NAČRT GRADBENIH KONSTRUKCIJ 3

INVESTITOR:

Občina Laško, Mestna ulica 2, 3270 Laško

OBJEKT:

INFO POINT RIMSKE TOPLICE

VRSTA PROJEKTNE DOKUMENTACIJE:

PROJEKT ZA IZVEDBO

ZA GRADNJO:

NOVOGRADNJA

PROJEKTANT:

SPINA NOVO MESTO d. o. o., RESSLOVA 7A, 8000 NOVO MESTO

Prokurist: MATIC OŽBOLT, univ. dipl. inž. grad.

ODGOVORNI PROJEKTANT:

MATIC OŽBOLT, univ. dipl. inž. grad.

ODGOVORNI VODJA PROJEKTA:

GORDANA VESEL, univ. dipl. inž. arh.

KRAJ IN DATUM IZDELAVE NAČRTA	OZN. NAČRTA	ŠT. IZVODA	ŠT. PROJEKTA:
NOVO MESTO, NOVEMBER 2017	**090 / 2017**	**1 2 3 4 5**	**37 / 2016**

3.2 KAZALO VSEBINE NAČRTA GRADBENE KONSTRUKCIJE

3.3 TEHNIČNO POROČILO

3.3.1 TEHNIČNI OPIS K STATIČNEMU RAČUNU

1.0 SPLOŠNO

Predmet načrta je dimenzioniranje elementov nosilne konstrukcije INFO CENTRA RIMSKE TOPLICE. Konstrukcijo objektov predstavlja armirano betonska vkopana klet ter AB plošča, na katero sta postavljena dva samostojna objekta INFO PROSTOR in BAR, izdelanih iz križno-lepljenih lesenih plošč (CLT) z lesenimi oz. jeklenimi okvirji v prečni smeri.
V sklopu načrta so izrisani armaturni načrti za AB del objekta ter dispozicijski načrti z detajli za leseni del objekta.
Račun je izveden v skladu z Evrokod standardi.

2.0 OBTEŽBA

Lokacija objekta:
- sneg: cona: **A2**; nadmorska višina **225**m.n.m.
- veter: cona: **1**; kategorija terena: **II**, vb,o= **20**m/s
- potres: ag = **0,150**g; kategorija tal **B**; faktor pomembnosti **II**

Koristna obtežba:
- kategorija površin: **C**; qk = 5,0 kN/m2

Zemljina:
- prostorninska teža zemljine - γz = **20** kN/m3
- kot notranjega trenja - φtr = **30**°
- zid je dimenzioniran na mirni zemeljski pritisk

3.0 VELIKOST OBJEKTA

INFO PROSTOR je tlorisnih dimenzij 12,20x3,40m Objekt je dvoetažen. Betonska klet je vkopana v zemljo do globine -3,20m, pritlični leseni del je skupne višine 3,70m, merjeno od kote 0,00m.

BAR je tlorisnih dimenzij 14,20x3,40m. Objekt je pritličen, prtilične je skupne višine 3,70m, merjeno od kote 0,00m.

4.0 TEMELJENJE OBJEKTA

Temeljenje objekta je plitvo na AB temelji plošči. Projektne napetosti v tleh pod temelji dosegajo vrednost pdmax=50kPa-faktorirane.
V izračunu je upoštevan modul reakcije tal k=10MN/m3.
Pred pričetkom izvedbe temeljev je potrebno pregledati temeljna tla in ugotoviti njihovo nosilnost, homogenost ter globalno stabilnost. V kolikor je ugotovljena nosilnost manjša od zgoraj navedene, je potrebno temelje razširiti ali jih poglobiti do tal ustrezne nosilnosti. V primeru nehomogenosti tal na območju objekta, je potrebno izvesti sanacijo tal, ki bo zagotavljala čim enakomernejše posedanje zgradbe.

5.0 NOSILNA KONSTRUKCIJA

5.1 INFO PROSTOR

5.1.1. BETONSKA KLET

Betonska klet je izvedena iz AB talne plošče debeline 20cm, AB stene debeline 20cm in AB plošče debeline 20cm. V celoti je vkopana.
Dostop v klet je izveden izven tlorisa zgornjega objekta, do nivoja kleti vodijo AB stopnice z debelino rame d=12cm.

5.1.2 LESENA KONSTRUKCIJA

Objekt je izveden iz CLT plošč - stene in plošče - z lesenim okvirjem v prečni smeri.

Stene objekta so iz CLT plošč debeline 10cm - CLT 100 L3s (3 slojna - 30-40-30). Stene so sidrane v spodnjo AB konstrukcijo s pomočjo sidrnih vijakov in priključnih kotnikov.

Strešna plošča je iz CLT plošč debeline 10cm - CLT 100 L3s (3 slojna - 30-40-30). Postavljena je na CLT stene objekta.

Atika je višine 70cm in je iz CLT plošč debeline 10cm - CLT plošč debeline 10cm - CLT 100 L3s (3 slojna - 30-40-30).

Horizontalna stabilnost objekta je zagotovljena s prečnimi CLT stenami oz. lesenim okvirjem, izvedenim iz lesenih stebrov b/h=20/60cm oz. nosilca b/h=20/68cm. Stebra sta postavljena na notranji strani stene, nosilec je postavljen na zgornji strani plošče. Stene in ploščo je potrebno vijačiti v leseni okvir.

5.2 BAR

5.2.1 AB BETONSKA PLOŠČA

Objekt je postavljen na AB temeljni plošči debeline 25cm. Pod temeljno ploščo se položi XPS izolacije minimalne deklarirane tlačne trdnosti 400kPa.

5.1.2 LESENA KONSTRUKCIJA

Stene in plošče so izvedene na enak način kot pri INFO PROSTORU.

Horizontalna stabilnost objekta je zagotovljena s prečnimi CLT stenami oz. dvema jeklenima okvirjema, izvedenim iz vročevaljanih profilov HEA180. Stebra sta postavljena na notranji strani stene, nosilec je postavljen na zgornji strani plošče. Stene in ploščo je potrebno vijačiti v leseni okvir.

Delavniški načrti konstrukcije so obvezni in jih mora izvajalec izdelati pred naročilom materiala ter poslati v pregled projektantu gradbenih konstrukcij. Pred začetkom gradnje morata delavniške načrte pisno potrditi projektant gradbenih konstrukcij in projektant arhitekture! Brez pisne potrditve gradnja ni dovoljena!

6.0 STATIČNI RAČUN IN DIMENZIONIRANJE

Nosilni elelementi betonske konstrukcije so izračunani s pomočjo računalniškega programa Tower 6.0 podjetja RADIMPEX. Nosilni okvirji so izračunani s pomočjo računalniškega programa RFEM 5.0 podjetja Dlubal. Elementi so modelirani z upoštevanjem dejansko dimenzioniranih prerezov in materialov konstrukcije.
Elementi lesene konstrukcije z detajli so preračunani s pomočjo programa Calculatis podjetja STORA ENSO.
V statičnem računu in pri dimenzioniranju konstrukcije so projektne obremenitve kombinirane po pravilih SIST EN 1990.
Potres ni merodajna obremenitev.

7.0 MATERIALI

Les:
Križno-lepljene CLT plošče so izvedene iz lamel trdnosti C24.
Leseni okvir se izdela iz lesa trdnostnega razreda GL24h.

Beton:
AB konstrukcije se izvajajo iz betona (SIST 1026:2016):
- C12/15 X0 **podbetoniranja in podložni beton**
- C25/30 XC2 v/cmax=0,60 Cl 0,2 Dmax32 S4 PV-I - min. zaščitna plast cmin,dur=25mm - **temelji in vkopane stene**
- C25/30 XC1 v/cmax=0,65 - min. zaščitna plast cmin,dur=15mm - **ostali AB elementi objekta**

Kvaliteta vgrajene armature je S500-B za palično armaturo in za varjene armaturne mreže. Armatura mora biti pred vgrajevanjem očiščena umazanije in rje, ki se lušči z armature. Siderne dolžine in preklopi armature se določajo po pravilih SIST EN 1992.
Za opaženje se lahko uporabljajo samo gladki, nepoškodovani opaži. Vse stene in stropovi so gladke AB površine brez naknadne obdelave, razen brušenja in kitanja. Opaži se pred uporabo očistijo in premažejo. Za premaze se lahko uporabljajo samo sredstva, ki so namenjena mazanju opažev.

Jeklo:
Kvaliteta konstrukcijskega jekla je S235 - JR.
Debelina vseh kotnih zvarov na konstrukciji je a=0,70t tanjšega elementa v spoju in a=t za cevi.
Vijačni spoji se izvajajo z vijaki kvalitete 8.8.

Ves jekleni material se pred izdelavo elementov jeklene konstrukcije očisti od umazanije, razmasti in očisti rje in sledi rje s peskanjem. Peskanje površine do Sa 2 ½. Antikorozijska zaščita izdelanih elementov jeklene konstrukcije se izvede v skladu z zahtevami standarda EN ISO 12944:
- za majhno korozijsko nevarnost –kategorije okolja C2 za notranje konstrukcije

Za jeklene konstrukcije znotraj objekta, majhna korozijska nevarnost, kategorija okolja C2, se predvidi antikorozijska zaščita po sistemu S1.09 iz tabele A.1, EN ISO 12944-5, 1998. Zaščitni sloj v delavnic iz primerja v debelini 80 μm (v enem nanosu ali 20 μm pred izdelavo elementa in 60 μm po izdelavi elementa), končni sloj iz alkidnega zaključnega sloja na gradbišču po montaži v debelini 80 μm.
Minimalna debelina vseh slojev je 160 μm.
Eventuelne poškodbe na vseh opisanih slojih se morajo pred nanosom naslednjega sloja popraviti.
Pri izdelavi jeklenih konstrukcije se upoštevajo tolerance, navedene v standardu SIST EN 1090-2: Izvedba jeklenih in aluminijastih konstrukcij: Tehnične zahteve za izvedbo jeklenih konstrukcij. Izvedba jeklenih in aluminijastih konstrukcij - 2. del: Tehnične zahteve za izvedbo jeklenih konstrukcij. Razred izvedbe konstrukcije je EX2.

Pred izvedbo jeklene konstrukcije je potrebno vse mere preveriti na mestu montaže.

8.0 STROKOVNI NADZOR IN KONTROLA KVALITETE

Kakovost vgrajenih materialov mora ustrezati odgovarjajočim standardom, predpisom in tehničnim pogojem.
Vsa dela se morajo izvajati v skladu s tehničnimi predpisi in predpisi iz varstva pri delu ter v skladu s predloženimi tehnološkimi navodili in navodili projektantov.
Tekom izvajanja gradbenih del mora investitor zagotoviti strokovni nadzor nad izvajanjem del. Vse eventualne spremembe in dopolnitve projekta morajo biti opravljene z vednostjo in soglasjem projektanta.

9.0 PREDPISI, UPOŠTEVANI PRI IZDELAVI NAČRTA

SIST EN 1990:2004 - Evrokod 0 - Osnove projektiranja konstrukcij
SIST EN 1991-1-1:2004 - Evrokod 1: Vplivi na konstrukcije
SIST EN 1992-1-1:2005 - Evrokod 2: Projektiranje betonskih konstrukcij
SIST EN 1993-1-1:2005 - Evrokod 3: Projektiranje jeklenih konstrukcij
SIST EN 1995-1-1:2004 - Evrokod 5: Projektiranje lesenih konstrukcij
SIST EN 1997-1:2005 - Evrokod 7: Geotehnično projektiranje
SIST EN 1998-1:2005 - Evrokod 8: Projektiranje potresnoodpornih konstrukcij

IZDELAL:

MATIC OŽBOLT, univ. dipl. inž. grad.

3.3.2 STATIČNI PRERAČUN

VSEBINA

številka strani

SPINA Novo mesto d.o.o.

AO ANALIZA OBTEŽB

STREŠNA PLOŠČA

α =	**2**	°	... naklon strehe
μ =	0,80		
Hnm =	**225**	m	... nadmorska višina
Veter - cona	**1**		... vetrovna cona
Sneg - cona	**A2**		... sneg cone

STALNA	pvc HI, filc				0,10 kN/m^2
	TI	20,0	cm	1,50	0,30 kN/m2
	CLT plošča	10,0	cm	5,50	0,55 kN/m^2
	instalacije				0,20 kN/m2
	mvc plošče	1,3	cm	15,00	0,19 kN/m2
				g =	1,34 kN/m^2
SNEG	sneg:			μ*1,293*(1+(Hnm/728)2)=	1,13 kN/m^2
				q =	1,13 kN/m^2

POHODNA PLOŠČA

STALNA	finalni tlak				0,20 kN/m^2
	CLT plošča	15,0	cm	5,50	0,83 kN/m^2
	TI	20,0	cm	1,50	0,30 kN/m2
	obloga	1,0	cm	1,50	0,50 kN/m2
				g =	1,83 kN/m^2
KORISTNA	koristna obtežba	kategorija **C3**			5,00 kN/m^2
				q =	5,00 kN/m^2

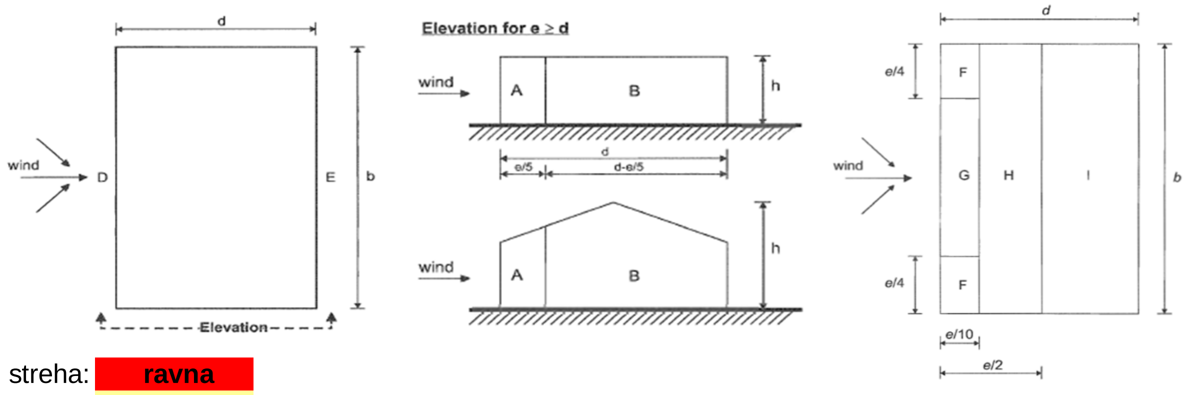
VETER Y

vb,o =	20,00	m/s	vb =	20,00 m/s
z =	4,00	m	... višina objekta	
	II		... kategorija terena (tabela 4.1)	
zo =	0,05	m		
z min =	2,00	m	kr =	0,19
vm =	16,65		cr =	0,83
qb =	0,25	kN/m^2	Iv =	0,23
qb (z) =	0,45	kN/m^2	...tlak pri največji hitrosti ob sunkih	

Veter Y: Tlak pravokotno na vertikalne stene

h < b višina < širine; vetrni pritisk konstanten po višini

b =	14	m				
d =	3,1	m				
e =	8	m				
	e > d					
h/d =	1,290	(tabela 7.1)				
D =	0,8	we,D =	0,36 kN/m2		e/5 =	1,6 m
E =	-0,5	we,E =	-0,23 kN/m2		d - e/5 =	4,96 m
A =	-1,2	we,A =	-0,54 kN/m2			
B =	-0,80	we,B =	-0,36 kN/m2			



streha:	ravna				
F- =	-1,20	we,F- =	-0,54 kN/m2	e/10 =	0,80 m
G- =	-0,80	we,G- =	-0,36 kN/m2	e/2 =	4,00 m
H- =	-0,70	we,H- =	-0,32 kN/m2	e/4 =	2,00 m
I+ =	0,20	we,I+ =	0,09 kN/m2		
I- =	-0,20	we,I- =	-0,09 kN/m2		

Obtežni primeri:

Wy	**samo zunanji pritisk**		
Stene		**Streha**	
we,spredaj=	0,36 kN/m^2	we,F =	-0,54 kN/m2
we,zadaj=	-0,23 kN/m^2	we,G =	-0,36 kN/m2
we,stran,A=	-0,54 kN/m^2	we, H =	-0,32 kN/m2
we,stran,B=	-0,36 kN/m^2	we,I+ =	0,09 kN/m2
		we,I- =	-0,09 kN/m2

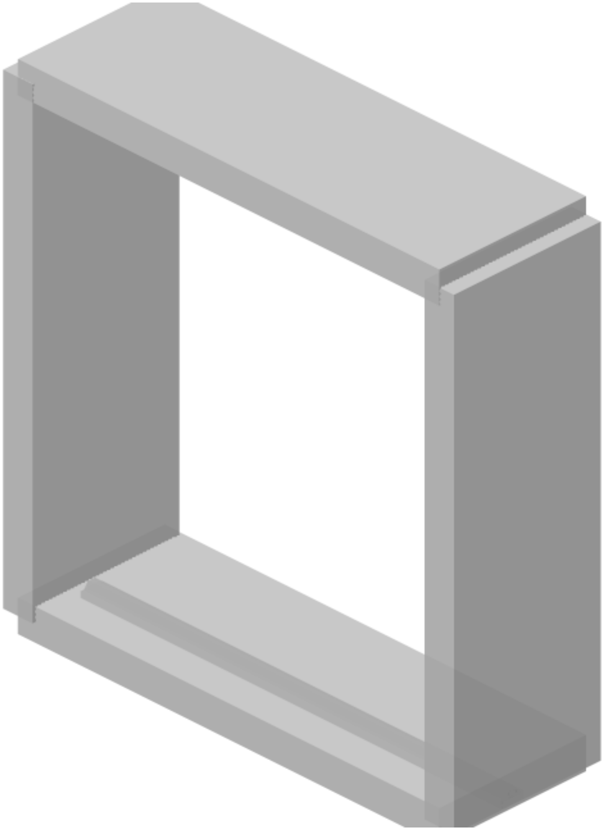
BETONSKA KLET

ZEMLJINA

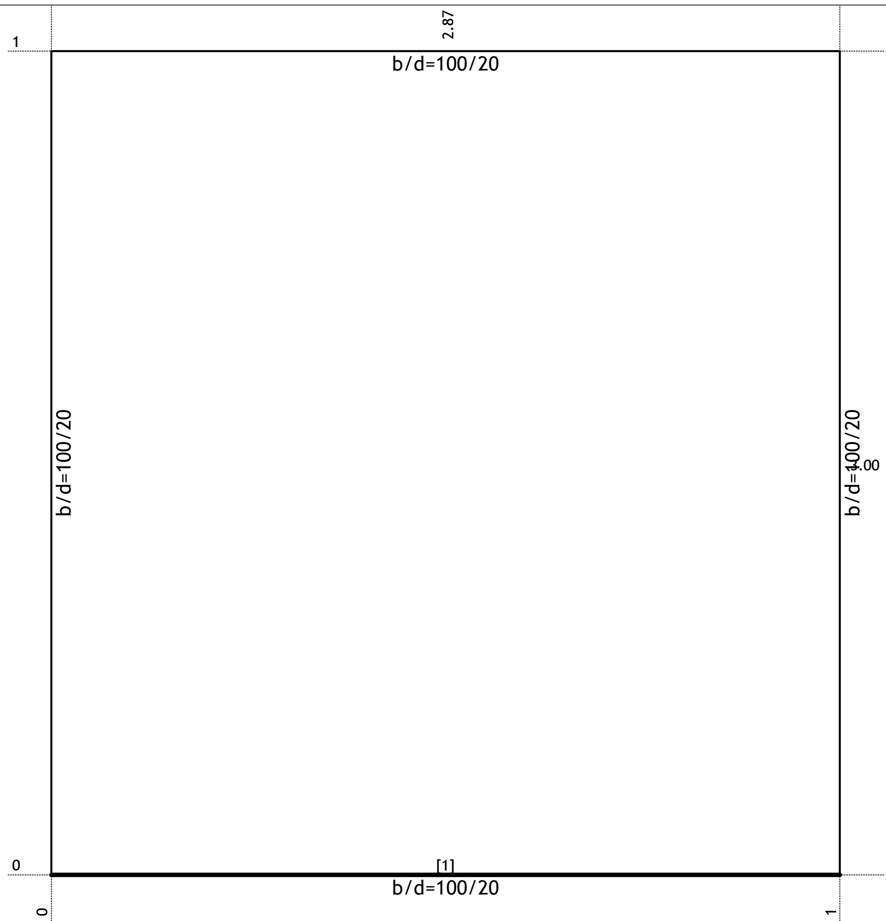
γzemljine =	20,00 kN/m3	trikotni razpored obtežbe
φ =	30,00 °	
ko = 1- sinφ =	0,50	
h vode =	3,00 m... kota vode	
h zemljine =	3,00 m... skupna višina	
qzgoraj =	2,00 kN/m2 … obtežba na nivoju terena	
σ zemljine,zgoraj =	1,00 kN/m2	
σ zemljine,kota vode =	31,00 kN/m2	
σ zemljine,spodaj=	31,00 kN/m2	

POZ 100 BETONSKA KLET

Vhodni podatki - Konstrukcija

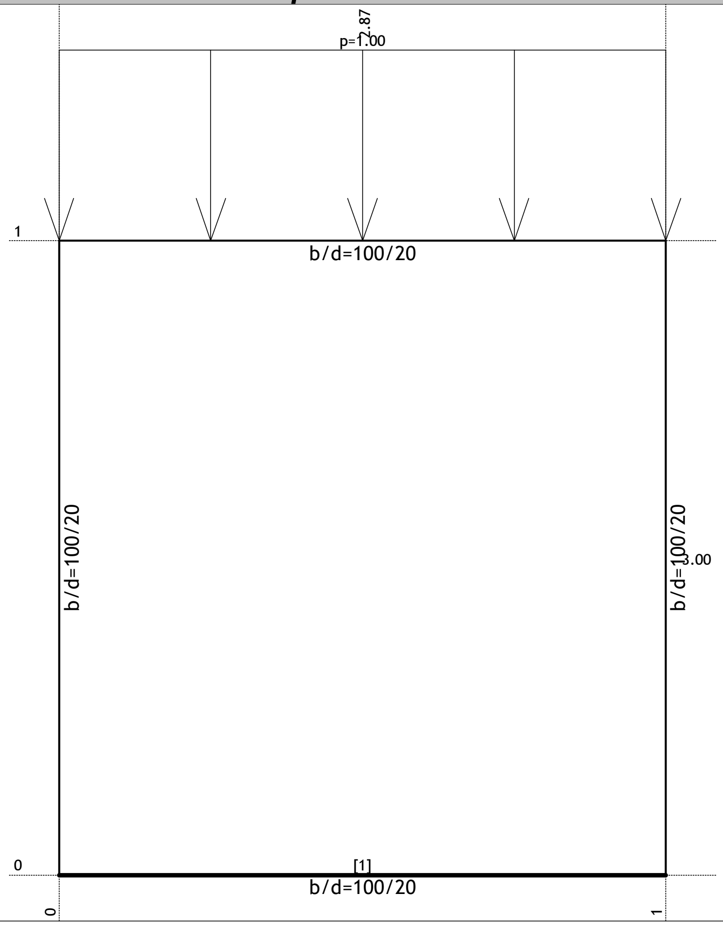


Izometrija

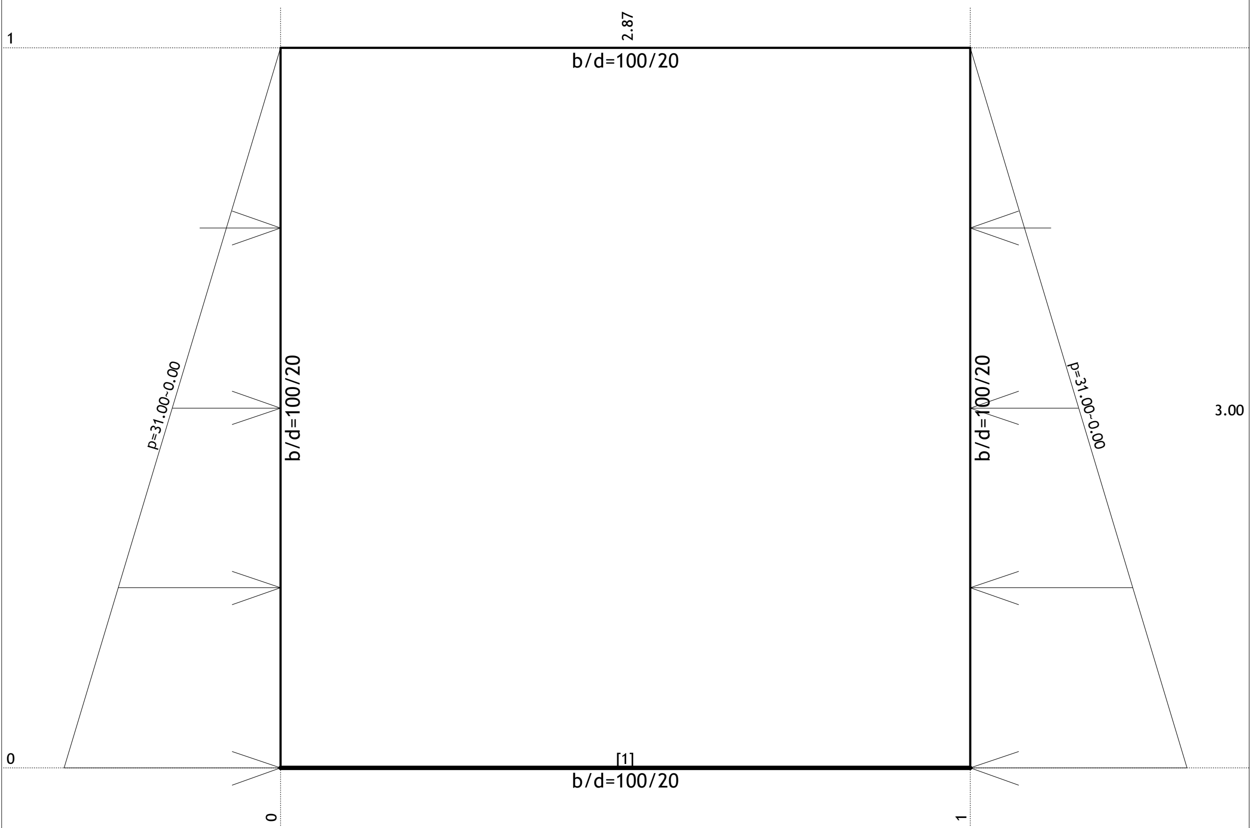


Vhodni podatki - Obtežba

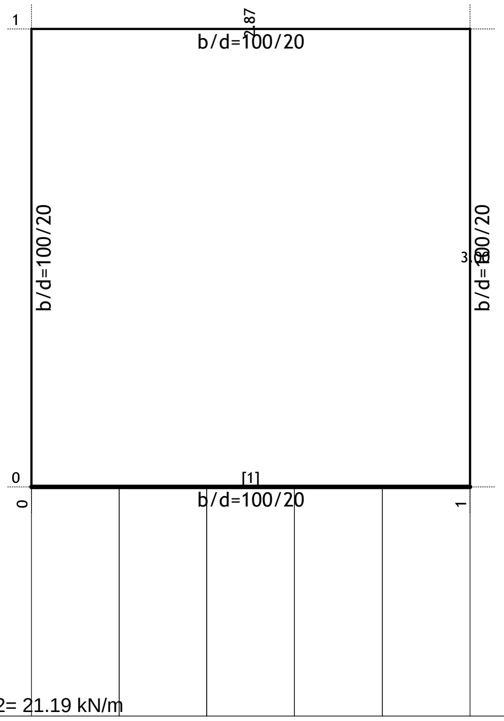
Obt. 1: Lastna, stalna (g)



Obt. 2: Zemljina

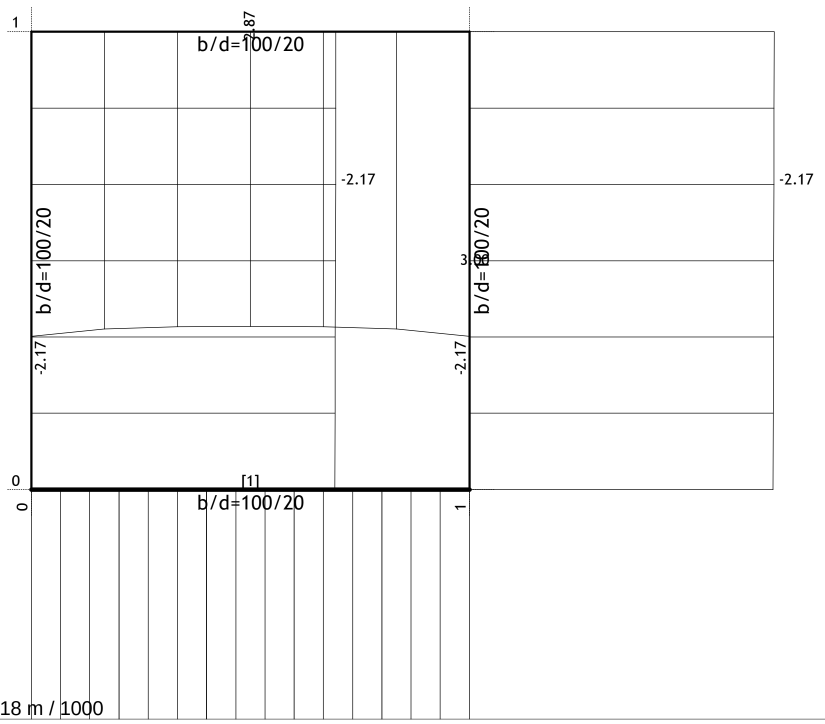


Obt. 3: I+II



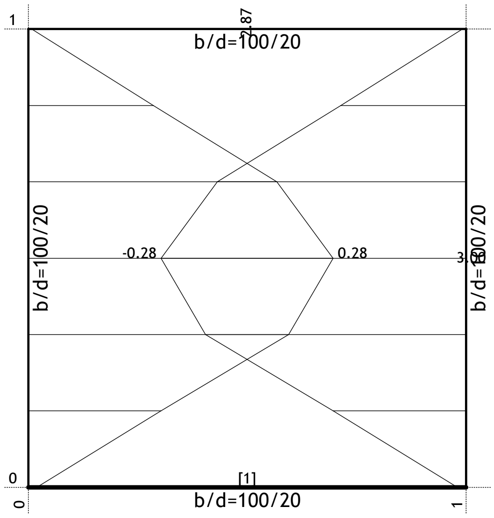
Vplivi v lin. podpori: max r2= 21.64 / min r2= 21.19 kN/m

Obt. 3: I+II



Vplivi v gredi: max Zp= -2.10 / min Zp= -2.18 m / 1000

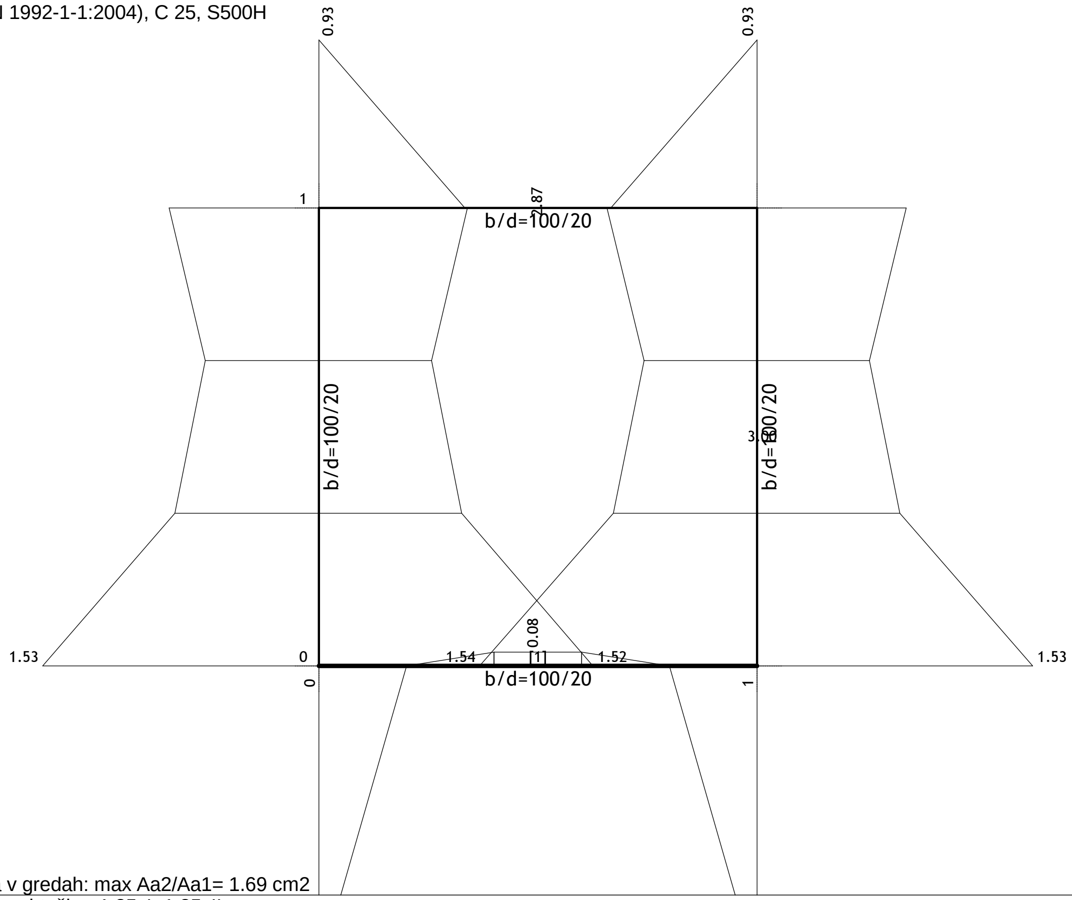
Obt. 3: I+II



Vplivi v gredi: max Xp= 0.28 / min Xp= -0.28 m / 1000

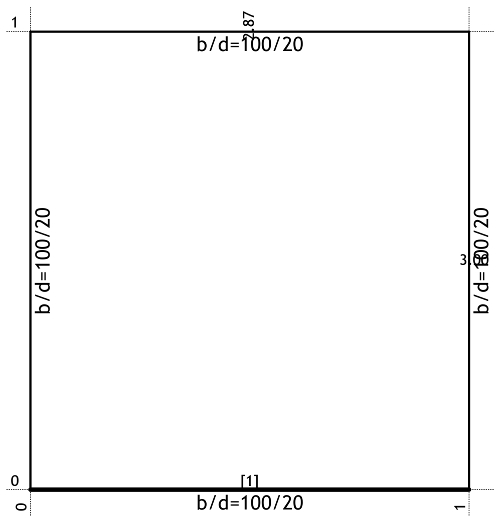
Dimenzioniranje (beton)

Merodajna obtežba: 1.35xI+1.35xII
EC 2 (EN 1992-1-1:2004), C 25, S500H



Armatura v gredah: max Aa2/Aa1= 1.69 cm2

Merodajna obtežba: 1.35xI+1.35xII
EC 2 (EN 1992-1-1:2004), C 25, S500H

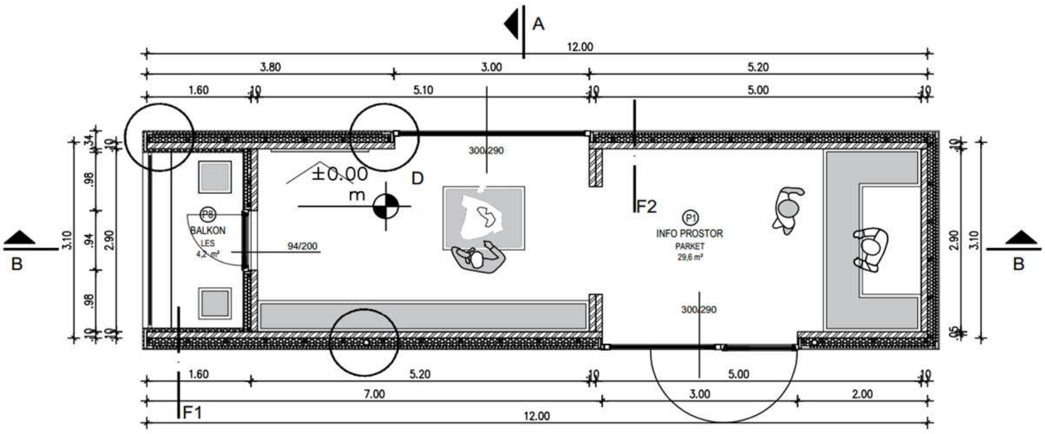


Armatura v gredah: max Aa,st= 0.00 cm2

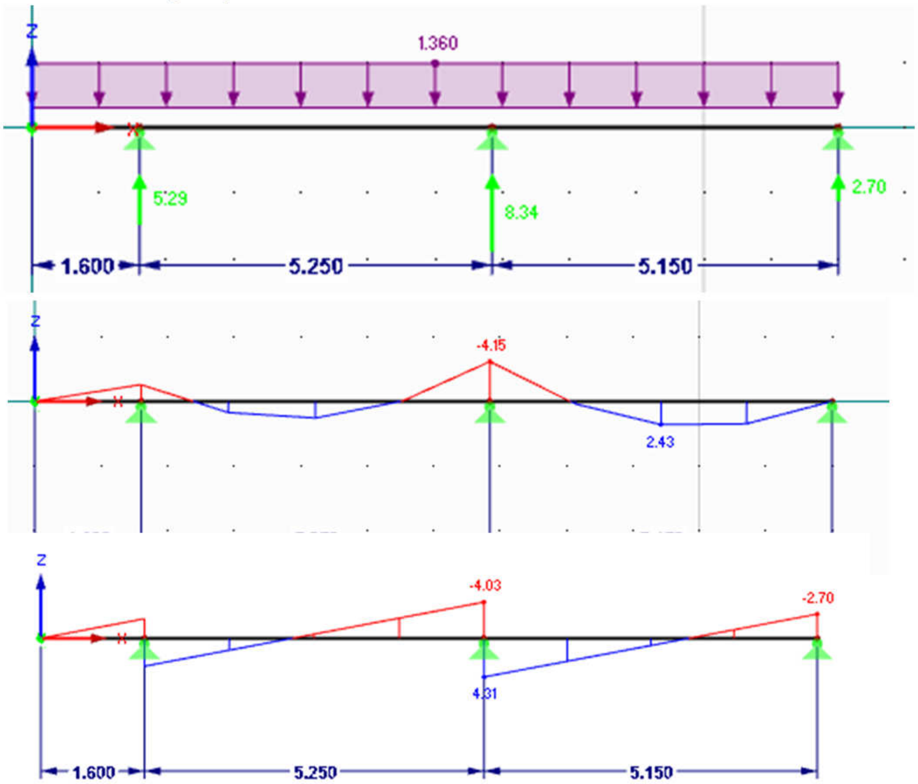
POZ 200 INFO PROSTOR

INFO PROSTOR - PORAZDELITEV HORIZONTALNE OBREMENITVE

wspredaj =	0,36 kN/m2
wzadaj =	0,23 kN/m2
h =	3 m
hp =	0,8 m
Fwzgoraj =	0,885 kN
Fwzgoraj,p =	0,472 kN
Sum =	1,357 kN
Fwspodaj =	0,345 kN



Obremenitev na stropno ploščo



SPINA NOVO MESTO D.O.O.

Preračun stika strop stena

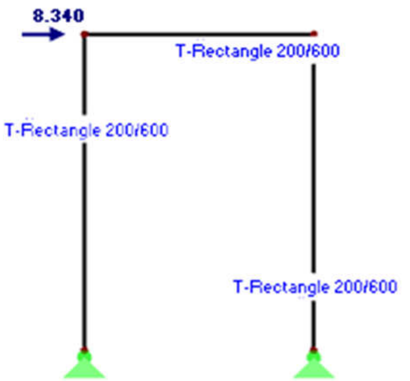
Med =1,50*(4,2+2,45) =	9,975 kNm
Fx = Med /h (=3m) =	3,325 kN
Fy =	0,708

Dimenzioniranje - glej izpiske

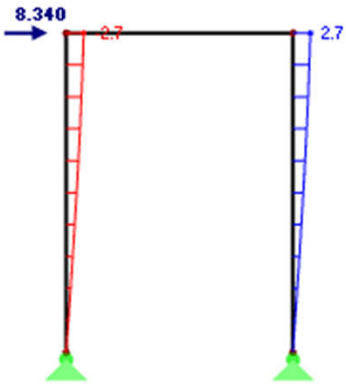
Preračun stika plošča - plošča

Dimenzioniranje - glej izpiske

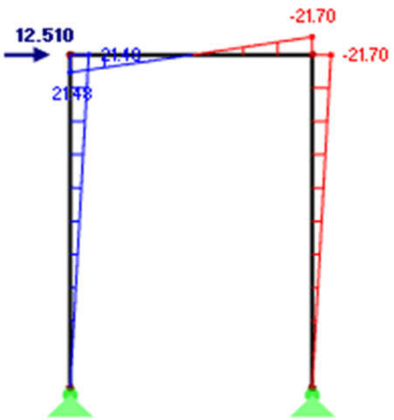
Preračun okvirja



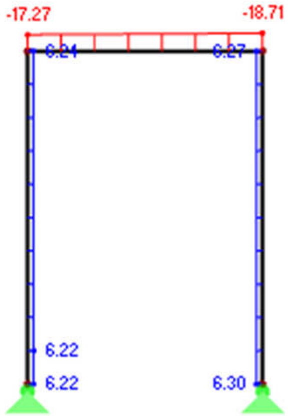
ux [mm]



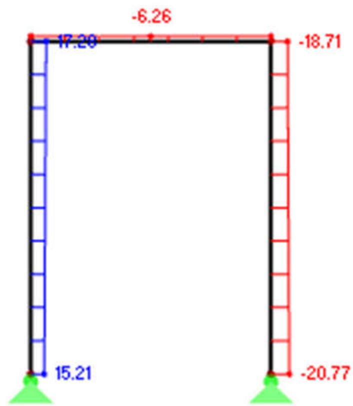
My[kNm]



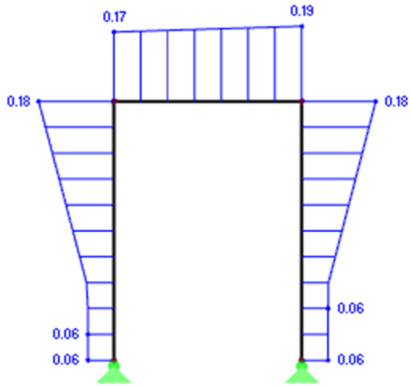
Ved [kN]



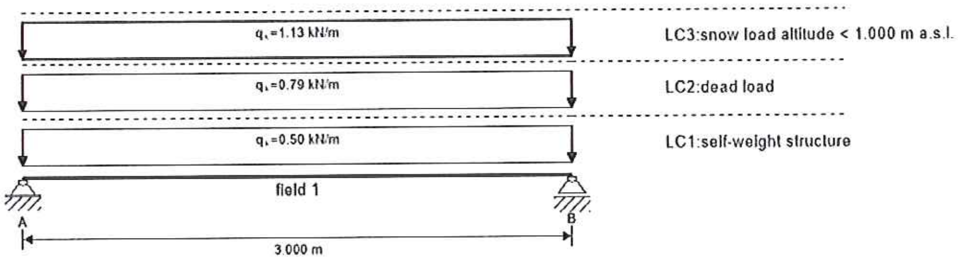
N [kN]



Kontrola napetosti

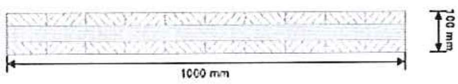


system



global utilization ratio									32 %
ULS	13 %	ULS fire	32 %	SLS	31 %	SLS vibration	0 %	support	1 %

section: CLT 100 L3s



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce
2	40.0 mm	90°	C24 spruce
3	30.0 mm	0°	C24 spruce
t_{CLT}	**100.0 mm**		

section fire: CLT 100 L3s

layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce
2	40.0 mm	90°	C24 spruce
t_{CLT}	**70.0 mm**		
time	**30 min**		

fire resistance class:R 30

fire protection layering : no additional fire protection

k_0	d_0	$d_{char,0,h}$	$d_{ef,h}$	$d_{char,0,v}$	$d_{ef,v}$
[-]	[mm]	[mm]	[mm]	[mm]	[mm]
1	7	20.0	27.0	0.0	0.0

material values

material	$f_{m,k}$	$f_{t,0,k}$	$f_{t,90,k}$	$f_{c,0,k}$	$f_{c,90,k}$	$f_{v,k}$	$f_{r,k\ min}$	$E_{0,mean}$	G_{mean}	$G_{r,mean}$
	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]
C24 spruce	24.00	14.00	0.12	21.00	2.50	4.00	1.25	12,500.00	460.00	50.00

load

load case groups

	load case category	Typ	duration	Kmod	γ_{inf}	γ_{sup}	Ψ_0	Ψ_1	Ψ_2
LC1	self-weight structure	G	permanet	0.6	1	1.35	1	1	1
LC2	dead load	G	permanet	0.6	1	1.35	1	1	1
LC3	snow load altitude	Q	short term	0.9	0	1.5	0.5	0.2	0

LC1:self-weight structure

continous load

field	load at start
	[kN/m]
1	0.50

LC2:dead load

continous load	
field	load at start
	[kN/m]
1	0.79

LC3:snow load altitude < 1.000 m a.s.l.

continous load	
field	load at start
	[kN/m]
1	1.13

ULS combinations

	combination rule
LCO1	1.35/1.00 * LC1 + 1.35/1.00 * LC2
LCO2	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3

ULS combinations fire

	combination rule
LCO1	1.00/1.00 * LC1 + 1.00/1.00 * LC2
LCO2	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3

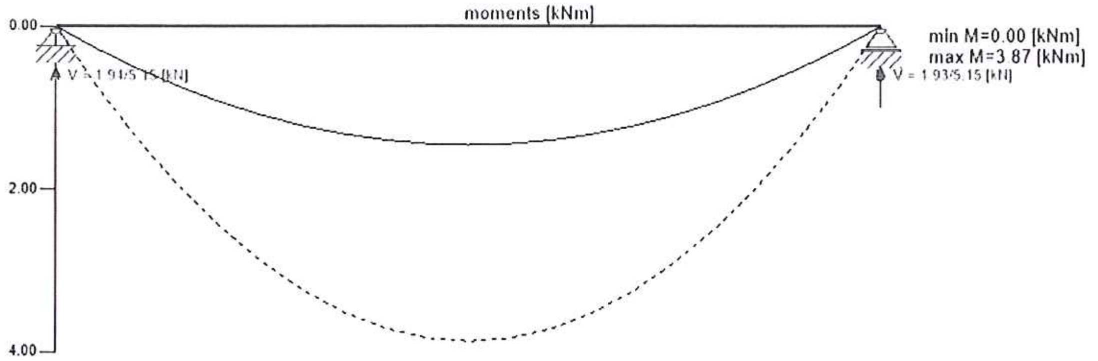
SLS characteristic combination

	combination rule
LCO1	1.00/1.00 * LC1 + 1.00/1.00 * LC2
LCO2	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC3

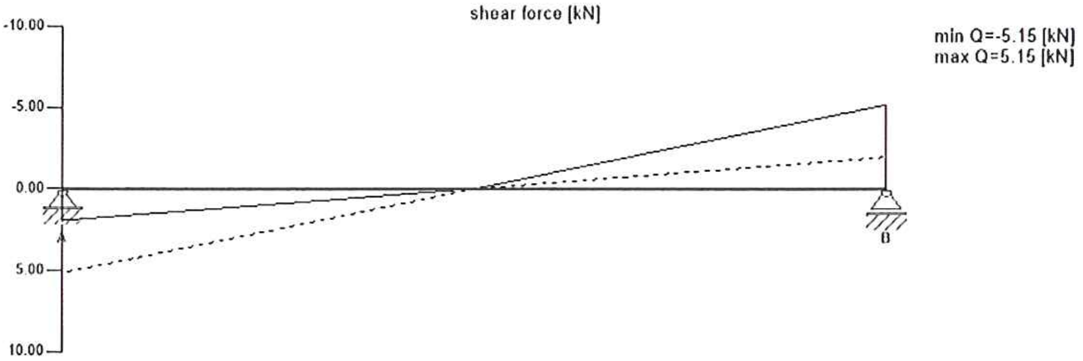
SLS quasi-permanent combination

	combination rule
LCO3	1.00/1.00 * LC1 + 1.00/1.00 * LC2
LCO4	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3

Ultimate limit state (ULS) - design results



Ultimate limit state (ULS) - design results



ULS flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	k_{sys}	$f_{m,d}$	M_d	$\sigma_{m,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[N/mm²]	[kNm]	[N/mm²]		
1	1.5	24.00	1.25	0.90	1.10	19.01	3.87	2.48	13 %	LCO2

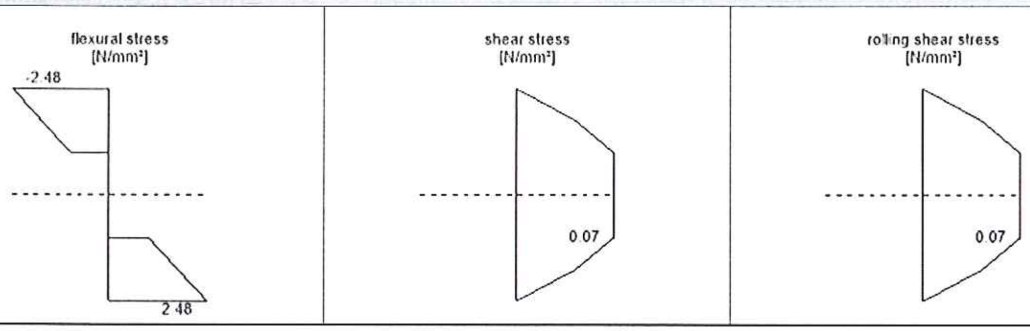
ULS shear analysis

field	dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	3.0	4.00	1.25	0.90	2.88	5.15	0.07	2 %	LCO2

ULS rolling shear

field	dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	3.0	1.05	1.25	0.90	0.76	5.15	0.07	9 %	LCO2

stress diagram



flexural stress analysis

M_d =	3.87 kNm		$f_{m,k}$ =	24.00	N/mm²
			γ_m =	1.25	
			k_{mod} =	0.90	
			k_{sys} =	1.10	
$\sigma_{m,d}$ =	2.48 N/mm²	<	$f_{m,d}$ =	19.01	N/mm² ✓

utilization ratio 13 %

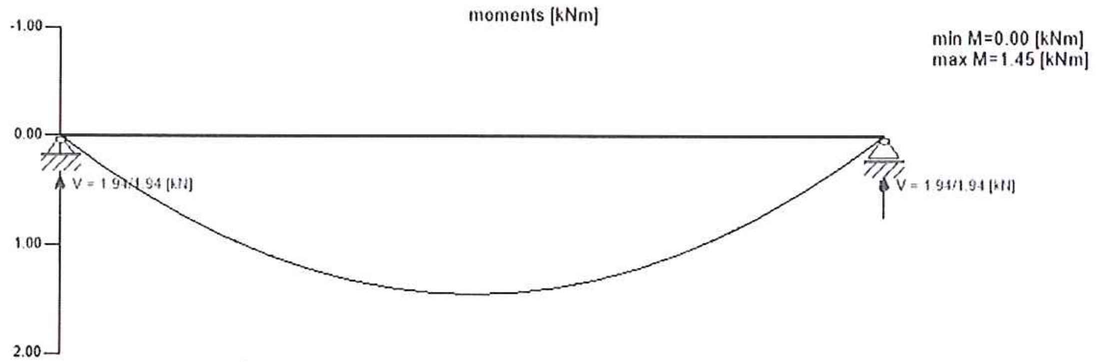
shear stress analysis

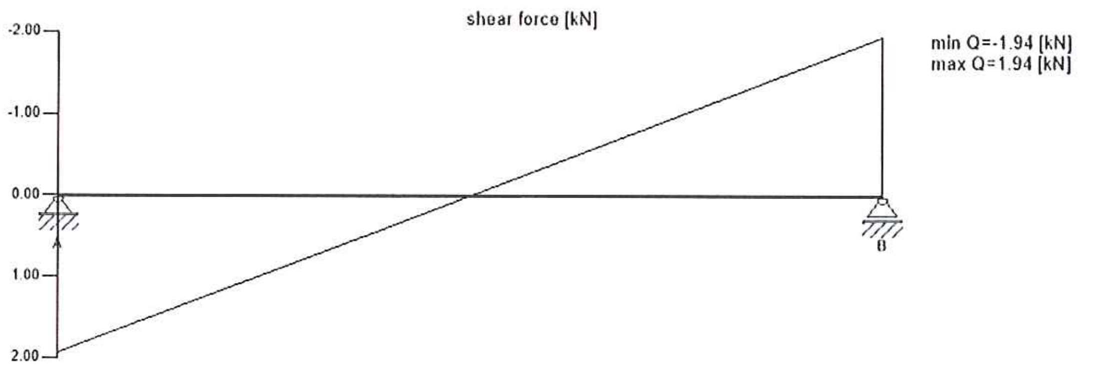
V_d =	5.15 kN		$f_{v,k}$ =	4.00	N/mm²
			γ_m =	1.25	
			k_{mod} =	0.90	
$\tau_{v,d}$ =	0.07 N/mm²	<	$f_{v,d}$ =	2.88	N/mm² ✓

utilization ratio 2 %

rolling shear analysis					
V_d =	5.15 kN		$f_{r,k}$ =	1.05 N/mm²	
			γ_m =	1.25	
			k_{mod} =	0.90	
$\tau_{r,d}$ =	0.07 N/mm²	<	$f_{r,d}$ =	0.76 N/mm²	✓
utilization ratio				9 %	

Ultimate limit state (ULS) fire design - results





ULS fire flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	k_{sys}	K_{fi}	$f_{m,d}$	M_d	$\sigma_{m,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[-]	[N/mm²]	[kNm]	[N/mm²]		
1	1.5	24.00	1.00	1.00	1.10	1.15	30.36	1.45	9.68	32 %	LCO1

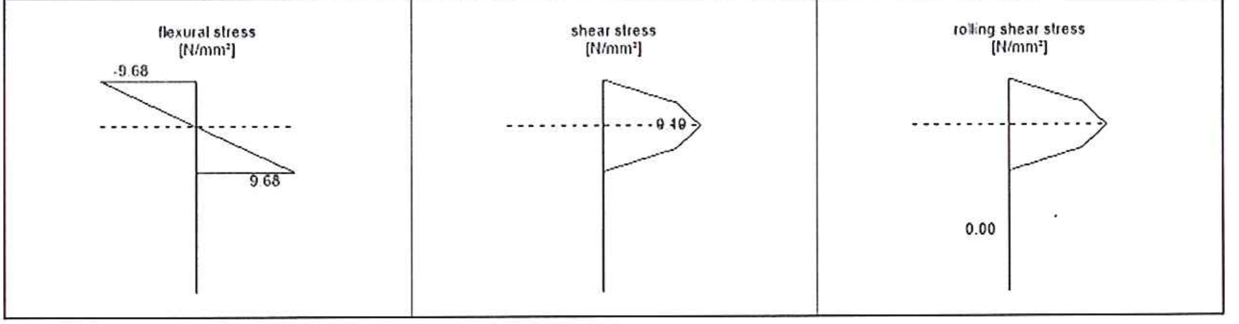
ULS fire shear analysis

field	dist.	$f_{v,k}$	γ_m	k_{mod}	K_{fi}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	3.0	4.00	1.00	1.00	1.15	4.60	1.94	0.10	2 %	LCO1

ULS fire rolling shear

field	dist.	$f_{r,k}$	γ_m	k_{mod}	K_{fi}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	3.0	1.05	1.00	1.00	1.15	1.21	1.94	0.00	0 %	LCO1

stress diagram



flexural stress analysis fire

M_d =	1.45	kNm		$f_{m,k}$ =	24.00	N/mm²	
				γ_m =	1.00		
				k_{mod} =	1.00		
				k_{sys} =	1.10		
				k_{fi} =	1.15		
$\sigma_{m,d}$ =	9.68	N/mm²	<	$f_{m,d}$ =	30.36	N/mm²	✓
utilization ratio							32 %

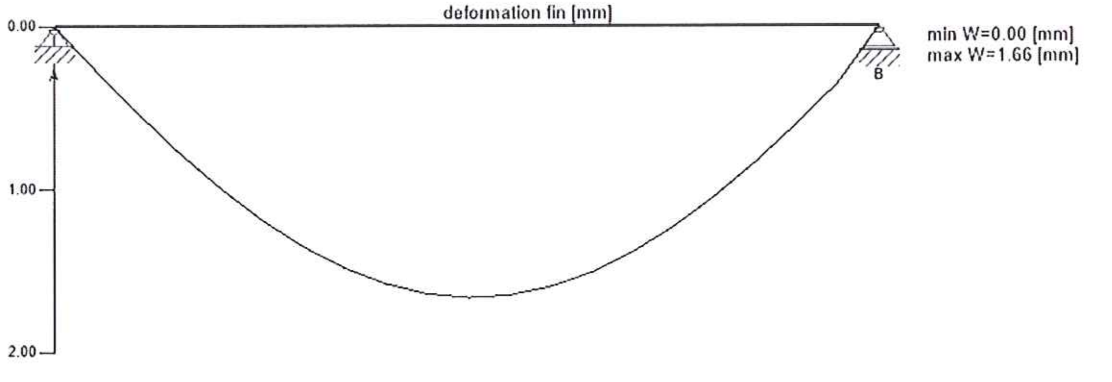
shear stress analysis fire

V_d =	1.94	kN		$f_{v,k}$ =	4.00	N/mm²	
				γ_m =	1.00		
				k_{mod} =	1.00		
				k_{fi} =	1.15		
$\tau_{v,d}$ =	0.10	N/mm²	<	$f_{v,d}$ =	4.60	N/mm²	✓
utilization ratio							2 %

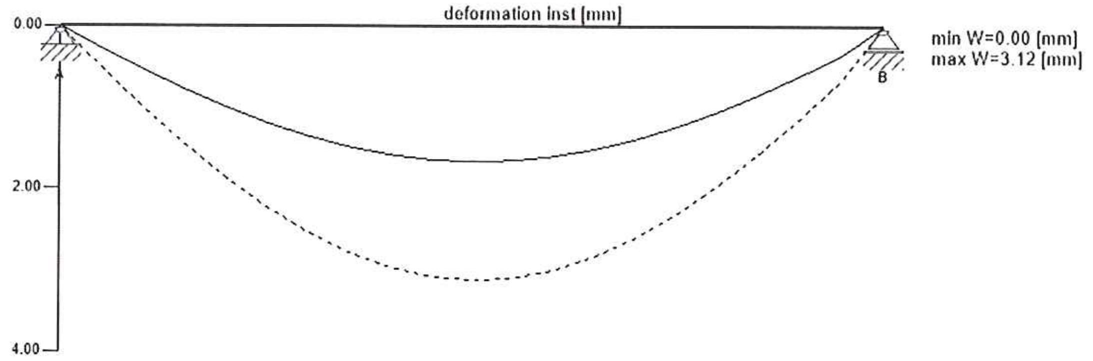
rolling shear analysis fire

V_d =	1.94	kN		$f_{r,k}$ =	1.05	N/mm²	
				γ_m =	1.00		
				k_{mod} =	1.00		
				k_{fi} =	1.15		
$\tau_{r,d}$ =	0.00	N/mm²	<	$f_{r,d}$ =	1.21	N/mm²	✓
utilization ratio							0 %

Service limit state design (SLS) - design results



Service limit state design (SLS) - design results



initial deflection [w_{char}]						
field	dist.	limit	w_{limit}	$w_{calc.}$	ratio	
	[m]	[-]	[mm]	[mm]		
1	1.5	1/300	10.0	3.1	31 %	LCO2

final deflection [w_{char}+$w_{q.p.}$*k_{def}]						
field	dist.	limit	w_{limit}	$w_{calc.}$	ratio	
	[m]	[-]	[mm]	[mm]		
1	1.5	1/150	20.0	4.8	24 %	LCO3

net final deflection [$w_{q.p.}$*(1+k_{def})]						
field	dist.	limit	w_{limit}	$w_{calc.}$	ratio	
	[m]	[-]	[m]	[mm]		
1	1.5	1/250	12.0	3.3	28 %	LCO3

support design													
nr.	type	width	area	k_{mod}	γ_m	$k_{c,90,k}$	$f_{c,k}$	$f_{c,d}$	V_{max}	V_{min}	$\sigma_{c,d}$		ratio
		[mm]	[cm²]	[-]	[-]	[-]	[N/mm²]	[N/mm²]	[kN]	[kN]	[N/mm²]		
A	rigid plate	100	1300.00	0.90	1.25	1.50	2.50	2.70	5.15	0.00	0.04	LCO2	1 %
B	rigid plate	100	1300.00	0.90	1.25	1.50	2.50	2.70	5.15	0.00	0.04	LCO2	1 %

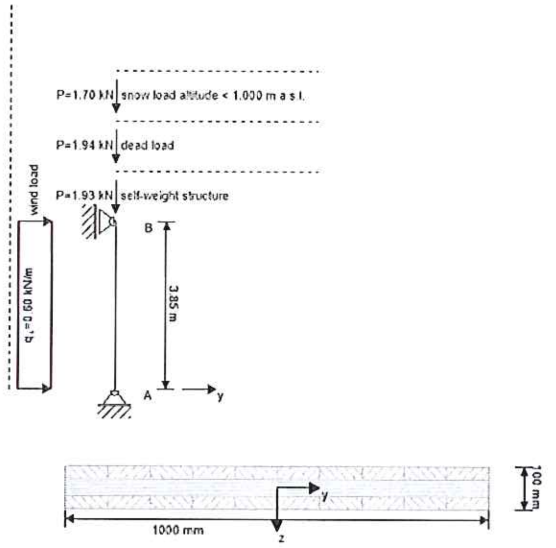
support reaction			
load case category	k_{mod}	A_V	B_V
		[kN]	
self-weight structure	0.6	0.75	0.75
		0.75	0.75
dead load	0.6	1.19	1.18
		1.19	1.18
snow load altitude < 1.000 m a.s.l.	0.9	1.69	1.69
		0.00	0.00

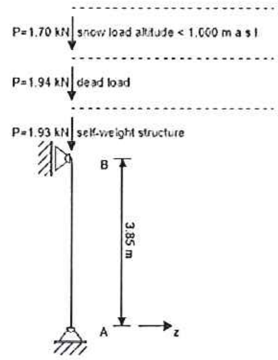
reference documents for this analysis	
English title	description
EN 338	EN 338 - Structural timber — Strength classes
EN 1995-1-1	EN 1995-1-1 - Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings
ETA-14/0349	European Technical Assessment ETA-14/0349 of 02.10.2014
Expertise Rolling shear - no edge gluing, H.J. Blass	Expertise on Rolling shear for CLT
EN 1995-1-2	EN 1995-1-2 - Eurocode 5 — Design of timber structures — Part 1-2: General — Structural fire design
Technical expertise 122/2011/02: analysis of load bearing capacity and separation performance of CLT elements	Verification of the load bearing capacity and the insulation criterion of CLT structures with Stora Enso CLT
Technical expertise 2434/2012 - BB: failure time tf of gypsum fire boards (GKF) according to ON B 3410	Expertise on failure time tf of gypsum wall fire boards according to ON B3410 and gypsum wall boards type DF according to EN 520
EN 1990	EN 1990 - Eurocode — Basis of structural design

reference documents for this analysis	
English title	description
ÖNorm B 1995-1-1 NA	ÖNORM EN 1995-1-1 - Austria - National Annex – Nationally determined parameters – Eurocode 5: Design of timber structures – Part 1-1: General-Common rules and rules for buildings
ÖNorm B 1995-1-2 NA	ÖNORM EN 1995-1-2 - Austria - National Annex - Eurocode 5: Design of timber structures — Part 1-2: General — Structural fire design — National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements
Fire safety in timber buildings - technical guildeline for Europe	Fire safety in timber buildings - technical guildeline for Europe; publishes by SP Technical Research Institute of Sweden
National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements, chapter 12	ÖNORM EN 1995-1-2 - National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements, chapter 12
Expertise Rolling shear, H.J. Blass	Expertise on rolling shear strength and rolling shear modulus of CLT panels
ÖNORM EN 1995-1-1_NA, chapter 7.3	ÖNORM EN 1995-1-1 - Austria - National Annex – Nationally determined parameters – Eurocode 5: Design of timber structures – Part 1-1: General-Common rules and rules for buildings; chapter 7.3

Disclaimer

system





global utilization ratio			3 %
ULS	3 %	ULS fire	-1 %

section: CLT 100 L3s

layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce
2	40.0 mm	90°	C24 spruce
3	30.0 mm	0°	C24 spruce
t_{CLT}	**100.0 mm**		

material values

material	$f_{m,k}$	$f_{t,0,k}$	$f_{t,90,k}$	$f_{c,0,k}$	$f_{c,90,k}$	$f_{v,k}$	$f_{r,k\ min}$	$E_{0,mean}$	G_{mean}	$G_{r,mean}$
	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]
C24 spruce	24.00	14.00	0.12	21.00	2.50	4.00	1.25	12,500.00	460.00	50.00

load

load case groups

	load case category	Typ	duration	Kmod	γ_{inf}	γ_{sup}	Ψ_0	Ψ_1	Ψ_2
LC1	self-weight structure	G	permanet	0.6	1	1.35	1	1	1
LC2	dead load	G	permanet	0.6	1	1.35	1	1	1
LC3	snow load altitude	Q	short term	0.9	0	1.5	0.5	0.2	0
LC4	wind load	Q	short term	0.9	0	1.5	0.6	0.2	0

LC1:self-weight structure

vertical load

P_k	ex. y	ex. z
[kN]	[m]	[m]
1.925	0.00	0.00

LC2:dead load

vertical load		
P_k	ex. y	ex. z
[kN]	[m]	[m]
1.94	0.00	0.00

LC3:snow load altitude < 1.000 m a.s.l.

vertical load		
P_k	ex. y	ex. z
[kN]	[m]	[m]
1.7	0.00	0.00

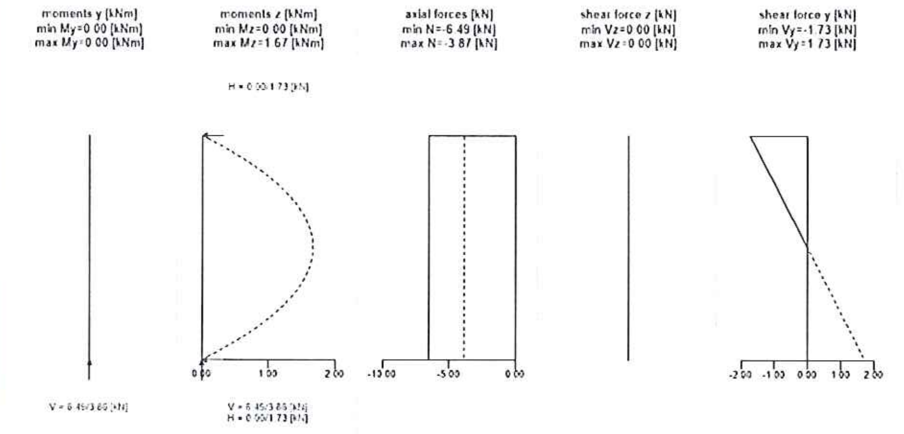
LC4:wind load

continous load
q_k
[kN/m]
0.6

ULS combinations

	combination rule
LCO1	1.35/1.00 * LC1 + 1.35/1.00 * LC2
LCO2	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3
LCO3	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.60 * LC4
LCO4	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4
LCO5	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.50 * LC3

Ultimate limit state (ULS) - design results



ULS flexural design

dist.	γ_m	k_{mod}	$k_{sys,y}$	$f_{m,k}$	$f_{m,y,d}$	$f_{t,d}$	$f_{c,d}$
[m]	[-]	[-]	[-]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]
1.93	1.25	0.90	1.10	24.00	19.01	10.08	15.12
$M_{y,d}$	$N_{c,d}$	$N_{t,d}$	$\sigma_{m,y,d}$	$\sigma_{c,d}$	$\sigma_{t,d}$	ratio	
[kNm]	[kN]	[kN]	[N/mm²]	[N/mm²]	[N/mm²]		
0.00	-6.49	0.00	0.00	0.11	0.00	1 %	LCO5

ULS shear analysis								
dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
3.85	4.00	1.25	0.90	2.88	0.00	0.00	0 %	LCO5

ULS rolling shear								
dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
3.85	1.05	1.25	0.90	0.76	0.00	0.00	0 %	LCO5

ULS shear design in plane of CLT - gross section								
dist.	$f_{v,IP,Gross,k}$	γ_m	k_{mod}	$f_{v,IP,Gross,d}$	V_d	$\tau_{IP,Gross,d}$	ratio	
[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kNm]	[N/mm²]		
0.0	3.50	1.25	0.90	2.52	1.73	0.03	1 %	LCO4

ULS shear design in plane of CLT - net section								
dist.	$f_{v,IP,Net,k}$	γ_m	k_{mod}	$f_{v,IP,Net,d}$	$V_{Net,d}$	$\tau_{v,IP,Net,d}$	ratio	
[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kNm]	[N/mm²]		
0.0	8.00	1.25	0.90	5.76	1.73	0.06	1 %	LCO4

ULS shear design in plane of CLT - gross section kombiniert						
dist.	γ_m	k_{mod}	V_d	$\tau_{v,d}$	ratio	
[m]	[-]	[-]	[kN]	[N/mm²]		
3.85	1.25	0.90	0.00	0.00	0 %	LCO5

ULS shear design in plane of CLT - net section kombiniert						
dist.	γ_m	k_{mod}	V_d	$\tau_{v,d}$	ratio	
[m]	[-]	[-]	[kN]	[N/mm²]		
3.85	1.25	0.90	0.00	0.00	0 %	LCO5

ULS torsional shear design in plane of CLT - in face glued surfaces										
$f_{v,T,Node,k}$	γ_m	k_{mod}	$f_{v,T,Node,d}$	$V_{\delta,d}$	δM_t	n	a	I_p	ratio	
[N/mm²]	[-]	[-]	[N/mm²]	[kNm]	[kNm]	[-]	[m]	[mm⁴]		
2.50	1.25	0.90	1.80	1.73	0.17	20	0.100	16666670.00	1 %	LCO4

ULS buckling design										
dist.	γ_m	k_{mod}	$k_{sys,y}$	$k_{sys,z}$	$f_{m,k}$	$f_{m,y,d}$	$f_{m,z,d}$	$f_{t,d}$	$f_{c,d}$	
[m]	[-]	[-]	[-]	[-]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	
1.93	1.25	0.90	1.10	1.00	24.00	19.01	17.28	0.00	15.12	
$l_{k,y}$	$l_{k,z}$	λ_y	λ_z	$\lambda_{rel,y}$	$\lambda_{rel,z}$	β_c	k_y	k_z	$k_{c,y}$	$k_{c,z}$
[m]	[m]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
3.850	3.850	107	13	1.70	0.21	0.2	2.09	0.51	0.30	1.00
$M_{y,d}$	$N_{c,d}$	$N_{t,d}$	$\sigma_{m,y,d}$	$\sigma_{m,z,d}$	$\sigma_{c,d}$	$\sigma_{t,d}$	ratio			
[kNm]	[kN]	[kN]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]				
0.00	-7.77	0.00	0.00	0.10	0.13	0.00	3 %	LCO3		

ULS lateral torsional buckling design									
dist.	γ_m	k_{mod}	$k_{sys,y}$	$f_{m,k}$	$f_{m,y,d}$	$f_{t,d}$	$f_{c,d}$		
[m]	[-]	[-]	[-]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]		
1.93	1.25	0.90	1.10	24.00	19.01	0.00	15.12		
l_{ef}	l_k	λ_y	$\lambda_{rel,y}$	$\lambda_{rel,m}$	β_c	k_y	$k_{c,y}$	$\sigma_{m,crit}$	k_{crit}
[m]	[m]	[-]	[-]	[-]	[-]	[-]	[-]	[N/mm²]	[-]
3.850	3.850	107	1.70	1.67	0.2	2.09	0.30	8.57	0.36
$M_{y,d}$	$N_{c,d}$	$N_{t,d}$	$\sigma_{m,y,d}$	$\sigma_{c,d}$	$\sigma_{t,d}$	ratio			
[kNm]	[kN]	[kN]	[N/mm²]	[N/mm²]	[N/mm²]				
0.00	-7.77	0.00	0.00	0.13	0.00	3 %	LCO3		

flexural stress analysis						
$M_{y,d}$ =	0.00	kNm		$f_{m,k}$ =	24.00	N/mm²
$N_{c,d}$ =	-6.49	kN		γ_m =	1.25	-
				k_{mod} =	0.90	-
				$k_{sys,y}$ =	1.10	-
$\sigma_{c,d}$ =	0.11	N/mm²		$f_{c,d}$ =	15.12	N/mm²
$\sigma_{m,y,d}$ =	0.00	N/mm²	<	$f_{m,y,d}$ =	19.01	N/mm² ✓
utilization ratio						1 %

shear stress analysis						
V_d =	0.00	kN		$f_{v,k}$ =	4.00	N/mm²
				γ_m =	1.25	-
				k_{mod} =	0.90	-
$\tau_{v,d}$ =	0.00	N/mm²	<	$f_{v,d}$ =	2.88	N/mm² ✓
utilization ratio						0 %

rolling shear analysis						
V_d =	0.00	kN		$f_{r,k}$ =	1.05	N/mm²
				γ_m =	1.25	-
				k_{mod} =	0.90	-
$\tau_{r,d}$ =	0.00	N/mm²	<	$f_{r,d}$ =	0.76	N/mm² ✓
utilization ratio						0 %

shear analysis gross section						
V_d =	1.73	kNm		$f_{v,IP,Gross,k}$ =	3.50	N/mm²
				γ_m =	1.25	-
				k_{mod} =	0.90	-
$\tau_{IP,Gross,d}$ =	0.03	N/mm²	<	$f_{v,IP,Gross,d}$ =	2.52	N/mm² ✓
utilization ratio						1 %

shear analysis net section						
$V_{Net,d}$ =	1.73	kNm		$f_{v,IP,Net,k}$ =	8.00	N/mm²
				γ_m =	1.25	-
				k_{mod} =	0.90	-
$\tau_{v,IP,Net,d}$ =	0.06	N/mm²	<	$f_{v,IP,Net,d}$ =	5.76	N/mm² ✓
utilization ratio						1 %

shear analysis gross section combined						
V_d =	0.00	kN		$f_{v,k}$ =	4.00	N/mm²
$V_{Gross,d}$ =	1.73	kNm		$f_{v,IP,Gross,k}$ =	3.50	N/mm²
				γ_m =	1.25	-
				k_{mod} =	0.90	-
$\tau_{v,d}$ =	0.00	N/mm²		$f_{v,d}$ =	2.88	N/mm²
$\tau_{IP,Gross,d}$ =	0.03	N/mm²	<	$f_{v,IP,Gross,d}$ =	2.52	N/mm² ✓
utilization ratio						0 %

shear analysis net section combined						
V_d =	0.00	kN		$f_{v,k}$ =	4.00	N/mm²
$V_{Net,d}$ =	1.73	kNm		$f_{v,IP,Net,k}$ =	8.00	N/mm²
				γ_m =	1.25	-
				k_{mod} =	0.90	-
$\tau_{v,d}$ =	0.00	N/mm²		$f_{v,d}$ =	2.88	N/mm²
$\tau_{IP,Net,d}$ =	0.06	N/mm²	<	$f_{v,IP,Net,d}$ =	5.76	N/mm² ✓
utilization ratio						0 %

torsional shear design in plane of CLT - in face glued surfaces						
$V_{\delta,d}$ =	1.73	kNm		$f_{v,T,Node,k}$ =	2.50	N/mm²
				γ_m =	1.25	-
				k_{mod} =	0.90	-
$\tau_{T,Node,d}$ =	0.03	N/mm²	<	$f_{v,T,Node,d}$ =	1.80	N/mm² ✓
utilization ratio						1 %

buckling analysis

$M_{y,d}$ =	0.00	kNm		$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	-7.77	kN		γ_m =	1.25	-	
				k_{mod} =	0.90	-	
				$k_{sys,y}$ =	1.10	-	
$\sigma_{c,d}$ =	0.13	N/mm²		$f_{c,d}$ =	15.12	N/mm²	
$\sigma_{m,y,d}$ =	0.00	N/mm²		$f_{m,y,d}$ =	19.01	N/mm²	
$\sigma_{m,z,d}$ =	0.10	N/mm²	<	$f_{m,z,d}$ =	17.28	N/mm²	✓
utilization ratio						3 %	

lateral torsional buckling analysis

$M_{y,d}$ =	0.00	kNm		$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	-7.77	kN		γ_m =	1.25	-	
				k_{mod} =	0.90	-	
				$k_{sys,y}$ =	1.10	-	
$\sigma_{c,d}$ =	0.13	N/mm²		$f_{c,d}$ =	15.12	N/mm²	
$\sigma_{m,y,d}$ =	0.00	N/mm²	<	$f_{m,y,d}$ =	19.01	N/mm²	✓
utilization ratio						3 %	

support reaction

load case category	k_{mod}	A_y	A_z	B_x	B_y	B_z
		[kN]	[kN]	[kN]	[kN]	[kN]
self-weight structure	0.6	0.00	0.00	1.92	0.00	0.00
		0.00	0.00	1.92	0.00	0.00
dead load	0.6	0.00	0.00	1.94	0.00	0.00
		0.00	0.00	1.94	0.00	0.00
snow load altitude < 1.000 m a.s.l.	0.9	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	1.70	0.00	0.00
wind load	0.9	1.15	0.00	0.00	1.15	0.00
		0.00	0.00	0.00	0.00	0.00

reference documents for this analysis

English title	description
EN 338	EN 338 - Structural timber — Strength classes
EN 1995-1-1	EN 1995-1-1 - Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings
ETA-14/0349	European Technical Assessment ETA-14/0349 of 02.10.2014
Expertise Rolling shear - no edge gluing, H.J. Blass	Expertise on Rolling shear for CLT
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Technical expertise 122/2011/02: analysis of load bearing capacity and separation performance of CLT elements	Verification of the load bearing capacity and the insulation criterion of CLT structures with Stora Enso CLT
Technical expertise 2434/2012 - BB: failure time tf of gypsum fire boards (GKF) according to ON B 3410	Expertise on failure time tf of gypsum wall fire boards according to ON B3410 and gypsum wall boards type DF according to EN 520
EN 1990	EN 1990 - Eurocode — Basis of structural design
ÖNorm B 1995-1-1 NA	ÖNORM EN 1995-1-1 - Austria - National Annex – Nationally determined parameters – Eurocode 5: Design of timber structures – Part 1-1: General-Common rules and rules for buildings
ÖNorm B 1995-1-2 NA	ÖNORM EN 1995-1-2 - Austria - National Annex - Eurocode 5: Design of timber structures — Part 1-2: General — Structural fire design — National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements
Fire safety in timber buildings - technical guildeline for Europe	Fire safety in timber buildings - technical guildeline for Europe; publishes by SP Technical Research Institute of Sweden
National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements, chapter 12	ÖNORM EN 1995-1-2 - National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements, chapter 12
Expertise Rolling shear, H.J. Blass	Expertise on rolling shear strength and rolling shear modulus of CLT panels
Expertise shear in plane of CLT, H.J. Blass	Expertise - revision of DIBt technical approval Z-9.1/599 - shear in the plane of CLT

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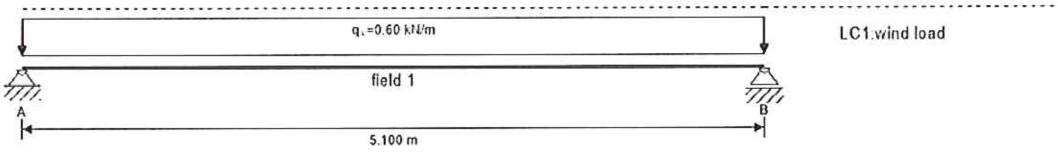
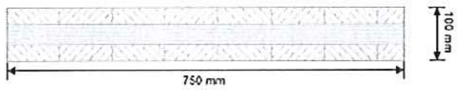
system



global utilization ratio									45 %
ULS	13 %	ULS fire	0 %	SLS	45 %	SLS vibration	0 %	support	-1 %

section: CLT 100 L3s



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce
2	40.0 mm	90°	C24 spruce
3	30.0 mm	0°	C24 spruce
t_{CLT}	**100.0 mm**		

material values

material	$f_{m,k}$	$f_{t,0,k}$	$f_{t,90,k}$	$f_{c,0,k}$	$f_{c,90,k}$	$f_{v,k}$	$f_{r,k\,min}$	$E_{0,mean}$	G_{mean}	$G_{r,mean}$
	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]
C24 spruce	24.00	14.00	0.12	21.00	2.50	4.00	1.25	12,500.00	460.00	50.00

load

load case groups

	load case category	Typ	duration	Kmod	γ_{inf}	γ_{sup}	Ψ_0	Ψ_1	Ψ_2
LC1	wind load	Q	short term	0.9	0	1.5	0.6	0.2	0

LC1:wind load

continous load

field	load at start
	[kN/m]
1	0.60

ULS combinations

	combination rule
LCO1	1.50/0.00 * LC1

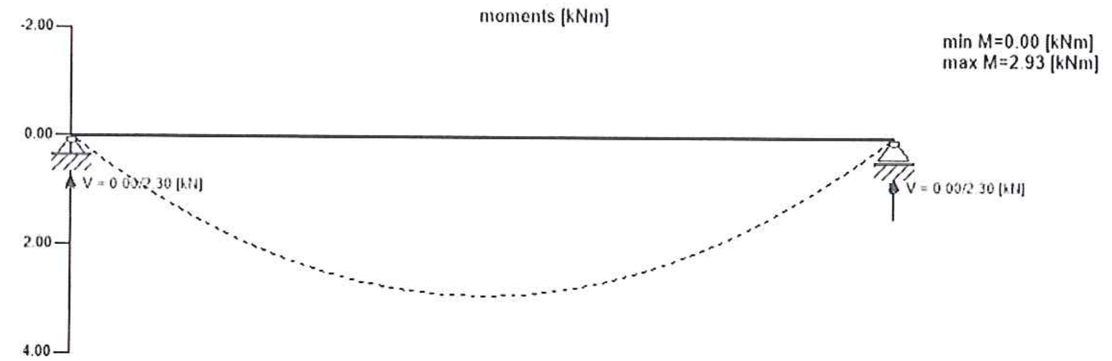
SLS characteristic combination

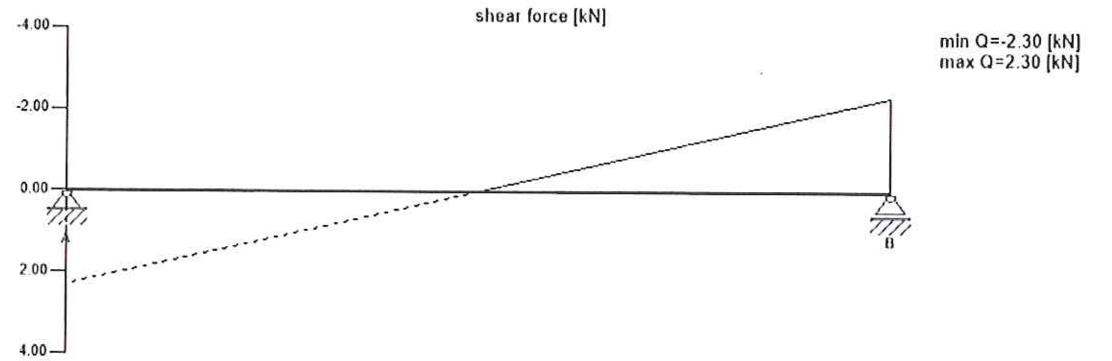
	combination rule
LCO1	1.00/0.00 * LC1

SLS quasi-permanent combination

	combination rule
LCO2	1.00/0.00 * 0.00 * LC1

Ultimate limit state (ULS) - design results





ULS flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	k_{sys}	$f_{m,d}$	M_d	$\sigma_{m,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[N/mm²]	[kNm]	[N/mm²]		
1	2.55	24.00	1.25	0.90	1.10	19.01	2.93	2.50	13 %	LCO1

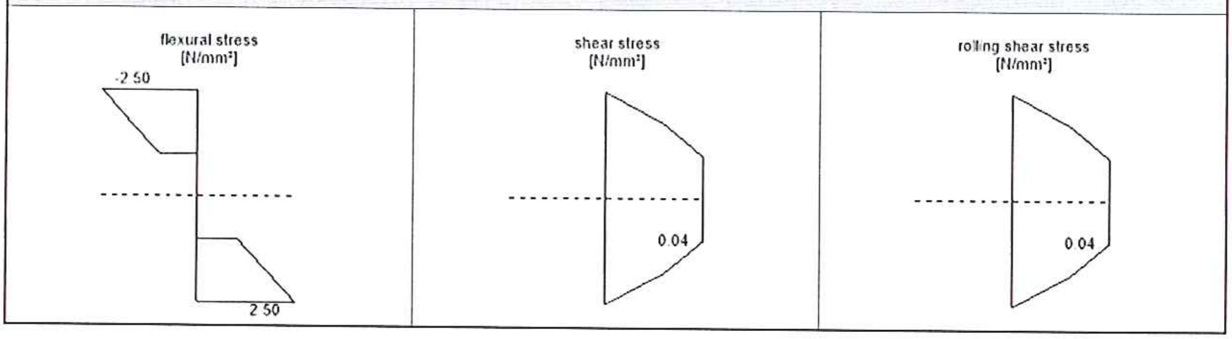
ULS shear analysis

field	dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	5.1	4.00	1.25	0.90	2.88	2.30	0.04	1 %	LCO1

ULS rolling shear

field	dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	5.1	1.05	1.25	0.90	0.76	2.30	0.04	5 %	LCO1

stress diagram



flexural stress analysis

M_d =	2.93	kNm		$f_{m,k}$ =	24.00	N/mm²		
				γ_m =	1.25			
				k_{mod} =	0.90			
				k_{sys} =	1.10			
$\sigma_{m,d}$ =	2.50	N/mm²	<	$f_{m,d}$ =	19.01	N/mm²		✓
utilization ratio							13 %	

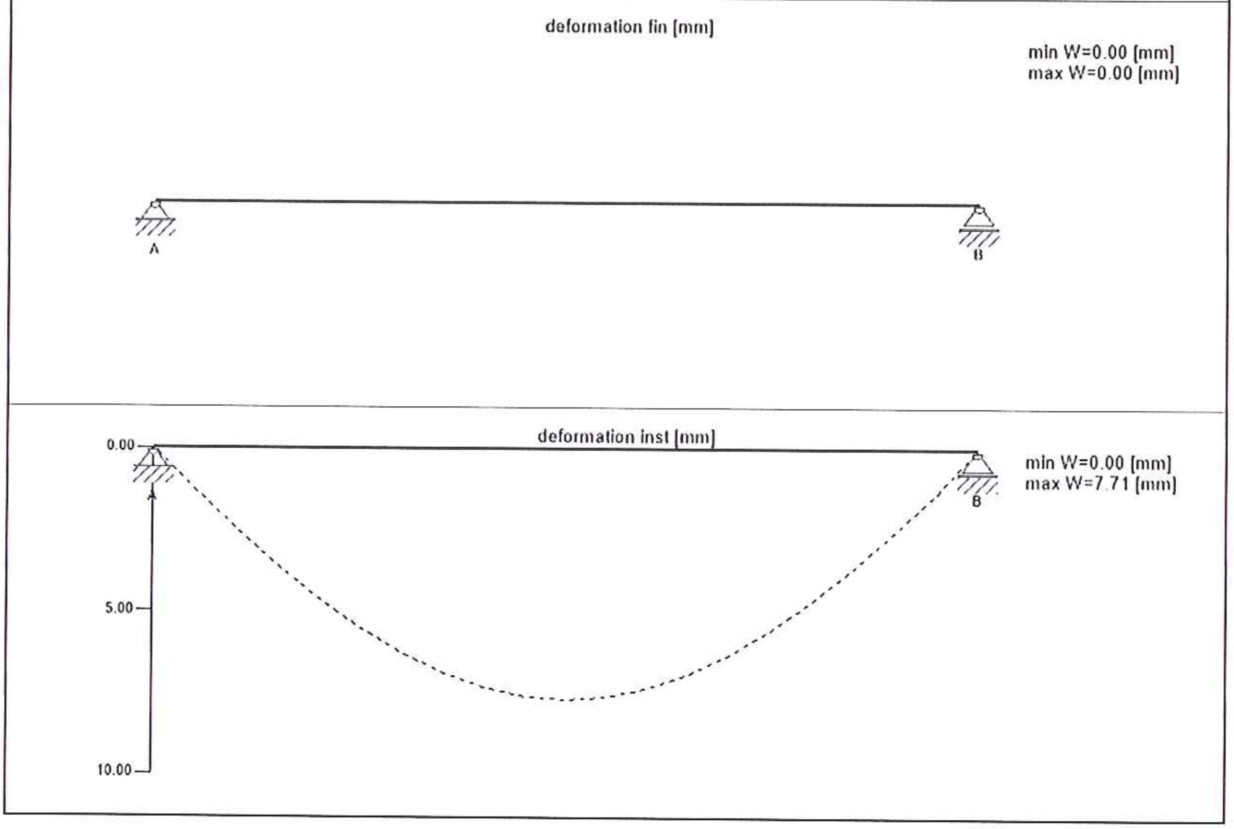
shear stress analysis

V_d =	2.30	kN		$f_{v,k}$ =	4.00	N/mm²		
				γ_m =	1.25			
				k_{mod} =	0.90			
$\tau_{v,d}$ =	0.04	N/mm²	<	$f_{v,d}$ =	2.88	N/mm²		✓
utilization ratio							1 %	

rolling shear analysis

V_d =	2.30	kN		$f_{r,k}$ =	1.05	N/mm²		
				γ_m =	1.25			
				k_{mod} =	0.90			
$\tau_{r,d}$ =	0.04	N/mm²	<	$f_{r,d}$ =	0.76	N/mm²		✓
utilization ratio							5 %	

Service limit state design (SLS) - design results



initial deflection [w_{char}]

field	dist.	limit	w_{limit}	$w_{calc.}$	ratio	
	[m]	[-]	[mm]	[mm]		
1	2.55	1/300	17.0	7.7	45 %	LCO1

final deflection [$w_{char}+w_{q.p.}*k_{def}$]

field	dist.	limit	w_{limit}	$w_{calc.}$	ratio	
	[m]	[-]	[mm]	[mm]		
1	0.0	1/150	34.0	7.7	23 %	LCO2

net final deflection [$w_{q.p.}*(1+k_{def})$]						
field	dist.	limit	w_{limit}	$w_{calc.}$	ratio	
	[m]	[-]	[m]	[mm]		
1	0.0	1/250	20.4	0.0	0 %	LCO2

support reaction			
load case category	k_{mod}	A_V	B_V
		[kN]	
wind load	0.9	1.53	1.53
		0.00	0.00

reference documents for this analysis	
English title	description
EN 338	EN 338 - Structural timber — Strength classes
EN 1995-1-1	EN 1995-1-1 - Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings
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ÖNORM EN 1995-1-1_NA, chapter 7.3	ÖNORM EN 1995-1-1 - Austria - National Annex – Nationally determined parameters – Eurocode 5: Design of timber structures – Part 1-1: General-Common rules and rules for buildings; chapter 7.3

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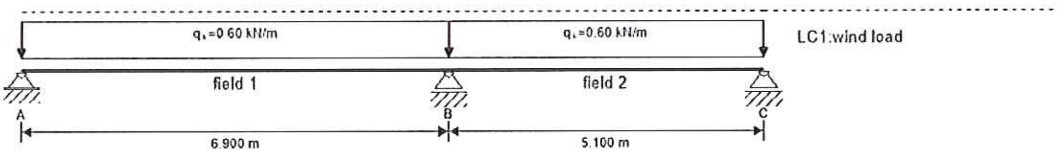


global utilization ratio									60 %
ULS	19 %	ULS fire	0 %	SLS	60 %	SLS vibration	0 %	support	-1 %

section: CLT 100 L3s

layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce
2	40.0 mm	90°	C24 spruce
3	30.0 mm	0°	C24 spruce
t_{CLT}	**100.0 mm**		

material values

material	$f_{m,k}$	$f_{t,0,k}$	$f_{t,90,k}$	$f_{c,0,k}$	$f_{c,90,k}$	$f_{v,k}$	$f_{r,k\ min}$	$E_{0,mean}$	G_{mean}	$G_{r,mean}$
	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]
C24 spruce	24.00	14.00	0.12	21.00	2.50	4.00	1.25	12,500.00	460.00	50.00

load

load case groups

	load case category	Typ	duration	Kmod	γ_{inf}	γ_{sup}	Ψ_0	Ψ_1	Ψ_2
LC1	wind load	Q	short term	0.9	0	1.5	0.6	0.2	0

LC1:wind load

continous load

field	load at start
	[kN/m]
1	0.60
2	0.60

ULS combinations

	combination rule
LCO1	1.50/0.00 * LC1

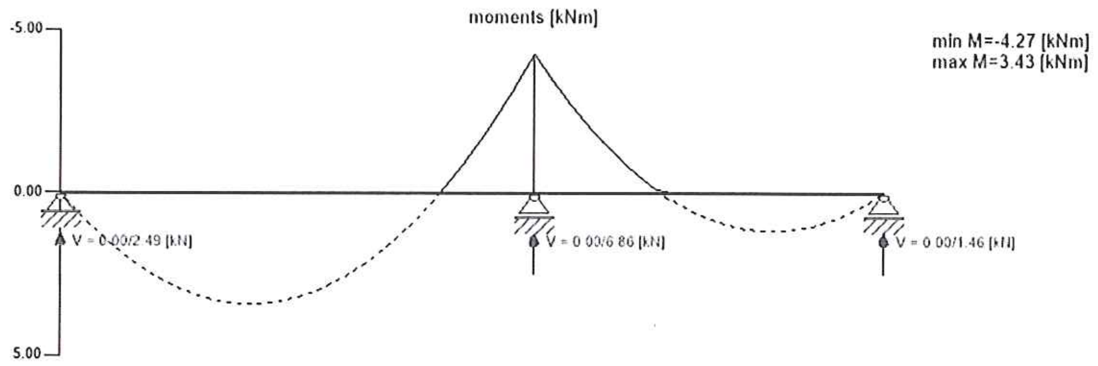
SLS characteristic combination

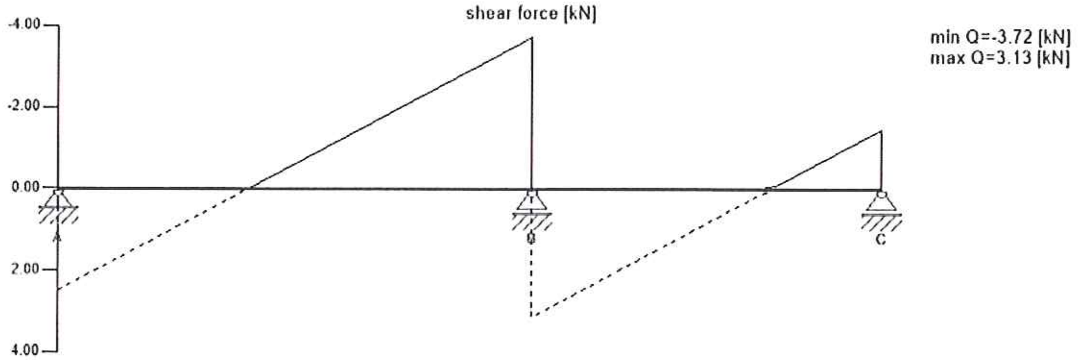
	combination rule
LCO1	1.00/0.00 * LC1

SLS quasi-permanent combination

	combination rule
LCO2	1.00/0.00 * 0.00 * LC1

Ultimate limit state (ULS) - design results





ULS flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	k_{sys}	$f_{m,d}$	M_d	$\sigma_{m,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[N/mm²]	[kNm]	[N/mm²]		
1	6.9	24.00	1.25	0.90	1.10	19.01	-4.27	3.65	19 %	LCO1
2	0.0	24.00	1.25	0.90	1.10	19.01	-4.27	3.65	19 %	LCO1

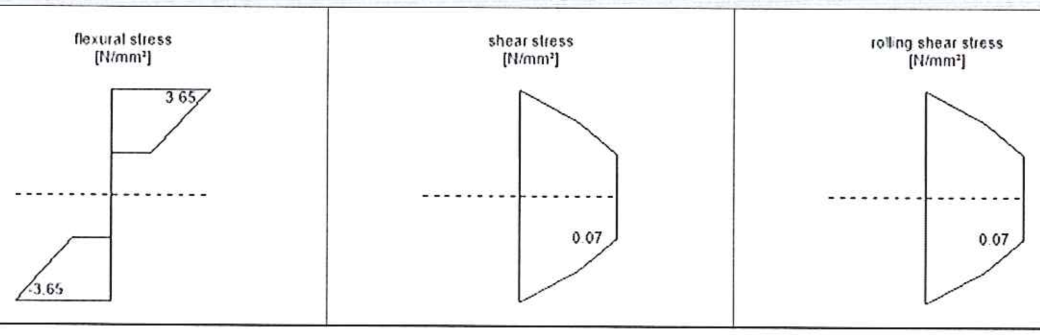
ULS shear analysis

field	dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	6.9	4.00	1.25	0.90	2.88	3.72	0.07	2 %	LCO1
2	0.0	4.00	1.25	0.90	2.88	3.13	0.06	2 %	LCO1

ULS rolling shear

field	dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	6.9	1.05	1.25	0.90	0.76	3.72	0.07	9 %	LCO1
2	0.0	1.05	1.25	0.90	0.76	3.13	0.06	7 %	LCO1

stress diagram

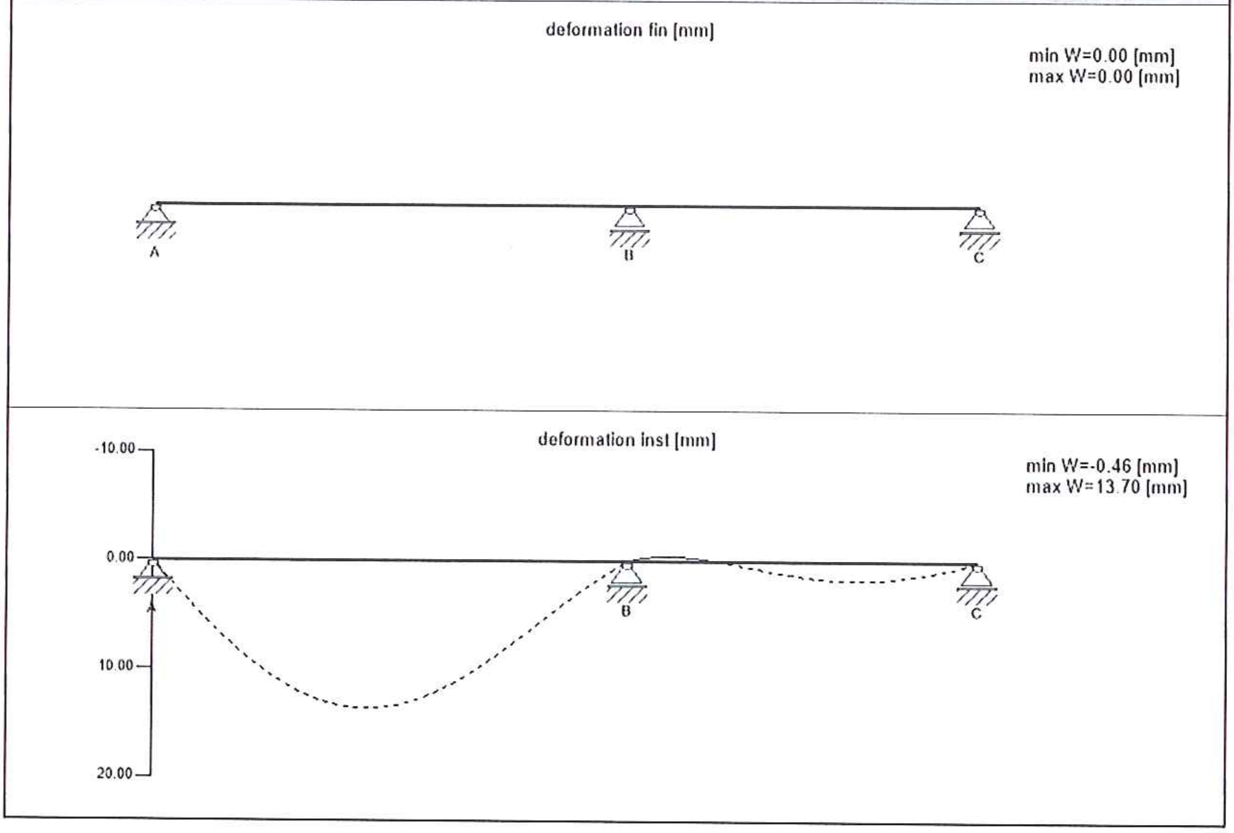


flexural stress analysis							
M_d =	-4.27	kNm		$f_{m,k}$ =	24.00	N/mm²	
				γ_m =	1.25		
				k_{mod} =	0.90		
				k_{sys} =	1.10		
$\sigma_{m,d}$ =	3.65	N/mm²	<	$f_{m,d}$ =	19.01	N/mm²	✓
utilization ratio						19 %	

shear stress analysis							
V_d =	3.72	kN		$f_{v,k}$ =	4.00	N/mm²	
				γ_m =	1.25		
				k_{mod} =	0.90		
$\tau_{v,d}$ =	0.07	N/mm²	<	$f_{v,d}$ =	2.88	N/mm²	✓
utilization ratio						2 %	

rolling shear analysis							
V_d =	3.72	kN		$f_{r,k}$ =	1.05	N/mm²	
				γ_m =	1.25		
				k_{mod} =	0.90		
$\tau_{r,d}$ =	0.07	N/mm²	<	$f_{r,d}$ =	0.76	N/mm²	✓
utilization ratio						9 %	

Service limit state design (SLS) - design results



initial deflection [w_{char}]						
field	dist.	limit	w_{limit}	$w_{calc.}$	ratio	
	[m]	[-]	[mm]	[mm]		
1	3.11	1/300	23.0	13.7	60 %	LCO1
2	3.32	1/300	17.0	1.7	10 %	LCO1

final deflection [w_{char}+$w_{q.p.}$*k_{def}]						
field	dist.	limit	w_{limit}	$w_{calc.}$	ratio	
	[m]	[-]	[mm]	[mm]		
1	0.0	1/150	46.0	13.7	30 %	LCO2
2	0.0	1/150	34.0	1.7	5 %	LCO2

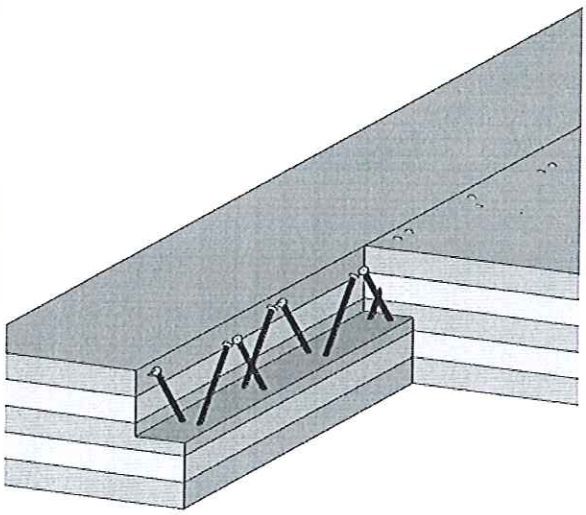
net final deflection [$w_{q.p.}$*(1+k_{def})]						
field	dist.	limit	w_{limit}	$w_{calc.}$	ratio	
	[m]	[-]	[m]	[mm]		
1	0.0	1/250	27.6	0.0	0 %	LCO2
2	0.0	1/250	20.4	0.0	0 %	LCO2

support reaction				
load case category	k_{mod}	A_V	B_V	C_V
			[kN]	
wind load	0.9	1.66	4.57	0.97
		0.00	0.00	0.00

reference documents for this analysis	
English title	description
EN 338	EN 338 - Structural timber — Strength classes
EN 1995-1-1	EN 1995-1-1 - Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings
ETA-14/0349	European Technical Assessment ETA-14/0349 of 02.10.2014
Expertise Rolling shear - no edge gluing, H.J. Blass	Expertise on Rolling shear for CLT
EN 1995-1-2	EN 1995-1-2 - Eurocode 5 — Design of timber structures — Part 1-2: General — Structural fire design
Technical expertise 122/2011/02: analysis of load bearing capacity and separation performance of CLT elements	Verification of the load bearing capacity and the insulation criterion of CLT structures with Stora Enso CLT
Technical expertise 2434/2012 - BB: failure time tf of gypsum fire boards (GKF) according to ON B 3410	Expertise on failure time tf of gypsum wall fire boards according to ON B3410 and gypsum wall boards type DF according to EN 520
EN 1990	EN 1990 - Eurocode — Basis of structural design
ÖNorm B 1995-1-1 NA	ÖNORM EN 1995-1-1 - Austria - National Annex – Nationally determined parameters – Eurocode 5: Design of timber structures – Part 1-1: General- Common rules and rules for buildings
ÖNorm B 1995-1-2 NA	ÖNORM EN 1995-1-2 - Austria - National Annex - Eurocode 5: Design of timber structures — Part 1-2: General — Structural fire design — National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements
Fire safety in timber buildings - technical guildeline for Europe	Fire safety in timber buildings - technical guildeline for Europe; publishes by SP Technical Research Institute of Sweden
National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements, chapter 12	ÖNORM EN 1995-1-2 - National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements, chapter 12
Expertise Rolling shear, H.J. Blass	Expertise on rolling shear strength and rolling shear modulus of CLT panels
ÖNORM EN 1995-1-1_NA, chapter 7.3	ÖNORM EN 1995-1-1 - Austria - National Annex – Nationally determined parameters – Eurocode 5: Design of timber structures – Part 1-1: General- Common rules and rules for buildings; chapter 7.3

Disclaimer

connection

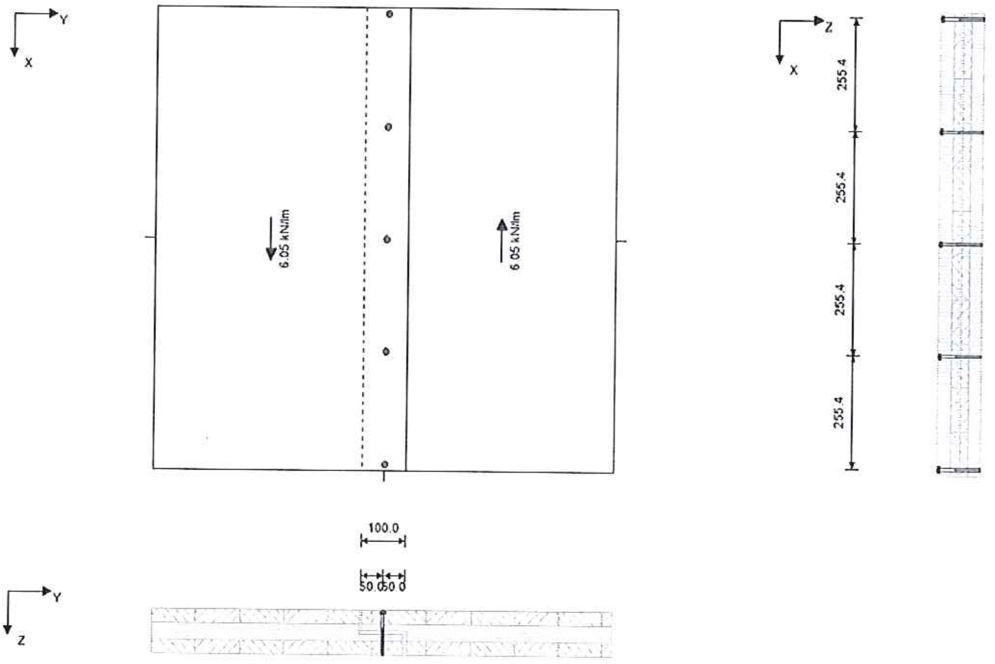


F_x	6.05	kN/lm
K_{mod}	1	-
material 1	C24 spruce	
panel 1	CLT 100 C3s	
orientation cover layer	X direction	
panel 2	CLT 100 C3s	
orientation cover layer	✓	
connector type	Rothoblaas TBS	
connectors	6/100	
setup	vertical	
diameter	6	mm
head diameter	15.5	mm
length	100	mm
thread length	60	mm
splice length	100	mm
number of rows	1	
pre-drilled	×	

analysis

Nachweis	Vorhanden	Grenzwert	Einheit	utilization
CLT width	100	72	mm	72 %
thickness 1	50	32	mm	63 %
thickness 2	50	32	mm	63 %
Fv	1545.25	1545.25	N	100 %
count	3.915	41.667	count / lm	9 %

system sketch



minimum spacing						
Name	$a_{1,min}$	$a_{2,min}$	$a_{3c,min}$	$a_{3t,min}$	$a_{4c,min}$	$a_{4t,min}$
	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
CLT top	24	15	36	36	15	36
CLT bottom	24	15	36	36	15	36

result in layers

element 1						
X	Dicke	Typ	α	l_{eff}	$l_{eff,v}$	$F_{ax,Rk}$
[mm]	[mm]		[°]	[mm]	[mm]	[N]
0	30	C	90	0	0	0
30	10	L	90	0	0	0
40	5	L	90	5	5	351
45	5	L	90	0	0	0

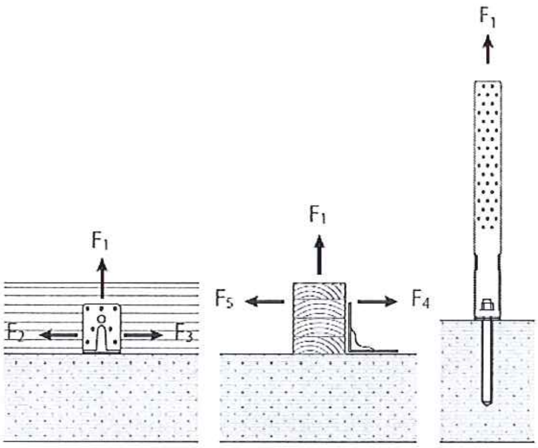
element 2						
X	Dicke	Typ	α	l_{eff}	$l_{eff,v}$	$F_{ax,Rk}$
[mm]	[mm]		[°]	[mm]	[mm]	[N]
50	5	L	90	0	0	0
55	15	L	90	15	15	1053
70	20	C	90	20	20	1404
90	10	C	90	0	0	0

results										
$b_{1,min}$	$b_{2,min}$	$f_{h,k,1}$	$f_{h,k,2}$	β	$t_{pen,1}$	$t_{pen,2}$	$l_{eff,1}$	$l_{eff,2}$	$t_{1,req}$	$t_{2,req}$
[mm]	[mm]	[N/mm²]	[N/mm²]	[-]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
72	72	24.49	24.49	1.00	50.00	50.00	5.00	35.00	32	32

results												
$M_{y,r,k}$	$F_{ax,Rk}$	$F_{head,Rk}$	$F_{tens,Rk}$	$F_{ki,Rk}$	$F_{v,Rk}$	$F_{v,Rd}$	$F_{v,Ed}$	$F_{ax,Rd}$	$F_{ax,Ed}$	Anz.	$Anz._{max}$	$a_{erf.}$
[Nmm]	[N]	[N]	[kN]	[kN]	[N]	[N]	[kN/lm]	[N]	[kN/lm]	[Stk/m]	[Stk/m]	[mm]
9493.71	351.002	2522.625	11.300	0.000	2008.82	1545.25	6.05	270.00	0.00	3.92	41.67	255

reference documents for this analysis	
English title	description
EN 338	EN 338 - Structural timber — Strength classes
EN 1995-1-1	EN 1995-1-1 - Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings
EN 1990	EN 1990 - Eurocode — Basis of structural design
ÖNorm B 1995-1-1 NA	ÖNORM EN 1995-1-1 - Austria - National Annex – Nationally determined parameters – Eurocode 5: Design of timber structures – Part 1-1: General-Common rules and rules for buildings
ÖNorm B 1995-1-2 NA	ÖNORM EN 1995-1-2 - Austria - National Annex - Eurocode 5: Design of timber structures — Part 1-2: General — Structural fire design — National specifications concerning ÖNORM EN 1995-1-2, national comments and national supplements
ETA-11/0030	ETA-11/0030 European Technical Approval; Rothoblaas; Self-tapping screws for use in timber structures
ETA-12/0063	SFS intec AG; Self-tapping screws for use in timber constructions
ETA-12/0062	SFA intec AG; ETA-12/0062; selftapping screws for use in timber constructions
ETA-11/0086	GH Various Angle Brackets
ETA-09/0322	GH Various Angle Brackets
ETA-11/0496	Rotho Blaas TITAN Angle Brackets

connection



F_1	0	kN
F_{23}	0.53	kN
K_{mod}	1	-
connectors	TITAN F - TCF200, Hv = 60 mm	

design F_{23}

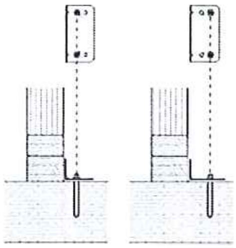
$F_{k,23}$ =	0.5	kN		$R_{k,23,Holz}$ =	15.1	kN	
				γ_m =	1.3	-	
				k_{mod} =	1.00	-	
$F_{d,23}$ =	0.5	kN	<	$R_{d,23}$ =	11.6	kN	✓

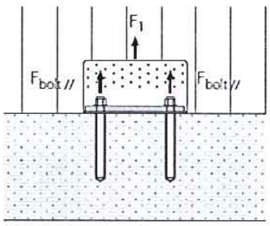
utilization ratio 5 %

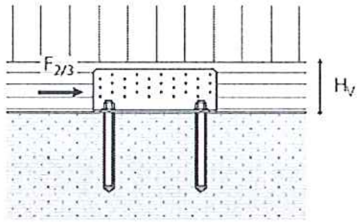
design forces for anchorage to concrete

design values, having "in" in the index refer to an inner anchor position
design values, having "out" in the index refer to an outer anchor position
see technical approvals and assessment documents

$F_{d,Bolt,23,in}$ = 0.3975 [kN]
$F_{d,Bolt,23,out}$ = 0.5088 [kN]







reference documents for this analysis

English title	description
EN 338	EN 338 - Structural timber — Strength classes
EN 1995-1-1	EN 1995-1-1 - Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings
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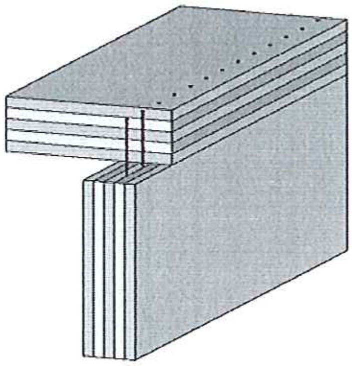
ETA-11/0030	ETA-11/0030 European Technical Approval; Rothoblaas; Self-tapping screws for use in timber structures
ETA-12/0063	SFS intec AG; Self-tapping screws for use in timber constructions
ETA-12/0062	SFA intec AG; ETA-12/0062; selftapping screws for use in timber constructions

reference documents for this analysis	
English title	description
ETA-11/0086	GH Various Angle Brackets
ETA-09/0322	GH Various Angle Brackets
ETA-11/0496	Rotho Blaas TITAN Angle Brackets

Disclaimer

connection

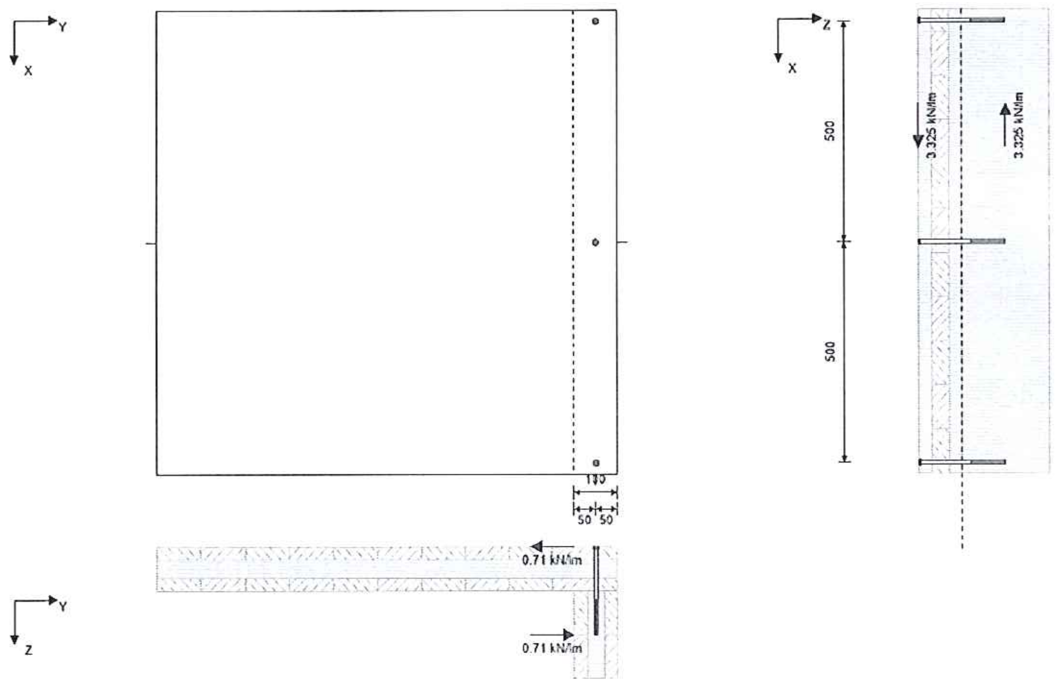


F_x	3.325	kN/lm
F_y	0.71	kN/lm
K_{mod}	1	-
material 1	C24 spruce	
panel 1	CLT 100 C3s	
orientation cover layer	X direction	
material 2	C24 spruce	
panel 2	CLT 100 C3s	
orientation cover layer	✓	
connector type	Rothoblaas HBS	
connectors	8/200	
setup	vertical	
diameter	8	mm
head diameter	14.5	mm
length	200	mm
thread length	80	mm
connector positions	✓	
pre-drilled	×	

analysis

Nachweis	Vorhanden	Grenzwert	Einheit	utilization
width 1	100	96	mm	96 %
width 2	100	96	mm	96 %
thickness 1	100	38	mm	38 %
thickness 2	100	81	mm	81 %
Fv	1699.98	2056.621	N	83 %
count	1.653	12.5	count / lm	13 %
splitting stress analysis	0.021	0.828	N/mm²	3 %

system sketch



minimum spacing						
Name	$a_{1,min}$	$a_{2,min}$	$a_{3c,min}$	$a_{3t,min}$	$a_{4c,min}$	$a_{4t,min}$
	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
CLT top	32	20	48	48	20	48
CLT bottom	80	32	56	96	24	48

result in layers

element 1						
X	Dicke	Typ	α	l_{eff}	$l_{eff,v}$	$F_{ax,Rk}$
[mm]	[mm]		[°]	[mm]	[mm]	[N]
0	30	C	90	0	0	0
30	40	L	90	0	0	0
70	30	C	90	0	0	0

results										
$b_{1,min}$	$b_{2,min}$	$f_{h,k,1}$	$f_{h,k,2}$	β	$t_{pen,1}$	$t_{pen,2}$	$l_{eff,1}$	$l_{eff,2}$	$t_{1,req}$	$t_{2,req}$
[mm]	[mm]	[N/mm²]	[N/mm²]	[-]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
96	96	21.21	7.07	3.00	100.00	100.00	0.00	85.00	38	81

results												
$M_{y,r,k}$	$F_{ax,Rk}$	$F_{head,Rk}$	$F_{tens,Rk}$	$F_{ki,Rk}$	$F_{v,Rk}$	$F_{v,Rd}$	$F_{v,Ed}$	$F_{ax,Rd}$	$F_{ax,Ed}$	Anz.	$Anz._{max}$	$a_{erf.}$
[Nmm]	[N]	[N]	[kN]	[kN]	[N]	[N]	[kN/lm]	[N]	[kN/lm]	[Stk/m]	[Stk/m]	[mm]
20057.48	2207.632	2207.625	20.100	0.000	2673.61	2056.62	3.40	1698.17	0.00	1.65	12.50	500

reference documents for this analysis	
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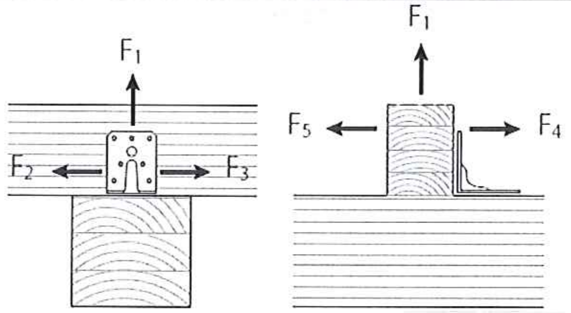
ETA-09/0322	GH Various Angle Brackets
ETA-11/0496	Rotho Blaas TITAN Angle Brackets

connection



F_1	0	kN
F_{23}	0	kN
F_{45}	0.52	kN
K_{mod}	1	-
connectors	WBR070	

design F_{45}

$F_{k,45}$ =	0.5	kN		$R_{k,45,Holz}$ =	6.8	kN	
				γ_m =	1.3	-	
				k_{mod} =	1.00	-	
$F_{d,45}$ =	0.5	kN	<	$R_{d,45}$ =	6.8	kN	✓

utilization ratio 8 %

reference documents for this analysis

English title	description
EN 338	EN 338 - Structural timber — Strength classes
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ETA-09/0322	GH Various Angle Brackets
ETA-11/0496	Rotho Blaas TITAN Angle Brackets

Disclaimer

SPOJ LESENIH OKVIRJEV

PRERAČUN OBREMENITEV NA VIJAK

Med = 21,70 kNm

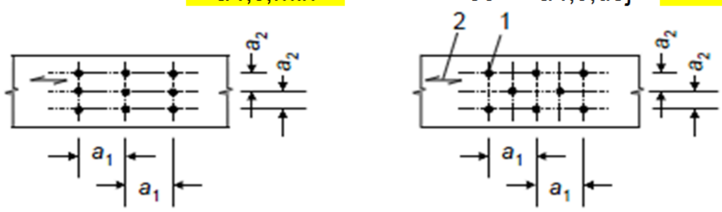
	r [cm]	n [kom]	n*ri2	Fed [kN]
1	15,00	4,00	900,00	12,05
2	21,22	4,00	1801,15	17,05
3	0,00	0,00	0,00	0,00
4	0,00	0,00	0,00	0,00
5	0,00	0,00	0,00	0,00
6	0,00	0,00	0,00	0,00
		SUM ri2 =	2701,15	
r max =	21,22		Fvedmax =	**17,05** kN

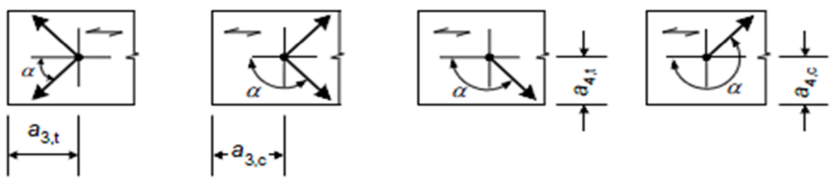
STRIŽNI SPOJ JEKLO-LES

DVOSTRIŽNI STIK

SREDINSKA JEKLENA PLOŠČA S POLJUBNO DEBELINO

LES	**GL24h**	lepljen	γm=	**1,25**		
ρles =	380,00	kg/m3	obtežba	**S**		
t1 =	100,00	mm	kmod =	**0,90**		
VIJAKI	**M20; 5.8**		α =	45		
d =	20	mm	a1,min =	94	a1,dej =	100 mm
do =	22	mm	a2,min =	80	a2,dej =	100 mm
fu,k =	500,00	N/mm2	a3,t,min =	140	a3,t,dej =	150 mm
			a4,t,min =	80	a4,t,dej =	100 mm
			a4,c,min =	60	a4,c,dej =	100 mm





-90° ≤ α ≤ 90°   90° ≤ α ≤ 270°   0° ≤ α ≤ 180°   180° ≤ α ≤ 360°

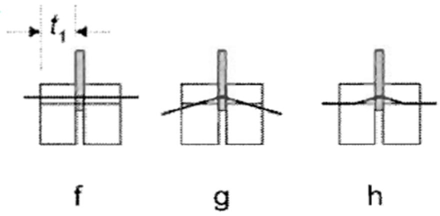
PLOČEVINA	**S 235**	fy,d =	23,50	kN/cm2	fu,b =	36,00 kN/cm2
t =	5,00	mm				

Razmaki med vijaki v pločevini

e1=2*do=	44 (1,2–2,5)	e1 dej =	150	mm
e2=1,5*do=	33 (1,2-1,5)	e2 dej =	150	mm
p1=3*do=	66 (2,2–3,75)	p1 dej =	60	mm
p2=3*do=	66 (2,4-3,0)	p2 dej =	60	mm

OBREMENITEV

Fved = 17,05 kN   α = 45 °



DIMENZIONIRANJE

fh,0,k = 24,93 N/mm2…bočna trdnost lesa
k90 = 1,60 mehki les
fh,α,k = 19,18 N/mm2…bočna trdnost lesa
My,r,k = 362050,58 Nmm…kar. Upogibni moment vijakov

Fv,rk = min (38,35 kN) = 27,10 kN
52,83 kN
27,10 kN

$$F_{v,Rk} = \min \begin{cases} f_{h,1,k}\, t_1\, d & (f) \\ f_{h,1,k}\, t_1\, d\left[\sqrt{2+\dfrac{4M_{y,Rk}}{f_{h,1,k}\, d\, t_1^2}}-1\right]+\dfrac{F_{ax,Rk}}{4} & (g) \\ 2{,}3\sqrt{M_{y,Rk}\, f_{h,1,k}\, d}+\dfrac{F_{ax,Rk}}{4} & (h) \end{cases}$$

Fax,rk zanemarimo
Nosilnost posameznega vijaka

Fved = 17,05 kN < Fvr,k = 19,51 kN

Nosilnost skupine vijakov

m = 2 vrsta   n = 1 kom   nef = 0,79

Fv,ed,1 = 12,18 kN < Fvr,k = 19,51 kN

- Kontrola bočnih pritiskov pločevina   α = 0,66

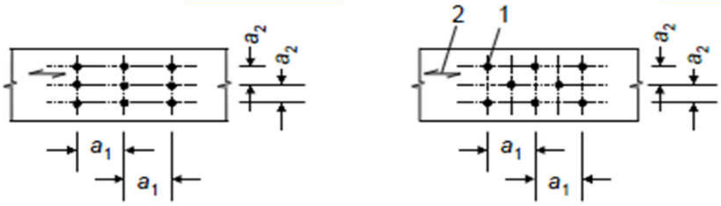
Fv,ed = 17,05 < Fb,rd = 47,45 kN   **OK**

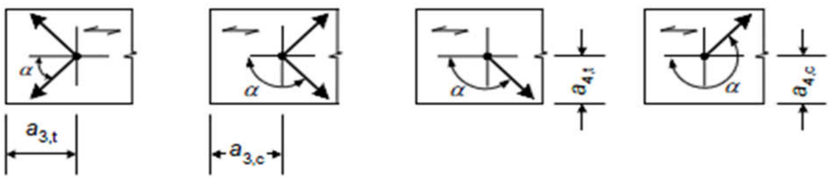
SPINA NOVO MESTO D.O.O.

SREDINSKA JEKLENA PLOŠČA S POLJUBNO DEBELINO

LES	**GL24h**	lepljen	γm=	**1,25**
ρles =	380,00	kg/m3	obtežba	**S**
t1 =	75,00	mm	kmod =	**0,90**

VIJAKI	**M12; 5.8**		α =	45		
d =	12	mm	a1,min =	56	a1,dej =	100 mm
do =	13	mm	a2,min =	48	a2,dej =	100 mm
fu,k =	500,00	N/mm2	a3,t,min =	84	a3,t,dej =	150 mm
			a4,t,min =	48	a4,t,dej =	100 mm
			a4,c,min =	36	a4,c,dej =	100 mm





-90° ≤ α ≤ 90°   90° ≤ α ≤ 270°   0° ≤ α ≤ 180°   180° ≤ α ≤ 360°

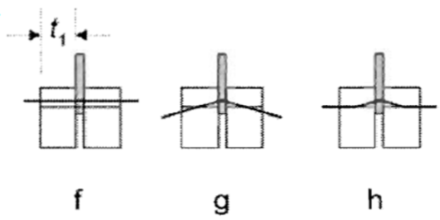
PLOČEVINA	**S 235**		fy,d =	23,50	kN/cm2	fu,b =	36,00 kN/cm2
t =	6,00	mm					

Razmaki med vijaki v pločevini

e1=2*do=	26	(1,2–2,5)	e1 dej =	150	mm
e2=1,5*do=	19,5	(1,2-1,5)	e2 dej =	150	mm
p1=3*do=	39	(2,2–3,75)	p1 dej =	60	mm
p2=3*do=	39	(2,4-3,0)	p2 dej =	60	mm

OBREMENITEV

Fved = 5,00 kN   α = 90 °



DIMENZIONIRANJE

fh,0,k =	27,42	N/mm2...bočna trdnost lesa
k90 =	1,48	mehki les
fh,α,k =	18,53	N/mm2...bočna trdnost lesa
My,r,k =	95931,78	Nmm...kar. Upogibni moment vijakov

$$F_{v,Rk} = \min \begin{cases} f_{h,1,k}\, t_1\, d & \text{(f)} \\ f_{h,1,k}\, t_1\, d \left[\sqrt{2 + \dfrac{4 M_{y,Rk}}{f_{h,1,k}\, d\, t_1^2}} - 1 \right] + \dfrac{F_{ax,Rk}}{4} & \text{(g)} \\ 2{,}3 \sqrt{M_{y,Rk}\, f_{h,1,k}\, d} + \dfrac{F_{ax,Rk}}{4} & \text{(h)} \end{cases}$$

Fv,rk = min (	16,67 kN) =	10,62	kN
	21,79 kN		
	10,62 kN		

Fax,rk zanemarimo

Nosilnost posameznega vijaka

Fved = 5,00 kN < Fvr,k = 7,65 kN

Nosilnost skupine vijakov

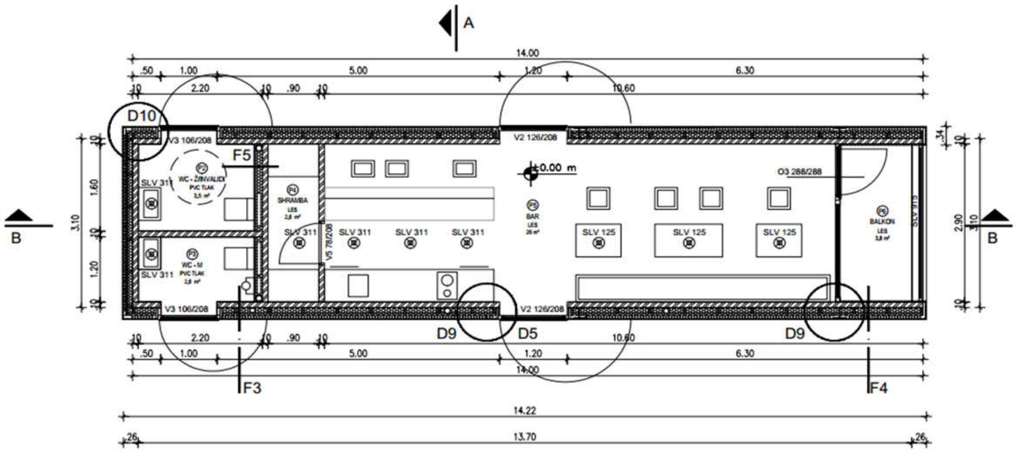
Stik - n8

m =	2	vrsta		n =	1	kom	nef =	0,89
Fv,ed,1 =	3,13	kN < Fvr,k =	7,65	kN				
- Kontrola bočnih pritiskov pločevina			α =	1,00				
Fv,ed =	5,00	< Fb,rd =	51,84	kN	**OK**			

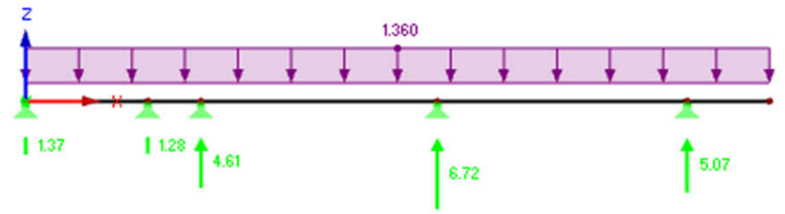
POZ 300 BAR

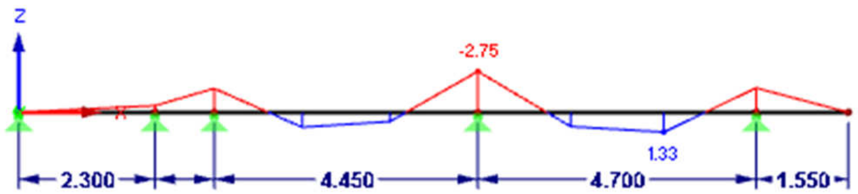
BAR - PORAZDELITEV HORIZONTALNE OBREMENITVE

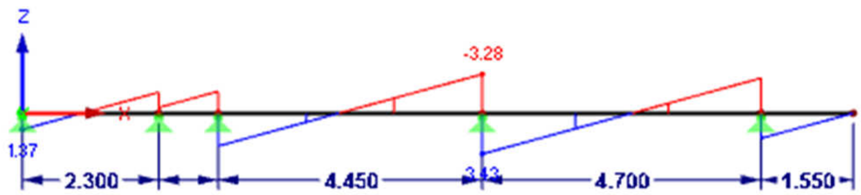
wspredaj =	0,36 kN/m2
wzadaj =	0,23 kN/m2
h =	3 m
hp =	0,8 m
Fwzgoraj =	0,885 kN
Fwzgoraj,p =	0,472 kN
Sum =	1,357 kN
Fwspodaj =	0,345 kN



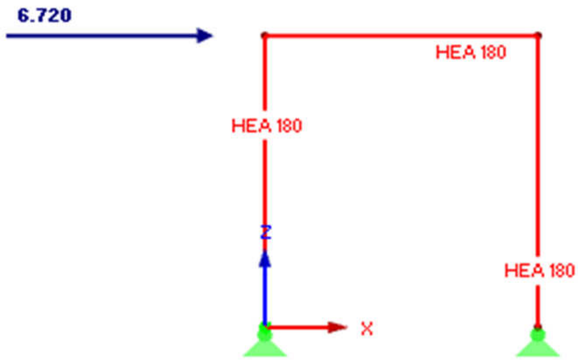
Obremenitev na stropno ploščo



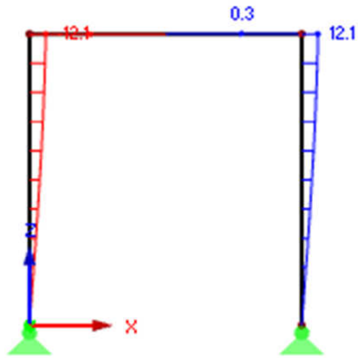




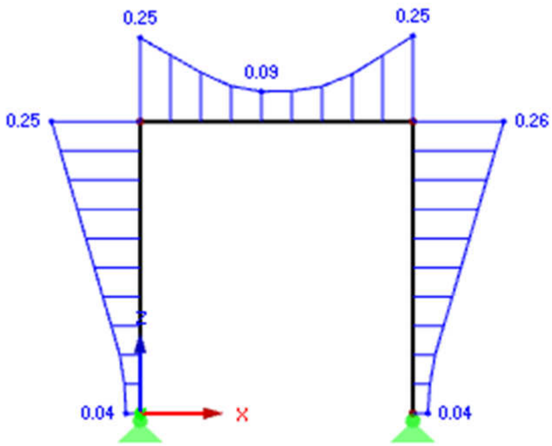
Preračun okvirja



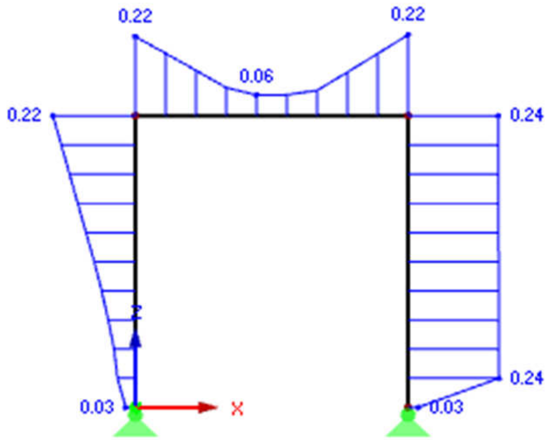
ux [mm]



Kontrola napetosti



Kontrola stabilnosti



SPINA NOVO MESTO D.O.O.

STIK HEA 180 - STEBER NOSILEC

VIJAČENI MOMENTNI SPOJ PREČKE NA STEBER (2 vrsti)

Material	Jeklo	**S 235**		Vijaki	**M20**	
	fy =	23,50	kN/cm2	d =	20	mm
	fu =	36,00	kN/cm2	As =	2,45	cm2
				A =	3,14	cm2
	št. vrstic vijakov	2		kvaliteta	**8.8**	
	št. stolpcev vijakov	4		fyb =	64,0	kN/cm2
	n vijakov	8		fub =	80,0	kN/cm2
				do =	22	mm
Obremenitev	Ned =	0,00	kN ...tlačna sila +			
	Med =	69,10	kNm			
	Ved =	0,00	kN			

Geometrija	Prečka	**HEA**	**180**	Steber	**HEA**	**180**	
	hp =	171,00	mm	hs =	171,00	mm	
	bp =	180,00	mm	bs =	180,00	mm	
	tfp =	9,50	mm	tfs =	9,50	mm	
	twp =	6,00	mm	tws =	6,00	mm	
	hwp =	152,00	mm	hws =	152,00	mm	

tčp = 25,00 mm …debelina čelne pločevine (tp ≈ dvijaka)

Preračun va	af,w=	5,00	mm…debelina vara pasnice
	aw,w=	3,00	mm…debelina vara stojine
	Iy,weld=	2808,03	cm4
	Wpl,y,w=	328,42	cm3 > Wpl,y,prečke

Razmaki med vijaki

Zahtevane			Dejanske		
e1 = 2*do =	44	mm (1,2–2,5	e1 dej =	40	mm
e2 = 1,5*do =	33	mm (1,2-1,5)	e2 dej =	35	mm
p1 = 3*do =	66	mm (2,2–3,7	p1 dej =	90	mm
p2 = 3*do =	66	mm (2,4-3,0)	p2 dej =	80	mm

Razporeditev obtežbe med vijaki

x1 =	40,00	mm	r1 =	35,25	mm
x2 =	90,00	mm	r2 = r max =	125,25	mm
x3 =	40,00	mm			
Med' =	6910,00	kNcm	tmax = Ft2 =	127,80	kN
			Ft1 =	35,97	kN
			Fc = Σ Ft + Ned =	163,77	kN

Kontrole

- Kontrole natezne nosilnosti vijakov

Ft,ed = Ft,max = 127,80 ≤ Ft,rd = 141,12 kN **OK**

SPINA NOVO MESTO D.O.O.

NOSILCI OGRAJE

POZ 101 SPODNJI NOSILEC OGRAJE

PROFIL **T 2** JEKLO **S 235** fy,d = 23,50 kN/cm2

h[mm]	b[mm]	tw[mm]	tf[mm]	r[mm]	A[cm2]	hi[mm]	d[mm]
140	65	10	10	5	19,5	140	65
Iy[cm4]	Wel.y[cm3]	Wpl.y[cm3]	iy [cm]	Iz[cm4]	Wel.z[cm3]	Wpl.z[cm3]	iz [cm]
395,00	79,00	744,60	10,05	2769,00	230,70	351,70	6,00
				It[cm4]	Iω [cm6]	E	G
				41,55	328,50	21000	8077

GEOMETRI Lmax = 3,00 m
a = 1,50 m…pozicija točkovne obtežbe
b = 1,50 m…(a<b)

OBTEŽBA	lastna teža				g =	0,15	kN/m
stalna	zid - klet	γ [kN/m3]	b [m]	h[m]			
		27,00	0,02	1	pg,zid =	0,54	kN/m
					g =	0,69	kN/m
koristna	od poz 101		x [m]	q [kN/m2]			
			1,00	1	pq,pl =	1,00	kN/m
					q =	1,00	kN/m
					qed =	2,44	kN/m
točkovna					Ag =	1,00	kN
					Aq =	0,00	kN
					Qed =	1,35	kN

REAKCIJE
Aed = qed*L/2 + Qed*b/L = 4,33 kN
Bed = qed*L/2 + Qed*a/L = 4,33 kN

DIMENZIONIRANJE

MSN upogib Med = qed*L2/8 + Qed*a*b*L = 3,75 kNm
σsd = Med/Wy = **4,75** kN/cm^2 < fy,d = **23,50** kN/cm^2

strig Ved = **4,33** kN < Vpl,rd = **189,95** kN

vijačenje M [mm] = 12 n [kom] = 2 As [cm2] = 0,843
kvaliteta 8 8 fyb = 64,00 fub = 80,00
Ved = **4,33** kN < Fv,rd = **53,95** kN

MSU Pomiki w = 5*(g+q)*L^4/(384*E*I) + Q*L3*(3*a/L-4*(a/L))/48*E*I

w = **0,28** cm < L / 500 = **0,60** cm

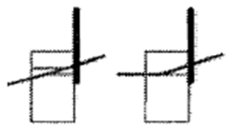
ENOSTRIŽNI STIK

TANKA PLOČEVINA (TANJŠA KOT 0,5*d)

$$F_{v,Rk} = \min \begin{cases} 0{,}4\, f_{h,k}\, t_1\, d \\ 1{,}15\sqrt{2\, M_{y,Rk}\, f_{h,k}\, d} + \dfrac{F_{ax,Rk}}{4} \end{cases}$$

LES	**C24**	masivni	γm=	**1,25**
ρles =	350,00	kg/m3	obtežba	**M**
t =	75,00	mm	kmod =	**0,80**

VIJAKI	**M10; 5.8**	
d =	10	mm
fu,k =	500,00	N/mm2
n =	3,00	



a b

OBREMENITEV

Fved = 4,50 kN

DIMENZIONIRANJE

fh,0,k = 25,83 N/mm2…bočna trdnost lesa

My,r,k = 59716,08 Nmm…kar. Upogibni moment vijakov

Fv,rk = min (7,75 kN) = 4,52 kN

4,52 kN

Fax,rk zanemarimo

Fv,ed = 1,50 kN < Fvr,k = 2,89 kN

SPINA NOVO MESTO D.O.O.

POZ 102 ZGORNJI NOSILEC OGRAJE

PROFIL **T 120** JEKLO **S 235** fy,d = 23,50 kN/cm2

h[mm]	b[mm]	tw[mm]	tf[mm]	r[mm]	A[cm2]	hi[mm]	d[mm]
140	60	7	10	5	20,4	98	140
Iy[cm4]	Wel.y[cm3]	Wpl.y[cm3]	iy [cm]	Iz[cm4]	Wel.z[cm3]	Wpl.z[cm3]	iz [cm]
605,00	86,4	103,00	5,45	62,7	14,8	28,3	1,75
				It[cm4]	Iω [cm6]	E	G
				5,68	1,8	21000	8077

GEOMETRI Lmax = 3,00 m
a = 1,50 m…pozicija točkovne obtežbe
b = 1,50 m…(a<b)

OBTEŽBA	lastna teža				g =	0,16	kN/m
stalna	zid - klet	γ [kN/m3]	b [m]	h[m]			
		5,00	0,25	0,1	pg,zid =	0,13	kN/m
					g =	0,29	kN/m
koristna	od poz 101		x [m]	q [kN/m2]			
			0,00	0	pq,pl =	0,00	kN/m
					q =	0,00	kN/m
					qed =	0,38	kN/m
točkovna					Ag =	2,00	kN
					Aq =	0,00	kN
					Qed =	2,70	kN

REAKCIJE
Aed = qed*L/2 + Qed*b/L = 1,93 kN
Bed = qed*L/2 + Qed*a/L = 1,93 kN

DIMENZIONIRANJE

MSN upogib Med = qed*L2/8 + Qed*a*b*L = 2,46 kNm
σsd = Med/WZ = **16,61** kN/cm^2 < fy,d = **23,50** kN/cm^2

strig Ved = **1,93** kN < Vpl,rd = **132,96** kN

vijačenje M [mm] = 12 n [kom] = 2 As [cm2] = 0,843
kvaliteta 8 8 fyb = 64,00 fub = 80,00
Ved = **1,93** kN < Fv,rd = **53,95** kN

MSU Pomiki w = 5*(g+q)*L^4/(384*E*I) + Q*L3*(3*a/L-4*(a/L))/48*E*I

w = **0,11** cm < L / 500 = **0,60** cm