KONUS

d. o. o. Zadar

Ul. Zrinsko Frankopanska 38/A, 23000 Zadar, OIB: 79463561604,
tel: 023/ 251-151, fax: 023/ 254-214, e-mail: konus@zd.t-com.hr

INVESTITOR:	**CENTAR ZA PRUŽANJE USLUA U ZAJEDNICI TEREZA** **Trg dr. Franje Tuđmana 1** **23450 Obrovac** **OIB 55465388570**
GRAĐEVINA:	**POSLOVNA ZGRADA** **Centar za pružanje usluga u zajednici Tereza u suterenu i prizemlju poslovne zgrade**
LOKACIJA:	**k.č. 188, k.o. Zaton Obrovački- stara izmjera, k.č. 1022 k.o. Obrovac - nova izmjera**
RAZINA RAZRADE:	**IZVEDBENI PROJEKT**
STRUKOVNA ODREDNICA:	**PROJEKT KONSTRUKCIJE**
OZNAKA PROJEKTA:	**148/2019 IZ**
ZAJEDNIČKA OZNAKA PROJEKTA:	**148/2019**
MAPA:	
DIO:	
GLAVNI PROJEKTANT:	**Mario Svaguša,** **dipl. ing. arh., A 2872**
PROJEKTANT:	**Vice Tadić,** **dipl. ing. građ., G250**
MJESTO I DATUM IZRADE:	**Zadar, srpanj, 2021.**
MJESTO I DATUM IZRADE ISPRAVKA :	

Direktor:
Vice Tadić dipl. ing. građ.

SADRŽAJ

TEHNIČKI DIO

PROJEKTNA DOKUMENTACIJA
Objekt posjeduje građevinsku dozvolu Klasa: UP-I-361-03/90-01/17, Urbroj: 2153-05-90-2, od 23. 07. 1990. godine.
Statički račun je izradilo poduzeće „Konzaltingplan“ RO za inženjering p.o. 2 Zagreb, Đure Šimunića 12, po odgovornom projektantu konstrukcije mr. Zlatku Maštroviću, dipl. ing. arh., teh. dnevnik broj 792 od kolovoza 1989. godine.
Temeljna konstrukcija objekta posjeduje zasebnu građevinsku dozvolu Klasa: UP-I-361003/89-01/81, Urbroj: 2153-05-89-2 od 31. 10. 1989. godine.
Glavni i izvedbeni projekt temeljne konstrukcije izrađen je od poduzeća „Geotehnika“ iz Zagreba, OOUR „Institut Geoekspert“ Sektor za temeljenje, broj elaborata 803-01-3-12-89.
Snimak izvedenog stanja izradilo je poduzeće Konus d.o.o. Zrinsko Frankopanska 38 a, 23000 Zadar, oznake 88/2018, po ovlaštenom arhitektu Mario Svaguša dipl. ing. arh. iz travnja 2018. godine

IZVEDENO STANJE
Gradnja objekta je započeta, izveden je dio armiranobetonskih radova koji je prikazan u Snimku izvedenog stanja. Izvedena je komplentna armiranobetonska konstrukcija glavne zgrade te temelji, zidovi i stupovi aneksa u suterenu. Aneks u suterenu je odvojen dilatacijskom razdjelnicom od glavne zgrade.

GLAVNA ZGRADA
Konstrukcija je projektirana kao armiranobetonska konstrukcija katnosti suteren, prizemlje, 1. kat i 2. kat. Konstruktivni sustav čine armiranobetonske stropne ploče (pretežno bez greda) stupovi i zidovi.
Na temelju geomehaničkih svojstava temeljnog tla, temeljenje objekta je izvedeno izvedbom bušenih pilota promjera 100 cm, koji opterećenje objekta preko naglavnog roštila i temeljne ploče prenosi u nosivi sloj vapnenačke stijene. Piloti se izvode do dubine koja osigurava ulazak pilota u nosivu vepnenačku stijenu minimalno 2 m. Naglavnu konstrukciju predstavljaju temeljni roštilj od armiranobetonskih greda dimenzija 50/100 cm, 70/100 cm odnosno temeljna ploča debljine 60 cm. Na mjestima pilota izvedeni su naglavni blokovi dimenzija 120 x 120 x 100 cm a ispod greda i ploče izveden je podložni beton debljine 10 cm. Za izvedbu temeljnog roštilja i temeljne ploče koristio se beton MB 30 II i armatura RA 400/500. Za izvedbu bušenih pilota se koristi beton MB 30 i armatura GA 240/360
Svi zidovi su izvedeni debljine 20 cm osim dva suterenska zida (jugoistočni vanjski zid i zid prema suterenskoj dilataciji) koji su izvedeni debljine 30 cm. Zidovi su armirani armaturnim mrežama kvalitete MAG 500/560 a rubna armatura je izvedena s kvalitetom GA 240/360. Svi zidovi debljine 20 cm su armirani obostrano mrežama Q 257 dok su svi zidovi debljine 30 cm armirani obostrano mrežama Q 503.
Stupovi su izveden kao pravokutni 60 x 60 cm i kružni stupovi Φ 60 cm. Svi stupovi su izvedeni betonom MB 30 i armaturom GA 240/360 osim stupova u osi I - prema planu pozicija iz statičkog računa. Oni su izvedeni betonom MB 30 i armirani sa RA 400/500.
Sve stropne konstrukcije su izvedene kao armiranobetonske ploče (pretežno bez greda) debljine 22 i 16 cm betonom MB 30. Armirane su armaturom MAG 500/560 te šipkama GA 240/360.
Grede su armirane uglavnom armaturom GA 240/360 a pojedine pozicije (posebno naznačene u projektu) su armirane sa RA 400/500.

Planirana čelična konstrukcija krovišta nije izvedena.

ANEKS U SUTERENU
Dilatacija u suterenu se temelji plitko na temeljnom roštilju, koji je postavljen na zamjenjujući tampon šljunka debljine 100 cm. Temeljni roštilj sa sastoji od greda dimenzija 70/100 cm koji su položeni na dobro zbijeni sloj šljunka debljine 100 cm. Za izvedbu temeljne konstrukcije koristio se beton MB 30 II. Kvaliteta armature koja se koristila je RA 400/500 za savojnu armaturu i armatura GA 240/360 za poprečnu armaturu (vilice).
Zidovi su izvedeni debljine 30 cm betonom MB 20, armirani obostrano mrežama Q 335 kvalitete MAG 500/560 te rubnom armaturom GA 240/360
Stupovi su izvedeni poprečnog presjeka 60 x 60 cm betonom MB 20, te su armirani armaturom GA 240/360.
Stubište te planirana armiranobetonska ploča nisu izvedeni. Također nisu izvedena ni dva planirana armiranobetoska stupa.

IZVEDBENI PROJEKT

Potrebno je izraditi izvedbeni projekt rekonstrukcije armiranobetonske konstrukcije koji obuhvaća plan oplate i armaturne nacrte betonske ploče garaže koja nije izvedena, te vanjskog čeličnog stubište i čelične konstrukcije kosog krovišta isto tako koji nisu izvedeni.

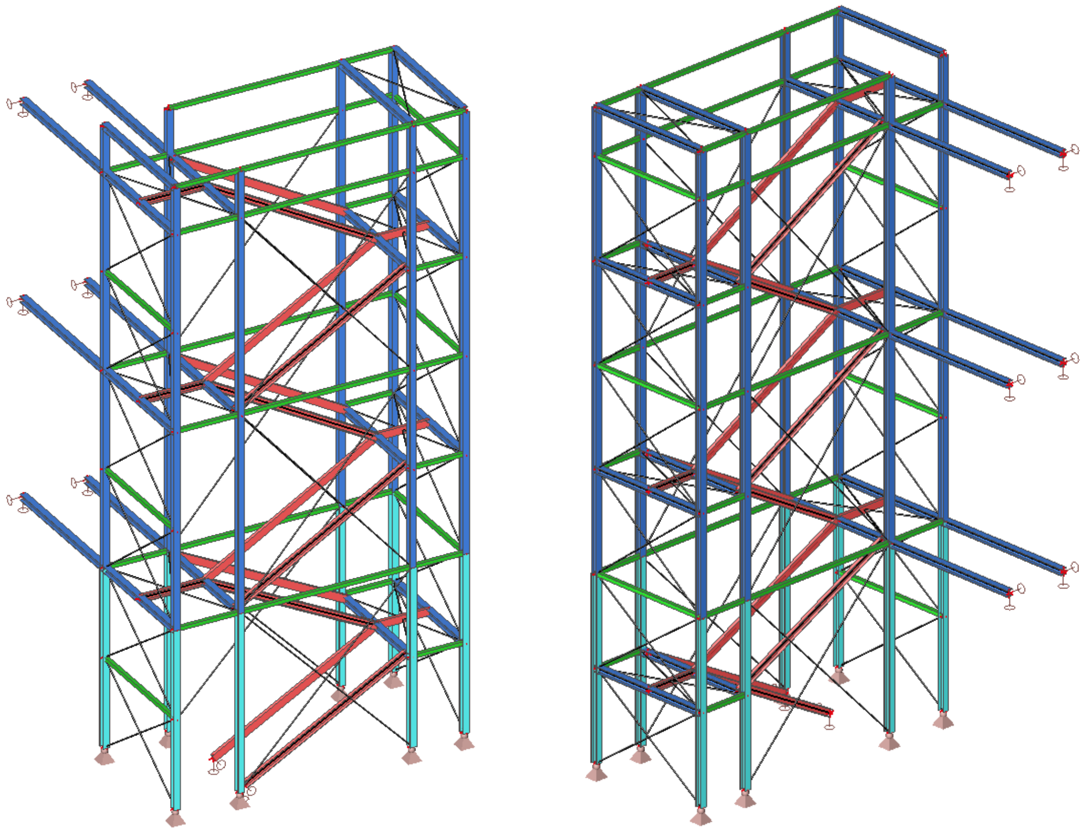
ČELIČNA KONSTRUKCIJA

SADRŽAJ

1.1. Proračun čelične konstrukcije vanjskog stubišta

U nastavku je proveden kontrolni proračun čelične nosive konstrukcije vanjskog stubišta Centra za pružanje usluga u zajednici Tereza u Obrovcu, nakon čega slijedi proračun priključaka osnovne nosive konstrukcije.

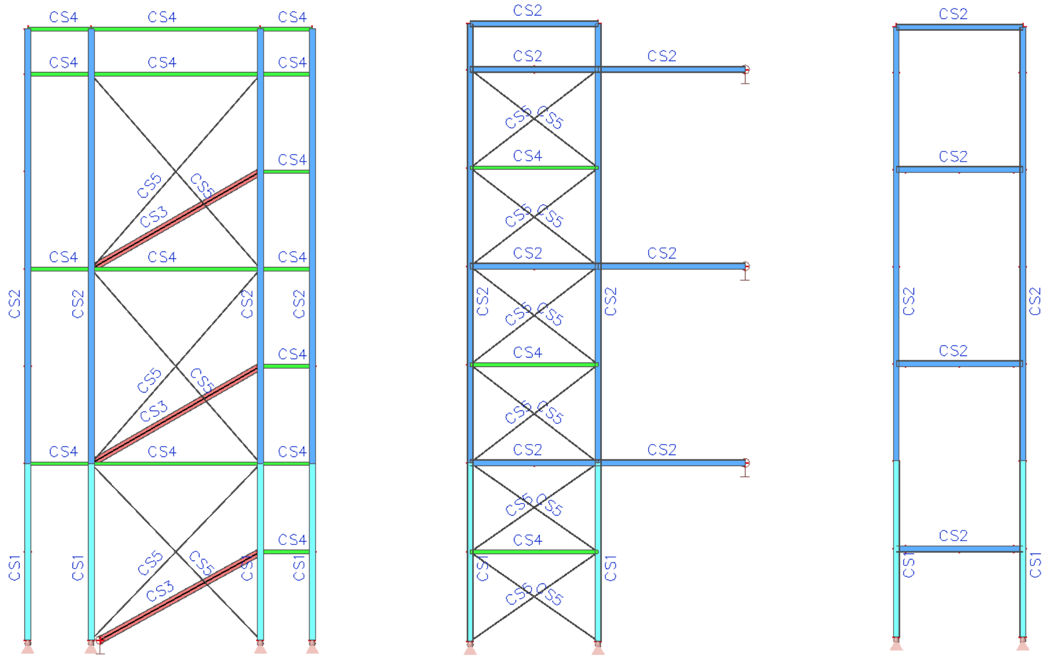
Prostorni prikaz konstrukcije



Horizontalna stabilizacija u podnim ravninama modelirana je kako bi se osigurala stabilnost konstrukcije. U stvarnosti će se u podnim ravninama izvesti čelično rešetkasto gazište, koje je samo po sebi kruće od horizontalne stabilizacije. **Slijedom navedenog, horizontalnu stabilizaciju u podnim ravninama nije potrebno izvesti.**

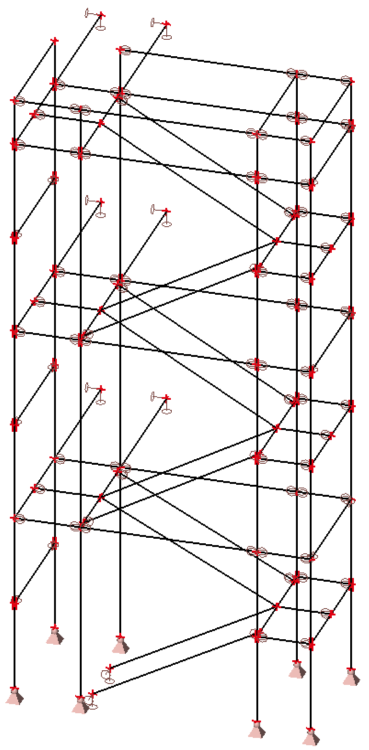
Poprečni presjeci u konstrukciji

Name	Type	Item material	Fabrication	A $[m^2]$	A_y $[m^2]$	I_y $[m^4]$	$W_{el.y}$ $[m^3]$	$W_{pl.y}$ $[m^3]$	Colour
	Detailed				A_z $[m^2]$	I_z $[m^4]$	$W_{el.z}$ $[m^3]$	$W_{pl.z}$ $[m^3]$	
CS1	HEB140	S 355	rolled	4.2960e-03	3.2839e-03	1.5090e-05	2.1560e-04	2.4540e-04	
					1.0326e-03	5.4970e-06	7.8520e-05	1.1980e-04	
CS2	HEA140	S 355	rolled	3.1400e-03	2.3063e-03	1.0300e-05	1.5500e-04	1.7333e-04	
					7.7401e-04	3.8900e-06	5.5600e-05	8.5000e-05	
CS3	UPE160	S 235	rolled	2.1700e-03	1.2618e-03	9.1100e-06	1.1400e-04	1.3200e-04	
					8.8953e-04	1.0700e-06	2.2600e-05	4.0700e-05	
CS4	RRK80/80/4	S 235	cold formed	1.1750e-03	6.2231e-04	1.1100e-06	2.7800e-05	3.3100e-05	
					6.2231e-04	1.1100e-06	2.7800e-05	3.3100e-05	
CS5	RD22	S 355	rolled	3.7994e-04	3.4254e-04	1.1258e-08	1.0235e-06	1.7467e-06	
					3.4254e-04	1.1258e-08	1.0235e-06	1.7467e-06	



Oslonci konstrukcije

Oslonci stupova modelirani su kao zglobni (ne prenose moment savijanja), dok su bočni prihvati na zid modelirani tako da ne prenose moment savijanja i uzdužnu silu.



Djelovanja na konstrukciju

Djelovanja na konstrukciju preuzeta su iz Glavnog projekta koji je izradio projektantski ured KONUS d.o.o. (projektant Vice Tadić, dipl.ing.građ., oznaka projekta 148/2019 GL-K).

Stalno opterećenje	$g = 1{,}40\ kN/m^2$
Uporabno opterećenje	$q = 3{,}00\ kN/m^2$
Opterećenje snijegom	$s_k = 0{,}75\ kN/m^2$
Opterećenje vjetrom	$v_b = 35\ m/s$
Temperatura [+]*	T = + 60°C
Temperatura [-]*	T = - 25°C

*S obzirom da je sustav stabiliziran vlačnim dijagonalama, temperaturno djelovanje (u obliku uzdužne sile) neće imati značajan utjecaj na konstrukciju. Slijedom navedenog, temperatura se neće razmatrati u nastavku.

Opterećenje snijegom sukladno normi HRN EN 1991-1-3.

Karakteristično opterećenje snijegom na tlu	$s_k = 0{,}75\ kN/m^2$
Koeficijent umanjenja za nagib α < 30°	$\mu_i = 0{,}8$
Opterećenje snijegom na konstrukciju	$s_1 = 0{,}75 \cdot 0{,}8 = 0{,}60\ kN/m^2$

Opterećenje vjetrom sukladno normi EN 1991-1-4.

Srednja brzina vjetra (okomito na plohu)	$v_{b,0} = 35\ m/s$
Kategorija terena: II (izolirane prepreke)	Ce(z=13,50 m) = 2,53
Referentni pritisak srednje brzine vjetra	$q_b = 0{,}77\ kN/m^2$

S obzirom da je arhitektonskim projektom predviđeno bočno oblaganje stubišta perforiranim limom, djelovanje vjetra razmatrat će se kao na zatvoreni objekt, čime je proračun na stani sigurnosti.

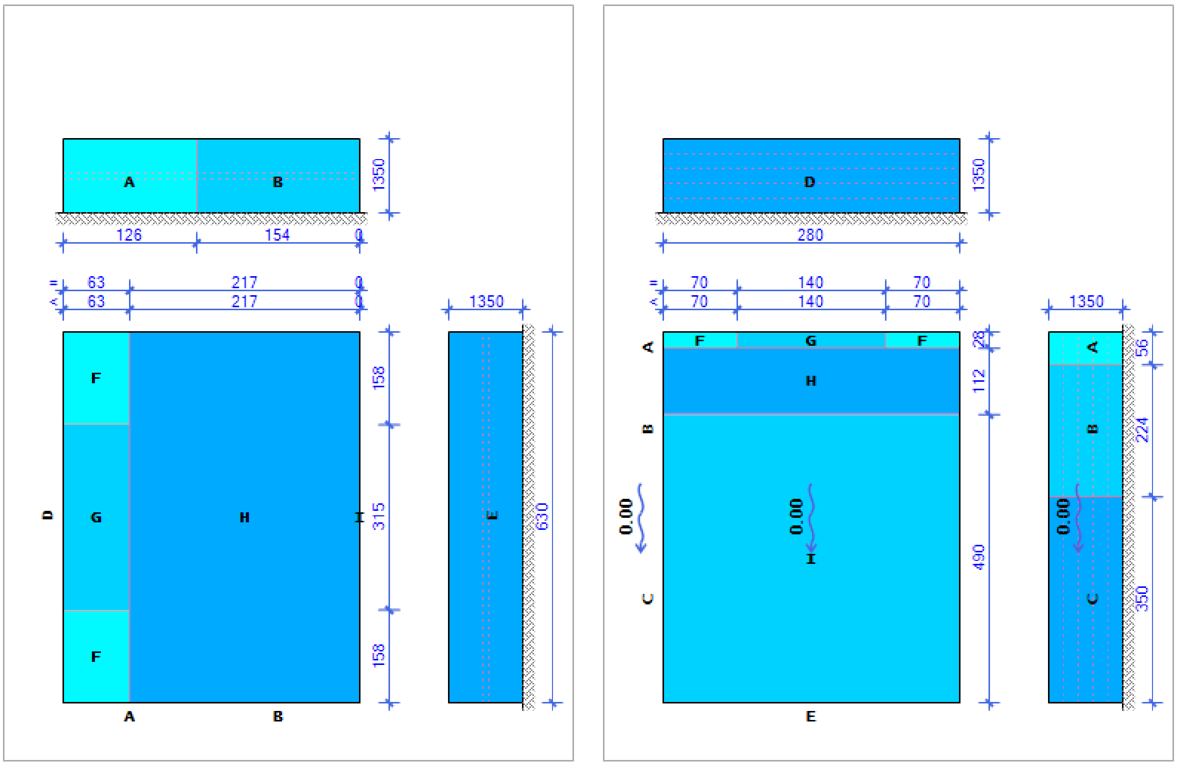
Vjetar puše s lijeve strane (slika lijevo):

$W_{LJ\ MAX}$	**A**	**B**	**C**	**D**	**E**		**F**	**G**	**H**	**I**
$C_{e(13.50)}$	-2.12	-0.97	-	2.13	-0.39	$C_{e(13.50)}$	-4.26	-2.83	-0.78	0.00
$C_{e(6.30)}$	-1.70	-0.78	-	1.72	-0.31					
$W_{LJ\ MIN}$										
$C_{e(13.50)}$	-3.08	-1.94	-	1.16	-1.36	$C_{e(13.50)}$	-5.23	-3.80	-1.74	0.00
$C_{e(6.30)}$	-2.48	-1.56	-	0.94	-1.09					

Vjetar puše sa gornje strane (slika desno):

$W_{GO\ MAX}$	**A**	**B**	**C**	**D**	**E**		**F**	**G**	**H**	**I**
$C_{e(13.50)}$	-1.91	-0.97	-0.39	2.13	-0.39	$C_{e(13.50)}$	-4.26	-3.30	-1.26	0.19
$C_{e(5.43)}$	-1.48	-0.75	-0.30	1.66	-0.30					
$W_{GO\ MIN}$										
$C_{e(13.50)}$	-2.88	-1.94	-1.36	1.16	-1.36	$C_{e(13.50)}$	-5.23	-4.26	-2.23	-0.78
$C_{e(5.43)}$	-2.24	-1.51	-1.05	0.90	-1.05					

Shematski prikaz ploha vjetra; smjer vjetra lijevo i gore:



Odabrane vrijednosti pritiskajućeg vjetra smjer Y:

w_D = 2,13 kN/m^2
w_E = -0,39 kN/m^2
w_B = (-2,12-0,97)/2 = -1,55 kN/m^2
$w_{pritisak}$ = 0 kN/m^2

Odabrane vrijednosti odižućeg vjetra smjer Y:

w_D = 1,16 kN/m^2
w_E = -1,36 kN/m^2
w_B = (-3,08-1,94)/2 = -2,51 kN/m^2
$w_{odizanje}$ = w_H = -1,74 kN/m^2

Odabrane vrijednosti pritiskajućeg vjetra smjer X:

w_D = 2,13 kN/m^2
w_E = -0,39 kN/m^2
w_B = (-0,97-0,39)/2 = -0,68 kN/m^2
$w_{pritisak}$ = 0,19 kN/m^2

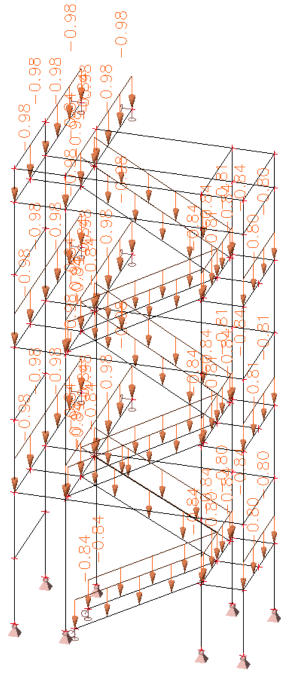
Odabrane vrijednosti odižućeg vjetra smjer X:

w_D = 1,16 kN/m^2
w_E = -1,36 kN/m^2
w_B = (-1,94-1,36)/2 = -1,65 kN/m^2
$w_{odizanje}$ = w_H = -2,23 kN/m^2

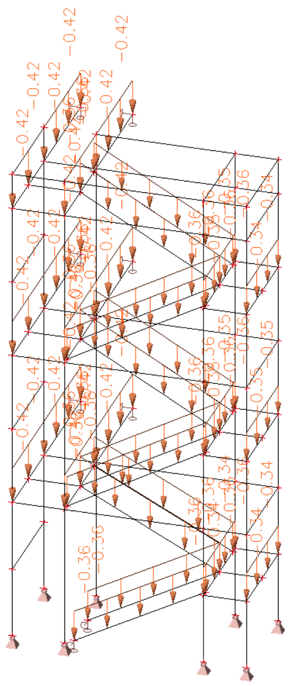
Shematski prikaz djelovanja na konstrukciju (vlastita težina uzeta automatski):

Name	Description	Load type	Action type	Load group	Spec	Duration
LC1	Vlastita tezina	Self weight	Permanent	LG1		
LC2	Stalno	Standard	Permanent	LG1		
LC3	Snijeg	Static	Variable	LG2	Standard	Medium
LC4	Uporabno	Static	Variable	LG3	Standard	Medium
LC5	Vjetar pritisak X	Static	Variable	LG3	Standard	Medium
LC6	Vjetar odizanje X	Static	Variable	LG3	Standard	Medium
LC7	Vjetar pritisak Y	Static	Variable	LG3	Standard	Medium
LC8	Vjetar odizanje Y	Static	Variable	LG3	Standard	Medium

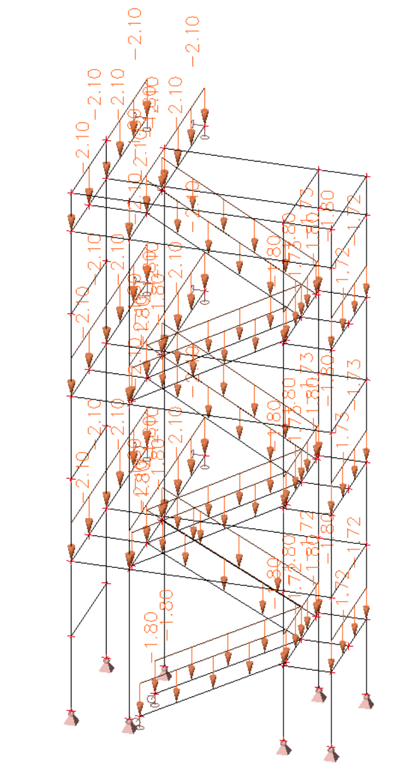
Name	Description	Load type	Action type	Load group
LC2	Stalno	Standard	Permanent	LG1



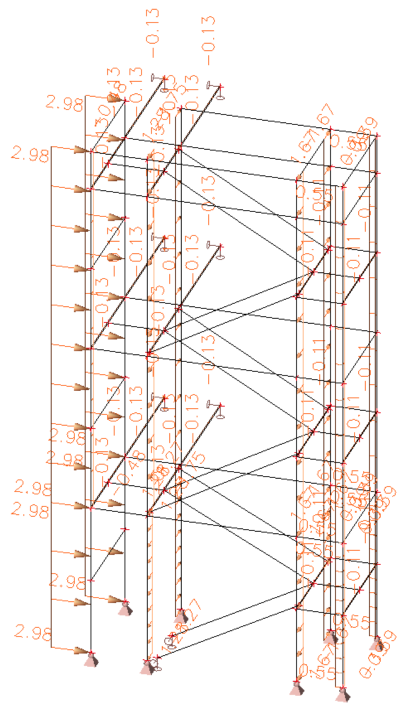
Name	Description	Load type	Action type	Load group	Spec	Duration
LC3	Snijeg	Static	Variable	LG2	Standard	Medium



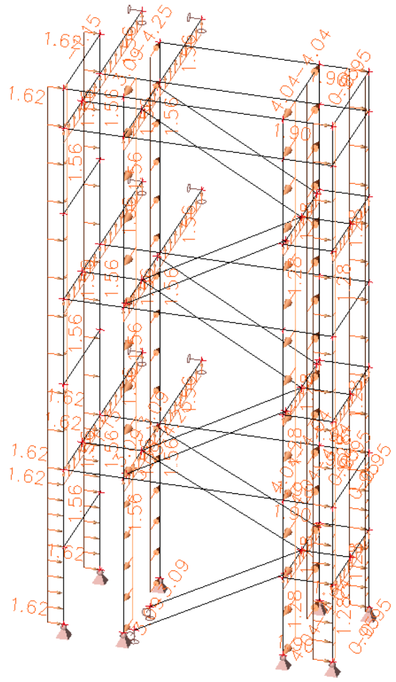
Name	Description	Load type	Action type	Load group	Spec	Duration
LC4	Uporabno	Static	Variable	LG3	Standard	Medium



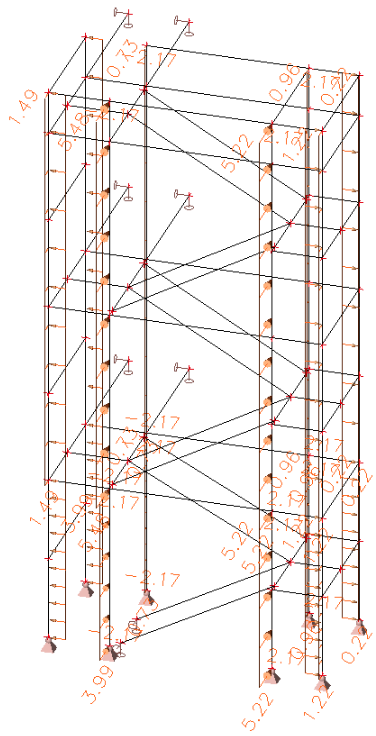
Name	Description	Load type	Action type	Load group	Spec	Duration
LC5	Vjetar pritisak X	Static	Variable	LG3	Standard	Medium



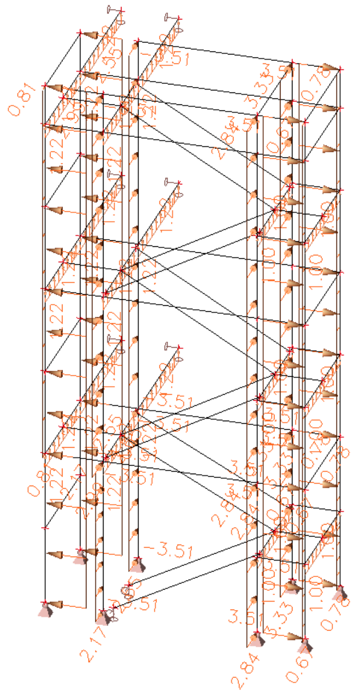
Name	Description	Load type	Action type	Load group	Spec	Duration
LC6	Vjetar odizanje X	Static	Variable	LG3	Standard	Medium



Name	Description	Load type	Action type	Load group	Spec	Duration
LC7	Vjetar pritisak Y	Static	Variable	LG3	Standard	Medium



Name	Description	Load type	Action type	Load group	Spec	Duration
LC8	Vjetar odizanje Y	Static	Variable	LG3	Standard	Medium



Kombinacije djelovanja na konstrukciju

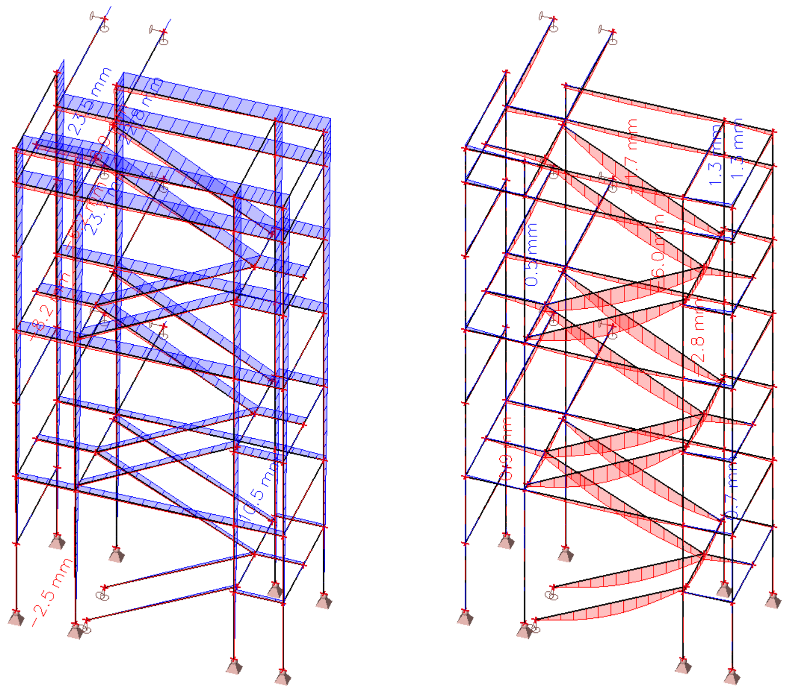
Name	Description	Type	Load cases	Coeff. [-]
GSN1		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
GSN2		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.50
GSN3		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC5 - Vjetar pritisak X	1.50
GSN4		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC7 - Vjetar pritisak Y	1.50
GSN5		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC6 - Vjetar odizanje X	1.50
GSN6		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC8 - Vjetar odizanje Y	1.50
GSN7		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC5 - Vjetar pritisak X	0.90
GSN8		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC7 - Vjetar pritisak Y	0.90
GSN9		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.50
			LC5 - Vjetar pritisak X	0.90
GSN10		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.50
			LC7 - Vjetar pritisak Y	0.90
GSN11		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC5 - Vjetar pritisak X	1.50
GSN12		Envelope - ultimate	LC1 - Vlastita tezina	1.35

Name	Description	Type	Load cases	Coeff. [-]
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.05
			LC5 - Vjetar pritisak X	1.50
GSN13		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC7 - Vjetar pritisak Y	1.50
GSN14		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.05
			LC7 - Vjetar pritisak Y	1.50
GSU1		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
GSU2		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	1.00
GSU3		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC5 - Vjetar pritisak X	1.00
GSU4		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC7 - Vjetar pritisak Y	1.00
GSU5		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC6 - Vjetar odizanje X	1.00
GSU6		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC8 - Vjetar odizanje Y	1.00
GSU7		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC5 - Vjetar pritisak X	0.60
GSU8		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC7 - Vjetar pritisak Y	0.60
GSU9		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	1.00
			LC5 - Vjetar pritisak X	0.60
GSU10		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	1.00
			LC7 - Vjetar pritisak Y	0.60
GSU11		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC5 - Vjetar pritisak X	1.00
GSU12		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	0.70
			LC5 - Vjetar pritisak X	1.00
GSU13		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC7 - Vjetar pritisak Y	1.00
GSU14		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	0.70
			LC7 - Vjetar pritisak Y	1.00

Pomaci i deformacije konstrukcije

U nastavku je dan grafički prikaz maksimalnih deformacija konstrukcije za anvelopu graničnog stanja uporabivosti.

Values: $\mathbf{u_y}$ (lijevo) i $\mathbf{u_z}$ (desno)
Class: Anvelopa GSU
Extreme 1D: Cross-section



Maksimalni pomak vrha objekta u_{max} = 23,5 mm < u_{dop} = H/300 = 13500/300 = 45 mm
Maksimalni progib tetive u_{max} = 6 mm < u_{dop} = L/250 = 4300/250 = 17,2 mm

Rezne sile u konstrukciji

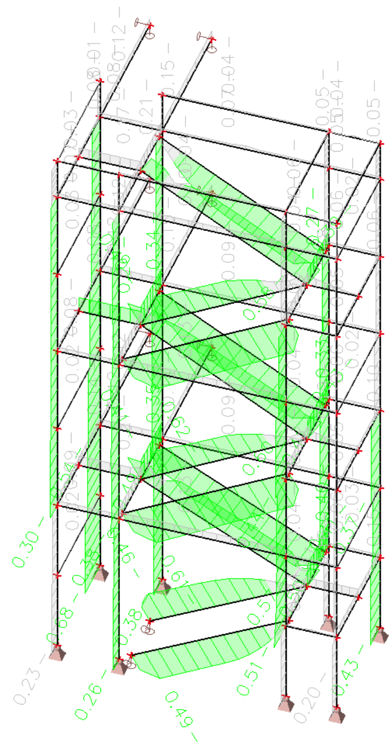
U nastavku je dan tablični prikaz maksimalnih reznih sila po tipu poprečnog presjeka za anvelopu GSN. Detaljan grafički prikaz reznih sila u pojedinim konstrukcijskim elementima dan je u točki 1.2. Proračun priključaka.

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B2	0.000	GSN14/1	CS1 - HEB140	**-348.77**	-5.02	-0.91	0.00	0.00	0.00
B7	1.950-	GSN6/2	CS1 - HEB140	**305.36**	-6.24	0.67	0.00	3.20	-2.15
B5	1.950+	GSN4/3	CS1 - HEB140	-26.01	1.32	**16.21**	0.00	-10.72	-1.39
B7	2.600-	GSN14/1	CS1 - HEB140	207.60	2.47	1.22	**0.00**	-1.37	-0.36
B8	1.950+	GSN5/4	CS1 - HEB140	-1.72	0.49	1.08	**0.00**	0.00	1.49
B3	3.900	GSN14/1	CS1 - HEB140	-34.13	-0.01	**-14.68**	0.00	**-11.70**	-0.03
B6	1.950-	GSN14/1	CS1 - HEB140	-67.00	0.55	2.97	0.00	**8.52**	1.07
B1	3.900	GSN12/5	CS1 - HEB140	-35.65	**-10.60**	-0.38	0.00	-0.63	**-7.31**
B1	3.900	GSN6/2	CS1 - HEB140	181.64	**12.52**	2.34	0.00	3.29	**8.75**
B113	0.000	GSN14/1	CS2 - HEA140	**-170.46**	-6.86	0.42	0.00	-1.46	5.20
B117	2.150-	GSN6/2	CS2 - HEA140	**141.22**	-6.17	0.50	0.00	2.29	-2.55
B17	2.600+	GSN6/2	CS2 - HEA140	-2.75	**-21.05**	-18.42	0.00	-2.19	3.21
B26	2.600+	GSN6/2	CS2 - HEA140	1.59	**20.71**	3.02	0.00	-8.02	-4.14
B17	2.800	GSN10/6	CS2 - HEA140	-9.58	-11.18	**-35.91**	0.02	-15.43	-0.75
B26	0.000	GSN9/7	CS2 - HEA140	5.91	-2.37	**28.06**	**0.02**	-10.33	0.00
B30	2.800	GSN14/1	CS2 - HEA140	-10.74	15.27	-18.92	-0.01	**-17.19**	0.00
B26	1.400+	GSN9/7	CS2 - HEA140	5.94	0.17	-11.81	**-0.02**	**12.29**	0.14
B113	4.300+	GSN3/8	CS2 - HEA140	-5.13	10.94	-0.39	0.00	0.75	**-7.90**
B113	4.300+	GSN6/2	CS2 - HEA140	-27.29	-12.90	0.50	0.00	-1.19	**9.38**
B49	0.000	GSN3/8	CS4 - RRK80/80/4	**-20.79**	0.00	0.09	-0.02	0.00	0.00
B43	0.000	GSN6/2	CS4 - RRK80/80/4	**32.46**	**0.00**	0.06	-0.06	**0.00**	**0.00**
B32	3.750	GSN3/8	CS4 - RRK80/80/4	2.19	0.00	**-0.23**	-0.02	0.00	0.00
B32	0.000	GSN3/8	CS4 - RRK80/80/4	2.19	0.00	**0.23**	-0.02	0.00	0.00
B60	0.000	GSN14/1	CS4 - RRK80/80/4	3.41	0.00	0.07	**-0.21**	0.00	0.00

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B33	0.000	GSN14/1	CS4 - RRK80/80/4	-0.71	0.00	0.07	**0.33**	0.00	0.00
B32	1.875-	GSN3/8	CS4 - RRK80/80/4	2.19	0.00	0.00	-0.02	**0.21**	0.00
B108	0.000	GSN12/5	CS3 - UPE160	**-12.44**	-0.09	5.40	0.00	-0.42	0.25
B110	4.323	GSN6/2	CS3 - UPE160	**29.43**	0.00	1.73	0.00	0.00	0.00
B109	4.323	GSN9/7	CS3 - UPE160	3.13	0.03	**-8.49**	0.00	-4.67	0.08
B66	0.000	GSN9/7	CS3 - UPE160	-0.55	-0.04	**8.17**	0.00	-3.71	0.06
B122	0.000	GSN14/1	CS3 - UPE160	0.25	**-0.43**	3.14	**0.00**	-4.18	0.60
B124	0.000	GSN6/2	CS3 - UPE160	1.32	0.71	0.48	**0.01**	-0.45	-0.82
B65	2.161-	GSN2/9	CS3 - UPE160	-0.22	0.00	0.00	0.00	**-8.23**	0.00
B61	2.025-	GSN10/6	CS3 - UPE160	0.22	-0.06	-0.40	0.00	**6.49**	-0.11
B125	0.000	GSN6/2	CS3 - UPE160	0.95	**0.72**	0.63	0.01	-0.61	**-0.83**
B109	0.000	GSN5/4	CS3 - UPE160	-7.19	-0.37	1.20	0.00	0.67	**0.79**
B95	0.000	GSN14/1	CS5 - RD22	**-85.20**	0.00	0.00	0.00	0.00	0.00
B94	3.412	GSN6/2	CS5 - RD22	**84.44**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Rezultati dimenzioniranja konstrukcije

U nastavku je dan grafički prikaz iskorištenosti elemenata konstrukcije za anvelopu graničnog stanja nosivosti, nakon čega slijedi detaljan postupak dimenzioniranja za kritični element po tipu poprečnog presjeka.



Dimenzioniranje donjeg segmenta stupa HEB 140

EN 1993-1-1 Code Check

National annex: Standard EN

Member B2	0.000 / 3.900 m	HEB140	S 355	Anvelopa GSN	0.68 -

Combination key
Anvelopa GSN / 1.35*LC1 + 1.35*LC2 + 1.05*LC4 + 1.50*LC7

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	355.0	MPa
Ultimate strength f_u	490.0	MPa
Fabrication	Rolled	

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

The critical check is on position 0.000 m

Internal forces	Calculated	Unit
N_{Ed}	-347.08	kN
$V_{y,Ed}$	-5.02	kN
$V_{z,Ed}$	-0.97	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	0.00	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]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	12	8.079e+04	8.079e+04	1.0	0.4	1.0	4.5	7.3	8.1	11.4	1
3	SO	55	12	8.079e+04	8.079e+04	1.0	0.4	1.0	4.5	7.3	8.1	11.4	1
4	I	92	7	8.079e+04	8.079e+04	1.0		1.0	13.1	26.8	30.9	34.2	1
5	SO	55	12	8.079e+04	8.079e+04	1.0	0.4	1.0	4.5	7.3	8.1	11.4	1
7	SO	55	12	8.079e+04	8.079e+04	1.0	0.4	1.0	4.5	7.3	8.1	11.4	1

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	4.2960e-03	m²
$N_{c,Rd}$	1525.08	kN
Unity check	0.23	-

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

η	1.20	
A_v	3.4930e-03	m²
$V_{pl,y,Rd}$	715.92	kN
Unity check	0.01	-

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

η	1.20	
A_v	1.3080e-03	m²
$V_{pl,z,Rd}$	268.09	kN
Unity check	0.00	-

The member satisfies the section check.

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

Classification for member buckling design
Decisive position for stability classification: 3.900 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	12	2.194e+04	-2.953e+04	-1.3	23.8	0.4	4.5	26.3	29.2	83.4	1
3	SO	55	12	5.121e+04	1.027e+05	0.5	0.5	1.0	4.5	7.3	8.1	11.9	1
4	I	92	7	4.323e+04	7.726e+04	0.6		1.0	13.1	26.8	30.9	40.0	1
5	SO	55	12	9.856e+04	1.500e+05	0.7	0.5	1.0	4.5	7.3	8.1	11.6	1
7	SO	55	12	6.928e+04	1.782e+04	0.3	1.0	1.0	4.5	7.3	8.1	16.8	1

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	1.950	3.900	m
Buckling factor k	2.00	0.78	
Buckling length l_{cr}	3.900	3.048	m
Critical Euler load N_{cr}	2056.26	1226.74	kN
Slenderness λ	65.80	85.20	
Relative slenderness λ_{rel}	0.86	1.11	
Limit slenderness $\lambda_{rel,0}$	0.20	0.20	
Buckling curve	b	c	
Imperfection α	0.34	0.49	
Reduction factor χ	0.69	0.48	
Buckling resistance $N_{b,Rd}$	951.13	660.41	kN

Flexural Buckling verification		
Cross-section area A	4.2960e-03	m²
Buckling resistance $N_{b,Rd}$	660.41	kN
Unity check	0.53	-

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.

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

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	4.2960e-03	m²
Plastic section modulus $W_{pl,y}$	2.4540e-04	m³
Plastic section modulus $W_{pl,z}$	1.1980e-04	m³
Design compression force N_{Ed}	347.08	kN
Design bending moment (maximum) $M_{y,Ed}$	-1.88	kNm
Design bending moment (maximum) $M_{z,Ed}$	5.19	kNm
Characteristic compression resistance N_{Rk}	1525.08	kN
Characteristic moment resistance $M_{y,Rk}$	87.12	kNm
Characteristic moment resistance $M_{z,Rk}$	42.53	kNm
Reduction factor χ_y	0.69	
Reduction factor χ_z	0.48	
Reduction factor χ_{LT}	1.00	
Interaction factor k_{yy}	0.94	
Interaction factor k_{yz}	0.80	
Interaction factor k_{zy}	0.50	
Interaction factor k_{zz}	1.04	

Maximum moment $M_{y,Ed}$ is derived from beam B2 position 1.950 m.
Maximum moment $M_{z,Ed}$ is derived from beam B2 position 3.900 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	2056.26	kN
Critical Euler load $N_{cr,z}$	1226.74	kN
Elastic critical load $N_{cr,T}$	3948.17	kN

Interaction method 1 parameters		
Plastic section modulus $W_{pl,y}$	2.4540e-04	m^3
Elastic section modulus $W_{el,y}$	2.1560e-04	m^3
Plastic section modulus $W_{pl,z}$	1.1980e-04	m^3
Elastic section modulus $W_{el,z}$	7.8520e-05	m^3
Second moment of area I_y	1.5090e-05	m^4
Second moment of area I_z	5.4970e-06	m^4
Torsional constant I_t	1.9726e-07	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	0.00	
Equivalent moment factor $C_{my,0}$	0.77	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	5.19	kNm
Maximum relative deflection δ_y	4.3	mm
Equivalent moment factor $C_{mz,0}$	0.89	
Factor μ_y	0.94	
Factor μ_z	0.83	
Factor ε_y	0.11	
Factor a_{LT}	0.99	
Critical moment for uniform bending $M_{cr,0}$	119.05	kNm
Relative slenderness $\lambda_{rel,0}$	0.86	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.33	
Equivalent moment factor C_{my}	0.83	
Equivalent moment factor C_{mz}	0.89	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor c_{LT}	0.03	
Factor d_{LT}	0.00	
Factor e_{LT}	0.02	
Factor w_y	1.14	
Factor w_z	1.50	
Factor n_{pl}	0.25	
Maximum relative slenderness $\lambda_{rel,max}$	1.11	
Factor C_{yy}	0.99	
Factor C_{yz}	1.01	
Factor C_{zy}	0.85	
Factor C_{zz}	1.00	

Unity check (6.61) = 0.36 + 0.02 + 0.11 = 0.49 -
Unity check (6.62) = 0.53 + 0.01 + 0.14 = 0.68 -

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	3.900	m
Web	unstiffened	
Web height h_w	116	mm
Web thickness t	7	mm
Material coefficient ε	0.81	
Shear correction factor η	1.20	

Shear Buckling verification	
Web slenderness h_w/t	16.57
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.

Dimenzioniranje gornjeg segmenta stupa HEA 140

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

Member B113	0.000 / 9.600 m	HEA140	S 355	Anvelopa GSN	0.54 -

Combination key
Anvelopa GSN / LC1 + 0.90*LC2 + 1.50*LC8

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	355.0	MPa
Ultimate strength f_u	490.0	MPa
Fabrication	Rolled	

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

The critical check is on position 0.000 m

Internal forces	Calculated	Unit
N_{Ed}	-111.95	kN
$V_{y,Ed}$	-11.11	kN
$V_{z,Ed}$	0.63	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	-1.86	kNm
$M_{z,Ed}$	8.42	kNm

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

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	8	1.492e+04	-1.046e+05	-7.0	23.8	0.1	6.5	165.9	184.4	83.4	1
3	SO	55	8	7.871e+04	1.982e+05	0.4	0.5	1.0	6.5	7.3	8.1	12.1	1
4	I	92	6	4.390e+04	2.736e+04	0.6		1.0	16.7	26.8	30.9	39.0	1
5	SO	55	8	5.634e+04	1.758e+05	0.3	0.5	1.0	6.5	7.3	8.1	12.2	1
7	SO	55	8	-7.454e+03	-1.269e+05								

The cross-section is classified as Class 1

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

A	3.1400e-03	m²
$N_{c,Rd}$	1114.70	kN
Unity check	0.10	-

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

$W_{pl,y}$	1.7333e-04	m³
$M_{pl,y,Rd}$	61.53	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),(6.13)

$W_{pl,z}$	8.5000e-05	m³
$M_{pl,z,Rd}$	30.18	kNm
Unity check	0.28	-

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

η	1.20	

A_v	2.4763e-03	m^2
$V_{pl,y,Rd}$	507.53	kN
Unity check	0.02	-

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

η	1.20	
A_v	1.0107e-03	m^2
$V_{pl,z,Rd}$	207.16	kN
Unity check	0.00	-

Combined Shear and Torsion check for V_y and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.26)

$V_{pl,T,y,Rd}$	507.50	kN
Unity check	0.02	-

Combined Shear and Torsion check for V_z and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.26)

$V_{pl,T,z,Rd}$	207.15	kN
Unity check	0.00	-

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

$M_{pl,y,Rd}$	61.53	kNm
α	2.00	
$M_{pl,z,Rd}$	30.18	kNm
β	1.00	

Unity check (6.41) = 0.00 + 0.28 = 0.28 -

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

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	8	-3.662e+04	-1.697e+05								
3	SO	55	8	3.444e+04	1.675e+05	0.2	0.5	1.0	6.5	7.3	8.1	12.4	1
4	I	92	6	4.156e+03	3.386e+04	0.1		1.0	16.7	26.8	30.9	48.1	1
5	SO	55	8	7.464e+04	2.077e+05	0.4	0.5	1.0	6.5	7.3	8.1	12.1	1
7	SO	55	8	3.584e+03	-1.295e+05	-36.1	23.8	0.0	6.5	1656.9	1841.0	83.4	1

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	2.150	4.300	m
Buckling factor k	2.00	0.58	
Buckling length l_{cr}	4.300	2.485	m
Critical Euler load N_{cr}	1154.57	1305.62	kN
Slenderness λ	75.08	70.60	

Buckling parameters	yy	zz	
Relative slenderness λ_{rel}	0.98	0.92	
Limit slenderness $\lambda_{rel,0}$	0.20	0.20	
Buckling curve	b	c	
Imperfection α	0.34	0.49	
Reduction factor χ	0.61	0.59	
Buckling resistance $N_{b,Rd}$	616.24	592.98	kN

Flexural Buckling verification		
Cross-section area A	3.1400e-03	m^2
Buckling resistance $N_{b,Rd}$	592.98	kN
Unity check	0.19	-

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 & 6.3.2.2 and formula (6.54)

LTB parameters		
Method for LTB curve	General case	
Plastic section modulus $W_{pl,y}$	1.7333e-04	m^3
Elastic critical moment M_{cr}	178.78	kNm
Relative slenderness $\lambda_{rel,LT}$	0.59	
Limit slenderness $\lambda_{rel,LT,0}$	0.20	

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}	4.300	m
Influence of load position	no influence	
Correction factor k	1.00	
Correction factor k_w	1.00	
LTB moment factor C_1	3.05	
LTB moment factor C_2	0.36	
LTB moment factor C_3	1.00	
Shear center distance d_z	0	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_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 area A	3.1400e-03	m^2
Plastic section modulus $W_{pl,y}$	1.7333e-04	m^3
Plastic section modulus $W_{pl,z}$	8.5000e-05	m^3
Design compression force N_{Ed}	111.95	kN
Design bending moment (maximum) $M_{y,Ed}$	-1.86	kNm
Design bending moment (maximum) $M_{z,Ed}$	9.38	kNm
Characteristic compression resistance N_{Rk}	1114.70	kN
Characteristic moment resistance $M_{y,Rk}$	61.53	kNm
Characteristic moment resistance $M_{z,Rk}$	30.18	kNm
Reduction factor χ_y	0.61	
Reduction factor χ_z	0.59	
Reduction factor χ_{LT}	1.00	
Interaction factor k_{yy}	0.96	
Interaction factor k_{yz}	0.68	
Interaction factor k_{zy}	0.53	
Interaction factor k_{zz}	0.97	

Maximum moment $M_{y,Ed}$ is derived from beam B113 position 0.000 m.
Maximum moment $M_{z,Ed}$ is derived from beam B113 position 4.300 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	1154.57	kN
Critical Euler load $N_{cr,z}$	1305.62	kN
Elastic critical load $N_{cr,T}$	1748.29	kN
Plastic section modulus $W_{pl,y}$	1.7333e-04	m^3
Elastic section modulus $W_{el,y}$	1.5500e-04	m^3
Plastic section modulus $W_{pl,z}$	8.5000e-05	m^3
Elastic section modulus $W_{el,z}$	5.5600e-05	m^3
Second moment of area I_y	1.0300e-05	m^4
Second moment of area I_z	3.8900e-06	m^4
Torsional constant I_t	7.7412e-08	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	0.27	
Equivalent moment factor $C_{my,0}$	0.85	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	9.38	kNm
Maximum relative deflection δ_y	3.6	mm
Equivalent moment factor $C_{mz,0}$	0.93	
Factor μ_y	0.96	
Factor μ_z	0.96	
Factor ε_y	0.34	
Factor a_{LT}	0.99	
Critical moment for uniform bending $M_{cr,0}$	58.69	kNm
Relative slenderness $\lambda_{rel,0}$	1.02	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.34	
Equivalent moment factor C_{my}	0.90	
Equivalent moment factor C_{mz}	0.93	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor c_{LT}	0.06	
Factor d_{LT}	0.03	
Factor e_{LT}	0.07	
Factor w_y	1.12	
Factor w_z	1.50	
Factor n_{pl}	0.11	
Maximum relative slenderness $\lambda_{rel,max}$	0.98	
Factor C_{yy}	1.00	
Factor C_{yz}	1.00	
Factor C_{zy}	0.94	
Factor C_{zz}	1.01	

Unity check (6.61) = 0.18 + 0.03 + 0.23 = 0.45 -
Unity check (6.62) = 0.19 + 0.02 + 0.33 = 0.54 -

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

Shear Buckling parameters		
Buckling field length a	9.600	m
Web	unstiffened	
Web height h_w	116	mm
Web thickness t	6	mm
Material coefficient ε	0.81	
Shear correction factor η	1.20	

Shear Buckling verification	
Web slenderness h_w/t	21.09
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.

Dimenzioniranje donjeg segmenta stupa HEB 140

Dimenzioniranje stabilizacije SHS 80/80/4

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

Member B45	**1.875 / 3.750 m**	**RRK80/80/4**	**S 235**	**Anvelopa GSN**	**0.13 -**

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
Anvelopa GSN / 1.35*LC1 + 1.35*LC2 + 1.50*LC5

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	235.0	MPa
Ultimate strength f_u	360.0	MPa
Fabrication	Cold formed	

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

The critical check is on position 1.875 m

Internal forces	Calculated	Unit
N_{Ed}	-9.27	kN
$V_{y,Ed}$	0.00	kN
$V_{z,Ed}$	0.00	kN
T_{Ed}	-0.03	kNm
$M_{y,Ed}$	0.21	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]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	68	4	5.409e+02	5.409e+02	1.0		1.0	17.0	33.0	38.0	42.0	1
3	I	68	4	1.315e+03	1.447e+04	0.1		1.0	17.0	33.0	38.0	60.0	1
5	I	68	4	1.524e+04	1.524e+04	1.0		1.0	17.0	33.0	38.0	42.0	1
7	I	68	4	1.447e+04	1.315e+03	0.1		1.0	17.0	33.0	38.0	60.0	1

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	1.1750e-03	m²
$N_{c,Rd}$	276.12	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)

$W_{pl,y}$	3.3100e-05	m³
$M_{pl,y,Rd}$	7.78	kNm
Unity check	0.03	-

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.1(5) and formula (6.1)

Elastic verification		
Fibre	10	
$\sigma_{N,Ed}$	7.9	MPa
$\sigma_{My,Ed}$	7.7	MPa
$\sigma_{Mz,Ed}$	0.0	MPa
$\sigma_{tot,Ed}$	15.6	MPa
$\tau_{Vy,Ed}$	0.0	MPa
$\tau_{Vz,Ed}$	0.0	MPa
$\tau_{t,Ed}$	0.6	MPa
$\tau_{tot,Ed}$	0.6	MPa

Elastic verification		
$\sigma_{von\ Mises,Ed}$	15.7	MPa
Unity check	0.07	-

Note: Since there is no shear force, the effect of the torsional moment cannot be accounted for in the plastic interaction. Therefore the elastic yield criterion according to EN 1993-1-1 article 6.2.1(5) is verified.

The member satisfies the section check.

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

Classification for member buckling design
Decisive position for stability classification: 1.875 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	68	4	5.409e+02	5.409e+02	1.0		1.0	17.0	33.0	38.0	42.0	1
3	I	68	4	1.315e+03	1.447e+04	0.1		1.0	17.0	33.0	38.0	60.0	1
5	I	68	4	1.524e+04	1.524e+04	1.0		1.0	17.0	33.0	38.0	42.0	1
7	I	68	4	1.447e+04	1.315e+03	0.1		1.0	17.0	33.0	38.0	60.0	1

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	3.750	3.750	m
Buckling factor k	1.00	1.00	
Buckling length l_{cr}	3.750	3.750	m
Critical Euler load N_{cr}	163.60	163.61	kN
Slenderness λ	122.01	122.01	
Relative slenderness λ_{rel}	1.30	1.30	
Limit slenderness $\lambda_{rel,0}$	0.20	0.20	
Buckling curve	c	c	
Imperfection α	0.49	0.49	
Reduction factor χ	0.39	0.39	
Buckling resistance $N_{b,Rd}$	97.69	97.69	kN

Flexural Buckling verification		
Cross-section area A	1.1750e-03	m²
Buckling resistance $N_{b,Rd}$	97.69	kN
Unity check	0.09	-

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	1.1750e-03	m²
Plastic section modulus $W_{pl,y}$	3.3100e-05	m³
Design compression force N_{Ed}	9.27	kN
Design bending moment (maximum) $M_{y,Ed}$	0.21	kNm
Design bending moment (maximum) $M_{z,Ed}$	0.00	kNm
Characteristic compression resistance N_{Rk}	276.12	kN
Characteristic moment resistance $M_{y,Rk}$	7.78	kNm
Reduction factor χ_y	0.39	
Reduction factor χ_z	0.39	

Bending and axial compression check parameters		
Reduction factor χ_{LT}	1.00	
Interaction factor k_{yy}	1.04	
Interaction factor k_{zy}	0.65	

Maximum moment $M_{y,Ed}$ is derived from beam B45 position 1.875 m.
Maximum moment $M_{z,Ed}$ is derived from beam B45 position 0.000 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	163.60	kN
Critical Euler load $N_{cr,z}$	163.61	kN
Elastic critical load $N_{cr,T}$	74384.31	kN
Plastic section modulus $W_{pl,y}$	3.3100e-05	m^3
Elastic section modulus $W_{el,y}$	2.7800e-05	m^3
Plastic section modulus $W_{pl,z}$	3.3100e-05	m^3
Elastic section modulus $W_{el,z}$	2.7800e-05	m^3
Second moment of area I_y	1.1100e-06	m^4
Second moment of area I_z	1.1100e-06	m^4
Torsional constant I_t	1.7400e-06	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 4 (Line load)	
Equivalent moment factor $C_{my,0}$	1.00	
Factor μ_y	0.96	
Factor μ_z	0.96	
Factor ε_y	0.98	
Factor a_{LT}	0.00	
Critical moment for uniform bending $M_{cr,0}$	151.63	kNm
Relative slenderness $\lambda_{rel,0}$	0.23	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.21	
Equivalent moment factor C_{my}	1.00	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor d_{LT}	0.00	
Factor w_y	1.19	
Factor w_z	1.19	
Factor n_{pl}	0.04	
Maximum relative slenderness $\lambda_{rel,max}$	1.30	
Factor C_{yy}	0.99	
Factor C_{zy}	0.94	

Unity check (6.61) = 0.09 + 0.03 + 0.00 = 0.13 -
Unity check (6.62) = 0.09 + 0.02 + 0.00 = 0.11 -

The member satisfies the stability check.

Dimenzioniranje tetive UPE 160

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

Member B67	0.360 / 4.323 m	UPE160	S 235	Anvelopa GSN	0.62 -

Combination key
Anvelopa GSN / 1.35*LC1 + 1.35*LC2 + 1.50*LC4 + 0.90*LC7

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	235.0	MPa
Ultimate strength f_u	360.0	MPa
Fabrication	Rolled	

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

The critical check is on position 0.360 m

Internal forces	Calculated	Unit
N_{Ed}	-9.02	kN
$V_{y,Ed}$	0.00	kN
$V_{z,Ed}$	-6.34	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	-2.51	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]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	UO	53	10	2.492e+04	2.492e+04	1.0	0.4	1.0	5.5	9.0	10.0	14.0	1
3	I	117	6	2.030e+04	-1.198e+04	-0.6		0.6	21.3	55.2	63.6	88.4	1
5	UO	53	10	-1.660e+04	-1.660e+04								

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	2.1700e-03	m²
$N_{c,Rd}$	509.95	kN
Unity check	0.02	-

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

$W_{pl,y}$	1.3200e-04	m³
$M_{pl,y,Rd}$	31.02	kNm
Unity check	0.08	-

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

η	1.20	
A_v	1.0062e-03	m²
$V_{pl,z,Rd}$	136.53	kN
Unity check	0.05	-

Combined Shear and Torsion check for V_z and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.27)

$V_{pl,T,z,Rd}$	136.52	kN
Unity check	0.05	-

Combined bending, axial force and shear force check

According to EN 1993-1-1 article 6.2.1 and formula (6.2)

$N_{pl,Rd}$	509.95	kN
$M_{pl,y,Rd}$	31.02	kNm
$M_{pl,z,Rd}$	9.56	kNm

Unity check (6.2) = 0.02 + 0.08 + 0.00 = 0.10 -

Note: No specific interaction formulae according to EN 1993-1-1 article 6.2.9.1 apply.
Therefore the plastic linear summation according to EN 1993-1-1 article 6.2.1(7) is verified.
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: 2.161 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	UO	53	10	7.041e+04	7.041e+04	1.0	0.4	1.0	5.5	9.0	10.0	14.0	1
3	I	117	6	5.529e+04	-5.033e+04	-0.9		0.5	21.3	68.2	78.5	113.6	1
5	UO	53	10	-6.545e+04	-6.545e+04								

The cross-section is classified as Class 1

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

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	4.323	4.323	m
Buckling factor k	1.00	1.00	
Buckling length l_{cr}	4.323	4.323	m
Critical Euler load N_{cr}	1010.52	118.69	kN
Slenderness λ	66.71	194.66	
Relative slenderness λ_{rel}	0.71	2.07	
Limit slenderness $\lambda_{rel,0}$	0.20	0.20	
Buckling curve	c	c	
Imperfection α	0.49	0.49	
Reduction factor χ	0.72	0.18	
Buckling resistance $N_{b,Rd}$	332.98	85.51	kN

Flexural Buckling verification		
Cross-section area A	2.1700e-03	m²
Buckling resistance $N_{b,Rd}$	85.51	kN
Unity check	0.11	-

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

Torsional buckling length l_{cr}	4.323	m
Elastic critical load $N_{cr,T}$	672.16	kN
Elastic critical load $N_{cr,TF}$	118.69	kN
Relative slenderness $\lambda_{rel,T}$	2.07	
Limit slenderness $\lambda_{rel,0}$	0.20	
Buckling curve	c	
Imperfection α	0.49	
Reduction factor χ	0.18	
Cross-section area A	2.1700e-03	m²
Buckling resistance $N_{b,Rd}$	85.51	kN
Unity check	0.11	-

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1 & 6.3.2.2 and formula (6.54)

LTB parameters		
Method for LTB curve	General case	
Plastic section modulus $W_{pl,y}$	1.3200e-04	m^3
Elastic critical moment M_{cr}	26.26	kNm
Relative slenderness $\lambda_{rel,LT}$	1.09	
Relative slenderness $\lambda_{rel,T}$	0.11	
Relative slenderness $\lambda_{rel,EXTRA}$	1.20	
Limit slenderness $\lambda_{rel,LT,0}$	0.20	
LTB curve	a	
Imperfection α_{LT}	0.21	
Reduction factor χ_{LT}	0.53	
Design buckling resistance $M_{b,Rd}$	14.92	kNm
Unity check	0.17	-

Note: $\lambda_{rel,EXTRA}$ is determined according to "Design rule for lateral torsional buckling of channel sections, 2007".

Mcr parameters		
LTB length l_{LT}	4.323	m
Influence of load position	no influence	
Correction factor k	1.00	
Correction factor k_w	1.00	
LTB moment factor C_1	1.13	
LTB moment factor C_2	0.45	
LTB moment factor C_3	0.53	
Shear center distance d_z	0	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_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 area A	2.1700e-03	m^2
Plastic section modulus $W_{pl,y}$	1.3200e-04	m^3
Design compression force N_{Ed}	9.02	kN
Design bending moment (maximum) $M_{y,Ed}$	-8.23	kNm
Design bending moment (maximum) $M_{z,Ed}$	0.00	kNm
Characteristic compression resistance N_{Rk}	509.95	kN
Characteristic moment resistance $M_{y,Rk}$	31.02	kNm
Reduction factor χ_y	0.72	
Reduction factor χ_z	0.18	
Reduction factor χ_{LT}	0.53	
Interaction factor k_{yy}	1.07	
Interaction factor k_{zy}	0.57	

Maximum moment $M_{y,Ed}$ is derived from beam B67 position 2.161 m.
Maximum moment $M_{z,Ed}$ is derived from beam B67 position 0.000 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	1010.52	kN
Critical Euler load $N_{cr,z}$	118.69	kN
Elastic critical load $N_{cr,T}$	672.16	kN
Plastic section modulus $W_{pl,y}$	1.3200e-04	m^3
Elastic section modulus $W_{el,y}$	1.1400e-04	m^3
Plastic section modulus $W_{pl,z}$	4.0700e-05	m^3
Elastic section modulus $W_{el,z}$	2.2600e-05	m^3
Second moment of area I_y	9.1100e-06	m^4
Second moment of area I_z	1.0700e-06	m^4
Torsional constant I_t	5.0727e-08	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 4 (Line load)	
Equivalent moment factor $C_{my,0}$	1.00	
Factor μ_y	1.00	
Factor μ_z	0.94	
Factor ε_y	17.37	
Factor a_{LT}	0.99	
Critical moment for uniform bending $M_{cr,0}$	23.30	kNm
Relative slenderness $\lambda_{rel,0}$	1.15	

Interaction method 1 parameters		
Limit relative slenderness $\lambda_{rel,0,lim}$	0.21	
Equivalent moment factor C_{my}	1.00	
Equivalent moment factor C_{mLT}	1.04	
Factor b_{LT}	0.00	
Factor d_{LT}	0.00	
Factor w_y	1.16	
Factor w_z	1.50	
Factor n_{pl}	0.02	
Maximum relative slenderness $\lambda_{rel,max}$	2.07	
Factor C_{yy}	0.98	
Factor C_{zy}	0.92	

Unity check (6.61) = 0.03 + 0.59 + 0.00 = 0.62 -
Unity check (6.62) = 0.11 + 0.31 + 0.00 = 0.42 -

The member satisfies the stability check.

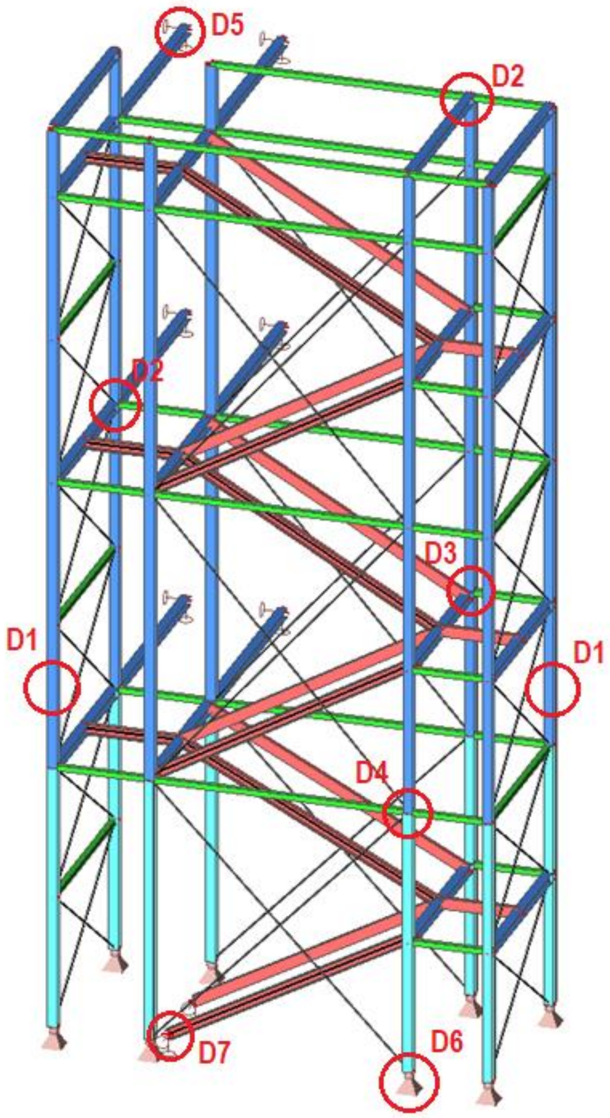
Dimenzioniranje dijagonale vertikalne stabilizacije Ø22

Sila u vlačnoj zategi N_{Ed} = 85,2 kN
Površina u zoni navoja A_{netto} = 3,03 cm^2

Napon u zategi $\sigma = N_{Ed} / A_{netto}$ = 85,2 / 3,03 = 28,1 kN/cm^2
Dopušteni napon σ_{dop} = 35,5 / 1,0 = 35,5 kN/cm^2 > 28,1 kN/cm^2 → zadovoljava (79%)

1.2. Proračun priključaka vanjskog stubišta

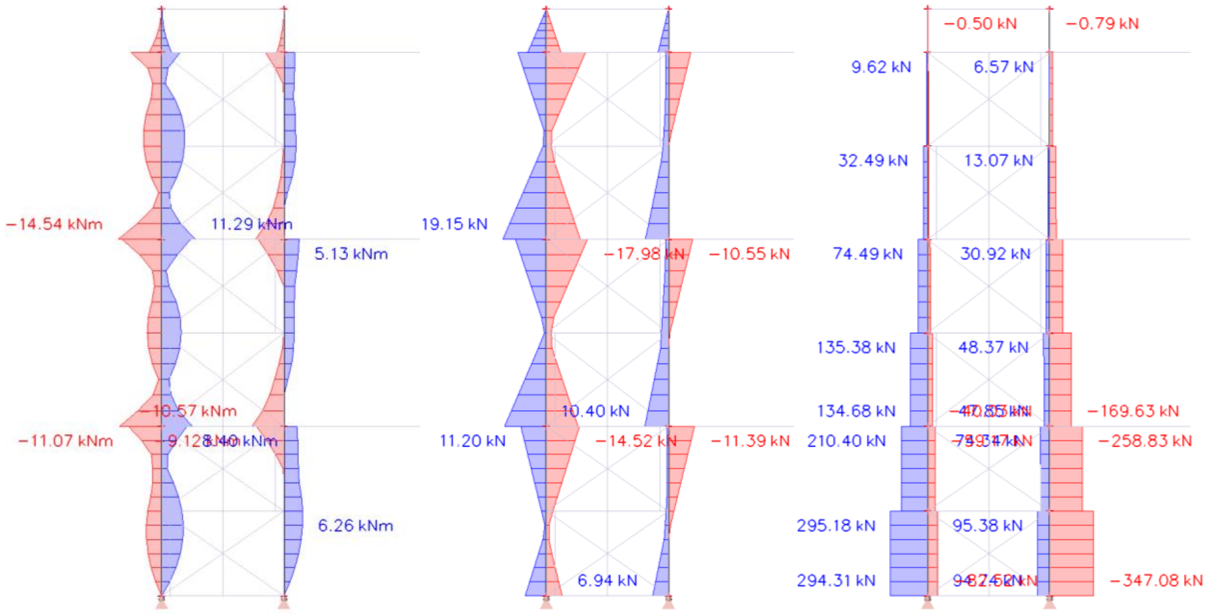
Svi širokopojasni profili čelične nosive konstrukcije izrađuju se čelika S355J2 sukladno normi HRN EN 10025, a hladnooblikovani cijevni profili od čelika S235JR sukladno normi HRN EN 10219. Svi limovi izrađuju se od čelika S355J2. Vijčani montažni spojevi izvode se vijcima kvalitete 8.8 (HRN EN 15048) i 10.9 (HRN EN 14399) prema proračunu danom u nastavku.



Nastavak stupa (D1)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti mjerodavnog okvira.

Values: M_y, V_z, N
Class: Anvelopa GSN
Extreme 1D: Member



Rezne sile u čvoru

$M_{y,Ed}$ = 0 kNm
$V_{z,Ed}$ = 14,5 kN
N_{Ed} = 135,4 kN (vlak)

Nastavak stupa izvodi se na 4,5 m visine (0,6-0,8 m od prve etaže), što bliže nultočki momentnog dijagrama, pri čemu se donji segment stupa (do nastavka) izvodi od valjanog I profila HEB140, dok se ostatak stupa izvodi profila HEA 140. Sukladno pravilima struke, nastavak stupa izvodi se kao spoj pune nosivosti IH1.A, kao DSTV spoj br. 406. Puna računska nosivost spoja za pritezanje 100%:

$M_{y,Rd}$ = 20,3 kNm
$V_{z,Rd}$ = 103,7 kN

Provjera otpornosti vijaka na vlak

$F_{Ed/vijak} = N_{Ed} / 4$ = 135,4 / 4 = 33,9 kN po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2}$ = 141,3 / 1,25 = 113 kN
113 kN > $F_{Ed/vijak}$ = 33,9 kN → zadovoljava (30%)

Provjera otpornosti vijaka na posmik

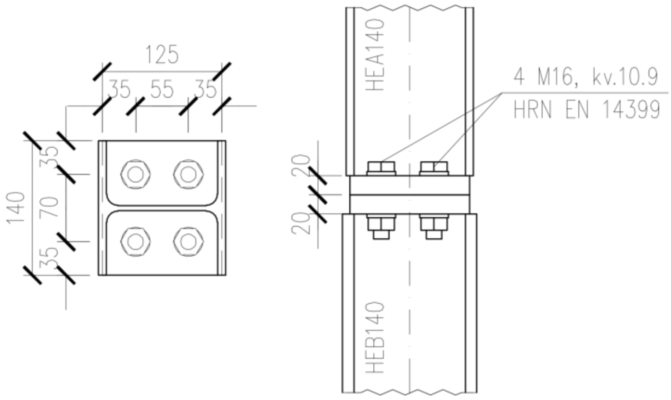
$F_{Ed/vijak} = V_{Ed} / 4$ = 14,5 / 4 = 3,6 kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2}$ = 78,5 / 1,25 = 62,8 kN
62,8 kN > $F_{Ed/vijak}$ = 3,6 kN → zadovoljava (6%)

S obzirom na minimalni iznos poprečne sile u čvoru te debljinu čeone ploče, pritisak po omotaču rupe nije mjerodavan te se neće dodatno provjeravati.

Geometrija spoja

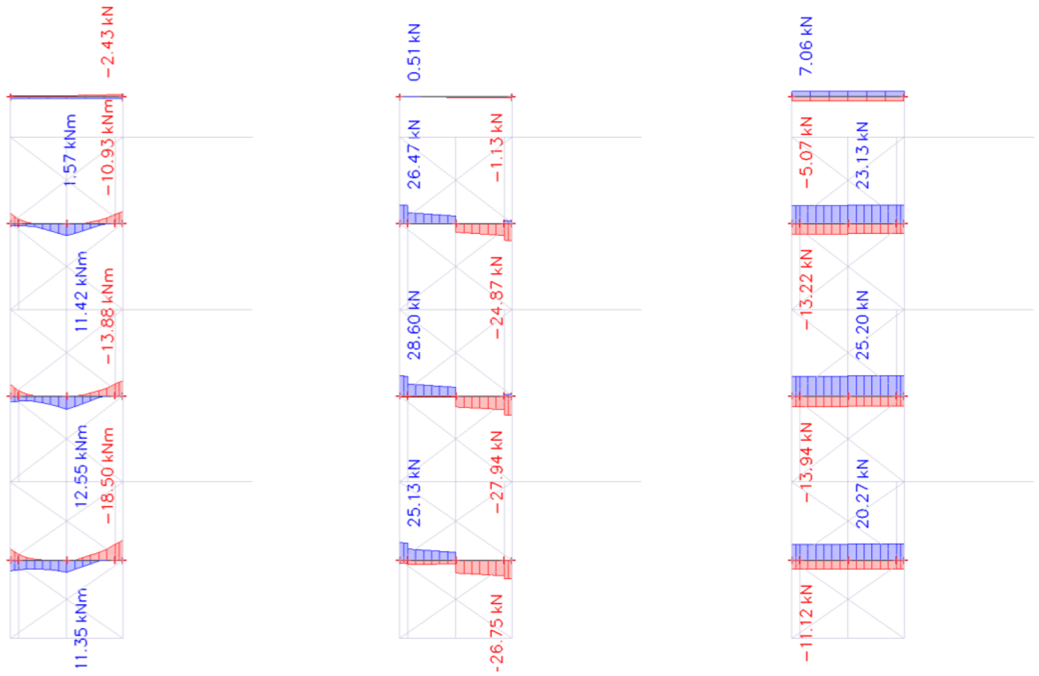
Vijci	4 M16, kv. 10.9, **vijke pritegnuti na 100%**
Čeone ploče	t = 20 mm, S355J2
Zavari	a_w = 4 mm (pojas), a_w = 4 mm (hrbat)



Spoj stup - greda (D2)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti mjerodavnog okvira.

Values: $\mathbf{M_y}$, $\mathbf{V_z}$, **N**
Class: Anvelopa GSN
Extreme 1D: Member



Spoj stup-greda izvodi se sukladno pravilima struke, kao spoj pune nosivosti IH1.A, kao DSTV spoj br. 406. Puna računska nosivost spoja za pritezanje 100%:

$M_{y,Rd}$ = 20,3 kNm
$V_{z,Rd}$ = 103,7 kN

Rezne sile u čvoru

$M_{y,Ed}$ = 18,5 kNm (za GSN14, nema vlaka)
$V_{z,Ed}$ = 28,6 kN
N_{Ed} = 25,2 kN (vlak za GSN5, M_y = 3,5 kNm)

Provjera otpornosti vijaka na vlak

$F_{Ed/vijak} = M_{Ed} / 2e$ = 18,5 / (2 · 0,09) = 102,7 kN po vijku → mjerodavno
$F_{Ed/vijak} = M_{Ed} / 2e + N_{Ed} / 4$ = 3,5 / (2 · 0,09) + 25,2 / 4 = 25,7 kN po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2}$ = 141,3 / 1,25 = 113 kN
113 kN > $F_{Ed/vijak}$ = 102,7 kN → zadovoljava (91%)

Provjera otpornosti vijaka na posmik

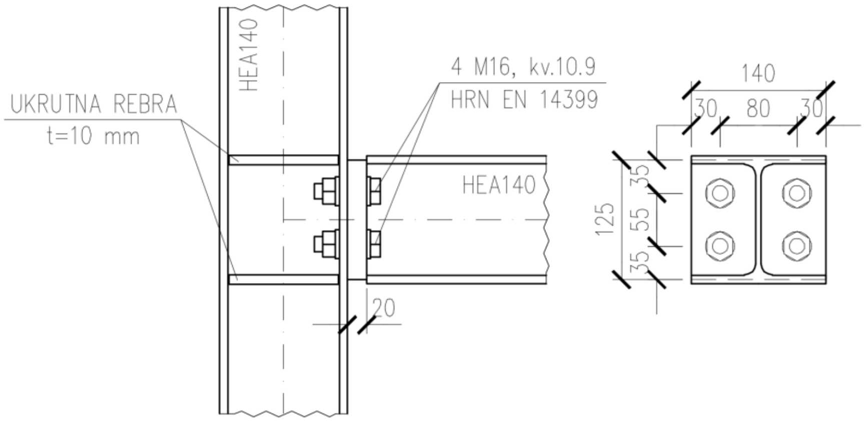
$F_{Ed/vijak} = V_{Ed} / 4$ = 28,6 / 4 = 7,2 kN po vijku

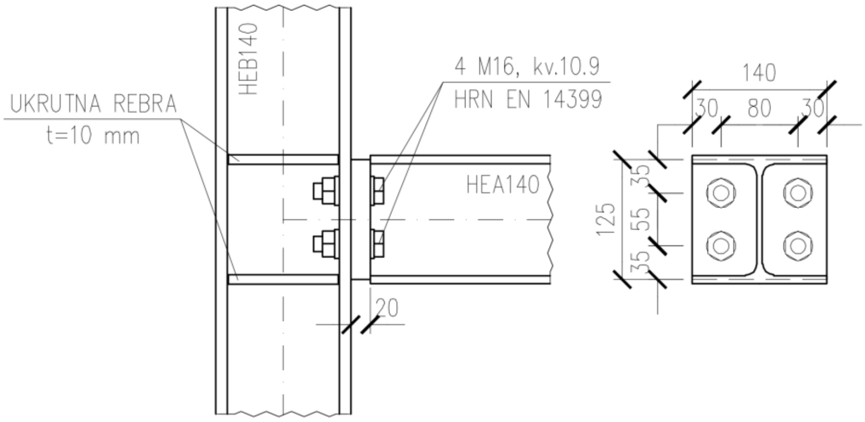
$F_{v,Rd} = F_{v,Rk} / \gamma_{M2}$ = 78,5 / 1,25 = 62,8 kN
62,8 kN > $F_{Ed/vijak}$ = 7,2 kN → zadovoljava (11%)

S obzirom na minimalni iznos poprečne sile u čvoru te debljinu čeone ploče, pritisak po omotaču rupe nije mjerodavan te se neće dodatno provjeravati.

Geometrija spoja

Vijci	4 M16, kv. 10.9, **vijke pritegnuti na 100%**
Čeona ploča	t = 20 mm, S355J2
Ukrutna rebra	t = 10 mm, S355J2
Zavari	a_w = 4 mm (pojas), a_w = 4 mm (hrbat)

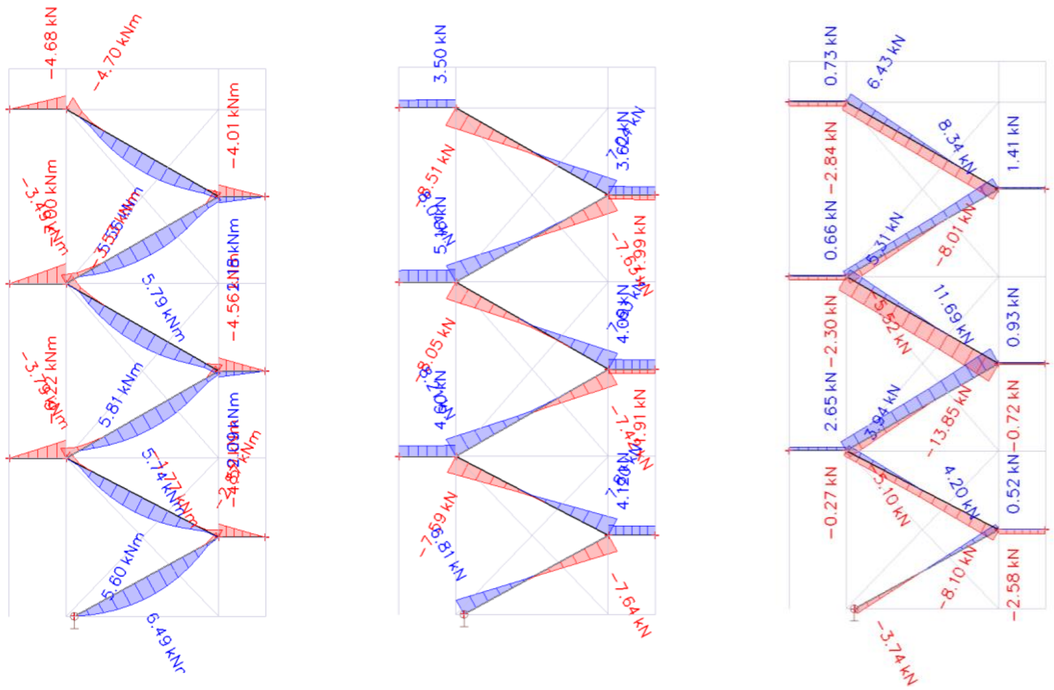




Spoj tetiva - greda (D3)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti tetiva s podestom.

Values: $\mathbf{M_y}$, $\mathbf{V_z}$, **N**
Class: Anvelopa GSN
Extreme 1D: Member



Tetiva i podest izvode se kao jedan sklop, zavareno, koji se polaže na grede okvira. Spoj s gredom ostvaruje se vijčanom vezom pojasnica profila UPE160 i HEA140, kako je prikazano u detalju.

Rezne sile u čvoru

$M_{y,Ed}$ = 7,0 kNm
$V_{z,Ed}$ = 8,5 kN
N_{Ed} = 13,9 kN

Provjera otpornosti vara

$a_w = 0,7 \cdot t_{min} = 0,7 \cdot 5,5 = 4$ mm
$L = 2 \cdot 70 + 2 \cdot 117 = 374$ mm

$\tau_{II} = V_{Ed} / 2a_w \cdot L = 8,5 \cdot 10^3 / 2 \cdot 4 \cdot 374 = 2,84$ N/mm^2
$\tau_\perp = \sigma_\perp = \sigma_w / \sqrt{2} = 61,5 / \sqrt{2} = 43,5$ N/mm^2

$\sigma_w = M / W_{el,w} = 7 \cdot 10^6 / 113900 = 61,5$ N/mm^2
$W_{el,w} = W_{y,UPE160} = 113900$ mm^3

$\sqrt{[\sigma_\perp^2 + 3 \cdot (\tau_\perp^2 + \tau_{II}^2)]} = \sqrt{[43,5^2 + 3 \cdot (43,5^2 + 2,84^2)]} = 87,1$ N/mm^2
$f_u / (\beta_w \cdot \gamma_{M2}) = 360 / 0,8 \cdot 1,25 = 360$ N/mm^2

87,1 N/mm^2 < 360 N/mm^2 → zadovoljava (24%)

Provjera otpornosti vijaka na posmik

$F_{v;Ed/vijak} = N_{Ed} / 2 = 13,9/2 = 7$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 75,4 / 1,25 = 60,3$ kN
60,3 kN > $F_{v;Ed/vijak}$ = 7 kN → zadovoljava (12%)

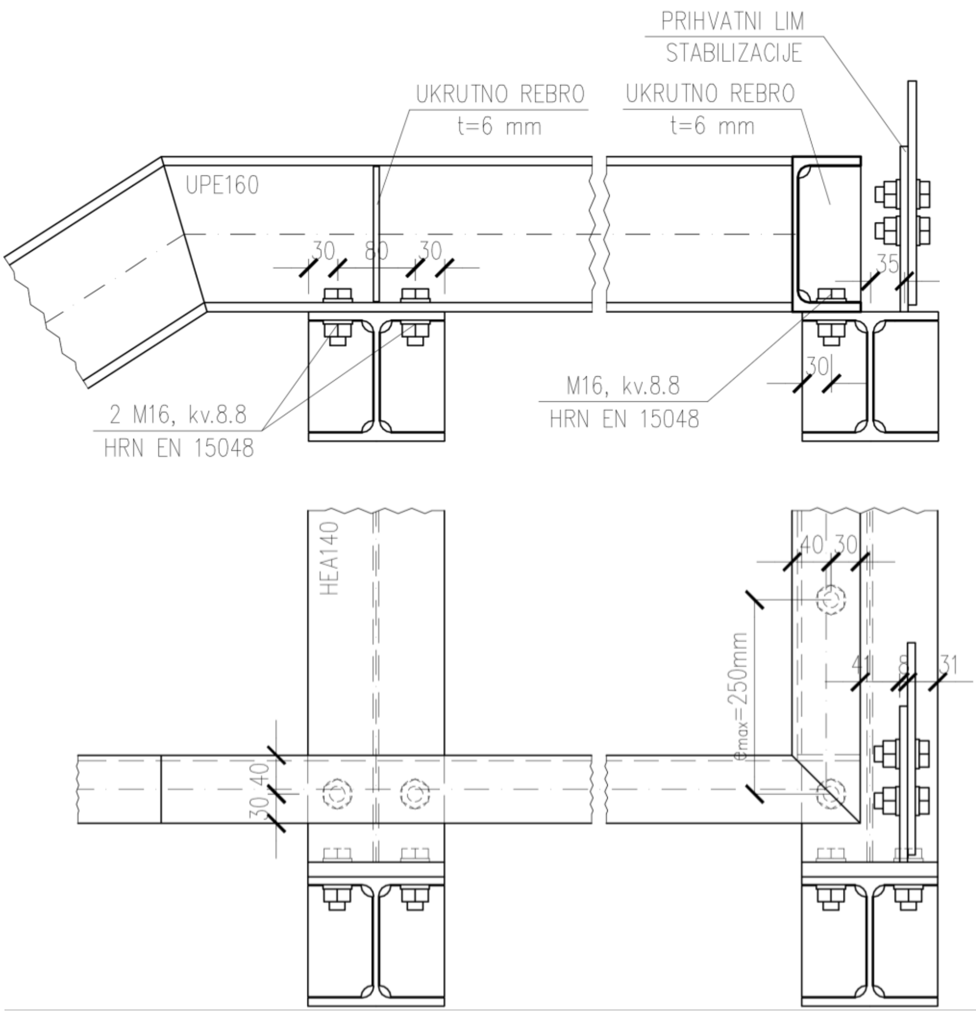
Provjera otpornosti ploče na pritisak po omotaču rupe

$F_{b,Rd} = (2{,}5 \cdot a \cdot f_u \cdot d \cdot t) / \gamma_{M2}$
$a = \min \{ e_1/3d_0 \, ; \, f_{ub} / f_u \, ; 1\} = \min \{ 30/3 \cdot 18 \, ; \, 80/36 \, ; 1\} = 0{,}56$
$F_{b,Rd} = (2{,}5 \cdot 0{,}56 \cdot 36 \cdot 1{,}6 \cdot 0{,}85) / 1{,}25 = 54{,}8$ kN

$54{,}8$ kN > $F_{v;Ed/vijak} = 7$ kN → zadovoljava (13%)

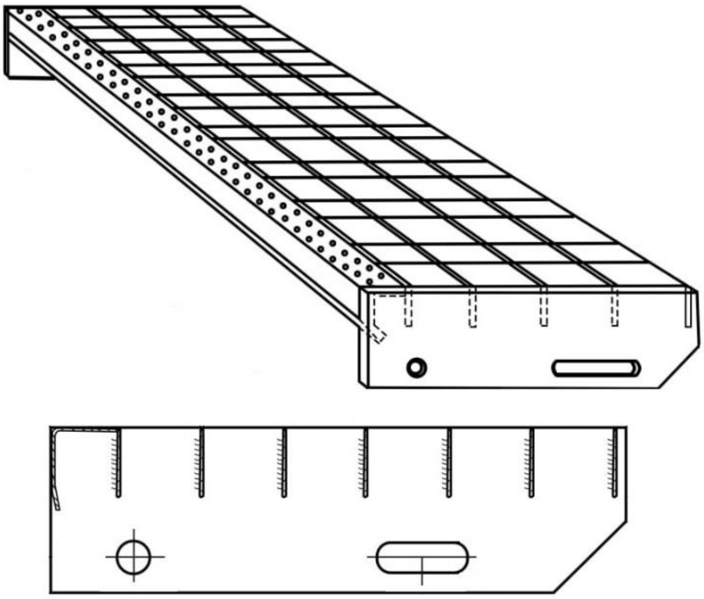
Geometrija spoja

Vijci	2 M16, kv. 8.8
Ukrutna rebra	t = 6 mm (UPE160), S355J2
Zavari	$a_w = 0{,}7t = 4$ mm



Spoj gazište - tetiva

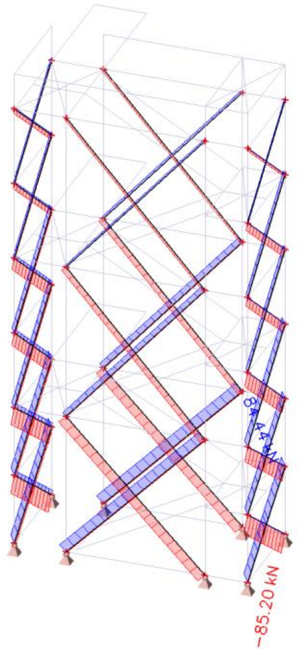
Spoj rešetkastog gazišta i tetive izvodi se vijčanom vezom hrpta tetive s tipskim limom zavarenim na rešetkasto gazište. Karakteristični detalj prikazan je u nastavku.



Detalj stabilizacije (D4)

U nastavku je dan grafički prikaz maksimalne uzdužne sile u stabilizaciji za anvelopu graničnog stanja nosivosti.

Values: **N**
Class: Anvelopa GSN
Extreme 1D: Global



Provjera otpornosti vara

$a_w = 4$ mm
L = 4 · 80 = 320 mm

$F_{w,Rk} = (f_u \cdot a \cdot L) / (\beta_w \sqrt{3}) = (51 \cdot 0{,}4 \cdot 32) / (0{,}9 \cdot \sqrt{3}) = 418{,}8$ kN

$F_{w,Rd} = F_{w,Rk} / \gamma_{M2} = 418{,}8 / 1{,}25 = 335$ kN
335 kN > $N_{Ed} = 85{,}2$ kN → zadovoljava (25%)

Provjera otpornosti vijaka na posmik

$F_{v;Ed/vijak} = N_{Ed} / 2 = 85{,}2/2 = 42{,}6$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 75{,}4 / 1{,}25 = 60{,}3$ kN
60,3 kN > $F_{v;Ed/vijak} = 42{,}6$ kN → zadovoljava (71%)

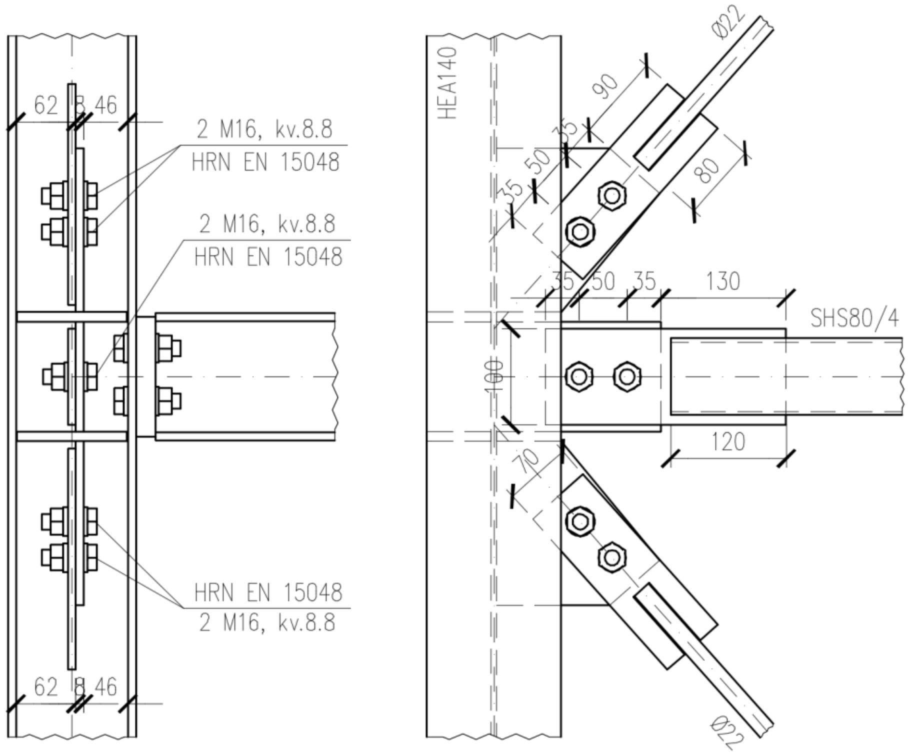
Provjera otpornosti ploče na pritisak po omotaču rupe

$F_{b,Rd} = (2{,}5 \cdot a \cdot f_u \cdot d \cdot t) / \gamma_{M2}$
$a = \min \{ e_1/3d_0 ; f_{ub} / f_u ; 1\} = \min \{ 35/3 \cdot 18 ; 100/51 ; 1\} = 0{,}65$
$F_{b,Rd} = (2{,}5 \cdot 0{,}65 \cdot 51 \cdot 1{,}6 \cdot 0{,}8) / 1{,}25 = 84{,}9$ kN

84,9 kN > $F_{v;Ed/vijak} = 42{,}6$ kN → zadovoljava (50%)

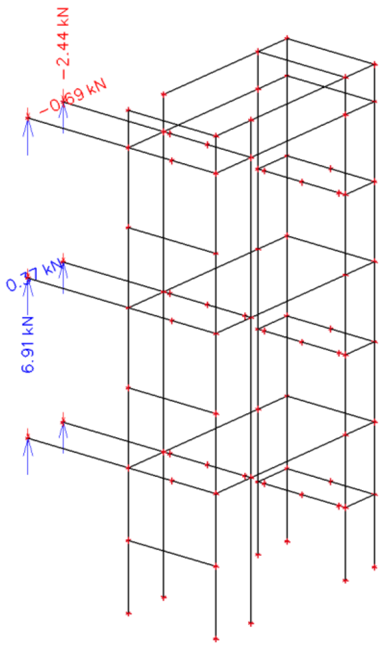
Geometrija spoja stabilizacije

Vijci	2 M16, kv. 8.8
Prihvatni limovi	t = 8 mm, S355J2
Zavari	a_w = 4 mm



Detalj bočnog prihvata na objekt (D5)

U nastavku je dan grafički prikaz maksimalnih reakcija bočnog prihvata na objekt za anvelopu graničnog stanja nosivosti. Bočni prihvati oblikovani su tako da ne prenose moment savijanja ni uzdužnu silu na objekt.



Bočni prihvat izvodi se kliznom vijčanom vezom grede stubišta sa prethodno ubetoniranim sidrenim sklopom. Sidreni sklop izvodi se od 2 lima debljine 15 mm, profila HEA 140 te istake za nasjedanje grede. Na istaci je potrebno predvidjeti šlic rupu u uzdužnom smjeru, kako je prikazano detaljem u nastavku.

Rezne sile u čvoru

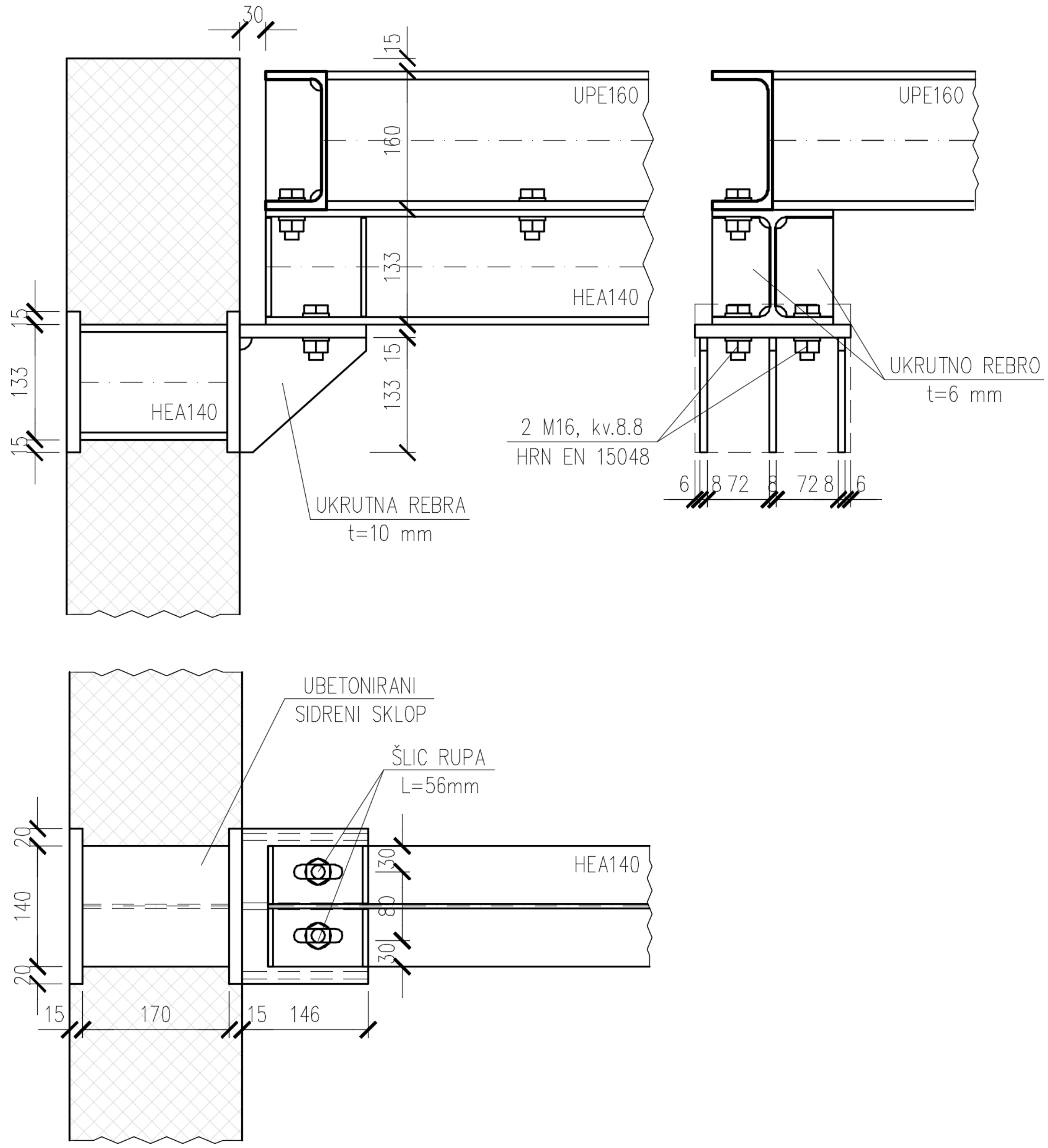
$V_{Ed,z}$ = 6,9 kN

$V_{Ed,y}$ = 0,7 kN

S obzirom na minimalne iznose reznih sila, spoj se izvodi isključivo konstruktivno te se neće dodatno provjeravati.

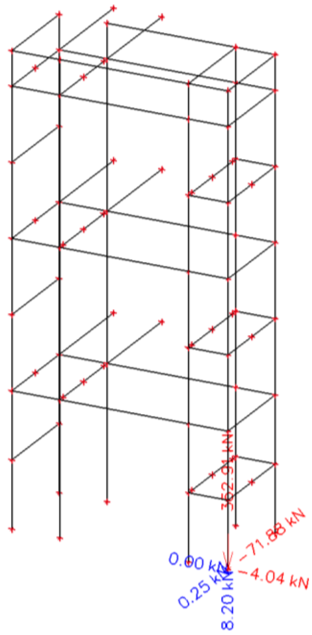
Geometrija spoja

Vijci	2 M16, kv. 8.8
Trn	HEA 140, S355J2
Čeone ploče	t = 15 mm, S355J2
Istaka	t = 15 mm, S355J2
Ukrutna rebra	t = 8 mm, S355J2
Zavari	a_w = 4 mm (pojas), a_w = 4 mm (hrbat)



Detalj sidrenja stupova (D6)

U nastavku je dan grafički prikaz reakcija konstrukcije za mjerodavnu kombinaciju GSN6.



Sidrenje stupova izvodi se prethodno ubetoniranim sidrenim sklopovima koji se sastoje od šablon ploče debljine 15 mm te 4 M20 navojne šipke kvalitete 8.8. Minimalna udaljenost sidra od ruba betona iznosi 90 mm. Dimenzije temelja prilagoditi navedenom. Beton se izvodi minimalno kao C25/30. Prilikom betoniranja potrebno je poravnati gornje lice šablon ploče s licem betona.

Rezne sile u čvoru

N_{Ed} = 352,9 kN (vlak)
V_{Ed} = 71,9 kN

Provjera otpornosti sidara na posmik

$V_{Ed/vijak} = V_{Ed} /4 = 71,9 / 4 = 18$ kN / po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 117,6 / 1,25 = 94,1$ kN
94,1 kN > $N_{Ed/vijak}$ = 18 kN → zadovoljava (19%)

Provjera pritiska na beton preko vijaka

$A = d \cdot 3d = 2 \cdot 3 \cdot 2 = 12$ cm^2
$\sigma_b = V_{Ed/vijak} / A = 18 / 12 = 1,50$ kN/cm^2

$\sigma_{dop} = f_{ck} /1,5 = 2,5/1,5 = 1,67$ kN/cm^2 > σ_b = 1,50 kN/cm^2 → zadovoljava (90%)

Provjera otpornosti sidara na vlak

$N_{Ed/vijak} = N_{Ed} /4 = 352,9 / 4 = 88,2$ kN / po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2} = 176,4 / 1,25 = 141,1$ kN
141,1 kN > $N_{Ed/vijak}$ = 88,2 kN → zadovoljava (63%)

Provjera otpornosti na čupanje

$\sigma_b = N_{Ed/vijak} / (d \cdot \pi \cdot L) = 88{,}2 / (2{,}0 \cdot \pi \cdot 70) = 0{,}20$ kN/cm^2
$\tau_{dop} = 0{,}27$ kN/cm^2

$0{,}27$ kN/cm^2 $> \sigma_b = 0{,}20$ kN/cm^2 → zadovoljava (74%)

Kako bi se povećala otpornost sidrenog elementa na čupanje, odnosno smanjio utjecaj na beton, na dnu je potrebno izvesti kontrapločice dimenzija 100/100/15 mm (vidi shemu).

Provjera pritiska na beton preko kontraploče

$A = 10 \cdot 10 = 100$ cm^2
$\sigma_b = N_{Ed/vijak} / A = 88{,}2/100 = 0{,}88$ kN/cm^2

$\sigma_{dop} = f_{ck} / 1{,}5 = 2{,}5/1{,}5 = 1{,}67$ kN/cm^2 $> \sigma_b = 0{,}88$ kN/cm^2 → zadovoljava (53%)

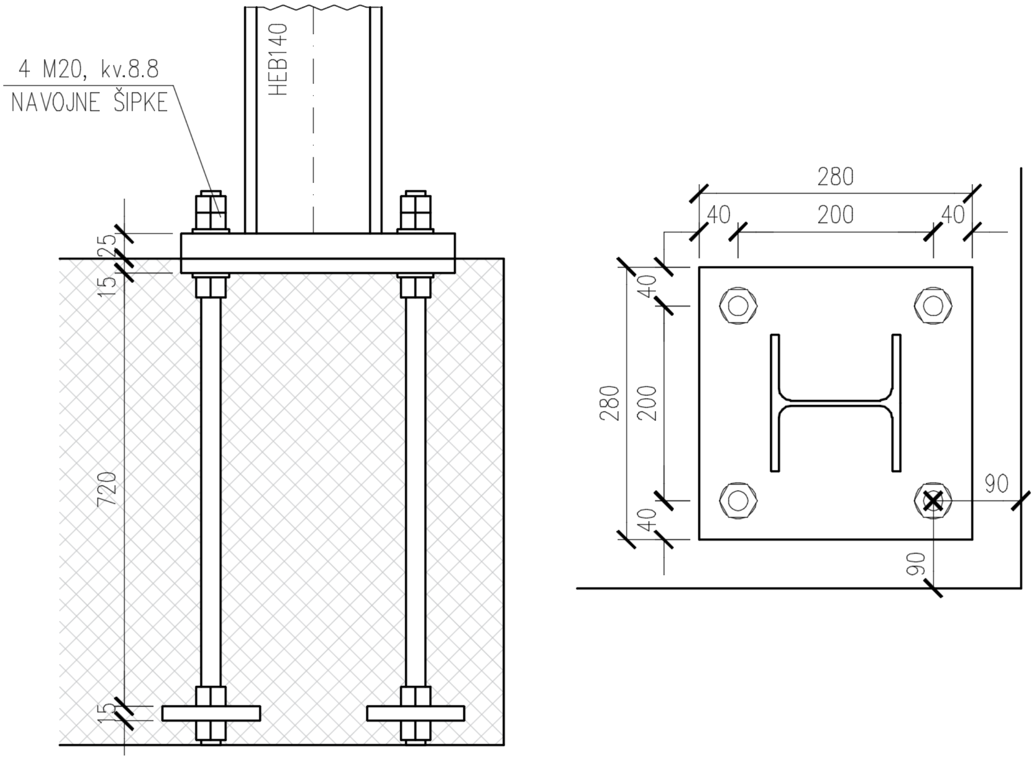
Provjera interakcije vlaka i posmika na vijke

$F_{v,Ed} / F_{v,Rd} + F_{t,Ed} / (1{,}4 \cdot F_{t,Rd}) = 18 / 94{,}1 + 88{,}2 / (1{,}4 \cdot 176{,}4) = 0{,}55 < 1{,}0$

Geometrija spoja

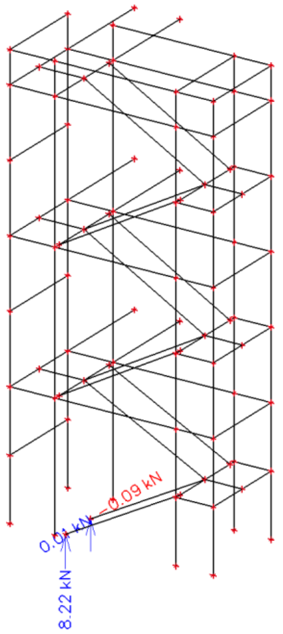
Vijci	4 M20, kv. 8,8, koristiti 2 matice, bez pritezanja
Čeona ploča	t = 25 mm, S355J2
Šablon ploča	t = 15 mm, S355J2
Kontrapločice	t = 15 mm, S355J2
Zavari	a_w = 4 mm (pojas), a_w = 4 mm (hrbat)

Za visinsko pozicioniranje šablon ploče i kontrapločica koristiti matice s pripadnim podložnim pločicama.

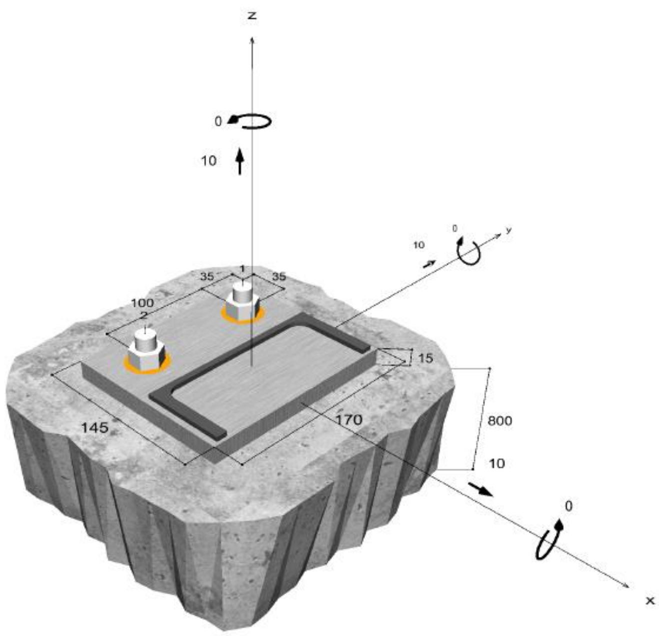


Detalj sidrenja tetiva

U nastavku je dan grafički prikaz reakcija tetive za anvelopu graničnog stanja nosivoti, nakon čega slijedi proračun sidrenja u programskom paketu C-FIX. Sidrenje tetiva izvodi se kemijskim sidrenjem sidara M20, kvalitete 8.8. Kemija kao Fischer FIS V ili jednakovrijedna.



S obzirom na minimalne iznose reakcija tetiva, sidrenje se izvodi konstruktivno. U uzdužnom smjeru (smjeru pružanja tetive) potrebno je predvidjeti šlic rupe duljine 40 mm.



Input data

Design method	Design Method EN1992-4:2018 bonded fastener
Base material	C25/30, EN 206
Concrete condition	Non-cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	Hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap filled
Type of loading	Permanent-Transient/Static
Base plate location	Base plate flush installed on base material
Base plate geometry	Polygon
Profile type	UPE 160

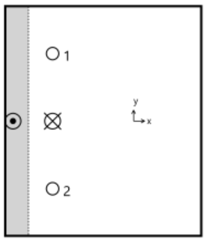
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	10.00	10.00	10.00	0.00	0.00	0.00	Permanent-Transient/Static

*) The required partial safety factors for actions are included

Resulting anchor forces

Anchor no.	Tensile action kN	Shear Action kN	Shear Action x kN	Shear Action y kN
1	15.25	5.10	-1.00	5.00
2	15.25	12.08	11.00	5.00



max. concrete compressive strain :	0.45 ‰
max. concrete compressive stress :	14.0 N/mm²
Resulting tensile actions :	30.50 kN , X/Y position (-60 / 0)
Resulting compression actions :	20.50 kN , X/Y position (-89 / 0)

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N,s} = \beta_{N,s;2} = 0.18 \leq 1$$
$$\beta_{V,s} = \beta_{Vs;2} = 0.24 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;2}^2 + \beta_{Vs;2}^2 = 0.09 \leq 1$$

Eq. (7.55)

Proof successful

Utilisation concrete

$$\beta_{N,p} = \beta_{N,p;1} = 0.43 \leq 1$$
$$\beta_{V,cp} = \beta_{V,cp;1} = 0.18 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,p;1}^{1.5} + \beta_{V,cp;1}^{1.5} = 0.36 \leq 1$$

Eq. (7.56)

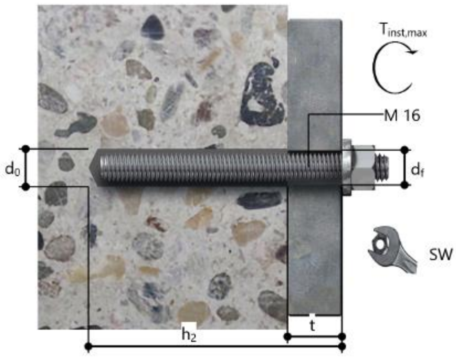
Installation data

Anchor

Anchor system	**fischer Injection system FIS V**	
Injection resin	FIS V 360 S (other cartridge sizes available)	Art.-No. 94405
Fixing element	Threaded rod FIS A M 16 x 200 8.8, zinc plated steel, Property Class 8.8	Art.-No. 517939
Accessories	FIS MR Plus	Art.-No. 545853
	FIS Extension tube 9mm	Art.-No. 48983
	Dispenser FIS DM S	Art.-No. 511118
	Compressed-air cleaning tool	Art.-No. 93286
	compressed air (oil-free), min. 6 bar	By job site.
	BSD 18	Art.-No. 1493
	SDS Chuck with internal thread M8	Art.-No. 530332
	Quattric II 18/200/250	Art.-No. 549956
	or alternatively	
	FHD 18/320/450	Art.-No. 546600
	Hammer drilling with or without suction	

Installation details

Thread diameter	M 16
Drill hole diameter	d_0 = 18 mm
Drill hole depth	h_2 = 165 mm
Calculated anchorage depth	h_{ef} = 150 mm
Drilling method	Hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap filled
Maximum torque	$T_{inst,max}$ = 60.0 Nm
Socket size	24 mm
Base plate thickness	t = 15 mm
Total fixing thickness Tfix,max	t_{fix} = 15 mm
Volume of resin per drill hole	20 ml/10 scale divisions

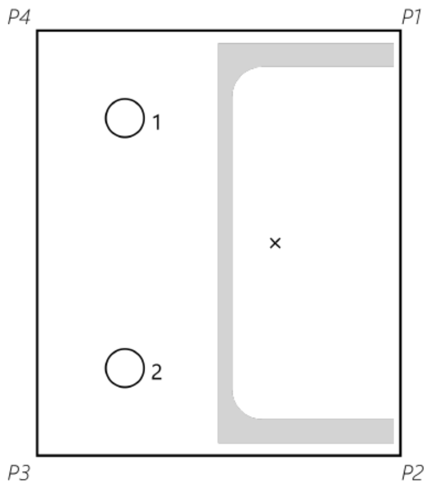


Base plate details

Base plate material	S 355 (St 52)
Base plate thickness	t = 15 mm
Clearance hole in base plate	d_f=20 mm

Attachment

Profile type	UPE 160



Anchor coordinates

Anchor no.	x mm	y mm
1	-60	50
2	-60	-50

Base plate coordinates

Point	x mm	y mm
P1	50	85
P2	50	-85
P3	-95	-85
P4	-95	85

Specifikacija osnovnog materijala

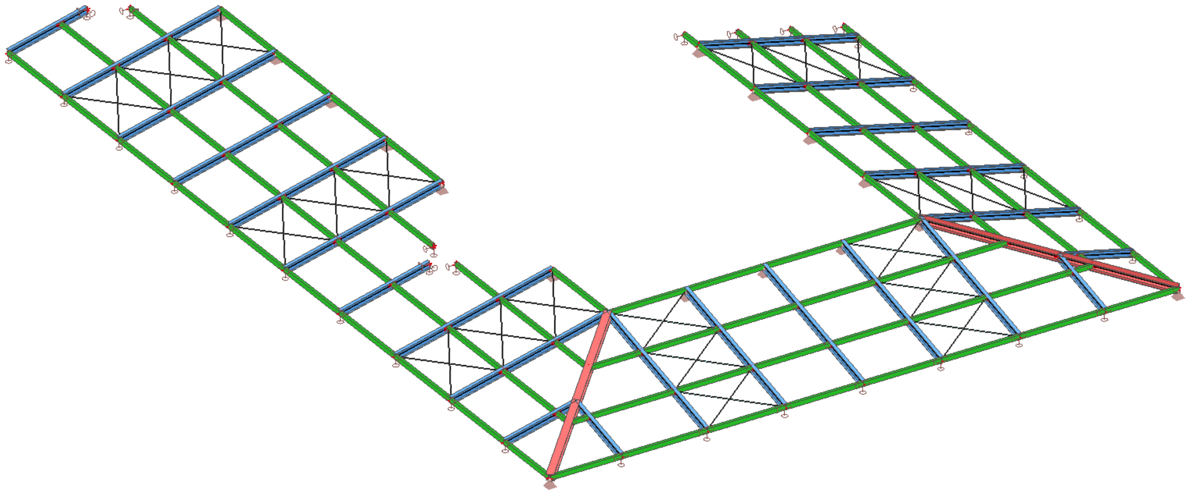
Cross-section	Material	Length [m]	Unit mass [kg/m]	Mass [kg]	Surface [m²]	Volume [m³]
CS1 - HEB140	S 355	31.200	33.7	1052.2	25.116	1.3404e-01
CS2 - HEA140	S 355	138.120	24.6	3404.5	109.667	4.3370e-01
CS3 - UPE160	S 235	58.785	17.0	1001.4	34.019	1.2756e-01
CS4 - RRK80/80/4	S 235	72.700	9.2	670.6	22.246	8.5422e-02
CS5 - RD22	S 355	194.065	3.0	578.8	13.377	7.3733e-02
Total		**494.870**		**6707.4**	**204.426**	**8.5445e-01**

NAPOMENA: Specifikacija je dobivena iz statičkog modela, odnosno na temelju osnih dužina elemenata te može služiti isključivo kao orijentacijska vrijednost za izradu troškovnika. Stvarnu težinu konstrukcije potrebno je uvećati cca 10% (zavari, limovi i spojna sredstva).

1.3. Proračun čelične konstrukcije krovišta

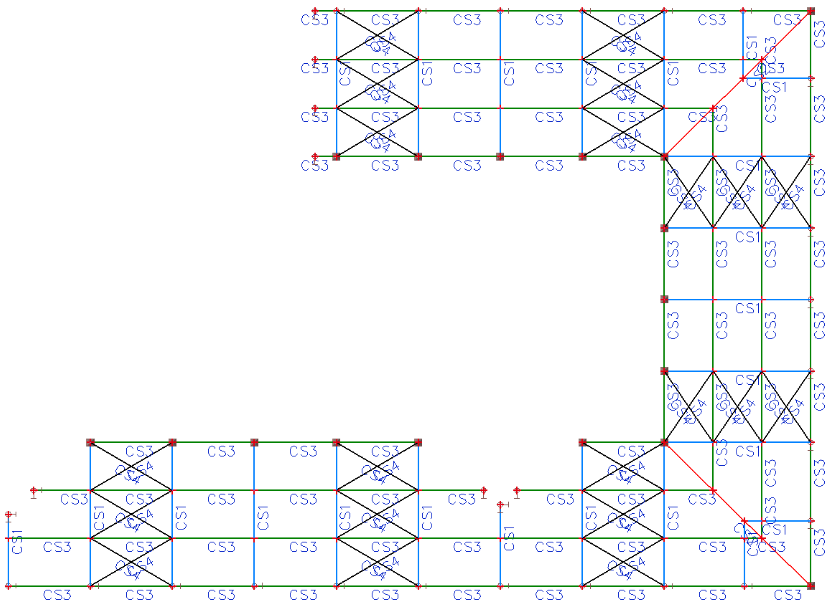
U nastavku je proveden kontrolni proračun čelične nosive konstrukcije krovišta Centra za pružanje usluga u zajednici Tereza u Obrovcu, nakon čega slijedi proračun priključaka osnovne nosive konstrukcije.

Prostorni prikaz konstrukcije



Poprečni presjeci u konstrukciji

Name	Type	Item material	Fabrication	A [m²]	A_y [m²]	I_y [m⁴]	$W_{el.y}$ [m³]	$W_{pl.y}$ [m³]	Colour
	Detailed				A_z [m²]	I_z [m⁴]	$W_{el.z}$ [m³]	$W_{pl.z}$ [m³]	
CS1	IPE240	S 355	rolled	3.9100e-03	2.4663e-03	3.8920e-05	3.2400e-04	3.6700e-04	
					1.5146e-03	2.8400e-06	4.7300e-05	7.3900e-05	
CS2	HEA240	S 355	rolled	7.6800e-03	5.6329e-03	7.7600e-05	6.7500e-04	7.4583e-04	
					1.8411e-03	2.7700e-05	2.3100e-04	3.5167e-04	
CS3	RRK150/100/4	S 235	cold formed	1.8950e-03	7.9194e-04	5.9500e-06	7.9300e-05	9.5700e-05	
					1.1577e-03	3.1900e-06	6.3700e-05	7.2500e-05	
CS4	RD12	S 355	rolled	1.1304e-04	1.0171e-04	9.9655e-10	1.6609e-07	2.8346e-07	
					1.0171e-04	9.9655e-10	1.6609e-07	2.8346e-07	



Oslonci konstrukcije

Svi nosivi elementi konstrukcije modelirani su kao proste grede, oslonjeni zglobno s jedne strane (nema prijenosa momenta savijanja), odnosno klizno s druge strane (nema prijenosa momenta i uzdužne sile).

Djelovanja na konstrukciju

Djelovanja na konstrukciju preuzeta su iz Glavnog projekta koji je izradio projektantski ured KONUS d.o.o. (projektant Vice Tadić, dipl.ing.građ., oznaka projekta 148/2019 GL-K).

Stalno opterećenje	$g = 0{,}70\ kN/m^2$
Uporabno opterećenje	$q = 1{,}00\ kN/m^2$
Opterećenje snijegom	$s_k = 0{,}75\ kN/m^2$
Opterećenje vjetrom	$v_b = 35\ m/s$

Opterećenje snijegom sukladno normi HRN EN 1991-1-3.

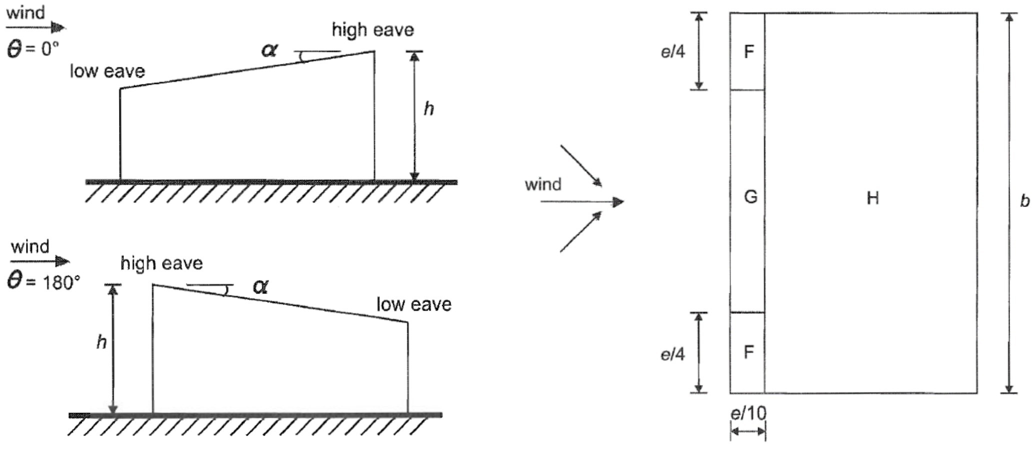
Karakteristično opterećenje snijegom na tlu	$s_k = 0{,}75\ kN/m^2$
Koeficijent umanjenja za nagib α < 30°	$\mu_i = 0{,}8$
Opterećenje snijegom na konstrukciju	$s_1 = 0{,}75 \cdot 0{,}8 = 0{,}60\ kN/m^2$

Opterećenje vjetrom sukladno normi EN 1991-1-4, točka 7.2.4. djelovanje krova na jednostrešne krovove.

Srednja brzina vjetra (okomito na plohu)	$v_{b,0} = 35\ m/s$
Kategorija terena: II (izolirane prepreke)	Ce(z=17 m) = 2,7
Referentni pritisak srednje brzine vjetra	$q_b = 0{,}77\ kN/m^2$
Koeficijenti unutarnjeg tlaka	$c_{pi} = +0{,}2\ /\ -0{,}3$

Vjetar puše slijeva/zdesna;

Pitch Angle α	Zone for wind direction $\theta = 0°$						Zone for wind direction $\theta = 180°$					
	F		G		H		F		G		H	
	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5°	-1,7	-2,5	-1,2	-2,0	-0,6	-1,2	-2,3	-2,5	-1,3	-2,0	-0,8	-1,2
	+0,0		+0,0		+0,0							
15°	-0,9	-2,0	-0,8	-1,5	-0,3		-2,5	-2,8	-1,3	-2,0	-0,9	-1,2
	+0,2		+0,2		+ 0,2							

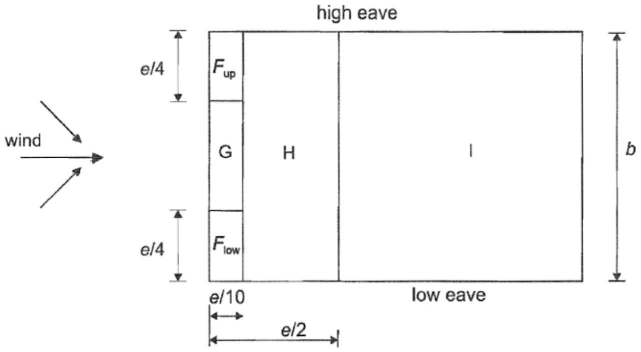


e = min [b;2h] = min [33 m; 2 · 16,9] = 33,0 m
e/10 = 33/10 = 3,3 m

Pritiskajući vjetar smjer x: w_0 = (0,2 + 0,2) · 2,7 · 0,77 = +0,83 kN/m^2
$w_{180,F}$ = (-2,5 + 0,2) · 2,7 · 0,77 = -4,78 kN/m^2
$w_{180,H}$ = (-0,9 + 0,2) · 2,7 · 0,77 = -1,46 kN/m^2

Odižući vjetar smjer x: $w_{0,F}$ = (-0,9 - 0,3) · 2,7 · 0,77 = -2,49 kN/m^2
$w_{0,H}$ = (-0,3 - 0,3) · 2,7 · 0,77 = -1,25 kN/m^2
$w_{180,F}$ = (-2,5 -0,3) · 2,7 · 0,77 = -5,82 kN/m^2
$w_{180,H}$ = (-0,9 -0,3) · 2,7 · 0,77 = -2,49 kN/m^2

Pitch Angle α	Zone for wind direction θ = 90°									
	F_{up}		F_{low}		G		H		I	
	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5°	-2,1	-2,6	-2,1	-2,4	-1,8	-2,0	-0,6	-1,2	-0,5	
15°	-2,4	-2,9	-1,6	-2,4	-1,9	-2,5	-0,8	-1,2	-0,7	-1,2



e = min [b;2h] = min [33 m; 2 · 16,9] = 33,0 m
e/10 = 33/10 = 3,3 m
e/2 = 33/2 = 15,0 m

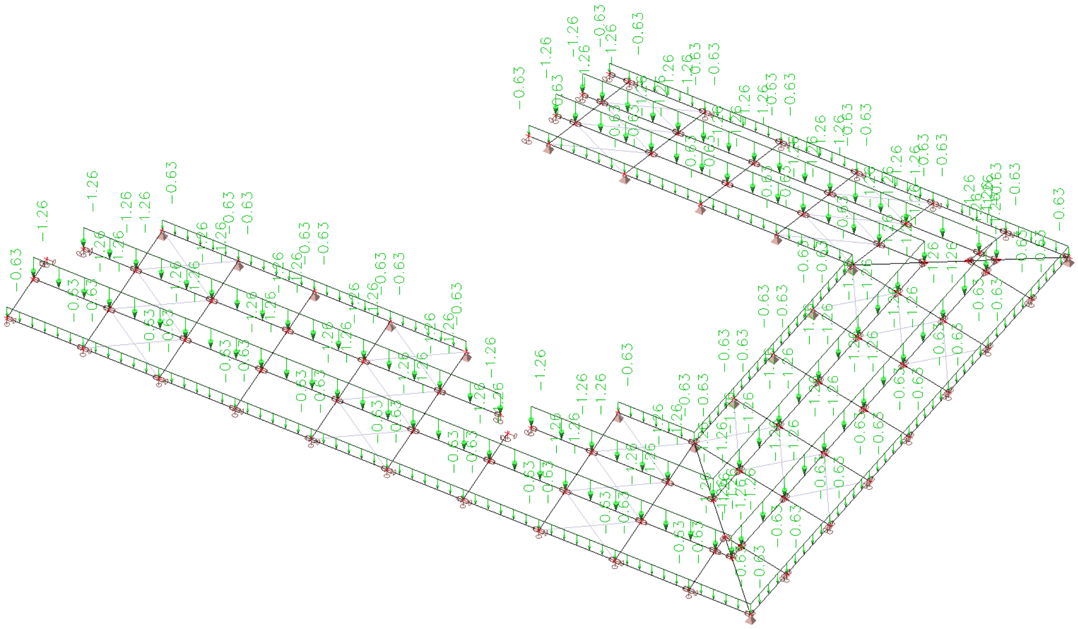
Pritiskajući vjetar smjer y: w = (0,0 + 0,2) · 2,7 · 0,77 = +0,42 kN/m^2

Odižući vjetar smjer y: $w_{90,F}$ = (-2,4 - 0,3) · 2,7 · 0,77 = -5,61 kN/m^2
$w_{90,H}$ = (-0,8 - 0,3) · 2,7 · 0,77 = -2,29 kN/m^2

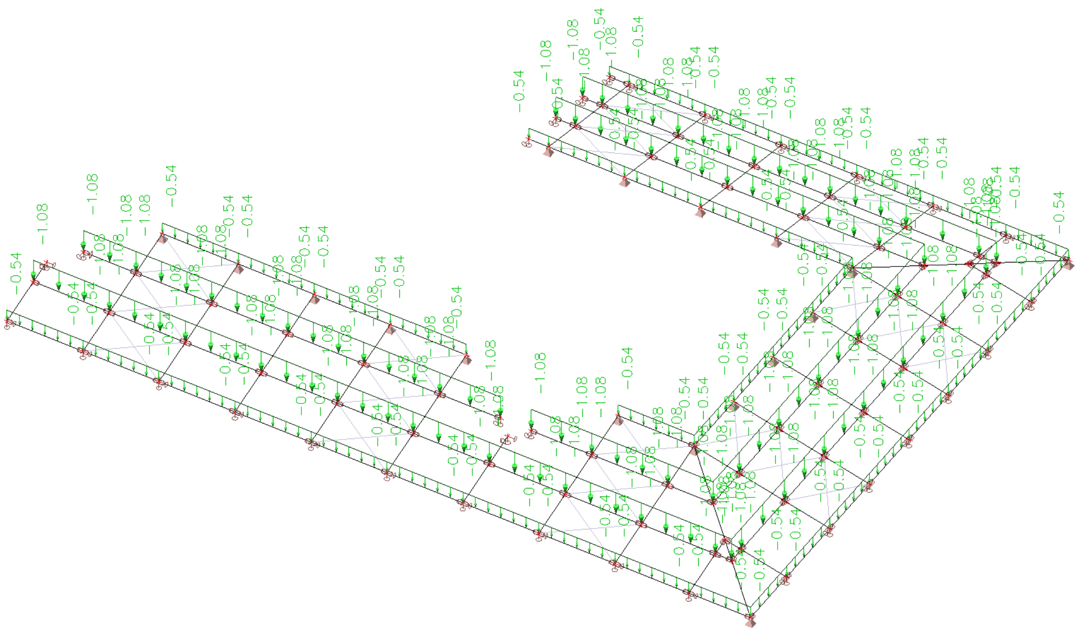
Shematski prikaz djelovanja na konstrukciju (vlastita težina uzeta automatski):

Name	Description	Load type	Action type	Load group	Spec	Duration
LC1	Vlastita tezina	Self weight	Permanent	LG1		
LC2	Stalno	Standard	Permanent	LG1		
LC3	Snijeg	Static	Variable	LG2	Standard	Medium
LC4	Korisno	Static	Variable	LG2	Standard	Medium
LC5	Vjetar pritisak +X	Static	Variable	LG3	Standard	Short
LC6	Vjetar odizanje +X	Static	Variable	LG3	Standard	Short
LC7	Vjetar pritisak -X	Static	Variable	LG3	Standard	Medium
LC8	Vjetar odizanje -X	Static	Variable	LG3	Standard	Medium
LC9	Vjetar pritisak Y	Static	Variable	LG3	Standard	Medium
LC10	Vjetar odizanje Y	Static	Variable	LG3	Standard	Medium

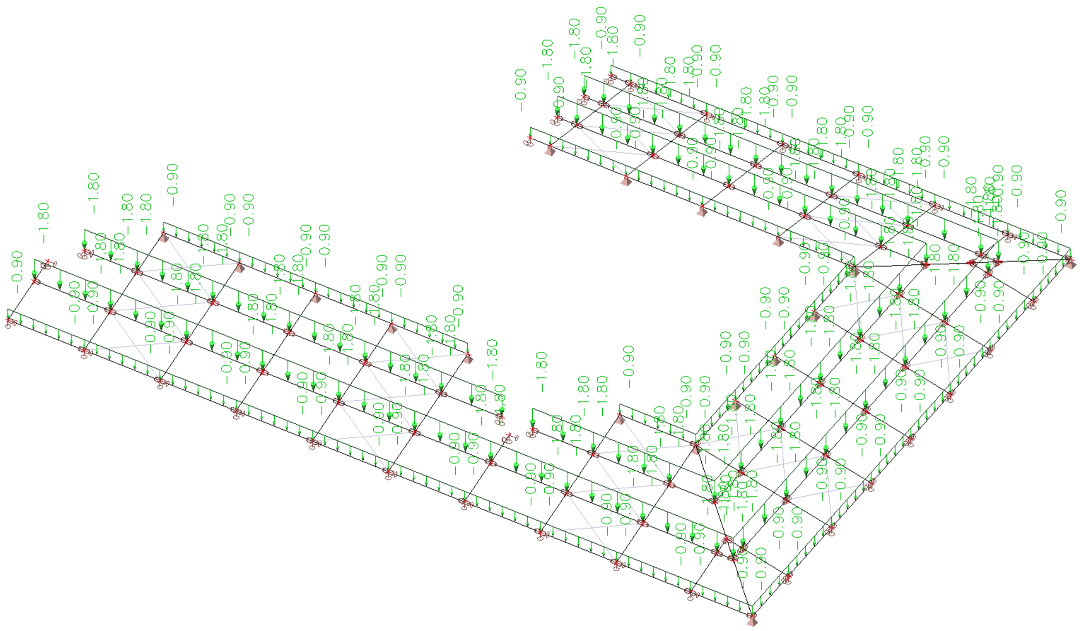
Name	Description	Load type	Action type	Load group
LC2	Stalno	Standard	Permanent	LG1



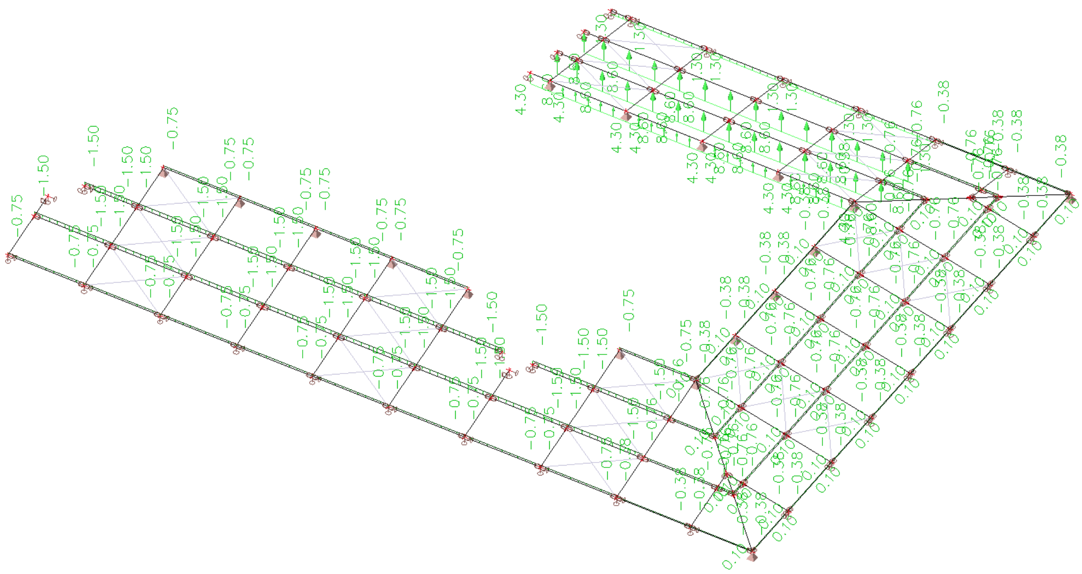
Name	Description	Load type	Action type	Load group	Spec	Duration
LC3	Snijeg	Static	Variable	LG2	Standard	Medium



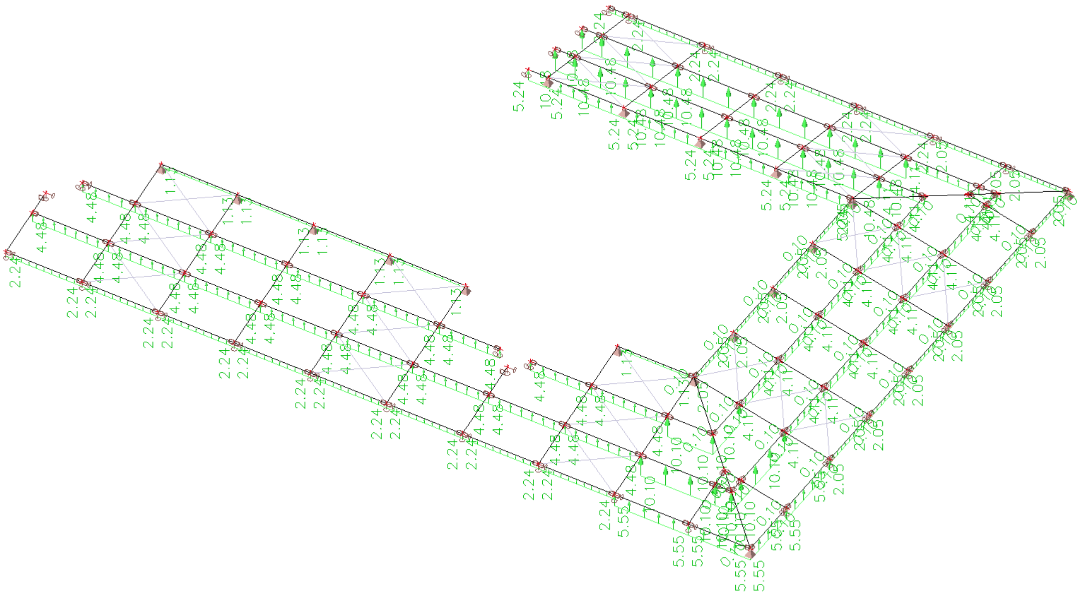
Name	Description	Load type	Action type	Load group	Spec	Duration
LC4	Korisno	Static	Variable	LG2	Standard	Medium



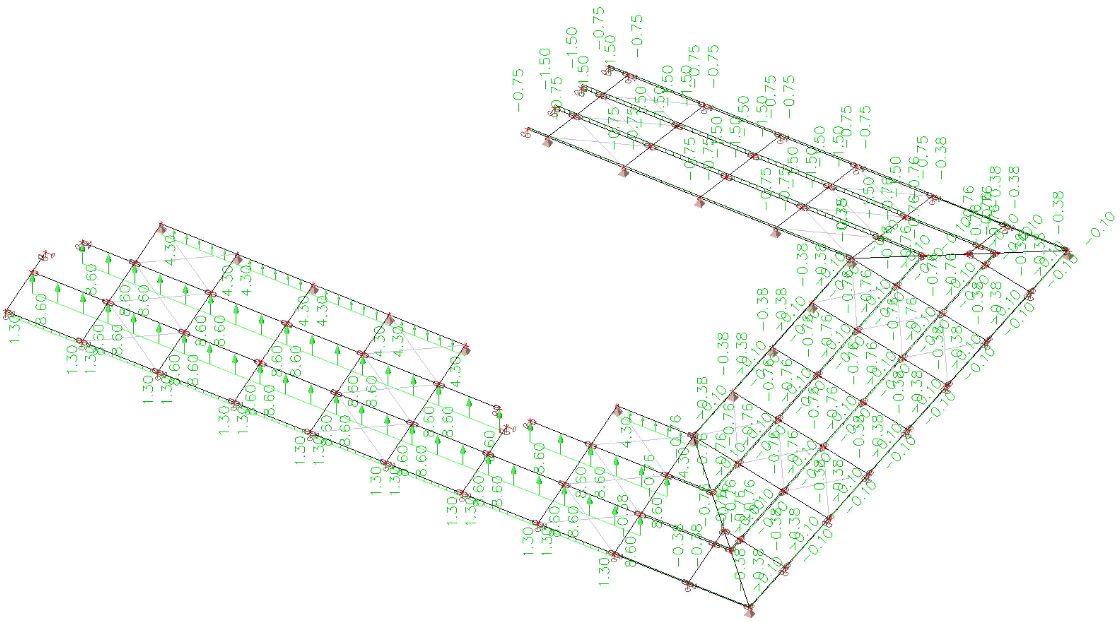
Name	Description	Load type	Action type	Load group	Spec	Duration
LC5	Vjetar pritisak +X	Static	Variable	LG3	Standard	Short



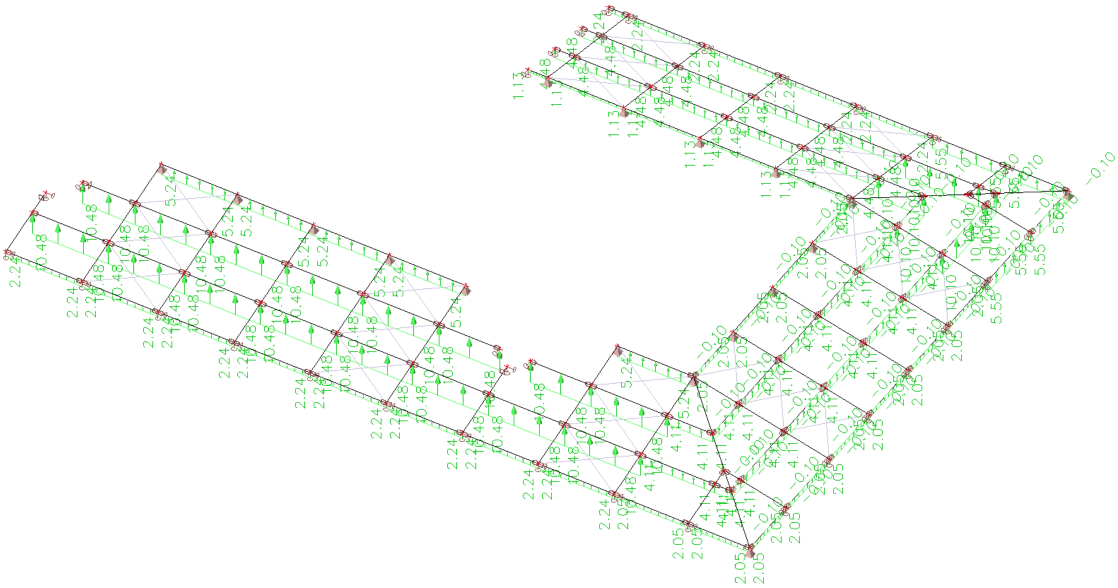
Name	Description	Load type	Action type	Load group	Spec	Duration
LC6	Vjetar odizanje +X	Static	Variable	LG3	Standard	Short



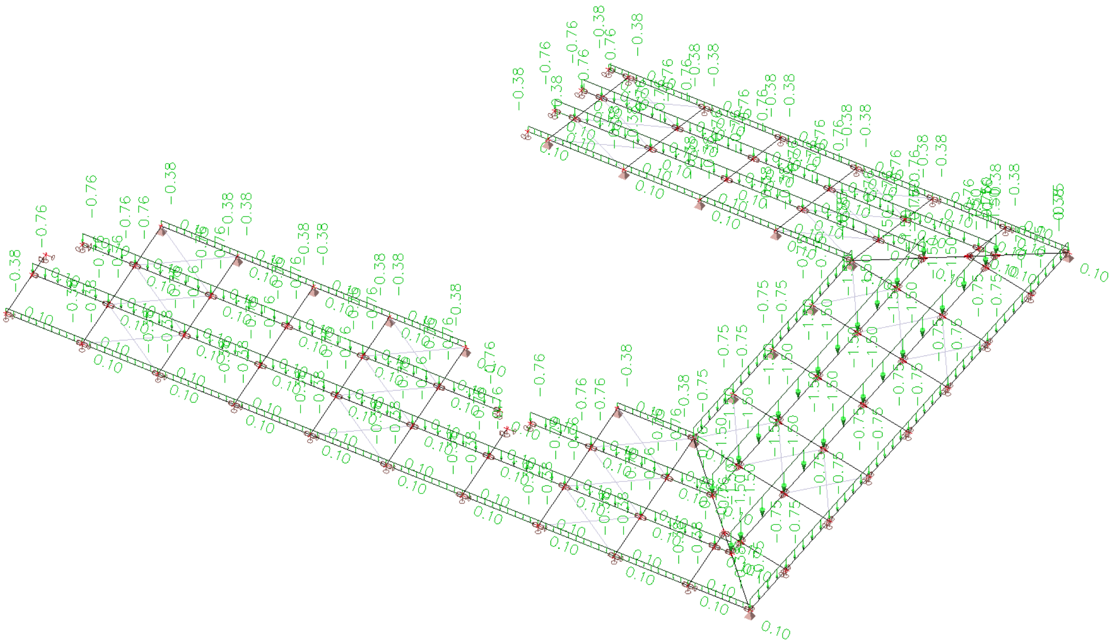
Name	Description	Load type	Action type	Load group	Spec	Duration
LC7	Vjetar pritisak -X	Static	Variable	LG3	Standard	Medium



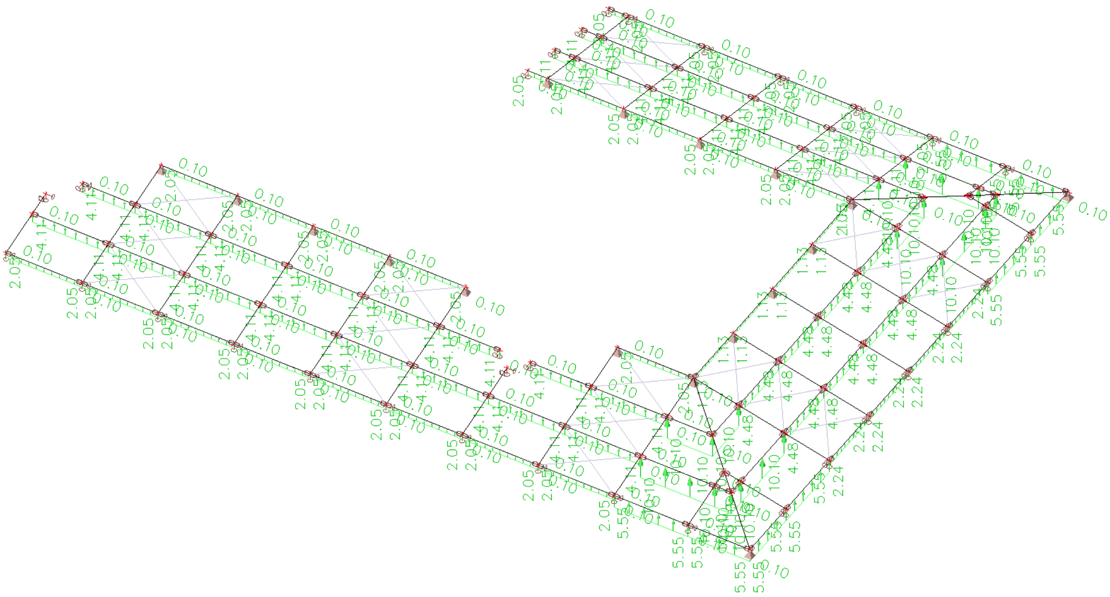
Name	Description	Load type	Action type	Load group	Spec	Duration
LC8	Vjetar odizanje -X	Static	Variable	LG3	Standard	Medium



Name	Description	Load type	Action type	Load group	Spec	Duration
LC9	Vjetar pritisak Y	Static	Variable	LG3	Standard	Medium



Name	Description	Load type	Action type	Load group	Spec	Duration
LC10	Vjetar odizanje Y	Static	Variable	LG3	Standard	Medium



Kombinacije djelovanja na konstrukciju

Name	Description	Type	Load cases	Coeff. [-]
GSN1		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
GSN2		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.50
GSN3		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC5 - Vjetar pritisak +X	1.50
GSN4		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC7 - Vjetar pritisak -X	1.50
GSN5		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC9 - Vjetar pritisak Y	1.50
GSN6		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC6 - Vjetar odizanje +X	1.50
GSN7		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC8 - Vjetar odizanje -X	1.50
GSN8		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC10 - Vjetar odizanje Y	1.50
GSN9		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC4 - Korisno	1.05
GSN10		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC5 - Vjetar pritisak +X	0.90
GSN11		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC7 - Vjetar pritisak -X	0.90
GSN12		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC9 - Vjetar pritisak Y	0.90
GSN13		Envelope - ultimate	LC1 - Vlastita tezina	1.35

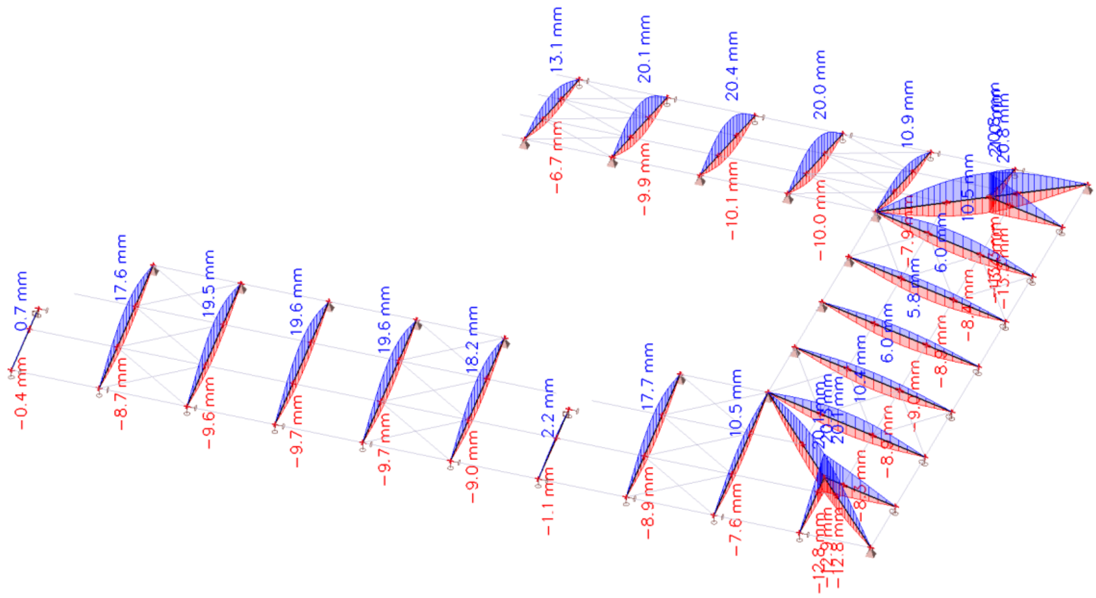
Name	Description	Type	Load cases	Coeff. [-]
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC4 - Korisno	1.50
GSN14		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.50
			LC5 - Vjetar pritisak +X	0.90
GSN15		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.50
			LC8 - Vjetar odizanje -X	0.90
GSN16		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.50
			LC9 - Vjetar pritisak Y	0.90
GSN17		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC5 - Vjetar pritisak +X	1.50
GSN18		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.05
			LC5 - Vjetar pritisak +X	1.50
GSN19		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC7 - Vjetar pritisak -X	1.50
GSN20		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.05
			LC7 - Vjetar pritisak -X	1.50
GSN21		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC9 - Vjetar pritisak Y	1.50
GSN22		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.05
			LC9 - Vjetar pritisak Y	1.50
GSU1		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
GSU2		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	1.00
GSU3		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC5 - Vjetar pritisak +X	1.00
GSU4		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC7 - Vjetar pritisak -X	1.00
GSU5		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC9 - Vjetar pritisak Y	1.00
GSU6		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC6 - Vjetar odizanje +X	1.00
GSU7		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC8 - Vjetar odizanje -X	1.00
GSU8		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC10 - Vjetar odizanje Y	1.00
GSU9		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC4 - Korisno	0.70
GSU10		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC5 - Vjetar pritisak +X	0.60
GSU11		Envelope - serviceability	LC1 - Vlastita tezina	1.00

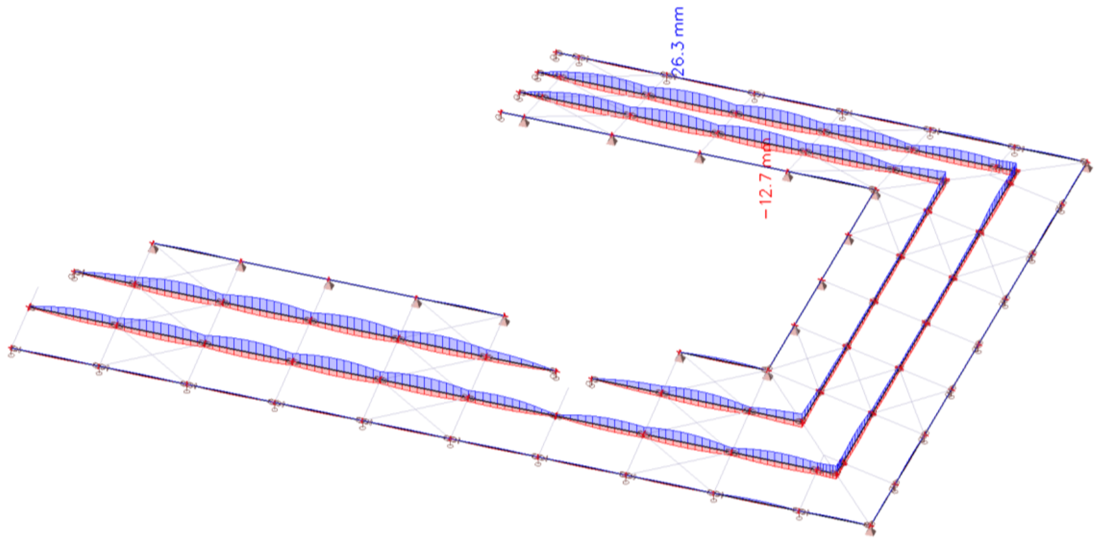
Name	Description	Type	Load cases	Coeff. [-]
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC7 - Vjetar pritisak -X	0.60
GSU12		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC9 - Vjetar pritisak Y	0.60
GSU13		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC4 - Korisno	1.00
GSU14		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	1.00
			LC5 - Vjetar pritisak +X	0.60
GSU15		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	1.00
			LC7 - Vjetar pritisak -X	0.60
GSU16		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	1.00
			LC9 - Vjetar pritisak Y	0.60
GSU17		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC5 - Vjetar pritisak +X	1.00
GSU18		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	0.70
			LC5 - Vjetar pritisak +X	1.00
GSU19		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC7 - Vjetar pritisak -X	1.00
GSU20		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	0.70
			LC7 - Vjetar pritisak -X	1.00
GSU21		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC9 - Vjetar pritisak Y	1.00
GSU22		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	0.70
			LC9 - Vjetar pritisak Y	1.00

Pomaci i deformacije konstrukcije

U nastavku je dan grafički prikaz maksimalnih deformacija konstrukcije za anvelopu graničnog stanja uporabivosti.

Values: **u_z**
Class: Anvelopa GSU





Maksimalni progib grebene grede u_{max} = 20,8 mm < u_{dop} = L/250 = 7800/250 = 31,2 mm
Maksimalni progib krovnog nosača u_{max} = 20,4 mm < u_{dop} = L/250 = 5600/250 = 22,4 mm
Maksimalni relativni progib podrožnice u_{max} = 26,3 - 20,1 = 6,2 mm < u_{dop} = L/200 = 3080/200 = 15,4 mm

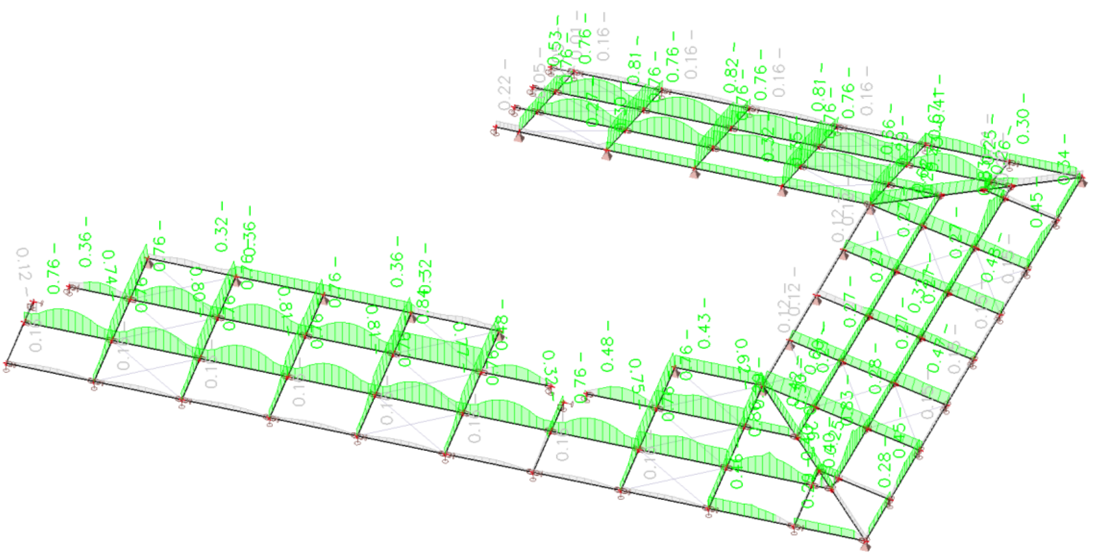
Rezne sile u konstrukciji

U nastavku je dan tablični prikaz maksimalnih reznih sila po tipu poprečnog presjeka za anvelopu GSN. Detaljan grafički prikaz reznih sila u pojedinim konstrukcijskim elementima dan je u točki 1.4. Proračun priključaka.

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B55	3.759+	GSN6/1	CS1 - IPE240	**-10.62**	-0.07	**42.95**	0.00	-78.76	0.02
B57	1.880-	GSN6/1	CS1 - IPE240	**10.66**	-0.01	-42.92	**0.00**	-79.19	-0.02
B12	1.886+	GSN8/2	CS1 - IPE240	-3.41	**-5.64**	14.10	0.00	-9.60	**3.87**
B7	1.854+	GSN8/2	CS1 - IPE240	-3.54	**5.79**	14.37	0.00	-9.62	**-3.90**
B56	1.880-	GSN6/1	CS1 - IPE240	10.42	-0.01	**-42.95**	0.00	**-80.07**	-0.03
B56	2.820-	GSN20/3	CS1 - IPE240	0.00	-0.01	0.00	0.00	**35.49**	0.03
B11	5.214+	GSN8/2	CS2 - HEA240	**-9.10**	0.01	32.43	0.00	-82.06	-0.04
B11	2.607-	GSN8/2	CS2 - HEA240	**9.36**	-0.02	-27.01	0.00	-69.96	-0.05
B52	3.643+	GSN22/4	CS2 - HEA240	2.20	**-0.04**	-2.81	0.00	50.83	0.14
B52	3.643-	GSN22/4	CS2 - HEA240	-3.39	**0.05**	8.38	0.00	50.83	0.14
B52	2.626-	GSN7/5	CS2 - HEA240	8.73	-0.02	**-27.45**	0.00	-71.54	-0.06
B52	5.251+	GSN7/5	CS2 - HEA240	-8.72	0.01	**33.10**	0.00	-83.86	-0.03
B11	5.214+	GSN4/6	CS2 - HEA240	2.33	0.03	-10.53	**-0.04**	15.86	-0.07
B52	5.251+	GSN3/7	CS2 - HEA240	2.25	-0.02	-10.78	**0.04**	15.99	0.08
B52	3.643-	GSN7/5	CS2 - HEA240	7.17	-0.04	-18.35	0.00	**-97.64**	-0.09
B52	3.643-	GSN16/8	CS2 - HEA240	-3.49	0.04	8.58	0.00	**51.89**	0.11
B11	3.555-	GSN20/3	CS2 - HEA240	-3.12	-0.03	5.78	-0.04	37.65	**-0.12**
B52	3.643+	GSN18/9	CS2 - HEA240	1.80	-0.04	-4.91	0.04	38.25	**0.14**
B38	0.000	GSN22/4	CS3 - RRK150/100/4	**-4.52**	0.00	7.39	0.73	0.00	0.00
B38	3.000	GSN8/2	CS3 - RRK150/100/4	**7.79**	0.00	20.81	-1.37	0.00	0.00
B29	0.000	GSN7/5	CS3 - RRK150/100/4	0.00	**-0.21**	-11.06	-1.28	0.16	**0.63**
B30	0.000	GSN7/5	CS3 - RRK150/100/4	0.06	0.00	**-22.24**	-1.41	0.00	0.00
B30	3.080	GSN7/5	CS3 - RRK150/100/4	0.06	0.00	**22.24**	-1.41	0.00	0.00
B69	0.000	GSN6/1	CS3 - RRK150/100/4	0.00	0.00	-4.54	**-5.88**	0.00	0.00
B39	0.000	GSN6/1	CS3 - RRK150/100/4	0.00	0.00	-4.62	**5.78**	0.00	0.00
B30	1.540-	GSN7/5	CS3 - RRK150/100/4	0.06	0.00	0.00	-1.41	**-17.12**	0.00
B28	0.000	GSN7/5	CS3 - RRK150/100/4	0.00	**0.16**	-13.32	-0.21	**7.22**	-0.09
B29	0.000	GSN18/9	CS3 - RRK150/100/4	0.00	0.08	4.82	0.29	-0.06	**-0.26**
B135	0.000	GSN22/4	CS4 - RD12	**-1.54**	0.00	0.00	0.00	0.00	0.00
B135	3.608	GSN7/5	CS4 - RD12	**1.65**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Rezultati dimenzioniranja konstrukcije

U nastavku je dan grafički prikaz iskorištenosti elemenata konstrukcije za anvelopu graničnog stanja nosivosti, nakon čega slijedi detaljan postupak dimenzioniranja za kritični element po tipu poprečnog presjeka.



Dimenzioniranje krovnog nosača IPE 240

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

Member B56	1.880 / 5.639 m	IPE240	S 355	Anvelopa GSN	0.82 -

Combination key
Anvelopa GSN / LC1 + 0.90*LC2 + 1.50*LC6

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	355.0	MPa
Ultimate strength f_u	490.0	MPa
Fabrication	Rolled	

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

The critical check is on position 1.880 m

Internal forces	Calculated	Unit
N_{Ed}	-0.07	kN
$V_{y,Ed}$	0.00	kN
$V_{z,Ed}$	0.28	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	-80.01	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 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	42	10	2.368e+05	2.372e+05	1.0	0.4	1.0	4.3	7.3	8.1	11.2	1
3	SO	42	10	2.364e+05	2.360e+05	1.0	0.4	1.0	4.3	7.3	8.1	11.2	1
4	I	190	6	1.957e+05	-1.957e+05	-1.0		0.5	30.7	58.6	67.4	100.5	1
5	SO	42	10	-2.367e+05	-2.371e+05								
7	SO	42	10	-2.364e+05	-2.360e+05								

The cross-section is classified as Class 1

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

A	3.9100e-03	m²
$N_{c,Rd}$	1388.05	kN
Unity check	0.00	-

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

$W_{pl,y}$	3.6700e-04	m³
$M_{pl,y,Rd}$	130.28	kNm
Unity check	0.61	-

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

$W_{pl,z}$	7.3900e-05	m³
$M_{pl,z,Rd}$	26.23	kNm
Unity check	0.00	-

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

η	1.20	
A_v	2.4834e-03	m²
$V_{pl,y,Rd}$	509.00	kN
Unity check	0.00	-

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

η	1.20	
A_v	1.9128e-03	m²
$V_{pl,z,Rd}$	392.04	kN
Unity check	0.00	-

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

$M_{pl,y,Rd}$	130.28	kNm
α	2.00	
$M_{pl,z,Rd}$	26.23	kNm
β	1.00	

Unity check (6.41) = 0.38 + 0.00 = 0.38 -

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

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	42	10	1.826e+03	9.358e+02	0.5	0.7	1.0	4.3	7.3	8.1	14.1	1
3	SO	42	10	2.596e+03	3.486e+03	0.7	0.5	1.0	4.3	7.3	8.1	11.5	1
4	I	190	6	2.283e+03	2.976e+03	0.8		1.0	30.7	26.8	30.9	37.0	2
5	SO	42	10	3.434e+03	4.324e+03	0.8	0.4	1.0	4.3	7.3	8.1	11.4	1
7	SO	42	10	2.664e+03	1.774e+03	0.7	0.6	1.0	4.3	7.3	8.1	13.0	1

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	5.639	1.880	m
Buckling factor k	1.00	0.85	
Buckling length l_{cr}	5.639	1.591	m
Critical Euler load N_{cr}	2536.73	2325.44	kN
Slenderness λ	56.52	59.03	
Relative slenderness λ_{rel}	0.74	0.77	
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 & 6.3.2.2 and formula (6.54)

LTB parameters		
Method for LTB curve	General case	
Plastic section modulus $W_{pl,y}$	3.6700e-04	m^3
Elastic critical moment M_{cr}	228.85	kNm
Relative slenderness $\lambda_{rel,LT}$	0.75	
Limit slenderness $\lambda_{rel,LT,0}$	0.20	
LTB curve	a	
Imperfection α_{LT}	0.21	
Reduction factor χ_{LT}	0.82	
Design buckling resistance $M_{b,Rd}$	97.20	kNm
Unity check	0.82	-

Mcr parameters		
LTB length l_{LT}	1.880	m
Influence of load position	no influence	
Correction factor k	1.00	
Correction factor k_w	1.00	
LTB moment factor C_1	1.00	
LTB moment factor C_2	0.00	
LTB moment factor C_3	1.00	
Shear center distance d_z	0	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_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 area A	3.9100e-03	m^2
Plastic section modulus $W_{pl,y}$	3.6700e-04	m^3
Plastic section modulus $W_{pl,z}$	7.3900e-05	m^3
Design compression force N_{Ed}	0.07	kN
Design bending moment (maximum) $M_{y,Ed}$	-80.04	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0.03	kNm
Characteristic compression resistance N_{Rk}	1388.05	kN
Characteristic moment resistance $M_{y,Rk}$	130.28	kNm
Characteristic moment resistance $M_{z,Rk}$	26.23	kNm
Reduction factor χ_y	1.00	
Reduction factor χ_z	1.00	
Reduction factor χ_{LT}	0.82	
Interaction factor k_{yy}	1.00	
Interaction factor k_{yz}	1.13	
Interaction factor k_{zy}	0.52	
Interaction factor k_{zz}	0.99	

Maximum moment $M_{y,Ed}$ is derived from beam B56 position 1.880 m.
Maximum moment $M_{z,Ed}$ is derived from beam B56 position 1.880 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	2536.73	kN
Critical Euler load $N_{cr,z}$	2325.44	kN
Elastic critical load $N_{cr,T}$	2943.52	kN
Plastic section modulus $W_{pl,y}$	3.6700e-04	m^3
Elastic section modulus $W_{el,y}$	3.2400e-04	m^3
Plastic section modulus $W_{pl,z}$	7.3900e-05	m^3
Elastic section modulus $W_{el,z}$	4.7300e-05	m^3
Second moment of area I_y	3.8920e-05	m^4
Second moment of area I_z	2.8400e-06	m^4
Torsional constant I_t	1.2336e-07	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-80.04	kNm
Maximum relative deflection δ_z	33.8	mm
Equivalent moment factor $C_{my,0}$	1.00	

Interaction method 1 parameters		
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	0.95	
Equivalent moment factor $C_{mz,0}$	0.99	
Factor μ_y	1.00	
Factor μ_z	1.00	
Factor ε_y	14439.70	
Factor a_{LT}	1.00	
Critical moment for uniform bending $M_{cr,0}$	228.85	kNm
Relative slenderness $\lambda_{rel,0}$	0.75	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.20	
Equivalent moment factor C_{my}	1.00	
Equivalent moment factor C_{mz}	0.99	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor c_{LT}	0.79	
Factor d_{LT}	0.00	
Factor e_{LT}	2.10	
Factor w_y	1.13	
Factor w_z	1.50	
Factor n_{pl}	0.00	
Maximum relative slenderness $\lambda_{rel,max}$	0.77	
Factor C_{yy}	1.00	
Factor C_{yz}	0.60	
Factor C_{zy}	1.00	
Factor C_{zz}	1.00	

Unity check (6.61) = 0.00 + 0.82 + 0.00 = 0.82 -
Unity check (6.62) = 0.00 + 0.43 + 0.00 = 0.43 -

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	5.639	m
Web	unstiffened	
Web height h_w	220	mm
Web thickness t	6	mm
Material coefficient ε	0.81	
Shear correction factor η	1.20	

Shear Buckling verification	
Web slenderness h_w/t	35.55
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.

Dimenzioniranje grebenog nosača HEA 240

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

Member B52	**5.251 / 7.877 m**	**HEA240**	**S 355**	**Anvelopa GSN**	**0.43 -**

Combination key
Anvelopa GSN / LC1 + 0.90*LC2 + 1.50*LC8

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	355.0	MPa
Ultimate strength f_u	490.0	MPa
Fabrication	Rolled	

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

The critical check is on position 5.251 m

Internal forces	Calculated	Unit
N_{Ed}	-8.72	kN
$V_{y,Ed}$	0.01	kN
$V_{z,Ed}$	33.10	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	-83.86	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 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	95	12	1.189e+05	1.190e+05	1.0	0.4	1.0	7.9	7.3	8.1	11.2	2
3	SO	95	12	1.188e+05	1.187e+05	1.0	0.4	1.0	7.9	7.3	8.1	11.2	2
4	I	164	8	8.970e+04	-8.743e+04	-1.0		0.5	21.9	57.2	65.9	98.1	1
5	SO	95	12	-1.166e+05	-1.167e+05								
7	SO	95	12	-1.166e+05	-1.165e+05								

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	7.6800e-03	m²
$N_{c,Rd}$	2726.40	kN
Unity check	0.00	-

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

$W_{pl,y}$	7.4583e-04	m³
$M_{pl,y,Rd}$	264.77	kNm
Unity check	0.32	-

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

$W_{pl,z}$	3.5167e-04	m³
$M_{pl,z,Rd}$	124.84	kNm
Unity check	0.00	-

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

η	1.20	

A_v	5.9737e-03	m²
$V_{pl,y,Rd}$	1224.38	kN
Unity check	0.00	-

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

η	1.20	
A_v	2.5140e-03	m²
$V_{pl,z,Rd}$	515.27	kN
Unity check	0.06	-

Combined Shear and Torsion check for V_y and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.26)

$V_{pl,T,y,Rd}$	1223.95	kN
Unity check	0.00	-

Combined Shear and Torsion check for V_z and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.26)

$V_{pl,T,z,Rd}$	515.09	kN
Unity check	0.06	-

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

$M_{pl,y,Rd}$	264.77	kNm
α	2.00	
$M_{pl,z,Rd}$	124.84	kNm
β	1.00	

Unity check (6.41) = 0.10 + 0.00 = 0.10 -

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

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	95	12	1.377e+05	1.381e+05	1.0	0.4	1.0	7.9	7.3	8.1	11.2	2
3	SO	95	12	1.376e+05	1.373e+05	1.0	0.4	1.0	7.9	7.3	8.1	11.2	2
4	I	164	8	1.037e+05	-1.025e+05	-1.0		0.5	21.9	57.9	66.6	99.4	1
5	SO	95	12	-1.365e+05	-1.369e+05								
7	SO	95	12	-1.364e+05	-1.361e+05								

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	7.877	2.626	m
Buckling factor k	1.00	1.00	
Buckling length l_{cr}	7.877	2.626	m
Critical Euler load N_{cr}	2592.05	8327.72	kN

Buckling parameters	yy	zz	
Slenderness λ	78.36	43.72	
Relative slenderness λ_{rel}	1.03	0.57	
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 & 6.3.2.2 and formula (6.54)

LTB parameters		
Method for LTB curve	General case	
Plastic section modulus $W_{pl,y}$	7.4583e-04	m^3
Elastic critical moment M_{cr}	1861.59	kNm
Relative slenderness $\lambda_{rel,LT}$	0.38	
Limit slenderness $\lambda_{rel,LT,0}$	0.20	
LTB curve	a	
Imperfection α_{LT}	0.21	
Reduction factor χ_{LT}	0.96	
Design buckling resistance $M_{b,Rd}$	230.76	kNm
Unity check	0.36	-

Mcr parameters		
LTB length l_{LT}	2.626	m
Influence of load position	no influence	
Correction factor k	1.00	
Correction factor k_w	1.00	
LTB moment factor C_1	1.80	
LTB moment factor C_2	0.00	
LTB moment factor C_3	1.00	
Shear center distance d_z	0	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_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 area A	7.6800e-03	m^2
Plastic section modulus $W_{pl,y}$	7.4583e-04	m^3
Plastic section modulus $W_{pl,z}$	3.5167e-04	m^3
Design compression force N_{Ed}	8.72	kN
Design bending moment (maximum) $M_{y,Ed}$	-97.64	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0.03	kNm
Characteristic compression resistance N_{Rk}	2726.40	kN
Characteristic moment resistance $M_{y,Rk}$	264.77	kNm
Characteristic moment resistance $M_{z,Rk}$	124.84	kNm
Reduction factor χ_y	1.00	
Reduction factor χ_z	1.00	
Reduction factor χ_{LT}	0.96	
Interaction factor k_{yy}	1.00	
Interaction factor k_{yz}	0.77	
Interaction factor k_{zy}	0.52	
Interaction factor k_{zz}	1.00	

Maximum moment $M_{y,Ed}$ is derived from beam B52 position 3.643 m.
Maximum moment $M_{z,Ed}$ is derived from beam B52 position 5.251 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	2592.05	kN
Critical Euler load $N_{cr,z}$	8327.72	kN

Interaction method 1 parameters		
Elastic critical load $N_{cr,T}$	9374.36	kN
Plastic section modulus $W_{pl,y}$	7.4583e-04	m^3
Elastic section modulus $W_{el,y}$	6.7500e-04	m^3
Plastic section modulus $W_{pl,z}$	3.5167e-04	m^3
Elastic section modulus $W_{el,z}$	2.3100e-04	m^3
Second moment of area I_y	7.7600e-05	m^4
Second moment of area I_z	2.7700e-05	m^4
Torsional constant I_t	3.9611e-07	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-97.64	kNm
Maximum relative deflection δ_z	35.4	mm
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) $M_{z,Ed}$	-0.03	kNm
Maximum relative deflection δ_y	0.0	mm
Equivalent moment factor $C_{mz,0}$	1.00	
Factor μ_y	1.00	
Factor μ_z	1.00	
Factor ε_y	127.33	
Factor a_{LT}	0.99	
Critical moment for uniform bending $M_{cr,0}$	1034.56	kNm
Relative slenderness $\lambda_{rel,0}$	0.51	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.27	
Equivalent moment factor C_{my}	1.00	
Equivalent moment factor C_{mz}	1.00	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor c_{LT}	0.19	
Factor d_{LT}	0.00	
Factor e_{LT}	1.59	
Factor w_y	1.10	
Factor w_z	1.50	
Factor n_{pl}	0.00	
Maximum relative slenderness $\lambda_{rel,max}$	1.03	
Factor C_{yy}	1.00	
Factor C_{yz}	0.90	
Factor C_{zy}	1.00	
Factor C_{zz}	1.00	

Unity check (6.61) = 0.00 + 0.42 + 0.00 = 0.43 -
Unity check (6.62) = 0.00 + 0.22 + 0.00 = 0.22 -

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	7.877	m
Web	unstiffened	
Web height h_w	206	mm
Web thickness t	8	mm
Material coefficient ε	0.81	
Shear correction factor η	1.20	

Shear Buckling verification	
Web slenderness h_w/t	27.47
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.

Dimenzioniranje podrožnice RHS 150/100/4

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

Member B38	1.500 / 3.000 m	RRK150/100/4	S 235	Anvelopa GSN	0.86 -

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
Anvelopa GSN / LC1 + 0.90*LC2 + 1.50*LC6

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	235.0	MPa
Ultimate strength f_u	360.0	MPa
Fabrication	Cold formed	

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

The critical check is on position 1.500 m

Internal forces	Calculated	Unit
N_{Ed}	7.73	kN
$V_{y,Ed}$	0.00	kN
$V_{z,Ed}$	0.00	kN
T_{Ed}	-1.34	kNm
$M_{y,Ed}$	-15.60	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]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	88	4	1.875e+05	1.875e+05	1.0		1.0	22.0	33.0	38.0	42.0	1
3	I	138	4	1.770e+05	-1.852e+05	-1.0		0.5	34.5	73.7	84.9	129.7	1
5	I	88	4	-1.957e+05	-1.957e+05								
7	I	138	4	-1.852e+05	1.770e+05	-1.0		0.5	34.5	73.7	84.9	129.7	1

The cross-section is classified as Class 1

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

A	1.8950e-03	m²
$N_{pl,Rd}$	445.32	kN
$N_{u,Rd}$	491.18	kN
$N_{t,Rd}$	445.32	kN
Unity check	0.02	-

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

$W_{pl,y}$	9.5700e-05	m³
$M_{pl,y,Rd}$	22.49	kNm
Unity check	0.69	-

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.1(5) and formula (6.1)

Elastic verification		
Fibre	10	
$\sigma_{N,Ed}$	-4.1	MPa
$\sigma_{My,Ed}$	-196.7	MPa
$\sigma_{Mz,Ed}$	0.0	MPa
$\sigma_{tot,Ed}$	-200.8	MPa
$\tau_{Vy,Ed}$	0.0	MPa

Elastic verification		
$\tau_{Vz,Ed}$	0.0	MPa
$\tau_{t,Ed}$	12.4	MPa
$\tau_{tot,Ed}$	12.4	MPa
$\sigma_{von\ Mises,Ed}$	201.9	MPa
Unity check	0.86	-

Note: Since there is no shear force, the effect of the torsional moment cannot be accounted for in the plastic interaction. Therefore the elastic yield criterion according to EN 1993-1-1 article 6.2.1(5) is verified.

The member satisfies the section check.

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

Classification for member buckling design
Decisive position for stability classification: 1.500 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	88	4	1.875e+05	1.875e+05	1.0		1.0	22.0	33.0	38.0	42.0	1
3	I	138	4	1.770e+05	-1.852e+05	-1.0		0.5	34.5	73.7	84.9	129.7	1
5	I	88	4	-1.957e+05	-1.957e+05								
7	I	138	4	-1.852e+05	1.770e+05	-1.0		0.5	34.5	73.7	84.9	129.7	1

The cross-section is classified as Class 1

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

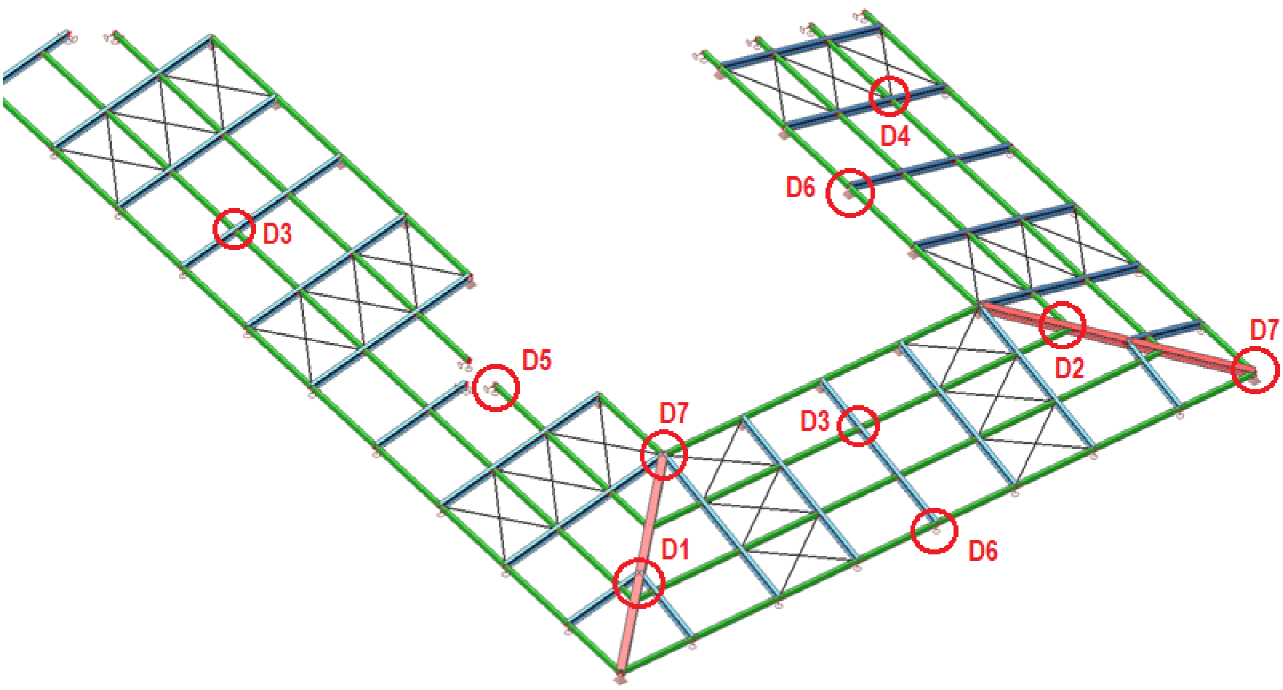
The member satisfies the stability check.

Dimenzioniranje dijagonale horizontalne stabilizacije Ø12

Sila u vlačnoj zategi	N_{Ed} = 1,65 kN
Površina u zoni navoja	A_{netto} = 0,84 cm²
Napon u zategi	$\sigma = N_{Ed} / A_{netto}$ = 1,65 / 0,84 = 2 kN/cm²
Dopušteni napon	σ_{dop} = 35,5 / 1,0 = 35,5 kN/cm² > 2 kN/cm² → zadovoljava (6%)

1.4. Proračun priključaka krovišta

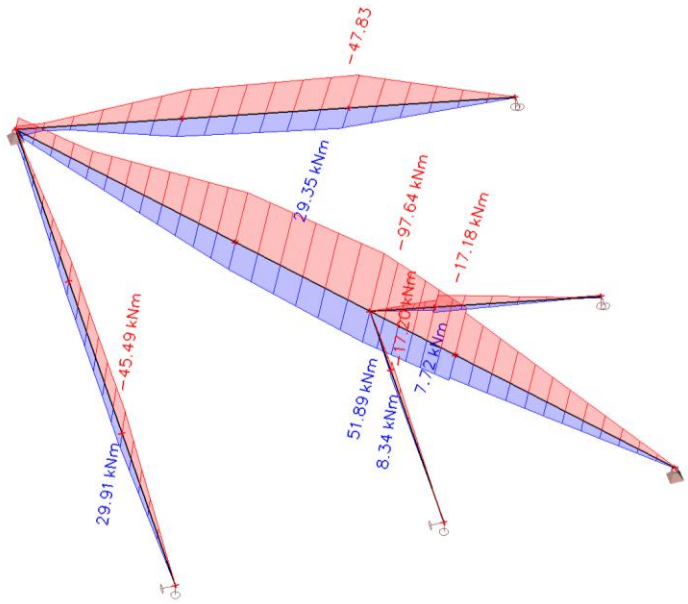
Svi širokopojasni profili čelične nosive konstrukcije izrađuju se čelika S355J2 sukladno normi HRN EN 10025, a hladnooblikovani cijevni profili od čelika S235JR sukladno normi HRN EN 10219. Svi limovi izrađuju se od čelika S355J2. Vijčani montažni spojevi izvode se vijcima kvalitete 8.8 (HRN EN 15048) i 10.9 (HRN EN 14399) prema proračunu danom u nastavku.



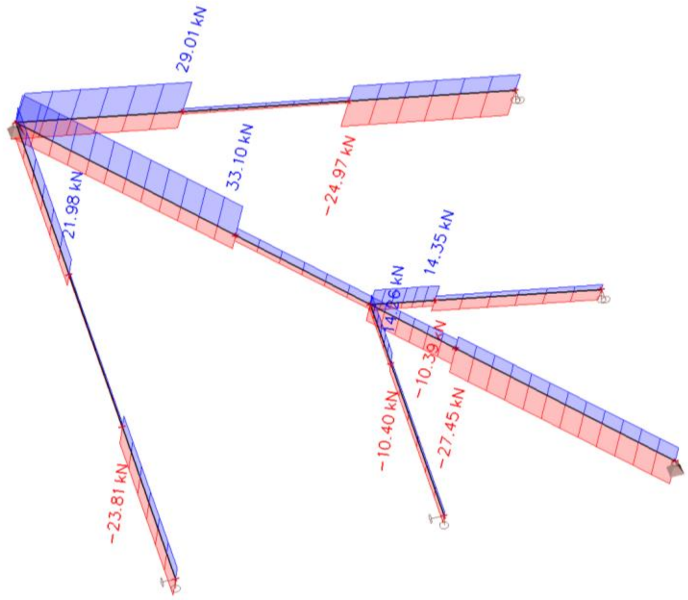
Spoj krovni nosač - grebena greda (D1)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti mjerodavnog grebena.

Values: $\mathbf{M_y}$
Class: Anvelopa GSN
Extreme 1D: Member

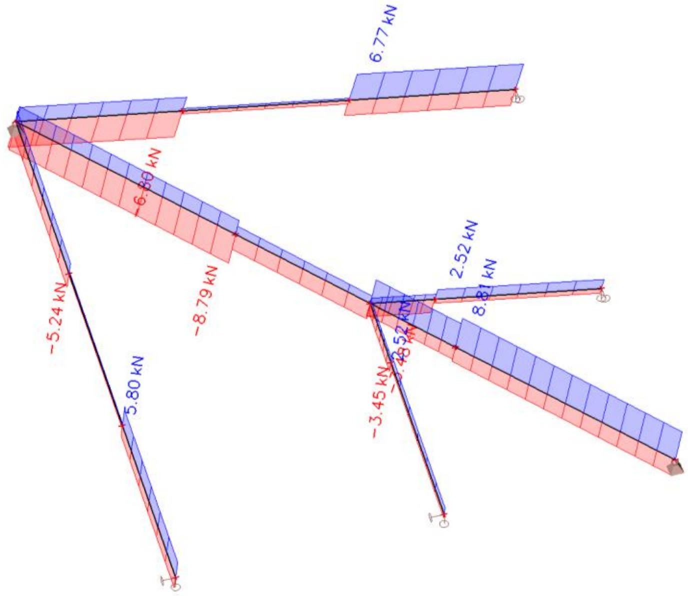


Values: $\mathbf{V_z}$
Class: Anvelopa GSN
Extreme 1D: Member



Values: **N**

Class: Anvelopa GSN
Extreme 1D: Member



Rezne sile u čvoru

$M_{y,Ed}$ = 17,2 kNm
$V_{z,Ed}$ = 14,4 kN
N_{Ed} = 2,6 kN (vlak)

Spoj krovnog nosača na grebenu gredu izvodi se varenjem I profila napravljenog od limova t= 10 mm na grebenu gredu (hvatanje prostorne geometrije) te momentnim nastavkom u polju. Nastavak se izvodi sukladno pravilima struke, kao spoj pune nosivosti IH1.A, kao DSTV spoj br. 82. Puna računska nosivost spoja za pritezanje 100%:

$M_{y,Rd}$ = 44,1 kNm
$V_{z,Rd}$ = 196,2 kN

Provjera otpornosti vijaka na vlak

$F_{Ed/vijak} = M_{Ed}/2e + N_{Ed} / 4 = 17,2 / (2 \cdot 0,16) + 2,6 / 4 = 54,4$ kN po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2} = 141,3 / 1,25 = 113$ kN
113 kN > $F_{Ed/vijak}$ = 54,4 kN → zadovoljava (48%)

Provjera otpornosti vijaka na posmik

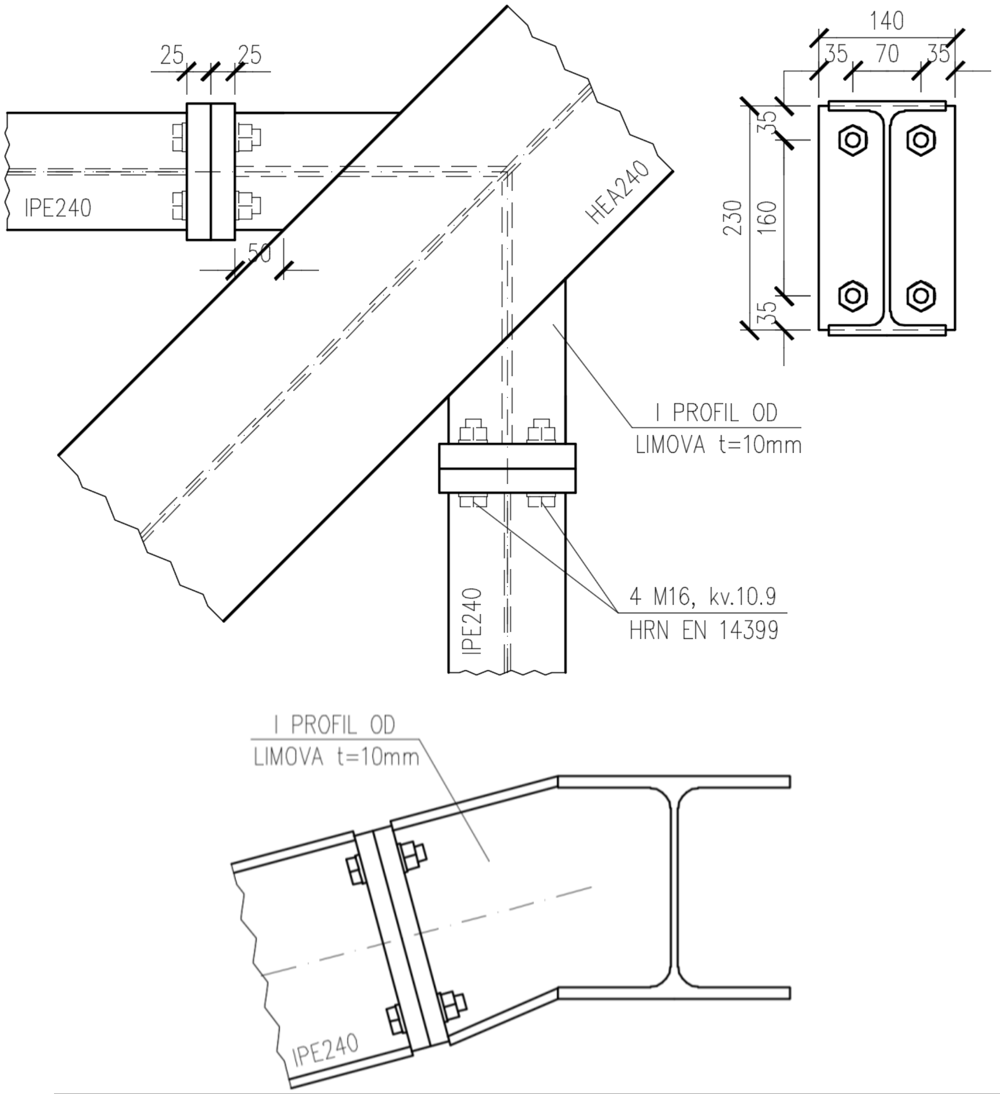
$F_{Ed/vijak} = V_{Ed} / 4 = 14,4 / 4 = 3,6$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 78,5 / 1,25 = 62,8$ kN
62,8 kN > $F_{Ed/vijak}$ = 3,6 kN → zadovoljava (6%)

S obzirom na minimalni iznos poprečne sile u čvoru te debljinu čeone ploče, pritisak po omotaču rupe nije mjerodavan te se neće dodatno provjeravati.

Geometrija spoja

Vijci	4 M16, kv. 10.9, **vijke pritegnuti na 100%**
Čeone ploče	t = 25 mm, S355J2
Zavari	a_w = 5 mm (pojas), a_w = 4 mm (hrbat)

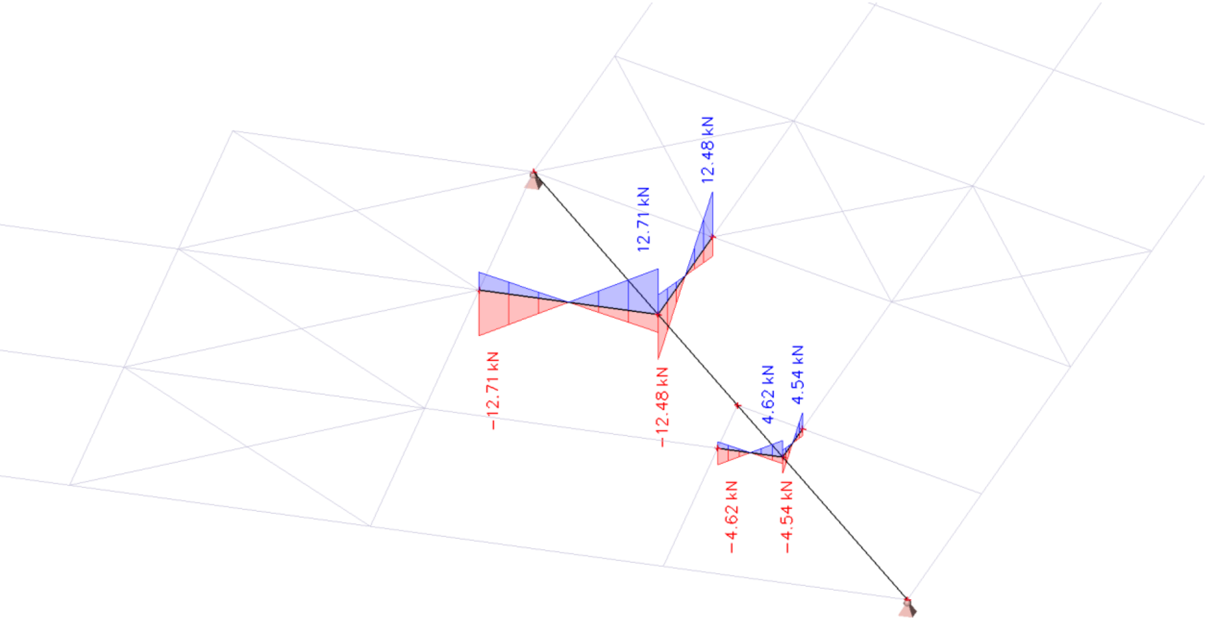


NAPOMENA: S obzirom da se radi o prostornom spoju, rješenje je dano principijelno. I profil od limova potrebno je prilagoditi stvarnoj geometriji spoja te prije izvedbe dostaviti predmetni detalj projektantu na uvid.

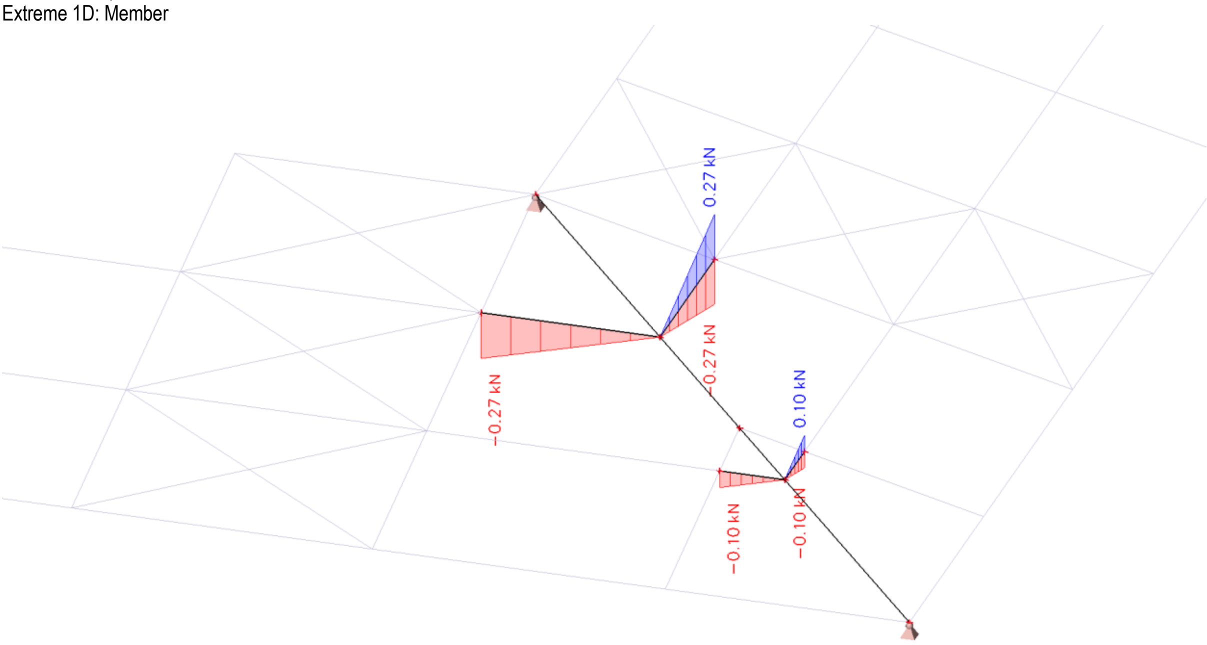
Spoj podrožnica - grebena greda (D2)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti mjerodavnog grebena.

Values: $\mathbf{V_z}$
Class: Anvelopa GSN
Extreme 1D: Member



Values: **N**
Class: Anvelopa GSN
Extreme 1D: Member



S obzirom da su podrožnice modelirane kao proste grede, iznosi reznih sila na mjestu spoja s glavnim nosačima su minimalni, a moment savijanja je jednak 0. Sukladno navedenom, spoj se izvodi isključivo konstruktivno.

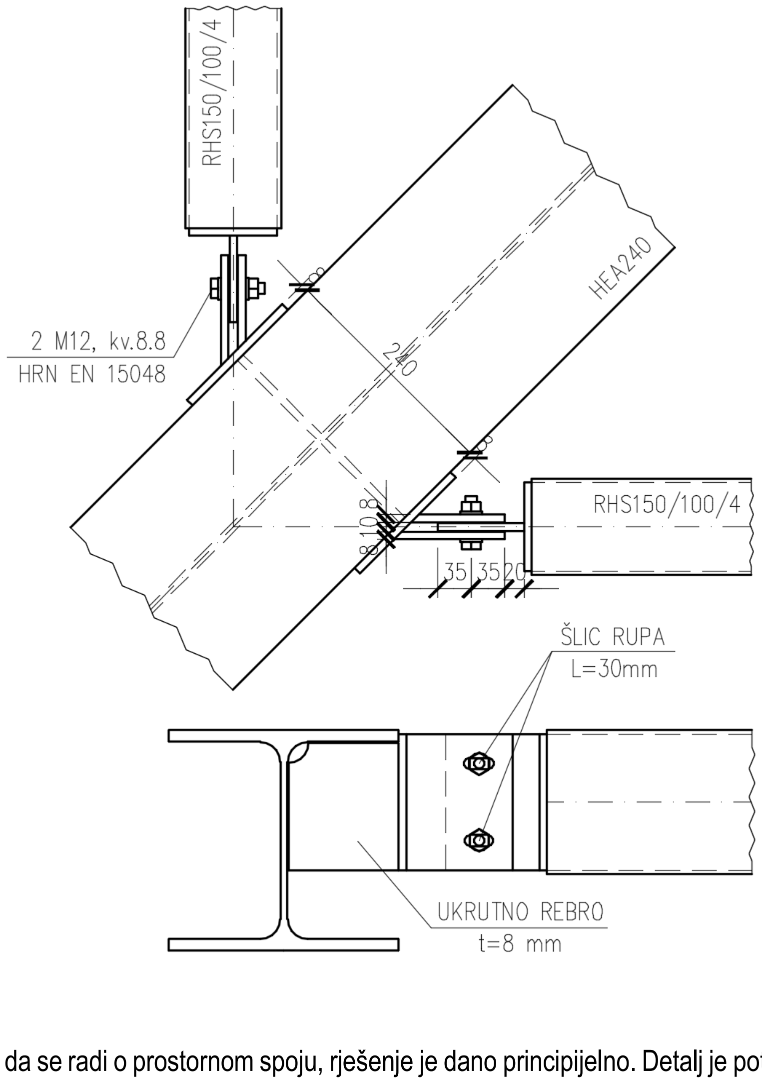
Provjera otpornosti vijaka na posmik

$F_{Ed/vijak} = V_{Ed} / 4 = 12{,}7 / 2 = 6{,}4$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 40{,}5 / 1{,}25 = 32{,}4$ kN
32,4 kN > $F_{Ed/vijak}$ = 6,4 kN → zadovoljava (20%)

Geometrija spoja

Vijci	2 M12, kv. 8.8
Čeona ploča	t = 8 mm, S355J2
Prihvatni limovi	t = 8 mm, S355J2
Ukrutna rebra	t = 8 mm, S355J2
Zavari	a_w = t = 4 mm

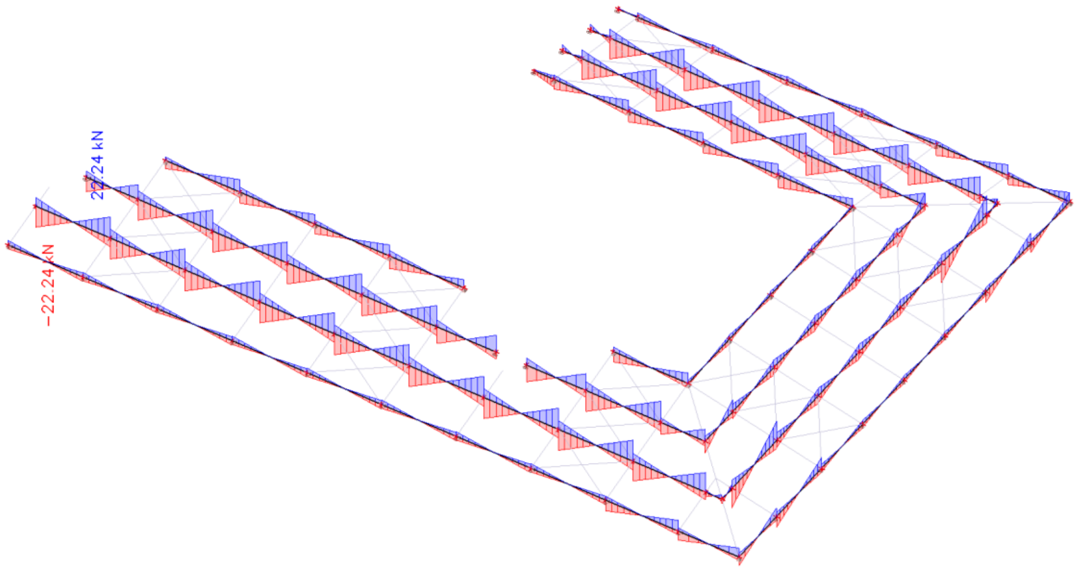


NAPOMENA: S obzirom da se radi o prostornom spoju, rješenje je dano principijelno. Detalj je potrebno prilagoditi stvarnoj geometriji spoja te prije izvedbe dostaviti projektantu na uvid.

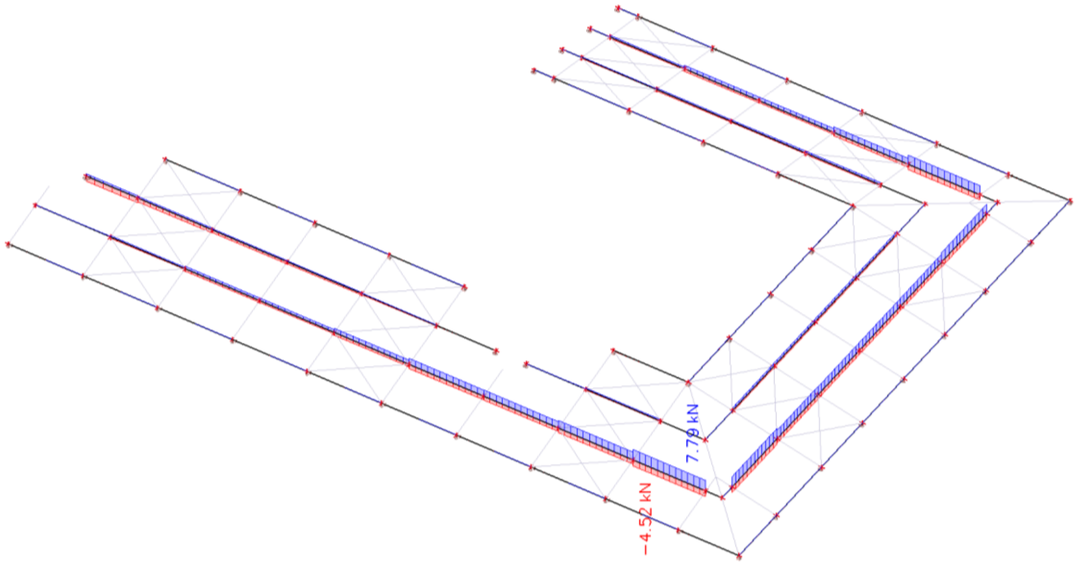
Spoj podrožnica - krovni nosač (D3)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti podrožnica.

Values: **V_z**
Class: Anvelopa GSN
Extreme 1D: Global



Values: **N**
Class: Anvelopa GSN
Extreme 1D: Global



S obzirom da su podrožnice modelirane kao proste grede, iznosi reznih sila na mjestu spoja s krovnim nosačima su minimalni, a moment savijanja je jednak 0. Sukladno navedenom, spoj se izvodi isključivo konstruktivno.

Provjera otpornosti vijaka na vlak

$F_{Ed/vijak} = N_{Ed} / 4 = 7,8 / 4 = 2$ kN po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2} = 60{,}7 / 1{,}25 = 48{,}6$ kN
$48{,}6$ kN > $F_{Ed/vijak} = 2$ kN → zadovoljava (4%)

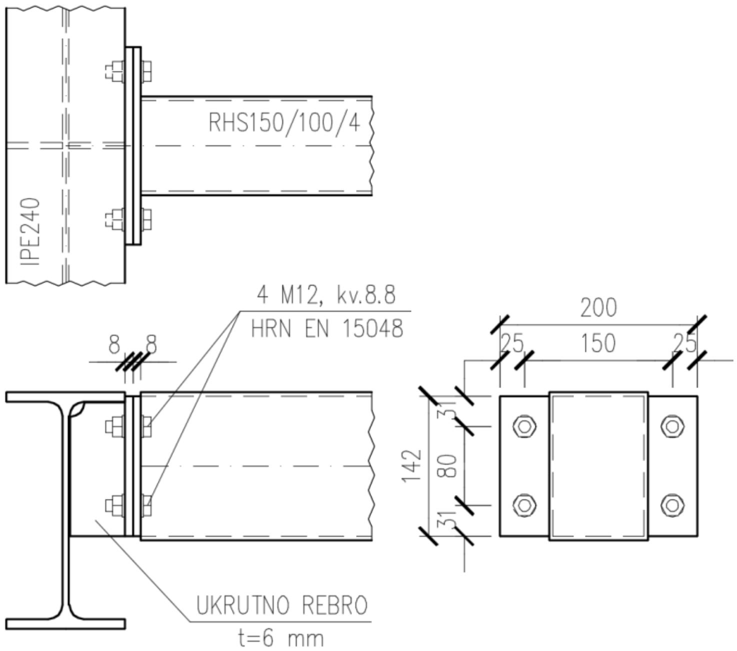
Provjera otpornosti vijaka na posmik

$F_{Ed/vijak} = V_{Ed} / 4 = 22{,}3 / 4 = 5{,}6$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 40{,}5 / 1{,}25 = 32{,}4$ kN
$32{,}4$ kN > $F_{Ed/vijak} = 5{,}6$ kN → zadovoljava (17%)

Geometrija spoja

Vijci	4 M12, kv. 8.8
Čeone ploče	t = 8 mm, S355J2
Ukrutna rebra	t = 6 mm, S355J2
Zavari	a_w = t = 4 mm

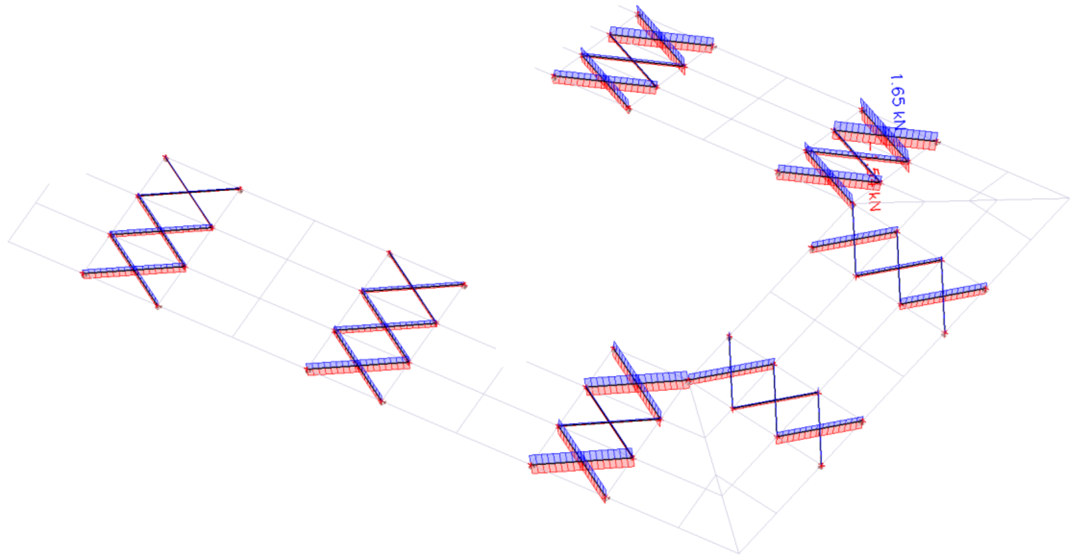


Detalj stabilizacije (D4)

U nastavku je dan grafički prikaz maksimalne uzdužne sile u stabilizaciji za anvelopu graničnog stanja nosivosti.

Values: **N**

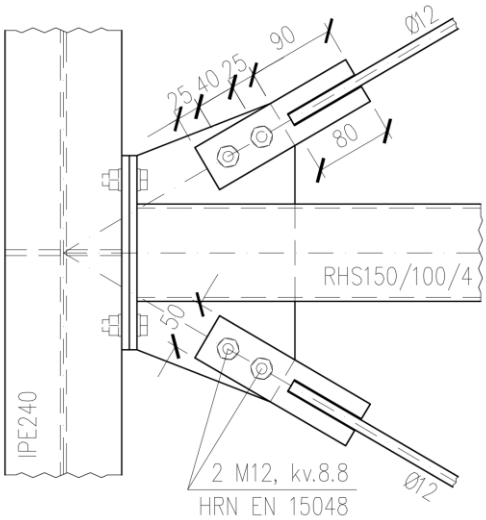
Class: Anvelopa GSN
Extreme 1D: Global



S obzirom na minimalni iznos uzdužne sile, spoj se izvodi isključivo konstruktivno.

Geometrija spoja

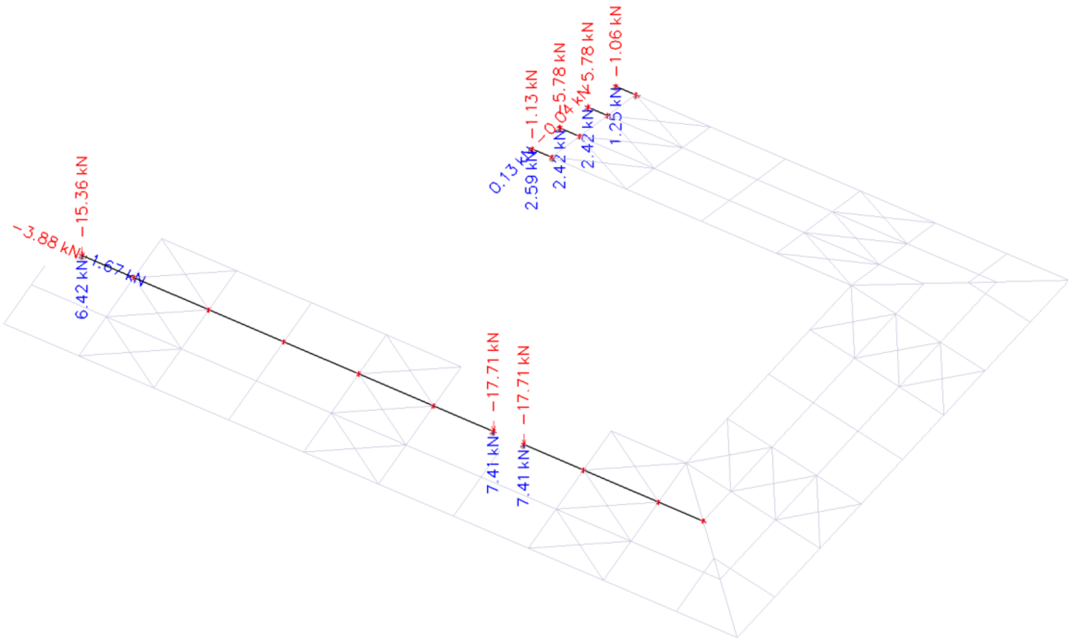
Vijci	2 M12, kv. 8.8
Prihvatni limovi	t = 8 mm, S355J2
Zavari	a_w = 4 mm



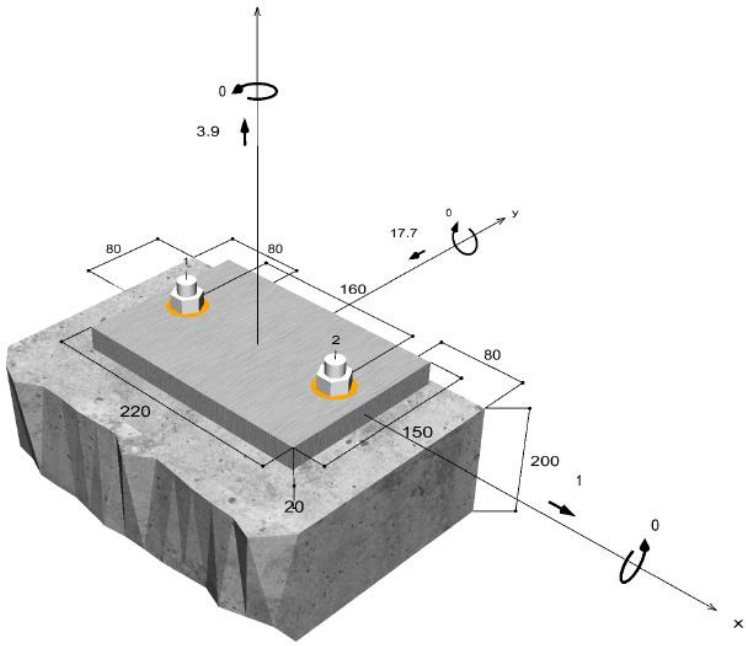
Napomena: prihvatne limove stabilizacije prošlicati kroz cijevni profil podrožnice.

Detalj sidrenja podrožnica (D5)

U nastavku je dan grafički prikaz reakcija podrožnica za anvelopu graničnog stanja nosivosti, nakon čega slijedi proračun sidrenja u programskom paketu C-FIX. Sidrenje se izvodi kemijskim sidrenjem sidara M16, kvalitete 8.8. Kemija kao Fischer FIS V ili jednakovrijedna.



S obzirom na minimalne iznose reakcija podrožnica, sidrenje se izvodi konstruktivno. Minimalna udaljenost osi sidra do ruba betona iznosi 80 mm. Ako se prilikom izmjere na terenu pokaže suprotno, potrebno je kontaktirati projektanta kako bi ponovio proračun te po potrebi dao alternativni prijedlog sidrenja.



Input data

Design method	Design Method EN1992-4:2018 bonded fastener
Base material	C25/30, EN 206
Concrete condition	Non-cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	Hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap filled
Type of loading	Permanent-Transient/Static
Base plate location	Base plate flush installed on base material
Base plate geometry	220 mm x 150 mm x 20 mm
Profile type	None

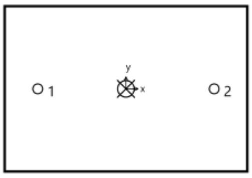
Design actions *⁾

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	3.90	1.00	-17.70	0.00	0.00	0.00	Permanent-Transient/Static

*⁾ The required partial safety factors for actions are included

Resulting anchor forces

Anchor no.	Tensile action kN	Shear Action kN	Shear Action x kN	Shear Action y kN
1	1.95	8.86	0.50	-8.85
2	1.95	8.86	0.50	-8.85



max. concrete compressive strain :	0.00 ‰
max. concrete compressive stress :	0.0 N/mm²
Resulting tensile actions :	3.90 kN , X/Y position (0 / 0)
Resulting compression actions :	0.00 kN , X/Y position (0 / 0)

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N,s} = \beta_{N,s;1} = 0.02 \leq 1$$
$$\beta_{V,s} = \beta_{V,s;1} = 0.18 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{V,s;1}^2 = 0.03 \leq 1$$

Eq. (7.55)

Proof successful

Utilisation concrete

$$\beta_{N,c} = \beta_{N,c;1} = 0.14 \leq 1$$
$$\beta_{V,c} = \beta_{V,c;2} = 0.50 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,c;1}^{1.5} + \beta_{V,c;2}^{1.5} = 0.41 \leq 1$$

Eq. (7.56)

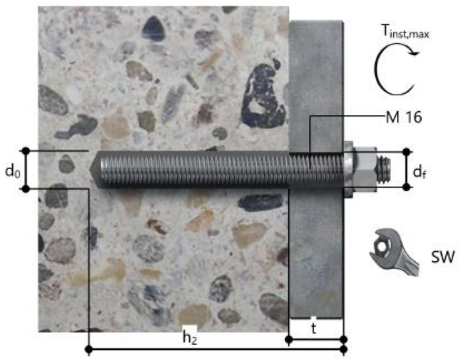
Installation data

Anchor

Anchor system	**fischer Injection system FIS V**		
Injection resin	FIS V 360 S (other cartridge sizes available)	Art.-No. 94405	
Fixing element	Threaded rod FIS A M 16 x 200 8.8, zinc plated steel, Property Class 8.8	Art.-No. 517939	
Accessories	FIS MR Plus	Art.-No. 545853	
	FIS Extension tube 9mm	Art.-No. 48983	
	Dispenser FIS DM S	Art.-No. 511118	
	Compressed-air cleaning tool	Art.-No. 93286	
	compressed air (oil-free), min. 6 bar	By job site.	
	BSD 18	Art.-No. 1493	
	SDS Chuck with internal thread M8	Art.-No. 530332	
	Quattric II 18/200/250	Art.-No. 549956	
	or alternatively		
	FHD 18/320/450	Art.-No. 546600	
	Hammer drilling with or without suction		

Installation details

Thread diameter	M 16
Drill hole diameter	d_0 = 18 mm
Drill hole depth	h_2 = 170 mm
Calculated anchorage depth	h_{ef} = 150 mm
Drilling method	Hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap filled
Maximum torque	$T_{inst,max}$ = 60.0 Nm
Socket size	24 mm
Base plate thickness	t = 20 mm
Total fixing thickness Tfix,max	t_{fix} = 20 mm
Volume of resin per drill hole	20 ml/10 scale divisions

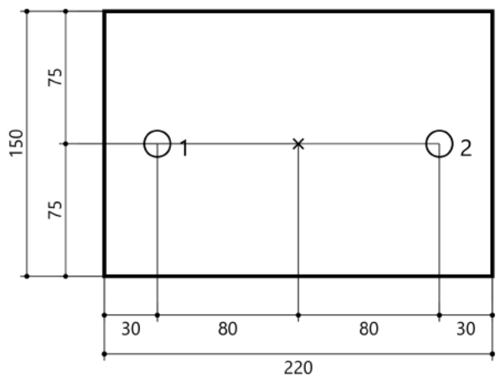


Base plate details

Base plate material	Not available
Base plate thickness	t = 20 mm
Clearance hole in base plate	d_f=20 mm

Attachment

Profile type	None

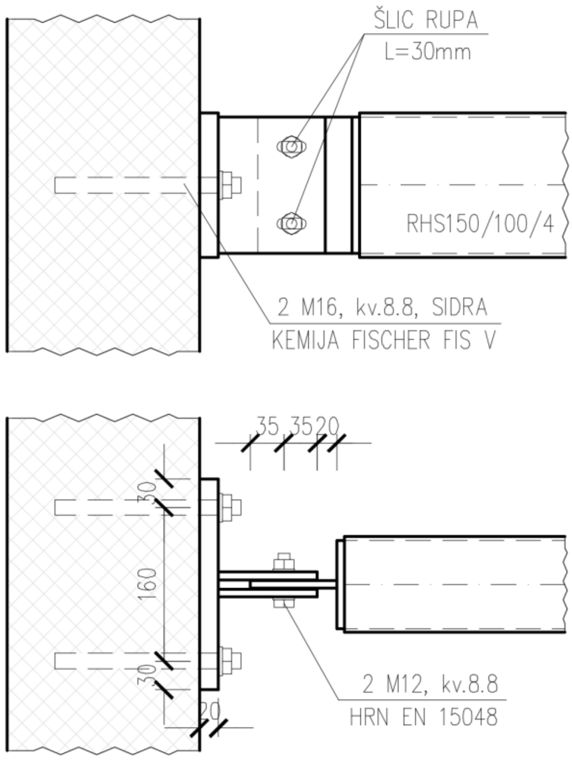


Anchor coordinates

Anchor no.	x mm	y mm
1	-80	0
2	80	0

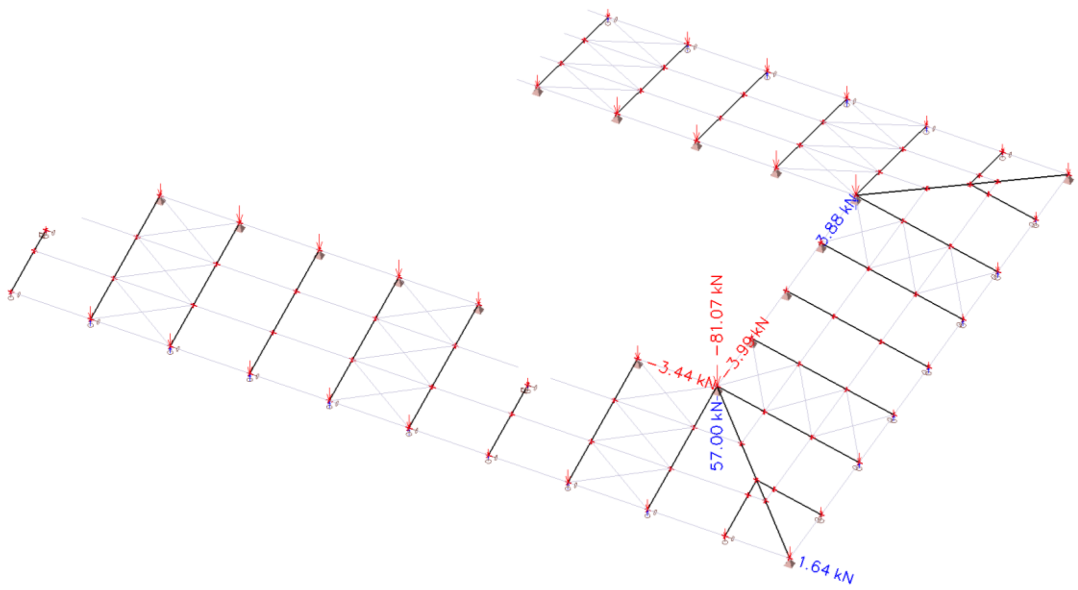
Geometrija spoja

Sidra	2 M16, kv. 8.8
Kemija	kao Fischer FIS V
Vijci	2 M12, kv. 8.8
Čeona ploča	t = 20 mm, S355J2
Prihvatni limovi	t = 8 mm, S355J2
Zavari	a_w = 4 mm



Detalj sidrenja krovnih nosača i grebena (D6 i D7)

U nastavku je dan grafički prikaz reakcija krovnih nosača za anvelopu graničnog stanja nosivosti.



Sidrenje krovnih nosača izvodi se prolaznim navojnim šipkama M24, kvalitete 8.8. s pripadnom kontrapločom debljine 25 mm. Minimalna udaljenost osi sidra do ruba betona iznosi 120 mm. Ako se prilikom izmjere na terenu pokaže suprotno, potrebno je kontaktirati projektanta kako bi ponovio proračun te po potrebi dao alternativni prijedlog sidrenja. Beton se izvodi minimalno kao C25/30.

Rezne sile u čvoru

V_{Ed} = 81,1 kN
N_{Ed} = 4,0 kN (vlak)

Provjera otpornosti sidara na posmik

$V_{Ed/vijak} = V_{Ed} /4 = 81,1 / 4 = 20,2$ kN / po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 169,4 / 1,25 = 135,5$ kN
135,5 kN > $N_{Ed/vijak}$ = 20,2 kN → zadovoljava (15%)

Provjera pritiska na beton preko vijaka

$A = d \cdot 3d = 2,4 \cdot 3 \cdot 2,4 = 17,3$ cm^2
$\sigma_b = V_{Ed/vijak} / A = 20,2 / 17,3 = 1,17$ kN/cm^2

$\sigma_{dop} = f_{ck} /1,5 = 2,5/1,5 = 1,67$ kN/cm^2 > $\sigma_b = 1,17$ kN/cm^2 → zadovoljava (70%)

Provjera otpornosti vijaka na posmik

$F_{Ed/vijak} = V_{Ed} / 2 = 81,1 / 2 = 40,6$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 169,4 / 1,25 = 135,5$ kN

135,5 kN > $N_{Ed/vijak}$ = 40,6 kN → zadovoljava (30%)

Provjera otpornosti hrpta na pritisak po omotaču rupe

$F_{b,Rd} = (2,5 \cdot a \cdot f_u \cdot d \cdot t) / \gamma_{M2}$

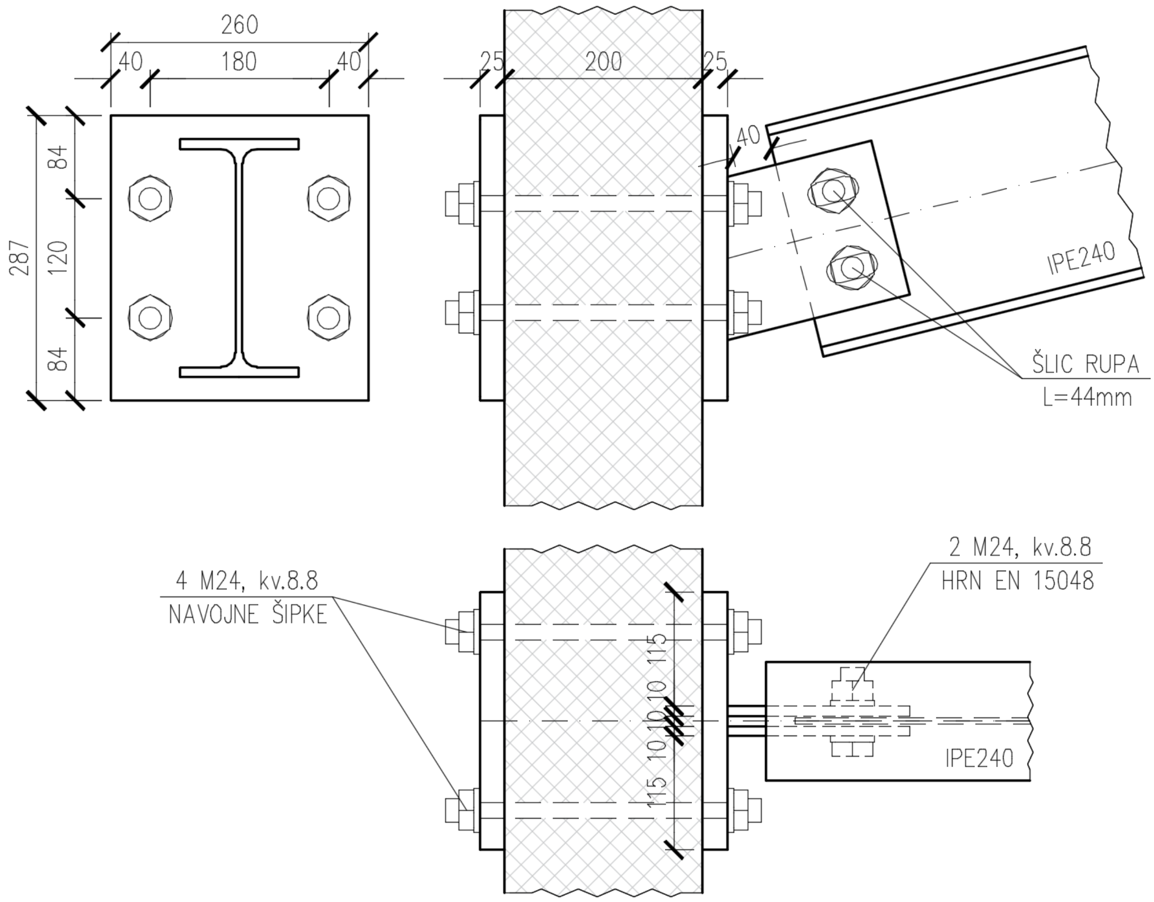
$a = \min \{ e_1/3d_0 \ ; f_{ub} / f_u \ ;1\} = \min \{ 50/3 \cdot 27 \ ; 100/51 \ ;1\} = 0,62$

$F_{b,Rd} = (2,5 \cdot 0,62 \cdot 51 \cdot 2,4 \cdot 0,62) / 1,25 = 94,1$ kN

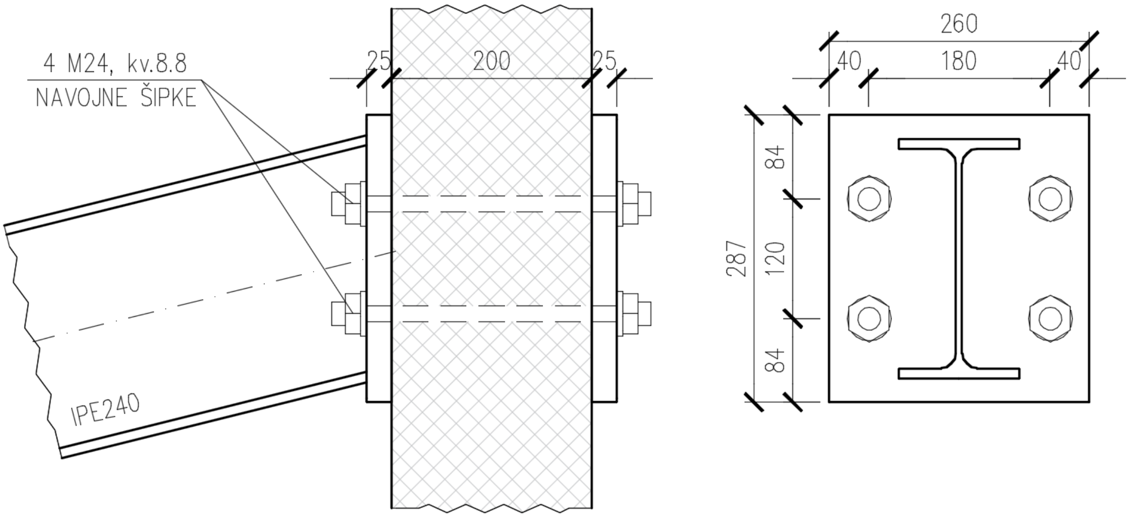
94,1 kN > $F_{v;Ed/vijak}$ = 40,6 kN → zadovoljava (43%)

Geometrija spoja krovnih nosača

Sidra	4 M24, kv. 8.8
Vijci	2 M24, kv. 8.8
Čeona ploča	t = 25 mm, S355J2
Prihvatni limovi	t = 10 mm, S355J2
Zavari	a_w = 4 mm



Prihvat krovnih nosača dolje



Prihvat krovnih nosača gore

Sidrenje grebena izvodi se preko sidrenog sklopa, prolaznim navojnim šipkama M24, kvalitete 8.8. s pripadnom kontrapločom debljine 25 mm. Sidreni sklop dalje se vijčano veže sa krovnim nosačima i/ili grebenom sukladno pravilima struke, detaljima IH1.A, DSTV. br. 82 (IPE240) i br. 430 (HEA240).

Geometrija nastavka krovnog nosača IPE 240

Vijci	4 M16, kv. 10.9, **vijke pritegnuti na 100%**
Čeone ploče	t = 25 mm, S355J2
Zavari	a_w = 5 mm (pojas), a_w = 4 mm (hrbat)

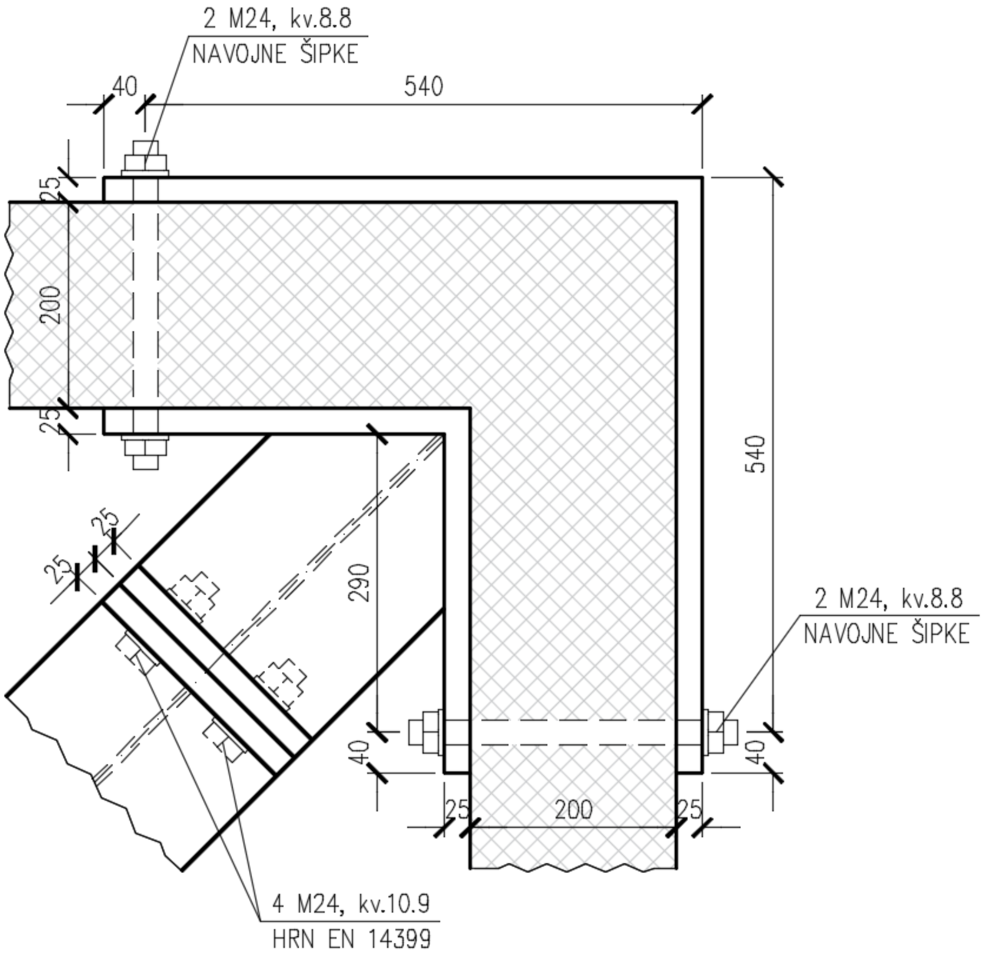
Geometrija nastavka grebena HEA 240

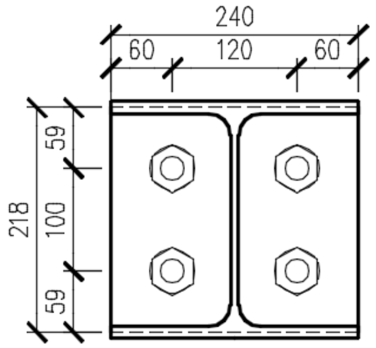
Vijci	4 M24, kv. 10.9, **vijke pritegnuti na 100%**
Čeone ploče	t = 25 mm, S355J2
Zavari	a_w = 5 mm (pojas), a_w = 4 mm (hrbat)

Geometrija sidrenog sklopa

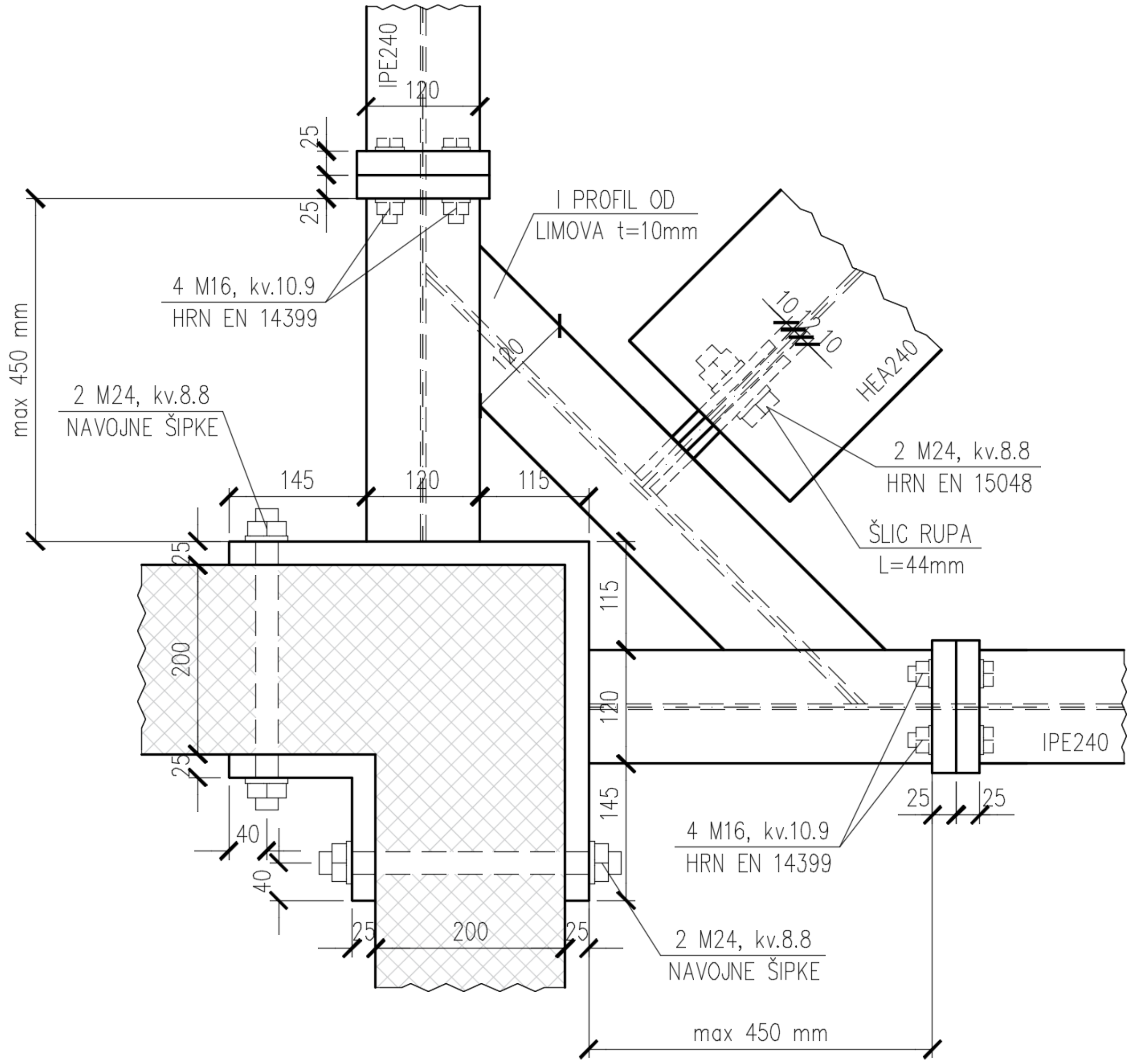
Sidra	4 M24, kv. 8.8
Čeona ploča	t = 25 mm, S355J2
Kontraploča	t = 25 mm, S355J2
Prihvatni limovi	t = 10 mm, S355J2
Zavari	a_w = 5 mm (pojas), a_w = 4 mm (hrbat)

* Maksimalna udaljenost nastavka od početka sidrenog sklopa iznosi 450 mm.





Prihvat grebene grede dolje



Prihvat grebene grede gore

Specifikacija osnovnog materijala

Cross-section	Material	Length [m]	Unit mass [kg/m]	Mass [kg]	Surface [m²]	Volume [m³]
CS1 - IPE240	S 355	111.674	30.7	3427.7	102.933	4.3664e-01
CS2 - HEA240	S 355	15.699	60.3	946.5	21.507	1.2057e-01
CS4 - RD12	S 355	147.431	0.9	130.8	5.543	1.6666e-02
CS3 - RRK150/100/4	S 235	226.393	14.9	3367.8	110.027	4.2901e-01
Total		**501.197**		**7872.7**	**240.010**	**1.0029e+00**

NAPOMENA: Specifikacija je dobivena iz statičkog modela, odnosno na temelju osnih dužina elemenata te može služiti isključivo kao orijentacijska vrijednost za izradu troškovnika. Stvarnu težinu konstrukcije potrebno je uvećati cca 10% (zavari, limovi i spojna sredstva).

ARMIRANO BETONSKA PLOČA

SADRŽAJ

TEHNIČKI DIO

PROJEKTNA DOKUMENTACIJA
Objekt posjeduje građevinsku dozvolu Klasa: UP-I-361-03/90-01/17, Urbroj: 2153-05-90-2, od 23. 07. 1990. godine.
Statički račun je izradilo poduzeće „Konzaltingplan“ RO za inženjering p.o. 2 Zagreb, Đure Šimunića 12, po odgovornom projektantu konstrukcije mr. Zlatku Maštroviću, dipl. ing. arh., teh. dnevnik broj 792 od kolovoza 1989. godine.
Temeljna konstrukcija objekta posjeduje zasebnu građevinsku dozvolu Klasa: UP-I-361003/89-01/81, Urbroj: 2153-05-89-2 od 31. 10. 1989. godine.
Glavni i izvedbeni projekt temeljne konstrukcije izrađen je od poduzeća „Geotehnika“ iz Zagreba, OOUR „Institut Geoekspert“ Sektor za temeljenje, broj elaborata 803-01-3-12-89.
Snimak izvedenog stanja izradilo je poduzeće Konus d.o.o. Zrinsko Frankopanska 38 a, 23000 Zadar, oznake 88/2018, po ovlaštenom arhitektu Mario Svaguša dipl. ing. arh. iz travnja 2018. godine

IZVEDENO STANJE
Gradnja objekta je započeta, izveden je dio armiranobetonskih radova koji je prikazan u Snimku izvedenog stanja. Izvedena je komplentna armiranobetonska konstrukcija glavne zgrade te temelji, zidovi i stupovi aneksa u suterenu. Aneks u suterenu je odvojen dilatacijskom razdjelnicom od glavne zgrade.

GLAVNA ZGRADA
Konstrukcija je projektirana kao armiranobetonska konstrukcija katnosti suteren, prizemlje, 1. kat i 2. kat. Konstruktivni sustav čine armiranobetonske stropne ploče (pretežno bez greda) stupovi i zidovi.
Na temelju geomehaničkih svojstava temeljnog tla, temeljenje objekta je izvedeno izvedbom bušenih pilota promjera 100 cm, koji opterećenje objekta preko naglavnog roštila i temeljne ploče prenosi u nosivi sloj vapnenačke stijene. Piloti se izvode do dubine koja osigurava ulazak pilota u nosivu vepnenačku stijenu minimalno 2 m. Naglavnu konstrukciju predstavljaju temeljni roštilj od armiranobetonskih greda dimenzija 50/100 cm, 70/100 cm odnosno temeljna ploča debljine 60 cm. Na mjestima pilota izvedeni su naglavni blokovi dimenzija 120 x 120 x 100 cm a ispod greda i ploče izveden je podložni beton debljine 10 cm. Za izvedbu temeljnog roštilja i temeljne ploče koristio se beton MB 30 II i armatura RA 400/500. Za izvedbu bušenih pilota se koristi beton MB 30 i armatura GA 240/360
Svi zidovi su izvedeni debljine 20 cm osim dva suterenska zida (jugoistočni vanjski zid i zid prema suterenskoj dilataciji) koji su izvedeni debljine 30 cm. Zidovi su armirani armaturnim mrežama kvalitete MAG 500/560 a rubna armatura je izvedena s kvalitetom GA 240/360.
Svi zidovi debljine 20 cm su armirani obostrano mrežama Q 257 dok su svi zidovi debljine 30 cm armirani obostrano mrežama Q 503.
Stupovi su izveden kao pravokutni 60 x 60 cm i kružni stupovi Φ 60 cm. Svi stupovi su izvedeni betonom MB 30 i armaturom GA 240/360 osim stupova u osi I - prema planu pozicija iz statičkog računa. Oni su izvedeni betonom MB 30 i armirani sa RA 400/500.
Sve stropne konstrukcije su izvedene kao armiranobetonske ploče (pretežno bez greda) debljine 22 i 16 cm betonom MB 30. Armirane su armaturom MAG 500/560 te šipkama GA 240/360.

Grede su armirane uglavnom armaturom GA 240/360 a pojedine pozicije (posebno naznačene u projektu) su armirane sa RA 400/500.
Planirana čelična konstrukcija krovišta nije izvedena.

ANEKS U SUTERENU
Dilatacija u suterenu se temelji plitko na temeljnom roštilju, koji je postavljen na zamjenjujući tampon šljunka debljine 100 cm. Temeljni roštilj sa sastoji od greda dimenzija 70/100 cm koji su položeni na dobro zbijeni sloj šljunka debljine 100 cm. Za izvedbu temeljne konstrukcije koristio se beton MB 30 II. Kvaliteta armature koja se koristila je RA 400/500 za savojnu armaturu i armatura GA 240/360 za poprečnu armaturu (vilice).
Zidovi su izvedeni debljine 30 cm betonom MB 20, armirani obostrano mrežama Q 335 kvalitete MAG 500/560 te rubnom armaturom GA 240/360
Stupovi su izvedeni poprečnog presjeka 60 x 60 cm betonom MB 20, te su armirani armaturom GA 240/360.
Stubište te planirana armiranobetonska ploča nisu izvedeni. Također nisu izvedena ni dva planirana armiranobetoska stupa.

IZVEDBENI PROJEKT

Potrebno je izraditi izvedbeni projekt rekonstrukcije armiranobetonske konstrukcije koji obuhvaća plan oplate i armaturne nacrte betonske ploče garaže koja nije izvedena, te vanjskog čeličnog stubište i čelične konstrukcije kosog krovišta isto tako koji nisu izvedeni.

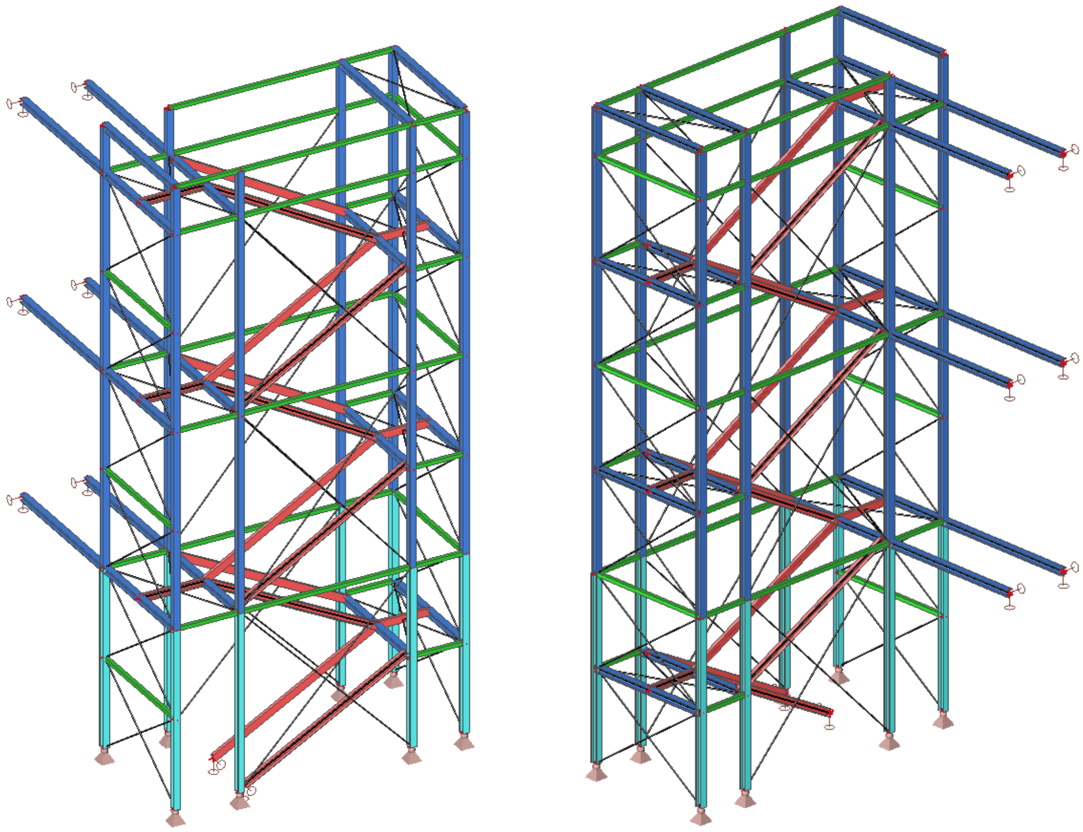
ČELIČNA KONSTRUKCIJA

SADRŽAJ

1.1. Proračun čelične konstrukcije vanjskog stubišta

U nastavku je proveden kontrolni proračun čelične nosive konstrukcije vanjskog stubišta Centra za pružanje usluga u zajednici Tereza u Obrovcu, nakon čega slijedi proračun priključaka osnovne nosive konstrukcije.

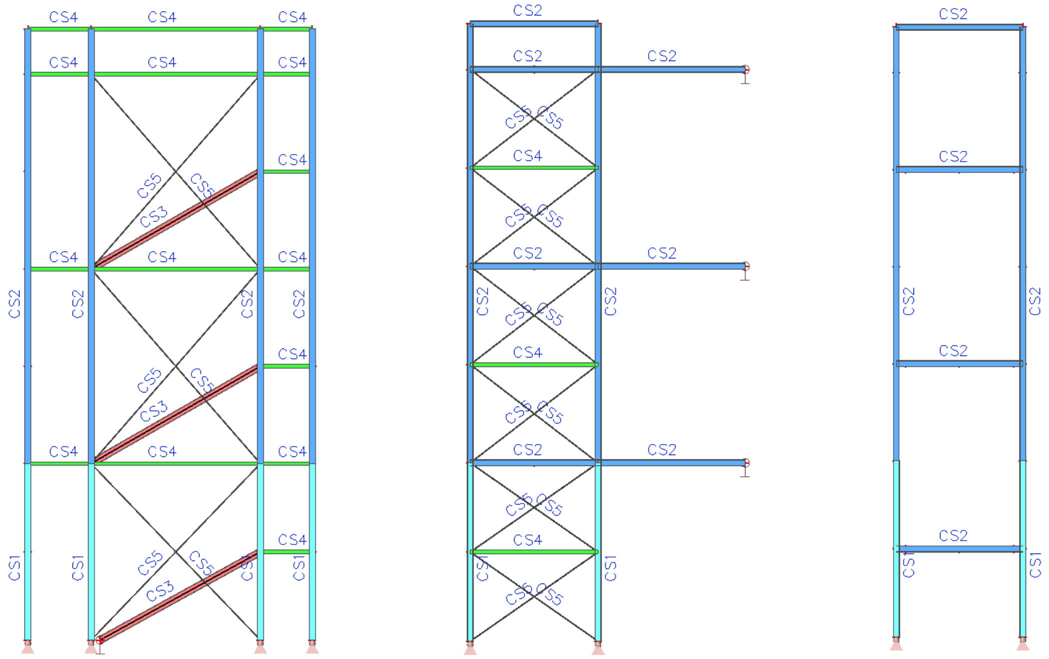
Prostorni prikaz konstrukcije



Horizontalna stabilizacija u podnim ravninama modelirana je kako bi se osigurala stabilnost konstrukcije. U stvarnosti će se u podnim ravninama izvesti čelično rešetkasto gazište, koje je samo po sebi kruće od horizontalne stabilizacije. **Slijedom navedenog, horizontalnu stabilizaciju u podnim ravninama nije potrebno izvesti.**

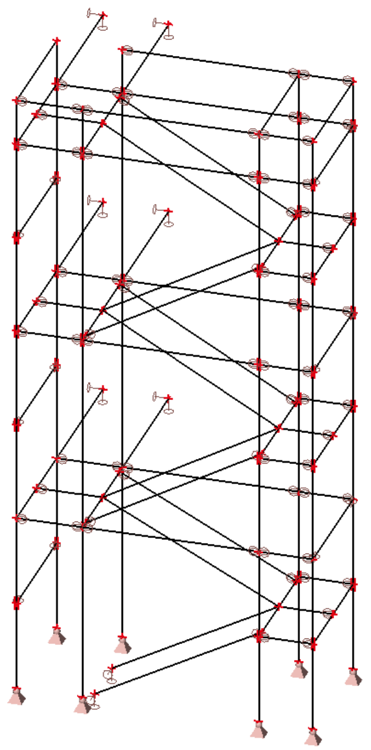
Poprečni presjeci u konstrukciji

Name	Type	Item material	Fabrication	A [m²]	A_y [m²]	I_y [m⁴]	$W_{el.y}$ [m³]	$W_{pl.y}$ [m³]	Colour
	Detailed				A_z [m²]	I_z [m⁴]	$W_{el.z}$ [m³]	$W_{pl.z}$ [m³]	
CS1	HEB140	S 355	rolled	4.2960e-03	2.2839e-03	1.5090e-05	2.1560e-04	2.4540e-04	
					1.0326e-03	5.4970e-06	7.8520e-05	1.1980e-04	
CS2	HEA140	S 355	rolled	3.1400e-03	2.3063e-03	1.0300e-05	1.5500e-04	1.7333e-04	
					7.7401e-04	3.8900e-06	5.5600e-05	8.5000e-05	
CS3	UPE160	S 235	rolled	2.1700e-03	1.2618e-03	9.1100e-06	1.1400e-04	1.3200e-04	
					8.8953e-04	1.0700e-06	2.2600e-05	4.0700e-05	
CS4	RRK80/80/4	S 235	cold formed	1.1750e-03	6.2231e-04	1.1100e-06	2.7800e-05	3.3100e-05	
					6.2231e-04	1.1100e-06	2.7800e-05	3.3100e-05	
CS5	RD22	S 355	rolled	3.7994e-04	3.4254e-04	1.1258e-08	1.0235e-06	1.7467e-06	
					3.4254e-04	1.1258e-08	1.0235e-06	1.7467e-06	



Oslonci konstrukcije

Oslonci stupova modelirani su kao zglobni (ne prenose moment savijanja), dok su bočni prihvati na zid modelirani tako da ne prenose moment savijanja i uzdužnu silu.



Djelovanja na konstrukciju

Djelovanja na konstrukciju preuzeta su iz Glavnog projekta koji je izradio projektantski ured KONUS d.o.o. (projektant Vice Tadić, dipl.ing.građ., oznaka projekta 148/2019 GL-K).

Stalno opterećenje	$g = 1{,}40\ kN/m^2$
Uporabno opterećenje	$q = 3{,}00\ kN/m^2$
Opterećenje snijegom	$s_k = 0{,}75\ kN/m^2$
Opterećenje vjetrom	$v_b = 35\ m/s$
Temperatura [+]*	T = + 60°C
Temperatura [-]*	T = - 25°C

*S obzirom da je sustav stabiliziran vlačnim dijagonalama, temperaturno djelovanje (u obliku uzdužne sile) neće imati značajan utjecaj na konstrukciju. Slijedom navedenog, temperatura se neće razmatrati u nastavku.

Opterećenje snijegom sukladno normi HRN EN 1991-1-3.

Karakteristično opterećenje snijegom na tlu	$s_k = 0{,}75\ kN/m^2$
Koeficijent umanjenja za nagib α < 30°	$\mu_i = 0{,}8$
Opterećenje snijegom na konstrukciju	$s_1 = 0{,}75 \cdot 0{,}8 = 0{,}60\ kN/m^2$

Opterećenje vjetrom sukladno normi EN 1991-1-4.

Srednja brzina vjetra (okomito na plohu)	$v_{b,0} = 35\ m/s$
Kategorija terena: II (izolirane prepreke)	Ce(z=13,50 m) = 2,53
Referentni pritisak srednje brzine vjetra	$q_b = 0{,}77\ kN/m^2$

S obzirom da je arhitektonskim projektom predviđeno bočno oblaganje stubišta perforiranim limom, djelovanje vjetra razmatrat će se kao na zatvoreni objekt, čime je proračun na stani sigurnosti.

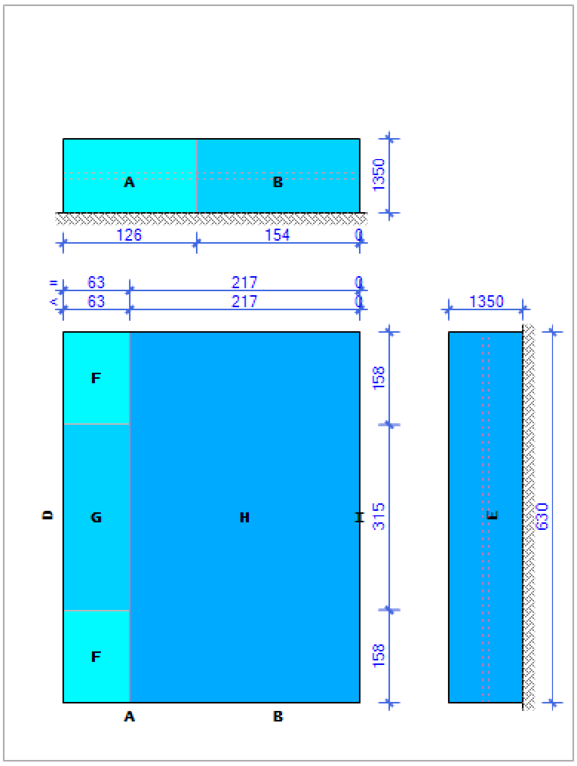
Vjetar puše s lijeve strane (slika lijevo):

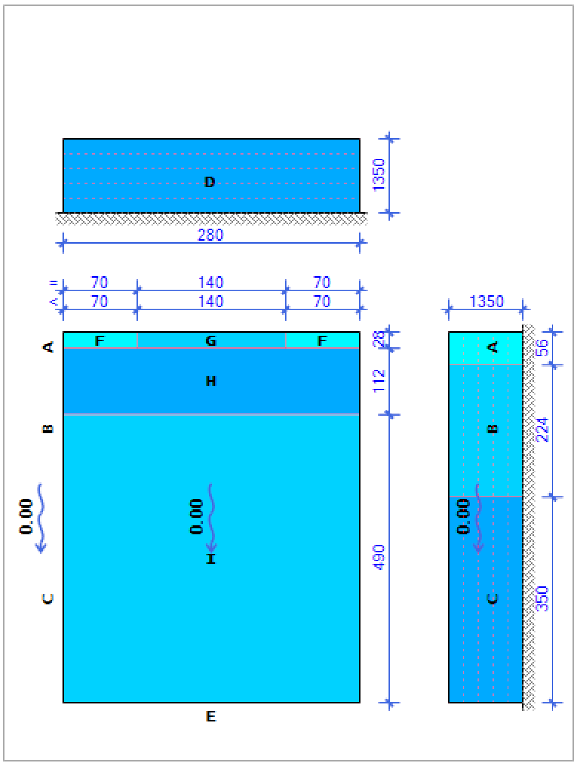
$W_{LJ\,MAX}$	**A**	**B**	**C**	**D**	**E**		**F**	**G**	**H**	**I**
$C_{e(13.50)}$	-2.12	-0.97	-	2.13	-0.39	$C_{e(13.50)}$	-4.26	-2.83	-0.78	0.00
$C_{e(6.30)}$	-1.70	-0.78	-	1.72	-0.31					
$W_{LJ\,MIN}$										
$C_{e(13.50)}$	-3.08	-1.94	-	1.16	-1.36	$C_{e(13.50)}$	-5.23	-3.80	-1.74	0.00
$C_{e(6.30)}$	-2.48	-1.56	-	0.94	-1.09					

Vjetar puše sa gornje strane (slika desno):

$W_{GO\,MAX}$	**A**	**B**	**C**	**D**	**E**		**F**	**G**	**H**	**I**
$C_{e(13.50)}$	-1.91	-0.97	-0.39	2.13	-0.39	$C_{e(13.50)}$	-4.26	-3.30	-1.26	0.19
$C_{e(5.43)}$	-1.48	-0.75	-0.30	1.66	-0.30					
$W_{GO\,MIN}$										
$C_{e(13.50)}$	-2.88	-1.94	-1.36	1.16	-1.36	$C_{e(13.50)}$	-5.23	-4.26	-2.23	-0.78
$C_{e(5.43)}$	-2.24	-1.51	-1.05	0.90	-1.05					

Shematski prikaz ploha vjetra; smjer vjetra lijevo i gore:





Odabrane vrijednosti pritiskajućeg vjetra smjer Y:

w_D = 2,13 kN/m²
w_E = -0,39 kN/m²
w_B = (-2,12-0,97)/2 = -1,55 kN/m²
$w_{pritisak}$ = 0 kN/m²

Odabrane vrijednosti odižućeg vjetra smjer Y:

w_D = 1,16 kN/m²
w_E = -1,36 kN/m²
w_B = (-3,08-1,94)/2 = -2,51 kN/m²
$w_{odizanje}$ = w_H = -1,74 kN/m²

Odabrane vrijednosti pritiskajućeg vjetra smjer X:

w_D = 2,13 kN/m²
w_E = -0,39 kN/m²
w_B = (-0,97-0,39)/2 = -0,68 kN/m²
$w_{pritisak}$ = 0,19 kN/m²

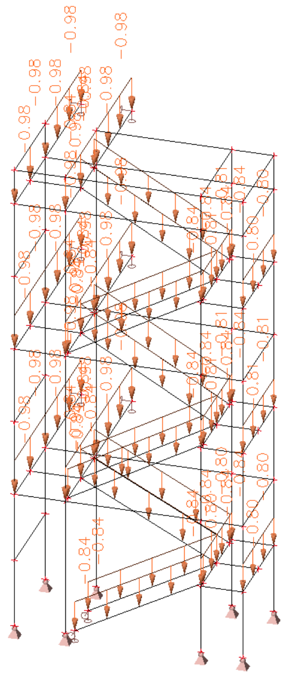
Odabrane vrijednosti odižućeg vjetra smjer X:

w_D = 1,16 kN/m²
w_E = -1,36 kN/m²
w_B = (-1,94-1,36)/2 = -1,65 kN/m²
$w_{odizanje}$ = w_H = -2,23 kN/m²

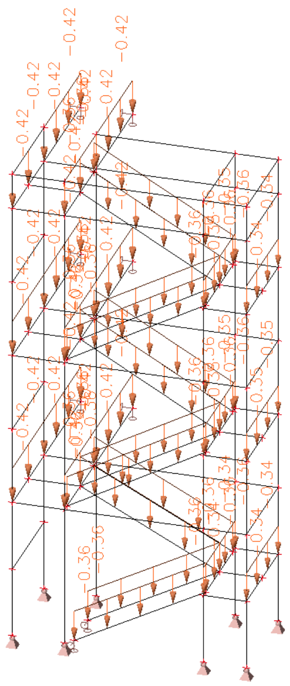
Shematski prikaz djelovanja na konstrukciju (vlastita težina uzeta automatski):

Name	Description	Load type	Action type	Load group	Spec	Duration
LC1	Vlastita tezina	Self weight	Permanent	LG1		
LC2	Stalno	Standard	Permanent	LG1		
LC3	Snijeg	Static	Variable	LG2	Standard	Medium
LC4	Uporabno	Static	Variable	LG3	Standard	Medium
LC5	Vjetar pritisak X	Static	Variable	LG3	Standard	Medium
LC6	Vjetar odizanje X	Static	Variable	LG3	Standard	Medium
LC7	Vjetar pritisak Y	Static	Variable	LG3	Standard	Medium
LC8	Vjetar odizanje Y	Static	Variable	LG3	Standard	Medium

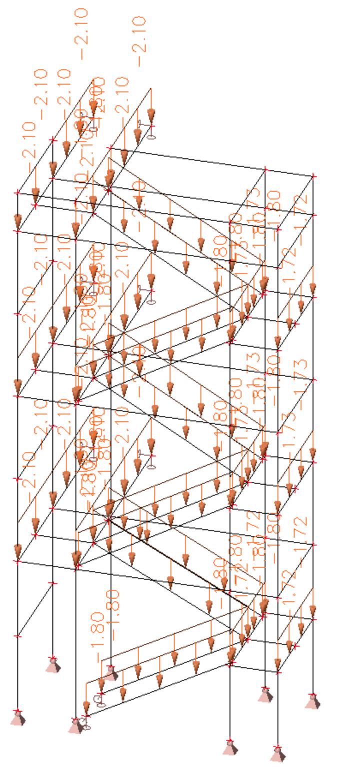
Name	Description	Load type	Action type	Load group
LC2	Stalno	Standard	Permanent	LG1



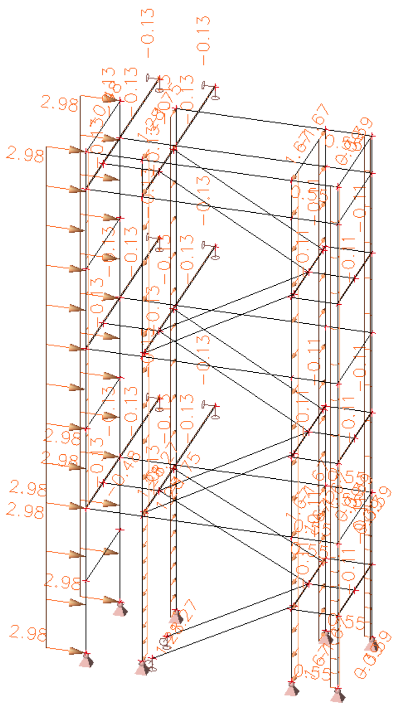
Name	Description	Load type	Action type	Load group	Spec	Duration
LC3	Snijeg	Static	Variable	LG2	Standard	Medium



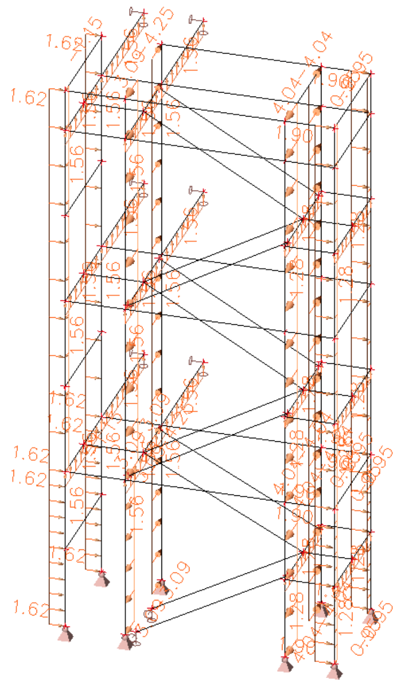
Name	Description	Load type	Action type	Load group	Spec	Duration
LC4	Uporabno	Static	Variable	LG3	Standard	Medium



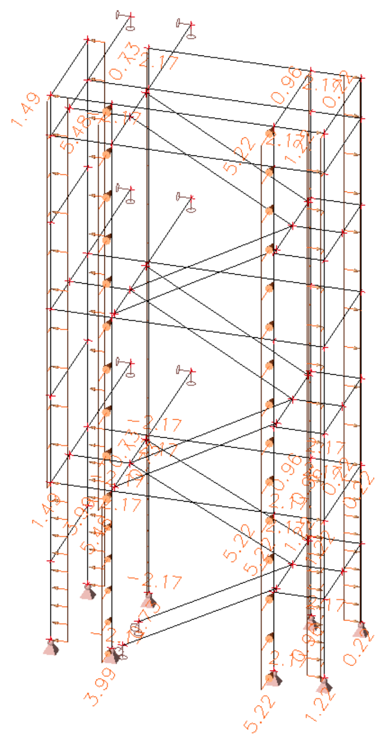
Name	Description	Load type	Action type	Load group	Spec	Duration
LC5	Vjetar pritisak X	Static	Variable	LG3	Standard	Medium



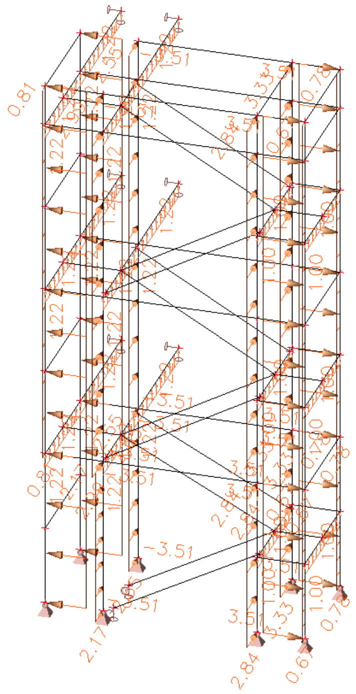
Name	Description	Load type	Action type	Load group	Spec	Duration
LC6	Vjetar odizanje X	Static	Variable	LG3	Standard	Medium



Name	Description	Load type	Action type	Load group	Spec	Duration
LC7	Vjetar pritisak Y	Static	Variable	LG3	Standard	Medium



Name	Description	Load type	Action type	Load group	Spec	Duration
LC8	Vjetar odizanje Y	Static	Variable	LG3	Standard	Medium



Kombinacije djelovanja na konstrukciju

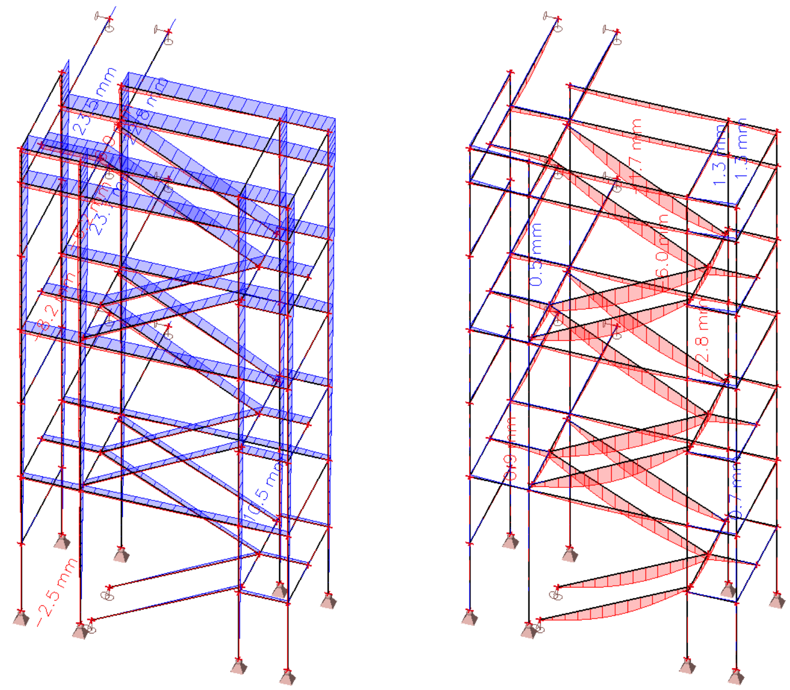
Name	Description	Type	Load cases	Coeff. [-]
GSN1		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
GSN2		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.50
GSN3		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC5 - Vjetar pritisak X	1.50
GSN4		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC7 - Vjetar pritisak Y	1.50
GSN5		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC6 - Vjetar odizanje X	1.50
GSN6		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC8 - Vjetar odizanje Y	1.50
GSN7		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC5 - Vjetar pritisak X	0.90
GSN8		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC7 - Vjetar pritisak Y	0.90
GSN9		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.50
			LC5 - Vjetar pritisak X	0.90
GSN10		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.50
			LC7 - Vjetar pritisak Y	0.90
GSN11		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC5 - Vjetar pritisak X	1.50
GSN12		Envelope - ultimate	LC1 - Vlastita tezina	1.35

Name	Description	Type	Load cases	Coeff. [-]
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.05
			LC5 - Vjetar pritisak X	1.50
GSN13		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC7 - Vjetar pritisak Y	1.50
GSN14		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Uporabno	1.05
			LC7 - Vjetar pritisak Y	1.50
GSU1		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
GSU2		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	1.00
GSU3		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC5 - Vjetar pritisak X	1.00
GSU4		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC7 - Vjetar pritisak Y	1.00
GSU5		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC6 - Vjetar odizanje X	1.00
GSU6		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC8 - Vjetar odizanje Y	1.00
GSU7		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC5 - Vjetar pritisak X	0.60
GSU8		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC7 - Vjetar pritisak Y	0.60
GSU9		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	1.00
			LC5 - Vjetar pritisak X	0.60
GSU10		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	1.00
			LC7 - Vjetar pritisak Y	0.60
GSU11		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC5 - Vjetar pritisak X	1.00
GSU12		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	0.70
			LC5 - Vjetar pritisak X	1.00
GSU13		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC7 - Vjetar pritisak Y	1.00
GSU14		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Uporabno	0.70
			LC7 - Vjetar pritisak Y	1.00

Pomaci i deformacije konstrukcije

U nastavku je dan grafički prikaz maksimalnih deformacija konstrukcije za anvelopu graničnog stanja uporabivosti.

Values: $\mathbf{u_y}$ (lijevo) i $\mathbf{u_z}$ (desno)
Class: Anvelopa GSU
Extreme 1D: Cross-section



Maksimalni pomak vrha objekta u_{max} = 23,5 mm < u_{dop} = H/300 = 13500/300 = 45 mm
Maksimalni progib tetive u_{max} = 6 mm < u_{dop} = L/250 = 4300/250 = 17,2 mm

Rezne sile u konstrukciji

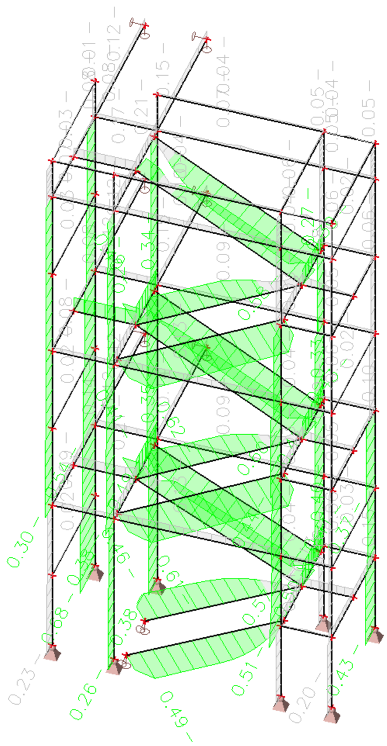
U nastavku je dan tablični prikaz maksimalnih reznih sila po tipu poprečnog presjeka za anvelopu GSN. Detaljan grafički prikaz reznih sila u pojedinim konstrukcijskim elementima dan je u točki 1.2. Proračun priključaka.

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B2	0.000	GSN14/1	CS1 - HEB140	**-348.77**	-5.02	-0.91	0.00	0.00	0.00
B7	1.950-	GSN6/2	CS1 - HEB140	**305.36**	-6.24	0.67	0.00	3.20	-2.15
B5	1.950+	GSN4/3	CS1 - HEB140	-26.01	1.32	**16.21**	0.00	-10.72	-1.39
B7	2.600-	GSN14/1	CS1 - HEB140	207.60	2.47	1.22	**0.00**	-1.37	-0.36
B8	1.950+	GSN5/4	CS1 - HEB140	-1.72	0.49	1.08	**0.00**	0.00	1.49
B3	3.900	GSN14/1	CS1 - HEB140	-34.13	-0.01	**-14.68**	0.00	**-11.70**	-0.03
B6	1.950-	GSN14/1	CS1 - HEB140	-67.00	0.55	2.97	0.00	**8.52**	1.07
B1	3.900	GSN12/5	CS1 - HEB140	-35.65	**-10.60**	-0.38	0.00	-0.63	**-7.31**
B1	3.900	GSN6/2	CS1 - HEB140	181.64	**12.52**	2.34	0.00	3.29	**8.75**
B113	0.000	GSN14/1	CS2 - HEA140	**-170.46**	-6.86	0.42	0.00	-1.46	5.20
B117	2.150-	GSN6/2	CS2 - HEA140	**141.22**	-6.17	0.50	0.00	2.29	-2.55
B17	2.600+	GSN6/2	CS2 - HEA140	-2.75	**-21.05**	-18.42	0.00	-2.19	3.21
B26	2.600+	GSN6/2	CS2 - HEA140	1.59	**20.71**	3.02	0.00	-8.02	-4.14
B17	2.800	GSN10/6	CS2 - HEA140	-9.58	-11.18	**-35.91**	0.02	-15.43	-0.75
B26	0.000	GSN9/7	CS2 - HEA140	5.91	-2.37	**28.06**	**0.02**	-10.33	0.00
B30	2.800	GSN14/1	CS2 - HEA140	-10.74	15.27	-18.92	-0.01	**-17.19**	0.00
B26	1.400+	GSN9/7	CS2 - HEA140	5.94	0.17	-11.81	**-0.02**	**12.29**	0.14
B113	4.300+	GSN3/8	CS2 - HEA140	-5.13	10.94	-0.39	0.00	0.75	**-7.90**
B113	4.300+	GSN6/2	CS2 - HEA140	-27.29	-12.90	0.50	0.00	-1.19	**9.38**
B49	0.000	GSN3/8	CS4 - RRK80/80/4	**-20.79**	0.00	0.09	-0.02	0.00	0.00
B43	0.000	GSN6/2	CS4 - RRK80/80/4	**32.46**	**0.00**	0.06	-0.06	**0.00**	**0.00**
B32	3.750	GSN3/8	CS4 - RRK80/80/4	2.19	0.00	**-0.23**	-0.02	0.00	0.00
B32	0.000	GSN3/8	CS4 - RRK80/80/4	2.19	0.00	**0.23**	-0.02	0.00	0.00
B60	0.000	GSN14/1	CS4 - RRK80/80/4	3.41	0.00	0.07	**-0.21**	0.00	0.00

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B33	0.000	GSN14/1	CS4 - RRK80/80/4	-0.71	0.00	0.07	**0.33**	0.00	0.00
B32	1.875-	GSN3/8	CS4 - RRK80/80/4	2.19	0.00	0.00	-0.02	**0.21**	0.00
B108	0.000	GSN12/5	CS3 - UPE160	**-12.44**	-0.09	5.40	0.00	-0.42	0.25
B110	4.323	GSN6/2	CS3 - UPE160	**29.43**	0.00	1.73	0.00	0.00	0.00
B109	4.323	GSN9/7	CS3 - UPE160	3.13	0.03	**-8.49**	0.00	-4.67	0.08
B66	0.000	GSN9/7	CS3 - UPE160	-0.55	-0.04	**8.17**	0.00	-3.71	0.06
B122	0.000	GSN14/1	CS3 - UPE160	0.25	**-0.43**	3.14	**0.00**	-4.18	0.60
B124	0.000	GSN6/2	CS3 - UPE160	1.32	0.71	0.48	**0.01**	-0.45	-0.82
B65	2.161-	GSN2/9	CS3 - UPE160	-0.22	0.00	0.00	0.00	**-8.23**	0.00
B61	2.025-	GSN10/6	CS3 - UPE160	0.22	-0.06	-0.40	0.00	**6.49**	-0.11
B125	0.000	GSN6/2	CS3 - UPE160	0.95	**0.72**	0.63	0.01	-0.61	**-0.83**
B109	0.000	GSN5/4	CS3 - UPE160	-7.19	-0.37	1.20	0.00	0.67	**0.79**
B95	0.000	GSN14/1	CS5 - RD22	**-85.20**	0.00	0.00	0.00	0.00	0.00
B94	3.412	GSN6/2	CS5 - RD22	**84.44**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Rezultati dimenzioniranja konstrukcije

U nastavku je dan grafički prikaz iskorištenosti elemenata konstrukcije za anvelopu graničnog stanja nosivosti, nakon čega slijedi detaljan postupak dimenzioniranja za kritični element po tipu poprečnog presjeka.



Dimenzioniranje donjeg segmenta stupa HEB 140

EN 1993-1-1 Code Check

National annex: Standard EN

Member B2	0.000 / 3.900 m	HEB140	S 355	Anvelopa GSN	0.68 -

Combination key
Anvelopa GSN / 1.35*LC1 + 1.35*LC2 + 1.05*LC4 + 1.50*LC7

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	355.0	MPa
Ultimate strength f_u	490.0	MPa
Fabrication	Rolled	

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

The critical check is on position 0.000 m

Internal forces	Calculated	Unit
N_{Ed}	-347.08	kN
$V_{y,Ed}$	-5.02	kN
$V_{z,Ed}$	-0.97	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	0.00	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]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	12	8.079e+04	8.079e+04	1.0	0.4	1.0	4.5	7.3	8.1	11.4	1
3	SO	55	12	8.079e+04	8.079e+04	1.0	0.4	1.0	4.5	7.3	8.1	11.4	1
4	I	92	7	8.079e+04	8.079e+04	1.0		1.0	13.1	26.8	30.9	34.2	1
5	SO	55	12	8.079e+04	8.079e+04	1.0	0.4	1.0	4.5	7.3	8.1	11.4	1
7	SO	55	12	8.079e+04	8.079e+04	1.0	0.4	1.0	4.5	7.3	8.1	11.4	1

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	4.2960e-03	m²
$N_{c,Rd}$	1525.08	kN
Unity check	0.23	-

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

η	1.20	
A_v	3.4930e-03	m²
$V_{pl,y,Rd}$	715.92	kN
Unity check	0.01	-

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

η	1.20	
A_v	1.3080e-03	m²
$V_{pl,z,Rd}$	268.09	kN
Unity check	0.00	-

The member satisfies the section check.

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

Classification for member buckling design
Decisive position for stability classification: 3.900 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	12	2.194e+04	-2.953e+04	-1.3	23.8	0.4	4.5	26.3	29.2	83.4	1
3	SO	55	12	5.121e+04	1.027e+05	0.5	0.5	1.0	4.5	7.3	8.1	11.9	1
4	I	92	7	4.323e+04	7.726e+04	0.6		1.0	13.1	26.8	30.9	40.0	1
5	SO	55	12	9.856e+04	1.500e+05	0.7	0.5	1.0	4.5	7.3	8.1	11.6	1
7	SO	55	12	6.928e+04	1.782e+04	0.3	1.0	1.0	4.5	7.3	8.1	16.8	1

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	1.950	3.900	m
Buckling factor k	2.00	0.78	
Buckling length l_{cr}	3.900	3.048	m
Critical Euler load N_{cr}	2056.26	1226.74	kN
Slenderness λ	65.80	85.20	
Relative slenderness λ_{rel}	0.86	1.11	
Limit slenderness $\lambda_{rel,0}$	0.20	0.20	
Buckling curve	b	c	
Imperfection α	0.34	0.49	
Reduction factor χ	0.69	0.48	
Buckling resistance $N_{b,Rd}$	951.13	660.41	kN

Flexural Buckling verification		
Cross-section area A	4.2960e-03	m²
Buckling resistance $N_{b,Rd}$	660.41	kN
Unity check	0.53	-

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.

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

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	4.2960e-03	m²
Plastic section modulus $W_{pl,y}$	2.4540e-04	m³
Plastic section modulus $W_{pl,z}$	1.1980e-04	m³
Design compression force N_{Ed}	347.08	kN
Design bending moment (maximum) $M_{y,Ed}$	-1.88	kNm
Design bending moment (maximum) $M_{z,Ed}$	5.19	kNm
Characteristic compression resistance N_{Rk}	1525.08	kN
Characteristic moment resistance $M_{y,Rk}$	87.12	kNm
Characteristic moment resistance $M_{z,Rk}$	42.53	kNm
Reduction factor χ_y	0.69	
Reduction factor χ_z	0.48	
Reduction factor χ_{LT}	1.00	
Interaction factor k_{yy}	0.94	
Interaction factor k_{yz}	0.80	
Interaction factor k_{zy}	0.50	
Interaction factor k_{zz}	1.04	

Maximum moment $M_{y,Ed}$ is derived from beam B2 position 1.950 m.
Maximum moment $M_{z,Ed}$ is derived from beam B2 position 3.900 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	2056.26	kN
Critical Euler load $N_{cr,z}$	1226.74	kN
Elastic critical load $N_{cr,T}$	3948.17	kN

Interaction method 1 parameters		
Plastic section modulus $W_{pl,y}$	2.4540e-04	m^3
Elastic section modulus $W_{el,y}$	2.1560e-04	m^3
Plastic section modulus $W_{pl,z}$	1.1980e-04	m^3
Elastic section modulus $W_{el,z}$	7.8520e-05	m^3
Second moment of area I_y	1.5090e-05	m^4
Second moment of area I_z	5.4970e-06	m^4
Torsional constant I_t	1.9726e-07	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	0.00	
Equivalent moment factor $C_{my,0}$	0.77	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	5.19	kNm
Maximum relative deflection δ_y	4.3	mm
Equivalent moment factor $C_{mz,0}$	0.89	
Factor μ_y	0.94	
Factor μ_z	0.83	
Factor ε_y	0.11	
Factor a_{LT}	0.99	
Critical moment for uniform bending $M_{cr,0}$	119.05	kNm
Relative slenderness $\lambda_{rel,0}$	0.86	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.33	
Equivalent moment factor C_{my}	0.83	
Equivalent moment factor C_{mz}	0.89	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor c_{LT}	0.03	
Factor d_{LT}	0.00	
Factor e_{LT}	0.02	
Factor w_y	1.14	
Factor w_z	1.50	
Factor n_{pl}	0.25	
Maximum relative slenderness $\lambda_{rel,max}$	1.11	
Factor C_{yy}	0.99	
Factor C_{yz}	1.01	
Factor C_{zy}	0.85	
Factor C_{zz}	1.00	

Unity check (6.61) = 0.36 + 0.02 + 0.11 = 0.49 -
Unity check (6.62) = 0.53 + 0.01 + 0.14 = 0.68 -

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	3.900	m
Web	unstiffened	
Web height h_w	116	mm
Web thickness t	7	mm
Material coefficient ε	0.81	
Shear correction factor η	1.20	

Shear Buckling verification	
Web slenderness h_w/t	16.57
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.

Dimenzioniranje gornjeg segmenta stupa HEA 140

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

Member B113	**0.000 / 9.600 m**	**HEA140**	**S 355**	**Anvelopa GSN**	**0.54 -**

Combination key
Anvelopa GSN / LC1 + 0.90*LC2 + 1.50*LC8

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	355.0	MPa
Ultimate strength f_u	490.0	MPa
Fabrication	Rolled	

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

The critical check is on position 0.000 m

Internal forces	Calculated	Unit
N_{Ed}	-111.95	kN
$V_{y,Ed}$	-11.11	kN
$V_{z,Ed}$	0.63	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	-1.86	kNm
$M_{z,Ed}$	8.42	kNm

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

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	8	1.492e+04	-1.046e+05	-7.0	23.8	0.1	6.5	165.9	184.4	83.4	1
3	SO	55	8	7.871e+04	1.982e+05	0.4	0.5	1.0	6.5	7.3	8.1	12.1	1
4	I	92	6	4.390e+04	2.736e+04	0.6		1.0	16.7	26.8	30.9	39.0	1
5	SO	55	8	5.634e+04	1.758e+05	0.3	0.5	1.0	6.5	7.3	8.1	12.2	1
7	SO	55	8	-7.454e+03	-1.269e+05								

The cross-section is classified as Class 1

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

A	3.1400e-03	m²
$N_{c,Rd}$	1114.70	kN
Unity check	0.10	-

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

$W_{pl,y}$	1.7333e-04	m³
$M_{pl,y,Rd}$	61.53	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),(6.13)

$W_{pl,z}$	8.5000e-05	m³
$M_{pl,z,Rd}$	30.18	kNm
Unity check	0.28	-

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

η	1.20	

A_v	2.4763e-03	m²
$V_{pl,y,Rd}$	507.53	kN
Unity check	0.02	-

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

η	1.20	
A_v	1.0107e-03	m²
$V_{pl,z,Rd}$	207.16	kN
Unity check	0.00	-

Combined Shear and Torsion check for V_y and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.26)

$V_{pl,T,y,Rd}$	507.50	kN
Unity check	0.02	-

Combined Shear and Torsion check for V_z and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.26)

$V_{pl,T,z,Rd}$	207.15	kN
Unity check	0.00	-

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

$M_{pl,y,Rd}$	61.53	kNm
α	2.00	
$M_{pl,z,Rd}$	30.18	kNm
β	1.00	

Unity check (6.41) = 0.00 + 0.28 = 0.28 -

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

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	8	-3.662e+04	-1.697e+05								
3	SO	55	8	3.444e+04	1.675e+05	0.2	0.5	1.0	6.5	7.3	8.1	12.4	1
4	I	92	6	4.156e+03	3.386e+04	0.1		1.0	16.7	26.8	30.9	48.1	1
5	SO	55	8	7.464e+04	2.077e+05	0.4	0.5	1.0	6.5	7.3	8.1	12.1	1
7	SO	55	8	3.584e+03	-1.295e+05	-36.1	23.8	0.0	6.5	1656.9	1841.0	83.4	1

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	2.150	4.300	m
Buckling factor k	2.00	0.58	
Buckling length l_{cr}	4.300	2.485	m
Critical Euler load N_{cr}	1154.57	1305.62	kN
Slenderness λ	75.08	70.60	

Buckling parameters	yy	zz	
Relative slenderness λ_{rel}	0.98	0.92	
Limit slenderness $\lambda_{rel,0}$	0.20	0.20	
Buckling curve	b	c	
Imperfection α	0.34	0.49	
Reduction factor χ	0.61	0.59	
Buckling resistance $N_{b,Rd}$	616.24	592.98	kN

Flexural Buckling verification		
Cross-section area A	3.1400e-03	m²
Buckling resistance $N_{b,Rd}$	592.98	kN
Unity check	0.19	-

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 & 6.3.2.2 and formula (6.54)

LTB parameters		
Method for LTB curve	General case	
Plastic section modulus $W_{pl,y}$	1.7333e-04	m³
Elastic critical moment M_{cr}	178.78	kNm
Relative slenderness $\lambda_{rel,LT}$	0.59	
Limit slenderness $\lambda_{rel,LT,0}$	0.20	

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}	4.300	m
Influence of load position	no influence	
Correction factor k	1.00	
Correction factor k_w	1.00	
LTB moment factor C_1	3.05	
LTB moment factor C_2	0.36	
LTB moment factor C_3	1.00	
Shear center distance d_z	0	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_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 area A	3.1400e-03	m²
Plastic section modulus $W_{pl,y}$	1.7333e-04	m³
Plastic section modulus $W_{pl,z}$	8.5000e-05	m³
Design compression force N_{Ed}	111.95	kN
Design bending moment (maximum) $M_{y,Ed}$	-1.86	kNm
Design bending moment (maximum) $M_{z,Ed}$	9.38	kNm
Characteristic compression resistance N_{Rk}	1114.70	kN
Characteristic moment resistance $M_{y,Rk}$	61.53	kNm
Characteristic moment resistance $M_{z,Rk}$	30.18	kNm
Reduction factor χ_y	0.61	
Reduction factor χ_z	0.59	
Reduction factor χ_{LT}	1.00	
Interaction factor k_{yy}	0.96	
Interaction factor k_{yz}	0.68	
Interaction factor k_{zy}	0.53	
Interaction factor k_{zz}	0.97	

Maximum moment $M_{y,Ed}$ is derived from beam B113 position 0.000 m.
Maximum moment $M_{z,Ed}$ is derived from beam B113 position 4.300 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	1154.57	kN
Critical Euler load $N_{cr,z}$	1305.62	kN
Elastic critical load $N_{cr,T}$	1748.29	kN
Plastic section modulus $W_{pl,y}$	1.7333e-04	m^3
Elastic section modulus $W_{el,y}$	1.5500e-04	m^3
Plastic section modulus $W_{pl,z}$	8.5000e-05	m^3
Elastic section modulus $W_{el,z}$	5.5600e-05	m^3
Second moment of area I_y	1.0300e-05	m^4
Second moment of area I_z	3.8900e-06	m^4
Torsional constant I_t	7.7412e-08	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	0.27	
Equivalent moment factor $C_{my,0}$	0.85	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{z,Ed}$	9.38	kNm
Maximum relative deflection δ_y	3.6	mm
Equivalent moment factor $C_{mz,0}$	0.93	
Factor μ_y	0.96	
Factor μ_z	0.96	
Factor ε_y	0.34	
Factor a_{LT}	0.99	
Critical moment for uniform bending $M_{cr,0}$	58.69	kNm
Relative slenderness $\lambda_{rel,0}$	1.02	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.34	
Equivalent moment factor C_{my}	0.90	
Equivalent moment factor C_{mz}	0.93	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor c_{LT}	0.06	
Factor d_{LT}	0.03	
Factor e_{LT}	0.07	
Factor w_y	1.12	
Factor w_z	1.50	
Factor n_{pl}	0.11	
Maximum relative slenderness $\lambda_{rel,max}$	0.98	
Factor C_{yy}	1.00	
Factor C_{yz}	1.00	
Factor C_{zy}	0.94	
Factor C_{zz}	1.01	

Unity check (6.61) = 0.18 + 0.03 + 0.23 = 0.45 -
Unity check (6.62) = 0.19 + 0.02 + 0.33 = 0.54 -

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

Shear Buckling parameters		
Buckling field length a	9.600	m
Web	unstiffened	
Web height h_w	116	mm
Web thickness t	6	mm
Material coefficient ε	0.81	
Shear correction factor η	1.20	

Shear Buckling verification	
Web slenderness h_w/t	21.09
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.

Dimenzioniranje donjeg segmenta stupa HEB 140

Dimenzioniranje stabilizacije SHS 80/80/4

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

Member B45	**1.875 / 3.750 m**	**RRK80/80/4**	**S 235**	**Anvelopa GSN**	**0.13 -**

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
Anvelopa GSN / 1.35*LC1 + 1.35*LC2 + 1.50*LC5

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	235.0	MPa
Ultimate strength f_u	360.0	MPa
Fabrication	Cold formed	

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

The critical check is on position 1.875 m

Internal forces	Calculated	Unit
N_{Ed}	-9.27	kN
$V_{y,Ed}$	0.00	kN
$V_{z,Ed}$	0.00	kN
T_{Ed}	-0.03	kNm
$M_{y,Ed}$	0.21	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]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	68	4	5.409e+02	5.409e+02	1.0		1.0	17.0	33.0	38.0	42.0	1
3	I	68	4	1.315e+03	1.447e+04	0.1		1.0	17.0	33.0	38.0	60.0	1
5	I	68	4	1.524e+04	1.524e+04	1.0		1.0	17.0	33.0	38.0	42.0	1
7	I	68	4	1.447e+04	1.315e+03	0.1		1.0	17.0	33.0	38.0	60.0	1

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	1.1750e-03	m²
$N_{c,Rd}$	276.12	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)

$W_{pl,y}$	3.3100e-05	m³
$M_{pl,y,Rd}$	7.78	kNm
Unity check	0.03	-

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.1(5) and formula (6.1)

Elastic verification		
Fibre	10	
$\sigma_{N,Ed}$	7.9	MPa
$\sigma_{My,Ed}$	7.7	MPa
$\sigma_{Mz,Ed}$	0.0	MPa
$\sigma_{tot,Ed}$	15.6	MPa
$\tau_{Vy,Ed}$	0.0	MPa
$\tau_{Vz,Ed}$	0.0	MPa
$\tau_{t,Ed}$	0.6	MPa
$\tau_{tot,Ed}$	0.6	MPa

Elastic verification		
$\sigma_{von\ Mises,Ed}$	15.7	MPa
Unity check	0.07	-

Note: Since there is no shear force, the effect of the torsional moment cannot be accounted for in the plastic interaction. Therefore the elastic yield criterion according to EN 1993-1-1 article 6.2.1(5) is verified.

The member satisfies the section check.

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

Classification for member buckling design
Decisive position for stability classification: 1.875 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	68	4	5.409e+02	5.409e+02	1.0		1.0	17.0	33.0	38.0	42.0	1
3	I	68	4	1.315e+03	1.447e+04	0.1		1.0	17.0	33.0	38.0	60.0	1
5	I	68	4	1.524e+04	1.524e+04	1.0		1.0	17.0	33.0	38.0	42.0	1
7	I	68	4	1.447e+04	1.315e+03	0.1		1.0	17.0	33.0	38.0	60.0	1

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	3.750	3.750	m
Buckling factor k	1.00	1.00	
Buckling length l_{cr}	3.750	3.750	m
Critical Euler load N_{cr}	163.60	163.61	kN
Slenderness λ	122.01	122.01	
Relative slenderness λ_{rel}	1.30	1.30	
Limit slenderness $\lambda_{rel,0}$	0.20	0.20	
Buckling curve	c	c	
Imperfection α	0.49	0.49	
Reduction factor χ	0.39	0.39	
Buckling resistance $N_{b,Rd}$	97.69	97.69	kN

Flexural Buckling verification		
Cross-section area A	1.1750e-03	m²
Buckling resistance $N_{b,Rd}$	97.69	kN
Unity check	0.09	-

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	1.1750e-03	m²
Plastic section modulus $W_{pl,y}$	3.3100e-05	m³
Design compression force N_{Ed}	9.27	kN
Design bending moment (maximum) $M_{y,Ed}$	0.21	kNm
Design bending moment (maximum) $M_{z,Ed}$	0.00	kNm
Characteristic compression resistance N_{Rk}	276.12	kN
Characteristic moment resistance $M_{y,Rk}$	7.78	kNm
Reduction factor χ_y	0.39	
Reduction factor χ_z	0.39	

Bending and axial compression check parameters		
Reduction factor χ_{LT}	1.00	
Interaction factor k_{yy}	1.04	
Interaction factor k_{zy}	0.65	

Maximum moment $M_{y,Ed}$ is derived from beam B45 position 1.875 m.
Maximum moment $M_{z,Ed}$ is derived from beam B45 position 0.000 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	163.60	kN
Critical Euler load $N_{cr,z}$	163.61	kN
Elastic critical load $N_{cr,T}$	74384.31	kN
Plastic section modulus $W_{pl,y}$	3.3100e-05	m^3
Elastic section modulus $W_{el,y}$	2.7800e-05	m^3
Plastic section modulus $W_{pl,z}$	3.3100e-05	m^3
Elastic section modulus $W_{el,z}$	2.7800e-05	m^3
Second moment of area I_y	1.1100e-06	m^4
Second moment of area I_z	1.1100e-06	m^4
Torsional constant I_t	1.7400e-06	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 4 (Line load)	
Equivalent moment factor $C_{my,0}$	1.00	
Factor μ_y	0.96	
Factor μ_z	0.96	
Factor ε_y	0.98	
Factor a_{LT}	0.00	
Critical moment for uniform bending $M_{cr,0}$	151.63	kNm
Relative slenderness $\lambda_{rel,0}$	0.23	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.21	
Equivalent moment factor C_{my}	1.00	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor d_{LT}	0.00	
Factor w_y	1.19	
Factor w_z	1.19	
Factor n_{pl}	0.04	
Maximum relative slenderness $\lambda_{rel,max}$	1.30	
Factor C_{yy}	0.99	
Factor C_{zy}	0.94	

Unity check (6.61) = 0.09 + 0.03 + 0.00 = 0.13 -
Unity check (6.62) = 0.09 + 0.02 + 0.00 = 0.11 -

The member satisfies the stability check.

Dimenzioniranje tetive UPE 160

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

Member B67	**0.360 / 4.323 m**	**UPE160**	**S 235**	**Anvelopa GSN**	**0.62 -**

Combination key
Anvelopa GSN / 1.35*LC1 + 1.35*LC2 + 1.50*LC4 + 0.90*LC7

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	235.0	MPa
Ultimate strength f_u	360.0	MPa
Fabrication	Rolled	

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

The critical check is on position 0.360 m

Internal forces	Calculated	Unit
N_{Ed}	-9.02	kN
$V_{y,Ed}$	0.00	kN
$V_{z,Ed}$	-6.34	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	-2.51	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]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	UO	53	10	2.492e+04	2.492e+04	1.0	0.4	1.0	5.5	9.0	10.0	14.0	1
3	I	117	6	2.030e+04	-1.198e+04	-0.6		0.6	21.3	55.2	63.6	88.4	1
5	UO	53	10	-1.660e+04	-1.660e+04								

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	2.1700e-03	m²
$N_{c,Rd}$	509.95	kN
Unity check	0.02	-

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

$W_{pl,y}$	1.3200e-04	m³
$M_{pl,y,Rd}$	31.02	kNm
Unity check	0.08	-

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

η	1.20	
A_v	1.0062e-03	m²
$V_{pl,z,Rd}$	136.53	kN
Unity check	0.05	-

Combined Shear and Torsion check for V_z and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.27)

$V_{pl,T,z,Rd}$	136.52	kN
Unity check	0.05	-

Combined bending, axial force and shear force check

According to EN 1993-1-1 article 6.2.1 and formula (6.2)

$N_{pl,Rd}$	509.95	kN
$M_{pl,y,Rd}$	31.02	kNm
$M_{pl,z,Rd}$	9.56	kNm

Unity check (6.2) = 0.02 + 0.08 + 0.00 = 0.10 -

Note: No specific interaction formulae according to EN 1993-1-1 article 6.2.9.1 apply.
Therefore the plastic linear summation according to EN 1993-1-1 article 6.2.1(7) is verified.
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: 2.161 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	UO	53	10	7.041e+04	7.041e+04	1.0	0.4	1.0	5.5	9.0	10.0	14.0	1
3	I	117	6	5.529e+04	-5.033e+04	-0.9		0.5	21.3	68.2	78.5	113.6	1
5	UO	53	10	-6.545e+04	-6.545e+04								

The cross-section is classified as Class 1

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

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	4.323	4.323	m
Buckling factor k	1.00	1.00	
Buckling length l_{cr}	4.323	4.323	m
Critical Euler load N_{cr}	1010.52	118.69	kN
Slenderness λ	66.71	194.66	
Relative slenderness λ_{rel}	0.71	2.07	
Limit slenderness $\lambda_{rel,0}$	0.20	0.20	
Buckling curve	c	c	
Imperfection α	0.49	0.49	
Reduction factor χ	0.72	0.18	
Buckling resistance $N_{b,Rd}$	332.98	85.51	kN

Flexural Buckling verification		
Cross-section area A	2.1700e-03	m²
Buckling resistance $N_{b,Rd}$	85.51	kN
Unity check	0.11	-

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

Torsional buckling length l_{cr}	4.323	m
Elastic critical load $N_{cr,T}$	672.16	kN
Elastic critical load $N_{cr,TF}$	118.69	kN
Relative slenderness $\lambda_{rel,T}$	2.07	
Limit slenderness $\lambda_{rel,0}$	0.20	
Buckling curve	c	
Imperfection α	0.49	
Reduction factor χ	0.18	
Cross-section area A	2.1700e-03	m²
Buckling resistance $N_{b,Rd}$	85.51	kN
Unity check	0.11	-

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1 & 6.3.2.2 and formula (6.54)

LTB parameters		
Method for LTB curve	General case	
Plastic section modulus $W_{pl,y}$	1.3200e-04	m^3
Elastic critical moment M_{cr}	26.26	kNm
Relative slenderness $\lambda_{rel,LT}$	1.09	
Relative slenderness $\lambda_{rel,T}$	0.11	
Relative slenderness $\lambda_{rel,EXTRA}$	1.20	
Limit slenderness $\lambda_{rel,LT,0}$	0.20	
LTB curve	a	
Imperfection α_{LT}	0.21	
Reduction factor χ_{LT}	0.53	
Design buckling resistance $M_{b,Rd}$	14.92	kNm
Unity check	0.17	-

Note: $\lambda_{rel,EXTRA}$ is determined according to "Design rule for lateral torsional buckling of channel sections, 2007".

Mcr parameters		
LTB length l_{LT}	4.323	m
Influence of load position	no influence	
Correction factor k	1.00	
Correction factor k_w	1.00	
LTB moment factor C_1	1.13	
LTB moment factor C_2	0.45	
LTB moment factor C_3	0.53	
Shear center distance d_z	0	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_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 area A	2.1700e-03	m^2
Plastic section modulus $W_{pl,y}$	1.3200e-04	m^3
Design compression force N_{Ed}	9.02	kN
Design bending moment (maximum) $M_{y,Ed}$	-8.23	kNm
Design bending moment (maximum) $M_{z,Ed}$	0.00	kNm
Characteristic compression resistance N_{Rk}	509.95	kN
Characteristic moment resistance $M_{y,Rk}$	31.02	kNm
Reduction factor χ_y	0.72	
Reduction factor χ_z	0.18	
Reduction factor χ_{LT}	0.53	
Interaction factor k_{yy}	1.07	
Interaction factor k_{zy}	0.57	

Maximum moment $M_{y,Ed}$ is derived from beam B67 position 2.161 m.
Maximum moment $M_{z,Ed}$ is derived from beam B67 position 0.000 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	1010.52	kN
Critical Euler load $N_{cr,z}$	118.69	kN
Elastic critical load $N_{cr,T}$	672.16	kN
Plastic section modulus $W_{pl,y}$	1.3200e-04	m^3
Elastic section modulus $W_{el,y}$	1.1400e-04	m^3
Plastic section modulus $W_{pl,z}$	4.0700e-05	m^3
Elastic section modulus $W_{el,z}$	2.2600e-05	m^3
Second moment of area I_y	9.1100e-06	m^4
Second moment of area I_z	1.0700e-06	m^4
Torsional constant I_t	5.0727e-08	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 4 (Line load)	
Equivalent moment factor $C_{my,0}$	1.00	
Factor μ_y	1.00	
Factor μ_z	0.94	
Factor ε_y	17.37	
Factor a_{LT}	0.99	
Critical moment for uniform bending $M_{cr,0}$	23.30	kNm
Relative slenderness $\lambda_{rel,0}$	1.15	

Interaction method 1 parameters		
Limit relative slenderness $\lambda_{rel,0,lim}$	0.21	
Equivalent moment factor C_{my}	1.00	
Equivalent moment factor C_{mLT}	1.04	
Factor b_{LT}	0.00	
Factor d_{LT}	0.00	
Factor w_y	1.16	
Factor w_z	1.50	
Factor n_{pl}	0.02	
Maximum relative slenderness $\lambda_{rel,max}$	2.07	
Factor C_{yy}	0.98	
Factor C_{zy}	0.92	

Unity check (6.61) = 0.03 + 0.59 + 0.00 = 0.62 -
Unity check (6.62) = 0.11 + 0.31 + 0.00 = 0.42 -

The member satisfies the stability check.

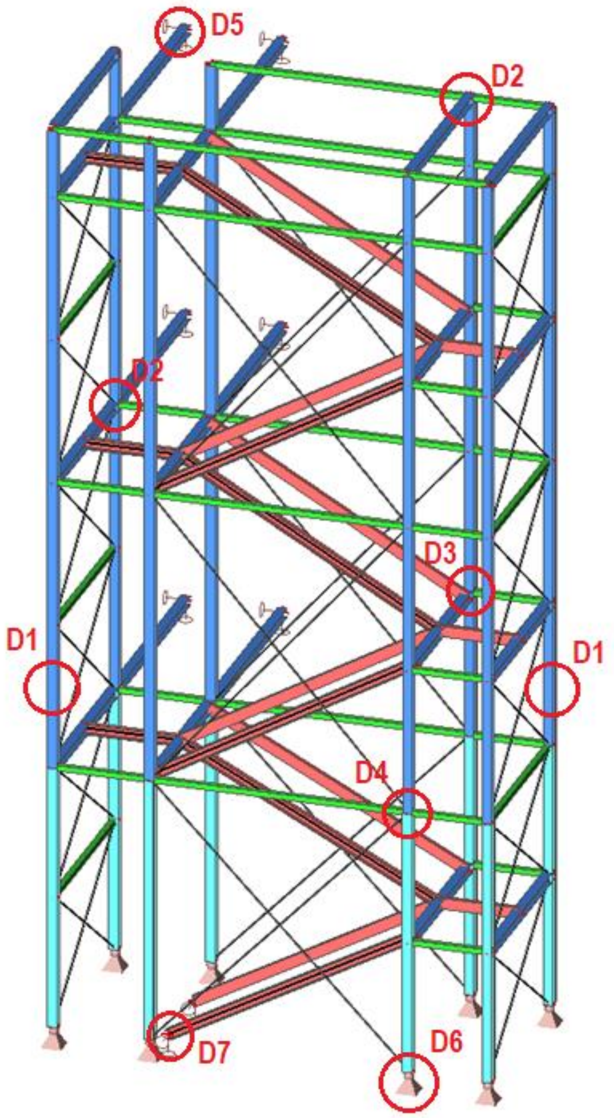
Dimenzioniranje dijagonale vertikalne stabilizacije Ø22

Sila u vlačnoj zategi N_{Ed} = 85,2 kN
Površina u zoni navoja A_{netto} = 3,03 cm^2

Napon u zategi $\sigma = N_{Ed} / A_{netto}$ = 85,2 / 3,03 = 28,1 kN/cm^2
Dopušteni napon σ_{dop} = 35,5 / 1,0 = 35,5 kN/cm^2 > 28,1 kN/cm^2 → zadovoljava (79%)

1.2. Proračun priključaka vanjskog stubišta

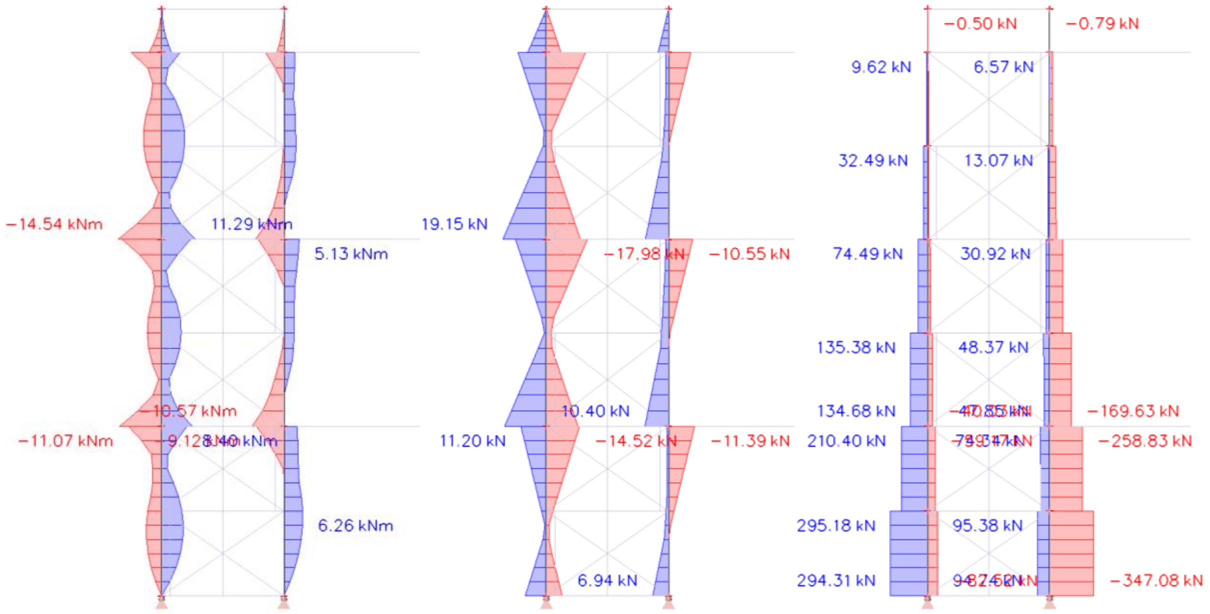
Svi širokopojasni profili čelične nosive konstrukcije izrađuju se čelika S355J2 sukladno normi HRN EN 10025, a hladnooblikovani cijevni profili od čelika S235JR sukladno normi HRN EN 10219. Svi limovi izrađuju se od čelika S355J2. Vijčani montažni spojevi izvode se vijcima kvalitete 8.8 (HRN EN 15048) i 10.9 (HRN EN 14399) prema proračunu danom u nastavku.



Nastavak stupa (D1)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti mjerodavnog okvira.

Values: M_y, V_z, N
Class: Anvelopa GSN
Extreme 1D: Member



Rezne sile u čvoru

$M_{y,Ed}$ = 0 kNm
$V_{z,Ed}$ = 14,5 kN
N_{Ed} = 135,4 kN (vlak)

Nastavak stupa izvodi se na 4,5 m visine (0,6-0,8 m od prve etaže), što bliže nultočki momentnog dijagrama, pri čemu se donji segment stupa (do nastavka) izvodi od valjanog I profila HEB140, dok se ostatak stupa izvodi profila HEA 140. Sukladno pravilima struke, nastavak stupa izvodi se kao spoj pune nosivosti IH1.A, kao DSTV spoj br. 406. Puna računska nosivost spoja za pritezanje 100%:

$M_{y,Rd}$ = 20,3 kNm
$V_{z,Rd}$ = 103,7 kN

Provjera otpornosti vijaka na vlak

$F_{Ed/vijak} = N_{Ed} / 4$ = 135,4 / 4 = 33,9 kN po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2}$ = 141,3 / 1,25 = 113 kN
113 kN > $F_{Ed/vijak}$ = 33,9 kN → zadovoljava (30%)

Provjera otpornosti vijaka na posmik

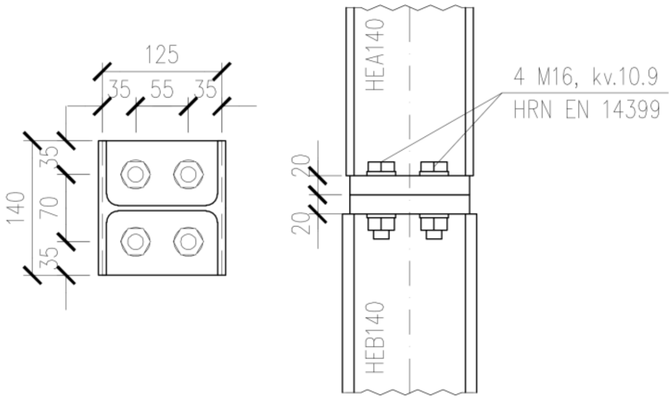
$F_{Ed/vijak} = V_{Ed} / 4$ = 14,5 / 4 = 3,6 kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2}$ = 78,5 / 1,25 = 62,8 kN
62,8 kN > $F_{Ed/vijak}$ = 3,6 kN → zadovoljava (6%)

S obzirom na minimalni iznos poprečne sile u čvoru te debljinu čeone ploče, pritisak po omotaču rupe nije mjerodavan te se neće dodatno provjeravati.

Geometrija spoja

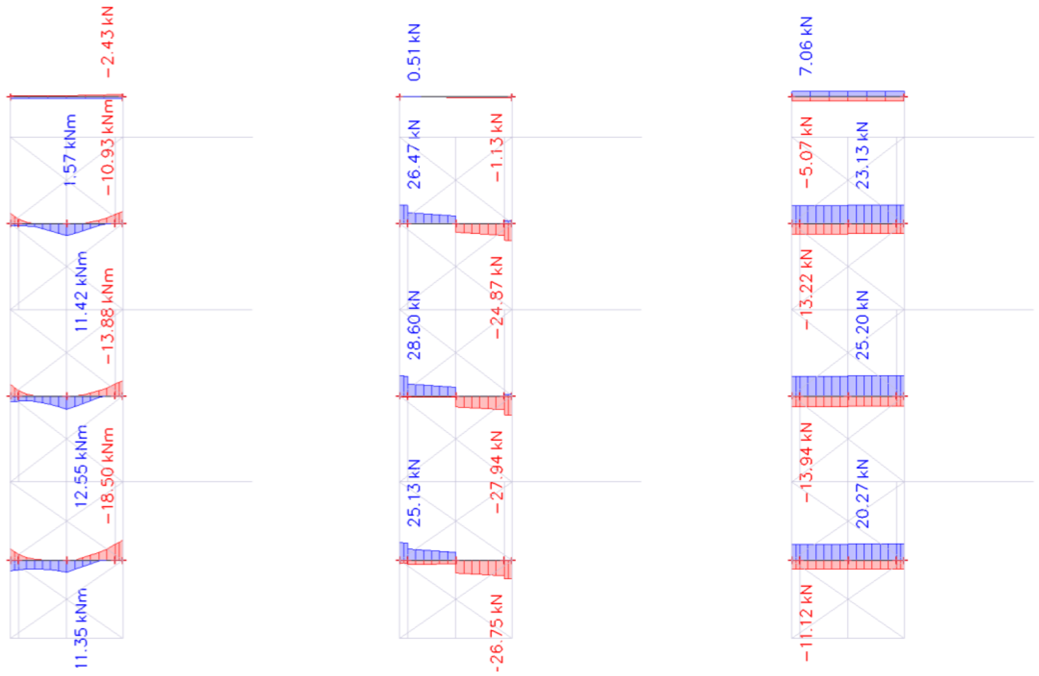
Vijci	4 M16, kv. 10.9, **vijke pritegnuti na 100%**
Čeone ploče	t = 20 mm, S355J2
Zavari	a_w = 4 mm (pojas), a_w = 4 mm (hrbat)



Spoj stup - greda (D2)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti mjerodavnog okvira.

Values: $\mathbf{M_y, V_z, N}$
Class: Anvelopa GSN
Extreme 1D: Member



Spoj stup-greda izvodi se sukladno pravilima struke, kao spoj pune nosivosti IH1.A, kao DSTV spoj br. 406. Puna računska nosivost spoja za pritezanje 100%:

$M_{y,Rd}$ = 20,3 kNm
$V_{z,Rd}$ = 103,7 kN

Rezne sile u čvoru

$M_{y,Ed}$ = 18,5 kNm (za GSN14, nema vlaka)
$V_{z,Ed}$ = 28,6 kN
N_{Ed} = 25,2 kN (vlak za GSN5, M_y = 3,5 kNm)

Provjera otpornosti vijaka na vlak

$F_{Ed/vijak} = M_{Ed} / 2e = 18{,}5 / (2 \cdot 0{,}09) = 102{,}7$ kN po vijku → mjerodavno
$F_{Ed/vijak} = M_{Ed} / 2e + N_{Ed} / 4 = 3{,}5 / (2 \cdot 0{,}09) + 25{,}2 / 4 = 25{,}7$ kN po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2} = 141{,}3 / 1{,}25 = 113$ kN
113 kN > $F_{Ed/vijak}$ = 102,7 kN → zadovoljava (91%)

Provjera otpornosti vijaka na posmik

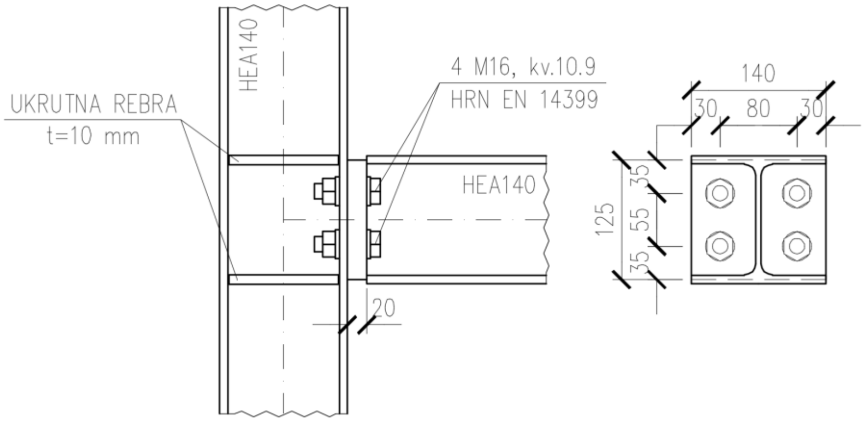
$F_{Ed/vijak} = V_{Ed} / 4 = 28{,}6 / 4 = 7{,}2$ kN po vijku

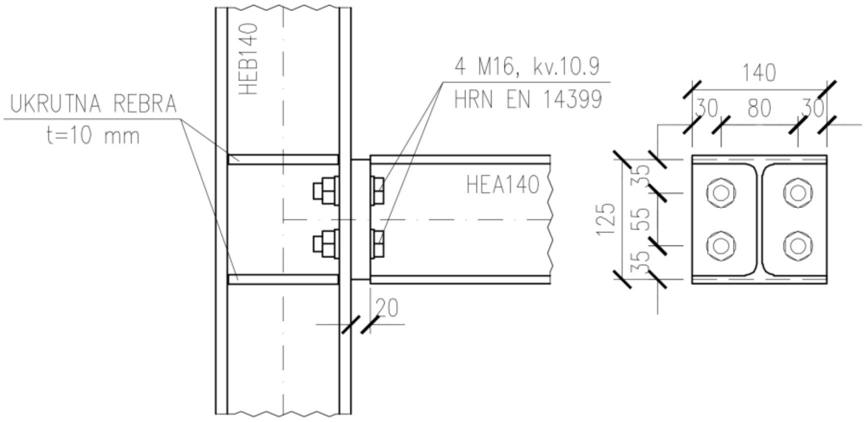
$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 78{,}5 / 1{,}25 = 62{,}8$ kN
62,8 kN > $F_{Ed/vijak}$ = 7,2 kN → zadovoljava (11%)

S obzirom na minimalni iznos poprečne sile u čvoru te debljinu čeone ploče, pritisak po omotaču rupe nije mjerodavan te se neće dodatno provjeravati.

Geometrija spoja

Vijci	4 M16, kv. 10.9, **vijke pritegnuti na 100%**
Čeona ploča	t = 20 mm, S355J2
Ukrutna rebra	t = 10 mm, S355J2
Zavari	a_w = 4 mm (pojas), a_w = 4 mm (hrbat)

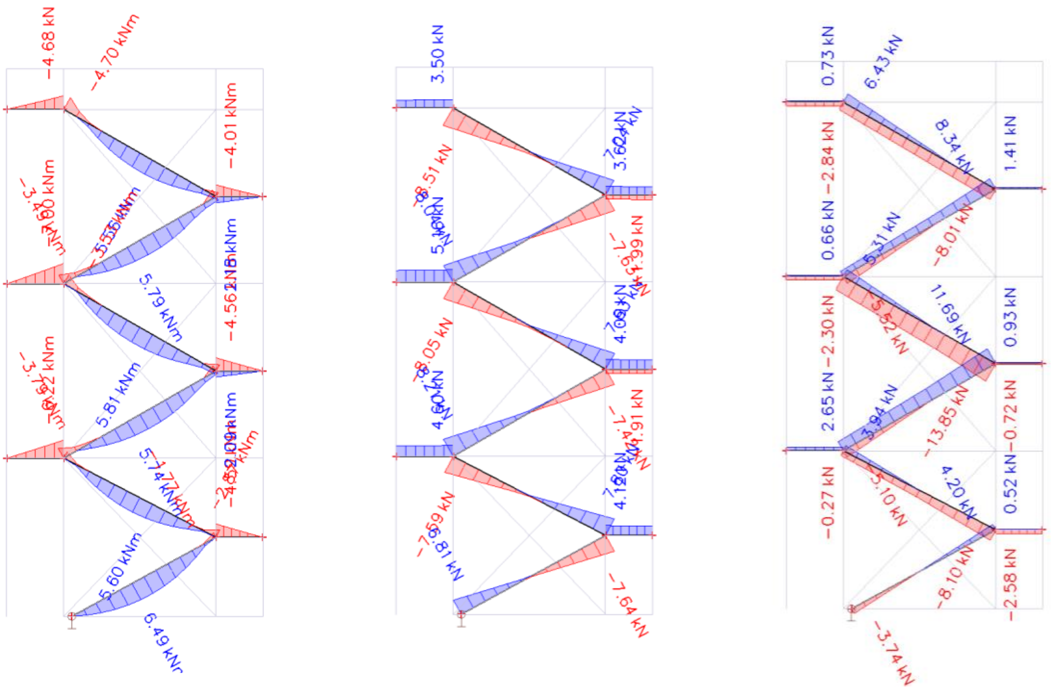




Spoj tetiva - greda (D3)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti tetiva s podestom.

Values: **M_y, V_z, N**
Class: Anvelopa GSN
Extreme 1D: Member



Tetiva i podest izvode se kao jedan sklop, zavareno, koji se polaže na grede okvira. Spoj s gredom ostvaruje se vijčanom vezom pojasnica profila UPE160 i HEA140, kako je prikazano u detalju.

Rezne sile u čvoru

$M_{y,Ed}$ = 7,0 kNm
$V_{z,Ed}$ = 8,5 kN
N_{Ed} = 13,9 kN

Provjera otpornosti vara

$a_w = 0,7 \cdot t_{min} = 0,7 \cdot 5,5 = 4$ mm
$L = 2 \cdot 70 + 2 \cdot 117 = 374$ mm

$\tau_{II} = V_{Ed} / 2a_w \cdot L = 8,5 \cdot 10^3 / 2 \cdot 4 \cdot 374 = 2,84$ N/mm²
$\tau_\perp = \sigma_\perp = \sigma_w / \sqrt{2} = 61,5 / \sqrt{2} = 43,5$ N/mm²

$\sigma_w = M / W_{el,w} = 7 \cdot 10^6 / 113900 = 61,5$ N/mm²
$W_{el,w} = W_{y,UPE160} = 113900$ mm³

$\sqrt{[\sigma_\perp^2 + 3 \cdot (\tau_\perp^2 + \tau_{II}^2)]} = \sqrt{[43,5^2 + 3 \cdot (43,5^2 + 2,84^2)]} = 87,1$ N/mm²
$f_u / (\beta_w \cdot \gamma_{M2}) = 360 / 0,8 \cdot 1,25 = 360$ N/mm²

87,1 N/mm² < 360 N/mm² → zadovoljava (24%)

Provjera otpornosti vijaka na posmik

$F_{v;Ed/vijak} = N_{Ed} / 2 = 13,9/2 = 7$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 75,4 / 1,25 = 60,3$ kN
60,3 kN > $F_{v;Ed/vijak}$ = 7 kN → zadovoljava (12%)

Provjera otpornosti ploče na pritisak po omotaču rupe

$F_{b,Rd} = (2,5 \cdot a \cdot f_u \cdot d \cdot t) / \gamma_{M2}$

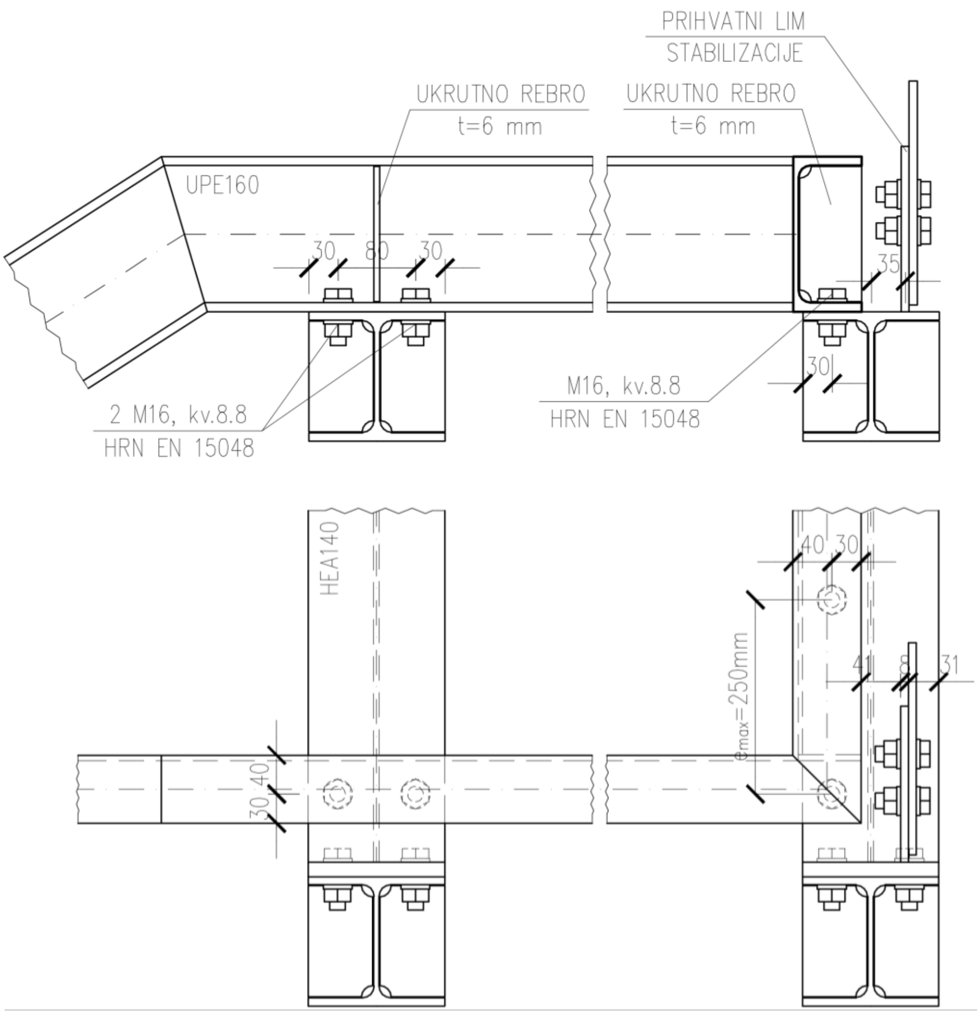
$a = \min \{ e_1/3d_0 ; f_{ub} / f_u ;1\} = \min \{ 30/3 \cdot 18 ; 80/36 ;1\} = 0,56$

$F_{b,Rd} = (2,5 \cdot 0,56 \cdot 36 \cdot 1,6 \cdot 0,85) / 1,25 = 54,8$ kN

$54,8$ kN $> F_{v;Ed/vijak} = 7$ kN → zadovoljava (13%)

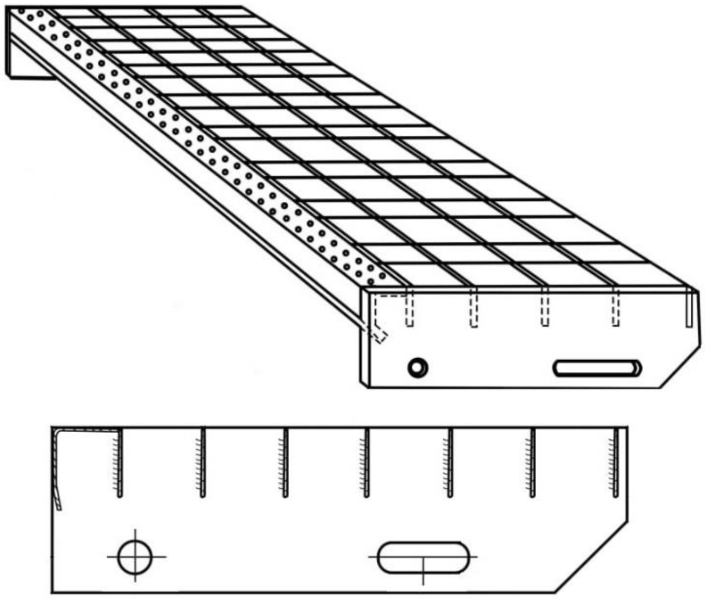
Geometrija spoja

Vijci	2 M16, kv. 8.8
Ukrutna rebra	t = 6 mm (UPE160), S355J2
Zavari	$a_w = 0,7t = 4$ mm



Spoj gazište - tetiva

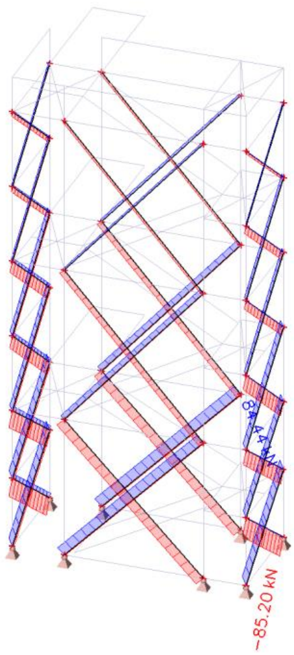
Spoj rešetkastog gazišta i tetive izvodi se vijčanom vezom hrpta tetive s tipskim limom zavarenim na rešetkasto gazište. Karakteristični detalj prikazan je u nastavku.



Detalj stabilizacije (D4)

U nastavku je dan grafički prikaz maksimalne uzdužne sile u stabilizaciji za anvelopu graničnog stanja nosivosti.

Values: **N**
Class: Anvelopa GSN
Extreme 1D: Global



Provjera otpornosti vara

$a_w = 4$ mm
$L = 4 \cdot 80 = 320$ mm

$F_{w,Rk} = (f_u \cdot a \cdot L) / (\beta_w \sqrt{3}) = (51 \cdot 0,4 \cdot 32) / (0,9 \cdot \sqrt{3}) = 418,8$ kN

$F_{w,Rd} = F_{w,Rk} / \gamma_{M2} = 418,8 / 1,25 = 335$ kN

335 kN > N_{Ed} = 85,2 kN → zadovoljava (25%)

Provjera otpornosti vijaka na posmik

$F_{v;Ed/vijak} = N_{Ed} / 2 = 85,2/2 = 42,6$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 75,4 / 1,25 = 60,3$ kN

60,3 kN > $F_{v;Ed/vijak}$ = 42,6 kN → zadovoljava (71%)

Provjera otpornosti ploče na pritisak po omotaču rupe

$F_{b,Rd} = (2,5 \cdot a \cdot f_u \cdot d \cdot t) / \gamma_{M2}$

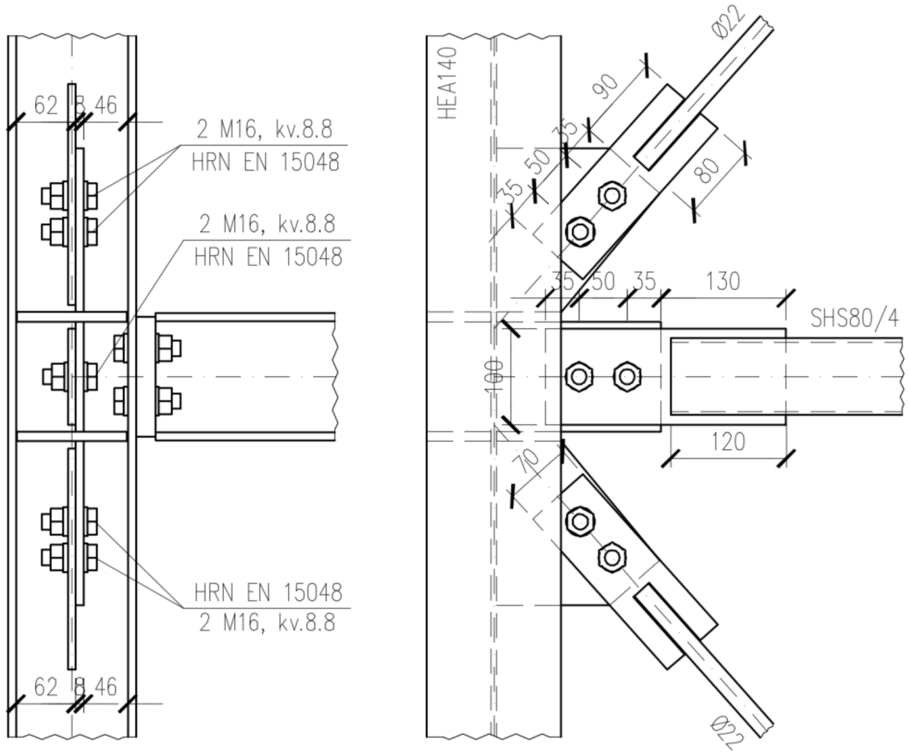
$a = \min \{ e_1/3d_0 ; f_{ub} / f_u ; 1\} = \min \{ 35/3 \cdot 18 ; 100/51 ; 1\} = 0,65$

$F_{b,Rd} = (2,5 \cdot 0,65 \cdot 51 \cdot 1,6 \cdot 0,8) / 1,25 = 84,9$ kN

84,9 kN > $F_{v;Ed/vijak}$ = 42,6 kN → zadovoljava (50%)

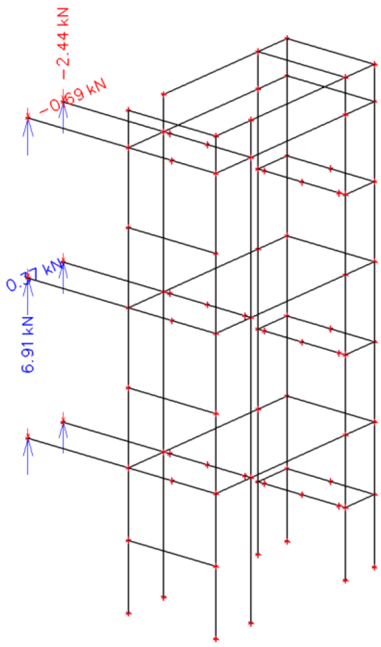
Geometrija spoja stabilizacije

Vijci	2 M16, kv. 8.8
Prihvatni limovi	t = 8 mm, S355J2
Zavari	a_w = 4 mm



Detalj bočnog prihvata na objekt (D5)

U nastavku je dan grafički prikaz maksimalnih reakcija bočnog prihvata na objekt za anvelopu graničnog stanja nosivosti. Bočni prihvati oblikovani su tako da ne prenose moment savijanja ni uzdužnu silu na objekt.



Bočni prihvat izvodi se kliznom vijčanom vezom grede stubišta sa prethodno ubetoniranim sidrenim sklopom. Sidreni sklop izvodi se od 2 lima debljine 15 mm, profila HEA 140 te istake za nasjedanje grede. Na istaci je potrebno predvidjeti šlic rupu u uzdužnom smjeru, kako je prikazano detaljem u nastavku.

Rezne sile u čvoru

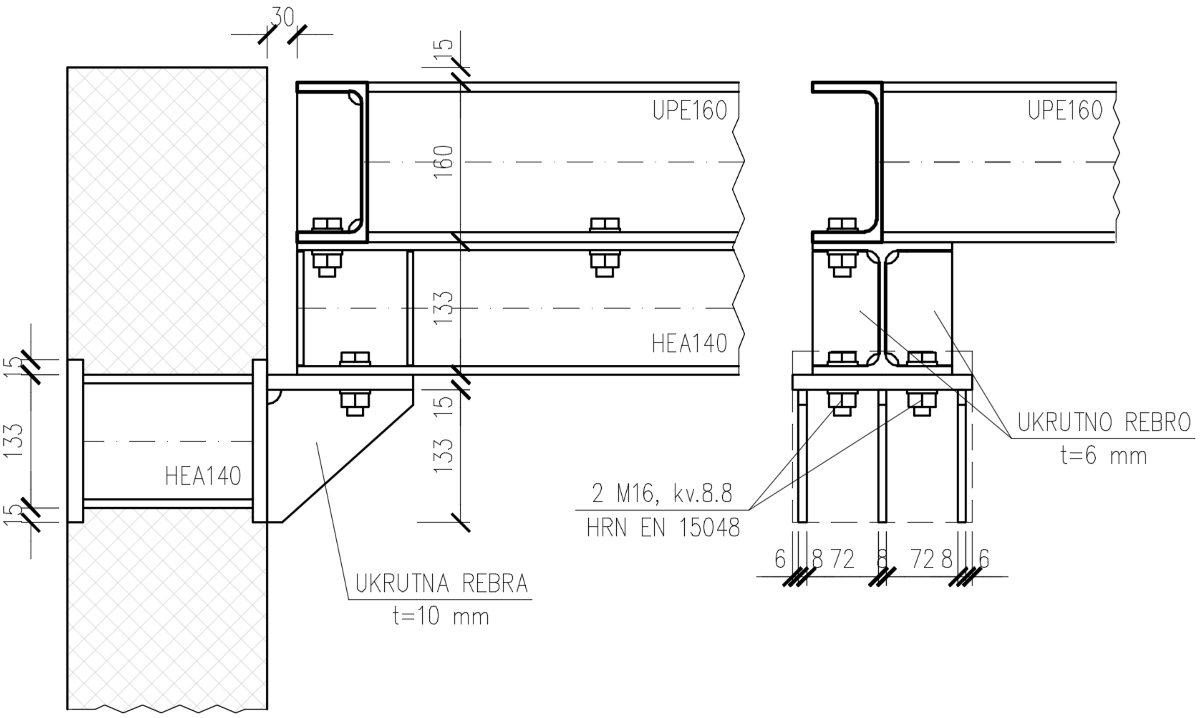
$V_{Ed,z}$ = 6,9 kN

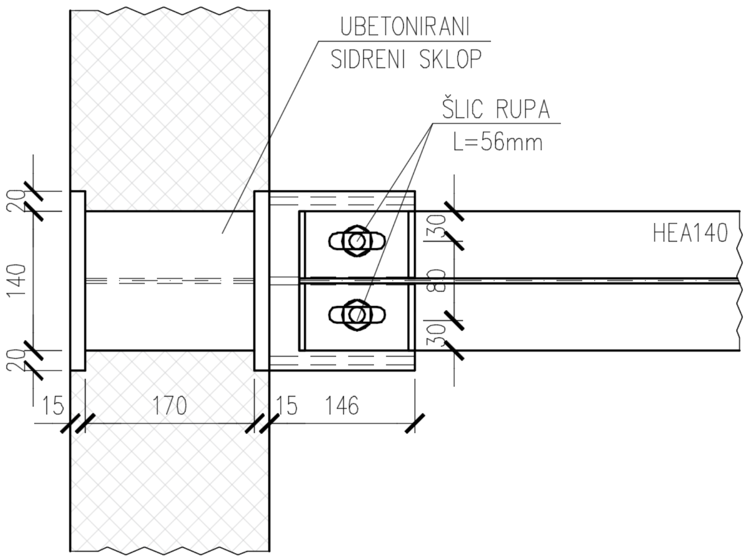
$V_{Ed,y}$ = 0,7 kN

S obzirom na minimalne iznose reznih sila, spoj se izvodi isključivo konstruktivno te se neće dodatno provjeravati.

Geometrija spoja

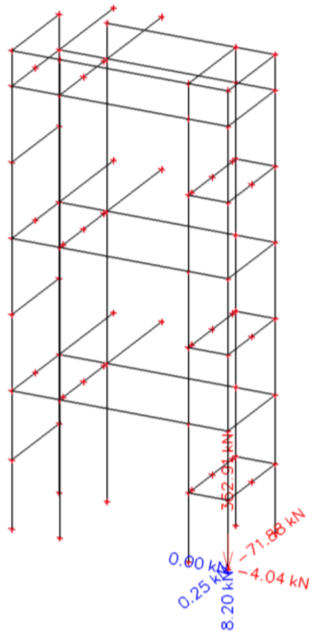
Vijci	2 M16, kv. 8.8
Trn	HEA 140, S355J2
Čeone ploče	t = 15 mm, S355J2
Istaka	t = 15 mm, S355J2
Ukrutna rebra	t = 8 mm, S355J2
Zavari	a_w = 4 mm (pojas), a_w = 4 mm (hrbat)





Detalj sidrenja stupova (D6)

U nastavku je dan grafički prikaz reakcija konstrukcije za mjerodavnu kombinaciju GSN6.



Sidrenje stupova izvodi se prethodno ubetoniranim sidrenim sklopovima koji se sastoje od šablon ploče debljine 15 mm te 4 M20 navojne šipke kvalitete 8.8. Minimalna udaljenost sidra od ruba betona iznosi 90 mm. Dimenzije temelja prilagoditi navedenom. Beton se izvodi minimalno kao C25/30. Prilikom betoniranja potrebno je poravnati gornje lice šablon ploče s licem betona.

Rezne sile u čvoru

N_{Ed} = 352,9 kN (vlak)
V_{Ed} = 71,9 kN

Provjera otpornosti sidara na posmik

$V_{Ed/vijak} = V_{Ed} /4 = 71,9 / 4 = 18$ kN / po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 117,6 / 1,25 = 94,1$ kN
94,1 kN > $N_{Ed/vijak}$ = 18 kN → zadovoljava (19%)

Provjera pritiska na beton preko vijaka

$A = d \cdot 3d = 2 \cdot 3 \cdot 2 = 12$ cm^2
$\sigma_b = V_{Ed/vijak} / A = 18 / 12 = 1,50$ kN/cm^2

$\sigma_{dop} = f_{ck} /1,5 = 2,5/1,5 = 1,67$ kN/cm^2 > σ_b = 1,50 kN/cm^2 → zadovoljava (90%)

Provjera otpornosti sidara na vlak

$N_{Ed/vijak} = N_{Ed} /4 = 352,9 / 4 = 88,2$ kN / po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2} = 176,4 / 1,25 = 141,1$ kN
141,1 kN > $N_{Ed/vijak}$ = 88,2 kN → zadovoljava (63%)

Provjera otpornosti na čupanje

$\sigma_b = N_{Ed/vijak} / (d \cdot \pi \cdot L) = 88{,}2 / (2{,}0 \cdot \pi \cdot 70) = 0{,}20$ kN/cm^2
$\tau_{dop} = 0{,}27$ kN/cm^2

$0{,}27$ kN/cm$^2 > \sigma_b = 0{,}20$ kN/cm^2 → zadovoljava (74%)

Kako bi se povećala otpornost sidrenog elementa na čupanje, odnosno smanjio utjecaj na beton, na dnu je potrebno izvesti kontrapločice dimenzija 100/100/15 mm (vidi shemu).

Provjera pritiska na beton preko kontraploče

$A = 10 \cdot 10 = 100$ cm^2
$\sigma_b = N_{Ed/vijak} / A = 88{,}2/100 = 0{,}88$ kN/cm^2

$\sigma_{dop} = f_{ck} / 1{,}5 = 2{,}5/1{,}5 = 1{,}67$ kN/cm$^2 > \sigma_b = 0{,}88$ kN/cm^2 → zadovoljava (53%)

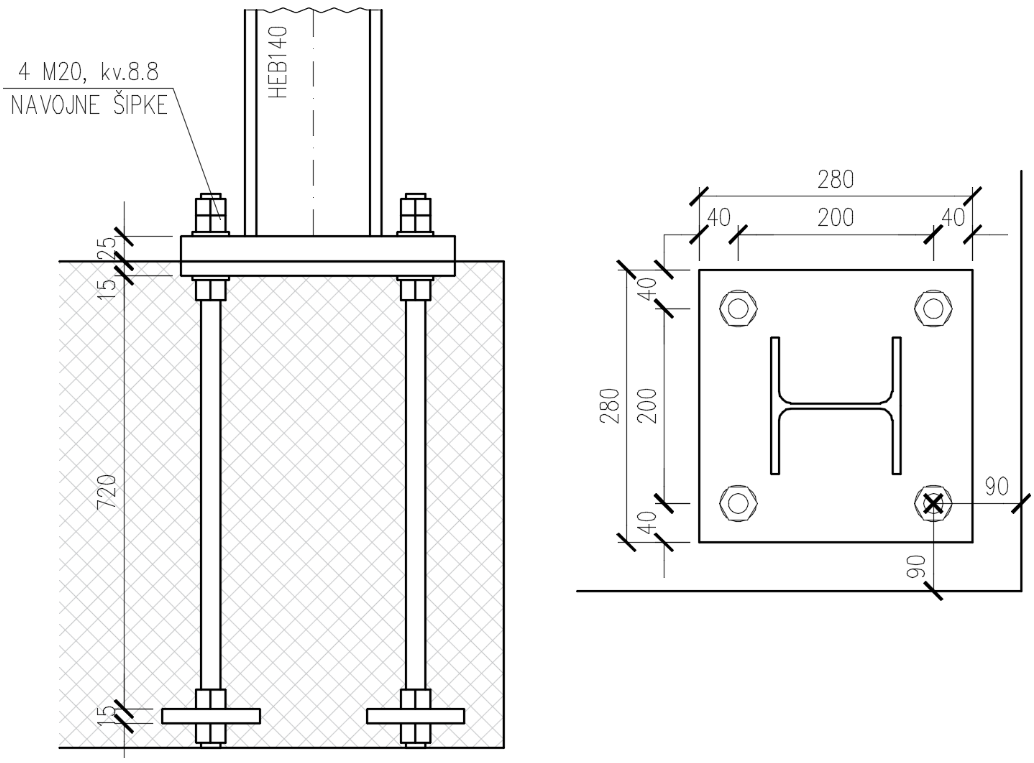
Provjera interakcije vlaka i posmika na vijke

$F_{v,Ed} / F_{v,Rd} + F_{t,Ed} / (1{,}4 \cdot F_{t,Rd}) = 18 / 94{,}1 + 88{,}2 / (1{,}4 \cdot 176{,}4) = 0{,}55 < 1{,}0$

Geometrija spoja

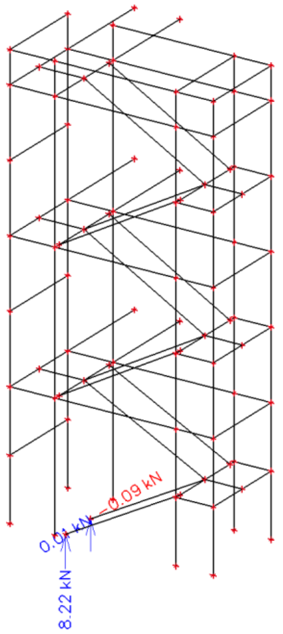
Vijci	4 M20, kv. 8,8, koristiti 2 matice, bez pritezanja
Čeona ploča	t = 25 mm, S355J2
Šablon ploča	t = 15 mm, S355J2
Kontrapločice	t = 15 mm, S355J2
Zavari	a_w = 4 mm (pojas), a_w = 4 mm (hrbat)

Za visinsko pozicioniranje šablon ploče i kontrapločica koristiti matice s pripadnim podložnim pločicama.

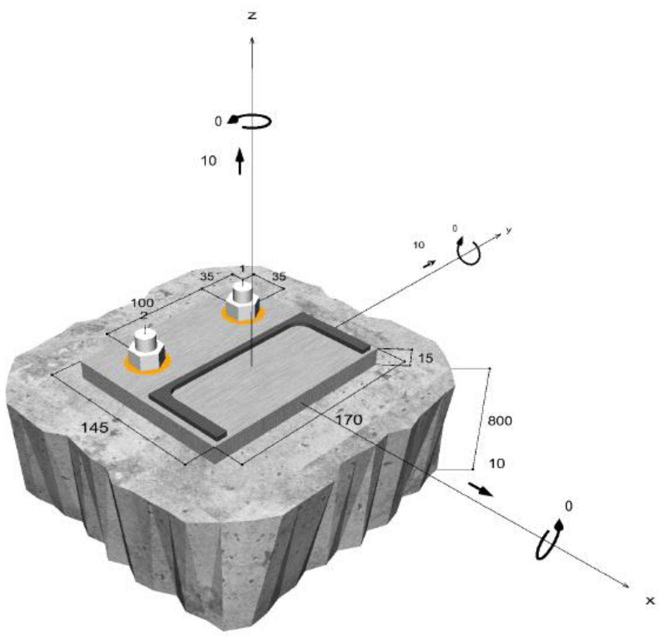


Detalj sidrenja tetiva

U nastavku je dan grafički prikaz reakcija tetive za anvelopu graničnog stanja nosivoti, nakon čega slijedi proračun sidrenja u programskom paketu C-FIX. Sidrenje tetiva izvodi se kemijskim sidrenjem sidara M20, kvalitete 8.8. Kemija kao Fischer FIS V ili jednakovrijedna.



S obzirom na minimalne iznose reakcija tetiva, sidrenje se izvodi konstruktivno. U uzdužnom smjeru (smjeru pružanja tetive) potrebno je predvidjeti šlic rupe duljine 40 mm.



Input data

Design method	Design Method EN1992-4:2018 bonded fastener
Base material	C25/30, EN 206
Concrete condition	Non-cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	Hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap filled
Type of loading	Permanent-Transient/Static
Base plate location	Base plate flush installed on base material
Base plate geometry	Polygon
Profile type	UPE 160

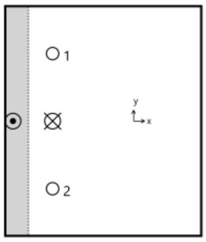
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	10.00	10.00	10.00	0.00	0.00	0.00	Permanent-Transient/Static

*) The required partial safety factors for actions are included

Resulting anchor forces

Anchor no.	Tensile action kN	Shear Action kN	Shear Action x kN	Shear Action y kN
1	15.25	5.10	-1.00	5.00
2	15.25	12.08	11.00	5.00



max. concrete compressive strain :	0.45 ‰
max. concrete compressive stress :	14.0 N/mm²
Resulting tensile actions :	30.50 kN , X/Y position (-60 / 0)
Resulting compression actions :	20.50 kN , X/Y position (-89 / 0)

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N,s} = \beta_{N,s;2} = 0.18 \leq 1$$
$$\beta_{V,s} = \beta_{Vs;2} = 0.24 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;2}^2 + \beta_{Vs;2}^2 = 0.09 \leq 1$$

Eq. (7.55)

Proof successful

Utilisation concrete

$$\beta_{N,p} = \beta_{N,p;1} = 0.43 \leq 1$$
$$\beta_{V,cp} = \beta_{V,cp;1} = 0.18 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,p;1}^{1.5} + \beta_{V,cp;1}^{1.5} = 0.36 \leq 1$$

Eq. (7.56)

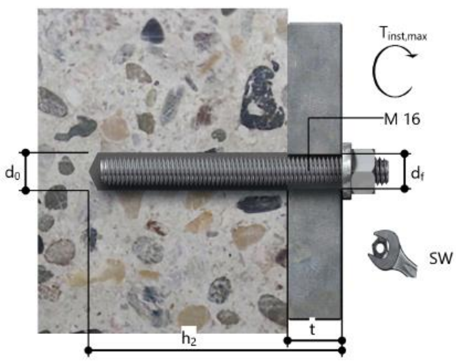
Installation data

Anchor

Anchor system	**fischer Injection system FIS V**	
Injection resin	FIS V 360 S (other cartridge sizes available)	Art.-No. 94405
Fixing element	Threaded rod FIS A M 16 x 200 8.8, zinc plated steel, Property Class 8.8	Art.-No. 517939
Accessories	FIS MR Plus	Art.-No. 545853
	FIS Extension tube 9mm	Art.-No. 48983
	Dispenser FIS DM S	Art.-No. 511118
	Compressed-air cleaning tool	Art.-No. 93286
	compressed air (oil-free), min. 6 bar	By job site.
	BSD 18	Art.-No. 1493
	SDS Chuck with internal thread M8	Art.-No. 530332
	Quattric II 18/200/250	Art.-No. 549956
	or alternatively	
	FHD 18/320/450	Art.-No. 546600
	Hammer drilling with or without suction	

Installation details

Thread diameter	M 16
Drill hole diameter	d_0 = 18 mm
Drill hole depth	h_2 = 165 mm
Calculated anchorage depth	h_{ef} = 150 mm
Drilling method	Hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap filled
Maximum torque	$T_{inst,max}$ = 60.0 Nm
Socket size	24 mm
Base plate thickness	t = 15 mm
Total fixing thickness Tfix,max	t_{fix} = 15 mm
Volume of resin per drill hole	20 ml/10 scale divisions

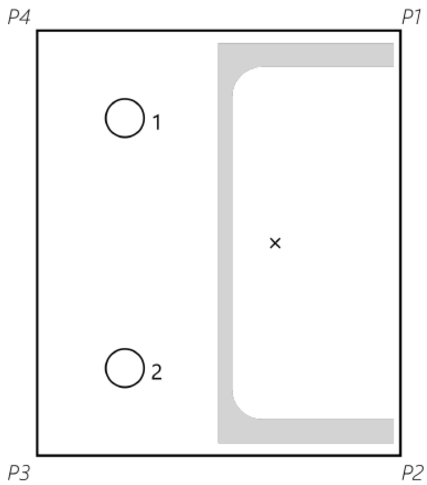


Base plate details

Base plate material	S 355 (St 52)
Base plate thickness	t = 15 mm
Clearance hole in base plate	d_f=20 mm

Attachment

Profile type	UPE 160



Anchor coordinates

Anchor no.	x mm	y mm
1	-60	50
2	-60	-50

Base plate coordinates

Point	x mm	y mm
P1	50	85
P2	50	-85
P3	-95	-85
P4	-95	85

Specifikacija osnovnog materijala

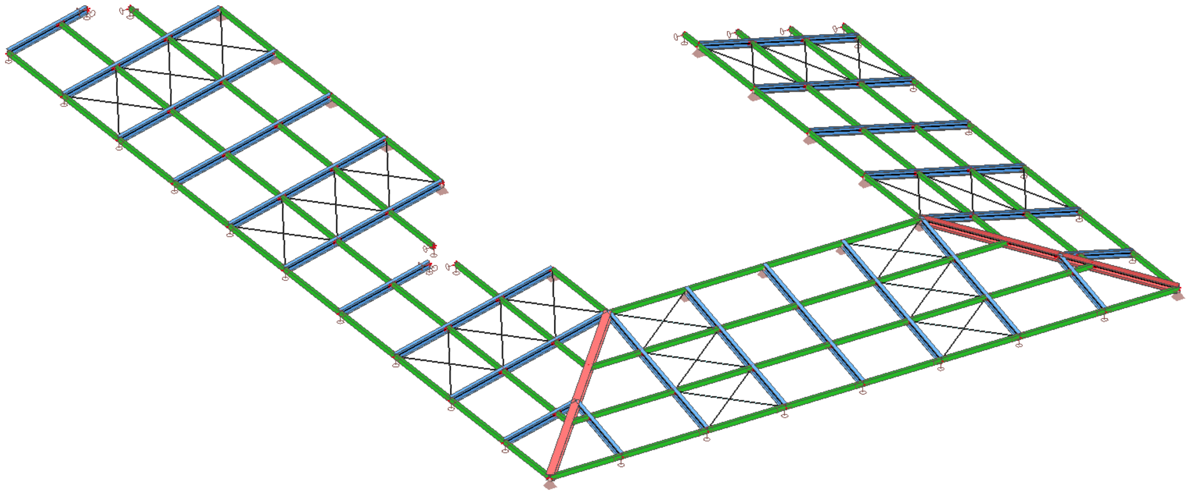
Cross-section	Material	Length [m]	Unit mass [kg/m]	Mass [kg]	Surface [m²]	Volume [m³]
CS1 - HEB140	S 355	31.200	33.7	1052.2	25.116	1.3404e-01
CS2 - HEA140	S 355	138.120	24.6	3404.5	109.667	4.3370e-01
CS3 - UPE160	S 235	58.785	17.0	1001.4	34.019	1.2756e-01
CS4 - RRK80/80/4	S 235	72.700	9.2	670.6	22.246	8.5422e-02
CS5 - RD22	S 355	194.065	3.0	578.8	13.377	7.3733e-02
Total		**494.870**		**6707.4**	**204.426**	**8.5445e-01**

NAPOMENA: Specifikacija je dobivena iz statičkog modela, odnosno na temelju osnih dužina elemenata te može služiti isključivo kao orijentacijska vrijednost za izradu troškovnika. Stvarnu težinu konstrukcije potrebno je uvećati cca 10% (zavari, limovi i spojna sredstva).

1.3. Proračun čelične konstrukcije krovišta

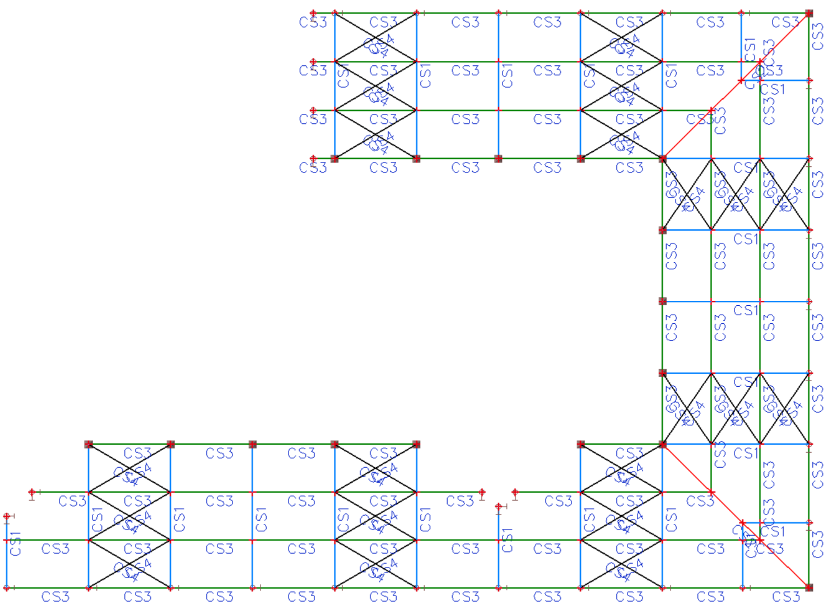
U nastavku je proveden kontrolni proračun čelične nosive konstrukcije krovišta Centra za pružanje usluga u zajednici Tereza u Obrovcu, nakon čega slijedi proračun priključaka osnovne nosive konstrukcije.

Prostorni prikaz konstrukcije



Poprečni presjeci u konstrukciji

Name	Type	Item material	Fabrication	A [m²]	A_y [m²]	I_y [m⁴]	$W_{el.y}$ [m³]	$W_{pl.y}$ [m³]	Colour
	Detailed				A_z [m²]	I_z [m⁴]	$W_{el.z}$ [m³]	$W_{pl.z}$ [m³]	
CS1	IPE240	S 355	rolled	3.9100e-03	2.4663e-03	3.8920e-05	3.2400e-04	3.6700e-04	
					1.5146e-03	2.8400e-06	4.7300e-05	7.3900e-05	
CS2	HEA240	S 355	rolled	7.6800e-03	5.6329e-03	7.7600e-05	6.7500e-04	7.4583e-04	
					1.8411e-03	2.7700e-05	2.3100e-04	3.5167e-04	
CS3	RRK150/100/4	S 235	cold formed	1.8950e-03	7.9194e-04	5.9500e-06	7.9300e-05	9.5700e-05	
					1.1577e-03	3.1900e-06	6.3700e-05	7.2500e-05	
CS4	RD12	S 355	rolled	1.1304e-04	1.0171e-04	9.9655e-10	1.6609e-07	2.8346e-07	
					1.0171e-04	9.9655e-10	1.6609e-07	2.8346e-07	



Oslonci konstrukcije

Svi nosivi elementi konstrukcije modelirani su kao proste grede, oslonjeni zglobno s jedne strane (nema prijenosa momenta savijanja), odnosno klizno s druge strane (nema prijenosa momenta i uzdužne sile).

Djelovanja na konstrukciju

Djelovanja na konstrukciju preuzeta su iz Glavnog projekta koji je izradio projektantski ured KONUS d.o.o. (projektant Vice Tadić, dipl.ing.građ., oznaka projekta 148/2019 GL-K).

Stalno opterećenje $g = 0{,}70$ kN/m^2
Uporabno opterećenje $q = 1{,}00$ kN/m^2
Opterećenje snijegom $s_k = 0{,}75$ kN/m^2
Opterećenje vjetrom $v_b = 35$ m/s

Opterećenje snijegom sukladno normi HRN EN 1991-1-3.

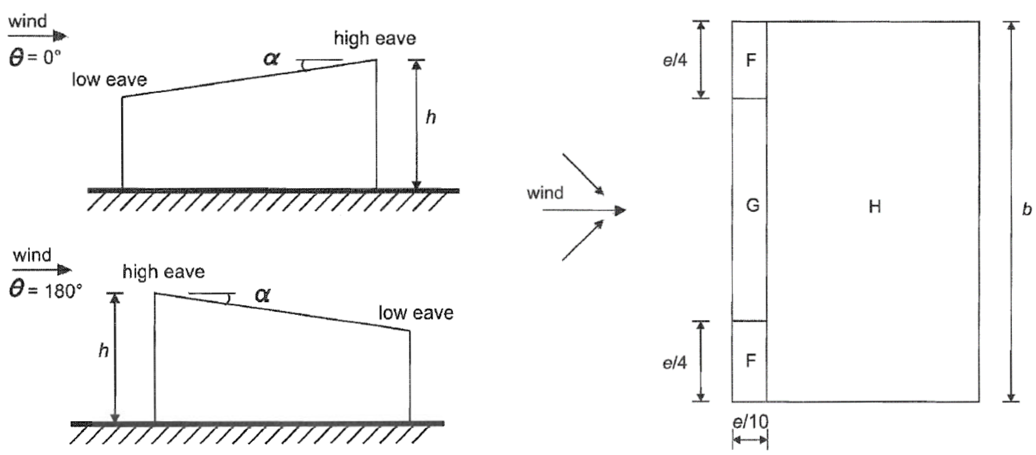
Karakteristično opterećenje snijegom na tlu $s_k = 0{,}75$ kN/m^2
Koeficijent umanjenja za nagib α < 30° $\mu_i = 0{,}8$
Opterećenje snijegom na konstrukciju $s_1 = 0{,}75 \cdot 0{,}8 = 0{,}60$ kN/m^2

Opterećenje vjetrom sukladno normi EN 1991-1-4, točka 7.2.4. djelovanje krova na jednostrešne krovove.

Srednja brzina vjetra (okomito na plohu) $v_{b,0} = 35$ m/s
Kategorija terena: II (izolirane prepreke) Ce(z=17 m) = 2,7
Referentni pritisak srednje brzine vjetra $q_b = 0{,}77$ kN/m^2
Koeficijenti unutarnjeg tlaka $c_{pi} = +0{,}2 / -0{,}3$

Vjetar puše slijeva/zdesna;

Pitch Angle α	Zone for wind direction θ = 0°						Zone for wind direction θ = 180°					
	F		G		H		F		G		H	
	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5°	-1,7	-2,5	-1,2	-2,0	-0,6	-1,2	-2,3	-2,5	-1,3	-2,0	-0,8	-1,2
	+0,0		+0,0		+0,0							
15°	-0,9	-2,0	-0,8	-1,5	-0,3		-2,5	-2,8	-1,3	-2,0	-0,9	-1,2
	+0,2		+0,2		+ 0,2							

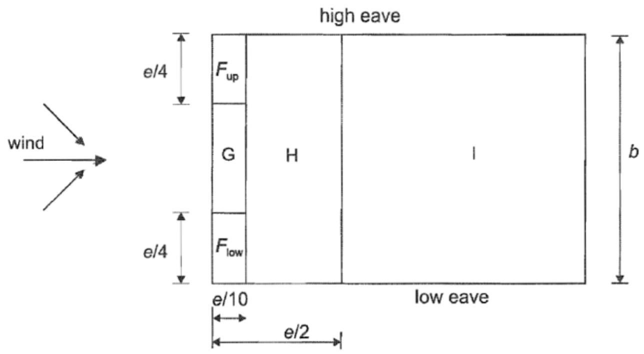


e = min [b;2h] = min [33 m; 2 · 16,9] = 33,0 m
e/10 = 33/10 = 3,3 m

Pritiskajući vjetar smjer x: w_0 = (0,2 + 0,2) · 2,7 · 0,77 = +0,83 kN/m^2
$w_{180,F}$ = (-2,5 + 0,2) · 2,7 · 0,77 = -4,78 kN/m^2
$w_{180,H}$ = (-0,9 + 0,2) · 2,7 · 0,77 = -1,46 kN/m^2

Odižući vjetar smjer x: $w_{0,F}$ = (-0,9 - 0,3) · 2,7 · 0,77 = -2,49 kN/m^2
$w_{0,H}$ = (-0,3 - 0,3) · 2,7 · 0,77 = -1,25 kN/m^2
$w_{180,F}$ = (-2,5 -0,3) · 2,7 · 0,77 = -5,82 kN/m^2
$w_{180,H}$ = (-0,9 -0,3) · 2,7 · 0,77 = -2,49 kN/m^2

Pitch Angle α	Zone for wind direction θ = 90°									
	F_{up}		F_{low}		G		H		I	
	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5°	-2,1	-2,6	-2,1	-2,4	-1,8	-2,0	-0,6	-1,2	-0,5	
15°	-2,4	-2,9	-1,6	-2,4	-1,9	-2,5	-0,8	-1,2	-0,7	-1,2



e = min [b;2h] = min [33 m; 2 · 16,9] = 33,0 m
e/10 = 33/10 = 3,3 m
e/2 = 33/2 = 15,0 m

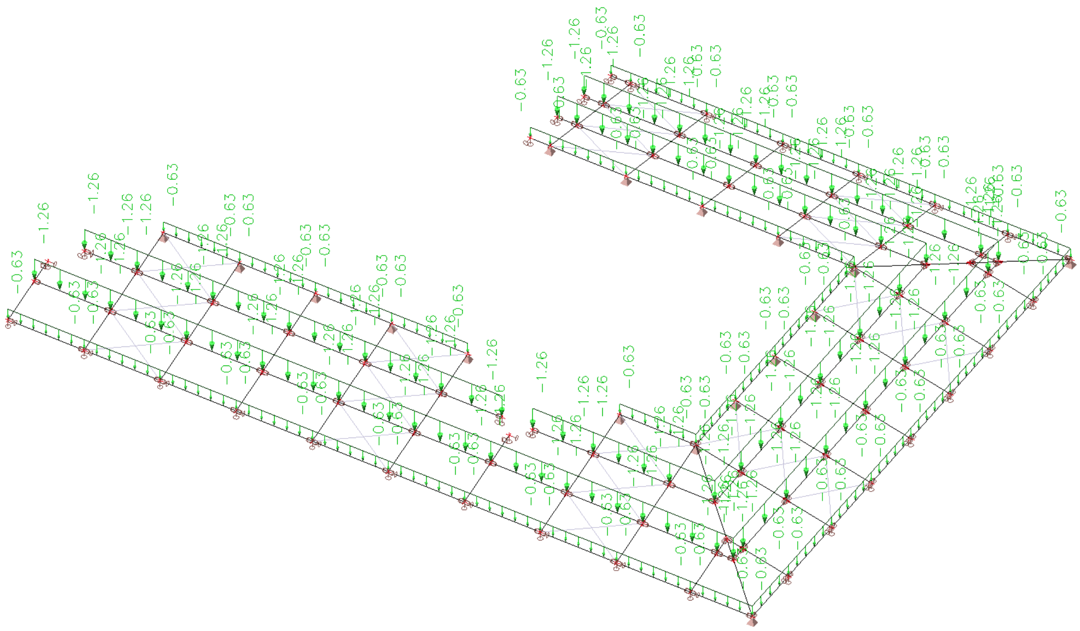
Pritiskajući vjetar smjer y: w = (0,0 + 0,2) · 2,7 · 0,77 = +0,42 kN/m^2

Odižući vjetar smjer y: $w_{90,F}$ = (-2,4 - 0,3) · 2,7 · 0,77 = -5,61 kN/m^2
$w_{90,H}$ = (-0,8 - 0,3) · 2,7 · 0,77 = -2,29 kN/m^2

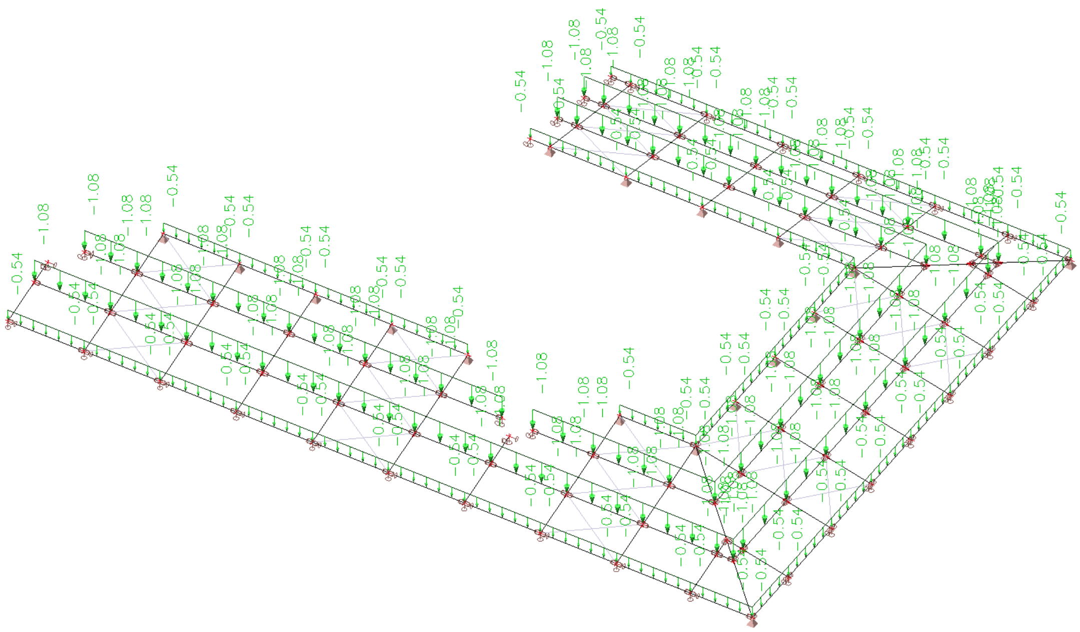
Shematski prikaz djelovanja na konstrukciju (vlastita težina uzeta automatski):

Name	Description	Load type	Action type	Load group	Spec	Duration
LC1	Vlastita tezina	Self weight	Permanent	LG1		
LC2	Stalno	Standard	Permanent	LG1		
LC3	Snijeg	Static	Variable	LG2	Standard	Medium
LC4	Korisno	Static	Variable	LG2	Standard	Medium
LC5	Vjetar pritisak +X	Static	Variable	LG3	Standard	Short
LC6	Vjetar odizanje +X	Static	Variable	LG3	Standard	Short
LC7	Vjetar pritisak -X	Static	Variable	LG3	Standard	Medium
LC8	Vjetar odizanje -X	Static	Variable	LG3	Standard	Medium
LC9	Vjetar pritisak Y	Static	Variable	LG3	Standard	Medium
LC10	Vjetar odizanje Y	Static	Variable	LG3	Standard	Medium

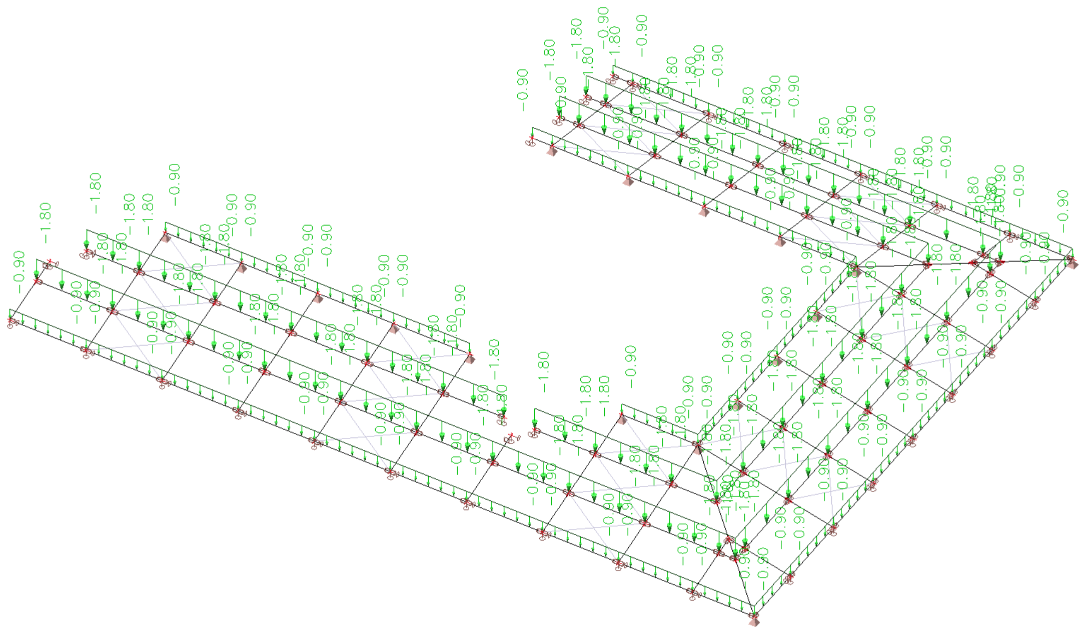
Name	Description	Load type	Action type	Load group
LC2	Stalno	Standard	Permanent	LG1



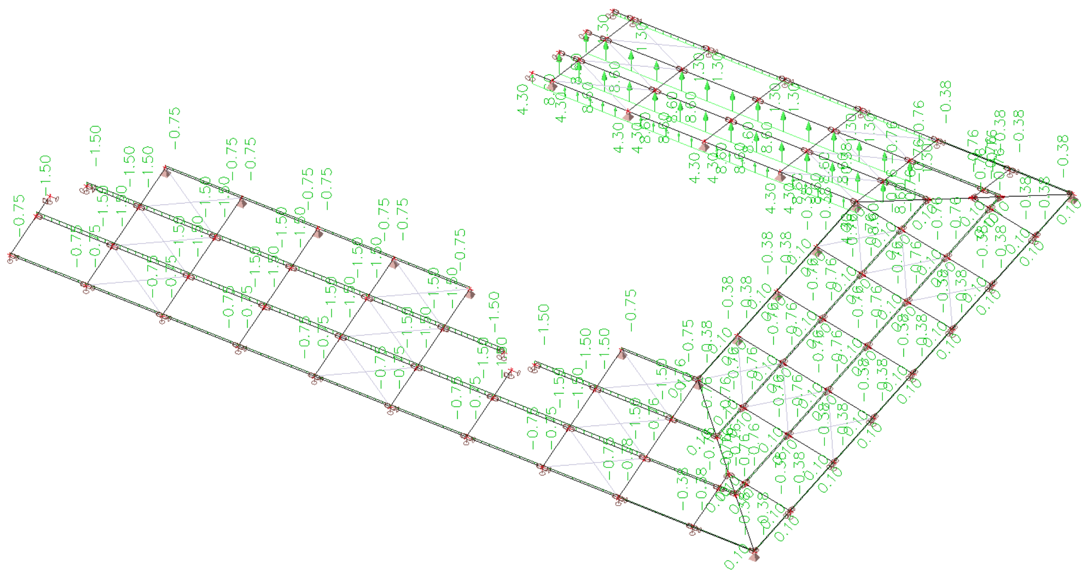
Name	Description	Load type	Action type	Load group	Spec	Duration
LC3	Snijeg	Static	Variable	LG2	Standard	Medium



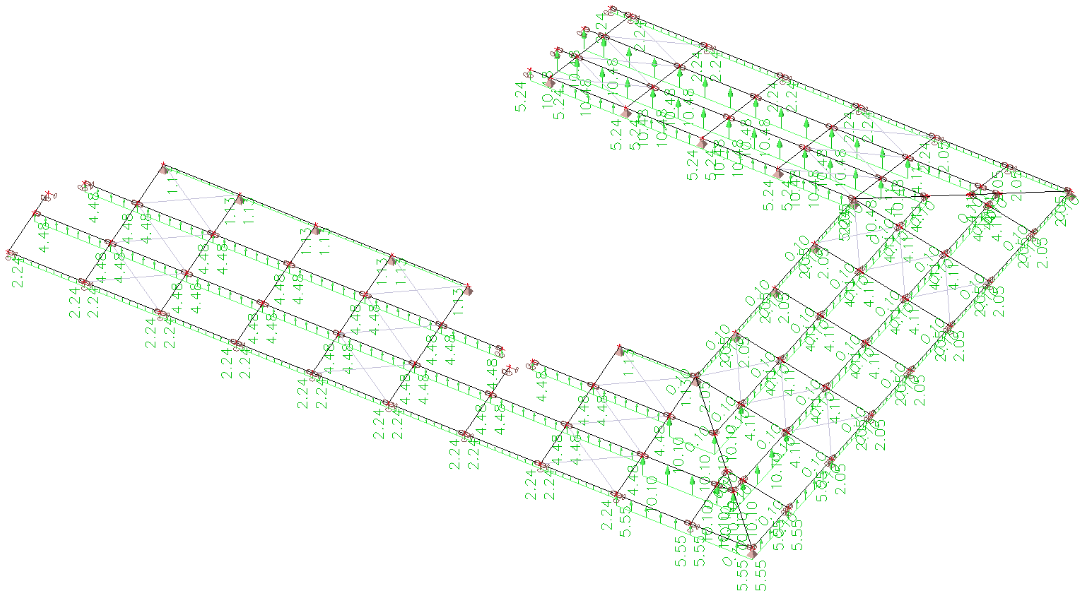
Name	Description	Load type	Action type	Load group	Spec	Duration
LC4	Korisno	Static	Variable	LG2	Standard	Medium



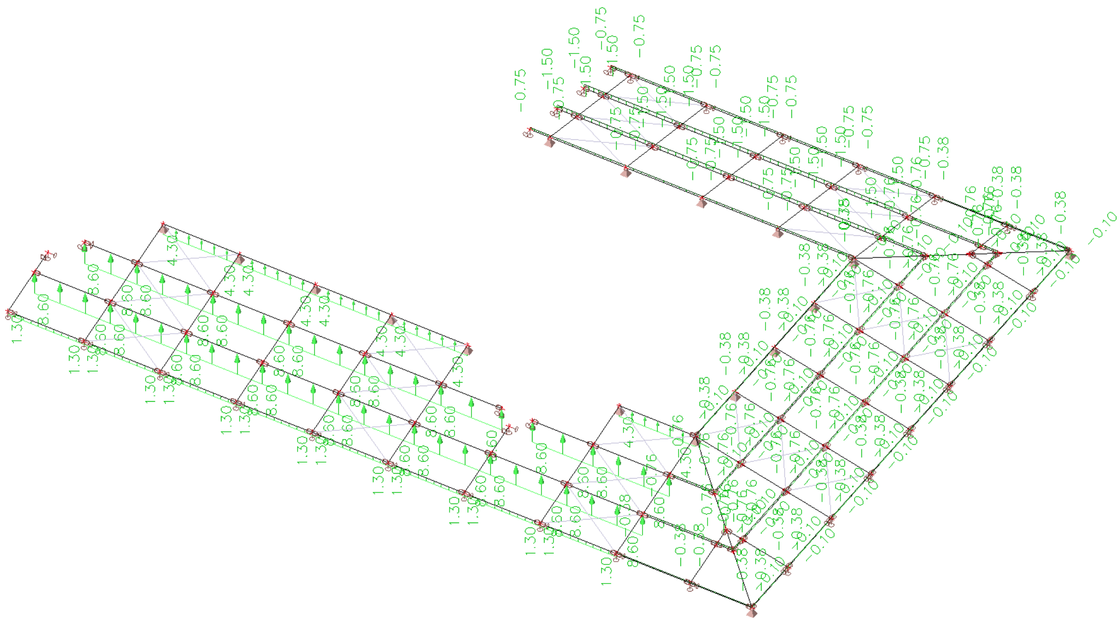
Name	Description	Load type	Action type	Load group	Spec	Duration
LC5	Vjetar pritisak +X	Static	Variable	LG3	Standard	Short



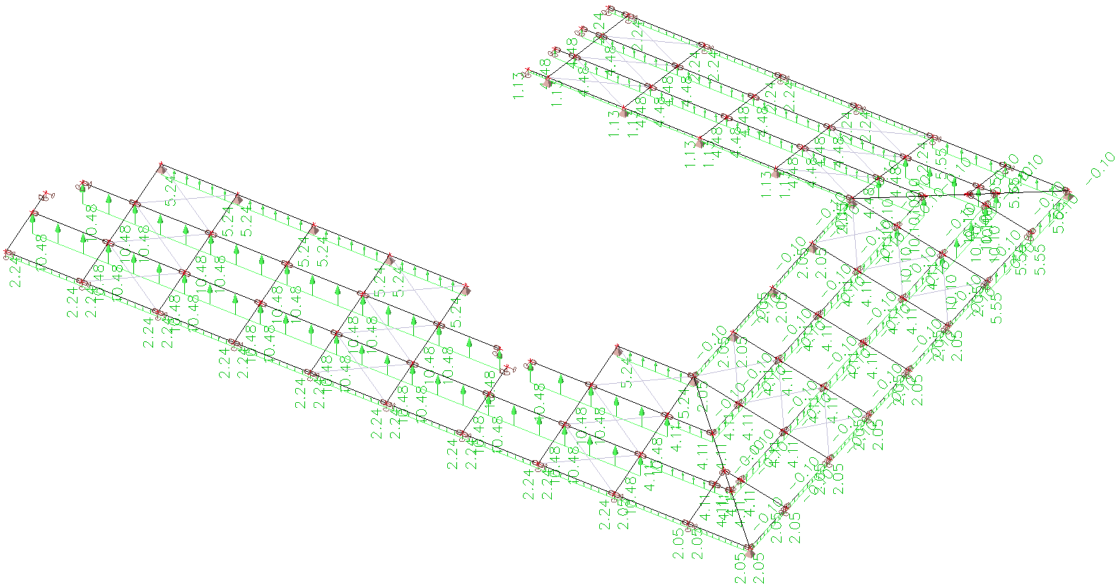
Name	Description	Load type	Action type	Load group	Spec	Duration
LC6	Vjetar odizanje +X	Static	Variable	LG3	Standard	Short



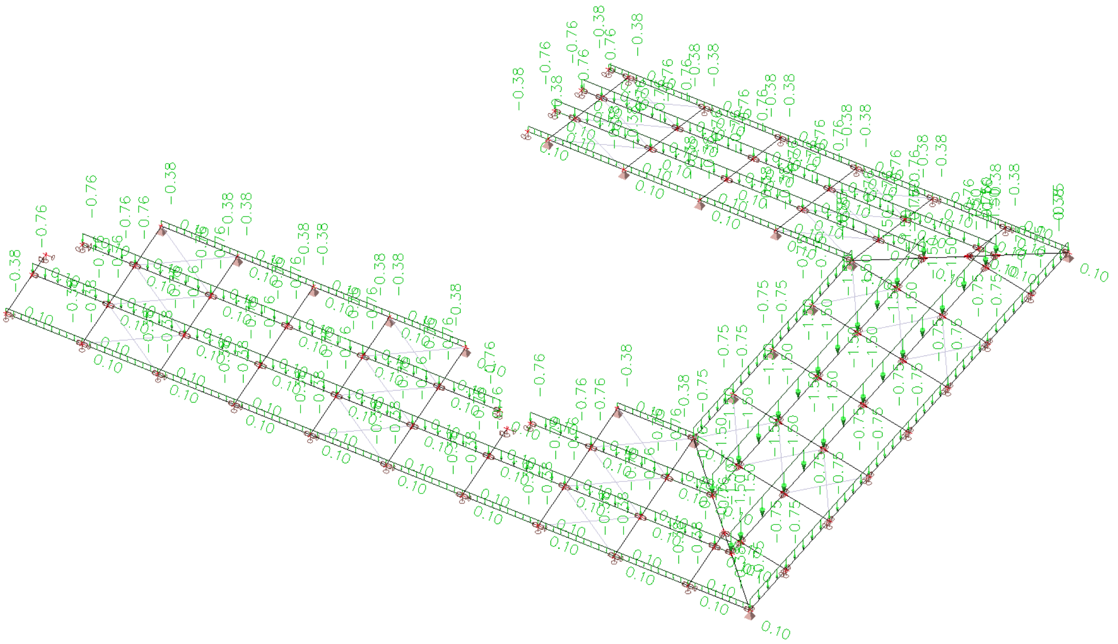
Name	Description	Load type	Action type	Load group	Spec	Duration
LC7	Vjetar pritisak -X	Static	Variable	LG3	Standard	Medium



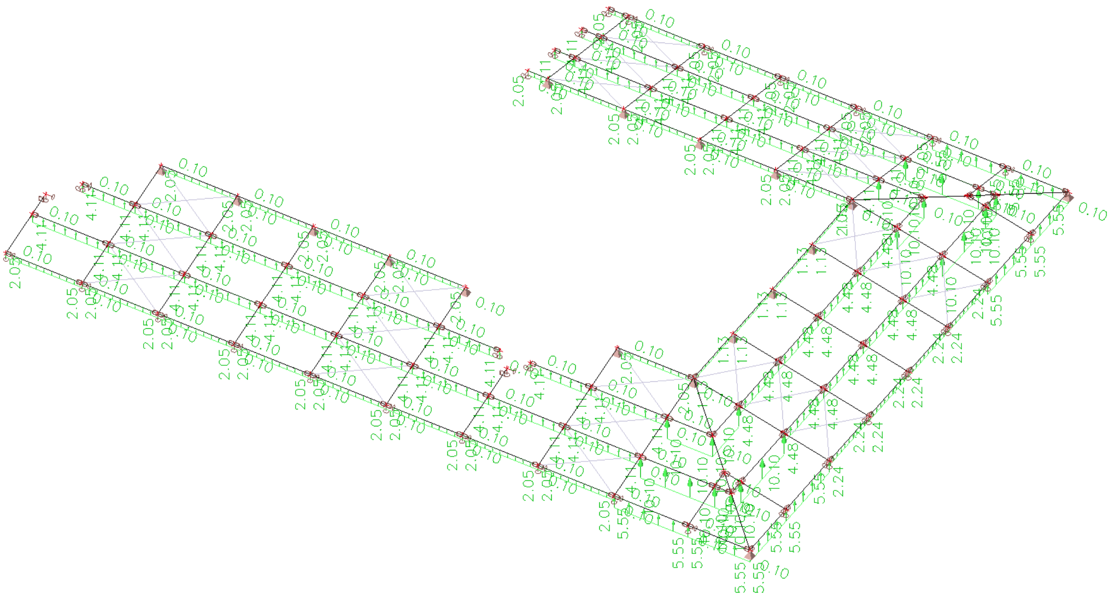
Name	Description	Load type	Action type	Load group	Spec	Duration
LC8	Vjetar odizanje -X	Static	Variable	LG3	Standard	Medium



Name	Description	Load type	Action type	Load group	Spec	Duration
LC9	Vjetar pritisak Y	Static	Variable	LG3	Standard	Medium



Name	Description	Load type	Action type	Load group	Spec	Duration
LC10	Vjetar odizanje Y	Static	Variable	LG3	Standard	Medium



Kombinacije djelovanja na konstrukciju

Name	Description	Type	Load cases	Coeff. [-]
GSN1		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
GSN2		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.50
GSN3		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC5 - Vjetar pritisak +X	1.50
GSN4		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC7 - Vjetar pritisak -X	1.50
GSN5		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC9 - Vjetar pritisak Y	1.50
GSN6		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC6 - Vjetar odizanje +X	1.50
GSN7		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC8 - Vjetar odizanje -X	1.50
GSN8		Envelope - ultimate	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	0.90
			LC10 - Vjetar odizanje Y	1.50
GSN9		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC4 - Korisno	1.05
GSN10		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC5 - Vjetar pritisak +X	0.90
GSN11		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC7 - Vjetar pritisak -X	0.90
GSN12		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	1.50
			LC9 - Vjetar pritisak Y	0.90
GSN13		Envelope - ultimate	LC1 - Vlastita tezina	1.35

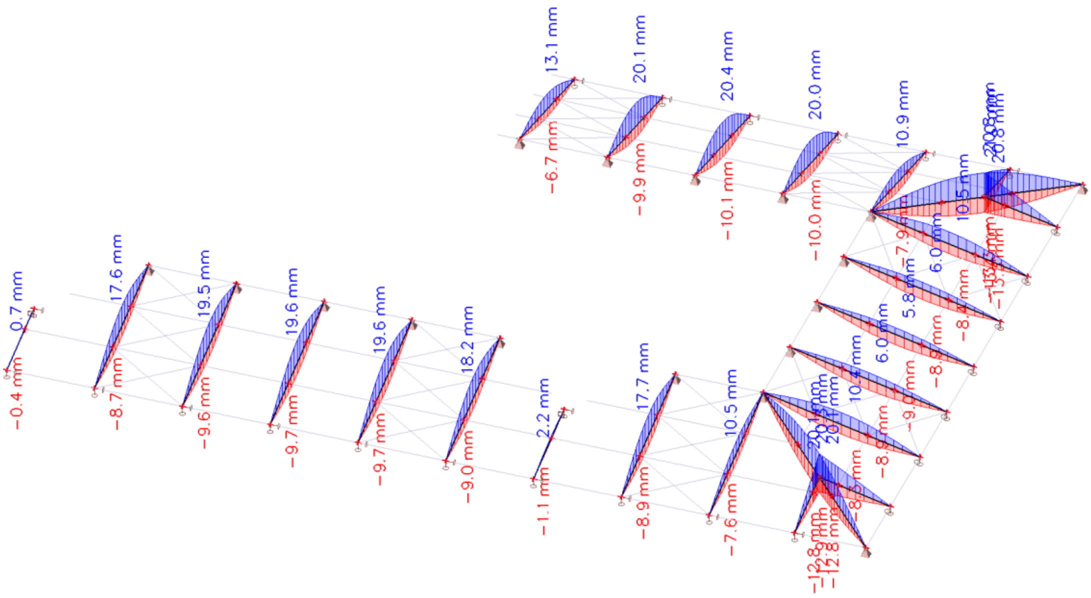
Name	Description	Type	Load cases	Coeff. [-]
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC4 - Korisno	1.50
GSN14		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.50
			LC5 - Vjetar pritisak +X	0.90
GSN15		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.50
			LC8 - Vjetar odizanje -X	0.90
GSN16		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.50
			LC9 - Vjetar pritisak Y	0.90
GSN17		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC5 - Vjetar pritisak +X	1.50
GSN18		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.05
			LC5 - Vjetar pritisak +X	1.50
GSN19		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC7 - Vjetar pritisak -X	1.50
GSN20		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.05
			LC7 - Vjetar pritisak -X	1.50
GSN21		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC3 - Snijeg	0.75
			LC9 - Vjetar pritisak Y	1.50
GSN22		Envelope - ultimate	LC1 - Vlastita tezina	1.35
			LC2 - Stalno	1.35
			LC4 - Korisno	1.05
			LC9 - Vjetar pritisak Y	1.50
GSU1		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
GSU2		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	1.00
GSU3		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC5 - Vjetar pritisak +X	1.00
GSU4		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC7 - Vjetar pritisak -X	1.00
GSU5		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC9 - Vjetar pritisak Y	1.00
GSU6		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC6 - Vjetar odizanje +X	1.00
GSU7		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC8 - Vjetar odizanje -X	1.00
GSU8		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC10 - Vjetar odizanje Y	1.00
GSU9		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC4 - Korisno	0.70
GSU10		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC5 - Vjetar pritisak +X	0.60
GSU11		Envelope - serviceability	LC1 - Vlastita tezina	1.00

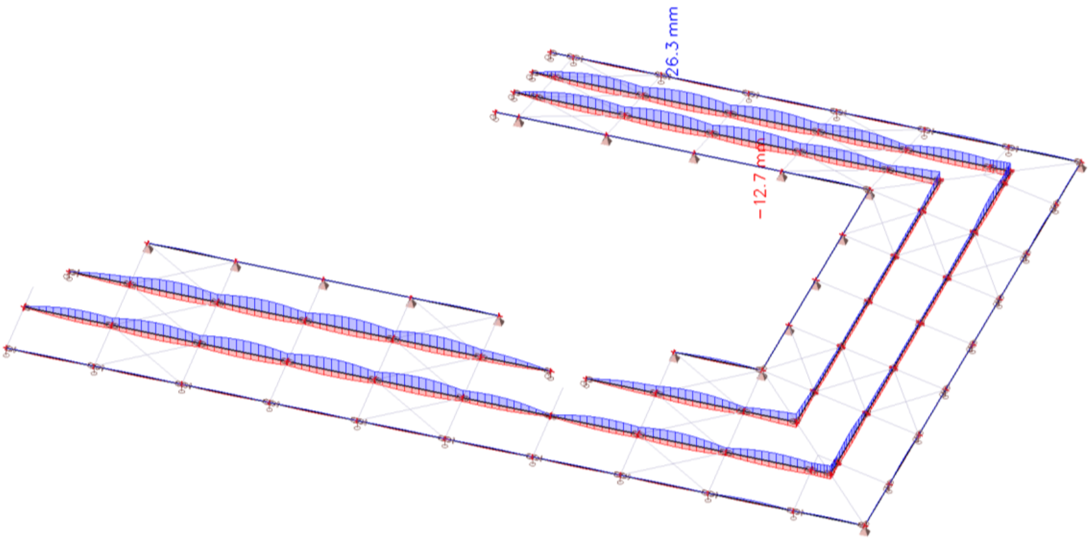
Name	Description	Type	Load cases	Coeff. [-]
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC7 - Vjetar pritisak -X	0.60
GSU12		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	1.00
			LC9 - Vjetar pritisak Y	0.60
GSU13		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC4 - Korisno	1.00
GSU14		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	1.00
			LC5 - Vjetar pritisak +X	0.60
GSU15		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	1.00
			LC7 - Vjetar pritisak -X	0.60
GSU16		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	1.00
			LC9 - Vjetar pritisak Y	0.60
GSU17		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC5 - Vjetar pritisak +X	1.00
GSU18		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	0.70
			LC5 - Vjetar pritisak +X	1.00
GSU19		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC7 - Vjetar pritisak -X	1.00
GSU20		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	0.70
			LC7 - Vjetar pritisak -X	1.00
GSU21		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC3 - Snijeg	0.50
			LC9 - Vjetar pritisak Y	1.00
GSU22		Envelope - serviceability	LC1 - Vlastita tezina	1.00
			LC2 - Stalno	1.00
			LC4 - Korisno	0.70
			LC9 - Vjetar pritisak Y	1.00

Pomaci i deformacije konstrukcije

U nastavku je dan grafički prikaz maksimalnih deformacija konstrukcije za anvelopu graničnog stanja uporabivosti.

Values: **u_z**
Class: Anvelopa GSU





Maksimalni progib grebene grede u_{max} = 20,8 mm < u_{dop} = L/250 = 7800/250 = 31,2 mm
Maksimalni progib krovnog nosača u_{max} = 20,4 mm < u_{dop} = L/250 = 5600/250 = 22,4 mm
Maksimalni relativni progib podrožnice u_{max} = 26,3 - 20,1 = 6,2 mm < u_{dop} = L/200 = 3080/200 = 15,4 mm

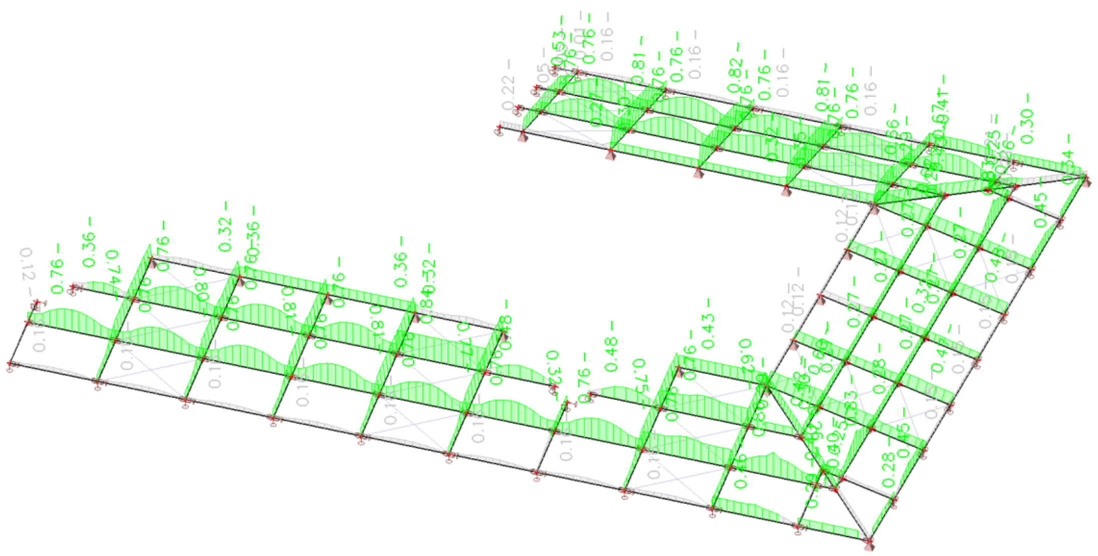
Rezne sile u konstrukciji

U nastavku je dan tablični prikaz maksimalnih reznih sila po tipu poprečnog presjeka za anvelopu GSN. Detaljan grafički prikaz reznih sila u pojedinim konstrukcijskim elementima dan je u točki 1.4. Proračun priključaka.

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B55	3.759+	GSN6/1	CS1 - IPE240	**-10.62**	-0.07	**42.95**	0.00	-78.76	0.02
B57	1.880-	GSN6/1	CS1 - IPE240	**10.66**	-0.01	-42.92	**0.00**	-79.19	-0.02
B12	1.886+	GSN8/2	CS1 - IPE240	-3.41	**-5.64**	14.10	0.00	-9.60	**3.87**
B7	1.854+	GSN8/2	CS1 - IPE240	-3.54	**5.79**	14.37	0.00	-9.62	**-3.90**
B56	1.880-	GSN6/1	CS1 - IPE240	10.42	-0.01	**-42.95**	0.00	**-80.07**	-0.03
B56	2.820-	GSN20/3	CS1 - IPE240	0.00	-0.01	0.00	0.00	**35.49**	0.03
B11	5.214+	GSN8/2	CS2 - HEA240	**-9.10**	0.01	32.43	0.00	-82.06	-0.04
B11	2.607-	GSN8/2	CS2 - HEA240	**9.36**	-0.02	-27.01	0.00	-69.96	-0.05
B52	3.643+	GSN22/4	CS2 - HEA240	2.20	**-0.04**	-2.81	0.00	50.83	0.14
B52	3.643-	GSN22/4	CS2 - HEA240	-3.39	**0.05**	8.38	0.00	50.83	0.14
B52	2.626-	GSN7/5	CS2 - HEA240	8.73	-0.02	**-27.45**	0.00	-71.54	-0.06
B52	5.251+	GSN7/5	CS2 - HEA240	-8.72	0.01	**33.10**	0.00	-83.86	-0.03
B11	5.214+	GSN4/6	CS2 - HEA240	2.33	0.03	-10.53	**-0.04**	15.86	-0.07
B52	5.251+	GSN3/7	CS2 - HEA240	2.25	-0.02	-10.78	**0.04**	15.99	0.08
B52	3.643-	GSN7/5	CS2 - HEA240	7.17	-0.04	-18.35	0.00	**-97.64**	-0.09
B52	3.643-	GSN16/8	CS2 - HEA240	-3.49	0.04	8.58	0.00	**51.89**	0.11
B11	3.555-	GSN20/3	CS2 - HEA240	-3.12	-0.03	5.78	-0.04	37.65	**-0.12**
B52	3.643+	GSN18/9	CS2 - HEA240	1.80	-0.04	-4.91	0.04	38.25	**0.14**
B38	0.000	GSN22/4	CS3 - RRK150/100/4	**-4.52**	0.00	7.39	0.73	0.00	0.00
B38	3.000	GSN8/2	CS3 - RRK150/100/4	**7.79**	0.00	20.81	-1.37	0.00	0.00
B29	0.000	GSN7/5	CS3 - RRK150/100/4	0.00	**-0.21**	-11.06	-1.28	0.16	**0.63**
B30	0.000	GSN7/5	CS3 - RRK150/100/4	0.06	0.00	**-22.24**	-1.41	0.00	0.00
B30	3.080	GSN7/5	CS3 - RRK150/100/4	0.06	0.00	**22.24**	-1.41	0.00	0.00
B69	0.000	GSN6/1	CS3 - RRK150/100/4	0.00	0.00	-4.54	**-5.88**	0.00	0.00
B39	0.000	GSN6/1	CS3 - RRK150/100/4	0.00	0.00	-4.62	**5.78**	0.00	0.00
B30	1.540-	GSN7/5	CS3 - RRK150/100/4	0.06	0.00	0.00	-1.41	**-17.12**	0.00
B28	0.000	GSN7/5	CS3 - RRK150/100/4	0.00	**0.16**	-13.32	-0.21	**7.22**	-0.09
B29	0.000	GSN18/9	CS3 - RRK150/100/4	0.00	0.08	4.82	0.29	-0.06	**-0.26**
B135	0.000	GSN22/4	CS4 - RD12	**-1.54**	0.00	0.00	0.00	0.00	0.00
B135	3.608	GSN7/5	CS4 - RD12	**1.65**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Rezultati dimenzioniranja konstrukcije

U nastavku je dan grafički prikaz iskorištenosti elemenata konstrukcije za anvelopu graničnog stanja nosivosti, nakon čega slijedi detaljan postupak dimenzioniranja za kritični element po tipu poprečnog presjeka.



Dimenzioniranje krovnog nosača IPE 240

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

Member B56	1.880 / 5.639 m	IPE240	S 355	Anvelopa GSN	0.82 -

Combination key
Anvelopa GSN / LC1 + 0.90*LC2 + 1.50*LC6

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	355.0	MPa
Ultimate strength f_u	490.0	MPa
Fabrication	Rolled	

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

The critical check is on position 1.880 m

Internal forces	Calculated	Unit
N_{Ed}	-0.07	kN
$V_{y,Ed}$	0.00	kN
$V_{z,Ed}$	0.28	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	-80.01	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 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	42	10	2.368e+05	2.372e+05	1.0	0.4	1.0	4.3	7.3	8.1	11.2	1
3	SO	42	10	2.364e+05	2.360e+05	1.0	0.4	1.0	4.3	7.3	8.1	11.2	1
4	I	190	6	1.957e+05	-1.957e+05	-1.0		0.5	30.7	58.6	67.4	100.5	1
5	SO	42	10	-2.367e+05	-2.371e+05								
7	SO	42	10	-2.364e+05	-2.360e+05								

The cross-section is classified as Class 1

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

A	3.9100e-03	m²
$N_{c,Rd}$	1388.05	kN
Unity check	0.00	-

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

$W_{pl,y}$	3.6700e-04	m³
$M_{pl,y,Rd}$	130.28	kNm
Unity check	0.61	-

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

$W_{pl,z}$	7.3900e-05	m³
$M_{pl,z,Rd}$	26.23	kNm
Unity check	0.00	-

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

η	1.20	
A_v	2.4834e-03	m²
$V_{pl,y,Rd}$	509.00	kN
Unity check	0.00	-

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

η	1.20	
A_v	1.9128e-03	m²
$V_{pl,z,Rd}$	392.04	kN
Unity check	0.00	-

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

$M_{pl,y,Rd}$	130.28	kNm
α	2.00	
$M_{pl,z,Rd}$	26.23	kNm
β	1.00	

Unity check (6.41) = 0.38 + 0.00 = 0.38 -

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

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	42	10	1.826e+03	9.358e+02	0.5	0.7	1.0	4.3	7.3	8.1	14.1	1
3	SO	42	10	2.596e+03	3.486e+03	0.7	0.5	1.0	4.3	7.3	8.1	11.5	1
4	I	190	6	2.283e+03	2.976e+03	0.8		1.0	30.7	26.8	30.9	37.0	2
5	SO	42	10	3.434e+03	4.324e+03	0.8	0.4	1.0	4.3	7.3	8.1	11.4	1
7	SO	42	10	2.664e+03	1.774e+03	0.7	0.6	1.0	4.3	7.3	8.1	13.0	1

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	5.639	1.880	m
Buckling factor k	1.00	0.85	
Buckling length l_{cr}	5.639	1.591	m
Critical Euler load N_{cr}	2536.73	2325.44	kN
Slenderness λ	56.52	59.03	
Relative slenderness λ_{rel}	0.74	0.77	
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 & 6.3.2.2 and formula (6.54)

LTB parameters		
Method for LTB curve	General case	
Plastic section modulus $W_{pl,y}$	3.6700e-04	m^3
Elastic critical moment M_{cr}	228.85	kNm
Relative slenderness $\lambda_{rel,LT}$	0.75	
Limit slenderness $\lambda_{rel,LT,0}$	0.20	
LTB curve	a	
Imperfection α_{LT}	0.21	
Reduction factor χ_{LT}	0.82	
Design buckling resistance $M_{b,Rd}$	97.20	kNm
Unity check	0.82	-

Mcr parameters		
LTB length l_{LT}	1.880	m
Influence of load position	no influence	
Correction factor k	1.00	
Correction factor k_w	1.00	
LTB moment factor C_1	1.00	
LTB moment factor C_2	0.00	
LTB moment factor C_3	1.00	
Shear center distance d_z	0	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_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 area A	3.9100e-03	m^2
Plastic section modulus $W_{pl,y}$	3.6700e-04	m^3
Plastic section modulus $W_{pl,z}$	7.3900e-05	m^3
Design compression force N_{Ed}	0.07	kN
Design bending moment (maximum) $M_{y,Ed}$	-80.04	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0.03	kNm
Characteristic compression resistance N_{Rk}	1388.05	kN
Characteristic moment resistance $M_{y,Rk}$	130.28	kNm
Characteristic moment resistance $M_{z,Rk}$	26.23	kNm
Reduction factor χ_y	1.00	
Reduction factor χ_z	1.00	
Reduction factor χ_{LT}	0.82	
Interaction factor k_{yy}	1.00	
Interaction factor k_{yz}	1.13	
Interaction factor k_{zy}	0.52	
Interaction factor k_{zz}	0.99	

Maximum moment $M_{y,Ed}$ is derived from beam B56 position 1.880 m.
Maximum moment $M_{z,Ed}$ is derived from beam B56 position 1.880 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	2536.73	kN
Critical Euler load $N_{cr,z}$	2325.44	kN
Elastic critical load $N_{cr,T}$	2943.52	kN
Plastic section modulus $W_{pl,y}$	3.6700e-04	m^3
Elastic section modulus $W_{el,y}$	3.2400e-04	m^3
Plastic section modulus $W_{pl,z}$	7.3900e-05	m^3
Elastic section modulus $W_{el,z}$	4.7300e-05	m^3
Second moment of area I_y	3.8920e-05	m^4
Second moment of area I_z	2.8400e-06	m^4
Torsional constant I_t	1.2336e-07	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-80.04	kNm
Maximum relative deflection δ_z	33.8	mm
Equivalent moment factor $C_{my,0}$	1.00	

Interaction method 1 parameters		
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	0.95	
Equivalent moment factor $C_{mz,0}$	0.99	
Factor μ_y	1.00	
Factor μ_z	1.00	
Factor ε_y	14439.70	
Factor a_{LT}	1.00	
Critical moment for uniform bending $M_{cr,0}$	228.85	kNm
Relative slenderness $\lambda_{rel,0}$	0.75	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.20	
Equivalent moment factor C_{my}	1.00	
Equivalent moment factor C_{mz}	0.99	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor c_{LT}	0.79	
Factor d_{LT}	0.00	
Factor e_{LT}	2.10	
Factor w_y	1.13	
Factor w_z	1.50	
Factor n_{pl}	0.00	
Maximum relative slenderness $\lambda_{rel,max}$	0.77	
Factor C_{yy}	1.00	
Factor C_{yz}	0.60	
Factor C_{zy}	1.00	
Factor C_{zz}	1.00	

Unity check (6.61) = 0.00 + 0.82 + 0.00 = 0.82 -
Unity check (6.62) = 0.00 + 0.43 + 0.00 = 0.43 -

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	5.639	m
Web	unstiffened	
Web height h_w	220	mm
Web thickness t	6	mm
Material coefficient ε	0.81	
Shear correction factor η	1.20	

Shear Buckling verification	
Web slenderness h_w/t	35.55
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.

Dimenzioniranje grebenog nosača HEA 240

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

Member B52	**5.251 / 7.877 m**	**HEA240**	**S 355**	**Anvelopa GSN**	**0.43 -**

Combination key
Anvelopa GSN / LC1 + 0.90*LC2 + 1.50*LC8

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	355.0	MPa
Ultimate strength f_u	490.0	MPa
Fabrication	Rolled	

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

The critical check is on position 5.251 m

Internal forces	Calculated	Unit
N_{Ed}	-8.72	kN
$V_{y,Ed}$	0.01	kN
$V_{z,Ed}$	33.10	kN
T_{Ed}	0.00	kNm
$M_{y,Ed}$	-83.86	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 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	95	12	1.189e+05	1.190e+05	1.0	0.4	1.0	7.9	7.3	8.1	11.2	2
3	SO	95	12	1.188e+05	1.187e+05	1.0	0.4	1.0	7.9	7.3	8.1	11.2	2
4	I	164	8	8.970e+04	-8.743e+04	-1.0		0.5	21.9	57.2	65.9	98.1	1
5	SO	95	12	-1.166e+05	-1.167e+05								
7	SO	95	12	-1.166e+05	-1.165e+05								

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	7.6800e-03	m²
$N_{c,Rd}$	2726.40	kN
Unity check	0.00	-

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

$W_{pl,y}$	7.4583e-04	m³
$M_{pl,y,Rd}$	264.77	kNm
Unity check	0.32	-

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

$W_{pl,z}$	3.5167e-04	m³
$M_{pl,z,Rd}$	124.84	kNm
Unity check	0.00	-

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

η	1.20	

A_v	5.9737e-03	m²
$V_{pl,y,Rd}$	1224.38	kN
Unity check	0.00	-

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

η	1.20	
A_v	2.5140e-03	m²
$V_{pl,z,Rd}$	515.27	kN
Unity check	0.06	-

Combined Shear and Torsion check for V_y and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.26)

$V_{pl,T,y,Rd}$	1223.95	kN
Unity check	0.00	-

Combined Shear and Torsion check for V_z and $\tau_{t,Ed}$
According to EN 1993-1-1 article 6.2.6 & 6.2.7 and formula (6.25),(6.26)

$V_{pl,T,z,Rd}$	515.09	kN
Unity check	0.06	-

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

$M_{pl,y,Rd}$	264.77	kNm
α	2.00	
$M_{pl,z,Rd}$	124.84	kNm
β	1.00	

Unity check (6.41) = 0.10 + 0.00 = 0.10 -

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

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	95	12	1.377e+05	1.381e+05	1.0	0.4	1.0	7.9	7.3	8.1	11.2	2
3	SO	95	12	1.376e+05	1.373e+05	1.0	0.4	1.0	7.9	7.3	8.1	11.2	2
4	I	164	8	1.037e+05	-1.025e+05	-1.0		0.5	21.9	57.9	66.6	99.4	1
5	SO	95	12	-1.365e+05	-1.369e+05								
7	SO	95	12	-1.364e+05	-1.361e+05								

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	7.877	2.626	m
Buckling factor k	1.00	1.00	
Buckling length l_{cr}	7.877	2.626	m
Critical Euler load N_{cr}	2592.05	8327.72	kN

Buckling parameters	yy	zz	
Slenderness λ	78.36	43.72	
Relative slenderness λ_{rel}	1.03	0.57	
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 & 6.3.2.2 and formula (6.54)

LTB parameters		
Method for LTB curve	General case	
Plastic section modulus $W_{pl,y}$	7.4583e-04	m^3
Elastic critical moment M_{cr}	1861.59	kNm
Relative slenderness $\lambda_{rel,LT}$	0.38	
Limit slenderness $\lambda_{rel,LT,0}$	0.20	
LTB curve	a	
Imperfection α_{LT}	0.21	
Reduction factor χ_{LT}	0.96	
Design buckling resistance $M_{b,Rd}$	230.76	kNm
Unity check	0.36	-

Mcr parameters		
LTB length l_{LT}	2.626	m
Influence of load position	no influence	
Correction factor k	1.00	
Correction factor k_w	1.00	
LTB moment factor C_1	1.80	
LTB moment factor C_2	0.00	
LTB moment factor C_3	1.00	
Shear center distance d_z	0	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_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 area A	7.6800e-03	m^2
Plastic section modulus $W_{pl,y}$	7.4583e-04	m^3
Plastic section modulus $W_{pl,z}$	3.5167e-04	m^3
Design compression force N_{Ed}	8.72	kN
Design bending moment (maximum) $M_{y,Ed}$	-97.64	kNm
Design bending moment (maximum) $M_{z,Ed}$	-0.03	kNm
Characteristic compression resistance N_{Rk}	2726.40	kN
Characteristic moment resistance $M_{y,Rk}$	264.77	kNm
Characteristic moment resistance $M_{z,Rk}$	124.84	kNm
Reduction factor χ_y	1.00	
Reduction factor χ_z	1.00	
Reduction factor χ_{LT}	0.96	
Interaction factor k_{yy}	1.00	
Interaction factor k_{yz}	0.77	
Interaction factor k_{zy}	0.52	
Interaction factor k_{zz}	1.00	

Maximum moment $M_{y,Ed}$ is derived from beam B52 position 3.643 m.
Maximum moment $M_{z,Ed}$ is derived from beam B52 position 5.251 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	2592.05	kN
Critical Euler load $N_{cr,z}$	8327.72	kN

Interaction method 1 parameters		
Elastic critical load $N_{cr,T}$	9374.36	kN
Plastic section modulus $W_{pl,y}$	7.4583e-04	m^3
Elastic section modulus $W_{el,y}$	6.7500e-04	m^3
Plastic section modulus $W_{pl,z}$	3.5167e-04	m^3
Elastic section modulus $W_{el,z}$	2.3100e-04	m^3
Second moment of area I_y	7.7600e-05	m^4
Second moment of area I_z	2.7700e-05	m^4
Torsional constant I_t	3.9611e-07	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 2 (General)	
Design bending moment (maximum) $M_{y,Ed}$	-97.64	kNm
Maximum relative deflection δ_z	35.4	mm
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) $M_{z,Ed}$	-0.03	kNm
Maximum relative deflection δ_y	0.0	mm
Equivalent moment factor $C_{mz,0}$	1.00	
Factor μ_y	1.00	
Factor μ_z	1.00	
Factor ε_y	127.33	
Factor a_{LT}	0.99	
Critical moment for uniform bending $M_{cr,0}$	1034.56	kNm
Relative slenderness $\lambda_{rel,0}$	0.51	
Limit relative slenderness $\lambda_{rel,0,lim}$	0.27	
Equivalent moment factor C_{my}	1.00	
Equivalent moment factor C_{mz}	1.00	
Equivalent moment factor C_{mLT}	1.00	
Factor b_{LT}	0.00	
Factor c_{LT}	0.19	
Factor d_{LT}	0.00	
Factor e_{LT}	1.59	
Factor w_y	1.10	
Factor w_z	1.50	
Factor n_{pl}	0.00	
Maximum relative slenderness $\lambda_{rel,max}$	1.03	
Factor C_{yy}	1.00	
Factor C_{yz}	0.90	
Factor C_{zy}	1.00	
Factor C_{zz}	1.00	

Unity check (6.61) = 0.00 + 0.42 + 0.00 = 0.43 -
Unity check (6.62) = 0.00 + 0.22 + 0.00 = 0.22 -

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	7.877	m
Web	unstiffened	
Web height h_w	206	mm
Web thickness t	8	mm
Material coefficient ε	0.81	
Shear correction factor η	1.20	

Shear Buckling verification	
Web slenderness h_w/t	27.47
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.

Dimenzioniranje podrožnice RHS 150/100/4

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

Member B38	1.500 / 3.000 m	RRK150/100/4	S 235	Anvelopa GSN	0.86 -

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
Anvelopa GSN / LC1 + 0.90*LC2 + 1.50*LC6

Partial safety factors	
γ_{M0} for resistance of cross-sections	1.00
γ_{M1} for resistance to instability	1.10
γ_{M2} for resistance of net sections	1.25

Material		
Yield strength f_y	235.0	MPa
Ultimate strength f_u	360.0	MPa
Fabrication	Cold formed	

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

The critical check is on position 1.500 m

Internal forces	Calculated	Unit
N_{Ed}	7.73	kN
$V_{y,Ed}$	0.00	kN
$V_{z,Ed}$	0.00	kN
T_{Ed}	-1.34	kNm
$M_{y,Ed}$	-15.60	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]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	88	4	1.875e+05	1.875e+05	1.0		1.0	22.0	33.0	38.0	42.0	1
3	I	138	4	1.770e+05	-1.852e+05	-1.0		0.5	34.5	73.7	84.9	129.7	1
5	I	88	4	-1.957e+05	-1.957e+05								
7	I	138	4	-1.852e+05	1.770e+05	-1.0		0.5	34.5	73.7	84.9	129.7	1

The cross-section is classified as Class 1

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

A	1.8950e-03	m²
$N_{pl,Rd}$	445.32	kN
$N_{u,Rd}$	491.18	kN
$N_{t,Rd}$	445.32	kN
Unity check	0.02	-

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

$W_{pl,y}$	9.5700e-05	m³
$M_{pl,y,Rd}$	22.49	kNm
Unity check	0.69	-

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.1(5) and formula (6.1)

Elastic verification		
Fibre	10	
$\sigma_{N,Ed}$	-4.1	MPa
$\sigma_{My,Ed}$	-196.7	MPa
$\sigma_{Mz,Ed}$	0.0	MPa
$\sigma_{tot,Ed}$	-200.8	MPa
$\tau_{Vy,Ed}$	0.0	MPa

Elastic verification		
$\tau_{Vz,Ed}$	0.0	MPa
$\tau_{t,Ed}$	12.4	MPa
$\tau_{tot,Ed}$	12.4	MPa
$\sigma_{von\ Mises,Ed}$	201.9	MPa
Unity check	0.86	-

Note: Since there is no shear force, the effect of the torsional moment cannot be accounted for in the plastic interaction. Therefore the elastic yield criterion according to EN 1993-1-1 article 6.2.1(5) is verified.

The member satisfies the section check.

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

Classification for member buckling design
Decisive position for stability classification: 1.500 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	I	88	4	1.875e+05	1.875e+05	1.0		1.0	22.0	33.0	38.0	42.0	1
3	I	138	4	1.770e+05	-1.852e+05	-1.0		0.5	34.5	73.7	84.9	129.7	1
5	I	88	4	-1.957e+05	-1.957e+05								
7	I	138	4	-1.852e+05	1.770e+05	-1.0		0.5	34.5	73.7	84.9	129.7	1

The cross-section is classified as Class 1

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

The member satisfies the stability check.

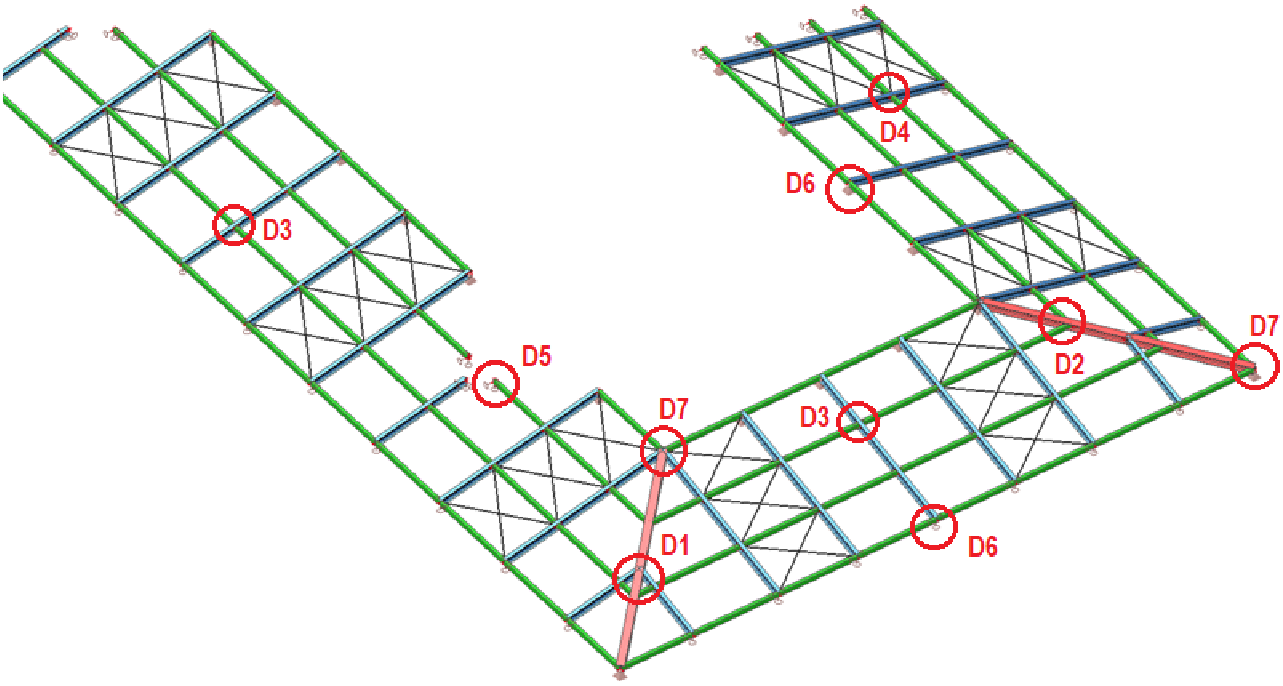
Dimenzioniranje dijagonale horizontalne stabilizacije Ø12

Sila u vlačnoj zategi N_{Ed} = 1,65 kN
Površina u zoni navoja A_{netto} = 0,84 cm²

Napon u zategi $\sigma = N_{Ed} / A_{netto}$ = 1,65 / 0,84 = 2 kN/cm²
Dopušteni napon σ_{dop} = 35,5 / 1,0 = 35,5 kN/cm² > 2 kN/cm² → zadovoljava (6%)

1.4. Proračun priključaka krovišta

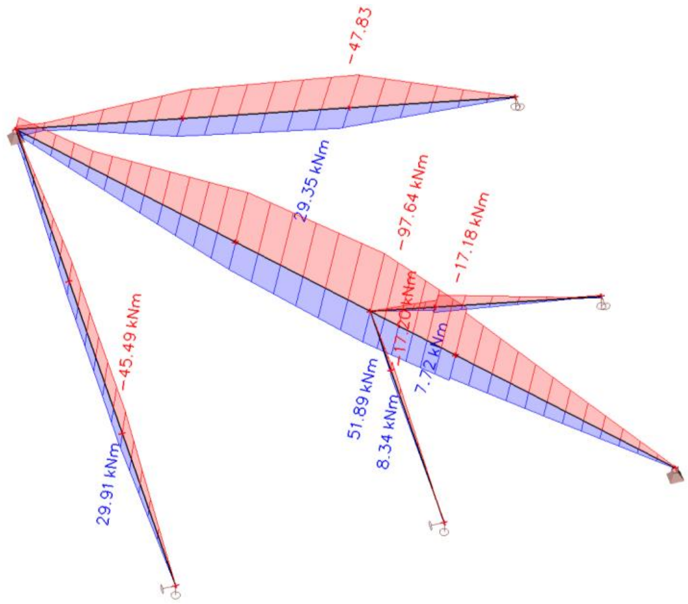
Svi širokopojasni profili čelične nosive konstrukcije izrađuju se čelika S355J2 sukladno normi HRN EN 10025, a hladnooblikovani cijevni profili od čelika S235JR sukladno normi HRN EN 10219. Svi limovi izrađuju se od čelika S355J2. Vijčani montažni spojevi izvode se vijcima kvalitete 8.8 (HRN EN 15048) i 10.9 (HRN EN 14399) prema proračunu danom u nastavku.



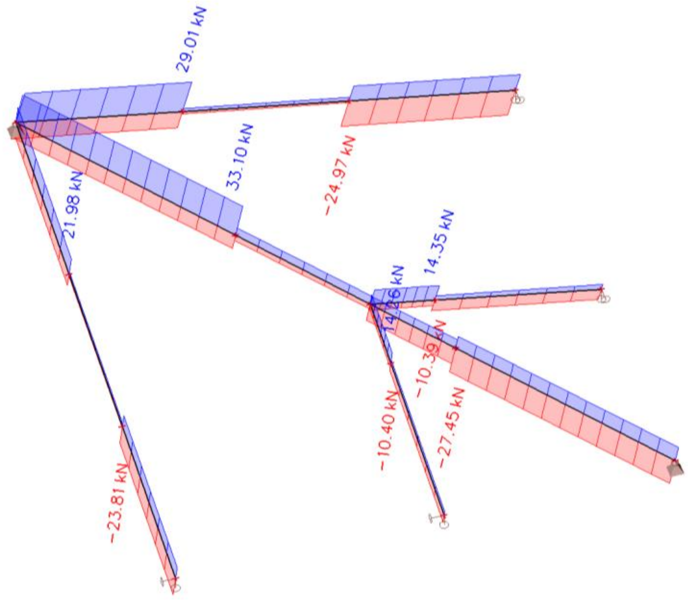
Spoj krovni nosač - grebena greda (D1)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti mjerodavnog grebena.

Values: **M_y**
Class: Anvelopa GSN
Extreme 1D: Member

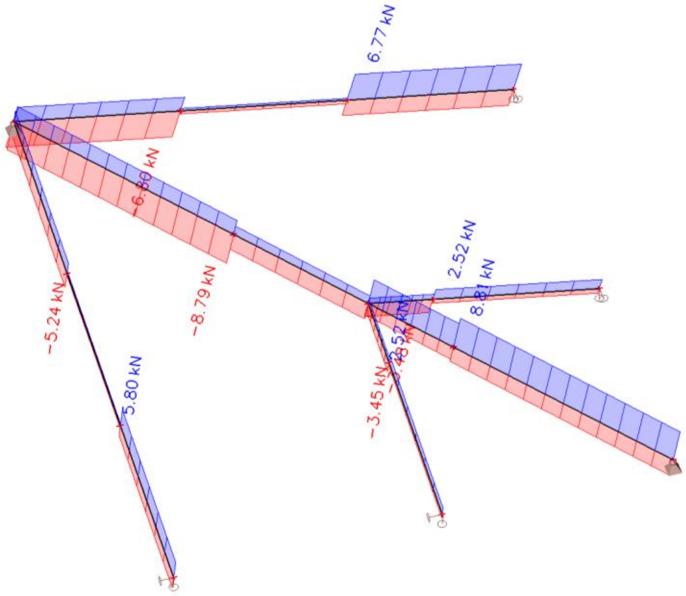


Values: **V_z**
Class: Anvelopa GSN
Extreme 1D: Member



Values: **N**

Class: Anvelopa GSN
Extreme 1D: Member



Rezne sile u čvoru

$M_{y,Ed}$ = 17,2 kNm
$V_{z,Ed}$ = 14,4 kN
N_{Ed} = 2,6 kN (vlak)

Spoj krovnog nosača na grebenu gredu izvodi se varenjem I profila napravljenog od limova t= 10 mm na grebenu gredu (hvatanje prostorne geometrije) te momentnim nastavkom u polju. Nastavak se izvodi sukladno pravilima struke, kao spoj pune nosivosti IH1.A, kao DSTV spoj br. 82. Puna računska nosivost spoja za pritezanje 100%:

$M_{y,Rd}$ = 44,1 kNm
$V_{z,Rd}$ = 196,2 kN

Provjera otpornosti vijaka na vlak

$F_{Ed/vijak} = M_{Ed}/2e + N_{Ed} / 4 = 17{,}2 / (2 \cdot 0{,}16) + 2{,}6 / 4 = 54{,}4$ kN po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2} = 141{,}3 / 1{,}25 = 113$ kN
113 kN > $F_{Ed/vijak}$ = 54,4 kN → zadovoljava (48%)

Provjera otpornosti vijaka na posmik

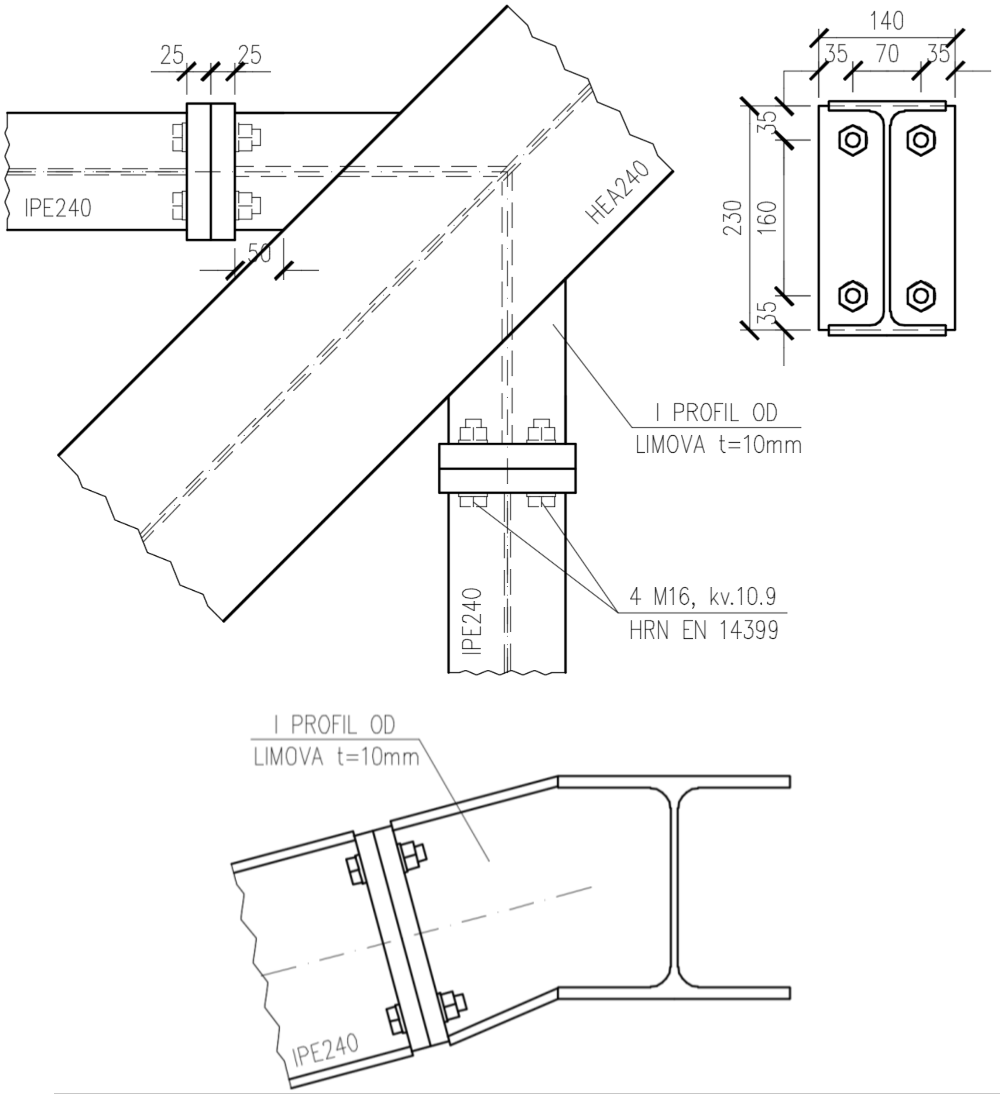
$F_{Ed/vijak} = V_{Ed} / 4 = 14{,}4 / 4 = 3{,}6$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 78{,}5 / 1{,}25 = 62{,}8$ kN
62,8 kN > $F_{Ed/vijak}$ = 3,6 kN → zadovoljava (6%)

S obzirom na minimalni iznos poprečne sile u čvoru te debljinu čeone ploče, pritisak po omotaču rupe nije mjerodavan te se neće dodatno provjeravati.

Geometrija spoja

Vijci	4 M16, kv. 10.9, **vijke pritegnuti na 100%**
Čeone ploče	t = 25 mm, S355J2
Zavari	a_w = 5 mm (pojas), a_w = 4 mm (hrbat)

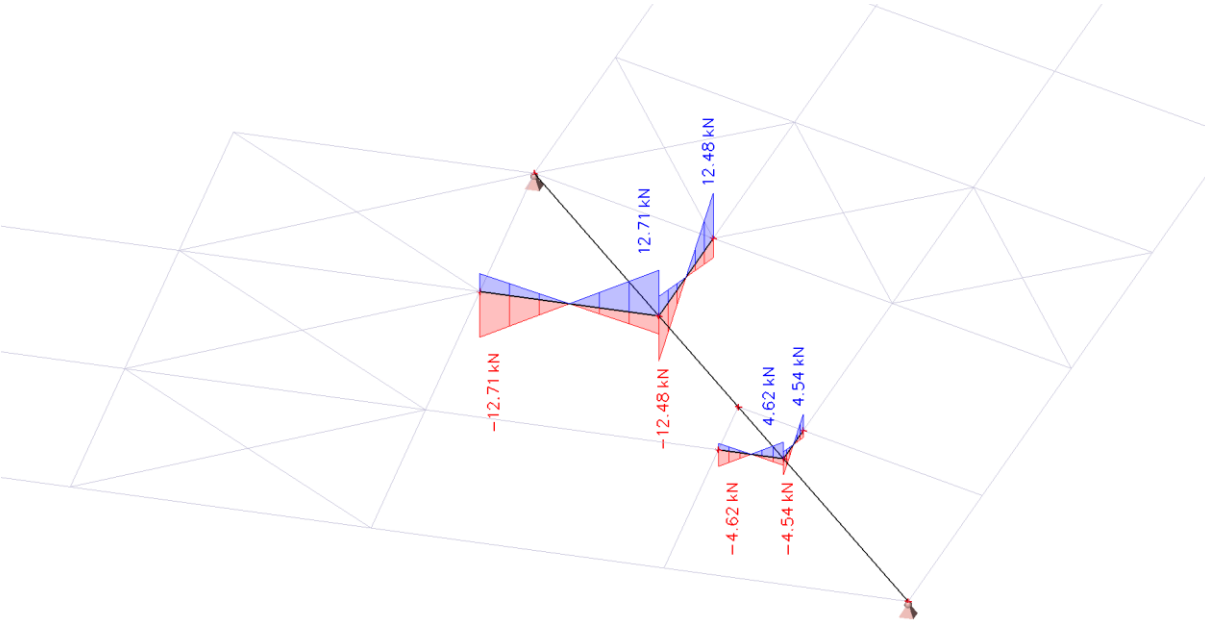


NAPOMENA: S obzirom da se radi o prostornom spoju, rješenje je dano principijelno. I profil od limova potrebno je prilagoditi stvarnoj geometriji spoja te prije izvedbe dostaviti predmetni detalj projektantu na uvid.

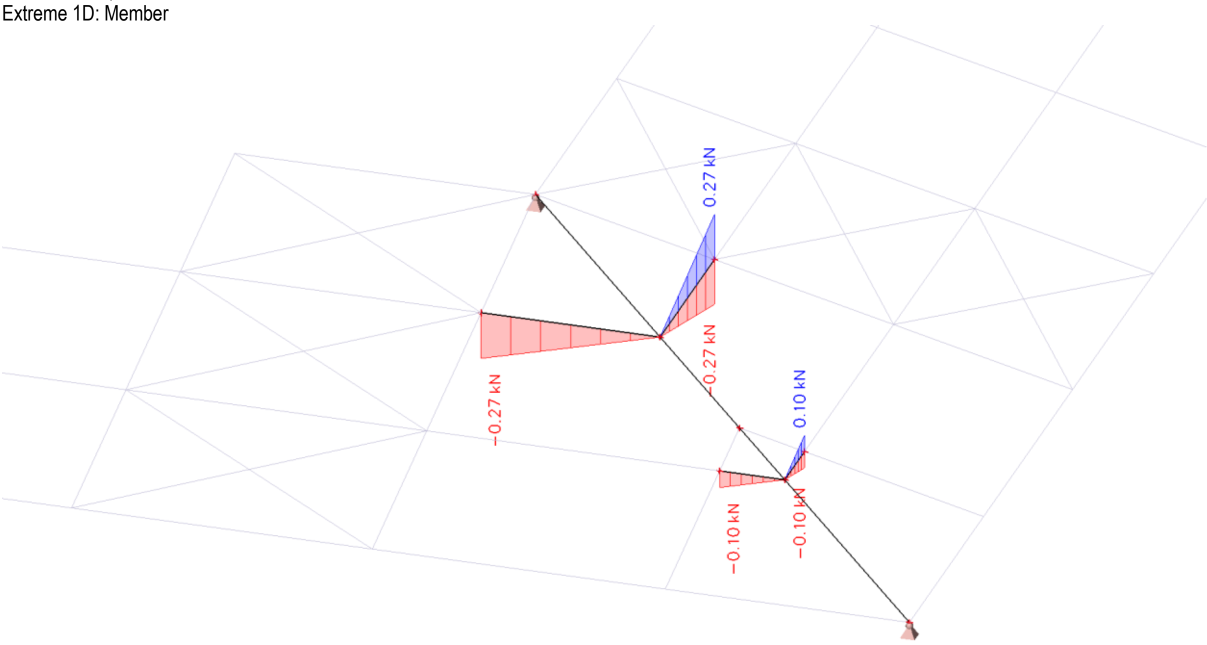
Spoj podrožnica - grebena greda (D2)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti mjerodavnog grebena.

Values: **V**
Class: Anvelopa GSN
Extreme 1D: Member



Values: **N**
Class: Anvelopa GSN
Extreme 1D: Member



S obzirom da su podrožnice modelirane kao proste grede, iznosi reznih sila na mjestu spoja s glavnim nosačima su minimalni, a moment savijanja je jednak 0. Sukladno navedenom, spoj se izvodi isključivo konstruktivno.

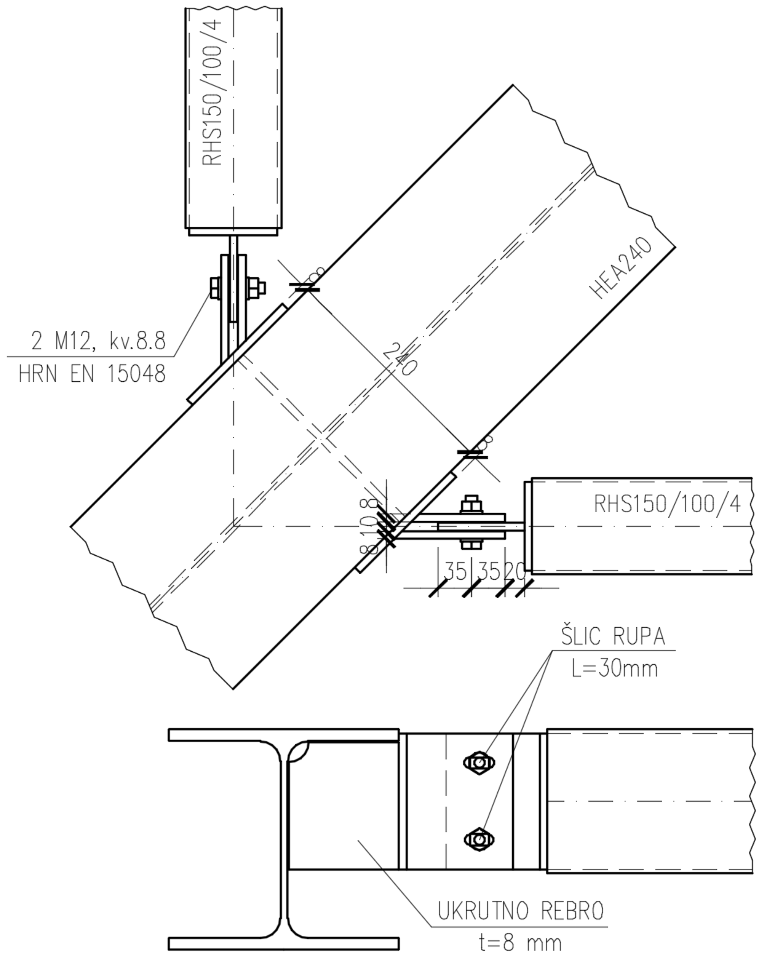
Provjera otpornosti vijaka na posmik

$F_{Ed/vijak} = V_{Ed} / 4 = 12{,}7 / 2 = 6{,}4$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 40{,}5 / 1{,}25 = 32{,}4$ kN
$32{,}4$ kN > $F_{Ed/vijak} = 6{,}4$ kN → zadovoljava (20%)

Geometrija spoja

Vijci	2 M12, kv. 8.8
Čeona ploča	t = 8 mm, S355J2
Prihvatni limovi	t = 8 mm, S355J2
Ukrutna rebra	t = 8 mm, S355J2
Zavari	a_w = t = 4 mm

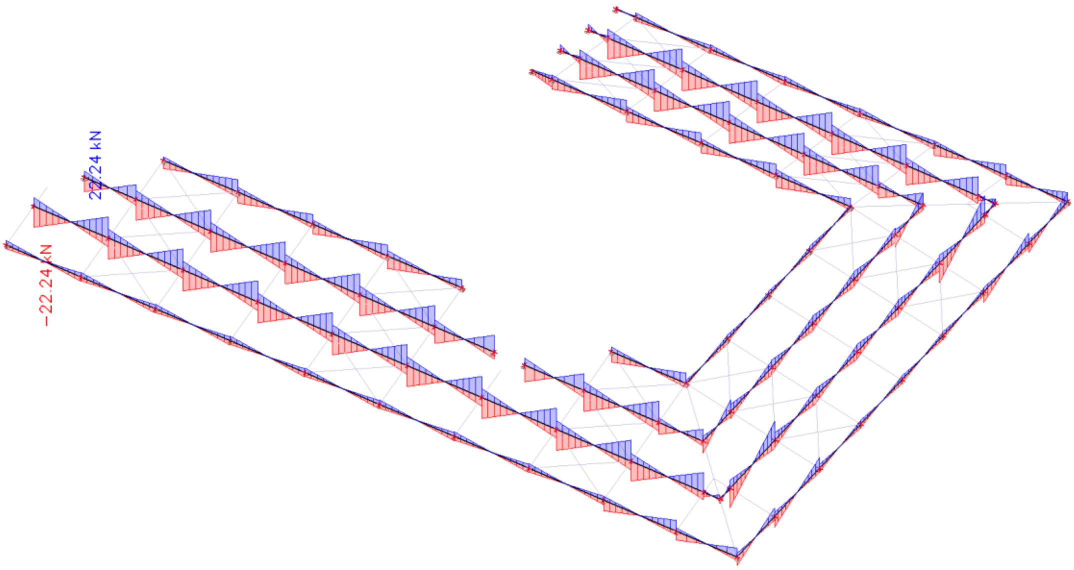


NAPOMENA: S obzirom da se radi o prostornom spoju, rješenje je dano principijelno. Detalj je potrebno prilagoditi stvarnoj geometriji spoja te prije izvedbe dostaviti projektantu na uvid.

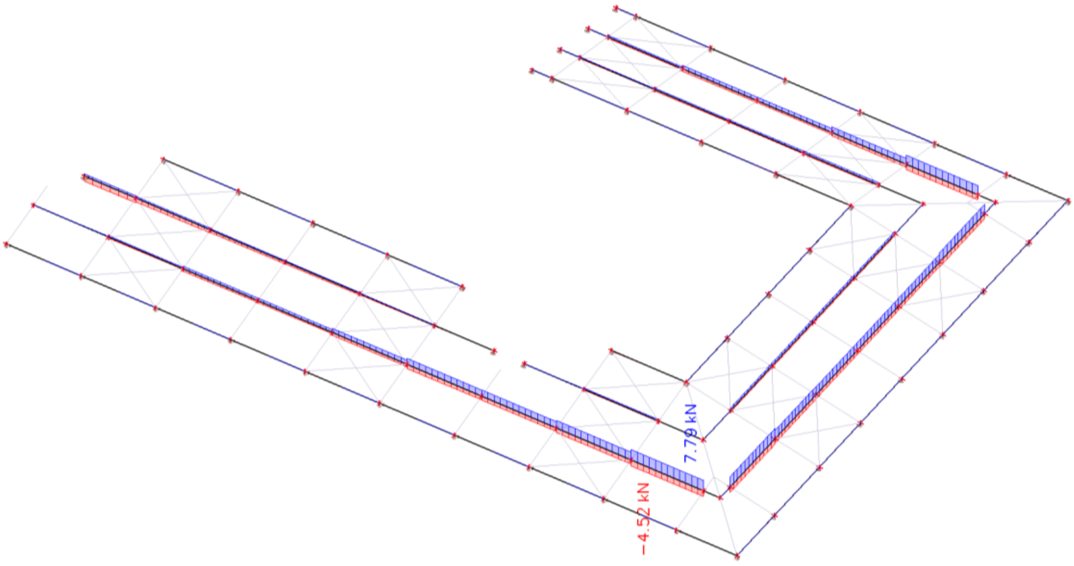
Spoj podrožnica - krovni nosač (D3)

U nastavku je dan grafički prikaz reznih sila za anvelopu graničnog stanja nosivosti podrožnica.

Values: **V_z**
Class: Anvelopa GSN
Extreme 1D: Global



Values: **N**
Class: Anvelopa GSN
Extreme 1D: Global



S obzirom da su podrožnice modelirane kao proste grede, iznosi reznih sila na mjestu spoja s krovnim nosačima su minimalni, a moment savijanja je jednak 0. Sukladno navedenom, spoj se izvodi isključivo konstruktivno.

Provjera otpornosti vijaka na vlak

$F_{Ed/vijak} = N_{Ed} / 4 = 7{,}8 / 4 = 2$ kN po vijku

$F_{t,Rd} = F_{t,Rk} / \gamma_{M2} = 60{,}7 / 1{,}25 = 48{,}6$ kN
48,6 kN > $F_{Ed/vijak}$ = 2 kN → zadovoljava (4%)

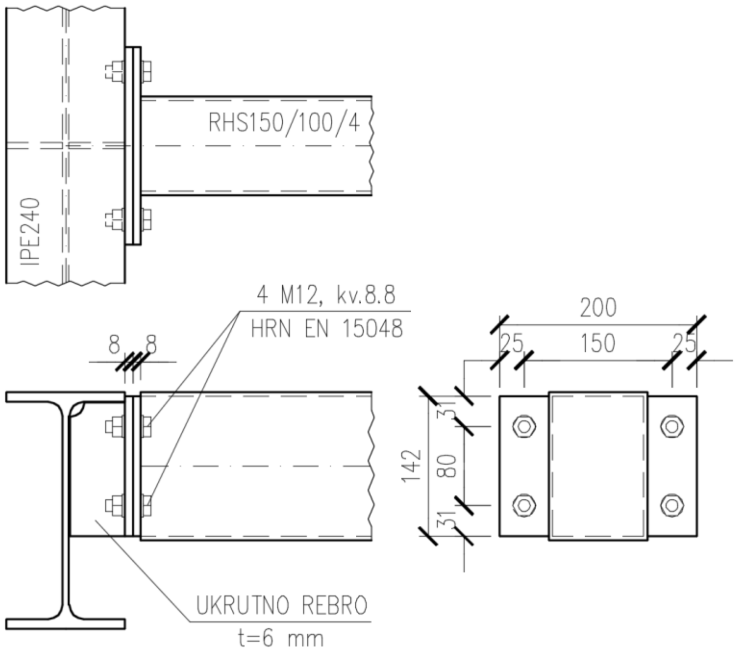
Provjera otpornosti vijaka na posmik

$F_{Ed/vijak} = V_{Ed} / 4 = 22{,}3 / 4 = 5{,}6$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 40{,}5 / 1{,}25 = 32{,}4$ kN
32,4 kN > $F_{Ed/vijak}$ = 5,6 kN → zadovoljava (17%)

Geometrija spoja

Vijci	4 M12, kv. 8.8
Čeone ploče	t = 8 mm, S355J2
Ukrutna rebra	t = 6 mm, S355J2
Zavari	a_w = t = 4 mm

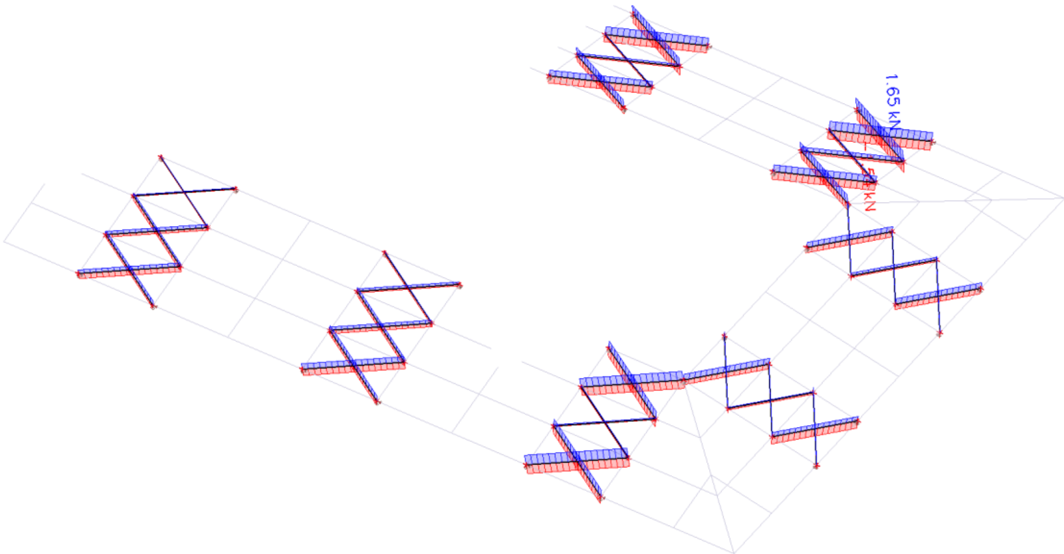


Detalj stabilizacije (D4)

U nastavku je dan grafički prikaz maksimalne uzdužne sile u stabilizaciji za anvelopu graničnog stanja nosivosti.

Values: **N**

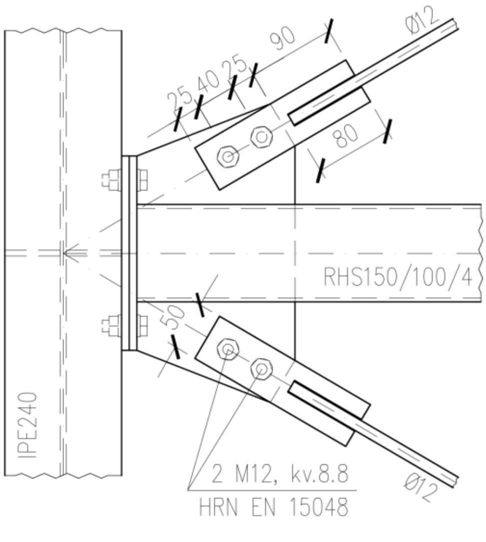
Class: Anvelopa GSN
Extreme 1D: Global



S obzirom na minimalni iznos uzdužne sile, spoj se izvodi isključivo konstruktivno.

Geometrija spoja

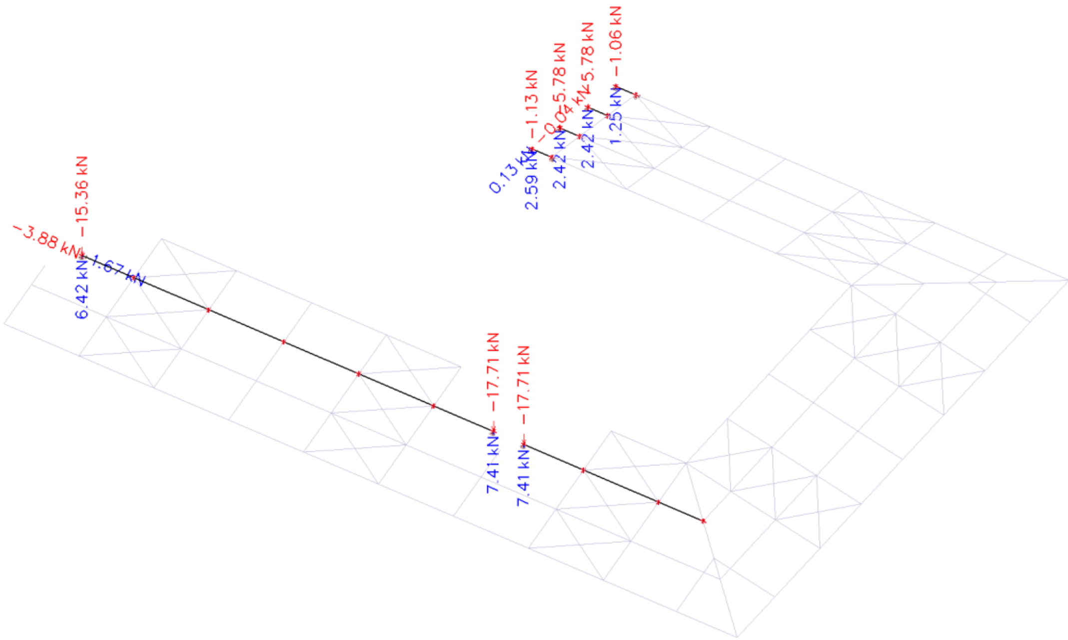
Vijci	2 M12, kv. 8.8
Prihvatni limovi	t = 8 mm, S355J2
Zavari	a_w = 4 mm



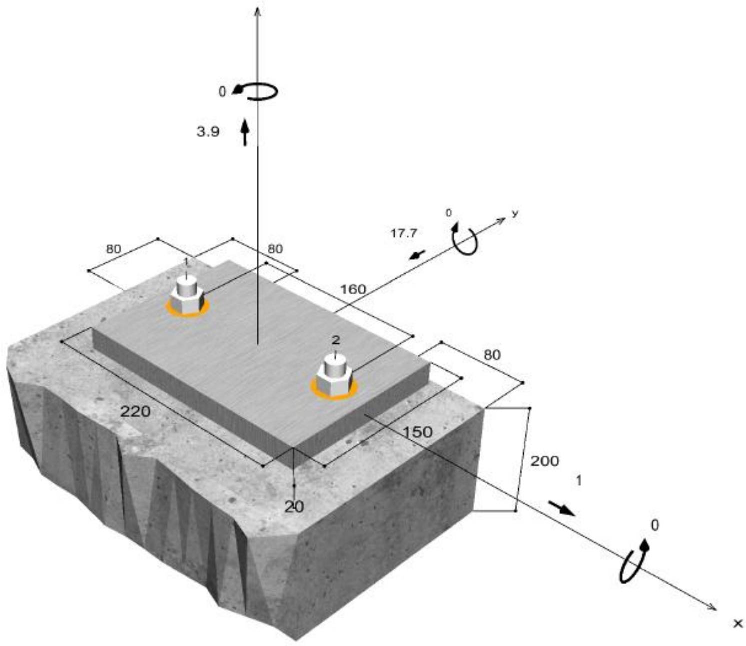
Napomena: prihvatne limove stabilizacije prošlicati kroz cijevni profil podrožnice.

Detalj sidrenja podrožnica (D5)

U nastavku je dan grafički prikaz reakcija podrožnica za anvelopu graničnog stanja nosivosti, nakon čega slijedi proračun sidrenja u programskom paketu C-FIX. Sidrenje se izvodi kemijskim sidrenjem sidara M16, kvalitete 8.8. Kemija kao Fischer FIS V ili jednakovrijedna.



S obzirom na minimalne iznose reakcija podrožnica, sidrenje se izvodi konstruktivno. Minimalna udaljenost osi sidra do ruba betona iznosi 80 mm. Ako se prilikom izmjere na terenu pokaže suprotno, potrebno je kontaktirati projektanta kako bi ponovio proračun te po potrebi dao alternativni prijedlog sidrenja.



Input data

Design method	Design Method EN1992-4:2018 bonded fastener
Base material	C25/30, EN 206
Concrete condition	Non-cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	Hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap filled
Type of loading	Permanent-Transient/Static
Base plate location	Base plate flush installed on base material
Base plate geometry	220 mm x 150 mm x 20 mm
Profile type	None

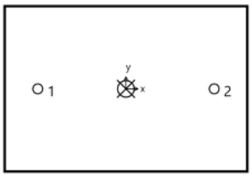
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	3.90	1.00	-17.70	0.00	0.00	0.00	Permanent-Transient/Static

*) The required partial safety factors for actions are included

Resulting anchor forces

Anchor no.	Tensile action kN	Shear Action kN	Shear Action x kN	Shear Action y kN
1	1.95	8.86	0.50	-8.85
2	1.95	8.86	0.50	-8.85



max. concrete compressive strain :	0.00 ‰
max. concrete compressive stress :	0.0 N/mm²
Resulting tensile actions :	3.90 kN , X/Y position (0 / 0)
Resulting compression actions :	0.00 kN , X/Y position (0 / 0)

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N,s} = \beta_{N,s;1} = 0.02 \leq 1$$
$$\beta_{V,s} = \beta_{V,s;1} = 0.18 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{V,s;1}^2 = 0.03 \leq 1$$

Eq. (7.55)

Proof successful

Utilisation concrete

$$\beta_{N,c} = \beta_{N,c;1} = 0.14 \leq 1$$
$$\beta_{V,c} = \beta_{V,c;2} = 0.50 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,c;1}^{1.5} + \beta_{V,c;2}^{1.5} = 0.41 \leq 1$$

Eq. (7.56)

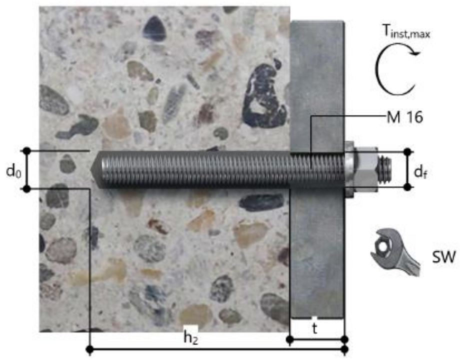
Installation data

Anchor

Anchor system	**fischer Injection system FIS V**		
Injection resin	FIS V 360 S (other cartridge sizes available)	Art.-No. 94405	
Fixing element	Threaded rod FIS A M 16 x 200 8.8, zinc plated steel, Property Class 8.8	Art.-No. 517939	
Accessories	FIS MR Plus	Art.-No. 545853	
	FIS Extension tube 9mm	Art.-No. 48983	
	Dispenser FIS DM S	Art.-No. 511118	
	Compressed-air cleaning tool	Art.-No. 93286	
	compressed air (oil-free), min. 6 bar	By job site.	
	BSD 18	Art.-No. 1493	
	SDS Chuck with internal thread M8	Art.-No. 530332	
	Quattric II 18/200/250	Art.-No. 549956	
	or alternatively		
	FHD 18/320/450	Art.-No. 546600	
	Hammer drilling with or without suction		

Installation details

Thread diameter	M 16
Drill hole diameter	d_0 = 18 mm
Drill hole depth	h_2 = 170 mm
Calculated anchorage depth	h_{ef} = 150 mm
Drilling method	Hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap filled
Maximum torque	$T_{inst,max}$ = 60.0 Nm
Socket size	24 mm
Base plate thickness	t = 20 mm
Total fixing thickness Tfix,max	t_{fix} = 20 mm
Volume of resin per drill hole	20 ml/10 scale divisions

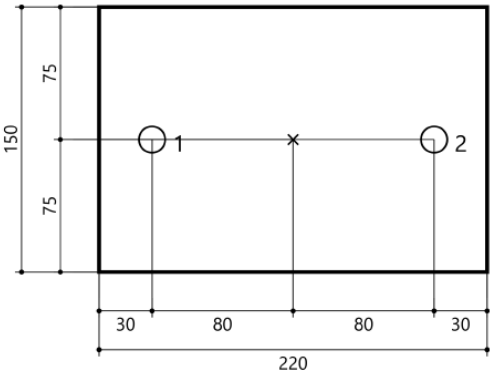


Base plate details

Base plate material	Not available
Base plate thickness	t = 20 mm
Clearance hole in base plate	d_f=20 mm

Attachment

Profile type	None

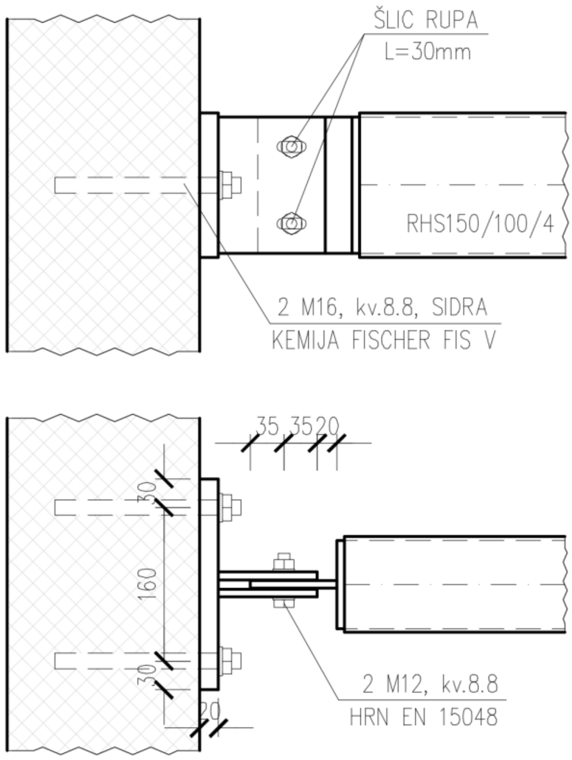


Anchor coordinates

Anchor no.	x mm	y mm
1	-80	0
2	80	0

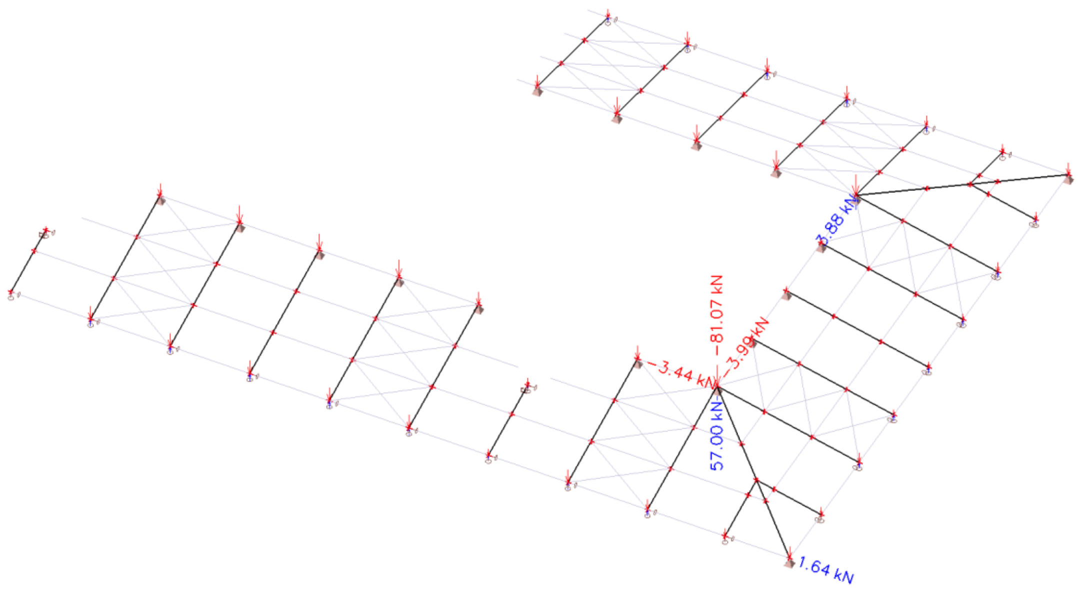
Geometrija spoja

Sidra	2 M16, kv. 8.8
Kemija	kao Fischer FIS V
Vijci	2 M12, kv. 8.8
Čeona ploča	t = 20 mm, S355J2
Prihvatni limovi	t = 8 mm, S355J2
Zavari	a_w = 4 mm



Detalj sidrenja krovnih nosača i grebena (D6 i D7)

U nastavku je dan grafički prikaz reakcija krovnih nosača za anvelopu graničnog stanja nosivosti.



Sidrenje krovnih nosača izvodi se prolaznim navojnim šipkama M24, kvalitete 8.8. s pripadnom kontrapločom debljine 25 mm. Minimalna udaljenost osi sidra do ruba betona iznosi 120 mm. Ako se prilikom izmjere na terenu pokaže suprotno, potrebno je kontaktirati projektanta kako bi ponovio proračun te po potrebi dao alternativni prijedlog sidrenja. Beton se izvodi minimalno kao C25/30.

Rezne sile u čvoru

V_{Ed} = 81,1 kN
N_{Ed} = 4,0 kN (vlak)

Provjera otpornosti sidara na posmik

$V_{Ed/vijak} = V_{Ed} /4 = 81,1 / 4 = 20,2$ kN / po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 169,4 / 1,25 = 135,5$ kN
135,5 kN > $N_{Ed/vijak}$ = 20,2 kN → zadovoljava (15%)

Provjera pritiska na beton preko vijaka

$A = d \cdot 3d = 2,4 \cdot 3 \cdot 2,4 = 17,3$ cm^2
$\sigma_b = V_{Ed/vijak} / A = 20,2 / 17,3 = 1,17$ kN/cm^2

$\sigma_{dop} = f_{ck} /1,5 = 2,5/1,5 = 1,67$ kN/cm^2 > σ_b = 1,17 kN/cm^2 → zadovoljava (70%)

Provjera otpornosti vijaka na posmik

$F_{Ed/vijak} = V_{Ed} / 2 = 81,1 / 2 = 40,6$ kN po vijku

$F_{v,Rd} = F_{v,Rk} / \gamma_{M2} = 169{,}4 / 1{,}25 = 135{,}5$ kN

$135{,}5$ kN $> N_{Ed/vijak} = 40{,}6$ kN → zadovoljava (30%)

Provjera otpornosti hrpta na pritisak po omotaču rupe

$F_{b,Rd} = (2{,}5 \cdot a \cdot f_u \cdot d \cdot t) / \gamma_{M2}$

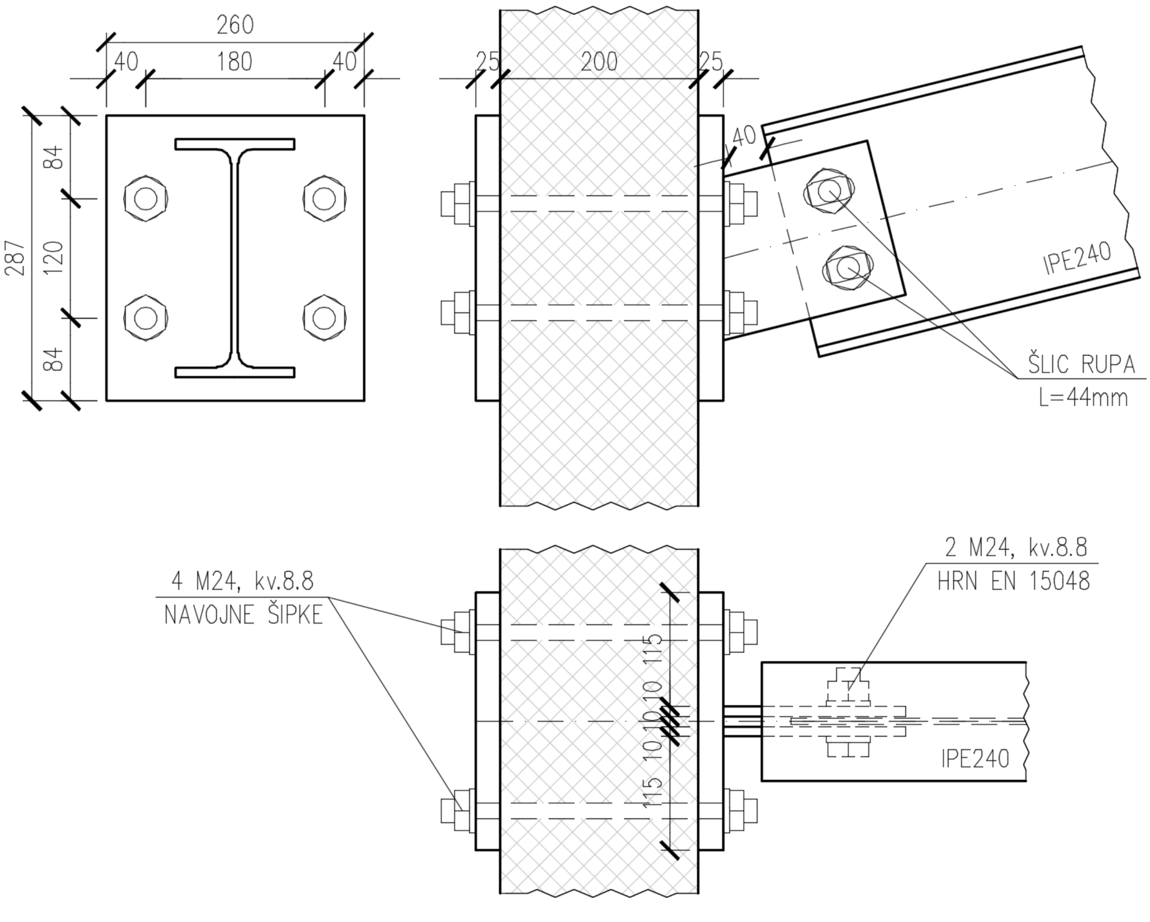
$a = \min \{ e_1/3d_0 ; f_{ub} / f_u ;1\} = \min \{ 50/3 \cdot 27 ; 100/51 ;1\} = 0{,}62$

$F_{b,Rd} = (2{,}5 \cdot 0{,}62 \cdot 51 \cdot 2{,}4 \cdot 0{,}62) / 1{,}25 = 94{,}1$ kN

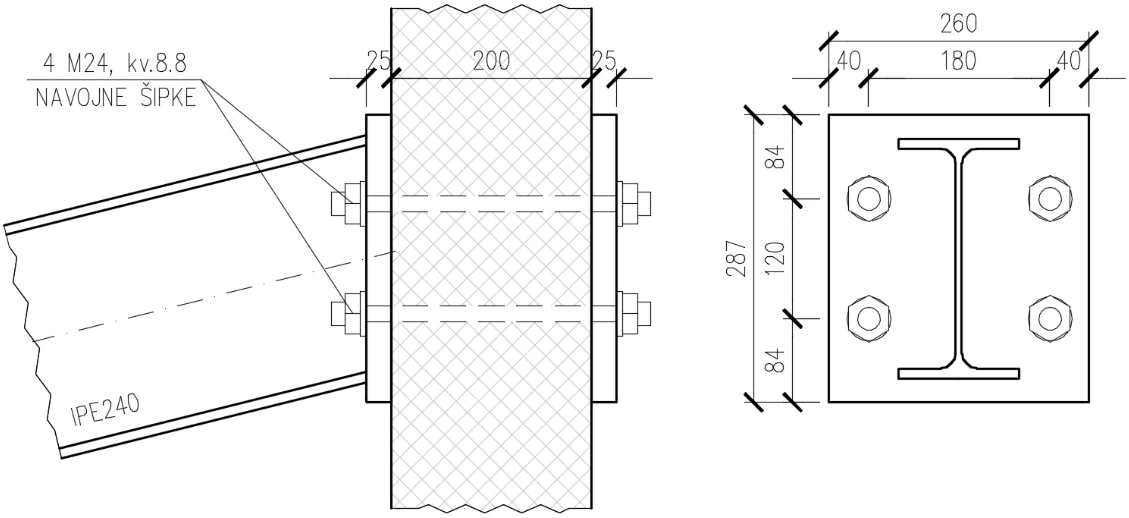
$94{,}1$ kN $> F_{v;Ed/vijak} = 40{,}6$ kN → zadovoljava (43%)

Geometrija spoja krovnih nosača

Sidra	4 M24, kv. 8.8
Vijci	2 M24, kv. 8.8
Čeona ploča	t = 25 mm, S355J2
Prihvatni limovi	t = 10 mm, S355J2
Zavari	a_w = 4 mm



Prihvat krovnih nosača dolje



Prihvat krovnih nosača gore

Sidrenje grebena izvodi se preko sidrenog sklopa, prolaznim navojnim šipkama M24, kvalitete 8.8. s pripadnom kontrapločom debljine 25 mm. Sidreni sklop dalje se vijčano veže sa krovnim nosačima i/ili grebenom sukladno pravilima struke, detaljima IH1.A, DSTV. br. 82 (IPE240) i br. 430 (HEA240).

Geometrija nastavka krovnog nosača IPE 240

Vijci	4 M16, kv. 10.9, **vijke pritegnuti na 100%**
Čeone ploče	t = 25 mm, S355J2
Zavari	a_w = 5 mm (pojas), a_w = 4 mm (hrbat)

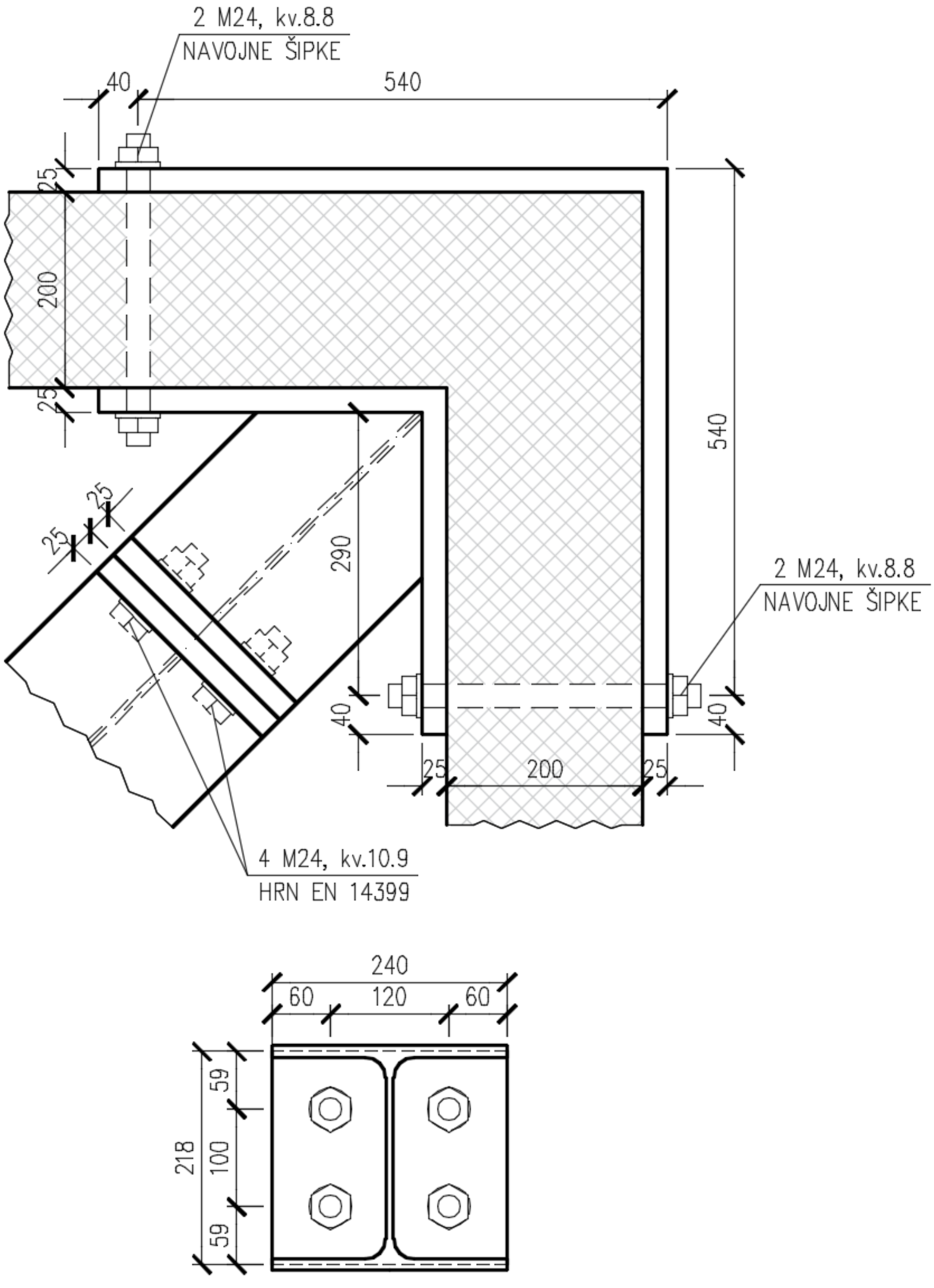
Geometrija nastavka grebena HEA 240

Vijci	4 M24, kv. 10.9, **vijke pritegnuti na 100%**
Čeone ploče	t = 25 mm, S355J2
Zavari	a_w = 5 mm (pojas), a_w = 4 mm (hrbat)

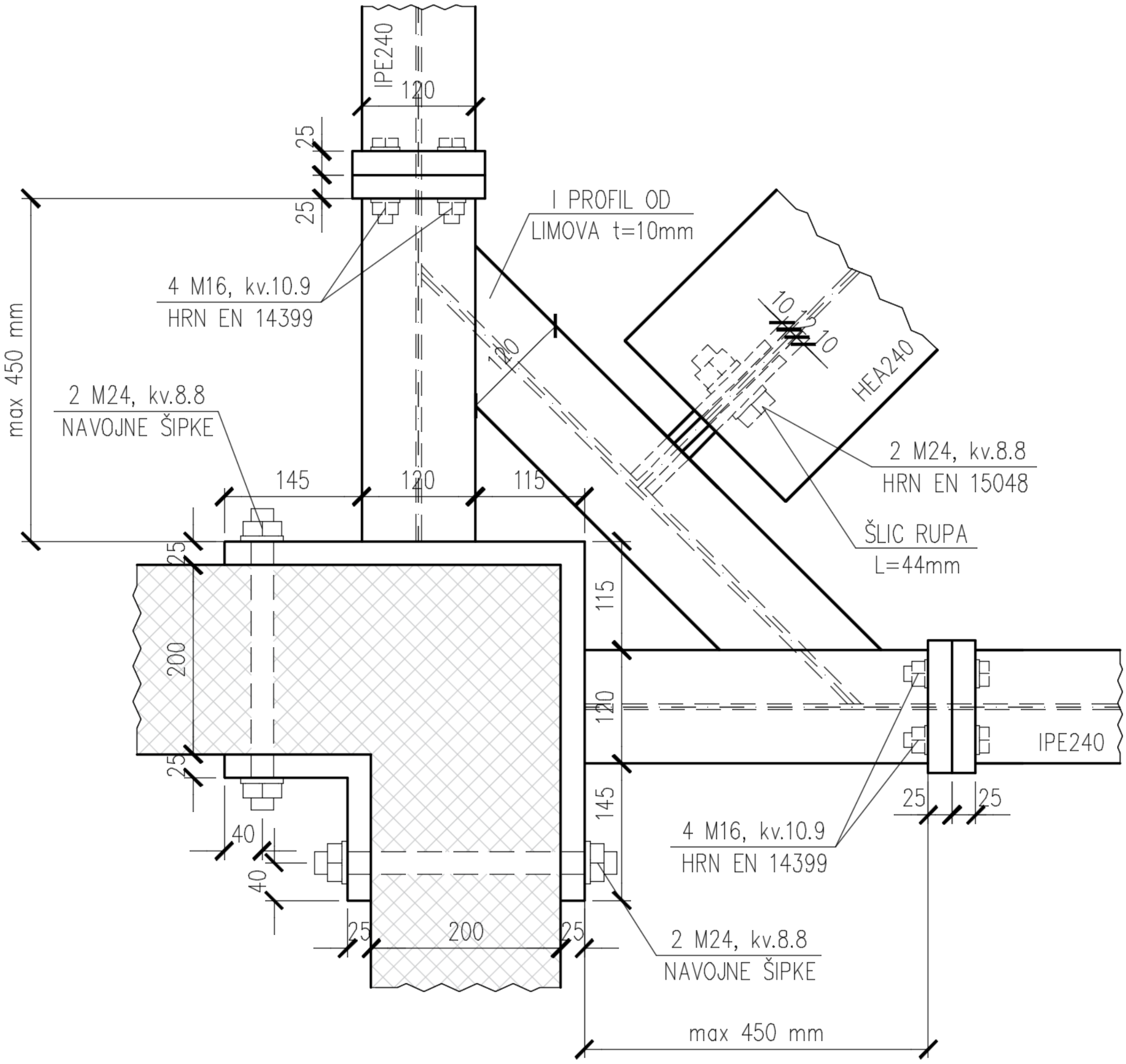
Geometrija sidrenog sklopa

Sidra	4 M24, kv. 8.8
Čeona ploča	t = 25 mm, S355J2
Kontraploča	t = 25 mm, S355J2
Prihvatni limovi	t = 10 mm, S355J2
Zavari	a_w = 5 mm (pojas), a_w = 4 mm (hrbat)

* Maksimalna udaljenost nastavka od početka sidrenog sklopa iznosi 450 mm.



Prihvat grebene grede dolje



Prihvat grebene grede gore

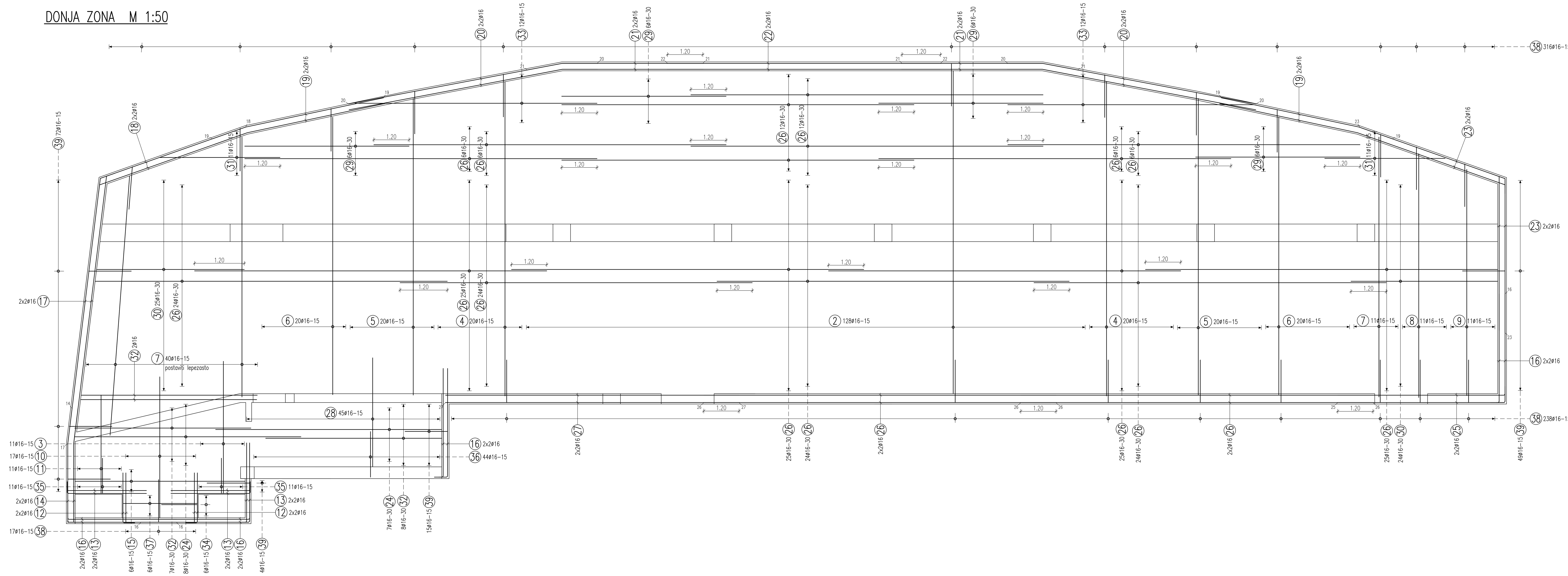
Specifikacija osnovnog materijala

Cross-section	Material	Length [m]	Unit mass [kg/m]	Mass [kg]	Surface [m²]	Volume [m³]
CS1 - IPE240	S 355	111.674	30.7	3427.7	102.933	4.3664e-01
CS2 - HEA240	S 355	15.699	60.3	946.5	21.507	1.2057e-01
CS4 - RD12	S 355	147.431	0.9	130.8	5.543	1.6666e-02
CS3 - RRK150/100/4	S 235	226.393	14.9	3367.8	110.027	4.2901e-01
Total		**501.197**		**7872.7**	**240.010**	**1.0029e+00**

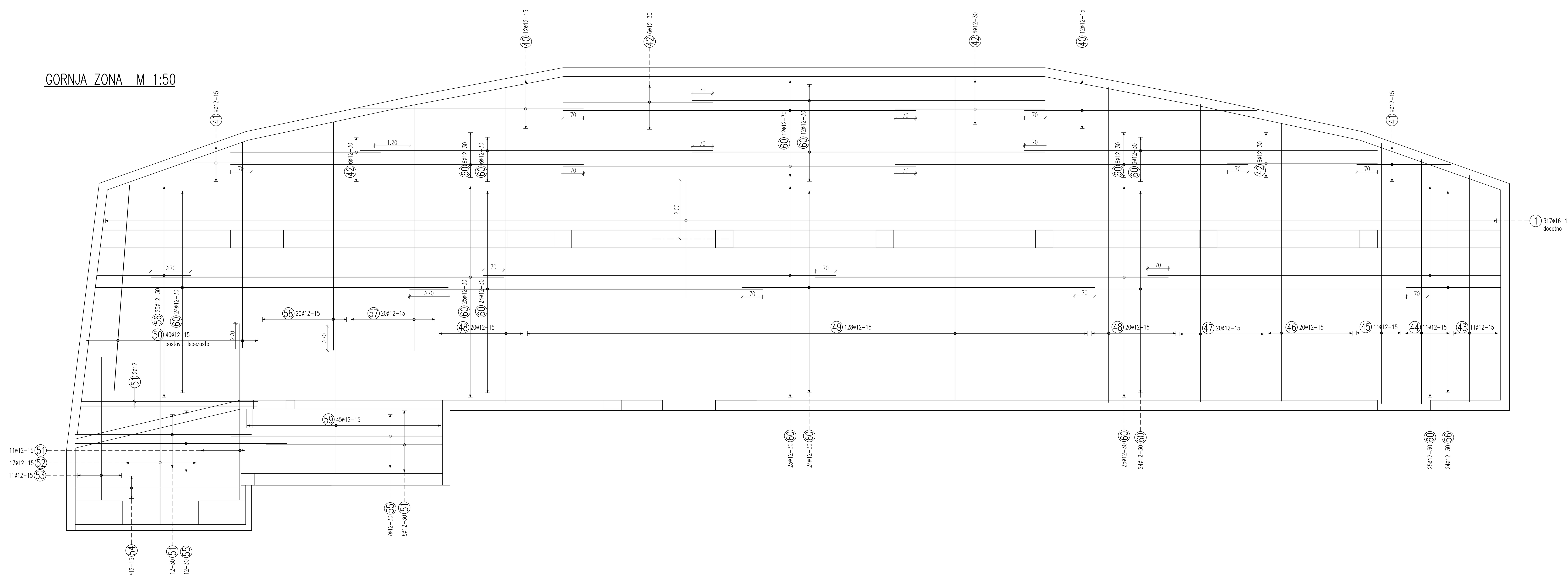
NAPOMENA: Specifikacija je dobivena iz statičkog modela, odnosno na temelju osnih dužina elemenata te može služiti isključivo kao orijentacijska vrijednost za izradu troškovnika. Stvarnu težinu konstrukcije potrebno je uvećati cca 10% (zavari, limovi i spojna sredstva).

ARMIRANO BETONSKA PLOČA

DONJA ZONA M 1:50



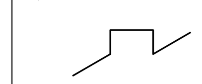
GORNJA ZONA M 1:50



<u>NOSACI ARMATURE GORNJE ZONE</u>

NOSACE POSTAVITI NA DONJE SIPKE DONJE ZONE

ploča d=25cm



(61) 710ø12 1,5kom/m2

(1) 317ø16 L=4.00 m; 400	(2) 128ø16 L=11.00 m; 1100	(3) 11ø16 L=4.50 m; 450	(4) 40ø16 L=10.70 m; 1070	(5) 40ø16 L=10.10 m; 1010
(6) 40ø16 L=9.45 m; 945	(7) 51ø16 L=8.85 m; 885	(8) 11ø16 L=8.30 m; 830	(9) 11ø16 L=7.70 m; 770	(10) 17ø16 L=4.80 m; 480
(11) 11ø16 L=3.35 m; 335	(12) 8ø16 L=2.00 m; 30, 170	(13) 12ø16 L=3.00 m; 30, 270	(14) 4ø16 L=4.18 m; 120, 268, 30	(15) 6ø16 L=5.80 m; 580
(16) 16ø16 L=4.00 m; 30, 370	(17) 4ø16 L=9.40 m; 30, 910	(18) 4ø16 L=5.55 m; 30, 525	(19) 8ø16 L=6.00 m; 120, 480	(20) 8ø16 L=8.60 m; 120, 740
(21) 8ø16 L=6.00 m; 120, 480	(22) 4ø16 L=9.30 m; 930	(23) 8ø16 L=5.55 m; 30, 525	(24) 15ø16 L=7.80 m; 780	(25) 4ø16 L=6.00 m; 30, 570
(26) 252ø16 L=12.00 m; 1200	(27) 4ø16 L=10.00 m; 1000	(28) 45ø16 L=3.70 m; 370	(29) 24ø16 L=5.60 m; 560	(30) 49ø16 L=5.00 m; 500
(31) 22ø16 L=1.59-5.85 m; 159-584	(32) 17ø16 L=6.00 m; 600	(33) 24ø16 L=3.49-11.26 m; 349-1126	(34) 6ø16 L=2.55 m; 120, 15, 120	(35) 22ø16 L=2.59 m; 120, 19, 120
(36) 44ø16 L=3.29 m; 155, 19, 155	(37) 6ø16 L=5.15 m; 250, 15, 250	(38) 571ø16 L=3.09 m; 145, 19, 145	(39) 140ø16 L=3.05 m; 145, 15, 145	(40) 24ø12 L=2.99-10.76 m; 299-1076
(41) 18ø12 L=1.44-4.85 m; 144-484	(42) 24ø12 L=5.20 m; 520	(43) 11ø12 L=7.70 m; 770	(44) 11ø12 L=8.30 m; 830	(45) 11ø12 L=8.85 m; 885
(46) 20ø12 L=9.45 m; 945	(47) 20ø12 L=10.10 m; 1010	(48) 40ø12 L=10.70 m; 1070	(49) 128ø12 L=11.00 m; 1100	(50) 40ø12 L=7.00 m; 700
(51) 28ø12 L=6.00 m; 600	(52) 17ø12 L=6.30 m; 630	(53) 11ø12 L=4.85 m; 485	(54) 6ø12 L=5.80 m; 580	(55) 15ø12 L=7.20 m; 720
(56) 49ø12 L=3.20 m; 320	(57) 20ø12 L=8.35 m; 835	(58) 20ø12 L=7.75 m; 775	(59) 45ø12 L=5.00 m; 500	(60) 244ø12 L=12.00 m; 1200
(61) 710ø12 L=1.03 m; 14, 25, 25				

NAPOMENE:

1. Klasa betona: C30/37
2. Vrsta betonskog čelika: B500B
3. Zaštitni sloj betona: c = 3 cm

ARMATURA PLOČE IZNAD PODRUMA

DONJA I GORNJA ZONA

K-01

130,0x84,1 cm

ISKAZ ARMATURE B500B

OBJEKT:

BR. NACRTA: K–01

GRADJEVINSKI DIO: ARMATURA PLOČE IZNAD PODRUMA

POZ	KOM	Ø	DUZINA	OBLIK	UKUPNO KG
1	317	16	4.00	400	2003.4
2	128	16	11.00	1100	2224.6
3	11	16	4.50	450	78.2
4	40	16	10.70	1070	676.2
5	40	16	10.10	1010	638.3
6	40	16	9.45	945	597.2
7	51	16	8.85	885	713.1
8	11	16	8.30	830	144.3
9	11	16	7.70	770	133.8
10	17	16	4.80	480	128.9
11	11	16	3.35	335	58.2
12	8	16	2.00	30 / 170	25.3
13	12	16	3.00	30 / 270	56.9
14	4	16	4.18	119, 173°, 15, 120, 268, 30	26.4
15	6	16	5.80	580	55.0
16	16	16	4.00	30 / 370	101.1
17	4	16	9.40	13, 116.4°, 27, 30, 910	59.4
18	4	16	5.55	525, 27, 30, 13, 116.4°	35.1

ISKAZ ARMATURE B500B

OBJEKT:

BR. NACRTA: K-01

GRADJEVINSKI DIO: ARMATURA PLOČE IZNAD PODRUMA

POZ	KOM	ø	DUZINA	OBLIK	UKUPNO KG
19	8	16	6.00	16 120 480 119 172.6°	75.8
20	8	16	8.60	118 169.3° 22 120 740	108.7
21	8	16	6.00	22 120 480 118 169.3°	75.8
22	4	16	9.30	930	58.8
23	8	16	5.55	10 109.4° 28 30 525	70.2
24	15	16	7.80	780	184.9
25	4	16	6.00	30 570	37.9
26	252	16	12.00	1200	4777.9
27	4	16	10.00	1000	63.2
28	45	16	3.70	370	263.1
29	24	16	5.60	560	212.4
30	49	16	5.00	500	387.1
31	22	16	1.59 bis 5.85	159-584 dl=42.6 broj podpozicija = 11	129.2
32	17	16	6.00	600	161.2
33	24	16	3.49 bis 11.26	349-1126 dl=70.6 broj podpozicija = 12	279.7
34	6	16	2.55	120 15 120	24.2

ISKAZ ARMATURE B500B

OBJEKT:

BR. NACRTA: K-01

GRADJEVINSKI DIO: ARMATURA PLOČE IZNAD PODRUMA

POZ	KOM	ø	DUZINA	OBLIK	UKUPNO KG
35	22	16	2.59	120 / 19 / 120	90.0
36	44	16	3.29	155 / 19 / 155	228.7
37	6	16	5.15	250 / 15 / 250	48.8
38	571	16	3.09	145 / 19 / 145	2787.7
39	140	16	3.05	145 / 15 / 145	674.7
40	24	12	2.99 bis 10.76	299–1076 dl=70.6 broj podpozicija = 12	146.6
41	18	12	1.44 bis 4.85	144–484 dl=42.6 broj podpozicija = 9	50.2
42	24	12	5.20	520	110.8
43	11	12	7.70	770	75.2
44	11	12	8.30	830	81.1
45	11	12	8.85	885	86.4
46	20	12	9.45	945	167.8
47	20	12	10.10	1010	179.4
48	40	12	10.70	1070	380.1
49	128	12	11.00	1100	1250.3
50	40	12	7.00	700	248.6

ISKAZ ARMATURE B500B

OBJEKT:

BR. NACRTA: K–01

GRADJEVINSKI DIO: ARMATURA PLOČE IZNAD PODRUMA

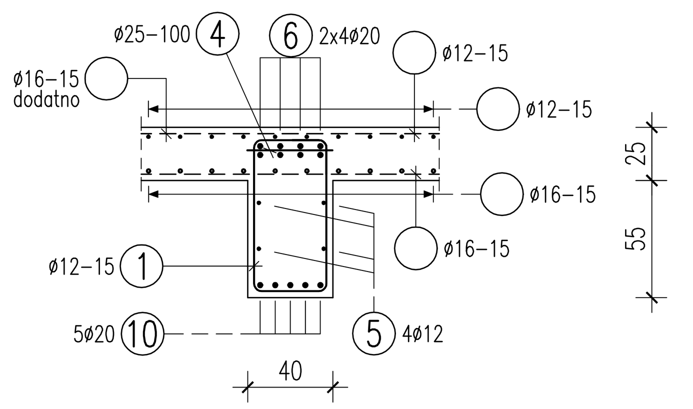
POZ	KOM	ø	DUZINA	OBLIK	UKUPNO KG
51	28	12	6.00	600	149.2
52	17	12	6.30	630	95.1
53	11	12	4.85	485	47.4
54	6	12	5.80	580	30.9
55	15	12	7.20	720	95.9
56	49	12	3.20	320	139.2
57	20	12	8.35	835	148.3
58	20	12	7.75	775	137.6
59	45	12	5.00	500	199.8
60	244	12	12.00	1200	2600.1
61	710	12	1.03	14 / 25 / 25 prostorna sipka	649.4

ISKAZ ARMATURE

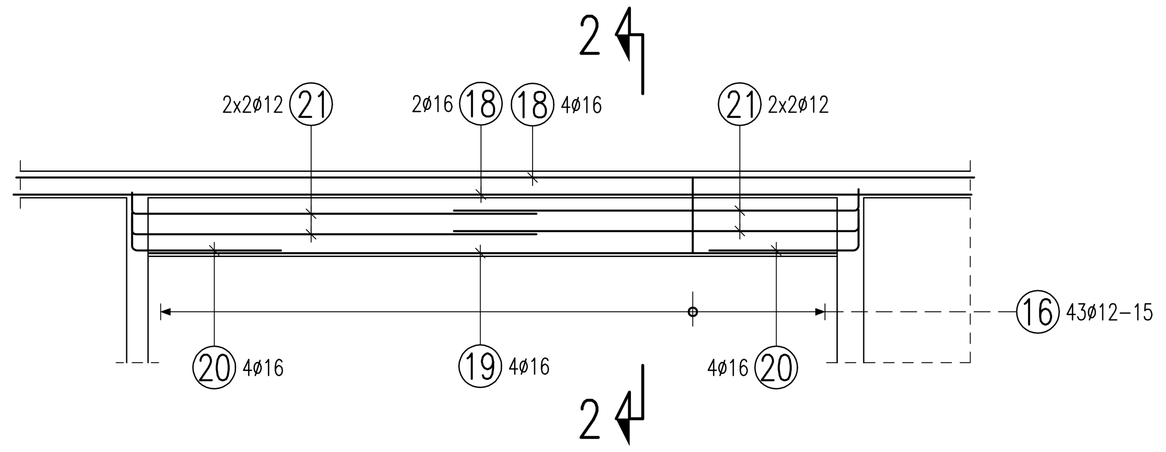
	ø		kg	
	12		7069.4	
	16		18495.4	
UKUPNO			25564.8	

Greda G1 M 1:50
40x80cm

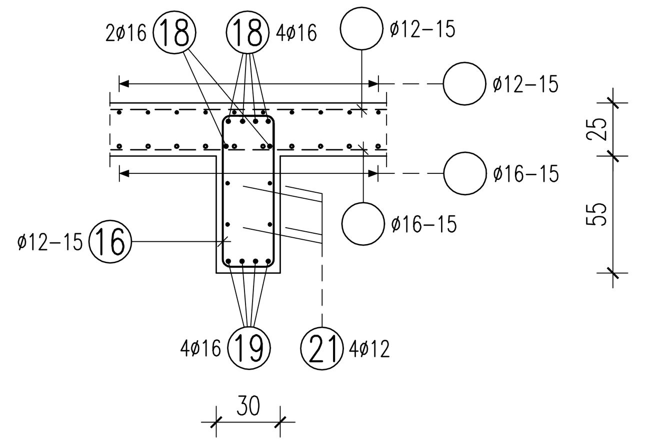
1–1 M 1:25



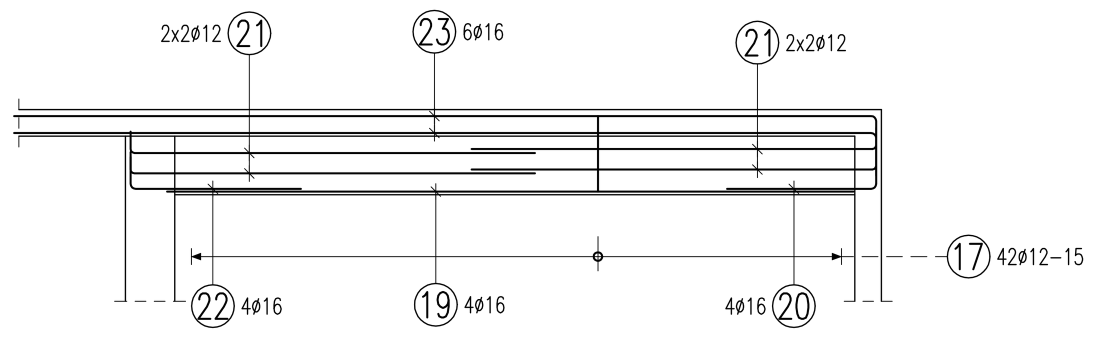
Greda G2 M 1:50
30x80cm



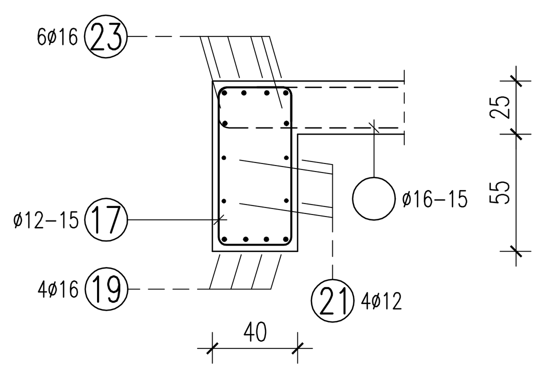
2–2 M 1:25



Greda G3 M 1:50
40x80cm



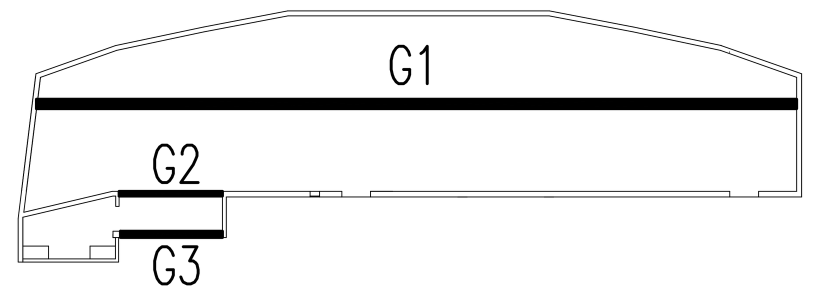
3–3 M 1:25



NAPOMENE:

1. Klasa betona: C30/37
2. Vrsta betonskog čelika: B500B
3. Zaštitni sloj betona: c = 3 cm

Pozicije greda



(1) 270ø12 L=2.42 m; 34 / 71	(2) 4ø12 L=6.00 m; 20 / 580	(3) 8ø20 L=4.00 m; 50 / 350	(4) 48ø25 L=0.40 m; 40	(5) 12ø12 L=12.00 m; 1200	(6) 24ø20 L=9.00 m; 725 / 145 / 30	(7) 26ø20 L=12.00 m; 1025 / 145 / 30	(8) 8ø20 L=3.00 m; 50 / 250	(9) 5ø20 L=8.50 m; 50 / 800	(10) 5ø20 L=7.50 m; 575 / 145 / 30	(11) 5ø20 L=8.50 m; 675 / 145 / 30	(12) 5ø20 L=7.00 m; 525 / 145 / 30
(13) 3ø20 L=2.50 m; 50 / 200	(14) 4ø12 L=6.00 m; 600	(15) 4ø12 L=4.20 m; 20 / 400	(16) 43ø12 L=2.22 m; 24 / 71	(17) 42ø12 L=2.48 m; 34 / 74	(18) 6ø16 L=9.00 m; 900	(19) 8ø16 L=6.45 m; 645	(20) 12ø16 L=1.70 m; 30 / 140	(21) 16ø12 L=4.00 m; 20 / 380	(22) 4ø16 L=1.90 m; 30 / 160	(23) 6ø16 L=8.50 m; 40 / 810	

ARMATURA GREDA IZNAD PODRUMA

K–02

118.9x59.4 cm

ISKAZ ARMATURE B500B

OBJEKT:

BR. NACRTA: K–02

GRADJEVINSKI DIO: ARMATURA GREDA IZNAD PODRUMA

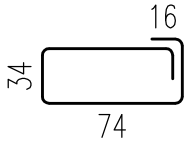
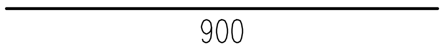
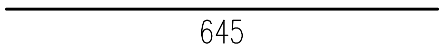
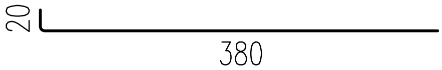
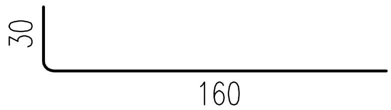
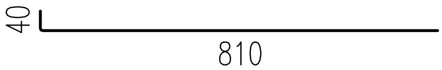
POZ	KOM	ø	DUZINA	OBLIK	UKUPNO KG
1	270	12	2.42	16 / 34 / 71	580.2
2	4	12	6.00	20 / 580	21.3
3	8	20	4.00	50 / 350	79.0
4	48	25	0.40	40	73.9
5	12	12	12.00	1200	127.9
6	24	20	9.00	725 / 145 / 5 / 30	533.8
7	26	20	12.00	1025 / 5 / 145 / 30	770.9
8	8	20	3.00	50 / 250	59.3
9	5	20	8.50	50 / 800	105.0
10	5	20	7.50	575 / 145 / 5 / 30	92.7
11	5	20	8.50	675 / 145 / 5 / 30	105.0
12	5	20	7.00	525 / 145 / 5 / 30	86.5
13	3	20	2.50	50 / 200	18.5
14	4	12	6.00	600	21.3
15	4	12	4.20	20 / 400	14.9
16	43	12	2.22	16 / 24 / 71	84.8

ISKAZ ARMATURE B500B

OBJEKT:

BR. NACRTA: K–02

GRADJEVINSKI DIO: ARMATURA GREDA IZNAD PODRUMA

POZ	KOM	∅	DUZINA	OBLIK	UKUPNO KG
17	42	12	2.48		92.5
18	6	16	9.00		85.3
19	8	16	6.45		81.5
20	12	16	1.70		32.2
21	16	12	4.00		56.8
22	4	16	1.90		12.0
23	6	16	8.50		80.6

ISKAZ ARMATURE

	∅		kg	
	12		999.7	
	16		291.6	
	20		1850.7	
	25		73.9	
UKUPNO			3215.9	