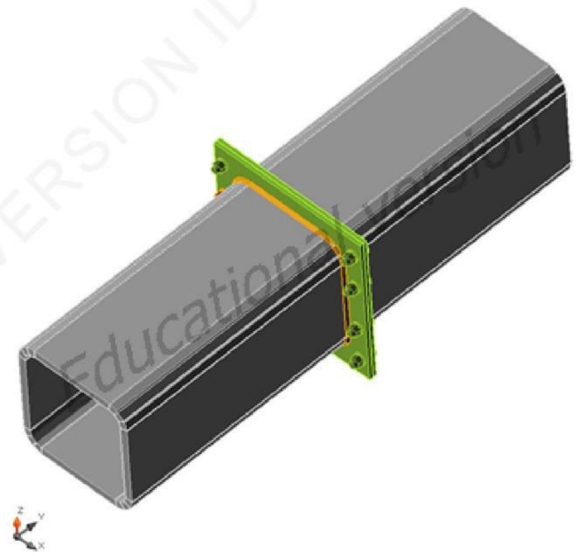
Name	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	Status
pp47	25,0	LE	296,4	0,0	OK
pp48	25,0	LE	300,1	0,0	OK
PP1a	12,0	LE	355,7	0,3	OK
PP1b	12,0	LE	355,6	0,3	OK

Design data

Material	f_y [MPa]	ε_{lim} [%]
S 355	355,0	5,0

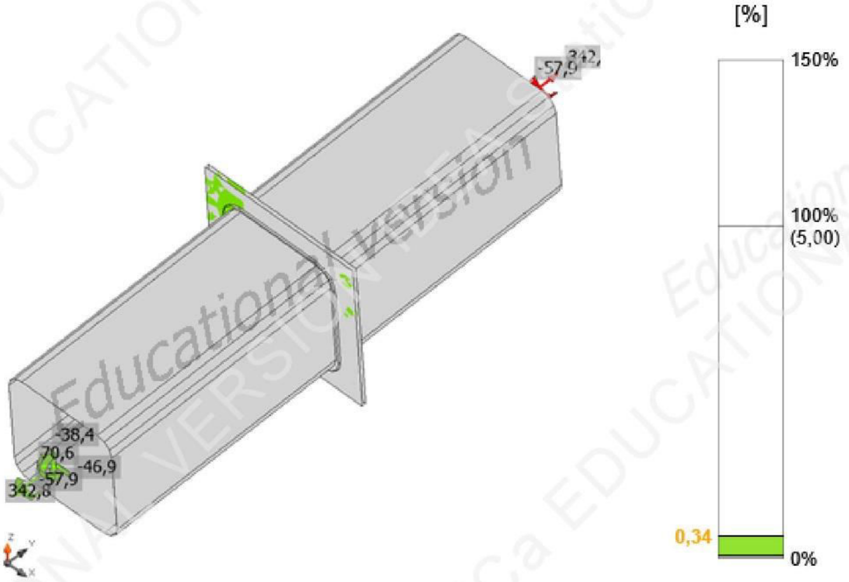
Symbol explanation

ε_{Pl}	Strain
σ_{Ed}	Eq. stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

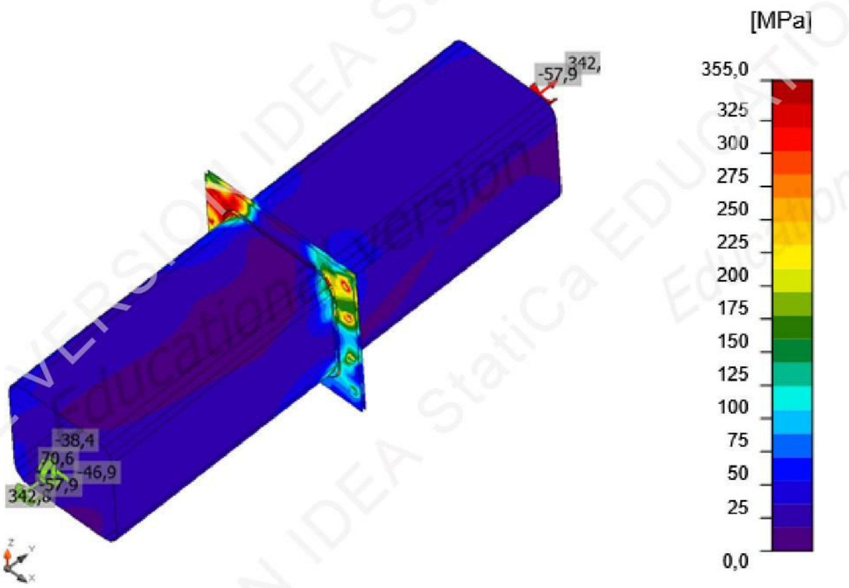


Overall check, LE

Project: **Montažni nastavak donjeg pojasa**
Project no:
Author:



Strain check, LE

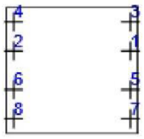


Equivalent stress, LE

Project: Montažni nastavak donjeg pojasa
Project no:
Author:

IDEA StatiCa®
Calculate yesterday's estimates

Bolts

	Name	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	LE	103,7	13,7	95,0	189,1	18,8	86,7	OK
	B2	LE	68,9	23,0	63,2	190,0	31,6	76,7	OK
	B3	LE	91,6	19,0	84,0	197,2	26,1	86,1	OK
	B4	LE	67,0	24,7	61,4	189,8	33,9	77,8	OK
	B5	LE	93,1	18,2	85,4	215,9	25,0	86,0	OK
	B6	LE	32,6	35,2	29,9	207,8	48,4	69,8	OK
	B7	LE	67,3	27,1	61,7	152,2	37,3	81,3	OK
	B8	LE	0,8	43,6	0,7	145,6	59,9	60,4	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M22 5.6 - 1	109,1	305,9	72,7

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Project: Montažni nastavak donjeg pojasa
Project no:
Author:

Detailed result for B1

Tension resistance check (EN 1993-1-8 Table 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 109,1 kN ≥ $F_t =$ 103,7 kN

where:

$k_2 = 0{,}90$ – Factor

$f_{ub} = 500{,}0$ MPa – Ultimate tensile strength of the bolt

$A_s = 303$ mm^2 – Tensile stress area of the bolt

$\gamma_{M2} = 1{,}25$ – Safety factor

Punching resistance check (EN 1993-1-8 Table 3.4)

$B_{p,Rd} = \frac{0{,}6 \pi d_m t_p f_u}{\gamma_{M2}} =$ 305,9 kN ≥ $F_t =$ 103,7 kN

where:

$d_m = 35$ mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

$t_p = 12$ mm – Thickness

$f_u = 490{,}0$ MPa – Ultimate strength

$\gamma_{M2} = 1{,}25$ – Safety factor

Shear resistance check (EN 1993-1-8 Table 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 72,7 kN ≥ $V =$ 13,7 kN

where:

$\beta_p = 1{,}00$ – Reducing factor

$\alpha_v = 0{,}60$ – Reducing factor

$f_{ub} = 500{,}0$ MPa – Ultimate tensile strength of the bolt

$A = 303$ mm^2 – Tensile stress area of the bolt

$\gamma_{M2} = 1{,}25$ – Safety factor

Project: Montažni nastavak donjeg pojasa
Project no:
Author:

Bearing resistance check (EN 1993-1-8 Table 3.4)

$$F_{b,Rd} = \frac{k_1 \alpha_b f_u d t}{\gamma_{M2}} = \quad 189{,}1 \quad \text{kN} \quad \geq \quad V = \quad 13{,}7 \quad \text{kN}$$

where:

$k_1 = 1{,}83$ – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = 1{,}00$ – Factor

$f_u = 490{,}0$ MPa – Ultimate strength

$d = 22$ mm – Nominal diameter of the fastener

$t = 12$ mm – Thickness

$\gamma_{M2} = 1{,}25$ – Safety factor

Interaction of tension and shear (EN 1993-1-8 Table 3.4)

$$U_{tts} = \frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1{,}4 F_{t,Rd}} = \quad 86{,}7 \quad \%$$

Utilization in tension

$$U_{tt} = \frac{F_{t,Ed}}{\min(F_{t,Rd}; B_{p,Rd})} = \quad 95{,}0 \quad \%$$

Utilization in shear

$$U_{ts} = \frac{V_{Ed}}{\min(F_{v,Rd}; F_{b,Rd})} = \quad 18{,}8 \quad \%$$

Symbol explanation

$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$	Tension force
$B_{p,Rd}$	Punching shear resistance
V	Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$	Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear
Ut_{ts}	Utilization in tension and shear EN 1993-1-8 table 3.4

Project: Montažni nastavak donjeg pojasa
Project no:
Author:

Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut$_c$ [%]	Status
		◢6,0◣	1411	LE	415,5	0,0	-222,6	89,5	-181,7	95,4	26,8	OK
PP1a	pp47	◢6,0◣	1411	LE	428,5	1,0	252,1	31,1	197,6	98,4	36,0	OK
		◢6,0◣	1411	LE	428,5	1,0	249,3	-44,3	-196,3	98,4	37,8	OK
PP1b	pp48	◢6,0◣	1411	LE	422,0	0,0	-240,6	-47,3	194,5	96,9	28,0	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 355	0,90	435,6	352,8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_{\perp}$	Perpendicular stress
$\tau_{\parallel}$	Shear stress parallel to weld axis
$\tau_{\perp}$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

Detailed result for PP1a pp47

Weld resistance check (EN 1993-1-8 4.5.3.2)

$$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) = 435{,}6 \text{ MPa} \geq \sigma_{w,Ed} = [\sigma_{\perp}^2 + 3(\tau_{\perp}^2 + \tau_{\parallel}^2)]^{0,5} = 428{,}5 \text{ MPa}$$

$$\sigma_{\perp,Rd} = 0,9 f_u/\gamma_{M2} = 352{,}8 \text{ MPa} \geq |\sigma_{\perp}| = 249{,}3 \text{ MPa}$$

where:

$f_u = 490{,}0$ MPa – Ultimate strength

$\beta_w = 0{,}90$ – appropriate correlation factor taken from Table 4.1

$\gamma_{M2} = 1{,}25$ – Safety factor

Stress utilization

$$U_t = \max\left(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}}; \frac{|\sigma_{\perp}|}{\sigma_{\perp,Rd}}\right) = 98{,}4 \ \%$$

Buckling

Buckling analysis was not calculated.

Project: Montažni nastavak donjeg pojasa
Project no:
Author:

Code settings

Item	Value	Unit	Reference
γ_{M0}	1,00	-	EN 1993-1-1: 6.1
γ_{M1}	1,00	-	EN 1993-1-1: 6.1
γ_{M2}	1,25	-	EN 1993-1-1: 6.1
γ_{M3}	1,25	-	EN 1993-1-8: 2.2
γ_{C}	1,50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient βj	0,67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0,10	-	
Friction coefficient - concrete	0,25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0,30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0,05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2,20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1,20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance	Yes		ETAG 001-C
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		
Local deformation check	No		
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1

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6.3. Montažni nastavak gornjeg pojasa

Project: **Montažni nastavak gornjeg pojasa**
Project no:
Author:

Project data

Project name	Montažni nastavak gornjeg pojasa
Project number	
Author	
Description	
Date	22.6.2019.
Design code	EN

Material

Steel	S 355

Project:	**Montažni nastavak gornjeg pojasa**
Project no:	
Author:	

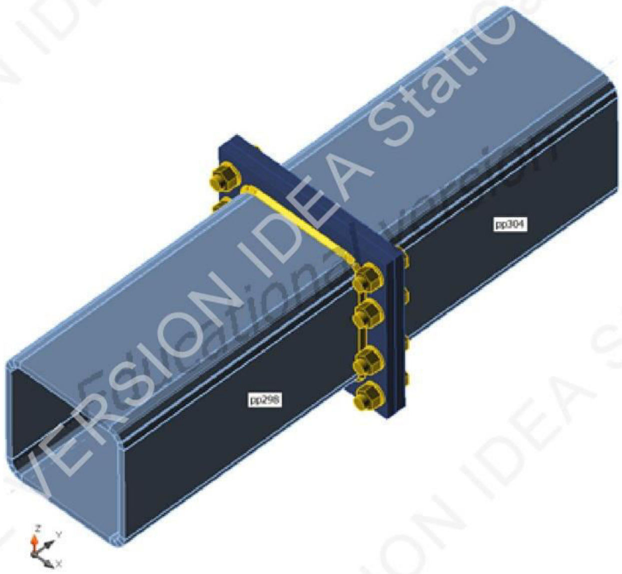
Project item Con N314

Design

Name	Con N314
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
pp304	6 - SHS400/400/20.0	90,0	-0,5	0,0	0	0	0	Position
pp298	5 - SHS400/400/20.0	-90,0	0,5	0,0	0	0	0	Position

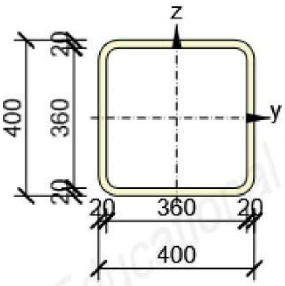
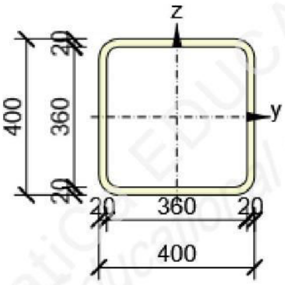


Cross-sections

Name	Material
6 - SHS400/400/20.0	S 355
5 - SHS400/400/20.0	S 355

Project: Montažni nastavak gornjeg pojasa
Project no:
Author:

Cross-sections

Name	Material	Drawing
6 - SHS400/400/20.0	S 355	
5 - SHS400/400/20.0	S 355	

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M36 5.6	M36 5.6	36	500,0	1018

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE	pp304	2180,1	-6,3	-26,5	-0,5	-5,6	-3,5
	pp298	2180,1	-6,3	26,5	-0,5	-5,6	3,5

Check

Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	0,2 < 5%	OK
Bolts	97,1 < 100%	OK
Welds	99,7 < 100%	OK
Buckling	Not calculated	

Project: **Montažni nastavak gornjeg pojasa**
Project no:
Author:

IDEA StatiCa® Calculate yesterday's estimates

Plates

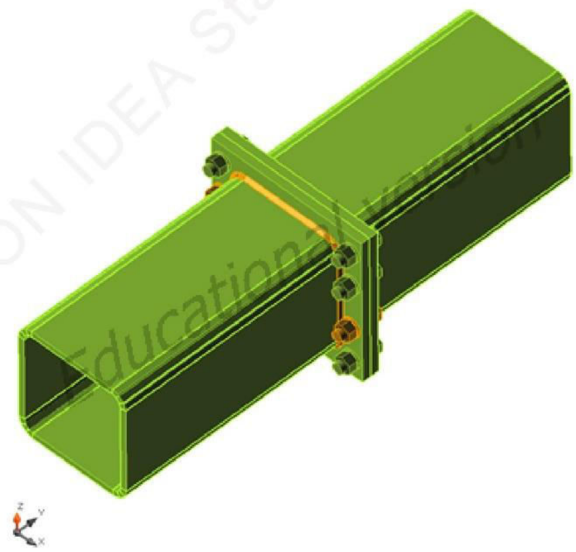
Name	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	Status
pp304	20,0	LE	355,2	0,1	OK
pp298	20,0	LE	355,2	0,1	OK
PP1a	30,0	LE	355,4	0,2	OK
PP1b	30,0	LE	355,4	0,2	OK

Design data

Material	f_y [MPa]	ε_{lim} [%]
S 355	355,0	5,0

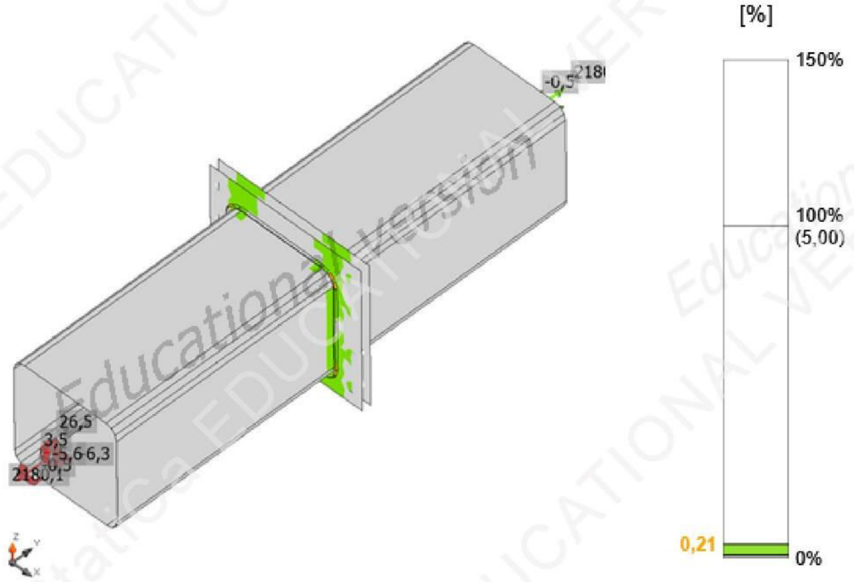
Symbol explanation

ε_{Pl}	Strain
σ_{Ed}	Eq. stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

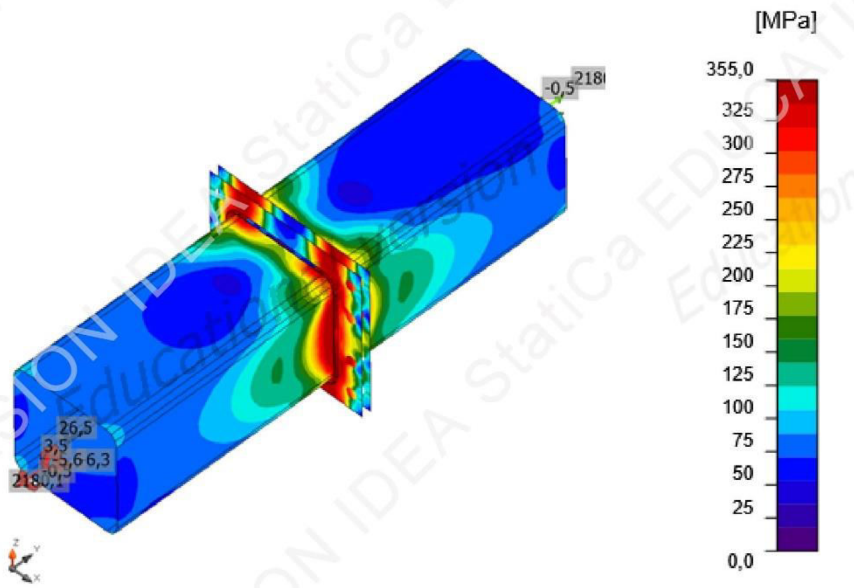


Overall check, LE

Project: **Montažni nastavak gornjeg pojasa**
Project no:
Author:



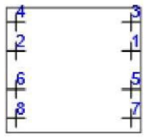
Strain check, LE



Equivalent stress, LE

Project: Montažni nastavak gornjeg pojasa
Project no:
Author:

Bolts

	Name	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	LE	282,1	3,2	95,9	523,9	1,6	70,1	OK
	B2	LE	278,3	2,9	94,6	529,8	1,5	69,0	OK
	B3	LE	243,3	3,8	82,7	260,9	1,9	61,0	OK
	B4	LE	241,1	3,5	82,0	284,9	1,8	60,4	OK
	B5	LE	285,6	3,1	97,1	534,3	1,6	70,9	OK
	B6	LE	281,8	2,8	95,8	545,8	1,4	69,8	OK
	B7	LE	249,1	4,0	84,7	302,4	2,0	62,5	OK
	B8	LE	247,0	3,3	84,0	281,8	1,7	61,7	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M36 5.6 - 1	294,1	1285,7	196,1

Project: **Montažni nastavak gornjeg pojasa**
Project no:
Author:

Detailed result for B5

Tension resistance check (EN 1993-1-8 Table 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 294,1 kN ≥ $F_t =$ 285,6 kN

where:

$k_2 = 0,90$ – Factor

$f_{ub} = 500,0$ MPa – Ultimate tensile strength of the bolt

$A_s = 817$ mm^2 – Tensile stress area of the bolt

$\gamma_{M2} = 1,25$ – Safety factor

Punching resistance check (EN 1993-1-8 Table 3.4)

$B_{p,Rd} = \frac{0,6 \pi d_m t_p f_u}{\gamma_{M2}} =$ 1285,7 kN ≥ $F_t =$ 285,6 kN

where:

$d_m = 58$ mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

$t_p = 30$ mm – Thickness

$f_u = 490,0$ MPa – Ultimate strength

$\gamma_{M2} = 1,25$ – Safety factor

Shear resistance check (EN 1993-1-8 Table 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 196,1 kN ≥ $V =$ 3,1 kN

where:

$\beta_p = 1,00$ – Reducing factor

$\alpha_v = 0,60$ – Reducing factor

$f_{ub} = 500,0$ MPa – Ultimate tensile strength of the bolt

$A = 817$ mm^2 – Tensile stress area of the bolt

$\gamma_{M2} = 1,25$ – Safety factor

Project: Montažni nastavak gornjeg pojasa
Project no:
Author:

Bearing resistance check (EN 1993-1-8 Table 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u d t}{\gamma_{M2}} =$ 534,3 kN ≥ $V =$ 3,1 kN

where:

$k_1 =$ 1,26	– Factor for edge distance and bolt spacing perpendicular to the direction of load transfer
$\alpha_b =$ 1,00	– Factor
$f_u =$ 490,0 MPa	– Ultimate strength
$d =$ 36 mm	– Nominal diameter of the fastener
$t =$ 30 mm	– Thickness
$\gamma_{M2} =$ 1,25	– Safety factor

Interaction of tension and shear (EN 1993-1-8 Table 3.4)

$U_{tts} = \frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1{,}4 F_{t,Rd}} =$ 70,9 %

Utilization in tension

$U_{tt} = \frac{F_{t,Ed}}{\min(F_{t,Rd}; B_{p,Rd})} =$ 97,1 %

Utilization in shear

$U_{ts} = \frac{V_{Ed}}{\min(F_{v,Rd}; F_{b,Rd})} =$ 1,6 %

Symbol explanation

$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$	Tension force
$B_{p,Rd}$	Punching shear resistance
V	Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$	Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear
Ut_{ts}	Utilization in tension and shear EN 1993-1-8 table 3.4

Project: Montažni nastavak gornjeg pojasa
Project no:
Author:

Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\|\|}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut_c [%]	Status
		◢8,0◣	1448	LE	434,2	4,2	279,5	-26,8	-190,0	99,7	67,2	OK
PP1a	pp304	◢8,0◣	1448	LE	429,9	1,7	29,2	54,4	241,6	98,7	58,0	OK
		◢8,0◣	1448	LE	429,8	1,7	28,5	-52,4	-242,0	98,7	58,0	OK
PP1b	pp298	◢8,0◣	1448	LE	434,1	4,2	279,2	25,3	190,3	99,7	67,2	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 355	0,90	435,6	352,8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_{\perp}$	Perpendicular stress
$\tau_{\|\|}$	Shear stress parallel to weld axis
$\tau_{\perp}$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

Weld resistance check (EN 1993-1-8 4.5.3.2)

$$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) = 435{,}6 \text{ MPa} \geq \sigma_{w,Ed} = [\sigma_{\perp}^2 + 3(\tau_{\perp}^2 + \tau_{\|}^2)]^{0,5} = 434{,}2 \text{ MPa}$$

$$\sigma_{\perp,Rd} = 0,9 f_u/\gamma_{M2} = 352{,}8 \text{ MPa} \geq |\sigma_{\perp}| = 279{,}5 \text{ MPa}$$

where:

f_u = 490,0 MPa – Ultimate strength

β_w = 0,90 – appropriate correlation factor taken from Table 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}}; \frac{|\sigma_{\perp}|}{\sigma_{\perp,Rd}}) = 99{,}7 \ \%$$

Buckling

Buckling analysis was not calculated.

Code settings

Project: Montažni nastavak gornjeg pojasa
Project no:
Author:

Item	Value	Unit	Reference
γ_{M0}	1,00	-	EN 1993-1-1: 6.1
γ_{M1}	1,00	-	EN 1993-1-1: 6.1
γ_{M2}	1,25	-	EN 1993-1-1: 6.1
γ_{M3}	1,25	-	EN 1993-1-8: 2.2
γ_{C}	1,50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient βj	0,67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0,10	-	
Friction coefficient - concrete	0,25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0,30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0,05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2,20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1,20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance	Yes		ETAG 001-C
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		
Local deformation check	No		
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1

6.4. Montažni nastavak ispune

Project: **Montažni nastavak ispune**
Project no:
Author:

Project data

Project name	Montažni nastavak ispune
Project number	
Author	
Description	
Date	22.6.2019.
Design code	EN

Material

Steel	S 355

Project: Montažni nastavak ispune
Project no:
Author:

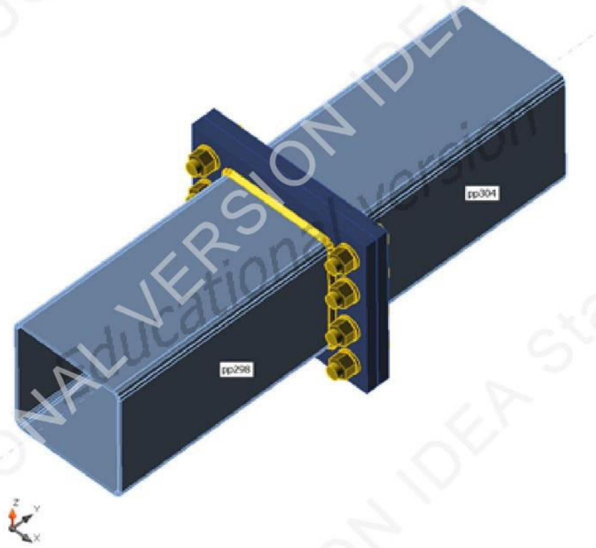
Project item Con N314

Design

Name	Con N314
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
pp304	8 - SHS250/250/6.3	90,0	-0,5	0,0	0	0	0	Position
pp298	7 - SHS250/250/6.3	-90,0	0,5	0,0	0	0	0	Position



Cross-sections

Name	Material
8 - SHS250/250/6.3	S 355
7 - SHS250/250/6.3	S 355

Project: Montažni nastavak ispune
Project no:
Author:

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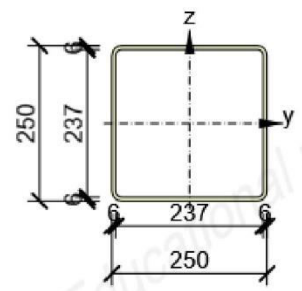
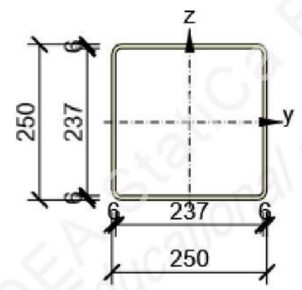
Cross-sections

Name	Material	Drawing
8 - SHS250/250/6.3	S 355	
7 - SHS250/250/6.3	S 355	

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M27 5.6	M27 5.6	27	500,0	573

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE	pp304	1101,0	1,0	17,2	-0,7	-28,3	-2,8
	pp298	1101,0	1,0	-17,2	-0,7	-28,3	-2,8

Check

Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	4,5 < 5%	OK
Bolts	99,7 < 100%	OK
Welds	98,7 < 100%	OK
Buckling	Not calculated	

Project: Montažni nastavak ispune
Project no:
Author:

Plates

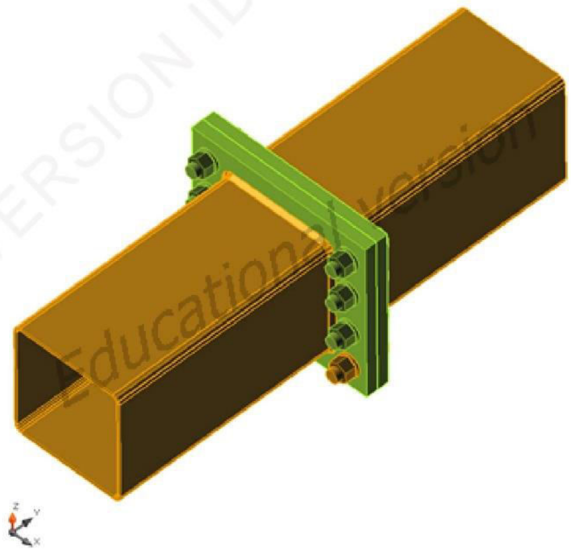
Name	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	Status
pp304	6,3	LE	364,4	4,5	OK
pp298	6,3	LE	364,5	4,5	OK
PP1a	26,0	LE	355,7	0,4	OK
PP1b	26,0	LE	355,8	0,4	OK

Design data

Material	f_y [MPa]	ε_{lim} [%]
S 355	355,0	5,0

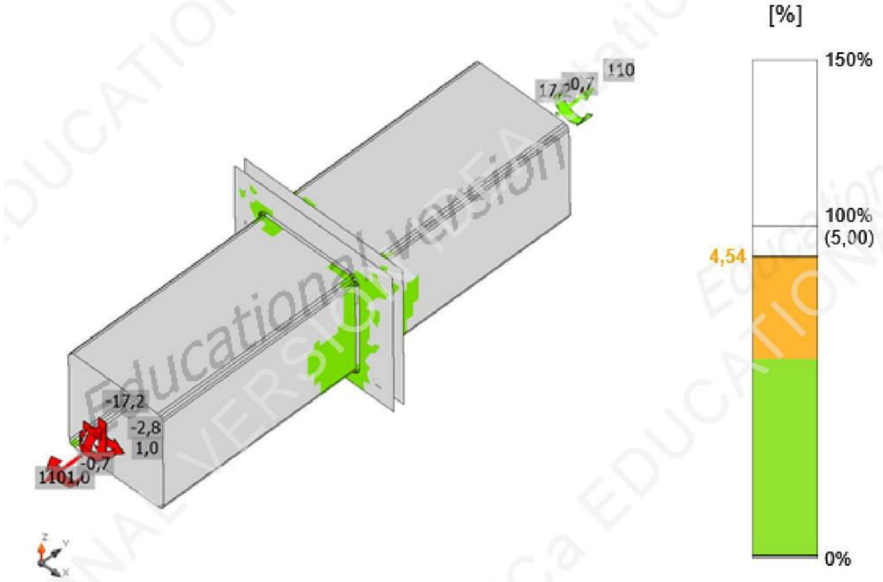
Symbol explanation

ε_{Pl}	Strain
σ_{Ed}	Eq. stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

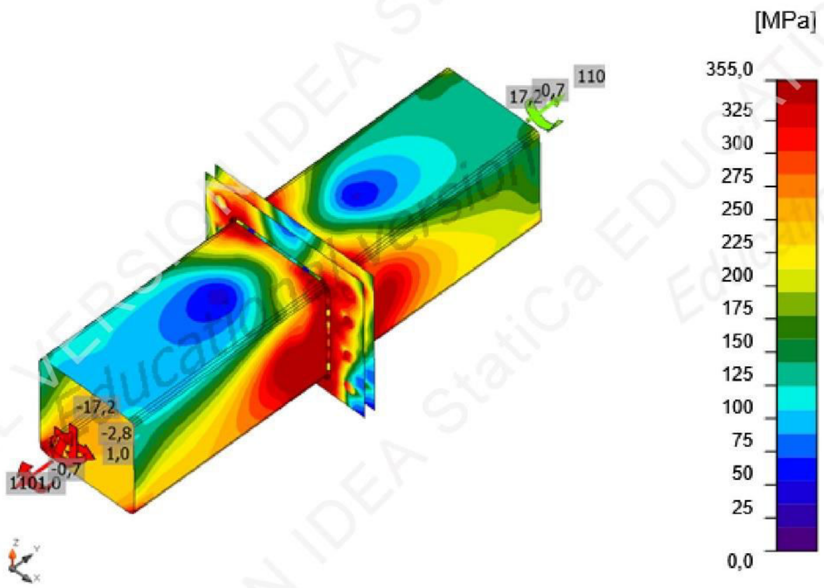


Overall check, LE

Project:	**Montažni nastavak ispune**
Project no:	
Author:	



Strain check, LE

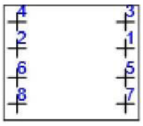


Equivalent stress, LE

Project: Montažni nastavak ispune
Project no:
Author:

IDEA StatiCa
Calculate yesterday's estimates

Bolts

	Name	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	LE	138,8	1,8	84,0	363,5	1,7	61,7	OK
	B2	LE	135,7	2,6	82,1	358,0	2,4	61,0	OK
	B3	LE	118,6	2,5	71,8	322,3	2,3	53,6	OK
	B4	LE	116,4	3,6	70,4	320,7	3,2	53,6	OK
	B5	LE	155,7	1,6	94,2	358,7	1,4	68,7	OK
	B6	LE	153,3	2,1	92,8	358,5	2,0	68,2	OK
	B7	LE	164,7	1,5	99,7	311,5	1,4	72,6	OK
	B8	LE	163,3	2,0	98,8	323,2	1,9	72,4	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M27 5.6 - 1	165,2	826,1	110,2

Project: **Montažni nastavak ispune**
Project no:
Author:

Detailed result for B7

Tension resistance check (EN 1993-1-8 Table 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 165,2 kN ≥ $F_t =$ 164,7 kN

where:

$k_2 = 0{,}90$ – Factor

$f_{ub} = 500{,}0$ MPa – Ultimate tensile strength of the bolt

$A_s = 459$ mm^2 – Tensile stress area of the bolt

$\gamma_{M2} = 1{,}25$ – Safety factor

Punching resistance check (EN 1993-1-8 Table 3.4)

$B_{p,Rd} = \frac{0{,}6 \pi d_m t_p f_u}{\gamma_{M2}} =$ 826,1 kN ≥ $F_t =$ 164,7 kN

where:

$d_m = 43$ mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

$t_p = 26$ mm – Thickness

$f_u = 490{,}0$ MPa – Ultimate strength

$\gamma_{M2} = 1{,}25$ – Safety factor

Shear resistance check (EN 1993-1-8 Table 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 110,2 kN ≥ $V =$ 1,5 kN

where:

$\beta_p = 1{,}00$ – Reducing factor

$\alpha_v = 0{,}60$ – Reducing factor

$f_{ub} = 500{,}0$ MPa – Ultimate tensile strength of the bolt

$A = 459$ mm^2 – Tensile stress area of the bolt

$\gamma_{M2} = 1{,}25$ – Safety factor

Project: Montažni nastavak ispune
Project no:
Author:

Bearing resistance check (EN 1993-1-8 Table 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u d t}{\gamma_{M2}} =$ 311,5 kN ≥ $V =$ 1,5 kN

where:

$k_1 = 2{,}04$ – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = 0{,}56$ – Factor

$f_u = 490{,}0$ MPa – Ultimate strength

$d = 27$ mm – Nominal diameter of the fastener

$t = 26$ mm – Thickness

$\gamma_{M2} = 1{,}25$ – Safety factor

Interaction of tension and shear (EN 1993-1-8 Table 3.4)

$U_{tts} = \frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1{,}4 F_{t,Rd}} =$ 72,6 %

Utilization in tension

$U_{tt} = \frac{F_{t,Ed}}{\min(F_{t,Rd};B_{p,Rd})} =$ 99,7 %

Utilization in shear

$U_{ts} = \frac{V_{Ed}}{\min(F_{v,Rd};F_{b,Rd})} =$ 1,4 %

Symbol explanation

$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$	Tension force
$B_{p,Rd}$	Punching shear resistance
V	Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$	Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear
Ut_{ts}	Utilization in tension and shear EN 1993-1-8 table 3.4

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Project: **Montažni nastavak ispune**
Project no:
Author:

Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_\perp$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_\perp$ [MPa]	Ut [%]	Ut_c [%]	Status
		◢6,0◣	952	LE	429,1	1,3	261,8	-20,6	-195,2	98,5	64,8	OK
PP1a	pp304	◢6,0◣	952	LE	429,8	1,7	129,5	82,7	221,7	98,7	62,1	OK
		◢6,0◣	952	LE	429,9	1,7	130,1	-82,2	-221,8	98,7	62,9	OK
PP1b	pp298	◢6,0◣	952	LE	429,0	1,3	260,9	22,3	195,3	98,5	64,9	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 355	0,90	435,6	352,8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_\perp$	Perpendicular stress
$\tau_{\parallel}$	Shear stress parallel to weld axis
$\tau_\perp$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

Detailed result for PP1a pp304

Weld resistance check (EN 1993-1-8 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 435,6 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0,5} =$ 429,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u/\gamma_{M2} =$ 352,8 MPa ≥ $|\sigma_\perp| =$ 130,1 MPa

where:

$f_u =$ 490,0 MPa – Ultimate strength

$\beta_w =$ 0,90 – appropriate correlation factor taken from Table 4.1

$\gamma_{M2} =$ 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}}; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 98,7 %

Buckling

Buckling analysis was not calculated.

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Project: Montažni nastavak ispune
Project no:
Author:

Code settings

Item	Value	Unit	Reference
γ_{M0}	1,00	-	EN 1993-1-1: 6.1
γ_{M1}	1,00	-	EN 1993-1-1: 6.1
γ_{M2}	1,25	-	EN 1993-1-1: 6.1
γ_{M3}	1,25	-	EN 1993-1-8: 2.2
γ_{C}	1,50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient βj	0,67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0,10	-	
Friction coefficient - concrete	0,25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0,30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0,05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2,20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1,20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance	Yes		ETAG 001-C
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		
Local deformation check	No		
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1

6.5. Spoj donjeg pojasa i ispune rešetke sa stupom

Project: **Spoj donjeg pojasa i ispune rešetke sa stupom**
Project no:
Author:

Project data

Project name	Spoj donjeg pojasa i ispune rešetke sa stupom
Project number	
Author	
Description	
Date	22.6.2019.
Design code	EN

Material

Steel	S 355

Project: Spoj donjeg pojasa i ispune rešetke sa stupom
Project no:
Author:

Project item Con N468

Design

Name	Con N468
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

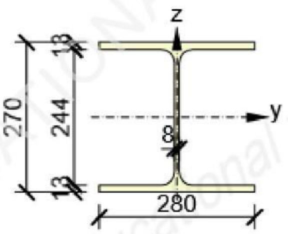
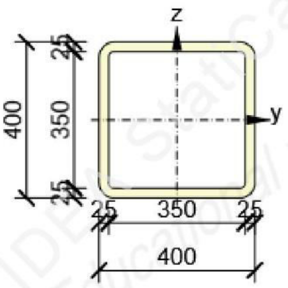
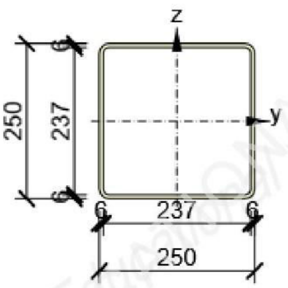
Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
pp11781	3 - HEA280	0,0	-90,0	270,0	0	0	0	Position
pp478	1 - SHS(Ju)400/400/25.0(RHS400x400)	90,0	10,8	0,0	0	0	0	Position
pp3073	2 - SHS250/250/6.3	90,0	-26,6	0,0	0	0	0	Position

Cross-sections

Name	Material
3 - HEA280	S 355
1 - SHS(Ju)400/400/25.0(RHS400x400)	S 355
2 - SHS250/250/6.3	S 355

Project: Spoj donjeg pojasa i ispune rešetke sa stupom
Project no:
Author:

Cross-sections

Name	Material	Drawing
3 - HEA280	S 355	
1 - SHS(Ju)400/400/25.0(RHS400x400)	S 355	
2 - SHS250/250/6.3	S 355	

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm²]
M16 5.6	M16 5.6	16	500,0	201

Project: Spoj donjeg pojasa i ispune rešetke sa stupom
Project no:
Author:

IDEA StatiCa® Calculate yesterday's estimates

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
GSN9(1)	pp11781	-70,0	-2,0	-3,2	0,0	-16,6	5,0
	pp11781	37,3	2,4	1,3	0,0	3,6	-5,0
	pp478	-43,5	-0,2	0,7	1,9	-10,3	-0,4
	pp3073	50,4	0,6	1,5	-1,3	-2,7	1,5
GSN7(2)	pp11781	173,8	2,0	-14,3	-0,1	-58,4	-3,3
	pp11781	-87,3	-9,9	-32,9	0,0	21,6	-1,1
	pp478	162,0	-2,7	-2,1	1,5	-33,6	5,2
	pp3073	-124,1	-5,1	1,4	-0,4	-3,2	-5,1
GSN8(3)	pp11781	72,1	0,7	0,2	0,0	-4,6	-1,7
	pp11781	-102,7	3,1	9,9	0,0	-8,3	9,7
	pp478	-62,6	1,6	-4,0	-5,8	-15,4	-4,9
	pp3073	56,8	2,1	-2,9	0,4	2,5	3,9
GSN11(4)	pp11781	-115,3	-2,3	3,1	0,0	5,9	5,1
	pp11781	28,1	8,0	20,5	0,0	-9,8	0,5
	pp478	-146,4	1,8	0,2	-1,6	-3,6	-4,9
	pp3073	134,2	3,9	-0,4	-0,8	-0,3	5,4
GSN10(5)	pp11781	-109,6	-2,3	3,3	0,0	7,4	5,0
	pp11781	27,8	8,0	19,7	0,0	-9,5	0,5
	pp478	-138,9	1,9	-0,4	-1,6	-2,0	-4,9
	pp3073	126,6	3,8	-0,5	-0,8	-0,2	5,3
GSN3(6)	pp11781	19,2	1,3	-6,3	0,0	-30,6	-2,5
	pp11781	-23,6	0,2	-7,1	0,0	7,4	3,9
	pp478	4,2	1,1	-0,5	-2,1	-20,7	-0,7
	pp3073	10,9	0,4	0,9	0,8	-2,5	0,0
GSN2(7)	pp11781	131,0	1,1	-4,1	0,0	-17,5	-2,2
	pp11781	-99,8	-3,1	-8,0	0,0	2,8	4,3
	pp478	44,5	-0,6	-5,9	-2,2	-15,7	-0,1
	pp3073	-35,0	-1,4	-1,7	-0,1	1,1	-0,2
GSN12(8)	pp11781	11,7	1,3	-3,6	0,0	-17,4	-2,8
	pp11781	-17,2	-0,1	-4,5	0,0	3,9	2,8
	pp478	5,0	-0,3	-1,1	-1,8	-12,7	-1,3
	pp3073	12,7	-0,4	0,4	0,5	-1,4	0,8
GSN12(9)	pp11781	17,3	0,4	-3,8	0,0	-18,2	-0,6
	pp11781	-17,4	0,1	-3,4	0,0	4,5	2,4
	pp478	-4,0	1,6	-1,6	-0,9	-11,7	0,5
	pp3073	4,3	0,8	0,4	0,6	-1,3	-1,0

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Project: Spoj donjeg pojasa i ispune rešetke sa stupom
Project no:
Author:

Check

Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	0,1 < 5%	OK
Bolts	95,7 < 100%	OK
Welds	95,6 < 100%	OK
Buckling	Not calculated	

Plates

Name	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	Status
pp11781-bfl 1	13,0	GSN7(2)	82,1	0,0	OK
pp11781-tfl 1	13,0	GSN7(2)	355,2	0,1	OK
pp11781-w 1	8,0	GSN7(2)	183,4	0,0	OK
pp478	25,0	GSN7(2)	158,5	0,0	OK
pp3073	6,3	GSN7(2)	286,1	0,1	OK
EP1	10,0	GSN7(2)	355,3	0,1	OK

Design data

Material	f_y [MPa]	ε_{lim} [%]
S 355	355,0	5,0

Symbol explanation

ε_{Pl}	Strain
σ_{Ed}	Eq. stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

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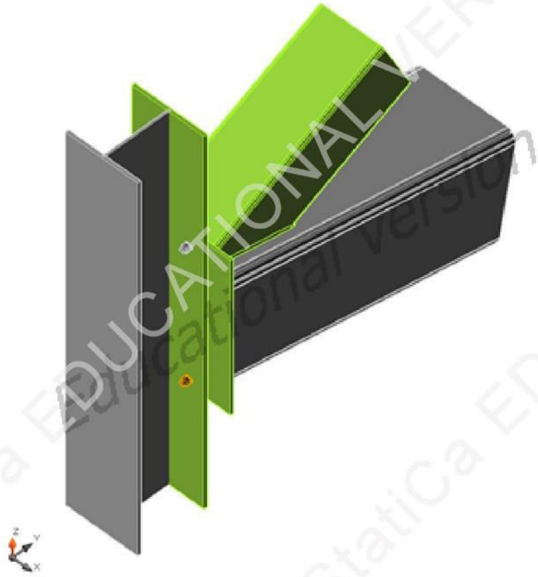
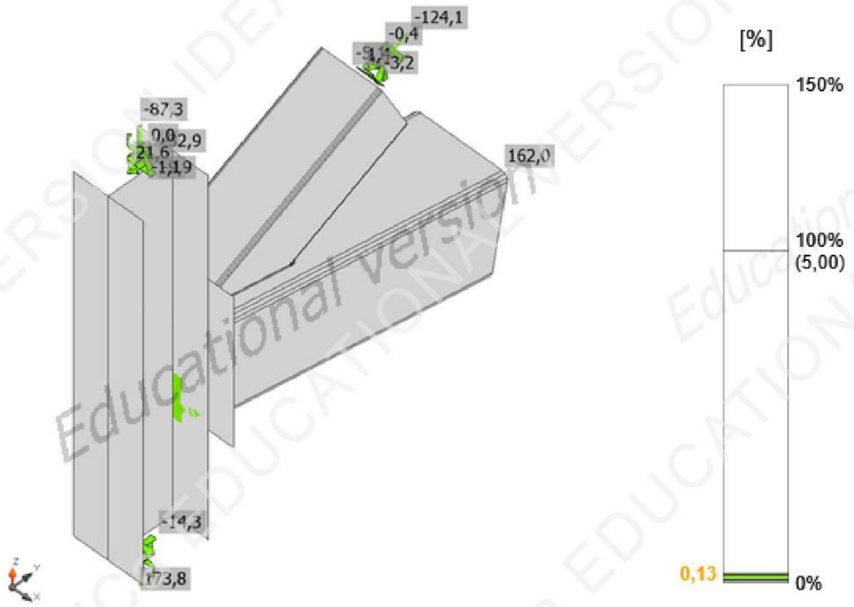
Project: **Spoj donjeg pojasa i ispune rešetke sa stupom**
Project no:
Author:

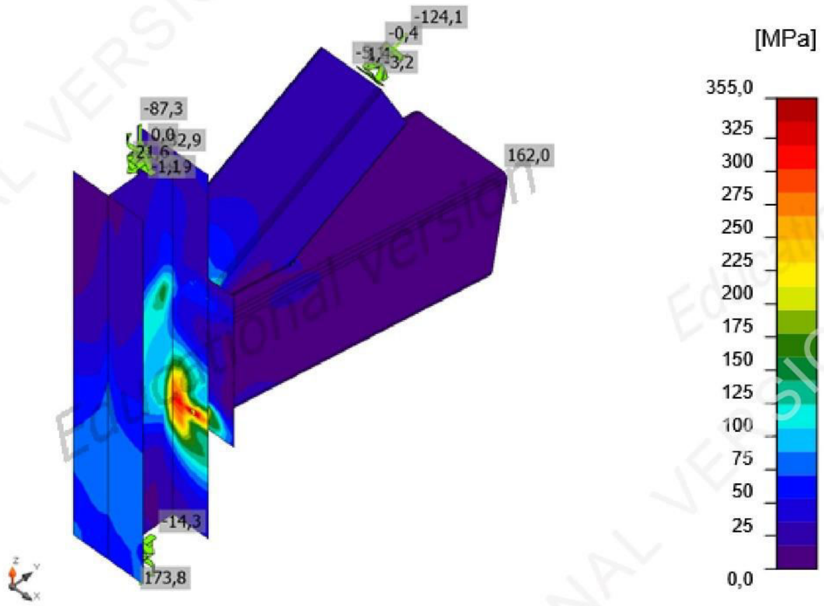


Overall check, GSN7(2)



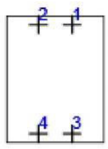
Strain check, GSN7(2)

Project:	**Spoj donjeg pojasa i ispune rešetke sa stupom**
Project no:	
Author:	



Equivalent stress, GSN7(2)

Bolts

	Name	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	GSN11(4)	1,5	2,8	2,7	156,8	7,5	9,4	OK
	B2	GSN11(4)	1,9	4,1	3,3	156,8	10,8	13,2	OK
	B3	GSN7(2)	50,6	2,6	89,6	156,8	7,0	71,0	OK
	B4	GSN7(2)	54,1	0,3	95,7	156,8	0,9	69,3	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M16 5.6 - 1	56,5	188,4	37,7

Project: **Spoj donjeg pojasa i ispune rešetke sa stupom**
Project no:
Author:

Detailed result for B4

Tension resistance check (EN 1993-1-8 Table 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 56,5 kN ≥ $F_t =$ 54,1 kN

where:

$k_2 = 0{,}90$ – Factor

$f_{ub} = 500{,}0$ MPa – Ultimate tensile strength of the bolt

$A_s = 157$ mm^2 – Tensile stress area of the bolt

$\gamma_{M2} = 1{,}25$ – Safety factor

Punching resistance check (EN 1993-1-8 Table 3.4)

$B_{p,Rd} = \frac{0{,}6 \pi d_m t_p f_u}{\gamma_{M2}} =$ 188,4 kN ≥ $F_t =$ 54,1 kN

where:

$d_m = 26$ mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

$t_p = 10$ mm – Thickness

$f_u = 490{,}0$ MPa – Ultimate strength

$\gamma_{M2} = 1{,}25$ – Safety factor

Shear resistance check (EN 1993-1-8 Table 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 37,7 kN ≥ $V =$ 0,3 kN

where:

$\beta_p = 1{,}00$ – Reducing factor

$\alpha_v = 0{,}60$ – Reducing factor

$f_{ub} = 500{,}0$ MPa – Ultimate tensile strength of the bolt

$A = 157$ mm^2 – Tensile stress area of the bolt

$\gamma_{M2} = 1{,}25$ – Safety factor

Project: **Spoj donjeg pojasa i ispune rešetke sa stupom**
Project no:
Author:

Bearing resistance check (EN 1993-1-8 Table 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u d t}{\gamma_{M2}} =$ 156,8 kN ≥ $V =$ 0,3 kN

where:

$k_1 = 2{,}50$ – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = 1{,}00$ – Factor

$f_u = 490{,}0$ MPa – Ultimate strength

$d = 16$ mm – Nominal diameter of the fastener

$t = 10$ mm – Thickness

$\gamma_{M2} = 1{,}25$ – Safety factor

Interaction of tension and shear (EN 1993-1-8 Table 3.4)

$U_{tts} = \frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1{,}4F_{t,Rd}} =$ 69,3 %

Utilization in tension

$U_{tt} = \frac{F_{t,Ed}}{\min(F_{t,Rd};B_{p,Rd})} =$ 95,7 %

Utilization in shear

$U_{ts} = \frac{V_{Ed}}{\min(F_{v,Rd};F_{b,Rd})} =$ 0,9 %

Symbol explanation

$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$	Tension force
$B_{p,Rd}$	Punching shear resistance
V	Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$	Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear
Ut_{ts}	Utilization in tension and shear EN 1993-1-8 table 3.4

Project: **Spoj donjeg pojasa i ispune rešetke sa stupom**
Project no:
Author:

Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_\perp$ [MPa]	$\tau_{\|\|}$ [MPa]	$\tau_\perp$ [MPa]	Ut [%]	Ut_c [%]	Status
		◢4,0◣	1468	GSN7(2)	141,6	0,0	-55,4	-33,9	67,2	32,5	12,5	OK
EP1	pp478	◢4,0◣	1468	GSN7(2)	386,2	0,0	257,7	-53,4	157,3	88,7	17,0	OK
		◢4,0◣	932	GSN7(2)	293,9	0,0	112,5	121,4	99,2	67,5	7,7	OK
pp478-w 3	pp3073	◢4,0◣	932	GSN7(2)	212,7	0,0	79,0	80,1	-81,2	48,8	5,6	OK
		◢4,0◣	283	GSN7(2)	416,2	0,0	126,5	222,2	-55,3	95,6	45,1	OK
pp11781-tfl 1	pp3073	◢4,0◣	283	GSN11(4)	361,2	0,0	87,6	184,3	83,4	82,9	15,6	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 355	0,90	435,6	352,8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_\perp$	Perpendicular stress
$\tau_{\|\|}$	Shear stress parallel to weld axis
$\tau_\perp$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

Detailed result for pp478-w 3 pp3073

Weld resistance check (EN 1993-1-8 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 435,6 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0,5} =$ 416,2 MPa

$\sigma_{\perp,Rd} = 0,9 f_u/\gamma_{M2} =$ 352,8 MPa ≥ $|\sigma_\perp| =$ 126,5 MPa

where:

$f_u =$ 490,0 MPa – Ultimate strength

$\beta_w =$ 0,90 – appropriate correlation factor taken from Table 4.1

$\gamma_{M2} =$ 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}}; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 95,6 %

Project: Spoj donjeg pojasa i ispune rešetke sa stupom
Project no:
Author:

Buckling

Buckling analysis was not calculated.

Code settings

Item	Value	Unit	Reference
γ_{M0}	1,00	-	EN 1993-1-1: 6.1
γ_{M1}	1,00	-	EN 1993-1-1: 6.1
γ_{M2}	1,25	-	EN 1993-1-1: 6.1
γ_{M3}	1,25	-	EN 1993-1-8: 2.2
γ_{C}	1,50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient βj	0,67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0,10	-	
Friction coefficient - concrete	0,25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0,30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0,05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2,20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1,20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance	Yes		ETAG 001-C
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		
Local deformation check	No		
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1

6.6. Spoj gonjeg pojasa rešetke sa stupom

Project: **Spoj gornjeg pojasa rešetke sa stupom**
Project no:
Author:

IDEA StatiCa®
Calculate yesterday's estimates

Project data

Project name	Spoj gornjeg pojasa rešetke sa stupom
Project number	
Author	
Description	
Date	22.6.2019.
Design code	EN

Material

Steel	S 355, BS

Project: Spoj gornjeg pojasa rešetke sa stupom
Project no:
Author:

Project item Con N419

Design

Name	Con N419
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

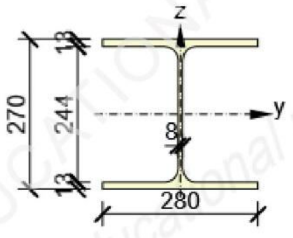
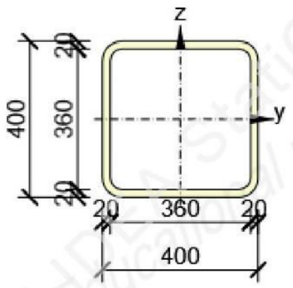
Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
pp11785	3 - HEA280	0,0	90,0	270,0	-270	0	0	Position
pp423	1 - SHS400/400/20.0	90,0	2,9	0,0	0	0	0	Position

Cross-sections

Name	Material
3 - HEA280	S 355
1 - SHS400/400/20.0	S 355

Project: Spoj gornjeg pojasa rešetke sa stupom
Project no:
Author:

Cross-sections

Name	Material	Drawing
3 - HEA280	S 355	
1 - SHS400/400/20.0	S 355	

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M12 5.6	M12 5.6	12	500,0	113

Project: Spoj gornjeg pojasa rešetke sa stupom
Project no:
Author:

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
GSN8(1)	pp11785	-70,0	4,8	-39,4	0,0	20,5	0,0
	pp423	41,0	17,0	2,3	-2,1	-20,6	5,1
GSN9(2)	pp11785	16,6	0,7	-4,7	0,0	6,3	-0,2
	pp423	3,3	0,7	5,8	-0,3	-6,3	-2,2
GSN7(3)	pp11785	-48,7	-2,8	-18,9	0,0	15,7	-1,2
	pp423	20,3	-14,1	-2,1	1,2	-15,7	-11,9
GSN12(4)	pp11785	-9,9	0,5	-8,8	0,0	6,7	-0,3
	pp423	8,8	-3,2	1,5	-0,7	-7,4	4,3
GSN12(5)	pp11785	-10,4	1,1	-7,5	0,0	7,4	-0,4
	pp423	7,5	5,5	2,1	-0,1	-6,7	-8,9
GSN2(6)	pp11785	-62,5	1,0	-30,0	0,0	16,7	-0,3
	pp423	32,6	2,8	-1,0	-0,5	-16,8	-1,1
GSN5(7)	pp11785	-62,2	1,4	-31,7	0,0	19,1	-0,5
	pp423	33,4	3,2	0,6	-0,6	-19,1	-2,4
GSN11(8)	pp11785	6,4	4,1	-13,4	0,0	8,3	0,3
	pp423	11,4	14,5	7,5	-1,7	-8,3	5,4
GSN10(9)	pp11785	6,2	4,1	-12,7	0,0	7,7	0,3
	pp423	11,4	14,4	7,1	-1,8	-7,7	5,3
GSN3(10)	pp11785	-14,5	1,4	-10,7	0,0	10,1	-0,6
	pp423	10,6	1,8	2,7	-0,6	-10,1	-4,1
GSN4(11)	pp11785	-62,5	1,5	-31,0	0,0	18,5	-0,5
	pp423	33,4	3,2	0,2	-0,7	-18,6	-2,5
GSN1(12)	pp11785	-17,4	0,9	-15,0	0,0	10,9	-0,4
	pp423	15,2	1,6	2,7	-0,4	-10,9	-2,3

Check

Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	0,3 < 5%	OK
Bolts	86,9 < 100%	OK
Welds	80,8 < 100%	OK
Buckling	Not calculated	

Project:	**Spoj gornjeg pojasa rešetke sa stupom**
Project no:	
Author:	

Plates

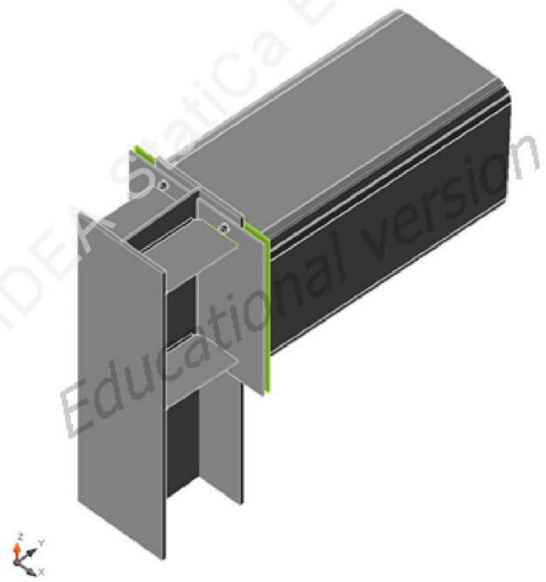
Name	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	Status
pp11785-bfl 1	13,0	GSN7(3)	164,5	0,0	OK
pp11785-tfl 1	13,0	GSN7(3)	260,4	0,0	OK
pp11785-w 1	8,0	GSN7(3)	52,3	0,0	OK
pp423	20,0	GSN7(3)	111,9	0,0	OK
EP1a	6,0	GSN7(3)	355,6	0,3	OK
EP1b	6,0	GSN7(3)	152,8	0,0	OK
EP1c	6,0	GSN8(1)	148,5	0,0	OK
STIFF1a	5,0	GSN8(1)	107,0	0,0	OK
STIFF1b	5,0	GSN12(5)	138,4	0,0	OK
STIFF1c	5,0	GSN8(1)	109,7	0,0	OK
STIFF1d	5,0	GSN7(3)	246,9	0,0	OK

Design data

Material	f_y [MPa]	ε_{lim} [%]
S 355	355,0	5,0

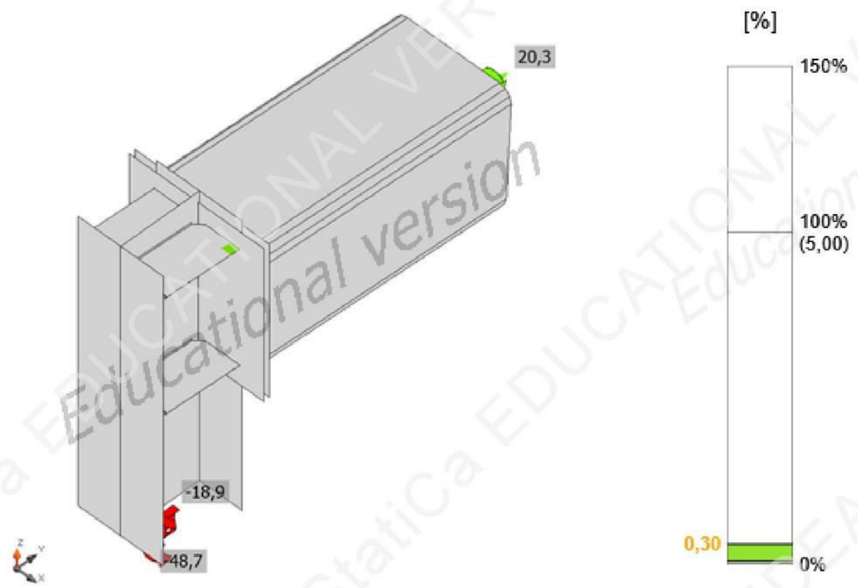
Symbol explanation

ε_{Pl}	Strain
σ_{Ed}	Eq. stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

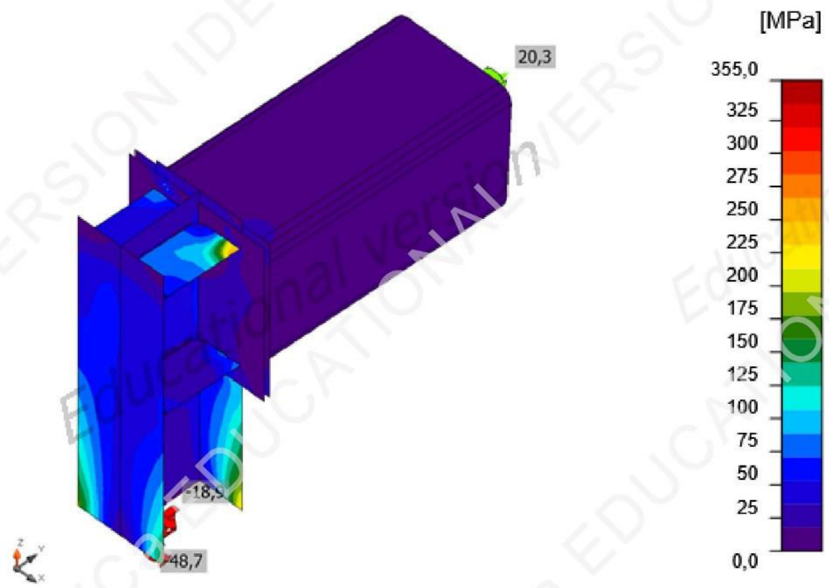


Overall check, GSN7(3)

Project:	**Spoj gornjeg pojasa rešetke sa stupom**
Project no:	
Author:	



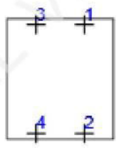
Strain check, GSN7(3)



Equivalent stress, GSN7(3)

Project: Spoj gornjeg pojasa rešetke sa stupom
Project no:
Author:

Bolts



Name	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
B1	GSN7(3)	16,1	4,4	52,7	70,6	21,6	59,2	OK
B2	GSN7(3)	26,6	2,1	86,9	70,6	10,1	72,2	OK
B3	GSN8(1)	1,5	6,3	4,9	70,6	31,0	34,5	OK
B4	GSN8(1)	26,4	2,3	86,2	70,6	11,2	72,8	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M12 5.6 - 1	30,6	86,5	20,4

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Project: **Spoj gornjeg pojasa rešetke sa stupom**
Project no:
Author:

Detailed result for B2

Tension resistance check (EN 1993-1-8 Table 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 30,6 kN ≥ $F_t =$ 26,6 kN

where:

$k_2 = 0{,}90$	– Factor
$f_{ub} = 500{,}0$ MPa	– Ultimate tensile strength of the bolt
$A_s = 85$ mm^2	– Tensile stress area of the bolt
$\gamma_{M2} = 1{,}25$	– Safety factor

Punching resistance check (EN 1993-1-8 Table 3.4)

$B_{p,Rd} = \frac{0{,}6\pi d_m t_p f_u}{\gamma_{M2}} =$ 86,5 kN ≥ $F_t =$ 26,6 kN

where:

$d_m = 20$ mm	– The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller
$t_p = 6$ mm	– Thickness
$f_u = 490{,}0$ MPa	– Ultimate strength
$\gamma_{M2} = 1{,}25$	– Safety factor

Shear resistance check (EN 1993-1-8 Table 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 20,4 kN ≥ $V =$ 2,1 kN

where:

$\beta_p = 1{,}00$	– Reducing factor
$\alpha_v = 0{,}60$	– Reducing factor
$f_{ub} = 500{,}0$ MPa	– Ultimate tensile strength of the bolt
$A = 85$ mm^2	– Tensile stress area of the bolt
$\gamma_{M2} = 1{,}25$	– Safety factor

Project: **Spoj gornjeg pojasa rešetke sa stupom**
Project no:
Author:

Bearing resistance check (EN 1993-1-8 Table 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u d t}{\gamma_{M2}} =$ 70,6 kN ≥ $V =$ 2,1 kN

where:

$k_1 = 2,50$ – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = 1,00$ – Factor

$f_u = 490,0$ MPa – Ultimate strength

$d = 12$ mm – Nominal diameter of the fastener

$t = 6$ mm – Thickness

$\gamma_{M2} = 1,25$ – Safety factor

Interaction of tension and shear (EN 1993-1-8 Table 3.4)

$U_{tts} = \frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1,4 F_{t,Rd}} =$ 72,2 %

Utilization in tension

$U_{tt} = \frac{F_{t,Ed}}{\min(F_{t,Rd}; B_{p,Rd})} =$ 86,9 %

Utilization in shear

$U_{ts} = \frac{V_{Ed}}{\min(F_{v,Rd}; F_{b,Rd})} =$ 10,1 %

Symbol explanation

$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$	Tension force
$B_{p,Rd}$	Punching shear resistance
V	Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$	Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear
Ut_{ts}	Utilization in tension and shear EN 1993-1-8 table 3.4

Project: Spoj gornjeg pojasa rešetke sa stupom
Project no:
Author:

Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut_c [%]	Status
pp11785-bfl 1	STIFF1a	◢4,0◣	112	GSN7(3)	45,9	0,0	3,8	22,6	13,7	10,5	5,2	OK
		◢4,0◣	112	GSN7(3)	52,9	0,0	4,6	-30,1	4,5	12,1	7,8	OK
pp11785-w 1	STIFF1a	◢4,0◣	196	GSN7(3)	49,8	0,0	3,4	-28,4	-4,0	11,4	10,3	OK
		◢4,0◣	196	GSN7(3)	40,6	0,0	3,0	20,9	-10,3	9,3	4,9	OK
pp11785-tfl 1	STIFF1a	◢4,0◣	112	GSN8(1)	124,0	0,0	33,2	56,8	39,1	28,5	15,3	OK
		◢4,0◣	112	GSN7(3)	103,4	0,0	41,5	0,6	-54,7	23,7	15,2	OK
pp11785-bfl 1	STIFF1b	◢4,0◣	112	GSN12(5)	37,5	0,0	0,3	-20,9	5,8	8,6	6,2	OK
		◢4,0◣	112	GSN8(1)	34,5	0,0	5,6	-16,7	-10,4	7,9	3,2	OK
pp11785-w 1	STIFF1b	◢4,0◣	196	GSN8(1)	37,3	0,0	4,2	-21,4	-0,7	8,6	5,5	OK
		◢4,0◣	196	GSN8(1)	45,3	0,0	-1,2	25,9	-3,6	10,4	7,9	OK
pp11785-tfl 1	STIFF1b	◢4,0◣	112	GSN12(5)	203,7	0,0	-83,5	-67,9	-83,1	46,8	17,9	OK
		◢4,0◣	112	GSN12(5)	179,9	0,0	-73,8	59,3	73,9	41,3	17,4	OK
pp11785-bfl 1	STIFF1c	◢4,0◣	112	GSN7(3)	30,3	0,0	-0,7	16,6	5,5	7,0	4,0	OK
		◢4,0◣	112	GSN7(3)	40,0	0,0	-2,2	-21,6	8,1	9,2	6,1	OK
pp11785-w 1	STIFF1c	◢4,0◣	196	GSN7(3)	47,4	0,0	-7,5	-21,1	-16,9	10,9	7,9	OK
		◢4,0◣	196	GSN8(1)	25,3	0,0	-2,0	-13,3	6,0	5,8	3,1	OK
pp11785-tfl 1	STIFF1c	◢4,0◣	112	GSN12(4)	95,1	0,0	-41,9	-26,4	-41,6	21,8	8,5	OK
		◢4,0◣	112	GSN8(1)	106,6	0,0	-55,0	30,2	43,2	24,5	13,3	OK
pp11785-bfl 1	STIFF1d	◢4,0◣	112	GSN7(3)	62,9	0,0	-3,2	-36,1	3,5	14,4	8,9	OK
		◢4,0◣	112	GSN7(3)	59,5	0,0	-6,3	31,4	13,5	13,7	6,5	OK
pp11785-w 1	STIFF1d	◢4,0◣	196	GSN7(3)	59,2	0,0	-0,3	32,9	-9,0	13,6	7,0	OK
		◢4,0◣	196	GSN7(3)	74,2	0,0	-0,6	-42,1	-8,1	17,0	13,7	OK
pp11785-tfl 1	STIFF1d	◢4,0◣	112	GSN7(3)	351,9	0,0	-155,2	-99,6	-152,7	80,8	30,0	OK
		◢4,0◣	112	GSN7(3)	308,2	0,0	-133,5	85,6	135,6	70,8	26,9	OK
		◢4,0◣	1449	GSN7(3)	233,8	0,0	152,2	23,4	-99,8	53,7	9,4	OK
EP1a	pp423	◢4,0◣	1449	GSN7(3)	156,3	0,0	-69,0	19,1	-78,7	35,9	6,8	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 355	0,90	435,6	352,8

Project: **Spoj gornjeg pojasa rešetke sa stupom**
Project no:
Author:

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_{\perp}$	Perpendicular stress
$\tau_{\parallel}$	Shear stress parallel to weld axis
$\tau_{\perp}$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

Detailed result for pp11785-tfl 1 STIFF1d

Weld resistance check (EN 1993-1-8 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 435,6 MPa ≥ $\sigma_{w,Ed} = [\sigma_{\perp}^2 + 3(\tau_{\perp}^2 + \tau_{\parallel}^2)]^{0,5} =$ 351,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u/\gamma_{M2} =$ 352,8 MPa ≥ $|\sigma_{\perp}| =$ 155,2 MPa

where:

$f_u =$ 490,0 MPa – Ultimate strength

$\beta_w =$ 0,90 – appropriate correlation factor taken from Table 4.1

$\gamma_{M2} =$ 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}}; \frac{|\sigma_{\perp}|}{\sigma_{\perp,Rd}}) =$ 80,8 %

Buckling

Buckling analysis was not calculated.

Code settings

Item	Value	Unit	Reference
γ_{M0}	1,00	-	EN 1993-1-1: 6.1
γ_{M1}	1,00	-	EN 1993-1-1: 6.1
γ_{M2}	1,25	-	EN 1993-1-1: 6.1
γ_{M3}	1,25	-	EN 1993-1-8: 2.2
γ_C	1,50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient βj	0,67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0,10	-	
Friction coefficient - concrete	0,25	-	EN 1993-1-8

Project: **Spoj gornjeg pojasa rešetke sa stupom**
Project no:
Author:

Item	Value	Unit	Reference
Friction coefficient in slip-resistance	0,30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0,05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2,20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1,20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance	Yes		ETAG 001-C
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		
Local deformation check	No		
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1

6.7. Spoj ispune s donjim pojasom

Project: **Spoj ispune s donjim pojasom**
Project no:
Author:

Project data

Project name	Spoj ispune s donjim pojasom
Project number	
Author	
Description	
Date	22.6.2019.
Design code	EN

Material

Steel	S 355

Project: Spoj ispune s donjim pojasom
Project no:
Author:

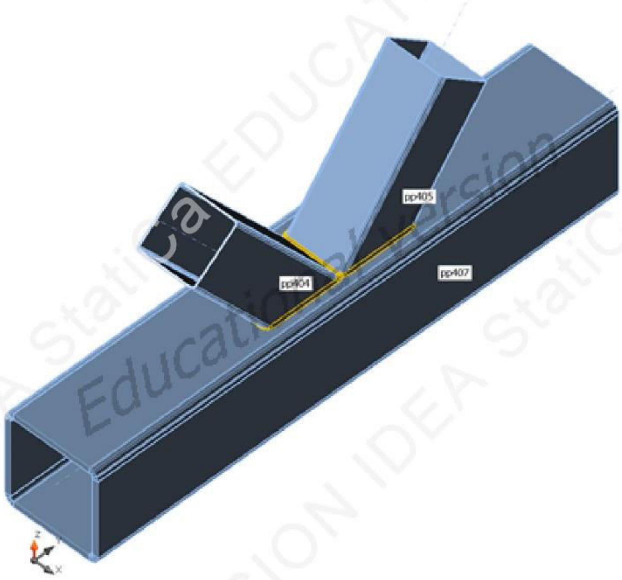
Project item Con N404

Design

Name	Con N404
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
pp407	2 - SHS(Ju)400/400/25.0(RHS400x400)	-90,0	0,0	0,0	0	0	0	Position
pp405	1 - SHS250/250/6.3	90,0	-51,3	0,0	0	0	0	Position
pp404	1 - SHS250/250/6.3	-90,0	-51,3	0,0	0	0	0	Position



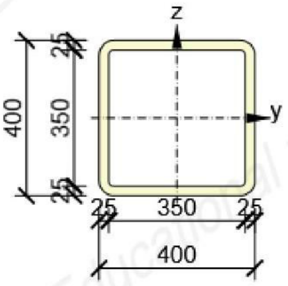
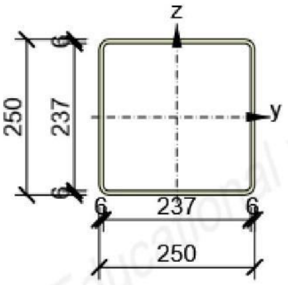
Cross-sections

Name	Material
2 - SHS(Ju)400/400/25.0(RHS400x400)	S 355
1 - SHS250/250/6.3	S 355

Project: Spoj ispune s donjim pojasom
Project no:
Author:

IDEA StatiCa
Calculate yesterday's estimates

Cross-sections

Name	Material	Drawing
2 - SHS(Ju)400/400/25.0(RHS400x400)	S 355	
1 - SHS250/250/6.3	S 355	

Project: **Spoj ispune s donjim pojasom**
Project no:
Author:

IDEA StatiCa® Calculate yesterday's estimates

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
GSN9(1)	pp407	87,1	-0,7	-6,7	-2,2	-9,9	0,2
	pp407	-26,2	-0,1	-26,4	3,9	11,9	-0,1
	pp405	69,6	-0,3	-0,7	0,2	0,9	-0,9
	pp404	-26,8	0,5	0,1	-0,2	-1,0	1,0
GSN5(2)	pp407	2795,2	-1,5	-23,0	-3,7	-60,5	-0,1
	pp407	-1581,2	0,3	-199,7	6,2	108,0	0,1
	pp405	1099,4	-0,5	-17,2	0,2	28,3	-1,3
	pp404	-809,1	0,7	10,7	-0,3	-19,2	1,5
GSN7(3)	pp407	2579,8	-3,6	-22,5	-2,2	-56,7	2,9
	pp407	-1440,2	4,1	-194,8	0,3	101,5	-2,2
	pp405	1037,3	0,1	-16,1	-0,3	26,4	0,6
	pp404	-754,2	-0,5	10,1	0,1	-18,3	-1,5
GSN8(4)	pp407	2790,4	0,2	-22,4	-5,0	-59,6	-2,6
	pp407	-1596,9	-2,7	-190,9	11,0	106,1	2,0
	pp405	1077,4	-0,9	-17,0	0,6	27,8	-2,8
	pp404	-799,0	1,6	10,4	-0,7	-18,7	3,8
GSN10(5)	pp407	142,7	1,0	-6,4	-3,5	-9,8	-2,3
	pp407	-78,2	-3,1	-20,4	8,7	11,7	1,8
	pp405	68,6	-0,8	-0,8	0,5	1,1	-2,4
	pp404	-33,6	1,4	0,0	-0,6	-0,8	3,3
GSN12(6)	pp407	715,4	-6,1	-9,8	-10,1	-18,5	0,9
	pp407	-404,1	6,1	-53,1	8,5	30,2	-1,3
	pp405	280,3	0,3	-4,3	0,6	6,9	-2,6
	pp404	-201,7	1,2	2,3	0,0	-4,6	3,1
GSN11(7)	pp407	152,0	1,0	-6,9	-3,5	-11,0	-2,5
	pp407	-76,7	-3,2	-31,2	8,7	13,7	2,0
	pp405	84,1	-0,8	-1,0	0,5	1,4	-2,4
	pp404	-34,8	1,4	0,3	-0,6	-1,3	3,3
GSN4(8)	pp407	2785,9	-1,6	-22,5	-3,7	-59,3	0,1
	pp407	-1582,7	0,4	-188,8	6,2	106,0	-0,1
	pp405	1083,8	-0,5	-17,0	0,2	27,9	-1,3
	pp404	-808,0	0,7	10,4	-0,3	-18,8	1,5
GSN12(9)	pp407	701,1	4,4	-9,6	5,3	-17,9	-0,8
	pp407	-397,2	-6,1	-57,7	-0,3	29,2	1,1
	pp405	288,7	-1,0	-4,4	-0,3	6,7	0,8
	pp404	-197,4	-0,2	2,4	-0,4	-4,8	-1,1
GSN3(10)	pp407	995,6	-1,4	-13,4	-4,1	-25,5	0,2
	pp407	-568,4	0,1	-78,3	7,0	41,5	-0,2
	pp405	395,9	-0,6	-6,0	0,3	9,4	-1,6
	pp404	-276,4	0,8	3,3	-0,4	-6,6	1,7
GSN2(11)	pp407	2682,9	-1,2	-21,7	-2,5	-56,4	0,0
	pp407	-1521,4	0,4	-178,8	4,1	101,3	0,0

Project: Spoj ispune s donjim pojasom
Project no:
Author:

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	pp405	1044,0	-0,3	-16,6	0,1	27,1	-0,8
	pp404	-782,0	0,5	10,0	-0,2	-17,9	1,0

Check

Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	0,2 < 5%	OK
Welds	98,1 < 100%	OK
Buckling	Not calculated	

Plates

Name	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	Status
pp407	25,0	GSN5(2)	223,8	0,0	OK
pp405	6,3	GSN5(2)	355,4	0,2	OK
pp404	6,3	GSN8(4)	355,1	0,1	OK

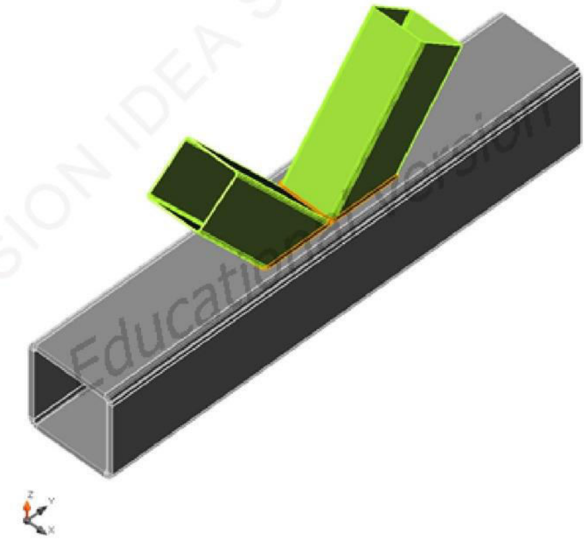
Design data

Material	f_y [MPa]	ε_{lim} [%]
S 355	355,0	5,0

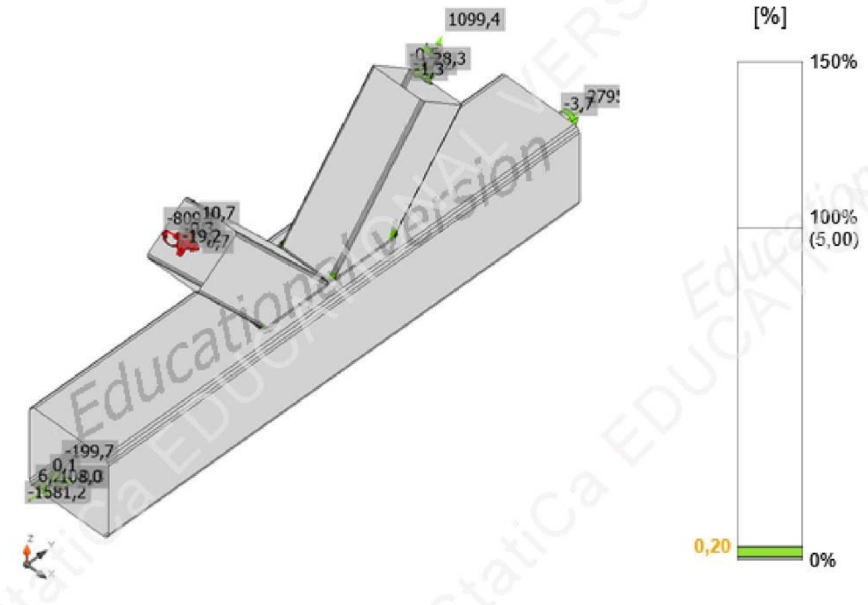
Symbol explanation

ε_{Pl}	Strain
σ_{Ed}	Eq. stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

Project: **Spoj ispune s donjim pojasom**
Project no:
Author:



Overall check, GSN5(2)



Strain check, GSN5(2)

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Project:	**Spoj ispune s donjim pojasom**
Project no:	
Author:	

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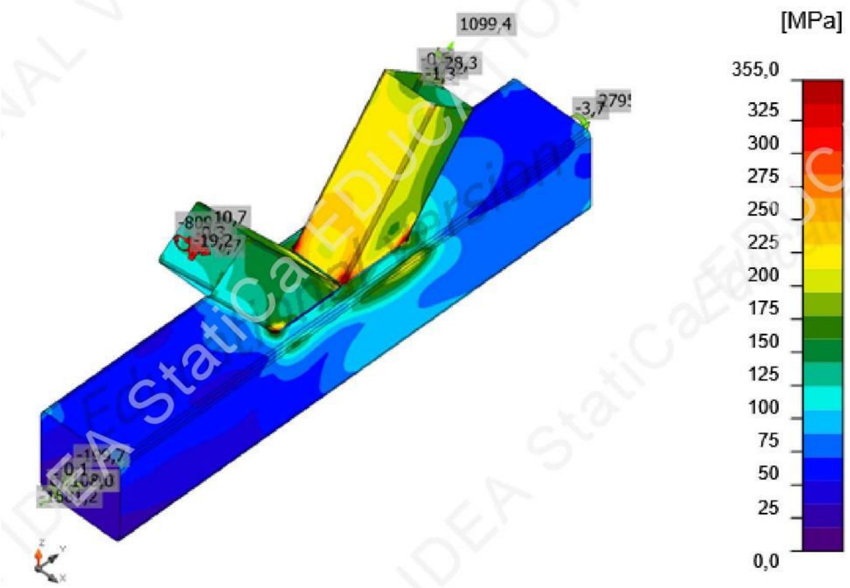

Equivalent stress, GSN5(2)

Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut_c [%]	Status
		◢6,0◣	1086	GSN5(2)	426,9	0,1	-130,1	-140,5	188,1	98,0	25,5	OK
pp407-w 3	pp404	◢6,0◣	1086	GSN8(4)	427,0	0,1	-252,6	163,3	-113,3	98,0	21,0	OK
		◢6,0◣	1086	GSN5(2)	427,1	0,2	204,7	186,0	-110,8	98,1	33,1	OK
pp407-w 3	pp405	◢6,0◣	1086	GSN5(2)	427,1	0,2	56,5	-72,6	233,4	98,1	33,0	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 355	0,90	435,6	352,8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_{\perp}$	Perpendicular stress
$\tau_{\parallel}$	Shear stress parallel to weld axis
$\tau_{\perp}$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

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Project: Spoj ispune s donjim pojasom
Project no:
Author:

IDEA StatiCa® Calculate yesterday's estimates

Detailed result for pp407-w 3 pp405

Weld resistance check (EN 1993-1-8 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 435,6 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0,5} =$ 427,1 MPa

$\sigma_{\perp,Rd} = 0,9 f_u/\gamma_{M2} =$ 352,8 MPa ≥ $|\sigma_\perp| =$ 56,5 MPa

where:

$f_u =$ 490,0 MPa – Ultimate strength

$\beta_w =$ 0,90 – appropriate correlation factor taken from Table 4.1

$\gamma_{M2} =$ 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}}; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 98,1 %

Buckling

Buckling analysis was not calculated.

Code settings

Item	Value	Unit	Reference
γ_{M0}	1,00	-	EN 1993-1-1: 6.1
γ_{M1}	1,00	-	EN 1993-1-1: 6.1
γ_{M2}	1,25	-	EN 1993-1-1: 6.1
γ_{M3}	1,25	-	EN 1993-1-8: 2.2
γ_C	1,50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient βj	0,67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0,10	-	
Friction coefficient - concrete	0,25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0,30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0,05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2,20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1,20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance	Yes		ETAG 001-C
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		
Local deformation check	No		
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1

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6.8. Spoj ispune sa gornjim pojasom

Project: **Spoj ispune s gornjim pojasom**
Project no:
Author:

Project data

Project name	Spoj ispune s gornjim pojasom
Project number	
Author	
Description	
Date	22.6.2019.
Design code	EN

Material

Steel	S 355

Project: Spoj ispune s gornjim pojasom
Project no:
Author:

Project item Con N405

Design

Name	Con N405
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

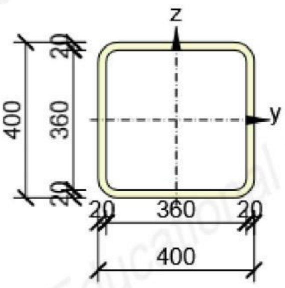
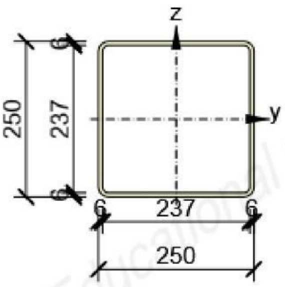
Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
pp406	2 - SHS400/400/20.0	90,0	0,0	0,0	0	0	0	Position
pp405	1 - SHS250/250/6.3	-90,0	51,3	0,0	0	0	0	Position
pp408	1 - SHS250/250/6.3	90,0	51,3	0,0	0	0	0	Position

Cross-sections

Name	Material
2 - SHS400/400/20.0	S 355
1 - SHS250/250/6.3	S 355

Project: **Spoj ispune s gornjim pojasom**
Project no:
Author:

Cross-sections

Name	Material	Drawing
2 - SHS400/400/20.0	S 355	
1 - SHS250/250/6.3	S 355	

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Project: Spoj ispune s gornjim pojasom
Project no:
Author:

IDEA StatiCa® Calculate yesterday's estimates

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
GSN5(1)	pp406	-2162,0	-3,3	-44,9	-0,1	-48,5	5,2
	pp406	3696,4	0,5	47,8	0,1	-8,2	-5,4
	pp405	1101,0	-0,5	15,9	0,2	-24,8	-0,2
	pp408	-1316,2	-0,2	-19,6	0,1	31,6	-0,5
GSN10(2)	pp406	-50,5	-4,6	-0,7	0,0	-6,4	8,8
	pp406	96,7	-4,5	1,6	0,8	4,8	-9,5
	pp405	69,7	-0,8	-0,1	0,5	-0,1	0,0
	pp408	-3,6	0,0	-1,1	-0,4	1,4	-0,8
GSN12(3)	pp406	-503,7	2,0	-11,5	0,3	-14,5	-4,5
	pp406	886,1	-7,1	10,5	-0,2	0,9	5,3
	pp405	289,9	-1,0	3,4	-0,3	-5,6	-0,6
	pp408	-304,5	-2,1	-5,3	-1,1	7,9	1,6
GSN12(4)	pp406	-493,0	-5,7	-11,7	-0,5	-14,8	9,8
	pp406	865,6	8,2	10,8	0,7	1,0	-11,3
	pp405	281,5	0,3	3,3	0,6	-5,4	0,3
	pp408	-312,7	1,9	-5,2	1,1	8,1	-2,3
GSN9(5)	pp406	18,4	-1,7	-0,4	-0,1	-6,7	2,3
	pp406	23,3	0,5	1,0	0,2	5,6	-2,6
	pp405	70,8	-0,3	-0,2	0,2	0,2	-0,2
	pp408	4,3	-0,1	-1,0	0,0	1,1	-0,3
GSN7(6)	pp406	-1961,6	0,4	-42,7	-0,2	-46,0	-3,0
	pp406	3407,7	6,7	43,8	-0,7	-7,0	3,3
	pp405	1038,9	0,1	14,8	-0,3	-23,1	-0,4
	pp408	-1239,8	-0,3	-18,5	0,5	29,6	0,1
GSN8(7)	pp406	-2179,5	-6,2	-44,1	0,0	-47,5	11,8
	pp406	3685,6	-4,4	47,5	0,7	-8,4	-12,3
	pp405	1079,0	-0,9	15,7	0,6	-24,5	-0,1
	pp408	-1293,5	-0,1	-19,3	-0,3	31,2	-1,0
GSN2(8)	pp406	-2110,0	-2,5	-43,5	0,0	-45,3	4,0
	pp406	3578,6	0,3	46,1	0,0	-9,3	-3,9
	pp405	1045,6	-0,3	15,3	0,1	-24,0	-0,1
	pp408	-1263,3	-0,1	-18,9	0,1	30,5	-0,3
GSN11(9)	pp406	-56,1	-4,5	-0,9	0,0	-6,8	8,9
	pp406	119,2	-4,6	2,0	0,8	4,7	-9,6
	pp405	85,3	-0,8	0,1	0,5	-0,3	0,0
	pp408	-19,1	0,0	-1,3	-0,4	1,6	-0,8
GSN13(10)	pp406	-501,1	-0,5	-11,5	0,0	-14,6	-0,6
	pp406	881,7	-2,1	10,5	0,1	0,9	0,5
	pp405	290,2	-0,6	3,4	-0,1	-5,6	-0,4
	pp408	-304,1	-0,8	-5,3	-0,4	8,0	0,4
GSN13(11)	pp406	-495,6	-3,2	-11,6	-0,3	-14,8	5,9
	pp406	870,0	3,2	10,7	0,4	1,0	-6,5

Project: Spoj ispune s gornjim pojasom
Project no:
Author:

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	pp405	281,2	0,0	3,4	0,4	-5,5	0,1
	pp408	-313,0	0,6	-5,2	0,4	8,1	-1,1
GSN6(12)	pp406	-673,9	-2,1	-15,6	-0,2	-19,5	3,2
	pp406	1193,1	0,5	14,7	0,3	0,7	-3,6
	pp405	395,9	-0,4	4,7	0,2	-7,6	-0,1
	pp408	-426,2	-0,1	-7,1	0,0	10,9	-0,4
GSN3(13)	pp406	-681,2	-3,2	-16,2	-0,2	-21,0	4,4
	pp406	1206,2	1,0	14,5	0,4	2,1	-5,0
	pp405	397,5	-0,6	4,7	0,3	-7,6	-0,3
	pp408	-429,2	-0,2	-7,2	0,0	11,1	-0,6
GSN4(14)	pp406	-2156,4	-3,4	-44,7	-0,1	-48,1	5,2
	pp406	3673,9	0,6	47,4	0,1	-8,1	-5,3
	pp405	1085,4	-0,5	15,8	0,2	-24,6	-0,2
	pp408	-1300,8	-0,2	-19,5	0,1	31,4	-0,5

Check

Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	0,7 < 5%	OK
Welds	98,6 < 100%	OK
Buckling	Not calculated	

Plates

Name	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	Status
pp406	20,0	GSN5(1)	355,1	0,1	OK
pp405	6,3	GSN5(1)	355,9	0,4	OK
pp408	6,3	GSN5(1)	356,5	0,7	OK

Design data

Material	f_y [MPa]	ε_{lim} [%]
S 355	355,0	5,0

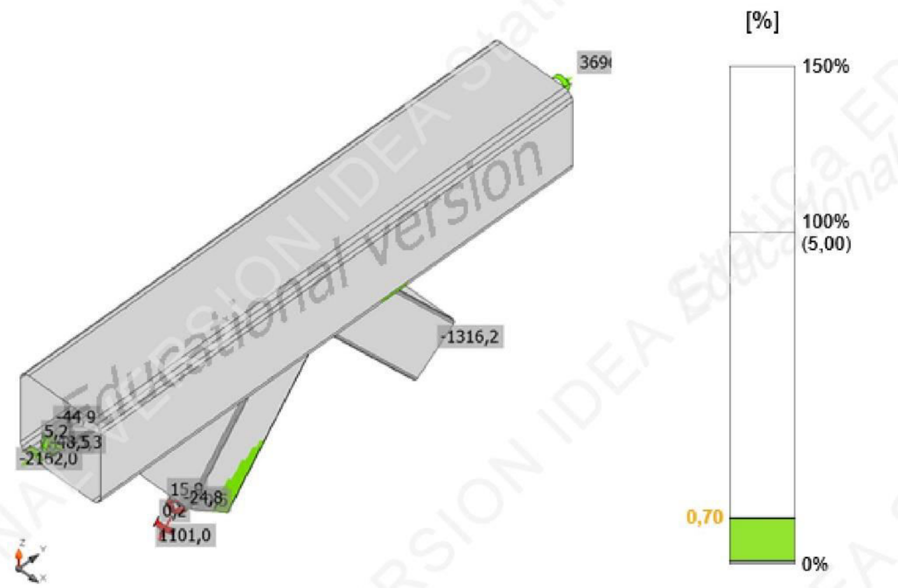
Symbol explanation

ε_{Pl}	Strain
σ_{Ed}	Eq. stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

Project: **Spoj ispune s gornjim pojasom**
Project no:
Author:

IDEA StatiCa® — Calculate yesterday's estimates

Overall check, GSN5(1)



Strain check, GSN5(1)

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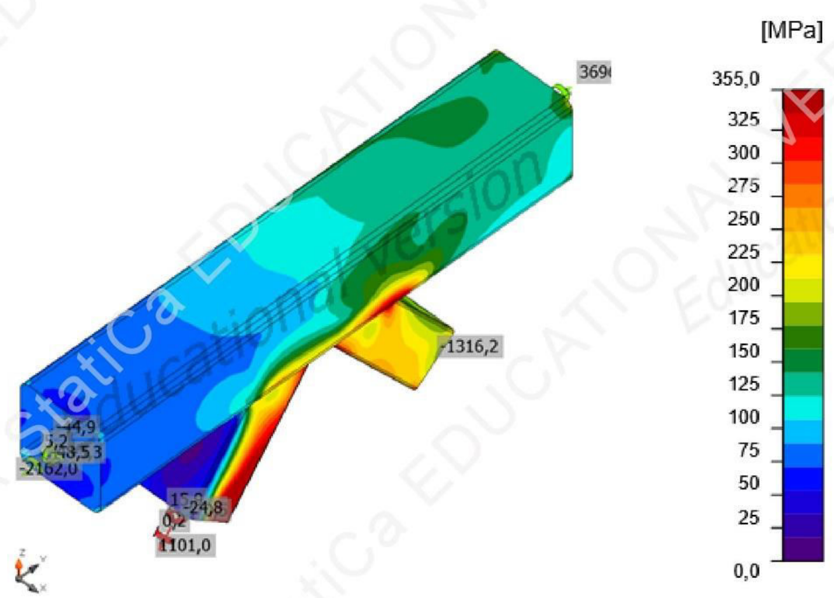
Project: **Spoj ispune s gornjim pojasom**
Project no:
Author:

IDEA StatiCa®
Calculate yesterday's estimates



Equivalent stress, GSN5(1)

Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\|\|}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut_c [%]	Status
		◢6,0◣	1086	GSN5(1)	428,3	0,8	115,5	116,8	-207,5	98,3	40,5	OK
pp406-w 1	pp405	◢6,0◣	1086	GSN5(1)	428,9	1,2	274,6	-99,3	162,3	98,5	42,4	OK
		◢6,0◣	1086	GSN5(1)	429,7	1,6	-246,3	96,1	179,1	98,6	38,9	OK
pp406-w 1	pp408	◢6,0◣	1086	GSN5(1)	427,5	0,4	-140,1	-167,8	-162,0	98,2	48,9	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 355	0,90	435,6	352,8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_{\perp}$	Perpendicular stress
$\tau_{\|\|}$	Shear stress parallel to weld axis
$\tau_{\perp}$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

Project: Spoj ispune s gornjim pojasom
Project no:
Author:

Detailed result for pp406-w 1 pp405

Weld resistance check (EN 1993-1-8 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 435,6 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0,5} =$ 429,7 MPa

$\sigma_{\perp,Rd} = 0,9 f_u/\gamma_{M2} =$ 352,8 MPa ≥ $|\sigma_\perp| =$ 246,3 MPa

where:

$f_u =$ 490,0 MPa – Ultimate strength

$\beta_w =$ 0,90 – appropriate correlation factor taken from Table 4.1

$\gamma_{M2} =$ 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}}; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 98,6 %

Buckling

Buckling analysis was not calculated.

Code settings

Item	Value	Unit	Reference
γ_{M0}	1,00	-	EN 1993-1-1: 6.1
γ_{M1}	1,00	-	EN 1993-1-1: 6.1
γ_{M2}	1,25	-	EN 1993-1-1: 6.1
γ_{M3}	1,25	-	EN 1993-1-8: 2.2
γ_{C}	1,50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient βj	0,67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0,10	-	
Friction coefficient - concrete	0,25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0,30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0,05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2,20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1,20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance	Yes		ETAG 001-C
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		
Local deformation check	No		
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1

8 / 8

7. TEŽINA KONSTRUKCIJE

Težina konstrukcije je izračunata u programu SCIA Engineer 2019.

Bill of material

Selection: All
Type of sorting: Material

Summary

Material	Mass [kg]	Surface [m^2]	Volume [m^3]
Steel	1536199,4	19306,638	1,9835e+02
Total	1536199,4	19306,638	1,9835e+02

Note: Value 'Surface' represents for 1D members the total exposed surface area, while for 2D members it corresponds only to the surface area of the centroidal plane.

Steel (1D)

Material	Density [kg/m^3]	Mass [kg]	Surface [m^2]	Volume [m^3]
S 355	7850,0	1536196,7	18951,831	1,9569e+02
BS	1,0	2,7	354,807	2,6606e+00
Total		1536199,4	19306,638	1,9835e+02

Slika 7.1. *Ukupna težina čelične konstrukcije*

Program daje vrijednost ukupne težine svih štapova rešetke.

Dijeljenjem vrijednosti sa tlocrtnom površinom čelične konstrukcije dobije se kilaža po metru kvadratnom:

$\frac{1536199{,}4\ \text{kg}}{19306{,}638\ \text{m}^2} = 79{,}57\ [kg/m^2]$ – težina čelične konstrukcije po m^2

8. DIMENZIONIRANJE TEMELJA SAMCA

8.1. Proračun dimenzija temlja samca

Dimenzije temelja: 4200×4200×1250 mm

Dopušteno naprezanje: σ=500 MPa

M_{sd}=131,35 kNm

N_{sd}=-7961,76 kN

h=1,25m

$$a = \sqrt{\frac{P}{\sigma}} = \sqrt{\frac{7961,76}{500}} = 3,99\ m\ \rightarrow odabrano\ a = 4,2\ m$$

Maksimalno djelovanje na temelj:

$N_{Ed,max}$=-7961,76 kN – tlak

Težina temelja:

N_t=4,2·4,2·1,25·25=551,25 kN

N_{Ed}=N_{Ed}'+N_t=7961,76+551,25=8513,01 Kn

Naprezanje ispod temelja:

$$\sigma_{1,2} \leq \sigma_{dop.tla} = 500\left(\frac{kN}{m^2}\right)$$

$$\sigma_{1,2} \leq \frac{N_{Ed}}{A} \pm \frac{M_{Ed}}{W}$$

A=4,2·4,2=17,64 m^2

$$W \leq \frac{b \cdot a^2}{6} = \frac{4,2^3}{6} = 12,35\ m^2$$

$$\sigma_1 = 493,24\frac{kN}{m^2} < 500\frac{kN}{m^2}$$

$$\sigma_2 = 471,96\frac{kN}{m^2} < 500\frac{kN}{m^2}$$

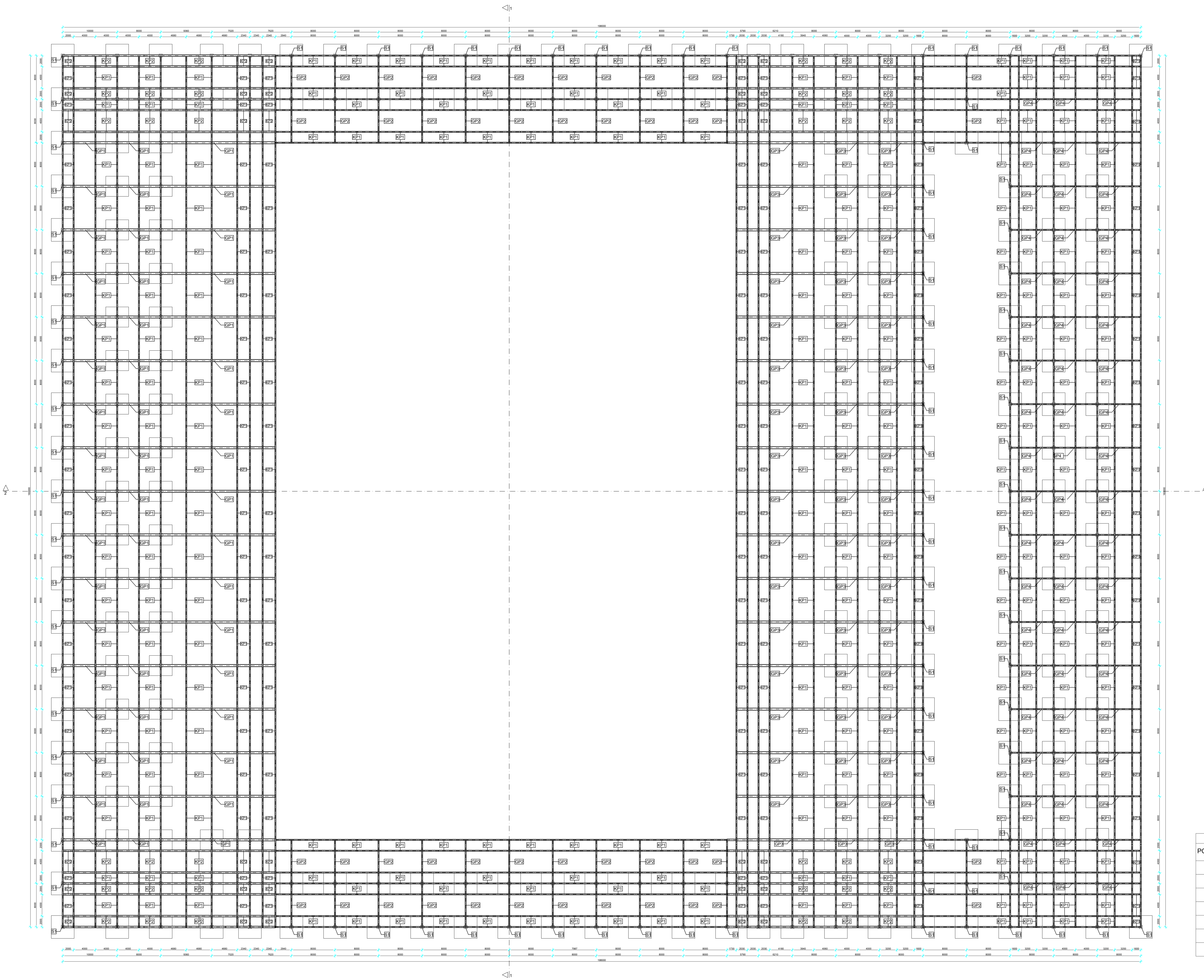
9. GRAFIČKI PRILOZI

Prilog 1: Plan pozicija nosive konstrukcije - tlocrt, M 1:250
Prilog 2: Plan pozicija nosive konstrukcije - presjek 1-1; M 1:100
Prilog 3: Plan pozicija nosive konstrukcije – presjek 2-2; M 1:100
Prilog 4: Radionički nacrt rešetke; M 1:50
Prilog 5: Spoj stupa s pločom; M 1:10
Prilog 6: Montažni nastavak donjeg pojasa; M 1:10
Prilog 7: Montažni nastavak gornjeg pojasa; M 1:10
Prilog 8: Montažni nastavak ispune; M 1:10
Prilog 9: Spoj donjeg pojasa i ispune rešetke sa stupom; M 1:10
Prilog 10: Spoj donjeg pojasa sa stupom; M 1:10
Prilog 11: Spoj ispune s donjim i gornjim pojasom; M 1:10

10. LITERATURA

[1] Androić B., Dujmović D., Džeba I., Metalne konstrukcije 1, IGH Zagreb, 1994
[2] Androić B., Dujmović D., Džeba I, Čelične konstrukcije 1, IA Projektiranje, Zagreb, 2009
[3] Prof. dr. sc. Ivica Boko, Predavanja

TLOCRT



PLAN POZICIJA
NOSIVE KONSTRUKCIJE
TLOCRT
M 1:250
ČELIK S355
BETON C40/50

PRIKAZ I OPIS POZICIJA		
POZICIJA	PROFIL	NAZIV
S1	HEA280	Stup
GP1	SHS400/400/20.0	Gornji pojas rešetke R1
GP2	SHS200/200/6.0	Gornji pojas rešetke R2
GP3	SHS400/400/10.0	Gornji pojas rešetke R3
GP4	SHS200/200/4.0	Gornji pojas rešetke R4
KP1	SHS200/200/10	Krovna podrožnica segmenta 1
KP2	SHS300/300/14.2	Krovna podrožnica segmenta 2

FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
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21000 SPLIT, MATICE HRVATSKE 15

PROGRAM:	PROJEKT ČELIČNE KONSTRUKCIJE STADIONA VIŠNJIK
STUDENT:	Monika Ćosić, 685
MENTOR:	Prof. dr. sc. Ivica Boko
SADRŽAJ:	PLAN POZICIJA - TLOCRT
MJERILO	1:250
DATUM	srpanj 2019.
PRILOG	1

PRESJEK 1-1

PRIKAZ I OPIS POZICIJA		
POZICIJA	PROFIL	NAZIV
S1	HEA280	Stup
GP2	SHS200/200/6.0	Gornji pojas rešetke R2
DP2	SHS200/200/14.2	Donji pojas rešetke R2
V2	SHS180/180/6.3	Vertikala rešetke R2
I2	SHS180/180/6.3	Ispuna rešetke R2
DP5-1	SHS350/350/16	Donji pojas sekundarne rešetke R5 segmenta 1
DP5-2	SHS80/80/6.0	Donji pojas sekundarne rešetke R5 segmenta 2
I5-1	SHS200/200/8.0	Ispuna sekundarne rešetke R5 segmenta 1
I5-2	SHS80/80/6.0	Ispuna sekundarne rešetke R5 segmenta 2
KP1	SHS200/200/10	Krovna podrožnica segmenta 1
BP	SHS120/120/5.0	Bočna podrožnica
BS	RD30	Bočni spreg

PLAN POZICIJA
NOSIVE KONSTRUKCIJE
PRESJEK 1-1
M 1:100
ČELIK S355
BETON C40/50

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STUDENT: Monika Ćosić, 685
MENTOR: Prof. dr. sc. Ivica Boko

SADRŽAJ: PLAN POZICIJA - PRESJEK 1-1
MJERILO 1:100
DATUM srpanj 2019.
PRILOG 2

PRIKAZ I OPIS POZICIJA		
POZICIJA	PROFIL	NAZIV
S1	HEA280	Stup
GP1	SHS400/400/20	Gornji pojas rešetke R1
DP1	SHS400/400/25	Donji pojas rešetke R1
V1	SHS250/250/8.0	Vertikala rešetke R1
I1	SHS250/250/6.3	Ispuna rešetke R1
GP3	SHS400/400/10	Gornji pojas rešetke R3
DP3	SHS400/400/20	Donji pojas rešetke R3
V3	SHS180/180/5.0	Vertikala rešetke R3
I3	SHS200/200/6.0	Ispuna rešetke R3
GP4	SHS200/200/4.0	Gornji pojas rešetke R4
DP4	SHS200/200/14.2	Donji pojas rešetke R4
V4	SHS140/140/6.0	Vertikala rešetke R4
I4	SHS140/140/4.0	Ispuna rešetke R4
KP1	SHS200/200/10	Krovna podrožnica segmenta 1
BP	SHS120/120/5.0	Bočna podrožnica
BS	RD30	Bočni spreg

PLAN POZICIJA
PRESJEK 2-2
M 1:100
ČELIK S355
BETON C40/50

FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
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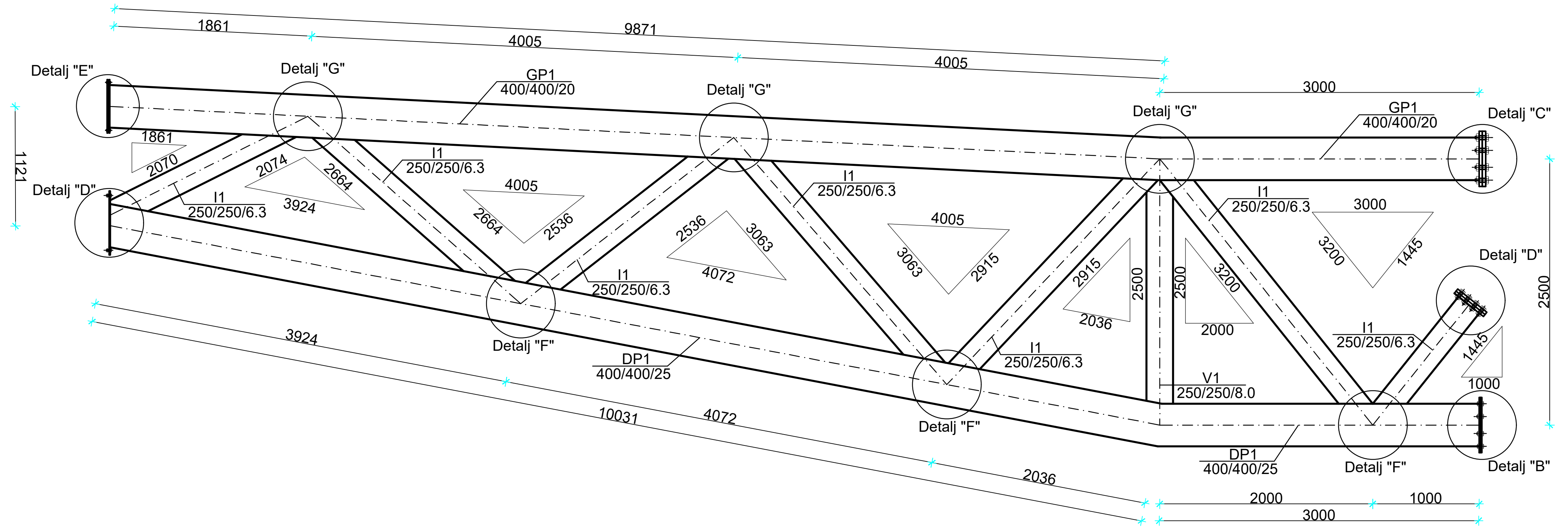
STUDENT: Monika Ćosić, 685	MENTOR: Prof. dr. sc. Ivica Boko
SADRŽAJ: PRESJEK 2-2	MJERILO 1:100
DATUM srpanj 2019.	PRILOG 3

RADIONIČKI NACRT REŠETKE R1

SEGMENT 1



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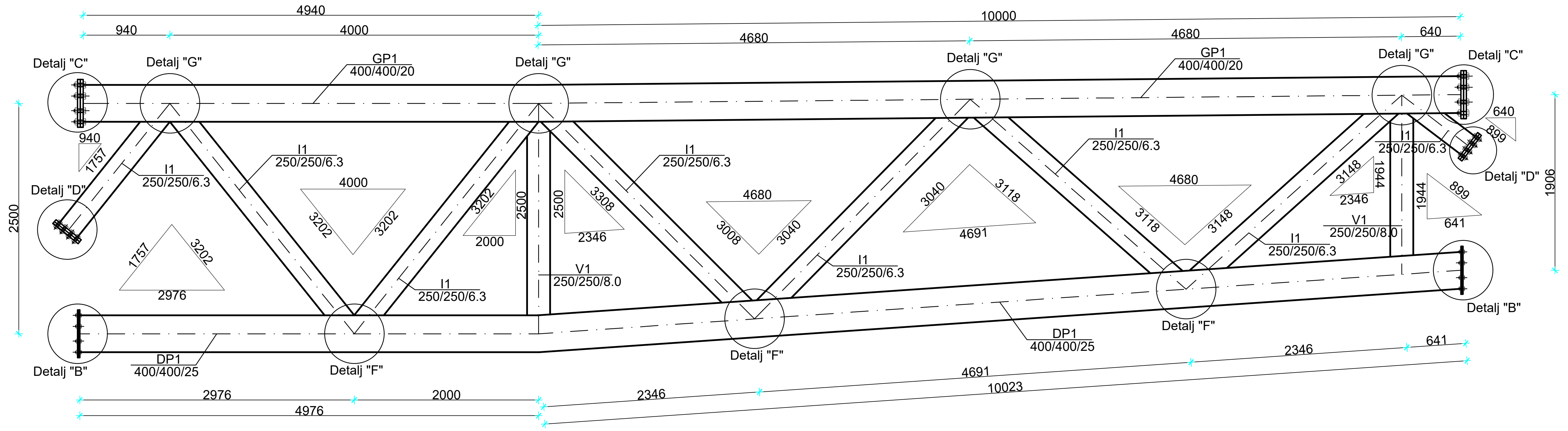

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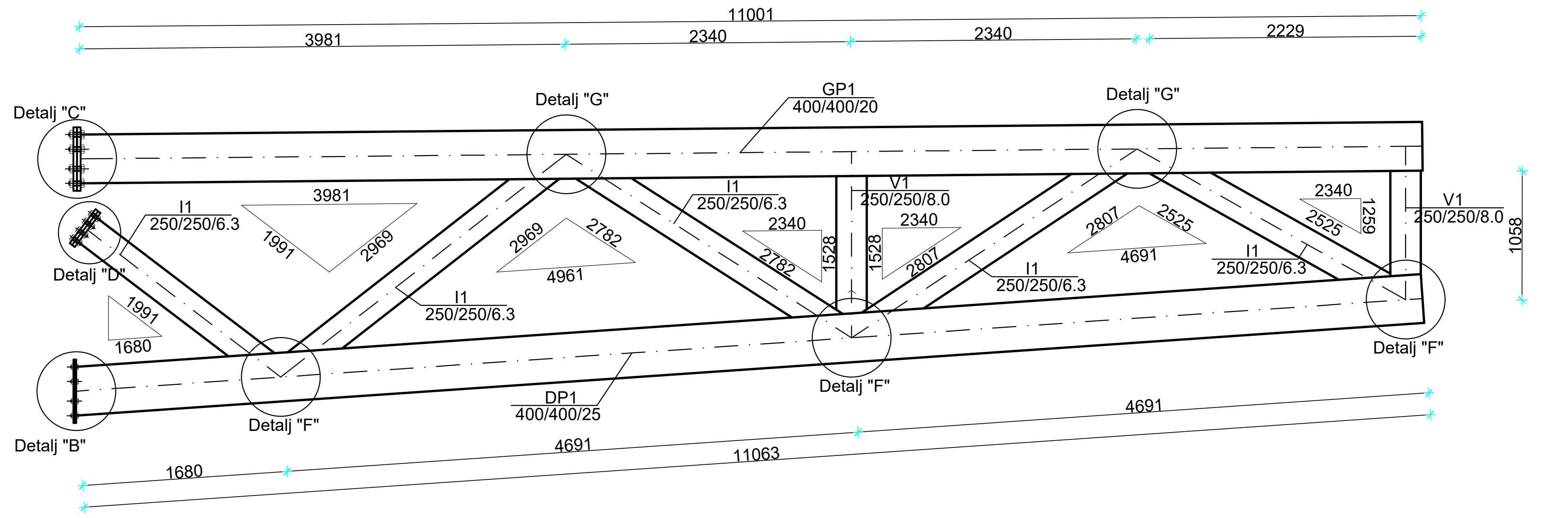
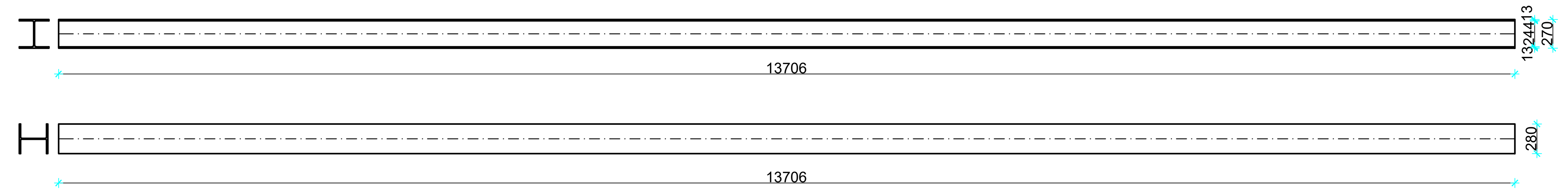


RADIONIČKI NACRT STUPA S1

STUP HEA280



RADIONIČKI NACRT
MJ 1:50
ČELIK S355

FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE
21000 SPLIT, MATICE HRVATSKE 15

PROGRAM:	PROJEKT ČELIČNE KONSTRUKCIJE STADIONA VIŠNJIK		
STUDENT: Monika Čosić, 685		MENTOR: Prof. dr. sc. Ivica Boko	
SADRŽAJ:	RADIONIČKI NACRT	MJERILO	1:50
DATUM	srpanj 2019.	PRILOG	4

ISKAZ MATERIJALA REŠETKE R1 - SEGMENT 1					
POZICIJA	PROFIL	DUŽINA (mm)	KOMADA	JED. MASA (kg/m)	UKUPNA MASA (kg)
DP1-1	SHS400/400/25	10031	1	294,38	2952,92
DP1-2	SHS400/400/25	3000	1	294,38	883,14
GP1-1	SHS400/400/20	9871	1	238,64	2355,62
GP1-2	SHS400/400/20	3000	1	238,64	715,92
I1-1	SHS250/250/6.3	2074	1	48,21	99,99
I1-2	SHS250/250/6.3	2664	1	48,21	128,43
I1-3	SHS250/250/6.3	2536	1	48,21	122,26
I1-4	SHS250/250/6.3	3063	1	48,21	147,67
I1-5	SHS250/250/6.3	2915	1	48,21	140,53
I1-6	SHS250/250/6.3	3200	1	48,21	154,27
I1-7	SHS250/250/6.3	1445	1	48,21	69,66
V1-1	SHS250/250/8.0	2500	1	60,79	151,98
				UKUPNO	7922,39

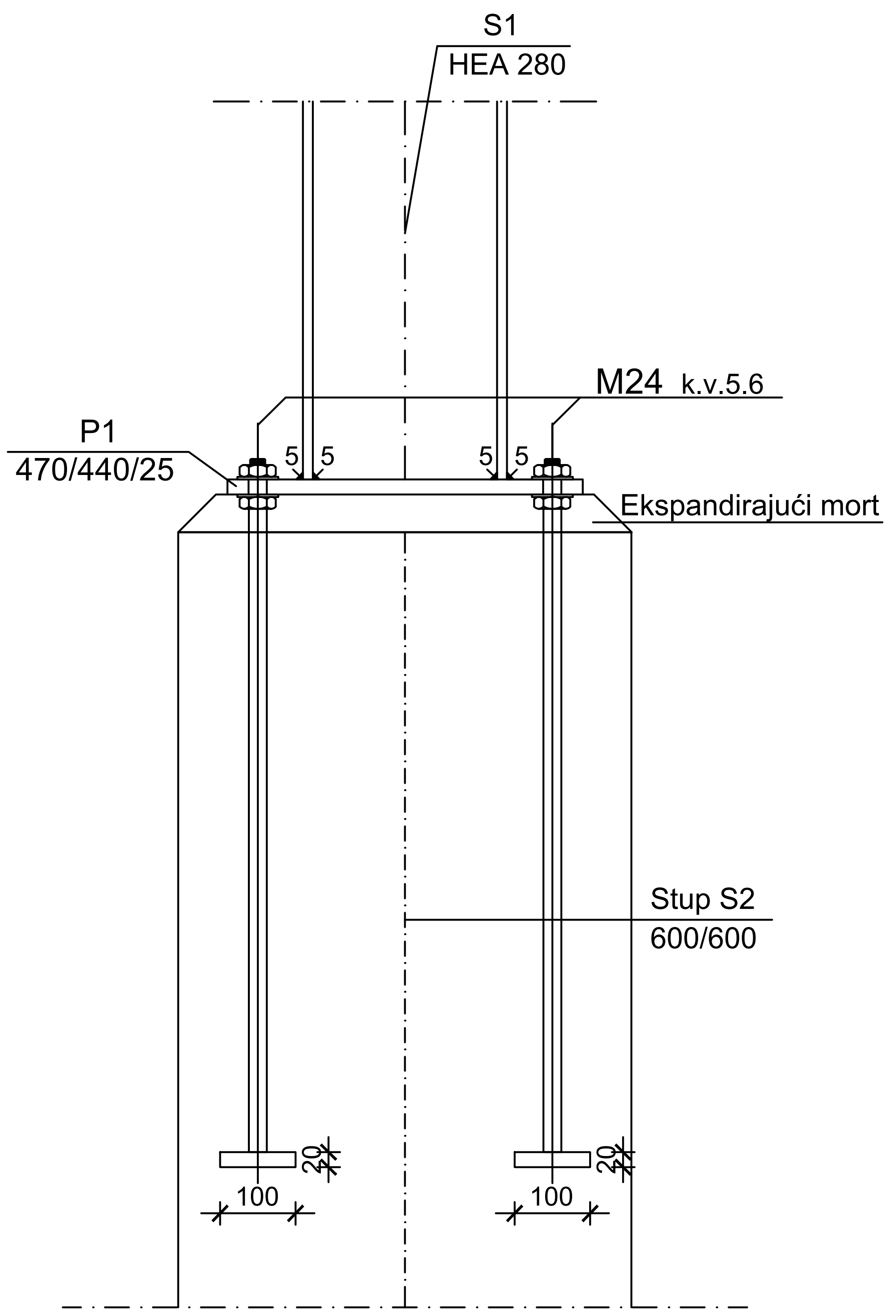
ISKAZ MATERIJALA REŠETKE R1 - SEGMENT 2					
POZICIJA	PROFIL	DUŽINA (mm)	KOMADA	JED. MASA (kg/m)	UKUPNA MASA (kg)
DP1-3	SHS400/400/25	4976	1	294,38	1464,83
DP1-4	SHS400/400/25	10023	1	294,38	2950,57
GP1-3	SHS400/400/20	4940	1	238,64	1178,88
GP1-4	SHS400/400/20	10000	1	238,64	238,64
I1-8	SHS250/250/6.3	1757	1	48,21	84,70
I1-9	SHS250/250/6.3	3202	1	48,21	154,37
I1-10	SHS250/250/6.3	3202	1	48,21	154,37
I1-11	SHS250/250/6.3	3308	1	48,21	159,48
I1-12	SHS250/250/6.3	3040	1	48,21	146,56
I1-13	SHS250/250/6.3	3118	1	48,21	150,32
I1-14	SHS250/250/6.3	3148	1	48,21	151,77
I1-15	SHS250/250/6.3	899	1	48,21	43,34
V1-2	SHS250/250/8.0	2500	1	60,79	151,98
V1-3	SHS250/250/8.0	1944	1	60,79	118,18
				UKUPNO	7147,99

ISKAZ MATERIJALA REŠETKE R1 - SEGMENT 3					
POZICIJA	PROFIL	DUŽINA (mm)	KOMADA	JED. MASA (kg/m)	UKUPNA MASA (kg)
DP1-5	SHS400/400/25	11063	1	294,38	3256,73
GP1-5	SHS400/400/20	11001	1	238,64	2625,28
I1-16	SHS250/250/6.3	1991	1	48,21	95,99
I1-17	SHS250/250/6.3	2969	1	48,21	143,14
I1-18	SHS250/250/6.3	2782	1	48,21	134,12
I1-19	SHS250/250/6.3	2807	1	48,21	135,33
I1-20	SHS250/250/6.3	2525	1	48,21	121,73
V1-4	SHS250/250/8.0	1528	1	60,79	92,89
V1-5	SHS250/250/8.0	1259	1	60,79	76,53
				UKUPNO	6681,74

ISKAZ MATERIJALA STUPA S1					
POZICIJA	PROFIL	DUŽINA (mm)	KOMADA	JED. MASA (kg/m)	UKUPNA MASA (kg)
S1	HEA280	13706	1	46,76	640,89

Detalj "A"
Spoj stupa s pločom
MJ 1:10

Presjek 1-1



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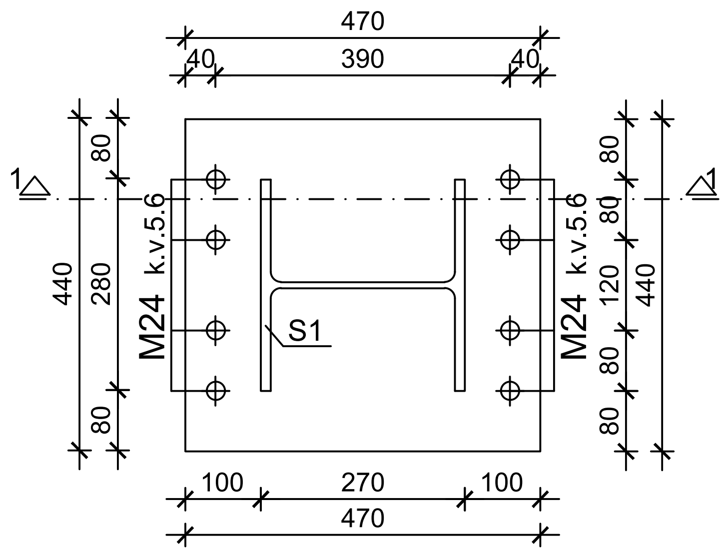

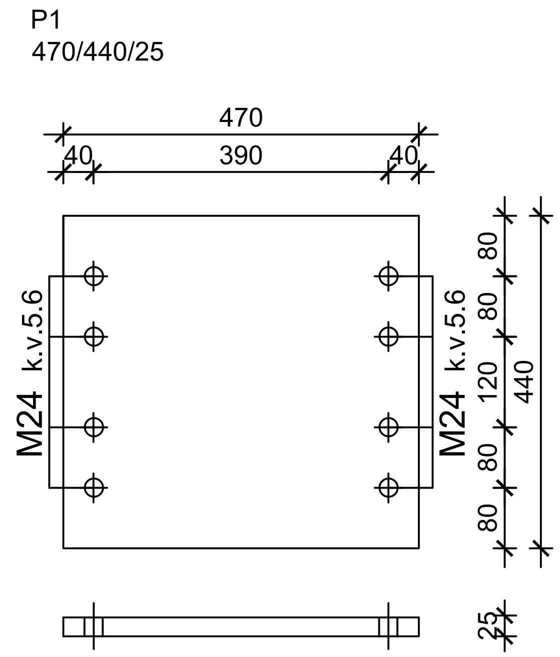

FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
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21000 SPLIT, MATICE HRVATSKE 15

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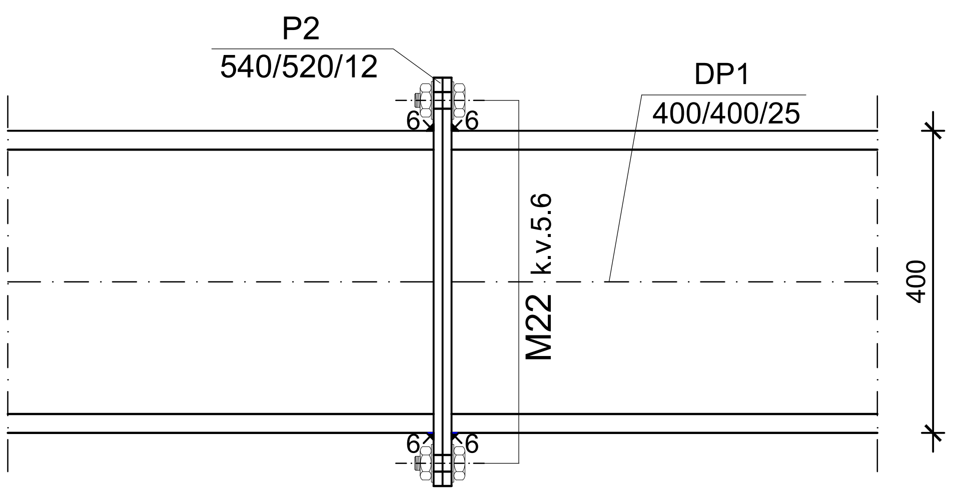
STUDENT: Monika Ćosić, 685	MENTOR: Prof. dr. sc. Ivica Boko
SADRŽAJ: SPOJ STUPA S PLOČOM	MJERILO 1:10
DATUM srpanj 2019.	PRILOG 5

Detalj "B"
Montažni nastavak donjeg pojasa
MJ 1:10

Tlocrt



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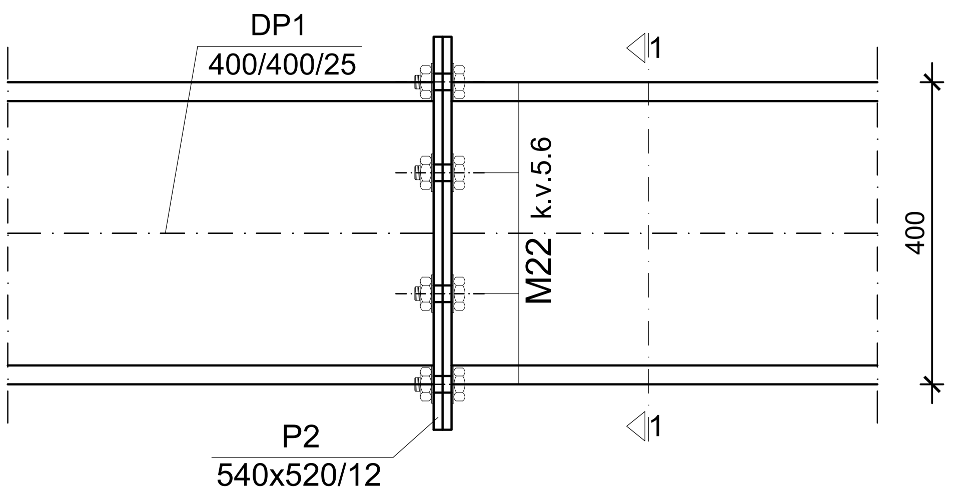
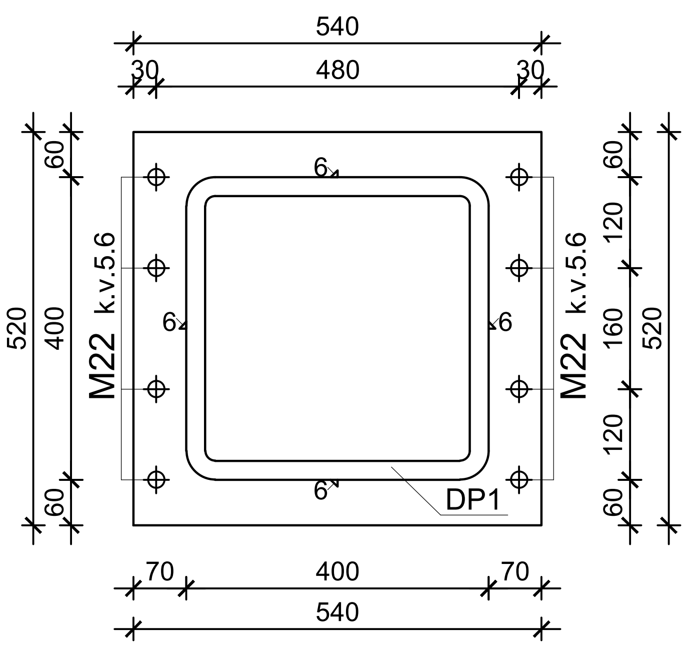
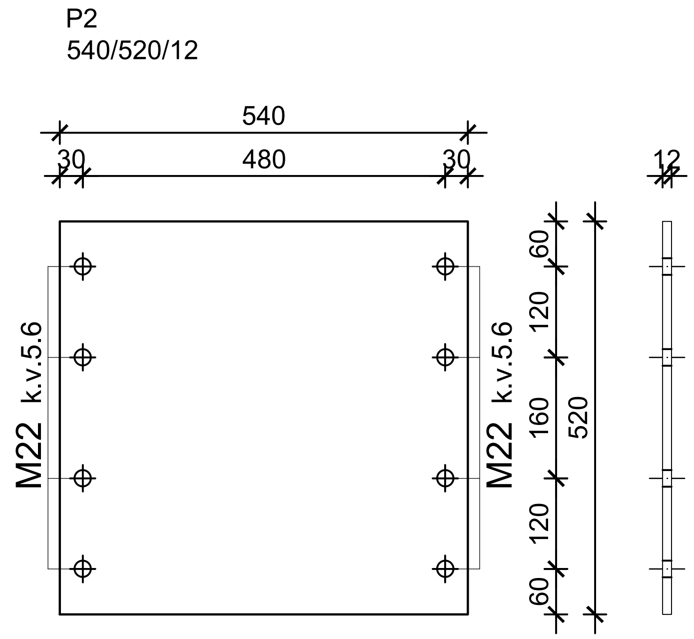


Presjek 1-1



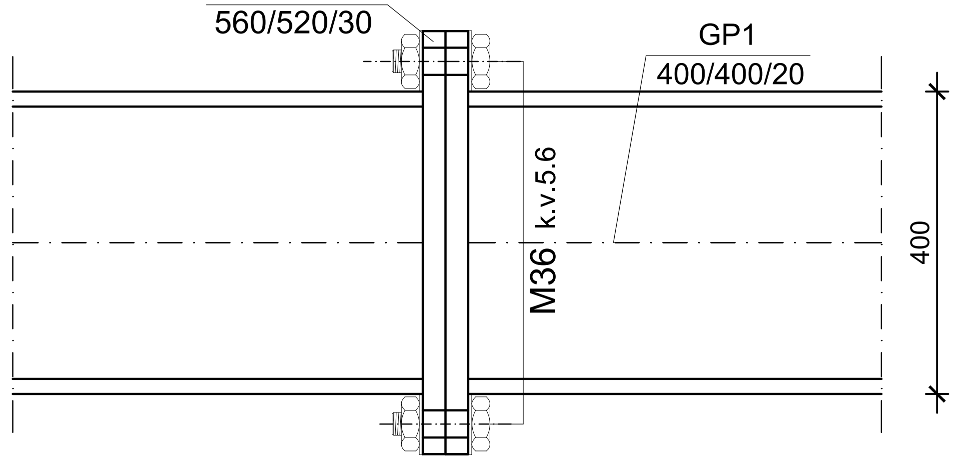


FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE
21000 SPLIT, MATICE HRVATSKE 15

PROGRAM:	PROJEKT ČELIČNE KONSTRUKCIJE STADIONA VIŠNJIK		
STUDENT: Monika Ćosić, 685	MENTOR: Prof. dr. sc. Ivica Boko		
SADRŽAJ:	MONTAŽNI NASTAVAK DONJEG POJASA	MJERILO	1:10
DATUM	srpanj 2019.	PRILOG	6

Detalj "C"
Montažni nastavak gornjeg pojasa
MJ 1:10

Tlocrt



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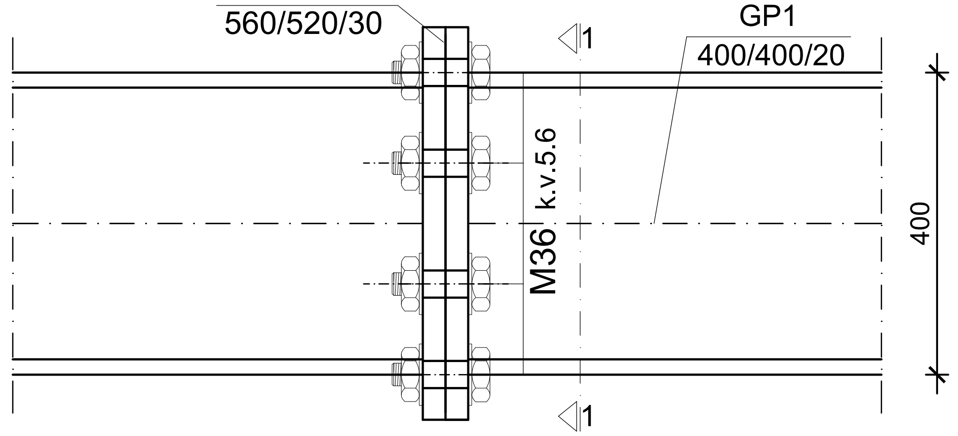
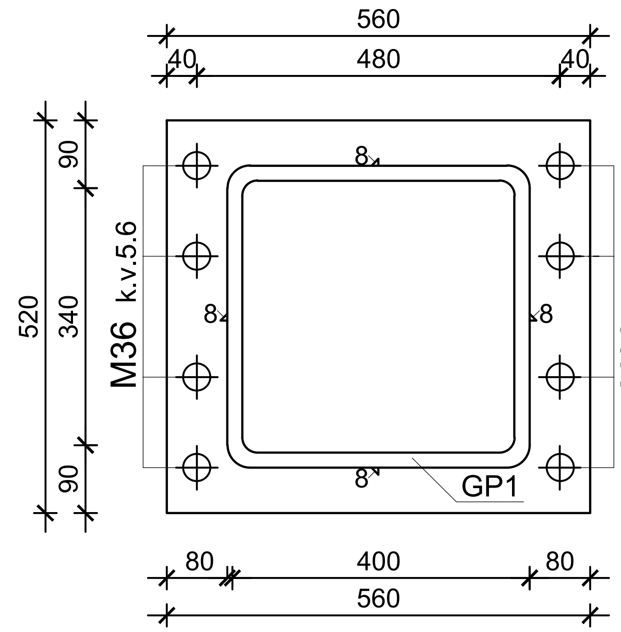
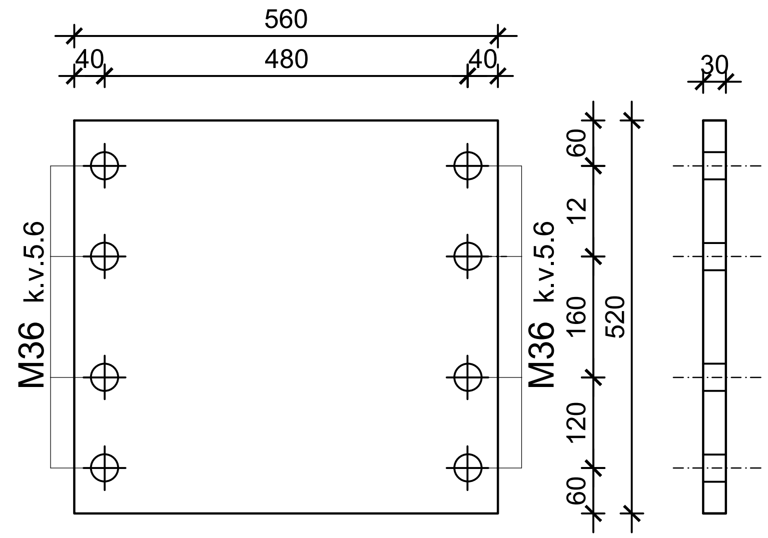


Presjek 1-1



P3
560/520/30

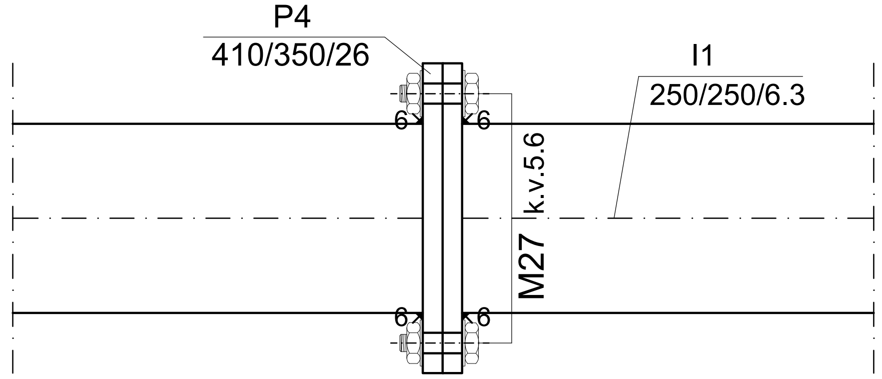


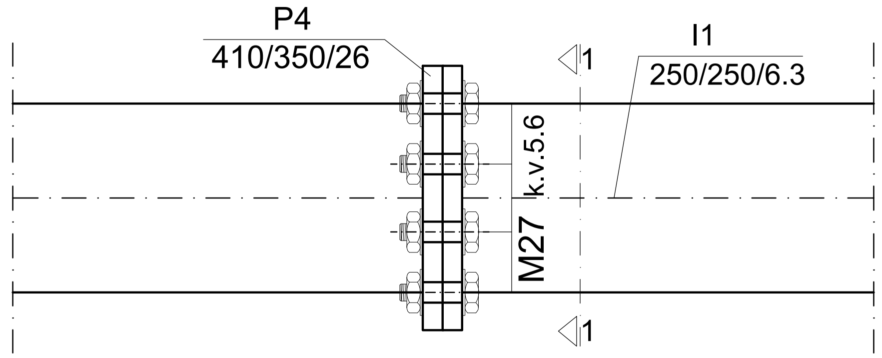
FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE
21000 SPLIT, MATICE HRVATSKE 15

PROGRAM:	PROJEKT ČELIČNE KONSTRUKCIJE STADIONA VIŠNJIK
STUDENT: Monika Ćosić, 685	MENTOR: Prof. dr. sc. Ivica Boko
SADRŽAJ: MONTAŽNI NASTAVAK GORNJEG POJASA	MJERILO 1:10
DATUM srpanj 2019.	PRILOG 7

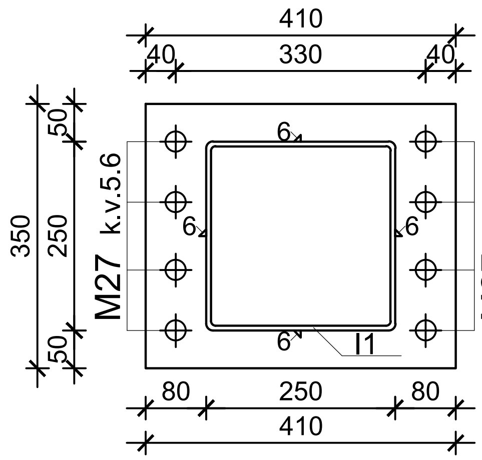
Detalj "D"
Montažni nastavak ispune

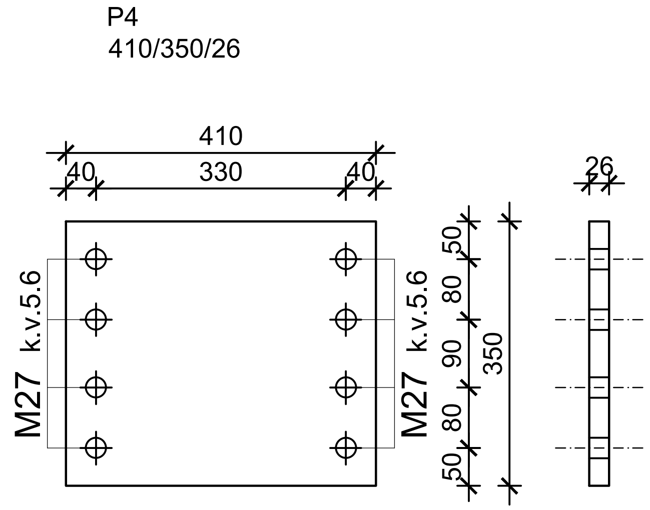
Tlocrt





Presjek 1-1



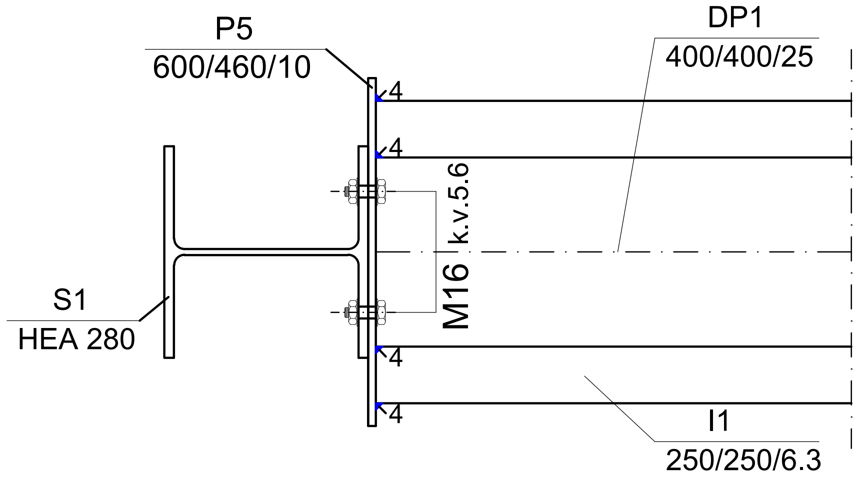


FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE
21000 SPLIT, MATICE HRVATSKE 15

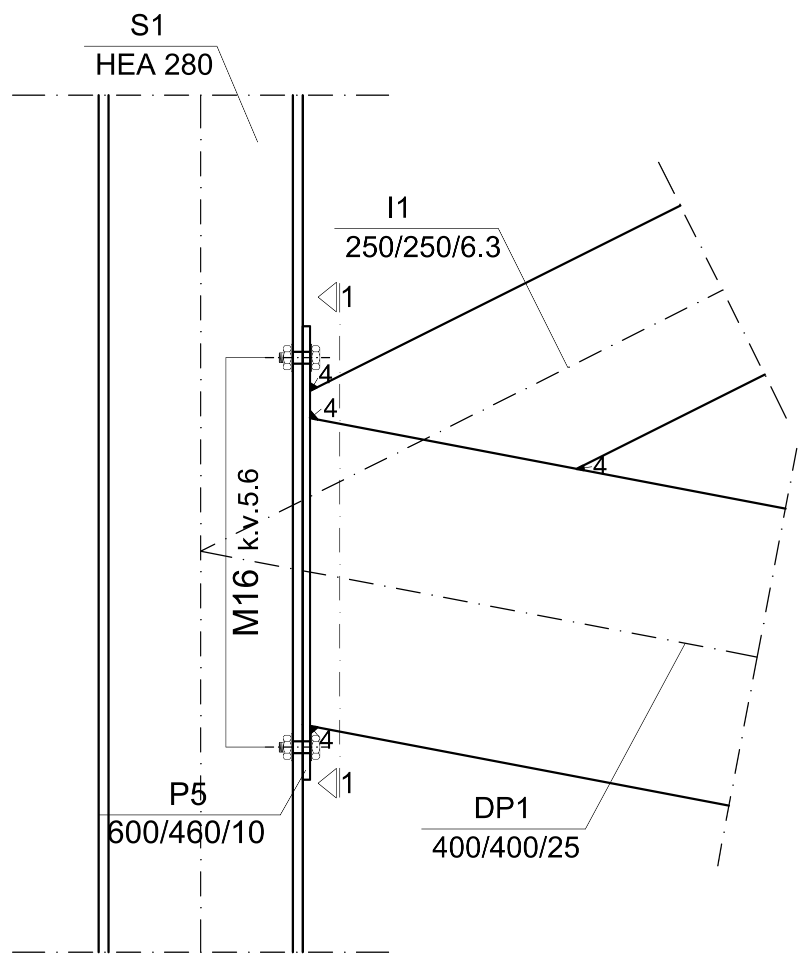
PROGRAM:	PROJEKT ČELIČNE KONSTRUKCIJE STADIONA VIŠNJIK
STUDENT: Monika Ćosić, 685	MENTOR: Prof. dr. sc. Ivica Boko
SADRŽAJ: MONTAŽNI NASTAVAK ISPUNE	MJERILO 1:10
DATUM srpanj 2019.	PRILOG 8

Detalj "E"
Spoj donjeg pojasa i ispune sa stupom
MJ 1:10

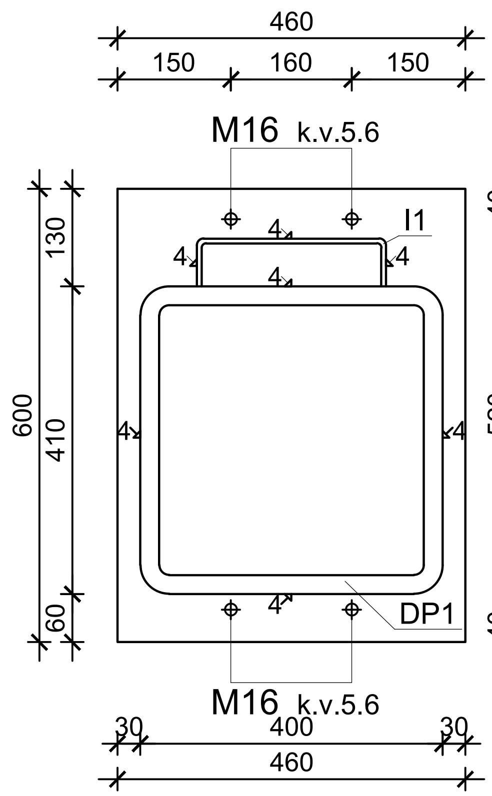
Tlocrt



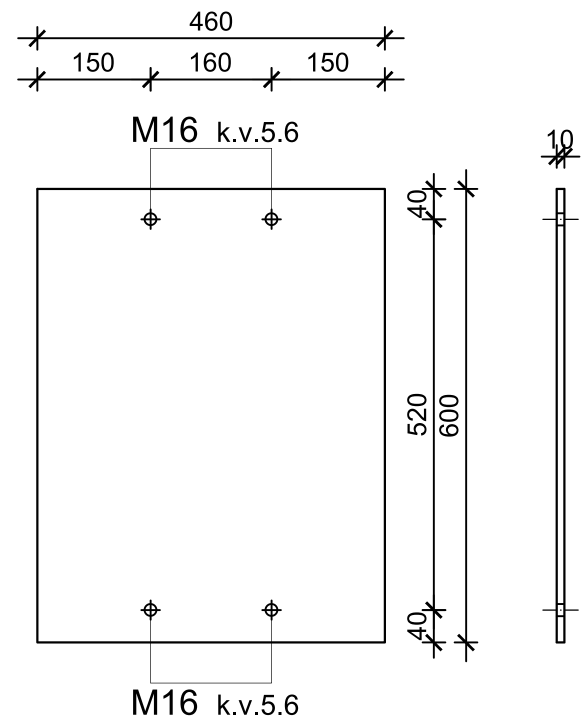
Pogled



Presjek 1-1



P5
460/600/10

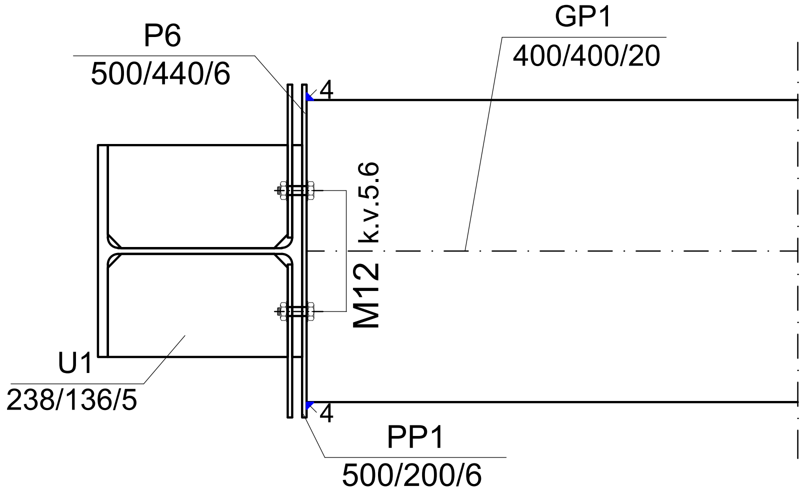


FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE
21000 SPLIT, MATICE HRVATSKE 15

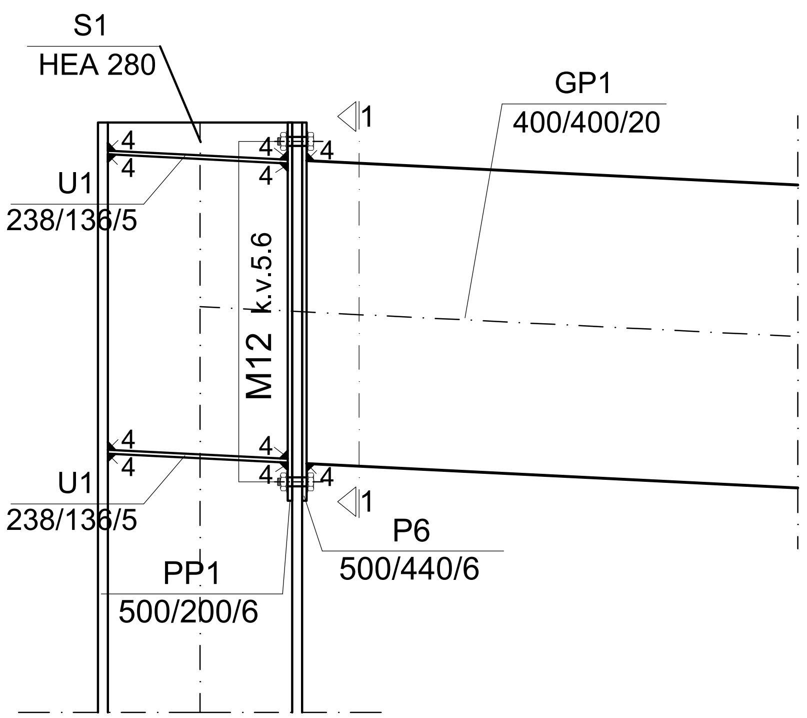
PROGRAM:	PROJEKT ČELIČNE KONSTRUKCIJE STADIONA VIŠNJIK
STUDENT: Monika Ćosić, 685	MENTOR: Prof. dr. sc. Ivica Boko
SADRŽAJ: SPOJ DONJEG POJASA I ISPUNE SA STUPOM	MJERILO 1:10
DATUM srpanj 2019.	PRILOG 9

Detalj "F"
Spoj gornjeg pojasa sa stupom
MJ 1:10

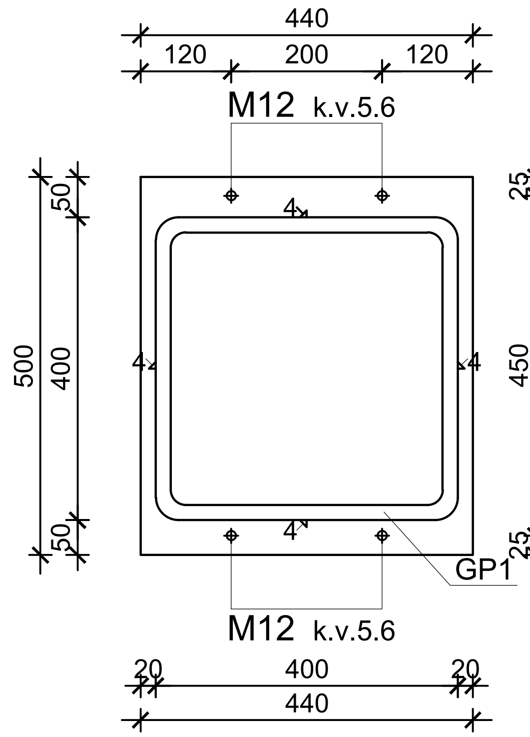
Tlocrt



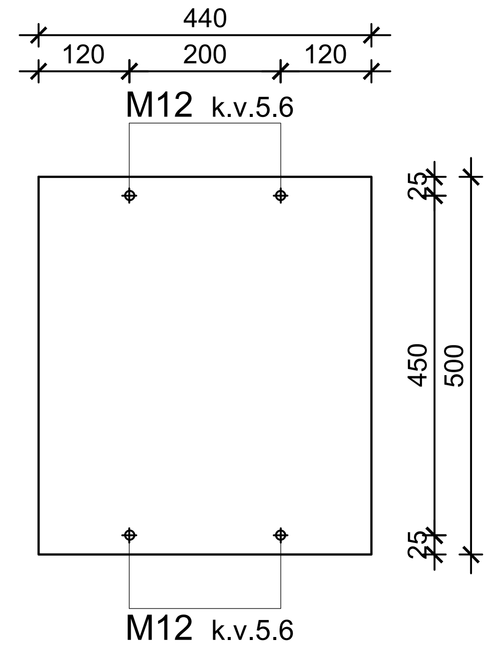
Pogled



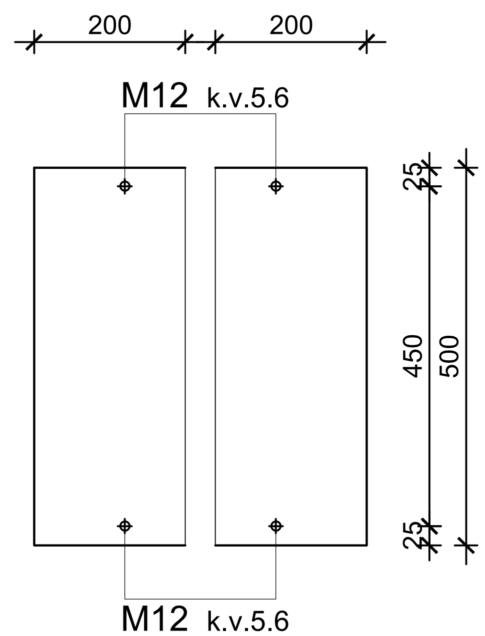
Presjek 1-1



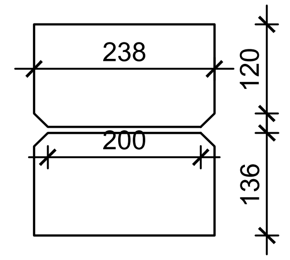
P6
500/440/6



PP1
500/200/6



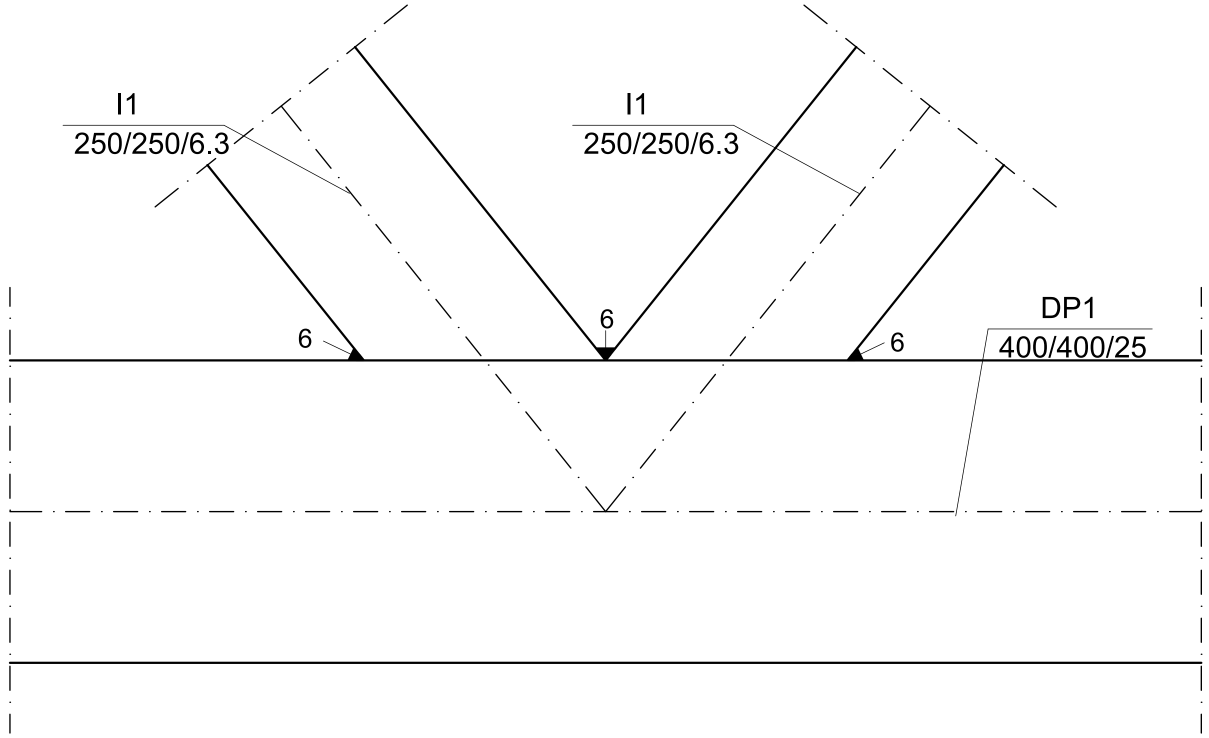
U1
238/136/5



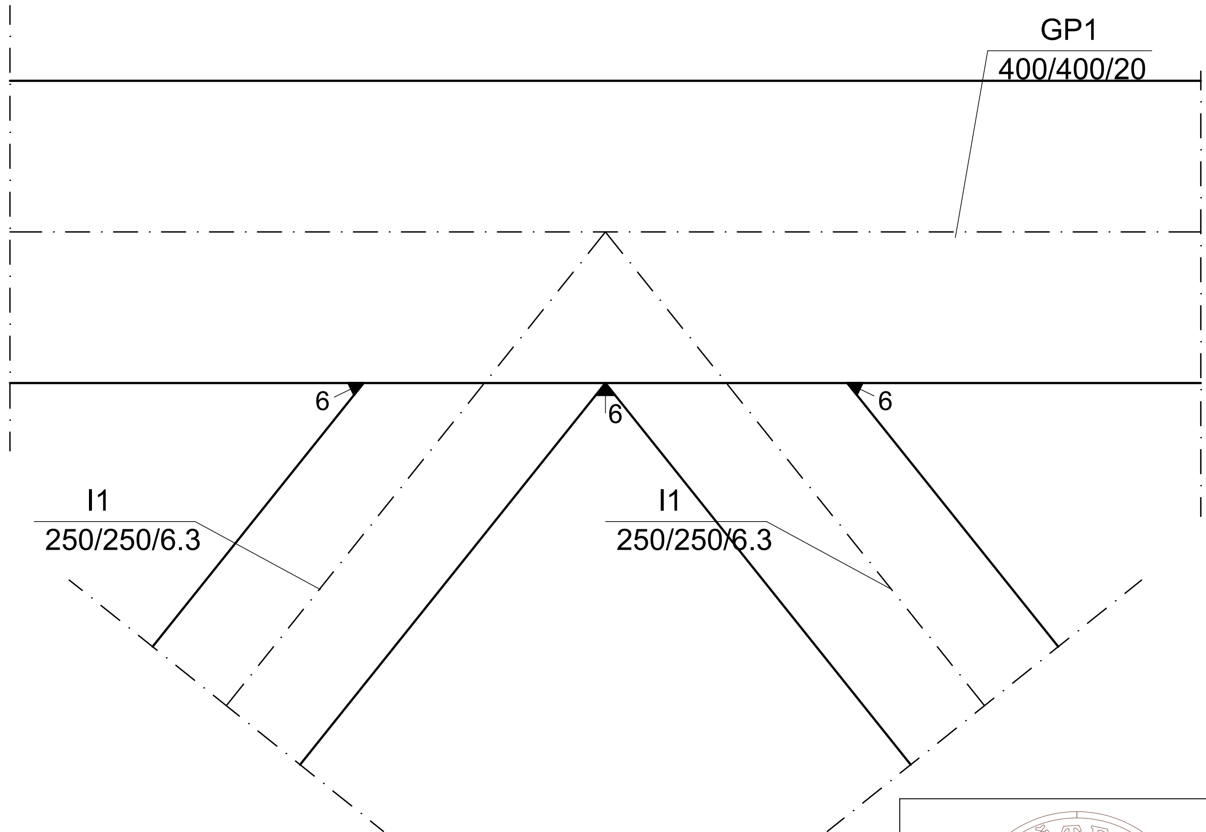
FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE
21000 SPLIT, MATICE HRVATSKE 15

PROGRAM:	PROJEKT ČELIČNE KONSTRUKCIJE STADIONA VIŠNJIK		
STUDENT: Monika Ćosić, 685		MENTOR: Prof. dr. sc. Ivica Boko	
SADRŽAJ:	SPOJ GORNJEG POJASA SA STUPOM	MJERILO	1:10
DATUM	srpanj 2019.	PRILOG	10

Detalj "G"
Spoj ispune s donjim pojasom
MJ 1:10



Detalj "H"
Spoj ispune s gornjim pojasom
MJ 1:10



FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE
KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE
21000 SPLIT, MATICE HRVATSKE 15

PROGRAM:	PROJEKT ČELIČNE KONSTRUKCIJE STADIONA VIŠNJIK		
STUDENT: Monika Ćosić, 685	MENTOR: Prof. dr. sc. Ivica Boko		
SADRŽAJ:	SPOJ ISPUNE S GORNJIM I DONJIM POJASOM	MJERILO	1:10
DATUM	srpanj 2019.	PRILOG	11