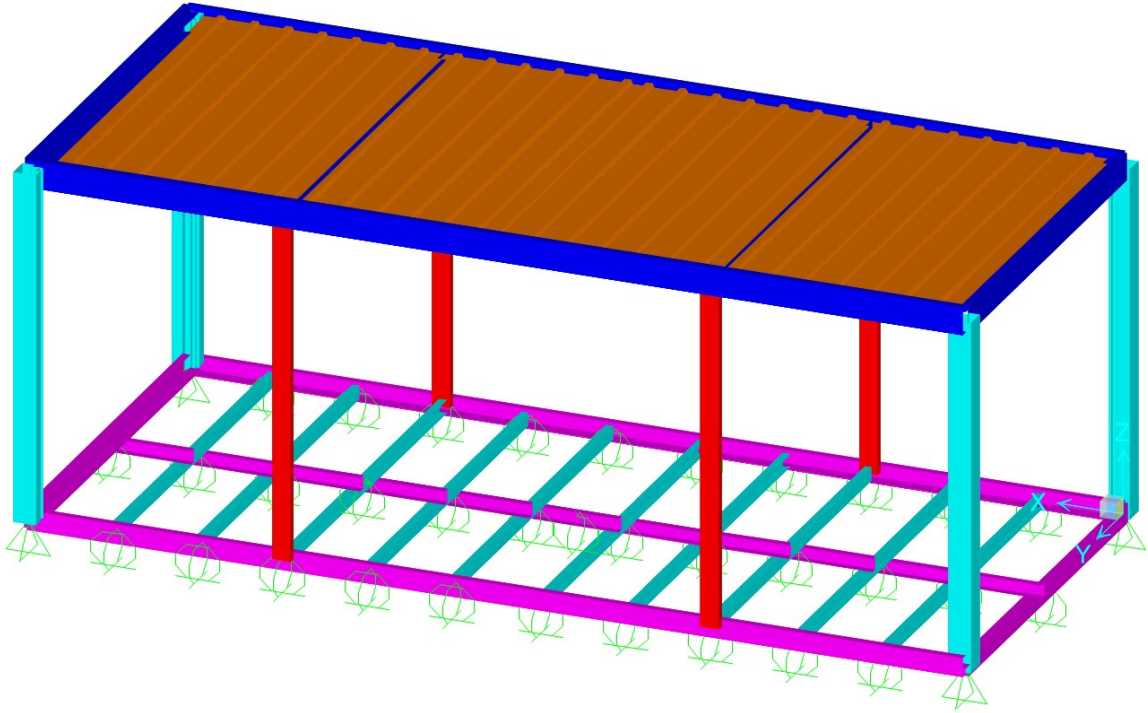


STATICAL REPORT for 3x7 METERS ONE STOREY CONTAINER



April 2022

1. INTRODUCTION	3
2. Reference and software.....	3
2.1. Refence.....	3
2.2. software.....	3
3. DESIGN PARAMETERS.....	5
4. METARIAL MECHANİCAL PROPERTIES	5
5. COMBINATIONS	6
6. FRAME ASSIGNMENTS	10
6.1. Frame Labels	10
6.2. Frame Section Assignments.....	10
7. DESIGN LOADS	11
7.1. Dead and Super Dead Load	11
7.2. Live Load	14
7.3. Wind Load	15
7.4. Snow Load.....	21
8. DYNAMIC ANALYSIS and DYNAMIC CONTROLS	24
9. STEEL FRAME DESIGN	31
10. DEFLECTION CHECK.....	33
10.1.Horizontal Deflection Check.....	33
10.2.Vertical Deflection Check.....	35

1. INTRODUCTION

This report was calculated static and dynamic analysis of 3x7 meters one storey container. This container height is 2.60 meters. Container will be built in PGermany.

The purpose of this report is to analyze the container under statical loads and quake loads. In order to analyze the structure, drawings from the owner are entered to the SAP2000 Integrated Structural Analysis and Design Software.

SAP2000-V19.2.2 is used to set up 3d structural system and analysed by using of finite element .

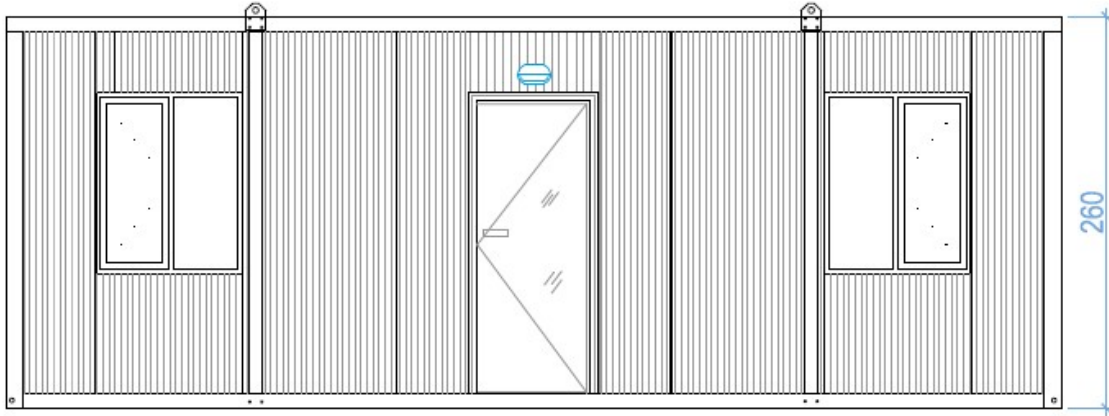
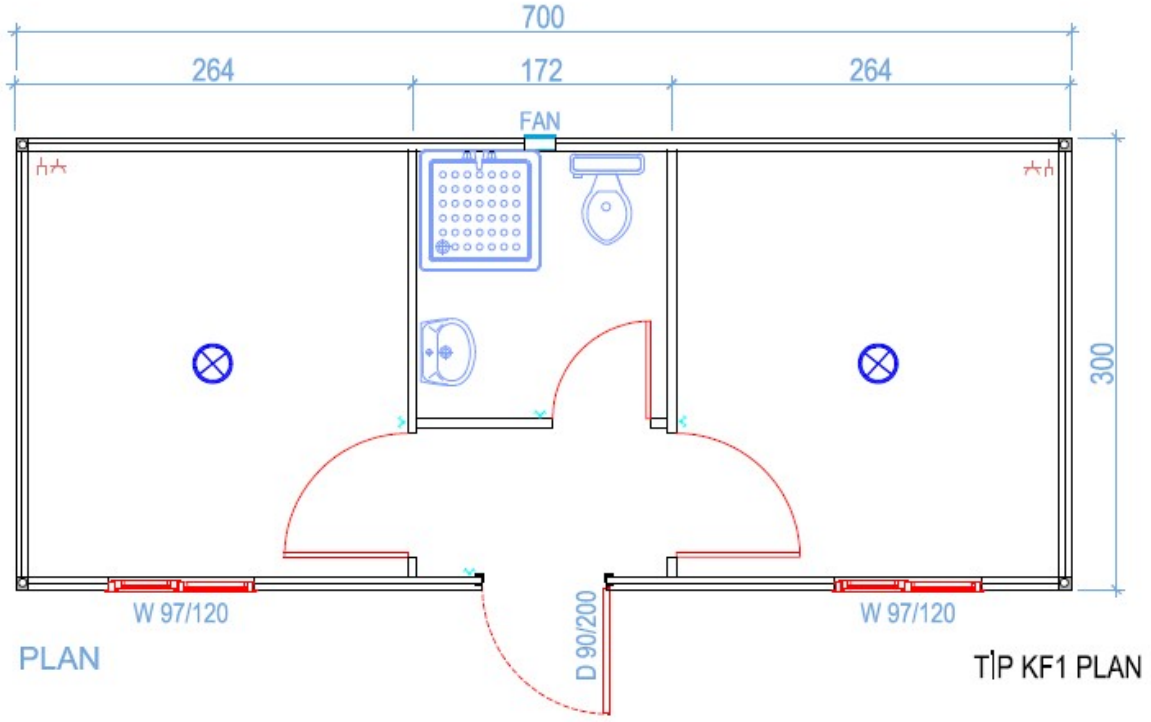
2. Reference and software

2.1. Refence

- EN 1990 Eurocode: Basis of structural design
- EN 1991 Eurocode 1: Actions on structures
- En 1998 Eurocode 8: 2004 Design of structures for earthquake resistance
- Steel member Design Code Eurocode 3-2005
- A review of the seismic hazard zonation in national building codes in the context of eurocode 8

2.2. software

CSI, SAP2000 (version 19.2.2): Intergated Software for Structural Analysis and Design, Computers and Structures, Inc., Berkeley, California.



ÖN CEPHE
FRONT VIEW

3. DESIGN PARAMETERS

- Seismic risk area :Zone 1
- Horizontal Ground Accel ag/g :0.041g
- Snow Load Participation n :0.2
- Building Importance Parameter I :1.0
- Structural behavior factor :4.0
- Soil Class :Stiff Soil Category C
- Snow load :84 kg/m²
- Wind Load : 28.5 m/s
- Analysis Method :Eurocode3-2005 Design Check(SAP 2000)

4. METARIAL MECHANICAL PROPERTIES

LIGHT GAUGE STEEL GRADE				
Class	Standart	Quality	Yielding Stress(kgf/cm ²)	Tension (kgf/cm ²)
1311	DINEN10327-04	DX51D+ Z	2300	2700
1335	DINEN10326-04	S350GD+ Z	3500	4200

Cold Formed Steel Profiles Quality SQ Grade 50 and SQ Grade 33 class;

$$\sigma_{\text{yielding}} = 2300 \text{ kg/cm}^2$$

$$\sigma_s = 0.6 \times 2300 = 1380 \text{ kg/cm}^2$$

$$\tau_{\text{torsion}} = \sigma_{\text{tension}} / \sqrt{3} = 2700 / \sqrt{3} = 1872 \text{ kg/cm}^2$$

$$E = 2.1 \times 10^6 \text{ kg/cm}^2$$

$$G = 810000 \text{ kg/cm}^2$$

Bold Quality :

High strength bolts of H8.8 quality used.

$$\sigma_{\text{yield}} = 6400 \text{ kg/cm}^2$$

$$\sigma_{\text{tensionultimate}} = 8000 \text{ kg/cm}^2$$

$$\tau = 3695 \text{ kg/cm}^2$$

5. COMBINATIONS

Load combinations was prepared according to Eurocode 0:2002

Eurocode 0:2002 allows load combinations to be defined based on EC0 equation 6.10 or the less favorable EC0 equations 6.10a and 6.10b [NDP].

$$\sum_{j \geq 1} \gamma_{G,j} G_{k,j} + \gamma_P P + \gamma_{Q,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \quad (\text{EC0 Eq. 6.10})$$

$$\sum_{j \geq 1} \gamma_{G,j} G_{k,j} + \gamma_P P + \gamma_{Q,1} \psi_{Q,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \quad (\text{EC0 Eq. 6.10a})$$

$$\sum_{j \geq 1} \xi_j \gamma_{G,j} G_{k,j} + \gamma_P P + \gamma_{Q,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \quad (\text{EC0 Eq. 6.10b})$$

Table A1.1 - Recommended values of ψ factors for buildings

Action	ψ_0	ψ_1	ψ_2
Imposed loads in buildings, category (see EN 1991-1-1)			
Category A : domestic, residential areas	0,7	0,5	0,3
Category B : office areas	0,7	0,5	0,3
Category C : congregation areas	0,7	0,7	0,6
Category D : shopping areas	0,7	0,7	0,6
Category E : storage areas	1,0	0,9	0,8
Category F : traffic area, vehicle weight $\leq 30\text{kN}$	0,7	0,7	0,6
Category G : traffic area, $30\text{kN} < \text{vehicle weight} \leq 160\text{kN}$	0,7	0,5	0,3
Category H : roofs	0	0	0
Snow loads on buildings (see EN 1991-1-3)*			
– Finland, Iceland, Norway, Sweden	0,70	0,50	0,20
– Remainder of CEN Member States, for sites located at altitude $H > 1000\text{ m a.s.l.}$	0,70	0,50	0,20
– Remainder of CEN Member States, for sites located at altitude $H \leq 1000\text{ m a.s.l.}$	0,50	0,20	0
Wind loads on buildings (see EN 1991-1-4)	0,6	0,2	0
Temperature (non-fire) in buildings (see EN 1991-1-5)	0,6	0,5	0
NOTE The ψ values may be set by the National annex. * For countries not mentioned below, see relevant local conditions.			

Table A1.3 - Design values of actions for use in accidental and seismic combinations of actions

Design situation	Permanent actions		Leading accidental or seismic action	Accompanying variable actions (**)	
	Unfavourable	Favourable		Main (if any)	Others
Accidental (*) (Eq. 6.11a/b)	$G_{kj, sup}$	$G_{kj, inf}$	A_d	ψ_{11} OR $\psi_{21} Q_{k,1}$	$\psi_{2,i} Q_{k,i}$
Seismic (Eq. 6.12a/b)	$G_{kj, sup}$	$G_{kj, inf}$	$\gamma_d A_{Ed}$ OR A_{Ed}	$\psi_{2,i} Q_{k,i}$	

(*) In the case of accidental design situations, the main variable action may be taken with its frequent or, as in seismic combinations of actions, its quasi-permanent values. The choice will be in the National annex, depending on the accidental action under consideration. See also EN 1991-1-2.

(**) Variable actions are those considered in Table A1.1.

LOAD TYPE

- DL→Dead load
- LL→Live load
- DL-R→Roof dead load
- DL-C→Covering dead load
- DL-F→Floor dead load
- +Wx→Wind +x
- -Wx→ Wind -x
- +Wy→ Wind +y
- -Wy→ Wind -y

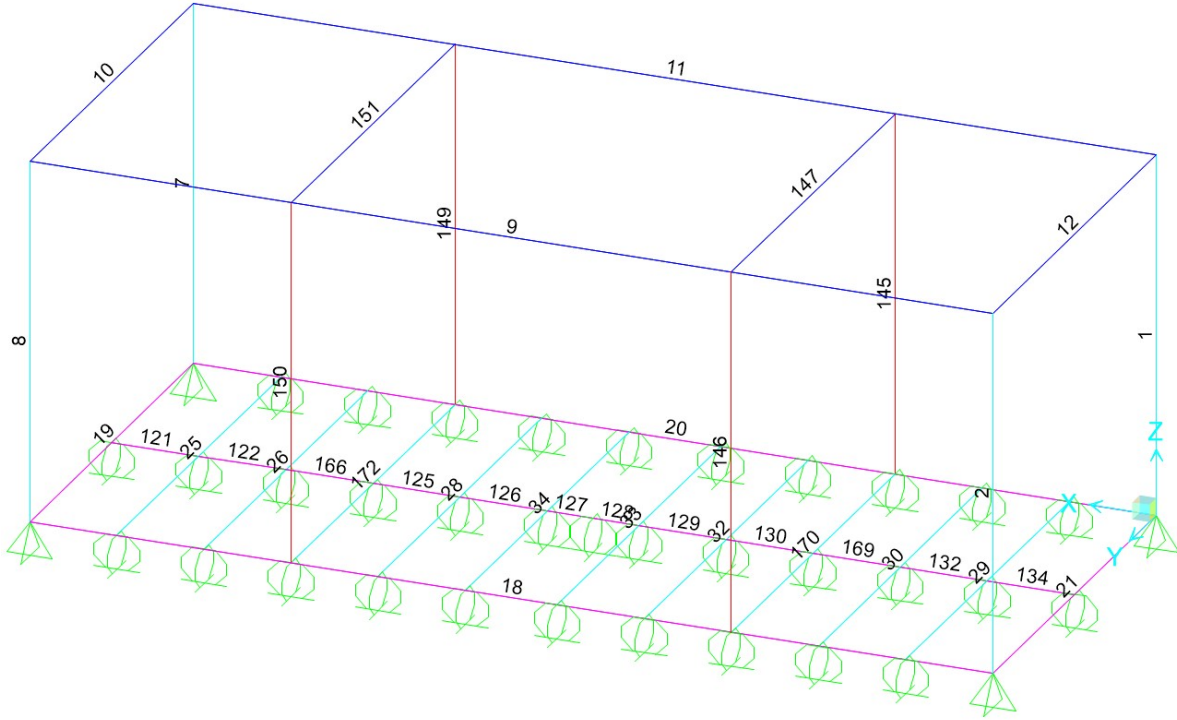
TABLE: Combination Definitions					
ComboName	ComboType	AutoDesign	CaseType	CaseName	ScaleFactor
Text	Text	Yes/No	Text	Text	Unitless
DL+LL	Linear Add	No	Linear Static	DL	1
DL+LL			Linear Static	LL	1
DL+LL			Linear Static	DL-f	1
DL+LL			Linear Static	DL-c	1
DL+LL			Linear Static	DL-r	1
1.35DL	Linear Add	No	Linear Static	D	1.35
1.35DL			Linear Static	DL-c	1.35
1.35DL			Linear Static	DL-f	1.35
1.35DL			Linear Static	DL-r	1.35
1.35DL+1.5LL	Linear Add	No	Linear Static	D	1.35
1.35DL+1.5LL			Linear Static	DL-c	1.35
1.35DL+1.5LL			Linear Static	DL-f	1.35
1.35DL+1.5LL			Linear Static	DL-r	1.35
1.35DL+1.5LL			Linear Static	LL	1.5
1.35DL+1.5LL+0.9Wx	Linear Add	No	Linear Static	D	1.35

1.35DL+1.5LL+0.9Wx			Linear Static	DL-c	1.35
1.35DL+1.5LL+0.9Wx			Linear Static	DL-f	1.35
1.35DL+1.5LL+0.9Wx			Linear Static	DL-r	1.35
1.35DL+1.5LL+0.9Wx			Linear Static	LL	1.5
1.35DL+1.5LL+0.9Wx			Linear Static	WX+	0.9
1.35DL+1.5LL-0.9Wx	Linear Add	No	Linear Static	D	1.35
1.35DL+1.5LL-0.9Wx			Linear Static	DL-c	1.35
1.35DL+1.5LL-0.9Wx			Linear Static	DL-f	1.35
1.35DL+1.5LL-0.9Wx			Linear Static	DL-r	1.35
1.35DL+1.5LL-0.9Wx			Linear Static	LL	1.5
1.35DL+1.5LL-0.9Wx			Linear Static	WX+	0.9
1.35DL+1.5LL+0.9Wy	Linear Add	No	Linear Static	D	1.35
1.35DL+1.5LL+0.9Wy			Linear Static	DL-c	1.35
1.35DL+1.5LL+0.9Wy			Linear Static	DL-f	1.35
1.35DL+1.5LL+0.9Wy			Linear Static	DL-r	1.35
1.35DL+1.5LL+0.9Wy			Linear Static	LL	1.5
1.35DL+1.5LL+0.9Wy			Linear Static	WY+	0.9
1.35DL+1.5LL-0.9Wy	Linear Add	No	Linear Static	D	1.35
1.35DL+1.5LL-0.9Wy			Linear Static	DL-c	1.35
1.35DL+1.5LL-0.9Wy			Linear Static	DL-f	1.35
1.35DL+1.5LL-0.9Wy			Linear Static	DL-r	1.35
1.35DL+1.5LL-0.9Wy			Linear Static	LL	1.5
1.35DL+1.5LL-0.9Wy			Linear Static	WY-	0.9
1.35DL+1.05LL+1.5Wx	Linear Add	No	Linear Static	D	1.35
1.35DL+1.05LL+1.5Wx			Linear Static	DL-c	1.35
1.35DL+1.05LL+1.5Wx			Linear Static	DL-f	1.35
1.35DL+1.05LL+1.5Wx			Linear Static	DL-r	1.35
1.35DL+1.05LL+1.5Wx			Linear Static	LL	1.05
1.35DL+1.05LL+1.5Wx			Linear Static	WX+	1.5
1.35DL+1.05LL-1.5Wx	Linear Add	No	Linear Static	D	1.35
1.35DL+1.05LL-1.5Wx			Linear Static	DL-c	1.35
1.35DL+1.05LL-1.5Wx			Linear Static	DL-f	1.35
1.35DL+1.05LL-1.5Wx			Linear Static	DL-r	1.35
1.35DL+1.05LL-1.5Wx			Linear Static	LL	1.05
1.35DL+1.05LL-1.5Wx			Linear Static	WX-	1.5
1.35DL+1.05LL+1.5Wy	Linear Add	No	Linear Static	D	1.35
1.35DL+1.05LL+1.5Wy			Linear Static	DL-c	1.35
1.35DL+1.05LL+1.5Wy			Linear Static	DL-f	1.35
1.35DL+1.05LL+1.5Wy			Linear Static	DL-r	1.35
1.35DL+1.05LL+1.5Wy			Linear Static	LL	1.05
1.35DL+1.05LL+1.5Wy			Linear Static	WY+	1.5
1.35DL+1.05LL-1.5Wy	Linear Add	No	Linear Static	D	1.35
1.35DL+1.05LL-1.5Wy			Linear Static	DL-c	1.35
1.35DL+1.05LL-1.5Wy			Linear Static	DL-f	1.35
1.35DL+1.05LL-1.5Wy			Linear Static	DL-r	1.35

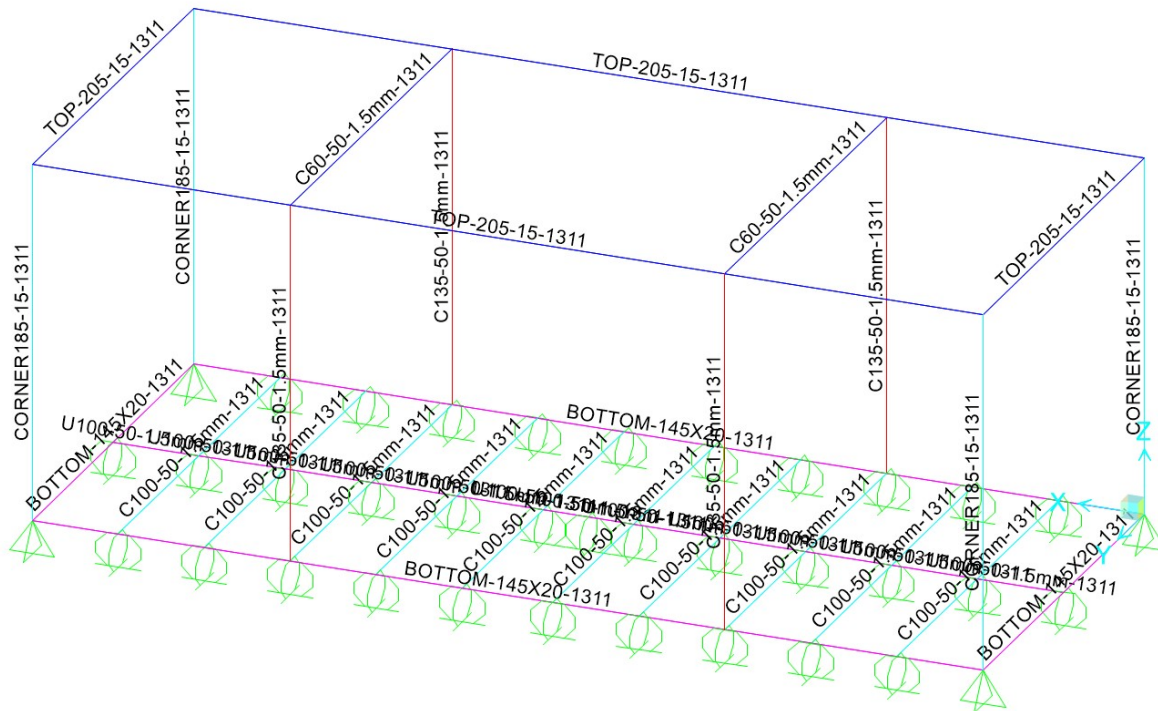
1.35DL+1.05LL-1.5Wy			Linear Static	LL	1.05
1.35DL+1.05LL-1.5Wy			Linear Static	WY-	1.5
1.35DL+1.5WX	Linear Add	No	Linear Static	D	1.35
1.35DL+1.5WX			Linear Static	DL-c	1.35
1.35DL+1.5WX			Linear Static	DL-f	1.35
1.35DL+1.5WX			Linear Static	DL-r	1.35
1.35DL+1.5WX			Linear Static	WX+	1.5
1.35DL-1.5WX	Linear Add	No	Linear Static	D	1.35
1.35DL-1.5WX			Linear Static	DL-c	1.35
1.35DL-1.5WX			Linear Static	DL-f	1.35
1.35DL-1.5WX			Linear Static	DL-r	1.35
1.35DL-1.5WX			Linear Static	WX-	1.5
1.35DL+1.5WY	Linear Add	No	Linear Static	D	1.35
1.35DL+1.5WY			Linear Static	DL-c	1.35
1.35DL+1.5WY			Linear Static	DL-f	1.35
1.35DL+1.5WY			Linear Static	DL-r	1.35
1.35DL+1.5WY			Linear Static	WY+	1.5
1.35DL-1.5WY	Linear Add	No	Linear Static	D	1.35
1.35DL-1.5WY			Linear Static	DL-c	1.35
1.35DL-1.5WY			Linear Static	DL-f	1.35
1.35DL-1.5WY			Linear Static	DL-r	1.35
1.35DL-1.5WY			Linear Static	WY-	1.5
DL+1.5WX	Linear Add	No	Linear Static	D	1
DL+1.5WX			Linear Static	DL-c	1
DL+1.5WX			Linear Static	DL-f	1
DL+1.5WX			Linear Static	DL-r	1
DL+1.5WX			Linear Static	WX+	1.5
DL-1.5WX	Linear Add	No	Linear Static	D	1
DL-1.5WX			Linear Static	DL-c	1
DL-1.5WX			Linear Static	DL-f	1
DL-1.5WX			Linear Static	DL-r	1
DL-1.5WX			Linear Static	WX-	1.5
DL+1.5WY	Linear Add	No	Linear Static	D	1
DL+1.5WY			Linear Static	DL-c	1
DL+1.5WY			Linear Static	DL-f	1
DL+1.5WY			Linear Static	DL-r	1
DL+1.5WY			Linear Static	WY+	1.5
DL-1.5WY	Linear Add	No	Linear Static	D	1
DL-1.5WY			Linear Static	DL-c	1
DL-1.5WY			Linear Static	DL-f	1
DL-1.5WY			Linear Static	DL-r	1
DL-1.5WY			Linear Static	WY-	1.5

6. FRAME ASSIGNMENTS

6.1. Frame Labels



6.2. Frame Section Assignments



7. DESIGN LOADS

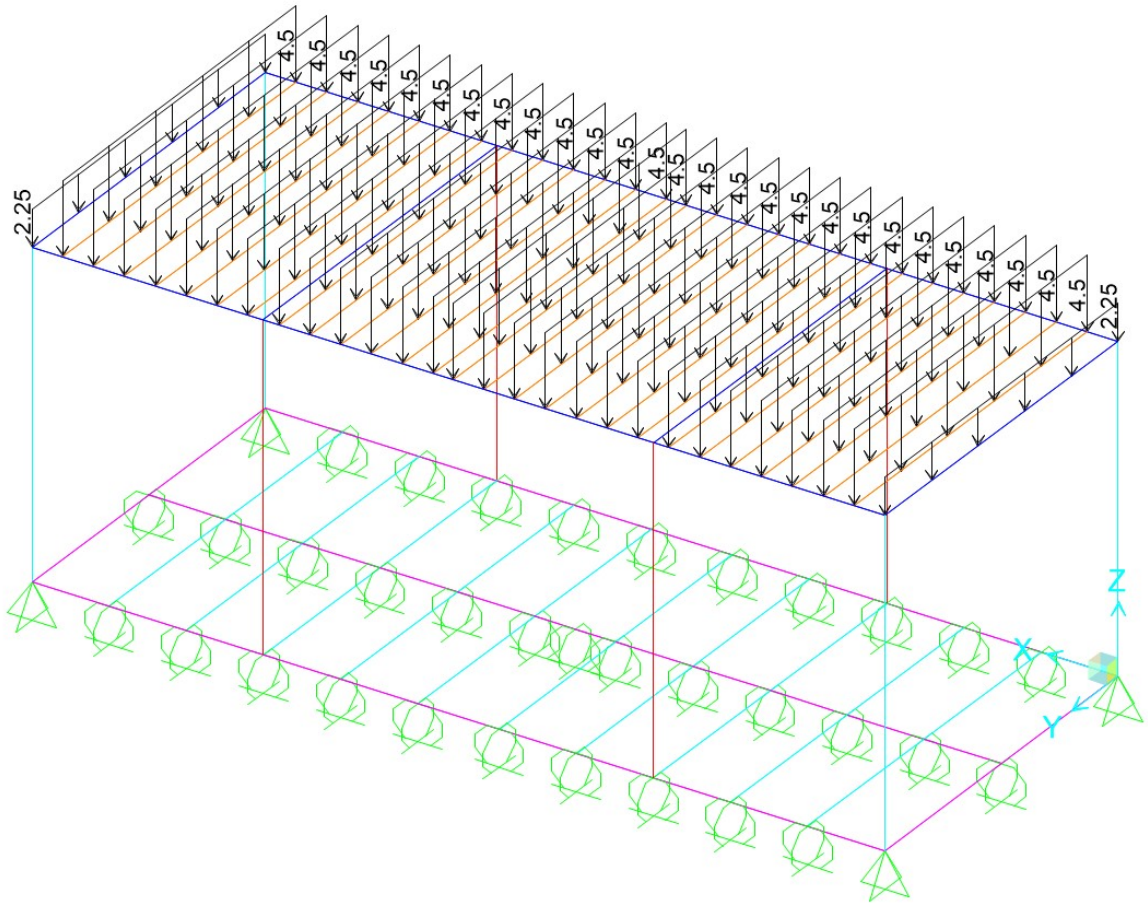
7.1. Dead and Super Dead Load

Self-weight of structural steel is considered by SAP2000 software, superdead loads are given below:

Roof covering loads; DL-R

100 mm Sandwich panel 18 kg/m²

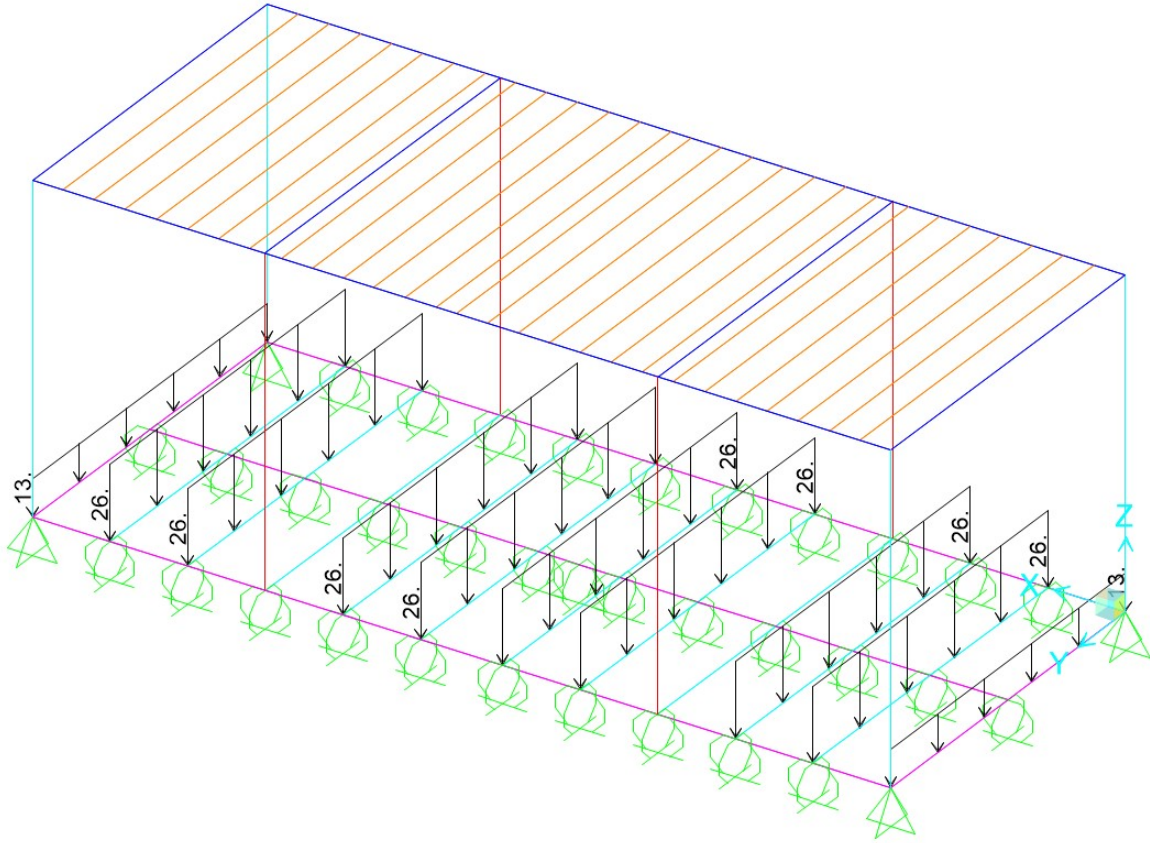
18 kg/m² x 0.25 m(Sandwich panel is contact chasis top profile at 25 cm to 25cm..)=4.5 kg/m



Bottom ceiling loads, DL-C

Cover material.....	6 kg/m ²
16mm Fibercement.....	26 kg/m ²
İsolation.....	3 kg/m ²
Sheet.....	5 kg/m ²
Total dead loads	40 kg/m ²

On chassis secondary profile: 40 kg/m² x 0.65 m= 26 kg/m



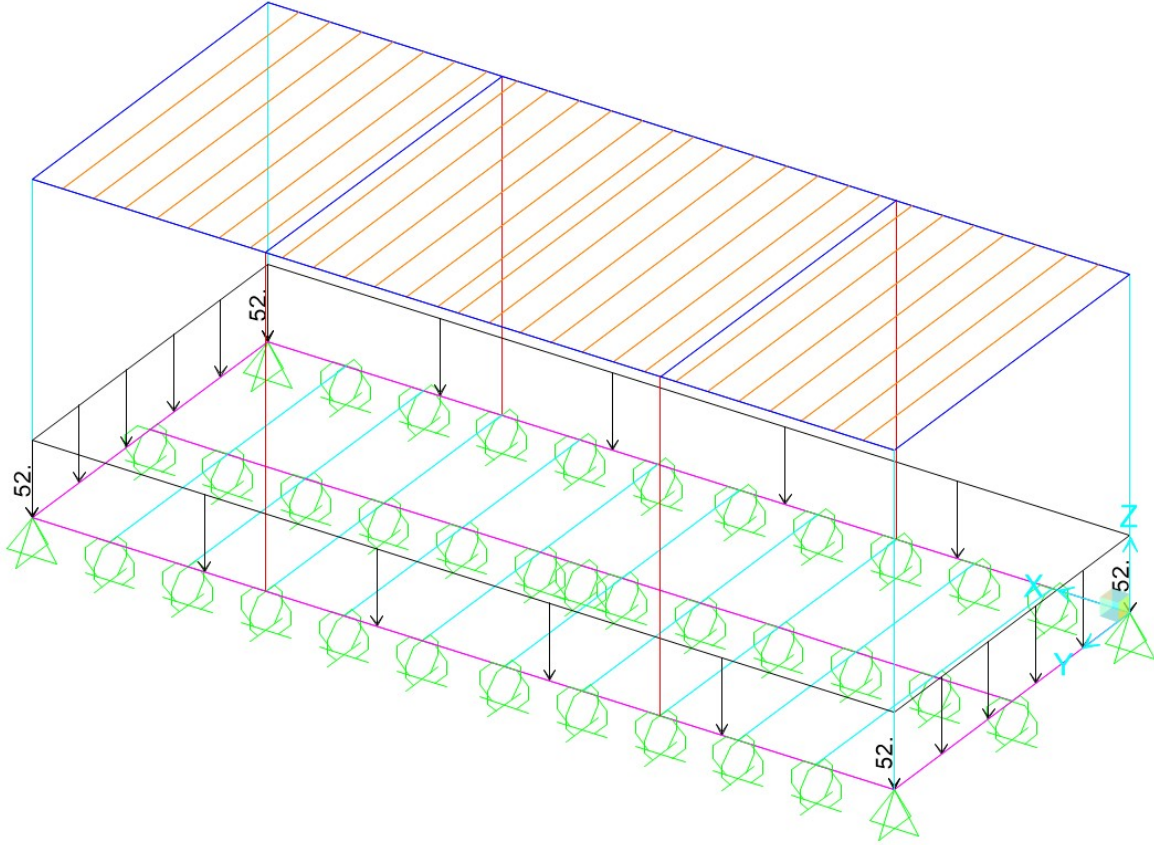
Wall covering loads; DL-F

100 mm Sandvich panel 17 kg/m²

Door , window ... additional load 3 kg/m²

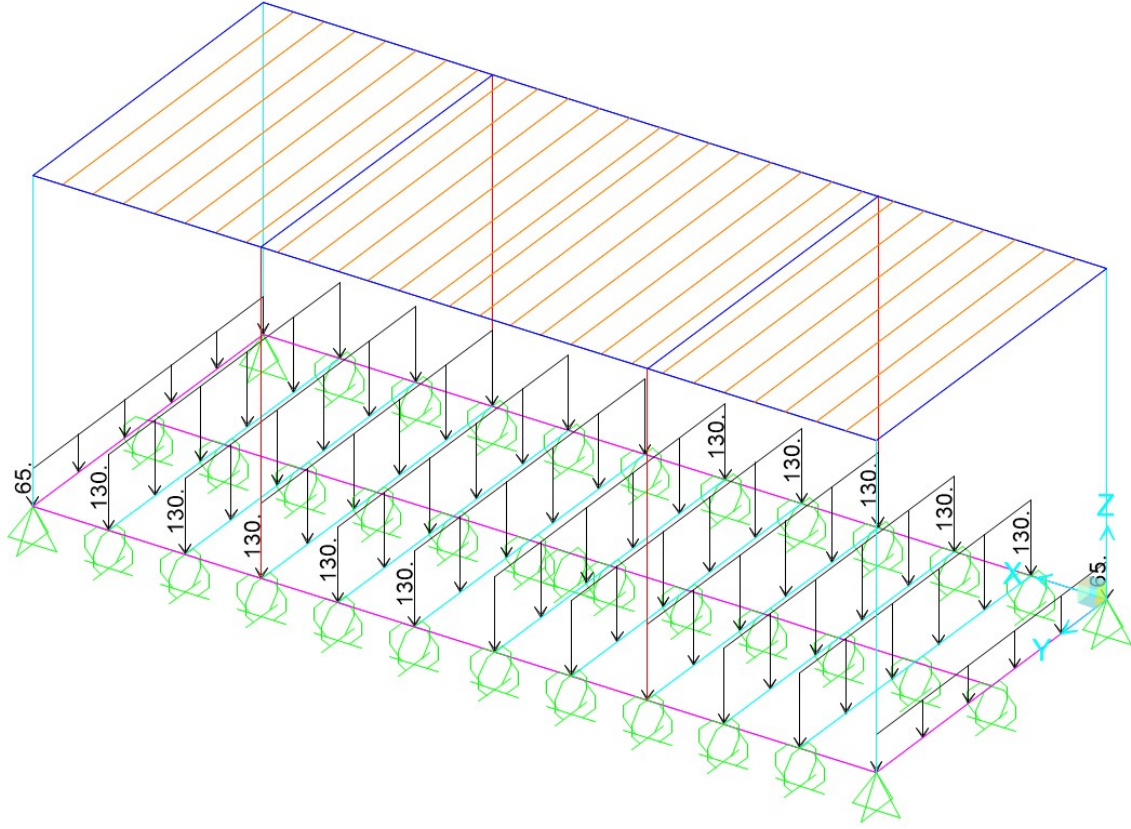
Total dead loads 20 kg/m²

2,6 m. x20 kg/m² =52 kg/ m. concentrated load on outer bottom chasisis.



Live Load: $LL=200 \text{ kg/m}^2$

On chassis secondary profile: $200 \text{ kg/m}^2 \times 0.65 \text{ m} = 130 \text{ kg/m}$



7.3. Wind Load

The Wind Load is applied according EN1991-1-4 Wind Loads.

Table 4.1 — Terrain categories and terrain parameters

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

According to Eurocode-1 Wind Action

$$q_p(z) = (1 + 7 * I_v(z)) \times \frac{1}{2} \times \rho \times V_m^2$$

$q_p(z)$ = the peak velocity pressure at height z , which includes mean and short term velocity fluctuations, should be determined

$\rho = 1.25 \text{ kg/m}^3$ The air density

k_1 (turbulence factor)=1.0

C_0 : (orography factor)=1.0

Eurocode 1: Actions on structures - General actions - Part 1-4: Wind actions										
TERRAIN	III	:Terrain Category						Z ₀	Z _{MIN}	
Z ₍₀₎	0.3						0	0.003	1	
Z _{MIN}	5						I	0.01	1	
kr	0.22	:Terrain Factor					II	0.05	2	
z	2.6	m	:Roof Height					III	0.3	5
V _b (V _{b,0})	28.5	m/s	102.60	km/saat	:Basic Wind Velocity			IV	1	10
cr(z)	0.61	:Roughness Factor,								
C _o (z)	1	:Orography Factor,								
V _m (z)	17	m/s	62	km/saat	:Mean wind					
q _b (z)	0.50765625	kN/m2	50.76563	kg/m2						
k ₁	1	:Terrain Factor								
I _v (z)	0.36	:Wind Turbulence								
q _p (z)	0.65	kN/m2	65	kg/m2	:Peak Velocity Pressure					
ce(z)	1.28	:Exposure Factor								
slope	%0	:Roof Slope								
Φ	0.00									
Φ=0°										
b	7	Horizontal dimension of building, measured normal to wind direction								
d	3	Horizontal dimension of building, measured parallel to wind direction								
e	5.20									
External pressure coefficients for walls (c _{pe,10} , c _{pe,1})										
h/d	A		B		C		D		E	
	c _{pe,10}	c _{pe,1}	c _{pe,10}	c _{pe,1}	c _{pe,10}	c _{pe,1}	c _{pe,10}	c _{pe,1}	c _{pe,10}	c _{pe,1}
5	-1.2	-1.4	-0.8	-1.1	-0.5	-0.5	0.8	1	-0.7	-0.7
1	-1.2	-1.4	-0.8	-1.1	-0.5	-0.5	0.8	1	-0.5	-0.5
≤0.25	-1.2	-1.4	-0.8	-1.1	-0.5	-0.5	0.7	1	-0.3	-0.3
h/d=0.87	-1.20	-1.40	-0.80	-1.10	-0.50	-0.50	0.78	1.00	-0.46	-0.46
The External Pressure Coefficient Cpe values for buildings with a loaded area (c _{pe,1} ,C _{pe,10})										
	A	B	C	D	E					
Loaded Areas(m2)	2.6	15.6	15	15	15					
Selected c _{pe,1} ,C _{pe,10}	-1.32	-0.80	-0.50	0.78	-0.46					
Total wind pressure for hipped roofs (kg/m2)										
C _{pi} =-0.3	-65	-32	-13	69	-10					
C _{pi} =+0.2	-90	-57	-38	44	-36					

Note: values in green colored cells were selected for wall pressure

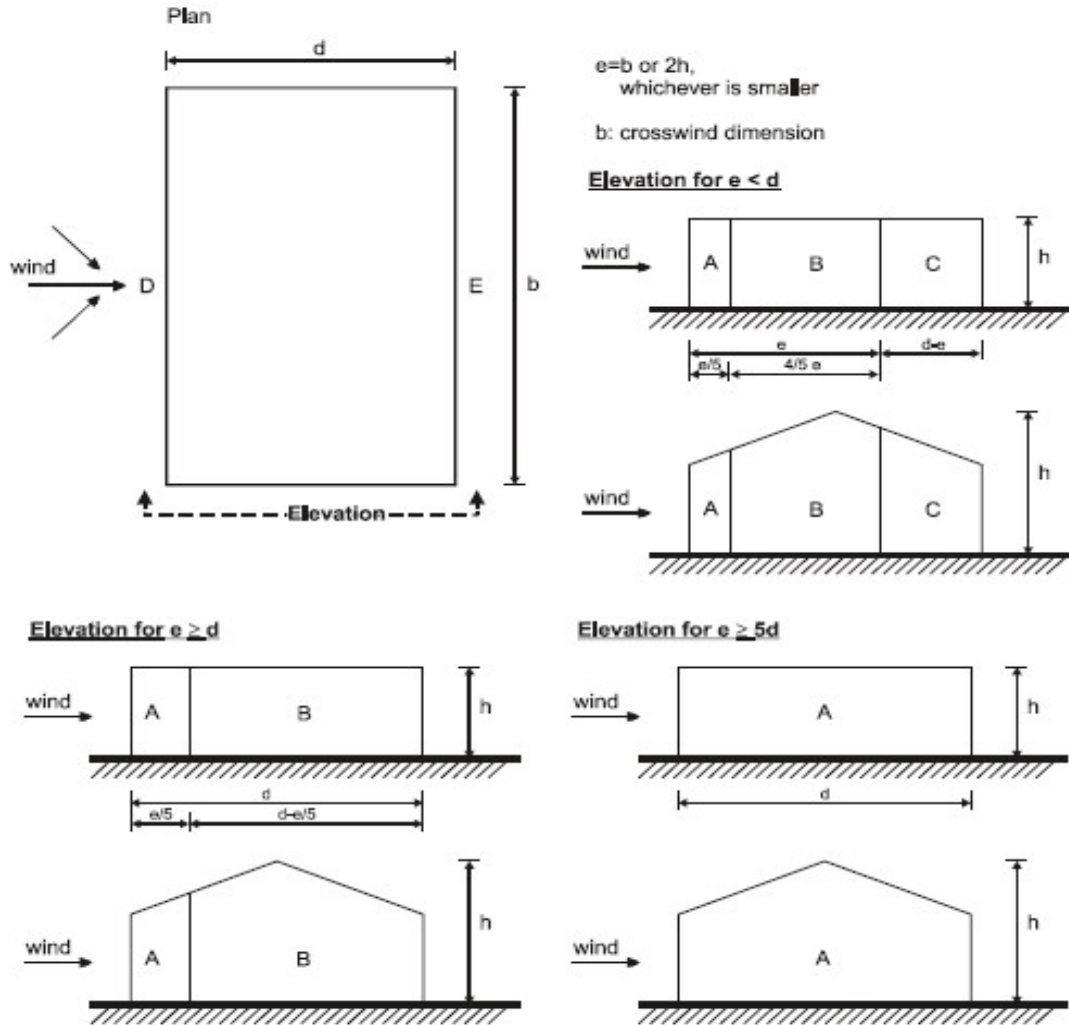
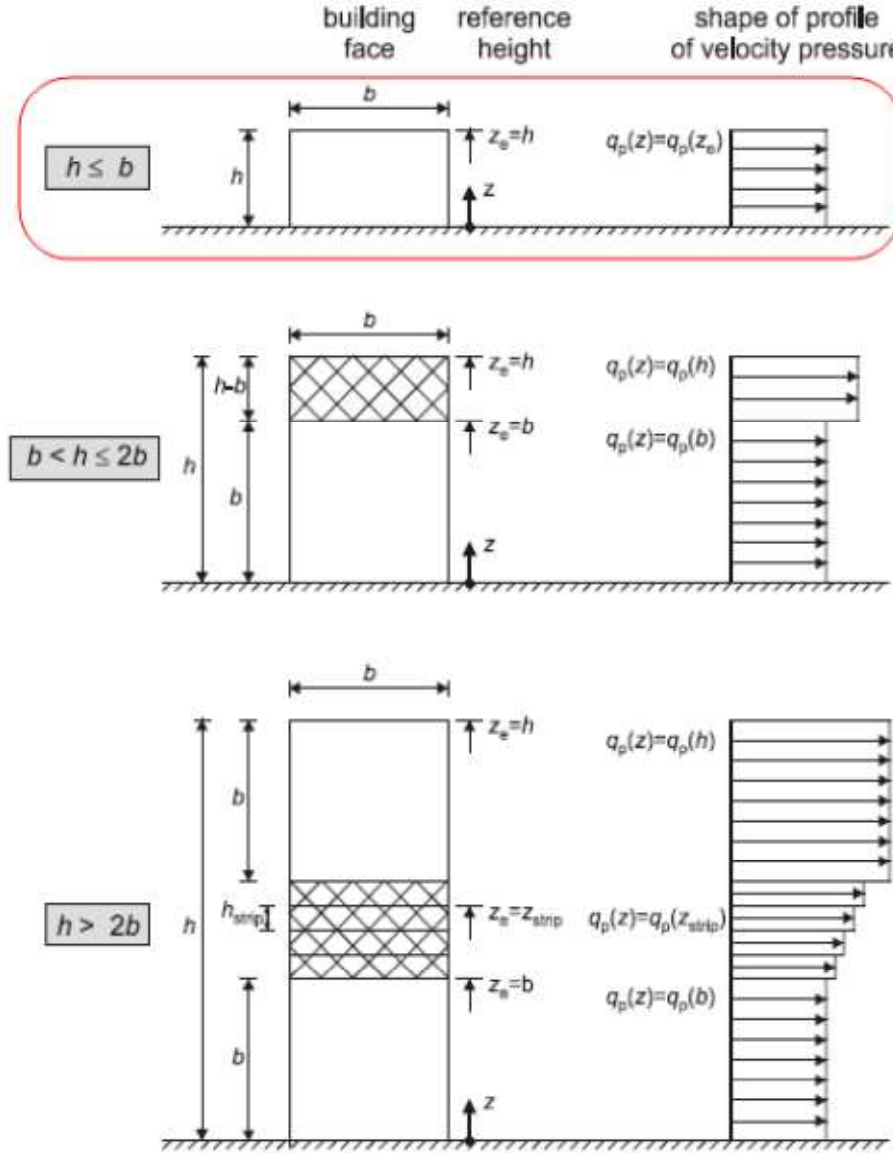


Figure 7.5 — Key for vertical walls

NOTE 1 The values of $c_{pe,10}$ and $c_{pe,1}$ may be given in the National Annex. The recommended values are given in Table 7.1, depending on the ratio h/d . For intermediate values of h/d , linear interpolation may be applied. The values of Table 7.1 also apply to walls of buildings with inclined roofs, such as duopitch and monopitch roofs.

BS EN 1991-1-4:2005
EN 1991-1-4:2005 (E)



NOTE The velocity pressure should be assumed to be uniform over each horizontal strip considered.

Figure 7.4 — Reference height, z_e , depending on h and b , and corresponding velocity pressure profile

(2) The external pressure coefficients $c_{pe,10}$ and $c_{pe,1}$ for zone A, B, C, D and E are defined in Figure 7.5.

BS EN 1991-1-4:2005
EN 1991-1-4:2005 (E)

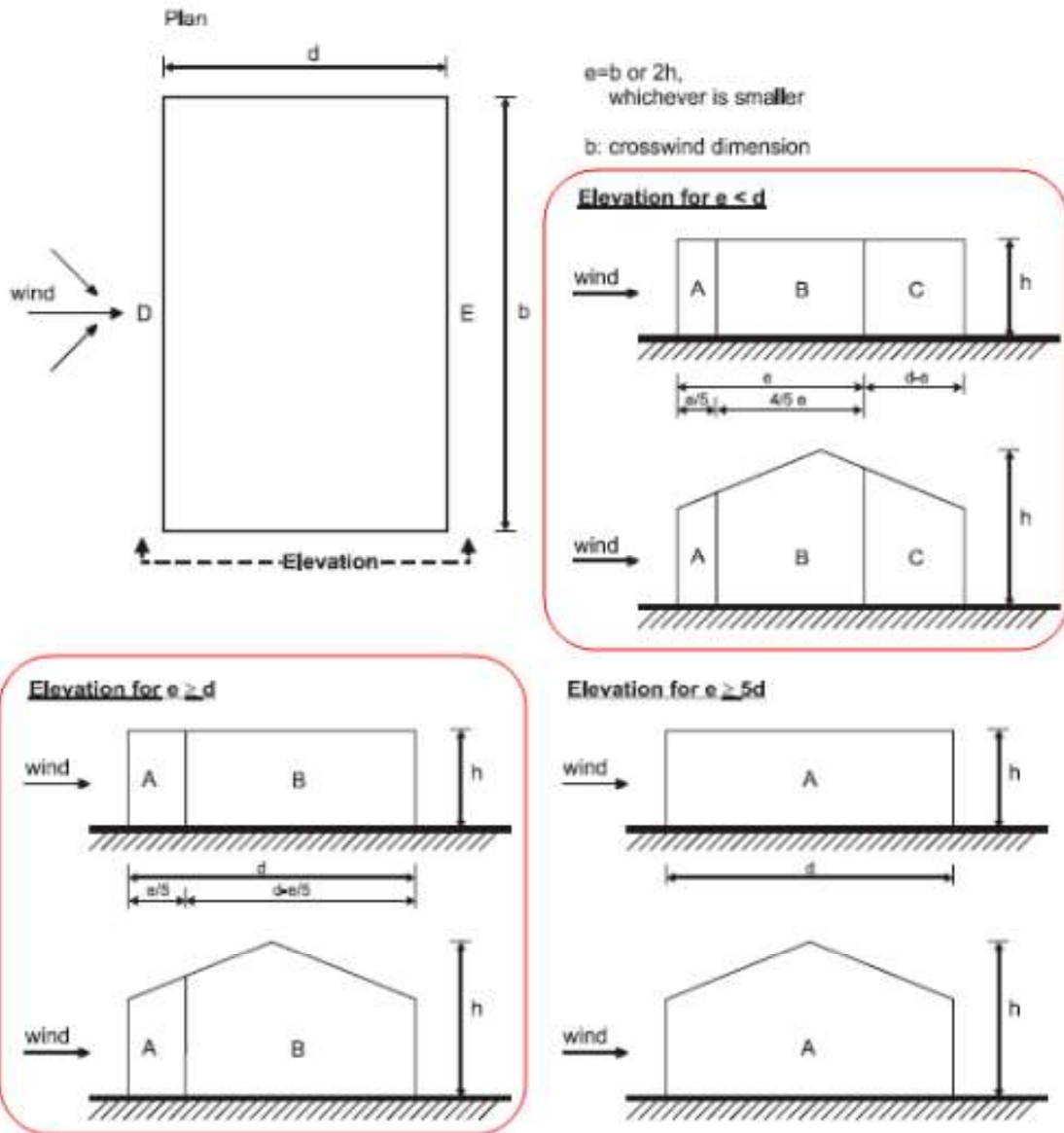
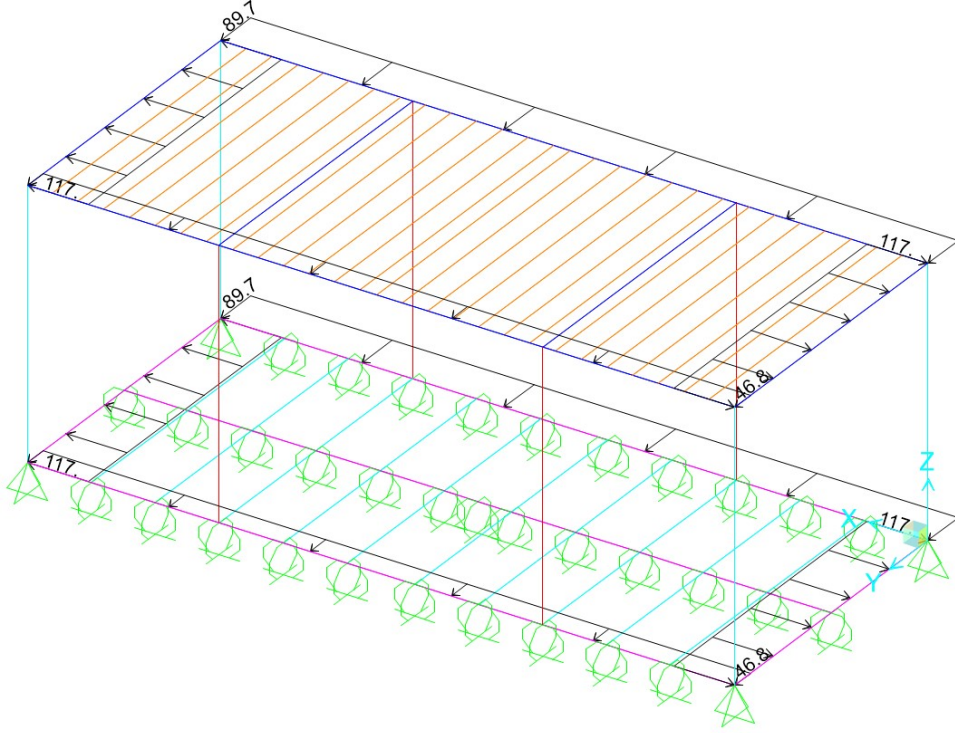


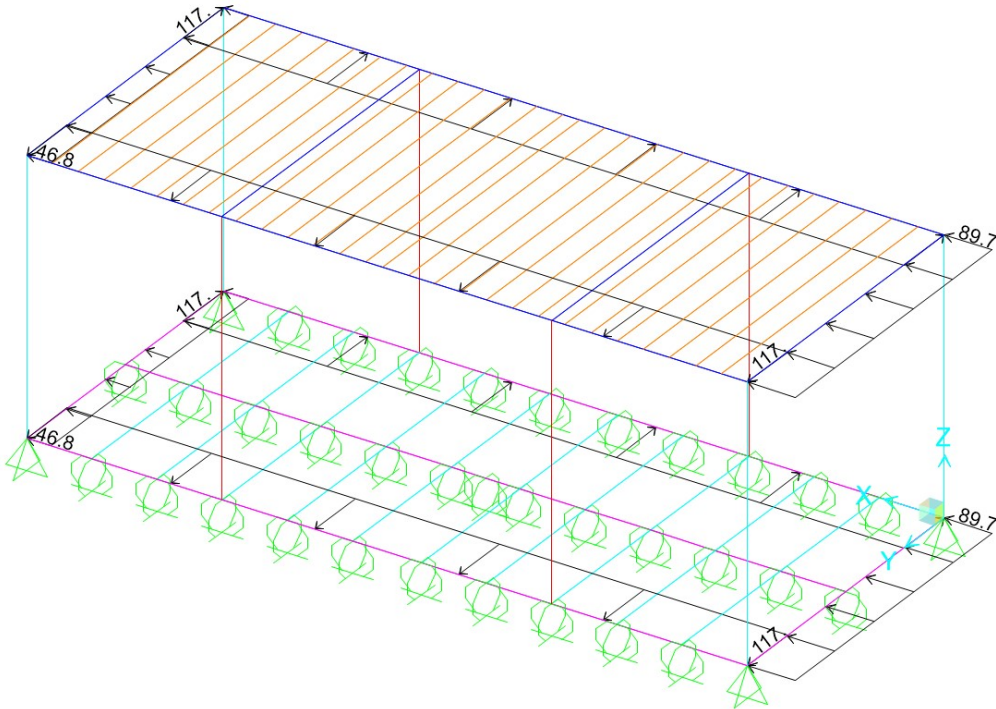
Figure 7.5 — Key for vertical walls

NOTE 1 The values of $c_{pe,10}$ and $c_{pe,1}$ may be given in the National Annex. The recommended values are given in Table 7.1, depending on the ratio h/d . For intermediate values of h/d , linear interpolation may be applied. The values of Table 7.1 also apply to walls of buildings with inclined roofs, such as duopitch and monopitch roofs.

**WIND LOADS FOR Y DIRECTION- LOADS ASSING ON CHASSIS TOP AND
BOTTOM PROFILES**



**WIND LOADS FOR X DIRECTION- LOADS ASSING ON CHASSIS TOP AND
BOTTOM PROFILES**



7.4. Snow Load

Table 1. Climatic regions and corresponding countries as given in [2]

Climatic Region	Associated Countries
Alpine Region	South Germany, Austria, North-West France, North Italy
Central East	Denmark, Germany
Greece	Greece
Iberian Peninsula	Spain, Portugal
Mediterranean Region	Italy, South France
Central West	The Netherlands, Belgium, Luxembourg, France
Sweden, Finland	Sweden, Finland
UK, Republic of Ireland	UK, Ireland
further maps	Czech Republic, Norway, Iceland, Poland

Table C.1. Altitude - Snow Load Relationships

Climatic Region	Expression
Alpine Region	$s_k = (0,642Z + 0,009) \left[1 + \left(\frac{A}{728} \right)^2 \right]$
Central East	$s_k = (0,264Z - 0,002) \left[1 + \left(\frac{A}{256} \right)^2 \right]$
Greece	$s_k = (0,420Z - 0,030) \left[1 + \left(\frac{A}{917} \right)^2 \right]$
Iberian Peninsula	$s_k = (0,190Z - 0,095) \left[1 + \left(\frac{A}{524} \right)^2 \right]$
Mediterranean Region	$s_k = (0,498Z - 0,209) \left[1 + \left(\frac{A}{452} \right)^2 \right]$
Central West	$s_k = 0,164Z - 0,082 + \frac{A}{966}$
Sweden, Finland	$s_k = 0,790Z + 0,375 + \frac{A}{336}$
UK, Republic of Ireland	$s_k = 0,140Z - 0,1 + \frac{A}{501}$

s_k is the characteristic snow load on the ground [kN/m²]
 A is the site altitude above Sea Level [m]
 Z is the zone number given on the map.

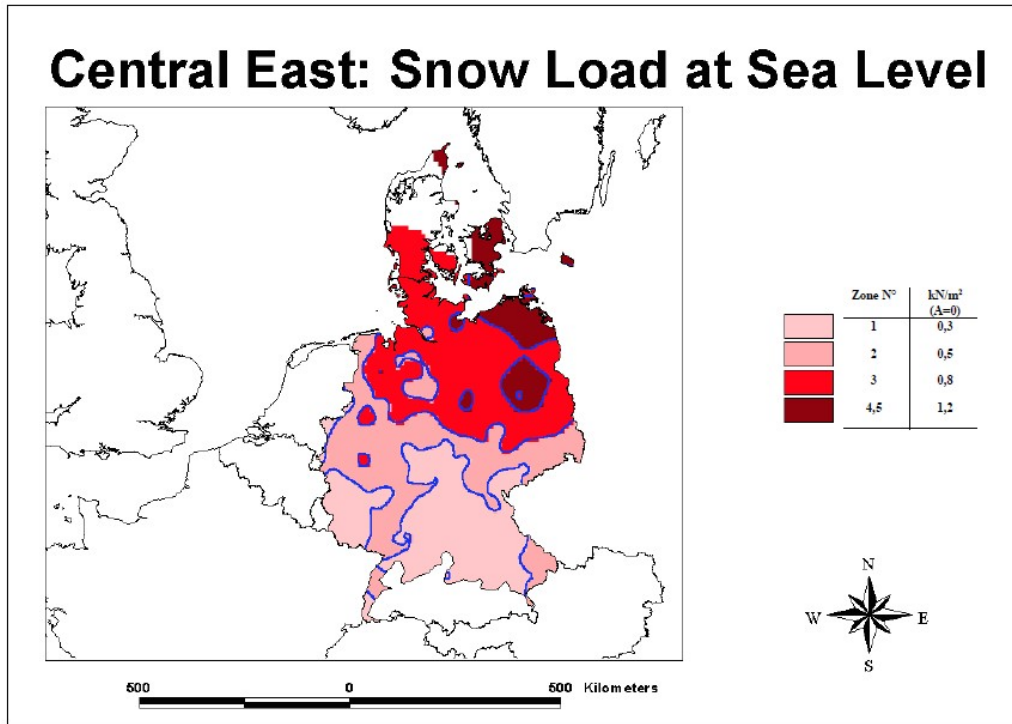


Figure C.3

Note: Brüggen is on Zone 3 snow load area and see level is 60 meters

Central East	$s_z = (0,264Z - 0,002) \left[1 + \left(\frac{A}{256} \right)^2 \right]$
--------------	--

Sk= 0.84 Kn/m2

Snow loads on the roof should be determined as follows:

$$s = \mu_i \times c_e \times c_t \times s_k$$

- where:
- μ_i is the roof shape coefficient
 - c_e is the exposure coefficient, usually taken as 1,0
 - c_t is the thermal coefficient, set to 1,0 for normal situations
 - s_k is the characteristic value of ground snow load for the relevant altitude

Roof shape coefficient

Shape coefficients are needed for an adjustment of the ground snow load to a snow load on the roof taking into account effects caused by non-drifted and drifted snow load arrangements.

The roof shape coefficient depends on the roof angle.

$$0^\circ \leq \alpha \leq 30^\circ \Rightarrow \mu_i = 0,8$$

EN 1991-1-3
§5.2.2 eq.5.1

EN 1991-1-3
§5.3
Table 5.1

Table 5.1 Recommended values of C_e for different topographies

Topography	C_e
Windswept ^a	0,8
Normal ^b	1,0
Sheltered ^c	1,2

^a *Windswept topography*: flat unobstructed areas exposed on all sides without, or little shelter afforded by terrain, higher construction works or trees.

^b *Normal topography*: areas where there is no significant removal of snow by wind on construction work, because of terrain, other construction works or trees.

^c *Sheltered topography*: areas in which the construction work being considered is considerably lower than the surrounding terrain or surrounded by high trees and/or surrounded by higher construction works.

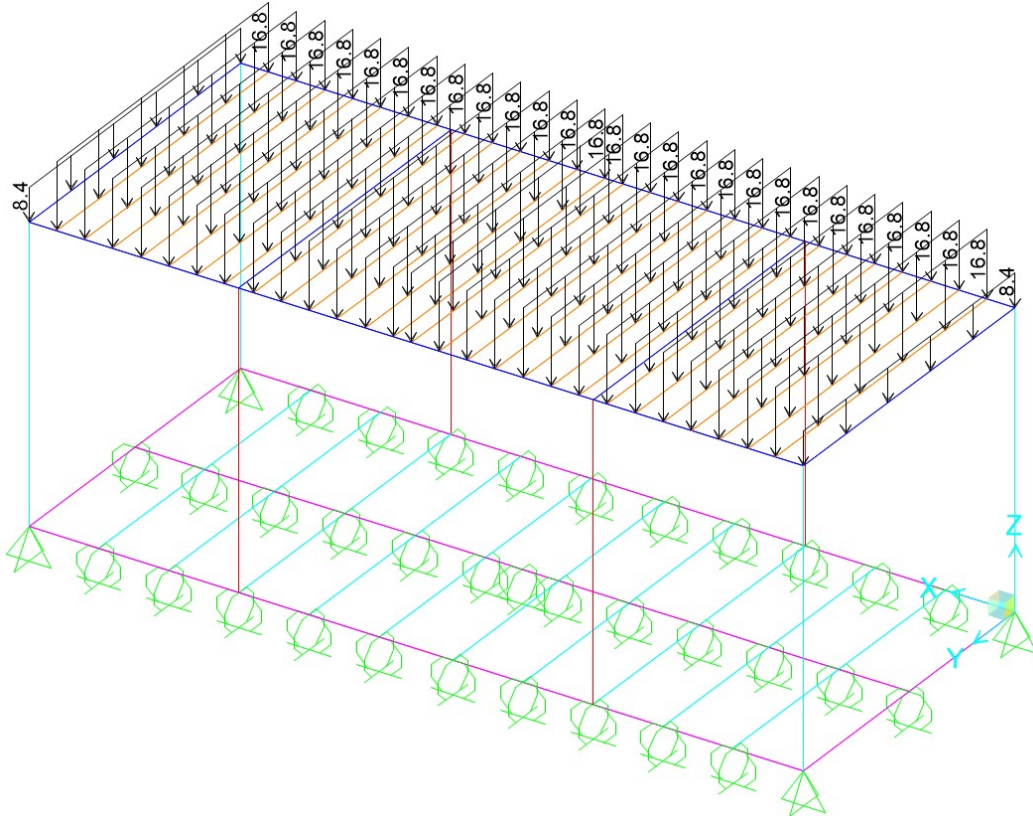
(8) The thermal coefficient C_t should be used to account for the reduction of snow loads on roofs with high thermal transmittance ($> 1 \text{ W/m}^2\text{K}$), in particular for some glass covered roofs, because of melting caused by heat loss.

For all other cases:

$$C_t = 1,0$$

$$s = \mu_{fi} C_e C_t s_k$$

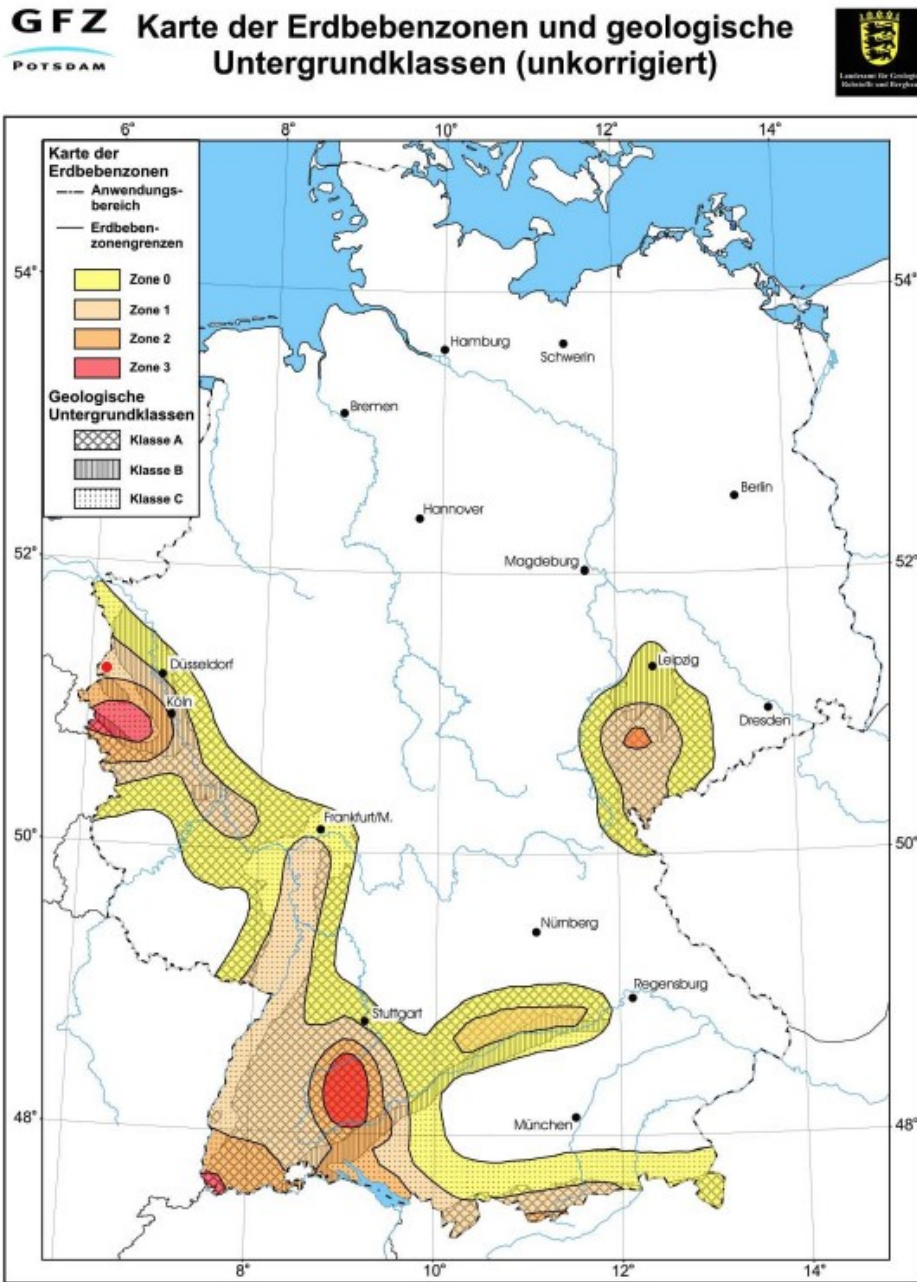
$$S: 0.8 \times 1 \times 1 \times 84 = 67.2 \text{ kg/m}^2 \times 0.25 \text{ m} : 16.8 \text{ kg/m}^2$$



8. DYNAMIC ANALYSIS and DYNAMIC CONTROLS

An analysis shall be conducted to determine the natural modes of vibration for structure. The analysis shall include a sufficient number of modes to obtain a combined modal mass participation of at least 90 percent of the actual mass in each of the ortogonal horizontal directions of response considered by model .

The seismic design is done according EC8 – Design of structures for earthquake resistance – General rules and rules for buildings.



Note: Brüggen city is on Zone 1 seismic area and ground type is Class C.

According to the new DIN 4149 T1, four seismic zones with three associated soil classes (A, B, C) are defined. The horizontal PGA for soil class A assigned to each zone, corresponding to a 10% probability of exceedance in 50 years, is as follows:

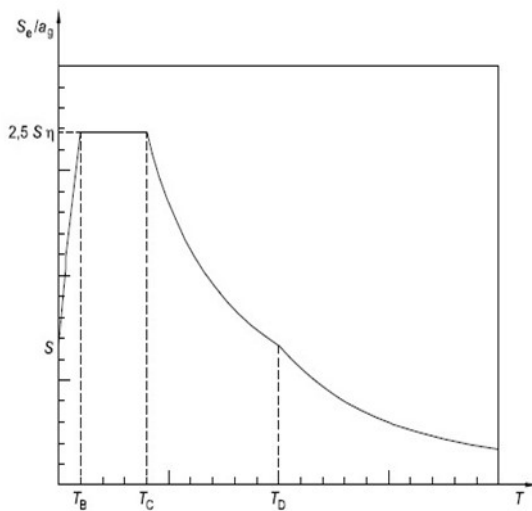
Peak Ground Acceleration a_o for ground class A

Seismic zone	Acceleration a_o in m/sec ²
0	0.25 (0.025g)
1	0.40 (0.041g)
2	0.65 (0.066g)
3	1.00 (0.102g)

Sources

- DIN 4149 "Bauten in deutschen Erdbebengebieten", 2002.
- GeoForschungsZentrum Potsdam (GFZ), <http://seismohazard.gfz-potsdam.de>.

- The site has been classified as Ground Type C
- Reference peak ground acceleration $a_{gR}=0.041g$
- Building Importance Class II
- Building Importance Factor $\gamma:1.0$
- Design ground acceleration $a_g: \gamma * a_{gR}: 0.022g * 1.0: 0.041g$
- For Ground type C and Type 1 elastic response spectrum the following seismic parameters are used: $S = 1.15$, $T_B = 0.2$ s, $T_C = 0.6$ s, $T_D = 2$ s



Basic shape of the elastic response spectrum in EN1998-1

$$0 \leq T \leq T_B : S_d(T) = a_g \cdot S \cdot \left[\frac{2}{3} + \frac{T}{T_B} \cdot \left(\frac{2.5}{q} - \frac{2}{3} \right) \right]$$

$$T_B \leq T \leq T_C : S_d(T) = a_g \cdot S \cdot \frac{2.5}{q}$$

$$T_C \leq T \leq T_D : S_d(T) \begin{cases} = a_g \cdot S \cdot \frac{2.5}{q} \cdot \left[\frac{T_C}{T} \right] \\ \geq \beta \cdot a_g \end{cases}$$

$$T_D \leq T : S_d(T) \begin{cases} = a_g \cdot S \cdot \frac{2.5}{q} \cdot \left[\frac{T_C T_D}{T^2} \right] \\ \geq \beta \cdot a_g \end{cases}$$

- The vertical earthquake strength was not calculated because there were no cases of a serious earthquake.

Response Spectrum EuroCode 8 - 2004 Function Definition

Function Name: EUC

Function Damping Ratio: 0.05

Parameters:

Country: CEN Default

Direction: Horizontal

Horizontal Ground Accel., ag/g: 0.041

Spectrum Type: 1

Ground Type: C

Soil Factor, S: 1.15

Acceleration Ratio, Avg/Ag:

Spectrum Period, Tb: 0.2

Spectrum Period, Tc: 0.6

Spectrum Period, Td: 2.

Lower Bound Factor, Beta: 0.2

Behavior Factor, q: 4.

Define Function:

Period	Acceleration
0.	0.0314
0.0667	0.0308
0.1333	0.0301
0.2	0.0295
0.6	0.0295
0.8333	0.0212
1.0667	0.0166
1.3	0.0136

Function Graph:

Display Graph: (0.9262 , 0.0804)

OK Cancel

➤ Earthquake mass factor

$$\sum G_{k,i} \cdot \psi_{E,i} \cdot Q_{k,i}$$

COMBINATIONS OF SEISMIC ACTIONS WITH OTHER ACTIONS

The combination coefficients Ψ_{Ei} for the calculation of the effects of the seismic actions shall be computed from the following expression:

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

Table 4.2: Values of φ for calculating Ψ_{Ei}

Type of variable action	Storey	φ
Categories A-C*	Roof	1,0
	Storeys with correlated occupancies	0,8
	Independently occupied storeys	0,5
Categories D-F* and Archives		1,0

* Categories as defined in EN 1991-1-1:2002.

* $\psi_{E,i}$: 0.3 Live load

* $\psi_{E,i}$: 0.2 Snow load

➤ Behaviour factors

The design is done for Medium Ductility Class **DCM**

Table 6.2: Upper limit of reference values of behaviour factors for systems regular in elevation

STRUCTURAL TYPE	Ductility Class	
	DCM	DCH
a) Moment resisting frames	4	$5\alpha_w/\alpha_1$
b) Frame with concentric bracings		
Diagonal bracings	4	4
V-bracings	2	2,5
c) Frame with eccentric bracings	4	$5\alpha_w/\alpha_1$
d) Inverted pendulum	2	$2\alpha_w/\alpha_1$
e) Structures with concrete cores or concrete walls	See section 5	
f) Moment resisting frame with concentric bracing	4	$4\alpha_w/\alpha_1$
g) Moment resisting frames with infills		
Unconnected concrete or masonry infills, in contact with the frame	2	2
Connected reinforced concrete infills	See section 7	
Infills isolated from moment frame (see moment frames)	4	$5\alpha_w/\alpha_1$

➤ X longitudinal direction behaviour factor

$q_{x,4}$ → In the longitudinal direction the building is considered as a braced frame with diagonal bracing.

➤ Y longitudinal direction behaviour factor

$q_{y,4}$ → In the transverse direction the building is considered as a moment frame.

Load Direction and Diaphragm Eccentricity

☒ Global X Direction

☐ Global Y Direction

Ecc. Ratio (All Diaph.)

Override Diaph. Eccen.

Time Period

☐ Approximate $C_t (m) =$

☒ Program Calc

☐ User Defined $T =$

Lateral Load Elevation Range

☒ Program Calculated

☐ User Specified

Max Z

Min Z

Parameters

Country

Ground Acceleration, a_g/g

Spectrum Type

Ground Type

Soil Factor, S

Spectrum Period, T_b

Spectrum Period, T_c

Spectrum Period, T_d

Lower Bound Factor, Beta

Behavior Factor, q

Correction Factor, Lambda

Load Direction and Diaphragm Eccentricity

☐ Global X Direction

☒ Global Y Direction

Ecc. Ratio (All Diaph.)

Override Diaph. Eccen.

Time Period

☐ Approximate $C_t (m) =$

☒ Program Calc

☐ User Defined $T =$

Lateral Load Elevation Range

☒ Program Calculated

☐ User Specified

Max Z

Min Z

Parameters

Country

Ground Acceleration, a_g/g

Spectrum Type

Ground Type

Soil Factor, S

Spectrum Period, T_b

Spectrum Period, T_c

Spectrum Period, T_d

Lower Bound Factor, Beta

Behavior Factor, q

Correction Factor, Lambda

TABLE: Auto Seismic - Eurocode8 2004

LoadPat	Dir	PercentEcc	EccOverride	PeriodCalc	UserZ	Country	Ag	SpecType
Text	Text	Unitless	Yes/No	Text	Yes/No	Text	Unitless	Text
EX	X	0.05	No	Prog Calc	No	CEN Default	0.041	1
EY	Y	0.05	No	Prog Calc	No	CEN Default	0.041	1
GroundType	SoilFact	Tb	Tc	Td	LBFact	BehaveFact	CorrFact	
Text	Unitless	Sec	Sec	Sec	Unitless	Unitless	Unitless	
C	1.15	0.2	0.6	2	0.2	4	1	
C	1.15	0.2	0.6	2	0.2	4	1	
TUsed	CoeffUsed	WeightUsed	BaseShear					
Sec	Unitless	Kgf	Kgf					
0.2063	0.029469	3832.09	112.93					
0.3494	0.029469	3832.09	112.93					

TABLE: Mass Source

MassSource	Elements	Masses	Loads	IsDefault	LoadPat	Multiplier
Text	Yes/No	Yes/No	Yes/No	Yes/No	Text	Unitless
MSSSRC1	No	No	Yes	Yes	DL-F	1
MSSSRC1					DL-C	1
MSSSRC1					DL-R	1
MSSSRC1					DL	1
MSSSRC1					S	0.2
MSSSRC1					LL	0.3

TABLE: Base Reactions

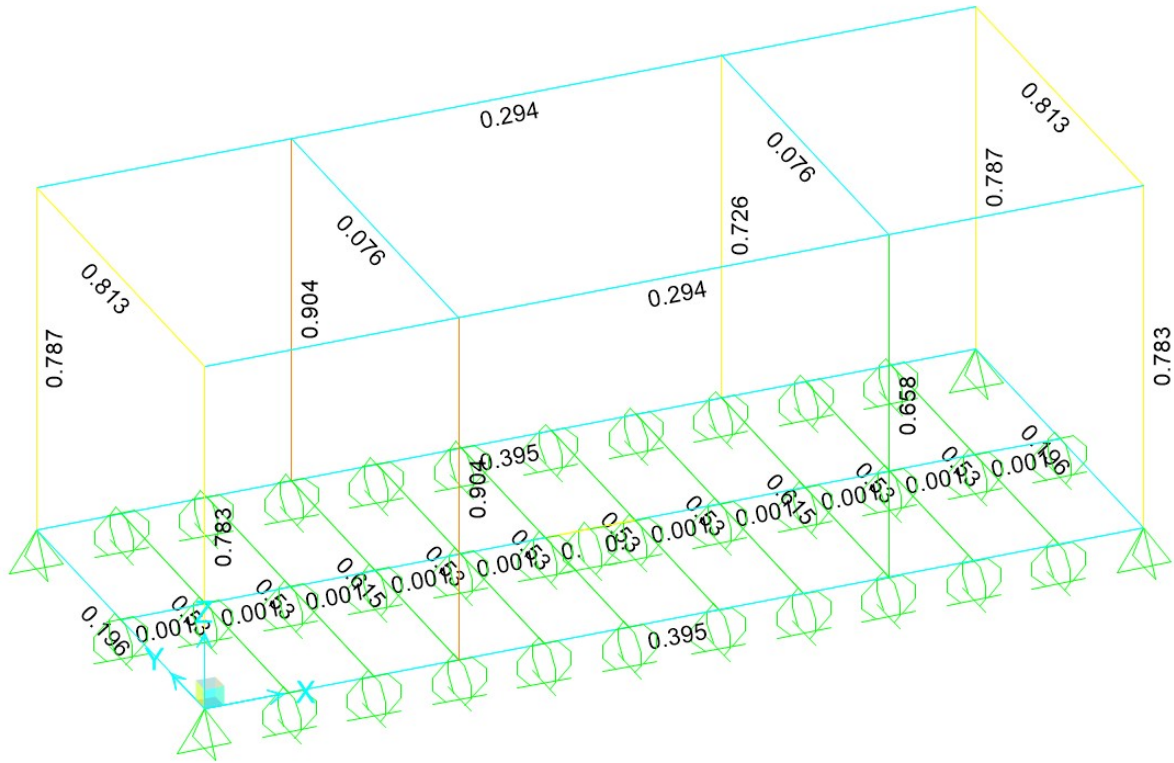
OutputCase	CaseType	StepType	GlobalFX	GlobalFY	GlobalFZ	GlobalMX	GlobalMY	GlobalMZ
Text	Text	Text	Kgf	Kgf	Kgf	Kgf-m	Kgf-m	Kgf-m
DL	LinStatic		9.934E-15	-4.857E-16	553.51	804.8	-1912.04	-5.975E-07
DL-F	LinStatic		-1.131E-14	-3.775E-15	1020.86	1484.34	-3526.06	-5.768E-07
DL-C	LinStatic		-2.897E-15	0	680.47	989.41	-2350.35	5.239E-16
DL-R	LinStatic		3.275E-14	-1.529E-14	366.41	532.76	-1266.18	-0.000001497
S	LinStatic		1.279E-13	-5.751E-14	1367.92	1988.96	-4727.05	-0.000005589
LL	LinStatic		-2.549E-14	0	4158.44	6046.37	-14363.25	1.52E-14
SPECY	LinRespSpec	Max	0.00000148	111.17	2.802E-08	293.85	0.000003728	384.25
SPECX	LinRespSpec	Max	112.96	0.00001998	0.02109	0.03066	287.08	164.25
EX	LinStatic		-112.93	-0.00001896	6.537E-13	1.407E-12	-293.61	182.36
EY	LinStatic		-3.513E-12	-111.14	-4.716E-13	293.61	-6.278E-12	-427.21

TABLE: Modal Load Participation Ratios				
OutputCase	ItemType	Item	Static	Dynamic
Text	Text	Text	Percent	Percent
MODAL	Acceleration	UX	100	99.9985
MODAL	Acceleration	UY	100	100
MODAL	Acceleration	UZ	99.6705	87.7656

TABLE: Modal Participating Mass Ratios						
OutputCase	StepType	StepNum	Period	UX	UY	UZ
Text	Text	Unitless	Sec	Unitless	Unitless	Unitless
MODAL	Mode	1	0.349405	8.949E-17	1	0
MODAL	Mode	2	0.206291	0.998	8.807E-17	9.465E-10
MODAL	Mode	3	0.199303	0	6.558E-08	4.687E-18
MODAL	Mode	4	0.044693	8.025E-09	4.377E-19	0.222
MODAL	Mode	5	0.044688	2.529E-16	0.000005262	1.851E-14
MODAL	Mode	6	0.018602	0.001377	3.852E-18	0.00004038
MODAL	Mode	7	0.018596	8.188E-15	7.051E-10	4.218E-13
MODAL	Mode	8	0.017823	1.691E-07	8.063E-18	0.578
MODAL	Mode	9	0.01781	2.224E-15	0.000005639	8.064E-13
MODAL	Mode	10	0.015247	0.00006262	1.678E-20	0.00005806
MODAL	Mode	11	0.015246	3.74E-16	7.315E-11	4.064E-15
MODAL	Mode	12	0.009143	5.855E-09	1.47E-19	0.065
MODAL	Mode	13	0.009143	1.728E-18	1.361E-07	5.917E-14
MODAL	Mode	14	0.007513	0.00004876	0	0.000001151
MODAL	Mode	15	0.00751	1.544E-17	2.919E-10	1.346E-16
MODAL	Mode	16	0.006864	2.786E-08	2.853E-19	0.013
MODAL	Mode	17	0.00686	2.742E-17	4.633E-07	6.976E-15
MODAL	Mode	18	0.00545	0.000005677	0	0.00007907

9. STEEL FRAME DESIGN

Design of steel member was according to Eurocode3-2005. The ratio of stress on the frame elements of the external to internal stresses in the should be less than 1. As shown in the figure below on the loads safely is all steel construction elements



Steel Design Summary Data –(Eurocode 3-2005) Ratio :

TABLE: Steel Design 1 - Summary Data - Eurocode 3-2005							
Frame	DesignSect	DesignType	Ratio	RatioType	Combo	Location	ErrMsg
Text	Text	Text	Unitless	Text	Text	m	Text
1	CORNER185-15-1311	Column	0.782645	PMM	EU-1.35DL+1.05LL+1.5WY	2.6	No Messages
2	CORNER185-15-1311	Column	0.78739	PMM	EU-1.35DL+1.05LL+1.5WY+0.75S	2.6	No Messages
7	CORNER185-15-1311	Column	0.78264	PMM	EU-1.35DL+1.05LL+1.5WY	2.6	No Messages
8	CORNER185-15-1311	Column	0.787402	PMM	EU-1.35DL+1.05LL+1.5WY+0.75S	2.6	No Messages
9	TOP-205-15-1311	Beam	0.294239	PMM	EU-1.35DL+1.05LL+1.5WX+0.75S	6.908	No Messages
10	SIGMA+TOP165-2mm	Beam	0.813002	PMM	EU-1.35DL+1.05LL+1.5WY+0.75S	0	No Messages
11	TOP-205-15-1311	Beam	0.294239	PMM	EU-1.35DL+1.05LL+1.5WX+0.75S	0	No Messages
12	SIGMA+TOP165-2mm	Beam	0.813	PMM	EU-1.35DL+1.05LL+1.5WY+0.75S	1.93867	No Messages
18	BOTTOM-145X20-1311	Beam	0.394617	PMM	EU-1.35DL+1.05LL+1.5WX+0.75S	6.908	No Messages
19	BOTTOM-145X20-1311	Beam	0.196479	PMM	EU-1.35DL+1.05LL+1.5WY	0	No Messages
20	BOTTOM-145X20-1311	Beam	0.394617	PMM	EU-1.35DL+1.05LL+1.5WX+0.75S	0	No Messages
21	BOTTOM-145X20-1311	Beam	0.196479	PMM	EU-1.35DL+1.05LL+1.5WY	0	No Messages
25	C100-50-1.5mm-1311	Beam	0.530394	PMM	EU-1.35DL+1.5LL	0	No Messages
26	C100-50-1.5mm-1311	Beam	0.530394	PMM	EU-1.35DL+1.5LL	0	No Messages
28	C100-50-1.5mm-1311	Beam	0.530394	PMM	EU-1.35DL+1.5LL	0	No Messages
29	C100-50-1.5mm-1311	Beam	0.530394	PMM	EU-1.35DL+1.5LL	0	No Messages
30	C100-50-1.5mm-1311	Beam	0.530394	PMM	EU-1.35DL+1.5LL	0	No Messages
32	C100-50-1.5mm-1311	Beam	0.530394	PMM	EU-1.35DL+1.5LL	0	No Messages
33	C100-50-1.5mm-1311	Beam	0.530394	PMM	EU-1.35DL+1.5LL	0	No Messages
34	C100-50-1.5mm-1311	Beam	0.530394	PMM	EU-1.35DL+1.5LL	0	No Messages
121	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
122	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
125	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
126	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
127	U100-50-1.5mm-1311	Beam	0.778682	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
128	U100-50-1.5mm-1311	Beam	0.778682	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
129	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
130	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
132	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
134	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
145	C135-50-1.5mm-1311	Column	0.903962	PMM	EU-1.35DL+1.05LL+1.5WX+0.75S	0	No Messages
146	C135-50-1.5mm-1311	Column	0.903962	PMM	EU-1.35DL+1.05LL+1.5WX+0.75S	0	No Messages
147	C60-50-1.5mm-1311	Beam	0.075832	PMM	EU-1.35DL	0	No Messages
149	C135-50-1.5mm-1311	Column	0.657591	PMM	EU-1.35DL+1.5LL-0.9WX+0.75S	0	No Messages
150	C135-50-1.5mm-1311	Column	0.725944	PMM	EU-1.35DL+1.05LL+1.5WY+0.75S	0	No Messages
151	C60-50-1.5mm-1311	Beam	0.075832	PMM	EU-1.35DL	0	No Messages
166	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
169	U100-50-1.5mm-1311	Beam	0.410155	PMM	EU-DL+0.3LL+SPECX+0.3SPECY	0	No Messages
170	C100-50-1.5mm-1311	Beam	0.614826	PMM	EU-1.35DL+1.5LL	0	No Messages
172	C100-50-1.5mm-1311	Beam	0.614826	PMM	EU-1.35DL+1.5LL	0	No Messages

10. DEFLECTION CHECK

10.1. Horizontal Deflection Check

DAMAGE LIMITATION STATE (4.4.3)

Limitation of interstorey drift

The following limits shall be observed:

a) for buildings having non-structural elements of brittle materials attached to the structure:

$$d_{\tau} v \leq 0,005 h ;$$

b) for buildings having ductile non-structural elements:

$$d_{\tau} v \leq 0,0075 h ;$$

c) for buildings having non-structural elements fixed in a way so as not to interfere with structural deformations, or without non-structural elements:

$$d_{\tau} v \leq 0,010 h$$

Note: For this building wind load is more effective than seismic load

X DIRECTION DEFLECTION CHECK

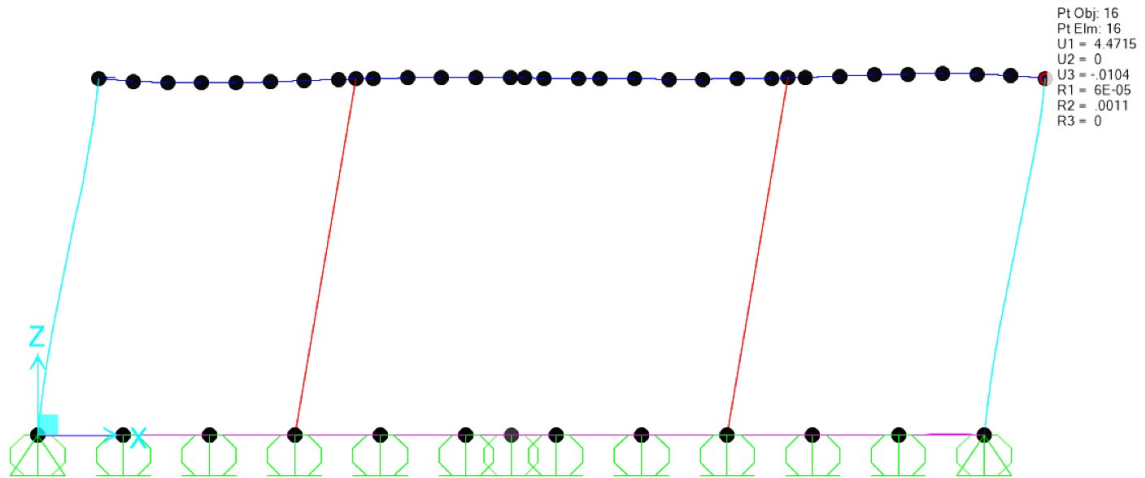
Max Deflection for X Direction $u_{lmax} = 1.38mm$

$$d_{ry} : 4.47 - 0 : 4.47mm$$

$$v : 0.5$$

$$d_{ry} \cdot v < 0.0075h \rightarrow 2.235mm < 0.0075 \cdot 2600 : 19.5mm \text{ ok}$$

Deformed Shape (WX+)



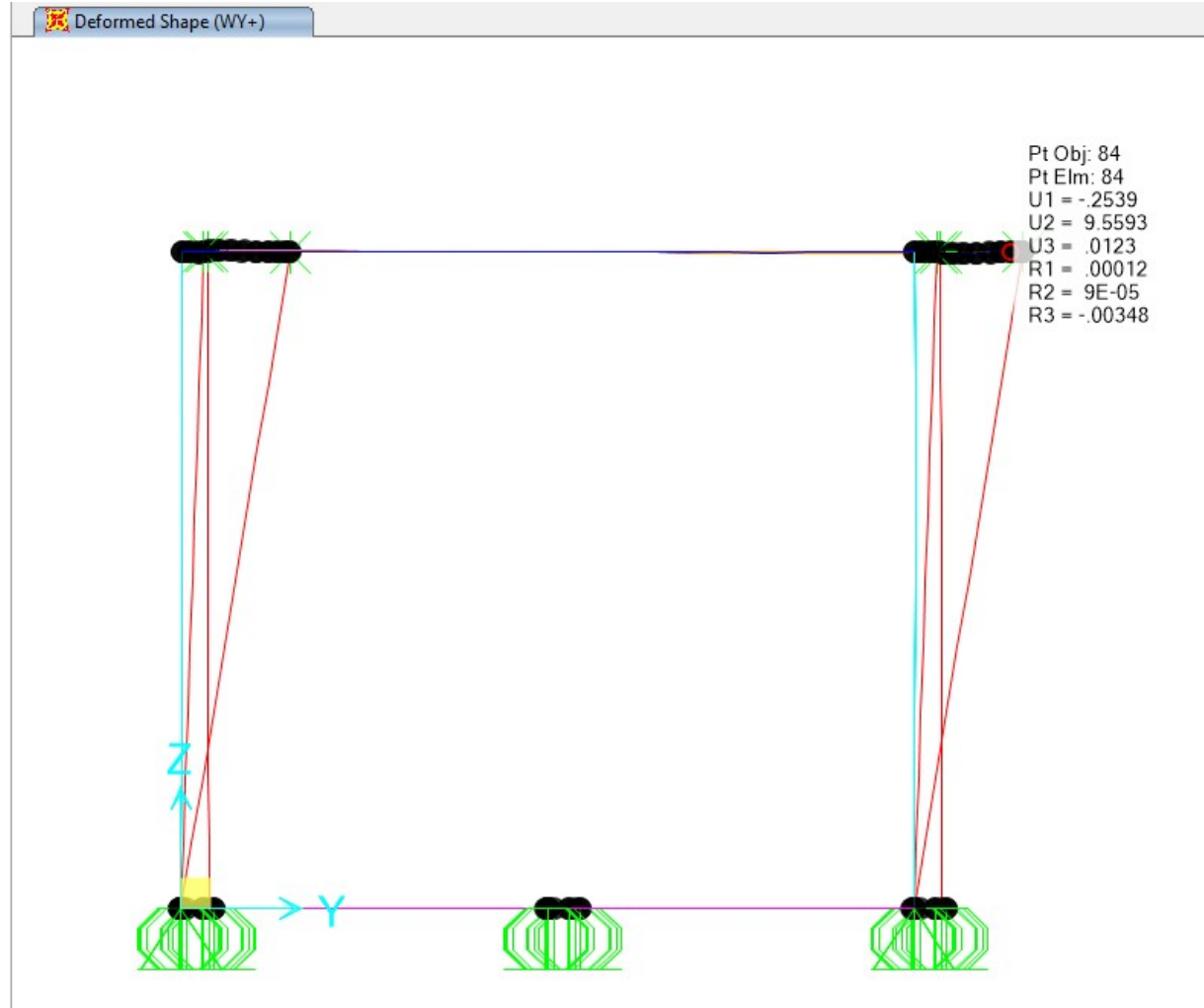
Y DIRECTION DEFLECTION CHECK

Max Deflection for Y Direction $u_{2\max} = 0.28mm$

$d_{ry} : 9.55 - 0 : 9.55mm$

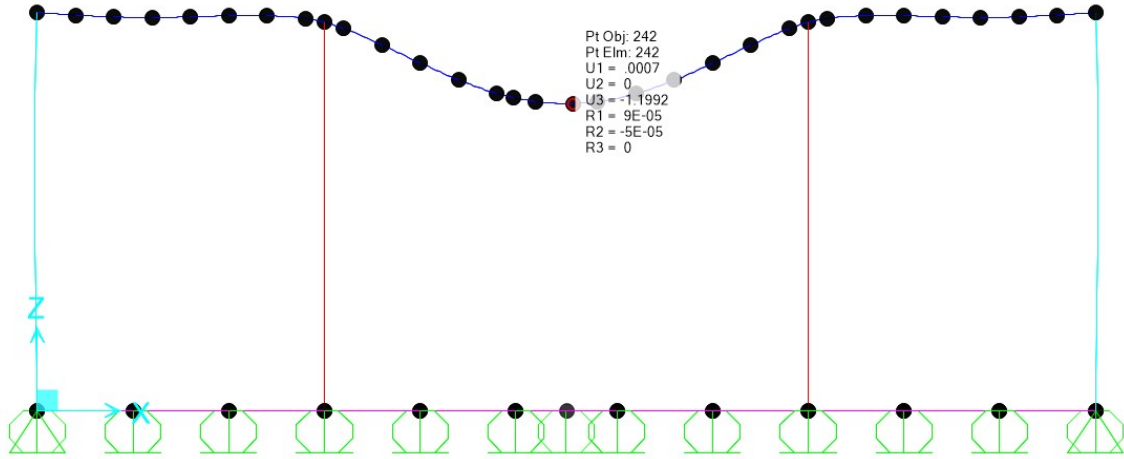
$\nu : 0.5$

$d_{ry} \cdot \nu < 0.0075h \rightarrow 4.77mm < 0.0075 * 2600 : 19.5mm \text{ ok}$



10.2. Vertical Deflection Check

Deformed Shape (D+LL+S)



➤ $1.2 \text{ mm} < L/300 = 2500/300 = 8.33 \text{ mm}$ (OK)