SCADA Pro 25tm
Structural Analysis & Design

User Manual

SAUDI BUILDING CODES

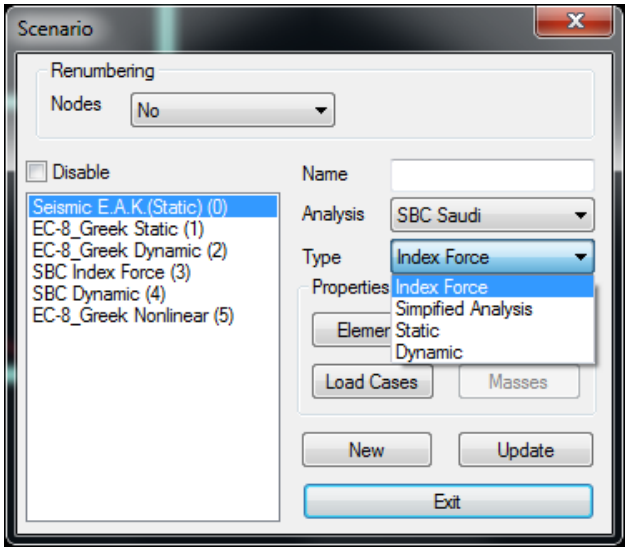
ACE HELLAS
INTEGRATED SOLUTIONS

D. SBC Saudi scenario

The Saudi Arabian regulation provides 4 analysis methods for the calculation seismic loads:

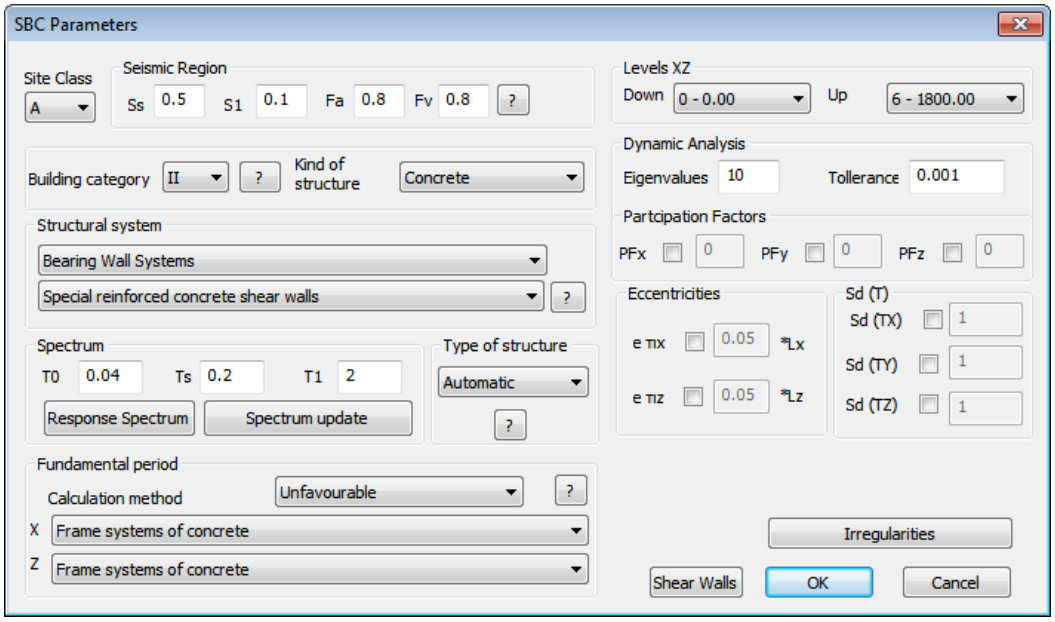
- Index Force Analysis Procedure (Section 10.7)
- Simplified Analysis Procedure (Section 10.8)
- Equivalent Lateral Force Procedure (Section 10.9)
- Modal Analysis Procedure (Section 10.10)

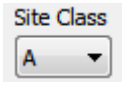
The process of creating the above 4 scenarios is the same as described previously for EC. From the new scenario creation box



You select SBC 301 as the analysis and then one of the 4 analysis methods.

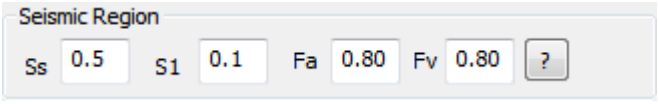
The The dialog box for entering and editing the parameters to perform analysis is the same for all 4 methods:



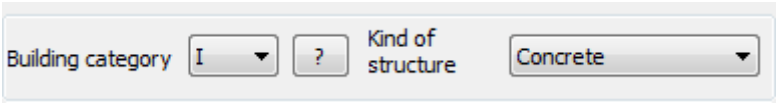
The first parameter concerns the Site Class 

according to par. 9.4.2, on the basis of which, inter alia, the Fa and Fv coefficients are determined (Table 9.4.3a & 9.4.3b).

The next group of parameters concerns the selection of the mapped maximum considered earthquake spectral response S1 and Ss according to par. 9.4.1.



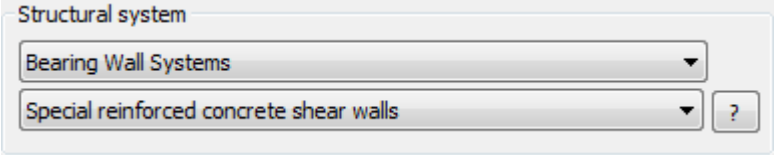
The selection of these two parameters in combination with the soil class automatically determines the values of the Fa and Fv coefficients, which can be modified by the designer.
The next parameter module



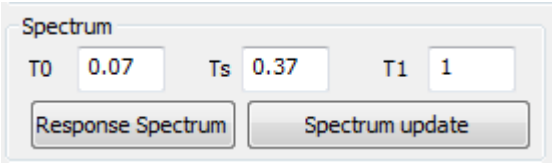
concerns the selection of the Building Category according to Table 1.6-1 as well as the selection the type of construction. The choice of key 

shows the categories of structures according to the corresponding table in SBC 301.

The next section

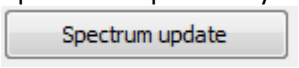


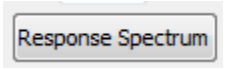
relates to the designer's selection of the Structural System of construction in accordance with Table 10.2 of SBC 301. This selection determines the value of the Response modification coefficient R which is used in various calculations, the value of the Deflection amplification factor Cd, which is used according to Sections 10.9.7.1 and 10.9.7.2 and finally the value of the overstrength factor Ωo. Finally, depending on the seismic category of the building, restrictions on the choice of the Structural System and a restriction on the maximum height of the building are specified.
The next section of the parameters concerns Design Response Spectrum according to par. 9.4.5 of SBC 301



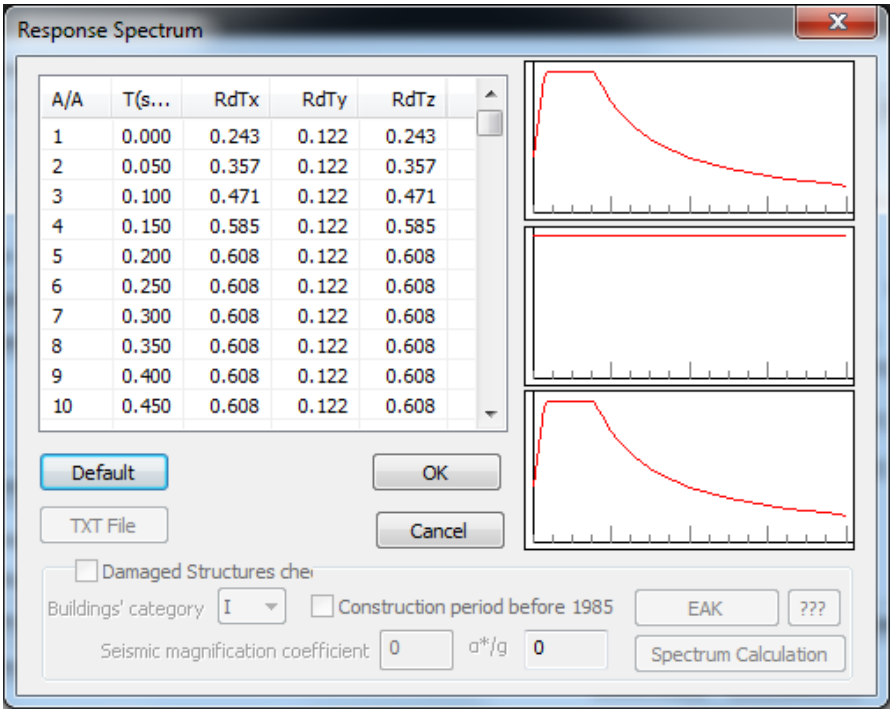
The application automatically calculates the values T0 and Ts based on the previously defined values S1 and Ss. Of course there is also the possibility of modification by the designer.

ATTENTION!
⚠ If any change is made to these values either automatically or by the designer in order to update the spectrum you must press the

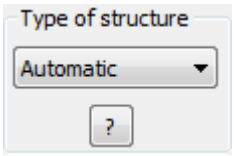


Pressing the button 

the dialog box with the design response range per direction appears



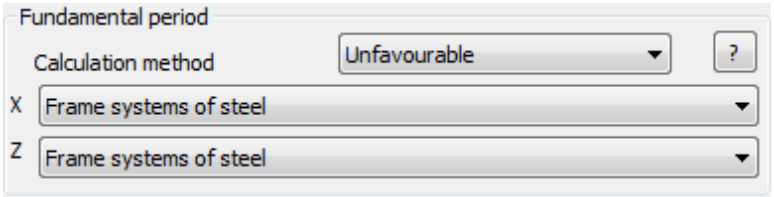
The next option concerns the automatic or manual definition of the construction type based on par. 10.3.



There are 3 options

- Automatic
- Flexible
- Rigid

The first option automatically determines the type of construction (Flexible or Rigid) based on par.10.3.1.3 and figure 10.3-1. With the next two options the designer determines the type.
The next parameters relate to the calculation of the fundamental period of the structure (Fundamental Period).

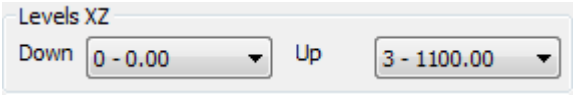


Par. 10.9.3 of SBC 301 provides 3 methods of calculating this size. Specific conditions must be met in order to apply each method. The program options are as follows:

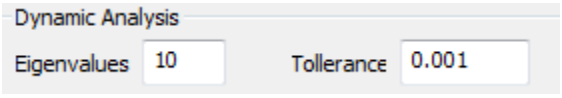
- Unfavourable
- Average
- Method 1
- Method 2
- Method 3

The first option takes as the final value of the fundamental eigenperiod of the structure the worst value obtained after the calculation based on each method separately. The second option selects the average of the three values and subsequent options select the specific value from that method. In each case two values are calculated, one for each direction of the earthquake. The next option is for the building type based on Table 10.9.3.2 and concerns the calculation with the first method (Eq. 10.9.3.2-1).

The next section concerns the determination of the lower and upper levels where the seismic load will be applied.

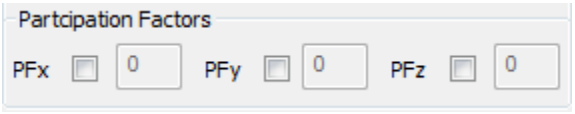


The following parameters are related to the dynamic analysis. More specifically in the following fields:

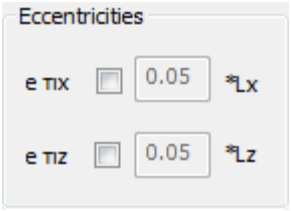


you specify the number of eigenmodes you want to take into account when performing the eigenmodal analysis as well as the accuracy factor of the calculations.

Then you can determine seismic force participation factors per seismic direction

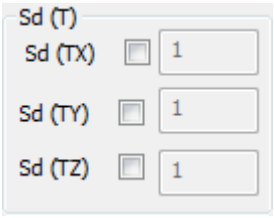


Check the corresponding checkbox and enter the seismic load factor. The default option is 1, and if for example you set PFx=2 the values of the spectrum in the X direction will be doubled. Similarly, in order to modify the coefficients for the calculation of the eccentricities



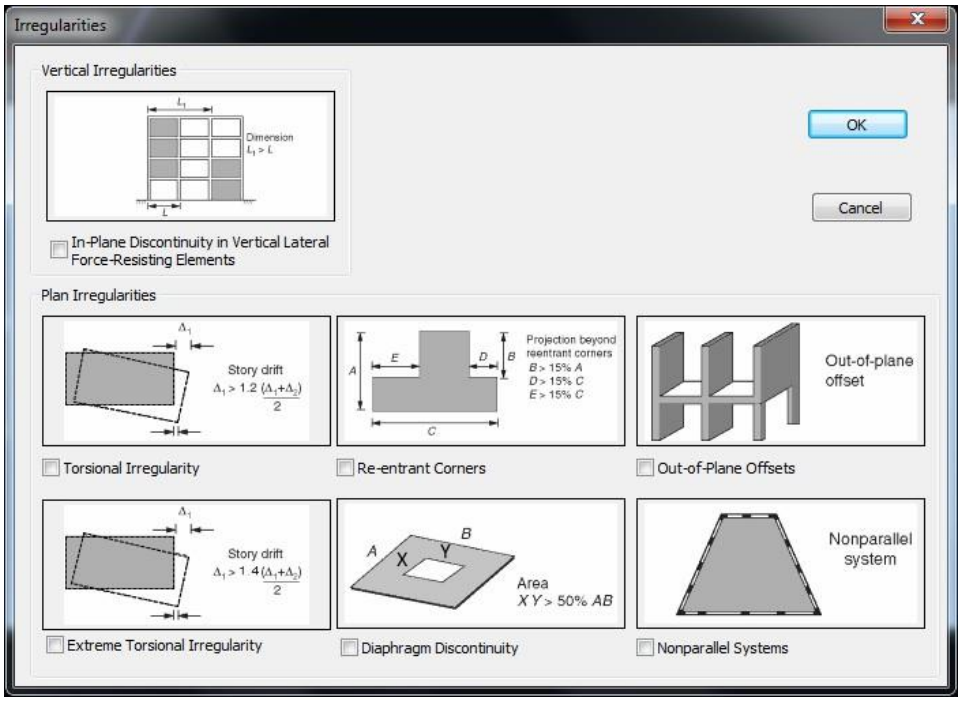
activate the corresponding checkbox and select the desired value.

Finally, in the section on the participation coefficients of the design spectra per direction



activate the coefficient for the corresponding spectrum and enter the value. For example, if you set Sd(TX)=2, the values of the design spectrum in the X direction will be doubled.

The next section concerns the determination of the non-conformity of the structure in plan and in height. This definition, among other things, determines the choice of analysis method based on Table 10.6.1. SBC 301 in Table 10.3.2.1 provides 6 criteria for plan view regularity.
In the following dialogue box

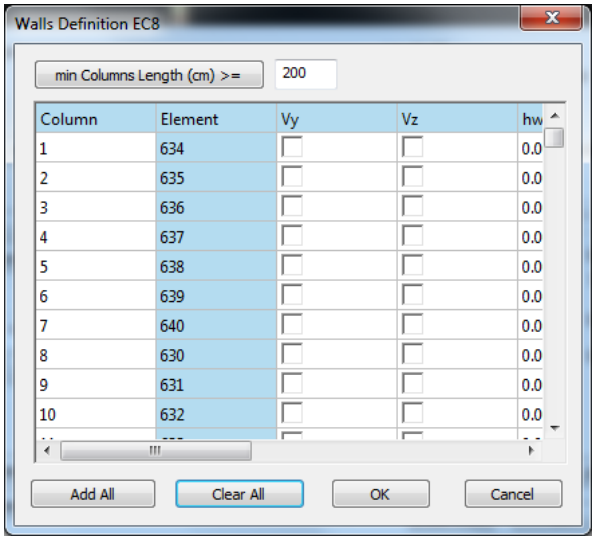


the planner determines in the Plan Irregularities section whether the corresponding criteria are met by checking the reverse option.

As far as regularities in height are concerned, there are also 6 criteria. Scada Pro automatically checks five of them and the designer only has to choose whether or not one of them is met by ticking the corresponding option.

The option of fixing the walls 

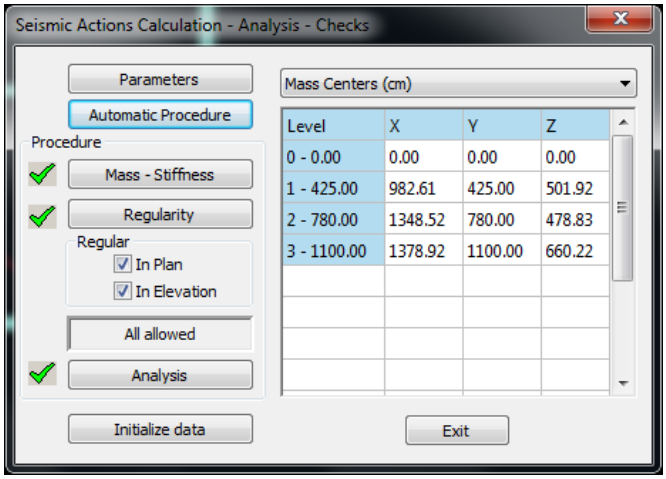
concerns the calculation of quantities necessary to determine the eigenperiod by the third method (Eq. 10.9.3.2-3).
In the dialog box that appears



Enter the min Length (cm) and select the "min Column Length" command to automatically define the walls per direction. The program automatically calculates the sizes required to calculate the eigenperiod.

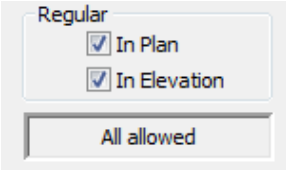
⚠ The definition of the walls is a mandatory step for the calculation of the eigenperiod with the third method.

After setting the parameters, from the dialog box of the analysis scenario run



press the key 

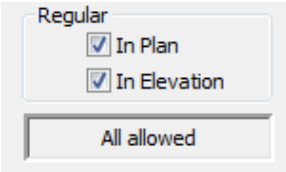
and the program automatically runs analysis procedure while performing all the required checks. Particular attention should be paid to the regularity checks



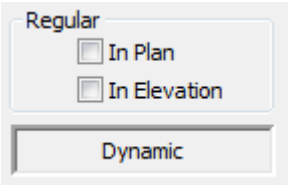
where before performing the final analysis the program gives the result of regularity in plan and elevation and based on the selection of the seismic category in the initial parameters.
The analysis or analyses allowed are then proposed on the basis of the result
(Table 10.6.1).

⚠ In the normality results, the researcher has the option of selecting or deselecting, if desired, one or both categories of normality. The program accordingly changes the prompt of the type of analysis allowed.

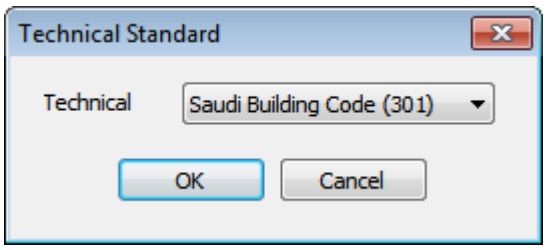
In the previous case the automatic check showed that the building is normal in plan and height and allows the use of any of the four methods.



However, if checkboxes are unchecked, which means that the building is not considered normal in plan and elevation, then the program suggests the dynamic analysis method.

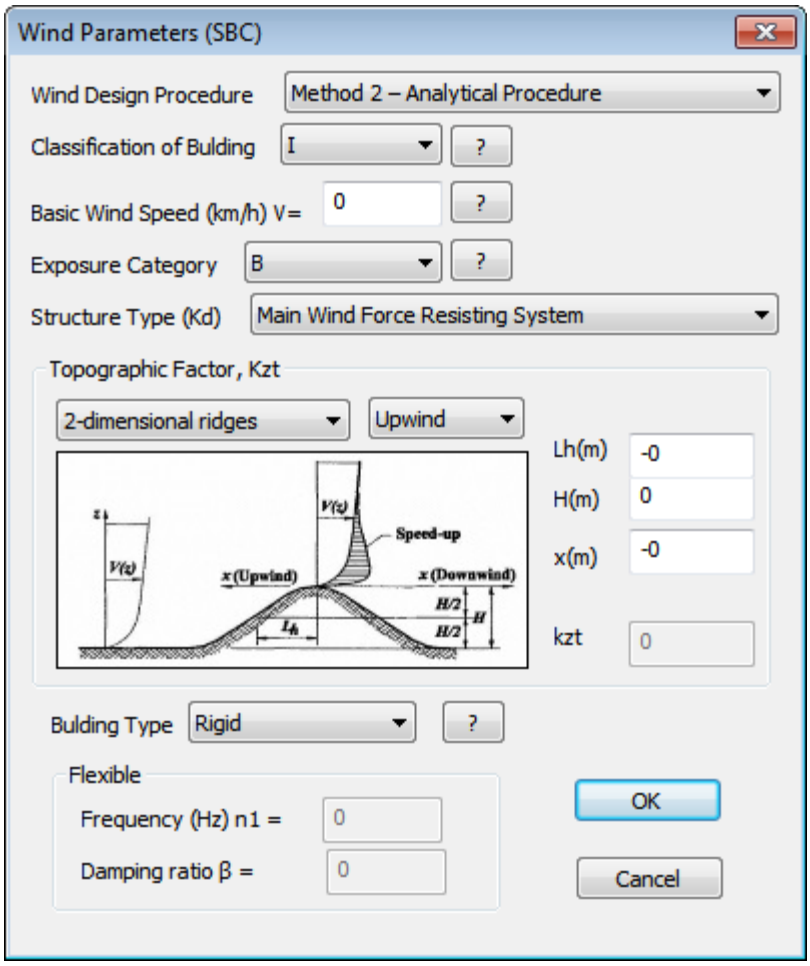


The **Saudi Arabian** regulation **(SBC 301)** has been integrated into SCADA Pro for wind loads. The following is a detailed description of parameters of this regulation when selected as a calculation regulation from the initial dialog box:



1.1 Wind :

By selecting the Wind parameters, the following dialog box appears:



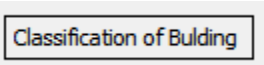
SBC 301 provides three methods for calculating wind loads (par. 6.1.2)

1. Simplified Method (Section 7.1)
2. Analytical Method (Section 7.2)
3. Aerodynamic Method (Section 7.3)

In SCADA Pro the first two methods have been integrated (The third method is based on experimental measurement results).

So in the first section of the parameters 

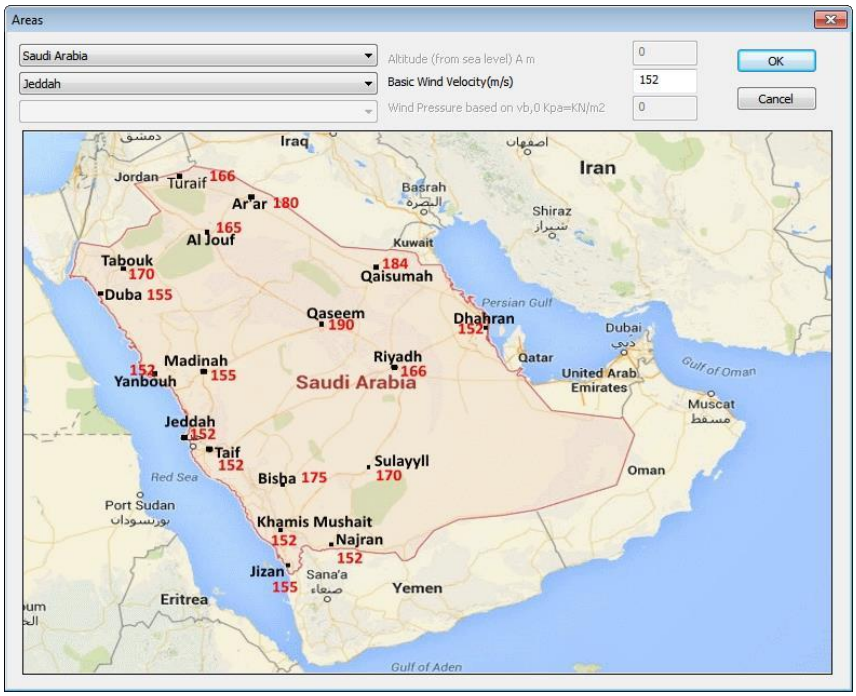
you select one of the two methods to be used for the calculation of the wind loads.
The first method applies only to buildings that meet specific criteria (par. 7.1.1).

The next parameter 

concerns the selection of building category based on Table 1.6-1. By pressing the 

button next to the parameter the corresponding table is displayed.

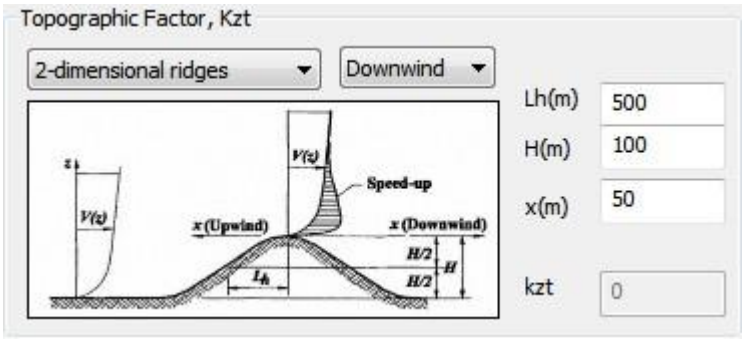
Then you set the basic wind speed Basic Wind Speed (km/h) based on map values (FIGURE 6.4-1) displayed by pressing the ?.



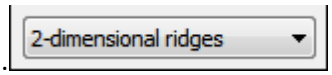
The parameter Exposure Category concerns the selection of the exposure category of the building based on 6.4.2.2 & 6.4.2.3.

The selection of the type of Structure Type (Kd) structure (TABLE 6.4-1) involves the selection of the Kd (Directionality Factor).

The next parameter module



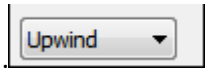
refers to the influence of the topographic configuration of the area in which the structure is located (FIGURE 6.4-2). The parameters are selected on the basis of which the Topographic Factor (Kzt) is calculated.

The first option concerns the topology of the soil . 

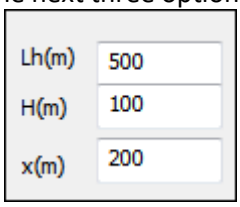
There are 5 options:

- Two-dimensional ridges
- Two-dimensional fronts
- Three-dimensional axisymmetric hill
- Flat, unobstructed areas and water surfaces
- Choice of user

The third option sets a value for the coefficient Kzt=1.
The fourth option involves the input of a Kzt value by the designer.

The next option concerns whether the place where the structure is located is downwind (Windward, Upwind) or Leeward (Downwind) . 

The next three options

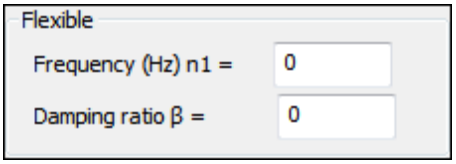


They concern data on the topography of the area
Lh: proximal distance (in metres) of the summit where the difference in ground elevation is equal to half the height of the hill or front
H: Height of the hill or front (in metres) in relation to the leeward side of the ground.
x: Leeward or downwind distance of the top (in metres) as in figure 6.4-2.

In the next parameter the type of building is selected based on the stiffness of the bulkheads. There are three options:

- Rigid
- Flexible
- Parapets

In case the construction type is set to Flexible, the following two parameters must be set:



If you have selected SBC 301 as the regulation, the printout is as follows:

WIND LOADS CALCULATION ACCORDING TO SBC 301 CHAPTER 7

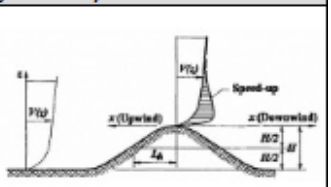
Design Method : Method 2 – Analytical Procedure

Basic Wind Parameters

DESCRIPTION	SYMBOL	UNITS	VALUE	REFERENCE
Classification of Building			I	Table 1.6-1
Importance Factor	I		0.77	Table 6.5-1
Country				Figure 6.4-1
City				Figure 6.4-1
Basic Wind Speed	V	(km/h)	165.00	Figure 6.4-1
Exposure Category			B	6.4.2.3
Structure Type			Main Wind Force Resisting System	Table 6.4-1
Wind Directionality Factor	Kd		0.85	Table 6.4-1

Topographic Factor (Kzt) Calculation (Figure 6.4-2)

DESCRIPTION	SYMBOL	UNITS	VALUE
Topography			2-dimensional ridges
Hill Height	H	(m)	-500.00
Half Hill Length	Lh	(m)	100.00
Distance from top of crest	x	(m)	-100.00
Building up/down wind			Upwind
Topographic Factor	Kzt		1.49



Building Type : Rigid | **Frequency (Hz) n1 =** | **Damping Ratio β =**

Gust Effect Factor (G) Calculation (7.2.7) Rigid Structure (7.2.7.1)

DESCRIPTION	SYMBOL	UNITS	WALL LEFT (w0)	WALL FRONT (w90)	WALL RIGHT (w180)	WALL BACK (w270)	REFERENCE
Mean height	h	(m)	4.00	4.00	4.00	4.00	
Width	B	(m)	6.00	6.00	6.00	6.00	
Equivalent height	/z	(m)	10.00	10.00	10.00	10.00	7.2.7.1
Constant	/ε		0.33	0.33	0.33	0.33	Table 7.2-1
Constant	l	(m)	100.00	100.00	100.00	100.00	Table 7.2-1
Minimum height	zmin	(m)	10.00	10.00	10.00	10.00	Table 7.2-1
Constant	c		0.30	0.30	0.30	0.30	Table 7.2-1
Constants	gq, gv		3.40/3.40	3.40/3.40	3.40/3.40	3.40/3.40	
Integral length scale	Lz	(m)	100.00	100.00	100.00	100.00	Table 6.4-1
Intensity of turbulence	Iz		0.30	0.30	0.30	0.30	Eq. 7.2-2
Background response	Q		0.93	0.93	0.93	0.93	Eq. 7.2-3
Gust Effect Factor	G		1.00	1.00	1.00	1.00	Eq. 7.2-1

WIND LOADS CALCULATION *
ACCORDING SBC 301 CHAPTER 7

ViALLS DATA

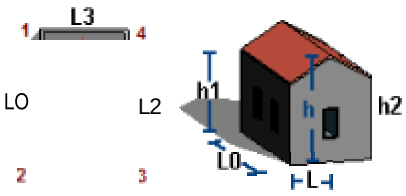
g	see,	c°nmm	H%efm	md	o,en	^o	c°-em	H%efm	md	o,en	^o	
		|ndi%u falls					EquixaeYXalls					
	1	6.00	3.00	18.00	0.00	0.00	6.00	3.00	18.00	0.00	0.00	No
	I	600	#00	2%X	000		600	#00	2%X			No
Front												
	1	6.00	3.00	18.00	0.00	0.00	6.00	3.00	18.00	0.00	0.00	No
	I	600	#00	2%X	000		600	#00	2%X			No
1/ga II Back	W4											
Totals				84.00					84.00			

BU TLDTNG T5 9 UALTF TED AT OPEN No

REFS DATA

Number	Roof Type	LO {rn}	L4 {rn}	L2 {rn}	L3 {rn}	Type of Roof Edge	Repetitions	h4 {rn}	M {m}	h {rn}	L {rn}
T	D apftch	6.00	6.00	6.00	6.00	Sharp Edges	1	3.00	3.00	4.00	3.00

Mi-"n ber	a0 (m)	a 4 (m)	at (m)	aa (m)	b0 (m)	b4 (m)	b2 (m)	b3 (m)	Ag (m2)
1									36.00



Enclosure Classification (Section 6.2

Bekxwela

2	Wa II Front						Yes			Mon		Mon
a 4	rva ii RigM 1/ga II E ec k	Q4	Q 'so	Q 'so	Qua	'ozio	Ye Yes	'a.lo	Qua	un Mon		un Mon

BUILOIM2 18 QUALIFIE D AB PART1ALLY E CLO8 ED LO1/g-RJ 8E BUILOIM2

BUILOIM2 18 QUALIFIE D AB E CLO8 ED