

PRILOGA 1C

NASLOVNA STRAN NAČRTA

PODATKI O GRADNJI

naziv gradnje	PRENOVA BRUSNIKOVE DOMAČIJE	
kratek opis gradnje	Predvidena je prenova obstoječe Brusnikove domačije. Obstoječi kamniti temelji se ohranijo in po potrebi sanirajo oziroma dobetonirajo; nove AB talne plošče kleti, svinjaka in pritličja so debeline 15 cm. Nova nosilna konstrukcija pritličja in mansarde je pretežno iz CLT sten debeline 100 mm, medetažna konstrukcija pa iz CLT plošč debeline 140 mm. Predvideni so tudi leseni in jekleni nosilci ter preklade. Ostrešje je leseno s špirovci, grebeni čopa in legami čopa dimenzij 12/22 cm.	
VRSTE GRADNJE	☐	NOVOGRADNJA - NOVOZGRAJEN OBJEKT
označiti vse ustrezne vrste gradnje	☐	NOVOGRADNJA - PRIZIDAVA
	☒	REKONSTRUKCIJA
	☐	SPREMEMBA NAMEMBNOSTI
	☐	ODSTRANITEV CELOTNEGA OBJEKTA
	☐	LEGALIZACIJA
	☐	MANJŠA REKONSTRUKCIJA

PODATKI O PROJEKTNI DOKUMENTACIJI

vrsta dokumentacije	PZI (projektna dokumentacija za izvedbo gradnje)
številka projekta	2024/08

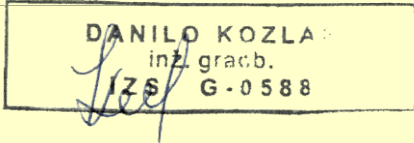
PODATKI O NAČRTU

strokovno področje načrta	2 Načrt s področja gradbeništva
naziv načrta	2.1 - Načrt gradbenih konstrukcij
številka načrta	2024/08-K
datum izdelave	sep 2026
datum spremembe	

PODATKI O PROJEKTANTU NAČRTA

projektant načrta (naziv družbe)	BAU-ING Danilo Kozlar s.p.
naslov	Kotlje 172, 2394 KOTLJE
odgovorna oseba projektanta načrta	Danilo KOZLAR inž. gradb.
podpis odgovorne osebe projektanta načrta	 BAU-ING Danilo Kozlar s.p. Kotlje 172, 2394 KOTLJE

PODATKI O IZDELOVALCU NAČRTA

ime in priimek pooblaščenega arhitekta, pooblaščenega inženirja	Danilo KOZLAR inž. gradb.,
identifikacijska številka	IZS G-0588
podpis pooblaščenega arhitekta, pooblaščenega inženirja	

PRILOGA 2C

IZJAVA PROJEKTANTA NAČRTA IN POOBLAŠČENEGA STOKOVNJAKA, KI JE IZDELAL NAČRT V PZI IN PID

PROJEKTANT NAČRTA

projektant načrta (naziv družbe)	BAU-ING Danilo Kozlar s.p.
naslov	Kotlje 172, 2394 KOTLJE
odgovorna oseba projektanta načrta	Danilo KOZLAR inž. gradb.

IN POOBLAŠČENI STROKOVNJAK, KI JE IZDELAL NAČRT

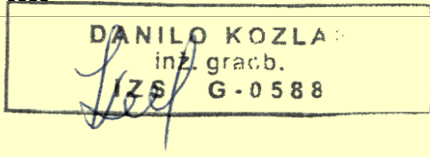
pooblaščen strokovnjak	Danilo KOZLAR inž. gradb.,
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IZJAVLJAVA:

da načrt

vrsta dokumentacije	PZI (projektna dokumentacija za izvedbo gradnje)
strokovno področje načrta	2 Načrt s področja gradbeništva
naziv načrta	2.1 - Načrt gradbenih konstrukcij
številka načrta	8972-8009-K
datum izdelave	oktober, 2025

upošteva relevantne predpise in druge normativne dokumente ter da so upoštevane ustrezne bistvene in druge zahteve.

pooblaščen strokovnjak	Danilo KOZLAR inž. gradb.,
identifikacijska številka	IZS G-0588
podpis pooblaščenega strokovnjaka	

odgovorna oseba projektanta načrta	Danilo KOZLAR inž. gradb.
podpis odgovorne osebe projektanta načrta	

2.1 NAČRT GRADBENIH KONSTRUKCIJ

INVESTITOR: **Občina Prevalje**

Trg 2A, 2391 Prevalje

OBJEKT: **PRENOVA BRUSNIKOVE DOMAČIJE**

VRSTA PROJEKTNE

DOKUMENTACIJE: **PZI**

VRSTA GRADNJE: **REKONSTRUKCIJA**

PROJEKTANT: **BAU-ING Danilo Kozlar s.p.**

Kotlje 172

2394 KOTLJE

ODGOVORNA OSEBA **Danilo KOZLAR inž. gradb.,**

PROJEKTANTA: **IZS G-0558**

ODGOVORNI VODJA **Maruša Zorec univ. dipl. inž. arh.**

PROJEKTA: **ZAPS A-1018**

ŠTEVILKA PROJEKTA: **2024/08**

ŠTEVILKA PROJEKTA: **2024/08-K**

KRAJ IN DATUM IZDELAVE: **Kotlje, sep 2026**

2.2 KAZALO VSEBINE NAČRTA GRADB. KONSTR.

št.: 2024/08-K

- 2.1. Naslovna stran
- 2.2. Kazalo vsebine načrta
- 2.3. Tehnično poročilo
 - 2.3.1. Splošno
 - 2.3.2. Konstrukcija
- 2.4. Obtežbe
- 2.5. Standardi
- 2.6. Statični izračun
- 2.7. Načrti

KAZALO NAČRTOV

- 1.0 Opažni_ pozicijski načrti
 - 1.1.1 AB TEMELJNA PLOŠČA KLETI IN SVINJAKA
 - 1.2.1 PRITLIČJE SIDRANJE PREKLADE STENE NOSICLI
 - 1.3.1 PRITLIČJE SIDRANJE PREKLADE STENE NOSICLI
 - 1.4.1 PRITLIČJE CLT STROP
 - 1.5.1 MANSARDA SIDRANJE STENE PREKLADE
 - 1.6.1 OSTREŠJE
- 2.0. Armaturni načrti
 - 2.1.1. AB TEMELJENJE
- 3.0. Armaturni izvlečki

2.3 TEHNIČNO POROČILO K NAČRTU GRADBENIH KONSTRUKCIJ

2.3.1 Splošno:

Predvidena je prenova obstoječe Brusnikove domačije. Obstoječi kamniti temelji se ohranijo in po potrebi sanirajo oziroma dobetonirajo; nove AB talne plošče kleti, svinjaka in pritličja so debeline 15 cm. Nova nosilna konstrukcija pritličja in mansarde je pretežno iz CLT sten debeline 100 mm, medetažna konstrukcija pa iz CLT plošč debeline 140 mm. Predvideni so tudi leseni in jekleni nosilci ter preklade. Ostrešje je leseno s špirovci, grebeni čopa in legami čopa dimenzij 12/22 cm.

2.3.2 Konstrukcija:

Obravnavani objekt je obstoječa Brusnikova domačija, pri kateri so predvideni konstrukcijski posegi v okviru prenove. Konstrukcija je zasnovana kot kombinacija obstoječih kamnitih temeljev, novih armiranobetonskih talnih plošč, CLT sten in stropnih plošč, lesenih nosilnih elementov ter posameznih jeklenih nosilcev.

Na nivoju kleti in svinjaka sta predvideni novi armiranobetonski talni plošči debeline 15 cm, izvedeni ob obstoječih kamnitih temeljih. Tudi nova AB talna plošča pritličja je debeline 15 cm. Obstoječe temelje je potrebno pred izvedbo pregledati; v kolikor ne bodo ustrezni, se jih sanira. Če nova AB talna plošča pritličja ne bo imela zadostnega naleganja na obstoječe temelje, se temelje ustrezno dobetonira. AB talna plošča pritličja se izvaja po kampadah, katerih velikost se prilagodi dejanskemu stanju na terenu. Pri izvedbi temeljenja je potrebno upoštevati navodila geomehanika. Na planumu temeljne plošče mora biti dosežena vrednost dinamičnega deformacijskega modula $E_{vd} = 45\text{--}50 \text{ MN/m}^2$.

Nova nosilna konstrukcija pritličja je pretežno izvedena iz CLT sten debeline 100 mm, trislojne sestave 30-40-30 mm z zunanjima slojema v vertikalni smeri. Stene se sidrajo z vezmi WHT 15 in WHT 30 ter s strižnimi povezavami Titan N – TCN 200 in kotniki TT1, skladno s pozicijskim načrtom. Vse nove stene pritličja in mansarde morajo biti medsebojno vertikalno poravnane.

Nad odprtinami so predvidene preklade iz CLT elementov debeline 100 mm tipa L3S oziroma lesene preklade C24 prereza 10/20 cm. V pritličju so predvideni tudi jekleni nosilci iz jekla S235, med drugim HEA160 in HEB220.

Medetažna konstrukcija nad pritličjem je izvedena iz pet-slojnih CLT plošč debeline 140 mm v sestavi 40-20-20-20-40 mm. Plošče se povezujejo z nosilnimi stenami in med seboj skladno s pozicijskimi načrti in detajli CLT spojev.

V mansardi so predvidene nove CLT stene debeline 100 mm, trislojne sestave 30-40-30 mm. Preklade stavbnega pohištva so predvidene iz CLT elementov debeline 100 mm tipa L3S. Sidranje stenskih elementov se izvede z vezmi in kotniki skladno s pozicijskim načrtom.

Strešna konstrukcija je lesena. Predvideni so špirovci 12/22 cm, grebeni čopa 12/22 cm in lege čopa 12/22 cm. Spoji, sidranje in izvedba lesenih elementov se izvedejo skladno s pozicijskim načrtom in pripadajočimi detajli.

Za armiranobetonske konstrukcije je predviden beton C25/30 in armatura B500B/S500, za lesene nosilne elemente konstrukcijski les razreda C24, za jeklene elemente pa jeklo S235.

Vse dimenzije, višinske kote in položaje konstrukcijskih elementov je potrebno pred izvedbo preveriti na objektu ter jih uskladiti z arhitekturnimi in ostalimi načrti projekta. Zaradi posegov v obstoječi objekt je potrebno dejansko stanje obstoječih temeljev in nosilnih elementov preveriti med izvedbo. Morebitne spremembe konstrukcije so dovoljene samo s soglasjem odgovornega projektanta gradbenih konstrukcij.

Temeljenje

Temeljenje izvesti na nosilnih peščeno-prodnatih tleh. Modul reakcije tal je predpostavljen med 30-40 MN/m³. Pred temeljenjem je potrebno s strani geomehanika ugotoviti dejansko nosilnost tal, ter ustrezno dimenzionirati temeljenje objekta, v primeru odstopanja od projektnih rešitev, ter predvidenih parametrov! Nosilnost temeljnih tal mora ob izkopu pregledati geomehanik in podati pisno mnenje.

V kolikor je dejanska nosilnost temeljnih tal manjša od predpisane oz. je modul reakcije temeljnih tal manjši od predpisanega v statičnem izračunu, se s strani geomehanika pisno poda predlog temeljenja.

Brez predhodnega obvestila odgovornega projektanta gradbenih konstrukcij in njegovega vpisa v gradbeni dnevnik izvajalca del se konstrukcijskih elementov v nobenem primeru ne sme spreminjati!

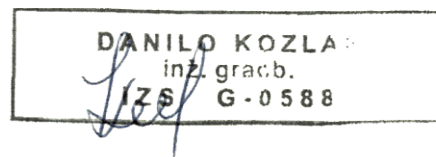
Nosilnost temeljnih tal mora ob izkopu pregledati geomehanik in podati pisno mnenje.

Skladno z 5. členom Pravilnika o mehanski odpornosti in stabilnosti objektov je načrt gradbenih konstrukcij izdelan na podlagi pravil evrokodov.

Kotlje, sep 2026

odgovorni projektant:

Danilo KOZLAR, inž. gradb.



2.4 OBTEŽBE

Upoštevana je lastna teža konstruktivnih elementov s specifično težo. Program sam upošteva obremenitve na podlagi izbranih prereзов konstruktivnih elementov oz. debeline plošč.

STREHA

Lastna teža konstrukcije:

Sloji:	Debelina [m]	Teža [kN/m ³]	Teža [kN/m ²]
Strešna kritina			0,60
Deske, late			0,20
Toplotna izolacija	0,15	0,5	0,08
Fotovoltaika			0,20
Knauf+podkonstrukcija			0,25
Lastna teža nosilne konstrukcije			Program
g (kN/m²) =			1,33

Koristna obtežba:

Kategorija površin	Qk[kN]	qk[kN/m ²]
kat. H - strehe dostopne za normalno vzdrževanje in popravila	1	0,4

TALNA IN MEDETAŽNA KONSTRUKCIJA

Lastna teža konstrukcije:

Sloji:	Debelina [m]	Teža [kN/m ³]	Teža [kN/m ²]
Finalni tlak			0,25
Cementni estrih	0,06	22	1,32
Toplotna izolacija	0,12	0,5	0,06
Lastna teža nosilne konstrukcije			Program
g (kN/m²) =			1,63

Koristne obtežbe:

Kategorija površin	Qk[kN]	qk[kN/m ²]
Kategorija površin - A - tla na splošno	2-3	2,0
Kategorija površin	Qk[kN]	qk[kN/m ²]
Kategorija površin - A - stopnice	2-4	4,0
Kategorija površin	Qk[kN]	qk[kN/m ²]
Kategorija površin - A - balkoni	2	4,0

2.5 STANDARDI, MATERIALI, OBTEŽBE

2.5.1. STANDARDI

Dimenzioniranje nosilnih konstrukcij se izdelava v skladu s skupino standardov Eurocode ter pripadajočimi nacionalnimi dodatki. Krovni standardi so sledeči:

Gradbeni zakon (GZ-1)

Pravilnik o mehanski odpornosti in stabilnosti objektov

SIST EN 1990: Osnove projektiranja konstrukcij

SIST EN 1991: Vplivi na konstrukcije

SIST EN 1992: Projektiranje betonskih konstrukcij

SIST EN 1993: Projektiranje jeklenih konstrukcij

SIST EN 1995: Projektiranje lesenih konstrukcij

SIST EN 1996: Projektiranje zidanih konstrukcij

SIST EN 1997: Geotehnično projektiranje

SIST EN 1998: Projektiranje potresno-odpornih konstrukcij

2.5.1.2. PROJEKTNA ŽIVLJENSKA DOBA OBJEKTA

Konstrukcija bo projektirana tako, da bo zagotovljena življenjska doba 50 let, kar ustreza 4. razredu po SIST EN 1990, preglednica 2.1 (stavbe in druge običajne konstrukcije). Trajnost konstrukcije bo zagotovljena le ob pogoju, da je izvedba kvalitetna, da je zagotovljen monitoring pregledov konstrukcije ter, da se aktivno izvajajo vsa potrebna vzdrževalna dela.

2.5.2. MATERIALI

2.5.2.1. Les

Uporabljeni les je smrekov, trdnostnega razreda C24, z naslednjimi karakterističnimi lastnostmi:

- upogibna trdnost	$f_{m,k} = 24,0 \text{ MPa},$
- natezna trdnost vzporedno z vlakni	$f_{t,0,k} = 14,5 \text{ MPa},$
- natezna trdnost pravokotno na vlakna	$f_{t,90,k} = 0,4 \text{ MPa},$
- tlačna trdnost vzporedno z vlakni	$f_{c,0,k} = 21,0 \text{ MPa},$
- tlačna trdnost pravokotno na vlakna	$f_{c,90,k} = 2,5 \text{ MPa},$
- strižna trdnost	$f_{v,k} = 4,0 \text{ MPa}.$

Srednja vrednost modula elastičnosti je $E_{0,mean} = 1,1 \text{ GPa}.$

2.5.2.2. Beton

Uporabljeni beton je trdnostnega razreda C25/30, z naslednjimi karakterističnimi lastnostmi:

- tlačna trdnost	$f_{c,k} = 25,0 \text{ MPa},$
- natezna trdnost	$f_{c,t,m} = 2,6 \text{ MPa}.$

Modul elastičnosti je $E_{c,m} = 31 \text{ GPa}.$

2.5.2.3. Jeklena armatura

Uporabljena rebrasta in mrežna jeklena armatura sta trdnostnega razreda B500-B, z naslednjimi karakterističnimi lastnostmi:

- trdnost na meji tečenja armature	$f_{y,k} = 50,0 \text{ MPa}.$
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Modul elastičnosti je $E_s = 200 \text{ GPa}.$ Srednja vrednost gostote jekla je $\rho = 7850 \text{ kg/m}^3.$

2.5.2.4. Opečni zidaki

Uporabljeni opečni zidaki so skupine 2, z naslednjimi karakterističnimi lastnostmi:

- uporabljena malta glede na sestavo je malta za splošno uporabo,	
- spoj zidakov: rege, povsem zapolnjene z malto	
- tlačna trdnost zidaka	$f_b = 10,0 \text{ MPa},$
- tlačna trdnost malte	$f_m = 5,0 \text{ MPa}.$

2.5.2.5. Varnostni faktorji materiala

Za dimenzioniranje uporabljamo projektne vrednosti lastnosti materiala, ki jih dobimo tako, da karakteristične vrednosti delimo z delnimi varnostnimi faktorji za material.

Varnostni faktorji materialov, betona, jekla in lesa.

projektna situacija	mejno stanje nosilnosti			mejno stanje uporabnosti		
	beton – γ_C	jeklo – γ_S	les – γ_M	beton – γ_C	jeklo – γ_S	les – γ_M
osnovna	1,50	1,15	1,30	1,00	1,00	1,00
nezgodna	1,20	1,00	1,00	-	-	-

Vsi vgrajeni materiali (jeklene pločevine, jekleni profili, vezna sredstva, beton, jeklo za armiranje, strižni čepi, itd, ...) morajo biti posredovani na trg gradbenih proizvodov v skladu z Zakonom o gradbenih proizvodih (ZGPro-1), Uradni list RS, št. 82/2013.

2.5.3. OBTEŽBE - FAKTORJI IN KOMBINACIJE

2.5.3.1. Varnostni faktorji obtežb

	Mejno stanje nosilnosti		Mejno stanje uporabnosti	
Vpliv	Stalni vpliv g_G	Spremenljivi vpliv g_Q	Stalni vpliv g_G	Spremenljivi vpliv g_Q
Ugoden	1	0	1	0
Neugoden	1,35	1,5	1	1

2.5.3.2. Kombinacijski faktorji obtežb

Vrsta obtežbe	γ_0	γ_1	γ_2
Kategorija A: bivalni prostori	0,7	0,5	0,3
Sneg	0,5	0,2	0
Veter	0,6	0,2	0

2.5.3.3. Obtežne kombinacije v mejnem stanju nosilnosti

projektna situacija	Stalna obtežba	posamezna spremenljiva obtežba		nezgodna ali potresna
		prevladujoča	ostale	
osnovna	$g_G G_k$	$g_{Q1} Q_k$	$g_{Qi} \gamma_{0i} Q_{ki}$	
potresna	G_k		$\gamma_{2i} Q_{ki}$	A_{gD}

Izraz za obremenitev konstrukcije za normalno projektno situacijo se glasi:

$$\sum_{j \geq 1} \gamma_{G,j} G_{k,j} + \gamma_{Q,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i}$$

2.5.3.3. Obtežne kombinacije v mejnem stanju uporabnosti

Kombinacija	Stalna obtežba G_d	Spremenljiva obtežba	
		prevladujoči vpliv	ostali vplivi
karakteristična	G_k	Q_{k1}	$\gamma_{0i} Q_{ki}$
pogosta	G_k	$\gamma_{11} Q_{k1}$	$\gamma_{2i} Q_{ki}$
navidezno stalna	G_k	$\gamma_{21} Q_{k1}$	$\gamma_{2i} Q_{ki}$

Karakteristična

$$\sum_{j \geq 1} G_{kj} + Q_{k1} + \sum_{i > 1} \psi_{0i} Q_{ki}$$

Pogosta

$$\sum_{j \geq 1} G_{kj} + \psi_{11} Q_{k1} + \sum_{i > 1} \psi_{2i} Q_{ki}$$

Navidezno stalna

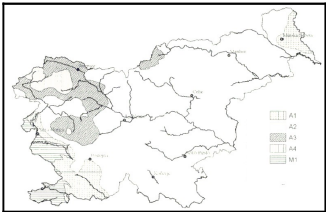
$$\sum_{j \geq 1} G_{kj} + \sum_{i \geq 1} \psi_{2i} Q_{ki}$$

2024/08-K

1. EC1-SNOW-001

SNOW LOAD ON THE GROUND
Eurocode 1 (EC1) Actions on structures, Snow load , EN1991-1-3:2003
(EC1 EN1991-1-3:2003 §4, Annex C)

Climatic region : Slovenia
Snow zone : A2
Altitude above sea level : 695 m



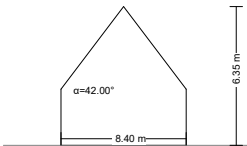
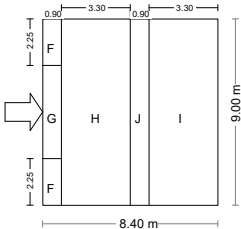
Snow load on the ground
 $S_k=1.293 \times [1+(695/728)^2]=2.471 \text{ kN/m}^2$

2. EC1-WIND-001

WIND PRESSURE ON ROOFS
Eurocode 1 (EC1) Actions on structures, Wind actions , EN1991-1-4:2005

2.1. Duopitch roof

Building height : h= 6.35 m
Building cross wind dimension: b= 9.00 m
Building depth : d= 8.40 m
Pitch angle : $\alpha_1= 42.00^\circ$
Pitch angle : $\alpha_2= 42.00^\circ$



2.2. Reference velocity (EN1991-1-4, §4.2)

vbo=20.00 m/s, Slovenia SIST EN, Zone: 5
vb= Cdir·Cseason·Vbo = 20.00 m/s

2.3. Terrain effects (EN1991-1-4, §4.3.2, Annex A)

Terrain category : II (EN1991-1-4, Tab.4.1)

Area with low vegetation and isolated obstacles (trees, buildings)

Roughness factor Cr(z) (EN1991-1-4, §4.3.2)

Terrain category: II, z=6.350m, zo=0.050m, zmin=2m, zmax:=200m, zoII=0.050m
kr=0.19·(0.050/0.05)^{0.07}=0.190
Cr(z)=kr·ln(z/zo)=0.190xln(6.350/0.050)=0.920

Orography factor Co(z) (EN1991-1-4, §4.3.3)

Co(z)=1.000 (EN1991-1-4, §4.3.3)

Turbulence factor Kt (EN1991-1-4, §4.4)

Kt=1.000

Exposure factor Ce(z) (EN1991-1-4, §4.5)

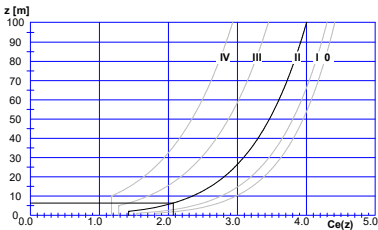
Terrain category: II (EN1991-1-4, Tab.4.1)

z= 6.35 m, kr=0.190, Iv(z)=0.206, Ce(z)= 2.071 (EN1991-1-4, eq.A. 4.8,4.7,4.4,4.3)

q(z)=Ce(z)·(½ρ)·Vb²=[0.001]x2.071x0.625x20.00²=0.518 kN/m²

2.4. Wind peak velocity pressure q(z)=Ce(z)·qb=Ce(z)·(0.625)·Vb² (EN1991-1-4, §4.5)

Vb=20.00m/sec
z=6.350m
Cr(z)=0.920
Co(z)=1.000
Kt=1.000
Ce(z)=2.071

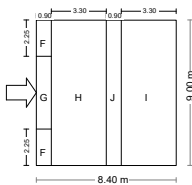


q(z)=Ce(z)·(½ρ)·Vb²
=[0.001]x2.071x0.625x20.00²
= 0.518 kN/m²

2.5. Wind forces on duopitch roof, wind direction: 0.00 (EN1991-1-4, §7.2.5)

Wind pressure coefficients Cpe (EN1991-1-4, Tab. 7.4a)

wind direction: θ=0.00
b=9.00m, d=8.40m, h=6.35m, e=min(b,2h)=9.00m
e/4=2.25m, e/10=0.90m, e/2=4.50m
Pitch angle: α=42.00°



Zone : F, A= 2.72m², Cpe,10=-0.10, Cpe,1=-0.30
Zone : F, A= 2.72m², Cpe,10=+0.70, Cpe,1=+0.70
Zone : G, A= 5.45m², Cpe,10=-0.10, Cpe,1=-0.30
Zone : G, A= 5.45m², Cpe,10=+0.70, Cpe,1=+0.70
Zone : H, A= 39.97m², Cpe,10=-0.04, Cpe,1=-0.04
Zone : H, A= 39.97m², Cpe,10=+0.56, Cpe,1=+0.56
Zone : I, A= 39.97m², Cpe,10=-0.24, Cpe,1=-0.24
Zone : I, A= 39.97m², Cpe,10=+0.00, Cpe,1=+0.00
Zone : J, A= 10.90m², Cpe,10=-0.34, Cpe,1=-0.34
Zone : J, A= 10.90m², Cpe,10=+0.00, Cpe,1=+0.00

Wind pressure on roof surfaces we=q(z)·Cpe=0.518xCpe [kN/m²] (EN1991-1-4, 5.1)

F		G		H		I		J	
we,10	we,1	we,10	we,1	we,10	we,1	we,10	we,1	we,10	we,1
-0.052	-0.155	-0.052	-0.155	-0.021	-0.021	-0.124	-0.124	-0.176	-0.176
+0.362	+0.362	+0.362	+0.362	+0.290	+0.290	+0.000	+0.000	+0.000	+0.000

Wind forces on roof surfaces $Q_e = w_{e,10} \cdot A$ [kN]

	F	G	H	I	J
Q=	-0.141 kN	Q= -0.282 kN	Q= -0.828 kN	Q= -4.967 kN	Q= -1.919 kN
Q=	+0.988 kN	Q= +1.975 kN	Q= +11.589 kN	Q= +0.000 kN	Q= +0.000 kN
Total force on roof surface (sum of all areas) : F1 = -8.3 kN , F = 15.5 kN					
Total moment of roof force around left edge : My1 = -47.4 kNm , My = 42.2 kNm					
Total moment of roof force around top edge : Mx1 = -37.3 kNm , Mx = 69.9 kNm					

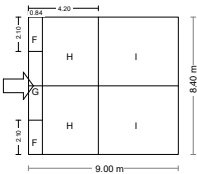
2.6. Wind forces on duopitch roof, wind direction: 90.00

(EN1991-1-4, §7.2.5)

Wind pressure coefficients C_{pe}

(EN1991-1-4, Tab. 7.4a)

wind direction: $\theta = 90.00$
 $b = 8.40\text{m}$, $d = 9.00\text{m}$, $h = 6.35\text{m}$, $e = \min(b, 2h) = 8.40\text{m}$
 $e/4 = 2.10\text{m}$, $e/10 = 0.84\text{m}$, $e/2 = 4.20\text{m}$
Pitch angle: $\alpha = 42.000$



Zone : F, $A = 2.37\text{m}^2$, $C_{pe,10} = -1.10$, $C_{pe,1} = -1.50$
Zone : G, $A = 4.75\text{m}^2$, $C_{pe,10} = -1.40$, $C_{pe,1} = -2.00$
Zone : H, $A = 37.98\text{m}^2$, $C_{pe,10} = -0.88$, $C_{pe,1} = -1.20$
Zone : I, $A = 54.26\text{m}^2$, $C_{pe,10} = -0.50$, $C_{pe,1} = -0.50$

Wind pressure on roof surfaces $w_e = q(z) \cdot C_{pe} = 0.518 \times C_{pe}$ [kN/m²]

(EN1991-1-4, 5.1)

F	G	H	I
$w_{e,10}$ $w_{e,1}$	$w_{e,10}$ $w_{e,1}$	$w_{e,10}$ $w_{e,1}$	$w_{e,10}$ $w_{e,1}$
-0.570 -0.777	-0.725 -1.036	-0.456 -0.621	-0.259 -0.259

Wind forces on roof surfaces $Q_e = w_{e,10} \cdot A$ [kN]

F	G	H	I
Q= -1.352 kN	Q= -3.442 kN	Q= -17.306 kN	Q= -14.047 kN
Total force on roof surface (sum of all areas) : F = -37.5 kN			
Total moment of roof force around left edge : My = -150.9 kNm			
Total moment of roof force around top edge : Mx = -131.6 kNm			

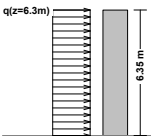
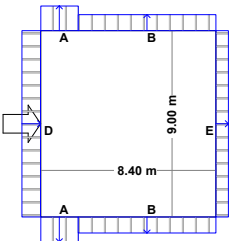
3. EC1-WIND-002

WIND PRESSURE ON VERTICAL WALLS

Eurocode 1 (EC1) Actions on structures, Wind actions , EN1991-1-4:2005

3.1. Rectangular plan building

Building height : $h = 6.35\text{ m}$
Building cross wind dimension: $b = 9.00\text{ m}$
Building depth : $d = 8.40\text{ m}$



3.2. Reference velocity

(EN1991-1-4, §4.2)

vbo=20.00 m/s, Slovenia SIST EN, Zone: 1
vb= Cdir·Cseason·Vbo = 20.00 m/s

3.3. Terrain effects

(EN1991-1-4, §4.3.2, Annex A)

Terrain category : II

(EN1991-1-4, Tab.4.1)

Area with low vegetation and isolated obstacles (trees, buildings)

Roughness factor Cr(z)

(EN1991-1-4, §4.3.2)

Terrain category: II, z=6.350m, zo=0.050m, zmin=2m, zmax:=200m, zoII=0.050m
kr=0.19·(0.050/0.05)^{0.07}=0.190
Cr(z)=kr·ln(z/zo)=0.190xln(6.350/0.050)=0.920

Orography factor Co(z)

(EN1991-1-4, §4.3.3)

Co(z)=1.000

(EN1991-1-4, §4.3.3)

Turbulence factor Kt

(EN1991-1-4, §4.4)

Kt=1.000

Exposure factor Ce(z)

(EN1991-1-4, §4.5)

Terrain category: II

(EN1991-1-4, Tab.4.1)

z= 6.35 m, kr=0.190, Iv(z)=0.206, Ce(z)= 2.071

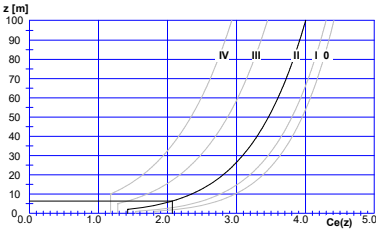
(EN1991-1-4, eq.A. 4.8,4.7,4.4,4.3)

q(z)=Ce(z)·(½ρ)·Vb²=[0.001]x2.071x0.625x20.00²=0.518 kN/m²

3.4. Wind peak velocity pressure q(z)=Ce(z)·qb=Ce(z)·(0.625)·Vb²

(EN1991-1-4, §4.5)

Vb=20.00m/sec
z=6.35m, Cr(z)=0.920, Co(z)=1.000, Kt=1.000
q(z)=Ce(z)·(½ρ)·Vb²=[0.001]Ce(z)x0.625x20.00²kN/m²
c(z)= 2.071
q(z)=[10⁻³]x2.071x0.625x20.00²= 0.52 kN/m²



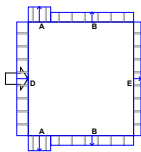
3.5. Wind forces on vertical walls

(EN1991-1-4, §7.2.2)

Wind pressure coefficients Cpe

(EN1991-1-4, Tab.7.1)

h/d=6.35/8.40=0.756, e=9.00m
Zone : A, (1.80xh), Cpe,10=-1.20, Cpe,1=-1.40
Zone : B, (6.60xh), Cpe,10=-0.80, Cpe,1=-1.10
Zone : D, (9.00xh), Cpe,10= 0.80, Cpe,1= 1.00
Zone : E, (9.00xh), Cpe,10=-0.43, Cpe,1=-0.43



Wind pressure on wall surfaces we=q(z)·Cpe [kN/m²]

(EN1991-1-4, 5.1)

	A		B		D		E	
	we,10	we,1	we,10	we,1	we,10	we,1	we,10	we,1
z= 6.35~ 0.00m,	-0.621	-0.725	-0.414	-0.570	0.414	0.518	-0.225	-0.225

Wind forces on wall surfaces Fw=we·A [kN]

			A(1.80m)	B(6.60m)	D(9.00m)	E(9.00m)
	zc[m]	dz[m]	Fw[kN]	Fw[kN]	Fw[kN]	Fw[kN]
z= 6.35~ 0.00m,	3.17	6.35	-7.102	-17.361	23.674	-12.871

Wind forces [kN] on wall surfaces, and moments [kNm] in respect to the base

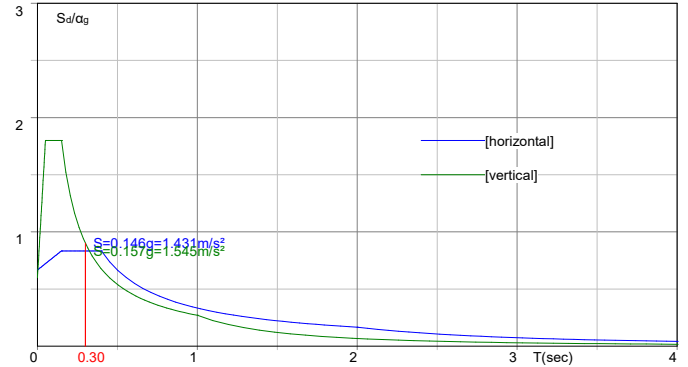
Zone : A, Force $F_w = -7.10$ kN, $z_c = 3.17$ m, Moment $M_w = z_c \cdot F_w = 22.55$ kNm
 Zone : B, Force $F_w = -17.36$ kN, $z_c = 3.17$ m, Moment $M_w = z_c \cdot F_w = 55.12$ kNm
 Zone : D, Force $F_w = 23.67$ kN, $z_c = 3.17$ m, Moment $M_w = z_c \cdot F_w = 75.17$ kNm
 Zone : E, Force $F_w = -12.87$ kN, $z_c = 3.17$ m, Moment $M_w = z_c \cdot F_w = 40.86$ kNm

4. EC8-SPEC-D-001**DESIGN ELASTIC RESPONSE SPECTRUM****4.1. Design (inelastic) response spectrum**

(EC8 EN1998-1-1:2004, §3.2.2.5)

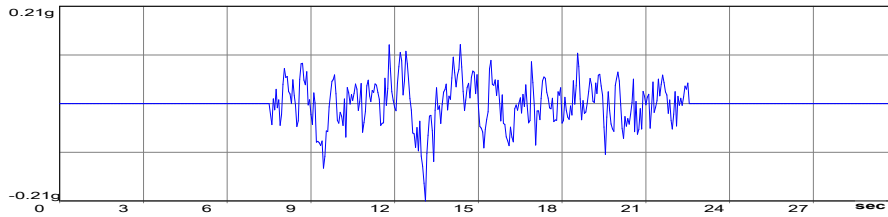
Horizontal acceleration ratio $a_g = 0.175 \times g$
 Soil factor $S = 1.00$
 Behavior factor [horizontal] $q = 3.00$
 Behavior factor [vertical] $q_v = 1.50$
 Vert./horiz. acceleration $a_{vg}/a_g = 0.90$
 $a_{vg} = 0.157 \times g$

Characteristic spectral periods
 [horizontal]
 $T_b = 0.15$ sec
 $T_c = 0.40$ sec
 $T_d = 2.00$ sec
 [vertical]
 $T_{vb} = 0.05$ sec
 $T_{vc} = 0.15$ sec
 $T_{vd} = 1.00$ sec



Ground type:

A- Rock -like geological formations

**4.2. Horizontal design (inelastic) response spectrum $S_d(T)$**

(EC8 EN1998-1-1:2004, Eq.3.13...Eq.3.16)

$0.00 \leq T < 0.15$: $S_d(T) = 0.175 \times 1.00 \times [2/3 + (T/0.15) \times (2.50/3.00 - 2/3)]$, $T=0.00$ $S_d=0.117g$, $T=0.15$ $S_d=0.146g$
 $0.15 \leq T < 0.40$: $S_d(T) = 0.175 \times 1.00 \times (2.50/3.00) = 0.146g$
 $0.40 \leq T < 2.00$: $S_d(T) = 0.175 \times 1.00 \times (2.50/3.00) \times [0.40/T]$, $T=0.40$ $S_d=0.146g$, $T=2.00$ $S_d=0.029g$
 $2.00 \leq T < 4.00$: $S_d(T) = 0.175 \times 1.00 \times (2.50/3.00) \times [0.40 \times 2.00/T^2]$, $T=2.00$ $S_d=0.029g$, $T=4.00$ $S_d=0.007g$

4.3. Vertical design (inelastic) response spectrum $S_{vd}(T)$

(EC8 EN1998-1-1:2004, Eq.3.13...Eq.3.16)

$0.00 \leq T < 0.05$: $S_{vd}(T) = 0.157 \times 1.0 \times [2/3 + (T/0.05) \times (3.00/1.50 - 2/3)]$, $T=0.00$ $S_d=0.105g$, $T=0.05$ $S_d=0.315g$
 $0.05 \leq T < 0.15$: $S_{vd}(T) = 0.157 \times 1.0 \times (3.00/1.50) = 0.315g$
 $0.15 \leq T < 1.00$: $S_{vd}(T) = 0.157 \times 1.0 \times (3.00/1.50) \times [0.15/T]$, $T=0.15$ $S_d=0.315g$, $T=1.00$ $S_d=0.047g$
 $1.00 \leq T < 4.00$: $S_{vd}(T) = 0.157 \times 1.0 \times (3.00/1.50) \times [0.15 \times 1.00/T^2]$, $T=1.00$ $S_d=0.047g$, $T=4.00$ $S_d=0.003g$

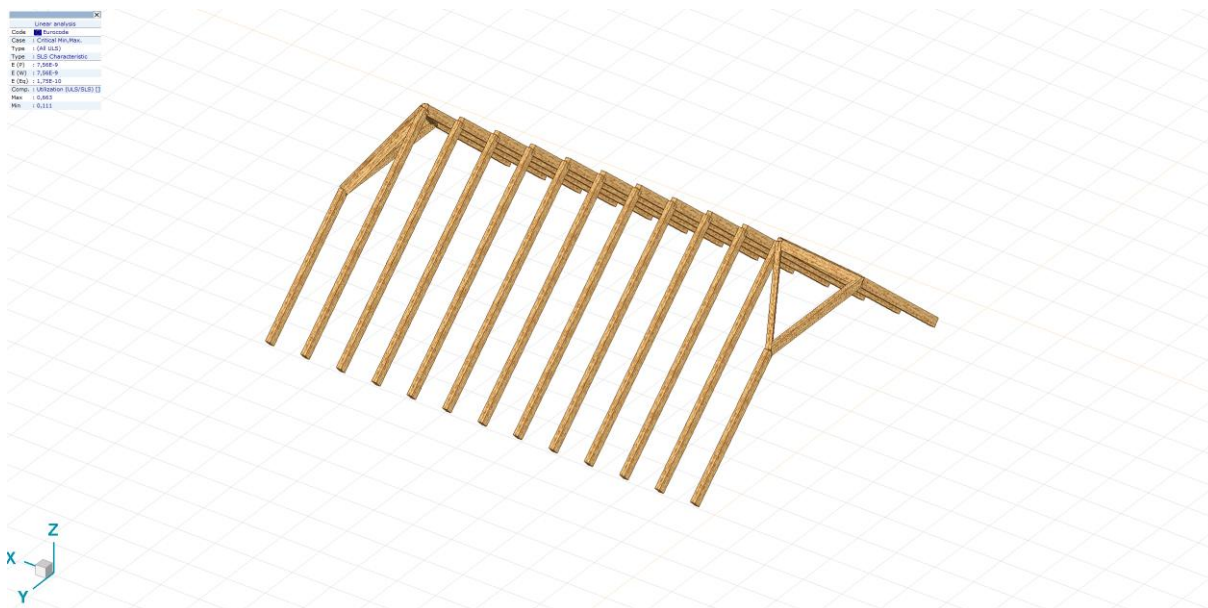
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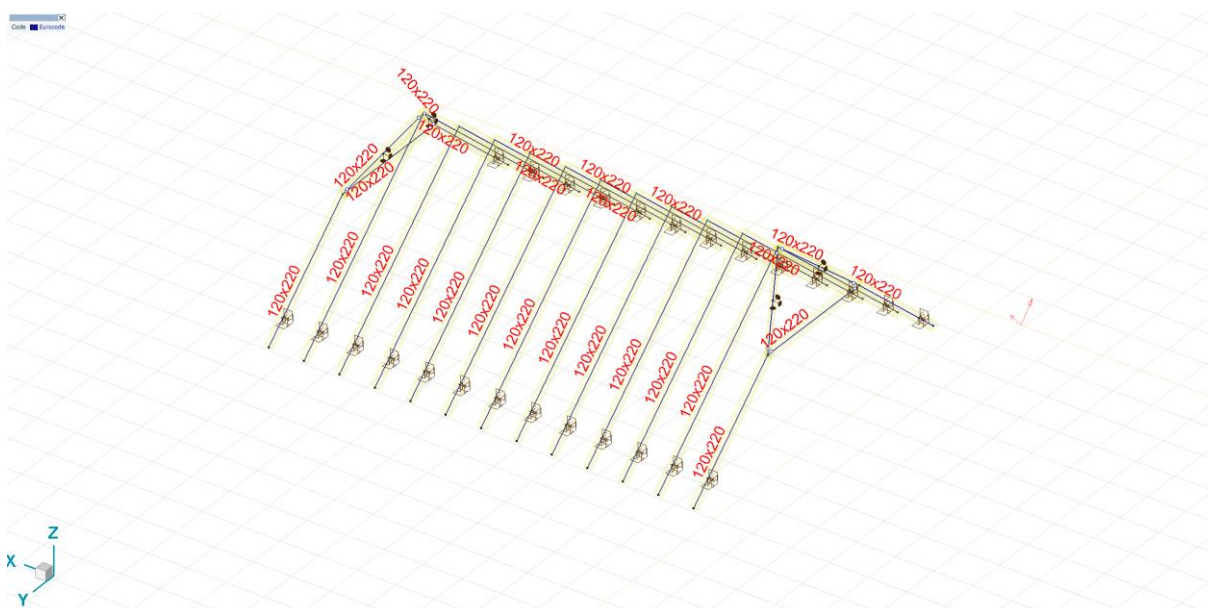
PRENOVA BRUSNIKOVE DOMAČIJE

Model konstrukcije



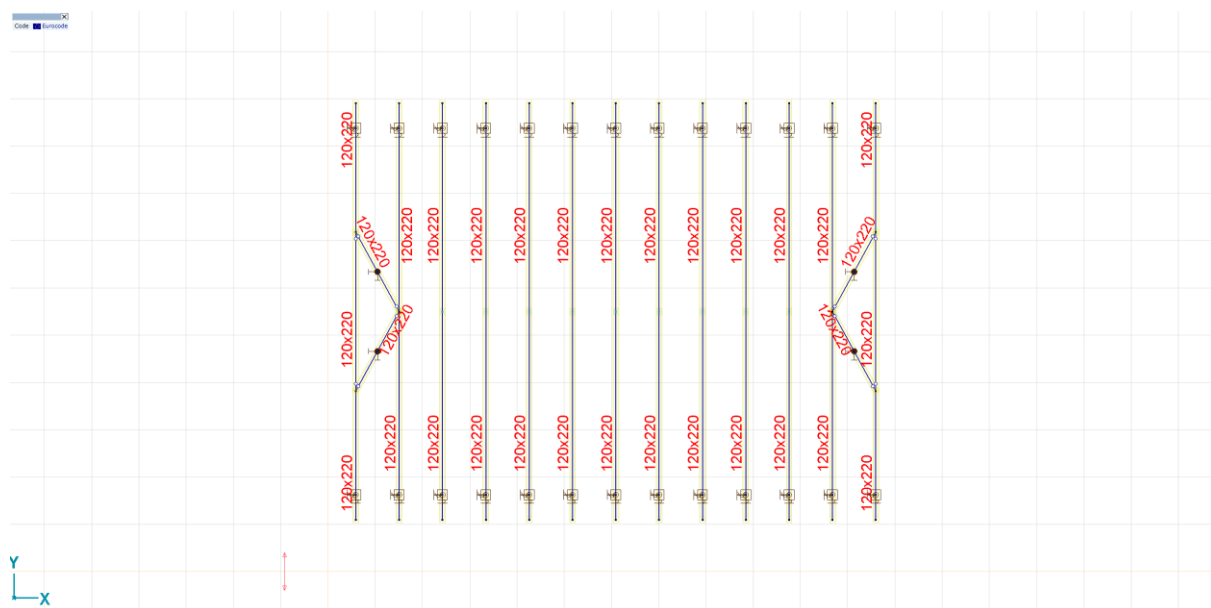
Model konstrukcije

Elementi konstrukcije - 3D pogled



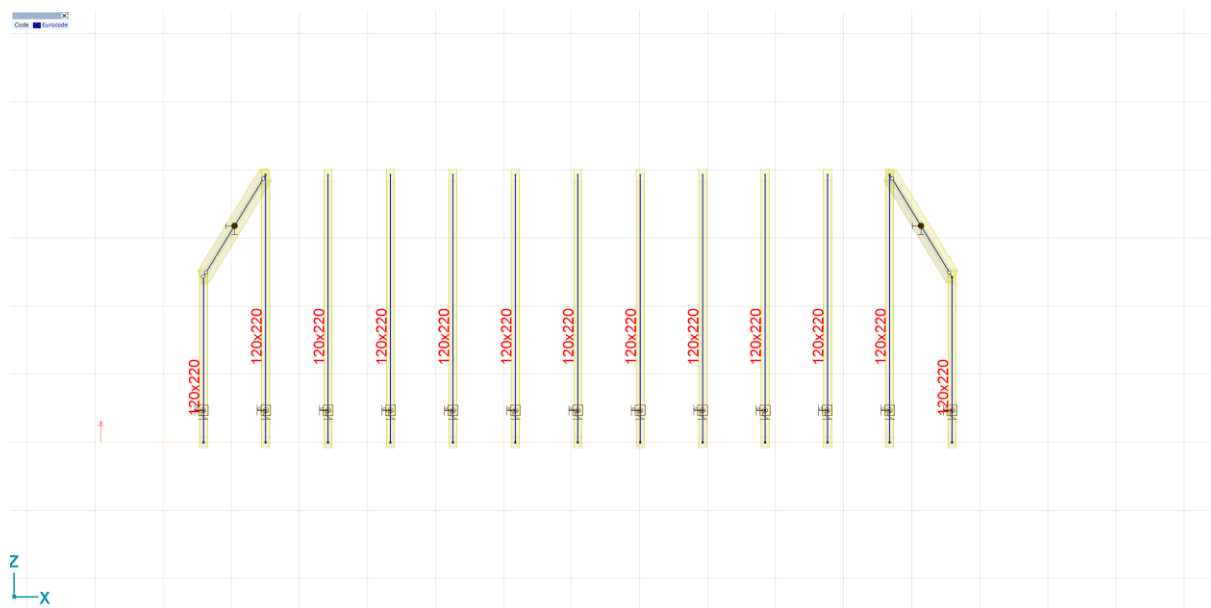
Elementi konstrukcije - 3D pogled

Elementi konstrukcije - tloris



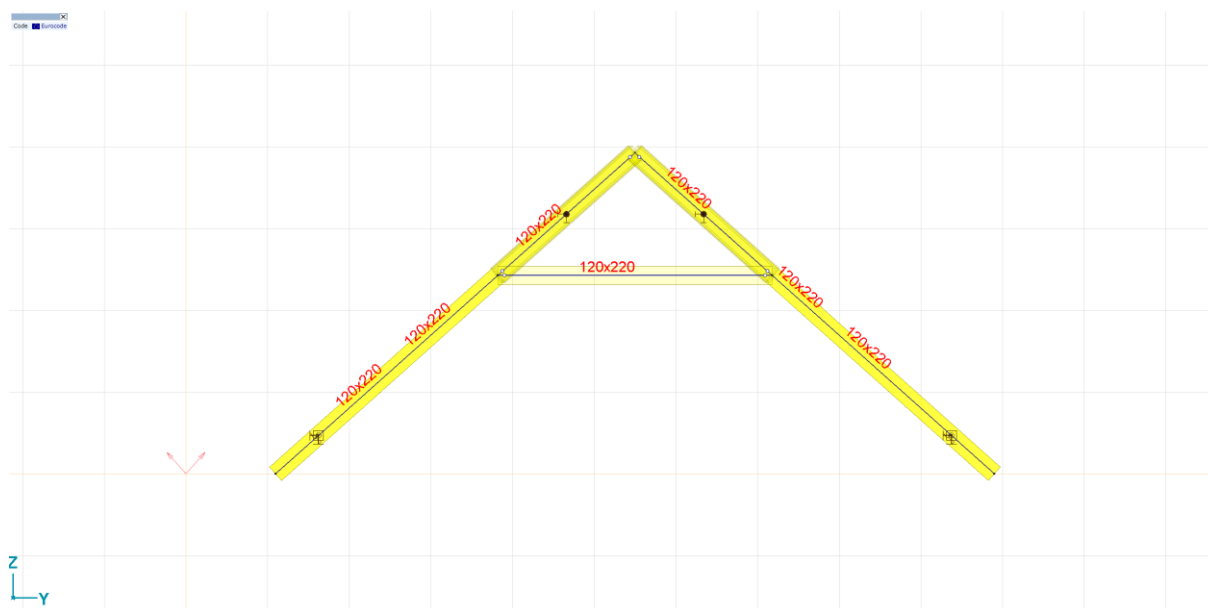
Elementi konstrukcije - tloris

Elementi konstrukcije - vzdolžni pogled



Elementi konstrukcije - vzdolžni pogled

Elementi konstrukcije - prečni pogled



Elementi konstrukcije - Prečni pogled

Uporabljeni materiali

Materials

	Name	Type	National design code	Material code	Model	E _x [N/mm ²]	E _y [N/mm ²]
1	C24	Timber	Eurocode	EN 338:2009	Linear	11000	370

	Name	ν	α _T [1/°C]	ρ [kg/m ³]	Material	Contour	Texture	P ₁	P ₂
1	C24	0,20	8E-6	420			Wood 1	Soft	E _{0,05} [N/mm ²] = 7400

	Name	P ₃	P ₄	P ₅	P ₆
1	C24	G _{mean} [N/mm ²] = 690	f _{mk} [N/mm ²] = 24,00	f _{t0k} [N/mm ²] = 14,00	f _{t90k} [N/mm ²] = 0,40

	Name	P ₇	P ₈	P ₉	P ₁₀	P ₁₁	P ₁₂	P ₁₃	P ₁₄
1	C24	f _{c0k} [N/mm ²] = 21,00	f _{c90k} [N/mm ²] = 2,50	f _{vk} [N/mm ²] = 4,00	k _{cr} = 0,67				

Name: Material name; **Type:** Type of material; **Model:** Material model; **E_x:** Young's modulus of elasticity in local x direction; **E_y:** Young's modulus of elasticity in local y direction; **ν:** Poisson's ratio; **α_T:** Thermal expansion coefficient; **ρ:** Density; **Material:** Material color; **Contour:** Material outline color; **P₁, P₂, P₃, P₄, P₅, P₆, P₇, P₈, P₉, P₁₀, P₁₁, P₁₂, P₁₃, P₁₄:** Design parameter;

Uporabljeni prečni prerezi

Cross-sections

	Name	Drawing	Process	Shape	h [mm]	b [mm]	tw [mm]	tf [mm]	r ₁ [mm]	r ₂ [mm]	r ₃ [mm]
1	120x220		Other	Rect.	220,0	120,0	0	0	0	0	0

	Name	A _x [mm ²]	A _y [mm ²]	A _z [mm ²]	I _x [mm ⁴]	I _y [mm ⁴]	I _z [mm ⁴]	I _{yz} [mm ⁴]	I ₁ [mm ⁴]	I ₂ [mm ⁴]	α [°]
1	120x220	26400,00	22000,00	22000,00	8,3429E+7	1,0648E+8	3,168E+7	0	1,0648E+8	3,168E+7	0

	Name	I _ω [mm ⁶]	W _{1,elt} [mm ³]	W _{1,elb} [mm ³]	W _{2,elt} [mm ³]	W _{2,elb} [mm ³]	W _{1,pl} [mm ³]	W _{2,pl} [mm ³]	i _y [mm]	i _z [mm]
1	120x220	3,8503E+10	968000,0	968000,0	527999,9	527999,9	1452000,0	792000,0	63,5	34,6

	Name	H _y [mm]	H _z [mm]	y _G [mm]	z _G [mm]	y _s [mm]	z _s [mm]	β _y [mm]	β _z [mm]	β _w [mm]	S.p.
1	120x220	120,0	220,0	60,0	110,0	0	0	0	0	0	5

Name: Cross-section name; **Process:** Manufacturing process; **h:** Cross-section height; **b:** Cross-section width; **tw:** Web thickness; **tf:** Flange thickness; **r₁, r₂, r₃:** Rounding radius; **A_x:** Cross-section area; **A_y, A_z:** Shear area; **I_x:** Torsional inertia; **I_y, I_z:** Flexural inertia; **I_{yz}:** Centrifugal inertia; **I₁, I₂:** Principal flexural inertia; **α:** Principal directions; **I_ω:** Warping constant; **W_{1,elt}, W_{1,elb}, W_{2,elt}, W_{2,elb}:** Elastic section modulus; **W_{1,pl}, W_{2,pl}:** Plastic section modulus; **i_y, i_z:** Radius of inertia; **H_y:** Dimension in local y direction; **H_z:** Dimension in local z direction; **y_G:** y coordinate of the center of gravity; **z_G:** z coordinate of the center of gravity; **y_s:** y coordinate of the shear (torsion) center relative to the center of gravity; **z_s:** z coordinate of the shear (torsion) center relative to the center of gravity; **β_y, β_z, β_w:** Wagner's coefficient; **S.p.:** Stress calculation points;

2024/08-K (Ostrešje)

PRENOVA BRUSNIKOVE DOMAČIJE

Obtežbe

G: Beam self weight

	Σ [kg]
1-62	1783,181
Total	1783,181

Σ : Total mass;

Stalna: Domain area load

	Element	Index	Direction	Type	In hole	Comp.	Value [kN/m ²]
	Panel	1	Global	Constant	no	pX =	0
						pY =	0
						pZ =	-1,40
	Panel	2	Global	Constant	no	pX =	0
						pY =	0
						pZ =	-1,40
	Panel	3	Global	Constant	no	pX =	0
						pY =	0
						pZ =	-1,40
	Panel	4	Global	Constant	no	pX =	0
						pY =	0
						pZ =	-1,40

In hole: Loads allowed on holes; **Comp.:** Component; **Value:** Load component value;

Koristna: Domain area load

	Element	Index	Direction	Type	In hole	Comp.	Value [kN/m ²]
	Panel	1	Global	Constant	no	pX =	0
						pY =	0
						pZ =	-0,40
	Panel	2	Global	Constant	no	pX =	0
						pY =	0
						pZ =	-0,40
	Panel	3	Global	Constant	no	pX =	0
						pY =	0
						pZ =	-0,40
	Panel	4	Global	Constant	no	pX =	0
						pY =	0
						pZ =	-0,40

In hole: Loads allowed on holes; **Comp.:** Component; **Value:** Load component value;

Snow load parameters

s_k [kN/m ²]	$\mu_1(0^\circ)$ [-]
2,50	0,800

s_k : Characteristic value of snow load on the ground; $\mu_1(0^\circ)$: Base value of the load shape coefficient;

Wind load parameters [Streha]

Direction	Terrain category	z_0 [m]	z_{min} [m]	c_{dir} []	I_v []	v_m [m/s]	q_p [kN/m ²]	ϕ [°]
X+	III	0,300	5,000	1,000	0,355	12,1	0,32	0
X-	III	0,300	5,000	1,000	0,355	12,1	0,32	0
Y+	III	0,300	5,000	1,000	0,355	12,1	0,32	90
Y-	III	0,300	5,000	1,000	0,355	12,1	0,32	90
$v_{b0} = 20,0$ m/s								
$c_{season} = 1,000$								

2024/08-K (Ostrešje)

PRENOVA BRUSNIKOVE DOMAČIJE

Direction	Terrain category	z_0 [m]	z_{min} [m]	c_{dir} []	I_v []	v_m [m/s]	q_p [kN/m ²]	ϕ [°]
$c_o = 1,000$								
$c_s c_d = 1,000$								
$p = 0,020$								

z_0 , z_{min} : Terrain parameter; c_{dir} : Directional factor; I_v : Turbulence factor; v_m : Design wind speed; q_p : Maximum wind pressure; ϕ : Wind direction relative to the ridge;

Wind load case parameters, [Streha], Wind [Streha] X+.Ps.O

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	0,700	0	0,22	0	0,22
F2	3,928	58,6	0,700	0	0,22	0	0,22
G1	3,928	58,6	0,700	0	0,22	0	0,22
G2	3,928	58,6	0,700	0	0,22	0	0,22
H1	3,928	58,6	0,690	0	0,22	0	0,22
H2	3,928	58,6	0,690	0	0,22	0	0,22
I1	3,928	58,6	-0,200	0	-0,06	0	-0,06
I2	3,928	58,6	-0,200	0	-0,06	0	-0,06
J	3,928	58,6	-0,300	0	-0,10	0	-0,10

z : Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w : Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] X+.Ps.P

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	0,700	0,200	0,22	0,06	0,16
F2	3,928	58,6	0,700	0,200	0,22	0,06	0,16
G1	3,928	58,6	0,700	0,200	0,22	0,06	0,16
G2	3,928	58,6	0,700	0,200	0,22	0,06	0,16
H1	3,928	58,6	0,690	0,200	0,22	0,06	0,16
H2	3,928	58,6	0,690	0,200	0,22	0,06	0,16
I1	3,928	58,6	-0,200	0,200	-0,06	0,06	-0,13
I2	3,928	58,6	-0,200	0,200	-0,06	0,06	-0,13
J	3,928	58,6	-0,300	0,200	-0,10	0,06	-0,16

z : Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w : Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] X+.Ps.S

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	0,700	-0,300	0,22	-0,10	0,32
F2	3,928	58,6	0,700	-0,300	0,22	-0,10	0,32
G1	3,928	58,6	0,700	-0,300	0,22	-0,10	0,32
G2	3,928	58,6	0,700	-0,300	0,22	-0,10	0,32
H1	3,928	58,6	0,690	-0,300	0,22	-0,10	0,32
H2	3,928	58,6	0,690	-0,300	0,22	-0,10	0,32
I1	3,928	58,6	-0,200	-0,300	-0,06	-0,10	0,03
I2	3,928	58,6	-0,200	-0,300	-0,06	-0,10	0,03
J	3,928	58,6	-0,300	-0,300	-0,10	-0,10	0

z : Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w : Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] X-.Ps.O

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	0,700	0	0,22	0	0,22
F2	3,928	58,6	0,700	0	0,22	0	0,22
G1	3,928	58,6	0,700	0	0,22	0	0,22
G2	3,928	58,6	0,700	0	0,22	0	0,22
H1	3,928	58,6	0,690	0	0,22	0	0,22

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Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
H2	3,928	58,6	0,690	0	0,22	0	0,22
I1	3,928	58,6	-0,200	0	-0,06	0	-0,06
I2	3,928	58,6	-0,200	0	-0,06	0	-0,06
J	3,928	58,6	-0,300	0	-0,10	0	-0,10

z: Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w: Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] X-.Ps.P

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	0,700	0,200	0,22	0,06	0,16
F2	3,928	58,6	0,700	0,200	0,22	0,06	0,16
G1	3,928	58,6	0,700	0,200	0,22	0,06	0,16
G2	3,928	58,6	0,700	0,200	0,22	0,06	0,16
H1	3,928	58,6	0,690	0,200	0,22	0,06	0,16
H2	3,928	58,6	0,690	0,200	0,22	0,06	0,16
I1	3,928	58,6	-0,200	0,200	-0,06	0,06	-0,13
I2	3,928	58,6	-0,200	0,200	-0,06	0,06	-0,13
J	3,928	58,6	-0,300	0,200	-0,10	0,06	-0,16

z: Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w: Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] X-.Ps.S

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	0,700	-0,300	0,22	-0,10	0,32
F2	3,928	58,6	0,700	-0,300	0,22	-0,10	0,32
G1	3,928	58,6	0,700	-0,300	0,22	-0,10	0,32
G2	3,928	58,6	0,700	-0,300	0,22	-0,10	0,32
H1	3,928	58,6	0,690	-0,300	0,22	-0,10	0,32
H2	3,928	58,6	0,690	-0,300	0,22	-0,10	0,32
I1	3,928	58,6	-0,200	-0,300	-0,06	-0,10	0,03
I2	3,928	58,6	-0,200	-0,300	-0,06	-0,10	0,03
J	3,928	58,6	-0,300	-0,300	-0,10	-0,10	0

z: Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w: Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] Y+.S.O

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	-1,100	0	-0,35	0	-0,35
F2	3,928	58,6	-1,100	0	-0,35	0	-0,35
G	3,928	58,6	-1,219	0	-0,39	0	-0,39
H1	3,928	58,6	-0,810	0	-0,26	0	-0,26
H2	3,928	58,6	-0,810	0	-0,26	0	-0,26
I1	3,928	58,6	-0,500	0	-0,16	0	-0,16
I2	3,928	58,6	-0,500	0	-0,16	0	-0,16

z: Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w: Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] Y+.S.P

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	-1,100	0,200	-0,35	0,06	-0,42
F2	3,928	58,6	-1,100	0,200	-0,35	0,06	-0,42
G	3,928	58,6	-1,219	0,200	-0,39	0,06	-0,45
H1	3,928	58,6	-0,810	0,200	-0,26	0,06	-0,32
H2	3,928	58,6	-0,810	0,200	-0,26	0,06	-0,32
I1	3,928	58,6	-0,500	0,200	-0,16	0,06	-0,22

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Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
I2	3,928	58,6	-0,500	0,200	-0,16	0,06	-0,22

z: Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w: Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] Y+.S.S

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	-1,100	-0,300	-0,35	-0,10	-0,26
F2	3,928	58,6	-1,100	-0,300	-0,35	-0,10	-0,26
G	3,928	58,6	-1,219	-0,300	-0,39	-0,10	-0,29
H1	3,928	58,6	-0,810	-0,300	-0,26	-0,10	-0,16
H2	3,928	58,6	-0,810	-0,300	-0,26	-0,10	-0,16
I1	3,928	58,6	-0,500	-0,300	-0,16	-0,10	-0,06
I2	3,928	58,6	-0,500	-0,300	-0,16	-0,10	-0,06

z: Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w: Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] Y-.S.O

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	-1,100	0	-0,35	0	-0,35
F2	3,928	58,6	-1,100	0	-0,35	0	-0,35
G	3,928	58,6	-1,219	0	-0,39	0	-0,39
H1	3,928	58,6	-0,810	0	-0,26	0	-0,26
H2	3,928	58,6	-0,810	0	-0,26	0	-0,26
I1	3,928	58,6	-0,500	0	-0,16	0	-0,16
I2	3,928	58,6	-0,500	0	-0,16	0	-0,16

z: Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w: Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] Y-.S.P

Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	-1,100	0,200	-0,35	0,06	-0,42
F2	3,928	58,6	-1,100	0,200	-0,35	0,06	-0,42
G	3,928	58,6	-1,219	0,200	-0,39	0,06	-0,45
H1	3,928	58,6	-0,810	0,200	-0,26	0,06	-0,32
H2	3,928	58,6	-0,810	0,200	-0,26	0,06	-0,32
I1	3,928	58,6	-0,500	0,200	-0,16	0,06	-0,22
I2	3,928	58,6	-0,500	0,200	-0,16	0,06	-0,22

z: Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w: Resultant wind pressure;

Wind load case parameters, [Streha], Wind [Streha] Y-.S.S

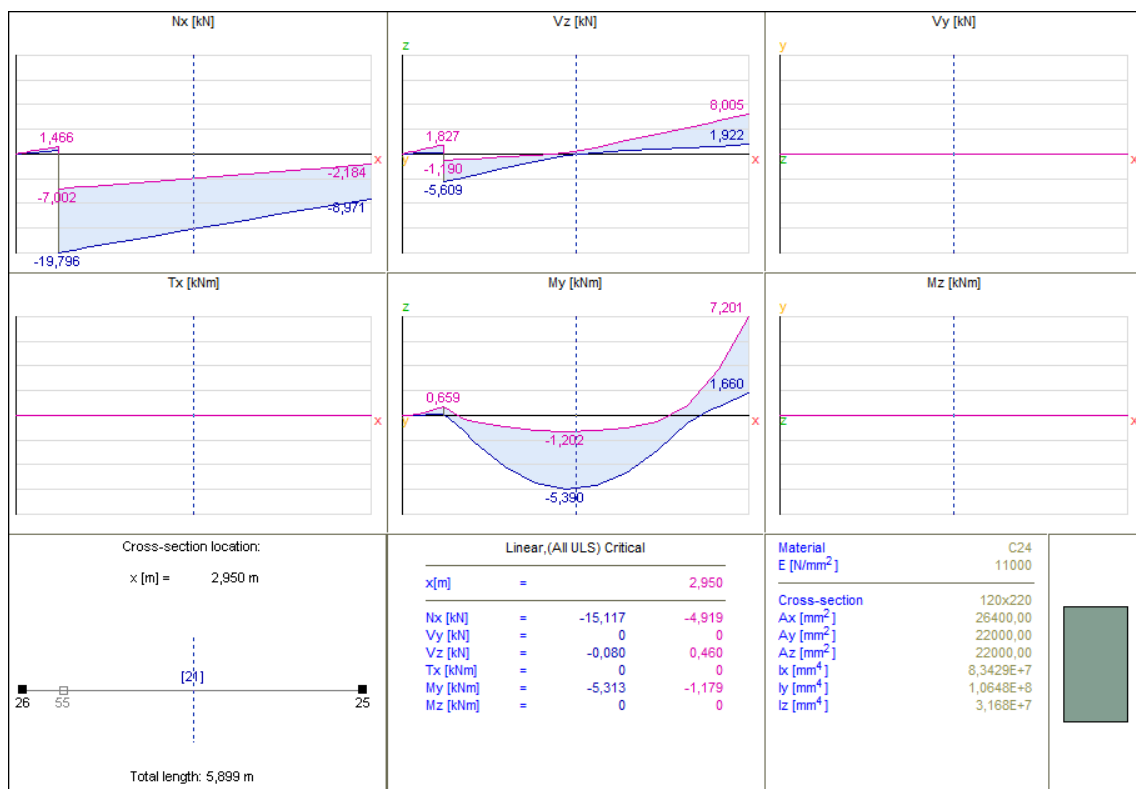
Zone	z [m]	α [°]	c_{pe}	c_{pi}	w_e [kN/m ²]	w_i [kN/m ²]	w [kN/m ²]
F1	3,928	58,6	-1,100	-0,300	-0,35	-0,10	-0,26
F2	3,928	58,6	-1,100	-0,300	-0,35	-0,10	-0,26
G	3,928	58,6	-1,219	-0,300	-0,39	-0,10	-0,29
H1	3,928	58,6	-0,810	-0,300	-0,26	-0,10	-0,16
H2	3,928	58,6	-0,810	-0,300	-0,26	-0,10	-0,16
I1	3,928	58,6	-0,500	-0,300	-0,16	-0,10	-0,06
I2	3,928	58,6	-0,500	-0,300	-0,16	-0,10	-0,06

z: Elevation of the zone; α : Angle of the roof; c_{pe} : External pressure factor; c_{pi} : Internal pressure coefficient; w_e : External wind pressure; w_i : Internal wind pressure; w: Resultant wind pressure;

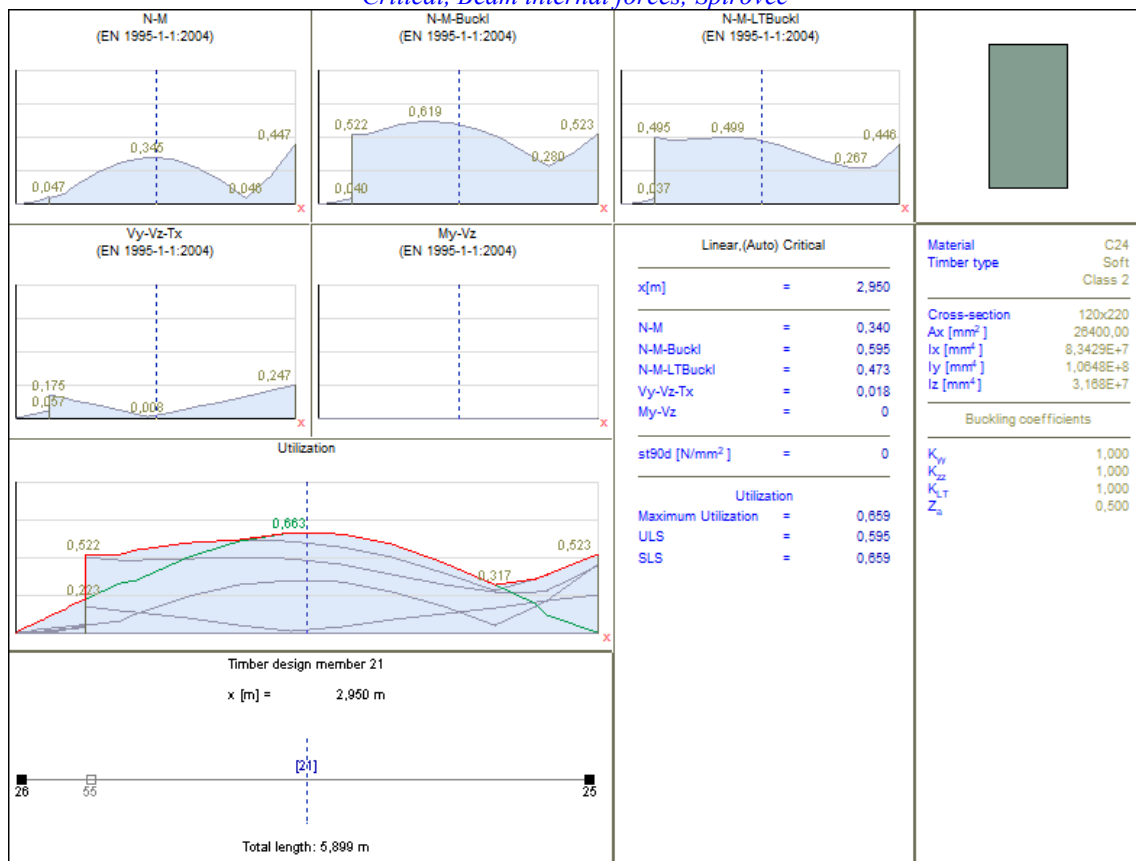
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Špirovec



Critical, Beam internal forces, Špirovec

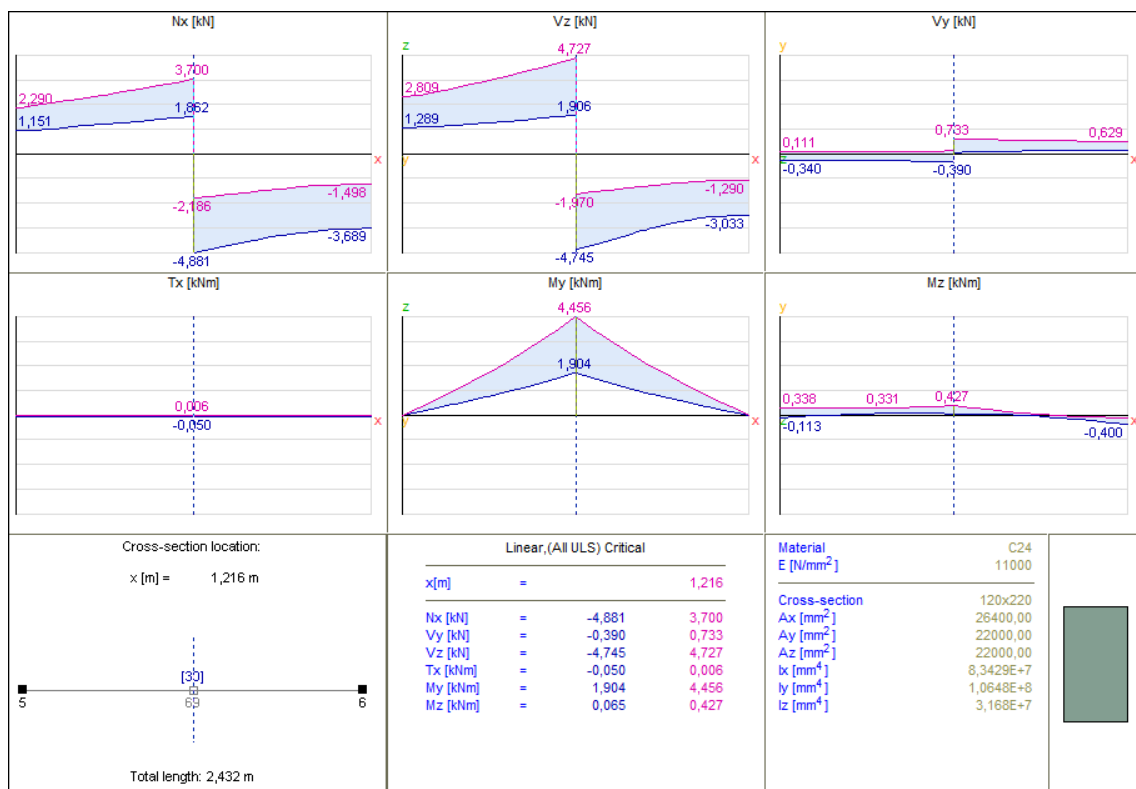


Critical, Utilization, Špirovec

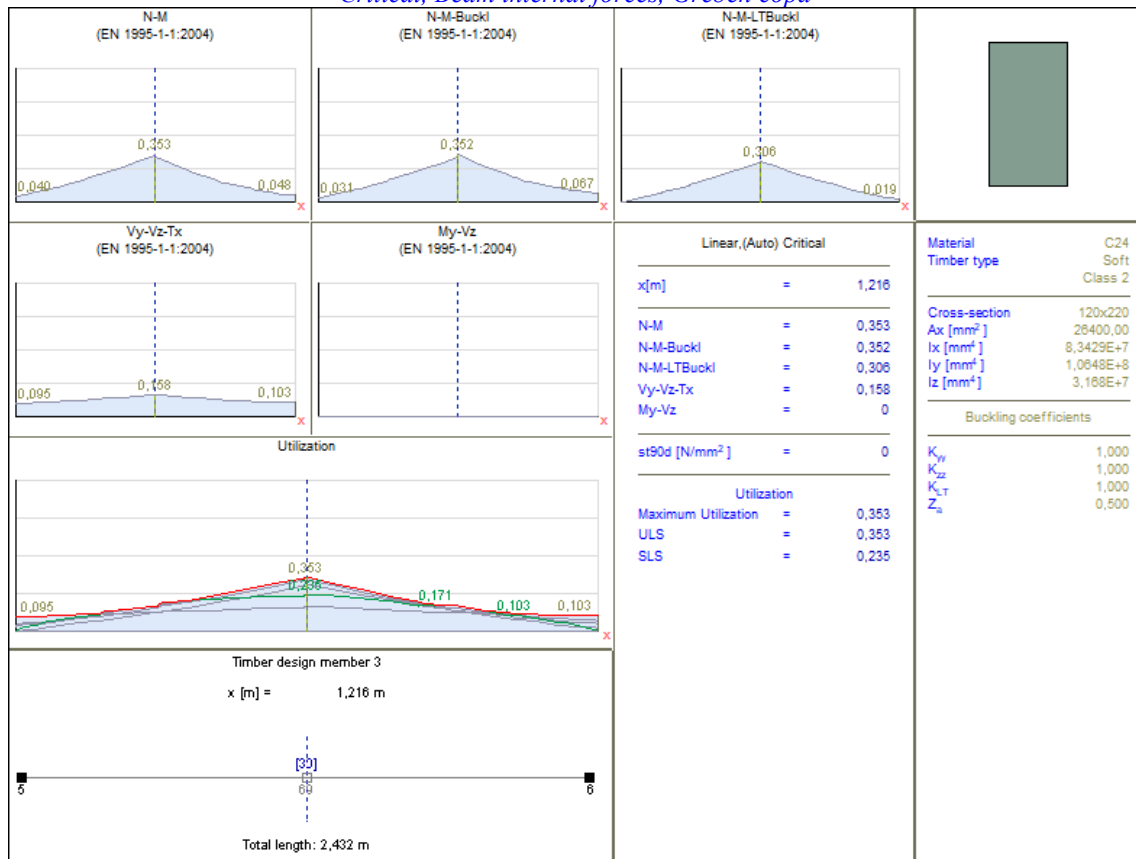
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PRENOVA BRUSNIKOVE DOMAČIJE

Greben čopa



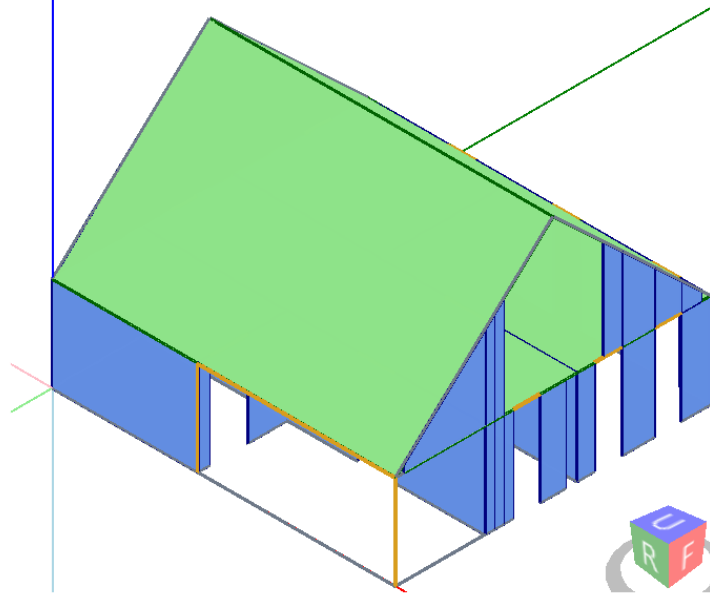
Critical, Beam internal forces, Greben čopa



Critical, Utilization, Greben čopa

TECHNICAL DESIGN CALCULATION REPORT

Design of Timber Structures



Project: 2024/08-K

Client:

Občina Prevalje, Trg 2A. 2391 Prevalje

Date: September, 2026

Design codes and standards

The analysis are done according to: Eurocodes.

1. EN 1990 – Eurocode 0

Basis of structural design

2. EN 1993-1-1 – Eurocode 3

Design of steel structures - Part 1-1: General rules and rules for buildings

3. EN 1993-1-5 – Eurocode 3

Design of steel structures - Part 1-5: Plated structural elements

4. EN 1993-1-8 – Eurocode 3

Design of steel structures - Part 1-8: Design of joints

5. EN 1995-1-1 – Eurocode 5

Design of timber structures - Part 1-1: General - Common rules and rules for buildings

6. EN 1995-1-2 – Eurocode 5

Design of timber structures - Part 1-2: General – Structural fire design

7. EN 1998-1-1 – Eurocode 8

Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings

8. EN 338

Structural timber - Strength classes

9. EN 14080

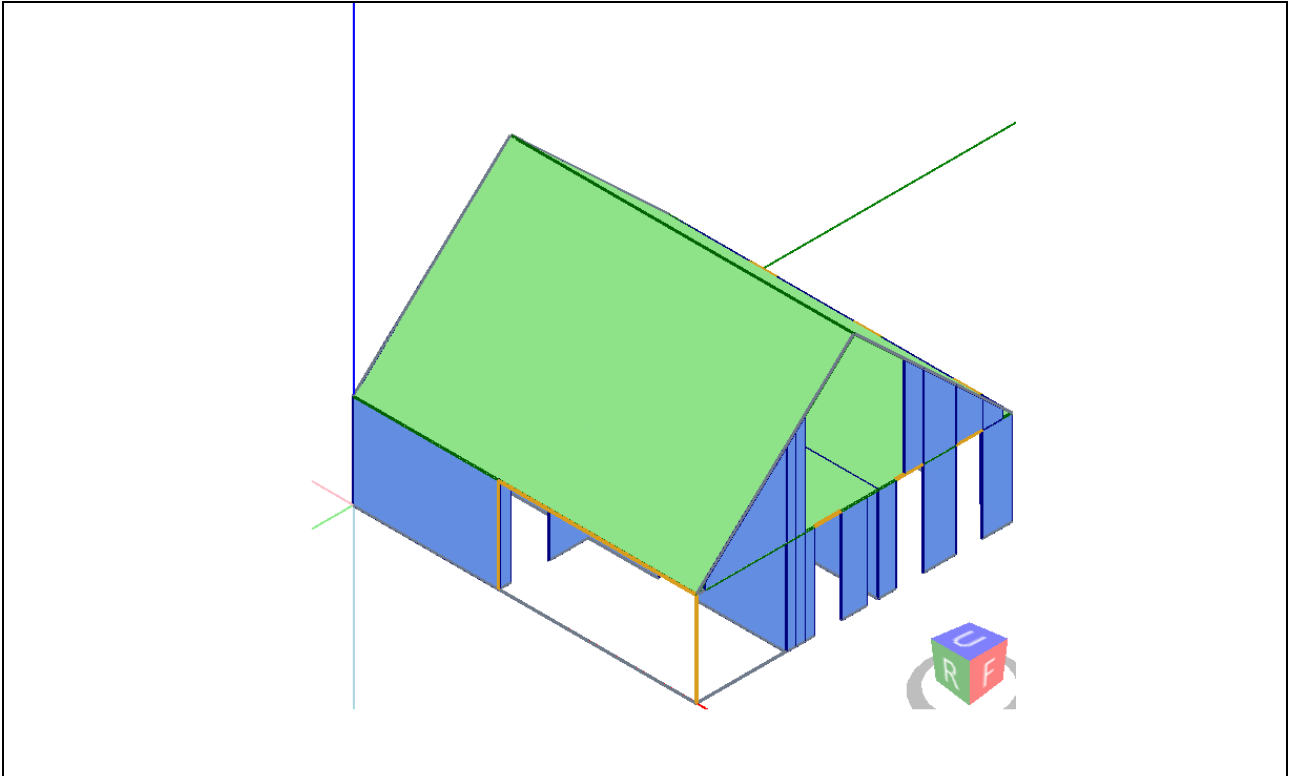
Timber structures - Glued laminated timber and glued solid timber - Requirements

10. EN 10025

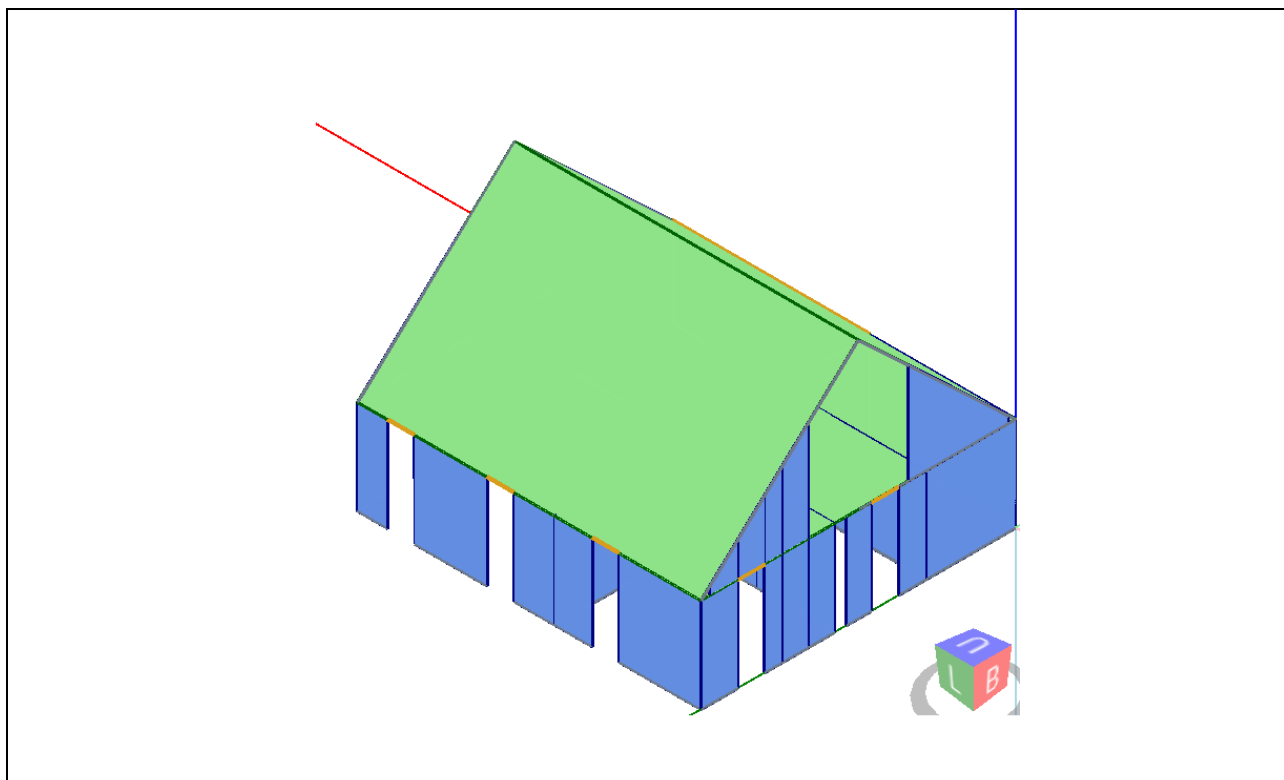
Hot rolled products of structural steels

General description of the building

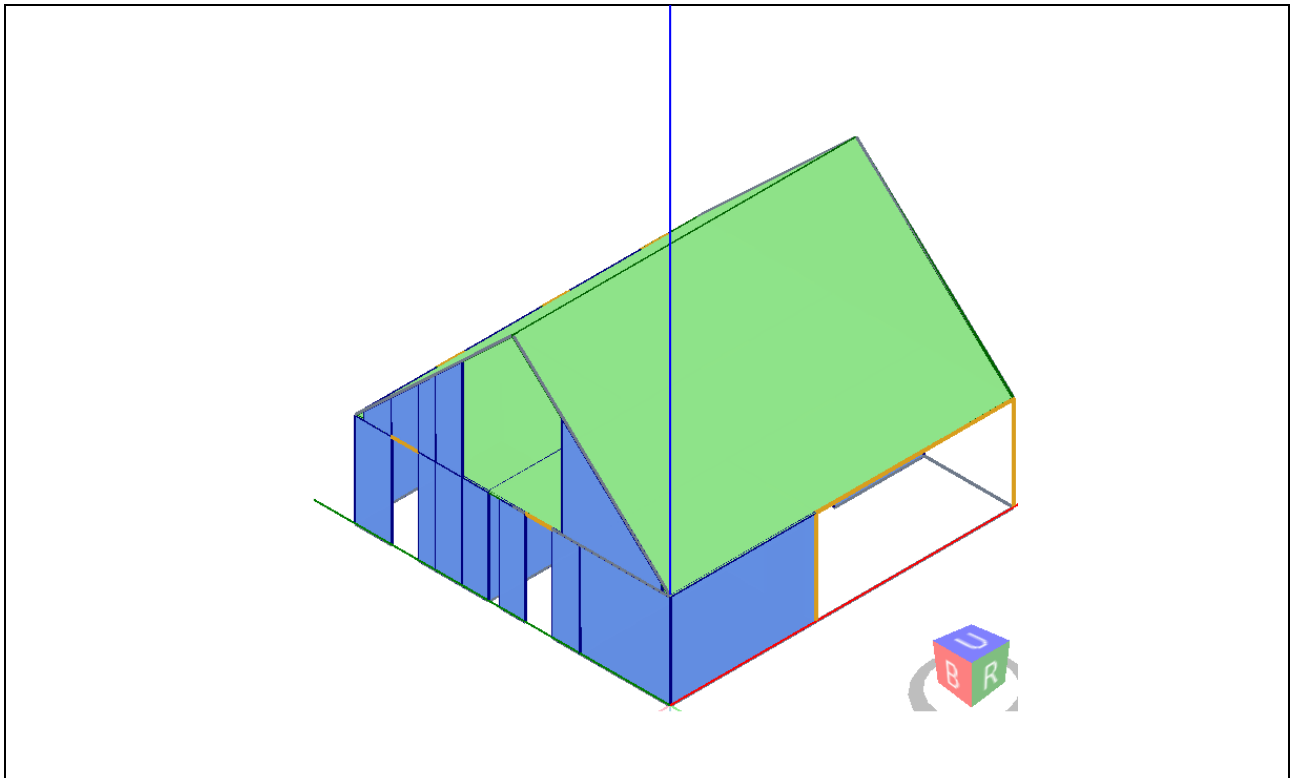
Three-dimensional view Southeast



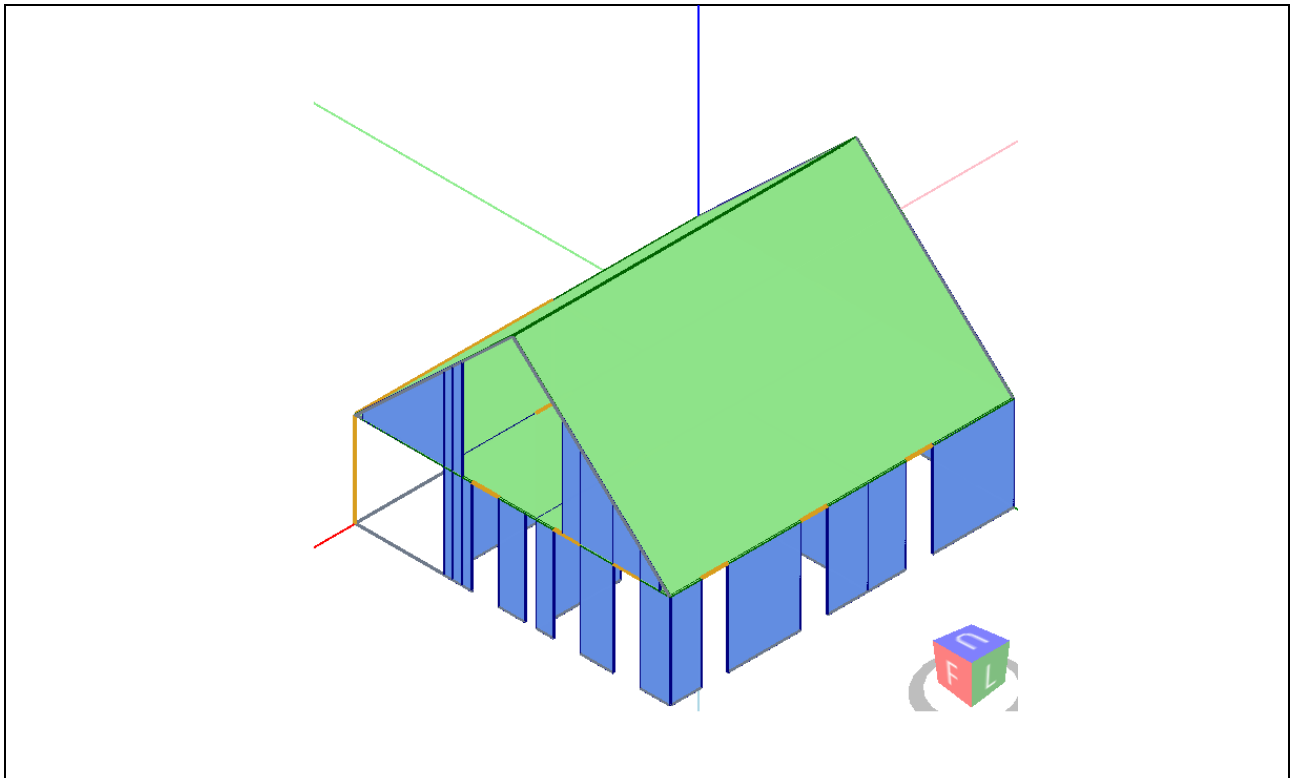
Three-dimensional view Northwest



Three-dimensional view Southwest



Three-dimensional view Northeast



Calculation software used

Calculation software features

The software used is *Timber Tech Buildings*, developed by Timber Tech srl, start up of the University of Trento (Italy).

Technical specifications

Name:	TimberTech Buildings
Software Producer:	TimberTech srl
	Via della Villa, 22/A
	I-38123 – Trento (TN) – Italy
Version:	112

Materials

Wooden materials

The materials used in the project are listed in the following tables.

Descr.	Description
$f_{m,k}$	Characteristic bending strength
$f_{t,0,k}$	Characteristic tensile strength along the grain
$f_{t,90,k}$	Characteristic tensile strength perpendicular to the grain
$f_{c,0,k}$	Characteristic compressive strength along the grain
$f_{c,90,k}$	Characteristic compressive strength perpendicular to the grain
$f_{v,k}$	Characteristic shear strength
$E_{0,mean}$	Mean value of modulus of elasticity along the grain
$E_{0,05}$	Fifth percentile value of modulus of elasticity along the grain
$E_{90,mean}$	Mean value of modulus of elasticity perpendicular to the grain
G_{mean}	Mean value of shear modulus
ρ_k	Characteristic density
$f_{v,k,inplane}$	Characteristic in-plane shear strength of CLT panel
$f_{R,k}$	Characteristic rolling shear strength
$f_{T,k}$	Torsional resistance of crossing surfaces
$G_{R,mean}$	Mean value of rolling shear modulus

Softwood

Descr.	$f_{m,k}$ [MPa]	$f_{t,0,k}$ [MPa]	$f_{t,90,k}$ [MPa]	$f_{c,0,k}$ [MPa]	$f_{c,90,k}$ [MPa]	$f_{v,k}$ [MPa]	$E_{0,mean}$ [MPa]	$E_{0,05}$ [MPa]	$E_{90,mean}$ [MPa]	G_{mean} [MPa]	ρ_k [kg/m ³]
C 24	24	14.5	0.4	21	2.5	4	11000	7400	370	690	350

CLT

Descr	$f_{m,k}$ [MPa]	$f_{t,0,k}$ [MPa]	$f_{t,90,k}$ [MPa]	$f_{c,0,k}$ [MPa]	$f_{c,90,k}$ [MPa]	$f_{v,k,plast}$ [MPa]	$f_{R,k}$ [MPa]	$f_{v,k,last}$ [MPa]	$f_{T,k}$ [MPa]	$E_{0,mean}$ [MPa]	$E_{0,05}$ [MPa]	$E_{90,mean}$ [MPa]	G_{mean} [MPa]	$G_{R,mean}$ [MPa]	ρ_k [kg/m ³]
C 24 XLAM	24	14.5	0.4	21	2.5	4	0.8	4	2.5	11000	7400	370	690	50	350

Steel material

The materials used in the project are listed in the following tables.

Descr.	Description
t	Nominal thickness of the element
$f_{y,k}$	Characteristic values of yield strength
$f_{u,k}$	Characteristic values of ultimate strength
E	Modulus of elasticity
G	Shear modulus
ν	Poisson's ratio in elastic stage

Descr.	t	$f_{y,k}$ [MPa]	$f_{u,k}$ [MPa]	E [MPa]	G [MPa]	ν [MPa]
S235 - EN 10025 -2	$t \leq 40$ mm	235	360	210000	80770	0.3

Concrete anchors

Manufacturer	Threaded-rod / Mechanical anchor code	Threaded-rod / Mechanical anchor descr.	Chemical anchor code	Chemical anchor descr.
Rotho Blaas	INA5816195	Threaded rod INA - 5.8 - M16 x 195	HYB420	Hybrid chemical anchor ETA-20/1285
Rotho Blaas	INA5812140	Threaded rod INA - 5.8 - M12 x 140	FIX420	Vinylester chemical anchor ETA-20/0363

Identification of structural elements

Vertical elements

The following table shows the positions of the individual walls. The last four columns show the coordinates of the ends of each wall.

X1 and Y1 indicate the coordinates of the starting point of the wall

X2 and Y2 indicate the coordinates of the end point of the wall

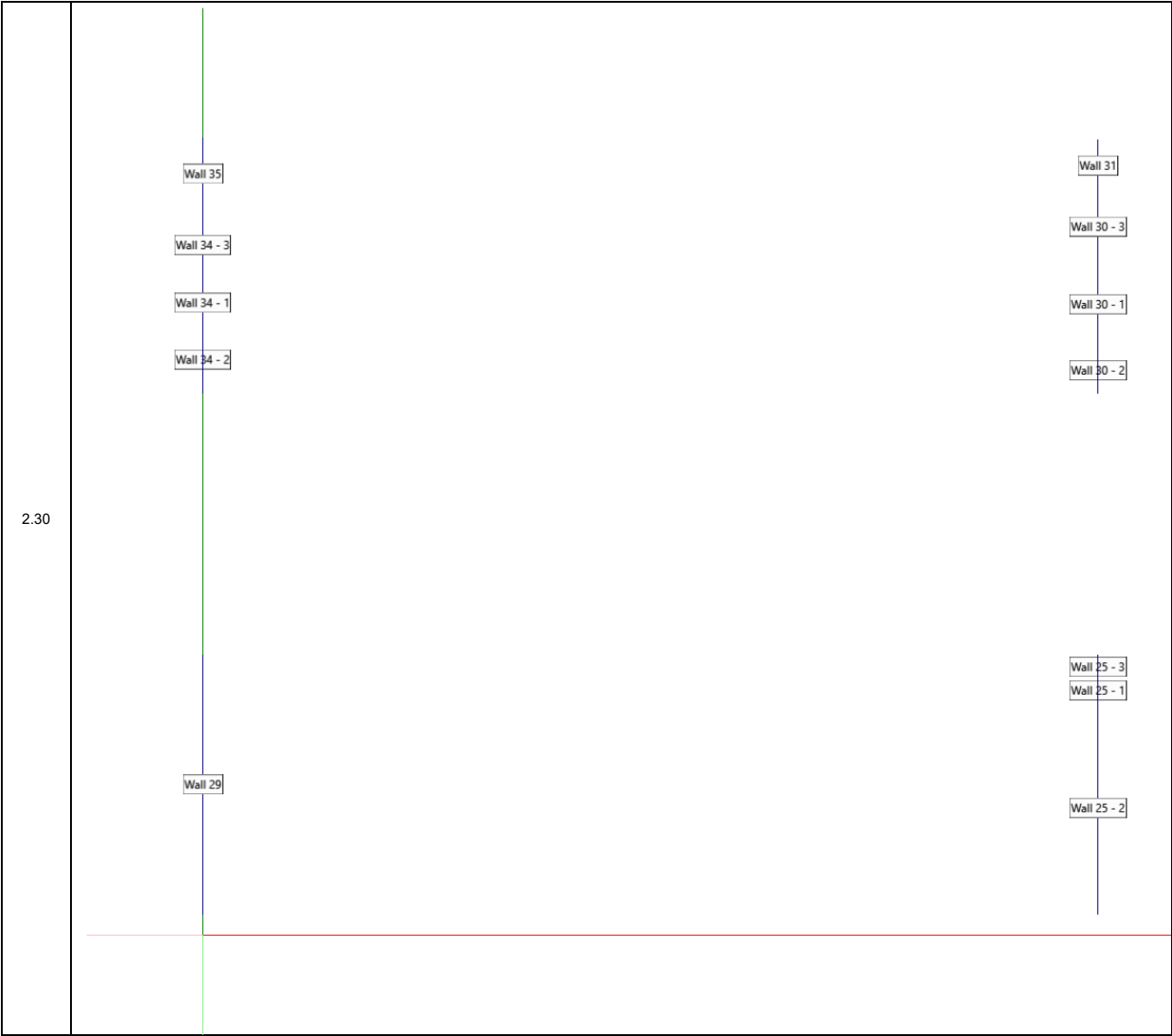
Wall name	Type of wall	Element resistant to horizontal loads	Height [m]	Length [m]	Altitude [m]	X1 [m]	Y1 [m]	X2 [m]	Y2 [m]
Wall 1	CLT	Yes	2.4	2.07	0	0	8.02	2.07	8.02
Wall 10	CLT	Yes	2.4	5.51	0	5.51	2.28	0	2.28
Wall 11	CLT	Yes	2.4	1.02	0	3.71	1.26	3.71	2.28
Wall 12	CLT	No	2.4	0.29	0	3.71	0.29	3.71	0
Wall 13	CLT	Yes	2.4	3.71	0	3.71	0	0	0
Wall 14	CLT	Yes	2.4	2.99	0	0	0	0	2.99
Wall 16	CLT	Yes	2.4	0.93	0	0	7.09	0	8.02
Wall 17	CLT	Yes	2.4	1.96	0	0	4.62	1.96	4.62
Wall 18	CLT	Yes	2.4	2.24	0	1.96	4.62	4.2	4.62
Wall 19	CLT	Yes	2.4	1.2	0	4.2	4.62	5.4	4.62
Wall 2	CLT	Yes	2.4	1.99	0	2.76	8.02	4.75	8.02
Wall 20	CLT	Yes	2.4	2.13	0	6.62	4.62	8.75	4.62
Wall 21	CLT	No	2.4	0.44	0	8.75	4.62	8.75	5.06
Wall 22	CLT	Yes	2.4	3.04	0	3.72	8.02	3.72	4.98
Wall 23	CLT	Yes	2.4	0.65	0	0	3.68	0	4.33
Wall 24 - 1	CLT	No	2.4	0.44	0	0	5.96	0	6.4
Wall 24 - 2	CLT	Yes	2.4	0.67	0	0	5.29	0	5.96
Wall 24 - 3	CLT	Yes	2.4	0.67	0	0	4.62	0	5.29
Wall 25 - 1	CLT	No	2.24	0.22	2.4	8.75	2.28	8.75	2.5
Wall 25 - 2	CLT	No	1.16	2.08	2.4	8.75	0.2	8.75	2.28
Wall 25 - 3	CLT	No	2.45	0.24	2.4	8.75	2.74	8.75	2.5
Wall 29	CLT	Yes	1.37	2.54	2.4	0	0.2	0	2.74
Wall 3	CLT	Yes	2.4	1.84	0	5.44	8.02	7.28	8.02
Wall 30 - 1	CLT	Yes	1.73	0.83	2.4	8.75	5.75	8.75	6.58
Wall 30 - 2	CLT	No	2.34	0.46	2.4	8.75	5.29	8.75	5.75
Wall 30 - 3	CLT	No	1.02	0.69	2.4	8.75	7.27	8.75	6.58
Wall 31	CLT	Yes	0.47	0.5	2.4	8.75	7.27	8.75	7.774
Wall 34 - 1	CLT	No	1.72	0.44	2.4	0	5.96	0	6.4
Wall 34 - 2	CLT	Yes	2.24	0.67	2.4	0	5.29	0	5.96
Wall 34 - 3	CLT	No	1.19	0.69	2.4	0	7.09	0	6.4
Wall 35	CLT	Yes	0.54	0.7	2.4	0	7.09	0	7.791
Wall 4	CLT	Yes	2.4	0.78	0	7.97	8.02	8.75	8.02
Wall 5	CLT	Yes	2.4	0.75	0	8.75	8.02	8.75	7.27
Wall 6	CLT	Yes	2.4	0.83	0	8.75	5.75	8.75	6.58
Wall 7	CLT	Yes	2.4	0.66	0	8.75	3.67	8.75	4.33
Wall 8 - 1	CLT	No	2.4	0.22	0	8.75	2.28	8.75	2.5
Wall 8 - 2	CLT	No	2.4	0.24	0	8.75	2.74	8.75	2.5
Wall 8 - 3	CLT	No	2.4	0.24	0	8.75	2.98	8.75	2.74
Wall 9	CLT	Yes	2.4	2.3	0	8.75	2.28	6.45	2.28

The following table shows the positions of the individual columns. X and Y are the coordinates of the point where the column is located.

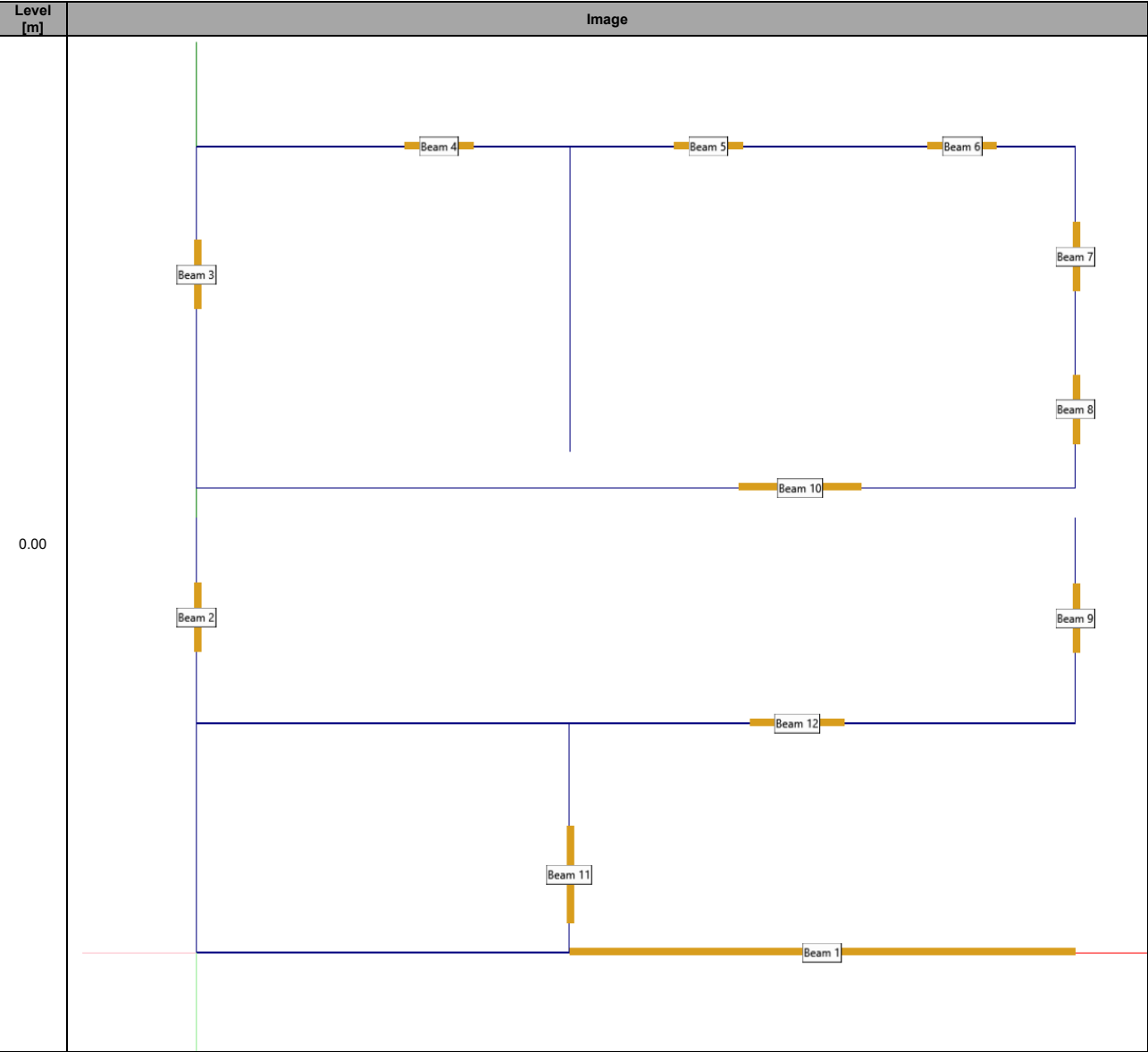
Column name	Height [m]	Altitude [m]	X [m]	Y [m]
Column 1	2.4	0	8.75	0
Column 2	2.4	0	3.71	0

Identification of vertical elements

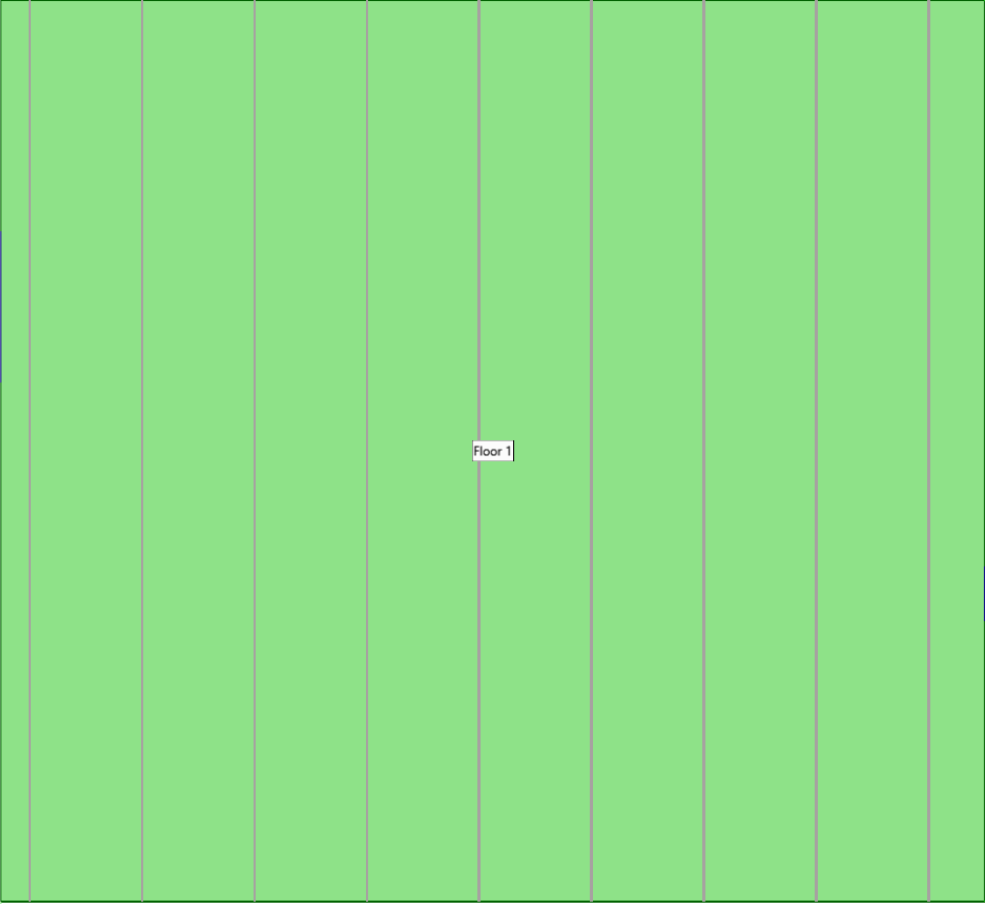
The diagram is a detailed architectural floor plan for Level 0.00. It features a grid of walls and columns. The walls are labeled as follows: Wall 1, Wall 2, Wall 3, Wall 4, Wall 5, Wall 6, Wall 7, Wall 8 - 1, Wall 8 - 2, Wall 8 - 3, Wall 9, Wall 10, Wall 11, Wall 12, Wall 13, Wall 14, Wall 16, Wall 17, Wall 19, Wall 20, Wall 21, Wall 22, Wall 23, Wall 24 - 1, and Wall 24 - 2. The columns are labeled Column 1 and Column 2. The plan also shows a series of walls labeled Wall 24 - 1 and Wall 24 - 2. The level is indicated as 0.00 on the left side. The plan is drawn with blue lines for walls and red lines for columns. The walls are of varying thicknesses, and the columns are represented by small squares. The plan is oriented with North at the top.



Identification of beams



Identification of floors

Level [m]	Image
0.00	 The diagram shows a large green rectangle representing a floor slab, divided into ten vertical strips by thin grey lines. A small label 'Floor 1' is centered within the rectangle. The entire diagram is enclosed in a black border. A red horizontal line is visible at the bottom of the diagram area.

Calculation method and numerical model

Model Description

Hypothesis adopted for the elements

The timber walls are constrained at the base by means of connection systems capable of transmitting both in-plane and out-of-plane actions action on the wall.

In the analysis, in presence of horizontal loads, some elements may be defined as “secondary”: this mean that their strength and stiffness are neglected in the calculation of the response of the building. In the model these elements are represented in terms of mass and they are designed only for vertical loads.

Rigid body rocking – Forces on hold-down / tie-down

The hold-down or tie-down systems are used to prevent the rotation of the wall caused by the overturning moment of the horizontal force. The hold-down, placed on the in-tensile edge of the wall, is loaded by a force equal to

$$T = \begin{cases} \left(\frac{M_{3-3}}{b} - \frac{N}{2} \right) \cdot \frac{1}{n_{anc}} & \text{for active hold – down} \\ 0 & \text{for inactive hold – down} \end{cases}$$

where:

b is the lever arm for the internal couple;

N is the axial vertical load acting on the wall;

M_{3-3} is the moment acting in the plane of the wall;

n_{anc} is the number of connections present at each end of the wall.

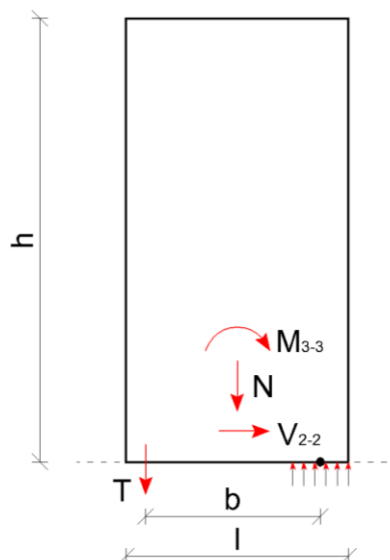


Figure: Calculation model of tensile force acting on the hold-down

Wall horizontal stiffness

The wall stiffness can be estimated considering the contributions of all the components, as shown below.

CLT walls

The overall stiffness of CLT walls is calculated taking into account the contribution of the following components:

- CLT panel (k_{XLAM})
- shear connections – angle brackets (k_a)
- hold-down or tie-down (k_h)

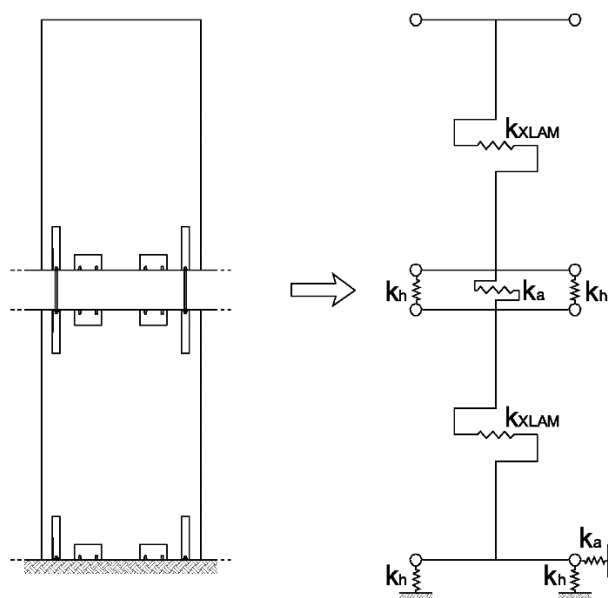


Figure: Mechanical model for CLT walls overall stiffness

The following table indicates the positions of the walls and their equivalent shear stiffness.

Wall name	Type of wall	Element resistant to horizontal loads	Height [m]	Length [m]	Equivalent shear stiffness [kN/m]
Wall 1	CLT	Yes	2.4	2.07	9687
Wall 10	CLT	Yes	2.4	5.51	37627
Wall 11	CLT	Yes	2.4	1.02	3128
Wall 12	CLT	No	2.4	0.29	0
Wall 13	CLT	Yes	2.4	3.71	24303
Wall 14	CLT	Yes	2.4	2.99	18338
Wall 16	CLT	Yes	2.4	0.93	2660
Wall 17	CLT	Yes	2.4	1.96	8958
Wall 18	CLT	Yes	2.4	2.24	10813
Wall 19	CLT	Yes	2.4	1.2	4133
Wall 2	CLT	Yes	2.4	1.99	9157
Wall 20	CLT	Yes	2.4	2.13	10085
Wall 21	CLT	No	2.4	0.44	0
Wall 22	CLT	Yes	2.4	3.04	28011
Wall 23	CLT	Yes	2.4	0.65	1390
Wall 24 - 1	CLT	No	2.4	0.44	0

Wall 24 - 2	CLT	Yes	2.4	0.67	1470
Wall 24 - 3	CLT	Yes	2.4	0.67	1470
Wall 25 - 1	CLT	No	2.24	0.22	0
Wall 25 - 2	CLT	No	1.16	2.08	0
Wall 25 - 3	CLT	No	2.45	0.24	0
Wall 29	CLT	Yes	1.37	2.54	4423
Wall 3	CLT	Yes	2.4	1.84	8165
Wall 30 - 1	CLT	Yes	1.73	0.83	2100
Wall 30 - 2	CLT	No	2.34	0.46	0
Wall 30 - 3	CLT	No	1.02	0.69	0
Wall 31	CLT	Yes	0.47	0.5	3792
Wall 34 - 1	CLT	No	1.72	0.44	0
Wall 34 - 2	CLT	Yes	2.24	0.67	1151
Wall 34 - 3	CLT	No	1.19	0.69	0
Wall 35	CLT	Yes	0.54	0.7	4049
Wall 4	CLT	Yes	2.4	0.78	1941
Wall 5	CLT	Yes	2.4	0.75	1807
Wall 6	CLT	Yes	2.4	0.83	2171
Wall 7	CLT	Yes	2.4	0.66	1430
Wall 8 - 1	CLT	No	2.4	0.22	0
Wall 8 - 2	CLT	No	2.4	0.24	0
Wall 8 - 3	CLT	No	2.4	0.24	0
Wall 9	CLT	Yes	2.4	2.3	11208

Types of structural elements and sign conventions

Linear elements

The linear elements are used to model beams and columns. They have a local reference system with respect to which stress/force components are shown. The sign convention adopted is shown in the figure below.

Force	Description	Unit of measure
N	Axial force	kN
M_{3-3}	Bending moment about local axis 3	kN m
V_2	Shear along local axis 2	kN
M_{2-2}	Bending moment about local axis 2	kN m
V_3	Shear along local axis 3	kN

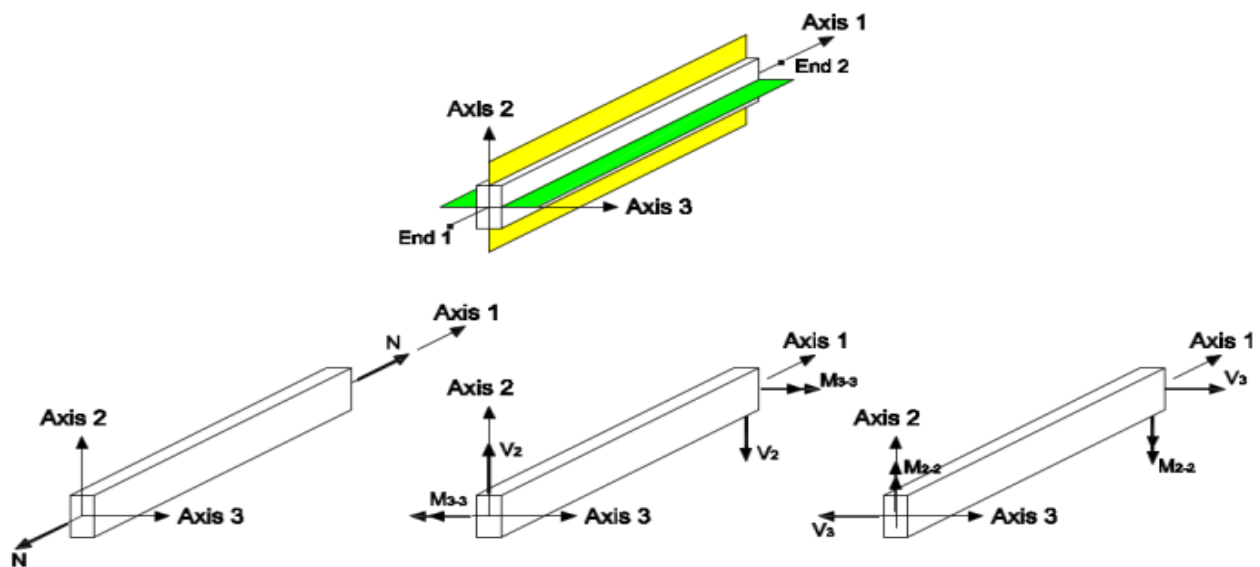


Figure: sign conventions for beams

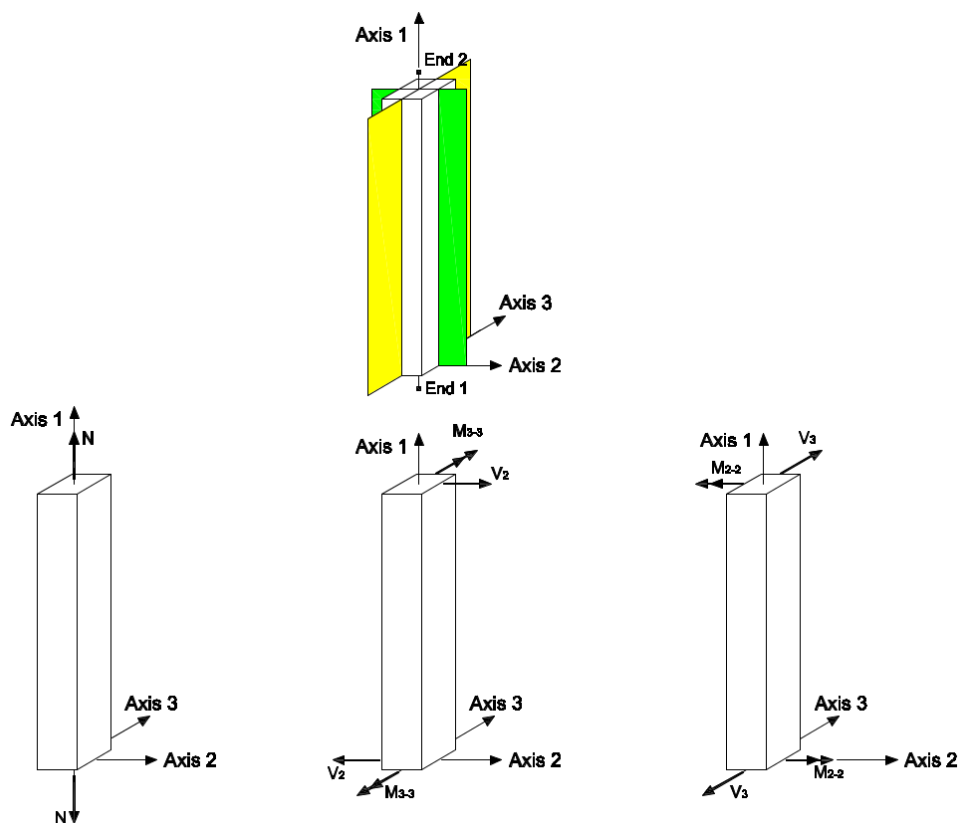


Figure: sign conventions for columns

Wall elements

The walls, regardless of type, have the following sign conventions.

	Actions per unit length	Description	Unit of measure
In-plane actions	n	Axial stress (per unit length)	kN/m
	m_{3-3}	Bending moment about local axis 3 (per unit length)	kNm/m
	v_2	Shear along local axis 2 (per unit length)	kN/m
Out-of-plane actions (plate)	m_{2-2}	Bending moment about local axis 2 (per unit length)	kNm/m
	v_3	Shear along local axis 3 (per unit length)	kN/m

	Actions	Description	Unit of measure
In-plane actions	N	Total axial force	kN
	M_{3-3}	Bending moment about local axis 3	kNm
	V_2	Shear along local axis 2	kN
Out-of-plane actions (plate)	M_{2-2}	Bending moment about local axis 3	kNm
	V_3	Shear along local axis 2	kN

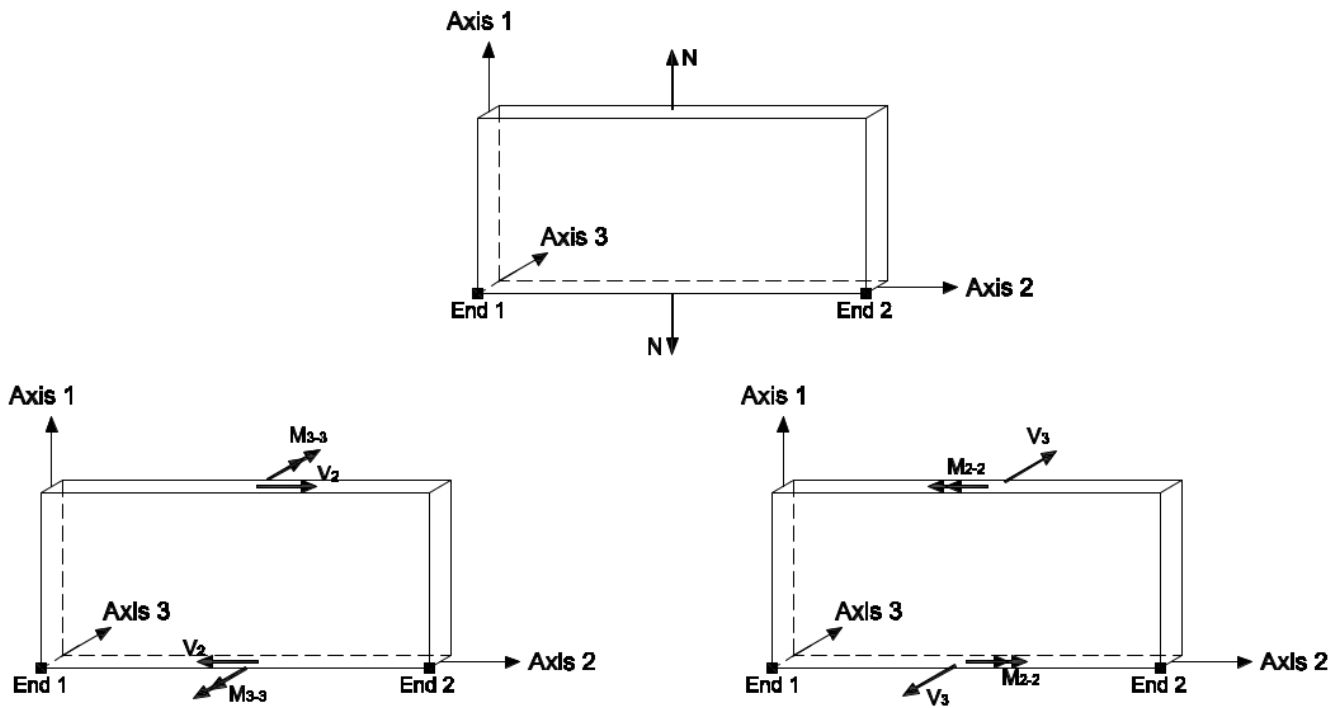


Figure: sign conventions for walls

Actions and design loads

Self-weight of structural materials

The weights of the structural materials are shown in the table below in kN/m³

Description	Specific weight γ [kN/m ³]
C 24	4.20
C 24 XLAM	4.20

Wind action

The wind action is evaluated in accordance with the European standard EN 1-1-4. The wind action is represented by a simplified set of forces whose effects is equivalent to the extreme effects of the turbulent wind.

Project data

Terrain category: Terrain category III

Basic wind velocity: 20 m/s

Mean wind

The mean wind velocity $v_m(z)$ at a height z above the terrain depends on the terrain roughness and orography and on the basic wind velocity according to the following expression:

$$v_m(z) = c_r(z) \cdot c_o(z) \cdot v_b$$

where:

$c_r(z)$ is the roughness factor that depends on the terrain category and on the height z above the terrain of the relevant point;

$c_o(z)$ is the orography factor taken as 1;

v_b is the basic wind velocity.

According to section 4.3.2 of EN 1991-1-4, the roughness factor can be determined as follows:

$$c_r(z) = k_r \cdot \ln\left(\frac{z}{z_0}\right) \quad \text{for } z_{min} \leq z \leq z_{max}$$

$$c_r(z) = c_r(z_{min}) \quad \text{for } z \leq z_{min}$$

where:

z_0 and z_{min} are defined according to the terrain category:

Terrain category		z_0	z_{min}
0	Sea or coastal area exposed to the open sea	0,003	1
I	Lakes or flat and horizontal area with negligible vegetation and without obstacles	0,01	1
II	Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights	0,05	2
III	Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)	0,3	5
IV	Area in which at least 15% of the surface is covered with buildings and their average height exceeds 15 m	1,0	10

k_r is the terrain factor calculated using:

$$k_r = 0,19 \cdot \left(\frac{z_0}{z_{0,II}} \right)^{0,07}$$

with: $z_{0,II} = 0,05 \text{ m}$

Wind turbulence

The turbulence intensity $I_v(z)$ at a height z is defined as the standard deviation of the turbulence divided by the mean wind velocity and it can be determined as:

$$I_v(z) = \frac{\sigma_v}{v_m(z)} = \frac{1}{c_o(z) \cdot \ln\left(\frac{z}{z_0}\right)} \quad \text{for } z_{min} \leq z \leq z_{max}$$

$$I_v(z) = I_v(z_{min}) \quad \text{for } z \leq z_{min}$$

Peak velocity pressure

The peak velocity pressure $q_p(z)$ at a height z can be determined as:

$$q_p(z) = [1 + 7 \cdot I_v(z)] \cdot \frac{1}{2} \cdot \rho \cdot v_m^2(z) = c_e(z) \cdot q_b$$

where:

$I_v(z)$ is the turbulence intensity;

ρ is the air density taken as 1.25 kg/m^3 ;

$v_m(z)$ is the mean wind velocity;

$c_e(z)$ is the exposure factor defined as $c_e(z) = \frac{q_p(z)}{q_b}$;

q_b is the basic wind pressure defined as $q_b = \frac{1}{2} \cdot \rho \cdot v_b^2$.

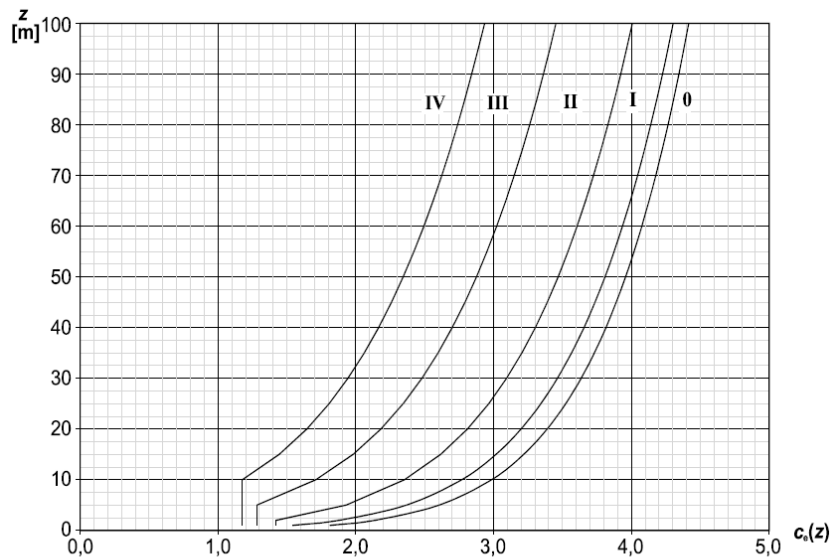


Figure 4.2 — Illustrations of the exposure factor $c_e(z)$ for $c_0=1,0$, $k_t=1,0$

The basic wind pressure results to be equal to:

$$q_b = 250 \text{ N/m}^2$$

Wind pressure on surfaces

The wind pressure acting on the external surfaces can be determined according to:

$$w_e(z_e) = q_p(z_e) \cdot c_{pe}$$

The wind pressure acting on the internal surfaces can be determined according to:

$$w_i(z_i) = q_p(z_i) \cdot c_{pi}$$

where:

c_{pe} is the pressure coefficient for the external pressure that can be calculated according to section 7.2 of EN 1991-1-4 or according to data supported by appropriate documentation or by experimental campaigns in wind tunnel;

c_{pi} is the pressure coefficient for the internal pressure.

The reference heights z_e to be considered in the calculation of the peak reference wind pressure are defined as follows:

- Windward surfaces of walls: the reference height changes along the structure height in accordance with point 7.2.2 on EN 1991-1-4;
- Leeward surfaces of walls: the reference height is equal to the maximum height of the building;
- Internal pressures: the reference height is equal to the maximum height of the building.

Wind forces

The wind forces for the whole structure or a structural component can be determined by calculating forces from surface pressures according to the following equations.

External forces:

$$F_{w,e} = c_s \cdot c_d \cdot \sum_{surfaces} w_e(z_e) \cdot A_{ref}$$

Internal forces:

$$F_{w,i} = \sum_{surfaces} w_i(z_i) \cdot A_{ref}$$

where:

- c_s is the size factor that takes into account the effect on wind actions from the non-simultaneous occurrence of peak wind pressures on the surfaces. It is taken equal to 1;
- c_d is the dynamic factor that takes into the effect of the vibrations of the structure due to turbulence. It is taken equal to 1.

Loads acting on the walls

The following table shows the loads acting on the walls.

Load name: Load ID

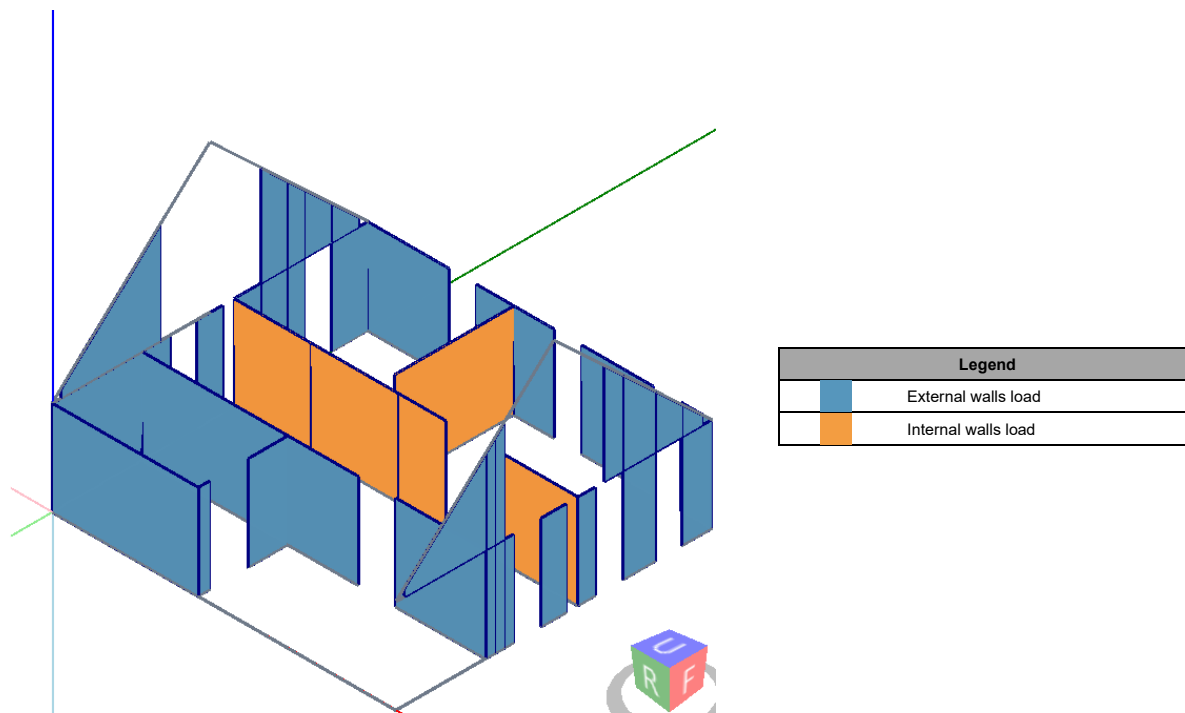
Position: Position of the wall: internal or external

$g_{1,k}$: Permanent action: self weight

$g_{2,k}$: Permanent action

$q_{wind,k}$: Variable actions: wind load on windward, leeward and lateral surfaces

Wall name	Position	Load name	$g_{1,k}$ [kN/m ²]	$g_{2,k}$ [kN/m ²]	$q_{wind,k}$ downwind [kN/m ²]	$q_{wind,k}$ windward [kN/m ²]	$q_{wind,k}$ lateral [kN/m ²]
Wall 1	External	External walls load	0.42	0.6	-0.22	0.38	-0.49
Wall 2	External	External walls load	0.42	0.6	-0.22	0.38	-0.49
Wall 3	External	External walls load	0.42	0.6	-0.22	0.38	-0.49
Wall 4	External	External walls load	0.42	0.6	-0.22	0.38	-0.49
Wall 5	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 6	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 7	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 8 - 1	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 9	External	External walls load	0.42	0.6	-0.22	0.38	-0.49
Wall 10	External	External walls load	0.42	0.6	-0.22	0.38	-0.49
Wall 11	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 12	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 13	External	External walls load	0.42	0.6	-0.22	0.38	-0.49
Wall 14	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 16	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 17	Internal	Internal walls load	0.42	0.6	0	0	0
Wall 18	Internal	Internal walls load	0.42	0.6	0	0	0
Wall 19	Internal	Internal walls load	0.42	0.6	0	0	0
Wall 20	Internal	Internal walls load	0.42	0.6	0	0	0
Wall 21	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 22	Internal	Internal walls load	0.42	0.6	0	0	0
Wall 23	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 24 - 1	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 25 - 1	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 29	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 30 - 1	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 31	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 34 - 1	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 35	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 25 - 2	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 25 - 3	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 30 - 2	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 30 - 3	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 34 - 2	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 34 - 3	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 8 - 2	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 24 - 2	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 8 - 3	External	External walls load	0.42	0.6	-0.22	0.37	-0.49
Wall 24 - 3	External	External walls load	0.42	0.6	-0.22	0.37	-0.49



Loads acting on the floors

The following table shows the characteristic values of the loads acting on the decks.

Load name: Load ID

Position: Position of the floor: internal or external

Environment: Load category

α : Roof pitch angle

$g_{1,k}$: Permanent action: self weight

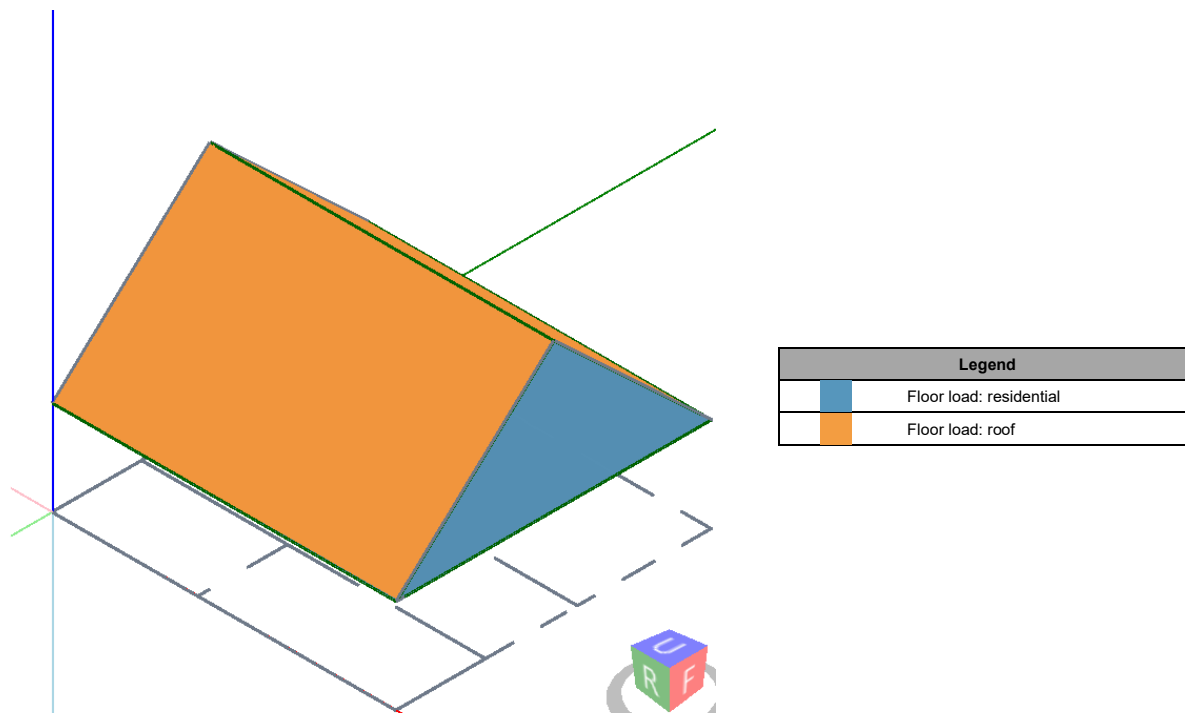
$g_{2,k}$: Permanent action

q_{k} : Variable actions

$q_{\text{snow},k}$: Variable actions: snow load

$q_{\text{wind},k}$: Variable actions: wind load

Floor name	Position	α [°]	Load name	Environment	$g_{1,k}$ [kN/m ²]	$g_{2,k}$ [kN/m ²]	q_{k} [kN/m ²]	$q_{\text{snow},k}$ [kN/m ²]	$q_{\text{wind},k}$ in depression [kN/m ²]	$q_{\text{wind},k}$ in pressure [kN/m ²]
Floor 1	Internal floor	0	Floor load: residential	Imposed loads category A: floors	0.59	2	2	0	0	0



Line loads

The following table shows the characteristic values of the line loads acting on the beams and the decks.

Load name: Load ID

Position: Position of the element: internal or external

Environment: Load category

$G_{1,k}$: Permanent action: self weight

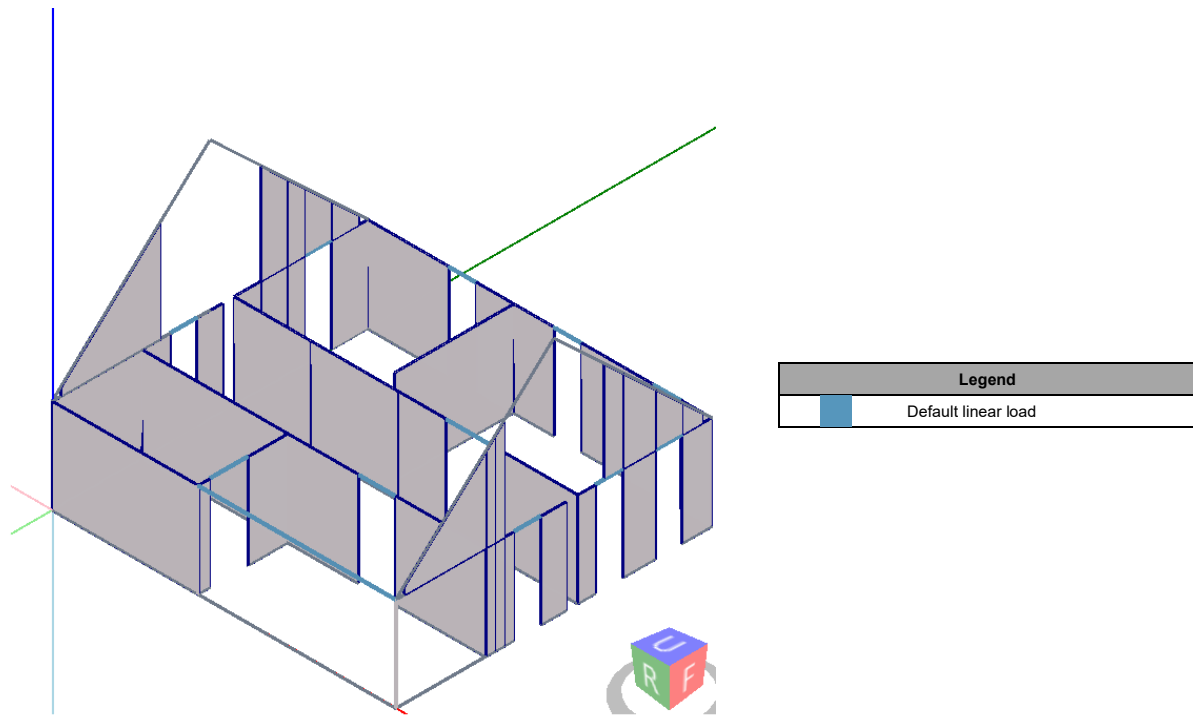
$G_{2,k}$: Permanent action

Q_{k} : Variable actions

$Q_{\text{snow},k}$: Variable actions: snow load

$Q_{\text{wind},k}$: Variable actions: wind load

Element name	Position	Load name	Environment	$G_{1,k}$ [kN/m]	$G_{2,k}$ [kN/m]	Q_k [kN/m]	$Q_{\text{snow},k}$ [kN/m]	$Q_{\text{wind},k}$ In depression [kN/m]	$Q_{\text{wind},k}$ In pressure [kN/m]
Beam 1	Internal load	Default linear load	-	0.72	0	-	0	0	0
Beam 2	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 3	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 4	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 5	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 6	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 7	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 8	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 9	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 10	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 11	Internal load	Default linear load	-	0.08	0	-	0	0	0
Beam 12	Internal load	Default linear load	-	0.08	0	-	0	0	0



Seismic actions

The seismic actions are evaluated according to the Eurocode 8 and the National annex. The earthquake motion at a given point on the surface is represented by an elastic ground acceleration response spectrum.

The response spectra are calculated using the design ground acceleration a_g on type A ground: the acceleration is equal to a_{gR} , the value of the reference peak ground acceleration on type A ground, times the importance factor γ_I .

The response spectrum for the damage limit requirement is obtained multiplying the reduction of the design ground acceleration a_g by the reduction factor ν .

The parameters defining the design ground acceleration a_g on type A ground and the acceleration values for the ULS and DLS are reported below:

The reduction factor of the Damage limitation Limit State spectrum: 0.5

Importance factor: 1

Limit States	a_g [g]
ULS – Ultimate Limit State	0.175
DLS – Damage Limitation limit State	0.088

The value of the periods T_B , T_C , T_D and of the soil factor S defining the shape of the elastic response spectrum depend on the ground type and on the spectrum type. The parameters used are reported below:

Spectrum type: Type 1

Ground type: A

S soil factor: 1

T_B lower limit of the period of the constant spectral acceleration branch: 0.15 s

T_C upper limit of the period of the constant spectral acceleration branch: 0.4 s

T_D value defining the beginning of the constant displacement response range of the spectrum: 2 s

Ground elastic response spectrum

For the horizontal components of the seismic action, the elastic response spectrum $S_e(T)$ is defined by the following expressions:

$$0 \leq T \leq T_B \quad S_e(T) = a_g \times S \times \left[1 + \frac{T}{T_B} \times (\eta \times 2,5 - 1) \right]$$

$$T_B \leq T \leq T_C \quad S_e(T) = a_g \times S \times \eta \times 2,5$$

$$T_C \leq T \leq T_D \quad S_e(T) = a_g \times S \times \eta \times 2,5 \left[\frac{T_C}{T} \right]$$

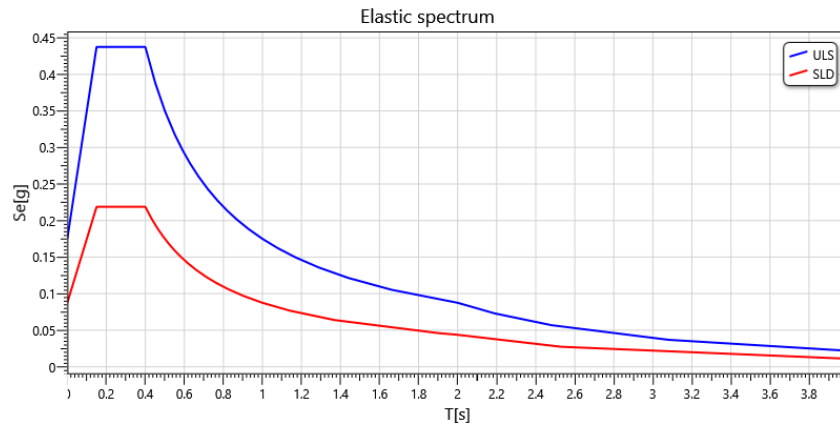
$$T \leq T_D \quad S_e(T) = a_g \times S \times \eta \times 2,5 \left[\frac{T_C T_D}{T^2} \right]$$

Horizontal elastic response spectra are reported below; they are calculated using the following values of the parameters η and ξ

$$\eta = 1$$

$$\xi = 5\%$$

η is the damping correction factor with a reference value of $\eta = 1$ for 5% viscous damping.



Design spectrum for elastic analysis (NO-COLLAPSE)

To avoid explicit inelastic structural analysis in design, the capacity of the structure to dissipate energy, through mainly ductile behavior of its elements and/or other mechanisms, is taken into account by performing an elastic analysis based on a response spectrum reduced with respect to the elastic one, henceforth called a "design spectrum". This reduction is accomplished by introducing the behavior factor q . The design spectrum is defined by the following expressions:

$$0 \leq T \leq T_B \quad S_d(T) = a_g \times S \times \left[\frac{2}{3} + \frac{T}{T_B} \times \left(\frac{2,5}{q} - \frac{2}{3} \right) \right]$$

$$T_B \leq T \leq T_C \quad S_d(T) = a_g \times S \times \frac{2,5}{q}$$

$$T_C \leq T \leq T_D \quad S_d(T) = \begin{cases} a_g \times S \times \frac{2,5}{q} \times \left[\frac{T_C}{T} \right] \\ \geq \beta \times a_g \end{cases}$$

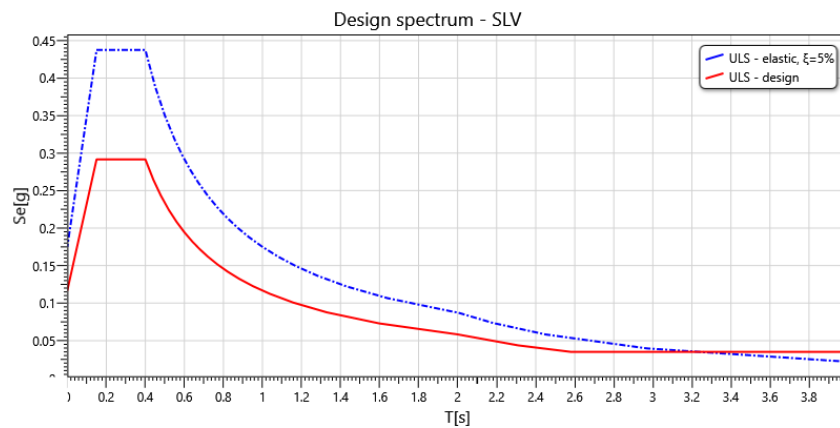
$$T \leq T_D \quad S_d(T) = \begin{cases} a_g \times S \times \frac{2,5}{q} \times \left[\frac{T_C T_D}{T^2} \right] \\ \geq \beta \times a_g \end{cases}$$

where:

β is the lower bound factor for the horizontal design spectrum equal to 0.2;

q is the behaviour factor: 1.5.

The horizontal elastic response spectra and the horizontal design spectrum (Ultimate Limit State) are shown below:



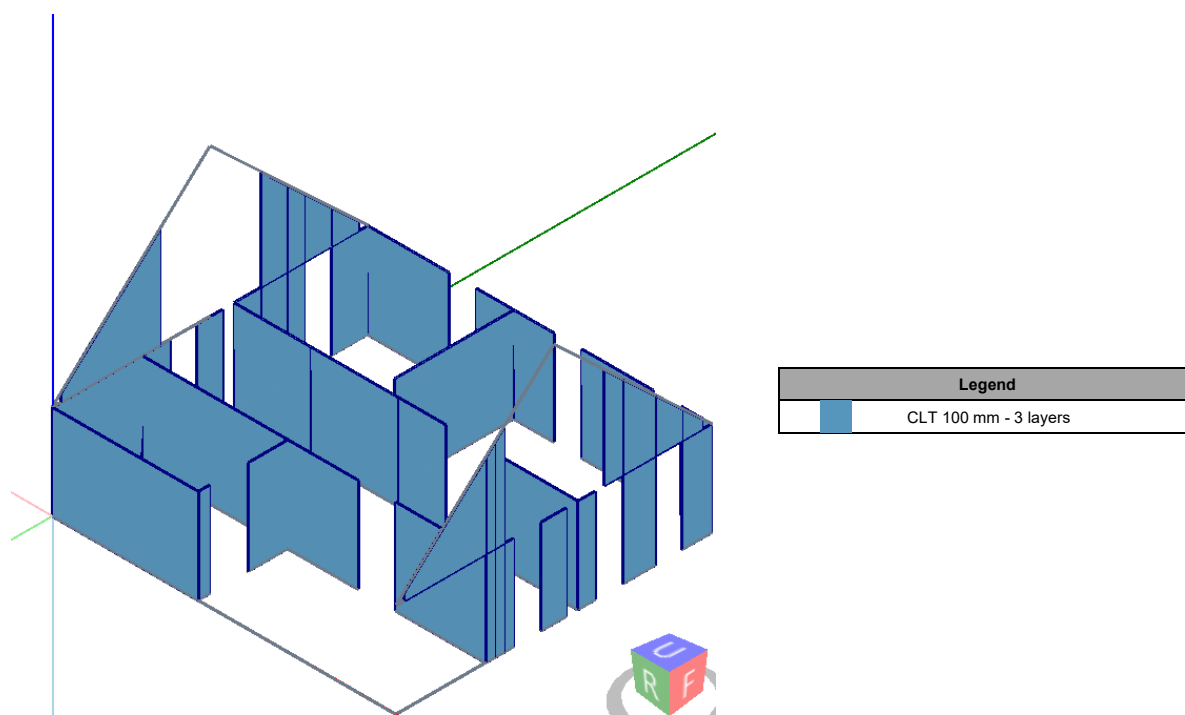
Sections of the structural elements

CLT walls

The following table shows the CLT walls characteristics.

Section name	Manufacturer	Panel name	Material	Layers number	Thickness [mm]	Layers	Orientation of the outer layers
CLT 100 mm - 3 layers	User defined	100 3s T	C 24 XLAM	3	100	30 - 40 - 30	Vertical

Walls definition



CLT floors

Floor geometric characteristic

h_b : CLT panel thickness

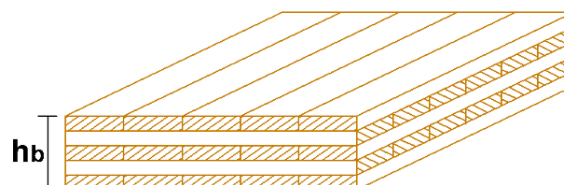
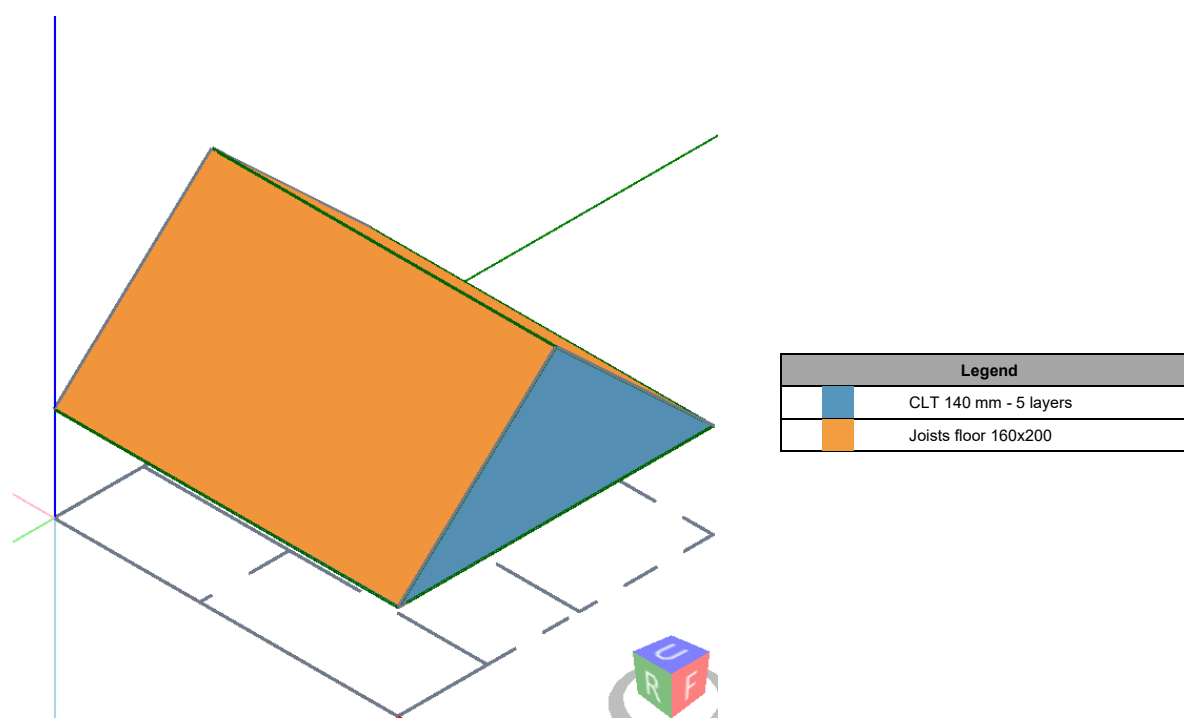


Figure: CLT floor geometric characteristics

The following table sets out the details concerning the CLT floors.

Section name	Manufacturer	CLT panel name	Material	Number of layers	Thickness h_b [mm]	Layers	External layers orientation
CLT 140 mm - 5 layers	User defined	140 5s L	C 24 XLAM	5	140	40 - 20 - 20 - 20 - 40	Parallel to the calculation direction

Floors definition



Cross section of timber linear elements

Rectangular sections

The following table sets out the details concerning every linear element with a rectangular cross section.

Section name	Material	Width b [mm]	Height h [mm]	b ₁ [mm]	h ₁ [mm]	b ₂ [mm]	h ₂ [mm]	Area A [mm ²]	J _{y-y} [mm ⁴]	J _{z-z} [mm ⁴]
100x200mm C24	C 24	100	200	-	-	-	-	20000	6.67E7	1.67E7

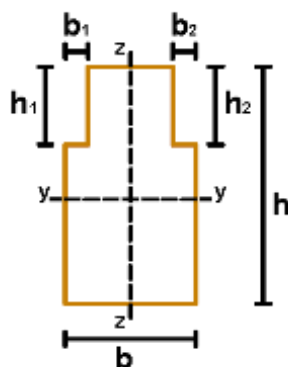


Figure: Geometric size of every timber rectangular cross section

Steel cross-sections

The following table provides the main proprieties of the steel cross-sections used in the project:

Section name	Material	Profile	Height h [mm]	Width b [mm]	t _f [mm]	t _w [mm]	A x10 ² [mm ²]	A _v x10 ² [mm ²]	W _{pl,y} x10 ³ [mm ³]	W _{el,y} x10 ³ [mm ³]	J _{y-y} x10 ⁴ [mm ⁴]	J _{z-z} x10 ⁴ [mm ⁴]
HEA 160	S235 - EN 10025 -2	HE 160 A	152	160	9	6	38.8	13.21	245.1	220.1	1673	615.6
HEB 220	S235 - EN 10025 -2	HE 220 B	220	220	16	9.5	91	27.92	827	735.5	8091	2843

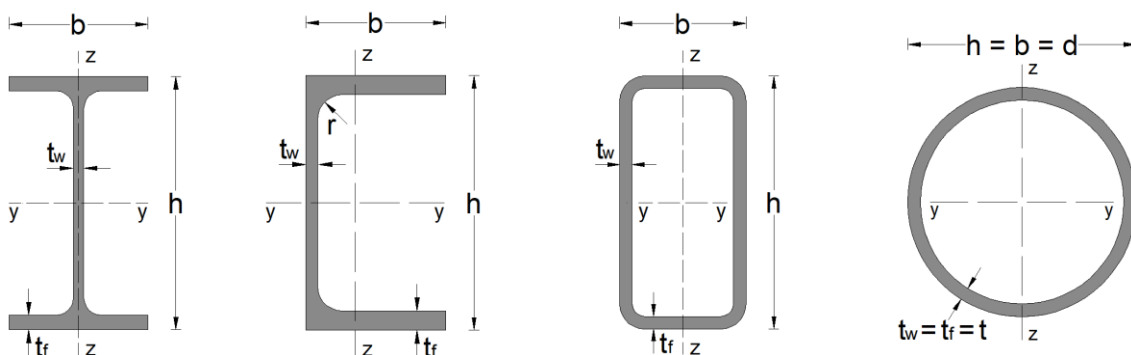
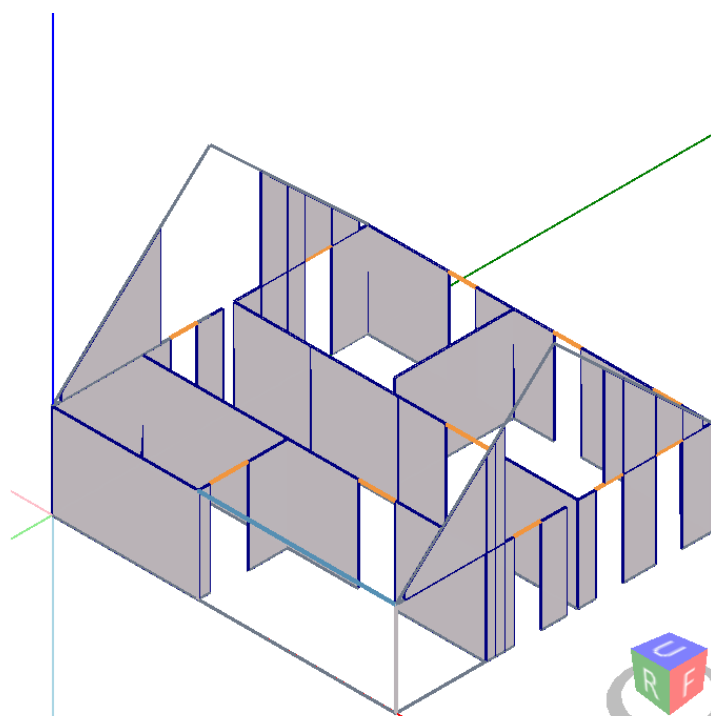
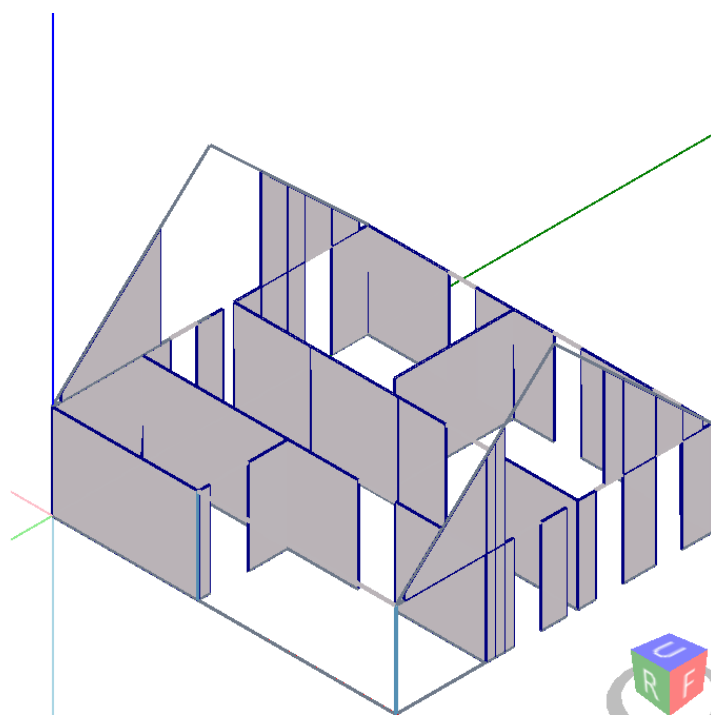


Figure: Geometric size of the steel cross-sections

Beams and columns definition



Legend	
	HEB 220
	100x200mm C24



Legend	
	HEA 160

Connections

Hold down

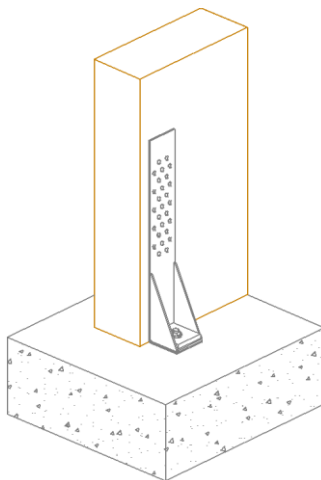


Figure: graphical representation of a hold down in a base connection (timber wall – foundation connection)

Connection name	Connection position	Manufacturer	Description	Fasteners	Threaded rods / Mechanical anchors	Chemical anchor	N° connection elements at each wall end
Ground tensile connection-hold down	Ground connection	Rotho Blaas	WHT 15	15 x Anker nail - LBA 4,0 x 60	1 x Threaded rod INA - 5.8 - M16 x 195	Hybrid chemical anchor ETA-20/1285	1
Ground tensile connection-hold down1	Ground connection	Rotho Blaas	WHT 15	15 x Anker nail - LBA 4,0 x 60	1 x Threaded rod INA - 5.8 - M16 x 195	Hybrid chemical anchor ETA-20/1285	2

Timber to concrete angle bracket

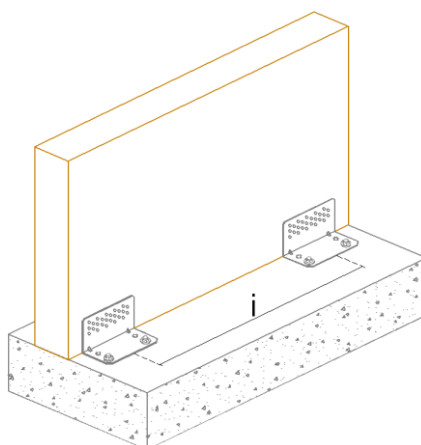


Figure: graphical representation of the shear connection with angle brackets

Connection name	Connection position	Manufacturer	Description	Fasteners	Threaded rods / Mechanical anchors	Chemical anchor	Number of sides	Spacing i [mm]
Ground shear connection - bracket1	Ground connection	Rotho Blaas	Titan N - TCN 200	30 x Anker nail - LBA 4,0 x 60	2 x Threaded rod INA - 5.8 - M12 x 140	Vinylester chemical anchor ETA-20/0363	1	2000
Ground shear connection - bracket2	Ground connection	Rotho Blaas	Titan N - TCN 200	30 x Anker nail - LBA 4,0 x 60	2 x Threaded rod INA - 5.8 - M12 x 140	Vinylester chemical anchor ETA-20/0363	1	1750
Ground shear connection - bracket3	Ground connection	Rotho Blaas	Titan N - TCN 200	30 x Anker nail - LBA 4,0 x 60	2 x Threaded rod INA - 5.8 - M12 x 140	Vinylester chemical anchor ETA-20/0363	1	750
Ground shear connection - bracket	Ground connection	Rotho Blaas	Titan N - TCN 200	30 x Anker nail - LBA 4,0 x 60	2 x Threaded rod INA - 5.8 - M12 x 140	Vinylester chemical anchor ETA-20/0363	1	500
Ground shear connection - bracket4	Ground connection	Rotho Blaas	Titan N - TCN 200	30 x Anker nail - LBA 4,0 x 60	2 x Threaded rod INA - 5.8 - M12 x 140	Vinylester chemical anchor ETA-20/0363	1	1000
Ground shear connection - bracket5	Ground connection	Rotho Blaas	Titan N - TCN 200	30 x Anker nail - LBA 4,0 x 60	2 x Threaded rod INA - 5.8 - M12 x 140	Vinylester chemical anchor ETA-20/0363	1	1250

Double hold down

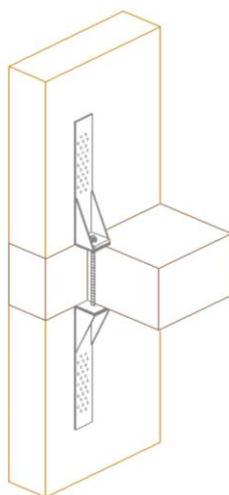


Figure: graphical representation of the hold down connection at the upper floors

Connection name	Connection position	Manufacturer	Description	Fasteners	Bolts / Threaded rods	N° connection elements at each wall end
Upper levels tensile connection - user	Upper level	Rotho Blaas	WHT 30	30 x Anker nail - LBA 4,0 x 60	1 x Threaded rod MGS - 4.8 - M20	1

Timber to timber angle bracket

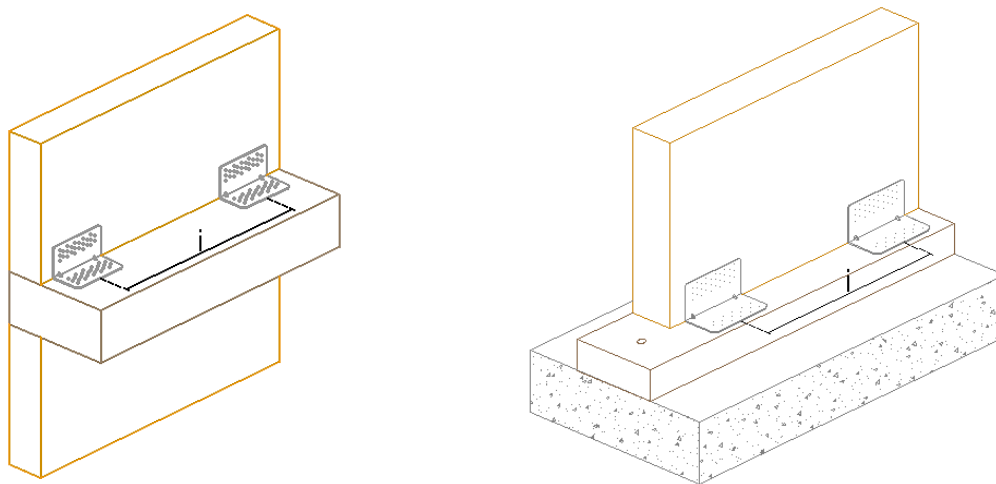
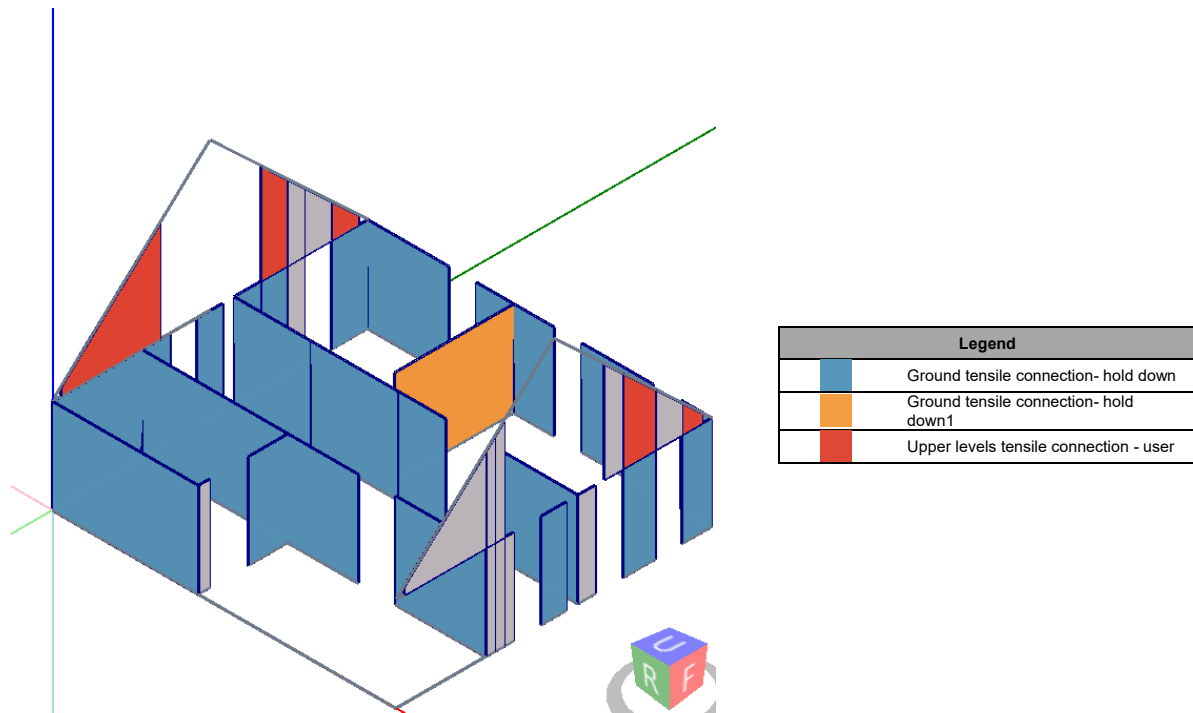


Figure: graphical representations of the timber to timber shear connection with angle brackets

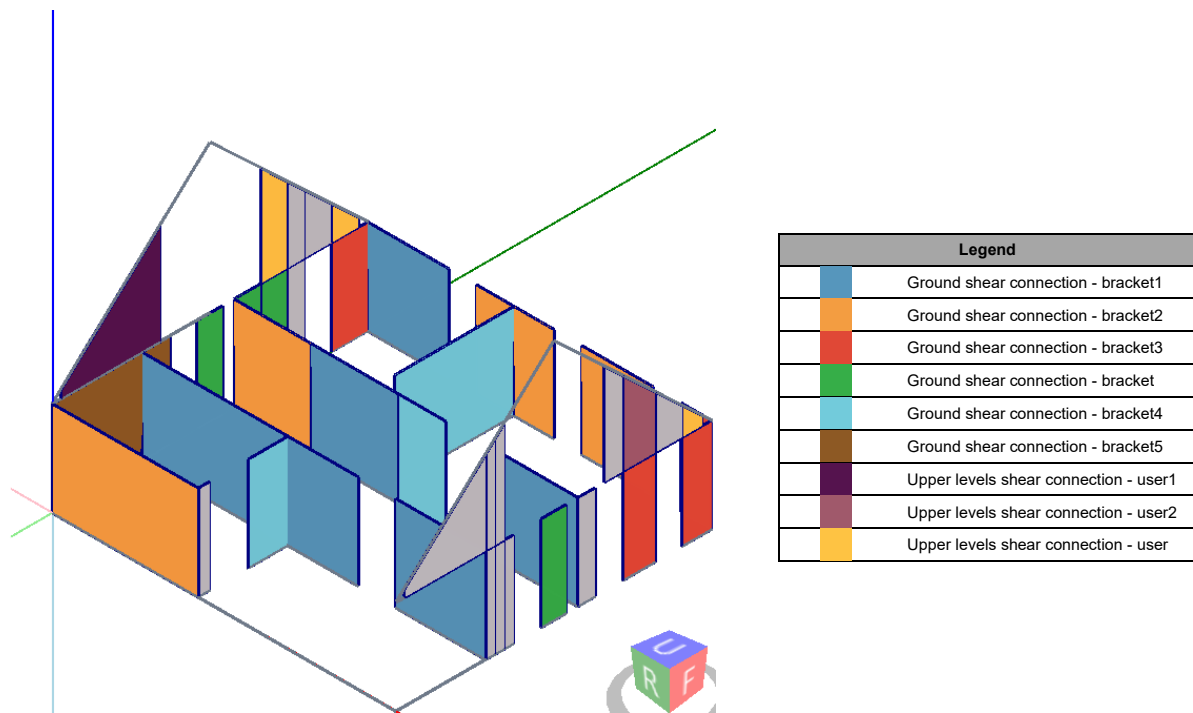
Connection name	Connection position	Manufacturer	Description	Number of fasteners on the vertical plate	Number of fasteners on the horizontal plate	Number of sides	Spacing i [mm]
Upper levels shear connection - user	Upper level	User defined	Angle bracket TT1	1 x Anker nail - 4,0 x 40	1 x Anker nail - 4,0 x 40	1	500
Upper levels shear connection - user1	Upper level	User defined	Angle bracket TT1	1 x Anker nail - 4,0 x 40	1 x Anker nail - 4,0 x 40	1	2000
Upper levels shear connection - user2	Upper level	User defined	Angle bracket TT1	1 x Anker nail - 4,0 x 40	1 x Anker nail - 4,0 x 40	1	750

Connections definition

Tensile



Shear



Combinations of actions

For each critical load case, the design values of the effects of actions shall be determined by combining the values of actions that are considered to occur simultaneously.

$$\sum_{j \geq 1} \gamma_{G,j} G_{k,j} + \gamma_{Q,1} Q_{k,1} + \sum_{i \geq 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} =$$

$$= \gamma_{G1} \cdot G_1 + \gamma_{G2} \cdot G_2 + \gamma_Q \cdot Q_{k1} + \gamma_{Q2} \cdot \psi_{02} \cdot Q_{k2} + \gamma_{Q3} \cdot \psi_{03} \cdot Q_{k3} + \dots$$

Combinations of actions for seismic design situations:

$$\sum_{j \geq 1} G_{k,j} + A_{Ed} + \sum_{i \geq 1} \psi_{2,i} Q_{k,i} =$$

$$= G_1 + G_2 + A_{Ed} + \psi_{21} \cdot Q_{k1} + \psi_{22} \cdot Q_{k2} + \dots$$

being:

- G₁ permanent actions: self weight;
- G₂ permanent actions;
- Q₁ characteristic value of the main variable action;
- Q_{ki} characteristic value of the i-th variable action;
- γ_{G1} is the partial factor for the self-weight action;
- γ_{G2} is the partial factor for the permanent actions action.

When permanent actions, as well as a portion of those, are fully defined in design process, it is possible to adopt the same partial factor employed for self-weight actions.

The following are the values of the combination coefficients used.

Action name	Description	Duration	ψ ₀	ψ ₁	ψ ₂
Q cat A	Category A: domestic, residential areas	Medium-term	0.7	0.5	0.3
Q cat B	Category B: office areas	Medium-term	0.7	0.5	0.3
Q cat C	Category C: congregation areas	Medium-term	0.7	0.7	0.6
Q cat D	Category D: shopping areas	Medium-term	0.7	0.7	0.6
Q cat E	Category E: storage areas	Long-term	1	0.9	0.8
Q cat F	Category F: traffic area, vehicle weight ≤ 30 kN	Long-term	0.7	0.7	0.6
Q cat G	Category G: traffic area, vehicle weight ≤ 160 kN	Long-term	0.7	0.5	0.3
Q cat H	Category H: roofs	Medium-term	0	0	0
Q cat I-A	Category I-A: practicable roofs of category A	Medium-term	0.7	0.5	0.3

Q cat I-B	Category I-B: practicable roofs of category B	Medium-term	0.7	0.5	0.3
Q cat I-C	Category I-C: practicable roofs of category C	Medium-term	0.7	0.7	0.6
Q cat I-D	Category I-D: practicable roofs of category D	Medium-term	0.7	0.7	0.6
Q cat I-E	Category I-E: practicable roofs of category E	Long-term	1	0.9	0.8
Ortho wind	Wind load	Instantaneous	0.6	0.2	0
Snow	Snow load (altitude <= 1000 mamsl)	Short-term	0.5	0.2	0
Snow	Snow load (altitude > 1000 mamsl)	Medium-term	0.7	0.5	0.2

Combinations of actions used

Vertical ULS loads combinations

The following table shows the ULS load combinations relevant for verifications in conditions of vertical load. The coefficient values listed correspond to the product of the partial safety factor γ_j and the combination factors ψ_{0j} .

The action of the wind is schematized with a uniform load orthogonal to each external wall.

Name	Duration	G1	G2	Q cat A	Q cat H	Snow	Ortho wind	Wind X	Wind Y	Dynamic SLV X	Dynamic SLV Y	Dynamic SLD X	Dynamic SLD Y
ULS 1	Permanent	1	1	0	0	0	0	0	0	0	0	0	0
ULS 2	Medium-term	1	1	1.5	0	0	0	0	0	0	0	0	0
ULS 3	Short-term	1	1	1.5	0	0.75	0	0	0	0	0	0	0
ULS 4	Instantaneous	1	1	1.5	0	0	0.9	0	0	0	0	0	0
ULS 5	Instantaneous	1	1	1.5	0	0.75	0.9	0	0	0	0	0	0
ULS 6	Medium-term	1	1	0	1.5	0	0	0	0	0	0	0	0
ULS 7	Medium-term	1	1	1.05	1.5	0	0	0	0	0	0	0	0
ULS 8	Short-term	1	1	0	1.5	0.75	0	0	0	0	0	0	0
ULS 9	Short-term	1	1	1.05	1.5	0.75	0	0	0	0	0	0	0
ULS 10	Instantaneous	1	1	0	1.5	0	0.9	0	0	0	0	0	0
ULS 11	Instantaneous	1	1	1.05	1.5	0	0.9	0	0	0	0	0	0
ULS 12	Instantaneous	1	1	0	1.5	0.75	0.9	0	0	0	0	0	0
ULS 13	Instantaneous	1	1	1.05	1.5	0.75	0.9	0	0	0	0	0	0
ULS 14	Short-term	1	1	0	0	1.5	0	0	0	0	0	0	0
ULS 15	Short-term	1	1	1.05	0	1.5	0	0	0	0	0	0	0
ULS 16	Instantaneous	1	1	0	0	1.5	0.9	0	0	0	0	0	0
ULS 17	Instantaneous	1	1	1.05	0	1.5	0.9	0	0	0	0	0	0
ULS 18	Instantaneous	1	1	0	0	0	1.5	0	0	0	0	0	0
ULS 19	Instantaneous	1	1	1.05	0	0	1.5	0	0	0	0	0	0
ULS 20	Instantaneous	1	1	0	0	0.75	1.5	0	0	0	0	0	0
ULS 21	Instantaneous	1	1	1.05	0	0.75	1.5	0	0	0	0	0	0
ULS 22	Permanent	1	1.35	0	0	0	0	0	0	0	0	0	0
ULS 23	Medium-term	1	1.35	1.5	0	0	0	0	0	0	0	0	0
ULS 24	Short-term	1	1.35	1.5	0	0.75	0	0	0	0	0	0	0
ULS 25	Instantaneous	1	1.35	1.5	0	0	0.9	0	0	0	0	0	0
ULS 26	Instantaneous	1	1.35	1.5	0	0.75	0.9	0	0	0	0	0	0
ULS 27	Medium-term	1	1.35	0	1.5	0	0	0	0	0	0	0	0
ULS 28	Medium-term	1	1.35	1.05	1.5	0	0	0	0	0	0	0	0
ULS 29	Short-term	1	1.35	0	1.5	0.75	0	0	0	0	0	0	0
ULS 30	Short-term	1	1.35	1.05	1.5	0.75	0	0	0	0	0	0	0
ULS 31	Instantaneous	1	1.35	0	1.5	0	0.9	0	0	0	0	0	0
ULS 32	Instantaneous	1	1.35	1.05	1.5	0	0.9	0	0	0	0	0	0
ULS 33	Instantaneous	1	1.35	0	1.5	0.75	0.9	0	0	0	0	0	0
ULS 34	Instantaneous	1	1.35	1.05	1.5	0.75	0.9	0	0	0	0	0	0
ULS 35	Short-term	1	1.35	0	0	1.5	0	0	0	0	0	0	0
ULS 36	Short-term	1	1.35	1.05	0	1.5	0	0	0	0	0	0	0
ULS 37	Instantaneous	1	1.35	0	0	1.5	0.9	0	0	0	0	0	0
ULS 38	Instantaneous	1	1.35	1.05	0	1.5	0.9	0	0	0	0	0	0
ULS 39	Instantaneous	1	1.35	0	0	0	1.5	0	0	0	0	0	0
ULS 40	Instantaneous	1	1.35	1.05	0	0	1.5	0	0	0	0	0	0
ULS 41	Instantaneous	1	1.35	0	0	0.75	1.5	0	0	0	0	0	0
ULS 42	Instantaneous	1	1.35	1.05	0	0.75	1.5	0	0	0	0	0	0
ULS 43	Permanent	1.35	1	0	0	0	0	0	0	0	0	0	0
ULS 44	Medium-term	1.35	1	1.5	0	0	0	0	0	0	0	0	0
ULS 45	Short-term	1.35	1	1.5	0	0.75	0	0	0	0	0	0	0
ULS 46	Instantaneous	1.35	1	1.5	0	0	0.9	0	0	0	0	0	0
ULS 47	Instantaneous	1.35	1	1.5	0	0.75	0.9	0	0	0	0	0	0
ULS 48	Medium-term	1.35	1	0	1.5	0	0	0	0	0	0	0	0
ULS 49	Medium-term	1.35	1	1.05	1.5	0	0	0	0	0	0	0	0
ULS 50	Short-term	1.35	1	0	1.5	0.75	0	0	0	0	0	0	0
ULS 51	Short-term	1.35	1	1.05	1.5	0.75	0	0	0	0	0	0	0
ULS 52	Instantaneous	1.35	1	0	1.5	0	0.9	0	0	0	0	0	0
ULS 53	Instantaneous	1.35	1	1.05	1.5	0	0.9	0	0	0	0	0	0
ULS 54	Instantaneous	1.35	1	0	1.5	0.75	0.9	0	0	0	0	0	0
ULS 55	Instantaneous	1.35	1	1.05	1.5	0.75	0.9	0	0	0	0	0	0
ULS 56	Short-term	1.35	1	0	0	1.5	0	0	0	0	0	0	0
ULS 57	Short-term	1.35	1	1.05	0	1.5	0	0	0	0	0	0	0
ULS 58	Instantaneous	1.35	1	0	0	1.5	0.9	0	0	0	0	0	0
ULS 59	Instantaneous	1.35	1	1.05	0	1.5	0.9	0	0	0	0	0	0
ULS 60	Instantaneous	1.35	1	0	0	0	1.5	0	0	0	0	0	0
ULS 61	Instantaneous	1.35	1	1.05	0	0	1.5	0	0	0	0	0	0
ULS 62	Instantaneous	1.35	1	0	0	0.75	1.5	0	0	0	0	0	0
ULS 63	Instantaneous	1.35	1	1.05	0	0.75	1.5	0	0	0	0	0	0
ULS 64	Permanent	1.35	1.35	0	0	0	0	0	0	0	0	0	0
ULS 65	Medium-term	1.35	1.35	1.5	0	0	0	0	0	0	0	0	0
ULS 66	Short-term	1.35	1.35	1.5	0	0.75	0	0	0	0	0	0	0
ULS 67	Instantaneous	1.35	1.35	1.5	0	0	0.9	0	0	0	0	0	0
ULS 68	Instantaneous	1.35	1.35	1.5	0	0.75	0.9	0	0	0	0	0	0
ULS 69	Medium-term	1.35	1.35	0	1.5	0	0	0	0	0	0	0	0
ULS 70	Medium-term	1.35	1.35	1.05	1.5	0	0	0	0	0	0	0	0
ULS 71	Short-term	1.35	1.35	0	1.5	0.75	0	0	0	0	0	0	0
ULS 72	Short-term	1.35	1.35	1.05	1.5	0.75	0	0	0	0	0	0	0
ULS 73	Instantaneous	1.35	1.35	0	1.5	0	0.9	0	0	0	0	0	0
ULS 74	Instantaneous	1.35	1.35	1.05	1.5	0	0.9	0	0	0	0	0	0
ULS 75	Instantaneous	1.35	1.35	0	1.5	0.75	0.9	0	0	0	0	0	0

ULS 76	Instantaneous	1.35	1.35	1.05	1.5	0.75	0.9	0	0	0	0	0	0
ULS 77	Short-term	1.35	1.35	0	0	1.5	0	0	0	0	0	0	0
ULS 78	Short-term	1.35	1.35	1.05	0	1.5	0	0	0	0	0	0	0
ULS 79	Instantaneous	1.35	1.35	0	0	1.5	0.9	0	0	0	0	0	0
ULS 80	Instantaneous	1.35	1.35	1.05	0	1.5	0.9	0	0	0	0	0	0
ULS 81	Instantaneous	1.35	1.35	0	0	0	1.5	0	0	0	0	0	0
ULS 82	Instantaneous	1.35	1.35	1.05	0	0	1.5	0	0	0	0	0	0
ULS 83	Instantaneous	1.35	1.35	0	0	0.75	1.5	0	0	0	0	0	0
ULS 84	Instantaneous	1.35	1.35	1.05	0	0.75	1.5	0	0	0	0	0	0

Horizontal ULS loads combinations

The following table shows the ULS load combinations relevant for verifications in conditions of vertical load. The coefficient values listed correspond to the product of the partial safety factor γ_j and the combination factors ψ_{0j} .

The action of the wind is schematized with a uniform load orthogonal to each external wall and it acts separately in the directions x, -x, y, -y.

Name	Duration	G1	G2	Q cat A	Q cat H	Snow	Ortho wind	Wind X	Wind Y	Dynamic SLV X	Dynamic SLV Y	Dynamic SLD X	Dynamic SLD Y
Horizontal ULS 1	Instantaneous	1	1	0	0	0	0	1.5	0	0	0	0	0
Horizontal ULS 2	Instantaneous	1	1	0	0	0	0	0	1.5	0	0	0	0
Horizontal ULS 3	Instantaneous	1	1	0	0	0	0	-1.5	0	0	0	0	0
Horizontal ULS 4	Instantaneous	1	1	0	0	0	0	0	-1.5	0	0	0	0
Horizontal ULS 5	Instantaneous	1.35	1.35	1.05	0	0.75	0	1.5	0	0	0	0	0
Horizontal ULS 6	Instantaneous	1.35	1.35	1.05	0	0.75	0	0	1.5	0	0	0	0
Horizontal ULS 7	Instantaneous	1.35	1.35	1.05	0	0.75	0	-1.5	0	0	0	0	0
Horizontal ULS 8	Instantaneous	1.35	1.35	1.05	0	0.75	0	0	-1.5	0	0	0	0

Combination of actions for rare SLS

Name	Duration	G1	G2	Q cat A	Q cat H	Snow	Ortho wind	Wind X	Wind Y	Dynamic SLV X	Dynamic SLV Y	Dynamic SLD X	Dynamic SLD Y
SLS characteristic 1	Permanent	1	1	0	0	0	0	0	0	0	0	0	0
SLS characteristic 2	Medium-term	1	1	1	0	0	0	0	0	0	0	0	0
SLS characteristic 3	Short-term	1	1	1	0	0.5	0	0	0	0	0	0	0
SLS characteristic 4	Instantaneous	1	1	1	0	0	0.6	0	0	0	0	0	0
SLS characteristic 5	Instantaneous	1	1	1	0	0.5	0.6	0	0	0	0	0	0
SLS characteristic 6	Medium-term	1	1	0	1	0	0	0	0	0	0	0	0
SLS characteristic 7	Medium-term	1	1	0.7	1	0	0	0	0	0	0	0	0
SLS characteristic 8	Short-term	1	1	0	1	0.5	0	0	0	0	0	0	0
SLS characteristic 9	Short-term	1	1	0.7	1	0.5	0	0	0	0	0	0	0
SLS characteristic 10	Instantaneous	1	1	0	1	0	0.6	0	0	0	0	0	0
SLS characteristic 11	Instantaneous	1	1	0.7	1	0	0.6	0	0	0	0	0	0
SLS characteristic 12	Instantaneous	1	1	0	1	0.5	0.6	0	0	0	0	0	0
SLS characteristic 13	Instantaneous	1	1	0.7	1	0.5	0.6	0	0	0	0	0	0
SLS characteristic 14	Short-term	1	1	0	0	1	0	0	0	0	0	0	0
SLS characteristic 15	Short-term	1	1	0.7	0	1	0	0	0	0	0	0	0
SLS characteristic 16	Instantaneous	1	1	0	0	1	0.6	0	0	0	0	0	0

SLS characteristic 17	Instantaneous	1	1	0.7	0	1	0.6	0	0	0	0	0	0
SLS characteristic 18	Instantaneous	1	1	0	0	0	1	0	0	0	0	0	0
SLS characteristic 19	Instantaneous	1	1	0.7	0	0	1	0	0	0	0	0	0
SLS characteristic 20	Instantaneous	1	1	0	0	0.5	1	0	0	0	0	0	0
SLS characteristic 21	Instantaneous	1	1	0.7	0	0.5	1	0	0	0	0	0	0

Seismic load combinations

The action effects due to the combination of the horizontal components of the seismic action are computed using the following combinations:

$$E_{Edx} + 0,3 \cdot E_{Edy}$$

$$0,3 \cdot E_{Edx} + E_{Edy}$$

Combinations of actions for Damage Limit State (SLD)

Name	Duration	G1	G2	Q cat A	Q cat H	Snow	Ortho wind	Wind X	Wind Y	Dynamic SLV X	Dynamic SLV Y	Dynamic SLD X	Dynamic SLD Y
Dynamic SLD 1 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	1	0.3
Dynamic SLD 1 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	1	0.3
Dynamic SLD 1 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	1	0.3
Dynamic SLD 1 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	1	0.3
Dynamic SLD 2 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	1	-0.3
Dynamic SLD 2 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	1	-0.3
Dynamic SLD 2 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	1	-0.3
Dynamic SLD 2 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	1	-0.3
Dynamic SLD 3 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-1	0.3
Dynamic SLD 3 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-1	0.3
Dynamic SLD 3 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-1	0.3
Dynamic SLD 3 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-1	0.3
Dynamic SLD 4 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-1	-0.3
Dynamic SLD 4 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-1	-0.3
Dynamic SLD 4 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-1	-0.3
Dynamic SLD 4 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-1	-0.3
Dynamic SLD 5 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	0.3	1
Dynamic SLD 5 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	0.3	1
Dynamic SLD 5 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	0.3	1
Dynamic SLD 5 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	0.3	1
Dynamic SLD 6 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	0.3	-1
Dynamic SLD 6 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	0.3	-1
Dynamic SLD 6 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	0.3	-1
Dynamic SLD 6 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	0.3	-1

Dynamic SLD 7 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-0.3	1
Dynamic SLD 7 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-0.3	1
Dynamic SLD 7 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-0.3	1
Dynamic SLD 7 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-0.3	1
Dynamic SLD 8 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-0.3	-1
Dynamic SLD 8 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-0.3	-1
Dynamic SLD 8 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-0.3	-1
Dynamic SLD 8 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0	0	-0.3	-1

Combinations of actions for Life Safety Limit State (SLV)

Name	Duration	G1	G2	Q cat A	Q cat H	Snow	Ortho wind	Wind X	Wind Y	Dynamic SLV X	Dynamic SLV Y	Dynamic SLD X	Dynamic SLD Y
Dynamic SLV 1 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	1	0.3	0	0
Dynamic SLV 1 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	1	0.3	0	0
Dynamic SLV 1 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	1	0.3	0	0
Dynamic SLV 1 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	1	0.3	0	0
Dynamic SLV 2 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	1	-0.3	0	0
Dynamic SLV 2 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	1	-0.3	0	0
Dynamic SLV 2 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	1	-0.3	0	0
Dynamic SLV 2 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	1	-0.3	0	0
Dynamic SLV 3 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-1	0.3	0	0
Dynamic SLV 3 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-1	0.3	0	0
Dynamic SLV 3 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-1	0.3	0	0
Dynamic SLV 3 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-1	0.3	0	0
Dynamic SLV 4 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-1	-0.3	0	0
Dynamic SLV 4 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-1	-0.3	0	0
Dynamic SLV 4 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-1	-0.3	0	0
Dynamic SLV 4 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-1	-0.3	0	0
Dynamic SLV 5 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	1	0	0
Dynamic SLV 5 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	1	0	0
Dynamic SLV 5 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	1	0	0
Dynamic SLV 5 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	1	0	0
Dynamic SLV 6 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	-1	0	0
Dynamic SLV 6 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	-1	0	0

Dynamic SLV 6 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	-1	0	0
Dynamic SLV 6 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	-1	0	0
Dynamic SLV 7 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	1	0	0
Dynamic SLV 7 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	1	0	0
Dynamic SLV 7 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	1	0	0
Dynamic SLV 7 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	1	0	0
Dynamic SLV 8 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	-1	0	0
Dynamic SLV 8 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	-1	0	0
Dynamic SLV 8 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	-1	0	0
Dynamic SLV 8 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	-1	0	0

Horizontal actions

Modal analysis

The modal analysis is used to determine the vibration modes of the structure, useful to understand the seismic behaviour of the building and to proceed with the linear dynamic analysis.

The modal analysis involves the solution of the generalized eigenvalue problem:

$$[K - \Omega^2 M] \Phi = 0$$

where K is the stiffness matrix, M the mass matrix, Ω^2 is the diagonal matrix of the eigenvalues and Φ is the corresponding matrix of eigenvectors or modal shapes (normalized with respect to the mass matrix); the seismic masses of the diaphragms are calculated with the following combination of vertical loads:

$$\sum G_{k,j} + \sum \psi_{Ei} \cdot Q_{ki} = G_1 + G_2 + \sum \psi_{Ei} \cdot Q_{ki}$$

where ψ_{Ei} is the combination coefficient for variable action i . The combination coefficients shall be computed from the following expression:

$$\psi_{Ei} = \varphi \cdot \psi_{2i}$$

Type of variable action	Storey	φ
Categories A-C (as defined in EN 1991-1-1)	Roof	1
	Storeys with correlated occupancies	0.8
	Independently occupied storeys	0.5
Categories D-F (as defined in EN 1991-1-1)		1

The base shear forces for DLS and ULS and the respective acceleration values are given below.

The eigenvalue, obtained by the solution of the generalized eigenvalue problem, is the square of the circular frequency ω related to the period, T , and to the frequency, f , by the following equations:

$$T = \frac{1}{f} \text{ and } f = \frac{\omega}{2\pi}$$

The participating mass ratio for the mode i -th, corresponding to an acceleration in the global axis X and Y and to a rotational acceleration around the vertical axis Z, is given by:

$$M_x^i = \frac{m_x^i}{\sum m_{x,j}} [\%]$$

$$M_y^i = \frac{m_y^i}{\sum m_{y,j}} [\%]$$

$$M_z^i = \frac{m_z^i}{\sum I_{z,j}} [\%]$$

where

$$m_x^i = \frac{([\Phi^i]^T M R_x)^2}{[\Phi^i]^T M \Phi^i}$$

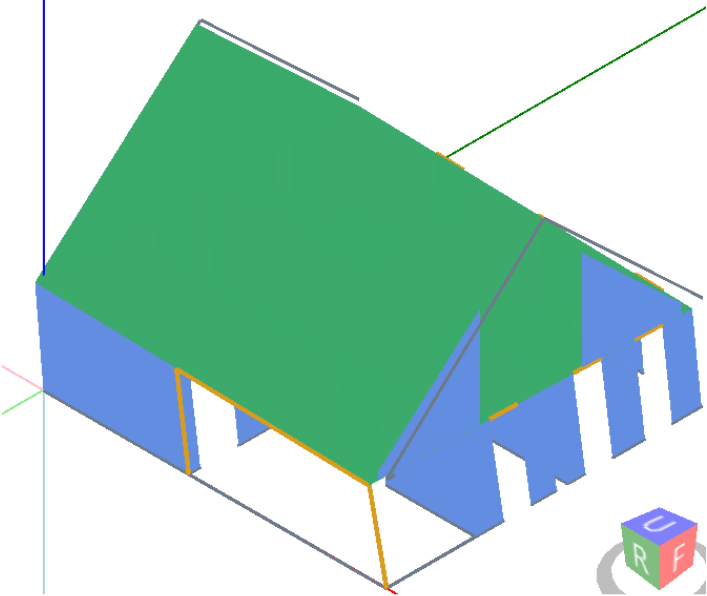
$$m_y^i = \frac{([\Phi^i]^T M R_y)^2}{[\Phi^i]^T M \Phi^i}$$

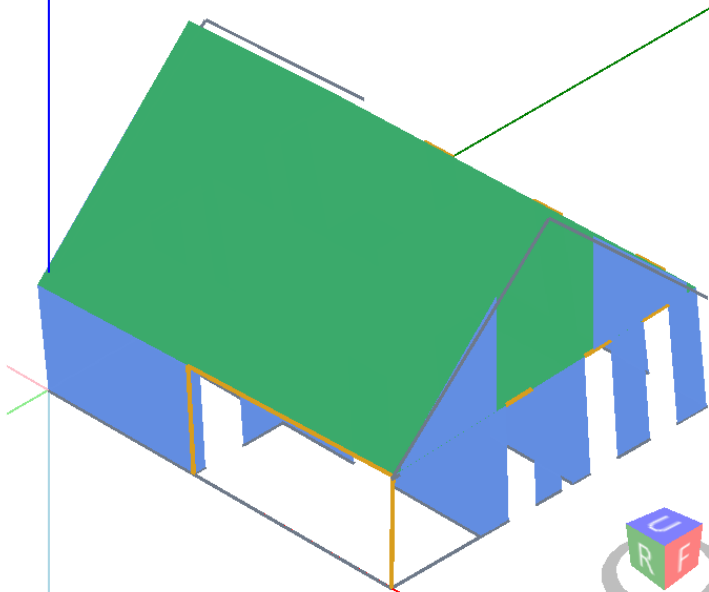
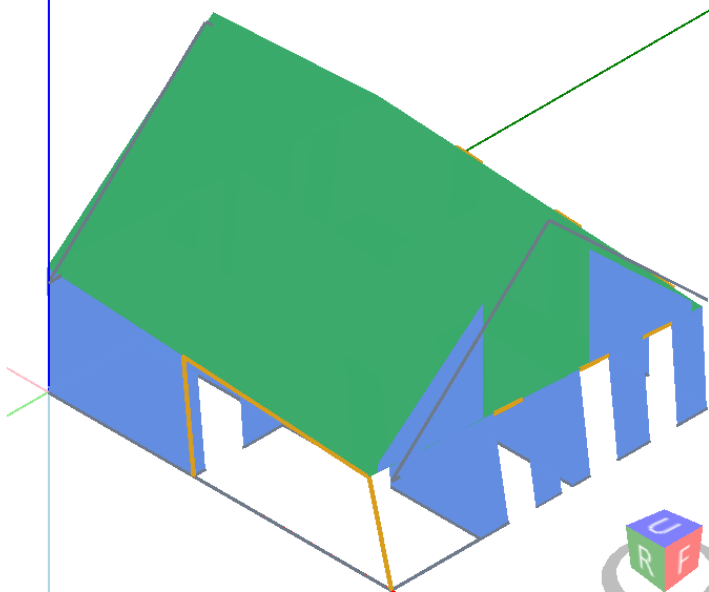
$$m_z^i = \frac{([\Phi^i]^T M R_z)^2}{[\Phi^i]^T M \Phi^i}$$

and where $\sum m_{x,j}$, $\sum m_{y,j}$ and $\sum I_{z,j}$ are the total masses acting in the axis X, Y and the total rotational inertia about the axis Z of the unrestrained j -th degrees of freedom.

Mode	Period [s]	Frequency [Hz]	M _x [%]	Sum M _x [%]	M _y [%]	Sum M _y [%]	M _z [%]	Sum M _z [%]
Mode 1	0.18	5.52	0.25	0.25	88.19	88.19	11.56	11.56
Mode 2	0.11	8.77	70.23	70.48	5.04	93.24	24.73	36.28
Mode 3	0.10	9.61	29.52	100.00	6.76	100.00	63.72	100.00

The table shows, limited to the first six modes of vibration, the corresponding period and the modal deformed shape.

Mode	Period [s]	Modal deformed shape
Mode 1	0.18	

Mode 2	0.11	
Mode 3	0.10	

Dynamic linear analysis

The dynamic linear analysis consists of:

- the calculation of the seismic effects (the seismic action is represented by the design response spectrum), of each of the vibration modes calculated in the modal analysis;
- combination of these effects.

The seismic effects of the structural model are obtained by the application of the following external loads:

$$F_x^i = \Gamma_x^i S_d(T_i) M \Phi^i$$

and

$$F_y^i = \Gamma_y^i S_d(T_i) M \Phi^i$$

where:

F_x^i and F_y^i are the external loads of the *i*-th vibration mode due to seismic action along X and Y;

$S_d(T_i)$ is the spectrum value corresponding to the *i*-th period;

Φ^i is the *i*-th modal shape;

Γ_x^i and Γ_y^i are the participating modal factor of the *i*-th mode given by:

$$\Gamma_x^i = \frac{[\Phi^i]^T M R_x}{[\Phi^i]^T M \Phi^i} \text{ and } \Gamma_y^i = \frac{[\Phi^i]^T M R_y}{[\Phi^i]^T M \Phi^i}$$

The effects for a given direction of acceleration (along X or Y) and for each of the vibration modes are combined with the Complete Quadratic Combination technique defined as:

$$E = \sqrt{\sum_j \sum_i \rho_{ij} \cdot E_i \cdot E_j}$$

where:

E_j is the effect of the *j*-th vibration mode;

ρ_{ij} is the correlation coefficient of the *i*-th mode and the *j*-th mode, given by:

$$\rho_{ij} = \frac{8 \cdot \xi^2 \cdot \beta_{ij}^{3/2}}{(1 + \beta_{ij}) \cdot [(1 - \beta_{ij})^2 + 4 \cdot \xi^2 \cdot \beta_{ij}]}$$

ξ is the damping ratio in the *i*-th and *j*-th modes;

$$\beta_{ij} = T_j / T_i.$$

The following table provides the diaphragms properties.

Diaphragm	Height above the base of the timber structure [m]	xG [m]	yG [m]	Accidental eccentricity ex [m]	Accidental eccentricity ey [m]	Mass i [kg]
1	3.21	4.31	3.99	0.44	0.40	42359

The following table provides, for each of the vibration mode, the corresponding period and value of the response spectrum, both SLV value and the SLD value.

Mode	Period [s]	SLV spectrum value [g]	SLD spectrum value [g]
Mode 1	0.19	0.29	0.22
Mode 2	0.12	0.25	0.19
Mode 3	0.10	0.23	0.17

Wind

The table below illustrates the horizontal forces acting on the storeys due to the wind action and the coordinates of their respective application points.

Diaphragm	Height above the reference plane [m]	xG,wind [m]	yG,wind [m]	Fx [kN]	Fy [kN]
1	3.21	4.38	4.01	6.11	3.96

The action effects

In this chapter are reported the internal stresses present in the structural elements and their connections caused by the different loads.

Walls

Wall name: Wall ID

N: Total axial force

V2: Shear force (in-plane)

V3: Shear force (out-of-plane)

M2-2: Bending moment (out-of-plane)

M3-3: Bending moment (in-plane)

dr: Interstorey drift

Load	Wall name	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]	dr [mm]
G1	Wall 1	6.37	0.00	0.00	0.00	0.00	0.00
G1	Wall 2	7.44	0.00	0.00	0.00	0.00	0.00
G1	Wall 3	6.81	0.00	0.00	0.00	0.00	0.00
G1	Wall 4	2.80	0.00	0.00	0.00	0.00	0.00
G1	Wall 5	1.02	0.00	0.00	0.00	0.00	0.00
G1	Wall 6	1.96	0.00	0.00	0.00	0.00	0.00
G1	Wall 7	0.69	0.00	0.00	0.00	0.00	0.00
G1	Wall 8 - 1	0.43	0.00	0.00	0.00	0.00	N/D
G1	Wall 9	6.63	0.00	0.00	0.00	0.00	0.00
G1	Wall 10	13.65	0.00	0.00	0.00	0.00	0.00
G1	Wall 11	1.07	0.00	0.00	0.00	0.00	0.00
G1	Wall 12	0.33	0.00	0.00	0.00	0.00	N/D
G1	Wall 13	9.92	0.00	0.00	0.00	0.00	0.00
G1	Wall 14	4.50	0.00	0.00	0.00	0.00	0.00
G1	Wall 16	1.28	0.00	0.00	0.00	0.00	0.00
G1	Wall 17	5.50	0.00	0.00	0.00	0.00	0.00
G1	Wall 18	6.28	0.00	0.00	0.00	0.00	0.00
G1	Wall 19	6.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 20	7.43	0.00	0.00	0.00	0.00	0.00
G1	Wall 21	0.63	0.00	0.00	0.00	0.00	N/D
G1	Wall 22	3.06	0.00	0.00	0.00	0.00	0.00
G1	Wall 23	0.68	0.00	0.00	0.00	0.00	0.00
G1	Wall 24 - 1	0.98	0.00	0.00	0.00	0.00	N/D
G1	Wall 25 - 1	0.21	0.00	0.00	0.00	0.00	N/D
G1	Wall 29	1.46	0.00	0.00	0.00	0.00	0.00
G1	Wall 30 - 1	0.61	0.00	0.00	0.00	0.00	0.00
G1	Wall 31	0.10	0.00	0.00	0.00	0.00	0.00
G1	Wall 34 - 1	0.32	0.00	0.00	0.00	0.00	N/D
G1	Wall 35	0.16	0.00	0.00	0.00	0.00	0.00
G1	Wall 25 - 2	1.01	0.00	0.00	0.00	0.00	N/D
G1	Wall 25 - 3	0.25	0.00	0.00	0.00	0.00	N/D
G1	Wall 30 - 2	0.45	0.00	0.00	0.00	0.00	N/D
G1	Wall 30 - 3	0.30	0.00	0.00	0.00	0.00	N/D
G1	Wall 34 - 2	0.63	0.00	0.00	0.00	0.00	0.00
G1	Wall 34 - 3	0.34	0.00	0.00	0.00	0.00	N/D
G1	Wall 8 - 2	0.49	0.00	0.00	0.00	0.00	N/D
G1	Wall 24 - 2	1.31	0.00	0.00	0.00	0.00	0.00
G1	Wall 8 - 3	0.27	0.00	0.00	0.00	0.00	N/D
G1	Wall 24 - 3	0.68	0.00	0.00	0.00	0.00	0.00
G2	Wall 1	26.74	0.00	0.00	0.00	0.00	0.00
G2	Wall 2	32.42	0.00	0.00	0.00	0.00	0.00
G2	Wall 3	30.26	0.00	0.00	0.00	0.00	0.00
G2	Wall 4	12.32	0.00	0.00	0.00	0.00	0.00
G2	Wall 5	1.41	0.00	0.00	0.00	0.00	0.00
G2	Wall 6	2.72	0.00	0.00	0.00	0.00	0.00
G2	Wall 7	0.95	0.00	0.00	0.00	0.00	0.00
G2	Wall 8 - 1	0.61	0.00	0.00	0.00	0.00	N/D
G2	Wall 9	16.23	0.00	0.00	0.00	0.00	0.00
G2	Wall 10	35.33	0.00	0.00	0.00	0.00	0.00
G2	Wall 11	1.47	0.00	0.00	0.00	0.00	0.00
G2	Wall 12	0.42	0.00	0.00	0.00	0.00	N/D
G2	Wall 13	42.16	0.00	0.00	0.00	0.00	0.00
G2	Wall 14	6.39	0.00	0.00	0.00	0.00	0.00
G2	Wall 16	1.79	0.00	0.00	0.00	0.00	0.00
G2	Wall 17	14.80	0.00	0.00	0.00	0.00	0.00

G2	Wall 18	16.92	0.00	0.00	0.00	0.00	0.00
G2	Wall 19	17.86	0.00	0.00	0.00	0.00	0.00
G2	Wall 20	21.04	0.00	0.00	0.00	0.00	0.00
G2	Wall 21	0.86	0.00	0.00	0.00	0.00	N/D
G2	Wall 22	4.38	0.00	0.00	0.00	0.00	0.00
G2	Wall 23	0.94	0.00	0.00	0.00	0.00	0.00
G2	Wall 24 - 1	1.36	0.00	0.00	0.00	0.00	N/D
G2	Wall 25 - 1	0.29	0.00	0.00	0.00	0.00	N/D
G2	Wall 29	2.09	0.00	0.00	0.00	0.00	0.00
G2	Wall 30 - 1	0.87	0.00	0.00	0.00	0.00	0.00
G2	Wall 31	0.14	0.00	0.00	0.00	0.00	0.00
G2	Wall 34 - 1	0.46	0.00	0.00	0.00	0.00	N/D
G2	Wall 35	0.23	0.00	0.00	0.00	0.00	0.00
G2	Wall 25 - 2	1.44	0.00	0.00	0.00	0.00	N/D
G2	Wall 25 - 3	0.35	0.00	0.00	0.00	0.00	N/D
G2	Wall 30 - 2	0.65	0.00	0.00	0.00	0.00	N/D
G2	Wall 30 - 3	0.42	0.00	0.00	0.00	0.00	N/D
G2	Wall 34 - 2	0.90	0.00	0.00	0.00	0.00	0.00
G2	Wall 34 - 3	0.49	0.00	0.00	0.00	0.00	N/D
G2	Wall 8 - 2	0.70	0.00	0.00	0.00	0.00	N/D
G2	Wall 24 - 2	1.87	0.00	0.00	0.00	0.00	0.00
G2	Wall 8 - 3	0.35	0.00	0.00	0.00	0.00	N/D
G2	Wall 24 - 3	0.96	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 1	6.37	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 2	8.45	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 3	7.05	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 4	2.82	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 8 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 9	11.76	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 10	27.40	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 11	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 12	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 13	7.19	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 14	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 16	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 17	11.98	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 18	13.69	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 19	16.13	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 20	18.09	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 21	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 22	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 23	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 24 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 25 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 30 - 1	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 34 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 25 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 25 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 30 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 30 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 34 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 34 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 8 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 24 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Q cat A	Wall 8 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Q cat A	Wall 24 - 3	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 1	4.97	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 2	6.03	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 3	5.87	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 4	2.39	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 8 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 10	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 11	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 12	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 13	8.46	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 14	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 16	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 18	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 21	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 22	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 23	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 24 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 25 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 30 - 1	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 34 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 25 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 25 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 30 - 2	0.00	0.00	0.00	0.00	0.00	N/D

Q cat H	Wall 30 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 34 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 34 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 8 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 24 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Q cat H	Wall 8 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Q cat H	Wall 24 - 3	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 1	22.68	0.00	0.00	0.00	0.00	0.00
Snow	Wall 2	27.53	0.00	0.00	0.00	0.00	0.00
Snow	Wall 3	26.81	0.00	0.00	0.00	0.00	0.00
Snow	Wall 4	10.91	0.00	0.00	0.00	0.00	0.00
Snow	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 8 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 10	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 11	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 12	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 13	38.64	0.00	0.00	0.00	0.00	0.00
Snow	Wall 14	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 16	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 18	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 21	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 22	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 23	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 24 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 25 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 30 - 1	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 34 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 25 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 25 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 30 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 30 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 34 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 34 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 8 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 24 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Snow	Wall 8 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Snow	Wall 24 - 3	0.00	0.00	0.00	0.00	0.00	0.00
Ortho wind	Wall 1	-7.73	0.00	1.22	0.73	0.00	0.00
Ortho wind	Wall 2	-9.38	0.00	1.17	0.70	0.00	0.00
Ortho wind	Wall 3	-9.14	0.00	1.09	0.65	0.00	0.00
Ortho wind	Wall 4	-3.72	0.00	0.46	0.28	0.00	0.00
Ortho wind	Wall 5	0.00	0.00	0.44	0.27	0.00	0.00
Ortho wind	Wall 6	0.00	0.00	0.49	0.29	0.00	0.00
Ortho wind	Wall 7	0.00	0.00	0.39	0.23	0.00	0.00
Ortho wind	Wall 8 - 1	0.00	0.00	0.13	0.08	0.00	N/D
Ortho wind	Wall 9	0.00	0.00	1.36	0.81	0.00	0.00
Ortho wind	Wall 10	0.00	0.00	3.25	1.95	0.00	0.00
Ortho wind	Wall 11	0.00	0.00	0.60	0.36	0.00	0.00
Ortho wind	Wall 12	0.00	0.00	0.17	0.10	0.00	N/D
Ortho wind	Wall 13	-13.17	0.00	2.19	1.31	0.00	0.00
Ortho wind	Wall 14	0.00	0.00	1.76	1.06	0.00	0.00
Ortho wind	Wall 16	0.00	0.00	0.55	0.33	0.00	0.00
Ortho wind	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00
Ortho wind	Wall 18	0.00	0.00	0.00	0.00	0.00	0.00
Ortho wind	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00
Ortho wind	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00
Ortho wind	Wall 21	0.00	0.00	0.26	0.16	0.00	N/D
Ortho wind	Wall 22	0.00	0.00	0.00	0.00	0.00	0.00
Ortho wind	Wall 23	0.00	0.00	0.38	0.23	0.00	0.00
Ortho wind	Wall 24 - 1	0.00	0.00	0.26	0.16	0.00	N/D
Ortho wind	Wall 25 - 1	0.00	0.00	0.12	0.07	0.00	N/D
Ortho wind	Wall 29	0.00	0.00	0.86	0.29	0.00	0.00
Ortho wind	Wall 30 - 1	0.00	0.00	0.35	0.15	0.00	0.00
Ortho wind	Wall 31	0.00	0.00	0.06	0.01	0.00	0.00
Ortho wind	Wall 34 - 1	0.00	0.00	0.19	0.08	0.00	N/D
Ortho wind	Wall 35	0.00	0.00	0.09	0.01	0.00	0.00
Ortho wind	Wall 25 - 2	0.00	0.00	0.59	0.17	0.00	N/D
Ortho wind	Wall 25 - 3	0.00	0.00	0.14	0.09	0.00	N/D
Ortho wind	Wall 30 - 2	0.00	0.00	0.26	0.15	0.00	N/D
Ortho wind	Wall 30 - 3	0.00	0.00	0.17	0.04	0.00	N/D
Ortho wind	Wall 34 - 2	0.00	0.00	0.37	0.21	0.00	0.00
Ortho wind	Wall 34 - 3	0.00	0.00	0.20	0.06	0.00	N/D
Ortho wind	Wall 8 - 2	0.00	0.00	0.14	0.08	0.00	N/D
Ortho wind	Wall 24 - 2	0.00	0.00	0.40	0.24	0.00	0.00
Ortho wind	Wall 8 - 3	0.00	0.00	0.14	0.08	0.00	N/D
Ortho wind	Wall 24 - 3	0.00	0.00	0.40	0.24	0.00	0.00
Wind X	Wall 1	0.00	0.50	0.00	0.00	1.19	0.05
Wind X	Wall 2	0.00	0.47	0.00	0.00	1.12	0.05
Wind X	Wall 3	0.00	0.42	0.00	0.00	1.00	0.05
Wind X	Wall 4	0.00	0.10	0.00	0.00	0.24	0.05
Wind X	Wall 5	0.00	0.02	0.00	0.00	0.04	0.01
Wind X	Wall 6	0.00	0.02	0.00	0.00	0.05	0.01
Wind X	Wall 7	0.00	0.01	0.00	0.00	0.03	0.01
Wind X	Wall 8 - 1	0.00	0.00	0.00	0.00	0.00	N/D

Wind X	Wall 9	0.00	0.48	0.00	0.00	1.15	0.04
Wind X	Wall 10	0.00	1.61	0.00	0.00	3.87	0.04
Wind X	Wall 11	0.00	0.00	0.00	0.00	0.01	0.00
Wind X	Wall 12	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 13	0.00	0.96	0.00	0.00	2.31	0.04
Wind X	Wall 14	0.00	0.07	0.00	0.00	0.17	0.00
Wind X	Wall 16	0.00	0.01	0.00	0.00	0.02	0.00
Wind X	Wall 17	0.00	0.41	0.00	0.00	0.99	0.05
Wind X	Wall 18	0.00	0.50	0.00	0.00	1.20	0.05
Wind X	Wall 19	0.00	0.19	0.00	0.00	0.46	0.05
Wind X	Wall 20	0.00	0.47	0.00	0.00	1.12	0.05
Wind X	Wall 21	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 22	0.00	0.04	0.00	0.00	0.10	0.00
Wind X	Wall 23	0.00	0.01	0.00	0.00	0.01	0.00
Wind X	Wall 24 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 25 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00
Wind X	Wall 30 - 1	0.00	0.00	0.00	0.00	0.00	0.00
Wind X	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00
Wind X	Wall 34 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00
Wind X	Wall 25 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 25 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 30 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 30 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 34 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Wind X	Wall 34 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 8 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 24 - 2	0.00	0.01	0.00	0.00	0.01	0.00
Wind X	Wall 8 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 24 - 3	0.00	0.01	0.00	0.00	0.01	0.00
Wind Y	Wall 1	0.00	0.20	0.00	0.00	0.49	0.02
Wind Y	Wall 2	0.00	0.19	0.00	0.00	0.46	0.02
Wind Y	Wall 3	0.00	0.17	0.00	0.00	0.41	0.02
Wind Y	Wall 4	0.00	0.04	0.00	0.00	0.10	0.02
Wind Y	Wall 5	0.00	0.17	0.00	0.00	0.41	0.09
Wind Y	Wall 6	0.00	0.20	0.00	0.00	0.49	0.09
Wind Y	Wall 7	0.00	0.13	0.00	0.00	0.32	0.09
Wind Y	Wall 8 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 9	0.00	0.08	0.00	0.00	0.18	0.01
Wind Y	Wall 10	0.00	0.26	0.00	0.00	0.61	0.01
Wind Y	Wall 11	0.00	0.22	0.00	0.00	0.52	0.07
Wind Y	Wall 12	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 13	0.00	0.43	0.00	0.00	1.04	0.02
Wind Y	Wall 14	0.00	0.94	0.00	0.00	2.25	0.05
Wind Y	Wall 16	0.00	0.14	0.00	0.00	0.33	0.05
Wind Y	Wall 17	0.00	0.04	0.00	0.00	0.10	0.00
Wind Y	Wall 18	0.00	0.05	0.00	0.00	0.12	0.00
Wind Y	Wall 19	0.00	0.02	0.00	0.00	0.05	0.00
Wind Y	Wall 20	0.00	0.05	0.00	0.00	0.11	0.00
Wind Y	Wall 21	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 22	0.00	1.94	0.00	0.00	4.65	0.07
Wind Y	Wall 23	0.00	0.07	0.00	0.00	0.17	0.05
Wind Y	Wall 24 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 25 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00
Wind Y	Wall 30 - 1	0.00	0.00	0.00	0.00	0.00	0.00
Wind Y	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00
Wind Y	Wall 34 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00
Wind Y	Wall 25 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 25 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 30 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 30 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 34 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Wind Y	Wall 34 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 8 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 24 - 2	0.00	0.08	0.00	0.00	0.18	0.05
Wind Y	Wall 8 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 24 - 3	0.00	0.08	0.00	0.00	0.18	0.05
Dynamic SLV X	Wall 1	0.00	9.47	0.00	0.00	22.72	0.98
Dynamic SLV X	Wall 2	0.00	8.95	0.00	0.00	21.47	0.98
Dynamic SLV X	Wall 3	0.00	7.98	0.00	0.00	19.15	0.98
Dynamic SLV X	Wall 4	0.00	1.90	0.00	0.00	4.55	0.98
Dynamic SLV X	Wall 5	0.00	0.87	0.00	0.00	2.08	0.48
Dynamic SLV X	Wall 6	0.00	1.04	0.00	0.00	2.50	0.48
Dynamic SLV X	Wall 7	0.00	0.68	0.00	0.00	1.64	0.48
Dynamic SLV X	Wall 8 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 9	0.00	6.15	0.00	0.00	14.75	0.55
Dynamic SLV X	Wall 10	0.00	20.63	0.00	0.00	49.51	0.55
Dynamic SLV X	Wall 11	0.00	1.24	0.00	0.00	2.98	0.40
Dynamic SLV X	Wall 12	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 13	0.00	12.57	0.00	0.00	30.17	0.52
Dynamic SLV X	Wall 14	0.00	13.06	0.00	0.00	31.35	0.71
Dynamic SLV X	Wall 16	0.00	1.89	0.00	0.00	4.55	0.71
Dynamic SLV X	Wall 17	0.00	6.13	0.00	0.00	14.72	0.68
Dynamic SLV X	Wall 18	0.00	7.40	0.00	0.00	17.76	0.68
Dynamic SLV X	Wall 19	0.00	2.83	0.00	0.00	6.79	0.68
Dynamic SLV X	Wall 20	0.00	6.90	0.00	0.00	16.57	0.68
Dynamic SLV X	Wall 21	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 22	0.00	11.11	0.00	0.00	26.65	0.40
Dynamic SLV X	Wall 23	0.00	0.99	0.00	0.00	2.38	0.71
Dynamic SLV X	Wall 24 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 25 - 1	0.00	0.00	0.00	0.00	0.00	N/D

Dynamic SLV X	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV X	Wall 30 - 1	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV X	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV X	Wall 34 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV X	Wall 25 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 25 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 30 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 30 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 34 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV X	Wall 34 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 8 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 24 - 2	0.00	1.05	0.00	0.00	2.51	0.71
Dynamic SLV X	Wall 8 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV X	Wall 24 - 3	0.00	1.05	0.00	0.00	2.51	0.71
Dynamic SLV Y	Wall 1	0.00	12.23	0.00	0.00	29.34	1.26
Dynamic SLV Y	Wall 2	0.00	11.56	0.00	0.00	27.73	1.26
Dynamic SLV Y	Wall 3	0.00	10.30	0.00	0.00	24.73	1.26
Dynamic SLV Y	Wall 4	0.00	2.45	0.00	0.00	5.88	1.26
Dynamic SLV Y	Wall 5	0.00	5.88	0.00	0.00	14.10	3.25
Dynamic SLV Y	Wall 6	0.00	7.06	0.00	0.00	16.94	3.25
Dynamic SLV Y	Wall 7	0.00	4.65	0.00	0.00	11.15	3.25
Dynamic SLV Y	Wall 8 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 9	0.00	3.64	0.00	0.00	8.74	0.32
Dynamic SLV Y	Wall 10	0.00	12.23	0.00	0.00	29.35	0.32
Dynamic SLV Y	Wall 11	0.00	6.10	0.00	0.00	14.64	1.95
Dynamic SLV Y	Wall 12	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 13	0.00	21.53	0.00	0.00	51.67	0.89
Dynamic SLV Y	Wall 14	0.00	19.06	0.00	0.00	45.74	1.04
Dynamic SLV Y	Wall 16	0.00	2.76	0.00	0.00	6.63	1.04
Dynamic SLV Y	Wall 17	0.00	3.58	0.00	0.00	8.58	0.40
Dynamic SLV Y	Wall 18	0.00	4.32	0.00	0.00	10.36	0.40
Dynamic SLV Y	Wall 19	0.00	1.65	0.00	0.00	3.96	0.40
Dynamic SLV Y	Wall 20	0.00	4.03	0.00	0.00	9.66	0.40
Dynamic SLV Y	Wall 21	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 22	0.00	54.70	0.00	0.00	131.29	1.95
Dynamic SLV Y	Wall 23	0.00	1.44	0.00	0.00	3.47	1.04
Dynamic SLV Y	Wall 24 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 25 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV Y	Wall 30 - 1	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV Y	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV Y	Wall 34 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV Y	Wall 25 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 25 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 30 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 30 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 34 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLV Y	Wall 34 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 8 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 24 - 2	0.00	1.53	0.00	0.00	3.67	1.04
Dynamic SLV Y	Wall 8 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLV Y	Wall 24 - 3	0.00	1.53	0.00	0.00	3.67	1.04
Dynamic SLD X	Wall 1	0.00	7.10	0.00	0.00	17.04	0.73
Dynamic SLD X	Wall 2	0.00	6.71	0.00	0.00	16.11	0.73
Dynamic SLD X	Wall 3	0.00	5.98	0.00	0.00	14.36	0.73
Dynamic SLD X	Wall 4	0.00	1.42	0.00	0.00	3.41	0.73
Dynamic SLD X	Wall 5	0.00	0.65	0.00	0.00	1.56	0.36
Dynamic SLD X	Wall 6	0.00	0.78	0.00	0.00	1.87	0.36
Dynamic SLD X	Wall 7	0.00	0.51	0.00	0.00	1.23	0.36
Dynamic SLD X	Wall 8 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 9	0.00	4.61	0.00	0.00	11.06	0.41
Dynamic SLD X	Wall 10	0.00	15.47	0.00	0.00	37.13	0.41
Dynamic SLD X	Wall 11	0.00	0.93	0.00	0.00	2.24	0.30
Dynamic SLD X	Wall 12	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 13	0.00	9.43	0.00	0.00	22.63	0.39
Dynamic SLD X	Wall 14	0.00	9.80	0.00	0.00	23.51	0.53
Dynamic SLD X	Wall 16	0.00	1.42	0.00	0.00	3.41	0.53
Dynamic SLD X	Wall 17	0.00	4.60	0.00	0.00	11.04	0.51
Dynamic SLD X	Wall 18	0.00	5.55	0.00	0.00	13.32	0.51
Dynamic SLD X	Wall 19	0.00	2.12	0.00	0.00	5.09	0.51
Dynamic SLD X	Wall 20	0.00	5.18	0.00	0.00	12.43	0.51
Dynamic SLD X	Wall 21	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 22	0.00	8.33	0.00	0.00	19.99	0.30
Dynamic SLD X	Wall 23	0.00	0.74	0.00	0.00	1.78	0.53
Dynamic SLD X	Wall 24 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 25 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD X	Wall 30 - 1	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD X	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD X	Wall 34 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD X	Wall 25 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 25 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 30 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 30 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 34 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD X	Wall 34 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 8 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 24 - 2	0.00	0.79	0.00	0.00	1.88	0.53
Dynamic SLD X	Wall 8 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD X	Wall 24 - 3	0.00	0.79	0.00	0.00	1.88	0.53

Dynamic SLD Y	Wall 1	0.00	9.17	0.00	0.00	22.01	0.95
Dynamic SLD Y	Wall 2	0.00	8.67	0.00	0.00	20.80	0.95
Dynamic SLD Y	Wall 3	0.00	7.73	0.00	0.00	18.55	0.95
Dynamic SLD Y	Wall 4	0.00	1.84	0.00	0.00	4.41	0.95
Dynamic SLD Y	Wall 5	0.00	4.41	0.00	0.00	10.58	2.44
Dynamic SLD Y	Wall 6	0.00	5.29	0.00	0.00	12.71	2.44
Dynamic SLD Y	Wall 7	0.00	3.49	0.00	0.00	8.36	2.44
Dynamic SLD Y	Wall 8 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 9	0.00	2.73	0.00	0.00	6.56	0.24
Dynamic SLD Y	Wall 10	0.00	9.17	0.00	0.00	22.01	0.24
Dynamic SLD Y	Wall 11	0.00	4.58	0.00	0.00	10.98	1.46
Dynamic SLD Y	Wall 12	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 13	0.00	16.15	0.00	0.00	38.75	0.66
Dynamic SLD Y	Wall 14	0.00	14.29	0.00	0.00	34.30	0.78
Dynamic SLD Y	Wall 16	0.00	2.07	0.00	0.00	4.98	0.78
Dynamic SLD Y	Wall 17	0.00	2.68	0.00	0.00	6.44	0.30
Dynamic SLD Y	Wall 18	0.00	3.24	0.00	0.00	7.77	0.30
Dynamic SLD Y	Wall 19	0.00	1.24	0.00	0.00	2.97	0.30
Dynamic SLD Y	Wall 20	0.00	3.02	0.00	0.00	7.25	0.30
Dynamic SLD Y	Wall 21	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 22	0.00	41.03	0.00	0.00	98.47	1.46
Dynamic SLD Y	Wall 23	0.00	1.08	0.00	0.00	2.60	0.78
Dynamic SLD Y	Wall 24 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 25 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD Y	Wall 30 - 1	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD Y	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD Y	Wall 34 - 1	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD Y	Wall 25 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 25 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 30 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 30 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 34 - 2	0.00	0.00	0.00	0.00	0.00	0.00
Dynamic SLD Y	Wall 34 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 8 - 2	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 24 - 2	0.00	1.15	0.00	0.00	2.75	0.78
Dynamic SLD Y	Wall 8 - 3	0.00	0.00	0.00	0.00	0.00	N/D
Dynamic SLD Y	Wall 24 - 3	0.00	1.15	0.00	0.00	2.75	0.78

Columns

Column name: Column ID

N: Total axial force

Load	Column name	N [kN]
G1	Column 1	6.85
G1	Column 2	6.47
G2	Column 1	24.55
G2	Column 2	23.12
Q cat A	Column 1	4.83
Q cat A	Column 2	4.76
Q cat H	Column 1	5.54
Q cat H	Column 2	5.24
Snow	Column 1	25.27
Snow	Column 2	23.91
Ortho wind	Column 1	-8.61
Ortho wind	Column 2	-8.15
Wind X	Column 1	0.00
Wind X	Column 2	0.00
Wind Y	Column 1	0.00
Wind Y	Column 2	0.00
Dynamic SLV X	Column 1	0.00
Dynamic SLV X	Column 2	0.00
Dynamic SLV Y	Column 1	0.00
Dynamic SLV Y	Column 2	0.00
Dynamic SLD X	Column 1	0.00
Dynamic SLD X	Column 2	0.00
Dynamic SLD Y	Column 1	0.00
Dynamic SLD Y	Column 2	0.00

Floors

Floor name: Floor ID

V2: Maximum shear stress along the local axis 2 for the most stressed element of the floor

M3-3: Maximum bending moment around local axis 3 for the most stressed element of the floor

W_{ist}: Maximum deformation for the most stressed element of the floor

Load	Floor name	V2 [kN]	M3-3 [kNm]	W _{ist} [mm]
G1	Floor 1	1.50	0.59	0.33
G2	Floor 1	3.98	2.02	1.09
Q cat A	Floor 1	3.98	2.02	1.07
Q cat H	Floor 1	0.00	0.00	0.00
Snow	Floor 1	0.00	0.00	0.00
Ortho wind	Floor 1	0.00	0.00	0.00
Wind X	Floor 1	0.00	0.00	0.00
Wind Y	Floor 1	0.00	0.00	0.00
Dynamic SLV X	Floor 1	0.00	0.00	0.00
Dynamic SLV Y	Floor 1	0.00	0.00	0.00
Dynamic SLD X	Floor 1	0.00	0.00	0.00
Dynamic SLD Y	Floor 1	0.00	0.00	0.00

Beams

Beam name: Beam ID

V2: Maximum shear stress along the local axis 2

M3-3: Maximum bending moment around local axis 3

W_{ist}: Maximum deformation for the most stressed element of the floor

Load	Beam name	V2 [kN]	M3-3 [kNm]	W _{ist} [mm]
G1	Beam 1	6.10	7.47	1.17
G1	Beam 2	0.03	0.00	0.00
G1	Beam 3	0.21	0.03	0.00
G1	Beam 4	0.95	0.15	0.01
G1	Beam 5	0.89	0.15	0.01
G1	Beam 6	0.41	0.07	0.00
G1	Beam 7	0.19	0.03	0.00
G1	Beam 8	0.32	0.05	0.00
G1	Beam 9	0.03	0.00	0.00
G1	Beam 10	1.30	0.38	0.08
G1	Beam 11	0.04	0.01	0.00
G1	Beam 12	0.85	0.19	0.02
G2	Beam 1	24.45	30.58	4.76
G2	Beam 2	0.00	0.00	0.00
G2	Beam 3	0.26	0.04	0.00
G2	Beam 4	5.16	0.78	0.05
G2	Beam 5	4.70	0.79	0.05
G2	Beam 6	2.80	0.51	0.03
G2	Beam 7	0.23	0.04	0.00
G2	Beam 8	0.41	0.07	0.00
G2	Beam 9	0.00	0.00	0.00
G2	Beam 10	4.25	1.23	0.25
G2	Beam 11	0.00	0.00	0.00
G2	Beam 12	2.74	0.62	0.08
Q cat A	Beam 1	4.81	6.09	0.95
Q cat A	Beam 2	0.00	0.00	0.00
Q cat A	Beam 3	0.00	0.00	0.00
Q cat A	Beam 4	1.39	0.25	0.02

Q cat A	Beam 5	1.37	0.24	0.02
Q cat A	Beam 6	0.00	0.00	0.00
Q cat A	Beam 7	0.00	0.00	0.00
Q cat A	Beam 8	0.00	0.00	0.00
Q cat A	Beam 9	0.00	0.00	0.00
Q cat A	Beam 10	4.25	1.23	0.25
Q cat A	Beam 11	0.00	0.00	0.00
Q cat A	Beam 12	2.74	0.62	0.08
Q cat H	Beam 1	5.51	6.97	1.09
Q cat H	Beam 2	0.00	0.00	0.00
Q cat H	Beam 3	0.00	0.00	0.00
Q cat H	Beam 4	1.08	0.15	0.01
Q cat H	Beam 5	0.95	0.16	0.01
Q cat H	Beam 6	0.80	0.14	0.01
Q cat H	Beam 7	0.00	0.00	0.00
Q cat H	Beam 8	0.00	0.00	0.00
Q cat H	Beam 9	0.00	0.00	0.00
Q cat H	Beam 10	0.00	0.00	0.00
Q cat H	Beam 11	0.00	0.00	0.00
Q cat H	Beam 12	0.00	0.00	0.00
Snow	Beam 1	25.17	31.82	4.95
Snow	Beam 2	0.00	0.00	0.00
Snow	Beam 3	0.00	0.00	0.00
Snow	Beam 4	4.92	0.70	0.04
Snow	Beam 5	4.35	0.72	0.05
Snow	Beam 6	3.65	0.66	0.04
Snow	Beam 7	0.00	0.00	0.00
Snow	Beam 8	0.00	0.00	0.00
Snow	Beam 9	0.00	0.00	0.00
Snow	Beam 10	0.00	0.00	0.00
Snow	Beam 11	0.00	0.00	0.00
Snow	Beam 12	0.00	0.00	0.00
Ortho wind	Beam 1	8.58	10.84	-1.69
Ortho wind	Beam 2	0.00	0.00	0.00
Ortho wind	Beam 3	0.00	0.00	0.00
Ortho wind	Beam 4	1.68	0.24	-0.01
Ortho wind	Beam 5	1.48	0.24	-0.02
Ortho wind	Beam 6	1.24	0.22	-0.01
Ortho wind	Beam 7	0.00	0.00	0.00
Ortho wind	Beam 8	0.00	0.00	0.00
Ortho wind	Beam 9	0.00	0.00	0.00
Ortho wind	Beam 10	0.00	0.00	0.00
Ortho wind	Beam 11	0.00	0.00	0.00
Ortho wind	Beam 12	0.00	0.00	0.00
Wind X	Beam 1	0.00	0.00	0.00
Wind X	Beam 2	0.00	0.00	0.00
Wind X	Beam 3	0.00	0.00	0.00
Wind X	Beam 4	0.00	0.00	0.00
Wind X	Beam 5	0.00	0.00	0.00
Wind X	Beam 6	0.00	0.00	0.00
Wind X	Beam 7	0.00	0.00	0.00
Wind X	Beam 8	0.00	0.00	0.00
Wind X	Beam 9	0.00	0.00	0.00
Wind X	Beam 10	0.00	0.00	0.00
Wind X	Beam 11	0.00	0.00	0.00
Wind X	Beam 12	0.00	0.00	0.00
Wind Y	Beam 1	0.00	0.00	0.00
Wind Y	Beam 2	0.00	0.00	0.00
Wind Y	Beam 3	0.00	0.00	0.00
Wind Y	Beam 4	0.00	0.00	0.00
Wind Y	Beam 5	0.00	0.00	0.00
Wind Y	Beam 6	0.00	0.00	0.00
Wind Y	Beam 7	0.00	0.00	0.00
Wind Y	Beam 8	0.00	0.00	0.00
Wind Y	Beam 9	0.00	0.00	0.00
Wind Y	Beam 10	0.00	0.00	0.00
Wind Y	Beam 11	0.00	0.00	0.00
Wind Y	Beam 12	0.00	0.00	0.00
Dynamic SLV X	Beam 1	0.00	0.00	0.00
Dynamic SLV X	Beam 2	0.00	0.00	0.00
Dynamic SLV X	Beam 3	0.00	0.00	0.00
Dynamic SLV X	Beam 4	0.00	0.00	0.00
Dynamic SLV X	Beam 5	0.00	0.00	0.00
Dynamic SLV X	Beam 6	0.00	0.00	0.00
Dynamic SLV X	Beam 7	0.00	0.00	0.00
Dynamic SLV X	Beam 8	0.00	0.00	0.00
Dynamic SLV X	Beam 9	0.00	0.00	0.00
Dynamic SLV X	Beam 10	0.00	0.00	0.00
Dynamic SLV X	Beam 11	0.00	0.00	0.00
Dynamic SLV X	Beam 12	0.00	0.00	0.00
Dynamic SLV Y	Beam 1	0.00	0.00	0.00
Dynamic SLV Y	Beam 2	0.00	0.00	0.00
Dynamic SLV Y	Beam 3	0.00	0.00	0.00
Dynamic SLV Y	Beam 4	0.00	0.00	0.00
Dynamic SLV Y	Beam 5	0.00	0.00	0.00
Dynamic SLV Y	Beam 6	0.00	0.00	0.00
Dynamic SLV Y	Beam 7	0.00	0.00	0.00
Dynamic SLV Y	Beam 8	0.00	0.00	0.00
Dynamic SLV Y	Beam 9	0.00	0.00	0.00

Dynamic SLV Y	Beam 10	0.00	0.00	0.00
Dynamic SLV Y	Beam 11	0.00	0.00	0.00
Dynamic SLV Y	Beam 12	0.00	0.00	0.00
Dynamic SLD X	Beam 1	0.00	0.00	0.00
Dynamic SLD X	Beam 2	0.00	0.00	0.00
Dynamic SLD X	Beam 3	0.00	0.00	0.00
Dynamic SLD X	Beam 4	0.00	0.00	0.00
Dynamic SLD X	Beam 5	0.00	0.00	0.00
Dynamic SLD X	Beam 6	0.00	0.00	0.00
Dynamic SLD X	Beam 7	0.00	0.00	0.00
Dynamic SLD X	Beam 8	0.00	0.00	0.00
Dynamic SLD X	Beam 9	0.00	0.00	0.00
Dynamic SLD X	Beam 10	0.00	0.00	0.00
Dynamic SLD X	Beam 11	0.00	0.00	0.00
Dynamic SLD X	Beam 12	0.00	0.00	0.00
Dynamic SLD Y	Beam 1	0.00	0.00	0.00
Dynamic SLD Y	Beam 2	0.00	0.00	0.00
Dynamic SLD Y	Beam 3	0.00	0.00	0.00
Dynamic SLD Y	Beam 4	0.00	0.00	0.00
Dynamic SLD Y	Beam 5	0.00	0.00	0.00
Dynamic SLD Y	Beam 6	0.00	0.00	0.00
Dynamic SLD Y	Beam 7	0.00	0.00	0.00
Dynamic SLD Y	Beam 8	0.00	0.00	0.00
Dynamic SLD Y	Beam 9	0.00	0.00	0.00
Dynamic SLD Y	Beam 10	0.00	0.00	0.00
Dynamic SLD Y	Beam 11	0.00	0.00	0.00
Dynamic SLD Y	Beam 12	0.00	0.00	0.00

Forces and moments acting at the base of the structure

In this chapter are reported the values of actions acting at the base of the walls and columns of the ground floor. With regard to the walls the first row of the table shows the values of the actions related to the ULS combination that maximizes the axial force, the second row shows the values of the actions related to the seismic or horizontal ULS combination that maximizes the moment acting in the plane of the wall M3-3 and the shear force V2 (also acting in the plane of the wall) and that, at the same time, minimizes the axial force N. Following is instead reported the actions at the foot of the walls associated with the different loads considered individually.

Walls

Wall name:	Wall ID
N:	Total axial force
V2:	Shear force (in-plane)
V3:	Shear force (out-of-plane)
M2-2:	Bending moment (out-of-plane)
M3-3:	Bending moment (in-plane)

Wall name	Length [m]	Load / Comb.	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]
Wall 1	2.07	ULS 78	85.41	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey+	35.02	15.07	0.00	0.00	36.16
		G1	6.37	0.00	0.00	0.00	0.00
		G2	26.74	0.00	0.00	0.00	0.00
		Q cat A	6.37	0.00	0.00	0.00	0.00
		Q cat H	4.97	0.00	0.00	0.00	0.00
		Snow	22.68	0.00	0.00	0.00	0.00
		Ortho wind	-7.73	0.00	1.22	0.00	0.00
		Wind X	0.00	0.50	0.00	0.00	1.19
		Wind Y	0.00	0.20	0.00	0.00	0.49
		Dynamic SLV X	0.00	9.47	0.00	0.00	22.72
		Dynamic SLV Y	0.00	12.23	0.00	0.00	29.34
		Dynamic SLD X	0.00	7.10	0.00	0.00	17.04
		Dynamic SLD Y	0.00	9.17	0.00	0.00	22.01
Wall 2	1.99	ULS 78	103.97	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey+	42.39	14.24	0.00	0.00	34.18
		G1	7.44	0.00	0.00	0.00	0.00
		G2	32.42	0.00	0.00	0.00	0.00
		Q cat A	8.45	0.00	0.00	0.00	0.00
		Q cat H	6.03	0.00	0.00	0.00	0.00
		Snow	27.53	0.00	0.00	0.00	0.00
		Ortho wind	-9.38	0.00	1.17	0.00	0.00
		Wind X	0.00	0.47	0.00	0.00	1.12
		Wind Y	0.00	0.19	0.00	0.00	0.46
		Dynamic SLV X	0.00	8.95	0.00	0.00	21.47
		Dynamic SLV Y	0.00	11.56	0.00	0.00	27.73
		Dynamic SLD X	0.00	6.71	0.00	0.00	16.11
		Dynamic SLD Y	0.00	8.67	0.00	0.00	20.80
Wall 3	1.84	ULS 78	97.66	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey+	39.18	12.70	0.00	0.00	30.47
		G1	6.81	0.00	0.00	0.00	0.00
		G2	30.26	0.00	0.00	0.00	0.00
		Q cat A	7.05	0.00	0.00	0.00	0.00
		Q cat H	5.87	0.00	0.00	0.00	0.00
		Snow	26.81	0.00	0.00	0.00	0.00
		Ortho wind	-9.14	0.00	1.09	0.00	0.00
		Wind X	0.00	0.42	0.00	0.00	1.00
		Wind Y	0.00	0.17	0.00	0.00	0.41
		Dynamic SLV X	0.00	7.98	0.00	0.00	19.15
		Dynamic SLV Y	0.00	10.30	0.00	0.00	24.73
		Dynamic SLD X	0.00	5.98	0.00	0.00	14.36

		Dynamic SLD Y	0.00	7.73	0.00	0.00	18.55
Wall 4	0.78	ULS 78	39.74	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey+	15.97	3.02	0.00	0.00	7.24
		G1	2.80	0.00	0.00	0.00	0.00
		G2	12.32	0.00	0.00	0.00	0.00
		Q cat A	2.82	0.00	0.00	0.00	0.00
		Q cat H	2.39	0.00	0.00	0.00	0.00
		Snow	10.91	0.00	0.00	0.00	0.00
		Ortho wind	-3.72	0.00	0.46	0.00	0.00
		Wind X	0.00	0.10	0.00	0.00	0.24
		Wind Y	0.00	0.04	0.00	0.00	0.10
		Dynamic SLV X	0.00	1.90	0.00	0.00	4.55
		Dynamic SLV Y	0.00	2.45	0.00	0.00	5.88
		Dynamic SLD X	0.00	1.42	0.00	0.00	3.41
		Dynamic SLD Y	0.00	1.84	0.00	0.00	4.41
Wall 5	0.75	ULS 70	3.28	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey+	2.43	6.14	0.00	0.00	14.72
		G1	1.02	0.00	0.00	0.00	0.00
		G2	1.41	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.44	0.00	0.00
		Wind X	0.00	0.02	0.00	0.00	0.04
		Wind Y	0.00	0.17	0.00	0.00	0.41
		Dynamic SLV X	0.00	0.87	0.00	0.00	2.08
		Dynamic SLV Y	0.00	5.88	0.00	0.00	14.10
		Dynamic SLD X	0.00	0.65	0.00	0.00	1.56
		Dynamic SLD Y	0.00	4.41	0.00	0.00	10.58
Wall 6	0.83	ULS 70	6.32	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey+	4.68	7.37	0.00	0.00	17.69
		G1	1.96	0.00	0.00	0.00	0.00
		G2	2.72	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.49	0.00	0.00
		Wind X	0.00	0.02	0.00	0.00	0.05
		Wind Y	0.00	0.20	0.00	0.00	0.49
		Dynamic SLV X	0.00	1.04	0.00	0.00	2.50
		Dynamic SLV Y	0.00	7.06	0.00	0.00	16.94
		Dynamic SLD X	0.00	0.78	0.00	0.00	1.87
		Dynamic SLD Y	0.00	5.29	0.00	0.00	12.71
Wall 7	0.66	ULS 70	2.22	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey+	1.64	4.85	0.00	0.00	11.65
		G1	0.69	0.00	0.00	0.00	0.00
		G2	0.95	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.39	0.00	0.00
		Wind X	0.00	0.01	0.00	0.00	0.03
		Wind Y	0.00	0.13	0.00	0.00	0.32
		Dynamic SLV X	0.00	0.68	0.00	0.00	1.64
		Dynamic SLV Y	0.00	4.65	0.00	0.00	11.15
		Dynamic SLD X	0.00	0.51	0.00	0.00	1.23
		Dynamic SLD Y	0.00	3.49	0.00	0.00	8.36
Wall 8 - 1	0.22	ULS 70	1.40	0.00	0.00	0.00	0.00
		Horizontal ULS 4	1.04	0.00	0.00	0.00	0.00
		G1	0.43	0.00	0.00	0.00	0.00
		G2	0.61	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.13	0.00	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD Y	0.00	0.00	0.00	0.00	0.00
Wall 9	2.30	ULS 66	48.50	0.00	0.00	0.00	0.00
		Dynamic SLV 4 ex+ ey-	26.39	9.83	0.00	0.00	23.60
		G1	6.63	0.00	0.00	0.00	0.00
		G2	16.23	0.00	0.00	0.00	0.00
		Q cat A	11.76	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	1.36	0.00	0.00
		Wind X	0.00	0.48	0.00	0.00	1.15
		Wind Y	0.00	0.08	0.00	0.00	0.18
		Dynamic SLV X	0.00	6.15	0.00	0.00	14.75
		Dynamic SLV Y	0.00	3.64	0.00	0.00	8.74
		Dynamic SLD X	0.00	4.61	0.00	0.00	11.06

		Dynamic SLD Y	0.00	2.73	0.00	0.00	6.56
Wall 10	5.51	ULS 66	107.22	0.00	0.00	0.00	0.00
		Dynamic SLV 4 ex+ ey-	57.20	33.01	0.00	0.00	79.23
		G1	13.65	0.00	0.00	0.00	0.00
		G2	35.33	0.00	0.00	0.00	0.00
		Q cat A	27.40	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	3.25	0.00	0.00
		Wind X	0.00	1.61	0.00	0.00	3.87
		Wind Y	0.00	0.26	0.00	0.00	0.61
		Dynamic SLV X	0.00	20.63	0.00	0.00	49.51
		Dynamic SLV Y	0.00	12.23	0.00	0.00	29.35
		Dynamic SLD X	0.00	15.47	0.00	0.00	37.13
		Dynamic SLD Y	0.00	9.17	0.00	0.00	22.01
Wall 11	1.02	ULS 70	3.43	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey+	2.54	6.47	0.00	0.00	15.54
		G1	1.07	0.00	0.00	0.00	0.00
		G2	1.47	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.60	0.00	0.00
		Wind X	0.00	0.00	0.00	0.00	0.01
		Wind Y	0.00	0.22	0.00	0.00	0.52
		Dynamic SLV X	0.00	1.24	0.00	0.00	2.98
		Dynamic SLV Y	0.00	6.10	0.00	0.00	14.64
		Dynamic SLD X	0.00	0.93	0.00	0.00	2.24
		Dynamic SLD Y	0.00	4.58	0.00	0.00	10.98
Wall 12	0.29	ULS 70	1.01	0.00	0.00	0.00	0.00
		Horizontal ULS 4	0.75	0.00	0.00	0.00	0.00
		G1	0.33	0.00	0.00	0.00	0.00
		G2	0.42	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.17	0.00	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD Y	0.00	0.00	0.00	0.00	0.00
Wall 13	3.71	ULS 78	135.82	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey-	54.23	29.49	0.00	0.00	70.78
		G1	9.92	0.00	0.00	0.00	0.00
		G2	42.16	0.00	0.00	0.00	0.00
		Q cat A	7.19	0.00	0.00	0.00	0.00
		Q cat H	8.46	0.00	0.00	0.00	0.00
		Snow	38.64	0.00	0.00	0.00	0.00
		Ortho wind	-13.17	0.00	2.19	0.00	0.00
		Wind X	0.00	0.96	0.00	0.00	2.31
		Wind Y	0.00	0.43	0.00	0.00	1.04
		Dynamic SLV X	0.00	12.57	0.00	0.00	30.17
		Dynamic SLV Y	0.00	21.53	0.00	0.00	51.67
		Dynamic SLD X	0.00	9.43	0.00	0.00	22.63
		Dynamic SLD Y	0.00	16.15	0.00	0.00	38.75
Wall 14	2.99	ULS 70	14.71	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex- ey+	10.90	28.30	0.00	0.00	67.92
		G1	4.50	0.00	0.00	0.00	0.00
		G2	6.39	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	1.76	0.00	0.00
		Wind X	0.00	0.07	0.00	0.00	0.17
		Wind Y	0.00	0.94	0.00	0.00	2.25
		Dynamic SLV X	0.00	13.06	0.00	0.00	31.35
		Dynamic SLV Y	0.00	19.06	0.00	0.00	45.74
		Dynamic SLD X	0.00	9.80	0.00	0.00	23.51
		Dynamic SLD Y	0.00	14.29	0.00	0.00	34.30
Wall 16	0.93	ULS 70	4.15	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex- ey+	3.07	4.10	0.00	0.00	9.85
		G1	1.28	0.00	0.00	0.00	0.00
		G2	1.79	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.55	0.00	0.00
		Wind X	0.00	0.01	0.00	0.00	0.02
		Wind Y	0.00	0.14	0.00	0.00	0.33
		Dynamic SLV X	0.00	1.89	0.00	0.00	4.55
		Dynamic SLV Y	0.00	2.76	0.00	0.00	6.63
		Dynamic SLD X	0.00	1.42	0.00	0.00	3.41

		Dynamic SLD Y	0.00	2.07	0.00	0.00	4.98
Wall 17	1.96	ULS 66	45.37	0.00	0.00	0.00	0.00
		Dynamic SLV 4 ex+ ey-	23.89	7.22	0.00	0.00	17.34
		G1	5.50	0.00	0.00	0.00	0.00
		G2	14.80	0.00	0.00	0.00	0.00
		Q cat A	11.98	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.00	0.00	0.00
		Wind X	0.00	0.41	0.00	0.00	0.99
		Wind Y	0.00	0.04	0.00	0.00	0.10
		Dynamic SLV X	0.00	6.13	0.00	0.00	14.72
		Dynamic SLV Y	0.00	3.58	0.00	0.00	8.58
		Dynamic SLD X	0.00	4.60	0.00	0.00	11.04
		Dynamic SLD Y	0.00	2.68	0.00	0.00	6.44
Wall 18	2.24	ULS 66	51.85	0.00	0.00	0.00	0.00
		Dynamic SLV 4 ex+ ey-	27.31	8.72	0.00	0.00	20.93
		G1	6.28	0.00	0.00	0.00	0.00
		G2	16.92	0.00	0.00	0.00	0.00
		Q cat A	13.69	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.00	0.00	0.00
		Wind X	0.00	0.50	0.00	0.00	1.20
		Wind Y	0.00	0.05	0.00	0.00	0.12
		Dynamic SLV X	0.00	7.40	0.00	0.00	17.76
		Dynamic SLV Y	0.00	4.32	0.00	0.00	10.36
		Dynamic SLD X	0.00	5.55	0.00	0.00	13.32
		Dynamic SLD Y	0.00	3.24	0.00	0.00	7.77
Wall 19	1.20	ULS 66	56.40	0.00	0.00	0.00	0.00
		Dynamic SLV 4 ex+ ey-	28.70	3.33	0.00	0.00	8.00
		G1	6.00	0.00	0.00	0.00	0.00
		G2	17.86	0.00	0.00	0.00	0.00
		Q cat A	16.13	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.00	0.00	0.00
		Wind X	0.00	0.19	0.00	0.00	0.46
		Wind Y	0.00	0.02	0.00	0.00	0.05
		Dynamic SLV X	0.00	2.83	0.00	0.00	6.79
		Dynamic SLV Y	0.00	1.65	0.00	0.00	3.96
		Dynamic SLD X	0.00	2.12	0.00	0.00	5.09
		Dynamic SLD Y	0.00	1.24	0.00	0.00	2.97
Wall 20	2.13	ULS 66	65.58	0.00	0.00	0.00	0.00
		Dynamic SLV 4 ex+ ey-	33.90	8.13	0.00	0.00	19.52
		G1	7.43	0.00	0.00	0.00	0.00
		G2	21.04	0.00	0.00	0.00	0.00
		Q cat A	18.09	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.00	0.00	0.00
		Wind X	0.00	0.47	0.00	0.00	1.12
		Wind Y	0.00	0.05	0.00	0.00	0.11
		Dynamic SLV X	0.00	6.90	0.00	0.00	16.57
		Dynamic SLV Y	0.00	4.03	0.00	0.00	9.66
		Dynamic SLD X	0.00	5.18	0.00	0.00	12.43
		Dynamic SLD Y	0.00	3.02	0.00	0.00	7.25
Wall 21	0.44	ULS 70	2.00	0.00	0.00	0.00	0.00
		Horizontal ULS 4	1.48	0.00	0.00	0.00	0.00
		G1	0.63	0.00	0.00	0.00	0.00
		G2	0.86	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.26	0.00	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD Y	0.00	0.00	0.00	0.00	0.00
Wall 22	3.04	ULS 70	10.05	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex+ ey+	7.44	58.03	0.00	0.00	139.28
		G1	3.06	0.00	0.00	0.00	0.00
		G2	4.38	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.00	0.00	0.00
		Wind X	0.00	0.04	0.00	0.00	0.10
		Wind Y	0.00	1.94	0.00	0.00	4.65
		Dynamic SLV X	0.00	11.11	0.00	0.00	26.65
		Dynamic SLV Y	0.00	54.70	0.00	0.00	131.29
		Dynamic SLD X	0.00	8.33	0.00	0.00	19.99

		Dynamic SLD Y	0.00	41.03	0.00	0.00	98.47
Wall 23	0.65	ULS 70	2.19	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex- ey+	1.62	2.14	0.00	0.00	5.15
		G1	0.68	0.00	0.00	0.00	0.00
		G2	0.94	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.38	0.00	0.00
		Wind X	0.00	0.01	0.00	0.00	0.01
		Wind Y	0.00	0.07	0.00	0.00	0.17
		Dynamic SLV X	0.00	0.99	0.00	0.00	2.38
		Dynamic SLV Y	0.00	1.44	0.00	0.00	3.47
		Dynamic SLD X	0.00	0.74	0.00	0.00	1.78
		Dynamic SLD Y	0.00	1.08	0.00	0.00	2.60
Wall 24 - 1	0.44	ULS 70	3.15	0.00	0.00	0.00	0.00
		Horizontal ULS 4	2.34	0.00	0.00	0.00	0.00
		G1	0.98	0.00	0.00	0.00	0.00
		G2	1.36	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.26	0.00	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD Y	0.00	0.00	0.00	0.00	0.00
Wall 8 - 2	0.24	ULS 70	1.60	0.00	0.00	0.00	0.00
		Horizontal ULS 4	1.19	0.00	0.00	0.00	0.00
		G1	0.49	0.00	0.00	0.00	0.00
		G2	0.70	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.14	0.00	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD Y	0.00	0.00	0.00	0.00	0.00
Wall 24 - 2	0.67	ULS 70	4.28	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex- ey+	3.17	2.27	0.00	0.00	5.44
		G1	1.31	0.00	0.00	0.00	0.00
		G2	1.87	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.40	0.00	0.00
		Wind X	0.00	0.01	0.00	0.00	0.01
		Wind Y	0.00	0.08	0.00	0.00	0.18
		Dynamic SLV X	0.00	1.05	0.00	0.00	2.51
		Dynamic SLV Y	0.00	1.53	0.00	0.00	3.67
		Dynamic SLD X	0.00	0.79	0.00	0.00	1.88
		Dynamic SLD Y	0.00	1.15	0.00	0.00	2.75
Wall 8 - 3	0.24	ULS 70	0.83	0.00	0.00	0.00	0.00
		Horizontal ULS 4	0.62	0.00	0.00	0.00	0.00
		G1	0.27	0.00	0.00	0.00	0.00
		G2	0.35	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.14	0.00	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLV Y	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD X	0.00	0.00	0.00	0.00	0.00
		Dynamic SLD Y	0.00	0.00	0.00	0.00	0.00
Wall 24 - 3	0.67	ULS 70	2.21	0.00	0.00	0.00	0.00
		Dynamic SLV 8 ex- ey+	1.64	2.27	0.00	0.00	5.44
		G1	0.68	0.00	0.00	0.00	0.00
		G2	0.96	0.00	0.00	0.00	0.00
		Q cat A	0.00	0.00	0.00	0.00	0.00
		Q cat H	0.00	0.00	0.00	0.00	0.00
		Snow	0.00	0.00	0.00	0.00	0.00
		Ortho wind	0.00	0.00	0.40	0.00	0.00
		Wind X	0.00	0.01	0.00	0.00	0.01
		Wind Y	0.00	0.08	0.00	0.00	0.18
		Dynamic SLV X	0.00	1.05	0.00	0.00	2.51
		Dynamic SLV Y	0.00	1.53	0.00	0.00	3.67
		Dynamic SLD X	0.00	0.79	0.00	0.00	1.88

		Dynamic SLD Y	0.00	1.15	0.00	0.00	2.75
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Columns

Column name: Column ID

N: Total axial force

Column name	Load / Comb.	N [kN]
Column 1	ULS 78	85.38
	G1	6.85
	G2	24.55
	Q cat A	4.83
	Q cat H	5.54
	Snow	25.27
	Ortho wind	-8.61
	Wind X	0.00
	Wind Y	0.00
	Dynamic SLV X	0.00
	Dynamic SLV Y	0.00
	Dynamic SLD X	0.00
	Dynamic SLD Y	0.00
Column 2	ULS 78	80.81
	G1	6.47
	G2	23.12
	Q cat A	4.76
	Q cat H	5.24
	Snow	23.91
	Ortho wind	-8.15
	Wind X	0.00
	Wind Y	0.00
	Dynamic SLV X	0.00
	Dynamic SLV Y	0.00
	Dynamic SLD X	0.00
	Dynamic SLD Y	0.00

Design of the structural elements

CLT floors

Calculation model

The calculation model adopted for the design of CLT in bending out-of-plane is that of mechanically jointed beams with deformable connection in accordance with Appendix B of EN 1995-1-1. The shear flexibility of the transverse layers is considered using the γ -method (gamma): namely with Möhler theory for CLT panel having up to 3 layers oriented in the direction of calculation and with Shelling theory for CLT panel having more than 3 layers oriented in the direction of calculation.

The effective bending stiffness is taken as:

$$EJ_{eff} = \sum_{i=1}^n (E_i J_i + \gamma_i E_i A_i a_i^2)$$

$$\gamma_i = \left[1 + \frac{\pi^2 E_i A_i}{G_R \cdot \frac{b}{d} \cdot l_{ref}^2} \right]^{-1}$$

where:

- J_i is the moment of inertia of layer i in reference to its neutral axis;
- A_i is the cross-sectional area of layer i ;
- a_i is the distance between the centre of gravity of layer i and centre of gravity of the CLT element;
- l_{ref} is the reference length of the span;
- G_R is the rolling shear modulus (mean value).

The reference length of the spans (l_{ref}) is taken, depending on the static scheme, as reported in the following table.

Structural scheme	Reference length of the span
Simply supported beam	$l_{ref} = l$
Span of a continuous beam	$l_{ref} = 0.8 l$
Internal support of a continuous beam	$l_{ref} = 0.8 l_{min}$
Cantilever	$l_{ref} = 2 l$

The following table shows, for each floor and relatively to the different spans, the values of the reference lengths of the spans, the effective moment of inertia of the cross-sections of the CLT floor and the structural scheme adopted.

Floor name	Calculation width of the strip of floor [m]	Reference length l_{ref} [m]	J_{eff} [mm ⁴]	Structural scheme
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Floor 1	1	1.82 1.87 2.72	1.428E8 1.451E8 1.733E8	
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Bending strength

The checks are conducted according to § 6.1.6 of EN 1995-1-1. The following expression shall be satisfied:

$$\frac{\sigma_{m,d}}{f_{m,d}} \leq 1$$

where:

$\sigma_{m,d}$ is the design bending stress;

$f_{m,d}$ is the design bending strength.

The following table illustrates the structural schemes and the envelopes of the diagram of the bending moment for the part of each floor with the most severe checks.

Floor name	Combination	Duration	Diagram M ₃₋₃	Bending stresses
Floor 1	ULS 65	Medium-term		

The checks are summarized below. The values resulting from the calculations, relating to each verification, are reported in the form of a percentage.

Floor name	Section	M ₃₋₃ [kNm]	J _{eff} [mm ⁴]	Comb.	Service class	k _{mod}	γ _M	f _{m,d} [MPa]	σ _{m,d} [MPa]	Check
Floor 1	CLT 140 mm - 5 layers	-6.85	145051844	ULS 65	1	0.8	1.25	15.36	2.52	16%

Shear strength

Shear strength of the layers parallel to the calculation direction

The checks are conducted according to § 6.1.7 of EN 1995-1-1. The following expression shall be satisfied:

$$\frac{\tau_{v,d}}{f_{v,d}} \leq 1$$

where:

$\tau_{v,d}$ is the design shear stress;

$f_{v,d}$ is the design shear strength for the actual condition.

The maximum design shear stress in the longitudinal layers can be evaluated using the following expression:

$$\tau_{v,d} = \frac{V_d \cdot S_{max}}{J_{eff} \cdot b}$$

where:

V_d is the total shear force at the location in question;

S_{max} is the first moment of area;

J_{eff} is the effective moment of inertia of the CLT element cross section;

b is the width of the CLT element cross section ($k_{cr} = 1$).

Rolling shear strength of the transversal layers

The checks are conducted according to § 6.1.7 of EN 1995-1-1. The following expression shall be satisfied:

$$\frac{\tau_{R,d}}{f_{v,R,d}} \leq 1$$

where:

$\tau_{R,d}$ the design rolling shear stress;

$f_{v,R,d}$ the design shear strength.

The maximum design shear stress in the transversal layers can be evaluated using the following expression:

$$\tau_{R,d} = \frac{V_d \cdot S_{R,max}}{J_{eff} \cdot b}$$

where:

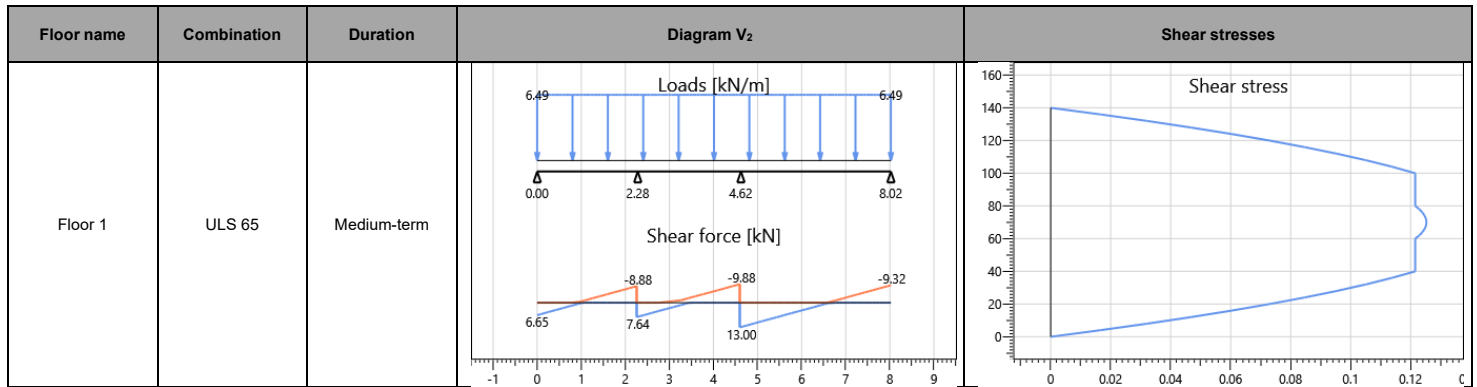
V_d is the total shear force at the location in question;

$S_{R,max}$ is the first moment of area;

J_{eff} is the effective moment of inertia of the CLT element cross section;

b is the width of the CLT element cross section ($k_{cr} = 1$).

The following table illustrates the structural schemes and the envelopes of the diagram of the shear force for the part of each floor with the most sever checks.



The checks are summarized below. The values resulting from the calculations, relating to each verification, are reported in the form of a percentage.

Floor name	Cross section	V_2 [kN]	J_{eff} [mm ⁴]	Comb.	Service Class	k_{mod}	γ_M	$f_{v,d}$ [MPa]	$\tau_{v,d}$ [MPa]	Check	$f_{R,d}$ [MPa]	$\tau_{R,d}$ [MPa]	Check
Floor 1	CLT 140 mm - 5 layers	13.00	173337646	ULS 65	1	0.8	1.25	2.56	0.13	5%	0.51	0.12	24%

Floors deflections (SLS)

The deflection checks are carried out according to § 2.2.3 of EN 1995-1-1.

The net deflection below a straight line between the supports, $w_{net,fin}$, is taken as:

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

where:

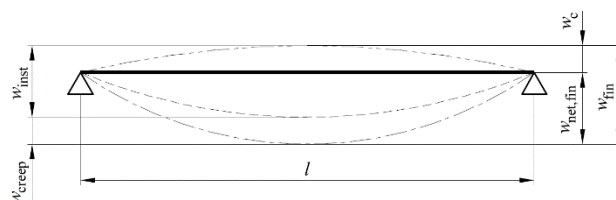
$w_{net,fin}$ is the net final deflection;

w_{inst} is the instantaneous deflection;

w_{creep} is the creep deflection;

w_c is the precamber (if applied);

w_{fin} is the final deflection.



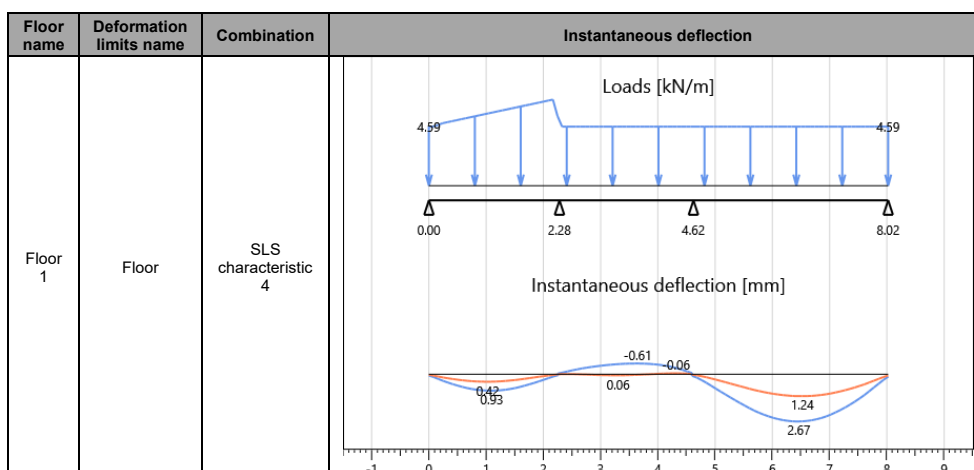
The limiting values for deflections of floors are assumed as shown in the following table.

Deformation limits name	$w_{inst, span}$	$w_{net, fin, span}$	$w_{inst, overhang}$	$w_{net, fin, overhang}$	Neglect overhang check for deformation < 0
Floor	$l/300$	$l/250$	$l/150$	$l/125$	Yes

Instantaneous deflection

The instantaneous deflection w_{inst} is calculated for the characteristic (rare) combination of actions.

The following table shows the deformation of each floor (relative to the element in which the deformation checks are the most severe).



The table below shows the instantaneous deflection checks of the floor elements.

Floor name	Section	Combination	Most restrictive check	w_{inst} [mm]	w_{inst} limit [mm]	Deflection limit	Check
Floor 1	CLT 140 mm - 5 layers	SLS characteristic 4	Internal span	2.67	11.34	$l/300$	24%

Final deflection

For structures consisting of members, components and connections with the same creep behaviour and under the assumption of a linear relationship between the actions and the corresponding deformations the final deformation, w_{fin} , may be taken as:

$$w_{fin} = w_{fin,G} + w_{fin,Q1} + \sum w_{fin,Qi}$$

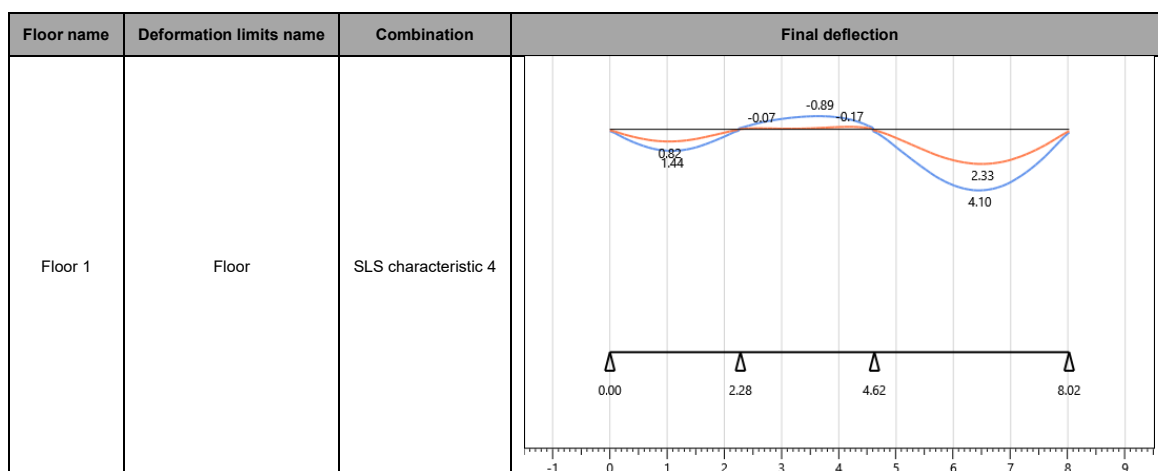
where:

$$w_{fin,G} = w_{inst,G} \cdot (1 + k_{def}) \quad \text{for a permanent action, G}$$

$$w_{fin,Q,1} = w_{inst,Q,1} \cdot (1 + \Psi_{2,1} \cdot k_{def}) \quad \text{for the leading variable action, Q}_1$$

$$w_{fin,Q,i} = w_{inst,Q,i} \cdot (\Psi_{0,i} + \Psi_{2,1} \cdot k_{def}) \quad \text{for accompanying variable actions, Q}_i (i>1)$$

The following table shows the deformation of each floor (relative to the element in which the deformation checks are the most severe).



The table below shows the final deflection checks of the floor elements.

Floor name	Section	Combination	Service class	k_{def}	Most restrictive check	w_{fin} [mm]	w_{fin} limit [mm]	Deflection limit	Check
Floor 1	CLT 140 mm - 5 layers	SLS characteristic 4	1	0.8	Internal span	4.10	13.61	$l/250$	30%

Floors vibrations (SLS)

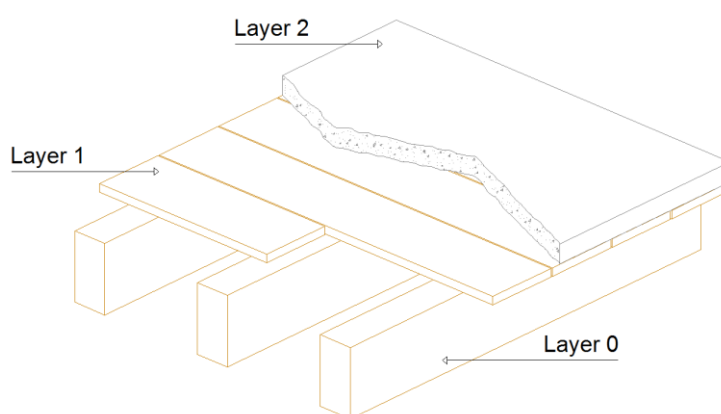
Vibrations checks on floors are carried out according to § 7.3 of EN 1995-1-1. In case of floors with a fundamental frequency greater or equal than 8 Hz, it will be evaluated the maximum value of vertical deflection induced by a vertical, static and concentrated force F acting on every point of the slab and the unit impulse velocity induced by an impulsive load acting in the point of the floor that provides the maximum response. In case of floors with a fundamental frequency lower than 8 Hz, it will be evaluated the maximum value of vertical acceleration induced by a dynamic load.

Stiffness of elements

Stiffness values for floor elements are taken as:

$$(EJ)_{TOT,l} = (EJ)_{0,l}$$

$$(EJ)_{TOT,b} = \sum_i (EJ)_{i,b} = (EJ)_{0,b} + (EJ)_{1,b} + (EJ)_{2,b}$$



where:

- $(EJ)_{0,l}$ is the stiffness of principal elements “Layer 0”, along the span;
- $(EJ)_{0,b}$ is the stiffness of principal elements, perpendicular to the span;
- $(EJ)_{1,b}$ is the stiffness of secondary element “Layer 1”, perpendicular to the span;
- $(EJ)_{2,b}$ is the stiffness of secondary element “Layer 2”, perpendicular to the span.

The following table shows, for every single floor, the stiffness used in the evaluation of vibration criterion.

Floor name	$(EJ)_{0,l}$ [Nm ² /m]	$(EJ)_{0,b}$ [Nm ² /m]	$(EJ)_{1,b}$ [Nm ² /m]	$(EJ)_{2,b}$ [Nm ² /m]	$(EJ)_{TOT,l}$ [Nm ² /m]	$(EJ)_{TOT,b}$ [Nm ² /m]
Floor 1	2.32E6	1.91E5	2.33E3	2.70E5	2.32E6	4.63E5

Minimum frequency criterion

The fundamental frequency of floors should satisfy the following expression:

$$f_1 > f_{1,min}$$

where:

f_1 is the fundamental frequency of the floor;

$f_{1,min}$ is the minimum frequency value, which depends on the chosen level of demand.

The minimum value $f_{1,min}$ is taken as in the following table.

	High demand	Normal demand
$f_{1,min}$	4.5 Hz	4.5 Hz

It is considered a quasi-permanent combination for loads in the calculation of the mass of the floor.

For the calculation of the fundamental natural frequency f_1 of the floor the transverse load-carrying effect is taken into account according to the following table.

Transverse load-carrying effect	k_b
Taken into account	$\sqrt{1 + \left(\frac{l}{b}\right)^4 \cdot \frac{(EJ)_{TOT,b}}{(EJ)_{TOT,l}}}$
Not taken into account	1

The value of effective width b_{eff} , which consider the effect of the transverse stiffness on the vertical deflection, is taken as:

$$b_{eff} = \min \left\{ \frac{l}{1,1} \cdot \sqrt[4]{\frac{(EJ)_{TOT,b}}{(EJ)_{TOT,l}}}, b \right\}$$

where:

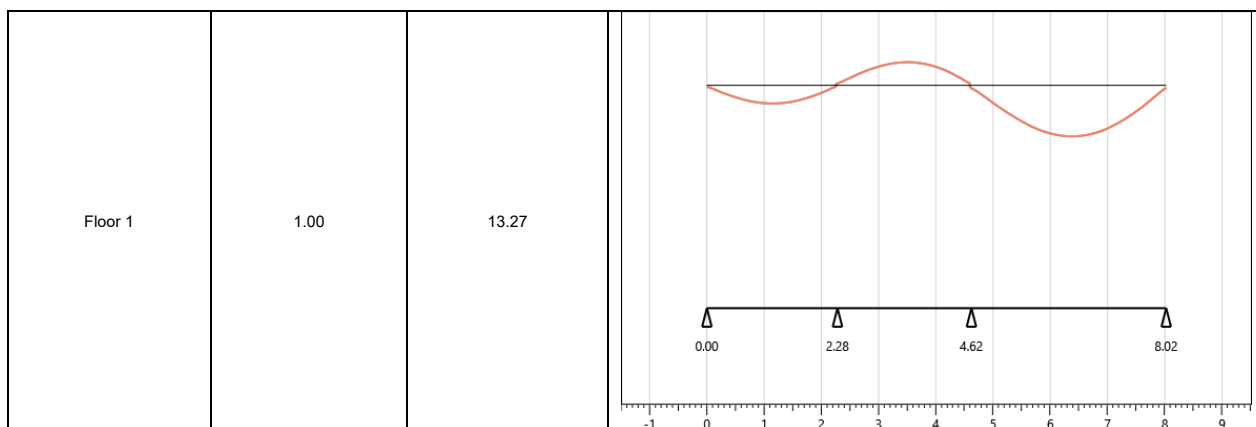
l is the length of the grater span;

b is the width of the floor;

b_{eff} is taken at least equal to the spacing between the joists, in case of joists floors, or at least equal to the width of the panel, in case of solid wood floors.

The following tables show, for every single floor (relative to the element in which the minimum frequency criterion is the most severe), the representation of the fundamental mode of vibration, b_{eff} values, modal mass values M^* , fundamental frequency values f_1 and relative checks.

Floor name	k_b	f_1 [Hz]	Fundamental vibration mode
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Floor name	Demand required	b_{eff} [m]	M^* [kg]	k_b	f_1 [Hz]	$f_{1,min}$ [Hz]	Check
Floor 1	Normal demand	2.07	1392	1.00	13.27	4.5	34%

Stiffness criterion – Static deflection under a concentrated load

Stiffness criterion checks are conducted evaluating the maximum instant deflection under a static concentrated force. This deflection should satisfy the following expression:

$$w_{1kN} < w_{1kN,lim}$$

where:

w_{1kN} is the vertical deflection caused by a static vertical force assumed equal to 1 kN;

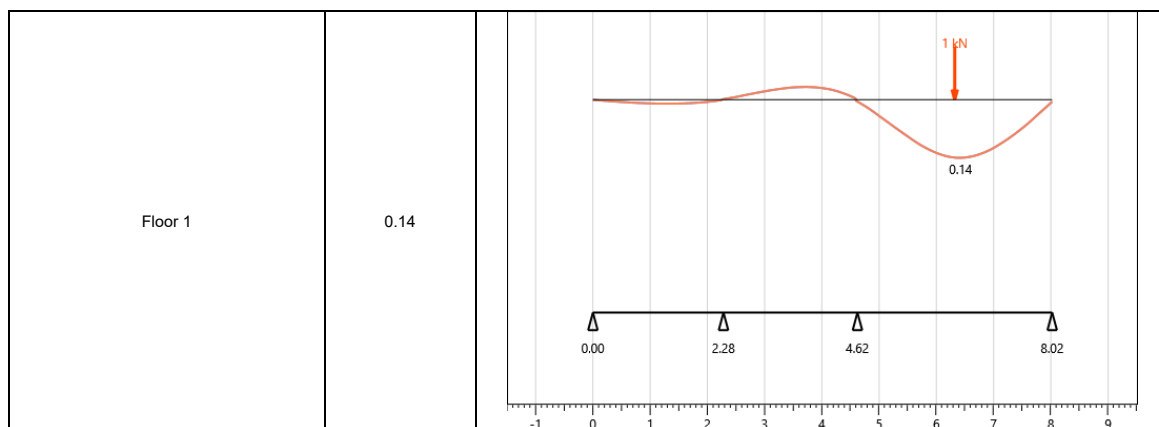
$w_{1kN,lim}$ is the limit value for deflection, which depends on the chosen level of demand.

Limit values $w_{1kN,lim}$ are taken as in the following table.

	High demand	Normal demand
Beam on two supports	0.5 mm	1 mm
Cantilevering beams	1 mm	2 mm

The following tables show, for every single floor (relative to the element in which the stiffness criterion is the most severe), the deformation under static force, w_{1kN} values and relative checks.

Floor name	w_{1kN} [mm]	Static deformation
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Floor name	Demand required	Most restrictive check	W _{1kN} [mm]	W _{1kN,lim} [mm/kN]	Check
Floor 1	Normal demand	Internal span	0.14	1	14%

Acceleration criterion (Floors with fundamental frequency lower than 8 Hz)

Acceleration criterion checks are conducted evaluating the maximum acceleration value caused by periodic actions:

$$a_{max} = 0,4 \cdot \frac{P_0 \cdot \alpha_i(f_1)}{M^*} \cdot \frac{1}{\sqrt{\left[\left(\frac{f_1}{f_F}\right)^2 - 1\right]^2 + \left(2\xi \frac{f_1}{f_F}\right)^2}}$$

where:

P_0 is the weight force of a person, equal to 700 N;

f_1 is the fundamental frequency of the floor;

f_F is the forcing frequency;

$\alpha_i(f_1)$ is the Fourier coefficient in dependence of the fundamental frequency of the floor;

ξ is the modal damping ratio;

M^* is the modal mass of the floor;

a_{lim} is the limit value for acceleration, which depends on the chosen level of demand.

The following table shows the parameters needed in the definition of maximum acceleration value.

Fundamental frequency f_1 [Hz]	Fourier coefficient $\alpha_i(f_1)$	Forcing frequency f_F [Hz]
$4,5 < f_1 \leq 5,1$	0,2	$f_F = f_1$
$5,1 < f_1 \leq 6,9$	0,06	$f_F = f_1$
$f_1 > 6,9$	0,06	6,9

Note the maximum acceleration a_{max} , evaluated at the point of application of the force P_0 , it is calculated the acceleration a in the generic point of the element in function of the modal shape, comparing this value with the value a_{lim} assumed as shown in the following table, in function of the required level of requirement.

	High demand	Normal demand
Beam on two supports	0.05 m/s ²	0.1 m/s ²
Cantilevering beams	0.1 m/s ²	0.2 m/s ²

The following table shows, for every single floor (relative to the element in which the acceleration criterion is the most severe), the parameters needed in the definition of maximum acceleration value and relative checks.

Floor name	Demand required	f_1 [Hz]	$\alpha_i(f_1)$ [-]	M^* [kg]	ξ [-]	Most restrictive check	a [m/s ²]	a_{lim} [m/s ²]	Check
Floor 1	Normal demand	N/D	N/D	N/D	0.02	N/D	N/D	N/D	Not applicable

Velocity response criterion (Floors with fundamental frequency higher than 8 Hz)

Unit impulse velocity response criterion checks are conducted evaluating vibration velocity response of the floor under a unit impulse equal to 1 Ns, limiting the upper frequency components to a value of 40 Hz. The vibration velocity response should satisfy the following expression:

$$v \leq v_{lim} = b(f_1 \xi - 1)$$

where:

b is a parameter which depends on the chosen level of demand;

f_1 is the fundamental frequency of the floor;

ξ is the modal damping ratio;

v_{lim} is the limit value for the unit impulse velocity.

Limit values b are taken as in the following table.

	High demand	Normal demand
b	150	120

The unit impulse velocity response v , is taken as:

$$v = \frac{4 \cdot (0,4 + 0,6 \cdot n_{40})}{m \cdot b \cdot l + 200}$$

where:

n_{40} is the number of first-order modes with natural frequencies up to 40 Hz;

m is the mass of the floor;

l is the length of the greater span.

The value of n_{40} is taken as:

$$n_{40} = \left\{ \left(\left(\frac{40}{f_1} \right)^2 - 1 \right) \cdot \left(\frac{b}{l} \right)^4 \cdot \frac{(EJ)_{TOT,l}}{(EJ)_{TOT,b}} \right\}^{0,25}$$

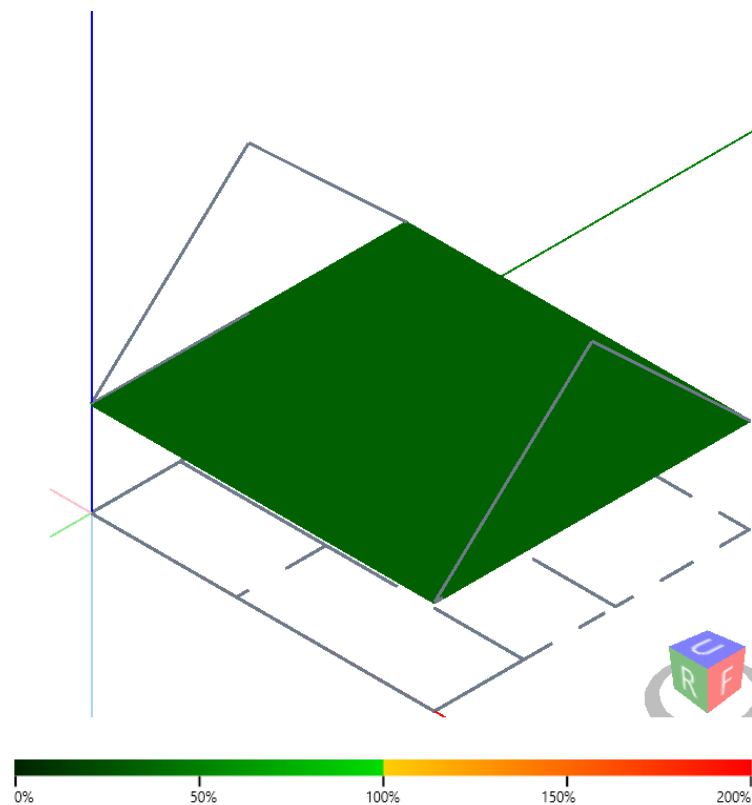
The following table shows, for every single floor (relative to the element in which the unit impulse velocity response criterion is the most severe), the parameters needed in the definition of maximum unit impulse velocity response value and relative checks.

Floor name	Demand required	f_1 [Hz]	ξ [-]	n_{40} [-]	v [m/(Ns ²)]	v_{lim} [m/(Ns ²)]	Check
Floor 1	Normal demand	13.27	0.02	6.49	1.74E-3	2.97E-2	6%

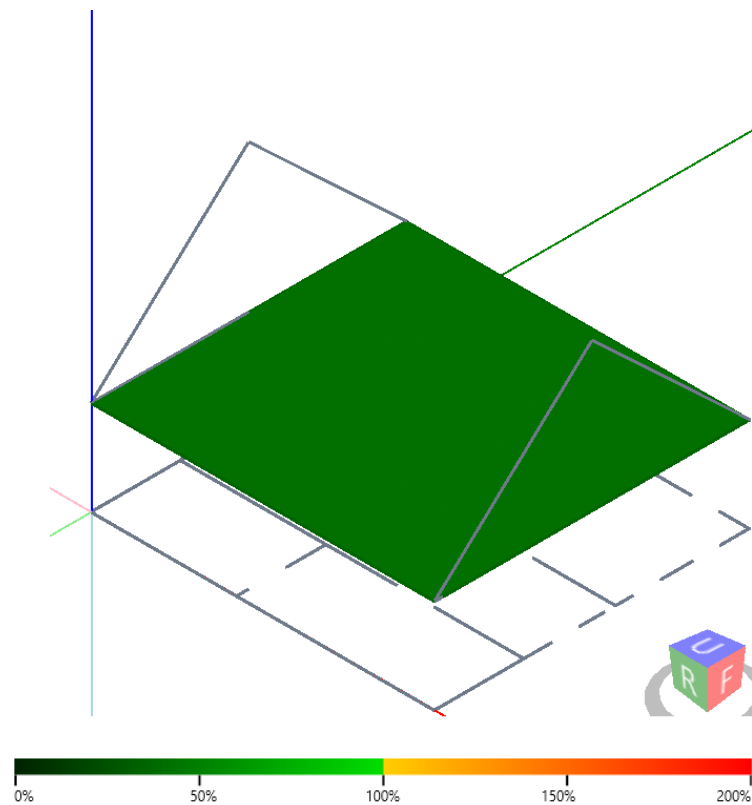
Verification percentage of floors

Ultimate Limit State (ULS)

Bending verifications

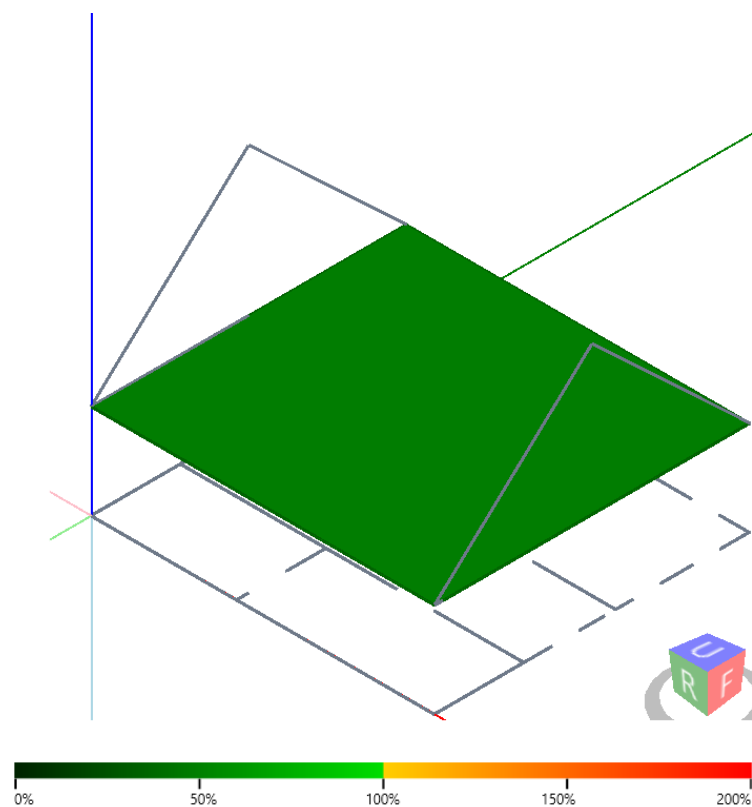


Shear verifications

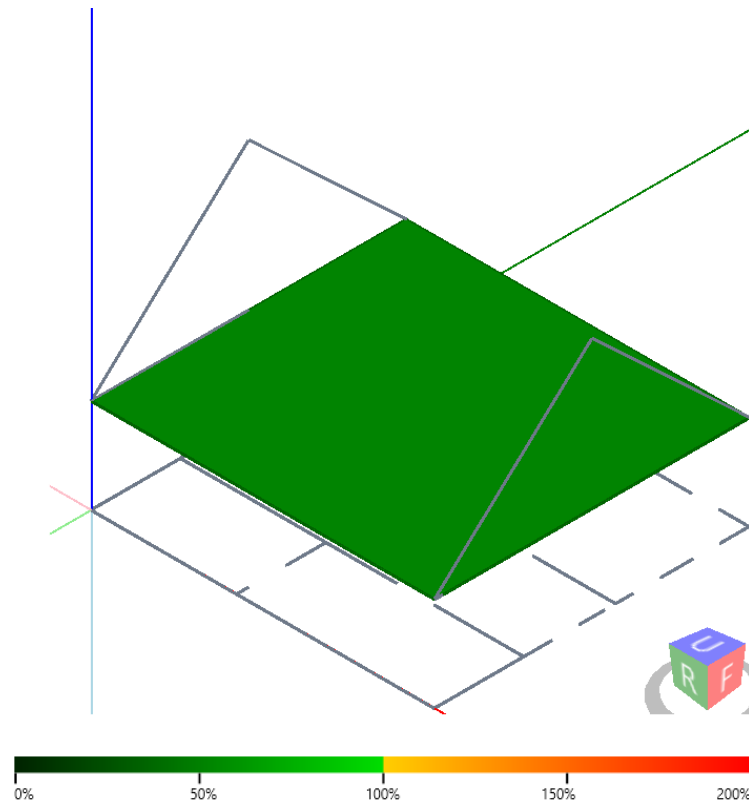


Serviceability Limit State (SLS)

Deflection verifications



Vibration verifications



Timber beams

Bending strength

The checks are conducted according to § 6.3.2 of EN 1995-1-1. The following expression shall be satisfied:

$$\frac{\sigma_{m,d}}{k_{crit} \cdot f_{m,d}} \leq 1$$

where:

$\sigma_{m,d}$ is the design bending stress;

$f_{m,d}$ is the design bending strength;

k_{crit} is a factor which takes into account the reduced bending strength due to lateral buckling.

The factor k_{crit} is assumed equal to 1.0 for beams in which the lateral displacement of the compressed edge is prevented over the entire length and the torsional rotation is prevented at the supports. Otherwise, the factor is determined from the following expression:

$$k_{crit} = \begin{cases} 1 & \text{for } \lambda_{rel,m} \leq 0,75 \\ 1,56 - 0,75\lambda_{rel,m} & \text{for } 0,75 \leq \lambda_{rel,m} \leq 1,4 \\ \frac{1}{\lambda_{rel,m}^2} & \text{for } 1,4 < \lambda_{rel,m} \end{cases}$$

in which the relative slenderness for bending is taken as:

$$\lambda_{rel,m} = \sqrt{\frac{f_{m,k}}{\sigma_{m,crit}}}$$

and $\sigma_{m,crit}$, the critical bending stress calculated according to the classical theory of stability is taken as:

$$\sigma_{m,crit} = \frac{M_{y,crit}}{W_y} = \frac{\pi \sqrt{E_{0,05} I_z G_{0,05} I_{tor}}}{l_{ef} W_y}$$

where:

$E_{0,05}$ is the fifth percentile value of modulus of elasticity parallel to grain;

$G_{0,05}$ is the fifth percentile value of shear modulus parallel to grain;

I_z is the second moment of area about the weak axis z;

I_{tor} is the torsional moment of inertia;

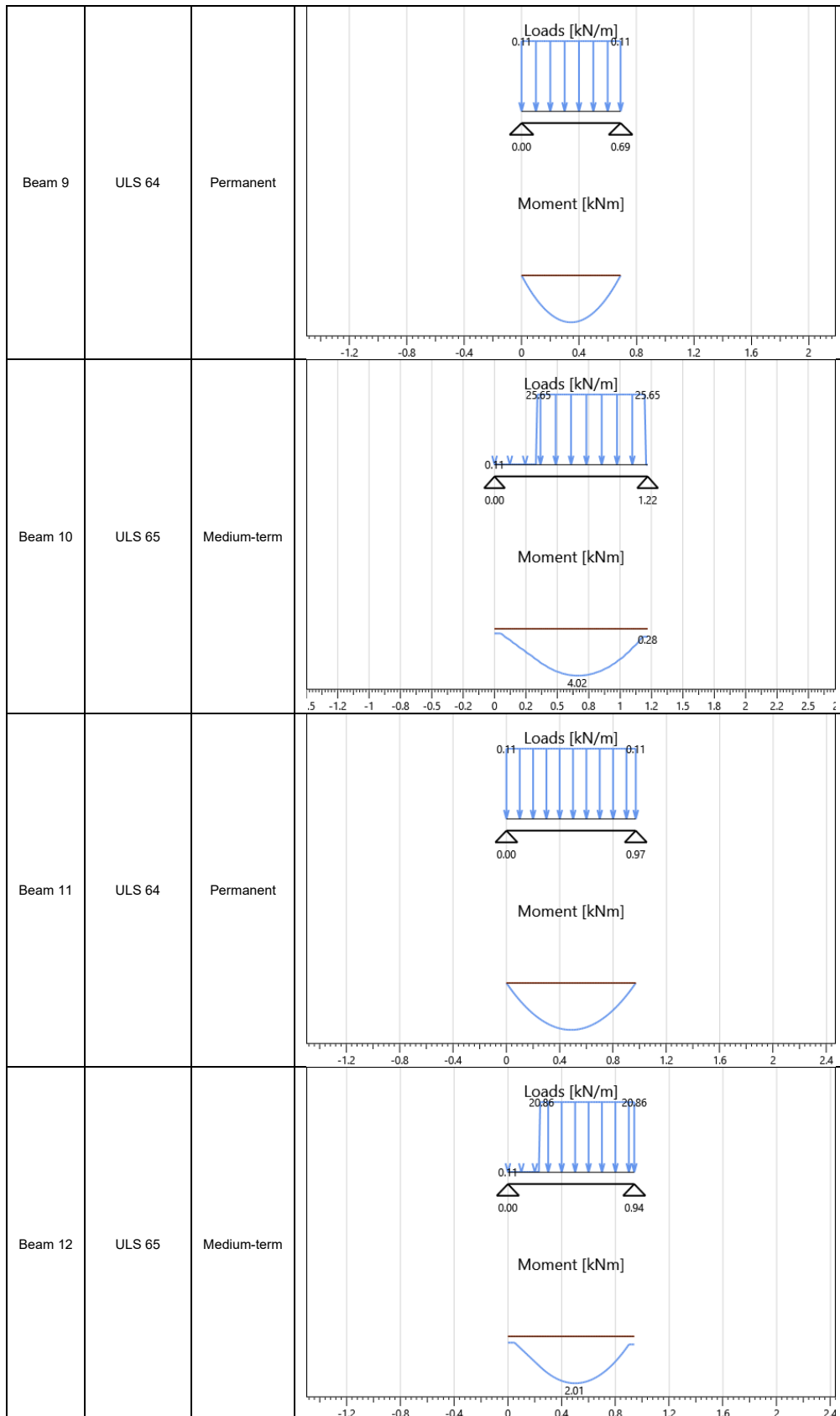
l_{ef} is the effective length of the beam, depending on the support conditions and the load configuration;

W_y is the section modulus about the strong axis y.

The following table shows, for each beam, the bending moment relating to the worst Ultimate Limit State combination.

Beam	Combination	Duration	Diagram M ₃₋₃
Beam 2	ULS 64	Permanent	Loads [kN/m] 0.11 0.11 0.00 0.69 Moment [kNm] 0.00
Beam 3	ULS 64	Permanent	Loads [kN/m] 2.19 1.31 0.00 0.69 Moment [kNm] 0.10
Beam 4	ULS 78	Short-term	Loads [kN/m] 61.31 61.31 11.72 0.00 0.69 Moment [kNm] 0.09

Beam 5	ULS 78	Short-term	Loads [kN/m] Moment [kNm]
Beam 6	ULS 78	Short-term	Loads [kN/m] Moment [kNm]
Beam 7	ULS 64	Permanent	Loads [kN/m] Moment [kNm]
Beam 8	ULS 64	Permanent	Loads [kN/m] Moment [kNm]



The checks are summarized below. The values resulting from the calculations, relating to each verification, are reported in the form of a percentage.

Beam name	Section	M _{3-3 max} [kNm]	W [mm ³]	Lateral restraints	σ _{m,crit} [MPa]	k _{crit}	Comb.	k _h	k _{mod}	γ _M	f _{m,d} [MPa]	σ _{m,d} [MPa]	Check
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Beam 2	100x200mm C24	0.01	666667	No torsional buckling	-	1.00	ULS 64	1.00	0.6	1.3	11.08	0.01	0%
Beam 3	100x200mm C24	0.10	666667	No torsional buckling	-	1.00	ULS 64	1.00	0.6	1.3	11.08	0.16	1%
Beam 4	100x200mm C24	2.55	666667	No torsional buckling	-	1.00	ULS 78	1.00	0.9	1.3	16.62	3.83	23%
Beam 5	100x200mm C24	2.60	666667	No torsional buckling	-	1.00	ULS 78	1.00	0.9	1.3	16.62	3.90	23%
Beam 6	100x200mm C24	1.77	666667	No torsional buckling	-	1.00	ULS 78	1.00	0.9	1.3	16.62	2.66	16%
Beam 7	100x200mm C24	0.09	666667	No torsional buckling	-	1.00	ULS 64	1.00	0.6	1.3	11.08	0.14	1%
Beam 8	100x200mm C24	0.16	666667	No torsional buckling	-	1.00	ULS 64	1.00	0.6	1.3	11.08	0.24	2%
Beam 9	100x200mm C24	0.01	666667	No torsional buckling	-	1.00	ULS 64	1.00	0.6	1.3	11.08	0.01	0%
Beam 10	100x200mm C24	4.02	666667	No torsional buckling	-	1.00	ULS 65	1.00	0.8	1.3	14.77	6.03	41%
Beam 11	100x200mm C24	0.01	666667	No torsional buckling	-	1.00	ULS 64	1.00	0.6	1.3	11.08	0.02	0%
Beam 12	100x200mm C24	2.01	666667	No torsional buckling	-	1.00	ULS 65	1.00	0.8	1.3	14.77	3.02	20%

Shear strength

The checks are conducted according to § 6.1.7 of EN 1995-1-1. The following expression shall be satisfied:

$$\frac{\tau_d}{f_{v,d}} \leq 1$$

where:

τ_d is the design shear stress;

$f_{v,d}$ is the design shear strength for the actual condition.

For the verification of shear resistance of members in bending, the influence of cracks should be taken into account using an effective width of the member given as:

$$b_{ef} = k_{cr} \cdot b$$

where b is the width of the relevant section where the maximum shear stress is.

The following value of k_{cr} are used

$k_{cr} = 0.67 (\leq 1)$ for solid timber

$k_{cr} = 0.67 (\leq 1)$ for glued laminated timber

The maximum design shear stress in a generic cross section can be evaluated using the following expression:

$$\tau_d = \frac{V_d \cdot S}{k_{cr} \cdot b \cdot J_{y-y}}$$

V_d is the design shear force;

S is the static moment of the cross section cut by the considered chord b ;

k_{cr} is the coefficient that takes into account the influence of cracks;

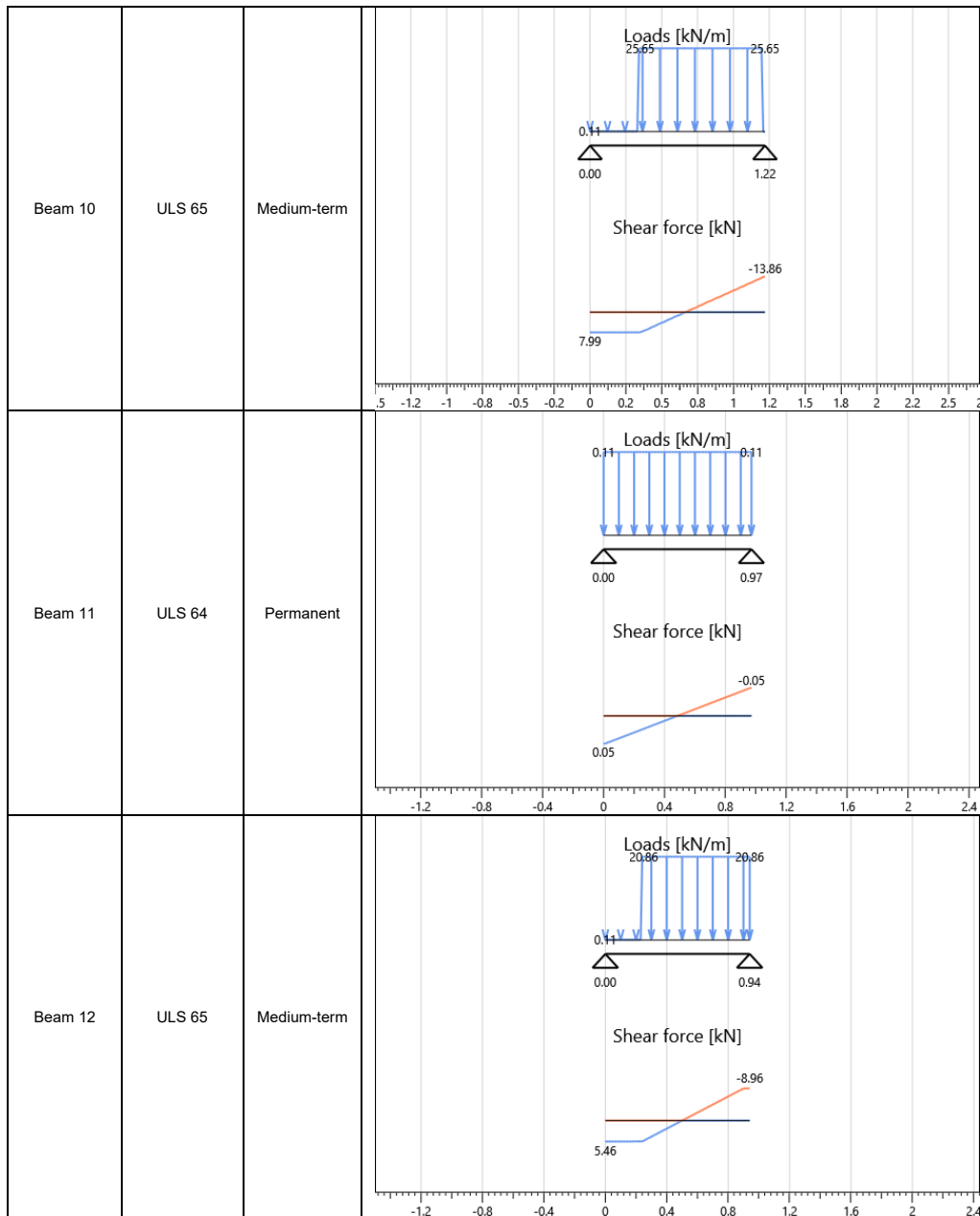
b is the chord where the shear stress is evaluated;

J_{y-y} is the moment of inertia with respect to the y axis.

The following table illustrates the structural schemes and the envelopes of the shear force diagram for each beam.

Beam name	Combination	Duration	Diagram V ₂
Beam 2	ULS 64	Permanent	Loads [kN/m] 0.11 0.11 0.00 0.69 Shear force [kN] 0.11 -0.11
Beam 3	ULS 64	Permanent	Loads [kN/m] 2.19 1.31 0.00 0.69 Shear force [kN] 0.63 -0.53
Beam 4	ULS 78	Short-term	Loads [kN/m] 61.31 61.31 11.72 0.00 0.69 Shear force [kN] 17.09 -9.11
Beam 5	ULS 78	Short-term	Loads [kN/m] 49.23 49.23 11.55 0.00 0.69 Shear force [kN] 15.51 -10.69

Beam 6	ULS 78	Short-term	Loads [kN/m] Shear force [kN]
Beam 7	ULS 64	Permanent	Loads [kN/m] Shear force [kN]
Beam 8	ULS 64	Permanent	Loads [kN/m] Shear force [kN]
Beam 9	ULS 64	Permanent	Loads [kN/m] Shear force [kN]



The checks are summarized below. The values resulting from the calculations, relating to each verification, are reported in the form of a percentage.

Beam name	Section	$V_{2, \max}$ [kN]	b [mm]	S [mm ³]	k_{cr}	Comb.	Service class	k_{mod}	γ_M	$f_{v,d}$ [MPa]	$\tau_{2,d}$ [MPa]	Check
Beam 2	100x200m m C24	0.04	100.00	500000.00	0.67	ULS 64	1	0.6	1.3	1.85	0.00	0%
Beam 3	100x200m m C24	0.63	100.00	500000.00	0.67	ULS 64	1	0.6	1.3	1.85	0.07	4%
Beam 4	100x200m m C24	17.09	100.00	500000.00	0.67	ULS 78	1	0.9	1.3	2.77	1.91	69%
Beam 5	100x200m m C24	15.51	100.00	500000.00	0.67	ULS 78	1	0.9	1.3	2.77	1.74	63%
Beam 6	100x200m m C24	9.81	100.00	500000.00	0.67	ULS 78	1	0.9	1.3	2.77	1.10	40%
Beam 7	100x200m m C24	0.55	100.00	500000.00	0.67	ULS 64	1	0.6	1.3	1.85	0.06	3%
Beam 8	100x200m m C24	0.98	100.00	500000.00	0.67	ULS 64	1	0.6	1.3	1.85	0.11	6%
Beam 9	100x200m m C24	0.04	100.00	500000.00	0.67	ULS 64	1	0.6	1.3	1.85	0.00	0%
Beam 10	100x200m m C24	13.86	100.00	500000.00	0.67	ULS 65	1	0.8	1.3	2.46	1.55	63%
Beam 11	100x200m m C24	0.05	100.00	500000.00	0.67	ULS 64	1	0.6	1.3	1.85	0.01	0%
Beam 12	100x200m m C24	8.96	100.00	500000.00	0.67	ULS 65	1	0.8	1.3	2.46	1.00	41%

Beams deflections (SLS)

The deflection checks are carried out according to § 2.2.3 of EN 1995-1-1.

The net deflection below a straight line between the supports, $w_{net,fin}$, is taken as:

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

where:

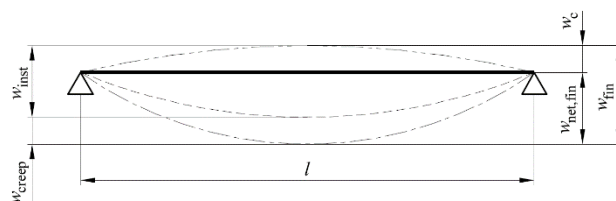
$w_{net,fin}$ is the net final deflection;

w_{inst} is the instantaneous deflection;

w_{creep} is the creep deflection;

w_c is the precamber (if applied);

w_{fin} is the final deflection.



The limiting values for deflections of beams are assumed as shown in the following table.

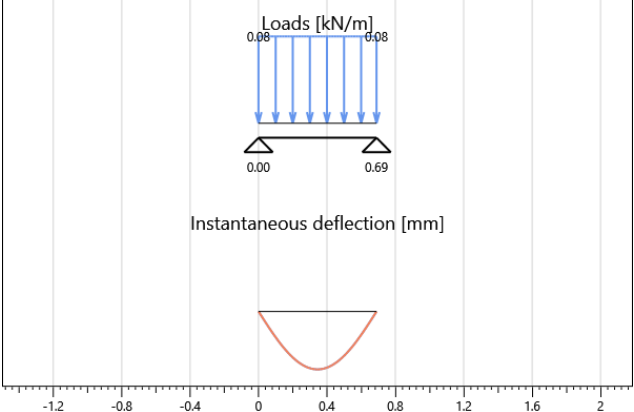
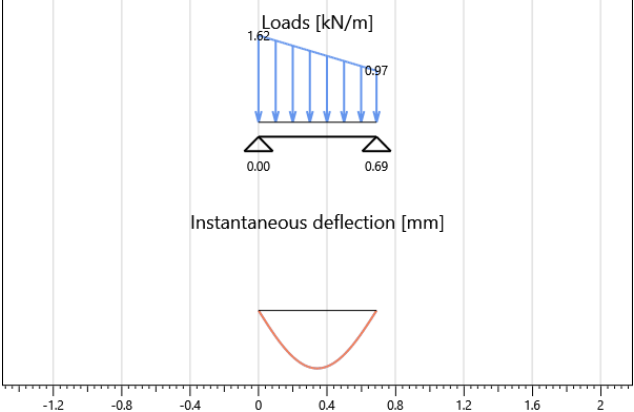
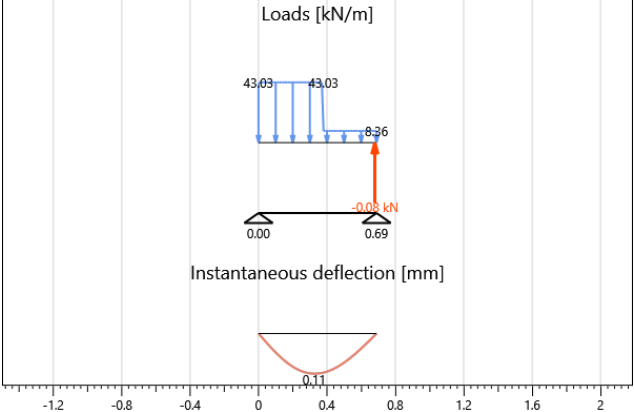
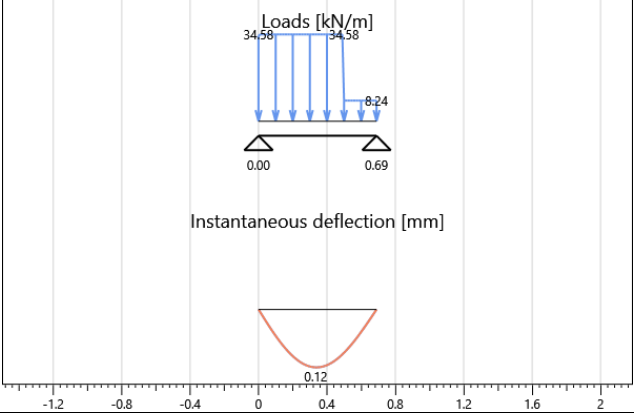
Deformation limits name	$w_{inst, span}$	$w_{net, fin, span}$	$w_{inst, overhang}$	$w_{net, fin, overhang}$	Neglect overhang check for deformation < 0
Timber beam	$l/300$	$l/250$	$l/150$	$l/125$	Yes

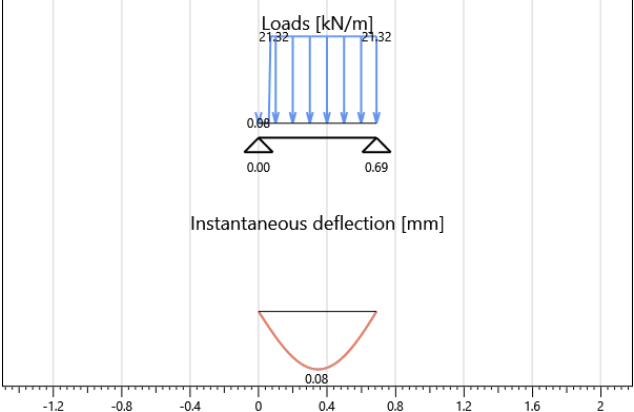
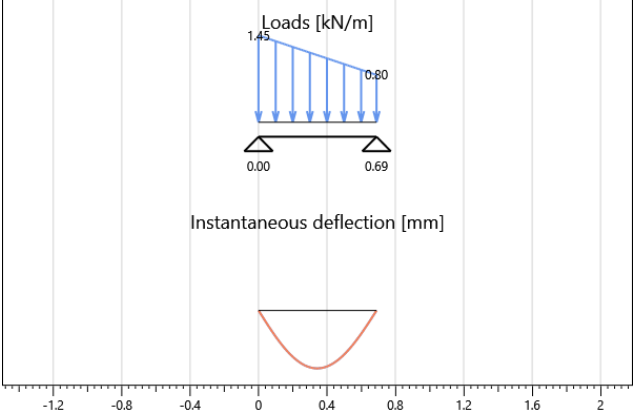
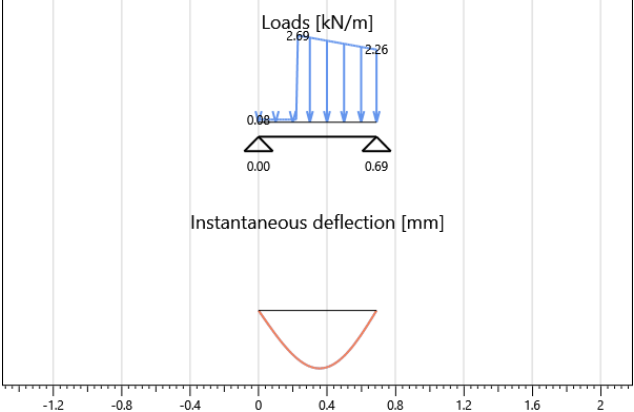
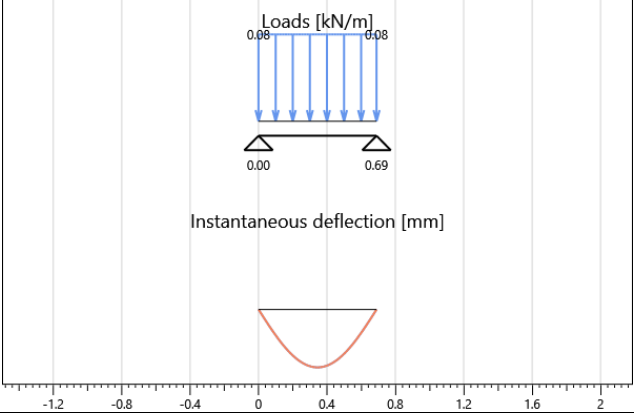
Instantaneous deflection

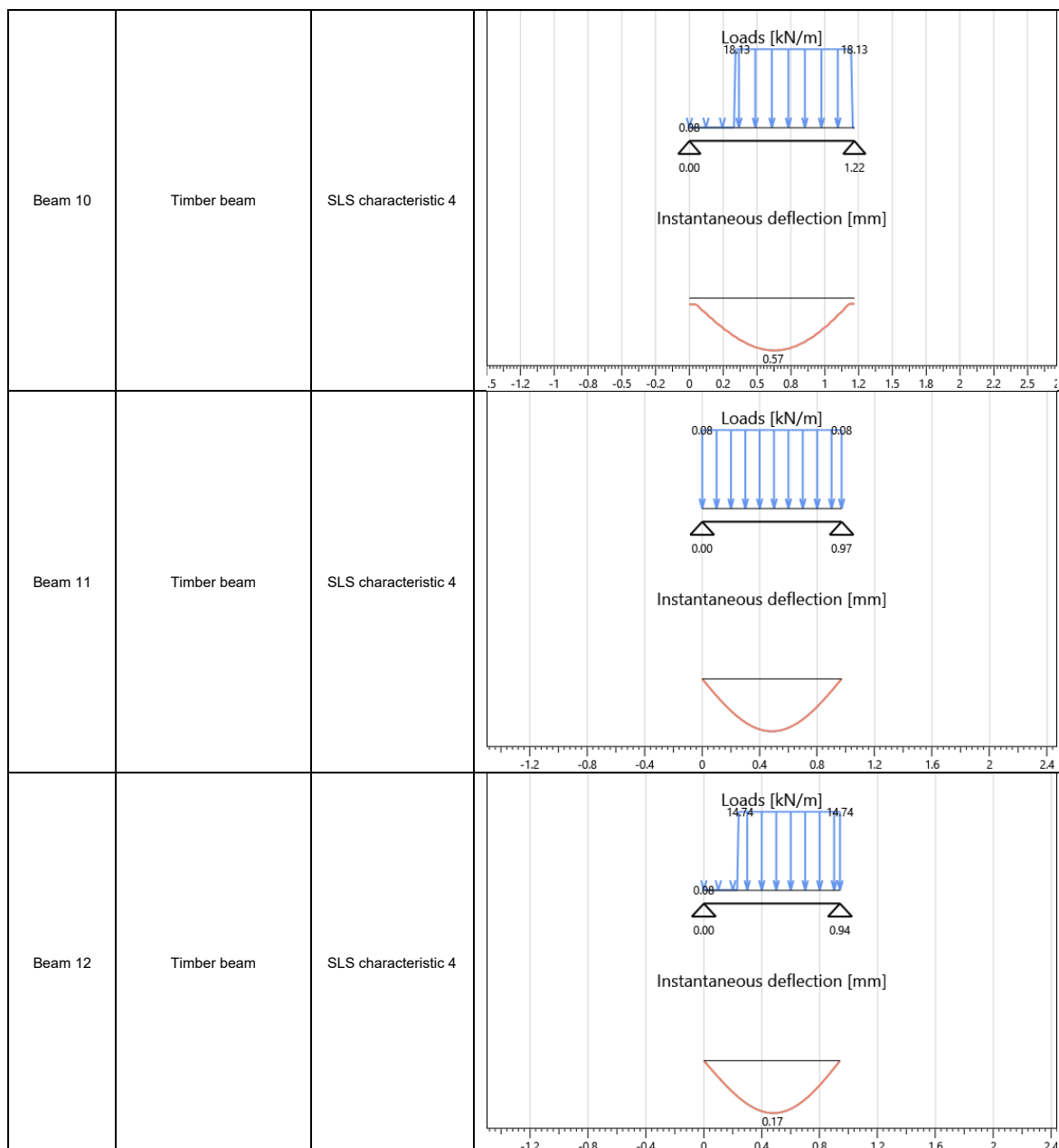
The instantaneous deflection w_{inst} is calculated for the characteristic (rare) combination of actions.

The following table shows the deformation of each beam.

Beam name	Deformation limits name	Combination	Instantaneous deflection
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Beam 2	Timber beam	SLS characteristic 4	 Loads [kN/m] 0.08 0.08 0.00 0.69 Instantaneous deflection [mm] 0.08
Beam 3	Timber beam	SLS characteristic 4	 Loads [kN/m] 1.62 0.97 0.00 0.69 Instantaneous deflection [mm] 0.11
Beam 4	Timber beam	SLS characteristic 15	 Loads [kN/m] 43.03 43.03 8.36 0.00 0.69 Instantaneous deflection [mm] 0.11
Beam 5	Timber beam	SLS characteristic 15	 Loads [kN/m] 34.58 34.58 8.24 0.00 0.69 Instantaneous deflection [mm] 0.12

Beam 6	Timber beam	SLS characteristic 14	 Loads [kN/m] Instantaneous deflection [mm]
Beam 7	Timber beam	SLS characteristic 4	 Loads [kN/m] Instantaneous deflection [mm]
Beam 8	Timber beam	SLS characteristic 4	 Loads [kN/m] Instantaneous deflection [mm]
Beam 9	Timber beam	SLS characteristic 4	 Loads [kN/m] Instantaneous deflection [mm]



The table below shows the instantaneous deflection checks of the beams.

Beam name	Section	Combination	Most restrictive check	w_{inst} [mm]	$w_{inst \text{ limit}}$ [mm]	Deflection limit	Check
Beam 2	100x200mm C24	SLS characteristic 4	Internal span	0.00	2.30	$l/300$	0%
Beam 3	100x200mm C24	SLS characteristic 4	Internal span	0.01	2.30	$l/300$	0%
Beam 4	100x200mm C24	SLS characteristic 15	Internal span	0.11	2.30	$l/300$	5%
Beam 5	100x200mm C24	SLS characteristic 15	Internal span	0.12	2.30	$l/300$	5%
Beam 6	100x200mm C24	SLS characteristic 14	Internal span	0.08	2.30	$l/300$	4%
Beam 7	100x200mm C24	SLS characteristic 4	Internal span	0.00	2.30	$l/300$	0%
Beam 8	100x200mm C24	SLS characteristic 4	Internal span	0.01	2.30	$l/300$	0%
Beam 9	100x200mm C24	SLS characteristic 4	Internal span	0.00	2.30	$l/300$	0%
Beam 10	100x200mm C24	SLS characteristic 4	Internal span	0.57	4.07	$l/300$	14%
Beam 11	100x200mm C24	SLS characteristic 4	Internal span	0.00	3.23	$l/300$	0%
Beam 12	100x200mm C24	SLS characteristic 4	Internal span	0.17	3.13	$l/300$	6%

Final deflection

For structures consisting of members, components and connections with the same creep behaviour and under the assumption of a linear relationship between the actions and the corresponding deformations the final deformation, w_{fin} , may be taken as:

$$w_{fin} = w_{fin,G} + w_{fin,Q1} + \sum w_{fin,Qi}$$

where:

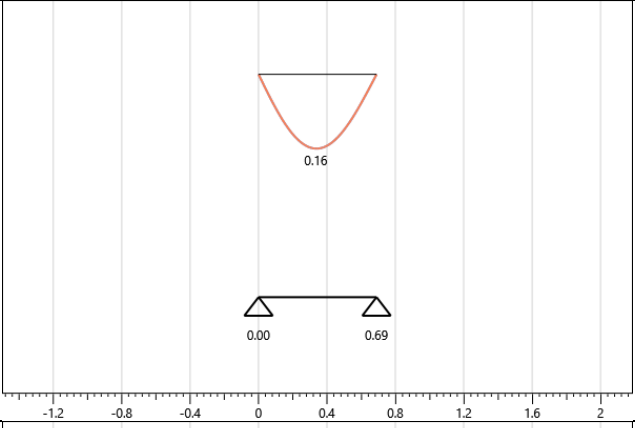
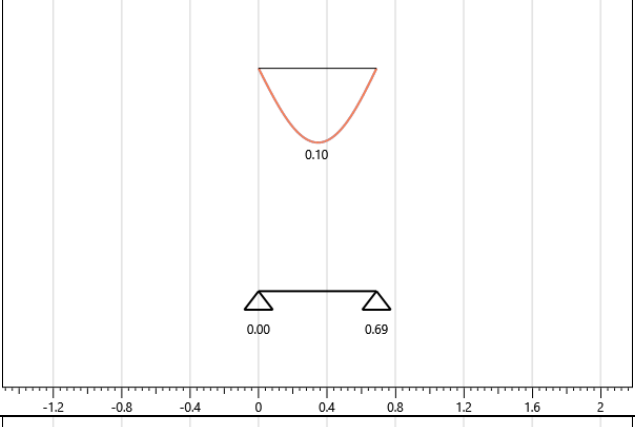
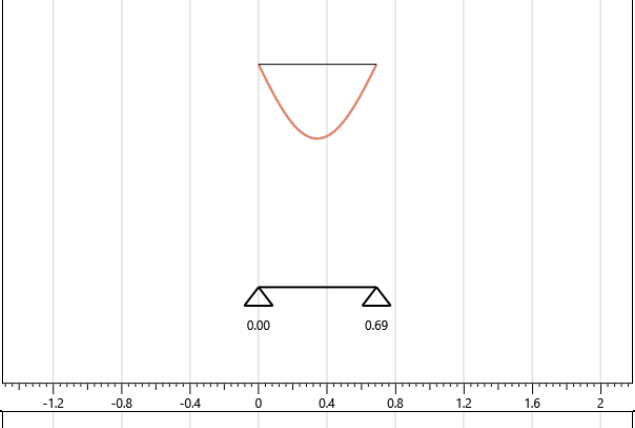
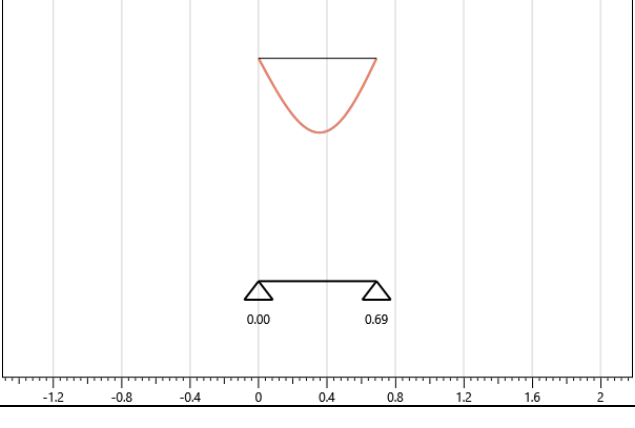
$$w_{fin,G} = w_{inst,G} \cdot (1 + k_{def}) \quad \text{for a permanent action, G}$$

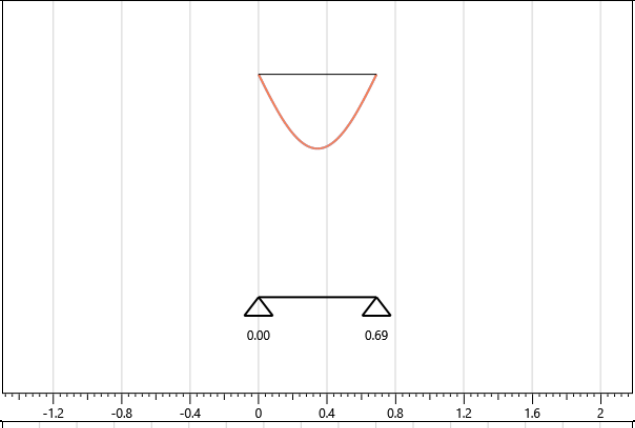
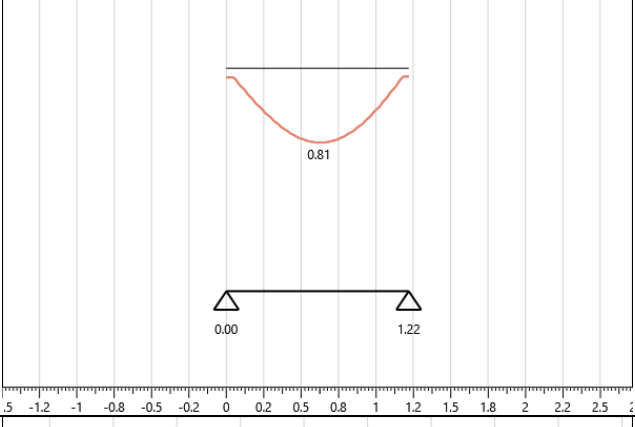
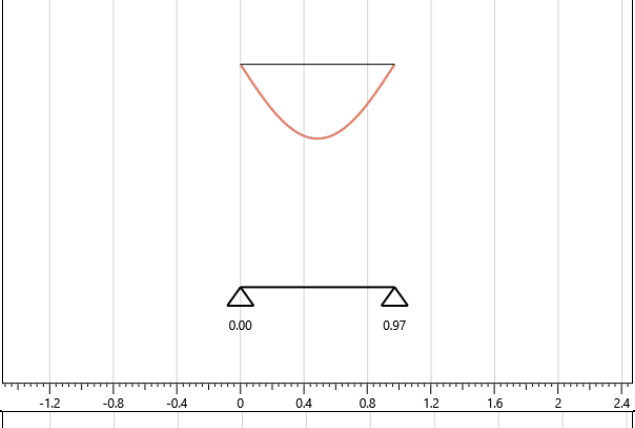
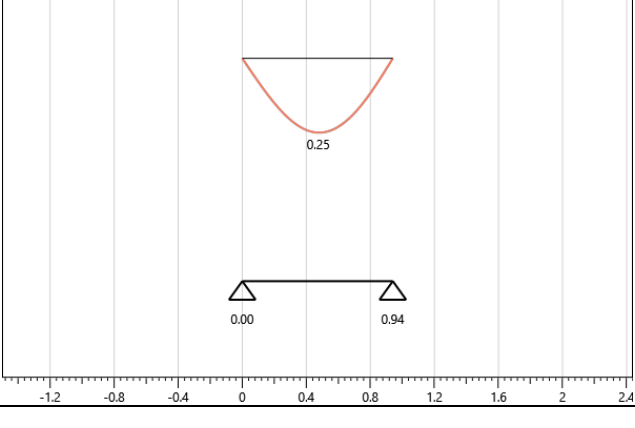
$$w_{fin,Q,1} = w_{inst,Q,1} \cdot (1 + \Psi_{2,1} \cdot k_{def}) \quad \text{for the leading variable action, } Q_1$$

$$w_{fin,Q,i} = w_{inst,Q,i} \cdot (\Psi_{0,i} + \Psi_{2,1} \cdot k_{def}) \quad \text{for accompanying variable actions, } Q_i (i>1)$$

The following table shows the deformation of each floor (relative to the element in which the deformation checks are the most severe).

Beam name	Deformation limits name	Combination	Final deflection
Beam 2	Timber beam	SLS characteristic 4	
Beam 3	Timber beam	SLS characteristic 4	
Beam 4	Timber beam	SLS characteristic 15	

Beam 5	Timber beam	SLS characteristic 15	
Beam 6	Timber beam	SLS characteristic 14	
Beam 7	Timber beam	SLS characteristic 4	
Beam 8	Timber beam	SLS characteristic 4	

Beam 9	Timber beam	SLS characteristic 4	
Beam 10	Timber beam	SLS characteristic 4	
Beam 11	Timber beam	SLS characteristic 4	
Beam 12	Timber beam	SLS characteristic 4	

The table below shows the final deflection checks for every beam.

Beam name	Section	Combination	Service class	k_{def}	Most restrictive check	w_{fin} [mm]	w_{fin} limit [mm]	Deflection limit	Check
Beam 2	100x200mm C24	SLS characteristic 4	1	0.6	Internal span	0.00	2.76	$l/250$	0%
Beam 3	100x200mm C24	SLS characteristic 4	1	0.6	Internal span	0.01	2.76	$l/250$	0%

Beam 4	100x200mm C24	SLS characteristic 15	1	0.6	Internal span	0.15	2.76	l/250	6%
Beam 5	100x200mm C24	SLS characteristic 15	1	0.6	Internal span	0.16	2.76	l/250	6%
Beam 6	100x200mm C24	SLS characteristic 14	1	0.6	Internal span	0.10	2.76	l/250	4%
Beam 7	100x200mm C24	SLS characteristic 4	1	0.6	Internal span	0.01	2.76	l/250	0%
Beam 8	100x200mm C24	SLS characteristic 4	1	0.6	Internal span	0.01	2.76	l/250	0%
Beam 9	100x200mm C24	SLS characteristic 4	1	0.6	Internal span	0.00	2.76	l/250	0%
Beam 10	100x200mm C24	SLS characteristic 4	1	0.6	Internal span	0.81	4.88	l/250	17%
Beam 11	100x200mm C24	SLS characteristic 4	1	0.6	Internal span	0.00	3.88	l/250	0%
Beam 12	100x200mm C24	SLS characteristic 4	1	0.6	Internal span	0.25	3.76	l/250	7%

Steel beams

Bending and shear checks

When the shear force is less than half the plastic shear resistance its effect on the moment resistance may be neglected.

$$V_{Ed} \leq 0.5 V_{pl,Rd}$$

Otherwise the reduced moment resistance should be taken as the design resistance of the cross-section, calculated using a reduced yield strength for the shear area A_v :

$$(1 - \rho) f_y$$

where

$$\rho = \left(\frac{2V_{Ed}}{V_{pl,Rd}} - 1 \right)^2$$

The reduced design plastic resistance moment allowing for the shear force may alternatively be obtained for I-cross-sections (class 1 or 2) with equal flanges and bending about the major axis as follows:

$$M_{c,V,Rd} = \frac{\left[W_{pl,y} - \frac{\rho \cdot A_w^2}{4 t_w} \right] f_{yk}}{\gamma_{M0}} \leq M_{c,Rd}$$

For circular hollow sections (class 1 or 2), the software uses a different equation that ensures higher safety standards:

$$M_{c,V,Rd} = \frac{W_{pl} f_{yk} (1 - \rho)}{\gamma_{M0}}$$

For all the class 3 cross-sections, the software uses a different equation, that ensures higher safety standards:

$$M_{c,V,Rd} = \frac{W_{el} f_{yk} (1 - \rho)}{\gamma_{M0}}$$

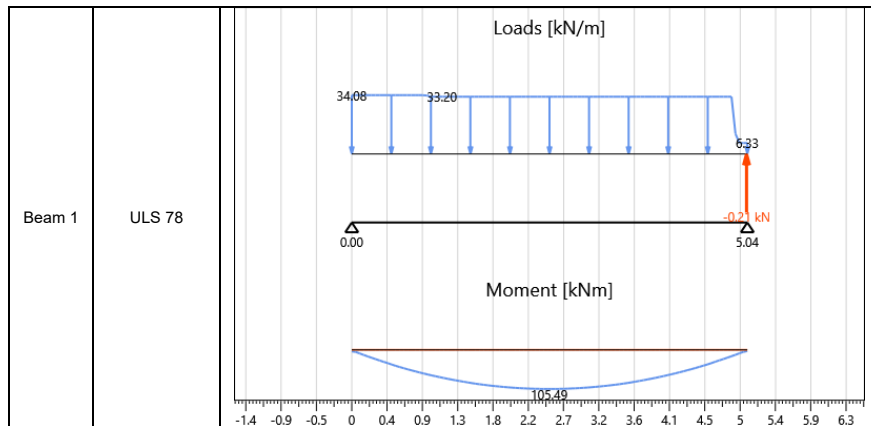
The partial factor for resistance of cross-section γ_{M0} is equal to 1.

It is assumed that the load is acting on the shear centre of the cross-section.

The following table provides, for each beam, the bending moment (the absolute value of the maximum bending moment M_{3-3} in the most stressed section) referring to the most severe ULS combination.

The table provides the structural schemes and the envelopes of the bending moment diagram for each beam.

Name	Combination	Diagram M_{3-3}
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Name	Profile	Steel grade	Cross section class	Combination	V ₂ [kN]	V ₂ /V _{pl,Rd} [%]	M _{3-3 max} [kNm]	M _{c,V,Rd} [kNm]	Check
Beam 1	HE 220 B	S235 - EN 10025 -2	1	ULS 78	0.14	0%	105.49	194.35	54%

Shear strength

The checks are conducted according to § 6.2.6 of EN 1993-1-1. The design value of the shear force at each cross section should satisfy:

$$\frac{V_{Ed}}{V_{pl,Rd}} \leq 1$$

where:

V_{Ed} is the design value of the shear force;

$V_{pl,Rd}$ is the plastic shear resistance.

The design resistance, in absence of torsion, is given by:

$$V_{pl,Rd} = \frac{A_v \cdot f_{yk}}{\sqrt{3} \cdot \gamma_{M0}}$$

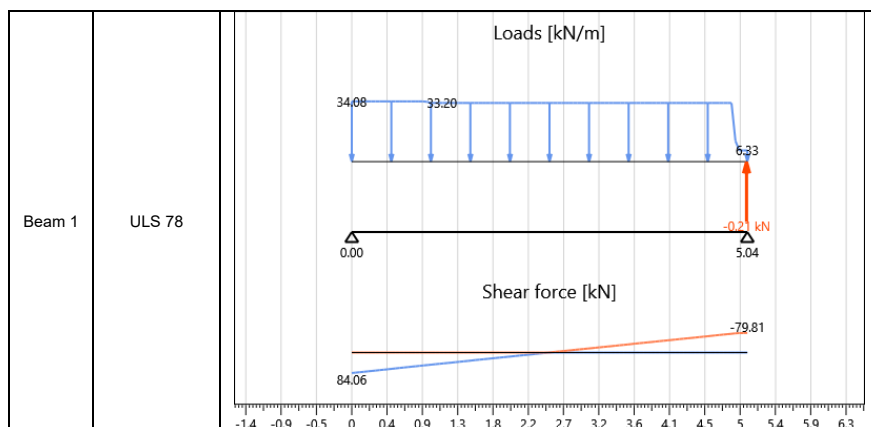
where:

A_v is the shear area

γ_{M0} is the partial factor for resistance of cross-sections equal to 1.

The following table provides, for each beam, the structural schemes and the envelopes of the shear forces.

Name	Combination	Diagram V ₂
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The shear checks are summarized below. The table reports the values in percent obtained from the calculations, relating to each verification.

Name	Profile	Steel grade	$A_v \times 10^2$ [mm ²]	Comb.	V_2 [kN]	$V_{pl,Rd}$ [kN]	Check
Beam 1	HE 220 B	S235 - EN 10025 -2	28	ULS 78	84.06	378.81	22%

Steel beams deflections (SLE)

Structural members shall be designed to have adequate deflections limits.

The total deflection of the element is given by:

$$w_{tot} = w_1 + w_2$$

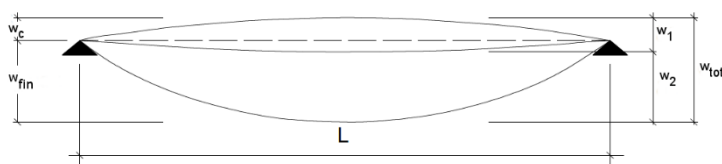
where:

w_c precamber in the unloaded structural member;

w_1 deflection under permanent loads;

w_2 deflection under variable loads;

$w_{fin} = w_{tot} - w_c$ the final deflection not taking into account the precamber.

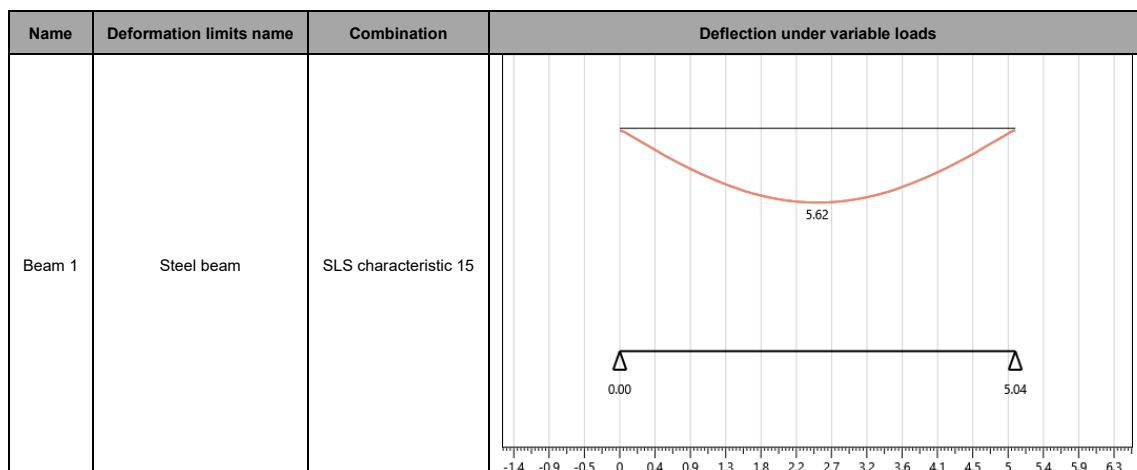


The following table provides the default limits of beams deflection where L is the effective beam span length or, in the case of cantilevering beams, the double value of the length.

Deformation limits name	$w_{2,span}$	$w_{fin,span}$	$w_{2,overhang}$	$w_{fin,overhang}$	Neglect overhang check for deformation < 0
Steel beam	$l/300$	$l/250$	$l/150$	$l/125$	Yes

Deflection under variable loads

The elastic deflection w_2 is calculated using the characteristic combination of the variable actions.



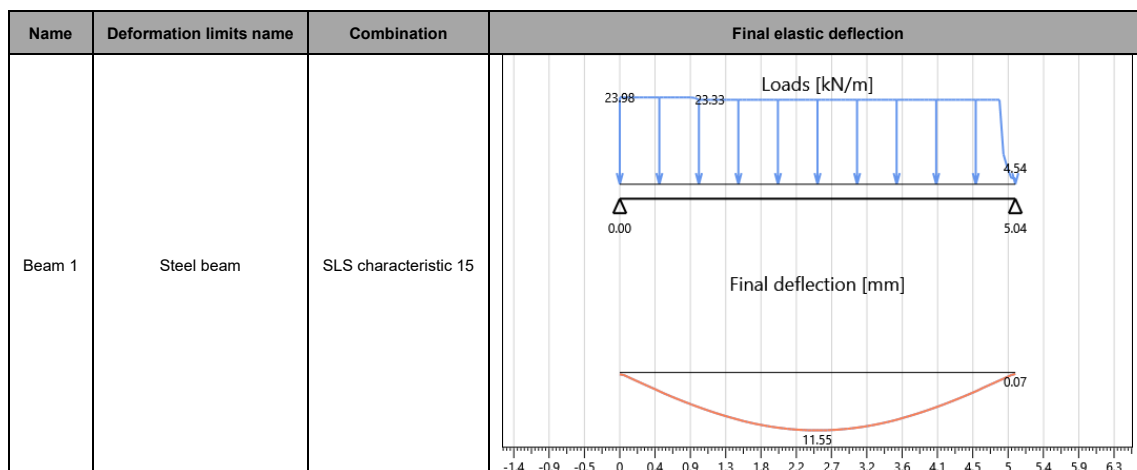
The following table provides the deflections checks of the steel beam under the variable loads.

Name	Profile	Combination	Most restrictive check	w_2 [mm]	$w_{2,limit}$ [mm]	Deflection limit	Check
Beam 1	HE 220 B	SLS characteristic 15	Internal span	5.62	16.80	$l/300$	33%

Final elastic deflection

The final deflection w_{fin} is the deflection under the permanent loads (w_1) and the variable loads (w_2).

The following tables provides, for each beam, the final deformations.



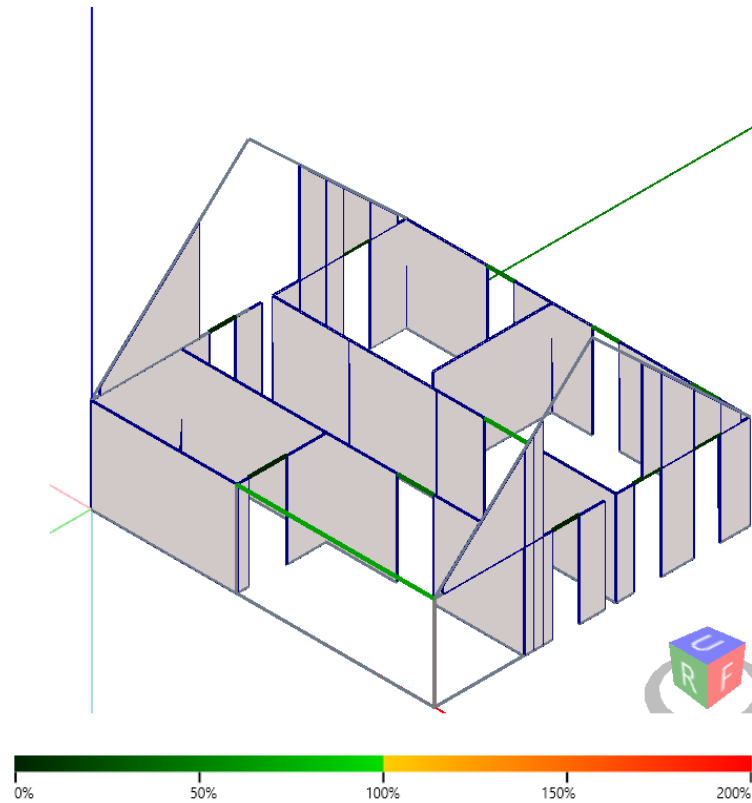
The following table provides the total deflection checks of the steel beams under the permanent and the variable loads.

Name	Profile	Combination	Most restrictive check	w_{fin} [mm]	$w_{fin,limit}$ [mm]	Deflection limit	Check
Beam 1	HE 220 B	SLS characteristic 15	Internal span	11.55	20.16	$l/250$	57%

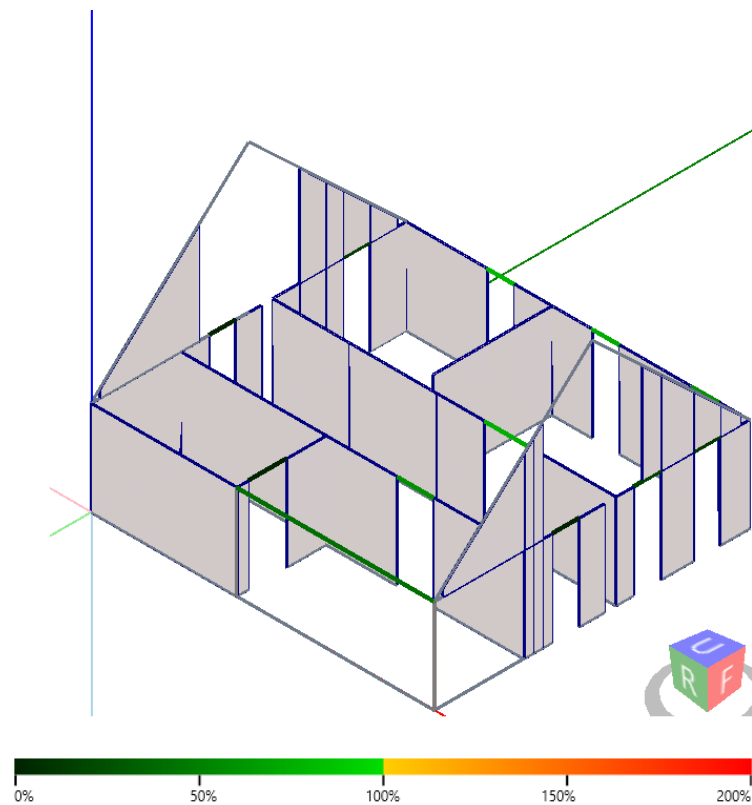
Verification percentage of beams

Ultimate Limit State (ULS)

Bending verifications

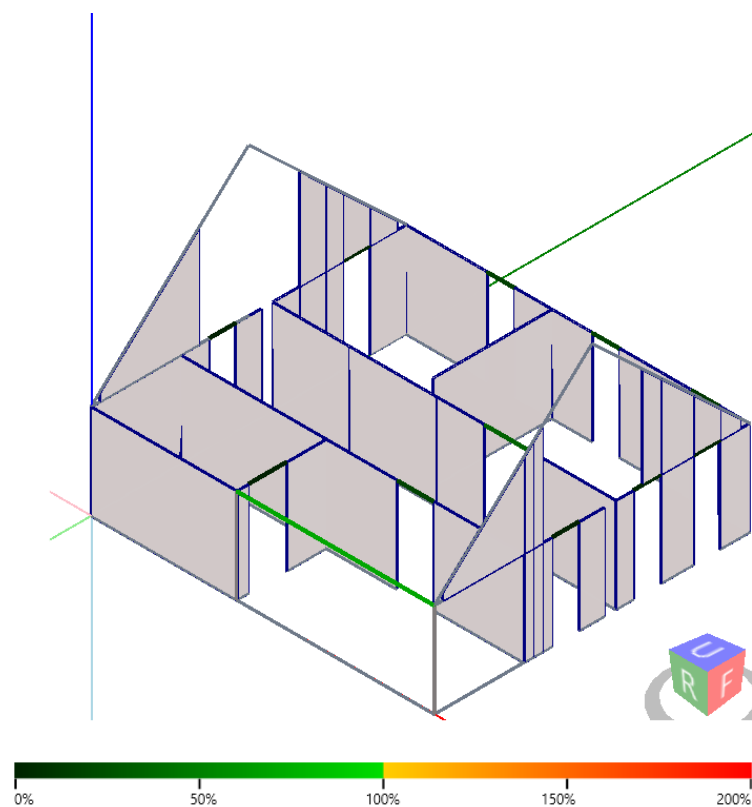


Shear verifications



Serviceability Limit State (SLS)

Deflection verifications



Steel columns

Buckling resistance

The buckling checks of the steel pillars are conducted according to the § 6.3.1 of EN 1993-1-1.

It is assumed that no torsional buckling of columns is occurring.

A compression member should be verified against buckling as follows:

$$\frac{N_{Ed}}{N_{b,Rd}} \leq 1$$

where:

N_{Ed} is the design value of the compression force;

$N_{b,Rd}$ is the design buckling resistance of the compression member:

$$N_{b,Rd} = \frac{\chi A f_{yk}}{\gamma_{M1}} \quad \text{for Class 1, 2 and 3 cross – sections}$$

$$N_{b,Rd} = \frac{\chi A_{eff} f_{yk}}{\gamma_{M1}} \quad \text{for Class 4 cross – sections}$$

where γ_{M1} is the partial factor for resistance of members to instability equal to 1, A and A_{eff} are the gross area and the effective area of the cross section (the effective area is calculated in accordance to § 4.4 of UNI EN 1993-1-5) and χ is the reduction factor for the relevant buckling mode, given by:

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} \text{ con } \chi \leq 1$$

where:

$$\Phi = 0.5 \left[1 + \alpha (\bar{\lambda} - 0.2) + \bar{\lambda}^2 \right]$$

α is an imperfection factor (Table 6.1 UNI EN 1993-1-1) corresponding to the appropriate buckling curve obtained from the Table 6.2 (UNI EN 1993-1-1);

$\bar{\lambda}$ is the non-dimensional slenderness in the case of flexural buckling given by:

$$\bar{\lambda} = \sqrt{\frac{A f_{yk}}{N_{cr}}} = \frac{L_{cr}}{i} \frac{1}{\lambda_1} \quad \text{for Class 1, 2 or 3 cross – sections}$$

$$\bar{\lambda} = \sqrt{\frac{A_{eff} f_{yk}}{N_{cr}}} = \frac{L_{cr}}{i} \sqrt{\frac{A_{eff}}{A}} \frac{1}{\lambda_1} \quad \text{for Class 4 cross – sections}$$

where:

N_{cr} is the elastic critical force for flexural buckling;

L_{cr} is the buckling length in the buckling plane considered;

i is the radius of gyration about the relevant axis, determined using the properties of the gross cross-section;

$\lambda_l = \pi \sqrt{\frac{E}{f_{yk}}}$ slenderness value to determine the relative slenderness.

The following table provides, for each column, the buckling checks referring to the most severe ULS combination.

Profile: The steel cross-section profile

Steel: Steel grade in accordance with the EN 10025-2

Class: Class of the steel cross-section

A: Gross or effective cross-section area depending on the section class

J_{y-y} : The cross-section moment of inertia about the y-y axis

J_{z-z} : The cross-section moment of inertia about the z-z axis

Comb.: The most severe load combination corresponding to the considered column

N: Axial force

$N_{b,Rd}$: The minimum design buckling resistance in the two principal directions

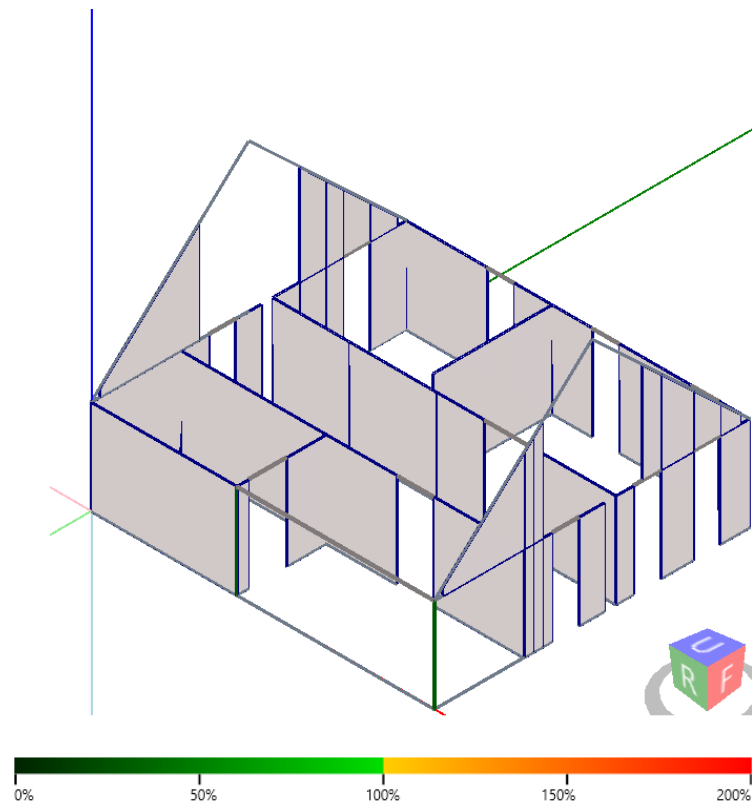
Check: Check in percent

Column name	Profile	Height [m]	Steel	Class	A $\times 10^2$ [mm ²]	J_{y-y} $\times 10^4$ [mm ⁴]	J_{z-z} $\times 10^4$ [mm ⁴]	Comb.	N [kN]	$N_{b,Rd}$ [kN]	Check
Column 1	HE 160 A	2.40	S235 - EN 10025 -2	1	38.8	1673	615.6	ULS 78	85.38	693.06	12%
Column 2	HE 160 A	2.40	S235 - EN 10025 -2	1	38.8	1673	615.6	ULS 78	80.81	693.06	12%

Verification percentage of columns

Ultimate Limit State (ULS)

Buckling verifications



CLT walls

Buckling of CLT walls

The stability checks of CLT walls are conducted with reference to what reported in 6.3.2 of EN 1995-1-1.

The values of the actions in the table below are related, for each wall, to the most severe combination of load for the Ultimate Limit State of stability.

Wall name	Length [m]	Comb.	Dur.	N [kN]	M2-2 [kNm]
Wall 1	2.07	ULS 78	Short-term	85.41	0.00
Wall 2	1.99	ULS 78	Short-term	103.97	0.00
Wall 3	1.84	ULS 78	Short-term	97.66	0.00
Wall 4	0.78	ULS 78	Short-term	39.74	0.00
Wall 5	0.75	ULS 82	Instantaneous	3.28	0.40
Wall 6	0.83	ULS 82	Instantaneous	6.32	0.44
Wall 7	0.66	ULS 82	Instantaneous	2.22	0.35
Wall 8 - 1	0.22	ULS 82	Instantaneous	1.40	0.12
Wall 9	2.30	ULS 65	Medium-term	48.50	0.00
Wall 10	5.51	ULS 65	Medium-term	107.22	0.00
Wall 11	1.02	ULS 82	Instantaneous	3.43	0.54
Wall 12	0.29	ULS 82	Instantaneous	1.01	0.15
Wall 13	3.71	ULS 78	Short-term	135.82	0.00
Wall 14	2.99	ULS 82	Instantaneous	14.71	1.59
Wall 16	0.93	ULS 82	Instantaneous	4.15	0.49
Wall 17	1.96	ULS 65	Medium-term	45.37	0.00
Wall 18	2.24	ULS 65	Medium-term	51.85	0.00
Wall 19	1.20	ULS 65	Medium-term	56.40	0.00
Wall 20	2.13	ULS 65	Medium-term	65.58	0.00
Wall 21	0.44	ULS 82	Instantaneous	2.00	0.23
Wall 22	3.04	ULS 64	Permanent	10.05	0.00
Wall 23	0.65	ULS 82	Instantaneous	2.19	0.34
Wall 24 - 1	0.44	ULS 82	Instantaneous	3.15	0.23
Wall 25 - 1	0.22	ULS 82	Instantaneous	0.68	0.10
Wall 29	2.54	ULS 82	Instantaneous	4.79	0.44
Wall 30 - 1	0.83	ULS 82	Instantaneous	1.99	0.23
Wall 31	0.50	ULS 82	Instantaneous	0.33	0.01
Wall 34 - 1	0.44	ULS 82	Instantaneous	1.05	0.12
Wall 35	0.70	ULS 82	Instantaneous	0.53	0.02
Wall 25 - 2	2.08	ULS 82	Instantaneous	3.31	0.26
Wall 25 - 3	0.24	ULS 82	Instantaneous	0.81	0.13
Wall 30 - 2	0.46	ULS 82	Instantaneous	1.48	0.23
Wall 30 - 3	0.69	ULS 82	Instantaneous	0.97	0.07
Wall 34 - 2	0.67	ULS 82	Instantaneous	2.07	0.31
Wall 34 - 3	0.69	ULS 82	Instantaneous	1.13	0.09
Wall 8 - 2	0.24	ULS 82	Instantaneous	1.60	0.13
Wall 24 - 2	0.67	ULS 82	Instantaneous	4.28	0.36
Wall 8 - 3	0.24	ULS 82	Instantaneous	0.83	0.13
Wall 24 - 3	0.67	ULS 82	Instantaneous	2.21	0.36

The stability checks of the CLT panels are performed considering a wall portion of unitary length.

Where both $\lambda_{rel,z} \leq 0,3$ and $\lambda_{rel,y} \leq 0,3$, the stresses should satisfy the expressions (6.19) and (6.20) in 6.2.4 of EN 1995-1-1.

In all other cases the stresses, which will be increased due to deflection, should satisfy the following expressions:

$$\frac{\sigma_{c,0,d}}{k_c \cdot f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} \leq 1$$

Mechanical model for the internal stress pattern in CLT elements

The calculation model adopted for the design of CLT in bending out-of-plane is that of mechanically jointed beams with deformable connection. The calculation of CLT elements is calculated as a mechanically jointed structure in accordance with Appendix B of EN 1995-1-1. The shear flexibility of the transverse layers is considered using the γ -method (gamma): namely with Möhler theory for

CLT panel having up to 3 layers oriented in the direction of calculation and with Shelling theory for CLT panel having more than 3 layers oriented in the direction of calculation.

The effective bending stiffness is taken as:

$$EJ_{eff} = \sum_{i=1}^n (E_i J_i + \gamma_i E_i A_i a_i^2)$$

$$\gamma_i = \left[1 + \frac{\pi^2 E_i A_i}{G_R \cdot \frac{b}{d} \cdot h^2} \right]^{-1}$$

where:

- J_i is the moment of inertia of layer i in reference to its neutral axis;
- A_i is the cross-sectional area of layer i;
- a_i is the distance between the centre of gravity of layer i and centre of gravity of the CLT element;
- h It is the height of the wall;
- G_R is the rolling shear modulus (mean value).

The results of the stability checks are reported below expressed as percentages.

- A_{net} : Cross sectional area of the wall portion considered in the verification (linear meter)
- J_{eff} : Cross sectional effective moment of inertia of the wall portion
- Comb.: The most severe combination of load
- k_{mod} : Modification factor taking into account the effect of the duration of load and moisture content
- γ_M : Partial factor for a material property
- $f_{c,0,k}$: Design compressive strength along the grain
- $f_{m,k}$: Design bending strength
- $\sigma_{c,0,d}$: Design compressive stress along the grain

Wall name	Section	h [m]	A_{net} [mm ² /m]	J_{eff} [mm ⁴ /m]	k_c	Comb.	Service Class	k_{mod}	γ_M	$f_{c,0,k}$ [MPa]	$f_{m,k}$ [MPa]	$\sigma_{c,0,d}$ [MPa]	$\sigma_{m,d}$ [MPa]	Check
Wall 1	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 78	1	0.9	1.25	21	24	0.74	0.00	9%
Wall 2	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 78	1	0.9	1.25	21	24	0.92	0.00	11%
Wall 3	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 78	1	0.9	1.25	21	24	0.87	0.00	10%
Wall 4	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 78	1	0.9	1.25	21	24	0.84	0.00	10%
Wall 5	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.07	0.36	3%
Wall 6	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.13	0.36	3%
Wall 7	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.06	0.36	3%
Wall 8 - 1	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.10	0.36	9%
Wall 9	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 65	1	0.8	1.25	21	24	0.38	0.00	5%
Wall 10	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 65	1	0.8	1.25	21	24	0.44	0.00	6%
Wall 11	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.06	0.36	2%

Wall 12	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.06	0.36	6%
Wall 13	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 78	1	0.9	1.25	21	24	0.65	0.00	8%
Wall 14	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.10	0.36	3%
Wall 16	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.07	0.36	3%
Wall 17	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 65	1	0.8	1.25	21	24	0.42	0.00	6%
Wall 18	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 65	1	0.8	1.25	21	24	0.50	0.00	7%
Wall 19	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 65	1	0.8	1.25	21	24	0.78	0.00	10%
Wall 20	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 65	1	0.8	1.25	21	24	0.61	0.00	8%
Wall 21	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.07	0.36	5%
Wall 22	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 64	1	0.6	1.25	21	24	0.06	0.00	1%
Wall 23	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.06	0.36	3%
Wall 24 - 1	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.12	0.36	5%
Wall 25 - 1	CLT 100 mm - 3 layers	2.24	60000	62796417	0.62	ULS 82	1	1.1	1.25	21	24	0.05	0.31	7%
Wall 29	CLT 100 mm - 3 layers	2.09	60000	48006818	0.56	ULS 82	1	1.1	1.25	21	24	0.05	0.13	1%
Wall 30 - 1	CLT 100 mm - 3 layers	1.73	60000	55793704	0.80	ULS 82	1	1.1	1.25	21	24	0.04	0.20	1%
Wall 31	CLT 100 mm - 3 layers	0.47	60000	14989851	0.97	ULS 82	1	1.1	1.25	21	24	0.01	0.03	0%
Wall 34 - 1	CLT 100 mm - 3 layers	1.72	60000	55541251	0.80	ULS 82	1	1.1	1.25	21	24	0.04	0.19	2%
Wall 35	CLT 100 mm - 3 layers	0.54	60000	18020934	0.97	ULS 82	1	1.1	1.25	21	24	0.01	0.03	0%
Wall 25 - 2	CLT 100 mm - 3 layers	1.66	60000	41831438	0.71	ULS 82	1	1.1	1.25	21	24	0.04	0.10	1%
Wall 25 - 3	CLT 100 mm - 3 layers	2.45	60000	64893481	0.55	ULS 82	1	1.1	1.25	21	24	0.05	0.37	8%
Wall 30 - 2	CLT 100 mm - 3 layers	2.34	60000	63853048	0.59	ULS 82	1	1.1	1.25	21	24	0.05	0.34	4%
Wall 30 - 3	CLT 100 mm - 3 layers	1.02	60000	37276955	0.93	ULS 82	1	1.1	1.25	21	24	0.02	0.08	1%
Wall 34 - 2	CLT 100 mm - 3 layers	2.24	60000	62846757	0.62	ULS 82	1	1.1	1.25	21	24	0.05	0.31	3%
Wall 34 - 3	CLT 100 mm - 3 layers	1.19	60000	42853397	0.91	ULS 82	1	1.1	1.25	21	24	0.03	0.10	1%
Wall 8 - 2	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.11	0.36	8%
Wall 24 - 2	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.11	0.36	4%
Wall 8 - 3	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.05	0.36	8%
Wall 24 - 3	CLT 100 mm - 3 layers	2.4	60000	64442336	0.57	ULS 82	1	1.1	1.25	21	24	0.05	0.36	3%

Compression perpendicular to the grain

In the area of wall support there are high local stresses perpendicular to the grain. The following expression shall be satisfied:

$$\sigma_{c,90,d} \leq k_{c,90,d} \cdot f_{c,90,d}$$

with

$$\sigma_{c,90,d} = \frac{F_{c,90,d}}{A_{full}}$$

where:

$\sigma_{c,90,d}$ is the design compressive stress in the contact area perpendicular to the grain;

$F_{c,90,d}$ is the design load of compression perpendicular to the grain;

A_{full} is the contact area on which the compression load (perpendicular to the grain) acts;

$f_{c,90,d}$ is the design compressive strength perpendicular to the grain;

$k_{c,90,d}$ is a factor taking into account the load configuration, possibility of splitting and degree of compressive deformation.

The values of the actions in the table below are related, for each wall, to the most severe combination of load for the Ultimate Limit State.

Wall name	Length [m]	Comb.	Dur.	N [kN]
Wall 1	2.07	ULS 78	Short-term	85.41
Wall 2	1.99	ULS 78	Short-term	103.97
Wall 3	1.84	ULS 78	Short-term	97.66
Wall 4	0.78	ULS 78	Short-term	39.74
Wall 5	0.75	ULS 64	Permanent	3.28
Wall 6	0.83	ULS 64	Permanent	6.32
Wall 7	0.66	ULS 64	Permanent	2.22
Wall 8 - 1	0.22	ULS 64	Permanent	1.40
Wall 9	2.30	ULS 65	Medium-term	48.50
Wall 10	5.51	ULS 65	Medium-term	107.22
Wall 11	1.02	ULS 64	Permanent	3.43
Wall 12	0.29	ULS 64	Permanent	1.01
Wall 13	3.71	ULS 78	Short-term	135.82
Wall 14	2.99	ULS 64	Permanent	14.71
Wall 16	0.93	ULS 64	Permanent	4.15
Wall 17	1.96	ULS 65	Medium-term	45.37
Wall 18	2.24	ULS 65	Medium-term	51.85
Wall 19	1.20	ULS 65	Medium-term	56.40
Wall 20	2.13	ULS 65	Medium-term	65.58
Wall 21	0.44	ULS 64	Permanent	2.00
Wall 22	3.04	ULS 64	Permanent	10.05
Wall 23	0.65	ULS 64	Permanent	2.19
Wall 24 - 1	0.44	ULS 64	Permanent	3.15
Wall 25 - 1	0.22	ULS 64	Permanent	0.68
Wall 29	2.54	ULS 64	Permanent	4.79
Wall 30 - 1	0.83	ULS 64	Permanent	1.99
Wall 31	0.50	ULS 64	Permanent	0.33
Wall 34 - 1	0.44	ULS 64	Permanent	1.05
Wall 35	0.70	ULS 64	Permanent	0.53
Wall 25 - 2	2.08	ULS 64	Permanent	3.31
Wall 25 - 3	0.24	ULS 64	Permanent	0.81
Wall 30 - 2	0.46	ULS 64	Permanent	1.48
Wall 30 - 3	0.69	ULS 64	Permanent	0.97
Wall 34 - 2	0.67	ULS 64	Permanent	2.07
Wall 34 - 3	0.69	ULS 64	Permanent	1.13
Wall 8 - 2	0.24	ULS 64	Permanent	1.60
Wall 24 - 2	0.67	ULS 64	Permanent	4.28
Wall 8 - 3	0.24	ULS 64	Permanent	0.83
Wall 24 - 3	0.67	ULS 64	Permanent	2.21

The compression checks of the CLT panels are performed considering a wall portion of unitary length.

Section: CLT element section

A_{full} : Contact area on which the compression load (perpendicular to the grain) acts

Comb.: The most severe combination of load

k_{mod} : Modification factor taking into account the effect of the duration of load and moisture content

γ_M : Partial factor for a material property

$f_{c,90,k}$: Design compressive strength perpendicular to the grain

$\sigma_{c,90,d}$: Design compressive stress in the contact area perpendicular to the grain

Wall name	Section	A_{full} [mm ² /m]	$k_{c,90}$	Comb.	Service class	k_{mod}	γ_M	$f_{c,90,k}$ [MPa]	$\sigma_{c,90,d}$ [MPa]	Check
Wall 1	CLT 100 mm - 3 layers	100000	1.5	ULS 78	1	0.9	1.25	2.5	0.44	16%
Wall 2	CLT 100 mm - 3 layers	100000	1.5	ULS 78	1	0.9	1.25	2.5	0.55	20%
Wall 3	CLT 100 mm - 3 layers	100000	1.5	ULS 78	1	0.9	1.25	2.5	0.52	19%
Wall 4	CLT 100 mm - 3 layers	100000	1.5	ULS 78	1	0.9	1.25	2.5	0.50	19%
Wall 5	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.04	2%
Wall 6	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.08	4%
Wall 7	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 8 - 1	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.06	3%
Wall 9	CLT 100 mm - 3 layers	100000	1.5	ULS 65	1	0.8	1.25	2.5	0.23	9%
Wall 10	CLT 100 mm - 3 layers	100000	1.5	ULS 65	1	0.8	1.25	2.5	0.27	11%
Wall 11	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 12	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 13	CLT 100 mm - 3 layers	100000	1.5	ULS 78	1	0.9	1.25	2.5	0.39	15%
Wall 14	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.06	3%
Wall 16	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.04	2%
Wall 17	CLT 100 mm - 3 layers	100000	1.5	ULS 65	1	0.8	1.25	2.5	0.25	11%
Wall 18	CLT 100 mm - 3 layers	100000	1.5	ULS 65	1	0.8	1.25	2.5	0.30	12%
Wall 19	CLT 100 mm - 3 layers	100000	1.5	ULS 65	1	0.8	1.25	2.5	0.47	19%
Wall 20	CLT 100 mm - 3 layers	100000	1.5	ULS 65	1	0.8	1.25	2.5	0.37	15%
Wall 21	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.04	2%
Wall 22	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 23	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 24 - 1	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.07	4%
Wall 25 - 1	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 29	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 30 - 1	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.02	1%
Wall 31	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.01	0%
Wall 34 - 1	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.02	1%
Wall 35	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.01	0%
Wall 25 - 2	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.02	1%
Wall 25 - 3	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 30 - 2	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 30 - 3	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.01	1%
Wall 34 - 2	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 34 - 3	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.02	1%
Wall 8 - 2	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.06	4%
Wall 24 - 2	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.06	4%
Wall 8 - 3	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%
Wall 24 - 3	CLT 100 mm - 3 layers	100000	1.5	ULS 64	1	0.6	1.25	2.5	0.03	2%

Shear (load in-plane)

The internal stress pattern in a CLT element subjected to shear forces can lead to failure of the material in two different mechanisms: shear bearing (mechanism I) in the boards and torsion-like (mechanism II) in the gluing interfaces.

The values of the actions in the table below are related, for each wall, to the most severe combination of load for the shear Ultimate Limit State.

Wall name	Length [m]	Comb.	Dur.	V2 [kN]
Wall 1	2.07	Dynamic SLV 8 ex+ ey+	Instantaneous	15.07
Wall 2	1.99	Dynamic SLV 8 ex+ ey+	Instantaneous	14.24
Wall 3	1.84	Dynamic SLV 8 ex+ ey+	Instantaneous	12.70
Wall 4	0.78	Dynamic SLV 8 ex+ ey+	Instantaneous	3.02
Wall 5	0.75	Dynamic SLV 8 ex+ ey+	Instantaneous	6.14
Wall 6	0.83	Dynamic SLV 8 ex+ ey+	Instantaneous	7.37
Wall 7	0.66	Dynamic SLV 8 ex+ ey+	Instantaneous	4.85
Wall 9	2.30	Dynamic SLV 4 ex+ ey-	Instantaneous	9.83
Wall 10	5.51	Dynamic SLV 4 ex+ ey-	Instantaneous	33.01
Wall 11	1.02	Dynamic SLV 8 ex+ ey+	Instantaneous	6.47
Wall 13	3.71	Dynamic SLV 8 ex+ ey-	Instantaneous	29.49
Wall 14	2.99	Dynamic SLV 8 ex- ey+	Instantaneous	28.30
Wall 16	0.93	Dynamic SLV 8 ex- ey+	Instantaneous	4.10
Wall 17	1.96	Dynamic SLV 4 ex+ ey-	Instantaneous	7.22
Wall 18	2.24	Dynamic SLV 4 ex+ ey-	Instantaneous	8.72
Wall 19	1.20	Dynamic SLV 4 ex+ ey-	Instantaneous	3.33
Wall 20	2.13	Dynamic SLV 4 ex+ ey-	Instantaneous	8.13
Wall 22	3.04	Dynamic SLV 8 ex+ ey+	Instantaneous	58.03
Wall 23	0.65	Dynamic SLV 8 ex- ey+	Instantaneous	2.14
Wall 29	2.54	Horizontal ULS 4	Instantaneous	0.00
Wall 30 - 1	0.83	Horizontal ULS 4	Instantaneous	0.00
Wall 31	0.50	Horizontal ULS 4	Instantaneous	0.00
Wall 35	0.70	Horizontal ULS 4	Instantaneous	0.00
Wall 34 - 2	0.67	Horizontal ULS 4	Instantaneous	0.00
Wall 24 - 2	0.67	Dynamic SLV 8 ex- ey+	Instantaneous	2.27
Wall 24 - 3	0.67	Dynamic SLV 8 ex- ey+	Instantaneous	2.27

Mechanism I - shear

The internal shear stress can be evaluated as

$$\tau_z = \frac{v_2}{\sum t_{i,ext}}$$

$$\tau_y = \frac{v_2}{\sum t_{i,int}}$$

where:

v_2 is the shear per linear metre acting on the CLT element;

$t_{i,ext}$ is the thickness of the i-th layer having orientation parallel to the external layers;

$t_{i,int}$ is the thickness of the i-th layer having orientation parallel to the internal layers;

τ_z is the shear stress acting on the layers having orientation parallel to the external layers;

τ_y is the shear stress acting on the layers having orientation parallel to the internal layers.

The stress to be used in the checks is the maximum between the two:

$$\tau_d = \max(\tau_z; \tau_y)$$

The following expression shall be satisfied

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

where:

$f_{v,d}$ the shear strength calculated as

$$f_{v,d} = \frac{k_{mod} \cdot f_{v,k}}{\gamma_M}$$

Mechanism II – torsion

The internal torsional stress can be expressed as

$$\tau_{T,d} = \frac{M_T}{W}$$

where:

M_T the internal torsional moment;

W the polar moment of resistance.

The polar moment of resistance is defined by the following expression

$$W = \frac{a_{ref}^3}{3}$$

where a_{ref} is the average width of the boards assumed equal to 150 mm.

The internal torsional moment M_T can be evaluated according to the model proposed in different European Technical Assessments (ETA) where the following expression is used

$$M_T = \frac{v_2 \cdot a_{ref}^2}{n_{strati-1}}$$

The following expression shall be satisfied

$$\tau_{T,d} \leq f_{T,d}$$

where:

$f_{T,d}$ the design value of the torsional strength of glued interfaces.

$$f_{T,d} = \frac{k_{mod} \cdot f_{T,k}}{\gamma_M}$$

Below is the table with the shear checks for each CLT wall. The two different mechanisms (shear and torsion) are verified.

Comb.: The most severe combination of load

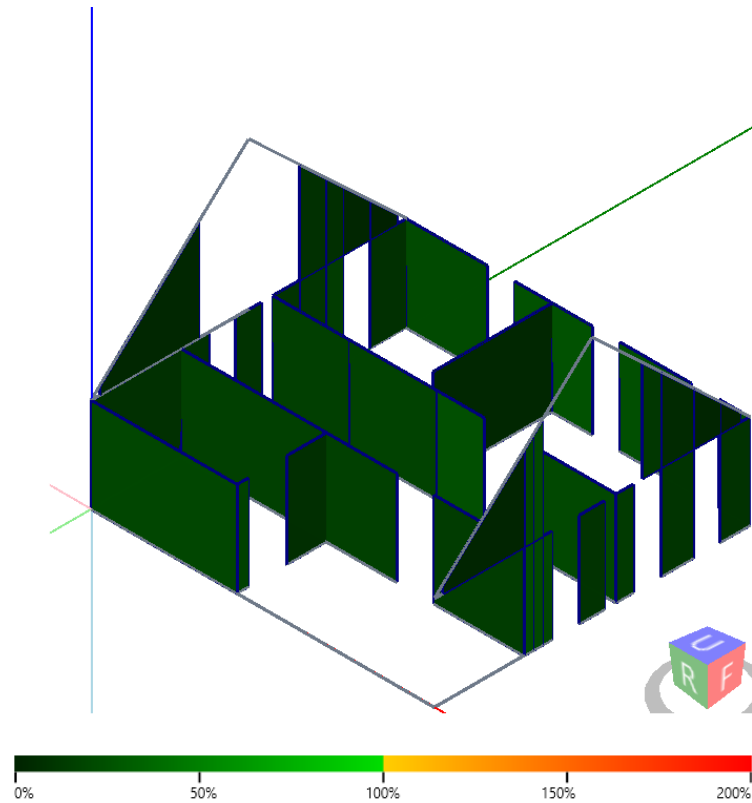
k_{mod} :	Modification factor taking into account the effect of the duration of load and moisture content
γ_M :	Partial factor for a material property
$f_{v,k}$:	CLT characteristic shear strength (Mechanism I)
T_d :	Design shear stress in the layers
M_T :	Torsional moment on every glued interfaces
W :	Polar moment of resistance
$f_{T,k}$:	Characteristic value of the torsional shear strength of the glued interfaces
$T_{T,d}$:	Design shear stress (due to torsion) in the external layers

Wall name	Section	Comb.	Service class	k_{mod}	γ_M	$f_{v,k}$ [MPa]	T_d [MPa]	Check - shear	M_T [Nmm]	W [mm ³]	$f_{T,k}$ [MPa]	$T_{T,d}$ [MPa]	Check torsion
Wall 1	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey+	1	1.1	1.25	4	0.18	5%	81877	1125000	2.5	0.07	3%
Wall 2	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey+	1	1.1	1.25	4	0.18	5%	80505	1125000	2.5	0.07	3%
Wall 3	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey+	1	1.1	1.25	4	0.17	5%	77632	1125000	2.5	0.07	3%
Wall 4	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey+	1	1.1	1.25	4	0.1	3%	43536	1125000	2.5	0.04	2%
Wall 5	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey+	1	1.1	1.25	4	0.2	6%	92028	1125000	2.5	0.08	4%
Wall 6	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey+	1	1.1	1.25	4	0.22	6%	99904	1125000	2.5	0.09	4%
Wall 7	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey+	1	1.1	1.25	4	0.18	5%	82714	1125000	2.5	0.07	3%
Wall 9	CLT 100 mm - 3 layers	Dynamic SLV 4 ex+ ey-	1	1.1	1.25	4	0.11	3%	48101	1125000	2.5	0.04	2%
Wall 10	CLT 100 mm - 3 layers	Dynamic SLV 4 ex+ ey-	1	1.1	1.25	4	0.15	4%	67407	1125000	2.5	0.06	3%
Wall 11	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey+	1	1.1	1.25	4	0.16	5%	71400	1125000	2.5	0.06	3%
Wall 13	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey-	1	1.1	1.25	4	0.2	6%	89424	1125000	2.5	0.08	4%
Wall 14	CLT 100 mm - 3 layers	Dynamic SLV 8 ex- ey+	1	1.1	1.25	4	0.24	7%	106479	1125000	2.5	0.09	4%
Wall 16	CLT 100 mm - 3 layers	Dynamic SLV 8 ex- ey+	1	1.1	1.25	4	0.11	3%	49657	1125000	2.5	0.04	2%
Wall 17	CLT 100 mm - 3 layers	Dynamic SLV 4 ex+ ey-	1	1.1	1.25	4	0.09	3%	41470	1125000	2.5	0.04	2%
Wall 18	CLT 100 mm - 3 layers	Dynamic SLV 4 ex+ ey-	1	1.1	1.25	4	0.1	3%	43797	1125000	2.5	0.04	2%
Wall 19	CLT 100 mm - 3 layers	Dynamic SLV 4 ex+ ey-	1	1.1	1.25	4	0.07	2%	31251	1125000	2.5	0.03	1%
Wall 20	CLT 100 mm - 3 layers	Dynamic SLV 4 ex+ ey-	1	1.1	1.25	4	0.1	3%	42961	1125000	2.5	0.04	2%
Wall 22	CLT 100 mm - 3 layers	Dynamic SLV 8 ex+ ey+	1	1.1	1.25	4	0.48	14%	214767	1125000	2.5	0.19	9%
Wall 23	CLT 100 mm - 3 layers	Dynamic SLV 8 ex- ey+	1	1.1	1.25	4	0.08	2%	37122	1125000	2.5	0.03	1%
Wall 29	CLT 100 mm - 3 layers	Horizontal ULS 4	1	0	0	0	0	0%	0	0	0	0	0%
Wall 30 - 1	CLT 100 mm - 3 layers	Horizontal ULS 4	1	0	0	0	0	0%	0	0	0	0	0%
Wall 31	CLT 100 mm - 3 layers	Horizontal ULS 4	1	0	0	0	0	0%	0	0	0	0	0%
Wall 35	CLT 100 mm - 3 layers	Horizontal ULS 4	1	0	0	0	0	0%	0	0	0	0	0%
Wall 34 - 2	CLT 100 mm - 3 layers	Horizontal ULS 4	1	0	0	0	0	0%	0	0	0	0	0%
Wall 24 - 2	CLT 100 mm - 3 layers	Dynamic SLV 8 ex- ey+	1	1.1	1.25	4	0.08	2%	38087	1125000	2.5	0.03	2%
Wall 24 - 3	CLT 100 mm - 3 layers	Dynamic SLV 8 ex- ey+	1	1.1	1.25	4	0.08	2%	38087	1125000	2.5	0.03	2%

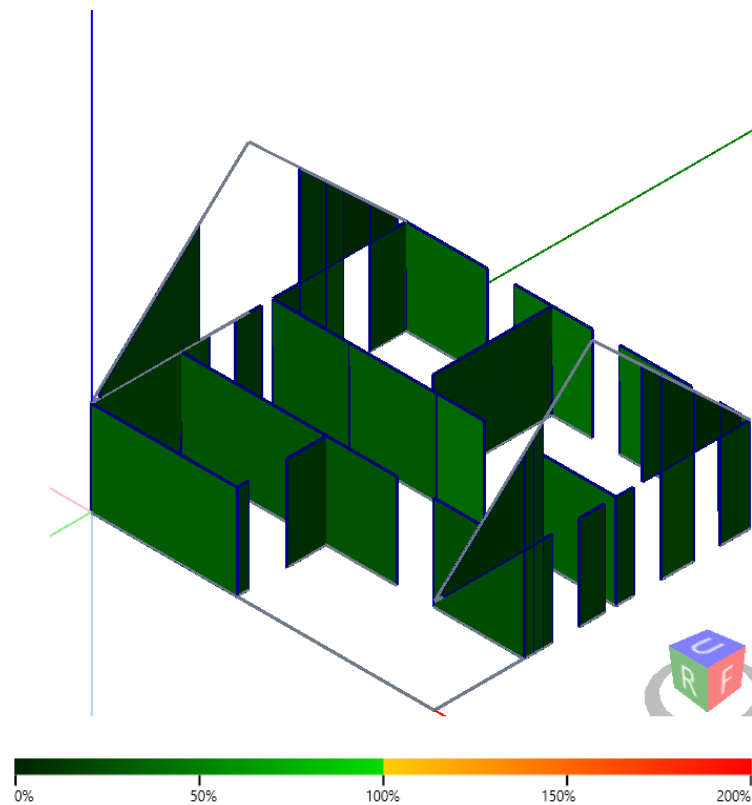
Verification percentage of walls

Ultimate Limit State (ULS)

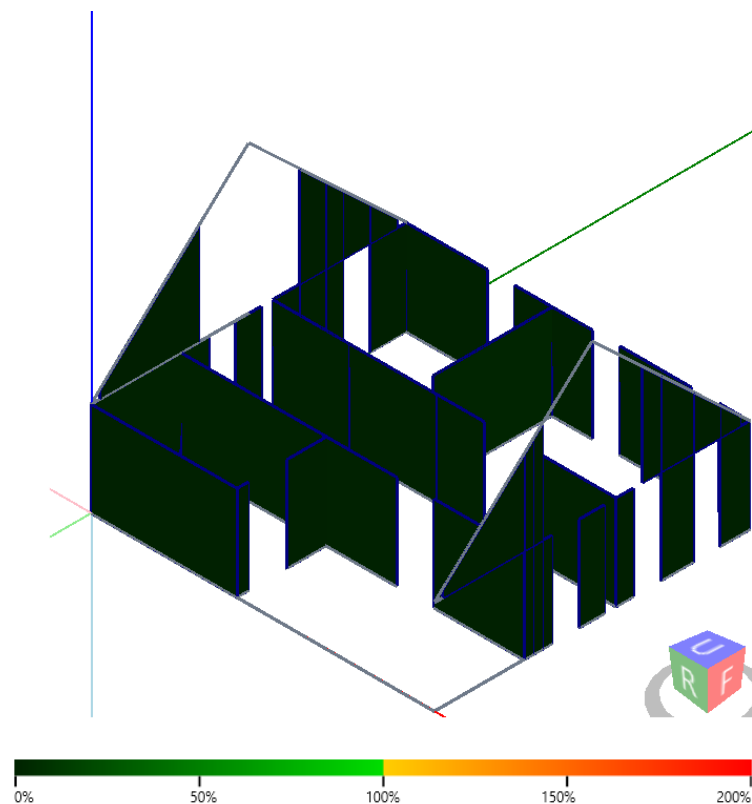
Buckling verifications



Compression perpendicular to the grain verifications

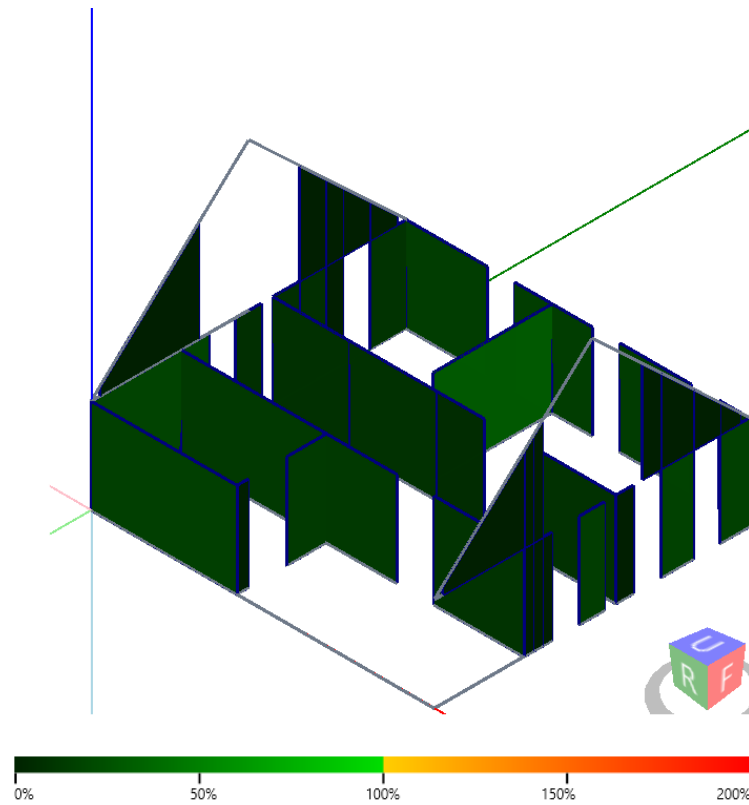


Shear verifications



Life Safety Limit State (SLV dynamic)

Shear verifications



Connections

Hold down – Connection at the base of the structure

The design resistance R_d of the hold-downs is determined as the minimum value among the resistances relating to the following failure modes:

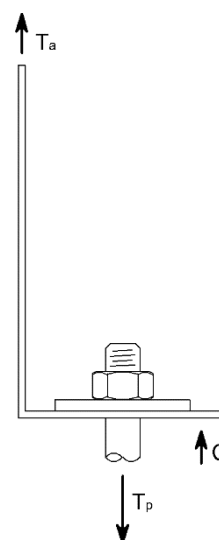
- nailing failure;
- hold-downs steel failure;
- failure of the concrete anchors.

Tensile force

The tensile force acting on the hold down (T_a) is evaluated as described in paragraph “Model Description”.

The tensile force acting on the concrete anchors is calculated taking into account the additional moment due to the non-alignment between the external force acting on the vertical flange of the hold down and the anchors themselves using a coefficient, indicated as k_t .

$$T_p = T_a \cdot k_t$$



Wall name	Length [m]	Connection name	N° of anchors at each wall end	Comb.	Dur.	N [kN]	M ₃₋₃ [kNm]	T _a [kN]	k _t	T _p [kN]
Wall 1	2.07	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	33.11	0.74	0.00	1.09	0.00
Wall 2	1.99	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	39.86	0.70	0.00	1.09	0.00
Wall 3	1.84	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	37.07	0.62	0.00	1.09	0.00
Wall 4	0.78	Ground tensile connection- hold down	1	Dynamic SLV 8 ex+ ey+	Instantaneous	15.97	7.24	1.30	1.09	1.42
Wall 5	0.75	Ground tensile connection- hold down	1	Dynamic SLV 8 ex+ ey+	Instantaneous	2.43	14.72	18.42	1.09	20.08
Wall 6	0.83	Ground tensile connection- hold down	1	Dynamic SLV 8 ex+ ey+	Instantaneous	4.68	17.69	18.97	1.09	20.68
Wall 7	0.66	Ground tensile connection- hold down	1	Dynamic SLV 8 ex+ ey+	Instantaneous	1.64	11.65	16.82	1.09	18.34
Wall 9	2.30	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	22.86	0.27	0.00	1.09	0.00
Wall 10	5.51	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	48.98	0.92	0.00	1.09	0.00
Wall 11	1.02	Ground tensile connection- hold down	1	Dynamic SLV 8 ex+ ey+	Instantaneous	2.54	15.54	13.96	1.09	15.22
Wall 13	3.71	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	52.08	1.56	0.00	1.09	0.00

Wall 14	2.99	Ground tensile connection- hold down	1	Dynamic SLV 8 ex-ey+	Instantaneous	10.90	67.92	17.27	1.09	18.82
Wall 16	0.93	Ground tensile connection- hold down	1	Dynamic SLV 8 ex-ey+	Instantaneous	3.07	9.85	9.06	1.09	9.87
Wall 17	1.96	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	20.30	0.15	0.00	1.09	0.00
Wall 18	2.24	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	23.20	0.18	0.00	1.09	0.00
Wall 19	1.20	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	23.86	0.07	0.00	1.09	0.00
Wall 20	2.13	Ground tensile connection- hold down	1	Horizontal ULS 4	Instantaneous	28.48	0.17	0.00	1.09	0.00
Wall 22	3.04	Ground tensile connection- hold down1	2	Dynamic SLV 8 ex-ey+	Instantaneous	7.44	139.28	21.05	1.09	22.94
Wall 23	0.65	Ground tensile connection- hold down	1	Dynamic SLV 8 ex-ey+	Instantaneous	1.62	5.15	7.11	1.09	7.75
Wall 24 - 2	0.67	Ground tensile connection- hold down	1	Dynamic SLV 8 ex-ey+	Instantaneous	3.17	5.44	6.54	1.09	7.13
Wall 24 - 3	0.67	Ground tensile connection- hold down	1	Dynamic SLV 8 ex-ey+	Instantaneous	1.64	5.44	7.31	1.09	7.96

Nailing resistance

The design value of the load-bearing capacity of the nailing is given by the following expression

$$R_{c,d} = \frac{k_{mod} \cdot R_{c,k,dens}}{\gamma_M}$$

where:

$R_{c,k,dens}$ is the characteristic value of the nailing resistance. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m³. k_{dens} can be evaluated using the formula $R_{c,k,dens} = R_{c,k} \cdot \left(\frac{\rho_k}{350}\right)^2$;

k_{mod} is the modification factor taking into account the effect of the duration of load and moisture content;

γ_M is the is the partial factor for the connections.

Steel resistance

The tensile design strength of the hold-down can be evaluated according to the formula

$$R_{s,d} = \frac{R_{s,k}}{\gamma_{M2}}$$

where:

$R_{s,k}$ is the characteristic value of the resistance of the hold-down;

γ_{M2} is the partial factor for resistance of cross-sections in tension to fracture.

Concrete anchors resistance

The tension resistance of the concrete anchors can be evaluated according to the formula

$$R_{p,d} = \frac{R_{p,k}}{\gamma}$$

where:

$R_{p,k}$ is the characteristic value of the resistance of the concrete anchors;

γ is the safety factor.

The checks are summarized in the following table which shows the characteristic values of the resistances associated with collapse of the various components.

Name: Name of the connection in which the hold-down is used

Comb.: The most severe combination of load

$T_{a,d}$: Design value of the tensile force acting on the hold down

$T_{p,d}$: Design value of the tensile force acting on the concrete anchors

k_{mod} : Modification factor taking into account the effect of the duration of load and moisture content

$k_{R,deg}$: Resistance degradation coefficient due to cyclic actions

γ_M : Partial safety factor

$R_{a,d}$: Design value of the hold down resistance, assumed to be the lower of the values of the design resistance of all the failure mechanisms associated with it

$R_{p,d}$: Design value of the concrete anchors resistance

$$T_{a,d} \leq R_{a,d} = \min(R_{c,d}; R_{s,d})$$

$$T_{p,d} \leq R_{p,d}$$

Wall name	Connection name	Comb.	Service class	$T_{a,d}$ [kN]	$R_{c,k,den}$ [kN]	$R_{s,k}$ [kN]	k_{mod}	$k_{R,deg}$	γ_M	γ_{M2}	$R_{a,d}$ [kN]	$T_{p,d}$ [kN]	$R_{p,k}$ [kN]	γ	$R_{p,d}$ [kN]	Failure mode	Check
Wall 1	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 2	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 3	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 4	Ground tensile connection-hold down	Dynamic SLV 8 ex+ ey+	1	1.30	36.80	30	1.1	1	1.3	1.25	24.00	1.42	73.8	1.5	49.20	Tension: steel connection element	5%

Wall 5	Ground tensile connection-hold down	Dynamic SLV 8 ex+ey+	1	18.42	36.80	30	1.1	1	1.3	1.25	24.00	20.08	73.8	1.5	49.20	Tension: steel connection element	77%
Wall 6	Ground tensile connection-hold down	Dynamic SLV 8 ex+ey+	1	18.97	36.80	30	1.1	1	1.3	1.25	24.00	20.68	73.8	1.5	49.20	Tension: steel connection element	79%
Wall 7	Ground tensile connection-hold down	Dynamic SLV 8 ex+ey+	1	16.82	36.80	30	1.1	1	1.3	1.25	24.00	18.34	73.8	1.5	49.20	Tension: steel connection element	70%
Wall 9	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 10	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 11	Ground tensile connection-hold down	Dynamic SLV 8 ex+ey+	1	13.96	36.80	30	1.1	1	1.3	1.25	24.00	15.22	73.8	1.5	49.20	Tension: steel connection element	58%
Wall 13	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 14	Ground tensile connection-hold down	Dynamic SLV 8 ex+ey+	1	17.27	36.80	30	1.1	1	1.3	1.25	24.00	18.82	73.8	1.5	49.20	Tension: steel connection element	72%
Wall 16	Ground tensile connection-hold down	Dynamic SLV 8 ex+ey+	1	9.06	36.80	30	1.1	1	1.3	1.25	24.00	9.87	73.8	1.5	49.20	Tension: steel connection element	38%
Wall 17	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 18	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 19	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 20	Ground tensile connection-hold down	Horizontal ULS 4	1	0.00	36.80	30	1.1	1	1.3	1.25	-	0.00	73.8	1.5	-	-	0%
Wall 22	Ground tensile connection-hold down1	Dynamic SLV 8 ex+ey+	1	21.05	36.80	30	1.1	1	1.3	1.25	24.00	22.94	73.8	1.5	49.20	Tension: steel connection element	88%
Wall 23	Ground tensile connection-hold down	Dynamic SLV 8 ex+ey+	1	7.11	36.80	30	1.1	1	1.3	1.25	24.00	7.75	73.8	1.5	49.20	Tension: steel connection element	30%
Wall 24 - 2	Ground tensile connection-hold down	Dynamic SLV 8 ex+ey+	1	6.54	36.80	30	1.1	1	1.3	1.25	24.00	7.13	73.8	1.5	49.20	Tension: steel connection element	27%
Wall 24 - 3	Ground tensile connection-hold down	Dynamic SLV 8 ex+ey+	1	7.31	36.80	30	1.1	1	1.3	1.25	24.00	7.96	73.8	1.5	49.20	Tension: steel connection element	30%

Hold down – Upper levels connection

The design resistance R_d of the tie downs is determined as the minimum value among the resistances relating to the following failure modes:

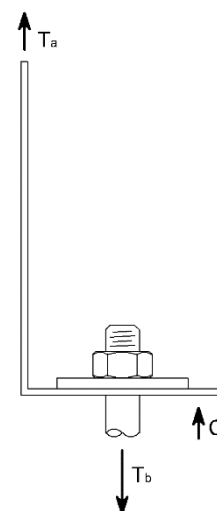
- nailing failure;
- hold-downs steel failure;
- failure of the bolt.

Tensile force

The tensile force acting on the hold down (T_a) is evaluated as described in paragraph “Model Description”.

The tensile force acting on the single bolt is calculated taking into account the numbers of bolts and additional moment due to the non-alignment between the external force acting on the vertical flange of the hold down and the bolt itself using a coefficient, indicated as k_t .

$$T_b = \frac{T_a \cdot k_t}{n_b}$$



Wall name	Length [m]	Connection name	N° of anchors at each wall end	Comb.	Dur.	N [kN]	M ₃₋₃ [kNm]	T _a [kN]	k _t	n _b	T _b [kN]
Wall 29	2.54	Upper levels tensile connection - user	1	Horizontal ULS 4	Instantaneous	3.55	0.00	0.00	1.09	1	0.00
Wall 30 - 1	0.83	Upper levels tensile connection - user	1	Horizontal ULS 4	Instantaneous	1.47	0.00	0.00	1.09	1	0.00
Wall 31	0.50	Upper levels tensile connection - user	1	Horizontal ULS 4	Instantaneous	0.24	0.00	0.00	1.09	1	0.00
Wall 35	0.70	Upper levels tensile connection - user	1	Horizontal ULS 4	Instantaneous	0.39	0.00	0.00	1.09	1	0.00
Wall 34 - 2	0.67	Upper levels tensile connection - user	1	Horizontal ULS 4	Instantaneous	1.53	0.00	0.00	1.09	1	0.00

Nailing resistance

The design value of the load-bearing capacity of the nailing is given by the following expression

$$R_{c,d} = \frac{k_{mod} \cdot R_{c,k,dens}}{\gamma_M}$$

where:

$R_{c,k,dens}$ is the characteristic value of the nailing resistance. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m³. k_{dens} can be evaluated using the formula $R_{c,k,dens} = R_{c,k} \cdot \left(\frac{\rho_k}{350}\right)^2$;

k_{mod} is the modification factor taking into account the effect of the duration of load and moisture content;

γ_M is the is the partial factor for the connections.

Steel resistance

The tensile design strength of the hold-down can be evaluated according to the formula

$$R_{s,d} = \frac{R_{s,k}}{\gamma_{M2}}$$

where:

$R_{s,k}$ is the characteristic value of the resistance of the tie-down;

γ_{M2} is the partial factor for resistance of cross-sections in tension to fracture.

Bolt resistance

The tension resistance of the bolt is evaluated as reported in the table 3.4 of EN 1993-1-8 by the following formula

$$R_{b,d} = \frac{0.9 \cdot f_{ub} \cdot A_s}{\gamma_{M2}}$$

where:

f_{ub} is the ultimate tensile strength of the bolt;

A_s the resistant area of the threaded portion of the shank of the anchor;

γ_{M2} is the partial factor for resistance of cross-sections in tension to fracture.

The checks are summarized in the following table which shows the characteristic values of the resistances associated with collapse of the various components.

Name:	Name of the connection in which the hold-down is used
Comb.:	The most severe combination of load
$T_{a,d}$:	Design value of the tensile force acting on the hold down
$T_{b,d}$:	Design value of the tensile force acting on the bolt
k_{mod} :	Modification factor taking into account the effect of the duration of load and moisture content
$k_{R,deg}$:	Resistance degradation coefficient due to cyclic actions

γ_M : Partial safety factor

$R_{a,d}$: Design value of the hold down resistance, assumed to be the lower of the values of the design resistance of all the failure mechanisms associated with it

$R_{b,d}$: Design value of the bolt resistance

$$T_{a,d} \leq R_{a,d} = \min(R_{c,d}; R_{s,d})$$

$$T_{b,d} \leq R_{b,d}$$

Wall name	Connection name	Comb.	Service Class	$T_{a,d}$ [kN]	$R_{c,k,dens}$ [kN]	$R_{s,k}$ [kN]	k_{mod}	$k_{R,deg}$	γ_M	γ_{M2}	$R_{a,d}$ [kN]	$T_{b,d}$ [kN]	$R_{b,k}$ [kN]	$R_{b,d}$ [kN]	Failure mode	Check
Wall 29	Upper levels tensile connection - user	Horizontal ULS 4	1	0.00	76.40	70	1.1	1	1.3	1.25	-	0.00	88.2	-	-	0%
Wall 30 - 1	Upper levels tensile connection - user	Horizontal ULS 4	1	0.00	76.40	70	1.1	1	1.3	1.25	-	0.00	88.2	-	-	0%
Wall 31	Upper levels tensile connection - user	Horizontal ULS 4	1	0.00	76.40	70	1.1	1	1.3	1.25	-	0.00	88.2	-	-	0%
Wall 35	Upper levels tensile connection - user	Horizontal ULS 4	1	0.00	76.40	70	1.1	1	1.3	1.25	-	0.00	88.2	-	-	0%
Wall 34 - 2	Upper levels tensile connection - user	Horizontal ULS 4	1	0.00	76.40	70	1.1	1	1.3	1.25	-	0.00	88.2	-	-	0%

Timber to concrete angle bracket – Connection at the base of the structure

The design resistance R_d of an angle bracket is determined as the minimum value among the resistances relating to the following failure modes:

- shear failure of the angle and/or of the group of fasteners of the connection;
- shear failure of the anchors connecting the concrete.

Shear force

The shear force acting on the single angle bracket is calculated by dividing the total shear force V_2 by the number of angle brackets present in the wall (taking into account the possible presence of angle brackets on both sides of the structural element).

$$V_a = \frac{V_2}{n_{anc}}$$

where:

V_2 is the design shear force on the considered wall;

n_{anc} is the number of shear connections present in the wall.

The shear force acting on the concrete anchors of each angle bracket is equal to V_a .

Wall name	Length [m]	Connection name	N of connections	Comb.	Dur.	V_2 [kN]	V_a [kN]
Wall 1	2.07	Ground shear connection - bracket1	1	Dynamic SLV 8 ex+ ey+	Instantaneous	15.07	15.07
Wall 2	1.99	Ground shear connection - bracket2	1	Dynamic SLV 8 ex+ ey+	Instantaneous	14.24	14.24
Wall 3	1.84	Ground shear connection - bracket2	1	Dynamic SLV 8 ex+ ey+	Instantaneous	12.70	12.70
Wall 4	0.78	Ground shear connection - bracket3	1	Dynamic SLV 8 ex+ ey+	Instantaneous	3.02	3.02
Wall 5	0.75	Ground shear connection - bracket3	1	Dynamic SLV 8 ex+ ey+	Instantaneous	6.14	6.14
Wall 6	0.83	Ground shear connection - bracket3	1	Dynamic SLV 8 ex+ ey+	Instantaneous	7.37	7.37
Wall 7	0.66	Ground shear connection - bracket	1	Dynamic SLV 8 ex+ ey+	Instantaneous	4.85	4.85
Wall 9	2.30	Ground shear connection - bracket1	1	Dynamic SLV 4 ex+ ey-	Instantaneous	9.83	9.83
Wall 10	5.51	Ground shear connection - bracket1	2	Dynamic SLV 4 ex+ ey-	Instantaneous	33.01	16.51
Wall 11	1.02	Ground shear connection - bracket4	1	Dynamic SLV 8 ex+ ey+	Instantaneous	6.47	6.47
Wall 13	3.71	Ground shear connection - bracket2	2	Dynamic SLV 8 ex+ ey-	Instantaneous	29.49	14.74
Wall 14	2.99	Ground shear connection - bracket5	2	Dynamic SLV 8 ex- ey+	Instantaneous	28.30	14.15
Wall 16	0.93	Ground shear connection - bracket3	1	Dynamic SLV 8 ex- ey+	Instantaneous	4.10	4.10
Wall 17	1.96	Ground shear connection - bracket2	1	Dynamic SLV 4 ex+ ey-	Instantaneous	7.22	7.22
Wall 18	2.24	Ground shear connection - bracket1	1	Dynamic SLV 4 ex+ ey-	Instantaneous	8.72	8.72
Wall 19	1.20	Ground shear connection - bracket4	1	Dynamic SLV 4 ex+ ey-	Instantaneous	3.33	3.33
Wall 20	2.13	Ground shear connection - bracket1	1	Dynamic SLV 4 ex+ ey-	Instantaneous	8.13	8.13
Wall 22	3.04	Ground shear connection - bracket4	3	Dynamic SLV 8 ex+ ey+	Instantaneous	58.03	19.34
Wall 23	0.65	Ground shear connection - bracket	1	Dynamic SLV 8 ex- ey+	Instantaneous	2.14	2.14
Wall 24 - 2	0.67	Ground shear connection - bracket	1	Dynamic SLV 8 ex- ey+	Instantaneous	2.27	2.27
Wall 24 - 3	0.67	Ground shear connection - bracket	1	Dynamic SLV 8 ex- ey+	Instantaneous	2.27	2.27

Angle bracket resistance

The design value of the shear bearing capacity of the angle bracket can be estimated from the characteristic value by means of the following expression

$$R_{a,d} = \frac{k_{mod} \cdot R_{a,k,dens}}{\gamma_M}$$

where:

$R_{a,k,dens}$ is the characteristic value of the nailing resistance. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m³. k_{dens} can be evaluated using the formula $R_{a,k,dens} = R_{a,k} \cdot \left(\frac{\rho_k}{350}\right)^2$.

Concrete anchors resistance

The shear resistance of the concrete anchors is evaluated by the following formula

$$R_{p,d} = \frac{R_{p,k}}{\gamma}$$

where:

$R_{p,k}$ is the characteristic value of the shear resistance of the concrete anchors;

γ is the safety factor.

The checks are summarized in the following table which illustrates the characteristic values of the resistances associated to the different components and their design values.

Name:	Name of the connection in which the angle bracket is used
Comb.:	The most severe combination of load
$V_{a,d}$:	Shear force acting on the angle bracket and on the concrete anchors
k_{mod} :	Modification factor taking into account the effect of the duration of load and moisture content
$k_{R,deg}$:	Resistance degradation coefficient due to cyclic actions
γ_M :	Partial safety factor
$R_{a,d}$:	Design value of the angle bracket resistance
$R_{p,d}$:	Design value of the concrete anchors resistance

$$V_{a,d} \leq R_{a,d}$$

$$V_{a,d} \leq R_{p,d}$$

Wall name	Connection name	Comb.	Service class	$V_{a,d}$ [kN]	$R_{a,k,dens}$ [kN]	k_{mod}	$k_{R,deg}$	γ_M	$R_{a,d}$ [kN]	$R_{p,k}$ [kN]	γ	$R_{p,d}$ [kN]	Failure mode	Check
Wall 1	Ground shear connection - bracket1	Dynamic SLV 8 ex+ ey+	1	15.07	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	58%
Wall 2	Ground shear connection - bracket2	Dynamic SLV 8 ex+ ey+	1	14.24	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	55%
Wall 3	Ground shear connection - bracket2	Dynamic SLV 8 ex+ ey+	1	12.70	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	49%
Wall 4	Ground shear connection - bracket3	Dynamic SLV 8 ex+ ey+	1	3.02	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	12%
Wall 5	Ground shear connection - bracket3	Dynamic SLV 8 ex+ ey+	1	6.14	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	24%
Wall 6	Ground shear connection - bracket3	Dynamic SLV 8 ex+ ey+	1	7.37	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	29%
Wall 7	Ground shear connection - bracket	Dynamic SLV 8 ex+ ey+	1	4.85	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	19%
Wall 9	Ground shear connection - bracket1	Dynamic SLV 4 ex+ ey-	1	9.83	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	38%
Wall 10	Ground shear connection - bracket1	Dynamic SLV 4 ex+ ey-	1	16.51	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	64%
Wall 11	Ground shear connection - bracket4	Dynamic SLV 8 ex+ ey+	1	6.47	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	25%
Wall 13	Ground shear connection - bracket2	Dynamic SLV 8 ex+ ey-	1	14.74	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	57%
Wall 14	Ground shear connection - bracket5	Dynamic SLV 8 ex- ey+	1	14.15	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	55%
Wall 16	Ground shear connection - bracket3	Dynamic SLV 8 ex- ey+	1	4.10	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	16%
Wall 17	Ground shear connection - bracket2	Dynamic SLV 4 ex+ ey-	1	7.22	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	28%
Wall 18	Ground shear connection - bracket1	Dynamic SLV 4 ex+ ey-	1	8.72	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	34%
Wall 19	Ground shear connection - bracket4	Dynamic SLV 4 ex+ ey-	1	3.33	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	13%
Wall 20	Ground shear connection - bracket1	Dynamic SLV 4 ex+ ey-	1	8.13	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	32%
Wall 22	Ground shear connection - bracket4	Dynamic SLV 8 ex+ ey+	1	19.34	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	75%
Wall 23	Ground shear connection - bracket	Dynamic SLV 8 ex- ey+	1	2.14	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	8%
Wall 24 - 2	Ground shear connection - bracket	Dynamic SLV 8 ex- ey+	1	2.27	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	9%
Wall 24 - 3	Ground shear connection - bracket	Dynamic SLV 8 ex- ey+	1	2.27	30.50	1.1	1	1.3	25.81	44.38	1.25	35.5	Shear: connection element	9%

Timber to timber angle bracket

The design resistance R_d of an angle bracket is determined as the resistance of the following failure mode:

- shear failure of the angle and/or of the group of fasteners of the connection.

Shear force

The shear force acting on the single angle bracket is calculated by dividing the total shear force V_2 by the number of angle brackets present in the wall (taking into account the possible presence of angle brackets on both sides of the structural element).

$$V_a = \frac{V_2}{n_{anc}}$$

where:

V_2 is the design shear force on the considered wall;

n_{anc} is the number of shear connections present in the wall.

Wall name	Length [m]	Connection name	N of connections	Comb.	Dur.	V2 [kN]	Va [kN]
Wall 29	2.54	Upper levels shear connection - user1	1	Horizontal ULS 4	Instantaneous	0.00	0.00
Wall 30 - 1	0.83	Upper levels shear connection - user2	1	Horizontal ULS 4	Instantaneous	0.00	0.00
Wall 31	0.50	Upper levels shear connection - user	1	Horizontal ULS 4	Instantaneous	0.00	0.00
Wall 35	0.70	Upper levels shear connection - user	1	Horizontal ULS 4	Instantaneous	0.00	0.00
Wall 34 - 2	0.67	Upper levels shear connection - user	1	Horizontal ULS 4	Instantaneous	0.00	0.00

Angle bracket resistance

The design value of the shear strength of the anchor is evaluated as

$$R_{a,d} = \frac{k_{mod} \cdot R_{a,k,dens}}{\gamma_M}$$

where:

$R_{a,k,dens}$ is the characteristic value of the nailing resistance. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m³. k_{dens} can be evaluated using the formula $R_{a,k,dens} = R_{a,k} \cdot \left(\frac{\rho_k}{350}\right)^2$;

k_{mod} is the modification factor taking into account the effect of the duration of load and moisture content;

γ_M is the partial factor for connections.

The checks are summarized in the following table which illustrates the characteristic values of the resistance associated to the angle brackets and their design values. The following expression shall be satisfied:

$$V_{a,d} \leq R_{a,d}$$

Name: Name of the connection in which the angle bracket is used

Comb.: The most severe combination of load

$V_{a,d}$: Design value of the force acting on the single angular

k_{mod} : Modification factor taking into account the effect of the duration of load and moisture content

$k_{R,deg}$: Resistance degradation coefficient due to cyclic actions

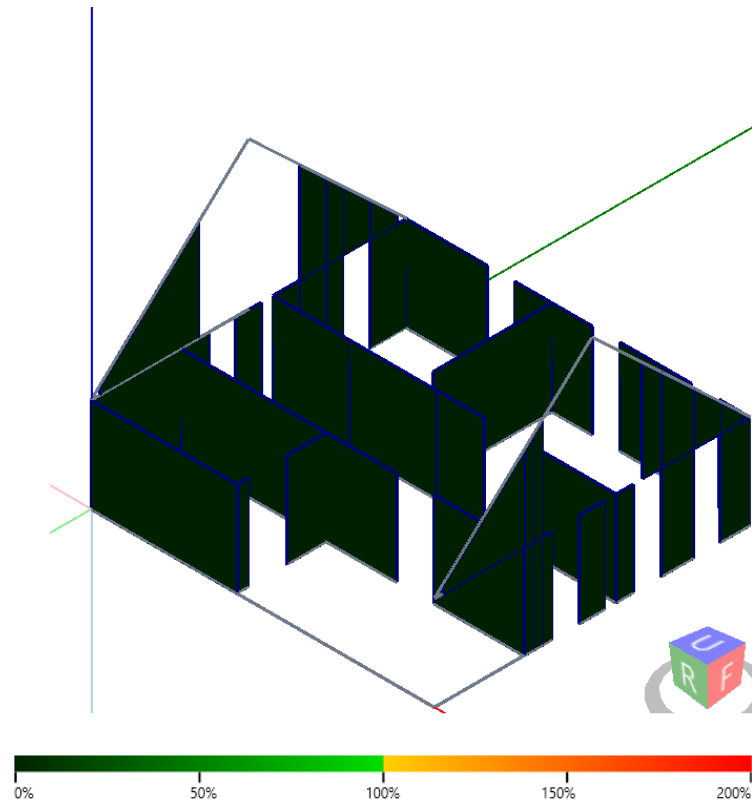
γ_M : Partial safety factor

Wall name	Connection name	Comb.	Service Class	$V_{a,d}$ [kN]	$R_{a,k,den}$ [kN]	k_{mod}	$k_{R,deg}$	γ_M	$R_{a,d}$ [kN]	Check
Wall 29	Upper levels shear connection - user1	Horizontal ULS 4	1	0.00	0.00	1.1	1	1.3	0.00	0%
Wall 30 - 1	Upper levels shear connection - user2	Horizontal ULS 4	1	0.00	0.00	1.1	1	1.3	0.00	0%
Wall 31	Upper levels shear connection - user	Horizontal ULS 4	1	0.00	0.00	1.1	1	1.3	0.00	0%
Wall 35	Upper levels shear connection - user	Horizontal ULS 4	1	0.00	0.00	1.1	1	1.3	0.00	0%
Wall 34 - 2	Upper levels shear connection - user	Horizontal ULS 4	1	0.00	0.00	1.1	1	1.3	0.00	0%

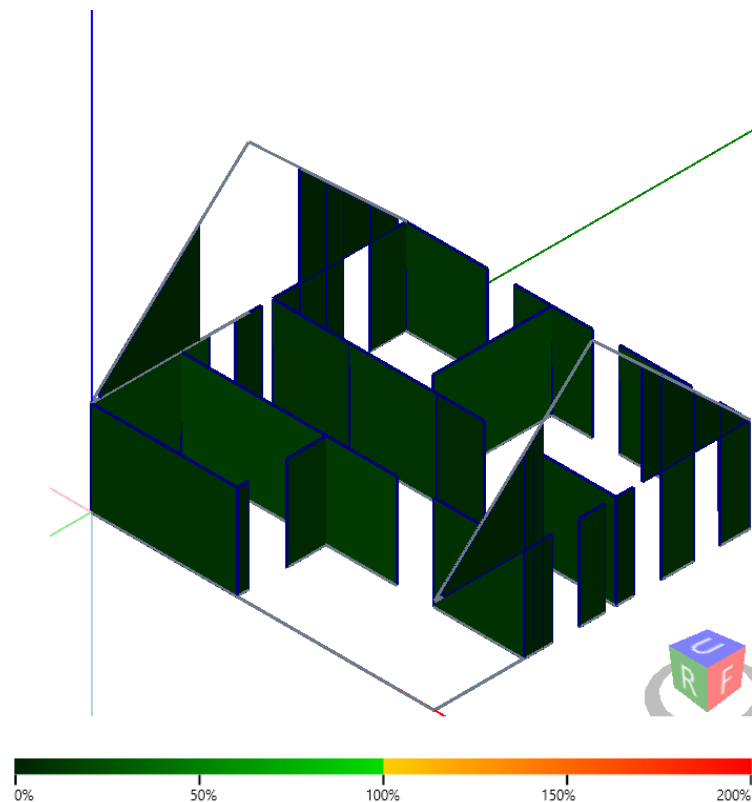
Verification percentage of connections

Ultimate Limit State (ULS)

Tensile connection elements verifications

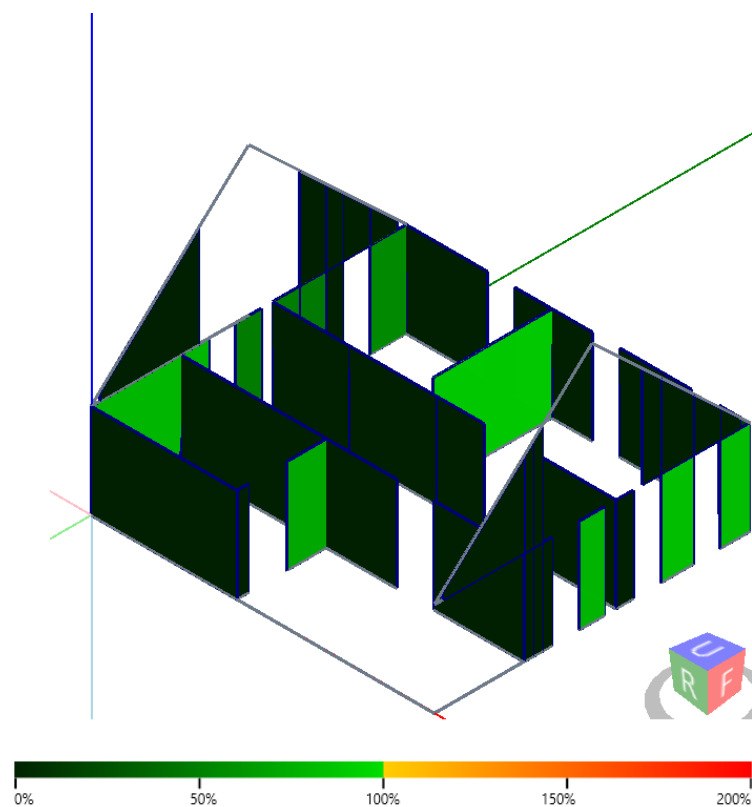


Shear connection elements verifications

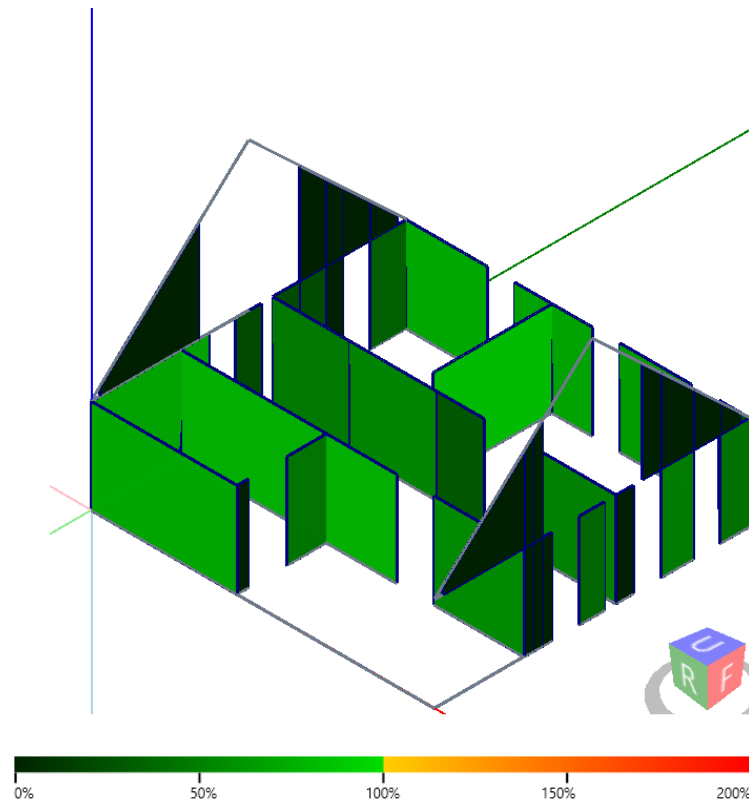


Life Safety Limit State (SLV dynamic)

Tensile connection elements verifications



Shear connection elements verifications



Damage Limitation - DLS

The “damage limitation requirement” is considered to have been satisfied, if, under a seismic action having a larger probability of occurrence than the design seismic action corresponding to the “no-collapse requirement” the interstorey drifts are limited in accordance with the following equation:

$$d_r < d_{r,lim} = 0.005 h$$

where:

d_r is the interstorey drift obtained applying the reduction factor $\nu = 0.5$ to the design ground acceleration a_g on type A ground;

h is the storey height.

The table below shows the seismic checks for the Damage Limit State.

Wall name: Wall ID

h : Storey height

Comb.: The most severe combination of load

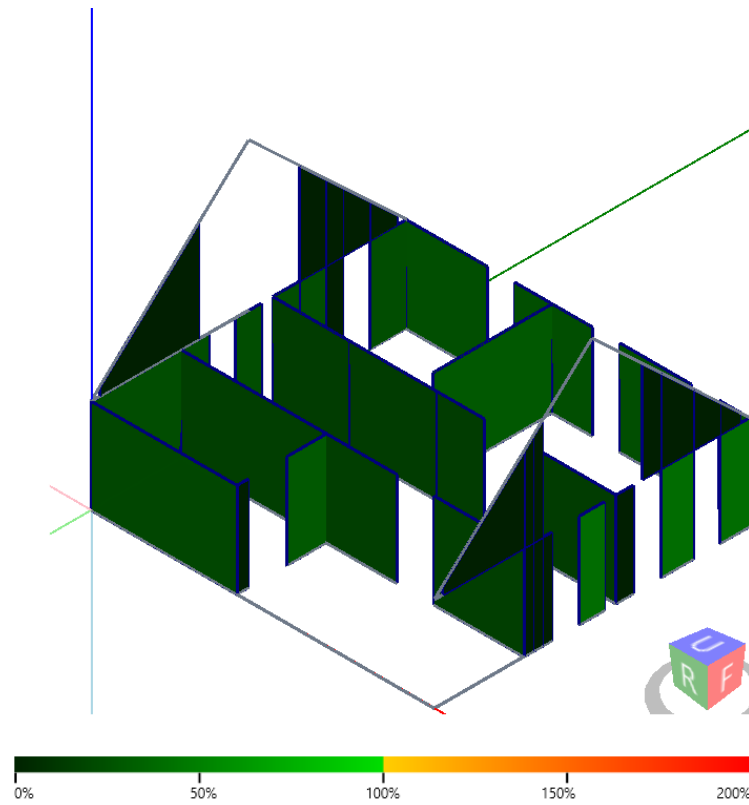
d_r : Evaluated interstorey drift

$d_{r,lim}$: Interstorey drift limit

The table provides the Damage Limit State checks in the case of Dynamic Linear Analysis.

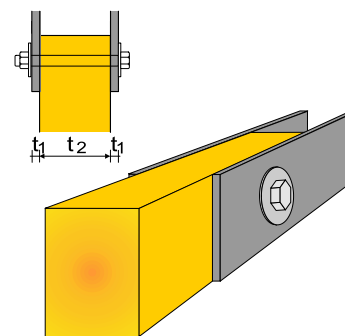
Wall	h [m]	Comb.	d_r [mm]	d_{lim} [mm]	Verifica
Wall 1	2.40	Dynamic SLD 5 ex+ ey+	1.17	12.00	10%
Wall 2	2.40	Dynamic SLD 5 ex+ ey+	1.17	12.00	10%
Wall 3	2.40	Dynamic SLD 5 ex+ ey+	1.17	12.00	10%
Wall 4	2.40	Dynamic SLD 5 ex+ ey+	1.17	12.00	10%
Wall 5	2.40	Dynamic SLD 5 ex+ ey+	2.55	12.00	21%
Wall 6	2.40	Dynamic SLD 5 ex+ ey+	2.55	12.00	21%
Wall 7	2.40	Dynamic SLD 5 ex+ ey+	2.55	12.00	21%
Wall 9	2.40	Dynamic SLD 4 ex+ ey-	0.66	12.00	5%
Wall 10	2.40	Dynamic SLD 4 ex+ ey-	0.66	12.00	5%
Wall 11	2.40	Dynamic SLD 5 ex+ ey+	1.55	12.00	13%
Wall 13	2.40	Dynamic SLD 5 ex+ ey-	0.91	12.00	8%
Wall 14	2.40	Dynamic SLD 5 ex- ey+	1.16	12.00	10%
Wall 16	2.40	Dynamic SLD 5 ex- ey+	1.16	12.00	10%
Wall 17	2.40	Dynamic SLD 4 ex+ ey-	0.60	12.00	5%
Wall 18	2.40	Dynamic SLD 4 ex+ ey-	0.60	12.00	5%
Wall 19	2.40	Dynamic SLD 4 ex+ ey-	0.60	12.00	5%
Wall 20	2.40	Dynamic SLD 4 ex+ ey-	0.60	12.00	5%
Wall 22	2.40	Dynamic SLD 5 ex+ ey+	1.55	12.00	13%
Wall 23	2.40	Dynamic SLD 5 ex- ey+	1.16	12.00	10%
Wall 29	1.37	Dynamic SLD 5 ex- ey-	0.00	6.87	0%
Wall 30 - 1	1.73	Dynamic SLD 5 ex- ey-	0.00	8.67	0%
Wall 31	0.47	Dynamic SLD 5 ex- ey-	0.00	2.33	0%
Wall 35	0.54	Dynamic SLD 5 ex- ey-	0.00	2.71	0%
Wall 34 - 2	2.24	Dynamic SLD 5 ex- ey-	0.00	11.20	0%
Wall 24 - 2	2.40	Dynamic SLD 5 ex- ey+	1.16	12.00	10%
Wall 24 - 3	2.40	Dynamic SLD 5 ex- ey+	1.16	12.00	10%

The verification percentages of walls are shown below.



2024/08-K**1. EC5-JOINT-009**

BOLTED CONNECTION, Steel plate-to-timber connection double shear
(EC5 EN1995-1-1:2009, §8.5.1.3)



Material properties (EC5 EN1995-1-1:2009, §3)

Timber class : C24

Service classes : Class 1, moisture content $\leq 12\%$ (§2.3.1.3)

Material factor $\gamma_M = 1.30$ (EC5 Tab. 2.3)

Load duration classes: Permanent (Table 2.1)

Cross section properties

Thickness of timber $d = 120.0$ mm, thickness of steel plate $t = 10.0$ mm

Characteristic material properties for timber (EC5 EN1995-1-1:2009, §2, §3)

Modification factor $K_{mod} = 0.60$ (EC5 Tab.3.1)

Material factor $\gamma_M = 1.30$ (EC5 Tab. 2.3)

$f_{t0k} = 14.50$ N/mm², $f_{t0d} = K_{mod} \cdot f_{t0k} / \gamma_M = 0.60 \times 14.50 / 1.30 = 6.69$ N/mm² (EC5 Eq.2.14)

Bolt properties (EC5 EN1995-1-1:2009 §8.5.1)

Bolt diameter $d = 10.0$ mm, washer with diameter ≥ 30.0 mm and thickness ≥ 3.0 mm.

Characteristic value of embedment strength (EC5 EN1995-1-1:2009 §8.5.1.1)

$f_{hk2} = 0.082(1 - 0.01d) \rho_k = 25.83$ N/mm², ($\rho_k = 350$ kg/m³, $d = 10.0$ mm) (EN1995-1-1 Eq.8.32)

Characteristic value for yield moment (EC5 EN1995-1-1:2009 §8.5.1.1)

$M_{yrk} = 0.30 f_{uk} \cdot d^{2.6} = 0.30 \times 400 \times 10.0^{2.6} = 47773$ Nmm ($f_{uk} = 400$ N/mm²) (EN1995-1-1 Eq.8.30)

Capacity of laterally loaded bolts-Double shear connection (EN1995-1-1 §8.2.3)

$t_2 = 120.0$ mm, thickness of steel plate $t = 10.0 \geq d = 10.0$ mm

$F_{vrk} = \text{the minimum of the values}$ (EC5 EN1995-1-1:2009 Eq.8.13(1), 8.13(m))

$0.50 f_{hk} \cdot t_2 \cdot d = 15.498$ kN

$2.30 \sqrt{M_{yrk} \cdot f_{hk} \cdot d} = 8.079$ kN

Lateral load-carrying capacity of bolt $R_d = 2 K_{mod} \cdot F_{vrk} / \gamma_M = 2 \times 0.60 \times 8.079 / 1.30 = 7.458$ kN

Togi stik špirovcev

Podatki

Prerez špirovca	120/220 mm
Kot med špirovcema	$\alpha = 97^\circ$
Upogibni moment	$M_{Ed} = 8.0 \text{ kN m}$
Vijaki	M10
Jekleni plošči	$2 \times t = 10 \text{ mm}$, obojestransko; vsaka v enem kosu
Nosilnost vijaka	$R_d = 7.458 \text{ kN}$
Robna razdalja za model	$e = 30 \text{ mm}$

Izračun

$$z = h - 2e = 220 - 2 \cdot 30 = 160 \text{ mm} = 0.160 \text{ m}$$

$$F_{vrsta} = \frac{M_{Ed}}{z} = \frac{8.0}{0.160} = 50.0 \text{ kN}$$

$$n_{vrsta} = \frac{F_{vrsta}}{R_d} = \frac{50.0}{7.458} = 6.70 \Rightarrow \boxed{7 \text{ vijakov}}$$

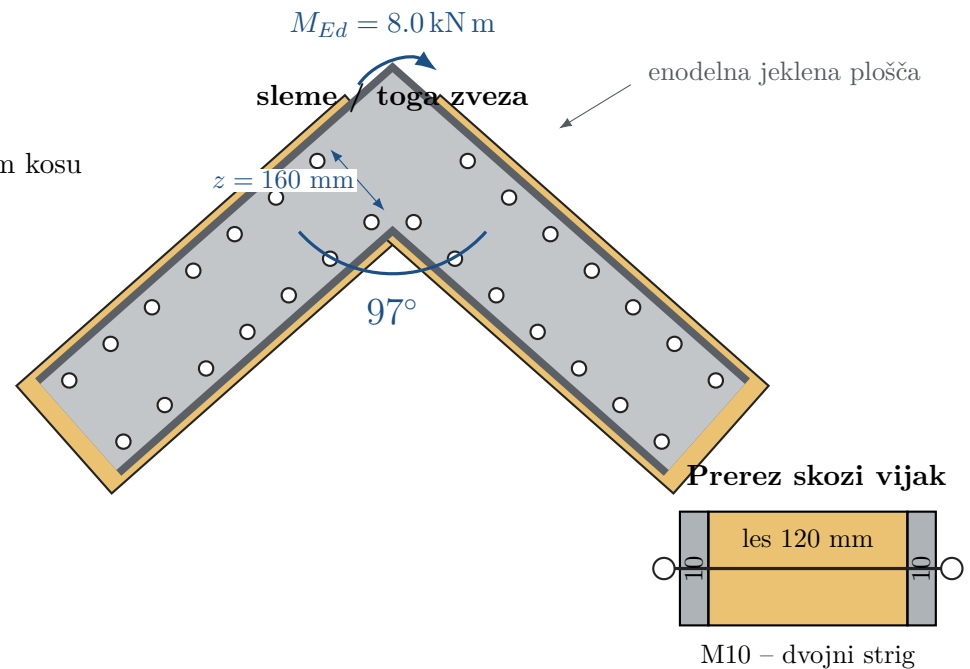
$$n_{\text{špirovec}} = 2 \cdot 7 = \boxed{14 \text{ vijakov M10}}$$

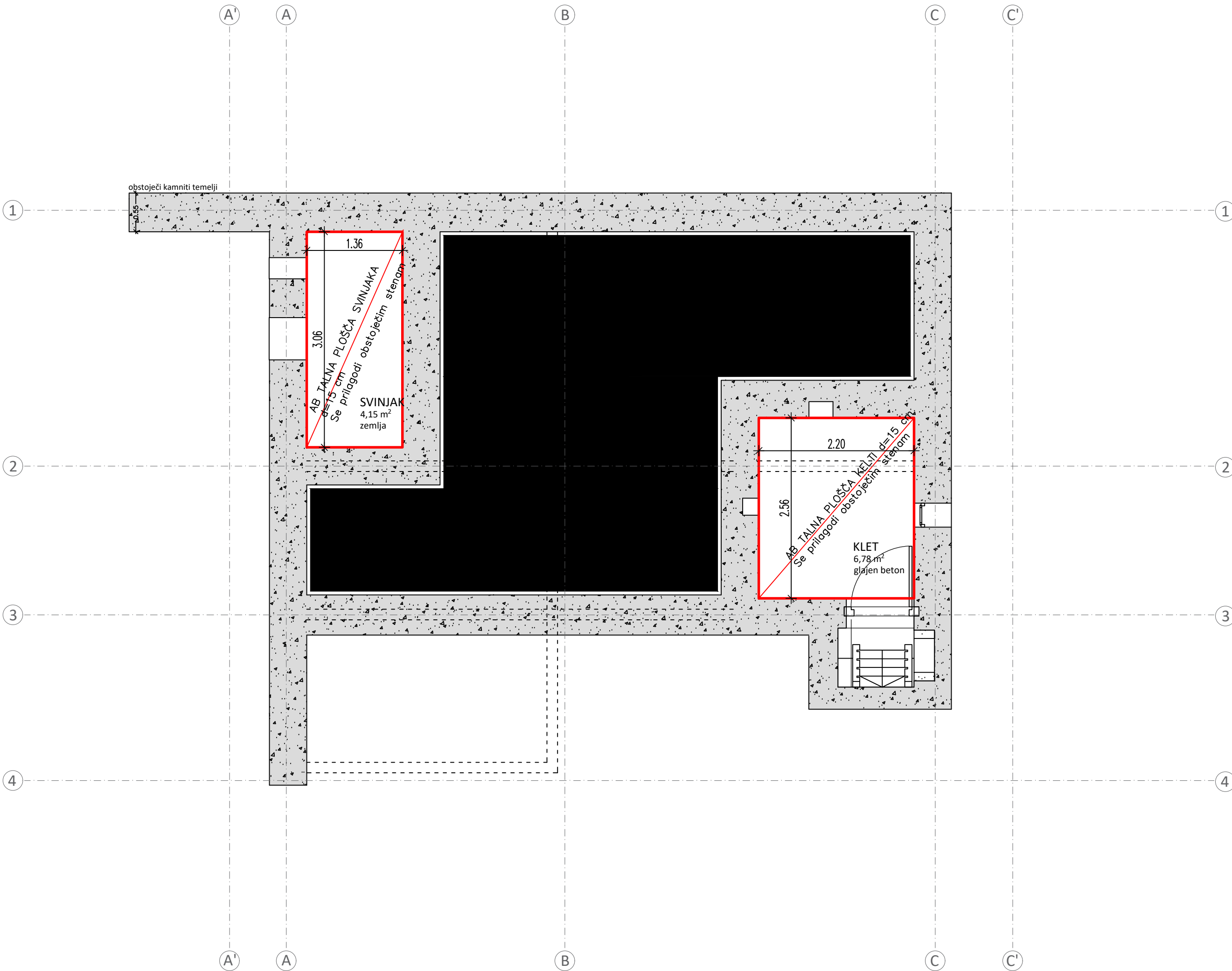
$$n_{\text{skupaj}} = 2 \cdot 14 = \boxed{28 \text{ skozi-vijakov M10}}$$

Na vsaki strani slemena: 2 vrsti po 7 vijakov M10.

Levi špirovec: 14 Desni špirovec: 14

Skica detajla





- OPOMBA:**
- V kolikor obstoječi temelji ne bodo ustrezni, se jih sanira
 - V kolikor nova AB talna plošča pritličja nebo imela dovol naleganja na ostoječe temelje, se temelje ustrezno dobetonira.
 - AB talna plošča pritličja se izvaja po kampadah. velikost kampad se prilagodi na terenu.

BETON C-25/30
ARMATURA B-500B / S-500
LES C24

Pri gradnji je potrebno upoštevati navodila geomehanika! Na planumu temeljne plošče mora biti vrednost dinamičnega deformacijskega modula $E_{vd} = 45 - 50 \text{ MN/m}^2$.

V skladu s predpisi, mora izvajalec pred pričetkom in med samim izvajanjem posameznih del, opraviti pregled projekta za izvedbo in opozoriti na morebitne ugotovljene pomanjkljivosti ter zahtevati njihovo odpravo.

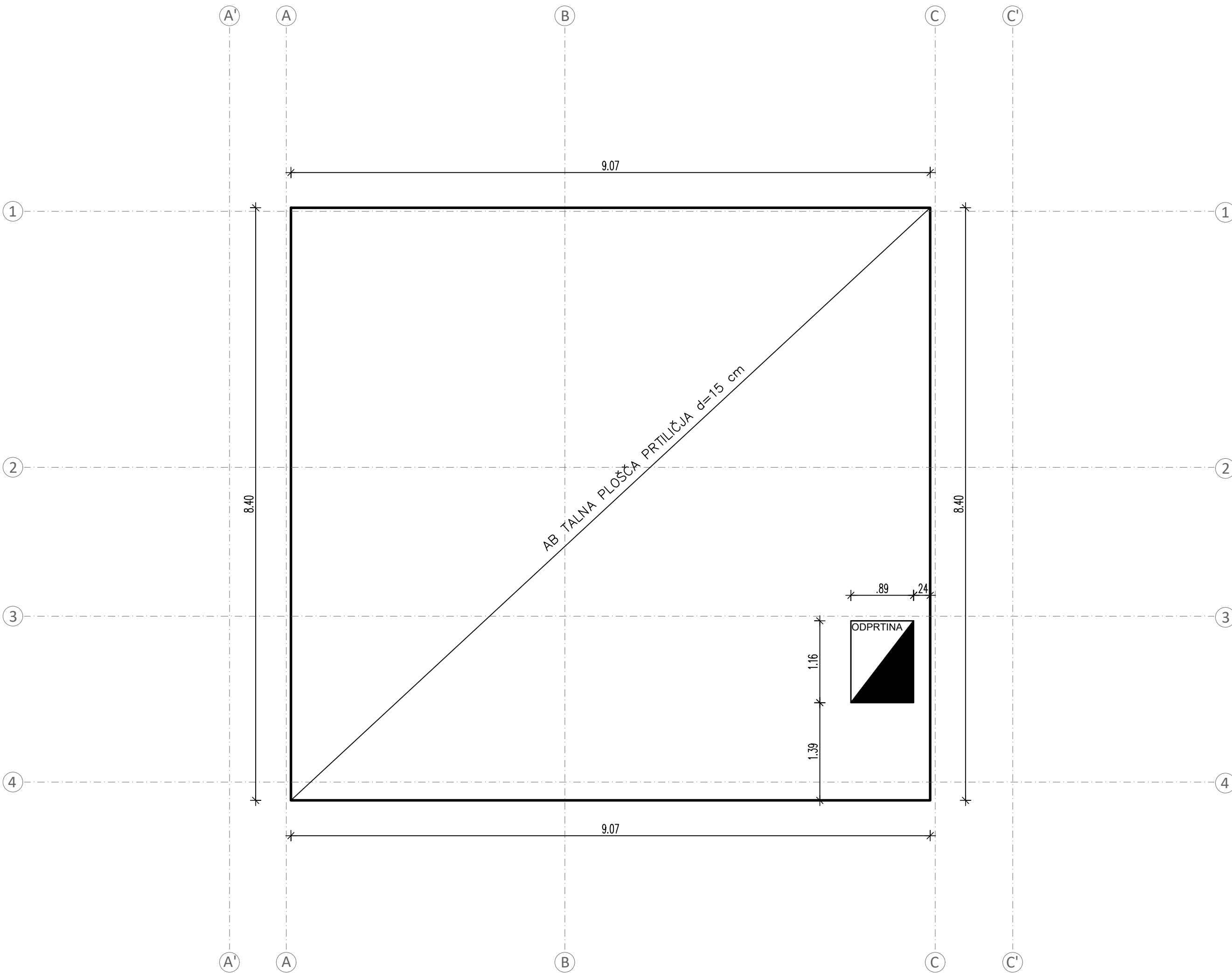
ZA PRAVLNOSTI IZVEDB JAMČI IZVAJALEC DEL!

SPREMEMBE IN DOPOLNITVE PROJEKTOV SO MOŽNE LE S PRISTANKOM PROJEKTANTOV!

VSE MERE PREVERITI NA LICU MESTA!

Opečna p.p. = Opečna prednapeta preklada

Projektant:		BAU-ING		BAU-ING Danilo Kozlar s.p. Kotlje 172, 2390 Kotlje tel.02/8218735, fax. 02/8223997 e-mail / bauing@netsi.net			
Investitor:							
Občina Prevalje Trg 2A. 2391 Prevalje							
Objekt:				Lokacija:	N.V. SLEME		
PRENOVA BRUSNIKOVE DOMAČIJE				Šentanel	694,13m		
Risba:		Id. št.:		Ime:		Podpis:	
POZICIJSKI/OPAŽNI NAČRT AB TEMELJNA PLOŠČA KLETI IN SVINJAKA		Odg. vodja projekta:		ZAPS A-1018 Maruša Zorec univ. dipl. inž. arh.			
		Odg. projektant načrta:		IZS G-0588 Danilo Kozlar inž. gr.			
		Obdeloval / risal:		Tim Balant mag. inž. grad. Tomaž Goričan mag. inž. grad.			
Načrt:		Faza:	Merilo:	Datum:	Projekt št.:	Načrt št.:	Risba št.:
2 GRADB. KONSTRUKCIJE		PZI	1:50	sep 2026	2024/08	2024/08-K	1.1.1



- OPOMBA:**
- V kolikor obstoječi temelji ne bodo ustrezni, se jih sanira
 - V kolikor nova AB talna plošča pritličja nebo imela dovol naleganja na ostoječe temelje, se temelje ustrezno dobetonira.
 - AB talna plošča pritličja se izvaja po kampadah. velikost kampad se prilagodi na terenu.

BETON C-25/30
ARMATURA B-500B / S-500
LES C24

Pri gradnji je potrebno upoštevati navodila geomehanika! Na planumu temeljne plošče mora biti vrednost dinamičnega deformacijskega modula $E_{vd} = 45 - 50 \text{ MN/m}^2$.

V skladu s predpisi, mora izvajalec pred pričetkom in med samim izvajanjem posameznih del, opraviti pregled projekta za izvedbo in opozoriti na morebitne ugotovljene pomanjkljivosti ter zahtevati njihovo odpravo.

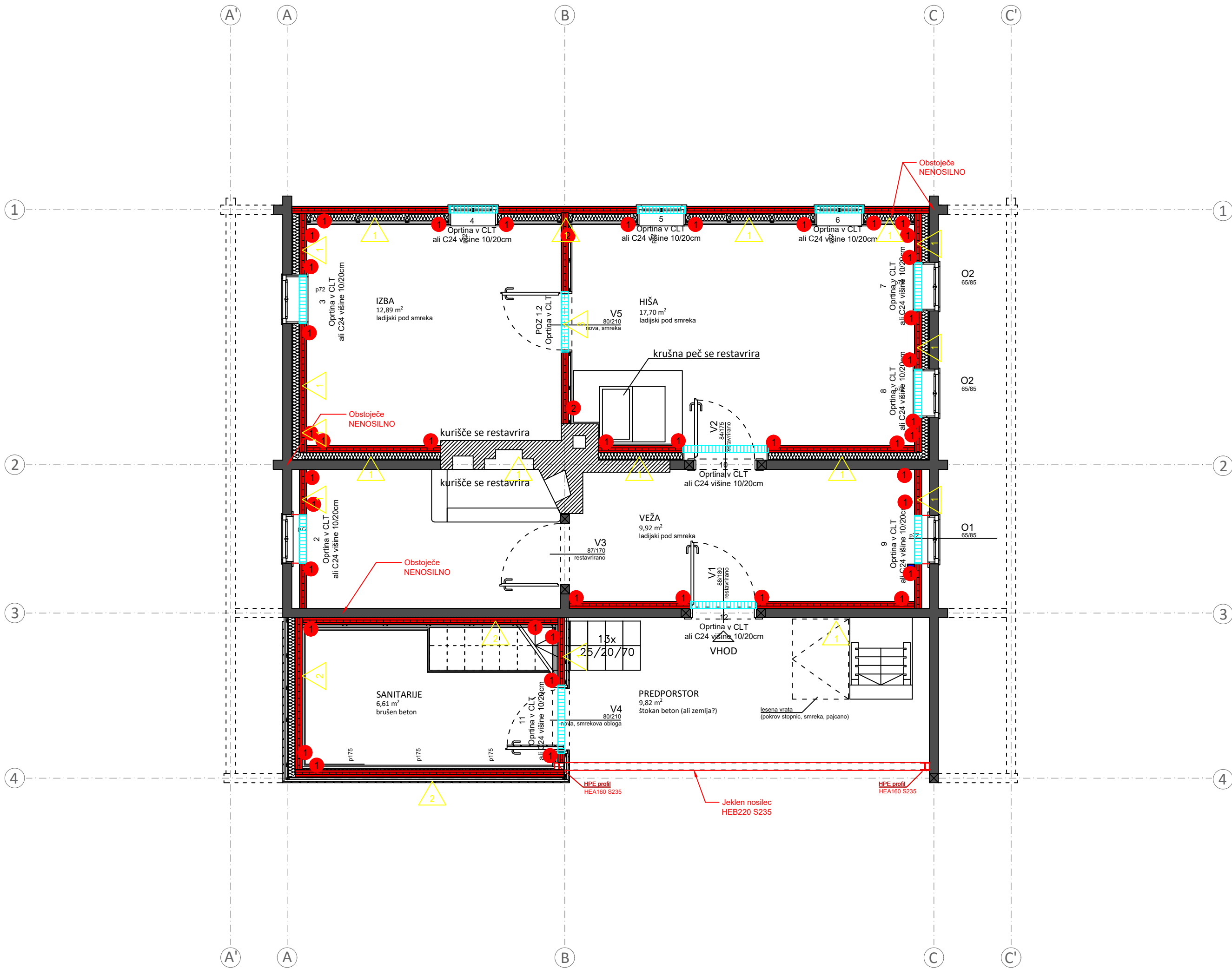
ZA PRAVLNOSTI IZVEDB JAMČI IZVAJALEC DEL!

SPREMEMBE IN DOPOLNITVE PROJEKTOV SO MOŽNE LE S PRISTANKOM PROJEKTANTOV!

VSE MERE PREVERITI NA LICU MESTA!

Opečna p.p. = Opečna prednapeta preklada

Projektant:		BAU-ING Danilo Kozlar s.p. Kotlje 172, 2390 Kotlje tel.02/8218735, fax. 02/8223997 e-mail / bauing@netsi.net	
Investitor:			
Občina Prevalje Trg 2A. 2391 Prevalje			
Objekt:		Lokacija:	N.V. SLEME
PRENOVA BRUSNIKOVE DOMAČIJE		Šentanel	694,13m
Risba:			
POZICIJSKI/OPAŽNI NAČRT		Id. št.:	Ime:
PRITLIČJE			Podpis:
SIDRANJE		Odg. vodja projekta:	ZAPS A-1018 Maruša Zorec univ. dipl. inž. arh.
PREKLADE		Odg. projektant načrta:	IZS G-0588 Danilo Kozlar inž. gr.
STENE		Obdeloval / risal:	Tim Balant mag. inž. grad.
NOSICLI			Tomaž Goričan mag. inž. grad.
Načrt:	Faza:	Merilo:	Datum:
2 GRADB. KONSTRUKCIJE	PZI	1:50	sep 2026
Projekt št:		Načrt št:	Risba št.:
2024/08		2024/08-K	1.2.1



OPOMBA:
Nove stene v pritličju in mansardi morajo biti poravnane ena na drugo !

OPOMBA:

Preklade
- Vse preklade stavbnega pohištva so CLT 100mm L3S ali C24 10/20cm
Stene
- 100 3s T - Thick. 100 mm - 3 s
30-40-30 - External layers vertical

Sidra:

n = connection number



HOLD DOWN

TENSILE FORCE CONNECTION
Connection: "WHT 15"
Wall connection: 15 x Anker nail - LBA 4,0 x 60
Anchor: 1 x Threaded rod INA - 5.8 - M16 x 195

ANGLE BRACKETS WITH ANCHORS

SHEAR FORCE CONNECTION
Connection: "Titan N - TCN 200"
Wall connection: 30 x Anker nail - LBA 4,0 x 60
Concrete connection: 2 x Threaded rod INA - 5.8 - M12 x 140



DOUBLE HOLD DOWN

TENSILE FORCE CONNECTION
Connection: "WHT 30"
Wall connection: 30 x Anker nail - LBA 4,0 x 60
Lower connection: 1 x Threaded rod INA - 5.8 - M20 x 245



ANGLE BRACKET

SHEAR FORCE CONNECTION
Connection: "Angle bracket TT1"
Wall connection: 1 x Anker nail - 4,0 x 40
Connection to the floor: 1 x Anker nail - 4,0 x 40

BETON C-25/30

ARMATURA B-500B / S-500

LES C24

Pri gradnji je potrebno upoštevati navodila geomehanika! Na planumu temeljne plošče mora biti vrednost dinamičnega deformacijskega modula $E_{vd} = 45 - 50 \text{ MN/m}^2$.

V skladu s predpisi, mora izvajalec pred pričetkom in med samim izvajanjem posameznih del, opraviti pregled projekta za izvedbo in opozoriti na morebitne ugotovljene pomanjkljivosti ter zahtevati njihovo odpravo.

ZA PRAVLNOSTI IZVEDB JAMČI IZVAJALEC DEL!

SPREMEMBE IN DOPOLNITVE PROJEKTOV SO MOŽNE LE S PRISTANKOM PROJEKTANTOV!

VSE MERE PREVERITI NA LICU MESTA!

Opečna p.p. = Opečna prednapeta preklada

Projektant:

BAU-ING

BAU-ING Danilo Kozlar s.p.
Kotlje 172, 2390 Kotlje
tel.02/8218735, fax. 02/8223997
e-mail / bauing@netsi.net

Investitor:

Občina Prevalje
Trg 2A. 2391 Prevalje

Objekt:

PRENOVA BRUSNIKOVE DOMAČIJE

Lokacija:

Šentanel

N.V. SLEME

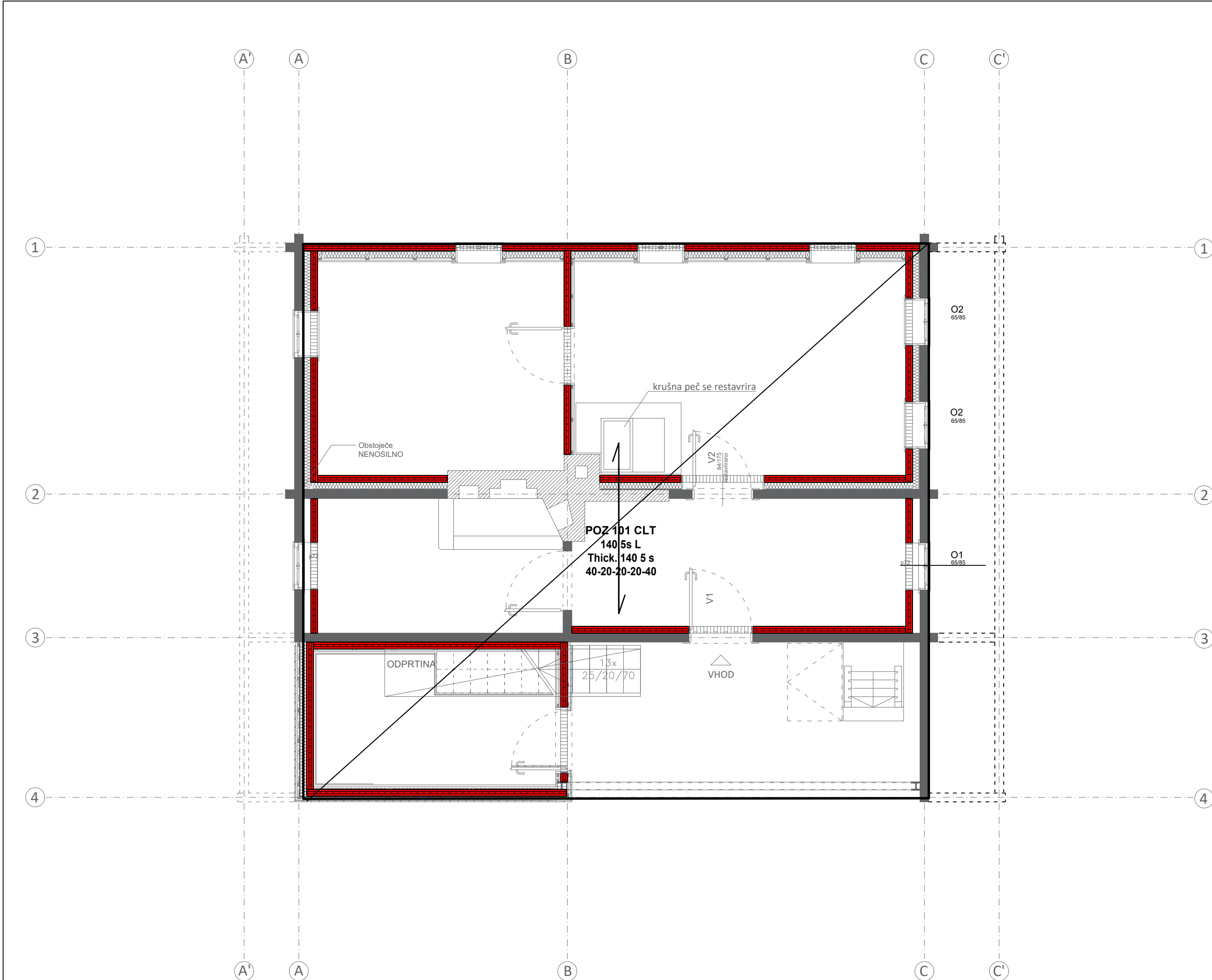
694,13m

Risba:

POZICIJSKI/OPAŽNI NAČRT
PRITLIČJE
SIDRANJE
PREKLADI
STENE
NOSILCI

Id. št.: Ime: Podpis:
Odg. vodja projekta: ZAPS A-1018 Maruša Zorec univ. dipl. inž. arh.
Odg. projektant načrta: IZS G-0588 Danilo Kozlar inž. gr.
Obdeloval / risal: Tim Balant mag. inž. grad. Tomaž Goričan mag. inž. grad.

Načrt: 2 GRADB. KONSTRUKCIJE Faza: PZI Merilo: 1:50 Datum: sep 2026 Projekt št.: 2024/08 Načrt št.: 2024/08-K Risba št.: 1.3.1



OPOMBA:
Nove stene v pritličju in mansardi morajo biti poravnane ena na drugo !

BETON C-25/30
ARMATURA B-500B / S-500
LES C24

Pri gradnji je potrebno upoštevati navodila geomehanika! Na planumu temeljne plošče mora biti vrednost dinamičnega deformacijskega modula $E_{vd} = 45 - 50 \text{ MN/m}^2$.

V skladu s predpisi, mora izvajalec pred pričetkom in med samim izvajanjem posameznih del, opraviti pregled projekta za izvedbo in opozoriti na morebitne ugotovljene pomanjkljivosti ter zahtevati njihovo odpravo.

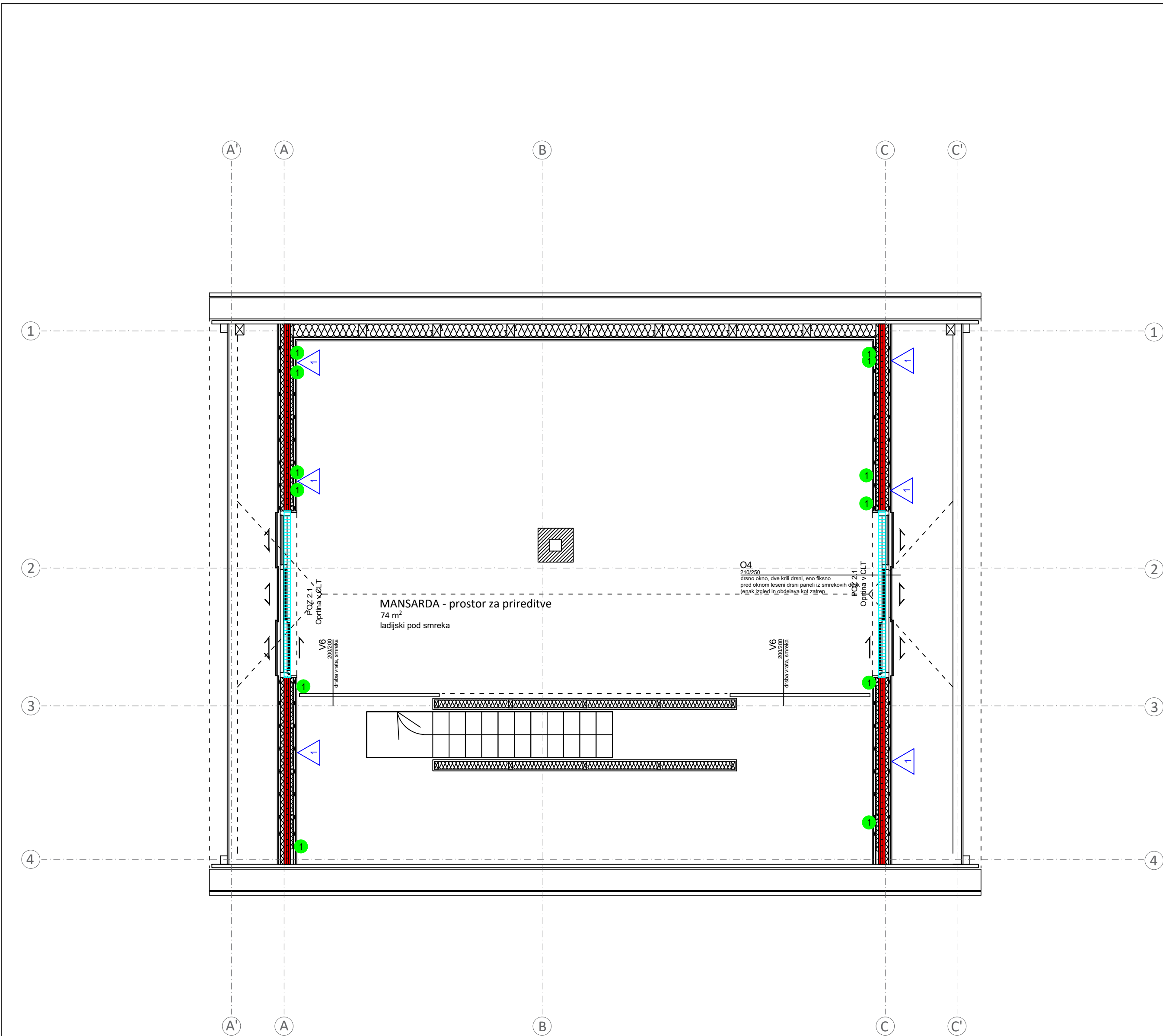
ZA PRAVLNOSTI IZVEDB JAMČI IZVAJALEC DEL!

SPREMEMBE IN DOPOLNITVE PROJEKTOV SO MOŽNE LE S PRISTANKOM PROJEKTANTOV!

VSE MERE PREVERITI NA LICU MESTA!

Opečna p.p. = Opečna prednapeta preklada

Projektant:		BAU-ING Danilo Kozlar s.p. Kotlje 172, 2390 Kotlje tel.02/8218735, fax. 02/8223997 e-mail / bauing@netsi.net											
Investitor:		Občina Prevalje Trg 2A. 2391 Prevalje											
Objekt:		PRENOVA BRUSNIKOVE DOMAČIJE		Lokacija: N.V. SLEME Šentanel 694,13m									
Risba:		POZICIJSKI/OPAŽNI NAČRT PRITLIČJE CLT STROP											
		Id. št.:		Ime:		Podpis:							
		Odg. vodja projekta:		ZAPS A-1018 Maruša Zorec univ. dipl. inž. arh.									
		Odg. projektant načrta:		IZS G-0588 Danilo Kozlar inž. gr.									
		Obdeloval / risal:		Tim Balant mag. inž. grad. Tomaž Goričan mag. inž. grad.									
Načrt:		Faza:		Datum:		Projekt št.:		Načrt št.:		Risba št.:			
2 GRADB. KONSTRUKCIJE		PZI		1:50		sep 2026		2024/08		2024/08-K		1.4.1	



OPOMBA:

Preklade
- Vse preklade stavbnega pohištva so CLT 100mm L3S

Stene
- 100 3s T - Thick. 100 mm - 3 s
30-40-30 - External layers vertical

Sidra:

n = connection number

n = connection number on one side of the wall
2n = connection number on the two sides of the wall

HOLD DOWN

TENSILE FORCE CONNECTION
Connection: "WHT 15"
Wall connection: 15 x Anker nail - LBA 4,0 x 60
Anchor: 1 x Threaded rod INA - 5.8 - M16 x 195

ANGLE BRACKETS WITH ANCHORS

SHEAR FORCE CONNECTION
Connection: "Titan N - TCN 200"
Wall connection: 30 x Anker nail - LBA 4,0 x 60
Concrete connection: 2 x Threaded rod INA - 5.8 - M12 x 140

DOUBLE HOLD DOWN

TENSILE FORCE CONNECTION
Connection: "WHT 30"
Wall connection: 30 x Anker nail - LBA 4,0 x 60
Lower connection: 1 x Threaded rod INA - 5.8 - M20 x 245

ANGLE BRACKET

SHEAR FORCE CONNECTION
Connection: "Angle bracket TT1"
Wall connection: 1 x Anker nail - 4,0 x 40
Connection to the floor: 1 x Anker nail - 4,0 x 40

BETON C-25/30
ARMATURA B-500B / S-500
LES C24

Pri gradnji je potrebno upoštevati navodila geomehanika! Na planumu temeljne plošče mora biti vrednost dinamičnega deformacijskega modula $E_{vd} = 45 - 50 \text{ MN/m}^2$.

V skladu s predpisi, mora izvajalec pred pričetkom in med samim izvajanjem posameznih del, opraviti pregled projekta za izvedbo in opozoriti na morebitne ugotovljene pomanjkljivosti ter zahtevati njihovo odpravo.

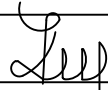
ZA PRAVLNOSTI IZVEDB JAMČI IZVAJALEC DEL!

SPREMEMBE IN DOPOLNITVE PROJEKTOV SO MOŽNE LE S PRISTANKOM PROJEKTANTOV!

VSE MERE PREVERITI NA LICU MESTA!

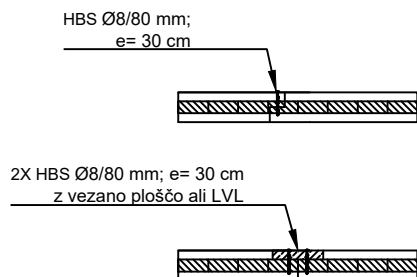
Opečna p.p. = Opečna prednapeta preklada

Projektant:		BAU-ING		BAU-ING Danilo Kozlar s.p. Kotlje 172, 2390 Kotlje tel.02/8218735, fax. 02/8223997 e-mail / bauing@netsi.net	
Investitor:					
Občina Prevalje Trg 2A. 2391 Prevalje					
Objekt:				Lokacija:	N.V. SLEME
PRENOVA BRUSNIKOVE DOMAČIJE				Šentanel	694,13m
Risba:		Id. št.: Ime: Podpis:			
POZICIJSKI/OPAŽNI NAČRT MANSARDA SIDRANJE STENE PREKLADE		Odg. vodja projekta: ZAPS A-1018 Maruša Zorec univ. dipl. inž. arh.			
		Odg. projektant načrta: IZS G-0588 Danilo Kozlar inž. gr. <i>[Signature]</i>			
		Obdeloval / risal: Tim Balant mag. inž. grad. Tomaž Goričan mag. inž. grad.			
Načrt:	Faza:	Merilo:	Datum:	Projekt št:	Načrt št:
2 GRADB. KONSTRUKCIJE	PZI	1:50	sep 2026	2024/08	2024/08-K
					Risba št.: 1.5.1

Projektant:		BAU-ING Danilo Kozlar s.p. Kotlje 172, 2390 Kotlje tel.02/8218735, fax. 02/8223997 e-mail / bauing@netsi.net	
Investitor:			
Občina Prevalje Trg 2A. 2391 Prevalje			
Objekt:		Lokacija:	
PRENOVA BRUSNIKOVE DOMAČIJE		Šentanel N.V. SLEME 694,13m	
Risba:			
POZICIJSKI/OPAŽNI NAČRT OSTREŠJE		Id. št.: Ime: Podpis:	
Odg. vodja projekta:		ZAPS A-1018 Maruša Zorec univ. dipl. inž. arh.	
Odg. projektant načrta:		IZS G-0588 Danilo Kozlar inž. gr. 	
Obdeloval / risal:		Tim Balant mag. inž. grad. Tomaž Goričan mag. inž. grad.	
Načrt:	Faza:	Merilo:	Datum:
2 GRADB. KONSTRUKCIJE	PZI	1:50	sep 2026
Projekt št.:		Načrt št.:	
2024/08		2024/08-K	
Risba št.:		1.6.1	

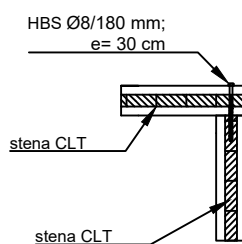
Stik stenskih elementov

CLT C3s 100mm

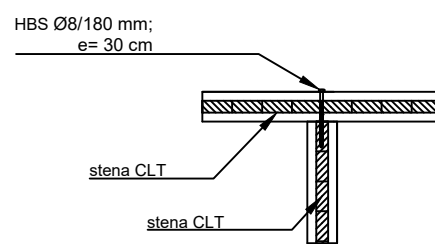


Stik stena-stena prečno

CLT C3s 100mm

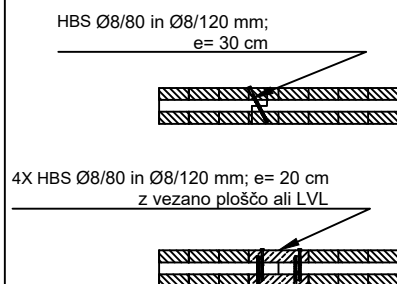


CLT C3s 100mm



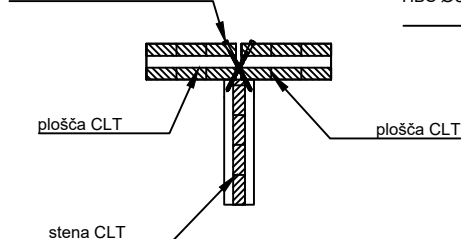
Povezava plošč po dolžini

CLT L3S in L5S

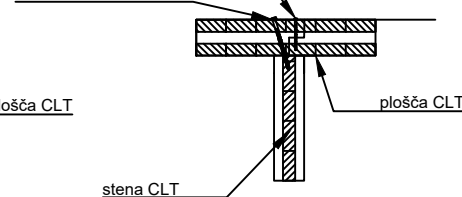


Stik plošča-stena

2X HBS Ø8/180 mm;
e=30 cm



HBS Ø60 mm;
e=30 cm
HBS Ø8/160 mm;
e=30 cm



Smer lamel CLT elementov je na detajlih prikazana simbolično.
Nosilna smer CLT elementov je določena in označena na načrtih

BAU-ING

BAU-ING Danilo Kozlar s.p.
Kotlje 172, 2390 Kotlje
tel.02/8218735, fax. 02/8223997
e-mail / bauing@netsi.net

Nina Marin
Ulica Milana Majcna 18, 1000 Ljubljana

ENOSTANOVANJSKA HIŠA ZADNJA VAS

POZICIJSKI/OPAŽNI NAČRT
CLT STIKI

Id. št.: Ime: Podpis:

Odg. vodja projekta: A-1223 MATEJ HÖFLER u.d.i.a.

Odg. projektant načrta: IZS G-0588 Danilo Kozlar inž. grad.

Obdeloval / risal: Tim Balant mag. inž. grad.
Tomaž Goričan mag. inž. grad.

2 GRADB. KONSTRUKCIJE

Faza:
PZI

Merilo:

Datum:
januar 2026

Projekt št.:
142/24-K

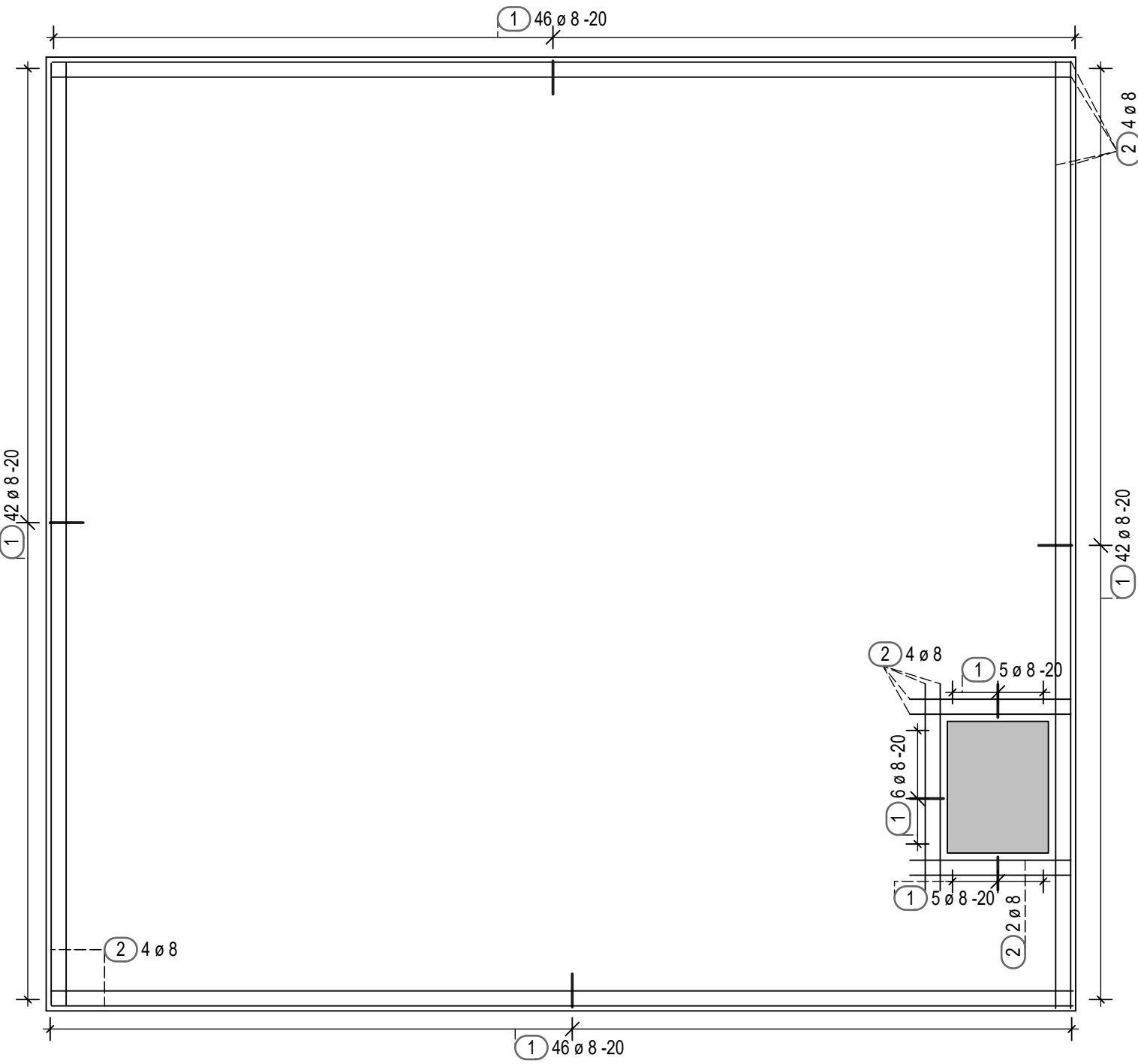
Risba št.:
1.7.1

ARMATURNI NAČRT, AB TEMELJNA PLOŠČA PRITILČJA

ROBNA ARMATURA

TLORIS

M 1:50

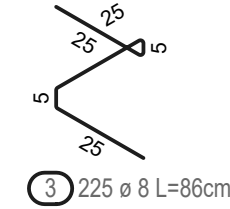
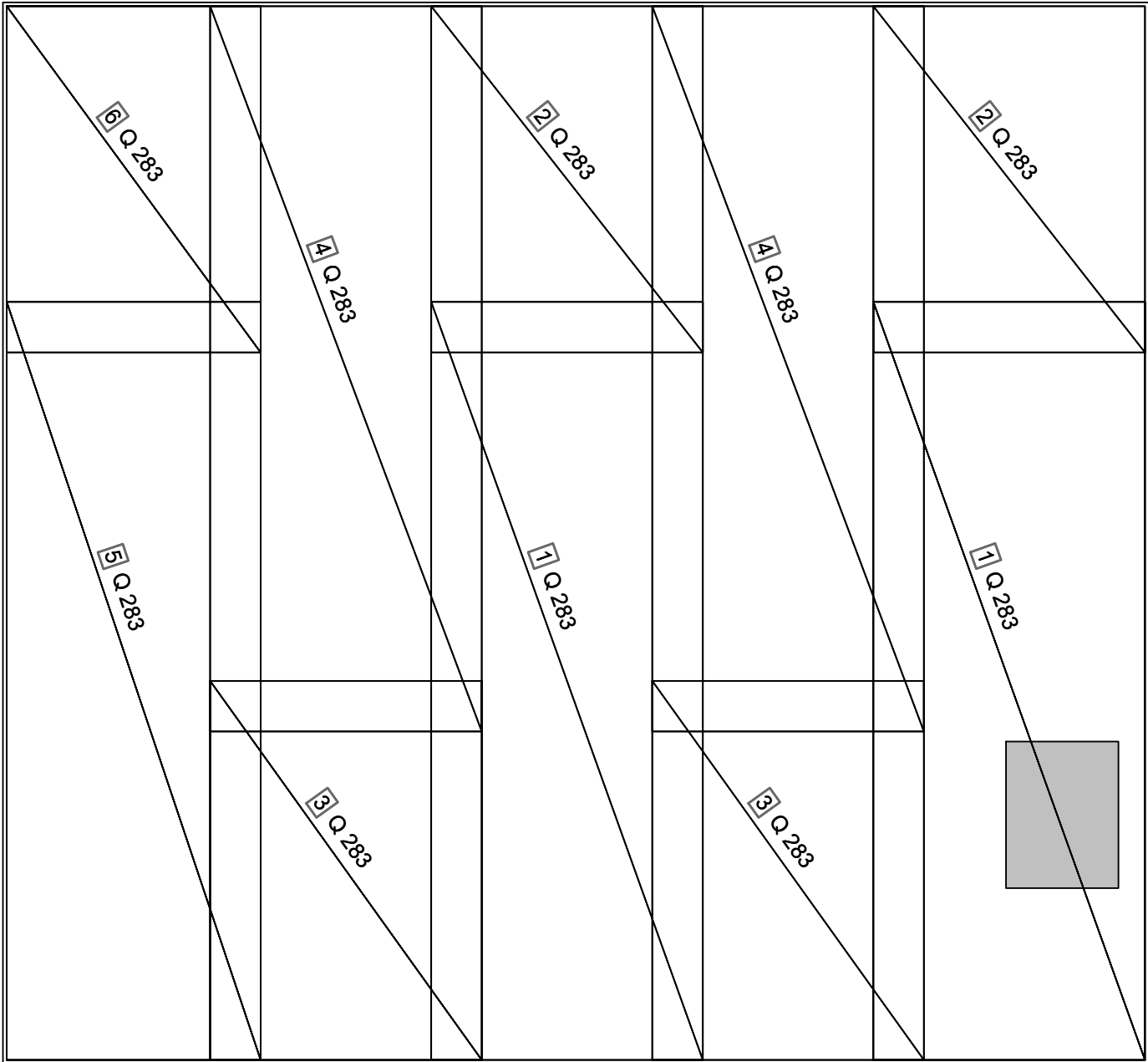


NAČRT POLAGANJA MREŽ, AB TEMELJNA PLOŠČA PRITILČJA

POZITIVNA/NEGATIVNA ARMATURA - DVOJNO ARMIRANJE

TLORIS

M 1:50

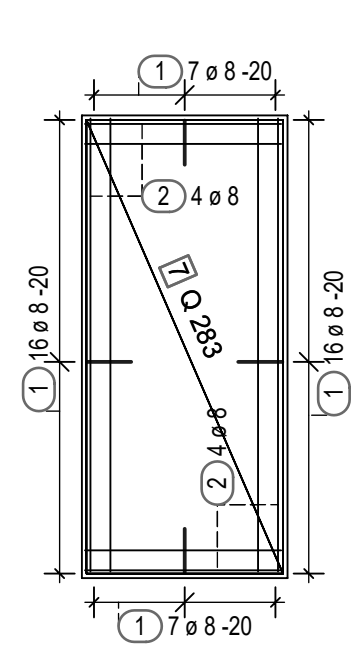


ARMATURNI NAČRT, AB TALNA PLOŠČA SVINJAKA

ROBNA ARMATURA

TLORIS

M 1:50

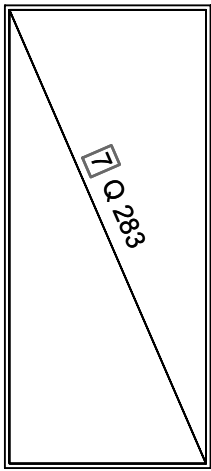


NAČRT POLAGANJA MREŽ, AB TALNA PLOŠČA SVINJAKA

POZITIVNA/NEGATIVNA ARMATURA - DVOJNO ARMIRANJE

TLORIS

M 1:50

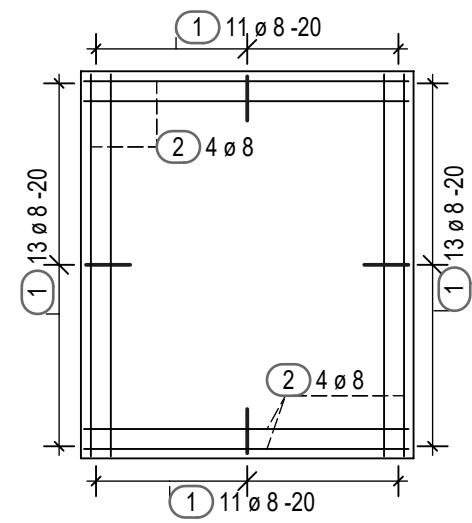


ARMATURNI NAČRT, AB TALNA PLOŠČA KLETI

ROBNA ARMATURA

TLORIS

M 1:50

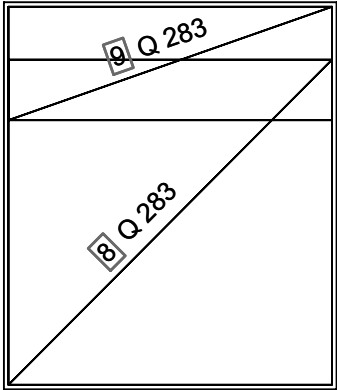


NAČRT POLAGANJA MREŽ, AB TALNA PLOŠČA KLETI

POZITIVNA/NEGATIVNA ARMATURA - DVOJNO ARMIRANJE

TLORIS

M 1:50

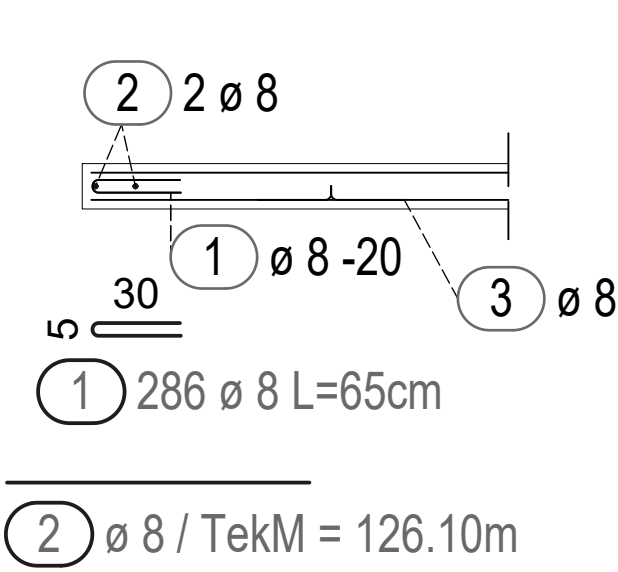


ARMATURNI NAČRT, AB TALNE PLOŠČE

ROBNA ARMATURA

PREREZ

M 1:25

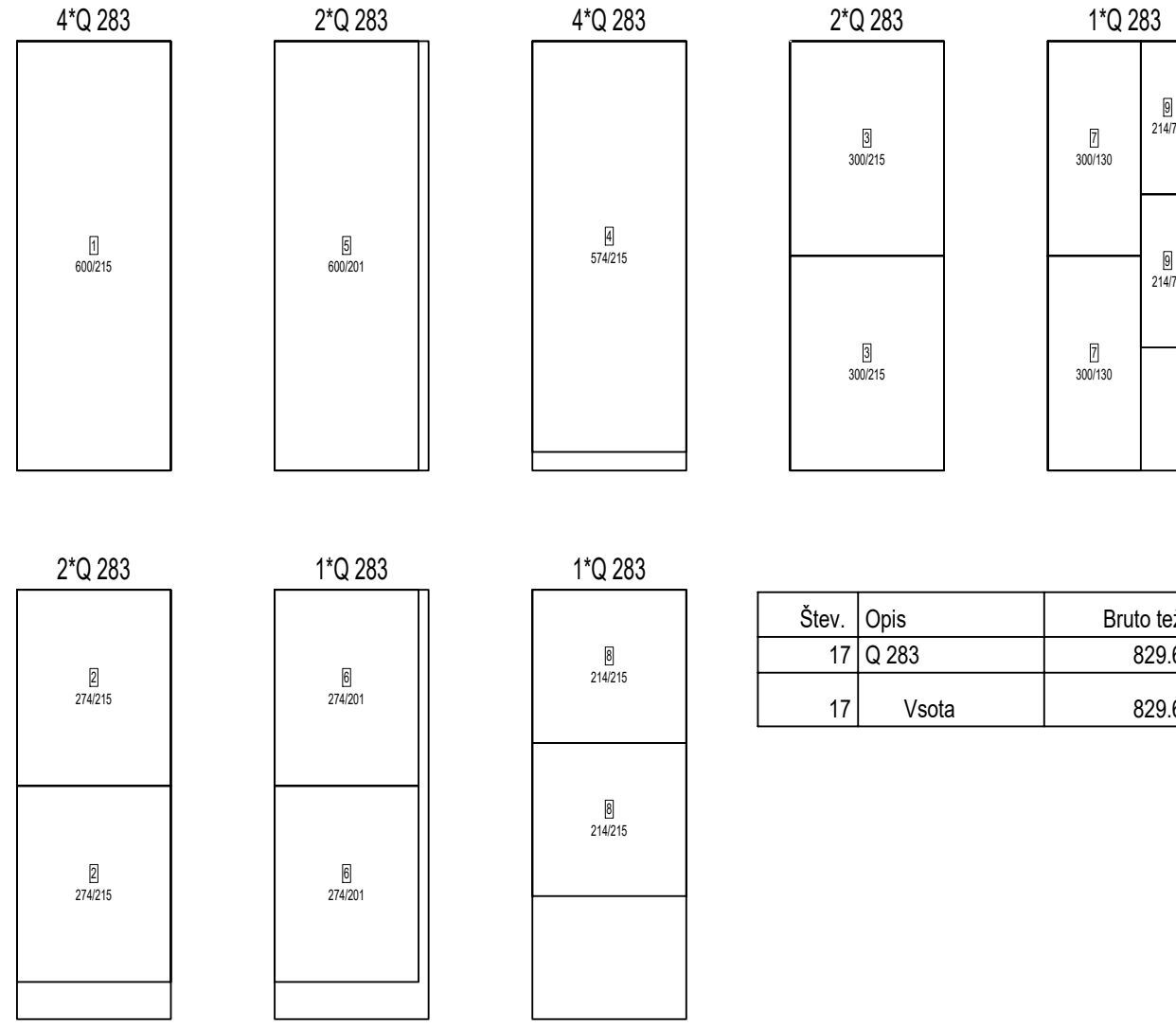


Seznam palic - oblika krivljenja

Poz.	Kosov	Fi	Posam. dolžina [m]	Kotirana oblika krivljenja (ni v merilu)	Skupna dolžina [m]	Teža [kg]
1	286	8	0.65		185.90	76.03
2	1	8	Tek.m		126.10	51.57
3	225	8	0.86		193.50	79.14

Skupna teža [kg] : 206.74

Razrez mrež - oblike krivljenja



V skladu s predpisi, mora izvajalec pred pričetkom in med samim izvajanjem posameznih del, opraviti pregled projekta za izvedbo in opozoriti na morebitne ugotovljene pomanjkljivosti ter zahtevati njihovo odpravo.

ZA PRAVILNOSTI IZVEDB JAMČI IZVAJALEC DEL!
SPREMEMBE IN DOPOLNITVE PROJEKTOV SO MOŽNE LE S
PRISTANKOM PROJEKTANTOV!
VSE MERE PREVERITI NA LICU MESTA!

OPOMBE:
-ZAGOTOVLJENI MORAJO BITI MINIMALNI PREKLOPI!
-DETALJI V SKLOPU PLOŠČE SO OBDELANI NA TEKOČI METER ALI NA KOMAD!
-ZAŠČITNI SLOJ BETONA JE min. 3,0 cm!
-PREKLOP ARMATURNIH PALIC JE MIN 50 X Ø PALICE!
-POTREBNE PREBOJE SKOZI AB ELEMENT USKLADITI Z IZVAJALCI STROJNINIH ELEKTRO INŠTALACIJ!
-PRI GRADNJI JE POTREBNO UPOŠTEVATI NAVODILA GEOMEHANIKA!
NA PLANUMU TEMELJNE PLOŠČE MORA BITI VREDNOST DINAMIČNEGA DEFORMACIJSKEGA MODULA E_{vd} = 45 - 50 MN/m²!

Projektant:

BAU-ING

BAU-ING, Danilo Kozlar s.p.
Kotlje 172, 2390 Kotlje
tel.02/8218735, fax. 02/8223997
e-mail / bauing@netsi.net

Investitor:

Občina Prevalje
Trg 2A. 2391 Prevalje

Lokacija:

Šentanel

N.V. ±0.00
694,13m

Objekt:

PRENOVA BRUSNIKOVE DOMAČIJE

Risba:

AB TEMELJENJE
Armaturni načrt

Id. št.:

Ime:

Podpis:

Odg. vodja projekta:

A-1018 Maruša Zorec u.d.i.a.

Odg. projektant načrta:

IZS G-0588 Danilo Kozlar inž. gr.

Obdeloval / risal:

Tim Balant mag. inž. grad.
Tomaž Goričan mag. inž. grad.

Načrt:

2 GRADB. KONSTRUKCIJE

Faza:

PZI

Merilo:

1:50

Datum:

sep. 2026

Projekt št.:

2024/08

Načrt št.:

2024/08-K

Risba št.:

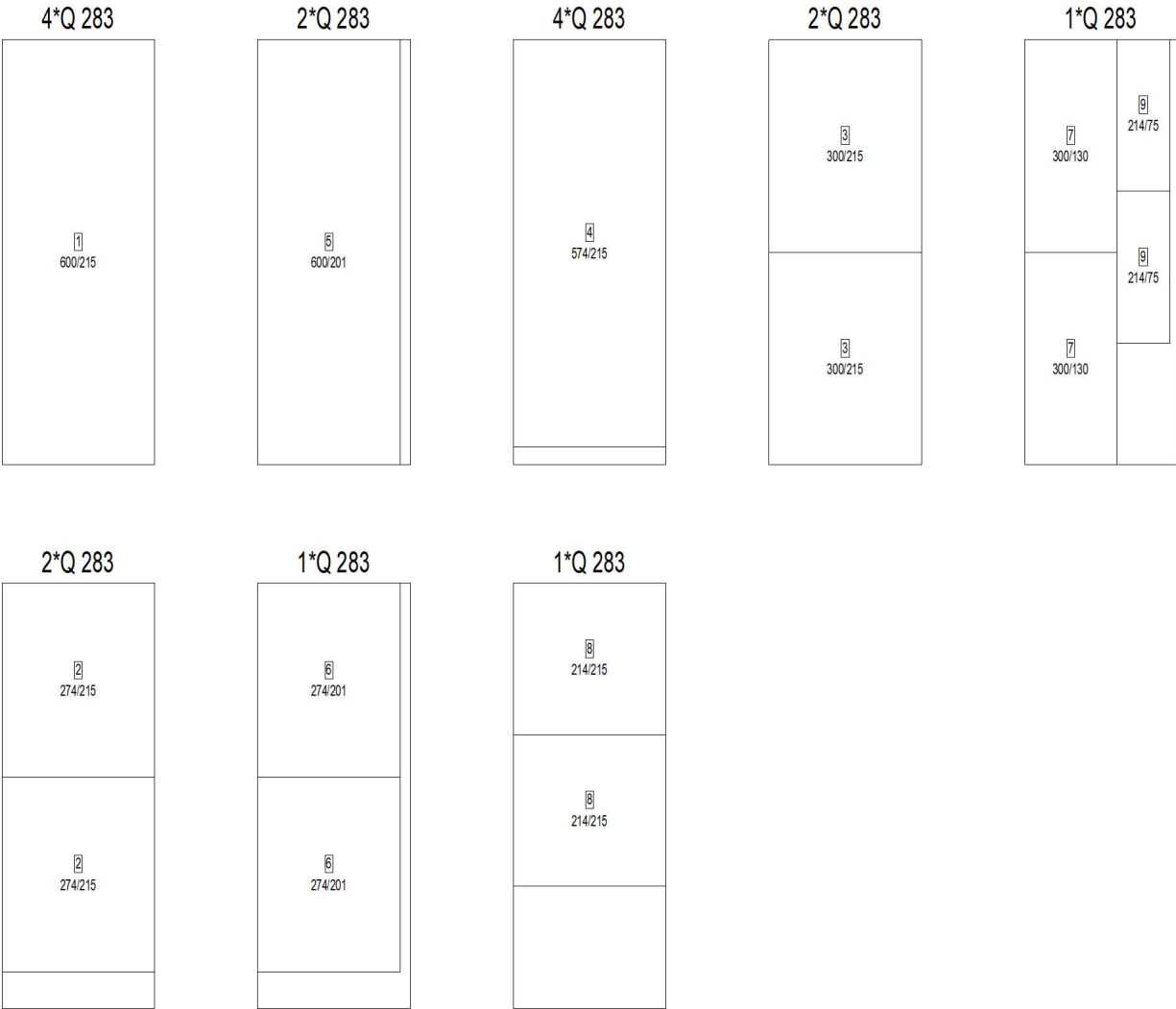
2.1.1.

V/S = 594 / 841 (0.50m2)

V/S = 594 / 841 (0.50m2)

Mreže - razrez mrež

Projekt: PRENOVA BRUSNIKOVE DOMAČIJE
K risbi: Armaturni načrt, AB Plošče
Gradbeni element: AB Plošče
Izdelal:
Datum / čas: 18. 09. 2026 / 15:34

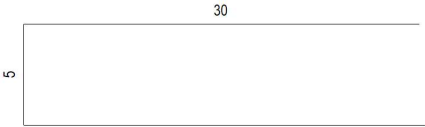
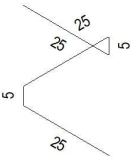


Štev.	Opis	Bruto teža
17	Q 283	829.60
17	Vsota	829.60

Seznam palic - oblike krivljenja

Projekt: PRENOVA BRUSNIKOVE DOMAČIJE
K risbi: Armaturni načrt, AB Plošče
Izdelal:
Datum / čas: 18. 09. 2026 / 15:35
Napotek:

Vse oblike palic

Pozicija	Kosov	Ø	Kotirana oblika palice	Posamezna dolžina	Skupna dolžina	Teža
		[mm]		[m]	[m]	[kg]
AB Plošče						
1	286	8		0.65	185,90	76,03
2	1	8		Tek.m	126,12	51,58
3	225	8		0.86	193,50	79,14
Vsota						206,76
Vsota preko vseh elementov						206,76
Število izvedb						1
Skupna teža						206,76