SUNSET

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SKYFREE^{G-3} STRUCTURAL ANALYSIS REPORT

SKYFREE SYSTEM STRUCTURAL ANALYSIS REPORT

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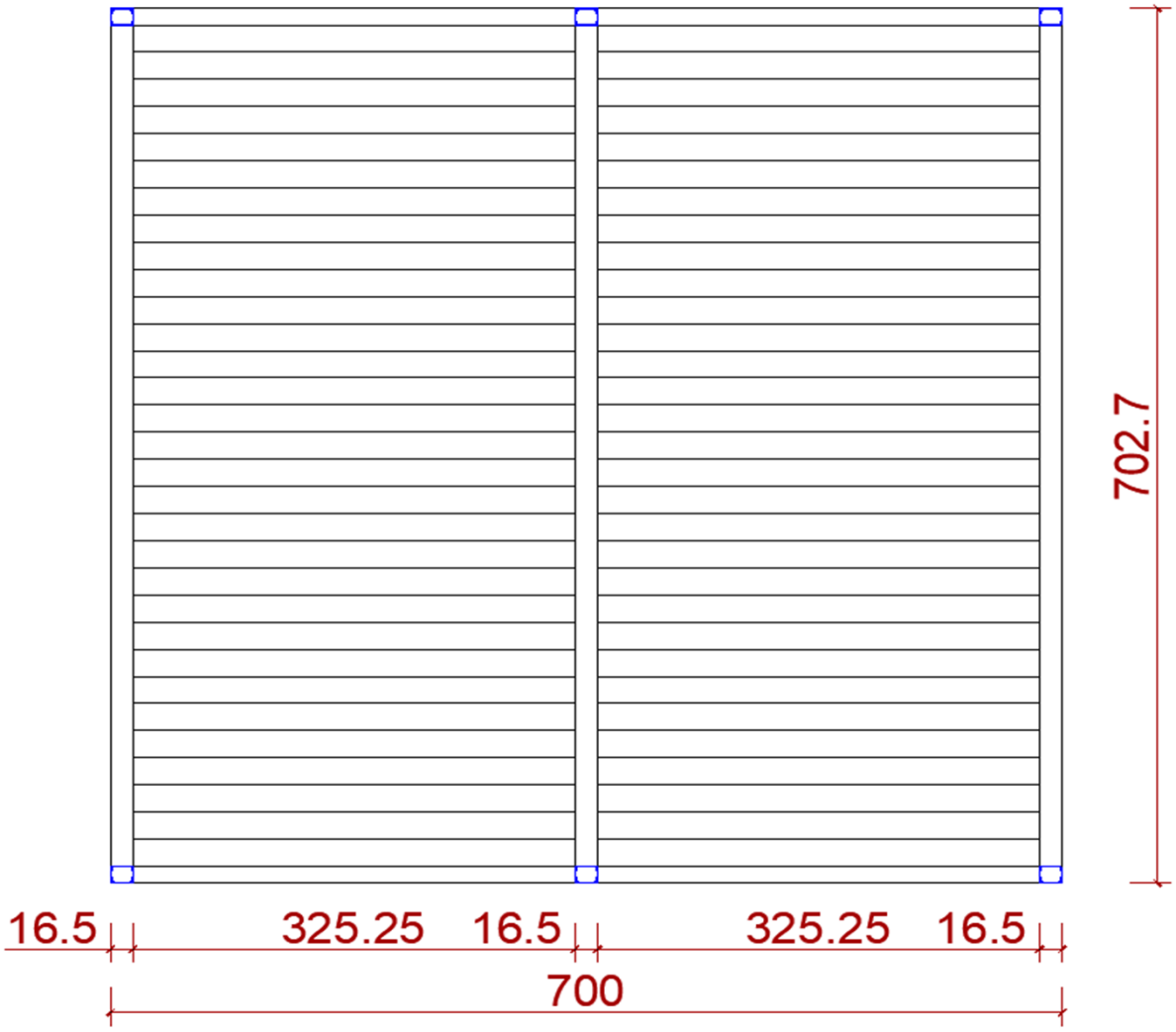
SKYFREE SYSTEM STRUCTURAL ANALYSIS REPORT

INTRODUCTION

GENERAL INFORMATION

This structural analysis report is provided for Skyfree system, which is considered as canopy type roof system without permanent walls on the perimeter of structure. Outer dimensions of structural on plan are 700x702.7 (cm).



Plan Dimensions of Skyfree

TYPES OF SKYFREE SYSTEM

Skyfree system is analysed for three types based on different pillar heights.

Type-1 H_{total} = 2.76m (H_{pillar} = 2.40m);

Front View of Type - 1

Type-2 H_{total} = 2.96m (H_{pillar} = 2.60m);

Front View of Type - 2

Type-3 H_{total} = 3.16m (H_{pillar} = 2.80m).

Front View of Type - 3

SKYFREE SYSTEM STRUCTURAL ANALYSIS REPORT

DESIGN CODES AND SPECIFITICATIONS

- ASD2000 Allowable Stress Design of elements
- Eurocode EN1990:2002 Basis of structural design
- Eurocode EN1991 - 1 - 3 Actions on structures - Part 1-3: General actions-Snow loads
- Eurocode EN1991 - 1 - 4 Actions on structures - Part 1-4: General actions-Wind loads
- Eurocode EN1998-1-1:2004 Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings
- Eurocode EN1999-1-1:2007 Design of aluminium structures - Part 1-1: General structural rules

UNITS

The units, which will be used for analysis of structure, are agreeable for international units.

- Length; mm; cm; m
- Forces; N; kN
- Strengths; N/mm^2; MPa
- Pressures; kN/m^2; kPa; kg/m^2
- Masses; kg, Ton

SOFTWARE

- CSI SAP2000 V21.0
- Autocad 2013
- MS Office 2010 Excel

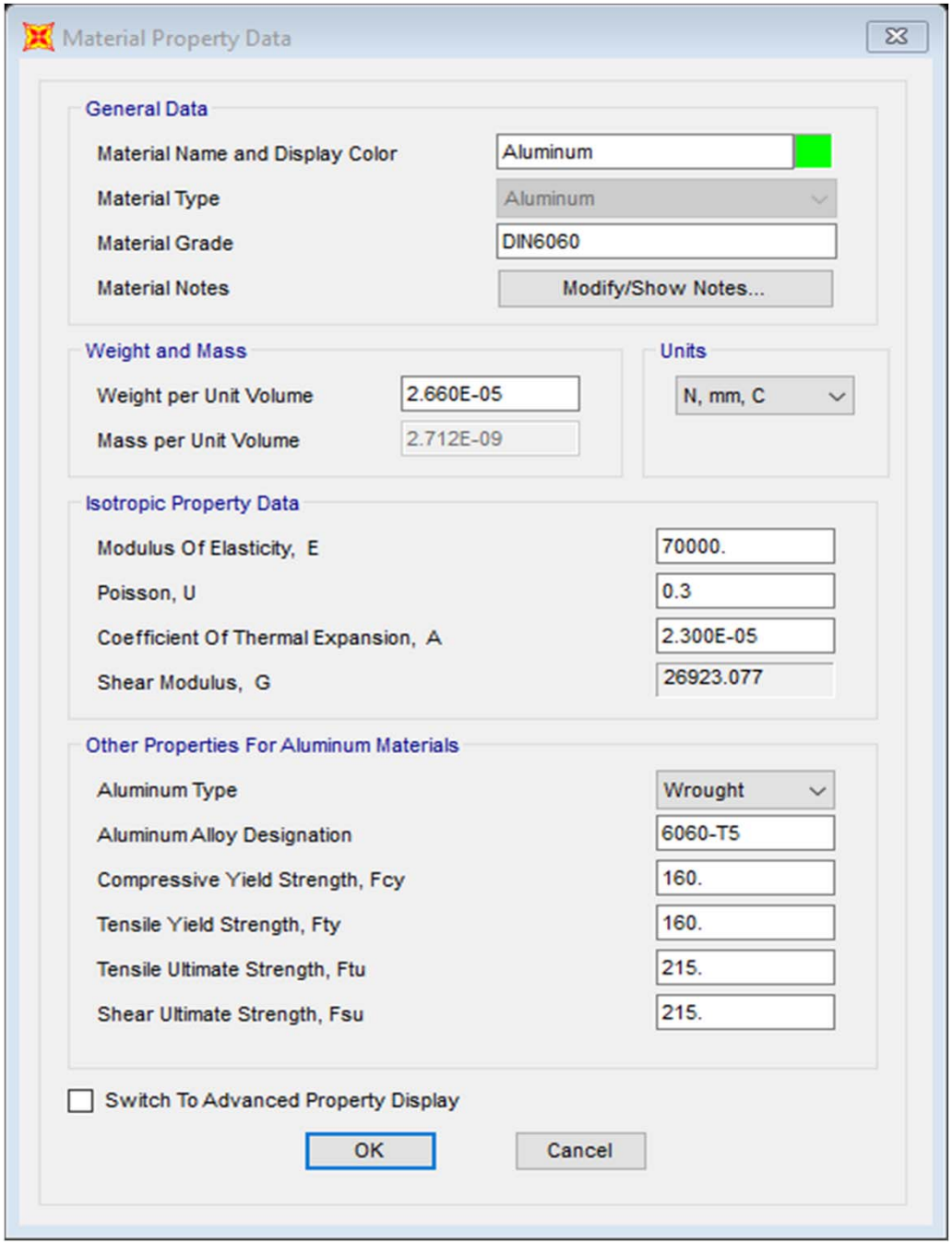
CHECKS

- Allowable stress limit checks (Demand/capacity controls (PMM analysis))
- Deformation controls (for roof elements vertical deflection, for pillar lateral displacement control)
- Buckling analysis (Buckling factor of pillars)

MATERIAL MECHANICAL PROPERTIES

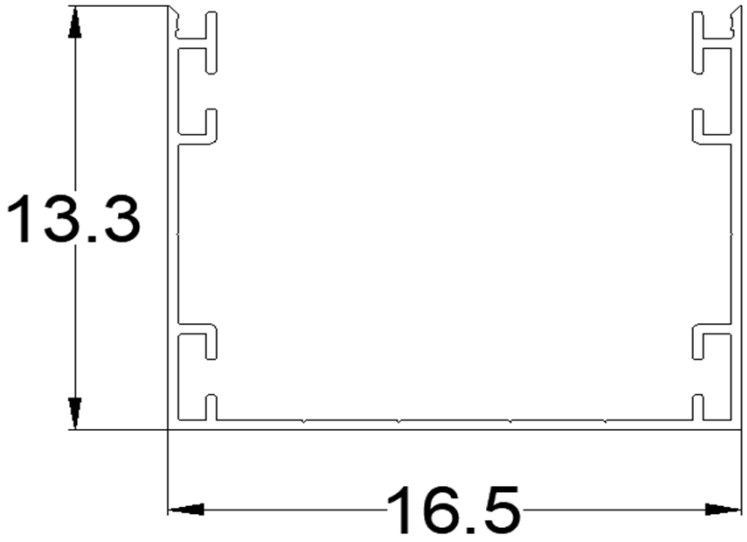
As per Eurocode EN1999-1-1:2007, material properties for DIN6060 aluminium class are listed below:

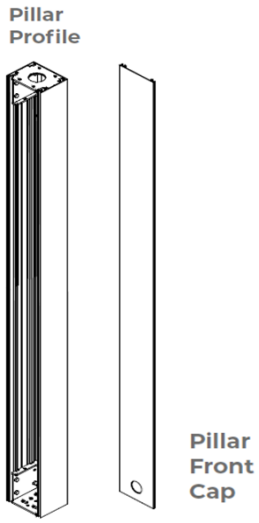
- Proof strength (yield strength) f_0 = 160 MPa (Ref.code Table 3.2b)
- Ultimate tensile strength f_u = 215 MPa (Ref.code Table 3.2b)
- Modulus of elasticity E = 70000 N/mm^2 (Ref.code 3.2.5)
- Shear modulus G = 27000 N/mm^2 (Ref.code 3.2.5)
- Poisson's ratio v = 0.3 (Ref.code 3.2.5)
- Coefficient of linear thermal expansion ρ = 2700 kg/m^3 (Ref.code 3.2.5)



SKYFREE ELEMENT SECTIONS, DIMENSION AND PROPERTIES

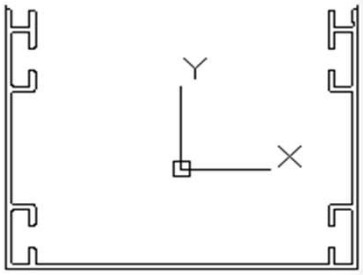
PILLAR Profile





As it can be seen from assembly instructions, after installation of pillar front side of the profile will be closed with pillar front cap. That's why pillar profile will be considered as U-shape section. Pillar cap does not give any advantages in terms of section rigidity during structural analysis. U-shape section major and minor axis are relevant with structural plan directions.

Pillar profile Autocad Massprop Section Properties Window



AutoCAD Text Window - PILLAR PROFILE_ORIGINAL.dwg

Edit

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Select objects: 1 found

Select objects:

 ----------------   REGIONS   ----------------

Area:                    16.9128
Perimeter:               113.4784
Bounding box:          X: -8.2500  --  8.2500
                       Y: -5.0493  --  8.2224
Centroid:              X: 0.0000
                       Y: 0.0000
Moments of inertia:    X: 358.5989
                       Y: 837.8679
Product of inertia:   XY: 0.0000
Radii of gyration:     X: 4.6046
                       Y: 7.0385
Principal moments and X-Y directions about centroid:
                       I: 358.5989 along [1.0000 0.0000]
                       J: 837.8679 along [0.0000 1.0000]

Write analysis to a file? [Yes/No] <N>: *Cancel*

Command:
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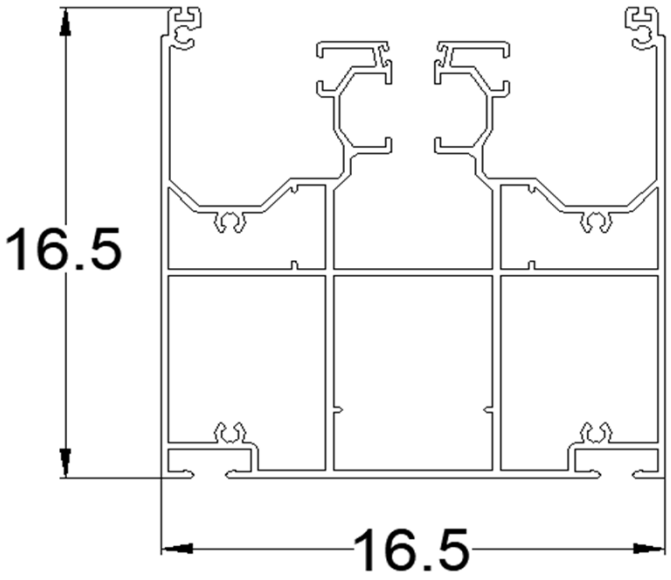
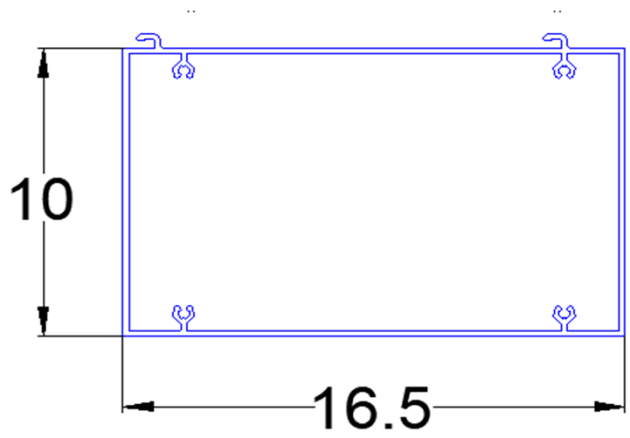
Note: All the properties are given in cm. Outer section dimensions are given for assignment of equivalent sections.

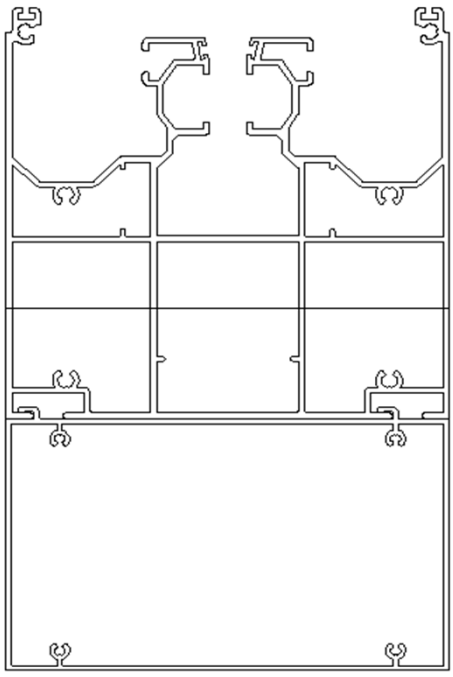
RAIL and SUPPORT BOX Profile





As it can be seen from assembly instructions, rail and support box profiles are connected together.
During analysis overall combined section will be considered.

Rail and Support box profile (combined) Autocad Massprop Section Properties Window



AutoCAD Text Window - RAIL PROFILE_ORIGINAL.dwg

Edit

```
Command: MASSPROP

Select objects: 1 found

Select objects:

 ----------------   REGIONS   ----------------

Area:                      43.7833
Perimeter:                 365.0119
Bounding box:           X: -8.2500  --   8.2500
                        Y: -14.4010  --  12.2190
Centroid:               X: 0.0000
                        Y: 0.0000
Moments of inertia:     X: 2426.8039
                        Y: 1391.9833
Product of inertia:    XY: 0.0000
Radii of gyration:      X: 7.4450
                        Y: 5.6385
Principal moments and X-Y directions about centroid:
                        I: 1391.9833 along [0.0000 -1.0000]
                        J: 2426.8039 along [1.0000 0.0000]

Write analysis to a file? [Yes/No] <N>:
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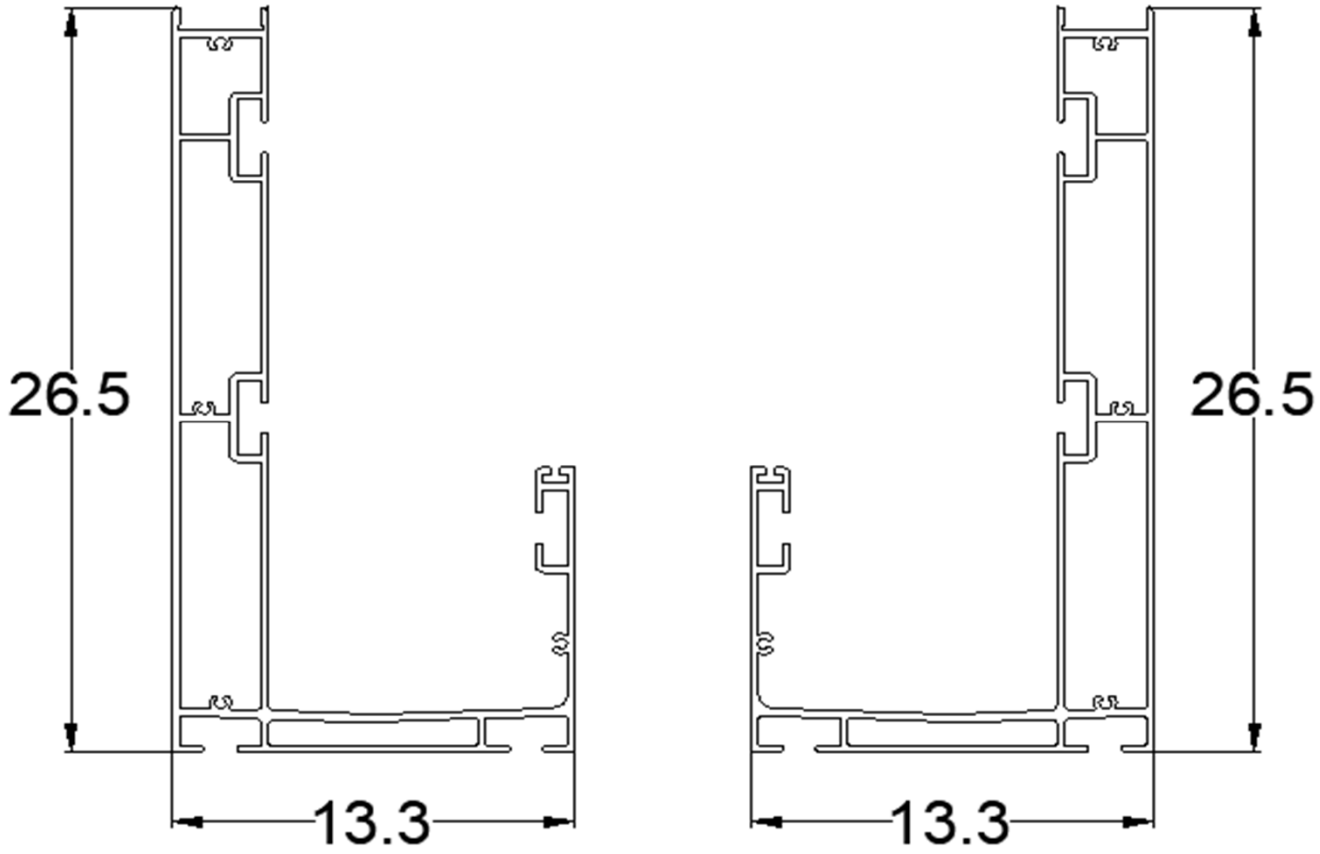
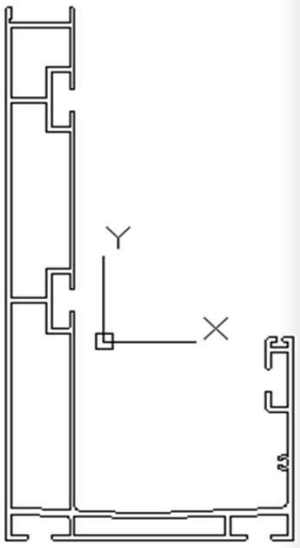
Note: All the properties are given in cm. Outer section dimensions are given for assignment of equivalent sections.

GUTTER Profile



Only one section will be assigned to model for front and back gutter profiles.

Left and right gutter profile Autocad Massprop Section Properties Window



AutoCAD Text Window - GUTTER PROFILE_ORIGINAL.dwg

Edit

```
Command: MASSPROP

Select objects: 1 found

Select objects:

 ----------------   REGIONS   ----------------

Area:                    27.0426
Perimeter:               208.4551
Bounding box:          X: -4.5127  --  8.7873
                       Y: -9.8261  --  16.7039
Centroid:              X: 0.0000
                       Y: 0.0000
Moments of inertia:    X: 1923.6261
                       Y: 563.4032
Product of inertia:   XY: -483.1886
Radii of gyration:     X: 8.4340
                       Y: 4.5644
Principal moments and X-Y directions about centroid:
                       I: 409.2348 along [0.3040 -0.9527]
                       J: 2077.7945 along [0.9527 0.3040]

Write analysis to a file? [Yes/No] <N>:
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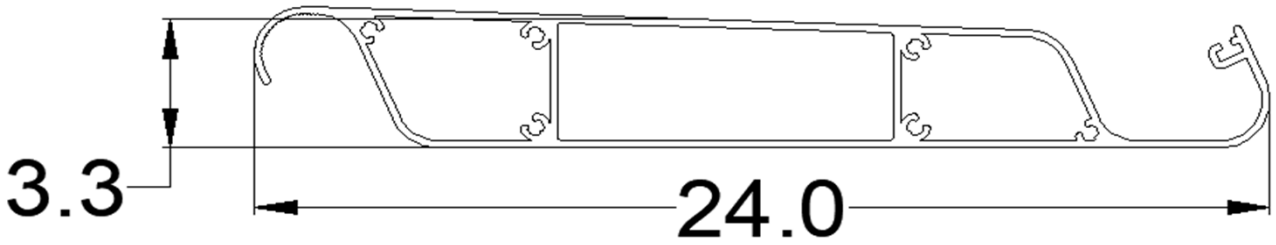
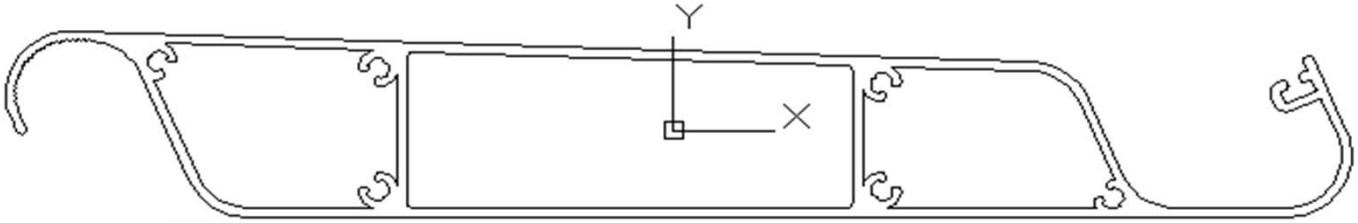
Note: All the properties are given in cm. Outer section dimensions are given for assignment of equivalent sections.

PANEL Profile



Panel profile lays on rails and is not rigidly connected to them.

Panel profile Autocad Massprop Section Properties Window



AutoCAD Text Window - PANEL PROFILE_ORIGINAL.dwg

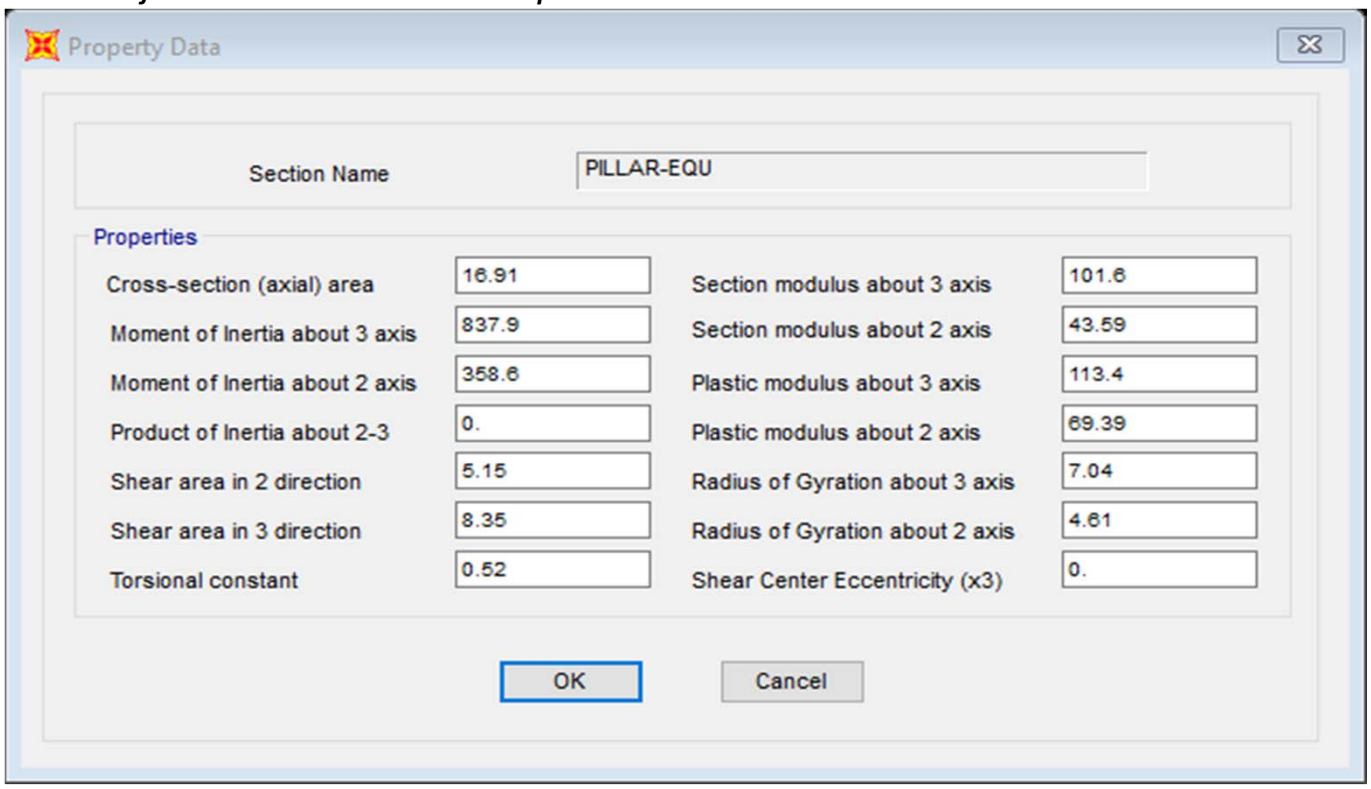
Edit

```
Command: MASSPROP

Select objects: 1 found

Select objects:

 ----------------   REGIONS   ----------------

Area:                    11.5535
Perimeter:               119.1995
Bounding box:          X: -11.9172  --  12.0828
                       Y: -1.6633  --  1.9223
Centroid:              X: 0.0000
                       Y: 0.0000
Moments of inertia:    X: 21.2921
                       Y: 536.0773
Product of inertia:   XY: -32.0742
Radii of gyration:     X: 1.3575
                       Y: 6.8117
Principal moments and X-Y directions about centroid:
                       I: 19.3013 along [0.9981 -0.0619]
                       J: 538.0680 along [0.0619 0.9981]

Write analysis to a file? [Yes/No] <N>:
```

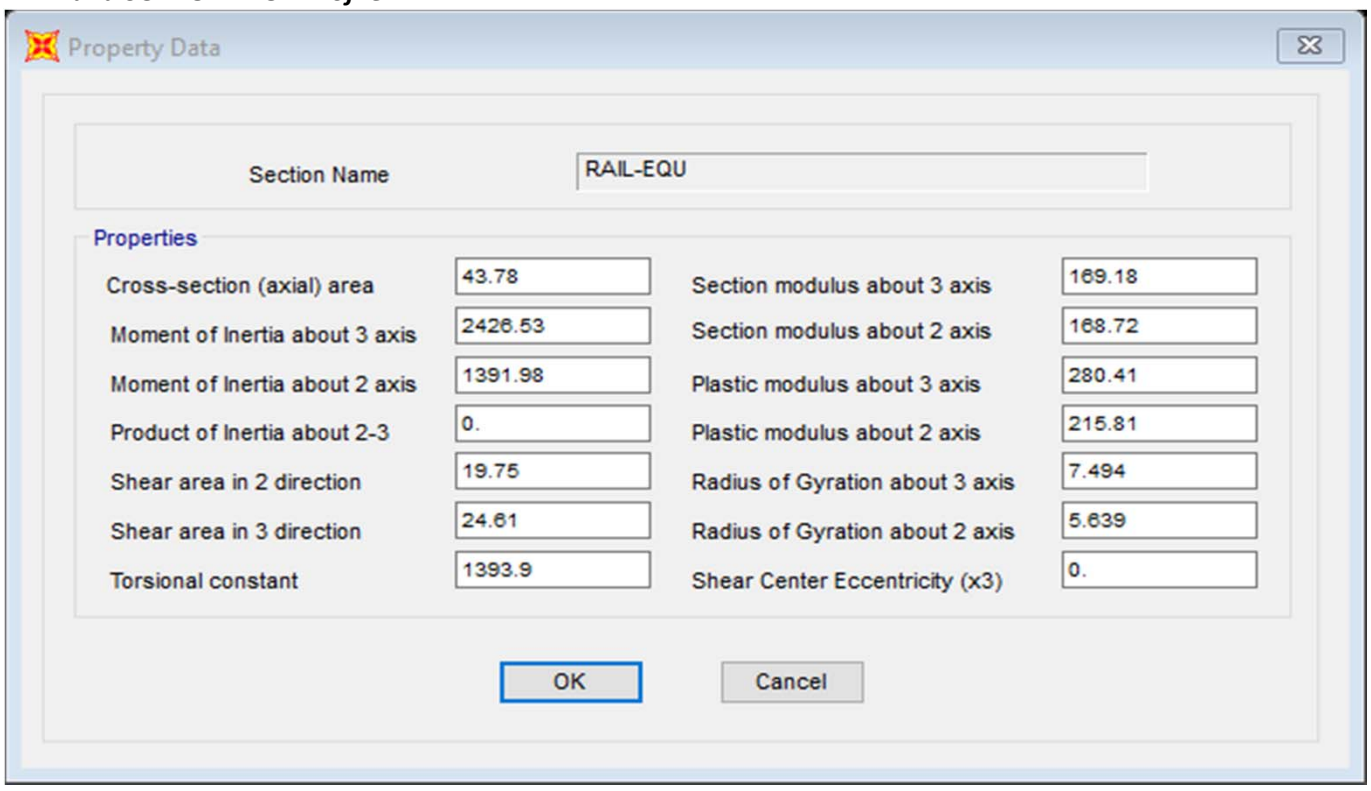
Note: All the properties are given in cm. Outer section dimensions are given for assignment of equivalent sections.

SKYFREE ELEMENT SECTIONS SAP2000 ASSIGNMENTS

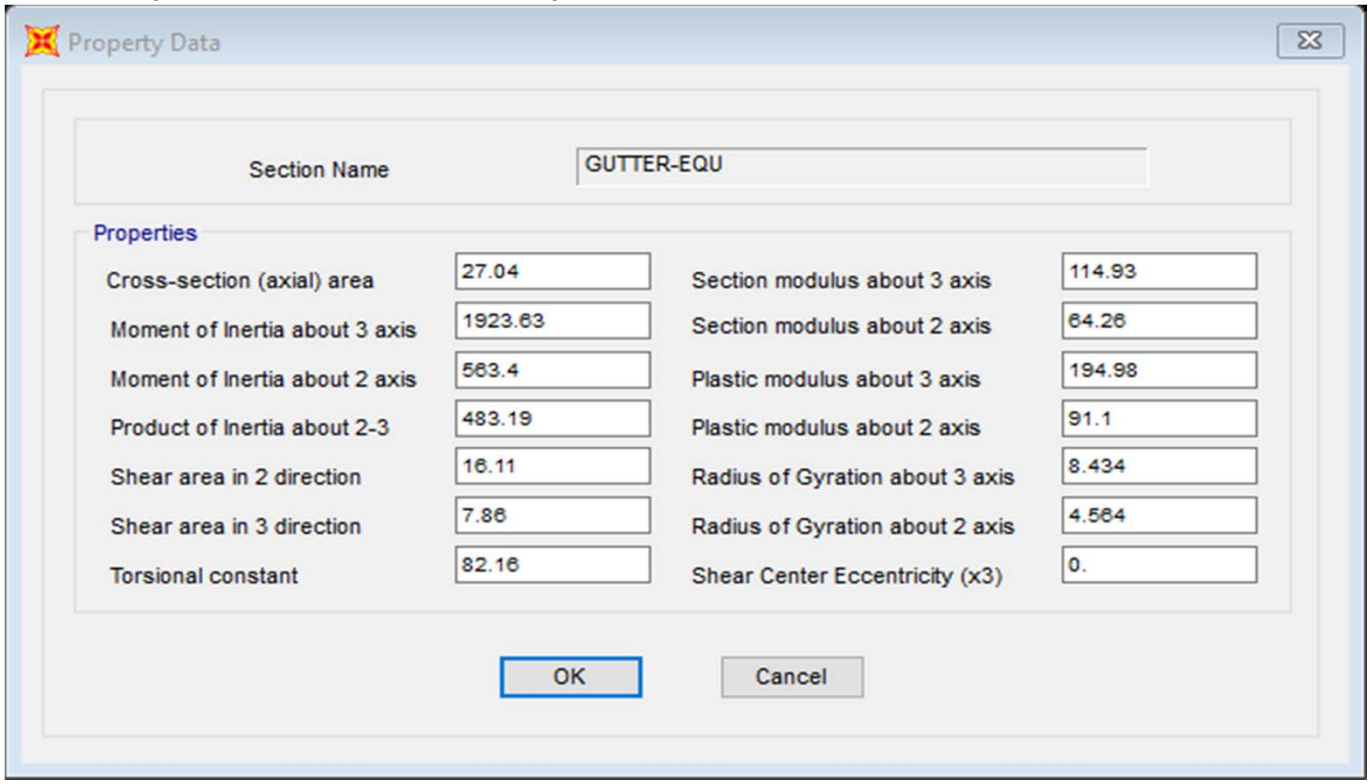
PILLAR Profile SAP2000 General Section Properties Window



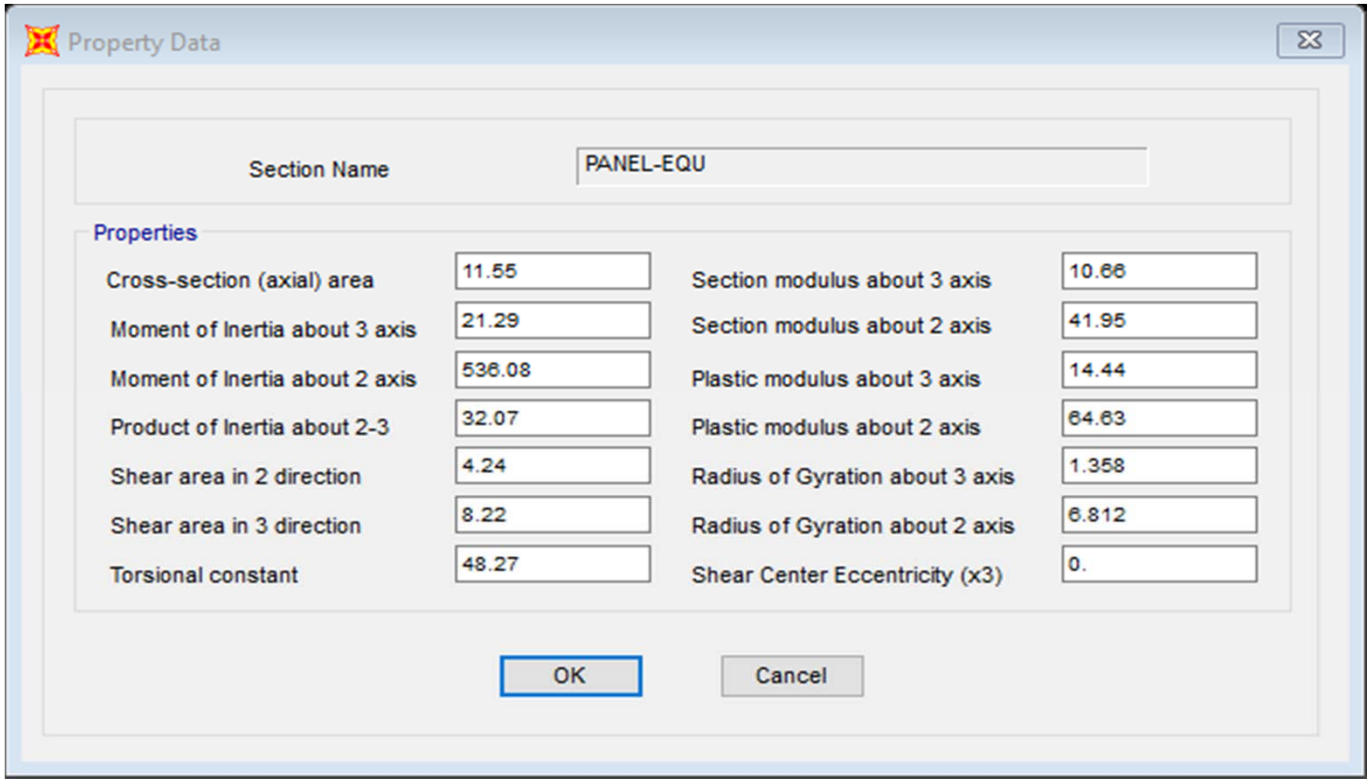
RAIL and SUPPORT BOX Profile



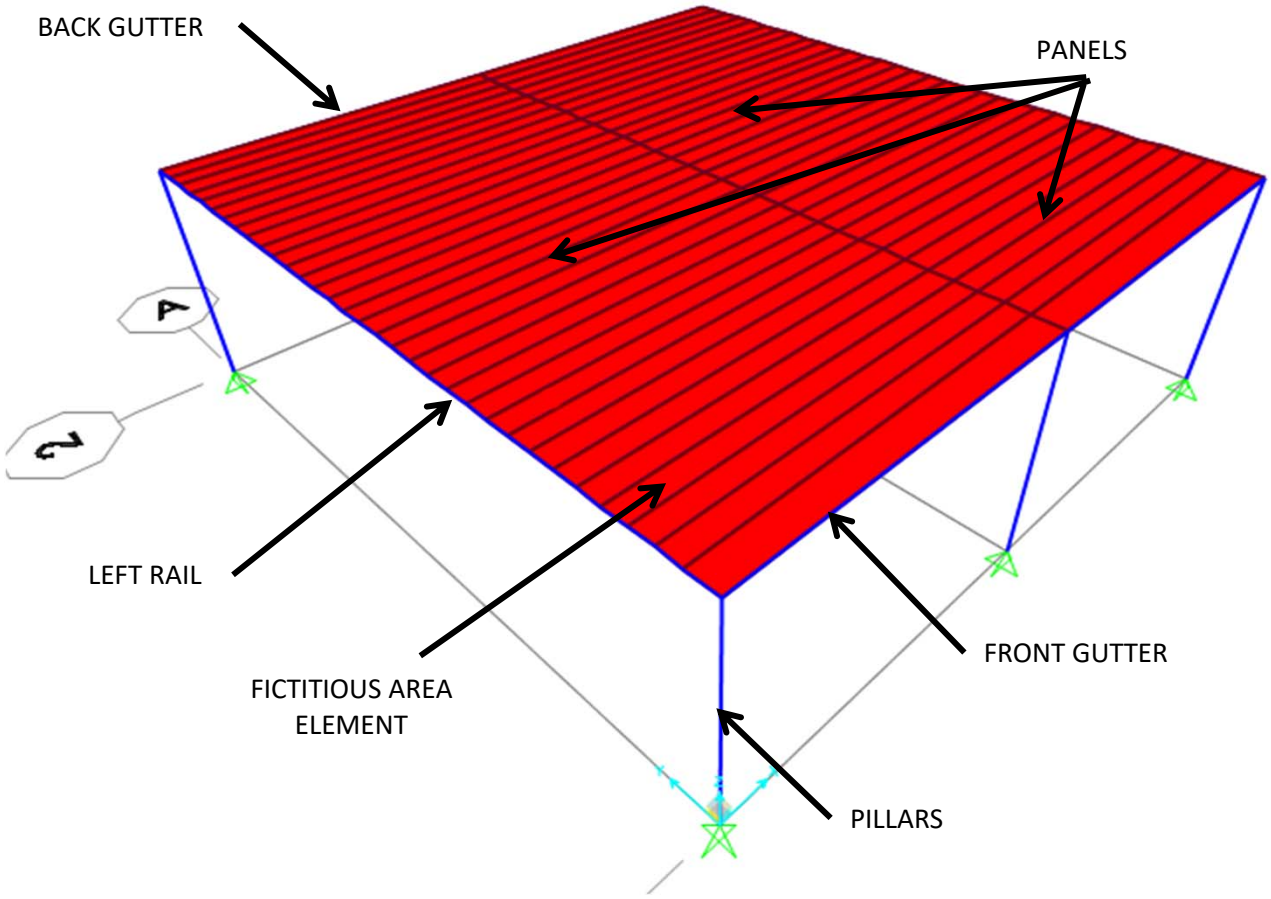
GUTTER Profile SAP2000 General Section Properties Window



PANEL Profile SAP2000 General Section Properties Window



SAP2000 3D MATHEMATICAL MODEL



- Structural elements are assigned with the sections defined in previous chapter.
- Fictitious area shell elements are defined with zero mass and weight, zero area and stiffness. They are given for assignment of snow and wind area load on structure and do not affect the structural behaviour.
- Moment releases are assigned to panel frame elements, as the **panels are not rigidly connected to rails***.
- **Only horizontal movement restraints are assigned to bottom end of pillars***.

(see for assembly instructions for clarification of connection detail)

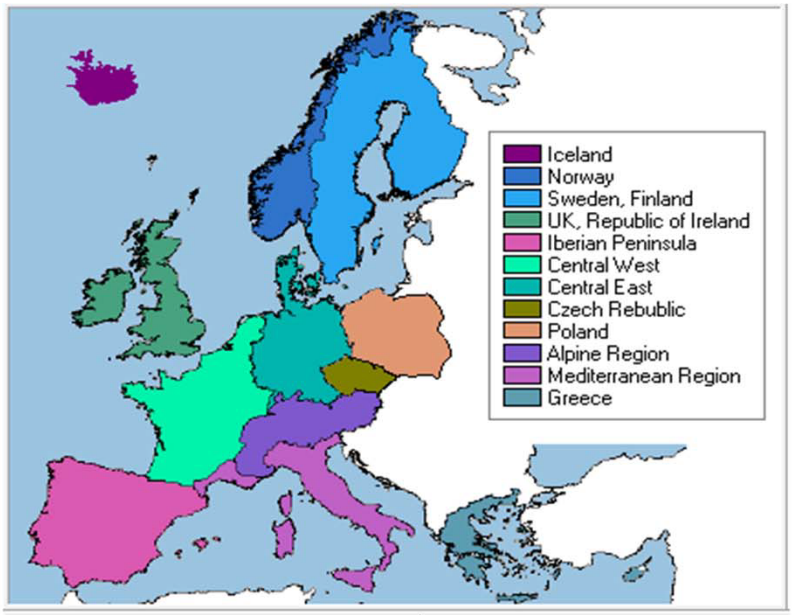
LOAD PATTERNS

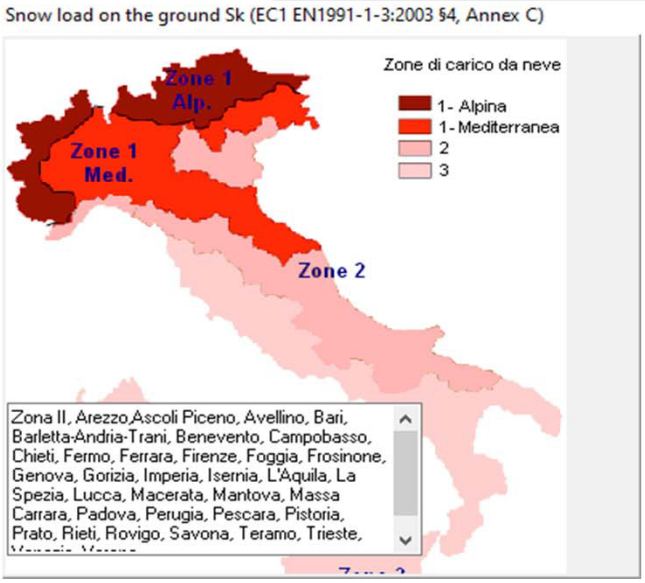
PERMANENT LOAD

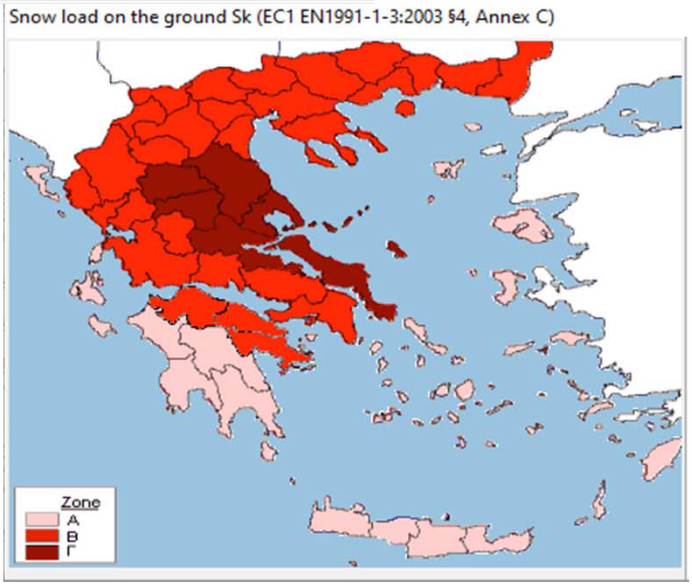
Only self-weight of structural elements will be considered as permanent action. Loads will be automatically calculated by SAP2000 software.

SNOW LOAD

The map of Europe is given below. Snow load value will be taken as an average value of obtained values from climatic region (snow) map of two countries mentioned above.

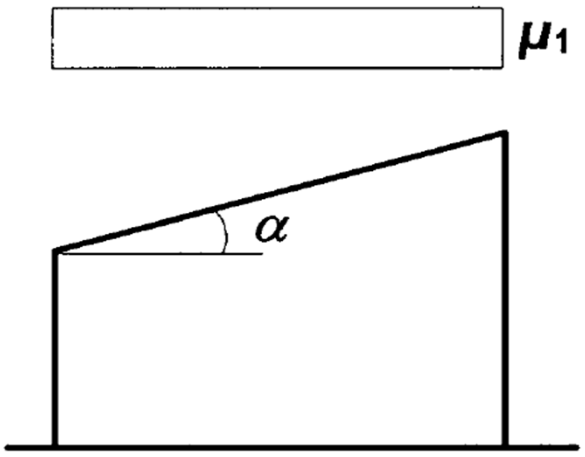


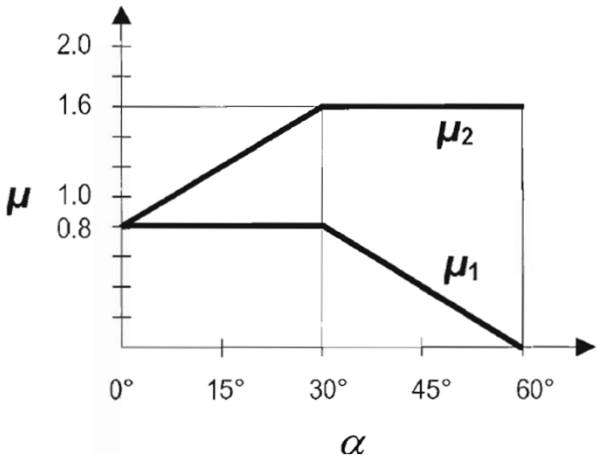




Italy Greece

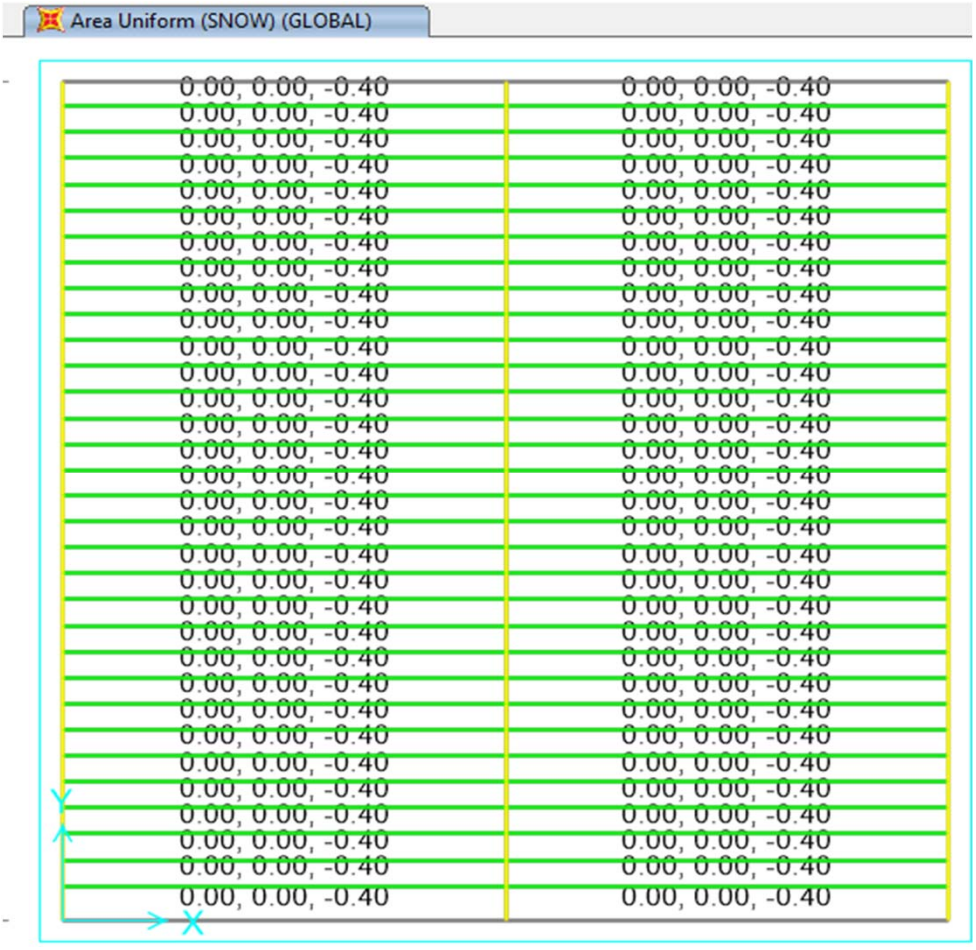
As per EC1 EN1991-1-3 Annex C, snow load values will be calculated based on design altitude (location above the sea level). Design altitude is selected equal 150m. For Italy Zone-3 and for Greece Zone-A are selected. Snow load values on ground are as follows: Greece: 0.411kN/m^2 (41kg/m^2); Italy: 0.60kN/m^2 (60kg/m^2).





- Skyfree structure will be considered as monopitch roof with the angle of pitch of roof equal 0 degrees.
- Snow load shape coefficient from the chart based on angle value: 0.80
- Characteristic value of snow load on the ground: **0.50 kN/m^2**
- Topography of location is selected normal
- Exposure and thermal coefficients based on location topography: 1.00
- Design value of snow load applied on the roof: 0.50 x 0.80 = **0.40 kN/m^2**

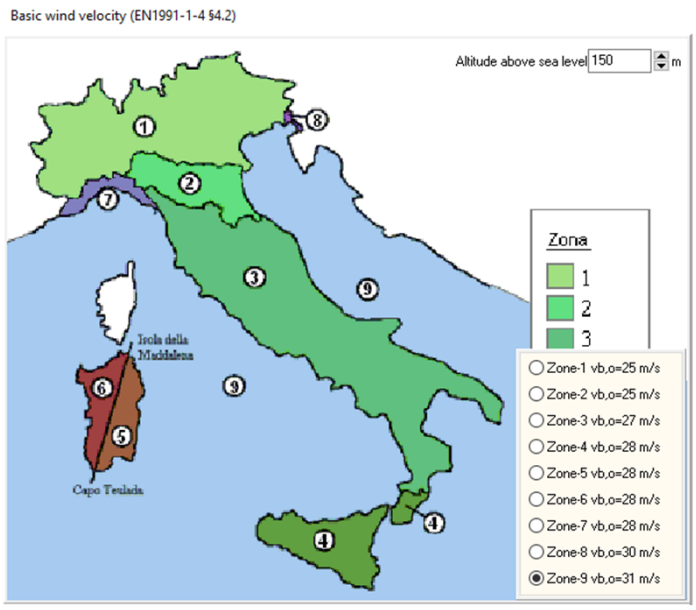
Snow pressure on roof surface



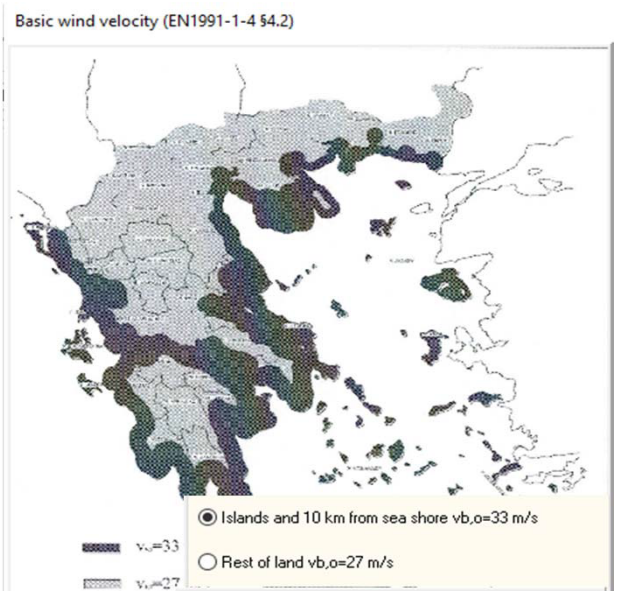
Note: "-" sign shows negative Z direction load application.

WIND LOAD

The map of Europe is given above. Wind velocity value will be taken as an average value of obtained values from climatic region (wind) map of two countries mentioned above.



Italy

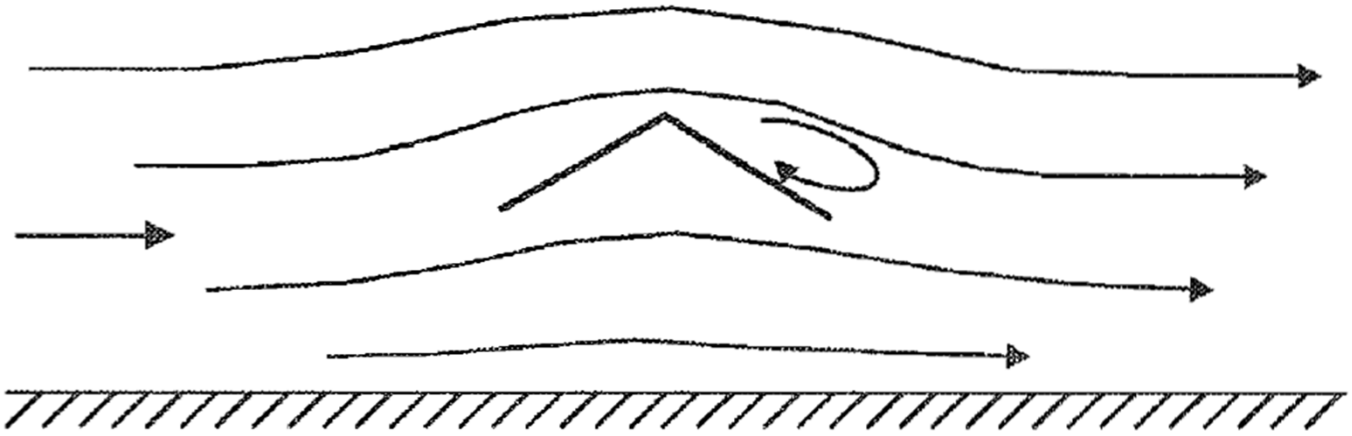


Greece

Fundamental value of basic wind velocity values ($v_{b,0}$) are as follows:

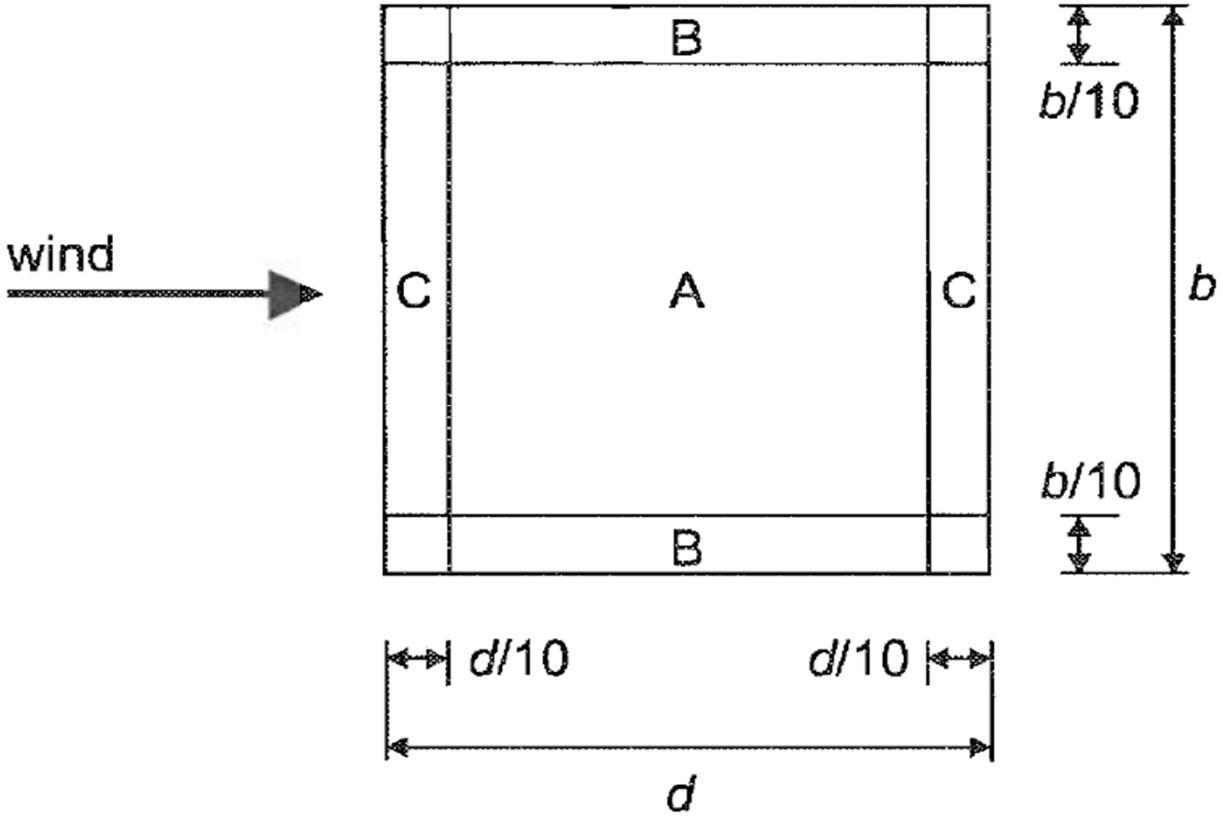
Italy: 31 m/s, Greece: 33 m/s. Basic wind velocity is taken equal 32 m/s.

Skyfree system is considered as empty, free standing monopitch canopy roof system by EC1-4 7.3.



- A canopy roof is defined as the roof of a structure that does not have permanent walls.
- For this case the factor of degree of blockage under the canopy roof is 0.
- Roof angle is equal zero (flat roof).
- The net effect of the wind pressure on the upper and lower surface for zones A, B, C on the roof surface are calculated from the corresponding net pressure coefficients.

Pressure zones for monopitch canopy roofs, reproduced from EN1991-1-4 Table 7.6



As it can be seen from the key plan above, area A is major action area. For simplicity of analysis wind load value for A will be applied over all the whole roof area.

- Negative pressure values correspond to <u>suction</u> directed away from the surface i.e. inducing uplift on the canopy roof.
- Net pressure coefficient for Zone A is given equal $c_{p,net,A}$ = - 0.60. (EN1991-1-4 Table 7.6)
- Terrain category is selected II (area with low vegetation such as grass and isolated obstacles with seperations of at least 20 obstacle height)
- The directional factor c_{dir} and the seasonal factor c_{season} are taken equal 1.0. (EN1991-1-4 4.2(2)P)
- In the following calculations the orography factor is considered as $c_0(z_e)$=1.00

SKYFREE SYSTEM STRUCTURAL ANALYSIS REPORT

Skyfree system is analysed for three types based on different structure overall heights.
Type-1 H_{total} = 2.76m; Type-2 H_{total} = 2.96m; Type-3 H_{total} = 3.16m.

Basic wind velocity (Ref. EN1991-1-4 4.2(2)P)
The basic wind velocity vb is defined as a function of the wind direction and terrain category
For all the values of H_{total} the basic wind velocity $v_b = c_{dir}.c_{season}.v_{b,0}$ = 32.00 m/s

Terrain roughness (Ref. EN1991-1-4 Table 4.1)
The roughness length z_0 = 0.050m and the minimum height z_{min} = 2.0m for terrain category II.
The terrain factor $k_r = 0.19\ (z_0/z_{0,II})^{0.07}$=0.19
The roughness factor $c_r(z_e)$:
for Type-1 H_{total} = 2.76m $c_r(z_e) = k_r.\ln(z_e/z_0)$ = 0.7621
for Type-2 H_{total} = 2.96m $c_r(z_e) = k_r.\ln(z_e/z_0)$ = 0.7754
for Type-3 H_{total} = 3.16m $c_r(z_e) = k_r.\ln(z_e/z_0)$ = 0.7878

Mean wind velocity (Ref. EN1991-1-4 Eq. 4.3)
The mean wind velocity $v_m(z_e)$ depends on the terrain roughness, terraing orography and the basic wind velocity:
for Type-1 H_{total} = 2.76m $v_m(z_e) = c_r(z_e).c_0(z_e).v_b$ = 24.39 m/s
for Type-2 H_{total} = 2.96m $v_m(z_e) = c_r(z_e).c_0(z_e).v_b$ = 24.81 m/s
for Type-3 H_{total} = 3.16m $v_m(z_e) = c_r(z_e).c_0(z_e).v_b$ = 25.21 m/s

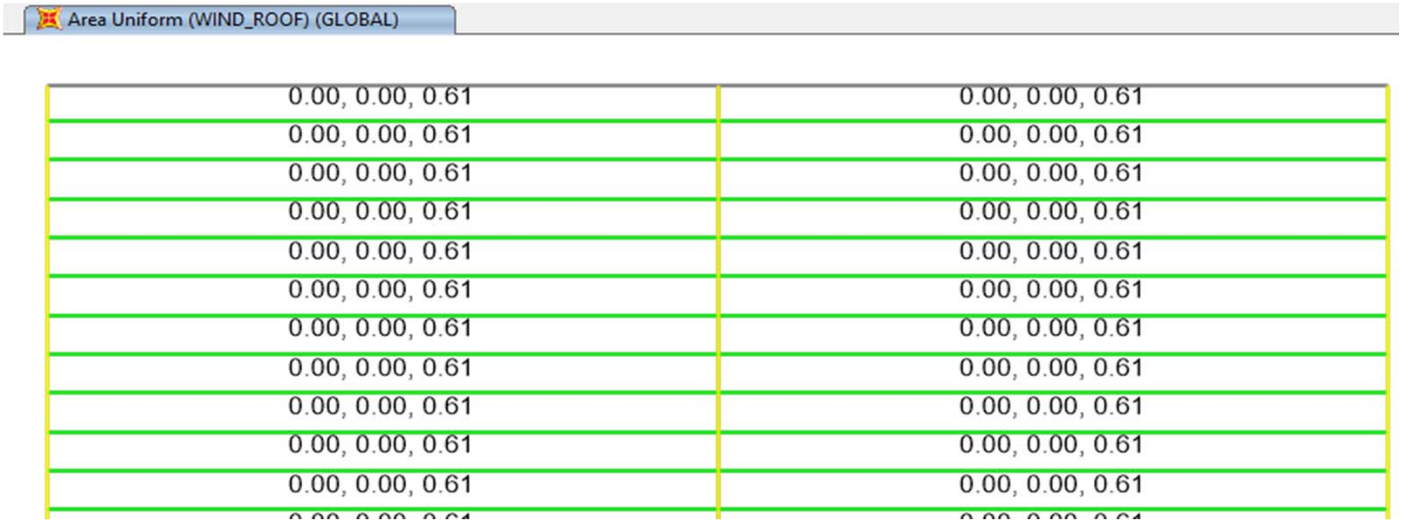
Wind turbulence (Ref. EN1991-1-4 Eq. 4.7)
The turbulence intensity $I_v(z_e)$ for the cases where $z_e > z_{min}$:
for Type-1 H_{total} = 2.76m $I_v(z_e) = k_1\,[c_0(z_e).\ln(z_e/z_0)]$ = 0.2493
for Type-2 H_{total} = 2.96m $I_v(z_e) = k_1\,[c_0(z_e).\ln(z_e/z_0)]$ = 0.2450
for Type-3 H_{total} = 3.16m $I_v(z_e) = k_1\,[c_0(z_e).\ln(z_e/z_0)]$ = 0.2412

Basic velocity pressure (Ref. EN1991-1-4 4.5(1))
For all the values of H_{total} the basic velocity pressure equals $q_b = (1/2).\rho.v_b^2$ = 0.64 kN/m^2

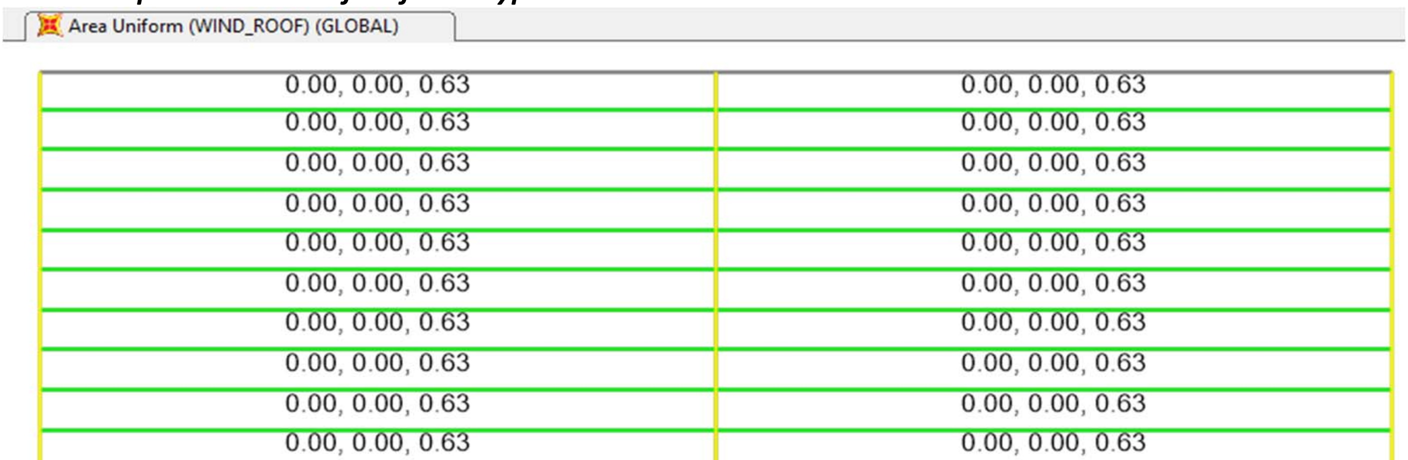
Peak velocity pressure (Ref. EN1991-1-4 Eq.4.8)
The peak velocity pressure includes mean and short-term velocity fluctuations.
for Type-1 H_{total} = 2.76m $q_p(z_e) = (1+7.I_v(z_e)).((1/2).\rho.v_m(z_e)^2$ = 1.020 kN/m^2
for Type-2 H_{total} = 2.96m $q_p(z_e) = (1+7.I_v(z_e)).((1/2).\rho.v_m(z_e)^2$ = 1.045 kN/m^2
for Type-3 H_{total} = 3.16m $q_p(z_e) = (1+7.I_v(z_e)).((1/2).\rho.v_m(z_e)^2$ = 1.068 kN/m^2

Net wind pressure on pressure zones (Ref. EN1991-1-4)
For structural surfaces consisting of only one skin net pressure effect is determined as:
for **Type-1 H_{total} = 2.76m** $w_{net} = c_{p,net}.q_p(z_e)$ = **-0.612 kN/m^2 (61 kg/m^2)** (for both directions of wind)
for **Type-2 H_{total} = 2.96m** $w_{net} = c_{p,net}.q_p(z_e)$ = **-0.627 kN/m^2 (63 kg/m^2)** (for both directions of wind)
for **Type-3 H_{total} = 3.16m** $w_{net} = c_{p,net}.q_p(z_e)$ = **-0.641 kN/m^2 (64kg/m^2)** (for both directions of wind)

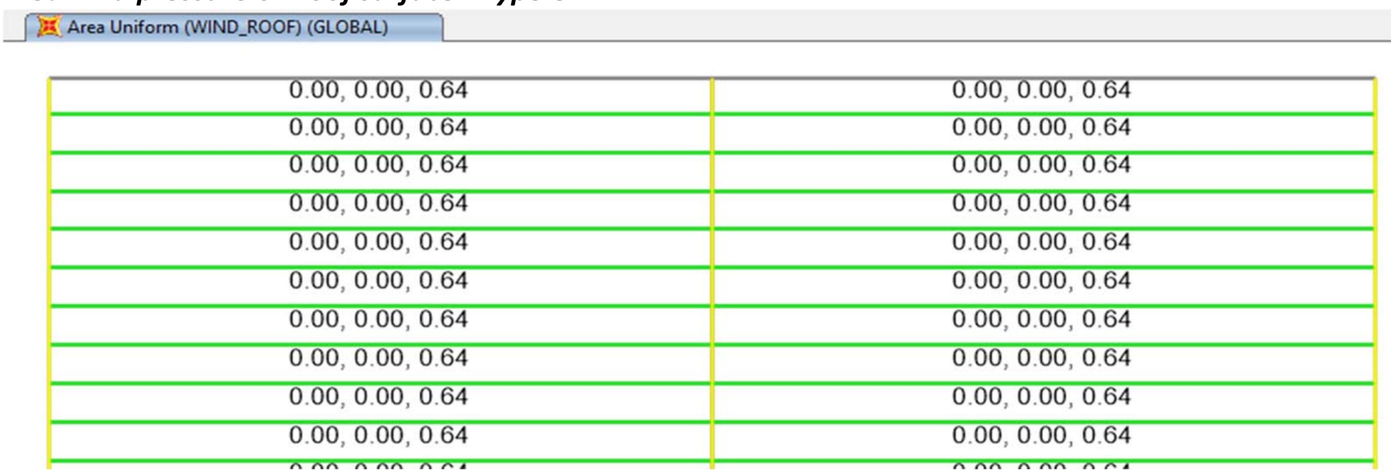
Net wind pressure on roof surface - Type-1



Net wind pressure on roof surface - Type-2



Net wind pressure on roof surface - Type-3

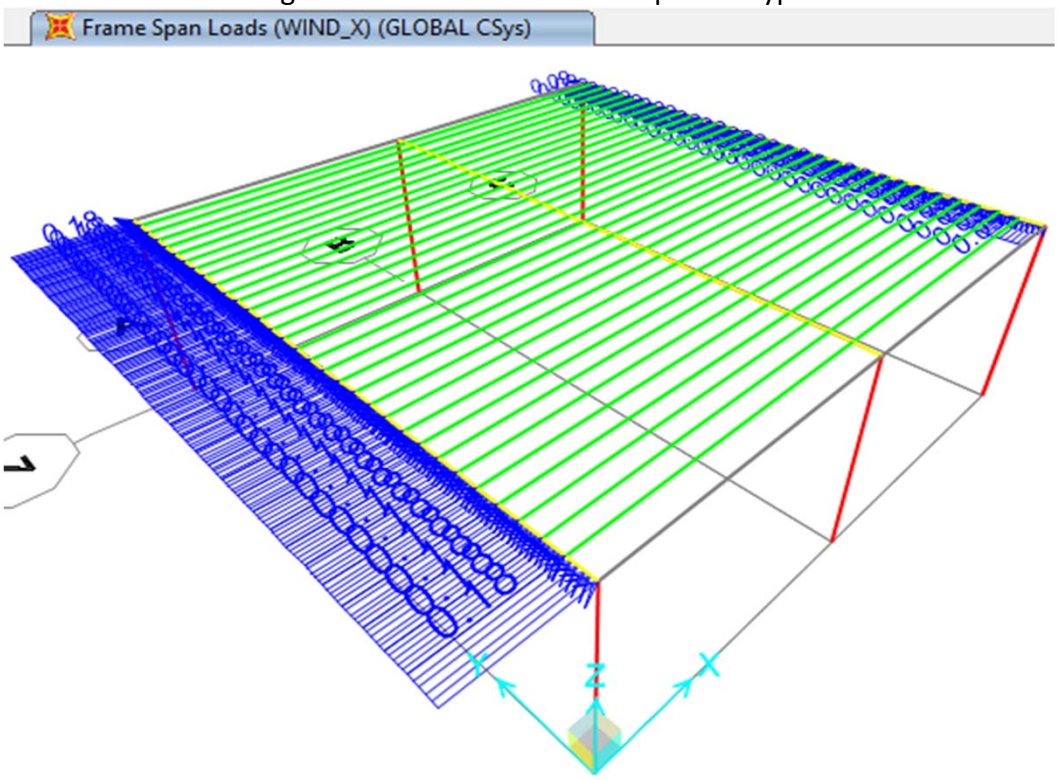


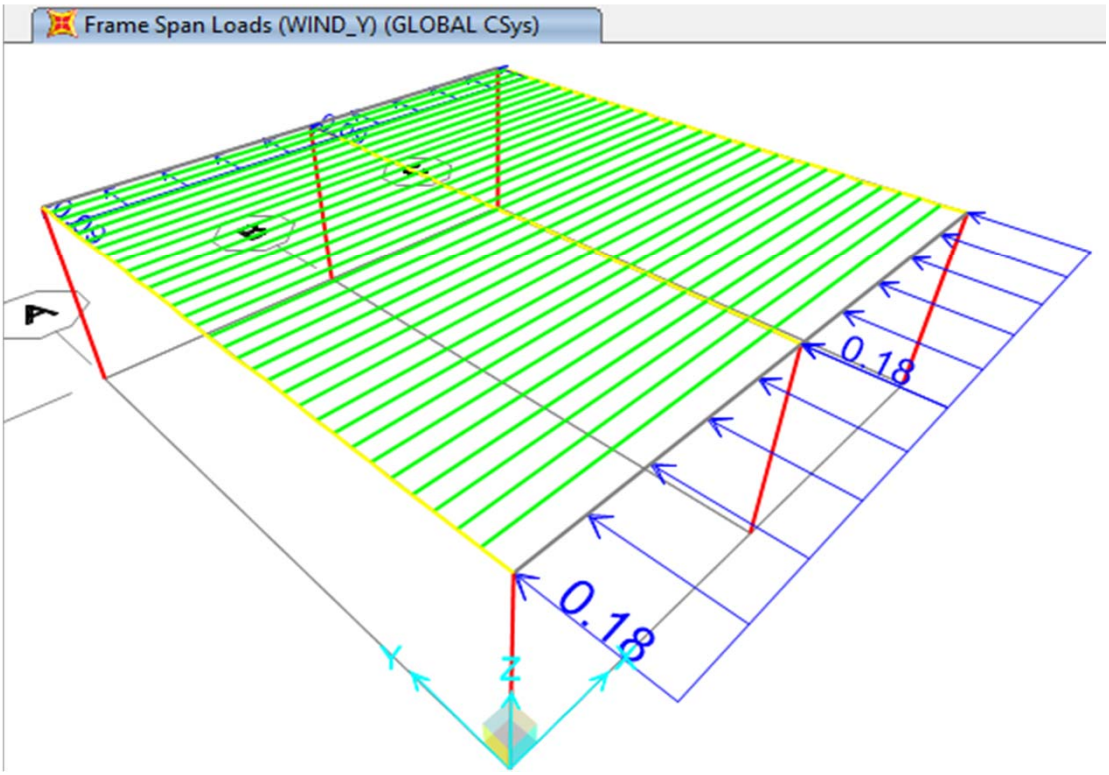
Note: Same values for wind in Y-direction is applied. Figures above are shown for correct assignment of calculated wind load values.

Note: Negative pressure values correspond to suction directed away from the surface i.e. inducing uplift on the canopy roof.

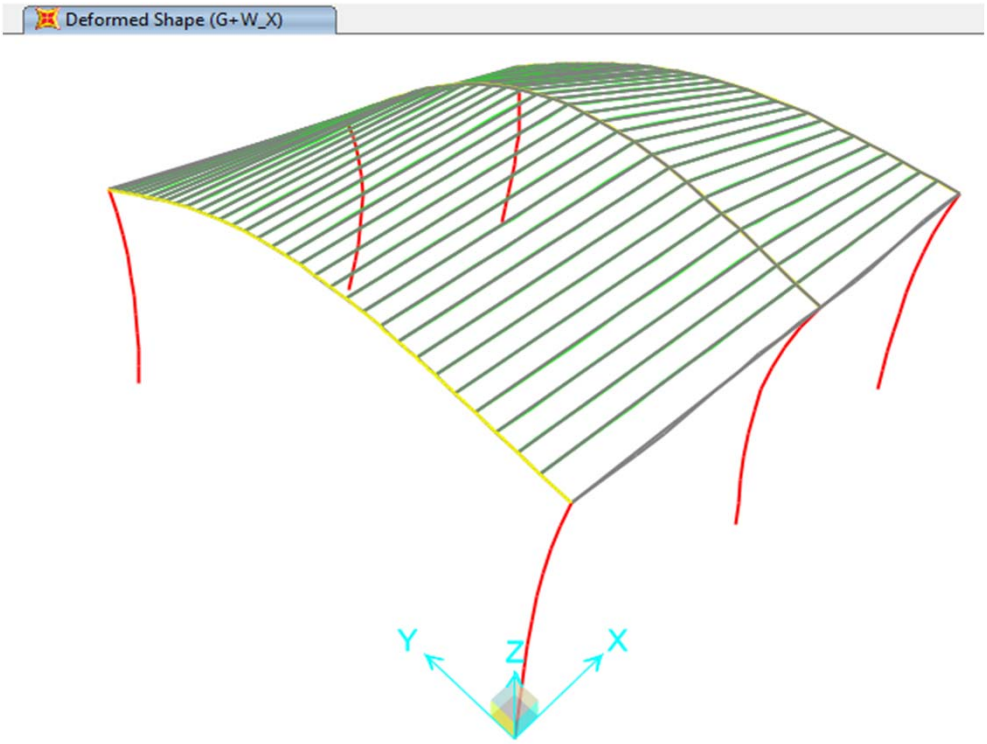
Net wind lateral pressure on rails

Proof height starting from pillar top end to roof surface equals 36cm. Lateral wind will be also applied to rail together with pressure on roof surface. For X-direction of wind uniform load will be applied as pressure on left rail, and as sucking to right rail. For Y-direction of wind uniform load will be applied as pressure on front gutter, and as sucking on back gutter. As three types of Skyfree is analysed, and pressure values of wind is different for each case, load assignment will be done seperately. Below wind load assignment is shown as an example for Type-1.

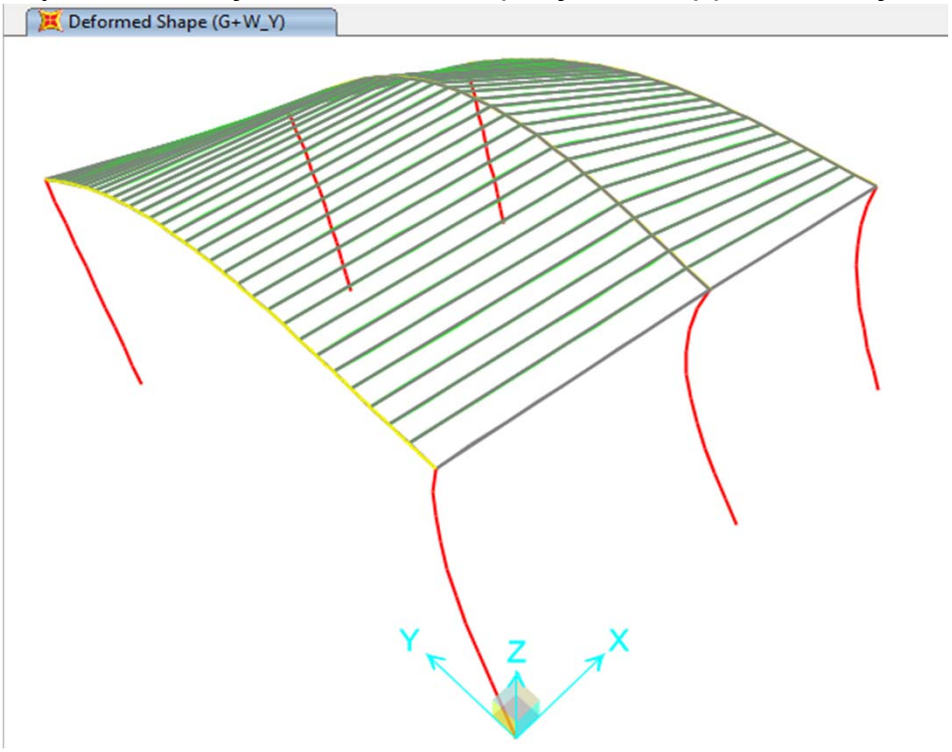




Representation of Total Wind Action (Roof + Lateral) (SAP2000 Deformed Shape)



Representation of Total Wind Action (Roof + Lateral) (SAP2000 Deformed Shape)



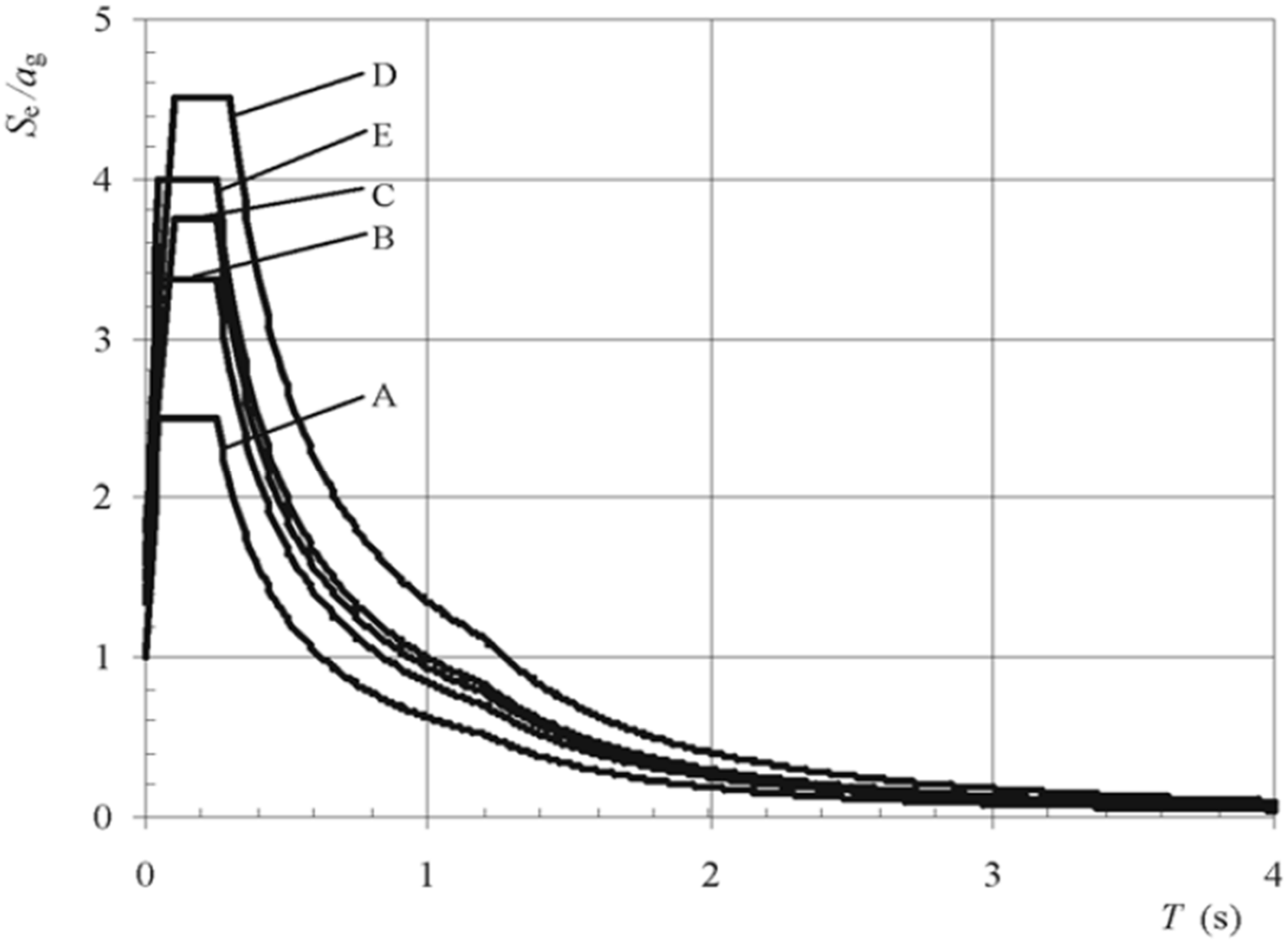
As it can be seen from the figures above, wind action is represented mostly as a sucking uplift from the roof surface, as the structure is considered as canopy roof system without enclosing permanent walls on perimeter.

EARTHQUAKE LOAD

In this chapter design to Eurocode-8-1-Part 1 will be considered (EC8).
For seismic analysis of structure Response Spectra will be assigned to mathematical model.

Selection of design response spectrum

Two types of elastic response spectra Type-1 and Type-2 are given in reference seismic code (EC8).
Type-2 spectrum will be adopted as the region of construction implementation is in high seismicity region.

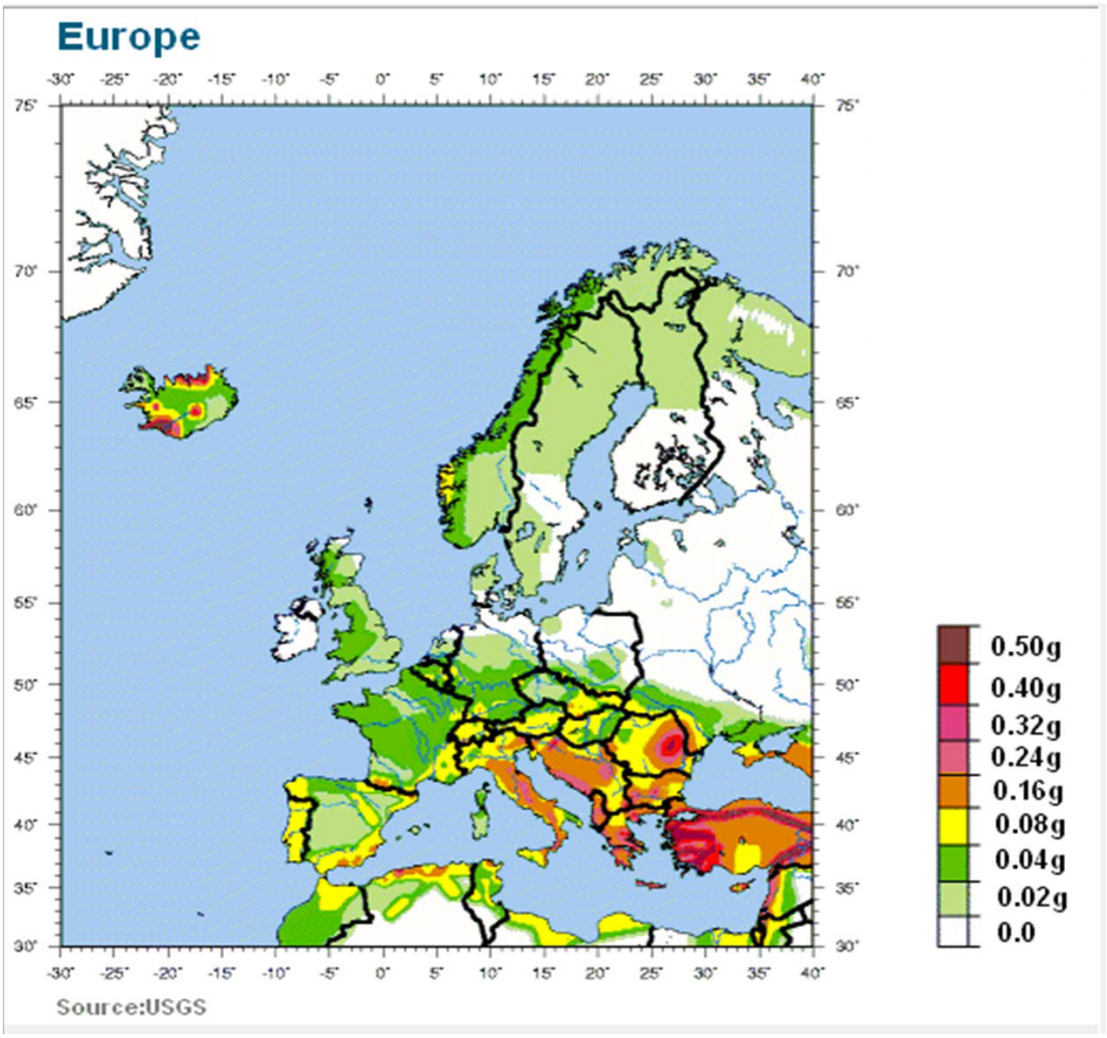


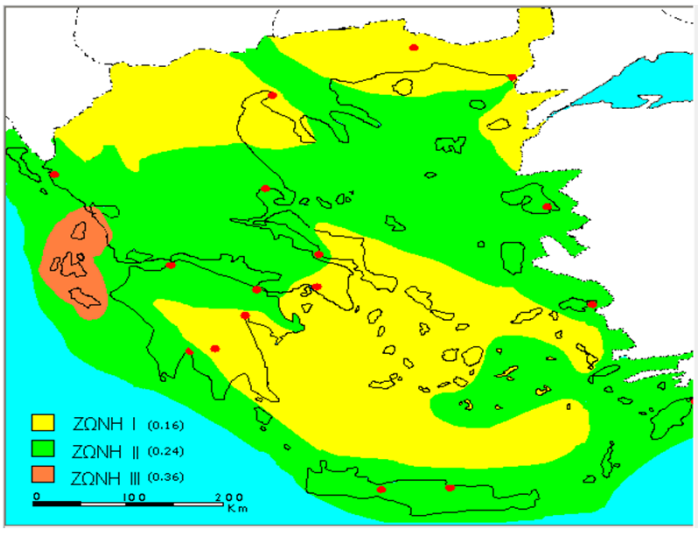
As the geotecnical design parameters are missed, Ground **Type-C** will be considered during seismic analysis.
Parameteres describing the elastic response spectra are listed below (Table 3.3-EC8).

Ground type	S	T_B (s)	T_C (s)	T_D (s)
A	1,0	0,05	0,25	1,2
B	1,35	0,05	0,25	1,2
C	1,5	0,10	0,25	1,2
D	1,8	0,10	0,30	1,2
E	1,6	0,05	0,25	1,2

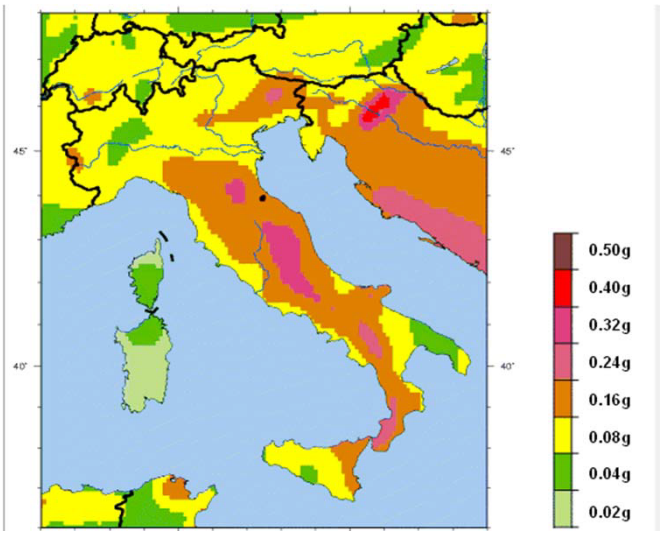
Seismic design parameters

Seismic hazard map of Europe is given below. PGA value will be taken as an average value of two countries mentioned above.





Greece



Italy

Referent value of PGA (Peak Ground Acceleration) is taken equal 0.25g.

Determination of structural behaviour factor

Basic values of the behaviour factor q0 for systems regular in elevation is given below (Table 5.1-EC8).

STRUCTURAL TYPE	DCM	DCH
Frame system, dual system, coupled wall system	$3,0\alpha_u/\alpha_1$	$4,5\alpha_u/\alpha_1$
Uncoupled wall system	3,0	$4,0\alpha_u/\alpha_1$
Torsionally flexible system	2,0	3,0
Inverted pendulum system	1,5	2,0

Skyfree system is considered as DCM (Ductility Class Medium) frame system.

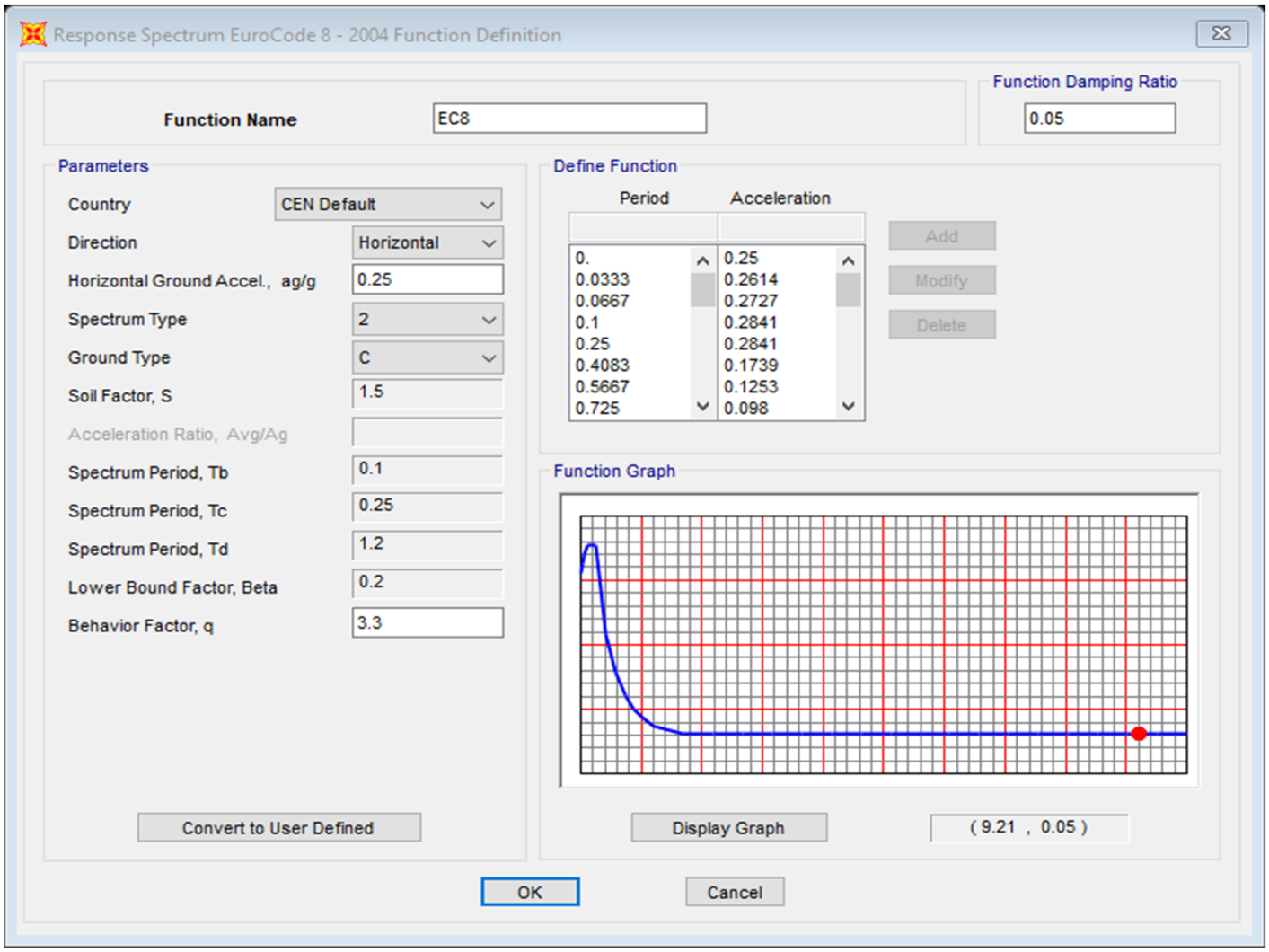
Multiplication factor for frames or frame-equivalent dual systems in case of one-storey buildings is taken equal 1.1. Then q0 is equal 3 x 1.1 = 3.3. The factor kw reflecting the prevailing failure mode shall be taken equal 1.00 for frame and frame-equivalent dual systems. Finally, the upper limit value of the behaviour factor q = q0 x kw = 3.3 x 1.0 = 3.3.

Determination of importance class

Importance class	Buildings
I	Buildings of minor importance for public safety, e.g. agricultural buildings, etc.
II	Ordinary buildings, not belonging in the other categories.
III	Buildings whose seismic resistance is of importance in view of the consequences associated with a collapse, e.g. schools, assembly halls, cultural institutions etc.
IV	Buildings whose integrity during earthquakes is of vital importance for civil protection, e.g. hospitals, fire stations, power plants, etc.

Skyfree system is considered as ordinary building and the value for importance class (II) will be taken equal 1.0 as per Table 4.3 EC8. Finally, design ground acceleration ag = agR * 1.0 = 0.25g.

SAP2000 Response Spectrum Function Definition (EC8)



Combination of the effects of the components of the seicmis action

Seicmis action may be computed using both of the two following combinations (EC8 4.3.3.5.1):

a) E_{Edx} "+" $0{,}30E_{Edy}$

b) $0{,}30E_{Edx}$ "+" E_{Edy}

Sign "+" implies "to be combined with"

Edx represents the action effects due to the application of the seismic action along the chosen horizontal axis X.

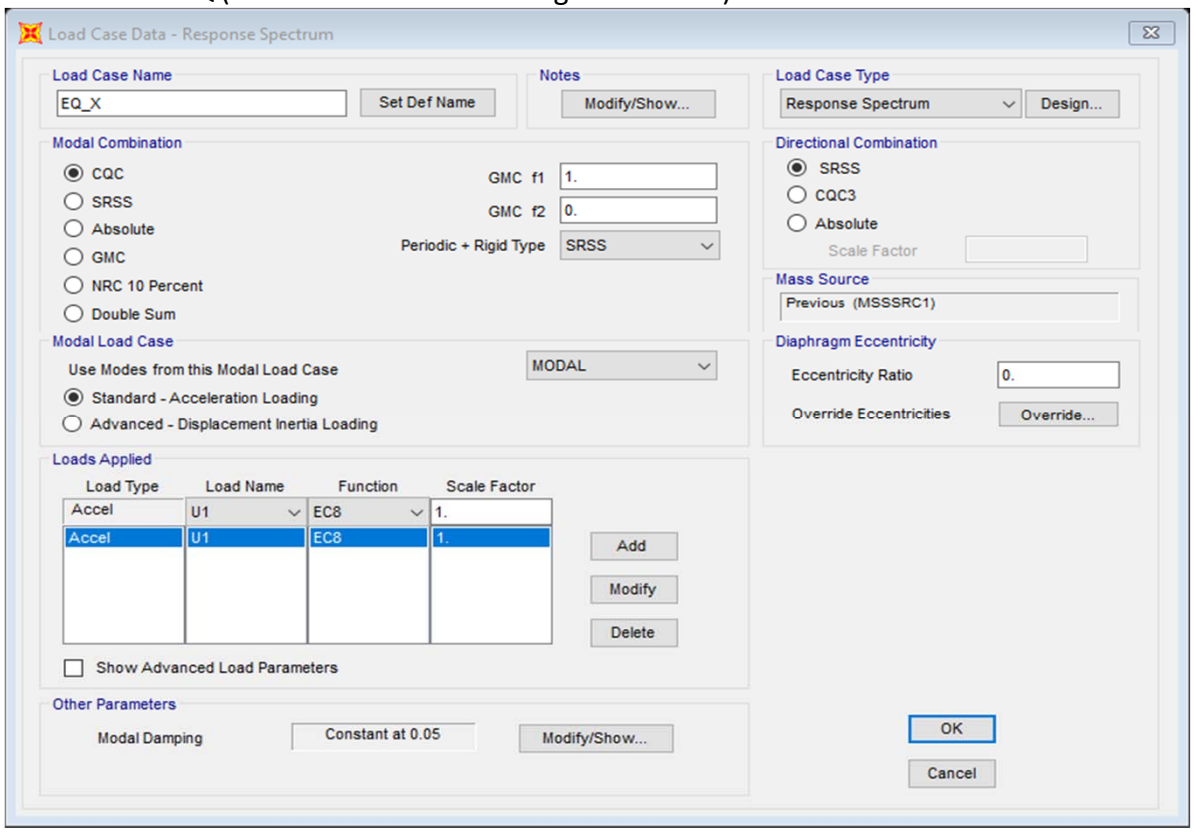
Edy represents the action effects due to the application of the same seismic action along the horizontal axis Y.

Vertical **Ez** will <u>not be applied</u> as the Skyfree system does not include cantilever and large spanning.

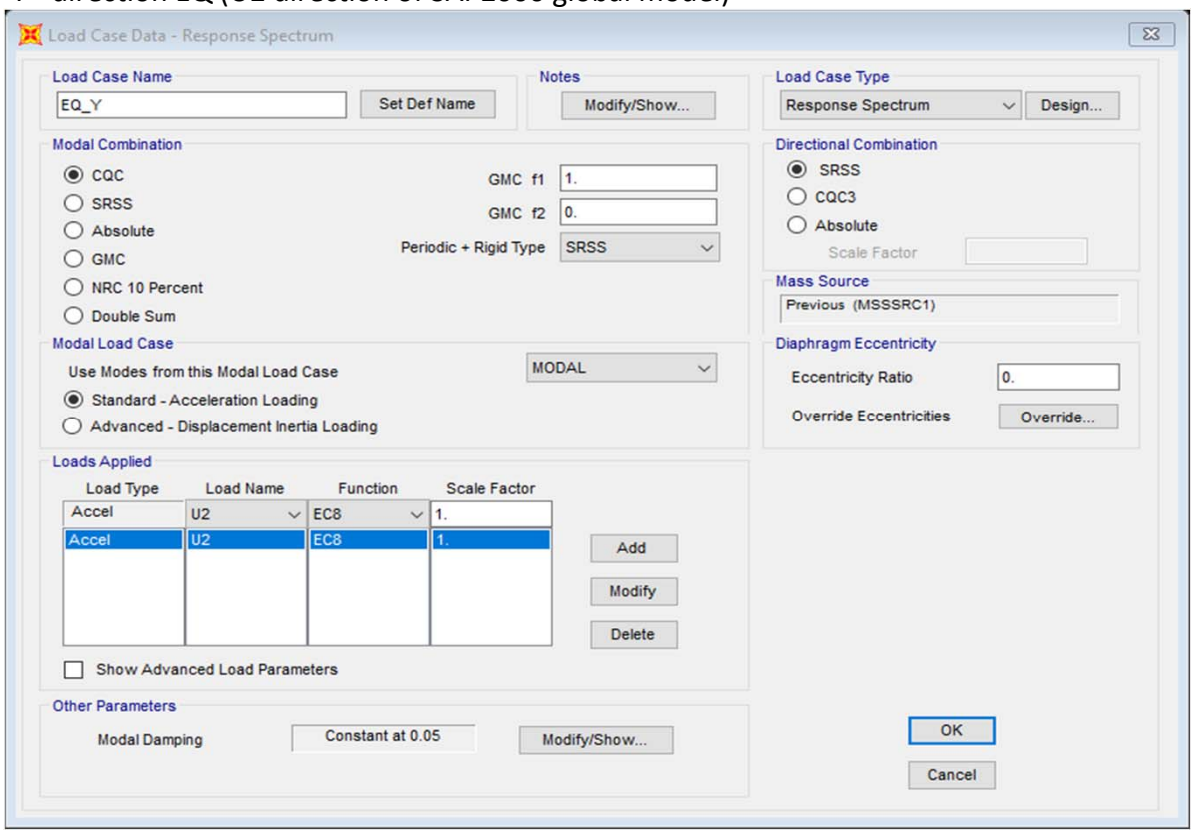
The system is same in different horizontal directions, the value of the behaviour factor will be same.

SAP2000 Earthquake Load Assignment

X - direction EQ (U1 direction of SAP2000 global model)



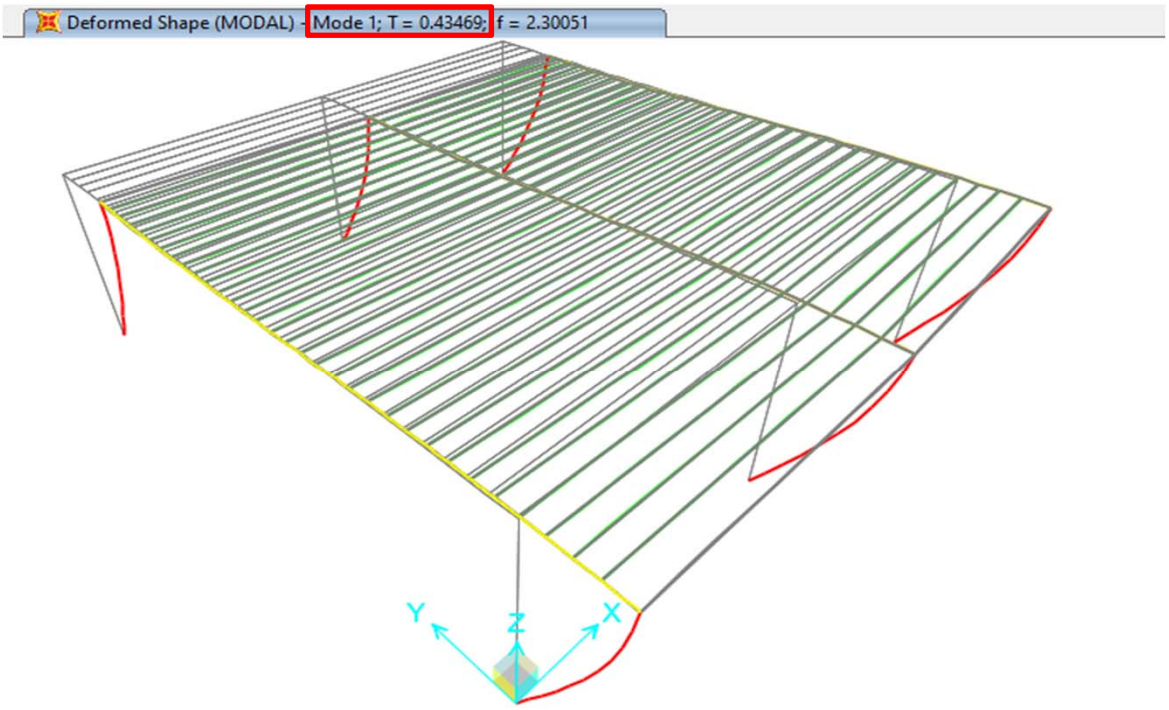
Y - direction EQ (U2 direction of SAP2000 global model)



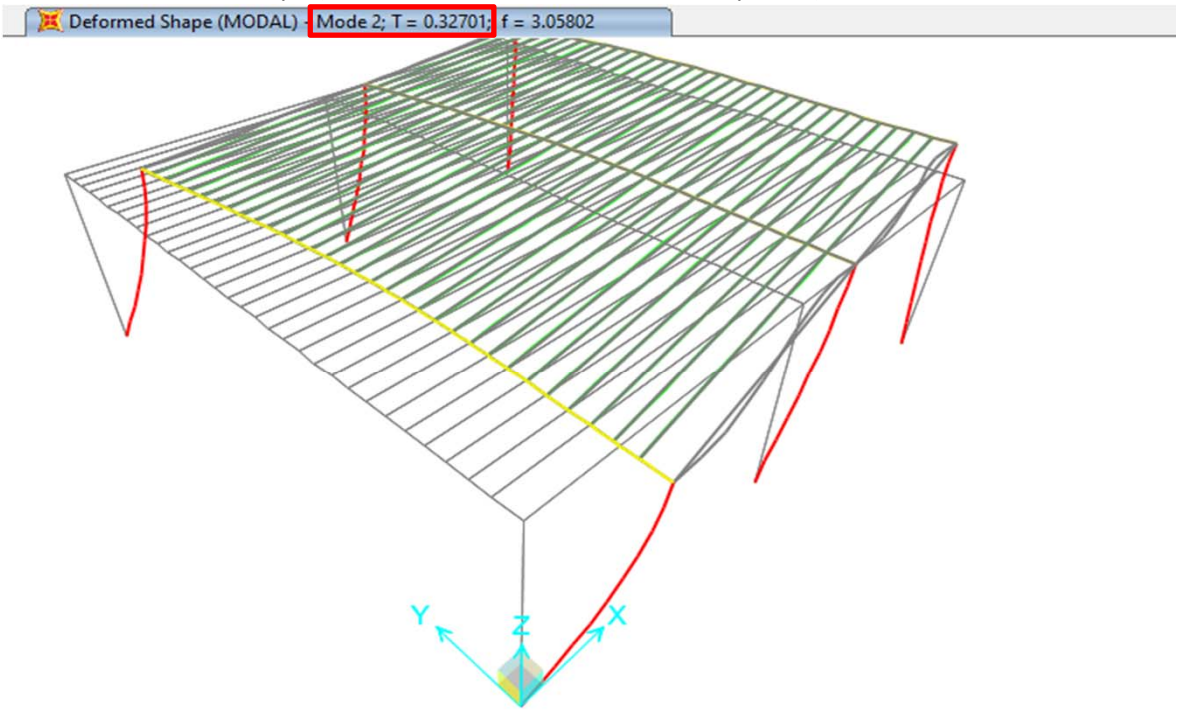
MODAL ANALYSIS RESULTS

TYPE - 1 MODAL ANALYSIS

Mode-1 Deformed Shape (Y-direction fundamental vibration period)



Mode-2 Deformed Shape (X-direction fundamental vibration period)

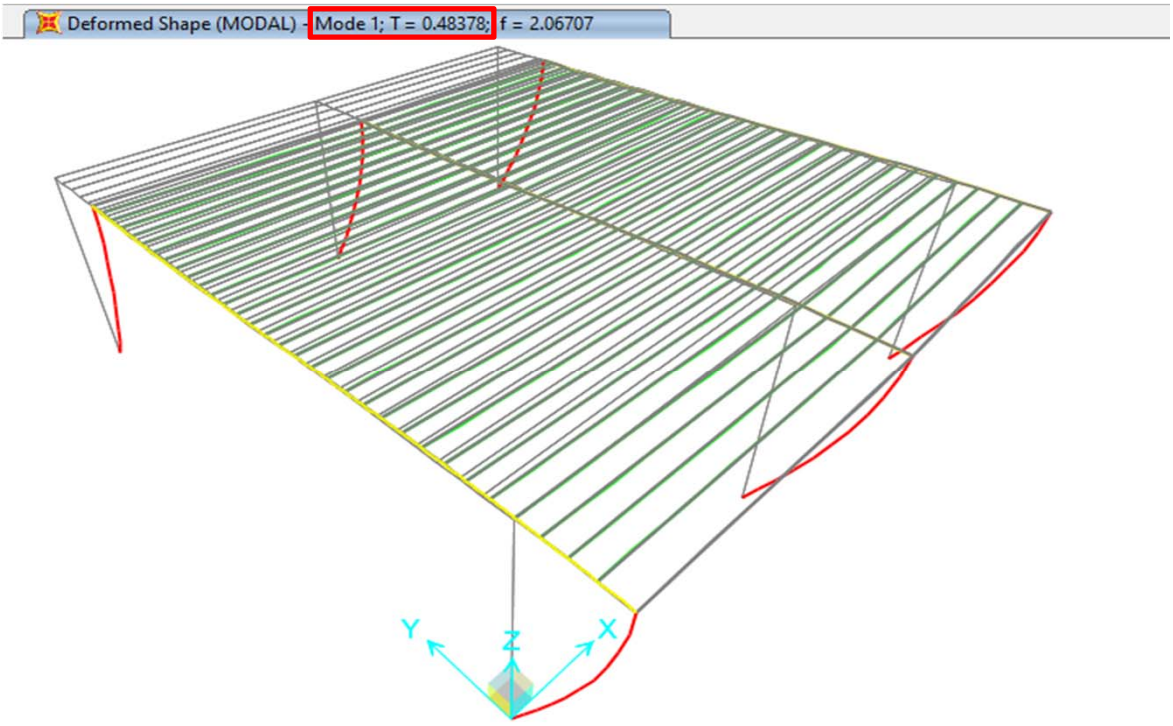


	OutputCase	StepType Text	StepNum Unitless	Period Sec	UX Unitless	UY Unitless	UZ Unitless
▶	MODAL	Mode	1	0.434685	0	0.9979	2.483E-08
	MODAL	Mode	2	0.327009	0.86792	0	0

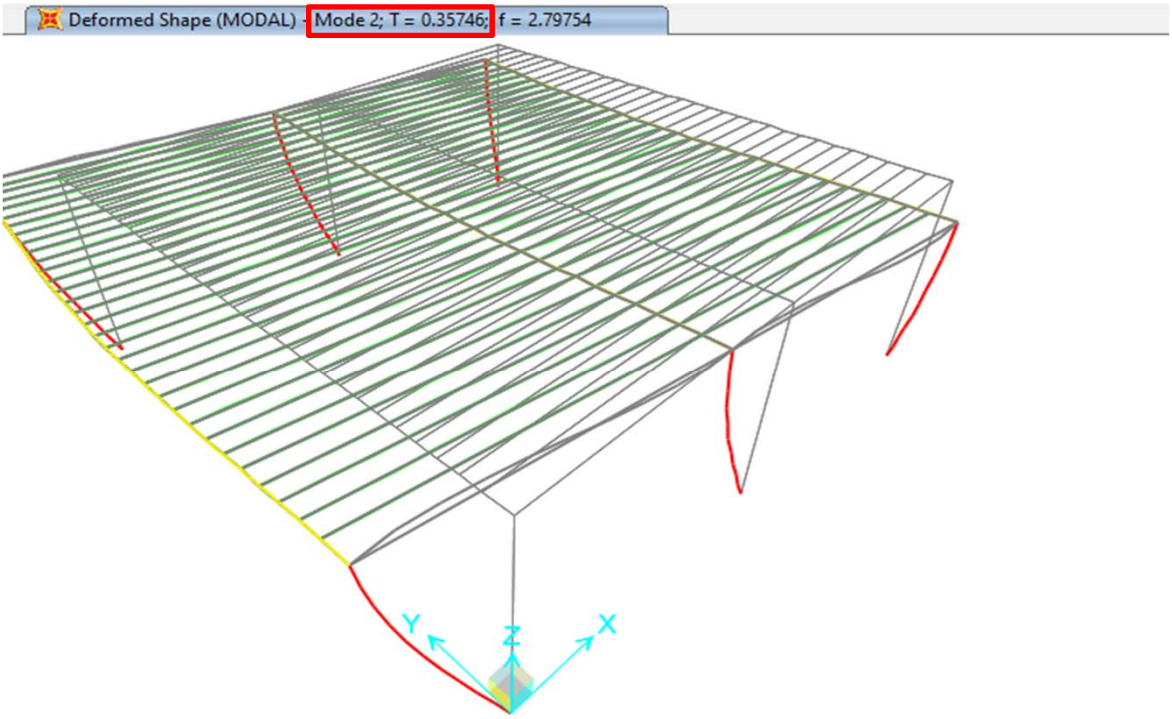
Modal mass participation ratios for both given modes are found to be acceptable.

TYPE - 2 MODAL ANALYSIS

Mode-1 Deformed Shape (Y-direction fundamental vibration period)



Mode-2 Deformed Shape (X-direction fundamental vibration period)

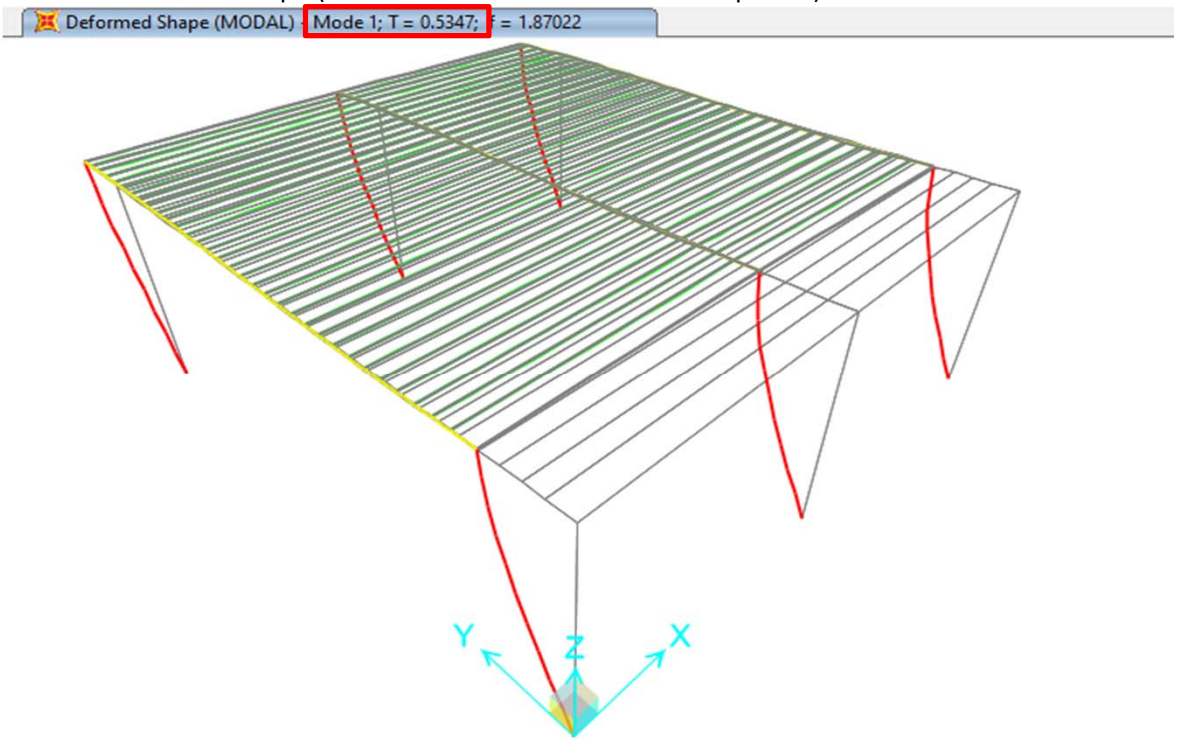


	OutputCase	StepType Text	StepNum Unitless	Period Sec	UX Unitless	UY Unitless	UZ Unitless
▶	MODAL	Mode	1	0.483776	0	0.99855	1.718E-08
	MODAL	Mode	2	0.357457	0.88971	0	0

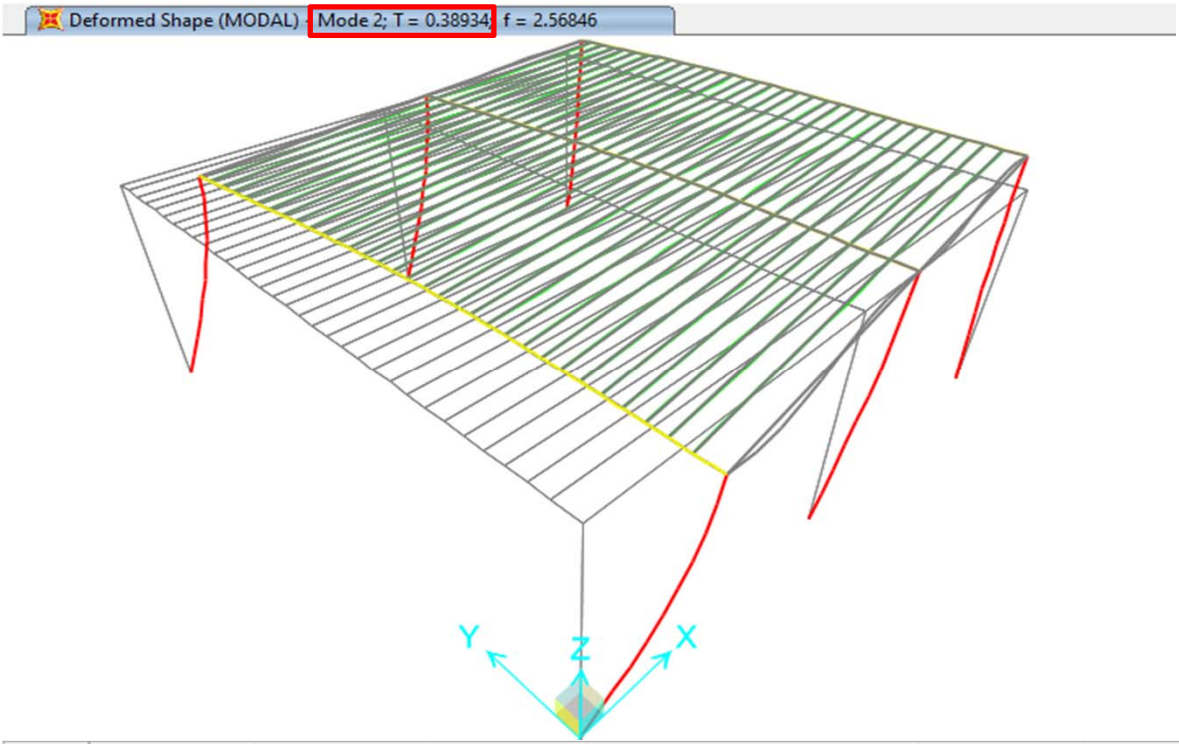
Modal mass participation ratios for both given modes are found to be acceptable.

TYPE - 3 MODAL ANALYSIS

Mode-1 Deformed Shape (Y-direction fundamental vibration period)



Mode-2 Deformed Shape (X-direction fundamental vibration period)



	OutputCase	StepType Text	StepNum Unitless	Period Sec	UX Unitless	UY Unitless	UZ Unitless
▶	MODAL	Mode	1	0.534696	0	0.99896	1.225E-08
	MODAL	Mode	2	0.389338	0.90948	0	0

Modal mass participation ratios for both given modes are found to be acceptable.

LOAD COMBINATIONS

Eurocode 1990:2002 (EC0) load combinations will be taken into account during Skyfree structural analysis. SLS (serviceablitiy limit state) load combinations and combinations of actions for seismic design will be applied. Then all the elements will be checked against PMM load bearing capacities under ASD provisions.

G: Permanent load (Only self-weight of elements)
S: Snow loads
W_X: Wind loads in X-direction (includes pressure on roof surface and uniform loads on rail)
W_Y: Wind loads in Y-direction (includes pressure on roof surface and uniform loads on gutter)
EQ_X: Earthquake loads in X-direction
EQ_Y: Earthquake loads in Y-direction

SERVICEABILITY LIMIT STATE

Characteristic combination will be taken into account (EC0 6.14B)

$$\sum_{j\geq 1} G_{k,j} "+" P "+" Q_{k,1} "+" \sum_{i>1} \psi_{0,i} Q_{k,i}$$

Values of psi factors are taken from Table A1.1 EC0. For snow loads $\psi_{0,i}$ = 0.50, for wind loads $\psi_{0,i}$ = 0.60.
SLS load combinations:

a) G + S
b) G + W_X
c) G + W_Y
d) G + S + 0.60*W_X
e) G + S + 0.60*W_Y
f) G + W_X + 0.50*S
g) G + W_Y + 0.50*S

SEISMIC DESIGN SITUATIONS

The combinations of actions for seismic design situations can be expressed as (EC0 6.12b)

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

Values of psi factors are taken from Table A1.1 EC0. For snow loads $\psi_{2,i}$ = 0, for wind loads $\psi_{2,i}$ = 0.
Earthquake load combinations:

a) G + EQ_x + 0.3*EQ_y
b) G + EQ_y + 0.3*EQ_x

Load Combinations (SAP2000 Define Load Combinations Window)

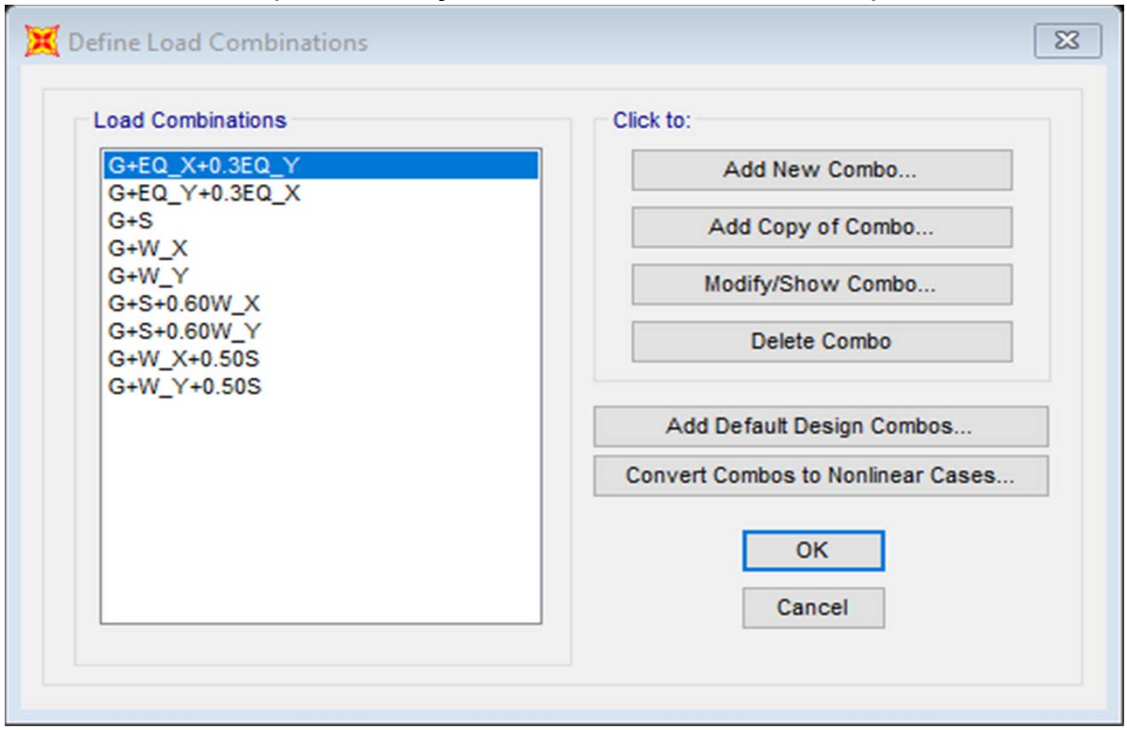


TABLE: Combination Definitions

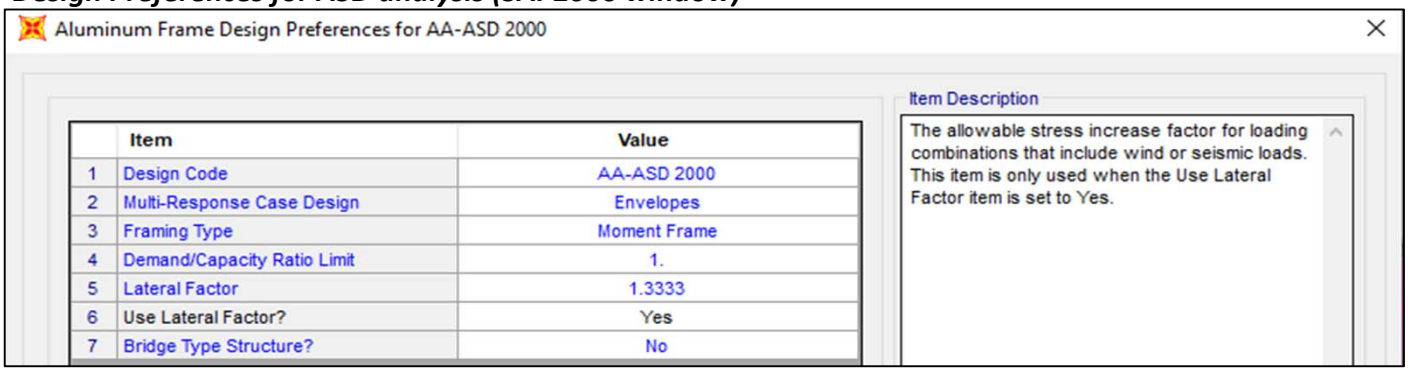
ComboName	ComboType	AutoDesign	CaseType	CaseName	ScaleFactor
Text	Text	Yes/No	Text	Text	Unitless
G+EQ_X+0.3EQ_Y	Linear Add	No	Linear Static	DEAD	1
G+EQ_X+0.3EQ_Y			Response Spectrum	EQ_X	1
G+EQ_X+0.3EQ_Y			Response Spectrum	EQ_Y	0.3
G+EQ_Y+0.3EQ_X	Linear Add	No	Linear Static	DEAD	1
G+EQ_Y+0.3EQ_X			Response Spectrum	EQ_X	0.3
G+EQ_Y+0.3EQ_X			Response Spectrum	EQ_Y	1
G+S	Linear Add	No	Linear Static	DEAD	1
G+S			Linear Static	SNOW	1
G+W_X	Linear Add	No	Linear Static	DEAD	1
G+W_X			Linear Static	WIND_X	1
G+W_X			Linear Static	WIND_ROOF	1
G+W_Y	Linear Add	No	Linear Static	DEAD	1
G+W_Y			Linear Static	WIND_Y	1
G+W_Y			Linear Static	WIND_ROOF	1
G+S+0.60W_X	Linear Add	No	Linear Static	DEAD	1
G+S+0.60W_X			Linear Static	SNOW	1
G+S+0.60W_X			Linear Static	WIND_X	0.6
G+S+0.60W_X			Linear Static	WIND_ROOF	0.6
G+S+0.60W_Y	Linear Add	No	Linear Static	DEAD	1
G+S+0.60W_Y			Linear Static	SNOW	1
G+S+0.60W_Y			Linear Static	WIND_Y	0.6
G+S+0.60W_Y			Linear Static	WIND_ROOF	0.6
G+W_X+0.50S	Linear Add	No	Linear Static	DEAD	1
G+W_X+0.50S			Linear Static	WIND_X	1
G+W_X+0.50S			Linear Static	WIND_ROOF	1
G+W_X+0.50S			Linear Static	SNOW	0.5
G+W_Y+0.50S	Linear Add	No	Linear Static	DEAD	1
G+W_Y+0.50S			Linear Static	WIND_Y	1
G+W_Y+0.50S			Linear Static	WIND_ROOF	1
G+W_Y+0.50S			Linear Static	SNOW	0.5

STRUCTURAL ELEMENT STRESS CHECKS

All the elements are analysed against PMM analysis (axial force-major and minor axes moments). Horizontal elements (gutters, rails and panels) behave mostly as flexural members because of no significant axial forces. on them. Vertical elements (pillars) are under combined bending with axial force on them.

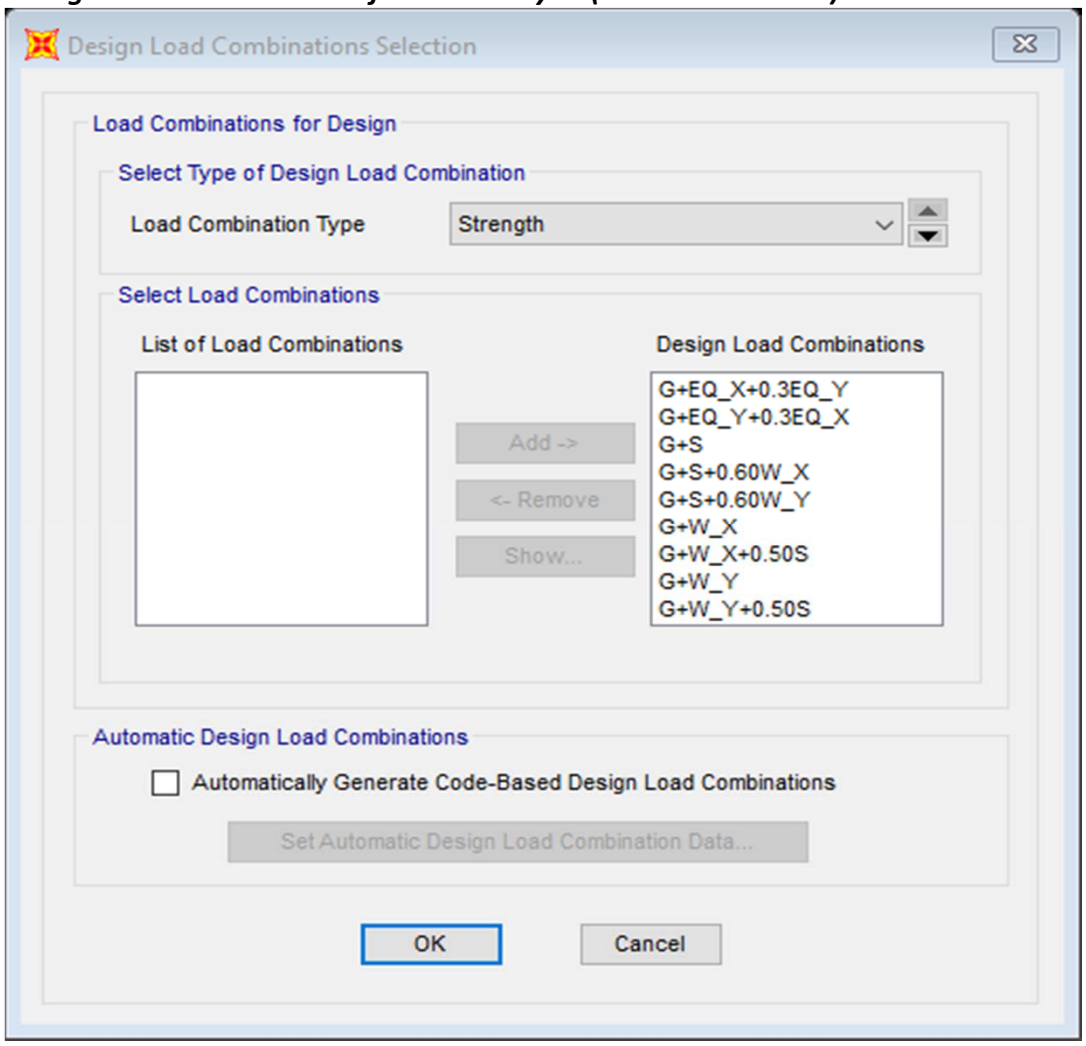
Below Demand/Capacity ratios for each element are given as SAP2000 analysis output. Element ratios with **value of lesser than 1 are on safe side and under-stressed**. Analysis are provided under ASD2000 (allowable stress design) provisions.

Design Preferences for ASD analysis (SAP2000 window)

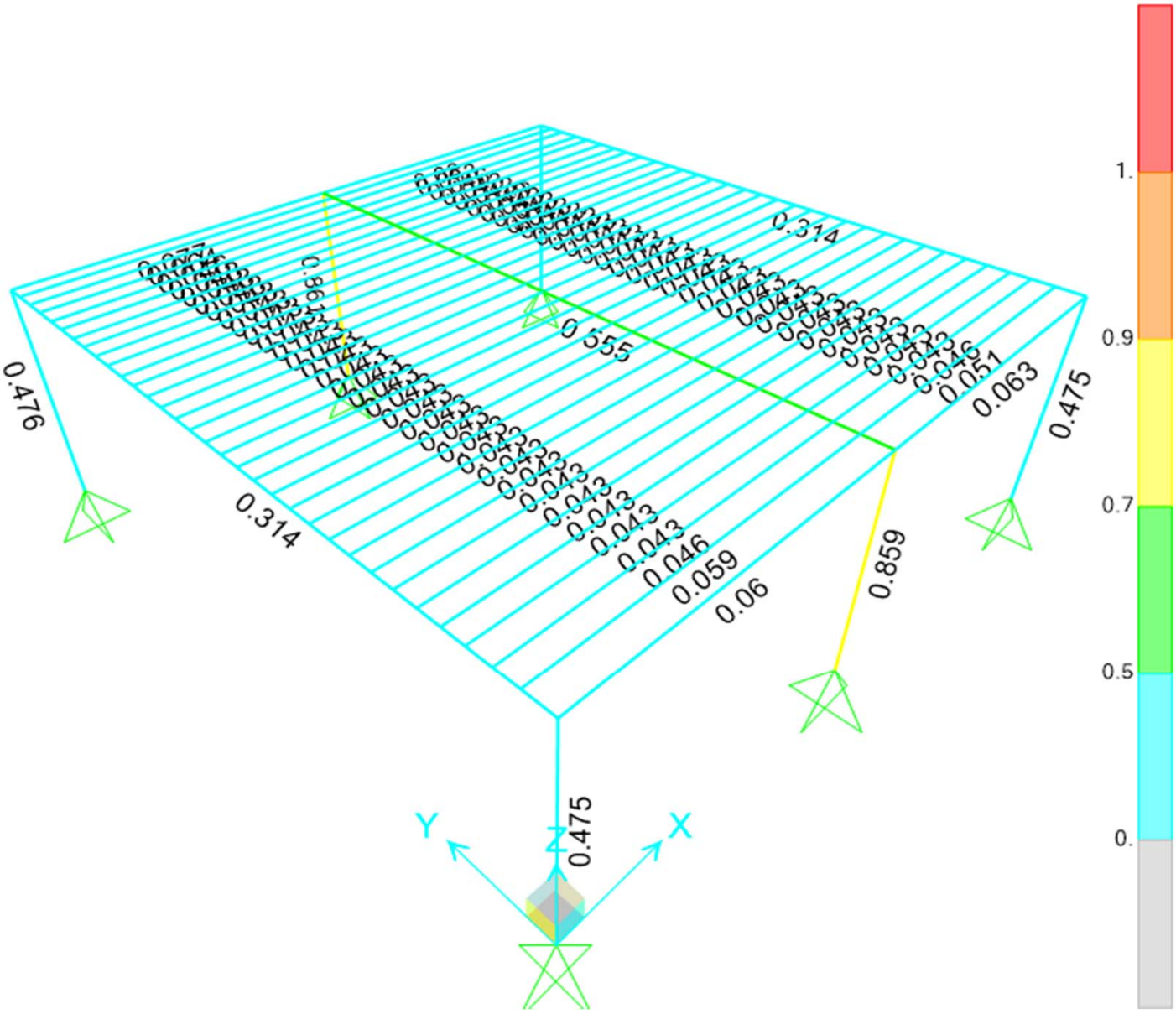


	Item	Value
1	Design Code	AA-ASD 2000
2	Multi-Response Case Design	Envelopes
3	Framing Type	Moment Frame
4	Demand/Capacity Ratio Limit	1.
5	Lateral Factor	1.3333
6	Use Lateral Factor?	Yes
7	Bridge Type Structure?	No

Design Load Combinations for ASD analysis (SAP2000 window)

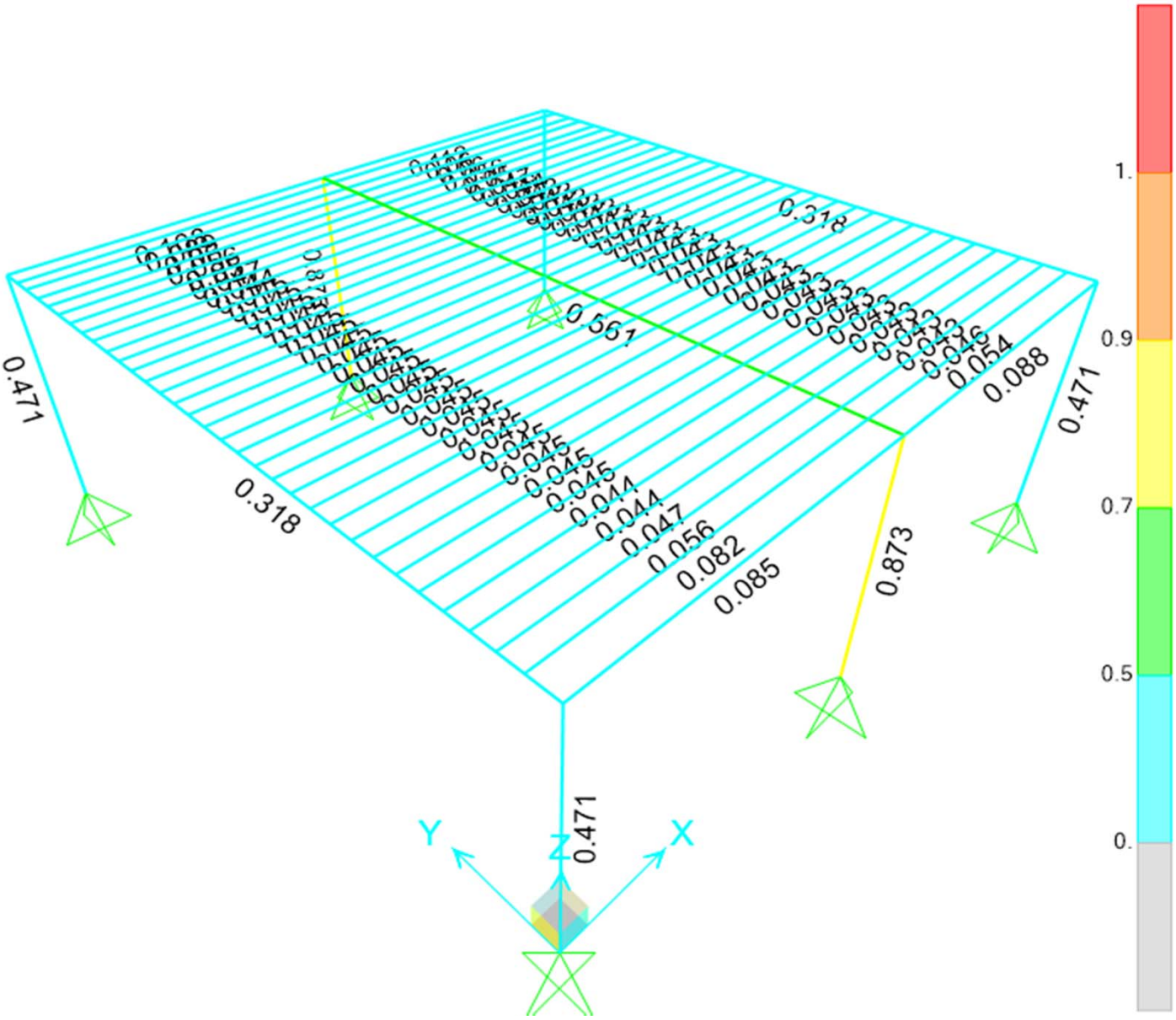


TYPE - 1 DEMAND/CAPACITY CHECKS



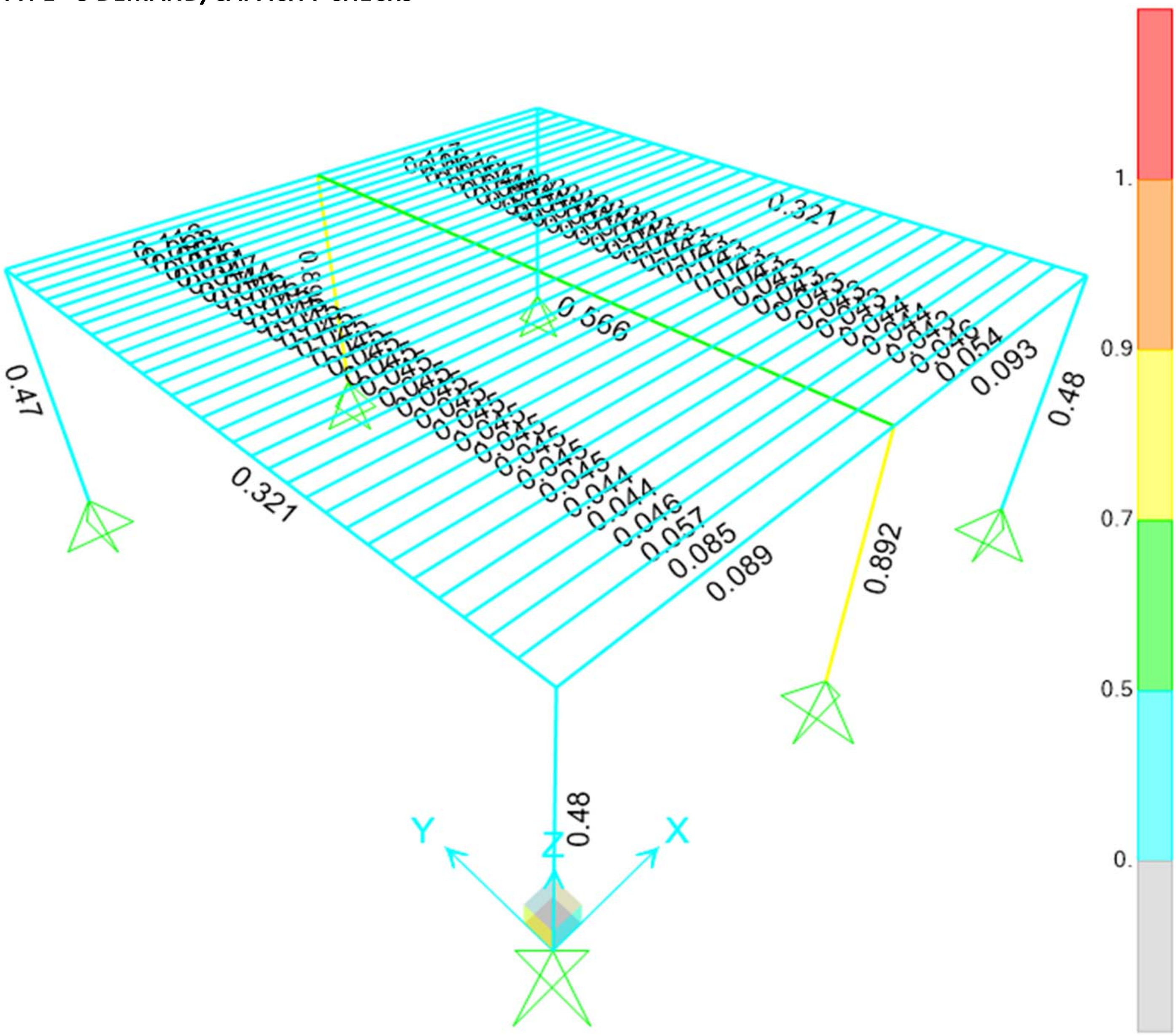
PMM capacity ratios are less than 1, all aluminium frames passed the stress/capacity check.

TYPE - 2 DEMAND/CAPACITY CHECKS



PMM capacity ratios are less than 1, all aluminium frames passed the stress/capacity check.

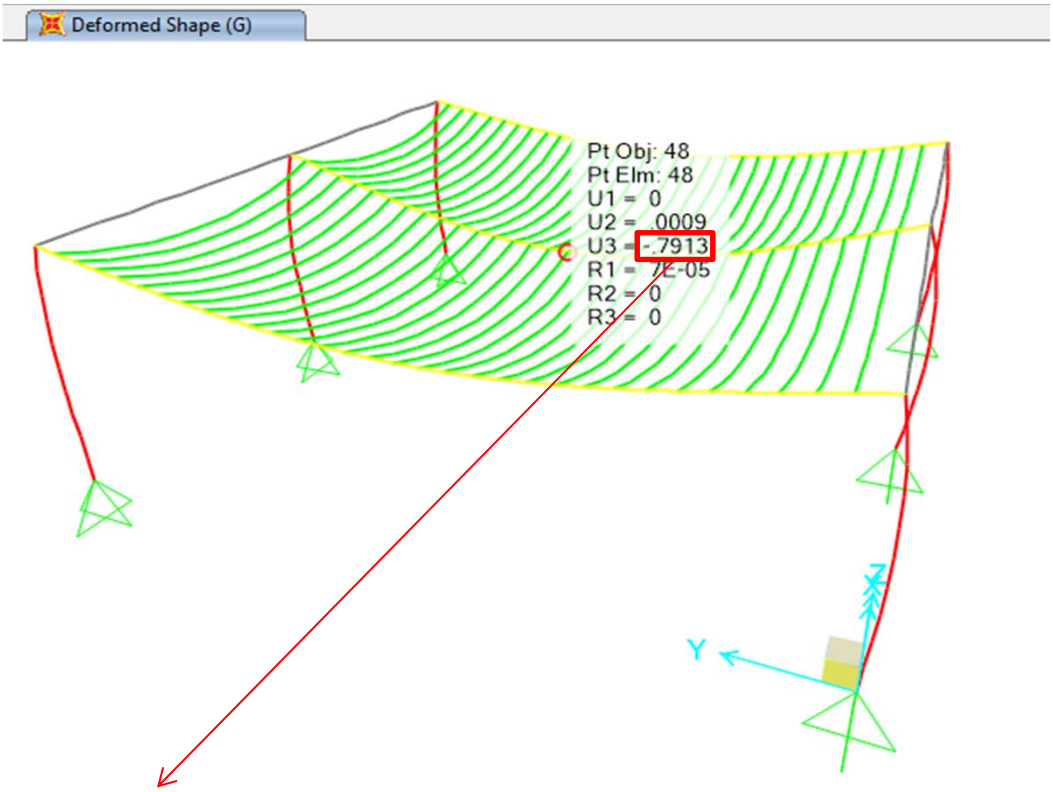
TYPE - 3 DEMAND/CAPACITY CHECKS



PMM capacity ratios are less than 1, all aluminium frames passed the stress/capacity check.

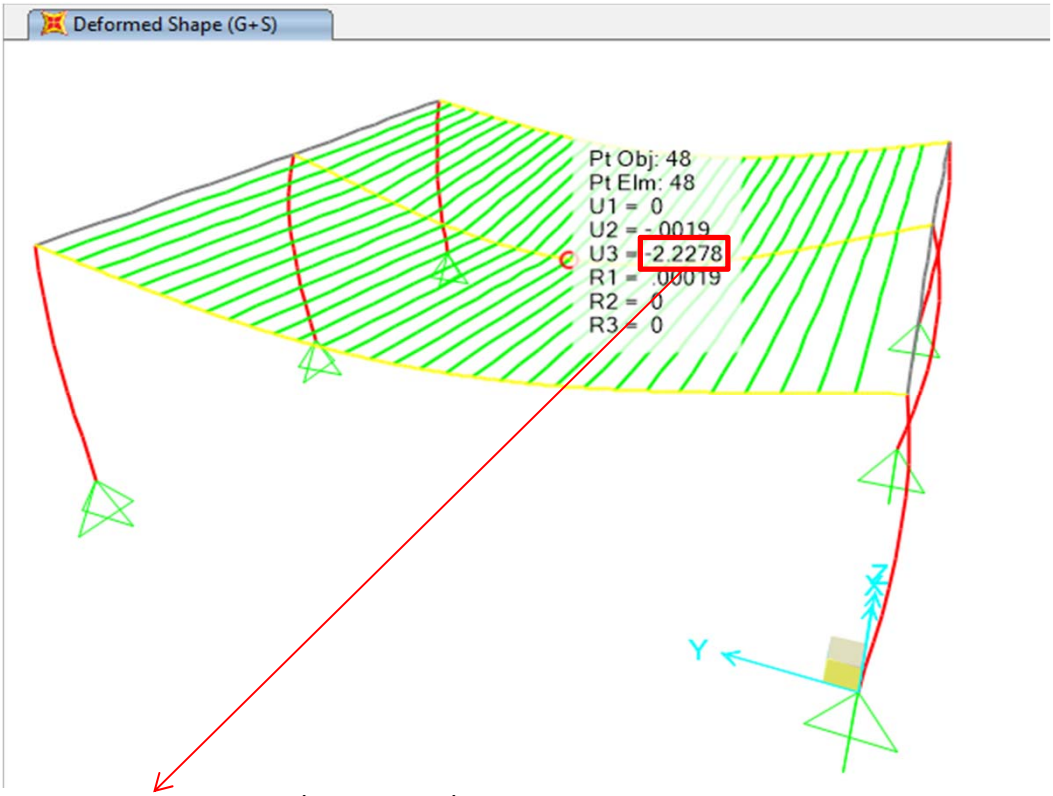
DEFORMATION CHECKS

TYPE - 1 RAIL DEFORMATION CHECKS UNDER SELF-WEIGHT OF ROOF ELEMENTS



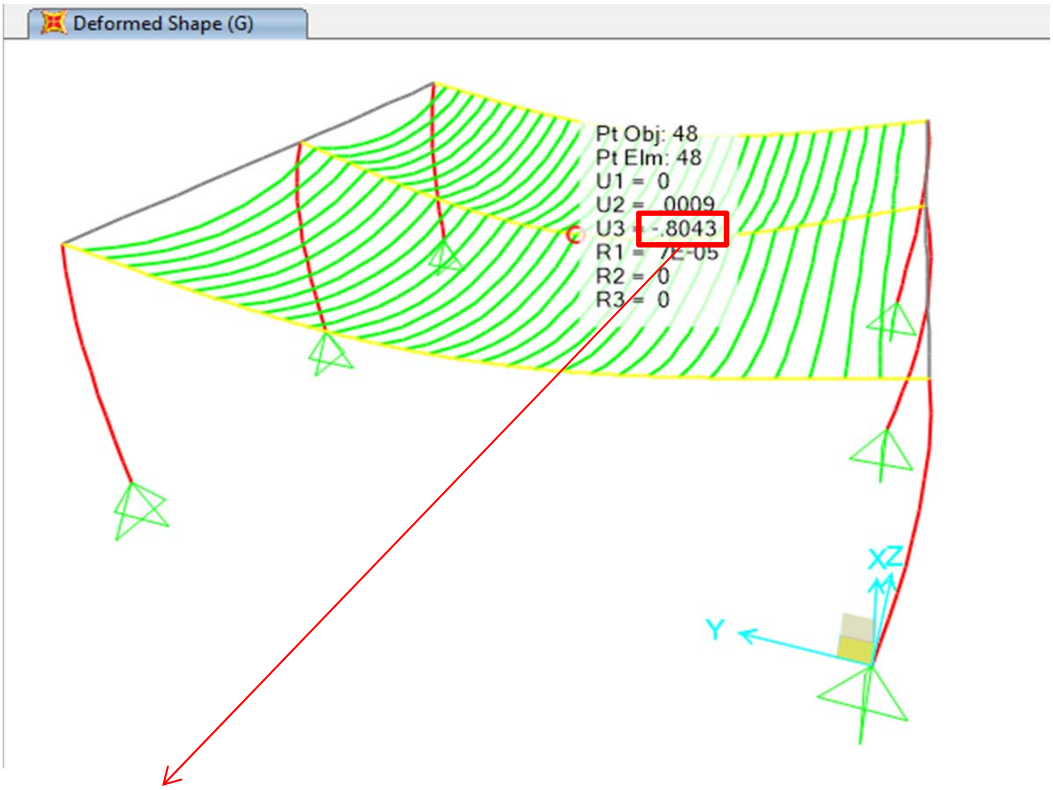
δ_{span} = 0.791cm < L_{span}/300=676.1/300=2.25cm (rail clear span in Y-direction was used) ***OK***

TYPE - 1 RAIL DEFORMATION CHECKS UNDER SELF-WEIGHT OF ROOF ELEMENTS + SNOW LOAD



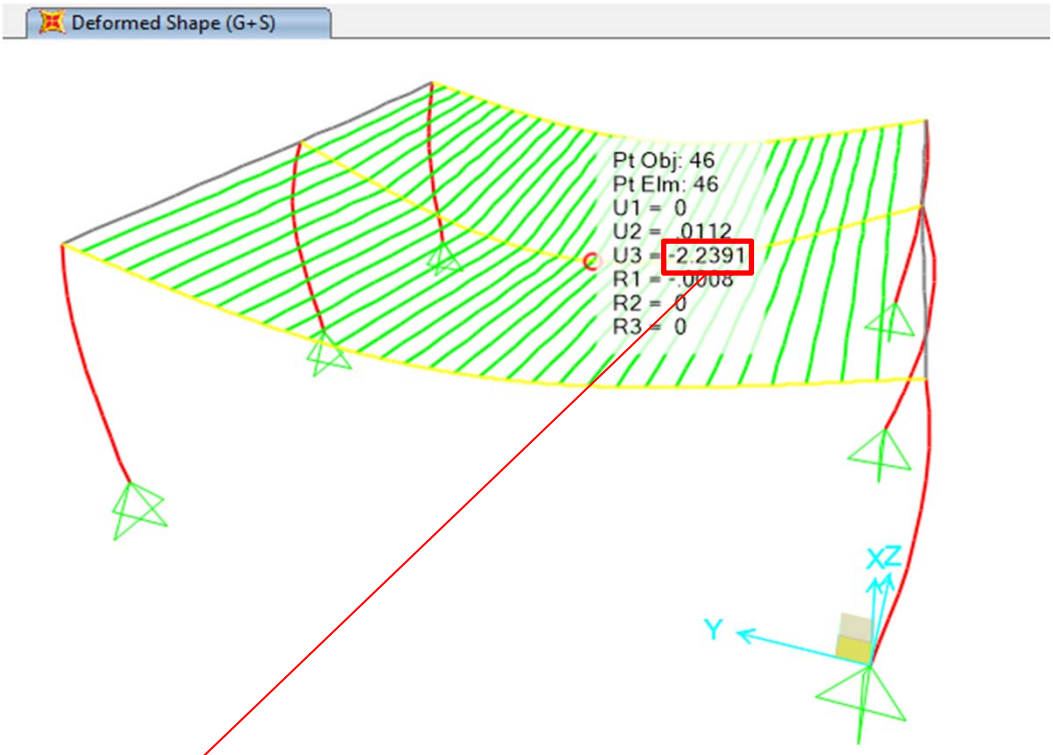
δ_{span} = 2.228cm < L_{span}/300=676.1/300=2.25cm (rail clear span in Y-direction was used) ***OK***

TYPE - 2 RAIL DEFORMATION CHECKS UNDER SELF-WEIGHT OF ROOF ELEMENTS



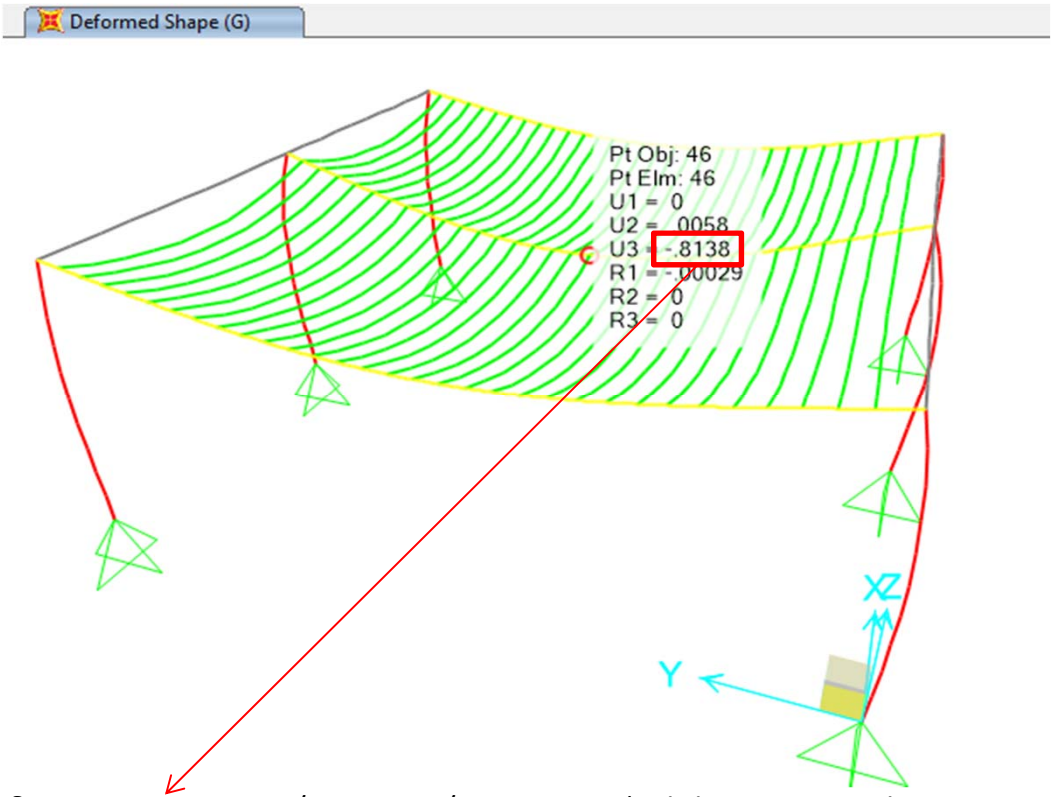
δ_{span} = 0.804cm < L_{span}/300=676.1/300=2.25cm (rail clear span in Y-direction was used) ***OK***

TYPE - 2 RAIL DEFORMATION CHECKS UNDER SELF-WEIGHT OF ROOF ELEMENTS + SNOW LOAD



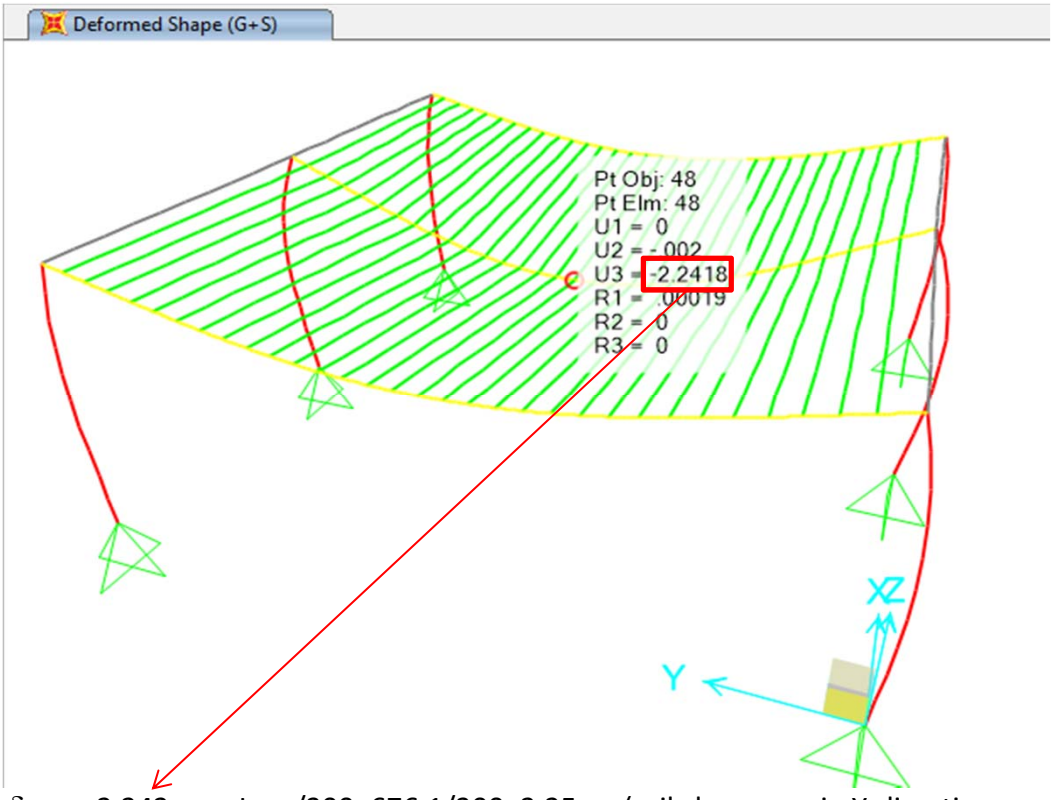
δ_{span} = 2.239cm < L_{span}/300=676.1/300=2.25cm (rail clear span in Y-direction was used) ***OK***

TYPE - 3 RAIL DEFORMATION CHECKS UNDER SELF-WEIGHT OF ROOF ELEMENTS



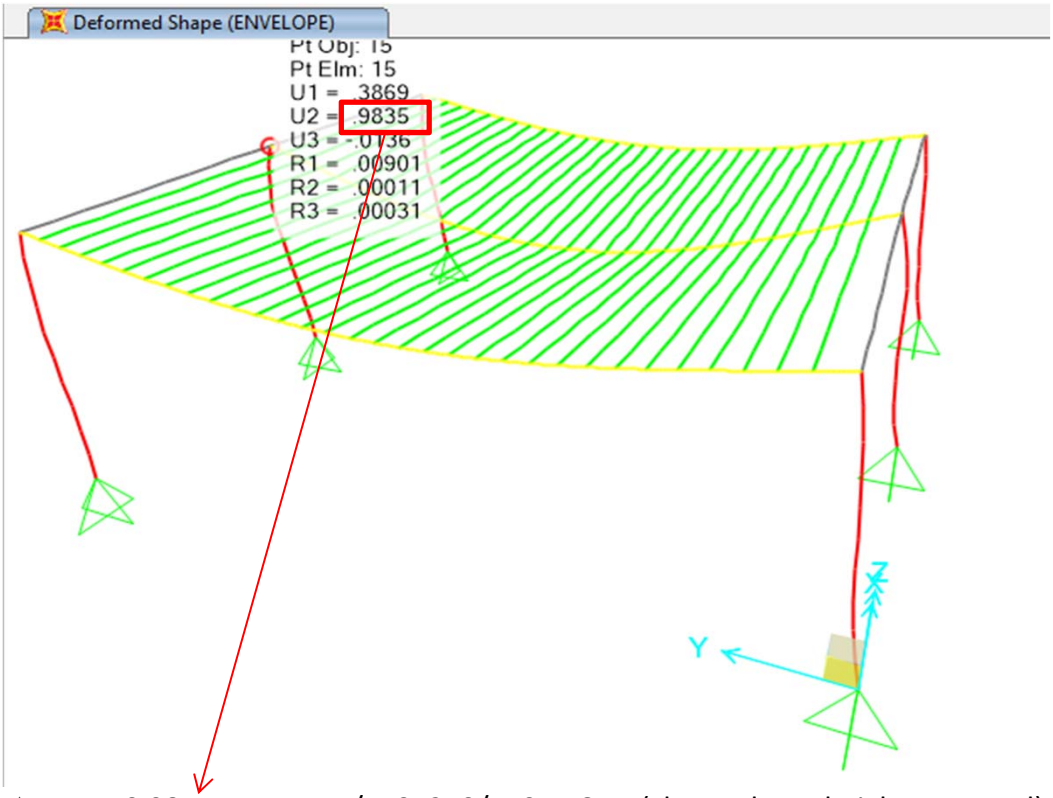
δ_{span} = 0.814cm < L_{span}/300=676.1/300=2.25cm (rail clear span in Y-direction was used) ***OK***

TYPE - 3 RAIL DEFORMATION CHECKS UNDER SELF-WEIGHT OF ROOF ELEMENTS + SNOW LOAD



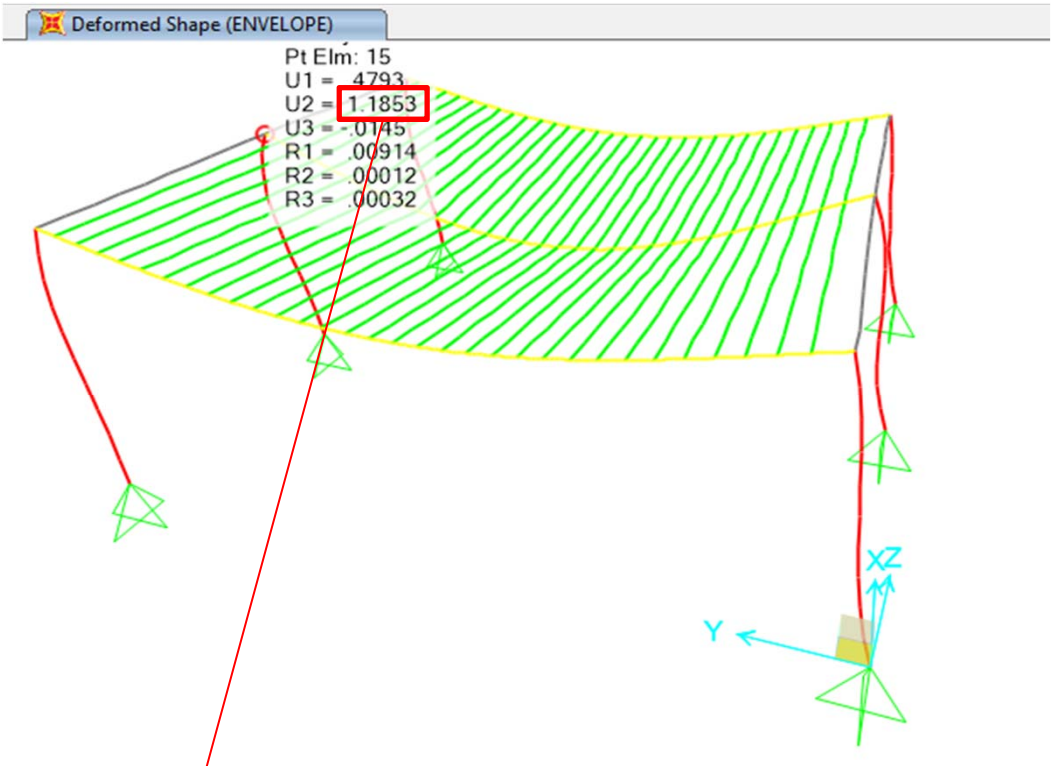
δ_{span} = 2.242cm < L_{span}/300=676.1/300=2.25cm (rail clear span in Y-direction was used) ***OK***

TYPE - 1 PILLAR DEFORMATION CHECK UNDER ENVELOPE OF ALL LOAD COMBINATIONS



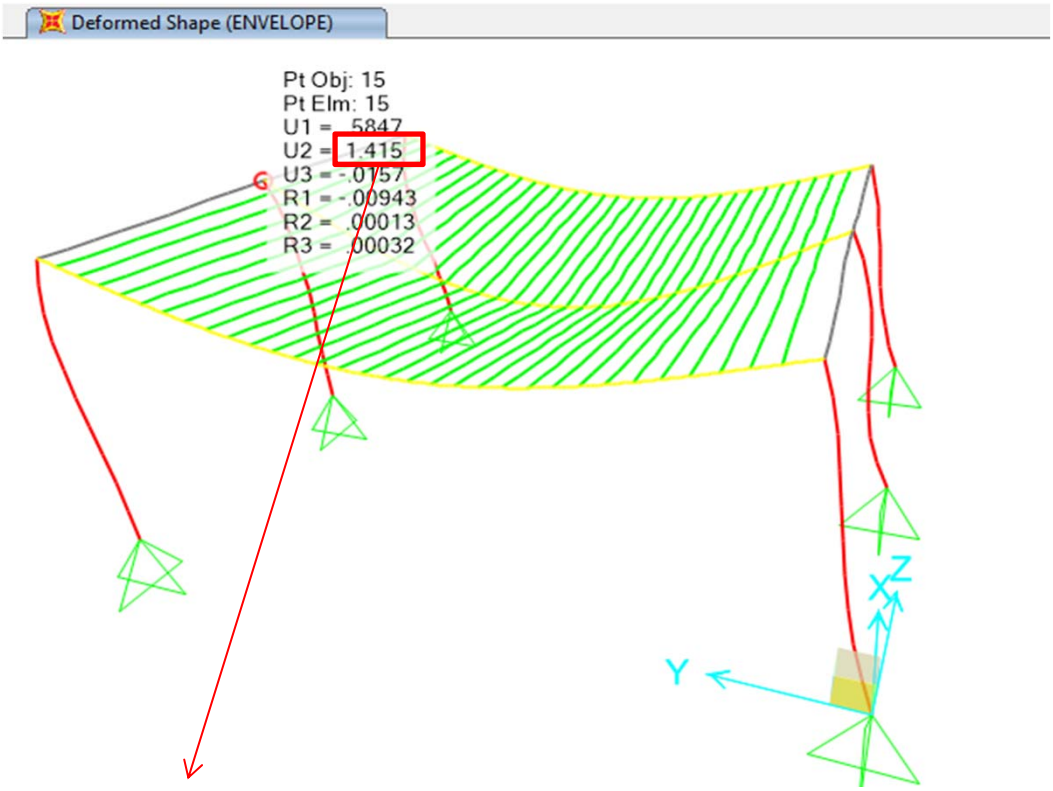
Δ_{column} = 0.984cm < H_{column}/150=240/150=1.6cm (clear column height was used) ***OK***

TYPE - 2 PILLAR DEFORMATION CHECK UNDER ENVELOPE OF ALL LOAD COMBINATIONS



Δ_{column} = 1.185cm < H_{column}/150=260/150=1.73cm (clear column height was used) ***OK***

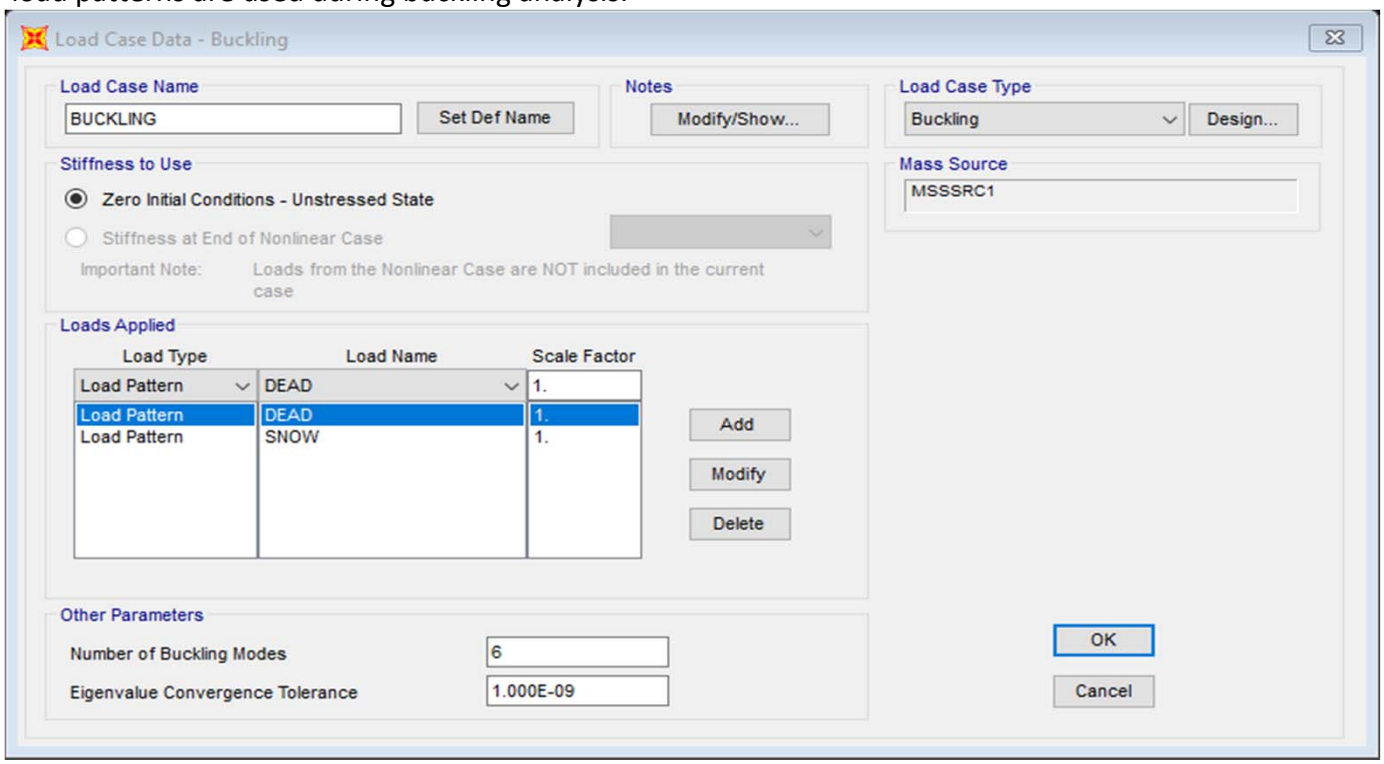
TYPE - 3 PILLAR DEFORMATION CHECK UNDER ENVELOPE OF ALL LOAD COMBINATIONS



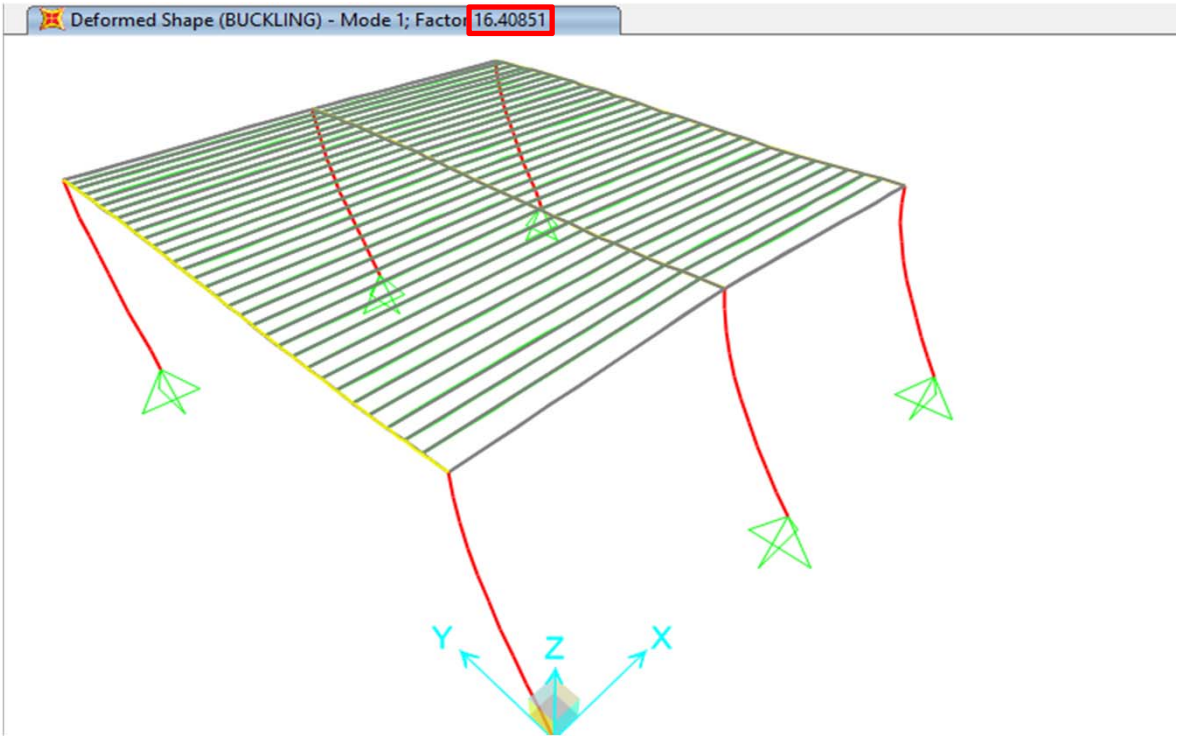
Δ_{column} = 1.415cm < H_{column}/150=280/150=1.86cm (clear column height was used) ***OK***

PILLAR BUCKLING ANALYSIS

It is observed that **G+S (self-weight + snow load)** combination gives more adverse axial force results on pillars. As buckling of vertical elements is directly related with axial force on the them, mentioned above load patterns are used during buckling analysis.



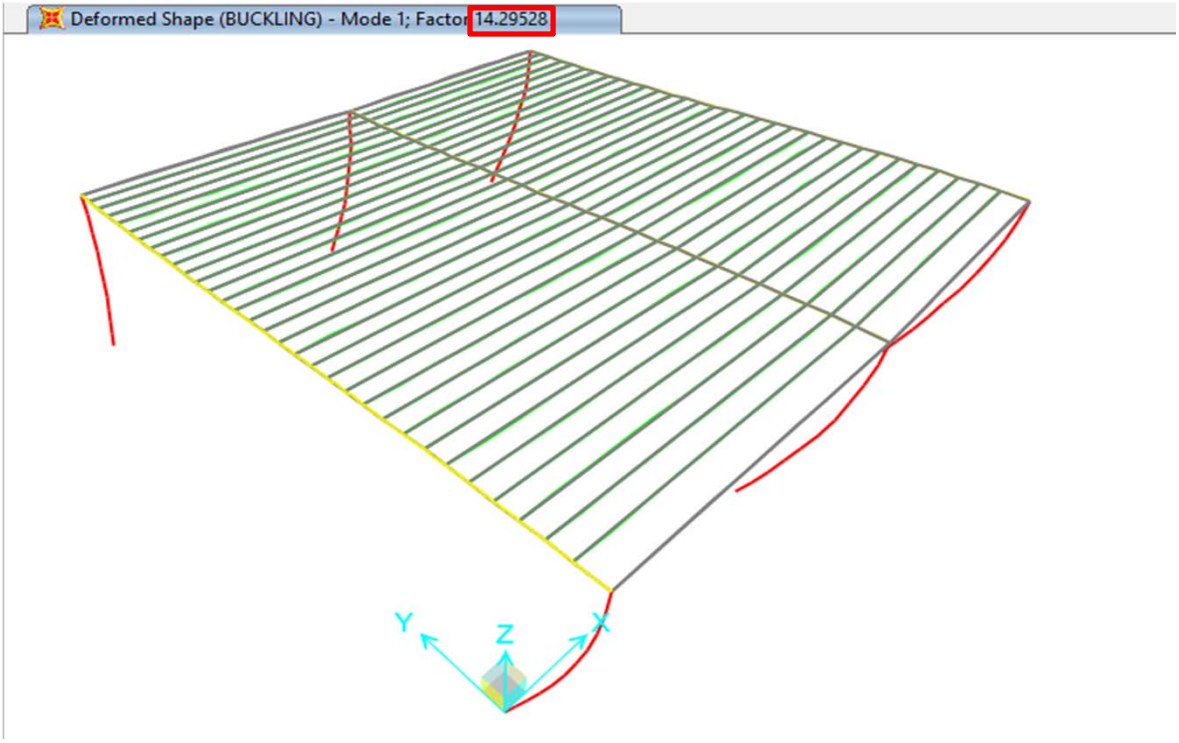
TYPE - 1 PILLAR BUCKLING ANALYSIS



Buckling factor=16.41 > 1 ***OK, Pillars are safe against buckling.***

This factor shows the ratio of theoretical critical first mode buckling force to an existing force on the pillars. (i.e how much existing force are lesser than the force when the system becomes unstable)

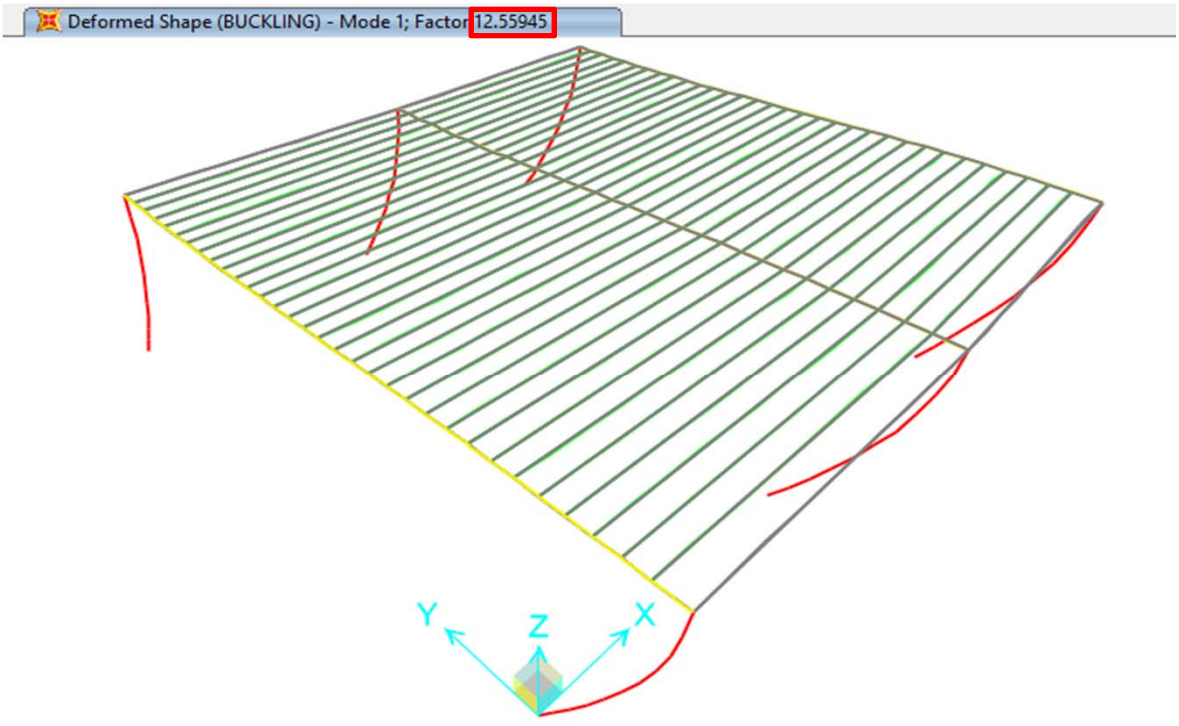
TYPE - 2 PILLAR BUCKLING ANALYSIS



Buckling factor=14.29 > 1 ***OK, Pillars are safe against buckling.***

This factor shows the ratio of theoretical critical first mode buckling force to an existing force on the pillars. (i.e how much existing force are lesser than the force when the system becomes unstable)

TYPE - 3 PILLAR BUCKLING ANALYSIS



Buckling factor=12.56 > 1 ***OK, Pillars are safe against buckling.***

This factor shows the ratio of theoretical critical first mode buckling force to an existing force on the pillars. (i.e how much existing force are lesser than the force when the system becomes unstable)

* To stay on the safe side tabulated snow load values are reduced by 20% from initially found ones during structural analysis calculations.

	SNOW (kN/m2)										
	2 RAILS				3 RAILS						
	150-250	251-300	301-350	351-375	376-400	401-450	451-500	501-550	551-600	601-650	651-700
	150	275	325	375	400	425	475	550	575	625	700
120,3	40,00	20,98	16,57	15,20	20,00	15,17	13,52	11,04	10,21	8,56	7,60
141,9	28,16	14,70	11,57	10,56	13,76	10,44	9,32	7,63	7,07	5,95	5,33
163,4	24,33	12,63	9,90	8,96	11,53	8,76	7,83	6,44	5,98	5,05	4,58
185	20,48	10,56	8,22	7,36	9,28	7,06	6,33	5,24	4,88	4,15	3,82
206,6	20,80	10,60	8,18	7,20	8,80	6,71	6,05	5,06	4,73	4,06	3,84
228,1	15,11	7,70	5,95	5,25	6,40	4,88	4,40	3,68	3,44	2,96	2,79
249,7	13,57	6,93	5,36	4,74	5,76	4,39	3,96	3,31	3,09	2,66	2,51
271,3	12,03	6,15	4,77	4,22	5,12	3,90	3,52	2,94	2,75	2,36	2,23
292,8	10,50	5,38	4,18	3,71	4,48	3,42	3,08	2,57	2,40	2,06	1,95
314,4	11,20	5,76	4,48	4,00	4,80	3,66	3,30	2,75	2,57	2,21	2,08
336	8,16	4,20	3,27	2,93	3,36	2,56	2,32	1,95	1,83	1,58	1,51
357,5	7,36	3,80	2,96	2,66	2,88	2,20	2,00	1,70	1,60	1,39	1,36
379,1	6,56	3,39	2,65	2,38	2,40	1,84	1,68	1,44	1,36	1,21	1,21
400,7	7,20	3,73	2,92	2,64	2,40	1,85	1,70	1,49	1,42	1,27	1,32
422,3	5,31	2,75	2,15	1,93	1,78	1,37	1,26	1,10	1,05	0,94	0,97
443,8	4,86	2,51	1,96	1,75	1,64	1,26	1,16	1,01	0,96	0,86	0,89
465,4	4,42	2,27	1,76	1,57	1,50	1,15	1,06	0,92	0,88	0,78	0,81
487	3,97	2,03	1,57	1,39	1,36	1,04	0,96	0,83	0,79	0,71	0,72
508,5	4,40	2,24	1,73	1,52	1,52	1,17	1,07	0,93	0,88	0,78	0,80
530,1	3,23	1,64	1,26	1,11	1,11	0,85	0,78	0,68	0,64	0,57	0,58
551,7	2,94	1,49	1,14	1,00	1,01	0,78	0,71	0,61	0,58	0,51	0,51
573,3	2,66	1,34	1,03	0,89	0,91	0,70	0,63	0,54	0,51	0,45	0,45
594,8	2,37	1,19	0,91	0,78	0,81	0,62	0,56	0,48	0,45	0,39	0,38
616,4	2,60	1,30	0,98	0,84	0,88	0,67	0,61	0,51	0,48	0,42	0,40
638	1,90	0,95	0,72	0,62	0,64	0,49	0,44	0,38	0,36	0,31	0,30
659,6	1,71	0,86	0,65	0,56	0,58	0,44	0,40	0,35	0,33	0,29	0,29
681,1	1,53	0,77	0,59	0,50	0,51	0,39	0,36	0,31	0,30	0,27	0,27
702,7	1,68	0,85	0,65	0,56	0,56	0,43	0,40	0,35	0,34	0,30	0,32

	SNOW (kg/m2)										
	2 RAILS				3 RAILS						
	150-250	251-300	301-350	351-375	376-400	401-450	451-500	501-550	551-600	601-650	651-700
	150	275	325	375	400	425	475	550	575	625	700
120,3	3200,00	1678,22	1325,51	1216,00	1600,00	1213,87	1081,60	883,20	817,07	684,80	608,00
141,9	2252,44	1176,27	926,00	844,65	1100,59	835,51	745,59	610,71	565,74	475,82	426,17
163,4	1946,31	1010,73	792,20	717,10	922,02	700,56	626,45	515,29	478,24	404,13	366,22
185	1638,76	844,42	657,79	588,95	742,61	564,98	506,76	419,44	390,33	332,12	305,99
206,6	1664,00	847,64	654,22	576,00	704,00	536,75	483,84	404,48	378,03	325,12	307,20
228,1	1208,66	616,39	476,18	419,95	512,14	390,46	351,94	294,17	274,92	236,41	223,29
249,7	1085,55	554,38	428,76	378,92	460,85	351,34	316,65	264,63	247,29	212,60	200,72
271,3	962,45	492,37	381,34	337,88	409,55	312,22	281,36	235,08	219,66	188,80	178,16
292,8	839,91	430,65	334,14	297,04	358,49	273,28	246,23	205,67	192,15	165,11	155,69
314,4	896,00	460,80	358,40	320,00	384,00	292,69	263,68	220,16	205,65	176,64	166,40
336	652,73	336,18	261,77	234,21	268,76	205,15	185,44	155,88	146,03	126,32	120,95
357,5	588,95	303,86	236,94	212,53	230,49	176,28	160,06	135,73	127,62	111,39	108,83
379,1	524,87	271,40	212,00	190,75	192,04	147,28	134,56	115,48	109,12	96,40	96,65
400,7	576,00	298,67	233,81	211,20	192,00	147,84	136,32	119,04	113,28	101,76	105,60
422,3	424,89	219,78	171,73	154,60	142,32	109,55	100,95	88,05	83,75	75,15	77,81
443,8	389,15	200,72	156,48	140,30	131,08	100,87	92,88	80,90	76,91	68,92	71,17
465,4	353,25	181,57	141,16	125,94	119,80	92,15	84,78	73,72	70,04	62,66	64,51
487	317,34	162,42	125,84	111,58	108,51	83,43	76,68	66,54	63,16	56,41	57,84
508,5	352,00	179,20	138,24	121,60	121,60	93,44	85,76	74,24	70,40	62,72	64,00
530,1	258,54	131,29	101,07	88,57	89,08	68,40	62,66	54,06	51,20	45,46	46,08
551,7	235,48	119,22	91,55	79,86	80,88	62,04	56,72	48,73	46,07	40,75	40,95
573,3	212,42	107,15	82,03	71,14	72,68	55,69	50,77	43,40	40,95	36,03	35,83
594,8	189,46	95,13	72,55	62,47	64,52	49,36	44,86	38,10	35,84	31,34	30,72
616,4	208,00	103,82	78,79	67,20	70,40	53,76	48,64	40,96	38,40	33,28	32,00
638	151,66	75,82	57,62	49,27	51,19	39,16	35,58	30,21	28,41	24,83	24,32
659,6	136,93	68,59	52,21	44,79	46,07	35,32	32,25	27,64	26,11	23,04	23,04
681,1	122,26	61,39	46,83	40,33	40,97	31,49	28,93	25,09	23,81	21,25	21,76
702,7	134,40	67,70	51,77	44,80	44,80	34,56	32,00	28,16	26,88	24,32	25,60

Structural analysis under wind action and estimation of wind speed have been performed considering ideal restrainment beetween panel and rail elements. For reasonable values of wind speed the calculated values are reduced by 50%.

	WIND (Beaufort)										
	2 RAILS				3 RAILS						
	150-250	251-300	301-350	351-375	376-400	401-450	451-500	501-550	551-600	601-650	651-700
	150	275	325	375	400	425	475	550	575	625	700
120,3	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
141,9	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
163,4	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
185	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
206,6	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
228,1	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
249,7	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
271,3	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
292,8	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
314,4	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
336	12,00	10,00	10,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
357,5	12,00	10,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
379,1	11,00	10,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
400,7	11,00	10,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
422,3	11,00	10,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
443,8	11,00	10,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
465,4	10,00	10,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
487	10,00	10,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
508,5	10,00	9,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
530,1	10,00	9,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
551,7	10,00	9,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
573,3	10,00	9,00	9,00	9,00	10,00	10,00	9,00	9,00	9,00	8,00	8,00
594,8	10,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	8,00	8,00
616,4	10,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	8,00	8,00
638	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	8,00	8,00	8,00
659,6	9,00	9,00	9,00	9,00	9,00	9,00	9,00	8,00	8,00	8,00	8,00
681,1	9,00	9,00	9,00	9,00	9,00	9,00	8,00	8,00	8,00	8,00	7,00
702,7	9,00	9,00	9,00	9,00	9,00	8,00	8,00	8,00	8,00	7,00	7,00

The Beaufort Scale

Wind force number (Beaufort number)	Description	Approximate speed at 20 ft (6.1 m) above the ground: mph	km/h	knots	m/s	Observation/Specification
0	Calm	< 1	< 1	< 1	< 0.5	Smoke rises vertically
1	Light Air	1-3	1-5	1-3	0.5-1.7	Smoke drifts slowly; wind vanes and flags stay still
2	Slight Breeze	4-7	6-11	4-6	1.8-3.5	Wind felt on face; leaves rustle; flags stir; wind vanes move
3	Gentle Breeze	8-12	12-19	7-10	3.6-5.7	Leaves and small twigs in constant motion; flags are unfurled and flap
4	Moderate Breeze	13-18	20-29	11-16	5.8-8.4	Dust and loose paper blow around; small branches move; flags flap
5	Fresh Breeze	19-24	30-39	17-21	8.5-11.1	Small trees with leaves begin to sway; flags ripple
6	Strong Breeze	25-31	40-50	22-27	11.2-14.2	Large branches sway; flags beat; air whistles around telephone and power wires
7	Moderate Gale	32-38	51-61	28-33	14.3-17.3	Whole trees sway; flags extended; it can be hard to walk into the wind
8	Fresh Gale	39-46	62-74	34-40	17.4-20.9	Twigs break off trees; walking is hindered
9	Strong Gale	47-54	75-85	41-47	21.0-24.5	Branches break off trees; slight damage to buildings (shingles blow off roofs)
10	Whole Gale	55-63	89-101	48-55	24.6-28.5	Trees broken or uprooted; buildings definitely damaged
11	Storm	64-73	102-118	56-63	28.6-33.0	Widespread damage to buildings; trees blow across the ground
12	Hurricane	74+	119+	64+	33.1+	Extreme destruction; trees and power lines knocked down

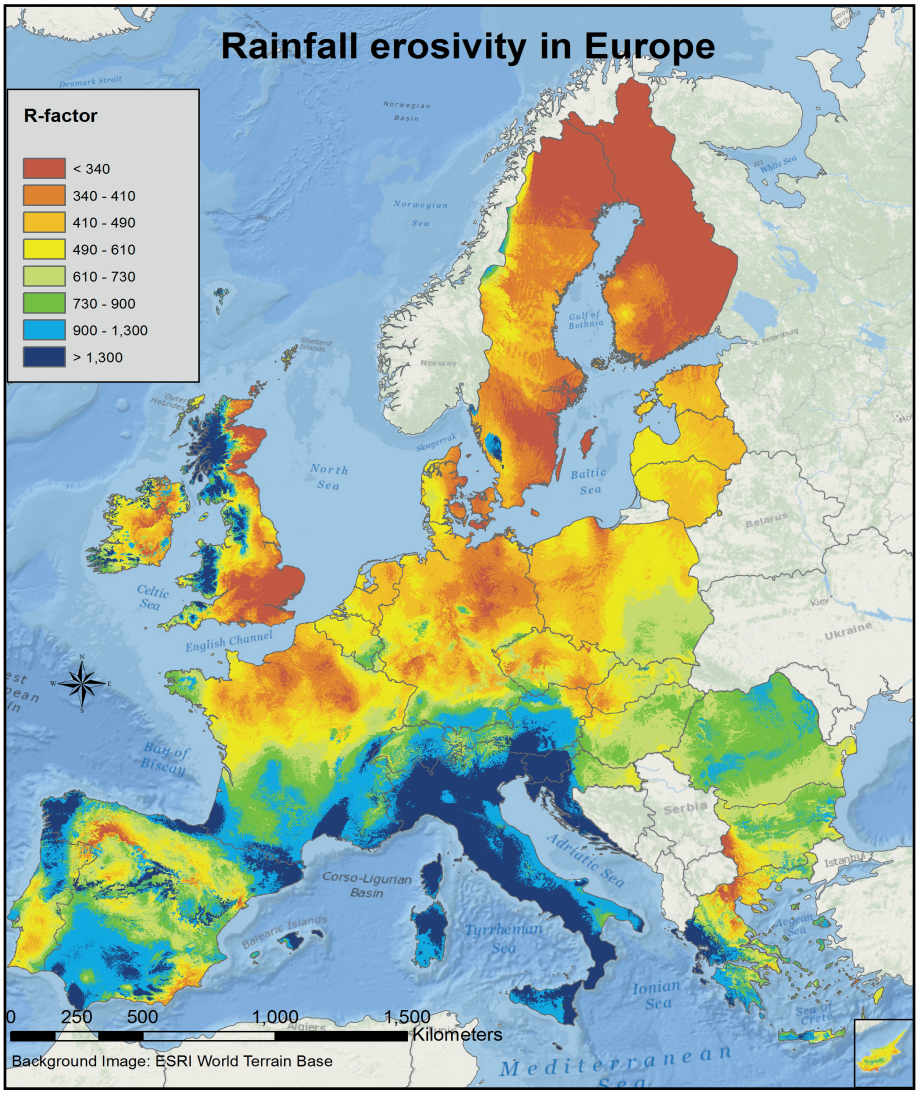
Adapted from Meteorology Education and Training website, http://www.meted.ucar.edu/

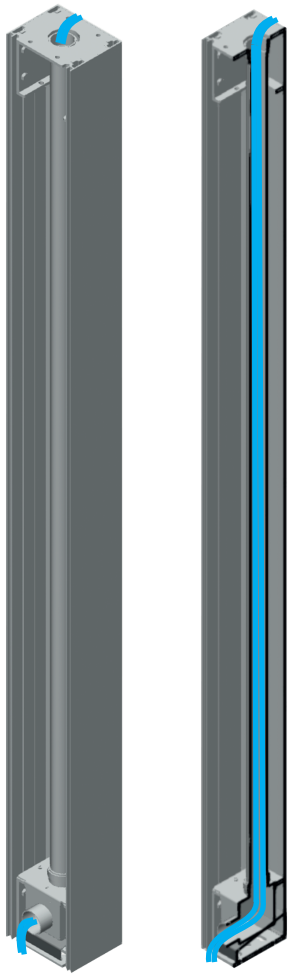
	WIND (kN/m2)										
	2 RAILS				3 RAILS						
	150-250	251-300	301-350	351-375	376-400	401-450	451-500	501-550	551-600	601-650	651-700
	150	275	325	375	400	425	475	550	575	625	700
120,3	1,60	1,04	0,82	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
141,9	1,60	1,04	0,82	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
163,4	1,60	1,04	0,82	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
185	1,60	1,04	0,82	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
206,6	1,60	1,04	0,82	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
228,1	1,59	1,04	0,82	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
249,7	1,57	1,03	0,81	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
271,3	1,55	1,02	0,81	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
292,8	1,54	1,02	0,81	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
314,4	1,52	1,01	0,80	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
336	1,44	0,97	0,78	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
357,5	1,36	0,94	0,77	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
379,1	1,28	0,90	0,75	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
400,7	1,20	0,86	0,73	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
422,3	1,14	0,84	0,72	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
443,8	1,09	0,82	0,71	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
465,4	1,04	0,79	0,70	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
487	0,99	0,77	0,68	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
508,5	0,94	0,75	0,67	0,60	0,84	0,81	0,74	0,65	0,62	0,56	0,47
530,1	0,91	0,74	0,67	0,60	0,82	0,79	0,73	0,64	0,61	0,56	0,47
551,7	0,88	0,72	0,66	0,60	0,80	0,78	0,72	0,64	0,61	0,55	0,47
573,3	0,84	0,71	0,65	0,60	0,79	0,76	0,71	0,63	0,60	0,55	0,47
594,8	0,81	0,69	0,64	0,60	0,77	0,75	0,69	0,62	0,59	0,54	0,46
616,4	0,78	0,68	0,64	0,60	0,76	0,73	0,68	0,61	0,58	0,54	0,46
638	0,75	0,66	0,63	0,59	0,70	0,68	0,63	0,57	0,54	0,50	0,43
659,6	0,73	0,65	0,62	0,58	0,65	0,63	0,59	0,53	0,50	0,46	0,40
681,1	0,71	0,63	0,61	0,58	0,59	0,58	0,54	0,48	0,47	0,43	0,37
702,7	0,68	0,62	0,59	0,57	0,54	0,52	0,49	0,44	0,43	0,39	0,34

	WIND (m/s)										
	2 RAILS				3 RAILS						
	150-250	251-300	301-350	351-375	376-400	401-450	451-500	501-550	551-600	601-650	651-700
	150	275	325	375	400	425	475	550	575	625	700
120,3	35,78	28,03	24,93	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
141,9	35,78	28,03	24,93	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
163,4	35,78	28,03	24,93	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
185	35,78	28,03	24,93	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
206,6	35,78	28,03	24,93	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
228,1	35,60	27,95	24,89	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
249,7	35,42	27,87	24,85	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
271,3	35,24	27,79	24,81	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
292,8	35,06	27,71	24,77	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
314,4	34,89	27,64	24,74	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
336	33,89	27,19	24,51	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
357,5	32,89	26,75	24,29	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
379,1	31,90	26,31	24,07	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
400,7	30,90	25,86	23,85	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
422,3	30,20	25,55	23,69	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
443,8	29,51	25,25	23,54	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
465,4	28,81	24,94	23,39	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
487	28,12	24,63	23,23	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
508,5	27,43	24,32	23,08	21,84	25,86	25,31	24,23	22,60	22,06	20,98	19,35
530,1	26,92	24,10	22,97	21,84	25,60	25,07	24,03	22,46	21,94	20,90	19,33
551,7	26,42	23,87	22,85	21,84	25,34	24,83	23,83	22,32	21,82	20,82	19,31
573,3	25,92	23,65	22,74	21,84	25,08	24,60	23,63	22,18	21,70	20,74	19,29
594,8	25,42	23,43	22,63	21,84	24,82	24,36	23,43	22,04	21,58	20,66	19,27
616,4	24,92	23,20	22,52	21,84	24,56	24,12	23,23	21,91	21,46	20,58	19,25
638	24,52	22,96	22,34	21,71	23,61	23,19	22,36	21,10	20,68	19,84	18,59
659,6	24,12	22,72	22,15	21,59	22,66	22,27	21,48	20,29	19,90	19,11	17,92
681,1	23,73	22,47	21,97	21,47	21,72	21,35	20,60	19,49	19,12	18,38	17,26
702,7	23,34	22,23	21,79	21,35	20,77	20,42	19,73	18,69	18,34	17,64	16,60

RAINFALL EROSIVITY CAPACITY (lt/s*ha)

	2 RAILS (4 PILLAR)				3 RAILS (6 PILLAR)						
	150-250	251-300	301-350	351-375	376-400	401-450	451-500	501-550	551-600	601-650	651-700
	150	275	325	375	400	425	475	550	575	625	700
120,3	21779	11879	10052	8712	12240	11520	10308	8902	8515	7834	6994
141,9	18464	10071	8522	7385	10377	9767	8739	7547	7219	6641	5930
163,4	16034	8746	7400	6414	9012	8482	7589	6554	6269	5767	5150
185	14162	7725	6536	5665	7959	7491	6703	5789	5537	5094	4548
206,6	12682	6917	5853	5073	7127	6708	6002	5183	4958	4561	4073
228,1	11486	6265	5301	4594	6456	6076	5436	4695	4491	4132	3689
249,7	10493	5723	4843	4197	5897	5550	4966	4289	4102	3774	3370
271,3	9657	5268	4457	3863	5428	5108	4571	3947	3776	3474	3101
292,8	8948	4881	4130	3579	5029	4733	4235	3657	3498	3219	2874
314,4	8333	4545	3846	3333	4684	4408	3944	3406	3258	2997	2676
336	7798	4253	3599	3119	4382	4125	3690	3187	3049	2805	2504
357,5	7329	3997	3382	2931	4119	3877	3469	2996	2865	2636	2354
379,1	6911	3770	3190	2764	3884	3656	3271	2825	2702	2486	2220
400,7	6539	3566	3018	2615	3675	3459	3095	2673	2556	2352	2100
422,3	6204	3384	2863	2482	3487	3282	2936	2536	2426	2232	1992
443,8	5904	3220	2725	2361	3318	3123	2794	2413	2308	2123	1896
465,4	5630	3071	2598	2252	3164	2978	2664	2301	2201	2025	1808
487	5380	2934	2483	2152	3024	2846	2546	2199	2103	1935	1728
508,5	5152	2810	2378	2061	2896	2725	2439	2106	2014	1853	1655
530,1	4942	2696	2281	1977	2778	2614	2339	2020	1932	1778	1587
551,7	4749	2590	2192	1900	2669	2512	2248	1941	1857	1708	1525
573,3	4570	2493	2109	1828	2568	2417	2163	1868	1787	1644	1468
594,8	4405	2403	2033	1762	2476	2330	2085	1800	1722	1584	1415
616,4	4250	2318	1962	1700	2389	2248	2012	1737	1662	1529	1365
638	4107	2240	1895	1643	2308	2172	1944	1679	1606	1477	1319
659,6	3972	2167	1833	1589	2232	2101	1880	1624	1553	1429	1276
681,1	3847	2098	1775	1539	2162	2035	1821	1572	1504	1384	1235
702,7	3728	2034	1721	1491	2095	1972	1765	1524	1458	1341	1197





System Pillars

Water draining
capacity for one pillar is 0,98 l/s


SUNSET
Engineering Team