A4

Ovaj projekt je sastavni dio građevinske dozvole
Klasa: UP/I-361-03/19-01/0000 3
Urbroj: 2186/01-08-00/1-19-0005
Varaždin 10.06.2019 OVLAŠTENA OSOBA

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GRAĐEVINA:	[illegible] i prenamjena sinagoge u građevinu javne namjene (p[illegible]no koncertna namjena)
LOKACIJA:	k.č.br. 2018, k.o. V[illegible]raždin Augusta Cesarca 1[illegible]
ZAJEDNIČKA OZNAKA PROJEKTA:	SVZ
BROJ TEHNIČKOG DNEVNIKA:	55/18

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DOPUNSKI PRORAČUN GLAVNOM PROJEKTU
STATIČKI PRORAČUN DRVENE KONSTRUKCIJE LUKOVICE

HELENA PAVER NJIRIĆ
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OVLAŠTENA ARHITEKTICA
A4

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DATUM IZRADE PROJEKTA:	Zagreb, travanj 2019.

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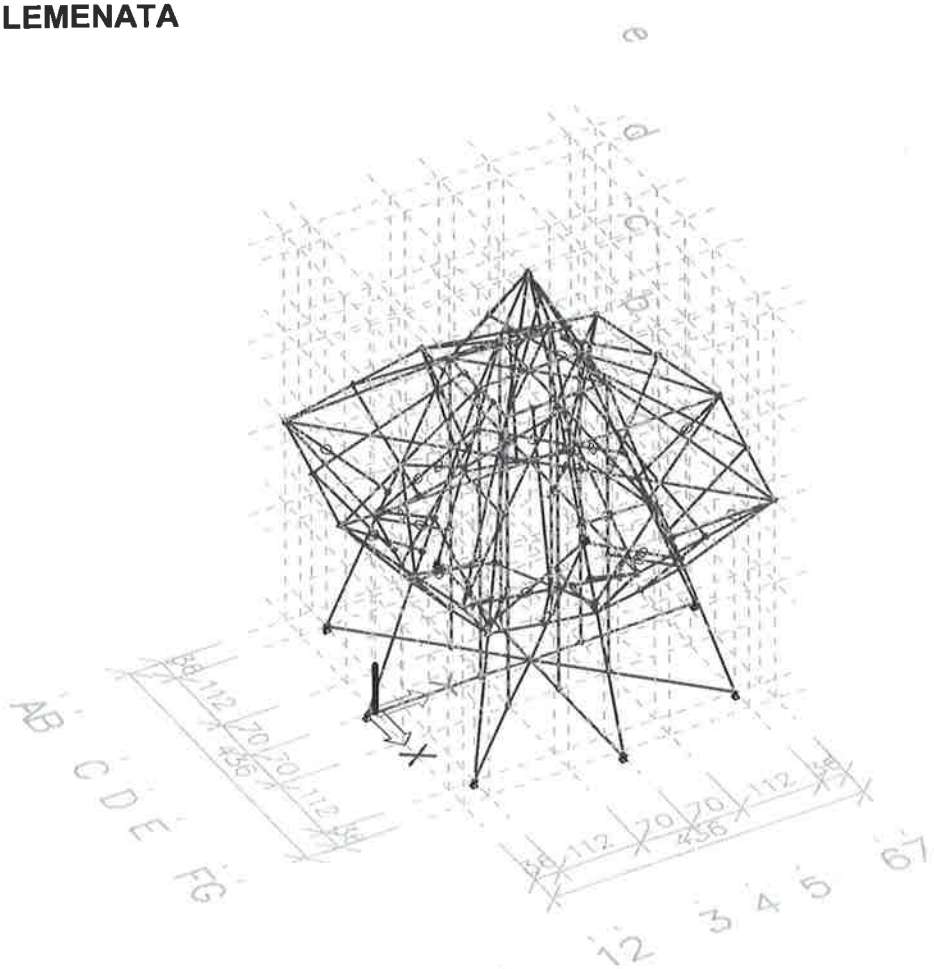
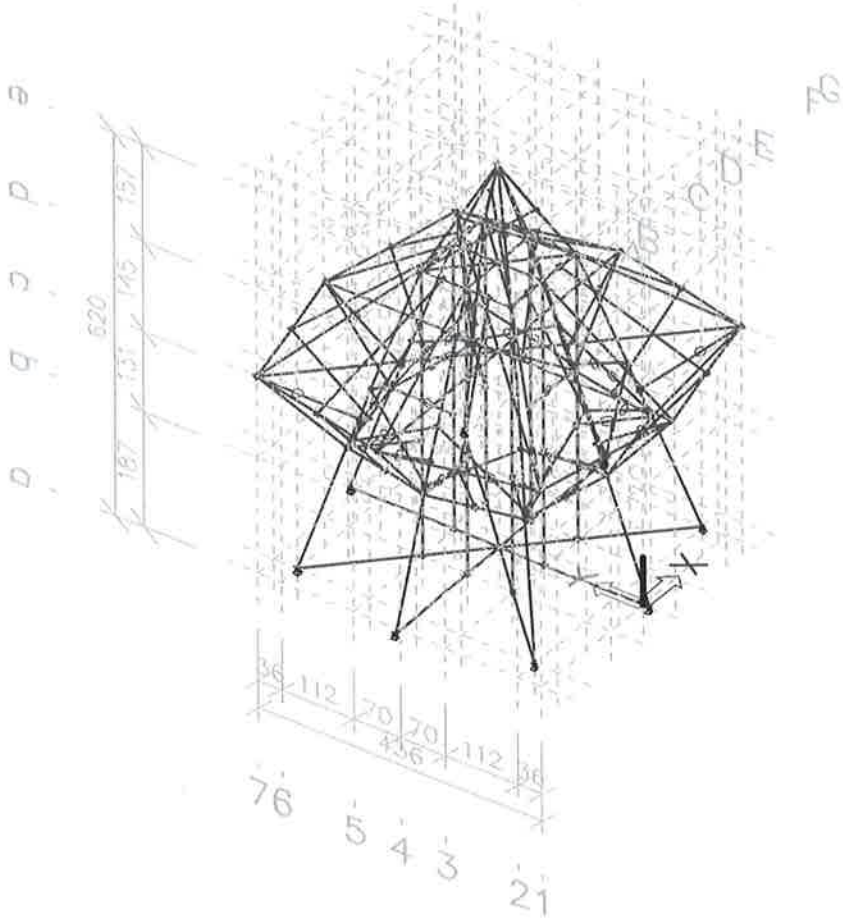
1. SHEMA ELEMENATA

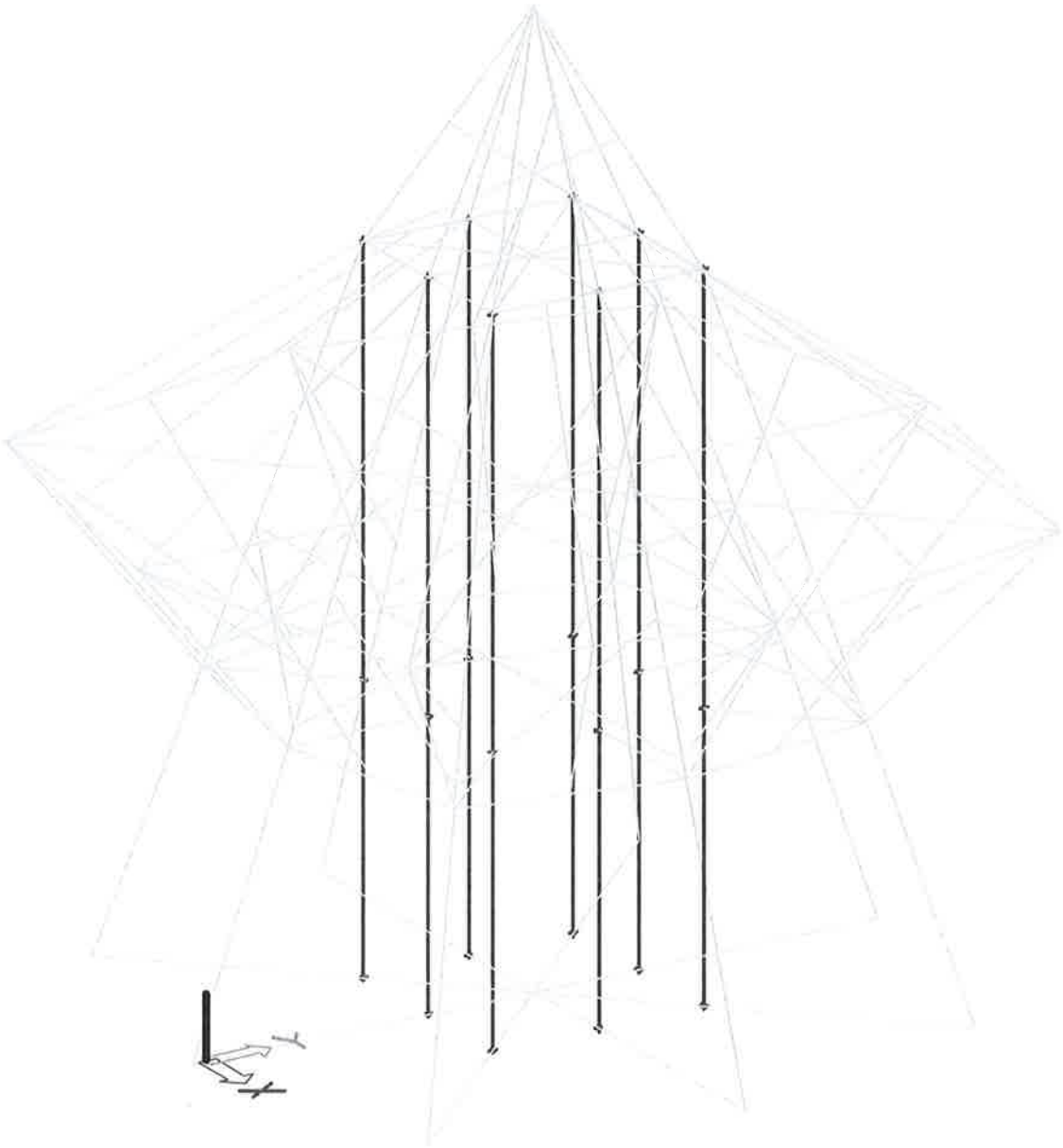
XY ravnina



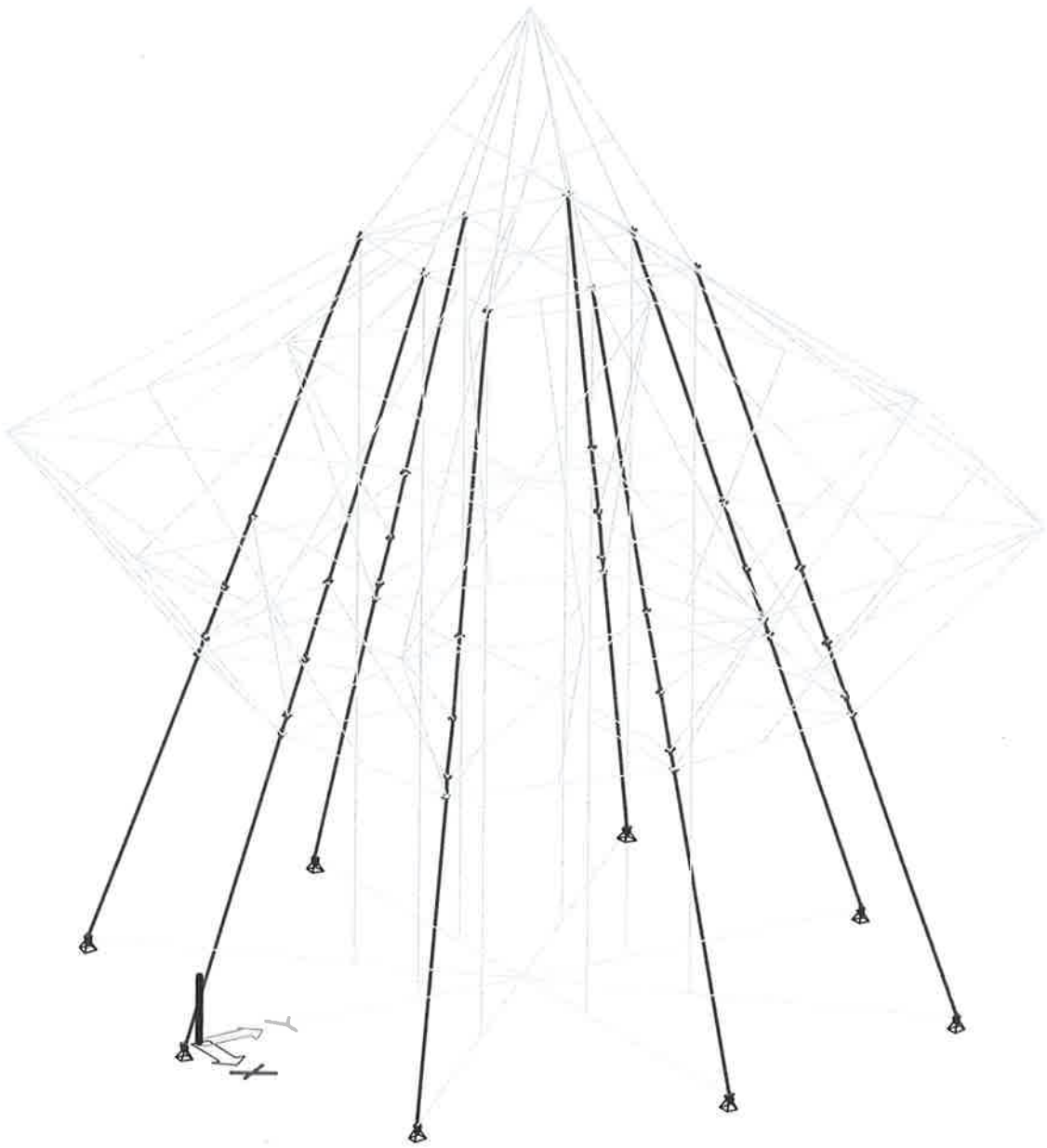
XZ ravnina



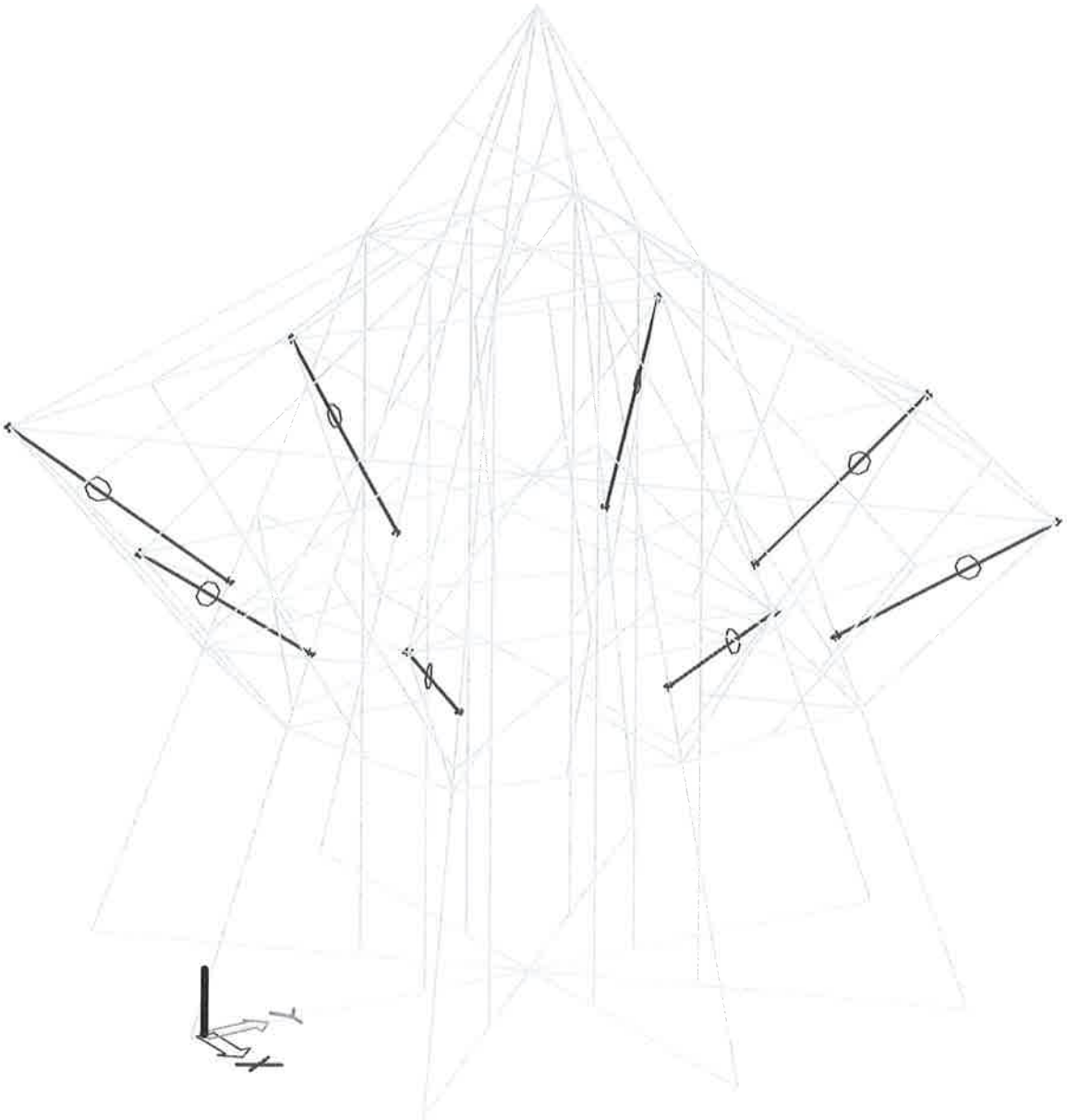
stupovi, b/h = 16/16 cm, C24



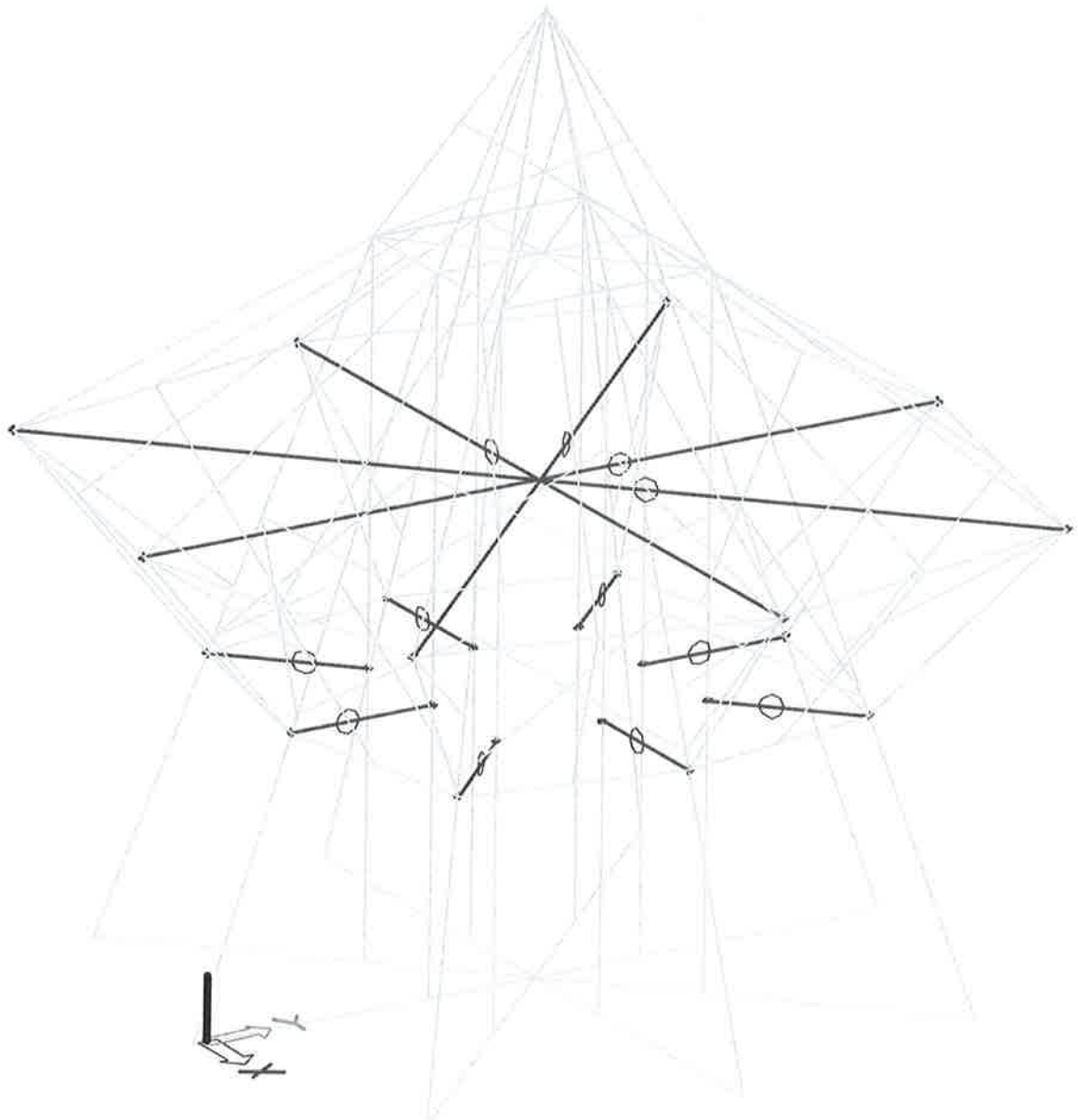
kosnici, b/h = 16/16 cm, C24



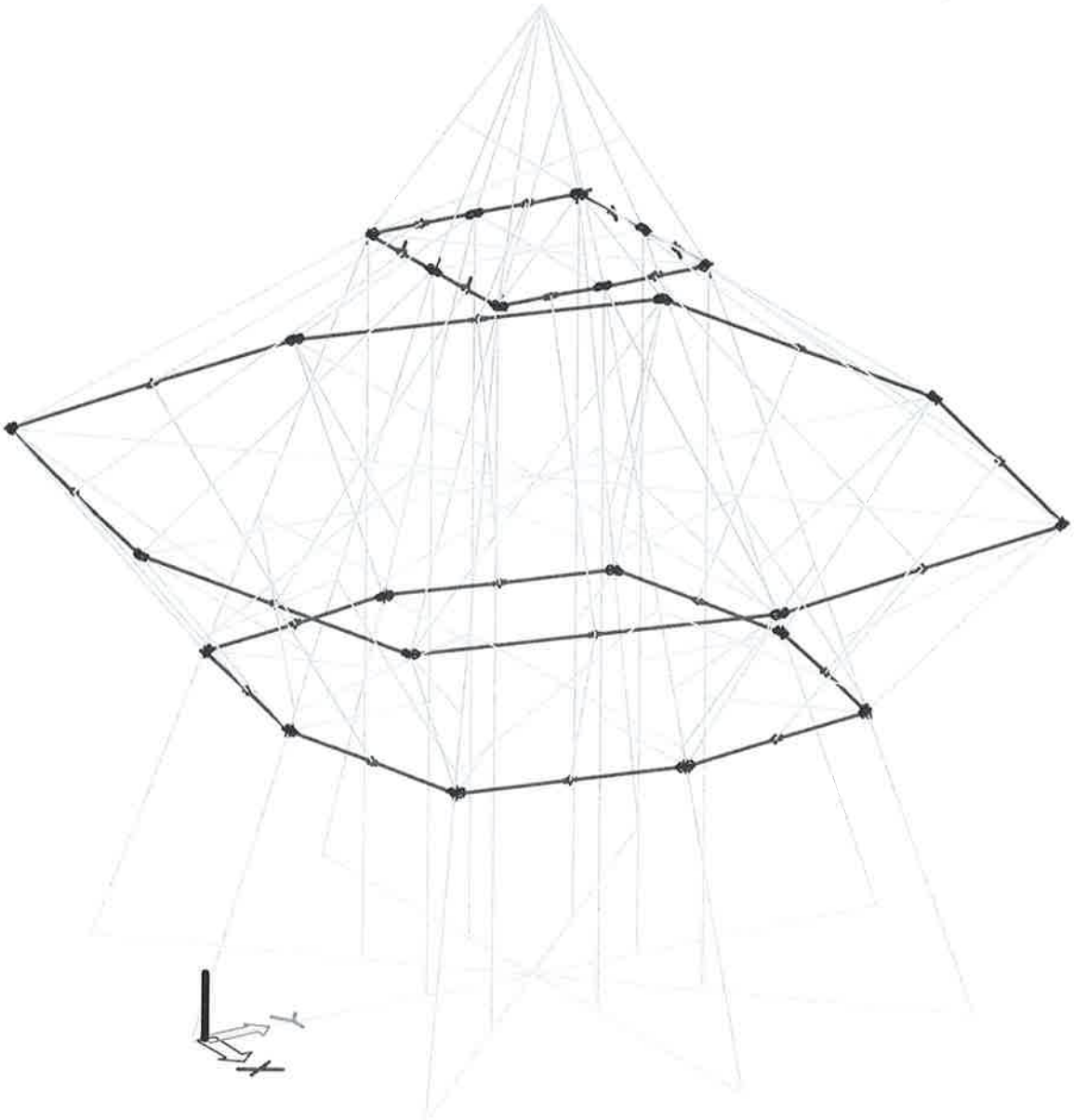
kosi stupovi, b/h = 12/12 cm, C24



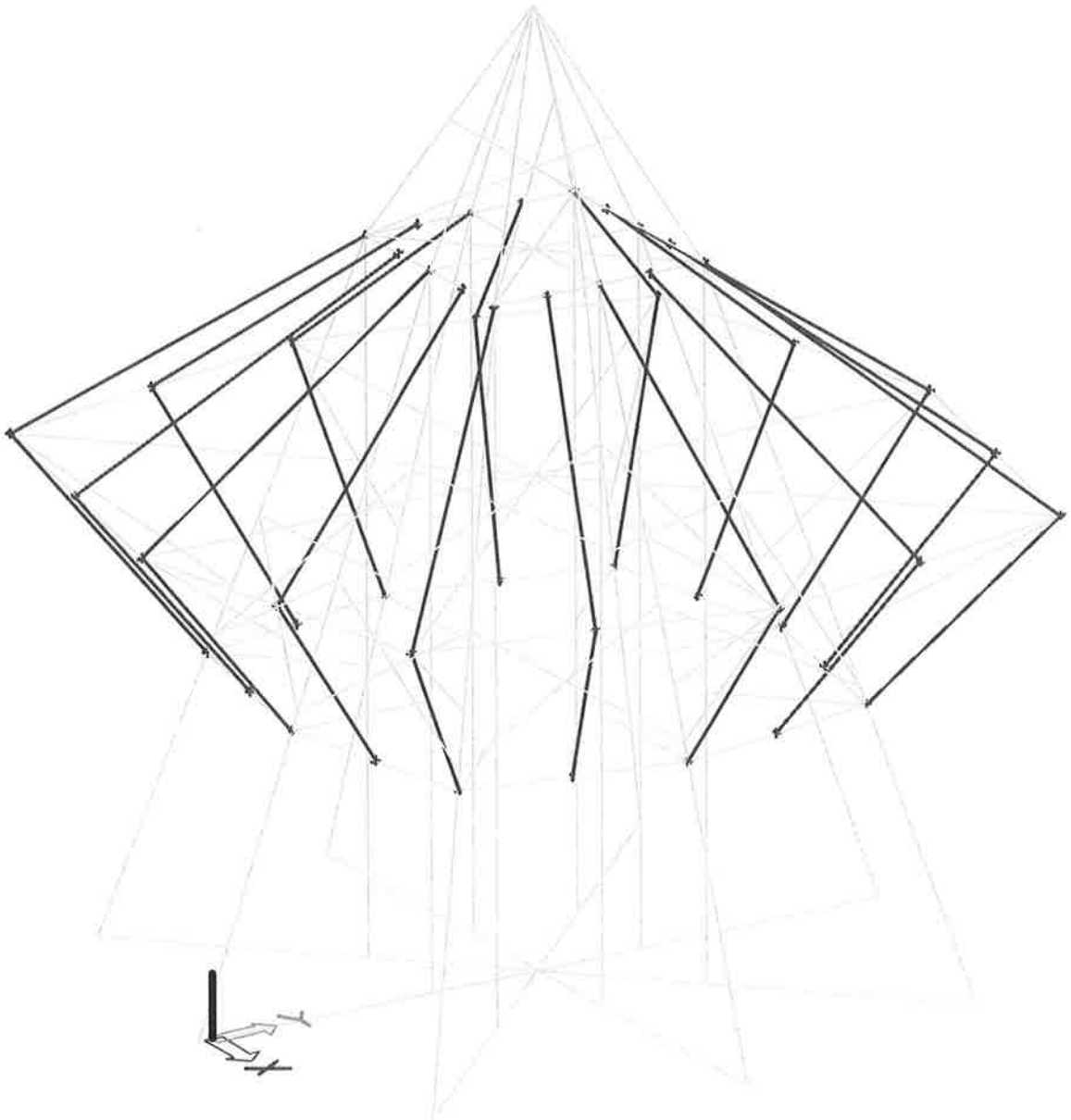
kliješta, b/h = 2*4/12 cm, C24



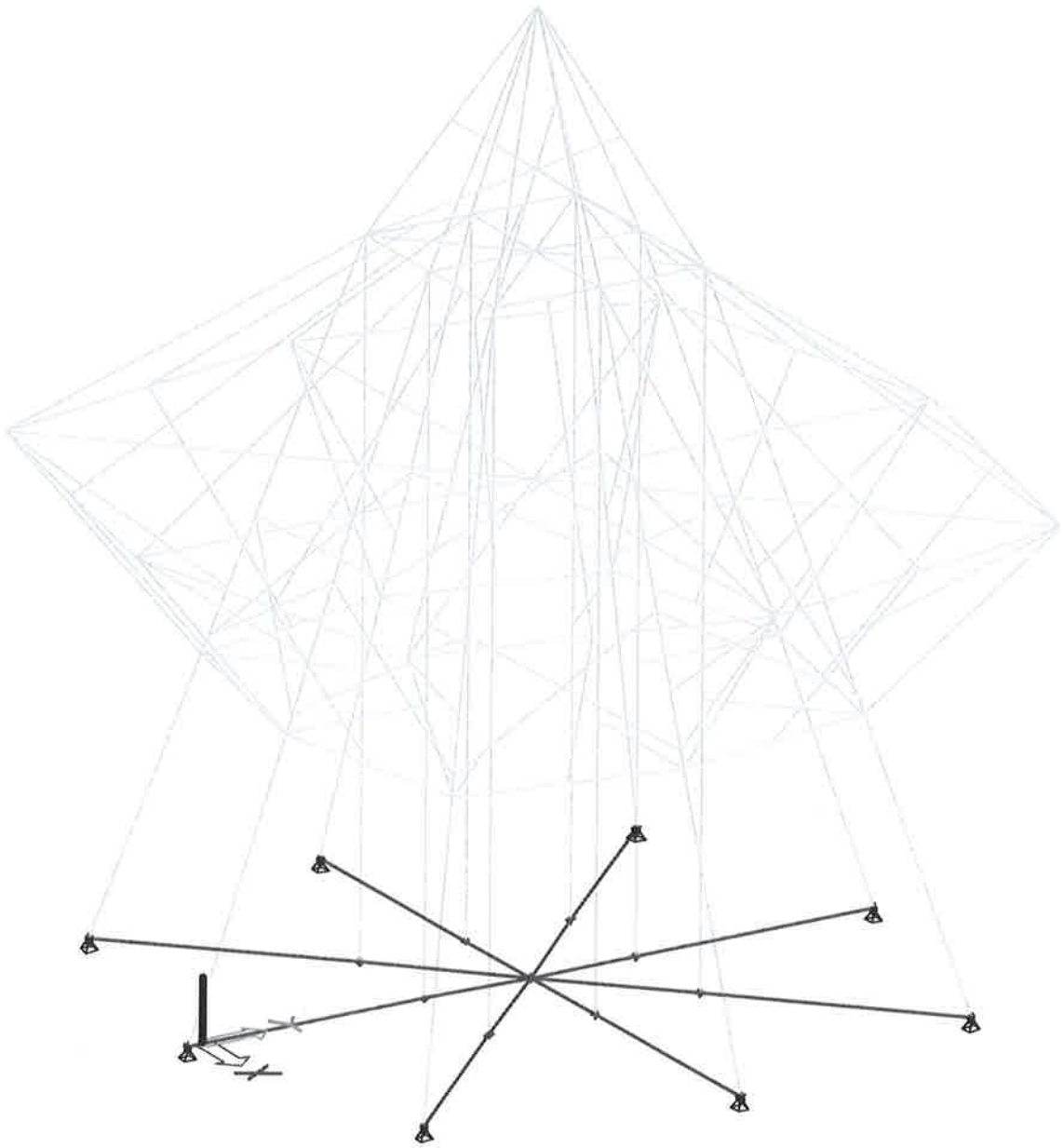
podrožnica, b/h = 16/16 cm, C24



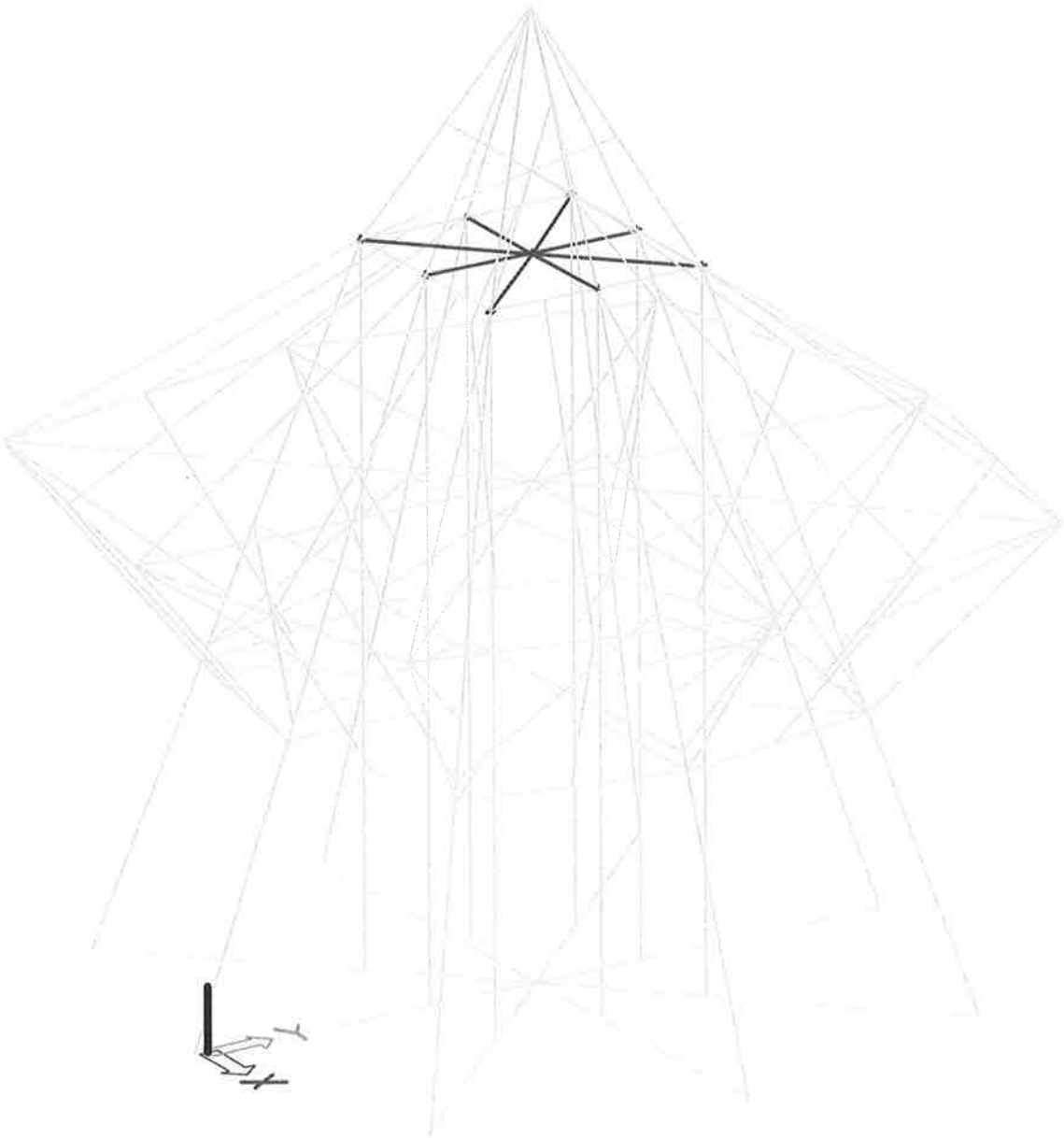
grebeni, b/h = 12/12 cm, C24



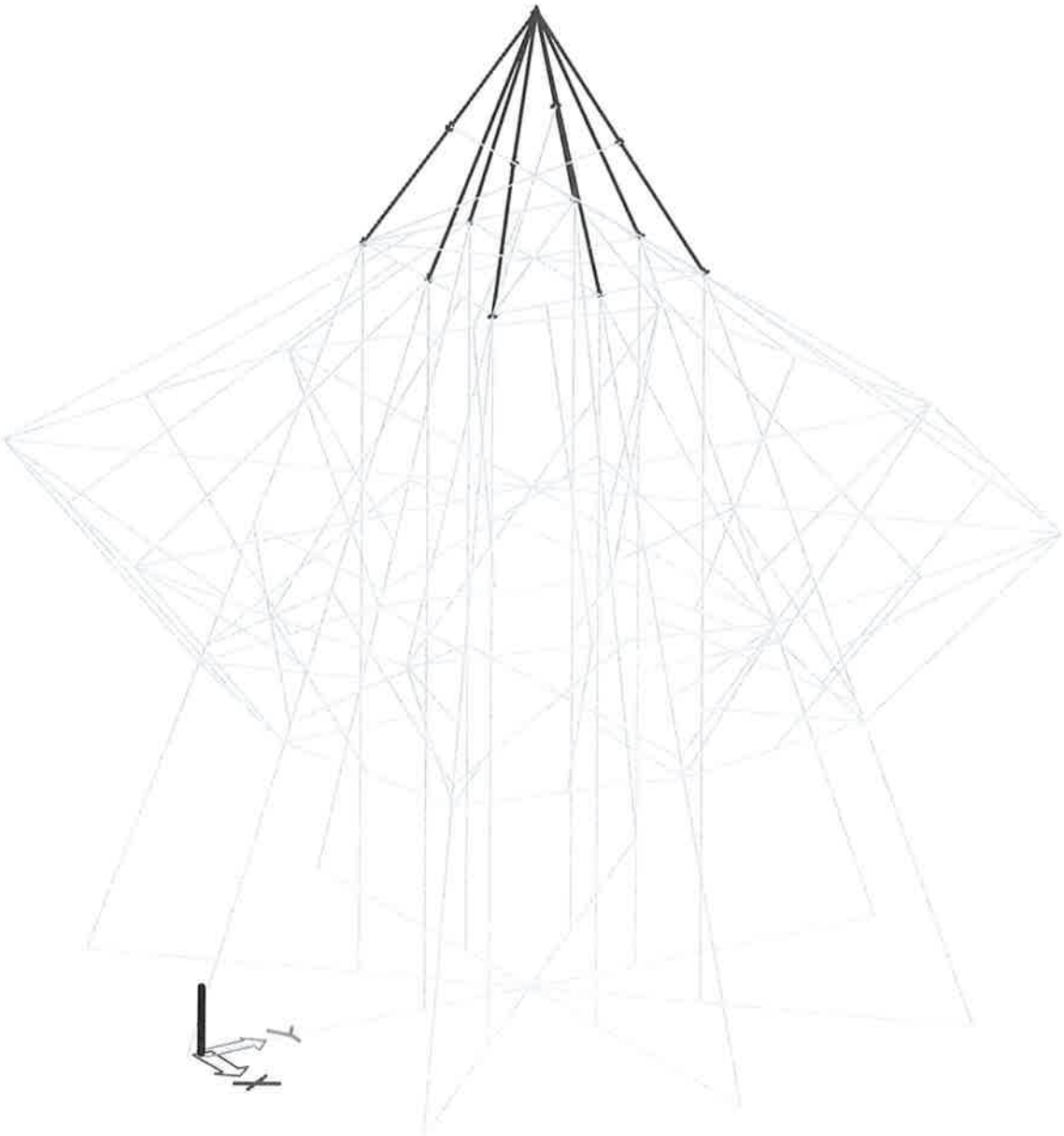
vezne grede dolje, b/h = 16/16 cm, C24



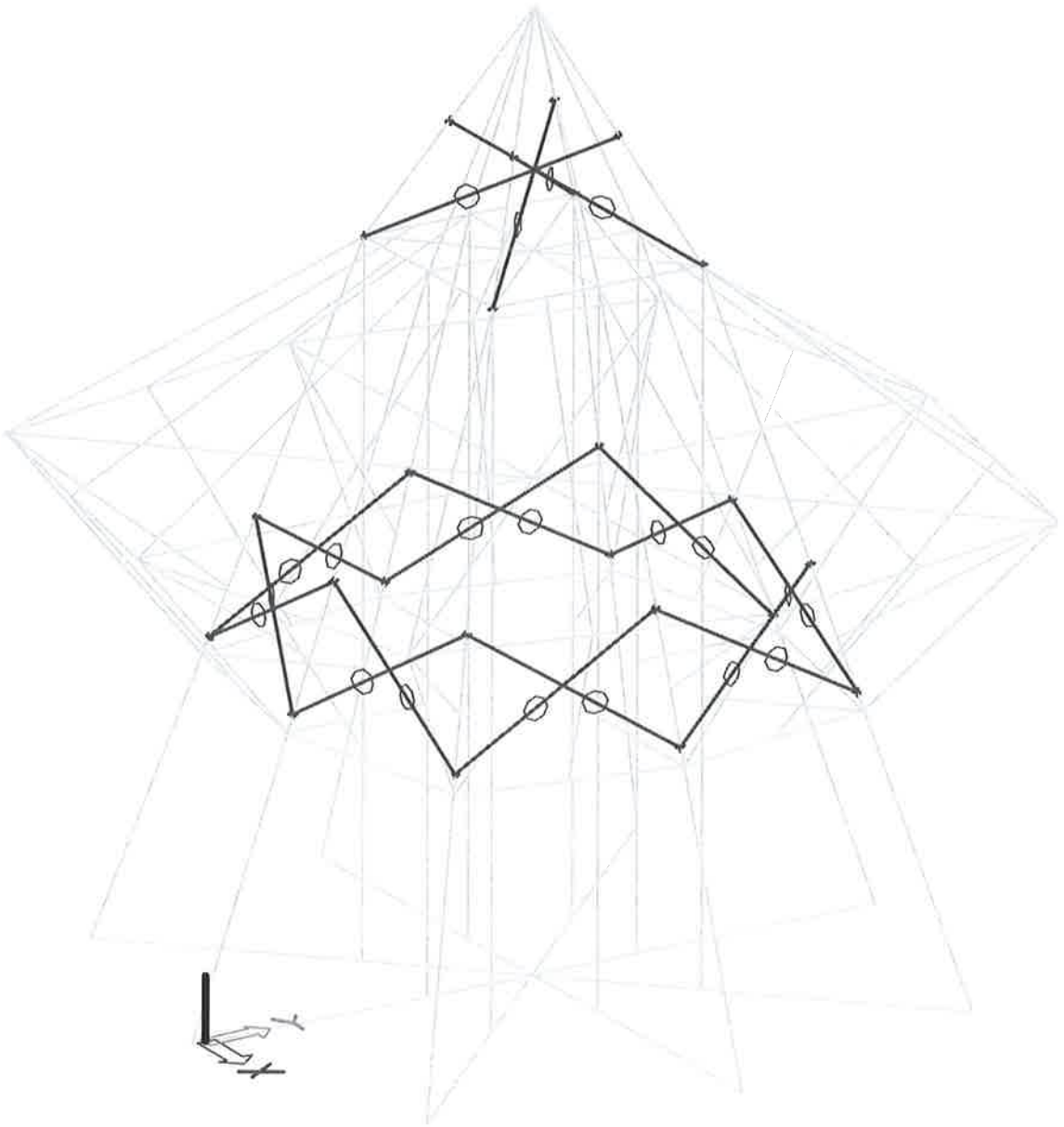
vezne grede gore, b/h = 12/12 cm, C24



gornji grebeni, b/h = 12/12 cm, C24



križevi, b/h = 12/12 cm, C24



2. TEHNIČKI OPIS

Predmet ovog dopunskog proračuna je nosiva drvena konstrukcija baroknog tornja koji se planira napraviti na zgradi sinagoge, na uličnom pročelju.

Nosivu konstrukciju donjeg dijela ("lukovica") tvore četiri para izduženih **stolica (u stupovima se javlja i tlak i vlak i spoj stupa sa veznom gredom dolje je zglobni)**. Stolice čine stupovi (dimenzija b/h = 16/16 cm, klasa drva C24), vezne grede dolje (dimenzija b/h = 16/16 cm, klasa drva C24), vezne grede gore (dimenzija b/h = 12/12 cm, klasa drva C24) i kosnici (dimenzija b/h = 16/16 cm, klasa drva C24). Statički sustav svih spomenutih elemenata stolice je prosta greda. Vezne grede, međusobno okomitih stolica, se spajaju u istoj horizontalnoj ravnini, pa je potrebno jednu prekinuti dok druga se nalazi iz jednog komada. Vezne grede druge dvije međusobno okomitih stolica se nalaze iznad ili ispod ravnine prvih spomenutih stolica.
Prema najizbočenijem dijelu lukovice, s polovice svakog kosnika, postaviti kose stupove (dimenzija b/h = 12/12 cm, klasa drva C24). Oni se s jedne strane upiru u kosnike, a s druge strane učepljuju u podrožnice. Kosi stupovi prenose samo uzdužnu silu.
Postoje tri kruga podrožnica (dimenzija b/h = 16/16 cm, klasa drva C24). Prvi krug je najviši, krajevi podrožnica se oslanjaju na čvorove koji spajaju stup, kosnik i veznu gredu gore, a preuzimaju opterećenje od grebena. Drugi krug je srednji. Krajevi podrožnica se oslanjaju na kose stupove, a prihvaćaju također opterećenja od grebena. Treći krug je najniži. Krajevi podrožnica se oslanjaju na kliješta. Statički sustav podrožnica je prosta greda. Svaki krug podrožnica čine osmerokutni vijenac.
Kliješta (dimenzija b/h = 2x4/12 cm, klasa drva C24) je potrebno staviti u dvije horizontalne ravnine. Prva ravnina je najistureniji dio lukovice; kliješta spajaju međusobno najudaljenije grebene, a pričvršćene su na kosnike i stupove. Druga ravnina u kojoj se polažu kliješta su na mjestu trećeg,najnižeg kruga podrožnica. Ta kliješta su također pričvršćena na kosnik i na stup. Prenose samo uzdužnu silu.
Grebeni (dimenzija b/h = 12/12 cm, klasa drva C24), kosim zasjecima naliježu na podrožnice. Oni daju projektiranu zakrivljenost grebena i krovnih ploha (nastaju daščanim opšavom svakog polja između dva susjedna grebena). Grebene postaviti obavezno u kuteve osmerokuta, no radi velikog osnog razmaka (e ≈ 2,3 m), potrebno je postaviti grebene po jedan između već spomenutih u kutevima osmerokuta.
Konstrukciju vrha čine gornji grebeni (dimenzija b/h = 12/12 cm, klasa drva C24),koji su također stabilizirani drvenim opšavom. Tako se sprečava izvijanje u krovnoj ravnini. Za smanjenu duljinu izvijanja u drugoj ravnini, potrebno je postaviti križeve. Statički sustav gornjih grebena je prosta greda. S jedne strane se oslanjaju na gornji osmerokutni vijenac podrožnica a drugi kraj završava u poluzglobu s drugom gredom.
Križeve (dimenzija b/h = 12/12 cm, klasa drva C24), potrebno je postaviti unutar konstrukcije vrha kako bi se smanjila duljina izvijanja van krovne plohe vrha. Postrebno ih je postaviti i između dva susjedna kosnika, kako bi se kosnicima smanjila duljina izvijanja.

Konstrukcija se temelji na postojećim zidovima sinagoge, na koje je potrebno izliti horizontalni AB serklaž. Proveden je dokaz sidrenja.

Svi elementi su svrstani u razred drva C24. To je standardna građa za naše podneblje, a ukoliko je neka druga vrsta dobavljiva slabijih tehničkih karakteristika, molimo kontaktirati projektanta konstrukcije.

Svi elementi konstrukcije računaju se za odgovarajuća opterećenja dana u hrvatskim normama niza HRN EN 1991. Proračun se provodi za djelovanje slijedećih utjecaja na konstrukciju: vlastite težine, dodatnog stalnog opterećenja, opterećenja snijegom te opterećenje vjetrom. Svaki slučaj opterećenja je razrađen i prikazan u poglavlju 3 ovog projekta.

Proračuni i dimenzioniranja su izvedeni pomoću SCIA Engineer, metodom konačnih elemenata. Za potrebe dokaza nosivosti i uporabljivosti konstrukcije te dimenzioniranje elemenata načinjen je 3D modeli konstrukcije.

3. ANALIZA OPTEREĆENJA

1. Vlastita težina

Programski paket Scia Engineer sama u obzir uzima vlastitu težinu elemenata.

2. Dodatno stalno opterećenje

drvena oplata	5 kN/m^3*0,02 m =	0,1	kN/m^2
limeni opšav	78,5 kN/m^3*0,005 m =	0,39	kN/m^2
	=	0,49	kN/m^2
	=	**0,5**	**kN/m^2**

osni razmak gornjih grebena e = 0,7 m	= 0,35	kN/m
osni razmak glavnih grebena e = 1,15 m	= 0,58	kN/m

3. Opterećenje snijegom

Lokacija: Varaždin
Zona: III - Kontinentalna Hrvatska

Karakteristično opterećenje snijegom na tlu:
s_k = 1,00 kN/m^2

Koeficijent izloženosti c_e = 1,00 (normalna topografija)
Koeficijent gubitka topline kroz krov c_t = 1,00 (izolirani krov)

Koeficijent oblika za lukovicu $\mu_i(\alpha_1) = \mu_i(\alpha_2)$ = 0,42
(α = 44°)

Opterećenje snijegom na krovu: $s = \mu_i C_e C_t s_k$ = **0,42 kN/m^2**

osni razmak glavnih grebena e = 1,15 m = 0,48 kN/m

Opterećenje na toranj neće se razmatrati jer je kut greda i horizontale preko 60 ° pa je i μ = 0 stoga nema opterećenja snijegom za toranj.

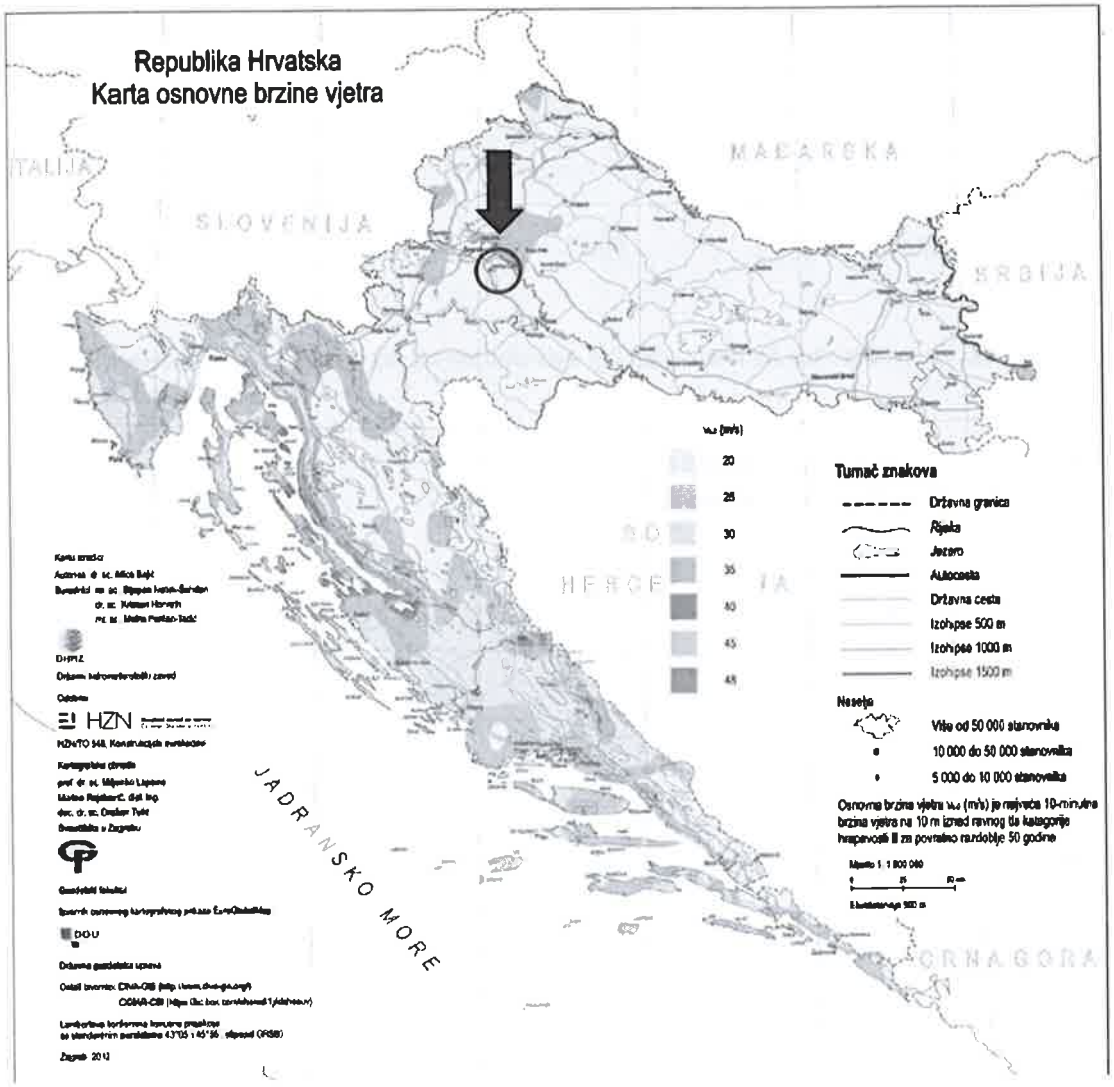
4. Opterećenje vjetrom

Lokacija: Varaždin

Zona:

Osnovna brzina vjetra:

$v_{b,0}$ = 20,00 m/s



Referentna brzina vjetra: $v_{ref}=c_{DIR} \times c_{TEM} \times c_{ALT} \times v_{b,0}$ = 20 m/s

c_{DIR} = 1,00 koeficijent smjera vjetra

c_{TEM} = 1,00 koeficijent ovisan o godišnjem dobu

c_{ALT} = 1,00 koeficijent nadmorske visine

Poredbeni tlak srednje brzine vjetra $q_{ref}=\rho/2 \times v_{ref}^2$ = 0,25 kN/m^2

ρ = 1,25 kg/m^3 gustoća zraka

Kategorija zemljišta: **IV** Područje s najmanje 15% površine prekrivene zgradama čija prosječna visina premašuje 15 m

Visina objekta iznad terena (najviša točka): h= 21,85 m

Koeficijent izloženosti: $c_e(z)$= 1,7

Koeficijent vanjskog pritiska za dvostrešne krovove:

Područje	A		B		C		D		E	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	−1,2	−1,4	−0,8	−1,1	−0,5		+0,8	+1,0	−0,7	
1	−1,2	−1,4	−0,8	−1,1	−0,5		+0,8	+1,0	−0,5	
≤ 0,25	−1,2	−1,4	−0,8	−1,1	−0,5		+0,7	+1,0	−0,3	

područje A:

c_e= 1,20 c_i= 0,00 $w = q_{ref} \times c_e(z) \times (c_{e+i}) =$ **0,51 kN/m²**

Unutarnji pritisak vjetra se ne može stvoriti jer će lukovica biti zatvorena sa svih strana. Odabiremo područje A jer daje maksimalni pritisak vjetra.

osni razmak gornjih grebena e = 0,7 m = 0,36 kN/m
osni razmak glavnih grebena e = 1,15 m = 0,59 kN/m

5. Kombinacije opterećenja

Elementi će biti proračunati prema EC5 propisima uz odgovarajuće parcijalne koeficijente sigurnosti za materijal i opterećenja.

slučajevi opterećenja:

Name	Description	Action type	Load group	Load type	Spec	Direction	Duration	Master load case
LC1	vl. tezina	Permanent	stalno	Self weight		-Z		
LC2	slojevi krova	Variable	snijeg	Static	Standard		Short	None
LC3	snijeg	Variable	snijeg	Static	Standard		Short	None
LC4	vjetar	Variable	vjetar	Static	Standard		Short	None

kombinacije:

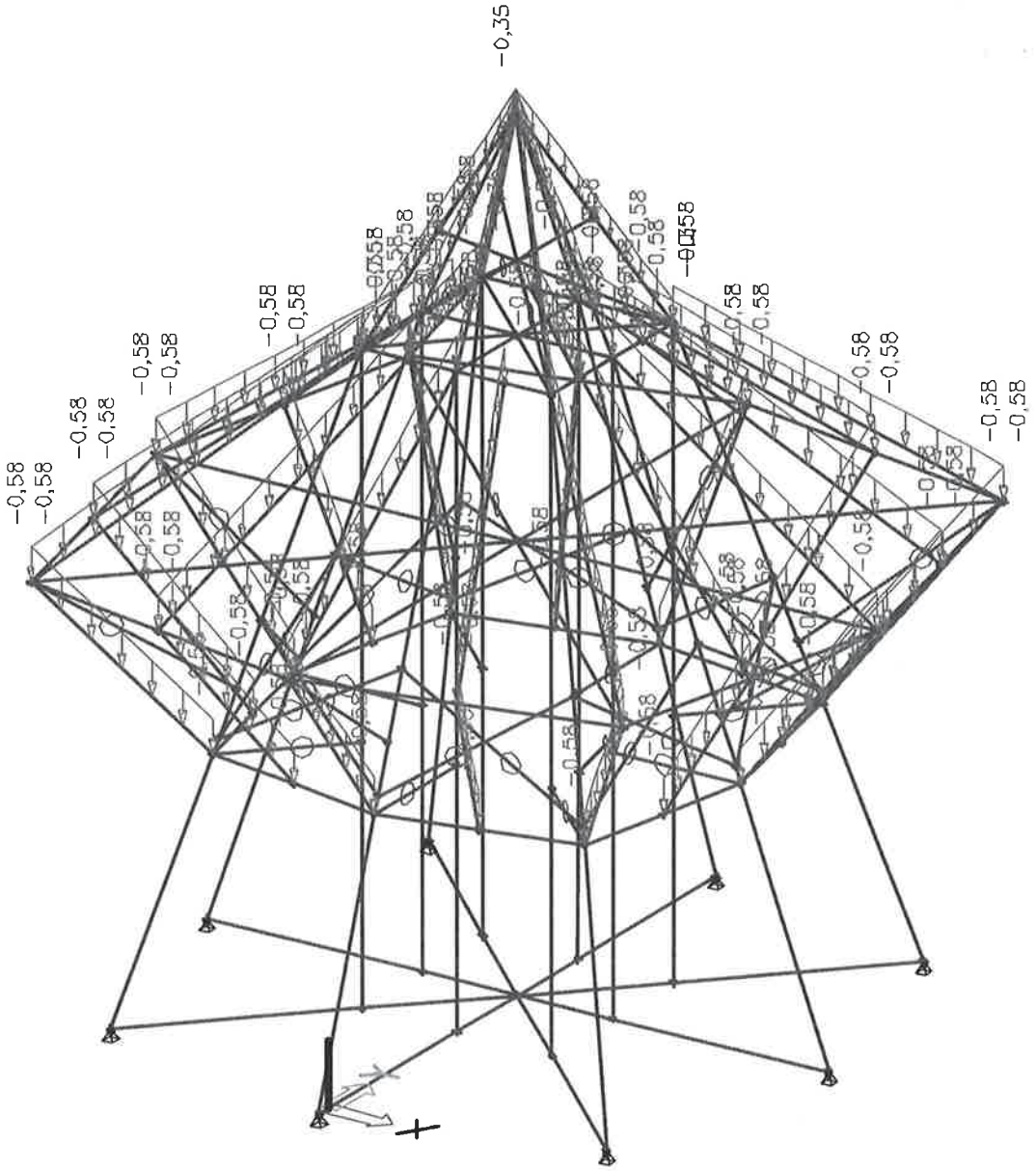
Name	Description	Type	Load cases	Coeff. [-]
CO1	g+dg+s+0,6w	Linear - ultimate	LC1 - vl. tezina	1,35
			LC2 - slojevi krova	1,35
			LC3 - snijeg	1,50
			LC4 - vjetar	0,90
CO2	g+dg+0,6s+w	Linear - ultimate	LC1 - vl. tezina	1,35
			LC2 - slojevi krova	1,35
			LC3 - snijeg	0,75
			LC4 - vjetar	1,50
CO3	g+dg+s+0,6w	Linear - serviceability	LC1 - vl. tezina	1,00
			LC2 - slojevi krova	1,00
			LC3 - snijeg	1,00
			LC4 - vjetar	0,60
CO4	g+dg+0,6s+w	Linear - serviceability	LC1 - vl. tezina	1,00
			LC2 - slojevi krova	1,00
			LC3 - snijeg	0,50
			LC4 - vjetar	1,00
CO5	g+dg	Linear - serviceability	LC1 - vl. tezina	1,00
			LC2 - slojevi krova	1,00

anvelopa:

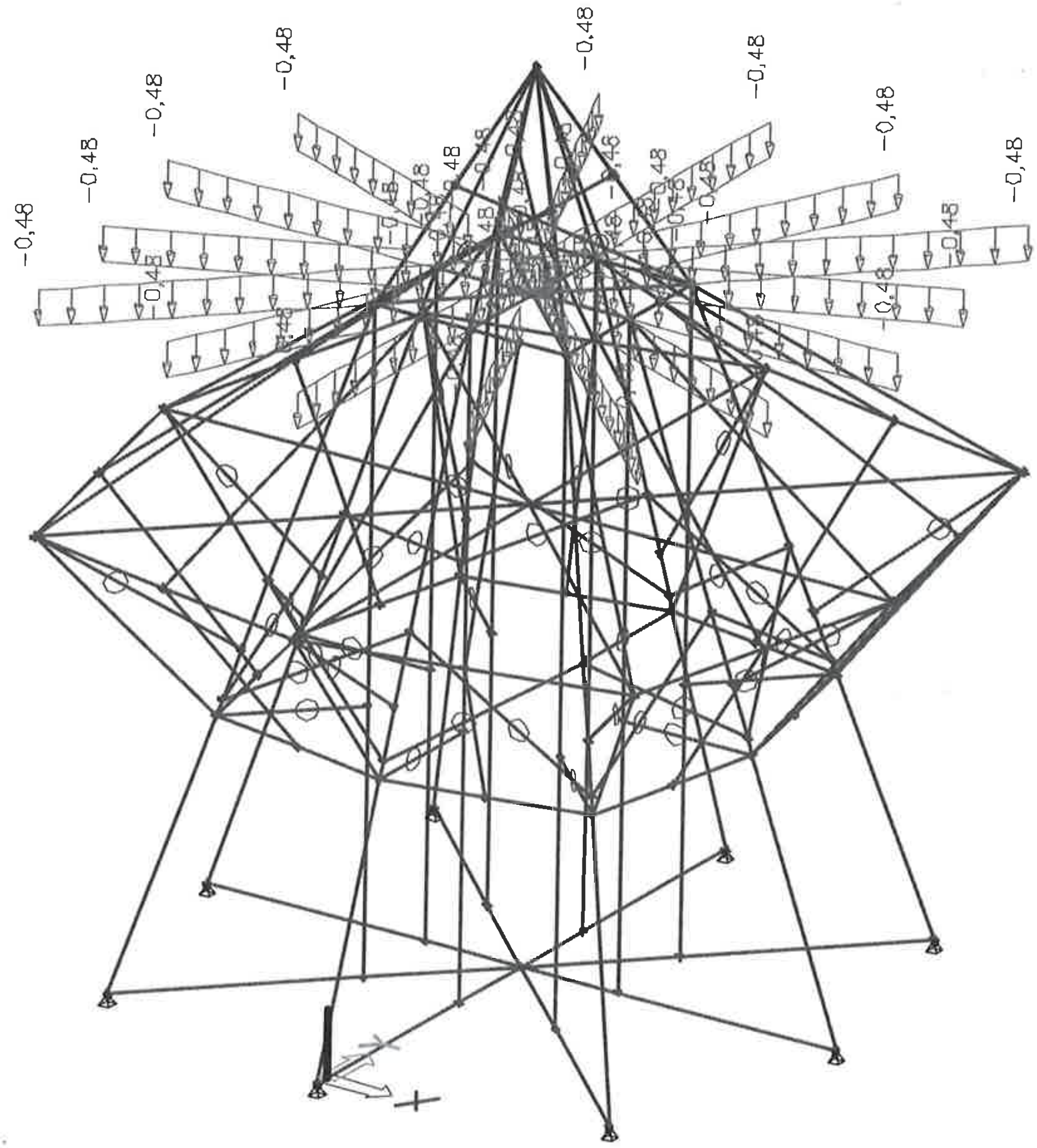
Name	List
ULS	CO1 - Linear - ultimate
	CO2 - Linear - ultimate
SLS	CO3 - Linear - serviceability
	CO4 - Linear - serviceability
	CO5 - Linear - serviceability

prikaz opterećenja:

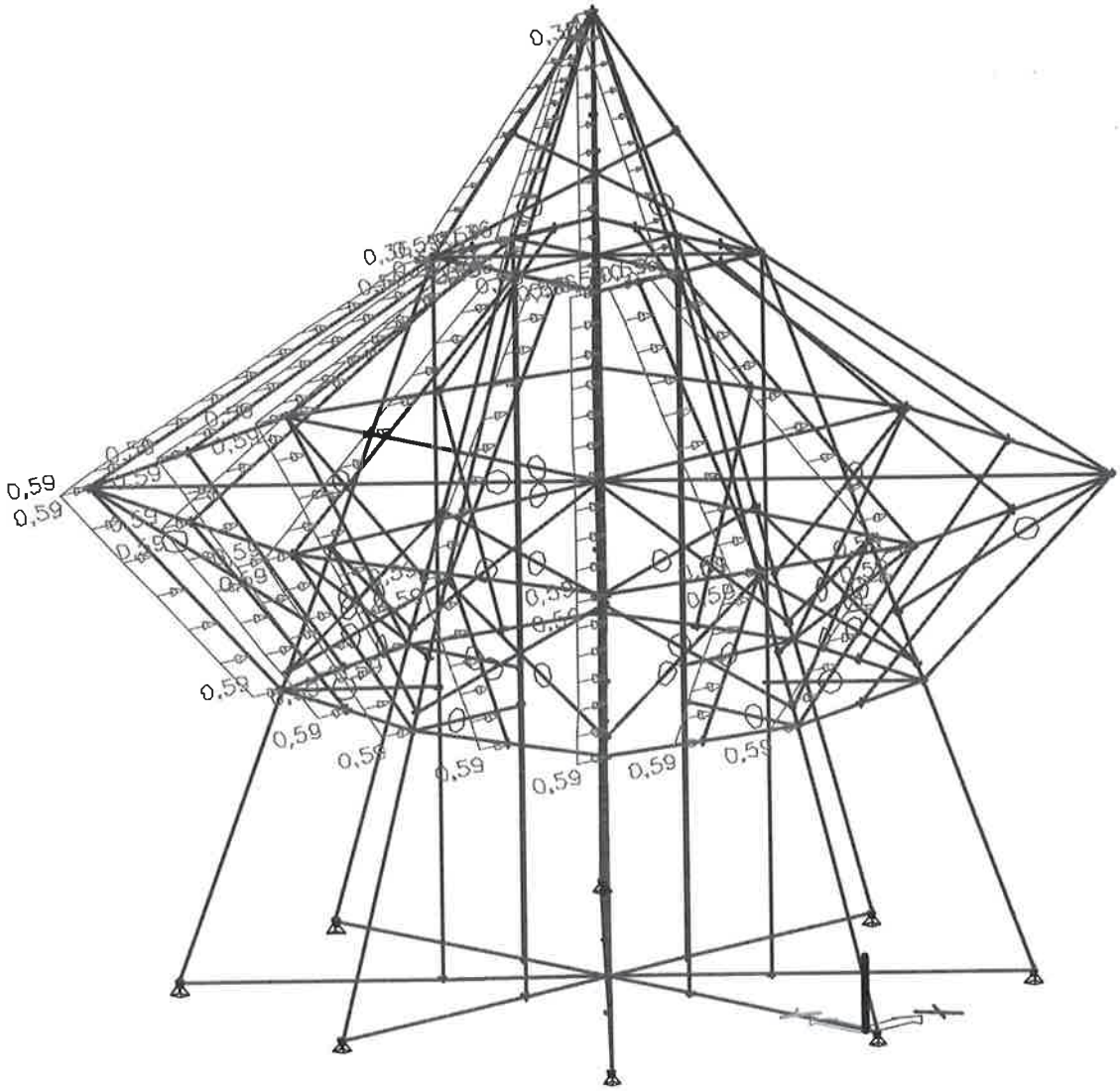
LC2 slojevi krova



LC3 opterećenje snijegom



LC4 opterećenje vjetrom



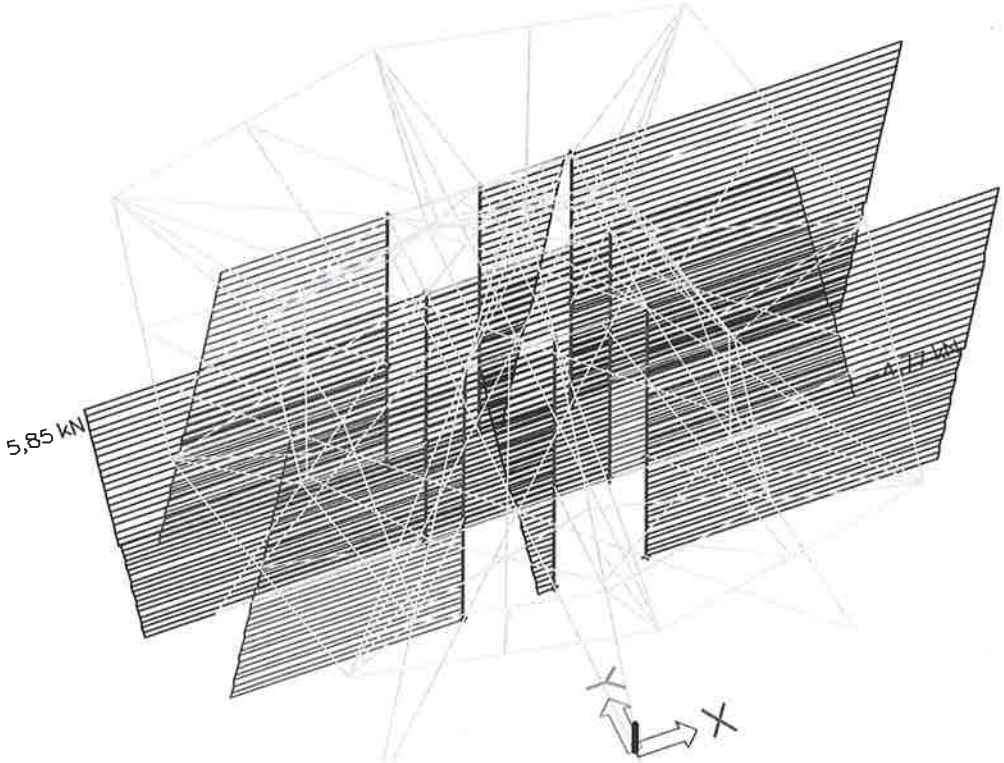
Iako se vjetar na plohu nanosi okomito, u EC nije obrađen slučaj baroknog tornja pa smo uveli neke preinake.

4. PRIKAZ UNUTARNJIH SILA I REAKCIJA

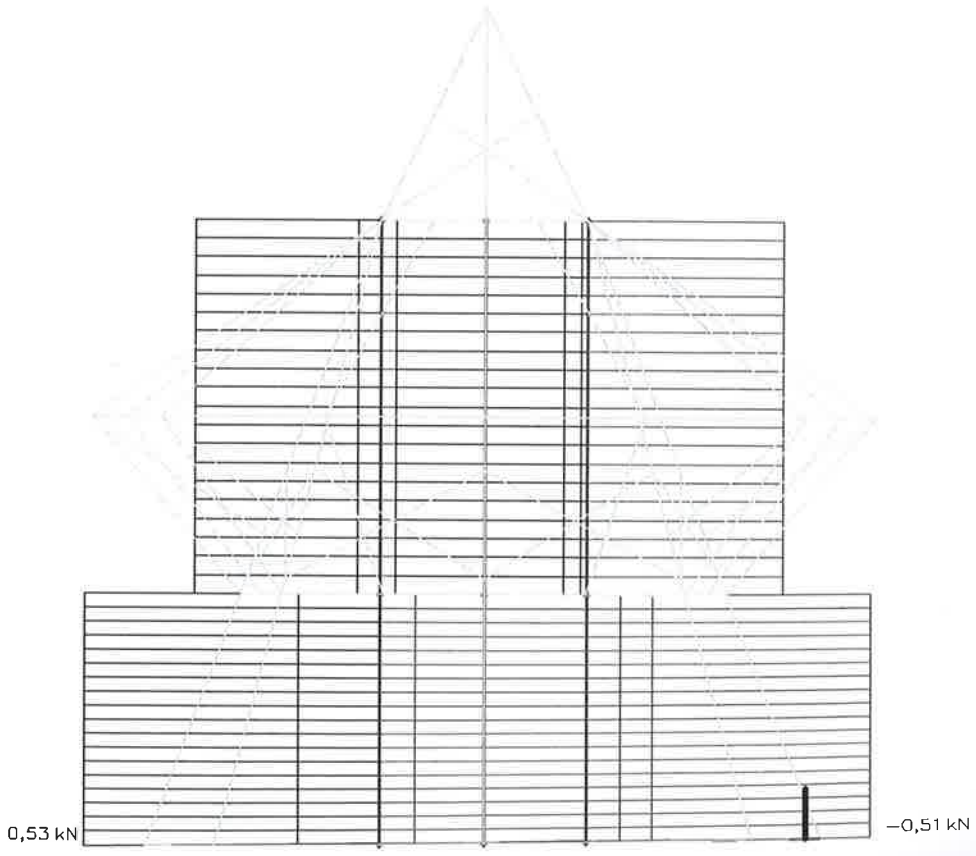
1. Prikaz unutarnjih sila za ULS

stupovi, b/h = 16/16 cm, C24

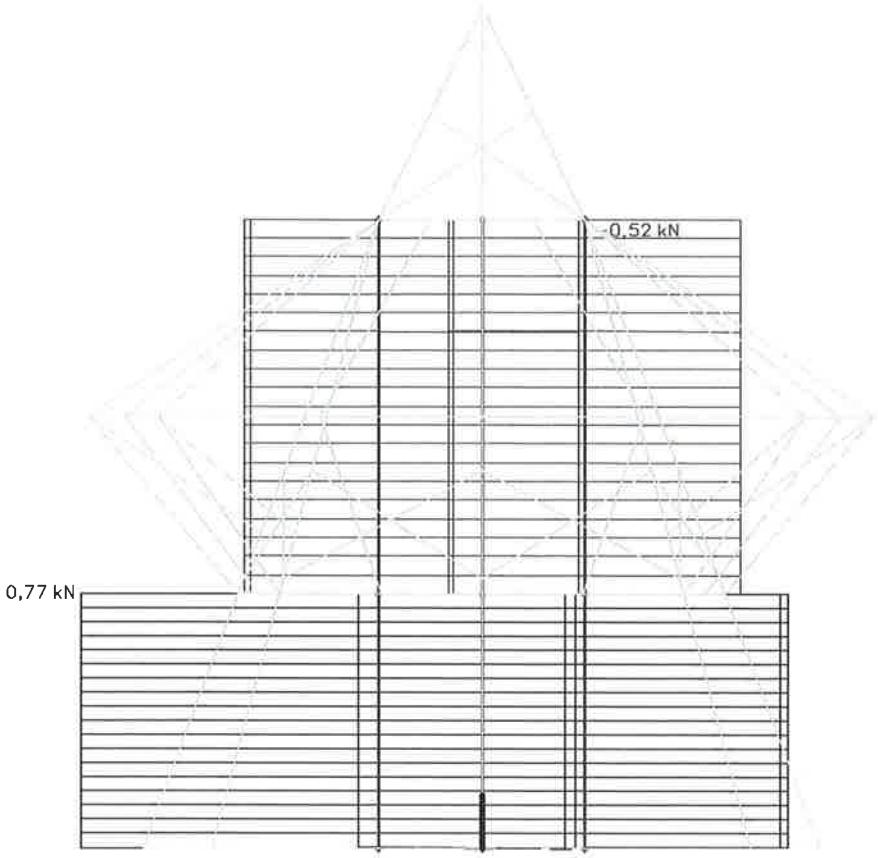
N



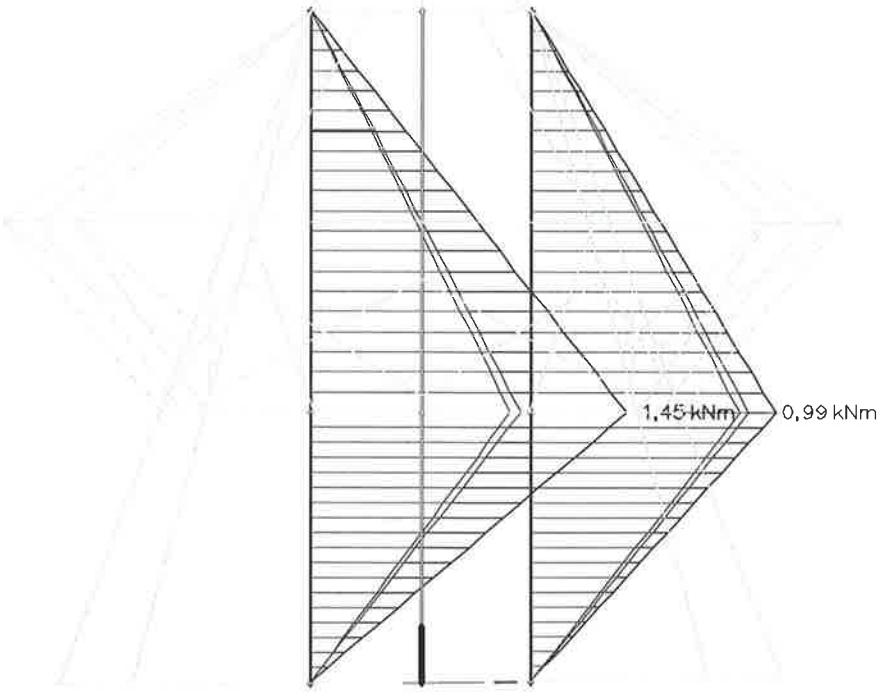
V_y



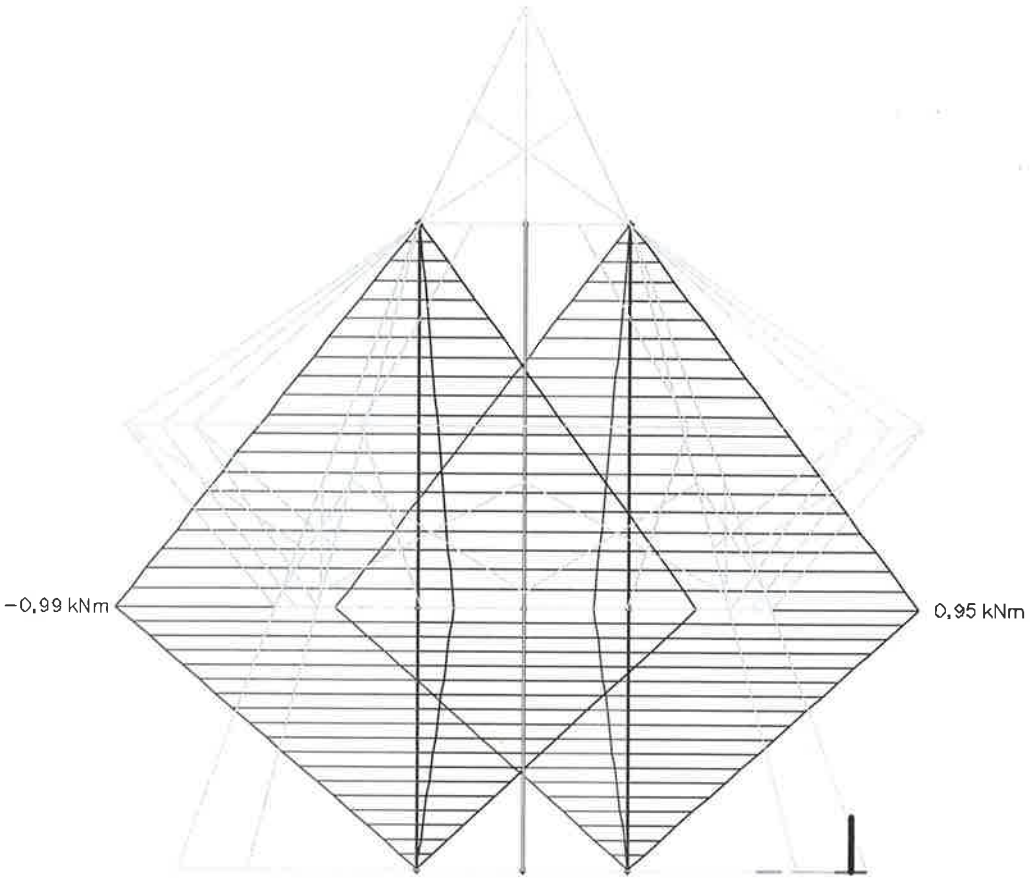
V_z



M_y

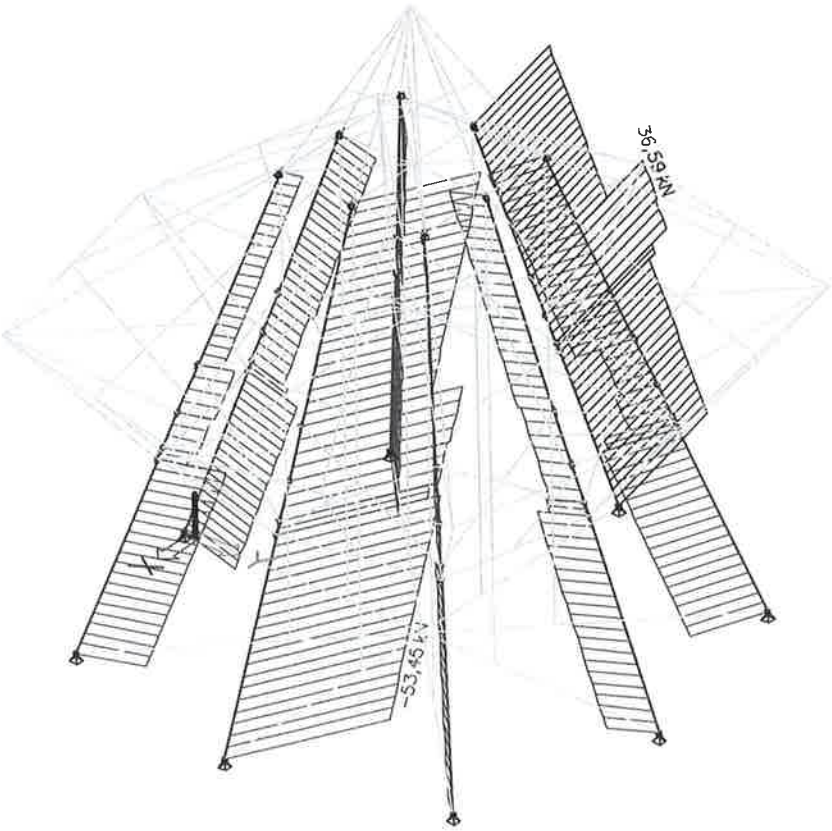


M_z

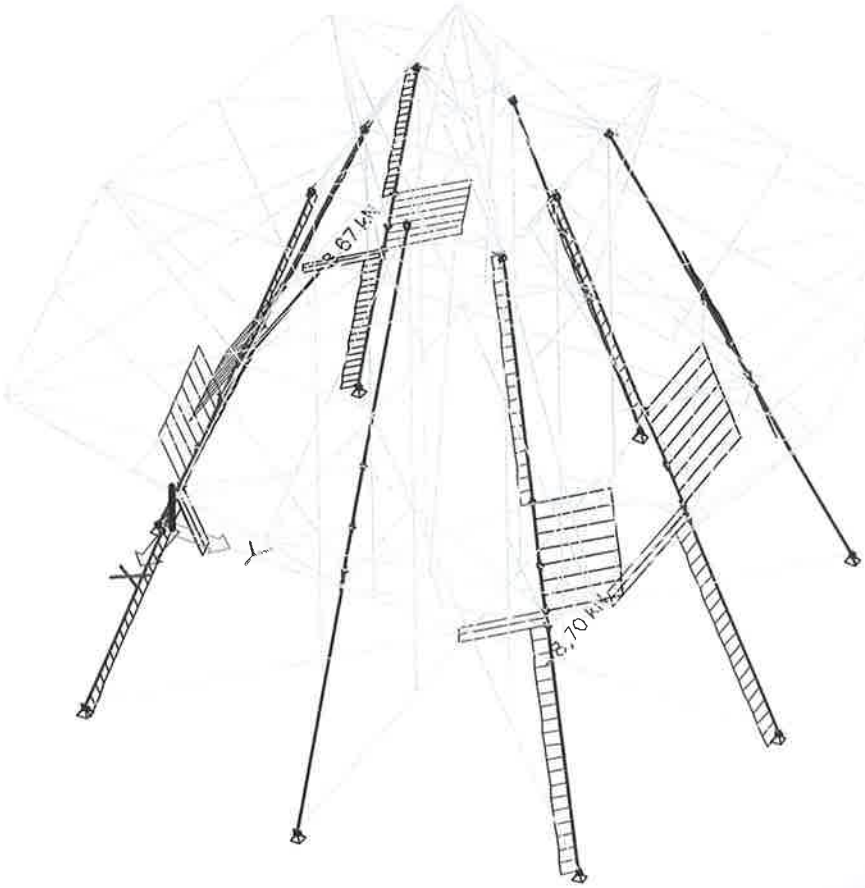


kosnici, b/h = 16/16 cm, C24

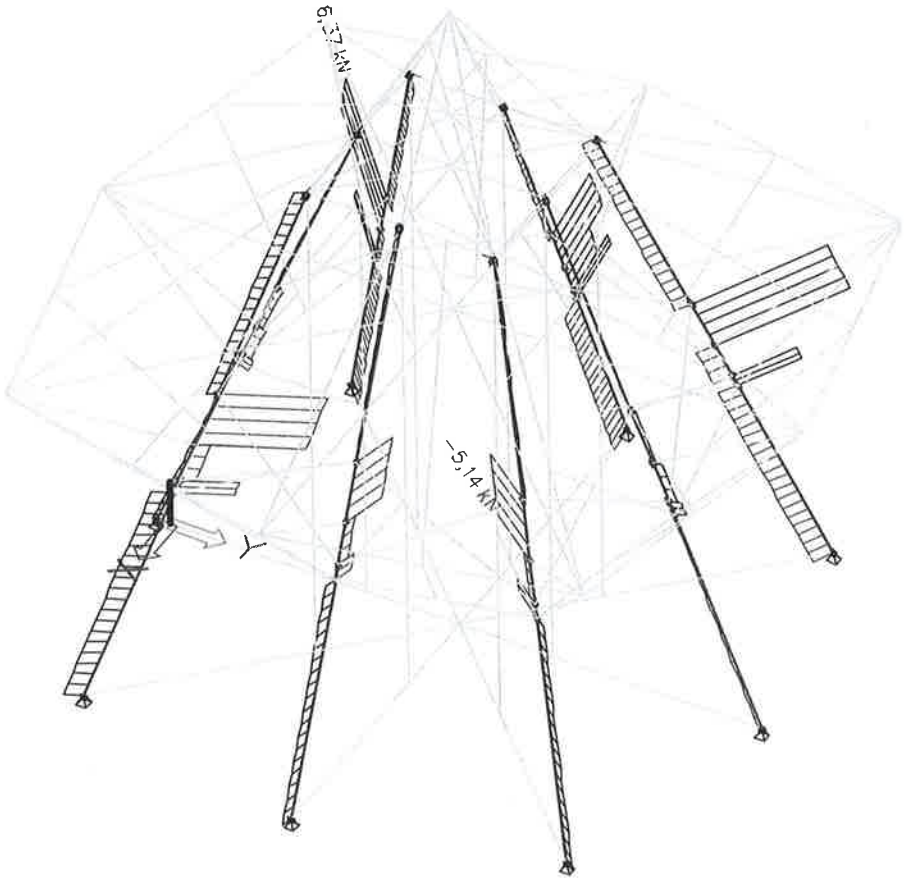
N



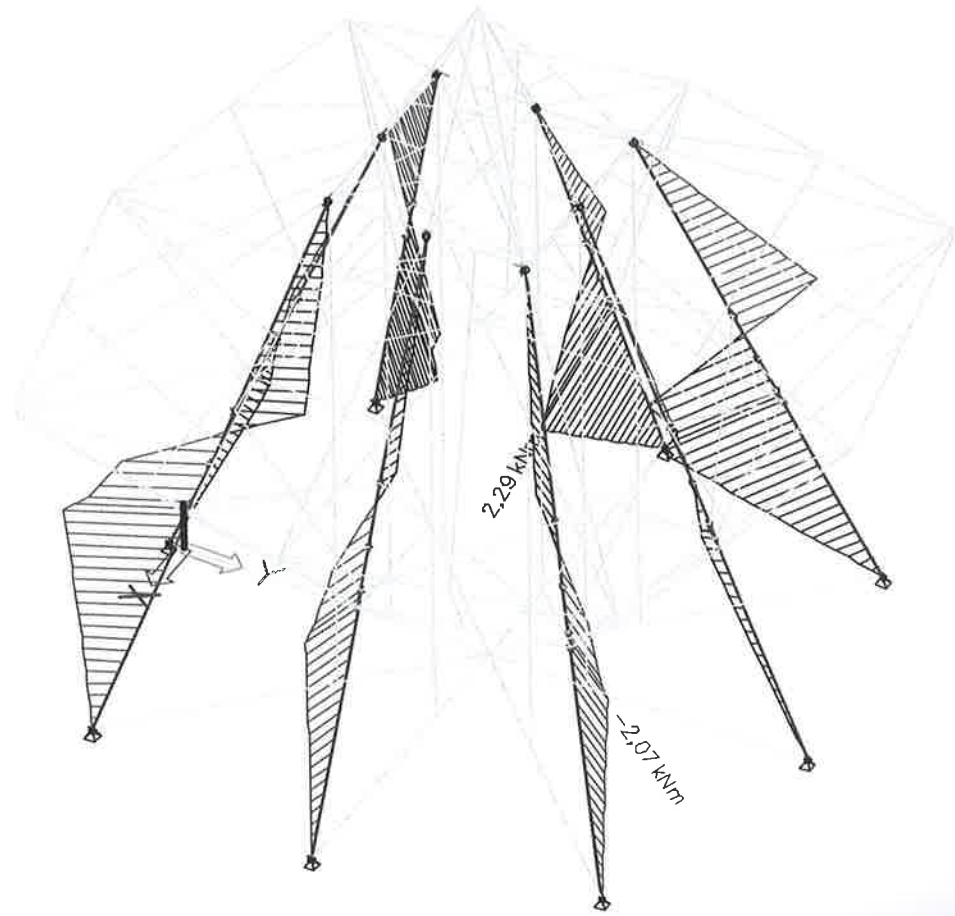
V_y



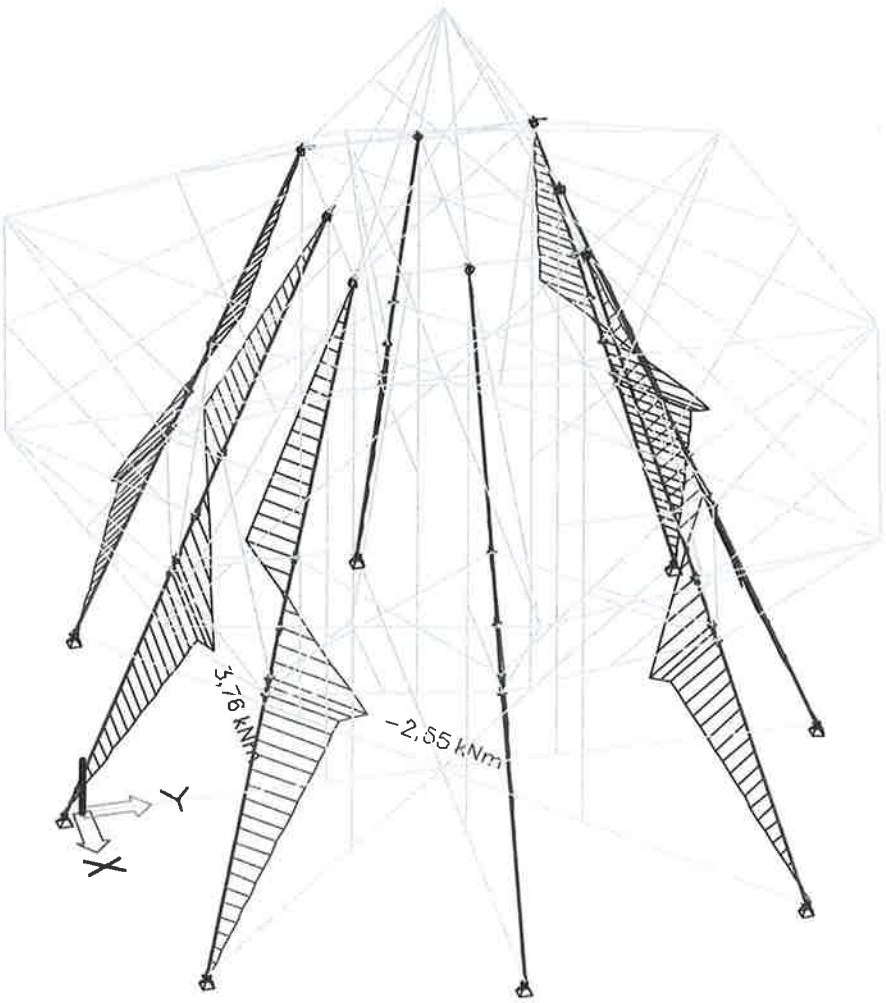
V_z



M_y

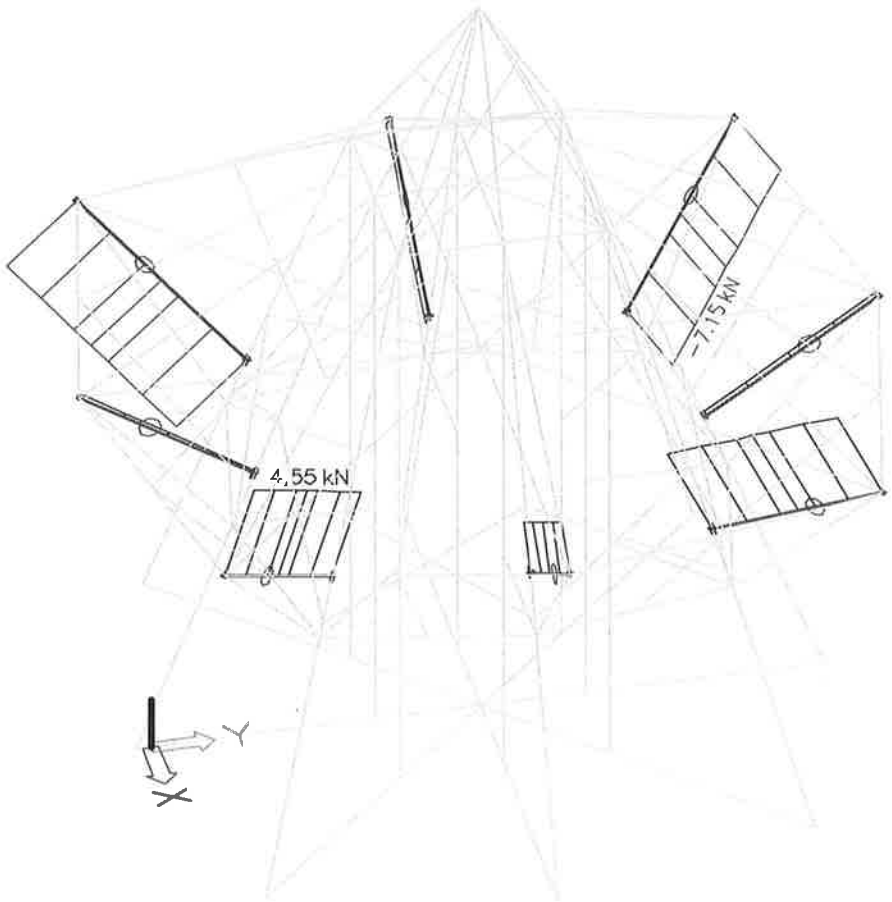


M_z



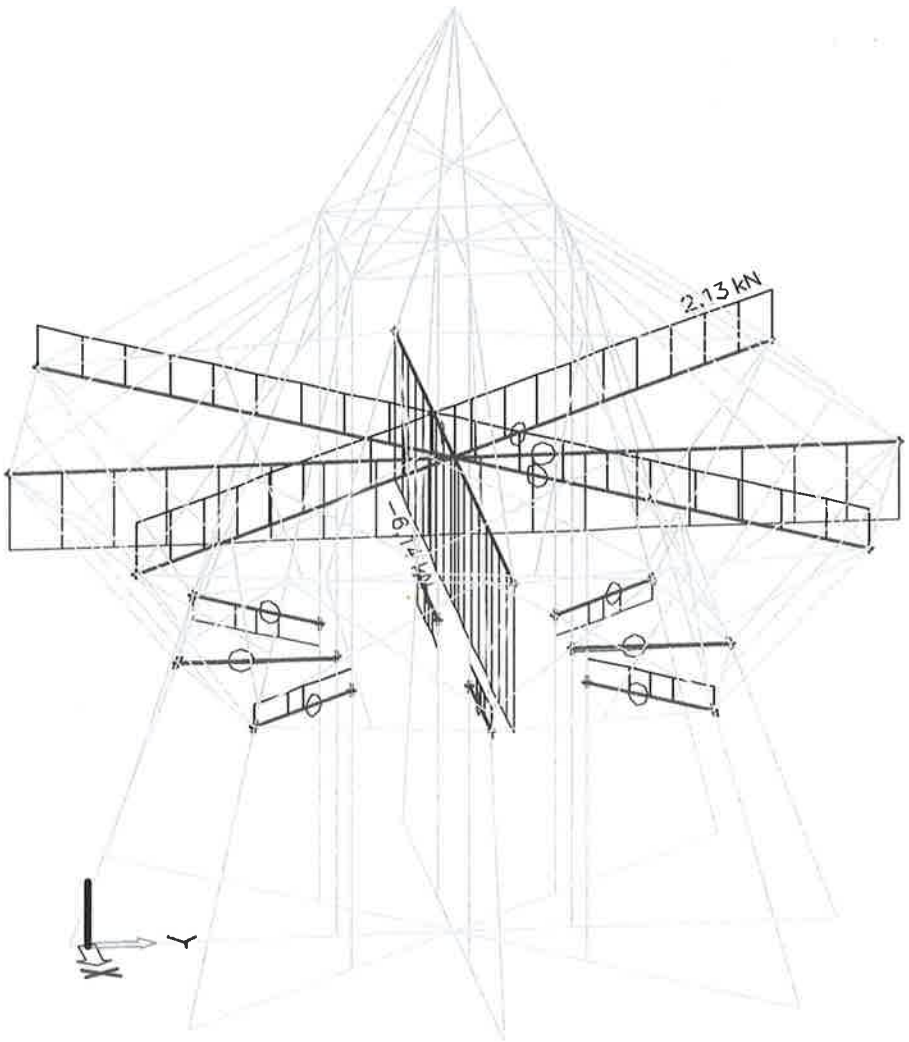
kosi stupovi, b/h = 12/12 cm, C24

N



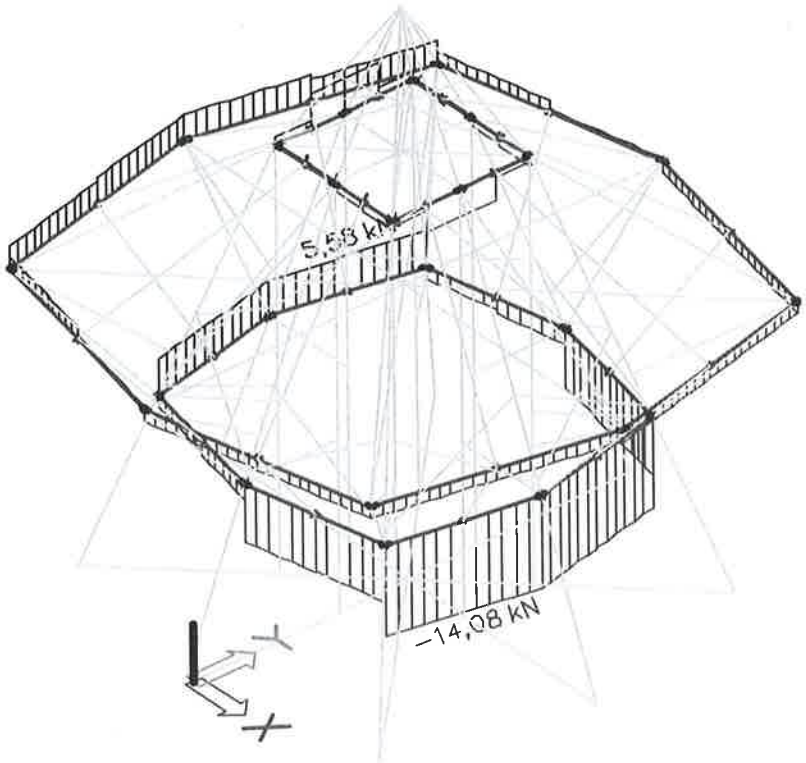
kliješta, b/h = 2*4/12 cm, C24

N

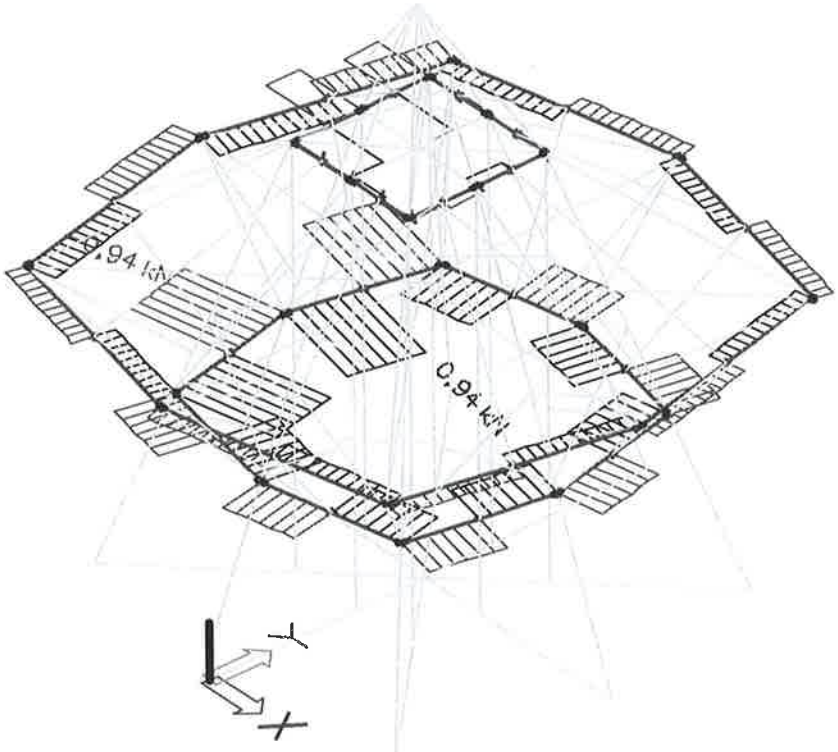


podrožnica, b/h = 16/16 cm, C24

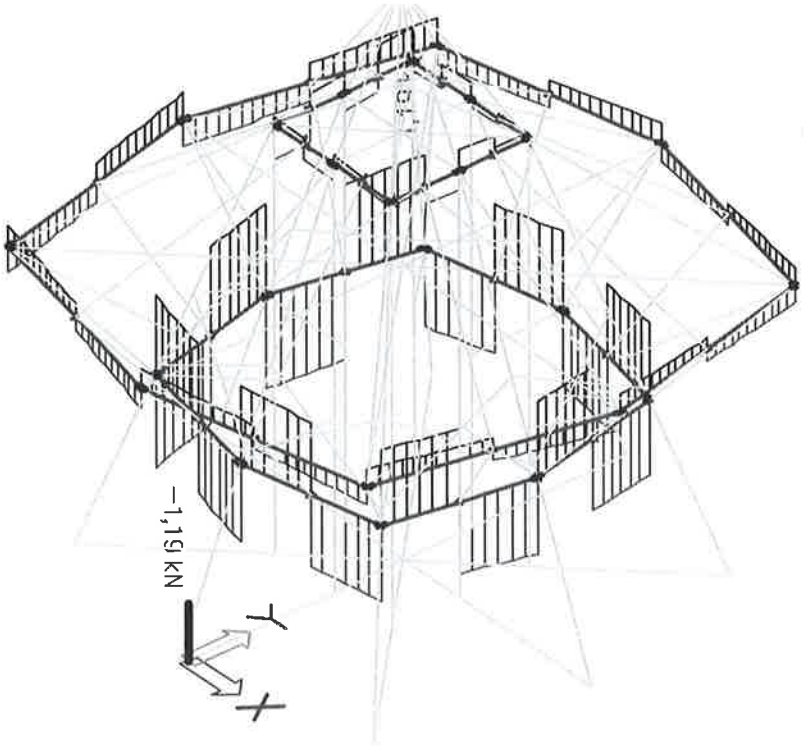
N



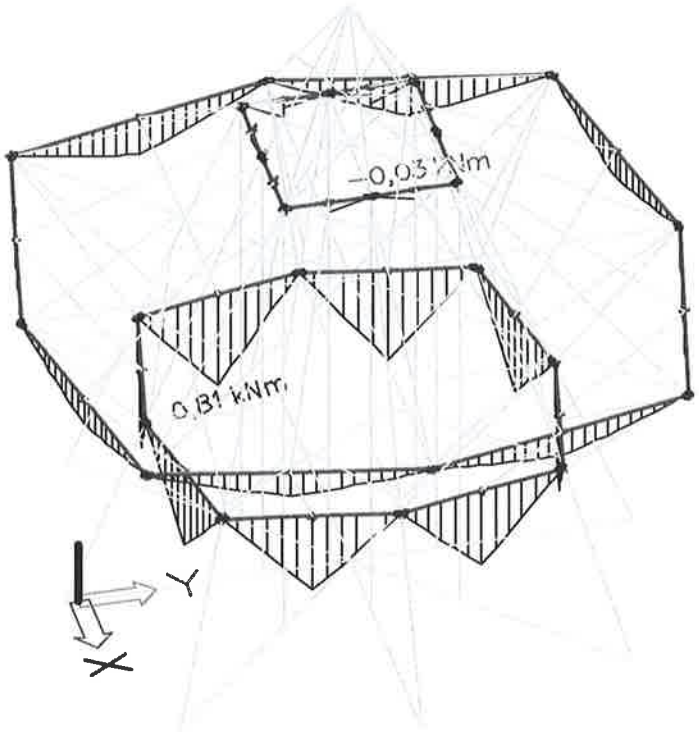
V_y



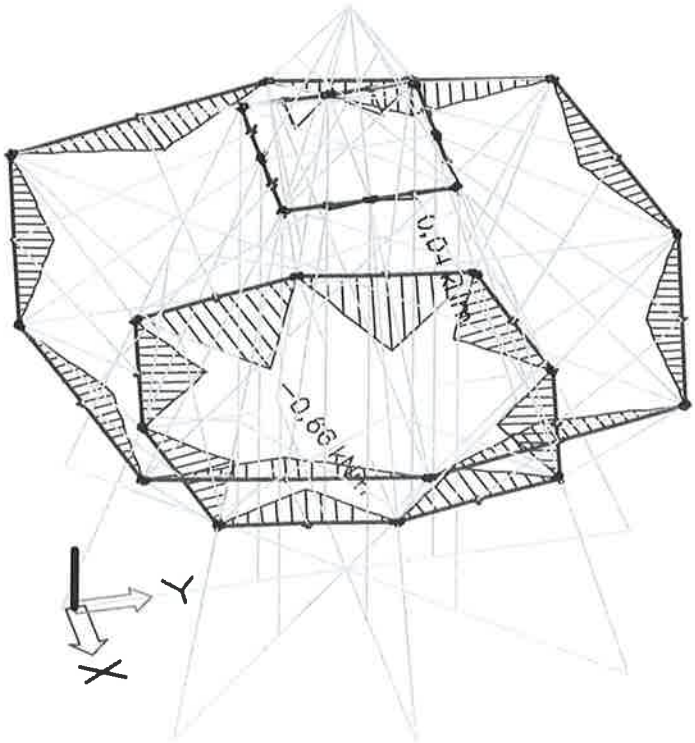
V_z



M_y

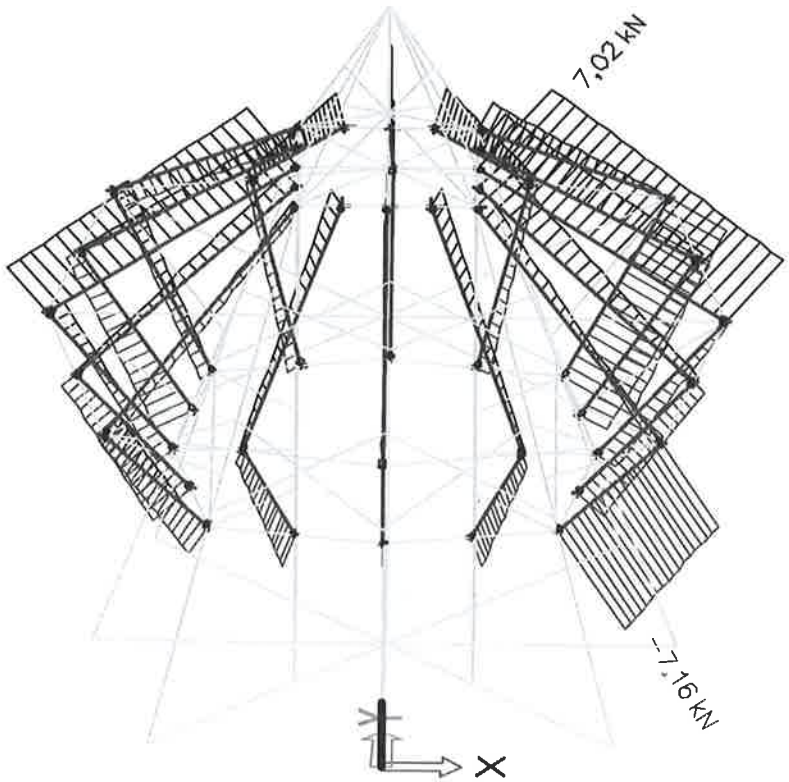


M_z

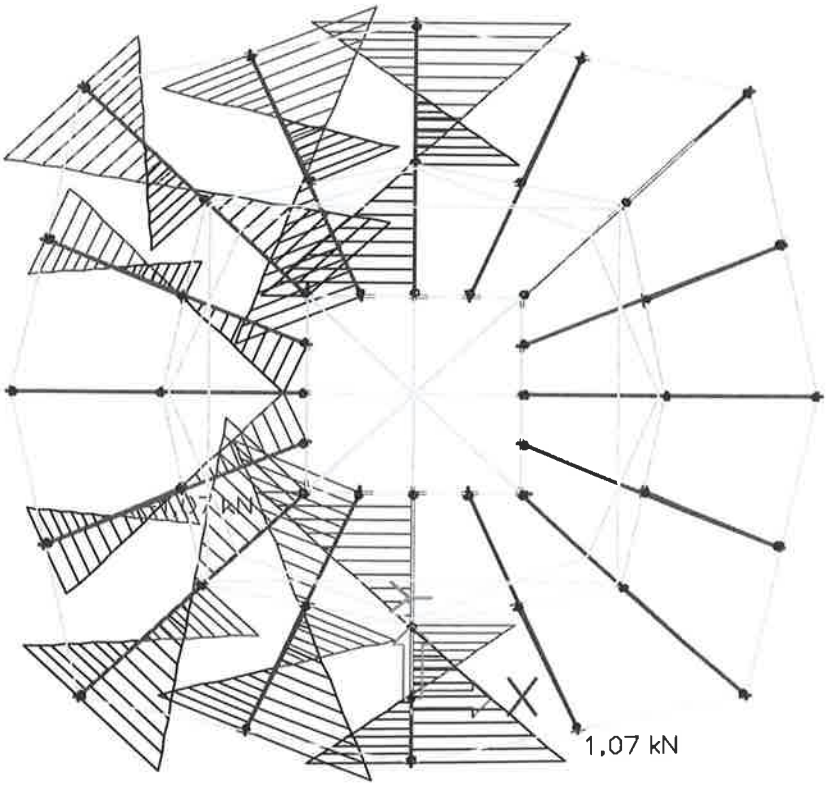


grebeni, b/h = 12/12 cm, C24

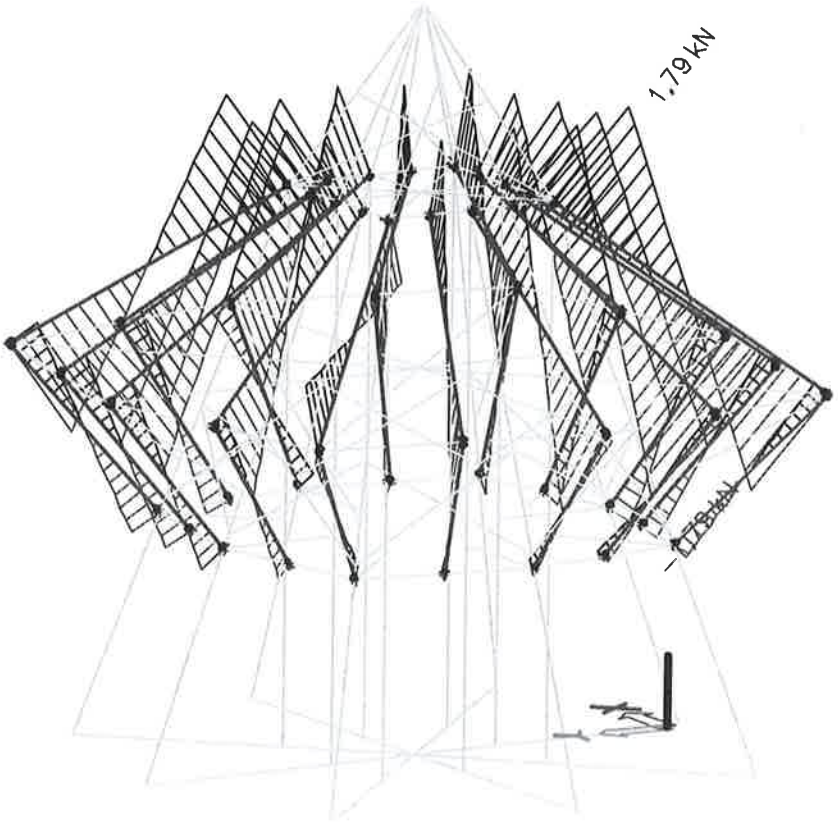
N



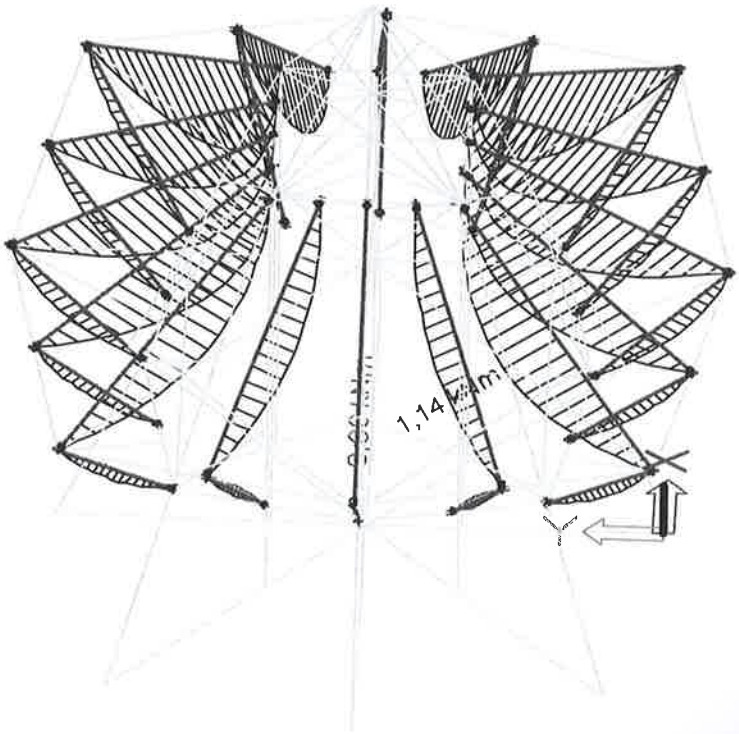
V_y



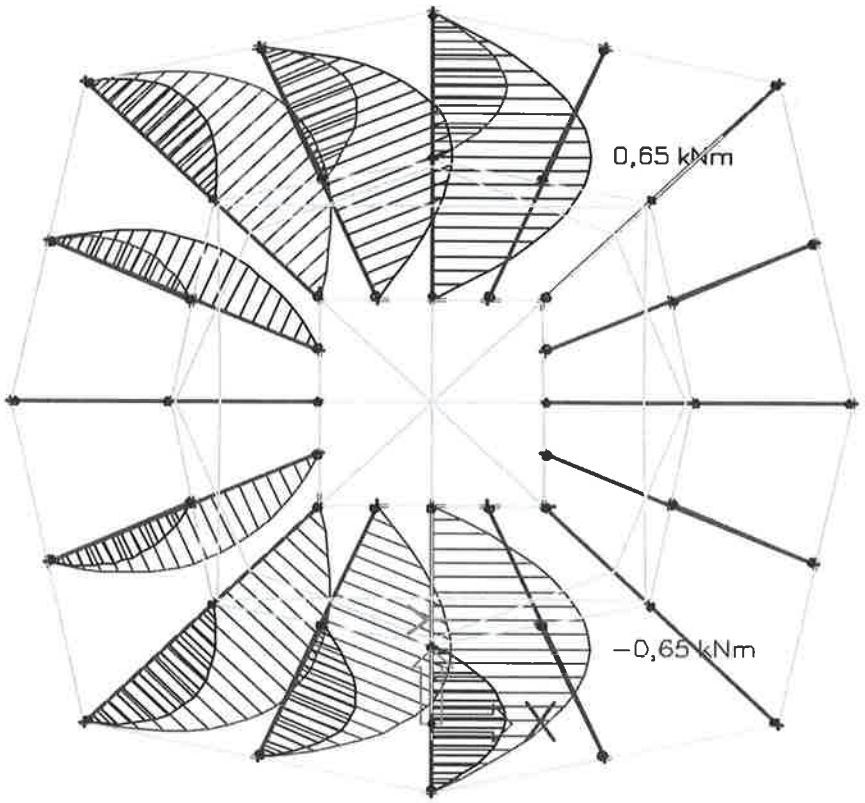
V_z



M_y

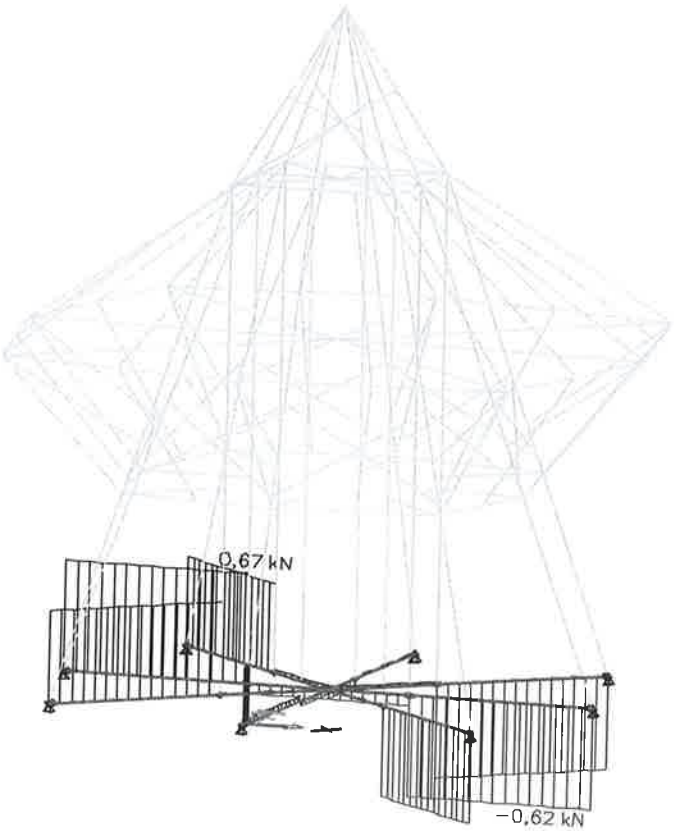


M_z

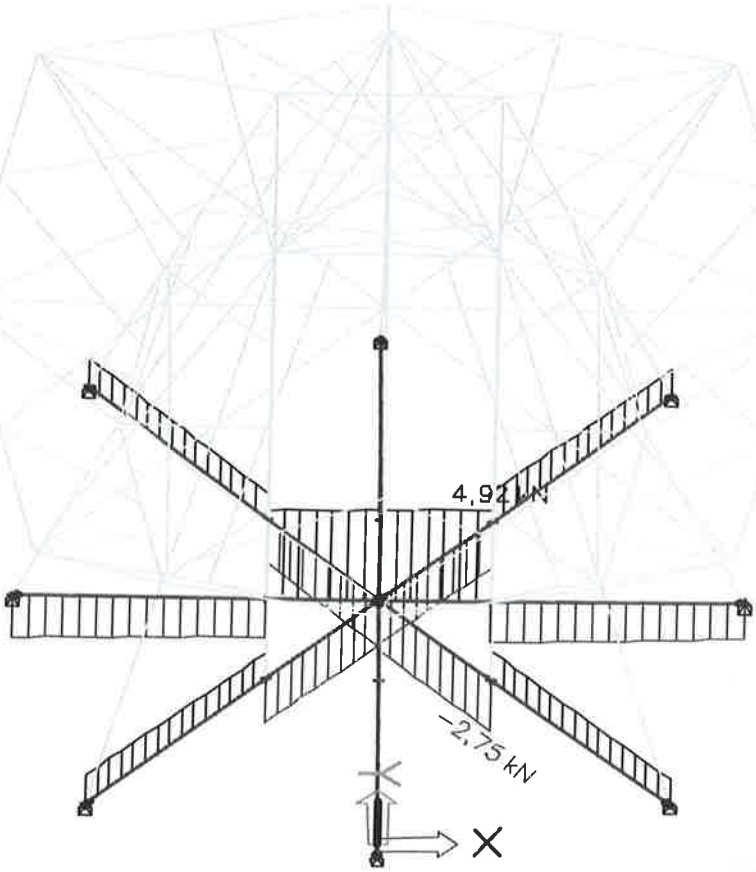


vezne grede dolje, b/h = 16/16 cm, C24

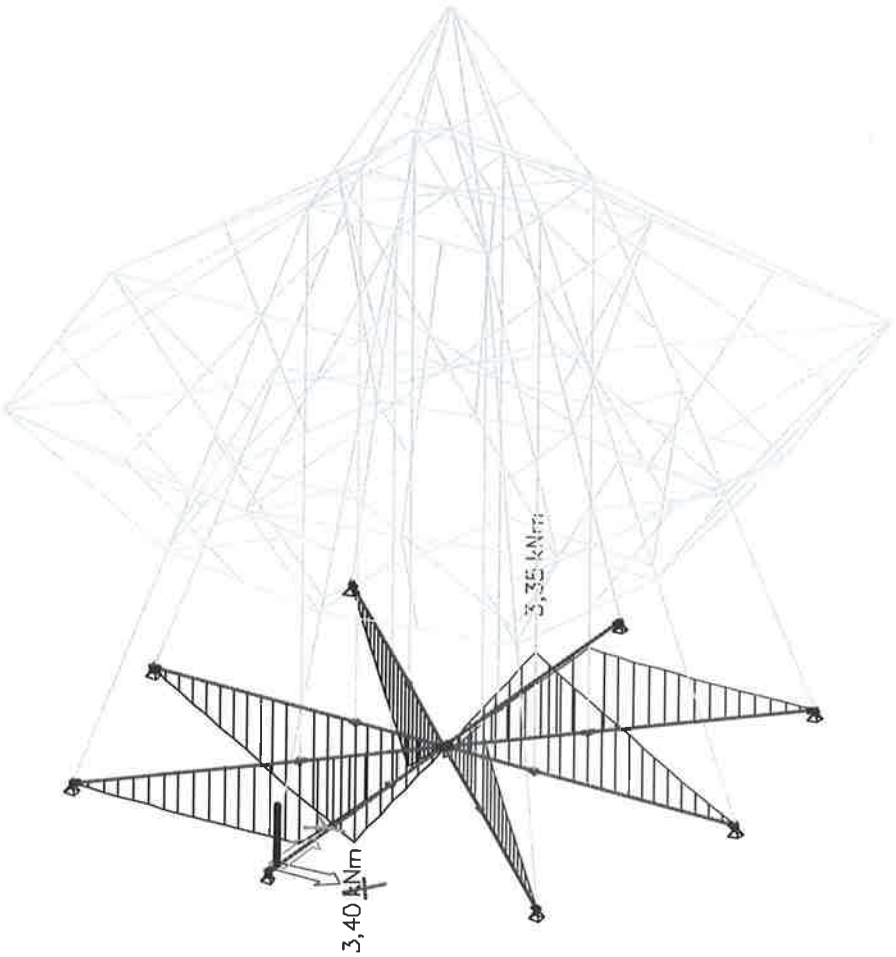
N



V_z

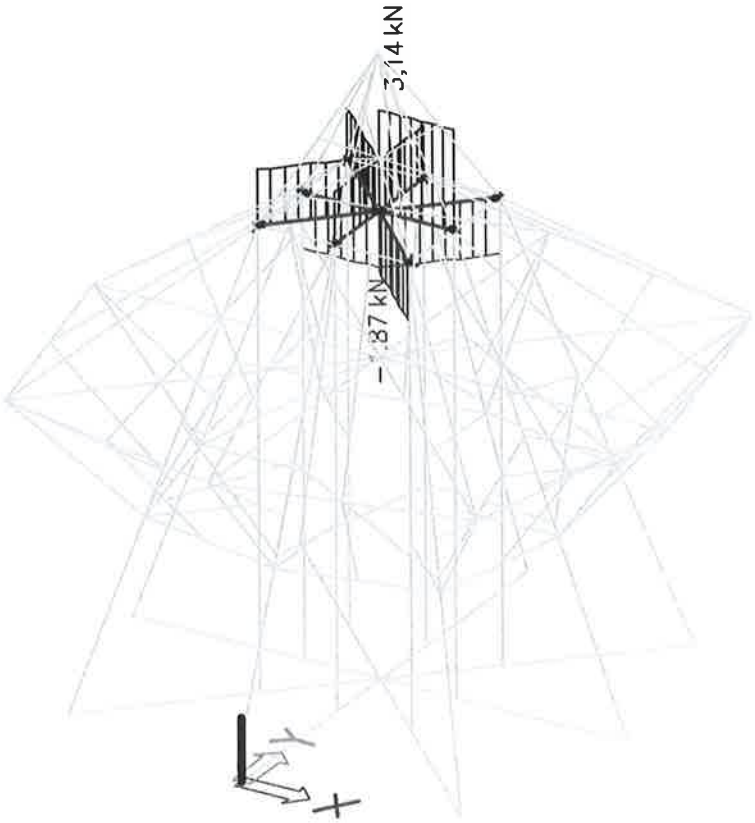


M_y

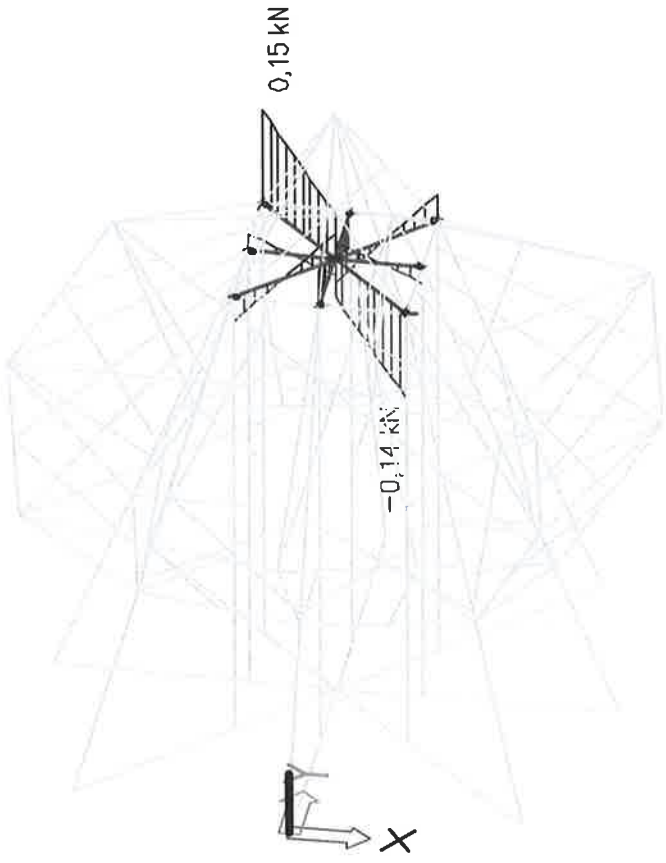


vezne grede gore, b/h = 12/12 cm, C24

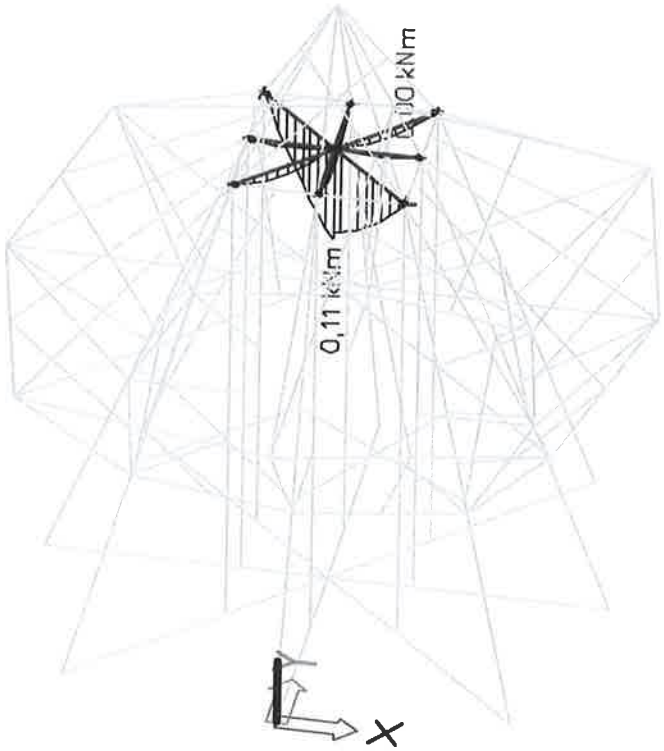
N



V_z

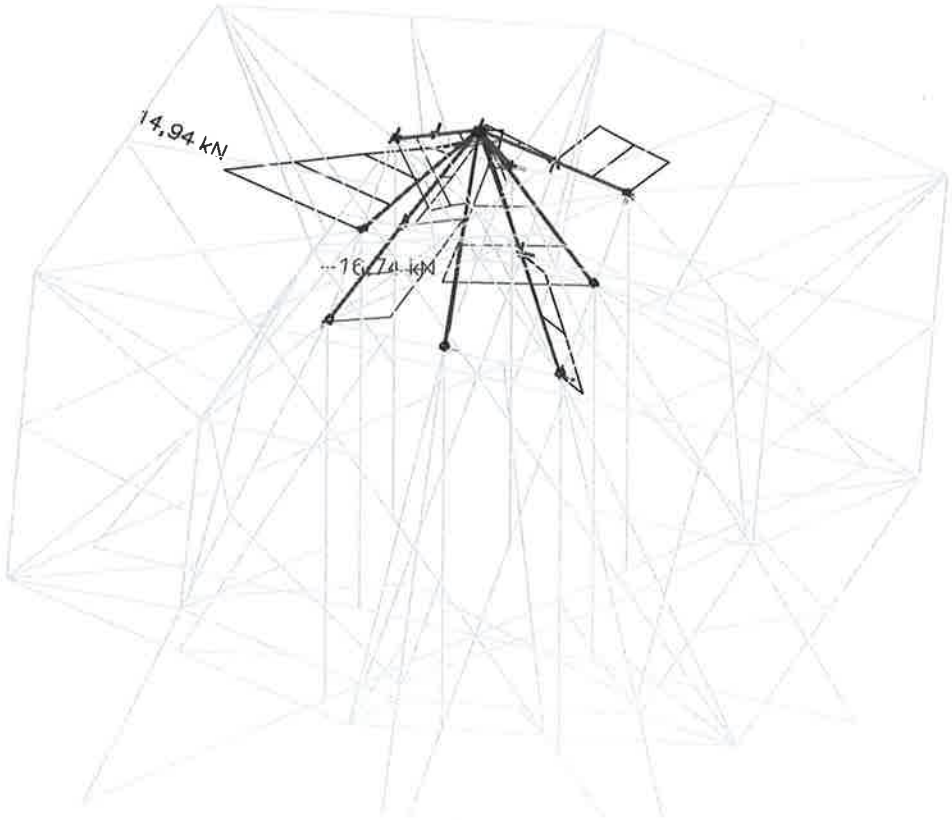


M_y

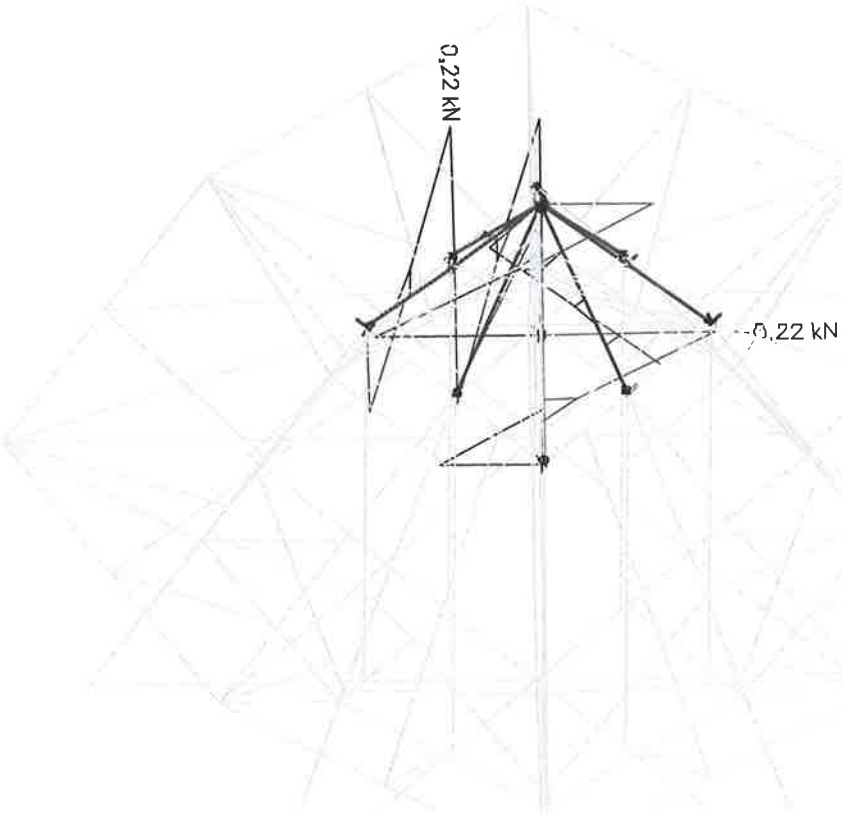


gornji grebeni, b/h = 12/12 cm, C24

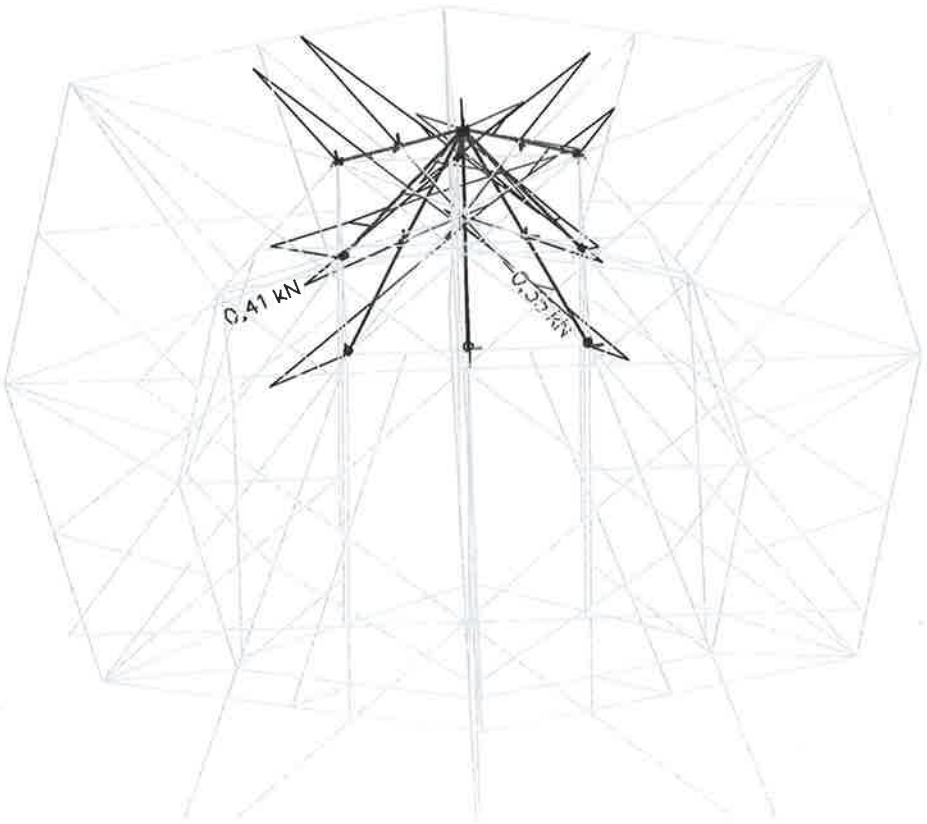
N



V_y

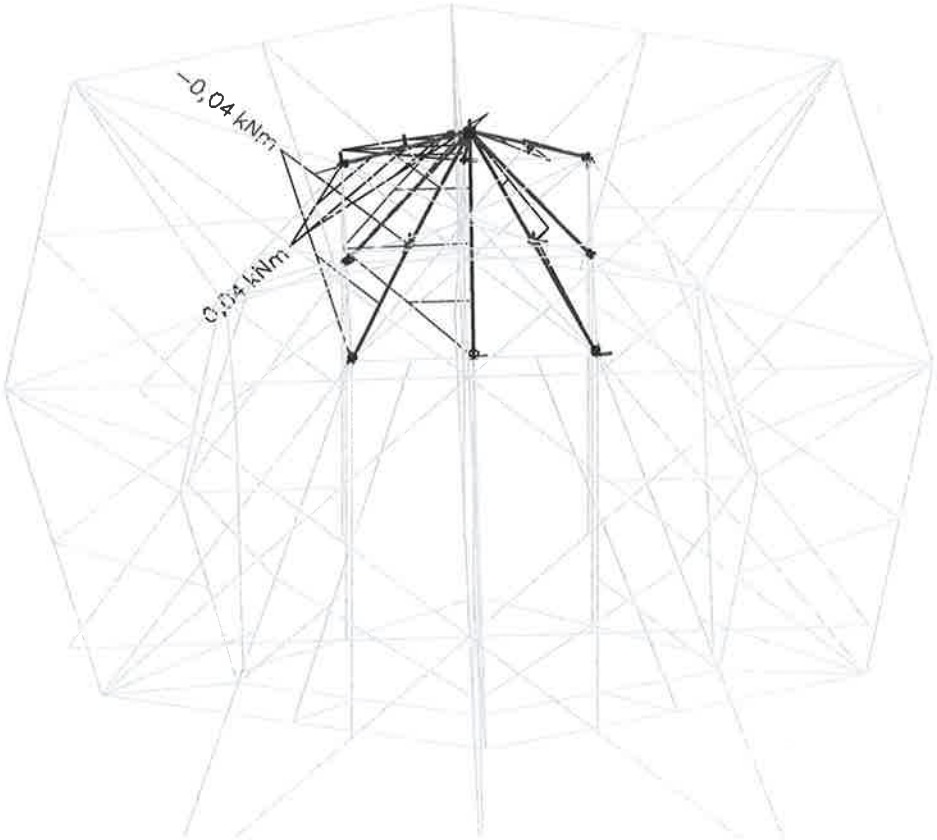


V_z



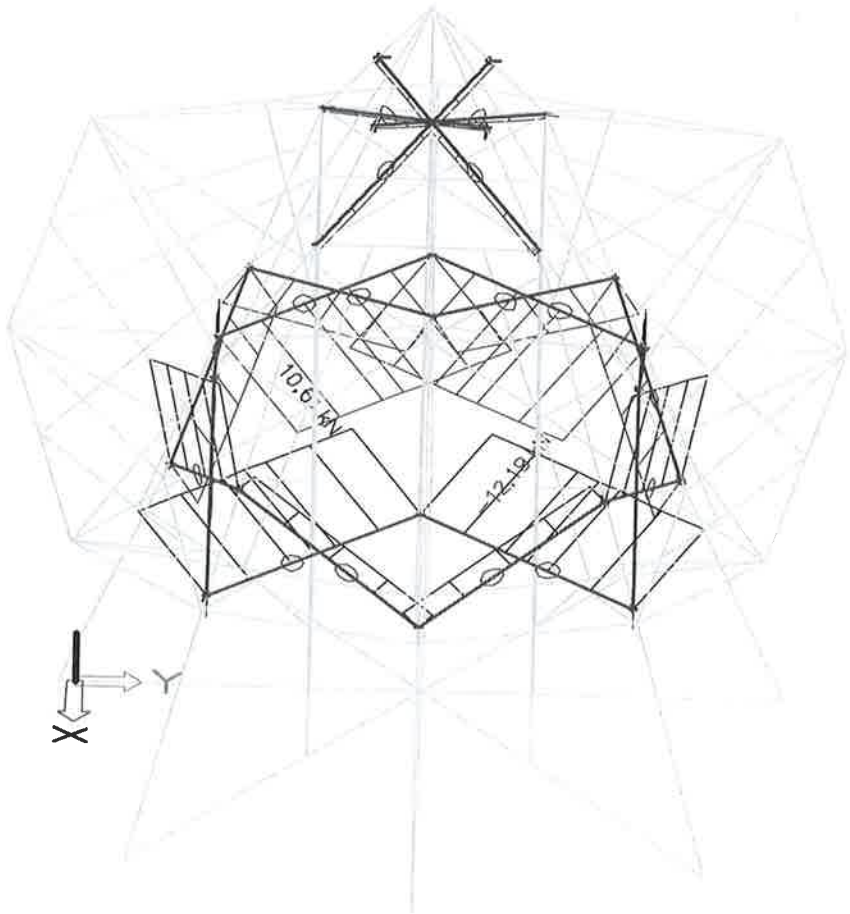
M_y

M_z



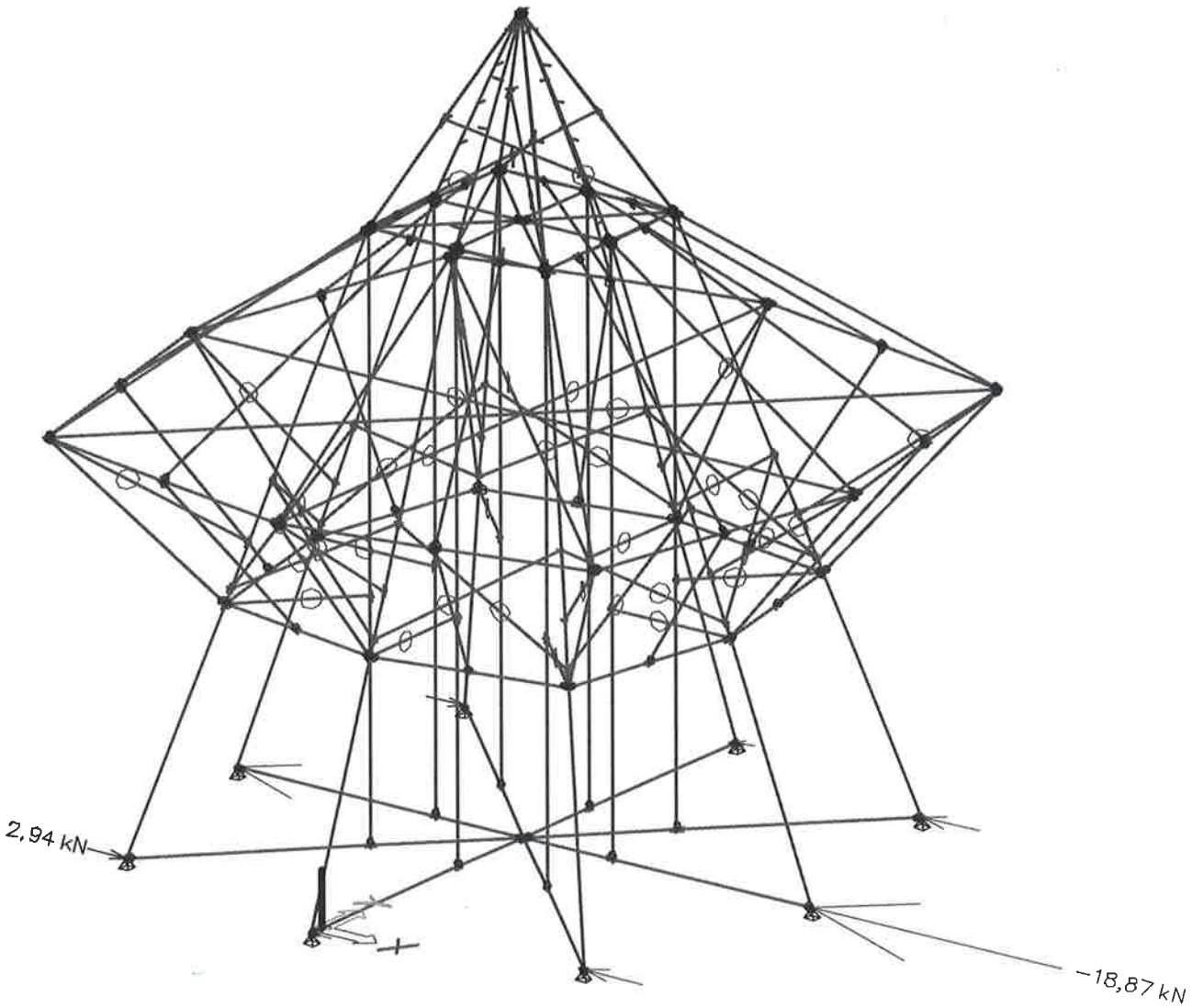
križevi, b/h = 12/12 cm, C24

N

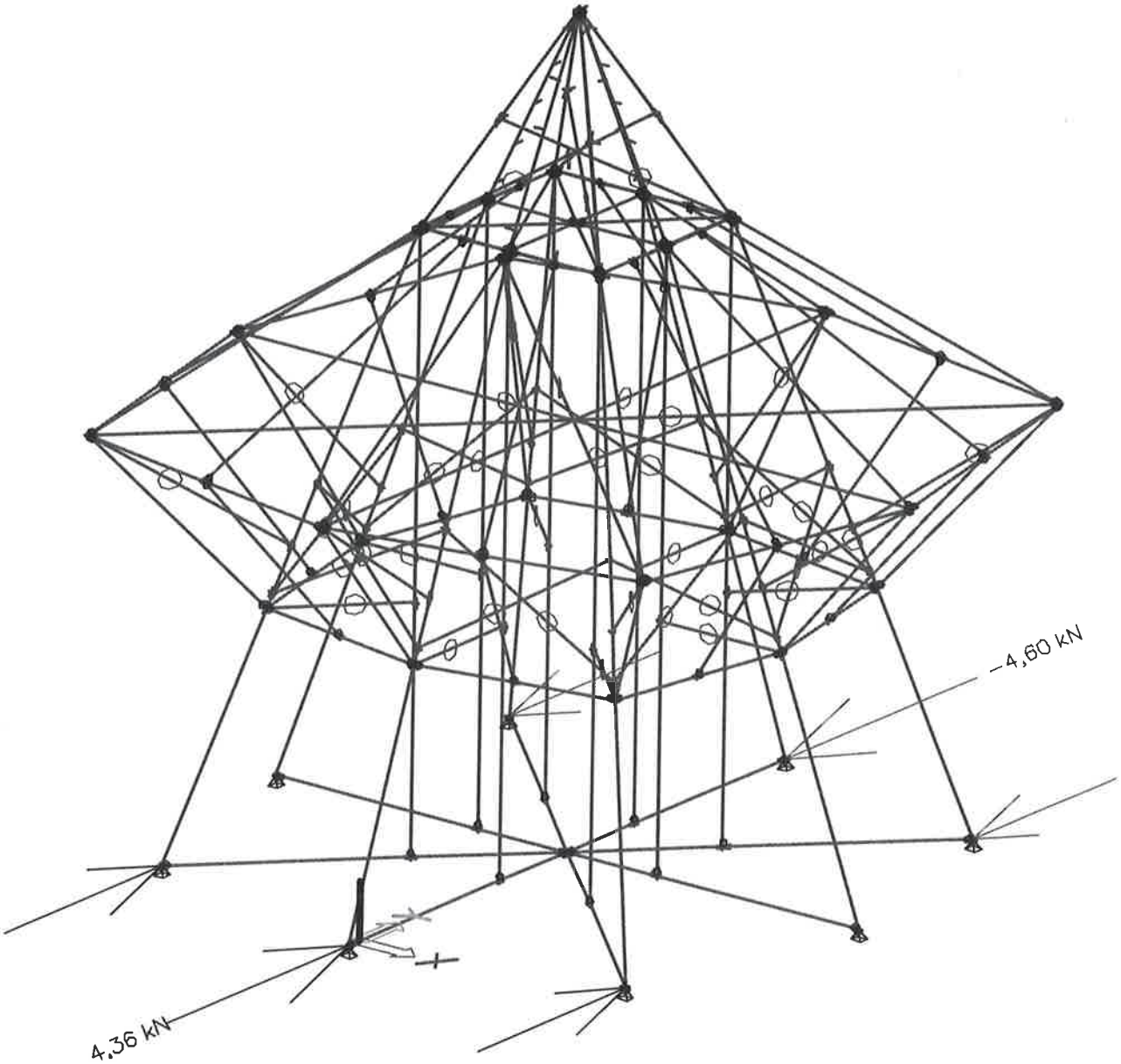


2. Prikaz reakcija za ULS

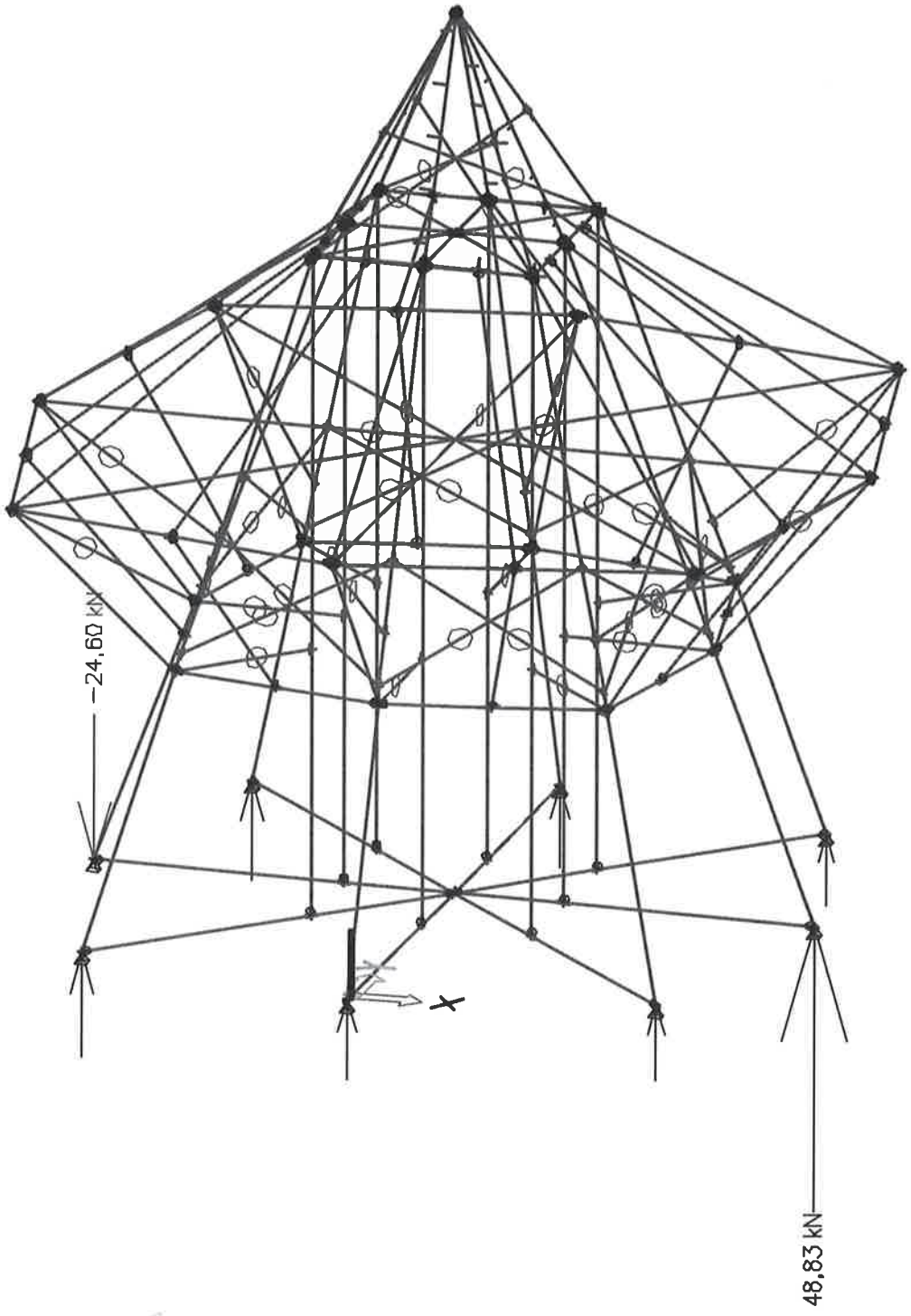
R_x



R_y



R_z

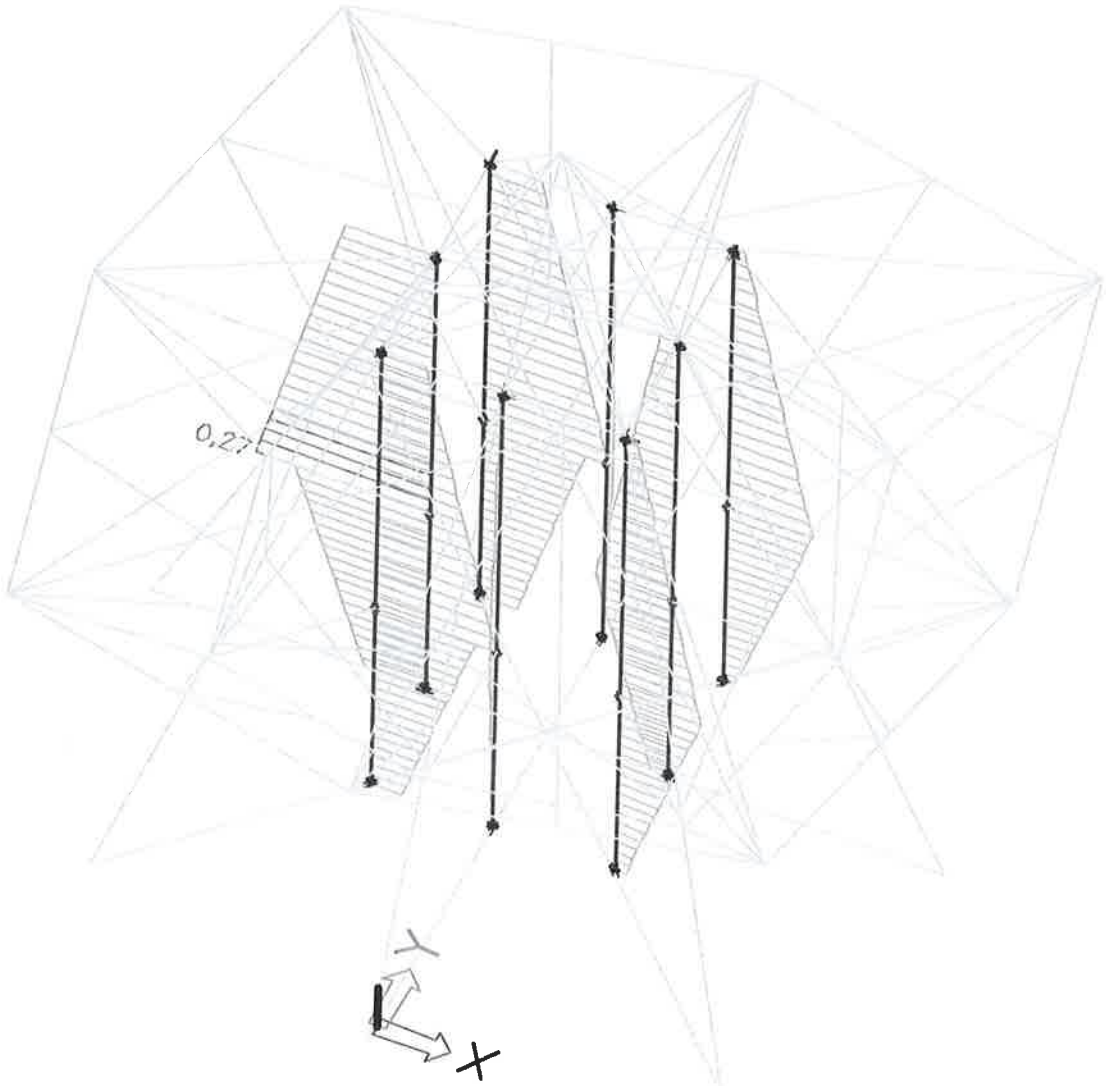


Support	Case	Rx [kN]	Ry [kN]	Rz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
Sn8/N7	CO2/1	**-18,87**	-0,03	**48,83**	2 0,00	0,00	0,00
Sn2/N20	CO1/2	**2,94**	3,77	17,84	0,00	0,00	0,00
Sn6/N14	CO1/2	-0,81	**-4,60**	14,04	0,00	0,00	0,00
Sn3/N8	CO1/2	-0,81	**4,36**	13,41	0,00	0,00	0,00
Sn1/N1	CO2/1	-11,16	-0,03	**-24,60**	1 0,00	0,00	0,00
Sn1/N1	CO1/2	-4,56	-0,04	-8,19	**0,00**	**0,00**	**0,00**

5. PRORAČUN ELEMENATA KONSTRUKCIJE

1. **stupovi**, b/h = 16/16 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B3
Class : ULS
Layer : stupovi

EN 1995-1-1 Code Check

Beam B3	**4,630 m**	**16/16 - RECT (160; 160)**	**C24 (EN 338)**	**ULS**	**0,27 -**

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

The critical check is on position **1,870** m.

Internal forces		
NEd	-6,38	kN
Vy,Ed	0,00	kN
Vz,Ed	-0,51	kN
TEd	0,00	kNm
My,Ed	1,40	kNm
Mz,Ed	0,00	kNm

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Compression parallel to the grain
According to EN 1995-1-1 article 6.1.4 and formula (6.2)

σc,0,d	0,2	MPa
fc,0,d	14,5	MPa
Unity check	0,02	-

Compression perpendicular to the grain
According to EN 1995-1-1 article 6.1.5 and formula (6.3)

Fc,90,d	1,25	kN
l	100	mm
lef	160	mm
b	160	mm
Aef	25600	mm^2
σc,90,d	0,0	MPa
Support condition	Discrete	
h	160	mm
kc,90	1,50	-
fc,90,d	1,7	MPa
Unity check	0,02	-

Bending
According to EN 1995-1-1 article 6.1.6 and formula (6.11),(6.12)

σm,y,d	2,0	MPa
kh,y	1,00	
fm,y,d	16,6	MPa
σm,z,d	0,0	MPa
kh,z	1,00	
fm,z,d	16,6	MPa
km	0,70	

Unity check (6.11) = 0,12 + 0,00 = 0,12 -
Unity check (6.12) = 0,09 + 0,00 = 0,09 -

Shear
According to EN 1995-1-1 article 6.1.7 and formula (6.13)

kcr	0,67	
τz,d	0,0	MPa

fv,d	2,8	MPa
Unity check τz	0,02	-

Torsion
According to EN 1995-1-1 article 6.1.8 and formula (6.14)

τtor,d	0,0	MPa
kshape	1,05	
fv,d	2,8	MPa
Unity check	0,00	-
Unity check Interaction Shear	0,00	-

Note: The Interaction equation has been added as a NCCI.

Combined Bending and Axial Compression
According to EN 1995-1-1 article 6.2.4 and formula (6.19),(6.20)

fc,0,d	14,5	MPa
fm,y,d	16,6	MPa
fm,z,d	16,6	MPa
km	0,70	

Unity check (6.19) = 0,00 + 0,12 + 0,00 = 0,12 -
Unity check (6.20) = 0,00 + 0,09 + 0,00 = 0,09 -

The member satisfies the section check.

..:: STABILITY CHECK ::..

Columns subjected to compression or combined compression and bending
According to EN 1995-1-1 article 6.3.2 and formula (6.23),(6.24)

Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	2,760	4,630	m
Buckling factor k	2,84	1,00	
Buckling length Lcr	7,829	4,630	m
Slenderness λ	169,50	100,24	-
Relative slenderness λ	2,87	1,70	-
Limit slenderness	0,30	0,30	-
Imperfection βc	0,20	0,20	-
Reduction factor kc	0,11	0,30	-

Unity check (6.23) = 0,15 + 0,12 + 0,00 = 0,27 -
Unity check (6.24) = 0,06 + 0,09 + 0,00 = 0,14 -

Beams subjected to bending or combined bending and compression
According to EN 1995-1-1 article 6.3.3 and formula (6.33),(6.35)

LTB Parameters		
Elastic critical moment My,crit	111,22	kNm
Critical bending stress σm,crit	162,9	MPa
Relative slenderness λrel,m	0,38	-
Reduction factor kcrit	1,00	-

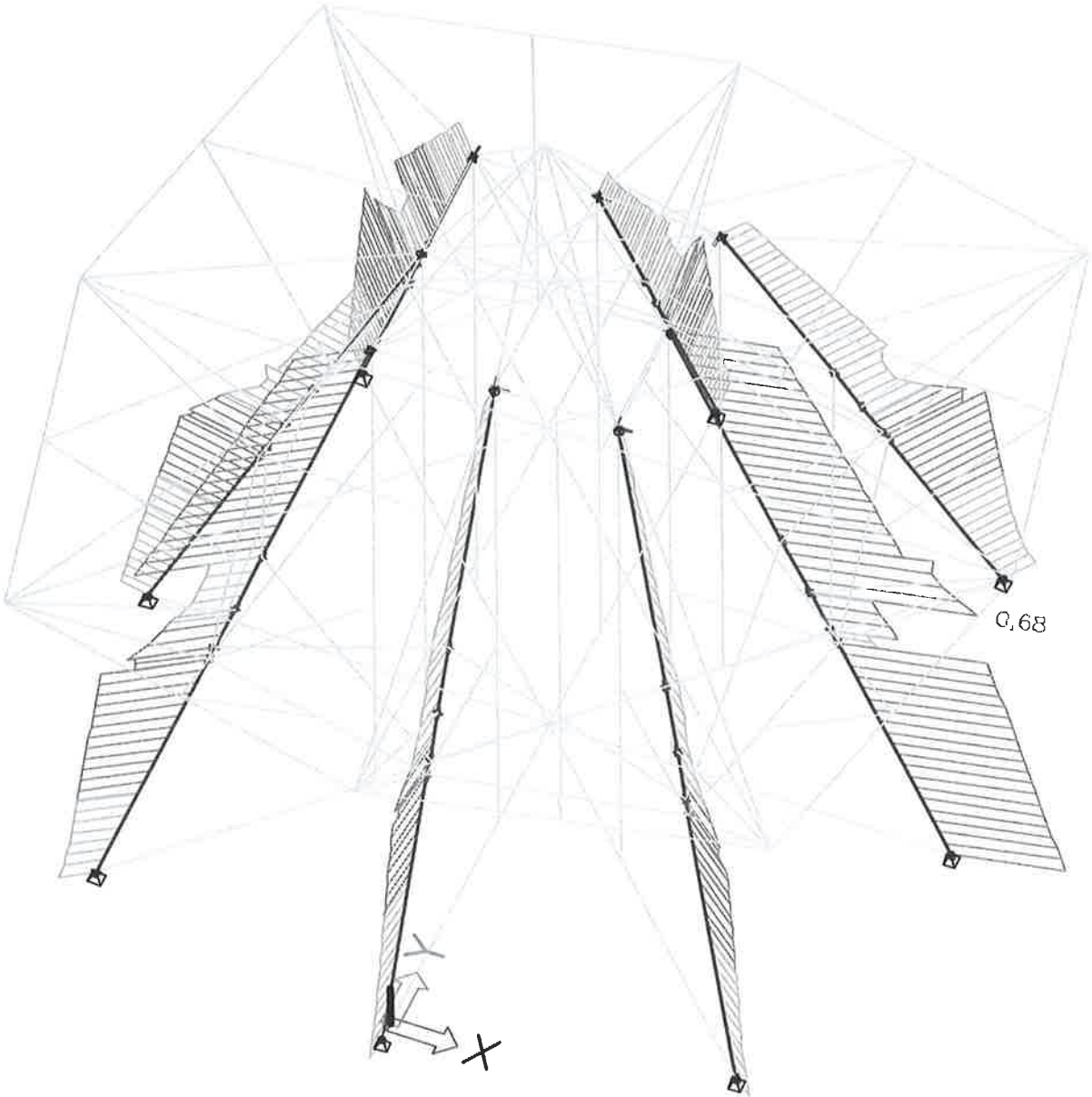
Unity check (6.33) = 0,12 -
Unity check (6.35) = 0,02 + 0,06 = 0,07 -

My,crit Parameters		
G0,05	462,5	MPa
LTB length L	4,630	m
Lef/L	0,80	
Effective length Lef	3,704	m
Influence of load position	no influence	

The member satisfies the stability check.

2. **kosnici**, b/h = 16/16 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B6
Class : ULS
Layer : kosnici

EN 1995-1-1 Code Check

Beam B6	**4,893 m**	**16/16 - RECT (160; 160)**	**C24 (EN 338)**	**ULS**	**0,68 -**

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

The critical check is on position **2,447** m.

Internal forces		
NEd	-52,82	kN
Vy,Ed	-0,07	kN
Vz,Ed	-3,57	kN
TEd	0,00	kNm
My,Ed	-1,22	kNm
Mz,Ed	-0,03	kNm

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Compression parallel to the grain
According to EN 1995-1-1 article 6.1.4 and formula (6.2)

σc,0,d	2,1	MPa
fc,0,d	14,5	MPa
Unity check	0,14	-

Compression perpendicular to the grain
According to EN 1995-1-1 article 6.1.5 and formula (6.3)

Fc,90,d	2,85	kN
l	100	mm
lef	160	mm
b	160	mm
Aef	25600	mm^2
σc,90,d	0,1	MPa
Support condition	Discrete	
h	160	mm
kc,90	1,00	-
fc,90,d	1,7	MPa
Unity check	0,06	-

Bending
According to EN 1995-1-1 article 6.1.6 and formula (6.11),(6.12)

σm,y,d	1,8	MPa
kh,y	1,00	
fm,y,d	16,6	MPa
σm,z,d	0,0	MPa
kh,z	1,00	
fm,z,d	16,6	MPa
km	0,70	

Unity check (6.11) = 0,11 + 0,00 = 0,11 -
Unity check (6.12) = 0,08 + 0,00 = 0,08 -

Shear
According to EN 1995-1-1 article 6.1.7 and formula (6.13)

kcr	0,67	
τy,d	0,0	MPa

τz,d	0,3	MPa
fv,d	2,8	MPa
Unity check τy	0,00	-
Unity check τz	0,11	-
Unity check Interaction	0,01	-

Note: The interaction equation has been added as a NCCI.

Torsion
According to EN 1995-1-1 article 6.1.8 and formula (6.14)

τtor,d	0,0	MPa
kshape	1,05	
fv,d	2,8	MPa
Unity check	0,00	-
Unity check Interaction Shear	0,01	-

Note: The interaction equation has been added as a NCCI.

Combined Bending and Axial Compression
According to EN 1995-1-1 article 6.2.4 and formula (6.19),(6.20)

fc,0,d	14,5	MPa
fm,y,d	16,6	MPa
fm,z,d	16,6	MPa
km	0,70	

Unity check (6.19) = 0,02 + 0,11 + 0,00 = 0,13 -
Unity check (6.20) = 0,02 + 0,08 + 0,00 = 0,10 -

The member satisfies the section check.

..:: STABILITY CHECK ::..

Columns subjected to compression or combined compression and bending
According to EN 1995-1-1 article 6.3.2 and formula (6.23),(6.24)

Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	2,447	0,842	m
Buckling factor k	2,12	1,50	
Buckling length Lcr	5,176	1,259	m
Slenderness λ	112,06	27,27	-
Relative slenderness λ	1,90	0,46	-
Limit slenderness	0,30	0,30	-
Imperfection βc	0,20	0,20	-
Reduction factor kc	0,25	0,96	-

Unity check (6.23) = 0,57 + 0,11 + 0,00 = 0,68 -
Unity check (6.24) = 0,15 + 0,08 + 0,00 = 0,23 -

Beams subjected to bending or combined bending and compression
According to EN 1995-1-1 article 6.3.3 and formula (6.33),(6.35)

LTB Parameters		
Elastic critical moment My,crit	611,58	kNm
Critical bending stress σm,crit	895,9	MPa
Relative slenderness λrel,m	0,16	-
Reduction factor kcrit	1,00	-

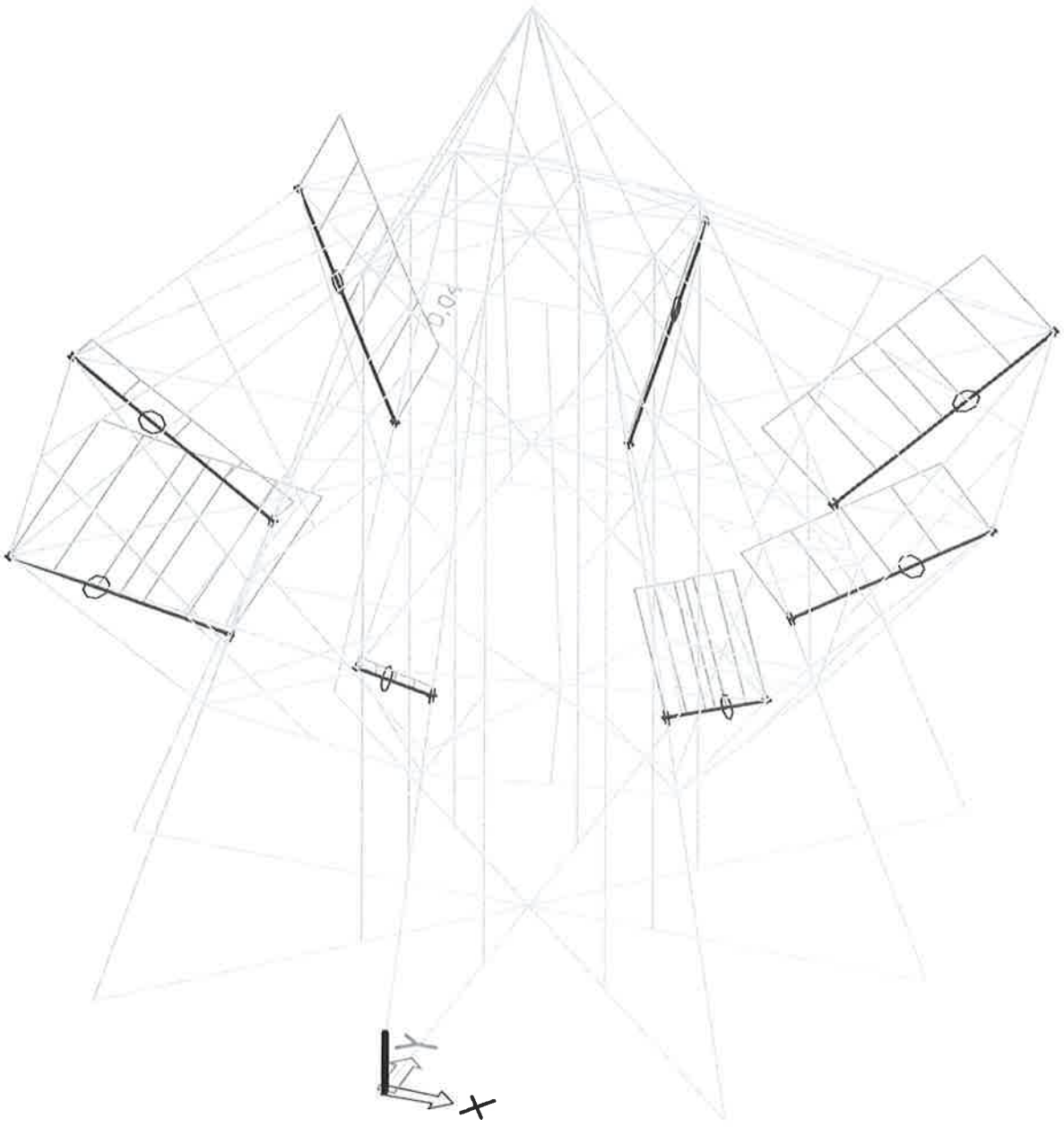
Unity check (6.33) = 0,11 -
Unity check (6.35) = 0,01 + 0,15 = 0,16 -

My,crit Parameters		
G0,05	462,5	MPa
LTB length L	0,842	m
Lef/L	0,80	
Effective length Lef	0,674	m
Influence of load position	no influence	

The member satisfies the stability check.

3. **kosi stupovi**, b/h = 12/12 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B35
Class : ULS
Layer : kosi stupovi

EN 1995-1-1 Code Check

Beam B35	**1,562 m**	**12/12 - RECT (120; 120)**	**C24 (EN 338)**	**ULS**	**0,04 -**

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

The critical check is on position **1,562** m.

Internal forces		
NEd	-7,23	kN
Vy,Ed	0,00	kN
Vz,Ed	0,00	kN
TEd	0,00	kNm
My,Ed	0,00	kNm
Mz,Ed	0,00	kNm

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Compression parallel to the grain
According to EN 1995-1-1 article 6.1.4 and formula (6.2)

σc,0,d	0,5	MPa
fc,0,d	14,5	MPa
Unity check	0,03	-

The member satisfies the section check.

..:: STABILITY CHECK ::..

Columns subjected to compression or combined compression and bending
According to EN 1995-1-1 article 6.3.2 and formula (6.23),(6.24)

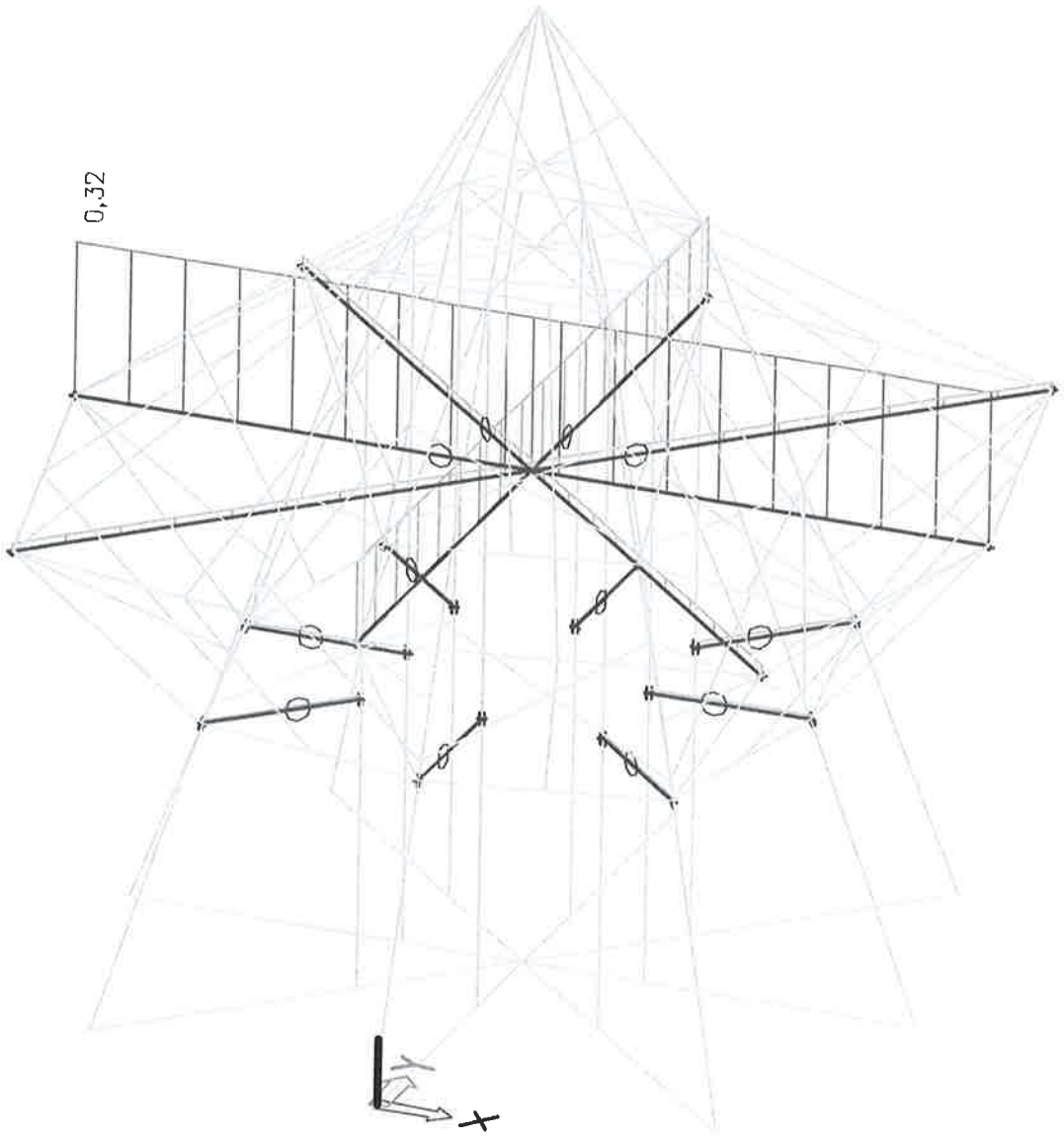
Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	1,562	1,562	m
Buckling factor k	1,00	1,00	
Buckling length Lcr	1,562	1,562	m
Slenderness λ	45,10	45,10	-
Relative slenderness λ	0,76	0,76	-
Limit slenderness	0,30	0,30	-
Imperfection βc	0,20	0,20	-
Reduction factor kc	0,84	0,84	-

Unity check (6.23) = 0,04 + 0,00 + 0,00 = 0,04 -
Unity check (6.24) = 0,04 + 0,00 + 0,00 = 0,04 -

The member satisfies the stability check.

4. **kliješta**, b/h = 2*4/12 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B26
Class : ULS
Layer : kliješta

EN 1995-1-1 Code Check

Beam B26	**5,296 m**	**2*4/12 - 2 Rect (40; 120; 140)**	**C24 (EN 338)**	**ULS**	**0,32 -**

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

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

Internal forces		
NEd	-6,19	kN
Vy,Ed	0,00	kN
Vz,Ed	0,00	kN
TEd	0,00	kNm
My,Ed	0,00	kNm
Mz,Ed	0,00	kNm

Note: Axis definition:
- Principal y axis in this code check is referring to the principal z axis in SCIA Engineer.
- Principal z axis in this code check is referring to the principal y axis in SCIA Engineer.

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Compression parallel to the grain
According to EN 1995-1-1 article 6.1.4 and formula (6.2)

σc,0,d	0,6	MPa
fc,0,d	14,5	MPa
Unity check	0,04	-

The member satisfies the section check.

..:: STABILITY CHECK ::..

Columns subjected to compression or combined compression and bending
According to EN 1995-1-1 article 6.3.2 and formula (6.23),(6.24)

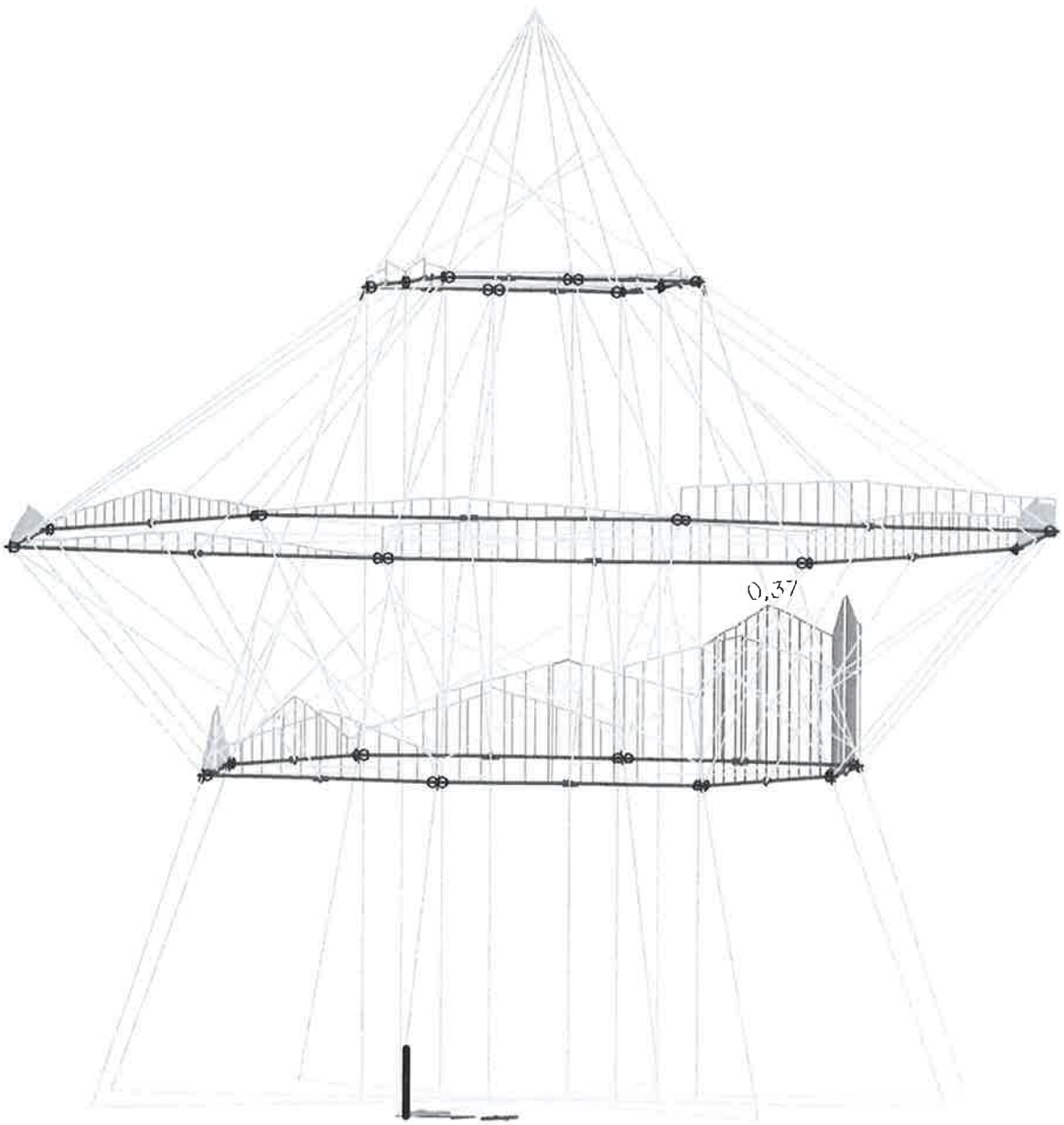
Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	5,296	5,296	m
Buckling factor k	1,00	1,00	
Buckling length Lcr	5,296	5,296	m
Slenderness λ	58,37	152,88	-
Relative slenderness λ	0,99	2,59	-
Limit slenderness	0,30	0,30	-
Imperfection βc	0,20	0,20	-
Reduction factor kc	0,70	0,14	-

Unity check (6.23) = 0,06 + 0,00 + 0,00 = 0,06 -
Unity check (6.24) = 0,32 + 0,00 + 0,00 = 0,32 -

The member satisfies the stability check.

5. **podrožnica**, b/h = 16/16 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B55
Class : ULS
Layer : podrožnice

EN 1995-1-1 Code Check

Beam B55	**1,395 m**	**16/16 - RECT (160; 160)**	**C24 (EN 338)**	**ULS**	**0,37 -**

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

The critical check is on position **0,698** m.

Internal forces		
NEd	-15,42	kN
Vy,Ed	0,39	kN
Vz,Ed	-0,88	kN
TEd	-0,03	kNm
My,Ed	0,65	kNm
Mz,Ed	-0,27	kNm

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Compression parallel to the grain
According to EN 1995-1-1 article 6.1.4 and formula (6.2)

σc,0,d	0,6	MPa
fc,0,d	14,5	MPa
Unity check	0,04	-

Compression perpendicular to the grain
According to EN 1995-1-1 article 6.1.5 and formula (6.3)

Fc,90,d	1,76	kN
l	100	mm
lef	160	mm
b	160	mm
Aef	25600	mm^2
σc,90,d	0,1	MPa
Support condition	Discrete	
h	160	mm
kc,90	1,50	-
fc,90,d	1,7	MPa
Unity check	0,03	-

Bending
According to EN 1995-1-1 article 6.1.6 and formula (6.11),(6.12)

σm,y,d	1,0	MPa
kh,y	1,00	
fm,y,d	16,6	MPa
σm,z,d	0,4	MPa
kh,z	1,00	
fm,z,d	16,6	MPa
km	0,70	

Unity check (6.11) = 0,06 + 0,02 = 0,07 -
Unity check (6.12) = 0,04 + 0,02 = 0,06 -

Shear
According to EN 1995-1-1 article 6.1.7 and formula (6.13)

kcr	0,67	
τy,d	0,0	MPa

τz,d	0,1	MPa
fv,d	2,8	MPa
Unity check τy	0,01	-
Unity check τz	0,03	-
Unity check Interaction	0,00	-

Note: The interaction equation has been added as a NCCI.

Torsion
According to EN 1995-1-1 article 6.1.8 and formula (6.14)

τtor,d	0,0	MPa
kshape	1,05	
fv,d	2,8	MPa
Unity check	0,01	-
Unity check Interaction Shear	0,01	-

Note: The interaction equation has been added as a NCCI.

Combined Bending and Axial Compression
According to EN 1995-1-1 article 6.2.4 and formula (6.19),(6.20)

fc,0,d	14,5	MPa
fm,y,d	16,6	MPa
fm,z,d	16,6	MPa
km	0,70	

Unity check (6.19) = 0,00 + 0,06 + 0,02 = 0,08 -
Unity check (6.20) = 0,00 + 0,04 + 0,02 = 0,07 -

The member satisfies the section check.

..:: STABILITY CHECK ::..

Columns subjected to compression or combined compression and bending
According to EN 1995-1-1 article 6.3.2 and formula (6.23),(6.24)

Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	0,698	1,395	m
Buckling factor k	10,00	1,00	
Buckling length Lcr	6,976	1,395	m
Slenderness λ	151,04	30,21	-
Relative slenderness λ	2,56	0,51	-
Limit slenderness	0,30	0,30	-
Imperfection βc	0,20	0,20	-
Reduction factor kc	0,14	0,95	-

Unity check (6.23) = 0,29 + 0,06 + 0,02 = 0,37 -
Unity check (6.24) = 0,04 + 0,04 + 0,02 = 0,11 -

Beams subjected to bending or combined bending and compression
According to EN 1995-1-1 article 6.3.3 and formula (6.33),(6.35)

LTB Parameters		
Elastic critical moment My,crit	369,04	kNm
Critical bending stress σm,crit	540,6	MPa
Relative slenderness λrel,m	0,21	-
Reduction factor kcrit	1,00	-

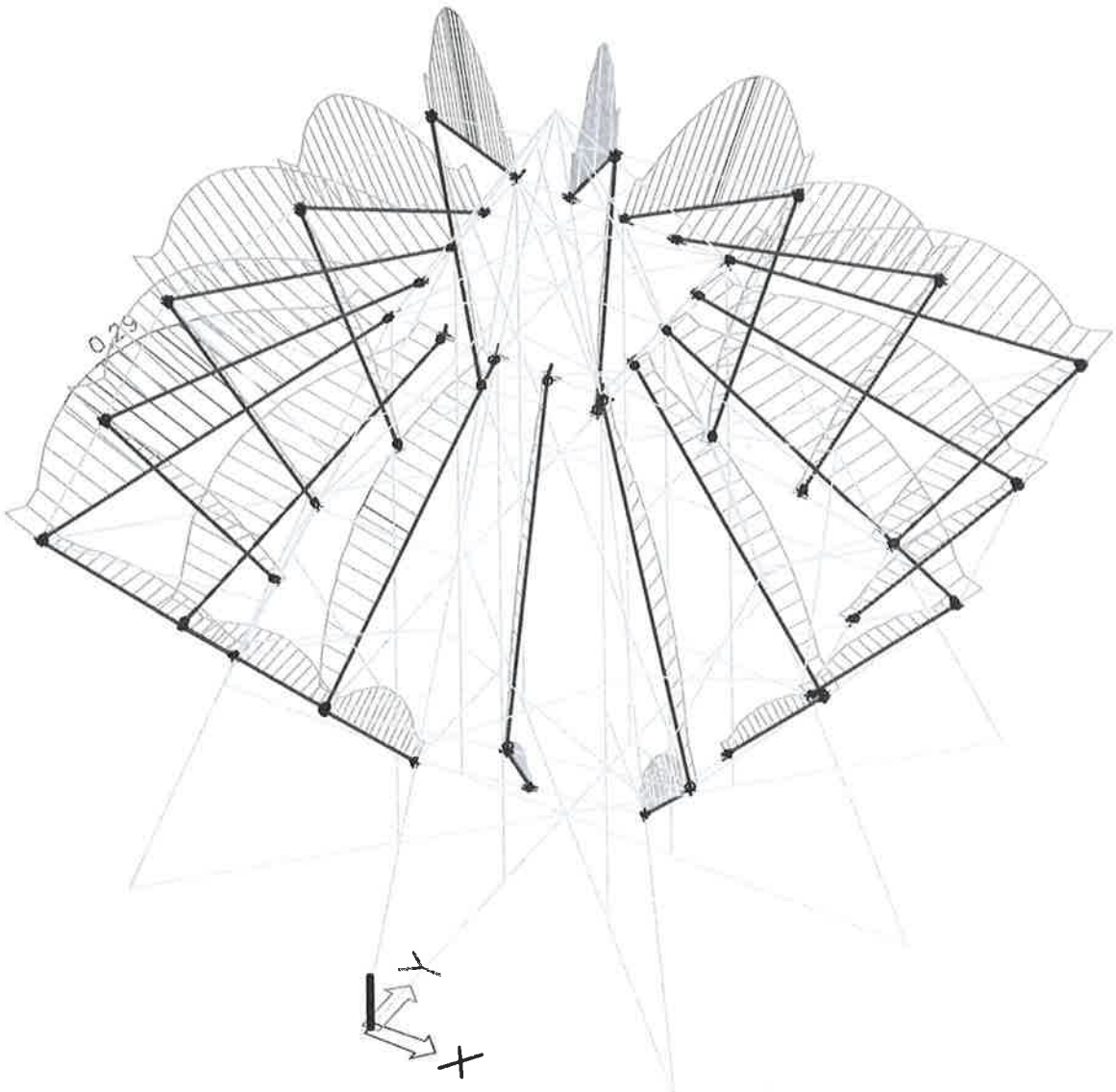
Unity check (6.33) = 0,06 -
Unity check (6.35) = 0,00 + 0,04 = 0,05 -

My,crit Parameters		
G0,05	462,5	MPa
LTB length L	1,395	m
Lef/L	0,80	
Effective length Lef	1,116	m
Influence of load position	no influence	

The member satisfies the stability check.

6. **grebeni**, b/h = 12/12 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B83
Class : ULS
Layer : grebeni

EN 1995-1-1 Code Check

Beam B83	**2,546 m**	**12/12 - RECT (120; 120)**	**C24 (EN 338)**	**ULS**	**0,29 -**

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

The critical check is on position **1,273** m.

Internal forces		
NEd	-1,05	kN
Vy,Ed	0,00	kN
Vz,Ed	0,00	kN
TEd	0,00	kNm
My,Ed	1,06	kNm
Mz,Ed	-0,51	kNm

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Compression parallel to the grain
According to EN 1995-1-1 article 6.1.4 and formula (6.2)

σc,0,d	0,1	MPa
fc,0,d	14,5	MPa
Unity check	0,01	-

Bending
According to EN 1995-1-1 article 6.1.6 and formula (6.11),(6.12)

σm,y,d	3,7	MPa
kh,y	1,05	
fm,y,d	17,4	MPa
σm,z,d	1,8	MPa
kh,z	1,05	
fm,z,d	17,4	MPa
km	0,70	

Unity check (6.11) = 0,21 + 0,07 = 0,28 -
Unity check (6.12) = 0,15 + 0,10 = 0,25 -

Torsion
According to EN 1995-1-1 article 6.1.8 and formula (6.14)

τtor,d	0,0	MPa
kshape	1,05	
fv,d	2,8	MPa
Unity check	0,00	-

Combined Bending and Axial Compression
According to EN 1995-1-1 article 6.2.4 and formula (6.19),(6.20)

fc,0,d	14,5	MPa
fm,y,d	17,4	MPa
fm,z,d	17,4	MPa
km	0,70	

Unity check (6.19) = 0,00 + 0,21 + 0,07 = 0,28 -
Unity check (6.20) = 0,00 + 0,15 + 0,10 = 0,25 -

The member satisfies the section check.

..:: STABILITY CHECK ::..

Columns subjected to compression or combined compression and bending
According to EN 1995-1-1 article 6.3.2 and formula (6.23),(6.24)

Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	2,546	2,546	m
Buckling factor k	1,00	1,00	
Buckling length Lcr	2,546	2,546	m
Slenderness λ	73,50	73,50	-
Relative slenderness λ	1,25	1,25	-
Limit slenderness	0,30	0,30	-
Imperfection βc	0,20	0,20	-
Reduction factor kc	0,51	0,51	-

Unity check (6.23) = 0,01 + 0,21 + 0,07 = 0,29 -
Unity check (6.24) = 0,01 + 0,15 + 0,10 = 0,26 -

Beams subjected to bending or combined bending and compression
According to EN 1995-1-1 article 6.3.3 and formula (6.33),(6.35)

LTB Parameters		
Elastic critical moment My,crit	56,88	kNm
Critical bending stress σm,crit	197,5	MPa
Relative slenderness λrel,m	0,35	-
Reduction factor kcrit	1,00	-

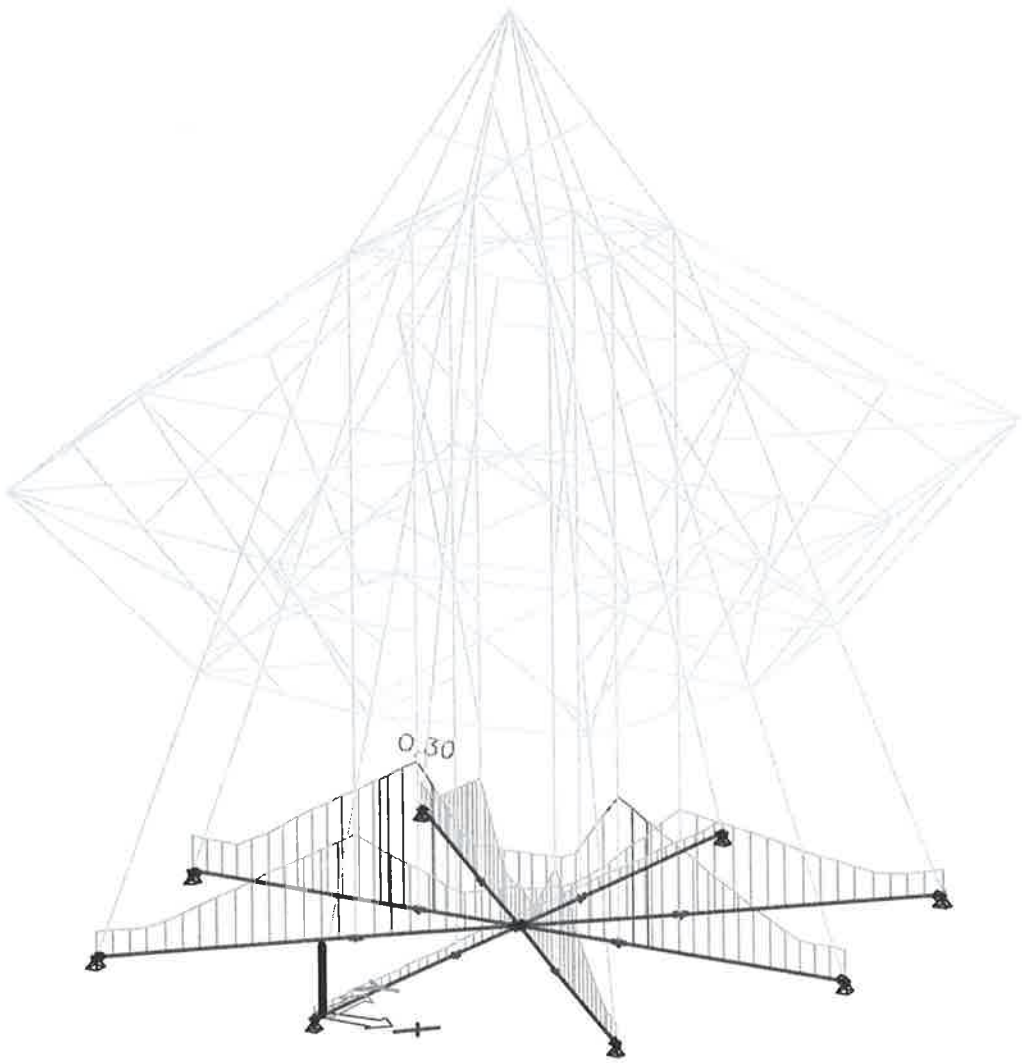
Unity check (6.33) = 0,21 -
Unity check (6.35) = 0,04 + 0,01 = 0,05 -

My,crit Parameters		
G0,05	462,5	MPa
LTB length L	2,546	m
Lef/L	0,90	
Effective length Lef	2,292	m
Influence of load position	no influence	

The member satisfies the stability check.

7. **vezne grede dolje**, b/h = 16/16 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B51
Class : ULS
Layer : vezne grede

EN 1995-1-1 Code Check

Beam B51	4,568 m	16/16 - RECT (160; 160)	C24 (EN 338)	ULS	0,30 -

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

The critical check is on position **2,984** m.

Internal forces		
NEd	0,69	kN
Vy,Ed	0,00	kN
Vz,Ed	-2,01	kN
TEd	0,00	kNm
My,Ed	3,36	kNm
Mz,Ed	0,00	kNm

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Tension parallel to the grain
According to EN 1995-1-1 article 6.1.2 and formula (6.1)

σt,0,d	0,0	MPa
kh	1,00	
ft,0,d	10,0	MPa
Unity check	0,00	-

Compression perpendicular to the grain
According to EN 1995-1-1 article 6.1.5 and formula (6.3)

Fc,90,d	6,67	kN
l	100	mm
lef	160	mm
b	160	mm
Aef	25600	mm^2
σc,90,d	0,3	MPa
Support condition	Discrete	
h	160	mm
kc,90	1,50	-
fc,90,d	1,7	MPa
Unity check	0,10	-

Bending
According to EN 1995-1-1 article 6.1.6 and formula (6.11),(6.12)

σm,y,d	4,9	MPa
kh,y	1,00	
fm,y,d	16,6	MPa
σm,z,d	0,0	MPa
kh,z	1,00	
fm,z,d	16,6	MPa
km	0,70	

Unity check (6.11) = 0,30 + 0,00 = 0,30 -
Unity check (6.12) = 0,21 + 0,00 = 0,21 -

Shear
According to EN 1995-1-1 article 6.1.7 and formula (6.13)

kcr	0,67	

τy,d	0,0	MPa
τz,d	0,2	MPa
fv,d	2,8	MPa
Unity check τy	0,00	-
Unity check τz	0,06	-
Unity check Interaction	0,00	-

Note: The interaction equation has been added as a NCCI.

Torsion
According to EN 1995-1-1 article 6.1.8 and formula (6.14)

τtor,d	0,0	MPa
kshape	1,05	
fv,d	2,8	MPa
Unity check	0,00	-
Unity check Interaction Shear	0,00	-

Note: The interaction equation has been added as a NCCI.

Combined Bending and Axial Tension
According to EN 1995-1-1 article 6.2.3 and formula (6.17),(6.18)

ft,0,d	10,0	MPa
fm,y,d	16,6	MPa
fm,z,d	16,6	MPa
km	0,70	

Unity check (6.17) = 0,00 + 0,30 + 0,00 = 0,30 -
Unity check (6.18) = 0,00 + 0,21 + 0,00 = 0,21 -

The member satisfies the section check.

..:: STABILITY CHECK ::..

Beams subjected to bending or combined bending and compression
According to EN 1995-1-1 article 6.3.3 and formula (6.33),(6.35)

LTB Parameters		
Elastic critical moment My,crit	112,73	kNm
Critical bending stress σm,crit	165,1	MPa
Relative slenderness λrel,m	0,38	-
Reduction factor kcrit	1,00	-

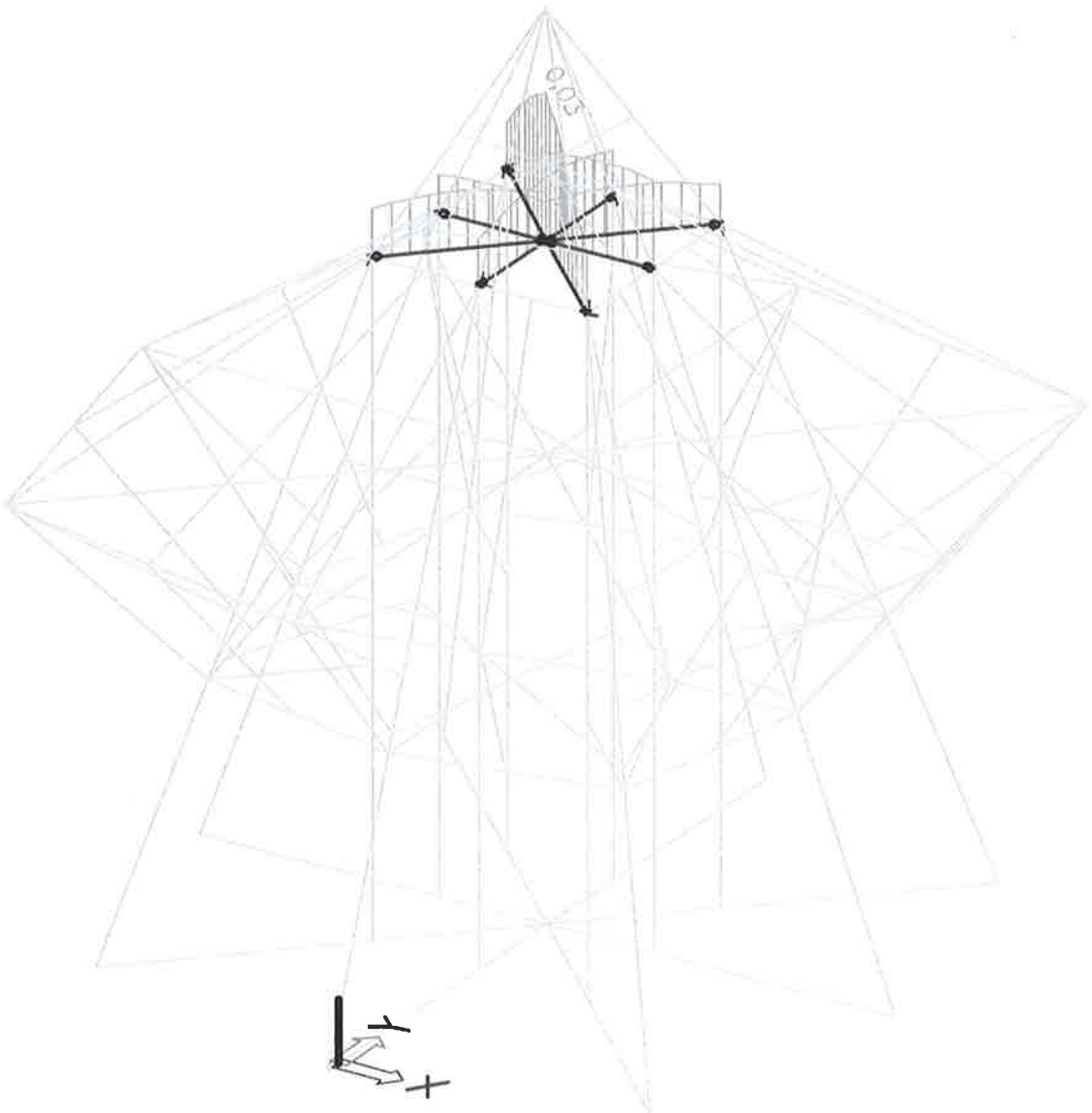
Unity check (6.33) = 0,30 -

My,crit Parameters		
G0,05	462,5	MPa
LTB length L	4,568	m
Lef/L	0,80	
Effective length Lef	3,654	m
Influence of load position	no influence	

The member satisfies the stability check.

8. **vezne grede gore**, b/h = 12/12 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B18
Class : ULS
Layer : vezne grede

EN 1995-1-1 Code Check

Beam B18	1,980 m	12/12 - RECT (120; 120)	C24 (EN 338)	ULS	0,03 -

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

The critical check is on position **0,990** m.

Internal forces		
NEd	-1,83	kN
Vy,Ed	0,00	kN
Vz,Ed	-0,06	kN
TEd	0,00	kNm
My,Ed	0,10	kNm
Mz,Ed	0,00	kNm

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Compression parallel to the grain
According to EN 1995-1-1 article 6.1.4 and formula (6.2)

σc,0,d	0,1	MPa
fc,0,d	14,5	MPa
Unity check	0,01	-

Compression perpendicular to the grain
According to EN 1995-1-1 article 6.1.5 and formula (6.3)

Fc,90,d	0,13	kN
l	100	mm
lef	160	mm
b	120	mm
Aef	19200	mm^2
σc,90,d	0,0	MPa
Support condition	Discrete	
h	120	mm
kc,90	1,50	-
fc,90,d	1,7	MPa
Unity check	0,00	-

Bending
According to EN 1995-1-1 article 6.1.6 and formula (6.11),(6.12)

σm,y,d	0,4	MPa
kh,y	1,05	
fm,y,d	17,4	MPa
σm,z,d	0,0	MPa
kh,z	1,05	
fm,z,d	17,4	MPa
km	0,70	

Unity check (6.11) = 0,02 + 0,00 = 0,02 -
Unity check (6.12) = 0,01 + 0,00 = 0,01 -

Shear
According to EN 1995-1-1 article 6.1.7 and formula (6.13)

kcr	0,67	
τy,d	0,0	MPa

τz,d	0,0	MPa
fv,d	2,8	MPa
Unity check τy	0,00	-
Unity check τz	0,00	-
Unity check Interaction	0,00	-

Note: The interaction equation has been added as a NCCI.

Torsion
According to EN 1995-1-1 article 6.1.8 and formula (6.14)

τtor,d	0,0	MPa
kshape	1,05	
fv,d	2,8	MPa
Unity check	0,00	-
Unity check Interaction Shear	0,00	-

Note: The interaction equation has been added as a NCCI.

Combined Bending and Axial Compression
According to EN 1995-1-1 article 6.2.4 and formula (6.19),(6.20)

fc,0,d	14,5	MPa
fm,y,d	17,4	MPa
fm,z,d	17,4	MPa
km	0,70	

Unity check (6.19) = 0,00 + 0,02 + 0,00 = 0,02 -
Unity check (6.20) = 0,00 + 0,01 + 0,00 = 0,01 -

The member satisfies the section check.

..:: STABILITY CHECK ::..

Columns subjected to compression or combined compression and bending
According to EN 1995-1-1 article 6.3.2 and formula (6.23),(6.24)

Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	1,980	0,990	m
Buckling factor k	1,00	2,14	
Buckling length Lcr	1,980	2,122	m
Slenderness λ	57,15	61,26	-
Relative slenderness λ	0,97	1,04	-
Limit slenderness	0,30	0,30	-
Imperfection βc	0,20	0,20	-
Reduction factor kc	0,71	0,66	-

Unity check (6.23) = 0,01 + 0,02 + 0,00 = 0,03 -
Unity check (6.24) = 0,01 + 0,01 + 0,00 = 0,03 -

Beams subjected to bending or combined bending and compression
According to EN 1995-1-1 article 6.3.3 and formula (6.33),(6.35)

LTB Parameters		
Elastic critical moment My,crit	146,26	kNm
Critical bending stress σm,crit	507,9	MPa
Relative slenderness λrel,m	0,22	-
Reduction factor kcrit	1,00	-

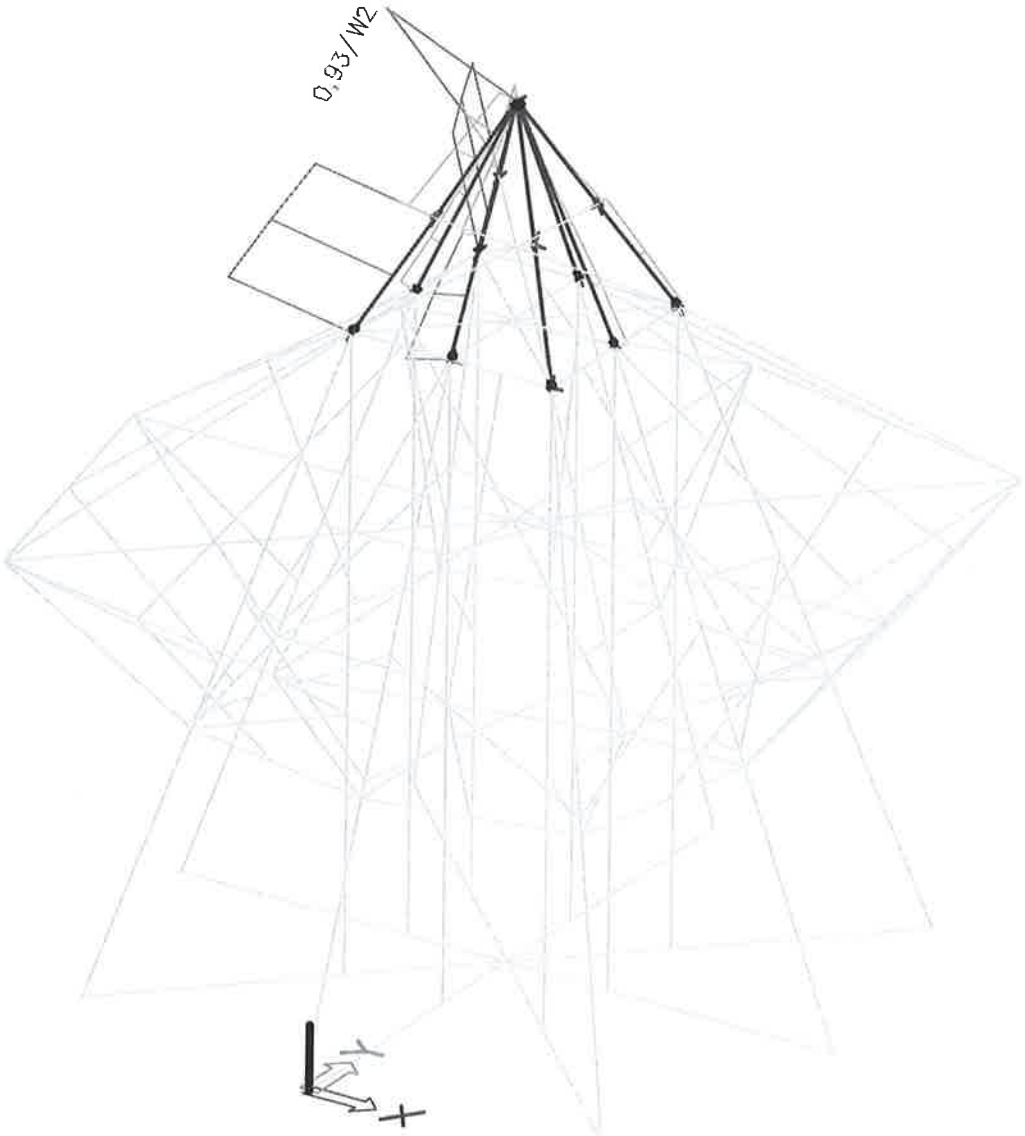
Unity check (6.33) = 0,02 -
Unity check (6.35) = 0,00 + 0,01 = 0,01 -

My,crit Parameters		
G0,05	462,5	MPa
LTB length L	0,990	m
Lef/L	0,90	
Effective length Lef	0,891	m
Influence of load position	no influence	

The member satisfies the stability check.

9. **gornji grebeni**, b/h = 12/12 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B103
Class : ULS
Layer : gornji grebeni

EN 1995-1-1 Code Check

Beam B103	**1,856 m**	**12/12 - RECT (120; 120)**	**C24 (EN 338)**	**ULS**	**0,83 -**

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

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

Internal forces		
NEd	-8,09	kN
Vy,Ed	0,14	kN
Vz,Ed	0,32	kN
TEd	0,00	kNm
My,Ed	0,00	kNm
Mz,Ed	0,00	kNm

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Compression parallel to the grain
According to EN 1995-1-1 article 6.1.4 and formula (6.2)

σc,0,d	0,6	MPa
fc,0,d	14,5	MPa
Unity check	0,04	-

Compression perpendicular to the grain
According to EN 1995-1-1 article 6.1.5 and formula (6.3)

Fc,90,d	0,32	kN
l	100	mm
lef	130	mm
b	120	mm
Aef	15600	mm²
σc,90,d	0,0	MPa
Support condition	Discrete	
h	120	mm
kc,90	1,50	-
fc,90,d	1,7	MPa
Unity check	0,01	-

Shear
According to EN 1995-1-1 article 6.1.7 and formula (6.13)

kcr	0,67	
τy,d	0,0	MPa
τz,d	0,0	MPa
fv,d	2,8	MPa
Unity check τy	0,01	-
Unity check τz	0,02	-
Unity check Interaction	0,00	-

Note: The interaction equation has been added as a NCCI.

Torsion
According to EN 1995-1-1 article 6.1.8 and formula (6.14)

τtor,d	0,0	MPa
kshape	1,05	
fv,d	2,8	MPa

Unity check	0,00	-
Unity check Interaction Shear	0,00	-

Note: The interaction equation has been added as a NCCI.

The member satisfies the section check.

..:: STABILITY CHECK ::..

Columns subjected to compression or combined compression and bending
According to EN 1995-1-1 article 6.3.2 and formula (6.23),(6.24)

Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	0,928	0,928	m
Buckling factor k	10,00	5,26	
Buckling length Lcr	9,280	4,884	m
Slenderness λ	267,90	140,99	-
Relative slenderness λ	4,54	2,39	-
Limit slenderness	0,30	0,30	-
Imperfection βc	0,20	0,20	-
Reduction factor kc	0,05	0,16	-

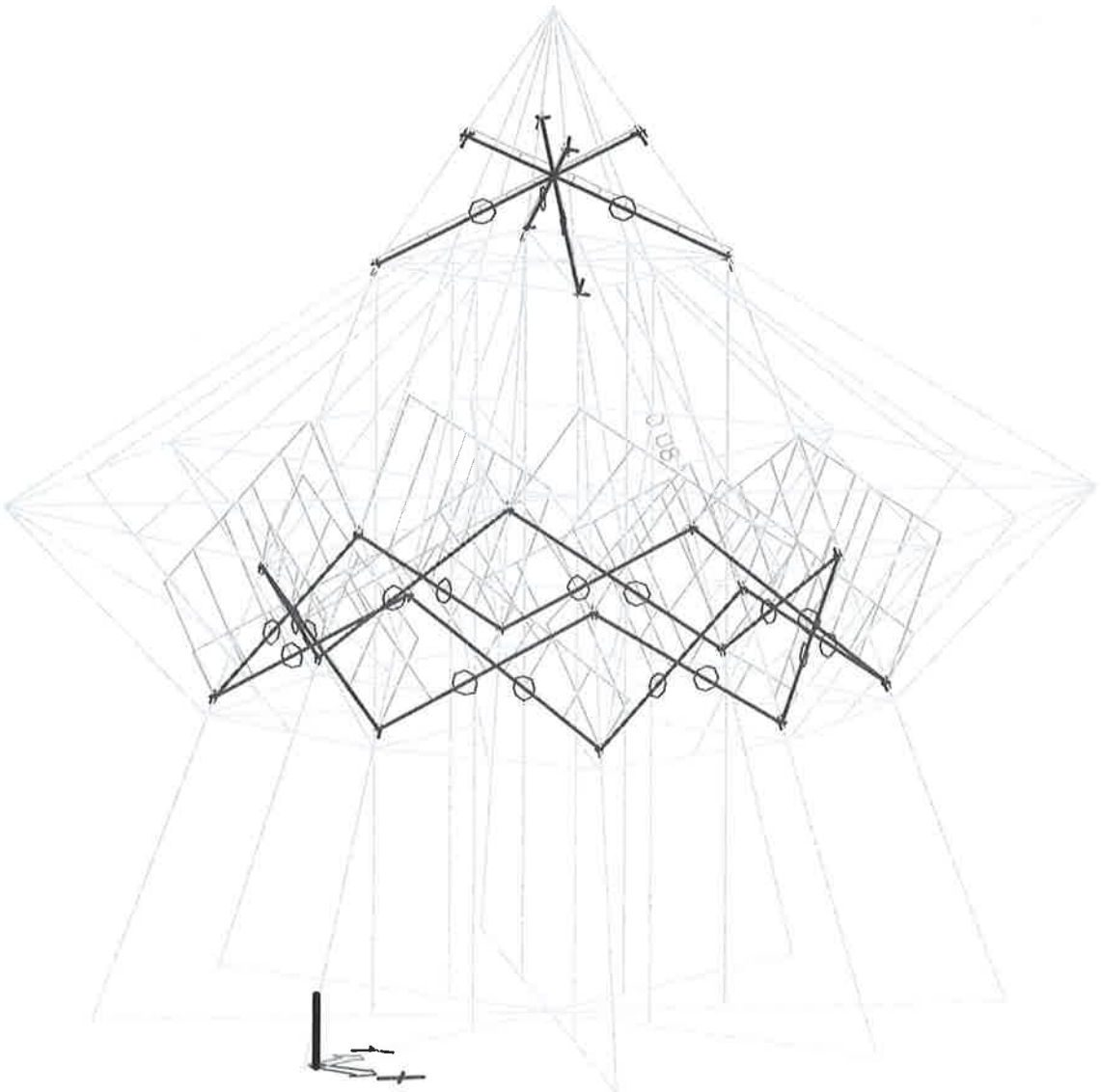
Unity check (6.23) = 0,83 + 0,00 + 0,00 = 0,83 -
Unity check (6.24) = 0,24 + 0,00 + 0,00 = 0,24 -

Warning: The slenderness 267,90 is larger than the limit value 200,00!

The member satisfies the stability check.

10. **križevi**, b/h = 12/12 cm, C24

Prikaz iskoristivosti elemenata za ULS:



Timber ULS check

Linear calculation, Extreme : Global
Selection : B117
Class : ULS
Layer : krizevi

EN 1995-1-1 Code Check

Beam B117	**1,560 m**	**12/12 - RECT (120; 120)**	**C24 (EN 338)**	**ULS**	**0,08 -**

Combination key
ULS / 1.35*LC1 + 1.35*LC2 + 0.75*LC3 + 1.50*LC4

Basic data	
Partial safety factor γM for Solid timber	1,30

Material data		
Bending (fm,k)	24,0	MPa
Tension (ft,0,k)	14,5	MPa
Tension (ft,90,k)	0,4	MPa
Compression (fc,0,k)	21,0	MPa
Compression (fc,90,k)	2,5	MPa
Shear (fv,k)	4,0	MPa
Type of timber	Solid	

The critical check is on position **1,560** m.

Internal forces		
NEd	11,66	kN
Vy,Ed	0,00	kN
Vz,Ed	0,00	kN
TEd	0,00	kNm
My,Ed	0,00	kNm
Mz,Ed	0,00	kNm

Modification factor	
Service Class	1
Load duration	Short term
Modification factor kmod	0,90

..:: SECTION CHECK ::..

Tension parallel to the grain
According to EN 1995-1-1 article 6.1.2 and formula (6.1)

σt,0,d	0,8	MPa
kh	1,05	
ft,0,d	10,5	MPa
Unity check	0,08	-

The member satisfies the section check.

..:: STABILITY CHECK ::..

The member satisfies the stability check.

6. ISKAZ DRVA

Material	Mass [kg]	Surface [m^2]	Unit volume mass [kg/m^3]	Volume [m^3]
C24 (EN 338)	2306,7	165,045	420,0	5,4922e+00

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Profis Anchor 2.8.0

Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	4. 4. 2019.
E-Mail:			

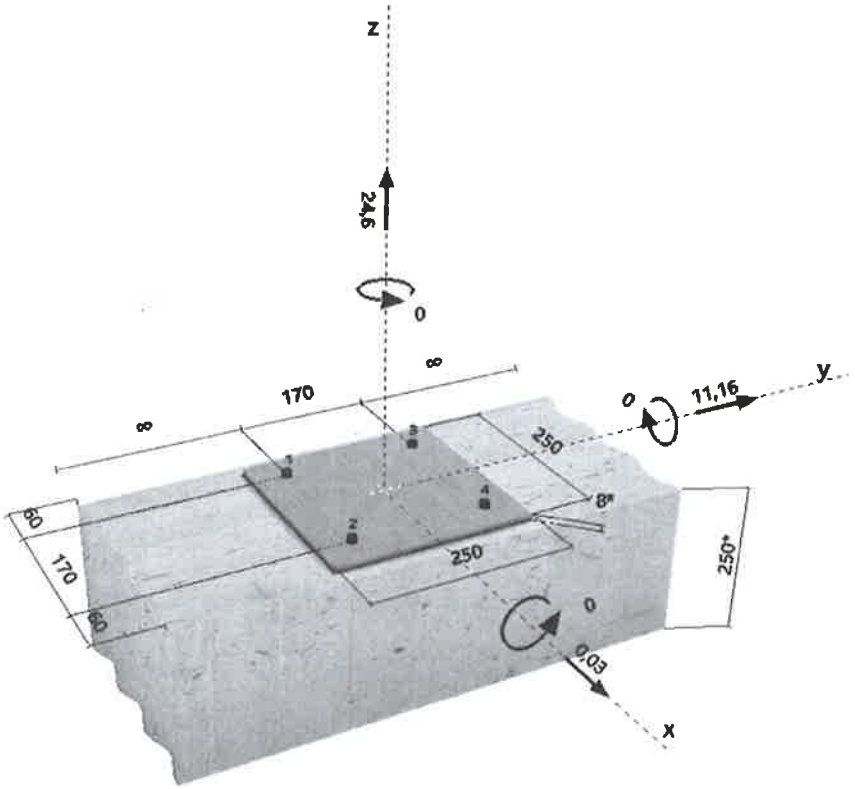
Specifier's comments:

1 Input data

Anchor type and diameter:	**HST3-R M12 hef2**
Effective embedment depth:	h_{ef} = 70 mm, h_{nom} = 80 mm
Material:	A4
Evaluation Service Report:	ETA-98/0001
Issued I Valid:	9. 2. 2018. | -
Proof:	Design method ETAG (No. 001 Annex C/2010)
Stand-off installation:	e_b = 0 mm (no stand-off); t = 8 mm
Anchor plate:	l_x x l_y x t = 250 mm x 250 mm x 8 mm; (Recommended plate thickness: not calculated
Profile:	no profile
Base material:	uncracked concrete, C25/30, $f_{c,cube}$ = 30,00 N/mm²; h = 250 mm
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	no reinforcement or reinforcement spacing >= 150 mm (any Ø) or >= 100 mm (Ø <= 10 mm) no longitudinal edge reinforcement

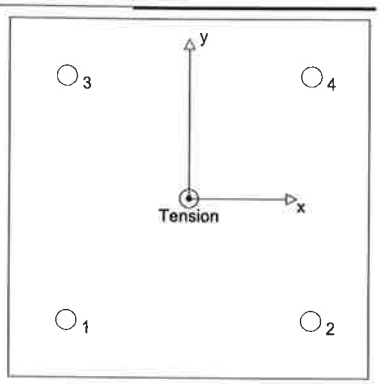
R - The anchor calculation is based on a rigid baseplate assumption.

Geometry [mm] & Loading [kN, kNm]



2 Load case/Resulting anchor forces

Load case: Design loads



Anchor reactions [kN]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	6,150	2,790	0,008	2,790
2	6,150	2,790	0,008	2,790
3	6,150	2,790	0,008	2,790
4	6,150	2,790	0,008	2,790

max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [N/mm²]
resulting tension force in (x/y)=(0/0): 24,600 [kN]
resulting compression force in (x/y)=(0/0): 0,000 [kN]

Anchor forces are calculated based on the assumption of a rigid baseplate.

3 Tension load (ETAG, Annex C, Section 5.2.2)

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel Strength*	6,150	30,357	21	OK
Pullout Strength*	6,150	18,257	34	OK
Concrete Breakout Strength**	24,600	47,034	53	OK
Splitting failure**	24,600	69,229	36	OK

* anchor having the highest loading **anchor group (anchors in tension)

3.1 Steel Strength

$N_{Rk,s}$ [kN]	$\gamma_{M,s}$	$N_{Rd,s}$ [kN]	N_{Sd} [kN]
42,500	1,400	30,357	6,150

3.2 Pullout Strength

$N_{Rk,p}$ [kN]	ψ_c	$\gamma_{M,p}$	$N_{Rd,p}$ [kN]	N_{Sd} [kN]
25,000	1,095	1,500	18,257	6,150

3.3 Concrete Breakout Strength

$A_{c,N}$ [mm²]	$A^0_{c,N}$ [mm²]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]		
110.200	44.100	105	210		
$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$
0	1,000	0	1,000	0,871	1,000
k_1	$N^0_{Rk,c}$ [kN]	$\gamma_{M,c}$	$N_{Rd,c}$ [kN]	N_{Sd} [kN]	
10,100	32,399	1,500	47,034	24,600	

3.4 Splitting failure

$A_{c,N}$ [mm²]	$A^0_{c,N}$ [mm²]	$c_{cr,sp}$ [mm]	$s_{cr,sp}$ [mm]	$\psi_{h,sp}$		
110.200	44.100	105	210	1,472		
$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$	k_1
0	1,000	0	1,000	0,871	1,000	10,100
$N^0_{Rk,c}$ [kN]	$\gamma_{M,sp}$	$N_{Rd,sp}$ [kN]	N_{Sd} [kN]			
32,399	1,500	69,229	24,600			

4 Shear load (ETAG, Annex C, Section 5.2.3)

	Load [kN]	Capacity [kN]	Utilization β_V [%]	Status
Steel Strength (without lever arm)*	2,790	29,360	10	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	11,160	130,755	9	OK
Concrete edge failure in direction x+**	5,580	35,229	16	OK

* anchor having the highest loading **anchor group (relevant anchors)

4.1 Steel Strength (without lever arm)

$V_{Rk,s}$ [kN]	$\gamma_{M,s}$	$V_{Rd,s}$ [kN]	V_{Sd} [kN]
36,700	1,250	29,360	2,790

4.2 Pryout Strength

$A_{c,N}$ [mm²]	$A^0_{c,N}$ [mm²]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	k-factor	
110,200	44,100	105	210	2,780	
$e_{c1,V}$ [mm]	$\psi_{ec1,N}$	$e_{c2,V}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$
0	1,000	0	1,000	0,871	1,000
$N^0_{Rk,c}$ [kN]	$\gamma_{M,c,p}$	$V_{Rd,cp}$ [kN]	V_{Sd} [kN]		
32,399	1,500	130,755	11,160		

4.3 Concrete edge failure in direction x+

l_f [mm]	d_{nom} [mm]	k_1	α	β	
70	12,0	2,400	0,108	0,072	
c_1 [mm]	$A_{c,V}$ [mm²]	$A^0_{c,V}$ [mm²]			
60	31.500	16.200			
$\psi_{s,V}$	$\psi_{h,V}$	$\psi_{\alpha,V}$	$e_{c,V}$ [mm]	$\psi_{ec,V}$	$\psi_{re,V}$
1,000	1,000	2,500	0	1,000	1,000
$V^0_{Rk,c}$ [kN]	$\gamma_{M,c}$	$V_{Rd,c}$ [kN]	V_{Sd} [kN]		
10,872	1,500	35,229	5,580		

5 Combined tension and shear loads (ETAG, Annex C, Section 5.2.4)

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0,523	0,158	1,500	45	OK

$\beta_N^\alpha + \beta_V^\alpha \leq 1,0$

6 Displacements (highest loaded anchor)

Short term loading:

N_{Sk} = 4,556 [kN] $\quad \delta_N$ = 0,077 [mm]
V_{Sk} = 2,067 [kN] $\quad \delta_V$ = 0,325 [mm]
δ_{NV} = 0,334 [mm]

Long term loading:

N_{Sk} = 4,556 [kN] $\quad \delta_N$ = 0,153 [mm]
V_{Sk} = 2,067 [kN] $\quad \delta_V$ = 0,482 [mm]
δ_{NV} = 0,506 [mm]

Comments: Tension displacements are valid with half of the required installation torque moment for uncracked concrete! Shear displacements are valid without friction between the concrete and the anchor plate! The gap due to the drilled hole and clearance hole tolerances are not included in this calculation!

The acceptable anchor displacements depend on the fastened construction and must be defined by the designer!

7 Warnings

- The anchor design methods in PROFIS Anchor require rigid anchor plates per current regulations (ETAG 001/Annex C, EOTA TR029, etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Anchor calculates the minimum required anchor plate thickness with FEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid base plate assumption is valid is not carried out by PROFIS Anchor. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Checking the transfer of loads into the base material is required in accordance with ETAG 001, Annex C(2010)Section 7! The software considers that the grout is installed under the anchor plate without creating air voids and before application of the loads.
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 4.1 of ETAG 001, Annex C! For larger diameters of the clearance hole see Chapter 1.1. of ETAG 001, Annex C!
- The accessory list in this report is for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.

Fastening meets the design criteria!

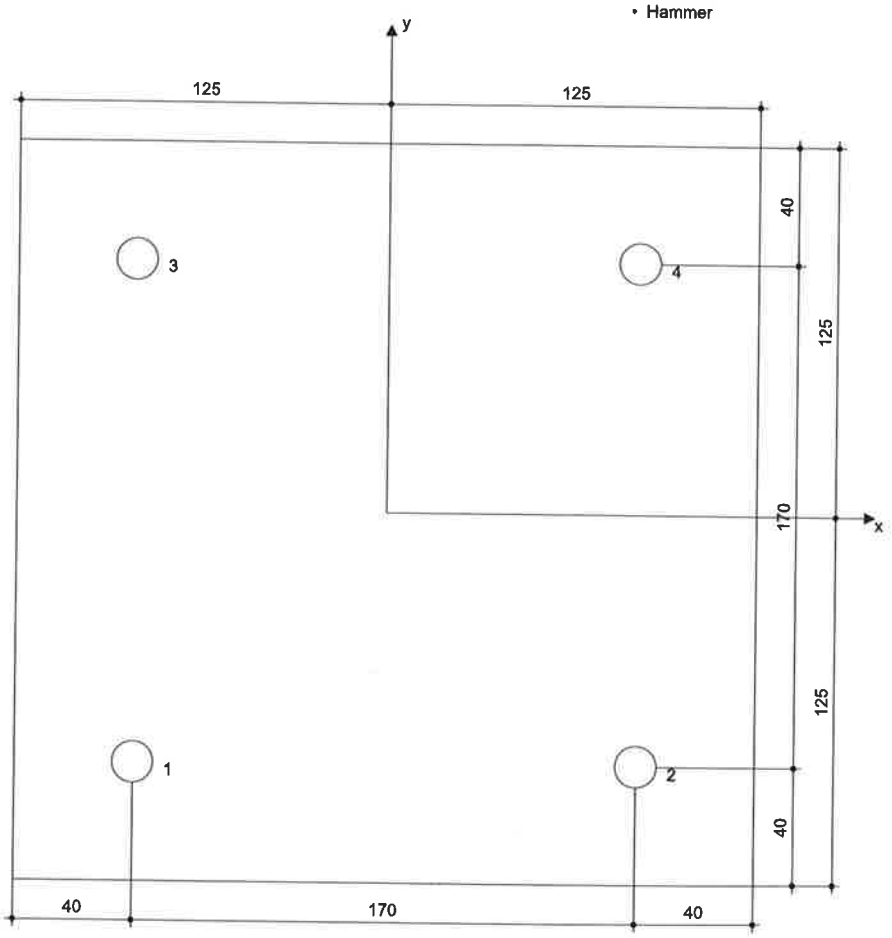
8 Installation data

Anchor plate, steel: -
Profile: no profile
Hole diameter in the fixture: d_f = 14 mm
Plate thickness (input): 8 mm
Recommended plate thickness: not calculated
Drilling method: Hammer drilled
Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Anchor type and diameter: HST3-R M12 hef2
Installation torque: 0,060 kNm
Hole diameter in the base material: 12 mm
Hole depth in the base material: 90 mm
Minimum thickness of the base material: 140 mm

8.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Manual blow-out pump	• Hilti SIW 22T-A impact screw driver • Torque wrench • Hammer



Coordinates Anchor [mm]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-85	-85	60	230	-	-
2	85	-85	230	60	-	-
3	-85	85	60	230	-	-
4	85	85	230	60	-	-

9 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

HST3 (-R) subject to:

Anchor size	M8	M10	M12	M16	M20	M24
Hammer drilling* 	TE2(-A) – TE30(-A)				TE40 – TE70	
Diamond core drilling* 	DD-30W, DD-EC1					
Setting tool* 	Setting tool HS-SC				-	
Hollow drill bit drilling* 	-		TE-CD, TE-YD			
Seismic Set/ Filling Set** 	Seismic/Filling Set M8-M20 (Carbon and Stainless Steel A4)					-

***Installation methods provided in ETA-98/0001**
**Seismic set needed to fill the annular gap between anchor and fixture:
No annular gap, double design resistance (agap=1)

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Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	4. 4. 2019.
E-Mail:			

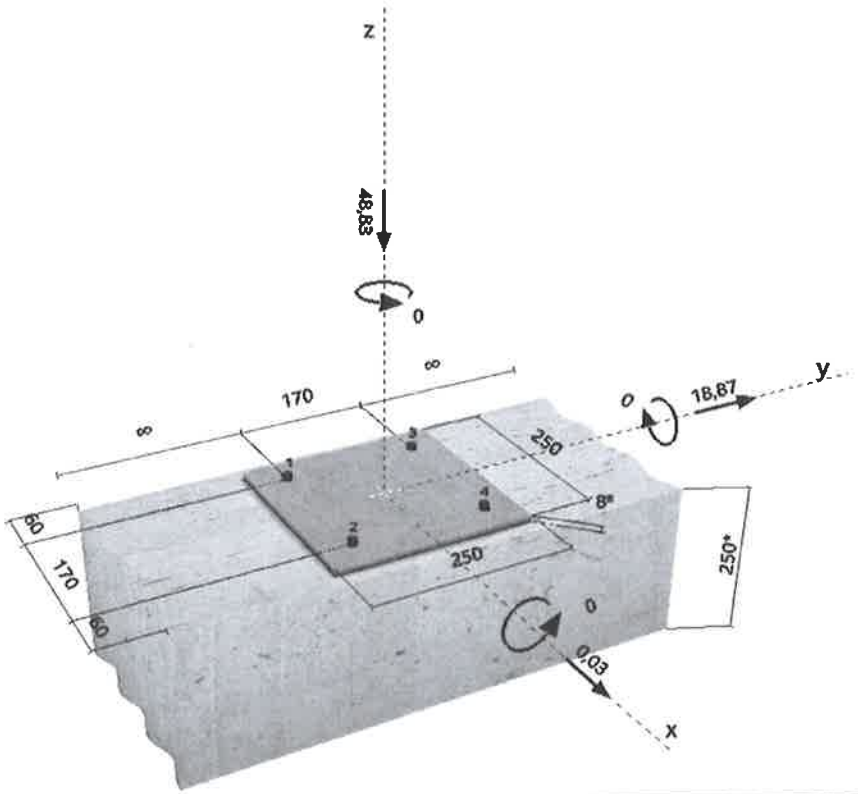
Specifier's comments:

1 Input data

Anchor type and diameter:	**HST3-R M12 hef2**
Effective embedment depth:	h_{ef} = 70 mm, h_{nom} = 80 mm
Material:	A4
Evaluation Service Report:	ETA-98/0001
Issued I Valid:	9. 2. 2018. | -
Proof:	Design method ETAG (No. 001 Annex C/2010)
Stand-off installation:	e_b = 0 mm (no stand-off); t = 8 mm
Anchor plate:	l_x x l_y x t = 250 mm x 250 mm x 8 mm; (Recommended plate thickness: not calculated
Profile:	no profile
Base material:	uncracked concrete, C25/30, $f_{c,cube}$ = 30,00 N/mm²; h = 250 mm
Installation:	**hammer drilled hole, installation condition: Dry**
Reinforcement:	no reinforcement or reinforcement spacing >= 150 mm (any Ø) or >= 100 mm (Ø <= 10 mm) no longitudinal edge reinforcement

R - The anchor calculation is based on a rigid baseplate assumption.

Geometry [mm] & Loading [kN, kNm]



Company:
Specifier:
Address:
Phone I Fax:
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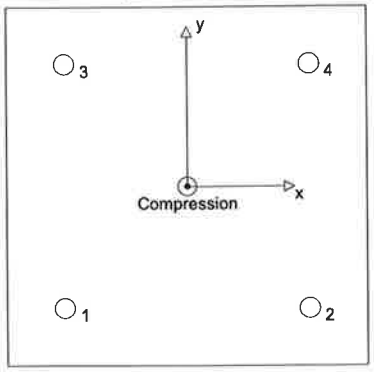
Page: 2
Project:
Sub-Project I Pos. No.:
Date: 4. 4. 2019.

2 Load case/Resulting anchor forces

Load case: Design loads



Anchor reactions [kN]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0,000	4,718	0,008	4,718
2	0,000	4,718	0,008	4,718
3	0,000	4,718	0,008	4,718
4	0,000	4,718	0,008	4,718

max. concrete compressive strain:	0,03 [‰]
max. concrete compressive stress:	0,78 [N/mm²]
resulting tension force in (x/y)=(0/0):	0,000 [kN]
resulting compression force in (x/y)=(0/0):	48,830 [kN]

Anchor forces are calculated based on the assumption of a rigid baseplate.

3 Tension load (ETAG, Annex C, Section 5.2.2)

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel Strength*	N/A	N/A	N/A	N/A
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	N/A	N/A	N/A	N/A
Splitting failure**	N/A	N/A	N/A	N/A

* anchor having the highest loading **anchor group (anchors in tension)

4 Shear load (ETAG, Annex C, Section 5.2.3)

	Load [kN]	Capacity [kN]	Utilization β_V [%]	Status
Steel Strength (without lever arm)*	4,718	29,360	17	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	18,870	130,755	15	OK
Concrete edge failure in direction x+**	9,435	35,231	27	OK

* anchor having the highest loading **anchor group (relevant anchors)

4.1 Steel Strength (without lever arm)

$V_{Rk,s}$ [kN]	$\gamma_{M,s}$	$V_{Rd,s}$ [kN]	V_{Sd} [kN]
36,700	1,250	29,360	4,718

4.2 Pryout Strength

$A_{c,N}$ [mm²]	$A^0_{c,N}$ [mm²]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	k-factor	
110.200	44.100	105	210	2,780	
$e_{c1,V}$ [mm]	$\psi_{ec1,N}$	$e_{c2,V}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$
0	1,000	0	1,000	0,871	1,000
$N^0_{Rk,c}$ [kN]	$\gamma_{M,c,p}$	$V_{Rd,cp}$ [kN]	V_{Sd} [kN]		
32,399	1,500	130,755	18,870		

4.3 Concrete edge failure in direction x+

l_f [mm]	d_{nom} [mm]	k_1	α	β	
70	12,0	2,400	0,108	0,072	
c_1 [mm]	$A_{c,V}$ [mm²]	$A^0_{c,V}$ [mm²]			
60	31.500	16.200			
$\psi_{s,V}$	$\psi_{h,V}$	$\psi_{\alpha,V}$	$e_{c,V}$ [mm]	$\psi_{ec,V}$	$\psi_{re,V}$
1,000	1,000	2,500	0	1,000	1,000
$V^0_{Rk,c}$ [kN]	$\gamma_{M,c}$	$V_{Rd,c}$ [kN]	V_{Sd} [kN]		
10,872	1,500	35,231	9,435		

5 Displacements (highest loaded anchor)

Short term loading:

N_{Sk} = 0,000 [kN] δ_N = 0,000 [mm]
V_{Sk} = 3,494 [kN] δ_V = 0,549 [mm]
δ_{NV} = 0,549 [mm]

Long term loading:

N_{Sk} = 0,000 [kN] δ_N = 0,000 [mm]
V_{Sk} = 3,494 [kN] δ_V = 0,815 [mm]
δ_{NV} = 0,815 [mm]

Comments: Tension displacements are valid with half of the required installation torque moment for uncracked concrete! Shear displacements are valid without friction between the concrete and the anchor plate! The gap due to the drilled hole and clearance hole tolerances are not included in this calculation!

The acceptable anchor displacements depend on the fastened construction and must be defined by the designer!

6 Warnings

- The anchor design methods in PROFIS Anchor require rigid anchor plates per current regulations (ETAG 001/Annex C, EOTA TR029, etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Anchor calculates the minimum required anchor plate thickness with FEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid base plate assumption is valid is not carried out by PROFIS Anchor. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Checking the transfer of loads into the base material is required in accordance with ETAG 001, Annex C(2010)Section 7! The software considers that the grout is installed under the anchor plate without creating air voids and before application of the loads.
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 4.1 of ETAG 001, Annex C! For larger diameters of the clearance hole see Chapter 1.1. of ETAG 001, Annex C!
- The accessory list in this report is for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.

Fastening meets the design criteria!

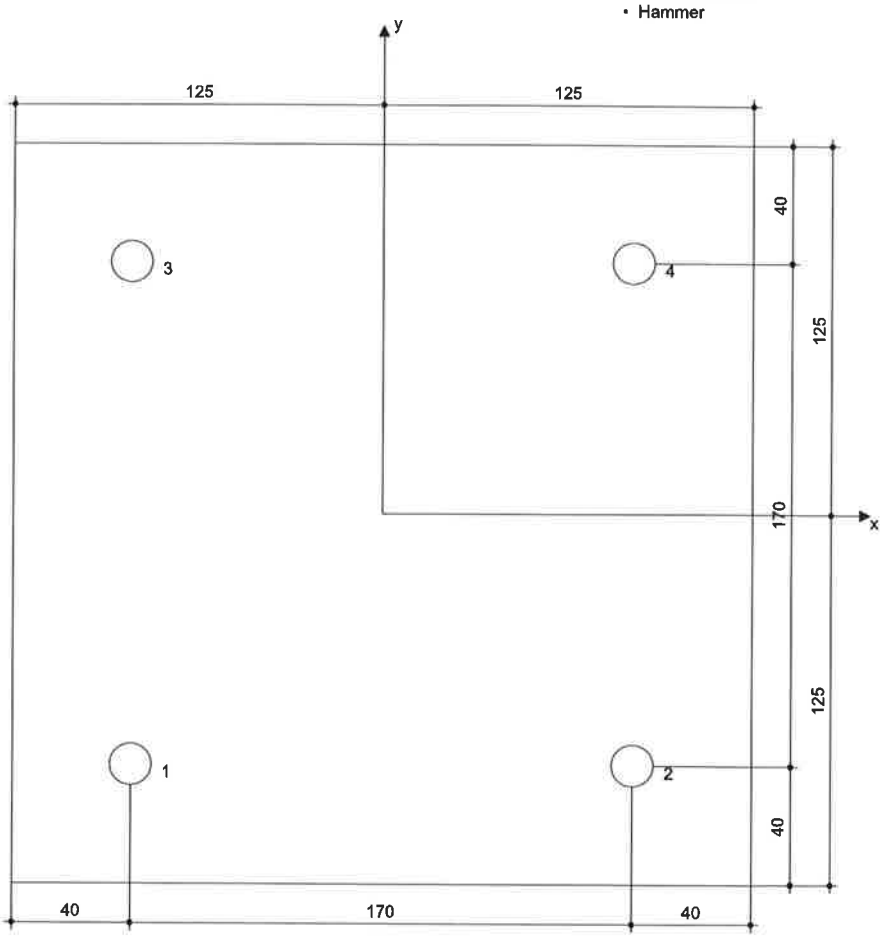
7 Installation data

Anchor plate, steel: -
Profile: no profile
Hole diameter in the fixture: d_f = 14 mm
Plate thickness (input): 8 mm
Recommended plate thickness: not calculated
Drilling method: Hammer drilled
Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Anchor type and diameter: HST3-R M12 hef2
Installation torque: 0,060 kNm
Hole diameter in the base material: 12 mm
Hole depth in the base material: 90 mm
Minimum thickness of the base material: 140 mm

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Manual blow-out pump	• Hilti SIW 22T-A impact screw driver • Torque wrench • Hammer



Coordinates Anchor [mm]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-85	-85	60	230	-	-
2	85	-85	230	60	-	-
3	-85	85	60	230	-	-
4	85	85	230	60	-	-

8 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

HST3 (-R) subject to:

Anchor size	M8	M10	M12	M16	M20	M24
Hammer drilling* 	TE2(-A) – TE30(-A)				TE40 – TE70	
Diamond core drilling* 	DD-30W, DD-EC1					
Setting tool* 	Setting tool HS-SC				-	
Hollow drill bit drilling* 	-		TE-CD, TE-YD			
Seismic Set/ Filling Set** 	Seismic/Filling Set M8-M20 (Carbon and Stainless Steel A4)					-

***Installation methods provided in ETA-98/0001**
**Seismic set needed to fill the annular gap between anchor and fixture:
No annular gap, double design resistance (agap=1)