RockWin Help

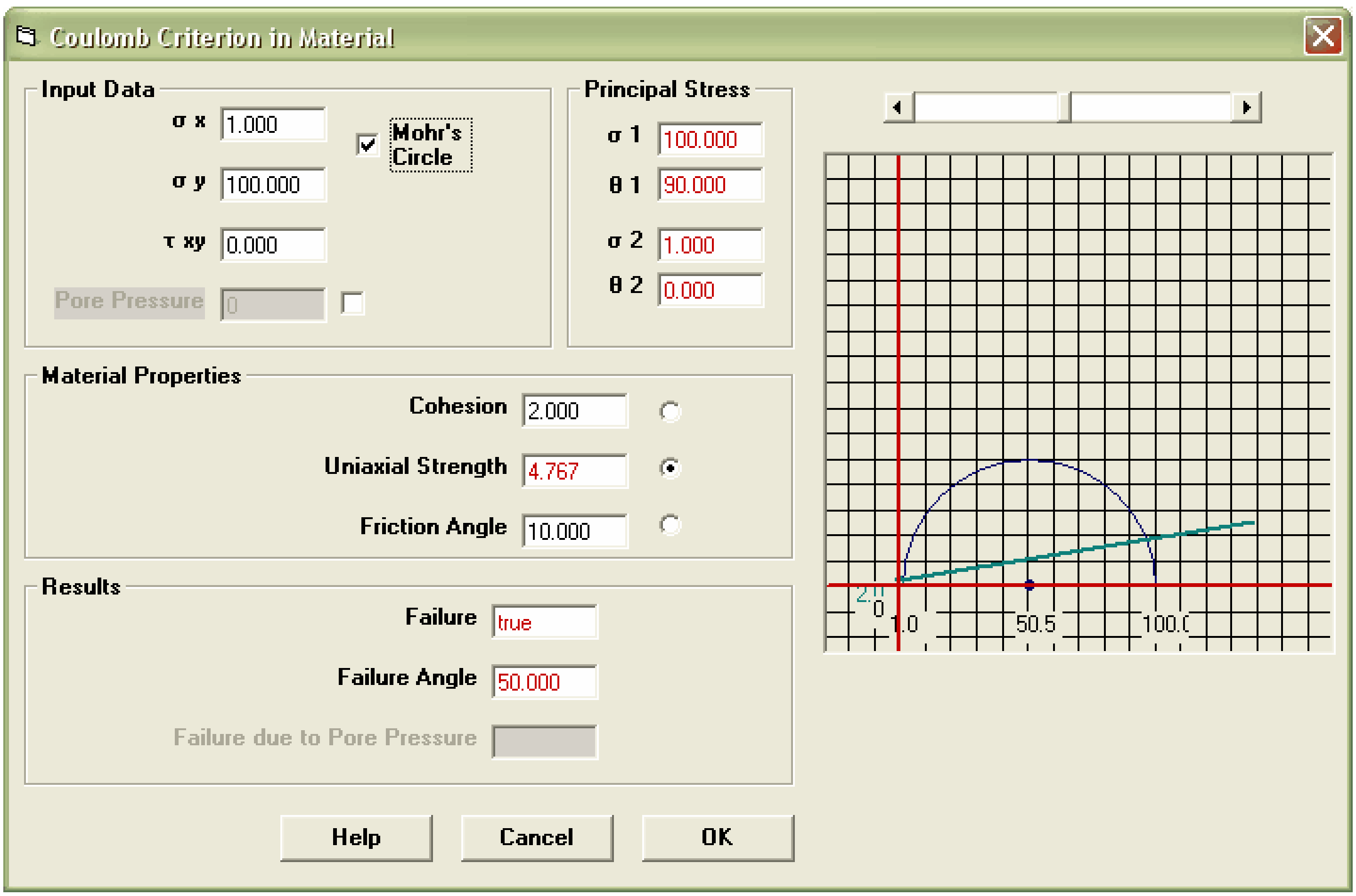


Table of Contents

Part I

1 RockWin

Help File Updated: Saturday, March 25, 2023.

1.1 Overview

The Rockwin package was developed to help mining and geotechnical engineering students gain insight to some of the basic concepts of 2D and 3D stress and strain analysis, failure criteria, interpretation of lab results and other aspects of geomechanics.

Part II

2 The File Menu

Description:

Use the File menu option to access various file management operations such as:

Creating New Files

Opening Existing Files

Saving Files

Saving Files under Different Names (Save As)

Setting up the Printer

Printing Files

Print Preview

Browsing Text Files

Exiting the Program

2.1 Creating New Files

Description:

Use the New option to erase the existing dataset (if any) from memory and create a new (blank) dataset. All related entries are set to their initial values.

Notes:

- The program will prompt you whether to save the current file to disk.

2.2 Opening Existing Files

Description:

Use the open option to load a file (dataset) from the disk into program memory.

To use Open:

- Select the Open option from the File menu. The program displays a listing of the available files in the current data directory.
- Optionally, select a different drive or directory using the mouse or the cursor control keys.
- Select or enter a filename.

Notes:

- If the file extension is omitted, the default extension will be appended.
- If the current dataset is not saved, the program will prompt whether to save changes or not before discarding the current dataset.

2.3 Saving Files

Description:

Use the Save option to save an existing file (dataset) to the drive or directory from which it was originally loaded. Any changes that were made since the last time the file was saved will be saved on the disk. The filename stays the same and the file remains in memory.

To use Save:

Select the Save option from the File menu.

Notes:

- If the file has never been saved using the Save As option, choosing Save automatically displays the Save As dialogue box, which prompts for a filename before saving it.

2.4 Saving Files under Different Names (Save As)

Description:

Use the Save As option to save a file and give it a new name.

To use Save As:

- Select the Save As option from the File menu. The program displays a listing of the available files in the current data directory.
- Optionally, select a different drive or directory.
- Select or enter a filename.

Notes:

- If the file exists, the program will prompt whether to overwrite the existing file.
- Use Save for a faster save operation.

2.5 Setting Up the Printer

Description:

Use this option to select the Printer to use for printing output and graphics. This printer becomes the Windows default printer.

To use this option:

Select the Printer from the drop-down list and click on OK.

2.6 Printing Files

Description:

Use the Print option to print the current dataset (file) from program memory to the default windows printer. The default printer may be set using the Setting Up the Printer menu option.

Notes:

- The file is send directly to the printer, without preview. Use the Print Preview option to preview the file and then send it to the printer.

2.7 Print Preview

Description:

The user may navigate through the Print Preview Window by using the vertical scroll bar.

The text in the window can be send directly to the printer, or it can be copied to the Windows clipboard for use in other applications.

Notes:

- This operation does not send any control characters to the printer. All output is ASCII text. The text prints in "Courier" or "Courier New" font in size 9. If these fonts are not available to the printer, then printed text will appear in the default printer font.
- Each printed page is formatted with preset margins as follows:
  - ✓ left margin = 1 inch
  - ✓ top margin = 1 inch
  - ✓ bottom margin = 1 inch
  - ✓ right margin = variable

2.8 Browsing Text Files

Description:

Use the browse option to view a text (ASCII) file in a specified directory. No editing is allowed during browsing.

Use the pattern field to specify a file pattern (i.e. *.txt). The file window will be reset to conform to the specified pattern. The default pattern is *.ALP. More than one patterns can be applied using “;” as delimiter (e.g. *.txt;*.dxf).

Use the *Set Font* command button to specify the type and size of font for the displayed text. These settings are saved in the RockWin.INI file.

Use the cursor control keys to move within the browse window.

2.9 Exiting the Program

Description:

Use the Exit option when ready to exit this program and return to the original environment. The program will prompt you to save the current file to disk, if not already saved.

Part III

3 The Input Menu

Description:

Use the Edit menu option to access various parameter input/edit forms such as:

Project Description

Project Input Parameters (this includes a number of options categorized thematically)

3.1 Project Description

Description:

This is an arbitrary 300 character description of the model being generated. It is a recommended to make this a fairly detailed description of the specifics of the input file. This text may be a single line of characters or may contain "carriage return characters".

The user can also set the type of units that will be used in the current project. The program is designed to use two different sets of units:

- English (i.e. ft, lbs, etc)
- Metric (i.e. m, kN, etc)

Note that calculations performed in many of the forms in this program are unitless, i.e. they work the same for any unit.

3.2 Project Input Parameters

Options:

Stress Analysis

Failure Criteria

Elasticity in 2D

Strain Analysis

Coordinate Transformation

Laboratory Evaluation

Roof Bolting

3.2.1 Stress Analysis

[2D](#)

[3D](#)

[Circular Openings](#)

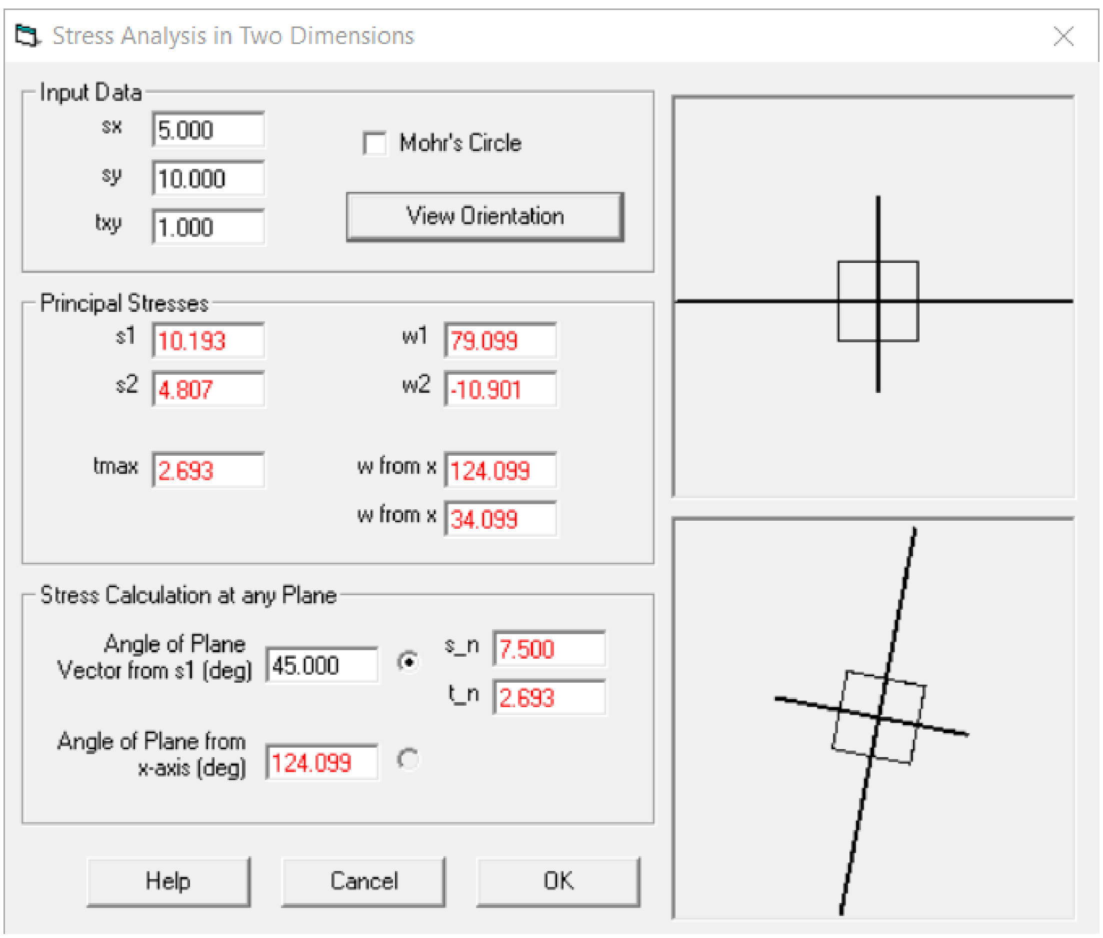
[Room and Pillar Mining](#)

[Point Load on Surface](#)

[Distributed Load on Surface](#)

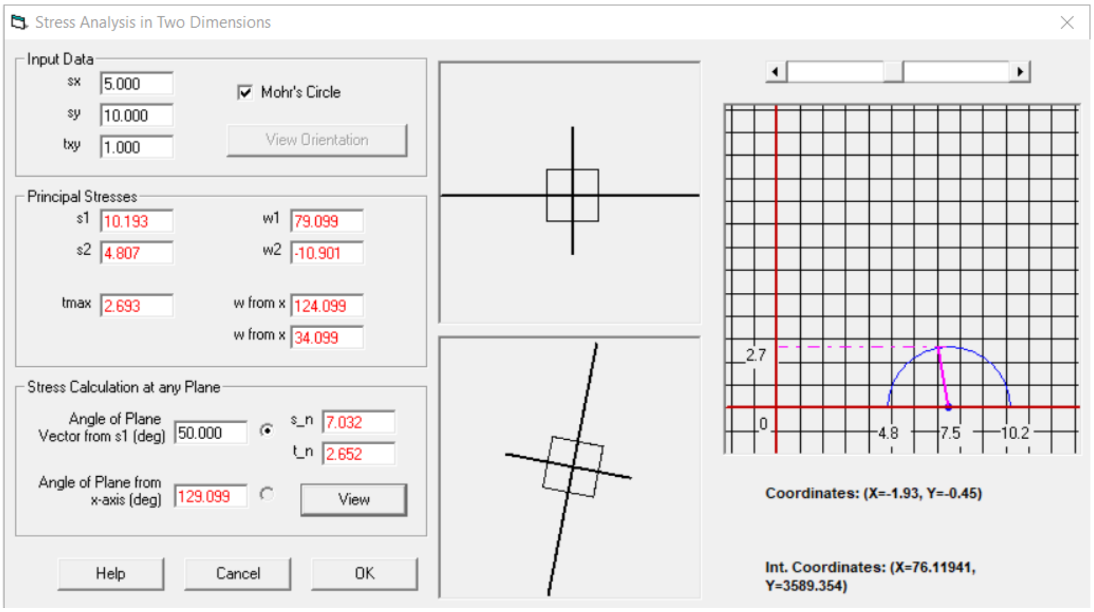
3.2.1.1 2D

This tool calculates the orientation and magnitude of the principle stresses from the two-dimensional stress state provided. The normal and shear stress on any plane, measured from the maximum principle stress direction, is also calculated. A diagram showing the orientation of the input data is shown next to the input data box in the image below. Click "View Orientation" to show a diagram showing the orientation of the principle stresses below.



Input numbers are in black. Results are shown in red.

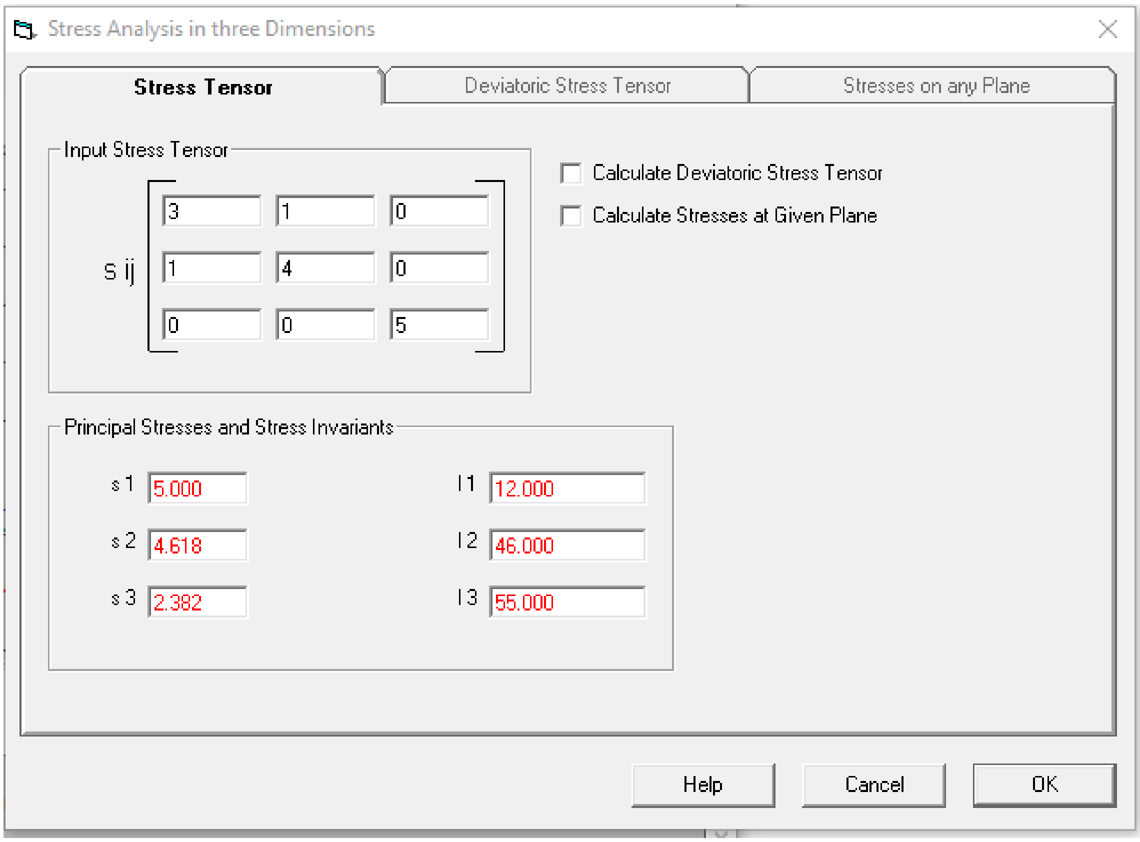
To view the Mohr's circle for the inputted stress state, check the box next to "Mohr's Circle" and a graph will extend to the right of the data entry area. The plane stress state is shown on the graph in pink.



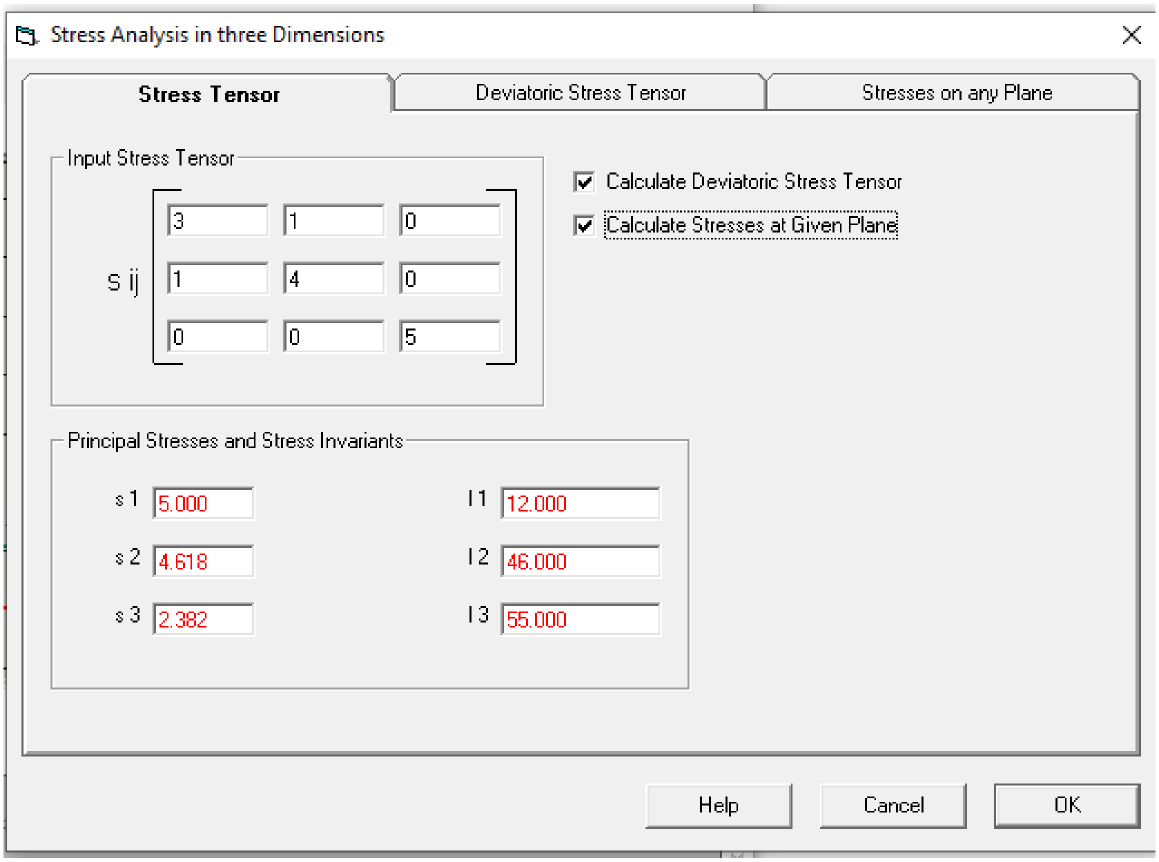
3.2.1.2 3D

This tool calculates the stress invariants and the magnitude of the principle stresses from the three-dimensional stress state provided.

To calculate the deviatoric stress tensor or stresses at a given plane, check the box next to the respective option and the additional tabs will be made available.



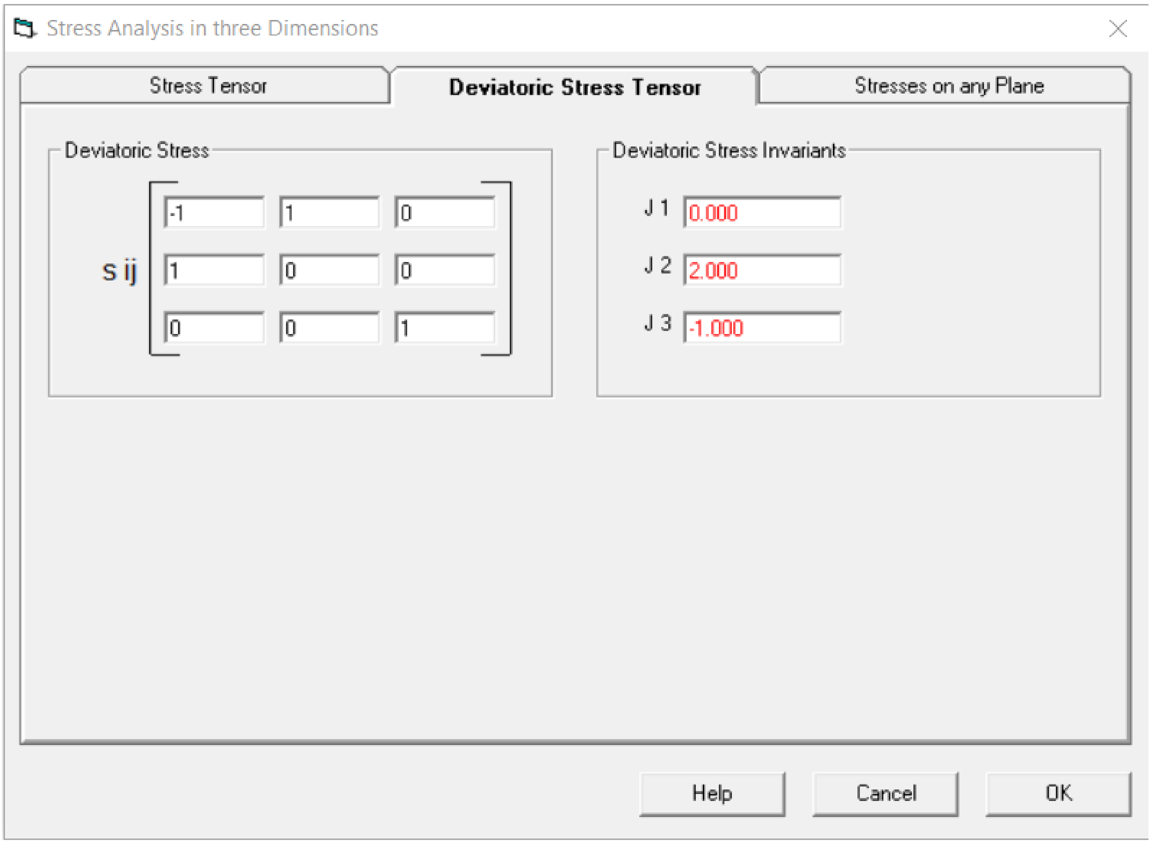
Additional tabs not available with check boxes unchecked.



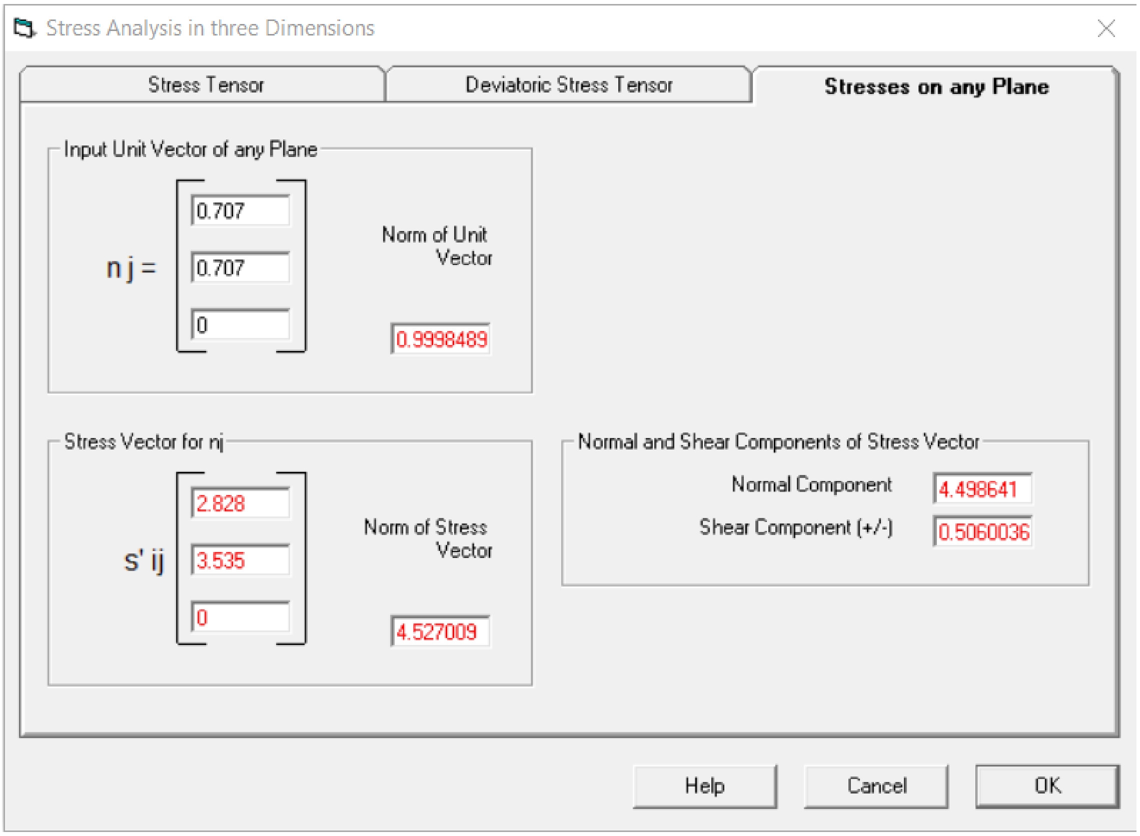
Additional tabs become available after check boxes are checked.

Input numbers are in black. Results are shown in red.

The deviatoric stress invariants are calculated by providing the deviatoric stress tensor.



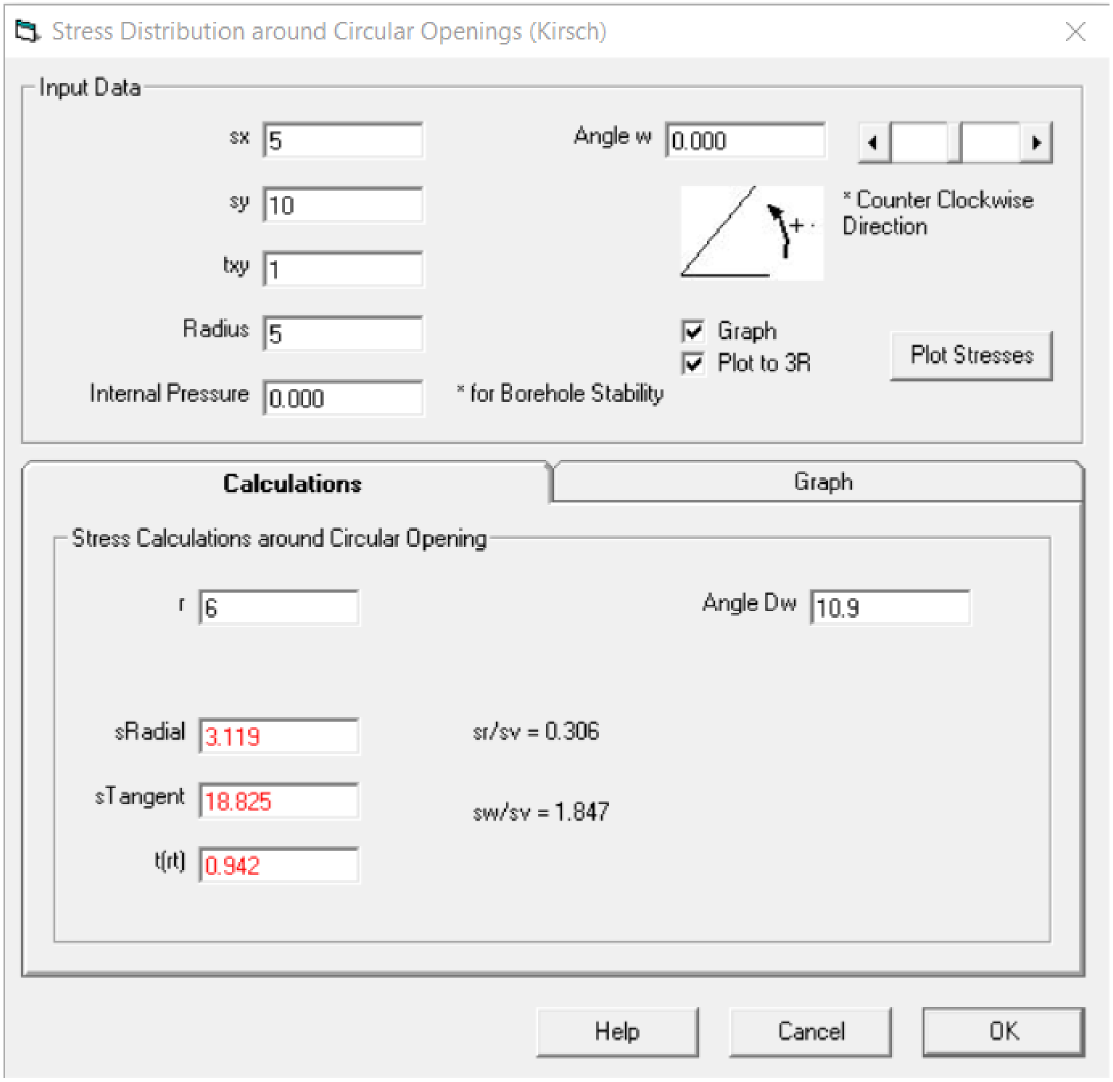
The stresses on any plane are calculated by providing the unit vector of the desired plane. The normal of the unit vector, stress vector, and normal and shear components of the stress vector are calculated.



3.2.1.3 Circular Openings

The stress around circular openings is calculated by providing the stress state, radius of the opening, and angle from the horizontal to the stress state desired.

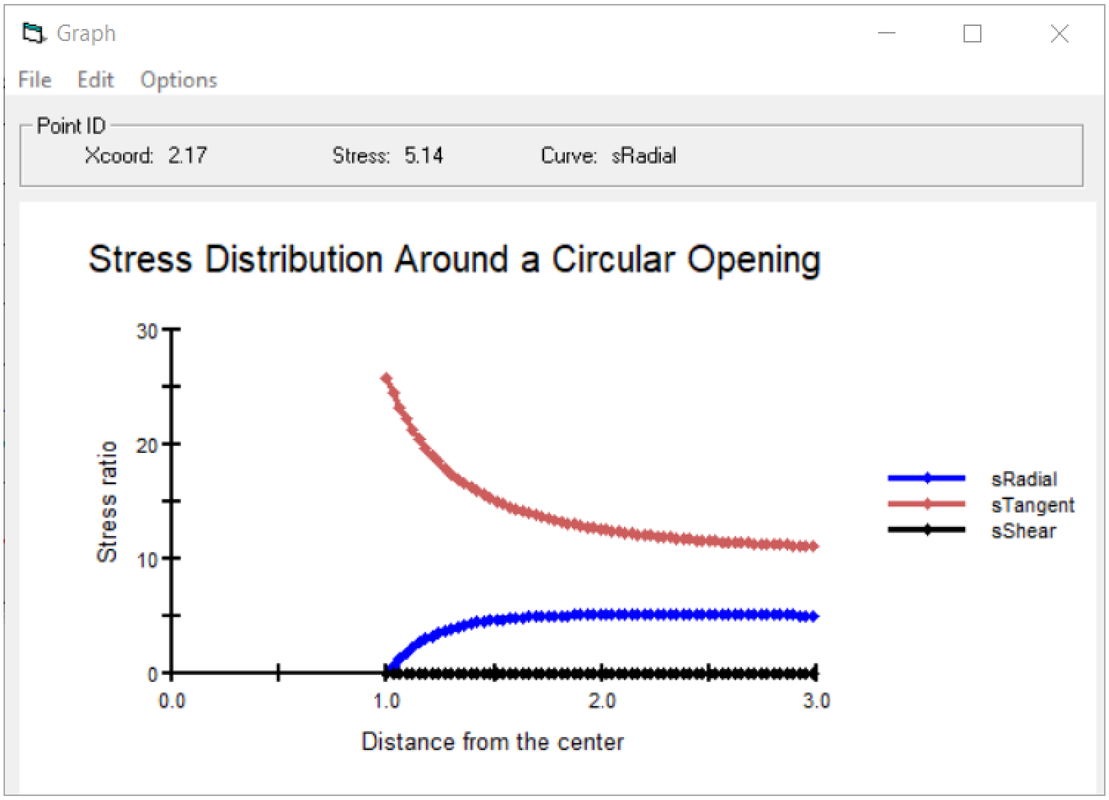
In the calculations tab, a radial distance greater than the radius of the opening can be entered to calculate the radial, tangential, and shear stress at that point. The stress ratios are also calculated.



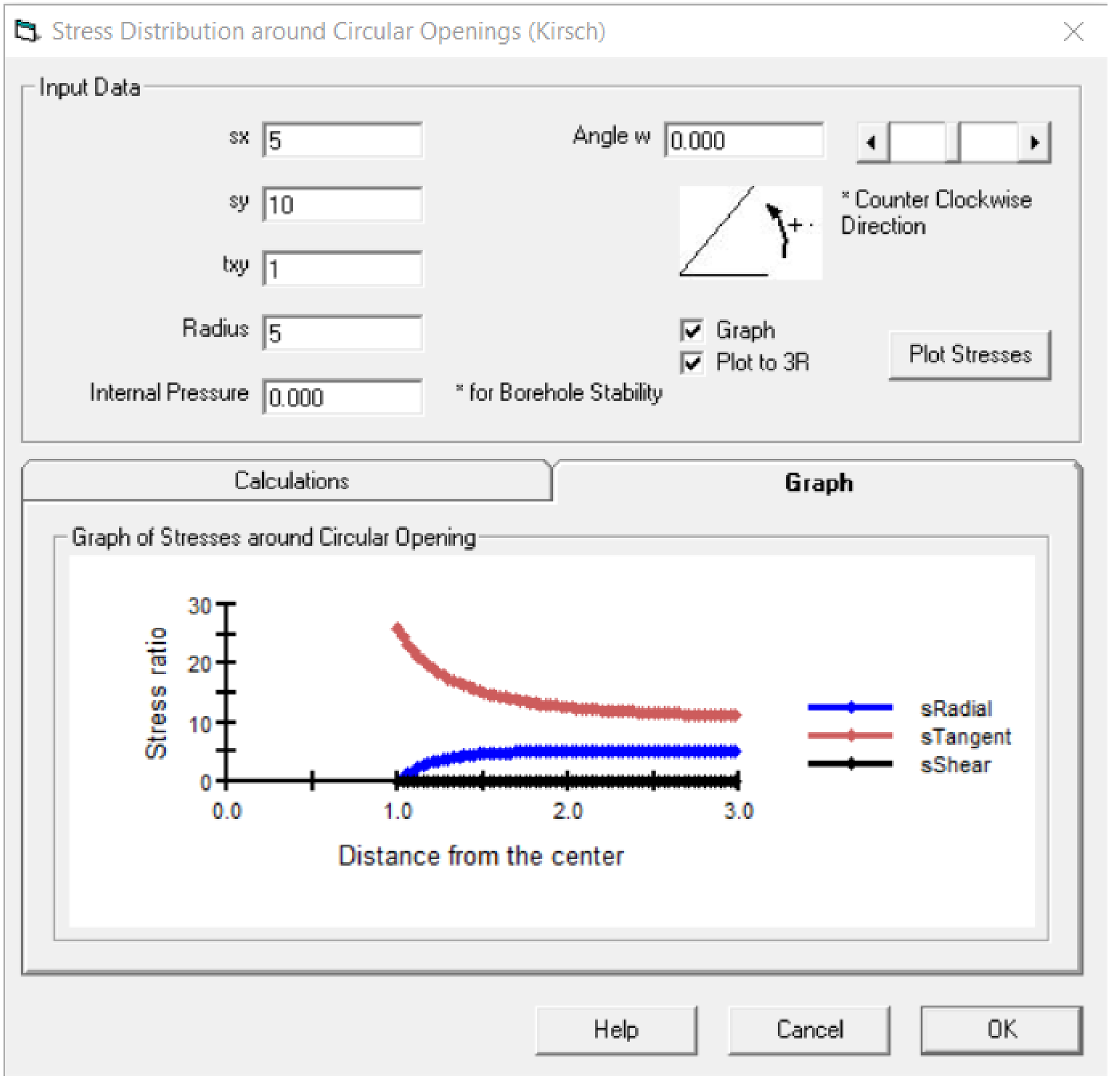
Input numbers are in black. Results are shown in red.

If the box next to "Graph" is checked, then the plot of the stress distribution around the opening at the location specified will open as soon as the stresses and radius are entered. To open this if it does not open automatically, check the box next to "Graph" and click "Plot Stresses".

To plot to 3 times the radius, check the box next to "Plot to 3R". Otherwise the graph will plot to 5 times the radius.

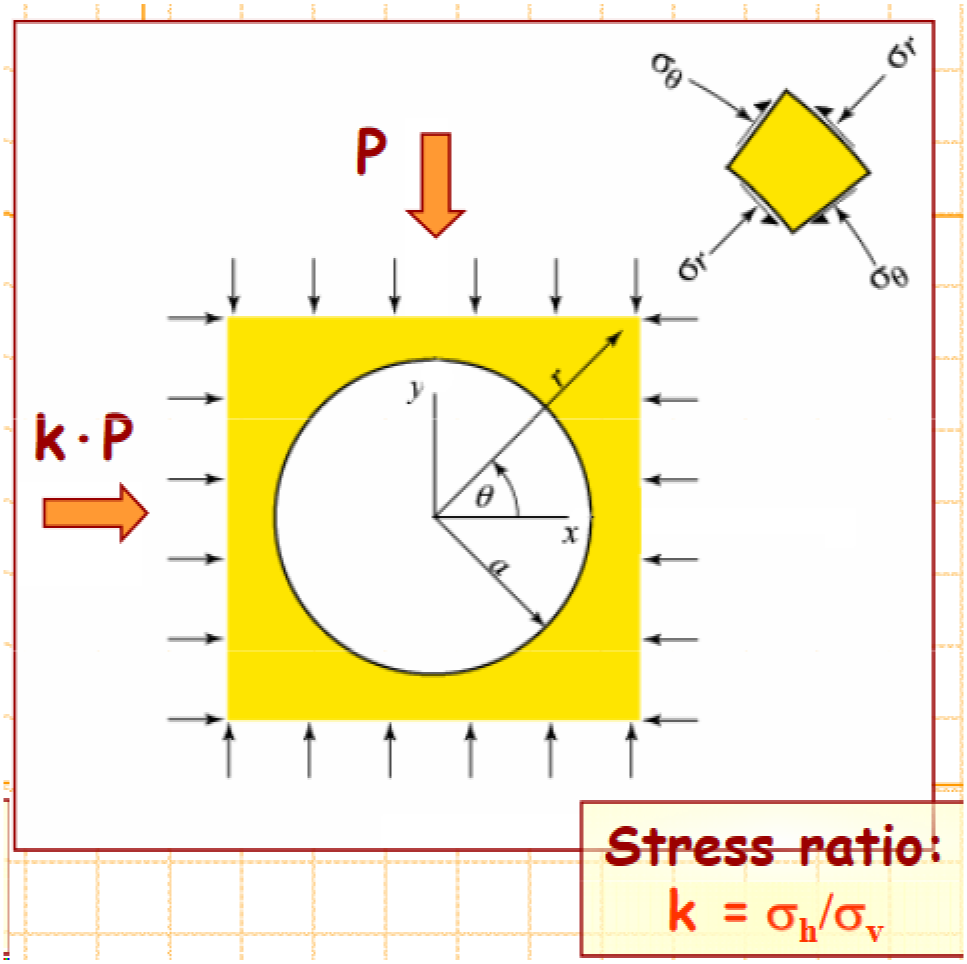


The radial, tangential, and shear stresses are plotted for the stress state and orientation provided. The x-axis is the distance from the center of the opening, expressed in radii. The y-axis is the stress ratio, and is unitless.



The graph can also be shown by clicking on the "Graph" tab.

The solutions and graphs are generated based on the formulation by Kirsch. The Kirsch equations are a set of closed-form solutions, derived from the theory of elasticity, used to calculate the stresses and displacements around a circular excavation in an infinite medium.


P
k·P
σθ
σr
σr
σθ
y
x
θ
r
a
Stress ratio:
k = σh/σv

$$\sigma_{rr} = \frac{p}{2}\left[(1+K)\left(1-\frac{a^2}{r^2}\right)-(1-K)\left(1-4\frac{a^2}{r^2}+\frac{3a^4}{r^4}\right)\cos 2\theta\right]$$

$$\sigma_{\theta\theta} = \frac{p}{2}\left[(1+K)\left(1+\frac{a^2}{r^2}\right)+(1-K)\left(1+\frac{3a^4}{r^4}\right)\cos 2\theta\right]$$

$$\sigma_{r\theta} = \frac{p}{2}\left[(1-K)\left(1+\frac{2a^2}{r^2}-\frac{3a^4}{r^4}\right)\sin 2\theta\right]$$

$$u_r = -\frac{pa^2}{4Gr}\left[(1+K)-(1-K)\left\{4(1-\nu)-\frac{a^2}{r^2}\right\}\cos 2\theta\right]$$

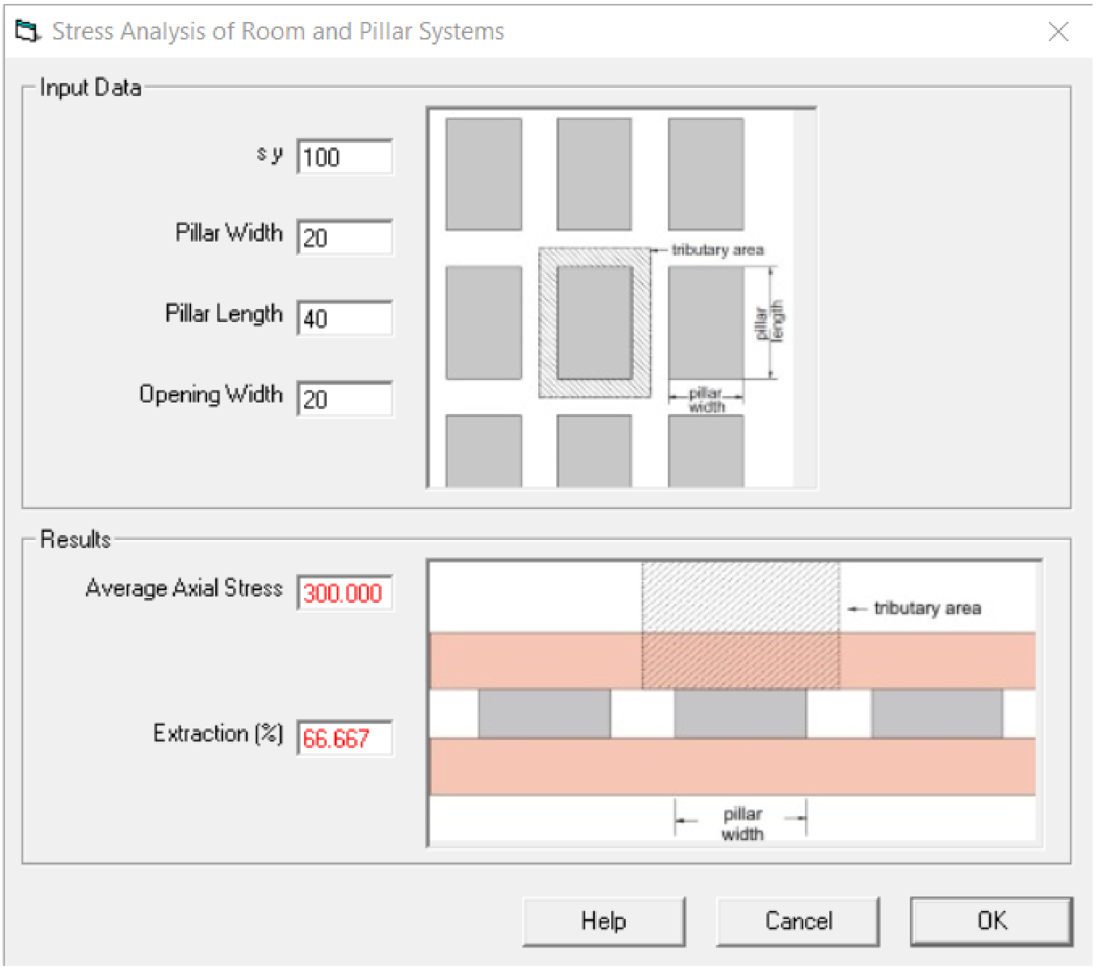
$$u_\theta = -\frac{pa^2}{4Gr}\left[(1-K)\left\{2(1-2\nu)+\frac{a^2}{r^2}\right\}\sin 2\theta\right]$$

(Erik Eberhardt – UBC Geological Engineering, ISRM Edition)

3.2.1.4 Room and Pillar Mining

The axial stress and extraction ratio of a room and pillar design are calculated by inputting vertical stress, pillar width, pillar length, and opening width.

The average axial stress on the pillars and extraction percentage are calculated.

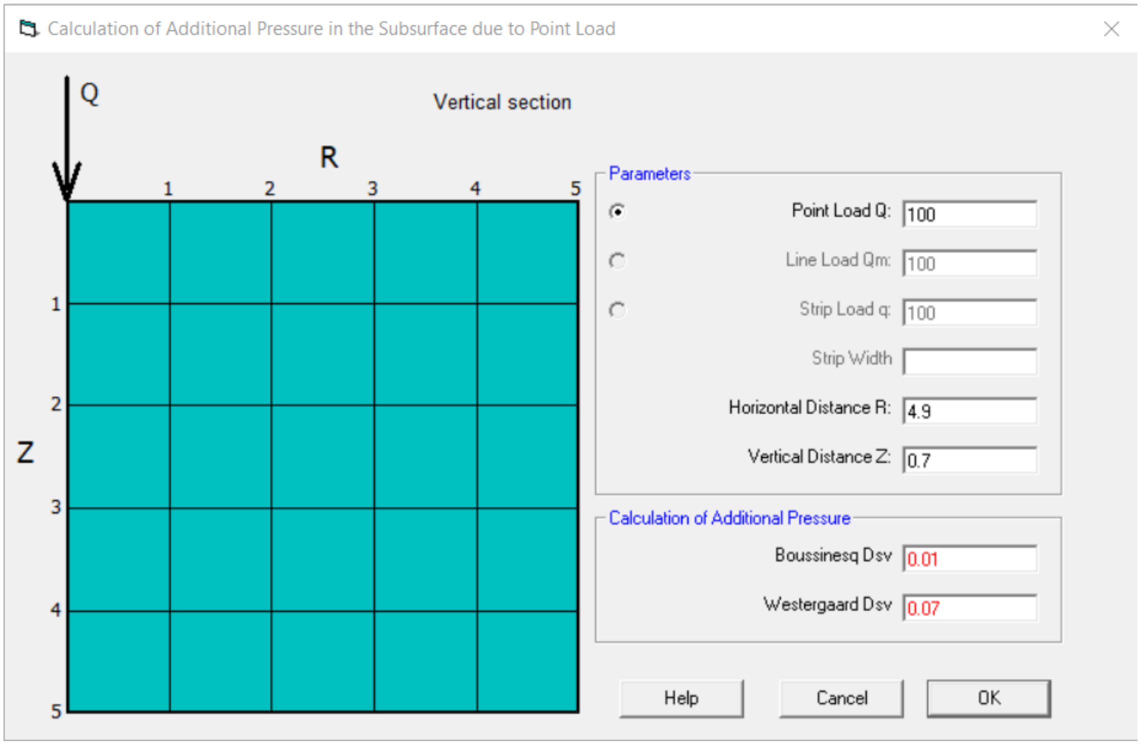


Input numbers are shown in black. Results are shown in red.

Units should be uniform, feet, lbs/sq.ft, etc.

3.2.1.5 Point, Line and Strip Load on Surface

This tool calculates the additional stress on a point underground due to a vertical point load on the surface. Enter the point load and horizontal and vertical distance of the point to calculate. The load can also be entered as a line load or a strip load by selecting the appropriate radio button option.



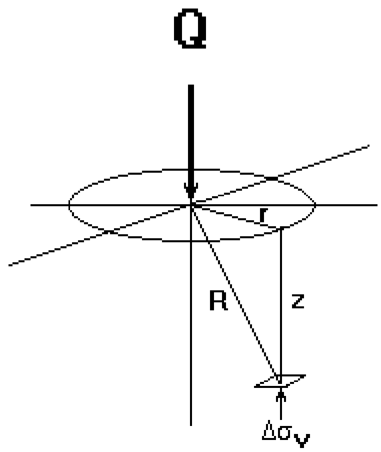
Input numbers in black. Results are shown in red.

Hovering the mouse over different points in the blue vertical section shown calculates the additional pressure at each of the points specified.

The French mathematician Boussinesq developed an expression for the stress distribution under a point load on the surface of a homogeneous, isotropic linearly elastic half space (i.e., "soil surface"). The soil is not really homogeneous and isotropic, it is usually layered. It is not linearly elastic, instead its elasticity generally increases with depth, becoming stiffer as the overburden stress increases. Boussinesq is very useful, however, because it represents the greatest stress that can be developed for a given loading condition.

The change in total stress at a depth z and radius r from the point of application of a Point Load Q is given by

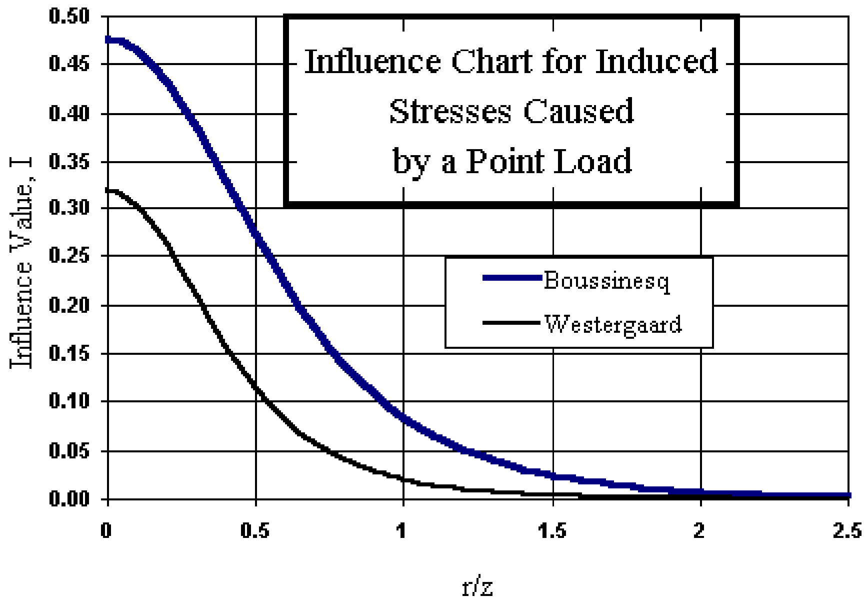
$$\Delta\sigma_v = \frac{3Q}{2\pi}\frac{z^3}{\left(r^2+z^2\right)^{5/2}} = \frac{Q}{z^2}\cdot\frac{3}{2\pi\left[1+\left(\frac{r}{z}\right)^2\right]^{5/2}} = \frac{Q}{z^2}\cdot I_B$$

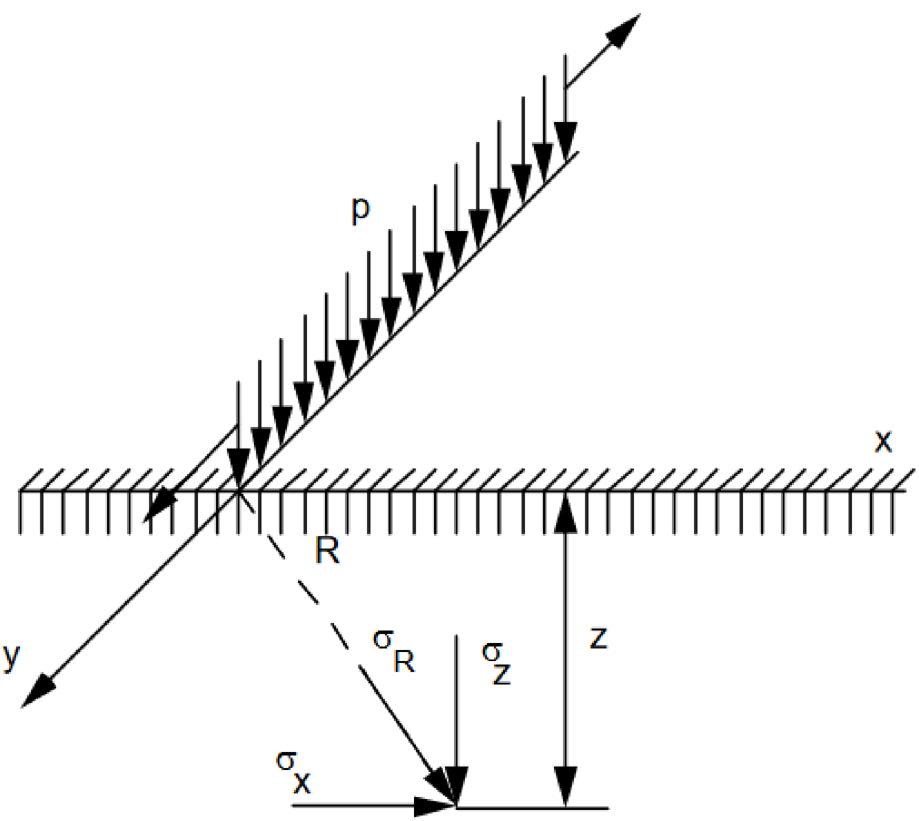


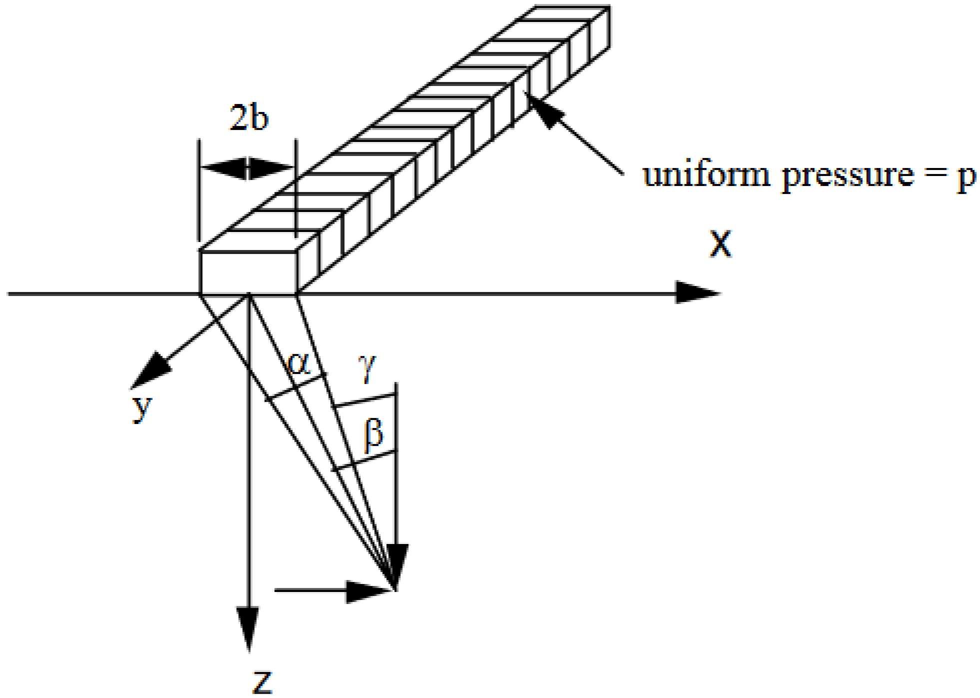
Westergaard produced a similar relationship for the case in which the soil is homogeneous but anisotropic, in which zero lateral deformation is allowed. This represents the other extreme from the Boussinesq solution. Real soil behavior generally falls between these two solutions. The Boussinesq solution is more commonly used because it yields higher vertical stress values; the Westergaard solution is primarily used as a comparison value. The Westergaard relationship is:

$$\Delta\sigma_v = \frac{Q}{z^2}\cdot\frac{1}{\pi\left[1+2\left(\frac{r}{z}\right)^2\right]^{5/2}} = \frac{Q}{z^2}\cdot I_W$$

Comparison between the two formulations:

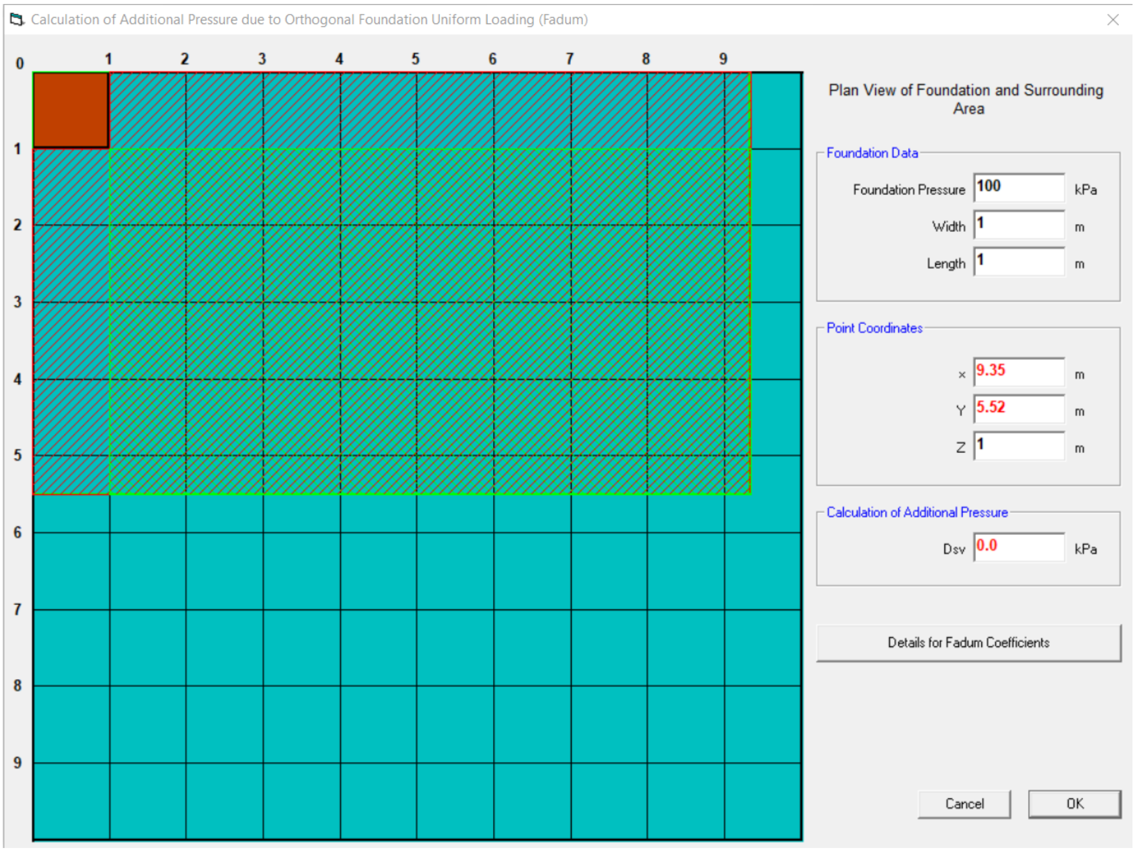

Influence Chart for Induced Stresses Caused by a Point Load
Influence Value, I
r/z
Boussinesq
Westergaard
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.5
1
1.5
2
2.5


p
x
R
y
σR
σz
z
σx



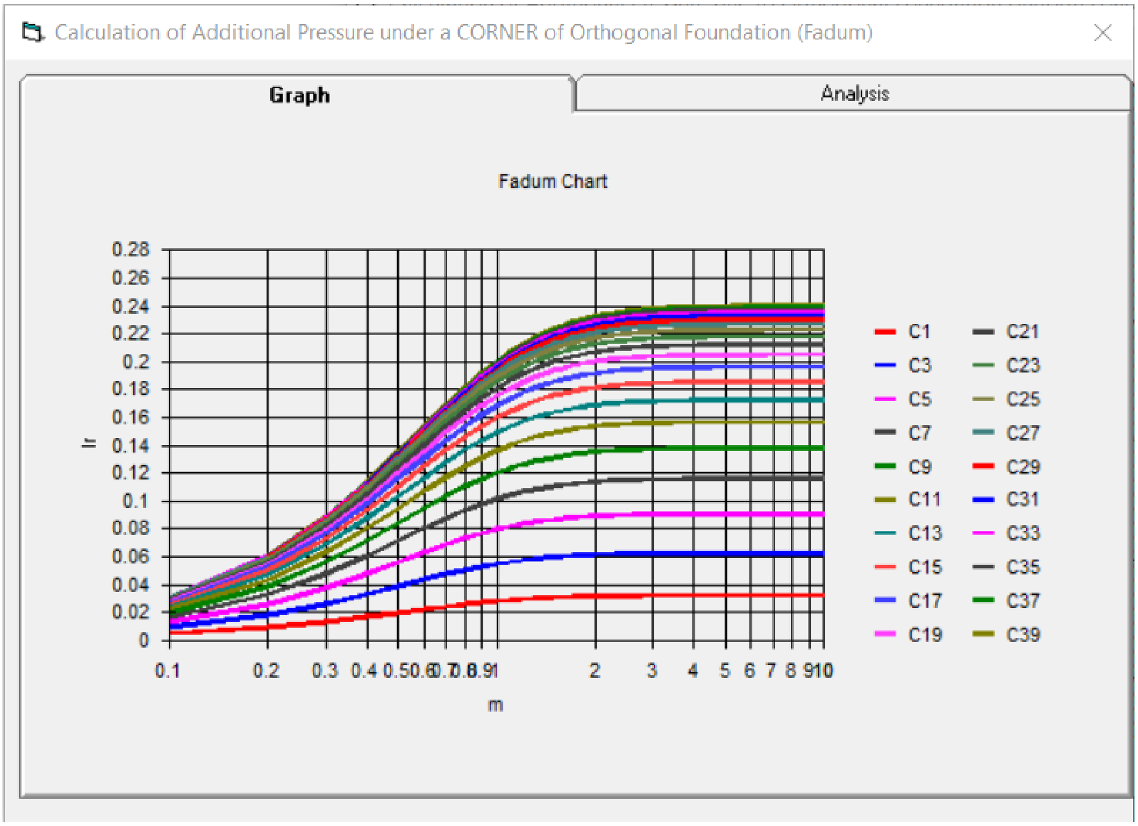
3.2.1.6 Distributed Load on Surface

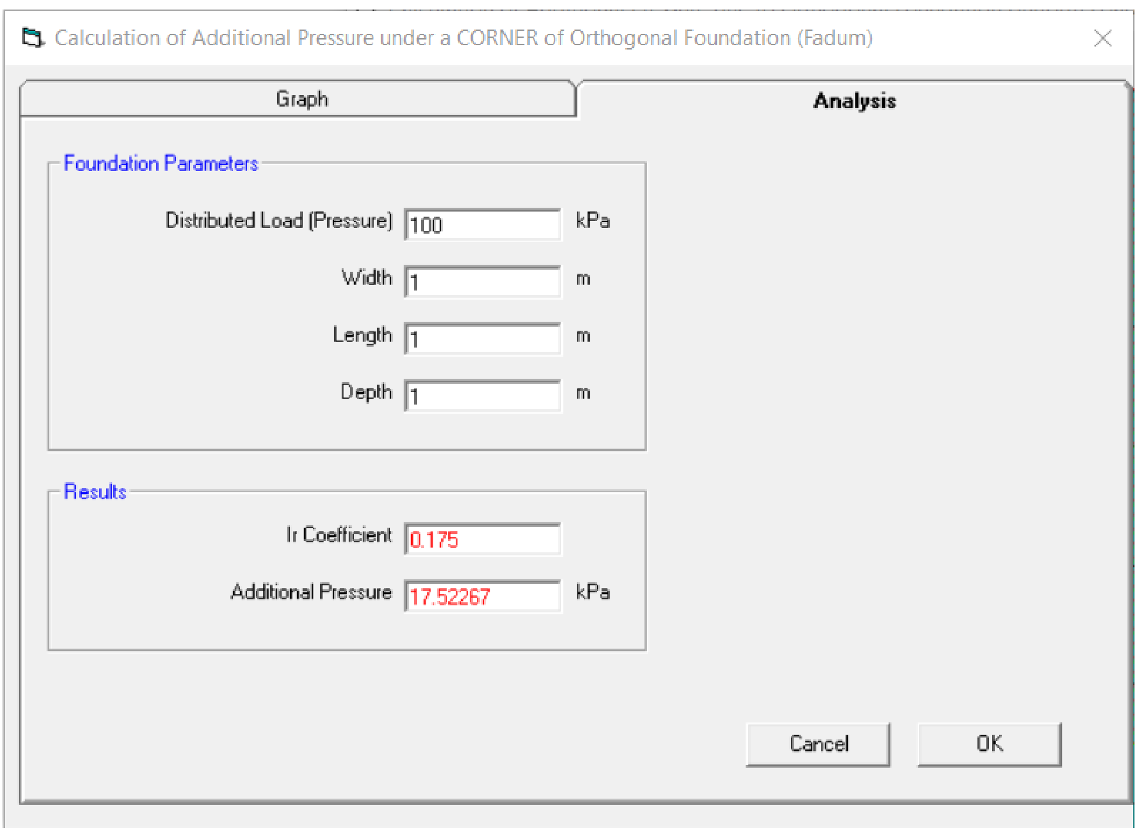
The additional pressure on a point underground from a distributed load on the surface is calculated using this tool.



Input numbers are in black. Results are shown in red.

Click on Details to get the following graph and different analysis options.


Calculation of Additional Pressure under a CORNER of Orthogonal Foundation (Fadum)
Graph
Analysis
Fadum Chart
Ir
m
C1 C3 C5 C7 C9 C11 C13 C15 C17 C19 C21 C23 C25 C27 C29 C31 C33 C35 C37 C39


Calculation of Additional Pressure under a CORNER of Orthogonal Foundation (Fadum)
Graph
Analysis
Foundation Parameters
Distributed Load (Pressure) 100 kPa
Width 1 m
Length 1 m
Depth 1 m
Results
Ir Coefficient 0.175
Additional Pressure 17.52267 kPa
Cancel
OK

The stresses and deformations generated in an elastic half space by a uniform, normal, surface pressure applied over a rectangular area, can be found by subdividing the rectangular
area into sufficiently small blocks and treating the stress applied by each block as a point load. Theoretically exact solutions may be obtained by integration:

$$\frac{\sigma_z}{p} = \frac{1}{4\pi}\left[F\left(1 + \frac{z^2}{R^2}\right) + \sin^{-1} F\right]$$

where:

$$F = \frac{2ABzR}{z^2R^2+A^2B^2}$$

$$R = \sqrt{A^2 + B^2 + z^2}$$

where p is the uniform vertical pressure applied over a rectangular area of dimensions A by B defined on a horizontal plane surface, and z is the depth beneath one corner to the point at which the vertical normal stress is to be calculated. Two dimensionless factors are defined as m = A/z and n = B/z. The entire right hand side of the first equation above can be considered an influence factor (Ir).

Values for the influence factor were calculated by Newmark (1935) and have been presented in tabular or graphical form by Fadum (1948), Spangler (1951), Taylor (1948), and others. Because of their usefulness, the influence factors have been tabulated below:

Influence Factors for the Vertical Compressive Stress Beneath One Corner of a Uniformly Loaded RectangularArea at the Surface

m/n	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.1	0.005	0.009	0.013	0.017	0.020	0.022	0.024	0.026	0.027
0.2	0.009	0.018	0.026	0.033	0.039	0.043	0.047	0.050	0.053
0.3	0.013	0.026	0.037	0.047	0.056	0.063	0.069	0.073	0.077
0.4	0.017	0.033	0.047	0.060	0.071	0.080	0.087	0.093	0.098
0.5	0.020	0.039	0.056	0.071	0.084	0.095	0.103	0.110	0.116
0.6	0.022	0.043	0.063	0.080	0.095	0.107	0.117	0.125	0.131
0.7	0.024	0.047	0.069	0.087	0.103	0.117	0.128	0.137	0.144
0.8	0.026	0.050	0.073	0.093	0.110	0.125	0.137	0.146	0.154
0.9	0.027	0.053	0.077	0.098	0.116	0.131	0.144	0.151	0.162
1.0	0.028	0.055	0.079	0.101	0.120	0.136	0.149	0.160	0.168
1.2	0.029	0.057	0.083	0.106	0.126	0.143	0.157	0.168	0.178
1.5	0.030	0.059	0.086	0.110	0.131	0.149	0.164	0.176	0.186
2.0	0.031	0.061	0.089	0.113	0.135	0.153	0.169	0.181	0.192
2.5	0.031	0.062	0.090	0.115	0.137	0.155	0.170	0.183	0.194
3.0	0.032	0.062	0.090	0.115	0.137	0.156	0.171	0.184	0.195
5.0	0.032	0.062	0.090	0.115	0.137	0.156	0,172	0.185	0.196
10.0	0.032	0.062	0.090	0.115	0.137	0.156	0.172	0.185	0.196
∞	0.032	0.062	0.090	0.115	0.137	0.156	0.172	0.185	0.196

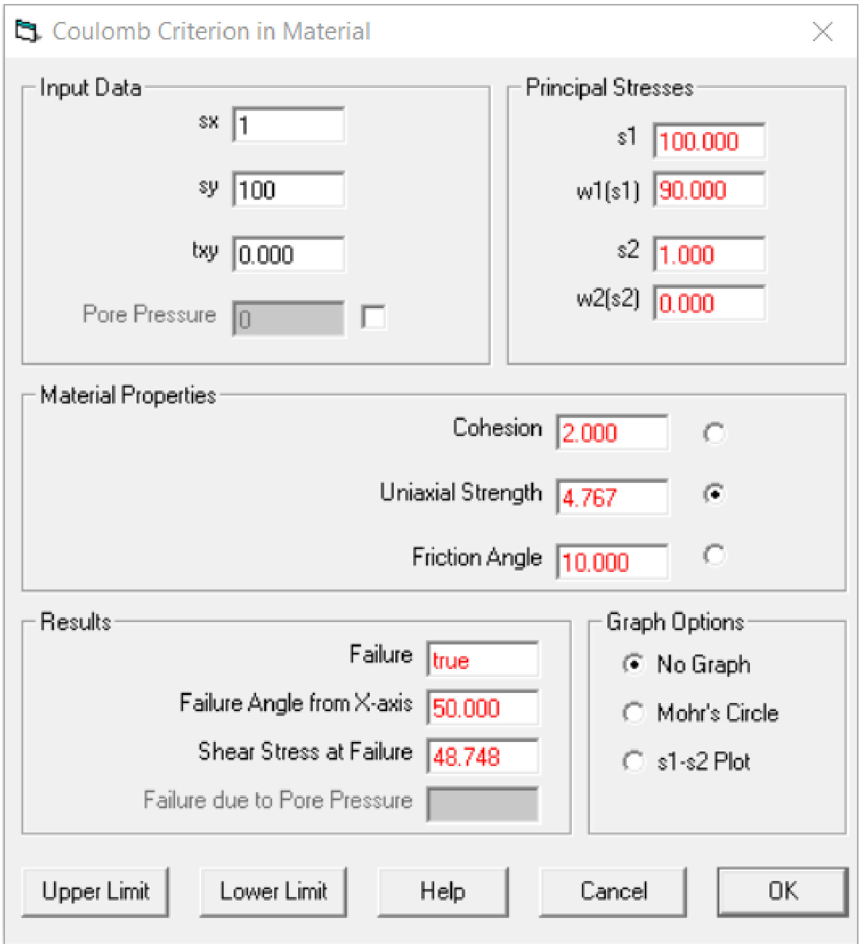
m/n	1.0	1.2	1.5	2.0	2.5	3.0	5.0	10.0	∞
0. 1	0.028	0.029	0.030	0.031	0.031	0.032	0.032	0.032	0.032
0.2	0.055	0.057	0.059	0.061	0.062	0.062	0.062	0.062	0.062
0.3	0.079	0.083	0.086	0.089	0.090	0.090	0.090	0.090	0.090
0.4	0.101	0.106	0.110	0.113	0.115	0.115	0.115	0.115	0.115
0.5	0.120	0.126	0.131	0.135	0.137	0.137	0.137	0.137	0.137
0.6	0.136	0.143	0.149	0.153	0.155	0.156	0.156	0.156	0.156
0.7	0.149	0.157	0.164	0.169	0.170	0.171	0.172	0.172	0.172
0.8	0.160	0.168	0.176	0.181	0.183	0.184	0.185	0.185	0.185
0.9	0.168	0.178	0.186	0.192	0.194	0.195	0.196	0.196	0.196
1.0	0.175	0.185	0.193	0.200	0.202	0.203	0.204	0.205	0.205
1.2	0.185	0.196	0.205	0.212	0.215	0.216	0.217	0.218	0.218
1.5	0.193	0.205	0.215	0.223	0.226	0.228	0.229	0.230	0.230
2.0	0.200	0.212	0.223	0.232	0.236	0.238	0.239	0.240	0.240
2.5	0.202	0.215	0.226	0.236	0.240	0.242	0.244	0.244	0.244
3.0	0.203	0.216	0.228	0.238	0.242	0.244	0.246	0.247	0.247
5.0	0.204	0.217	0.229	0.239	0.244	0.246	0.249	0.249	0.249
10.0	0.205	0.218	0.230	0.240	0.244	0.247	0.249	0.250	0.250
∞	0.205	0.218	0.230	0.240	0.244	0.247	0.249	0.250	0.250

3.2.2 Failure Criteria

3.2.2.1 Coulomb in Material

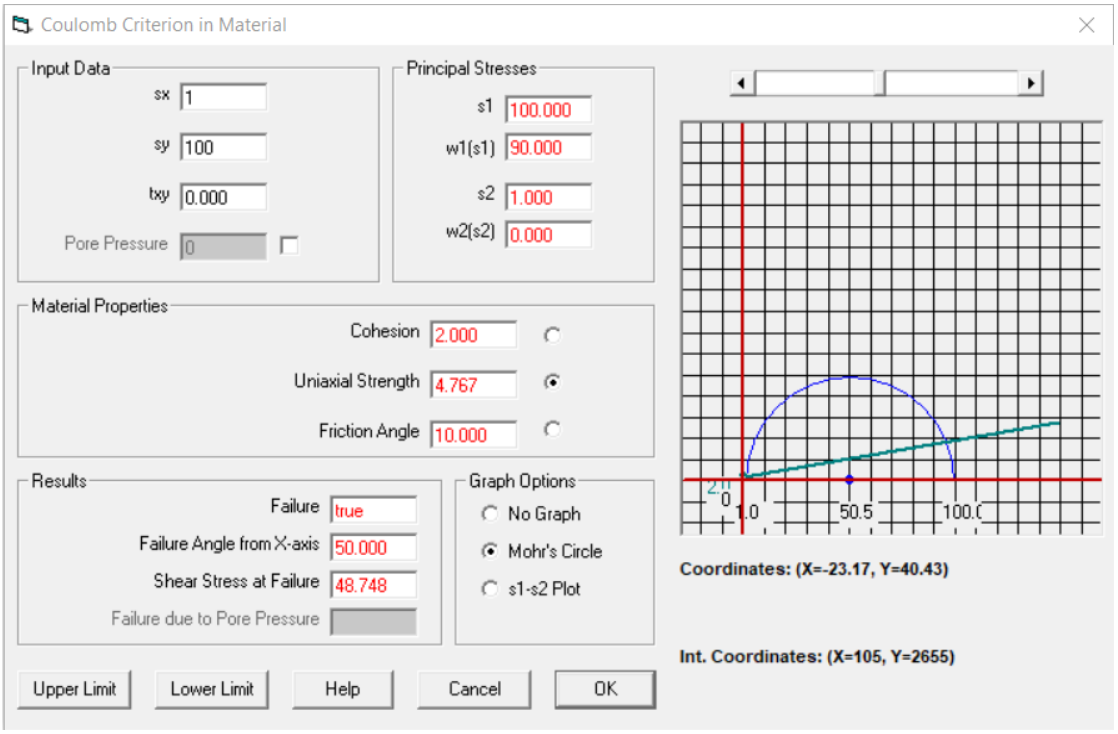
The Coulomb failure criterion of a material are calculated using this tool. To calculate, enter the stress state and two of the three provided material properties. Select the dot next to the material property that will not be provided and enter values for the two other material properties. The magnitude and orientation of the principle stresses are calculated for the stress state. The failure state is determined. If the material fails, then the failure angle and shear stress at failure are calculated.

To display no graph, select the dot next to "No Graph".

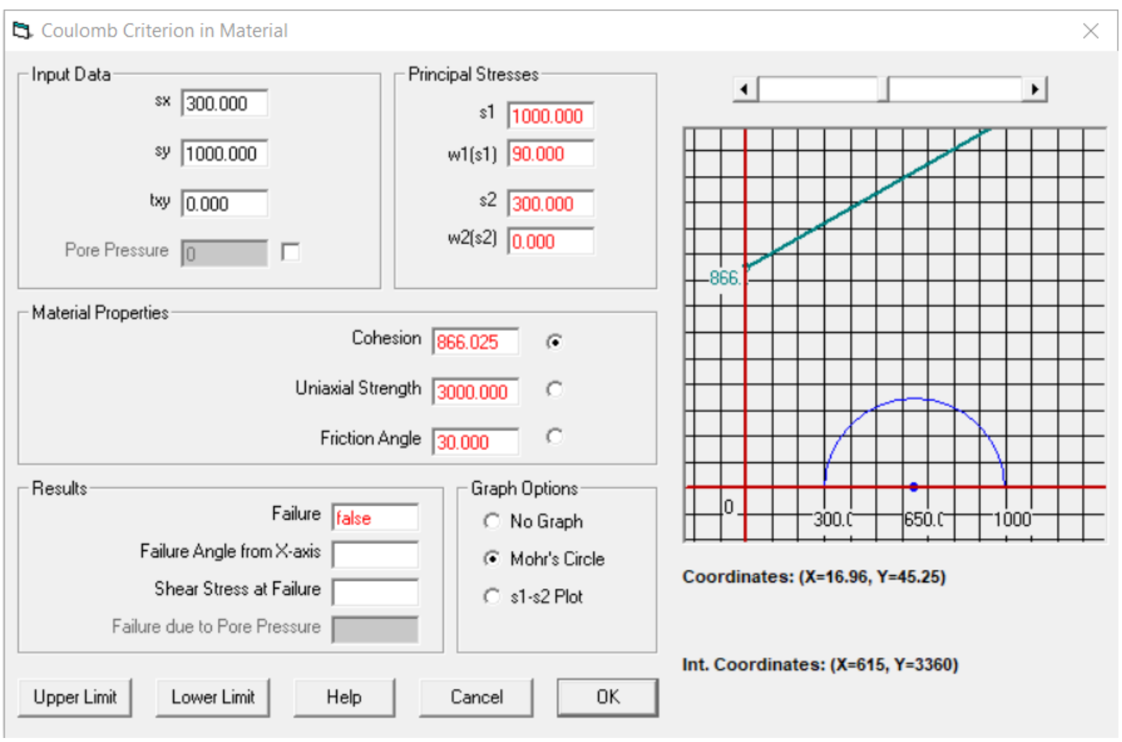


Input numbers are shown in black. Results are shown in red.

To display the Mohr's circle and failure criteria for the stress state, select the dot next to "Mohr's Circle".

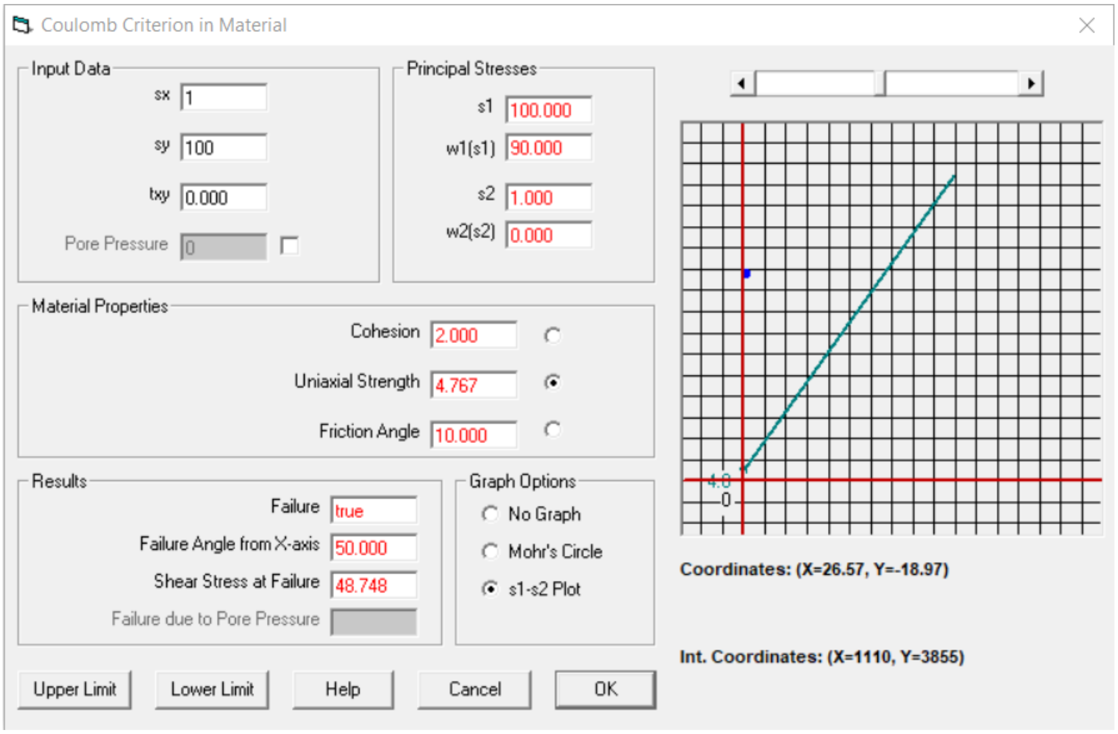


Material failed

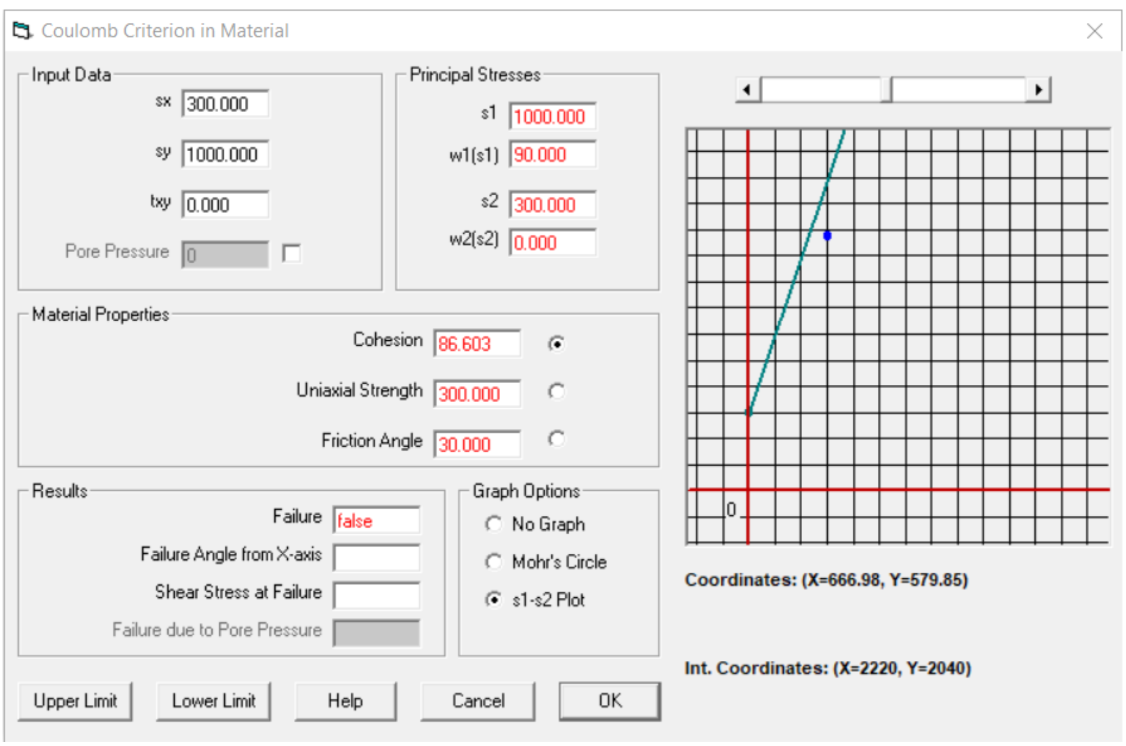


Material did not fail

To display the σ1-σ2 plot and failure criterion for the stress state, select the dot next to "s1-s2 Plot".

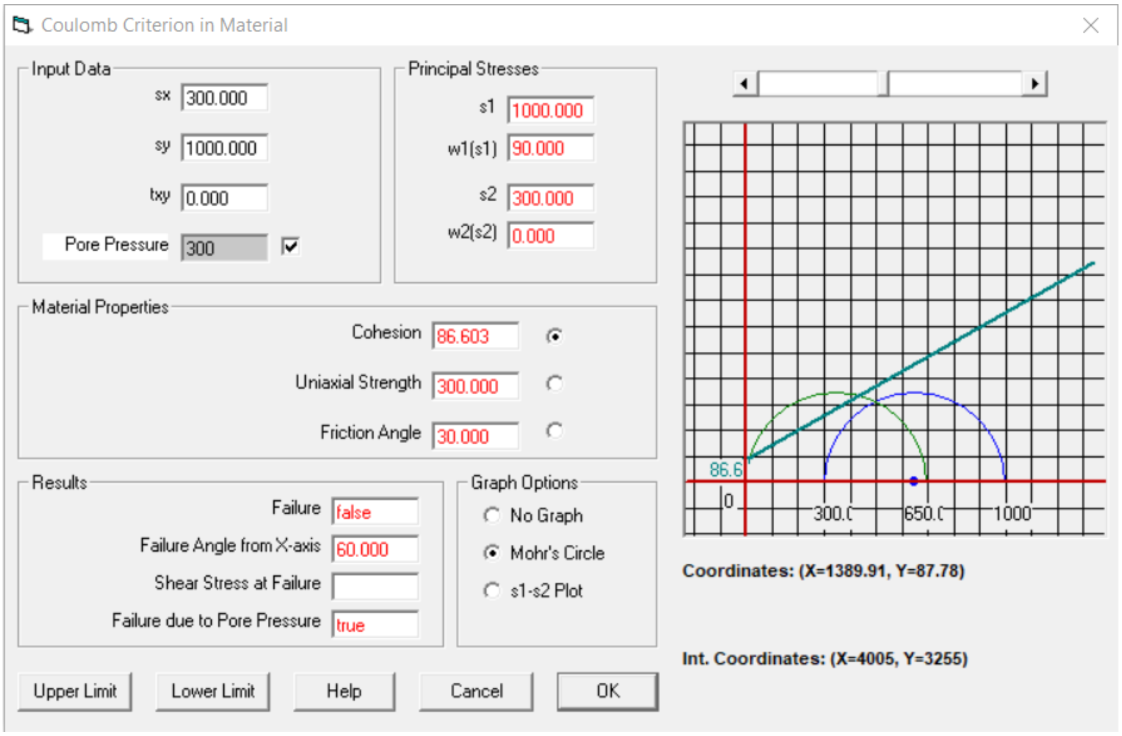


Material failed



Material did not fail

The pore pressure of a material can also be entered to determine if the material fails due to pore pressure. Check the box next to pore pressure and enter the value for pore pressure. The failure angle is calculated for pore pressure failure.

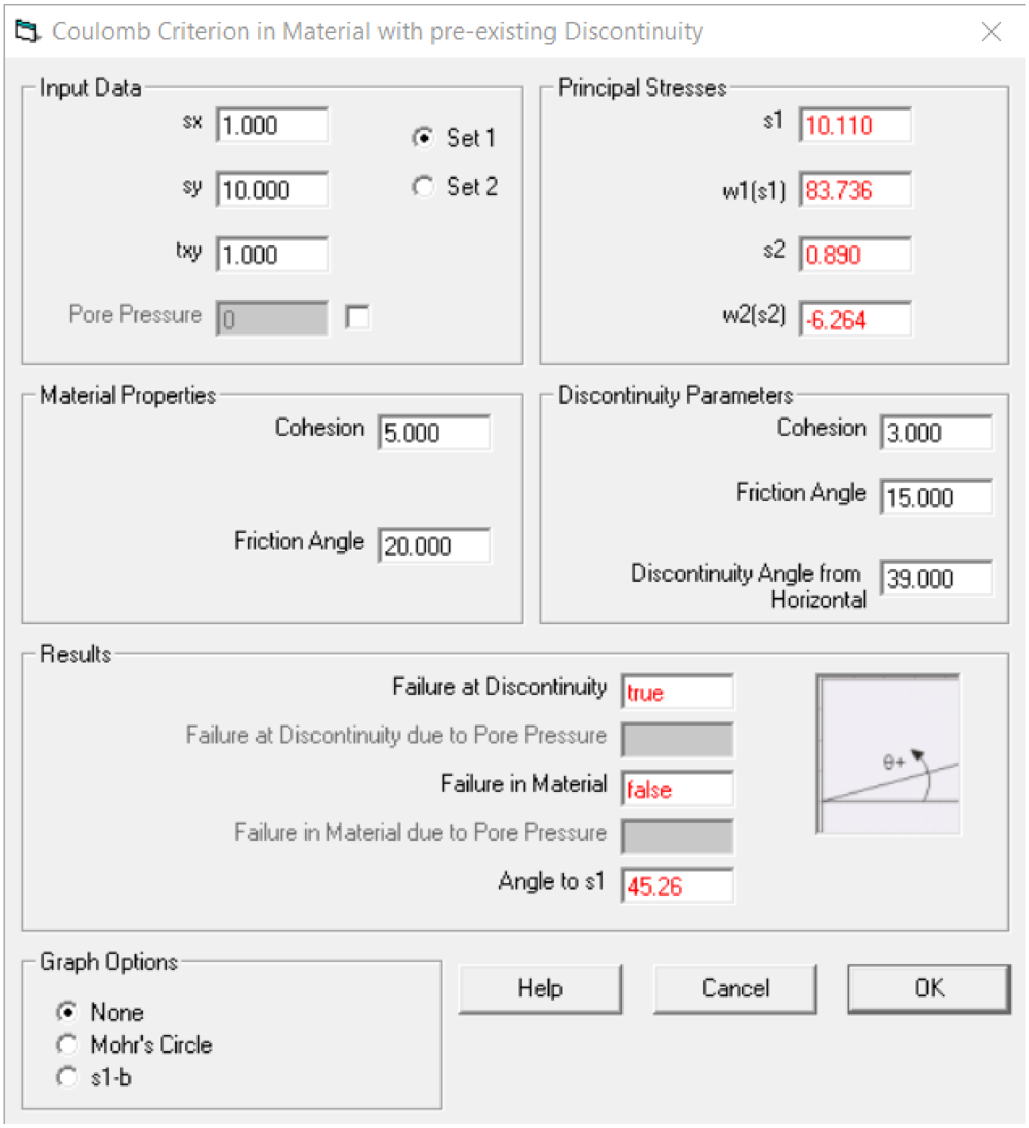


Material failed due to pore pressure

3.2.2.2 Coulomb in Material with Joint

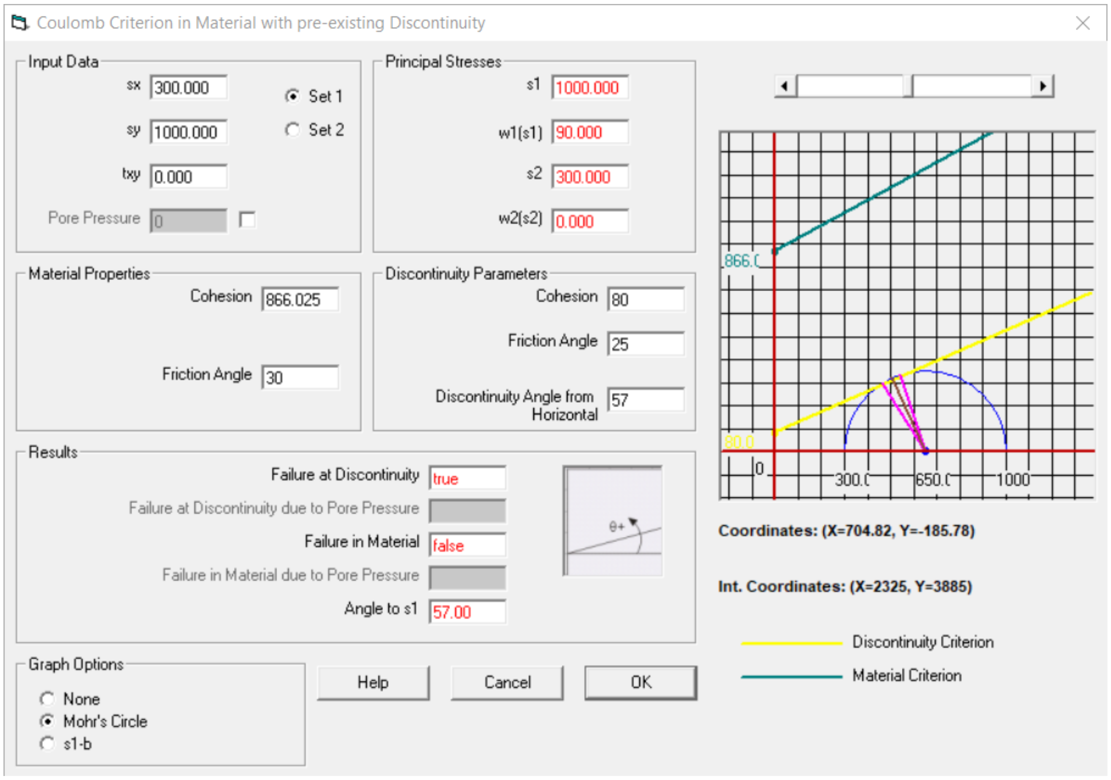
This tool calculates the Coulomb failure criteria for material with a pre-existing discontinuity. The stress state of the rock, material properties, and discontinuity parameters are entered and the failure state of the material is determined. The material failure due to the discontinuity and material itself are determined. The angle to the maximum principle stress is calculated.

To display no graph, select the dot next to "No Graph".

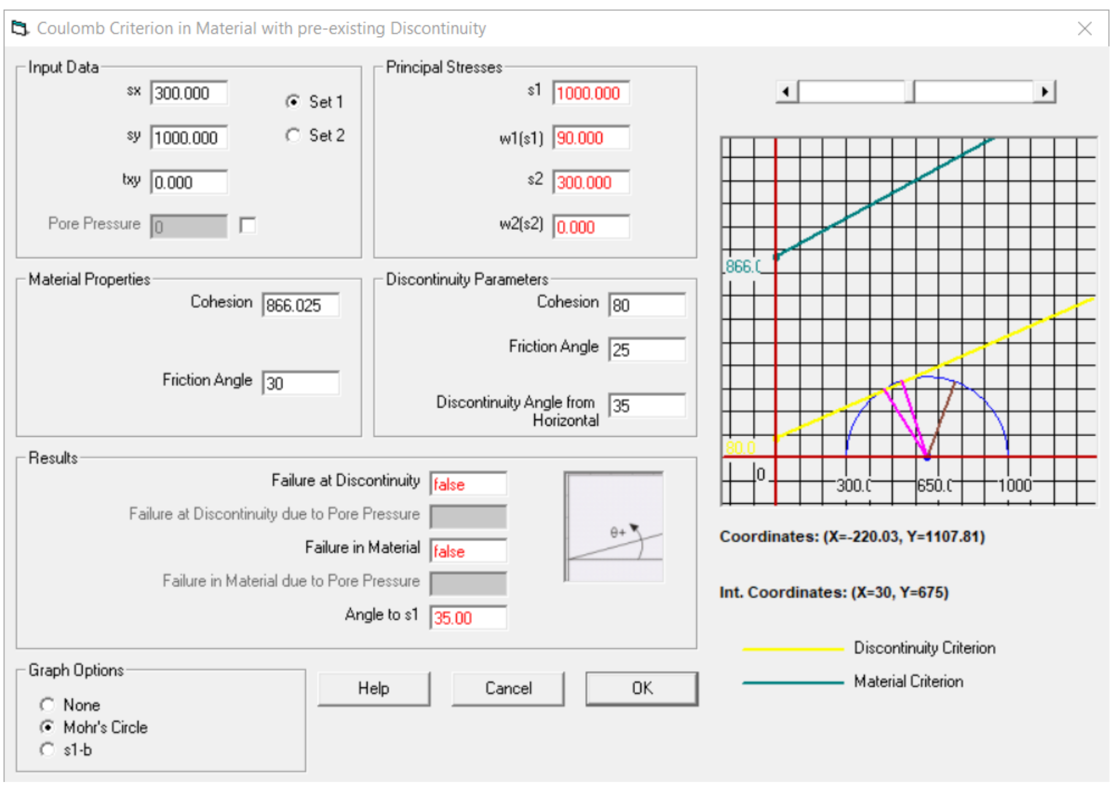


Input numbers are shown in black. Results are shown in red. This option allows for 2 sets of parameters to be analyzed at the same time by selecting "Set 1" or "Set 2".

To display Mohr's circle and failure criteria for the stress state, select the dot next to "Mohr's Circle".

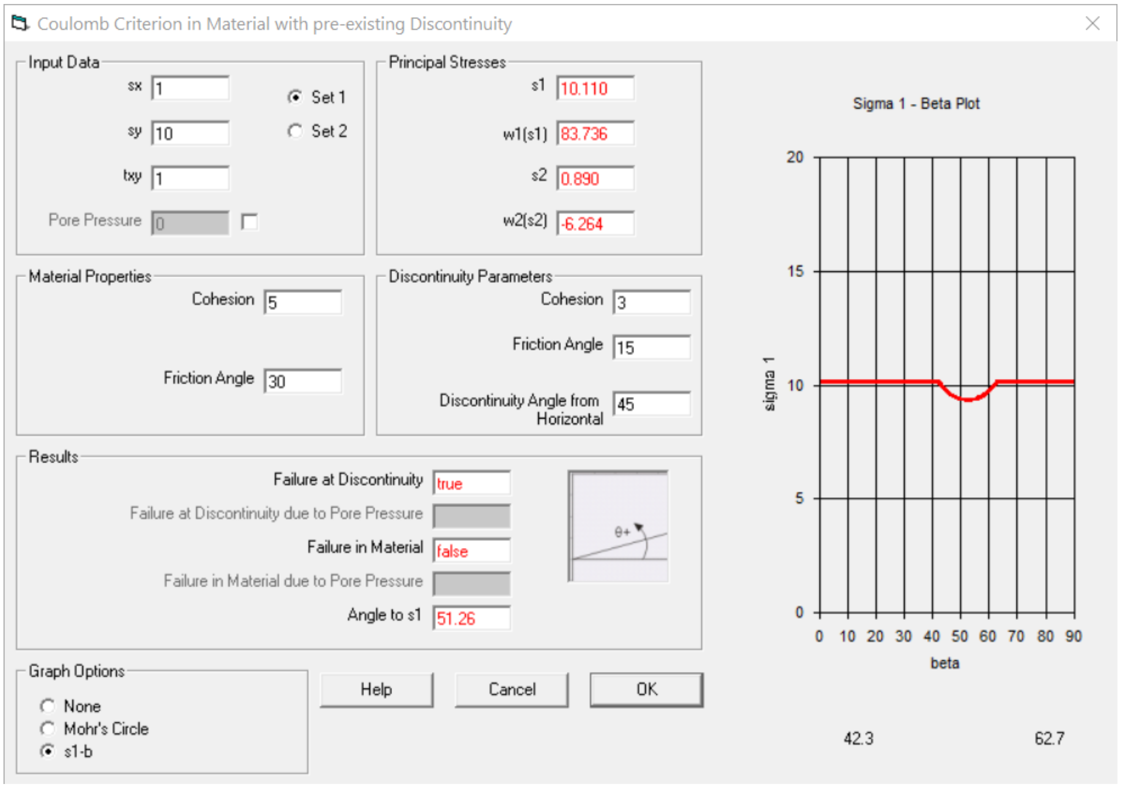


Material failed due to discontinuity

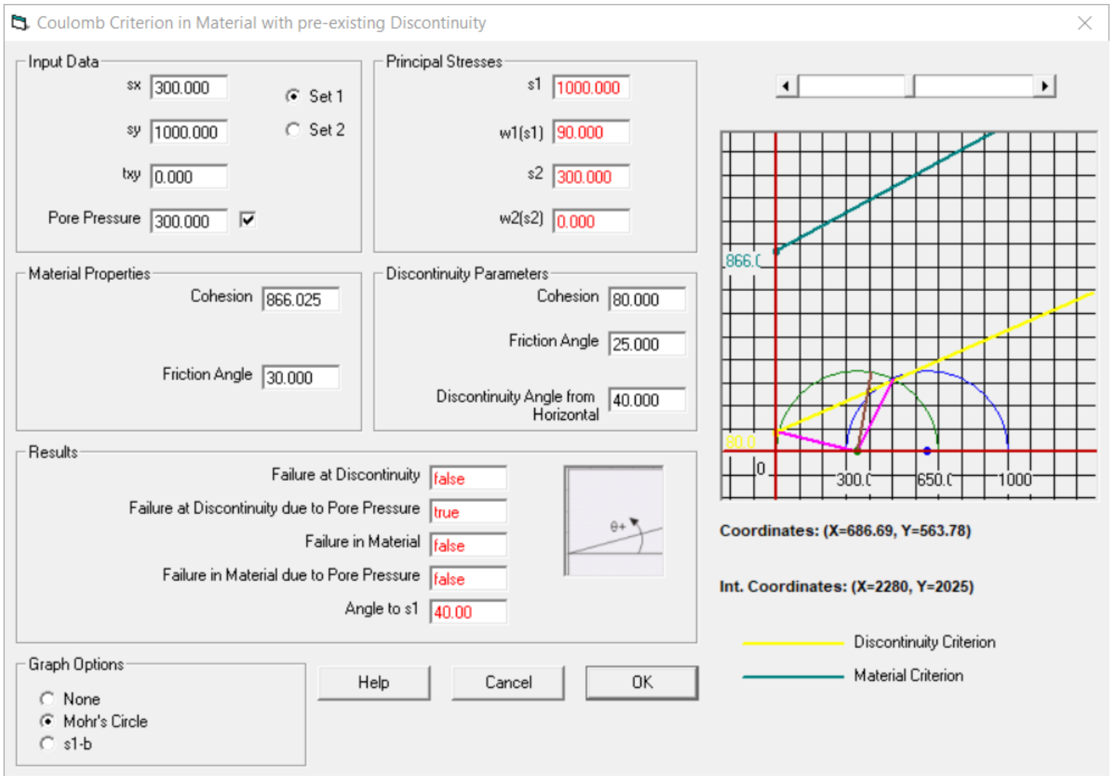


Material did not fail

To display the σ1-β plot, select the dot next to "s1-b".



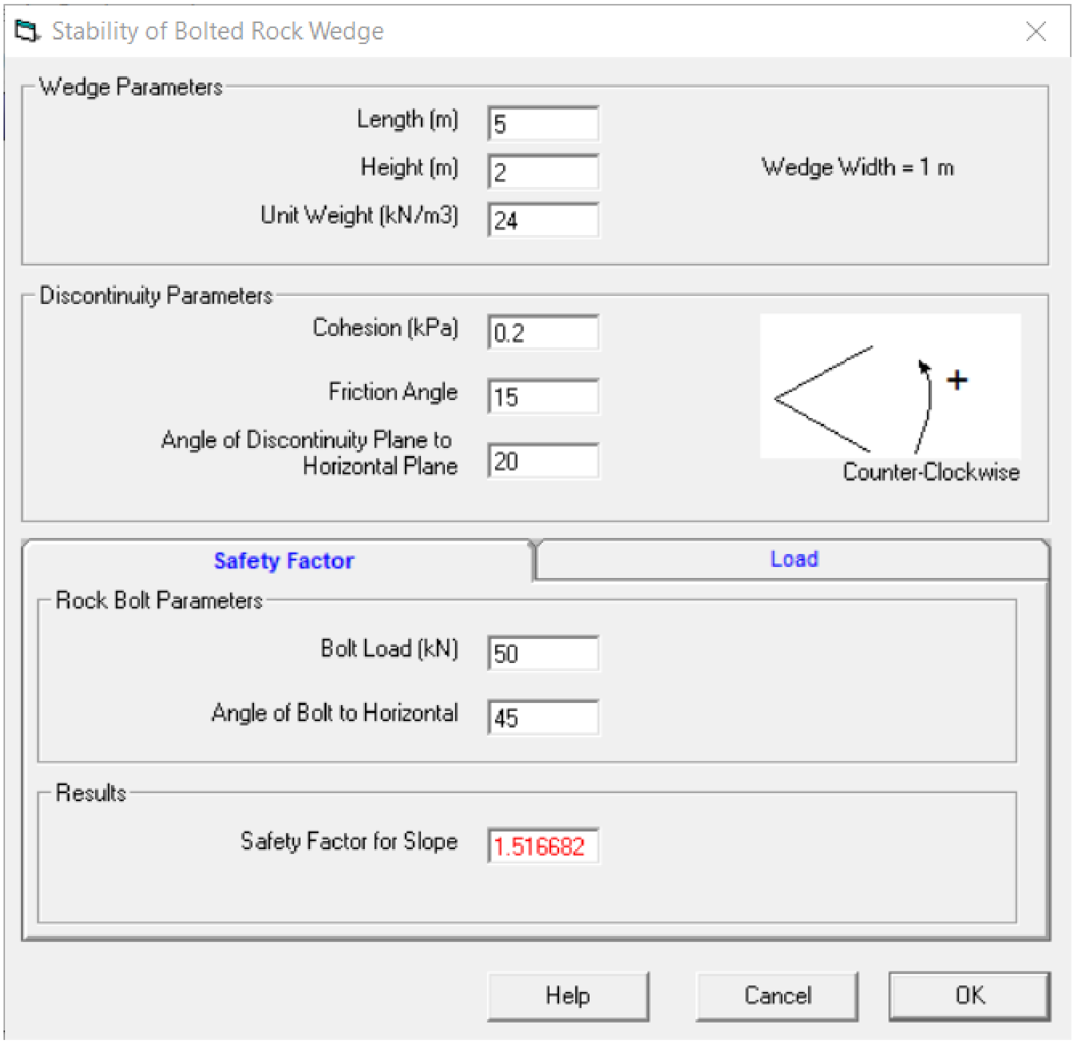
To determine if the material or discontinuity fail due to pore pressure, check the box next to pore pressure and enter a value for pore pressure.



Failed at discontinuity due to pore pressure

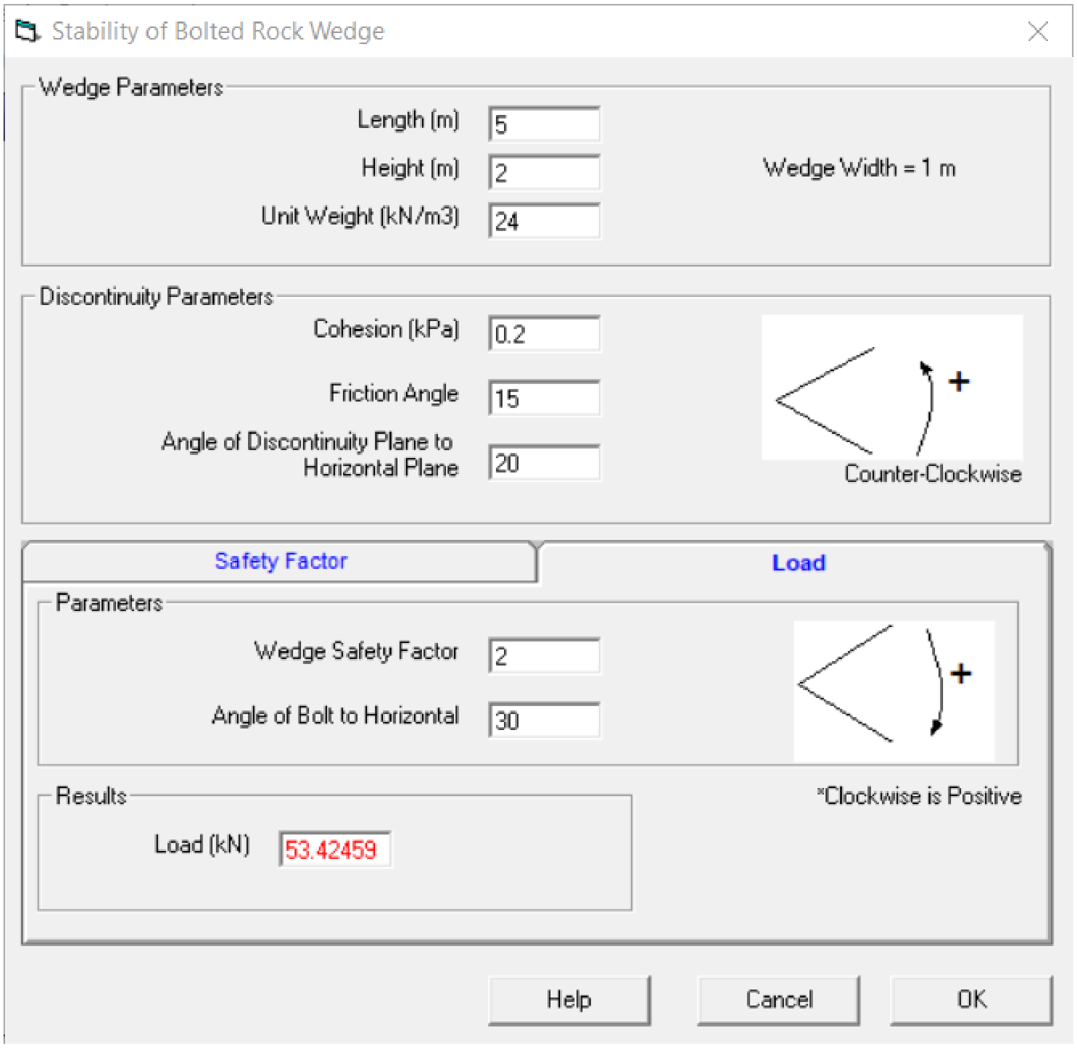
3.2.2.3 Coulomb in Material with Bolted Joint

This tool calculates the load on a bolt holding a rock wedge. The wedge and discontinuity parameters are entered. To calculate the safety factor for a known bolt load, click on the "Safety Factor" tab and enter the bolt load and angle.

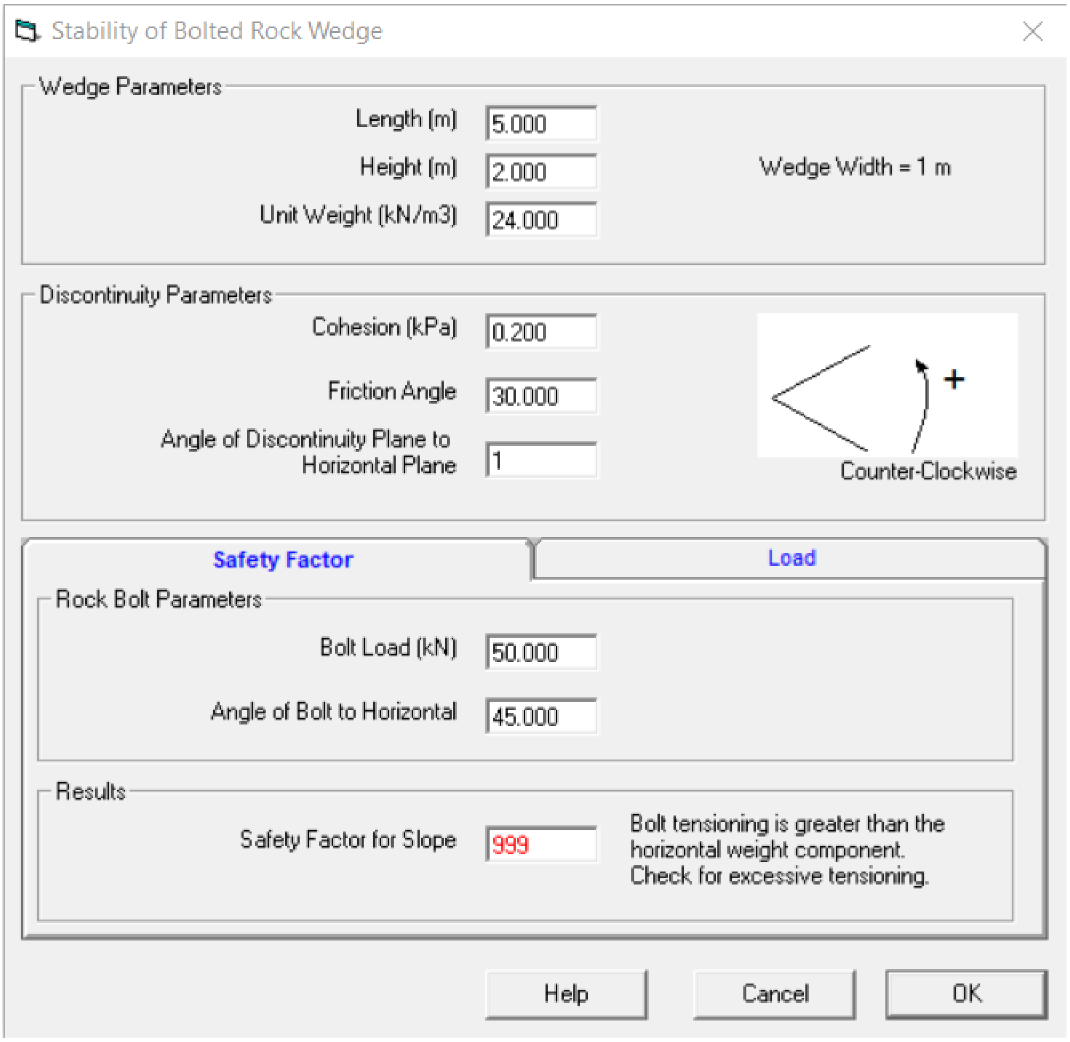


Input numbers are shown in black. Results are shown in red.

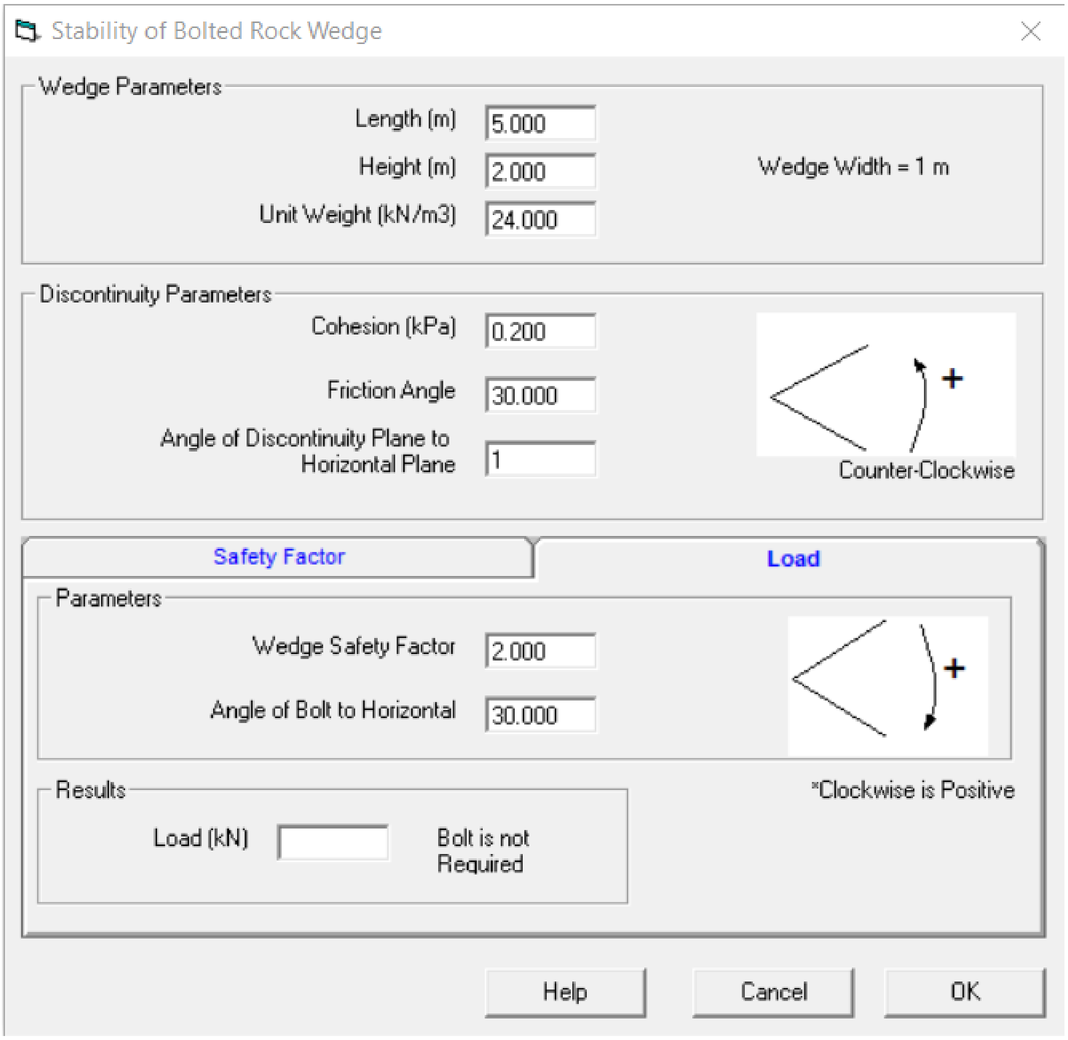
To calculate the load required of a bolt to achieve a specified safety factor, click on the "Load" tab and enter the wedge safety factor.



If values are entered that cause the bolt tensioning to exceed the horizontal weight component, a message will display as shown below.



If the slope is stable without a bolt, a message will display as shown below.

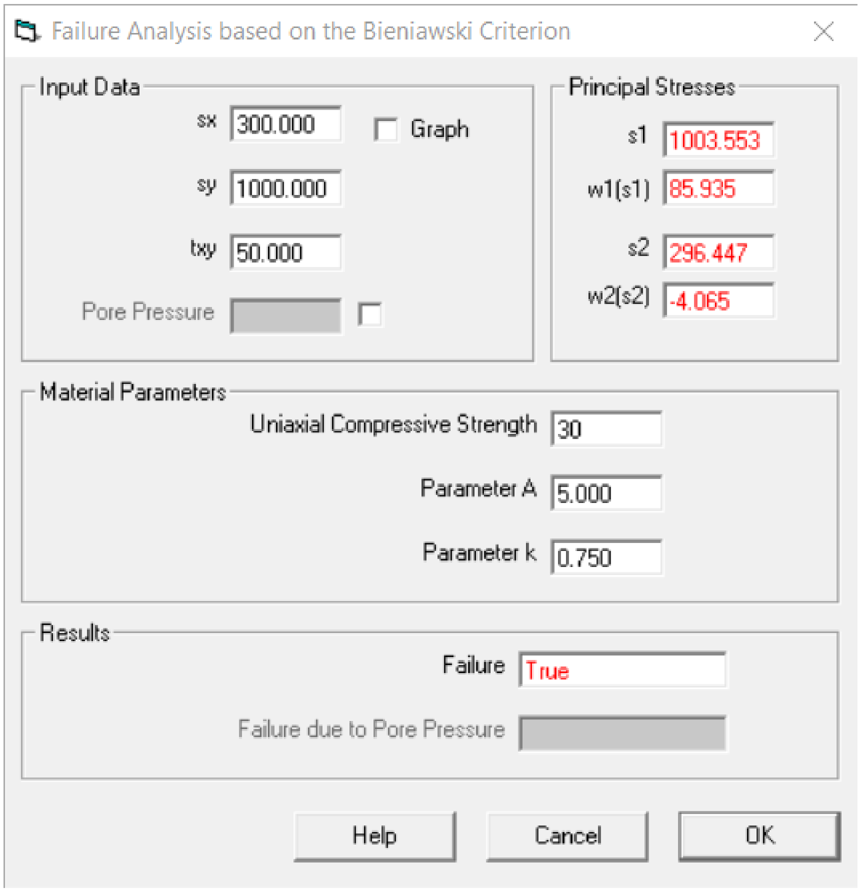


3.2.2.4 Coulomb in Bolted Rock Slope

Option is not ready yet.

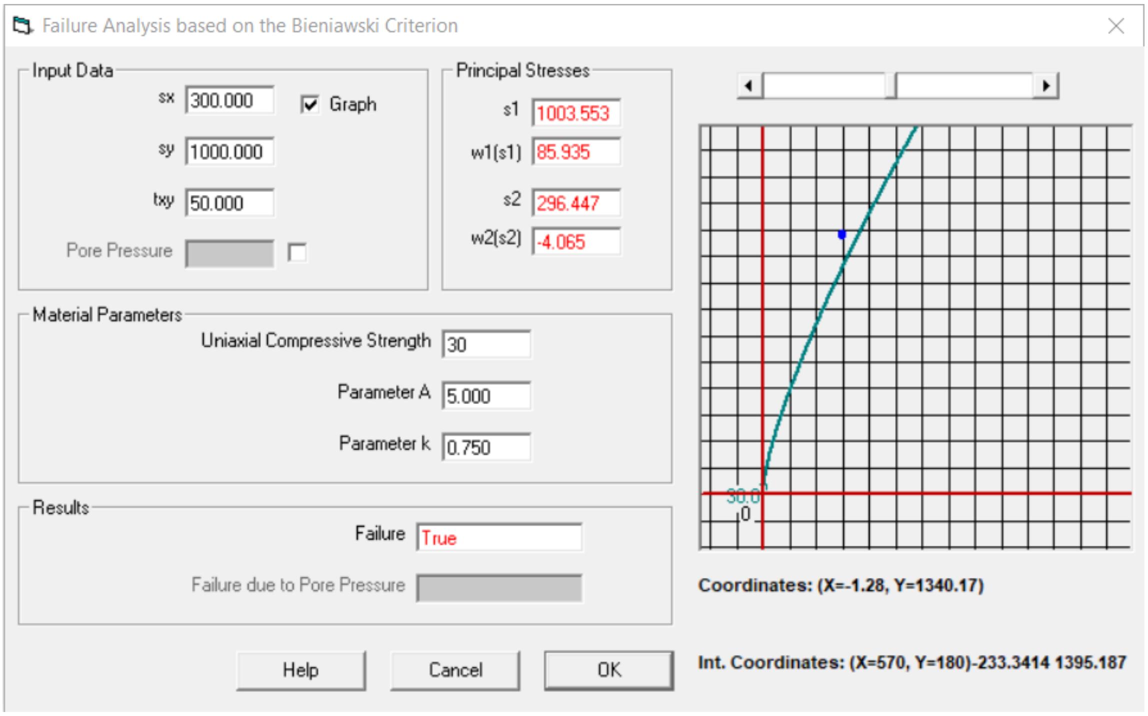
3.2.2.5 Bieniawski

The Bieniawski failure criterion are determined using this tool. Enter the stress state and Bieniawski material properties to calculate. The magnitude and orientation of the principle stresses are calculated and the failure state is determined.

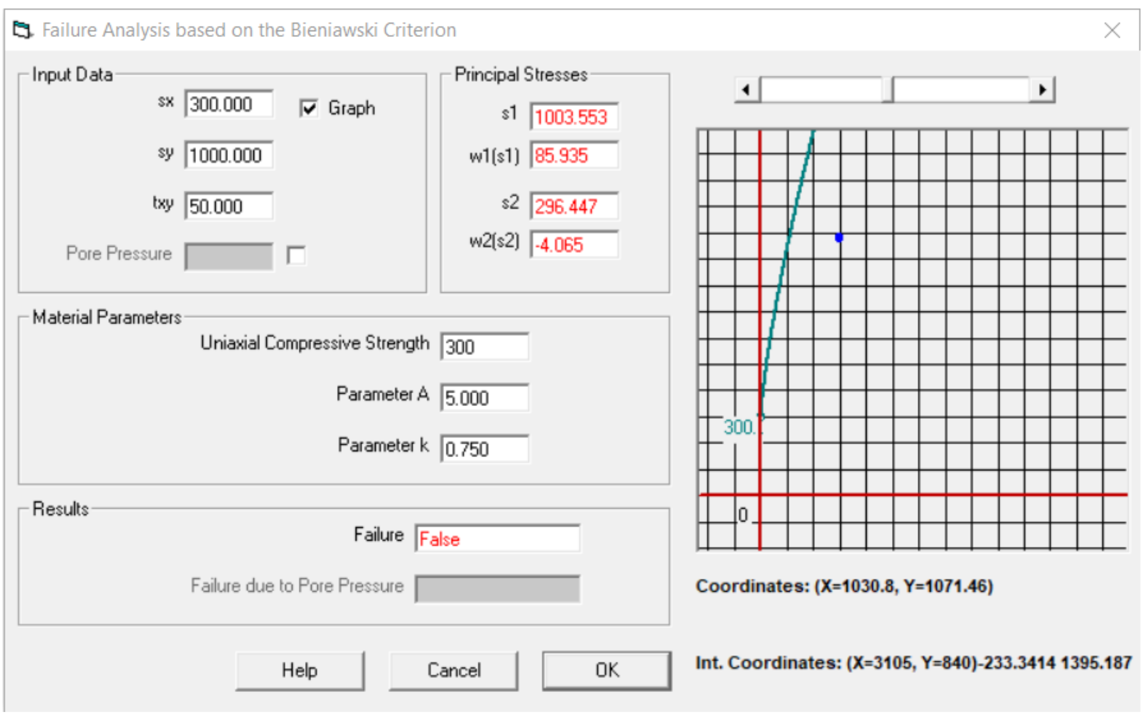


Input numbers are shown in black. Results are shown in red.

Select the box next to "Graph" to display a graph.



Material failed



Material did not fail

Coefficients for Bieniawski Criterion (Bieniawski, 1984)

Rock Type	A	B
Norite	5.0	0.80

Quartzite	4.5	0.78
Sandstone	4.0	0.75
Siltstone	3.0	0.70
Mudstone	3.0	0.70

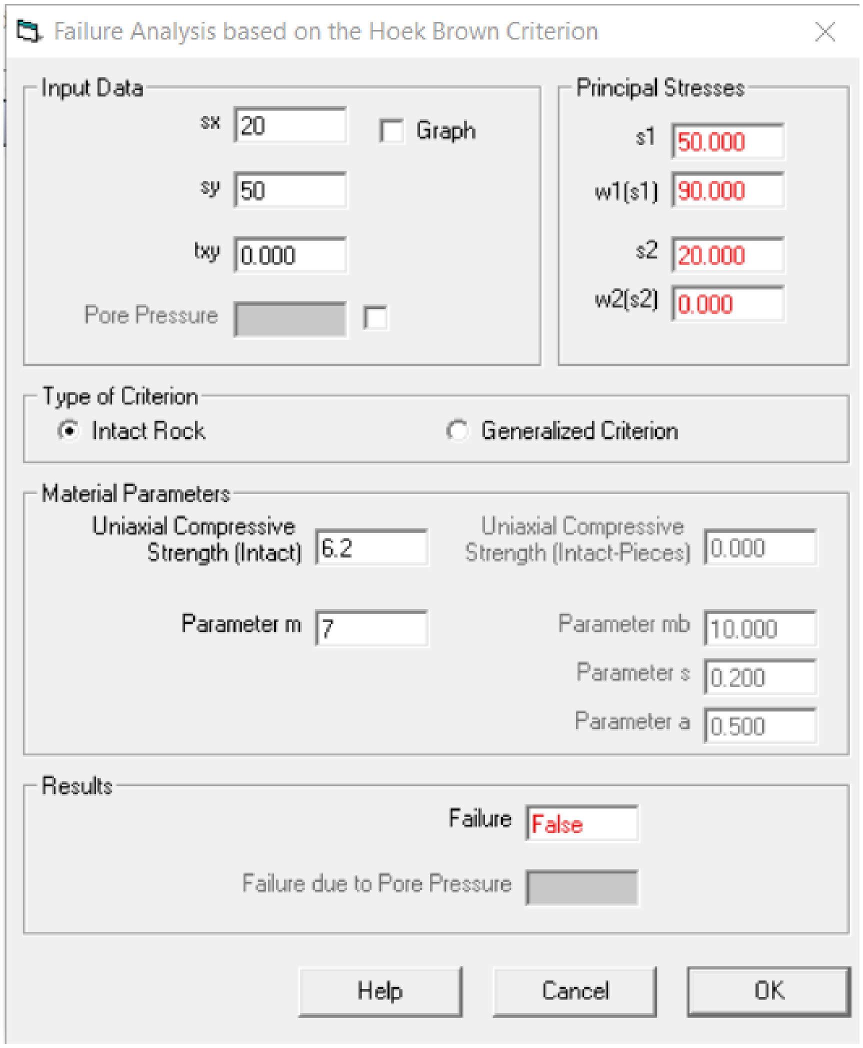
The Bieniawski criterion is given by the equation below.

$$\frac{\sigma_1}{\sigma_c} = 1 + A\left[\frac{\sigma_3}{\sigma_c}\right]^k$$

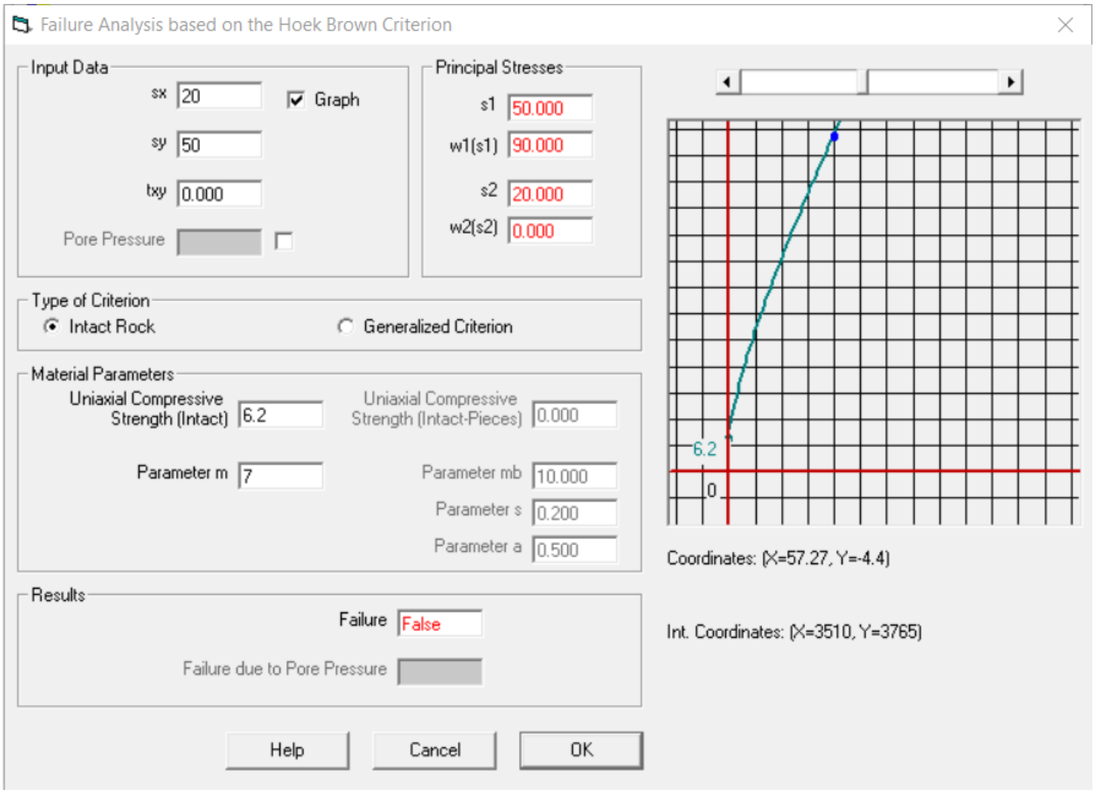
3.2.2.6 Hoek - Brown

The Hoek-Brown failure criteria are determined using this tool. Enter the stress state and select the type of criterion to use.

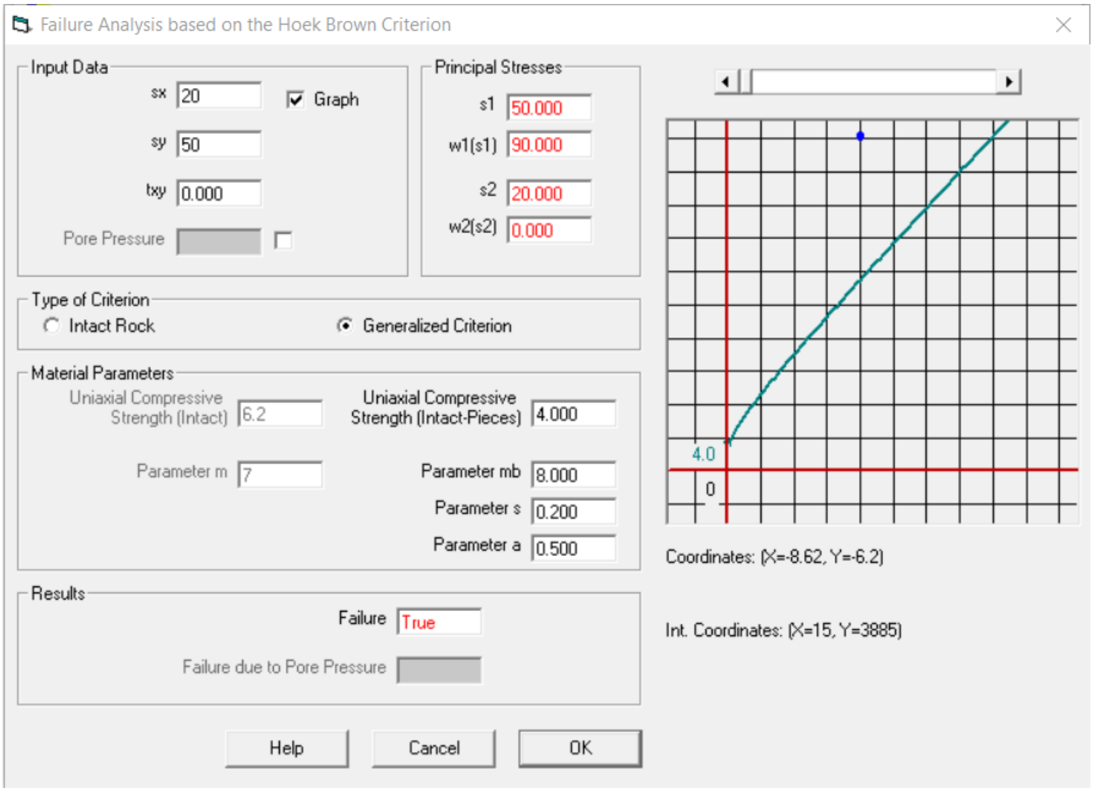
For intact rock criterion, select the dot next to "Intact Rock". Enter the intact UCS (uniaxial compressive stress state), and Hoek-Brown parameter m. The failure state is then determined and shown below.



Input numbers are shown in black. Results are shown in red.



For the generalized criterion, select the dot next to "Generalized Criterion". Enter the UCS for intact rock, and parameters mb, s, and a.



The Hoek-Brown criterion for intact rock is given by the equation below.

$$\frac{\sigma_1}{\sigma_c} = \frac{\sigma_3}{\sigma_c} + \left[m\frac{\sigma_3}{\sigma_c} + 1\right]^{0.5}$$

The table below lists values for parameter m of the Hoek-Brown intact rock criterion (Hoek, 2007).

Rock type	Class	Group	Texture: Coarse	Medium	Fine	Very fine
SEDIMENTARY	Clastic		Conglomerates* (21 ± 3) Breccias (19 ± 5)	Sandstones 17 ± 4	Siltstones 7 ± 2 Greywackes (18 ± 3)	Claystones 4 ± 2 Shales (6 ± 2) Marls (7 ± 2)
	Non-Clastic	Carbonates	Crystalline Limestone (12 ± 3)	Sparitic Limestones (10 ± 2)	Micritic Limestones (9 ± 2)	Dolomites (9 ± 3)
		Evaporites		Gypsum 8 ± 2	Anhydrite 12 ± 2	
		Organic				Chalk 7 ± 2
METAMORPHIC	Non Foliated		Marble 9 ± 3	Hornfels (19 ± 4) Metasandstone (19 ± 3)	Quartzites 20 ± 3	
	Slightly foliated		Migmatite (29 ± 3)	Amphibolites 26 ± 6		
	Foliated**		Gneiss 28 ± 5	Schists 12 ± 3	Phyllites (7 ± 3)	Slates 7 ± 4
IGNEOUS	Plutonic	Light	Granite 32 ± 3 Diorite 25 ± 5 Granodiorite (29 ± 3)			
		Dark	Gabbro 27 ± 3 Norite 20 ± 5	Dolerite (16 ± 5)		
	Hypabyssal		Porphyries (20 ± 5)		Diabase (15 ± 5)	Peridotite (25 ± 5)
	Volcanic	Lava		Rhyolite (25 ± 5) Andesite 25 ± 5	Dacite (25 ± 3) Basalt (25 ± 5)	Obsidian (19 ± 3)
		Pyroclastic	Agglomerate (19 ± 3) Breccia (19 ± 5)		Tuff (13 ± 5)	

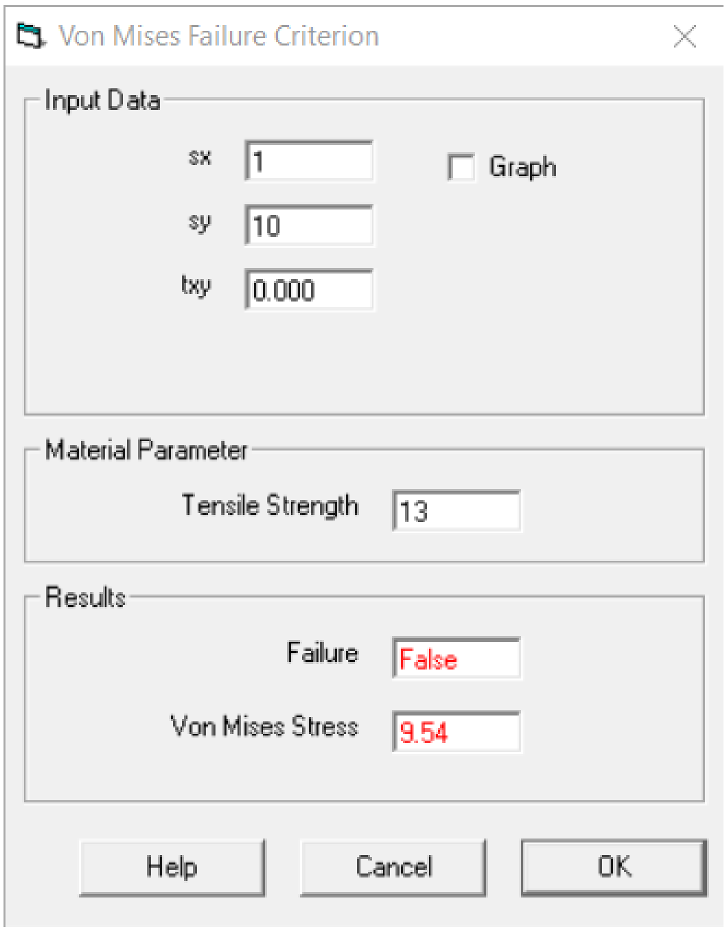
* Conglomerates and breccias may present a wide range of m_i values depending on the nature of the cementing material and the degree of cementation, so they may range from values similar to sandstone to values used for fine grained sediments.
**These values are for intact rock specimens tested normal to bedding or foliation. The value of m_i will be significantly different if failure occurs along a weakness plane.

The Hoek-Brown criterion for the rock mass (or generalized criterion) is given by the equation below.

$$\sigma_1' = \sigma_3' + \sigma_{ci}\left[m_b\frac{\sigma_3'}{\sigma_{ci}} + s\right]^a$$

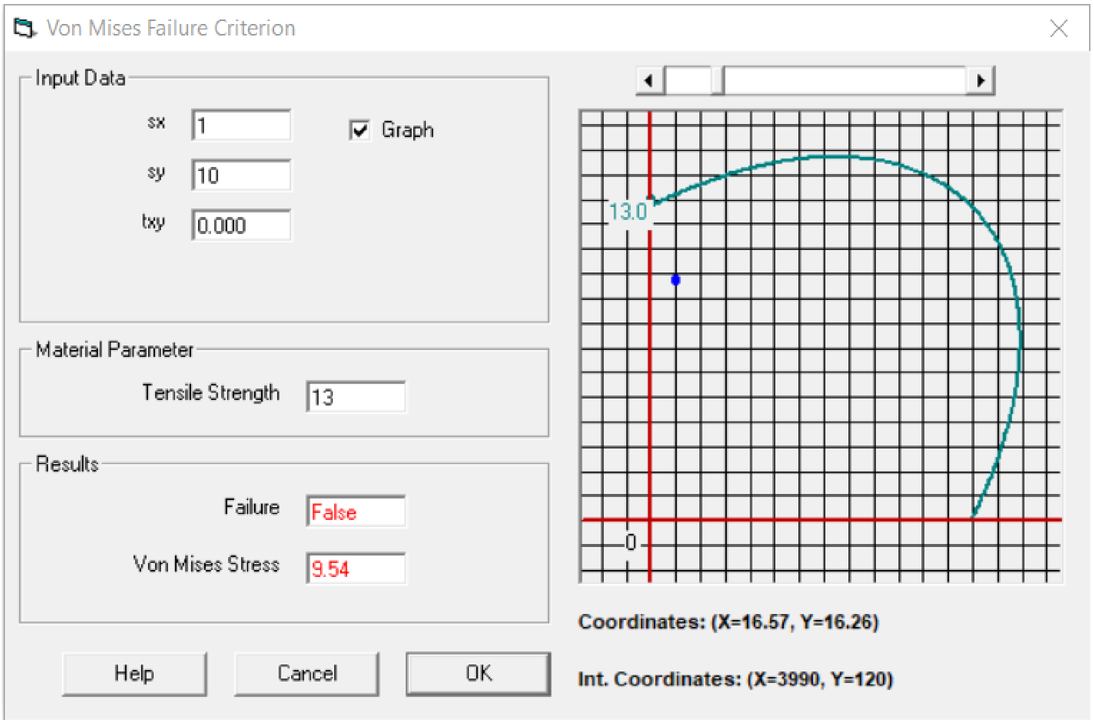
3.2.2.7 Von Mises

The von Mises failure criterion is determined using this tool. The stress state and tensile strength are entered and the failure state is determined. The Von Mises stress is calculated for the given state.

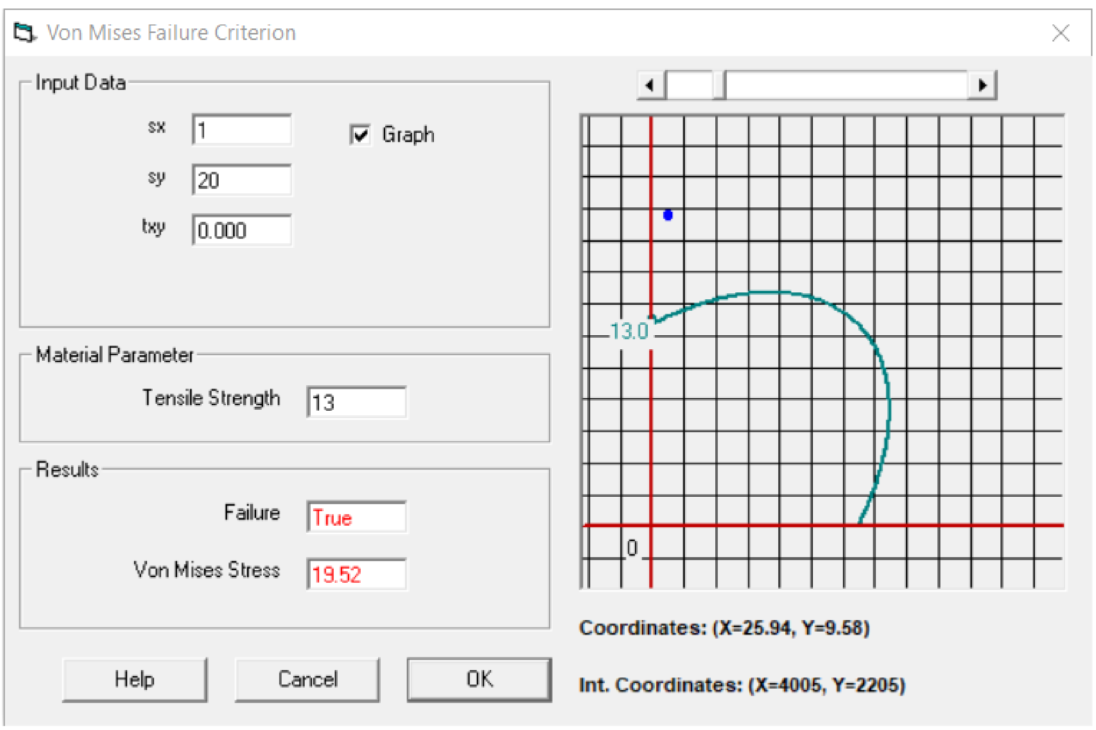


Input numbers in black. Results are shown in red.

To display a graph, select the box next to "Graph".



Material did not



Material failed

The equation for the von Mises Stress or equivalent stress is given below.

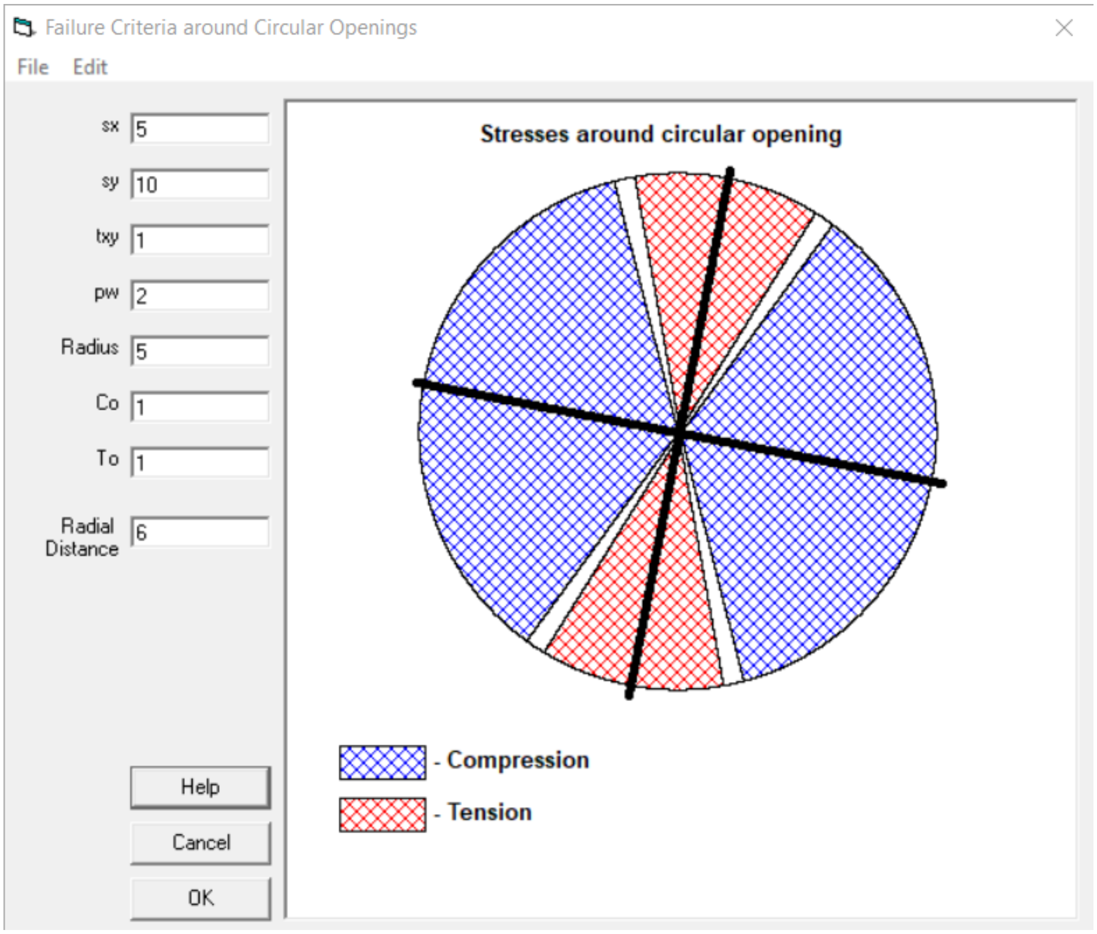
$$\sigma_{eq} = \sqrt{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}/\sqrt{2} \leq \sigma_y$$

$$\sigma_{eq} = \sqrt{(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_z - \sigma_x)^2 + 6(\tau_{xy}^2 + \tau_{yz}^2 + \tau_{zx}^2)}/\sqrt{2}$$

$$\sigma_{eq} = \sqrt{\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2} = \sqrt{\sigma_{xx}^2 + \sigma_{yy}^2 - \sigma_{xx}\sigma_{yy} + 3\tau_{xy}^2} \leq \sigma_y$$

3.2.2.8 Circular Openings

This tool illustrates the stresses around a circular opening at a specified radial distance. The stress state and dimensions are entered and a visual displaying the stress around the opening is displayed.



Input numbers are shown in black.

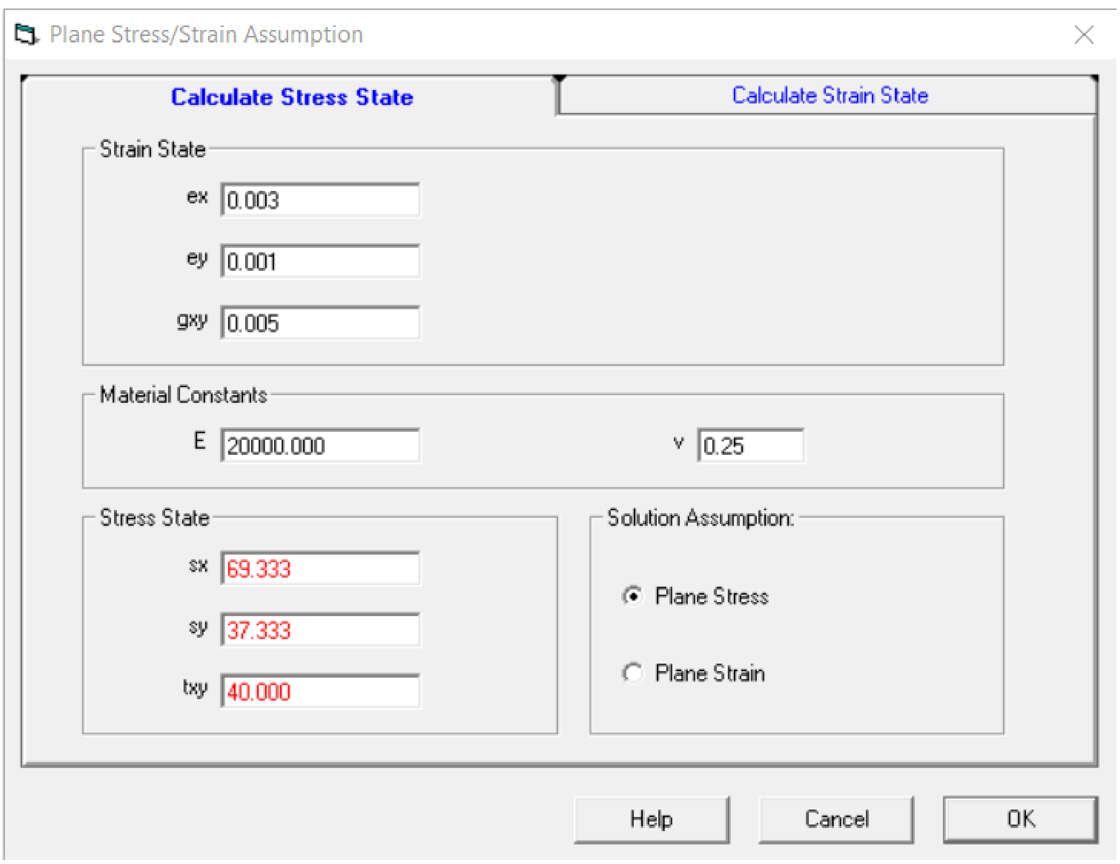
The principle stress orientation is shown with the black lines. Areas of tension and compression are highlighted.

sy corresponds to vertical far field stress and sx corresponds to horizontal far field stress (far field stresses are the insitu stresses before the opening was created.

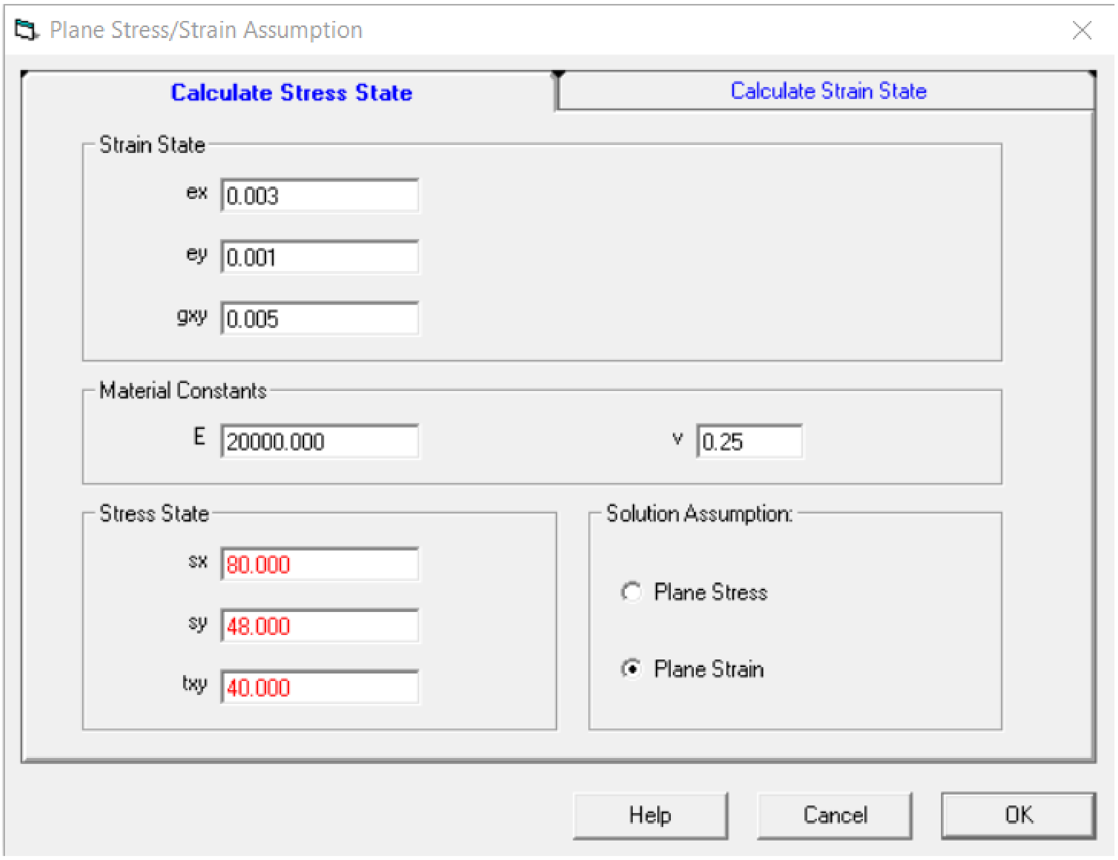
3.2.3 Elasticity in 2D

The user can calculate the strain based on stress values and the stress based on strain values for the two-dimensional plane stress and plain strain analyses for elastic materials.

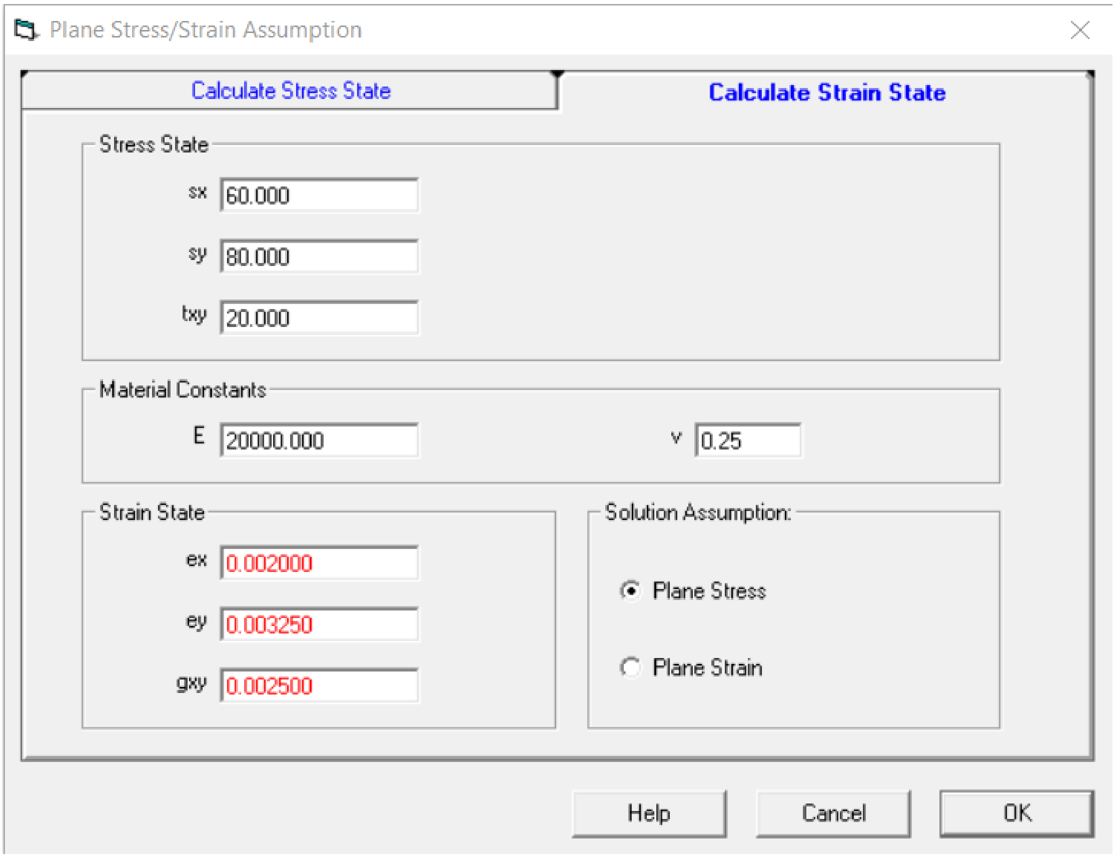
To calculate stress state, click on the "Calculate Stress State" tab and enter the strain state and material constants. Select whether the solution should be based on the assumption of plane stress or plane strain by clicking on the dot next to the respective option.

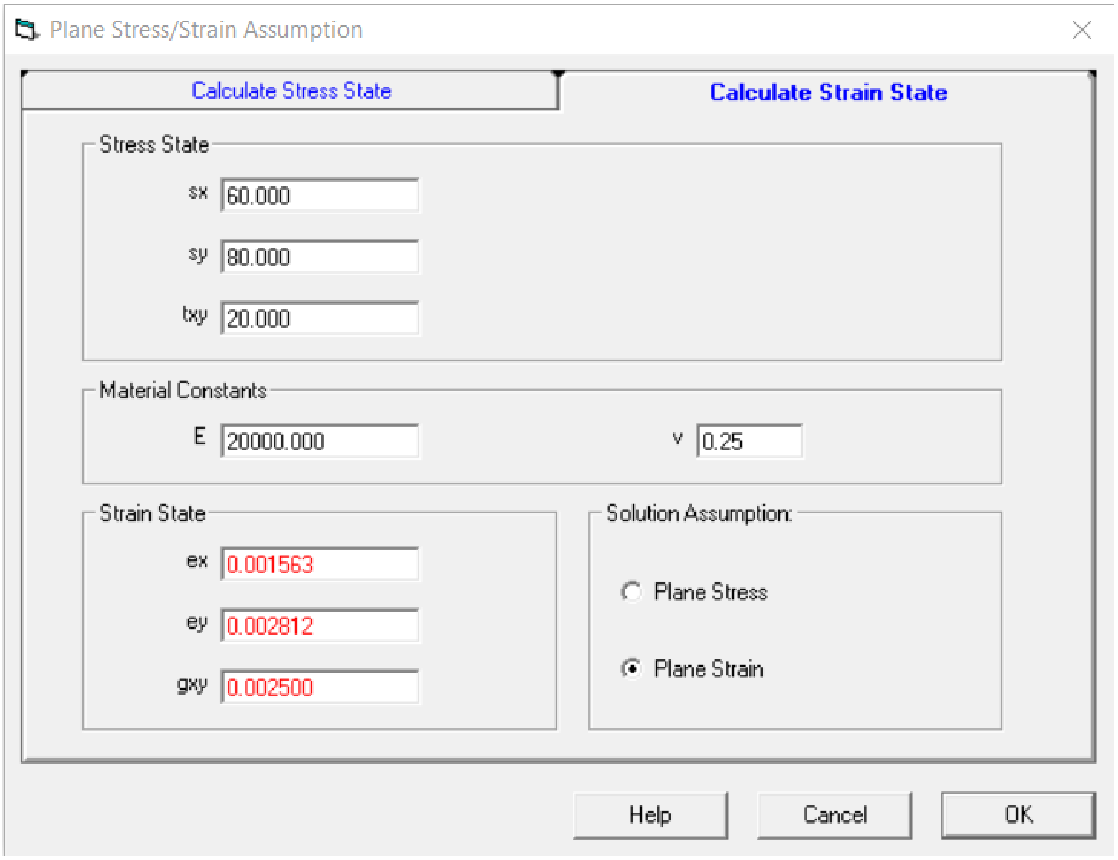


Input numbers are shown in black. Results are shown in red.



To calculate strain state, click on the "Calculate Strain State" tab and enter the stress state and material constants. Select whether the solution should be based on the assumption of plane stress or plane strain by clicking on the dot next to the respective option.

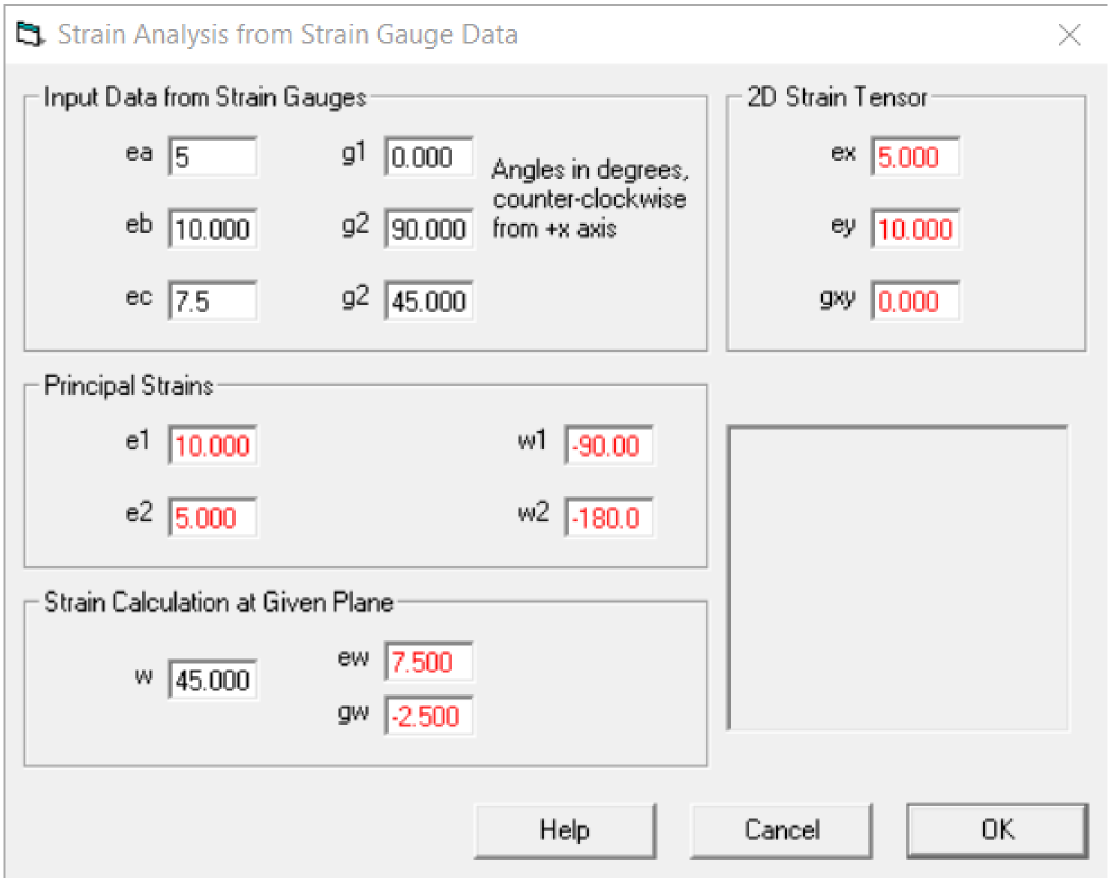

Plane Stress/Strain Assumption
Calculate Stress State
Calculate Strain State
Stress State
sx 60.000
sy 80.000
txy 20.000
Material Constants
E 20000.000
v 0.25
Strain State
ex 0.002000
ey 0.003250
gxy 0.002500
Solution Assumption:
Plane Stress
Plane Strain
Help
Cancel
OK



3.2.4 Strain Analysis

The principle strains magnitude and orientation is calculated using this tool. Input data from strain gauges is entered. The two-dimensional strain tensor is calculated with the principle strains.

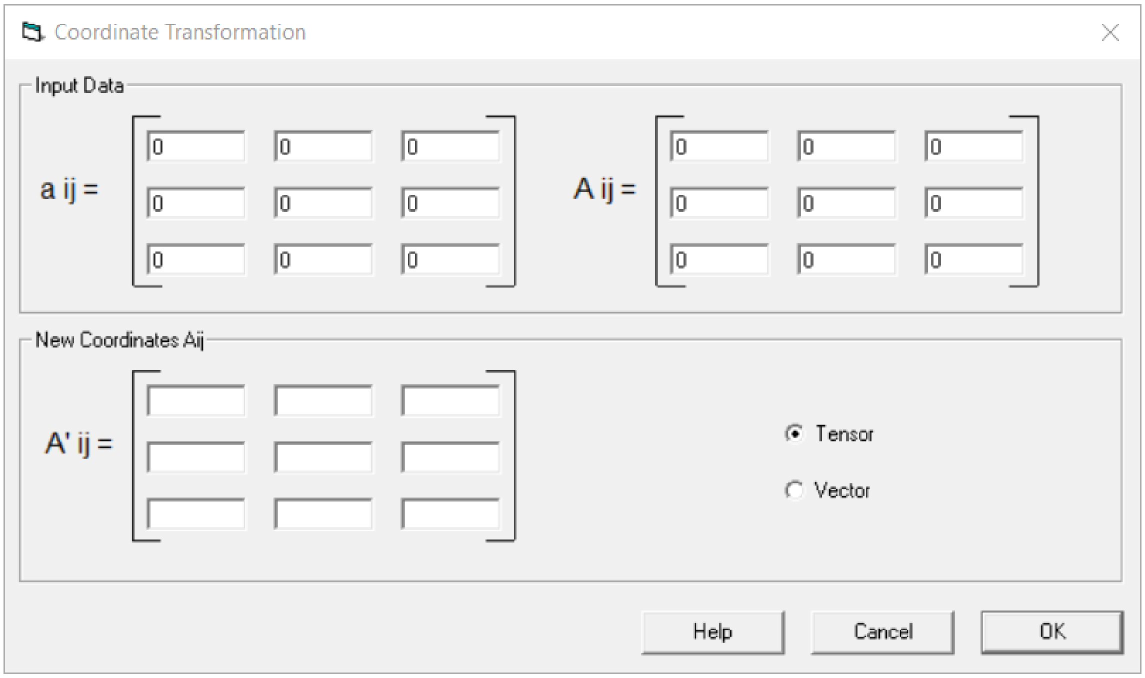
The strain state at a given plane can also be calculated by entering a value for the angle of the plane.



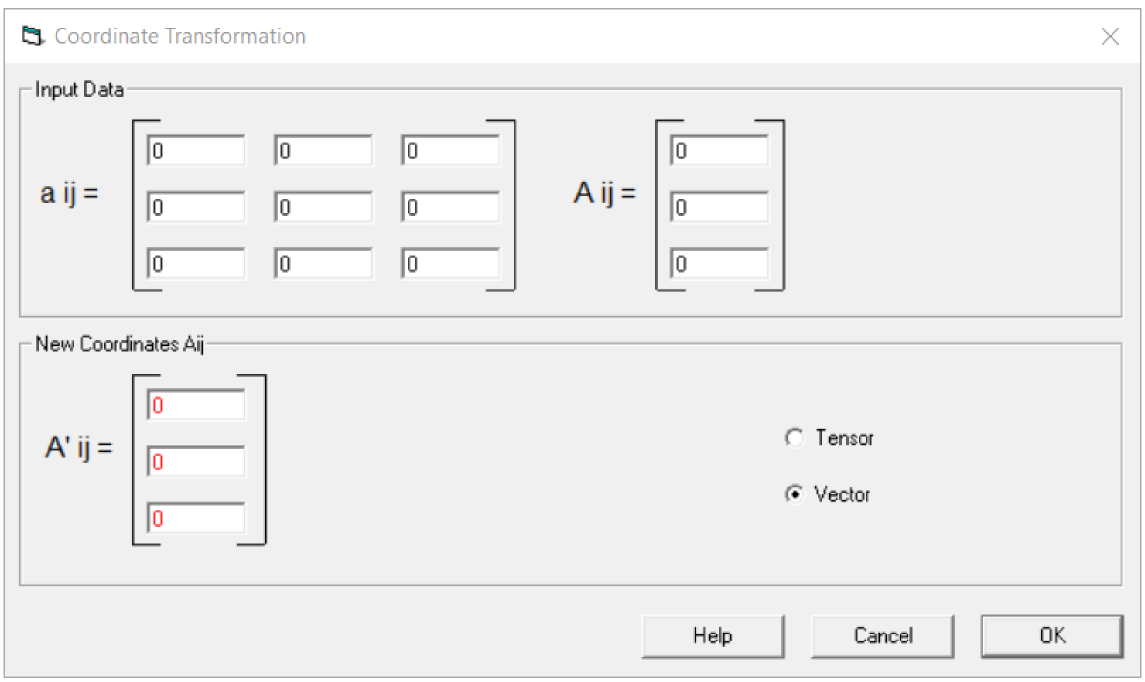
Input numbers are shown in black. Results are shown in red.

3.2.5 Coordinate Transformation

Coordinate transformation can be facilitated using this tool. Select whether a tensor or vector is needed and enter the data to get the new coordinates.

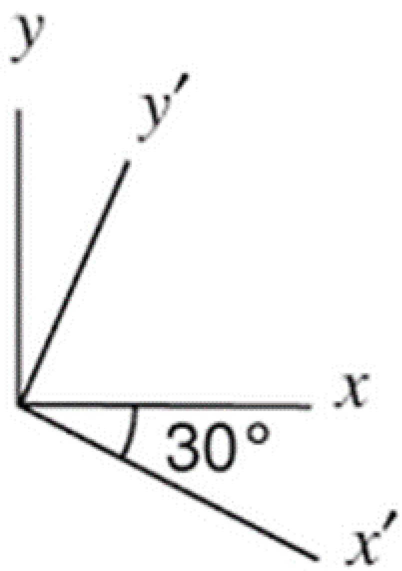


Input numbers are shown in black. Results are shown in red.



Note: The transformation matrix should have a norm = 1.

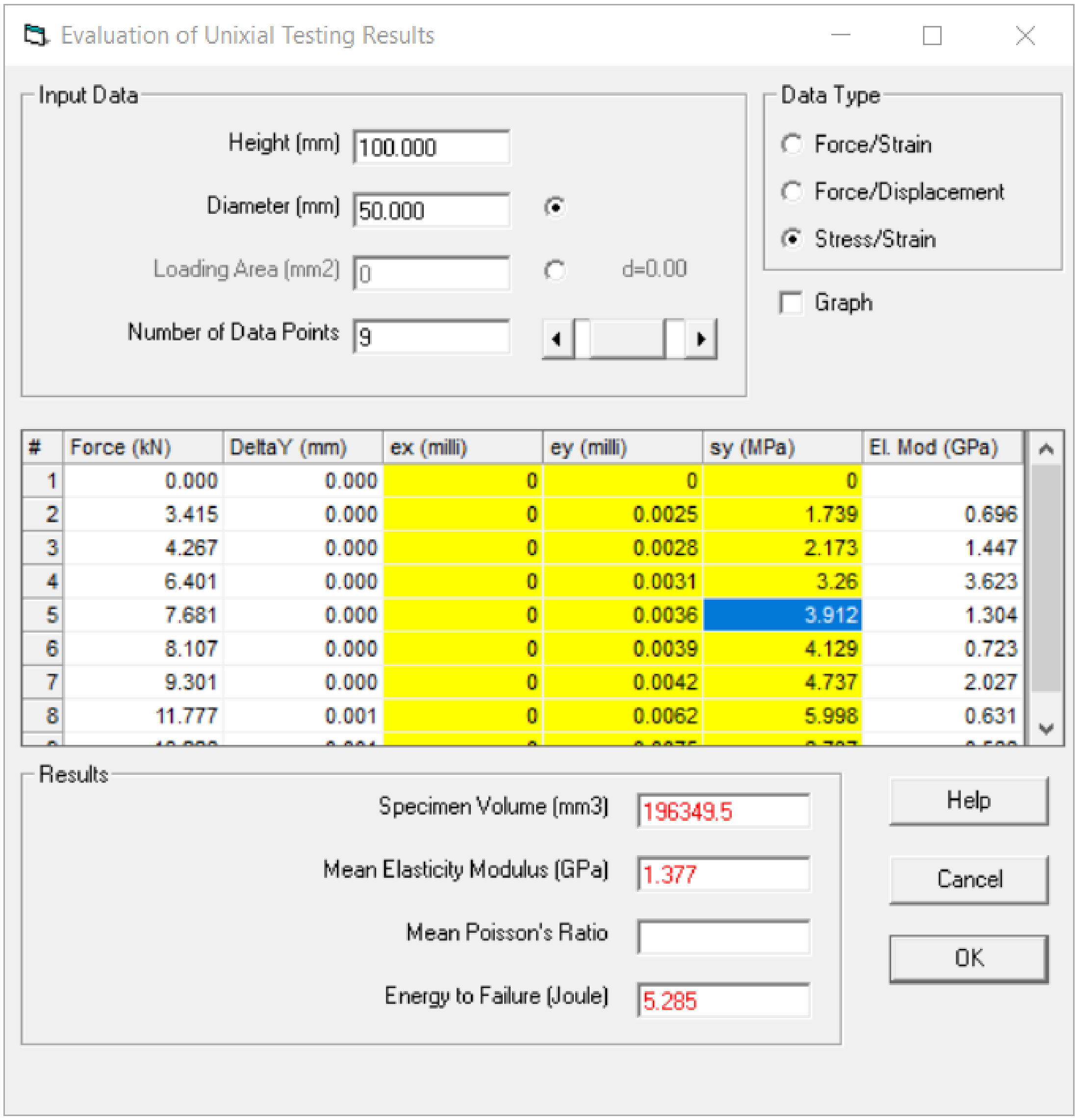
Example of cosine matrix is shown below:



$$Q = \begin{bmatrix} cos(x',x) & \cos(x',y) \\ \cos(y',x) & \cos(y',y) \end{bmatrix} = \begin{bmatrix} cos(30) & \cos(120) \\ \cos(60) & \cos(30) \end{bmatrix}$$

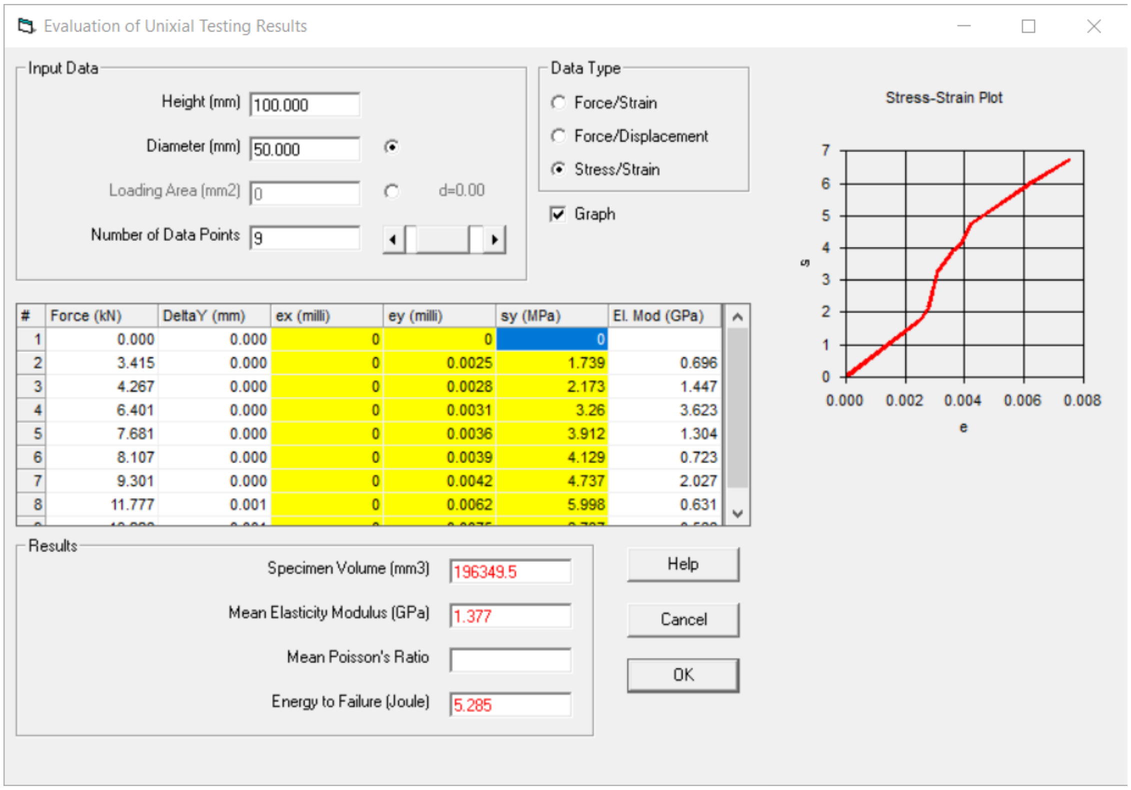
3.2.6 Evaluation of Uniaxial Testing Results

This form helps evaluate data collected during uniaxial testing of rocks. To enter data in the table, click on one of the cells in a yellow highlighted column. Enter the value for the cell in the pop-up window and press Ok.



Input numbers are shown in black. Results are shown in red.

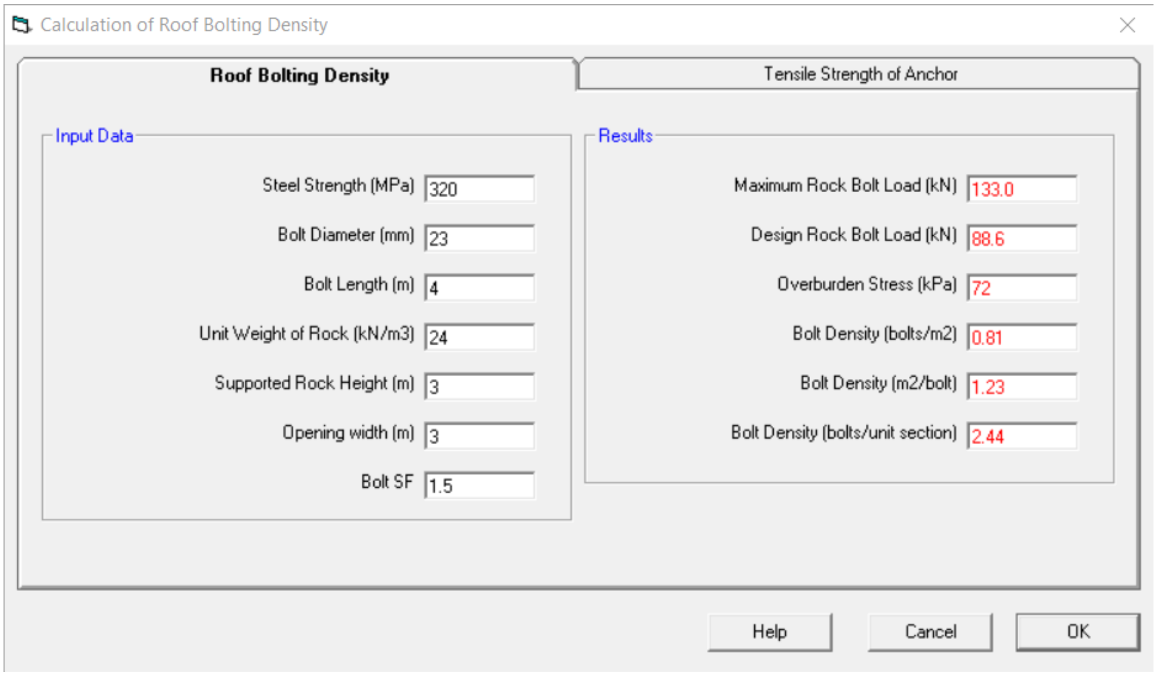
To display a stress-strain plot of the data, select the box next to "Graph".



3.2.7 Roof Bolting

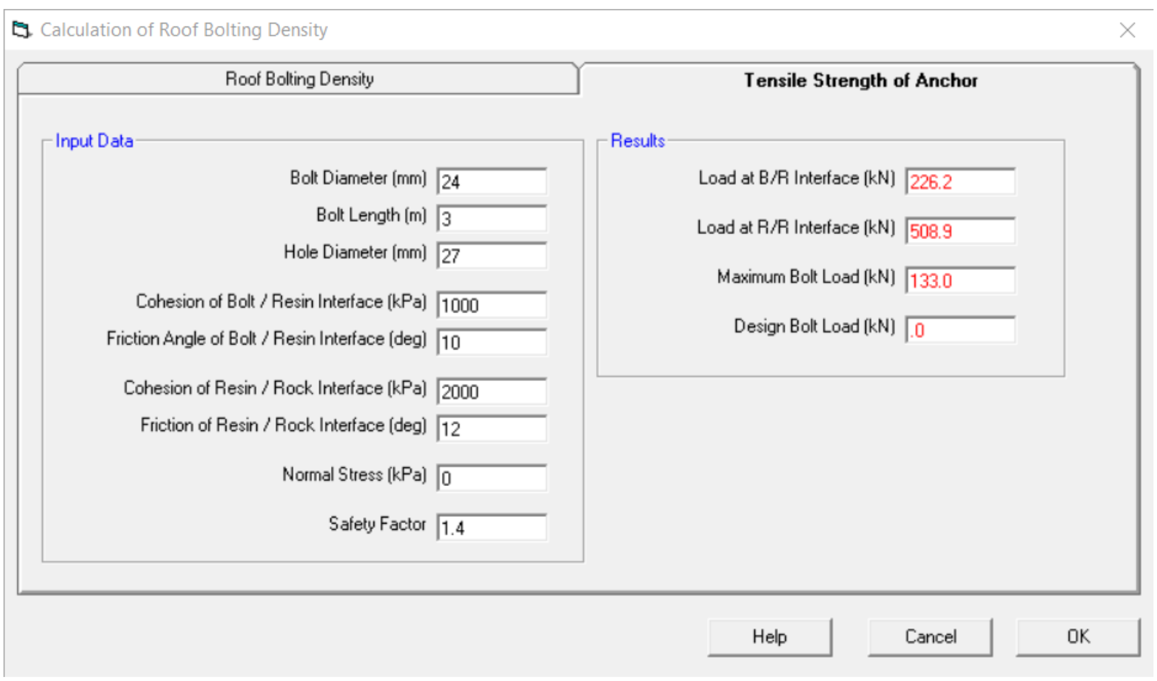
This tool assists in determining appropriate roof bolting densities.

To determine the roof bolting density necessary for a given design select the "Roof Bolting Density" tab and enter the bolt, rock, and design parameters. The bolt load, stress, and bolt density is calculated.



Input numbers are shown in black. Results are shown in red.

To determine the tensile strength of the anchor, select the "Tensile Strength of Anchor" tab and enter the bolt, rock, and design parameters. The load at the anchor interfaces and bolt load are calculated.



Part IV

4 The Utilities Menu

Settings

Options

Unit Conversions

File Conversion (not available at this time)

Clear History Window

This option clears the history (activity) window.

Close/Restore History Window

This option closes or restores the history (activity) window according to the current window status.

Copy History Window

This option copies the contents of the history window to the clipboard. You can then paste them to any text handling program for further processing.

4.1 Settings

Description:

This form is used to define a number of default parameters and settings for the RockWin program:

Default Units:

This setting controls the default units for a new or blank project file by configuring the Units field in the Project Description form. Upon entering and accepting project input parameters the default setting in the Project Description form can not be changed. This setting is saved in the RockWin.INI file.

Default File Extension for Input Files:

This setting is the default 3-letter extension used in the Open and Save dialog boxes in the File Menu. This setting is saved in the RockWin.INI file.

Data Path:

This setting is the default path used in the Open and Save dialog boxes in the File Menu. This setting is saved in the RockWin.INI file.

Show Disclaimer:

This parameter controls whether the disclaimer message will be displayed when loading the RockWin program. This setting is saved in the RockWin.INI file.

Maximize Main Menu Window:

This parameter controls whether the main menu window will be maximized when loading the RockWin program. This setting is saved in the RockWin.INI file.

Keep Recent Filelist:

This parameter controls whether the program will keep the four (4) recently accessed data files (opened or saved) as menu items in the File Menu. This setting is saved in the RockWin.INI file.

Reminder of Annual Updates:

This parameter controls whether the program will display a warning that a year has elapsed since the last update of the program. The update date is internally stored and it is not related with the install date. Annual updates ensure that any bugs that have been discovered are fixed regularly. This setting is saved in the RockWin.INI file.

Display Command History Window:

This parameter controls whether the program will display recently executed commands (and their resulting actions). This setting is saved in the RockWin.INI file.

Maximum Characters in Command History Window:

This parameter sets the maximum number of characters displayed in the command history window, before it is cleared. This setting is enabled only if the Display Command History Window option is enabled. This setting is saved in the RockWin.INI file.

History Font:

This button sets the type and size of font used in the command history window. This setting is enabled only if the Display Command History Window option is enabled. This setting is saved in the RockWin.INI file.

Enable Toolbar:

This settings controls whether the program will display a toolbar under the main menu options or not. The toolbar is not editable. This setting is saved in the RockWin.INI file.

Short Names in Filelist:

This parameter controls whether the program will display the filenames in the recently accessed list in a short or long format (i.e. including the whole path). This setting is saved in the RockWin.INI file.

Load Last Input File:

When this setting is enabled, the program will automatically load the most recently saved datafile (i.e. the top in the recently accessed files). This setting is saved in the RockWin.INI file.

Copy Example Files:

When this setting is enabled, the program will automatically copy all example files from the "Program Files" directory to the user home directory (i.e. MyDocuments/MyTUC).

This procedure runs upon every program invocation unless disabled. The modified files will not be overridden, but missing files will be replaced. This setting is saved in the RockWin.INI file.

External ASCII Viewer:

The user can set the application name of an external ASCII viewer for viewing reports and other ASCII files generated by the program. The default viewer in NOTEPAD.EXE supplied with the windows operating system. Note that prior to Windows2000, NOTEPAD.EXE could only edit / display files up to 64K. This setting is saved in the RockWin.INI file.

4.1.1 RockWin.INI

Description:

This file is automatically created by the RockWin program the first time it is executed. It should reside in the home directory of the RockWin program, i.e. \RockWin. It contains the following entries (the sequence and parameter values may be different in the actual file):

```
[Settings]
DefaultUnits=0
DisplayActionWin=1
MaxDisplaySize=300
KeepFileNames=1
ShowDisclaim=0
DataPath=C:\RockWin\
FileExtension=RMT

[FileMenu]
MaxLastFiles=4
LastFile1=C:\RockWin\S1.RMT
LastFile2=C:\RockWin\S2.RMT
LastFile3=C:\RockWin\S3.RMT
LastFile4=C:\RockWin\S4.RMT

[TextBrowse]
BrowseFontName=Courier New
BrowseFontSize=10
BrowseFontBold=0
BrowseFontItalic=0
```

Notes:

- If this file is deleted, it will be automatically reconstructed the next time the program is executed but the various settings will default to their original values.

4.2 Options

Description:

This form is used to define a number of default parameters and settings for the RockWin program:

General Options

Edit Menu Options

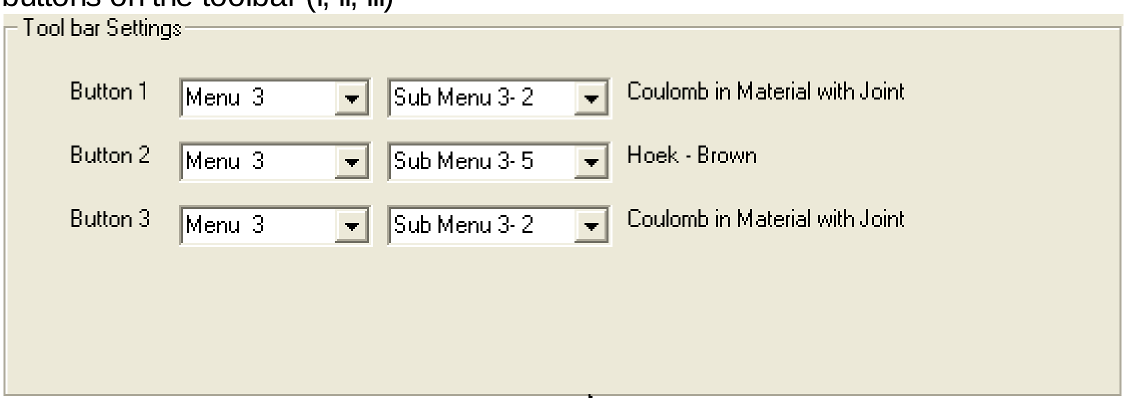
- English menus: If this option is enabled, all menus will appear in English. Otherwise, they will appear in Greek
- Always show Mohr's Circle when Form Loads: If this option is enabled, then in the forms where a Mohr's circle is plotted the option will automatically be activated when the form is loaded even if no data have been loaded.
- These settings are saved in the RockWin.INI file.

Print Options

If this option is enabled, then whenever the input data are printed, a three-line header is prepended with the program version, filename, etc. These settings are saved in the RockWin.INI file.

Default Settings

This option allows the user to set the form to load at the click of the three quick access buttons on the toolbar (I, II, III)



Advanced

Create a File Association

Use this option to create an association between the program executable and the extension of the project files. Thus, double-clicking on a project file, will invoke the RockWin program. These settings are saved in the RockWin.INI file.

Debug (Graph)

Use this option to allow showing native graph coordinates in forms where a graph is generated. These settings are saved in the RockWin.INI file.

Circular Openings (extend)

Use this option to specify the default x axis extend in the circular opening graphs in terms of number of radii. These settings are saved in the RockWin.INI file.

4.3 Unit Conversions

Description:

This utility can be used to convert between English and metric units for 4 types of units:

Length
Conversion between inches, feet, centimeters, and meters is supported.

Load
Conversion between lbsF (pounds force), tonsF (short) (short tons force), kN (kiloNewton), MN (MegaNewton), and kips (thousands of pounds) is supported.

Load Gradient
Conversion between lbsF/in (pounds force per inch), lbsF/ft (pounds force per foot), kN/m (kiloNewton per meter), and MN/m (MegaNewton per meter) is supported.

Stress
Conversion between psi (pounds per square inch), ksi (thousand pounds per square inch), psf (pounds per square foot), Pa (Pascals), and MPa (MegaPascals) is supported.

Stress (Pressure) Gradient
Conversion between psi/in (psi per inch), psi/ft (psi per foot), Pa/m (Pascal per meter), and MPa/m (MegaPascal per meter) is supported.

Notes:

- 1 Pa = 1 Newton per square meter
- 1 psi = 1 pound per square inch

4.4 File Conversion

Description:

This utility can be used to convert the **current** file to a different set of units. If the file is in English units, then it can only be converted to metric and vice versa.

Notes:

- The current file should already be saved before accessing the conversion option.

- The current file is then substituted with the converted file.
- A prefix is added to the name of the converted file.

Part V

5 The Help Menu

Use the Help menu option to access various help options, the About Rockwin form, the Disclaimer form, as well as information regarding the current version of the program.

See Also:

- About RockWin
- Disclaimer
- Program Updates

5.1 About RockWin

The RockWin program was created and is currently maintained by created by Prof. Zach Agioutantis, TUC & UKy.

The contribution of the following individuals is acknowledged:

1. Mr. Kostas Seiradakis, Mineral Resources Engineer, TUC, for the development of part of the original routines, and
2. Mr. Thomas Vallas, Mineral Resources Engineer, TUC, for the development of the surface loading routines

5.2 Disclaimer

This software is provided 'AS IS' without warranty of any kind including express or implied warranties of merchantability or fitness for a particular purpose. By acceptance and use of this software, which is conveyed to the user without consideration by the developers, the user expressly waives any and all claims for damage and/or suits for personal injury or property damage resulting from any direct, indirect, incidental, special or consequential damages, or damages for loss of profits, revenue, data or property use, incurred by the user or any third party, whether in an action in contract or tort, arising from access to, or use of, this software in whole or in part.

See also: Program Updates

5.3 Program Updates

No further development or upgrades for this software is planned. However, minor updates may be issued periodically. This program is automatically set to remind the user to check the program web site for an updated version a calendar year after each revision. If an update exists, the user may manually download the setup file and install the new version.

5.4 References

Hoek, E. (2007). *Practical rock engineering*.

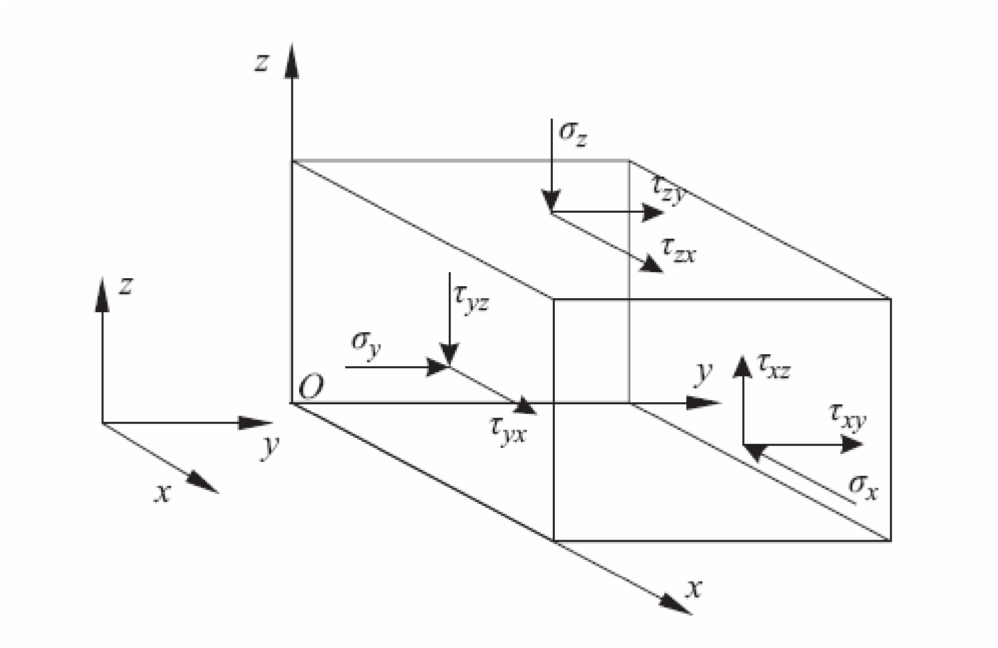
5.5 HelpButton

Position the cursor on any item on the form and press F1 for context sensitive help.

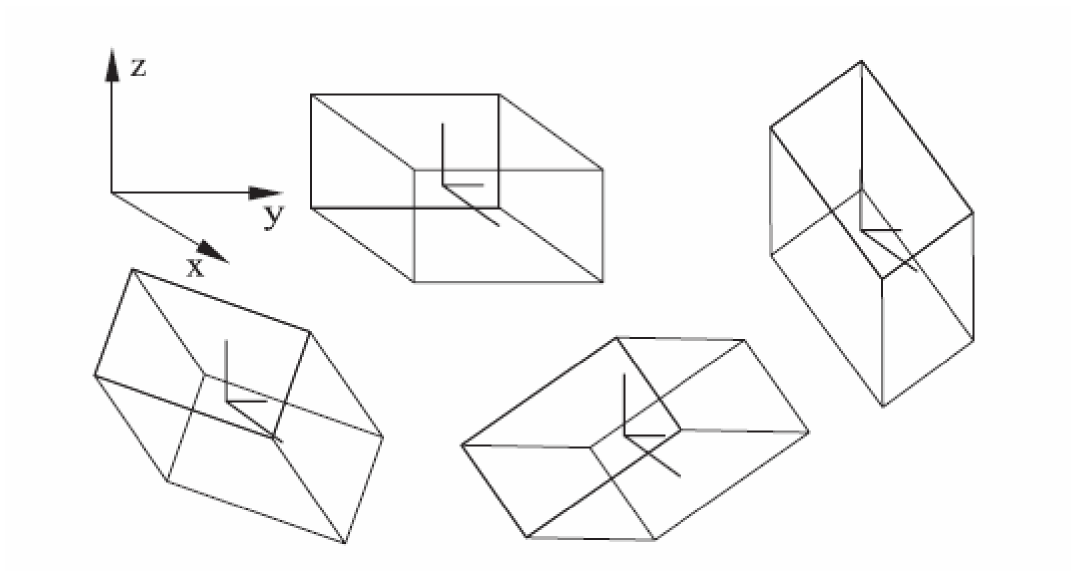
Part VI

6 List of Figures

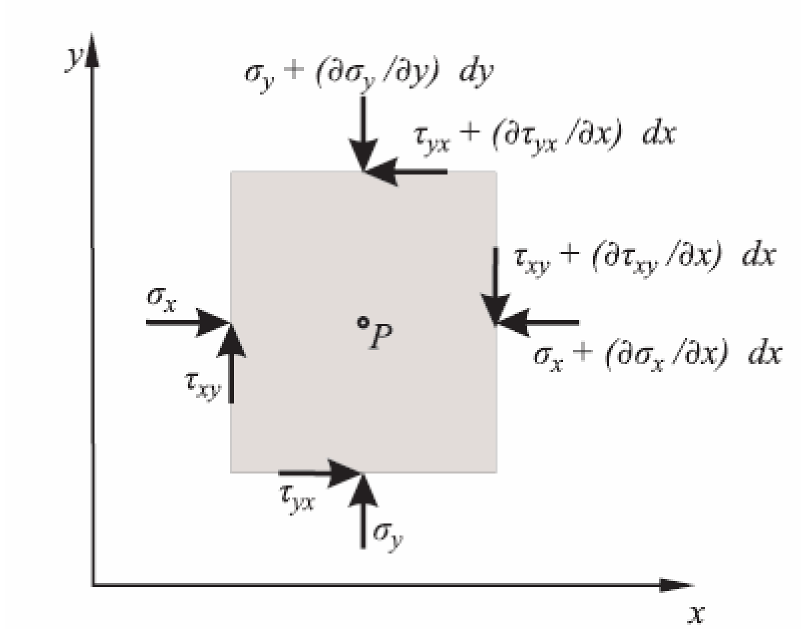
6.1 Figure 1

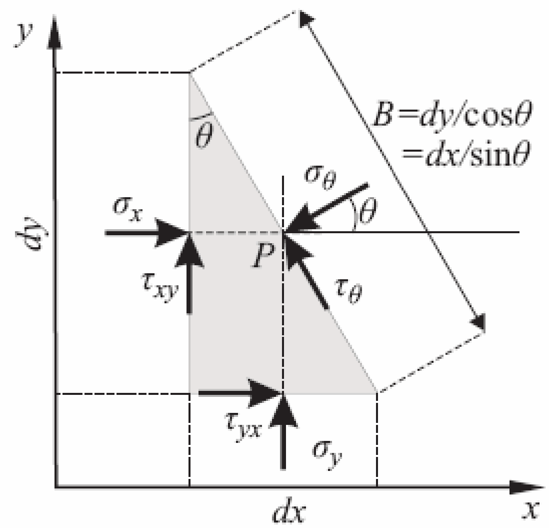


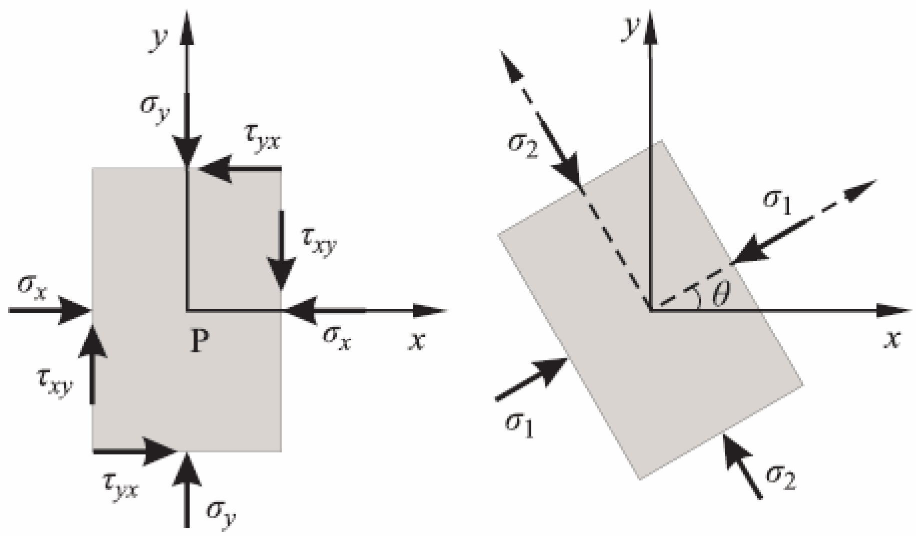
6.2 Figure 2



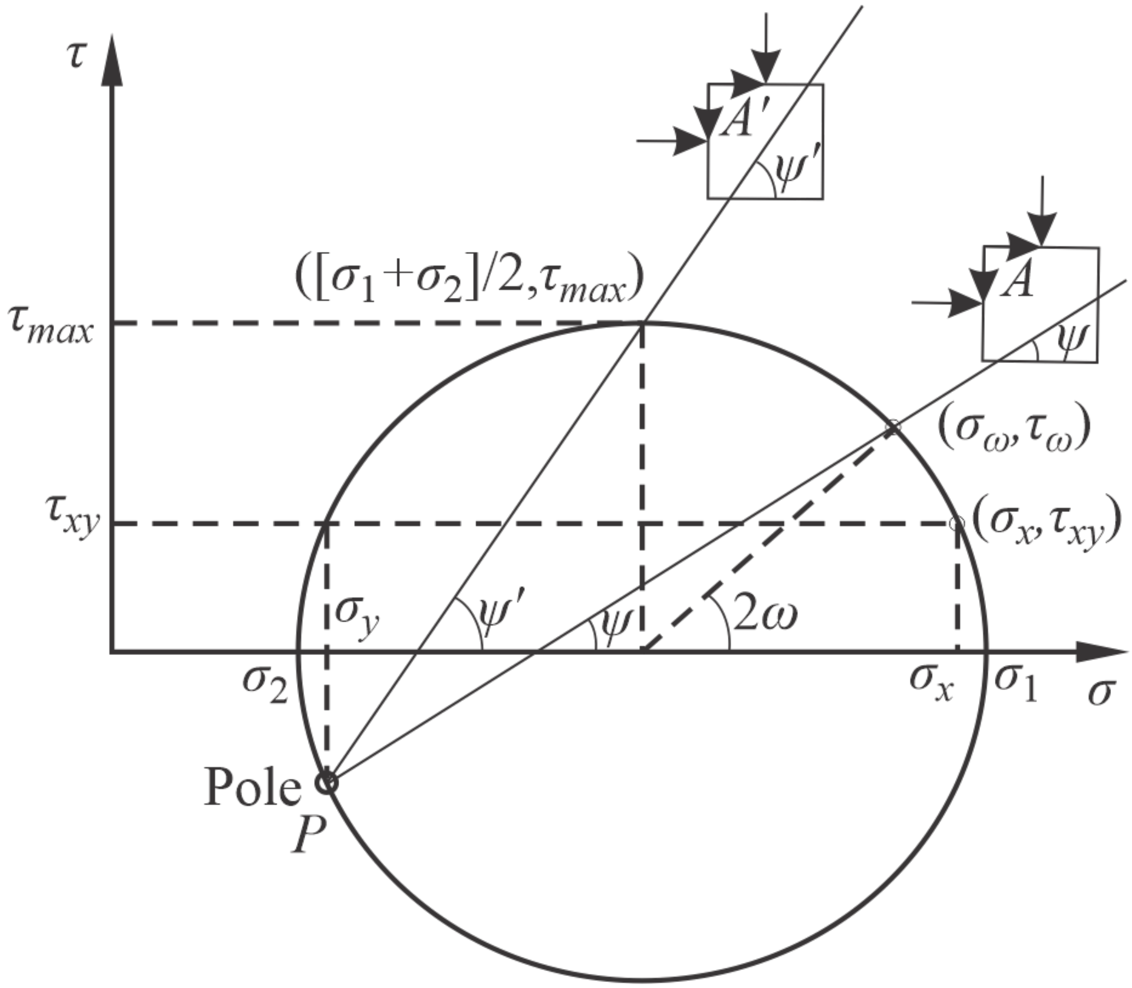
6.3 Figure 3



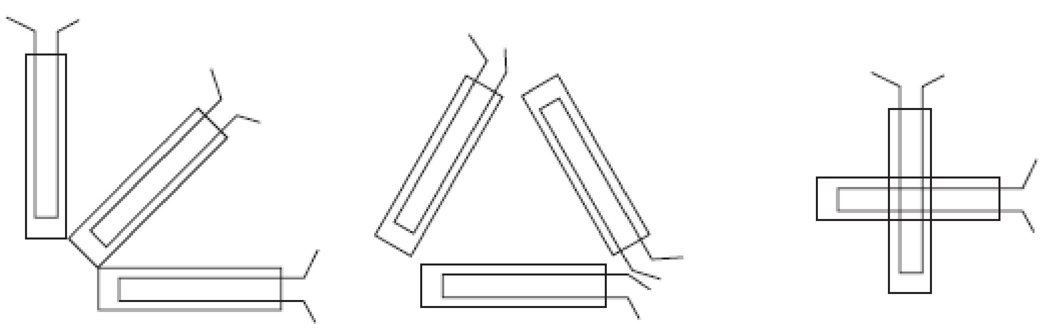

y
B=dy/cosθ
=dx/sinθ
θ
σθ
θ
σx
dy
P
τxy
τθ
τyx
σy
dx
x


y
σy
τyx
τxy
σx
P
σx
x
τxy
τyx
σy
y
σ2
σ1
θ
x
σ1
σ2

6.4 Figure 4



6.5 Figure 5



6.6 Figure 6

6.7 Figure 7

6.8 Figure 8

Index

- A -

- B -

- C -

- E -

- F -

- H -

- O -

- P -

- R -

- S -

- T -

- U -

- V -