

1. NASLOVNA STRAN S KLJUČNIMI PODATKI O NAČRTU

ŠTEVILČNA OZNAKA NAČRTA IN VRSTA NAČRTA
3 - NAČRT GRADBENIH KONSTRUKCIJ, LESENA KONSTRUKCIJA
ŠT. BK-005/2018

INVESTITOR
OBČINA BLED
Cesta svobode 13
4260 Bled

NAROČNIK
GUŽIČ TRPLAN ARHITEKTI d.o.o.
Ciril-Metodov trg 15
1000 Ljubljana

OBJEKT
MEDGENERACIJSKI CENTER VEZENINE BLED

VRSTA PROJEKTNE DOKUMENTACIJE
PROJEKT ZA PRIDOBITEV GRADBENEGA DOVOLJENJA - PGD

ZA GRADNJO
NOVOGRADNJA

PROJEKTANT
CBD d.o.o.; Lopata 19g, 3000 CELJE
Odg. oseba: dr. Bruno DUJIČ

ODGOVORNI PROJEKTANT
Dr. Bruno DUJIČ, univ.dipl.inž.grad., IZS G-2454

ŠTEVILKA NAČRTA, KRAJ IN DATUM IZDELAVE NAČRTA
BK-005/2018, Celje, junij 2018

ODGOVORNI VODJA PROJEKTA
Gregor TRPLAN, univ. dipl. inž. arh., ZAPS 0895-A

2. KAZALO VSEBINE NAČRTA GRADBENIH KONSTRUKCIJ št. BK-005/2018 – PGD

1	Naslovna stran
2	Kazalo vsebine načrta
3	Izjava odgovornega projektanta načrta
4	Tehnično poročilo
5	Statično poročilo in risbe 01 – NGK: Tloris temeljev 02 – NGK: Tloris pritličja 03 – NGK: Tloris 1. nadstropja 04 – NGK: Tloris 2. nadstropja 05 – NGK: Tloris 3. nadstropja 06 – NGK: Prerez B-B

3. IZJAVA ODGOVORNEGA PROJEKTANTA NAČRTA V PROJEKTU ZA PRIDOBITEV GRADBENEGA DOVOLJENJA

Odgovorni projektant načrta gradbenih konstrukcij št. BK-005/2018 - PGD

dr. Bruno Dujič, univ.dipl.inž.grad.

IZJAVLJAM

1. da je 3 Načrt gradbenih konstrukcij skladen s prostorskim aktom,
2. da je načrt skladen z gradbenimi predpisi,
3. da je načrt skladen s projektnimi pogoji oziroma soglasji za priključitev,
4. da so bile pri izdelavi načrta upoštevane vse ustrezne bistvene zahteve in da je načrt izdelan tako, da bo gradnja, izvedena v skladu z njim, zanesljiva,
5. da so v načrtu upoštevane zahteve elaboratov.

Št. načrta
BK-005/2018

Ime in priimek
dr. Bruno Dujič, univ.dipl.inž.grad.
IZS-G-2454

Kraj in datum izdelave
Celje, junij 2018

Osebni žig, podpis

3.4 TEHNIČNO POROČILO

Izračun je izveden na podlagi pravil Evrokodov.

Poročilo obravnava novogradnjo Medgeneracijskega centra Vezenine Bled. Objekt je štiri etažen (P + 1N + 2 N + 3N) in je tlorisnih dimenzij 23,80 x 33,20 m. Višina objekta nad koto terena je 16,55 m.

- **Strešna konstrukcija**

Strešna konstrukcija ravne strehe nad strojnico (POZ 400) in nad drugim nadstropjem (POZ 300) se izvede iz pet-slojnih lesenih križno lepljenih Xlam (CLT) plošč debeline 160 mm (CLT L5s 160 mm). Plošče nalegajo na zunanje in notranje Xlam stene ter vmesne nosilce. Plošča POZ 300 je v osi B in C podprta z vzdolžnimi lesenimi gredami (POZ 301 in POZ 302), ki so sestavljene iz dveh nosilcev dimenzij 20/88 cm; GL32h in so podprti z lesenimi stebri v oseh 3 in 4.

- **Medetažna konstrukcija**

Medetažna konstrukcija (POZ 200 in POZ 100) se izvede iz sedem-slojnih lesenih križno lepljenih Xlam (CLT) plošč debeline 220 mm (CLT L7s-2 220 mm). Plošče se nosijo preko zunanjih in notranjih CLT sten, robnih atičnih nosilcev in jeklenih nosilcev. Previsni deli objekta se nosijo preko konzolnih CLT sten.

- **Stene objekta**

Zunanje in notranje stene objekta se izvedejo iz lesenih križno lepljenih Xlam (CLT) elementov. Debelina sten v 3. nadstropju je 100 mm, v 2. in 1. nadstropju 100 mm in 120 mm in v pritličju 100 mm, 120 mm in 140 mm. Na previsnih delih objekta so zunanji sloji sten usmerjeni horizontalno in izvedeni sestavljeni po višini s spodnjim delom do višine proizvodnega formata 295 cm, ki deluje kot stenski nosilec.

Stene objekta se sidrajo s strižnimi in dvižnimi kotniki v AB temeljno ploščo. V pritličju in 1. nadstropju se uporabi strižne kotnike ABR 255, v 2. in 3. nadstropju pa strižne kotnike ABR 105. Pod stenami pritličja mora biti izvedena hidroizolacija za preprečitev kapilarnega dviga vode v leseno konstrukcijo.

- **Stopnišče**

Stopnišče se izvede iz lesenih križno lepljenih Xlam (CLT) elementov. Nastopne ploskve so debeline 140 mm in so vpete v CLT stene na levi strani ter v CLT ograjo na desni strani. Ograja se izvede iz pet-slojne CLT plošče debeline 140 mm in služi kot nosilec stopniščne rame, ki je podprt na enem robu z AB temeljno oz. CLT medetažno ploščo, na drugem robu pa z jeklenim nosilcem HEB 180, S 235, ki je vpet v obodne CLT stene stopnišča.

- **AB temeljna plošča**

Objekt je temeljen na temeljni plošči debeline 40 cm, ki je izven oboda lesen konstrukcije podaljšana za 36 cm. Temeljna plošča je izvedena iz betona trdnostnega razreda C 25/30 in armature trdnostnega razreda S 500. Izračun temeljenja je izveden na podlagi elaborata geotehničnih raziskav št. 1-8/2017, ki ga je izdelal GRACEN d.o.o., Krivec 92, 1000 Ljubljana maja 2018, in določa modul reakcije tal $K = 15.000 - 20.000 \text{ kN/m}^3$. V primeru odstopanj je potrebno uskladiti načrt temeljev. V primeru kakršnihkoli nejasnosti je potrebno kontaktirati projektanta.

3.5 STATIČNO POROČILO

OBTEŽBA

○ **Lastna in stalna obtežba ravne nepohodne strehe:**

○ Nasutje prodec 4 cm:	$g_{st.} = 0,80 \text{ kN/m}^2$
○ hidroizolacija:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ toplotna izolacija 16 cm:	$g_{st.} = 0,05 \text{ kN/m}^2$
○ bitumenska folija:	$g_{st.} = 0,05 \text{ kN/m}^2$
○ Xlam plošča 16 cm:	$g_{st.} = 0,80 \text{ kN/m}^2 \text{ (l.t.)}$
○ ZI – Drvolit akustik:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ Spuščen strop:	$g_{st.} = 0,25 \text{ kN/m}^2$

$$g = 1,35 \text{ kN/m}^2 + \text{l.t.} = 2,15 \text{ kN/m}^2$$

○ **Lastna in stalna obtežba ravne pohodne strehe:**

○ Lesene podnice:	$g_{st.} = 0,15 \text{ kN/m}^2$
○ hidroizolacija:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ toplotna izolacija 10 cm:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ bitumenska folija:	$g_{st.} = 0,05 \text{ kN/m}^2$
○ Xlam plošča 22 cm:	$g_{st.} = 1,10 \text{ kN/m}^2 \text{ (l.t.)}$
○ ZI – Drvolit akustik:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ Spuščen strop:	$g_{st.} = 0,25 \text{ kN/m}^2$

$$g = 0,75 \text{ kN/m}^2 + \text{l.t.} = 1,82 \text{ kN/m}^2$$

○ **Lastna in stalna obtežba ravne zelene strehe:**

○ Ozelenitev 11 cm:	$g_{st.} = 2,00 \text{ kN/m}^2$
○ hidroizolacija:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ toplotna izolacija 24 cm:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ bitumenska folija:	$g_{st.} = 0,05 \text{ kN/m}^2$
○ Xlam plošča 22 cm:	$g_{st.} = 1,10 \text{ kN/m}^2 \text{ (l.t.)}$
○ ZI – Drvolit akustik:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ Spuščen strop:	$g_{st.} = 0,25 \text{ kN/m}^2$

$$g = 2,60 \text{ kN/m}^2 + \text{l.t.} = 3,70 \text{ kN/m}^2$$

○ **Lastna in stalna obtežba tal na terenu:**

○ finalni tlak:	$g_{st.} = 0,20 \text{ kN/m}^2$
○ estrih 6,5 cm:	$g_{st.} = 1,65 \text{ kN/m}^2$
○ zvočna in toplotna izolacija:	$g_{st.} = 0,15 \text{ kN/m}^2$
○ AB plošča 40 cm:	$g_{st.} = 10,00 \text{ kN/m}^2$

$$g = 2,00 \text{ kN/m}^2 + \text{l.t.} = 12,00 \text{ kN/m}^2$$

○ **Lastna in stalna obtežba zunanje stene:**

○ Lesena fasada:	$g_{st.} = 0,18 \text{ kN/m}^2$
○ podkonstrukcija:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ toplotna izolacija 24 cm:	$g_{st.} = 0,12 \text{ kN/m}^2$
○ križno lepljena lesena stena 14 cm:	$g_{st.} = 0,70 \text{ kN/m}^2 \text{ (l.t.)}$
<hr/>	
$g = 1,10 \text{ kN/m}^2$	

○ **Lastna in stalna obtežba notranje stene:**

○ križnolepljena lesena stena 10/12/14 cm:	$g_{st.} = 0,70 \text{ kN/m}^2$
○ inštalacijska ravnina s TI:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ mavčno-kartonske plošče:	$g_{st.} = 0,25 \text{ kN/m}^2$
<hr/>	
$g = 1,05 \text{ kN/m}^2$	

○ **Lastna in stalna obtežba lesene medetažne konstrukcije:**

○ finalni tlak:	$g_{st.} = 0,20 \text{ kN/m}^2$
○ estrih 7,5 cm:	$g_{st.} = 1,90 \text{ kN/m}^2$
○ zvočna in toplotna izolacija:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ nasutje 7 cm:	$g_{st.} = 1,25 \text{ kN/m}^2$
○ Xlam plošča 22 cm:	$g_{st.} = 1,10 \text{ kN/m}^2 \text{ (l.t.)}$
○ ZI – Drvolit akustik:	$g_{st.} = 0,10 \text{ kN/m}^2$
○ Spuščen strop:	$g_{st.} = 0,25 \text{ kN/m}^2$
<hr/>	

$$g = 3,80 \text{ kN/m}^2 + \text{l.t.} = 4,90 \text{ kN/m}^2$$

○ **Koristna obtežba:**

kategorija C1: $q_k = 3,0 \text{ kN/m}^2$

kategorija C2: $q_k = 4,0 \text{ kN/m}^2$

kategorija C4: $q_k = 5,0 \text{ kN/m}^2$

○ **Spremenljiva obtežba strehe - obtežba snega:**

Po EC1 za območje Bled: cona A2; 510 m n.v. $\rightarrow s_k = 2,87 \text{ kN/m}^2$

$$q_s = \mu_i C_e C_t s_k = 0,8 * 2,87 \text{ kN/m}^2 = 2,30 \text{ kN/m}^2$$

○ **Obtežba vetra:**

Po EC1 za območje Bled – cona 1:

$v_{ref,0} = 20 \text{ m/s}$; $C_e = 2,70$ (kategorija terena II.)

$$q_b = \frac{\rho * v_{ref}^2}{2} = \frac{1,25 * 20^2}{2} = 250,0 \text{ N/m}^2 = 0,25 \text{ kN/m}^2$$

$$q_p = q_b * C_e = 0,68 \text{ kN/m}^2$$

○ **Potresna obtežba:**

- pospešek temeljnih tal: $a_g = \gamma_I \times a_{gR} = 1,2 \times 0,175g = 0,210g$
- klasifikacija temeljnih tal: elaborat geotehničnih raziskav št. 1 – 8/2018, ki ga je izdelalo podjetje Gracen d.o.o., poda tip tal kategorije B

Preglednica 3.2: Vrednosti parametrov, ki opisujejo priporočen elastični spekter odziva tipa 1

Tip tal	S	T_B (s)	T_C (s)	T_D (s)
A	1,0	0,15	0,4	2,0
B	1,2	0,15	0,5	2,0
C	1,15	0,20	0,6	2,0
D	1,35	0,20	0,8	2,0
E	1,4	0,15	0,5	2,0

- faktor pomembnosti stavbe: $\gamma_I = 1,2$; faktor redukcije potresnih sil: $q = 2,0$

Preglednica 4.3: Kategorije pomembnosti za stavbe

Kategorija pomembnosti	Stavbe
I	Stavbe manjše pomembnosti za varnost ljudi, npr. kmetijski objekti in podobno
II	Običajne stavbe, ki ne sodijo v druge kategorije
III	Stavbe, katerih potresna odpornost je pomembna glede na posledice porušitve, npr. šole, dvorane za srečanja, kulturne ustanove in podobno
IV	Stavbe, katerih integriteta med potresi je življenjskega pomena za civilno zaščito, npr. bolnišnice, gasilske postaje, elektrarne in podobno

- višina stavbe 16,55 m; osnovna nihajna doba stavbe $T_0 = 0,05 \cdot H^{\frac{3}{4}} = 0,41$ s

Določitev potresnih sil objekta:

Določitev mase objekta:

POZ 400	$g \text{ [kN/m}^2\text{]}$	$A \text{ [m}^2\text{]}$	$G \text{ [kN]}$
Streha (brez teže snega):	2,15	114,0	245,1
Obtežba sten (3. N):	$g \text{ [kN/m']}$	$L \text{ [m']}$	$G \text{ [kN]}$
	2,90	55,1	160,0
POZ 300	$g \text{ [kN/m}^2\text{]}$	$A \text{ [m}^2\text{]}$	$G, Q \text{ [kN]}$
Ravna streha (brez teže snega):	2,15	443,0	952,5
Obtežba medetažne konstr.:	4,90	102,0	499,8
Koristna obtežba medetaže:	2,00	102,0	204,0
Obtežba sten (2. N):	$g \text{ [kN/m']}$	$L \text{ [m']}$	$G \text{ [kN]}$
	4,84	112,3	543,5
POZ 200	$g \text{ [kN/m}^2\text{]}$	$A \text{ [m}^2\text{]}$	$G, Q \text{ [kN]}$
Obtežba medetažne konstr.:	4,90	474,0	2322,6
Obtežba terase:	1,82	65,0	118,3
Koristna obtežba medetaže:	5,00	474,0	2370,0
Koristna obtežba terase:	2,50	65,0	162,5
Obtežba sten (1. N):	$g \text{ [kN/m']}$	$L \text{ [m']}$	$G \text{ [kN]}$
	4,57	162,7	742,7
POZ 100	$g \text{ [kN/m}^2\text{]}$	$A \text{ [m}^2\text{]}$	$G, Q \text{ [kN]}$
Obtežba medetažne konstr.:	4,90	477,0	2337,3
Obtežba zelene strehe:	3,70	47,0	173,9
Koristna obtežba medetaže:	3,00	477,0	1431,0
Obtežba sten (P/2):	$g \text{ [kN/m']}$	$L \text{ [m']}$	$G \text{ [kN]}$
	4,73	63,5	300,4

Etaža	G	Q	ψ_2	ρ	ψ_B	$G + \psi_B \cdot Q$
POZ 400	325,1					325,1
POZ 300	1804,0	204,0	0,6	1,0	0,6	1804,0
POZ 200	3084,0	2532,5	0,6	1,0	0,6	4603,5
POZ 100	3032,7	1431,0	0,6	1,0	0,6	3891,3

Skupna masa: $M_{tot} = 10624,0 \text{ kN}$

Določitev potresne sile:

$T_B < T_0 < T_C$

Tip tal	B
Kategorija pomembnosti objekta γ_I	1,20
Projektni pospešek $a_g \text{ [g]}$	0,210
Faktor redukcije potr. sil $[q]$	2,0
Vrednost v spektru pospeškov	$S_d = 0,315$

Potresna sila (Base shear) $F_b = 3346,6 \text{ kN}$

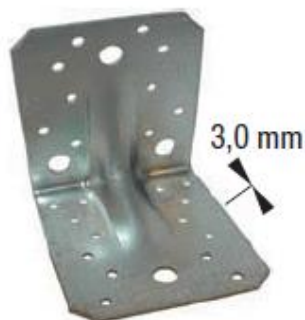
Razdelitev potresnih sil po etažah:

Etaža	$z_i \text{ [m]}$	$W_i \text{ [kN]}$	$F_i \text{ [kN]}$	$F_{tot,i} \text{ [kN]}$
POZ 400	16,17	325,1	201,4	201,4
POZ 300	13,40	1804,0	926,1	1127,6
POZ 200	8,82	4603,5	1555,6	2683,1
POZ 100	4,45	3891,3	663,4	3346,6

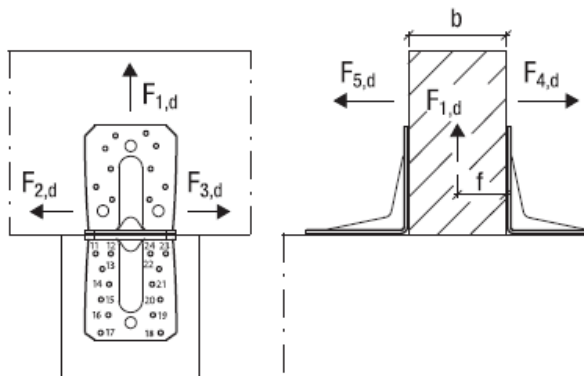
$\sum z_i \cdot W_i \text{ [kNm]} = 87350,42$

DOLOČITEV SISTEMA SIDRANJA LESENE KRIŽNO LEPLJENE KONSTRUKCIJE:

○ STRIŽNI KOTNIKI ABR 105:



ABR105



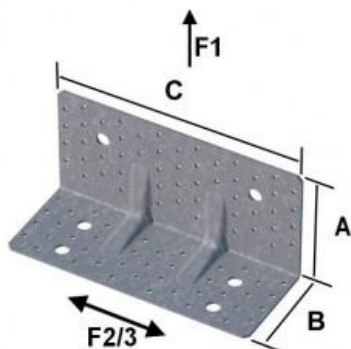
Art.No.	Verbindungsmittel	Charakteristische Werte der Tragfähigkeit [kN], 2 Winkel pro Anschluss					
		Teilausnagelung			Vollausnagelung		
		$R_{1,k}$	$R_{2/3,k}$	$R_{4/5,k}^{*)}$	$R_{1,k}$	$R_{2/3,k}$	$R_{4/5,k}^{*)}$
ABR9020	CSA5,0x40	-	-	-	13,4	12,6	$\frac{6,9}{k_{mod}^{0,5}}$
	CNA4,0x50	-	-	-	6,3	12,2	-
ABR9015	CSA5,0x40	-	-	-	11,6	10,5	$\frac{5,4}{k_{mod}^{0,5}}$
	CNA4,0x50	-	-	-	5,4	8,1	-
ABR90	CNA4,0x40	5,3	5,7	$\frac{7,4}{k_{mod}^{0,25}}$	7,9	9,2	$\frac{9,2}{k_{mod}^{0,75}}$
	CNA4,0x60	8,8	7,3	$\frac{10,5}{k_{mod}^{0,25}}$	13,3	11,8	$\frac{10,4}{k_{mod}^{0,75}}$
ABR105	CNA4,0x40	5,9	7,7	$\frac{8,9}{k_{mod}^{0,5}}$	10,7	14,5	$\frac{13,9}{k_{mod}^{0,3}}$
	CNA4,0x60	9,8	11,6	$\frac{12,8}{k_{mod}^{0,3}}$	17,8	20,2	$\frac{16,4}{k_{mod}^{0,75}}$
ABR70	CNA4,0x40	3,0	4,8	$\frac{2,3}{k_{mod}^{0,75}}$	5,3	5,0	$\frac{3,5}{k_{mod}^{0,4}}$
ABR100	CSA5,0x40	-	-	-	25,6; $\frac{25,1}{k_{mod}}$	20,3	4,2
	CNA4,0x50	-	-	-	15,4	14,2	
ABR98	CNA4,0x50	7	6,9	11,5	11,8	13,7	13,3
ABRL98	CNA4,0x50	9	8,8	12,9	15,7	17,5	13,7
ABR170	CNA4,0x40	-	-	-	7,4	16,4	$\frac{9,6}{k_{mod}^{0,2}}$
ABR220	CNA4,0x60	-	-	-	$\frac{11,4}{k_{mod}^{0,2}}$	21,1	$k_{mod}^{0,2}$
E20/3	CNA4,0x50	8,8	20,2	-	11,7	26,5	-
E9/2,5	CNA4,0x50	$\frac{3,46}{k_{mod}^{0,2}}$	8,9	-	$\frac{8,5}{k_{mod}^{0,1}}$	13,0	-

Uporabljeni so žebli CNA 4,0x60 mm, kotnik je polno žebljan
(vrednosti v tabeli veljajo za 2 kotnika)

• **Nosilnost kotnika ABR 105_potres:**

- Dvižna nosilnost kotnika: $R_{1,d} = 0,5 \cdot k_{\text{mod}} \frac{R_{1,k}}{\gamma_M} = 0,5 \cdot 1,1 \frac{11,7kN}{1,0} = 6,44kN$
- Strižna nosilnost kotnika $R_{2,3,d} = 0,5 \cdot k_{\text{mod}} \frac{R_{2,3,k}}{\gamma_M} = 0,5 \cdot 1,1 \frac{26,5kN}{1,0} = 14,58kN$

○ **STRIŽNI KOTNIKI ABR 255:**

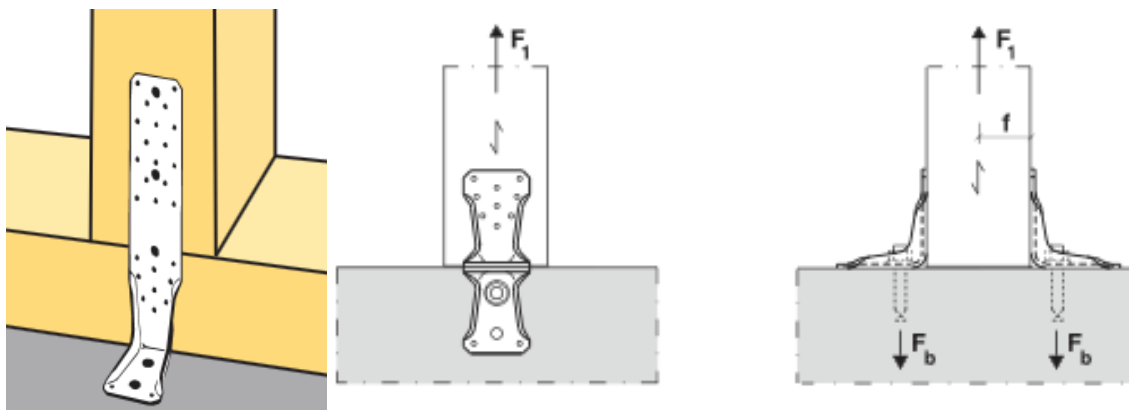


ABR255	Verbindungsmittel		Charakteristische Werte der Tragfähigkeit [kN]		
	Schenkel A	Schenkel B	1 Winkel pro Anschluss		
			$F_{1,k}$	$F_{2,k} / F_{3,k}$	Nagelbild
Holz - Holz	52 CNA4,0x50	41 CNA4,0x50	18,8	45,9	Vollausnagelung
Holz - Holz	30 CNA4,0x50	23 CNA4,0x50	15,9	38	Teilausnagelung
Holz - Beton	52 CNA4,0x50	2 Ø12mm	20	37,7	Vollausnagelung
Holz - Beton	30 CNA4,0x50	2 Ø12mm	20	28,3	Teilausnagelung

• **Nosilnost kotnika ABR255_potres:**

- Dvižna nosilnost kotnika: $R_{1,d} = k_{\text{mod}} \frac{R_{1,k}}{\gamma_M} = 1,1 \frac{20,0kN}{1,0} = 22,0kN$
- Strižna nosilnost kotnika: $R_{2,3,d} = k_{\text{mod}} \frac{R_{2,3,k}}{\gamma_M} = 1,1 \frac{37,7kN}{1,0} = 41,5kN$

○ **DVIŽNI KOTNIKI AKR 285:**



Art.No. NEU	Verbindungsmittel	Charakteristische Werte der Tragfähigkeit [kN]	
		2 Winkel je Anschluss $R_{1,k}$	1 Winkel je Anschluss $R_{1,k}$
AKR95G-B	CNA4,0x40	8,9	4,4
AKR95LG-B	CNA4,0x40	8,7	4,4
AKR135G	CNA4,0x40	17,8	8,9
AKR135LG	CNA4,0x40	17,3	8,7
AKR285G-B	CNA4,0x40	26,5	13,3
AKR285LG-B	CNA4,0x40	26,0	13,0

Uporabljeni so žebli CNA 4,0x60 mm, kotnik je polno žebljan

• **Nosilnost kotnika_potres:**

○ Dvižna nosilnost kotnika: $R_{1,d} = k_{\text{mod}} \frac{R_{1,k}}{\gamma_M} = 1,1 \frac{13,3 \text{ kN}}{1,0} = 14,63 \text{ kN}$

Potreben razmik sidrnih elementov sten v primeru potresne obtežbe:

Razmik in pozicije strižnih ter dvižnih kotnikov za stene posamezne etaže določimo iz potresne analize, kjer so podani izpisi za horizontalno strižno silo, moment in vertikalno osno silo, ki odpade na posamezno steno. Strižne obremenitve prevzamemo s strižnimi kotniki, momentne obremenitve pa s dvižnimi kotniki na robovih sten.

V pritličju in 1. nadstropju se uporabi strižne kotnike ABR 255, v 2. in 3. nadstropju pa strižne kotnike ABR 105.

Točni razmiki in pozicije strižnih in dvižnih kotnikov se določijo v fazi PZI.

MATERIALNE KARAKTERISTIKE ZA LESENO KONSTRUKCIJO:

Masivni les in križno lepljene plošče (CLT) C 24 ($\gamma_m = 1,30$):

Trdnosti [N/cm ²]:			upogib	nateg	nateg ⊥	tlak	tlak ⊥	strig	kotalni strig
Karakteristična trdnost [N/cm ²]			2400	1400	50	2100	250	250	125
Računska trdnost glede na trajanje obtežbe [kN/cm ²]	P	k_{mod} = 0,6	1108	646	23	969	115	115	58
	L	k_{mod} = 0,7	1292	754	27	1131	135	135	67
	M	k_{mod} = 0,8	1477	862	31	1292	154	154	77
	S	k_{mod} = 0,9	1662	969	35	1454	173	173	86

Togosti (modul) [kN/cm ²]:		
elast. m. paral.	E _{0,g,mean}	1100
elast. m. paral.	E _{0,05,g}	740
elast. m. prav.	E _{90,g,mean}	37
strižni modul	G _{g,mean}	69
modul kotalnega striga	G _{R,mean}	50

Lameliran lepljen les GL24h ($\gamma_m = 1,25$):

Trdnosti [N/cm ²]:			upogib	nateg	nateg ⊥	tlak	tlak ⊥	strig
Karakteristična trdnost [N/cm ²]			2400	1650	40	2400	270	270
Računska trdnost glede na trajanje obtežbe [kN/cm ²]	P (nad 10 let)	k_{mod} = 0,6	1152	792	19	1152	130	130
	L (od 6 mes. do 10 let)	k_{mod} = 0,7	1344	924	22	1344	151	151
	M (od 1 tedna do 6 mes.)	k_{mod} = 0,8	1536	1056	26	1536	173	173
	S (manj kot 1 teden)	k_{mod} = 0,9	1728	1188	29	1728	194	194

Togosti (modul) [kN/cm ²]:		
elast. m. paral.	E _{0,g,mean}	1160
elast. m. paral.	E _{0,05,g}	940
elast. m. prav.	E _{90,g,mean}	39
strižni modul	G _{g,mean}	72

Pri izračunu pomikov zaradi lezenja je upoštevan koeficient $k_{def} = 0,6$, ki po SIST EN 1995-1-1:2005 velja za masivni in lepljeni les razreda S1, katerega vlažnost dosega do 12%.

Pomiki lesenih konstrukcij so računani po MSU s spodaj navedenimi enačbami in omejeni z dopustnimi vrednostmi upogibov po SIST EN 1995-1-1:2005:

$$w_{inst} = w_{inst,G} + w_{inst,Q1} + \Psi_{0,i} \cdot w_{inst,Qi} \leq \left\{ \frac{1}{300} \text{ (prostoležeči nosilec); } \frac{1}{150} \text{ (konzola)} \right\}$$

$$w_{net,fin} = w_{inst} + w_{creep} =$$

$$= w_{inst,G} \cdot (1 + k_{def}) + w_{inst,Q1} \cdot (1 + \Psi_{2,1} \cdot k_{def}) + w_{inst,Qi} \cdot (\Psi_{0,i} + \Psi_{2,i} \cdot k_{def}) \leq$$

$$\leq \left\{ \frac{1}{250} \text{ (prostoležeči nosilec); } \frac{1}{125} \text{ (konzola)} \right\}$$

STATIČNI PRERAČUN NOSILNIH ELEMENTOV

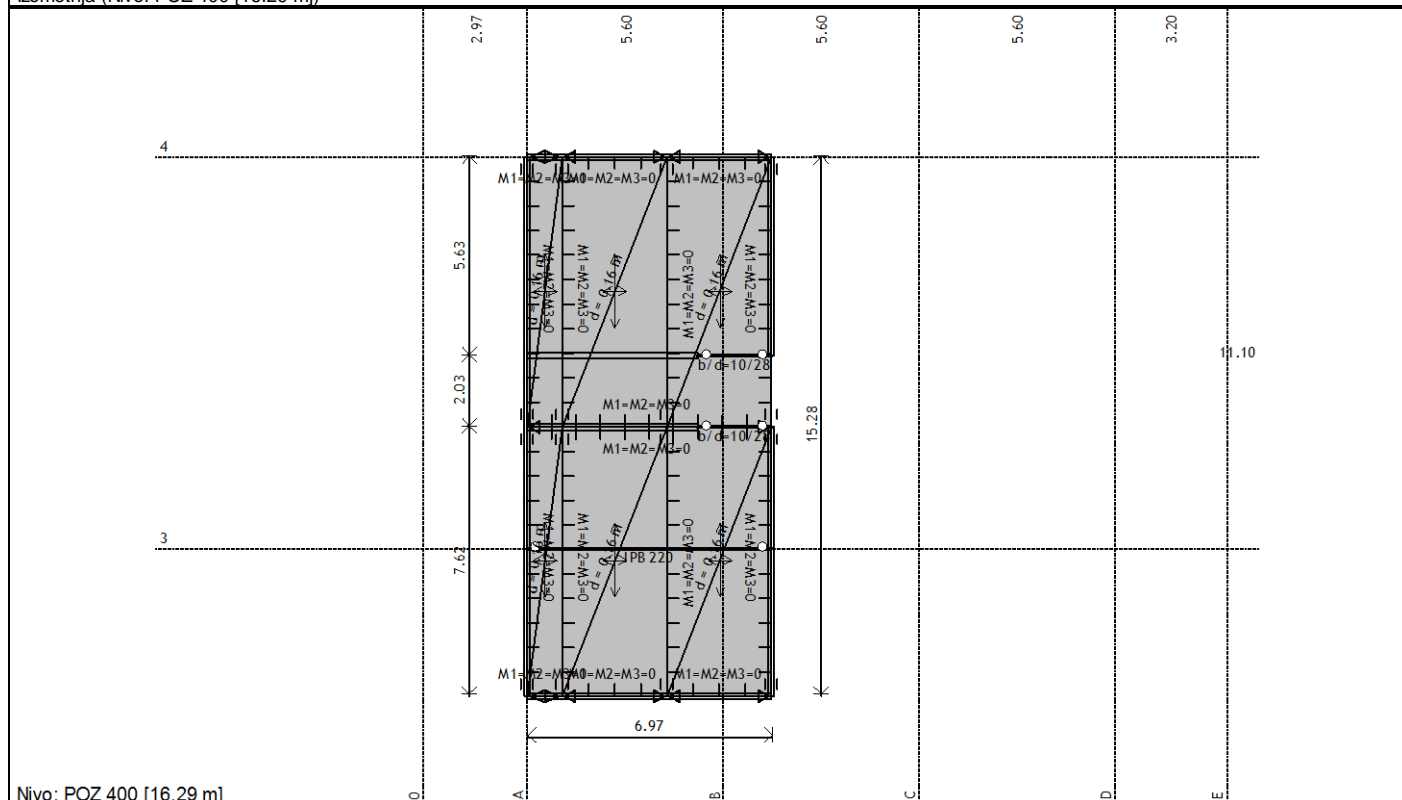
POZ 400

POZ 400: strešna plošča nad strojnico

Strešno ploščo izvedemo iz križno lepljenih masivnih lesenih plošč debeline 160 mm, ki nalegajo na lesene stene in vmesni jekleni nosilec.

- POZ 400: plošča CLT L5s 160 mm
- POZ 401: jekleni nosilec HEB 220; S 235
- POZ 402: leseni prekladi 10/28 cm; C 24

Izometrija (Nivo: POZ 400 [16.29 m])



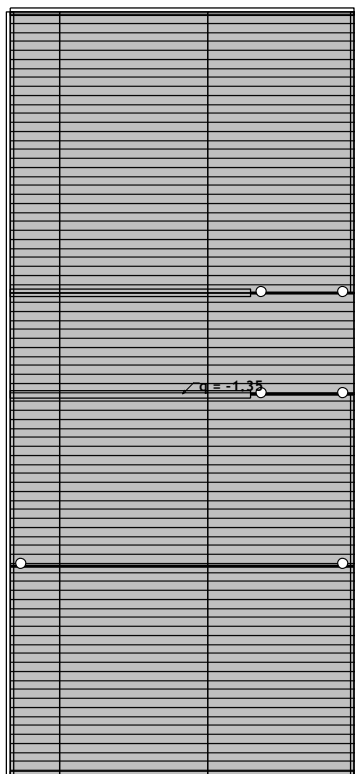
Vhodni podatki - Obtežba

Lista obtežnih primerov

LC	Naziv
1	Stalna + l.t. (g)
2	Koristna
3	Sneg
4	Komb.: MSN-01 (1.35xI+1.5xII+0.75xIII)
5	Komb.: MSN-02 (1.35xI+1.05xII+1.5xIII)

6	Komb.: MSU-01 (I+II+0.5xIII)
7	Komb.: MSU-02 (I+0.7xII+III)
8	Komb.: MSU-fin-01 (1.6xI+1.18xII+0.5xIII)
9	Komb.: MSU-fin-02 (1.6xI+0.88xII+III)

Obt. 1: Stalna + l.t. (g)



Nivo: POZ 400 [16.29 m]

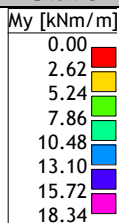
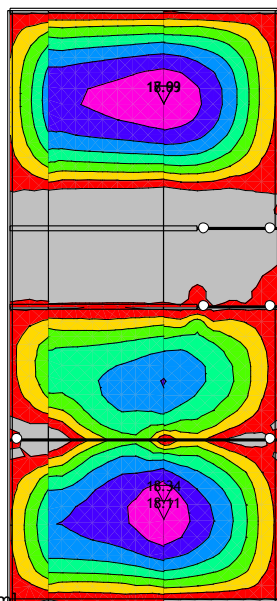
Obt. 3: Sneg



Nivo: POZ 400 [16.29 m]

Statični preračun

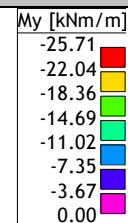
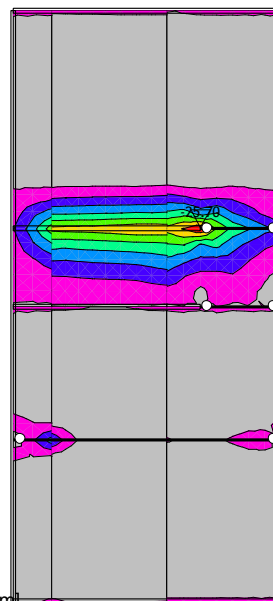
Obt. 10: [MSN] 4,5



Nivo: POZ 400 [16.29 m]

Vplivi v plošči: max My= 18.34 / min My= 0.00 kNm/m

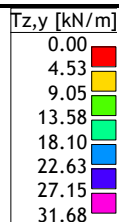
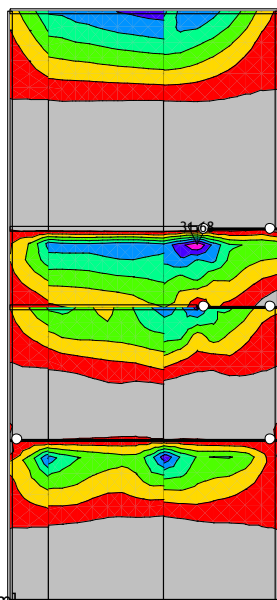
Obt. 10: [MSN] 4,5



Nivo: POZ 400 [16.29 m]

Vplivi v plošči: max My= 0.00 / min My= -25.70 kNm/m

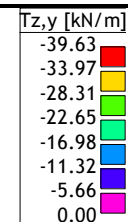
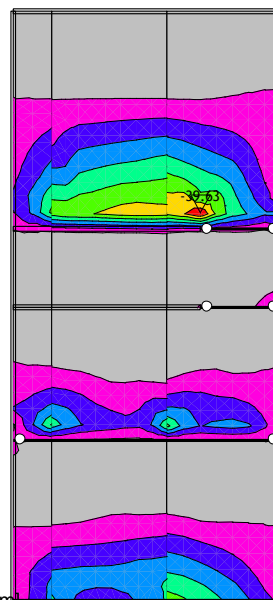
Obt. 10: [MSN] 4,5



Nivo: POZ 400 [16.29 m]

Vplivi v plošči: max Tz,y= 31.68 / min Tz,y= 0.00 kN/m

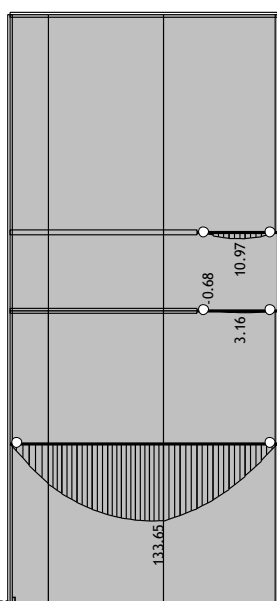
Obt. 10: [MSN] 4,5



Nivo: POZ 400 [16.29 m]

Vplivi v plošči: max Tz,y= 0.00 / min Tz,y= -39.63 kN/m

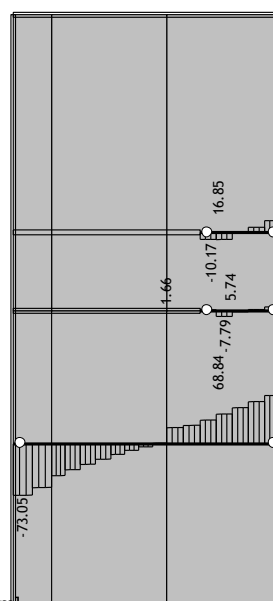
Obt. 10: [MSN] 4,5



Nivo: POZ 400 [16.29 m]

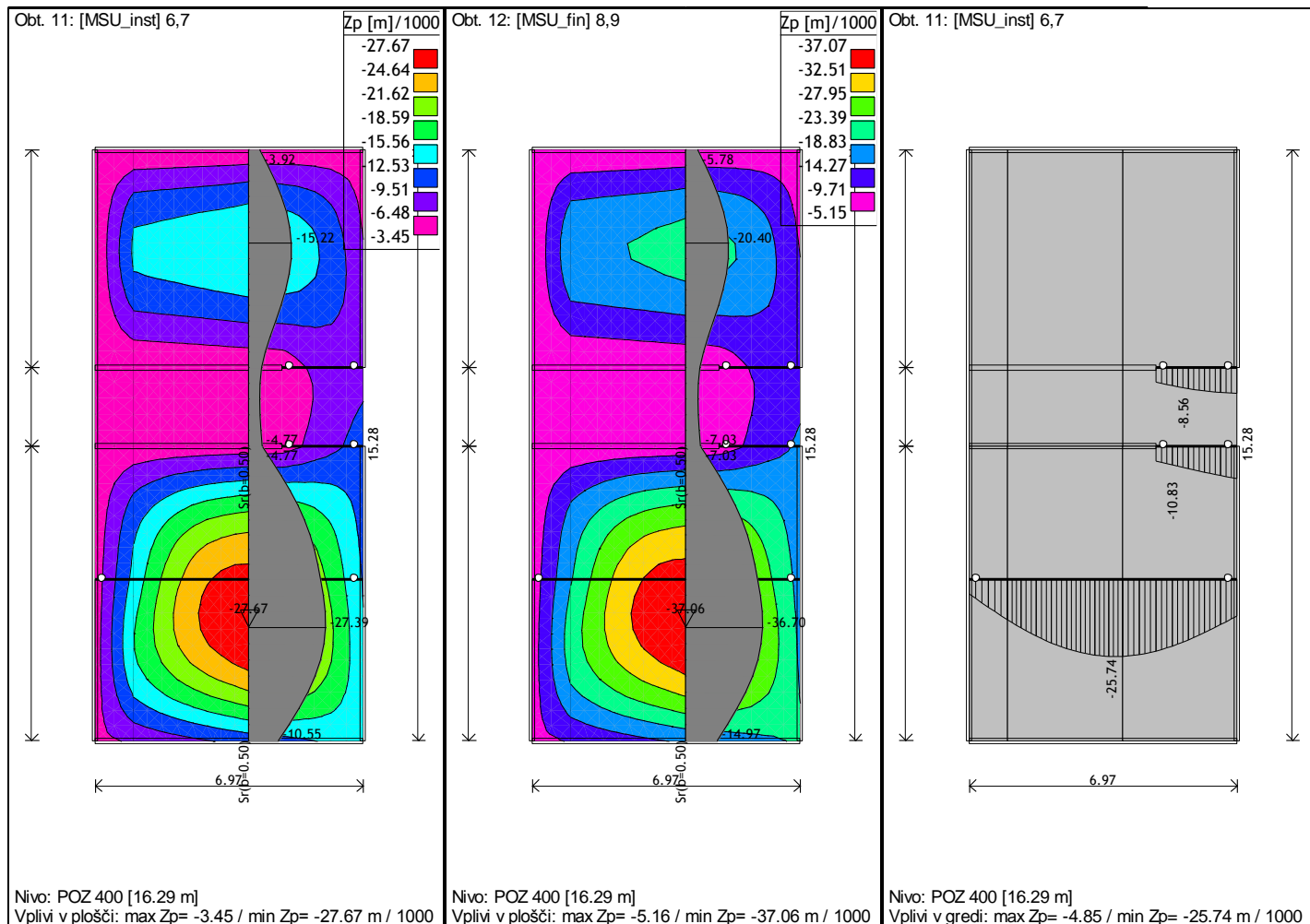
Vplivi v gredi: max M3= 133.65 / min M3= -0.68 kNm

Obt. 10: [MSN] 4,5



Nivo: POZ 400 [16.29 m]

Vplivi v gredi: max T2= 68.84 / min T2= -73.05 kN



Kontrola povesov za MSU:

POZ 400:

$w(\text{MSU,inst}) = 1,5 - 0,3 \text{ cm} = 1,2 \text{ cm} < w(\text{dop}) = L / 300 = 1,9 \text{ cm} \rightarrow \text{OK}$

$w(\text{MSU,fin}) = 2,0 - 0,6 \text{ cm} = 1,4 \text{ cm} < w(\text{dop}) = L / 250 = 2,3 \text{ cm} \rightarrow \text{OK}$

POZ 401:

$w(\text{MSU,inst}) = 2,6 - 0,5 \text{ cm} = 2,1 \text{ cm} < w(\text{dop}) = L / 300 = 2,3 \text{ cm} \rightarrow \text{OK}$

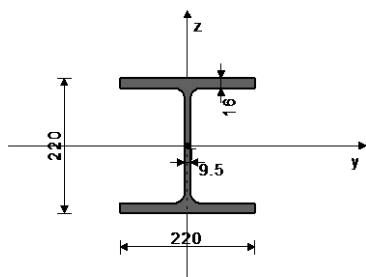
Dimenzioniranje (jeklo)

POZ 401: HEB 220; S235

PREČNI PREREZ: IPB 220 [S 235] [Set: 21]

EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza



($f_y = 23.5 \text{ kN/cm}^2$, $f_u = 36.0 \text{ kN/cm}^2$)

$A_x =$	91.000	cm ²
$A_y =$	63.120	cm ²
$A_z =$	27.880	cm ²
$I_x =$	76.800	cm ⁴
$I_y =$	8090.0	cm ⁴
$I_z =$	2840.0	cm ⁴
$W_y =$	735.45	cm ³
$W_z =$	258.18	cm ³
$W_{y,pl} =$	839.82	cm ³
$W_{z,pl} =$	387.20	cm ³
$y_{M0} =$	1.100	
$y_{M1} =$	1.100	
$y_{M2} =$	1.250	
$A_{net}/A =$	0.900	

[mm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽEB

5. $\gamma = 0.79$

4. $\gamma = 0.58$

PALICA IZPOSTAVLJENA NATEGU IN UPOGIBU

(obtežni primer 5, na 363.5 cm od začetka palice)

Računska osna sila	$N_{sd} =$	0.451	kN
Prečna sila v y smeri	$V_{sd,y} =$	17.747	kN
Prečna sila v z smeri	$V_{sd,z} =$	0.854	kN
Upogibni moment okoli y osi	$M_{sd,y} =$	133.20	kNm
Upogibni moment okoli z osi	$M_{sd,z} =$	3.948	kNm
Moment torzije	$M_t =$	0.031	kNm
Sistemska dolžina palice	$L =$	697.00	cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV

Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.3 Nateg

Plast.rač.nosilnost bruto prereza

Mejna rač.nosilnost neto prereza

Računska nos. na nateg

Pogoj 5.13: $N_{sd} \leq N_{t,Rd}$ (0.45 <= 1944.09)

$N_{pl,Rd} =$	1944.1	kN
$N_{u,Rd} =$	2122.8	kN
$N_{t,Rd} =$	1944.1	kN

5.4.5 Upogib y-y

Računski plastični moment

Računska nos.na lokalno izbočitev

Računski elastični moment

Računska nosilnost na upogib

Pogoj 5.17: $M_{sd,y} \leq M_{c,Rd,y}$ (133.20 <= 179.42)

$M_{pl,Rd} =$	179.42	kNm
$M_{o,Rd} =$	157.12	kNm
$M_{el,Rd} =$	157.12	kNm
$M_{c,Rd} =$	179.42	kNm

5.4.5 Upogib z-z

Računski plastični moment

Računska nos.na lokalno izbočitev

Računski elastični moment

Računska nosilnost na upogib

Pogoj 5.17: $M_{sd,z} \leq M_{c,Rd,z}$ (3.95 <= 82.72)

$M_{pl,Rd} =$	82.720	kNm
$M_{o,Rd} =$	55.157	kNm
$M_{el,Rd} =$	55.157	kNm
$M_{c,Rd} =$	82.720	kNm

5.4.6 Strig

Računska plast.nos.na strig z-z

Pogoj 5.20: $V_{sd,z} \leq V_{pl,Rd,z}$ (0.85 <= 343.88)

$V_{pl,Rd} =$	343.88	kN
---------------	--------	----

Računska plast.nos.na strig y-y

Pogoj 5.20: $V_{sd,y} \leq V_{pl,Rd,y}$ (17.75 <= 778.54)

$V_{pl,Rd} =$	778.54	kN
---------------	--------	----

5.4.9 Upogib z osno in prečno silo

Ni potrebno zmanjšanje upogibne nosilnosti

Pogoj: $V_{sd,z} \leq 50\%V_{pl,Rd,z}$ i $V_{sd,y} \leq 50\%V_{pl,Rd,y}$

5.4.8 Upogib in osna sila

Razmerje $M_{sd,y} / M_{pl,Rd,y}$

Razmerje $M_{sd,z} / M_{pl,Rd,z}$

0.742

0.048

Pogoj 5.36: (0.79 <= 1)

5.5 NOSILNOST ELEMENTOV

5.5.2 Bočna zvrnitev upogibnih nosilcev

Koeficient

Koeficient

Koeficient

Koef.dolžine za uklon

Koef.ukl.dolžine za vbočenje

Koordinata

Koordinata

Razmak med bočnimi podporami

Sektorski vztrajnostni moment

Krit.moment bočne zvrnitve

Koeficient

Koeficient imperf.

Brezdimenz.vitkost

Koeficient zmanjšanja

Računska uklonska nosilnost

C1 =	1.132	
C2 =	0.459	
C3 =	0.525	
k =	1.000	
kw =	1.000	
zg =	0.000	cm
zj =	0.000	cm
L =	100.00	cm
Iw =	2.95e+5	cm6
Mcr =	7131.8	kNm
βw =	1.000	
αLT =	0.210	
χLT_ =	0.166	
χLT =	1.000	
Mb,Rd =	179.42	kNm

5.5.3 Upogib in nateg

Redukcijski koef.za vektorske vplive

Elast.odp.mom.za krajne

tlač.vlakno

Efektivni rač.notranji moment

Pogoj 5.50: $M_{eff,sd} \leq M_{b,Rd}$ (133.17 <= 179.42)

$\psi_{vec} =$	0.800
$W_{com} =$	735.45 cm3
$M_{eff, sd} =$	133.17 kNm

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

za strig v ravnini z-z

Višina stojine

Debelina stojine

Ni prečnih ojačitev v sredini

Koeficient izbočenja pri strigu

Ni potrebna kontrola izbočenja zaradi striga

Pogoj: $d / t_w \leq 69 \epsilon$ (19.79 <= 69.00)

d =	18.800 cm
tw =	0.950 cm
kT =	5.340

5.6.7 Interakcija prečne sile, upogiba in osne sile

za strig v ravnini z-z

Računski plastični moment pasnic

Pogoji 5.66a in 5.66b so izpolnjeni

$M_{f,Rd} =$	165.44	kNm
--------------	--------	-----

5.7 VNOS KONCENTRIRANIH SIL V STOJINO

5.7.7 Uklon pasnice v smeri stojine

Koeficient(razred pasnice 1)

Površina stojine

Površina tlač.pasnice

Preprečen je uklon pasnice v smeri stojine

Pogoj 5.80: (19.79 <= 206.57)

k =	0.300
A _w =	20.900 cm ²
A _{fc} =	35.200 cm ²

KONTROLA STRIŽNE NOSILNOSTI

(obtežni primer 5, začetek palice)

Računska osna sila	$N_{sd} =$	-2.718	kN
Prečna sila v y smeri	$V_{sd,y} =$	5.097	kN
Prečna sila v z smeri	$V_{sd,z} =$	-73.048	kN
Sistemska dolžina palice	$L =$	697.00	cm

5.4 NOSILNOST PREČNIH PREREZOV

5.4.6 Strig

Računska plast.nos.na strig z-z

Pogoj 5.20: $V_{sd,z} \leq V_{pl,Rd,z}$ (73.05 <= 343.88)

$V_{pl,Rd} =$	343.88	kN
---------------	--------	----

Računska plast.nos.na strig y-y

Pogoj 5.20: $V_{sd,y} \leq V_{pl,Rd,y}$ (5.10 <= 778.54)

$V_{pl,Rd} =$	778.54	kN
---------------	--------	----

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

za strig v ravnini z-z

Višina stojine

Debelina stojine

Ni prečnih ojačitev v sredini

Koeficient izbočenja pri strigu

Ni potrebna kontrola izbočenja zaradi striga

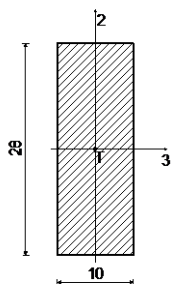
Pogoj: $d / t_w \leq 69 \epsilon$ (19.79 <= 69.00)

d =	18.800	cm
tw =	0.950	cm
kT =	5.340	

Dimenzioniranje (les)

POZ 402: preklada

Monolitni les - iglavci in mehki listavci - C24
Eksploatacijski razred 1
EUROCODE



FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽB
5. $\gamma=0.61$ 4. $\gamma=0.44$

KONTROLA NORMALNIH NAPETOSTI
(obtežni primer 5, na 126.0 cm od začetka palice)

Računska osna sila	N =	-4.428 kN
Prečna sila v smeri osi 2	T2 =	-1.174 kN
Prečna sila v smeri osi 3	T3 =	-1.413 kN
Upogibni moment okoli osi 2	M2 =	0.288 kNm
Upogibni moment okoli osi 3	M3 =	-10.969 kNm

KONTROLA NAPETOSTI - TLAK IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetraino
Korekcijski koeficient

Parcialni koef. za karakteristike
materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Faktor oblik (za pravokotni prerez)

Karakteristična tlačna trdnost

Računska tlačna trdnost

Karakteristična upogibna trdnost

Računska upogibna trdnost - os 2

Računska upogibna trdnost - os 3

Relativna vitkost

Relativna vitkost

Normalne tlačne napetosti

Odpornostni moment

Normalna upogibna napetost okoli osi 2

$$\sigma_{m2,d} \leq f_{m2,d} \quad (0.617 \leq 16.017)$$

Izkoriščenost prereza je 3.9%

Odpornostni moment

Normalna upogibna napetost okoli osi 3

Kmod = 0.800
ym = 1.300

Kh_2 = 1.084

Kh_3 = 1.000

km = 0.700

fc,0,k = 21.000 MPa

fc,0,d = 12.923 MPa

fm,k = 24.000 MPa

fm,2,d = 16.017 MPa

fm,3,d = 14.769 MPa

λrel,2 = 0.587

λrel,3 = 0.587

σc,0,d = 0.158 MPa

W2 = 466.67 cm³

σm2,d = 0.617 MPa

W3 = 1306.7 cm³

σm3,d = 8.395 MPa

$$\sigma_{m3,d} \leq f_{m3,d} \quad (8.395 \leq 14.769)$$

Izkoriščenost prereza je 56.8%

TLAK IN UPOGIB - VELIKA VITKOST

Začetna imperfekcija

Koeficient

Koeficient

Koeficient

Koeficient

β#χ = 0.200

k3 = 0.513

k2 = 0.701

kc,3 = 1.019

kc,2 = 0.922

$$(\sigma_{c,0,d} / (k_{c,2} \times f_{c,0,d})) + k_m \times (\sigma_{m3,d} / f_{m3,d}) + \sigma_{m2,d} / f_{m2,d} \leq 1 \quad (0.450 \leq 1)$$

Izkoriščenost prereza je 45.0%

$$(\sigma_{c,0,d} / (k_{c,3} \times f_{c,0,d})) + \sigma_{m3,d} / f_{m3,d} + k_m \times (\sigma_{m2,d} / f_{m2,d}) \leq 1 \quad (0.607 \leq 1)$$

Izkoriščenost prereza je 60.7%

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Razmak pridrženih točk pravokotno na smer osi 2

Kmod = 0.800

ym = 1.300

lef = 100.00 cm

E0.05 = 7400.0 MPa

G0.05 = 460.00 MPa

ltor = 7240.1 cm⁴

I2 = 2333.3 cm⁴

W3 = 1306.7 cm³

σm,crit = 182.32 MPa

λrel = 0.363

k_krit = 1.000

σm3,d = 8.395 MPa

$$\sigma_{m3,d} \leq k_{krit} \times f_{m3,d} \quad (8.395 \leq 14.769)$$

Izkoriščenost prereza je 56.8%

KONTROLA STRIŽNIH NAPETOSTI

(obtežni primer 5, konec palice)

Prečna sila v smeri osi 2

T2 = 16.851 kN

Prečna sila v smeri osi 3

T3 = -0.839 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod = 0.800

ym = 1.300

fv,k = 2.500 MPa

fv,d = 1.538 MPa

A = 280.00 cm²

τ2,d = 0.903 MPa

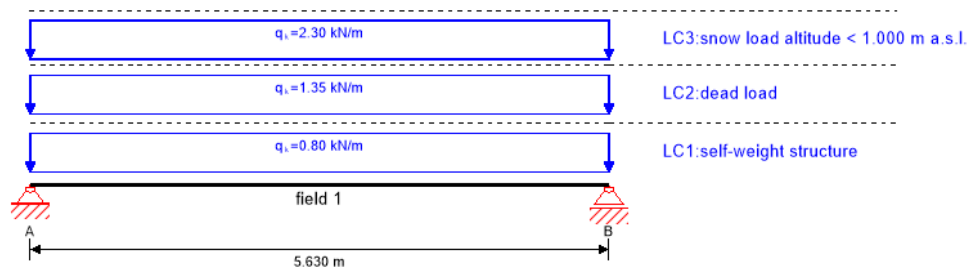
τ3,d = 0.045 MPa

τs = 0.904 MPa

$$\tau_s \leq f_{v,d} \quad (0.904 \leq 1.538)$$

Izkoriščenost prereza je 58.8%

system

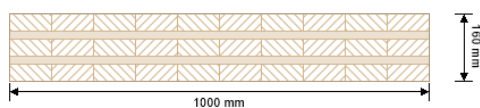


global utilization ratio

88 %

ULS	35 %	ULS fire	0 %	SLS	88 %	SLS vibration	0 %	support	-1 %
-----	------	----------	-----	-----	------	---------------	-----	---------	------

section: CLT 160 L5s



layer	thickness	orientation	material
1	40.0 mm	0°	C24 spruce
2	20.0 mm	90°	C24 spruce
3	40.0 mm	0°	C24 spruce
4	20.0 mm	90°	C24 spruce
5	40.0 mm	0°	C24 spruce
t _{CLT}	160.0 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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
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	K _{mod}	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 < 1.000 m a.s.l.	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	0.80

LC2:dead load

continous load

field	load at start
	[kN/m]
1	1.35

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

continous load

field	load at start
	[kN/m]
1	2.30

ULS combinations

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

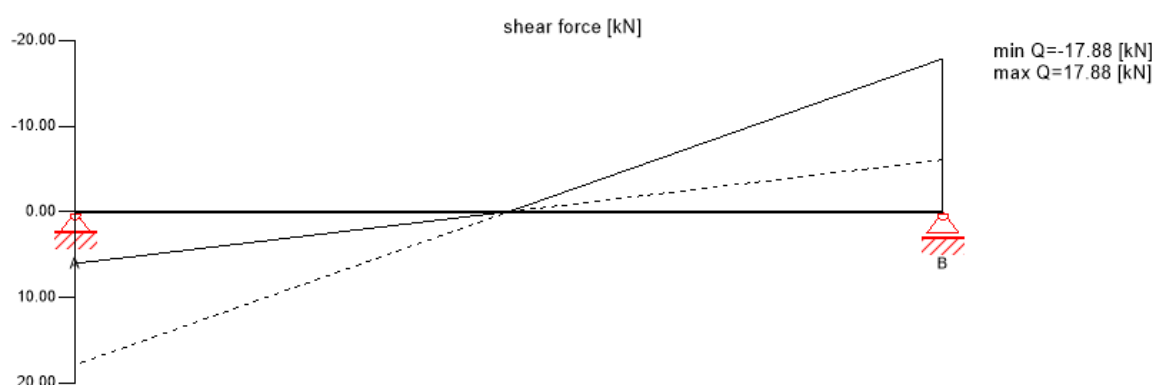
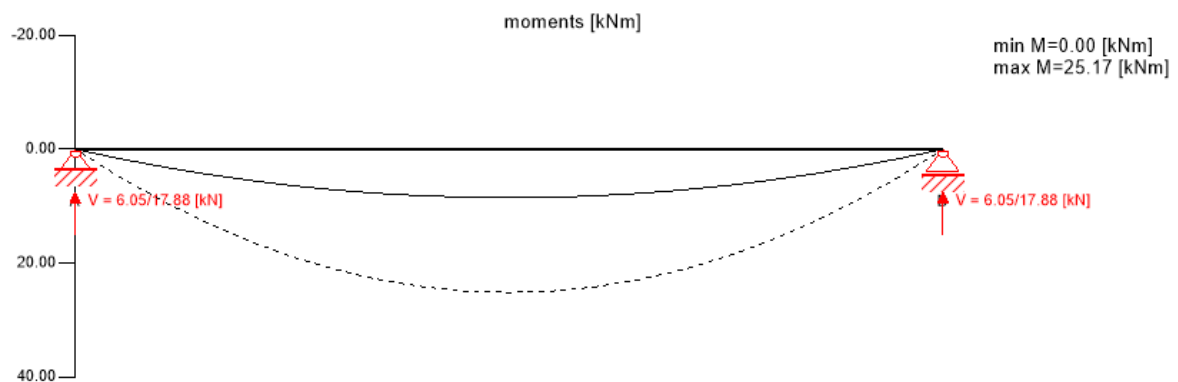
SLS characteristic combination

	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

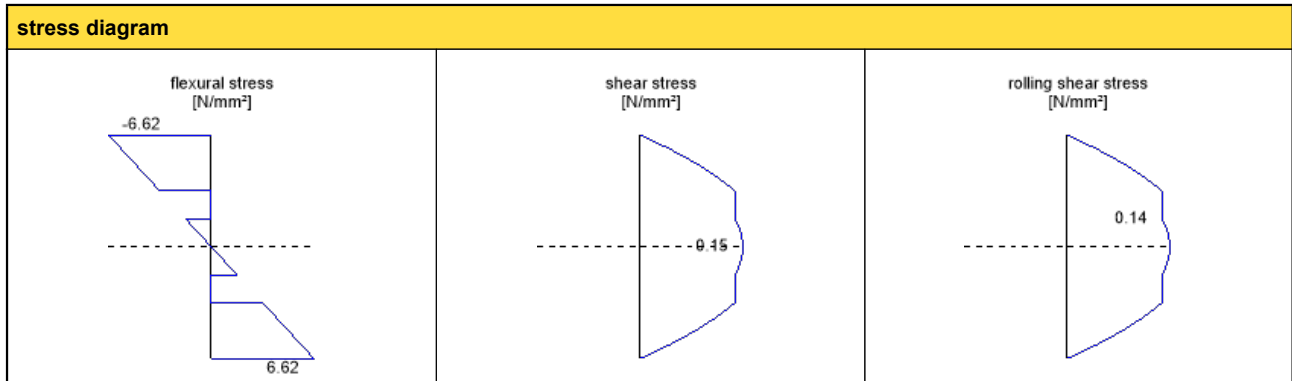


ULS flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	$k_{sys,y}$	$f_{m,y,d}$	$M_{y,d}$	$\sigma_{m,y,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
1	2.82	24.00	1.25	0.90	1.10	19.01	25.17	6.62	35 %	LCO2

ULS shear analysis									
field	dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.63	4.00	1.25	0.90	2.88	-17.88	0.15	5 %	LCO2

ULS rolling shear									
field	dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$T_{r,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.63	1.25	1.25	0.90	0.90	-17.88	0.14	16 %	LCO2

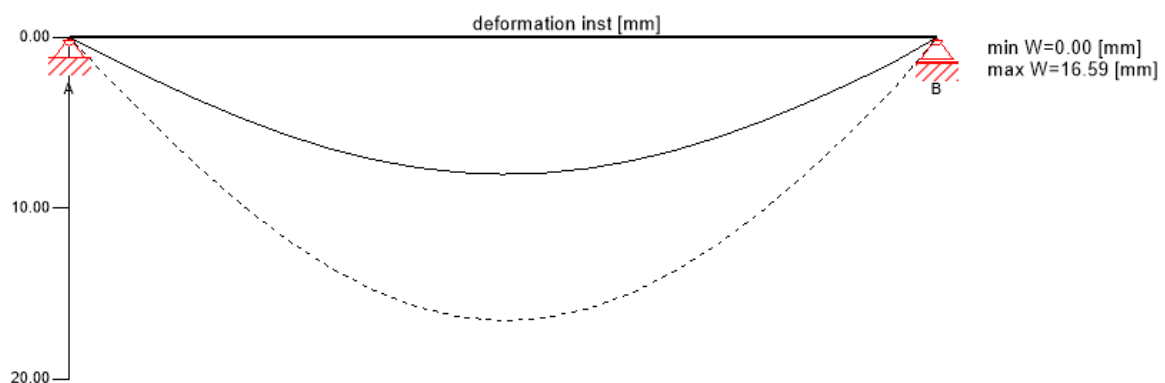
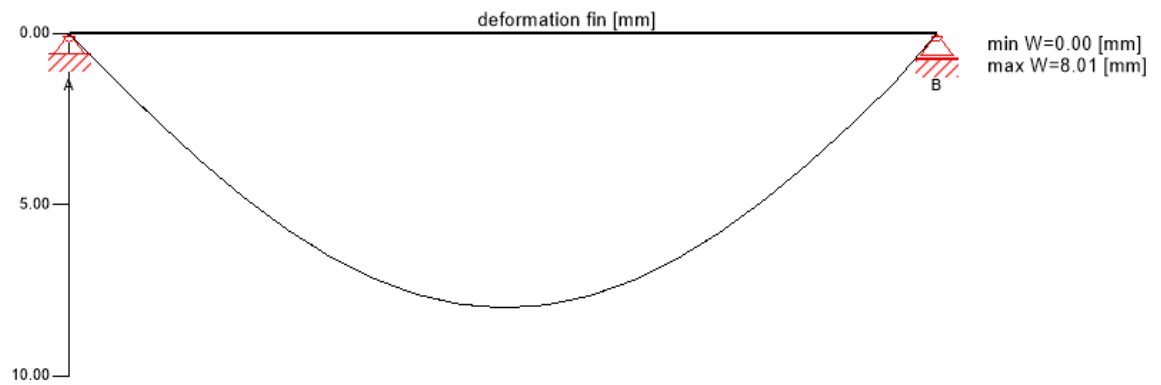


flexural stress analysis									
$M_{y,d}$	=	25.17	kNm	$f_{m,k}$	=	24.00	N/mm ²		
$N_{t,d}$	=	0.00	kN	γ_m	=	1.25	-		
				k_{mod}	=	0.90	-		
				$k_{sys,y}$	=	1.10	-		
$\sigma_{t,d}$	=	0.00	N/mm ²	$f_{t,d}$	=	10.08	N/mm ²		
$\sigma_{m,y,d}$	=	6.62	N/mm ²	$f_{m,y,d}$	=	19.01	N/mm ²	<	✓
utilization ratio								35 %	

shear stress analysis									
V_d	=	-	kN	$f_{v,k}$	=	4.00	N/mm ²		
		17.88		γ_m	=	1.25			
				k_{mod}	=	0.90			
$T_{v,d}$	=	0.15	N/mm ²	$f_{v,d}$	=	2.88	N/mm ²	<	✓
utilization ratio								5 %	

rolling shear analysis									
V_d	=	-17.88	kN	$f_{r,k}$	=	1.25	N/mm ²		
				γ_m	=	1.25	-		
				k_{mod}	=	0.90	-		
$T_{r,d}$	=	0.14	N/mm ²	$f_{r,d}$	=	0.90	N/mm ²	<	✓
utilization ratio								16 %	

Service limit state design (SLS) - design results



initial deflection [w_{char}]

field	dist.	limit	W_{limit}	$W_{calc.}$	ratio	
	[m]	[-]	[mm]	[mm]		
1	2.82	1/300	18.8	16.6	88 %	LCO2

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

field	dist.	limit	W_{limit}	$W_{calc.}$	ratio	
	[m]	[-]	[mm]	[mm]		
1	2.82	1/150	37.5	23.0	61 %	LCO3

net final deflection [$w_{q.p.} \cdot (1+k_{def})$]

field	dist.	limit	W_{limit}	$W_{calc.}$	ratio	
	[m]	[-]	[mm]	[mm]		
1	2.82	1/250	22.5	14.4	64 %	LCO3

support reaction

load case category	k_{mod}	A_V	B_V
		[kN]	
self-weight structure	0.6	2.25	2.25
		2.25	2.25
dead load	0.6	3.80	3.80
		3.80	3.80
snow load altitude < 1.000 m a.s.l.	0.9	6.47	6.47
		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

reference documents for this analysis	
English title	description
Expertise Rolling shear - no edge gluing, H.J. Blass EN 1995-1-2	Expertise on Rolling shear for CLT 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 t_f of gypsum fire boards (GKF) according to ON B 3410 EN 1990	Expertise on failure time t_f of gypsum wall fire boards according to ON B3410 and gypsum wall boards type DF according to EN 520 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 guideline for Europe	Fire safety in timber buildings - technical guideline 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

The software was created to assist engineers in their daily business. The software is an engineering software that is dealing with a very complex matter of structural analysis and building physics analysis. Therefore, this software shall only be operated by skilled, experienced engineers, with a deep understanding of structural engineering and building physics related to timber structures. The user of the software is obliged to check all input values, no matter if they were given by the user or given by default by the software and all results for plausibility.

The use of the results of the software should not be relied upon as the basis for any decision or action. Any use of results of the software is only allowed, if the results have been verified and approved regarding completeness and correctness by a project structural/building physics engineer. The user has the possibility to make print-outs from the software. Any modification of those are not allowed.

Stora Enso Wood Products GmbH does not assume any warranty regarding the software. The software has been developed with utmost diligence, nevertheless Stora Enso Wood Products GmbH, neither expressly nor implicitly, provides any warranty in terms of accuracy, validity, timeliness and completeness of information and data created by the software. Stora Enso Wood Products GmbH does also not assume any warranty for the general usability of the software, its suitability for a special purpose or for the compatibility of the software with the ones of third party producers or providers.

Stora Enso Wood Products GmbH is only liable for damages caused by gross negligence or intent through Stora Enso Wood Products GmbH; the liability for slight negligence is excluded. This does not apply to personal injury. Under the aforementioned conditions Stora Enso Wood Products GmbH is as well not liable for operational failures or the loss of programs and/or data of the user's data processing system.

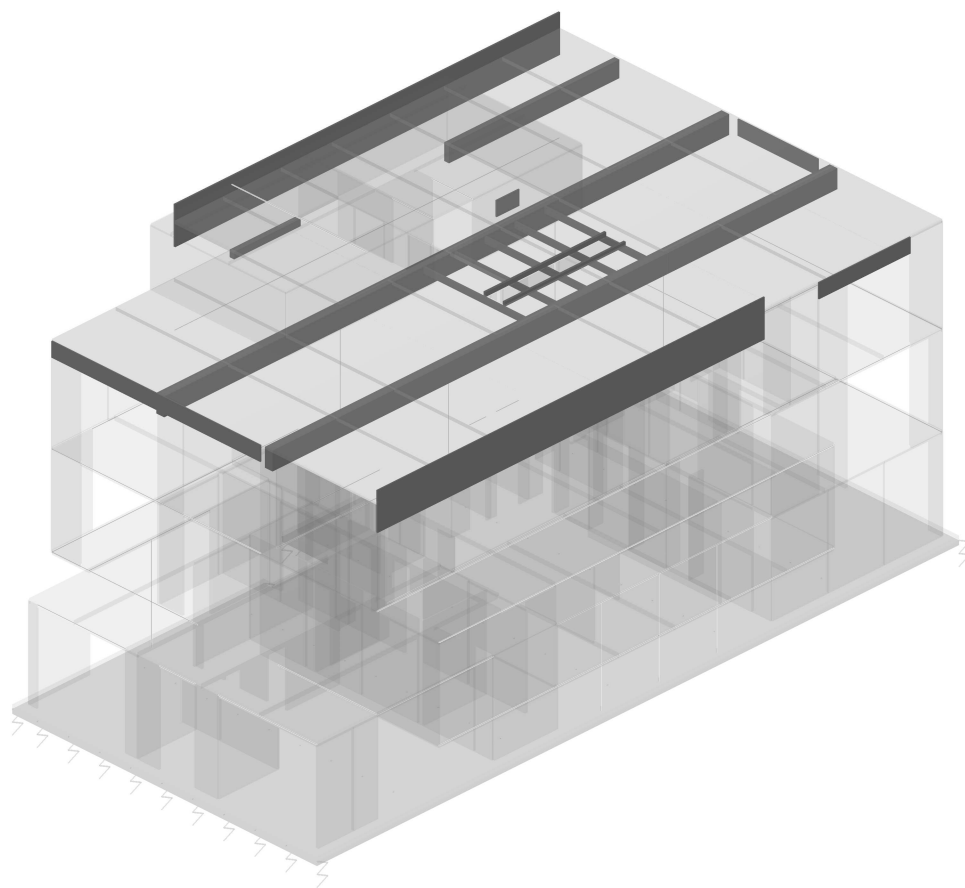
Applicable Law: These terms of use shall be governed by the laws of Austria excluding however any conflict of laws rules and any laws regarding the Convention of the International Sale of Goods (CISG).

Vhodni podatki - Konstrukcija**POZ 300**

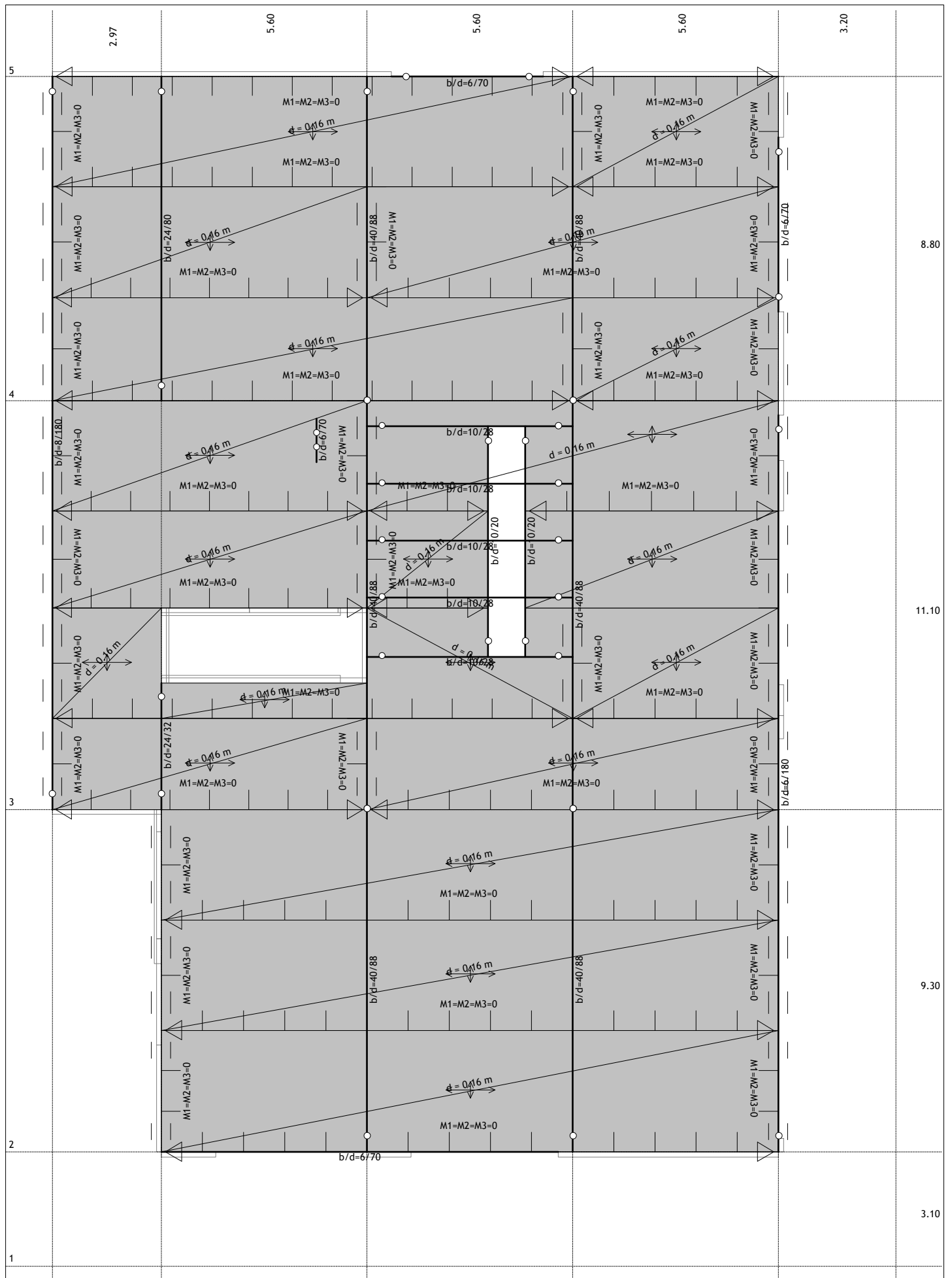
POZ 300: strešna plošča

Strešno konstrukcijo izvedemo z vzdolžnimi nosilci v oseh B in C - v vsaki osi po dva nosilca - na katere nalega CLT plošča debeline 160 mm. Plošča nalega na CLT stene in se nad odprtinami nosi preko robnega nosilca sestavljenega iz atike in preklade.

- POZ 300: plošča CLT L5s 160 mm
- POZ 301: dvojni leseni nosilec 2 x 20/88 cm; GL32h
- POZ 302: dvojni leseni nosilec 2 x 20/88 cm; GL32h
- POZ 303: lesni nosilec (atika+preklada) CL L3s 100 mm; h = 180 mm - zunanji sloji horizontalno
- POZ 305: preklopniki ob svetlobniku 10/28 cm; C 24
- POZ 310: dvojni steber 2 x 20/40 cm; GL24h



Izometrija (Nivo: POZ 300 [13.49 m])



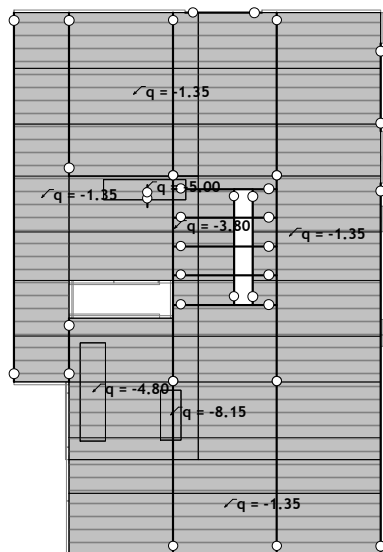
Vhodni podatki - Obtežba

Lista obtežnih primerov

LC	Naziv
1	Stalna + l.t. (g)
2	Koristna
3	Sneg
4	Komb.: MSN-01 (1.35xI+1.5xII+0.75xIII)
5	Komb.: MSN-02 (1.35xI+1.05xII+1.5xIII)

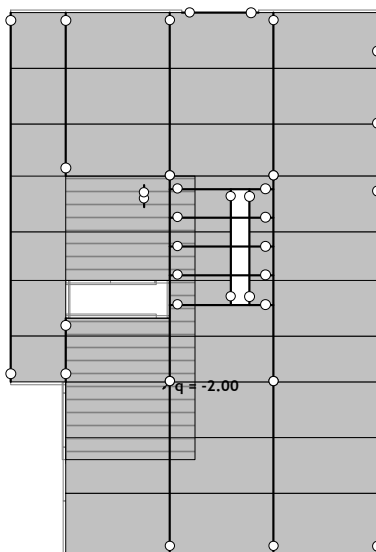
LC	Naziv
6	Komb.: MSU-01 (I+II+0.5xIII)
7	Komb.: MSU-02 (I+0.7xII+III)
8	Komb.: MSU-fin-01 (1.6xI+1.18xII+0.5xIII)
9	Komb.: MSU-fin-02 (1.6xI+0.88xII+III)

Obt. 1: Stalna + l.t. (g)



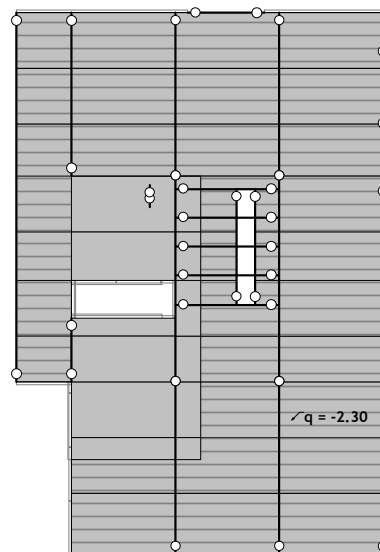
Nivo: POZ 300 [13.49 m]

Obt. 2: Koristna



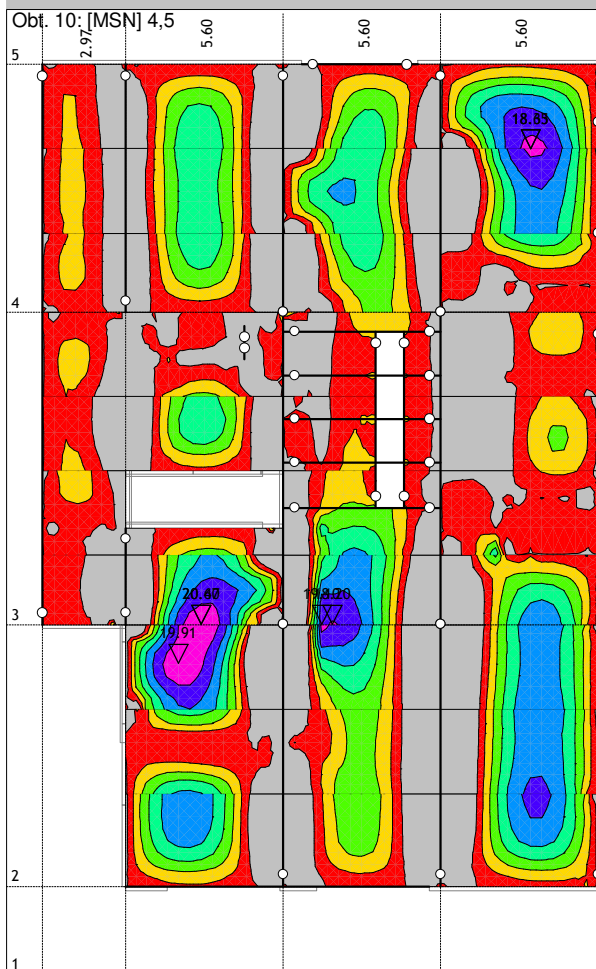
Nivo: POZ 300 [13.49 m]

Obt. 3: Sneg

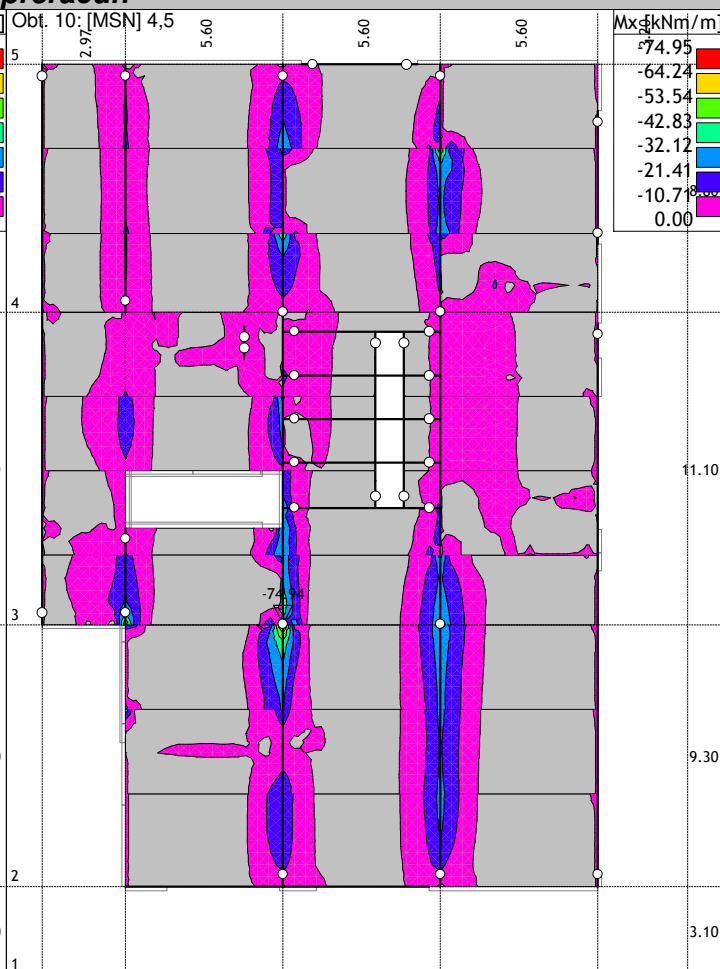
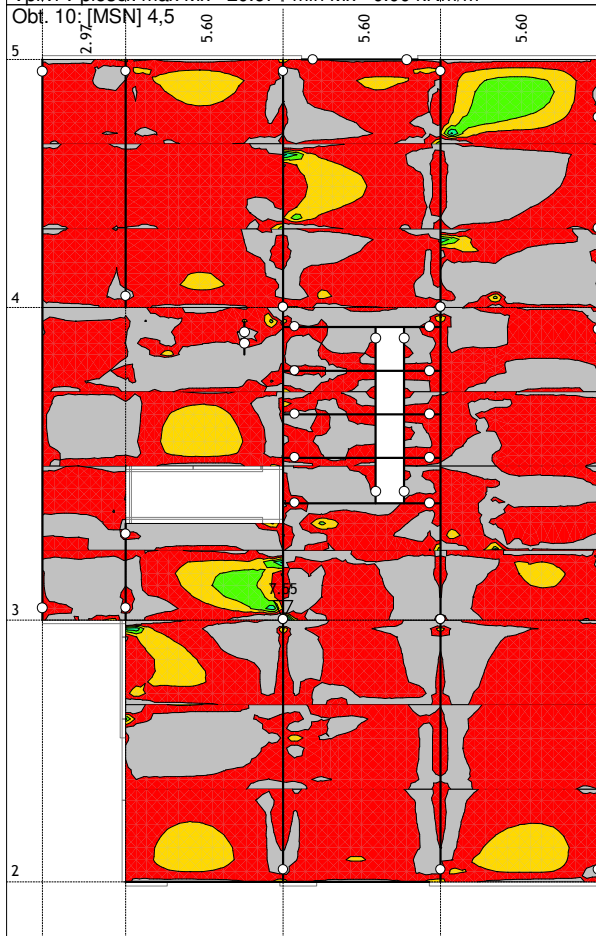


Nivo: POZ 300 [13.49 m]

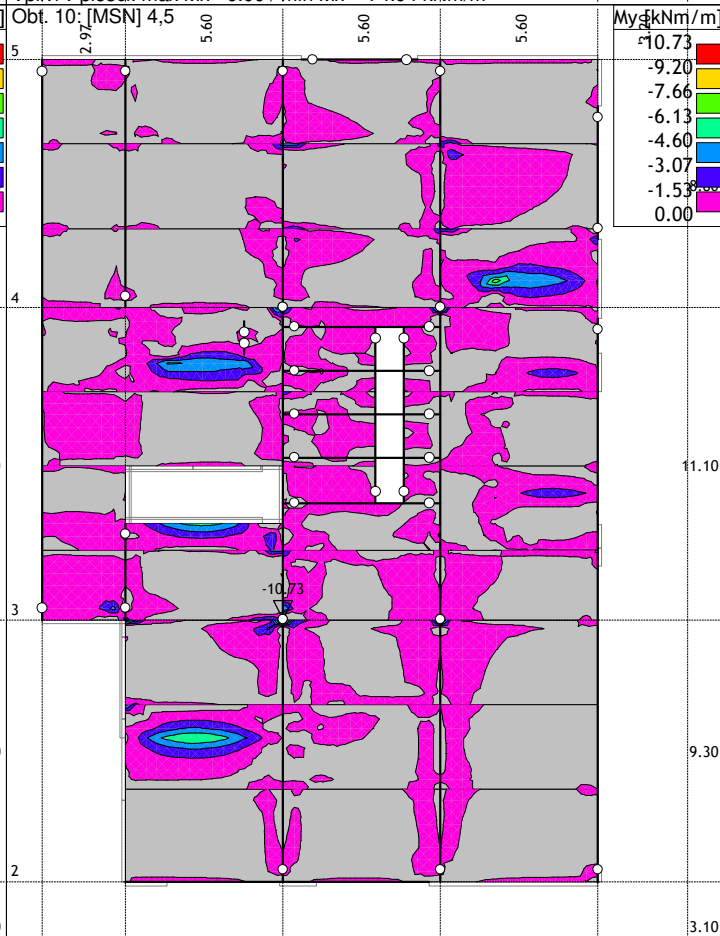
Statični preračun

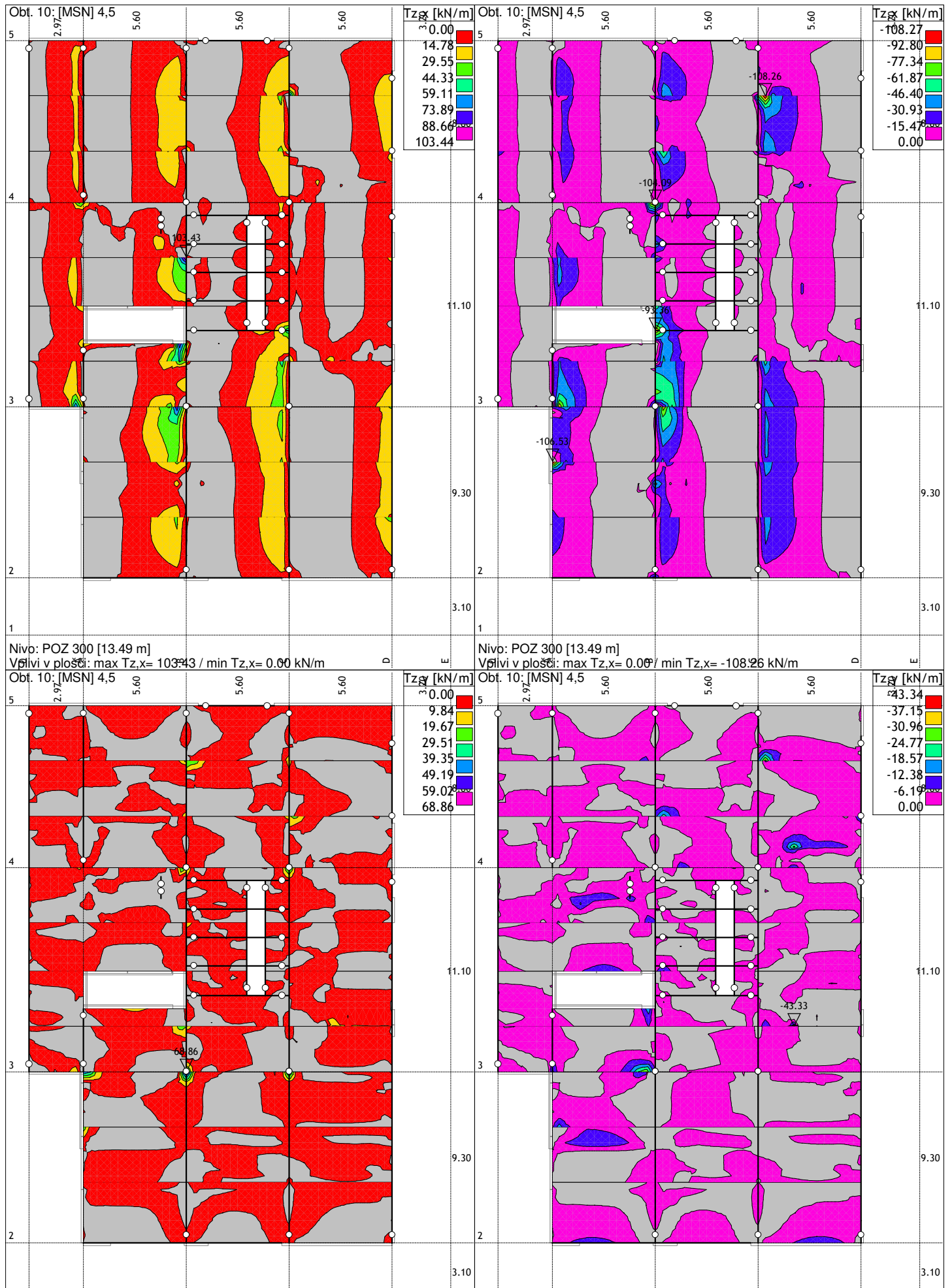


Nivo: POZ 300 [13.49 m]
Vplivi v plošči: max Mx= 20.67 / min Mx= 0.00 kNm/m

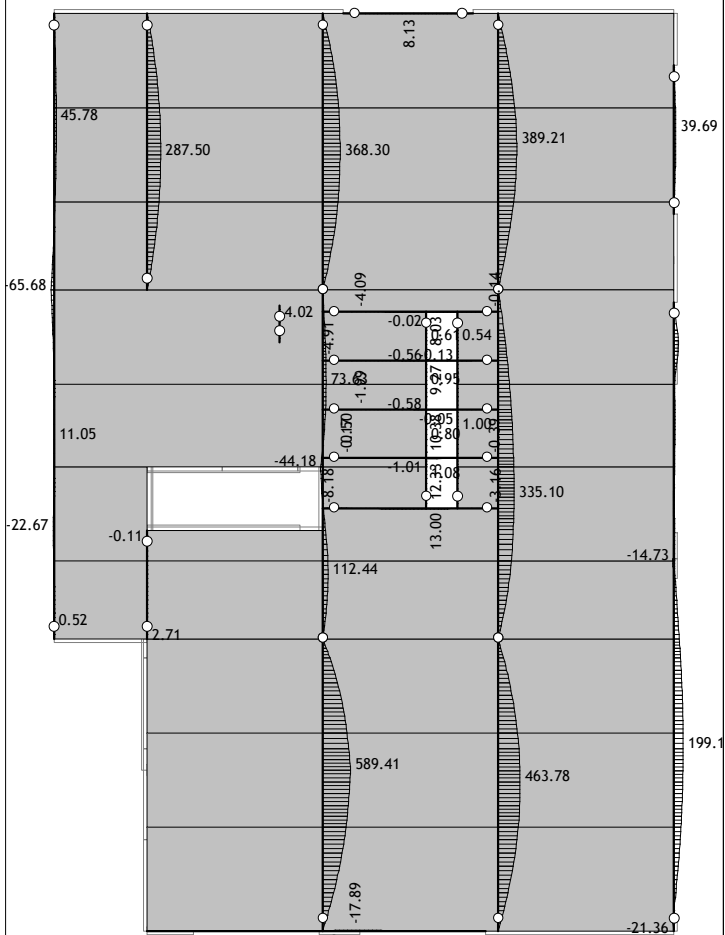


Nivo: POZ 300 [13.49 m]
Vplivi v plošči: max Mx= 0.00 / min Mx= -74.94 kNm/m



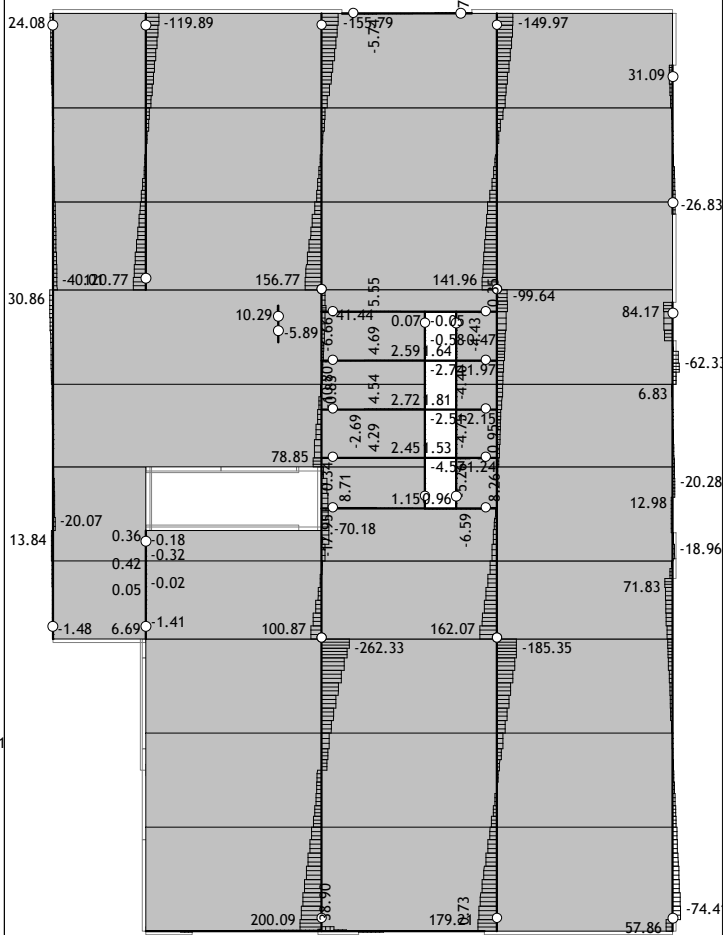


Obt. 10: [MSN] 4,5



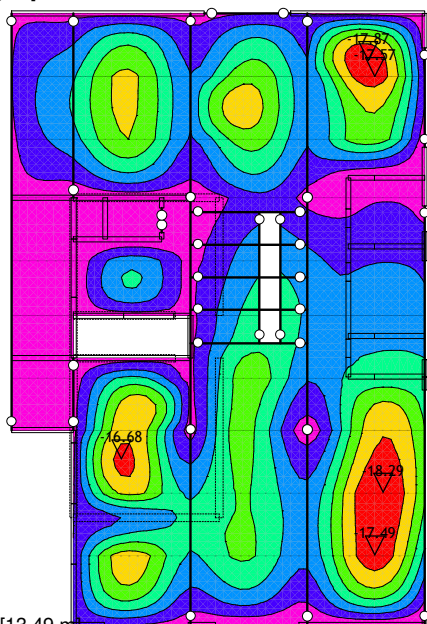
Nivo: POZ 300 [13.49 m]
Vplivi v gredi: max M3= 589.41 / min M3= -65.68 kNm

Obt. 10: [MSN] 4,5

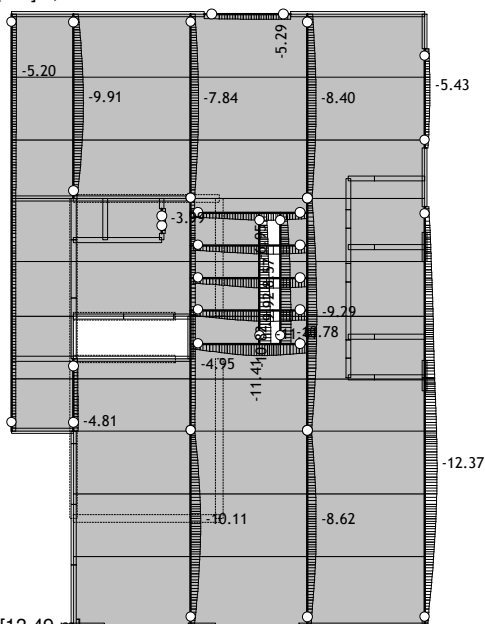


Nivo: POZ 300 [13.49 m]
Vplivi v gredi: max T2= 200.09 / min T2= -262.33 kNm

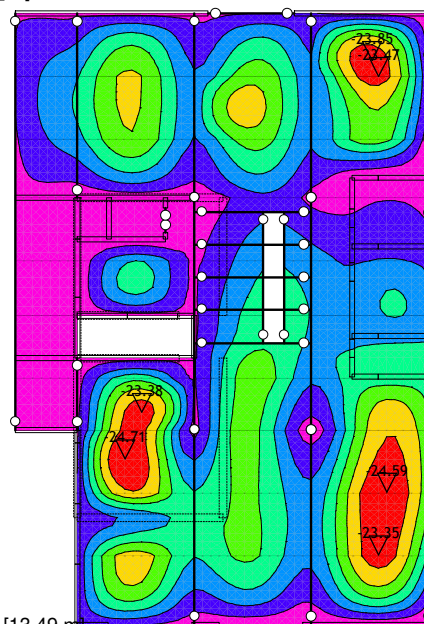
Obt. 11: [MSU_inst] 6,7


 Nivo: POZ 300 [13.49 m]
 Vplivi v plošči: max Zp= -3.13 / min Zp= -18.29 m / 1000

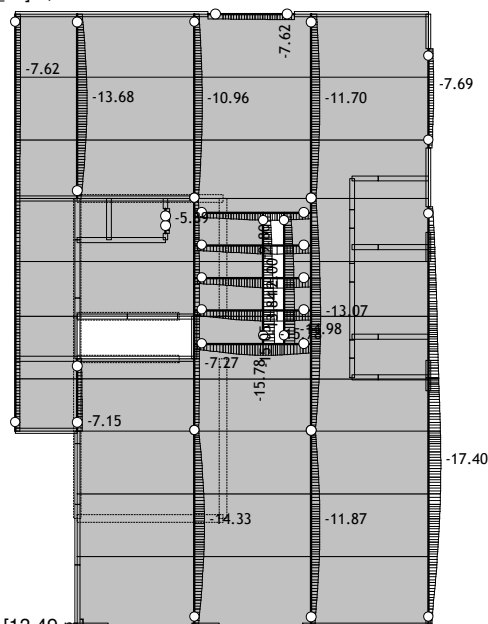
Obt. 11: [MSU_inst] 6,7


 Nivo: POZ 300 [13.49 m]
 Vplivi v gredi: max Zp= -3.09 / min Zp= -12.37 m / 1000

Obt. 12: [MSU_fin] 8,9


 Nivo: POZ 300 [13.49 m]
 Vplivi v plošči: max Zp= -4.59 / min Zp= -24.71 m / 1000

Obt. 12: [MSU_fin] 8,9


 Nivo: POZ 300 [13.49 m]
 Vplivi v gredi: max Zp= -4.55 / min Zp= -17.40 m / 1000

Kontrola povesov za MSU:

POZ 300:

$w(\text{MSU,inst}) = 2,1 - 1,1 = 1,0 \text{ cm} < w(\text{dop}) = L / 300 = 1,9 \text{ cm} \rightarrow \text{OK}$

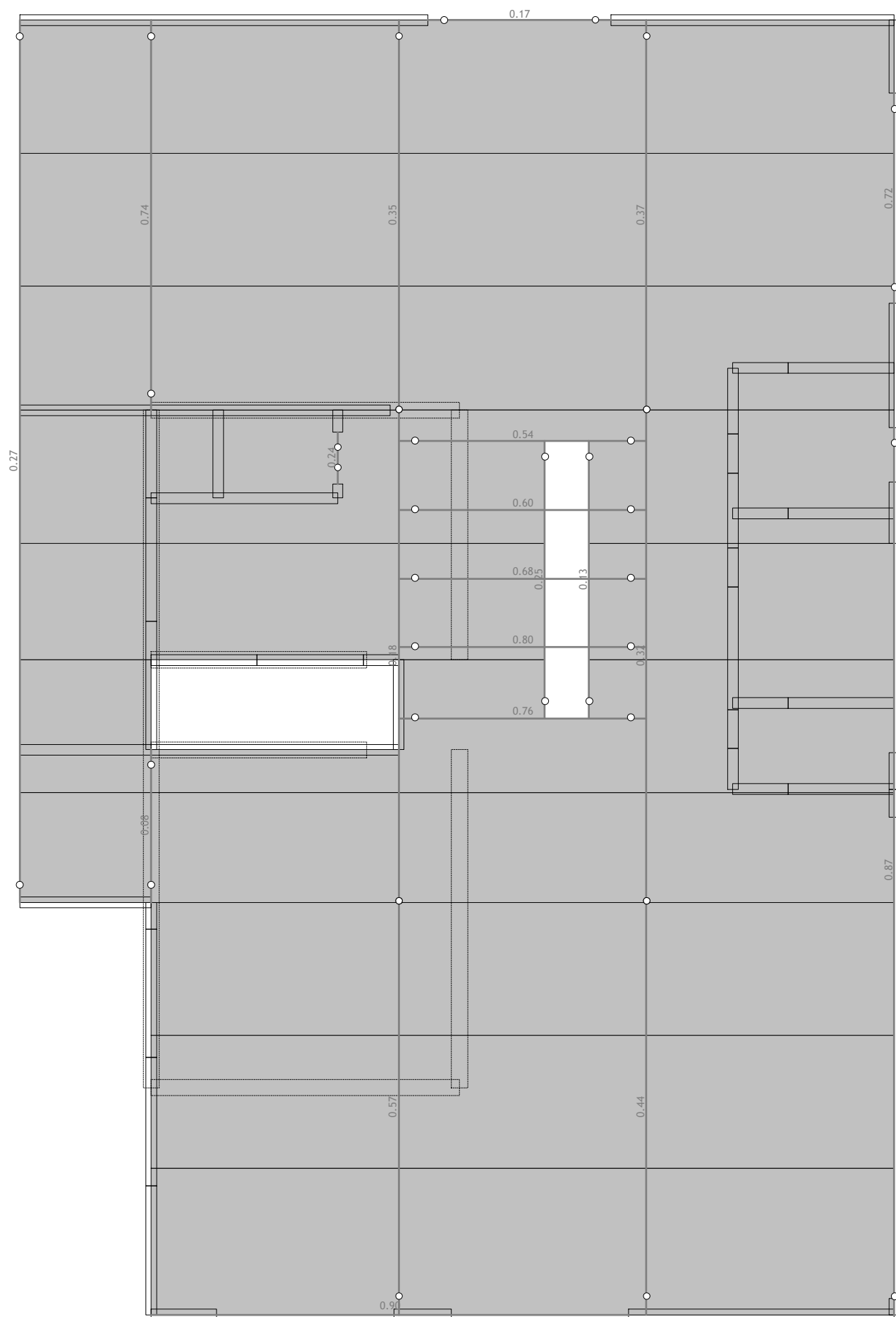
$w(\text{MSU,fin}) = 2,7 - 1,5 = 1,2 \text{ cm} < w(\text{dop}) = L / 250 = 2,3 \text{ cm} \rightarrow \text{OK}$

POZ 301 in 302:

$w(\text{MSU,inst}) = 1,3 - 0,4 = 0,9 \text{ cm} < w(\text{dop}) = L / 300 = 3,1 \text{ cm} \rightarrow \text{OK}$

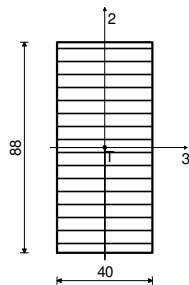
$w(\text{MSU,fin}) = 1,7 - 0,5 = 1,2 \text{ cm} < w(\text{dop}) = L / 250 = 3,7 \text{ cm} \rightarrow \text{OK}$

Dimenzioniranje (les)



POZ 301: strešni nosilec 2x20/88 cm; GL32h

Lepljen lameliran les - GL32h
v smeri zgornjega roba palice
Debelina lamele 2.00 cm
Eksploatacijski razred 1
EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
5. $\gamma = 0.57$ 4. $\gamma = 0.48$

KONTROLA NORMALNIH NAPETOSTI

(obtežni primer 5, na 418.0 cm od začetka palice)

Računska osna sila	N = 34.008 kN
Prečna sila v smeri osi 2	T2 = -52.342 kN
Prečna sila v smeri osi 3	T3 = -1.191 kN
Upogibni moment okoli osi 2	M2 = 3.995 kNm
Upogibni moment okoli osi 3	M3 = -589.35 kNm

KONTROLA NAPETOSTI - NATEG IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetraino
Korekcijski koeficient
Parcialni koef. za karakteristike materiala
Dodatek za elemente z malimi dimenzijami - os 2

Kmod = 0.800
 $\gamma_m = 1.250$

Dodatek za elemente z malimi dimenzijami - os 3

Kh_2 = 1.041

Dodatek za elemente z malimi dimenzijami - nateg

Kh_3 = 1.000

Karakteristična natezna trdnost
Računska natezna trdnost
Faktor oblik (za pravokotni prerez)
Karakteristična upogibna trdnost
Računska upogibna trdnost - os 2
Računska upogibna trdnost - os 3
Normalna natezna napetost
Odpornostni moment
Normalna upogibna napetost okoli osi 2

ft,0,k = 22.500 MPa
ft,0,d = 14.996 MPa
km = 0.700
fm,k = 32.000 MPa
fm,2,d = 21.327 MPa
fm,3,d = 20.480 MPa
ot,0,d = 0.097 MPa
W2 = 23467 cm³
om2,d = 0.170 MPa

$$\sigma_{m,2,d} \leq f_{m,2,d} (0.170 \leq 21.327)$$

Izkoriščenost prereza je 0.8%

Odpornostni moment
Normalna upogibna napetost okoli osi 3

W3 = 51627 cm³
 $\sigma_{m,3,d} = 11.416 \text{ MPa}$

$$\sigma_{m,3,d} \leq f_{m,3,d} (11.416 \leq 20.480)$$

Izkoriščenost prereza je 55.7%

$$\sigma_{t,0,d} / f_{t,0,d} + k_m \times (\sigma_{m,3,d} / f_{m,3,d}) + \sigma_{m,2,d} / f_{m,2,d} \leq 1$$

$$(0.405 \leq 1)$$

Izkoriščenost prereza je 40.5%

$$\sigma_{t,0,d} / f_{t,0,d} + \sigma_{m,3,d} / f_{m,3,d} + k_m \times (\sigma_{m,2,d} / f_{m,2,d}) \leq 1$$

$$(0.569 \leq 1)$$

Izkoriščenost prereza je 56.9%

KONTROLA STRIŽNIH NAPETOSTI
(obtežni primer 5, začetek palice)

Prečna sila v smeri osi 2	T2 = -262.33 kN
Prečna sila v smeri osi 3	T3 = -2.507 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient	Kmod = 0.800
Parcialni koef. za karakteristike materiala	$\gamma_m = 1.250$
Karakteristična strižna napetost	fv,k = 3.800 MPa
Računska strižna trdnost	fv,d = 2.432 MPa
Površina prečnega prereza	A = 3520.0 cm ²
Dejanska strižna napetost (os 2)	$\tau_{2,d} = 1.118 \text{ MPa}$
Dejanska strižna napetost (os 3)	$\tau_{3,d} = 0.011 \text{ MPa}$
Superponirana strižna napetost	$\tau_s = 1.118 \text{ MPa}$

$$\tau_s \leq f_{v,d} (1.118 \leq 2.432)$$

Izkoriščenost prereza je 46.0%

DOKAZ STABILNOSTI ELEMENTA

(obtežni primer 5, na 418.0 cm od začetka palice)

Računska osna sila	N = 30.924 kN
Prečna sila v smeri osi 2	T2 = 34.340 kN
Prečna sila v smeri osi 3	T3 = 3.638 kN
Upogibni moment okoli osi 2	M2 = 4.349 kNm
Upogibni moment okoli osi 3	M3 = -589.41 kNm

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient
Parcialni koef. za karakteristike materiala
Razmak pridržanih točk pravokotno na smer osi 2

Kmod = 0.800
 $\gamma_m = 1.250$

5% fraktil modula E paralelno z vlakni
5% fraktil strižnega modula G

lef = 100.00 cm
E0.05 = 11100 MPa
G0.05 = 570.00 MPa

Torzijski vztrajnostni moment

I_{tor} = 1.33e+6 cm⁴

Vztrajnostni moment

I₂ = 4.69e+5 cm⁴

Odpornostni moment

W3 = 51627 cm³

Kritična napetost uklona

$\sigma_{m,crit} = 1211.6 \text{ MPa}$

Relativna vitkost za uklon

$\lambda_{rel} = 0.163$

Koeficient

k_{krit} = 1.000

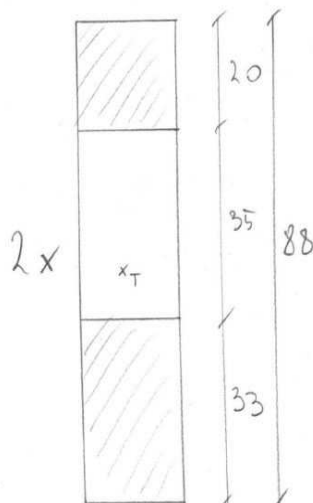
Normalna upogibna napetost okoli osi 3

$\sigma_{m,3,d} = 11.417 \text{ MPa}$

$$\sigma_{m,3,d} \leq k_{krit} \times f_{m,3,d} (11.417 \leq 20.480)$$

Izkoriščenost prereza je 55.7%

POZ 301: STREŠNI NOSILEC - KONTROLA PREBOJEV



$$\left. \begin{aligned} I_{y,ff} &= 2031209 \text{ cm}^4 \\ e_T &= 48.3 \text{ cm} \end{aligned} \right\} W_{y,ff} = 42054 \text{ cm}^3$$

$$M_{rd} = W_{y,ff} \cdot f_{m,d} = 42054 \text{ cm}^3 \cdot 2.048 \frac{\text{N}}{\text{cm}^2} = 861.2 \text{ kNm} \checkmark$$

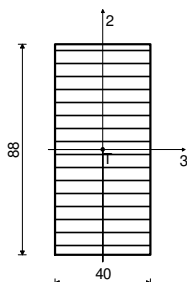
$$A_{s,ff} = 800 \text{ cm}^2$$

$$V_{rd} = A_{s,ff} \cdot f_{vd} = 800 \text{ cm}^2 \cdot 0.243 \frac{\text{N}}{\text{cm}^2} = 194.4 \text{ kN} \checkmark$$

⇒ POZ 301: 2x 20/88 cm; GL32h

POZ 302: strešni nosilec 2x20/88 cm; GL32h

Lepljen lameliran les - GL32h
v smeri zgornjega roba palice
Debelina lamele 2.00 cm
Eksploatacijski razred 1
EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
5. $\gamma=0.44$ 4. $\gamma=0.33$

KONTROLA NORMALNIH NAPETOSTI

(obtežni primer 5, na 455.0 cm od začetka palice)

Računska osna sila	N =	-8.195 kN
Prečna sila v smeri osi 2	T2 =	3.614 kN
Prečna sila v smeri osi 3	T3 =	4.589 kN
Upogibni moment okoli osi 2	M2 =	2.382 kNm
Upogibni moment okoli osi 3	M3 =	-463.78 kNm

KONTROLA NAPETOSTI - TLAK IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetraino
Korekcijski koeficient
Parcialni koef. za karakteristike materiala
Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Faktor oblik (za pravokotni prerez)

Karakteristična tlačna trdnost

Računska tlačna trdnost

Karakteristična upogibna trdnost

Računska upogibna trdnost - os 2

Računska upogibna trdnost - os 3

Relativna vitkost

Relativna vitkost

Normalne tlačne napetosti

Odpornostni moment

Normalna upogibna napetost okoli osi 2

Kmod = 0.800

$\gamma_m = 1.250$

Kh_2 = 1.041

Kh_3 = 1.000

km = 0.700

fc,0,k = 29.000 MPa

fc,0,d = 18.560 MPa

fm,k = 32.000 MPa

fm,2,d = 21.327 MPa

fm,3,d = 20.480 MPa

$\lambda_{rel,2} = 0.141$

$\lambda_{rel,3} = 0.141$

oc,0,d = 0.023 MPa

W2 = 23467 cm³

om2,d = 0.102 MPa

$$\sigma_{m2,d} \leq f_{m2,d} (0.102 \leq 21.327)$$

Izkoriščenost prereza je 0.5%

Odpornostni moment

W3 = 51627 cm³

Normalna upogibna napetost okoli osi 3

$\sigma_{m3,d} = 8.983$ MPa

$$\sigma_{m3,d} \leq f_{m3,d} (8.983 \leq 20.480)$$

Izkoriščenost prereza je 43.9%

TLAK IN UPOGIB - MALA VITKOST

$$(\sigma_{c,0,d} / f_{c,0,d})^2 + k_m \times (\sigma_{m3,d} / f_{m3,d}) + \sigma_{m2,d} / f_{m2,d} \leq 1$$

$$(0.312 \leq 1)$$

Izkoriščenost prereza je 31.2%

$$(\sigma_{c,0,d} / f_{c,0,d})^2 + \sigma_{m3,d} / f_{m3,d} + k_m \times (\sigma_{m2,d} / f_{m2,d}) \leq 1$$

$$(0.442 \leq 1)$$

Izkoriščenost prereza je 44.2%

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Razmak pridržanih točk pravokotno na smer osi 2

Kmod = 0.800

$\gamma_m = 1.250$

lef = 100.00 cm

E0.05 = 11100 MPa

G0.05 = 570.00 MPa

ltor = 1.33e+6 cm⁴

I2 = 4.69e+5 cm⁴

W3 = 51627 cm³

$\sigma_{m,crit} = 1211.6$ MPa

$\lambda_{rel} = 0.163$

k_krit = 1.000

$\sigma_{m3,d} = 8.983$ MPa

$$\sigma_{m3,d} \leq k_{krit} \times f_{m3,d} (8.983 \leq 20.480)$$

Izkoriščenost prereza je 43.9%

KONTROLA STRIŽNIH NAPETOSTI

(obtežni primer 5, začetek palice)

Prečna sila v smeri osi 2

T2 = -185.35 kN

Prečna sila v smeri osi 3

T3 = 0.628 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod = 0.800

$\gamma_m = 1.250$

fv,k = 3.800 MPa

fv,d = 2.432 MPa

A = 3520.0 cm²

$\tau_{2,d} = 0.790$ MPa

$\tau_{3,d} = 0.003$ MPa

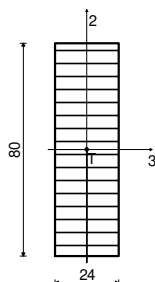
$\tau_s = 0.790$ MPa

$$\tau_s \leq f_{v,d} (0.790 \leq 2.432)$$

Izkoriščenost prereza je 32.5%

POZ 303: leseni nosilec

Lepljen lameliran les - GL24h
v smeri zgornjega roba palice
Debelina lamele 2.00 cm
Eksploatacijski razred 1
EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
5. $\gamma=0.74$ 4. $\gamma=0.55$

KONTROLA NORMALNIH NAPETOSTI

(obtežni primer 5, na 450.0 cm od začetka palice)

Računska osna sila	N =	9.043 kN
Prečna sila v smeri osi 2	T2 =	-1.912 kN
Prečna sila v smeri osi 3	T3 =	-1.729 kN
Upogibni moment okoli osi 2	M2 =	0.365 kNm
Upogibni moment okoli osi 3	M3 =	-287.50 kNm

KONTROLA NAPETOSTI - NATEG IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Dodatek za elemente z malimi dimenzijami - nateg

Karakteristična natezna trdnost	ft,0,k =	16.500 MPa
Računska natezna trdnost	ft,0,d =	11.573 MPa
Faktor oblik (za pravokotni prerez)	km =	0.700
Karakteristična upogibna trdnost	fm,k =	24.000 MPa
Računska upogibna trdnost - os 2	fm,2,d =	16.834 MPa
Računska upogibna trdnost - os 3	fm,3,d =	15.360 MPa
Normalna natezna napetost	ot,0,d =	0.047 MPa
Odpornostni moment	W2 =	7680.0 cm ³
Normalna upogibna napetost okoli osi 2	om2,d =	0.047 MPa

$$\sigma_{m2,d} \leq f_{m2,d} (0.047 \leq 16.834)$$

Izkoriščenost prereza je 0.3%

Odpornostni moment	W3 =	25600 cm ³
--------------------	------	-----------------------

Normalna upogibna napetost okoli osi 3

$\sigma_{m3,d} = 11.230$ MPa

$$\sigma_{m3,d} \leq f_{m3,d} (11.230 \leq 15.360)$$

Izkoriščenost prereza je 73.1%

$$\sigma_{t,0,d} / f_{t,0,d} + k_m \times (\sigma_{m3,d} / f_{m3,d}) + \sigma_{m2,d} / f_{m2,d} \leq 1$$

$$(0.519 \leq 1)$$

Izkoriščenost prereza je 51.9%

$$\sigma_{t,0,d} / f_{t,0,d} + \sigma_{m3,d} / f_{m3,d} + k_m \times (\sigma_{m2,d} / f_{m2,d}) \leq 1$$

$$(0.737 \leq 1)$$

Izkoriščenost prereza je 73.7%

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Razmak pridrženih točk pravokotno na smer osi 2

Kmod = 0.800

$\gamma_m = 1.250$

lef = 100.00 cm

E0.05 = 9400.0 MPa

G0.05 = 480.00 MPa

I_{tor} = 3.00e+5 cm⁴

I₂ = 92160 cm⁴

W3 = 25600 cm³

$\sigma_{m,crit} = 433.58$ MPa

$\lambda_{rel} = 0.235$

k_{krit} = 1.000

$\sigma_{m3,d} = 11.230$ MPa

$$\sigma_{m3,d} \leq k_{krit} \times f_{m3,d} (11.230 \leq 15.360)$$

Izkoriščenost prereza je 73.1%

KONTROLA STRIŽNIH NAPETOSTI

(obtežni primer 5, konec palice)

Prečna sila v smeri osi 2	T2 =	120.77 kN
Prečna sila v smeri osi 3	T3 =	3.270 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod = 0.800

$\gamma_m = 1.250$

f_{v,k} = 2.700 MPa

f_{v,d} = 1.728 MPa

A = 1920.0 cm²

$\tau_{2,d} = 0.944$ MPa

$\tau_{3,d} = 0.026$ MPa

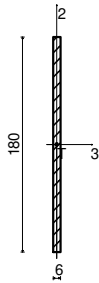
$\tau_s = 0.944$ MPa

$$\tau_s \leq f_{v,d} (0.944 \leq 1.728)$$

Izkoriščenost prereza je 54.6%

POZ 304: robni strešni nosilec (atika+preklada): CLT L3s 100 mm

Monolitni les - iglavci in mehki listavci - C24
Eksploatacijski razred 1
EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽB

5. $\gamma=0.87$ 4. $\gamma=0.75$

KONTROLA NORMALNIH NAPETOSTI

(obtežni primer 5, na 580.0 cm od začetka palice)

Računska osna sila	N =	-31.498 kN
Prečna sila v smeri osi 2	T2 =	-3.274 kN
Prečna sila v smeri osi 3	T3 =	0.000 kN
Upogibni moment okoli osi 2	M2 =	0.000 kNm
Upogibni moment okoli osi 3	M3 =	-199.16 kNm

KONTROLA NAPETOSTI - TLAK IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Faktor oblik (za pravokotni prerez)

Karakteristična tlačna trdnost

Računska tlačna trdnost

Karakteristična upogibna trdnost

Računska upogibna trdnost - os 2

Računska upogibna trdnost - os 3

Relativna vitkost

Relativna vitkost

Normalne tlačne napetosti

Odpornostni moment

Normalna upogibna napetost okoli osi 3

$$\sigma_{m3,d} \leq f_{m,3,d} \quad (6.147 \leq 14.769)$$

Izkoriščenost prereza je 41.6%

TLAK IN UPOGIB - VELIKA VITKOST

Začetna imperfekcija

Koeficient

Koeficient

Koeficient

$$\beta \chi = 0.200$$

$$k_3 = 0.474$$

$$k_2 = 1.047$$

$$k_{c,3} = 1.057$$

Koeficient

$$k_{c,2} = 0.705$$

$$(\sigma_{c,0,d} / (k_{c,2} \times f_{c,0,d})) + k_m \times (\sigma_{m3,d} / f_{m,3,d}) + \sigma_{m2,d} / f_{m,2,d} \leq 1 \quad (0.323 \leq 1)$$

Izkoriščenost prereza je 32.3%

$$(\sigma_{c,0,d} / (k_{c,3} \times f_{c,0,d})) + \sigma_{m3,d} / f_{m,3,d} + k_m \times (\sigma_{m2,d} / f_{m,2,d}) \leq 1 \quad (0.438 \leq 1)$$

Izkoriščenost prereza je 43.8%

KONTROLA STRIŽNIH NAPETOSTI

(obtežni primer 5, konec palice)

Prečna sila v smeri osi 2	T2 =	84.172 kN
Prečna sila v smeri osi 3	T3 =	0.000 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Kmod =	0.800
γ_m =	1.300
$f_{v,k}$ =	2.500 MPa
$f_{v,d}$ =	1.538 MPa
A =	1080.0 cm ²
$\tau_{2,d}$ =	1.169 MPa

$$\tau_{2,d} \leq f_{v,d} \quad (1.169 \leq 1.538)$$

Izkoriščenost prereza je 76.0%

DOKAZ STABILNOSTI ELEMENTA

(obtežni primer 5, na 580.0 cm od začetka palice)

Računska osna sila	N =	-31.027 kN
Prečna sila v smeri osi 2	T2 =	2.240 kN
Prečna sila v smeri osi 3	T3 =	0.000 kN
Upogibni moment okoli osi 2	M2 =	0.000 kNm
Upogibni moment okoli osi 3	M3 =	-199.16 kNm

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Razmak pridržanih točk pravokotno na smer osi 2

5% fraktil modula E paralelno z vlakni

5% fraktil strižnega modula G

Torzijski vztrajnostni moment

Vztrajnostni moment

Odpornostni moment

Kritična napetost uklona

Relativna vitkost za uklon

Koeficient

Normalna upogibna napetost okoli osi 3

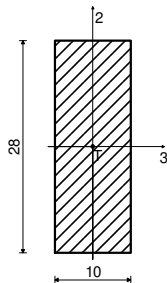
Kmod =	0.800
γ_m =	1.300
l_{ef} =	100.00 cm
$E_{0.05}$ =	7400.0 MPa
$G_{0.05}$ =	460.00 MPa
I_{tor} =	12735 cm ⁴
I_2 =	3240.0 cm ⁴
W_3 =	32400 cm ³
$\sigma_{m,crit}$ =	11.492 MPa
λ_{rel} =	1.445
k_{krit} =	0.479
$\sigma_{m3,d}$ =	6.147 MPa

$$\sigma_{m3,d} \leq k_{krit} \times f_{m,3,d} \quad (6.147 \leq 7.072)$$

Izkoriščenost prereza je 86.9%

POZ 305: preklopniki ob svetlobniku

Monolitni les - iglavci in mehki listavci - C24
Eksplotacijski razred 1
EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽEB

5. $\gamma = 0.80$ 4. $\gamma = 0.62$

KONTROLA NORMALNIH NAPETOSTI

(obežni primer 5, na 230.0 cm od začetka palice)

Računska osna sila	N =	-32.790 kN
Prečna sila v smeri osi 2	T2 =	-4.059 kN
Prečna sila v smeri osi 3	T3 =	-1.467 kN
Upogibni moment okoli osi 2	M2 =	0.721 kNm
Upogibni moment okoli osi 3	M3 =	-12.328 kNm

KONTROLA NAPETOSTI - TLAK IN UPOGIB

Vrsta obežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Faktor oblik (za pravokotni prerez)

Karakteristična tlačna trdnost

Računska tlačna trdnost

Karakteristična upogibna trdnost

Računska upogibna trdnost - os 2

Računska upogibna trdnost - os 3

Relativna vitkost

Relativna vitkost

Normalne tlačne napetosti

Odpornostni moment

Normalna upogibna napetost okoli osi 2

$$\sigma_{m2,d} \leq f_{m2,d} (1.546 \leq 16.017)$$

Izkoriščenost prereza je 9.7%

Odpornostni moment

Normalna upogibna napetost okoli osi 3

Kmod = 0.800

$\gamma_m = 1.300$

Kh_2 = 1.084

Kh_3 = 1.000

km = 0.700

fc,0,k = 21.000 MPa

fc,0,d = 12.923 MPa

fm,k = 24.000 MPa

fm,2,d = 16.017 MPa

fm,3,d = 14.769 MPa

$\lambda_{rel,2} = 0.587$

$\lambda_{rel,3} = 0.587$

$\sigma_{c,0,d} = 1.171$ MPa

W2 = 466.67 cm³

$\sigma_{m2,d} = 1.546$ MPa

W3 = 1306.7 cm³

$\sigma_{m3,d} = 9.435$ MPa

$$\sigma_{m3,d} \leq f_{m3,d} (9.435 \leq 14.769)$$

Izkoriščenost prereza je 63.9%

TLAK IN UPOGIB - VELIKA VITKOST

Začetna imperfekcija

Koeficient

Koeficient

Koeficient

Koeficient

$\beta_{\#} = 0.200$

k3 = 0.513

k2 = 0.701

kc,3 = 1.019

kc,2 = 0.922

$$(\sigma_{c,0,d} / (k_{c,2} \times f_{c,0,d})) + k_m \times (\sigma_{m3,d} / f_{m3,d}) + \sigma_{m2,d} / f_{m2,d} \leq 1 (0.642 \leq 1)$$

Izkoriščenost prereza je 64.2%

$$(\sigma_{c,0,d} / (k_{c,3} \times f_{c,0,d})) + \sigma_{m3,d} / f_{m3,d} + k_m \times (\sigma_{m2,d} / f_{m2,d}) \leq 1 (0.795 \leq 1)$$

Izkoriščenost prereza je 79.5%

DOKAZ BOČNE STABILNOSTI

Vrsta obežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Razmak pridržanih točk pravokotno na smer osi 2

Kmod = 0.800

$\gamma_m = 1.300$

lef = 100.00 cm

E0.05 = 7400.0 MPa

G0.05 = 460.00 MPa

I_{tor} = 7240.1 cm⁴

I2 = 2333.3 cm⁴

W3 = 1306.7 cm³

$\sigma_{m,crit} = 182.32$ MPa

$\lambda_{rel} = 0.363$

k_{krit} = 1.000

$\sigma_{m3,d} = 9.435$ MPa

$$\sigma_{m3,d} \leq k_{krit} \times f_{m3,d} (9.435 \leq 14.769)$$

Izkoriščenost prereza je 63.9%

KONTROLA STRIŽNIH NAPETOSTI

(obežni primer 5, na 86.7 cm od začetka palice)

Prečna sila v smeri osi 2

T2 = -5.257 kN

Prečna sila v smeri osi 3

T3 = -0.522 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod = 0.800

$\gamma_m = 1.300$

fv,k = 2.500 MPa

fv,d = 1.538 MPa

A = 280.00 cm²

$\tau_{2,d} = 0.282$ MPa

$\tau_{3,d} = 0.028$ MPa

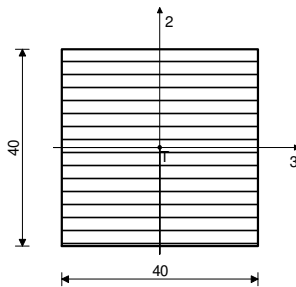
$\tau_s = 0.283$ MPa

$$\tau_s \leq f_{v,d} (0.283 \leq 1.538)$$

Izkoriščenost prereza je 18.4%

POZ 310: stebri 2x 20/40 cm; GL24h

Lepljen lameliran les - GL24h
v smeri zgornjega roba palice
Debelina lamele 2.00 cm
Eksploatacijski razred 1
EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
4. $\gamma = 0.35$ 5. $\gamma = 0.33$

KONTROLA NORMALNIH NAPETOSTI
(obtežni primer 4, konec palice)

Računska osna sila	N =	-166.60 kN
Prečna sila v smeri osi 2	T2 =	1.214 kN
Prečna sila v smeri osi 3	T3 =	-10.895 kN
Upogibni moment okoli osi 2	M2 =	46.719 kNm
Upogibni moment okoli osi 3	M3 =	2.437 kNm

KONTROLA NAPETOSTI - TLAK IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetraino
Korekcijski koeficient
Parcialni koef. za karakteristike materiala
Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Faktor oblik (za pravokotni prerez)

Karakteristična tlačna trdnost

Računska tlačna trdnost

Karakteristična upogibna trdnost

Računska upogibna trdnost

Relativna vitkost

Relativna vitkost

Normalne tlačne napetosti

Odpornostni moment

Normalna upogibna napetost okoli osi 2

Kmod = 0.800

$\gamma_m = 1.250$

Kh_2 = 1.041

Kh_3 = 1.041

km = 0.700

fc,0,k = 24.000 MPa

fc,0,d = 15.360 MPa

fm,k = 24.000 MPa

fm,d = 15.996 MPa

$\lambda_{rel,2} = 0.637$

$\lambda_{rel,3} = 0.637$

oc,0,d = 1.041 MPa

W2 = 10667 cm³

om2,d = 4.380 MPa

$$\sigma_{m2,d} \leq f_{m,d} \quad (4.380 \leq 15.996)$$

Izkoriščenost prereza je 27.4%

Odpornostni moment

Normalna upogibna napetost okoli osi 3

W3 = 10667 cm³

om3,d = 0.228 MPa

$$\sigma_{m3,d} \leq f_{m,d} \quad (0.228 \leq 15.996)$$

Izkoriščenost prereza je 1.4%

TLAK IN UPOGIB - VELIKA VITKOST

Začetna imperfekcija

Koeficient

Koeficient

Koeficient

Koeficient

$\beta_{\#x} = 0.100$

k3 = 0.719

k2 = 0.719

kc,3 = 0.948

kc,2 = 0.948

$$(\sigma_{c,0,d} / (k_{c,2} \times f_{c,0,d})) + k_m \times (\sigma_{m3,d} / f_{m,d}) + \sigma_{m2,d} / f_{m,d} \leq 1 \quad (0.355 \leq 1)$$

Izkoriščenost prereza je 35.5%

$$(\sigma_{c,0,d} / (k_{c,3} \times f_{c,0,d})) + \sigma_{m3,d} / f_{m,d} + k_m \times (\sigma_{m2,d} / f_{m,d}) \leq 1 \quad (0.277 \leq 1)$$

Izkoriščenost prereza je 27.7%

KONTROLA STRIŽNIH NAPETOSTI
(obtežni primer 4, začetek palice)

Prečna sila v smeri osi 2

Prečna sila v smeri osi 3

T2 = 1.214 kN

T3 = -10.895 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod = 0.800

$\gamma_m = 1.250$

fv,k = 2.700 MPa

fv,d = 1.728 MPa

A = 1600.0 cm²

$\tau_{2,d} = 0.011$ MPa

$\tau_{3,d} = 0.102$ MPa

ts = 0.103 MPa

$$\tau_s \leq f_{v,d} \quad (0.103 \leq 1.728)$$

Izkoriščenost prereza je 5.9%

DOKAZ STABILNOSTI ELEMENTA
(obtežni primer 5, začetek palice)

Računska osna sila

Prečna sila v smeri osi 2

Prečna sila v smeri osi 3

Upogibni moment okoli osi 2

Upogibni moment okoli osi 3

N = -208.31 kN

T2 = 1.485 kN

T3 = -9.240 kN

M2 = -2.603 kNm

M3 = -4.222 kNm

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Razmak pridržanih točk pravokotno na smer osi 2

Kmod = 0.800

$\gamma_m = 1.250$

lef = 457.00 cm

E0.05 = 9400.0 MPa

G0.05 = 480.00 MPa

ltor = 3.61e+5 cm⁴

I2 = 2.13e+5 cm⁴

W3 = 10667 cm³

$\sigma_{m,crit} = 379.67$ MPa

$\lambda_{rel} = 0.251$

k_krit = 1.000

om3,d = 0.396 MPa

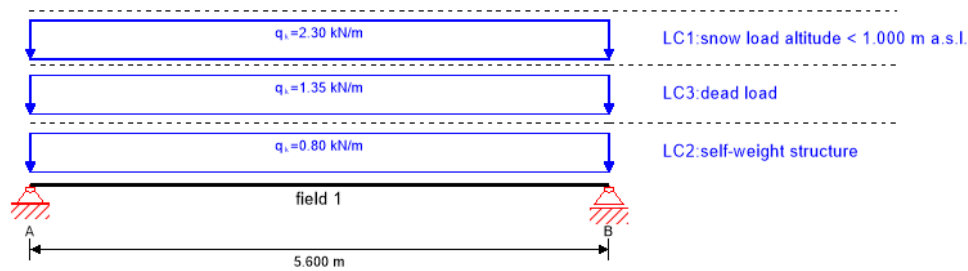
$$\sigma_{m,3,d} \leq k_{krit} \times f_{m,3,d} \quad (0.396 \leq 15.996)$$

Izkoriščenost prereza je 2.5%

Kontrola kontaktnih napetosti:

$$N_d / A = 380 \text{ kN} / (46 \times 46 \text{ cm}) = 0,18 \text{ kN/cm}^2 < k_{c,90} \times f_{c,90,d} = 0,19 \text{ kN/cm}^2 \rightarrow \text{OK}$$

system

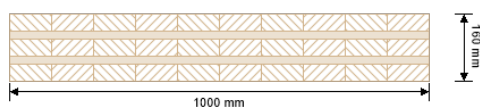


global utilization ratio

87 %

ULS	34 %	ULS fire	0 %	SLS	87 %	SLS vibration	0 %	support	-1 %
-----	------	----------	-----	-----	------	---------------	-----	---------	------

section: CLT 160 L5s



layer	thickness	orientation	material
1	40.0 mm	0°	C24 spruce
2	20.0 mm	90°	C24 spruce
3	40.0 mm	0°	C24 spruce
4	20.0 mm	90°	C24 spruce
5	40.0 mm	0°	C24 spruce
t_{CLT}	160.0 mm		

material values

material	$f_{m,k}$	$f_{t,0,k}$	$f_{t,90,k}$	$f_{c,0,k}$	$f_{c,90,k}$	$f_{v,k}$	$f_{r,k \text{ min}}$	$E_{0,mean}$	G_{mean}	$G_{r,mean}$
	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
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
LC2	self-weight structure	G	permanet	0.6	1	1.35	1	1	1
LC3	dead load	G	permanet	0.6	1	1.35	1	1	1
LC1	snow load altitude < 1.000 m a.s.l.	Q	short term	0.9	0	1.5	0.5	0.2	0

LC2:self-weight structure

continous load

field	load at start
	[kN/m]
1	0.80

LC3:dead load

continous load

field	load at start
	[kN/m]
1	1.35

LC1:snow load altitude < 1.000 m a.s.l.

continous load

field	load at start
	[kN/m]
1	2.30

ULS combinations

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

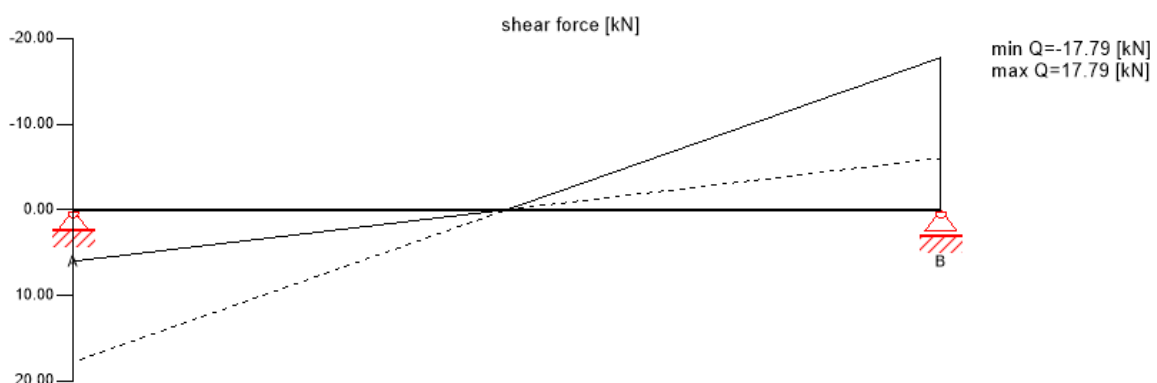
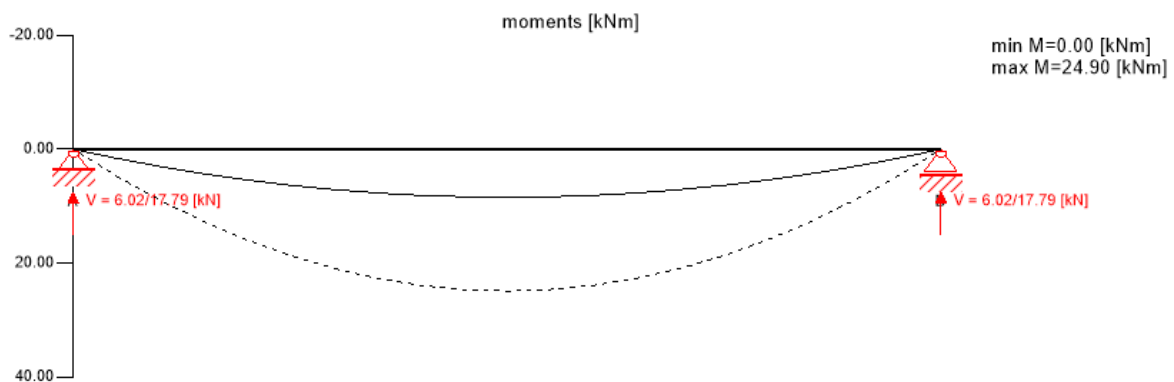
SLS characteristic combination

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

SLS quasi-permanent combination

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

Ultimate limit state (ULS) - design results

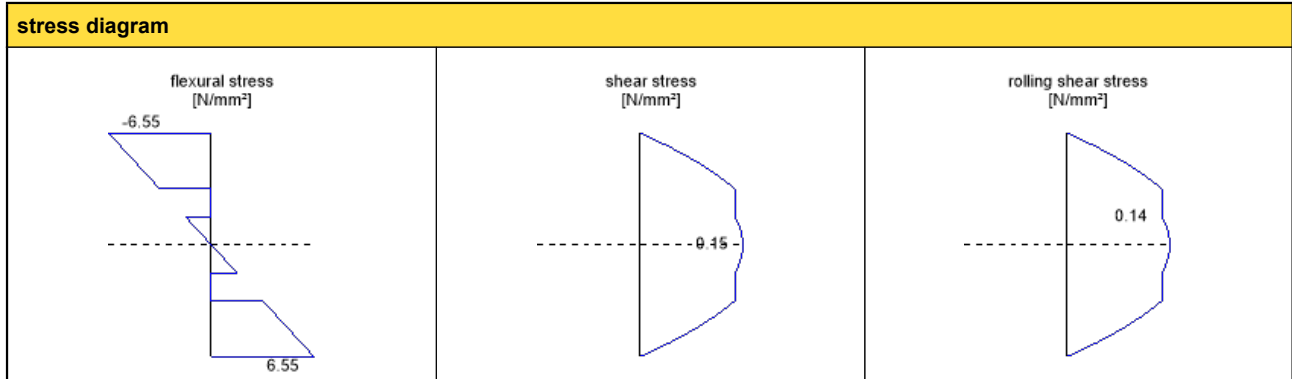


ULS flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	$k_{sys,y}$	$f_{m,y,d}$	$M_{y,d}$	$\sigma_{m,y,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
1	2.8	24.00	1.25	0.90	1.10	19.01	24.90	6.55	34 %	LCO2

ULS shear analysis									
field	dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	0.0	4.00	1.25	0.90	2.88	17.79	0.15	5 %	LCO2

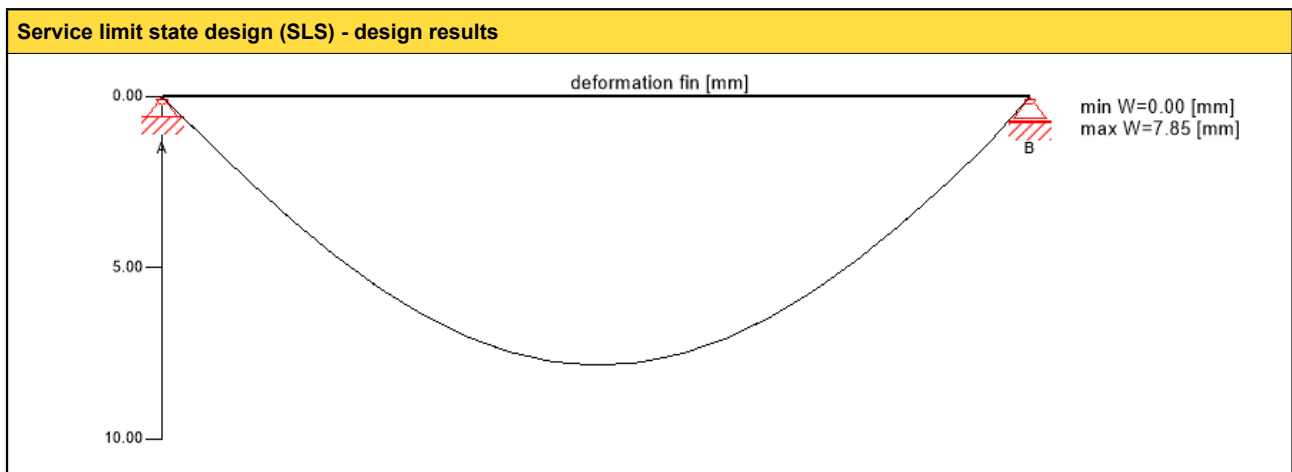
ULS rolling shear									
field	dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$T_{r,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	0.0	1.25	1.25	0.90	0.90	17.79	0.14	16 %	LCO2



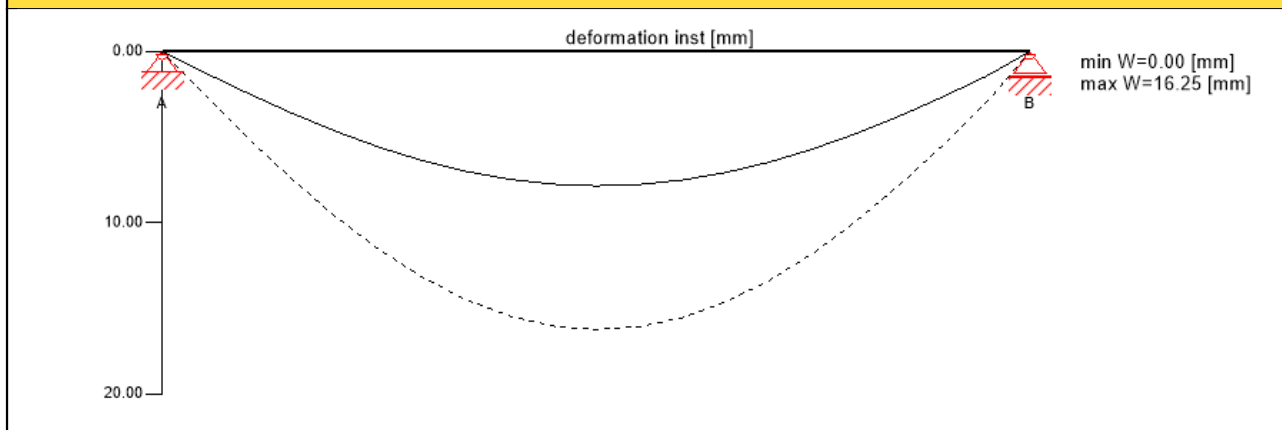
flexural stress analysis									
$M_{y,d}$	=	24.90	kNm	$f_{m,k}$	=	24.00	N/mm ²		
$N_{t,d}$	=	0.00	kN	γ_m	=	1.25	-		
				k_{mod}	=	0.90	-		
				$k_{sys,y}$	=	1.10	-		
$\sigma_{t,d}$	=	0.00	N/mm ²	$f_{t,d}$	=	10.08	N/mm ²		
$\sigma_{m,y,d}$	=	6.55	N/mm ²	$f_{m,y,d}$	=	19.01	N/mm ²		✓
utilization ratio								34 %	

shear stress analysis									
V_d	=	17.79	kN	$f_{v,k}$	=	4.00	N/mm ²		
				γ_m	=	1.25	-		
				k_{mod}	=	0.90	-		
$T_{v,d}$	=	0.15	N/mm ²	$f_{v,d}$	=	2.88	N/mm ²		✓
utilization ratio								5 %	

rolling shear analysis									
V_d	=	17.79	kN	$f_{r,k}$	=	1.25	N/mm ²		
				γ_m	=	1.25	-		
				k_{mod}	=	0.90	-		
$T_{r,d}$	=	0.14	N/mm ²	$f_{r,d}$	=	0.90	N/mm ²		✓
utilization ratio								16 %	



Service limit state design (SLS) - design results



initial deflection [w_{char}]

field	dist. [m]	limit [-]	w_{limit} [mm]	$w_{calc.}$ [mm]	ratio	
1	2.8	1/300	18.7	16.2	87 %	LCO2

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

field	dist. [m]	limit [-]	w_{limit} [mm]	$w_{calc.}$ [mm]	ratio	
1	2.8	1/150	37.3	22.5	60 %	LCO3

net final deflection [$w_{q.p.} \cdot (1+k_{def})$]

field	dist. [m]	limit [-]	w_{limit} [mm]	$w_{calc.}$ [mm]	ratio	
1	2.8	1/250	22.4	14.1	63 %	LCO3

support reaction

load case category	k_{mod}	A_v	B_v
		[kN]	
self-weight structure	0.6	2.24	2.24
		2.24	2.24
dead load	0.6	3.78	3.78
		3.78	3.78
snow load altitude < 1.000 m a.s.l.	0.9	6.44	6.44
		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 t_f of gypsum fire boards (GKF) according to ON B 3410	Expertise on failure time t_f 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 guideline for Europe	Fire safety in timber buildings - technical guideline for Europe; publishes by SP Technical Research Institute of Sweden

reference documents for this analysis	
English title	description
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

The software was created to assist engineers in their daily business. The software is an engineering software that is dealing with a very complex matter of structural analysis and building physics analysis. Therefore, this software shall only be operated by skilled, experienced engineers, with a deep understanding of structural engineering and building physics related to timber structures. The user of the software is obliged to check all input values, no matter if they were given by the user or given by default by the software and all results for plausibility.

The use of the results of the software should not be relied upon as the basis for any decision or action. Any use of results of the software is only allowed, if the results have been verified and approved regarding completeness and correctness by a project structural/building physics engineer. The user has the possibility to make print-outs from the software. Any modification of those are not allowed.

Stora Enso Wood Products GmbH does not assume any warranty regarding the software. The software has been developed with utmost diligence, nevertheless Stora Enso Wood Products GmbH, neither expressly nor implicitly, provides any warranty in terms of accuracy, validity, timeliness and completeness of information and data created by the software. Stora Enso Wood Products GmbH does also not assume any warranty for the general usability of the software, its suitability for a special purpose or for the compatibility of the software with the ones of third party producers or providers.

Stora Enso Wood Products GmbH is only liable for damages caused by gross negligence or intent through Stora Enso Wood Products GmbH; the liability for slight negligence is excluded. This does not apply to personal injury. Under the aforementioned conditions Stora Enso Wood Products GmbH is as well not liable for operational failures or the loss of programs and/or data of the user's data processing system.

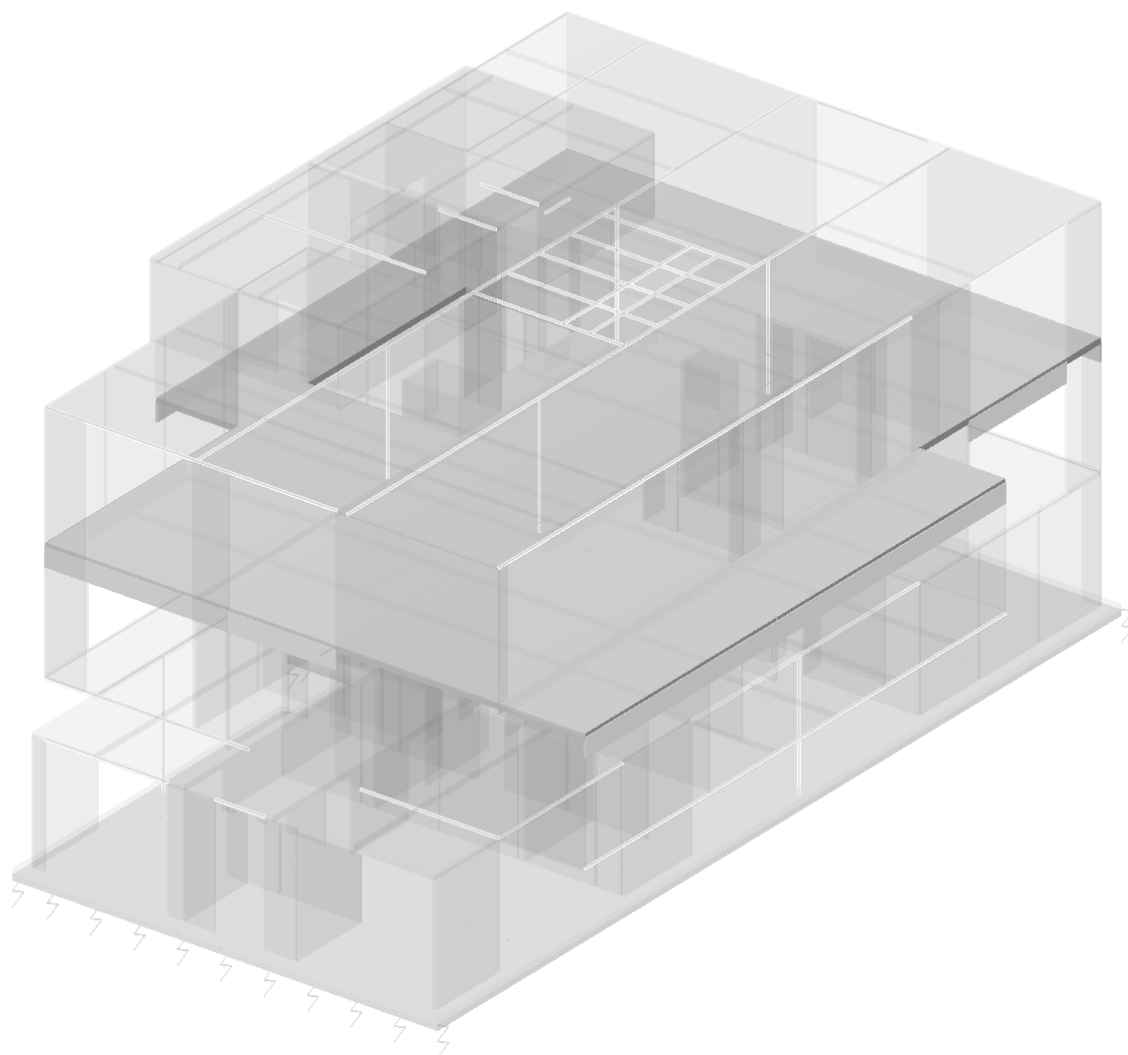
Applicable Law: These terms of use shall be governed by the laws of Austria excluding however any conflict of laws rules and any laws regarding the Convention of the International Sale of Goods (CISG).

POZ 200

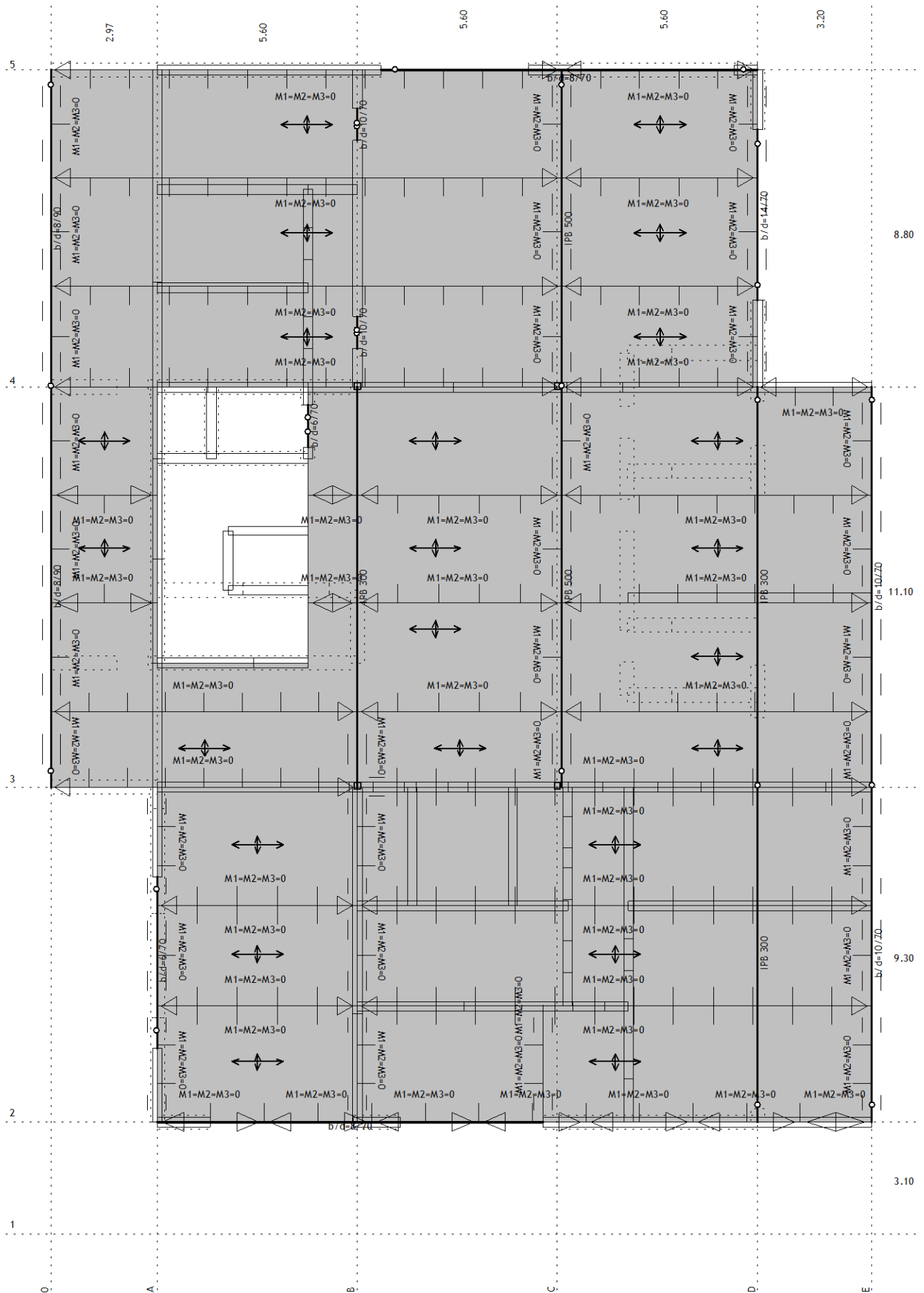
POZ 200: medetažna plošča nad 1. nadstropjem

Medetažno ploščo izvedemo s križno lepljenimi lesenimi ploščami debeline 220 mm. Plošče nalegajo na lesene stene, v oseh B in C so podprte v jeklenima nosilcema, na previsnem delu se plošča nosi preko robnega nosilca, ki je obešan na konzolne stene drugega nadstropja.

- POZ 200: plošča CLT L7s-2 220 mm
- POZ 201: jekleni nosilec HEB 300; S 235
- POZ 202: jekleni nosilec HEB 500; S 235
- POZ 203: jekleni nosilec HEB 300; S 235
- POZ 204: robni nosilec pod ploščo CLT L5s 140 mm; h = 70 cm - zunanji sloji horizontalno
- POZ 205: lesena preklada 14/70 cm; GL24h
- POZ 206: robni nosilec pod ploščo CLT L3s 120 mm; h = 90 cm - zunanji sloji horizontalno
- POZ 210: vertikalna ojačitev CLT stene 12/28 cm; C 24



Izometrija (Nivo: POZ 200 [8.92 m])



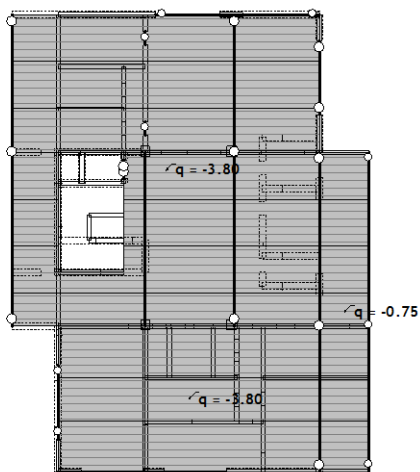
Vhodni podatki - Obtežba

Lista obtežnih primerov

LC	Naziv
1	Stalna + l.t. (g)
2	Koristna
3	Sneg
4	Komb.: MSN-01 (1.35xI+1.5xII+0.75xIII)
5	Komb.: MSN-02 (1.35xI+1.05xII+1.5xIII)

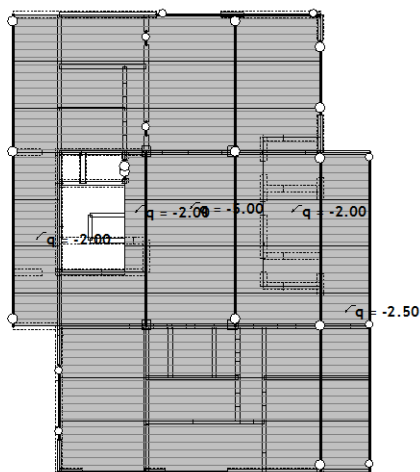
6	Komb.: MSU-01 (I+II+0.5xIII)
7	Komb.: MSU-02 (I+0.7xII+III)
8	Komb.: MSU-fin-01 (1.6xI+1.18xII+0.5xIII)
9	Komb.: MSU-fin-02 (1.6xI+0.88xII+III)

Obt. 1: Stalna + l.t. (g)



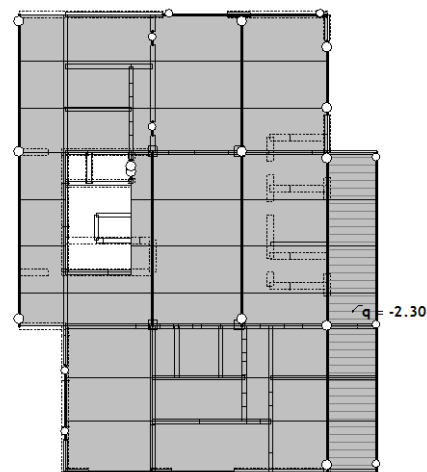
Nivo: POZ 200 [8.92 m]

Obt. 2: Koristna



Nivo: POZ 200 [8.92 m]

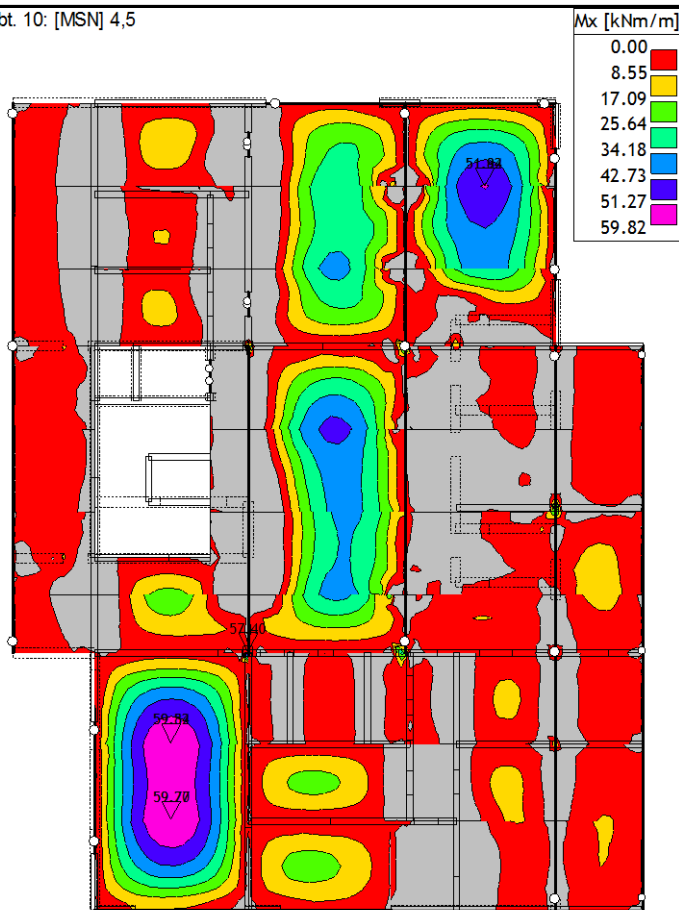
Obt. 3: Sneg



Nivo: POZ 200 [8.92 m]

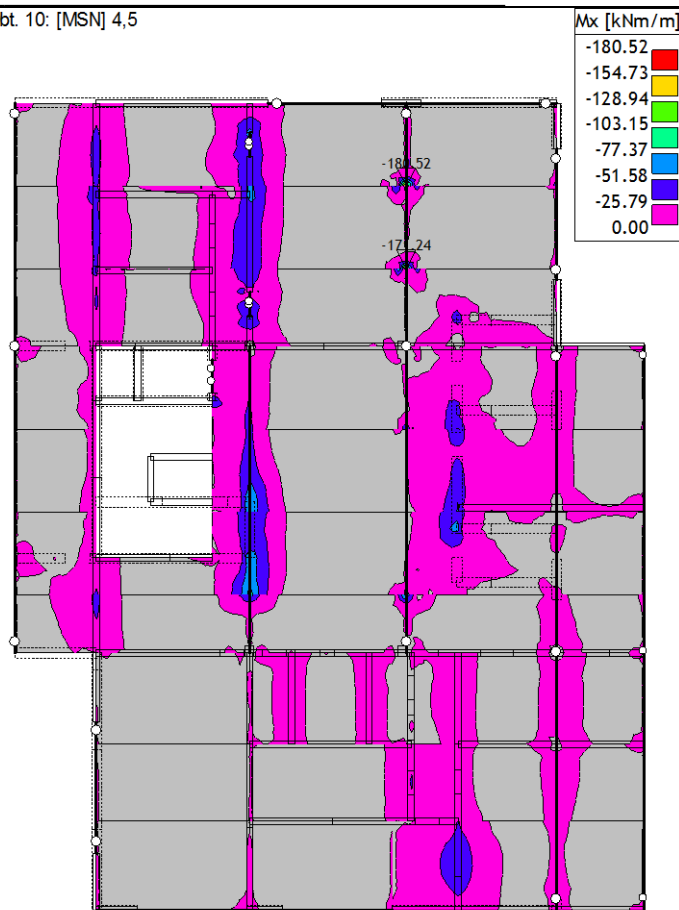
Statični preračun

Obt. 10: [MSN] 4,5



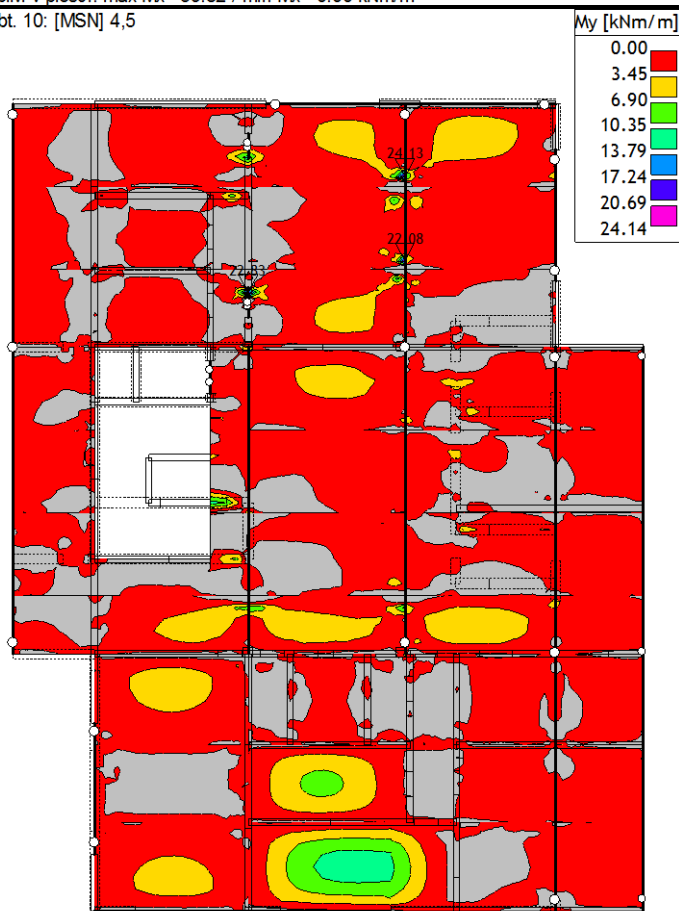
Nivo: POZ 200 [8.92 m]
Vplivi v plošči: max Mx= 59.82 / min Mx= 0.00 kNm/m

Obt. 10: [MSN] 4,5



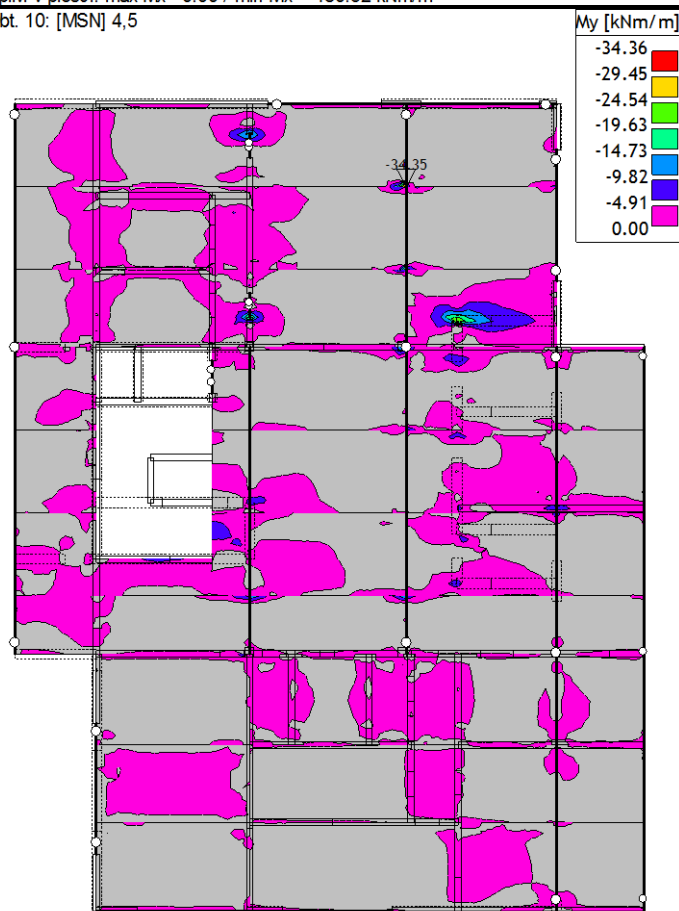
Nivo: POZ 200 [8.92 m]
Vplivi v plošči: max Mx= 0.00 / min Mx= -180.52 kNm/m

Obt. 10: [MSN] 4,5



Nivo: POZ 200 [8.92 m]
Vplivi v plošči: max My= 24.13 / min My= 0.00 kNm/m

Obt. 10: [MSN] 4,5



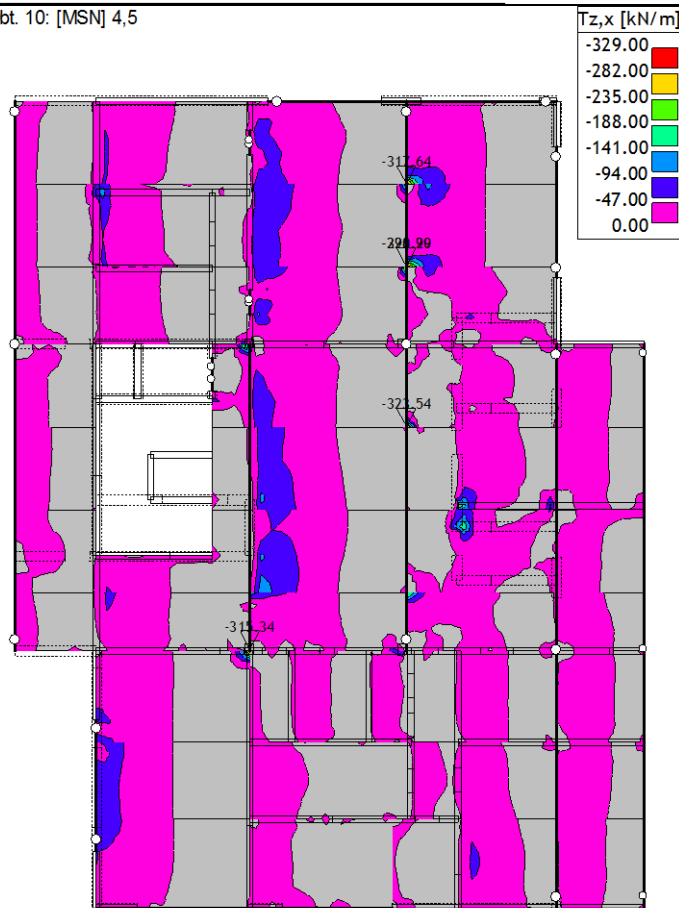
Nivo: POZ 200 [8.92 m]
Vplivi v plošči: max My= 0.00 / min My= -34.35 kNm/m

Obt. 10: [MSN] 4,5



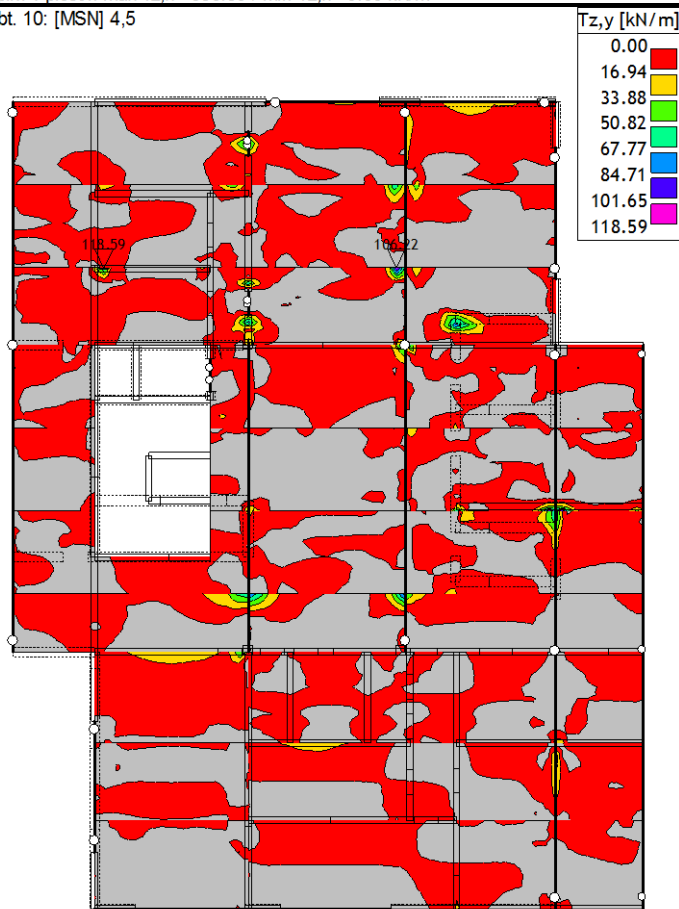
Nivo: POZ 200 [8.92 m]
Vplivi v plošči: max $T_{z,x} = 586.86$ / min $T_{z,x} = 0.00$ kN/m

Obt. 10: [MSN] 4,5



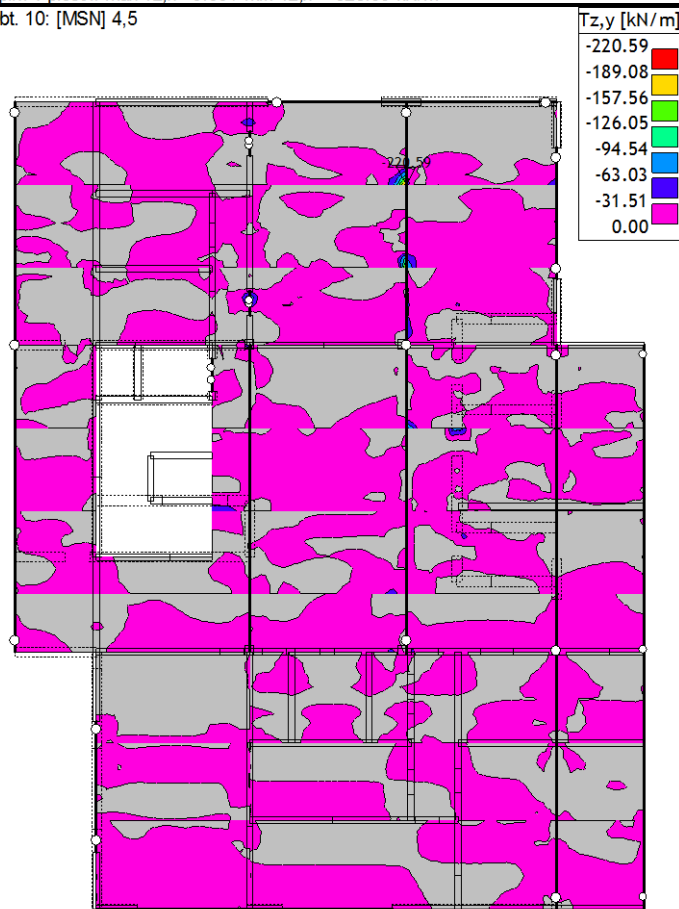
Nivo: POZ 200 [8.92 m]
Vplivi v plošči: max $T_{z,x} = 0.00$ / min $T_{z,x} = -328.99$ kN/m

Obt. 10: [MSN] 4,5



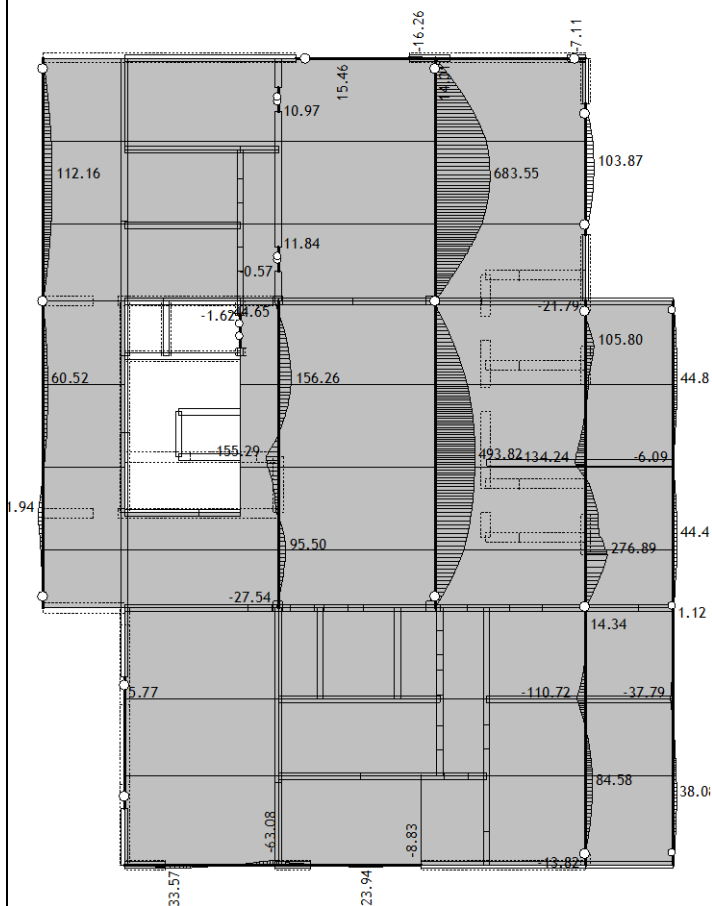
Nivo: POZ 200 [8.92 m]
Vplivi v plošči: max $T_{z,y} = 118.59$ / min $T_{z,y} = 0.00$ kN/m

Obt. 10: [MSN] 4,5



Nivo: POZ 200 [8.92 m]
Vplivi v plošči: max $T_{z,y} = 0.00$ / min $T_{z,y} = -220.59$ kN/m

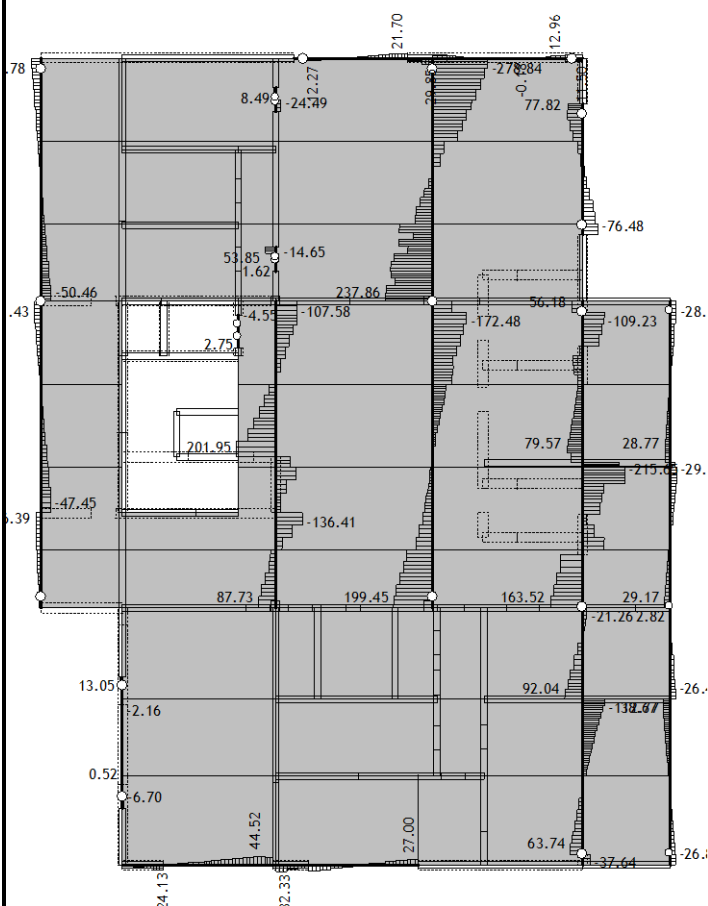
Obt. 10: [MSN] 4,5



Nivo: POZ 200 [8.92 m]

Vplivi v gredi: max M3= 683.55 / min M3= -155.29 kNm

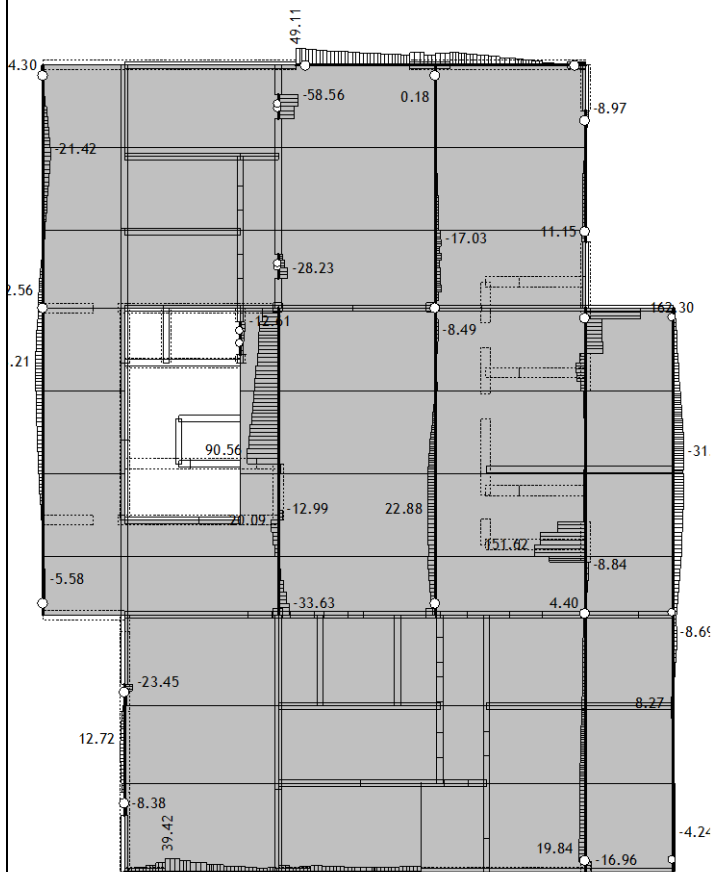
Obt. 10: [MSN] 4,5



Nivo: POZ 200 [8.92 m]

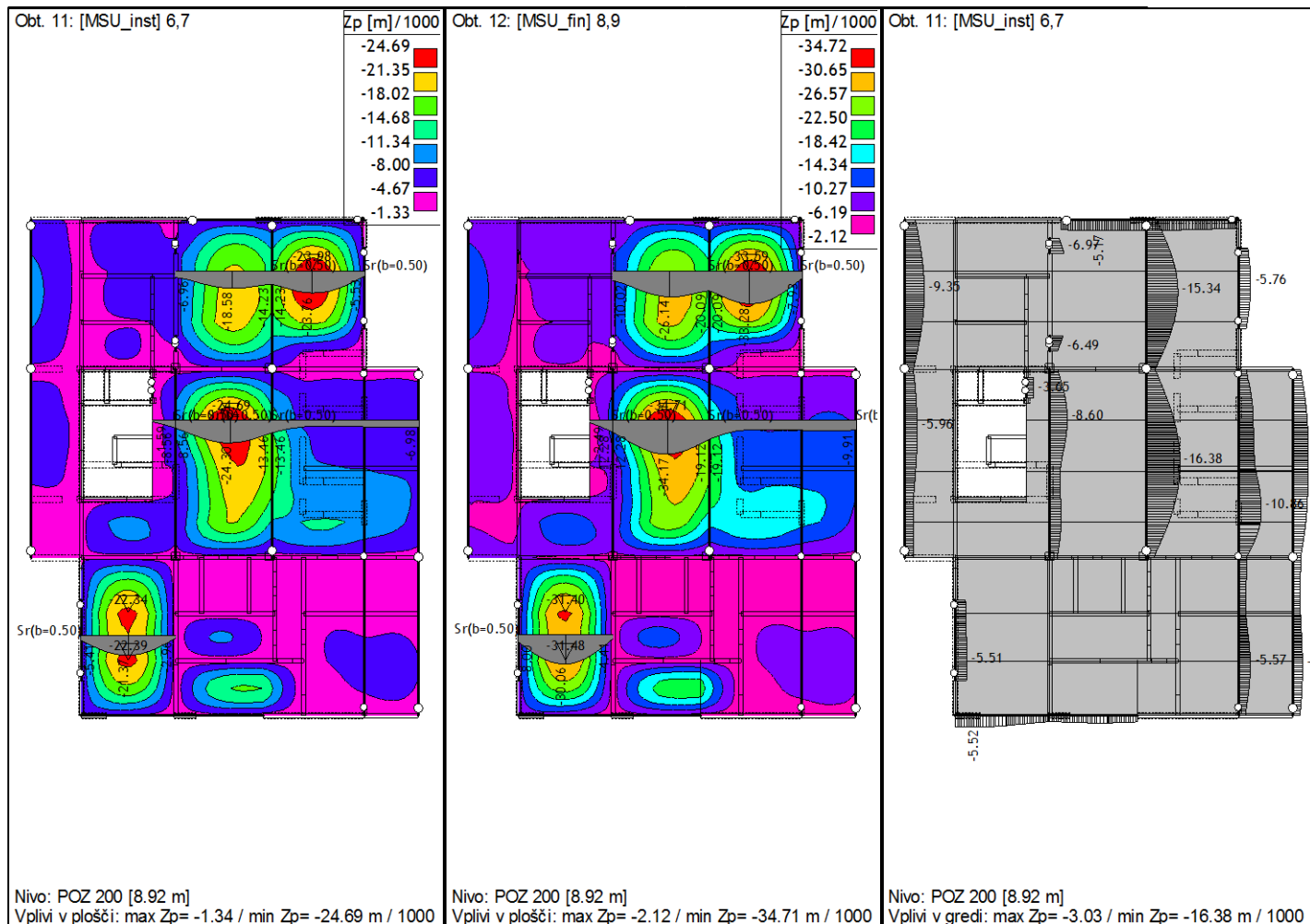
Vplivi v gredi: max T2= 237.86 / min T2= -278.84 kN

Obt. 10: [MSN] 4,5



Nivo: POZ 200 [8.92 m]

Vplivi v gredi: max N1= 151.62 / min N1= -162.30 kN



Kontrola povesov za MSU:

POZ 200:

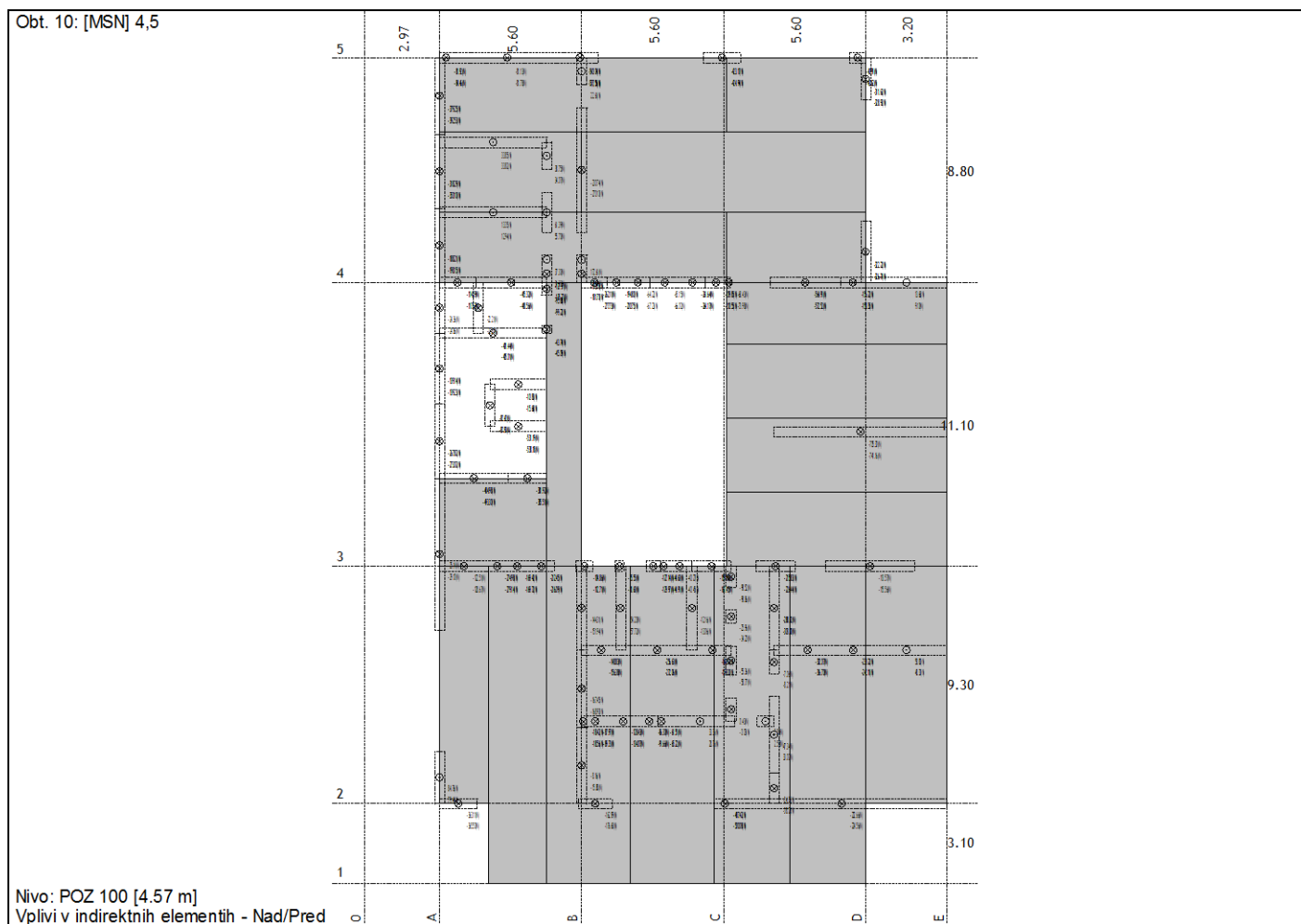
$w(\text{MSU,inst}) = 2,4 - 1,3 \text{ cm} = 1,1 \text{ cm} < w(\text{dop}) = L / 300 = 1,9 \text{ cm} \rightarrow \text{OK}$

$w(\text{MSU,fin}) = 3,4 - 1,9 \text{ cm} = 1,5 \text{ cm} < w(\text{dop}) = L / 250 = 2,3 \text{ cm} \rightarrow \text{OK}$

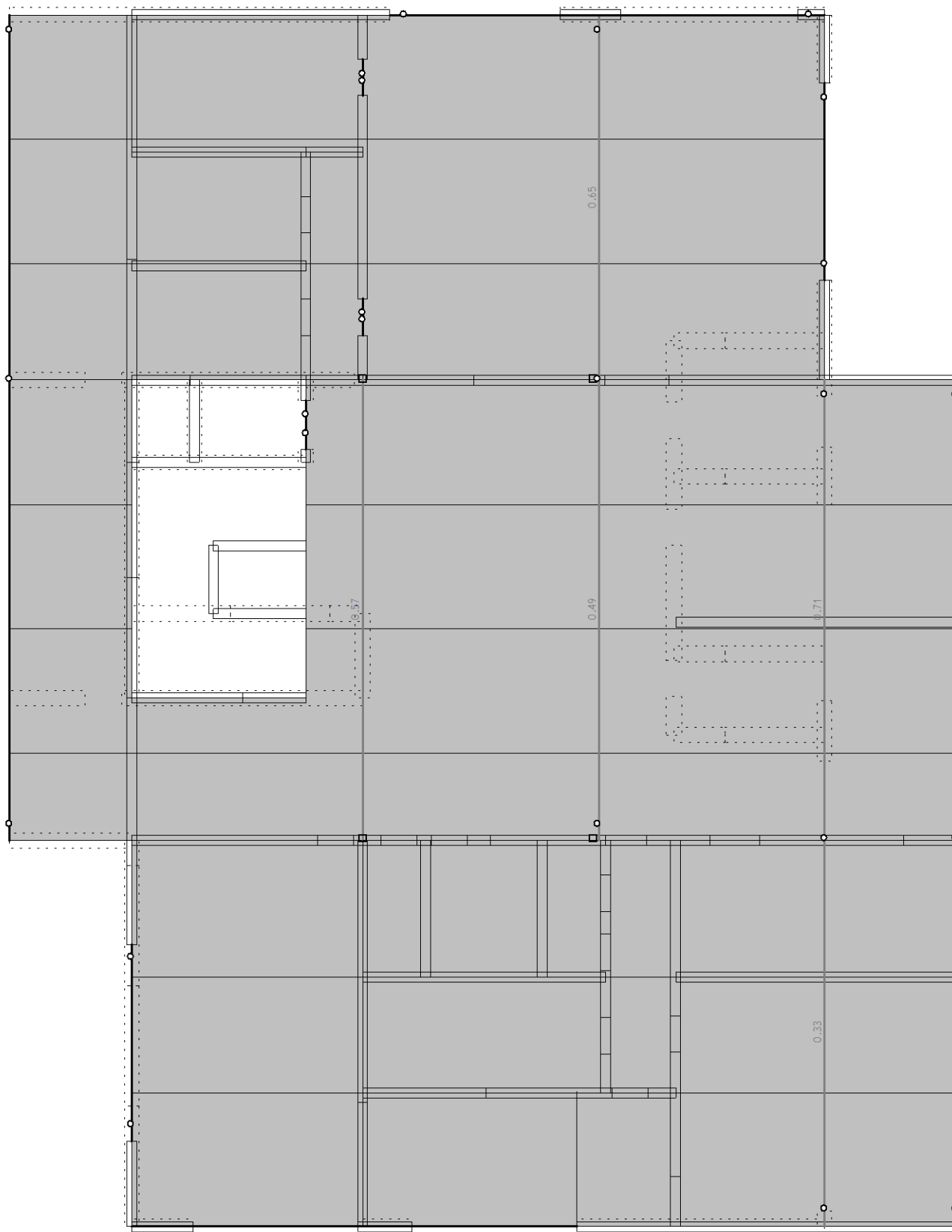
POZ 202:

$w(\text{MSU,inst}) = 1,6 - 0,4 \text{ cm} = 1,2 \text{ cm} < w(\text{dop}) = L / 300 = 3,7 \text{ cm} \rightarrow \text{OK}$

Prikaz osnih sil v CLT stenah 1. nadstropja:



Dimenzioniranje (jeklo)

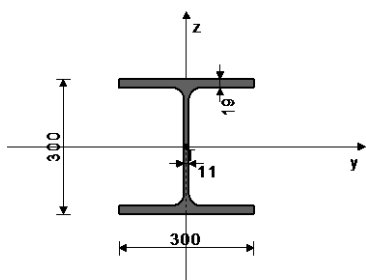


Nivo: POZ 200 [8.92 m]
Kontrola stabilnosti

POZ 201: HEB 300; S 235

PREČNI PREREZ: IPB 300 [S 235] [Set: 4]
EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza



Ax =	149.00	cm ²
Ay =	101.65	cm ²
Az =	47.350	cm ²
Ix =	186.00	cm ⁴
Iy =	25170	cm ⁴
Iz =	8560.0	cm ⁴
Wy,pl =	1678.0	cm ³
Wz =	570.67	cm ³
Wy,pl =	1865.8	cm ³
Wz,pl =	855.00	cm ³
yM0 =	1.100	
yM1 =	1.100	
yM2 =	1.250	
Anet/A =	0.900	

[mm]

(fy = 23.5 kN/cm², fu = 36.0 kN/cm²)

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
4. γ=0.57 5. γ=0.48

PALICA IZPOSTAVLJENA NATEGU IN UPOGIBU
(obtežni primer 4, na 563.0 cm od začetka palice)

Računska osna sila	Nsd =	90.564	kN
Prečna sila v y smeri	Vsd_y =	21.601	kN
Prečna sila v z smeri	Vsd_z =	201.95	kN
Upogibni moment okoli y osi	Msd_y =	-153.20	kNm
Upogibni moment okoli z osi	Msd_z =	-8.561	kNm
Moment torzije	Mt =	0.411	kNm
Sistemska dolžina palice	L =	1110.0	cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV
Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.3 Nateg

Plast.rač.nosilnost bruto prereza	Npl.Rd =	3183.2	kN
Mejna rač.nosilnost neto prereza	Nu.Rd =	3475.9	kN
Računska nos. na nateg	Nt.Rd =	3183.2	kN

Pogoj 5.13: Nsd <= Nt.Rd (90.56 <= 3183.18)

5.4.5 Upogib y-y

Računski plastični moment	Mpl.Rd =	398.60	kNm
Računska nos.na lokalno izbočitev	Mo.Rd =	358.48	kNm
Računski elastični moment	Mel.Rd =	358.48	kNm
Računska nosilnost na upogib	Mc.Rd =	398.60	kNm

Pogoj 5.17: Msd_y <= Mc.Rd_y (153.20 <= 398.60)

5.4.5 Upogib z-z

Računski plastični moment	Mpl.Rd =	182.66	kNm
Računska nos.na lokalno izbočitev	Mo.Rd =	121.92	kNm
Računski elastični moment	Mel.Rd =	121.92	kNm
Računska nosilnost na upogib	Mc.Rd =	182.66	kNm

Pogoj 5.17: Msd_z <= Mc.Rd_z (8.56 <= 182.66)

5.4.6 Strig

Računska plast.nos.na strig z-z	Vpl.Rd =	355.47	kN
---------------------------------	----------	--------	----

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (201.95 <= 355.47)

Računska plast.nos.na strig y-y

Vpl.Rd = 1242.9 kN

Pogoj 5.20: Vsd_y <= Vpl.Rd_y (21.60 <= 1242.90)

5.4.9 Upogib z osno in prečno silo

Koeficient zmanjšanja	ρ =	0.019
Zmanjšana meja plastičnosti	fy* =	23.064 kN/cm ²
Zmanjšana plast.upogibna nosilnost	Mv.Rd_y =	391.20 kNm
Zmanjšana plast.upogibna nosilnost	Mv.Rd_z =	179.27 kNm

5.4.8 Upogib in osna sila

Razmerje Nsd / Npl.Rd	0.028
Razmerje Msd_y / Mpl.Rd_y	0.392
Razmerje Msd_z / Mpl.Rd_z	0.048

Pogoj 5.36: (0.47 <= 1)

5.5 NOSILNOST ELEMENTOV

5.5.2 Bočna zvrnitev upogibnih nosilcev

Koeficient	C1 =	1.132
Koeficient	C2 =	0.459
Koeficient	C3 =	0.525
Koef.ukl.dolžine za uklon	k =	1.000
Koef.ukl.dolžine za vbočenje	kw =	1.000
Koordinata	zg =	0.000 cm
Koordinata	zj =	0.000 cm
Razmak med bočnimi podporami	L =	100.00 cm
Sektorski vztrajnostni moment	Iw =	1.69e+6 cm ⁶
Krit.moment bočne zvrnitve	Mcr =	28800 kNm
Koeficient	βw =	1.000
Koeficient imperf.	αLT =	0.210
Brezdimenz.vitkost	λLT =	0.123
Koeficient zmanjšanja	χLT =	1.000
Računska uklonska nosilnost	Mb.Rd =	398.60 kNm

5.5.3 Upogib in nateg

Redukcijski koef.za vektorske vplive	ψvec =	0.800
Elast.odp.mom.za krajne tlač.vlakno	Wcom =	1678.0 cm ³

Efektivni rač.notranji moment

Meff.sd = 145.04 kNm

Pogoj 5.50: Meff.sd <= Mb.Rd (145.04 <= 398.60)

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

za strig v ravnini z-z

Višina stojine	d =	26.200 cm
Debelina stojine	tw =	1.100 cm
Ni prečnih ojačitev v sredini		
Koeficient izbočenja pri strigu	kr =	5.340

Ni potrebna kontrola izbočenja zaradi striga

Pogoj: d / tw <= 69 ε (23.82 <= 69.00)

5.6.7 Interakcija prečne sile, upogiba in osne sile

za strig v ravnini z-z

Računski plastični moment pasnic	Mf.Rd =	302.22 kNm
----------------------------------	---------	------------

Pogoji 5.66a in 5.66b so izpolnjeni

5.7 VNOS KONCENTRIRANIH SIL V STOJINO

5.7.7 Uklon pasnice v smeri stojine

Koeficient(razred pasnice 1)	k =	0.300
Površina stojine	Aw =	33.000 cm ²
Površina tlač.pasnice	Afc =	57.000 cm ²

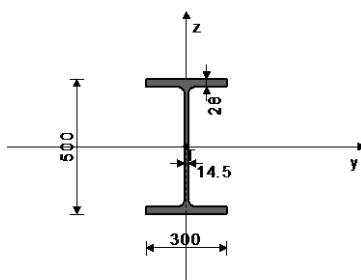
Preprečen je uklon pasnice v smeri stojine

Pogoj 5.80: (23.82 <= 203.98)

POZ 202: HEB 500; S 235

PREČNI PREREZ: IPB 500 [S 235] [Set: 3]
EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza



Ax =	239.00	cm ²
Ay =	148.82	cm ²
Az =	90.180	cm ²
Ix =	540.00	cm ⁴
Iy =	1.07e+5	cm ⁴
Iz =	12620	cm ⁴
Wy =	4288.0	cm ³
Wz =	841.33	cm ³
Wy,pl =	4959.4	cm ³
Wz,pl =	1260.0	cm ³
yM0 =	1.100	
yM1 =	1.100	
yM2 =	1.250	
Anet/A =	0.900	

[mm]

(fy = 23.5 kN/cm², fu = 36.0 kN/cm²)

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
4. γ=0.65 5. γ=0.55

PALICA IZPOSTAVLJENA PRITISKU IN UPOGIBU
(obtežni primer 4, na 438.0 cm od začetka palice)

Računska osna sila	Nsd =	-6.696	kN
Prečna sila v y smeri	Vsd_y =	3.266	kN
Prečna sila v z smeri	Vsd_z =	20.317	kN
Upogibni moment okoli y osi	Msd_y =	683.12	kNm
Upogibni moment okoli z osi	Msd_z =	1.612	kNm
Moment torzije	Mt =	0.460	kNm
Sistemska dolžina palice	L =	880.00	cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV
Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.4 Tlak		
Plastična računska nosilnost	Npl.Rd =	5105.9 kN
Računska nosilnost na tlak	Nc.Rd =	5105.9 kN

Pogoj 5.16: Nsd <= Nc.Rd (6.70 <= 5105.91)

5.4.5 Upogib y-y		
Računski plastični moment	Mpl.Rd =	1059.5 kNm
Računska nos. na lokalno izbočitev	Mo.Rd =	916.07 kNm
Računski elastični moment	Mel.Rd =	916.07 kNm
Računska nosilnost na upogib	Mc.Rd =	1059.5 kNm

Pogoj 5.17: Msd_y <= Mc.Rd_y (683.12 <= 1059.50)

5.4.5 Upogib z-z		
Računski plastični moment	Mpl.Rd =	269.18 kNm
Računska nos. na lokalno izbočitev	Mo.Rd =	179.74 kNm
Računski elastični moment	Mel.Rd =	179.74 kNm
Računska nosilnost na upogib	Mc.Rd =	269.18 kNm

Pogoj 5.17: Msd_z <= Mc.Rd_z (1.61 <= 269.18)

5.4.6 Strig		
Računska plast.nos.na strig z-z	Vpl.Rd =	1112.3 kN

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (20.32 <= 1112.31)

Računska plast.nos.na strig y-y	Vpl.Rd =	1835.6 kN
---------------------------------	----------	-----------

Pogoj 5.20: Vsd_y <= Vpl.Rd_y (3.27 <= 1835.59)

5.4.9 Upogib z osno in prečno silo
Ni potrebno zmanjšanje upogibne nosilnosti
Pogoj: Vsd_z <= 50%Vpl.Rd_z i Vsd_y <= 50%Vpl.Rd_y

5.4.8 Upogib in osna sila		
Razmerje Msd_y / Mpl.Rd_y		0.645

Pogoj 5.36: (0.65 <= 1)

5.5 NOSILNOST ELEMENTOV

5.5.1 Uklonska nosilnost		
Uklonska dolžina y-y	ly =	100.00 cm
Vztrajnostni radij y-y	iy =	21.179 cm
Vitkost y-y	λy =	4.722
Relativna vitkost y-y	λ_y =	0.050
Uklonska krivulja za os y-y: A	α =	0.210
Koeficient nepopolnosti	χy =	1.000
Koeficient efektivnega prereza	βA =	1.000
Računska uklonska nosilnost	Nb.Rd_y =	5105.9 kN

Pogoj 5.45: Nsd <= Nb.Rd_y (6.70 <= 5105.91)

Uklonska dolžina z-z	lz =	100.00 cm
Vztrajnostni radij z-z	iz =	7.267 cm
Vitkost z-z	λz =	13.762
Relativna vitkost z-z	λ_z =	0.147
Uklonska krivulja za os z-z: B	α =	0.340
Koeficient nepopolnosti	χz =	1.000
Koeficient efektivnega prereza	βA =	1.000
Računska uklonska nosilnost	Nb.Rd_z =	5105.9 kN

Pogoj 5.45: Nsd <= Nb.Rd_z (6.70 <= 5105.91)

5.5.2 Bočna zvrnitev upogibnih nosilcev		
Koeficient	C1 =	1.132
Koeficient	C2 =	0.459
Koeficient	C3 =	0.525
Koef. ukl.dolžine za uklon	k =	1.000
Koef. ukl.dolžine za vbočenje	kw =	1.000
Koordinata	zg =	0.000 cm
Koordinata	zj =	0.000 cm
Razmak med bočnimi podporami	L =	100.00 cm
Sektorski vztrajnostni moment	Iw =	7.02e+6 cm ⁶
Krit.moment bočne zvrnitve	Mcr =	70861 kNm
Koeficient	βw =	1.000
Koeficient imperf.	αLT =	0.210
Brezdimenz.vitkost	ALT =	0.128
Koeficient zmanjšanja	χLT =	1.000
Računska uklonska nosilnost	Mb.Rd =	1059.5 kNm
Kontrola bočne zvrnitve ni potrebna: λ_LT <= 0.4		

5.5.4 Upogib in tlak		
Koeficient nepopolnosti	χmin =	1.000
Nsd / ...		0.001
Koeficient oblike momenta	βy =	1.297
Koeficient	μy =	0.086
Koeficient	ky =	1.000
ky * My / ...		0.645
Koeficient oblike momenta	βz =	1.028
Koeficient	μz =	0.213
Koeficient	kz =	1.000
kz * Mz / ...		0.006

Pogoj 5.51: (0.65 <= 1)

Koeficient nepopolnosti	χ_z =	1.000
Nsd / ...		0.001
Koeficient nepopolnosti	χLT =	1.000
Koef.obl.mom.za bočno zvrnitev	βM.LT =	1.297
Koeficient	μLT =	-0.121
Koeficient	kLT =	1.000
kLT * My / ...		0.645
Koeficient oblike momenta	βz =	1.028
Koeficient	μz =	0.213
Koeficient	kz =	1.000
kz * Mz / ...		0.006

Pogoj 5.52: (0.65 <= 1)

5.6 LOKALNO IZBOČENJE ZARADI STRIGA		
za strig v ravnini z-z		
Višina stojine	d =	44.400 cm
Debelina stojine	tw =	1.450 cm
Ni prečnih ojačitev v sredini		
Koeficient izbočenja pri strigu	kr =	5.340
Ni potrebna kontrola izbočenja zaradi striga		

Pogoj: d / tw <= 69 ε (30.62 <= 69.00)

5.6.7 Interakcija prečne sile, upogiba in osne sile		
za strig v ravnini z-z		
Računski plastični moment pasnic	Mf.Rd =	897.27 kNm

Pogoji 5.66a in 5.66b so izpolnjeni

5.7 VNOS KONCENTRIRANIH SIL V STOJINO		
5.7.7 Uklon pasnice v smeri stojine		
Koeficient(razred pasnice 1)	k =	0.300
Površina stojine	Aw =	72.500 cm ²
Površina tlač.pasnice	Afc =	84.000 cm ²
Preprečen je uklon pasnice v smeri stojine		

Pogoj 5.80: (30.62 <= 249.06)

KONTROLA STRIŽNE NOSILNOSTI
(obtežni primer 4, začetek palice)

Računska osna sila	Nsd =	-5.033 kN
Prečna sila v y smeri	Vsd_y =	1.086 kN
Prečna sila v z smeri	Vsd_z =	-278.84 kN
Moment torzije	Mt =	-2.607 kNm
Sistemska dolžina palice	L =	880.00 cm

5.4 NOSILNOST PREČNIH PREREZOV

5.4.6 Strig		
Računska plast.nos.na strig z-z	Vpl.Rd =	1112.3 kN
Pogoj 5.20: Vsd_z <= Vpl.Rd_z (278.84 <= 1112.31)		
Računska plast.nos.na strig y-y	Vpl.Rd =	1835.6 kN
Pogoj 5.20: Vsd_y <= Vpl.Rd_y (1.09 <= 1835.59)		

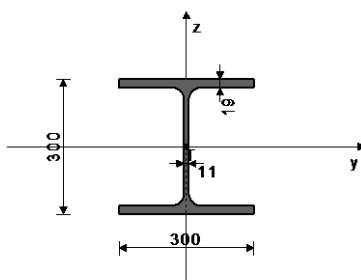
5.6 LOKALNO IZBOČENJE ZARADI STRIGA		
za strig v ravnini z-z		
Višina stojine	d =	44.400 cm
Debelina stojine	tw =	1.450 cm
Ni prečnih ojačitev v sredini		
Koeficient izbočenja pri strigu	kr =	5.340
Ni potrebna kontrola izbočenja zaradi striga		

Pogoj: d / tw <= 69 ε (30.62 <= 69.00)

POZ 203: HEB 300; S 235

PREČNI PREREZ: IPB 300 [S 235] [Set: 2]
EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza



Ax =	149.00	cm ²
Ay =	101.65	cm ²
Az =	47.350	cm ²
Ix =	186.00	cm ⁴
Iy =	25170	cm ⁴
Iz =	8560.0	cm ⁴
Wy =	1678.0	cm ³
Wz =	570.67	cm ³
Wy,pl =	1865.8	cm ³
Wz,pl =	855.00	cm ³
yM0 =	1.100	
yM1 =	1.100	
yM2 =	1.250	
Anet/A =	0.900	

[mm]

(fy = 23.5 kN/cm², fu = 36.0 kN/cm²)

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
5. γ=0.71 4. γ=0.70

PALICA IZPOSTAVLJENA PRITISKU IN UPOGIBU
(obtežni primer 5, na 918.0 cm od začetka palice)

Računska osna sila	Nsd =	-3.818	kN
Prečna sila v y smeri	Vsd_y =	-5.694	kN
Prečna sila v z smeri	Vsd_z =	114.63	kN
Upogibni moment okoli y osi	Msd_y =	276.89	kNm
Upogibni moment okoli z osi	Msd_z =	-2.711	kNm
Moment torzije	Mt =	0.052	kNm
Sistemska dolžina palice	L =	1110.0	cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV
Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.4 Tlak		
Plastična računska nosilnost	Npl.Rd =	3183.2 kN
Računska nosilnost na tlak	Nc.Rd =	3183.2 kN

Pogoj 5.16: Nsd <= Nc.Rd (3.82 <= 3183.18)

5.4.5 Upogib y-y		
Računski plastični moment	Mpl.Rd =	398.60 kNm
Računska nos. na lokalno izbočitev	Mo.Rd =	358.48 kNm
Računski elastični moment	Mel.Rd =	358.48 kNm
Računska nosilnost na upogib	Mc.Rd =	398.60 kNm

Pogoj 5.17: Msd_y <= Mc.Rd_y (276.89 <= 398.60)

5.4.5 Upogib z-z		
Računski plastični moment	Mpl.Rd =	182.66 kNm
Računska nos. na lokalno izbočitev	Mo.Rd =	121.92 kNm
Računski elastični moment	Mel.Rd =	121.92 kNm
Računska nosilnost na upogib	Mc.Rd =	182.66 kNm

Pogoj 5.17: Msd_z <= Mc.Rd_z (2.71 <= 182.66)

5.4.6 Strig		
Računska plast.nos. na strig z-z	Vpl.Rd =	584.03 kN

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (114.63 <= 584.03)

Računska plast.nos. na strig y-y	Vpl.Rd =	1253.8 kN
----------------------------------	----------	-----------

Pogoj 5.20: Vsd_y <= Vpl.Rd_y (5.69 <= 1253.78)

5.4.9 Upogib z osno in prečno silo
Ni potrebno zmanjšanje upogibne nosilnosti
Pogoj: Vsd_z <= 50%Vpl.Rd_z i Vsd_y <= 50%Vpl.Rd_y

5.4.8 Upogib in osna sila		
Razmerje Msd_y / Mpl.Rd_y	0.695	
Razmerje Msd_z / Mpl.Rd_z	0.015	

Pogoj 5.36: (0.71 <= 1)

5.5 NOSILNOST ELEMENTOV

5.5.1 Uklonska nosilnost		
Uklonska dolžina y-y	ly =	100.00 cm
Vztrajnostni radij y-y	iy =	12.997 cm
Vitkost y-y	λy =	7.694
Relativna vitkost y-y	λ_y =	0.082
Uklonska krivulja za os y-y: A	α =	0.210
Koeficient nepopolnosti	χy =	1.000
Koeficient efektivnega prereza	βA =	1.000
Računska uklonska nosilnost	Nb.Rd_y =	3183.2 kN

Pogoj 5.45: Nsd <= Nb.Rd_y (3.82 <= 3183.18)

Uklonska dolžina z-z	lz =	100.00 cm
Vztrajnostni radij z-z	iz =	7.580 cm
Vitkost z-z	λz =	13.193
Relativna vitkost z-z	λ_z =	0.141
Uklonska krivulja za os z-z: B	α =	0.340
Koeficient nepopolnosti	χz =	1.000
Koeficient efektivnega prereza	βA =	1.000
Računska uklonska nosilnost	Nb.Rd_z =	3183.2 kN

Pogoj 5.45: Nsd <= Nb.Rd_z (3.82 <= 3183.18)

5.5.2 Bočna zvrnitev upogibnih nosilcev		
Koeficient	C1 =	1.132
Koeficient	C2 =	0.459
Koeficient	C3 =	0.525
Koef. ukl. dolžine za uklon	k =	1.000
Koef. ukl. dolžine za vbočenje	kw =	1.000
Koordinata	zg =	0.000 cm
Koordinata	zj =	0.000 cm
Razmak med bočnimi podporami	L =	100.00 cm
Sektorski vztrajnostni moment	Iw =	1.69e+6 cm ⁶
Krit.moment bočne zvrnitve	Mcr =	28800 kNm
Koeficient	βw =	1.000
Koeficient imperf.	αLT =	0.210
Brezdimenz.vitkost	ALT =	0.123
Koeficient zmanjšanja	χLT =	1.000
Računska uklonska nosilnost	Mb.Rd =	398.60 kNm
Kontrola bočne zvrnitve ni potrebna: λ_LT <= 0.4		

5.5.4 Upogib in tlak		
Koeficient nepopolnosti	χmin =	1.000
Nsd / ...		0.001
Koeficient oblike momenta	βy =	1.083
Koeficient	μy =	-0.038
Koeficient	ky =	1.000
ky * My / ...		0.695
Koeficient oblike momenta	βz =	1.063
Koeficient	μz =	0.235
Koeficient	kz =	1.000
kz * Mz / ...		0.015

Pogoj 5.51: (0.71 <= 1)

Koeficient nepopolnosti	χ_z =	1.000
Nsd / ...		0.001
Koeficient nepopolnosti	χLT =	1.000
Koef.obl.mom.za bočno zvrnitev	βM.LT =	1.083
Koeficient	μLT =	-0.127
Koeficient	kLT =	1.000
kLT * My / ...		0.695
Koeficient oblike momenta	βz =	1.063
Koeficient	μz =	0.235
Koeficient	kz =	1.000
kz * Mz / ...		0.015

Pogoj 5.52: (0.71 <= 1)

5.6 LOKALNO IZBOČENJE ZARADI STRIGA		
za strig v ravnini z-z		
Višina stojine	d =	26.200 cm
Debelina stojine	tw =	1.100 cm
Ni prečnih ojačitev v sredini		
Koeficient izbočenja pri strigu	kr =	5.340
Ni potrebna kontrola izbočenja zaradi striga		

Pogoj: d / tw <= 69 ε (23.82 <= 69.00)

5.6.7 Interakcija prečne sile, upogiba in osne sile		
za strig v ravnini z-z		
Računski plastični moment pasnic	Mf.Rd =	365.32 kNm

Pogoji 5.66a in 5.66b so izpolnjeni

5.7 VNOS KONCENTRIRANIH SIL V STOJINO		
5.7.7 Uklon pasnice v smeri stojine		
Koeficient(razred pasnice 1)	k =	0.300
Površina stojine	Aw =	33.000 cm ²
Površina tlač.pasnice	Afc =	57.000 cm ²
Preprečen je uklon pasnice v smeri stojine		

Pogoj 5.80: (23.82 <= 203.98)

KONTROLA STRIŽNE NOSILNOSTI
(obtežni primer 5, na 630.0 cm od začetka palice)

Računska osna sila	Nsd =	5.677 kN
Prečna sila v y smeri	Vsd_y =	-20.788 kN
Prečna sila v z smeri	Vsd_z =	-215.65 kN
Upogibni moment okoli y osi	Msd_y =	-26.669 kNm
Upogibni moment okoli z osi	Msd_z =	-1.473 kNm
Moment torzije	Mt =	0.047 kNm
Sistemska dolžina palice	L =	1110.0 cm

5.4 NOSILNOST PREČNIH PREREZOV		
5.4.6 Strig		
Računska plast.nos. na strig z-z	Vpl.Rd =	355.47 kN

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (215.65 <= 355.47)

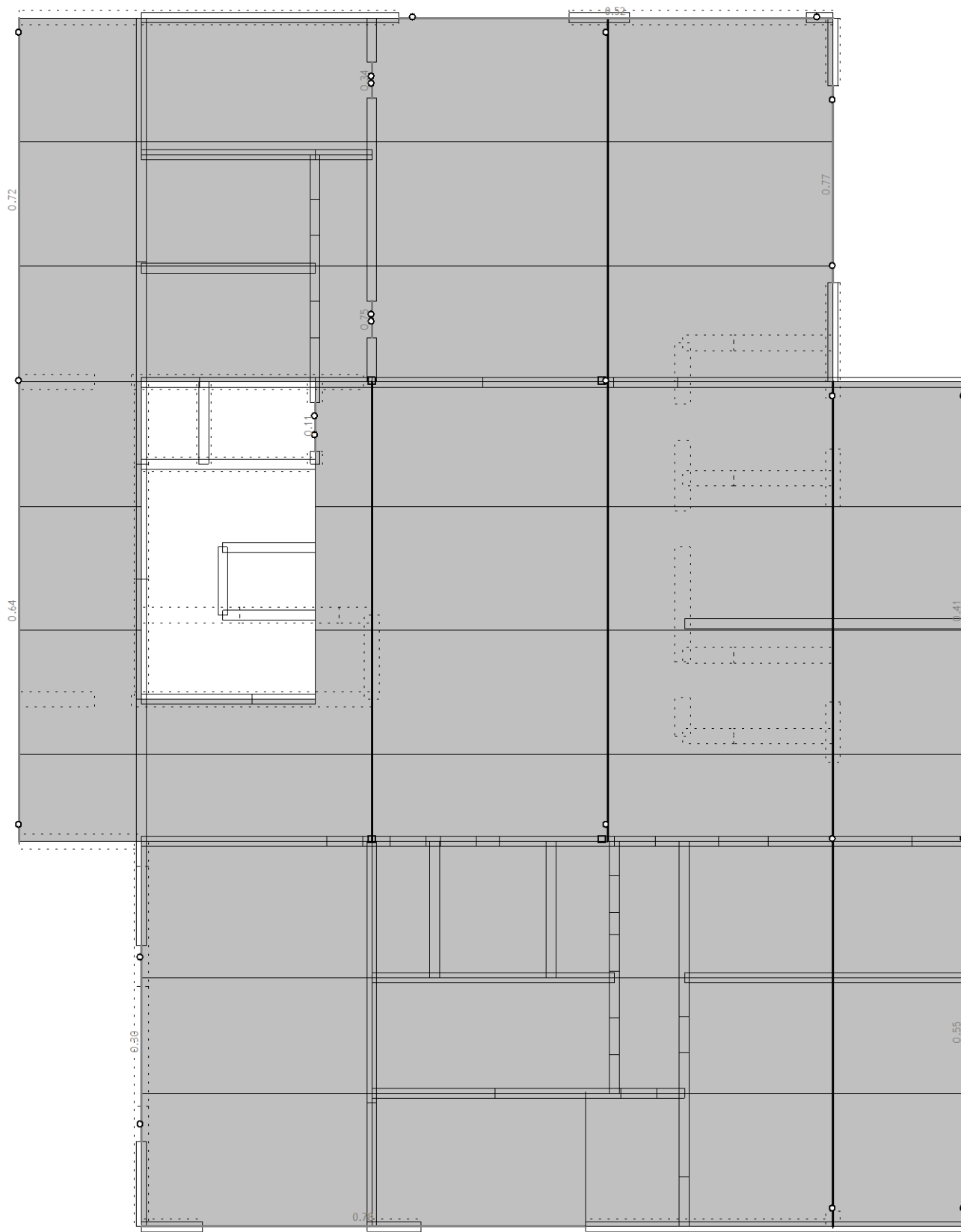
Računska plast.nos. na strig y-y	Vpl.Rd =	1216.1 kN
----------------------------------	----------	-----------

Pogoj 5.20: Vsd_y <= Vpl.Rd_y (20.79 <= 1216.12)

5.6 LOKALNO IZBOČENJE ZARADI STRIGA		
za strig v ravnini z-z		
Višina stojine	d =	26.200 cm
Debelina stojine	tw =	1.100 cm
Ni prečnih ojačitev v sredini		
Koeficient izbočenja pri strigu	kr =	5.340
Ni potrebna kontrola izbočenja zaradi striga		

Pogoj: d / tw <= 69 ε (23.82 <= 69.00)

Dimenzioniranje (les)



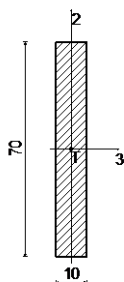
Nivo: POZ 200 [8.92 m]
Kontrola stabilnosti

POZ 204: preklada nad okni CLT L5s 140 mm

Monoliten les - iglavci in mehki listavci - C24

Eksploatacijski razred 1

EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
5. $\gamma=0.55$ 4. $\gamma=0.50$

KONTROLA NORMALNIH IN STRIŽNIH NAPETOSTI
(obtežni primer 5, na 601.0 cm od začetka palice)

Računska osna sila	N =	8.272 kN
Prečna sila v smeri osi 2	T2 =	38.671 kN
Prečna sila v smeri osi 3	T3 =	-6.239 kN
Upogibni moment okoli osi 2	M2 =	1.234 kNm
Upogibni moment okoli osi 3	M3 =	37.791 kNm

KONTROLA NAPETOSTI - NATEG IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Dodatek za elemente z malimi dimenzijami - nateg

Karakteristična natezna trdnost	$f_{t,0,k}$ =	14.000 MPa
Računska natezna trdnost	$f_{t,0,d}$ =	9.343 MPa
Faktor oblik (za pravokotni prerez)	k_m =	0.700
Karakteristična upogibna trdnost	$f_{m,k}$ =	24.000 MPa
Računska upogibna trdnost - os 2	$f_{m,2,d}$ =	16.017 MPa
Računska upogibna trdnost - os 3	$f_{m,3,d}$ =	14.769 MPa
Normalna natezna napetost	$\sigma_{t,0,d}$ =	0.118 MPa
Odpornostni moment	W_2 =	1166.7 cm ³
Normalna upogibna napetost okoli osi 2	$\sigma_{m,2,d}$ =	1.058 MPa

$$\sigma_{m,2,d} \leq f_{m,2,d} \quad (1.058 \leq 16.017)$$

Izkoriščenost prereza je 6.6%

Odpornostni moment	W_3 =	8166.7 cm ³
Normalna upogibna napetost okoli osi 3	$\sigma_{m,3,d}$ =	4.627 MPa

$$\sigma_{m,3,d} \leq f_{m,3,d} \quad (4.627 \leq 14.769)$$

Izkoriščenost prereza je 31.3%

$$\sigma_{t,0,d} / f_{t,0,d} + k_m \times (\sigma_{m,3,d} / f_{m,3,d}) + \sigma_{m,2,d} / f_{m,2,d} \leq 1 \quad (0.298 \leq 1)$$

Izkoriščenost prereza je 29.8%

$$\sigma_{t,0,d} / f_{t,0,d} + \sigma_{m,3,d} / f_{m,3,d} + k_m \times (\sigma_{m,2,d} / f_{m,2,d}) \leq 1 \quad (0.372 \leq 1)$$

Izkoriščenost prereza je 37.2%

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

K_{mod} =	0.800
γ_m =	1.300
$f_{v,k}$ =	2.500 MPa
$f_{v,d}$ =	1.538 MPa
A =	700.00 cm ²
$\tau_{2,d}$ =	0.829 MPa
$\tau_{3,d}$ =	0.134 MPa
τ_s =	0.839 MPa

$$\tau_s \leq f_{v,d} \quad (0.839 \leq 1.538)$$

Izkoriščenost prereza je 54.6%

DOKAZ STABILNOSTI ELEMENTA

(obtežni primer 5, na 241.2 cm od začetka palice)

Računska osna sila	N =	-3.412 kN
Prečna sila v smeri osi 2	T2 =	-3.389 kN
Prečna sila v smeri osi 3	T3 =	0.000 kN
Upogibni moment okoli osi 3	M3 =	-38.083 kNm

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Razmak pridržanih točk pravokotno na smer osi 2

K_{mod} =	0.800
γ_m =	1.300
l_{ef} =	100.00 cm
$E_{0.05}$ =	7400.0 MPa
$G_{0.05}$ =	460.00 MPa
I_{tor} =	21424 cm ⁴
I_2 =	5833.3 cm ⁴
W_3 =	8166.7 cm ³
$\sigma_{m,crit}$ =	79.343 MPa
λ_{rel} =	0.550
k_{krit} =	1.000
$\sigma_{m,3,d}$ =	4.663 MPa

5% fraktil modula E paralelno z vlakni

5% fraktil strižnega modula G

Torzijski vztrajnostni moment

Vztrajnostni moment

Odpornostni moment

Kritična napetost uklona

Relativna vitkost za uklon

Koeficient

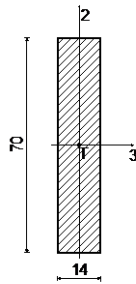
Normalna upogibna napetost okoli osi 3

$$\sigma_{m,3,d} \leq k_{krit} \times f_{m,3,d} \quad (4.663 \leq 14.769)$$

Izkoriščenost prereza je 31.6%

POZ 205: lesena preklada

Monolitni les - iglavci in mehki listavci - C24
Eksploatacijski razred 1
EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽB
4. $\gamma = 0.77$ 5. $\gamma = 0.65$

KONTROLA NORMALNIH NAPETOSTI
(obtežni primer 4, na 247.0 cm od začetka palice)

Računska osna sila	N =	7.573 kN
Prečna sila v smeri osi 2	T2 =	-6.753 kN
Prečna sila v smeri osi 3	T3 =	0.000 kN
Upogibni moment okoli osi 2	M2 =	0.095 kNm
Upogibni moment okoli osi 3	M3 =	-103.87 kNm

KONTROLA NAPETOSTI - NATEG IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Dodatek za elemente z malimi dimenzijami - nateg

Karakteristična natezna trdnost	Kmod =	0.800
Računska natezna trdnost	ym =	1.300
Faktor oblik (za pravokotni prerez)	Kh_2 =	1.014
Karakteristična upogibna trdnost	Kh_3 =	1.000
Računska upogibna trdnost - os 2	Kh_t =	1.014
Računska upogibna trdnost - os 3	ft,0,k =	14.000 MPa
Normalna natezna napetost	ft,0,d =	8.735 MPa
Odpornostni moment	km =	0.700
Normalna upogibna napetost okoli osi 2	fm,k =	24.000 MPa
	fm,2,d =	14.974 MPa
	fm,3,d =	14.769 MPa
	ot,0,d =	0.077 MPa
	W2 =	2286.7 cm3
	om2,d =	0.042 MPa

$$\sigma_{m2,d} \leq f_{m2,d} \quad (0.042 \leq 14.974)$$

Izkoriščenost prereza je 0.3%

Odpornostni moment	W3 =	11433 cm3
Normalna upogibna napetost okoli osi 3	om3,d =	9.084 MPa

$$\sigma_{m3,d} \leq f_{m3,d} \quad (9.084 \leq 14.769)$$

Izkoriščenost prereza je 61.5%

$$\sigma_{t,0,d} / f_{t,0,d} + k_m \times (\sigma_{m3,d} / f_{m3,d} + k_m \times \sigma_{m2,d} / f_{m2,d}) \leq 1 \quad (0.442 \leq 1)$$

Izkoriščenost prereza je 44.2%

$$\sigma_{t,0,d} / f_{t,0,d} + \sigma_{m3,d} / f_{m3,d} + k_m \times (\sigma_{m2,d} / f_{m2,d}) \leq 1 \quad (0.626 \leq 1)$$

Izkoriščenost prereza je 62.6%

KONTROLA STRIŽNIH NAPETOSTI

(obtežni primer 4, na 451.5 cm od začetka palice)

Prečna sila v smeri osi 2	T2 =	77.816 kN
Prečna sila v smeri osi 3	T3 =	0.148 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod =	0.800
ym =	1.300
fv,k =	2.500 MPa
fv,d =	1.538 MPa
A =	980.00 cm2
t2,d =	1.191 MPa
t3,d =	0.002 MPa
ts =	1.191 MPa

$$t_s \leq f_{v,d} \quad (1.191 \leq 1.538)$$

Izkoriščenost prereza je 77.4%

DOKAZ STABILNOSTI ELEMENTA

(obtežni primer 4, na 247.0 cm od začetka palice)

Računska osna sila	N =	6.144 kN
Prečna sila v smeri osi 2	T2 =	8.881 kN
Prečna sila v smeri osi 3	T3 =	0.000 kN
Upogibni moment okoli osi 2	M2 =	0.096 kNm
Upogibni moment okoli osi 3	M3 =	-103.87 kNm

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Razmak pridržanih točk pravokotno na smer osi 2

5% fraktil modula E paralelno z vlakni

5% fraktil strižnega modula G

Torzijski vztrajnostni moment

Vztrajnostni moment

Odpornostni moment

Kritična napetost uklona

Relativna vitkost za uklon

Koeficient

Normalna upogibna napetost okoli osi 3

Kmod =	0.800
ym =	1.300
lef =	100.00 cm
E0.05 =	7400.0 MPa
G0.05 =	460.00 MPa
Itor =	56428 cm4
I2 =	16007 cm4
W3 =	11433 cm3
om,crit =	152.36 MPa
arel =	0.397
k_krit =	1.000
om3,d =	9.084 MPa

$$\sigma_{m3,d} \leq k_{krit} \times f_{m3,d} \quad (9.084 \leq 14.769)$$

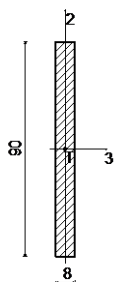
Izkoriščenost prereza je 61.5%

POZ 206: robni nosilec pod ploščo: CLT L3s 120 mm

Monoliten les - iglavci in mehki listavci - C24

Eksplotacijski razred 1

EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽB
4. $\gamma=0.72$ 5. $\gamma=0.60$

KONTROLA NORMALNIH NAPETOSTI
(obežni primer 4, na 442.0 cm od začetka palice)

Računska osna sila	N =	-17.982 kN
Prečna sila v smeri osi 2	T2 =	3.186 kN
Prečna sila v smeri osi 3	T3 =	0.000 kN
Upogibni moment okoli osi 2	M2 =	0.000 kNm
Upogibni moment okoli osi 3	M3 =	-112.16 kNm

KONTROLA NAPETOSTI - TLAK IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Faktor oblik (za pravokotni prerez)

Karakteristična tlačna trdnost

Računska tlačna trdnost

Karakteristična upogibna trdnost

Računska upogibna trdnost - os 2

Računska upogibna trdnost - os 3

Relativna vitkost

Normalne tlačne napetosti

Odpornostni moment

Normalna upogibna napetost okoli osi 3

Kmod = 0.800
ym = 1.300

Kh_2 = 1.134

Kh_3 = 1.000

km = 0.700

fc,0,k = 21.000 MPa

fc,0,d = 12.923 MPa

fm,k = 24.000 MPa

fm,2,d = 16.748 MPa

fm,3,d = 14.769 MPa

arel,2 = 0.734

arel,3 = 0.734

sc,0,d = 0.250 MPa

W3 = 10800 cm³

sm3,d = 10.386 MPa

$\sigma_{m3,d} \leq f_{m3,d} (10.386 \leq 14.769)$

Izkoriščenost prereza je 70.3%

TLAK IN UPOGIB - VELIKA VITKOST

Začetna imperfekcija

Koeficient

Koeficient

Koeficient

Koeficient

$\beta_{\chi} = 0.200$

k3 = 0.479

k2 = 0.813

kc,3 = 1.049

kc,2 = 0.861

$(\sigma_{c,0,d} / (k_{c,2} \times f_{c,0,d})) + k_m \times (\sigma_{m3,d} / f_{m,3,d}) + \sigma_{m2,d} / f_{m,2,d} \leq 1 (0.515 \leq 1)$

Izkoriščenost prereza je 51.5%

$(\sigma_{c,0,d} / (k_{c,3} \times f_{c,0,d})) + \sigma_{m3,d} / f_{m,3,d} + k_m \times (\sigma_{m2,d} / f_{m,2,d}) \leq 1 (0.722 \leq 1)$

Izkoriščenost prereza je 72.2%

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Razmak pridrženih točk pravokotno na smer osi 2

Kmod = 0.800

ym = 1.300

lef = 100.00 cm

E0.05 = 7400.0 MPa

G0.05 = 460.00 MPa

I_{tor} = 14611 cm⁴

I₂ = 3840.0 cm⁴

W3 = 10800 cm³

σ_{m,crit} = 40.199 MPa

arel = 0.773

k_{krit} = 0.980

σ_{m3,d} = 10.386 MPa

$\sigma_{m3,d} \leq k_{krit} \times f_{m3,d} (10.386 \leq 14.481)$

Izkoriščenost prereza je 71.7%

KONTROLA STRIŽNIH NAPETOSTI

(obežni primer 4, začetek palice)

Prečna sila v smeri osi 2

Prečna sila v smeri osi 3

T2 = -50.463 kN

T3 = 0.951 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod = 0.800

ym = 1.300

f_{v,k} = 2.500 MPa

f_{v,d} = 1.538 MPa

A = 720.00 cm²

τ_{2,d} = 1.051 MPa

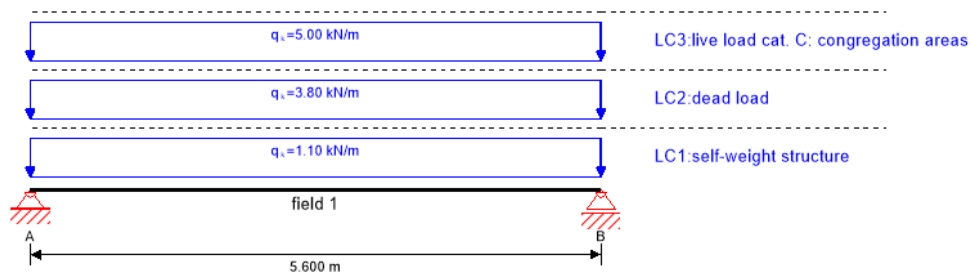
τ_{3,d} = 0.020 MPa

τ_s = 1.051 MPa

$\tau_s \leq f_{v,d} (1.051 \leq 1.538)$

Izkoriščenost prereza je 68.3%

system

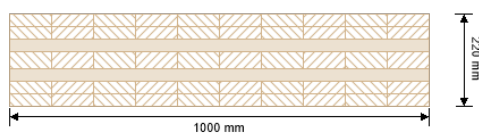


global utilization ratio

95 %

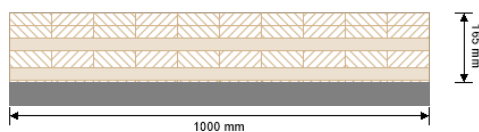
ULS	40 %	ULS fire	45 %	SLS	95 %	SLS vibration	84 %	support	-1 %
-----	------	----------	------	-----	------	---------------	------	---------	------

section: CLT 220 L7s - 2



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce
2	30.0 mm	0°	C24 spruce
3	30.0 mm	90°	C24 spruce
4	40.0 mm	0°	C24 spruce
5	30.0 mm	90°	C24 spruce
6	30.0 mm	0°	C24 spruce
7	30.0 mm	0°	C24 spruce
t _{CLT}	220.0 mm		

section fire: CLT 220 L7s - 2



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce
2	30.0 mm	0°	C24 spruce
3	30.0 mm	90°	C24 spruce
4	40.0 mm	0°	C24 spruce
5	30.0 mm	90°	C24 spruce
6	5.0 mm	0°	C24 spruce
t _{CLT}	165.0 mm		

fire resistance class: R 60

fire protection layering : no additional fire protection

time	k ₀	d ₀	d _{char,0,h}	d _{ef,h}	d _{char,0,v}	d _{ef,v}
60 min						
	[-]	[mm]	[mm]	[mm]	[mm]	[mm]
1	7	48.0	55.0	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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
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	K _{mod}	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	live load cat. C: congregation areas	Q	short term	0.9	0	1.5	0.7	0.7	0.6

LC1:self-weight structure

continous load

field	load at start
	[kN/m]
1	1.10

LC2:dead load

continous load

field	load at start
	[kN/m]
1	3.80

LC3:live load cat. C: congregation areas

continous load

field	load at start
	[kN/m]
1	5.00

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	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.60 * LC3$

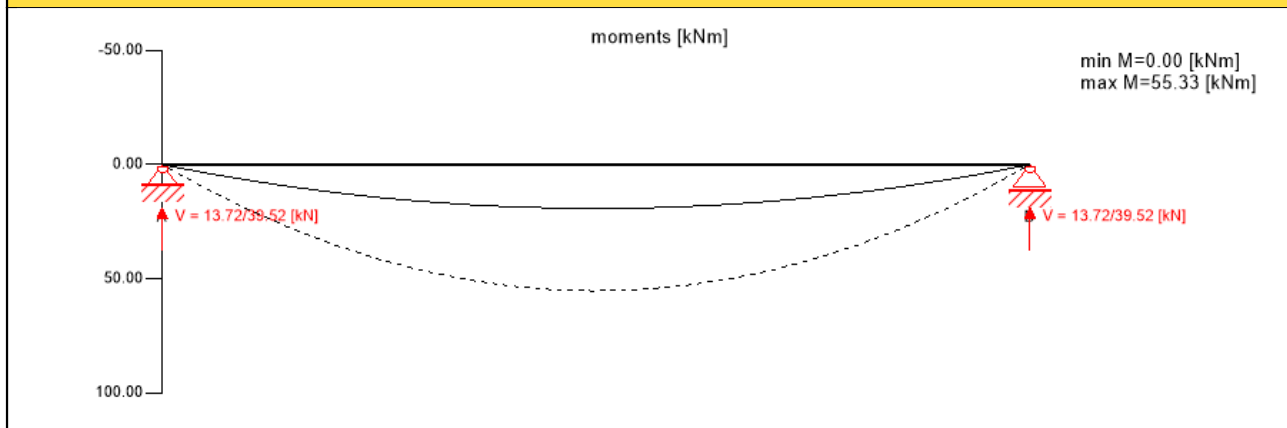
SLS characteristic combination

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

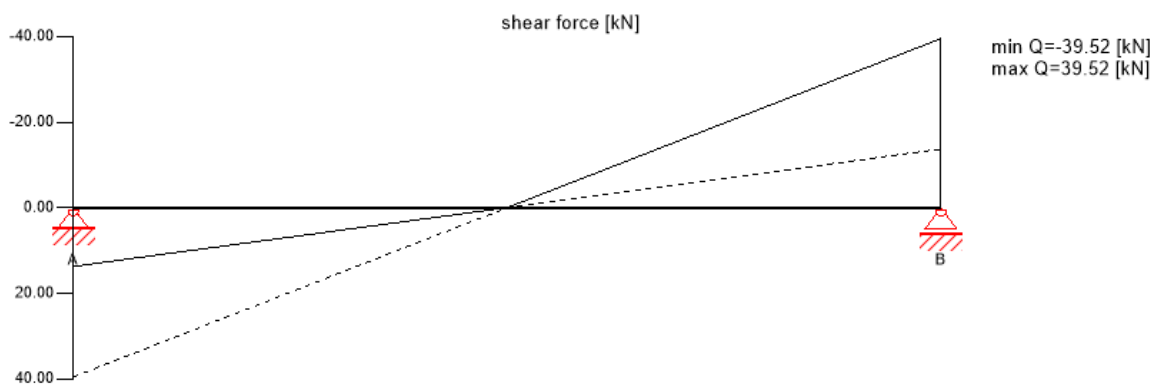
SLS quasi-permanent combination

	combination rule
LCO3	$1.00/1.00 * LC1 + 1.00/1.00 * LC2$
LCO4	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.60 * LC3$

Ultimate limit state (ULS) - design results



Ultimate limit state (ULS) - design results



ULS flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	$k_{sys,y}$	$f_{m,y,d}$	$M_{y,d}$	$\sigma_{m,y,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
1	2.8	24.00	1.25	0.90	1.10	19.01	55.33	-7.52	40 %	LCO2

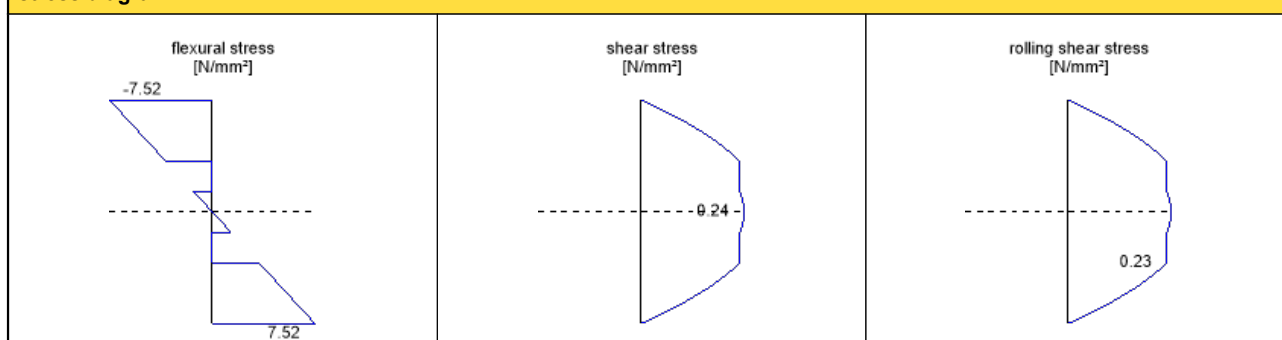
ULS shear analysis

field	dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.6	4.00	1.25	0.90	2.88	-39.52	0.24	8 %	LCO2

ULS rolling shear

field	dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.6	1.15	1.25	0.90	0.83	-39.52	0.23	28 %	LCO2

stress diagram



flexural stress analysis

$M_{y,d} =$	55.33	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{t,d} =$	0.00	kN	$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
			$k_{sys,y} =$	1.10	-
$\sigma_{t,d} =$	0.00	N/mm ²	$f_{t,d} =$	10.08	N/mm ²
$\sigma_{m,y,d} =$	-7.52	N/mm ²	$f_{m,y,d} =$	19.01	N/mm ²

utilization ratio

40 %

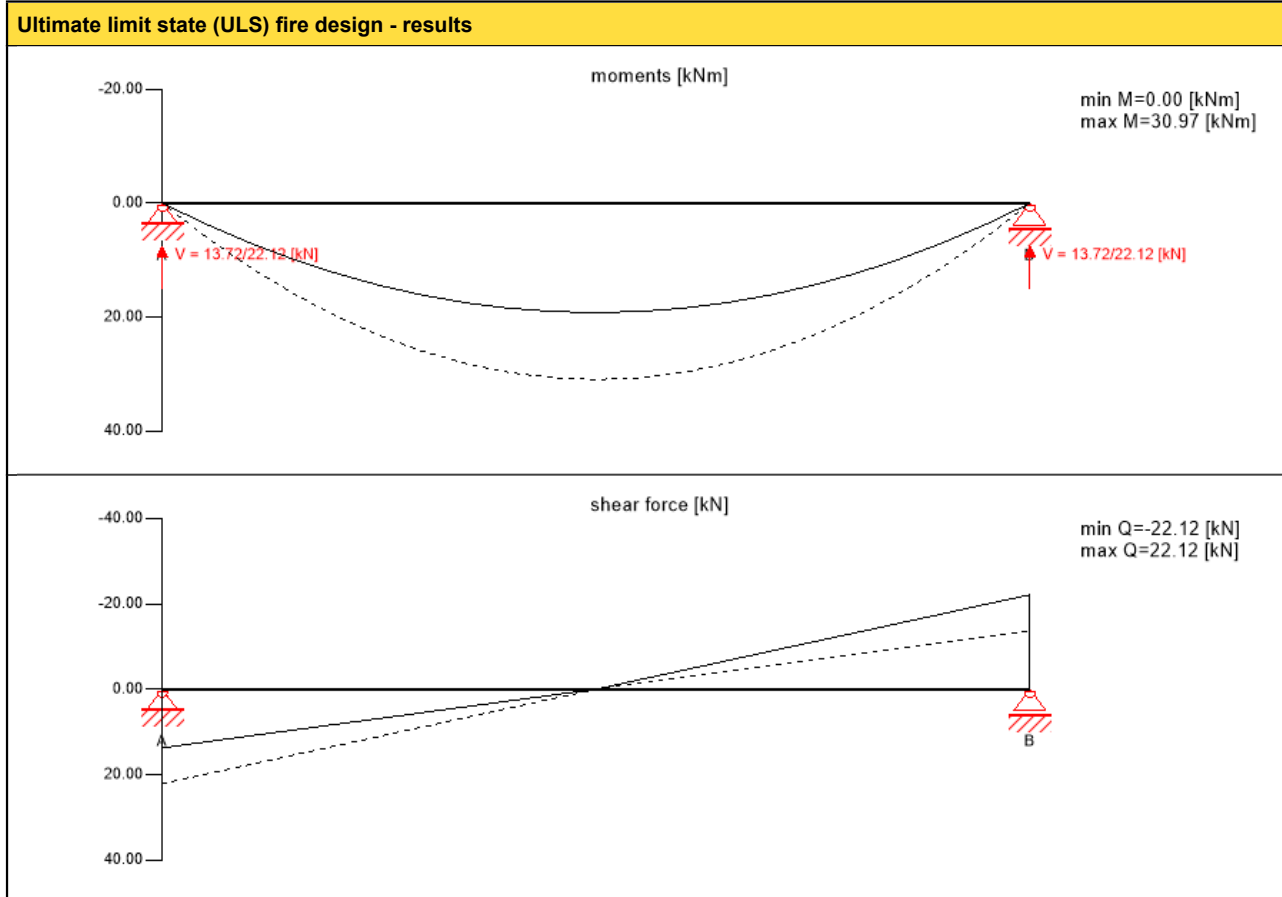
shear stress analysis

$V_d =$	-	kN	$f_{v,k} =$	4.00	N/mm ²
	39.52		$\gamma_m =$	1.25	
			$k_{mod} =$	0.90	
$\tau_{v,d} =$	0.24	N/mm ²	$f_{v,d} =$	2.88	N/mm ²

utilization ratio

8 %

rolling shear analysis					
$V_d =$	-39.52	kN	$f_{r,k} =$	1.15	N/mm ²
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
$T_{r,d} =$	0.23	N/mm ²	$f_{r,d} =$	0.83	N/mm ²
					✓
utilization ratio					28 %

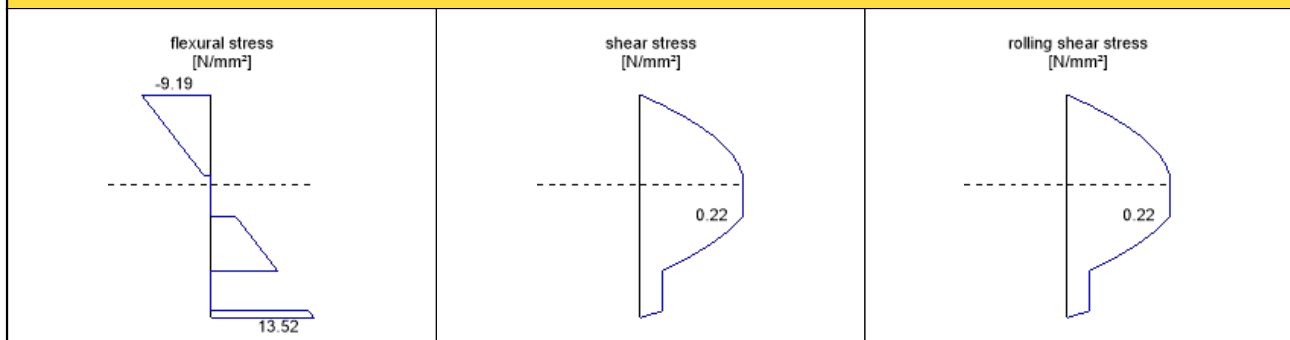


ULS fire flexural design											
field	dist.	$f_{m,k}$	γ_m	k_{mod}	$k_{sys,y}$	k_{fi}	$f_{m,y,d}$	$M_{y,d}$	$\sigma_{m,y,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
1	2.8	24.00	1.00	1.00	1.10	1.15	30.36	30.97	13.52	45 %	LCO2

ULS fire shear analysis										
field	dist.	$f_{v,k}$	γ_m	k_{mod}	k_{fi}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.6	4.00	1.00	1.00	1.15	4.60	-22.12	0.22	5 %	LCO2

ULS fire rolling shear										
field	dist.	$f_{r,k}$	γ_m	k_{mod}	k_{fi}	$f_{r,d}$	V_d	$T_{r,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.6	1.15	1.00	1.00	1.15	1.32	-22.12	0.22	16 %	LCO2

stress diagram



flexural stress analysis fire

$M_{y,d} =$	30.97 kNm	$f_{m,k} =$	24.00 N/mm²
$N_{t,d} =$	0.00 kN	$\gamma_m =$	1.00 -
		$k_{mod} =$	1.00 -
		$k_{sys,y} =$	1.10 -
		$k_{fi} =$	1.15 -
$\sigma_{t,d} =$	0.00 N/mm²	$f_{t,d} =$	16.10 N/mm²
$\sigma_{m,y,d} =$	13.52 N/mm²	$f_{m,y,d} =$	30.36 N/mm²

utilization ratio

45 %

shear stress analysis fire

$V_d =$	- kN	$f_{v,k} =$	4.00 N/mm²
22.12		$\gamma_m =$	1.00
		$k_{mod} =$	1.00
		$k_{fi} =$	1.15
$\tau_{v,d} =$	0.22 N/mm²	$f_{v,d} =$	4.60 N/mm²

utilization ratio

5 %

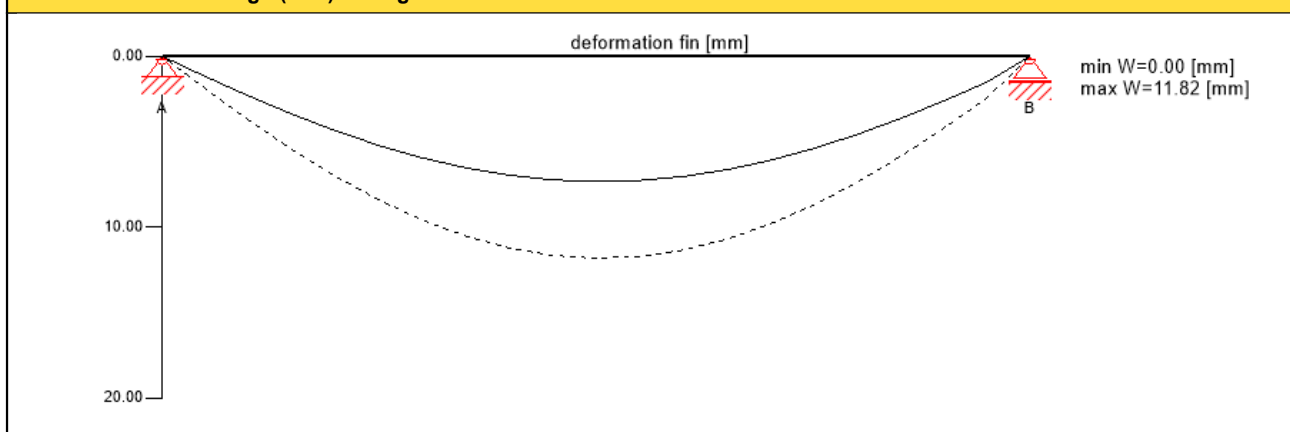
rolling shear analysis fire

$V_d =$	-22.12 kN	$f_{r,k} =$	1.15 N/mm²
		$\gamma_m =$	1.00 -
		$k_{mod} =$	1.00 -
		$k_{fi} =$	1.15 -
$\tau_{r,d} =$	0.22 N/mm²	$f_{r,d} =$	1.32 N/mm²

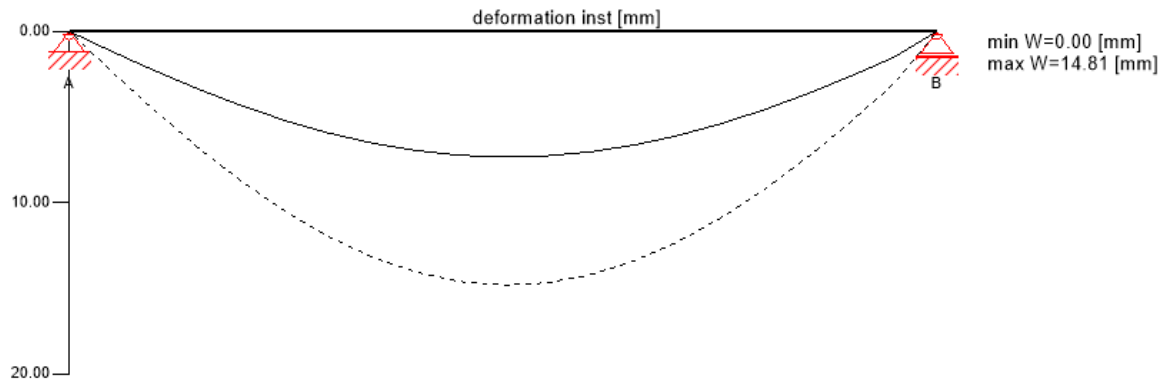
utilization ratio

16 %

Service limit state design (SLS) - design results



Service limit state design (SLS) - design results



initial deflection [w_{char}]

field	dist. [m]	limit [-]	W_{limit} [mm]	$W_{calc.}$ [mm]	ratio	
1	2.8	1/300	18.7	14.8	79 %	LCO2

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

field	dist. [m]	limit [-]	W_{limit} [mm]	$W_{calc.}$ [mm]	ratio	
1	2.8	1/150	37.3	24.3	65 %	LCO4

net final deflection [$w_{q.p.} \cdot (1+k_{def})$]

field	dist. [m]	limit [-]	W_{limit} [mm]	$W_{calc.}$ [mm]	ratio	
1	2.8	1/250	22.4	21.3	95 %	LCO4

vibration analysis

general	
total mass	27.97 [t]
tributary width	3.2 [m]
stiffness longitudinal direction	10116.7 [kNm ²]
stiffness cross direction	1570.0 [kNm ²]
modal damping	5.0 [%]
α	0.1 [-]
man weight	700.0 [N]
modal mass	13971.2 [kg]

analysis							
criterion	calc.	class I	class II	class I	class II	cl. I	cl. II
frequency criterion min	7.13 [Hz]	4.5 [Hz]	4.5 [Hz]	63 %	63 %	✓	✓
frequency criterion	7.13 [Hz]	8.0 [Hz]	6.0 [Hz]	112 %	84 %	-	✓
acceleration criterion	0.012 [m/s ²]	0.05 [m/s ²]	0.1 [m/s ²]	23 %	12 %	✓	✓
stiffness criterion	0.113 [mm]	0.25 [mm]	0.5 [mm]	45 %	23 %	✓	✓

support reaction

load case category	k_{mod}	A_v	B_v
		[kN]	
self-weight structure	0.6	3.08	3.08
dead load	0.6	10.64	10.64
live load cat. C: congregation areas	0.9	14.00	14.00
		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 t_f of gypsum fire boards (GKF) according to ON B 3410	Expertise on failure time t_f 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 guideline for Europe	Fire safety in timber buildings - technical guideline 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

The software was created to assist engineers in their daily business. The software is an engineering software that is dealing with a very complex matter of structural analysis and building physics analysis. Therefore, this software shall only be operated by skilled, experienced engineers, with a deep understanding of structural engineering and building physics related to timber structures. The user of the software is obliged to check all input values, no matter if they were given by the user or given by default by the software and all results for plausibility.

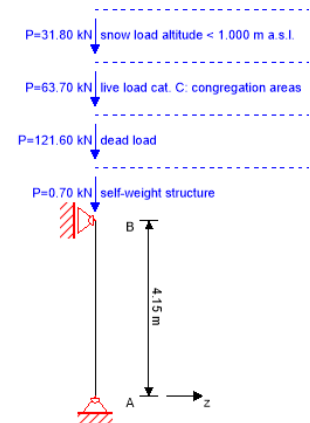
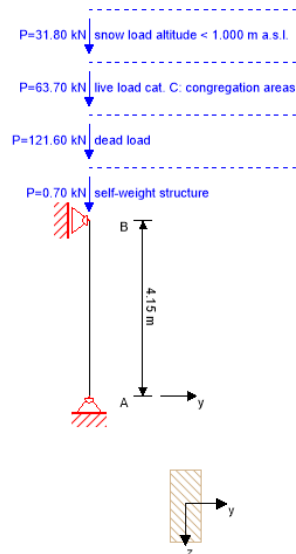
The use of the results of the software should not be relied upon as the basis for any decision or action. Any use of results of the software is only allowed, if the results have been verified and approved regarding completeness and correctness by a project structural/building physics engineer. The user has the possibility to make print-outs from the software. Any modification of those are not allowed.

Stora Enso Wood Products GmbH does not assume any warranty regarding the software. The software has been developed with utmost diligence, nevertheless Stora Enso Wood Products GmbH, neither expressly nor implicitly, provides any warranty in terms of accuracy, validity, timeliness and completeness of information and data created by the software. Stora Enso Wood Products GmbH does also not assume any warranty for the general usability of the software, its suitability for a special purpose or for the compatibility of the software with the ones of third party producers or providers.

Stora Enso Wood Products GmbH is only liable for damages caused by gross negligence or intent through Stora Enso Wood Products GmbH; the liability for slight negligence is excluded. This does not apply to personal injury. Under the aforementioned conditions Stora Enso Wood Products GmbH is as well not liable for operational failures or the loss of programs and/or data of the user's data processing system.

Applicable Law: These terms of use shall be governed by the laws of Austria excluding however any conflict of laws rules and any laws regarding the Convention of the International Sale of Goods (CISG).

system



global utilization ratio

75 %

ULS 75 % ULS fire 67 %

section: wooden beam 12/28

	section width	section height	area	ly	lz
	[cm]	[cm]	[mm ²]	[mm ⁴]	[mm ⁴]
	12	28	33,600	219,520,000	40,320,000

section fire: wooden beam 12/28

	section width	section height	area	ly	lz
	[cm]	[cm]	[mm ²]	[mm ⁴]	[mm ⁴]
	6.5	22.5	14,625	61,699,210	5,149,219

fire resistance class: R 60	time	60 min				
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	48.0	55.0	48.0	55.0

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}	E _{0,5}
	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
C24 spruce	24.00	14.00	0.40	21.00	2.50	2.30	0.80	11,000.00	690.00	7,400.00

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	live load cat. C: congregation areas	Q	short term	0.9	0	1.5	0.7	0.7	0.6
LC4	snow load altitude < 1.000 m a.s.l.	Q	short term	0.9	0	1.5	0.5	0.2	0

LC1:self-weight structure

vertical load

P _k	ex. y	ex. z
[kN]	[m]	[m]
0.6972	0.00	0.00

LC2:dead load

vertical load

P _k	ex. y	ex. z
[kN]	[m]	[m]
121.6	0.00	0.00

LC3:live load cat. C: congregation areas

vertical load

P _k	ex. y	ex. z
[kN]	[m]	[m]
63.7	0.00	0.00

LC4:snow load altitude < 1.000 m a.s.l.

vertical load

P _k	ex. y	ex. z
[kN]	[m]	[m]
31.8	0.00	0.00

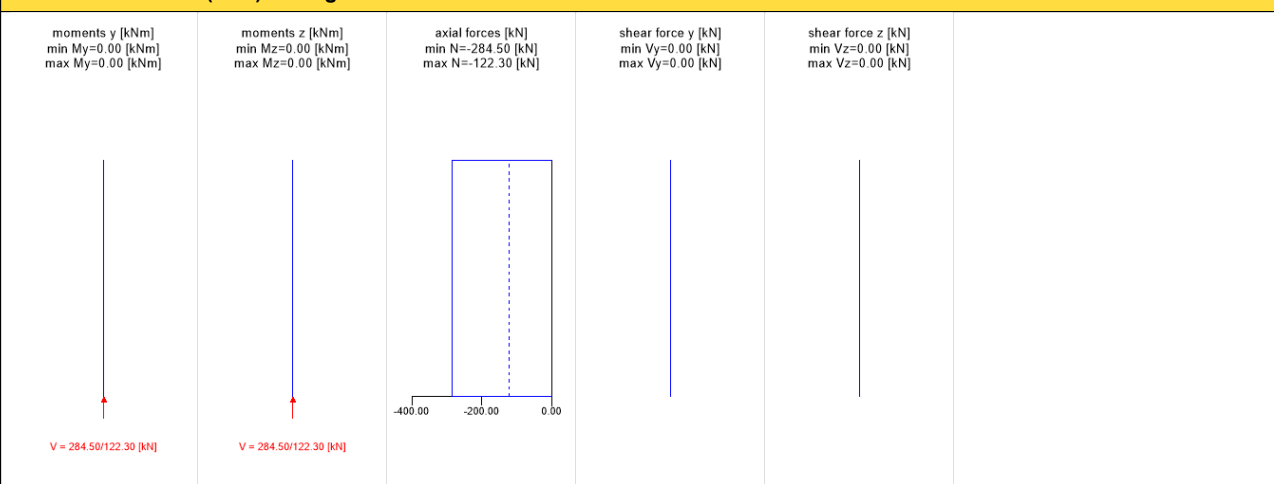
ULS combinations

	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	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.50 * LC4$
LCO4	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4$
LCO5	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.70 * LC3$

ULS combinations fire

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

Ultimate limit state (ULS) - design results



ULS flexural design

dist.	γ_m	k_{mod}	$k_{sys,z}$	$f_{m,k}$	$f_{m,y,d}$	$f_{m,z,d}$	$f_{t,d}$	$f_{c,d}$
[m]	[-]	[-]	[-]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
0.0	1.30	0.90	1.00	24.00	16.62	16.62	10.13	14.54
$M_{y,d}$	$N_{c,d}$	$N_{t,d}$	$\sigma_{m,y,d}$	$\sigma_{c,d}$	$\sigma_{t,d}$	ratio		
[kNm]	[kN]	[kN]	[N/mm ²]	[N/mm ²]	[N/mm ²]			
0.00	-284.50	0.00	0.00	8.47	0.00	34 %	LCO3	

ULS shear analysis Y

dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
4.15	2.30	1.30	0.90	1.59	0.00	0.00	0 %	LCO5

ULS shear analysis Z

dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
4.15	2.30	1.30	0.90	1.59	0.00	0.00	0 %	LCO5

ULS shear analysis combined

dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	$V_{y,d}$	$V_{z,d}$	$T_{v,y,d}$	$T_{v,z,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[kN]	[N/mm ²]	[N/mm ²]		
4.15	2.30	1.30	0.90	1.59	0.00	0.00	0.00	0.00	0 %	LCO5

flexural stress analysis

$M_{y,d} =$	0.00	kNm	$f_{m,k} =$	24.00	N/mm ²		
$N_{c,d} =$	-284.50	kN	$\gamma_m =$	1.30	-		
			$k_{mod} =$	0.90	-		
			$k_{sys,y} =$	1.00	-		
$\sigma_{c,d} =$	8.47	N/mm ²	$f_{c,d} =$	14.54	N/mm ²		
$\sigma_{m,y,d} =$	0.00	N/mm ²	$f_{m,y,d} =$	16.62	N/mm ²		✓
utilization ratio							34 %

shear stress analysis Y

$V_d =$	0.00	kN	$f_{v,k} =$	2.30	N/mm ²		
			$\gamma_m =$	1.30	-		
			$k_{mod} =$	0.90	-		
$T_{v,d} =$	0.00	N/mm ²	$f_{v,d} =$	1.59	N/mm ²		✓
utilization ratio							0 %

shear stress analysis Z					
$V_d =$	0.00	kN	$f_{v,k} =$	2.30	N/mm ²
			$\gamma_m =$	1.30	-
			$k_{mod} =$	0.90	-
$T_{v,d} =$	0.00	N/mm ²	$f_{v,d} =$	1.59	N/mm ²
					<
utilization ratio					0 %

shear stress analysis					
$V_{y,d} =$	0.00	kN	$V_{z,d} =$	0.00	kN
$f_{v,k} =$	2.30	N/mm ²	$\gamma_m =$	1.30	-
$f_{v,d} =$	1.59	N/mm ²	$k_{mod} =$	0.90	-
$T_{v,y,d} =$	0.00	N/mm ²	$T_{v,z,d} =$	0.00	N/mm ²
utilization ratio					0 %

buckling analysis					
$M_{y,d} =$	0.00	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{c,d} =$	-284.50	kN	$\gamma_m =$	1.30	-
			$k_{mod} =$	0.90	-
			$k_{sys,y} =$	1.00	-
$\sigma_{c,d} =$	8.47	N/mm ²	$f_{c,d} =$	14.54	N/mm ²
$\sigma_{m,y,d} =$	0.00	N/mm ²	$f_{m,y,d} =$	16.62	N/mm ²
$\sigma_{m,z,d} =$	0.00	N/mm ²	$f_{m,z,d} =$	16.62	N/mm ²
					<
utilization ratio					75 %

lateral torsional buckling analysis					
$M_{y,d} =$	0.00	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{c,d} =$	-284.50	kN	$\gamma_m =$	1.30	-
			$k_{mod} =$	0.90	-
			$k_{sys,y} =$	1.00	-
$\sigma_{c,d} =$	8.47	N/mm ²	$f_{c,d} =$	14.54	N/mm ²
$\sigma_{m,y,d} =$	0.00	N/mm ²	$f_{m,y,d} =$	16.62	N/mm ²
					<
utilization ratio					61 %

Ultimate limit state (ULS) fire design - results

ULS fire flexural design								
dist.	γ_m	k_{mod}	$k_{sys,y}$	k_{fi}	$f_{m,k}$	$f_{m,y,d}$	$f_{t,d}$	$f_{c,d}$
[m]	[-]	[-]	[-]	[-]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
0.0	1.30	0.90	1.00	1.00	24.00	16.62	10.13	14.54
$M_{y,d}$	$N_{c,d}$	$N_{t,d}$	$\sigma_{m,y,d}$	$\sigma_{c,d}$	$\sigma_{t,d}$	ratio		
[kNm]	[kN]	[kN]	[N/mm ²]	[N/mm ²]	[N/mm ²]			
0.00	-	0.00	0.00	10.98	0.00	17 %		
	160.52					LCO2		

ULS fire shear analysis Y										
dist.	$f_{v,k}$	γ_m	k_{mod}	$k_{sys,y}$	k_{fi}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
4.15	2.30	1.00	1.00	1.00	1.25	2.88	0.00	0.00	0 %	LCO5

ULS fire shear analysis Z										
dist.	$f_{v,k}$	γ_m	k_{mod}	$k_{sys,y}$	k_{fi}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
4.15	2.30	1.00	1.00	1.00	1.25	2.88	0.00	0.00	0 %	LCO5

ULS fire shear analysis combined											
dist.	$f_{v,k}$	γ_m	k_{mod}	$k_{sys,y}$	k_{fi}	$f_{v,d}$	$V_{y,d}$	$V_{z,d}$	$T_{v,y,d}$	$T_{v,z,d}$	ratio
[m]	[N/mm ²]	[-]	[-]	[-]	[-]	[N/mm ²]	[kN]	[kN]	[N/mm ²]	[N/mm ²]	
4.15	2.30	1.00	1.00	1.00	1.25	2.88	0.00	0.00	0.00	0.00	0 %
											LCO5

flexural stress analysis fire					
$M_{y,d} =$	0.00	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{c,d} =$	-160.52	kN	$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{sys,y} =$	1.00	-
			$k_{fi} =$	1.25	-
$\sigma_{c,d} =$	10.98	N/mm ²	$f_{c,d} =$	26.25	N/mm ²
$\sigma_{m,y,d} =$	0.00	N/mm ²	$f_{m,y,d} =$	30.00	N/mm ²
		<			✓
utilization ratio				17 %	

shear stress analysis Y fire					
$V_d =$	0.00	kN	$f_{v,k} =$	2.30	N/mm ²
			$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{fi} =$	1.25	-
$\tau_{v,d} =$	0.00	N/mm ²	$f_{v,d} =$	2.88	N/mm ²
		<			✓
utilization ratio				0 %	

shear stress analysis Z fire					
$V_d =$	0.00	kN	$f_{v,k} =$	2.30	N/mm ²
			$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{fi} =$	1.25	-
$\tau_{v,d} =$	0.00	N/mm ²	$f_{v,d} =$	2.88	N/mm ²
		<			✓
utilization ratio				0 %	

shear stress analysis fire					
$V_{y,d} =$	0.00	kN	$V_{z,d} =$	0.00	kN
$f_{v,k} =$	2.30	N/mm ²	$\gamma_m =$	1.00	-
			$k_{fi} =$	1.25	-
$f_{v,d} =$	2.88	N/mm ²	$k_{mod} =$	1.00	-
$\tau_{v,y,d} =$	0.00	N/mm ²	$\tau_{v,z,d} =$	0.00	N/mm ²
utilization ratio				0 %	

buckling analysis fire					
$M_{y,d} =$	0.00	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{c,d} =$	-160.52	kN	$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{sys,y} =$	1.00	-
			$k_{fi} =$	1.25	-
$\sigma_{c,d} =$	10.98	N/mm ²	$f_{c,d} =$	26.25	N/mm ²
$\sigma_{m,y,d} =$	0.00	N/mm ²	$f_{m,y,d} =$	30.00	N/mm ²
$\sigma_{m,z,d} =$	0.00	N/mm ²	$f_{m,z,d} =$	30.00	N/mm ²
		<			✓
utilization ratio				67 %	

lateral torsional buckling analysis fire					
$M_{y,d} =$	0.00	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{c,d} =$	-160.52	kN	$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{sys,y} =$	1.00	-
			$k_{fi} =$	1.25	-
$\sigma_{c,d} =$	10.98	N/mm ²	$f_{c,d} =$	26.25	N/mm ²
$\sigma_{m,y,d} =$	0.00	N/mm ²	$f_{m,y,d} =$	30.00	N/mm ²
		<			✓
utilization ratio				55 %	

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	0.70	0.00	0.00
		0.00	0.00	0.70	0.00	0.00
dead load	0.6	0.00	0.00	121.60	0.00	0.00
		0.00	0.00	121.60	0.00	0.00
live load cat. C: congregation areas	0.9	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	63.70	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

support reaction						
load case category	k _{mod}	A _y	A _z	B _x	B _y	B _z
		[kN]	[kN]	[kN]	[kN]	[kN]
		0.00	0.00	31.80	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
EN 1995-1-2	EN 1995-1-2 - Eurocode 5 — Design of timber structures — Part 1-2: General — Structural fire design
EN 14080	EN 14080 - Timber Structures - Glued laminated timber and glued solid timber - Requirements
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 guideline for Europe	Fire safety in timber buildings - technical guideline 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

Disclaimer

The software was created to assist engineers in their daily business. The software is an engineering software that is dealing with a very complex matter of structural analysis and building physics analysis. Therefore, this software shall only be operated by skilled, experienced engineers, with a deep understanding of structural engineering and building physics related to timber structures. The user of the software is obliged to check all input values, no matter if they were given by the user or given by default by the software and all results for plausibility.

The use of the results of the software should not be relied upon as the basis for any decision or action. Any use of results of the software is only allowed, if the results have been verified and approved regarding completeness and correctness by a project structural/building physics engineer. The user has the possibility to make print-outs from the software. Any modification of those are not allowed.

Stora Enso Wood Products GmbH does not assume any warranty regarding the software. The software has been developed with utmost diligence, nevertheless Stora Enso Wood Products GmbH, neither expressly nor implicitly, provides any warranty in terms of accuracy, validity, timeliness and completeness of information and data created by the software. Stora Enso Wood Products GmbH does also not assume any warranty for the general usability of the software, its suitability for a special purpose or for the compatibility of the software with the ones of third party producers or providers.

Stora Enso Wood Products GmbH is only liable for damages caused by gross negligence or intent through Stora Enso Wood Products GmbH; the liability for slight negligence is excluded. This does not apply to personal injury. Under the aforementioned conditions Stora Enso Wood Products GmbH is as well not liable for operational failures or the loss of programs and/or data of the user's data processing system.

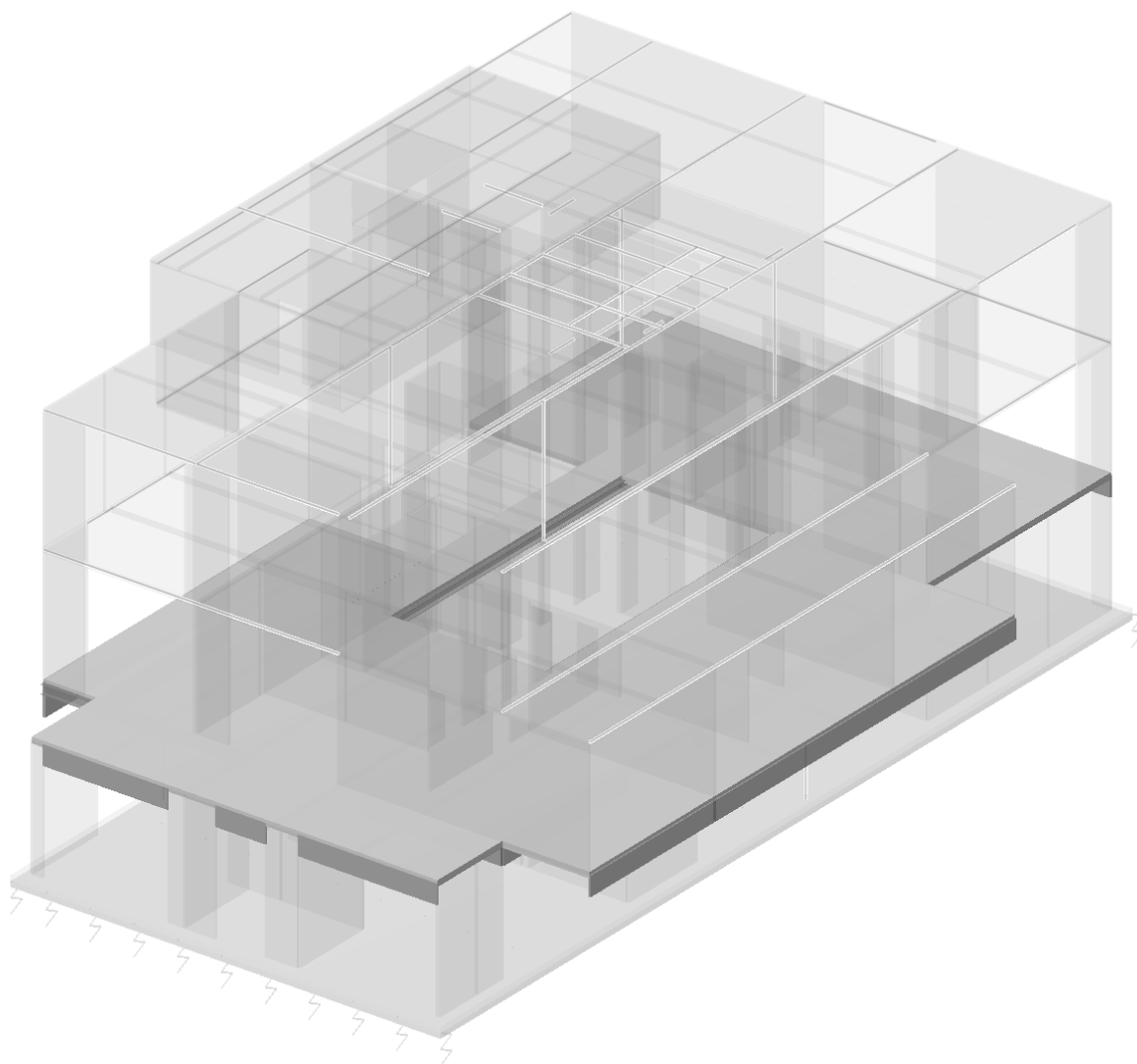
Applicable Law: These terms of use shall be governed by the laws of Austria excluding however any conflict of laws rules and any laws regarding the Convention of the International Sale of Goods (CISG).

POZ 100

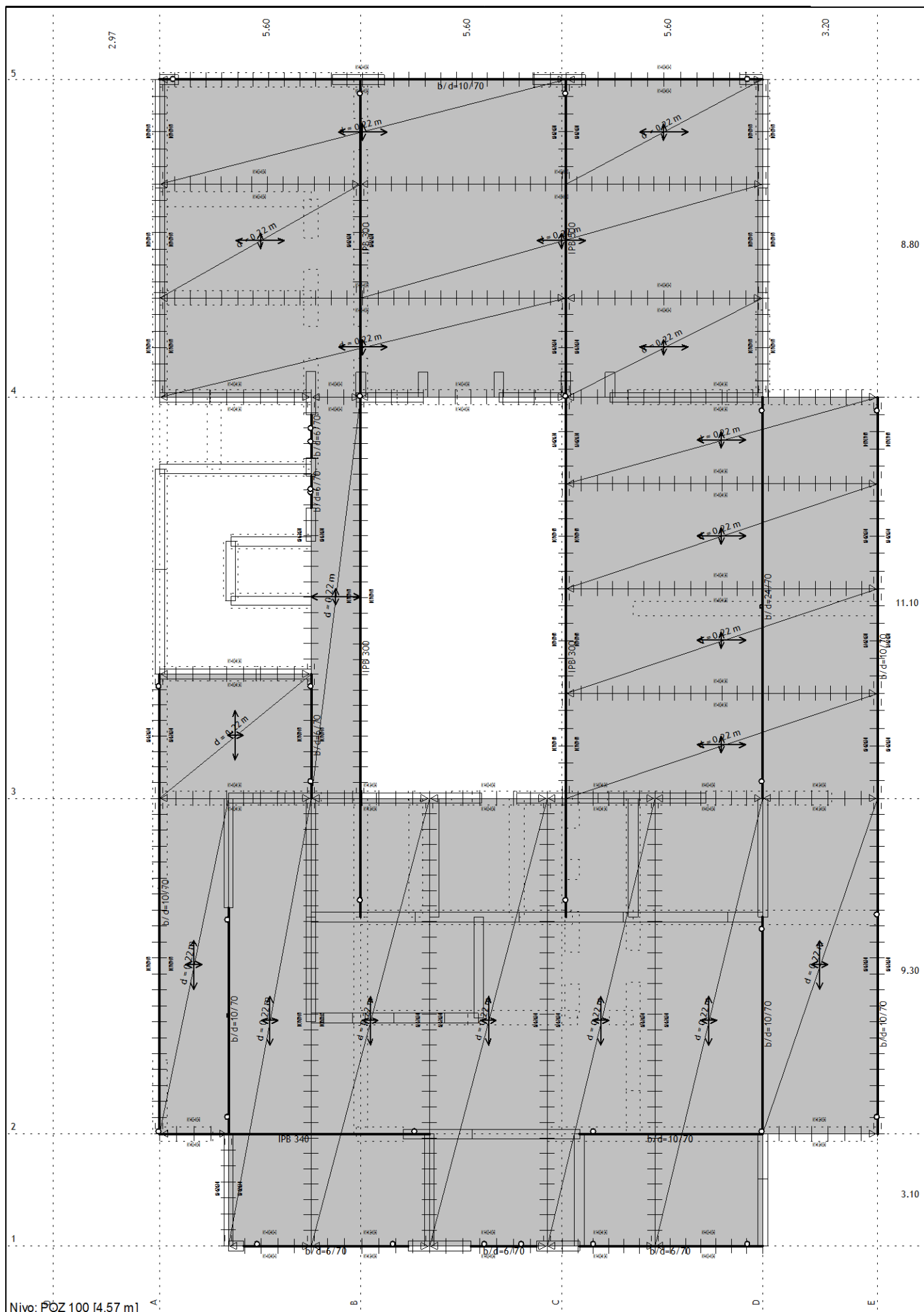
POZ 100: medetažna plošča nad pritličjem

Medetažno ploščo izvedemo s križno lepljenimi lesenimi ploščami debeline 220 mm. Plošče nalegajo na lesene stene, v oseh B in C so podprte v jeklenima nosilcema, na previsnem delu se plošča nosi preko robnega nosilca, ki je obešan na konzolne stene prvega nadstropja.

- POZ 100: plošča CLT L7s-2 220 mm
- POZ 101: jekleni nosilec HEB 300; S 235
- POZ 102: jekleni nosilec HEB 500; S 235
- POZ 103: leseni nosilec 24/70 cm; GL24h
- POZ 104: preklada CLT L5s 140 mm; h = 70 cm - zunanji sloji horizontalno
- POZ 105: preklada CLT L5s 140 mm; h = 70 cm - zunanji sloji horizontalno
- POZ 106: robni nosilec pod ploščo CLT L5s 140 mm; h = 70 cm - zunanji sloji horizontalno
- POZ 107: konzolni jekleni nosilec HEB 340; S 235



Izometrija (Nivo: POZ 100 [4.57 m])



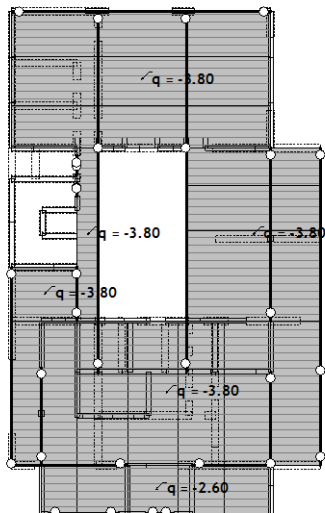
Vhodni podatki - Obtežba

Lista obtežnih primerov

LC	Naziv
1	Stalna + i.t. (g)
2	Koristna
3	Sneg
4	Komb.: MSN-01 (1.35xI+1.5xII+0.75xIII)
5	Komb.: MSN-02 (1.35xI+1.05xII+1.5xIII)

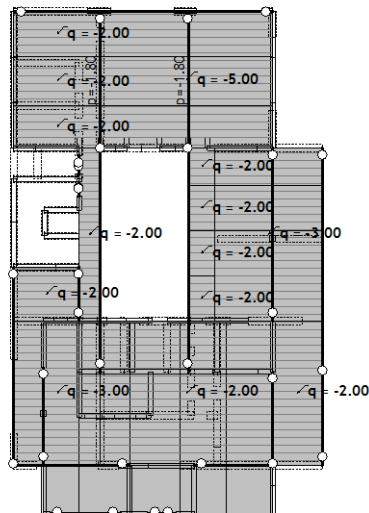
6	Komb.: MSU-01 (I+II+0.5xIII)
7	Komb.: MSU-02 (I+0.7xII+III)
8	Komb.: MSU-fin-01 (1.6xI+1.18xII+0.5xIII)
9	Komb.: MSU-fin-02 (1.6xI+0.88xII+III)

Obt. 1: Stalna + i.t. (g)



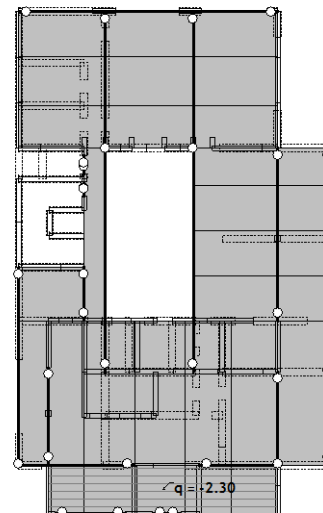
Nivo: POZ 100 [4.57 m]

Obt. 2: Koristna



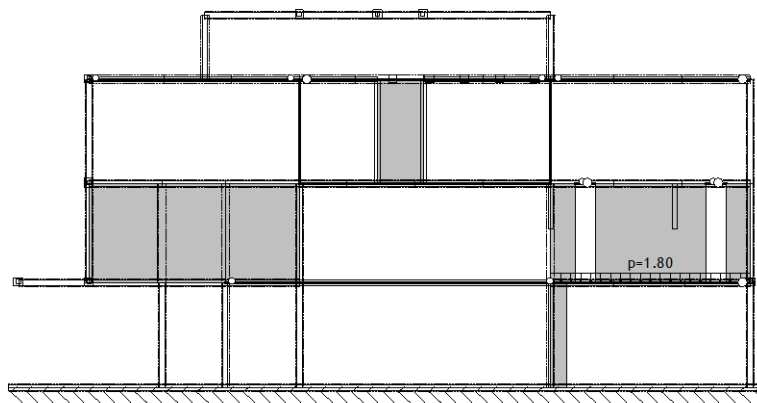
Nivo: POZ 100 [4.57 m]

Obt. 3: Sneg



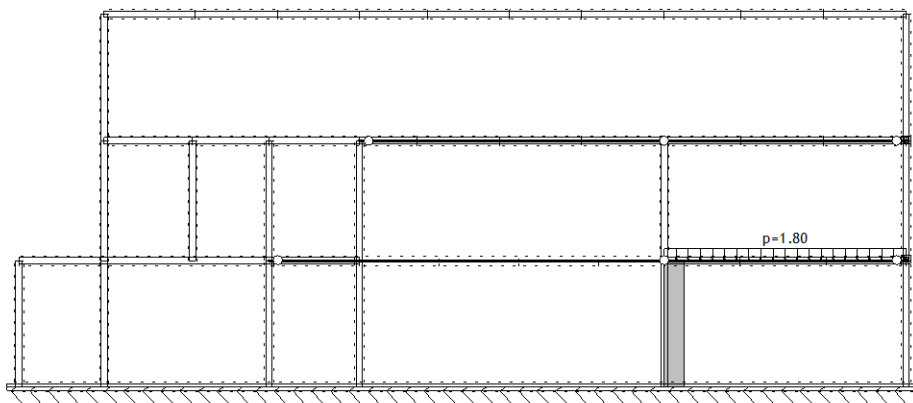
Nivo: POZ 100 [4.57 m]

Obt. 2: Koristna



Okvir: V_18

Obt. 2: Koristna



Okvir: V_7

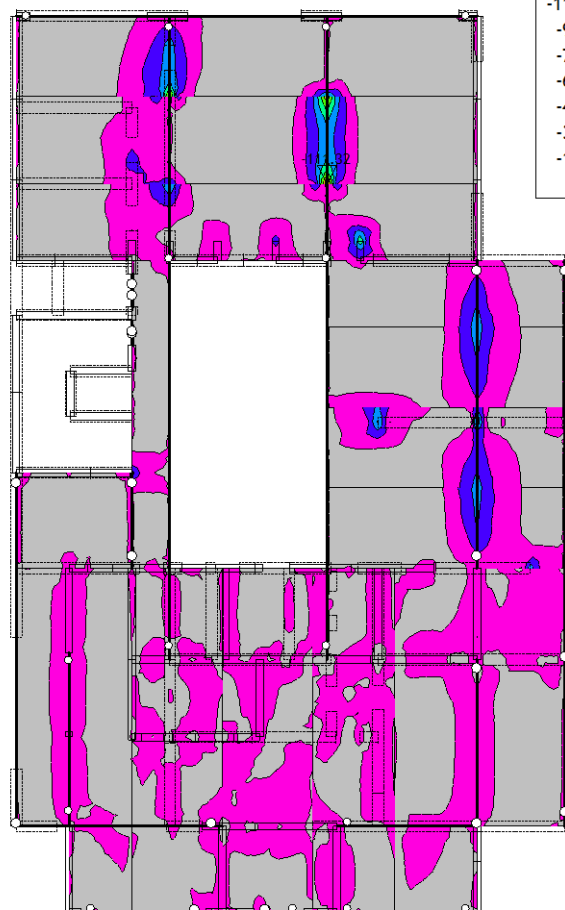
Statični preračun

Obt. 10: [MSN] 4,5



Nivo: POZ 100 [4.57 m]
Vplivi v plošči: max $M_x = 43.08$ / min $M_x = 0.00$ kNm/m

Obt. 10: [MSN] 4,5



Nivo: POZ 100 [4.57 m]
Vplivi v plošči: max $M_x = 0.00$ / min $M_x = -111.32$ kNm/m

Obt. 10: [MSN] 4,5



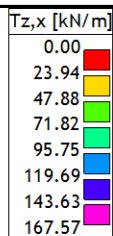
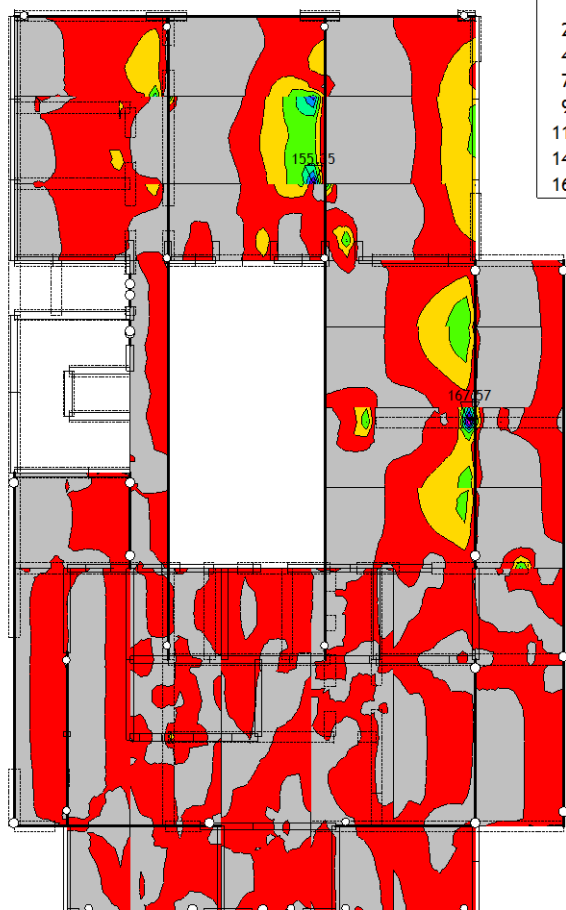
Nivo: POZ 100 [4.57 m]
Vplivi v plošči: max $M_y = 69.11$ / min $M_y = 0.00$ kNm/m

Obt. 10: [MSN] 4,5

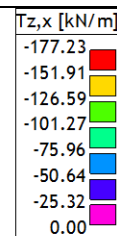


Nivo: POZ 100 [4.57 m]
Vplivi v plošči: max $M_y = 0.00$ / min $M_y = -50.69$ kNm/m

Obt. 10: [MSN] 4,5



Obt. 10: [MSN] 4,5



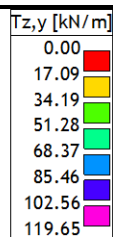
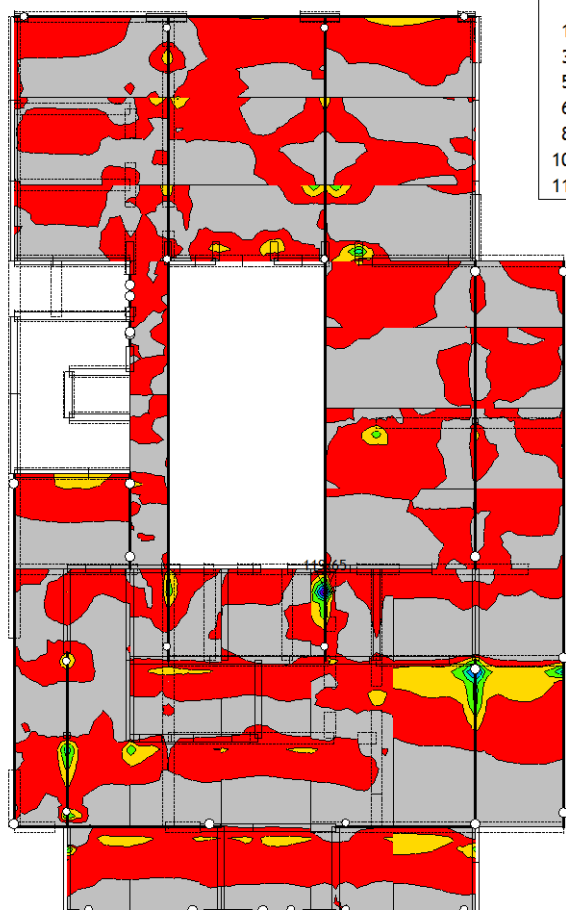
Nivo: POZ 100 [4.57 m]

Vplivi v plošči: max Tz,x= 167.57 / min Tz,x= 0.00 kN/m

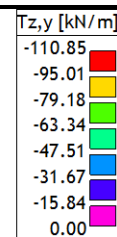
Nivo: POZ 100 [4.57 m]

Vplivi v plošči: max Tz,x= 0.00 / min Tz,x= -177.22 kN/m

Obt. 10: [MSN] 4,5



Obt. 10: [MSN] 4,5



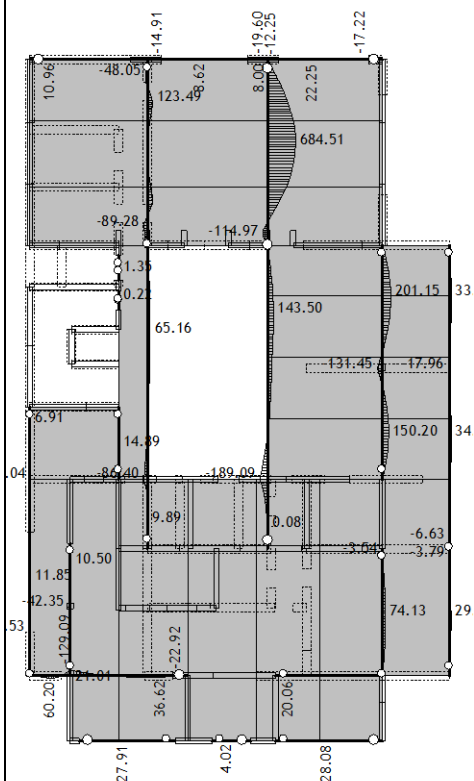
Nivo: POZ 100 [4.57 m]

Vplivi v plošči: max Tz,y= 119.65 / min Tz,y= 0.00 kN/m

Nivo: POZ 100 [4.57 m]

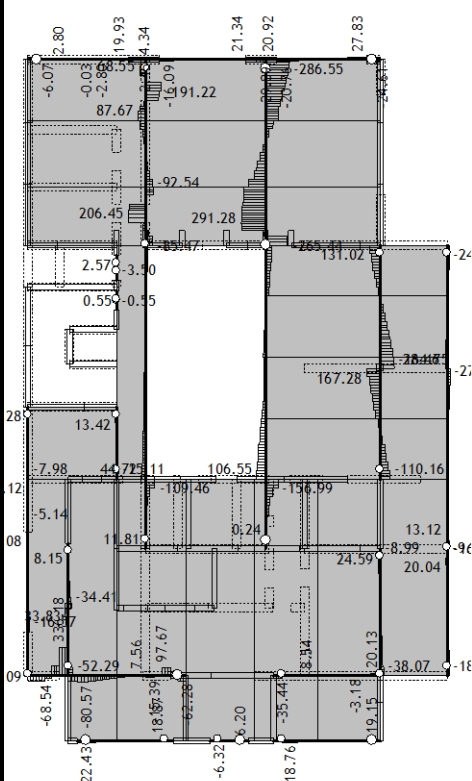
Vplivi v plošči: max Tz,y= 0.00 / min Tz,y= -110.85 kN/m

Obt. 10: [MSN] 4,5



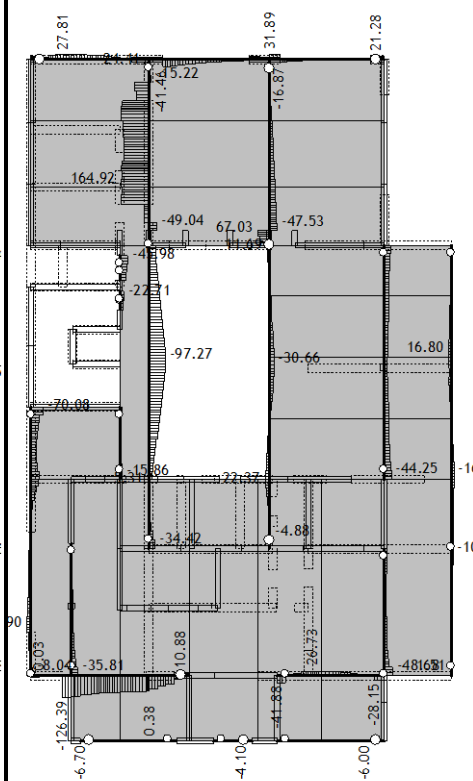
Nivo: POZ 100 [4.57 m]
Vplivi v gredi: max M3= 684.51 / min M3= -189.09 kNm

Obt. 10: [MSN] 4,5



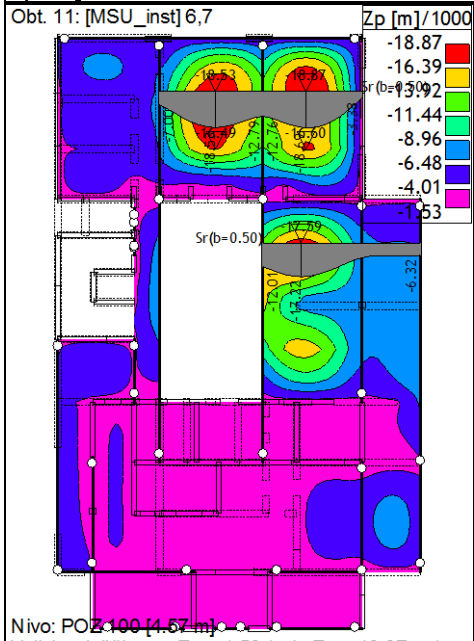
Nivo: POZ 100 [4.57 m]
Vplivi v gredi: max T2= 336.18 / min T2= -286.55 kN

Obt. 10: [MSN] 4,5



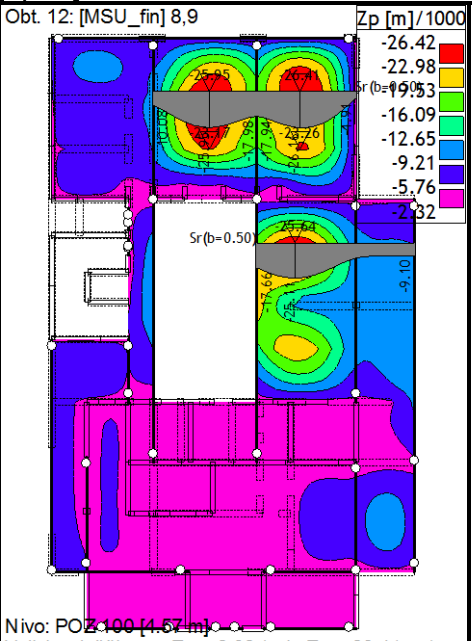
Nivo: POZ 100 [4.57 m]
Vplivi v gredi: max N1= 164.92 / min N1= -126.39 kN

Obt. 11: [MSU_inst] 6,7



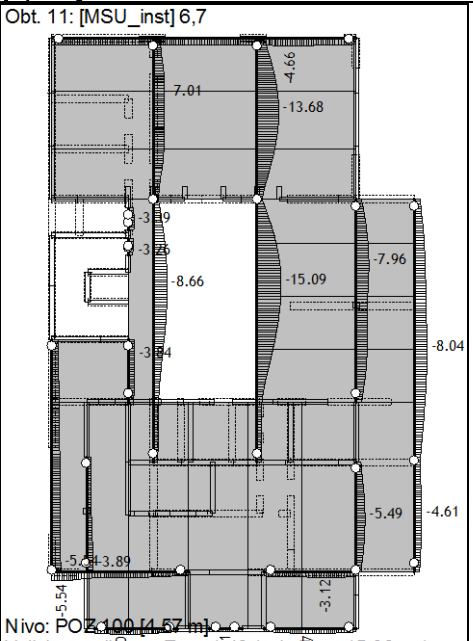
Nivo: POZ 100 [4.57 m]
Vplivi v plošči: max Zp= -1.53 / min Zp= -18.87 m / ...

Obt. 12: [MSU_fin] 8,9



Nivo: POZ 100 [4.57 m]
Vplivi v plošči: max Zp= -2.32 / min Zp= -26.41 m / ...

Obt. 11: [MSU_inst] 6,7



Nivo: POZ 100 [4.57 m]
Vplivi v gredi: max Zp= -1.49 / min Zp= -15.09 m / ...

Kontrola povesov za MSU:

POZ 100:

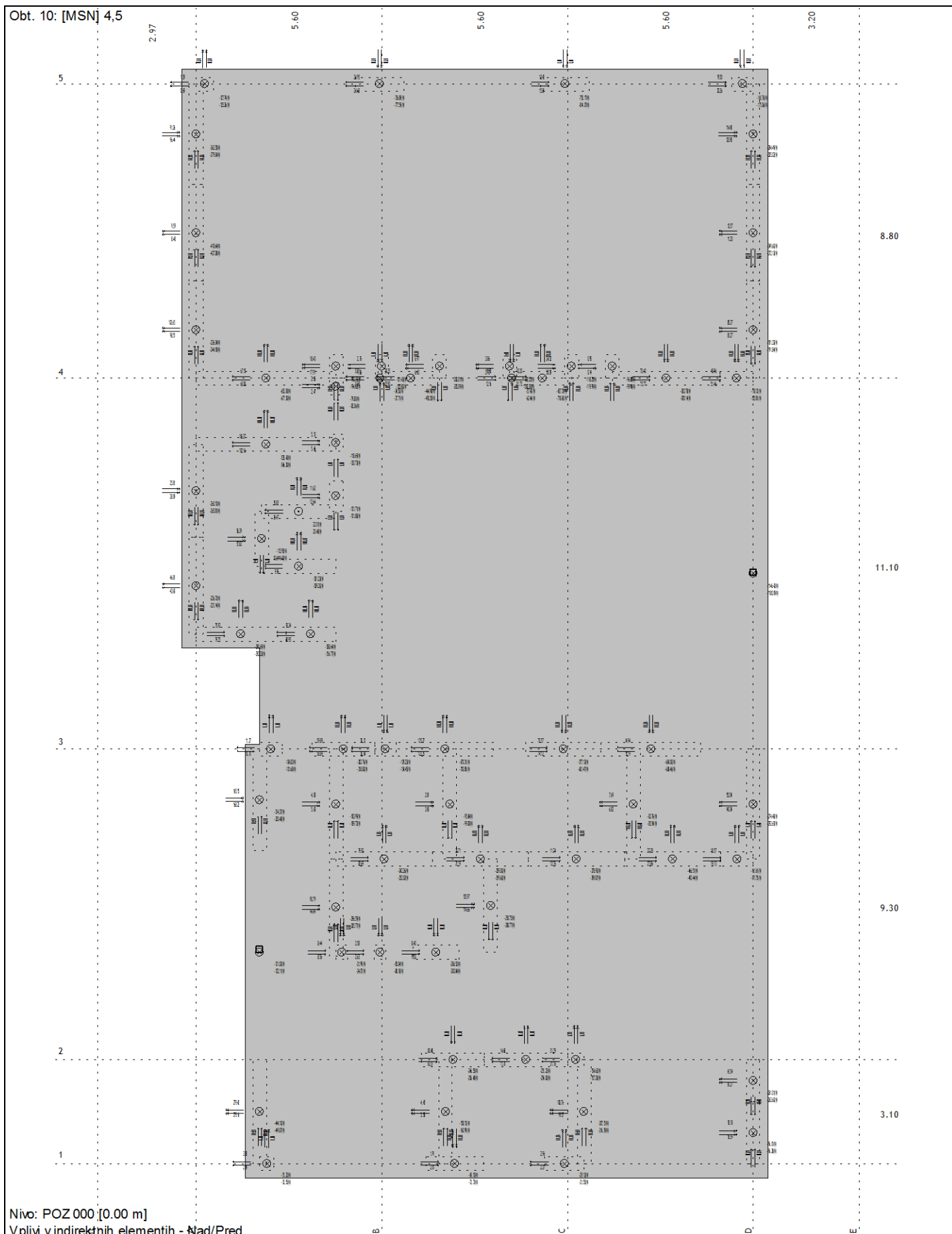
$w(\text{MSU}, \text{inst}) = 1,8 - 0,6 \text{ cm} = 1,2 \text{ cm} < w(\text{dop}) = L / 300 = 1,9 \text{ cm} \rightarrow \text{OK}$

$w(\text{MSU}, \text{fin}) = 2,6 - 0,8 \text{ cm} = 1,8 \text{ cm} < w(\text{dop}) = L / 250 = 2,3 \text{ cm} \rightarrow \text{OK}$

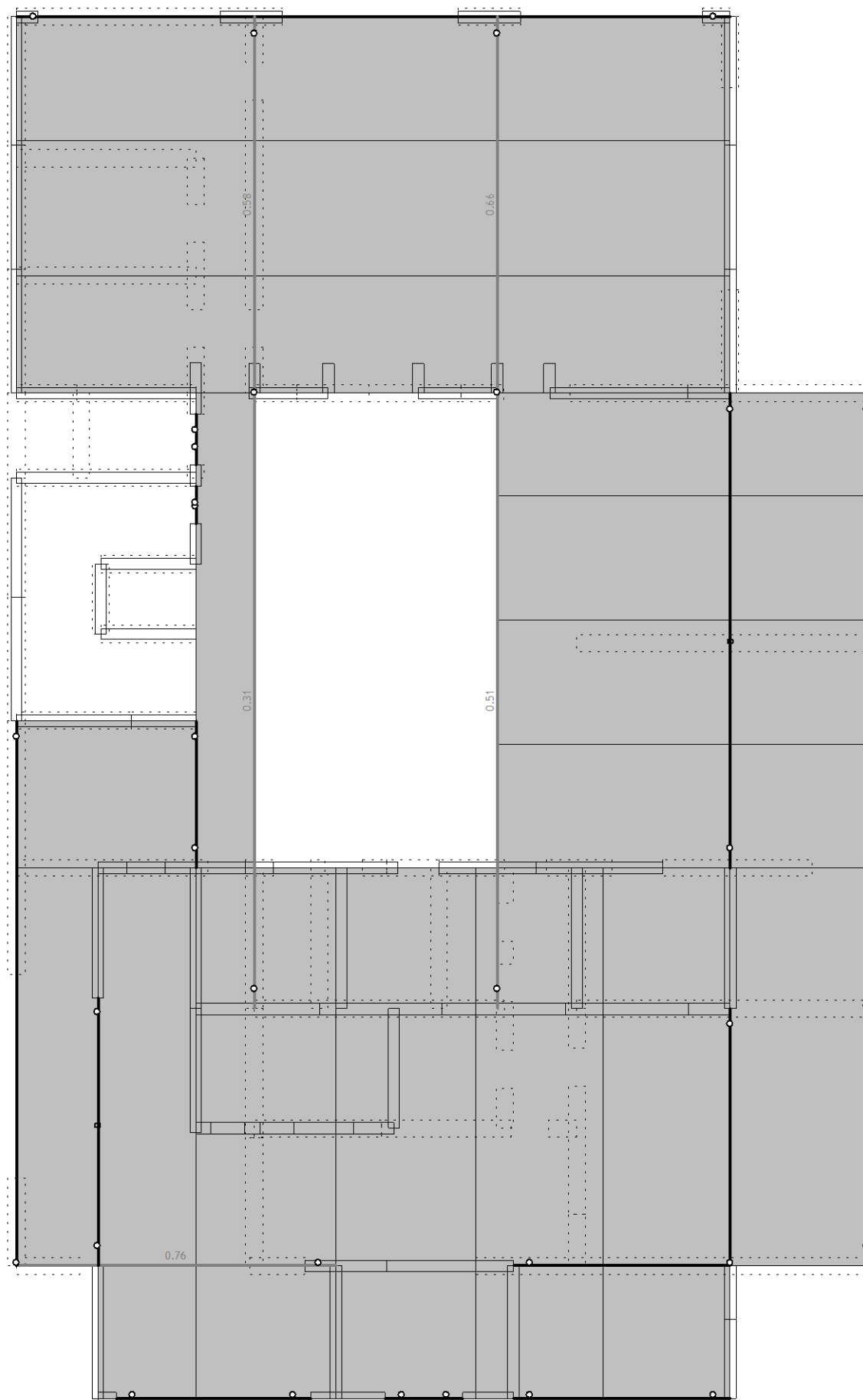
POZ 102:

$w(\text{MSU}, \text{inst}) = 1,5 - 0,2 \text{ cm} = 1,3 \text{ cm} < w(\text{dop}) = L / 300 = 3,7 \text{ cm} \rightarrow \text{OK}$

Prikaz osnih sil v stenah in stebrih pritličja:



Dimenzioniranje (jeklo)

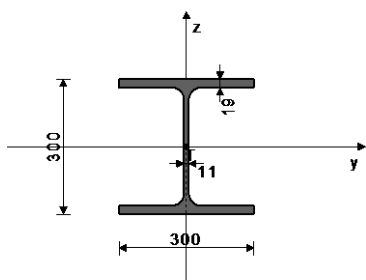


Nivo: POZ 100 [4.57 m]
Kontrola stabilnosti

POZ 101: HEB 300; S 235

PREČNI PREREZ: IPB 300 [S 235] [Set: 4]
EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza



Ax =	149.00	cm ²
Ay =	101.65	cm ²
Az =	47.350	cm ²
Ix =	186.00	cm ⁴
Iy =	25170	cm ⁴
Iz =	8560.0	cm ⁴
Wy,pl =	1678.0	cm ³
Wz =	570.67	cm ³
Wy,pl =	1865.8	cm ³
Wz,pl =	855.00	cm ³
yM0 =	1.100	
yM1 =	1.100	
yM2 =	1.250	
Anet/A =	0.900	

[mm]

(fy = 23.5 kN/cm², fu = 36.0 kN/cm²)

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
4. γ=0.58 5. γ=0.49

PALICA IZPOSTAVLJENA NATEGU IN UPOGIBU
(obtežni primer 4, na 195.0 cm od začetka palice)

Računska osna sila	Nsd =	153.51	kN
Prečna sila v y smeri	Vsd_y =	18.647	kN
Prečna sila v z smeri	Vsd_z =	14.711	kN
Upogibni moment okoli y osi	Msd_y =	123.49	kNm
Upogibni moment okoli z osi	Msd_z =	2.168	kNm
Moment torzije	Mt =	-0.229	kNm
Sistemska dolžina palice	L =	880.00	cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV
Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.3 Nateg

Plast.rač.nosilnost bruto prereza	Npl.Rd =	3183.2	kN
Mejna rač.nosilnost neto prereza	Nu.Rd =	3475.9	kN
Računska nos. na nateg	Nt.Rd =	3183.2	kN

Pogoj 5.13: Nsd <= Nt.Rd (153.51 <= 3183.18)

5.4.5 Upogib y-y

Računski plastični moment	Mpl.Rd =	398.60	kNm
Računska nos.na lokalno izbočitev	Mo.Rd =	358.48	kNm
Računski elastični moment	Mel.Rd =	358.48	kNm
Računska nosilnost na upogib	Mc.Rd =	398.60	kNm

Pogoj 5.17: Msd_y <= Mc.Rd_y (123.49 <= 398.60)

5.4.5 Upogib z-z

Računski plastični moment	Mpl.Rd =	182.66	kNm
Računska nos.na lokalno izbočitev	Mo.Rd =	121.92	kNm
Računski elastični moment	Mel.Rd =	121.92	kNm
Računska nosilnost na upogib	Mc.Rd =	182.66	kNm

Pogoj 5.17: Msd_z <= Mc.Rd_z (2.17 <= 182.66)

5.4.6 Strig

Računska plast.nos.na strig z-z	Vpl.Rd =	584.03	kN
---------------------------------	----------	--------	----

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (14.71 <= 584.03)

Računska plast.nos.na strig y-y

Vpl.Rd =	1253.8	kN
----------	--------	----

Pogoj 5.20: Vsd_y <= Vpl.Rd_y (18.65 <= 1253.78)

5.4.9 Upogib z osno in prečno silo

Ni potrebno zmanjšanje upogibne nosilnosti

Pogoj: Vsd_z <= 50%Vpl.Rd_z i Vsd_y <= 50%Vpl.Rd_y

5.4.8 Upogib in osna sila

Razmerje Nsd / Npl.Rd	0.048
Razmerje Msd_y / Mpl.Rd_y	0.310
Razmerje Msd_z / Mpl.Rd_z	0.012

Pogoj 5.36: (0.37 <= 1)

5.5 NOSILNOST ELEMENTOV

5.5.2 Bočna zvrnitev upogibnih nosilcev

Koeficient	C1 =	1.132
Koeficient	C2 =	0.459
Koeficient	C3 =	0.525
Koef. ukl.dolžine za uklon	k =	1.000
Koef. ukl.dolžine za vbočenje	kw =	1.000
Koordinata	zg =	0.000 cm
Koordinata	zj =	0.000 cm
Razmak med bočnimi podporami	L =	100.00 cm
Sektorski vztrajnostni moment	Iw =	1.69e+6 cm6
Krit.moment bočne zvrnitve	Mcr =	28800 kNm
Koeficient	βw =	1.000
Koeficient imperf.	αLT =	0.210
Brezdimenz.vitkost	λLT =	0.123
Koeficient zmanjšanja	χLT =	1.000
Računska uklonska nosilnost	Mb.Rd =	398.60 kNm

5.5.3 Upogib in nateg

Redukcijski koef.za vektorske vplive

Elast.odp.mom.za krajne

tlač.vlakno

Efektivni rač.notranji moment

Pogoj 5.50: Meff.sd <= Mb.Rd (109.66 <= 398.60)

ψvec =	0.800
Wcom =	1678.0 cm3
Meff.sd =	109.66 kNm

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

za strig v ravnini z-z

Višina stojine

Debelina stojine

Ni prečnih ojačitev v sredini

Koeficient izbočenja pri strigu

Ni potrebna kontrola izbočenja zaradi striga

Pogoj: d / tw <= 69 ε (23.82 <= 69.00)

d =	26.200 cm
tw =	1.100 cm
kr =	5.340

5.6.7 Interakcija prečne sile, upogiba in osne sile

za strig v ravnini z-z

Računski plastični moment pasnic

Pogoj 5.66a in 5.66b so izpolnjeni

Mf.Rd =	364.47	kNm
---------	--------	-----

5.7 VNOS KONCENTRIRANIH SIL V STOJINO

5.7.7 Uklon pasnice v smeri stojine

Koeficient(razred pasnice 1)

Površina stojine

Površina tlač.pasnice

Preprečen je uklon pasnice v smeri stojine

Pogoj 5.80: (23.82 <= 203.98)

k =	0.300
Aw =	33.000 cm2
Afc =	57.000 cm2

KONTROLA STRIŽNE NOSILNOSTI

(obtežni primer 4, na 772.0 cm od začetka palice)

Računska osna sila	Nsd =	28.357	kN
Prečna sila v y smeri	Vsd_y =	-3.803	kN
Prečna sila v z smeri	Vsd_z =	206.45	kN
Upogibni moment okoli y osi	Msd_y =	-66.546	kNm
Upogibni moment okoli z osi	Msd_z =	1.635	kNm
Moment torzije	Mt =	0.272	kNm
Sistemska dolžina palice	L =	880.00	cm

5.4 NOSILNOST PREČNIH PREREZOV

5.4.6 Strig

Računska plast.nos.na strig z-z

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (206.45 <= 355.47)

Vpl.Rd =	355.47	kN
----------	--------	----

Računska plast.nos.na strig y-y

Pogoj 5.20: Vsd_y <= Vpl.Rd_y (3.80 <= 1126.70)

Vpl.Rd =	1126.7	kN
----------	--------	----

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

za strig v ravnini z-z

Višina stojine

Debelina stojine

Ni prečnih ojačitev v sredini

Koeficient izbočenja pri strigu

Ni potrebna kontrola izbočenja zaradi striga

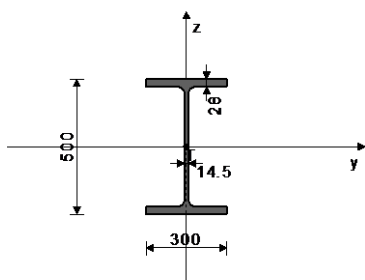
Pogoj: d / tw <= 69 ε (23.82 <= 69.00)

d =	26.200	cm
tw =	1.100	cm
kr =	5.340	

POZ 102: HEB 500; S 235

PREČNI PREREZ: IPB 500 [S 235] [Set: 3]
EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza



Ax =	239.00	cm ²
Ay =	148.82	cm ²
Az =	90.180	cm ²
Ix =	540.00	cm ⁴
Iy =	1.07e+5	cm ⁴
Iz =	12620	cm ⁴
Wy =	4288.0	cm ³
Wz =	841.33	cm ³
Wy,pl =	4959.4	cm ³
Wz,pl =	1260.0	cm ³
yM0 =	1.100	
yM1 =	1.100	
yM2 =	1.250	
Anet/A =	0.900	

[mm]

(fy = 23.5 kN/cm², fu = 36.0 kN/cm²)FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB
4. γ=0.66 5. γ=0.55PALICA IZPOSTAVLJENA PRITISKU IN UPOGIBU
(obtežni primer 4, na 366.7 cm od začetka palice)

Računska osna sila	Nsd =	-20.127	kN
Prečna sila v y smeri	Vsd_y =	2.302	kN
Prečna sila v z smeri	Vsd_z =	-34.398	kN
Upogibni moment okoli y osi	Msd_y =	684.10	kNm
Upogibni moment okoli z osi	Msd_z =	-2.339	kNm
Moment torzije	Mt =	0.189	kNm
Sistemska dolžina palice	L =	880.00	cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV
Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.4 Tlak

Plastična računska nosilnost

Npl.Rd = 5105.9 kN

Računska nosilnost na tlak

Nc.Rd = 5105.9 kN

Pogoj 5.16: Nsd <= Nc.Rd (20.13 <= 5105.91)

5.4.5 Upogib y-y

Računski plastični moment

Mpl.Rd = 1059.5 kNm

Računska nos. na lokalno izbočitev

Mo.Rd = 916.07 kNm

Računski elastični moment

Mel.Rd = 916.07 kNm

Računska nosilnost na upogib

Mc.Rd = 1059.5 kNm

Pogoj 5.17: Msd_y <= Mc.Rd_y (684.10 <= 1059.50)

5.4.5 Upogib z-z

Računski plastični moment

Mpl.Rd = 269.18 kNm

Računska nos. na lokalno izbočitev

Mo.Rd = 179.74 kNm

Računski elastični moment

Mel.Rd = 179.74 kNm

Računska nosilnost na upogib

Mc.Rd = 269.18 kNm

Pogoj 5.17: Msd_z <= Mc.Rd_z (2.34 <= 269.18)

5.4.6 Strig

Računska plast.nos.na strig z-z

Vpl.Rd = 1112.3 kN

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (34.40 <= 1112.31)

Računska plast.nos.na strig y-y

Vpl.Rd = 1835.6 kN

Pogoj 5.20: Vsd_y <= Vpl.Rd_y (2.30 <= 1835.59)

5.4.9 Upogib z osno in prečno silo

Ni potrebno zmanjšanje upogibne nosilnosti

Pogoj: Vsd_z <= 50%Vpl.Rd_z i Vsd_y <= 50%Vpl.Rd_y

5.4.8 Upogib in osna sila

Razmerje Msd_y / Mpl.Rd_y

0.646

Pogoj 5.36: (0.66 <= 1)

5.5 NOSILNOST ELEMENTOV

5.5.1 Uklonska nosilnost

Uklonska dolžina y-y

l_y = 100.00 cm

Vztrajnostni radij y-y

i_y = 21.179 cm

Vitkost y-y

λ_y = 4.722

Relativna vitkost y-y

λ_y = 0.050

Uklonska krivulja za os y-y: A

α = 0.210

Koefficient nepopolnosti

χ_y = 1.000

Koefficient efektivnega prereza

β_A = 1.000

Računska uklonska nosilnost

Nb.Rd_y = 5105.9 kN

Pogoj 5.45: Nsd <= Nb.Rd_y (20.13 <= 5105.91)

Uklonska dolžina z-z

l_z = 100.00 cm

Vztrajnostni radij z-z

i_z = 7.267 cm

Vitkost z-z

λ_z = 13.762

Relativna vitkost z-z

λ_z = 0.147

Uklonska krivulja za os z-z: B

α = 0.340

Koefficient nepopolnosti

χ_z = 1.000

Koefficient efektivnega prereza

β_A = 1.000

Računska uklonska nosilnost

Nb.Rd_z = 5105.9 kN

Pogoj 5.45: Nsd <= Nb.Rd_z (20.13 <= 5105.91)

5.5.2 Bočna zvrnitev upogibnih nosilcev

Koefficient

C1 = 1.132

Koefficient

C2 = 0.459

Koefficient

C3 = 0.525

Koef. ukl.dolžine za uklon

k = 1.000

Koef. ukl.dolžine za vbočenje

kw = 1.000

Koordinata

zg = 0.000 cm

Koordinata

zj = 0.000 cm

Razmak med bočnimi podporami

L = 100.00 cm

Sektorski vztrajnostni moment

Iw = 7.02e+6 cm⁶

Krit.moment bočne zvrnitve

Mcr = 70861 kNm

Koefficient

βw = 1.000

Koefficient imperf.

αLT = 0.210

Brezdimenz.vitkost

λLT = 0.128

Koefficient zmanjšanja

χLT = 1.000

Računska uklonska nosilnost

Mb.Rd = 1059.5 kNm

Kontrola bočne zvrnitve ni potrebna: λ_LT <= 0.4

5.5.4 Upogib in tlak

Koefficient nepopolnosti

χmin = 1.000

Nsd / ...

0.004

Koefficient oblike momenta

βy = 1.253

Koefficient

μy = 0.081

Koefficient

ky = 1.000

ky * My / ...

0.645

Koefficient oblike momenta

βz = 1.099

Koefficient

μz = 0.234

Koefficient

kz = 0.999

kz * Mz / ...

0.009

Pogoj 5.51: (0.66 <= 1)

Koefficient nepopolnosti

χ_z = 1.000

Nsd / ...

0.004

Koefficient nepopolnosti

χLT = 1.000

Koef.obl.mom.za bočno zvrnitev

βMLT = 1.253

Koefficient

μLT = -0.122

Koefficient

kLT = 1.000

kLT * My / ...

0.646

Koefficient oblike momenta

βz = 1.099

Koefficient

μz = 0.234

Koefficient

kz = 0.999

kz * Mz / ...

0.009

Pogoj 5.52: (0.66 <= 1)

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

za strig v ravnini z-z

Višina stojine

d = 44.400 cm

Debelina stojine

tw = 1.450 cm

Ni prečnih ojačitev v sredini

Koefficient izbočenja pri strigu

kr = 5.340

Ni potrebna kontrola izbočenja zaradi striga

Pogoj: d / tw <= 69 ε (30.62 <= 69.00)

5.6.7 Interakcija prečne sile, upogiba in osne sile

za strig v ravnini z-z

Računski plastični moment pasnic

Mf.Rd = 897.26 kNm

Pogoji 5.66a in 5.66b so izpolnjeni

5.7 VNOS KONCENTRIRANIH SIL V STOJINO

5.7.7 Uklon pasnice v smeri stojine

Koefficient(razred pasnice 1)

k = 0.300

Površina stojine

Aw = 72.500 cm²

Površina tlač.pasnice

Afc = 84.000 cm²

Preprečen je uklon pasnice v smeri stojine

Pogoj 5.80: (30.62 <= 249.06)

KONTROLA STRIŽNE NOSILNOSTI

(obtežni primer 4, na 779.7 cm od začetka palice)

Računska osna sila

Nsd = -44.395 kN

Prečna sila v y smeri

Vsd_y = 1.835 kN

Prečna sila v z smeri

Vsd_z = 291.28 kN

Upogibni moment okoli y osi

Msd_y = -25.256 kNm

Upogibni moment okoli z osi

Msd_z = -2.007 kNm

Moment torzije

Mt = 0.058 kNm

Sistemska dolžina palice

L = 880.00 cm

5.4 NOSILNOST PREČNIH PREREZOV

5.4.6 Strig

Računska plast.nos.na strig z-z

Vpl.Rd = 794.08 kN

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (291.28 <= 794.08)

Računska plast.nos.na strig y-y

Vpl.Rd = 1594.2 kN

Pogoj 5.20: Vsd_y <= Vpl.Rd_y (1.84 <= 1594.16)

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

za strig v ravnini z-z

Višina stojine

d = 44.400 cm

Debelina stojine

tw = 1.450 cm

Ni prečnih ojačitev v sredini

Koefficient izbočenja pri strigu

kr = 5.340

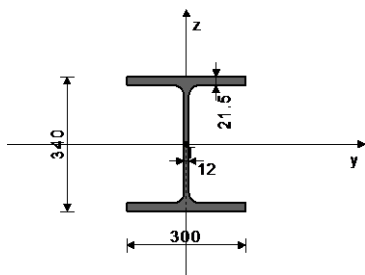
Ni potrebna kontrola izbočenja zaradi striga

Pogoj: d / tw <= 69 ε (30.62 <= 69.00)

POZ 107: HEB 340; S 235

PREČNI PREREZ: IPB 340 [S 235] [Set: 19]
EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza

(fy = 23.5 kN/cm², fu = 36.0 kN/cm²)

Ax =	171.00	cm ²
Ay =	114.81	cm ²
Az =	56.190	cm ²
Ix =	258.00	cm ⁴
Iy =	36660	cm ⁴
Iz =	9690.0	cm ⁴
Wy =	2156.5	cm ³
Wz =	646.00	cm ³
Wy,pl =	2428.3	cm ³
Wz,pl =	967.50	cm ³
yM0 =	1.100	
yM1 =	1.100	
yM2 =	1.250	
Anet/A =	0.900	

[mm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB

4. γ=0.76

5. γ=0.76

PALICA IZPOSTAVLJENA PRITISKU IN UPOGIBU
(obtežni primer 4, na 192.0 cm od začetka palice)

Računska osna sila	Nsd =	-125.59	kN
Prečna sila v y smeri	Vsd_y =	-32.932	kN
Prečna sila v z smeri	Vsd_z =	336.18	kN
Upogibni moment okoli y osi	Msd_y =	-127.91	kNm
Upogibni moment okoli z osi	Msd_z =	17.278	kNm
Moment torzije	Mt =	-0.041	kNm
Sistemska dolžina palice	L =	752.00	cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV

Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.4 Tlak

Plastična računska nosilnost	Npl.Rd =	3653.2	kN
Računska nosilnost na tlak	Nc.Rd =	3653.2	kN

Pogoj 5.16: Nsd <= Nc.Rd (125.59 <= 3653.18)

5.4.5 Upogib y-y

Računski plastični moment	Mpl.Rd =	518.77	kNm
Računska nos. na lokalno izbočitev	Mo.Rd =	460.70	kNm
Računski elastični moment	Mel.Rd =	460.70	kNm
Računska nosilnost na upogib	Mc.Rd =	518.77	kNm

Pogoj 5.17: Msd_y <= Mc.Rd_y (127.91 <= 518.77)

5.4.5 Upogib z-z

Računski plastični moment	Mpl.Rd =	206.69	kNm
Računska nos. na lokalno izbočitev	Mo.Rd =	138.01	kNm
Računski elastični moment	Mel.Rd =	138.01	kNm
Računska nosilnost na upogib	Mc.Rd =	206.69	kNm

Pogoj 5.17: Msd_z <= Mc.Rd_z (17.28 <= 206.69)

5.4.6 Strig

Računska plast.nos.na strig z-z	Vpl.Rd =	439.59	kN
---------------------------------	----------	--------	----

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (336.18 <= 439.59)

Računska plast.nos.na strig y-y	Vpl.Rd =	1359.8	kN
---------------------------------	----------	--------	----

Pogoj 5.20: Vsd_y <= Vpl.Rd_y (32.93 <= 1359.79)

5.4.9 Upogib z osno in prečno silo

Koeficient zmanjšanja	$\rho =$	0.280
Zmanjšana meja plastičnosti	$f_y^* =$	16.911 kN/cm ²
Zmanjšana plast.upogibna nosilnost	$M_{v,Rd_y} =$	373.32 kNm
Zmanjšana plast.upogibna nosilnost	$M_{v,Rd_z} =$	148.74 kNm

5.4.8 Upogib in osna sila

Razmerje Nsd / Npl.Rd		0.034
Razmerje Msd_y / Mpl.Rd_y		0.343
Razmerje Msd_z / Mpl.Rd_z		0.116

Pogoj 5.36: (0.49 <= 1)

5.5 NOSILNOST ELEMENTOV

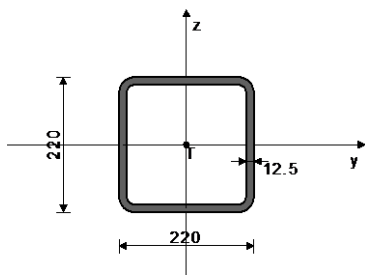
5.5.1 Uklonska nosilnost

Uklonska dolžina y-y	$l_y =$	100.00	cm
Vztrajnostni radij y-y	$i_y =$	14.642	cm
Vitkost y-y	$\lambda_y =$	6.830	
Relativna vitkost y-y	$\lambda_{\text{rel}} =$	0.067	

POZ 110: jekleni steber

PREČNI PREREZ: HOP [] 220x220x12.5 [S 235] [Set: 1]
EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza

(fy = 23.5 kN/cm², fu = 36.0 kN/cm²)

Ax =	99.730	cm ²
Ay =	49.865	cm ²
Az =	49.865	cm ²
Ix =	11456	cm ⁴
Iy =	7006.5	cm ⁴
Iz =	7006.5	cm ⁴
Wy =	636.95	cm ³
Wz =	636.95	cm ³
Wy,pl =	808.28	cm ³
Wz,pl =	774.88	cm ³
yM0 =	1.100	
yM1 =	1.100	
yM2 =	1.250	
Anet/A =	0.900	

[mm]

Uklonska krivulja za os y-y: B	$\alpha =$	0.340
Koeficient nepopolnosti	$\chi_y =$	1.000
Koeficient efektivnega prereza	$\beta_A =$	0.853
Računska uklonska nosilnost	$N_{b,Rd,y} =$	3116.6 kN

Pogoj 5.45: Nsd <= Nb.Rd_y (125.59 <= 3116.62)

Uklonska dolžina z-z	$l_z =$	100.00	cm
Vztrajnostni radij z-z	$i_z =$	7.528	cm
Vitkost z-z	$\lambda_z =$	13.284	
Relativna vitkost z-z	$\lambda_{_z} =$	0.131	
Uklonska krivulja za os z-z: C	$\alpha =$	0.490	
Koeficient nepopolnosti	$\chi_z =$	1.000	
Koeficient efektivnega prereza	$\beta_A =$	0.853	
Računska uklonska nosilnost	$N_{b,Rd_z} =$	3116.6	kN

Pogoj 5.45: Nsd <= Nb.Rd_z (125.59 <= 3116.62)

5.5.2 Bočna zvrnitev upogibnih nosilcev

Koeficient	C1 =	1.132
Koeficient	C2 =	0.459
Koeficient	C3 =	0.525
Koef. ukl.dolžine za uklon	k =	1.000
Koef. ukl.dolžine za vbočenje	kw =	1.000
Koordinata	zg =	0.000 cm
Koordinata	zj =	0.000 cm
Razmak med bočnimi podporami	L =	100.00 cm
Sektorski vztrajnostni moment	Iw =	2.45e+6 cm ⁶
Krit.moment bočne zvrnitve	Mcr =	36911 kNm
Koeficient	βw =	1.000
Koeficient imperf.	αLT =	0.210
Brezdimenz.vitkost	λLT =	0.124
Koeficient zmanjšanja	χLT =	1.000
Računska uklonska nosilnost	Mb.Rd =	518.77 kNm
Kontrola bočne zvrnitve ni potrebna: λ LT <= 0.4		

5.5.4 Upogib in tlak

Koeficient nepopolnosti	χmin =	1.000
Nsd / ...		0.034
Koeficient oblike momenta	βy =	1.006
Koeficient	μy =	-0.008
Koeficient	ky =	1.000
ky * My / ...		0.247
Koeficient oblike momenta	βz =	1.006
Koeficient	μz =	0.238
Koeficient	kz =	0.993
kz * Mz / ...		0.083

Pogoj 5.51: (0.36 <= 1)

Koeficient nepopolnosti	χ_z =	1.000
Nsd / ...		0.034
Koeficient nepopolnosti	χLT =	1.000
Koef.obl.mom.za bočno zvrnitev	βM.LT =	1.006
Koeficient	μLT =	-0.130
Koeficient	kLT =	1.004
kLT * My / ...		0.248
Koeficient oblike momenta	βz =	1.006
Koeficient	μz =	0.238
Koeficient	kz =	0.993
kz * Mz / ...		0.083

Pogoj 5.52: (0.36 <= 1)

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

Višina stojine	d =	29.700	cm
Debelina stojine	tw =	1.200	cm
Ni prečnih ojačitev v sredini			
Koeficient izbočenja pri strigu	kt =	5.340	

Ni potrebna kontrola izbočenja zaradi striga

Pogoj: d / tw <= 69 ε (24.75 <= 69.00)

5.6.7 Interakcija prečne sile, upogiba in osne sile

za strig v ravnini z-z		
Računski plastični moment pasnic	Mf.Rd =	374.63 kNm

Pogoji 5.66a in 5.66b so izpolnjeni

5.7 VNOS KONCENTRIRANIH SIL V STOJINO

5.7.7 Uklon pasnice v smeri stojine		
Koeficient(razred pasnice 1)	k =	0.300
Površina stojine	Aw =	40.800 cm2
Površina tlač.pasnice	Afc =	64.500 cm2
Preprečen je uklon pasnice v smeri stojine		
Pogoj 5.80: (24.75 <= 213.22)		

Pogoj 5.80: (24.75 <= 213.22)

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB

4. γ=0.65

5. γ=0.64

PALICA IZPOSTAVLJENA CENTRIČNEMU TLAKU
(obtežni primer 4, konec palice)

Računska osna sila	Nsd =	-1180.1	kN
Moment torzije	Mt =	-0.074	kNm
Sistemska dolžina palice	L =	457.00	cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV

Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.4 Tlak

Plastična računska nosilnost	Npl.Rd =	2130.6	kN
Računska nosilnost na tlak	Nc.Rd =	2130.6	kN

Pogoj 5.16: Nsd <= Nc.Rd (1180.09 <= 2130.60)

5.5 NOSILNOST ELEMENTOV

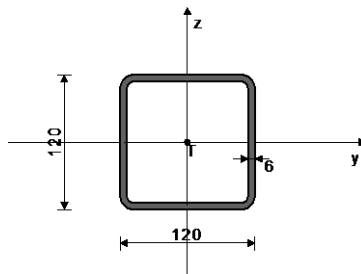
5.5.1 Uklonska nosilnost

Uklonska dolžina y-y	$l_y =$	457.00	cm
Vztrajnostni radij y-y	$i_y =$	8.382	cm
Vitkost y-y	$\lambda_y =$	54.523	
Relativna vitkost y-y	$\lambda_{_y} =$	0.581	
Uklonska krivulja za os y-y: B	$\alpha =$	0.340	

Koeficient nepopolnosti	$\chi_y =$	0.847	Relativna vitkost z-z	$\lambda_z =$	0.581
Koeficient efektivnega prereza	$\beta_A =$	1.000	Uklonska krivulja za os z-z: B	$\alpha =$	0.340
Računska uklonska nosilnost	$Nb.Rd_y =$	1803.9 kN	Koeficient nepopolnosti	$\chi_z =$	0.847
Pogoj 5.45: $Nsd \leq Nb.Rd_y$ (1180.09 \leq 1803.87)			Koeficient efektivnega prereza	$\beta_A =$	1.000
Uklonska dolžina z-z	$i_z =$	457.00 cm	Računska uklonska nosilnost	$Nb.Rd_z =$	1803.9 kN
Vztrajnostni radij z-z	$i_z =$	8.382 cm	Pogoj 5.45: $Nsd \leq Nb.Rd_z$ (1180.09 \leq 1803.87)		
Vitkost z-z	$\lambda_z =$	54.523			

POZ 111: jekleni steberPREČNI PREREZ: HOP [] 120x120x6 [S 235] [Set: 2]
EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza



$A_x =$	26.430 cm ²
$A_y =$	13.215 cm ²
$A_z =$	13.215 cm ²
$I_x =$	910.28 cm ⁴
$I_y =$	562.14 cm ⁴
$I_z =$	562.14 cm ⁴
$W_y =$	93.690 cm ³
$W_z =$	93.690 cm ³
$W_{y,pl} =$	117.07 cm ³
$W_{z,pl} =$	112.86 cm ³
$y_{M0} =$	1.100
$y_{M1} =$	1.100
$y_{M2} =$	1.250
$A_{net}/A =$	0.900

(fy = 23.5 kN/cm², fu = 36.0 kN/cm²)

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB

4. $\gamma = 0.42$ 5. $\gamma = 0.38$ PALICA IZPOSTAVLJENA CENTRIČNEMU TLAKU
(obtežni primer 4, konec palice)

Računska osna sila	$Nsd =$	-132.11 kN
Sistemska dolžina palice	$L =$	457.00 cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV

Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.4 Tlak

Plastična računska nosilnost

 $N_{pl.Rd} =$ 564.64 kN

Računska nosilnost na tlak

 $N_{c.Rd} =$ 564.64 kN**Pogoj 5.16: $Nsd \leq N_{c.Rd}$ (132.11 \leq 564.64)**

5.5 NOSILNOST ELEMENTOV

5.5.1 Uklonska nosilnost

Uklonska dolžina y-y

 $i_y =$ 457.00 cm

Vztrajnostni radij y-y

 $i_y =$ 4.612 cm

Vitkost y-y

 $\lambda_y =$ 99.093

Relativna vitkost y-y

 $\lambda_y =$ 1.055

Uklonska krivulja za os y-y: B

 $\alpha =$ 0.340

Koeficient nepopolnosti

 $\chi_y =$ 0.562

Koeficient efektivnega prereza

 $\beta_A =$ 1.000

Računska uklonska nosilnost

 $Nb.Rd_y =$ 317.54 kN**Pogoj 5.45: $Nsd \leq Nb.Rd_y$ (132.11 \leq 317.54)**

Uklonska dolžina z-z

 $i_z =$ 457.00 cm

Vztrajnostni radij z-z

 $i_z =$ 4.612 cm

Vitkost z-z

 $\lambda_z =$ 99.093

Relativna vitkost z-z

 $\lambda_z =$ 1.055

Uklonska krivulja za os z-z: B

 $\alpha =$ 0.340

Koeficient nepopolnosti

 $\chi_z =$ 0.562

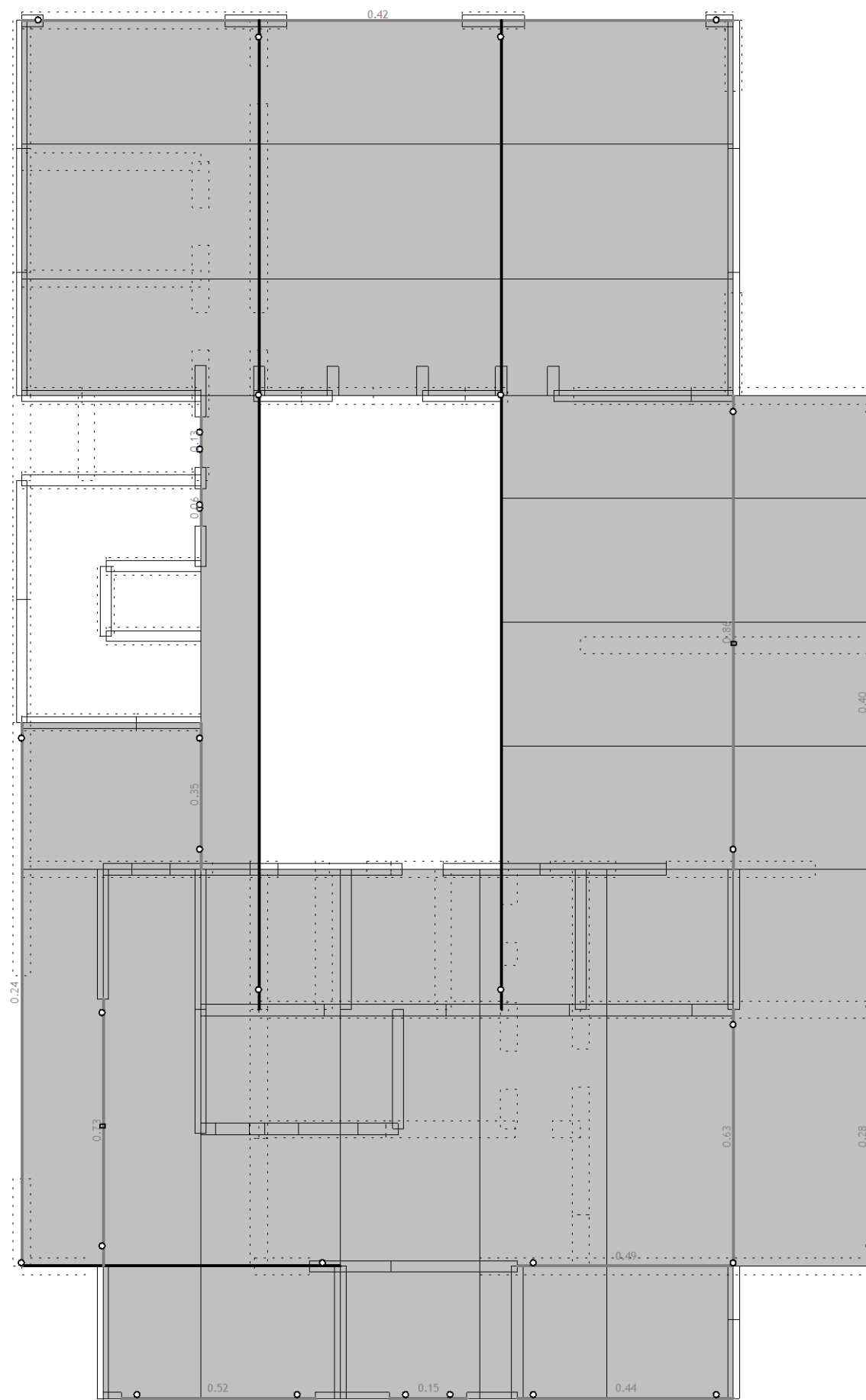
Koeficient efektivnega prereza

 $\beta_A =$ 1.000

Računska uklonska nosilnost

 $Nb.Rd_z =$ 317.54 kN**Pogoj 5.45: $Nsd \leq Nb.Rd_z$ (132.11 \leq 317.54)**

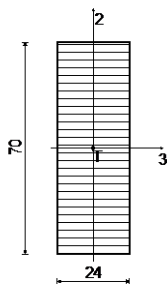
Dimenzioniranje (les)



Nivo: POZ 100 [4.57 m]
Kontrola stabilnosti

POZ 103: nosilec nad vhodnimi vrati

Lepljen lameliran les - GL24h
v smeri zgornjega roba palice
Debelina lamele 2.00 cm
Eksploatacijski razred 1
EUROCODE



FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽEB
4. $\gamma=0.86$ 5. $\gamma=0.78$

KONTROLA NORMALNIH NAPETOSTI
(obtežni primer 4, na 870.0 cm od začetka palice)

Računska osna sila	N =	-26.712 kN
Prečna sila v smeri osi 2	T2 =	24.124 kN
Prečna sila v smeri osi 3	T3 =	1.882 kN
Upogibni moment okoli osi 3	M3 =	-201.15 kNm

KONTROLA NAPETOSTI - TLAK IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Faktor oblik (za pravokotni prerez)

Karakteristična tlačna trdnost

Računska tlačna trdnost

Karakteristična upogibna trdnost

Računska upogibna trdnost - os 2

Računska upogibna trdnost - os 3

Relativna vitkost

Relativna vitkost

Normalne tlačne napetosti

Odpornostni moment

Normalna upogibna napetost okoli osi 3

Kmod = 0.800
ym = 1.250

Kh_2 = 1.096

Kh_3 = 1.000

km = 0.700

fc,0,k = 24.000 MPa

fc,0,d = 15.360 MPa

fm,k = 24.000 MPa

fm,2,d = 16.834 MPa

fm,3,d = 15.360 MPa

λrel,2 = 0.232

λrel,3 = 0.232

σc,0,d = 0.159 MPa

W3 = 19600 cm³

σm,3,d = 10.263 MPa

$\sigma_{m,3,d} \leq f_{m,3,d} (10.263 \leq 15.360)$

Izkoriščenost prereza je 66.8%

TLAK IN UPOGIB - MALA VITKOST

$$(\sigma_{c,0,d} / f_{c,0,d})^2 + k_m \times (\sigma_{m,3,d} / f_{m,3,d}) + \sigma_{m,2,d} / f_{m,2,d} \leq 1$$

$$(0.668 \leq 1)$$

Izkoriščenost prereza je 46.8%

$$(\sigma_{c,0,d} / f_{c,0,d})^2 + \sigma_{m,3,d} / f_{m,3,d} + k_m \times (\sigma_{m,2,d} / f_{m,2,d}) \leq 1$$

$$(0.668 \leq 1)$$

Izkoriščenost prereza je 66.8%

KONTROLA STRIŽNIH NAPETOSTI

(obtežni primer 4, na 526.0 cm od začetka palice)

Prečna sila v smeri osi 2

T2 = 167.28 kN

Prečna sila v smeri osi 3

T3 = -2.174 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod = 0.800

ym = 1.250

f_{v,k} = 2.700 MPa

f_{v,d} = 1.728 MPa

A = 1680.0 cm²

τ_{2,d} = 1.494 MPa

τ_{3,d} = 0.019 MPa

τ_s = 1.494 MPa

$$\tau_s \leq f_{v,d} (1.494 \leq 1.728)$$

Izkoriščenost prereza je 86.4%

DOKAZ STABILNOSTI ELEMENTA

(obtežni primer 4, na 870.0 cm od začetka palice)

Računska osna sila

N = -25.625 kN

Prečna sila v smeri osi 2

T2 = -7.778 kN

Prečna sila v smeri osi 3

T3 = 1.978 kN

Upogibni moment okoli osi 3

M3 = -201.15 kNm

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetraino

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Razmak pridržanih točk pravokotno na smer osi 2

Kmod = 0.800

ym = 1.250

l_{ef} = 100.00 cm

E0.05 = 9400.0 MPa

G0.05 = 480.00 MPa

I_{tor} = 2.53e+5 cm⁴

I₂ = 80640 cm⁴

W₃ = 19600 cm³

σ_{m,crit} = 486.62 MPa

λ_{rel} = 0.222

k_{krit} = 1.000

σ_{m,3,d} = 10.263 MPa

$$\sigma_{m,3,d} \leq k_{krit} \times f_{m,3,d} (10.263 \leq 15.360)$$

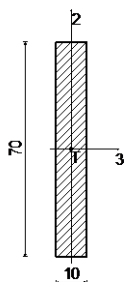
Izkoriščenost prereza je 66.8%

POZ 104: preklada nad vrati: CLT L5s 140 mm, h = 70 cm, zun. sloji horizontalno

Monoliten les - iglavci in mehki listavci - C24

Eksploatacijski razred 1

EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBTEŽB

4. $\gamma=0.73$

5. $\gamma=0.70$

KONTROLA NORMALNIH NAPETOSTI

(obtežni primer 4, na 322.0 cm od začetka palice)

Računska osna sila	N =	-10.090 kN
Prečna sila v smeri osi 2	T2 =	33.835 kN
Prečna sila v smeri osi 3	T3 =	0.133 kN
Upogibni moment okoli osi 2	M2 =	0.000 kNm
Upogibni moment okoli osi 3	M3 =	42.243 kNm

KONTROLA NAPETOSTI - TLAK IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Faktor oblik (za pravokotni prerez)

Karakteristična tlačna trdnost

Računska tlačna trdnost

Karakteristična upogibna trdnost

Računska upogibna trdnost - os 2

Računska upogibna trdnost - os 3

Relativna vitkost

Relativna vitkost

Normalne tlačne napetosti

Odpornostni moment

Normalna upogibna napetost okoli osi 3

$$\sigma_{m3,d} \leq f_{m,3,d} \text{ (5.173} \leq \text{14.769)}$$

Izkoriščenost prereza je 35.0%

TLAK IN UPOGIB - VELIKA VITKOST

Začetna imperfekcija

Koeficient

Koeficient

Koeficient

$\beta \chi$	0.200
k_3	0.480
k_2	0.655
$k_{c,3}$	1.048

Koeficient

$k_{c,2} = 0.945$

$$(\sigma_{c,0,d} / (k_{c,2} \times f_{c,0,d})) + k_m \times (\sigma_{m3,d} / f_{m,3,d}) + \sigma_{m2,d} / f_{m,2,d} \leq 1 \text{ (0.257} \leq \text{1)}$$

Izkoriščenost prereza je 25.7%

$$(\sigma_{c,0,d} / (k_{c,3} \times f_{c,0,d})) + \sigma_{m3,d} / f_{m,3,d} + k_m \times (\sigma_{m2,d} / f_{m,2,d}) \leq 1 \text{ (0.361} \leq \text{1)}$$

Izkoriščenost prereza je 36.1%

KONTROLA STRIŽNIH NAPETOSTI

(obtežni primer 4, začetek palice)

Prečna sila v smeri osi 2	T2 =	-52.292 kN
Prečna sila v smeri osi 3	T3 =	0.290 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod =	0.800
γ_m =	1.300
$f_{v,k}$ =	2.500 MPa
$f_{v,d}$ =	1.538 MPa
A =	700.00 cm ²
$\tau_{2,d}$ =	1.121 MPa
$\tau_{3,d}$ =	0.006 MPa
τ_s =	1.121 MPa

$$\tau_s \leq f_{v,d} \text{ (1.121} \leq \text{1.538)}$$

Izkoriščenost prereza je 72.8%

DOKAZ STABILNOSTI ELEMENTA

(obtežni primer 4, na 322.0 cm od začetka palice)

Računska osna sila	N =	-8.800 kN
Prečna sila v smeri osi 2	T2 =	-34.412 kN
Prečna sila v smeri osi 3	T3 =	0.000 kN
Upogibni moment okoli osi 2	M2 =	0.000 kNm
Upogibni moment okoli osi 3	M3 =	42.348 kNm

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike

materiala

Razmak pridržanih točk pravokotno na smer osi 2

Kmod =	0.800
γ_m =	1.300
l_{ef} =	100.00 cm
$E_{0.05}$ =	7400.0 MPa
$G_{0.05}$ =	460.00 MPa
I_{tor} =	21424 cm ⁴
I_2 =	5833.3 cm ⁴
W_3 =	8166.7 cm ³
$\sigma_{m,crit}$ =	79.343 MPa
λ_{rel} =	0.550
k_{krit} =	1.000
$\sigma_{m3,d}$ =	5.185 MPa

5% fraktil modula E paralelno z vlakni

5% fraktil strižnega modula G

Torzijski vztrajnostni moment

Vztrajnostni moment

Odpornostni moment

Kritična napetost uklona

Relativna vitkost za uklon

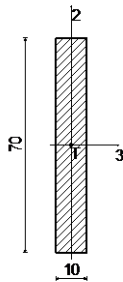
Koeficient

Normalna upogibna napetost okoli osi 3

$$\sigma_{m3,d} \leq k_{krit} \times f_{m,3,d} \text{ (5.185} \leq \text{14.769)}$$

Izkoriščenost prereza je 35.1%

POZ 105: preklada nad vrati: CLT L5s 140 mm, h = 70 cm, zun. sloji horizontalno
Monoliten les - iglavci in mehki listavci - C24
Eksploatacijski razred 1
EUROCODE



FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽB
4. $\gamma=0.63$ 5. $\gamma=0.57$

KONTROLA NORMALNIH NAPETOSTI
(obtežni primer 4, na 281.6 cm od začetka palice)

Računska osna sila	N =	-12.647 kN
Prečna sila v smeri osi 2	T2 =	-2.026 kN
Prečna sila v smeri osi 3	T3 =	0.199 kN
Upogibni moment okoli osi 2	M2 =	0.000 kNm
Upogibni moment okoli osi 3	M3 =	-74.128 kNm

KONTROLA NAPETOSTI - TLAK IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient
Parcialni koef. za karakteristike
materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Faktor oblik (za pravokotni prerez)

Karakteristična tlačna trdnost

Računska tlačna trdnost

Karakteristična upogibna trdnost

Računska upogibna trdnost - os 2

Računska upogibna trdnost - os 3

Relativna vitkost

Relativna vitkost

Normalne tlačne napetosti

Odpornostni moment

Normalna upogibna napetost okoli osi 3

Kmod = 0.800
ym = 1.300

Kh_2 = 1.084

Kh_3 = 1.000

km = 0.700

fc,0,k = 21.000 MPa

fc,0,d = 12.923 MPa

fm,k = 24.000 MPa

fm,2,d = 16.017 MPa

fm,3,d = 14.769 MPa

arel,2 = 0.517

arel,3 = 0.517

sc,0,d = 0.181 MPa

W3 = 8166.7 cm³

sm3,d = 9.077 MPa

$\sigma_{m3,d} \leq f_{m3,d}$ (9.077 <= 14.769)

Izkoriščenost prereza je 61.5%

TLAK IN UPOGIB - VELIKA VITKOST

Začetna imperfekcija

Koeficient

Koeficient

Koeficient

Koeficient

$\beta_{\chi} = 0.200$

k3 = 0.480

k2 = 0.655

kc,3 = 1.048

kc,2 = 0.945

$$(\sigma_{c,0,d} / (k_{c,2} \times f_{c,0,d})) + k_m \times (\sigma_{m3,d} / f_{m,3,d}) + \sigma_{m2,d} / f_{m,2,d} \leq 1 \quad (0.445 \leq 1)$$

Izkoriščenost prereza je 44.5%

$$(\sigma_{c,0,d} / (k_{c,3} \times f_{c,0,d})) + \sigma_{m3,d} / f_{m,3,d} + k_m \times (\sigma_{m2,d} / f_{m,2,d}) \leq 1 \quad (0.628 \leq 1)$$

Izkoriščenost prereza je 62.8%

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike
materiala

Razmak pridrženih točk pravokotno na smer osi 2

Kmod = 0.800

ym = 1.300

lef = 100.00 cm

E0.05 = 7400.0 MPa

G0.05 = 460.00 MPa

I_{tor} = 21424 cm⁴

I₂ = 5833.3 cm⁴

W3 = 8166.7 cm³

σ_{m,crit} = 79.343 MPa

λ_{rel} = 0.550

k_{krit} = 1.000

σ_{m3,d} = 9.077 MPa

$$\sigma_{m3,d} \leq k_{krit} \times f_{m3,d} \quad (9.077 \leq 14.769)$$

Izkoriščenost prereza je 61.5%

KONTROLA STRIŽNIH NAPETOSTI

(obtežni primer 4, začetek palice)

Prečna sila v smeri osi 2

Prečna sila v smeri osi 3

T2 = -38.071 kN

T3 = 0.343 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike
materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod = 0.800

ym = 1.300

f_{v,k} = 2.500 MPa

f_{v,d} = 1.538 MPa

A = 700.00 cm²

τ_{2,d} = 0.816 MPa

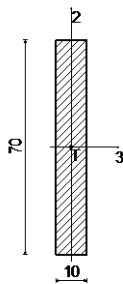
τ_{3,d} = 0.007 MPa

τ_s = 0.816 MPa

$$\tau_s \leq f_{v,d} \quad (0.816 \leq 1.538)$$

Izkoriščenost prereza je 53.0%

POZ 106: robni nosilec pod ploščo: CLT L5s 140 mm, h = 70 cm, zun. sloji horizontalno
Monolitni les - iglavci in mehki listavci - C24
Eksploatacijski razred 1
EUROCODE



[cm]

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽB
4. $\gamma=0.40$ 5. $\gamma=0.34$

KONTROLA NORMALNIH NAPETOSTI
(obtežni primer 4, na 281.4 cm od začetka palice)

Računska osna sila	N =	9.743 kN
Prečna sila v smeri osi 2	T2 =	3.963 kN
Upogibni moment okoli osi 3	M3 =	-33.431 kNm

KONTROLA NAPETOSTI - NATEG IN UPOGIB

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Dodatek za elemente z malimi dimenzijami - os 2

Dodatek za elemente z malimi dimenzijami - os 3

Dodatek za elemente z malimi dimenzijami - nateg

Karakteristična natezna trdnost	Kh_t =	1.084
Računska natezna trdnost	ft,0,k =	14.000 MPa
Faktor oblik (za pravokotni presek)	ft,0,d =	9.343 MPa
Karakteristična upogibna trdnost	km =	0.700
Računska upogibna trdnost - os 2	fm,k =	24.000 MPa
Računska upogibna trdnost - os 3	fm,2,d =	16.017 MPa
Normalna natezna napetost	fm,3,d =	14.769 MPa
Odpornostni moment	ot,0,d =	0.139 MPa
Normalna upogibna napetost okoli osi 2	W3 =	8166.7 cm3
Normalna upogibna napetost okoli osi 3	σm3,d =	4.094 MPa

$\sigma_{m3,d} \leq f_{m,3,d}$ (4.094 <= 14.769)

Izkoriščenost prereza je 27.7%

$$\sigma_{t,0,d} / f_{t,0,d} + k_m \times (\sigma_{m3,d} / f_{m,3,d}) + \sigma_{m2,d} / f_{m,2,d} \leq 1$$

$$(0.292 \leq 1)$$

Izkoriščenost prereza je 20.9%

$$\sigma_{t,0,d} / f_{t,0,d} + \sigma_{m3,d} / f_{m,3,d} + k_m \times (\sigma_{m2,d} / f_{m,2,d}) \leq 1$$

$$(0.292 \leq 1)$$

Izkoriščenost prereza je 29.2%

KONTROLA STRIŽNIH NAPETOSTI

(obtežni primer 4, na 584.0 cm od začetka palice)

Prečna sila v smeri osi 2	T2 =	28.462 kN
Prečna sila v smeri osi 3	T3 =	-0.799 kN

KONTROLA NAPETOSTI - STRIG

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Karakteristična strižna napetost

Računska strižna trdnost

Površina prečnega prereza

Dejanska strižna napetost(os 2)

Dejanska strižna napetost(os 3)

Superponirana strižna napetost

Kmod =	0.800
γm =	1.300
fv,k =	2.500 MPa
fv,d =	1.538 MPa
A =	700.00 cm2
τ2,d =	0.610 MPa
τ3,d =	0.017 MPa
τs =	0.610 MPa

$$\tau_s \leq f_{v,d}$$

$$(0.610 \leq 1.538)$$

Izkoriščenost prereza je 39.7%

DOKAZ STABILNOSTI ELEMENTA

(obtežni primer 4, na 902.9 cm od začetka palice)

Računska osna sila	N =	-3.640 kN
Prečna sila v smeri osi 2	T2 =	0.181 kN
Upogibni moment okoli osi 3	M3 =	-34.486 kNm

DOKAZ BOČNE STABILNOSTI

Vrsta obtežbe: @1@osnovno - srednjetrojno

Korekcijski koeficient

Parcialni koef. za karakteristike materiala

Razmak pridržanih točk pravokotno na smer osi 2

Kmod =	0.800
γm =	1.300

5% fraktil modula E paralelno z vlakni

5% fraktil strižnega modula G

Torzijski vztrajnostni moment

Vztrajnostni moment

Odpornostni moment

Kritična napetost uklona

Relativna vitkost za uklon

Koeficient

Normalna upogibna napetost okoli osi 3

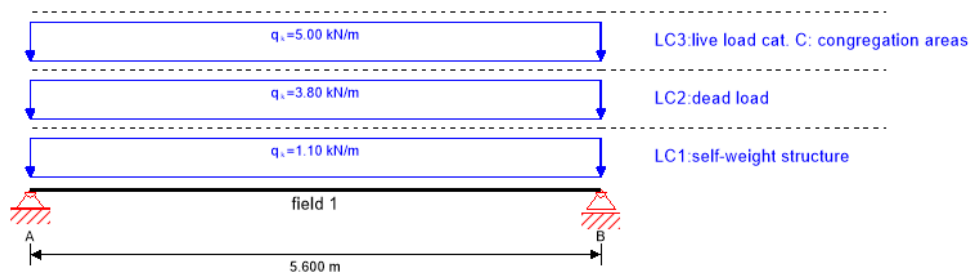
lef =	100.00 cm
E0.05 =	7400.0 MPa
G0.05 =	460.00 MPa
I _{tor} =	21424 cm4
I ₂ =	5833.3 cm4
W3 =	8166.7 cm3
σ _{m,crit} =	79.343 MPa
λ _{rel} =	0.550
k _{krit} =	1.000
σ _{m3,d} =	4.223 MPa

$$\sigma_{m3,d} \leq k_{krit} \times f_{m,3,d}$$

$$(4.223 \leq 14.769)$$

Izkoriščenost prereza je 28.6%

system

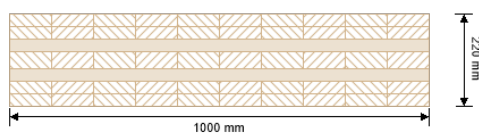


global utilization ratio

95 %

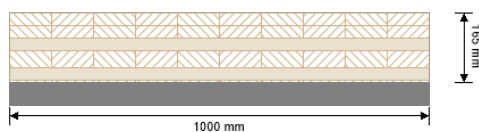
ULS	40 %	ULS fire	45 %	SLS	95 %	SLS vibration	84 %	support	-1 %
-----	------	----------	------	-----	------	---------------	------	---------	------

section: CLT 220 L7s - 2



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce
2	30.0 mm	0°	C24 spruce
3	30.0 mm	90°	C24 spruce
4	40.0 mm	0°	C24 spruce
5	30.0 mm	90°	C24 spruce
6	30.0 mm	0°	C24 spruce
7	30.0 mm	0°	C24 spruce
t _{CLT}	220.0 mm		

section fire: CLT 220 L7s - 2



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce
2	30.0 mm	0°	C24 spruce
3	30.0 mm	90°	C24 spruce
4	40.0 mm	0°	C24 spruce
5	30.0 mm	90°	C24 spruce
6	5.0 mm	0°	C24 spruce
t _{CLT}	165.0 mm		

fire resistance class: R 60

fire protection layering : no additional fire protection

time	60 min				
k	d ₀	d _{char,0,h}	d _{ef,h}	d _{char,0,v}	d _{ef,v}
[-]	[mm]	[mm]	[mm]	[mm]	[mm]
1	7	48.0	55.0	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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
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	K _{mod}	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	live load cat. C: congregation areas	Q	short term	0.9	0	1.5	0.7	0.7	0.6

LC1:self-weight structure

continous load

field	load at start
	[kN/m]
1	1.10

LC2:dead load

continous load

field	load at start
	[kN/m]
1	3.80

LC3:live load cat. C: congregation areas

continous load

field	load at start
	[kN/m]
1	5.00

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	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.60 * LC3$

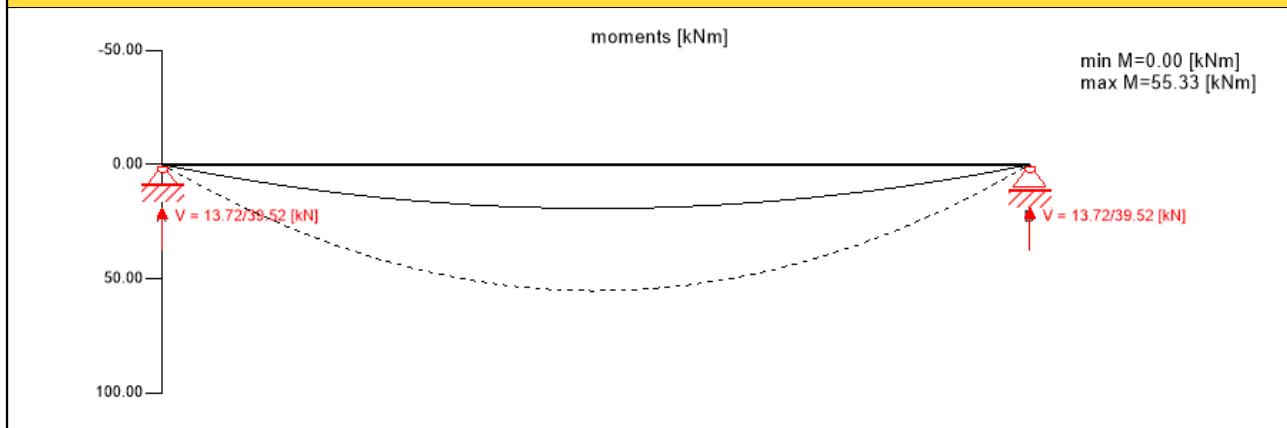
SLS characteristic combination

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

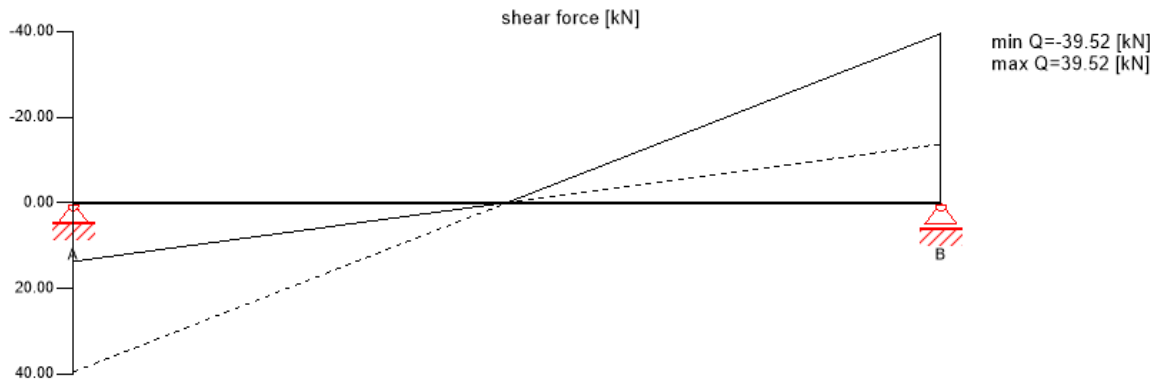
SLS quasi-permanent combination

	combination rule
LCO3	$1.00/1.00 * LC1 + 1.00/1.00 * LC2$
LCO4	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.60 * LC3$

Ultimate limit state (ULS) - design results



Ultimate limit state (ULS) - design results



ULS flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	$k_{sys,y}$	$f_{m,y,d}$	$M_{y,d}$	$\sigma_{m,y,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
1	2.8	24.00	1.25	0.90	1.10	19.01	55.33	-7.52	40 %	LCO2

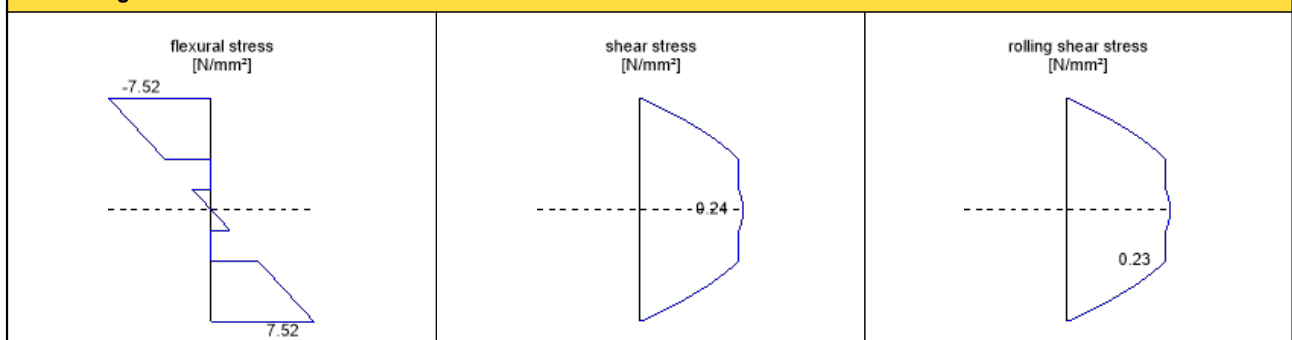
ULS shear analysis

field	dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.6	4.00	1.25	0.90	2.88	-39.52	0.24	8 %	LCO2

ULS rolling shear

field	dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.6	1.15	1.25	0.90	0.83	-39.52	0.23	28 %	LCO2

stress diagram



flexural stress analysis

$M_{y,d} =$	55.33	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{t,d} =$	0.00	kN	$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
			$k_{sys,y} =$	1.10	-
$\sigma_{t,d} =$	0.00	N/mm ²	$f_{t,d} =$	10.08	N/mm ²
$\sigma_{m,y,d} =$	-7.52	N/mm ²	$f_{m,y,d} =$	19.01	N/mm ²

utilization ratio

40 %

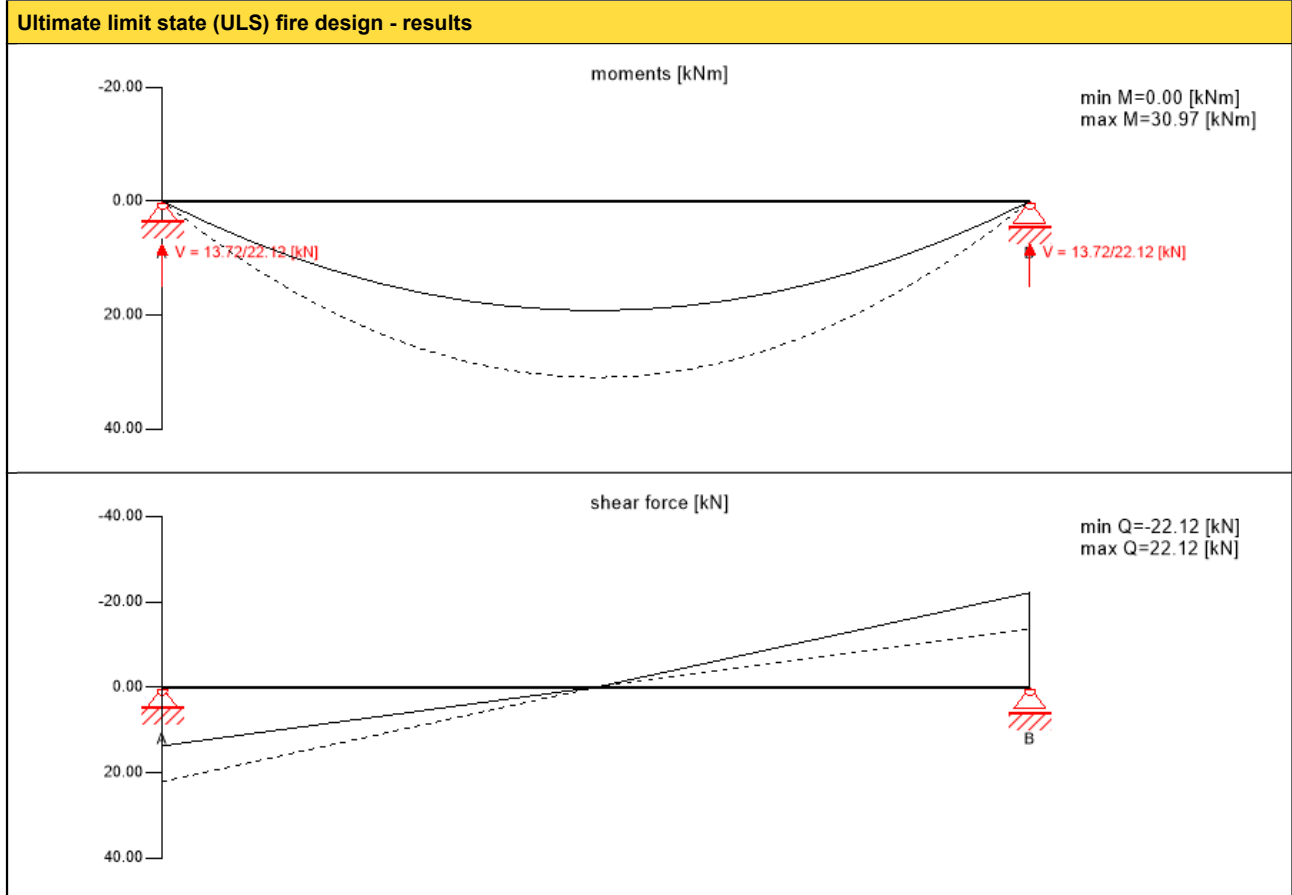
shear stress analysis

$V_d =$	-	kN	$f_{v,k} =$	4.00	N/mm ²
	39.52		$\gamma_m =$	1.25	
			$k_{mod} =$	0.90	
$\tau_{v,d} =$	0.24	N/mm ²	$f_{v,d} =$	2.88	N/mm ²

utilization ratio

8 %

rolling shear analysis					
$V_d =$	-39.52	kN	$f_{r,k} =$	1.15	N/mm ²
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
$T_{r,d} =$	0.23	N/mm ²	$f_{r,d} =$	0.83	N/mm ²
					< ✓
utilization ratio					28 %

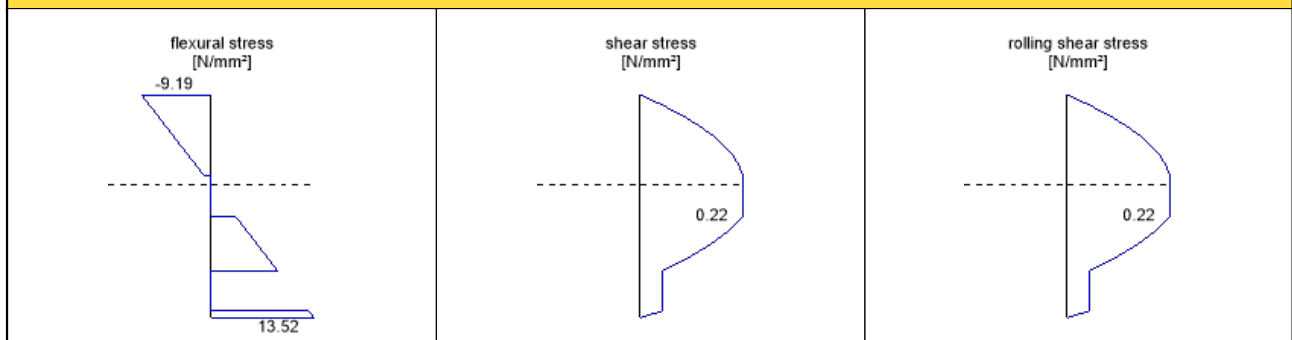


ULS fire flexural design											
field	dist.	$f_{m,k}$	γ_m	k_{mod}	$k_{sys,y}$	k_{fi}	$f_{m,y,d}$	$M_{y,d}$	$\sigma_{m,y,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
1	2.8	24.00	1.00	1.00	1.10	1.15	30.36	30.97	13.52	45 %	LCO2

ULS fire shear analysis										
field	dist.	$f_{v,k}$	γ_m	k_{mod}	k_{fi}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.6	4.00	1.00	1.00	1.15	4.60	-22.12	0.22	5 %	LCO2

ULS fire rolling shear										
field	dist.	$f_{r,k}$	γ_m	k_{mod}	k_{fi}	$f_{r,d}$	V_d	$T_{r,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.6	1.15	1.00	1.00	1.15	1.32	-22.12	0.22	16 %	LCO2

stress diagram



flexural stress analysis fire

$M_{y,d} =$	30.97 kNm	$f_{m,k} =$	24.00 N/mm²
$N_{t,d} =$	0.00 kN	$\gamma_m =$	1.00 -
		$k_{mod} =$	1.00 -
		$k_{sys,y} =$	1.10 -
		$k_{fi} =$	1.15 -
$\sigma_{t,d} =$	0.00 N/mm²	$f_{t,d} =$	16.10 N/mm²
$\sigma_{m,y,d} =$	13.52 N/mm²	$f_{m,y,d} =$	30.36 N/mm²

utilization ratio

45 %

shear stress analysis fire

$V_d =$	- kN	$f_{v,k} =$	4.00 N/mm²
22.12		$\gamma_m =$	1.00
		$k_{mod} =$	1.00
		$k_{fi} =$	1.15
$\tau_{v,d} =$	0.22 N/mm²	$f_{v,d} =$	4.60 N/mm²

utilization ratio

5 %

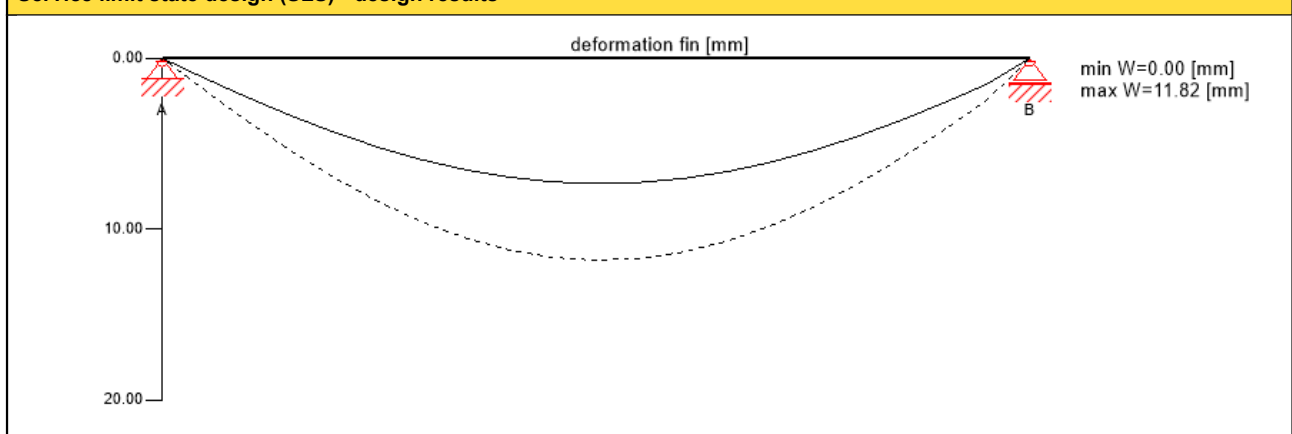
rolling shear analysis fire

$V_d =$	-22.12 kN	$f_{r,k} =$	1.15 N/mm²
		$\gamma_m =$	1.00 -
		$k_{mod} =$	1.00 -
		$k_{fi} =$	1.15 -
$\tau_{r,d} =$	0.22 N/mm²	$f_{r,d} =$	1.32 N/mm²

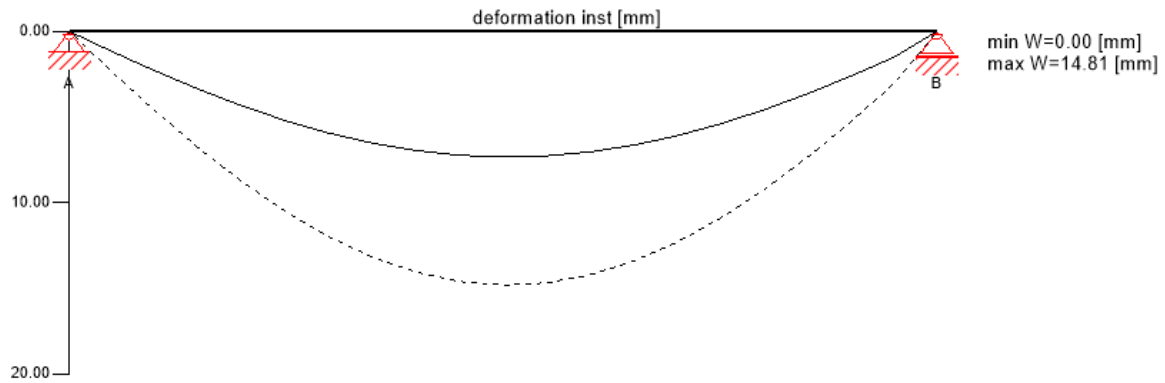
utilization ratio

16 %

Service limit state design (SLS) - design results



Service limit state design (SLS) - design results



initial deflection [w_{char}]

field	dist. [m]	limit [-]	w_{limit} [mm]	$w_{calc.}$ [mm]	ratio	
1	2.8	1/300	18.7	14.8	79 %	LCO2

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

field	dist. [m]	limit [-]	w_{limit} [mm]	$w_{calc.}$ [mm]	ratio	
1	2.8	1/150	37.3	24.3	65 %	LCO4

net final deflection [$w_{q.p.} \cdot (1+k_{def})$]

field	dist. [m]	limit [-]	w_{limit} [mm]	$w_{calc.}$ [mm]	ratio	
1	2.8	1/250	22.4	21.3	95 %	LCO4

vibration analysis

general	
total mass	27.97 [t]
tributary width	3.2 [m]
stiffness longitudinal direction	10116.7 [kNm ²]
stiffness cross direction	1570.0 [kNm ²]
modal damping	5.0 [%]
α	0.1 [-]
man weight	700.0 [N]
modal mass	13971.2 [kg]

analysis							
criterion	calc.	class I	class II	class I	class II	cl. I	cl. II
frequency criterion min	7.13 [Hz]	4.5 [Hz]	4.5 [Hz]	63 %	63 %	✓	✓
frequency criterion	7.13 [Hz]	8.0 [Hz]	6.0 [Hz]	112 %	84 %	-	✓
acceleration criterion	0.012 [m/s ²]	0.05 [m/s ²]	0.1 [m/s ²]	23 %	12 %	✓	✓
stiffness criterion	0.113 [mm]	0.25 [mm]	0.5 [mm]	45 %	23 %	✓	✓

support reaction

load case category	k_{mod}	A_v	B_v
		[kN]	
self-weight structure	0.6	3.08	3.08
dead load	0.6	10.64	10.64
live load cat. C: congregation areas	0.9	14.00	14.00
		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 t_f of gypsum fire boards (GKF) according to ON B 3410	Expertise on failure time t_f 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 guideline for Europe	Fire safety in timber buildings - technical guideline 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

The software was created to assist engineers in their daily business. The software is an engineering software that is dealing with a very complex matter of structural analysis and building physics analysis. Therefore, this software shall only be operated by skilled, experienced engineers, with a deep understanding of structural engineering and building physics related to timber structures. The user of the software is obliged to check all input values, no matter if they were given by the user or given by default by the software and all results for plausibility.

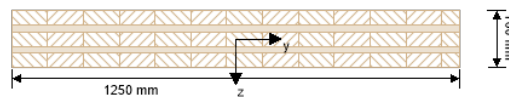
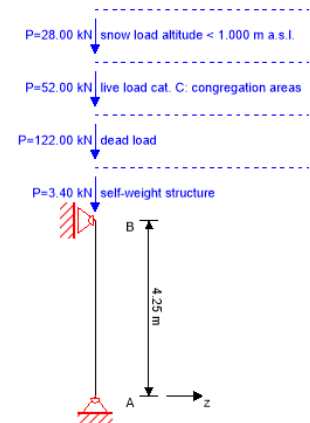
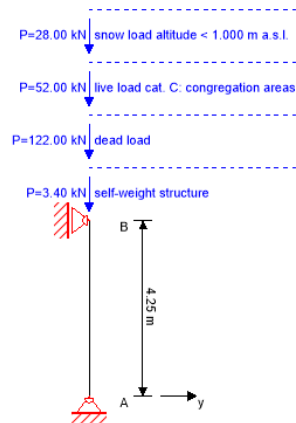
The use of the results of the software should not be relied upon as the basis for any decision or action. Any use of results of the software is only allowed, if the results have been verified and approved regarding completeness and correctness by a project structural/building physics engineer. The user has the possibility to make print-outs from the software. Any modification of those are not allowed.

Stora Enso Wood Products GmbH does not assume any warranty regarding the software. The software has been developed with utmost diligence, nevertheless Stora Enso Wood Products GmbH, neither expressly nor implicitly, provides any warranty in terms of accuracy, validity, timeliness and completeness of information and data created by the software. Stora Enso Wood Products GmbH does also not assume any warranty for the general usability of the software, its suitability for a special purpose or for the compatibility of the software with the ones of third party producers or providers.

Stora Enso Wood Products GmbH is only liable for damages caused by gross negligence or intent through Stora Enso Wood Products GmbH; the liability for slight negligence is excluded. This does not apply to personal injury. Under the aforementioned conditions Stora Enso Wood Products GmbH is as well not liable for operational failures or the loss of programs and/or data of the user's data processing system.

Applicable Law: These terms of use shall be governed by the laws of Austria excluding however any conflict of laws rules and any laws regarding the Convention of the International Sale of Goods (CISG).

system

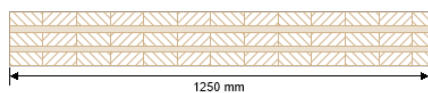


global utilization ratio

37 %

ULS	37 %	ULS fire	-1 %
-----	------	----------	------

section: CLT 160 L5s



layer	thickness	orientation	material
1	40.0 mm	0°	C24 spruce
2	20.0 mm	90°	C24 spruce
3	40.0 mm	0°	C24 spruce
4	20.0 mm	90°	C24 spruce
5	40.0 mm	0°	C24 spruce
t _{CLT}	160.0 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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
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	K _{mod}	γ _{inf}	γ _{sup}	ψ ₀	ψ ₁	ψ ₂
LC2	self-weight structure	G	permanet	0.6	1	1.35	1	1	1
LC3	dead load	G	permanet	0.6	1	1.35	1	1	1
LC4	live load cat. C: congregation areas	Q	short term	0.9	0	1.5	0.7	0.7	0.6
LC1	snow load altitude < 1.000 m a.s.l.	Q	short term	0.9	0	1.5	0.5	0.2	0

LC2:self-weight structure

vertical load

P _k	ex. y	ex. z
[kN]	[m]	[m]
3.4	0.00	0.00

LC3:dead load

vertical load

P_k	ex. y	ex. z
[kN]	[m]	[m]
122	0.23	0.00

LC4:live load cat. C: congregation areas

vertical load

P_k	ex. y	ex. z
[kN]	[m]	[m]
52	0.23	0.00

LC1:snow load altitude < 1.000 m a.s.l.

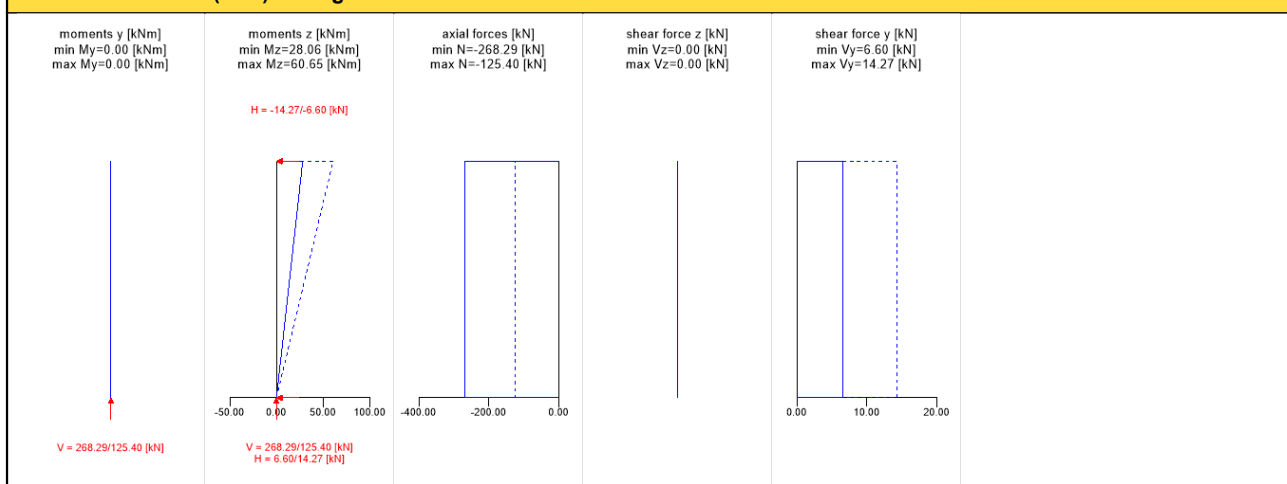
vertical load

P_k	ex. y	ex. z
[kN]	[m]	[m]
28	0.23	0.00

ULS combinations

	combination rule
LCO1	$1.35/1.00 * LC2 + 1.35/1.00 * LC3$
LCO2	$1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.50/0.00 * LC4$
LCO3	$1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.50 * LC1$
LCO4	$1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.50/0.00 * LC1$
LCO5	$1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.50/0.00 * LC1 + 1.50/0.00 * 0.70 * LC4$

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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
4.25	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/mm ²]	[N/mm ²]	[N/mm ²]		
0.00	-268.29	0.00	0.00	1.79	0.00	13 %	LCO3

ULS shear analysis								
dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
4.25	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	$T_{r,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
4.25	1.25	1.25	0.90	0.90	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	$T_{IP,Gross,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
0.0	3.50	1.25	0.90	2.52	14.27	0.11	4 %	LCO3

ULS shear design in plane of CLT - net section								
dist.	$f_{v,IP,Net,k}$	γ_m	k_{mod}	$f_{v,IP,Net,d}$	$V_{Net,d}$	$T_{v,IP,Net,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
0.0	8.00	1.25	0.90	5.76	14.27	0.43	7 %	LCO3

ULS shear design in plane of CLT - gross section kombiniert						
dist.	γ_m	k_{mod}	V_d	$T_{v,d}$	ratio	
[m]	[-]	[-]	[kN]	[N/mm ²]		
0.0	1.25	0.90	0.00	0.00	0 %	LCO3

ULS shear design in plane of CLT - net section kombiniert						
dist.	γ_m	k_{mod}	V_d	$T_{v,d}$	ratio	
[m]	[-]	[-]	[kN]	[N/mm ²]		
0.0	1.25	0.90	0.00	0.00	1 %	LCO3

ULS torsional shear design in plane of CLT - in face glued surfaces										
$f_{v,T,Node,k}$	γ_m	k_{mod}	$f_{v,T,Node,d}$	$V_{5,d}$	δM_t	n	a	I_p	ratio	
[N/mm ²]	[-]	[-]	[N/mm ²]	[kNm]	[kNm]	[-]	[m]	[mm ⁴]		
2.50	1.25	0.90	1.80	14.27	2.14	32	0.150	84375010.00	3 %	LCO3

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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]		
4.25	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]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	
4.250	4.250	84	12	1.35	0.19	0.2	1.51	0.51	0.46	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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]					
0.00	-	0.00	0.00	1.94	1.79	0.00	37 %	LCO3			
	268.29										

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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]			
4.25	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/mm ²]	[-]	
4.250	4.250	84	1.35	1.40	0.2	1.51	0.46	12.28	0.51	
$M_{y,d}$	$N_{c,d}$	$N_{t,d}$	$\sigma_{m,y,d}$	$\sigma_{c,d}$	$\sigma_{t,d}$	ratio				
[kNm]	[kN]	[kN]	[N/mm ²]	[N/mm ²]	[N/mm ²]					
0.00	-	0.00	0.00	1.79	0.00	31 %	LCO3			
	268.29									

flexural stress analysis					
$M_{y,d} =$	0.00	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{c,d} =$	-268.29	kN	$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
			$k_{sys,y} =$	1.10	-
$\sigma_{c,d} =$	1.79	N/mm ²	$f_{c,d} =$	15.12	N/mm ²
$\sigma_{m,y,d} =$	0.00	N/mm ²	$f_{m,y,d} =$	19.01	N/mm ²
		<			✓
utilization ratio					13 %

shear stress analysis					
$V_d =$	0.00	kN	$f_{v,k} =$	4.00	N/mm ²
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
$T_{v,d} =$	0.00	N/mm ²	$f_{v,d} =$	2.88	N/mm ²
		<			✓
utilization ratio					0 %

rolling shear analysis					
$V_d =$	0.00	kN	$f_{r,k} =$	1.25	N/mm ²
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
$T_{r,d} =$	0.00	N/mm ²	$f_{r,d} =$	0.90	N/mm ²
		<			✓
utilization ratio					0 %

shear analysis gross section					
$V_d =$	14.27	kNm	$f_{v,IP,Gross,k} =$	3.50	N/mm ²
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
$T_{IP,Gross,d} =$	0.11	N/mm ²	$f_{v,IP,Gross,d} =$	2.52	N/mm ²
		<			✓
utilization ratio					4 %

shear analysis net section					
$V_{Net,d} =$	14.27	kNm	$f_{v,IP,Net,k} =$	8.00	N/mm ²
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
$T_{v,IP,Net,d} =$	0.43	N/mm ²	$f_{v,IP,Net,d} =$	5.76	N/mm ²
		<			✓
utilization ratio					7 %

shear analysis gross section combined					
$V_d =$	0.00	kN	$f_{v,k} =$	4.00	N/mm ²
$V_{Gross,d} =$	14.27	kNm	$f_{v,IP,Gross,k} =$	3.50	N/mm ²
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
$T_{v,d} =$	0.00	N/mm ²	$f_{v,d} =$	2.88	N/mm ²
$T_{IP,Gross,d} =$	0.11	N/mm ²	$f_{v,IP,Gross,d} =$	2.52	N/mm ²
		<			✓
utilization ratio					0 %

shear analysis net section combined					
$V_d =$	0.00	kN	$f_{v,k} =$	4.00	N/mm ²
$V_{Net,d} =$	14.27	kNm	$f_{v,IP,Net,k} =$	8.00	N/mm ²
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
$T_{v,d} =$	0.00	N/mm ²	$f_{v,d} =$	2.88	N/mm ²
$T_{IP,Net,d} =$	0.43	N/mm ²	$f_{v,IP,Net,d} =$	5.76	N/mm ²
		<			✓
utilization ratio					1 %

torsional shear design in plane of CLT - in face glued surfaces					
$V_{\bar{o},d} =$	14.27	kNm	$f_{v,T,Node,k} =$	2.50	N/mm ²
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
$T_{T,Node,d} =$	0.06	N/mm ²	$f_{v,T,Node,d} =$	1.80	N/mm ²
		<			✓
utilization ratio					3 %

buckling analysis					
$M_{y,d} =$	0.00	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{c,d} =$	-268.29	kN	$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
			$k_{sys,y} =$	1.10	-
$\sigma_{c,d} =$	1.79	N/mm ²	$f_{c,d} =$	15.12	N/mm ²
$\sigma_{m,y,d} =$	0.00	N/mm ²	$f_{m,y,d} =$	19.01	N/mm ²
$\sigma_{m,z,d} =$	1.94	N/mm ²	$f_{m,z,d} =$	17.28	N/mm ²
		<			✓
utilization ratio				37 %	

lateral torsional buckling analysis					
$M_{y,d} =$	0.00	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{c,d} =$	-268.29	kN	$\gamma_m =$	1.25	-
			$k_{mod} =$	0.90	-
			$k_{sys,y} =$	1.10	-
$\sigma_{c,d} =$	1.79	N/mm ²	$f_{c,d} =$	15.12	N/mm ²
$\sigma_{m,y,d} =$	0.00	N/mm ²	$f_{m,y,d} =$	19.01	N/mm ²
		<			✓
utilization ratio				31 %	

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	3.40	0.00	0.00
		0.00	0.00	3.40	0.00	0.00
dead load	0.6	-6.60	0.00	122.00	6.60	0.00
		-6.60	0.00	122.00	6.60	0.00
live load cat. C: congregation areas	0.9	0.00	0.00	0.00	2.81	0.00
		-2.81	0.00	52.00	0.00	0.00
snow load altitude < 1.000 m a.s.l.	0.9	0.00	0.00	0.00	1.52	0.00
		-1.52	0.00	28.00	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 t_f of gypsum fire boards (GKF) according to ON B 3410	Expertise on failure time t_f 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 guideline for Europe	Fire safety in timber buildings - technical guideline 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

Disclaimer

The software was created to assist engineers in their daily business. The software is an engineering software that is dealing with a very complex matter of structural analysis and building physics analysis. Therefore, this software shall only be operated by skilled, experienced engineers, with a deep understanding of structural engineering and building physics related to timber structures. The user of the software is obliged to check all input values, no matter if they were given by the user or given by default by the software and all results for plausibility.
The use of the results of the software should not be relied upon as the basis for any decision or action. Any use of results of the software is only allowed, if the results have been



verified and approved regarding completeness and correctness by a project structural/building physics engineer. The user has the possibility to make print-outs from the software. Any modification of those are not allowed.

Stora Enso Wood Products GmbH does not assume any warranty regarding the software. The software has been developed with utmost diligence, nevertheless Stora Enso Wood Products GmbH, neither expressly nor implicitly, provides any warranty in terms of accuracy, validity, timeliness and completeness of information and data created by the software. Stora Enso Wood Products GmbH does also not assume any warranty for the general usability of the software, its suitability for a special purpose or for the compatibility of the software with the ones of third party producers or providers.

Stora Enso Wood Products GmbH is only liable for damages caused by gross negligence or intent through Stora Enso Wood Products GmbH; the liability for slight negligence is excluded. This does not apply to personal injury. Under the aforementioned conditions Stora Enso Wood Products GmbH is as well not liable for operational failures or the loss of programs and/or data of the user's data processing system.

Applicable Law: These terms of use shall be governed by the laws of Austria excluding however any conflict of laws rules and any laws regarding the Convention of the International Sale of Goods (CISG).

Vhodni podatki - Konstrukcija**POZ 000**

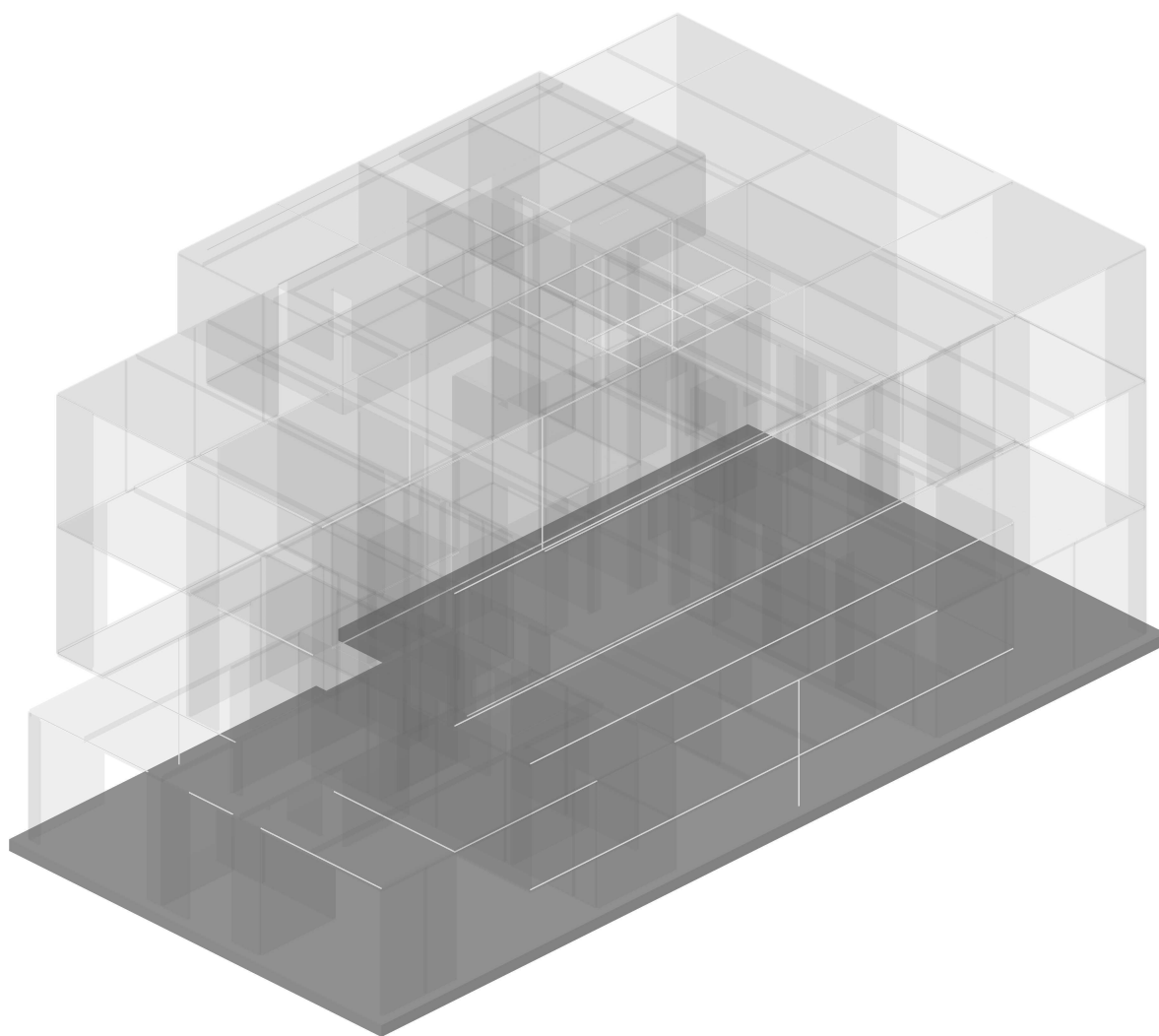
POZ 000: AB temeljna plošča

Temeljna plošča objekta:

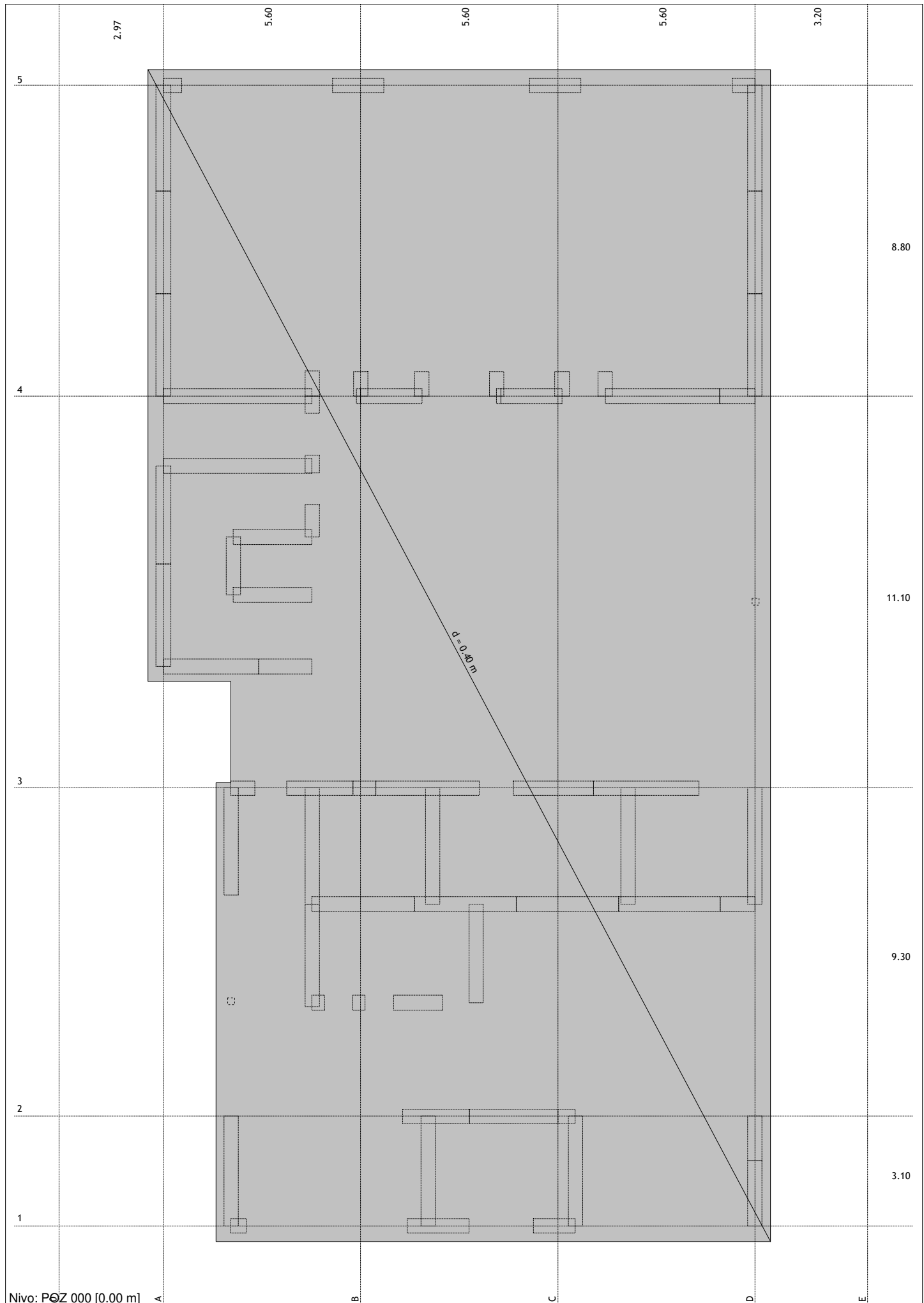
- debelina: $d = 40 \text{ cm}$
- beton: C 25/30
- armaturno jeklo: S 500

Modul reakcije tal:

v preračunu je upotevan modul reakcije tal $K = 17.500 \text{ kN/m}^3$ na podlagi elaborata geotehničnih raziskav št. 1-8/2018, izdelal Gracen d.o.o., maj 2018.



Izometrija (Nivo: POZ 000 [0.00 m])



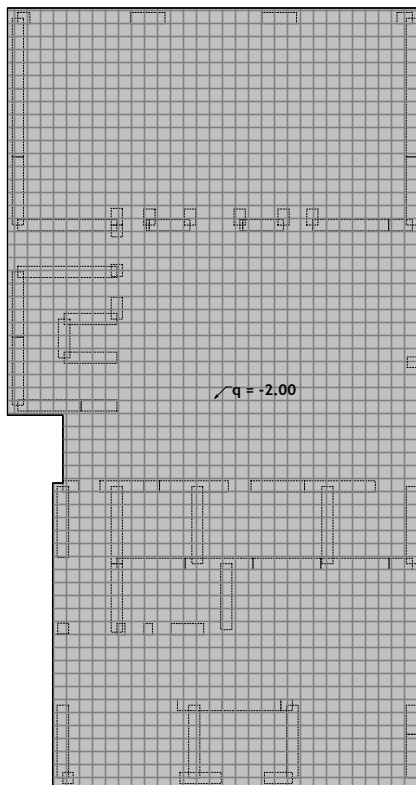
Vhodni podatki - Obtežba

Lista obtežnih primerov

LC	Naziv
1	Stalna + l.t. (g)
2	Koristna
3	Sneg
4	Komb.: MSN-01 (1.35xI+1.5xII+0.75xIII)
5	Komb.: MSN-02 (1.35xI+1.05xII+1.5xIII)

LC	Naziv
6	Komb.: MSU-01 (I+II+0.5xIII)
7	Komb.: MSU-02 (I+0.7xII+III)
8	Komb.: MSU-fin-01 (1.6xI+1.18xII+0.5xIII)
9	Komb.: MSU-fin-02 (1.6xI+0.88xII+III)

Obt. 1: Stalna + l.t. (g)

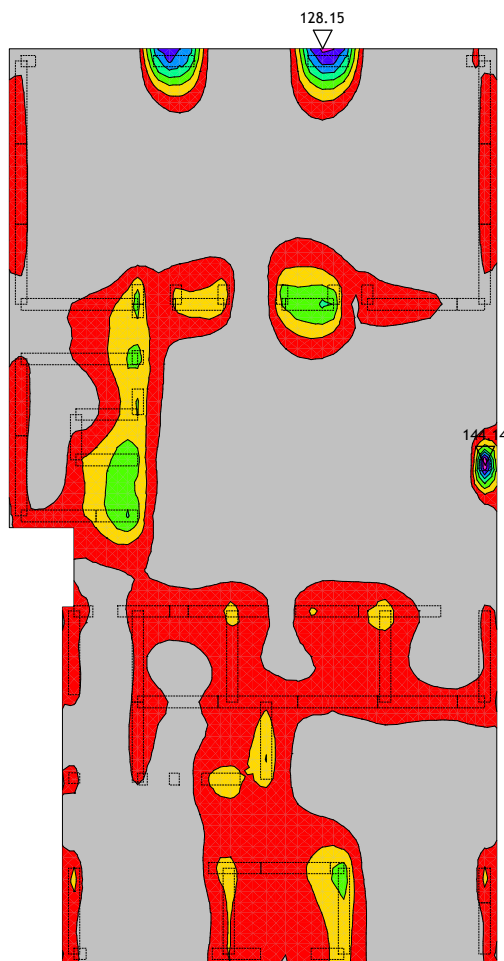


Nivo: POZ 000 [0.00 m]

Koristne obtežbe na AB temeljno ploščo v preračunu ne upoštevamo, ker ima ugoden vpliv na zmanjšanje zgornje armature v plošči.

Statični preračun

Obt. 10: [MSN] 4,5

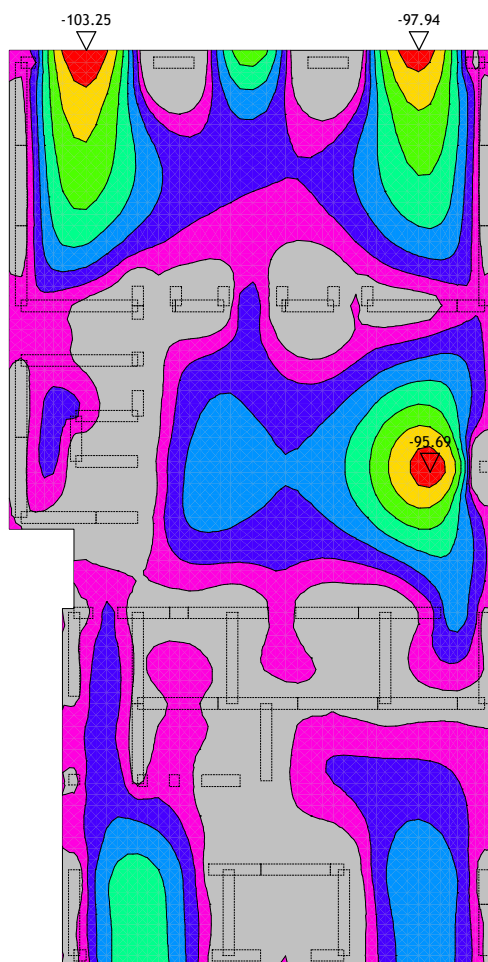


Mx [kNm/m]
0.00
20.59
41.18
61.77
82.37
102.96
123.55
144.14

Nivo: POZ 000 [0.00 m]

Vplivi v plošči: max Mx= 144.14 / min Mx= 0.00 kNm/m

Obt. 10: [MSN] 4,5

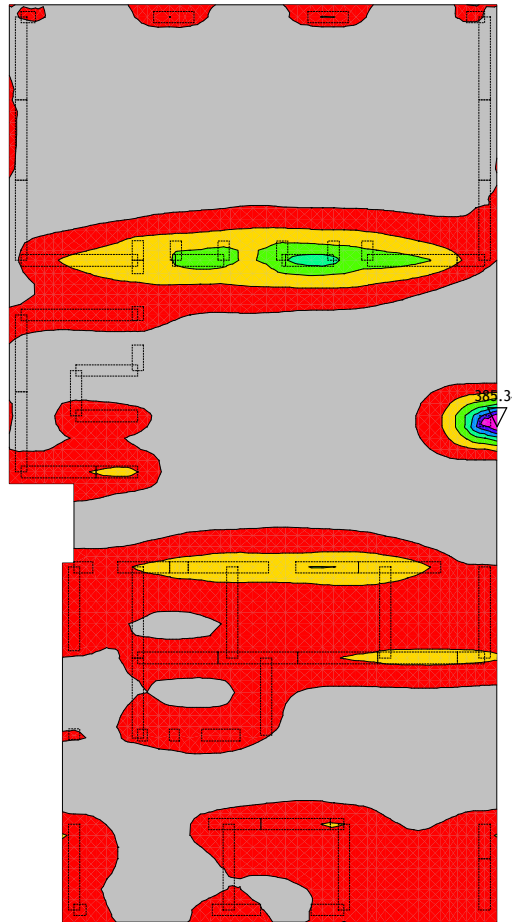


Mx [kNm/m]
-103.26
-88.51
-73.76
-59.01
-44.25
-29.50
-14.75
0.00

Nivo: POZ 000 [0.00 m]

Vplivi v plošči: max Mx= 0.00 / min Mx= -103.25 kNm/m

Obt. 10: [MSN] 4,5

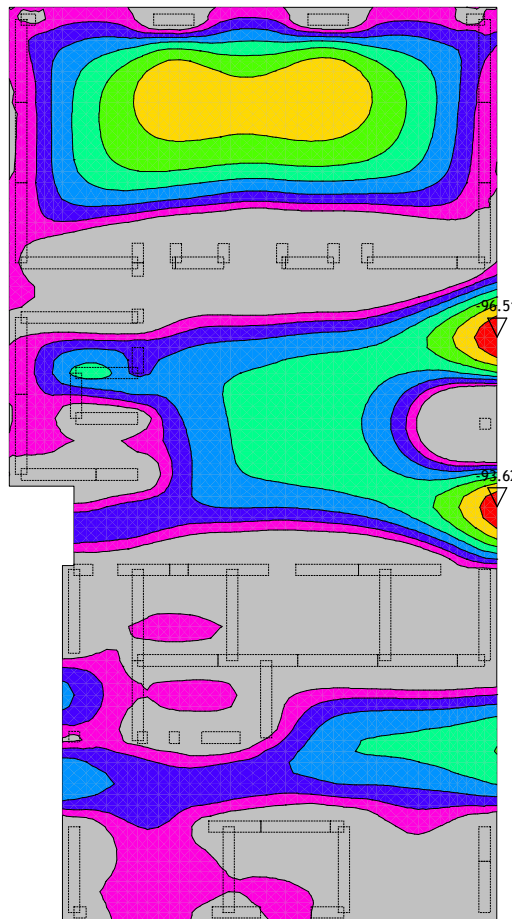


My [kNm/m]
0.00
55.05
110.10
165.15
220.20
275.25
330.30
385.35

Nivo: POZ 000 [0.00 m]

Vplivi v plošči: max My= 385.34 / min My= 0.00 kNm/m

Obt. 10: [MSN] 4,5

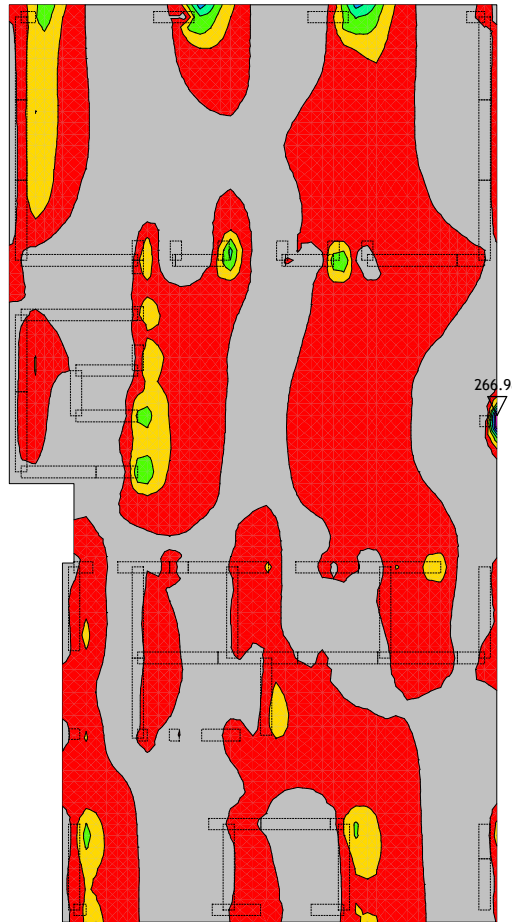


My [kNm/m]
-96.52
-82.73
-68.94
-55.15
-41.37
-27.58
-13.79
0.00

Nivo: POZ 000 [0.00 m]

Vplivi v plošči: max My= 0.00 / min My= -96.51 kNm/m

Obt. 10: [MSN] 4,5

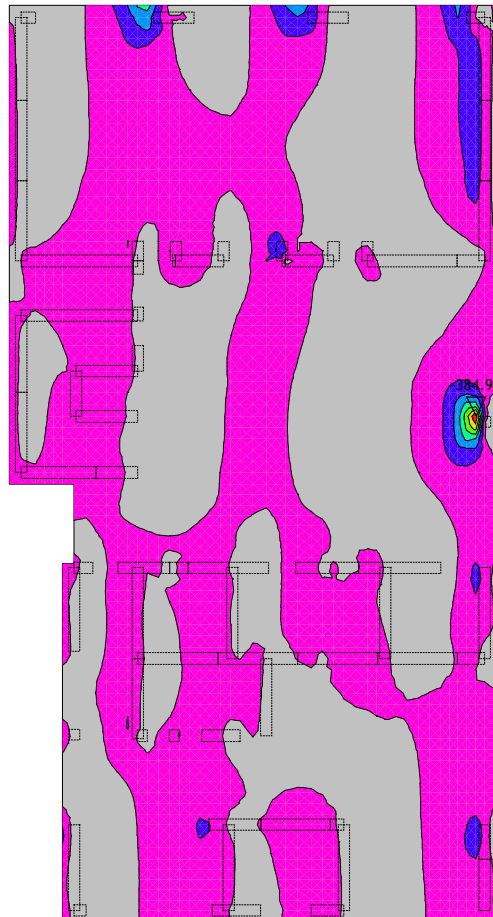


Tz,x [kN/m]
0.00
38.14
76.28
114.42
152.56
190.70
228.84
266.98

Nivo: POZ 000 [0.00 m]

Vplivi v plošči: max Tz,x= 266.98 / min Tz,x= 0.00 kN/m

Obt. 10: [MSN] 4,5

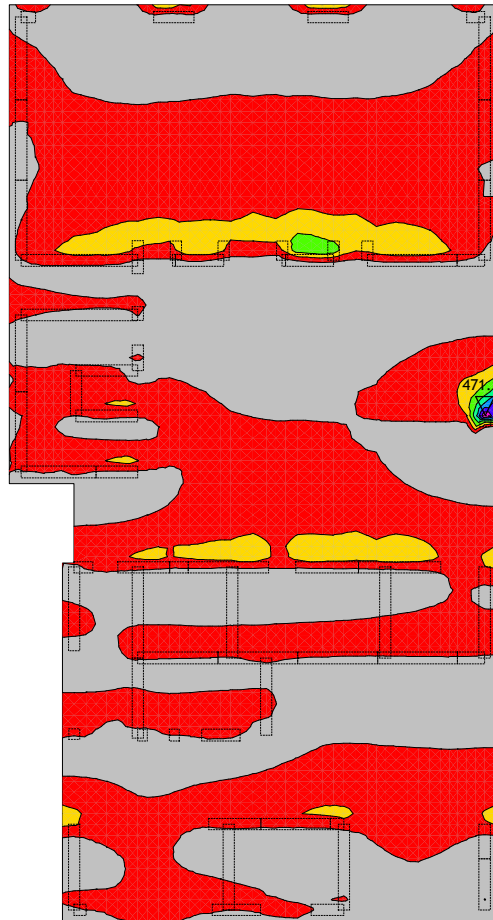


Tz,x [kN/m]
-384.94
-329.95
-274.96
-219.97
-164.97
-109.98
-54.99
0.00

Nivo: POZ 000 [0.00 m]

Vplivi v plošči: max Tz,x= 0.00 / min Tz,x= -384.94 kN/m

Obt. 10: [MSN] 4,5

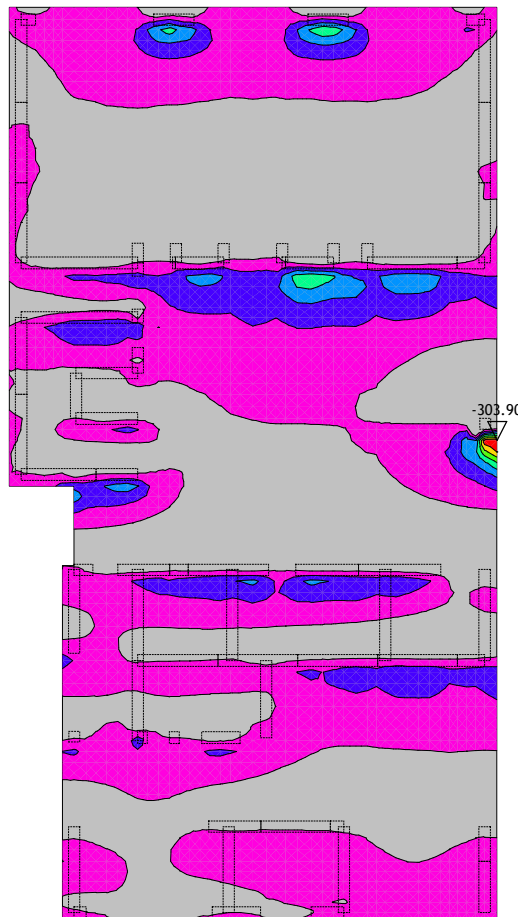


Tz,y [kN/m]
0.00
67.30
134.61
201.91
269.21
336.51
403.82
471.12

Nivo: POZ 000 [0.00 m]

Vplivi v plošči: max Tz,y= 471.12 / min Tz,y= 0.00 kN/m

Obt. 10: [MSN] 4,5

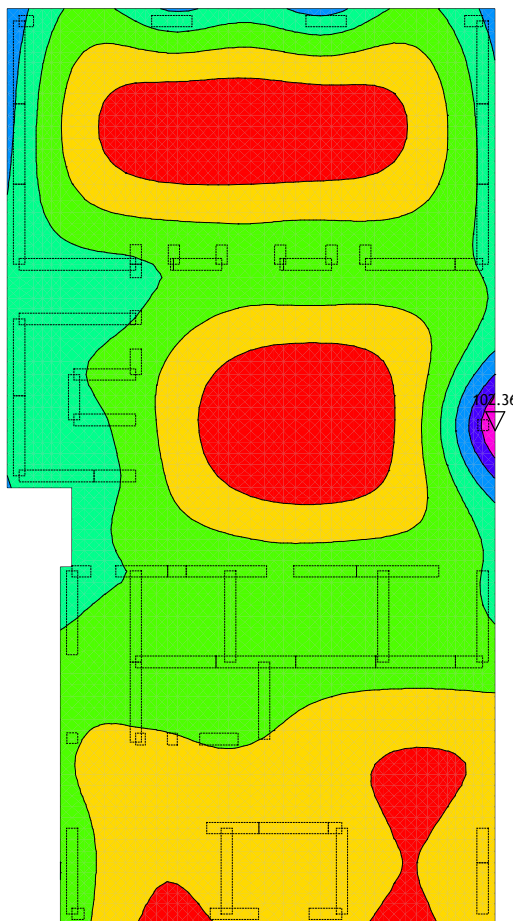


Tz,y [kN/m]
-303.90
-260.49
-217.07
-173.66
-130.24
-86.83
-43.41
0.00

Nivo: POZ 000 [0.00 m]

Vplivi v plošči: max Tz,y= 0.00 / min Tz,y= -303.90 kN/m

Obt. 11: [MSU_inst] 6,7

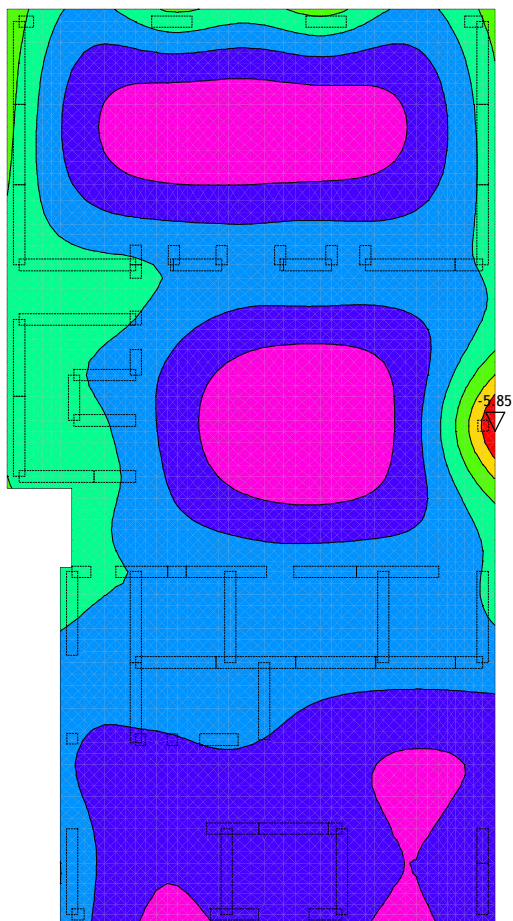


σ, tal [kN/m ²]
10.76
23.85
36.93
50.02
63.11
76.20
89.28
102.37

Nivo: POZ 000 [0.00 m]

Vplivi v pov.podpori: max σ, tal = 102.36 / min σ, tal = 10.76 kN/m²

Obt. 11: [MSU_inst] 6,7



s, tal [m]/1000
-5.85
-5.10
-4.35
-3.60
-2.86
-2.11
-1.36
-0.61

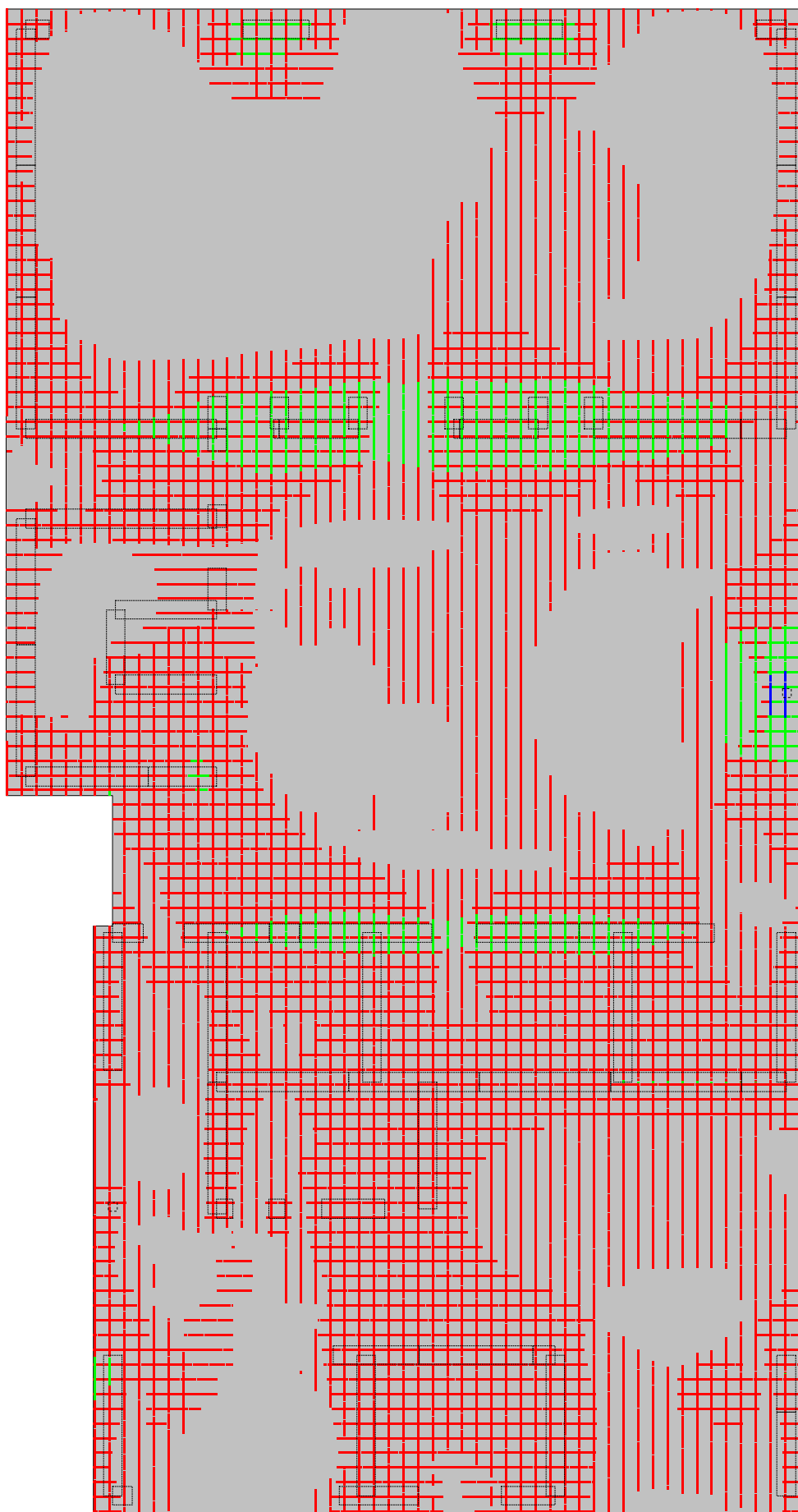
Nivo: POZ 000 [0.00 m]

Vplivi v pov.podpori: max s, tal = -0.62 / min s, tal = -5.85 m / 1000

Dimenzioniranje (beton)

Osvojena armatura
EC 2 (EN 1992-1-1:2004), C 25, S500H, a=6.00 cm

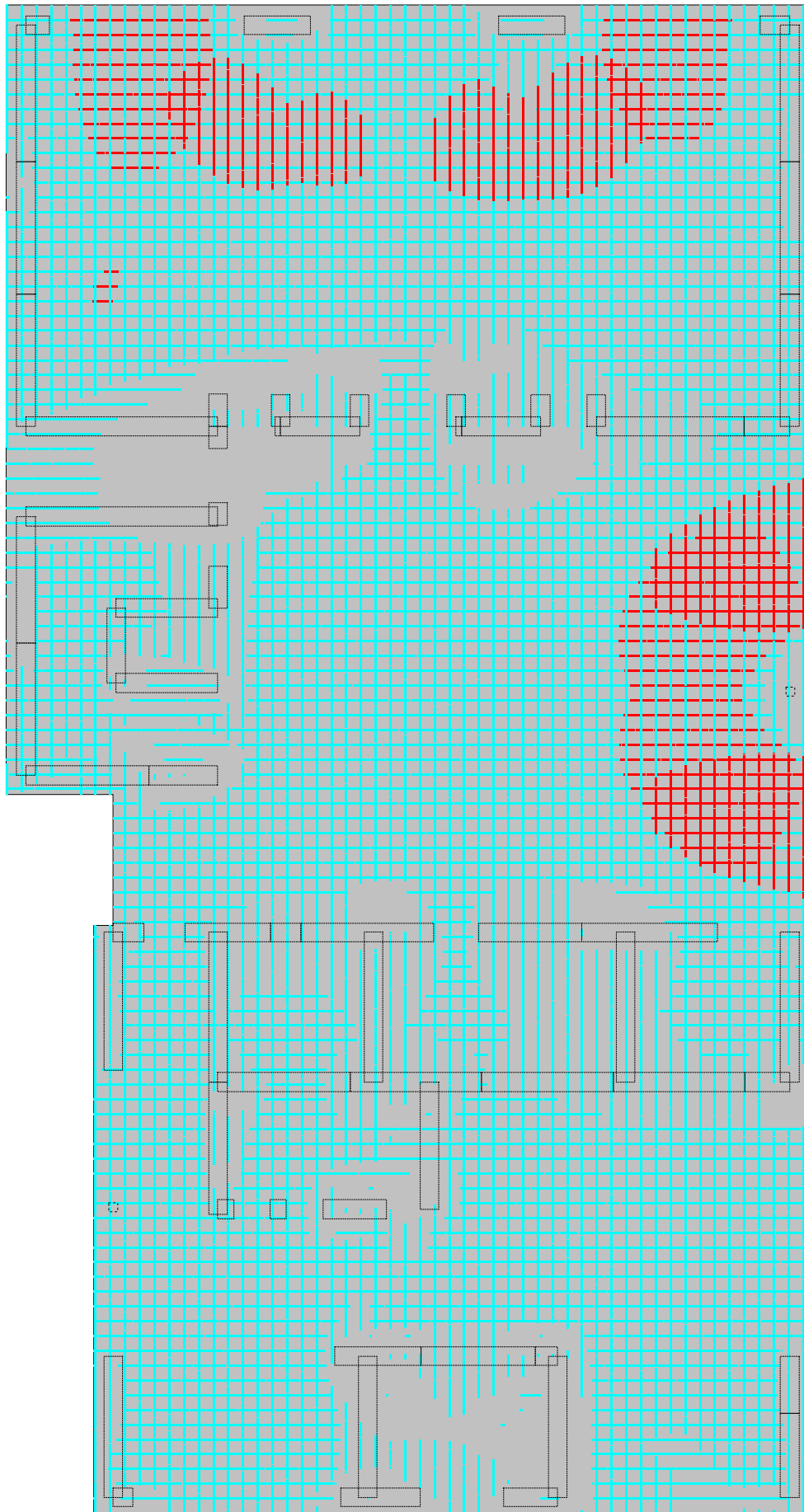
Aa - sp.cona [cm ² /m]	
0.00	
5.03	
18.06	
31.08	



Nivo: POZ 000 [0.00 m]
Aa - sp.cona

Osvojena armatura
EC 2 (EN 1992-1-1:2004), C 25, S500H, $a=4.00$ cm

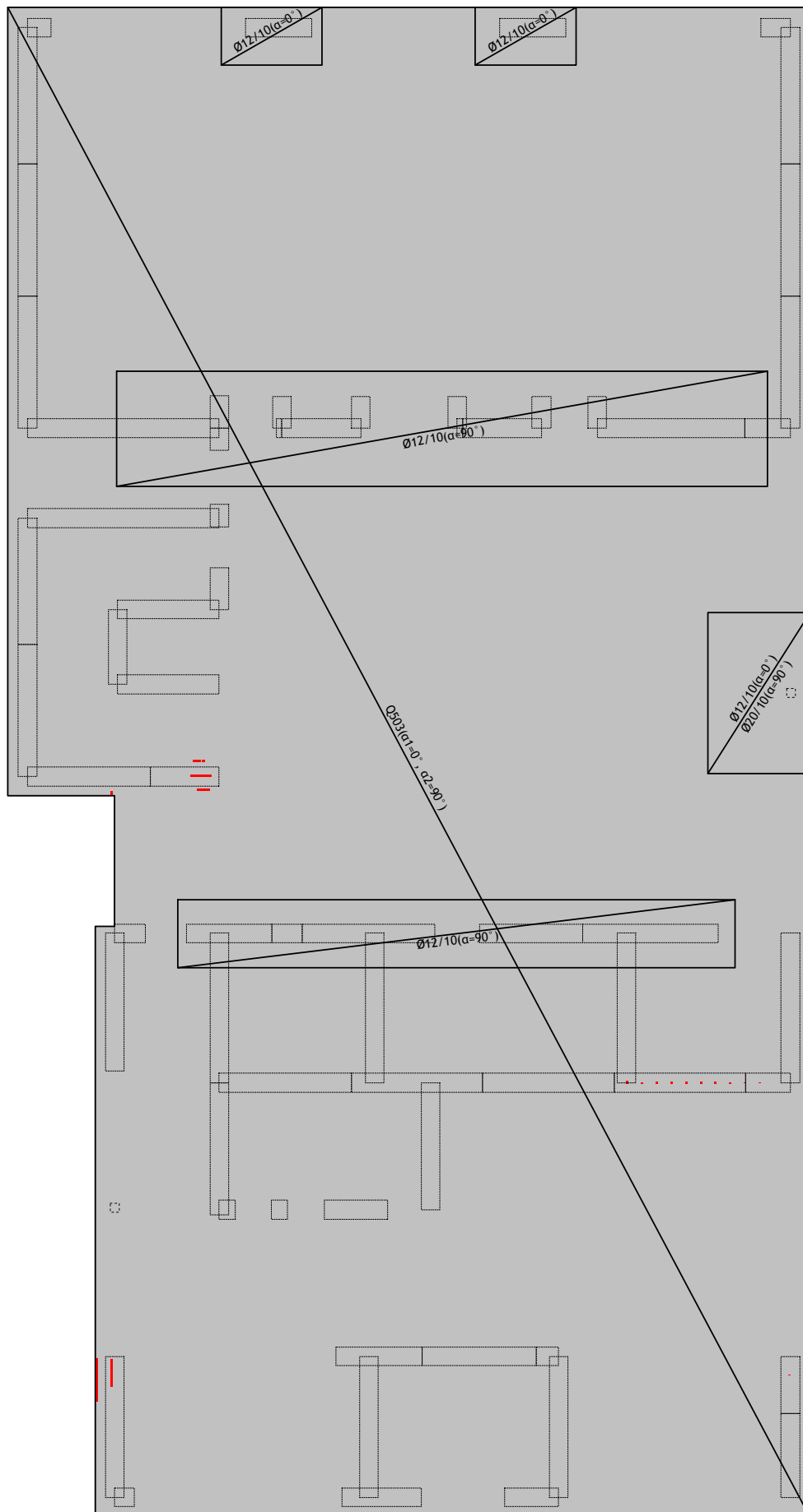
Aa - zg.cona [cm^2/m]	
-10.79	■
-5.03	■
0.00	■



Nivo: POZ 000 [0.00 m]
Aa - zg.cona

Osvojena armatura
EC 2 (EN 1992-1-1:2004), C 25, S500H, $a=6.00$ cm

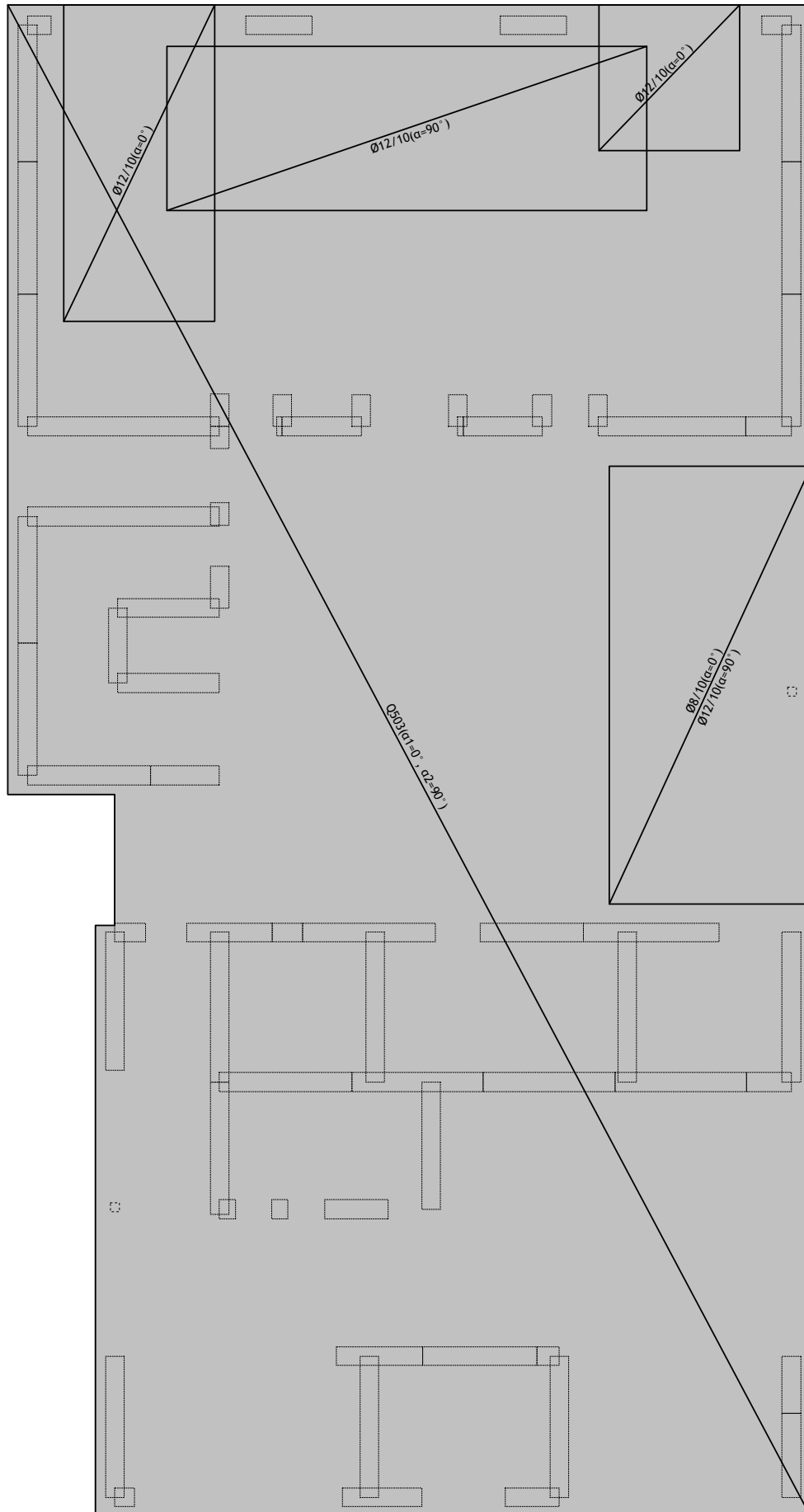
Aa - sp.cona [cm ² /m]	
0.00	
5.03	
18.06	
31.08	



Nivo: POZ 000 [0.00 m]
Aa - sp.cona

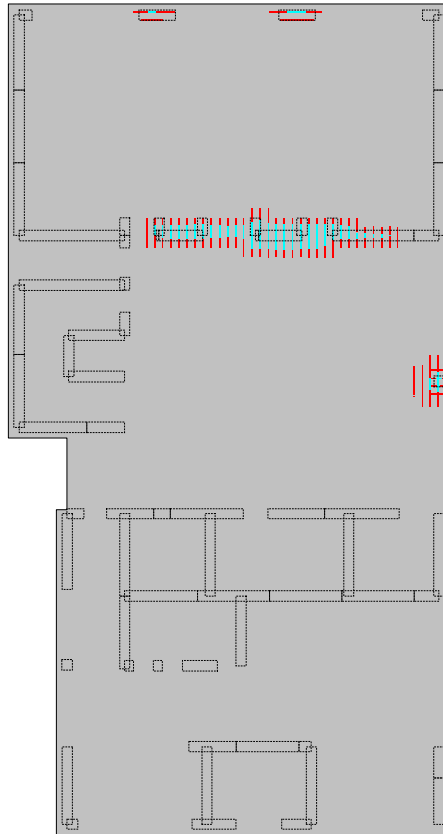
Osvojena armatura
EC 2 (EN 1992-1-1:2004), C 25, S500H, a=4.00 cm

Aa - zg.cona [cm ² /m]	
-10.79	
-5.03	
0.00	



Nivo: POZ 000 [0.00 m]
Aa - zg.cona

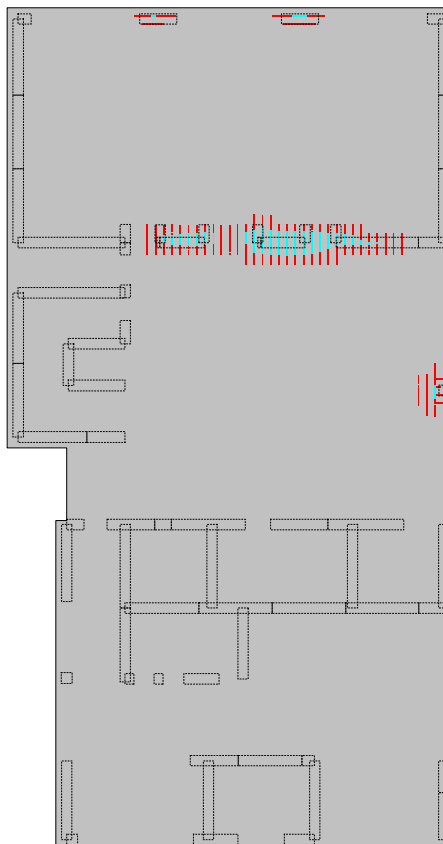
Merodajna obtežba: 6,7
EC 2 (EN 1992-1-1:2004), C 25, S500H



ak2/ak1,t0 [mm]	
0.00	■
0.13	■
0.26	■

Nivo: POZ 000 [0.00 m]
max ak2/ak1,t0= 0.26 mm

Merodajna obtežba: 6,7
EC 2 (EN 1992-1-1:2004), C 25, S500H

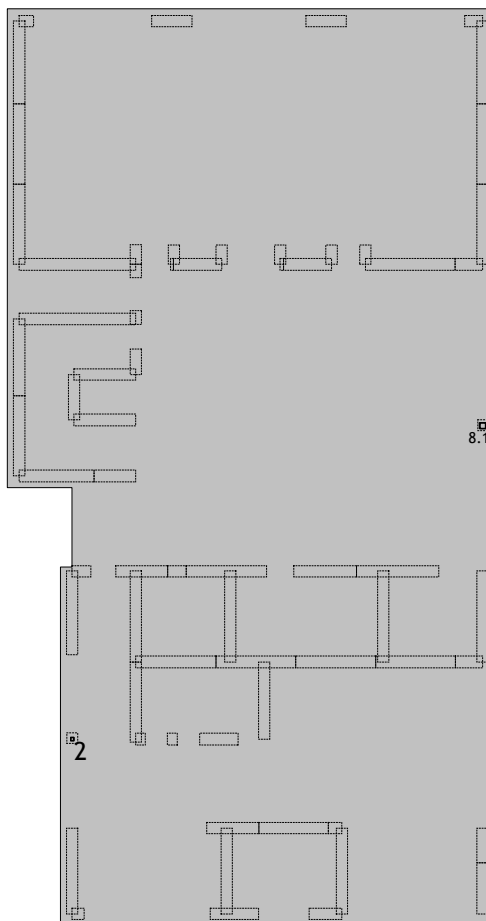


ak2/ak1,t∞ [mm]	
0.00	■
0.15	■
0.30	■

Nivo: POZ 000 [0.00 m]
max ak2/ak1,t∞= 0.29 mm

Kontrola razpok AB temeljne plošče za MSU:

ak, max = 0,30 < ak,dop = 0,30 --> **OK**



Nivo: POZ 000 [0.00 m]

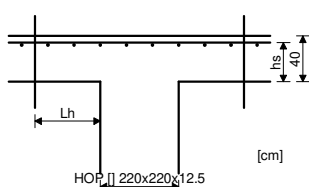
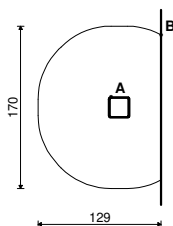
Kontrola plošč na preboj - dispozicija

Kontrola plošč proti preboju - POZ 110

Nivo: POZ 000 [0.00 m]

Prerez 1 (16.80,17.66,0.00)

C 25



KONTROLA PREREZA OB ROBU STEBRA

Merodajna kombinacija:

1.35xI+1.50xII+0.75xIII

Merodajna strižna napetost (točka A)

Debelina plošče

Statična višina plošče

Trdnost betona

Računska trdnost betona

Koeficient

Koeficient

Maksimalna odpornost

ved = 0.873 MPa

d,pl = 0.400 m

hs = 0.370 m

fck = 25.000 MPa

fcd = 16.667 MPa

v = 0.540

γc = 1.500

vRd,max = 0.40 × v × fcd = 3.600 MPa

Pogoj: ved ≤ vRd,max (0.87 ≤ 3.60)

Pogoj je izpolnjen.

KONTROLA KRITIČNEGA PREREZA 1. (Lh = 0.74m od roba stebra)

Merodajna kombinacija:

1.35xI+1.50xII+0.75xIII

Merodajna strižna napetost (točka B)

ved = 0.895 MPa

Debelina plošče

Statična višina plošče

Obseg kritičnega prereza

Trdnost betona

Računska trdnost betona

Koeficient

Koeficient

Maksimalna odpornost

d,pl = 0.400 m

hs = 0.370 m

u1 = 3.646 m

fck = 25.000 MPa

fcd = 16.667 MPa

v = 0.540

γc = 1.500

vRd,max = 0.40 × v × fcd = 3.600 MPa

Pogoj: ved ≤ vRd,max (0.90 ≤ 3.60)

Pogoj je izpolnjen.

Obstoječa armatura v plošči

Površina armature - smer 1

Procent armiranja - smer 1

Površina armature - smer 2

Procent armiranja - smer 2

Srednja vrednost procenta armiranja

Koeficient

Koeficient

Koeficient

Koeficient

Normalna napetost v betonu

Odpornost proti preboju plošče brez dodatne armature za varnost.

Aa,1 = 10.053 cm²

p,1 = 0.272 %

Aa,2 = 16.336 cm²

p,2 = 0.442 %

pl = 0.346 %

CRd,c = 0.120

K1 = 0.100

k,vmin = 0.035

vmin = 0.400

σcp = -0.036 MPa

vRd,c = 0.424 MPa

Pogoj: ved ≤ vRd,c (0.90 ≤ 0.42)

Potrebna je dodatna armatura proti preboju plošče.

Razmerje

ved / vRd,c = 2.111

Armatura za varnost proti preboju plošče S500H

Kot proti glavni armaturi

Razmak med palicami v radialni smeri

α = 90°

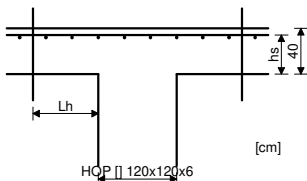
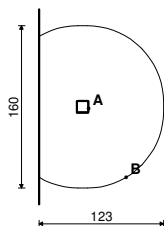
sr = 20.000 cm

Potrebna površina armature

Asw = 8.191 cm²

Kontrola plošče proti preboju - POZ 111

Nivo: POZ 000 [0.00 m]
Prerez 2 (1.92,6.32,0.00)
C 25



KONTROLA KRITIČNEGA PREREZA 1. (Lh = 0.74m od roba stebra)

Merodajna kombinacija:

1.35xI+1.50xII+0.75xIII

Merodajna strižna napetost (točka B)

Debelina plošče

Statična višina plošče

ved = 0.091 MPa

d,pl = 0.400 m

hs = 0.370 m

Obseg kritičnega prereza

u1 = 3.450 m

Trdnost betona

fck = 25.000 MPa

Računska trdnost betona

fcd = 16.667 MPa

Koeficient

v = 0.540

Koeficient

γc = 1.500

Maksimalna odpornost

vRd,max = 0.40 × v × fcd = 3.600 MPa

Pogoj: ved ≤ vRd,max (0.09 ≤ 3.60)

Pogoj je izpolnjen.

KONTROLA PREREZA OB ROBU STEBRA

Merodajna kombinacija:

1.35xI+1.50xII+0.75xIII

Merodajna strižna napetost (točka A)

Debelina plošče

Statična višina plošče

ved = 0.054 MPa

d,pl = 0.400 m

hs = 0.370 m

Trdnost betona

fck = 25.000 MPa

Računska trdnost betona

fcd = 16.667 MPa

Koeficient

v = 0.540

Koeficient

γc = 1.500

Maksimalna odpornost

vRd,max = 0.40 × v × fcd = 3.600 MPa

Pogoj: ved ≤ vRd,max (0.05 ≤ 3.60)

Pogoj je izpolnjen.

Obstoječa armatura v plošči

Površina armature - smer 1

Aa,1 = 5.027 cm²

Procent armiranja - smer 1

ρ,1 = 0.136 %

Površina armature - smer 2

Aa,2 = 5.027 cm²

Procent armiranja - smer 2

ρ,2 = 0.136 %

Srednja vrednost procenta armiranja

ρl = 0.136 %

Koeficient

CRd,c = 0.120

Koeficient

K1 = 0.100

Koeficient

k, vmin = 0.035

Koeficient

vmin = 0.400

Normalna napetost v betonu

σcp = -0.036 MPa

Odpornost proti preboju plošče brez dodatne armature za varnost.

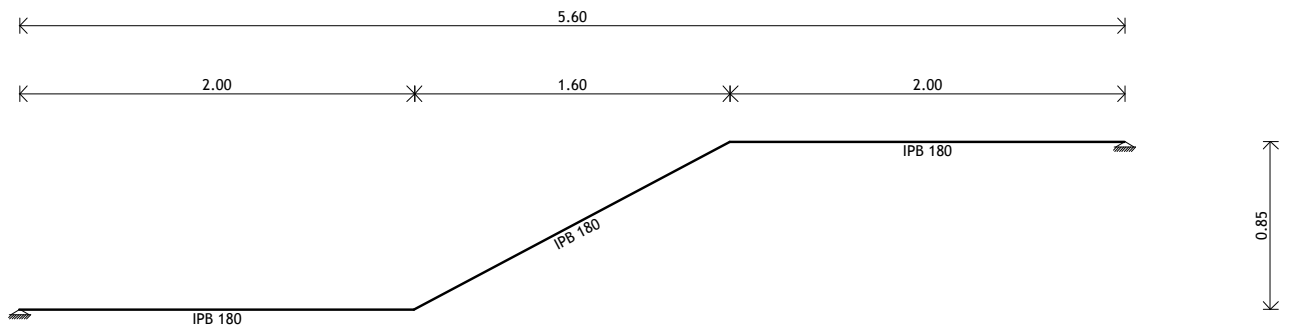
vRd,c = 0.396 MPa

Pogoj: ved ≤ vRd,c (0.09 ≤ 0.40)

Pogoj je izpolnjen, ni potrebna dodatna armatura proti preboju plošče.

Pod jeklenim stebrom POZ 110 je v temeljni plošči potrebna dodatna strižna armatura proti preboju.

STOPNIŠČE



Vhodni podatki - Obtežba

Lista obtežnih primerov

LC	Naziv
1	Stalna + l.t. (g)
2	Koristna

LC	Naziv
3	Komb.: MSN (1.35xI+1.5xII)
4	Komb.: MSU (I+II)

Obtežba:

- lastna teža: upoštevana v programu

- stalna teža:

$$g' = 1,2 \text{ kN/m}^2 \times 1,0 \text{ m} = 1,2 \text{ kN/m}$$

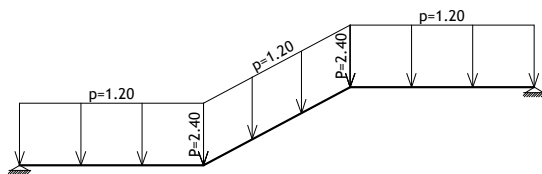
$$G = g' \times 2,3 \text{ m} + 1,0 \text{ kN (l.t. ograde)} = 2,4 \text{ kN}$$

-koristna obtežba:

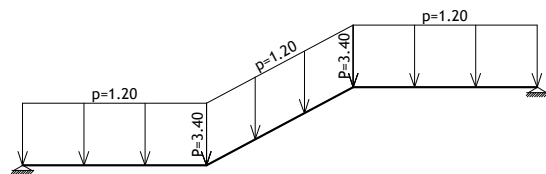
$$q' = 3,0 \text{ kN/m}^2 \times 1,0 \text{ m} = 3,0 \text{ kN/m}$$

$$G = q' \times 2,3 \text{ m} = 3,4 \text{ kN}$$

Obt. 1: Stalna + l.t. (g)

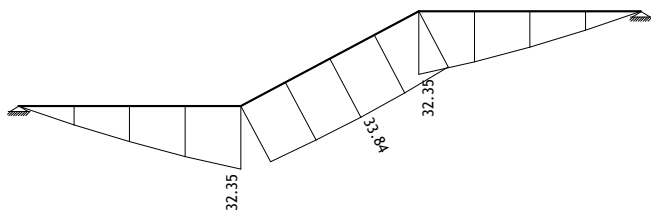


Obt. 2: Koristna



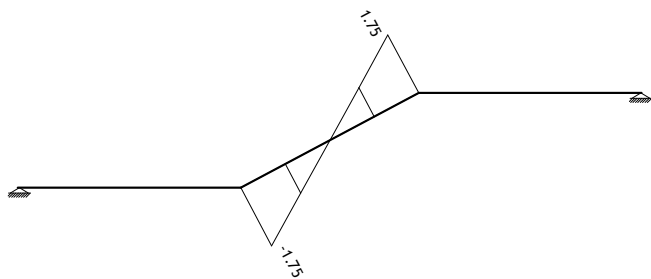
Statični preračun

Obt. 3: MSN



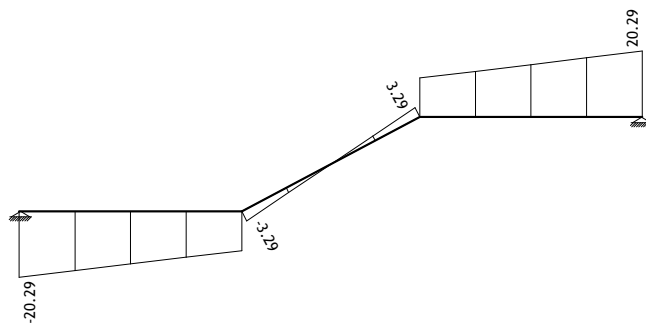
Vplivi v gredi: max M3= 33.84 / min M3= 0.00 kNm

Obt. 3: MSN



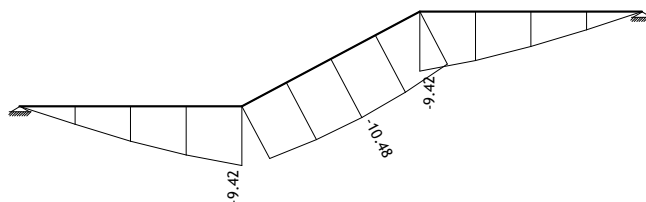
Vplivi v gredi: max N1= 1.75 / min N1= -1.75 kN

Obt. 3: MSN



Vplivi v gredi: max T2= 20.29 / min T2= -20.29 kN

Obt. 4: MSU



Vplivi v gredi: max Zp= -0.00 / min Zp= -10.48 m / 1000

Kontrola povesov za MSU:

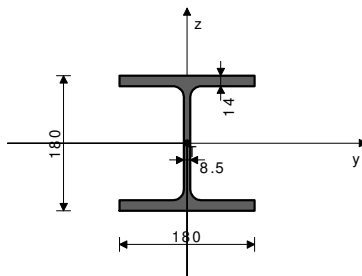
$$w(\text{MSU}) = 1,0 \text{ cm} < w(\text{dop}) = L / 300 = 1,9 \text{ cm} \rightarrow \text{OK}$$

Dimenzioniranje (jeklo)

Jekleni nosilec pod stopnicami: HEB 180; S 235

PREČNI PREREZ: IPB 180 [S 235] [Set: 1]
EUROCODE 3 (ENV)

GEOMETRIJSKE KARAKTERISTIKE prereza



Ax =	65.300 cm ²
Ay =	45.010 cm ²
Az =	20.290 cm ²
Ix =	42.300 cm ⁴
Iy =	3830.0 cm ⁴
Iz =	1360.0 cm ⁴
Wy =	425.56 cm ³
Wz =	151.11 cm ³
Wy,pl =	490.63 cm ³
Wz,pl =	226.80 cm ³
γM0 =	1.100
γM1 =	1.100
γM2 =	1.250
Anet/A =	0.900

(fy = 23.5 kN/cm², fu = 36.0 kN/cm²)

FAKTORJI IZKORIŠČENOSTI PO KOMBINACIJAH OBEŽB

3. γ=0.32

PALICA IZPOSTAVLJENA PRITISKU IN UPOGIBU

(obtežni primer 3, na 80.5 cm od začetka palice)

Računska osna sila	Nsd =	-0.194 kN
Prečna sila v z smeri	Vsd_z =	-0.366 kN
Upogibni moment okoli y osi	Msd_y =	33.761 kNm
Sistemska dolžina palice	L =	181.18 cm

5.3 KLASIFIKACIJA PREČNIH PREREZOV

Razred prereza 1

5.4 NOSILNOST PREČNIH PREREZOV

5.4.4 Tlak

Plastična računska nosilnost

Npl.Rd = 1395.0 kN

Računska nosilnost na tlak

Nc.Rd = 1395.0 kN

Pogoj 5.16: Nsd <= Nc.Rd (0.19 <= 1395.05)

5.4.5 Upogib y-y

Računski plastični moment

Mpl.Rd = 104.82 kNm

Računska nos. na lokalno izbočitev

Mo.Rd = 90.914 kNm

Računski elastični moment

Mel.Rd = 90.914 kNm

Računska nosilnost na upogib

Mc.Rd = 104.82 kNm

Pogoj 5.17: Msd_y <= Mc.Rd_y (33.76 <= 104.82)

5.4.6 Strig

Računska plast.nos. na strig z-z

Vpl.Rd = 250.26 kN

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (0.37 <= 250.26)

5.4.9 Upogib z osno in prečno silo

Ni potrebno zmanjšanje upogibne nosilnosti

Pogoj: Vsd_z <= 50%Vpl.Rd_z

5.4.8 Upogib in osna sila

Razmerje Msd_y / Mpl.Rd_y

0.322

Pogoj 5.36: (0.32 <= 1)

5.5 NOSILNOST ELEMENTOV

5.5.1 Uklonska nosilnost

Uklonska dolžina y-y

ly = 100.00 cm

Vztrajnostni radij y-y

iy = 7.658 cm

Vitkost y-y

λy = 13.057

Relativna vitkost y-y

λ_y = 0.139

Uklonska krivulja za os y-y: B

α = 0.340

Koeficient nepopolnosti

χ_y = 1.000

Koeficient efektivnega prereza

βA = 1.000

Računska uklonska nosilnost

Nb.Rd_y = 1395.0 kN

Pogoj 5.45: Nsd <= Nb.Rd_y (0.19 <= 1395.05)

Uklonska dolžina z-z

lz = 100.00 cm

Vztrajnostni radij z-z

iz = 4.564 cm

Vitkost z-z

λz = 21.912

Relativna vitkost z-z

λ_z = 0.233

Uklonska krivulja za os z-z: C

α = 0.490

Koeficient nepopolnosti

χ_z = 0.983

Koeficient efektivnega prereza

βA = 1.000

Računska uklonska nosilnost

Nb.Rd_z = 1371.4 kN

Pogoj 5.45: Nsd <= Nb.Rd_z (0.19 <= 1371.36)

5.5.2 Bočna zvrnitev upogibnih nosilcev

Koeficient

C1 = 1.000

Koeficient

C2 = 0.000

Koeficient

C3 = 1.000

Koef. ukl. dolžine za uklon

k = 1.000

Koef. ukl. dolžine za vbočenje

kw = 1.000

Koordinata

zg = 0.000 cm

Koordinata

zj = 0.000 cm

Razmak med bočnimi podporami

L = 100.00 cm

Sektorski vztrajnostni moment

Iw = 93746 cm⁶

Krit. moment bočne zvrnitve

Mcr = 2537.7 kNm

Koeficient

βw = 1.000

Koeficient imperf.

αLT = 0.210

Brezdimenz. vitkost

λLT = 0.213

Koeficient zmanjšanja

χLT = 0.997

Računska uklonska nosilnost

Mb.Rd = 104.51 kNm

Kontrola bočne zvrnitve ni potrebna: λLT <= 0.4

5.5.4 Upogib in tlak

Koeficient nepopolnosti

χmin = 0.983

Nsd / ...

0.000

Koeficient oblike momenta

βy = 1.100

Koeficient

μy = -0.097

Koeficient

ky = 1.000

ky * My / ...

0.322

Pogoj 5.51: (0.32 <= 1)

Koeficient nepopolnosti

χ_z = 0.983

Nsd / ...

0.000

Koeficient nepopolnosti

χLT = 0.997

Koef. obl. mom. za bočno zvrnitev

βM.LT = 1.100

Koeficient

μLT = -0.111

Koeficient

kLT = 1.000

kLT * My / ...

0.323

Pogoj 5.52: (0.32 <= 1)

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

za strig v ravlini z-z

Višina stojine

d = 15.200 cm

Debelina stojine

tw = 0.850 cm

Ni prečnih ojačitev v sredini

Koeficient izbočenja pri strigu

kτ = 5.340

Ni potrebna kontrola izbočenja zaradi striga

Pogoj: d / tw <= 69 g (17.88 <= 69.00)

5.6.7 Interakcija prečne sile, upogiba in osne sile

za strig v ravlini z-z

Računski plastični moment pasnic

Mf.Rd = 96.905 kNm

Pogoji 5.66a in 5.66b so izpolnjeni

5.7 VNOS KONCENTRIRANIH SIL V STOJINO

5.7.7 Uklon pasnice v smeri stojine

Koeficient (razred pasnice 1)

k = 0.300

Površina stojine

Aw = 15.300 cm²

Površina tlač. pasnice

Afc = 25.200 cm²

Preprečen je uklon pasnice v smeri stojine

Pogoj 5.80: (17.88 <= 208.89)

KONTROLA STRIŽNE NOSILNOSTI

(obtežni primer 3, začetek palice)

Računska osna sila

Nsd = -1.748 kN

Prečna sila v z smeri

Vsd_z = -3.290 kN

Upogibni moment okoli y osi

Msd_y = 32.354 kNm

Sistemska dolžina palice

L = 181.18 cm

5.4 NOSILNOST PREČNIH PREREZOV

5.4.6 Strig

Računska plast.nos. na strig z-z

Vpl.Rd = 250.26 kN

Pogoj 5.20: Vsd_z <= Vpl.Rd_z (3.29 <= 250.26)

5.6 LOKALNO IZBOČENJE ZARADI STRIGA

za strig v ravlini z-z

Višina stojine

d = 15.200 cm

Debelina stojine

tw = 0.850 cm

Ni prečnih ojačitev v sredini

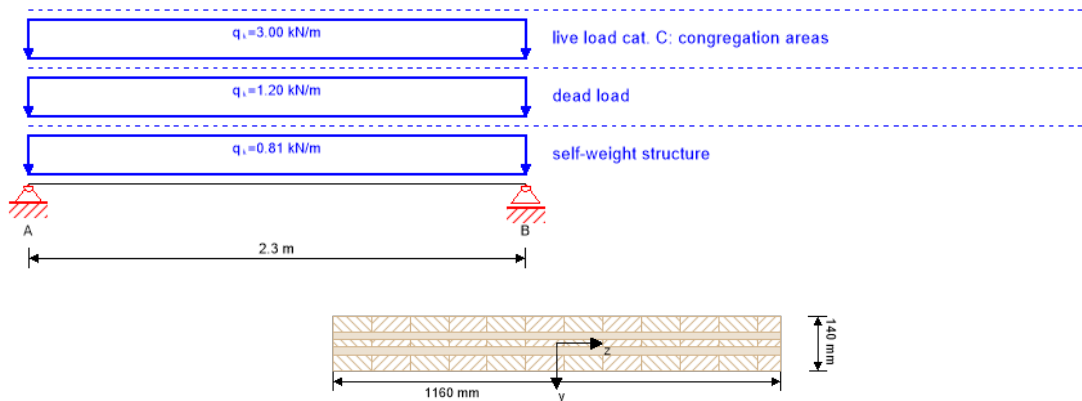
Koeficient izbočenja pri strigu

kτ = 5.340

Ni potrebna kontrola izbočenja zaradi striga

Pogoj: d / tw <= 69 g (17.88 <= 69.00)

system



global utilization ratio

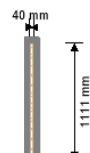
5 %

ULS 5 % ULS fire 4 %

section: CLT 140 C5s

	layer	thickness	orientation	material
	1	40.0 mm	90°	C24 spruce
	2	20.0 mm	0°	C24 spruce
	3	20.0 mm	90°	C24 spruce
	4	20.0 mm	0°	C24 spruce
	5	40.0 mm	90°	C24 spruce
	t _{CLT}	140.0 mm		

section fire: CLT 140 C5s

	layer		thickness	orientation		material	
	1		10.0 mm	0°		C24 spruce	
	2		20.0 mm	90°		C24 spruce	
	3		10.0 mm	0°		C24 spruce	
	t _{CLT}		40.0 mm				
fire resistance class:R 60		time		60 min			
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	86.0	93.0	42.0	49.0

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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
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	live load cat. C: congregation areas	Q	short term	0.9	0	1.5	0.7	0.7	0.6

LC1:self-weight structure

continous load

q_k
[kN/m]
0.812

LC2:dead load

continous load

q_k
[kN/m]
1.2

LC3:live load cat. C: congregation areas

continous load

q_k
[kN/m]
3

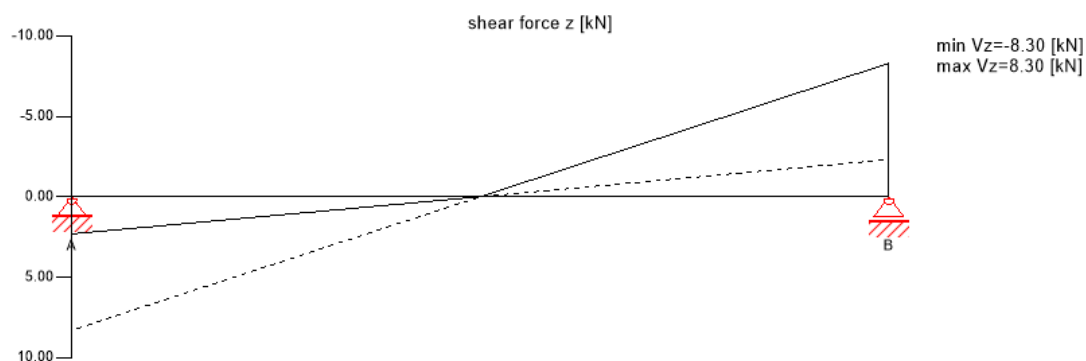
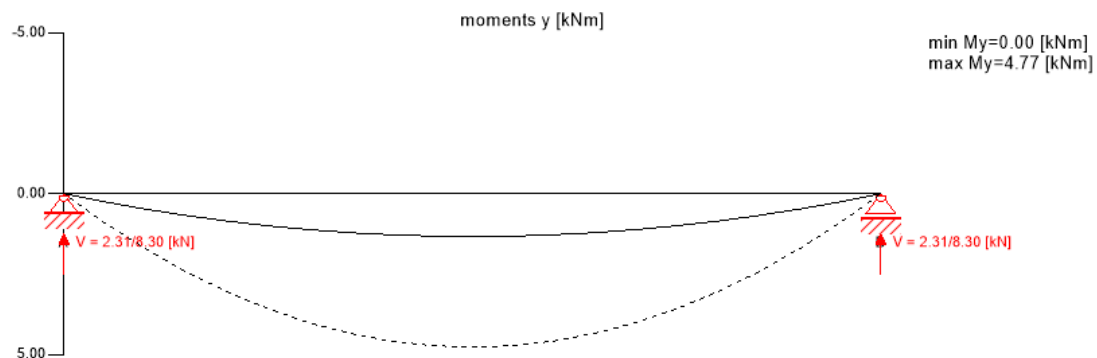
ULS combinations

	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	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.60 * LC3$

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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
1.15	1.25	0.90	1.00	24.00	17.28	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/mm ²]	[N/mm ²]	[N/mm ²]		
4.77	0.00	0.00	0.21	0.00	0.00	1 %	LCO2

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	$T_{IP,Gross,d}$	ratio
[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]	
0.0	3.50	1.25	0.90	2.52	8.30	0.08	3 %

ULS shear design in plane of CLT - net section							
dist.	$f_{v,IP,Net,k}$	γ_m	k_{mod}	$f_{v,IP,Net,d}$	$V_{Net,d}$	$T_{v,IP,Net,d}$	ratio
[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]	
0.0	8.00	1.25	0.90	5.76	8.30	0.27	5 %

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/mm ²]	[-]	[-]	[N/mm ²]	[kNm]	[kNm]	[-]	[m]	[mm ⁴]		
2.50	1.25	0.90	1.80	8.30	1.24	28	0.150	84375010.00	2 %	LCO2

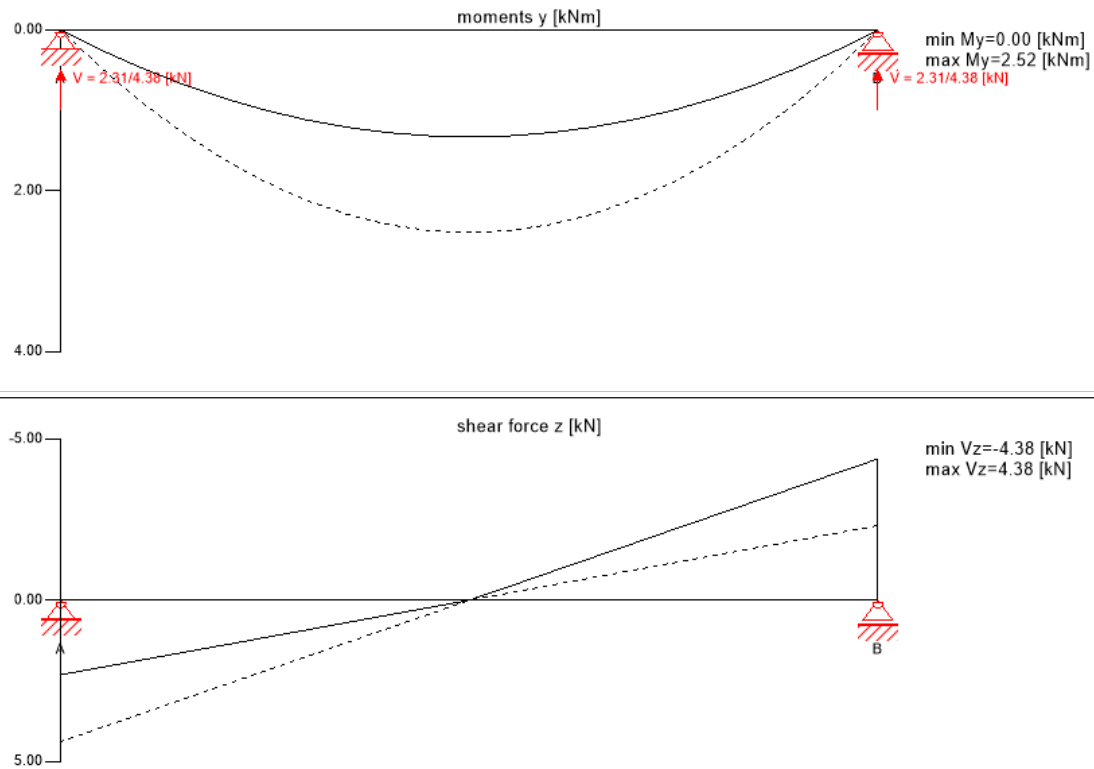
flexural stress analysis										
$M_{y,d} =$	4.77	kNm	$f_{m,k} =$	24.00	N/mm ²					
$N_{c,d} =$	0.00	kN	$\gamma_m =$	1.25	-					
			$k_{mod} =$	0.90	-					
			$k_{sys,y} =$	1.00	-					
$\sigma_{c,d} =$	0.00	N/mm ²	$f_{c,d} =$	15.12	N/mm ²					
$\sigma_{m,y,d} =$	0.21	N/mm ²	$f_{m,y,d} =$	17.28	N/mm ²					✓
utilization ratio									1 %	

shear analysis gross section										
$V_d =$	8.30	kNm	$f_{v,IP,Gross,k} =$	3.50	N/mm ²					
			$\gamma_m =$	1.25	-					
			$k_{mod} =$	0.90	-					
$T_{IP,Gross,d} =$	0.08	N/mm ²	$f_{v,IP,Gross,d} =$	2.52	N/mm ²					✓
utilization ratio									3 %	

shear analysis net section										
$V_{Net,d} =$	8.30	kNm	$f_{v,IP,Net,k} =$	8.00	N/mm ²					
			$\gamma_m =$	1.25	-					
			$k_{mod} =$	0.90	-					
$T_{v,IP,Net,d} =$	0.27	N/mm ²	$f_{v,IP,Net,d} =$	5.76	N/mm ²					✓
utilization ratio									5 %	

torsional shear design in plane of CLT - in face glued surfaces										
$V_{\delta,d} =$	8.30	kNm	$f_{v,T,Node,k} =$	2.50	N/mm ²					
			$\gamma_m =$	1.25	-					
			$k_{mod} =$	0.90	-					
$T_{T,Node,d} =$	0.04	N/mm ²	$f_{v,T,Node,d} =$	1.80	N/mm ²					✓
utilization ratio									2 %	

Ultimate limit state (ULS) fire design - results



ULS fire flexural design

dist.	γ_m	k_{mod}	$k_{sys,y}$	k_{fi}	$f_{m,k}$	$f_{m,y,d}$	$f_{t,d}$	$f_{c,d}$
[m]	[-]	[-]	[-]	[-]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
1.15	1.00	1.00	1.00	1.15	24.00	27.60	16.10	24.15
$M_{y,d}$	$N_{c,d}$	$N_{t,d}$	$\sigma_{m,y,d}$	$\sigma_{c,d}$	$\sigma_{t,d}$	ratio		
[kNm]	[kN]	[kN]	[N/mm ²]	[N/mm ²]	[N/mm ²]			
2.52	0.00	0.00	0.61	0.00	0.00	2 %	LCO2	

ULS fire shear design in plane of CLT - gross section

dist.	$f_{v,IP,Gross,k}$	γ_m	k_{mod}	k_{fi}	$f_{v,IP,Gross,d}$	V_d	$T_{IP,Gross,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
0.0	3.50	1.00	1.00	1.15	4.03	4.38	0.15	4 %	LCO2

ULS fire shear design in plane of CLT - net section

dist.	$f_{v,IP,Net,k}$	γ_m	k_{mod}	k_{fi}	$f_{v,IP,Net,d}$	$V_{Net,d}$	$T_{v,IP,Net,d}$	ratio	
[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
0.0	8.00	1.00	1.00	1.15	9.20	4.38	0.30	3 %	LCO2

ULS fire 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/mm ²]	[-]	[-]	[N/mm ²]	[kNm]	[kNm]	[-]	[m]	[mm ⁴]		
2.50	1.00	1.00	2.88	4.38	0.66	14	0.150	84375010.00	1 %	LCO2

flexural stress analysis fire

$M_{y,d} =$	2.52	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{c,d} =$	0.00	kN	$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{sys,y} =$	1.00	-
			$k_{fi} =$	1.15	-
$\sigma_{c,d} =$	0.00	N/mm ²	$f_{c,d} =$	24.15	N/mm ²
$\sigma_{m,y,d} =$	0.61	N/mm ²	$f_{m,y,d} =$	27.60	N/mm ²

utilization ratio

2 %

shear analysis gross section fire

$V_d =$	4.38	kNm	$f_{v,IP,Gross,k} =$	3.50	N/mm ²
			$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{fi} =$	1.15	-
$T_{IP,Gross,d} =$	0.15	N/mm ²	$f_{v,IP,Gross,d} =$	4.03	N/mm ²

utilization ratio 4 %

shear analysis net section fire

$V_{Net,d} =$	4.38	kNm	$f_{v,IP,Net,k} =$	8.00	N/mm ²
			$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{fi} =$	1.15	-
$T_{v,IP,Net,d} =$	0.30	N/mm ²	$f_{v,IP,Net,d} =$	9.20	N/mm ²

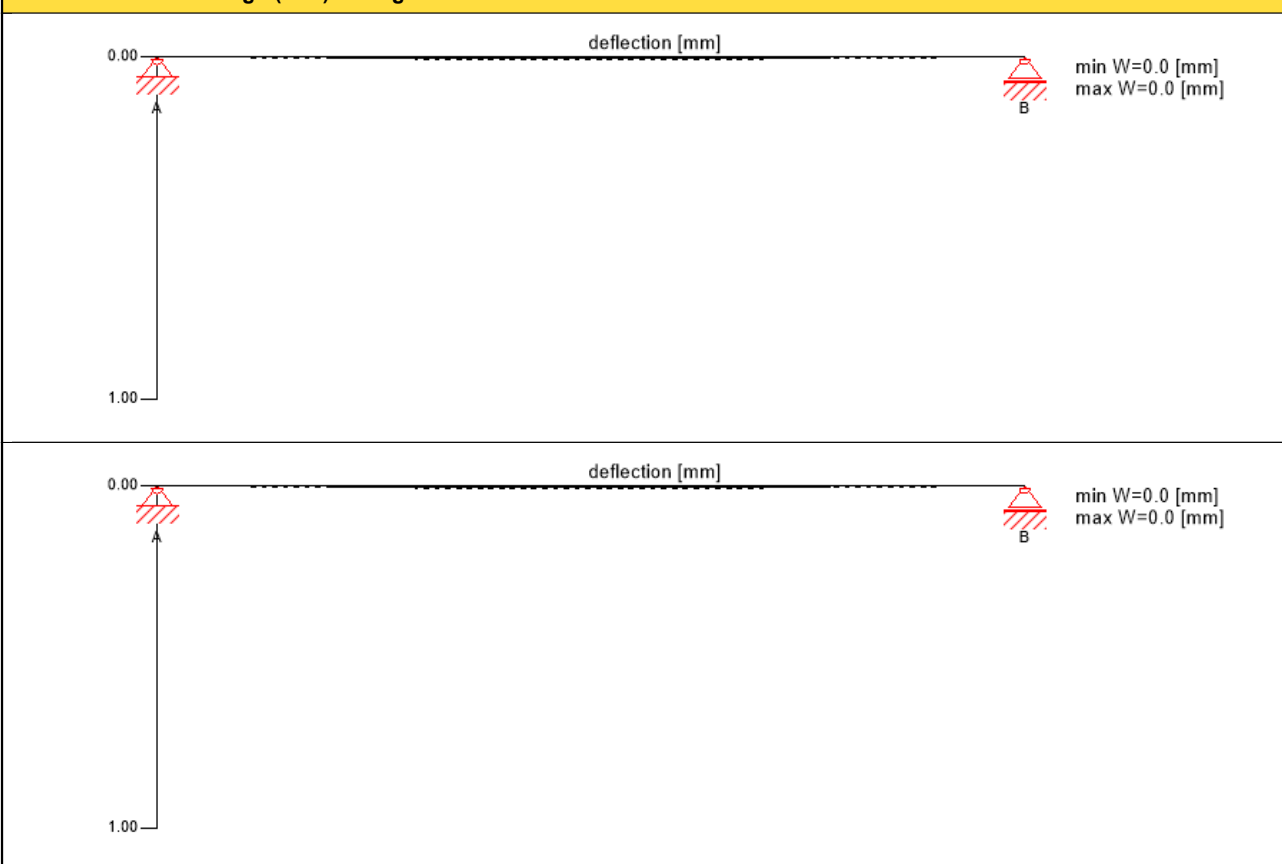
utilization ratio 3 %

torsional shear design in plane of CLT - in face glued surfaces fire

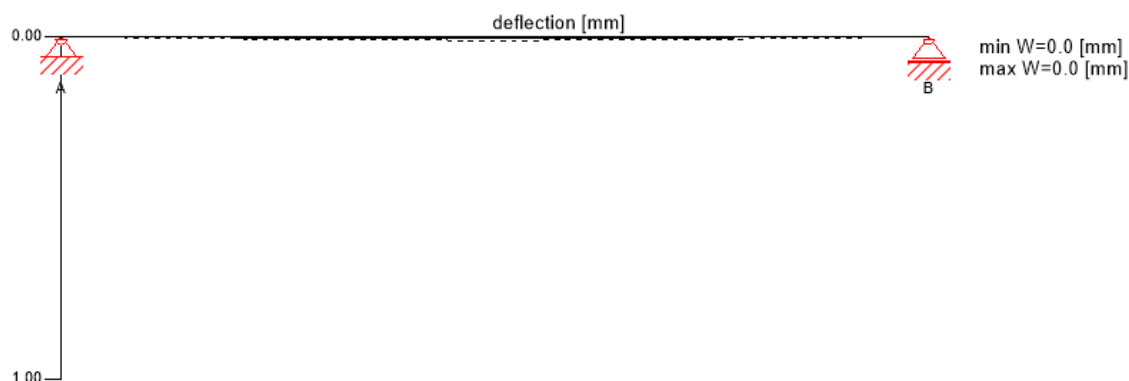
$V_{\delta,d} =$	4.38	kNm	$f_{v,T,Node,k} =$	2.50	N/mm ²
			$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{fi} =$	1.15	-
$T_{T,Node,d} =$	0.04	N/mm ²	$f_{v,T,Node,d} =$	2.88	N/mm ²

utilization ratio 1 %

Service limit state design (SLS) - design results



Service limit state design (SLS) - design results



initial deflection [w_{char}]

K_{def}	L_{ref}	limit	$W_{calc.}$	ratio
	[m]	[-]	[mm]	
0.8	2.3	1/300	0.0	0 %

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

K_{def}	L_{ref}	limit	$W_{calc.}$	ratio
	[m]	[-]	[mm]	
0.8	2.3	1/150	0.0	0 %

net final deflection [$w_{q.p.} \cdot (1 + k_{def})$]

K_{def}	L_{ref}	limit	$W_{calc.}$	ratio
	[m]	[-]	[mm]	
0.8	2.3	1/250	0.0	0 %

support reaction

load case category	k_{mod}	A_z	A_{my}	B_z	B_{my}
		[kN]	[kNm]	[kN]	[kNm]
self-weight structure	0.6	0.93	0.00	0.93	0.00
		0.93	0.00	0.93	0.00
dead load	0.6	1.38	0.00	1.38	0.00
		1.38	0.00	1.38	0.00
live load cat. C: congregation areas	0.9	3.45	0.00	3.45	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
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 t_f of gypsum fire boards (GKF) according to ON B 3410	Expertise on failure time t_f 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 guideline for Europe	Fire safety in timber buildings - technical guideline for Europe; publishes by SP Technical Research Institute of Sweden

reference documents for this analysis	
English title	description
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

Disclaimer

The software was created to assist engineers in their daily business. The software is an engineering software that is dealing with a very complex matter of structural analysis and building physics analysis. Therefore, this software shall only be operated by skilled, experienced engineers, with a deep understanding of structural engineering and building physics related to timber structures. The user of the software is obliged to check all input values, no matter if they were given by the user or given by default by the software and all results for plausibility.

The use of the results of the software should not be relied upon as the basis for any decision or action. Any use of results of the software is only allowed, if the results have been verified and approved regarding completeness and correctness by a project structural/building physics engineer. The user has the possibility to make print-outs from the software. Any modification of those are not allowed.

Stora Enso Wood Products GmbH does not assume any warranty regarding the software. The software has been developed with utmost diligence, nevertheless Stora Enso Wood Products GmbH, neither expressly nor implicitly, provides any warranty in terms of accuracy, validity, timeliness and completeness of information and data created by the software. Stora Enso Wood Products GmbH does also not assume any warranty for the general usability of the software, its suitability for a special purpose or for the compatibility of the software with the ones of third party producers or providers.

Stora Enso Wood Products GmbH is only liable for damages caused by gross negligence or intent through Stora Enso Wood Products GmbH; the liability for slight negligence is excluded. This does not apply to personal injury. Under the aforementioned conditions Stora Enso Wood Products GmbH is as well not liable for operational failures or the loss of programs and/or data of the user's data processing system.

Applicable Law: These terms of use shall be governed by the laws of Austria excluding however any conflict of laws rules and any laws regarding the Convention of the International Sale of Goods (CISG).

POTRESNA ANALIZA

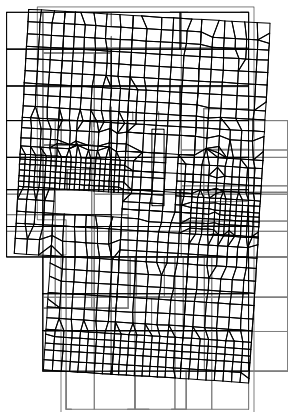
Potresna analiza objekta

Pospešek temeljnih tal: $a_g = 0,175 \text{ g}$

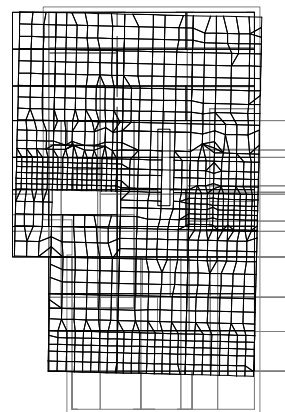
Faktor pomembnosti stavbe: $\gamma = 1,2$

Faktor redukcije potresnih sil: $q = 2,0$

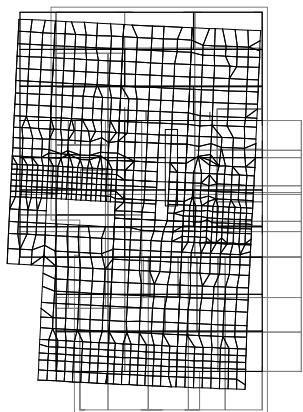
Klasifikacija temeljnih tal: elaborat geotehničnih raziskav št. 1-8/2018, ki ga je izdelal Gracen d.o.o., maj 2018, poda tip tal kategorije B.



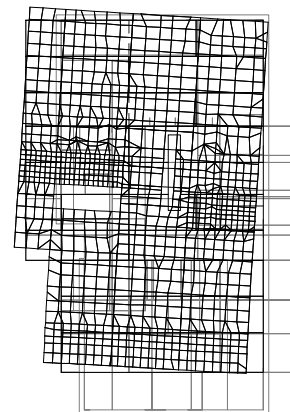
Izometrija (Zgoraj) (Nivo: POZ 300 [13.49 m])
Nihajna oblika: 1/6 [T=0.1914sec / f=5.22Hz]



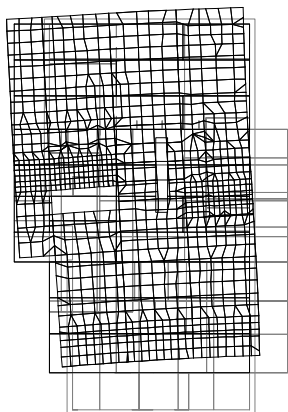
Izometrija (Zgoraj) (Nivo: POZ 300 [13.49 m])
Nihajna oblika: 2/6 [T=0.1838sec / f=5.44Hz]



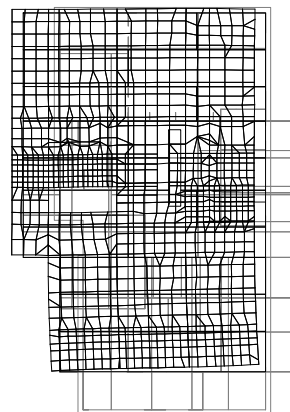
Izometrija (Zgoraj) (Nivo: POZ 300 [13.49 m])
Nihajna oblika: 3/6 [T=0.1628sec / f=6.14Hz]



Izometrija (Zgoraj) (Nivo: POZ 300 [13.49 m])
Nihajna oblika: 4/6 [T=0.1336sec / f=7.48Hz]



Izometrija (Zgoraj) (Nivo: POZ 300 [13.49 m])
Nihajna oblika: 5/6 [T=0.0966sec / f=10.35Hz]



Izometrija (Zgoraj) (Nivo: POZ 300 [13.49 m])
Nihajna oblika: 6/6 [T=0.0865sec / f=11.56Hz]

Modalna analiza

Napredne opcije seizmičnega preračuna:

Mase grupirane v nivojih izbranih etaž
Preprečeno nihanje v Z smeri

Faktorji obtežb za preračun mas

No	Naziv	Koeficient
1	Stalna + l.t. (g)	1.00
2	Koristna	0.60
3	Sneg	0.00
4	Sx +	0.00

No	Naziv	Koeficient
5	Sx -	0.00
6	Sy +	0.00
7	Sy -	0.00

Razporeditev mas po višini objekta

Nivo	Z [m]	X [m]	Y [m]	Masa [T]	T/m ²
POZ 400	16.29	3.39	15.92	32.07	0.30
POZ 300	13.49	6.46	17.76	205.08	0.39
POZ 200	8.92	8.18	17.81	504.29	0.87
POZ 100	4.57	9.15	16.57	1124.71	2.22
Skupno:	6.93	8.49	17.03	1866.16	

Položaj centra togosti po višini objekta (približna metoda)

Nivo	Z [m]	X [m]	Y [m]
POZ 400	16.29	1.03	16.11
POZ 300	13.49	1.21	21.13
POZ 200	8.92	4.27	17.65
POZ 100	4.57	5.49	13.51

Nihajne dobe konstrukcije

No	T [s]	f [Hz]
1	0.1975	5.0627
2	0.1843	5.4262
3	0.1680	5.9533
4	0.1374	7.2803
5	0.1003	9.9746
6	0.0891	11.2226

Seizmični preračun

Seizmični preračun: EC8 (EN 1998) SLO

Kategorija tal: B
Kategorija pomena: III ($\gamma=1.2$)
Razmerje a/g : 0.17
Koeficient dušenja: 0.05
Slučajna ekscentričnost mase etaže: $e_i = \pm 0.050 \times L_i$

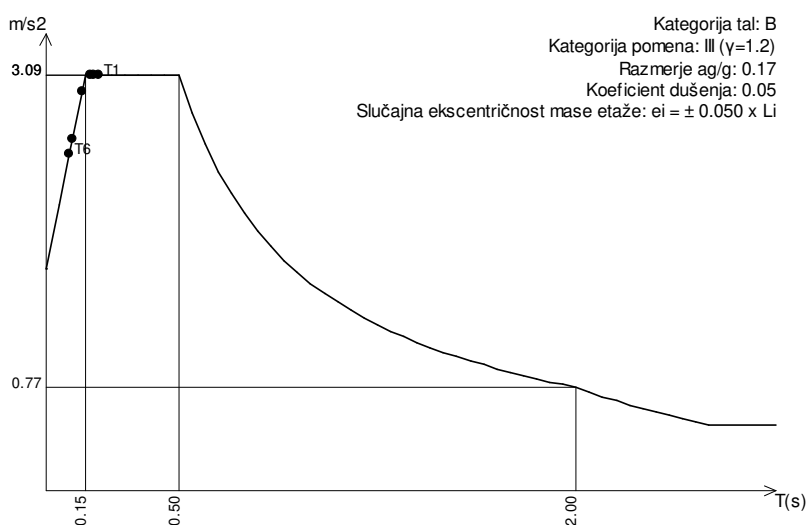
Faktorji smeri potresa:

Obtežni primer	Kot α [°]	k, α	$k, \alpha+90^\circ$	k_z	Faktor Q_i
Sx	0	1.000	0.000	0.000	2.000
Sy	90	1.000	0.000	0.000	2.000

Tip spektra

Obtežni primer	S	T _b	T _c	T _d
Sx	1.200	0.150	0.500	2.000
Sy	1.200	0.150	0.500	2.000

Projektni spekter



Sx (+e)

Nivo	Z [m]	Ton 1			Ton 2			Ton 3		
		Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]
POZ 400	16.29	83.90	-10.47	-2.87	0.74	-0.48	-0.07	64.85	53.57	-0.02
POZ 300	13.49	501.17	-166.97	-4.32	4.74	-4.63	-0.15	299.52	376.68	1.81
POZ 200	8.92	856.14	-373.63	-6.27	8.25	-8.87	-0.00	345.23	612.23	-2.69
POZ 100	4.57	1175.9	-529.51	-62.22	-5.15	-11.56	-0.60	378.51	751.13	-34.26
POZ 000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Σ		2617.1	-1080.58	-75.69	8.58	-25.54	-0.82	1088.1	1793.6	-35.16

Nivo	Z [m]	Ton 4			Ton 5			Ton 6		
		Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]
POZ 400	16.29	46.26	-38.21	-4.47	-8.06	-19.40	-0.60	-69.97	16.87	12.01
POZ 300	13.49	196.27	-170.70	-6.10	-20.15	-135.10	-6.63	-279.93	93.74	24.49
POZ 200	8.92	158.99	-251.58	-2.67	46.15	43.92	-5.42	151.24	5.16	4.70
POZ 100	4.57	142.29	-350.00	-20.43	115.11	374.39	-20.38	954.54	-282.27	53.56
POZ 000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Σ		543.81	-810.50	-33.67	133.05	263.81	-33.03	755.88	-166.50	94.76

Sx (-e)

Nivo	Z [m]	Ton 1			Ton 2			Ton 3		
		Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]
POZ 400	16.29	83.90	-10.47	-2.87	0.74	-0.48	-0.07	64.85	53.57	-0.02
POZ 300	13.49	501.17	-166.97	-4.32	4.74	-4.63	-0.15	299.52	376.68	1.81
POZ 200	8.92	856.14	-373.63	-6.27	8.25	-8.87	-0.00	345.23	612.23	-2.69
POZ 100	4.57	1175.9	-529.51	-62.22	-5.15	-11.56	-0.60	378.51	751.13	-34.26
POZ 000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Σ		2617.1	-1080.58	-75.69	8.58	-25.54	-0.82	1088.1	1793.6	-35.16

Nivo	Z [m]	Ton 4			Ton 5			Ton 6		
		Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]
POZ 400	16.29	46.26	-38.21	-4.47	-8.06	-19.40	-0.60	-69.97	16.87	12.01
POZ 300	13.49	196.27	-170.70	-6.10	-20.15	-135.10	-6.63	-279.93	93.74	24.49
POZ 200	8.92	158.99	-251.58	-2.67	46.15	43.92	-5.42	151.24	5.16	4.70
POZ 100	4.57	142.29	-350.00	-20.43	115.11	374.39	-20.38	954.54	-282.27	53.56
POZ 000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Σ		543.81	-810.50	-33.67	133.05	263.81	-33.03	755.88	-166.50	94.76

Sy (+e)

Nivo	Z [m]	Ton 1			Ton 2			Ton 3		
		Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]
POZ 400	16.29	-34.64	4.32	1.19	-2.22	1.42	0.20	106.89	88.30	-0.04
POZ 300	13.49	-206.93	68.94	1.78	-14.12	13.79	0.44	493.72	620.92	2.98
POZ 200	8.92	-353.49	154.27	2.59	-24.55	26.41	0.01	569.07	1009.2	-4.43
POZ 100	4.57	-485.52	218.63	25.69	15.34	34.42	1.80	623.93	1238.1	-56.47

POZ 000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$\Sigma=$	-1080.58	446.16	31.25	-25.54	76.03	2.45	1793.6	2956.5	-57.96

Nivo	Z [m]	Ton 4			Ton 5			Ton 6		
		Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]
POZ 400	16.29	-68.95	56.95	6.67	-15.98	-38.46	-1.19	15.41	-3.72	-2.65
POZ 300	13.49	-292.52	254.41	9.09	-39.95	-267.88	-13.14	61.66	-20.65	-5.39
POZ 200	8.92	-236.95	374.95	3.98	91.50	87.08	-10.76	-33.31	-1.14	-1.04
POZ 100	4.57	-212.07	521.65	30.44	228.24	742.35	-40.42	-210.26	62.18	-11.80
POZ 000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$\Sigma=$	-810.50	1208.0	50.18	263.81	523.09	-65.50	-166.50	36.68	-20.87

Sy (-e)

Nivo	Z [m]	Ton 1			Ton 2			Ton 3		
		Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]
POZ 400	16.29	-34.64	4.32	1.19	-2.22	1.42	0.20	106.89	88.30	-0.04
POZ 300	13.49	-206.93	68.94	1.78	-14.12	13.79	0.44	493.72	620.92	2.98
POZ 200	8.92	-353.49	154.27	2.59	-24.55	26.41	0.01	569.07	1009.2	-4.43
POZ 100	4.57	-485.52	218.63	25.69	15.34	34.42	1.80	623.93	1238.1	-56.47
POZ 000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$\Sigma=$	-1080.58	446.16	31.25	-25.54	76.03	2.45	1793.6	2956.5	-57.96

Nivo	Z [m]	Ton 4			Ton 5			Ton 6		
		Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]	Px [kN]	Py [kN]	Pz [kN]
POZ 400	16.29	-68.95	56.95	6.67	-15.98	-38.46	-1.19	15.41	-3.72	-2.65
POZ 300	13.49	-292.52	254.41	9.09	-39.95	-267.88	-13.14	61.66	-20.65	-5.39
POZ 200	8.92	-236.95	374.95	3.98	91.50	87.08	-10.76	-33.31	-1.14	-1.04
POZ 100	4.57	-212.07	521.65	30.44	228.24	742.35	-40.42	-210.26	62.18	-11.80
POZ 000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$\Sigma=$	-810.50	1208.0	50.18	263.81	523.09	-65.50	-166.50	36.68	-20.87

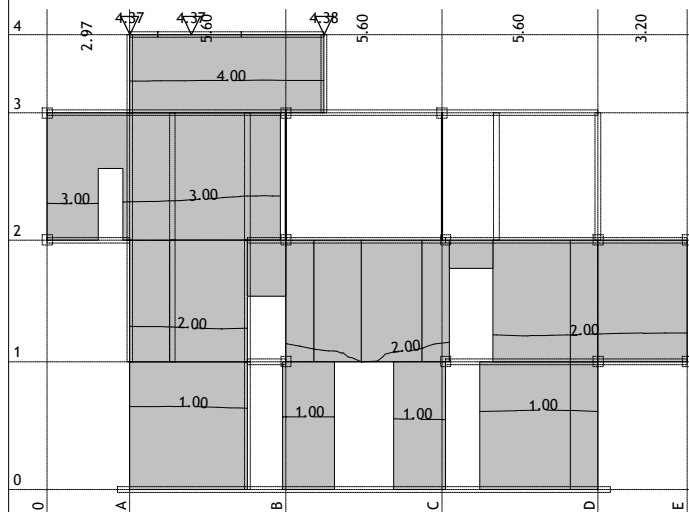
Faktorji participacije - relativno sodelovanje

Ton \ Naziv	1. Sx (+e)	2. Sx (-e)	3. Sy (+e)	4. Sy (-e)
1	0.509	0.509	0.085	0.085
2	0.002	0.002	0.014	0.014
3	0.211	0.211	0.564	0.564
4	0.106	0.106	0.230	0.230
5	0.026	0.026	0.100	0.100
6	0.147	0.147	0.007	0.007

Faktorji participacije - angažiranje mase

Ton	U [$\alpha=0^\circ$]	U [$\alpha=90^\circ$]
1	46.10	7.86
2	0.15	1.32
3	19.51	53.01
4	10.15	22.55
5	2.88	11.32
6	18.19	0.88
ΣU (%)	96.98	96.95

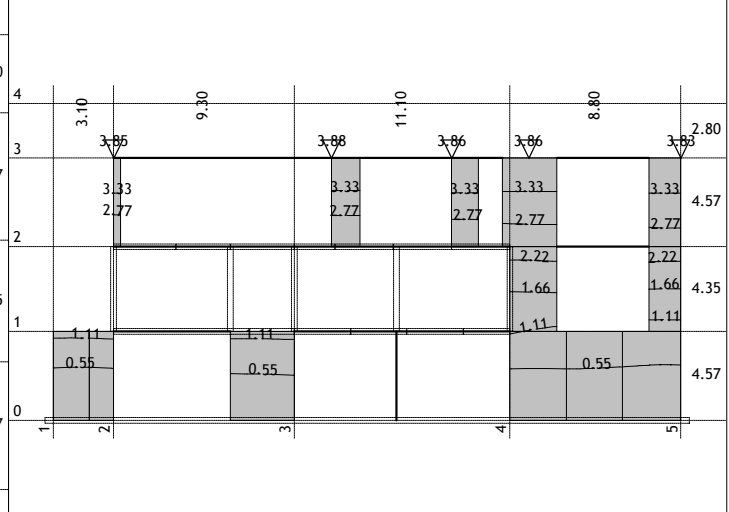
Obt. 23: [Potres X, Y] 12,13



Okvir: H_5

Vplivi v plošči: max Xp= 4.38 / min Xp= 0.00 m / 1000

Obt. 23: [Potres X, Y] 12,13

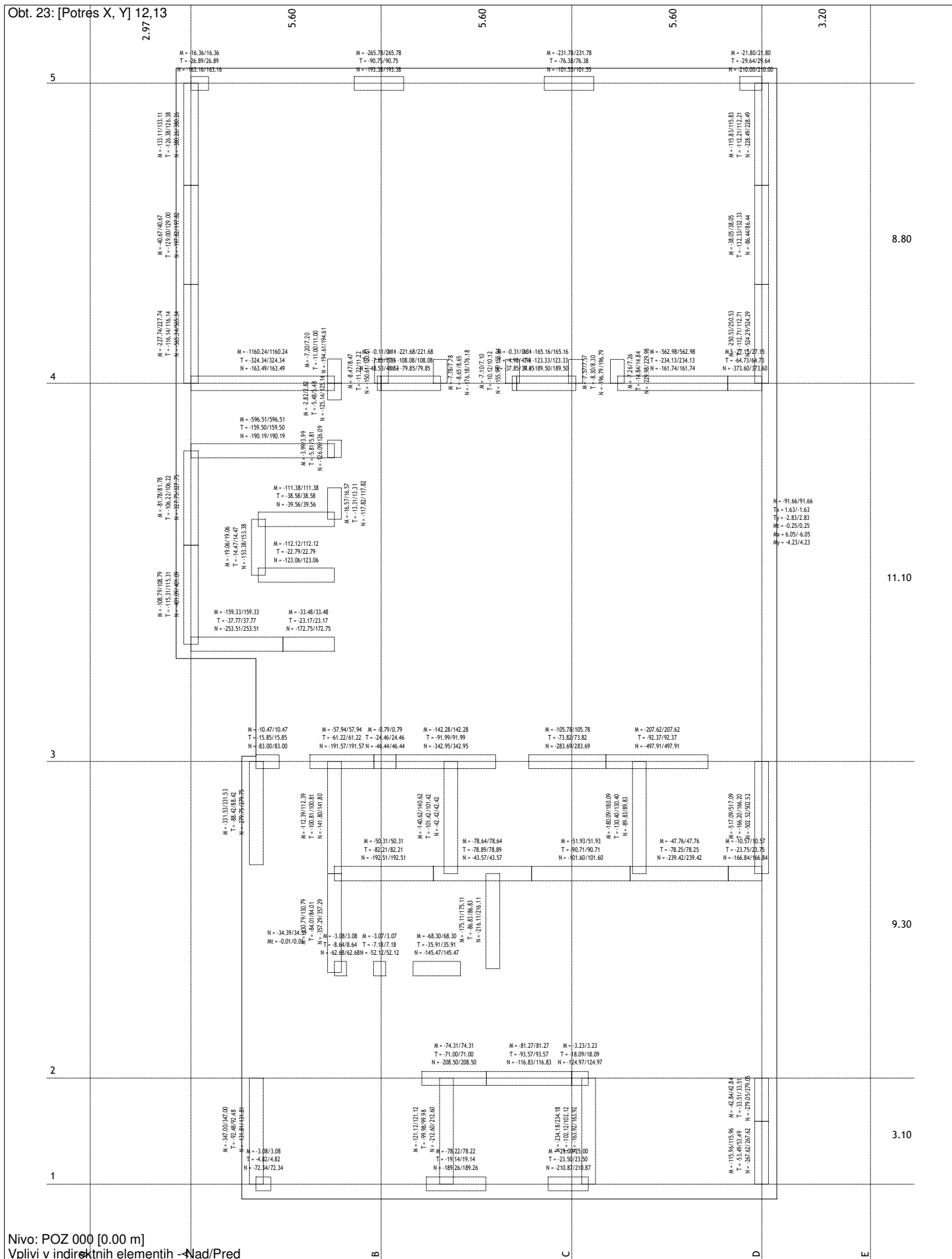


Okvir: V_9

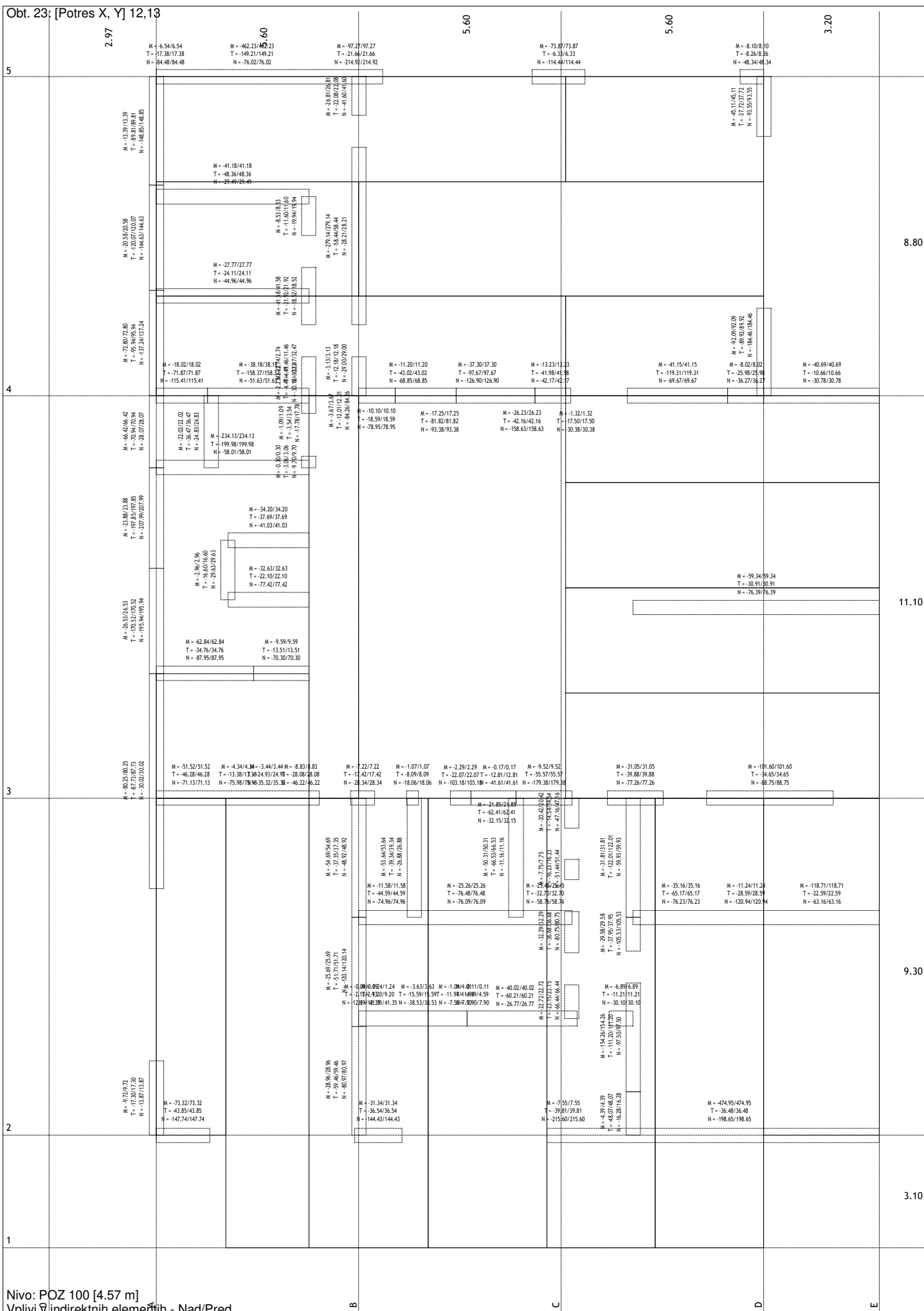
Vplivi v plošči: max Yp= 3.88 / min Yp= 0.00 m / 1000

Statični preračun

Prikaz potresnih obremenitev na stene in stebre po posameznih etažah:

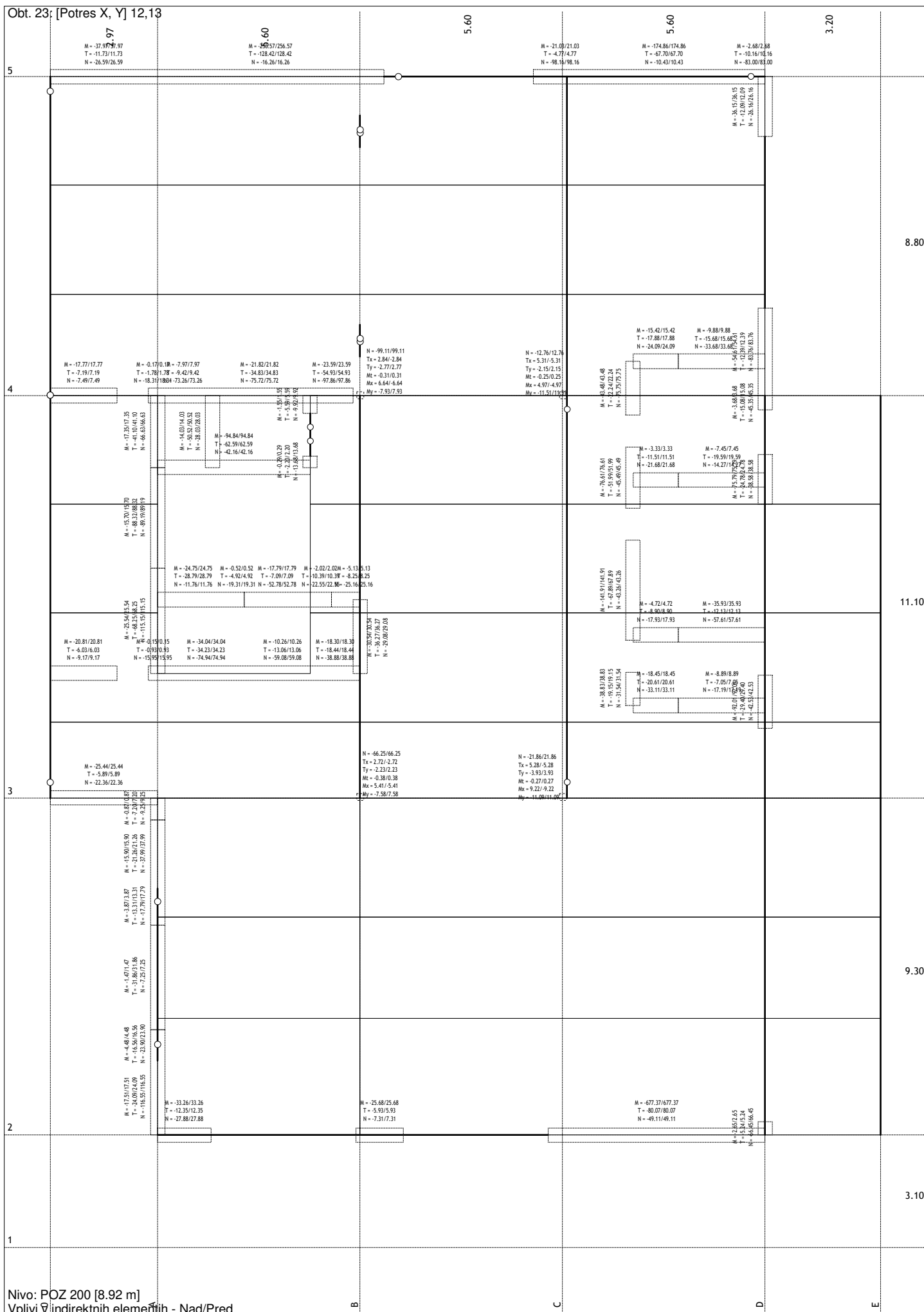


Obt. 23: [Potres X, Y] 12,13



Nivo: POZ 100 [4.57 m]
Vplivi indirektnih elementih - Nad/Pred

Obt. 23: [Potres X, Y] 12,13



Nivo: POZ 200 [8.92 m]
Vplivi indirektnih elementih - Nad/Pred

