

# Projekt izložbenog paviljona na Pelješcu

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UNIVERSITY OF SPLIT



**SVEUČILIŠTE U SPLITU**  
**FAKULTET GRAĐEVINARSTVA ARHITEKTURE I GEODEZIJE**

# **DIPLOMSKI RAD**

**Loris Bulić**

**Split, 2019.**

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**FAKULTET GRAĐEVINARSTVA ARHITEKTURE I GEODEZIJE**

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## ***Sažetak:***

Tema diplomskog rada je proračun čelične konstrukcije izložbenog paviljona smještenog na poluotoku Pelješcu. Napravljen je numerički model konstrukcije gdje je izvršena provjera stabilnosti i dimenzioniranje elemenata konstrukcije prema normi Eurokod 3. U finalnoj fazi proračunati su spojevi uz korištenje programa IDEA STATICA 2019, izrađeni nacrti te je napravljen iskaz materijala .

## ***Ključne riječi:***

Izložbeni paviljon, čelična konstrukcija, numerički model, spojevi, nacrti, iskaz materijala

# **Exhibition pavilion project on Pelješac peninsula**

## ***Abstract:***

The topic of this thesis is the analysis of steel structure for exhibition pavilion located on Pelješac peninsula. A numerical model SCIA 2019 was used to check the stability of the structure and for member design (by using Eurocode 3). Finally, structure connections were calculated with the help of software IDEA STATICA 2019. The thesis contains basic design drawings and the bill of material.

## ***Keywords:***

Exhibition pavilion, steel structure, numerical model, connections, drawings, bill of material



**SVEUČILIŠTE U SPLITU**

**FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE**

**STUDIJ: DIPLOMSKI SVEUČILIŠNI STUDIJ GRAĐEVINARSTVA**

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**BROJ INDEKSA:** 687

**KATEDRA:** **Katedra za metalne i drvene konstrukcije**

**PREDMET:** Metalne konstrukcije

### **ZADATAK ZA DIPLOMSKI RAD**

Tema: Projekt izložbenog paviljona na Pelješcu

Opis zadatka:

Zadatak diplomskog rada je proračun nosive čelične konstrukcije izložbenog paviljona na otoku Pelješcu. Potrebno je za predmetnu konstrukciju izraditi analizu graničnog stanja nosivosti, graničnog stanja uporabljivosti, proračun karakterističnih spojeva te izraditi pripadajuće izvedbene nacрте (plan pozicija, karakteristične presjeke, detalje spojeva i radioničke nacрте).

U Splitu, 07.03.2019.

Voditelj Diplomskog rada:

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za završne i diplomske ispite:

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## 1. Tehnički opis

### 1.1. Opis konstrukcije

Predmet ovog projekta je izrada čelične konstrukcije izložbenog paviljona na Pelješcu. Parcela predviđena za gradnju nalazi se na vrhu brežuljka, s pristupnom cestom smještenom na sjevernoj strani parcele.

Sjeverni dio parcele služiti će kao parkirni prostor za 85 vozila, s uređenim pješačkim stazama i drvećem kao prirodnim zaklonom od sunca.

Konstrukcija se sastoji od izlomljenog poligonalnog oblika koji možemo promatrati kao dio osmerokuta s izbačenim južnim pročeljem. Možemo je podijeliti na tri zone: unutarnji prsten s razmakom od 6 metara između rešetki, vanjski prsten s razmakom od 8 metara i južno pročelje s razmakom od 5 metara.

Ukupna širina objekta iznosi 43,18 metara, ukupna duljina objekta iznosi 90,31 metar. Ukupna površina krovne plohe je 2168,13 m<sup>2</sup>.

Visina objekta varira od 10,8 m do 11,5 m. Svi stupovi su visine 10 m, a varijabilna je visina rešetke koja ovisi o maksimalnom rasponu između stupova. Najviša rešetka nalazi se u vanjskom prstenu, te je visine 1,5m dok se najmanja nalazi u unutarnjem prstenu te je visine 0,8 m. Krovna ploha je u odnosu na horizontalnu ravninu nagnuta pod kutom  $\alpha = 3^\circ$  što je ekvivalentno padu od 5%.

Glavnu konstrukciju čine ravninske rešetke međusobne udaljenosti 6 m, odnosno 8 metara u vanjskom prstenu. One su međusobno pridržane ravninskim rešetkama čija udaljenost varira u rasponu od 2,65 m do 6,81 m. Vrsta rešetke je N rešetka (Prattova rešetka).

Sekundarnu konstrukciju tvore podrožnice i spregovi. Podrožnice se oslanjaju na gornji pojas rešetke. Kao pokrov koriste se aluminijski sendvič paneli. Stabilizacija paviljona je ostvarena sa spregovima u krovnim i bočnim ravninama, postavljanjem krovnih spregova u vanjskom prstenu i bočnih spregova na 3 pročelja. Sekundarna konstrukcija je zglobno vezana za glavnu konstrukciju.

Stupovi su upeto vezani za temelje. Spoj stupa i rešetkaste konstrukcije ostvarit će se čeonim pločama i vijcima, gdje se vrh stupa direktno veže za donji pojas rešetke.

Temelji su armirano betonski temelji samci, kvadratnog tlocrtnog oblika i dimenzija 3,0 x 3,0 x 0,5 metara.

## 1.2. Konstruktivni elementi

### **Krovna rešetka**

Proračunom, za gornji i donji pojas rešetke, su odabrani šuplji vrućevaljani pravokutni profili:

- CFRHS 200x100x6
- CFRHS 180x100x5
- CFRHS 120x50x3
- CFRHS 120x80x5
- CFRHS 200x80x5
- CFRHS 140x60x5
- CFRHS 140x70x4

Za ispune rešetke odabrani su šuplji vrućevaljani pravokutni profili:

- CFRHS 150x50x3
- CFRHS 50x50x3
- CFRHS 60x60x4

Pri odabiru profila vodilo se računa o izbjegavanju proboja pri spajanju ispuna na pojas, stoga su ispune okrenute za 90°.

### **Stupovi**

Proračunom su odabrani vanjski stupovi europskih širokopojasnih H profila HEA 550 i HEA 320, ukupne dužine 10 000 (mm).

**Podrožnice**

Proračunom su odabrane podrožnice europskih širokopojsnih H profila IPE 160 AA.

**Spregovi**

Proračunom su odabrani puni kružni profili RD20 (čelična šipka  $\varnothing 20$ )

**1.3. Proračun konstrukcije**

Proračun konstrukcije izveden je u programskom paketu SCIA engineer 2018. Proračun reznih sila, pomaka konstrukcije te dimenzioniranje konstruktivnih elemenata izveden je korištenjem programa SCIA engineer 2018, dok je za nacрте korišten AutoCAD 2017. Proračun spojeva je napravljen u IDEA StatiCi 10.

Proračun je proveden po teoriji prvoga reda dakle na nedeformiranoj konstrukciji pri čemu nisu uzete u obzir početne imperfekcije konstruktivnih elemenata.

Proračunom su obuhvaćena sva djelovanja na konstrukciju:

- Vlastita težina
- Dodatno stalno opterećenje
- Opterećenje vjetrom
- Opterećenje snijegom
- Temperaturno opterećenje

Opterećenja su na konstrukciju zadana uz pomoć naredbe load panela, koja opterećenje po površini panela raspodjeljuju na krovnu rešetku.

Konstrukcija je prikazana prostornim modelom s opterećenjima koja djeluju okomito i u ravnini krovnih i bočnih ploha(panela).

Uzimajući u obzir lokaciju objekta napravljena je analiza opterećenja koja obuhvaća djelovanje snijega, vjetra i temperature. Objekt se nalazi na području Pelješca, nadmorske visine 215 m što spada u I. zonu te daje karakterističnu vrijednost opterećenja snijegom na tlu. Za opterećenje vjetrom uzeta je zona I, kategorija zemljišta II te je uzeta u obzir visina objekta i njegova zaštićenost.


Vjetar je dominantno opterećenje za ovakav tip objekta stoga mu je posvećena velika pažnja te je proračunat kao 3D vjetar u SCIA Enginneru, sa 16 različitih vrsta opterećenja ovisno o smjeru vjetra.

Za svaki element konstrukcije određena je mjerodavna kombinacija opterećenja za provjeru graničnog stanja nosivosti i graničnog stanja uporabljivosti.

Rezultati prikazani u ovom projektu uključuju rezne sile i pomake određenih dijelova konstrukcije. Rezne sile su dane u jedinicama kN za poprečne i uzdužne sile, kNm za momente te u mm za pomake konstrukcije.

#### 1.4. Svojstva materijala

Svi elementi konstrukcije (krovnna rešetka, stupovi, podrožnice, spregovi i spojne ploče) izrađeni su od građevinskog čelika S355.

Name	S 355
<b>Code independent</b>	
Material type	Steel
Thermal expansion [m/mK]	0,00
Unit mass [kg/m <sup>3</sup> ]	7850,0
E modulus [MPa]	2,1000e+05
Poisson coeff.	0,3
Independent G modulus	<input type="checkbox"/>
G modulus [MPa]	8,0769e+04
Log. decrement (non-uniform...)	0,15
Colour	
Thermal expansion (for fire r...)	0,00
Specific heat [J/gK]	6,0000e-01
Thermal conductivity [W/mK]	4,5000e+01
<b>Material behaviour for n...</b>	
Material behaviour	Elastic
<b>EC3</b>	
Ultimate strength [MPa]	490,0
Yield strength [MPa]	355,0
Thickness range	...

Slika 1.4.1 Svojstva odabranog čelika



Korišteni vijci u konstrukciji su: M12, M27 i M30 kvalitete vijaka 5.6., M16 kvalitete vijaka 5.8. i M20 kvalitete vijaka 6.8.

Temelji su izrađeni od armiranog betona klase C 25/35, s betonskim čelikom B500B kao armaturom.

Za oblogu paviljona koriste se sendvič paneli vlastite težine 25 kg/m<sup>2</sup>.

## 1.5. Zaštita elemenata

### 1.5.1. Antikorozivna zaštita

Prema odredbama "Pravilnika o tehničkim mjerama i uvjetima za zaštitu čeličnih konstrukcije od korozije" svi dijelovi čelične konstrukcije moraju biti zaštićeni.

Korozija je oksidacija željeza do koje dolazi uz prisustvo vlage i raznih nečistoća. Svi elementi objekta zaštićeni su od korozije pocinčavanjem. To podrazumijeva nanošenje prevlake cinka po toplom postupku. Masa i debljina prevlake određene su pravilnikom i ne mogu biti manje od 500 g/m<sup>2</sup> na elementu debljine 5mm. Prije samog pocinčavanja potrebno je sve čelične elemente odmastiti, očistiti razblaženom otopinom klorovodične kiseline te isprati hladnom vodom. Neposredno prije pocinčavanja, čelična konstrukcija se stavlja u taljevinu ili otopinu za flusiranje. Kao vrsta zaštite od korozije odabrana je zaštita vrućim pocinčavanjem i zaštitnim premazom. Ukupna debljina zaštitnog sloja usvaja se 200 µm.

### 1.5.2. Protupožarna zaštita

Pri izvedbi osigurat će se provedba svih propisa o zaštiti od požara. Pristup i intervencija vatrogasnog vozila omogućit će se sa sjeverne strane parcele. Zahtijevana vatrootpornost elemenata čelične konstrukcije F60. Odabrana je zaštita F60 jer sa radi o tipu objekta u kojem se, u svom punom kapacitetu, može nalaziti veći broj ljudi. Osiguranje vatrootpornosti osiguravamo specijalnim ekspandirajućim premazima.

## 1.6. Montaža konstrukcije

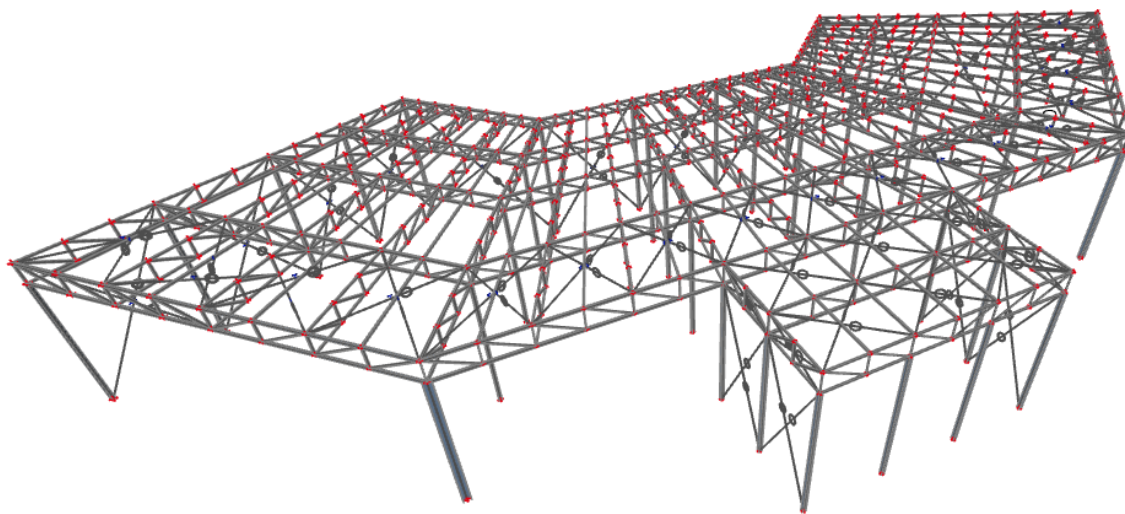
Način izvedbe konstrukcije objekta je montažno. Elementi predgotovljeni stižu na gradilište te se međusobno spajaju vijcima. Spajanjem segmenata montirat će se nosiva konstrukcija.

Montaža započinje s postavljanjem stupova u temelje, koji se pridržavaju dizalicom dok se ne postigne vertikalnost. Nakon učvršćivanja stupova u temelj, koje se izvodi vijcima na pločama, može se krenuti si montažom krovne konstrukcije. Prvo se montiraju svi dijelovi konstrukcije iznad stupova a nakon toga slijedi montaža ostalih dijelova konstrukcije.

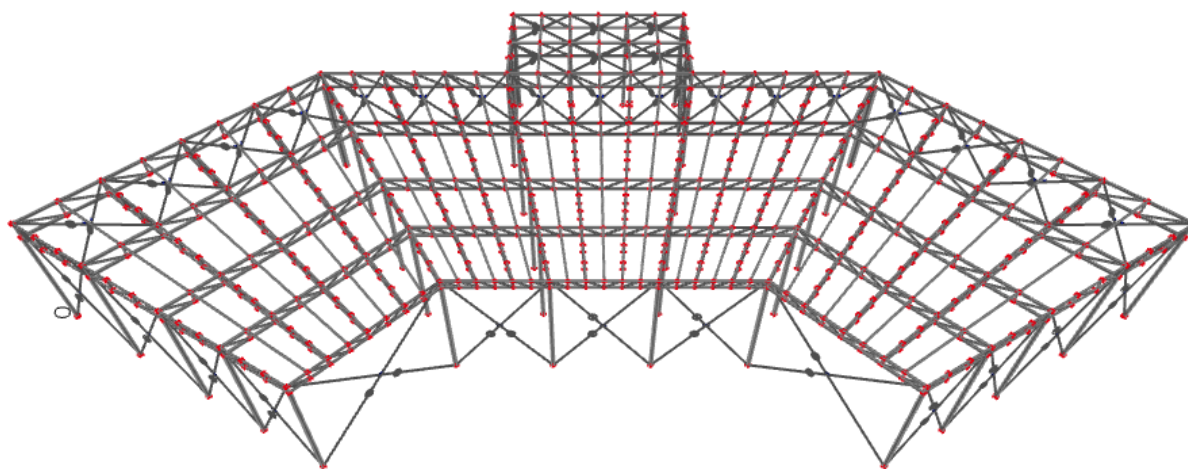
Pri montaži je potrebno u suradnji s geodetima vršiti stalne kontrole kako bi montaža što bolje prošla.

## 2. Numerički model

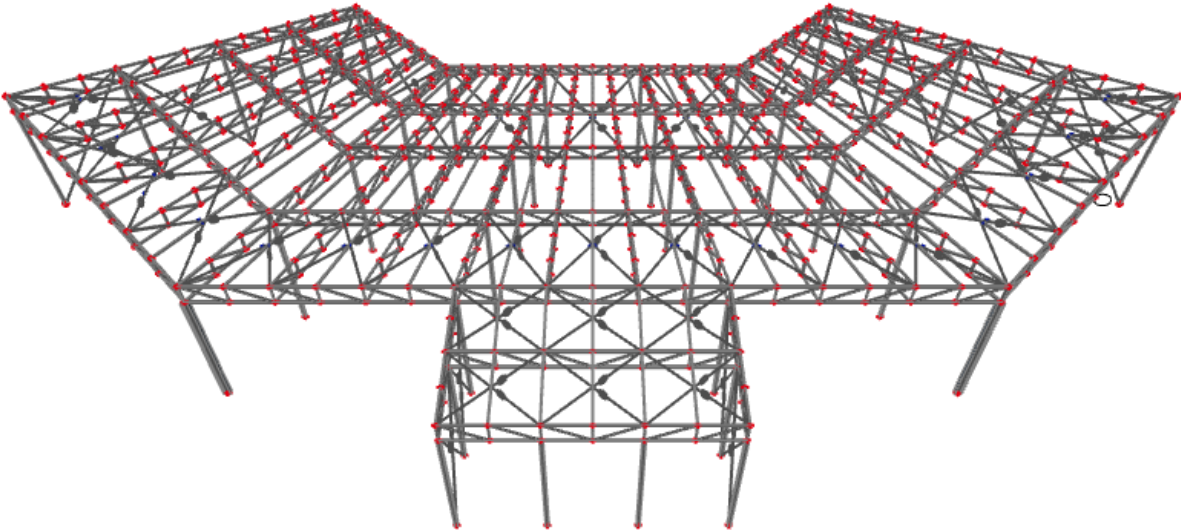
Numerički 3D model izrađen je u SCIA Engineer 18



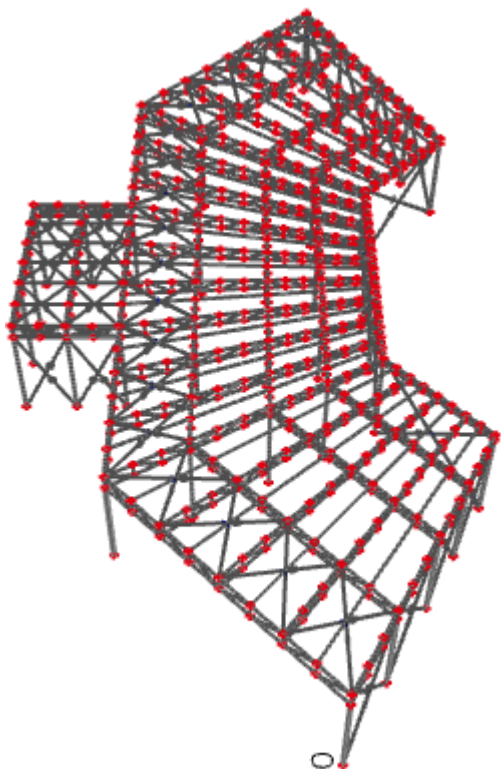
*Slika 1.6.1 Izometrijski prikaz modela*



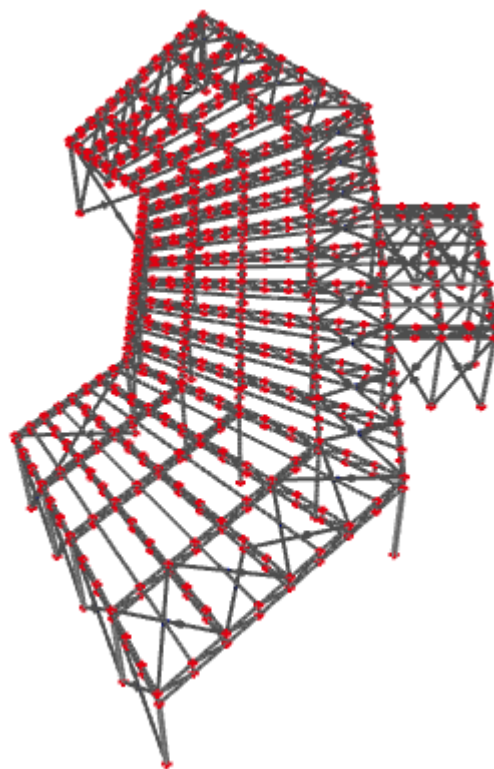
*Slika 1.6.2 Sjeverno pročelje*



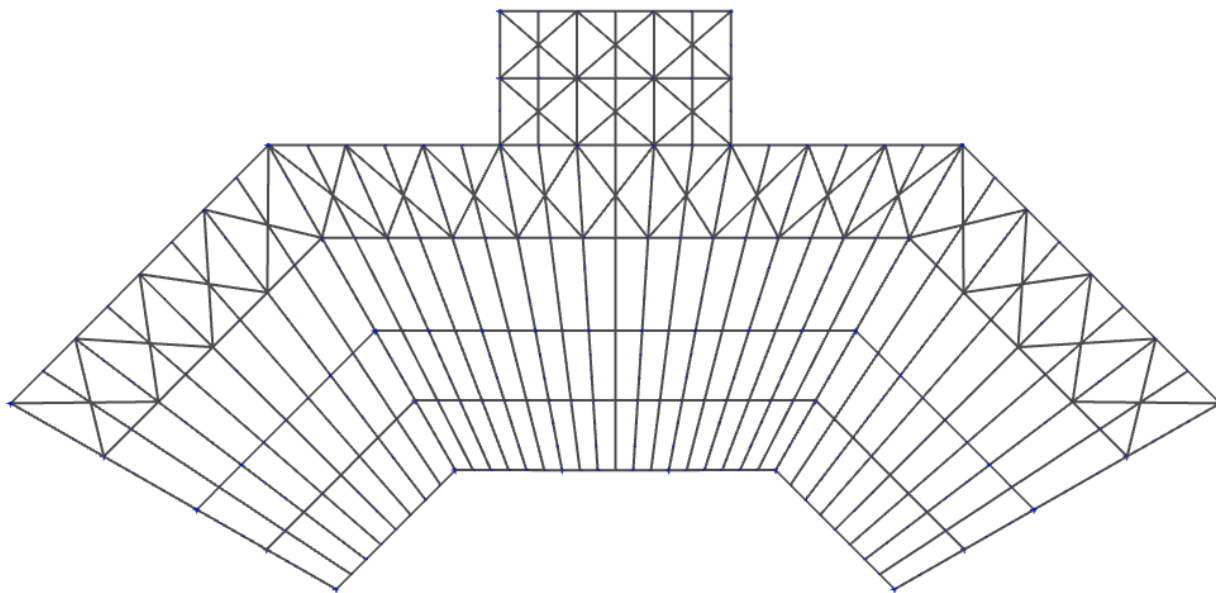
Slika 1.6.3 Južno pročelje



*Slika 1.6.4 Istočno pročelje*



*Slika 1.6.5 Zapadno pročelje*



*Slika 1.6.6 Tlocrt*

### 3. Analiza opterećenja

#### 3.1. Dodatno stalno opterećenje

- pokrov  $g = 0.25kN/m^2$

- instalacije  $g = 0.10kN/m^2$

- vlastita težina – biti će dodana u sklopu računalnog programa

$$\sum g = 0.35kN/m^2$$

### 3.2. Opterećenje snijegom

Proračun djelovanja snijega napravljen je prema Eurocodu 1 [1].

Opterećenje snijegom na krovu

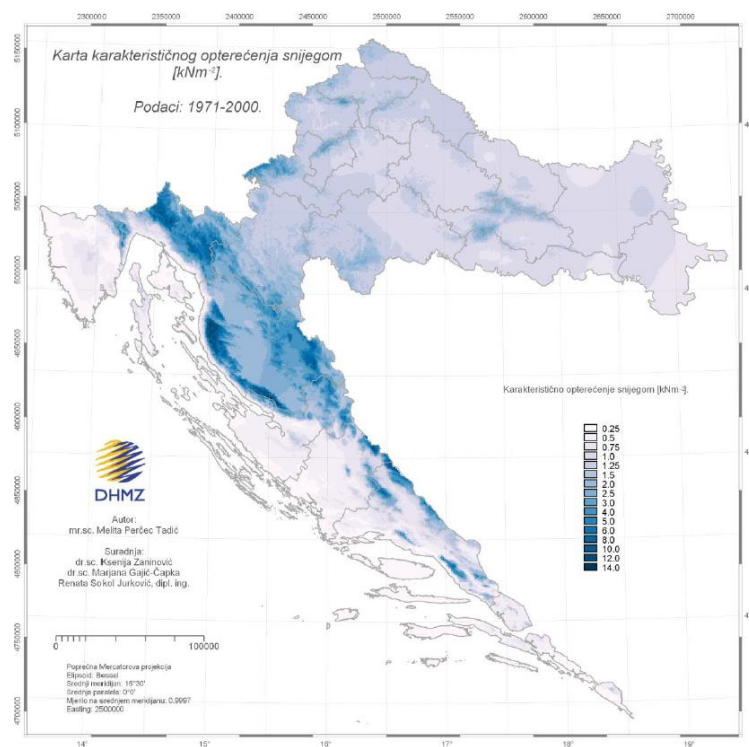
$$s = \mu_1 \cdot C_e \cdot C_t \cdot s_k$$

-  $\mu_1$  - koef. oblika za opterećenje snijegom

krov nagiba  $0^\circ \leq \alpha \leq 30^\circ \Rightarrow \mu_1 = 0,8$

-  $s_k$  - karakteristična vrijednost opterećenja na tlu u  $[kN/m^2]$

zona Pelješac, područje 1., nadmorska visina 215 m  $\Rightarrow s_k = 0,25 kN/m^2$



Slika 3.2.1 Karta karakterističnog opterećenja snijegom  $[kNm^2]$

-  $C_e$  - koef. izloženosti  $\Rightarrow C_e = 1,0$

-  $C_t$  - toplinski koef.  $\Rightarrow C_t = 1,0$

$$\Rightarrow s = 0,8 \cdot 1,0 \cdot 1,0 \cdot 0,25 = 0,2 [kN/m^2]$$

### 3.3. Opterećenje vjetrom

Proračun djelovanja vjetra na konstrukciju napravljen je prema Eurocodu 1 [2].

- pritisak vjetra na vanjske površine:  $w_e = q_p \cdot c_e(z_e) \cdot c_{pe}$  [kN/m<sup>2</sup>]

- pritisak vjetra na unutarnje površine:  $w_i = q_p \cdot c_e(z_i) \cdot c_{pi}$  [kN/m<sup>2</sup>]

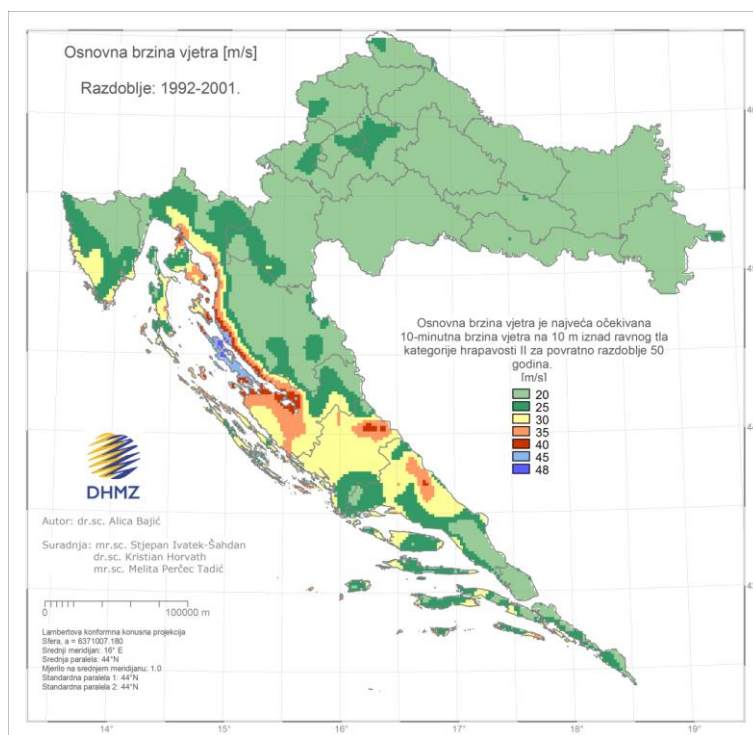
gdje je:

$q_{ref}$  – poredbeni tlak vjetra pri srednjoj brzini vjetra

$C_e(z_e); C_e(z_i)$  – koeficijenti izloženosti koji uzimaju u obzir neravnine terena

$z_e; z_i$  – poredbene visine za lokalni ili unutarnji tlak

$c_{pe}; c_{pi}$  – vanjski i unutarnji koeficijent pritiska



Slika 3.3.1 Karta osnovne brzine vjetra

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



gdje je:

$v_b$  – osnovna brzina vjetra

$\rho$  – gustoća zraka ( $\rho=1,25 \text{ kg/m}^3$ )

Osnovna brzina vjetra  $v_b$ , dana je izrazom:

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

gdje je:

$v_b$  – osnovna brzina vjetra

$C_{dir}$  – koeficijent smjera vjetra (obično uzima vrijednost 1,0)

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

Osnovni pritisak vjetra:

$$v_b = 20,0 \left( \frac{m}{s} \right) \rightarrow$$

očitano za Pelješac

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

$$v_b = v_{b,0} \cdot C_{dir} \cdot C_{season} = 20 \cdot 1,0 \cdot 1,0 = 20,0 \left( \frac{m}{s} \right)$$

$$\rho = 1,25 \frac{kg}{m^3}$$

$$q_b = \frac{\rho}{2} \cdot v_b^2 = \frac{1,25}{2} \cdot 20,0^2 = 250 \left( \frac{N}{m^2} \right) = 0,25 \left( \frac{kN}{m^2} \right)$$

Faktor terena  $k_r$  -za kategoriju terena II :

$$k_r = 0,19 \cdot \left( \frac{z_0}{z_{0,II}} \right)^{0,07} = 0,19 \cdot \left( \frac{0,3}{0,05} \right)^{0,07} = 0,215$$

$$C_{r(z)} = k_r \cdot \ln\left(\frac{z}{z_0}\right) = 0,215 \cdot \ln\left(\frac{12}{0,3}\right) = 0,793$$

$$C_{0(z)} = 1,0$$

Srednja brzina vjetra iznad terena:

$$v_{m(11,84)} = v_b \cdot C_{r(z)} \cdot C_{0(z)} = 20 \cdot 0,793 \cdot 1,0 = 15,86 \left(\frac{m}{s}\right)$$

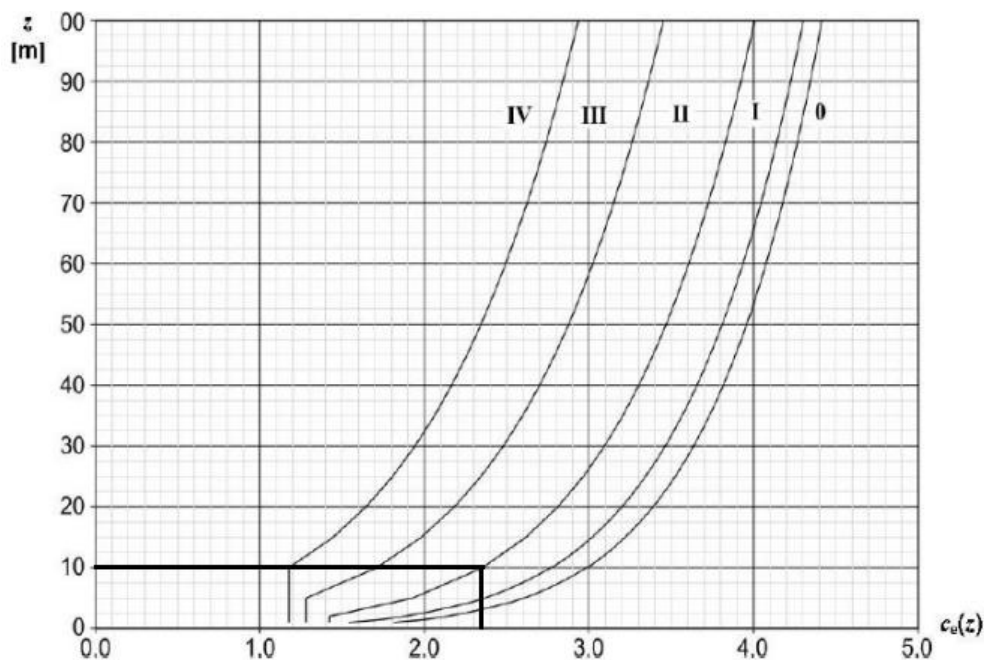
Intezitet turbulencije:

$$I_{v(z)} = \frac{k_1}{C_{0(z)} \cdot \ln\left(\frac{z}{z_0}\right)} = \frac{1}{1 \cdot \ln\left(\frac{12,0}{0,3}\right)} = 0,271$$

Pritisak brzine vjetra pri udaru:

$$q_{p(z)} = C_e(z) \cdot q_b = 2,35 * 0,25 = 0,59 \text{ kN/m}^2$$

$C_e(z) = 2,35$  - očitani faktor izloženosti sa slike 3.3.2

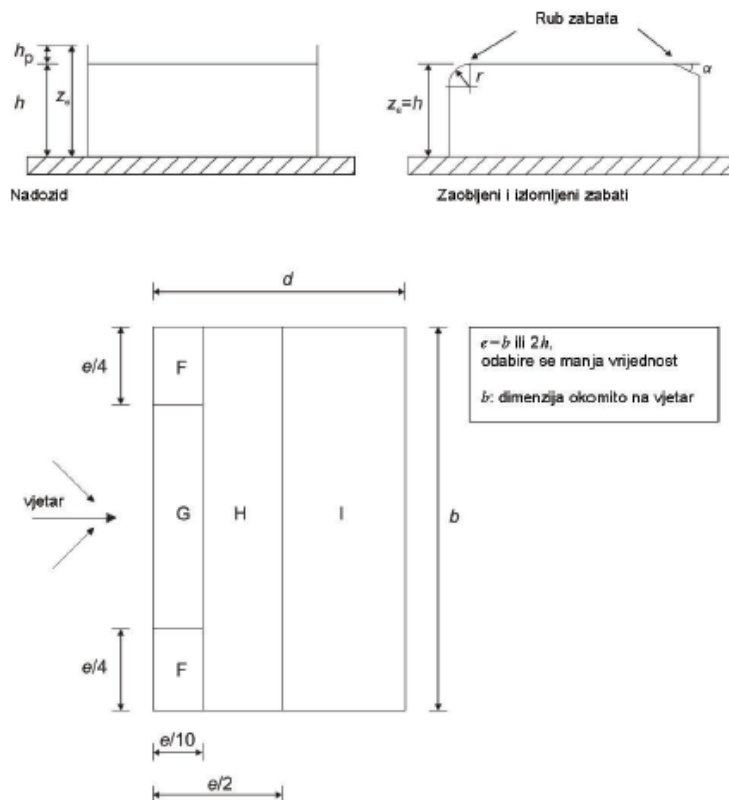


Slika 5. Grafički prikaz faktora izloženosti  $c_e(z)$  za  $c_0=1,0$  i  $k_1=1,0$

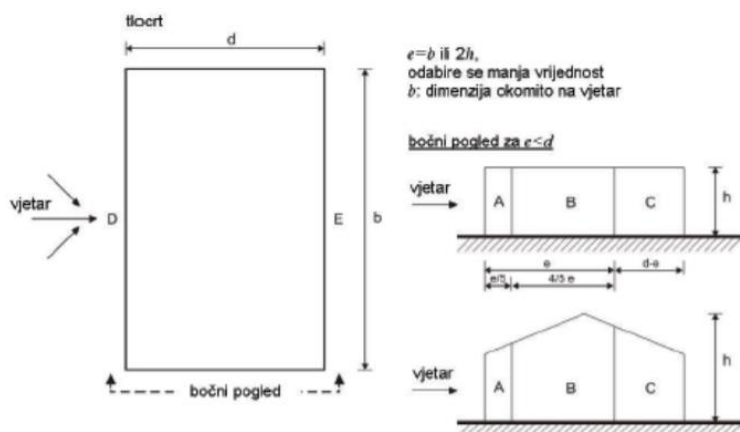
Slika 3.3.2 Grafički prikaz faktora izloženosti

3.3.1. Djelovanje vjetra na krov

Djelovanje vjetra na konstrukciju modeliramo kao djelovanje na halu pravokutnog oblika dimenzija 90 x 33 m, visine 11,5 m.



Slika 3.3.3 Prikaz područja vjetra za ravne krovove



Slika 3.3.4 Prikaz područja vjetra za vertikalne zidove

Vrsta krova		Područje							
		F		G		H		I	
		$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
Oštri zabati		-1,8	-2,5	-1,2	-2,0	-0,7	-1,2	+0,2	-0,2
S nadozidima	$h_p/h = 0,025$	-1,6	-2,2	-1,1	-1,8	-0,7	-1,2	+0,2	-0,2
	$h_p/h = 0,05$	-1,4	-2,0	-0,9	-1,6	-0,7	-1,2	+0,2	-0,2
	$h_p/h = 0,10$	-1,2	-1,8	-0,8	-1,4	-0,7	-1,2	+0,2	-0,2
Zaobljeni zabati	$r/h = 0,05$	-1,0	-1,5	-1,2	-1,8	-0,4		+0,2	-0,2
	$r/h = 0,10$	-0,7	-1,2	-0,8	-1,4	-0,3		+0,2	-0,2
	$r/h = 0,20$	-0,5	-0,8	-0,5	-0,8	-0,3		+0,2	-0,2
Izlomljeni zabati	$\alpha = 30^\circ$	-1,0	-1,5	-1,0	-1,5	-0,3		+0,2	-0,2
	$\alpha = 45^\circ$	-1,2	-1,8	-1,3	-1,9	-0,4		+0,2	-0,2
	$\alpha = 60^\circ$	-1,3	-1,9	-1,3	-1,9	-0,5		+0,2	-0,2

NAPOMENA 1: Za krovove s nadozidima ili zaobljenim zabatima, smije se upotrebljavati linearna interpolacija za međuvrijednosti  $h_p/h$  i  $r/h$ .

NAPOMENA 2: Za krovove s izlomljenim zabatima, smije se upotrebljavati linearna interpolacija između  $\alpha = 30^\circ$ ,  $45^\circ$  i  $60^\circ$ . Za  $\alpha > 60^\circ$  smije se upotrebljavati linearna interpolacija između vrijednosti za  $\alpha = 60^\circ$  i vrijednosti za ravne krovove s oštrim (izlomljenim) zabatima.

NAPOMENA 3: U području I, gdje su dane i pozitivne i negativne vrijednosti, u obzir treba uzeti obje vrijednosti.

NAPOMENA 4: Za sami izlomljeni zabat, koeficijenti vanjskog tlaka dani su u tablici 7.4a „Koeficijenti vanjskog tlaka za dvostrešne krovove; smjer vjetra 0°“, područje F i G, ovisno o nagibu izlomljenog zabata.

NAPOMENA 5: Za sami zaobljeni zabat, koeficijent vanjskog tlaka dani su linearnom interpolacijom duž krivulje, između vrijednosti na zidu i na krovu.

NAPOMENA 6: Za mansardne strehe čije su horizontalne dimenzije manje od  $e/10$  treba uzeti vrijednosti za oštre strehe. Za definiciju  $e$  vidjeti sliku 7.5

Tablica 3.3-1 Preporučene vrijednosti koeficijenata vanjskog tlaka za ravne krovove

### Određivanje koeficijenata unutarnjeg pritiska

Koeficijenti  $c_{pi}$  ovise o veličini i raspodjeli otvora na oblozi hale (fasada i krov). U ovom primjeru nije definiran raspored i veličina otvora, zato se za vrijednost  $c_{pi}$  usvaja vrijednost iz normi.

- Unutrašnji koeficijent pritiska  $\rightarrow c_{pi} = \pm 0,3$

Pri određivanju vjetra na vertikalne zidove izračunat je odnos visine i bočne stranice

$$h/d = 11,5/33 = 0,35$$

Područje	A		B		C		D		E	
	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,7	
1	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,5	
$\leq 0,25$	-1,2	-1,4	-0,8	-1,1	-0,5		+0,7	+1,0	-0,3	

Tablica 3.3-2 Preporučene vrijednosti tlaka za vertikalne zidove

Rezultirajuće djelovanje tlaka po zonama

$$w_e = q_{ref} \cdot c_e(z_e) \cdot c_{pe} \quad [\text{kN/m}^2]$$

$$q_{ref} = 0,25 \text{ kN/m}^2, \quad c_e(z_e) = 2,35$$

PODRUČJE	A	B	C	D	E	F	G	H	I
$c_{pe,10}$	-1,20	-0,80	-0,50	0,70	-0,30	-1,80	-1,20	-0,70	-0,20
$w_{e1} \text{ (kN/m}^2\text{)}$	-0,71	-0,21	-0,29	0,41	0,17	-1,06	-0,71	-0,41	-0,12

Tablica 3.3-3 Djelovanje tlaka po zonama

Rezultirajuće djelovanje podtlaka po zonama

$$w_i = q_{ref} \cdot c_i(z_i) \cdot c_{pi} \quad [\text{kN/m}^2]$$

$$q_{ref} = 0,25 \text{ kN/m}^2, \quad c_e(z_e) = 2,35$$

$$w_i = 0,25 \cdot 2,35 \cdot \pm 0,3 = \pm 0,176 \text{ kN/m}^2$$

Rezultirajuće djelovanje vjetra

$$w_k = w_e - w_i \quad [\text{kN/m}^2]$$

Vjetar W1 pozitivni unutarnji pritisak-nadtlak ( $c_{pi} = +0,3$ )

PODRUČJE	A	B	C	D	E	F	G	H	I
$w_e$ (kN/m <sup>2</sup> )	-0,71	-0,21	-0,29	0,41	0,17	-1,06	-0,71	-0,41	-0,12
$w_i$ (kN/m <sup>2</sup> )	0,176	0,176	0,176	0,176	0,176	0,176	0,176	0,176	0,176
$w_{uk}$ (kN/m <sup>2</sup> )	-0,534	-0,034	-0,114	0,586	0,346	-0,884	-0,534	-0,768	0,056

Tablica 3.3-4 Ukupno djelovanje po zonama - tlak

Vjetar W2 negativni unutarnji pritisak-podtlak ( $c_{pi} = -0,3$ )

PODRUČJE	A	B	C	D	E	F	G	H	I
$w_e$ (kN/m <sup>2</sup> )	-0,71	-0,21	-0,29	0,41	0,17	-1,06	-0,71	-0,41	-0,12
$w_i$ (kN/m <sup>2</sup> )	-0,176	-0,176	-0,176	-0,176	-0,176	-0,176	-0,176	-0,176	-0,176
$w_{uk}$ (kN/m <sup>2</sup> )	-0,886	-0,386	-0,466	0,234	-0,006	-1,236	-0,886	-0,586	-0,296

Tablica 3.3-5 ukupno djelovanje po zonama - podtlak

### 3.3.2. Opterećenje vjetrom trenjem po krovu

$$F_{fr} = c_{fr} \cdot q_p(z) \cdot A_{fr} - \text{sila trenja}$$

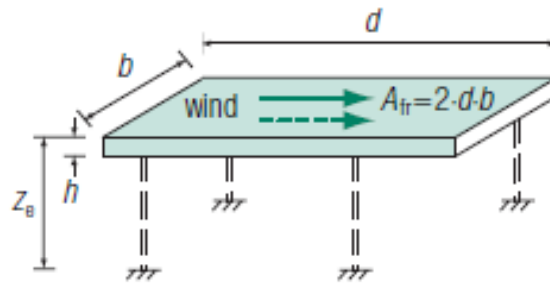
$$c_{fr} = 0,04 - \text{koef. trenja za narebreni lim (vjerojatni pokrov)}$$

$$q_p(z) = c_e(z) \cdot q_{ref} - \text{tlak "vršne" (referentne) brzine}$$

$$C_{e(z)} = 2,35 - \text{koef. izloženosti}$$

$$q_{ref} - \text{poredbeni tlak pri srednjoj brzini vjetra}$$

$$A_{fr} - \text{površina usporedno sa smjerom vjetra}$$



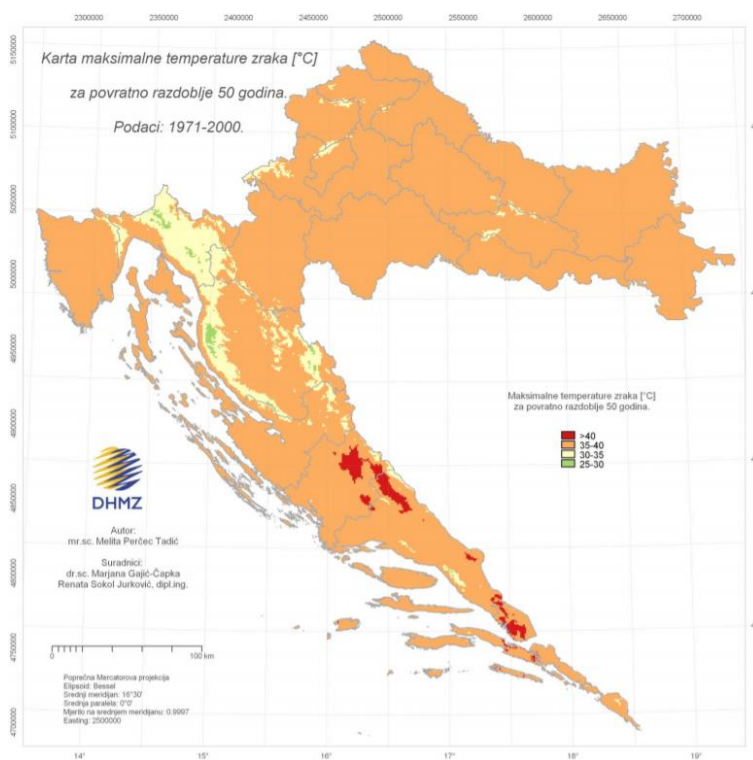
Slika 3.3.5 Trenje vjetra po krovu

Referentna površina:

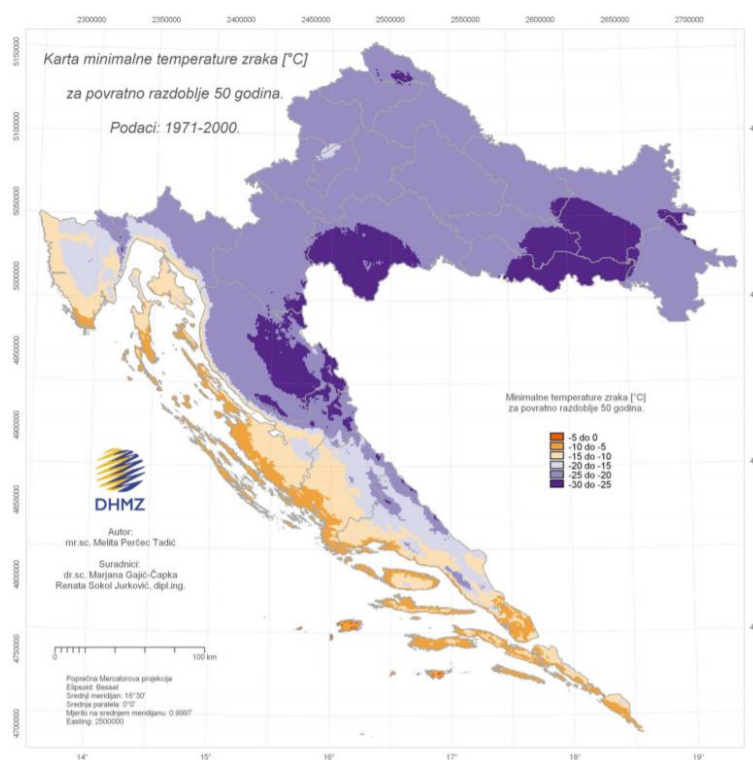
$$A_{fr} = 2 \cdot b \cdot d = 2 \cdot 90 \cdot 33 \text{ m} = 5940 \text{ m}^2$$

$$F_{fr} = 0,04 \cdot 2,35 \cdot 0,25 \cdot 5940 = 139,59 \text{ kN}$$

## 3.4. Temperaturno opterećenje



Slika 3.4.1 Karta maksimalne temperature zraka



Slika 3.4.2 Karta minimalne temperature zraka



Proračun temperaturnih djelovanja napravljen je prema Eurocodu 1 [3].

Promatrani objekt nalazi se u zoni Pelješac, područje 1., nadmorske visine 215 m.

Najviša temperatura u hladu:  $T_{max} = 40 \text{ }^{\circ}\text{C}$

Najniža temperatura u hladu:  $T_{min} = -10 \text{ }^{\circ}\text{C}$

Pretpostavlja se djelovanje jednolike temperature promjene u svim presjecima.

Pretpostavljena temperatura pri montaži konstrukcije  $T = 15 \text{ }^{\circ}\text{C}$ .

1. Maksimalna pozitivna temperaturna promjena:  $T_{max} = 40 \text{ }^{\circ}\text{C} - 15 \text{ }^{\circ}\text{C} = 25 \text{ }^{\circ}\text{C}$ .

2. Maksimalna negativna temperaturna promjena:  $T_{min} = -10 \text{ }^{\circ}\text{C} - 15 \text{ }^{\circ}\text{C} = -25 \text{ }^{\circ}\text{C}$ .

Pri dimenzioniranju elemenata u obzir nije uzeto temperaturno opterećenje, zbog svog zanemarivog učinka na konstrukciju.

## 4. Rezultati

### 4.1. Pomaci konstrukcije

#### Displacement of nodes

Linear calculation, Extreme : Global

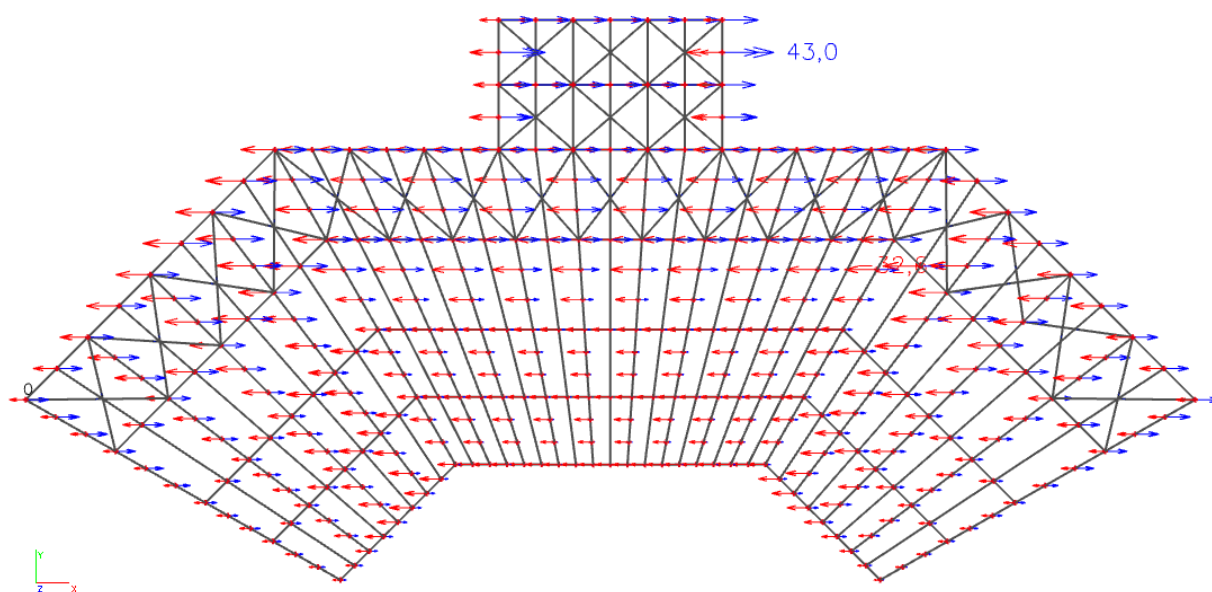
Selection : All

Combinations : SLS-Char (auto)

Node	Case	Ux [mm]	Uy [mm]	Uz [mm]	Fix [mrad]	Fiy [mrad]	Fiz [mrad]
N951	SLS-Char (auto)/7	<b>-32,6</b>	-26,0	-25,9	1,2	2,5	-0,1
N1124	SLS-Char (auto)/8	<b>43,0</b>	-16,8	2,2	0,1	1,7	-2,4
N909	SLS-Char (auto)/9	21,2	<b>-42,5</b>	1,5	-2,0	-1,1	-0,4
N294	SLS-Char (auto)/7	-16,9	<b>42,7</b>	-11,7	-1,0	-2,5	0,1
N684	SLS-Char (auto)/7	-18,4	32,8	<b>-46,8</b>	0,0	-0,5	0,8
N478	SLS-Char (auto)/10	4,0	19,5	<b>5,2</b>	0,5	-0,1	-0,5
N680	SLS-Char (auto)/11	-7,3	15,8	1,6	<b>-5,9</b>	3,5	3,6
N579	SLS-Char (auto)/12	7,5	-18,2	-0,1	<b>3,7</b>	-0,5	-0,1
N314	SLS-Char (auto)/11	-22,2	38,0	-10,3	2,4	<b>-5,2</b>	-0,8
N734	SLS-Char (auto)/13	3,7	1,0	-12,2	2,5	<b>4,4</b>	0,2
N568	SLS-Char (auto)/14	8,1	1,5	1,8	0,9	-1,3	<b>-6,6</b>
N568	SLS-Char (auto)/15	6,1	-23,1	-1,7	-0,2	0,2	<b>5,8</b>

Slika 4.1.1 Pikaz maksimalnih pomaka čvorova

### 5.1.1 Horizontalni pomak



Slika 4.1.2 Pomak konstrukcije u x smjeru

Horizontalni pomak  $u_x=43,0\text{mm}$

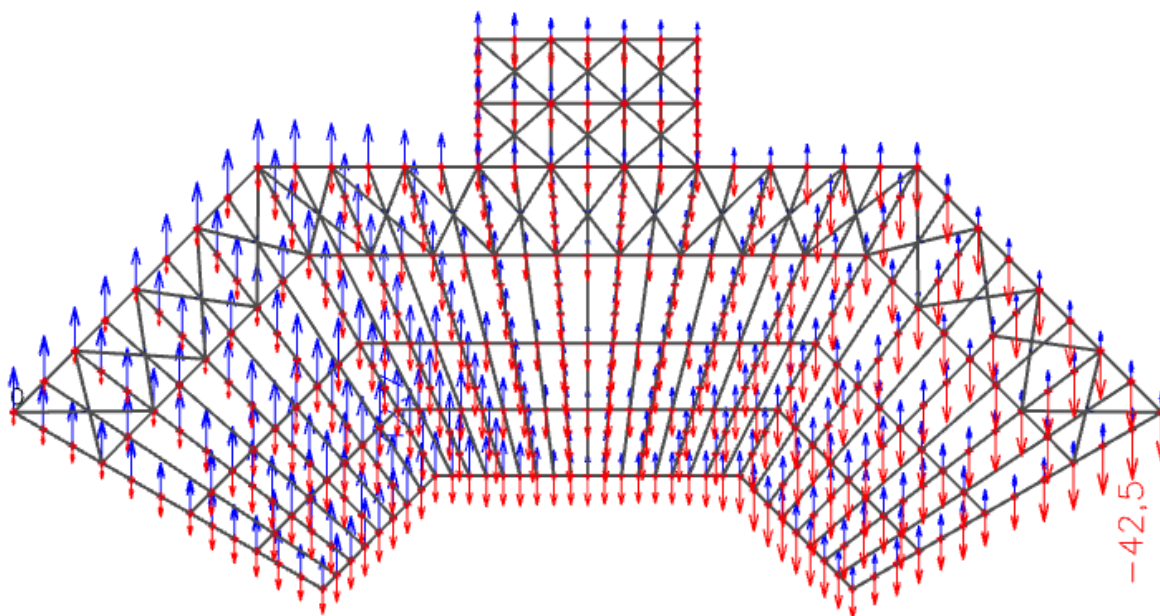
Horizontalni pomak  $u_y=42,7\text{ mm}$

Dopušteni horizontalni pomak:

$$U_{\text{dop}} = \frac{h}{250} = \frac{11500}{250} = 46 \text{ mm}$$

$U_{\text{dop}} = 46 \text{ [mm]} > U_x = 43,0 \text{ [mm]} \rightarrow \text{Zadovoljava}$

$U_{\text{dop}} = 46 \text{ [mm]} > U_y = 42,7 \text{ [mm]} \rightarrow \text{Zadovoljava}$



Slika 4.1.3 Pomak konstrukcije u y smjeru

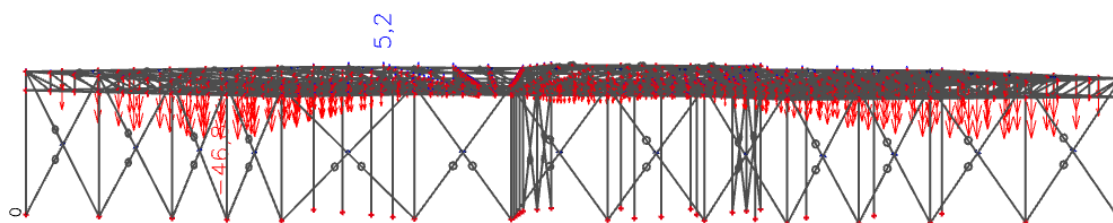
#### 5.1.2. Vertikalni pomak konstrukcije

Vertikalni pomak  $u_y = 46,8 \text{ mm}$

Dopušteni vertikalni pomak:

$$U_{\text{dop}} = \frac{l}{250} = \frac{27250}{250} = 109 \text{ mm}$$

$U_{\text{dop}} = 109 \text{ [mm]} > U_x = 46,8 \text{ [mm]} \rightarrow \text{Zadovoljava}$



Slika 4.1.4 Pomak konstrukcije u z smjeru

## 4.2. Težina konstrukcije

Težina konstrukcije izračunata je u programu SCIA Engineer 2018.

Iz slike 5.2.1 vidljivo je da je ukupna masa konstrukcije 88827,4 kg, a ukupna površina konstrukcije 2311,793 m<sup>2</sup>. Dijeljenjem mase konstrukcije s tlocrtnom površinom konstrukcije dobivamo kilažu po metru kvadratnom.

$$\frac{88827,4}{2311,793} = 38,42 \text{ [kg/m}^2\text{]}$$

### Bill of material

Name	Mass [kg]	Surface [m <sup>2</sup> ]	Volume [m <sup>3</sup> ]
Total results :	88827,4	2311,793	1,1316e+01

#### Explanations of symbols

Surface Note: only one surface of each 2D member is taken into account for calculation of the surface area.

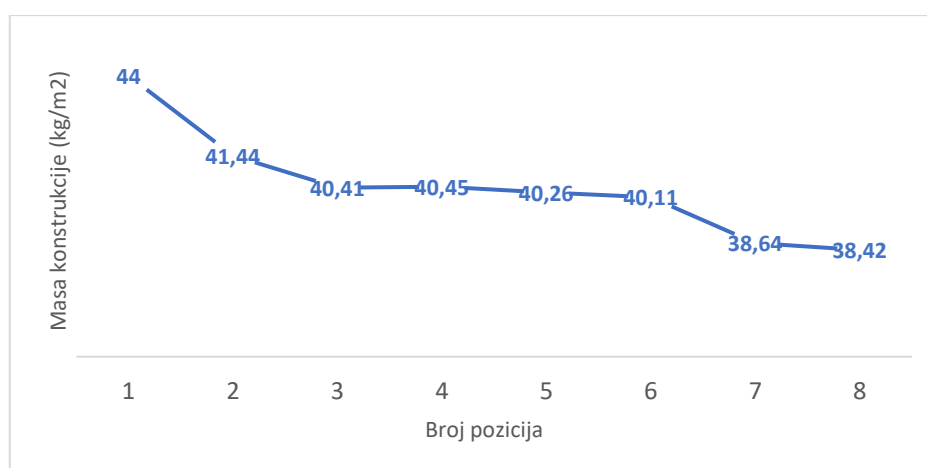
Material	Mass [kg]	Surface [m <sup>2</sup> ]	Unit volume mass [kg/m <sup>3</sup> ]	Volume [m <sup>3</sup> ]
S 355	88827,3	2311,789	7850,0	1,1316e+01

Slika 4.2.1 Iskaz materijala

## 4.3. Ovisnost težine o broju pozicija

Tablica 4.3-1 Masa konstrukcije i broj pozicija

Masa konstrukcije (kg/m <sup>2</sup> )	Broj pozicija
44	8
41,44	9
40,41	10
40,45	11
40,26	12
40,11	13
38,64	14
38,42	15



Slika 4.3.1 Prikaz ovisnosti mase konstrukcije o broju pozicija

Prilikom dimenzioniranja elemenata uvedene su pozicije, kako bi postigli što bolju iskoristivost poprečnih presjeka i što manju težinu same konstrukcije.

## 4.4. Kontrola naprezanja

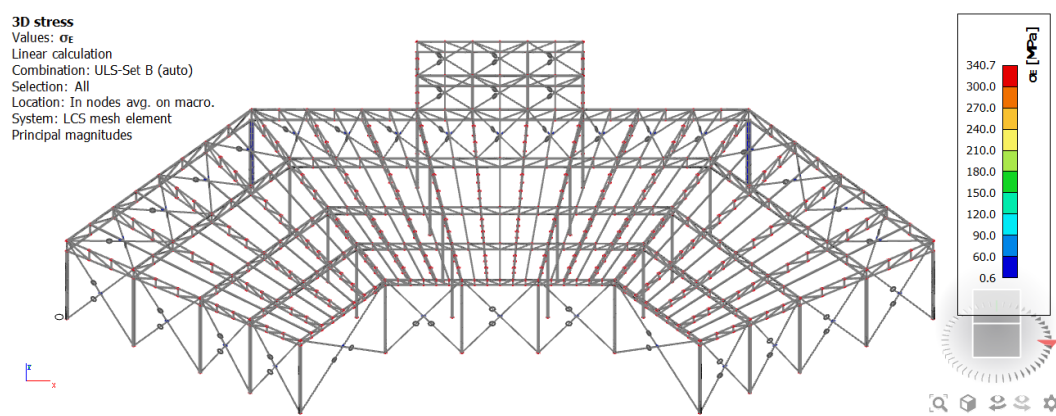
U projektu je odabrana građevinski čelik S 355. S označava Steel, odnosno čelik a 355 je granica popuštanja čelika. Ovisno o debljini elementa  $t$ , promatramo sljedeću tablicu.

Tablica 4.4-1 Standardne kvalitete

NOMINALNA KVALITETA EN1993-1-1	NOMINALNA KVALITETA ENV1993-1-1	Debljina elementa $t$ [mm]			
		$t \leq 40$ mm		$40 \text{ mm} < t \leq 80$ mm	
		$f_y$ [N/mm <sup>2</sup> ]	$f_u$ [N/mm <sup>2</sup> ]	$f_y$ [N/mm <sup>2</sup> ]	$f_u$ [N/mm <sup>2</sup> ]
EN 10025-2					
S 235	Fe-360	235	360	215	360
S 275	Fe-430	275	430	255	410
S 355	Fe-510	355	510	335	470
S 450	---	440	550	410	550

$f_y$  - granica popuštanja čelika,

$f_u$  - čvrstoća čelika.



Slika 4.4.1 Rezultati proračuna naprezanja

## 3D stress

Linear calculation

Combination: ULS-Set B (auto)

Selection: All

Location: In nodes avg. on macro. System: LCS mesh element

Principal magnitudes

Results on 1D member

Extreme 1D: Global

Name	dx [m]	Fibre	Case	$\sigma_E$ [MPa]	$\sigma_1$ [MPa]	$\sigma_2$ [MPa]	$T_{xy} / T_{xs}$ [MPa]	$T_{xz} / T_{xs}$ [MPa]
B1365	9,000-	4	ULS-Set B (auto)/1	0,0	0,0	0,0	0,0	0,0
B2677	11,180	1	ULS-Set B (auto)/2	340,7	340,7	0,0	0,0	0,0

Name	Combination key
ULS-Set B (auto)/1	LC1 + Dodatno stalno + 1.50*3DWind15 + 0.90*temp +
ULS-Set B (auto)/2	LC1 + Dodatno stalno + 1.50*3DWind9 + 0.90*temp +

Slika 4.4.2 Rezultati proračuna naprezanja

## 5. Dimenzioniranje

## 5.1. Dimenzioniranje stupova

HEA 550

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS26 - HEA550

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

Member B551	0,000 / 10,000 m	HEA550	S 355	ULS-Set B (auto)	0,72 -
-------------	------------------	--------	-------	------------------	--------

<b>Combination key</b>	
ULS-Set B (auto) / 1.35*LC1 + 0.90*Snjeg + 1.35*Dodatno stalno + 1.50*3DWind10 + 0.90*temp +	

<b>Partial safety factors</b>	
$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

<b>Material</b>		
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
$N_{Ed}$	-101,32	kN
$V_{y,Ed}$	-45,98	kN
$V_{z,Ed}$	-53,02	kN
$T_{Ed}$	0,00	kNm
$M_{y,Ed}$	328,11	kNm
$M_{z,Ed}$	121,13	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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_\sigma$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	117	24	-1,081e+05	-2,388e+05								
3	SO	117	24	-3,360e+04	9,711e+04	-0,35	0,65	0,74	4,86	9,86	10,95	13,79	1
4	I	438	13	-5,940e+04	6,897e+04	-0,86		0,53	35,04	54,14	62,81	87,30	1
5	SO	117	24	1,176e+05	2,483e+05	0,47	0,49	1,00	4,86	7,32	8,14	11,91	1
7	SO	117	24	4,317e+04	-8,754e+04	-2,03	23,80	0,33	4,86	38,58	42,87	83,35	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	2,1200e-02	m <sup>2</sup>
$N_{c,Rd}$	7526,00	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)

$W_{pl,y}$	4,6250e-03	m <sup>3</sup>
$M_{pl,y,Rd}$	1641,88	kNm
Unity check	0,20	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	1,1083e-03	m <sup>3</sup>
$M_{pl,z,Rd}$	393,46	kNm
Unity check	0,31	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	1,4894e-02	m <sup>2</sup>
$V_{d,y,Rd}$	3052,61	kN
Unity check	0,02	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)



$\eta$	1,20	
$A_v$	8,3960e-03	m <sup>2</sup>
$V_{pl,z,Rd}$	1720,84	kN
Unity check	0,03	

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

$M_{pl,y,Rd}$	1641,88	kNm
$\alpha$	2,00	
$M_{pl,z,Rd}$	393,46	kNm
$\beta$	1,00	

Unity check (6.41) = 0,04 + 0,31 = 0,35 -

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

**Note:** Since the axial force satisfies both criteria (6.33) and (6.34) of EN 1993-1-1 article 6.2.9.1(4) its effect on the moment resistance about the y-y axis is neglected.

**Note:** Since the axial force satisfies criteria (6.35) of EN 1993-1-1 article 6.2.9.1(4) its effect on the moment resistance about the z-z axis is neglected.

The member satisfies the section check.

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

**Classification for member buckling design**

Decisive position for stability classification: 10,000 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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class 4 Limit [-]
1	SO	117	24	3,743e+03	3,743e+03	1,00	0,43	1,00	4,86	7,32	8,14	11,39	1
3	SO	117	24	3,743e+03	3,743e+03	1,00	0,43	1,00	4,86	7,32	8,14	11,39	1
4	I	438	13	3,743e+03	3,743e+03	1,00		1,00	35,04	22,78	27,66	30,92	4
5	SO	117	24	3,743e+03	3,743e+03	1,00	0,43	1,00	4,86	7,32	8,14	11,39	1
7	SO	117	24	3,743e+03	3,743e+03	1,00	0,43	1,00	4,86	7,32	8,14	11,39	1

**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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	SO	117	3,550e+05	3,550e+05	1,00	0,43	0,32	1,00	117		
3	SO	117	3,550e+05	3,550e+05	1,00	0,43	0,32	1,00	117		
4	I	438	3,550e+05	3,550e+05	1,00	4,00	0,76	0,94	410	205	205
5	SO	117	3,550e+05	3,550e+05	1,00	0,43	0,32	1,00	117		
7	SO	117	3,550e+05	3,550e+05	1,00	0,43	0,32	1,00	117		

**Effective section My+**

**Effective width calculation**

According to EN 1993-1-5 article 4.4

Id	Type	$b_p$ [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	SO	117	-3,550e+05	-3,550e+05							
3	SO	117	-3,550e+05	-3,550e+05							
4	I	438	3,013e+05	-3,013e+05	-1,00	23,90	0,31	1,00	219	88	131
5	SO	117	3,550e+05	3,550e+05	1,00	0,43	0,32	1,00	117		
7	SO	117	3,550e+05	3,550e+05	1,00	0,43	0,32	1,00	117		

**Effective section Mz+**

**Effective width calculation**

According to EN 1993-1-5 article 4.4

Id	Type	$b_p$ [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	SO	117	-7,869e+04	-3,550e+05							
3	SO	117	3,550e+05	7,869e+04	0,22	0,53	0,29	1,00	117		
4	I	438	0,000e+00	0,000e+00							
5	SO	117	3,550e+05	7,869e+04	0,22	0,53	0,29	1,00	117		
7	SO	117	-7,869e+04	-3,550e+05							

Effective properties			
Effective area	$A_{eff}$	2,0829e-02	m <sup>2</sup>
Effective second moment of area	$I_{eff,y}$	1,1195e-03	m <sup>4</sup>
	$I_{eff,z}$	1,0819e-04	m <sup>4</sup>
Effective section modulus	$W_{eff,y}$	4,1462e-03	m <sup>3</sup>
	$W_{eff,z}$	7,2128e-04	m <sup>3</sup>



Effective properties			
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	10,000	10,000	m
Buckling factor k	2,00	0,70	
Buckling length $l_{cr}$	20,024	7,000	m
Critical Euler load $N_{cr}$	5789,51	4568,22	kN
Slenderness $\lambda$	87,12	98,07	
Relative slenderness $\lambda_{rel}$	1,13	1,27	
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:** For this I-section the Torsional(-Flexural) buckling resistance is higher than the resistance for Flexural buckling. Therefore Torsional(-Flexural) buckling is not printed on the output.

**Lateral Torsional Buckling check**

According to EN 1993-1-1 article 6.3.2.1 &amp; 6.3.2.3 and formula (6.54)

LTB parameters		
Method for LTB curve	Alternative case	
Effective section modulus $W_{eff,y}$	4,1462e-03	m <sup>3</sup>
Elastic critical moment $M_{cr}$	2172,84	kNm
Relative slenderness $\lambda_{rel,LT}$	0,82	
Limit slenderness $\lambda_{rel,LT,0}$	0,40	

**Note:** The slenderness or bending moment is such that Lateral Torsional Buckling effects may be ignored according to EN 1993-1-1 article 6.3.2.2(4).

Mcr parameters		
LTB length $l_T$	10,000	m
Influence of load position	no influence	
Correction factor k	1,00	
Correction factor $k_w$	1,00	
LTB moment factor $C_1$	2,21	
LTB moment factor $C_2$	0,12	
LTB moment factor $C_3$	1,00	
Shear center distance $d_z$	0	mm
Distance of load application $z_p$	0	mm
Mono-symmetry constant $\beta_y$	0	mm
Mono-symmetry constant $z_j$	0	mm

**Note:** C parameters are determined according to ECCS 119 2006 / Galea 2002.

**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 $A_{eff}$	2,0829e-02	m <sup>2</sup>
Effective section modulus $W_{eff,y}$	4,1462e-03	m <sup>3</sup>
Effective section modulus $W_{eff,z}$	7,2128e-04	m <sup>3</sup>
Design compression force $N_{Ed}$	101,32	kN
Design bending moment (maximum) $M_{y,Ed}$	328,11	kNm
Design bending moment (maximum) $M_{z,Ed}$	121,13	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance $N_{Rk}$	7394,43	kN
Characteristic moment resistance $M_{y,Rk}$	1471,91	kNm
Characteristic moment resistance $M_{z,Rk}$	256,05	kNm
Reduction factor $\chi_y$	1,00	
Reduction factor $\chi_z$	1,00	
Modified reduction factor $\chi_{LT,mod}$	1,00	
Interaction factor $k_{yy}$	1,03	
Interaction factor $k_{yz}$	1,00	
Interaction factor $k_{zy}$	1,03	
Interaction factor $k_{zz}$	1,00	

Maximum moment  $M_{y,Ed}$  is derived from beam B551 position 0,000 m.

Maximum moment  $M_{z,Ed}$  is derived from beam B551 position 0,000 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	5789,51	kN
Critical Euler load $N_{cr,z}$	4568,22	kN
Elastic critical load $N_{cr,T}$	7480,53	kN

Interaction method 1 parameters		
Effective section modulus $W_{eff,y}$	4,1462e-03	m <sup>3</sup>
Second moment of area $I_y$	1,1200e-03	m <sup>4</sup>
Second moment of area $I_z$	1,0800e-04	m <sup>4</sup>
Torsional constant $I_t$	3,5200e-06	m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	328,11	kNm
Maximum relative deflection $\delta_z$	-6,7	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) $M_{z,Ed}$	121,13	kNm
Maximum relative deflection $\delta_y$	7,4	mm
Equivalent moment factor $C_{mz,0}$	0,98	
Factor $\mu_y$	1,00	
Factor $\mu_z$	1,00	
Factor $e_y$	16,27	
Factor $a_{LT}$	1,00	
Critical moment for uniform bending $M_{cr,0}$	984,85	kNm
Relative slenderness $\lambda_{rel,0}$	1,22	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,29	
Equivalent moment factor $C_{my}$	1,00	
Equivalent moment factor $C_{mz}$	0,98	
Equivalent moment factor $C_{mLT}$	1,01	

Unity check (6.61) =  $0,01 + 0,23 + 0,47 = 0,72$  -

Unity check (6.62) =  $0,01 + 0,23 + 0,47 = 0,72$  -

#### 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 $a$	10,000	m
Web	unstiffened	
Web height $h_w$	492	mm
Web thickness $t$	13	mm
Material coefficient $\epsilon$	0,81	
Shear correction factor $\eta$	1,20	

Shear Buckling verification		
Web slenderness $h_w/t$	39,36	
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.

Student version

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS27 - HEA320

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

**Member B445** | **0,000 / 10,000 m** | **HEA320** | **S 355** | **ULS-Set B (auto)** | **0,52 -**

**Combination key**  
 ULS-Set B (auto) / 1.35\*LC1 + 0.90\*Snjeg + 1.35\*Dodatno stalno + 1.50\*3DWind10 + 0.90\*Temp -

**Partial safety factors**

$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ 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
$N_{Ed}$	-177,11	kN
$V_{y,Ed}$	-30,34	kN
$V_{z,Ed}$	-18,42	kN
$T_{Ed}$	0,00	kNm
$M_{y,Ed}$	55,85	kNm
$M_{z,Ed}$	80,32	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	118	16	-5,784e+04	-1,941e+05	0,10	0,55	1,00	7,65	7,32	8,14	12,68	2
3	SO	118	16	1,460e+04	1,508e+05	0,10	0,55	1,00	7,65	7,32	8,14	12,68	2
4	I	225	9	-1,316e+04	4,163e+04	-0,32		0,62	25,00	42,23	49,83	56,90	1
5	SO	118	16	8,631e+04	2,226e+05	0,39	0,50	1,00	7,65	7,32	8,14	12,07	2
7	SO	118	16	1,388e+04	-1,224e+05	-8,82	23,80	0,10	7,65	225,25	250,27	83,35	1

**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	1,2400e-02	m <sup>2</sup>
$N_{c,Rd}$	4402,00	kN
Unity check	0,04	-

**Bending moment check for  $M_y$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	1,6292e-03	m <sup>3</sup>
$M_{pl,y,Rd}$	578,36	kNm
Unity check	0,10	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	7,0833e-04	m <sup>3</sup>
$M_{pl,z,Rd}$	251,46	kNm
Unity check	0,32	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	9,6240e-03	m <sup>2</sup>
$V_{pl,y,Rd}$	1972,53	kN
Unity check	0,02	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	4,0765e-03	m <sup>2</sup>
$V_{pl,z,Rd}$	835,52	kN
Unity check	0,02	

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

$M_{pl,y,Rd}$	578,36	kNm
$\alpha$	2,00	
$M_{pl,z,Rd}$	251,46	kNm
$\beta$	1,00	

Unity check (6.41) = 0,01 + 0,32 = 0,33 -

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

**Note:** Since the axial force satisfies both criteria (6.33) and (6.34) of EN 1993-1-1 article 6.2.9.1(4) its effect on the moment resistance about the y-y axis is neglected.

**Note:** Since the axial force satisfies criteria (6.35) of EN 1993-1-1 article 6.2.9.1(4) its effect on the moment resistance about the z-z axis 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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\Psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	118	16	-5,784e+04	-1,941e+05								
3	SO	118	16	1,460e+04	1,508e+05	0,10	0,55	1,00	7,65	7,32	8,14	12,68	2
4	I	225	9	-1,316e+04	4,163e+04	-0,32		0,62	25,00	42,23	49,83	56,90	1
5	SO	118	16	8,631e+04	2,226e+05	0,39	0,50	1,00	7,65	7,32	8,14	12,07	2
7	SO	118	16	1,388e+04	-1,224e+05	-8,82	23,80	0,10	7,65	225,25	250,27	83,35	1

**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	10,000	10,000	m
Buckling factor k	2,00	0,70	
Buckling length $l_{cr}$	20,024	7,000	m
Critical Euler load $N_{cr}$	1183,75	2956,65	kN
Slenderness $\lambda$	147,35	93,23	
Relative slenderness $\lambda_{rel}$	1,93	1,22	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	b	c	
Imperfection $\alpha$	0,34	0,49	
Reduction factor $\chi$	0,22	0,42	
Buckling resistance $N_{b,Rd}$	983,59	1867,56	kN

**Flexural Buckling verification**

Cross-section area A	1,2400e-02	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	983,59	kN
Unity check	0,18	-

**Torsional(-Flexural) Buckling check**

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

**Note:** For this I-section the Torsional(-Flexural) buckling resistance is higher than the resistance for Flexural buckling. Therefore Torsional(-Flexural) buckling is not printed on the output.

**Lateral Torsional Buckling check**

According to EN 1993-1-1 article 6.3.2.1 & 6.3.2.3 and formula (6.54)

LTB parameters		
Method for LTB curve	Alternative case	
Plastic section modulus $W_{pl,y}$	1,6292e-03	m <sup>3</sup>
Elastic critical moment $M_{cr}$	1606,79	kNm
Relative slenderness $\lambda_{rel,LT}$	0,60	
Limit slenderness $\lambda_{rel,LT,0}$	0,40	

**Note:** The slenderness or bending moment is such that Lateral Torsional Buckling effects may be ignored according to EN 1993-1-1 article 6.3.2.2(4).



Mcr parameters		
LTB length $l_{LT}$	10,000	m
Influence of load position	no influence	
Correction factor $k$	1,00	
Correction factor $k_{sw}$	1,00	
LTB moment factor $C_1$	3,88	
LTB moment factor $C_2$	0,71	
LTB moment factor $C_3$	0,41	
Shear center distance $d_z$	0	mm
Distance of load application $z_D$	0	mm
Mono-symmetry constant $\beta_y$	0	mm
Mono-symmetry constant $z_1$	0	mm

**Note:** C parameters are determined according to ECCS 119 2006 / Galea 2002.

#### 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	1,2400e-02	m <sup>2</sup>
Plastic section modulus $W_{pl,y}$	1,6292e-03	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	7,0833e-04	m <sup>3</sup>
Design compression force $N_{Ed}$	177,11	kN
Design bending moment (maximum) $M_{y,Ed}$	55,85	kNm
Design bending moment (maximum) $M_{z,Ed}$	80,32	kNm
Characteristic compression resistance $N_{Rk}$	4402,00	kN
Characteristic moment resistance $M_{y,Rk}$	578,36	kNm
Characteristic moment resistance $M_{z,Rk}$	251,46	kNm
Reduction factor $\chi_y$	0,22	
Reduction factor $\chi_z$	0,42	
Modified reduction factor $\chi_{LT,mod}$	1,00	
Interaction factor $K_{yy}$	1,01	
Interaction factor $K_{yz}$	0,76	
Interaction factor $K_{zy}$	0,62	
Interaction factor $K_{zz}$	1,05	

Maximum moment  $M_{y,Ed}$  is derived from beam B445 position 0,000 m.

Maximum moment  $M_{z,Ed}$  is derived from beam B445 position 0,000 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	1183,75	kN
Critical Euler load $N_{cr,z}$	2956,65	kN
Elastic critical load $N_{cr,T}$	4919,19	kN
Plastic section modulus $W_{pl,y}$	1,6292e-03	m <sup>3</sup>
Elastic section modulus $W_{el,y}$	1,4800e-03	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	7,0833e-04	m <sup>3</sup>
Elastic section modulus $W_{el,z}$	4,6600e-04	m <sup>3</sup>
Second moment of area $I_y$	2,2900e-04	m <sup>4</sup>
Second moment of area $I_z$	6,9900e-05	m <sup>4</sup>
Torsional constant $I_t$	1,0800e-06	m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	55,85	kNm
Maximum relative deflection $\delta_z$	-1,4	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) $M_{z,Ed}$	80,32	kNm
Maximum relative deflection $\delta_y$	7,4	mm
Equivalent moment factor $C_{mz,0}$	0,95	
Factor $\mu_y$	0,88	
Factor $\mu_z$	0,96	
Factor $e_y$	2,64	
Factor $a_{LT}$	1,00	
Critical moment for uniform bending $M_{cr,0}$	414,47	kNm
Relative slenderness $\lambda_{rel,0}$	1,18	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,38	
Equivalent moment factor $C_{my}$	0,95	
Equivalent moment factor $C_{mz}$	0,95	
Equivalent moment factor $C_{mLT}$	1,00	
Factor $b_{LT}$	0,02	
Factor $c_{LT}$	0,20	
Factor $d_{LT}$	0,03	
Factor $e_{LT}$	0,09	
Factor $w_y$	1,10	
Factor $w_z$	1,50	
Factor $r_{pl}$	0,04	
Maximum relative slenderness $\lambda_{rel,max}$	1,93	
Factor $C_{yy}$	0,98	
Factor $C_{yz}$	0,82	
Factor $C_{zy}$	0,89	
Factor $C_{zz}$	0,93	

Unity check (6.61) =  $0,18 + 0,10 + 0,24 = 0,52$  -

Unity check (6.62) =  $0,09 + 0,06 + 0,33 = 0,49$  -

**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	10,000	m
Web	unstiffened	
Web height $h_w$	279	mm
Web thickness t	9	mm
Material coefficient $\epsilon$	0,81	
Shear correction factor $\eta$	1,20	

**Shear Buckling verification**

Web slenderness $h_w/t$	31,00
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.

Student version

Student version

## 5.2. Dimenzioniranje rešetke

200X100X6

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS6 - CFRHS200X100X6

**EN 1993-1-1 Code Check**

National annex: Standard EN

**Member B1428** 0,000 / 2,882 m **CFRHS200X100X6** **S 355** **ULS-Set B (auto)** **0,73 -**

Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

**Combination key**

ULS-Set B (auto) / 1.35\*LC1 + 0.90\*Snjeg + 1.35\*Dodatno stalno + 1.50\*3DWind10 + 0.90\*temp +

**Partial safety factors**

$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

**Material**

Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

...:SECTION CHECK:...

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
$N_{Ed}$	-472,90	kN
$V_{y,Ed}$	-2,08	kN
$V_{z,Ed}$	4,53	kN
$T_{Ed}$	0,32	kNm
$M_{y,Ed}$	2,81	kNm
$M_{z,Ed}$	2,76	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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_\sigma$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	82	6	1,050e+05	1,442e+05	0,73	1,00	13,67	13,67	22,78	27,66	34,14	1
3	I	182	6	1,481e+05	1,782e+05	0,83	1,00	30,33	30,33	22,78	27,66	32,84	3
5	I	82	6	1,763e+05	1,370e+05	0,78	1,00	13,67	13,67	22,78	27,66	33,51	1
7	I	182	6	1,331e+05	1,031e+05	0,77	1,00	30,33	30,33	22,78	27,66	33,55	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 $\epsilon$	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 $c/t_f$	13,67
Reference slenderness ratio $c/t_{ref,y}$	0,00
Reference slenderness ratio $c/t_{ref,z}$	0,82
Interpolated section modulus $W_{3,y}$	2,1327e-04 m <sup>3</sup>
Interpolated section modulus $W_{3,z}$	1,1827e-04 m <sup>3</sup>

**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	3,3630e-03	m <sup>2</sup>
$N_{c,Rd}$	1193,87	kN
Unity check	0,40	-

**Bending moment check for  $M_y$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,y}$	2,1327e-04	m <sup>3</sup>
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$M_{3,y,Rd}$	75,71	kNm
Unity check	0,04	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,z}$	1,1827e-04	m <sup>3</sup>
$M_{3,z,Rd}$	41,69	kNm
Unity check	0,07	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	1,1210e-03	m <sup>2</sup>
$V_{pl,y,Rd}$	229,76	kN
Unity check	0,01	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	2,2420e-03	m <sup>2</sup>
$V_{pl,z,Rd}$	459,52	kN
Unity check	0,01	-

**Torsion check**

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

Fibre	1	
$T_{Ed}$	1,4	MPa
$T_{Rd}$	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)

$M_{N,3,y,Rd}$	45,72	kNm
$\alpha$	2,02	
$M_{N,3,z,Rd}$	25,36	kNm
$\beta$	2,02	

Unity check (5.41) = 0,00 + 0,01 = 0,02

**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: 0,288 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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	82	6	1,027e+05	1,335e+05	0,77		1,00	13,67	22,78	27,66	33,61	1
3	I	182	6	1,372e+05	1,794e+05	0,76		1,00	30,33	22,78	27,66	33,67	3
5	I	82	6	1,785e+05	1,477e+05	0,83		1,00	13,67	22,78	27,66	32,89	1
7	I	182	6	1,441e+05	1,018e+05	0,71		1,00	30,33	22,78	27,66	34,42	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	2,882	2,882	m
Buckling factor k	1,00	0,91	
Buckling length $l_{cr}$	2,882	2,609	m
Critical Euler load $N_{cr}$	4249,83	1757,18	kN
Slenderness $\lambda$	40,50	62,98	
Relative slenderness $\lambda_{rel}$	0,53	0,82	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	c	c	
Imperfection $\alpha$	0,49	0,49	
Reduction factor $\chi$	0,93	0,65	
Buckling resistance $N_{b,Rd}$	986,20	772,34	kN



Flexural Buckling verification		
Cross-section area A	3,3630e-03	m <sup>2</sup>
Buckling resistance N <sub>b,Rd</sub>	772,34	kN
Unity check	0,51	-

**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 a RHS section with 'h / b < 10 / λ<sub>rel,z</sub>'.

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	3,3630e-03	m <sup>2</sup>
Interpolated section modulus W <sub>3,y</sub>	2,1327e-04	m <sup>3</sup>
Interpolated section modulus W <sub>3,z</sub>	1,1827e-04	m <sup>3</sup>
Design compression force N <sub>Ed</sub>	472,90	kN
Design bending moment (maximum) M <sub>y,Ed</sub>	5,38	kNm
Design bending moment (maximum) M <sub>z,Ed</sub>	-3,02	kNm
Characteristic compression resistance N <sub>Rk</sub>	1193,87	kN
Characteristic moment resistance M <sub>y,Rk</sub>	75,71	kNm
Characteristic moment resistance M <sub>z,Rk</sub>	41,99	kNm
Reduction factor χ <sub>y</sub>	0,83	
Reduction factor χ <sub>z</sub>	0,65	
Reduction factor χ <sub>LT</sub>	1,00	
Interaction factor K <sub>yy</sub>	1,10	
Interaction factor K <sub>yz</sub>	0,59	
Interaction factor K <sub>zy</sub>	0,75	
Interaction factor K <sub>zz</sub>	0,94	

Maximum moment M<sub>y,Ed</sub> is derived from beam B1428 position 1,153 m.Maximum moment M<sub>z,Ed</sub> is derived from beam B1428 position 2,882 m.

Interaction method 1 parameters		
Critical Euler load N <sub>cr,y</sub>	4249,83	kN
Critical Euler load N <sub>cr,z</sub>	1757,18	kN
Elastic critical load N <sub>cr,T</sub>	169904,98	kN
Interpolated section modulus W <sub>3,y</sub>	2,1327e-04	m <sup>3</sup>
Elastic section modulus W <sub>el,y</sub>	1,7033e-04	m <sup>3</sup>
Interpolated section modulus W <sub>3,z</sub>	1,1827e-04	m <sup>3</sup>
Elastic section modulus W <sub>el,z</sub>	1,1538e-04	m <sup>3</sup>
Second moment of area I <sub>y</sub>	1,7033e-05	m <sup>4</sup>
Second moment of area I <sub>z</sub>	5,7691e-06	m <sup>4</sup>
Torsional constant I <sub>t</sub>	1,4170e-05	m <sup>4</sup>
Method for equivalent moment factor C <sub>my,0</sub>	Table A.2 Line 2 (General)	
Design bending moment (maximum) M <sub>y,Ed</sub>	5,38	kNm
Maximum relative deflection δ <sub>z</sub>	-1,3	mm
Equivalent moment factor C <sub>my,0</sub>	1,01	
Method for equivalent moment factor C <sub>mz,0</sub>	Table A.2 Line 2 (General)	
Design bending moment (maximum) M <sub>z,Ed</sub>	-3,02	kNm
Maximum relative deflection δ <sub>y</sub>	0,4	mm
Equivalent moment factor C <sub>mz,0</sub>	0,78	
Factor μ <sub>y</sub>	0,98	
Factor μ <sub>z</sub>	0,88	
Factor ε <sub>y</sub>	0,22	
Factor a <sub>LT</sub>	0,17	
Critical moment for uniform bending M <sub>cr,0</sub>	1287,72	kNm
Relative slenderness λ <sub>rel,0</sub>	0,24	
Limit relative slenderness λ <sub>rel,0,lim</sub>	0,20	
Equivalent moment factor C <sub>my</sub>	1,01	
Equivalent moment factor C <sub>mz</sub>	0,78	
Equivalent moment factor C <sub>mLT</sub>	1,00	
Factor b <sub>LT</sub>	0,00	
Factor c <sub>LT</sub>	0,00	
Factor d <sub>LT</sub>	0,00	
Factor e <sub>LT</sub>	0,01	
Factor w <sub>y</sub>	1,25	
Factor w <sub>z</sub>	1,03	
Factor η <sub>pl</sub>	0,40	
Maximum relative slenderness λ <sub>rel,max</sub>	0,82	
Factor C <sub>yy</sub>	1,01	
Factor C <sub>yz</sub>	0,97	
Factor C <sub>zy</sub>	0,89	
Factor C <sub>zz</sub>	1,01	

Unity check (6.61) =  $0,48 + 0,08 + 0,04 = 0,60$  -  
Unity check (6.62) =  $0,61 + 0,05 + 0,07 = 0,73$  -  
The member satisfies the stability check.

Student version

Student version

Student version

150X50X3

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS7 - CFRHS150X50X3

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

Member B1991	3,020 / 3,020 m	CFRHS150X50X3	S 355	ULS-Set B (auto)	0,82 -
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Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

<b>Combination key</b>	
ULS-Set B (auto) / 1.35*LC1 + 1.50*Snjeg + 1.35*Dodatno stalno + 0.90*3DWind6 + 1.50*temp +	

<b>Partial safety factors</b>	
$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

<b>Material</b>		
Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

....SECTION CHECK:....

The critical check is on position 3,020 m

Internal forces	Calculated	Unit
$N_{Ed}$	-85,13	kN
$V_{y,Ed}$	-0,09	kN
$V_{z,Ed}$	-0,16	kN
$T_{Ed}$	0,00	kNm
$M_{y,Ed}$	0,00	kNm
$M_{z,Ed}$	-0,14	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_o$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	41	3	8,002e+04	6,924e+04	0,87		1,00	13,67	22,78	27,66	32,43	1
3	I	141	3	6,845e+04	6,845e+04	1,00		1,00	47,00	22,78	27,66	30,92	4
5	I	41	3	6,924e+04	8,002e+04	0,87		1,00	13,67	22,78	27,66	32,43	1
7	I	141	3	8,081e+04	8,081e+04	1,00		1,00	47,00	22,78	27,66	30,92	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_o$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	I	41	3,550e+05	3,550e+05	1,00	4,00	0,30	1,00	41	21	21
3	I	141	3,550e+05	3,550e+05	1,00	4,00	1,02	0,77	109	54	54
5	I	41	3,550e+05	3,550e+05	1,00	4,00	0,30	1,00	41	21	21
7	I	141	3,550e+05	3,550e+05	1,00	4,00	1,02	0,77	109	54	54

**Effective section Mz-**

**Effective width calculation**

According to EN 1993-1-5 article 4.4

Id	Type	$b_p$ [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_o$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	I	41	3,135e+05	-2,531e+05	-0,81	19,26	0,13	1,00	23	9	14
3	I	141	-2,946e+05	-2,946e+05							
5	I	41	3,135e+05	-2,531e+05	-0,81	19,26	0,13	1,00	23	9	14
7	I	141	3,550e+05	3,550e+05	1,00	4,00	1,02	0,77	109	54	54

<b>Effective properties</b>			
Effective area	$A_{eff}$	9,4661e-04	m <sup>2</sup>
Effective second moment of area	$I_{eff,y}$	2,9849e-06	m <sup>4</sup>
Effective section modulus	$W_{eff,y}$	3,9799e-05	m <sup>3</sup>
		$I_{eff,z}$	4,6776e-07
		$W_{eff,z}$	1,7206e-05

Effective properties			
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)

$A_{eff}$	9,4661e-04	m <sup>2</sup>
$N_{c,Rd}$	336,05	kN
Unity check	0,25	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,z,min}$	1,7206e-05	m <sup>3</sup>
$M_{c,z,Rd}$	6,11	kNm
Unity check	0,02	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	2,8525e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	58,46	kN
Unity check	0,00	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	8,5575e-04	m <sup>2</sup>
$V_{pl,z,Rd}$	175,39	kN
Unity check	0,00	-

**Torsion check**

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

Fibre	1	
$T_{Ed}$	0,0	MPa
$T_{Rd}$	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		
$A_{eff}$	9,4661e-04	m <sup>2</sup>
$e_{N,y}$	0	mm
$e_{N,z}$	0	mm
$W_{eff,y}$	3,9799e-05	m <sup>3</sup>
$W_{eff,z}$	1,7206e-05	m <sup>3</sup>

Normal stresses		
$\sigma_{N,Ed}$	89,9	MPa
$\sigma_{M_y,Ed}$	0,0	MPa
$\sigma_{M_z,Ed}$	8,1	MPa
$\sigma_{tot,Ed}$	98,0	MPa
Unity check	0,28	-

The member satisfies the section check.

**....:STABILITY CHECK:....****Classification for member buckling design**

Decisive position for stability classification: 3,020 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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\phi}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class 4 Limit [-]
1	I	41	3	8,002e+04	6,924e+04	0,87		1,00	13,67	22,78	27,66	32,43	1
3	I	141	3	6,845e+04	6,845e+04	1,00		1,00	47,00	22,78	27,66	30,92	4
5	I	41	3	6,924e+04	8,002e+04	0,87		1,00	13,67	22,78	27,66	32,43	1
7	I	141	3	8,081e+04	8,081e+04	1,00		1,00	47,00	22,78	27,66	30,92	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	3,020	3,020	m
Buckling factor k	1,00	0,90	
Buckling length $l_{cr}$	3,020	2,714	m
Critical Euler load $N_{cr}$	678,63	148,18	kN
Slenderness $\lambda$	59,03	126,33	
Relative slenderness $\lambda_{rel}$	0,70	1,51	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	c	c	
Imperfection $\alpha$	0,49	0,49	
Reduction factor $\chi$	0,72	0,31	
Buckling resistance $N_{b,Rd}$	242,76	105,05	kN

Flexural Buckling verification		
Cross-section effective area $A_{eff}$	9,4661e-04	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	105,05	kN
Unity check	0,81	-

#### 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.

#### 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 $A_{eff}$	9,4661e-04	m <sup>2</sup>
Effective section modulus $W_{eff,y}$	3,9799e-05	m <sup>3</sup>
Effective section modulus $W_{eff,z}$	1,7206e-05	m <sup>3</sup>
Design compression force $N_{Ed}$	85,13	kN
Design bending moment (maximum) $M_{y,Ed}$	0,12	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0,14	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance $N_{Rk}$	336,05	kN
Characteristic moment resistance $M_{y,Rk}$	14,13	kNm
Characteristic moment resistance $M_{z,Rk}$	6,11	kNm
Reduction factor $\chi_y$	0,72	
Reduction factor $\chi_z$	0,31	
Reduction factor $\chi_{LT}$	1,00	
Interaction factor $K_{yy}$	1,10	
Interaction factor $K_{yz}$	0,69	
Interaction factor $K_{zy}$	0,60	
Interaction factor $K_{zz}$	0,37	

Maximum moment  $M_{y,Ed}$  is derived from beam B1991 position 1,510 m.

Maximum moment  $M_{z,Ed}$  is derived from beam B1991 position 3,020 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	678,63	kN
Critical Euler load $N_{cr,z}$	148,18	kN
Elastic critical load $N_{cr,T}$	39522,78	kN
Effective section modulus $W_{eff,y}$	3,9799e-05	m <sup>3</sup>
Second moment of area $I_y$	2,9855e-06	m <sup>4</sup>
Second moment of area $I_z$	5,2650e-07	m <sup>4</sup>
Torsional constant $I_t$	1,5022e-06	m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 4 (Line load)	
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 $\psi_z$	-1,00	
Equivalent moment factor $C_{mz,0}$	0,31	
Factor $\mu_y$	0,96	
Factor $\mu_z$	0,52	
Factor $\epsilon_y$	0,03	
Factor $\alpha_{LT}$	0,50	
Critical moment for uniform bending $M_{cr,0}$	120,66	kNm
Relative slenderness $\lambda_{rel,0}$	0,34	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,17	
Equivalent moment factor $C_{my}$	1,00	
Equivalent moment factor $C_{mz}$	0,31	
Equivalent moment factor $C_{mLT}$	1,00	

Unity check (6.61) =  $0,35 + 0,01 + 0,02 = 0,38$  -

Unity check (6.62) =  $0,81 + 0,01 + 0,01 = 0,82$  -

The member satisfies the stability check.



180x100x5

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS14 - CFRHS180X100X5

**EN 1993-1-1 Code Check**

National annex: Standard EN

<b>Member B1661</b>	<b>2,437 / 2,437 m</b>	<b>CFRHS180X100X5</b>	<b>S 355</b>	<b>ULS-Set B (auto)</b>	<b>0,86 -</b>
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Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

<b>Combination key</b>	
ULS-Set B (auto) / 1.35*LC1 + 0.90*Snjeg + 1.35*Dodatno stalno + 1.50*3DWind10 + 0.90*temp +	

<b>Partial safety factors</b>	
$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

<b>Material</b>		
Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

....SECTION CHECK:....

The critical check is on position 2,437 m

Internal forces	Calculated	Unit
$N_{Ed}$	-319,88	kN
$V_{y,Ed}$	0,46	kN
$V_{z,Ed}$	4,24	kN
$T_{Ed}$	0,63	kNm
$M_{y,Ed}$	1,24	kNm
$M_{z,Ed}$	0,06	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_G$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	85	5	1,111e+05	1,124e+05	0,99		1,00	17,00	22,78	27,66	31,03	1
3	I	165	5	1,130e+05	1,311e+05	0,86		1,00	33,00	22,78	27,66	32,48	4
5	I	85	5	1,316e+05	1,304e+05	0,99		1,00	17,00	22,78	27,66	31,02	1
7	I	165	5	1,298e+05	1,116e+05	0,86		1,00	33,00	22,78	27,66	32,50	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_G$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	I	85	3,550e+05	3,550e+05	1,00	4,00	0,37	1,00	85	42	42
3	I	165	3,550e+05	3,550e+05	1,00	4,00	0,71	0,97	160	80	80
5	I	85	3,550e+05	3,550e+05	1,00	4,00	0,37	1,00	85	42	42
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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_G$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	I	85	-3,550e+05	-3,550e+05							
3	I	165	3,347e+05	-3,347e+05	-1,00	23,90	0,29	1,00	82	33	49
5	I	85	3,550e+05	3,550e+05	1,00	4,00	0,37	1,00	85	42	42
7	I	165	3,347e+05	-3,347e+05	-1,00	23,90	0,29	1,00	82	33	49

**Effective section Mz+**

**Effective width calculation**

According to EN 1993-1-5 article 4.4

Id	Type	$b_p$ [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_G$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	I	85	3,180e+05	-3,111e+05	-0,98	23,32	0,15	1,00	43	17	26
3	I	165	3,550e+05	3,550e+05	1,00	4,00	0,71	0,97	160	80	80
5	I	85	3,180e+05	-3,111e+05	-0,98	23,32	0,15	1,00	43	17	26
7	I	165	-3,481e+05	-3,481e+05	-	-	-	-	-	-	-

Effective properties		
Effective area	$A_{eff}$	2,5841e-03 m <sup>2</sup>
Effective second moment of area	$I_{eff,y}$	1,1240e-05 m <sup>4</sup>
	$I_{eff,z}$	4,4586e-06 m <sup>4</sup>
Effective section modulus	$W_{eff,y}$	1,2489e-04 m <sup>3</sup>
	$W_{eff,z}$	8,8348e-05 m <sup>3</sup>
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)

$A_{eff}$	2,5841e-03	m <sup>2</sup>
$N_{c,Rd}$	917,35	kN
Unity check	0,35	-

**Bending moment check for  $M_y$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,y,min}$	1,2489e-04	m <sup>3</sup>
$M_{c,y,Rd}$	44,33	kNm
Unity check	0,03	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,z,min}$	8,8348e-05	m <sup>3</sup>
$M_{c,z,Rd}$	31,36	kNm
Unity check	0,00	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	-
$A_v$	9,4143e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	192,95	kN
Unity check	0,00	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	-
$A_v$	1,6946e-03	m <sup>2</sup>
$V_{pl,z,Rd}$	347,32	kN
Unity check	0,01	-

**Torsion check**

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

Fibre	1	-
$T_{Ed}$	3,8	MPa
$T_{Rd}$	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		
$A_{eff}$	2,5841e-03	m <sup>2</sup>
$e_{N,y}$	0	mm
$e_{N,z}$	0	mm
$W_{eff,y}$	1,2489e-04	m <sup>3</sup>
$W_{eff,z}$	8,8348e-05	m <sup>3</sup>

Normal stresses		
$\sigma_{N,Ed}$	123,8	MPa
$\sigma_{M_y,Ed}$	9,9	MPa
$\sigma_{M_z,Ed}$	0,7	MPa
$\sigma_{tot,Ed}$	134,4	MPa
Unity check	0,38	-

The member satisfies the section check.

**.....STABILITY CHECK:.....****Classification for member buckling design**

Decisive position for stability classification: 2,437 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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class 4
1	I	85	5	1,111e+05	1,124e+05	0,99		1,00	17,00	22,78	27,66	31,03	1
3	I	165	5	1,130e+05	1,311e+05	0,86		1,00	33,00	22,78	27,66	32,48	4
5	I	85	5	1,316e+05	1,304e+05	0,99		1,00	17,00	22,78	27,66	31,02	1
7	I	165	5	1,298e+05	1,116e+05	0,86		1,00	33,00	22,78	27,66	32,50	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	2,437	4,874	m
Buckling factor k	1,00	0,65	
Buckling length $l_{cr}$	2,437	3,180	m
Critical Euler load $N_{cr}$	3924,09	925,98	kN
Slenderness $\lambda$	37,31	76,81	
Relative slenderness $\lambda_{rel}$	0,48	1,00	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	c	c	
Imperfection $\alpha$	0,49	0,49	
Reduction factor $\chi$	0,85	0,54	
Buckling resistance $N_{b,Rd}$	781,74	497,80	kN

**Flexural Buckling verification**

Cross-section effective area $A_{eff}$	2,5841e-03	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	497,80	kN
Unity check	0,64	-

**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 $A_{eff}$	2,5841e-03	m <sup>2</sup>
Effective section modulus $W_{eff,y}$	1,2489e-04	m <sup>3</sup>
Effective section modulus $W_{eff,z}$	8,8348e-05	m <sup>3</sup>
Design compression force $N_{Ed}$	319,88	kN
Design bending moment (maximum) $M_{y,Ed}$	-9,91	kNm
Design bending moment (maximum) $M_{z,Ed}$	-1,07	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance $N_{Rk}$	917,35	kN
Characteristic moment resistance $M_{y,Rk}$	44,33	kNm
Characteristic moment resistance $M_{z,Rk}$	31,36	kNm
Reduction factor $\chi_y$	0,85	
Reduction factor $\chi_z$	0,54	
Reduction factor $\chi_{LT}$	1,00	
Interaction factor $k_{yy}$	1,03	
Interaction factor $k_{yz}$	1,09	
Interaction factor $k_{zy}$	0,84	
Interaction factor $k_{zz}$	0,89	

Maximum moment  $M_{y,Ed}$  is derived from beam B1661 position 0,000 m.

Maximum moment  $M_{z,Ed}$  is derived from beam B1661 position 0,000 m.

**Interaction method 1 parameters**

Critical Euler load $N_{cr,y}$	3924,09	kN
Critical Euler load $N_{cr,z}$	925,98	kN
Elastic critical load $N_{cr,T}$	141423,11	kN
Effective section modulus $W_{eff,y}$	1,2489e-04	m <sup>3</sup>
Second moment of area $I_y$	1,1242e-05	m <sup>4</sup>
Second moment of area $I_z$	4,5177e-06	m <sup>4</sup>
Torsional constant I <sub>t</sub>	1,0448e-05	m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-9,91	kNm
Maximum relative deflection $\delta_z$	1,4	mm



Interaction method 1 parameters		
Equivalent moment factor $C_{my,0}$	0,96	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	-1,07	kNm
Maximum relative deflection $\delta_y$	0,5	mm
Equivalent moment factor $C_{mz,0}$	0,72	
Factor $\mu_y$	0,99	
Factor $\mu_z$	0,81	
Factor $\epsilon_y$	0,64	
Factor $a_{1,T}$	0,07	
Critical moment for uniform bending $M_{cr,0}$	577,35	kNm
Relative slenderness $\lambda_{rel,0}$	0,28	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,32	
Equivalent moment factor $C_{my}$	0,96	
Equivalent moment factor $C_{mz}$	0,72	
Equivalent moment factor $C_{m1,T}$	1,00	

Unity check (6.61) =  $0,41 + 0,23 + 0,04 = 0,68$  -  
 Unity check (6.62) =  $0,64 + 0,19 + 0,03 = 0,86$  -

The member satisfies the stability check.

Student version

Student version

120x40x6

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS16 - CFRHS120X40X6

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

**Member B1709** | **0,000 / 2,739 m** | **CFRHS120X40X6** | **S 355** | **ULS-Set B (auto)** | **0,94 -**

Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections.  
 The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

**Combination key**  
 ULS-Set B (auto) / 1.35\*LC1 + 0.90\*Snjeg + 1.35\*Dodatno  
 stalno + 1.50\*3DWind10 + 0.90\*Temp -

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

Material		
Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

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

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
$N_{Ed}$	-83,47	kN
$V_{y,Ed}$	0,21	kN
$V_{z,Ed}$	-0,45	kN
$T_{Ed}$	-0,01	kNm
$M_{y,Ed}$	0,71	kNm
$M_{z,Ed}$	0,00	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_\sigma$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	22	6	3,338e+04	3,338e+04	1,00		1,00	3,67	22,78	27,66	30,92	1
3	I	102	6	3,508e+04	6,412e+04	0,55		1,00	17,00	22,78	27,66	36,68	1
5	I	22	6	6,583e+04	6,583e+04	1,00		1,00	3,67	22,78	27,66	30,92	1
7	I	102	6	6,412e+04	3,508e+04	0,55		1,00	17,00	22,78	27,66	36,68	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	1,6830e-03	m <sup>2</sup>
$N_{c,Rd}$	597,47	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)

$W_{pl,y}$	5,6890e-05	m <sup>3</sup>
$M_{pl,y,Rd}$	20,20	kNm
Unity check	0,04	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	4,2075e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	86,24	kN
Unity check	0,00	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	1,2622e-03	m <sup>2</sup>
$V_{pl,z,Rd}$	258,71	kN
Unity check	0,00	-

**Torsion check**

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

Fibre	1	
$T_{Ed}$	0,1	MPa
$T_{Rd}$	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 (6.31)

$M_{N,y,Rd}$	20,20	kNm
Unity check	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: 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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class [-]
1	I	22	6	3,338e+04	3,338e+04	1,00		1,00	3,67	22,78	27,66	30,92	1
3	I	102	6	3,508e+04	6,412e+04	0,55		1,00	17,00	22,78	27,66	36,68	1
5	I	22	6	6,583e+04	6,583e+04	1,00		1,00	3,67	22,78	27,66	30,92	1
7	I	102	6	6,412e+04	3,508e+04	0,55		1,00	17,00	22,78	27,66	36,68	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	2,739	2,739
Buckling factor $k$	1,00	1,00
Buckling length $l_{cr}$	2,739	2,739
Critical Euler load $N_{cr}$	690,76	113,22
Slenderness $\lambda$	71,06	175,52
Relative slenderness $\lambda_{rel}$	0,93	2,30
Limit slenderness $\lambda_{rel,0}$	0,20	0,20
Buckling curve	c	c
Imperfection $\alpha$	0,49	0,49
Reduction factor $\chi$	0,58	0,15
Buckling resistance $N_{b,Rd}$	347,43	92,04

**Flexural Buckling verification**

Cross-section area A	1,6830e-03	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	92,04	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	alternative method 1	
Interaction method	alternative method 1	
Cross-section area A	1,6830e-03	m <sup>2</sup>
Plastic section modulus $W_{pl,y}$	5,6890e-05	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	2,5080e-05	m <sup>3</sup>
Design compression force $N_{Ed}$	83,47	kN
Design bending moment (maximum) $M_{y,Ed}$	0,71	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,15	kNm
Characteristic compression resistance $N_{Rk}$	597,47	kN
Characteristic moment resistance $M_{y,Rk}$	20,20	kNm
Characteristic moment resistance $M_{z,Rk}$	8,90	kNm
Reduction factor $\chi_y$	0,58	

Bending and axial compression check parameters	
Reduction factor $\chi_z$	0,15
Reduction factor $\chi_{LT}$	1,00
Interaction factor $k_{yy}$	0,82
Interaction factor $k_{yz}$	4,50
Interaction factor $k_{zy}$	0,20
Interaction factor $k_{zz}$	1,41

Maximum moment  $M_{y,Ed}$  is derived from beam B1709 position 0,000 m.  
 Maximum moment  $M_{z,Ed}$  is derived from beam B1709 position 1,369 m.

Interaction method 1 parameters	
Critical Euler load $N_{cr,y}$	690,76 kN
Critical Euler load $N_{cr,z}$	113,22 kN
Elastic critical load $N_{cr,T}$	59003,73 kN
Plastic section modulus $W_{pl,y}$	5,6890e-05 m <sup>3</sup>
Elastic section modulus $W_{el,y}$	4,1660e-05 m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	2,5080e-05 m <sup>3</sup>
Elastic section modulus $W_{el,z}$	2,0490e-05 m <sup>3</sup>
Second moment of area $I_y$	2,4997e-06 m <sup>4</sup>
Second moment of area $I_z$	4,0970e-07 m <sup>4</sup>
Torsional constant $I_t$	1,2597e-06 m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)
Ratio of end moments $\psi_y$	-0,74
Equivalent moment factor $C_{my,0}$	0,59
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 4 (Line load)
Equivalent moment factor $C_{mz,0}$	1,02
Factor $\mu_y$	0,95
Factor $\mu_z$	0,30
Factor $\epsilon_y$	0,34
Factor $a_{LT}$	0,50
Critical moment for uniform bending $M_{cr,0}$	107,46 kNm
Relative slenderness $\lambda_{rel,0}$	0,43
Limit relative slenderness $\lambda_{rel,0,lim}$	0,23
Equivalent moment factor $C_{my}$	0,68
Equivalent moment factor $C_{mz}$	1,02
Equivalent moment factor $C_{mLT}$	1,00
Factor $b_{LT}$	0,00
Factor $q_{LT}$	0,00
Factor $d_{LT}$	0,00
Factor $e_{LT}$	0,00
Factor $w_y$	1,37
Factor $w_z$	1,22
Factor $\eta_{pl}$	0,14
Maximum relative slenderness $\lambda_{rel,max}$	2,30
Factor $C_{yy}$	0,89
Factor $C_{yz}$	0,46
Factor $C_{zy}$	0,73
Factor $C_{zz}$	0,82

Unity check (6.61) = 0,24 + 0,03 + 0,07 = 0,34 -

Unity check (6.62) = 0,91 + 0,01 + 0,02 = 0,94 -

The member satisfies the stability check.

Student version

120x80x3

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS15 - CFRHS120X80X3

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

<b>Member B1313</b>	<b>0,000 / 1,994 m</b>	<b>CFRHS120X80X3</b>	<b>S 355</b>	<b>ULS-Set B (auto)</b>	<b>0,57 -</b>
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Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

<b>Combination key</b>	
ULS-Set B (auto) / 1.35*LC1 + 0.90*Snjeg + 1.35*Dodatno stalno + 1.50*3DWind14 + 0.90*temp +	

<b>Partial safety factors</b>	
$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

<b>Material</b>		
Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

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

The critical check is on position 0,000 m

<b>Internal forces</b>	<b>Calculated</b>	<b>Unit</b>
$N_{Ed}$	-76,58	kN
$V_{y,Ed}$	0,21	kN
$V_{z,Ed}$	0,49	kN
$T_{Ed}$	-0,05	kNm
$M_{y,Ed}$	-0,83	kNm
$M_{z,Ed}$	-0,10	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	71	3	9,121e+04	8,526e+04	0,93		1,00	23,67	22,78	27,66	31,63	2
3	I	111	3	8,393e+04	4,389e+04	0,52		1,00	37,00	22,78	27,66	37,05	3
5	I	71	3	4,306e+04	4,901e+04	0,88		1,00	23,67	22,78	27,66	32,28	2
7	I	111	3	5,034e+04	9,038e+04	0,56		1,00	37,00	22,78	27,66	36,53	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	I	71	3,550e+05	3,550e+05	1,00	4,00	0,51	1,00	71	36	36
3	I	111	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	101	50	50
5	I	71	3,550e+05	3,550e+05	1,00	4,00	0,51	1,00	71	36	36
7	I	111	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	101	50	50

**Effective section My-**

**Effective width calculation**

According to EN 1993-1-5 article 4.4

Id	Type	$b_p$ [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	I	71	3,550e+05	3,550e+05	1,00	4,00	0,51	1,00	71	36	36
3	I	111	3,368e+05	-3,368e+05	-1,00	23,90	0,33	1,00	56	22	33
5	I	71	-3,550e+05	-3,550e+05							
7	I	111	3,368e+05	-3,368e+05	-1,00	23,90	0,33	1,00	56	22	33

**Effective section Mz-**

**Effective width calculation**

According to EN 1993-1-5 article 4.4



Id	Type	$b_p$ [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_G$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	I	71	3,281e+05	-3,086e+05	-0,94	22,38	0,22	1,00	37	15	22
3	I	111	-3,355e+05	-3,355e+05							
5	I	71	3,281e+05	-3,086e+05	-0,94	22,38	0,22	1,00	37	15	22
7	I	111	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	101	50	50

Effective properties					
Effective area	$A_{eff}$	1,0780e-03	m <sup>2</sup>		
Effective second moment of area	$I_{eff,y}$	2,3016e-06	m <sup>4</sup>	$I_{eff,z}$	1,1864e-06 m <sup>4</sup>
Effective section modulus	$W_{eff,y}$	3,8360e-05	m <sup>3</sup>	$W_{eff,z}$	2,8873e-05 m <sup>3</sup>
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)

$A_{eff}$	1,0780e-03	m <sup>2</sup>
$N_{c,Rd}$	382,68	kN
Unity check	0,20	-

**Bending moment check for  $M_y$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,y,min}$	3,8360e-05	m <sup>3</sup>
$M_{c,y,Rd}$	13,62	kNm
Unity check	0,06	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,z,min}$	2,8873e-05	m <sup>3</sup>
$M_{c,z,Rd}$	10,25	kNm
Unity check	0,01	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	4,5640e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	93,54	kN
Unity check	0,00	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	6,8460e-04	m <sup>2</sup>
$V_{pl,z,Rd}$	140,32	kN
Unity check	0,00	-

**Torsion check**

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

Fibre	1	
$T_{Ed}$	1,0	MPa
$T_{Rd}$	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		
$A_{eff}$	1,0780e-03	m <sup>2</sup>
$e_{N,y}$	0	mm
$e_{N,z}$	0	mm
$W_{eff,y}$	3,8360e-05	m <sup>3</sup>
$W_{eff,z}$	2,8873e-05	m <sup>3</sup>

Normal stresses		
$\sigma_{N,Ed}$	71,0	MPa
$\sigma_{My,Ed}$	21,6	MPa
$\sigma_{Mz,Ed}$	3,6	MPa
$\sigma_{tot,Ed}$	96,3	MPa
Unity check	0,27	-

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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class 4 Limit [-]
1	I	71	3	9,121e+04	8,526e+04	0,93	1,00	23,67	22,78	27,66	31,63	2	
3	I	111	3	8,393e+04	4,389e+04	0,52	1,00	37,00	22,78	27,66	37,05	3	
5	I	71	3	4,306e+04	4,901e+04	0,88	1,00	23,67	22,78	27,66	32,28	2	
7	I	111	3	5,034e+04	9,038e+04	0,56	1,00	37,00	22,78	27,66	36,53	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	1,994	3,987	m
Buckling factor k	1,00	0,80	
Buckling length $l_{cr}$	1,994	3,205	m
Critical Euler load $N_{cr}$	1200,42	249,09	kN
Slenderness $\lambda$	44,38	97,44	
Relative slenderness $\lambda_{rel}$	0,56	1,24	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	c	c	
Imperfection $\alpha$	0,49	0,49	
Reduction factor $\chi$	0,81	0,42	
Buckling resistance $N_{b,Rd}$	308,50	158,95	kN

**Flexural Buckling verification**

Cross-section effective area $A_{eff}$	1,0780e-03	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	158,95	kN
Unity check	0,48	-

**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 $A_{eff}$	1,0780e-03	m <sup>2</sup>
Effective section modulus $W_{eff,y}$	3,8360e-05	m <sup>3</sup>
Effective section modulus $W_{eff,z}$	2,8873e-05	m <sup>3</sup>
Design compression force $N_{Ed}$	76,58	kN
Design bending moment (maximum) $M_{y,Ed}$	-0,83	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,35	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance $N_{Rk}$	382,68	kN
Characteristic moment resistance $M_{y,Rk}$	13,62	kNm
Characteristic moment resistance $M_{z,Rk}$	10,25	kNm
Reduction factor $\chi_y$	0,81	
Reduction factor $\chi_z$	0,42	
Reduction factor $\chi_{LT}$	1,00	
Interaction factor $k_{yy}$	1,03	
Interaction factor $k_{yz}$	1,25	
Interaction factor $k_{zy}$	0,83	
Interaction factor $k_{zz}$	1,00	

Maximum moment  $M_{y,Ed}$  is derived from beam B1313 position 0,000 m.

Maximum moment  $M_{z,Ed}$  is derived from beam B1314 position 0,000 m.

**Interaction method 1 parameters**

Critical Euler load $N_{cr,y}$	1200,42	kN
Critical Euler load $N_{cr,z}$	249,09	kN
Elastic critical load $N_{cr,T}$	66673,63	kN
Effective section modulus $W_{eff,y}$	3,8360e-05	m <sup>3</sup>
Second moment of area $I_y$	2,3020e-06	m <sup>4</sup>
Second moment of area $I_z$	1,2343e-06	m <sup>4</sup>
Torsional constant $I_t$	2,5547e-06	m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-0,83	kNm
Maximum relative deflection $\delta_z$	0,4	mm

Interaction method 1 parameters		
Equivalent moment factor $C_{my,0}$	0,98	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	0,35	kNm
Maximum relative deflection $\delta_y$	-1,3	mm
Equivalent moment factor $C_{mz,0}$	0,88	
Factor $\mu_y$	0,99	
Factor $\mu_z$	0,79	
Factor $\epsilon_y$	0,30	
Factor $a_{1,T}$	0,00	
Critical moment for uniform bending $M_{cr,0}$	182,35	kNm
Relative slenderness $\lambda_{rel,0}$	0,27	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,31	
Equivalent moment factor $C_{my}$	0,98	
Equivalent moment factor $C_{mz}$	0,88	
Equivalent moment factor $C_{m1,T}$	1,00	

Unity check (6.61) =  $0,25 + 0,06 + 0,04 = 0,35$  -  
 Unity check (6.62) =  $0,48 + 0,05 + 0,03 = 0,57$  -

The member satisfies the stability check.

Student version

Student version



50x50x3

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS17 - CFRHS50X50X3

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

**Member B1218** | **0,000 / 2,230 m** | **CFRHS50X50X3** | **S 355** | **ULS-Set B (auto)** | **0,72 -**

Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

**Combination key**  
 ULS-Set B (auto) / 1.35\*LC1 + 0.90\*Snejg + 1.35\*Dodatno stalno + 1.50\*3DWind14 + 0.90\*temp +

**Partial safety factors**

$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

**Material**

Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

....SECTION CHECK:....

The critical check is on position **0,000 m**

Internal forces	Calculated	Unit
$N_{Ed}$	-40,78	kN
$V_{y,Ed}$	0,06	kN
$V_{z,Ed}$	0,01	kN
$T_{Ed}$	0,00	kNm
$M_{y,Ed}$	0,01	kNm
$M_{z,Ed}$	0,00	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	41	3	7,472e+04	7,472e+04	1,00		1,00	13,67	22,78	27,66	30,92	1
3	I	41	3	7,481e+04	7,603e+04	0,98		1,00	13,67	22,78	27,66	31,09	1
5	I	41	3	7,612e+04	7,612e+04	1,00		1,00	13,67	22,78	27,66	30,92	1
7	I	41	3	7,603e+04	7,481e+04	0,98		1,00	13,67	22,78	27,66	31,09	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	5,4100e-04	m <sup>2</sup>
$N_{c,Rd}$	192,06	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)

$W_{pl,y}$	9,3900e-06	m <sup>3</sup>
$M_{pl,y,Rd}$	3,33	kNm
Unity check	0,00	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	2,7050e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	55,44	kN
Unity check	0,00	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	2,7050e-04	m <sup>2</sup>
$V_{pl,z,Rd}$	55,44	kN
Unity check	0,00	-

**Torsion check**

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

Fibre	1	
$T_{Ed}$	0,0	MPa
$T_{Rd}$	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 (6.31)

$M_{N,y,Rd}$	3,33	kNm
Unity check	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: 1,338 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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	41	3	7,036e+04	7,668e+04	0,92		1,00	13,67	22,78	27,66	31,83	1
3	I	41	3	7,738e+04	8,059e+04	0,96		1,00	13,67	22,78	27,66	31,35	1
5	I	41	3	8,036e+04	7,404e+04	0,92		1,00	13,67	22,78	27,66	31,79	1
7	I	41	3	7,334e+04	7,013e+04	0,96		1,00	13,67	22,78	27,66	31,39	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	$\chi_y$	$\chi_z$
Sway type	sway	non-sway
System length L	2,230	2,230
Buckling factor $k$	1,00	1,00
Buckling length $l_{cr}$	2,230	2,230
Critical Euler load $N_{cr}$	81,12	81,12
Slenderness $\lambda$	117,57	117,57
Relative slenderness $\lambda_{rel}$	1,54	1,54
Limit slenderness $\lambda_{rel,0}$	0,20	0,20
Buckling curve	c	c
Imperfection $\alpha$	0,49	0,49
Reduction factor $\chi$	0,30	0,30
Buckling resistance $N_{b,Rd}$	58,06	58,06

Flexural Buckling verification		
Cross-section area A	5,4100e-04	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	58,06	kN
Unity check	0,70	-

**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	5,4100e-04	m <sup>2</sup>
Plastic section modulus $W_{pl,y}$	9,3900e-06	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	9,3900e-06	m <sup>3</sup>
Design compression force $N_{Ed}$	40,78	kN
Design bending moment (maximum) $M_{y,Ed}$	0,02	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,03	kNm
Characteristic compression resistance $N_{Rk}$	192,06	kN
Characteristic moment resistance $M_{y,Rk}$	3,33	kNm
Characteristic moment resistance $M_{z,Rk}$	3,33	kNm
Reduction factor $\chi_y$	0,30	

Bending and axial compression check parameters	
Reduction factor $\chi_z$	0,30
Reduction factor $\chi_{LT}$	1,00
Interaction factor $k_{yy}$	1,06
Interaction factor $k_{yz}$	1,43
Interaction factor $k_{zy}$	0,86
Interaction factor $k_{zz}$	1,40

Maximum moment  $M_{y,Ed}$  is derived from beam B1218 position 2,230 m.  
 Maximum moment  $M_{z,Ed}$  is derived from beam B1218 position 1,115 m.

Interaction method 1 parameters	
Critical Euler load $N_{cr,y}$	81,12 kN
Critical Euler load $N_{cr,z}$	81,12 kN
Elastic critical load $N_{cr,T}$	36099,60 kN
Plastic section modulus $W_{pl,y}$	9,3900e-06 m <sup>3</sup>
Elastic section modulus $W_{el,y}$	7,7900e-06 m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	9,3900e-06 m <sup>3</sup>
Elastic section modulus $W_{el,z}$	7,7900e-06 m <sup>3</sup>
Second moment of area $I_y$	1,9470e-07 m <sup>4</sup>
Second moment of area $I_z$	1,9470e-07 m <sup>4</sup>
Torsional constant $I_t$	3,2130e-07 m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)
Ratio of end moments $\psi_y$	0,27
Equivalent moment factor $C_{my,0}$	0,84
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 4 (Line load)
Equivalent moment factor $C_{mz,0}$	1,02
Factor $\mu_y$	0,59
Factor $\mu_z$	0,59
Factor $\epsilon_y$	0,04
Factor $a_{LT}$	0,00
Critical moment for uniform bending $M_{cr,0}$	45,91 kNm
Relative slenderness $\lambda_{rel,0}$	0,27
Limit relative slenderness $\lambda_{rel,0,lim}$	0,21
Equivalent moment factor $C_{my}$	0,84
Equivalent moment factor $C_{mz}$	1,02
Equivalent moment factor $C_{mLT}$	1,00
Factor $b_{LT}$	0,00
Factor $q_{LT}$	0,00
Factor $d_{LT}$	0,00
Factor $e_{LT}$	0,00
Factor $w_y$	1,21
Factor $w_z$	1,21
Factor $\eta_{pl}$	0,21
Maximum relative slenderness $\lambda_{rel,max}$	1,54
Factor $C_{yy}$	0,93
Factor $C_{yz}$	0,50
Factor $C_{zy}$	0,69
Factor $C_{zz}$	0,85

Unity check (6.61) = 0,70 + 0,01 + 0,01 = 0,72 -

Unity check (6.62) = 0,70 + 0,01 + 0,01 = 0,72 -

The member satisfies the stability check.

Student version

120x80x5

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS19 - CFRHS120X80X5

**EN 1993-1-1 Code Check**

National annex: Standard EN

<b>Member B1129</b>	<b>2,877 / 2,877 m</b>	<b>CFRHS120X80X5</b>	<b>S 355</b>	<b>ULS-Set B (auto)</b>	<b>0,66 -</b>
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Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

**Combination key**

ULS-Set B (auto) / 1.35\*LC1 + 1.50\*Srjeg + 1.35\*Dodatno stalno + 0.90\*3DWind1 + 1.50\*Temp -

**Partial safety factors**

$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

**Material**

Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

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

The critical check is on position 2,877 m

Internal forces	Calculated	Unit
$N_{Ed}$	-19,16	kN
$V_{y,Ed}$	0,01	kN
$V_{z,Ed}$	-0,91	kN
$T_{Ed}$	0,03	kNm
$M_{y,Ed}$	-2,02	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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	65	5	4,404e+04	4,273e+04	0,97	1,00	13,00	22,78	27,66	31,24	1	
3	I	105	5	3,976e+04	-2,040e+04	-0,51	0,66	21,00	38,90	46,13	65,09	1	
5	I	65	5	-2,316e+04	-2,185e+04								
7	I	105	5	-1,888e+04	4,128e+04	-0,46	0,69	21,00	36,96	43,95	62,55	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	1,8360e-03	m <sup>2</sup>
$N_{C,Rd}$	651,78	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)

$W_{pl,y}$	7,2450e-05	m <sup>3</sup>
$M_{pl,y,Rd}$	25,72	kNm
Unity check	0,08	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	5,4740e-05	m <sup>3</sup>
$M_{pl,z,Rd}$	19,43	kNm
Unity check	0,00	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	7,3440e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	150,52	kN
Unity check	0,00	-



**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	1,1016e-03	m <sup>2</sup>
$V_{pl,z,Rd}$	225,78	kN
Unity check	0,00	-

**Torsion check**

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

Fibre	1	
$T_{Ed}$	0,3	MPa
$T_{Rd}$	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)

$M_{N,y,Rd}$	25,72	kNm
$\alpha$	1,66	
$M_{N,z,Rd}$	19,43	kNm
$\beta$	1,66	

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: 2,877 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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\Psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	65	5	4,404e+04	4,273e+04	0,97		1,00	13,00	22,78	27,66	31,24	1
3	I	105	5	3,976e+04	-2,040e+04	-0,51		0,66	21,00	38,90	46,13	65,09	1
5	I	65	5	-2,315e+04	-2,185e+04								
7	I	105	5	-1,888e+04	4,128e+04	-0,46		0,69	21,00	36,96	43,95	62,55	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	2,877	17,263	m
Buckling factor k	1,00	0,61	
Buckling length $l_{cr}$	2,877	10,560	m
Critical Euler load $N_{cr}$	884,13	34,90	kN
Slenderness $\lambda$	65,61	330,19	
Relative slenderness $\lambda_{rel}$	0,86	4,32	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	c	c	
Imperfection $\alpha$	0,49	0,49	
Reduction factor $\chi$	0,63	0,05	
Buckling resistance $N_{b,Rd}$	407,66	31,34	kN

**Flexural Buckling verification**

Cross-section area A	1,8360e-03	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	31,34	kN
Unity check	0,61	-

**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	1,8360e-03	m <sup>2</sup>
Plastic section modulus $W_{pl,y}$	7,2450e-05	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	5,4740e-05	m <sup>3</sup>
Design compression force $N_{Ed}$	19,16	kN
Design bending moment (maximum) $M_{y,Ed}$	-2,02	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,18	kNm
Characteristic compression resistance $N_{Rk}$	651,78	kN
Characteristic moment resistance $M_{y,Rk}$	25,72	kNm
Characteristic moment resistance $M_{z,Rk}$	19,43	kNm
Reduction factor $\chi_y$	0,63	
Reduction factor $\chi_z$	0,05	
Reduction factor $\chi_{l,T}$	1,00	
Interaction factor $k_{yy}$	1,23	
Interaction factor $k_{yz}$	0,92	
Interaction factor $k_{zy}$	0,58	
Interaction factor $k_{zz}$	0,62	

Maximum moment  $M_{y,Ed}$  is derived from beam B1129 position 2,877 m.  
 Maximum moment  $M_{z,Ed}$  is derived from beam B1135 position 2,877 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	884,13	kN
Critical Euler load $N_{cr,z}$	34,90	kN
Elastic critical load $N_{cr,T}$	110290,71	kN
Plastic section modulus $W_{pl,y}$	7,2450e-05	m <sup>3</sup>
Elastic section modulus $W_{el,y}$	5,8860e-05	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	5,4740e-05	m <sup>3</sup>
Elastic section modulus $W_{el,z}$	4,6940e-05	m <sup>3</sup>
Second moment of area $I_y$	3,5314e-06	m <sup>4</sup>
Second moment of area $I_z$	1,8778e-06	m <sup>4</sup>
Torsional constant $I_t$	4,0227e-06	m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-2,02	kNm
Maximum relative deflection $\delta_z$	1,3	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) $M_{z,Ed}$	0,18	kNm
Maximum relative deflection $\delta_y$	3,3	mm
Equivalent moment factor $C_{mz,0}$	0,58	
Factor $\mu_y$	0,99	
Factor $\mu_z$	0,46	
Factor $e_y$	3,29	
Factor $a_{l,T}$	0,00	
Critical moment for uniform bending $M_{cr,0}$	65,14	kNm
Relative slenderness $\lambda_{rel,0}$	0,63	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,19	
Equivalent moment factor $C_{my}$	0,99	
Equivalent moment factor $C_{mz}$	0,58	
Equivalent moment factor $C_{m,T}$	1,00	
Factor $b_{l,T}$	0,00	
Factor $q_{l,T}$	0,00	
Factor $d_{l,T}$	0,00	
Factor $e_{l,T}$	0,00	
Factor $w_y$	1,23	
Factor $w_z$	1,17	
Factor $\eta_{pl}$	0,03	
Maximum relative slenderness $\lambda_{rel,max}$	4,32	
Factor $C_{yy}$	0,81	
Factor $C_{yz}$	0,81	
Factor $C_{zy}$	0,50	
Factor $C_{zz}$	0,96	

Unity check (6.61) = 0,05 + 0,10 + 0,01 = 0,15 -  
 Unity check (6.62) = 0,61 + 0,05 + 0,01 = 0,66 -

The member satisfies the stability check.

Student version

50x50x2

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS18 - CFRHS50X50X3

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

**Member B1133** | **0,000 / 3,245 m** | **CFRHS50X50X3** | **S 355** | **ULS-Set B (auto)** | **0,71 -**

Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

**Combination key**  
 ULS-Set B (auto) / 1.35\*LC1 + 1.50\*Snjeg + 1.35\*Dodatno stalno + 0.90\*3DWind6 + 1.50\*Temp -

**Partial safety factors**

$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

**Material**

Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

....SECTION CHECK:....

The critical check is on position **0,000 m**

Internal forces	Calculated	Unit
$N_{Ed}$	-20,87	kN
$V_{y,Ed}$	0,08	kN
$V_{z,Ed}$	0,00	kN
$T_{Ed}$	-0,02	kNm
$M_{y,Ed}$	0,01	kNm
$M_{z,Ed}$	0,00	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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	41	3	3,715e+04	3,715e+04	1,00		1,00	13,67	22,78	27,66	30,92	1
3	I	41	3	3,734e+04	3,984e+04	0,94		1,00	13,67	22,78	27,66	31,61	1
5	I	41	3	4,003e+04	4,003e+04	1,00		1,00	13,67	22,78	27,66	30,92	1
7	I	41	3	3,984e+04	3,734e+04	0,94		1,00	13,67	22,78	27,66	31,61	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	5,4100e-04	m <sup>2</sup>
$N_{c,Rd}$	192,06	kN
Unity check	0,11	-

**Bending moment check for  $M_y$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	9,3900e-06	m <sup>3</sup>
$M_{pl,y,Rd}$	3,33	kNm
Unity check	0,00	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	2,7050e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	55,44	kN
Unity check	0,00	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	2,7050e-04	m <sup>2</sup>
$V_{pl,z,Rd}$	55,44	kN
Unity check	0,00	-

**Torsion check**

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

Fibre	1	
$T_{Ed}$	1,5	MPa
$T_{Rd}$	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 (6.31)

$M_{N,y,Rd}$	3,33	kNm
Unity check	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: 1,622 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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\Psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	41	3	2,948e+04	4,331e+04	0,68		1,00	13,67	22,78	27,66	34,77	1
3	I	41	3	4,459e+04	4,828e+04	0,92		1,00	13,67	22,78	27,66	31,76	1
5	I	41	3	4,754e+04	3,372e+04	0,71		1,00	13,67	22,78	27,66	34,39	1
7	I	41	3	3,243e+04	2,874e+04	0,89		1,00	13,67	22,78	27,66	32,19	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	3,245	3,245
Buckling factor $k$	1,00	1,00
Buckling length $l_{cr}$	3,245	3,245
Critical Euler load $N_{cr}$	38,33	38,33
Slenderness $\lambda$	171,04	171,04
Relative slenderness $\lambda_{rel}$	2,24	2,24
Limit slenderness $\lambda_{rel,0}$	0,20	0,20
Buckling curve	c	c
Imperfection $\alpha$	0,49	0,49
Reduction factor $\chi$	0,16	0,16
Buckling resistance $N_{b,Rd}$	30,97	30,97

Flexural Buckling verification		
Cross-section area A	5,4100e-04	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	30,97	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	5,4100e-04	m <sup>2</sup>
Plastic section modulus $W_{pl,y}$	9,3900e-06	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	9,3900e-06	m <sup>3</sup>
Design compression force $N_{Ed}$	20,87	kN
Design bending moment (maximum) $M_{y,Ed}$	0,02	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,07	kNm
Characteristic compression resistance $N_{Rk}$	192,06	kN
Characteristic moment resistance $M_{y,Rk}$	3,33	kNm
Characteristic moment resistance $M_{z,Rk}$	3,33	kNm
Reduction factor $\chi_y$	0,16	



Bending and axial compression check parameters	
Reduction factor $\chi_z$	0,16
Reduction factor $\chi_{LT}$	1,00
Interaction factor $k_{yy}$	1,19
Interaction factor $k_{yz}$	1,34
Interaction factor $k_{zy}$	1,21
Interaction factor $k_{zz}$	1,34

Maximum moment  $M_{y,Ed}$  is derived from beam B1133 position 3,245 m.  
 Maximum moment  $M_{z,Ed}$  is derived from beam B1133 position 1,622 m.

Interaction method 1 parameters	
Critical Euler load $N_{cr,y}$	38,33 kN
Critical Euler load $N_{cr,z}$	38,33 kN
Elastic critical load $N_{cr,T}$	36075,74 kN
Plastic section modulus $W_{pl,y}$	9,3900e-06 m <sup>3</sup>
Elastic section modulus $W_{el,y}$	7,7900e-06 m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	9,3900e-06 m <sup>3</sup>
Elastic section modulus $W_{el,z}$	7,7900e-06 m <sup>3</sup>
Second moment of area $I_y$	1,9470e-07 m <sup>4</sup>
Second moment of area $I_z$	1,9470e-07 m <sup>4</sup>
Torsional constant $I_t$	3,2130e-07 m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)
Ratio of end moments $\psi_y$	0,51
Equivalent moment factor $C_{my,0}$	0,93
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 4 (Line load)
Equivalent moment factor $C_{mz,0}$	1,02
Factor $\mu_y$	0,50
Factor $\mu_z$	0,50
Factor $\epsilon_y$	0,08
Factor $a_{LT}$	0,00
Critical moment for uniform bending $M_{cr,0}$	31,55 kNm
Relative slenderness $\lambda_{rel,0}$	0,33
Limit relative slenderness $\lambda_{rel,0,lim}$	0,19
Equivalent moment factor $C_{my}$	0,93
Equivalent moment factor $C_{mz}$	1,02
Equivalent moment factor $C_{mLT}$	1,00
Factor $b_{LT}$	0,00
Factor $q_{LT}$	0,00
Factor $d_{LT}$	0,00
Factor $e_{LT}$	0,00
Factor $w_y$	1,21
Factor $w_z$	1,21
Factor $\eta_{pl}$	0,11
Maximum relative slenderness $\lambda_{rel,max}$	2,24
Factor $C_{yy}$	0,86
Factor $C_{yz}$	0,50
Factor $C_{zy}$	0,51
Factor $C_{zz}$	0,83

Unity check (6.61) = 0,67 + 0,01 + 0,03 = 0,71 -

Unity check (6.62) = 0,67 + 0,01 + 0,03 = 0,71 -

The member satisfies the stability check.

Student version

200x80x5

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS21 - CFRHS200X80X5

**EN 1993-1-1 Code Check**

National annex: Standard EN

<b>Member B1538</b>	<b>2,668 / 2,668 m</b>	<b>CFRHS200X80X5</b>	<b>S 355</b>	<b>ULS-Set B (auto)</b>	<b>0,59 -</b>
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Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

<b>Combination key</b>	
ULS-Set B (auto) / 1.35*LC1 + 0.90*Snjeg + 1.35*Dodatno stalno + 1.50*3DWind10 + 0.90*temp +	

<b>Partial safety factors</b>	
γ <sub>M0</sub> for resistance of cross-sections	1,00
γ <sub>M1</sub> for resistance to instability	1,00
γ <sub>M2</sub> for resistance of net sections	1,25

<b>Material</b>	
Yield strength f <sub>y</sub>	355,0 MPa
Ultimate strength f <sub>u</sub>	490,0 MPa
Fabrication	Cold formed

....SECTION CHECK:....

The critical check is on position 2,668 m

<b>Internal forces</b>	<b>Calculated</b>	<b>Unit</b>
N <sub>Ed</sub>	-126,01	kN
V <sub>z,Ed</sub>	-0,21	kN
V <sub>y,Ed</sub>	-5,47	kN
T <sub>Ed</sub>	-0,07	kNm
M <sub>y,Ed</sub>	-1,73	kNm
M <sub>z,Ed</sub>	0,32	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 <sub>1</sub> [kN/m <sup>2</sup> ]	σ <sub>2</sub> [kN/m <sup>2</sup> ]	ψ [-]	k <sub>σ</sub> [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	65	5	5,768e+04	6,457e+04	0,89		1,00	13,00	22,78	27,66	32,11	1
3	I	185	5	6,442e+04	3,916e+04	0,61		1,00	37,00	22,78	27,66	35,79	4
5	I	65	5	3,795e+04	3,106e+04	0,82		1,00	13,00	22,78	27,66	33,00	1
7	I	185	5	3,121e+04	5,647e+04	0,55		1,00	37,00	22,78	27,66	36,60	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 <sub>p</sub> [mm]	σ <sub>1</sub> [kN/m <sup>2</sup> ]	σ <sub>2</sub> [kN/m <sup>2</sup> ]	ψ [-]	k <sub>σ</sub> [-]	λ <sub>p</sub> [-]	ρ [-]	b <sub>e</sub> [mm]	b <sub>e1</sub> [mm]	b <sub>e2</sub> [mm]
1	I	65	3,550e+05	3,550e+05	1,00	4,00	0,28	1,00	65	33	33
3	I	185	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	168	84	84
5	I	65	3,550e+05	3,550e+05	1,00	4,00	0,28	1,00	65	33	33
7	I	185	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	168	84	84

**Effective section My-**

**Effective width calculation**

According to EN 1993-1-5 article 4.4

Id	Type	b <sub>p</sub> [mm]	σ <sub>1</sub> [kN/m <sup>2</sup> ]	σ <sub>2</sub> [kN/m <sup>2</sup> ]	ψ [-]	k <sub>σ</sub> [-]	λ <sub>p</sub> [-]	ρ [-]	b <sub>e</sub> [mm]	b <sub>e1</sub> [mm]	b <sub>e2</sub> [mm]
1	I	65	3,550e+05	3,550e+05	1,00	4,00	0,28	1,00	65	33	33
3	I	185	3,368e+05	-3,368e+05	-1,00	23,90	0,33	1,00	93	37	56
5	I	65	-3,550e+05	-3,550e+05							
7	I	185	3,368e+05	-3,368e+05	-1,00	23,90	0,33	1,00	93	37	56

**Effective section Mz+**

**Effective width calculation**

According to EN 1993-1-5 article 4.4

Id	Type	$b_p$ [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_G$ [-]	$\lambda_p$ [-]	$\rho$ [-]	$b_e$ [mm]	$b_{e1}$ [mm]	$b_{e2}$ [mm]
1	I	65	3,092e+05	-2,858e+05	-0,92	21,97	0,12	1,00	34	14	20
3	I	185	3,550e+05	3,550e+05	1,00	4,00	0,80	0,91	168	84	84
5	I	65	3,092e+05	-2,858e+05	-0,92	21,97	0,12	1,00	34	14	20
7	I	185	-3,315e+05	-3,315e+05	1,00	4,00	0,80	0,91	168	84	84

Effective properties		
Effective area	$A_{eff}$	2,4611e-03 m <sup>2</sup>
Effective second moment of area	$I_{eff,y}$	1,2688e-05 m <sup>4</sup>
	$I_{eff,z}$	2,8771e-06 m <sup>4</sup>
Effective section modulus	$W_{eff,y}$	1,2688e-04 m <sup>3</sup>
	$W_{eff,z}$	6,9693e-05 m <sup>3</sup>
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)

$A_{eff}$	2,4611e-03	m <sup>2</sup>
$N_{c,Rd}$	873,68	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)

$W_{eff,y,min}$	1,2688e-04	m <sup>3</sup>
$M_{c,y,Rd}$	45,04	kNm
Unity check	0,04	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.15)

$W_{eff,z,min}$	6,9693e-05	m <sup>3</sup>
$M_{c,z,Rd}$	24,74	kNm
Unity check	0,01	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	-
$A_v$	7,5314e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	154,36	kN
Unity check	0,00	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	-
$A_v$	1,8829e-03	m <sup>2</sup>
$V_{pl,z,Rd}$	385,91	kN
Unity check	0,01	-

**Torsion check**

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

Fibre	1	-
$T_{Ed}$	0,5	MPa
$T_{Rd}$	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		
$A_{eff}$	2,4611e-03	m <sup>2</sup>
$e_{N,y}$	0	mm
$e_{N,z}$	0	mm
$W_{eff,y}$	1,2688e-04	m <sup>3</sup>
$W_{eff,z}$	6,9693e-05	m <sup>3</sup>

Normal stresses		
$\sigma_{N,Ed}$	51,2	MPa
$\sigma_{M_y,Ed}$	13,7	MPa
$\sigma_{M_z,Ed}$	4,6	MPa
$\sigma_{tot,Ed}$	69,4	MPa
Unity check	0,20	-

The member satisfies the section check.

**.....STABILITY CHECK:.....****Classification for member buckling design**

Decisive position for stability classification: 1,868 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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class 4 Limit [-]
1	I	65	5	2,880e+04	3,916e+04	0,74	1,00	13,00	22,78	27,66	34,04	1	
3	I	185	5	4,067e+04	6,688e+04	0,61	1,00	37,00	22,78	27,66	35,78	4	
5	I	65	5	6,679e+04	5,642e+04	0,84	1,00	13,00	22,78	27,66	32,68	1	
7	I	185	5	5,492e+04	2,871e+04	0,52	1,00	37,00	22,78	27,66	37,05	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	2,668	8,004	m
Buckling factor k	1,00	0,53	
Buckling length $l_{cr}$	2,668	4,220	m
Critical Euler load $N_{cr}$	3695,30	349,69	kN
Slenderness $\lambda$	38,45	124,99	
Relative slenderness $\lambda_{rel}$	0,49	1,58	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	c	c	
Imperfection $\alpha$	0,49	0,49	
Reduction factor $\chi$	0,85	0,29	
Buckling resistance $N_{b,Rd}$	743,20	253,17	kN

#### Flexural Buckling verification

Cross-section effective area $A_{eff}$	2,4611e-03	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	253,17	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 $A_{eff}$	2,4611e-03	m <sup>2</sup>
Effective section modulus $W_{eff,y}$	1,2688e-04	m <sup>3</sup>
Effective section modulus $W_{eff,z}$	6,9693e-05	m <sup>3</sup>
Design compression force $N_{Ed}$	126,01	kN
Design bending moment (maximum) $M_{y,Ed}$	3,93	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,82	kNm
Additional moment $\Delta M_{y,Ed}$	0,00	kNm
Additional moment $\Delta M_{z,Ed}$	0,00	kNm
Characteristic compression resistance $N_{Rk}$	873,68	kN
Characteristic moment resistance $M_{y,Rk}$	45,04	kNm
Characteristic moment resistance $M_{z,Rk}$	24,74	kNm
Reduction factor $\chi_y$	0,85	
Reduction factor $\chi_z$	0,29	
Reduction factor $\chi_{LT}$	1,00	
Interaction factor $k_{yy}$	1,03	
Interaction factor $k_{yz}$	1,13	
Interaction factor $k_{zy}$	0,74	
Interaction factor $k_{zz}$	0,81	

Maximum moment  $M_{y,Ed}$  is derived from beam B1538 position 0,534 m.

Maximum moment  $M_{z,Ed}$  is derived from beam B1538 position 0,000 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	3695,30	kN
Critical Euler load $N_{cr,z}$	349,69	kN
Elastic critical load $N_{cr,T}$	109738,38	kN
Effective section modulus $W_{eff,y}$	1,2688e-04	m <sup>3</sup>
Second moment of area $I_y$	1,2691e-05	m <sup>4</sup>
Second moment of area $I_z$	3,0044e-06	m <sup>4</sup>
Torsional constant $I_t$	8,0838e-06	m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	3,93	kNm
Maximum relative deflection $\delta_z$	-1,0	mm

Interaction method 1 parameters		
Equivalent moment factor $C_{my,0}$	1,00	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	0,82	kNm
Maximum relative deflection $\delta_y$	-2,1	mm
Equivalent moment factor $C_{mz,0}$	0,73	
Factor $\mu_y$	0,99	
Factor $\mu_z$	0,71	
Factor $\epsilon_y$	0,60	
Factor $a_{1,T}$	0,36	
Critical moment for uniform bending $M_{cr,0}$	252,02	kNm
Relative slenderness $\lambda_{rel,0}$	0,42	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,29	
Equivalent moment factor $C_{my}$	1,00	
Equivalent moment factor $C_{mz}$	0,73	
Equivalent moment factor $C_{m1,T}$	1,00	

Unity check (6.61) =  $0,17 + 0,09 + 0,04 = 0,30$  -  
 Unity check (6.62) =  $0,50 + 0,06 + 0,03 = 0,59$  -

The member satisfies the stability check.

Student version

Student version



140x60x5

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS22 - CFRHS140X60X5

**EN 1993-1-1 Code Check**

National annex: Standard EN

<b>Member B2307</b>	<b>2,575 / 2,575 m</b>	<b>CFRHS140X60X5</b>	<b>S 355</b>	<b>ULS-Set B (auto)</b>	<b>0,79 -</b>
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Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

**Combination key**

ULS-Set B (auto) / 1.35\*LC1 + 0.90\*Snjeg + 1.35\*Dodatno stalno + 1.50\*3DWind5 + 0.90\*temp +

**Partial safety factors**

$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

**Material**

Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

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

The critical check is on position 2,575 m

Internal forces	Calculated	Unit
$N_{Ed}$	-46,41	kN
$V_{y,Ed}$	0,00	kN
$V_{z,Ed}$	-3,06	kN
$T_{Ed}$	0,01	kNm
$M_{y,Ed}$	-1,15	kNm
$M_{z,Ed}$	0,11	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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_\sigma$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	45	5	4,136e+04	4,568e+04	0,91		1,00	9,00	22,78	27,66	31,97	1
3	I	125	5	4,481e+04	1,104e+04	0,25		1,00	25,00	22,78	27,66	41,86	2
5	I	45	5	9,214e+03	4,892e+03	0,53		1,00	9,00	22,78	27,66	36,93	1
7	I	125	5	5,763e+03	3,953e+04	0,15		1,00	25,00	22,78	27,66	43,94	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	1,8360e-03	m <sup>2</sup>
$N_{c,Rd}$	651,78	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)

$W_{pl,y}$	7,8300e-05	m <sup>3</sup>
$M_{pl,y,Rd}$	27,80	kNm
Unity check	0,04	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	4,2880e-05	m <sup>3</sup>
$M_{pl,z,Rd}$	15,22	kNm
Unity check	0,01	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	5,5080e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	112,89	kN
Unity check	0,00	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	1,2852e-03	m <sup>2</sup>
$V_{pl,z,Rd}$	263,41	kN
Unity check	0,01	-

**Torsion check**

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

Fibre	1	
$T_{Ed}$	0,2	MPa
$T_{Rd}$	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)

$M_{N,y,Rd}$	27,80	kNm
$\alpha$	1,67	
$M_{N,z,Rd}$	15,22	kNm
$\beta$	1,67	

Unity check (6.41) = 0,00 + 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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	45	5	4,465e+04	4,906e+04	0,91		1,00	9,00	22,78	27,66	31,91	1
3	I	125	5	4,795e+04	7,792e+03	0,16		1,00	25,00	22,78	27,66	43,58	2
5	I	45	5	5,695e+03	1,286e+03	0,23		1,00	9,00	22,78	27,66	42,27	1
7	I	125	5	2,402e+03	4,256e+04	0,06		1,00	25,00	22,78	27,66	45,97	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	2,575	7,725	m
Buckling factor k	1,00	0,73	
Buckling length $l_{cr}$	2,575	5,659	m
Critical Euler load $N_{cr}$	1331,41	71,94	kN
Slenderness $\lambda$	53,46	229,99	
Relative slenderness $\lambda_{rel}$	0,70	3,01	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	c	c	
Imperfection $\alpha$	0,49	0,49	
Reduction factor $\chi$	0,72	0,09	
Buckling resistance $N_{b,Rd}$	472,47	61,60	kN

**Flexural Buckling verification**

Cross-section area A	1,8360e-03	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	61,60	kN
Unity check	0,75	-

**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	1,8360e-03	m <sup>2</sup>
Plastic section modulus $W_{pl,y}$	7,8300e-05	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	4,2880e-05	m <sup>3</sup>
Design compression force $N_{Ed}$	46,41	kN
Design bending moment (maximum) $M_{y,Ed}$	-1,37	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0,29	kNm
Characteristic compression resistance $N_{Rk}$	651,78	kN
Characteristic moment resistance $M_{y,Rk}$	27,80	kNm
Characteristic moment resistance $M_{z,Rk}$	15,22	kNm
Reduction factor $\chi_y$	0,72	
Reduction factor $\chi_z$	0,09	
Reduction factor $\chi_{l,T}$	1,00	
Interaction factor $k_{yy}$	1,30	
Interaction factor $k_{yz}$	0,92	
Interaction factor $k_{zy}$	0,50	
Interaction factor $k_{zz}$	0,54	

Maximum moment  $M_{y,Ed}$  is derived from beam B2307 position 0,000 m.  
Maximum moment  $M_{z,Ed}$  is derived from beam B1559 position 2,575 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	1331,41	kN
Critical Euler load $N_{cr,z}$	71,94	kN
Elastic critical load $N_{cr,T}$	82311,53	kN
Plastic section modulus $W_{pl,y}$	7,8300e-05	m <sup>3</sup>
Elastic section modulus $W_{el,y}$	6,0840e-05	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	4,2880e-05	m <sup>3</sup>
Elastic section modulus $W_{el,z}$	3,7050e-05	m <sup>3</sup>
Second moment of area $I_y$	4,2589e-06	m <sup>4</sup>
Second moment of area $I_z$	1,1116e-06	m <sup>4</sup>
Torsional constant $I_t$	2,9797e-06	m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-1,37	kNm
Maximum relative deflection $\delta_z$	-0,4	mm
Equivalent moment factor $C_{my,0}$	0,98	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	-0,29	kNm
Maximum relative deflection $\delta_y$	-1,6	mm
Equivalent moment factor $C_{mz,0}$	0,50	
Factor $\mu_y$	0,99	
Factor $\mu_z$	0,38	
Factor $e_y$	0,89	
Factor $a_{l,T}$	0,30	
Critical moment for uniform bending $M_{cr,0}$	96,42	kNm
Relative slenderness $\lambda_{rel,0}$	0,54	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,20	
Equivalent moment factor $C_{my}$	0,98	
Equivalent moment factor $C_{mz}$	0,50	
Equivalent moment factor $C_{m,T}$	1,00	
Factor $b_{l,T}$	0,00	
Factor $q_{l,T}$	0,00	
Factor $d_{l,T}$	0,00	
Factor $e_{l,T}$	0,00	
Factor $w_y$	1,29	
Factor $w_z$	1,16	
Factor $\eta_{pl}$	0,07	
Maximum relative slenderness $\lambda_{rel,max}$	3,01	
Factor $C_{yy}$	0,78	
Factor $C_{yz}$	0,85	
Factor $C_{zy}$	0,49	
Factor $C_{zz}$	0,98	

Unity check (6.61) = 0,10 + 0,06 + 0,02 = 0,18 -

Unity check (6.62) = 0,75 + 0,02 + 0,01 = 0,79 -

The member satisfies the stability check.

Student version

140x70x4

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS23 - CFRHS140X70X4

**EN 1993-1-1 Code Check**

National annex: Standard EN

<b>Member B2210</b>	<b>2,575 / 2,575 m</b>	<b>CFRHS140X70X4</b>	<b>S 355</b>	<b>ULS-Set B (auto)</b>	<b>0,84 -</b>
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Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

**Combination key**

ULS-Set B (auto) / 1.35\*LC1 + 0.90\*Snjeg + 1.35\*Dodatno stalno + 1.50\*3DWind10 + 0.90\*temp +

**Partial safety factors**

$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

**Material**

Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

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

The critical check is on position 2,575 m

Internal forces	Calculated	Unit
$N_{Ed}$	-88,90	kN
$V_{y,Ed}$	-0,03	kN
$V_{z,Ed}$	-4,68	kN
$T_{Ed}$	-0,02	kNm
$M_{y,Ed}$	-1,52	kNm
$M_{z,Ed}$	-0,03	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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	58	4	8,342e+04	8,200e+04	0,98		1,00	14,50	22,78	27,66	31,10	1
3	I	128	4	8,036e+04	3,094e+04	0,39		1,00	32,00	22,78	27,66	39,31	3
5	I	58	4	2,949e+04	3,091e+04	0,95		1,00	14,50	22,78	27,66	31,42	1
7	I	128	4	3,255e+04	8,198e+04	0,40		1,00	32,00	22,78	27,66	39,10	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 $\epsilon$	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 $c/t_f$	14,50
Reference slenderness ratio $c/t_{ref,y}$	0,00
Reference slenderness ratio $c/t_{ref,z}$	1,00
Interpolated section modulus $W_{3,y}$	7,0070e-05 m <sup>3</sup>
Interpolated section modulus $W_{3,z}$	3,8050e-05 m <sup>3</sup>

**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	1,5750e-03	m <sup>2</sup>
$N_{c,Rd}$	559,13	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)

$W_{s,y}$	7,0070e-05	m <sup>3</sup>
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M <sub>3,y,Rd</sub>	24,87	kNm
Unity check	0,06	-

**Bending moment check for M<sub>z</sub>**  
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

W <sub>pl,y</sub>	3,8050e-05	m <sup>3</sup>
M <sub>3,z,Rd</sub>	13,51	kNm
Unity check	0,00	-

**Shear check for V<sub>y</sub>**  
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A <sub>v</sub>	5,2500e-04	m <sup>2</sup>
V <sub>pl,y,Rd</sub>	107,60	kN
Unity check	0,00	-

**Shear check for V<sub>z</sub>**  
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A <sub>v</sub>	1,0500e-03	m <sup>2</sup>
V <sub>pl,z,Rd</sub>	215,21	kN
Unity check	0,02	-

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

Fibre	1	
T <sub>Ed</sub>	0,3	MPa
T <sub>Rd</sub>	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 <sub>N,3,y,Rd</sub>	20,92	kNm
α	1,71	
M <sub>N,3,z,Rd</sub>	11,36	kNm
β	2,71	

Unity check (5.41) = 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: 2,575 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 <sub>1</sub> [kN/m <sup>2</sup> ]	σ <sub>2</sub> [kN/m <sup>2</sup> ]	ψ [-]	k <sub>σ</sub> [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	58	4	8,342e+04	8,200e+04	0,98		1,00	14,50	22,78	27,66	31,10	1
3	I	128	4	8,036e+04	3,094e+04	0,39		1,00	32,00	22,78	27,66	39,31	3
5	I	58	4	2,949e+04	3,091e+04	0,95		1,00	14,50	22,78	27,66	31,42	1
7	I	128	4	3,255e+04	8,198e+04	0,40		1,00	32,00	22,78	27,66	39,10	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	2,575	7,725	m
Buckling factor k	1,00	0,57	
Buckling length l <sub>cr</sub>	2,575	4,403	m
Critical Euler load N <sub>cr</sub>	1227,34	142,40	kN
Slenderness λ	51,57	151,41	
Relative slenderness λ <sub>rel</sub>	0,67	1,98	
Limit slenderness λ <sub>rel,0</sub>	0,20	0,20	
Buckling curve	c	c	
Imperfection α	0,49	0,49	
Reduction factor χ	0,74	0,20	
Buckling resistance N <sub>b,Rd</sub>	413,83	111,45	kN

Flexural Buckling verification		
Cross-section area A	1,5750e-03	m <sup>2</sup>
Buckling resistance N <sub>b,Rd</sub>	111,45	kN
Unity check	0,30	-

**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 / λ<sub>rel,z</sub>'. 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	1,5750e-03	m <sup>2</sup>
Interpolated section modulus W <sub>3,y</sub>	7,0070e-05	m <sup>3</sup>
Interpolated section modulus W <sub>3,z</sub>	3,8050e-05	m <sup>3</sup>
Design compression force N <sub>Ed</sub>	88,90	kN
Design bending moment (maximum) M <sub>y,Ed</sub>	-1,52	kNm
Design bending moment (maximum) M <sub>z,Ed</sub>	-0,07	kNm
Characteristic compression resistance N <sub>Rk</sub>	559,13	kN
Characteristic moment resistance M <sub>y,Rk</sub>	24,87	kNm
Characteristic moment resistance M <sub>z,Rk</sub>	13,51	kNm
Reduction factor χ <sub>y</sub>	0,74	
Reduction factor χ <sub>z</sub>	0,20	
Reduction factor χ <sub>LT</sub>	1,00	
Interaction factor K <sub>yy</sub>	1,31	
Interaction factor K <sub>yz</sub>	0,62	
Interaction factor K <sub>zy</sub>	0,57	
Interaction factor K <sub>zz</sub>	0,50	

Maximum moment M<sub>y,Ed</sub> is derived from beam B2210 position 2,575 m.Maximum moment M<sub>z,Ed</sub> is derived from beam B1520 position 0,000 m.

Interaction method 1 parameters		
Critical Euler load N <sub>cr,y</sub>	1227,34	kN
Critical Euler load N <sub>cr,z</sub>	142,40	kN
Elastic critical load N <sub>cr,T</sub>	78914,94	kN
Interpolated section modulus W <sub>3,y</sub>	7,0070e-05	m <sup>3</sup>
Elastic section modulus W <sub>el,y</sub>	5,6090e-05	m <sup>3</sup>
Interpolated section modulus W <sub>3,z</sub>	3,8050e-05	m <sup>3</sup>
Elastic section modulus W <sub>el,z</sub>	3,8050e-05	m <sup>3</sup>
Second moment of area I <sub>y</sub>	3,9260e-06	m <sup>4</sup>
Second moment of area I <sub>z</sub>	1,3318e-06	m <sup>4</sup>
Torsional constant I <sub>t</sub>	3,2602e-06	m <sup>4</sup>
Method for equivalent moment factor C <sub>my,0</sub>	Table A.2 Line 2 (General)	
Design bending moment (maximum) M <sub>y,Ed</sub>	-1,52	kNm
Maximum relative deflection δ <sub>z</sub>	-1,1	mm
Equivalent moment factor C <sub>my,0</sub>	0,99	
Method for equivalent moment factor C <sub>mz,0</sub>	Table A.2 Line 2 (General)	
Design bending moment (maximum) M <sub>z,Ed</sub>	-0,07	kNm
Maximum relative deflection δ <sub>y</sub>	-0,2	mm
Equivalent moment factor C <sub>mz,0</sub>	0,44	
Factor μ <sub>y</sub>	0,98	
Factor μ <sub>z</sub>	0,43	
Factor ε <sub>y</sub>	0,48	
Factor a <sub>LT</sub>	0,17	
Critical moment for uniform bending M <sub>cr,0</sub>	110,39	kNm
Relative slenderness λ <sub>rel,0</sub>	0,47	
Limit relative slenderness λ <sub>rel,0,lim</sub>	0,22	
Equivalent moment factor C <sub>my</sub>	0,99	
Equivalent moment factor C <sub>mz</sub>	0,44	
Equivalent moment factor C <sub>mLT</sub>	1,00	
Factor b <sub>LT</sub>	0,00	
Factor c <sub>LT</sub>	0,00	
Factor d <sub>LT</sub>	0,00	
Factor e <sub>LT</sub>	0,00	
Factor w <sub>y</sub>	1,25	
Factor w <sub>z</sub>	1,00	
Factor η <sub>pl</sub>	0,16	
Maximum relative slenderness λ <sub>rel,max</sub>	1,98	
Factor C <sub>yy</sub>	0,80	
Factor C <sub>yz</sub>	1,00	
Factor C <sub>zy</sub>	0,54	
Factor C <sub>zz</sub>	1,00	

Unity check (6.61) =  $0,21 + 0,08 + 0,00 = 0,30$  -

Unity check (6.62) =  $0,80 + 0,03 + 0,00 = 0,84$  -

The member satisfies the stability check.

Student version

Student version

Student version



60x60x4

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS28 - CFRHS60X60X4

**EN 1993-1-1 Code Check**

National annex: Standard EN

<b>Member B470</b>	<b>0,000 / 1,500 m</b>	<b>CFRHS60X60X4</b>	<b>S 355</b>	<b>ULS-Set B (auto)</b>	<b>0,92 -</b>
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Note: EN 1993-1-3 article 1.1(3) specifies that this part does not apply to cold formed CHS and RHS sections. The default EN 1993-1-1 code check is executed instead of the EN 1993-1-3 code check.

**Combination key**

ULS-Set B (auto) / 1.35\*LC1 + 0.90\*Snjeg + 1.35\*Dodatno stalno + 1.50\*3DWind10 + 0.90\*temp +

**Partial safety factors**

$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

**Material**

Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Cold formed	

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

The critical check is on position 0,000 m

Internal forces	Calculated	Unit
$N_{Ed}$	-126,59	kN
$V_{y,Ed}$	-1,31	kN
$V_{z,Ed}$	4,32	kN
$T_{Ed}$	-0,12	kNm
$M_{y,Ed}$	-1,02	kNm
$M_{z,Ed}$	0,90	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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	48	4	1,637e+05	2,634e+05	0,62		1,00	12,00	22,78	27,66	35,59	1
3	I	48	4	2,623e+05	1,502e+05	0,57		1,00	12,00	22,78	27,66	36,30	1
5	I	48	4	1,325e+05	3,288e+04	0,25		1,00	12,00	22,78	27,66	41,83	1
7	I	48	4	3,392e+04	1,461e+05	0,23		1,00	12,00	22,78	27,66	42,15	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	8,5500e-04	m <sup>2</sup>
$N_{c,Rd}$	303,52	kN
Unity check	0,42	-

**Bending moment check for  $M_y$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	1,7640e-05	m <sup>3</sup>
$M_{pl,y,Rd}$	6,26	kNm
Unity check	0,16	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	1,7640e-05	m <sup>3</sup>
$M_{pl,z,Rd}$	6,26	kNm
Unity check	0,14	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	4,2750e-04	m <sup>2</sup>
$V_{pl,y,Rd}$	87,62	kN
Unity check	0,01	-

**Shear check for  $V_z$**

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	4,2750e-04	m <sup>2</sup>
$V_{pl,z,Rd}$	87,62	kN
Unity check	0,05	-

**Torsion check**

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

Fibre	1	
$T_{Ed}$	5,0	MPa
$T_{Rd}$	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)

$M_{y,Rd}$	4,68	kNm
$\alpha$	2,07	
$M_{z,Rd}$	4,68	kNm
$\beta$	2,07	

Unity check (6.41) = 0,04 + 0,03 = 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: 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]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\alpha}$ [-]	$\alpha$ [-]	c/t [-]	Class 1	Class 2	Class 3	Class
										Limit [-]	Limit [-]	Limit [-]	
1	I	48	4	1,537e+05	2,634e+05	0,62		1,00	12,00	22,78	27,66	35,59	1
3	I	48	4	2,523e+05	1,502e+05	0,57		1,00	12,00	22,78	27,66	36,30	1
5	I	48	4	1,325e+05	3,288e+04	0,25		1,00	12,00	22,78	27,66	41,83	1
7	I	48	4	3,392e+04	1,461e+05	0,23		1,00	12,00	22,78	27,66	42,15	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	1,500	1,500	m
Buckling factor k	1,00	0,52	
Buckling length $l_{cr}$	1,500	0,784	m
Critical Euler load $N_{cr}$	401,17	1469,04	kN
Slenderness $\lambda$	66,46	34,73	
Relative slenderness $\lambda_{rel}$	0,87	0,45	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	c	c	
Imperfection $\alpha$	0,49	0,49	
Reduction factor $\chi$	0,62	0,87	
Buckling resistance $N_{b,Rd}$	187,72	263,48	kN

**Flexural Buckling verification**

Cross-section area A	8,5500e-04	m <sup>2</sup>
Buckling resistance $N_{b,Rd}$	187,72	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	8,5500e-04	m <sup>2</sup>
Plastic section modulus $W_{pl,y}$	1,7640e-05	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	1,7640e-05	m <sup>3</sup>
Design compression force $N_{Ed}$	126,59	kN
Design bending moment (maximum) $M_{y,Ed}$	-1,02	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,90	kNm
Characteristic compression resistance $N_{Rk}$	303,52	kN
Characteristic moment resistance $M_{y,Rk}$	6,26	kNm
Characteristic moment resistance $M_{z,Rk}$	6,26	kNm
Reduction factor $\chi_y$	0,62	
Reduction factor $\chi_z$	0,87	
Reduction factor $\chi_{l,T}$	1,00	
Interaction factor $k_{yy}$	0,98	
Interaction factor $k_{yz}$	0,60	
Interaction factor $k_{zy}$	0,77	
Interaction factor $k_{zz}$	0,99	

Maximum moment  $M_{y,Ed}$  is derived from beam B470 position 0,000 m.  
Maximum moment  $M_{z,Ed}$  is derived from beam B470 position 0,000 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	401,17	kN
Critical Euler load $N_{cr,z}$	1469,04	kN
Elastic critical load $N_{cr,T}$	57827,38	kN
Plastic section modulus $W_{pl,y}$	1,7640e-05	m <sup>3</sup>
Elastic section modulus $W_{el,y}$	1,4520e-05	m <sup>3</sup>
Plastic section modulus $W_{pl,z}$	1,7640e-05	m <sup>3</sup>
Elastic section modulus $W_{el,z}$	1,4520e-05	m <sup>3</sup>
Second moment of area $I_y$	4,3550e-07	m <sup>4</sup>
Second moment of area $I_z$	4,3550e-07	m <sup>4</sup>
Torsional constant $I_t$	7,2640e-07	m <sup>4</sup>
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-1,02	kNm
Maximum relative deflection $\delta_z$	-1,2	mm
Equivalent moment factor $C_{my,0}$	0,83	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	0,90	kNm
Maximum relative deflection $\delta_y$	0,4	mm
Equivalent moment factor $C_{mz,0}$	0,93	
Factor $\mu_y$	0,85	
Factor $\mu_z$	0,99	
Factor $e_y$	0,47	
Factor $a_{l,T}$	0,00	
Critical moment for uniform bending $M_{cr,0}$	153,73	kNm
Relative slenderness $\lambda_{rel,0}$	0,20	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,28	
Equivalent moment factor $C_{my}$	0,83	
Equivalent moment factor $C_{mz}$	0,93	
Equivalent moment factor $C_{m,T}$	1,00	
Factor $b_{l,T}$	0,00	
Factor $c_{l,T}$	0,00	
Factor $d_{l,T}$	0,00	
Factor $e_{l,T}$	0,00	
Factor $w_y$	1,21	
Factor $w_z$	1,21	
Factor $\eta_{pl}$	0,42	
Maximum relative slenderness $\lambda_{rel,max}$	0,87	
Factor $C_{yy}$	1,05	
Factor $C_{yz}$	0,87	
Factor $C_{zy}$	0,93	
Factor $C_{zz}$	1,01	

Unity check (6.61) = 0,67 + 0,16 + 0,09 = 0,92 -

Unity check (6.62) = 0,48 + 0,12 + 0,14 = 0,75 -

The member satisfies the stability check.

Student version

## 5.3. Dimenzioniranje podrožnice

IPE160A

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: All  
 Filter: Cross-section = CS9 - IPE160A

**EN 1993-1-1 Code Check**

National annex: Standard EN

Member B2581	7,883 / 7,883 m	IPE160A	S 355	ULS-Set B (auto)	0,80 -
--------------	-----------------	---------	-------	------------------	--------

**Combination key**

ULS-Set B (auto) / 1.35\*LC1 + 0.90\*Snjeg + 1.35\*Dodatno  
 stalno + 1.50\*3DWind14 + 0.90\*temp +

**Partial safety factors**

$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ 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 7,883 m

Internal forces	Calculated	Unit
$N_{Ed}$	-19,96	kN
$V_{y,Ed}$	-0,02	kN
$V_{z,Ed}$	-0,83	kN
$T_{Ed}$	0,00	kNm
$M_{y,Ed}$	-1,25	kNm
$M_{z,Ed}$	-0,09	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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\psi$ [-]	$k_{\sigma}$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	30	6	2,787e+04	3,274e+04	0,85	0,44	1,00	5,08	7,32	8,14	11,36	1
3	SO	30	6	2,430e+04	1,943e+04	0,80	0,51	1,00	5,08	7,32	8,14	12,17	1
4	I	127	4	2,391e+04	7,612e+02	0,03		1,00	31,80	22,78	27,66	46,56	3
5	SO	30	6	-3,199e+03	-8,067e+03								
7	SO	30	6	3,715e+02	5,240e+03	0,07	0,56	1,00	5,08	7,32	8,14	12,73	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 $\epsilon$	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 $c/t_w$	31,80
Flange slenderness ratio $c/t_f$	5,08
Reference slenderness ratio $c/t_{ref,y}$	0,00
Reference slenderness ratio $c/t_{ref,z}$	0,00
Interpolated section modulus $W_{3,y}$	9,9100e-05 m <sup>3</sup>
Interpolated section modulus $W_{3,z}$	2,0700e-05 m <sup>3</sup>

**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	1,6200e-03	m <sup>2</sup>
$N_{y,Rd}$	575,10	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)

$W_{3,y}$	9,9100e-05	m <sup>3</sup>
$M_{3,y,Rd}$	35,18	kNm
Unity check	0,04	-

**Bending moment check for  $M_z$** 

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{3,z}$	2,0700e-05	m <sup>3</sup>
$M_{3,z,Rd}$	7,35	kNm
Unity check	0,01	-

**Shear check for  $V_y$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	1,0196e-03	m <sup>2</sup>
$V_{pl,y,Rd}$	208,98	kN
Unity check	0,00	-

**Shear check for  $V_z$** 

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

$\eta$	1,20	
$A_v$	7,8220e-04	m <sup>2</sup>
$V_{pl,z,Rd}$	160,32	kN
Unity check	0,01	-

**Torsion check**

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

Fibre	2	
$T_{Ed}$	0,0	MPa
$T_{Rd}$	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)

$M_{3,y,Rd}$	33,96	kNm
$\alpha$	2,00	
$M_{3,z,Rd}$	7,34	kNm
$\beta$	1,00	

Unity check (6.41) =  $0,00 + 0,01 = 0,01$

**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: 7,883 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 &amp; 2

Id	Type	c [mm]	t [mm]	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\Psi$ [-]	$k_\sigma$ [-]	$\alpha$ [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class [-]
1	SO	30	6	2,787e+04	3,274e+04	0,85	0,44	1,00	5,08	7,32	8,14	11,36	1
3	SO	30	6	2,430e+04	1,943e+04	0,80	0,51	1,00	5,08	7,32	8,14	12,17	1
4	I	127	4	2,391e+04	7,612e+02	0,03		1,00	31,80	22,78	27,66	46,56	3
5	SO	30	6	-3,199e+03	-8,067e+03								
7	SO	30	6	3,715e+02	5,240e+03	0,07	0,56	1,00	5,08	7,32	8,14	12,73	1

**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	7,883	7,883	m
Buckling factor k	1,00	0,81	
Buckling length $l_{cr}$	7,883	6,366	m
Critical Euler load $N_{cr}$	229,81	27,82	kN
Slenderness $\lambda$	120,87	347,41	
Relative slenderness $\lambda_{rel}$	1,58	4,55	
Limit slenderness $\lambda_{rel,0}$	0,20	0,20	
Buckling curve	a	b	
Imperfection $\alpha$	0,21	0,34	
Reduction factor $\chi$	0,34	0,05	
Buckling resistance $N_{b,Rd}$	195,47	25,88	kN

Flexural Buckling verification		
Cross-section area A	1,6200e-03	m <sup>2</sup>
Buckling resistance N <sub>b,Rd</sub>	25,88	kN
Unity check	0,77	-

**Torsional(-Flexural) Buckling check**

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

**Note:** For this I-section the Torsional(-Flexural) buckling resistance is higher than the resistance for Flexural buckling. Therefore Torsional(-Flexural) buckling is not printed on the output.

**Lateral Torsional Buckling check**

According to EN 1993-1-1 article 6.3.2.1 & 6.3.2.3 and formula (6.54)

LTB parameters		
Method for LTB curve	Alternative case	
Interpolated section modulus W <sub>3,y</sub>	9,9100e-05	m <sup>3</sup>
Elastic critical moment M <sub>cr</sub>	10,96	kNm
Relative slenderness λ <sub>rel,LT</sub>	1,79	
Limit slenderness λ <sub>rel,LT,0</sub>	0,40	

**Note:** The slenderness or bending moment is such that Lateral Torsional Buckling effects may be ignored according to EN 1993-1-1 article 6.3.2.2(4).

Mcr parameters		
LTB length l <sub>LT</sub>	7,883	m
Influence of load position	no influence	
Correction factor k	1,00	
Correction factor k <sub>sw</sub>	1,00	
LTB moment factor C <sub>1</sub>	1,98	
LTB moment factor C <sub>2</sub>	0,81	
LTB moment factor C <sub>3</sub>	0,41	
Shear center distance d <sub>z</sub>	0	mm
Distance of load application z <sub>0</sub>	0	mm
Mono-symmetry constant β <sub>y</sub>	0	mm
Mono-symmetry constant z <sub>1</sub>	0	mm

**Note:** C parameters are determined according to ECCS 119 2006 / Galea 2002.

**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	1,6200e-03	m <sup>2</sup>
Interpolated section modulus W <sub>3,y</sub>	9,9100e-05	m <sup>3</sup>
Interpolated section modulus W <sub>3,z</sub>	2,0700e-05	m <sup>3</sup>
Design compression force N <sub>Ed</sub>	19,96	kN
Design bending moment (maximum) M <sub>y,Ed</sub>	-1,25	kNm
Design bending moment (maximum) M <sub>z,Ed</sub>	-0,09	kNm
Characteristic compression resistance N <sub>Rk</sub>	575,10	kN
Characteristic moment resistance M <sub>y,Rk</sub>	35,18	kNm
Characteristic moment resistance M <sub>z,Rk</sub>	7,35	kNm
Reduction factor χ <sub>y</sub>	0,34	
Reduction factor χ <sub>z</sub>	0,05	
Modified reduction factor χ <sub>LT,mod</sub>	1,00	
Interaction factor k <sub>yy</sub>	2,11	
Interaction factor k <sub>yz</sub>	0,71	
Interaction factor k <sub>zy</sub>	0,65	
Interaction factor k <sub>zz</sub>	0,31	

Maximum moment M<sub>y,Ed</sub> is derived from beam B2581 position 7,883 m.

Maximum moment M<sub>z,Ed</sub> is derived from beam B2581 position 7,883 m.

Interaction method 1 parameters		
Critical Euler load N <sub>cr,y</sub>	229,81	kN
Critical Euler load N <sub>cr,z</sub>	27,82	kN
Elastic critical load N <sub>cr,T</sub>	367,44	kN
Interpolated section modulus W <sub>3,y</sub>	9,9100e-05	m <sup>3</sup>
Elastic section modulus W <sub>el,y</sub>	8,7800e-05	m <sup>3</sup>
Interpolated section modulus W <sub>3,z</sub>	2,0700e-05	m <sup>3</sup>
Elastic section modulus W <sub>el,z</sub>	1,3300e-05	m <sup>3</sup>
Second moment of area I <sub>y</sub>	6,8900e-06	m <sup>4</sup>
Second moment of area I <sub>z</sub>	5,4400e-07	m <sup>4</sup>
Torsional constant I <sub>t</sub>	1,9600e-08	m <sup>4</sup>
Method for equivalent moment factor C <sub>my,0</sub>	Table A.2 Line 2 (General)	
Design bending moment (maximum) M <sub>y,Ed</sub>	-1,25	kNm
Maximum relative deflection δ <sub>z</sub>	-2,7	mm
Equivalent moment factor C <sub>my,0</sub>	0,96	
Method for equivalent moment factor C <sub>mz,0</sub>	Table A.2 Line 1 (Linear)	
Ratio of end moments η <sub>z</sub>	-0,86	
Equivalent moment factor C <sub>mz,0</sub>	0,30	
Factor μ <sub>y</sub>	0,94	
Factor μ <sub>z</sub>	0,29	



Interaction method 1 parameters		
Factor $\beta_{yT}$	1,16	
Factor $\alpha_{1T}$	1,00	
Critical moment for uniform bending $M_{cr,C}$	5,53	kNm
Relative slenderness $\lambda_{rel,0}$	2,52	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,20	
Equivalent moment factor $C_{my}$	0,98	
Equivalent moment factor $C_{mz}$	0,30	
Equivalent moment factor $C_{m1T}$	1,85	
Factor $b_{1T}$	0,00	
Factor $q_{1T}$	0,01	
Factor $d_{1T}$	0,00	
Factor $e_{1T}$	0,00	
Factor $w_y$	1,13	
Factor $w_z$	1,50	
Factor $\eta_{pl}$	0,03	
Maximum relative slenderness $\lambda_{rel,max}$	4,55	
Factor $C_{yy}$	0,89	
Factor $C_{yz}$	0,97	
Factor $C_{zy}$	0,46	
Factor $C_{zz}$	0,99	

Unity check (6.61) =  $0,10 + 0,08 + 0,01 = 0,19$  -

Unity check (6.62) =  $0,77 + 0,02 + 0,00 = 0,80$  -

#### 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 $a$	7,883	m
Web	unstiffened	
Web height $h_w$	145	mm
Web thickness $t$	4	mm
Material coefficient $\epsilon$	0,81	
Shear correction factor $\eta$	1,20	

#### Shear Buckling verification

Web slenderness $h_w/t$	36,30
Web slenderness limit	48,82

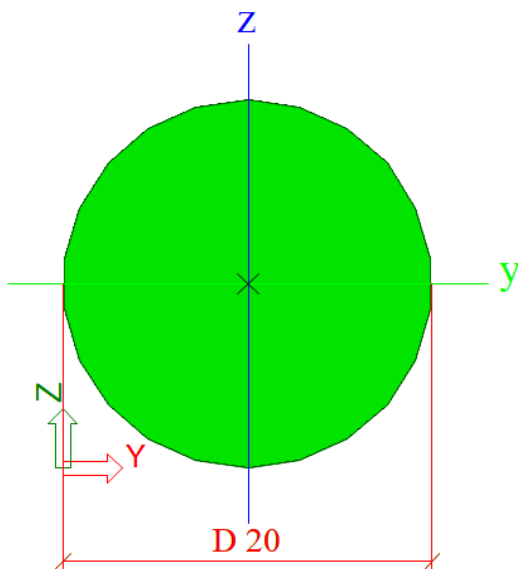
**Note:** The web slenderness is such that Shear Buckling effects may be ignored according to EN 1993-1-5 article 5.1(2).

The member satisfies the stability check.

Student version

## 5.4. Dimenzioniranje sprega

Spreg je zbog nemogućnosti dimenzioniranja nelinearnim proračunom proračunat na način da je izvršena provjera na najveću vlačnu silu.



Slika 5.4.1 Poprečni presjek sprega

**Internal forces on member**

Linear calculation, Extreme : Global, System : Principal

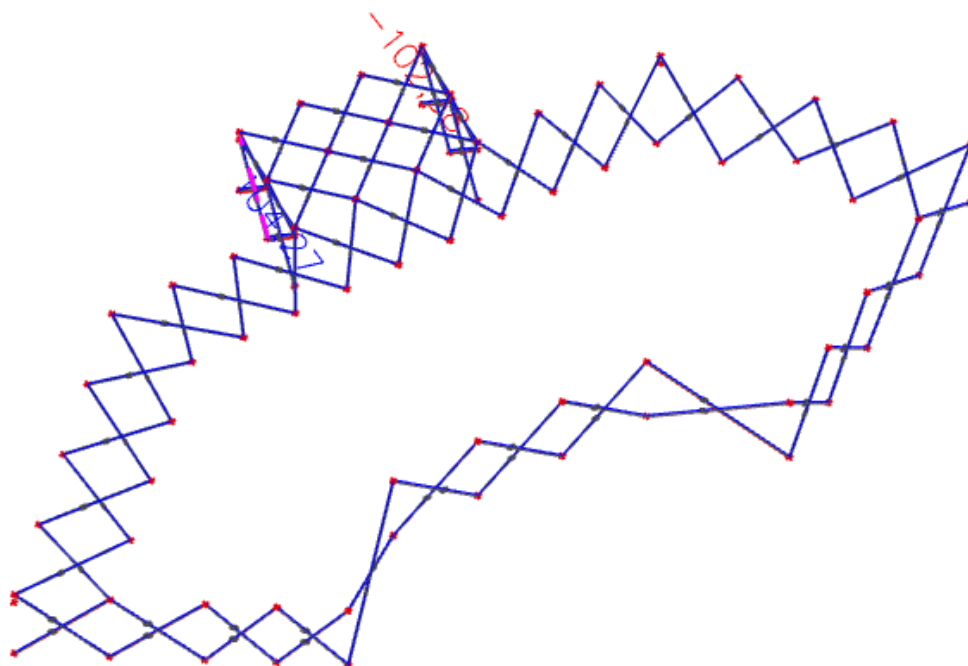
Selection : All

Combinations : ULS-Set B (auto)

Cross-section : CS10 - RD20

Member	css	dx [m]	Case	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
B2702	CS10 - RD20	11,180	ULS-Set B (auto)/16	<b>-102,38</b>	0,00	0,00	0,00	0,00	0,00
B2677	CS10 - RD20	11,180	ULS-Set B (auto)/17	<b>104,27</b>	0,00	0,00	0,00	0,00	0,00
B2615	CS10 - RD20	0,000	ULS-Set B (auto)/18	-1,86	<b>0,00</b>	<b>0,00</b>	<b>0,00</b>	<b>0,00</b>	<b>0,00</b>

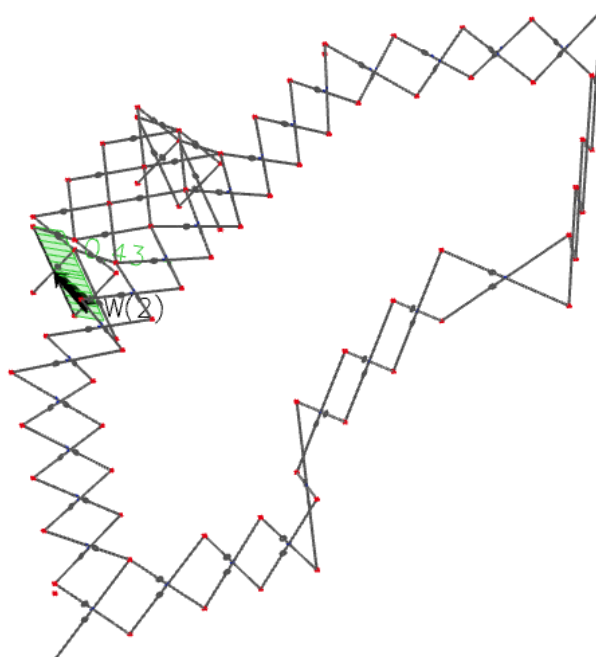




Slika 5.4.2 Maksimalna uzdužna sila u spregu

**EC-EN 1993 Steel check ULS**

Values: **UC<sub>Overall</sub>**  
 Linear calculation  
 Combination: ULS-Set B (auto)16  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: B2677  
 Filter: Cross-section = CS10 - RD20  
 There are 2 warnings on selected members. 2 of them are shown.



Slika 5.4.3 Iskorištenost sprega

**EC-EN 1993 Steel check ULS**

Linear calculation  
 Combination: ULS-Set B (auto)16  
 Coordinate system: Principal  
 Extreme 1D: Global  
 Selection: B2677  
 Filter: Cross-section = CS10 - RD20

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

<b>Member B2677</b>	<b>11,180 / 11,180 m</b>	<b>RD20</b>	<b>S 355</b>	<b>ULS-Set B (auto)16</b>	<b>0,43 -</b>
---------------------	--------------------------	-------------	--------------	---------------------------	---------------

<b>Combination key</b>
ULS-Set B (auto)16 / 1.35*LC1 + 1.35*Dodatno stalno + 0.90*3DWind9

<b>Partial safety factors</b>	
$\gamma_{M0}$ for resistance of cross-sections	1,00
$\gamma_{M1}$ for resistance to instability	1,00
$\gamma_{M2}$ for resistance of net sections	1,25

<b>Material</b>		
Yield strength $f_y$	355,0	MPa
Ultimate strength $f_u$	490,0	MPa
Fabrication	Rolled	

**Warning:** Strength reduction in function of the thickness is not supported for this type of cross-section.

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

The critical check is on position 11,180 m

Internal forces	Calculated	Unit
$N_{Ed}$	48,07	kN
$V_{y,Ed}$	0,00	kN
$V_{z,Ed}$	0,00	kN
$T_{Ed}$	0,00	kNm
$M_{y,Ed}$	0,00	kNm
$M_{z,Ed}$	0,00	kNm

**Classification for cross-section design**

**Warning:** Classification is not supported for this type of cross-section.  
 The section is checked as elastic, class 3.

**Tension check**

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

A	3,1400e-04	m <sup>2</sup>
$N_{pl,Rd}$	111,47	kN
$N_{u,Rd}$	110,78	kN
$N_{t,Rd}$	110,78	kN
Unity check	0,43	-

The member satisfies the section check.

Student version

## 6. Spojevi

### 6.1. Spoj stup temelj

#### Steel connection

Name	Conn
Node	N393
Connection type	Frame bolted
Connection geometry	Column base
Calculation type	Internal forces
Lc/Combi	ULS-Set B (auto)

Connected beams

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B660	CS26 - HEA550	S 355	10,000	N393	N392	column (100)

#### Parts of connection

Bolts

M30 - 5.6 (ISO 4014, ISO 4032, ISO 7089)			
Name		Bolt pattern	2 bolts/row
Internal bolts distance [mm]	200	External bolts distance [mm]	
Length [mm]	1340	Reference	Bottom of the end plate
1.Location [mm]	775	2.Location [mm]	606
7.Location [mm]	234	8.Location [mm]	65

End-plate

EP			
Material	S 355	Left extension [mm]	200
Thickness[mm]	25	Right extension [mm]	200
Input	Top/Bottom/Left/Right	Total width [mm]	700
Top extension [mm]	150	Total height [mm]	840
Bottom extension [mm]	150		

#### Connection analysis: Side [B660]

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

ULS-Set B (auto)	
N <sub>Ed</sub>	-65.00 kN
V <sub>z,Ed</sub>	-54.38 kN
M <sub>y,Ed</sub>	341.69 kNm

Left side in Compression, Right side in Tension.

.....STRONG-AXIS CALCULATION:...

#### 2. T-stub in compression

According to EN 1993-1-8 Article 6.2.5

Bearing width data		
α	1.50	-
β <sub>j</sub>	0.60	-
f <sub>cd</sub>	16.67	MPa
f <sub>j</sub>	15.00	MPa
c	70.22	mm

#### 3. Design moment resistance M<sub>j,y</sub>,R<sub>d</sub>

##### 3.1. Design resistance of basic components

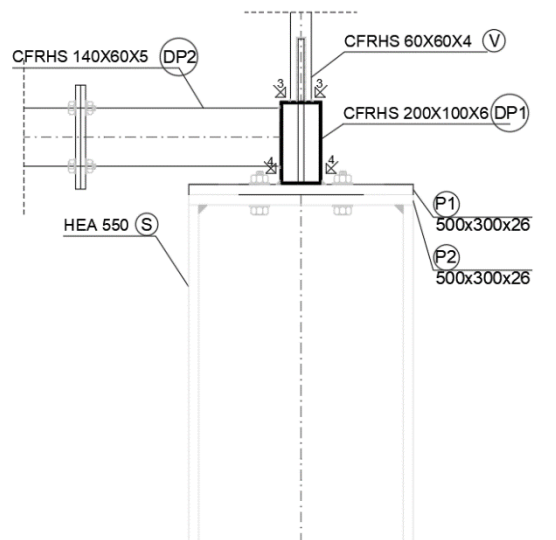
##### 3.1.1. Column flange and web in compression - Left side

According to EN 1993-1-8 Article 6.2.6.7

F <sub>c,fb</sub> ,R <sub>d</sub> data		
Section class	1	
M <sub>c,Rd</sub>	1641.88	kNm
h <sub>b</sub> -t <sub>fb</sub>	516.00	mm
F <sub>c,fb,Rd</sub>	3181.93	kN

##### 3.1.2. Concrete in compression under the left column flange

According to EN 1993-1-8 Article 6.2.6.9



Fc,pl,Rd data		
beff	164.44	mm
leff	440.44	mm
Aeff	72423.43	mm <sup>2</sup>
Fc,pl,Rd	1086.35	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	561.00	mm <sup>2</sup>
k2	0.90	-
Beta	0.85	-
Ft,Rd	171.67	kN
Lb	311.80	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 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 right 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
2	44.16	-	497.77	✓	-	Bolt-row adjacent to beam flange
1	-	-	-	-	-	Bolt-row outside of beam

row	p (p1+p2)	e	ex	m	mx	n	λ1U	λ2U	αU	λ1L	λ2L	αL
2	0.00+186.00	250.00	-	84.70	-	105.87	0.25	0.13	8.00	-	-	-
1	0.00+0.00	250.00	64.80	-	69.36	64.80	-	-	-	-	-	-

row	leff,cp,i	leff,nc,i
2	532.18	677.59
1	347.50	279.22

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
2	532.18	677.59	361.57	✓	1583.57	585.18	343.33	343.33
1	279.22	279.22	378.45	✓	1068.13	396.72	343.33	343.33

row	beff,t,wb	Ft,wb,Rd,i
2	532.18	2361.55
1	-	-

#### 3.1.4.1. Base plate in bending under the right column flange

row	Ft,pl,Rd,i	Ft,pl,Rd,g	Ft,pl,Rd,r
2	343.33	-	343.33
1	343.33	-	343.33

Ft,pl,Rd = 686.66 kN

#### 3.1.4.2. Column web in tension under the right column flange

row	Ft,wc,Rd,i	Ft,wc,Rd,g	Ft,wc,Rd,r
2	2361.55	-	2361.55
1	-	-	-

Ft,wc,Rd = 2361.55 kN

### 3.2. Determination of Mj,y,Rd

According to EN 1993-1-8 Article 6.2.8.3 Table 6.7

Mj,Rd data		
FC,l,Rd	1086.35	kN
zC,l	258.00	mm
FT,r,Rd	686.66	kN
zT,r	270.60	mm
z	528.60	mm
e	5257.15	mm

Mj,y,Rd = 381.70 kNm

### 4. Design shear resistance VRd

Vz,Rd data		
Vz,Rd	628.32	kN
Fv,Rd	78.54	kN
e1,ep	64.80	mm
p1	169.20	mm
Alfa d plate	0.65	
Alfa b plate	0.65	

Vz,Rd data		
Fb,ep,Rd	481.09	kN
Alfa_b (6.2) plate	0.35	
F1,yb,Rd	134.64	kN
F2,yb,Rd	78.54	kN

## 5. Stiffness calculation

### 5.1. Design rotational stiffness

According to EN 1993-1-8 Article 6.3.4  
Bolt-rows under the right column flange

row	k15[mm]	k16[mm]	keff[mm]
2	11.63	2.88	2.31
1	11.11	2.88	2.29

Sj data		
kC,l	20.82	mm
zC,l	258.00	mm
kT,r	4.59	mm
zT,r	270.60	mm
z	528.60	mm
ek	-162.54	mm
e	5257.15	mm
Sj,ini	227.61	MNm/rad
mu	2.22	
Sj	102.71	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	1120000000.00	mm <sup>4</sup>
Lc	10000.00	mm
λ0,rel	0.57	-
Sj,ini limit	22.85	MNm/rad

System RIGID

### 5.3. Ductility classification

In the endplate we have the following :  
 $t > 0.53 \sqrt{f_{ub}/f_y}$  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	1.20	MPa
good bond condition	no	-
μ1	0.70	-
μ2	1.00	-
fbd	1.89	MPa
Ft,bolt	171.67	kN
As,prov	561.00	mm <sup>2</sup>
As,req	572.22	mm <sup>2</sup>
σ,sd	306.00	MPa
lb,rqd	1217.35	mm
bar shape	Straight	-
α1	1.00	-
lbd	1217.35	mm

Anchorage data - straight		
d	30.00	mm
lbd,c	966.15	mm

Anchorage data		
lbd	1217.35	mm
lbd,c	966.15	mm
lb,min	365.20	mm
lbd	1217.35	mm

### 6.2. Calculation weldsize

#### 6.2.1. Calculation af

data		
Mj,y,Rd	146.79	kNm
α	1.40	
h	516.00	mm
FRd	398.27	kN

data		
Nt,Rd	2556.00	kN
fu	490.00	MPa
$\beta_w$	0.90	
minimum af	13.83	mm
af	14.00	mm

**6.2.2. Calculation aw**

data		
Ft	686.66	kN
Fv	13.74	kN
lw	1075.89	mm
fu	490.00	MPa
$\beta_w$	0.90	
minimum aw (a2)	7.20	mm
aw	8.00	mm

....:RESULTS:...

**7. Unity checks**

Unity checks	
My,Ed/Mj,y,Rd	0.90
Vz,Ed/Vz,Rd	0.09

The connection satisfies.

**Moment-rotation diagram: Side [B660] - Strong axis**



**Stiffness classification: Side [B660] - Strong axis**





## 6.2 Vlačni nastavak rešetke

**Project:**  
**Project no:**  
**Author:**

**Project data**

Project name  
Project number  
Author  
Description  
Date 27.6.2019.  
Design code EN

**Material**

Steel S 355

Project:  
Project no:  
Author:



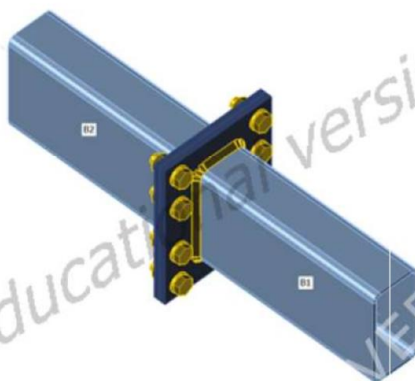
### Project item CON1

#### Design

Name: CON1  
Description:  
Analysis: Stress, strain/ loads in equilibrium

#### Beams and columns

Name	Cross-section	$\beta$ - Direction [°]	$\gamma$ - Pitch [°]	$\alpha$ - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
B1	1 - RHSCF200/100/6.0	0,0	0,0	0,0	0	0	0	Node
B2	2 - RHSCF200/100/6.0	180,0	0,0	0,0	0	0	0	Node



#### Cross-sections

Name	Material
1 - RHSCF200/100/6.0	S 355
2 - RHSCF200/100/6.0	S 355

#### Bolts

Name	Bolt assembly	Diameter [mm]	$f_u$ [MPa]	Gross area [mm <sup>2</sup> ]
M20 6.8	M20 6.8	20	600,0	314

Project:  
Project no:  
Author:



#### Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	B1	354,6	0,4	1,3	-0,3	5,2	-1,0
	B2	354,6	0,4	-1,3	-0,3	5,2	1,0

#### Check

##### Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	1,1 < 5%	OK
Bolts	92,7 < 100%	OK
Welds	98,2 < 100%	OK
Buckling	Not calculated	

##### Plates

Name	Thickness [mm]	Loads	$\sigma_{Ed}$ [MPa]	$\epsilon_{pl}$ [%]	Status
B1	6,0	LE1	325,0	1,1	OK
B2	6,0	LE1	325,0	1,1	OK
PP1a	12,0	LE1	324,0	0,6	OK
PP1b	12,0	LE1	324,0	0,6	OK

##### Design data

Material	$f_y$ [MPa]	$\epsilon_{lim}$ [%]
S 355	355,0	5,0

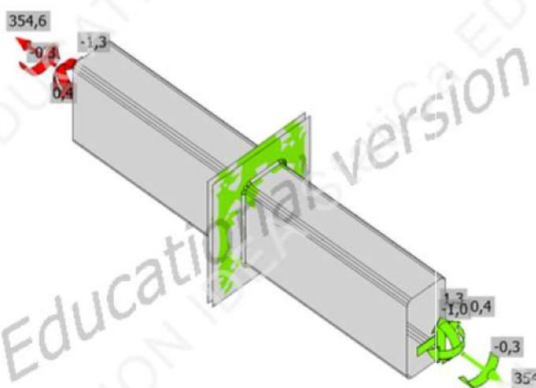
##### Symbol explanation

$\epsilon_{pl}$	Strain
$\sigma_{Ed}$	Eq. stress
$f_y$	Yield strength
$\epsilon_{lim}$	Limit of plastic strain

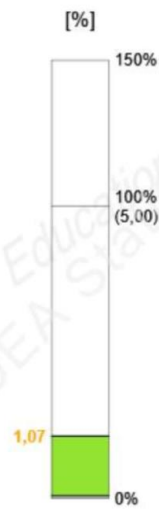
Project:  
Project no:  
Author:



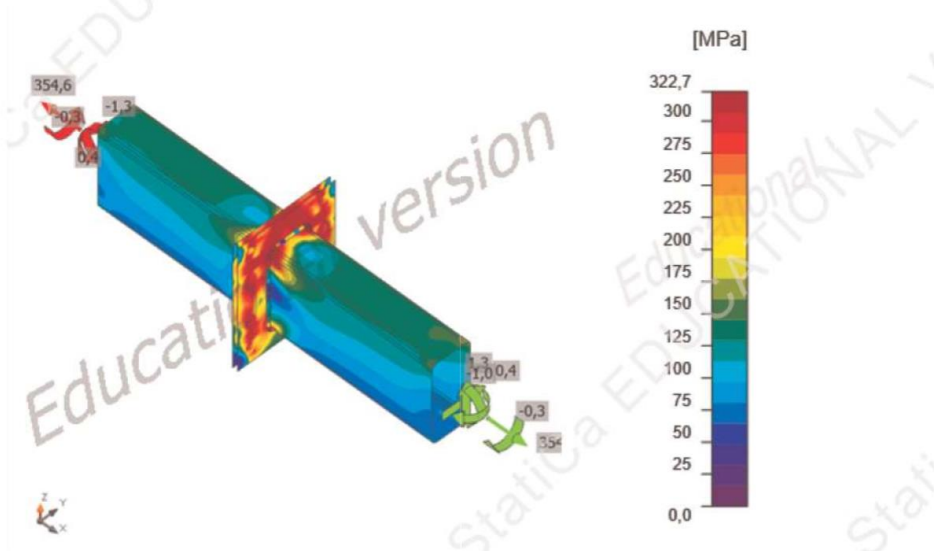
Overall check, LE1



Strain check, LE1



Project:  
Project no:  
Author:



Equivalent stress, LE1

**Bolts**

	Name	Loads	$F_{t,Ed}$ [kN]	V [kN]	$U_{t_t}$ [%]	$F_{b,Rd}$ [kN]	$U_{t_s}$ [%]	$U_{t_{ts}}$ [%]	Status
	B1	LE1	89,6	0,3	84,6	95,1	0,3	60,8	OK
	B2	LE1	89,1	0,5	84,1	141,9	0,5	60,6	OK
	B3	LE1	98,2	0,1	92,7	110,8	0,1	66,4	OK
	B4	LE1	96,3	0,3	90,9	234,1	0,3	65,3	OK
	B5	LE1	75,1	0,2	70,9	100,3	0,2	50,9	OK
	B6	LE1	66,4	0,5	62,7	118,5	0,6	45,4	OK
	B7	LE1	91,9	0,0	86,9	228,5	0,0	62,1	OK
	B8	LE1	90,1	0,3	85,2	161,6	0,4	61,2	OK

**Design data**

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M20 6.8 - 1	105,8	297,2	90,4

Project:  
Project no:  
Author:



#### 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 $V_y, V_z$ 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
$U_t$	Utilization in tension
$U_s$	Utilization in shear
$U_{ts}$	Utilization in tension and shear EN 1993-1-8 table 3.4

#### Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	$\epsilon_{pl}$ [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	$U_t$ [%]	$U_{tc}$ [%]	Status
PP1a	B1	7,0	555	LE1	427,5	0,4	338,6	56,8	-139,6	98,2	44,0	OK
PP1b	B2	7,0	555	LE1	427,5	0,4	338,5	-57,5	-139,3	98,2	43,9	OK

#### Design data

	$\beta_w$ [-]	$\sigma_{w,Rd}$ [MPa]	$0.9 \sigma$ [MPa]
S 355	0,90	435,6	352,8

#### Symbol explanation

$\epsilon_{pl}$	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
$0.9 \sigma$	Perpendicular stress resistance - $0.9 \cdot f_u / \gamma_{M2}$
$\beta_w$	Correlation factor EN 1993-1-8 tab. 4.1
$U_t$	Utilization
$U_{tc}$	Weld capacity utilization

#### Buckling

Buckling analysis was not calculated.

#### Code settings

Item	Value	Unit	Reference
$\gamma_{M0}$	1,10	-	EN 1993-1-1: 6.1
$\gamma_{M1}$	1,00	-	EN 1993-1-1: 6.1
$\gamma_{M2}$	1,25	-	EN 1993-1-1: 6.1
$\gamma_{M3}$	1,25	-	EN 1993-1-8: 2.2
$\gamma_C$	1,50	-	EN 1992-1-1: 2.4.2.4
$\gamma_{inst}$	1,20	-	ETAG 001-C: 3.2.1

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Project:  
Project no:  
Author:



Item	Value	Unit	Reference
Joint coefficient $\beta_j$	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 $a_b$ 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

## 6.3 Tlačni nastavak rešetke

Project:

Project no:

Author:



### Project data

Project name

Project number

Author

Description

Date 27.6.2019.

Design code EN

### Material

Steel S 355

Project:  
Project no:  
Author:



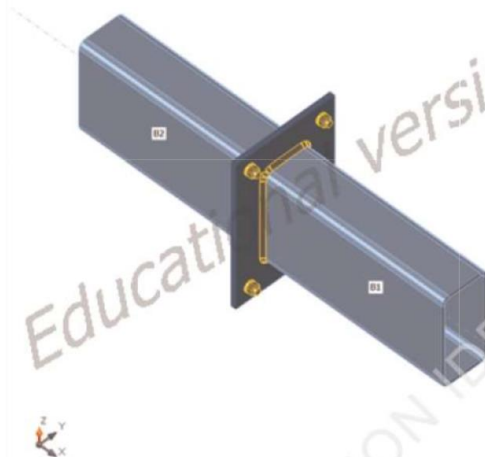
### Project item Spoj resetke

#### Design

Name Spoj resetke  
Description  
Analysis Stress, strain/ loads in equilibrium

#### Beams and columns

Name	Cross-section	$\beta$ - Direction [°]	$\gamma$ - Pitch [°]	$\alpha$ - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
B1	1 - RHSCF200/100/6.0	0,0	0,0	0,0	0	0	0	Node
B2	1 - RHSCF200/100/6.0	180,0	0,0	0,0	0	0	0	Node



#### Cross-sections

Name	Material
1 - RHSCF200/100/6.0	S 355

#### Bolts

Name	Bolt assembly	Diameter [mm]	$f_u$ [MPa]	Gross area [mm <sup>2</sup> ]
M12 5.6	M12 5.6	12	500,0	113

#### Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	B1	-472,9	-2,1	-7,0	0,3	5,4	-3,0
	B2	-472,9	-2,1	7,0	0,3	5,4	3,0

Project:  
Project no:  
Author:



## Check

### Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	0,0 < 5%	OK
Bolts	11,2 < 100%	OK
Welds	92,3 < 100%	OK
Buckling	Not calculated	

### Plates

Name	Thickness [mm]	Loads	$\sigma_{Ed}$ [MPa]	$\epsilon_{pl}$ [%]	Status
B1	6,0	LE1	256,5	0,0	OK
B2	6,0	LE1	278,4	0,0	OK
PP1a	5,0	LE1	37,4	0,0	OK
PP1b	5,0	LE1	37,2	0,0	OK

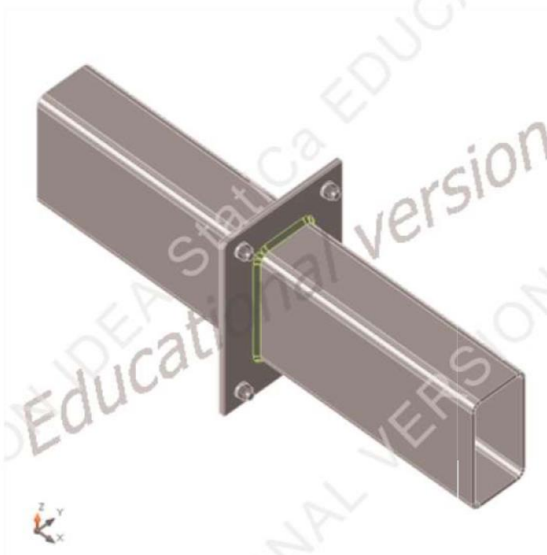
### Design data

Material	$f_y$ [MPa]	$\epsilon_{lim}$ [%]
S 355	355,0	5,0

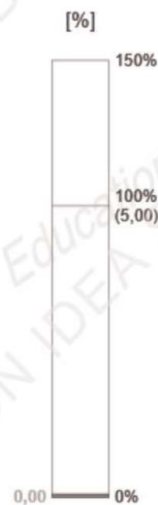
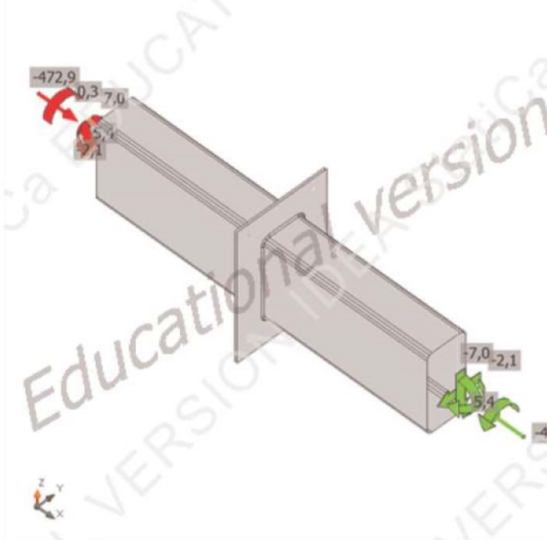
### Symbol explanation

$\epsilon_{pl}$	Strain
$\sigma_{Ed}$	Eq. stress
$f_y$	Yield strength
$\epsilon_{lim}$	Limit of plastic strain

Project:  
Project no:  
Author:

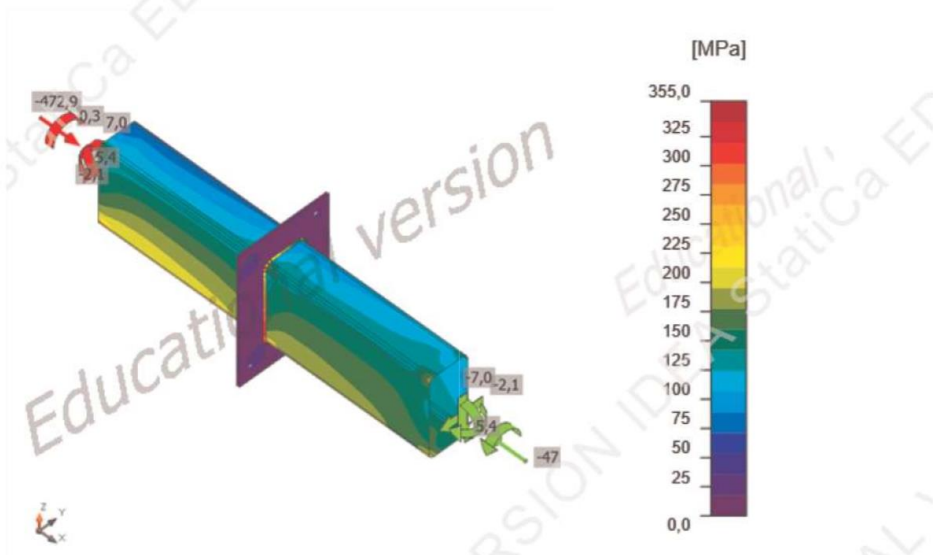


Overall check, LE1



Strain check, LE1

Project:  
Project no:  
Author:



Equivalent stress, LE1

**Bolts**

	Name	Loads	$F_{t,Ed}$ [kN]	V [kN]	$U_t$ [%]	$F_{b,Rd}$ [kN]	$U_s$ [%]	$U_{ts}$ [%]	Status
	B1	LE1	0,1	2,2	0,3	50,0	11,0	11,2	OK
	B2	LE1	0,1	1,8	0,2	54,2	8,6	8,8	OK
	B3	LE1	0,1	2,0	0,4	45,3	9,9	10,2	OK
	B4	LE1	0,1	1,5	0,3	45,3	7,2	7,4	OK

**Design data**

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M12 5.6 - 1	30,6	72,0	20,4

**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  $V_y, V_z$  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
- $U_t$  Utilization in tension
- $U_s$  Utilization in shear
- $U_{ts}$  Utilization in tension and shear EN 1993-1-8 table 3.4



Project:  
Project no:  
Author:



### Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	$\epsilon_{pI}$ [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut <sub>c</sub> [%]	Status
PP1a	B2	▲5,0	555	LE1	402,2	0,0	-230,8	-14,3	189,6	92,3	55,4	OK
PP1b	B1	▲5,0	555	LE1	400,6	0,0	-227,1	24,6	188,9	92,0	55,3	OK

### Design data

	$\beta_w$ [-]	$\sigma_{w,Rd}$ [MPa]	0.9 $\sigma$ [MPa]
S 355	0,90	435,6	352,8

### Symbol explanation

$\epsilon_{pI}$	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 $\sigma$	Perpendicular stress resistance - 0.9*fu/γM2
$\beta_w$	Correlation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Ut <sub>c</sub>	Weld capacity utilization

### Buckling

Buckling analysis was not calculated.

### Code settings

Item	Value	Unit	Reference
γ <sub>M0</sub>	1,00	-	EN 1993-1-1: 6.1
γ <sub>M1</sub>	1,00	-	EN 1993-1-1: 6.1
γ <sub>M2</sub>	1,25	-	EN 1993-1-1: 6.1
γ <sub>M3</sub>	1,25	-	EN 1993-1-8: 2.2
γ <sub>C</sub>	1,50	-	EN 1992-1-1: 2.4.2.4
γ <sub>inst</sub>	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient β <sub>j</sub>	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 a <sub>b</sub> in bearing check.	Yes		EN 1993-1-8: tab 3.4

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Project:

Project no:

Author:



Item	Value	Unit	Reference
Cracked concrete	Yes		
Local deformation check	No		
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1

## 6.4. Spoj ispuna donji pojas

**Project:**  
**Project no:**  
**Author:**



### Project data

Project name  
Project number  
Author  
Description  
Date 4.7.2019.  
Design code EN

### Material

Steel S 355

Project:  
Project no:  
Author:



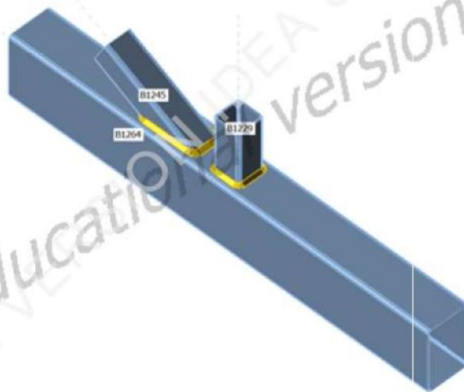
## Project item Con N624

### Design

Name Con N624  
Description  
Analysis Stress, strain/ loads in equilibrium

### Beams and columns

Name	Cross-section	$\beta$ - Direction [°]	$\gamma$ - Pitch [°]	$\alpha$ - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
B1229	1 - CFRHS50X50X3(RHS50x50)	0,0	-90,0	0,0	0	0	0	Position
B1245	1 - CFRHS50X50X3(RHS50x50)	180,0	-27,8	0,0	0	0	0	Position
B1264	2 - CFRHS120X80X3(RHS120x80)	0,0	0,0	0,0	0	0	0	Position



### Cross-sections

Name	Material
1 - CFRHS50X50X3(RHS50x50)	S 355
2 - CFRHS120X80X3(RHS120x80)	S 355

Project:  
Project no:  
Author:



## Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
ULS-Set(1)	B1229	-1,2	0,0	-0,6	0,0	0,2	0,0
	B1245	2,5	0,0	0,1	0,0	-0,1	0,0
	B1264	4,9	-0,4	-0,1	0,1	-0,1	-0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(2)	B1229	-9,8	0,0	0,1	0,0	0,0	0,0
	B1245	20,4	0,0	0,0	0,0	0,0	0,0
	B1264	28,3	-0,1	-0,2	-0,1	-0,2	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(3)	B1229	-6,9	0,0	0,1	0,0	0,0	0,0
	B1245	14,5	0,0	0,0	0,0	0,0	0,0
	B1264	2,3	0,1	-0,1	-0,1	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(4)	B1229	-1,4	0,0	-0,6	0,0	0,2	0,0
	B1245	2,8	0,0	0,1	0,0	-0,1	0,0
	B1264	33,0	-0,5	-0,1	0,1	-0,2	-0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(5)	B1229	-8,7	0,0	0,9	0,0	-0,2	0,0
	B1245	17,8	0,0	-0,1	0,0	0,0	0,0
	B1264	-58,9	0,3	-0,1	-0,2	-0,1	0,3
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(6)	B1229	-4,3	0,0	-0,3	0,0	0,1	0,0
	B1245	9,4	0,0	0,1	0,0	0,0	0,0
	B1264	58,3	0,0	-0,2	0,0	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(7)	B1229	-5,0	0,0	-0,2	0,0	0,1	0,0
	B1245	10,1	0,0	0,0	0,0	0,0	0,0
	B1264	5,7	-0,2	-0,1	0,0	-0,2	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(8)	B1229	-5,1	0,0	0,8	0,0	-0,2	0,0
	B1245	10,3	0,0	-0,1	0,0	0,0	0,0
	B1264	-33,2	0,2	0,0	-0,1	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(9)	B1229	-1,8	0,0	-0,6	0,0	0,2	0,0
	B1245	3,6	0,0	0,1	0,0	-0,1	0,0
	B1264	34,1	-0,5	-0,1	0,0	-0,2	-0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(10)	B1229	-7,5	0,0	-0,2	0,0	0,1	0,0
	B1245	15,9	0,0	0,1	0,0	0,0	0,0
	B1264	30,9	0,1	-0,2	0,0	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(11)	B1229	-4,9	0,0	0,8	0,0	-0,2	0,0
	B1245	10,0	0,0	-0,1	0,0	0,1	0,0

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Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1264	-61,2	0,3	0,0	-0,1	0,0	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(12)	B1229	-5,1	0,0	-0,5	0,0	0,2	0,0
	B1245	10,5	0,0	0,1	0,0	-0,1	0,0
	B1264	35,3	-0,5	-0,1	0,0	-0,2	-0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(13)	B1229	-8,8	0,0	-0,2	0,0	0,1	0,0
	B1245	18,7	0,0	0,1	0,0	-0,1	0,0
	B1264	20,6	-0,2	-0,2	0,0	-0,1	-0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(14)	B1229	-9,7	0,0	0,0	0,0	0,0	0,0
	B1245	20,5	0,0	0,0	0,0	-0,1	0,0
	B1264	28,9	-0,1	-0,2	-0,1	-0,1	-0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(15)	B1229	-5,4	0,0	0,8	0,0	-0,2	0,0
	B1245	11,0	0,0	-0,1	0,0	0,0	0,0
	B1264	-60,1	0,3	0,0	-0,2	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(16)	B1229	-8,9	0,0	0,9	0,0	-0,2	0,0
	B1245	18,1	0,0	-0,1	0,0	0,0	0,0
	B1264	-30,8	0,3	-0,1	-0,2	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(17)	B1229	-9,8	0,0	0,6	0,0	-0,2	0,0
	B1245	20,1	0,0	0,0	0,0	0,0	0,0
	B1264	-1,9	0,2	-0,1	-0,1	-0,2	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(18)	B1229	-1,3	0,0	-0,3	0,0	0,1	0,0
	B1245	2,4	0,0	0,0	0,0	0,0	0,0
	B1264	3,4	-0,3	-0,1	0,0	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(19)	B1229	-5,1	0,0	0,1	0,0	0,0	0,0
	B1245	10,7	0,0	0,0	0,0	0,0	0,0
	B1264	1,7	0,0	-0,1	0,0	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(20)	B1229	-4,9	0,0	-0,5	0,0	0,2	0,0
	B1245	10,2	0,0	0,1	0,0	-0,1	0,0
	B1264	7,2	-0,4	-0,1	0,0	-0,1	-0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(21)	B1229	-5,7	0,0	-0,3	0,0	0,1	0,0
	B1245	12,2	0,0	0,1	0,0	0,0	0,0
	B1264	30,3	0,1	-0,2	0,0	0,0	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(22)	B1229	-6,9	0,0	0,8	0,0	-0,2	0,0
	B1245	14,1	0,0	-0,1	0,0	0,0	0,0

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Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1264	-32,6	0,2	-0,1	-0,1	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(23)	B1229	-5,0	0,0	0,5	0,0	-0,1	0,0
	B1245	10,5	0,0	0,0	0,0	0,0	0,0
	B1264	-32,0	0,1	-0,1	-0,1	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(24)	B1229	-7,6	0,0	0,1	0,0	0,0	0,0
	B1245	16,1	0,0	0,0	0,0	0,0	0,0
	B1264	30,1	0,3	-0,2	-0,1	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(25)	B1229	-4,3	0,0	0,0	0,0	0,0	0,0
	B1245	9,3	0,0	0,0	0,0	0,0	0,0
	B1264	28,9	0,2	-0,2	0,0	0,0	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(26)	B1229	-8,7	0,0	0,0	0,0	0,0	0,0
	B1245	18,5	0,0	0,1	0,0	0,0	0,0
	B1264	5,1	0,1	-0,2	-0,1	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(27)	B1229	-8,8	0,0	0,1	0,0	0,0	0,0
	B1245	18,6	0,0	0,0	0,0	0,0	0,0
	B1264	4,6	0,2	-0,2	-0,1	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(28)	B1229	-9,4	0,0	0,6	0,0	-0,2	0,0
	B1245	19,6	0,0	0,0	0,0	0,0	0,0
	B1264	-48,7	0,3	-0,2	-0,1	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(29)	B1229	-1,5	0,0	-0,3	0,0	0,1	0,0
	B1245	2,7	0,0	0,0	0,0	0,0	0,0
	B1264	31,5	-0,3	0,0	0,0	-0,2	-0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(30)	B1229	-8,2	0,0	0,9	0,0	-0,2	0,0
	B1245	16,9	0,0	-0,1	0,0	0,0	0,0
	B1264	-60,0	0,3	-0,1	-0,2	-0,1	0,3
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(31)	B1229	-4,1	0,0	-0,3	0,0	0,1	0,0
	B1245	9,1	0,0	0,1	0,0	0,0	0,0
	B1264	30,2	0,1	-0,2	0,0	0,0	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(32)	B1229	-4,9	0,0	-0,2	0,0	0,1	0,0
	B1245	10,7	0,0	0,0	0,0	-0,1	0,0
	B1264	-10,0	-0,2	-0,1	0,0	0,0	-0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(33)	B1229	-4,8	0,0	-0,2	0,0	0,1	0,0
	B1245	9,5	0,0	0,0	0,0	0,0	0,0

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Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1264	32,7	-0,3	-0,1	0,0	-0,2	-0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(34)	B1229	-5,2	0,0	-0,2	0,0	0,1	0,0
	B1245	10,4	0,0	0,0	0,0	0,0	0,0
	B1264	33,8	-0,3	-0,1	0,0	-0,2	-0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(35)	B1229	-9,4	0,0	0,4	0,0	-0,1	0,0
	B1245	19,7	0,0	0,0	0,0	0,0	0,0
	B1264	-48,1	0,2	-0,2	-0,1	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(36)	B1229	-5,1	0,0	0,4	0,0	-0,1	0,0
	B1245	10,8	0,0	0,0	0,0	0,0	0,0
	B1264	-49,6	0,1	-0,1	-0,1	0,0	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(37)	B1229	-4,9	0,0	-0,1	0,0	0,0	0,0
	B1245	10,6	0,0	0,0	0,0	0,0	0,0
	B1264	-20,3	-0,1	-0,1	0,0	0,0	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(38)	B1229	-4,2	0,0	-0,3	0,0	0,1	0,0
	B1245	9,1	0,0	0,1	0,0	0,0	0,0
	B1264	29,7	0,1	-0,2	0,0	0,0	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(39)	B1229	-4,4	0,0	0,0	0,0	0,0	0,0
	B1245	9,3	0,0	0,0	0,0	0,0	0,0
	B1264	28,4	0,2	-0,2	-0,1	0,0	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(40)	B1229	-5,9	0,0	0,1	0,0	0,0	0,0
	B1245	12,4	0,0	0,0	0,0	0,0	0,0
	B1264	29,0	0,3	-0,2	-0,1	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(41)	B1229	-7,7	0,0	0,1	0,0	0,0	0,0
	B1245	16,1	0,0	0,0	0,0	0,0	0,0
	B1264	29,6	0,3	-0,2	-0,1	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(42)	B1229	-8,4	0,0	0,8	0,0	-0,2	0,0
	B1245	17,2	0,0	-0,1	0,0	0,0	0,0
	B1264	-32,0	0,3	-0,1	-0,2	-0,1	0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(43)	B1229	-8,3	0,0	0,5	0,0	-0,1	0,0
	B1245	17,3	0,0	0,0	0,0	0,0	0,0
	B1264	-30,8	0,1	-0,1	-0,1	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(44)	B1229	-6,8	0,0	0,5	0,0	-0,1	0,0
	B1245	14,2	0,0	0,0	0,0	0,0	0,0

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Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1264	-31,4	0,1	-0,1	-0,1	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(45)	B1229	-5,1	0,0	-0,2	0,0	0,1	0,0
	B1245	11,0	0,0	0,0	0,0	-0,1	0,0
	B1264	18,1	-0,3	-0,1	0,0	-0,1	-0,2
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(46)	B1229	-4,5	0,0	0,0	0,0	0,0	0,0
	B1245	9,5	0,0	0,0	0,0	0,0	0,0
	B1264	57,0	0,2	-0,1	0,0	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(47)	B1229	-8,1	0,0	0,5	0,0	-0,2	0,0
	B1245	17,0	0,0	0,0	0,0	0,0	0,0
	B1264	-58,9	0,2	-0,1	-0,1	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(48)	B1229	-6,1	0,0	0,0	0,0	0,0	0,0
	B1245	12,7	0,0	0,0	0,0	0,0	0,0
	B1264	57,1	0,2	-0,2	-0,1	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(49)	B1229	-4,6	0,0	0,0	0,0	0,0	0,0
	B1245	9,6	0,0	0,0	0,0	0,0	0,0
	B1264	56,5	0,2	-0,1	-0,1	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(50)	B1229	-6,6	0,0	0,5	0,0	-0,1	0,0
	B1245	13,9	0,0	0,0	0,0	0,0	0,0
	B1264	-59,5	0,2	-0,1	-0,1	0,0	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(51)	B1229	-7,9	0,0	0,1	0,0	0,0	0,0
	B1245	16,4	0,0	0,0	0,0	0,0	0,0
	B1264	57,7	0,2	-0,2	-0,1	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(52)	B1229	-6,4	0,0	0,1	0,0	0,0	0,0
	B1245	13,3	0,0	0,0	0,0	0,0	0,0
	B1264	57,1	0,2	-0,2	-0,1	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(53)	B1229	-4,4	0,0	-0,3	0,0	0,1	0,0
	B1245	9,4	0,0	0,1	0,0	0,0	0,0
	B1264	-57,8	0,0	-0,2	0,0	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(54)	B1229	-4,8	0,0	0,5	0,0	-0,1	0,0
	B1245	10,2	0,0	0,0	0,0	0,0	0,0
	B1264	-60,1	0,1	-0,1	-0,1	0,0	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(55)	B1229	-6,3	0,0	0,5	0,0	-0,1	0,0
	B1245	13,3	0,0	0,0	0,0	0,0	0,0

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Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1264	-59,5	0,1	-0,1	-0,1	0,0	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(56)	B1229	-7,6	0,0	-0,2	0,0	0,1	0,0
	B1245	16,2	0,0	0,1	0,0	0,0	0,0
	B1264	59,5	0,1	-0,2	0,0	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(57)	B1229	-7,4	0,0	-0,2	0,0	0,1	0,0
	B1245	15,9	0,0	0,1	0,0	0,0	0,0
	B1264	31,4	0,1	-0,2	0,0	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(58)	B1229	-5,6	0,0	-0,3	0,0	0,1	0,0
	B1245	12,2	0,0	0,1	0,0	0,0	0,0
	B1264	30,8	0,1	-0,2	0,0	0,0	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(59)	B1229	-7,6	0,0	-0,1	0,0	0,0	0,0
	B1245	15,5	0,0	0,0	0,0	0,0	0,0
	B1264	36,8	-0,2	-0,1	-0,1	-0,2	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(60)	B1229	-9,1	0,0	0,1	0,0	0,0	0,0
	B1245	19,1	0,0	0,0	0,0	0,0	0,0
	B1264	51,4	0,1	-0,2	-0,1	-0,2	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(61)	B1229	-4,8	0,0	0,3	0,0	-0,1	0,0
	B1245	10,2	0,0	0,0	0,0	0,0	0,0
	B1264	-50,3	0,1	-0,1	-0,1	0,0	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(62)	B1229	-2,8	0,0	-0,3	0,0	0,1	0,0
	B1245	5,5	0,0	0,0	0,0	0,0	0,0
	B1264	4,0	-0,3	-0,1	0,0	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(63)	B1229	-6,1	0,0	-0,2	0,0	0,1	0,0
	B1245	13,1	0,0	0,1	0,0	0,0	0,0
	B1264	58,9	0,0	-0,2	0,0	-0,1	0,0
	B1264	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(64)	B1229	-7,8	0,0	0,1	0,0	0,0	0,0
	B1245	16,4	0,0	0,0	0,0	0,0	0,0
	B1264	58,2	0,2	-0,2	-0,1	-0,1	0,1
	B1264	0,0	0,0	0,0	0,0	0,0	0,0

Project:  
Project no:  
Author:



**Check**

**Summary**

Name	Value	Status
Analysis	100,0%	OK
Plates	0,0 < 5%	OK
Welds	76,6 < 100%	OK
Buckling	Not calculated	

**Plates**

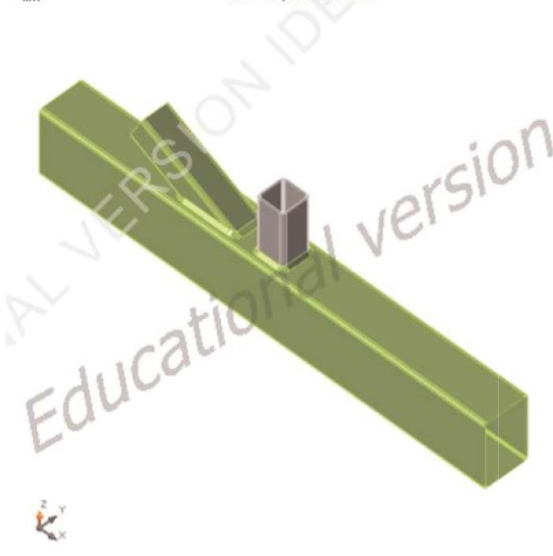
Name	Thickness [mm]	Loads	$\sigma_{Ed}$ [MPa]	$\epsilon_{pI}$ [%]	Status
B1229	3,0	ULS-Set(16)	242,7	0,0	OK
B1245	3,0	ULS-Set(14)	261,5	0,0	OK
B1264	3,0	ULS-Set(5)	311,0	0,0	OK

**Design data**

Material	$f_y$ [MPa]	$\epsilon_{lim}$ [%]
S 355	355,0	5,0

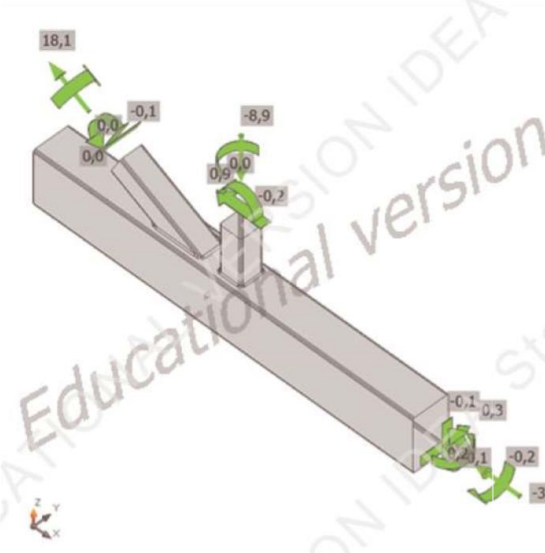
**Symbol explanation**

- $\epsilon_{pI}$  Strain
- $\sigma_{Ed}$  Eq. stress
- $f_y$  Yield strength
- $\epsilon_{lim}$  Limit of plastic strain

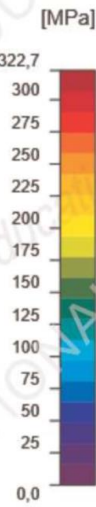
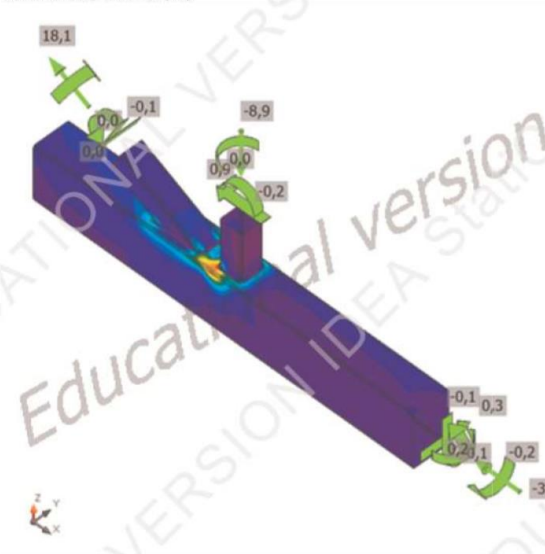


Overall check, ULS-Set(16)

Project:  
Project no:  
Author:



Strain check, ULS-Set(16)



Equivalent stress, ULS-Set(16)



Project:  
Project no:  
Author:



### Welds (Plastic redistribution)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	$\epsilon_{pl}$ [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut <sub>c</sub> [%]	Status
B1264-w 3	B1229	4,0	180	ULS-Set(16)	315,6	0,0	-268,6	43,8	85,1	76,1	12,4	OK
B1264-w 3	B1245	4,0	285	ULS-Set(14)	333,8	0,0	96,5	183,8	15,9	76,6	9,1	OK

### Design data

	$\beta_w$ [-]	$\sigma_{w,Rd}$ [MPa]	0.9 $\sigma$ [MPa]
S 355	0,90	435,6	352,8

### Symbol explanation

$\epsilon_{pl}$	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 $\sigma$	Perpendicular stress resistance - 0.9*fu/γM2
$\beta_w$	Correlation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Ut <sub>c</sub>	Weld capacity utilization

### Buckling

Buckling analysis was not calculated.

### Code settings

Item	Value	Unit	Reference
Y <sub>M0</sub>	1,10	-	EN 1993-1-1: 6.1
Y <sub>M1</sub>	1,00	-	EN 1993-1-1: 6.1
Y <sub>M2</sub>	1,25	-	EN 1993-1-1: 6.1
Y <sub>M3</sub>	1,25	-	EN 1993-1-8: 2.2
Y <sub>C</sub>	1,50	-	EN 1992-1-1: 2.4.2.4
Y <sub>inst</sub>	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient β <sub>j</sub>	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 a <sub>b</sub> in bearing check.	Yes		EN 1993-1-8: tab 3.4

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Project:

Project no:

Author:



Item	Value	Unit	Reference
Cracked concrete	Yes		
Local deformation check	No		
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1

## 6.5. Spoj ispuna gornji pojas

**Project:**  
**Project no:**  
**Author:**



### Project data

Project name  
Project number  
Author  
Description  
Date 1.7.2019.  
Design code EN

### Material

Steel S 355

Project:  
Project no:  
Author:



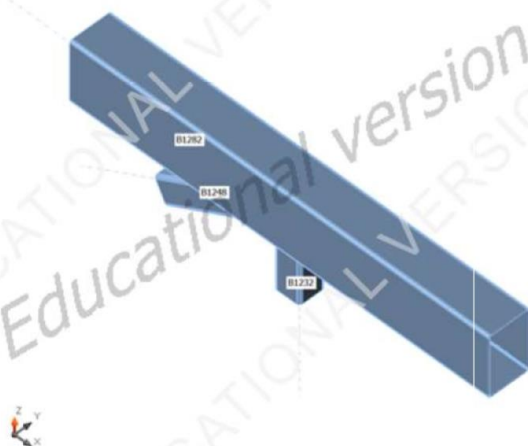
## Project item Con N629

### Design

Name: Con N629  
Description:  
Analysis: Stress, strain/ loads in equilibrium

### Beams and columns

Name	Cross-section	$\beta$ - Direction [°]	$\gamma$ - Pitch [°]	$\alpha$ - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
B1232	1 - CFRHS50X50X3(RHS50x50)	0,0	90,0	0,0	0	0	0	Position
B1248	1 - CFRHS50X50X3(RHS50x50)	180,0	27,8	0,0	0	0	0	Position
B1282	2 - CFRHS120X80X2.5(RHS120x80)	0,0	0,0	0,0	0	0	0	Position



### Cross-sections

Name	Material
1 - CFRHS50X50X3(RHS50x50)	S 355
2 - CFRHS120X80X2.5(RHS120x80)	S 355

Project:  
Project no:  
Author:



### Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
ULS-Set(1)	B1232	-2,7	0,0	0,1	0,0	0,0	0,0
	B1248	4,0	0,0	0,0	0,0	0,0	0,0
	B1282	19,0	1,3	0,2	0,0	-0,1	0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(2)	B1232	-11,8	0,0	0,3	0,0	-0,1	0,0
	B1248	9,5	0,0	-0,1	0,0	0,1	0,0
	B1282	8,0	1,5	-0,5	0,0	-0,2	0,2
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(3)	B1232	-5,6	0,0	0,2	0,0	-0,1	0,0
	B1248	2,0	0,0	0,0	0,0	0,0	0,0
	B1282	-11,0	-0,1	-0,3	0,0	-0,1	-0,1
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(4)	B1232	-3,1	0,0	0,1	0,0	0,0	0,0
	B1248	5,0	0,0	0,0	0,0	0,0	0,0
	B1282	45,5	1,4	0,3	0,0	-0,1	0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(5)	B1232	-11,5	0,0	0,3	0,0	-0,1	0,0
	B1248	8,6	0,0	-0,1	0,0	0,1	0,0
	B1282	-16,0	1,5	-0,6	0,0	-0,1	0,2
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(6)	B1232	-8,6	0,0	0,2	0,0	-0,1	0,0
	B1248	1,2	0,0	0,1	0,0	0,0	0,0
	B1282	-65,9	-3,3	-0,6	0,1	0,0	-1,4
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(7)	B1232	-9,8	0,0	0,3	0,0	-0,1	0,0
	B1248	8,3	0,0	-0,1	0,0	0,1	0,0
	B1282	-13,2	3,2	-0,3	0,0	-0,1	0,9
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(8)	B1232	-7,5	0,0	0,2	0,0	-0,1	0,0
	B1248	8,5	0,0	-0,1	0,0	0,1	0,0
	B1282	-10,6	3,2	-0,1	0,0	-0,1	1,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(9)	B1232	-3,0	0,0	0,1	0,0	0,0	0,0
	B1248	5,0	0,0	0,0	0,0	0,0	0,0
	B1282	43,0	1,4	0,3	0,0	-0,1	0,6
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(10)	B1232	-4,8	0,0	0,1	0,0	0,0	0,0
	B1248	5,1	0,0	0,0	0,0	0,0	0,0
	B1282	42,0	-0,3	0,1	0,0	-0,2	-0,2
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(11)	B1232	-5,0	0,0	0,1	0,0	0,0	0,0
	B1248	1,7	0,0	0,1	0,0	0,0	0,0

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Project:  
Project no:  
Author:



Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1282	-36,3	-3,1	-0,2	0,0	0,0	-1,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(12)	B1232	-7,4	0,0	0,2	0,0	-0,1	0,0
	B1248	1,6	0,0	0,1	0,0	0,0	0,0
	B1282	-39,0	-3,2	-0,5	0,1	-0,1	-1,4
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(13)	B1232	-10,5	0,0	0,3	0,0	-0,1	0,0
	B1248	5,9	0,0	-0,1	0,0	0,1	0,0
	B1282	-29,5	0,8	-0,6	0,0	-0,1	0,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(14)	B1232	-2,7	0,0	0,1	0,0	0,0	0,0
	B1248	0,9	0,0	-0,1	0,0	0,0	0,0
	B1282	-16,7	2,9	-0,1	0,0	0,0	0,9
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(15)	B1232	-2,8	0,0	0,1	0,0	0,0	0,0
	B1248	4,0	0,0	0,0	0,0	0,0	0,0
	B1282	21,4	1,3	0,2	0,0	-0,1	0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(16)	B1232	-3,0	0,0	0,1	0,0	0,0	0,0
	B1248	0,4	0,0	0,0	0,0	0,0	0,0
	B1282	-57,7	-1,5	-0,1	0,0	0,0	-0,6
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(17)	B1232	-3,7	0,0	0,2	0,0	-0,1	0,0
	B1248	0,4	0,0	-0,1	0,0	0,0	0,0
	B1282	-17,1	2,9	-0,2	0,0	-0,1	0,9
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(18)	B1232	-10,8	0,0	0,3	0,0	-0,1	0,0
	B1248	10,1	0,0	-0,1	0,0	0,1	0,0
	B1282	8,1	1,6	-0,3	0,0	-0,1	0,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(19)	B1232	-4,0	0,0	0,1	0,0	-0,1	0,0
	B1248	-0,1	0,0	0,0	0,0	0,0	0,0
	B1282	-57,8	-1,5	-0,3	0,0	0,0	-0,7
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(20)	B1232	-4,2	0,0	0,1	0,0	-0,1	0,0
	B1248	1,5	0,0	0,0	0,0	0,0	0,0
	B1282	-8,2	-0,1	-0,2	0,0	-0,1	-0,1
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(21)	B1232	-6,0	0,0	0,1	0,0	-0,1	0,0
	B1248	1,2	0,0	0,1	0,0	0,0	0,0
	B1282	-36,5	-3,1	-0,4	0,1	0,0	-1,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(22)	B1232	-8,9	0,0	0,3	0,0	-0,1	0,0
	B1248	8,9	0,0	-0,1	0,0	0,1	0,0

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Project:  
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Author:



Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1282	-13,2	3,2	-0,1	0,0	-0,1	1,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(23)	B1232	-6,3	0,0	0,2	0,0	-0,1	0,0
	B1248	8,9	0,0	-0,1	0,0	0,1	0,0
	B1282	16,3	3,3	0,1	0,0	-0,1	1,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(24)	B1232	-7,7	0,0	0,2	0,0	-0,1	0,0
	B1248	9,3	0,0	-0,1	0,0	0,1	0,0
	B1282	13,8	3,3	0,0	0,0	-0,1	1,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(25)	B1232	-7,2	0,0	0,2	0,0	-0,1	0,0
	B1248	0,8	0,0	0,1	0,0	0,0	0,0
	B1282	-63,4	-3,2	-0,5	0,1	0,0	-1,4
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(26)	B1232	-9,2	0,0	0,3	0,0	-0,1	0,0
	B1248	9,9	0,0	-0,1	0,0	0,1	0,0
	B1282	10,9	3,3	-0,1	0,0	-0,1	1,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(27)	B1232	-7,6	0,0	0,2	0,0	-0,1	0,0
	B1248	6,0	0,0	0,0	0,0	0,0	0,0
	B1282	36,6	-0,4	-0,1	0,1	-0,2	-0,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(28)	B1232	-5,7	0,0	0,1	0,0	-0,1	0,0
	B1248	0,3	0,0	0,1	0,0	0,0	0,0
	B1282	-60,5	-3,2	-0,5	0,1	0,0	-1,4
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(29)	B1232	-7,8	0,0	0,2	0,0	-0,1	0,0
	B1248	2,6	0,0	0,1	0,0	0,0	0,0
	B1282	-41,7	-3,1	-0,4	0,1	-0,1	-1,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(30)	B1232	-6,6	0,0	0,3	0,0	-0,1	0,0
	B1248	1,3	0,0	-0,1	0,0	0,0	0,0
	B1282	-22,5	2,8	-0,4	0,0	-0,1	0,8
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(31)	B1232	-8,3	0,0	0,3	0,0	-0,1	0,0
	B1248	1,6	0,0	0,0	0,0	0,0	0,0
	B1282	-25,6	1,2	-0,6	0,1	-0,1	0,1
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(32)	B1232	-3,3	0,0	0,1	0,0	0,0	0,0
	B1248	1,4	0,0	0,0	0,0	0,0	0,0
	B1282	-33,6	-1,4	0,0	0,0	0,0	-0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(33)	B1232	-7,5	0,0	0,2	0,0	-0,1	0,0
	B1248	6,0	0,0	0,0	0,0	0,0	0,0

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Project:  
Project no:  
Author:



Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1282	34,1	-0,3	-0,1	0,0	-0,2	-0,2
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(34)	B1232	-3,9	0,0	0,1	0,0	-0,1	0,0
	B1248	0,0	0,0	0,0	0,0	0,0	0,0
	B1282	-50,8	-1,0	-0,3	0,0	0,0	-0,4
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(35)	B1232	-6,0	0,0	0,2	0,0	-0,1	0,0
	B1248	8,0	0,0	-0,1	0,0	0,1	0,0
	B1282	-7,8	3,3	0,0	0,0	0,0	1,0
	B1282	0,0	0,0	0,0	0,0	-0,0	0,0
ULS-Set(36)	B1232	-8,9	0,0	0,2	0,0	-0,1	0,0
	B1248	2,1	0,0	0,1	0,0	0,0	0,0
	B1282	-41,8	-3,2	-0,6	0,1	-0,1	-1,4
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(37)	B1232	-5,7	0,0	0,2	0,0	-0,1	0,0
	B1248	5,0	0,0	0,0	0,0	0,0	0,0
	B1282	16,1	1,2	0,1	0,0	-0,1	0,4
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(38)	B1232	-7,5	0,0	0,3	0,0	-0,1	0,0
	B1248	1,5	0,0	0,0	0,0	0,0	0,0
	B1282	-33,4	1,6	-0,5	0,0	-0,1	0,4
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(39)	B1232	-8,6	0,0	0,3	0,0	-0,1	0,0
	B1248	2,6	0,0	0,0	0,0	0,0	0,0
	B1282	-1,5	1,2	-0,6	0,1	-0,2	0,2
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(40)	B1232	-9,0	0,0	0,3	0,0	-0,1	0,0
	B1248	3,3	0,0	0,0	0,0	0,0	0,0
	B1282	4,8	0,7	-0,5	0,1	-0,2	0,1
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(41)	B1232	-8,4	0,0	0,2	0,0	-0,1	0,0
	B1248	5,3	0,0	0,0	0,0	0,0	0,0
	B1282	26,2	-0,2	-0,2	0,1	-0,2	-0,2
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(42)	B1232	-8,9	0,0	0,2	0,0	-0,1	0,0
	B1248	8,6	0,0	-0,1	0,0	0,1	0,0
	B1282	13,4	1,6	-0,3	0,0	-0,1	0,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(43)	B1232	-8,0	0,0	0,2	0,0	-0,1	0,0
	B1248	9,2	0,0	-0,1	0,0	0,1	0,0
	B1282	13,5	1,7	-0,2	0,0	-0,1	0,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(44)	B1232	-8,7	0,0	0,3	0,0	-0,1	0,0
	B1248	8,9	0,0	-0,1	0,0	0,1	0,0

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Project:  
Project no:  
Author:



Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1282	13,4	3,3	-0,2	0,0	-0,1	1,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(45)	B1232	-10,1	0,0	0,3	0,0	-0,1	0,0
	B1248	9,3	0,0	-0,1	0,0	0,1	0,0
	B1282	10,8	3,2	-0,3	0,0	-0,1	0,9
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(46)	B1232	-7,1	0,0	0,2	0,0	-0,1	0,0
	B1248	0,7	0,0	0,1	0,0	0,0	0,0
	B1282	-63,1	-3,2	-0,6	0,1	0,0	-1,4
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(47)	B1232	-4,7	0,0	0,1	0,0	0,0	0,0
	B1248	0,8	0,0	0,1	0,0	0,0	0,0
	B1282	-60,4	-3,1	-0,3	0,0	0,0	-1,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(48)	B1232	-3,0	0,0	0,1	0,0	0,0	0,0
	B1248	1,8	0,0	-0,1	0,0	0,0	0,0
	B1282	7,4	3,0	0,0	0,0	-0,1	1,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(49)	B1232	-7,5	0,0	0,2	0,0	-0,1	0,0
	B1248	1,7	0,0	0,1	0,0	0,0	0,0
	B1282	-65,8	-3,2	-0,4	0,1	0,0	-1,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(50)	B1232	-5,8	0,0	0,2	0,0	-0,1	0,0
	B1248	1,3	0,0	0,0	0,0	0,0	0,0
	B1282	-63,1	-1,5	-0,2	0,0	0,0	-0,6
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(51)	B1232	-5,6	0,0	0,2	0,0	-0,1	0,0
	B1248	1,8	0,0	-0,1	0,0	0,0	0,0
	B1282	-22,1	2,9	-0,2	0,0	-0,1	0,9
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(52)	B1232	-6,9	0,0	0,2	0,0	-0,1	0,0
	B1248	0,8	0,0	0,0	0,0	0,0	0,0
	B1282	-63,2	-1,6	-0,4	0,0	0,0	-0,7
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(53)	B1232	-8,4	0,0	0,2	0,0	-0,1	0,0
	B1248	5,3	0,0	0,0	0,0	0,0	0,0
	B1282	27,7	-0,3	-0,2	0,1	-0,2	-0,2
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(54)	B1232	-4,6	0,0	0,1	0,0	0,0	0,0
	B1248	5,5	0,0	0,0	0,0	0,0	0,0
	B1282	42,7	1,3	0,2	0,0	-0,2	0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(55)	B1232	-8,7	0,0	0,3	0,0	-0,1	0,0
	B1248	1,4	0,0	0,0	0,0	0,0	0,0

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Project:  
Project no:  
Author:



Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1282	-59,5	-2,1	-0,6	0,1	-0,1	-0,9
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(56)	B1232	-6,0	0,0	0,1	0,0	-0,1	0,0
	B1248	5,9	0,0	0,0	0,0	0,0	0,0
	B1282	40,1	1,3	0,1	0,0	-0,2	0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(57)	B1232	-7,3	0,0	0,2	0,0	-0,1	0,0
	B1248	5,0	0,0	0,0	0,0	0,0	0,0
	B1282	12,5	-0,4	-0,1	0,1	-0,1	-0,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(58)	B1232	-7,3	0,0	0,2	0,0	-0,1	0,0
	B1248	8,3	0,0	-0,1	0,0	0,1	0,0
	B1282	16,2	3,3	-0,1	0,0	-0,1	1,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(59)	B1232	-9,2	0,0	0,2	0,0	-0,1	0,0
	B1248	3,0	0,0	0,0	0,0	0,0	0,0
	B1282	-19,4	-2,0	-0,5	0,1	-0,2	-0,9
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(60)	B1232	-4,3	0,0	0,1	0,0	-0,1	0,0
	B1248	0,9	0,0	0,0	0,0	0,0	0,0
	B1282	-33,8	-1,5	-0,2	0,0	0,0	-0,6
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(61)	B1232	-10,5	0,0	0,3	0,0	-0,1	0,0
	B1248	9,1	0,0	-0,1	0,0	0,1	0,0
	B1282	-16,0	1,5	-0,4	0,0	-0,1	0,2
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(62)	B1232	-10,9	0,0	0,3	0,0	-0,1	0,0
	B1248	7,4	0,0	-0,1	0,0	0,1	0,0
	B1282	10,6	0,9	-0,5	0,1	-0,2	0,1
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(63)	B1232	-8,0	0,0	0,3	0,0	-0,1	0,0
	B1248	3,1	0,0	0,0	0,0	0,0	0,0
	B1282	6,7	1,7	-0,4	0,0	-0,2	0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(64)	B1232	-6,1	0,0	0,1	0,0	-0,1	0,0
	B1248	1,2	0,0	0,1	0,0	0,0	0,0
	B1282	-62,9	-3,2	-0,4	0,1	0,0	-1,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(65)	B1232	-7,8	0,0	0,2	0,0	-0,1	0,0
	B1248	9,4	0,0	-0,1	0,0	0,1	0,0
	B1282	13,4	3,3	0,0	0,0	-0,1	1,0
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(66)	B1232	-7,7	0,0	0,2	0,0	-0,1	0,0
	B1248	8,2	0,0	-0,1	0,0	0,1	0,0

Project:  
Project no:  
Author:



Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	B1282	-10,6	1,6	-0,2	0,0	0,0	0,3
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(67)	B1232	-6,8	0,0	0,3	0,0	-0,1	0,0
	B1248	2,2	0,0	-0,1	0,0	0,0	0,0
	B1282	1,6	2,9	-0,3	0,0	-0,2	0,9
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(68)	B1232	-10,0	0,0	0,3	0,0	-0,1	0,0
	B1248	8,0	0,0	-0,1	0,0	0,1	0,0
	B1282	-13,2	1,5	-0,5	0,0	-0,1	0,2
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(69)	B1232	-8,2	0,0	0,2	0,0	-0,1	0,0
	B1248	2,8	0,0	0,0	0,0	0,0	0,0
	B1282	-17,7	-1,0	-0,4	0,1	-0,1	-0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(70)	B1232	-7,7	0,0	0,2	0,0	-0,1	0,0
	B1248	1,2	0,0	0,0	0,0	0,0	0,0
	B1282	-57,8	-1,1	-0,5	0,0	-0,1	-0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0
ULS-Set(71)	B1232	-5,5	0,0	0,2	0,0	-0,1	0,0
	B1248	4,9	0,0	0,0	0,0	0,0	0,0
	B1282	13,6	1,3	0,1	0,0	-0,1	0,5
	B1282	0,0	0,0	0,0	0,0	0,0	0,0

### Check

#### Summary

Name	Value	Status
Analysis	100,0%	OK
Plates	0,1 < 5%	OK
Welds	98,5 < 100%	OK
Buckling	Not calculated	

#### Plates

Name	Thickness [mm]	Loads	$\sigma_{Ed}$ [MPa]	$\epsilon_{Pl}$ [%]	Status
B1232	3,0	ULS-Set(2)	282,4	0,0	OK
B1248	3,0	ULS-Set(26)	160,8	0,0	OK
B1282	2,5	ULS-Set(2)	355,2	0,1	OK

#### Design data

Material	$f_y$ [MPa]	$\epsilon_{lim}$ [%]
S 355	355,0	5,0



Project:  
Project no:  
Author:

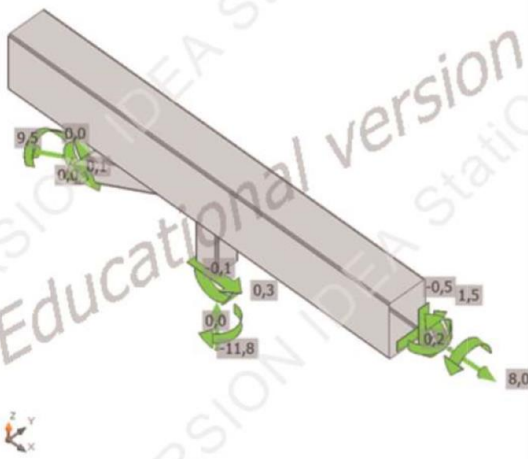


**Symbol explanation**

$\epsilon_{pl}$	Strain
$\sigma_{Ed}$	Eq. stress
$f_y$	Yield strength
$\epsilon_{lim}$	Limit of plastic strain



Overall check, ULS-Set(2)

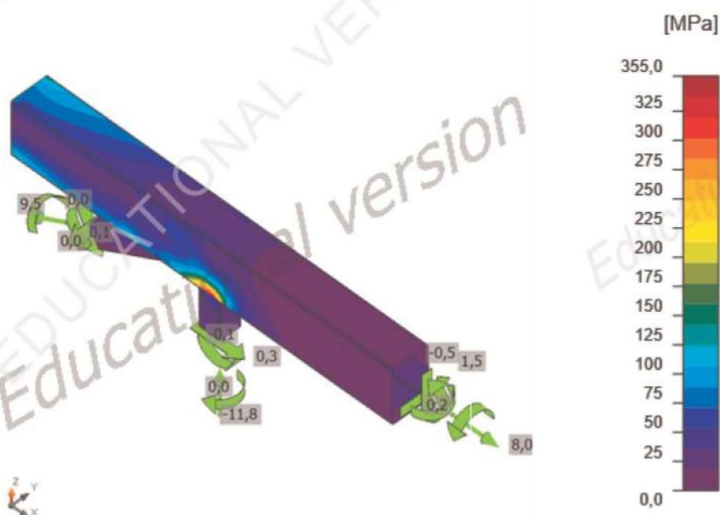




Project:  
Project no:  
Author:



Strain check, ULS-Set(2)



Equivalent stress, ULS-Set(2)

**Welds (Plastic redistribution)**

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	$\epsilon_{pl}$ [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut <sub>c</sub> [%]	Status
B1282-w 1	B1232	▲2,5	180	ULS-Set(2)	429,1	1,3	-55,6	4,4	245,6	98,5	35,8	OK
B1282-w 1	B1248	▲2,5	285	ULS-Set(27)	296,2	0,0	43,7	50,8	-161,4	68,0	6,2	OK

**Design data**

	$\beta_w$ [-]	$\sigma_{w,Rd}$ [MPa]	$0.9 \sigma$ [MPa]
S 355	0,90	435,6	352,8

**Symbol explanation**

- $\epsilon_{pl}$  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
- $0.9 \sigma$  Perpendicular stress resistance -  $0.9 \cdot f_u / \gamma_{M2}$
- $\beta_w$  Corelation factor EN 1993-1-8 tab. 4.1
- Ut Utilization
- Ut<sub>c</sub> Weld capacity utilization

Project:  
Project no:  
Author:



### Buckling

Buckling analysis was not calculated.

### Code settings

Item	Value	Unit	Reference
YM0	1,00	-	EN 1993-1-1: 6.1
YM1	1,00	-	EN 1993-1-1: 6.1
YM2	1,25	-	EN 1993-1-1: 6.1
YM3	1,25	-	EN 1993-1-8: 2.2
Yc	1,50	-	EN 1992-1-1: 2.4.2.4
Yinst	1,20	-	ETAG 001-C: 3.2.1
Joint coefficient $\beta_j$	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 $\alpha_b$ 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 stup rešetka

## 1) Osnovni materijal:

Čelik S355

$$f_y = 355 \text{ N/mm}^2$$

$$E = 210 \text{ GPa}$$

## 2) Kontrola vara

- dužina vara pojasnice:

$$l_p = O = 2 \cdot 250 + 100 = 600 \text{ (mm)}$$

- max debljina vara s obzirom na debljinu stijenke nosača

$$a_{\max} = 0.7 \cdot t_{\min}$$

$$t_{\min} = 4,2 \text{ (mm)}$$

$$\Rightarrow a_{\max} = 0.7 \cdot t_{\min} = 0.7 \cdot 6 = 4,2 \text{ (mm)}$$

$$a_{\text{odabrano}} = 4 \text{ (mm)}$$

Za pretpostavljeni var  $a=4$ (mm):

$$\text{- uzdužna sila: } F_{w,Rd} = \frac{F_{w,Rk}}{1.25} \cdot \frac{L}{100} = \frac{130,9}{1.25} \cdot \frac{600}{100} = 628,32 \text{ (kN)}$$

uvjet nosivosti:

$$N = F_{w,Sd} \leq F_{w,Rd}$$

$$104,14 \text{ (kN)} \leq 628,32 \text{ (kN)}$$

Var  $a=4$  mm zadovoljava.

## 3) Proračun vijaka

Pretpostavljeni vijci: M 16, k.v.5.6, n=4 vijka

- udaljenost  $c_{\min}$  vijaka od ruba pojasnice:

$$c_{\min} = 2 \cdot d + a \cdot \sqrt{2} = 2 \cdot 16 + 4 \cdot \sqrt{2} = 37,66 \text{ (mm)}$$

Usvojeno  $c=40$  mm.

- otpornost vijaka na vlak:

$$F_{t,Rd} = \frac{F_{t,Rk}}{\gamma_{M1}} = \frac{70,7}{1,25} = 56,56 \text{ (kN)}$$

uvjet nosivosti

$$F_{t,Rd} > F_{t,Sd} / 2$$

$$56,56 \text{ kN} > 104,14 / 4 = 26,035 \text{ (kN)}$$

- otpornost vijaka na posmik:

$$F_{v,Rd} = \frac{F_{v,Rk}}{\gamma_{M1}} = \frac{47,1}{1,25} = 37,68 \text{ (kN)}$$

uvjet nosivosti

$$F_{v,Rd} > F_{v,Sd}$$

$$37,68 \text{ kN} > F_{v,Sd} = V_{Sd} / 4 = 31,33 / 4 = 7,83 \text{ (kN)}$$

- interakcija uzdužne i odrezne sile na vijak:

$$\frac{F_{v,Sd}}{F_{v,Rd}} + \frac{F_{t,Sd}}{1,4 \cdot F_{t,Rd}} \leq 1$$

$$\frac{7,83}{37,68} + \frac{26,035}{1,4 \cdot 56,56} = 0,53 \leq 1$$

→ Vijci zadovoljavaju.

#### 4) Proračun ploče

- proračun dimenzija ploče:

$$b_{pl,min} = b + 2 \cdot a \cdot \sqrt{2} + 20 \text{ mm} = 250 + 2 \cdot 4 \cdot \sqrt{2} + 20 = 281,31 \text{ (mm)}$$

Odabrane dimenzije ploče: 500x300 mm

Proračun debljine ploče:

- pritisak po omotaču rupe osnovnog materijala:

$$F_{V,Sd} = \frac{V_{Sd}}{2} = 15,66 \text{ (kN)} \equiv F_{b,Sd}$$

$$F_{b,Rd} = \frac{F_{b,Rk}}{1,25} \cdot \frac{t_{pl}}{10} = \frac{162,9}{1,25} \cdot \frac{t_{pl}}{10} = F_{b,Sd} = 15,66 \text{ (kN)}$$

$$\Rightarrow t_{pl}^{\min} = 1,20 \text{ (mm)}$$

- savijanje ploče od vlačnih vijaka:

$$M_{Sd} = F_{t,Sd} \cdot c = 104,14 \cdot 2 \cdot 0,05 = 10,414 \text{ (kNm)}$$

$$M_{Sd} \leq \frac{W_{\min} \cdot f_y}{1,1} \Rightarrow W_{\min} = \frac{1,1 \cdot M_{Sd}}{f_y} = \frac{b_{pl} \cdot t_{pl}^{\min}}{6}$$

$$t_{pl}^{\min} = \sqrt{\frac{1,1 \cdot M_{Sd} \cdot 6}{b_{pl} \cdot f_y}} = \sqrt{\frac{1,1 \cdot 10,41 \cdot 100 \cdot 6}{30 \cdot 35,5}} = 2,53 \text{ (cm)}$$

$$t_{pl} \geq 2,53 \text{ (cm)} \Rightarrow t_{pl,odabrano} = 26 \text{ (mm)}$$

Usvojene dimenzije ploče: 500x300x26 mm

## 7. Temelj

Proračun temelja izvršen je u programu Aspalathos kalkulator, gdje je temelj dimenzioniran na najveći moment koji se javlja pri graničnom stanju nosivosti.

**BETON**

C 25/30

 $\gamma_b = 24 \text{ kN/m}^3$ **ARMATURA**

B 500/550

 $f_{yk} = 500 \text{ N/mm}^2$  $\gamma_s = 1,15$  $f_{yd} = f_{yk} / \gamma_s = 434,8 \text{ N/mm}^2$ **TLO** $f_{tla,dop} = 0,4 \text{ MN/m}^2$ **REZNE SILE** $N = -124,28 \text{ kN}$  $M_z = 347,39 \text{ kN}$ **SILE**

$$A = b_x \cdot b_y = 9 \text{ m}^2$$

$$W_x = \frac{b_x \cdot b_y^2}{6} = 4,5 \text{ m}^2$$

$$W_y = \frac{b_y \cdot b_x^2}{6} = 4,5 \text{ m}^2$$

$$N_{sd} = N - \gamma_b \cdot b_x \cdot b_y \cdot d = -448,28 \text{ kN}$$

$$M_{sd,x} = M_x + N \cdot c_x = 0 \text{ kNm}$$

$$M_{sd,y} = M_y + N \cdot c_x = 347,39 \text{ kNm}$$

$$e_x = \frac{M_{sd,y}}{N_{sd}} = -77,49 \text{ cm}$$

$$e_y = \frac{M_{sd,x}}{N_{sd}} = 0 \text{ cm}$$

**NAPREZANJA U TLU**

$$\sigma_1 = 0,00 \text{ MN/m}^2$$

$$\sigma_2 = 0,13739 \text{ MN/m}^2$$

$$\sigma_3 = 0,13739 \text{ MN/m}^2$$

$$\sigma_4 = 0,00 \text{ MN/m}^2$$

**ARMATURA**

$$M_{1-1} = 2,1 \text{ kNm}$$

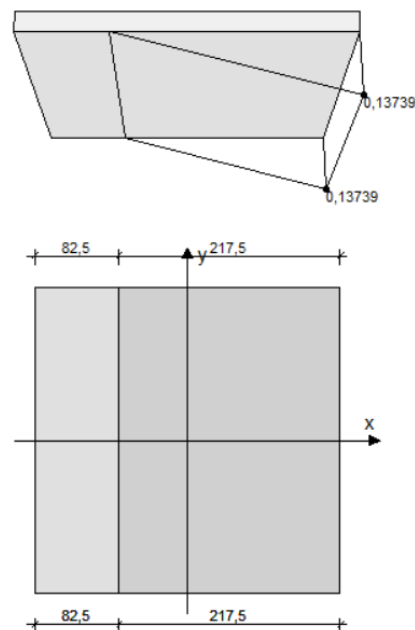
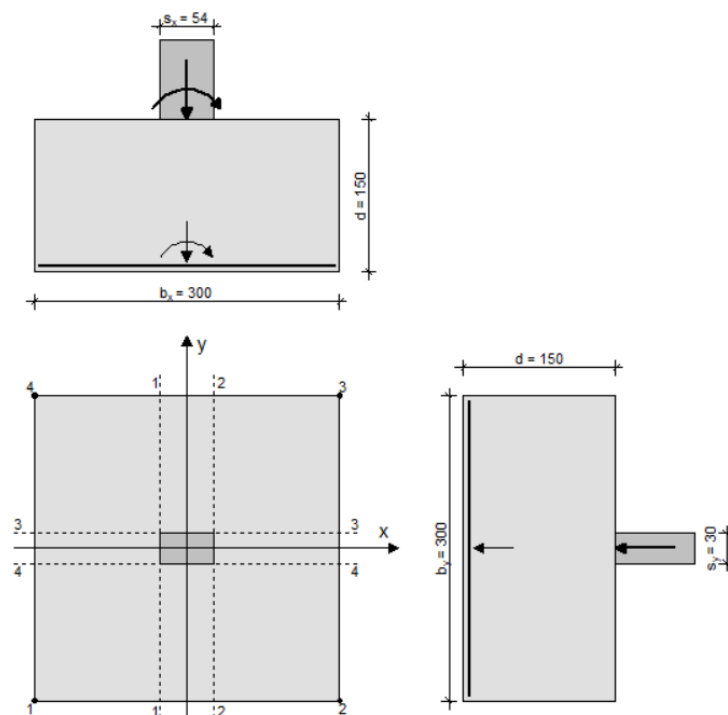
$$M_{2-2} = 253,02 \text{ kNm}$$

$$M_{3-3} = 32,9 \text{ kNm}$$

$$M_{4-4} = 32,9 \text{ kNm}$$

$$A_{sx} = \frac{M_{2-2}}{0,9 \cdot d \cdot f_{yd}} = 4,46 \text{ cm}^2$$

$$A_{sy} = \frac{M_{3-3}}{0,9 \cdot d \cdot f_{yd}} = 0,58 \text{ cm}^2$$





## 8. Nacrti

## 9. Reference

[1] HRN EN 1991-1-3 : DJELOVANJA NA KONSTRUKCIJE – OPTEREĆENJE SNIJEGOM

[2] HRN EN 1991-1-4 : DJELOVANJA NA KONSTRUKCIJE – OPTEREĆENJE VJETROM

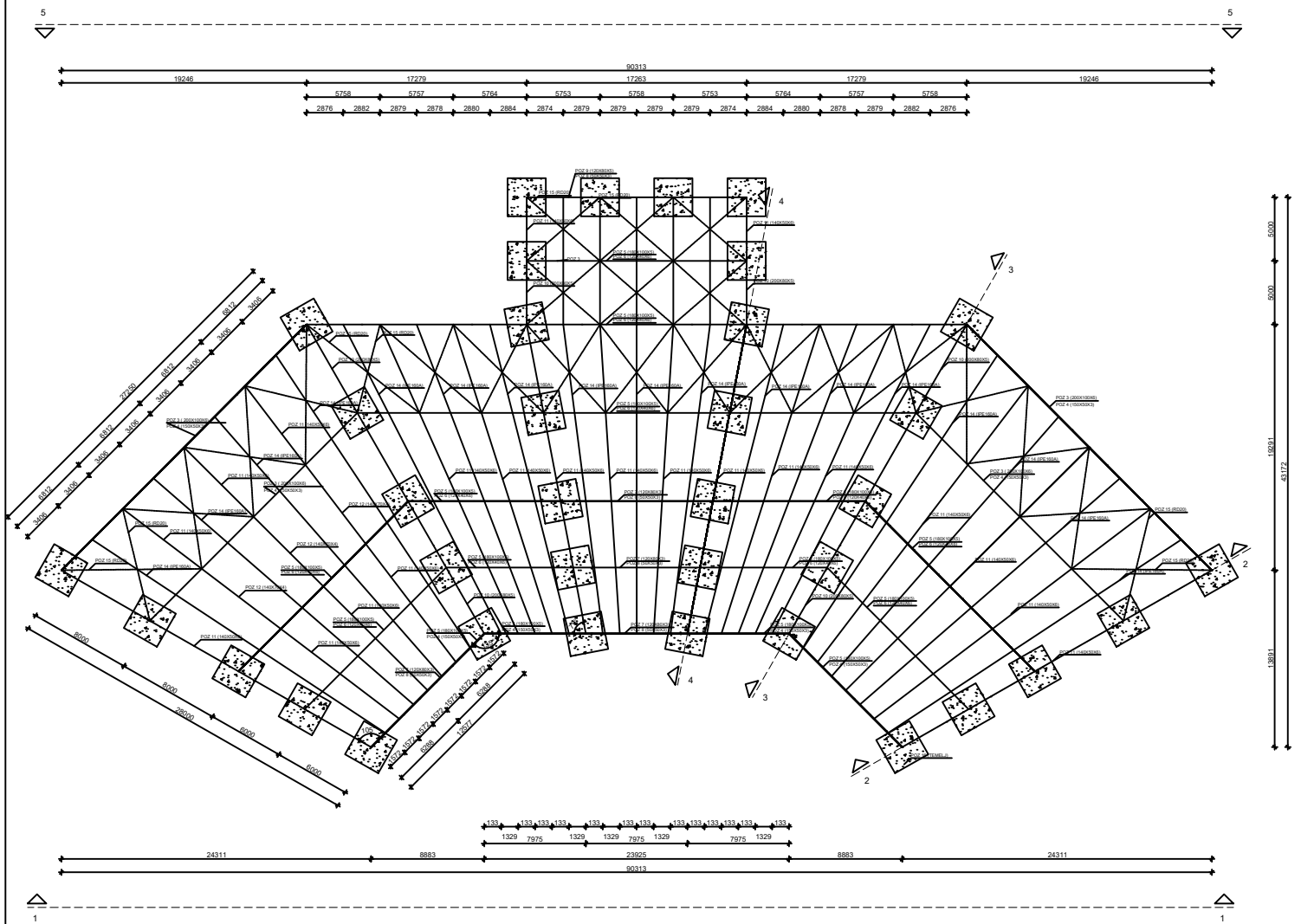
[3] HRN EN 1991-1-5 : DJELOVANJA NA KONSTRUKCIJE – TOPLINSKA DJELOVANJA

[http://klima.hr/k1/k1\\_9/SLnormY7100p50\\_detaljno.pdf](http://klima.hr/k1/k1_9/SLnormY7100p50_detaljno.pdf) - Snijeg

[http://klima.hr/k1/k1\\_9/obvY9201p50\\_detaljno.pdf](http://klima.hr/k1/k1_9/obvY9201p50_detaljno.pdf) -Vjetar

[http://www.kartografija.hr/tl\\_files/Hkd/dogadjaji/Svjetski%20dan%20GISa/prezentcije/03\\_2012\\_Svjetski%20dan%20GIS\\_temperature\\_MPTadic\\_web.pdf](http://www.kartografija.hr/tl_files/Hkd/dogadjaji/Svjetski%20dan%20GISa/prezentcije/03_2012_Svjetski%20dan%20GIS_temperature_MPTadic_web.pdf) -Temperatura

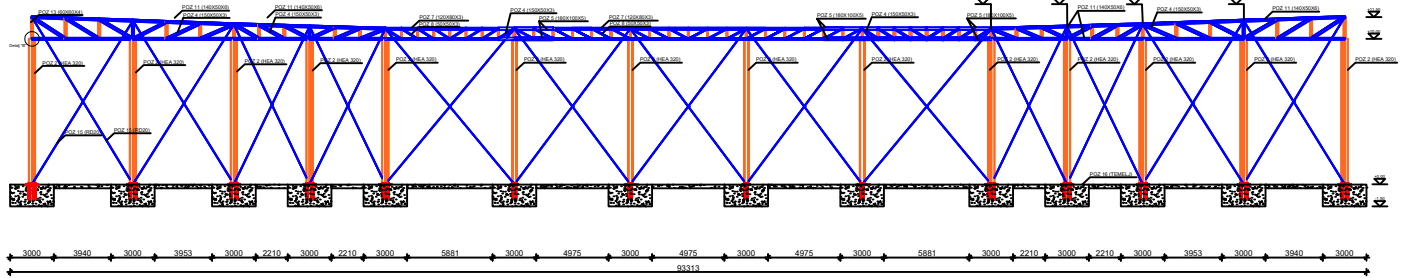
TLOCRT



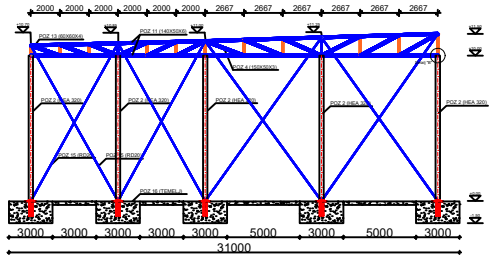
PLAN POZICIJA NOSIVE KONSTRUKCIJE  
 M 1:100  
 ČELIK S365  
 BETON C 25/30

	DOPUNJENA TABLA KONSTRUKCIJA IZ OBLASTI GRAĐEVINARSTVA I PROMETNEGA PROMETA	
	Lora Buki, 087	dr. sc. N. Tudić
PROJEKTOVALA IZVEDENIČKI PROJEKTOVALA IZVEDENIČKI	PROJEKTOVALA IZVEDENIČKI PROJEKTOVALA IZVEDENIČKI	PROJEKTOVALA IZVEDENIČKI PROJEKTOVALA IZVEDENIČKI

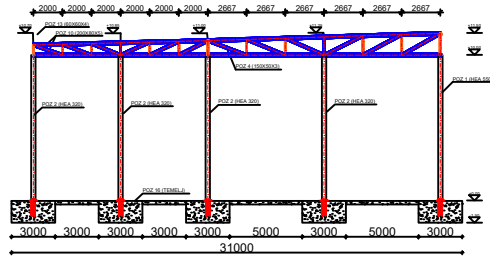
POGLED 1-1



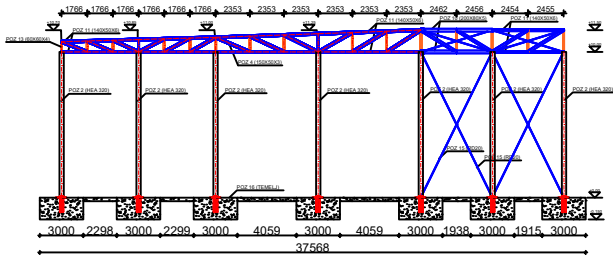
PRESJEK 2-2



PRESJEK 3-3



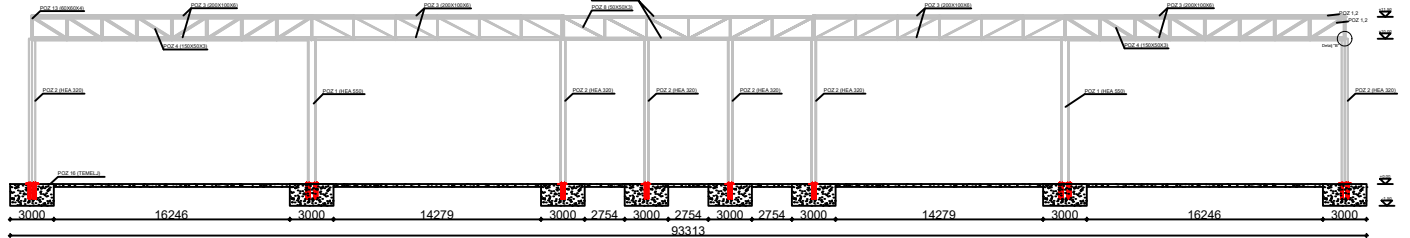
PRESJEK 4-4



POZICIJA	PROFIL	NAZIV
POZ. 1	HEA 550	Šip 1
POZ. 2	HEA 320	Šip 2
POZ. 3	CFRHS 200X100M	Četvrti donji pojas rešetke
POZ. 4	CFRHS 150X50K3	Diagonala rešetke
POZ. 5	CFRHS 180X100K3	Četvrti donji pojas rešetke
POZ. 6	CFRHS 120X60M	Diagonala rešetke
POZ. 7	CFRHS 120X60K3	Četvrti donji pojas rešetke
POZ. 8	CFRHS 50x50K3	Diagonala rešetke
POZ. 9	CFRHS 120X60K5	Četvrti donji pojas rešetke
POZ. 10	CFRHS 200X80K5	Četvrti donji pojas rešetke
POZ. 11	CFRHS 140X50K6	Četvrti donji pojas rešetke
POZ. 12	CFRHS 140X70K4	Četvrti donji pojas rešetke
POZ. 13	CFRHS 60X60K4	Vertikalna
POZ. 14	IPE 165A	Pročelnica
POZ. 15	RD 20	Stropnjača
POZ. 16	TEMELJ	Temeljni stup

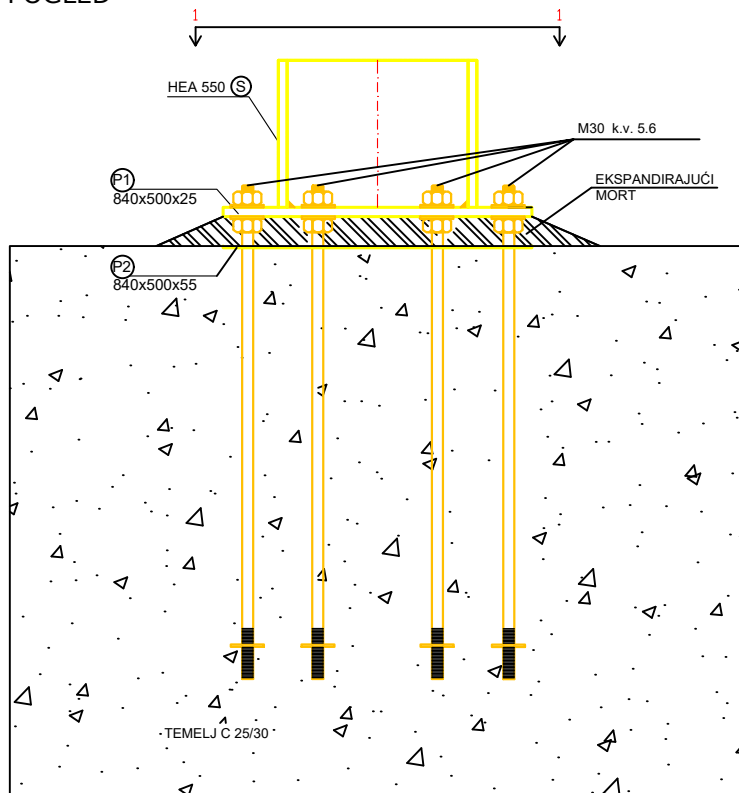
PLAN POZICIJA NOSIVE KONSTRUKCIJE  
M 1:100  
ČELIK S355  
BETON C 25/30

POGLED 5-5



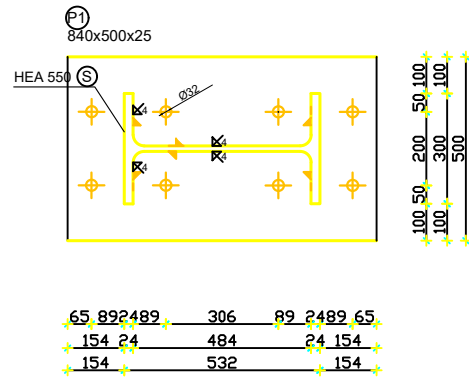
	ODLUČENJE IZ KONSTRUKCIJSKOG OBLASTNOG PRAVILNIKA NA OBLASTI:
	Loma Pušk. 887 10000 10000
Datum: 10.10.2023. Str. 9. Iz 9.	Projektant:
Datum: 10.10.2023. Str. 9. Iz 9.	Projektant:

POGLED



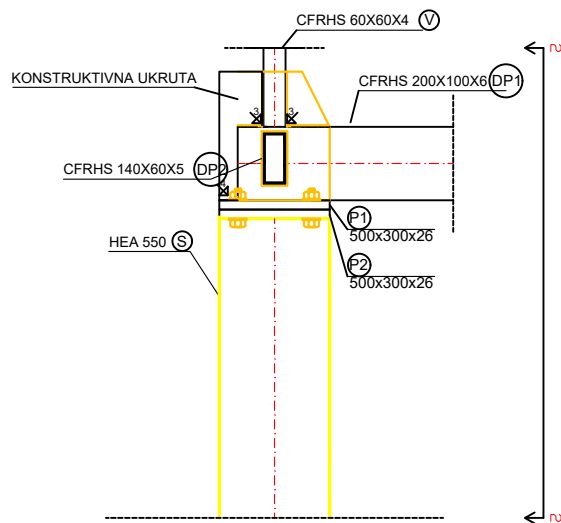
DETALJ "A"  
SPOJ STUP-TEMELJ  
M 1:10

PRESJEK 1-1

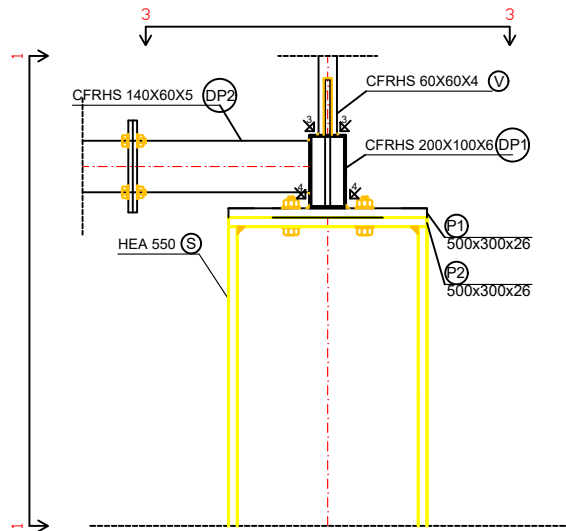


<p>FAKULTET GRAĐEVINARSTVA I ARHITEKTURE I ODJEL ZA KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE 20000 SPILE, KAMENJE, HRVATSKO, 15</p>	DIPLOMSKI RAD	
	PROGRAM: KONSTRUKCIJA IZLOŽBENOG PAVILJONA NA PELJEŠČU	
	STUDENT: Loris Bulić, 687	MENTOR: dr.sc. N.Torić
	ŠADRŽAJ DATUM	SPOJ STUP TEMELJ 2018./2019.

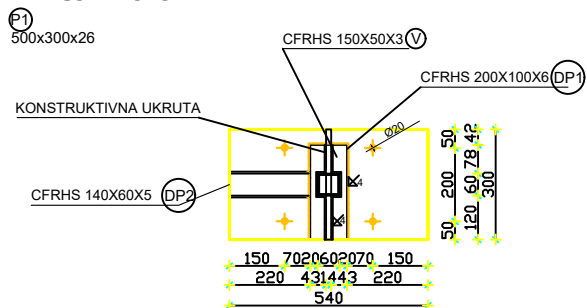
POGLED 1




POGLED 2



PRESJEK 3-3

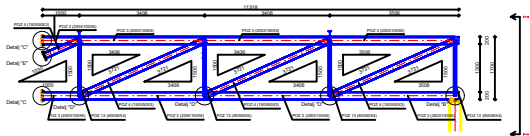


7.4 DETALJ "B"  
SPOJ STUP-REŠETKA  
M 1:10

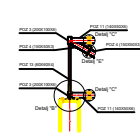
 <p>FAKULTET GRAĐEVINARSTVA I ARHITEKTURE I ODJEL ZA KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE 20000 SPILE, KAMENICE, HRVATSKA, 15</p>	DIPLOMSKI RAD	
	PROGRAM: KONSTRUKCIJA IZLOŽBENOG PAVILJONA NA PELJEŠČU	
	STUDENT: Loris Bulić, 687	MENTOR: dr. sc. N. Torić
	SAĐRŽAJ: DETALJ SPOJA STUP REŠETKA	MJERILO: 1:10
	DATUM: 2018./2019	PRILOG: 4



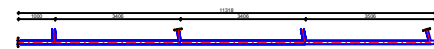
POGLED



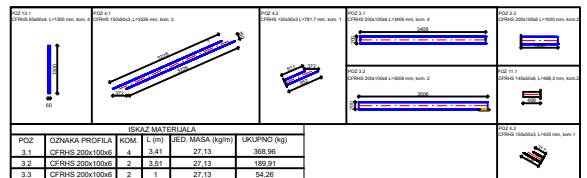
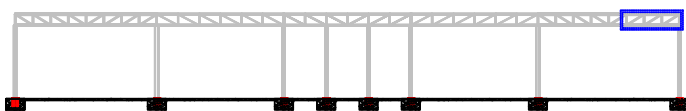
PRESJEK A-A



TLOCRT SEGMENTA



POGLED 5-5 segment

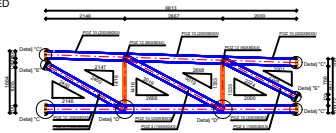


RISIKOZ MATERIJALA					
POZ	OZNAKA PROFILA	KOM	L (m)	JED. MASA (kg/m)	UKUPNO (kg)
3.1	CFRHS 200x100x6	4	3,41	27,13	368,96
3.2	CFRHS 200x100x6	2	3,51	27,13	189,91
3.3	CFRHS 200x100x6	2	1	27,13	54,26
13.1	CFRHS 60x60x4	4	1,30	7,03	36,57
4.1	CFRHS 160x60x3	3	3,25	6,14	49,53
4.2	CFRHS 160x60x3	1	0,78	6,14	7,31
11.1	CFRHS 140x50x3	2	0,47	16,77	15,76
11.1	CFRHS 140x50x3	1	0,43	6,14	3,93
UKUPNO ZA SVAKO ELEMENTI IZOPISANE MATERIJALE, tona				2	765,33+76,53=841,86

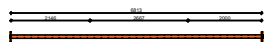
RADIONIČKI NACRT SEGMENTA 1  
MJ 1:50

	DIPLOMSKI RAD	
	KONSTRUKCIJA OZBONJNO PAVILJONA NA PELEJCU	
	Loris Bulić, 687	© sc. N. Tonić
	Radionički nacrti	1:50
Datum: 2019. 02.09.		Stranica: 6

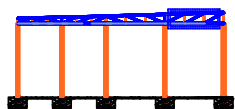
POGLED



TLOCRT SEGMENTA



POGLED 3-3 segment



POZ	OZNAKA PROFILA	KOM	1, (m)	VRH	MAZA (kg/m)	UKUPNO (kg)	
10.1	CFRHS 200x80x5	1	2,67	21,2	56,60		
10.2	CFRHS 200x80x5	1	2,12	21,2	44,94		
10.3	CFRHS 200x80x5	1	2,12	21,2	42,7		
10.4	CFRHS 200x80x5	1	2,15	21,2	45,58		
10.5	CFRHS 200x80x5	1	2,67	21,2	56,60		
10.6	CFRHS 200x80x5	1	2	21,2	42,4		
4.1	CFRHS 150x50x3	1	2,58	9,14	23,58		
4.2	CFRHS 150x50x3	1	2,29	9,14	20,56		
4.3	CFRHS 150x50x3	1	1,99	9,14	16,28		
13.1	CFRHS 60x40x4	2	1,22	7,03	17,15		
UKUPNO NA SVAKOM ELEMENTU (IZDATI-MATERIALNA VRT)						2	367,19+38,72+403,91

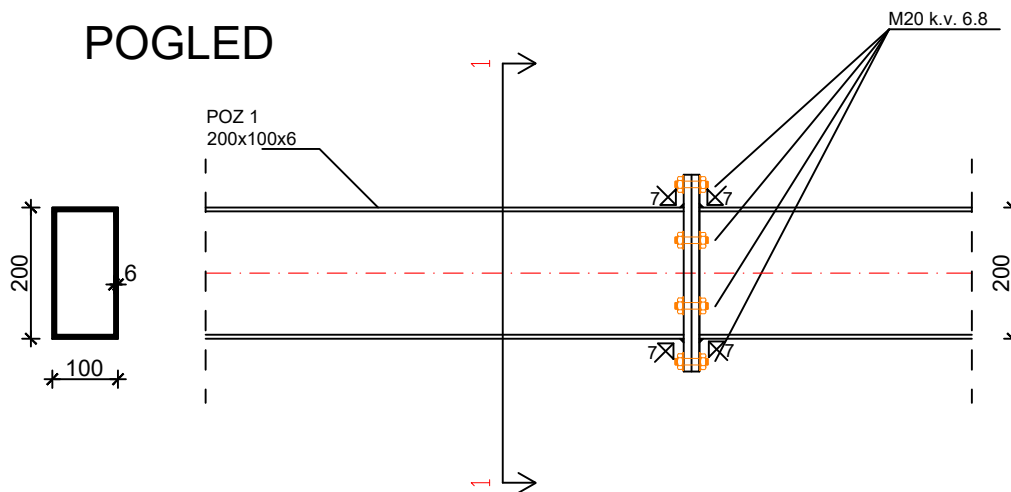
RADIONIČKI NACRT SEGMENTA 2  
MJ 1:50

	DIPLOMSKI RAD	
	KONSTRUKCIJA ODŠEDNICE PAVILJONA NA PELEŠCU	
Autor: Loris Bulić, 687	Mentor:	© sc. N. Tonč
Datum:	Radionički nacrt segment 2	Skala: 1:50
Datum: 2019. 02.09.	Stranica: 6	Ukupno: 6

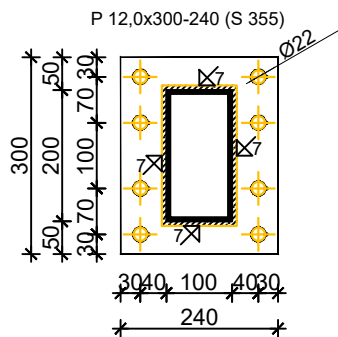
# DETALJ "C"

## MONTAŽNI NASTAVAK REŠETKE

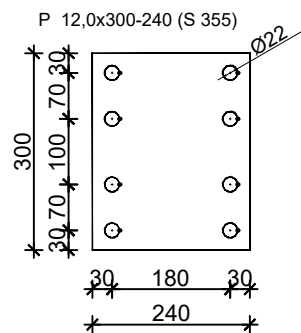
### M 1:10




**PRESJEK 1-1**



**PLOČICA**

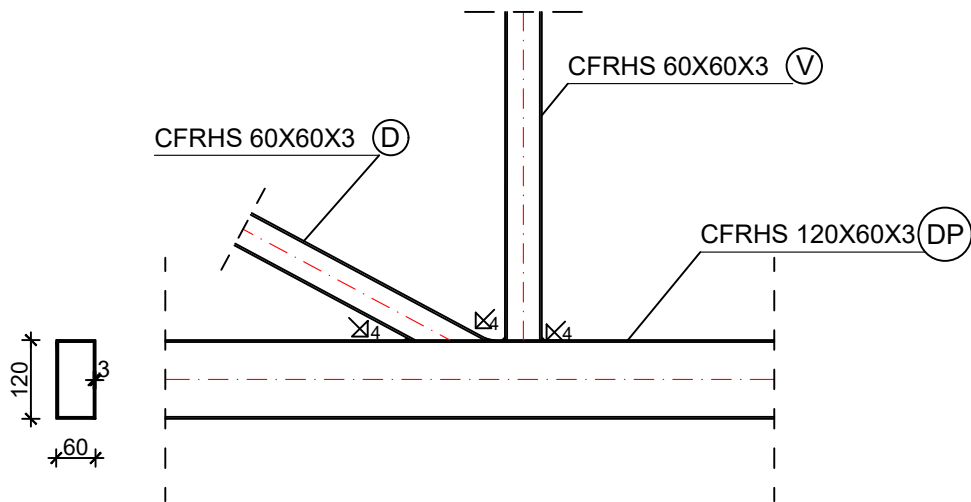



 <p>FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE 21000 SPLIT, MATICE HRVATSKE 15</p>	<b>DIPLOMSKI RAD</b>	
	PROGRAM: KONSTRUKCIJA IZLOŽBENOG PAVILJONA NA PELJEŠCU	
	STUDENT:  <b>Loris Bulić, 687</b>	MENTOR:  <b>dr.sc. N.Torić</b>
	SADRŽAJ: MONTAŽNI NASTAVAK REŠETKE	MJERILO: <b>1:10</b>
	DATUM: <b>2018./2019</b>	PRILOG: <b>7</b>

# DETALJ "D"

## VAR ISPUNE NA GLAVNI POJAS

### M 1:10

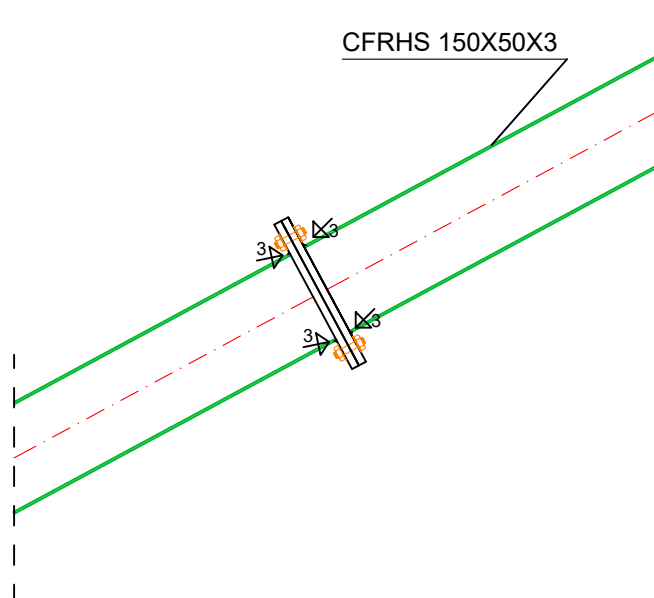


 <p>FAKULTET GRADEVINARSTVA, ARHITEKTURE I GEODEZIJE KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE 21000 SPLIT, MATICE HRVATSKE 15</p>	<b>DIPLOMSKI RAD</b>	
	PROGRAM: KONSTRUKCIJA IZLOŽBENOG PAVILJONA NA PELJEŠČU	
	STUDENT:  <b>Loris Bulić, 687</b>	MENTOR:  <b>dr.sc. N.Torić</b>
	SADRŽAJ DETALJ VARA ISPUNE NA GL.POJAS	MJERILO <b>1:10</b>
	DATUM <b>2018./2019</b>	PRILOG <b>8</b>

# DETALJ "E"

## MONTAŽNI NASTAVAK DIJAGONALE REŠETKE

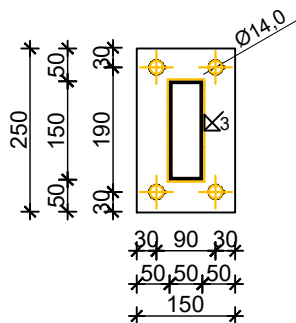
### M 1:10



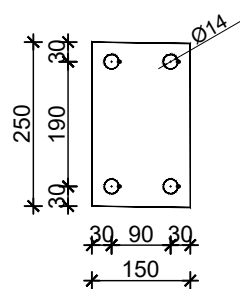
PRESJEK 1-1


PLOČICA

P 10,0x250-150 (S 355)



P 10,0x250-150 (S 355)



 <p>FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE KATEDRA ZA METALNE I DRVENE KONSTRUKCIJE 21000 SPLIT, MATICE HRVATSKE 15</p>	<b>DIPLOMSKI RAD</b>		
	PROGRAM: KONSTRUKCIJA IZLOŽBENOG PAVILJONA NA PELJEŠCU		
	STUDENT:  <b>Loris Bulić, 687</b>	MENTOR:  <b>dr.sc. N.Torić</b>	
	SADRŽAJ	MONTAŽNI NASTAVAK DIJAGONALE REŠETKE	MJERILO 1:10
	DATUM	2018./2019	PRILOG 9