

Bubble3D

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About



Bubble 3D

This software is designed for simulation of stress increase (ΔP) due to foundation load in subsurface soil layers, and visualization of ground settlement. The results provided by Bubble 3D and its visual presentations are **FOR EDUCATIONAL PURPOSES ONLY**, and cannot be relied on for a real project. The objective of Bubble 3D is to assist the geotechnical engineer in understanding stress - deformation under the footing by way of graphical presentation. We noted that we do not recommend using the results of settlement estimations provided by Bubble 3D for real projects. however, its results could be used as a general ballpark estimate. Please read [this article](#) for details.

Although all efforts have been undertaken to ensure that this software is of the highest possible quality and that the results obtained are correct, the authors do not warrant the functions contained in the program will meet your requirements or that the operation of the program will be uninterrupted or error-free. The authors are not responsible and assume no liability for any results or any use made thereof, nor for any damages or litigation that may result from the use of the software for any purpose. All results to be verified independently by user.

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Vancouver, Canada

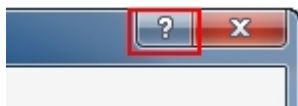
License Agreement

View our online [End User License Agreement](#)

Licensing Help

View our online [Licensing Help](#)

Using Help



Help button is placed at the top-right corner of all pages, as shown on this screenshot. In order to load the help content associated with each page please click on the question mark button. Alternatively, you can use Help menu to access the help contents.

Units System

This version of Bubble 3D supports the following unit systems:

- Metric units (kg, m)
- US CUstomary units (lb, ft)

You can set the unit system on the [Options](#) page.

Methodology & Application

Bubble 3D is an advanced program to replace your Excel spreadsheets; This program is not a sophisticated finite element or finite difference software! It is critical for the user to understand the assumptions, weak points and limitations of this program.

The way Bubble 3D works, it discretizes the model (defined by dimensions B x L x H) into small soil elements. When a foundation load is applied at the ground surface, Bubble 3D conducts the following analyses:

1. The program divides each load area (i.e. foundation load, surcharge, etc) into small triangles (i.e. Cells). The equivalent point load is calculated at the centroid of each triangle.
2. The model is divided into soil elements. Each soil element is a cube of $\Delta x * \Delta y * \Delta z$ defined by the user.
3. The program goes through each soil element; The δP resulted from each load Cell is calculated at the center of the soil elements. Please note there are several load cells for which δP will be calculated at the center of this soil element.
4. At each soil element ΔP is calculated by summation of all δP resulted from all load Cells.
5. Now the program knows ΔP at the center the all soil elements. At the next step, Bubble 3D calculates elastic and consolidation settlement for all soil elements.

Once the analyses is completed, the program provides a graphical representation for settlement, stress increase, etc.

Elastic Settlement Analysis

The program covers the following methods:

Half-Space Elastic Settlement: using the following equation:

$$S_e = \frac{Bq_0}{E_s} (1 - \mu_s^2) \alpha \quad (\text{Harr, 1966})$$

where:

S_e : elastic settlement of the soil element,

B : width of the soil element, i.e. the lesser of ΔX or ΔY ,

q_0 : the stress increase ΔP at this soil element,

μ_s : Poisson's ratio of the soil,

α : function of shape and flexibility of foundation. Bubble 3D uses $\alpha = 0.85$ for flexible foundation and $\alpha = 0.88$ for rigid foundation.

Fully Elastic Settlement: This method assumes that soil elements comprise of perfectly elastic material. The following equation is used:

$$\delta L = P.L / (A \times E)$$

where:

δL : compression (settlement) of the soil element in Z direction,

P: stress increase, converted to load, at the center of the soil element (i.e. $P = \Delta P * \Delta X * \Delta Y$),
 L: length of the soil element in direction of the load (i.e. $L = \Delta Z$),
 A: cross sectional area of the soil element (i.e. $A = \Delta X * \Delta Y$),
 E: modulus of elasticity of the soil element.

Consolidation Settlement Analysis

The program estimates the consolidation settlement of each soil element based on Terzaghi 1-D consolidation theory.

Ground Settlement

Settlement at the ground surface for each soil element is calculated based on a summation of settlement ($\Delta S = \Delta S_e + \Delta S_c$) of all soil elements exactly below that soil element (i.e. all soil elements sharing the same X and Y, but different Z).

Getting Started ...

When starting a new analysis with Bubble 3D, take the following steps:

Step 1: Define soil stratigraphy at the site. This includes defining site dimensions, various soil layers and groundwater conditions. See [this article](#) for more details.

Step 2: Define foundation loads. You can define Rectangular or Circular foundations using Bubble 3D and you can define voids within each footing. See [this article](#) for more details.

Step 3: Select a presentation mode. Use the list at the top of the page, to the right side of the main toolbar to select your desired mode. See [this article](#) for more details.

Note: If this is the first time you use this software make sure you check the [Options](#) page.

Define Site Data

Start creating a new model by entering site data comprising of the following data (use [Input Data](#)→[Site Data](#) menu):

Subsurface Soil Conditions

Please enter site (model) settings and define soil stratigraphy at the site:

Site Data

Please enter the dimensions of the model:

B: (m) in X direction

L: (m) in Y direction

Please specify the size of each soil element:

dX: (m)

dY: (m)

dZ: (m)

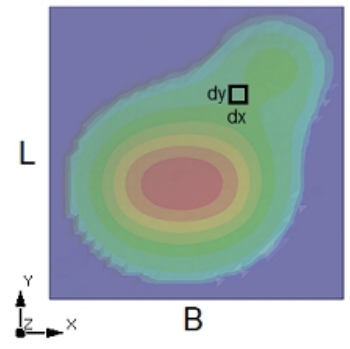
Ground surface topography elevations:

El.: (m)

☒ Groundwater table elevations:

El.: (m)

Note:
For this site, we recommend soil element sizes of greater than 0.3 (m).
Smaller element size could result in significantly slower analysis.



Subsurface Layers

Enter all soil layers starting from ground surface:

Layer Name	Layer Thickness (m)	Color	Unit Weight (kN/m ³)	Es (MPa)	Poisson Ratio	Void Ratio	Cc	Cs
Sand 1	4	Green	18	10	0.35	0.65	0	0
Clay 2	5	Brown	19	2	0.4	0.9	0.25	0.05

[Delete Soil Layer](#)

Model Properties: comprising width (B, in X direction) and length (L, in Y direction) as well as the size of each soil element. It is recommended that the size of each soil element be selected to be greater than 2% of the model width. Smaller element size could result in significantly slower analysis.

Elevations: Ground surface elevation is automatically set at El. +0.00; Groundwater elevation (if exists) should always be entered as a negative number (i.e. below ground surface).

Subsurface Layers: Enter a list of all soil layers starting from ground surface. This includes a name for the soil layer, its thickness, unit weight (γ), modulus of elasticity (E_s), Poisson ratio (ν), void ratio (e) and consolidation parameters (C_s and C_c). You can also assign a color to each layer. In order to delete a soil layer, click on the corresponding row in the table, and click on [Delete Soil Layer](#) link at the bottom-left corner of the table.

When data entry is completed, click on Save button. If you have not entered data for foundation loads, please see [this article](#).


Define Foundation Loads

Foundations may be modeled in Bubble 3D with Rectangular or Circular shape (use [Input Data→Loads](#) menu).



Loads

Enter all foundation loads:

Footing Shape	X (m)	Y (m)	B (m)	L (m)	Bearing Pressure	# of Cells	Hole (void)
Rectangle	5.5	5.5	4	4	100	50	...

 Delete Load

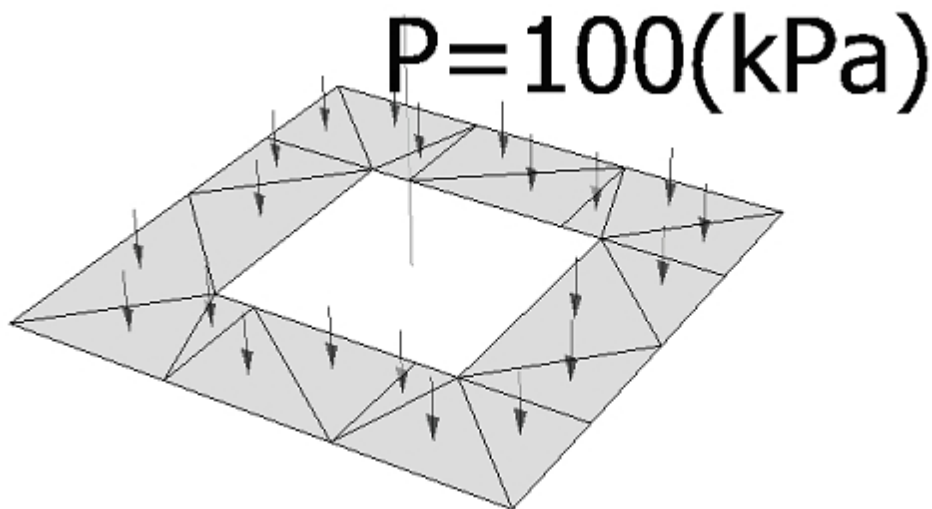
Note:
 Rectangle: X and Y refer to the bottom-left corner of the load. B and L are in X and Y directions, respectively.
 Circle: X and Y refer to the center of the load. For a circular load, B and L should be the same number.

 Close  Save

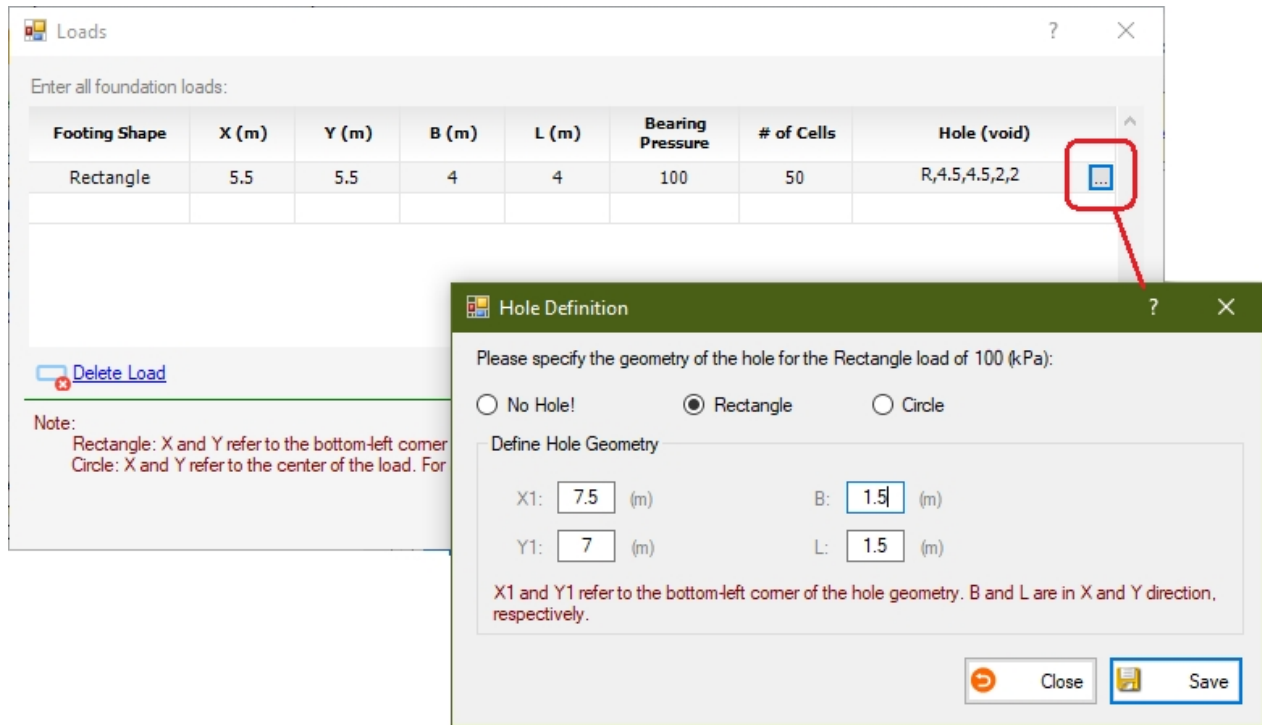
Rectangle: X and Y refer to the bottom-left corner of the load. B and L are in X and Y directions, respectively.

Circle: X and Y refer to the center of the load. For a circular load, B and L should be the same number.

Number of cells is applicable to rectangular loads. The program will use the number of cells entered by user to discretize the footing geometry into triangular cells. Then based on the Bearing Pressure defined for that load, the program will calculate the resulting point load - based on the area of each cell- at the centroid of each cell (see example below).



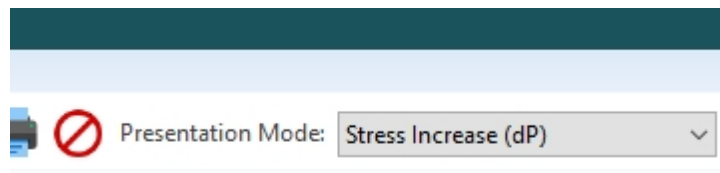
Holes: you can define 'holes' to cut certain area out of the geometry of a footing. In order to define a hole, click on the last column in the table and click on ... button at the right end of this column to open Hole Definition dialog box (see below).



Please note the hole geometry must be completely outside the footing geometry.

Presentation Modes

When the analysis is completed, you can choose your desired Presentation Mode from the following list:



Stress Increase (ΔP)

This will show the stress increase in the model, due to the foundation loads. The ΔP shown is summation of stress increases resulted from all foundation loads (i.e. $\Delta P = \Delta P_1 + \Delta P_2 + \dots$).

Elastic Settlement (δSe)

This will show the elastic settlement calculated for the soil element at that depth, based on the ΔP described above.

Consolidation Settlement (δSc)

This will show the consolidation settlement calculated for the soil element at that depth, based on the ΔP described above. Normally consolidated conditions as assumed.

Total Settlement (δS)

This will show the total settlement calculated for the soil element at that depth, based on the ΔP described above ($\delta S = \delta Se + \delta Sc$).

Overburden Stress (σv)

This will show the total overburden stress for each soil element.

Effective Overburden Stress (σ'_v)

This will show the effective overburden stress for each soil element.

Ground Surface Settlement

This will show the ground surface settlement. Each settlement for each soil element at the ground surface is calculated based on a summation of δS for all soil elements located below that surface soil element. In this mode, user can specify the 'scale factor' for visualization of ground surface settlement.

Tabular Results

This page provides the details of calculations for each soil element in the model. Each row in the table represents data for one soil element.

X, Y, Z: refer to the coordinates of the soil element.

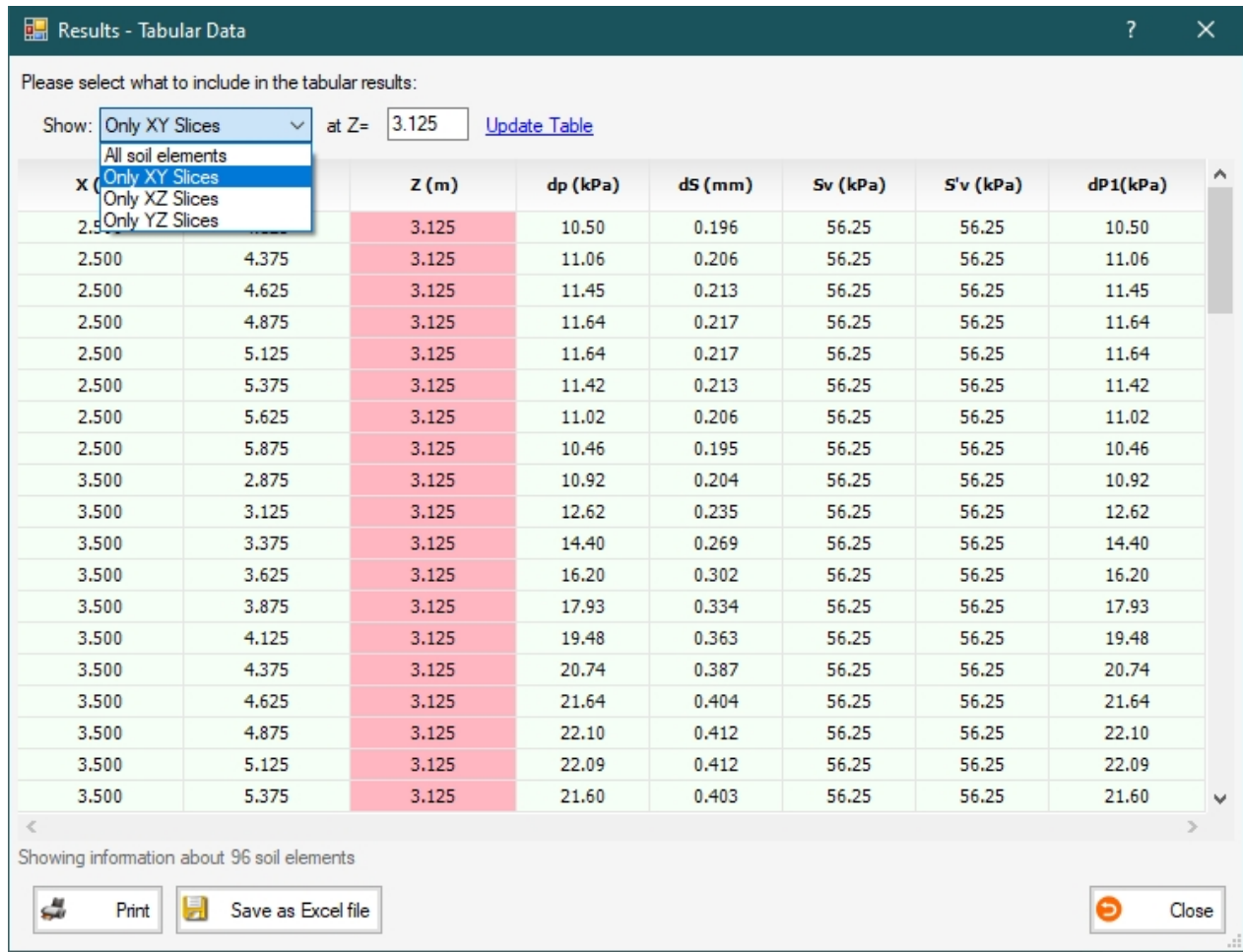
δp : this is the summation of stress increases at this element due to all loads.

δS : this is the settlement of this element due to this δP ; Please note $\delta S = \delta S_e + \delta S_c$.

S: this is the settlement of this soil element .

σ_v and σ'_v : refer to the total and effective overburden stress at the center of this soil element.

The individual δP values due to each foundation load will be listed at the end of the above-noted columns. You can print or save this table in Microsoft Excel format.



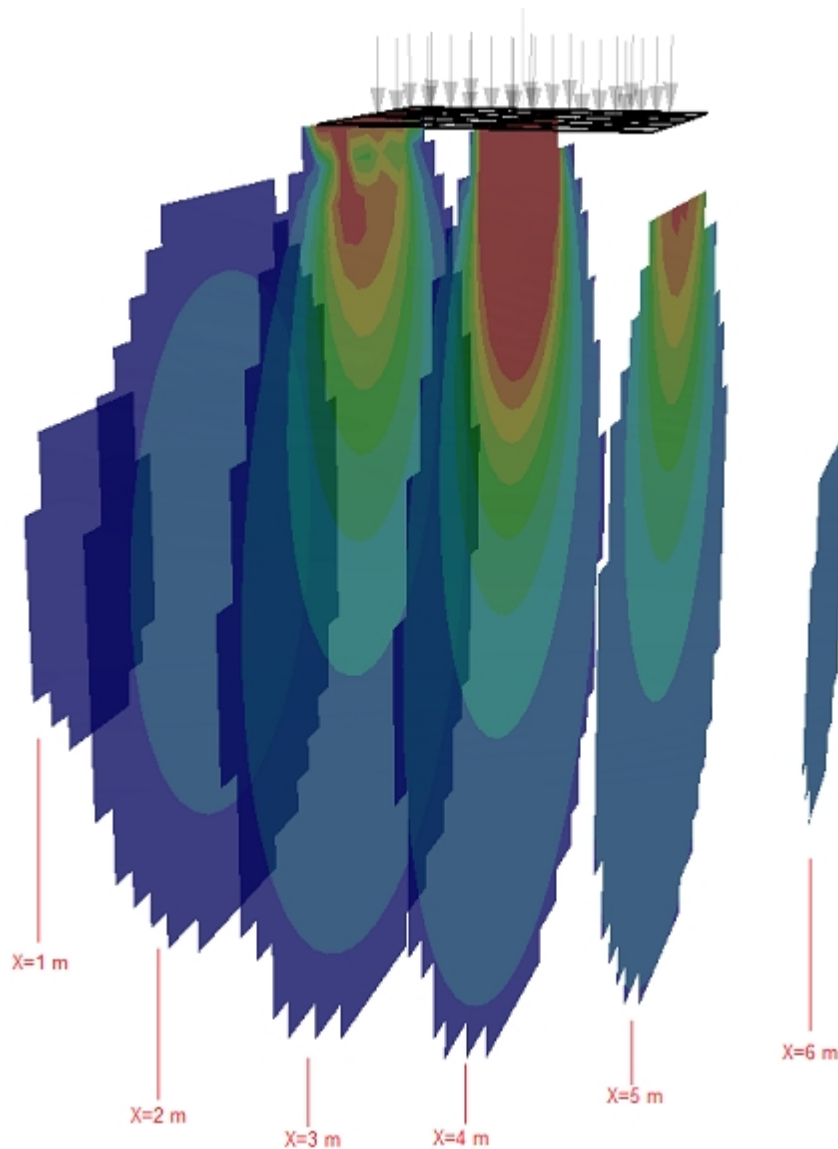
You can choose to filter data for a specific [stress slices](#) by choosing the slice plane and a value for the X / Y / Z of the slice.

Stress Slice

Bubble 3D presents stress distribution in 'slices' at all three main planes:

- **XY Slices:** these are horizontal slices in XY plane. These slices are automatically generated at different depths (i.e. different Z values) with DZ interval, as defined on the [Site Data](#) page.
- **YZ Slices:** these are vertical slices in YZ plane. These slices are automatically generated at different X values with DX interval, as defined on the [Site Data](#) page.
- **XZ Slices:** these are vertical slices in XZ plane. These slices are automatically generated at different Y values with DY interval, as defined on the [Site Data](#) page.

You can turn on/off series of these slices, from the list of [Information Layers](#). If you would like to filter certain slices (e.g. between YZ slices between X1 and X2), you can [filter slices](#). The following figure shows 6 different YZ stress slices generated at different X values (slices in other 2 planes are turned off for clarity).



Tools & Options

Various tools and options are available, please choose from the list to see the details.

Auto-Rotate

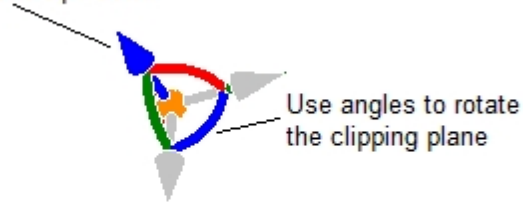
Auto-Rotate moves the camera around the model with a constant speed (deg./sec) which is defined on the [Options](#) page. You can access this feature from [Tools→Auto-Rotate](#) menu or from the main toolbar using the camera icon.

Clipping Plane

Clipping plane allows you to cut through the stress bulbs at any location and by any angle. You can access this function from [Tools→Clipping Plane](#) menu or from the corresponding button on the main toolbar.

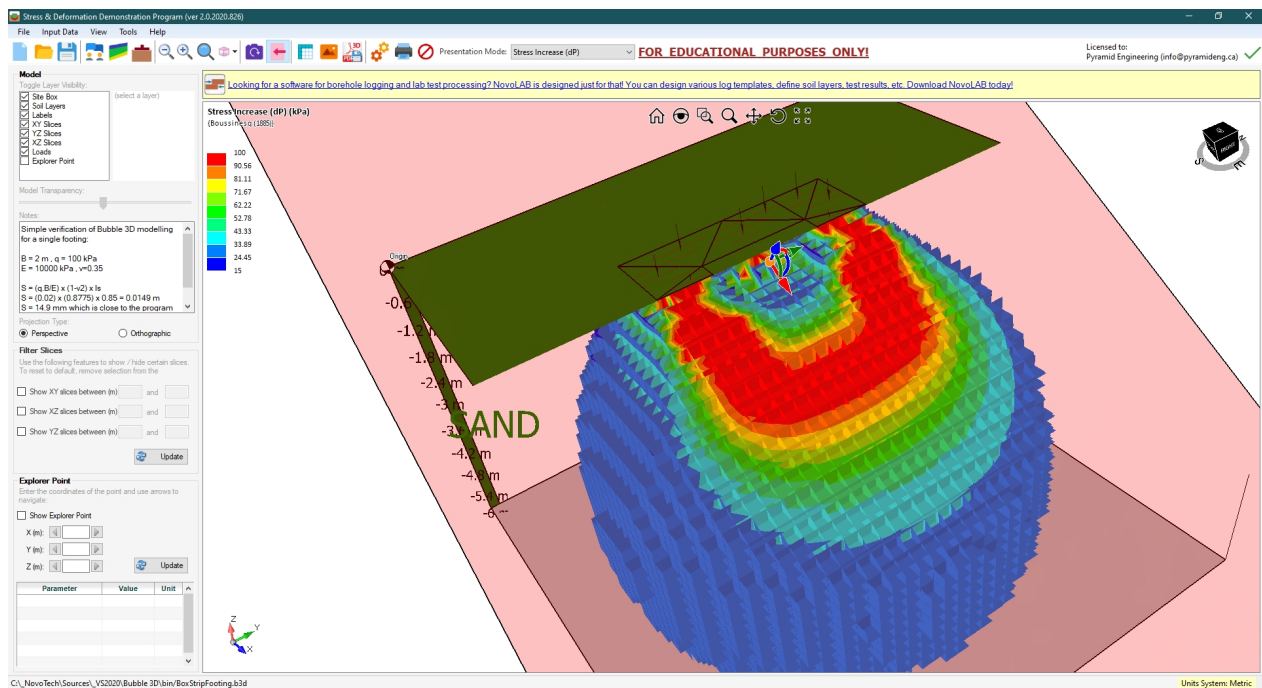
Once this feature is activated, a green plane will be shown at the ground surface. At the center of this plane 3 arrows and 3 angles are shown. Use the blue arrow and angles to move the plane up/down and to change the angle of the plane. The plane cuts through the stress bulb(s) and shows only the part of the bulb(s) located below the clipping plane.

Use the **blue** arrow to move the clipping plane up / down



Use angles to rotate the clipping plane

In order to exit the clipping mode, click on toolbar button to turn clipping off.



Filtering Slices

This feature is only available when [Presentation Mode](#) of "Stress Increase" is selected. By default, the program shows all slices in each plane. You can turn on/off stress planes from the [Information Layers](#) panel.

You can filter [stress slices](#) using Filter Slices panel. Activate the desired checkbox and enter the range of slices to be shown, then press Update button. If you would like to see the stress details for filtered slices, click on the lightning icon to the right of the text boxes. This will open [tabular results](#) page.


Filter Slices

Use the following features to show / hide certain slices.
To reset to default, remove selection from the

☒ XY slices between Z (m) and ⚡

☐ XZ slices between Y (m) and ⚡

☐ YZ slices between X (m) and ⚡

 **Update**

Explorer Point

Explorer Point allows to navigate through the model and view the details of the analysis at each soil element. The Explorer Point shows in the model as a golden sphere.

Explorer Point


Enter the coordinates of the point and use arrows to navigate:

☒ Show Explorer Point

X (m):

Y (m):

Z (m):

 **Update**

Parameter	Value	Unit	
Stress Increase (dP)	55.880	(kPa)	<input type="button" value="▲"/> <input type="button" value="▼"/>
Elastic Settlement (dSe)	9.974	(mm)	
Consolidation	47.361	(mm)	
Total Settlement (dS)	57.335	(mm)	
Overburden Stress (Sv)	72.000	(kPa)	
Effective Overburden	13.160	(kPa)	

Options

This page may be accessed via [Tools→Options](#) menu. You can choose analysis methods as well as viewer settings.

Options
?
X

Analysis Settings

Elastic Settlement:
Rigid footing (semi-infinite) $\alpha=0.85$
Stress Increase Method:
Boussinesq (1885), Holtz & Kovacs (1981)

Consolidation Settlement:
1-D Terzaghi Consolidation
Units System:
Metric (kN, m)

Disregard soil elements with $\Delta p < 30$ %

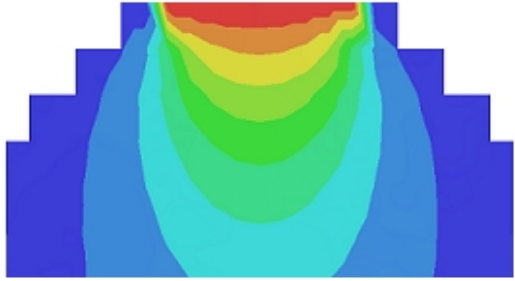
Viewer Default Settings

Background Color:
White
Auto-Rotate Speed:
1 deg./sec

Projection Type:
Perspective
Rendering Engine:
OpenGL

☒ Show Explorer Point
☒ Show Site Box

☒ Show Cell Loads
☒ Show Cell Load Labels



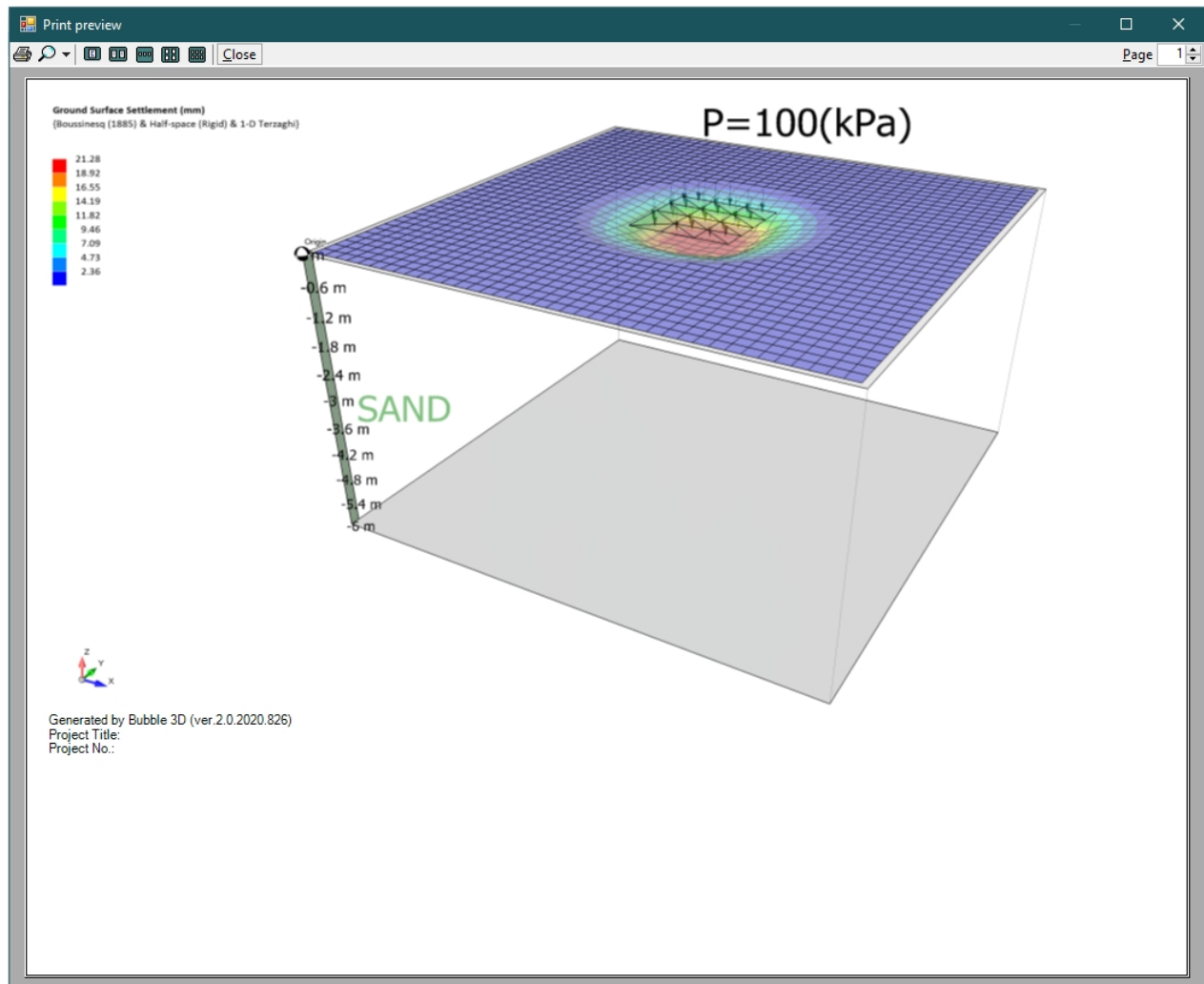
Close
Save

For a detailed discussion of methodologies used in Bubble 3D please see [Methodology & Application](#).

Disregard soil elements with $\Delta P < \%$: This allows the program to filter out certain soil elements with their ΔP (received cumulatively from all foundation loads) less than a certain percentage of the maximum foundation loads. The lower this number is, more soil elements will be involved in the entire analysis; this will slow down the analysis and will increase the estimated settlements.

Print

You can print the current view of the Bubble 3D model. To access this function, use [File→Print](#) menu.

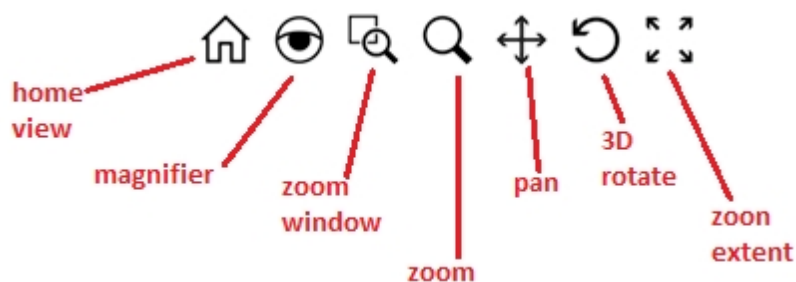


Viewer

Here you can learn more about how to use the 3D viewer.

Working with 3D Viewer

The 3D viewer of Bubble 3D allows user interaction with the model. Various actions may be performed using the toolbar at the top of the viewer:



In order to rotate the model, hold down the middle button of the mouse (i.e. scroll wheel), and move the mouse to rotate the scene. If that does not work on your mouse, click on the "3D Rotate" button from the toolbar (see above) and move the mouse to your desired view.

Information Layers

In Bubble 3D , all available data layers could be turned on/off by using the checkbox before each item on the "Model" section at the top-left portion of the screen:

Site Box Includes the top and bottom planes of all soil layers, and groundwater table.

Soil Layers Represents all soil layers of this model.

Labels Represents all labels (layer names, depth scale, etc).

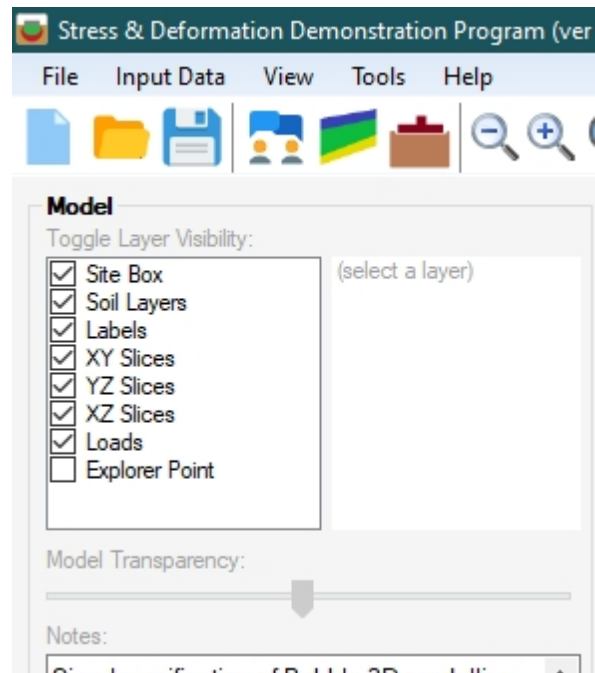
XY Slices Show the stress distribution in all slices in the XY plane.

YZ Slices Show the stress distribution in all slices in the YZ plane.

XZ Slices Show the stress distribution in all slices in the XZ plane.

Loads Contains the geometry of all footing loads.

Explorer Point Turns on/off the [Explorer Point](#).

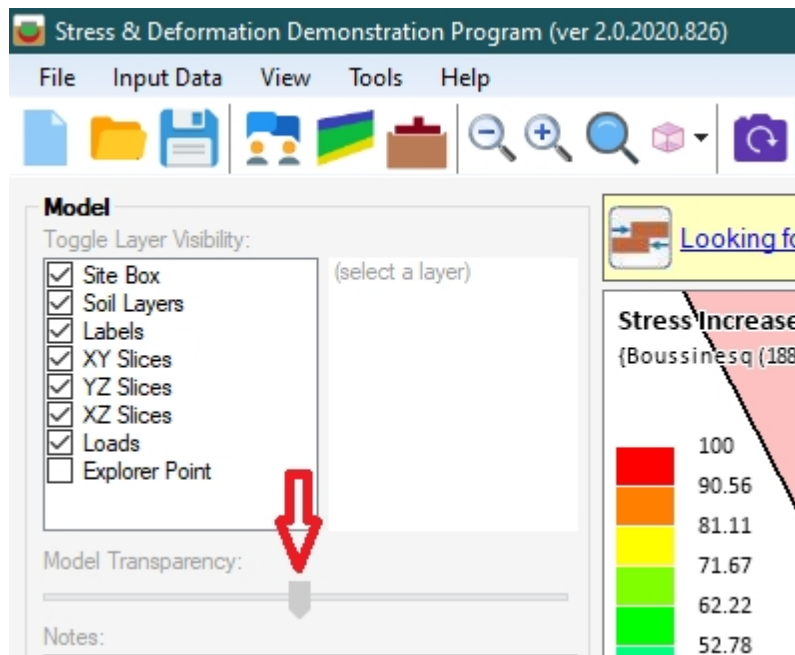


Adjusting Transparency

To change the transparency level of the model, simply click on the slide-bar below the list of layers, and adjust the transparency.

Transparency

To change the transparency level of the model, simply click on the slide-bar below the list of layers, and adjust the transparency.

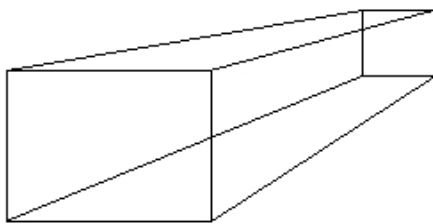


Projection Type

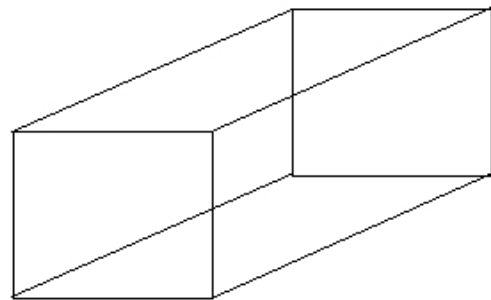
Bubble 3D viewer supports the following two projection types:

- Perspective
- Orthographic

In the perspective view (the default), objects that are far away are smaller than those nearby. In the orthographic view, all objects appear at the same scale. Since some prefer one over the other, both options are available.



Perspective projection

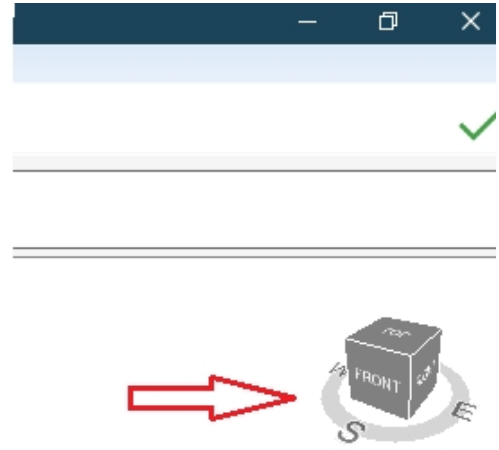
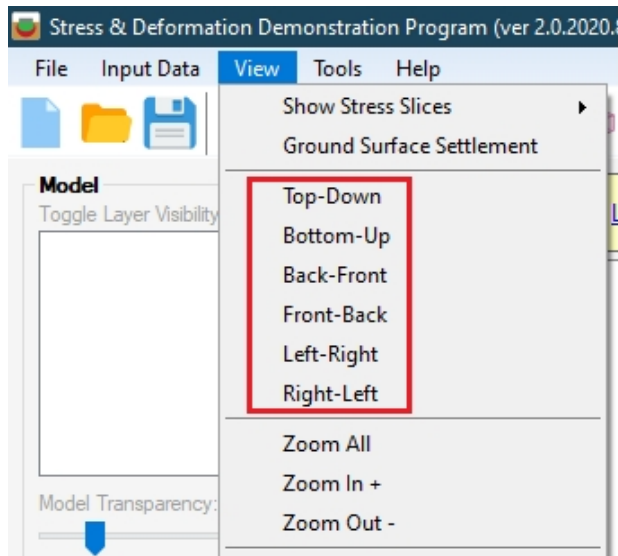


Orthographic projection

Perspective viewpoints give more information about depth and are often easier to view because you use perspective views in real life. Orthographic viewpoints make it much easier to compare two objects, as there is no question about how the viewpoint may affect the perception of distance.

Face Views

Pre-defined face views may be selected from the [View](#) menu, or using the cub icon at the top-right corner of the screen.



Export

You can export your model to image and 3D PDF formats.

To Image

This feature is used to save the current view of the Bubble 3D model as an image. To access this feature, click on [File→Export→Image](#) menu.

To 3D PDF

In its simplest form, a 3D PDF is a standard Adobe PDF document that contains interactive 3D content such as text and other data types, 2D Graphics, 3D Graphics (3D CAD data), plus from a user perspective: the ability to interact with the document on many levels ([open an example here](#)).

You can export your VisLog model to 3D PDF format from [File→Export](#) menu.

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