ΤΕΥΧΟΣ ΣΤΑΤΙΚΩΝ ΥΠΟΛΟΓΙΣΜΩΝ

ΚΕΝΤΡΙΚΗ ΑΓΟΡΑ ΘΕΣΣΑΛΟΝΙΚΗΣ Α.Ε.

ΠΕΡΙΦΡΑΞΗ ΑΠΟ ΟΠΛΙΣΜΕΝΟ ΣΚΥΡΟΔΕΜΑ

ΜΕ ΚΙΓΚΛΙΔΩΜΑ ΑΣΦΑΛΕΙΑΣ ΣΤΟ ΑΝΩ ΜΕΡΟΣ ΑΥΤΟΥ

ΜΕΛΕΤΗΤΗΣ : ΑΘΑΝΑΣΙΟΣ ΠΡΑΤΤΟΣ

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Sustainability & Construction

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2. Load Calculations

Eurocode Applied.com

Free online calculation tools for structural design according to Eurocodes

Project:	ΚΕΝΤΡΙΚΗ ΑΓΟΡΑ ΘΕΣΣΑΛΟΝΙΚΗΣ
Subject:	ΤΟΙΧΟΣ ΑΠΟ ΟΠΛΙΣΜΕΝΟ ΣΚΥΡΟΔΕΜΑ
Designer:	ΑΘΑΝΑΣΙΟΣ ΠΡΑΤΤΟΣ
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Eurocode 1

Wind load on free-standing walls and parapets (net pressure coefficients)

Description:

Calculation of wind load action effects on free-standing walls and parapets. The net wind pressure for zones A, B, C, D along the length of the structure are calculated from the net pressure coefficients corresponding to the overall effect on the front and back faces

According to:

EN 1991-1-4:2005+A1:2010 Section 7.4.1

Supported National Annexes:

A) Calculation of pressure coefficients: Only countries that adopt CEN recommended values for section 7.4.1 of EN1991-1-4 are supported. B) Peak velocity pressure: The value of the peak velocity pressure can be specified manually. Otherwise automatic calculation of peak velocity pressure is supported, in addition to countries that adopt the CEN recommended values for NDPs, also for the following National Annexes: Finland, Portugal. The National Annexes of Germany, Norway, Spain, Sweden, Switzerland are NOT supported (enter peak velocity pressure manually).

Input

Terrain category	=	0	
Basic wind velocity	v_b =	33	m/s
Length of wall	l =	30	m
Height of wall above ground	h =	2	m
Distance of the base of the wall from the ground	h_{base} =	0	m
Length of return corner	l_{corner} =	0	m
Solidity ratio	φ =	1	
Orography factor at reference height z_e	$c_0(z_e)$ =	1	

Nationally Defined Parameters

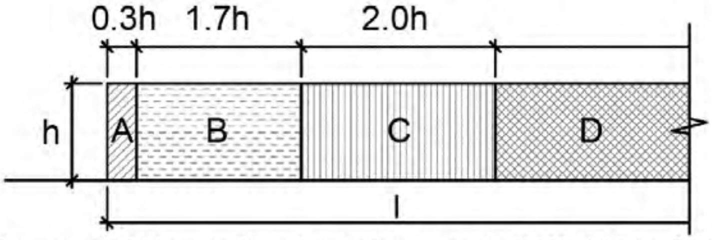
Air density	ρ =	1.25	kg/m^3

Additional rules defined in the National Annex for the calculation of peak velocity pressure $q_p(z_e)$ = None

Net pressure coefficients $c_{p,net}$ = Default

Results

Net wind pressure on zone A	$w_{net,A}$ = 4.947 kN/m^2
Net wind pressure on zone B	$w_{net,B}$ = 3.055 kN/m^2
Net wind pressure on zone C	$w_{net,C}$ = 2.473 kN/m^2
Net wind pressure on zone D	$w_{net,D}$ = 1.746 kN/m^2



Pressure zones for free-standing walls and parapets (see also EN1991-1-4 Figure 7.19)

Notes

1. The calculated net wind pressure w_{net} corresponds to the overall wind effect on the surface including both the external wind pressure and the internal wind pressure.
2. Pressure zones that are not applicable for the examined structure are denoted by N/A.
3. For the case of walls sheltered by other upwind walls having equal or larger height the net wind pressure can reduced by the shelter factor as specified in EN1991-1-4 §7.4.2
4. The calculated wind action effects are characteristic values (unfactored). Appropriate load factors should be applied for the relevant design situation. For ULS verifications the partial load factor γ_Q = 1.50 is applicable for variable actions.

Details

Input Data

- Terrain category: = 0
- Basic wind velocity: v_b = 33 m/s
- Length of wall: l = 30 m
- Height of wall above ground: h = 2 m
- Distance of the base of the wall from the ground: h_{base} = 0 m
- Length of return corner: l_{corner} = 0 m
- Solidity ratio: φ = 1
- Orography factor at reference height z_e: $c_0(z_e)$ = 1

Nationally Defined Parameters

- Air density: ρ = 1.25 kg/m^3
- Additional rules defined in the National Annex for the calculation of peak velocity pressure $q_p(z_e)$: = None
- Net pressure coefficients $c_{p,net}$: = Default

Calculation of peak velocity pressure

Reference height

The reference height for the wind action z_e is equal to the maximum height above ground of the free standing wall, as specified in *EN1991-1-4 §7.4.1(2)*. Therefore:

$z_e = h + h_{base}$ = 2.000 m + 0.000 m = 2.000 m

Basic wind velocity

The basic wind velocity v_b is defined in *EN1991-1-4 §4.2(2)P* as a function of the wind direction and time of year at 10 m above ground of terrain category II. The value of v_b includes the effects of the directional factor c_{dir} and the seasonal factor c_{season} and it is provided in the National Annex. In the following calculations the basic wind velocity is considered as v_b = 33.00 m/s.

Terrain roughness

The roughness length z_0 and the minimum height z_{min} are specified in *EN1991-1-4 Table 4.1* as a function of the terrain category. For terrain category 0 the corresponding values are: z_0 = 0.003 m and z_{min} = 1.0 m.

The terrain factor k_r depending on the roughness length z_0 = 0.003 m is calculated in accordance with *EN1991-1-4 equation (4.5)*:

$k_r = 0.19 \cdot (z_0 / z_{0,II})^{0.07} = 0.19 \cdot (0.003\ m / 0.050\ m)^{0.07} = 0.1560$

The roughness factor $c_r(z_e)$ at the reference height z_e accounts for the variability of the mean wind velocity at the site. It is calculated in accordance with *EN1991-1-4 equation 4.4*. For the examined case $z_e \geq z_{min}$:

$c_r(z_e) = k_r \cdot \ln(\max\{z_e, z_{min}\} / z_0) = 0.1560 \cdot \ln(\max\{2.000\ m, 1.0\ m\} / 0.003\ m) = 1.0146$

Orography factor

Where orography (e.g. hills, cliffs etc.) is significant its effect in the wind velocities should be taken into account using an orography factor $c_0(z_e)$ different than 1.0, as specified in *EN1994-1-1 §4.3.3*. The recommended procedure in *EN1994-1-1 §4.3.3* for calculation of the orography factor $c_0(z_e)$ is described in *EN1994-1-1 §A.3*.

In the following calculations the orography factor is considered as $c_0(z_e)$ = 1.000.

Mean wind velocity

The mean wind velocity $v_m(z_e)$ at reference height z_e depends on the terrain roughness, terrain orography and the basic wind velocity v_b. It is determined using *EN1991-1-4 equation (4.3)*:

$v_m(z_e) = c_r(z_e) \cdot c_0(z_e) \cdot v_b = 1.0146 \cdot 1.000 \cdot 33.00\ m/s = 33.48\ m/s$

Wind turbulence

The turbulence intensity $I_v(z_e)$ at reference height z_e is defined as the standard deviation of the turbulence divided by the mean wind velocity. It is calculated in accordance with *EN1991-1-4 equation 4.7*. For the examined case $z_e \geq z_{min}$.

$I_v(z_e) = k_I / [\ c_0(z_e) \cdot \ln(\max\{z_e, z_{min}\} / z_0)\ ] = 1.000 / [\ 1.000 \cdot \ln(\max\{2.000\ m, 1.0\ m\} / 0.003\ m)\ ] = 0.1538$

Basic velocity pressure

The basic velocity pressure q_b is the pressure corresponding to the wind momentum determined at the basic wind velocity v_b. The basic velocity pressure is calculated according to the fundamental relation specified in *EN1991-14 §4.5(1)*:

$q_b = (1/2) \cdot \rho \cdot v_b^2 = (1/2) \cdot 1.25\ kg/m^3 \cdot (33.00\ m/s)^2 = 681\ N/m^2 = 0.681\ kN/m^2$

where ρ is the density of the air in accordance with *EN1991-1-4 §4.5(1)*. In this calculation the following value is considered: $\rho = 1.25\ kg/m^3$. Note that by definition 1 N = 1 kg·m/s^2.

Peak velocity pressure

The peak velocity pressure $q_p(z_e)$ at reference height z_e includes mean and short-term velocity fluctuations. It is determined according to *EN1991-1-4 equation 4.8*:

$q_p(z_e) = (1 + 7 \cdot I_v(z_e)) \cdot (1/2) \cdot \rho \cdot v_m(z_e)^2 = (1 + 7 \cdot 0.1538) \cdot (1/2) \cdot 1.25\ \text{kg/m}^3 \cdot (33.48\ \text{m/s})^2 = 1455\ \text{N/m}^2$
$\Rightarrow q_p(z_e) = 1.455\ \text{kN/m}^2$

Note that by definition 1 N = 1 kg·m/s^2.

Calculation of the distribution of net wind pressure on the structure

Net pressure coefficients

The wind load on the structure is expressed in terms of net pressure coefficients for four zones A, B, C, D as defined in *EN1991-1-4 Figure 7.19* that is reproduced above. The most adverse Zone A extends for lengths from 0 to 0.3h from the free edge. Zone B extends from 0.3h to 2h. Zone C extends from 2h to 4h. Zone D extends for length beyond 4h. For the examined wall where l/h = 30.000 m / 2.000 m = 15.000 the applicable zones are zones A, B, C, D.

The net pressure coefficient $c_{p,net}$ for each of zones A, B, C, D is defined in *EN1991-1-4 Table 7.9* as a function of the wall aspect ratio l/h, the length of the return corner l_{corner} and the solidity ratio φ. For the examined case: l/h = 30.000 m / 2.000 m = 15.000, l_{corner}/h = 0.000 m / 2.000 m = 0.000, and φ = 1.000. Therefore according to *EN1991-1-4 Table 7.9* the following net pressure coefficient are obtained, using linear interpolation:

Zone	Net pressure coefficient
Zone A	$c_{p,net,A} = 3.400$
Zone B	$c_{p,net,B} = 2.100$
Zone C	$c_{p,net,C} = 1.700$
Zone D	$c_{p,net,D} = 1.200$

Net wind pressure

The net wind pressure on the structure w_{net} corresponds to the net pressure effect on the front and the back faces of the wall. The net pressure on surface is derived from the calculated value of the peak velocity pressure $q_p(z_e)$ = 1.455 kN/m^2 by application of the appropriate net pressure coefficient $c_{p,net}$ as specified in *EN1991-1-4 §5.2*.

$$w_{net} = q_p(z_e) \cdot c_{p,net}$$

For the different pressure zones on the wall the following net pressures are obtained:

Zone	Net wind pressure
Zone A	$w_{net,A} = 4.947\ \text{kN/m}^2$
Zone B	$w_{net,B} = 3.055\ \text{kN/m}^2$
Zone C	$w_{net,C} = 2.473\ \text{kN/m}^2$
Zone D	$w_{net,D} = 1.746\ \text{kN/m}^2$

- Zone A extends from 0 to 0.3h = 0.600 m.

- Zone B extends from 0.3h = 0.600 m to 2h = 4.000 m.

- Zone C extends from 2h = 4.000 m to 4h = 8.000 m.

- Zone D extends from 4h = 8.000 m up to the full length.

Additional notes

- The net pressure corresponds to the overall wind effect on the front face and the back face of the wall.
- The calculated wind action effects are characteristic values (unfactored). Appropriate load factors should be applied for the relevant design situation. For ULS verifications the partial load factor γ_Q = 1.50 is

applicable for variable actions according to EN1990.

3. Setup manager

Combination setup

Category H loading not to be combined with snow or wind	✓

Psi factors

Load	Psi0	Psi1	Psi2
CategoryA	0.7	0.5	0.3
CategoryB	0.7	0.5	0.3
CategoryC	0.7	0.7	0.6
CategoryD	0.7	0.7	0.6
CategoryE	1	0.9	0.8
CategoryF	0.7	0.7	0.6
CategoryG	0.7	0.5	0.3
CategoryH	0	0	0
Snow	0.5	0.2	0
Wind	0.6	0.2	0
Temperature	0.6	0.5	0

Load combination factors

Permanent action - unfavorable	1,35
Permanent action - favorable	1,00
Leading variable action	1,50
Accompanying variable action	1,50
Reduction factor ksi [-]	0,93
Permanent action - unfavorable	1,00
Permanent action - favorable	1,00
Leading variable action	1,30
Accompanying variable action	1,30

Road bridges

gr1b not to be combined with other non-traffic loads	✓
Snow or wind load not to be combined with gr2	✓
Snow or wind load not to be combined with gr3	✓
Snow or wind load not to be combined with gr4	✓
Snow not to be combined with gr1a and gr1b	✓
Wind loads not to be combined with Thermal loads	✓
Snow loads and wind loads not to be combined with construction activity	✓

Road bridges

Load	Psi0	Psi1	Psi2
Traffic - gr1a - TS	0.75	0.75	0
Traffic - gr1a - UDL	0.4	0.4	0
Traffic - gr1a - Pedestr. + cycle track	0.4	0.4	0
Traffic - gr1b - Single axle	0	0.75	0
Traffic - gr2 - Horizontal forces	0	0	0
Traffic - gr3 - Pedestrian loads	0	0.4	0
Traffic - gr4 - Crowd loading	0	0	0
Traffic - gr5 - Special vehicles	0	0	0
Wind forces - FWk - Persistent	0.6	0.2	0
Wind forces - FWk - Execution	0.8	0	0
Wind forces - F*W - Design	1	0	0
Thermal actions - Tk	0.6	0.6	0.5
Snow loads - QSn,k - Execution	0.8	0	0
Construction loads - Qc	1	0	1

Road bridges

Permanent action - unfavorable	1,35
Permanent action - favorable	1,00
Leading variable action - unfavorable due to road or pedestrian	1,35
Accompanying variable action - unfavorable due to road or pedestrian	1,35
Leading variable action - all other	1,50
Accompanying variable action - all other	1,50
Reduction factor ksi	0,85
Permanent action - unfavorable	1,00
Permanent action - favorable	1,00
Leading variable action - unfavorable due to road or pedestrian	1,15

Accompanying variable action - unfavorable due to road or pedestrian	1,15
Leading variable action - all other	1,30
Accompanying variable action - all other	1,30

Footbridges

Qfvk not to be combined with other non-traffic loads	✓
Wind loads not to be combined with Thermal loads	✓
Snow loads not to be combined with gr1 and gr2	✓
Snow loads and wind loads not to be combined with construction activity	✓

Footbridges

Load	Psi0	Psi1	Psi2
Traffic - gr1	0.4	0.4	0
Traffic - Qfvk	0	0	0
Traffic - gr2	0	0	0
Wind forces - FWk	0.3	0.2	0
Thermal actions - Tk	0.6	0.6	0.5
Snow loads - QSn,k - Execution	0.8	0	0
Construction loads - Qc	1	0	1

Footbridges

Permanent action - unfavorable	1,35
Permanent action - favorable	1,00
Leading variable action - unfavorable due to road or pedestrian	1,35
Accompanying variable action - unfavorable due to road or pedestrian	1,35
Leading variable action - all other	1,50
Accompanying variable action - all other	1,50
Reduction factor ksi	0,85
Permanent action - unfavorable	1,00
Permanent action - favorable	1,00
Leading variable action - unfavorable due to road or pedestrian	1,15
Accompanying variable action - unfavorable due to road or pedestrian	1,15
Leading variable action - all other	1,30
Accompanying variable action - all other	1,30

Railway bridges

Snow loads not to be taken into account	✓
Wind action not to be combined with gr13 or gr23	✓
Wind action not to be combined with gr16, gr17, gr26, gr27	✓
Snow loads and wind loads not to be combined with constr. activity	✓

Railway bridges

Load	Psi0	Psi1	Psi2
Traffic - gr11 (LM71 + SW/0)	0.8	0.8	0
Traffic - gr12 (LM71 + SW/0)	0.8	0.8	0
Traffic - gr13 (Braking/traction)	0.8	0.8	0
Traffic - gr14 (Centrifugal/nosing)	0.8	0.8	0
Traffic - gr15 (Unloaded train)	0.8	0.8	0
Traffic - gr16 (SW/2)	0.8	0.8	0
Traffic - gr17 (SW/2)	0.8	0.8	0
Traffic - gr21 (LM71 + SW/0)	0.8	0.7	0
Traffic - gr22 (LM71 + SW/0)	0.8	0.7	0
Traffic - gr23 (Braking/traction)	0.8	0.7	0
Traffic - gr24 (Centrifugal/nosing)	0.8	0.7	0
Traffic - gr26 (SW/2)	0.8	0.7	0
Traffic - gr27 (SW2)	0.8	0.7	0
Traffic - gr31 (LM71 + SW/0)	0.8	0.6	0
Aerodynamic effects	0.8	0.5	0
General maintenance loading...	0.8	0.5	0
Wind forces - FWk - Characteristic	0.75	0.5	0
Wind forces - F**W - Design	1	0	0
Thermal actions - Tk	0.6	0.6	0.5
Snow loads - QSn,k - Execution	0.8	0	0
Construction loads - Qc	1	0	1

Railway bridges

Permanent action - unfavorable	1,35

Permanent action - favorable	1,00
Leading variable action - unfavorable due to railway	1,45
Accompanying variable action - unfavorable due to railway	1,45
Leading variable action - unfavorable due to railway gr 16-17	1,20
Accompanying variable action - unfavorable due to railway gr 16-17	1,20
Leading variable action - unfavorable due to railway gr 26-27	1,20
Accompanying variable action - unfavorable due to railway gr 26-27	1,20
Leading variable action - all other	1,50
Accompanying variable action - all other	1,50
Reduction factor ksi	0,85
Permanent action - unfavorable	1,00
Permanent action - favorable	1,00
Leading variable action - unfavorable due to railway	1,25
Accompanying variable action - unfavorable due to railway	1,25
Leading variable action - all other	1,30
Accompanying variable action - all other	1,30

4. Cross-sections

CS2		
Type	Rectangle	
Detailed	1500; 200	
Shape type	Thick-walled	
Item material	C30/37	
Fabrication	concrete	
Colour		
A [m^2]	3,0000e-01	
A_y [m^2], A_z [m^2]	2,5000e-01	2,5000e-01
A_L [m^2/m], A_D [m^2/m]	3,4000e+00	3,4000e+00
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	100	750
α [deg]	0,00	
I_y [m^4], I_z [m^4]	5,6250e-02	1,0000e-03
i_y [mm], i_z [mm]	433	58
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	7,5000e-02	1,0000e-02
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	0,0000e+00	0,0000e+00
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	0,00e+00	0,00e+00
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	0,00e+00	0,00e+00
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	3,6640e-03	0,0000e+00
$β_y$ [mm], $β_z$ [mm]	0	0
Picture		

Explanations of symbols	
A	Area
A_y	Shear Area in principal y-direction
A_z	Shear Area in principal z-direction
A_L	Circumference per unit length
A_D	Drying surface per unit length
$c_{Y.UCS}$	Centroid coordinate in Y-direction of Input axis system
$c_{Z.UCS}$	Centroid coordinate in Z-direction of Input axis system
$I_{Y.LCS}$	Second moment of area about the YLCS axis

Explanations of symbols	
$I_{Z.LCS}$	Second moment of area about the ZLCS axis
$I_{YZ.LCS}$	Product moment of area in the LCS system
α	Rotation angle of the principal axis system
I_y	Second moment of area about the principal y-axis
I_z	Second moment of area about the principal z-axis
i_y	Radius of gyration about the principal

Explanations of symbols	
	y-axis
i_z	Radius of gyration about the principal z-axis
$W_{el.y}$	Elastic section modulus about the principal y-axis
$W_{el.z}$	Elastic section modulus about the principal z-axis
$W_{pl.y}$	Plastic section modulus about the principal y-axis
$W_{pl.z}$	Plastic section modulus about the principal z-axis
$M_{pl.y.+}$	Plastic moment about the principal y-axis for a positive My moment

Explanations of symbols	
$M_{pl.y.-}$	Plastic moment about the principal y-axis for a negative My moment
$M_{pl.z.+}$	Plastic moment about the principal z-axis for a positive Mz moment
$M_{pl.z.-}$	Plastic moment about the principal z-axis for a negative Mz moment
d_y	Shear center coordinate in principal y-direction measured from the centroid - Not calculated or simplified
d_z	Shear center coordinate in principal z-direction measured from the centroid - Not calculated or simplified
I_t	Torsional constant - Not calculated or simplified
I_w	Warping constant - Not calculated or simplified
β_y	Mono-symmetry constant about the principal y-axis
β_z	Mono-symmetry constant about the principal z-axis

5. Materials

Name	Type	ρ [kg/m³]	Density in fresh state [kg/m³]	E_{mod} [MPa]	μ	α [m/mK]	$f_{c.k.28}$ [MPa]	Colour
C25/30	Concrete	2500,0	2600,0	3,1500e+04	0.2	0,00	25,00	
C30/37	Concrete	2500,0	2600,0	3,2800e+04	0.2	0,00	30,00	

Explanations of symbols	
Density in fresh state	The value in the density in fresh state property is used only in case a composite deck is input and its self-weight load is taken into account.

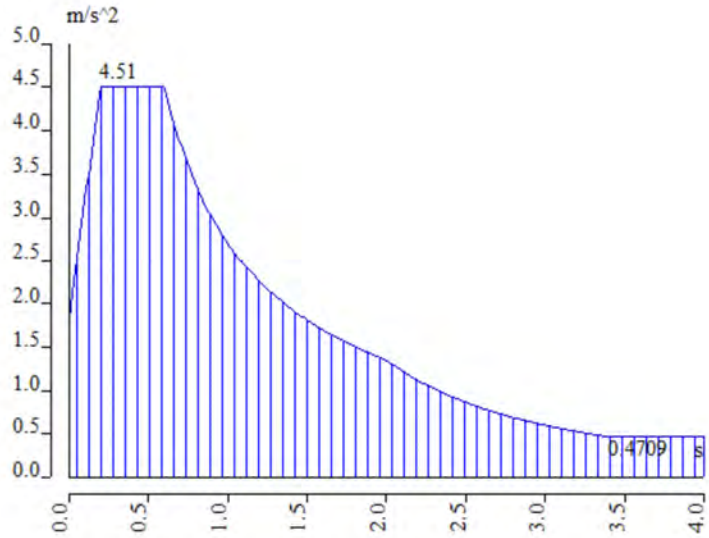
Reinforcement EC2

Name	Type	ρ [kg/m³]	E_{mod} [MPa]	G_{mod} [MPa]	α [m/mK]	$f_{y.k}$ [MPa]
B 500C	Reinforcement steel	7850,0	2,0000e+05	8,3333e+04	0,00	500,0

6. Subsoils

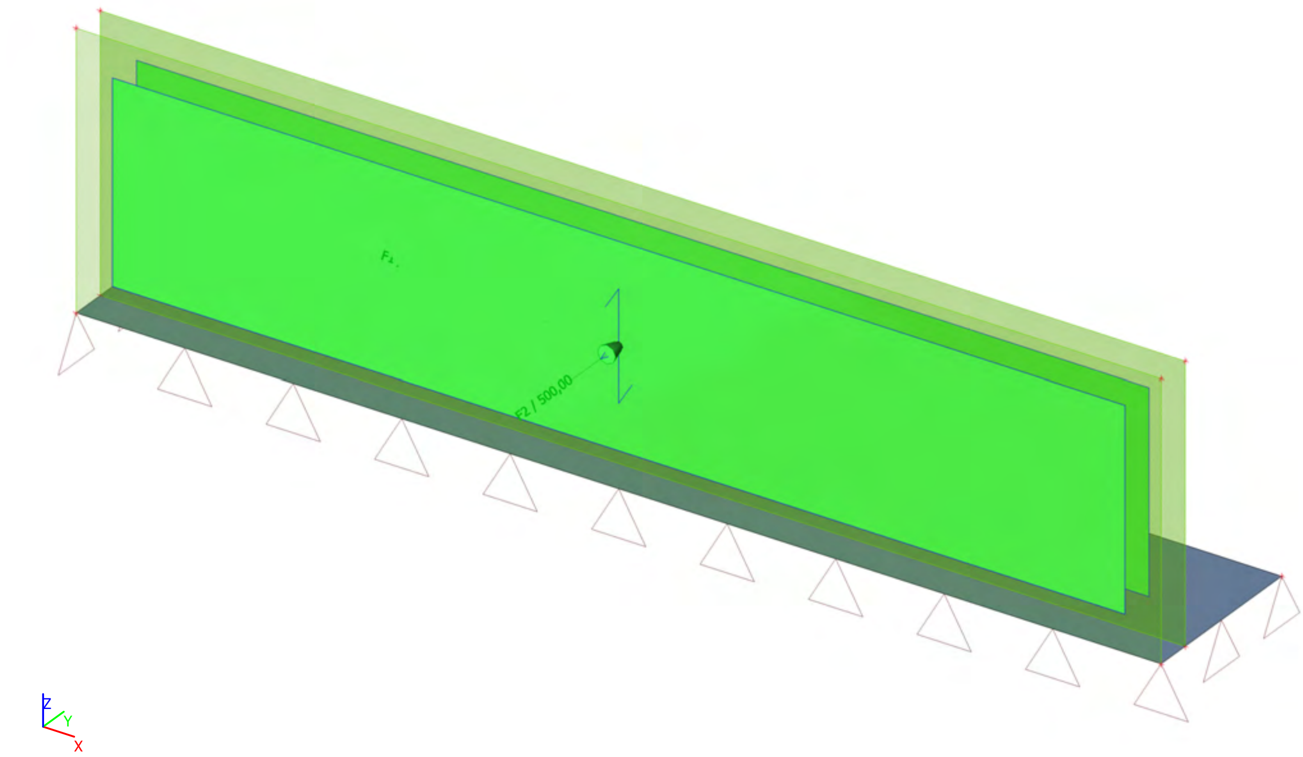
Name	C1x [MN/m³]	C1z	C1y [MN/m³]	Stiffness [MN/m³]	C2x [MN/m]	C2y [MN/m]
Sub3	5,0000e+00	Flexible	5,0000e+00	1,0000e+01	0,0000e+00	0,0000e+00

7. Seismic spectrums

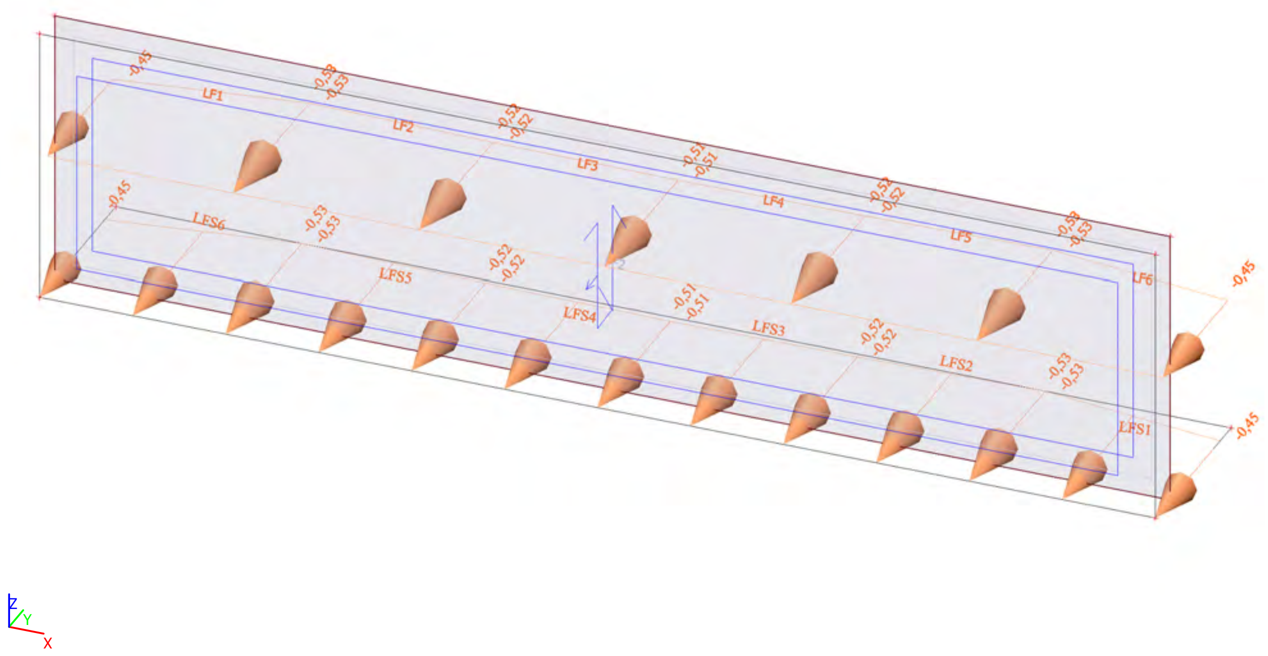
Name UniqueID	Type drawing	Info	Drawing
FS1	Period	Type code - Eurocode Subsoil type - C Direction - Horizontal Spectrum type - type 1 coeff accel. ag - 0.24 ag - design acceleration - 2.3544 beta - 0.2 q - behaviour factor - 1.5	

8. ΦΟΡΤΙΣΤΙΚΕΣ ΚΑΤΑΣΤΑΣΕΙΣ

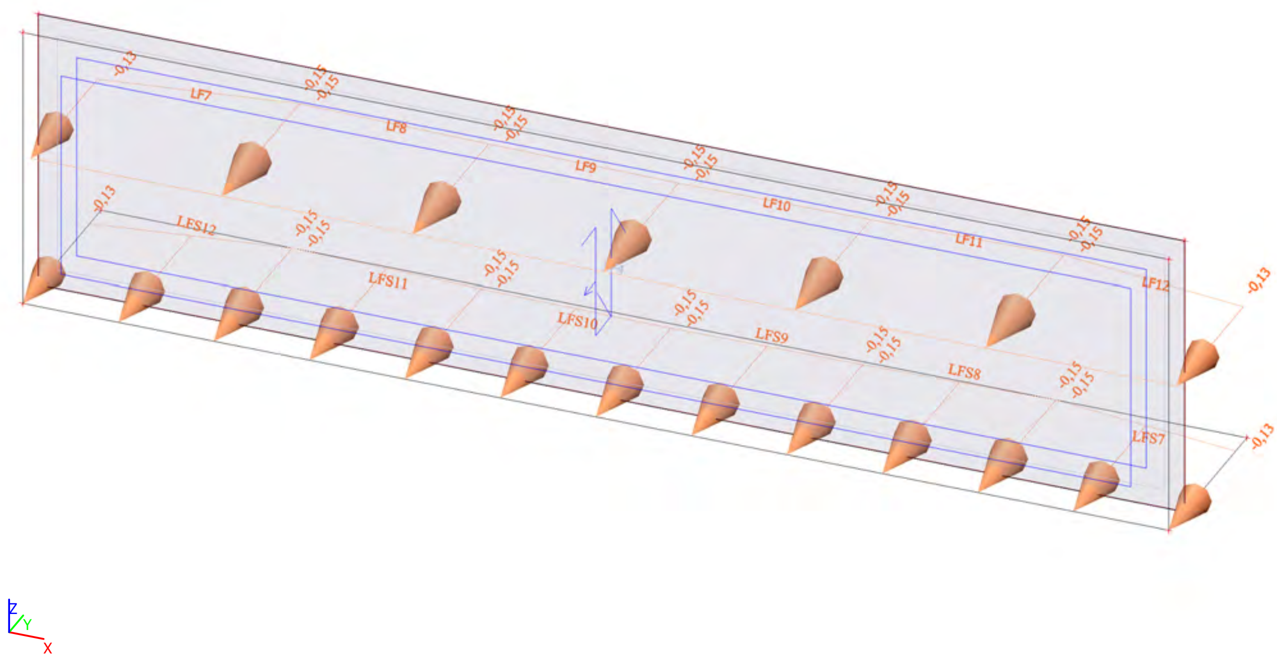
8.1. ΔΥΝΑΜΗ ΚΡΟΥΣΗΣ



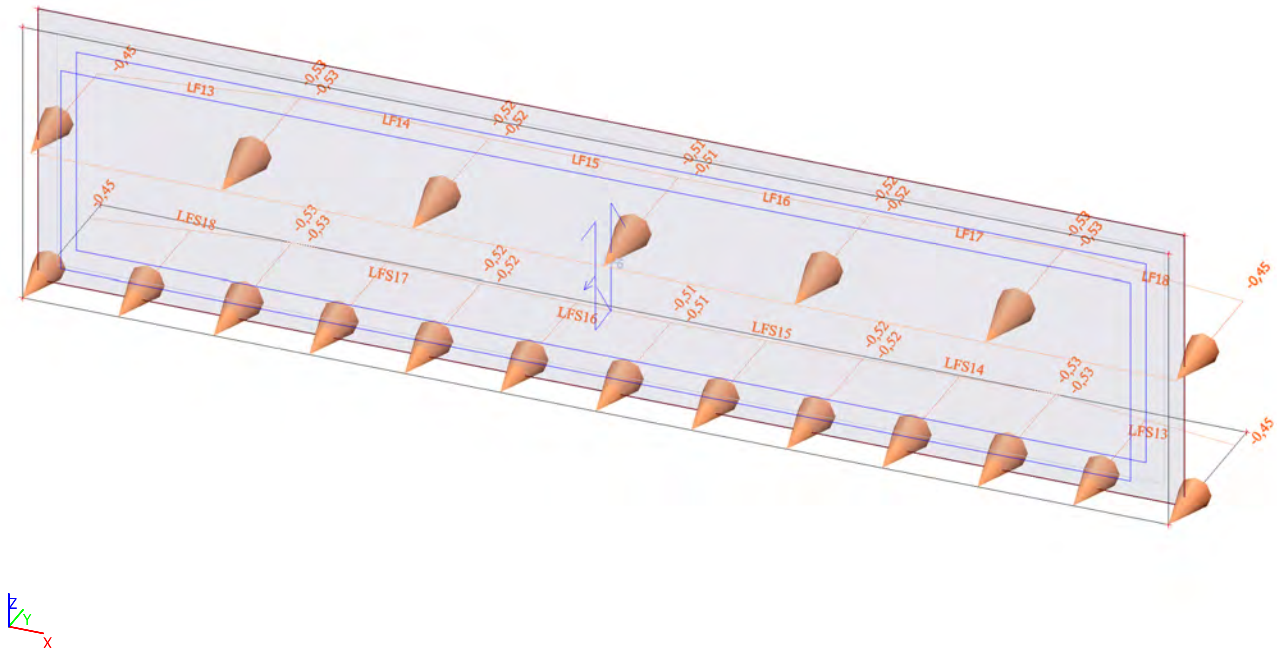
8.2. WIND 01



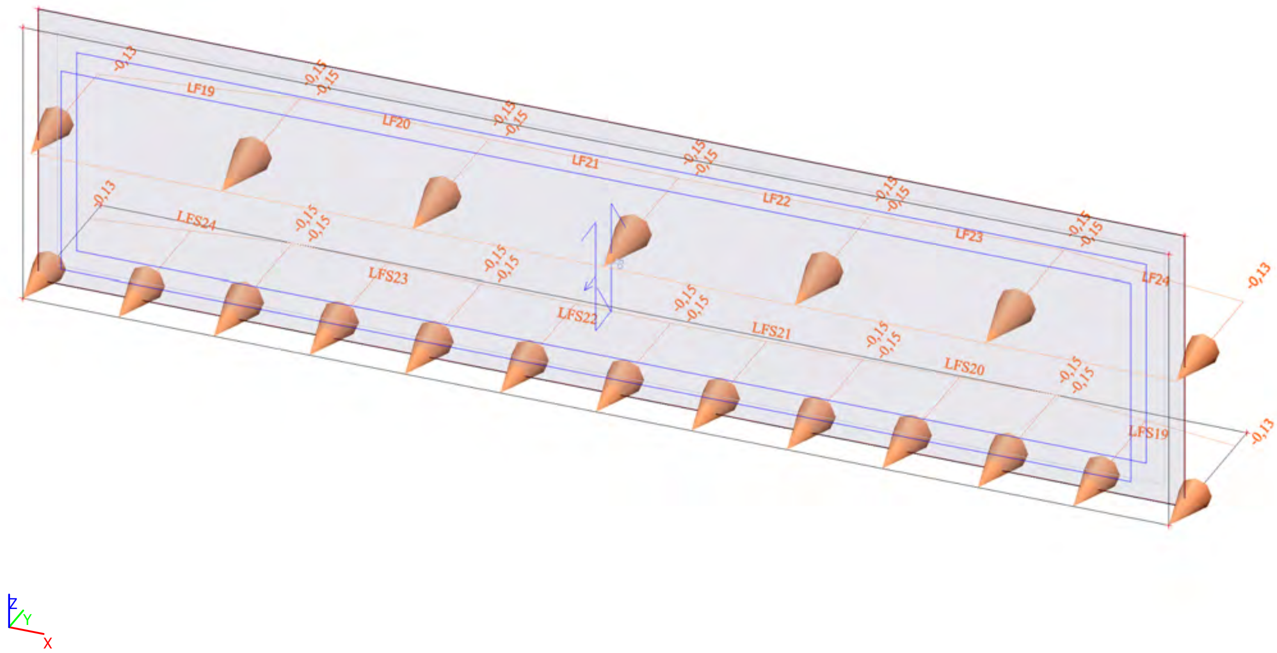
8.3. WIND 02



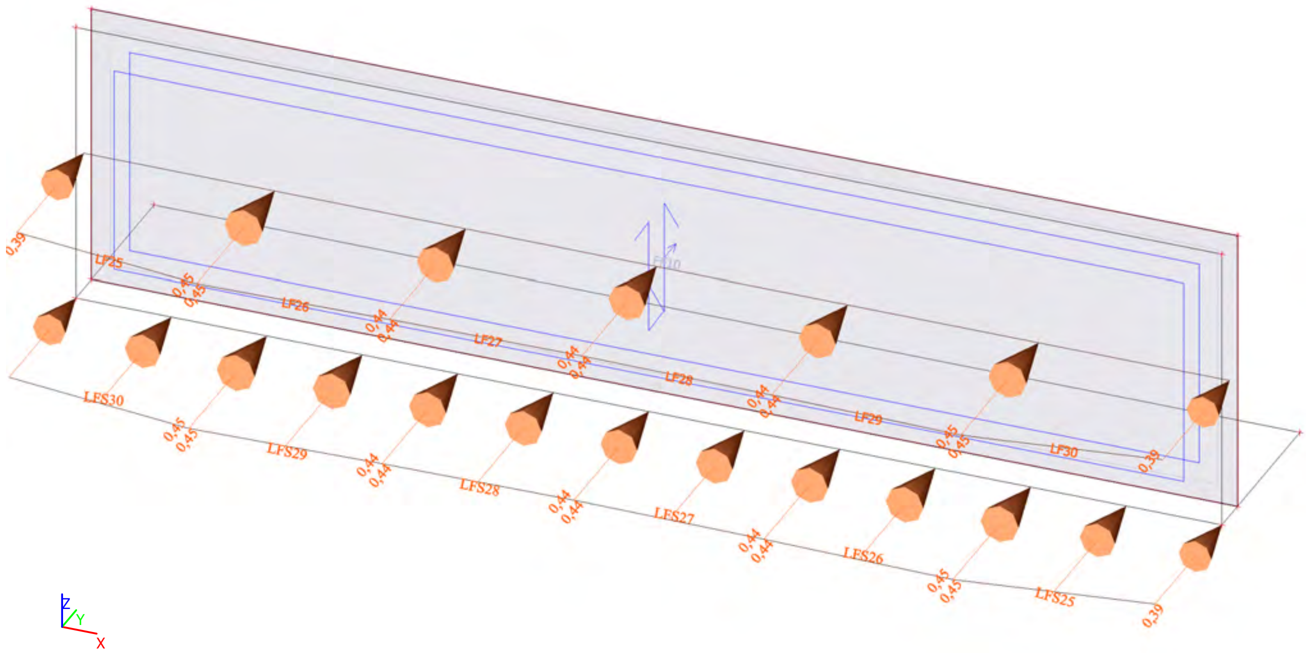
8.4. WIND 03



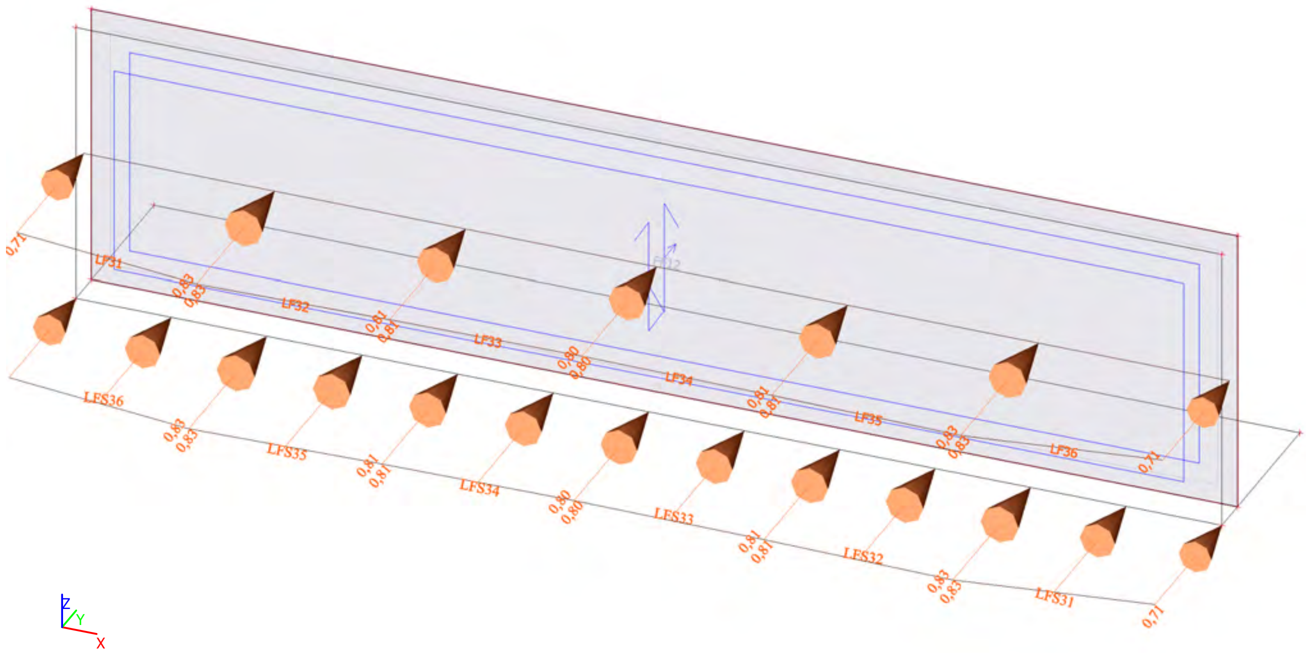
8.5. WIND 04



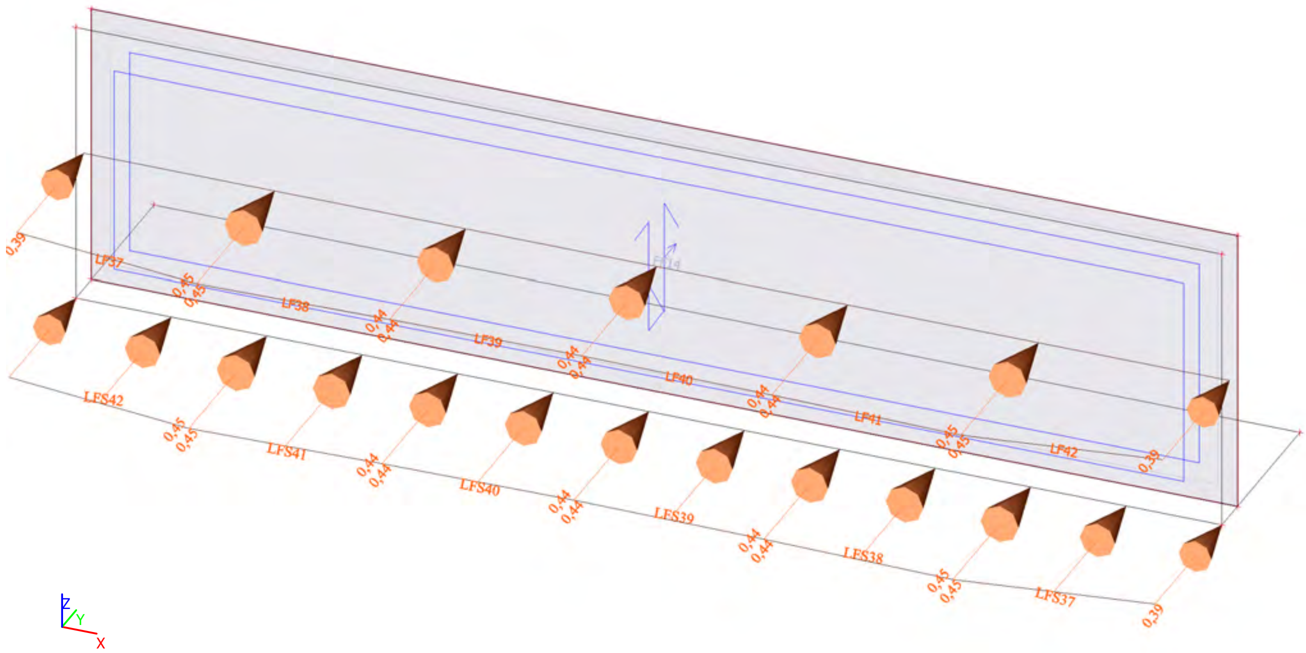
8.6. WIND 05



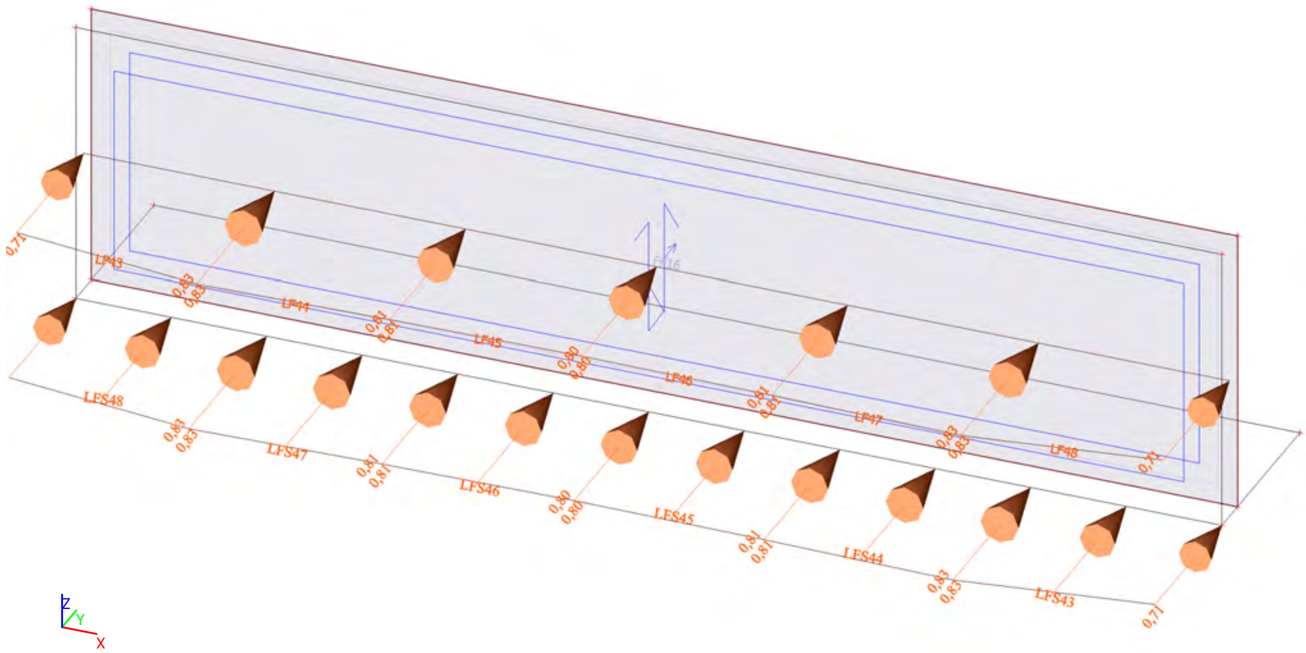
8.7. WIND 06



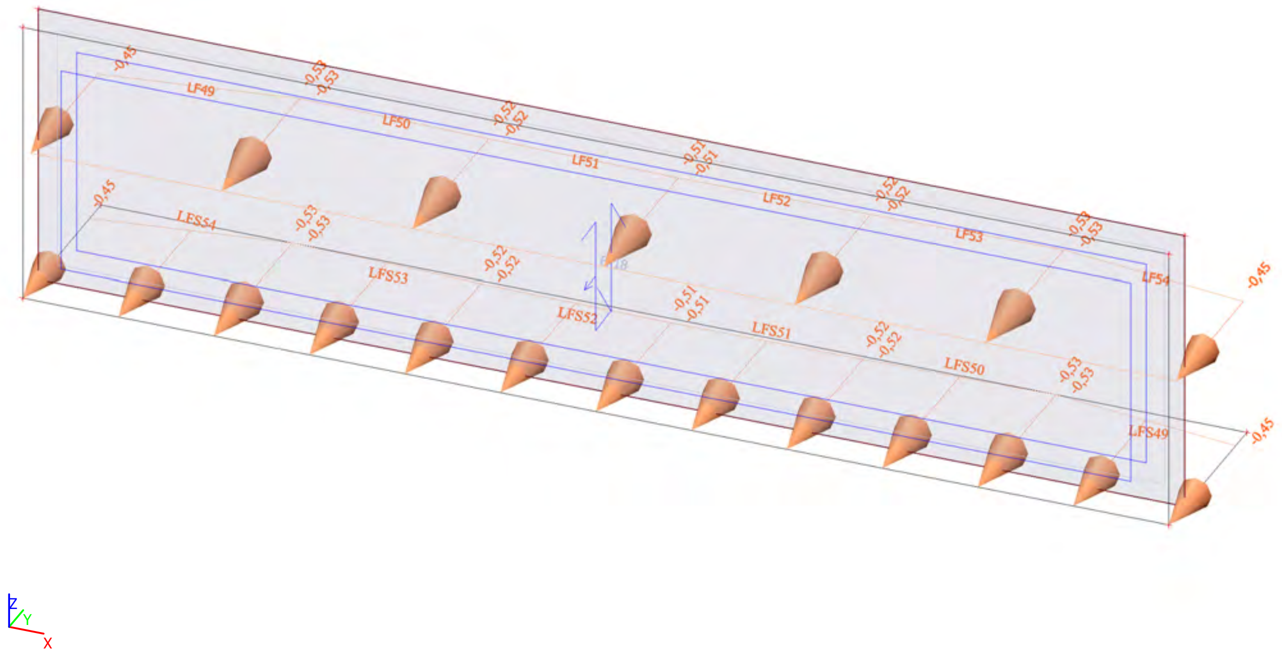
8.8. WIND 07



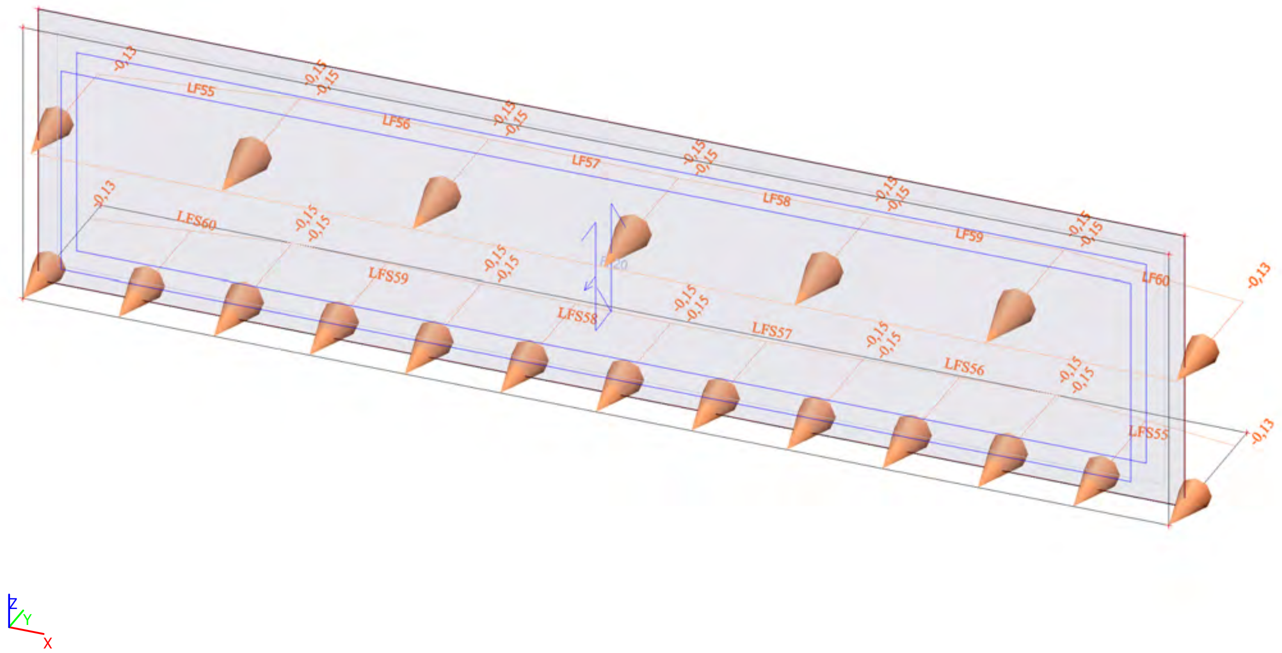
8.9. WIND 08



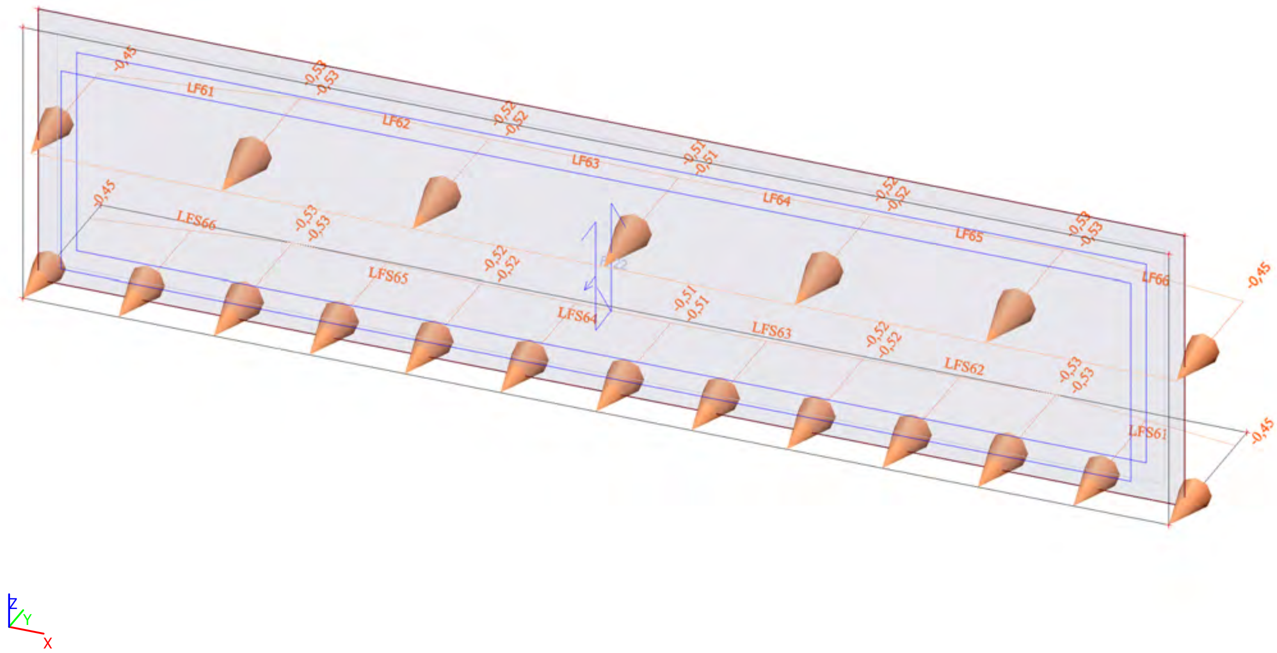
8.10. WIND 09



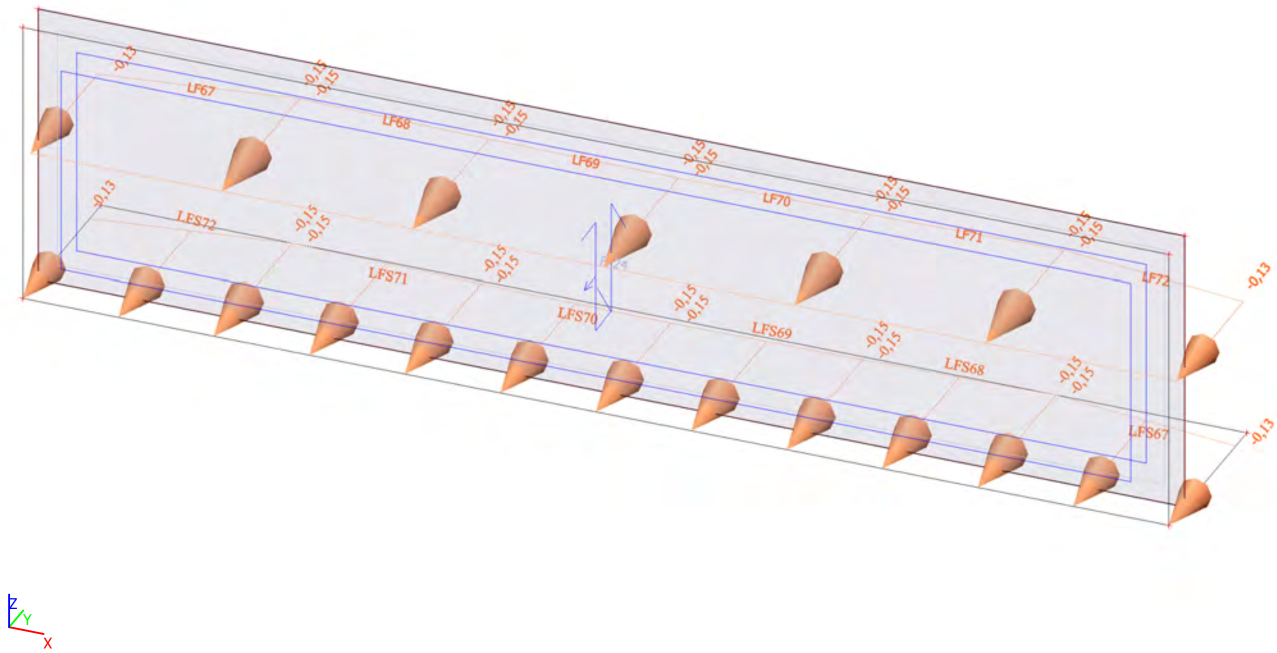
8.11. WIND 10



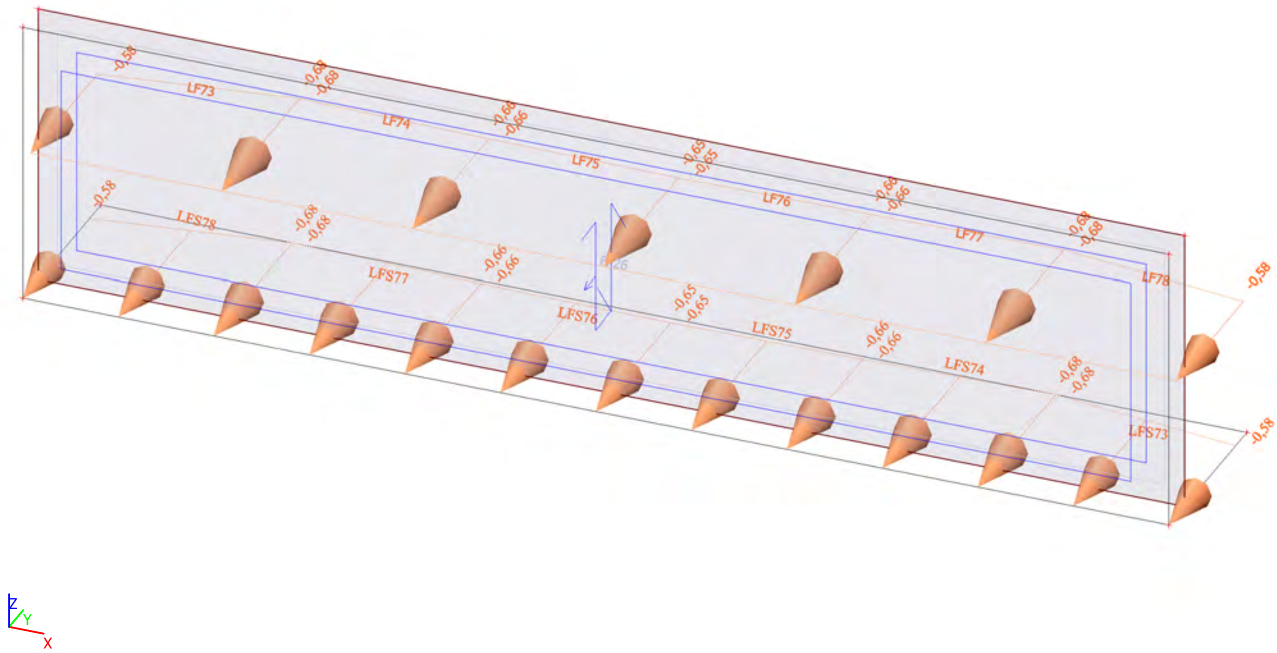
8.12. WIND 11



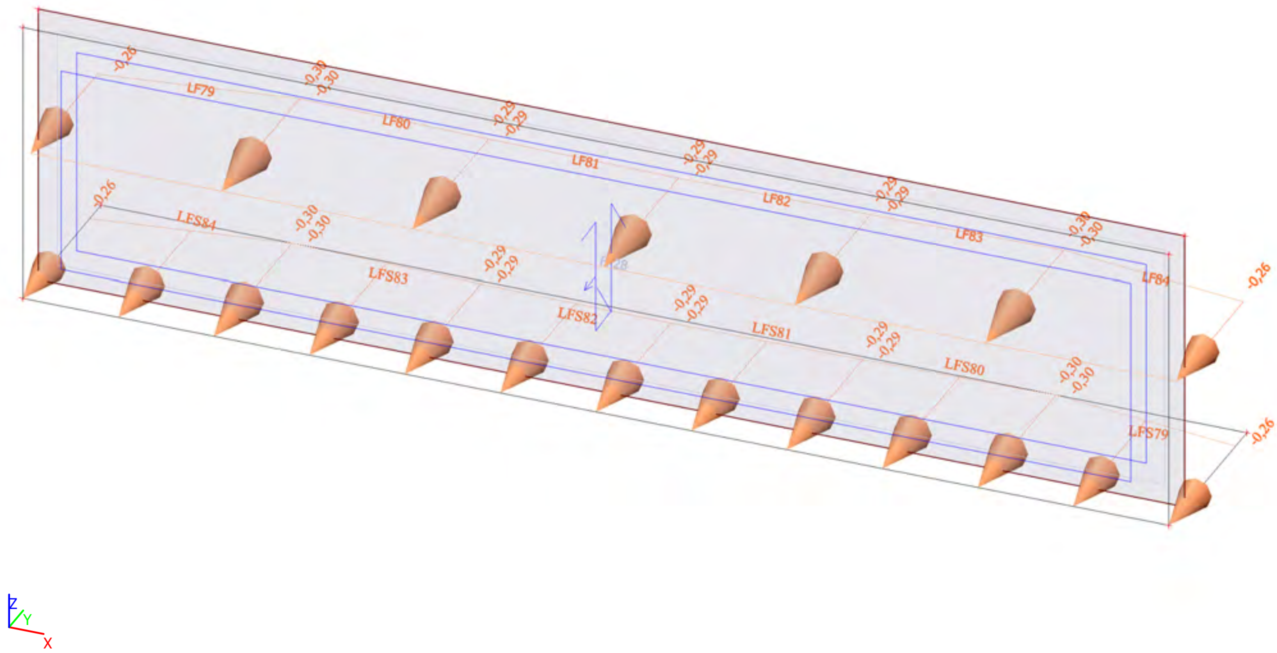
8.13. WIND 12



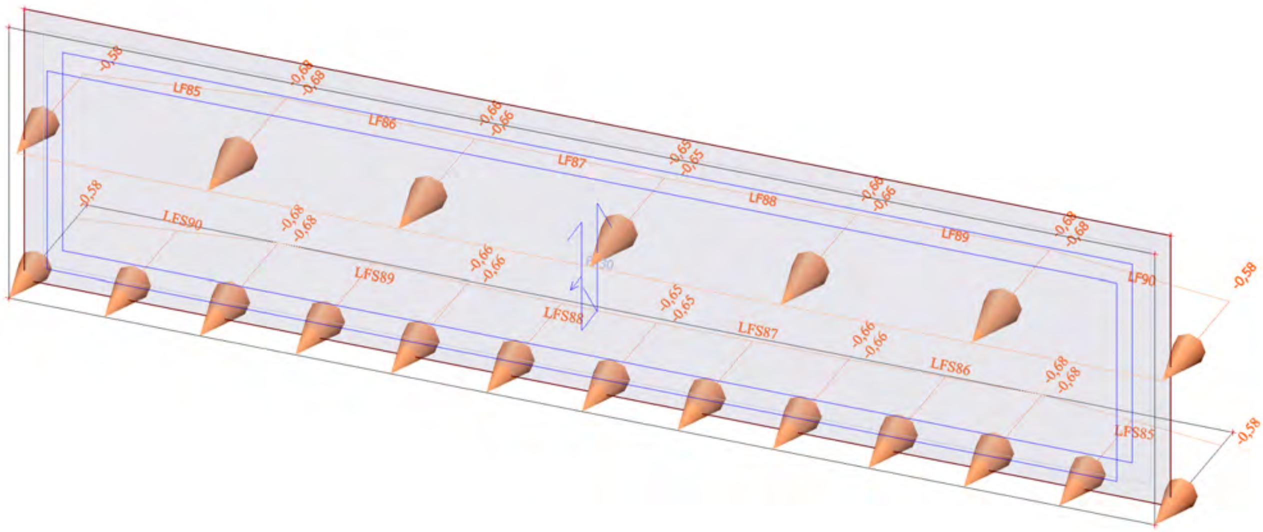
8.14. WIND 13



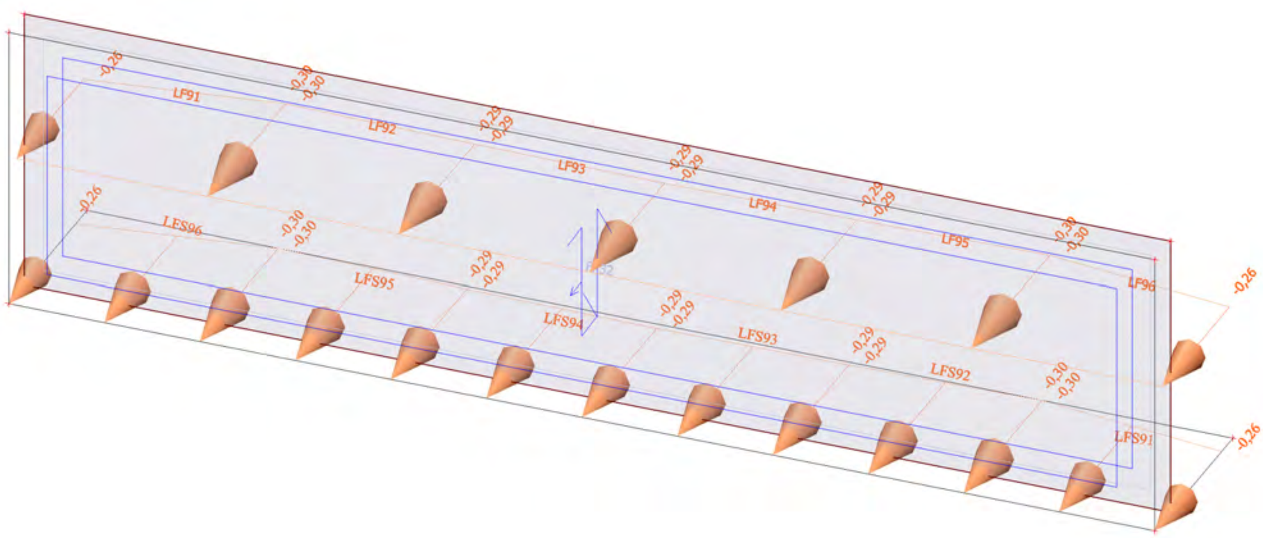
8.15. WIND 14



8.16. WIND 15



8.17. WIND 16



Name	Description Spec	Action type Load type	LoadGroup	Direction	Master load case
LC1		Permanent Self weight	LG1	-Z	
LC2	ΤΥΧΑΙΑ ΚΡΟΥΣΗ	Permanent Standard	LG2		
LC3	EARTHQUAKE X Seismicity	Variable Dynamic	LG6		None
LC4	EARTHQUAKE Y Seismicity	Variable Dynamic	LG6		None
3DWind1	0, + CPE, + CPI Static wind	Variable Static	Snow1		None
3DWind2	0, + CPE, - CPI Static wind	Variable Static	Snow1		None
3DWind3	0, - CPE, + CPI Static wind	Variable Static	Snow1		None
3DWind4	0, - CPE, - CPI Static wind	Variable Static	Snow1		None
3DWind5	90, + CPE, + CPI Static wind	Variable Static	Snow1		None
3DWind6	90, + CPE, - CPI Static wind	Variable Static	Snow1		None
3DWind7	90, - CPE, + CPI Static wind	Variable Static	Snow1		None
3DWind8	90, - CPE, - CPI Static wind	Variable Static	Snow1		None
3DWind9	180, + CPE, + CPI Static wind	Variable Static	Snow1		None
3DWind10	180, + CPE, - CPI Static wind	Variable Static	Snow1		None
3DWind11	180, - CPE, + CPI Static wind	Variable Static	Snow1		None
3DWind12	180, - CPE, - CPI Static wind	Variable Static	Snow1		None
3DWind13	270, + CPE, + CPI Static wind	Variable Static	Snow1		None
3DWind14	270, + CPE, - CPI Static wind	Variable Static	Snow1		None
3DWind15	270, - CPE, + CPI Static wind	Variable Static	Snow1		None
3DWind16	270, - CPE, - CPI Static wind	Variable Static	Snow1		None

9. Load groups

Name	Load	Relation	Type
LG1	Permanent		
LG2	Permanent		
LG6	Seismic	Together	
Wind	Variable	Exclusive	Wind
Snow	Variable	Exclusive	Snow
Snow1	Variable	Exclusive	Wind

10. Combinations

Name	Description	Type	Load cases	Coeff. [-]
CO1	ΔΥΣΜΕΝΕΣΤΕΡΗ	EN-ULS (STR/GEO) Set B	LC1	1,00
			LC2 - ΤΥΧΑΙΑ ΚΡΟΥΣΗ	1,00
			3DWind1 - 0, + CPE, + CPI	1,00
			3DWind2 - 0, + CPE, - CPI	1,00
			3DWind3 - 0, - CPE, + CPI	1,00
			3DWind4 - 0, - CPE, - CPI	1,00
			3DWind5 - 90, + CPE, + CPI	1,00
			3DWind6 - 90, + CPE, - CPI	1,00
			3DWind7 - 90, - CPE, + CPI	1,00

Name	Description	Type	Load cases	Coeff. [-]
			3DWind8 - 90, - CPE, - CPI	1,00
			3DWind9 - 180, + CPE, + CPI	1,00
			3DWind10 - 180, + CPE, - CPI	1,00
			3DWind11 - 180, - CPE, + CPI	1,00
			3DWind12 - 180, - CPE, - CPI	1,00
			3DWind13 - 270, + CPE, + CPI	1,00
			3DWind14 - 270, + CPE, - CPI	1,00
			3DWind15 - 270, - CPE, + CPI	1,00
			3DWind16 - 270, - CPE, - CPI	1,00
CO2	ΣΕΙΣΜΟΣ	EN-Seismic	LC1	1,00
			LC2 - ΤΥΧΑΙΑ ΚΡΟΥΣΗ	1,00
			LC3 - EARTHQUAKE X	1,00
			LC4 - EARTHQUAKE Y	1,00
			3DWind1 - 0, + CPE, + CPI	1,00
			3DWind2 - 0, + CPE, - CPI	1,00
			3DWind3 - 0, - CPE, + CPI	1,00
			3DWind4 - 0, - CPE, - CPI	1,00
			3DWind5 - 90, + CPE, + CPI	1,00
			3DWind6 - 90, + CPE, - CPI	1,00
			3DWind7 - 90, - CPE, + CPI	1,00
			3DWind8 - 90, - CPE, - CPI	1,00
			3DWind9 - 180, + CPE, + CPI	1,00
			3DWind10 - 180, + CPE, - CPI	1,00
			3DWind11 - 180, - CPE, + CPI	1,00
			3DWind12 - 180, - CPE, - CPI	1,00
			3DWind13 - 270, + CPE, + CPI	1,00
			3DWind14 - 270, + CPE, - CPI	1,00
			3DWind15 - 270, - CPE, + CPI	1,00
			3DWind16 - 270, - CPE, - CPI	1,00

11. Concrete combinations

Name	Load cases	Coeff. [-]	use to determine Code Dependent Deflections (CDD) caused by creep
			use to determine permanent Code Dependent Deflections (CDD)
CC1	LC1	1,00	✓
	LC2 - ΤΥΧΑΙΑ ΚΡΟΥΣΗ	1,00	✓
	3DWind1 - 0, + CPE, + CPI	1,00	
	3DWind2 - 0, + CPE, - CPI	1,00	
	3DWind3 - 0, - CPE, + CPI	1,00	
	3DWind4 - 0, - CPE, - CPI	1,00	
	3DWind5 - 90, + CPE, + CPI	1,00	
	3DWind6 - 90, + CPE, - CPI	1,00	
	3DWind7 - 90, - CPE, + CPI	1,00	
	3DWind8 - 90, - CPE, - CPI	1,00	
	3DWind9 - 180, + CPE, + CPI	1,00	
	3DWind10 - 180, + CPE, - CPI	1,00	
	3DWind11 - 180, - CPE, + CPI	1,00	
	3DWind12 - 180, - CPE, - CPI	1,00	
	3DWind13 - 270, + CPE, + CPI	1,00	
	3DWind14 - 270, + CPE, - CPI	1,00	
	3DWind15 - 270, - CPE, + CPI	1,00	
	3DWind16 - 270, - CPE, - CPI	1,00	

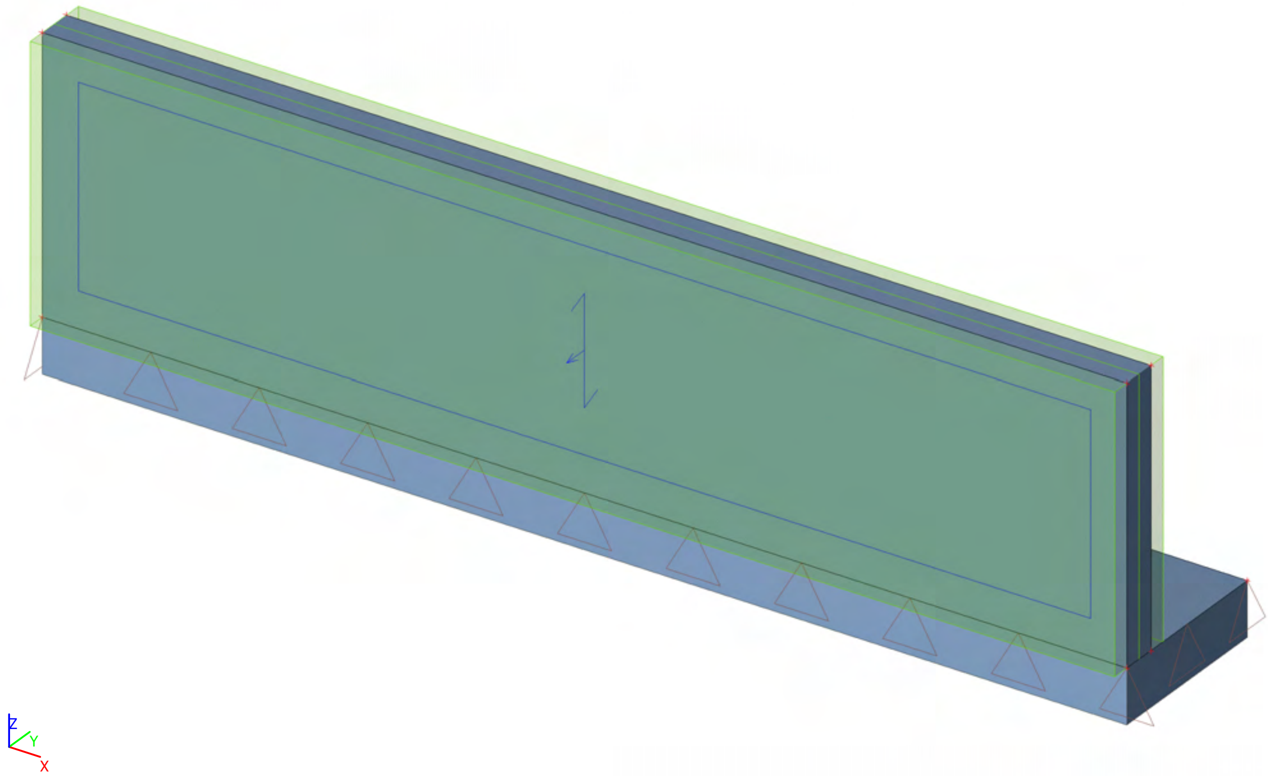
12. Mesh setup

Name	MeshSetup1
Generation of eccentric elements on members with variable height	×
Generation of nodes in connections of beam elements	×
Generation of nodes under concentrated loads on beam elements	✓
Hanging nodes for prestressing	✓
Use automatic mesh refinement	×

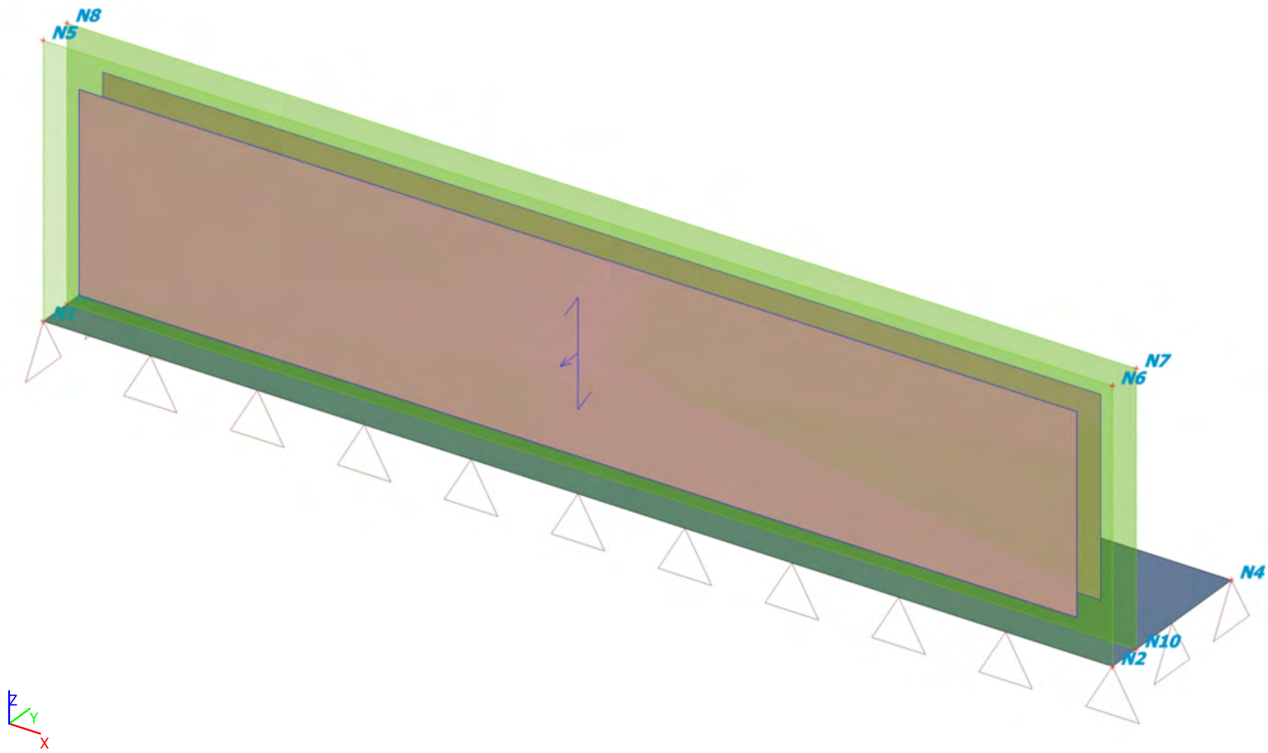
Division on haunches and arbitrary members	5
Division for 2D-1D upgrade	50
Average number of tiles of 1d element	5
Average size of 2d element/curved element [m]	5,000
Minimal length of beam element [m]	0,100
Maximal length of beam element [m]	1000,000
Average size of cables, tendons, elements on subsoil, nonlinear soil spring [m]	5,000
Maximal out of plane angle of a quadrilateral [mrad]	30,0
Predefined mesh ratio	1.5
Minimal distance between two points [m]	0.001
Average size of panel element [m]	1,000
Mesh refinement following the beam type	None
Definition of mesh element size for panels	Manual

13. Solver setup

Name	SolverSetup1
Neglect shear force deformation (Ay, Az >> A)	×
Initial stress	×
Use IRS (Improved Reduced System) method	×
Apply property modifiers	✓
Number of thicknesses of rib plate	20
Maximum soil interaction iterations	10
Maximum iterations	20
Number of increments	1
Number of critical values	2
Number of sections on average member	10
Number of eigenmodes	10
Step for soil/water pressure [m]	0,500
C1x [MN/m^3]	1,0000e-01
C1y [MN/m^3]	1,0000e-01
C1z [MN/m^3]	1,0000e+01
C2x [MN/m]	5,0000e+00
C2y [MN/m]	5,0000e+00
Coefficient for reinforcement	1
Warning when maximal translation is greater than [mm]	1000,0
Warning when maximal rotation is greater than [mrad]	100,0
Parallelism tolerance for automatic calculation [deg]	10,00
Span length ratio L/beff,max (1 side) for automatic calculation [-]	8,00
Simply supported beam [-]	1,00
Inner span [-]	0,70
End span [-]	0,85
Cantilever [-]	2,00
Solver precision ratio	1
Soil combination	None
Bending theory of plate/shell analysis	Mindlin
Type of solver	Direct
Type of eigen value solver	Lanczos
Type of eigen value solver	Lanczos
Method of calculation	Picard



14. NODES

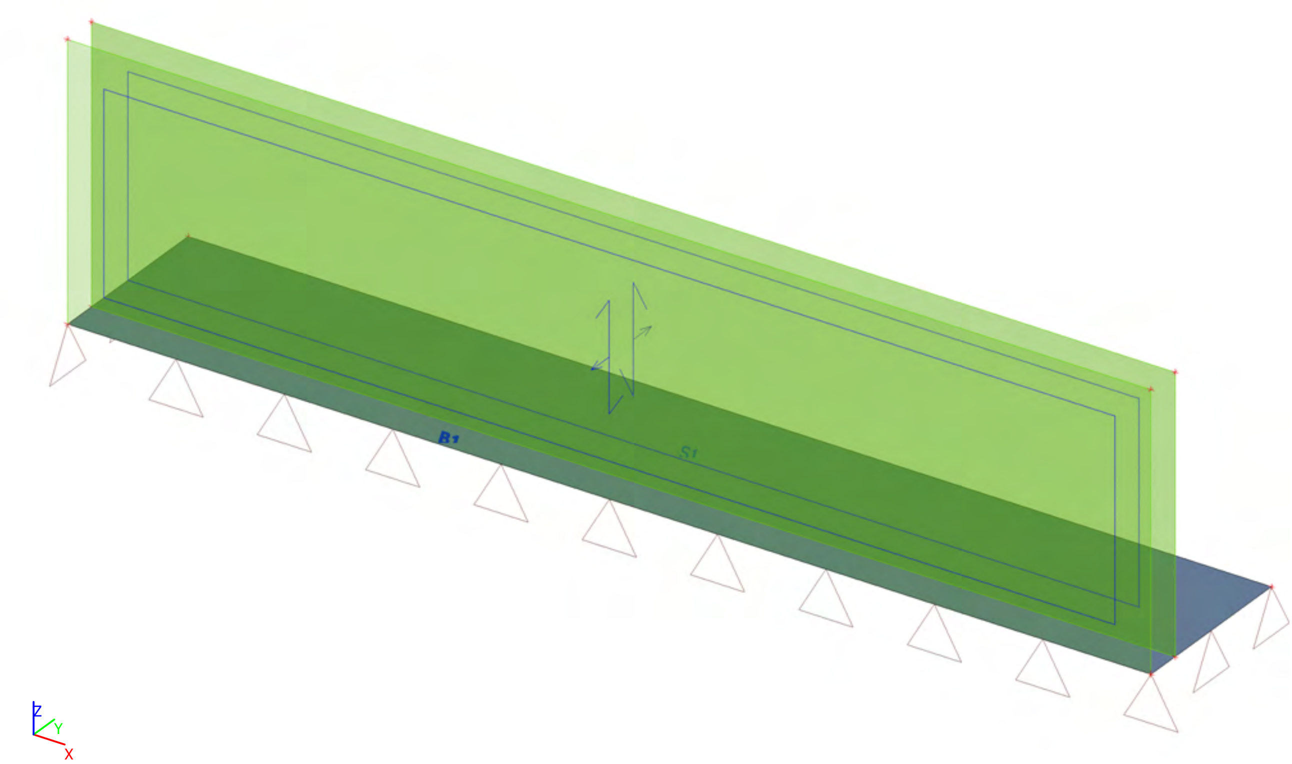


Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	1,059	3,863	0,000
N2	7,059	3,863	0,000
N3	1,059	4,863	0,000
N4	7,059	4,863	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N5	1,059	3,863	1,500
N6	7,059	3,863	1,500
N7	7,059	4,063	1,500
N8	1,059	4,063	1,500

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N9	1,059	4,063	0,000
N10	7,059	4,063	0,000

15. MEMBERS



Name	CrossSection	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - Rectangle (1500; 200)	C30/37	6,000	N1	N2	beam (80)

16. ΕΣΩΤΕΡΙΚΕΣ ΔΥΝΑΜΕΙΣ

16.1. Internal forces on member

Linear calculation, Extreme : Member, System : Principal
Selection : All
Class : GEO

Member	css	dx [m]	Case	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
B1	CS2 - Rectangle	3,000	CO1/1	**-853,19**	315,00	-152,38	-31,92	-135,90	-36,71
B1	CS2 - Rectangle	3,000	CO1/2	**498,89**	-360,00	-152,38	-31,92	-134,58	**-37,61**
B1	CS2 - Rectangle	3,000	CO1/3	497,96	**-360,00**	-152,38	-31,92	-135,17	-37,20
B1	CS2 - Rectangle	3,000	CO1/3	-852,04	**315,00**	-152,38	-31,92	-135,17	-37,20
B1	CS2 - Rectangle	6,000	CO1/1	76,59	-327,58	**-187,40**	-72,03	-125,33	11,88
B1	CS2 - Rectangle	0,000	CO1/4	-321,78	209,39	**-86,63**	6,01	-187,45	9,30
B1	CS2 - Rectangle	6,000	CO1/2	78,67	-327,45	-186,83	**-72,15**	-123,15	11,10
B1	CS2 - Rectangle	0,000	CO1/2	-430,89	282,46	-117,92	**8,30**	-249,37	11,25
B1	CS2 - Rectangle	0,000	CO1/1	-432,97	282,59	-117,35	8,19	**-251,55**	**12,02**
B1	CS2 - Rectangle	6,000	CO1/5	59,14	-242,50	-138,15	-53,49	**-90,31**	7,90

16.2. Internal forces EN 1992-1-1

Linear calculation, Extreme : Member
Selection : All
Class : GEO

Internal forces

Member	d_x [m]	Case	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]	N_{rec} [kN]	V_y rec [kN]	V_z rec [kN]	M_x rec [kNm]	M_y rec [kNm]	M_z rec [kNm]
B1	0,000	CO1/1	-432,97	282,59	-117,35	8,19	-251,55	12,02	-432,97	282,59	-117,35	8,19	**-251,5**	12,02
B1	0,000	CO1/2	-430,89	282,46	-117,92	8,30	-249,37	11,25	-430,89	282,46	-117,92	8,30	**-249,3**	11,25

Explanations of symbols	
N	Normal forces
V_y	Shear force Vy
V_z	Shear force Vz
M_x	Torsion moment Mx
M_y	Bending moment My
M_z	Bending moment Mz

Explanations of symbols	
N_{rec}	Recalculated normal forces
V_y rec	Recalculated shear force Vy
V_z rec	Recalculated shear force Vz
M_x rec	Recalculated torsion moment Mx
M_y rec	Recalculated bending moment My
M_z rec	Recalculated bending moment Mz

16.3. Internal forces (Check)

Linear calculation
Class: GEO
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N [kN] N_{Ed} [kN]	V_y [kN] V_{Edy} [kN]	V_z [kN] V_{Edz} [kN]	M_x [kNm] M_{Edx} [kNm]	M_y [kNm] M_{Edy} [kNm]	M_z [kNm] M_{Edz} [kNm]
B1	3,000+	CO1/1	**-853,19**	**315,00**	-152,38	-31,92	-135,90	-36,71
			-853,19	**315,00**	-152,38	-31,92	-163,81	-36,71
B1	6,000	CO1/1	76,59	-327,58	**-187,41**	-72,03	-125,33	11,88
			76,59	-327,58	**-187,41**	-72,03	-127,88	11,88
B1	0,000	CO1/2	-321,78	209,39	**-86,63**	6,01	-187,45	9,30
			-321,78	209,39	**-86,63**	6,01	-187,45	9,30
B1	6,000	CO1/3	78,67	-327,45	-186,83	**-72,15**	-123,15	11,10
			78,67	-327,45	-186,83	**-72,15**	-125,91	11,10
B1	0,000	CO1/3	-430,89	282,46	-117,92	**8,30**	-249,38	11,25
			-430,89	282,46	-117,92	**8,30**	-249,38	11,25
B1	0,000	CO1/1	-432,97	282,59	-117,35	8,19	**-251,55**	**12,02**
			-432,97	282,59	-117,35	8,19	**-251,55**	**12,02**
B1	6,000	CO1/4	59,14	-242,50	-138,15	-53,49	**-90,31**	7,90
			59,14	-242,50	-138,15	-53,49	**-92,44**	7,90
B1	3,000-	CO1/3	**498,89**	**-360,00**	-152,38	-31,92	-134,58	**-37,61**
			498,89	**-360,00**	-152,38	-31,92	-162,29	**-37,61**

Name	Combination key
CO1/1	1.35*LC1 + 1.35*LC2 + 0.90*3DWind6
CO1/2	LC1 + LC2 + 1.50*3DWind6
CO1/3	1.35*LC1 + 1.35*LC2 + 0.90*3DWind13
CO1/4	LC1 + LC2 + 1.50*3DWind13

17. Cross-section characteristics EN 1992-1-1

Linear calculation, Extreme : Member
Selection : All
Load cases : LC1

Cross section characteristics for selected members

Member	d_x [m]	Case	Y_c [mm] / Z_c [mm]	t_y [mm] / t_z [mm]	A [mm^2] / b_w [mm]	I_y [mm^4] / I_z [mm^4]	S_y [mm^3] / S_z [mm^3]	W_{y+} [mm^3] / W_{z+} [mm^3]	W_{y-} [mm^3] / W_{z-} [mm^3]	i_y [mm] / i_z [mm]
B1	0,000	LC1	100	0	300000	56250002235	0	75000003	75000003	433
			750	0	200	1000000047	0	10000001	10000001	58

18. ΕΛΕΓΧΟΣ ΡΗΓΜΑΤΩΣΗΣ

18.1. Check crack width (SLS)

Linear calculation
Load case: LC3
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{cr} [kN] N [kN]	M_{cry} [kNm] M_y [kNm]	M_{crz} [kNm] M_z [kNm]	σ_{ct} [MPa] f_{ct_eff} [MPa]	σ_s [MPa] x_r [mm]	s_{r_max} [mm] ε_{sm_cm} [1e-4]	w [mm] w_{max} [mm]	UC [-] Check
B1	3,000-	LC3	**0,00** **0,00**	**227,67** **0,24**	**0,14** **0,00**	**0,00** 2,90	**0,0** 0	0 0,0	**0,000** **0,300**	0,00 **OK**
B1	0,000	LC3	**367,42** **2,73**	**132,21** **0,98**	**0,60** **0,00**	**0,02** 2,90	**0,0** 0	0 0,0	0,000 0,300	0,00 OK

18.2. Check crack width (SLS)

Linear calculation
Load case: LC4
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{cr} [kN] N [kN]	M_{cry} [kNm] M_y [kNm]	M_{crz} [kNm] M_z [kNm]	σ_{ct} [MPa] f_{ct_eff} [MPa]	σ_s [MPa] x_r [mm]	s_{r_max} [mm] ε_{sm_cm} [1e-4]	w [mm] w_{max} [mm]	UC [-] Check
B1	3,000-	LC4	93,90 **0,78**	**103,02** **0,85**	**13,37** **0,11**	0,02 2,90	**0,0** 0	0 0,0	**0,000** **0,300**	0,00 **OK**
B1	1,200	LC4	106,13 0,78	**137,70** 1,01	**8,43** **0,06**	0,02 2,90	0,0 0	0 0,0	0,000 0,300	0,00 OK
B1	1,800	LC4	**106,84** 0,78	126,86 0,92	9,83 0,07	**0,02** 2,90	0,0 0	0 0,0	0,000 0,300	0,00 OK
B1	0,000	LC4	**92,30** 0,78	129,47 **1,09**	9,96 0,08	**0,02** 2,90	**0,0** 0	0 0,0	0,000 0,300	0,00 OK

18.3. Check crack width (SLS)

Linear calculation
Load case: 3DWind1
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{cr} [kN] N [kN]	M_{cry} [kNm] M_y [kNm]	M_{crz} [kNm] M_z [kNm]	σ_{ct} [MPa] f_{ct_eff} [MPa]	σ_s [MPa] x_r [mm]	s_{r_max} [mm] ε_{sm_cm} [1e-4]	w [mm] w_{max} [mm]	UC [-] Check
B1	2,400	3DWind1	**52,96** **0,81**	43,19 0,66	-22,54 -0,34	**0,04** 2,90	**0,0** 0	0 0,0	**0,000** **0,300**	0,00 **OK**
B1	3,000-	3DWind1	52,97 0,81	**38,80** **0,59**	**-23,11** **-0,35**	0,04 2,90	0,0 0	0 0,0	0,000 0,300	0,00 OK
B1	0,000	3DWind1	**55,02** 0,81	**57,63** **0,85**	**-20,58** **-0,30**	**0,04** 2,90	**0,0** 0	0 0,0	0,000 0,300	0,00 OK

18.4. Check crack width (SLS)

Linear calculation
Load case: LC2
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{cr} [kN] N [kN]	M_{cry} [kNm] M_y [kNm]	M_{crz} [kNm] M_z [kNm]	σ_{ct} [MPa] f_{ct_eff} [MPa]	σ_s [MPa] x_r [mm]	s_{r_max} [mm] ε_{sm_cm} [1e-4]	w [mm] w_{max} [mm]	UC [-] Check
B1	0,600	LC2	-269,40 -182,31	**-267,53** **-181,04**	3,74 2,53	1,96 2,90	0,0 0	0 0,0	0,000 0,300	0,00 OK
B1	6,000	LC2	78,04	-120,90	11,55	2,13	0,0	0	0,000	0,00

Name	dx [m]	Case	N_{cr} [kN] N [kN]	M_{cry} [kNm] M_y [kNm]	M_{crz} [kNm] M_z [kNm]	σ_{ct} [MPa] f_{ct_eff} [MPa]	σ_s [MPa] x_r [mm]	s_{r_max} [mm] ε_{sm_cm} [1e-4]	w [mm] w_{max} [mm]	UC [-] Check
			57,40	**-88,92**	8,49	2,90	0	0,0	**0,300**	OK
B1	3,000+	LC2	**-863,84** **-631,33**	-156,57 -114,43	**-37,72** -27,57	2,12 2,90	0,0 0	0 0,0	0,000 0,300	0,00 OK
B1	3,000-	LC2	**202,02** **368,67**	**-62,70** -114,43	-15,11 **-27,57**	**5,29** 2,90	**387,1** 43	404 12,0	**0,485** 0,300	1,62 **NOT OK**
B1	5,400	LC2	-207,37 -80,35	-232,42 -90,06	6,30 2,44	**1,12** 2,90	0,0 0	0 0,0	0,000 0,300	0,00 OK
B1	0,000	LC2	-439,11 -320,06	-248,39 -181,04	**11,80** **8,60**	2,11 2,90	**0,0** 0	0 0,0	0,000 0,300	0,00 OK

19. ΕΛΕΓΧΟΣ ΣΕΙΣΜΟΥ

19.1. ΣΕΙΣΜΟΣ X

19.1.1. Internal forces (Check)

Linear calculation
Load case: LC3
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N [kN] N_{Ed} [kN]	V_y [kN] V_{Edy} [kN]	V_z [kN] V_{Edz} [kN]	M_x [kNm] M_{Edx} [kNm]	M_y [kNm] M_{Edy} [kNm]	M_z [kNm] M_{Edz} [kNm]
B1	0,000	LC3	**2,73** **2,73**	**0,02** **0,02**	**0,44** **0,44**	**0,38** **0,38**	**0,98** **0,98**	**0,00** **0,00**
B1	3,000-	LC3	**0,00** **0,00**	0,02 0,02	0,44 0,44	0,38 0,38	**0,00** **0,24**	**0,00** **0,00**

19.1.2. EARTHQUAKE X

Linear calculation, Extreme : No
Selection : All
Load cases : LC3
Modal results : Accelerations
Evaluation for : Sum

Member	Case	Node	X [m]	Y [m]	Z [m]	Ax [mm/s^2]	Ay [mm/s^2]	Az [mm/s^2]	Alphax [mrad/s^2]	Alphay [mrad/s^2]	Alphaz [mrad/s^2]
S1	LC3	N1	1,059	3,863	0,000	2364,2	1327,6	2567,3	72,8	855,7	454,5
S1	LC3	N3	1,059	4,863	0,000	2591,5	1327,1	2505,8	64,9	840,5	454,2
S1	LC3	N4	7,059	4,863	0,000	2591,5	1327,1	2505,8	64,9	840,5	454,2
S1	LC3	N2	7,059	3,863	0,000	2364,2	1327,6	2567,3	72,8	855,7	454,5
S1	LC3	5	4,059	3,863	0,000	2364,3	0,0	0,0	0,0	852,9	454,1

19.1.3. Check crack width (SLS)

Linear calculation
Load case: LC3
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{cr} [kN] N [kN]	M_{cry} [kNm] M_y [kNm]	M_{crz} [kNm] M_z [kNm]	σ_{ct} [MPa] f_{ct_eff} [MPa]	σ_s [MPa] x_r [mm]	s_{r_max} [mm] ε_{sm_cm} [1e-4]	w [mm] w_{max} [mm]	UC [-] Check
B1	3,000-	LC3	**0,00** **0,00**	**227,67** **0,24**	**0,14** **0,00**	**0,00** 2,90	**0,0** 0	0 0,0	**0,000** **0,300**	0,00 **OK**
B1	0,000	LC3	**367,42** **2,73**	**132,21** **0,98**	**0,60** **0,00**	**0,02** 2,90	**0,0** 0	0 0,0	0,000 0,300	0,00 OK

19.1.4. Check capacity-interaction diagram

Linear calculation
Load case: LC3

Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{Ed} [kN]	M_{Edy} [kNm] M_{Edz} [kNm]	Method	N_{Rd+} [kN] N_{Rd-} [kN]	M_{Rdy+} [kNm] M_{Rdy-} [kNm]	M_{Rdz+} [kNm] M_{Rdz-} [kNm]	UC [-] Check
B1	3,000-	LC3	**0,00**	**0,24** **0,00**	NuMu	0,00 0,00	**690,81** -690,83	0,42 -0,42	0,00 OK
B1	1,800	LC3	1,09	0,63 0,00	NuMu	620,13 -2130,99	357,77 **-1229,41**	1,09 -3,75	0,00 OK
B1	0,000	LC3	**2,73**	**0,98** **0,00**	NuMu	**765,67** **-3191,07**	275,51 -1148,23	**1,25** **-5,19**	0,00 OK

19.1.5. Check capacity-response

Linear calculation
Load case: LC3
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{Ed} [kN]	M_{Edy} [kNm] M_{Edz} [kNm]	Fibre Bar	x [mm]	d [mm] z [mm]	ε_{cc} [1e-4] σ_{cc} [MPa]	ε_{sc} [1e-4] σ_{sc} [MPa]	ε_{st} [1e-4] σ_{st} [MPa]	UC [-] Check
B1	3,000-	LC3	0,00	0,24 0,00	3 3	**474**	**1166** **1007**	0,0 -0,01	**0,0** -0,1	0,0 0,2	0,00 OK
B1	0,600	LC3	2,18	0,98 0,00	3 3	191	1062 987	0,0 **-0,02**	0,0 **-0,2**	0,1 2,2	0,00 OK
B1	0,000	LC3	2,73	0,98 0,00	3 3	161	1043 975	**0,0** -0,02	0,0 -0,2	**0,1** **2,5**	0,00 **OK**

19.1.6. Slenderness(Check)

Linear calculation
Load case: LC3
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	L_y [m] L_z [m]	β_{zz} [-] β_{yy} [-]	l_{oy} [m] l_{oz} [m]	i_{cy} [m] i_{cz} [m]	λ_y [-] λ_z [-]	λ_{limy} [-] λ_{limz} [-]
B1	0,000	LC3	**6,000** **6,000**	**1,00** **1,05**	**6,284** **6,000**	4,3301e-01 5,7735e-02	**14,51** **103,92**	**0,00** **0,00**

19.2. ΣΕΙΣΜΟΣ Y

19.2.1. Internal forces (Check)

Linear calculation
Load case: LC4
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N [kN] N_{Ed} [kN]	V_y [kN] V_{Edy} [kN]	V_z [kN] V_{Edz} [kN]	M_x [kNm] M_{Edx} [kNm]	M_y [kNm] M_{Edy} [kNm]	M_z [kNm] M_{Edz} [kNm]
B1	0,000	LC4	**0,78** **0,78**	**0,10** **0,10**	**0,58** **0,58**	**0,13** **0,13**	**1,09** **1,09**	0,08 0,08
B1	2,400	LC4	0,78 0,78	0,02 0,02	0,12 0,12	0,03 0,03	**0,84** 0,87	0,09 0,09
B1	3,000-	LC4	0,78 0,78	**0,00** **0,00**	**0,00** **0,00**	**0,00** **0,00**	0,85 **0,85**	**0,11** **0,11**
B1	1,200	LC4	0,78 0,78	0,06 0,06	0,35 0,35	0,08 0,08	0,91 1,01	**0,06** **0,06**

19.2.2. EARTHQUAKE Y

Linear calculation, Extreme : No
Selection : All
Load cases : LC4
Modal results : Accelerations
Evaluation for : Sum

Member	Case	Node	X [m]	Y [m]	Z [m]	Ax [mm/s²]	Ay [mm/s²]	Az [mm/s²]	Alphax [mrad/s²]	Alphay [mrad/s²]	Alphaz [mrad/s²]
S1	LC4	N1	1,059	3,863	0,000	7,7	3004,6	1140,7	1832,2	6,2	23,8
S1	LC4	N3	1,059	4,863	0,000	11,8	3003,5	780,8	1823,0	9,2	26,2
S1	LC4	N4	7,059	4,863	0,000	11,8	3003,5	780,8	1823,0	9,2	26,2
S1	LC4	N2	7,059	3,863	0,000	7,7	3004,6	1140,7	1832,2	6,2	23,8
S1	LC4	5	4,059	3,863	0,000	0,0	3037,4	1136,3	1827,7	0,0	0,0

19.2.3. Check crack width (SLS)

Linear calculation
Load case: LC4
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{cr} [kN] N [kN]	M_{cry} [kNm] M_y [kNm]	M_{crz} [kNm] M_z [kNm]	σ_{ct} [MPa] f_{ct_eff} [MPa]	σ_s [MPa] x_r [mm]	s_{r_max} [mm] ε_{sm_cm} [1e-4]	w [mm] w_{max} [mm]	UC [-] Check
B1	3,000-	LC4	93,90 **0,78**	**103,02** **0,85**	**13,37** **0,11**	0,02 2,90	**0,0** 0	0 0,0	**0,000** **0,300**	0,00 **OK**
B1	1,200	LC4	106,13 0,78	**137,70** 1,01	**8,43** **0,06**	0,02 2,90	0,0 0	0 0,0	0,000 0,300	0,00 OK
B1	1,800	LC4	**106,84** 0,78	126,86 0,92	9,83 0,07	**0,02** 2,90	0,0 0	0 0,0	0,000 0,300	0,00 OK
B1	0,000	LC4	**92,30** 0,78	129,47 **1,09**	9,96 0,08	**0,02** 2,90	**0,0** 0	0 0,0	0,000 0,300	0,00 OK

19.2.4. Check capacity-interaction diagram

Linear calculation
Load case: LC4
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{Ed} [kN]	M_{Edy} [kNm] M_{Edz} [kNm]	Method	N_{Rd+} [kN] N_{Rd-} [kN]	M_{Rdy+} [kNm] M_{Rdy-} [kNm]	M_{Rdz+} [kNm] M_{Rdz-} [kNm]	UC [-] Check
B1	0,000	LC4	**0,78**	1,09 0,08	NuMu	315,05 -508,37	441,94 -713,12	34,01 -54,88	0,00 OK
B1	1,800	LC4	0,78	0,92 0,07	NuMu	**356,30** **-621,27**	423,06 -737,68	32,78 -57,15	0,00 OK
B1	0,600	LC4	**0,78**	**1,09** 0,07	NuMu	325,42 -544,81	**456,49** -764,24	29,05 -48,64	0,00 OK
B1	1,200	LC4	0,78	1,01 **0,06**	NuMu	346,24 -609,33	449,23 **-790,58**	27,51 -48,42	0,00 OK
B1	3,000-	LC4	0,78	**0,85** **0,11**	NuMu	323,93 -520,88	355,41 -571,49	**46,13** **-74,17**	0,00 OK

19.2.5. Check capacity-response

Linear calculation
Load case: LC4
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N_{Ed} [kN]	M_{Edy} [kNm] M_{Edz} [kNm]	Fibre Bar	x [mm]	d [mm] z [mm]	ε_{cc} [1e-4] σ_{cc} [MPa]	ε_{sc} [1e-4] σ_{sc} [MPa]	ε_{st} [1e-4] σ_{st} [MPa]	UC [-] Check
B1	1,200	LC4	0,78	1,01 0,06	3 3	**174**	**409** **320**	**0,0** -0,04	**0,0** -0,4	**0,1** 1,5	0,00 OK
B1	3,000-	LC4	0,78	0,85 0,11	3 13	105	223 169	0,0 **-0,05**	0,0 -0,3	0,1 1,6	0,00 OK
B1	0,000	LC4	0,78	1,09 0,08	3 13	151	337 259	0,0 -0,05	0,0 **-0,5**	0,1 **1,7**	0,00 **OK**

19.2.6. Slenderness(Check)

Linear calculation
Load case: LC4
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	L_y [m] L_z [m]	β_{zz} [-] β_{yy} [-]	l_{oy} [m] l_{oz} [m]	i_{cy} [m] i_{cz} [m]	λ_y [-] λ_z [-]	λ_{limy} [-] λ_{limz} [-]
B1	0,000	LC4	**6,000** **6,000**	**1,00** **1,05**	**6,284** **6,000**	4,3301e-01 5,7735e-02	**14,51** **103,92**	**0,00** **0,00**

20. ΟΠΛΙΣΗ ΠΕΔΙΛΟΥ

20.1. Calculation of concrete nominal cover to reinforcement - Eurocodes

Eurocode Applied.com

Free online calculation tools for structural design according to Eurocodes

Project:	ΚΕΝΤΡΙΚΗ ΑΓΟΡΑ ΘΕΣΣΑΛΟΝΙΚΗΣ
Subject:	ΜΕΤΑΛΛΙΚΟ ΣΤΕΓΑΣΤΡΟ
Designer:	ΑΘΑΝΑΣΙΟΣ ΠΡΑΤΤΟΣ
Date:	02/08/2025

Eurocode 2

Concrete nominal cover and minimum concrete class for durability (reinforcement bars and prestressing tendons)

Description:

Calculation of required nominal concrete cover cnom for reinforcement steel and prestressing steel

According to:

EN 1992-1-1:2004+AC2:2010 Section 4.4, Annex E

Supported National Annexes:

Nationally Defined Parameters (NDPs) automatically filled for supported countries

Input

Concrete characteristic strength	f_{ck} =	30	MPa
Type of reinforcement / tendon	=	Reinforcement bar	
Maximum diameter of reinforcement / tendon	Φ =	16	mm
Environment exposure class for durability (XC, XD, XS)	=	XC4	
Environment exposure class for attack (XF, XA)	=	XA1	

Exposure classes related to environmental conditions in accordance with EN 206-1

XO	No risk of corrosion or attack - Very dry (concrete inside buildings with very low air humidity)	XD1	Chlorides - Moderate humidity (surfaces exposed to airborne chlorides)
XC1	Carbonation - Dry or permanently wet (interior of buildings with very low air humidity, permanently submerged in water)	XD2	Chlorides - Wet or rarely dry (swimming pools, exposure to industrial waters containing chlorides)
XC2	Carbonation - Wet, rarely dry (long-term water contact, many foundations)	XD3	Chlorides - Cyclic wet & dry (bridge parts exposed to spray containing chlorides, pavements, car park slabs)
XC3	Carbonation - Moderate humidity (interior of buildings with moderate or high air humidity, external concrete sheltered from rain)	XS1	Sea water - Airborne salts not in direct contact with sea water (structures near to or on the coast)
XC4	Carbonation - Cyclic wet & dry (concrete subject to water contact not within exposure class XC2)	XS2	Sea water - Permanently submerged (parts of marine structures)
XF1	Freeze/Thaw - Moderate water saturation without de-icing agents (vertical concrete surfaces exposed to rain and freezing)	XS3	Sea water - Tidal splash & spray zones (parts of marine structures)

XF2	Freeze/Thaw - Moderate water saturation with de-icing agents (vertical concrete surfaces of road structures exposed to freezing and airborne de-icing agents)	**XA1**	Chemical attack - Slightly aggressive chemical environment (natural soils and ground water according to EN 206-1 Table 2)
XF3	Freeze/Thaw - High water saturation without de-icing agents (horizontal concrete surfaces exposed to rain and freezing)	**XA2**	Chemical attack - Moderately aggressive chemical environment (natural soils and ground water according to EN 206-1 Table 2)
XF4	Freeze/Thaw - High water saturation without de-icing agents (road and bridge decks exposed to de-icing agents, concrete surfaces exposed to direct spray containing de-icing agents and freezing, splash zones of marine structures exposed to freezing)	**XA3**	Chemical attack - Highly aggressive chemical environment (natural soils and ground water according to EN 206-1 Table 2)

Design working life = 50 years

Member with slab geometry = No

Concrete cast against uneven surface = None

Special quality control of the concrete production = No

Nominal aggregate size greater than 32 mm = No

Nationally Defined Parameters

Allowance for deviation to calculate nominal cover Δc_{dev} = 10

Nationally Defined Parameters = Greece

Results

Nominal concrete cover c_{nom} = 45.0 mm

Minimum concrete strength class for concrete corrosion (exposure classes XC, XS, XD) = C30/37 ⇒ ok

Minimum concrete strength class for concrete attack (exposure classes XF, XA) = C28/35 ⇒ ok

Notes

1. Minimum cover may be reduced or increased for special conditions such as a) use of stainless steel, b) coating protection, c) uneven surfaces other than the ones examined, d) abrasion on the concrete surface, e) air entrainment of more than 4%, f) fabrication subjected to quality assurance system or accurate monitoring g) in-situ concrete placed against an existing concrete surface. For more information see EN1992-1-1 sections 4.4.1.2(7) to (13), 4.4.1.3(3) and the National Annex.

Details

Input Data

- Concrete characteristic strength: f_{ck} = 30 MPa
- Type of reinforcement / tendon: = Reinforcement bar
- Maximum diameter of reinforcement / tendon: Φ = 16 mm
- Environment exposure class for durability (XC, XD, XS): = XC4
- Environment exposure class for attack (XF, XA): = XA1

- Design working life: = 50 years
- Member with slab geometry: = No
- Concrete cast against uneven surface: = None
- Special quality control of the concrete production: = No
- Nominal aggregate size greater than 32 mm: = No

Nationally Defined Parameters

- Allowance for deviation to calculate nominal cover: Δc_{dev} = 10
- Nationally Defined Parameters: = Greece

Calculation of structural class

The structural class is calculated according to the rules specified in *EN1992-1-1 Table 4.3N*:

- The initial structural class is S4 (corresponding to the reference design working life of 50 years)
- The minimum structural class is S1

Therefore the structural class is S4.

Calculation of concrete cover for durability

Minimum concrete cover for protection against corrosion (exposure classes XC, XS, XD)

For reinforcement steel the minimum cover for durability against corrosion $c_{min,dur}$ is calculated in accordance with *EN1992-1-1 Table 4.4N*.

For structural class S4 and exposure class XC4 the minimum cover for durability is equal to $c_{min,dur}$ = 35.0 mm.

Minimum concrete cover for protection against freeze/thaw or chemical attack (exposure classes XF, XA)

Where freeze/thaw or chemical attack on concrete (exposure classes XF, XA) is expected special attention should be given to the concrete composition (see EN 206-1 Section 6). According to *EN 1992-1-1 §4.4.1.2(12)* the minimum concrete cover calculated for the protection of concrete against corrosion (exposure classes XC, XS, XD) will normally be sufficient for the protection of concrete against attack (exposure classes XF, XA).

Therefore the minimum concrete cover for durability is $c_{min,dur}$ = 35.0 mm.

Calculation of concrete cover for bond

The minimum cover for bond $c_{min,b}$ is calculated in accordance with *EN1992-1-1 §4.4.1.2(3)*.

For reinforcement bars the minimum cover for bond is calculated in accordance with *EN1992-1-1 Table 4.2N* as: $c_{min,b} = 1.0 \cdot \Phi$, where Φ is the diameter of the reinforcement bar (or equivalent diameter of bundled bars).

Therefore minimum cover for bond is $c_{min,b}$ = 16.0 mm.

Calculation of minimum concrete cover

According to *EN1992-1-1 §4.4.1.2(2)P* the greater value of concrete cover satisfying the requirements for both bond and durability is used:

$$c_{min} = \max\{c_{min,b}, c_{min,dur} + \Delta c_{dur,y} - \Delta c_{dur,st} - \Delta c_{dur,add}, 10\ \text{mm}\}$$

According to *EN1992-1-1 §4.4.1.2(6)* the additive safety element is $\Delta c_{dur,y}$ = 0.0 mm.

The following modification factors are not applicable:

- Reduction of minimum cover for use of stainless steel $\Delta c_{dur,st}$ = 0 mm
- Reduction of minimum cover for use of additional protection $\Delta c_{dur,add}$ = 0 mm.

Therefore the minimum concrete cover is calculated as:

$$c_{min} = \max\{16.0\ \text{mm}, 35.0\ \text{mm} + 0.0\ \text{mm} - 0\ \text{mm} - 0\ \text{mm}, 10\ \text{mm}\} = 35.0\ \text{mm}$$

Calculation of nominal concrete cover

The nominal concrete cover c_{nom} is calculated by adding to the minimum cover c_{min} the allowance for deviation Δc_{dev}, as specified in *EN1992-1-1 §4.4.1.3(1)P*.

In this calculation the allowance for deviation is considered as Δc_{dev} = 10.0 mm.

The required nominal concrete cover is:

$$c_{nom} = c_{min} + \Delta c_{dev} = 35.0\ \text{mm} + 10.0\ \text{mm} = 45.0\ \text{mm}$$

Therefore the required nominal concrete cover is c_{nom} = 45.0 mm.

Calculation of minimum concrete class for durability

The required minimum concrete class for durability is calculated in accordance with *EN1992-1-1 Annex E Table E.1* depending on the exposure class.

- The exposure class for the case of concrete corrosion is XC4 and the required minimum concrete class is C30/37.
- The exposure class for the case of attack to concrete is XA1 and the required minimum concrete class is C28/35.

20.2. Member 2D - design - required areas - Ultimate Combination

Linear calculation, Extreme : Global
Selection : All
Combinations : CO1
Required reinforcement

The main lower reinforcement in direction 1 for selected 2D members

Member	elem	Case	n1- [kN/m]	z- [mm]	x- [mm]	ε_{s-} [1e-4]	ε_{c-} [1e-4]	σ_{s1-} [MPa]	σ_{c-} [MPa]	$A_{s,user1-}$ [mm²/m]	$A_{s,add1-}$ [mm²/m]	$A_{s,total1-}$ [mm²/m]	E/W1-
S1	1	CO1	1062,89	248	31	259,5	-35,0	456,07	-14,17	0	**2331**	**2331**	101

The main lower reinforcement in direction 2 for selected 2D members

Member	elem	Case	n2- [kN/m]	z- [mm]	x- [mm]	ε_{s-} [1e-4]	ε_{c-} [1e-4]	σ_{s2-} [MPa]	σ_{c-} [MPa]	$A_{s,user2-}$ [mm²/m]	$A_{s,add2-}$ [mm²/m]	$A_{s,total2-}$ [mm²/m]	E/W2-
S1	1	CO1	901,82	248	31	259,5	-35,0	456,07	-14,17	0	**1977**	**1977**	101

The main upper reinforcement in direction 1 for selected 2D members

Member	elem	Case	n1+ [kN/m]	z+ [mm]	x+ [mm]	ε_{s+} [1e-4]	ε_{c+} [1e-4]	σ_{s1+} [MPa]	σ_{c+} [MPa]	$A_{s,user1+}$ [mm²/m]	$A_{s,add1+}$ [mm²/m]	$A_{s,total1+}$ [mm²/m]	E/W1+
S1	2	CO1	910,97	251	24	351,5	-35,0	464,31	-14,17	0	**1962**	**1962**	101

The main upper reinforcement in direction 2 for selected 2D members

Member	elem	Case	n2+ [kN/m]	z+ [mm]	x+ [mm]	ε_{s+} [1e-4]	ε_{c+} [1e-4]	σ_{s2+} [MPa]	σ_{c+} [MPa]	$A_{s,user2+}$ [mm²/m]	$A_{s,add2+}$ [mm²/m]	$A_{s,total2+}$ [mm²/m]	E/W2+
S1	2	CO1	632,64	251	24	351,5	-35,0	464,31	-14,17	0	**1363**	**1363**	101

Shear reinforcement for selected 2D members

Member	elem	Case	β_v [deg]	Θ [deg]	τ_D [MPa]	τ_{R1} [MPa]	A_{sw} [mm²/m²]	E/Ws
S1	3	CO1	-99,09	21,80	1,18	0,22	**1413**	201

Explanation of errors and warnings

Error number	Description
1	Calculation successful. There are no error messages.
200	Shear reinforcement is not required.

20.3. Member 2D - design - required areas - Earthquake Combination

Required reinforcement

20.4. Used Reinforcement

Πέδιλο Θεμελίωσης ύψους 1μ (2,50μ x 1,50μ) :

- Άνω & Κάτω στρώσηκατά X: Φ16 / 150mm (1341 mm²)

- Άνω & Κάτω στρώσηκατά Y: Φ16 / 150mm (1341 mm²)

21. ΟΠΛΙΣΗ ΤΟΙΧΙΟΥ

21.1. Reinforcement zones data

Stirrups layer

Name	Position number	Span	Diameter [mm]	Distance to begin [m]	Real distance [m]	Diameter [mm]	Real distance [m]
Member	**Material**	**Zone**	**Numbers**	**Distance to end [m]**		**Numbers**	
SL	1	1	10,0	0,075	0,150	10,0	0,150
B1	B 500C	1	40	0,075			

Longitudinal reinforcement layer

Name	Position number	Diameter [mm]	Detailing	Bar	x_{beg} [mm]	y_{beg} [mm]	z_{beg} [mm]	Lenght for presentation [m]
Member	Material	Number of bars			x_{end} [mm]	y_{end} [mm]	z_{end} [mm]	
L2-S1E2	3	12,0	×	1	0	135	1449	6,000
B1	B 500C	2		2	0	65	1449	6,000
					6000	135	1449	
					6000	65	1449	
L3-S1E4	4	12,0	×	1	0	84	51	6,000
B1	B 500C	2		2	0	116	51	6,000
					6000	84	51	
					6000	116	51	
L5-S1E3	6	12,0	×	1	0	51	1298	6,000
B1	B 500C	9		2	0	51	1161	6,000
					6000	0	0	
					6000	0	0	
L6-S1E1	7	12,0	×	1	0	149	202	6,000
B1	B 500C	9		2	0	149	339	6,000
					6000	0	0	
					6000	0	0	

21.2. Bill of reinforcement

Selection : All
The lengths of longitudinal reinforcement bars and stirrups are calculated without rounded bends.
Type of position number : Global

Member	#	[mm]	Material	Length [m]	Number of bars	B 500C length [m]	B 500C weight [kg]
B1	1	10	B 500C	4,740	40	189,600	116,9
B1	3	12	B 500C	6,000	2	12,000	10,7
B1	4	12	B 500C	6,000	2	12,000	10,7
B1	6	12	B 500C	6,000	9	54,000	47,9
B1	7	12	B 500C	6,000	9	54,000	47,9
		10	Total for diameter			189,600	116,9
		12	Total for diameter			132,000	117,2
			Total for material			321,600	234,1
			Total			321,600	234,1