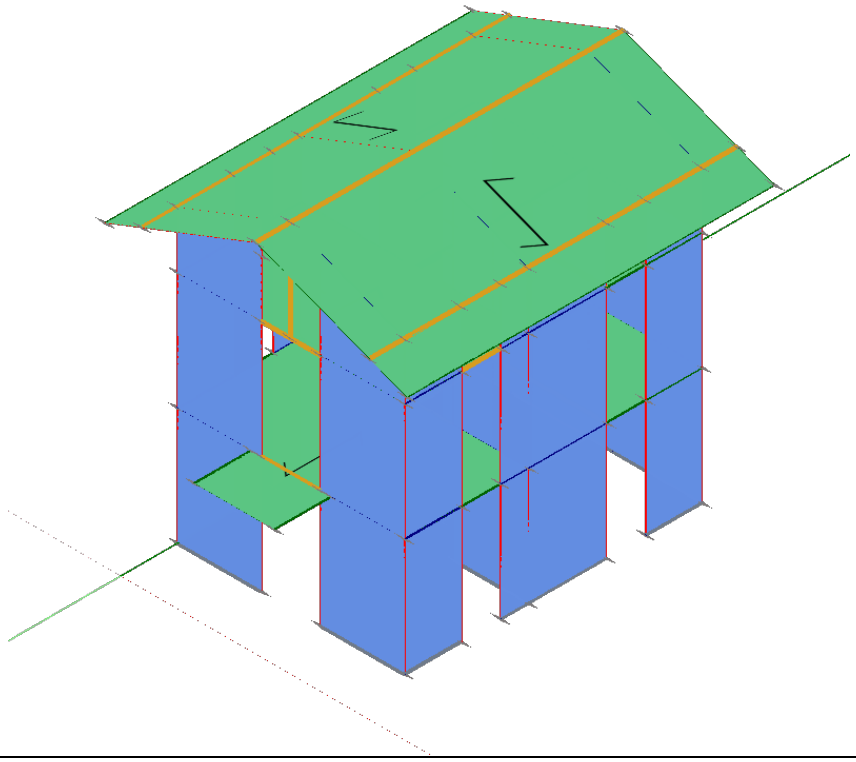
TECHNICAL DESIGN CALCULATION REPORT

Design Of Timber Structures



Project: Timber framed building – Single family house

Location: Ferla	**Address: Via Rodegna, 24**
City: Ferla	**Province: Siracusa**

Client:
Timber Tech s.r.l.

Building company:
Timber Tech s.r.l.

Structural designer:
Timber Tech s.r.l.

Date: Friday, July 3, 2015

Design codes and standards

1. **EN 1993-1-1 – Eurocode 3**

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

2. **EN 1993-1-8 – Eurocode 3**

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

3. **EN 1995-1-1 – Eurocode 5**

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

4. **EN 338**

   Structural timber - Strength classes

5. **EN 1194**

   Timber structures - Glued laminated timber - Strength classes and determination of characteristic values

6. **EN 14080**

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

General description of the building

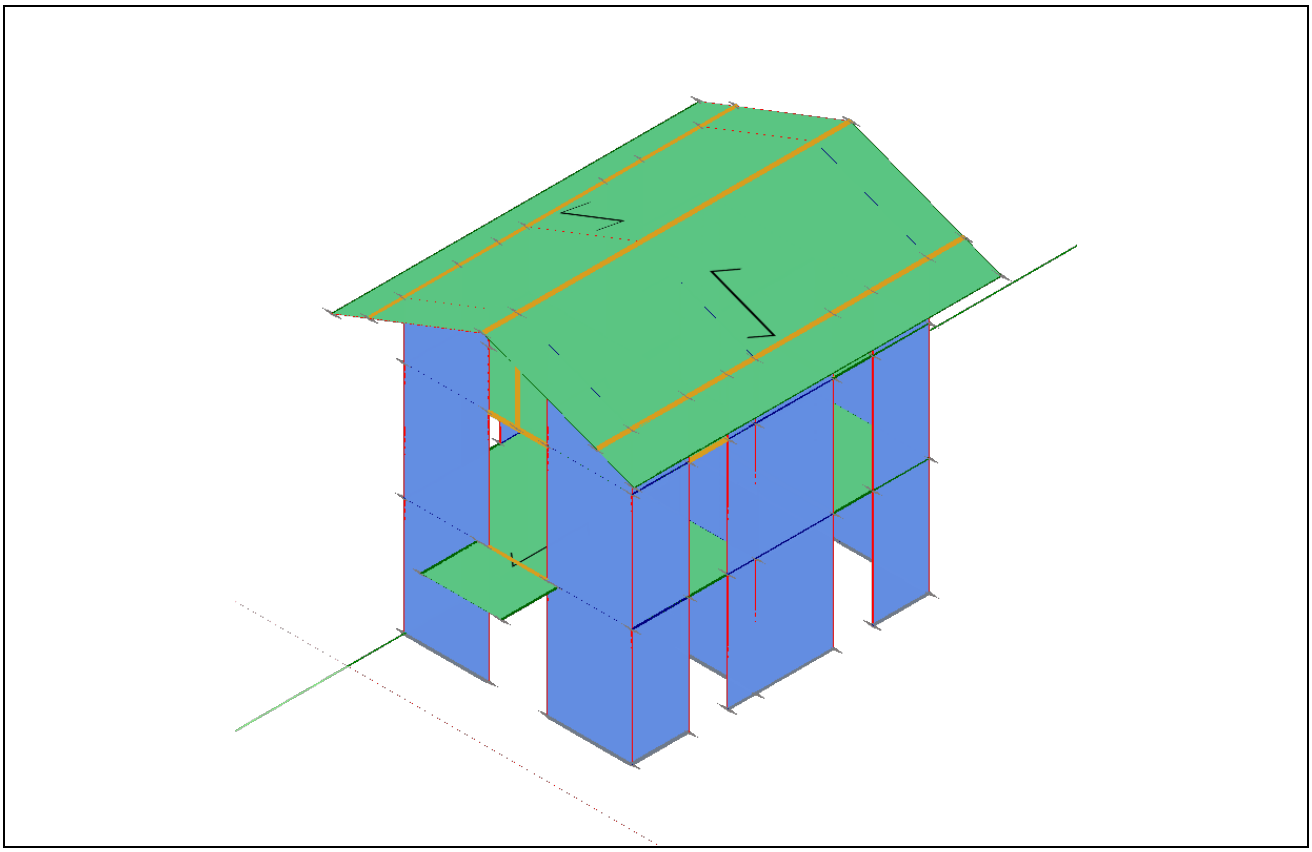
Location

Region:	Sicilia
Province:	Siracusa
City:	Ferla
Place:	Ferla
Address:	Via Rodegna, 24
Latitude:	37.1216°
Longitude:	14.9404°
Elevation mamsl:	556 m

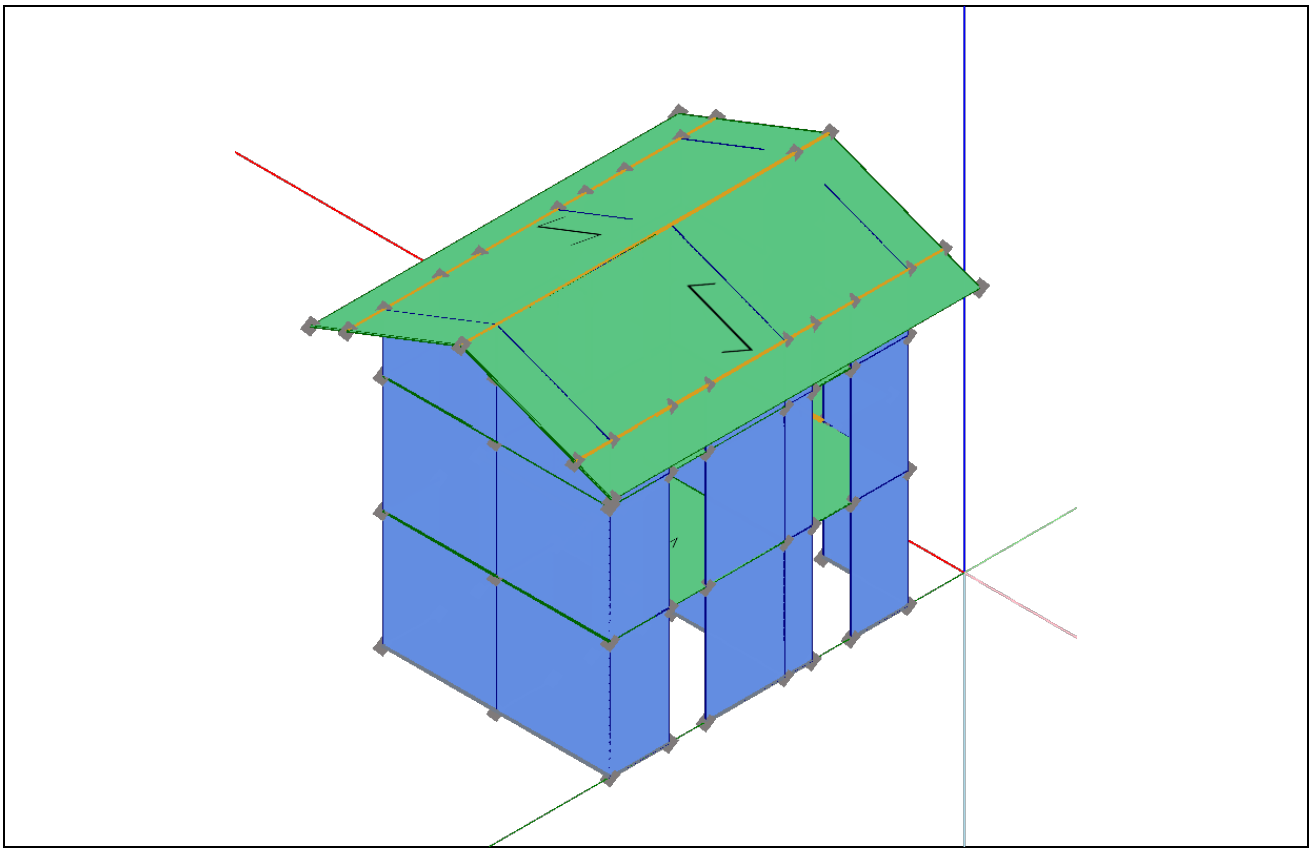
Description

Number of storeys:	3
Building length:	8.85 m
Building width:	6.84 m
Building height:	7.6 m

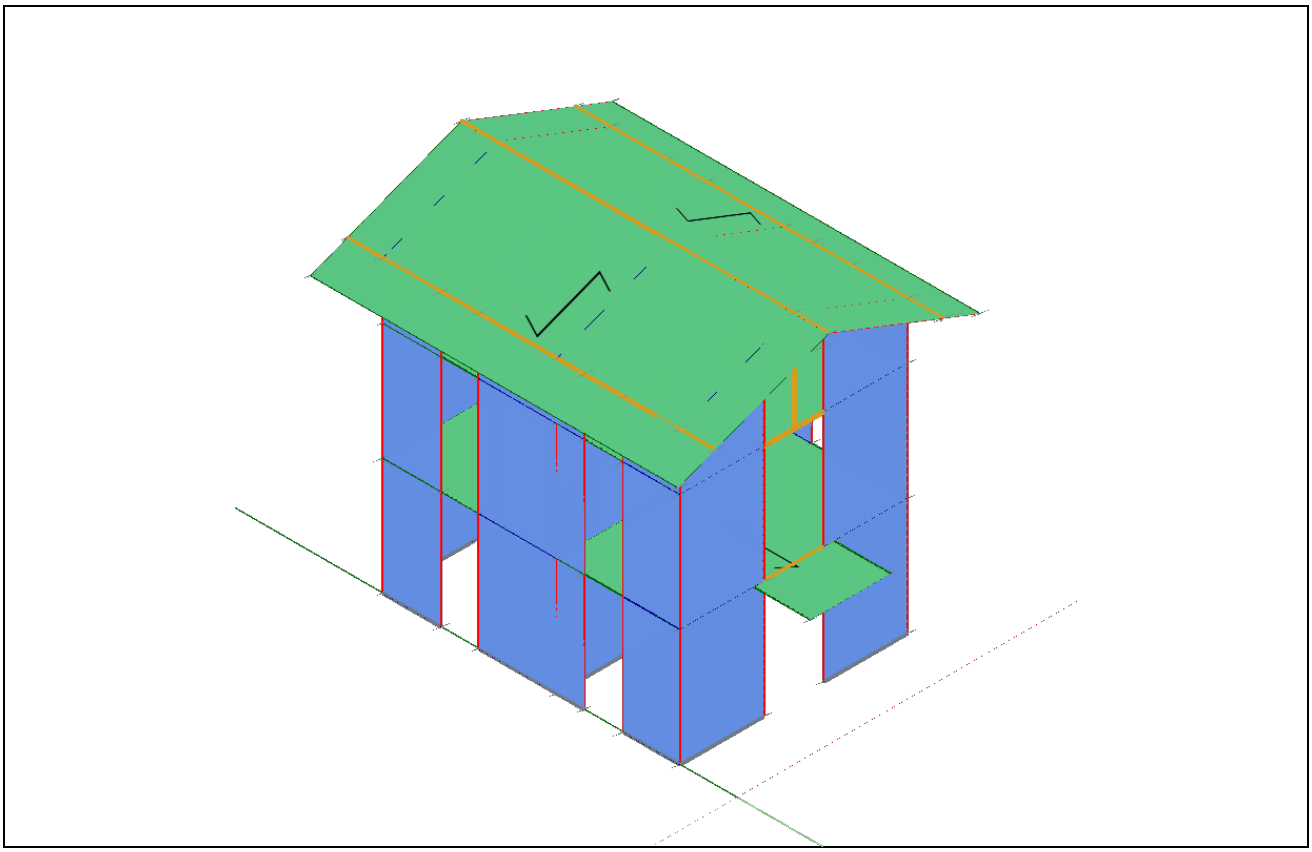
Three-dimensional view Southeast



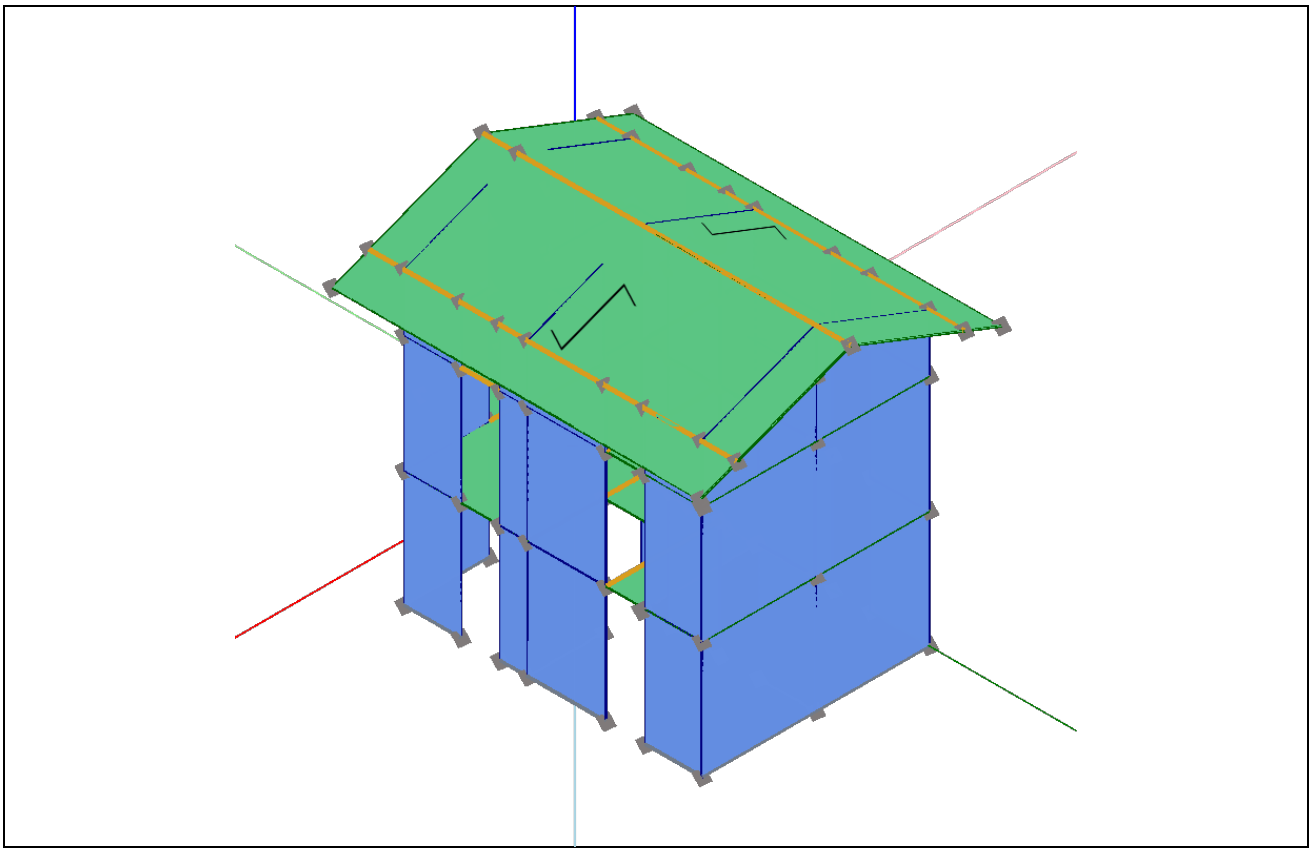
Three-dimensional view Northwest



Three-dimensional view South West



Three-dimensional view North East



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:	Timber Tech Buildings
Version:	2.20150622.1646R
Software Producer:	Timber Tech s.r.l.
	Via della Villa, 22/A
	I-38123 – Villazzano – Trento (TN) – Italy
	www.timbertech.it

License registered to Timber Tech s.r.l.

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

Homogeneous glued-laminated timber

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]
GL 24h	24	16.5	0.4	24	2.7	2.7	11600	9400	390	720	380

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	0.4	21	2.5	4	11000	7400	370	690	350

OSB

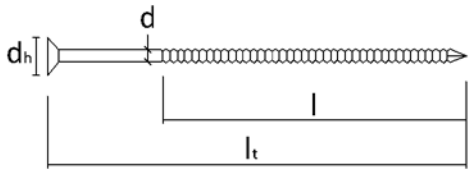
Descr.	Standard	Utilization	$f_{v,k}$ [MPa]	G_{mean} [MPa]	ρ_k [kg/m^3]
OSB/3	EN 300 Tipo OSB/3	Moist environment	6.8	1080	550

Gypsum

Descr.	Standard	Utilization	$f_{v,k}$ [MPa]	G_{mean} [MPa]	ρ_k [kg/m^3]
Gypsum-fibreboard	ETA	Moist environment	3.6	1600	1150

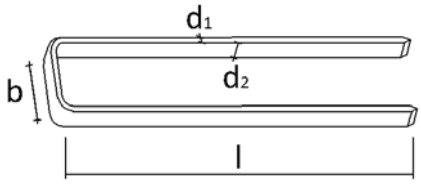
Metal fasteners

Nails with improved adhesion



Manufacturer	Code	Descr.	l [mm]	d [mm]	d_h [mm]	f_{uk} [MPa]
RING HZ9 2,8/3,1 x 80	HZ900037	RING HZ9 2,8/3,1 x 80	80	2.8	4.3	600

Staples



Manufacturer	Code	Descr.	l [mm]	Cross-section type	Cross-section dimensions d1xd2 [mm]	Width b [mm]	f_{uk} [MPa]
Staples G32 gypsum-fibreboard	HZ900105	Staples G32 gypsum-fibreboard	32	Rectangular	1.40 x 1.65	11.7	800

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.

The floors are schematized simply supported by the walls or by the beams and the columns are modelled with hinged ends.

The horizontal elements are considered infinitely rigid in their plane and with three degrees of freedom: two translational and one rotational.

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-tension edge of the wall, is loaded by a force equal to

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

where:

b is the lever arm for the internal couple, assumed equal to $0.9 \cdot l$, where l is the length of the wall

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 corner of the wall

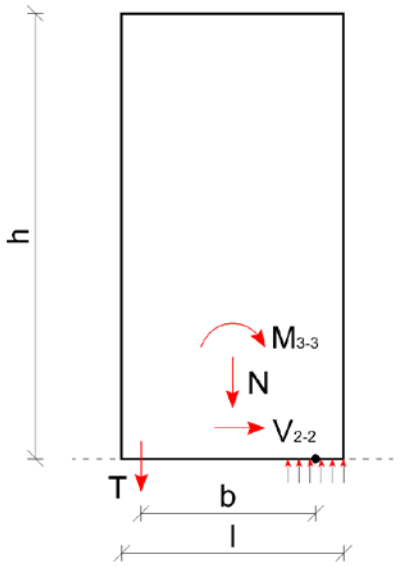


Figure: Calculation model for determining the tensile force acting on the hold-down

Structural elements

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

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

X2 e 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	Frame	Yes	2.66	1.33	0	0	6.715	0	8.045
Wall 10	Frame	Yes	2.66	2.58	0	0	4.095	2.58	4.095
Wall 11	Frame	Yes	2.66	1.28	0	0	2.575	0	1.295
Wall 12	Frame	Yes	2.66	1.91	0	0	1.295	1.905	1.295
Wall 13	Frame	Yes	2.66	1.91	0	3.255	1.295	5.16	1.295
Wall 14	Frame	Yes	2.66	1.28	0	5.16	1.295	5.16	2.575
Wall 15	Frame	Yes	2.66	1.33	2.66	0	6.715	0	8.045
Wall 16	Frame	Yes	2.66	2.58	2.66	0	8.045	2.58	8.045
Wall 17	Frame	Yes	2.66	2.58	2.66	2.58	8.045	5.16	8.045
Wall 18	Frame	Yes	2.66	1.28	2.66	5.16	8.045	5.16	6.765

Wall 19	Frame	Yes	2.66	1.3	2.66	2.58	8.045	2.58	6.75
Wall 2	Frame	Yes	2.66	2.58	0	0	8.045	2.58	8.045
Wall 20	Frame	Yes	2.66	2.4	2.66	5.16	5.87	5.16	3.47
Wall 21	Frame	Yes	2.66	1.72	2.66	5.16	4.095	3.445	4.095
Wall 22	Frame	Yes	2.66	1.15	2.66	2.58	4.72	2.58	5.87
Wall 23	Frame	Yes	2.66	2.4	2.66	0	5.87	0	3.47
Wall 24	Frame	Yes	2.66	2.58	2.66	0	4.095	2.58	4.095
Wall 25	Frame	Yes	2.66	1.28	2.66	0	2.575	0	1.295
Wall 26	Frame	Yes	2.66	1.91	2.66	0	1.295	1.905	1.295
Wall 27	Frame	Yes	2.66	1.91	2.66	3.255	1.295	5.16	1.295
Wall 28	Frame	Yes	2.66	1.28	2.66	5.16	1.295	5.16	2.575
Wall 3	Frame	Yes	2.66	2.58	0	2.58	8.045	5.16	8.045
Wall 32	Frame	Yes	1.59	1.72	5.32	5.16	4.095	3.445	4.095
Wall 36	Frame	Yes	1.28	1.28	5.32	5.16	6.765	5.16	8.045
Wall 38	Frame	Yes	1.28	1.33	5.32	0	8.045	0	6.715
Wall 39	Frame	Yes	1.28	2.4	5.32	0	5.87	0	3.47
Wall 4	Frame	Yes	2.66	1.28	0	5.16	8.045	5.16	6.765
Wall 40	Frame	Yes	1.28	1.28	5.32	0	2.575	0	1.295
Wall 41	Frame	Yes	2.28	1.15	5.32	2.58	4.72	2.58	5.87
Wall 42	Frame	Yes	1.82	2.58	5.32	2.58	4.095	0	4.095
Wall 43	Frame	Yes	1.82	2.58	5.32	2.58	8.045	5.16	8.045
Wall 44	Frame	Yes	1.75	2.58	5.32	0	8.045	2.58	8.045
Wall 47	Frame	Yes	1.63	1.91	5.32	0	1.295	1.905	1.295
Wall 49	Frame	Yes	1.67	1.91	5.32	3.255	1.295	5.16	1.295
Wall 5	Frame	Yes	2.66	1.3	0	2.58	8.045	2.58	6.75

Wall 50	Frame	Yes	1.28	1.28	5.32	5.16	1.295	5.16	2.575
Wall 6	Frame	Yes	2.66	2.4	0	5.16	5.87	5.16	3.47
Wall 67	Frame	Yes	1.28	2.4	5.32	5.16	3.47	5.16	5.87
Wall 7	Frame	Yes	2.66	1.72	0	5.16	4.095	3.445	4.095
Wall 8	Frame	Yes	2.66	1.15	0	2.58	4.72	2.58	5.87
Wall 9	Frame	Yes	2.66	2.4	0	0	5.87	0	3.47

The following table shows the positions of the columns.

X e Y are the coordinates of the point where the column is located

Column name	Height [m]	Altitude [m]	X [m]	Y [m]
Column 1	2.28	5.32	2.58	1.295

Wall horizontal stiffness

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

Timber framed shear walls

In the case of framed walls the overall stiffness is calculated taking into account the contribution of the following components:

- sheeting boards (k_s)
- sheet-fasteners slip (k_c)
- shear connections – angle brackets (k_a)
- hold-down or tie-down (k_h)

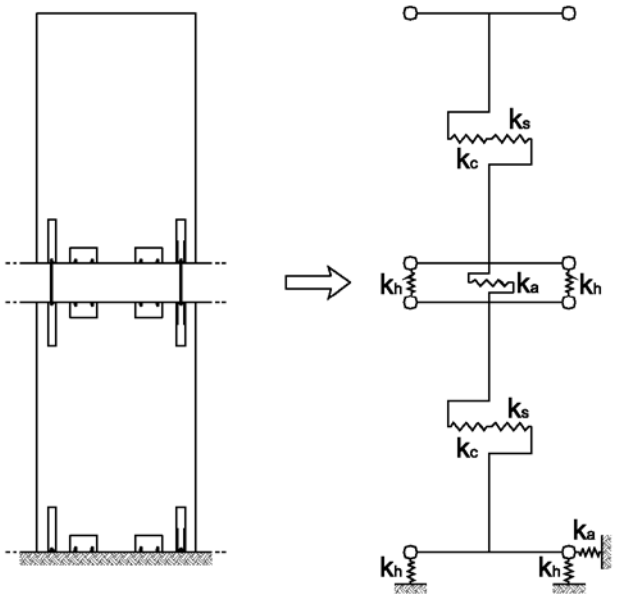


Figure: Mechanical model for determining framed walls overall stiffness

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	Frame	Yes	2.66	1.33	1601
Wall 10	Frame	Yes	2.66	2.58	4047
Wall 11	Frame	Yes	2.66	1.28	1528
Wall 12	Frame	Yes	2.66	1.91	2628
Wall 13	Frame	Yes	2.66	1.91	2628
Wall 14	Frame	Yes	2.66	1.28	1528
Wall 15	Frame	Yes	2.66	1.33	510
Wall 16	Frame	Yes	2.66	2.58	1674
Wall 17	Frame	Yes	2.66	2.58	1674

Wall 18	Frame	Yes	2.66	1.28	476
Wall 19	Frame	Yes	2.66	1.3	486
Wall 2	Frame	Yes	2.66	2.58	4047
Wall 20	Frame	Yes	2.66	2.4	1466
Wall 21	Frame	Yes	2.66	1.72	813
Wall 22	Frame	Yes	2.66	1.15	392
Wall 23	Frame	Yes	2.66	2.4	2401
Wall 24	Frame	Yes	2.66	2.58	1674
Wall 25	Frame	Yes	2.66	1.28	476
Wall 26	Frame	Yes	2.66	1.91	975
Wall 27	Frame	Yes	2.66	1.91	975
Wall 28	Frame	Yes	2.66	1.28	476
Wall 3	Frame	Yes	2.66	2.58	4047
Wall 32	Frame	Yes	1.59	1.72	1393
Wall 36	Frame	Yes	1.28	1.28	1172
Wall 38	Frame	Yes	1.28	1.33	1234
Wall 39	Frame	Yes	1.28	2.4	2856
Wall 4	Frame	Yes	2.66	1.28	1528
Wall 40	Frame	Yes	1.28	1.28	1172

Wall 41	Frame	Yes	2.28	1.15	436
Wall 42	Frame	Yes	1.82	2.58	2162
Wall 43	Frame	Yes	1.82	2.58	2162
Wall 44	Frame	Yes	1.75	2.58	2269
Wall 47	Frame	Yes	1.63	1.91	1559
Wall 49	Frame	Yes	1.67	1.91	1511
Wall 5	Frame	Yes	2.66	1.3	1550
Wall 50	Frame	Yes	1.28	1.28	1172
Wall 6	Frame	Yes	2.66	2.4	3585
Wall 67	Frame	Yes	1.28	2.4	2856
Wall 7	Frame	Yes	2.66	1.72	2331
Wall 8	Frame	Yes	2.66	1.15	1335
Wall 9	Frame	Yes	2.66	2.4	3585

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

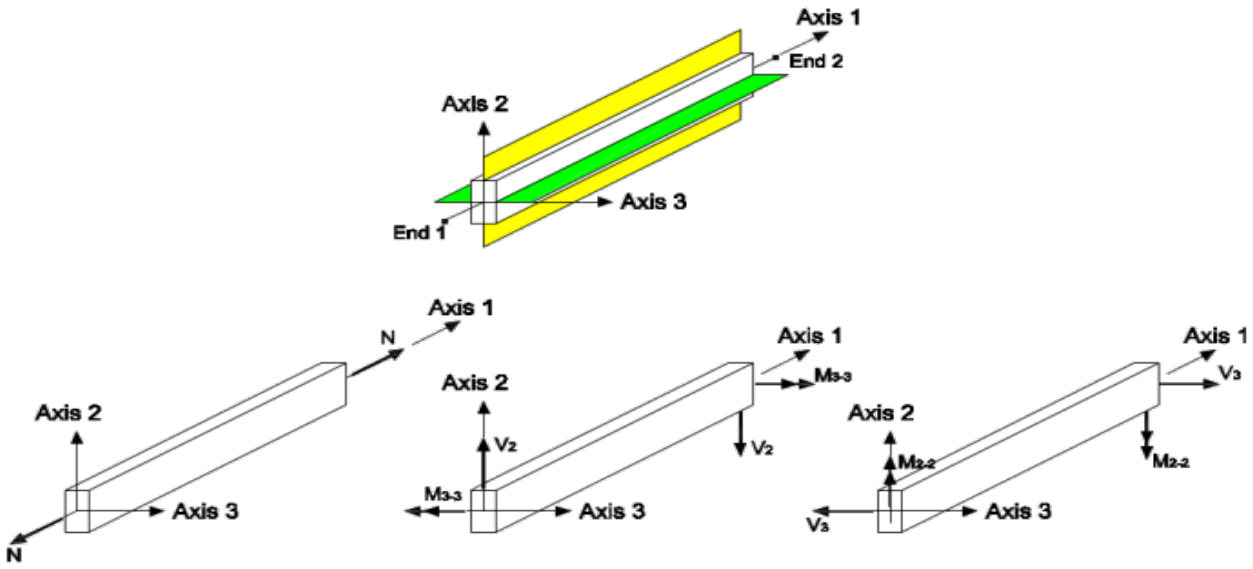


Figure: sign conventions for beams

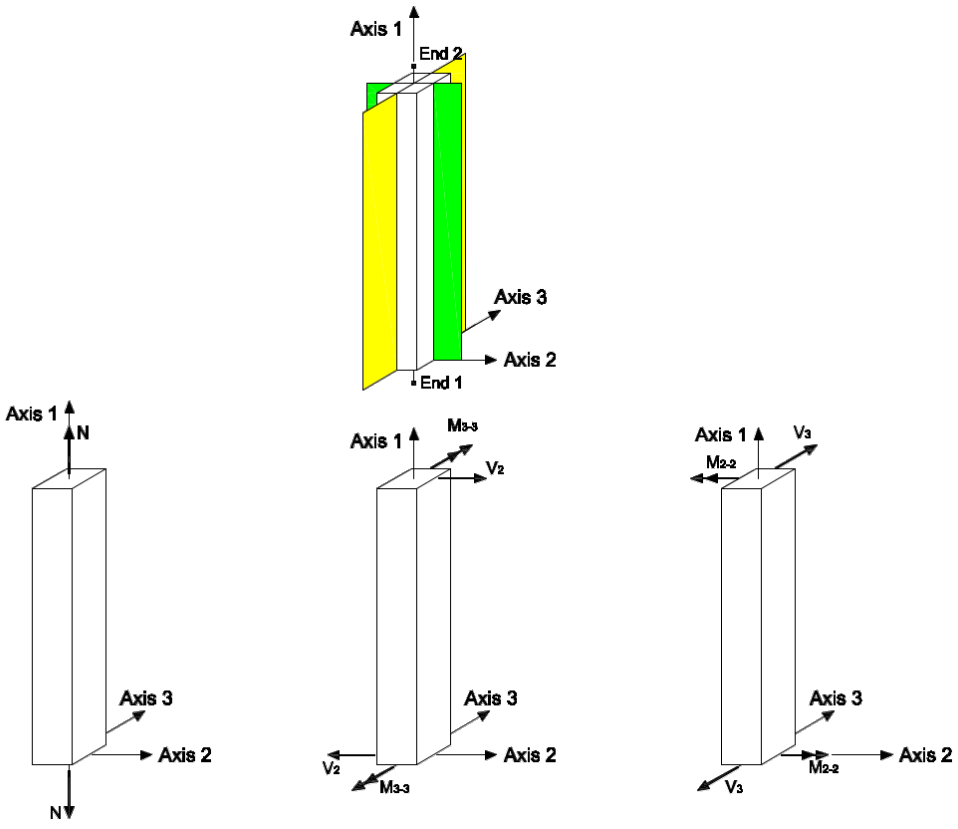


Figure: sign conventions for columns

Wall elements

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

	Stress	Description	Unit of measure
In-plane stresses	**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 stresses (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

	Force	Description	Unit of measure
In-plane stresses	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 stresses (plate)	M_{2-2}	Bending moment about local axis 3	kNm
	V_3	Shear along local axis 2	kN

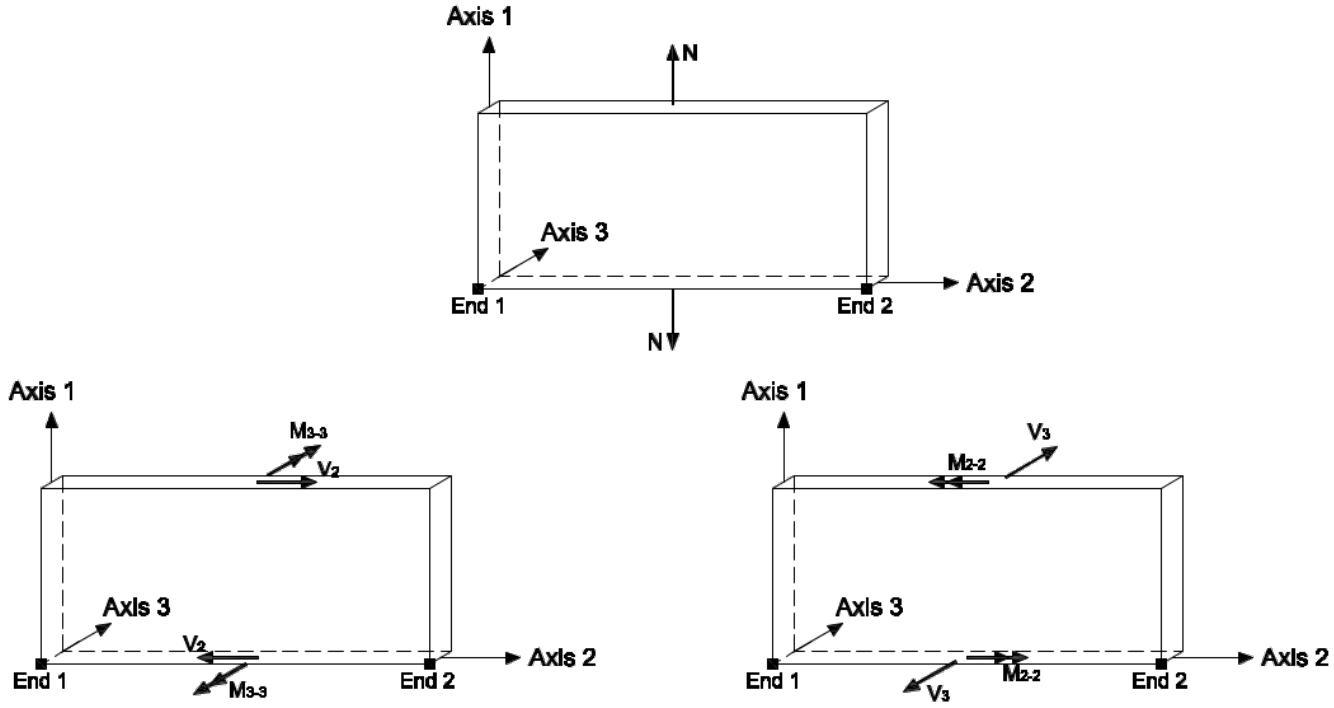


Figure: sign conventions for walls

Actions and design loads

Self-weight of structural materials

The weights of the structural materials are shown in the table below.

Description	Specific weight ɣ [kN/m^3]
GL 24h	6
C 24	6
OSB/3	8
Gypsum-fibreboard	15

Snow loads

The snow load is evaluated in accordance with the Italian Standard (3.4 - NTC '08).

Snow load on the roof can be evaluated using expression 3.3.7 NTC '08

$$q_s = \mu_i \cdot q_{sk} \cdot C_E \cdot C_t$$

where

q_s is the value of the snow load on the roof

μ_i is the shape coefficient

q_{sk} is the characteristic ground snow load

C_E is the exposure coefficient

C_t is the thermal coefficient

Characteristic ground snow load at the site

Province: Siracusa

Elevation mamsl: 556 m

Snow load zone: Zone III

Characteristic ground snow load: 1.19 kN/m^2

Topographic category: Normal topography :

Exposure coefficient: 1

Thermal coefficient: 1

Snow is not prevented from sliding off: No

Snow load on the roof

The value of the snow load acting on each roof is shown in the following table. [omissis]

Wind actions

The wind load is evaluated in accordance with the Italian standard (section 3.3 of NTC '08). The wind action is represented by a simplified set of pressures or forces whose effects are equivalent to the extreme effects of the turbulent wind. For the usual structures the wind action are considered as equivalent static actions evaluated as described in § 3.3.3 NTC '08.

Project data

Province: Siracusa

Elevation mamsl: 556 m

Wind load zone: Zone 4

Terrain roughness class: Class B

Distance from the coast: Hinterland

Exposure category: IV

Reference mean (basic) velocity

The fundamental value of the basic wind velocity, v_b, is the characteristic 10 minutes mean wind velocity, irrespective of wind direction and time of year, at 10 m above ground level in terrain with exposure category II (Tab. 3.3.II) and referring to a return period of 50 years.

The value of the basic wind velocity v_b is given by the expression:

$$v_b = v_{b,0} \qquad \text{for } a_s \leq a_0$$

$$v_b = v_{b,0} + k_a \cdot (a_s - a_0) \qquad \text{for } a_0 < a_s \leq 1500 \text{ m}$$

where:

$v_{b,0}$, a_0, k_a	are factors which are dependent on the site where the building is located (Fig. 3.3.1.)
a_s	is the altitude above sea level (in m) of the site where the building is located.
$v_{b,0}$	28 m/s
a_0	500 m
k_a	0.020 1/s

Reference velocity: 29.12 m/s

Reference velocity pressure

The reference velocity pressure q_b (in N/m²) is given by the expression:

$$q_b = \frac{1}{2} \cdot \rho \cdot v_b^2$$

where

v_b is the reference velocity of the wind (in m/s);

ρ is the air density conventionally assumed constant and equal to 1,25 kg/m^3.

So

q_b 529.98 N/m^2

Wind pressure acting on the building surfaces

The wind pressure acting on the building surfaces is given by the following expression

$$p = q_b \cdot c_e \cdot c_p \cdot c_d$$

where

q_b is reference velocity pressure

c_e is the exposure factor depending on the height z on the ground; it can be calculated with the following expression:

$$c_e(z) = k_r^2 \cdot c_t \cdot \ln\left(\frac{z}{z_0}\right) \cdot \left[7 + c_t \cdot \ln\left(\frac{z}{z_0}\right)\right] \quad \text{for } z \geq z_{min}$$

$$c_e(z) = c_e(z_{\min}) \quad \text{for } z < z_{min}$$

where

c_t is the topography factor

c_p is the pressure coefficient

c_d is the dynamic factor which takes into account the increasing effect from vibrations due to turbulence

The values assumed in the calculations for the coefficients mentioned above are reported in the following tables.

Description	Value
Dynamic factor	1

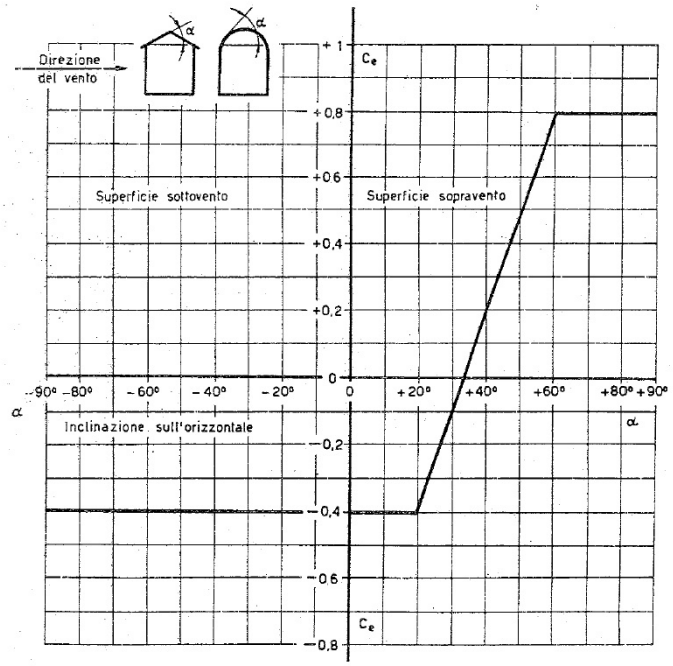


Figure: Values of the coefficient c_{pe} depending on the inclination of the surface.

Below are the values of c_{pe} e c_{pi}. The internal pressure coefficient, which gives the effect of the wind on the internal surfaces of buildings, is equal to zero if the building is airtight, conversely it is equal to ±0.2 if the building has openings. Internal and external pressures are considered to act at the same time. The worst combination of external and internal pressures are considered for every combination of possible openings.

Building element	Inclined at an angle [°]	c_{pe}
Windward wall	90	0.8
Leeward wall	90	-0.4
Leeward roof pitch	-	-0.4

Type of construction	c_{pi}
Open building	0.2

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

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]
Wall 1	External	External wall load	0.48	0.45	-0.52	0.87
Wall 2	External	External wall load	0.45	0.45	-0.52	0.87
Wall 3	External	External wall load	0.45	0.45	-0.52	0.87
Wall 4	External	External wall load	0.49	0.45	-0.52	0.87
Wall 5	Internal	Internal wall load	0.48	0.29	0	0
Wall 6	External	External wall load	0.44	0.45	-0.52	0.87
Wall 7	Internal	Internal wall load	0.47	0.29	0	0
Wall 8	Internal	Internal wall load	0.51	0.29	0	0
Wall 9	External	External wall load	0.44	0.45	-0.52	0.87
Wall 10	Internal	Internal wall load	0.45	0.29	0	0
Wall 11	External	External wall load	0.49	0.45	-0.52	0.87
Wall 12	External	External wall load	0.45	0.45	-0.52	0.87
Wall 13	External	External wall load	0.45	0.45	-0.52	0.87
Wall 14	External	External wall load	0.49	0.45	-0.52	0.87
Wall 15	External	External wall load	0.48	0.45	-0.52	0.87
Wall 16	External	External wall load	0.45	0.45	-0.52	0.87
Wall 17	External	External wall load	0.45	0.45	-0.52	0.87

Wall 18	External	External wall load	0.49	0.45	-0.52	0.87
Wall 19	Internal	Internal wall load	0.48	0.29	0	0
Wall 20	External	External wall load	0.44	0.45	-0.52	0.87
Wall 21	Internal	Internal wall load	0.47	0.29	0	0
Wall 22	Internal	Internal wall load	0.51	0.29	0	0
Wall 23	External	External wall load	0.44	0.45	-0.52	0.87
Wall 24	Internal	Internal wall load	0.45	0.29	0	0
Wall 25	External	External wall load	0.49	0.45	-0.52	0.87
Wall 26	External	External wall load	0.45	0.45	-0.52	0.87
Wall 27	External	External wall load	0.45	0.45	-0.52	0.87
Wall 28	External	External wall load	0.49	0.45	-0.52	0.87
Wall 32	Internal	Internal wall load	0.56	0.29	0	0
Wall 36	External	External wall load	0.58	0.45	-0.52	0.87
Wall 38	External	External wall load	0.57	0.45	-0.52	0.87
Wall 39	External	External wall load	0.56	0.45	-0.52	0.87
Wall 40	External	External wall load	0.58	0.45	-0.52	0.87
Wall 41	Internal	Internal wall load	0.55	0.29	0	0
Wall 42	Internal	Internal wall load	0.51	0.29	0	0
Wall 43	External	External wall load	0.51	0.45	-0.52	0.87
Wall 44	External	External wall load	0.52	0.45	-0.52	0.87
Wall 47	External	External wall load	0.53	0.45	-0.52	0.87
Wall 49	External	External wall load	0.53	0.45	-0.52	0.87
Wall 50	External	External wall load	0.58	0.45	-0.52	0.87
Wall 67	External	External wall load	0.56	0.45	-0.52	0.87

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

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

$q_{,wind,k}$: 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]	$q_{,snow,k}$ [kN/m^2]	$q_{,wind,k}$ leeward [kN/m^2]	$q_{,wind,k}$ windward [kN/m^2]
Floor 2	Internal floor	0	Residential enviroment load	Variabile cat. A - Locali di abitazione e relativi servizi, alberghi	0.27	0	2	0	0	0
Floor 9	Internal floor	0	Residential enviroment load	Variabile cat. A - Locali di abitazione e relativi servizi, alberghi	0.27	0	2	0	0	0
Floor 14	Internal floor	0	Residential enviroment load	Variabile cat. A - Locali di abitazione e relativi servizi, alberghi	0.27	0	2	0	0	0
Floor 16	Internal floor	0	Residential enviroment load	Variabile cat. A - Locali di abitazione e relativi servizi, alberghi	0.27	0	2	0	0	0
Floor 18	Internal floor	21	Residential enviroment load	Variabile cat. A - Locali di abitazione e relativi servizi, alberghi	0.27	0	2	0	0	0
Floor 19	Internal floor	21	Residential enviroment load	Variabile cat. A - Locali di abitazione e relativi servizi, alberghi	0.27	0	2	0	0	0
Floor 21	Internal floor	0	Residential enviroment load	Variabile cat. A - Locali di abitazione e relativi servizi, alberghi	0.27	0	2	0	0	0
Floor 22	Internal floor	0	Residential enviroment load	Variabile cat. A - Locali di abitazione e relativi servizi, alberghi	0.27	0	2	0	0	0

Seismic action

The seismic action was evaluated according to the Italian standard NTC '08. The response spectra are calculated using three parameters depending on the characteristic of the site in question:

a_g is the design ground acceleration on type A ground (Peak Ground Acceleration)

F_0 is the horizontal spectral acceleration amplification factor

T_C^* is the period when the spectrum constant-velocity starts

The main parameters regarding the structure and the seismic parameters of the site are summarized below with reference to different limit states.

Type of construction: Ordinary structures

Nominal service life of the structure: 50

Use Class: Class II - § 2.4.2 Building with normal crowding, without hazardous contents to the environment and without essential public functions

Use Class parameter C_u: 1

Reference Service Life ($V_R = V_N \cdot C_U$): 50

Limit States	P_{VR}	T_R [years]	a_g [g]	F0	T_C^*
SLO – Operational Limit State	81%	30	0.049	2.42	0.25
SLD – Damage Limit State	63%	50	0.067	2.52	0.27
SLV – Life Safety Limit State	10%	475	0.277	2.28	0.42
SLC – Collapse Prevention Limit State	5%	975	0.400	2.33	0.48

The following are the parameters of the site affecting the local seismic response.

Ground type: A - Tab. 3.2.II Rock or other rock-like geological formation, including at most 3 m of weaker material at the surface

Topographic category: T2 - Tab. 3.2.IV Slopes with average slope angles i > 15 °

Ratio between the altitude of the site (h) and the height of the cliff H 50%

Topographic amplification factor S_T: 1.100

Limit states	S_S	C_C	S	T_B [s]	T_C [s]	T_D [s]
SLO – Operational Limit State	1.00	1.00	1.10	0.08	0.25	1.80
SLD – Damage Limit State	1.00	1.00	1.10	0.09	0.27	1.87
SLV – Life Safety Limit State	1.00	1.00	1.10	0.14	0.42	2.71
SLC – Collapse Prevention Limit State	1.00	1.00	1.10	0.16	0.48	3.20

where

S is the Soil Factor

S_S stratigraphic amplification factor

C_C a coefficient depending on the category of subsoil

T_B is the period when the plateau at constant acceleration of the spectrum starts

T_C is the period when this plateau ends

T_D is the value defining the beginning of the constant displacement response range of the spectrum

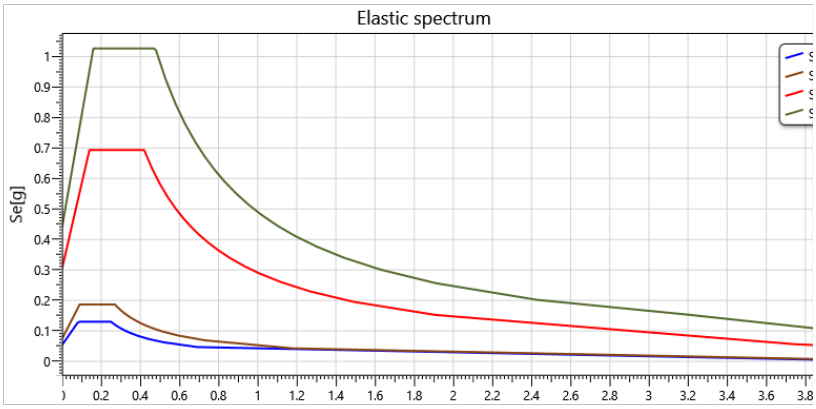
Horizontal elastic response spectra

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

η 1.00

ξ 5%

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



Design spectra ULS

To avoid explicit inelastic structural analysis in design, the capacity of the structure to dissipate energy, through mainly ductile behaviour 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 behaviour factor q.

The design spectrum for elastic analysis $S_d(T)$ can be calculated by substituting η with 1/q in formulas 3.2.4 NTC '08 where q is the behaviour factor.

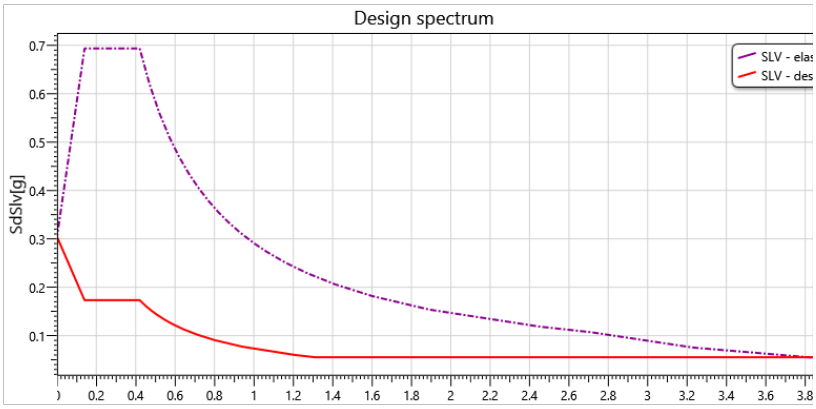
$$q = q_0 \cdot K_R$$

K_R is a reduction factor of the value of the behaviour factor q for buildings non-regular in elevation

Below are the parameters relating to the characteristics of the building:

Elevation Regularity:	Yes
K_R:	1.0
Ductility class:	Ductility class "A"
Structural typology:	Nailed wall panels - Tab. 7.7.I Nailed wall panels with nailed diaphragms, connected with nails and bolts - reduced values of q0
Base value of the behavior factor q_0:	4.00
Behaviour factor q:	4.00

The horizontal elastic response spectra and the horizontal design spectrum (Life Safety Limit State) are shown below.



Sections of the structural elements

Framed walls

Frame geometric characteristics

t: thickness of the frame

h_b: thickness of top and sole plates

$b_{s,int}$: width of the internal studs

$b_{s,ext}$: width of the external studs

i_m: average studs spacing

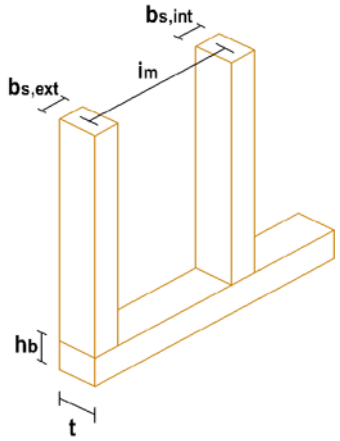


Figure: dimensions of the frame elements

Sheeting boards geometric characteristics

b_s: sheeting boards width

$s_{c,b}$: spacing of fasteners along the perimeter of every sheet

$s_{c,i}$: spacing of internal fasteners

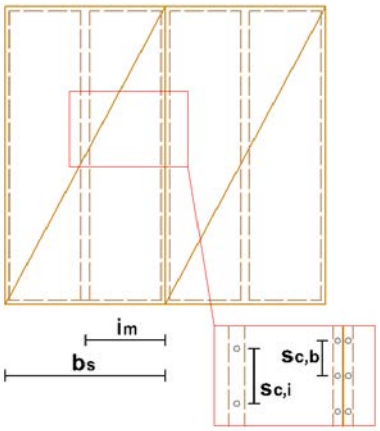


Figure: dimensions of the sheeting boards and fasteners spacing

In the first of the following tables are reported the characteristics of the frame of each wall, while in the second are reported the characteristics of the sheeting board.

Section name	# sides with sheeting board	Material	Frame thickness t [mm]	Thickness of top and sole plates h_b [mm]	Width of the internal studs $b_{s,int}$ [mm]	Width of the external studs $b_{s,ext}$ [mm]	Average studs spacing i_m [mm]
Framed wall - OSB - 2 sides	2	C 24	160	60	60	110	600
Framed wall - Gypsum-fibreboard - 1 side	1	C 24	160	100	100	100	625

Section name	Side	Material	Sheeting board thickness t_s [mm]	Sheeting boards width b_s [mm]	Frame-sheeting board fastener	Perimetric fasteners spacing $S_{c,b}$ [mm]	Internal fasteners spacing i $S_{c,i}$ [mm]
Framed wall - OSB - 2 sides	1	OSB/3	15	1200	RING HZ9 2,8/3,1 x 80	100	200
Framed wall - OSB - 2 sides	2	OSB/3	15	1200	RING HZ9 2,8/3,1 x 80	100	200
Framed wall - Gypsum-fibreboard - 1 side	1	Gypsum-fibreboard	15	1250	Staples G32 gypsum-fibreboard	75	150

Floors with timber joists

Elements geometric characteristics

h_b: Cross section height

b_b: Cross section width

i_b: Joists spacing

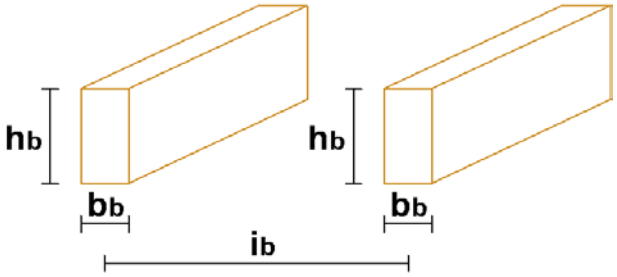


Figure: geometric characteristics of the floor

The following table sets out the details concerning the floor with joists.

Section name	Material	Cross section height h_b [mm]	Cross section width b_b [mm]	Joists spacing i_b [mm]
Joists floor 160x200	C 24	200	160	700

Glued laminated timber floor with vertical layers

Floor geometric characteristics

h_b: Floor thickness

b_b: Width of every element

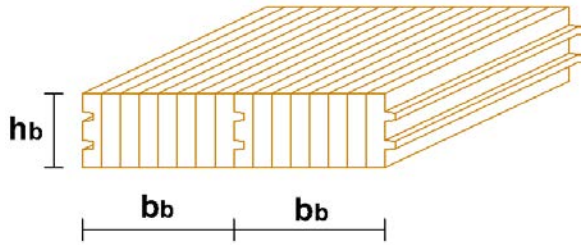


Figure: Floor geometric characteristics

The following table sets out the details concerning the glued laminated timber floors with vertical layers.

Section name	Material	Floor thickness h_b [mm]	Width of every element b_b [mm]
Solid wood floor	GL 24h	140	1000

Cross section of timber linear elements

The following table sets out the details concerning the cross section of every linear element.

Section name	Material	Width b [mm]	Height h [mm]	Area A [mm^2]	$J_{y\text{-}y}$ [mm^4]	$J_{z\text{-}z}$ [mm^4]
Section 160x240 Gl24h	GL 24h	160	240	38400	1.84E8	8.19E7
Sezione 120x180 GL24	GL 24h	120	180	21600	5.83E7	2.59E7

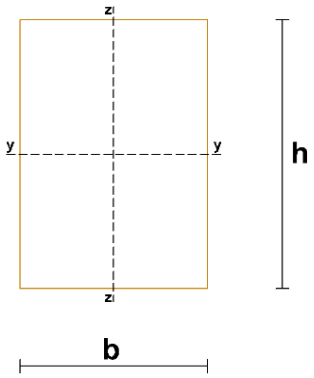


Figure: Geometric size of every timber cross section

Connections

Hold Down

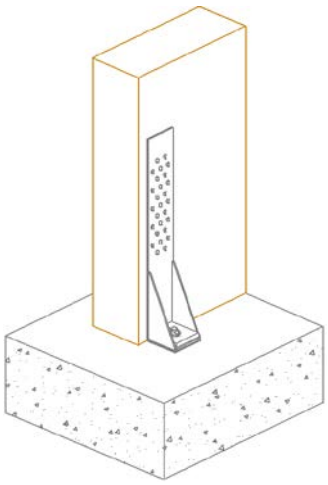


Figure: graphical representation of a hold-down in a base connection (timber wall – foundation connection)

Connection name	Connection position	Manufacturer	Description	Fasteners number	Fastener typology	Anchor	Type of anchor	Anchorage depth [mm]	Number of hold-down at each wall end
Ground connection - hold down - shear angle bracket	Ground connection	Rotho Blass	WHT 440	30	Chiodi Anker 4,0 X 40	M16 5.8	Resina vinilestere ETA-09/0078	160	1

Punched metal plate/Punched strap for tension force

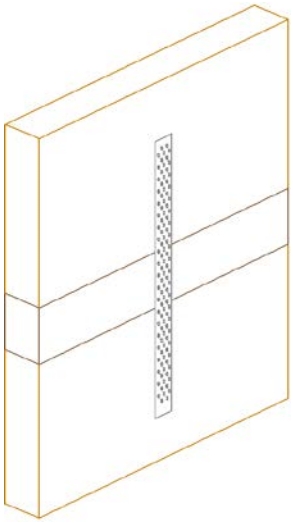


Figure: graphical representation of a punched strap

Connection name	Connection position	Manufacturer	Description	Width [mm]	Length [mm]	Thickness [mm]	Steel grade	Number of fasteners at each end	Fasteners typology	Number of connections at each wall end
Upper level connection - punched strap - metal plate	Upper level	Rotho Blaas	Metal plate80x300 sp. 2 mm	80	300	2	S250	7	ANKER 4,0 x 60	1
Upper level connection - punched strap - metal plate_A	Upper level	Rotho Blaas	Metal plate80x300 sp. 2 mm	80	300	2	S250	15	ANKER 4,0 x 60	1
Upper level connection - punched strap - metal plate_2piano	Upper level	Rotho Blaas	Metal plate80x300 sp. 2 mm	80	300	2	S250	7	ANKER 4,0 x 60	1

Punched metal plate/Punched strap for shear force

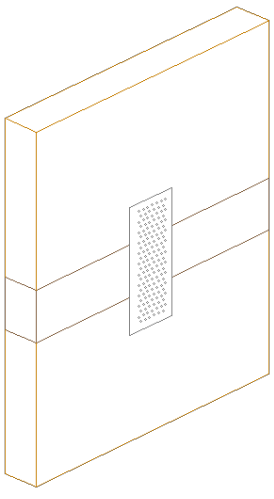


Figure: graphical representation of a punched metal plate

Connection name	Connection position	Manufacturer	Description	Width [mm]	Length [mm]	Thickness [mm]	Steel grade	Number of fasteners at each end	Fasteners typology	Metal paltes spacing i [mm]
Ground connection - hold down - shear angle bracket	Upper level	Rotho Blaas	Punched metal plate 120x200 th. 2 mm	120	200	2	S250	10	ANKER 4,0 x 40	500
Upper level connection - punched strap - metal plate	Upper level	Rotho Blaas	Punched metal plate 200x300 th. 2 mm	200	300	2	S250	15	ANKER 4,0 x 60	500
Upper level connection - punched strap - metal plate_A	Upper level	Rotho Blaas	Punched metal plate 200x300 th. 2 mm	200	300	2	S250	15	ANKER 4,0 x 60	500
Upper level connection - punched strap - metal plate_2piano	Upper level	Rotho Blaas	Punched metal plate 200x300 th. 2 mm	200	300	2	S250	10	ANKER 4,0 x 60	500

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.

Combination of actions for persistent or transient design situations (fundamental combination - ULS):

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

Combination of actions for seismic design situations E:

$$E + G_1 + G_2 + P + \psi_{21} \cdot Q_{k1} + \psi_{22} \cdot Q_{k2} + \cdots$$

being

G_1 permanent action: self weight

G_2 permanent actions

Q_1 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

The following are the values of the combination coefficients used.

Snow/wind loads

Load name	Description	Load-duration	ψ_0	ψ_1	ψ_2
Wind	Wind pressure	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

Variable actions

Recommended values of ψ factors for buildings

Category name	Description	Load-duration	ψ_0	ψ_1	ψ_2
Live load cat.A	Live load cat.A: domestic, residential areas	Medium-term	0,7	0,5	0,3
Live load cat.B	Live load cat.B: office areas	Medium-term	0,7	0,5	0,3
Live load cat.C	Live load cat.C: shopping areas	Medium-term	0,7	0,7	0,6
Live load cat.D	Live load cat.D: storage areas	Medium-term	0,7	0,7	0,6

Live load cat.E	Live load cat.E: Libraries, archives, warehouses and industrial areas	Long-term	1,0	0,9	0,8
Live load cat.F	Live load cat.F: traffic area, vehicle weight ≤ 30kN	Long-term	0,7	0,7	0,6
Live load cat.G	Live load cat.G: traffic area, vehicle weight > 30 kN	Long-term	0,7	0,5	0,3
Live load cat.H	Live load cat.H: roofs accessible only for maintenance	Medium-term	0	0	0
Live load cat.H2-A	Live load cat.H2-A: Practicable roofs of category A areas	Medium-term	0	0	0
Live load cat.H2-B	Live load cat.H2-B: Practicable roofs of category B areas	Medium-term	0	0	0
Live load cat.H2-C	Live load cat.H2-C: Practicable roofs of category C areas	Medium-term	0	0	0
Live load cat.H2-D	Live load cat.H2-D: Practicable roofs of category D areas	Medium-term	0	0	0
Live load cat.H2-E	Live load cat.H2-E: Practicable roofs of category E areas	Medium-term	0	0	0

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.

Nome	Durata	G1	G2	Variable cat.A	Orthogonal wind	Wind X	Wind Y	Seismic ULS X	Seismic ULS Y	Seismic SLS X	Seismic SLS Y
ULS 1	Permanent	1	0	0	0	0	0	0	0	0	0
ULS 2	Medium-term	1	0	1.5	0	0	0	0	0	0	0
ULS 3	Instantaneous	1	0	1.5	0.9	0	0	0	0	0	0
ULS 4	Instantaneous	1	0	0	1.5	0	0	0	0	0	0
ULS 5	Instantaneous	1	0	1.05	1.5	0	0	0	0	0	0
ULS 6	Permanent	1	1.5	0	0	0	0	0	0	0	0
ULS 7	Medium-term	1	1.5	1.5	0	0	0	0	0	0	0
ULS 8	Instantaneous	1	1.5	1.5	0.9	0	0	0	0	0	0
ULS 9	Instantaneous	1	1.5	0	1.5	0	0	0	0	0	0
ULS 10	Instantaneous	1	1.5	1.05	1.5	0	0	0	0	0	0
ULS 11	Permanent	1.3	0	0	0	0	0	0	0	0	0
ULS 12	Medium-term	1.3	0	1.5	0	0	0	0	0	0	0
ULS 13	Instantaneous	1.3	0	1.5	0.9	0	0	0	0	0	0
ULS 14	Instantaneous	1.3	0	0	1.5	0	0	0	0	0	0
ULS 15	Instantaneous	1.3	0	1.05	1.5	0	0	0	0	0	0
ULS 16	Permanent	1.3	1.5	0	0	0	0	0	0	0	0
ULS 17	Medium-term	1.3	1.5	1.5	0	0	0	0	0	0	0
ULS 18	Instantaneous	1.3	1.5	1.5	0.9	0	0	0	0	0	0
ULS 19	Instantaneous	1.3	1.5	0	1.5	0	0	0	0	0	0
ULS 20	Instantaneous	1.3	1.5	1.05	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.

Nome	Durata	G1	G2	Variable cat.A	Orthogonal wind	Wind X	Wind Y	Seismic ULS X	Seismic ULS Y	Seismic SLS X	Seismic SLS Y
Horizontal	Instantaneous	1	0	0	0	1.5	0	0	0	0	0

ULS 1											
Horizontal ULS 2	Instantaneous	1	0	0	0	0	1.5	0	0	0	0
Horizontal ULS 3	Instantaneous	1	0	0	0	-1.5	0	0	0	0	0
Horizontal ULS 4	Instantaneous	1	0	0	0	0	-1.5	0	0	0	0
Horizontal ULS 5	Instantaneous	1.3	1.5	0.7	0	1.5	0	0	0	0	0
Horizontal ULS 6	Instantaneous	1.3	1.5	0.7	0	0	1.5	0	0	0	0
Horizontal ULS 7	Instantaneous	1.3	1.5	0.7	0	-1.5	0	0	0	0	0
Horizontal ULS 8	Instantaneous	1.3	1.5	0.7	0	0	-1.5	0	0	0	0

Combination of actions for rare SLS

Nome	Durata	G1	G2	Variable cat.A	Orthogonal wind	Wind X	Wind Y	Seismic ULS X	Seismic ULS Y	Seismic SLS X	Seismic SLS Y
SLS characteristic 1	Permanent	1	1	0	0	0	0	0	0	0	0
SLS characteristic 2	Medium-term	1	1	1	0	0	0	0	0	0	0
SLS characteristic 3	Instantaneous	1	1	1	0.6	0	0	0	0	0	0
SLS characteristic 4	Instantaneous	1	1	0	1	0	0	0	0	0	0
SLS characteristic 5	Instantaneous	1	1	0.7	1	0	0	0	0	0	0

Seismic load combinations

The seismic load combination used are those proposed by Italian technical standards NTC ‘08.

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

$$1{,}00 \cdot E_x + 0{,}3 \cdot E_y$$

with rotation of the multipliers.

Combinations of actions for Life Safety Limit State (SLV)

Nome	Durata	G1	G2	Variable cat.A	Orthogonal wind	Wind X	Wind Y	Seismic ULS X	Seismic ULS Y	Seismic SLS X	Seismic SLS Y
Seismic ULS 1 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	1	0.3	0	0
Seismic ULS 1 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	1	0.3	0	0
Seismic ULS 1 ex- ey+	Instantaneous	1	1	0.3	0	0	0	1	0.3	0	0
Seismic ULS 1 ex- ey-	Instantaneous	1	1	0.3	0	0	0	1	0.3	0	0
Seismic ULS 2 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	1	-0.3	0	0
Seismic ULS 2 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	1	-0.3	0	0
Seismic ULS 2 ex- ey+	Instantaneous	1	1	0.3	0	0	0	1	-0.3	0	0
Seismic ULS 2 ex- ey-	Instantaneous	1	1	0.3	0	0	0	1	-0.3	0	0
Seismic ULS 3 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	-1	0.3	0	0
Seismic ULS 3 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	-1	0.3	0	0
Seismic ULS 3 ex- ey+	Instantaneous	1	1	0.3	0	0	0	-1	0.3	0	0
Seismic ULS 3 ex- ey-	Instantaneous	1	1	0.3	0	0	0	-1	0.3	0	0
Seismic ULS 4 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	-1	-0.3	0	0
Seismic ULS 4 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	-1	-0.3	0	0
Seismic ULS 4 ex- ey+	Instantaneous	1	1	0.3	0	0	0	-1	-0.3	0	0
Seismic ULS 4 ex- ey-	Instantaneous	1	1	0.3	0	0	0	-1	-0.3	0	0
Seismic ULS 5 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0.3	1	0	0
Seismic ULS 5 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0.3	1	0	0
Seismic ULS 5 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0.3	1	0	0
Seismic ULS 5 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0.3	1	0	0
Seismic ULS 6 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0.3	-1	0	0
Seismic ULS 6 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0.3	-1	0	0
Seismic ULS 6 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0.3	-1	0	0
Seismic ULS 6 ex-	Instantaneous	1	1	0.3	0	0	0	0.3	-1	0	0

ey-											
Seismic ULS 7 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	-0.3	1	0	0
Seismic ULS 7 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	-0.3	1	0	0
Seismic ULS 7 ex- ey+	Instantaneous	1	1	0.3	0	0	0	-0.3	1	0	0
Seismic ULS 7 ex- ey-	Instantaneous	1	1	0.3	0	0	0	-0.3	1	0	0
Seismic ULS 8 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	-0.3	-1	0	0
Seismic ULS 8 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	-0.3	-1	0	0
Seismic ULS 8 ex- ey+	Instantaneous	1	1	0.3	0	0	0	-0.3	-1	0	0
Seismic ULS 8 ex- ey-	Instantaneous	1	1	0.3	0	0	0	-0.3	-1	0	0

Combinations of actions for Damage Limit State (SLD)

Nome	Durata	G1	G2	Variable cat.A	Orthogonal wind	Wind X	Wind Y	Seismic ULS X	Seismic ULS Y	Seismic SLS X	Seismic SLS Y
Seismic SLS 1 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	1	0.3
Seismic SLS 1 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	1	0.3
Seismic SLS 1 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	1	0.3
Seismic SLS 1 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	1	0.3
Seismic SLS 2 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	1	-0.3
Seismic SLS 2 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	1	-0.3
Seismic SLS 2 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	1	-0.3
Seismic SLS 2 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	1	-0.3
Seismic SLS 3 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-1	0.3
Seismic SLS 3 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-1	0.3
Seismic SLS 3 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-1	0.3
Seismic SLS 3 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-1	0.3
Seismic SLS 4 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-1	-0.3
Seismic SLS 4 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-1	-0.3
Seismic SLS 4 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-1	-0.3
Seismic SLS 4 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-1	-0.3
Seismic SLS 5 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	1
Seismic SLS 5 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	1
Seismic SLS 5 ex- ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	1
Seismic SLS 5 ex- ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	1
Seismic SLS 6 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	-1
Seismic SLS 6 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	-1

Seismic SLS 6 ex-ey+	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	-1
Seismic SLS 6 ex-ey-	Instantaneous	1	1	0.3	0	0	0	0	0	0.3	-1
Seismic SLS 7 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	1
Seismic SLS 7 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	1
Seismic SLS 7 ex-ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	1
Seismic SLS 7 ex-ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	1
Seismic SLS 8 ex+ ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	-1
Seismic SLS 8 ex+ ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	-1
Seismic SLS 8 ex-ey+	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	-1
Seismic SLS 8 ex-ey-	Instantaneous	1	1	0.3	0	0	0	0	0	-0.3	-1

Horizontal actions

Seismic analysis

The analysis of the structure subject to seismic action is performed using linear equivalent static analysis which involves the application of equivalent static horizontal forces to all storeys.

For buildings with heights of up to 40 m the value of T1 (in s) may be approximated by the following expression:

$$T_1 = C_1 \cdot H^{\frac{3}{4}}$$

where:

H is the height of the building, in m, from the foundation or from the top of a rigid basement

C_1 is 0,05 as proposed by NTC '08 for structures different from moment resistant space steel frames, moment resistant space concrete frames and eccentrically braced steel frames.

The structure has a period T_1 equal to 0.23 s.

When the fundamental mode shape is approximated by horizontal displacements increasing linearly along the height, the horizontal forces Fi should be taken as being given by:

$$F_i = \frac{F_h \cdot z_i \cdot W_i}{\sum_j z_j \cdot W_j}$$

where:

$F_h = S_d(T_1) \cdot W \cdot \frac{\lambda}{g}$ is the base shear force

F_i is the horizontal force acting on storey i

W_i e W_j are the storey weights

z_i e z_j are the heights, with respect to the foundation, of the masses i and j

$S_d(T_1)$ is the ordinate of the design spectrum at period T_1

W is the total weight of the construction

λ is the correction factor, the value of which is equal to: λ = 0,85 if T1 < 2 T_C and the building has more than two storeys, or λ = 1,0 otherwise

g is the acceleration of gravity

The inertial effects of the design seismic action shall be evaluated by taking into account the presence of the masses associated with all gravity loads appearing in the following combination of actions:

$$G_1 + G_2 + \sum_j \psi_{2j} \cdot Q_{kj}$$

The base shear forces for SLD and SLV and the respective acceleration values are given below.

Ordinate of the design spectrum SLV Sd (T_1): 0.17 g

Total base shear force F_h SLV: 34.76 kN

Ordinate of the spectrum SLD Sd (T_1): 0.19 g

Total base shear force F_h SLD: 37.43 kN

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

Storey	Height above foundation zi [m]	xG [m]	yG [m]	Mass i [kg]	Fi,SLV [kN]	Fi,SLD [kN]
1	2.66	2.52	4.74	8903	6.97	7.51
2	5.32	2.51	4.80	7543	11.81	12.72
3	7.6	2.58	4.72	7143	15.98	17.21

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.

Storey	Height above foundation [m]	xG,wind [m]	yG,wind [m]	Fx [kN]	Fy [kN]
1	2.66	2.58	4.32	20.45	14.27
2	5.32	2.58	4.67	16.35	12.88
3	7.6	2.58	4.67	7.02	5.75

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)

Va: Shear force on the single connection

Ta: Tensile force on the single anchor

dr: Interstory drift

Load	Wall name	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]	Va [kN]	Ta [kN]	dr [mm]
G1	Wall 1	6.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 2	12.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 3	11.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 4	6.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 5	3.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 6	11.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 7	7.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 8	7.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 9	10.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 10	16.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 11	6.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 12	10.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 13	10.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 14	6.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 15	4.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 16	7.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 17	7.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 18	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 19	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 20	8.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 21	4.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 22	4.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 23	7.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 24	11.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 25	4.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 26	6.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 27	6.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 28	4.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 32	1.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 36	2.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 38	2.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 39	4.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 40	2.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 41	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 42	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 43	3.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 44	3.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 47	2.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 49	2.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00

G1	Wall 50	2.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G1	Wall 67	4.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 1	3.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 2	8.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 3	8.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 4	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 5	1.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 6	7.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 7	3.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 8	2.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 9	7.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 10	5.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 11	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 12	5.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 13	5.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 14	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 15	2.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 16	5.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 17	5.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 18	2.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 19	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 20	4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 21	2.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 22	1.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 23	4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 24	3.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 25	2.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 26	3.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 27	3.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 28	2.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 32	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 36	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 38	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 39	1.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 40	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 41	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 42	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 43	2.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 44	2.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 47	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 49	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 50	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G2	Wall 67	1.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 1	10.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 2	26.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 3	16.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 4	10.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 6	23.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 7	13.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 8	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 9	16.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 10	54.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 11	10.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 12	24.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 13	25.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 14	10.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 15	10.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 16	16.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 17	11.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 18	10.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 20	19.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 21	7.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 22	10.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 23	16.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 24	36.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 25	10.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 26	14.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 27	14.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 28	10.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 36	10.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Variable cat.A	Wall 38	10.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 39	16.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 40	10.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 41	5.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 42	17.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 43	6.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 44	6.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 47	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 49	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 50	10.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variable cat.A	Wall 67	16.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 1	0.00	0.00	1.53	1.02	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 2	0.00	0.00	2.97	1.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 3	0.00	0.00	2.97	1.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 4	0.00	0.00	1.47	0.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 6	0.00	0.00	2.76	1.84	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 9	0.00	0.00	2.76	1.84	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 11	0.00	0.00	1.47	0.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 12	0.00	0.00	2.19	1.46	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 13	0.00	0.00	2.19	1.46	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 14	0.00	0.00	1.47	0.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 15	0.00	0.00	1.53	1.02	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 16	0.00	0.00	2.97	1.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 17	0.00	0.00	2.97	1.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 18	0.00	0.00	1.47	0.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 20	0.00	0.00	2.76	1.84	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 23	0.00	0.00	2.76	1.84	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 25	0.00	0.00	1.47	0.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 26	0.00	0.00	2.19	1.46	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 27	0.00	0.00	2.19	1.46	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 28	0.00	0.00	1.47	0.98	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 36	0.00	0.00	0.71	0.23	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 38	0.00	0.00	0.74	0.24	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 39	0.00	0.00	1.33	0.43	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 40	0.00	0.00	0.71	0.23	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 43	0.00	0.00	2.03	0.92	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 44	0.00	0.00	1.95	0.85	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 47	0.00	0.00	1.34	0.55	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 49	0.00	0.00	1.38	0.57	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 50	0.00	0.00	0.71	0.23	0.00	0.00	0.00	0.00
Orthogonal wind	Wall 67	0.00	0.00	1.33	0.43	0.00	0.00	0.00	0.00

Wind X	Wall 1	0.00	0.35	0.00	0.00	1.27	0.00	0.00	0.22
Wind X	Wall 2	0.00	7.94	0.00	0.00	35.54	0.00	0.00	1.96
Wind X	Wall 3	0.00	7.94	0.00	0.00	35.51	0.00	0.00	1.96
Wind X	Wall 4	0.00	0.33	0.00	0.00	1.31	0.00	0.00	0.22
Wind X	Wall 5	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Wind X	Wall 6	0.00	0.78	0.00	0.00	3.35	0.00	0.00	0.22
Wind X	Wall 7	0.00	5.35	0.00	0.00	22.36	0.00	0.00	2.29
Wind X	Wall 8	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Wind X	Wall 9	0.00	0.78	0.00	0.00	3.59	0.00	0.00	0.22
Wind X	Wall 10	0.00	9.29	0.00	0.00	41.04	0.00	0.00	2.29
Wind X	Wall 11	0.00	0.33	0.00	0.00	1.20	0.00	0.00	0.22
Wind X	Wall 12	0.00	6.65	0.00	0.00	28.18	0.00	0.00	2.53
Wind X	Wall 13	0.00	6.65	0.00	0.00	28.17	0.00	0.00	2.53
Wind X	Wall 14	0.00	0.33	0.00	0.00	1.31	0.00	0.00	0.22
Wind X	Wall 15	0.00	0.11	0.00	0.00	0.34	0.00	0.00	0.22
Wind X	Wall 16	0.00	4.52	0.00	0.00	14.42	0.00	0.00	2.70
Wind X	Wall 17	0.00	4.52	0.00	0.00	14.40	0.00	0.00	2.70
Wind X	Wall 18	0.00	0.14	0.00	0.00	0.42	0.00	0.00	0.30
Wind X	Wall 19	0.00	0.02	0.00	0.00	0.05	0.00	0.00	0.04
Wind X	Wall 20	0.00	0.44	0.00	0.00	1.26	0.00	0.00	0.30
Wind X	Wall 21	0.00	2.52	0.00	0.00	8.13	0.00	0.00	3.10
Wind X	Wall 22	0.00	0.01	0.00	0.00	0.04	0.00	0.00	0.04
Wind X	Wall 23	0.00	0.54	0.00	0.00	1.52	0.00	0.00	0.22
Wind X	Wall 24	0.00	5.19	0.00	0.00	16.34	0.00	0.00	3.10
Wind X	Wall 25	0.00	0.11	0.00	0.00	0.32	0.00	0.00	0.22
Wind X	Wall 26	0.00	3.30	0.00	0.00	10.49	0.00	0.00	3.39
Wind X	Wall 27	0.00	3.30	0.00	0.00	10.48	0.00	0.00	3.39
Wind X	Wall 28	0.00	0.14	0.00	0.00	0.42	0.00	0.00	0.30
Wind X	Wall 32	0.00	0.90	0.00	0.00	1.42	0.00	0.00	0.64
Wind X	Wall 36	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.03
Wind X	Wall 38	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.03
Wind X	Wall 39	0.00	0.08	0.00	0.00	0.10	0.00	0.00	0.03
Wind X	Wall 40	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.03
Wind X	Wall 41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind X	Wall 42	0.00	1.39	0.00	0.00	2.52	0.00	0.00	0.64
Wind X	Wall 43	0.00	1.30	0.00	0.00	2.36	0.00	0.00	0.60
Wind X	Wall 44	0.00	1.37	0.00	0.00	2.38	0.00	0.00	0.60
Wind X	Wall 47	0.00	1.05	0.00	0.00	1.71	0.00	0.00	0.67
Wind X	Wall 49	0.00	1.02	0.00	0.00	1.70	0.00	0.00	0.67
Wind X	Wall 50	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.03
Wind X	Wall 67	0.00	0.08	0.00	0.00	0.10	0.00	0.00	0.03
Wind Y	Wall 1	0.00	3.24	0.00	0.00	13.01	0.00	0.00	2.02
Wind Y	Wall 2	0.00	0.02	0.00	0.00	1.00	0.00	0.00	0.00
Wind Y	Wall 3	0.00	0.02	0.00	0.00	1.00	0.00	0.00	0.00
Wind Y	Wall 4	0.00	3.10	0.00	0.00	12.84	0.00	0.00	2.03
Wind Y	Wall 5	0.00	3.14	0.00	0.00	11.99	0.00	0.00	2.03
Wind Y	Wall 6	0.00	7.28	0.00	0.00	32.99	0.00	0.00	2.03
Wind Y	Wall 7	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00
Wind Y	Wall 8	0.00	2.70	0.00	0.00	10.66	0.00	0.00	2.03
Wind Y	Wall 9	0.00	7.25	0.00	0.00	38.01	0.00	0.00	2.02
Wind Y	Wall 10	0.00	0.01	0.00	0.00	0.33	0.00	0.00	0.00
Wind Y	Wall 11	0.00	3.09	0.00	0.00	12.34	0.00	0.00	2.02
Wind Y	Wall 12	0.00	0.02	0.00	0.00	0.75	0.00	0.00	0.01
Wind Y	Wall 13	0.00	0.02	0.00	0.00	0.75	0.00	0.00	0.01
Wind Y	Wall 14	0.00	3.10	0.00	0.00	12.84	0.00	0.00	2.03
Wind Y	Wall 15	0.00	1.34	0.00	0.00	4.40	0.00	0.00	2.63
Wind Y	Wall 16	0.00	0.35	0.00	0.00	0.95	0.00	0.00	0.21
Wind Y	Wall 17	0.00	0.35	0.00	0.00	0.95	0.00	0.00	0.21
Wind Y	Wall 18	0.00	1.43	0.00	0.00	4.59	0.00	0.00	3.00
Wind Y	Wall 19	0.00	1.37	0.00	0.00	3.64	0.00	0.00	2.82
Wind Y	Wall 20	0.00	4.40	0.00	0.00	13.63	0.00	0.00	3.00
Wind Y	Wall 21	0.00	0.06	0.00	0.00	0.16	0.00	0.00	0.07
Wind Y	Wall 22	0.00	1.10	0.00	0.00	3.46	0.00	0.00	2.82
Wind Y	Wall 23	0.00	6.32	0.00	0.00	18.73	0.00	0.00	2.63
Wind Y	Wall 24	0.00	0.12	0.00	0.00	0.32	0.00	0.00	0.07
Wind Y	Wall 25	0.00	1.25	0.00	0.00	4.12	0.00	0.00	2.63
Wind Y	Wall 26	0.00	0.26	0.00	0.00	0.71	0.00	0.00	0.27
Wind Y	Wall 27	0.00	0.26	0.00	0.00	0.71	0.00	0.00	0.27
Wind Y	Wall 28	0.00	1.43	0.00	0.00	4.59	0.00	0.00	3.00
Wind Y	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Y	Wall 36	0.00	0.62	0.00	0.00	0.79	0.00	0.00	0.53
Wind Y	Wall 38	0.00	0.65	0.00	0.00	0.83	0.00	0.00	0.53
Wind Y	Wall 39	0.00	1.50	0.00	0.00	1.92	0.00	0.00	0.53
Wind Y	Wall 40	0.00	0.62	0.00	0.00	0.79	0.00	0.00	0.53

Wind Y	Wall 41	0.00	0.23	0.00	0.00	0.52	0.00	0.00	0.53
Wind Y	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Y	Wall 43	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Wind Y	Wall 44	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Wind Y	Wall 47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Y	Wall 49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Y	Wall 50	0.00	0.62	0.00	0.00	0.79	0.00	0.00	0.53
Wind Y	Wall 67	0.00	1.51	0.00	0.00	1.93	0.00	0.00	0.53
Seismic ULS X	Wall 1	0.00	0.13	0.00	0.00	0.71	0.00	0.00	0.08
Seismic ULS X	Wall 2	0.00	6.74	0.00	0.00	38.05	0.00	0.00	1.67
Seismic ULS X	Wall 3	0.00	6.74	0.00	0.00	38.00	0.00	0.00	1.67
Seismic ULS X	Wall 4	0.00	0.12	0.00	0.00	0.76	0.00	0.00	0.08
Seismic ULS X	Wall 5	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Seismic ULS X	Wall 6	0.00	0.29	0.00	0.00	2.06	0.00	0.00	0.08
Seismic ULS X	Wall 7	0.00	4.17	0.00	0.00	22.25	0.00	0.00	1.79
Seismic ULS X	Wall 8	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Seismic ULS X	Wall 9	0.00	0.29	0.00	0.00	2.30	0.00	0.00	0.08
Seismic ULS X	Wall 10	0.00	7.24	0.00	0.00	41.31	0.00	0.00	1.79
Seismic ULS X	Wall 11	0.00	0.12	0.00	0.00	0.67	0.00	0.00	0.08
Seismic ULS X	Wall 12	0.00	4.93	0.00	0.00	27.17	0.00	0.00	1.88
Seismic ULS X	Wall 13	0.00	4.93	0.00	0.00	27.14	0.00	0.00	1.88
Seismic ULS X	Wall 14	0.00	0.12	0.00	0.00	0.76	0.00	0.00	0.08
Seismic ULS X	Wall 15	0.00	0.11	0.00	0.00	0.36	0.00	0.00	0.21
Seismic ULS X	Wall 16	0.00	5.50	0.00	0.00	20.12	0.00	0.00	3.29
Seismic ULS X	Wall 17	0.00	5.50	0.00	0.00	20.07	0.00	0.00	3.29
Seismic ULS X	Wall 18	0.00	0.14	0.00	0.00	0.43	0.00	0.00	0.28
Seismic ULS X	Wall 19	0.00	0.02	0.00	0.00	0.05	0.00	0.00	0.04
Seismic ULS X	Wall 20	0.00	0.42	0.00	0.00	1.28	0.00	0.00	0.28
Seismic ULS X	Wall 21	0.00	2.98	0.00	0.00	11.16	0.00	0.00	3.66
Seismic ULS X	Wall 22	0.00	0.01	0.00	0.00	0.04	0.00	0.00	0.04
Seismic ULS X	Wall 23	0.00	0.51	0.00	0.00	1.53	0.00	0.00	0.21
Seismic ULS X	Wall 24	0.00	6.14	0.00	0.00	22.05	0.00	0.00	3.66
Seismic ULS X	Wall 25	0.00	0.10	0.00	0.00	0.34	0.00	0.00	0.21
Seismic ULS X	Wall 26	0.00	3.84	0.00	0.00	14.04	0.00	0.00	3.93
Seismic ULS X	Wall 27	0.00	3.84	0.00	0.00	14.02	0.00	0.00	3.93
Seismic ULS X	Wall 28	0.00	0.14	0.00	0.00	0.43	0.00	0.00	0.28
Seismic ULS X	Wall 32	0.00	2.03	0.00	0.00	3.23	0.00	0.00	1.46
Seismic ULS X	Wall 36	0.00	0.06	0.00	0.00	0.07	0.00	0.00	0.05
Seismic ULS X	Wall 38	0.00	0.06	0.00	0.00	0.08	0.00	0.00	0.05
Seismic ULS X	Wall 39	0.00	0.14	0.00	0.00	0.17	0.00	0.00	0.05
Seismic ULS X	Wall 40	0.00	0.06	0.00	0.00	0.07	0.00	0.00	0.05
Seismic ULS X	Wall 41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seismic ULS X	Wall 42	0.00	3.16	0.00	0.00	5.73	0.00	0.00	1.46
Seismic ULS X	Wall 43	0.00	3.00	0.00	0.00	5.44	0.00	0.00	1.39
Seismic ULS X	Wall 44	0.00	3.15	0.00	0.00	5.49	0.00	0.00	1.39
Seismic ULS X	Wall 47	0.00	2.36	0.00	0.00	3.84	0.00	0.00	1.51
Seismic ULS X	Wall 49	0.00	2.29	0.00	0.00	3.82	0.00	0.00	1.51
Seismic ULS X	Wall 50	0.00	0.06	0.00	0.00	0.07	0.00	0.00	0.05
Seismic ULS X	Wall 67	0.00	0.14	0.00	0.00	0.18	0.00	0.00	0.05
Seismic ULS Y	Wall 1	0.00	3.44	0.00	0.00	16.81	0.00	0.00	2.15
Seismic ULS Y	Wall 2	0.00	0.05	0.00	0.00	1.16	0.00	0.00	0.01

Seismic ULS Y	Wall 3	0.00	0.05	0.00	0.00	1.16	0.00	0.00	0.01
Seismic ULS Y	Wall 4	0.00	3.25	0.00	0.00	16.49	0.00	0.00	2.13
Seismic ULS Y	Wall 5	0.00	3.32	0.00	0.00	14.25	0.00	0.00	2.14
Seismic ULS Y	Wall 6	0.00	7.64	0.00	0.00	43.02	0.00	0.00	2.13
Seismic ULS Y	Wall 7	0.00	0.01	0.00	0.00	0.19	0.00	0.00	0.00
Seismic ULS Y	Wall 8	0.00	2.86	0.00	0.00	13.43	0.00	0.00	2.14
Seismic ULS Y	Wall 9	0.00	7.71	0.00	0.00	51.04	0.00	0.00	2.15
Seismic ULS Y	Wall 10	0.00	0.01	0.00	0.00	0.40	0.00	0.00	0.00
Seismic ULS Y	Wall 11	0.00	3.28	0.00	0.00	15.93	0.00	0.00	2.15
Seismic ULS Y	Wall 12	0.00	0.04	0.00	0.00	0.87	0.00	0.00	0.01
Seismic ULS Y	Wall 13	0.00	0.04	0.00	0.00	0.87	0.00	0.00	0.01
Seismic ULS Y	Wall 14	0.00	3.25	0.00	0.00	16.49	0.00	0.00	2.13
Seismic ULS Y	Wall 15	0.00	2.01	0.00	0.00	7.66	0.00	0.00	3.94
Seismic ULS Y	Wall 16	0.00	0.48	0.00	0.00	1.29	0.00	0.00	0.29
Seismic ULS Y	Wall 17	0.00	0.48	0.00	0.00	1.29	0.00	0.00	0.29
Seismic ULS Y	Wall 18	0.00	2.12	0.00	0.00	7.83	0.00	0.00	4.45
Seismic ULS Y	Wall 19	0.00	2.04	0.00	0.00	5.42	0.00	0.00	4.19
Seismic ULS Y	Wall 20	0.00	6.52	0.00	0.00	22.70	0.00	0.00	4.45
Seismic ULS Y	Wall 21	0.00	0.08	0.00	0.00	0.21	0.00	0.00	0.10
Seismic ULS Y	Wall 22	0.00	1.64	0.00	0.00	5.83	0.00	0.00	4.19
Seismic ULS Y	Wall 23	0.00	9.47	0.00	0.00	30.53	0.00	0.00	3.94
Seismic ULS Y	Wall 24	0.00	0.16	0.00	0.00	0.44	0.00	0.00	0.10
Seismic ULS Y	Wall 25	0.00	1.88	0.00	0.00	7.19	0.00	0.00	3.94
Seismic ULS Y	Wall 26	0.00	0.36	0.00	0.00	0.97	0.00	0.00	0.37
Seismic ULS Y	Wall 27	0.00	0.36	0.00	0.00	0.97	0.00	0.00	0.37
Seismic ULS Y	Wall 28	0.00	2.12	0.00	0.00	7.83	0.00	0.00	4.45
Seismic ULS Y	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seismic ULS Y	Wall 36	0.00	1.72	0.00	0.00	2.20	0.00	0.00	1.47
Seismic ULS Y	Wall 38	0.00	1.81	0.00	0.00	2.31	0.00	0.00	1.46
Seismic ULS Y	Wall 39	0.00	4.18	0.00	0.00	5.35	0.00	0.00	1.46
Seismic ULS Y	Wall 40	0.00	1.72	0.00	0.00	2.20	0.00	0.00	1.46
Seismic ULS Y	Wall 41	0.00	0.64	0.00	0.00	1.46	0.00	0.00	1.47
Seismic ULS Y	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seismic ULS Y	Wall 43	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Seismic ULS Y	Wall 44	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Seismic ULS Y	Wall 47	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Seismic ULS Y	Wall 49	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Seismic ULS Y	Wall 50	0.00	1.72	0.00	0.00	2.20	0.00	0.00	1.47
Seismic ULS Y	Wall 67	0.00	4.19	0.00	0.00	5.37	0.00	0.00	1.47
Seismic SLS X	Wall 1	0.00	0.14	0.00	0.00	0.76	0.00	0.00	0.09
Seismic SLS X	Wall 2	0.00	7.26	0.00	0.00	40.97	0.00	0.00	1.79
Seismic SLS X	Wall 3	0.00	7.26	0.00	0.00	40.92	0.00	0.00	1.79
Seismic SLS X	Wall 4	0.00	0.13	0.00	0.00	0.82	0.00	0.00	0.09
Seismic SLS X	Wall 5	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Seismic SLS X	Wall 6	0.00	0.31	0.00	0.00	2.22	0.00	0.00	0.09
Seismic SLS X	Wall 7	0.00	4.49	0.00	0.00	23.96	0.00	0.00	1.93
Seismic SLS X	Wall 8	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Seismic SLS X	Wall 9	0.00	0.31	0.00	0.00	2.47	0.00	0.00	0.09
Seismic SLS X	Wall 10	0.00	7.80	0.00	0.00	44.49	0.00	0.00	1.93

Seismic SLS X	Wall 11	0.00	0.13	0.00	0.00	0.72	0.00	0.00	0.09
Seismic SLS X	Wall 12	0.00	5.31	0.00	0.00	29.26	0.00	0.00	2.02
Seismic SLS X	Wall 13	0.00	5.31	0.00	0.00	29.23	0.00	0.00	2.02
Seismic SLS X	Wall 14	0.00	0.13	0.00	0.00	0.82	0.00	0.00	0.09
Seismic SLS X	Wall 15	0.00	0.12	0.00	0.00	0.39	0.00	0.00	0.23
Seismic SLS X	Wall 16	0.00	5.92	0.00	0.00	21.67	0.00	0.00	3.54
Seismic SLS X	Wall 17	0.00	5.92	0.00	0.00	21.62	0.00	0.00	3.54
Seismic SLS X	Wall 18	0.00	0.15	0.00	0.00	0.46	0.00	0.00	0.31
Seismic SLS X	Wall 19	0.00	0.02	0.00	0.00	0.05	0.00	0.00	0.04
Seismic SLS X	Wall 20	0.00	0.45	0.00	0.00	1.38	0.00	0.00	0.31
Seismic SLS X	Wall 21	0.00	3.21	0.00	0.00	12.01	0.00	0.00	3.95
Seismic SLS X	Wall 22	0.00	0.02	0.00	0.00	0.04	0.00	0.00	0.04
Seismic SLS X	Wall 23	0.00	0.55	0.00	0.00	1.65	0.00	0.00	0.23
Seismic SLS X	Wall 24	0.00	6.61	0.00	0.00	23.75	0.00	0.00	3.95
Seismic SLS X	Wall 25	0.00	0.11	0.00	0.00	0.37	0.00	0.00	0.23
Seismic SLS X	Wall 26	0.00	4.13	0.00	0.00	15.13	0.00	0.00	4.24
Seismic SLS X	Wall 27	0.00	4.13	0.00	0.00	15.10	0.00	0.00	4.24
Seismic SLS X	Wall 28	0.00	0.15	0.00	0.00	0.46	0.00	0.00	0.31
Seismic SLS X	Wall 32	0.00	2.19	0.00	0.00	3.48	0.00	0.00	1.57
Seismic SLS X	Wall 36	0.00	0.06	0.00	0.00	0.08	0.00	0.00	0.05
Seismic SLS X	Wall 38	0.00	0.06	0.00	0.00	0.08	0.00	0.00	0.05
Seismic SLS X	Wall 39	0.00	0.15	0.00	0.00	0.19	0.00	0.00	0.05
Seismic SLS X	Wall 40	0.00	0.06	0.00	0.00	0.08	0.00	0.00	0.05
Seismic SLS X	Wall 41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seismic SLS X	Wall 42	0.00	3.40	0.00	0.00	6.17	0.00	0.00	1.57
Seismic SLS X	Wall 43	0.00	3.23	0.00	0.00	5.86	0.00	0.00	1.49
Seismic SLS X	Wall 44	0.00	3.39	0.00	0.00	5.91	0.00	0.00	1.49
Seismic SLS X	Wall 47	0.00	2.54	0.00	0.00	4.14	0.00	0.00	1.63
Seismic SLS X	Wall 49	0.00	2.46	0.00	0.00	4.11	0.00	0.00	1.63
Seismic SLS X	Wall 50	0.00	0.06	0.00	0.00	0.08	0.00	0.00	0.05
Seismic SLS X	Wall 67	0.00	0.15	0.00	0.00	0.19	0.00	0.00	0.05
Seismic SLS Y	Wall 1	0.00	3.71	0.00	0.00	18.11	0.00	0.00	2.32
Seismic SLS Y	Wall 2	0.00	0.05	0.00	0.00	1.25	0.00	0.00	0.01
Seismic SLS Y	Wall 3	0.00	0.05	0.00	0.00	1.25	0.00	0.00	0.01
Seismic SLS Y	Wall 4	0.00	3.51	0.00	0.00	17.76	0.00	0.00	2.29
Seismic SLS Y	Wall 5	0.00	3.57	0.00	0.00	15.34	0.00	0.00	2.30
Seismic SLS Y	Wall 6	0.00	8.22	0.00	0.00	46.33	0.00	0.00	2.29
Seismic SLS Y	Wall 7	0.00	0.01	0.00	0.00	0.21	0.00	0.00	0.00
Seismic SLS Y	Wall 8	0.00	3.08	0.00	0.00	14.47	0.00	0.00	2.30
Seismic SLS Y	Wall 9	0.00	8.30	0.00	0.00	54.97	0.00	0.00	2.32
Seismic SLS Y	Wall 10	0.00	0.01	0.00	0.00	0.43	0.00	0.00	0.00
Seismic SLS Y	Wall 11	0.00	3.54	0.00	0.00	17.15	0.00	0.00	2.32
Seismic SLS Y	Wall 12	0.00	0.04	0.00	0.00	0.94	0.00	0.00	0.02
Seismic SLS Y	Wall 13	0.00	0.04	0.00	0.00	0.94	0.00	0.00	0.02
Seismic SLS Y	Wall 14	0.00	3.51	0.00	0.00	17.76	0.00	0.00	2.29
Seismic SLS Y	Wall 15	0.00	2.16	0.00	0.00	8.25	0.00	0.00	4.25
Seismic SLS Y	Wall 16	0.00	0.52	0.00	0.00	1.39	0.00	0.00	0.31
Seismic SLS Y	Wall 17	0.00	0.52	0.00	0.00	1.39	0.00	0.00	0.31
Seismic SLS Y	Wall 18	0.00	2.28	0.00	0.00	8.43	0.00	0.00	4.79

Seismic SLS Y	Wall 19	0.00	2.20	0.00	0.00	5.84	0.00	0.00	4.52
Seismic SLS Y	Wall 20	0.00	7.02	0.00	0.00	24.45	0.00	0.00	4.79
Seismic SLS Y	Wall 21	0.00	0.08	0.00	0.00	0.23	0.00	0.00	0.10
Seismic SLS Y	Wall 22	0.00	1.77	0.00	0.00	6.28	0.00	0.00	4.52
Seismic SLS Y	Wall 23	0.00	10.20	0.00	0.00	32.89	0.00	0.00	4.25
Seismic SLS Y	Wall 24	0.00	0.17	0.00	0.00	0.47	0.00	0.00	0.10
Seismic SLS Y	Wall 25	0.00	2.02	0.00	0.00	7.74	0.00	0.00	4.25
Seismic SLS Y	Wall 26	0.00	0.39	0.00	0.00	1.04	0.00	0.00	0.40
Seismic SLS Y	Wall 27	0.00	0.39	0.00	0.00	1.04	0.00	0.00	0.40
Seismic SLS Y	Wall 28	0.00	2.28	0.00	0.00	8.43	0.00	0.00	4.79
Seismic SLS Y	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seismic SLS Y	Wall 36	0.00	1.85	0.00	0.00	2.37	0.00	0.00	1.58
Seismic SLS Y	Wall 38	0.00	1.94	0.00	0.00	2.49	0.00	0.00	1.58
Seismic SLS Y	Wall 39	0.00	4.50	0.00	0.00	5.76	0.00	0.00	1.58
Seismic SLS Y	Wall 40	0.00	1.85	0.00	0.00	2.36	0.00	0.00	1.58
Seismic SLS Y	Wall 41	0.00	0.69	0.00	0.00	1.57	0.00	0.00	1.58
Seismic SLS Y	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seismic SLS Y	Wall 43	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Seismic SLS Y	Wall 44	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Seismic SLS Y	Wall 47	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Seismic SLS Y	Wall 49	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Seismic SLS Y	Wall 50	0.00	1.85	0.00	0.00	2.37	0.00	0.00	1.58
Seismic SLS Y	Wall 67	0.00	4.52	0.00	0.00	5.78	0.00	0.00	1.58

Columns

Column name: Column ID

N: Total axial force

Load	Column name	N [kN]
G1	Column 1	2.39
G2	Column 1	0.00
Variable cat.A	Column 1	10.28
Orthogonal wind	Column 1	0.00
Wind X	Column 1	0.00
Wind Y	Column 1	0.00
Seismic ULS X	Column 1	0.00
Seismic ULS Y	Column 1	0.00
Seismic SLS X	Column 1	0.00
Seismic SLS Y	Column 1	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 2	0.32	0.19	0.13
G1	Floor 9	0.38	0.27	0.08
G1	Floor 14	0.37	0.37	0.51
G1	Floor 16	0.37	0.37	0.51
G1	Floor 18	0.27	0.13	-0.06
G1	Floor 19	0.27	0.14	-0.06
G1	Floor 21	0.25	0.11	0.05
G1	Floor 22	0.25	0.11	0.05
G2	Floor 2	0.00	0.00	0.00
G2	Floor 9	0.00	0.00	0.00
G2	Floor 14	0.00	0.00	0.00
G2	Floor 16	0.00	0.00	0.00
G2	Floor 18	0.00	0.00	0.00
G2	Floor 19	0.00	0.00	0.00
G2	Floor 21	0.00	0.00	0.00
G2	Floor 22	0.00	0.00	0.00
Variable cat.A	Floor 2	2.38	1.37	0.96
Variable cat.A	Floor 9	2.78	1.96	0.61
Variable cat.A	Floor 14	2.75	2.73	3.79
Variable cat.A	Floor 16	2.75	2.73	3.79
Variable cat.A	Floor 18	1.98	1.00	-0.42
Variable cat.A	Floor 19	1.99	1.01	-0.42
Variable cat.A	Floor 21	1.84	0.83	0.35
Variable cat.A	Floor 22	1.84	0.83	0.35
Orthogonal wind	Floor 2	0.00	0.00	0.00
Orthogonal wind	Floor 9	0.00	0.00	0.00
Orthogonal wind	Floor 14	0.00	0.00	0.00
Orthogonal wind	Floor 16	0.00	0.00	0.00
Orthogonal wind	Floor 18	0.00	0.00	0.00
Orthogonal wind	Floor 19	0.00	0.00	0.00
Orthogonal wind	Floor 21	0.00	0.00	0.00
Orthogonal wind	Floor 22	0.00	0.00	0.00
Wind X	Floor 2	0.00	0.00	0.00
Wind X	Floor 9	0.00	0.00	0.00
Wind X	Floor 14	0.00	0.00	0.00
Wind X	Floor 16	0.00	0.00	0.00
Wind X	Floor 18	0.00	0.00	0.00
Wind X	Floor 19	0.00	0.00	0.00
Wind X	Floor 21	0.00	0.00	0.00
Wind X	Floor 22	0.00	0.00	0.00
Wind Y	Floor 2	0.00	0.00	0.00
Wind Y	Floor 9	0.00	0.00	0.00
Wind Y	Floor 14	0.00	0.00	0.00
Wind Y	Floor 16	0.00	0.00	0.00
Wind Y	Floor 18	0.00	0.00	0.00
Wind Y	Floor 19	0.00	0.00	0.00
Wind Y	Floor 21	0.00	0.00	0.00
Wind Y	Floor 22	0.00	0.00	0.00
Seismic ULS X	Floor 2	0.00	0.00	0.00
Seismic ULS X	Floor 9	0.00	0.00	0.00
Seismic ULS X	Floor 14	0.00	0.00	0.00
Seismic ULS X	Floor 16	0.00	0.00	0.00
Seismic ULS X	Floor 18	0.00	0.00	0.00

Seismic ULS X	Floor 19	0.00	0.00	0.00
Seismic ULS X	Floor 21	0.00	0.00	0.00
Seismic ULS X	Floor 22	0.00	0.00	0.00
Seismic ULS Y	Floor 2	0.00	0.00	0.00
Seismic ULS Y	Floor 9	0.00	0.00	0.00
Seismic ULS Y	Floor 14	0.00	0.00	0.00
Seismic ULS Y	Floor 16	0.00	0.00	0.00
Seismic ULS Y	Floor 18	0.00	0.00	0.00
Seismic ULS Y	Floor 19	0.00	0.00	0.00
Seismic ULS Y	Floor 21	0.00	0.00	0.00
Seismic ULS Y	Floor 22	0.00	0.00	0.00
Seismic SLS X	Floor 2	0.00	0.00	0.00
Seismic SLS X	Floor 9	0.00	0.00	0.00
Seismic SLS X	Floor 14	0.00	0.00	0.00
Seismic SLS X	Floor 16	0.00	0.00	0.00
Seismic SLS X	Floor 18	0.00	0.00	0.00
Seismic SLS X	Floor 19	0.00	0.00	0.00
Seismic SLS X	Floor 21	0.00	0.00	0.00
Seismic SLS X	Floor 22	0.00	0.00	0.00
Seismic SLS Y	Floor 2	0.00	0.00	0.00
Seismic SLS Y	Floor 9	0.00	0.00	0.00
Seismic SLS Y	Floor 14	0.00	0.00	0.00
Seismic SLS Y	Floor 16	0.00	0.00	0.00
Seismic SLS Y	Floor 18	0.00	0.00	0.00
Seismic SLS Y	Floor 19	0.00	0.00	0.00
Seismic SLS Y	Floor 21	0.00	0.00	0.00
Seismic SLS Y	Floor 22	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	0.78	0.23	0.06
G1	Beam 2	0.38	0.08	0.01
G1	Beam 4	0.89	0.50	0.50
G1	Beam 6	0.38	0.08	0.01
G1	Beam 8	0.89	0.50	0.50
G1	Beam 17	0.06	0.01	0.00
G1	Beam 20	0.71	0.29	0.02
G1	Beam 21	1.73	0.64	-0.08
G1	Beam 22	0.71	0.29	0.02
G1	Beam 33	1.56	0.93	0.07
G2	Beam 1	0.00	0.00	0.00
G2	Beam 2	0.00	0.00	0.00
G2	Beam 4	0.00	0.00	0.00
G2	Beam 6	0.00	0.00	0.00
G2	Beam 8	0.00	0.00	0.00
G2	Beam 17	0.00	0.00	0.00
G2	Beam 20	0.00	0.00	0.00
G2	Beam 21	0.00	0.00	0.00
G2	Beam 22	0.00	0.00	0.00
G2	Beam 33	0.00	0.00	0.00
Variable cat.A	Beam 1	5.11	1.49	0.41
Variable cat.A	Beam 2	2.39	0.48	0.06

Variable cat.A	Beam 4	5.33	2.89	2.90
Variable cat.A	Beam 6	2.39	0.51	0.06
Variable cat.A	Beam 8	5.33	2.89	2.90
Variable cat.A	Beam 17	0.00	0.00	0.00
Variable cat.A	Beam 20	3.92	1.57	0.12
Variable cat.A	Beam 21	9.54	3.51	-0.41
Variable cat.A	Beam 22	3.92	1.57	0.12
Variable cat.A	Beam 33	6.71	4.03	0.29
Orthogonal wind	Beam 1	0.00	0.00	0.00
Orthogonal wind	Beam 2	0.00	0.00	0.00
Orthogonal wind	Beam 4	0.00	0.00	0.00
Orthogonal wind	Beam 6	0.00	0.00	0.00
Orthogonal wind	Beam 8	0.00	0.00	0.00
Orthogonal wind	Beam 17	0.00	0.00	0.00
Orthogonal wind	Beam 20	0.00	0.00	0.00
Orthogonal wind	Beam 21	0.00	0.00	0.00
Orthogonal wind	Beam 22	0.00	0.00	0.00
Orthogonal wind	Beam 33	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 4	0.00	0.00	0.00
Wind X	Beam 6	0.00	0.00	0.00
Wind X	Beam 8	0.00	0.00	0.00
Wind X	Beam 17	0.00	0.00	0.00
Wind X	Beam 20	0.00	0.00	0.00
Wind X	Beam 21	0.00	0.00	0.00
Wind X	Beam 22	0.00	0.00	0.00
Wind X	Beam 33	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 4	0.00	0.00	0.00
Wind Y	Beam 6	0.00	0.00	0.00
Wind Y	Beam 8	0.00	0.00	0.00
Wind Y	Beam 17	0.00	0.00	0.00
Wind Y	Beam 20	0.00	0.00	0.00
Wind Y	Beam 21	0.00	0.00	0.00
Wind Y	Beam 22	0.00	0.00	0.00
Wind Y	Beam 33	0.00	0.00	0.00
Seismic ULS X	Beam 1	0.00	0.00	0.00
Seismic ULS X	Beam 2	0.00	0.00	0.00
Seismic ULS X	Beam 4	0.00	0.00	0.00
Seismic ULS X	Beam 6	0.00	0.00	0.00
Seismic ULS X	Beam 8	0.00	0.00	0.00
Seismic ULS X	Beam 17	0.00	0.00	0.00
Seismic ULS X	Beam 20	0.00	0.00	0.00
Seismic ULS X	Beam 21	0.00	0.00	0.00
Seismic ULS X	Beam 22	0.00	0.00	0.00
Seismic ULS X	Beam 33	0.00	0.00	0.00
Seismic ULS Y	Beam 1	0.00	0.00	0.00
Seismic ULS Y	Beam 2	0.00	0.00	0.00
Seismic ULS Y	Beam 4	0.00	0.00	0.00
Seismic ULS Y	Beam 6	0.00	0.00	0.00
Seismic ULS Y	Beam 8	0.00	0.00	0.00
Seismic ULS Y	Beam 17	0.00	0.00	0.00
Seismic ULS Y	Beam 20	0.00	0.00	0.00
Seismic ULS Y	Beam 21	0.00	0.00	0.00
Seismic ULS Y	Beam 22	0.00	0.00	0.00
Seismic ULS Y	Beam 33	0.00	0.00	0.00
Seismic SLS X	Beam 1	0.00	0.00	0.00
Seismic SLS X	Beam 2	0.00	0.00	0.00
Seismic SLS X	Beam 4	0.00	0.00	0.00
Seismic SLS X	Beam 6	0.00	0.00	0.00
Seismic SLS X	Beam 8	0.00	0.00	0.00
Seismic SLS X	Beam 17	0.00	0.00	0.00
Seismic SLS X	Beam 20	0.00	0.00	0.00
Seismic SLS X	Beam 21	0.00	0.00	0.00
Seismic SLS X	Beam 22	0.00	0.00	0.00
Seismic SLS X	Beam 33	0.00	0.00	0.00
Seismic SLS Y	Beam 1	0.00	0.00	0.00
Seismic SLS Y	Beam 2	0.00	0.00	0.00
Seismic SLS Y	Beam 4	0.00	0.00	0.00

Seismic SLS Y	Beam 6	0.00	0.00	0.00
Seismic SLS Y	Beam 8	0.00	0.00	0.00
Seismic SLS Y	Beam 17	0.00	0.00	0.00
Seismic SLS Y	Beam 20	0.00	0.00	0.00
Seismic SLS Y	Beam 21	0.00	0.00	0.00
Seismic SLS Y	Beam 22	0.00	0.00	0.00
Seismic SLS Y	Beam 33	0.00	0.00	0.00

Forces and moments acting on foundations

In this chapter are reported the values of actions acting at the base of the walls and columns of the ground floor. They refer to the ULS combination that maximizes the axial loads and to 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	1.33	ULS 17	29.90	0.00	0.00	0.00	0.00
		G1	6.27	0.00	0.00	0.00	0.00
		G2	3.95	0.00	0.00	0.00	0.00
		Variable cat.A	10.55	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	1.53	1.02	0.00
		Wind X	0.00	0.35	0.00	0.00	1.27
		Wind Y	0.00	3.24	0.00	0.00	13.01
		Seismic ULS X	0.00	0.13	0.00	0.00	0.71
		Seismic ULS Y	0.00	3.44	0.00	0.00	16.81
		Seismic SLS X	0.00	0.14	0.00	0.00	0.76
		Seismic SLS Y	0.00	3.71	0.00	0.00	18.11
Wall 2	2.58	ULS 17	68.81	0.00	0.00	0.00	0.00
		G1	12.47	0.00	0.00	0.00	0.00
		G2	8.24	0.00	0.00	0.00	0.00
		Variable cat.A	26.83	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	2.97	1.98	0.00
		Wind X	0.00	7.94	0.00	0.00	35.54
		Wind Y	0.00	0.02	0.00	0.00	1.00
		Seismic ULS X	0.00	6.74	0.00	0.00	38.05
		Seismic ULS Y	0.00	0.05	0.00	0.00	1.16
		Seismic SLS X	0.00	7.26	0.00	0.00	40.97
		Seismic SLS Y	0.00	0.05	0.00	0.00	1.25
Wall 3	2.58	ULS 17	51.54	0.00	0.00	0.00	0.00
		G1	11.04	0.00	0.00	0.00	0.00
		G2	8.25	0.00	0.00	0.00	0.00
		Variable cat.A	16.54	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	2.97	1.98	0.00
		Wind X	0.00	7.94	0.00	0.00	35.51
		Wind Y	0.00	0.02	0.00	0.00	1.00
		Seismic ULS X	0.00	6.74	0.00	0.00	38.00
		Seismic ULS Y	0.00	0.05	0.00	0.00	1.16
		Seismic SLS X	0.00	7.26	0.00	0.00	40.92
		Seismic SLS Y	0.00	0.05	0.00	0.00	1.25
Wall 4	1.28	ULS 17	29.34	0.00	0.00	0.00	0.00
		G1	6.15	0.00	0.00	0.00	0.00
		G2	3.80	0.00	0.00	0.00	0.00
		Variable cat.A	10.43	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	1.47	0.98	0.00
		Wind X	0.00	0.33	0.00	0.00	1.31
		Wind Y	0.00	3.10	0.00	0.00	12.84
		Seismic ULS X	0.00	0.12	0.00	0.00	0.76
		Seismic ULS Y	0.00	3.25	0.00	0.00	16.49
		Seismic SLS X	0.00	0.13	0.00	0.00	0.82
		Seismic SLS Y	0.00	3.51	0.00	0.00	17.76
Wall 5	1.30	ULS 16	7.31	0.00	0.00	0.00	0.00
		G1	3.33	0.00	0.00	0.00	0.00
		G2	1.98	0.00	0.00	0.00	0.00
		Variable cat.A	0.00	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	0.00	0.00	0.00
		Wind X	0.00	0.00	0.00	0.00	0.05
		Wind Y	0.00	3.14	0.00	0.00	11.99
		Seismic ULS X	0.00	0.00	0.00	0.00	0.05
		Seismic ULS Y	0.00	3.32	0.00	0.00	14.25
		Seismic SLS X	0.00	0.00	0.00	0.00	0.05

		Seismic SLS Y	0.00	3.57	0.00	0.00	15.34
Wall 6	2.40	ULS 17	60.75	0.00	0.00	0.00	0.00
		G1	11.63	0.00	0.00	0.00	0.00
		G2	7.13	0.00	0.00	0.00	0.00
		Variable cat.A	23.29	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	2.76	1.84	0.00
		Wind X	0.00	0.78	0.00	0.00	3.35
		Wind Y	0.00	7.28	0.00	0.00	32.99
		Seismic ULS X	0.00	0.29	0.00	0.00	2.06
		Seismic ULS Y	0.00	7.64	0.00	0.00	43.02
		Seismic SLS X	0.00	0.31	0.00	0.00	2.22
		Seismic SLS Y	0.00	8.22	0.00	0.00	46.33
Wall 7	1.72	ULS 17	35.85	0.00	0.00	0.00	0.00
		G1	7.78	0.00	0.00	0.00	0.00
		G2	3.42	0.00	0.00	0.00	0.00
		Variable cat.A	13.74	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	0.00	0.00	0.00
		Wind X	0.00	5.35	0.00	0.00	22.36
		Wind Y	0.00	0.00	0.00	0.00	0.16
		Seismic ULS X	0.00	4.17	0.00	0.00	22.25
		Seismic ULS Y	0.00	0.01	0.00	0.00	0.19
		Seismic SLS X	0.00	4.49	0.00	0.00	23.96
		Seismic SLS Y	0.00	0.01	0.00	0.00	0.21
Wall 8	1.15	ULS 17	37.25	0.00	0.00	0.00	0.00
		G1	7.28	0.00	0.00	0.00	0.00
		G2	2.52	0.00	0.00	0.00	0.00
		Variable cat.A	16.00	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	0.00	0.00	0.00
		Wind X	0.00	0.00	0.00	0.00	0.04
		Wind Y	0.00	2.70	0.00	0.00	10.66
		Seismic ULS X	0.00	0.00	0.00	0.00	0.04
		Seismic ULS Y	0.00	2.86	0.00	0.00	13.43
		Seismic SLS X	0.00	0.00	0.00	0.00	0.04
		Seismic SLS Y	0.00	3.08	0.00	0.00	14.47
Wall 9	2.40	ULS 17	48.05	0.00	0.00	0.00	0.00
		G1	10.25	0.00	0.00	0.00	0.00
		G2	7.13	0.00	0.00	0.00	0.00
		Variable cat.A	16.02	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	2.76	1.84	0.00
		Wind X	0.00	0.78	0.00	0.00	3.59
		Wind Y	0.00	7.25	0.00	0.00	38.01
		Seismic ULS X	0.00	0.29	0.00	0.00	2.30
		Seismic ULS Y	0.00	7.71	0.00	0.00	51.04
		Seismic SLS X	0.00	0.31	0.00	0.00	2.47
		Seismic SLS Y	0.00	8.30	0.00	0.00	54.97
Wall 10	2.58	ULS 17	111.51	0.00	0.00	0.00	0.00
		G1	16.79	0.00	0.00	0.00	0.00
		G2	5.28	0.00	0.00	0.00	0.00
		Variable cat.A	54.52	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	0.00	0.00	0.00
		Wind X	0.00	9.29	0.00	0.00	41.04
		Wind Y	0.00	0.01	0.00	0.00	0.33
		Seismic ULS X	0.00	7.24	0.00	0.00	41.31
		Seismic ULS Y	0.00	0.01	0.00	0.00	0.40
		Seismic SLS X	0.00	7.80	0.00	0.00	44.49
		Seismic SLS Y	0.00	0.01	0.00	0.00	0.43
Wall 11	1.28	ULS 17	29.29	0.00	0.00	0.00	0.00
		G1	6.15	0.00	0.00	0.00	0.00
		G2	3.80	0.00	0.00	0.00	0.00
		Variable cat.A	10.40	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	1.47	0.98	0.00
		Wind X	0.00	0.33	0.00	0.00	1.20
		Wind Y	0.00	3.09	0.00	0.00	12.34
		Seismic ULS X	0.00	0.12	0.00	0.00	0.67
		Seismic ULS Y	0.00	3.28	0.00	0.00	15.93
		Seismic SLS X	0.00	0.13	0.00	0.00	0.72
		Seismic SLS Y	0.00	3.54	0.00	0.00	17.15
Wall 12	1.91	ULS 17	58.52	0.00	0.00	0.00	0.00
		G1	10.31	0.00	0.00	0.00	0.00
		G2	5.97	0.00	0.00	0.00	0.00
		Variable cat.A	24.11	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	2.19	1.46	0.00
		Wind X	0.00	6.65	0.00	0.00	28.18
		Wind Y	0.00	0.02	0.00	0.00	0.75
		Seismic ULS X	0.00	4.93	0.00	0.00	27.17
		Seismic ULS Y	0.00	0.04	0.00	0.00	0.87
		Seismic SLS X	0.00	5.31	0.00	0.00	29.26
		Seismic SLS Y	0.00	0.04	0.00	0.00	0.94
Wall 13	1.91	ULS 17	60.98	0.00	0.00	0.00	0.00
		G1	10.50	0.00	0.00	0.00	0.00
		G2	5.97	0.00	0.00	0.00	0.00
		Variable cat.A	25.58	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	2.19	1.46	0.00
		Wind X	0.00	6.65	0.00	0.00	28.17
		Wind Y	0.00	0.02	0.00	0.00	0.75
		Seismic ULS X	0.00	4.93	0.00	0.00	27.14
		Seismic ULS Y	0.00	0.04	0.00	0.00	0.87
		Seismic SLS X	0.00	5.31	0.00	0.00	29.23

		Seismic SLS Y	0.00	0.04	0.00	0.00	0.94
Wall 14	1.28	ULS 17	29.37	0.00	0.00	0.00	0.00
		G1	6.21	0.00	0.00	0.00	0.00
		G2	3.80	0.00	0.00	0.00	0.00
		Variable cat.A	10.40	0.00	0.00	0.00	0.00
		Orthogonal wind	0.00	0.00	1.47	0.98	0.00
		Wind X	0.00	0.33	0.00	0.00	1.31
		Wind Y	0.00	3.10	0.00	0.00	12.84
		Seismic ULS X	0.00	0.12	0.00	0.00	0.76
		Seismic ULS Y	0.00	3.25	0.00	0.00	16.49
		Seismic SLS X	0.00	0.13	0.00	0.00	0.82
		Seismic SLS Y	0.00	3.51	0.00	0.00	17.76

Design of the structural elements

Joist floors / Glued laminated timber floors

Bending strength

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

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

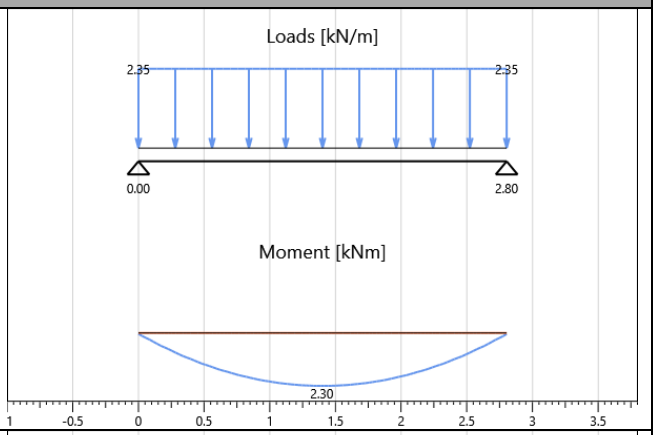
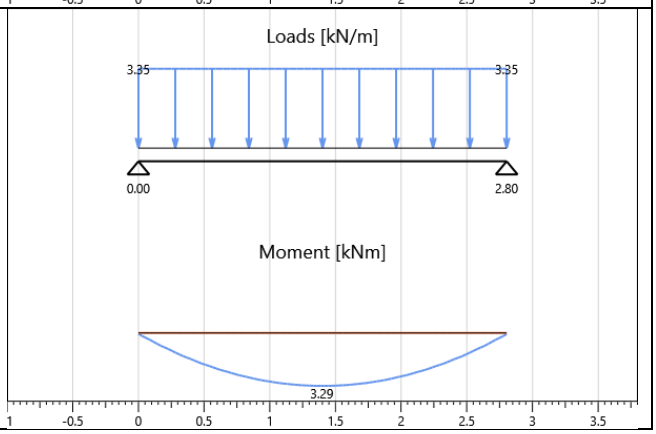
where:

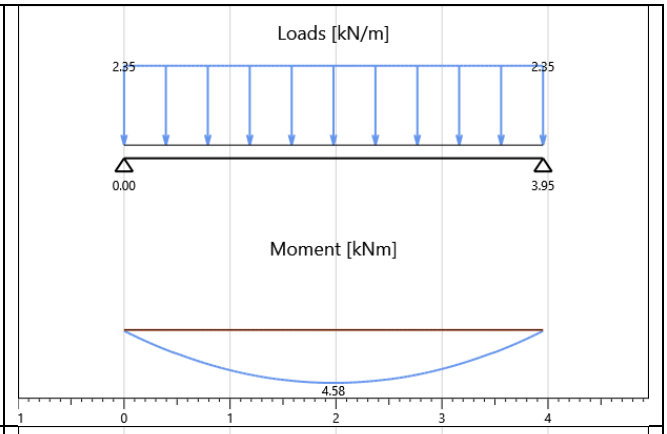
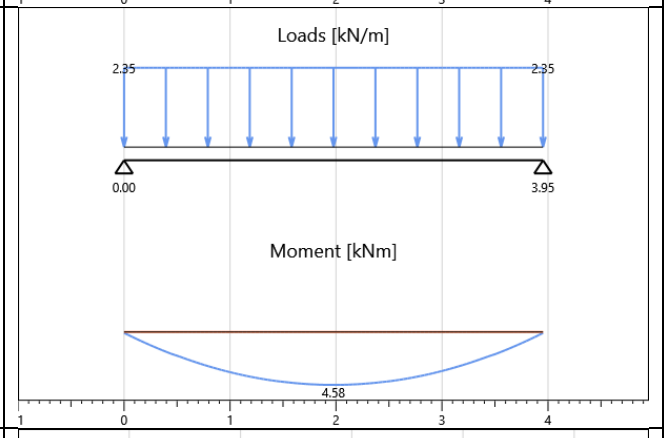
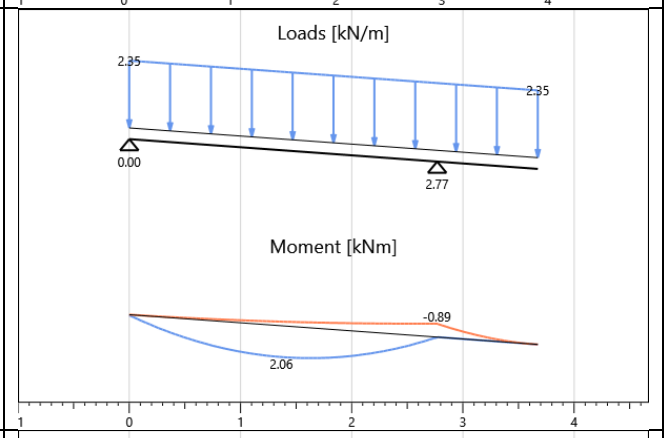
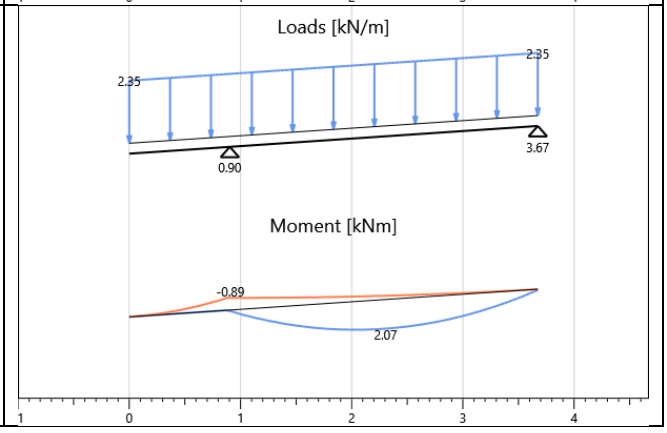
$\sigma_{m,d}$ is the design bending stress

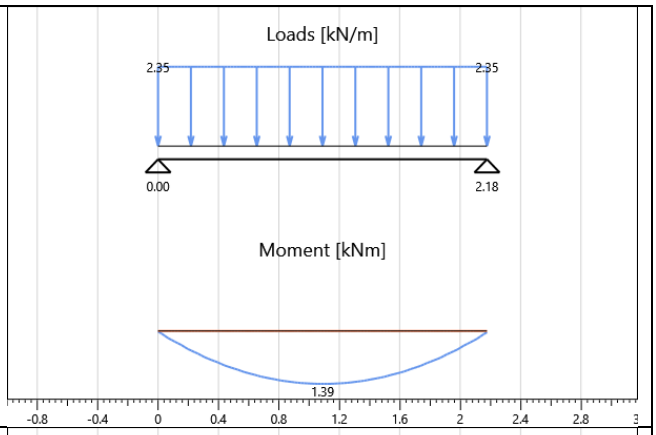
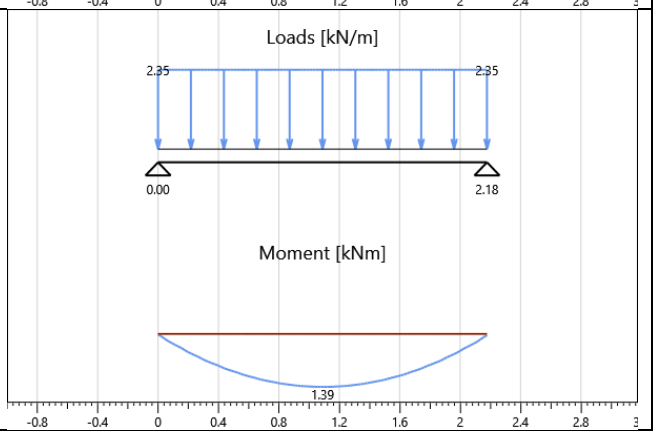
$f_{m,d}$ is the design bending strength

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

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.

Floor name	Combination	Duration	Diagram M_{3-3}
Floor 2	ULS 12	Medium-term	
Floor 9	ULS 12	Medium-term	

Floor 14	ULS 12	Medium-term	
Floor 16	ULS 12	Medium-term	
Floor 18	ULS 12	Medium-term	
Floor 19	ULS 12	Medium-term	

Floor 21	ULS 12	Medium-term	
Floor 22	ULS 12	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	$M_{3\text{-}3\ max}$ [kNm]	W [mm^3]	k_{crit}	Comb.	k_{mod}	γ_M	$f_{m,d}$ [MPa]	$\sigma_{m,d}$ [MPa]	Check
Floor 2	Joists floor 160x200	2.30	1066667	1.00	ULS 12	0.8	1.5	12.80	2.16	17%
Floor 9	Solid wood floor	3.29	3266667	1.00	ULS 12	0.8	1.45	13.24	1.01	8%
Floor 14	Joists floor 160x200	4.58	1066667	1.00	ULS 12	0.8	1.5	12.80	4.29	34%
Floor 16	Joists floor 160x200	4.58	1066667	1.00	ULS 12	0.8	1.5	12.80	4.29	34%
Floor 18	Joists floor 160x200	2.06	1066667	1.00	ULS 12	0.8	1.5	12.80	1.93	15%
Floor 19	Joists floor 160x200	2.07	1066667	1.00	ULS 12	0.8	1.5	12.80	1.94	15%
Floor 21	Joists floor 160x200	1.39	1066667	1.00	ULS 12	0.8	1.5	12.80	1.30	10%
Floor 22	Joists floor 160x200	1.39	1066667	1.00	ULS 12	0.8	1.5	12.80	1.30	10%

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 of the member.

The following value of k_{cr} are used

k_{cr} = 0.67 for solid timber

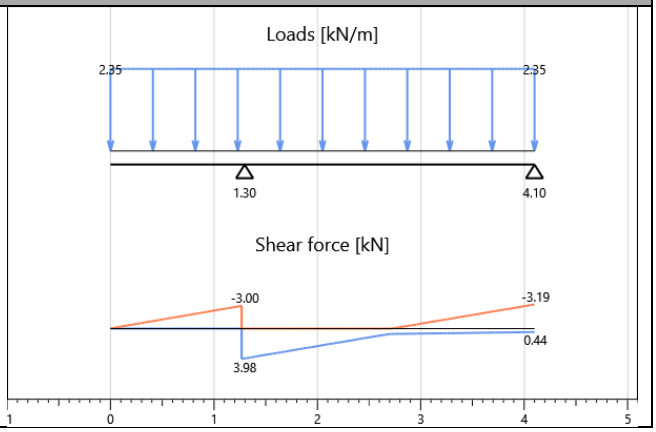
k_{cr} = 0.67 for glued laminated timber

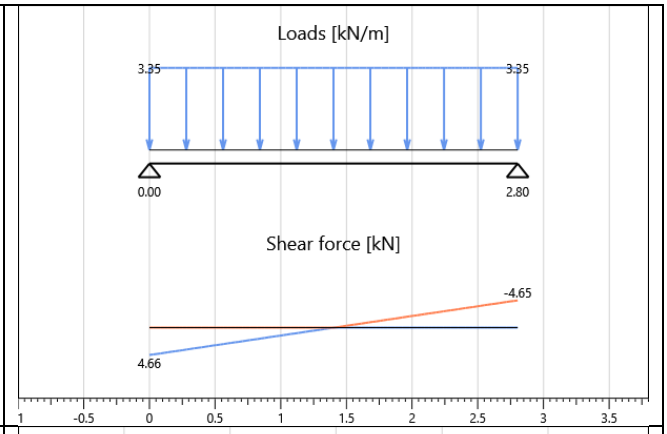
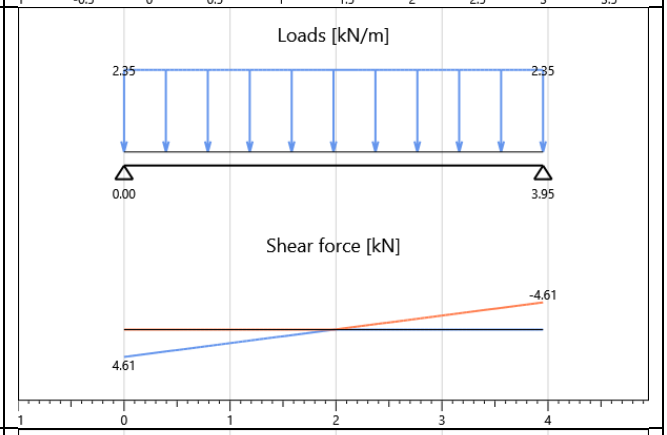
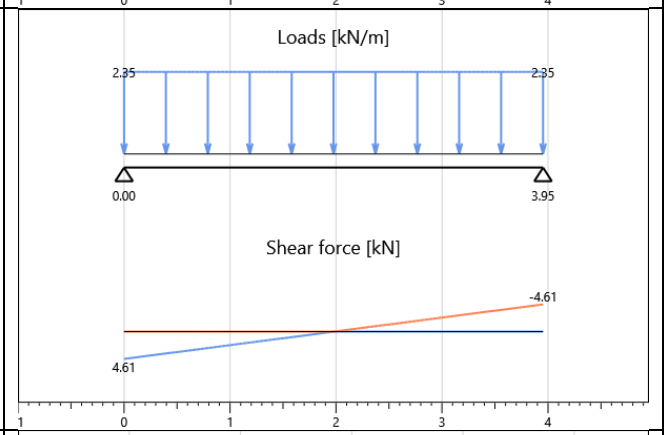
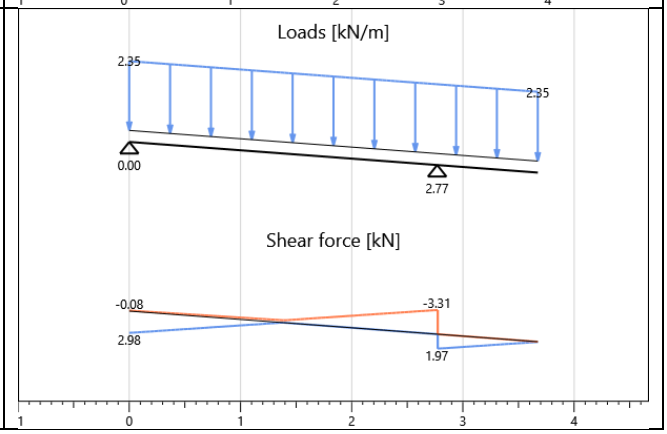
The maximum design shear stress in a rectangular cross section can be evaluated using the following expression:

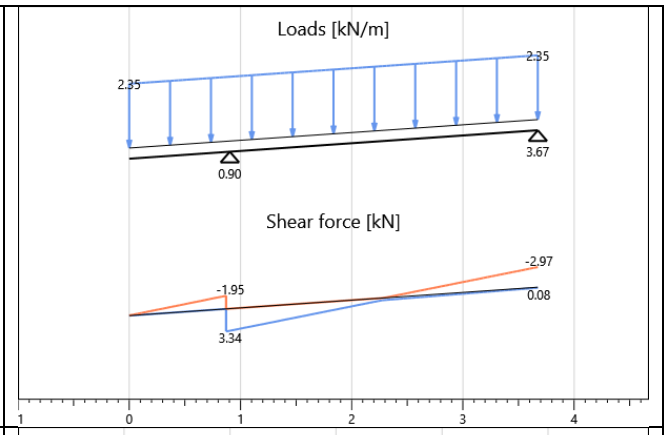
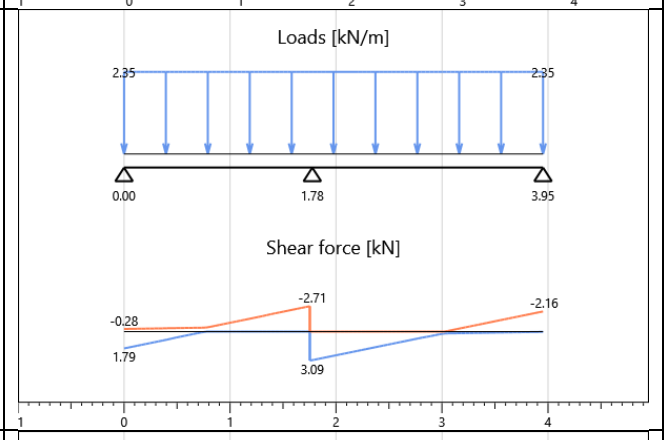
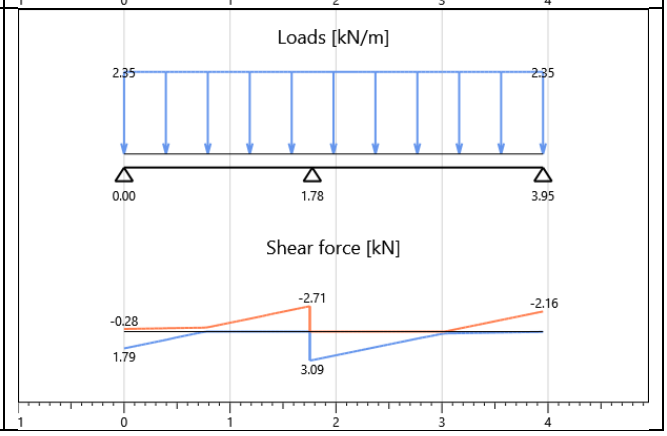
$$\tau_d = \frac{3}{2} \cdot \frac{V_d}{k_{cr} \cdot A}$$

where A is the area of a joist cross section.

The following table illustrates the structural schemes and the envelopes of the shear force diagram for the joist of each floor where the checks are more severe.

Floor name	Combination	Duration	Diagram V_2
Floor 2	ULS 12	Medium-term	

Floor 9	ULS 12	Medium-term	
Floor 14	ULS 12	Medium-term	
Floor 16	ULS 12	Medium-term	
Floor 18	ULS 12	Medium-term	

Floor 19	ULS 12	Medium-term	
Floor 21	ULS 12	Medium-term	
Floor 22	ULS 12	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	$V_{2\ max}$ [kN]	Area [mm^2]	k_{cr}	Comb.	k_{mod}	γ_M	$f_{v,d}$ [MPa]	$\tau_{2,d}$ [MPa]	Check
Floor 2	Joists floor 160x200	3.98	32000	0.67	ULS 12	0.8	1.5	2.13	0.28	13%
Floor 9	Solid wood floor	4.66	140000	0.67	ULS 12	0.8	1.45	1.93	0.07	4%
Floor 14	Joists floor 160x200	4.61	32000	0.67	ULS 12	0.8	1.5	2.13	0.32	15%
Floor 16	Joists floor 160x200	4.61	32000	0.67	ULS 12	0.8	1.5	2.13	0.32	15%
Floor 18	Joists floor 160x200	3.31	32000	0.67	ULS 12	0.8	1.5	2.13	0.23	11%

Floor 19	Joists floor 160x200	3.34	32000	0.67	ULS 12	0.8	1.5	2.13	0.23	11%
Floor 21	Joists floor 160x200	3.09	32000	0.67	ULS 12	0.8	1.5	2.13	0.22	10%
Floor 22	Joists floor 160x200	3.09	32000	0.67	ULS 12	0.8	1.5	2.13	0.22	10%

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:

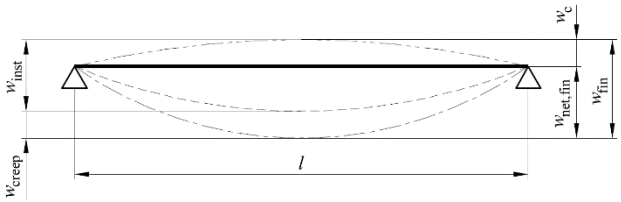
$w_{net,fin}$ is the net final deflection

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



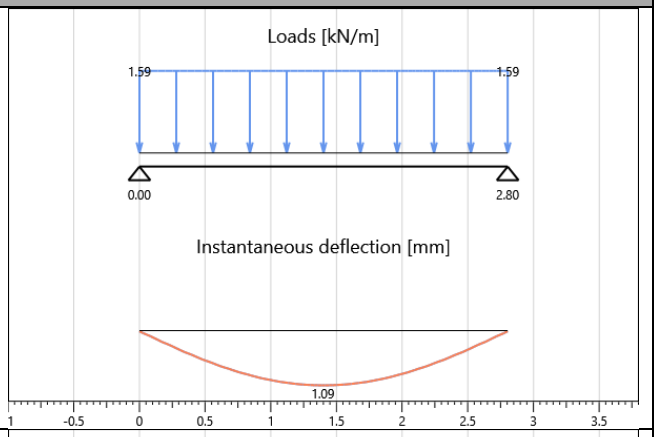
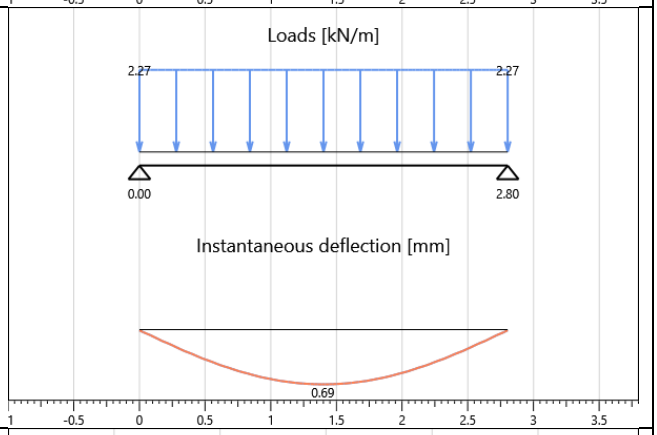
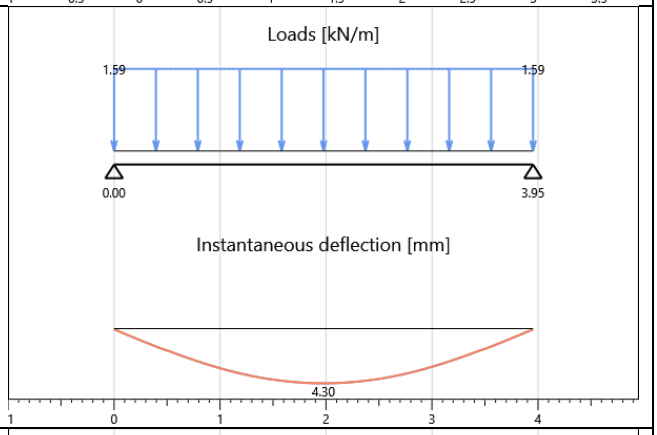
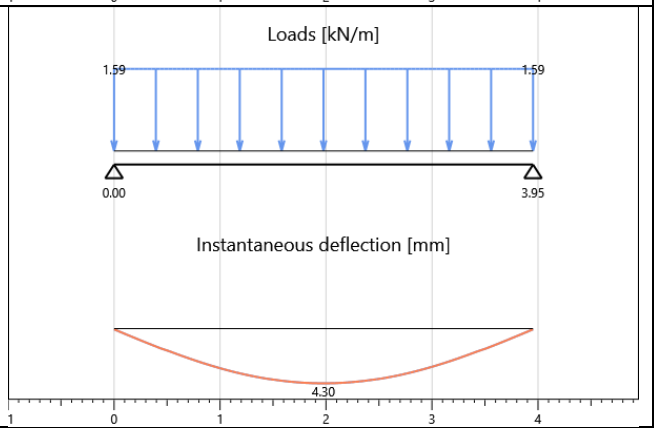
The limiting values for deflections of floors are assumed as shown in the following table.

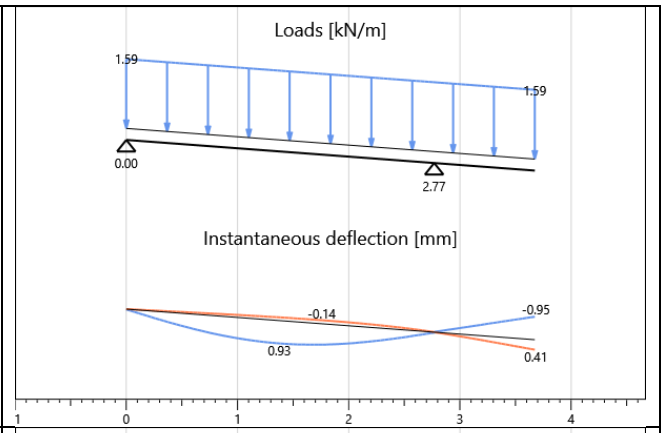
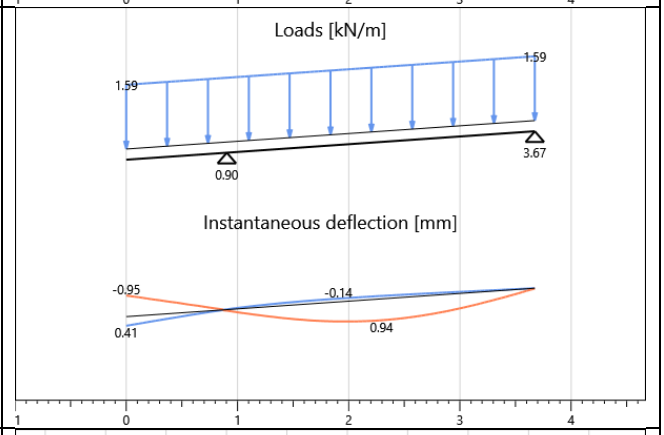
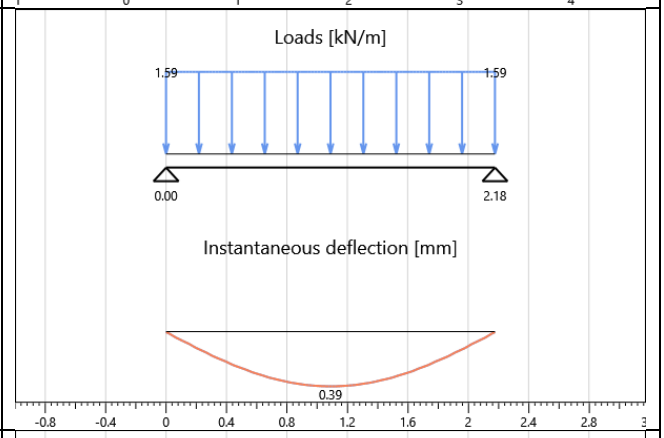
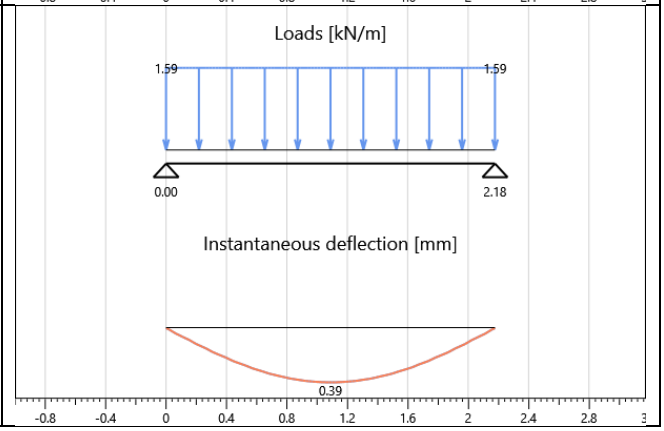
	w_{inst}	$w_{net,fin}$
Beam on two supports	l/300	l/250
Cantilevering beams	l/150	l/125

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 more severe).

Floor name	Combination	Instantaneous deflection
Floor 2	SLS characteristic 2	
Floor 9	SLS characteristic 2	
Floor 14	SLS characteristic 2	
Floor 16	SLS characteristic 2	

Floor 18	SLS characteristic 2	
Floor 19	SLS characteristic 2	
Floor 21	SLS characteristic 2	
Floor 22	SLS characteristic 2	

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

Floor name	Combination	More restrictive check	w_{inst} [mm]	$w_{inst\ limit}$ [mm]	Check
Floor 2	SLS characteristic 2	Overhang	1.64	8.64	19%
Floor 9	SLS characteristic 2	Internal span	0.69	9.34	7%
Floor 14	SLS characteristic 2	Internal span	4.30	13.18	33%
Floor 16	SLS characteristic 2	Internal span	4.30	13.18	33%
Floor 18	SLS characteristic 2	Overhang	-0.95	6.03	16%
Floor 19	SLS characteristic 2	Overhang	-0.95	6.03	16%
Floor 21	SLS characteristic 2	Internal span	0.39	7.26	5%
Floor 22	SLS characteristic 2	Internal span	0.39	7.26	5%

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:

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

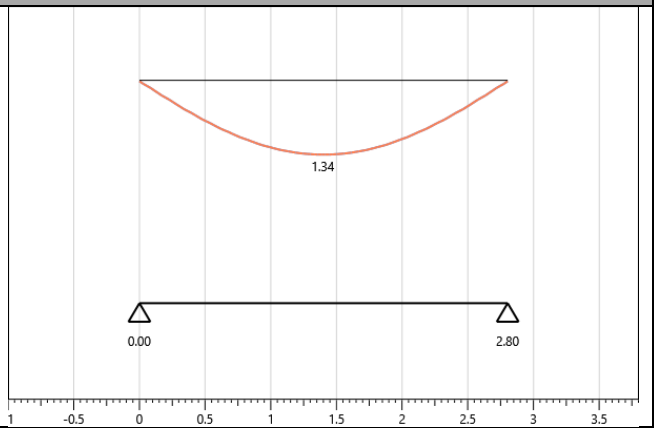
where:

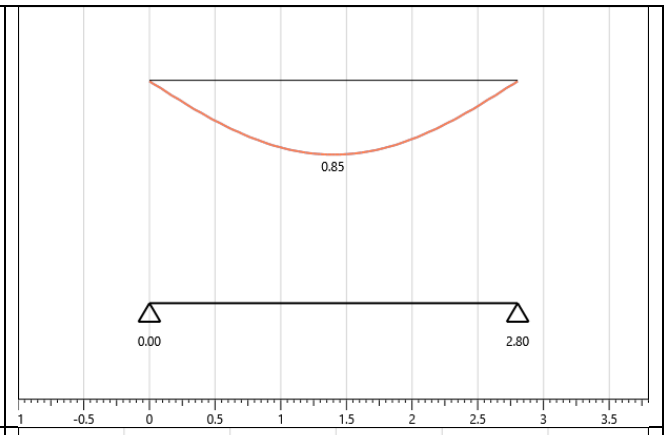
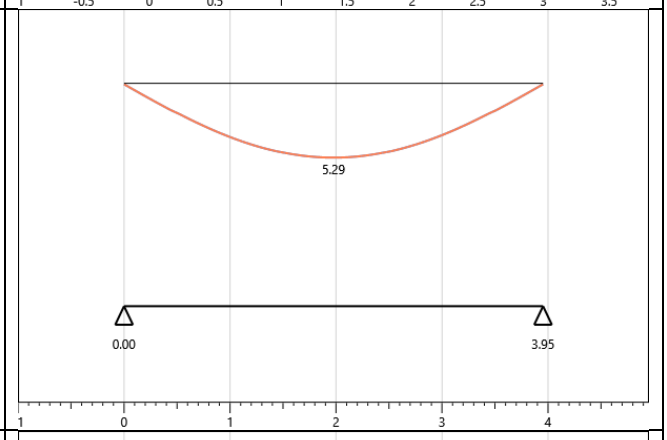
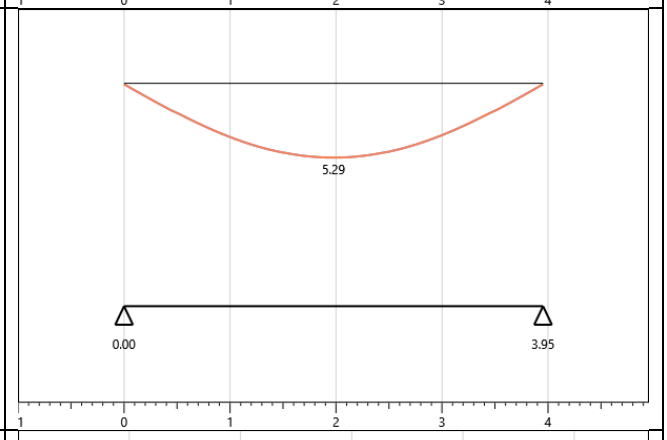
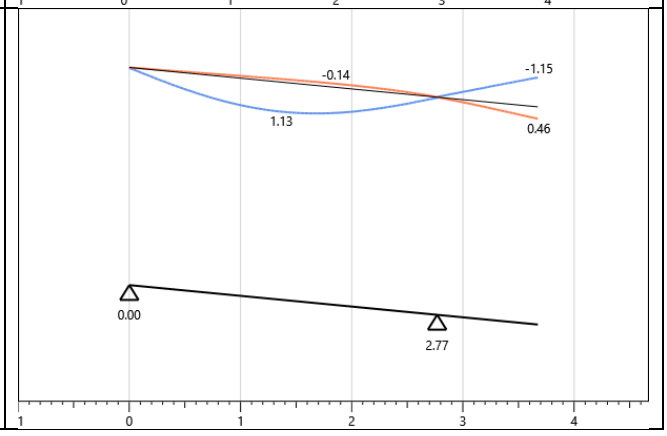
$w_{fin,G} = w_{inst,G} \cdot (1 + k_{def})$ for a permanent action, G

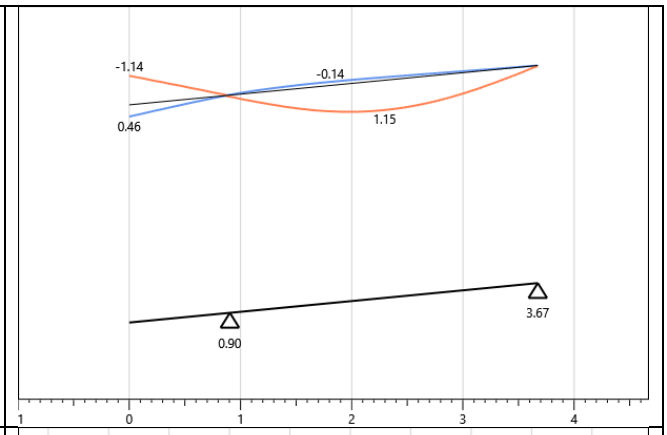
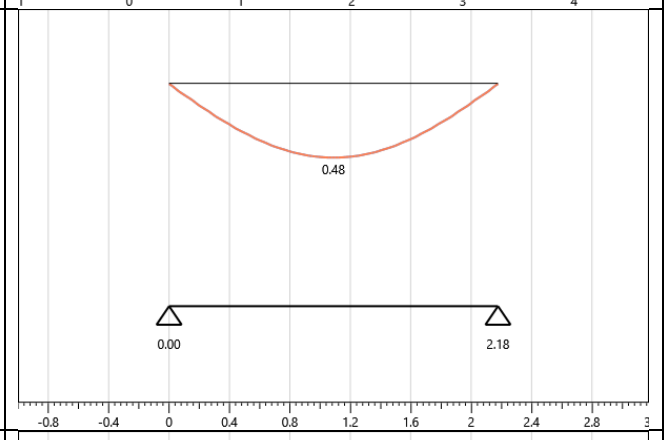
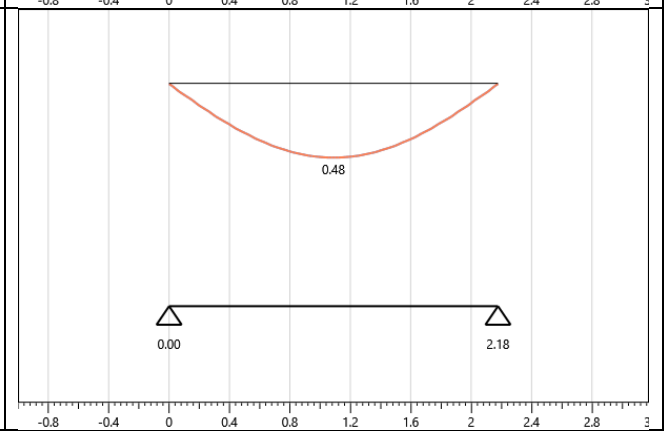
$w_{fin,Q,1} = w_{inst,Q,1} \cdot (1 + \Psi_{2,1} \cdot k_{def})$ for the leading variable action, Q_1

$w_{fin,Q,i} = w_{inst,Q,i} \cdot (\Psi_{0,i} + \Psi_{2,1} \cdot k_{def})$ 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 more severe).

Floor name	Combination	Final deflection
Floor 2	SLS characteristic 2	

Floor 9	SLS characteristic 2	
Floor 14	SLS characteristic 2	
Floor 16	SLS characteristic 2	
Floor 18	SLS characteristic 2	

Floor 19	SLS characteristic 2	
Floor 21	SLS characteristic 2	
Floor 22	SLS characteristic 2	

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

Floor name	Combination	More restrictive check	w_{fin} [mm]	$w_{fin\ limit}$ [mm]	Check
Floor 2	SLS characteristic 2	Overhang	1.95	10.37	19%
Floor 9	SLS characteristic 2	Internal span	0.85	11.21	8%
Floor 14	SLS characteristic 2	Internal span	5.29	15.81	33%
Floor 16	SLS characteristic 2	Internal span	5.29	15.81	33%
Floor 18	SLS characteristic 2	Overhang	-1.15	7.24	16%

Floor 19	SLS characteristic 2	Overhang	-1.14	7.23	16%
Floor 21	SLS characteristic 2	Internal span	0.48	8.71	6%
Floor 22	SLS characteristic 2	Internal span	0.48	8.71	6%

Beams

Bending strength

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

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

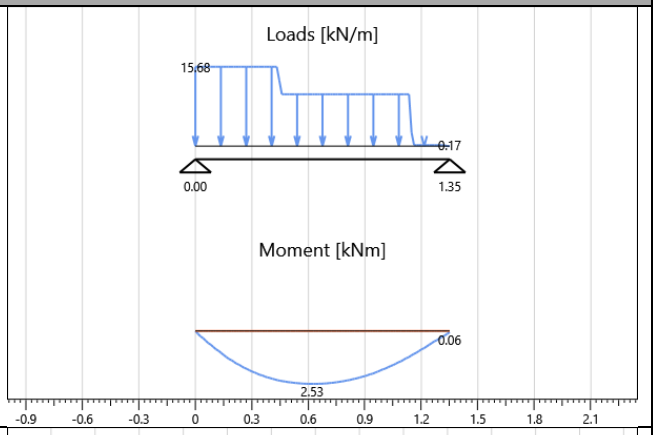
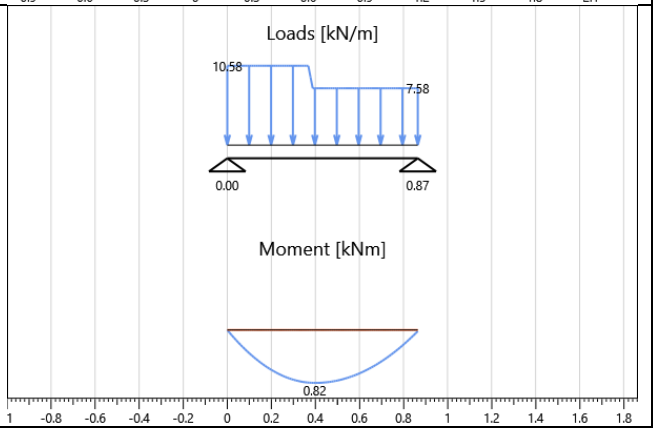
where:

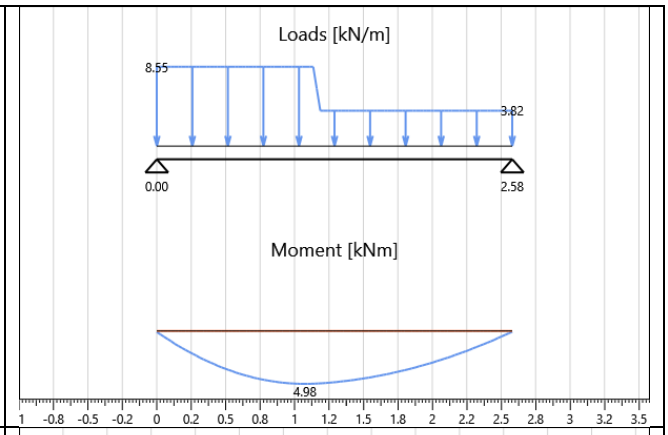
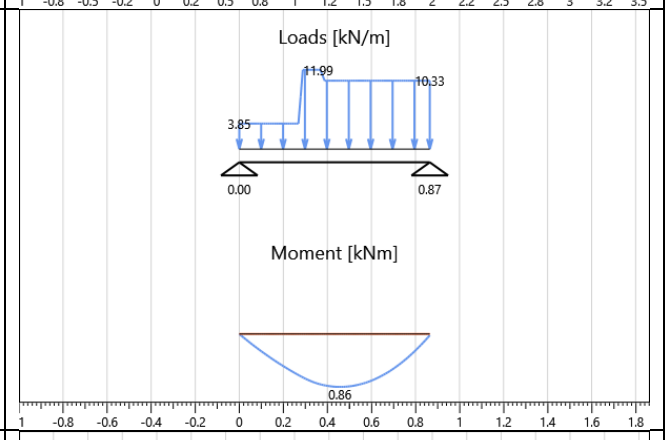
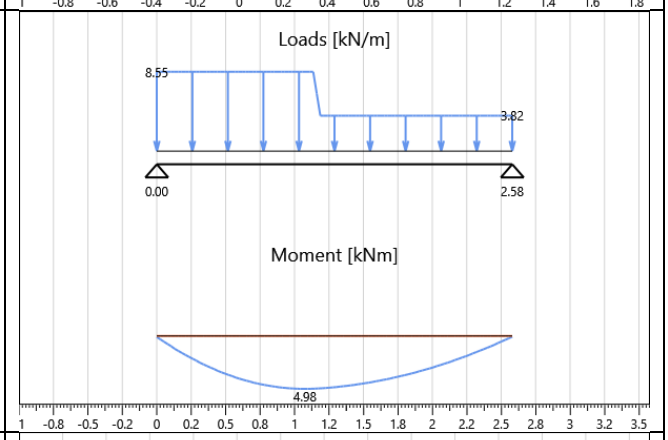
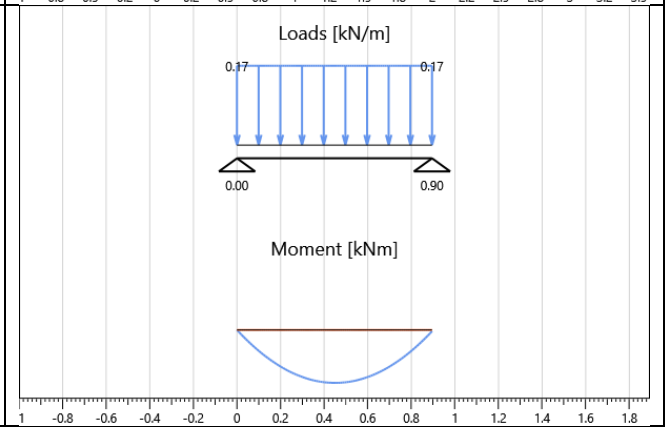
$\sigma_{m,d}$ is the design bending stress

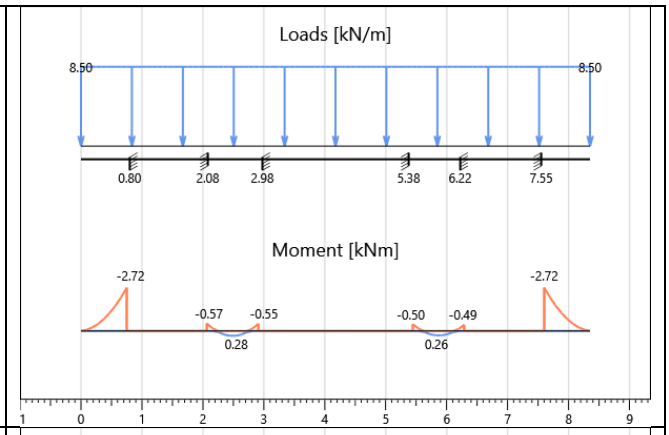
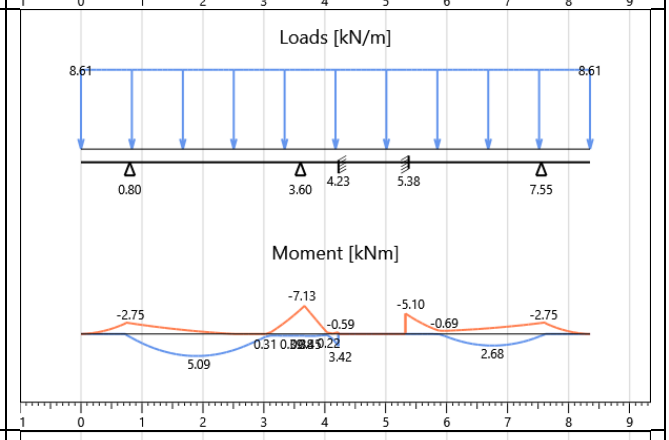
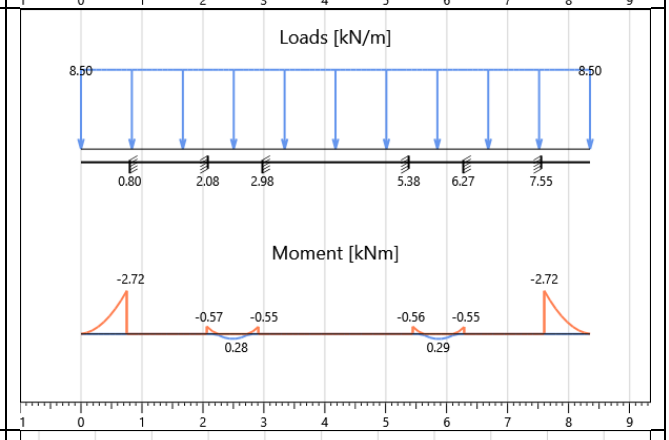
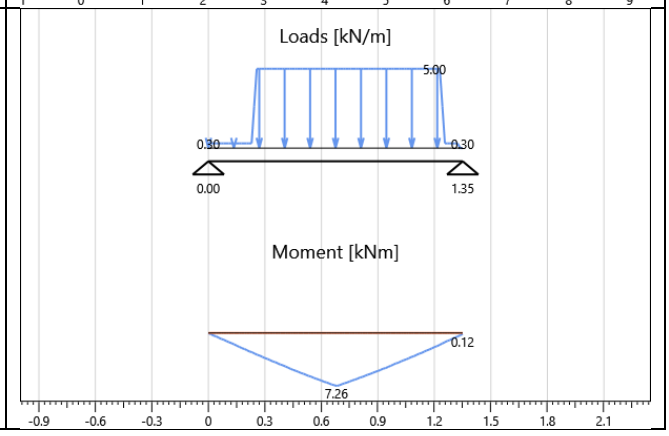
$f_{m,d}$ is the design bending strength

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

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.

Beam name	Combination	Duration	Diagram M_{3-3}
Beam 1	ULS 12	Medium-term	
Beam 2	ULS 12	Medium-term	

Beam 4	ULS 12	Medium-term	
Beam 6	ULS 12	Medium-term	
Beam 8	ULS 12	Medium-term	
Beam 17	ULS 11	Permanent	

Beam 20	ULS 12	Medium-term	
Beam 21	ULS 12	Medium-term	
Beam 22	ULS 12	Medium-term	
Beam 33	ULS 12	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.

Beam name	Section	$M_{3\text{-}3\ max}$ [kNm]	W [mm^3]	k_{crit}	Comb.	k_{mod}	γ_M	$f_{m,d}$ [MPa]	$\sigma_{m,d}$ [MPa]	Check
Beam 1	Sezione 120x180 GL24	2.53	648000	1.00	ULS 12	0.8	1.45	13.24	3.91	30%
Beam 2	Sezione 120x180 GL24	0.82	648000	1.00	ULS 12	0.8	1.45	13.24	1.27	10%
Beam 4	Sezione 120x180 GL24	4.98	648000	1.00	ULS 12	0.8	1.45	13.24	7.69	58%
Beam 6	Sezione 120x180 GL24	0.86	648000	1.00	ULS 12	0.8	1.45	13.24	1.33	10%
Beam 8	Sezione 120x180 GL24	4.98	648000	1.00	ULS 12	0.8	1.45	13.24	7.69	58%
Beam 17	Sezione 120x180 GL24	0.02	648000	1.00	ULS 11	0.6	1.45	9.93	0.03	0%
Beam 20	Section 160x240 Gl24h	2.72	1536000	1.00	ULS 12	0.8	1.45	13.24	1.77	13%
Beam 21	Section 160x240 Gl24h	7.13	1536000	1.00	ULS 12	0.8	1.45	13.24	4.64	35%
Beam 22	Section 160x240 Gl24h	2.72	1536000	1.00	ULS 12	0.8	1.45	13.24	1.77	13%
Beam 33	Section 160x240 Gl24h	7.26	1536000	1.00	ULS 12	0.8	1.45	13.24	4.72	36%

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 of the member.

The following value of k_{cr} are used

k_{cr} = 0.67 for solid timber

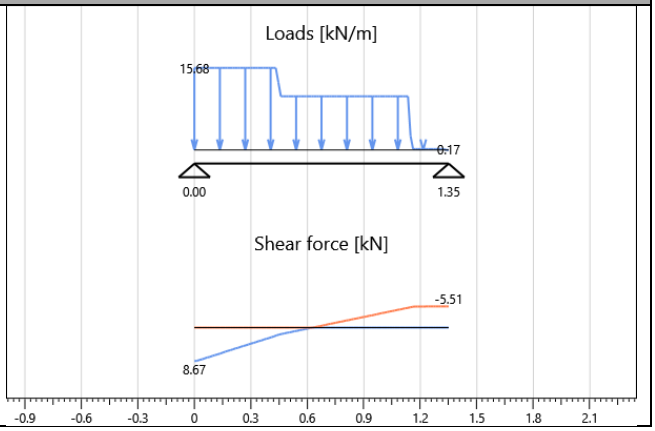
k_{cr} = 0.67 for glued laminated timber

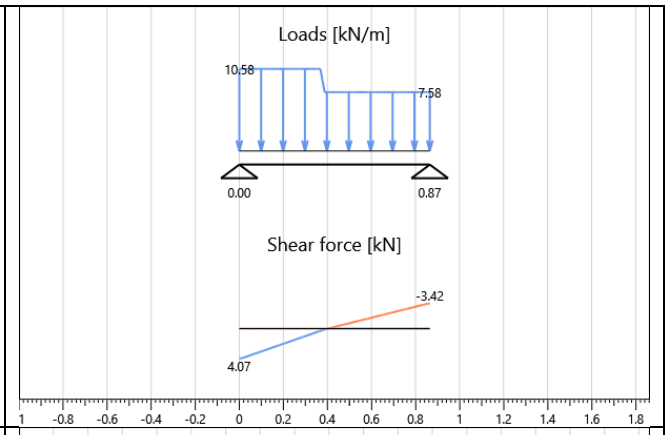
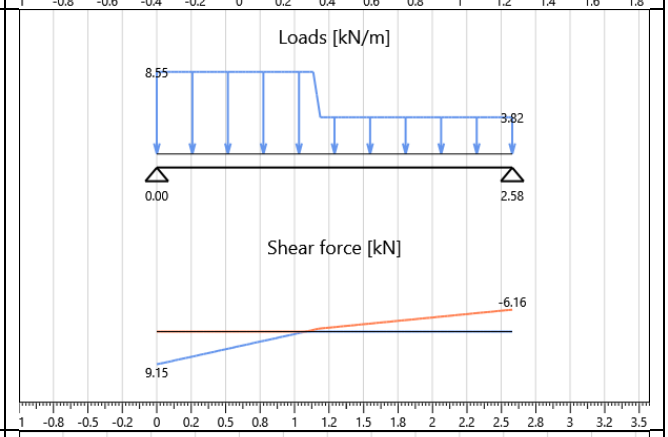
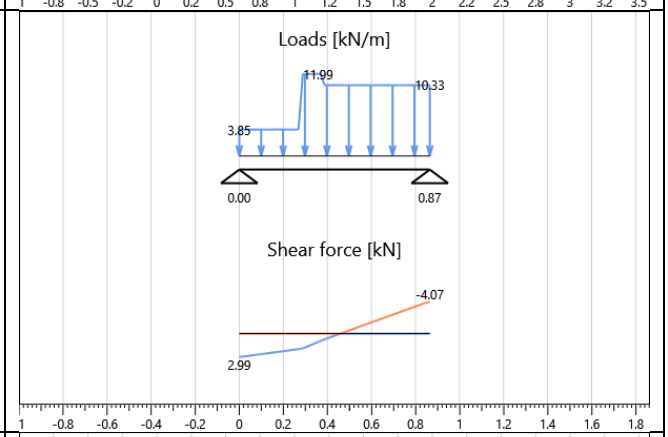
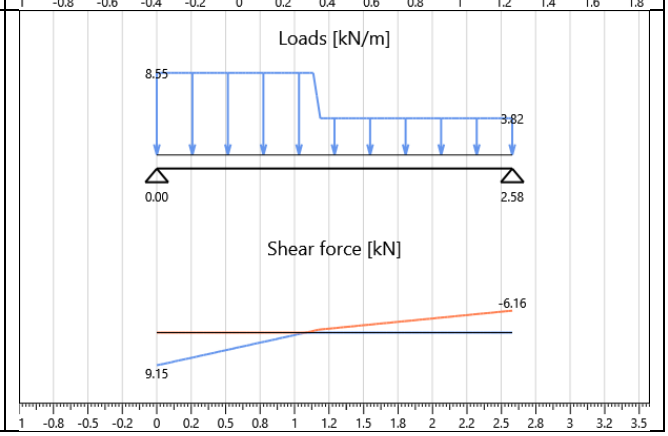
The maximum design shear stress in a rectangular cross section can be evaluated using the following expression:

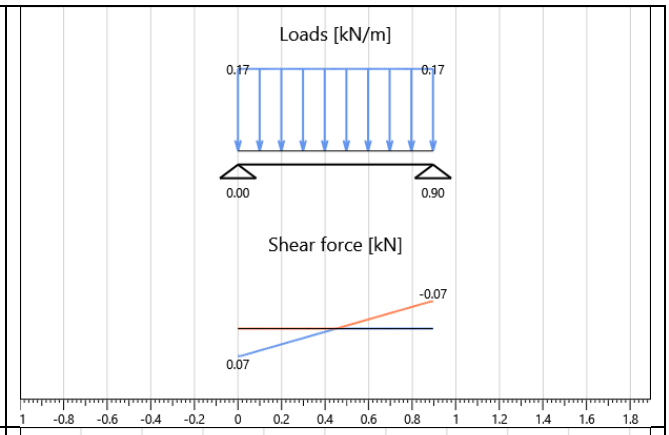
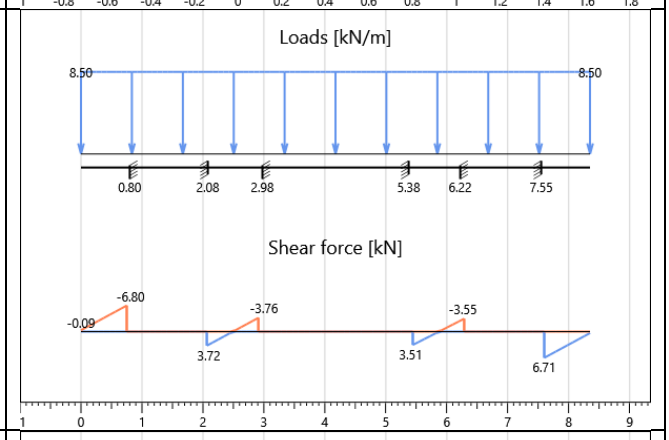
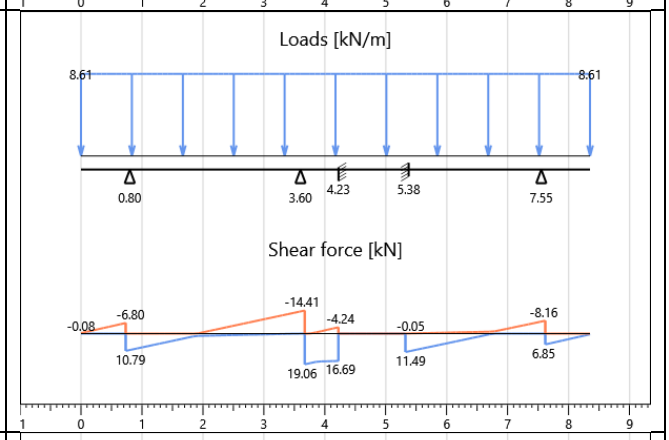
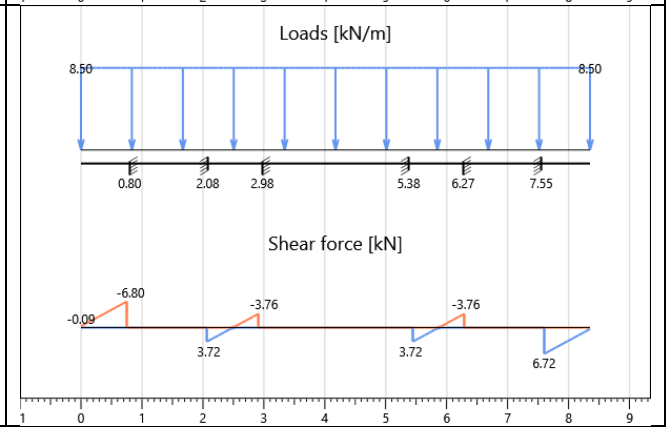
$$\tau_d = \frac{3}{2} \cdot \frac{V_d}{k_{cr} \cdot A}$$

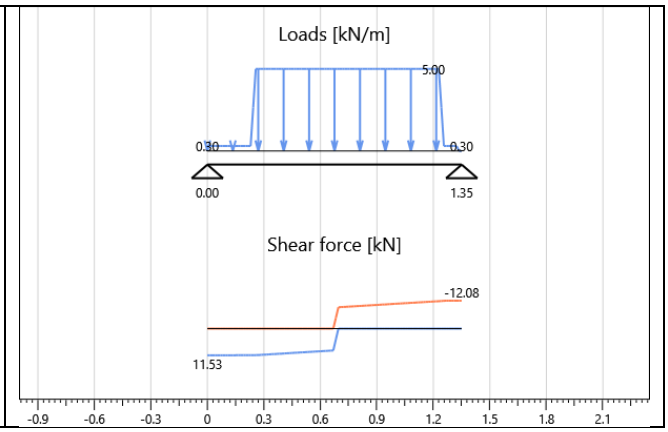
where A is the area of a joist cross section.

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 1	ULS 12	Medium-term	

Beam 2	ULS 12	Medium-term	
Beam 4	ULS 12	Medium-term	
Beam 6	ULS 12	Medium-term	
Beam 8	ULS 12	Medium-term	

Beam 17	ULS 11	Permanent	
Beam 20	ULS 12	Medium-term	
Beam 21	ULS 12	Medium-term	
Beam 22	ULS 12	Medium-term	

Beam 33	ULS 12	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.

Beam name	Section	$V_{2\ max}$ [kN]	Area [mm²]	k_{cr}	Comb.	k_{mod}	γ_M	$f_{v,d}$ [MPa]	$\tau_{2,d}$ [MPa]	Check
Beam 1	Sezione 120x180 GL24	8.67	21600	0.67	ULS 12	0.8	1.45	1.49	0.90	60%
Beam 2	Sezione 120x180 GL24	4.07	21600	0.67	ULS 12	0.8	1.45	1.49	0.42	28%
Beam 4	Sezione 120x180 GL24	9.15	21600	0.67	ULS 12	0.8	1.45	1.49	0.95	64%
Beam 6	Sezione 120x180 GL24	4.07	21600	0.67	ULS 12	0.8	1.45	1.49	0.42	28%
Beam 8	Sezione 120x180 GL24	9.15	21600	0.67	ULS 12	0.8	1.45	1.49	0.95	64%
Beam 17	Sezione 120x180 GL24	0.07	21600	0.67	ULS 11	0.6	1.45	1.12	0.01	1%
Beam 20	Section 160x240 Gl24h	6.80	38400	0.67	ULS 12	0.8	1.45	1.49	0.40	27%
Beam 21	Section 160x240 Gl24h	19.06	38400	0.67	ULS 12	0.8	1.45	1.49	1.11	75%
Beam 22	Section 160x240 Gl24h	6.80	38400	0.67	ULS 12	0.8	1.45	1.49	0.40	27%
Beam 33	Section 160x240 Gl24h	12.08	38400	0.67	ULS 12	0.8	1.45	1.49	0.70	47%

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:

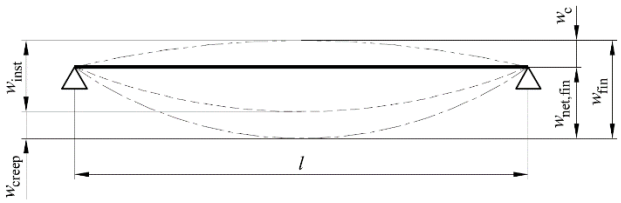
$w_{net,fin}$ is the net final deflection

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



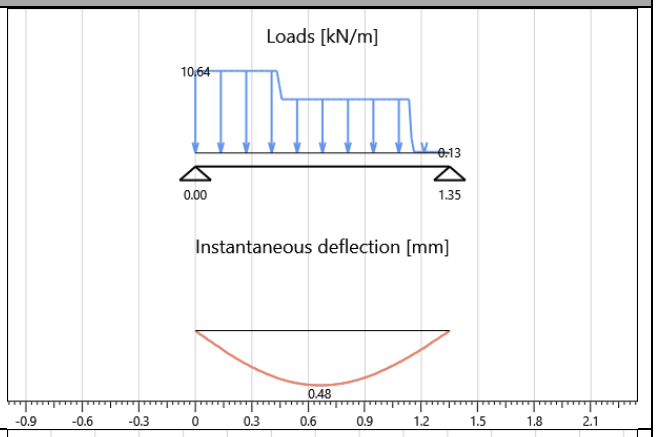
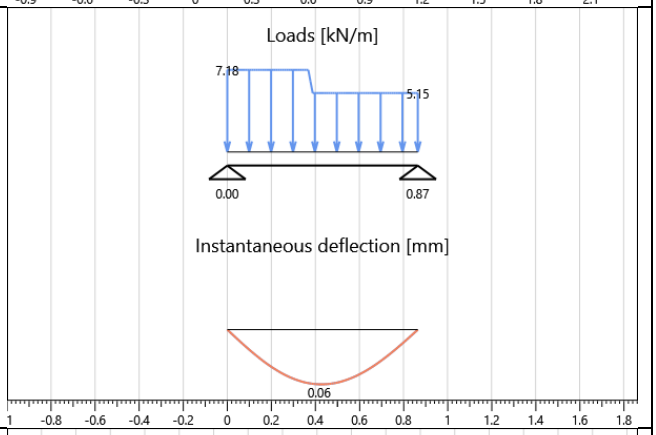
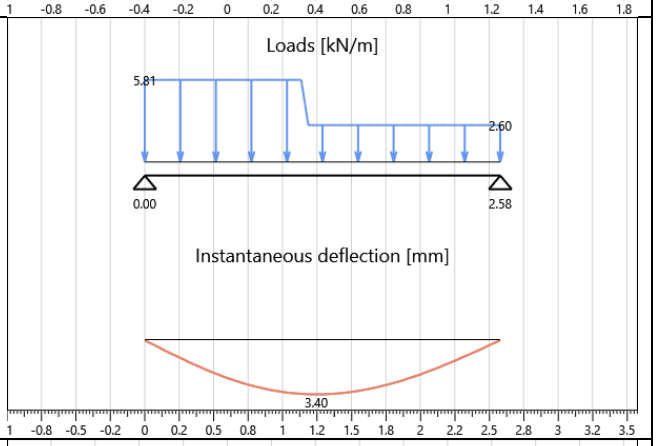
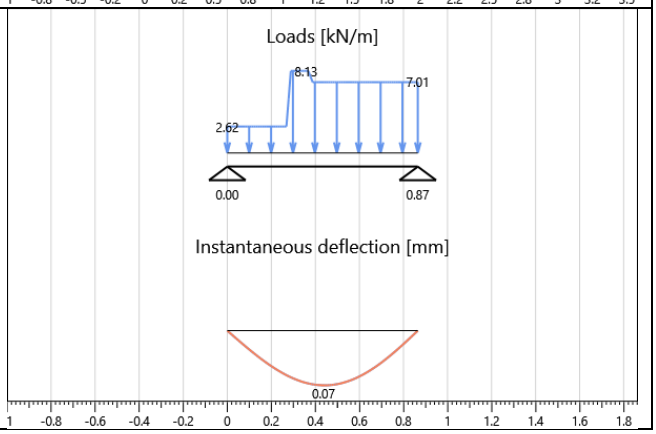
The limiting values for deflections of beams are assumed as shown in the following table.

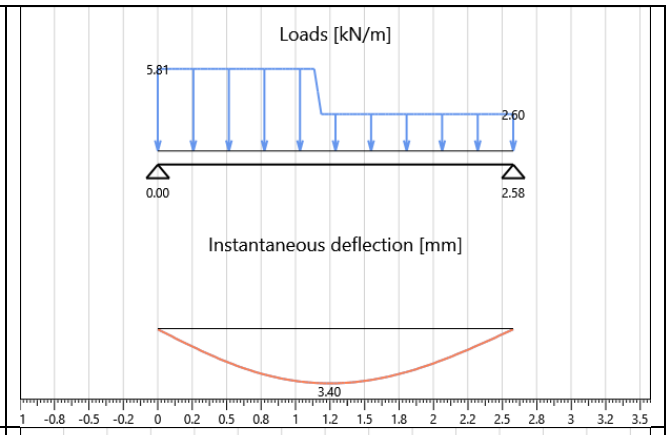
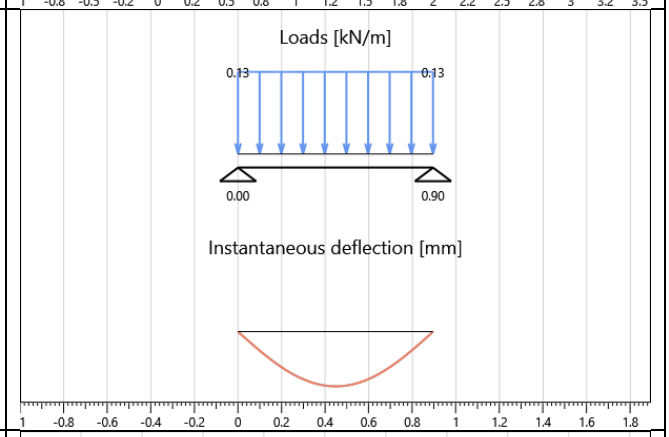
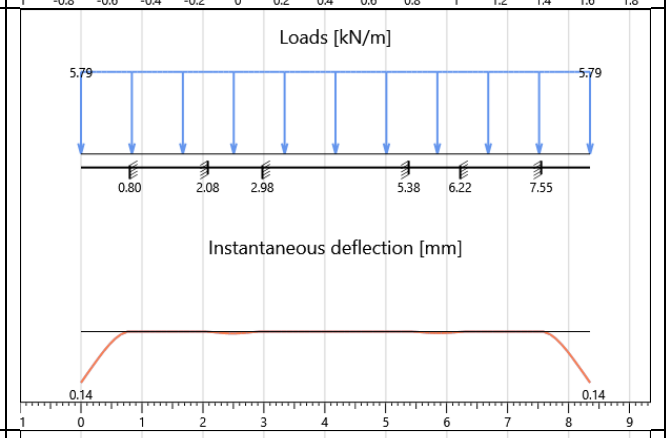
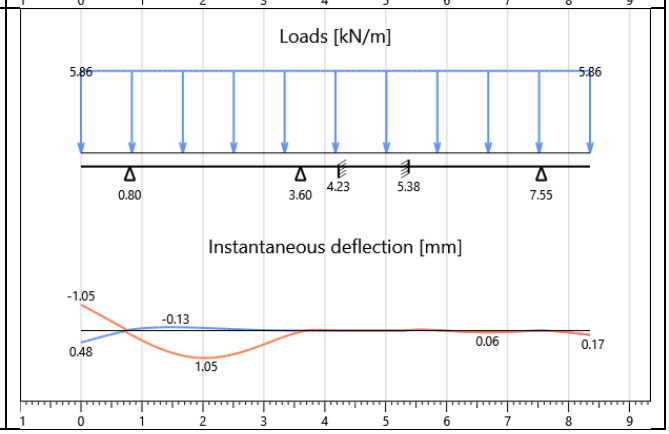
	w_{inst}	$w_{net,fin}$
Beam on two supports	l/300	l/250
Cantilevering beams	l/150	l/125

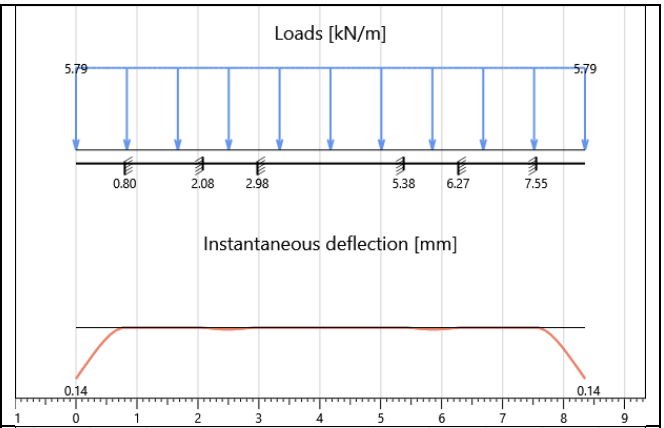
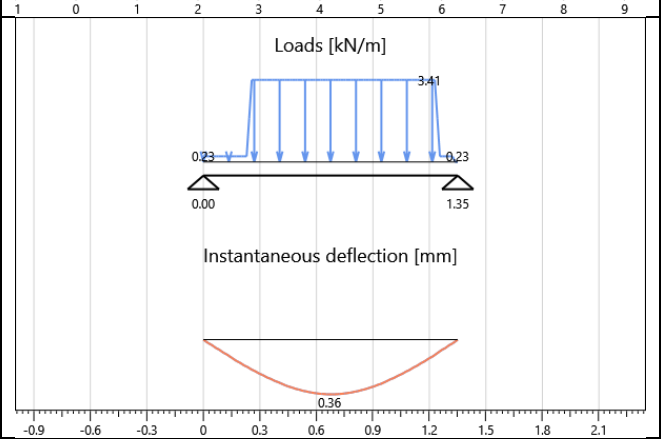
Instantaneous deflection

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	Combination	Instantaneous deflection
Beam 1	SLS characteristic 2	
Beam 2	SLS characteristic 2	
Beam 4	SLS characteristic 2	
Beam 6	SLS characteristic 2	

Beam 8	SLS characteristic 2	
Beam 17	SLS characteristic 1	
Beam 20	SLS characteristic 2	
Beam 21	SLS characteristic 2	

Beam 22	SLS characteristic 2	
Beam 33	SLS characteristic 2	

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

Beam name	Combination	More restrictive check	w_{inst} [mm]	$w_{inst\ limit}$ [mm]	Check
Beam 1	SLS characteristic 2	Internal span	0.48	4.50	11%
Beam 2	SLS characteristic 2	Internal span	0.06	2.88	2%
Beam 4	SLS characteristic 2	Internal span	3.40	8.60	40%
Beam 6	SLS characteristic 2	Internal span	0.07	2.88	2%
Beam 8	SLS characteristic 2	Internal span	3.40	8.60	40%
Beam 17	SLS characteristic 1	Internal span	0.00	2.98	0%
Beam 20	SLS characteristic 2	Overhang	0.14	5.33	3%
Beam 21	SLS characteristic 2	Overhang	-1.05	5.33	20%
Beam 22	SLS characteristic 2	Overhang	0.14	5.33	3%
Beam 33	SLS characteristic 2	Internal span	0.36	4.50	8%

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:

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

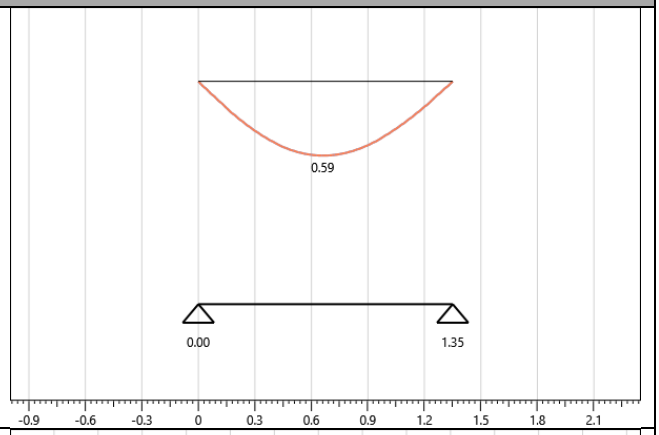
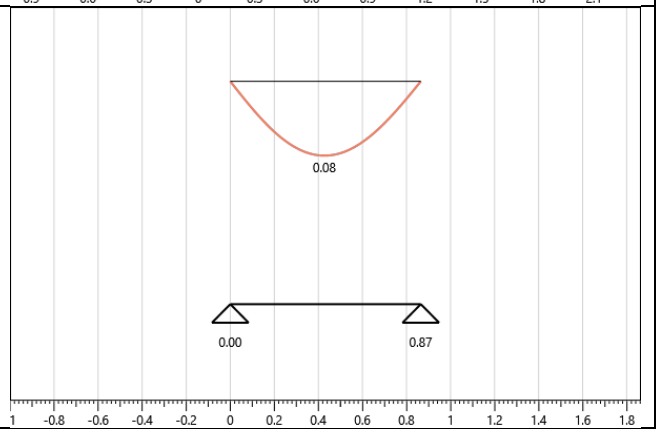
where:

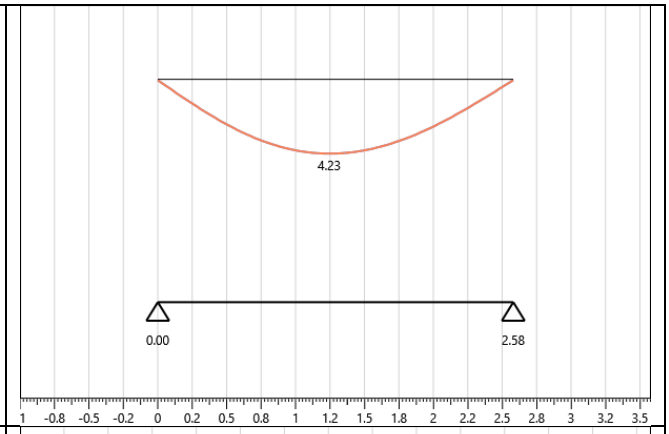
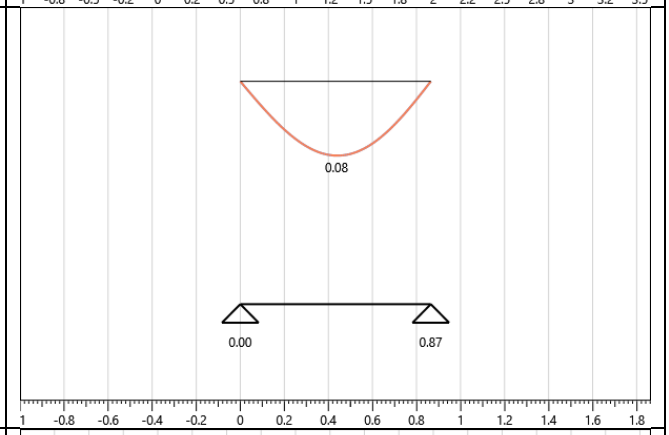
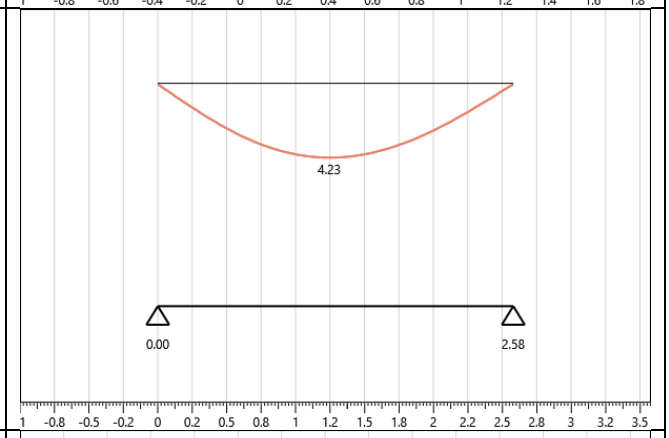
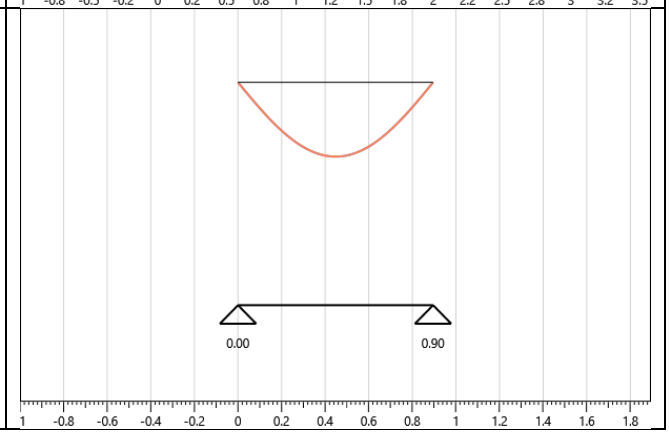
$w_{fin,G} = w_{inst,G} \cdot (1 + k_{def})$ for a permanent action, G

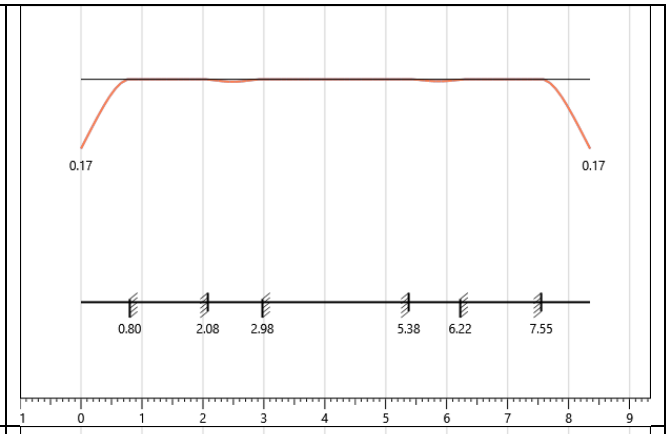
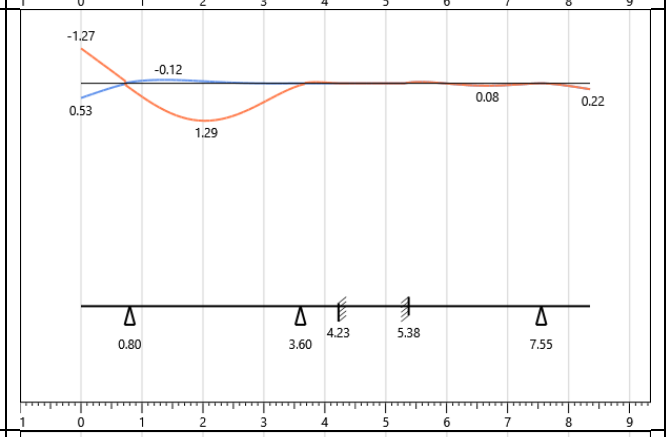
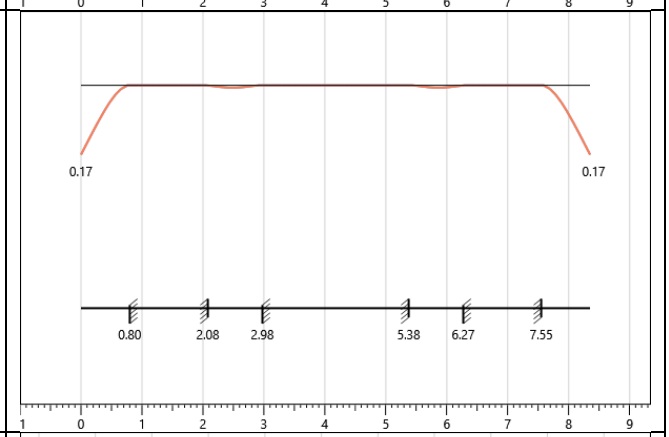
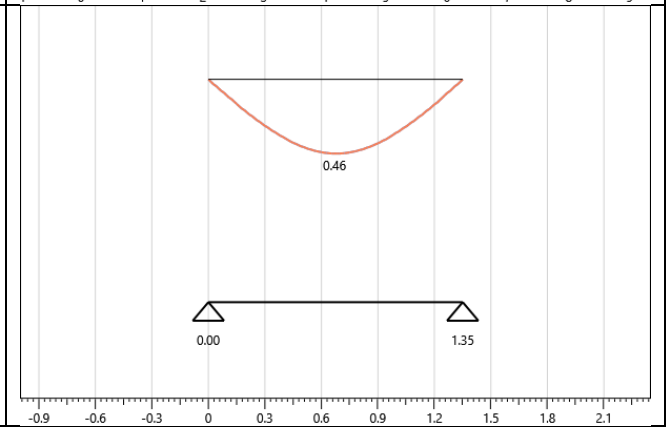
$w_{fin,Q,1} = w_{inst,Q,1} \cdot (1 + \Psi_{2,1} \cdot k_{def})$ for the leading variable action, Q_1

$w_{fin,Q,i} = w_{inst,Q,i} \cdot (\Psi_{0,i} + \Psi_{2,1} \cdot k_{def})$ 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 more severe).

Beam name	Combination	Final deflection
Beam 1	SLS characteristic 2	
Beam 2	SLS characteristic 2	

Beam 4	SLS characteristic 2	
Beam 6	SLS characteristic 2	
Beam 8	SLS characteristic 2	
Beam 17	SLS characteristic 1	

Beam 20	SLS characteristic 2	
Beam 21	SLS characteristic 2	
Beam 22	SLS characteristic 2	
Beam 33	SLS characteristic 2	

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

Beam name	Combination	More restrictive check	w_{fin} [mm]	$w_{fin\ limit}$ [mm]	Check
Beam 1	SLS characteristic 2	Internal span	0.59	5.40	11%
Beam 2	SLS characteristic 2	Internal span	0.08	3.46	2%
Beam 4	SLS characteristic 2	Internal span	4.23	10.32	41%
Beam 6	SLS characteristic 2	Internal span	0.08	3.46	2%
Beam 8	SLS characteristic 2	Internal span	4.23	10.32	41%
Beam 17	SLS characteristic 1	Internal span	0.00	3.58	0%
Beam 20	SLS characteristic 2	Overhang	0.17	6.40	3%
Beam 21	SLS characteristic 2	Overhang	-1.27	6.40	20%
Beam 22	SLS characteristic 2	Overhang	0.17	6.40	3%
Beam 33	SLS characteristic 2	Internal span	0.46	5.40	8%

Columns

Stability of columns

The stability of columns subjected to compression is verified in accordance with § 6.3.2 of EN 1995-1-1.

The relative slenderness ratios should be taken as:

$$\lambda_{rel,y} = \frac{\lambda_{,y}}{\pi} \cdot \sqrt{\frac{f_{c,0,k}}{E_{0,05}}}$$

and

$$\lambda_{rel,z} = \frac{\lambda_{,z}}{\pi} \cdot \sqrt{\frac{f_{c,0,k}}{E_{0,05}}}$$

where

$\lambda_{,y}$ e $\lambda_{rel,y}$ are the slenderness ratios corresponding to bending about the y-axis (deflection in the z-direction);

$\lambda_{,z}$ e $\lambda_{rel,z}$ are the slenderness ratios corresponding to bending about the z-axis (deflection in the y-direction);

Where both $\lambda_{rel,z} \leq 0,3$ and $\lambda_{rel,y} \leq 0,3$, the stresses should satisfy the expressions (6.19) e (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:

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

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

where the symbols are defined as follows:

$$k_{c,y} = \frac{1}{k_y + \sqrt{k_y^2 - \lambda_{rel,y}^2}}$$

$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}}$$

$$k_y = 0,5 \cdot \left(1 + \beta_c \cdot \left(\lambda_{rel,y} - 0,3\right) + \lambda_{rel,y}^2\right)$$

$$k_z = 0,5 \cdot \left(1 + \beta_c \cdot \left(\lambda_{rel,z} - 0,3\right) + \lambda_{rel,z}^2\right)$$

where:

β_c is a factor for members within the straightness limits defined in Section 10 of EN 1995-1-1 and assumes the following values

$$\beta_c = \begin{cases} 0{,}2 \; for \; solid \; timber \\ 0{,}1 \; for \; glued \; laminated \; timber \; and \; LVL \end{cases}$$

The values of the actions in the tables below are related, for each pillar, to the more severe combination of load for the Ultimate Limit State of instability.

Comb.: More severe combination of load

Dur.: Load duration

N: Axial force

V_2: Shear force along the local axis 2

V_3: Shear force along the local axis 3

$M_{2\text{-}2}$: Bending moment about local axis 2

$M_{3\text{-}3}$: Bending moment about local axis 3

Column name	Comb.	Dur.	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]
Column 1	ULS 12	Medium-term	18.52	0.00	0.00	0.00	0.00

The following table summarizes the stability checks for the columns.

Sect.: Column cross section

h: Column height

Area: Cross sectional area of the column

J_y: Area moment of inertia with respect to the y axis

J_z: Area moment of inertia with respect to the z axis

Comb.: More severe load combination

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

$\sigma_{c,0,d}$: Design compressive stress along the grain

Column name	Sect.	h [m]	Area [mm^2]	J_y [mm^4]	J_z [mm^4]	kc,y	kc,z	Comb	k_{mod}	γ_M	$f_{c,0,k}$	$\sigma_{c,0,d}$ [MPa]	Check
Column 1	Section 160x240 Gl24h	2.28	38400	1.84E8	8.19E7	0.97	0.90	ULS 12	0.8	1.45	13.24	0.48	4%

Framed Walls

Stability of the studs

The stability of the studs subjected to compression is verified in accordance with § 6.3.2 of EN 1995-1-1. Specifically, the checked elements are the internal and the external studs which are more loaded. These elements (stud or column in a sheathed wall) are braced against buckling in the in-plane direction therefore checks are performed only in the orthogonal direction.

Where both $\lambda_{rel,z} \leq 0,3$ and $\lambda_{rel,y} \leq 0,3$, the stresses should satisfy the expressions (6.19) e (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 expression:

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

The values of the actions in the tables below are related, for each pillar, to the more severe combination of load for the Ultimate Limit State of instability.

Wall name	Length [m]	Comb.	Dur.	N [kN]	M2-2 [kNm]
Wall 1	1.33	ULS 20	Instantaneous	25.16	1.53
Wall 2	2.58	ULS 20	Instantaneous	56.74	2.96
Wall 3	2.58	ULS 20	Instantaneous	44.09	2.96
Wall 4	1.28	ULS 20	Instantaneous	24.65	1.47
Wall 5	1.30	ULS 16	Permanent	7.31	0.00
Wall 6	2.40	ULS 20	Instantaneous	50.27	2.76
Wall 7	1.72	ULS 17	Medium-term	35.85	0.00
Wall 8	1.15	ULS 17	Medium-term	37.25	0.00
Wall 9	2.40	ULS 20	Instantaneous	40.84	2.76
Wall 10	2.58	ULS 17	Medium-term	111.51	0.00
Wall 11	1.28	ULS 20	Instantaneous	24.61	1.47
Wall 12	1.91	ULS 20	Instantaneous	47.67	2.19
Wall 13	1.91	ULS 20	Instantaneous	49.47	2.19
Wall 14	1.28	ULS 20	Instantaneous	24.69	1.47
Wall 15	1.33	ULS 20	Instantaneous	20.57	1.53
Wall 16	2.58	ULS 20	Instantaneous	35.54	2.96
Wall 17	2.58	ULS 20	Instantaneous	29.20	2.96

Wall 18	1.28	ULS 20	Instantaneous	20.20	1.47
Wall 19	1.30	ULS 16	Permanent	3.67	0.00
Wall 20	2.40	ULS 20	Instantaneous	37.72	2.76
Wall 21	1.72	ULS 17	Medium-term	20.42	0.00
Wall 22	1.15	ULS 17	Medium-term	24.67	0.00
Wall 23	2.40	ULS 20	Instantaneous	32.88	2.76
Wall 24	2.58	ULS 17	Medium-term	73.48	0.00
Wall 25	1.28	ULS 20	Instantaneous	20.16	1.47
Wall 26	1.91	ULS 20	Instantaneous	29.29	2.19
Wall 27	1.91	ULS 20	Instantaneous	29.09	2.19
Wall 28	1.28	ULS 20	Instantaneous	20.24	1.47
Wall 32	1.72	ULS 16	Permanent	3.22	0.00
Wall 36	1.28	ULS 20	Instantaneous	15.75	0.34
Wall 38	1.33	ULS 20	Instantaneous	15.98	0.35
Wall 39	2.40	ULS 20	Instantaneous	24.93	0.64
Wall 40	1.28	ULS 20	Instantaneous	15.72	0.34
Wall 41	1.15	ULS 17	Medium-term	12.09	0.00
Wall 42	2.58	ULS 17	Medium-term	34.98	0.00
Wall 43	2.58	ULS 18	Instantaneous	17.16	0.83
Wall 44	2.58	ULS 18	Instantaneous	17.20	0.77
Wall 47	1.91	ULS 19	Instantaneous	4.78	0.82
Wall 49	1.91	ULS 19	Instantaneous	4.75	0.86
Wall 50	1.28	ULS 20	Instantaneous	15.72	0.34
Wall 67	2.40	ULS 20	Instantaneous	25.09	0.64

The following table summarizes the stability checks for the studs of the framed walls.

Section: type of cross-section of the stud

h_{stud}: Stud height

A_{stud}: Cross sectional area of the stud

J_{stud}: Cross sectional moment of inertia of the stud

Comb.: More severe load combination

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

$f_{c,0,k}$: Characteristic compressive strength along the grain

$f_{m,k}$: Design bending strength

$\sigma_{c,0,d}$: Design compressive stress along the grain

$\sigma_{m,d}$: Design bending stress about the principal axis

Wall name	Section	Stud	h_{stud} [mm]	A_{stud} [mm^2]	J_{stud} [mm^4]	kc_{stud}	Comb.	k_{mod}	γ_M	$f_{c,0,k}$	$f_{m,k}$	N [kN]	$\sigma_{c,0,d}$ [MPa]	$\sigma_{m,d}$ [MPa]	Check
Wall 1	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	8.59	0.89	2.57	25%
Wall 1	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	8.42	0.48	0.96	11%
Wall 2	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	11.45	1.19	2.69	29%
Wall 2	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	8.49	0.48	0.80	10%
Wall 3	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	8.50	0.89	2.69	26%
Wall 3	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	10.21	0.58	0.80	11%
Wall 4	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	8.63	0.90	2.57	25%
Wall 4	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	8.40	0.48	0.90	10%
Wall 5	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 16	0.6	1.5	21.00	24.00	3.24	0.34	0.00	6%
Wall 5	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 16	0.6	1.5	21.00	24.00	2.10	0.12	0.00	2%
Wall 6	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	8.95	0.93	2.69	26%
Wall 6	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	16.81	0.96	0.80	15%
Wall 7	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 17	0.8	1.5	21.00	24.00	12.83	1.34	0.00	17%
Wall 7	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 17	0.8	1.5	21.00	24.00	10.67	0.61	0.00	8%
Wall 8	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 17	0.8	1.5	21.00	24.00	14.91	1.55	0.00	20%

Wall 8	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 17	0.8	1.5	21.00	24.00	33.69	1.91	0.00	24%
Wall 9	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	8.95	0.93	2.69	26%
Wall 9	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	7.65	0.43	0.80	9%
Wall 10	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 17	0.8	1.5	21.00	24.00	32.29	3.36	0.00	42%
Wall 10	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 17	0.8	1.5	21.00	24.00	16.79	0.95	0.00	12%
Wall 11	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	8.63	0.90	2.57	25%
Wall 11	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	8.03	0.46	0.90	10%
Wall 12	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	10.00	1.04	2.69	27%
Wall 12	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	20.67	1.17	0.93	18%
Wall 13	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	10.59	1.10	2.57	27%
Wall 13	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	20.81	1.18	0.80	17%
Wall 14	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	8.63	0.90	2.57	25%
Wall 14	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	8.41	0.48	0.90	10%
Wall 15	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	6.62	0.69	2.57	23%
Wall 15	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	7.06	0.40	0.96	10%
Wall 16	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	6.52	0.68	2.69	24%
Wall 16	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	5.80	0.33	0.80	8%
Wall 17	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	4.91	0.51	2.69	22%
Wall 17	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	8.41	0.48	0.80	10%
Wall 18	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	6.64	0.69	2.57	23%
Wall 18	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	7.12	0.40	0.90	10%
Wall 19	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 16	0.6	1.5	21.00	24.00	1.62	0.17	0.00	3%
Wall 19	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 16	0.6	1.5	21.00	24.00	1.06	0.06	0.00	1%
Wall 20	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	6.96	0.73	2.69	24%
Wall 20	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	11.13	0.63	0.80	11%

Wall 21	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 17	0.8	1.5	21.00	24.00	7.57	0.79	0.00	10%
Wall 21	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 17	0.8	1.5	21.00	24.00	6.08	0.35	0.00	4%
Wall 22	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 17	0.8	1.5	21.00	24.00	11.70	1.22	0.00	15%
Wall 22	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 17	0.8	1.5	21.00	24.00	23.58	1.34	0.00	17%
Wall 23	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	6.96	0.73	2.69	24%
Wall 23	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	6.56	0.37	0.80	9%
Wall 24	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 17	0.8	1.5	21.00	24.00	25.80	2.69	0.00	34%
Wall 24	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 17	0.8	1.5	21.00	24.00	14.31	0.81	0.00	10%
Wall 25	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	6.64	0.69	2.57	23%
Wall 25	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	6.76	0.38	0.90	9%
Wall 26	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	5.92	0.62	2.69	23%
Wall 26	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	12.66	0.72	0.93	13%
Wall 27	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	5.36	0.56	2.69	22%
Wall 27	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	12.29	0.70	0.80	12%
Wall 28	Framed wall - OSB - 2 sides	Internal	2660.00	9600	20480000	0.71	ULS 20	1	1.5	21.00	24.00	6.64	0.69	2.57	23%
Wall 28	Framed wall - OSB - 2 sides	External	2660.00	17600	37546667	0.71	ULS 20	1	1.5	21.00	24.00	7.13	0.41	0.90	10%
Wall 32	Framed wall - Gypsum - fibreboard - 1 side	Internal	1764.63	16000	34133333	0.90	ULS 16	0.6	1.5	21.00	24.00	1.28	0.08	0.00	1%
Wall 32	Framed wall - Gypsum - fibreboard - 1 side	External	1944.82	16000	34133333	0.87	ULS 16	0.6	1.5	21.00	24.00	0.57	0.04	0.00	0%
Wall 36	Framed wall - Gypsum - fibreboard - 1 side	Internal	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	4.87	0.30	0.37	5%
Wall 36	Framed wall - Gypsum - fibreboard - 1 side	External	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	5.60	0.35	0.21	4%
Wall 38	Framed wall - Gypsum - fibreboard - 1 side	Internal	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	4.86	0.30	0.37	5%

Wall 38	Framed wall - Gypsum - fibreboard - 1 side	External	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	5.73	0.36	0.24	4%
Wall 39	Framed wall - Gypsum - fibreboard - 1 side	Internal	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	5.97	0.37	0.39	5%
Wall 39	Framed wall - Gypsum - fibreboard - 1 side	External	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	5.40	0.34	0.21	4%
Wall 40	Framed wall - Gypsum - fibreboard - 1 side	Internal	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	4.87	0.30	0.37	5%
Wall 40	Framed wall - Gypsum - fibreboard - 1 side	External	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	5.57	0.35	0.21	4%
Wall 41	Framed wall - Gypsum - fibreboard - 1 side	Internal	2280.00	16000	34133333	0.80	ULS 17	0.8	1.5	21.00	24.00	10.06	0.63	0.00	7%
Wall 41	Framed wall - Gypsum - fibreboard - 1 side	External	2280.00	16000	34133333	0.80	ULS 17	0.8	1.5	21.00	24.00	12.80	0.80	0.00	9%
Wall 42	Framed wall - Gypsum - fibreboard - 1 side	Internal	2037.82	16000	34133333	0.85	ULS 17	0.8	1.5	21.00	24.00	1.33	0.08	0.00	1%
Wall 42	Framed wall - Gypsum - fibreboard - 1 side	External	2280.00	16000	34133333	0.80	ULS 17	0.8	1.5	21.00	24.00	30.79	1.92	0.00	21%
Wall 43	Framed wall - Gypsum - fibreboard - 1 side	Internal	1795.63	16000	34133333	0.89	ULS 18	1	1.5	21.00	24.00	1.50	0.09	0.47	4%
Wall 43	Framed wall - Gypsum - fibreboard - 1 side	External	2280.00	16000	34133333	0.80	ULS 18	1	1.5	21.00	24.00	8.63	0.54	0.25	6%
Wall 44	Framed wall - Gypsum - fibreboard - 1 side	Internal	2006.82	16000	34133333	0.86	ULS 18	1	1.5	21.00	24.00	1.69	0.11	0.43	4%
Wall 44	Framed wall - Gypsum - fibreboard - 1 side	External	2280.00	16000	34133333	0.80	ULS 18	1	1.5	21.00	24.00	8.75	0.55	0.26	6%
Wall 47	Framed wall - Gypsum - fibreboard - 1 side	Internal	1764.63	16000	34133333	0.90	ULS 19	1	1.5	21.00	24.00	1.51	0.09	0.63	5%
Wall 47	Framed wall - Gypsum -	External	2018.44	16000	34133333	0.86	ULS 19	1	1.5	21.00	24.00	0.94	0.06	0.36	3%

	fibreboard - 1 side													
Wall 49	Framed wall - Gypsum - fibreboard - 1 side	Internal	1534.08	16000	34133333	0.93	ULS 19	1	1.5	21.00	24.00	1.31	0.08	0.66	5%
Wall 49	Framed wall - Gypsum - fibreboard - 1 side	External	1280.27	16000	34133333	0.96	ULS 19	1	1.5	21.00	24.00	1.11	0.07	0.37	3%
Wall 50	Framed wall - Gypsum - fibreboard - 1 side	Internal	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	4.87	0.30	0.37	5%
Wall 50	Framed wall - Gypsum - fibreboard - 1 side	External	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	5.66	0.35	0.22	4%
Wall 67	Framed wall - Gypsum - fibreboard - 1 side	Internal	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	5.96	0.37	0.39	5%
Wall 67	Framed wall - Gypsum - fibreboard - 1 side	External	1280.00	16000	34133333	0.96	ULS 20	1	1.5	21.00	24.00	5.59	0.35	0.21	4%

Compression perpendicular to the grain

The studs are supported at the base by the bottom plate which is stressed by compression forces 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

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

where:

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

$F_{c,90,d}$ is the design compressive load perpendicular to the grain

A_{ef} is the effective contact area in compression perpendicular to the grain

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

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

The effective contact area perpendicular to the grain, A_{ef}, should be determined taking into account an effective contact length parallel to the grain, where the actual contact length, l, at each side is increased by 30 mm, but not more than a, l or l1/2, see Figure 6.2 of EN 1995-1-1.

The value of $k_{c,90}$ should be taken as 1,0 unless the conditions in the following paragraphs apply. For members on continuous supports, provided that $l_1 \geq 2h$ (see Figure 6.2a of EN 1995-1-1), the value of $k_{c,90}$ should be taken as:

$k_{c,90}$ = 1,25 for solid softwood timber

$k_{c,90}$ = 1,5 for glued laminated softwood timber

where h is the depth of the member and l is the contact length.

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

Wall name	Length [m]	Comb.	Dur.	N [kN]
Wall 1	1.33	ULS 17	Medium-term	29.90
Wall 2	2.58	ULS 17	Medium-term	68.81

Wall 3	2.58	ULS 17	Medium-term	51.54
Wall 4	1.28	ULS 17	Medium-term	29.34
Wall 5	1.30	ULS 16	Permanent	7.31
Wall 6	2.40	ULS 17	Medium-term	60.75
Wall 7	1.72	ULS 17	Medium-term	35.85
Wall 8	1.15	ULS 17	Medium-term	37.25
Wall 9	2.40	ULS 17	Medium-term	48.05
Wall 10	2.58	ULS 17	Medium-term	111.51
Wall 11	1.28	ULS 17	Medium-term	29.29
Wall 12	1.91	ULS 17	Medium-term	58.52
Wall 13	1.91	ULS 17	Medium-term	60.98
Wall 14	1.28	ULS 17	Medium-term	29.37
Wall 15	1.33	ULS 17	Medium-term	25.31
Wall 16	2.58	ULS 17	Medium-term	43.01
Wall 17	2.58	ULS 17	Medium-term	34.35
Wall 18	1.28	ULS 17	Medium-term	24.89
Wall 19	1.30	ULS 16	Permanent	3.67
Wall 20	2.40	ULS 17	Medium-term	46.59
Wall 21	1.72	ULS 17	Medium-term	20.42
Wall 22	1.15	ULS 17	Medium-term	24.67
Wall 23	2.40	ULS 17	Medium-term	40.09
Wall 24	2.58	ULS 17	Medium-term	73.48
Wall 25	1.28	ULS 17	Medium-term	24.85
Wall 26	1.91	ULS 17	Medium-term	35.76
Wall 27	1.91	ULS 17	Medium-term	35.50
Wall 28	1.28	ULS 17	Medium-term	24.92
Wall 32	1.72	ULS 16	Permanent	3.22
Wall 36	1.28	ULS 17	Medium-term	20.44
Wall 38	1.33	ULS 17	Medium-term	20.73
Wall 39	2.40	ULS 17	Medium-term	32.14

Wall 40	1.28	ULS 17	Medium-term	20.40
Wall 41	1.15	ULS 17	Medium-term	12.09
Wall 42	2.58	ULS 17	Medium-term	34.98
Wall 43	2.58	ULS 17	Medium-term	17.16
Wall 44	2.58	ULS 17	Medium-term	17.20
Wall 47	1.91	ULS 17	Medium-term	7.71
Wall 49	1.91	ULS 17	Medium-term	7.69
Wall 50	1.28	ULS 17	Medium-term	20.40
Wall 67	2.40	ULS 17	Medium-term	32.36

The following table summarizes the compression perpendicular to the grain checks for the plates of the framed walls.

Wall name: Wall ID

A_{eff}: Effective contact area in compression perpendicular to the grain of the bottom plate

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

Comb.: More severe combination

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

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

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

Wall name	Section	Stud	A_{eff} [mm^2]	$k_{c,90}$	Comb.	k_{mod}	γ_M	$f_{c,90,k}$ [MPa]	N [kN]	$\sigma_{c,90,d}$ [MPa]	Check
Wall 1	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	9.85	0.36	22%
Wall 1	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	10.16	0.45	27%
Wall 2	Framed wall - OSB - 2 sides	Internal	25600.00	1.00	ULS 17	0.8	1.5	2.50	13.07	0.51	38%
Wall 2	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	10.54	0.47	28%
Wall 3	Framed wall - OSB - 2 sides	Internal	25600.00	1.00	ULS 17	0.8	1.5	2.50	7.88	0.31	23%
Wall 3	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	12.69	0.57	34%

Wall 4	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	9.89	0.36	22%
Wall 4	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	10.21	0.46	27%
Wall 5	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 16	0.6	1.5	2.50	3.24	0.12	10%
Wall 5	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 16	0.6	1.5	2.50	2.10	0.09	7%
Wall 6	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	10.31	0.38	23%
Wall 6	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	21.72	0.97	58%
Wall 7	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	12.83	0.47	28%
Wall 7	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	10.67	0.48	29%
Wall 8	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	14.91	0.55	33%
Wall 8	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	33.69	1.50	90%
Wall 9	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	10.31	0.38	23%
Wall 9	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	9.36	0.42	25%
Wall 10	Framed wall - OSB - 2 sides	Internal	25600.00	1.00	ULS 17	0.8	1.5	2.50	32.29	1.26	95%
Wall 10	Framed wall - OSB - 2 sides	External	20800.00	1.00	ULS 17	0.8	1.5	2.50	16.79	0.81	61%
Wall 11	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	9.89	0.36	22%
Wall 11	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	9.72	0.43	26%
Wall 12	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	11.67	0.43	26%
Wall 12	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	26.63	1.19	71%
Wall 13	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	12.55	0.46	28%
Wall 13	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	26.96	1.20	72%
Wall 14	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	9.89	0.36	22%
Wall 14	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	10.20	0.46	27%
Wall 15	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	7.88	0.29	17%
Wall 15	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	8.81	0.39	24%
Wall 16	Framed wall - OSB - 2 sides	Internal	25600.00	1.00	ULS 17	0.8	1.5	2.50	9.44	0.37	28%
Wall 16	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	7.27	0.32	19%
Wall 17	Framed wall - OSB - 2 sides	Internal	25600.00	1.00	ULS 17	0.8	1.5	2.50	5.34	0.21	16%
Wall 17	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	10.65	0.48	29%

Wall 18	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	7.90	0.29	17%
Wall 18	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	8.93	0.40	24%
Wall 19	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 16	0.6	1.5	2.50	1.62	0.06	5%
Wall 19	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 16	0.6	1.5	2.50	1.06	0.05	4%
Wall 20	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	8.32	0.31	18%
Wall 20	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	14.43	0.64	39%
Wall 21	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	7.57	0.28	17%
Wall 21	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	6.08	0.27	16%
Wall 22	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	11.70	0.43	26%
Wall 22	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	23.58	1.05	63%
Wall 23	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	8.32	0.31	18%
Wall 23	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	8.27	0.37	22%
Wall 24	Framed wall - OSB - 2 sides	Internal	25600.00	1.00	ULS 17	0.8	1.5	2.50	25.80	1.01	76%
Wall 24	Framed wall - OSB - 2 sides	External	20800.00	1.00	ULS 17	0.8	1.5	2.50	14.31	0.69	52%
Wall 25	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	7.90	0.29	17%
Wall 25	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	8.44	0.38	23%
Wall 26	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	6.83	0.25	15%
Wall 26	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	16.17	0.72	43%
Wall 27	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	6.29	0.23	14%
Wall 27	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	15.77	0.70	42%
Wall 28	Framed wall - OSB - 2 sides	Internal	27200.00	1.25	ULS 17	0.8	1.5	2.50	7.90	0.29	17%
Wall 28	Framed wall - OSB - 2 sides	External	22400.00	1.25	ULS 17	0.8	1.5	2.50	8.92	0.40	24%
Wall 32	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 16	0.6	1.5	2.50	1.28	0.05	4%
Wall 32	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 16	0.6	1.5	2.50	0.57	0.03	2%
Wall 36	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	6.20	0.24	15%
Wall 36	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	7.34	0.35	21%
Wall 38	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	6.19	0.24	14%

Wall 38	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	7.50	0.36	22%
Wall 39	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	7.66	0.30	18%
Wall 39	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	7.08	0.34	20%
Wall 40	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	6.19	0.24	15%
Wall 40	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	7.30	0.35	21%
Wall 41	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	10.06	0.39	24%
Wall 41	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	12.80	0.62	37%
Wall 42	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	1.33	0.05	3%
Wall 42	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	30.79	1.48	89%
Wall 43	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	1.63	0.06	4%
Wall 43	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	8.63	0.41	25%
Wall 44	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	1.69	0.07	4%
Wall 44	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	8.75	0.42	25%
Wall 47	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	1.51	0.06	4%
Wall 47	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	4.02	0.19	12%
Wall 49	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	1.45	0.06	3%
Wall 49	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	4.05	0.19	12%
Wall 50	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	6.20	0.24	15%
Wall 50	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	7.41	0.36	21%
Wall 67	Framed wall - Gypsum-fibreboard - 1 side	Internal	25600.00	1.25	ULS 17	0.8	1.5	2.50	7.65	0.30	18%
Wall 67	Framed wall - Gypsum-fibreboard - 1 side	External	20800.00	1.25	ULS 17	0.8	1.5	2.50	7.34	0.35	21%

The shear strength of framed shear walls

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

Wall name	Length [m]	Comb.	Dur.	V2 [kN]
Wall 1	1.33	Horizontal ULS 2	Instantaneous	4.86
Wall 2	2.58	Horizontal ULS 1	Instantaneous	11.91
Wall 3	2.58	Horizontal ULS 1	Instantaneous	11.91
Wall 4	1.28	Horizontal ULS 2	Instantaneous	4.65
Wall 5	1.30	Horizontal ULS 2	Instantaneous	4.71
Wall 6	2.40	Horizontal ULS 2	Instantaneous	10.92
Wall 7	1.72	Horizontal ULS 1	Instantaneous	8.02
Wall 8	1.15	Horizontal ULS 2	Instantaneous	4.06
Wall 9	2.40	Horizontal ULS 2	Instantaneous	10.87
Wall 10	2.58	Horizontal ULS 1	Instantaneous	13.93
Wall 11	1.28	Horizontal ULS 2	Instantaneous	4.63
Wall 12	1.91	Horizontal ULS 1	Instantaneous	9.98
Wall 13	1.91	Horizontal ULS 1	Instantaneous	9.98
Wall 14	1.28	Horizontal ULS 2	Instantaneous	4.65
Wall 15	1.33	Seismic ULS 6 ex- ey-	Instantaneous	2.18
Wall 16	2.58	Horizontal ULS 1	Instantaneous	6.79
Wall 17	2.58	Horizontal ULS 1	Instantaneous	6.79
Wall 18	1.28	Seismic ULS 5 ex- ey+	Instantaneous	2.33
Wall 19	1.30	Seismic ULS 5 ex- ey+	Instantaneous	2.07
Wall 20	2.40	Seismic ULS 5 ex- ey+	Instantaneous	7.16
Wall 21	1.72	Horizontal ULS 1	Instantaneous	3.78
Wall 22	1.15	Seismic ULS 5 ex- ey+	Instantaneous	1.67
Wall 23	2.40	Seismic ULS 6 ex- ey-	Instantaneous	10.26
Wall 24	2.58	Horizontal ULS 1	Instantaneous	7.79
Wall 25	1.28	Seismic ULS 6 ex- ey-	Instantaneous	2.03
Wall 26	1.91	Horizontal ULS 1	Instantaneous	4.95

Wall 27	1.91	Horizontal ULS 1	Instantaneous	4.95
Wall 28	1.28	Seismic ULS 5 ex-ey+	Instantaneous	2.33
Wall 32	1.72	Seismic ULS 1 ex-ey+	Instantaneous	2.09
Wall 36	1.28	Seismic ULS 5 ex-ey+	Instantaneous	1.88
Wall 38	1.33	Seismic ULS 6 ex-ey-	Instantaneous	1.97
Wall 39	2.40	Seismic ULS 6 ex-ey-	Instantaneous	4.57
Wall 40	1.28	Seismic ULS 6 ex-ey-	Instantaneous	1.88
Wall 41	1.15	Seismic ULS 5 ex-ey+	Instantaneous	0.64
Wall 42	2.58	Seismic ULS 1 ex-ey+	Instantaneous	3.25
Wall 43	2.58	Seismic ULS 2 ex+ ey+	Instantaneous	3.36
Wall 44	2.58	Seismic ULS 2 ex+ ey+	Instantaneous	3.53
Wall 47	1.91	Seismic ULS 1 ex-ey+	Instantaneous	2.66
Wall 49	1.91	Seismic ULS 1 ex-ey+	Instantaneous	2.58
Wall 50	1.28	Seismic ULS 5 ex-ey+	Instantaneous	1.88
Wall 67	2.40	Seismic ULS 5 ex-ey+	Instantaneous	4.59

Lateral load-carrying capacity of metal fasteners

The design load-carrying capacity of a cantilevered panel secured against uplift is determined using the simplified method of analysis for walls proposed by EN 1995-1-1 9.2.4.2 “Simplified analysis of wall diaphragms – Method A”.

For a wall made up of several wall panels, the design racking load-carrying capacity of a wall should be calculated from:

$$F_{v,Rd} = \sum_i F_{i,v,Rd}$$

where:

$F_{i,v,Rd}$ is the design racking load-carrying capacity of the wall panel in accordance with 9.2.4.2(3) and 9.2.4.2(5) of EN 1995-1-1.

Wall panels which contain a door or window opening should not be considered to contribute to the racking load-carrying capacity.

The design racking load-carrying capacity of each wall panel, $F_{i,v,Rd}$, against a force $F_{i,v,Ed}$ should be calculated from:

$$F_{i,v,Rd} = \frac{F_{t,Rd} \cdot b_i \cdot c_i}{s}$$

where:

$F_{t,Rd}$ is the lateral design capacity of an individual fastener. For fasteners along the edges of an individual sheet, the design lateral load-carrying capacity should be increased by a factor of 1,2 over the corresponding values given in Section 8 of EN 1995-1-1. In determining the fastener spacing in accordance with the requirements of Section 8, the edges should be assumed to be unloaded.

b_i is the wall panel width

s is the fastener spacing

c_i a coefficient dependent on the ratio between base and height of a single wall panel.

For wall panels with sheets on both sides the following rules apply:

- if the sheets and fasteners are of the same type and dimension then the total racking load carrying capacity of the wall should be taken as the sum of the racking load-carrying capacities of the individual sides

- if different types of sheets are used, 75 % of the racking load-carrying capacity of the weaker side may, unless some other value is shown to be valid, be taken into consideration if fasteners with similar slip moduli are used. In other cases not more than 50 % should be taken into consideration.

Fasteners strength

The resistance of each fastener is estimated according to the theory of Johansen presented in 8.2.2 EN 1995-1-1 for panel-to-timber connections (Single shear).

The characteristic load-carrying capacity for nails, staples, bolts, dowels and screws per shear plane per fastener, should be taken as the minimum value found from the following expressions

$$F_{v,Rk,a} = f_{h,1,k} \cdot t_1 \cdot d$$

$$F_{v,Rk,b} = f_{h,2,k} \cdot t_2 \cdot d$$

$$F_{v,Rk,c} = \frac{f_{h,1,k} \cdot t_1 \cdot d}{1+\beta} \cdot \left[\sqrt{\beta + 2\beta^2 \left[1 + \frac{t_2}{t_1} + \left(\frac{t_2}{t_1} \right)^2 \right] + \beta^3 \left(\frac{t_2}{t_1} \right)^2} - \beta \left(1 + \frac{t_2}{t_1} \right) \right]$$

$$F_{v,Rk,d} = 1{,}05 \cdot \frac{f_{h,1,k} \cdot t_1 \cdot d}{2+\beta} \cdot \left[\sqrt{2\beta(1+\beta) + \frac{4\beta(2+\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot t_1^2}} - \beta \right]$$

$$F_{v,Rk,e} = 1{,}05 \cdot \frac{f_{h,1,k} \cdot t_2 \cdot d}{1+2\beta} \cdot \left[\sqrt{2\beta^2(1+\beta) + \frac{4\beta(1+2\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot t_2^2}} - \beta \right]$$

$$F_{v,Rk,f} = 1{,}15 \cdot \sqrt{\frac{2\beta}{1+\beta}} \sqrt{2 \cdot M_{y,Rk} \cdot f_{h,1,k} \cdot d}$$

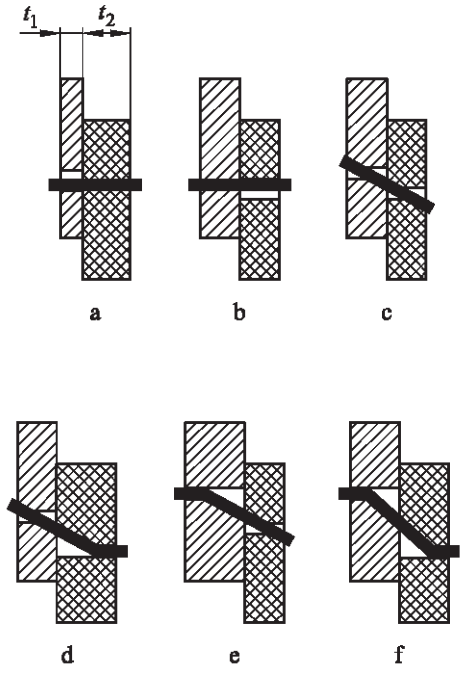


Figure: Failure modes for timber and panel connections.

The following table shows the resistances of the fasteners used to assemble the panels of the walls.

Section	Side	Fasteners	K_{ser} [N/mm]	Failure mode	$F_{v,Rk}$ [N]
Framed wall - OSB - 2 sides	1	RING HZ9 2,8/3,1 x 80	918	d	672
Framed wall - OSB - 2 sides	2	RING HZ9 2,8/3,1 x 80	918	d	672
Framed wall - Gypsum-fibreboard - 1 side	1	Staples G32 gypsum-fibreboard	545	e	428

Check of the bearing capacity of the walls related to the lateral load-carrying capacity of metal fasteners

The following table summarizes the geometric characteristics of the wall panels and their load-bearing capacity $F_{i,v,Rk}$. This table also indicates whether the panels fulfil the geometrical requirements of 9.2.4.2(2) EN 1995-1-1.

Wall name	Section	Panel	b_i [mm]	N panels	c_i	Geometric check	$F_{i,v,Rk}$ side 1 [kN]	$F_{i,v,Rk}$ side 2 [kN]
Wall 1	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 1	Framed wall - OSB - 2 sides	Leftovers	130.00	1	0.10	no	0.00	0.00
Wall 2	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 2	Framed wall - OSB - 2 sides	Leftovers	180.00	1	0.14	no	0.00	0.00
Wall 3	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 3	Framed wall - OSB - 2 sides	Leftovers	180.00	1	0.14	no	0.00	0.00
Wall 4	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 4	Framed wall - OSB - 2 sides	Leftovers	80.00	1	0.06	no	0.00	0.00
Wall 5	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 5	Framed wall - OSB - 2 sides	Leftovers	95.00	1	0.07	no	0.00	0.00
Wall 6	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 7	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 7	Framed wall - OSB - 2 sides	Leftovers	515.00	1	0.39	no	0.00	0.00
Wall 8	Framed wall - OSB - 2 sides	Standard	1200.00	0	0.90	ok	8.73	0.00
Wall 8	Framed wall - OSB - 2 sides	Leftovers	1150.00	1	0.86	ok	8.01	0.00

Wall 9	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 10	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 10	Framed wall - OSB - 2 sides	Leftovers	180.00	1	0.14	no	0.00	0.00
Wall 11	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 11	Framed wall - OSB - 2 sides	Leftovers	80.00	1	0.06	no	0.00	0.00
Wall 12	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 12	Framed wall - OSB - 2 sides	Leftovers	705.00	1	0.53	ok	3.01	0.00
Wall 13	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 13	Framed wall - OSB - 2 sides	Leftovers	705.00	1	0.53	ok	3.01	0.00
Wall 14	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 14	Framed wall - OSB - 2 sides	Leftovers	80.00	1	0.06	no	0.00	0.00
Wall 15	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 15	Framed wall - OSB - 2 sides	Leftovers	130.00	1	0.10	no	0.00	0.00
Wall 16	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 16	Framed wall - OSB - 2 sides	Leftovers	180.00	1	0.14	no	0.00	0.00
Wall 17	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 17	Framed wall - OSB - 2 sides	Leftovers	180.00	1	0.14	no	0.00	0.00
Wall 18	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 18	Framed wall - OSB - 2 sides	Leftovers	80.00	1	0.06	no	0.00	0.00
Wall 19	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 19	Framed wall - OSB - 2 sides	Leftovers	95.00	1	0.07	no	0.00	0.00
Wall 20	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 21	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00

Wall 21	Framed wall - OSB - 2 sides	Leftovers	515.00	1	0.39	no	0.00	0.00
Wall 22	Framed wall - OSB - 2 sides	Standard	1200.00	0	0.90	ok	8.73	0.00
Wall 22	Framed wall - OSB - 2 sides	Leftovers	1150.00	1	0.86	ok	8.01	0.00
Wall 23	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 24	Framed wall - OSB - 2 sides	Standard	1200.00	2	0.90	ok	8.73	0.00
Wall 24	Framed wall - OSB - 2 sides	Leftovers	180.00	1	0.14	no	0.00	0.00
Wall 25	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 25	Framed wall - OSB - 2 sides	Leftovers	80.00	1	0.06	no	0.00	0.00
Wall 26	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 26	Framed wall - OSB - 2 sides	Leftovers	705.00	1	0.53	ok	3.01	0.00
Wall 27	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 27	Framed wall - OSB - 2 sides	Leftovers	705.00	1	0.53	ok	3.01	0.00
Wall 28	Framed wall - OSB - 2 sides	Standard	1200.00	1	0.90	ok	8.73	0.00
Wall 28	Framed wall - OSB - 2 sides	Leftovers	80.00	1	0.06	no	0.00	0.00
Wall 32	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	1	1.00	ok	8.56	0.00
Wall 32	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	465.00	1	0.58	ok	1.86	0.00
Wall 36	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	1	1.00	ok	8.56	0.00
Wall 36	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	30.00	1	0.05	no	0.00	0.00
Wall 38	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	1	1.00	ok	8.56	0.00
Wall 38	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	80.00	1	0.13	no	0.00	0.00
Wall 39	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	1	1.00	ok	8.56	0.00
Wall 39	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	1150.00	1	1.00	ok	7.87	0.00
Wall 40	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	1	1.00	ok	8.56	0.00

Wall 40	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	30.00	1	0.05	no	0.00	0.00
Wall 41	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	0	1.00	ok	8.56	0.00
Wall 41	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	1150.00	1	1.00	ok	7.87	0.00
Wall 42	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	2	1.00	ok	8.56	0.00
Wall 42	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	80.00	1	0.09	no	0.00	0.00
Wall 43	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	2	1.00	ok	8.56	0.00
Wall 43	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	80.00	1	0.09	no	0.00	0.00
Wall 44	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	2	1.00	ok	8.56	0.00
Wall 44	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	80.00	1	0.09	no	0.00	0.00
Wall 47	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	1	1.00	ok	8.56	0.00
Wall 47	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	655.00	1	0.80	ok	3.61	0.00
Wall 49	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	1	1.00	ok	8.56	0.00
Wall 49	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	655.00	1	0.78	ok	3.52	0.00
Wall 50	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	1	1.00	ok	8.56	0.00
Wall 50	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	30.00	1	0.05	no	0.00	0.00
Wall 67	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250.00	1	1.00	ok	8.56	0.00
Wall 67	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	1150.00	1	1.00	ok	7.87	0.00

The following table instead shows checks with reference to the most significant load combinations.

Wall name	Section	Comb.	Dur.	k_{mod1}	k_{mod2}	γ_M	$F_{v,Rd}$ [kN]	$F_{v,Ed}$ [kN]	Check
Wall 1	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.5	11.63	4.86	31%
Wall 2	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	23.27	11.91	20%
Wall 3	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	23.27	11.91	20%
Wall 4	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.5	11.63	4.65	31%

Wall 5	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.5	11.63	4.71	31%
Wall 6	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.5	23.27	10.92	20%
Wall 7	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	11.63	8.02	40%
Wall 8	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.5	10.69	4.06	33%
Wall 9	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.5	23.27	10.87	19%
Wall 10	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	23.27	13.93	23%
Wall 11	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.5	11.63	4.63	31%
Wall 12	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	15.65	9.98	33%
Wall 13	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	15.65	9.98	33%
Wall 14	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.5	11.63	4.65	31%
Wall 15	Framed wall - OSB - 2 sides	Seismic ULS 6 ex- ey-	Instantaneous	1	1	1.5	11.63	2.18	14%
Wall 16	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	23.27	6.79	11%
Wall 17	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	23.27	6.79	11%
Wall 18	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.5	11.63	2.33	16%
Wall 19	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.5	11.63	2.07	14%
Wall 20	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.5	23.27	7.16	13%
Wall 21	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	11.63	3.78	19%
Wall 22	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.5	10.69	1.67	14%
Wall 23	Framed wall - OSB - 2 sides	Seismic ULS 6 ex- ey-	Instantaneous	1	1	1.5	23.27	10.26	18%
Wall 24	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	23.27	7.79	13%
Wall 25	Framed wall - OSB - 2 sides	Seismic ULS 6 ex- ey-	Instantaneous	1	1	1.5	11.63	2.03	14%
Wall 26	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	15.65	4.95	17%
Wall 27	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.5	15.65	4.95	17%

Wall 28	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.5	11.63	2.33	16%
Wall 32	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 1 ex- ey+	Instantaneous	1	-	1.5	6.95	2.09	18%
Wall 36	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 5 ex- ey+	Instantaneous	1	-	1.5	5.71	1.88	26%
Wall 38	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 6 ex- ey-	Instantaneous	1	-	1.5	5.71	1.97	26%
Wall 39	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 6 ex- ey-	Instantaneous	1	-	1.5	10.96	4.57	17%
Wall 40	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 6 ex- ey-	Instantaneous	1	-	1.5	5.71	1.88	26%
Wall 41	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 5 ex- ey+	Instantaneous	1	-	1.5	5.25	0.64	11%
Wall 42	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 1 ex- ey+	Instantaneous	1	-	1.5	11.41	3.25	11%
Wall 43	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 2 ex+ ey+	Instantaneous	1	-	1.5	11.41	3.36	11%
Wall 44	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 2 ex+ ey+	Instantaneous	1	-	1.5	11.41	3.53	12%
Wall 47	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 1 ex- ey+	Instantaneous	1	-	1.5	8.11	2.66	17%
Wall 49	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 1 ex- ey+	Instantaneous	1	-	1.5	8.05	2.58	17%
Wall 50	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 5 ex- ey+	Instantaneous	1	-	1.5	5.71	1.88	26%
Wall 67	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 5 ex- ey+	Instantaneous	1	-	1.5	10.96	4.59	17%

Shear strength of the sheeting boards

The design load-carrying capacity of a cantilevered panel secured against uplift is determined using the simplified method of analysis for walls proposed by EN 1995-1-1 9.2.4.2 “Simplified analysis of wall diaphragms – Method A”.

For a wall made up of several wall panels, the design racking load-carrying capacity of a wall should be calculated from:

$$F_{v,Rd} = \sum_i F_{i,v,Rd}$$

where:

$F_{i,v,Rd}$ is the design racking load-carrying capacity of the wall panel in accordance with 9.2.4.2(3) and 9.2.4.2(5) of EN 1995-1-1.

The load-carrying capacity of a sheeting panel $F_{i,v,Rd}$ is:

$$F_{i,j,v,Rd} = f_{j,v,d} \cdot b_i \cdot t_{i,j}$$

where:

$F_{i,j,v,Rd}$ is the shear strength of the single sheet, in which the first subscript indicates the panel of belonging and the second the side, external or internal

$f_{j,v,d}$ is the shear strength of the single sheeting board

b_i is the panel width

$t_{i,j}$ is the thickness of the sheeting board

The following table summarizes the load-bearing capacity $F_{i,v,Rk}$ of the wall panels. This table also indicates whether the panels fulfil the geometrical requirements of 9.2.4.2(2) EN 1995-1-1.

Wall name	Section	Panel	b_i [mm]	N of panels	c_i	Geometric check	$F_{i,v,Rk}$ lato 1 [kN]	$F_{i,v,Rk}$ lato 2 [kN]
Wall 1	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 1	Framed wall - OSB - 2 sides	Leftovers	130	1	0.10	no	0.00	0.00
Wall 2	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40
Wall 2	Framed wall - OSB - 2 sides	Leftovers	180	1	0.14	no	0.00	0.00
Wall 3	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40
Wall 3	Framed wall - OSB - 2 sides	Leftovers	180	1	0.14	no	0.00	0.00
Wall 4	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 4	Framed wall - OSB - 2 sides	Leftovers	80	1	0.06	no	0.00	0.00
Wall 5	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 5	Framed wall - OSB - 2 sides	Leftovers	95	1	0.07	no	0.00	0.00
Wall 6	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40
	Framed wall - OSB - 2 sides	Leftovers	0	1	0.00	no	0.00	0.00
Wall 7	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 7	Framed wall - OSB - 2 sides	Leftovers	515	1	0.39	no	0.00	0.00
Wall 8	Framed wall - OSB - 2 sides	Standard	1200	0	0.90	ok	122.40	122.40
Wall 8	Framed wall - OSB - 2 sides	Leftovers	1150	1	0.86	ok	117.30	117.30

Wall 9	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40
	Framed wall - OSB - 2 sides	Leftovers	0	1	0.00	no	0.00	0.00
Wall 10	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40
Wall 10	Framed wall - OSB - 2 sides	Leftovers	180	1	0.14	no	0.00	0.00
Wall 11	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 11	Framed wall - OSB - 2 sides	Leftovers	80	1	0.06	no	0.00	0.00
Wall 12	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 12	Framed wall - OSB - 2 sides	Leftovers	705	1	0.53	ok	71.91	71.91
Wall 13	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 13	Framed wall - OSB - 2 sides	Leftovers	705	1	0.53	ok	71.91	71.91
Wall 14	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 14	Framed wall - OSB - 2 sides	Leftovers	80	1	0.06	no	0.00	0.00
Wall 15	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 15	Framed wall - OSB - 2 sides	Leftovers	130	1	0.10	no	0.00	0.00
Wall 16	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40
Wall 16	Framed wall - OSB - 2 sides	Leftovers	180	1	0.14	no	0.00	0.00
Wall 17	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40
Wall 17	Framed wall - OSB - 2 sides	Leftovers	180	1	0.14	no	0.00	0.00
Wall 18	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 18	Framed wall - OSB - 2 sides	Leftovers	80	1	0.06	no	0.00	0.00
Wall 19	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 19	Framed wall - OSB - 2 sides	Leftovers	95	1	0.07	no	0.00	0.00
Wall 20	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40

	Framed wall - OSB - 2 sides	Leftovers	0	1	0.00	no	0.00	0.00
Wall 21	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 21	Framed wall - OSB - 2 sides	Leftovers	515	1	0.39	no	0.00	0.00
Wall 22	Framed wall - OSB - 2 sides	Standard	1200	0	0.90	ok	122.40	122.40
Wall 22	Framed wall - OSB - 2 sides	Leftovers	1150	1	0.86	ok	117.30	117.30
Wall 23	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40
	Framed wall - OSB - 2 sides	Leftovers	0	1	0.00	no	0.00	0.00
Wall 24	Framed wall - OSB - 2 sides	Standard	1200	2	0.90	ok	122.40	122.40
Wall 24	Framed wall - OSB - 2 sides	Leftovers	180	1	0.14	no	0.00	0.00
Wall 25	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 25	Framed wall - OSB - 2 sides	Leftovers	80	1	0.06	no	0.00	0.00
Wall 26	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 26	Framed wall - OSB - 2 sides	Leftovers	705	1	0.53	ok	71.91	71.91
Wall 27	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 27	Framed wall - OSB - 2 sides	Leftovers	705	1	0.53	ok	71.91	71.91
Wall 28	Framed wall - OSB - 2 sides	Standard	1200	1	0.90	ok	122.40	122.40
Wall 28	Framed wall - OSB - 2 sides	Leftovers	80	1	0.06	no	0.00	0.00
Wall 32	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	1	1.00	ok	67.50	0.00
Wall 32	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	465	1	0.58	ok	25.11	0.00
Wall 36	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	1	1.00	ok	67.50	0.00
Wall 36	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	30	1	0.05	no	0.00	0.00
Wall 38	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	1	1.00	ok	67.50	0.00
Wall 38	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	80	1	0.13	no	0.00	0.00

Wall 39	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	1	1.00	ok	67.50	0.00
Wall 39	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	1150	1	1.00	ok	62.10	0.00
Wall 40	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	1	1.00	ok	67.50	0.00
Wall 40	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	30	1	0.05	no	0.00	0.00
Wall 41	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	0	1.00	ok	67.50	0.00
Wall 41	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	1150	1	1.00	ok	62.10	0.00
Wall 42	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	2	1.00	ok	67.50	0.00
Wall 42	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	80	1	0.09	no	0.00	0.00
Wall 43	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	2	1.00	ok	67.50	0.00
Wall 43	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	80	1	0.09	no	0.00	0.00
Wall 44	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	2	1.00	ok	67.50	0.00
Wall 44	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	80	1	0.09	no	0.00	0.00
Wall 47	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	1	1.00	ok	67.50	0.00
Wall 47	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	655	1	0.80	ok	35.37	0.00
Wall 49	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	1	1.00	ok	67.50	0.00
Wall 49	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	655	1	0.78	ok	35.37	0.00
Wall 50	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	1	1.00	ok	67.50	0.00
Wall 50	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	30	1	0.05	no	0.00	0.00
Wall 67	Framed wall - Gypsum-fibreboard - 1 side	Standard	1250	1	1.00	ok	67.50	0.00
Wall 67	Framed wall - Gypsum-fibreboard - 1 side	Leftovers	1150	1	1.00	ok	62.10	0.00

The following table instead shows checks with reference to the most significant load combinations.

Wall name	Section	Comb.	Dur.	$k_{mod\ side1}$	$k_{mod\ side2}$	γ_M	γ_{M2}	$F_{v,Rd}$ [kN]	$F_{v,Ed}$ [kN]	Check
Wall 1	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.4	-	174.86	4.86	2%

Wall 2	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	349.71	11.91	1%
Wall 3	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	349.71	11.91	1%
Wall 4	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.4	-	174.86	4.65	2%
Wall 5	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.4	-	174.86	4.71	2%
Wall 6	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.4	-	349.71	10.92	1%
Wall 7	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	174.86	8.02	3%
Wall 8	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.4	-	167.57	4.06	2%
Wall 9	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.4	-	349.71	10.87	1%
Wall 10	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	349.71	13.93	2%
Wall 11	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.4	-	174.86	4.63	2%
Wall 12	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	277.59	9.98	2%
Wall 13	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	277.59	9.98	2%
Wall 14	Framed wall - OSB - 2 sides	Horizontal ULS 2	Instantaneous	1	1	1.4	-	174.86	4.65	2%
Wall 15	Framed wall - OSB - 2 sides	Seismic ULS 6 ex- ey-	Instantaneous	1	1	1.4	-	174.86	2.18	1%
Wall 16	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	349.71	6.79	1%
Wall 17	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	349.71	6.79	1%
Wall 18	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.4	-	174.86	2.33	1%
Wall 19	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.4	-	174.86	2.07	1%
Wall 20	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.4	-	349.71	7.16	1%
Wall 21	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	174.86	3.78	1%
Wall 22	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.4	-	167.57	1.67	1%
Wall 23	Framed wall - OSB - 2 sides	Seismic ULS 6 ex- ey-	Instantaneous	1	1	1.4	-	349.71	10.26	1%
Wall 24	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	349.71	7.79	1%

Wall 25	Framed wall - OSB - 2 sides	Seismic ULS 6 ex- ey-	Instantaneous	1	1	1.4	-	174.86	2.03	1%
Wall 26	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	277.59	4.95	1%
Wall 27	Framed wall - OSB - 2 sides	Horizontal ULS 1	Instantaneous	1	1	1.4	-	277.59	4.95	1%
Wall 28	Framed wall - OSB - 2 sides	Seismic ULS 5 ex- ey+	Instantaneous	1	1	1.4	-	174.86	2.33	1%
Wall 32	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 1 ex- ey+	Instantaneous	1	-	1.5	-	61.74	2.09	2%
Wall 36	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 5 ex- ey+	Instantaneous	1	-	1.5	-	45.00	1.88	3%
Wall 38	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 6 ex- ey-	Instantaneous	1	-	1.5	-	45.00	1.97	3%
Wall 39	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 6 ex- ey-	Instantaneous	1	-	1.5	-	86.40	4.57	2%
Wall 40	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 6 ex- ey-	Instantaneous	1	-	1.5	-	45.00	1.88	3%
Wall 41	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 5 ex- ey+	Instantaneous	1	-	1.5	-	41.40	0.64	1%
Wall 42	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 1 ex- ey+	Instantaneous	1	-	1.5	-	90.00	3.25	1%
Wall 43	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 2 ex+ ey+	Instantaneous	1	-	1.5	-	90.00	3.36	1%
Wall 44	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 2 ex+ ey+	Instantaneous	1	-	1.5	-	90.00	3.53	2%
Wall 47	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 1 ex- ey+	Instantaneous	1	-	1.5	-	68.58	2.66	2%
Wall 49	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 1 ex- ey+	Instantaneous	1	-	1.5	-	68.58	2.58	2%
Wall 50	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 5 ex- ey+	Instantaneous	1	-	1.5	-	45.00	1.88	3%
Wall 67	Framed wall - Gypsum-fibreboard - 1 side	Seismic ULS 5 ex- ey+	Instantaneous	1	-	1.5	-	86.40	4.59	2%

Shear buckling of the sheet

According to 9.2.4.1 of EN 1995-1-1 shear buckling of the sheet may be disregarded, provided that

$$\frac{b_{net}}{t} \leq 100$$

where

b_{net} is the clear distance between studs

t is the thickness of the sheet

Connections

Hold Down – Connections 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 four failure modes:

- Nailing failure
- Hold-downs steel failure
- Failure of the anchor
- Extraction of the anchor

Forces on the hold-downs

Wall name	Length [m]	Connection name	N° of anchors at each wall end	Comb.	Dur.	N [kN]	M_{3-3} [kNm]	Ta [kN]
Wall 1	1.33	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 2	Instantaneous	6.27	19.51	13.17
Wall 2	2.58	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 1	Instantaneous	12.47	53.30	16.72
Wall 3	2.58	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 1	Instantaneous	11.04	53.27	17.42
Wall 4	1.28	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 2	Instantaneous	6.15	19.26	13.65
Wall 5	1.30	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 2	Instantaneous	3.33	17.99	13.77
Wall 6	2.40	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 2	Instantaneous	11.63	49.48	17.09
Wall 7	1.72	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 1	Instantaneous	7.78	33.54	17.84
Wall 8	1.15	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 2	Instantaneous	7.28	15.98	11.80
Wall 9	2.40	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 2	Instantaneous	10.25	57.01	21.27
Wall 10	2.58	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 1	Instantaneous	16.79	61.56	18.12
Wall 11	1.28	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 2	Instantaneous	6.15	18.51	12.99
Wall 12	1.91	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 1	Instantaneous	10.31	42.27	19.50
Wall 13	1.91	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 1	Instantaneous	10.50	42.25	19.39
Wall 14	1.28	Ground connection - hold down - shear angle bracket	1	Horizontal ULS 2	Instantaneous	6.21	19.26	13.62

Nailing resistance

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

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

where

$\mathrm{R_{c,k,dens}}$ is the characteristic resistance of the nailing, corrected to take account of the actual density of the material used according to the formula $\mathrm{R_{c,k,dens}} = \mathrm{R_{c,k}} \cdot \left(\frac{\rho_k}{350}\right)^2$ where $\mathrm{R_{c,k}}$ was evaluated as described in the document ETA-11/0086 for WHT 340-440-540-620, and as described in ETA-09/0324 for WKR285, or on the basis of the data introduced by the user

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

Hold-down steel resistance

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

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

where

$\mathrm{R_{s,k}}$ is the characteristic value of the resistance of the angle bracket obtained in the document ETA-11/0086 for WHT 340-440-540-620, and obtained in the document ETA-09/0324 for WKR285, or on the basis of the data introduced by the user;

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

Tension resistance of the anchor

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

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

being:

$\mathrm{f_{ub}}$ is the ultimate tensile strength of the anchor

$\mathrm{A_s}$ 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

Pull-out resistance of the anchor

The characteristic value of pull-out resistance refers to a single anchor regardless of the effects due to the spacing or distances from the edges. Moreover concrete is considered to be non-cracked concrete, dry and at a standard temperature for the actual depth of anchorage

The design pull-out resistance can be calculated as

$$R_{pull,d} = \frac{R_{pull,k}}{\gamma_{Mc}}$$

where

$R_{pull,k}$ is the characteristic value of the pull-out resistance is calculated in accordance with the instructions of the European Technical Approval ETA-09/0078

γ_{Mc} is the corresponding partial safety factor assumed as proposed in the document ETA-09/0078

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.: More severe combination of load

T_{Ed}: Design value of the tensile force

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

R_d: Design value of the resistance, assumed as the lower of the values of the design resistance of all the failure mechanisms considered

$$T_{Ed} \leq R_d = min.\left(R_{c,d}; R_{s,d}; R_{t,d}; R_{pull,d}\right)$$

Wall name	Connection name	Comb.	T_{Ed} [kN]	$R_{c,k}$ [kN]	$R_{s,k}$ [kN]	$R_{t,k}$ [kN]	$R_{pull,k}$ [kN]	k_{mod}	γ_M	γ_{M2}	γ_{Me}	R_d [kN]	Failure mode	Check
Wall 1	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	13.17	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	42%
Wall 2	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	16.72	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	53%
Wall 3	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	17.42	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	55%

Wall 4	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	13.65	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	43%
Wall 5	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	13.77	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	44%
Wall 6	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	17.09	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	54%
Wall 7	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	17.84	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	57%
Wall 8	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	11.80	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	38%
Wall 9	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	21.27	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	68%
Wall 10	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	18.12	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	58%
Wall 11	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	12.99	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	41%
Wall 12	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	19.50	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	62%
Wall 13	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	19.39	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	62%
Wall 14	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	13.62	47.1	63.4	70.65	108.57	1	1.5	1.25	1.8	31.40	Nailed connection	43%

Connections with punched metal plate/punched strap

The design resistance R_d of a punched strap is determined as the minimum value among the resistances relating to the following failure modes:

- Nailing failure
- Punched strap steel failure

Forces on the tie-downs

Wall name	Length [m]	Connection name	N° of connections at each all end	Comb.	Dur.	N [kN]	M_{3-3} [kNm]	Ta [kN]
Wall 15	1.33	Upper level connection - punched strap - metal plate	1	Horizontal ULS 2	Instantaneous	4.58	-6.60	3.22
Wall 16	2.58	Upper level connection - punched strap - metal plate	1	Horizontal ULS 1	Instantaneous	7.99	21.62	5.32
Wall 17	2.58	Upper level connection - punched strap - metal plate	1	Horizontal ULS 1	Instantaneous	7.26	21.59	5.67
Wall 18	1.28	Upper level connection - punched strap - metal plate	1	Horizontal ULS 2	Instantaneous	4.50	-6.89	3.73
Wall 19	1.30	Upper level connection - punched strap - metal plate	1	Horizontal ULS 2	Instantaneous	1.67	-5.46	3.85
Wall 20	2.40	Upper level connection - punched strap - metal plate	1	Horizontal ULS 2	Instantaneous	8.18	-20.45	5.38
Wall 21	1.72	Upper level connection - punched strap - metal plate	1	Horizontal ULS 1	Instantaneous	4.74	12.19	5.53
Wall 22	1.15	Upper level connection - punched strap - metal plate	1	Horizontal ULS 2	Instantaneous	4.83	-5.19	2.60
Wall 23	2.40	Upper level connection - punched strap - metal plate_A	1	Horizontal ULS 2	Instantaneous	7.45	-28.09	9.28
Wall 24	2.58	Upper level connection - punched strap - metal plate	1	Horizontal ULS 1	Instantaneous	11.14	24.51	4.98
Wall 25	1.28	Upper level connection - punched strap - metal plate	1	Horizontal ULS 2	Instantaneous	4.49	-6.18	3.12
Wall 26	1.91	Upper level connection - punched strap - metal plate	1	Horizontal ULS 1	Instantaneous	6.65	15.73	5.85
Wall 27	1.91	Upper level connection - punched strap - metal plate	1	Horizontal ULS 1	Instantaneous	6.61	15.72	5.86
Wall 28	1.28	Upper level connection - punched strap - metal plate	1	Horizontal ULS 2	Instantaneous	4.55	-6.89	3.70
Wall 32	1.72	Upper level connection - punched strap - metal plate_2piano	1	Seismic ULS 1 ex- ey+	Instantaneous	2.35	3.33	0.98
Wall 36	1.28	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	2.84	-0.06	0.00
Wall 38	1.33	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	2.89	0.06	0.00
Wall 39	2.40	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	4.64	0.15	0.00

Wall 40	1.28	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	2.84	0.06	0.00
Wall 41	1.15	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	2.38	0.00	0.00
Wall 42	2.58	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	5.46	3.78	0.00
Wall 43	2.58	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	3.48	3.54	0.00
Wall 44	2.58	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	3.52	3.58	0.00
Wall 47	1.91	Upper level connection - punched strap - metal plate_2piano	1	Seismic ULS 1 ex- ey+	Instantaneous	4.04	4.33	0.51
Wall 49	1.91	Upper level connection - punched strap - metal plate_2piano	1	Seismic ULS 1 ex- ey+	Instantaneous	4.02	4.30	0.50
Wall 50	1.28	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	2.84	-0.06	0.00
Wall 67	2.40	Upper level connection - punched strap - metal plate_2piano	1	Horizontal ULS 1	Instantaneous	4.67	-0.15	0.00

Punched strap tensile resistance

The tensile resistance of the punched element is evaluated on the basis of the indications of 6.2.3 EN 1993-1-1. For sections with holes the design tension resistance $N_{t,Rd}$ should be taken as the smaller of the design plastic resistance of the gross cross-section and the design ultimate resistance of the net cross-section at holes for fasteners.

The design plastic resistance of the gross cross-section is calculated as

$$R_{pl,Rd} = \frac{A \cdot f_y}{\gamma_{M0}}$$

where

A is the area of the gross cross-section

f_y is the nominal values of the yield strength of steel

γ_{M0} is the partial factor for resistance of cross-sections

The the design ultimate resistance of the net cross-section at holes for fasteners can be calculated with the following expression:

$$R_{u,Rd} = \frac{0.9 \cdot A_{net} \cdot f_u}{\gamma_{M2}}$$

in cui

A_{net} is the cross sectional net area

f_u is the ultimate strength of the yield strength of steel

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

Nailing resistance

The characteristic resistance of the connection was calculated as the product between the number of connectors inserted and bearing capacity of the single fastener

$$\mathrm{R_{c,k}} = \mathrm{n_{conn}} \cdot \mathrm{R_{k,conn}}$$

where the bearing capacity of the single fastener $\mathrm{R_{k,conn}}$ is evaluated using Johansen theory. The design value of the load-bearing capacity is given by

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

where

$\mathrm{R_{c,k}}$ is the characteristic resistance of the fastener

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 shows the characteristic values of resistance associated with the different failure modes of the components.

Name: Name of the connection in which the punched strap is used

Comb.: More severe combination of load

T_{Ed}: Design force

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

γ_M: Partial factor

R_d: Design value of the resistance, assumed as the lower of the values of the design resistance of all the failure mechanisms considered

$$T_{Ed} \leq min.(R_{pl,Rd};\ R_{u,d};\ R_{c,d})$$

Wall name	Connection name	Comb.	T_{Ed} [kN]	$R_{c,k}$ [kN]	$R_{pl,k}$ [kN]	$R_{u,k}$ [kN]	k_{mod}	γ_M	γ_{M0}	γ_{M2}	R_d [kN]	Failure mode	Check
Wall 15	Upper level connection - punched strap - metal plate	Horizontal ULS 2	3.22	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	48%

Wall 16	Upper level connection - punched strap - metal plate	Horizontal ULS 1	5.32	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	79%
Wall 17	Upper level connection - punched strap - metal plate	Horizontal ULS 1	5.67	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	84%
Wall 18	Upper level connection - punched strap - metal plate	Horizontal ULS 2	3.73	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	55%
Wall 19	Upper level connection - punched strap - metal plate	Horizontal ULS 2	3.85	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	57%
Wall 20	Upper level connection - punched strap - metal plate	Horizontal ULS 2	5.38	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	79%
Wall 21	Upper level connection - punched strap - metal plate	Horizontal ULS 1	5.53	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	82%
Wall 22	Upper level connection - punched strap - metal plate	Horizontal ULS 2	2.60	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	38%
Wall 23	Upper level connection - punched strap - metal plate_A	Horizontal ULS 2	9.28	21.75	40	35.64	1	1.5	1.05	1.25	14.50	Nailed connection	64%
Wall 24	Upper level connection - punched strap - metal plate	Horizontal ULS 1	4.98	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	74%
Wall 25	Upper level connection - punched strap - metal plate	Horizontal ULS 2	3.12	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	46%
Wall 26	Upper level connection - punched strap - metal plate	Horizontal ULS 1	5.85	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	86%
Wall 27	Upper level connection - punched strap - metal plate	Horizontal ULS 1	5.86	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	87%
Wall 28	Upper level connection - punched strap - metal plate	Horizontal ULS 2	3.70	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	55%
Wall 32	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 1 ex- ey+	0.98	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	14%
Wall 36	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%
Wall 38	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%
Wall 39	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%
Wall 40	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%
Wall 41	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%
Wall 42	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%

Wall 43	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%
Wall 44	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%
Wall 47	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 1 ex- ey+	0.51	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	7%
Wall 49	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 1 ex- ey+	0.50	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	7%
Wall 50	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%
Wall 67	Upper level connection - punched strap - metal plate_2piano	Horizontal ULS 1	0.00	10.15	40	35.64	1	1.5	1.05	1.25	6.77	Nailed connection	0%

Shear connections with punched metal plate

The design resistance R_d of a punched metal plate is determined as the minimum value among the resistances relating to the following failure modes:

- Shear failure of the metal plate
- Shear failure of the group of fasteners of the connection

Shear forces

The shear force acting on the single metal plate is calculated by dividing the total shear force V_2 by the number of metal plates 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.	V_2 [kN]	Va [kN]
Wall 1	1.33	Ground connection - hold down - shear angle bracket	2	Horizontal ULS 2	Instantaneous	4.86	2.43
Wall 2	2.58	Ground connection - hold down - shear angle bracket	5	Horizontal ULS 1	Instantaneous	11.91	2.38
Wall 3	2.58	Ground connection - hold down - shear angle bracket	5	Horizontal ULS 1	Instantaneous	11.91	2.38
Wall 4	1.28	Ground connection - hold down - shear angle bracket	2	Horizontal ULS 2	Instantaneous	4.65	2.33
Wall 5	1.30	Ground connection - hold down - shear angle bracket	2	Horizontal ULS 2	Instantaneous	4.71	2.35
Wall 6	2.40	Ground connection - hold down - shear angle bracket	4	Horizontal ULS 2	Instantaneous	10.92	2.73
Wall 7	1.72	Ground connection - hold down - shear angle bracket	3	Horizontal ULS 1	Instantaneous	8.02	2.67
Wall 8	1.15	Ground connection - hold down - shear angle bracket	2	Horizontal ULS 2	Instantaneous	4.06	2.03
Wall 9	2.40	Ground connection - hold down - shear angle bracket	4	Horizontal ULS 2	Instantaneous	10.87	2.72
Wall 10	2.58	Ground connection - hold down - shear angle bracket	5	Horizontal ULS 1	Instantaneous	13.93	2.79
Wall 11	1.28	Ground connection - hold down - shear angle bracket	2	Horizontal ULS 2	Instantaneous	4.63	2.32
Wall 12	1.91	Ground connection - hold down - shear angle bracket	3	Horizontal ULS 1	Instantaneous	9.98	3.33

Wall 13	1.91	Ground connection - hold down - shear angle bracket	3	Horizontal ULS 1	Instantaneous	9.98	3.33
Wall 14	1.28	Ground connection - hold down - shear angle bracket	2	Horizontal ULS 2	Instantaneous	4.65	2.33
Wall 15	1.33	Upper level connection - punched strap - metal plate	2	Seismic ULS 6 ex-ey-	Instantaneous	2.18	1.09
Wall 16	2.58	Upper level connection - punched strap - metal plate	5	Horizontal ULS 1	Instantaneous	6.79	1.36
Wall 17	2.58	Upper level connection - punched strap - metal plate	5	Horizontal ULS 1	Instantaneous	6.79	1.36
Wall 18	1.28	Upper level connection - punched strap - metal plate	2	Seismic ULS 5 ex-ey+	Instantaneous	2.33	1.16
Wall 19	1.30	Upper level connection - punched strap - metal plate	2	Seismic ULS 5 ex-ey+	Instantaneous	2.07	1.03
Wall 20	2.40	Upper level connection - punched strap - metal plate	4	Seismic ULS 5 ex-ey+	Instantaneous	7.16	1.79
Wall 21	1.72	Upper level connection - punched strap - metal plate	3	Horizontal ULS 1	Instantaneous	3.78	1.26
Wall 22	1.15	Upper level connection - punched strap - metal plate	2	Seismic ULS 5 ex-ey+	Instantaneous	1.67	0.83
Wall 23	2.40	Upper level connection - punched strap - metal plate_A	4	Seismic ULS 6 ex-ey-	Instantaneous	10.26	2.56
Wall 24	2.58	Upper level connection - punched strap - metal plate	5	Horizontal ULS 1	Instantaneous	7.79	1.56
Wall 25	1.28	Upper level connection - punched strap - metal plate	2	Seismic ULS 6 ex-ey-	Instantaneous	2.03	1.02
Wall 26	1.91	Upper level connection - punched strap - metal plate	3	Horizontal ULS 1	Instantaneous	4.95	1.65
Wall 27	1.91	Upper level connection - punched strap - metal plate	3	Horizontal ULS 1	Instantaneous	4.95	1.65
Wall 28	1.28	Upper level connection - punched strap - metal plate	2	Seismic ULS 5 ex-ey+	Instantaneous	2.33	1.16
Wall 32	1.72	Upper level connection - punched strap - metal plate_2piano	3	Seismic ULS 1 ex-ey+	Instantaneous	2.09	0.70
Wall 36	1.28	Upper level connection - punched strap - metal plate_2piano	2	Seismic ULS 5 ex-ey+	Instantaneous	1.88	0.94
Wall 38	1.33	Upper level connection - punched strap - metal plate_2piano	2	Seismic ULS 6 ex-ey-	Instantaneous	1.97	0.99
Wall 39	2.40	Upper level connection - punched strap - metal plate_2piano	4	Seismic ULS 6 ex-ey-	Instantaneous	4.57	1.14
Wall 40	1.28	Upper level connection - punched strap - metal plate_2piano	2	Seismic ULS 6 ex-ey-	Instantaneous	1.88	0.94
Wall 41	1.15	Upper level connection - punched strap - metal plate_2piano	2	Seismic ULS 5 ex-ey+	Instantaneous	0.64	0.32
Wall 42	2.58	Upper level connection - punched strap - metal plate_2piano	5	Seismic ULS 1 ex-ey+	Instantaneous	3.25	0.65

Wall 43	2.58	Upper level connection - punched strap - metal plate_2piano	5	Seismic ULS 2 ex+ ey+	Instantaneous	3.36	0.67
Wall 44	2.58	Upper level connection - punched strap - metal plate_2piano	5	Seismic ULS 2 ex+ ey+	Instantaneous	3.53	0.71
Wall 47	1.91	Upper level connection - punched strap - metal plate_2piano	3	Seismic ULS 1 ex- ey+	Instantaneous	2.66	0.89
Wall 49	1.91	Upper level connection - punched strap - metal plate_2piano	3	Seismic ULS 1 ex- ey+	Instantaneous	2.58	0.86
Wall 50	1.28	Upper level connection - punched strap - metal plate_2piano	2	Seismic ULS 5 ex- ey+	Instantaneous	1.88	0.94
Wall 67	2.40	Upper level connection - punched strap - metal plate_2piano	4	Seismic ULS 5 ex- ey+	Instantaneous	4.59	1.15

Metal plate bearing capacity

The design value of the shear strength of single metal plate is calculated as indicated in 6.2.6 of EN 1993-1-1 through the following expression

$$R_{s,d} = \frac{\mathrm{A_v} \cdot \mathrm{f_y}/\sqrt{3}}{\gamma_{M0}}$$

where

$\mathrm{A_v}$ is the net shear area

$\mathrm{f_y}$ is the nominal values of yield strength of metal plate steel

γ_{M0} is the partial factor for resistance of cross-sections

Fasteners bearing capacity

The characteristic resistance of the connection is calculated as the product between the number of fasteners inserted and the bearing capacity of the single fastener

$$\mathrm{R_{c,k}} = \mathrm{n_{conn}} \cdot \mathrm{R_{k,conn}}$$

where the resistance of the single connector $\mathrm{R_{k,conn}}$ is evaluated using the theory of Johansen. The design value of the load-bearing capacity is given by

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

where:

$\mathrm{R_{c,k}}$ is the characteristic resistance of the connection

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 table below where the characteristic value of the metal plate resistance and the relative design values are reported.

$$V_{Ed} \leq min\,(R_{s,d};\, R_{c,d})$$

Connection name: Name of the connection in which the metal plate is used

Comb.: More severe combination of load

$V_{a,Ed}$: Design value of the force acting on each plate

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

γ_M is the partial factor for connections

Wall name	Connection name	Comb.	$V_{a,Ed}$ [kN]	$R_{c,k}$ [kN]	k_{mod}	γ_M	$R_{c,d}$ [kN]	Fasteners check	$R_{s,k}$ [kN]	γ_{M0}	$R_{s,d}$ [kN]	Metal plate check
Wall 1	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	2.43	11.1	1	1.5	7.40	33%	25.98	1.05	24.74	10%
Wall 2	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	2.38	11.1	1	1.5	7.40	32%	25.98	1.05	24.74	10%
Wall 3	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	2.38	11.1	1	1.5	7.40	32%	25.98	1.05	24.74	10%
Wall 4	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	2.33	11.1	1	1.5	7.40	31%	25.98	1.05	24.74	9%
Wall 5	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	2.35	11.1	1	1.5	7.40	32%	25.98	1.05	24.74	10%
Wall 6	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	2.73	11.1	1	1.5	7.40	37%	25.98	1.05	24.74	11%
Wall 7	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	2.67	11.1	1	1.5	7.40	36%	25.98	1.05	24.74	11%
Wall 8	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	2.03	11.1	1	1.5	7.40	27%	25.98	1.05	24.74	8%

Wall 9	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	2.72	11.1	1	1.5	7.40	37%	25.98	1.05	24.74	11%
Wall 10	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	2.79	11.1	1	1.5	7.40	38%	25.98	1.05	24.74	11%
Wall 11	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	2.32	11.1	1	1.5	7.40	31%	25.98	1.05	24.74	9%
Wall 12	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	3.33	11.1	1	1.5	7.40	45%	25.98	1.05	24.74	13%
Wall 13	Ground connection - hold down - shear angle bracket	Horizontal ULS 1	3.33	11.1	1	1.5	7.40	45%	25.98	1.05	24.74	13%
Wall 14	Ground connection - hold down - shear angle bracket	Horizontal ULS 2	2.33	11.1	1	1.5	7.40	31%	25.98	1.05	24.74	9%
Wall 15	Upper level connection - punched strap - metal plate	Seismic ULS 6 ex- ey-	1.09	21.75	1	1.5	14.50	8%	43.3	1.05	41.24	3%
Wall 16	Upper level connection - punched strap - metal plate	Horizontal ULS 1	1.36	21.75	1	1.5	14.50	9%	43.3	1.05	41.24	3%
Wall 17	Upper level connection - punched strap - metal plate	Horizontal ULS 1	1.36	21.75	1	1.5	14.50	9%	43.3	1.05	41.24	3%
Wall 18	Upper level connection - punched strap - metal plate	Seismic ULS 5 ex- ey+	1.16	21.75	1	1.5	14.50	8%	43.3	1.05	41.24	3%
Wall 19	Upper level connection - punched strap - metal plate	Seismic ULS 5 ex- ey+	1.03	21.75	1	1.5	14.50	7%	43.3	1.05	41.24	3%
Wall 20	Upper level connection - punched strap - metal plate	Seismic ULS 5 ex- ey+	1.79	21.75	1	1.5	14.50	12%	43.3	1.05	41.24	4%
Wall 21	Upper level connection - punched strap - metal plate	Horizontal ULS 1	1.26	21.75	1	1.5	14.50	9%	43.3	1.05	41.24	3%
Wall 22	Upper level connection -	Seismic ULS 5 ex- ey+	0.83	21.75	1	1.5	14.50	6%	43.3	1.05	41.24	2%

	punched strap - metal plate											
Wall 23	Upper level connection - punched strap - metal plate_A	Seismic ULS 6 ex- ey-	2.56	21.75	1	1.5	14.50	18%	43.3	1.05	41.24	6%
Wall 24	Upper level connection - punched strap - metal plate	Horizontal ULS 1	1.56	21.75	1	1.5	14.50	11%	43.3	1.05	41.24	4%
Wall 25	Upper level connection - punched strap - metal plate	Seismic ULS 6 ex- ey-	1.02	21.75	1	1.5	14.50	7%	43.3	1.05	41.24	2%
Wall 26	Upper level connection - punched strap - metal plate	Horizontal ULS 1	1.65	21.75	1	1.5	14.50	11%	43.3	1.05	41.24	4%
Wall 27	Upper level connection - punched strap - metal plate	Horizontal ULS 1	1.65	21.75	1	1.5	14.50	11%	43.3	1.05	41.24	4%
Wall 28	Upper level connection - punched strap - metal plate	Seismic ULS 5 ex- ey+	1.16	21.75	1	1.5	14.50	8%	43.3	1.05	41.24	3%
Wall 32	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 1 ex- ey+	0.70	14.5	1	1.5	9.67	7%	43.3	1.05	41.24	2%
Wall 36	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 5 ex- ey+	0.94	14.5	1	1.5	9.67	10%	43.3	1.05	41.24	2%
Wall 38	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 6 ex- ey-	0.99	14.5	1	1.5	9.67	10%	43.3	1.05	41.24	2%
Wall 39	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 6 ex- ey-	1.14	14.5	1	1.5	9.67	12%	43.3	1.05	41.24	3%
Wall 40	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 6 ex- ey-	0.94	14.5	1	1.5	9.67	10%	43.3	1.05	41.24	2%
Wall 41	Upper level connection - punched	Seismic ULS 5 ex- ey+	0.32	14.5	1	1.5	9.67	3%	43.3	1.05	41.24	1%

	strap - metal plate_2piano											
Wall 42	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 1 ex- ey+	0.65	14.5	1	1.5	9.67	7%	43.3	1.05	41.24	2%
Wall 43	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 2 ex+ ey+	0.67	14.5	1	1.5	9.67	7%	43.3	1.05	41.24	2%
Wall 44	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 2 ex+ ey+	0.71	14.5	1	1.5	9.67	7%	43.3	1.05	41.24	2%
Wall 47	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 1 ex- ey+	0.89	14.5	1	1.5	9.67	9%	43.3	1.05	41.24	2%
Wall 49	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 1 ex- ey+	0.86	14.5	1	1.5	9.67	9%	43.3	1.05	41.24	2%
Wall 50	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 5 ex- ey+	0.94	14.5	1	1.5	9.67	10%	43.3	1.05	41.24	2%
Wall 67	Upper level connection - punched strap - metal plate_2piano	Seismic ULS 5 ex- ey+	1.15	14.5	1	1.5	9.67	12%	43.3	1.05	41.24	3%

Damage Limit State - Limitation of interstory drift

Damage limitation states are those associated with damage beyond which specified service requirements are no longer met.

An adequate degree of reliability against unacceptable damage shall be ensured by satisfying the deformation limits or other relevant limits defined in Italian Standard NTC '08.

In the case of civil and industrial constructions, if the temporary unavailability is due to excessive interstory drifts, this condition can be considered fulfilled when the displacements between two floors, obtained from the analysis with the design seismic action (SLD), are smaller than the limit specified below.

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

where

d_r is the interstory drift

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.: More severe combination of load

dr: Evaluated interstory drift

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

Wall name	h [m]	Comb.	d_r [mm]	d_{lim} [mm]	Check
Wall 1	2.66	Seismic SLS 6 ex- ey-	2.51	13.30	19%
Wall 2	2.66	Seismic SLS 1 ex+ ey-	2.02	13.30	15%
Wall 3	2.66	Seismic SLS 1 ex+ ey-	2.02	13.30	15%
Wall 4	2.66	Seismic SLS 5 ex- ey+	2.49	13.30	19%
Wall 5	2.66	Seismic SLS 5 ex- ey+	2.31	13.30	17%
Wall 6	2.66	Seismic SLS 5 ex- ey+	2.49	13.30	19%
Wall 7	2.66	Seismic SLS 2 ex- ey-	1.99	13.30	15%

Wall 8	2.66	Seismic SLS 5 ex- ey+	2.31	13.30	17%
Wall 9	2.66	Seismic SLS 6 ex- ey-	2.51	13.30	19%
Wall 10	2.66	Seismic SLS 2 ex- ey-	1.99	13.30	15%
Wall 11	2.66	Seismic SLS 6 ex- ey-	2.51	13.30	19%
Wall 12	2.66	Seismic SLS 2 ex- ey-	2.30	13.30	17%
Wall 13	2.66	Seismic SLS 2 ex- ey-	2.30	13.30	17%
Wall 14	2.66	Seismic SLS 5 ex- ey+	2.49	13.30	19%
Wall 15	2.66	Seismic SLS 6 ex- ey-	4.60	13.30	35%
Wall 16	2.66	Seismic SLS 2 ex+ ey+	4.06	13.30	31%
Wall 17	2.66	Seismic SLS 2 ex+ ey+	4.06	13.30	31%
Wall 18	2.66	Seismic SLS 5 ex- ey+	5.26	13.30	40%
Wall 19	2.66	Seismic SLS 5 ex- ey+	4.58	13.30	34%
Wall 20	2.66	Seismic SLS 5 ex- ey+	5.26	13.30	40%
Wall 21	2.66	Seismic SLS 1 ex- ey+	4.12	13.30	31%
Wall 22	2.66	Seismic SLS 5 ex- ey+	4.58	13.30	34%
Wall 23	2.66	Seismic SLS 6 ex- ey-	4.60	13.30	35%
Wall 24	2.66	Seismic SLS 1 ex- ey+	4.12	13.30	31%
Wall 25	2.66	Seismic SLS 6 ex- ey-	4.60	13.30	35%
Wall 26	2.66	Seismic SLS 1 ex- ey+	4.91	13.30	37%
Wall 27	2.66	Seismic SLS 1 ex- ey+	4.91	13.30	37%
Wall 28	2.66	Seismic SLS 5 ex- ey+	5.26	13.30	40%
Wall 32	1.59	Seismic SLS 1 ex- ey+	1.62	7.95	20%
Wall 36	1.28	Seismic SLS 5 ex- ey+	1.73	6.40	27%
Wall 38	1.28	Seismic SLS 6 ex- ey-	1.72	6.40	27%
Wall 39	1.28	Seismic SLS 6 ex- ey-	1.72	6.40	27%

Wall 40	1.28	Seismic SLS 6 ex- ey-	1.72	6.40	27%
Wall 41	2.28	Seismic SLS 5 ex- ey+	1.58	11.40	14%
Wall 42	1.81	Seismic SLS 1 ex- ey+	1.62	9.08	18%
Wall 43	1.81	Seismic SLS 2 ex+ ey+	1.67	9.08	18%
Wall 44	1.74	Seismic SLS 2 ex+ ey+	1.67	8.73	19%
Wall 47	1.63	Seismic SLS 1 ex- ey+	1.84	8.15	23%
Wall 49	1.67	Seismic SLS 1 ex- ey+	1.84	8.35	22%
Wall 50	1.28	Seismic SLS 5 ex- ey+	1.73	6.40	27%
Wall 67	1.28	Seismic SLS 5 ex- ey+	1.73	6.40	27%