KAZALO VSEBINE TEHNIČNEGA POROČILA

TEHNIČNO POROČILO – STATIČNI IZRAČUN

A. ZASNOVA

Obstoječe ostrešje se predela tako, da se na dve strani ostrešja predvidi nova frčada. Primarna konstrukcijo frčado tvorijo špirovci dimenzije 12/14 cm, ki se na zgornji strani naloži na vmesne lege obsoječe strešne konstrukcije. Lege se nadviša za višino, ki je potrebna za zagotovitev ustreznega naklona strešine in višine prostorov v notranjosti. Na eni strani se prostor poveča z balkonom, ki se na AB venca podpre z dvema jeklenima nosilcema HEB160 prečno, ter na to s stropniki 8/14 cm na razmiku do 62,5 cm vzdolžno.

B. STANDARDI

Standardi, ki so bili upoštevani v izračunih:
EN 1990, Eurocode: Osnove projektiranja konstrukcij
EN 1991, Eurocode 1: Vplivi na konstrukcije
EN 1992, Eurocode 2: Projektiranje betonskih konstrukcij
EN 1993, Eurocode 3: Projektiranje jeklenih konstrukcij
EN 1995, Eurocode 5: Projektiranje lesenih konstrukcij
EN 1998, Eurocode 8: Projektiranje potresnoodpornih konstrukcij

C. OBTEŽBE

C.1. Stalne obtežbe

C.1.a. Lastna in stalna teža strehe objekta

Streha je prekrita s pločevinasto kritino. Skupna upoštevana teža sestave strehe:
$g = 0{,}90\ kN/cm^2$

C.2. Spremenljive obtežbe

C.2.a. Obtežba snega

Kot strehe:	26°	$C_e = 1$	$\mu = 0{,}80$
Cona:	A2	$C_t = 1$	$s_k = 1{,}59\ kN/m^2$
Nadmorska višina:	350 m	=>	**$s = \mu\, C_e\, C_t\, s_k = 1{,}27\ kN/m^2$**

C.2.b. Obtežba vetra

Vetrovna cona:	Cona 1	Osnovna hitrost vetra (v_{ref}):	20,00 m/s
Nadmorska višina:	350 m	Faktor izpostavljenosti $c_e(z)$:	1,44
Kategorija hrapavosti:	III	Koeficient tlaka (c_{pe}):	0,7
Višina objekta:	6,5 m	Veter pravokotno (srk):	**$-w = 0{,}29\ kN/m^2$**
		Veter pravokotno (tlak):	**$w = 0{,}25\ kN/m^2$**

C.2.c. Koristna obtežba stropa

Koristna obtežba stropa:
$q_k = 2{,}0\ kN/m^2$

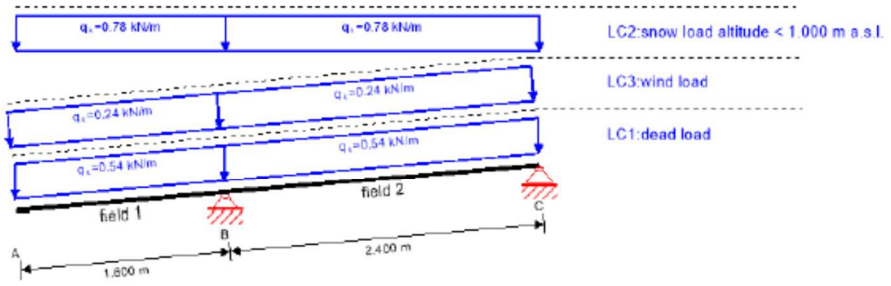
D. Statični izračun konstrukcije

D.1. Streha – POZ100

D.1.a. P101 – Špirovci 12/14 cm, max. razmik 60 cm

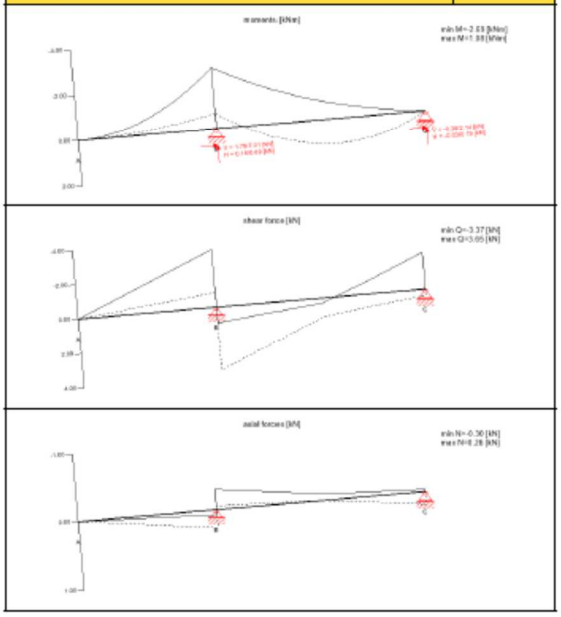
Ligno univ.dipl.inž.grad. Aleš Pančur	project element	DU Grosuplje P101, e = 60 cm	page date	1 22.04.2020

system



section: wooden beam 12/14; **material**: C24 spruce; **service class**: service class 1; **fire resistance class**: R 0

utilization 96 %



flexural stress analysis					41 %
$M_{y,d}$ =	-2.69	kNm	$f_{m,k}$ =	24.00	N/mm²
$N_{t,d}$ =	0.26	kN	$f_{t,k}$ =	14.00	N/mm²
$\sigma_{t,d}$ =	0.02	N/mm²	$f_{t,d}$ =	10.13	N/mm²
$\sigma_{m,y,d}$ =	6.87	N/mm²<	$f_{m,y,d}$ =	16.85	N/mm² ✓
shear stress analysis					19 %
V_d =	3.35	kN	$f_{v,k}$ =	2.30	N/mm²
$\tau_{v,d}$ =	0.30	N/mm²<	$f_{v,d}$ =	1.59	N/mm² ✓
lateral torsional buckling analysis					41 %
$M_{y,d}$ =	-2.69	kNm	$f_{m,k}$ =	24.00	N/mm²
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	14.54	N/mm²
$\sigma_{m,y,d}$ =	6.87	N/mm²<	$f_{m,y,d}$ =	16.85	N/mm² ✓
flexural stress analysis fire					6 %
$M_{y,d}$ =	-0.69	kNm	$f_{m,k}$ =	24.00	N/mm²
$N_{t,d}$ =	0.08	kN	$f_{t,k}$ =	14.00	N/mm²
$\sigma_{t,d}$ =	0.00	N/mm²	$f_{t,d}$ =	18.30	N/mm²
$\sigma_{m,y,d}$ =	1.76	N/mm²<	$f_{m,y,d}$ =	30.42	N/mm² ✓
shear stress analysis fire					3 %
V_d =	0.86	kN	$f_{v,k}$ =	2.30	N/mm²
$\tau_{v,d}$ =	0.08	N/mm²<	$f_{v,d}$ =	2.88	N/mm² ✓
lateral torsional buckling analysis fire					6 %
$M_{y,d}$ =	-0.69	kNm	$f_{m,k}$ =	24.00	N/mm²
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	26.25	N/mm²
$\sigma_{m,y,d}$ =	1.76	N/mm²<	$f_{m,y,d}$ =	30.42	N/mm² ✓

w_{inst} = w[char]

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/300	10.7	10.2	96 %
2	0.6	L/300	8.0	1.3	16 %

w_{fin} = w[char] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/150	21.3	11.9	56 %
2	0.6	L/150	16.0	1.3	8 %

$w_{net,fin}$ = w[q.p.] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/250	12.8	4.4	34 %
2	0.6	L/250	9.6	0.1	1 %

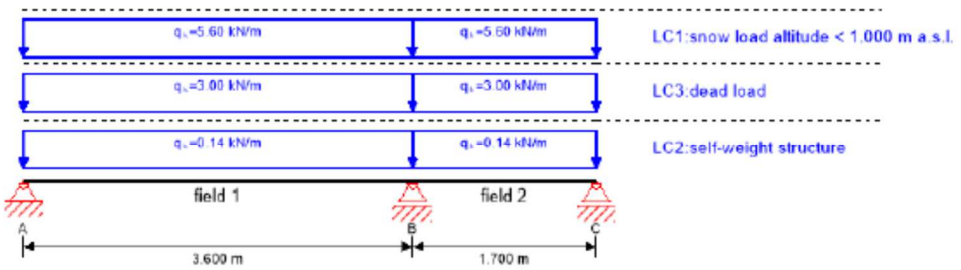
support reaction					
load case category	k_{mod}	B_V	B_H	C_V	C_H
		[kN]			
dead load	0.6	1.80	0.00	0.36	0.00

support reaction					
load case category	k_{mod}	B_V	B_H	C_V	C_H
		[kN]			
		1.80	0.00	0.36	0.00
snow load altitude < 1.000 m a.s.l.	0.9	2.59	0.00	0.93	0.00
		0.00	0.00	-0.41	0.00
wind load	0.9	0.80	0.08	0.29	0.00
		0.00	0.00	-0.13	0.00

D.1.b. P102 – Kapna lega 14/20 cm

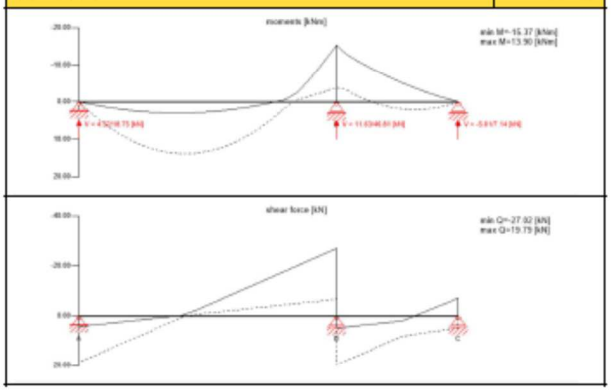
Ligno univ.dipl.inž.grad. Aleš Pančur	project element	DU Grosuplje P102a	page date	1 22.04.2020

system



section: wooden beam 14/20; **material**: C24 spruce; **service class**: service class 1; **fire resistance class**: R 0

utilization 99 %



flexural stress analysis 99 %

$M_{y,d}$ =	-15.37	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.00	kN	$f_{t,k}$ =	14.00	N/mm²	
$\sigma_{t,d}$ =	0.00	N/mm²	$f_{t,d}$ =	9.83	N/mm²	
$\sigma_{m,y,d}$ =	16.47	N/mm² <	$f_{m,y,d}$ =	16.62	N/mm²	✓

shear stress analysis 82 %

V_d =	24.49	kN	$f_{v,k}$ =	2.30	N/mm²	
$\tau_{v,d}$ =	1.31	N/mm² <	$f_{v,d}$ =	1.59	N/mm²	✓

lateral torsional buckling analysis 99 %

$M_{y,d}$ =	-15.37	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²	
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	14.54	N/mm²	
$\sigma_{m,y,d}$ =	16.47	N/mm² <	$f_{m,y,d}$ =	16.62	N/mm²	✓

flexural stress analysis fire 14 %

$M_{y,d}$ =	-3.82	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.00	kN	$f_{t,k}$ =	14.00	N/mm²	
$\sigma_{t,d}$ =	0.00	N/mm²	$f_{t,d}$ =	17.74	N/mm²	
$\sigma_{m,y,d}$ =	4.09	N/mm² <	$f_{m,y,d}$ =	30.00	N/mm²	✓

shear stress analysis fire 11 %

V_d =	6.08	kN	$f_{v,k}$ =	2.30	N/mm²	
$\tau_{v,d}$ =	0.33	N/mm² <	$f_{v,d}$ =	2.88	N/mm²	✓

lateral torsional buckling analysis fire 14 %

$M_{y,d}$ =	-3.82	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²	
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	26.25	N/mm²	
$\sigma_{m,y,d}$ =	4.09	N/mm² <	$f_{m,y,d}$ =	30.00	N/mm²	✓

w_{inst} = w[char]

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/300	12.0	10.9	90 %
2	0.6	L/300	5.7	0.2	3 %

w_{fin} = w[char] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/150	24.0	13.1	55 %
2	0.6	L/150	11.3	0.2	2 %

$w_{net,fin}$ = w[q.p.] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/250	14.4	6.0	41 %
2	0.6	L/250	6.8	0.0	0 %

support reaction				
load case category	k_{mod}	A_V	B_V	C_V
		[kN]		
snow load altitude < 1.000 m a.s.l.	0.9	8.37	20.74	4.38
		-0.18	0.00	-3.62
self-weight structure	0.6	0.20	0.52	0.02
		0.20	0.52	0.02
dead load	0.6	4.39	11.11	0.40
		4.39	11.11	0.40

D.1.c. P103 – Soha 14/14 cm

POZ 103 SOHA

1. Material

Kvaliteta	C24	$\gamma_{m,connection}$	1,30	
Trajanje obtežbe	M	k_{mod} =	0,80	Srednjetrajna
Material	Masivni les	γ_m =	1,30	
Razred uporabnosti	1.	k_{def} =	0,60	

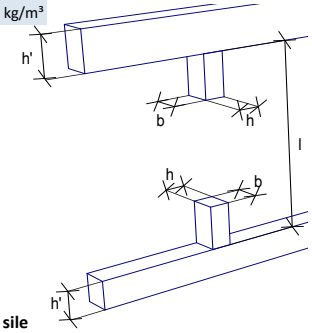
Notranji bivalni prostori razen kuhinj in kopalnic, pisarniški in trgovski prostori

G,Q

l,u=L

Trdnost	**Karakteristična**		**Projektna**	$f_d = k_{mod,q} * f_k / \gamma_M$
Upogib	$f_{m,k}$	2,400 kN/cm²	$f_{m,d}$	1,477 kN/cm²
Nateg, paralelno	$f_{t,0,k}$	1,400 kN/cm²	$f_{t,0,d}$	0,862 kN/cm²
Nateg, pravokotno	$f_{t,90,k}$	0,050 kN/cm²	$f_{t,90,d}$	0,031 kN/cm²
Tlak, paralelno	$f_{c,0,k}$	2,100 kN/cm²	$f_{c,0,d}$	1,292 kN/cm²
Tlak, pravokotno	$f_{c,90,k}$	0,250 kN/cm²	$f_{c,90,d}$	0,154 kN/cm²
Strig	$f_{v,k}$	0,250 kN/cm²	$f_{v,d}$	0,154 kN/cm²

Def. moduli		**Gostota**	
El. Modul, paralelno	$E_{0,mean}$ 1100 kN/cm²	karakteristična, ρ_k	350 kg/m³
El. Modul, paralelno	$E_{0,05}$ 740 kN/cm²	povprečna, ρ_{mean}	420 kg/m³
El. Modul, pravokotno	$E_{90,mean}$ 37 kN/cm²		
Strižni modul	G_{mean} 69 kN/cm²		



2. Geometrija

Višina **L = 280,0 cm**

3. Obtežba

Način vnosa	Nefaktoriran	
Stalna obtežba	**G =**	**11,80 kN**
Spremenljiva obtežba	**Q_1 =**	**20,70 kN**
	Q_2 =	

4. Obremenitev

Kombinacije

Notranje sile

$N_{sd,1} = 1,35G+1,5Q_1+1,5*0,6*Q_2$ = **46,98 kN** ...merodajna — **NEd = 46,98 kN**

$N_{sd,2} = 1,35*(G+Q_1+Q_2)$ = 43,88 kN

Pravokotni prerez

			Karakteristike		
debelina (v steni debelina stene)	**b =**	**14,0 cm**	prerez	**A =**	196,0 cm²
širina	**h =**	**14,0 cm**	strižni prerez	**A_s = A *2/3 =**	130,7 cm²
odpornostni mom.	**W_y =**	457 cm³	odpornostni mom.	**W_z =**	457 cm³
vztrajnostni mom.	**I_y =**	3201 cm⁴	vztrajnostni mom.	**I_z =**	3201 cm⁴
	i_y =	4 cm		**i_z =**	4 cm

5. Kontrole

MSN

	$\lambda_{rel,y}$ =	1,175	β_c =	0,20	Masivni les
	$\lambda_y = l_{u,y}/i_y$ =	69,282	k_y =	1,278	
			$k_{c,y}$ =	0,562	

Kontrola uklon y-y $\sigma_{c,0,d} = N_{Ed}/A$ = 0,240 kN/cm² < $k_{c,y} f_{c,0,d}$ = 0,726 kN/cm² OK

	$\lambda_{rel,z}$ =	1,175	β_c =	0,20	Masivni les
	$\lambda_z = l_{u,z}/i_z$ =	69,282	k_z =	1,278	
			$k_{c,z}$ =	0,562	

Kontrola uklon z-z $\sigma_{c,0,d} = N_{Ed}/A$ = 0,240 kN/cm² < $k_{c,y} f_{c,0,d}$ = 0,726 kN/cm² OK

Izkoriščenost je: 33,0%

Kontrola kontaktnih napetosti **(EC5-1-1+A1:2008)**

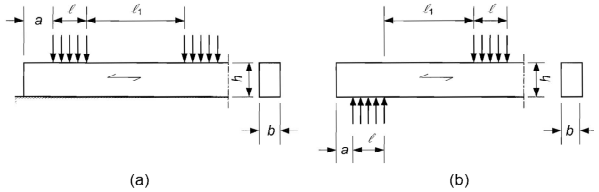
Tip podpiranja: Točkovne podpore

Kontrola potrebna

Obtežba ob robu prečnika: Da

(za $l_1 \geq 2h$) $k_{c,90}$ = 1,50

Aef = b(h+3cm) = 238,0 cm²



(b) - po EC5 $\sigma_{c,90,d} = N_{Ed}/A_{ef}$ = 0,197 kN/cm² < $k_{c,90} * f_{c,90,d}$ = 0,231 kN/cm² OK

Potrebna stična površina: b = 14 cm

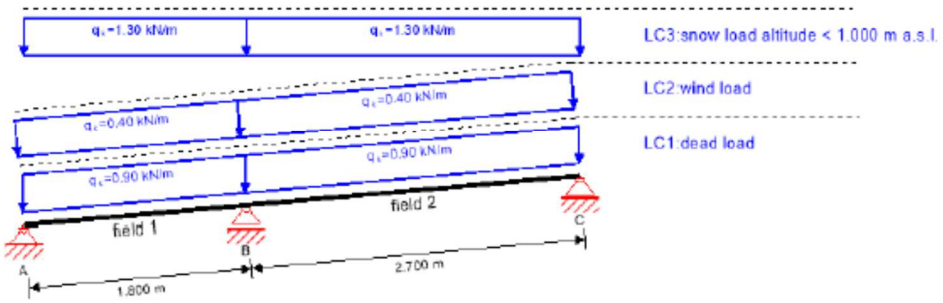
POZ 103 $l_{potr,b}$ = 8,54 cm

POZ 103 SOHA 14/14cm

D.1.d. P104 – Špirovci 12/14 cm, max. razmik 100 cm

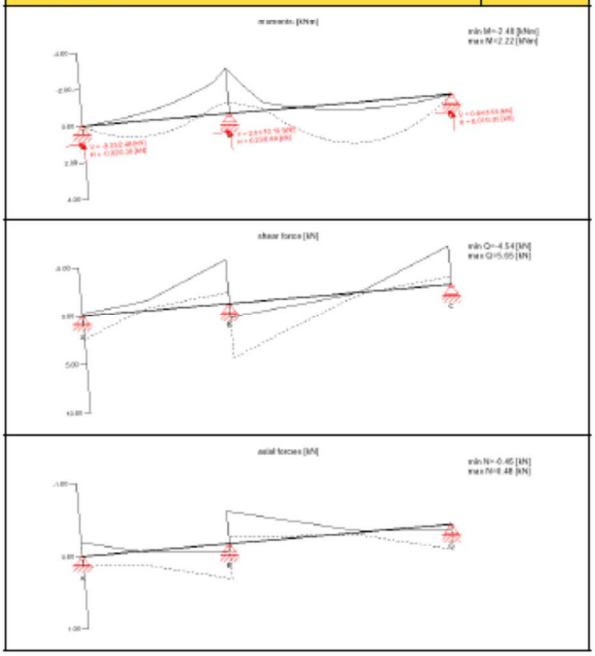
Ligno univ.dipl.inž.grad. Aleš Pančur	project element	DU Grosuplje P104	page date	1 22.04.2020

system



section: wooden beam 12/14; **material**: C24 spruce; **service class**: service class 1; **fire resistance class**: R 0

utilization 38 %



flexural stress analysis 38 %

$M_{y,d}$ =	-2.48	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.48	kN	$f_{t,k}$ =	14.00	N/mm²	
$\sigma_{t,d}$ =	0.03	N/mm²	$f_{t,d}$ =	10.13	N/mm²	
$\sigma_{m,y,d}$ =	6.34	N/mm² <	$f_{m,y,d}$ =	16.85	N/mm²	✓

shear stress analysis 29 %

V_d =	5.16	kN	$f_{v,k}$ =	2.30	N/mm²	
$\tau_{v,d}$ =	0.46	N/mm² <	$f_{v,d}$ =	1.59	N/mm²	✓

lateral torsional buckling analysis 38 %

$M_{y,d}$ =	-2.48	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²	
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	14.54	N/mm²	
$\sigma_{m,y,d}$ =	6.34	N/mm² <	$f_{m,y,d}$ =	16.85	N/mm²	✓

flexural stress analysis fire 5 %

$M_{y,d}$ =	-0.64	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.10	kN	$f_{t,k}$ =	14.00	N/mm²	
$\sigma_{t,d}$ =	0.01	N/mm²	$f_{t,d}$ =	18.30	N/mm²	
$\sigma_{m,y,d}$ =	1.62	N/mm² <	$f_{m,y,d}$ =	30.42	N/mm²	✓

shear stress analysis fire 4 %

V_d =	1.32	kN	$f_{v,k}$ =	2.30	N/mm²	
$\tau_{v,d}$ =	0.12	N/mm² <	$f_{v,d}$ =	2.88	N/mm²	✓

lateral torsional buckling analysis fire 5 %

$M_{y,d}$ =	-0.64	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²	
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	26.25	N/mm²	
$\sigma_{m,y,d}$ =	1.62	N/mm² <	$f_{m,y,d}$ =	30.42	N/mm²	✓

w_{inst} = w[char]

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/300	6.0	0.5	9 %
2	0.6	L/300	9.0	3.4	37 %

w_{fin} = w[char] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/150	12.0	0.5	4 %
2	0.6	L/150	18.0	4.0	22 %

$w_{net,fin}$ = w[q.p.] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/250	7.2	0.0	1 %
2	0.6	L/250	10.8	1.8	16 %

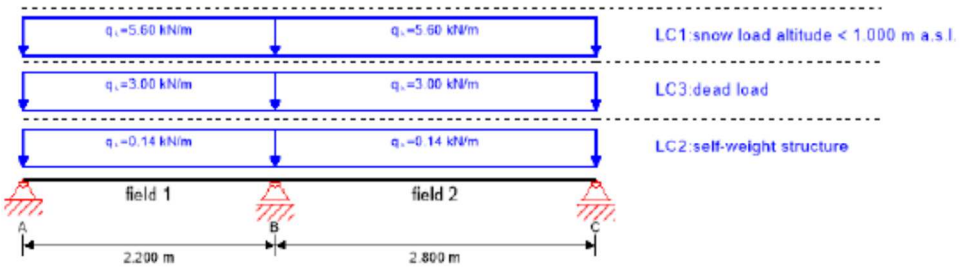
support reaction							
load case category	k_{mod}	A_V	A_H	B_V	B_H	C_V	C_H
		[kN]					
dead load	0.6	0.46	0.00	2.62	0.00	0.98	0.00

support reaction							
load case category	k_{mod}	A_V	A_H	B_V	B_H	C_V	C_H
		[kN]					
		0.46	0.00	2.62	0.00	0.98	0.00
wind load	0.9	0.32	0.16	1.17	0.00	0.46	0.00
		-0.13	0.00	0.00	0.00	-0.02	0.00
snow load altitude < 1.000 m a.s.l.	0.9	1.05	0.00	3.76	0.00	1.49	0.00
		-0.39	0.00	0.00	0.00	-0.08	0.00

D.1.e. P105 – Vmesna lega 14/20 cm

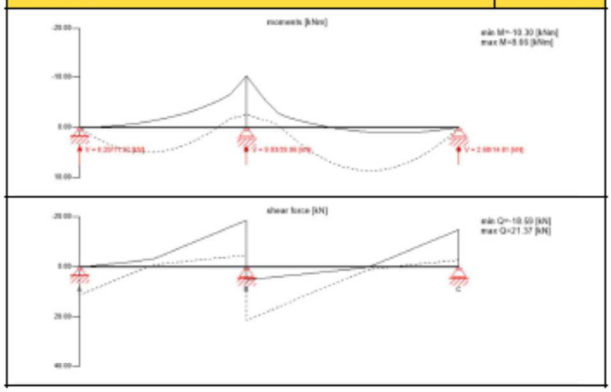
Ligno univ.dipl.inž.grad. Aleš Pančur	project element	DU Grosuplje P105	page date	1 22.04.2020

system



section: wooden beam 14/20; **material**: C24 spruce; **service class**: service class 1; **fire resistance class**: R 0

utilization 66 %



flexural stress analysis						**66 %**
$M_{y,d}$ =	-10.30	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.00	kN	$f_{t,k}$ =	14.00	N/mm²	
$\sigma_{t,d}$ =	0.00	N/mm²	$f_{t,d}$ =	9.83	N/mm²	
$\sigma_{m,y,d}$ =	11.04	N/mm² <	$f_{m,y,d}$ =	16.62	N/mm²	✓
shear stress analysis						**63 %**
V_d =	18.85	kN	$f_{v,k}$ =	2.30	N/mm²	
$\tau_{v,d}$ =	1.01	N/mm² <	$f_{v,d}$ =	1.59	N/mm²	✓
lateral torsional buckling analysis						**66 %**
$M_{y,d}$ =	-10.30	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²	
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	14.54	N/mm²	
$\sigma_{m,y,d}$ =	11.04	N/mm² <	$f_{m,y,d}$ =	16.62	N/mm²	✓
flexural stress analysis fire						**9 %**
$M_{y,d}$ =	-2.56	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.00	kN	$f_{t,k}$ =	14.00	N/mm²	
$\sigma_{t,d}$ =	0.00	N/mm²	$f_{t,d}$ =	17.74	N/mm²	
$\sigma_{m,y,d}$ =	2.74	N/mm² <	$f_{m,y,d}$ =	30.00	N/mm²	✓
shear stress analysis fire						**9 %**
V_d =	4.68	kN	$f_{v,k}$ =	2.30	N/mm²	
$\tau_{v,d}$ =	0.25	N/mm² <	$f_{v,d}$ =	2.88	N/mm²	✓
lateral torsional buckling analysis fire						**9 %**
$M_{y,d}$ =	-2.56	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²	
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	26.25	N/mm²	
$\sigma_{m,y,d}$ =	2.74	N/mm² <	$f_{m,y,d}$ =	30.00	N/mm²	✓

w_{inst} = w[char]

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/300	7.3	1.4	19 %
2	0.6	L/300	9.3	4.2	45 %

w_{fin} = w[char] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/150	14.7	1.6	11 %
2	0.6	L/150	18.7	4.9	26 %

$w_{net,fin}$ = w[q.p.] + w[q.p.]*kdef

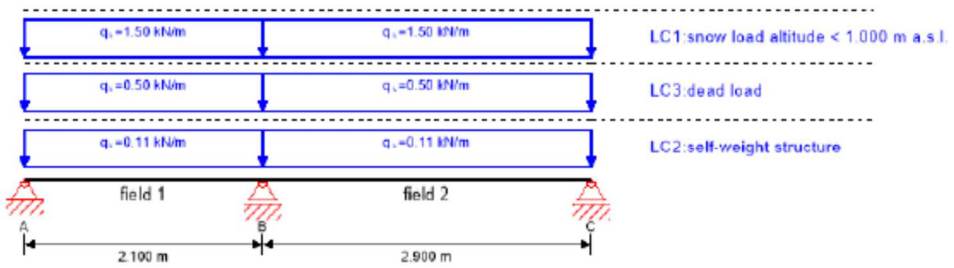
field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/250	8.8	0.3	4 %
2	0.6	L/250	11.2	2.0	18 %

support reaction				
load case category	k_{mod}	A_V	B_V	C_V
		[kN]		
snow load altitude < 1.000 m a.s.l.	0.9	5.48	17.70	6.74
		-1.40	0.00	-0.53
self-weight structure	0.6	0.10	0.44	0.16
		0.10	0.44	0.16
dead load	0.6	2.19	9.48	3.33
		2.19	9.48	3.33

D.1.f. P106 – Kapna lega 14/16 cm

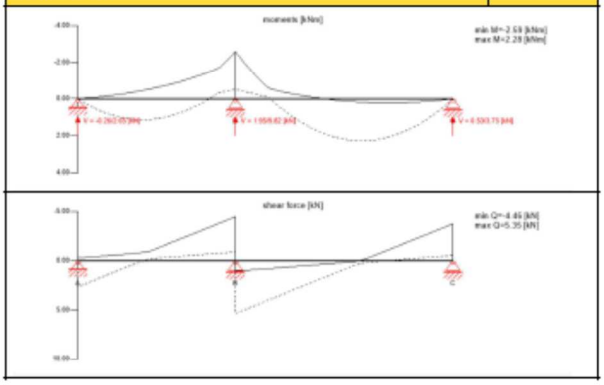
Ligno univ.dipl.inž.grad. Aleš Pančur	project element	DU Grosuplje P106	page date	1 22.04.2020

system



section: wooden beam 14/16; **material**: C24 spruce; **service class**: service class 1; **fire resistance class**: R 0

utilization 26 %



flexural stress analysis						**26 %**
$M_{y,d}$ =	-2.59	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.00	kN	$f_{t,k}$ =	14.00	N/mm²	
$\sigma_{t,d}$ =	0.00	N/mm²	$f_{t,d}$ =	9.83	N/mm²	
$\sigma_{m,y,d}$ =	4.33	N/mm²<	$f_{m,y,d}$ =	16.62	N/mm²	✓
shear stress analysis						**20 %**
V_d =	4.86	kN	$f_{v,k}$ =	2.30	N/mm²	
$\tau_{v,d}$ =	0.33	N/mm²<	$f_{v,d}$ =	1.59	N/mm²	✓
lateral torsional buckling analysis						**26 %**
$M_{y,d}$ =	-2.59	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²	
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	14.54	N/mm²	
$\sigma_{m,y,d}$ =	4.33	N/mm²<	$f_{m,y,d}$ =	16.62	N/mm²	✓
flexural stress analysis fire						**3 %**
$M_{y,d}$ =	-0.51	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.00	kN	$f_{t,k}$ =	14.00	N/mm²	
$\sigma_{t,d}$ =	0.00	N/mm²	$f_{t,d}$ =	17.74	N/mm²	
$\sigma_{m,y,d}$ =	0.86	N/mm²<	$f_{m,y,d}$ =	30.00	N/mm²	✓
shear stress analysis fire						**2 %**
V_d =	0.97	kN	$f_{v,k}$ =	2.30	N/mm²	
$\tau_{v,d}$ =	0.06	N/mm²<	$f_{v,d}$ =	2.88	N/mm²	✓
lateral torsional buckling analysis fire						**3 %**
$M_{y,d}$ =	-0.51	kNm	$f_{m,k}$ =	24.00	N/mm²	
$N_{c,d}$ =	0.00	kN	$f_{c,k}$ =	21.00	N/mm²	
$\sigma_{c,d}$ =	0.00	N/mm²	$f_{c,d}$ =	26.25	N/mm²	
$\sigma_{m,y,d}$ =	0.86	N/mm²<	$f_{m,y,d}$ =	30.00	N/mm²	✓

w_{inst} = w[char]

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/300	7.0	0.6	8 %
2	0.6	L/300	9.7	2.3	24 %

w_{fin} = w[char] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/150	14.0	0.6	4 %
2	0.6	L/150	19.3	2.6	14 %

$w_{net,fin}$ = w[q.p.] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.6	L/250	8.4	0.1	1 %
2	0.6	L/250	11.6	0.9	8 %

support reaction				
load case category	k_{mod}	A_V	B_V	C_V
		[kN]		
snow load altitude < 1.000 m a.s.l.	0.9	1.41	4.79	1.86
		-0.44	0.00	-0.12
self-weight structure	0.6	0.07	0.36	0.13
		0.07	0.36	0.13
dead load	0.6	0.32	1.60	0.58
		0.32	1.60	0.58

D.1.a.P107 – Soha 14/14 cm

POZ 107 SOHA

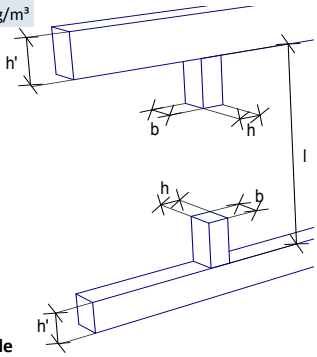
1. Material

Kvaliteta	C24	$\gamma_{m,connection}$	1,30	
Trajanje obtežbe	M	k_{mod} =	0,80	Srednjetrajna
Material	Masivni les	γ_m =	1,30	
Razred uporabnosti	1.	k_{def} =	0,60	

Notranji bivalni prostori razen kuhinj in kopalnic, pisarniški in trgovski prostori

Trdnost	**Karakteristična**		**Projektna** $f_d = k_{mod,q} * f_k / \gamma_M$	
Upogib	$f_{m,k}$	2,400 kN/cm²	$f_{m,d}$	1,477 kN/cm²
Nateg, paralelno	$f_{t,0,k}$	1,400 kN/cm²	$f_{t,0,d}$	0,862 kN/cm²
Nateg, pravokotno	$f_{t,90,k}$	0,050 kN/cm²	$f_{t,90,d}$	0,031 kN/cm²
Tlak, paralelno	$f_{c,0,k}$	2,100 kN/cm²	$f_{c,0,d}$	1,292 kN/cm²
Tlak, pravokotno	$f_{c,90,k}$	0,250 kN/cm²	$f_{c,90,d}$	0,154 kN/cm²
Strig	$f_{v,k}$	0,250 kN/cm²	$f_{v,d}$	0,154 kN/cm²

Def. moduli		**Gostota**	
El. Modul, paralelno	$E_{0,mean}$ 1100 kN/cm²	karakteristična, ρ_k	350 kg/m³
El. Modul, paralelno	$E_{0,05}$ 740 kN/cm²	povprečna, ρ_{mean}	420 kg/m³
El. Modul, pravokotno	$E_{90,mean}$ 37 kN/cm²		
Strižni modul	G_{mean} 69 kN/cm²		



2. Geometrija

Višina **L = 280,0 cm**

3. Obtežba

Način vnosa	Nefaktoriran	
Stalna obtežba	**G =**	**17,70 kN**
Spremenljiva obtežba	**Q_1 =**	**9,90 kN**
	Q_2 =	

4. Obremenitev

Kombinacije **Notranje sile**

$N_{sd,1} = 1,35G+1,5Q_1+1,5*0,6*Q_2$ = **38,75 kN** ...merodajna **NEd = 38,75 kN**

$N_{sd,2} = 1,35*(G+Q_1+Q_2)$ = 37,26 kN

Pravokotni prerez			**Karakteristike**		
debelina (v steni debelina stene)	**b =**	**14,0 cm**	prerez	**A =**	196,0 cm²
širina	**h =**	**14,0 cm**	strižni prerez	**$A_s = A*2/3$ =**	130,7 cm²
odpornostni mom.	**W_y =**	457 cm³	odpornostni mom.	**W_z =**	457 cm³
vztrajnostni mom.	**I_y =**	3201 cm⁴	vztrajnostni mom.	**I_z =**	3201 cm⁴
	i_y =	4 cm		**i_z =**	4 cm

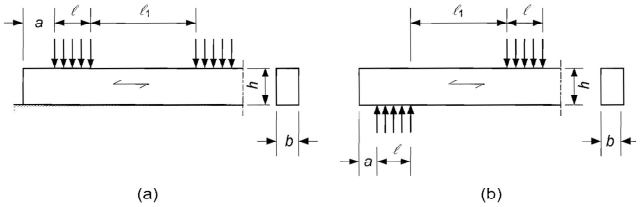
5. Kontrole

MSN

	$\lambda_{rel,y}$ =	1,175	β_c =	0,20	Masivni les
	$\lambda_y = l_{u,y}/i_y$ =	69,282	**k_y** =	1,278	
			$k_{c,y}$ =	0,562	
Kontrola uklon y-y	$\sigma_{c,0,d} = N_{Ed}/A$ =	0,198 kN/cm²	< $k_{c,y} f_{c,0,d}$ =	0,726 kN/cm²	OK
	$\lambda_{rel,z}$ =	1,175	β_c =	0,20	Masivni les
	$\lambda_z = l_{u,z}/i_z$ =	69,282	**k_z** =	1,278	
			$k_{c,z}$ =	0,562	
Kontrola uklon z-z	$\sigma_{c,0,d} = N_{Ed}/A$ =	0,198 kN/cm²	< $k_{c,y} f_{c,0,d}$ =	0,726 kN/cm²	OK

Izkoriščenost je: 27,2%

Kontrola kontaktnih napetosti **(EC5-1-1+A1:2008)**



Tip podpiranja: Točkovne podpore

Kontrola potrebna

Obtežba ob robu prečnika: Da

(za $l_1 \geq 2h$) $k_{c,90}$ = 1,50

Aef = b(h+3cm) = 238,0 cm²

(b) - po EC5	$\sigma_{c,90,d} = N_{Ed}/A_{ef}$ =	0,163 kN/cm²	< $k_{c,90} * f_{c,90,d}$ =	0,231 kN/cm²	OK

Potrebna stična površina: b = 14 cm

POZ 107 $l_{potr,b}$ = 5,99 cm

POZ 107 SOHA 14/14cm

D.1.b. P108 – Nosilci balkona 8/14 cm, e = 62,5 cm

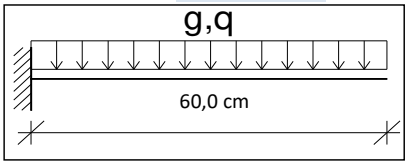
POZ 108 Nosilec balkona - konzola

1. Material

Kvaliteta	C24	$\gamma_{m,connection}$	1,30	
Trajanje obtežbe	M	k_{mod} =	0,80	Srednjetrajna
Material	Masivni les	γ_m =	1,30	
Razred uporabnosti	1.	k_{def} =	0,60	

Notranji bivalni prostori razen kuhinj in kopalnic, pisarniški in trgovski prostori

Trdnost	**Karakteristična**		**Projektna**	$f_d = k_{mod,q} * f_k / \gamma_M$
Upogib	$f_{m,k}$	2,400 kN/cm²	$f_{m,d}$	1,477 kN/cm²
Nateg, paralelno	$f_{t,0,k}$	1,400 kN/cm²	$f_{t,0,d}$	0,862 kN/cm²
Nateg, pravokotno	$f_{t,90,k}$	0,050 kN/cm²	$f_{t,90,d}$	0,031 kN/cm²
Tlak, paralelno	$f_{c,0,k}$	2,100 kN/cm²	$f_{c,0,d}$	1,292 kN/cm²
Tlak, pravokotno	$f_{c,90,k}$	0,250 kN/cm²	$f_{c,90,d}$	0,154 kN/cm²
Strig	$f_{v,k}$	0,250 kN/cm²	$f_{v,d}$	0,154 kN/cm²
Def. moduli			**Gostota**	
El. Modul, paralelno	$E_{0,mean}$	1100 kN/cm²	karakteristična, ρ_k	350 kg/m³
El. Modul, paralelno	$E_{0,05}$	740 kN/cm²	povprečna, ρ_{mean}	420 kg/m³
El. Modul, pravokotno	$E_{90,mean}$	37 kN/cm²		
Strižni modul	G_{mean}	69 kN/cm²		



2. Geometrija

Dolžina konzole **L =** **60,0 cm**

3. Obtežba

				Nefaktorirano (za gerber)	
Stalna obtežba	**g =**	**2,00 kN/m**		**Med,g**	**0,37 kNm**
Lastna teža nosilca	**upoštevana v stalni obtežbi:**	Ne		**Med,q**	**0,45 kNm**
	g_L =	**0,046 kN/m**		**Med**	**0,82 kNm**
Obtežba snega	**s =**	**2,50 kN/m**		**Ved,g**	**1,23 kNm**
Obtežba vetra	**w =**	**0,00 kN/m**		**Ved,q**	**1,50 kNm**
				Ved	**2,73 kNm**

4. Obremenitev

Kombinacije

			Notranje sile in momenti	
$q_{Ed,1}$ = 1,35*g+1,5*s+1,5*0,6*w =	**6,51 kN/m**	**...merodajna**	**MEd = $q_{Ed}*L^2/2$ =**	**1,17 kNm**
$q_{Ed,2}$ = 1,35*(g+s+w) =	6,14 kN/m		**VEd = $q_{Ed}*L$ =**	**3,91 kN**

Pravokotni prerez

			Karakteristike		
			prerez	**A =**	112,0 cm²
širina	**b =**	**8,0 cm**	odpornostni mom.	**W =**	261 cm³
višina	**h =**	**14,0 cm**	vztrajnostni mom.	**I =**	1829 cm⁴
			strižni prerez	**A_s = A *2/3 =**	74,7 cm²

5. Kontrole

MSN

Kontrola upogibnih momentov	M_{Ed} =	1,17 kNm	< $M_{Rd} = W_y * f_{m,d}$ =	3,86 kNm	OK
Kontrola strižnih sil	V_{Ed} =	3,91 kN	< $V_{Rd} = A_s * f_{v,d}$ =	11,49 kN	OK

MSU

Kontrola povesa

Začetni pomiki	$u_{inst,g}$ =	0,02 cm	$w = gL^4/8E_{0,mean}I_y$		
	$u_{inst,q}$ =	0,02 cm	$w = qL^4/8E_{0,mean}I_y$		
Kontrola začetnih pomikov	$u_{inst} = u_{inst,g} + u_{inst,q}$ =	**0,04 cm**	< $u_{dop} = L'/150$ =	**0,40 cm**	OK
Končni pomiki	ψ_2 =	0	(sneg in veter)		
	$u_{fin,g} = u_{inst,g}*(1+k_{def})$ =	0,03 cm			
	$u_{fin,q} = u_{inst,q}*(1+\psi_2*k_{def})$ =	0,02 cm			
Kontrola končnih pomikov	$u_{fin} = u_{fin,g} + u_{fin,q}$ =	**0,05 cm**	< $u_{dop} = L'/125$ =	**0,48 cm**	OK
Kontrola bočne zvrnitve	$\sigma_{m,crit} = E_{0,05}*0,78*b^2/hl_{ef}$ =	87,954 kN/cm²	$\lambda_{rel,m} = \sqrt{(f_{m,k}/\sigma_{m,crit})}$ =	0,165	
			k_{crit} =	1,00	
	$\sigma_{md} = M_{Ed}/W$ =	0,449 kN/cm²	< $k_{crit}\ f_{m,d}$ =	1,477 kN/cm²	OK

POZ 108 Nosilec balkona - konzola 8/14cm	**Izkoriščenost je:**	**34,0%**

D.1.a.P109 – Prečni nosilec balkona HEB 160

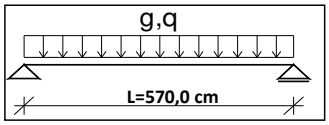
POZ 109 NOSILEC BALKONA

1. Material

Material	S235				
E =	21000 kN/cm²	f_y =	23,5 kN/cm²	f_u =	36,0 kN/cm²
Tip profila	HEB				
Oznaka:	HEB160	A =	54,3 cm²	i_y =	6,78 cm
h =	16,0 cm	A_s =	17,6 cm²	i_z =	4,05 cm
b =	16,0 cm	I_y =	2492 cm⁴	Iz =	889 cm⁴
m =	42,60 kg/m	W_y =	311 cm³	Wz =	111 cm³
Razred kompaktnosti	3	I_w =	47940 cm⁶	I_t =	31,24 cm⁴
Varnostni faktor γ_M=	1,0				

2. Geometrija

Razdalja med podporami **L =** **5,70 m**



3. Obremenitve

Lastna teža	upoštevana v stalni obtežbi:	Ne			
	Lastna teža - g_L	0,418 kN/m			
Obtežba po celem nosilcu	**Linijska obtežba**	**Kategorija**	**kN/m**	**Začetek (m)**	**Konec (m)**
Da	g	Stalna obtežba	2,60		
Da	q_1 (Ψ_o=0,7)	Koristna A	3,30		
Da	q_2 (Ψ_o=0,7)	Koristna A			
Točkovna obtežba	**Tip obtežbe**	**Kategorija**	**kN**	**Pozicija (m)**	
1	Stalna_obtežba				
2	Stalna_obtežba				
3	Stalna_obtežba				
4	Spremenljiva_obtežba	Veter			

Kombinacije	**MSN1**	**MSN2**	**MSN3**	**MSU**	
Obtežbe	$1,35*g+1,5*q_1+1,5*\Psi_0*q_2$	$1,35*g+1,5*q_2+1,5*\Psi_0*q_1$	$q_{Ed,2} = 1,35*(g+s+w)$	$q_{Ed,1} = g+s+w$	Ψ_2
g_L	0,56 kN/m	0,56 kN/m	0,56 kN/m	0,42 kN/m	0,00
g	3,51 kN/m	3,51 kN/m	3,51 kN/m	2,60 kN/m	0,00
q_1	4,95 kN/m	3,47 kN/m	4,46 kN/m	3,30 kN/m	0,30
q_2	0,00 kN/m	0,00 kN/m	0,00 kN/m	0,00 kN/m	0,30
1	0,00 kN	0,00 kN	0,00 kN	0,00 kN	0,00
2	0,00 kN	0,00 kN	0,00 kN	0,00 kN	0,00
3	0,00 kN	0,00 kN	0,00 kN	0,00 kN	0,00
4	0,00 kN	0,00 kN	0,00 kN	0,00 kN	0,00

Rezultati (ovojnice):					Merodajno
Maximalni moment M_{Ed} =	36,65 kNm	**Pozicija od leve podpore =**	2,85 m		**MSN1**
Maximalna prečna sila V_{Ed} =	25,72 kN	**Pozicija od leve podpore =**	5,70 m		**MSN1**
Maximalni pomik u_{max} =	16,51 mm	**Pozicija od leve podpore =**	2,85 m	Poves	**MSU**
Reakcije (faktorirano, združeno):					
R_L =	-25,72 kN	**R_D =**	25,72 kN		
Reakcije (nefaktorirano):					
$R_{L,g}$ =	-8,60 kN	**$R_{D,g}$ =**	-8,60 kN		
$R_{L,q}$ =	-9,41 kN	**$R_{D,q}$ =**	-9,41 kN		

Diagram upogibnih momentov (M) - ovojnica MSN

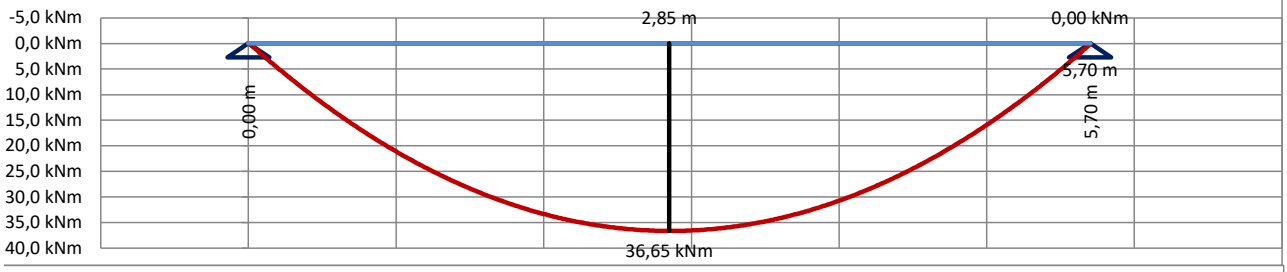


Diagram prečnih sil (V) - ovojnica MSN

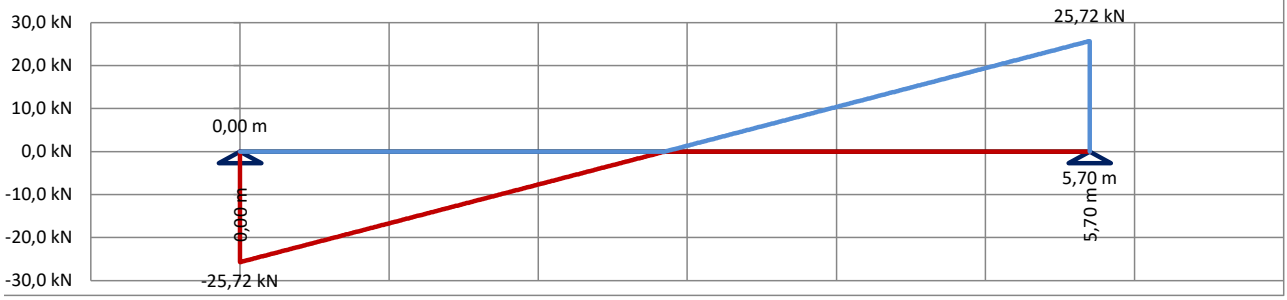
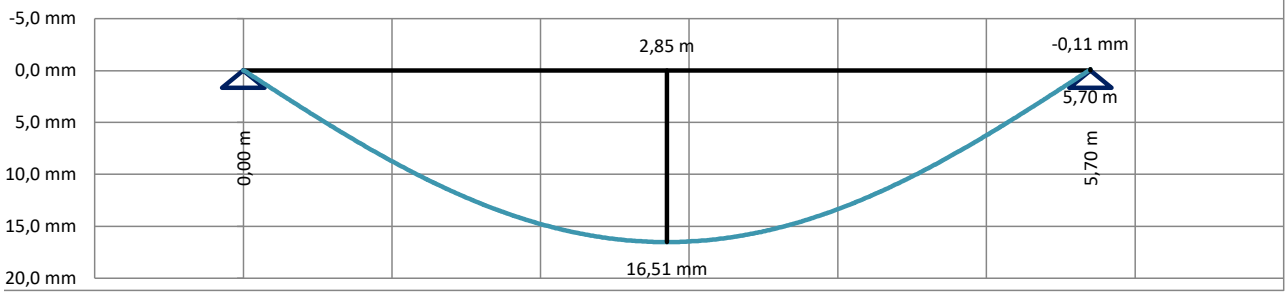


Diagram pomikov (u)



5. Kontrole

KONTROLE

Kontrola upogibnih momentov	**MEd = 36,65 kNm**	< $M_{Rd}=W_y*f_y/\gamma_M$ =	**73,2 kNm**	OK
Kontrola strižnih napetosti	**VEd = 25,72 kN**	< $V_{Rd}=A_s*f_y/\gamma_M\sqrt{3}$ =	**238,7 kN**	OK
Kontrola povesa	**1,65 cm**	"< udop = L'/300 ="	**1,90 cm**	OK
POZ 109 NOSILEC BALKONA HEB160		**Izkoriščenost je:**	**86,9%**	Merodajno: Pomik

E. PRILOGE

E.1. Pozicije mansarde
E.2. Pozicije strešja
E.3. Pozicije v prerezu