SlopeStab & SlopeStabi
Slope-stability calculations
Manual

Version 1.6
Psicons AB
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General presentation

The SlopeStab program was made to be an, easy to use, tool for civil engineers. The main advantage with the SlopeStab program is it´s simplicity and the graphic interface.
The program will run on Apple Macintosh machines running MacOS Ventura or later. A version of the software will also run on iOS 16 or later but with some limitations especially regarding the user interface.
The original version of the softwares was written during the late 1980’s so a lot of things has changed. Most significant is the dramatic increase of computing power. Today a normal slope is fully run in a few seconds and this has made it unnecessary to store calculation results so the only files available and possible to store are input files (simple text files).
The program is built to use different methods for calculating the slope-stability. In this version only the Swedish (ordinary) method of slices and simplified Bishop´s method can be used applied on circular failure-surfaces. If the program sell's and the costumers are interested then more methods and different failure-surfaces might be implemented.
Following three main different windows are used to communicate with the user:

TextWindow - Contains text produced by the software.
GraphWindow - Contains graphics hopefully displaying the problem.
InputWindow - Contains editfields for defining the inputdata.

On MacOS a picture of the accomplished problem is seen in the Input Window. On iOS the user have to shift to the Graphic Window (Visual check) to se the slope as a picture.
The input files can be edited and the format will be presented later. However it is just to run the slope to list information into the TextWindow, copy it to the ClipBoardFile and transfer it to a spreadsheet or word-processing program. The same goes for pictures. Of course you can print anything in the text or the graphics windows.
The program is simple and fast to run and learn. Exactly how it is supposed to work and calculate will be explained later. However it is easy to misuse the program and the responsibility for the translation of the results into the real world will always be on the user. So give the methods some time and learn how the program works through a careful study of the examples at the end of this manual and in the examples folder. There may also be unknown bugs in the program. So use it with care and good luck.

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If you are on an iPhone (iPad) you can skip until page 5.

The Menubar (macOS)

The menubar has most of the standard parts that's recommended by Apple and some application specific parts for control of the program.

File

The File menu takes care of opening and saving of files, printing and closing

Save input

This menu item will only bee seen when there is **inputdata** to save. Choose it and you will get the standard save dialog. Print the name you want to give the file in the edit field and choose the save button.

Open input

Open input will display the standard choose file box. Just select the **inputfile** you want to open and double click or choose the open button.

Print Text Window

(if TextWindow frontmost and there are text in the TextWindow)
Print content of the text window

Print GraphWindow (if GraphWindow frontmost)

Print content of the graph window

Close

Closes the front most window (if both the GraphWindow and the TextWindow are closed the program will terminate).

Edit

Undo

Not supported.

If Text Window is frontmost
Cut
Copy
Paste
Delete
Select all

If Graph Window is frontmost
Copy GraphWindow

Window

InputWindow
Brings the InputWindow to the front. (More on this later)

TextWindow
Brings the TextWindow to the front.

GraphWindow
Brings the GraphWindow to the front.Results

Results

Run slope
Will run the analyse of the slope according to search data set up and slope set up. Main data for lowest safety factor according to “simplified Bishop” for each circle centre will be saved and sorted in escalating order.

When the slope set up is run data from the the failure arc with the lowest safety factor for the circle centre with the lowest safety factor is written into the TextWindow (what’s written will be explained later).

Show details
Recalculates and shows the analyse of the slope in view. The data from the analyse will be appended to the TextWindow and the GraphWindow will be updated with the slices in the analyse.

Next
Brings up next failure arc in safety factor sequence based on analyse according to “Bishop simplified method of slices” (explained later).

Previous
Brings up previous failure arc in safety factor sequence based on analyse according to “Bishop simplified method of slices” (explained later).

First
Brings up the the failure arc with the lowest safety factor for the circle center with the lowest safety factor.

If you are a Mac user you can skip to page 12.

iOS interface

iPhones and other iOS devices does not have the menu system of Mac computers or all the space that is available on a computer screen so the user interface has to be made differently. The implementation in SlopeStabi (the version for iOS) is based on a series of screens. After the important message screen (land slides and slope stability is serious business) that always is the first screen when starting the program comes a window with three buttons:

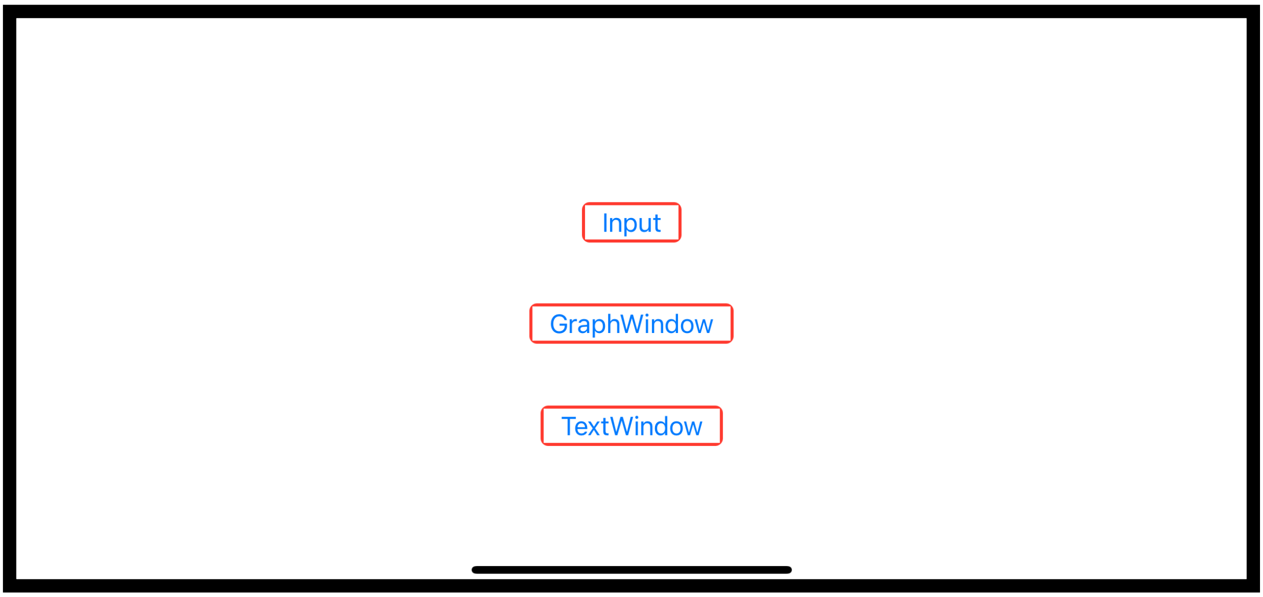


Figure 1: Main choice screen (iOS)

The upper button (Input) moves on to the input screen which will be explained later. The middle button (GraphWindow) moves on to a screen where most of the action takes place. The lower button moves on to the text screen which contains the text output of the program (the same as on Mac). Lets start with the input screen:

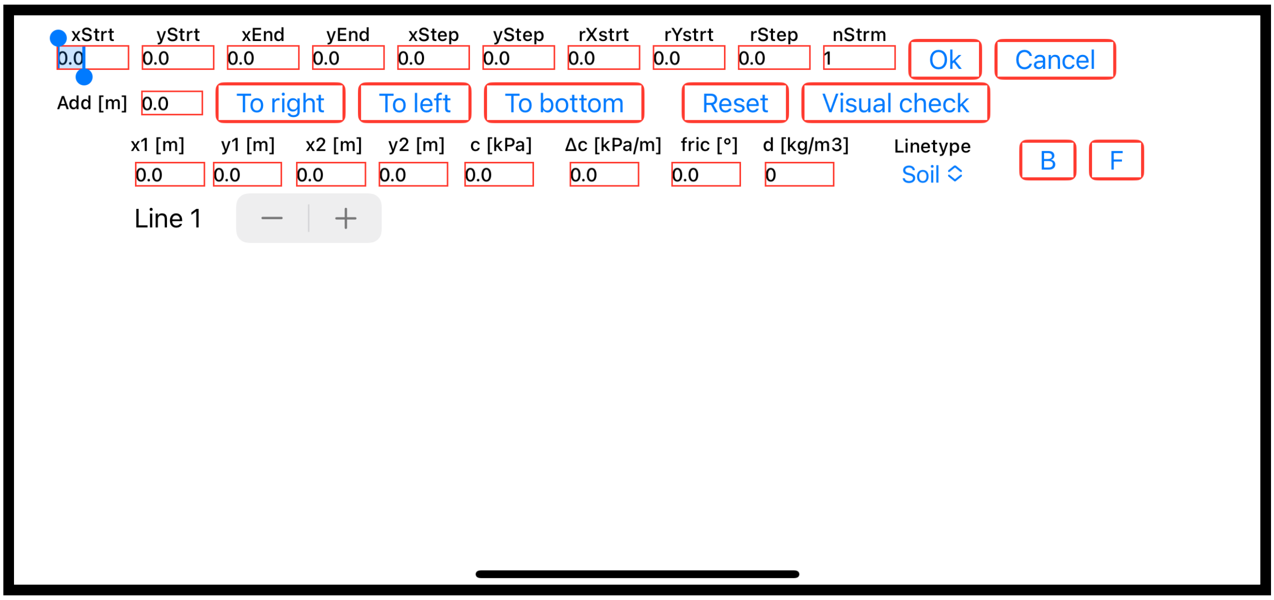


Figure 2: Input screen (iOS). 2023-10-03, a reset button was introduced to facilitate a fresh start for setting up a new slope. 2023-12-05 a new line property was introduced defining a clay with changing cohesion values with depth.

This screen is contains the same edit fields as on Mac but has three additional buttons. “Visual check”, “B” and “F”. The “Visual check” button replaces the visual display of the set up input window on a Mac computer and brings up a screen exactly the same as seen on the Mac version but with a back button on the upper left corner. The button “B” steps one step back and the button “F” steps one step forward. For further explanation see Figures 7 to 9 in the Mac section.

Pressing the middle button (GraphWindow) brings up a screen showing the same as the “GraphWindow” on the Mac version but with some additional buttons as seen and explained below in Figure 3:

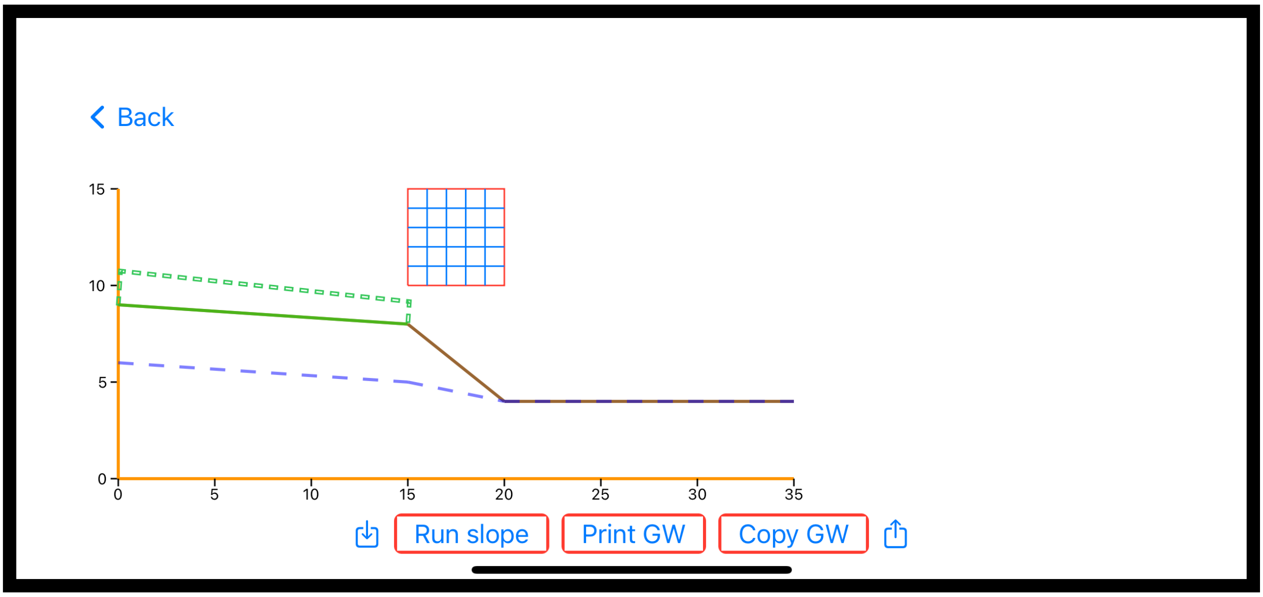


Figure 3: Main action screen (GraphWindow) with action buttons before Run slope is executed (from file Example 1).

The “Print GW” button sends the screen to a printer using “AirPrint” and “Copy GW” will place a .pdf version of the screen (without buttons) in the clip board. If there are any text in the text screen an additional button “Print TW” will be visible. This button sends the text in the text screen to a printer using “AirPrint”.

Pressing the “Run slope” button will start the calculations to evaluate the slope set up. After a while the screen change as below in Figure 4:

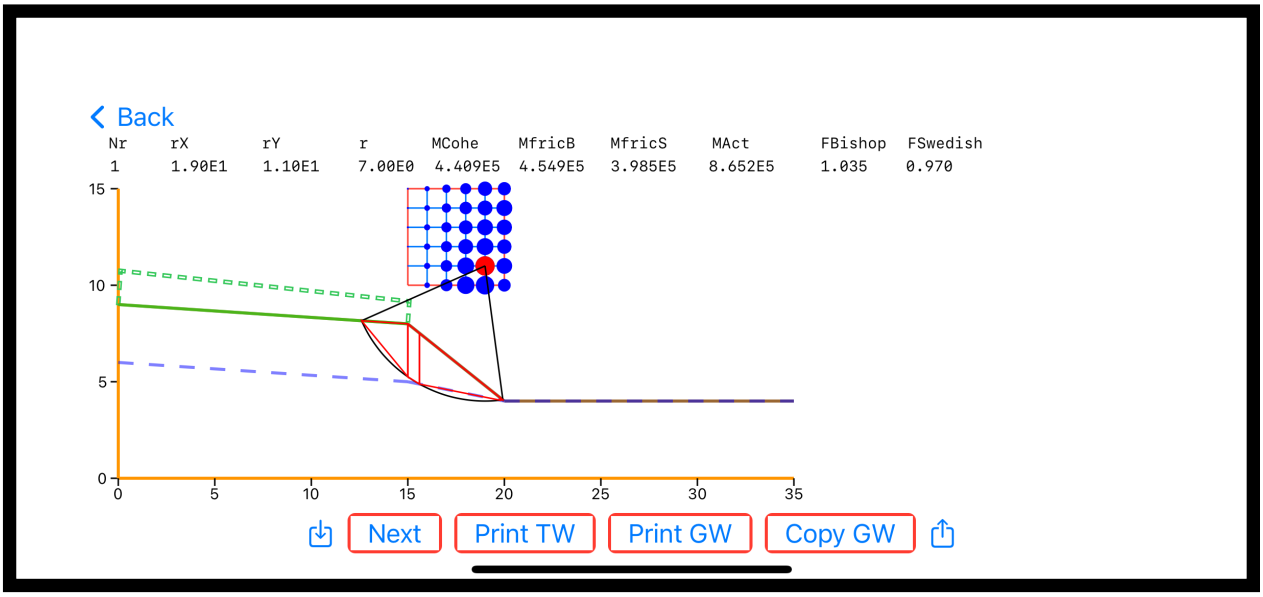


Figure 4: Screen after "Run slope" executed (from file Example 1).

Pressing the button "Next" will bring up the next failure arc in an ascending sequence of calculated safety factors according to simplified Bishop's method of slices as seen on Figure 5 below.

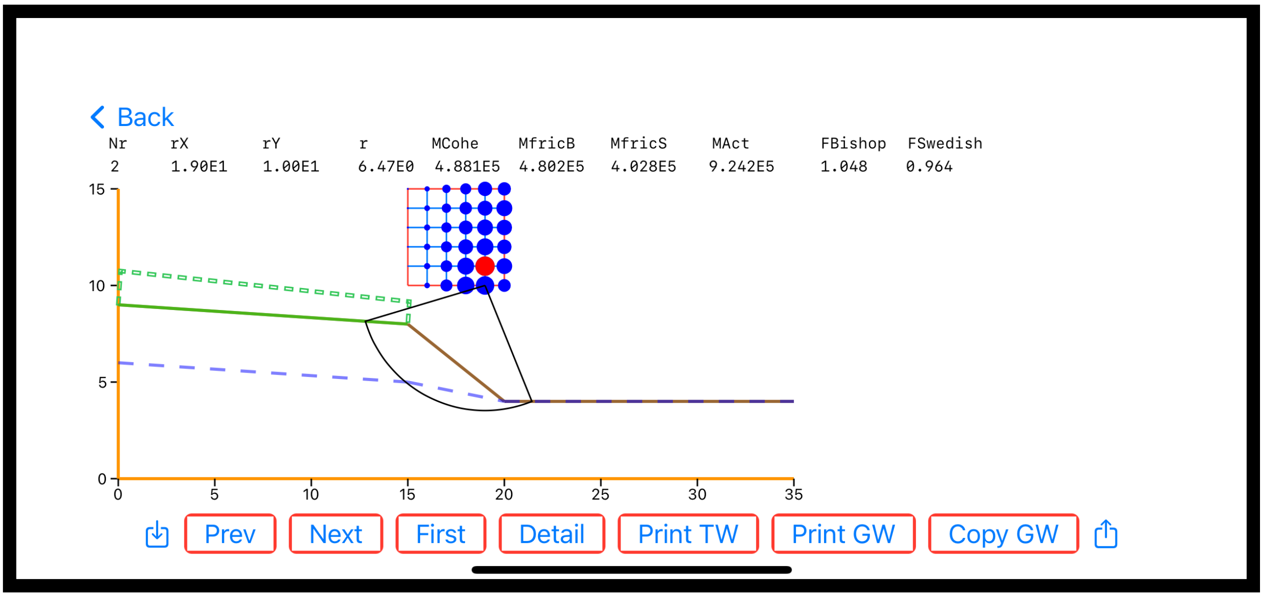


Figure 5: Examination of other failure arcs than the one with lowest safety factor according to simplified Bishop's method of slices (from file Example 1).

Pressing the "Detail" button will show the analyse of this failure arc on the screen as seen in Figure 6 below.

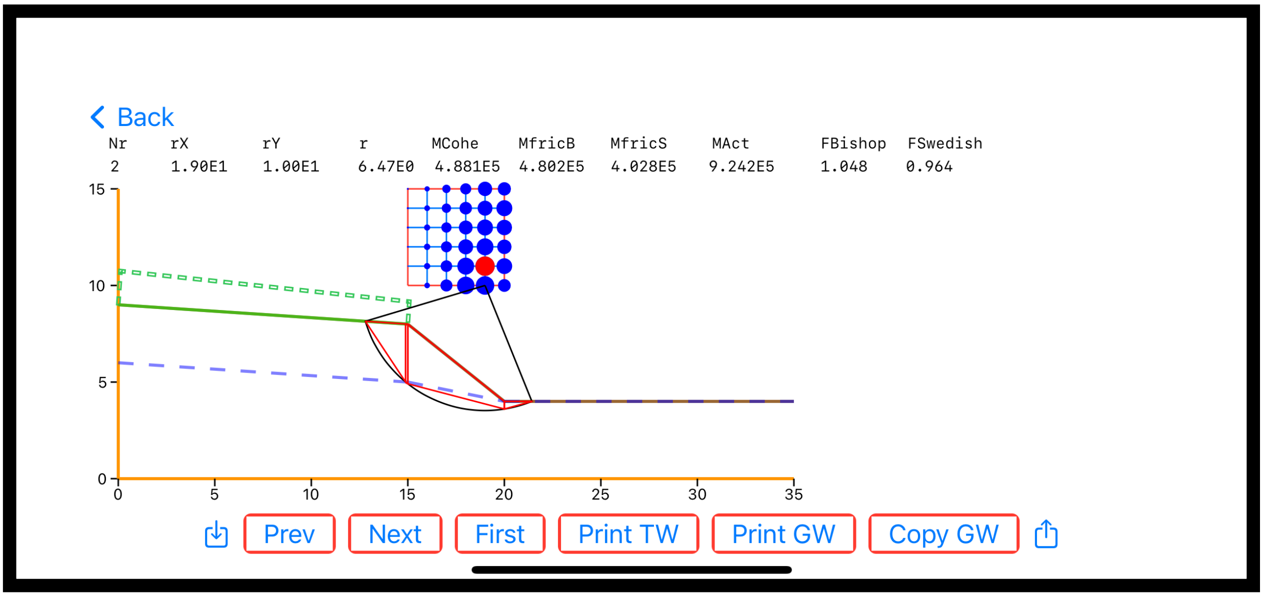


Figure 6: Another failure arc than the one with lowest safety factor analysed (from file Example 1)

Observe the down arrow button on the left side which is to read a file from the iPhone storage or from iCloud (example files and other files can be uploaded from psiconsab.se). The up arrow button on the right side is for storing the input file either in the iPhones internal storage or on iCloud.
The remaining of this manual is valid for both Mac and iPhone (iPad).

Window: InputWindow

The following window will show:

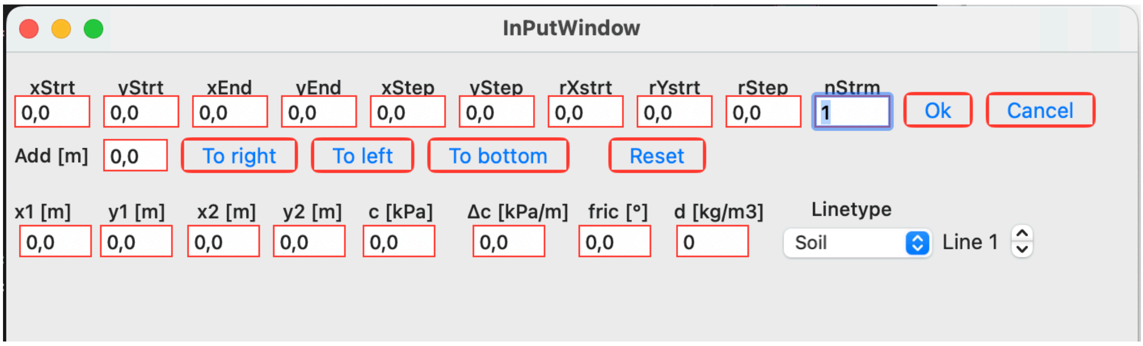


Figure 7: If no inputdata exists then this is what you get when selecting InputWindow.

This window is for creating the search data and geometrical input of the slope by defining line geometry, line type, the soil properties, water levels and loads. You walk around the different edit fields with the mouse, the up and down arrow-keys, return key or the tab key. The buttons "To right", "To left" and "To bottom" and the Add [m] edit field are used to move the slope around the x-y plane (changing distances to boundaries).

The searchdata

The searchdata is made by filling in the first line beginning at xStrt and ending in rStep in figure 1. The edit field nStrim ("nStr…") defines minimum number of slices in the calculations.

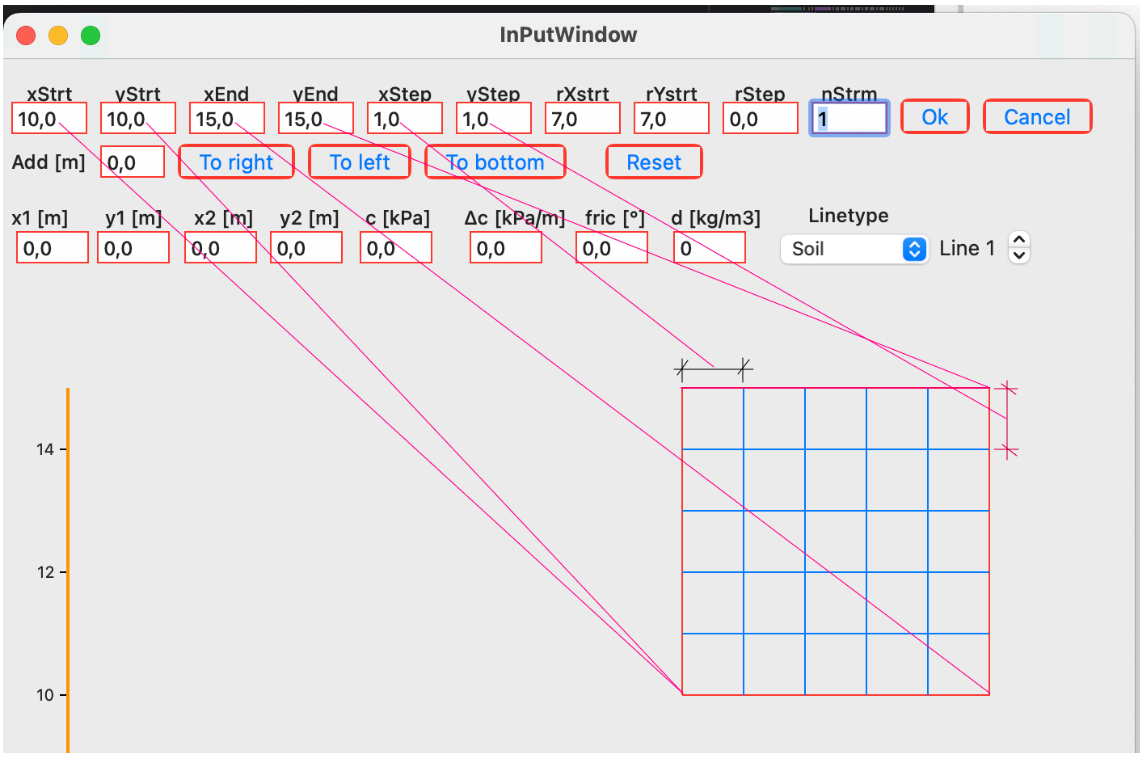


Figure 8: Defining the search square.

The searchdata is made up of two parts. The first part is a square defining what circle centers to be used when looking for the most critical slope. The limits of that square is defined with xStrt, yStrt,xEnd and yEnd. xStep and yStep divides the square into a net where the intersections of vertical and horizontal lines will be the later investigated center's. See figure 8.
The last part defines a point (rXstrt & rYstrt) where the calculated first arc will intersect for all the center's. The value of rStep defines the radius increment with which the radius will increase when going from one slope to next under the same slope-centre (see figure 9). If rStep is set to zero the program is forced to use only one slope (the first) for each centre (see the Free water example).

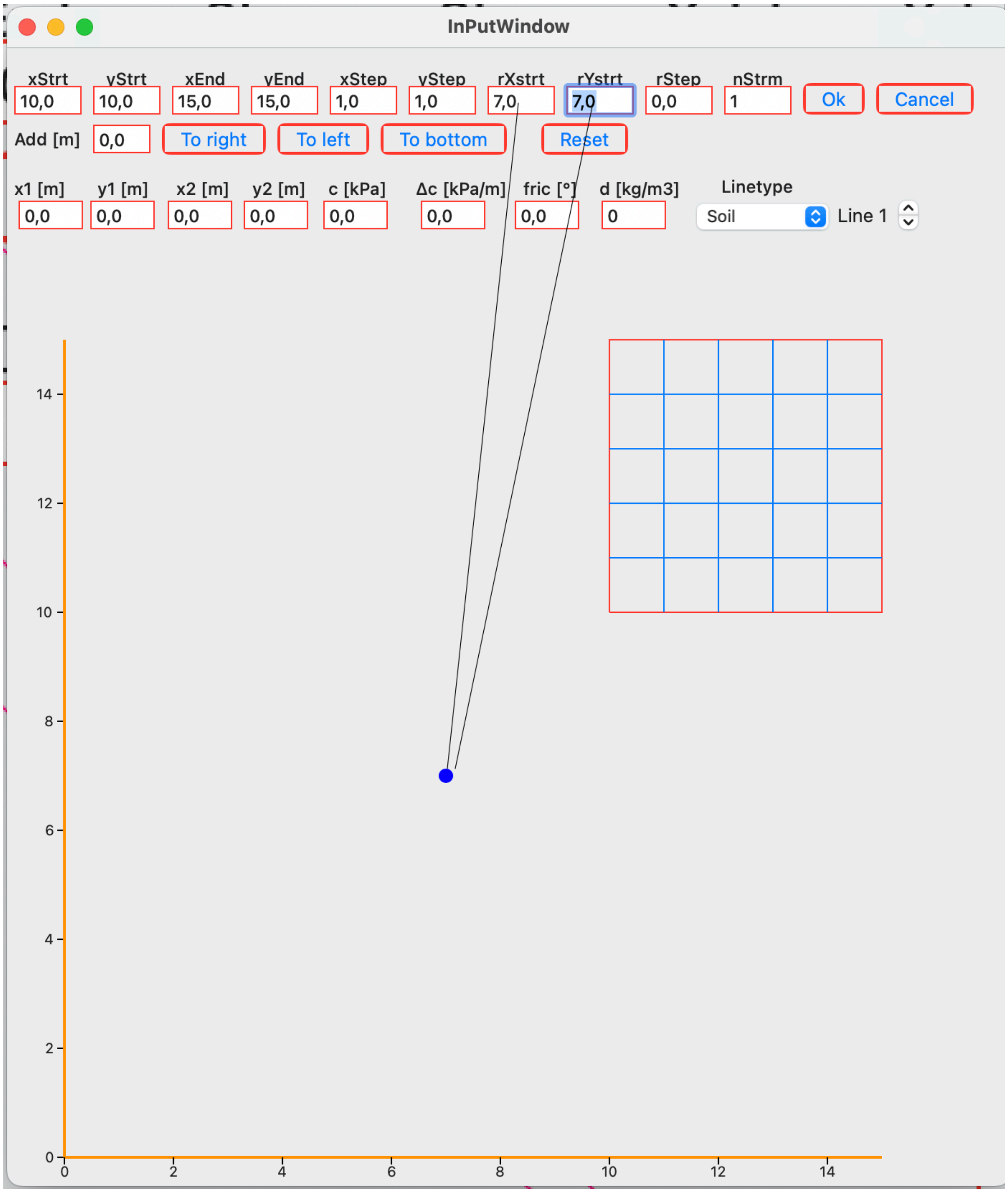


Figure 9: When a new set of calculations starts at a fresh centre the program must know where to place the first slope-circle. The point defined with rXstrt and rYstrt will be intersected with the first slope-circle.

Definition of a Line

The line of edit fields below (beginning with "x1 [m]") is for setting up the slope geometry and properties. A lines geometry is defined by to points (x1&y1 and x2&y2). At present there are three different line types. A new line is created when moving forward standing on the last line's last edit field (density if standing on a "Soil" line). A line is deleted if 0 values are set for x1, y1 ,x2 and y2 followed by clicking OK (press if iPhone)

The Soil Line

On the right side of the row of edit fields is a scroll menu to choose line type. Choose"Soil" and the line will be a soil line (as done in the figure). A soil line defines the material properties under the line until the next soil-line or the x-axis.In figure 10 you can see an example with two lines defined. Notice the "Line 2" and that line 2 is red and thicker. This tell's you which line that's present in the edit boxes which help's you to exactly know what line you are editing. To change the line to edit press the control arrows to the right of the "Line x" or use the up arrow, down arrow, return or tab keys. The Δc parameter describes a clay with changing properties with depth. Reference elevation is the highest of y1 and y2.

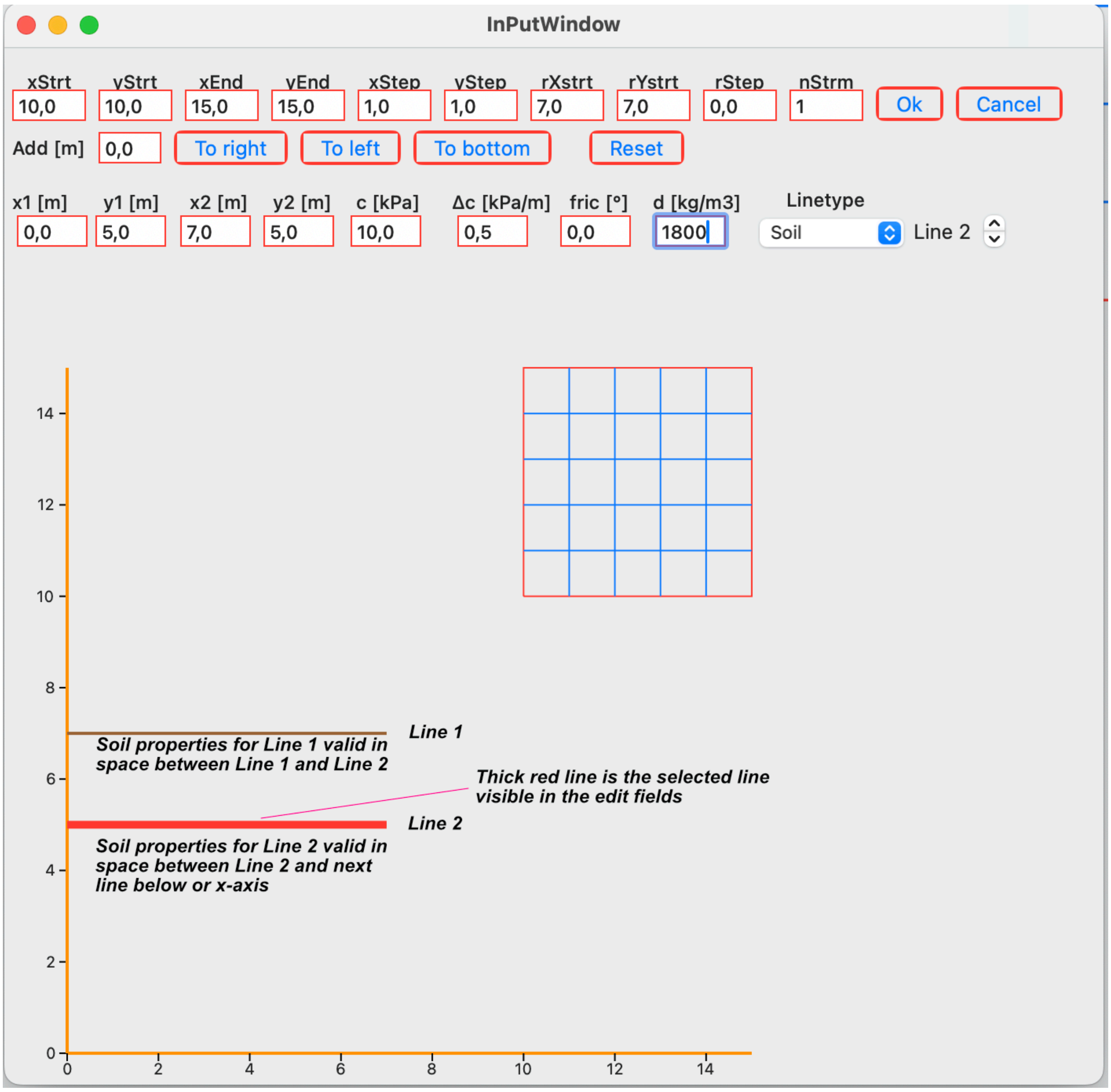


Figure 10: Example of Soil-lines and how they are defined. The Soil-properties present in the edit fields are valid until the next soil-line (Line 2).

The Water Line

If "Water" is chosen the line will be a water line. A water-line only changes the effective stress under it and because of that reduces the frictional resistance along the failure arc. It does not affect the cohesional part of the resistance. The amount of reduction depends on used calculation method as will be explained later. If the present line is a water line then the three last edit boxes of the line-definition will have different meanings than for the soil line as can be seen in figure 5. The Δh [m] edit fields defines eventual artesian water pressure head in meters at the left and right end. The soil density and friction boxes has no meaning. Remember that the water line only affects the effective stress so if you are going to model free water surfaces you have to ad area loads simulating the load from the water on to the soil slope. Also remember that if the density of the soil is significantly greater under the water line you have to add a new soil-line with a higher density at the same place as the water line. Study the examples at the end of this manual.

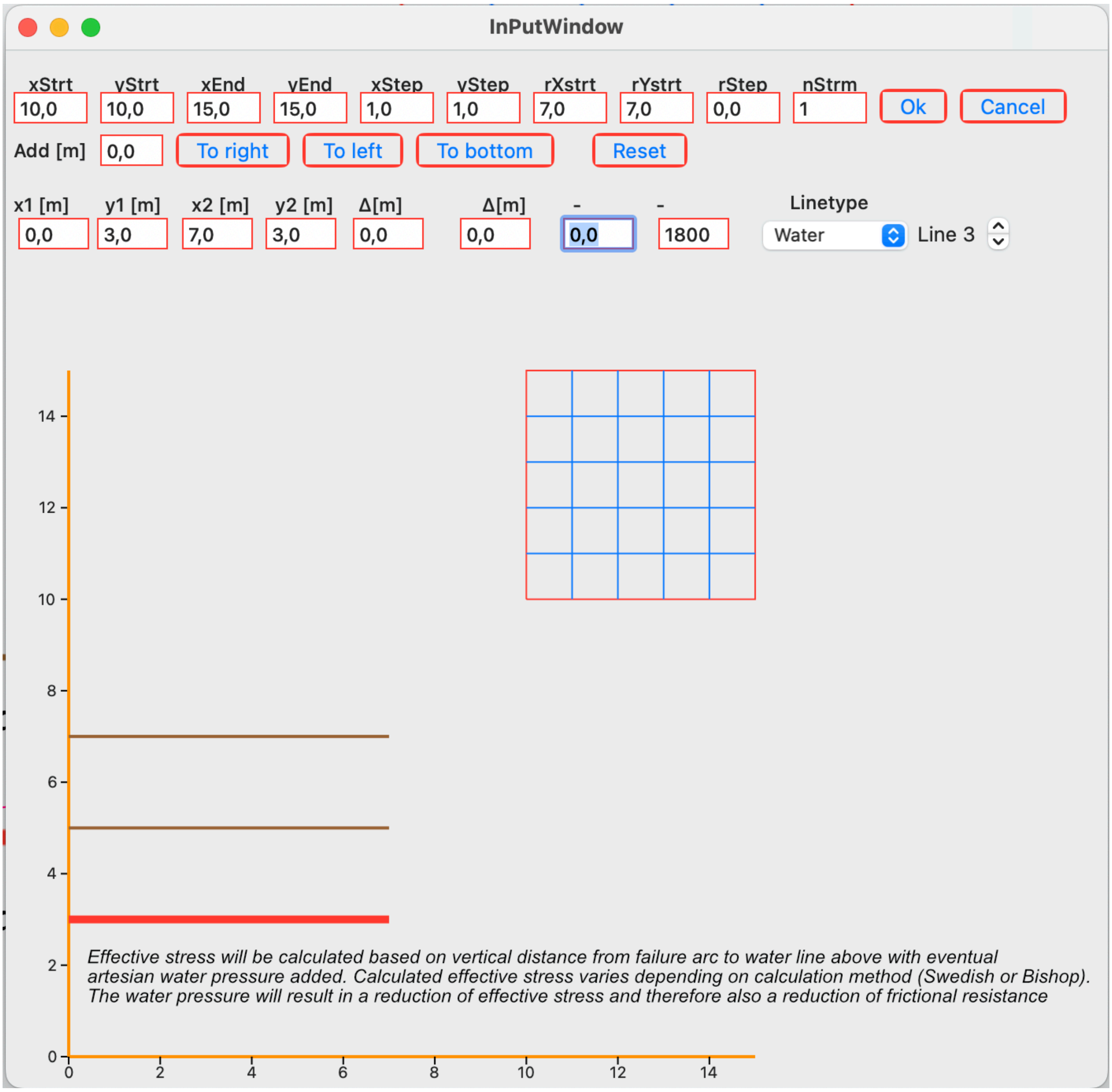


Figure 11: The definition of a Water line.

The AreaLoad Line

Choose the "AreaLoad" and the present line will be defined as an area-load (strip-load) line. An areaload will have effect on the soil under it. As with the water line the meaning of the last three edit boxes of the present line will change. The area-load is input as kPa. Different values can be applied at the line-start and the line end to achieve differently shaped load forms along the line. The load-direction is always perpendicular to the line. (If you want to have a vertical load on a non-horizontal soil-surface just apply a horizontal area-load line over the soil-surface.) For a sloping line the program will divide the load into a horizontal and a vertical component. The vertical component will affect the effective stress along the failure arc under it and ad to the moments created by the weight of the soil. The horizontal component will only add an area load moment. You can change the load-direction by moving the line-ends. If the point defined with x1 and y1 are to the left of the the point defined with x2 and y2 the vertical component of the load will act in the gravitational direction (negative y). If x1 and x2 are the same then no vertical part exists. y1 is lesser then y2 then the load-direction will be to the right. If y1 is greater than y2 the load-direction will be to the left. When an area load is defined a green dotted line will appear indicating the load form and the load direction. Se figure 12.

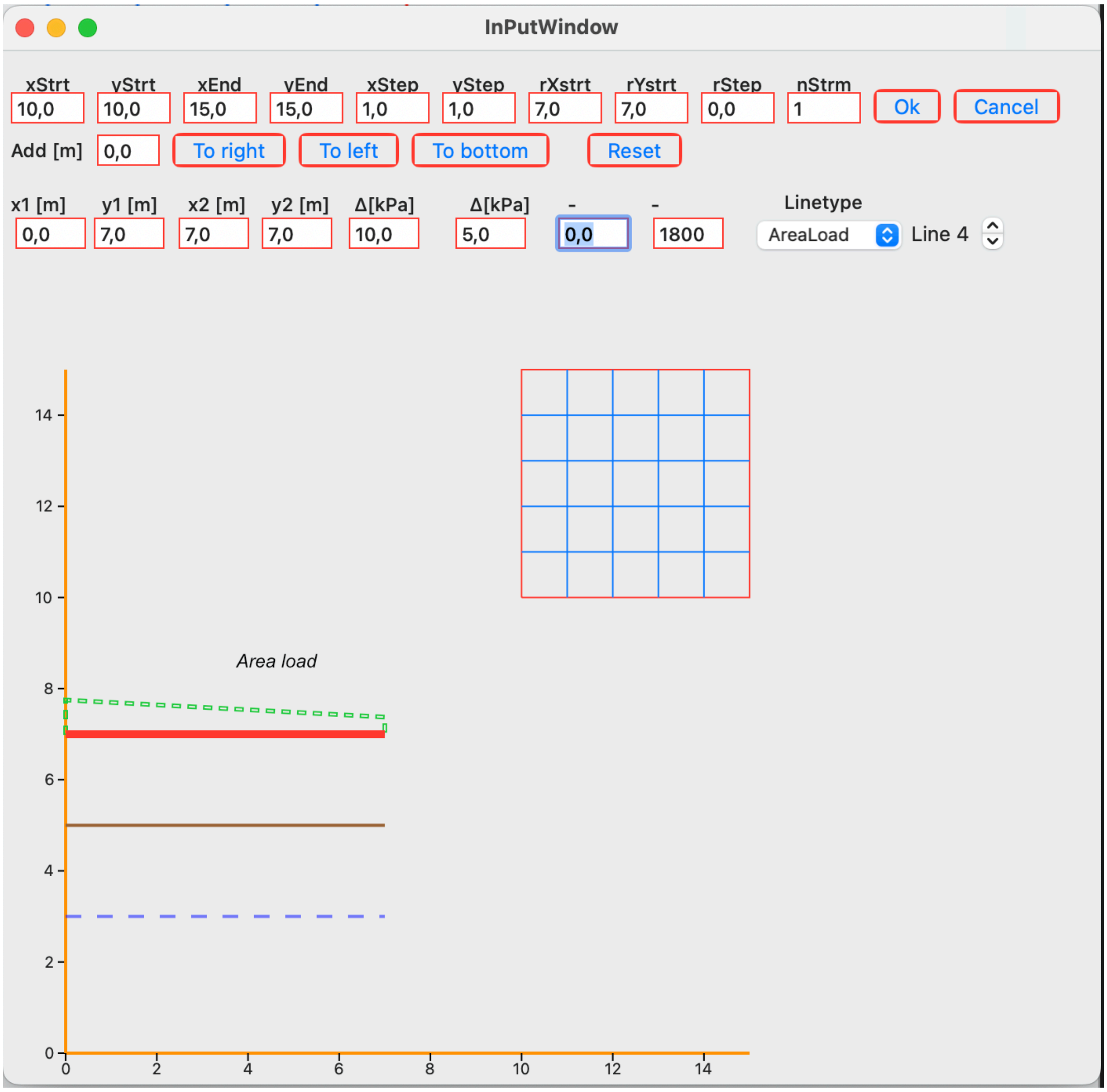


Figure 12: The AreaLoad line.

For details about how to change the load direction study the "Rotate AreaLoads" file in the examples folder that can be downloaded from psiconsab.se.

Calculation methods

At present only two different calculation methods can be used. As earlier mentioned this may change in the future.

General part

When the input is made three boundaries are set up from the coordinates of the soil lines. If any of the failure arc crossings with a line passes any of the side boundaries the program will continue with the next slope centre. Also if the failure arc passes the bottom line a new arc centre will be started. On the left side the boundary is from the x-axis to the top soil line with the lowest x-coordinate (should be 0). The bottom boundary is the x-axis (y=0). On the right side the boundary is the right end of the soil line with the highest x-coordinate with the highest y-value (see figure 13).

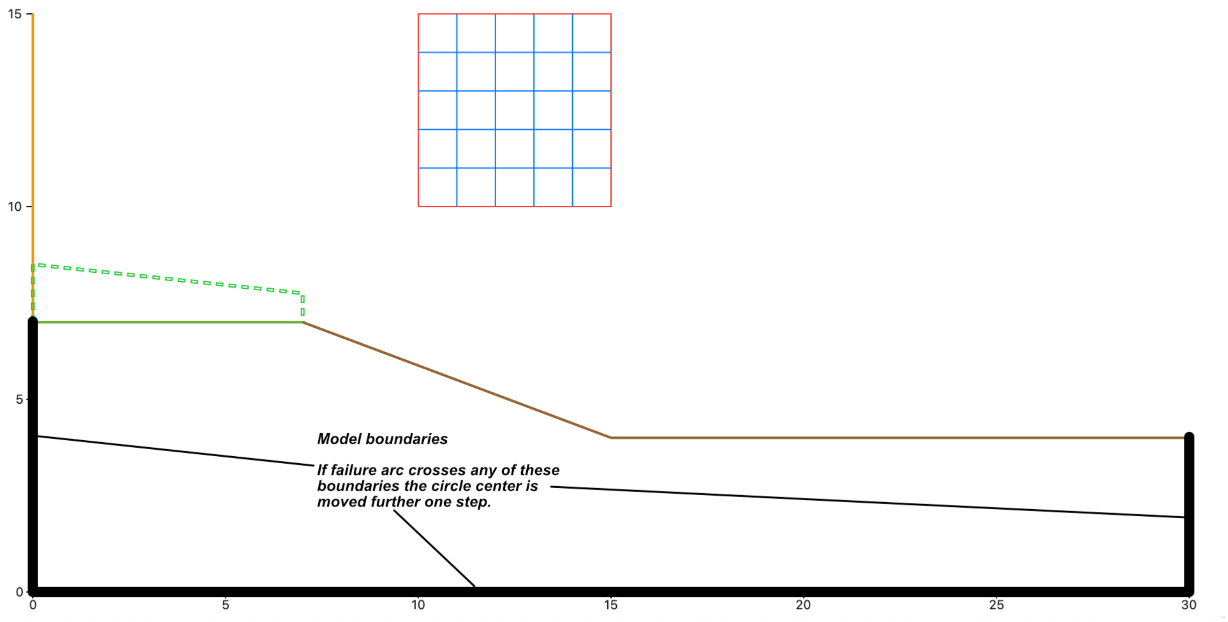


Figure 13: The soil lines defines three boundaries. If a failure arcs crossing with a soil line passes outside any of these boundaries the program will continue with the next slope centre.

The program divides the area above the failure circle in vertical slices in the same manner as you might have done if you were calculating by hand. Each slice is divided in different parts separated by soil lines and for the last part, the intersected failure arc. It calculates the mass and the mass centre for each part. For each part it calculates the acting moment from the soil-mass and adds them to get the total moment and weight for each slice (see figure 14). After that it calculates the moments and the loads from vertical parts of arealoads if there are any present in or above the slice. The vertical loads and the soil weights are the input for calculating the total vertical stress along the part of the failure arc that's intersecting the slice. If there are water-lines above the failure arc then the water pressure in the slice, along the failure arc is calculated based on first water line above taking in account possible artesian pressures. If there are horizontal forces present from arealoads in or above the slice then the moments from them are added to the acting area load moments.

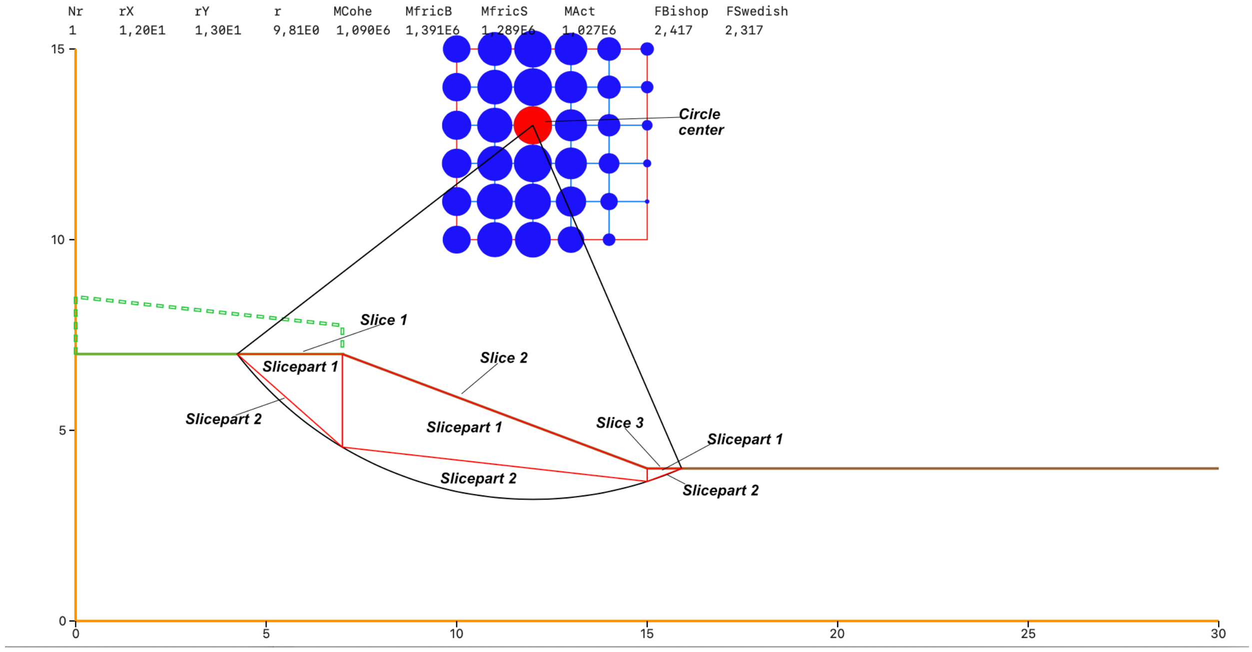


Figure 14: The program first divides the slope into vertical slices then divides each slice into parts separated by soil lines and for the last part, the intersected failure arc.

The general formula for calculating the total safety factor is:

$$F = \frac{Resisting\ moments}{Acting\ moments}$$

or

$$F = \frac{MFric + MCohe}{ABS\,(MSoil + MStrip)}$$

Where MFric is the resisting moment from the soils inner friction and MCohe is the resisting moment from the soils cohesion. MSoil is the acting moment from the soilweight and MStrip is the acting moment from arealoads:

The only thing that´s different between the two implemented methods is how the resisting moment coming from the soils internal friction and the present effective stress is calculated. All other things such as the soil weight, the water pressure, the acting moment from soil weight and area loads and the resisting moments from the soils cohesion are the same. Here comes some common definitions and formulas:

$$MCohesion = R \sum_{i=1}^{Nslices} ArcL_i\, C_i$$

Where $ArcL_i$ is the curved length of the failure arc that's intersected by the slice i (same as CSL in the text window (screen)).

C_i is the cohesion given by the first line above the failure arc in the slice with addition of eventual cohesion increase with depth according to the Δc [kPa/m] input.

R is the radius of the failure arc.

$$MFriction = R \sum_{i=1}^{Nslices} tan\ \phi_i\ \overline{N_i}$$

Where N_i is the effective stress perpendicular to the failure arc in the middle of the slice i and ϕ_i is the inner friction angle given by the first line above the failure arc in the slice. The effective stress is calculated differently with different calculation models.

$$MSoil = \sum_{i=1}^{Nslices} \sum_{j=1}^{N\ parts} Area_j\ dens_j\ horisontal\ arm_j$$

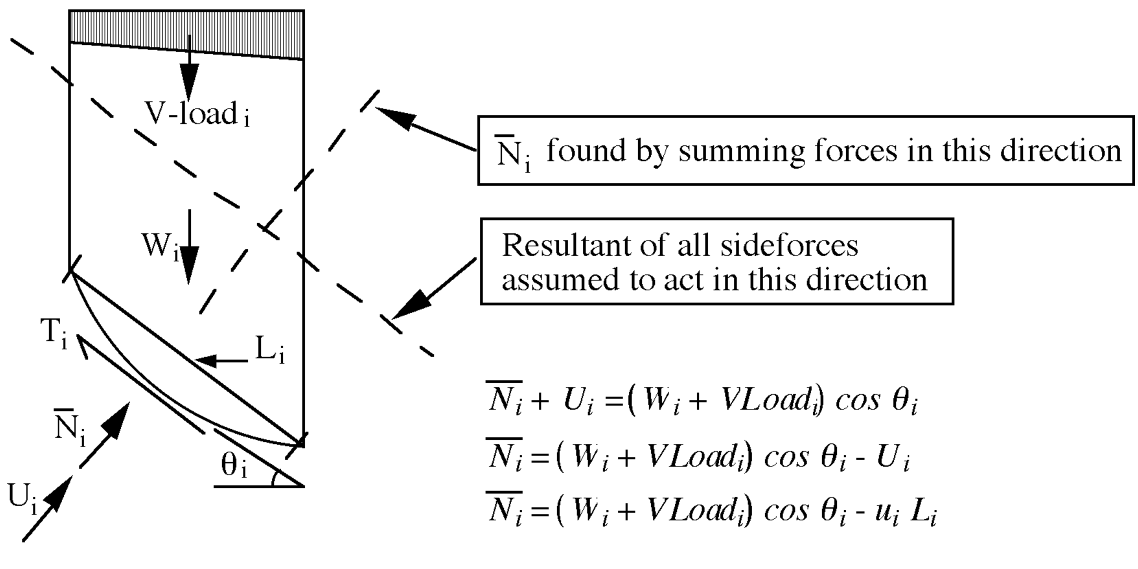
Where area is the area of the slice part j and dens is the density defined by the soil line on top of the slice part j. The horizontal arm is the horizontal distance from the slope-centre to the mass centre for the slice part j.

$$MStripLoad = \sum_{i=1}^{N\ Slices} \sum_{k=1}^{N\ Loads} AreaLoad_k\ Moment\ arm_k$$

Where N Loads stands for the number of area-loads in or directly above the slice i.
For the next chapter's the following three definitions are important. W_i is the weight of the slice i and u_i is the water pressure along the failure arc in the middle of the slice i. V-load$_i$ is the sum of the vertical parts of area loads above or inside the slice i.

Swedish Method of Slices

This method was first proposed by Fellenius somewhere around 1936. It assumes that the resultant from all side forces acting on a slice is parallel with the failure arc (see figure 15).



$$\overline{N_i} + U_i = (W_i + VLoad_i)\ cos\ \theta_i$$
$$\overline{N_i} = (W_i + VLoad_i)\ cos\ \theta_i - U_i$$
$$\overline{N_i} = (W_i + VLoad_i)\ cos\ \theta_i - u_i\ L_i$$

Figure 15: Forces considered in the Swedish method of slices.

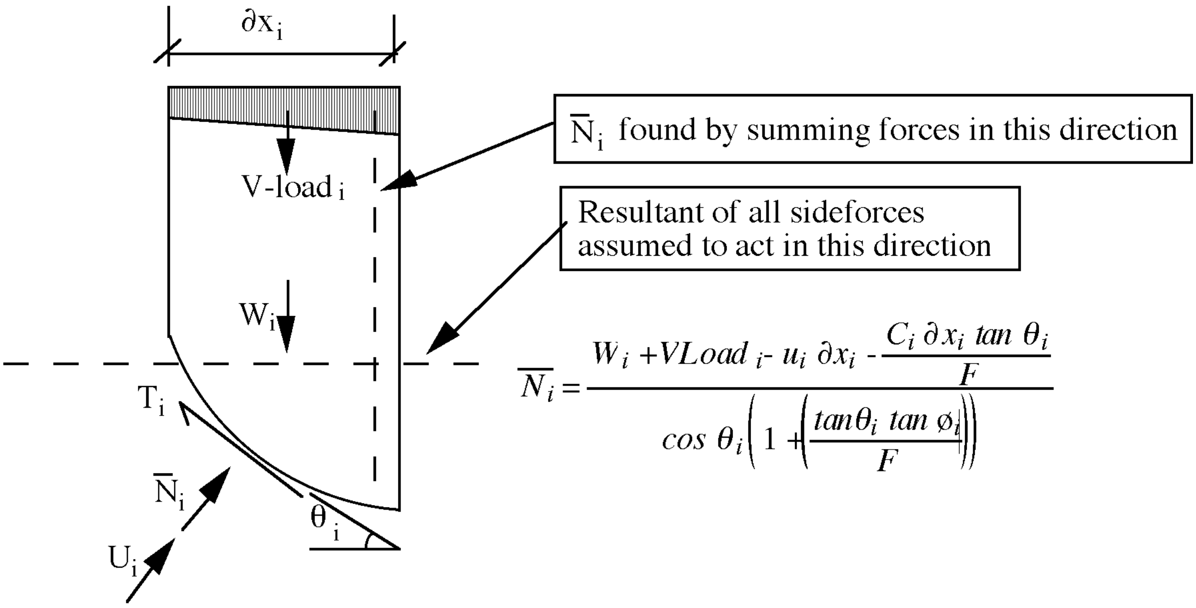
The following formula defines the safety-factor:

$$F = \frac{R \sum_{i=1}^{N\,Slices} C_i\, ArcL_i + \tan \phi_i \left((W_i + VLoad_i) \cos \theta_i - u_i\, L_i \right)}{\sum_{i=1}^{N\,Slices} \left(\sum_{j=1}^{N\,parts} Area_j\, dens_j\, horisontal\, arm_j + \sum_{k=1}^{N\,Loads} AreaLoad_k\, Moment\, arm_k \right)}$$

Some things are worth mentioned here. For the first it is possible to have a water force U_i greater than $(W_i + VLoad_i) \cos(\theta_i)$. If that happens then the effective stress will get a negative value. This would imply that the frictional properties of the soil has a destabilizing effect which of course is impossible, so in this program negative values of effective stresses are set to zero based on the separate slices.
Another important thing is that the Swedish method of slices usually gives a result on the safe side and that the calculated safety-factor usually is 10 to 20% lower than the real value. In some cases though, errors up to 60% have been observed.

Bishop´s simplified Method

This method was described by Bishop in 1955. The Bishop method is a little bit more complicated than the Swedish method of slices. The base assumption is that the resultant from all side-forces acting on a slice is horizontal (see figure 16).



$$\overline{N}_i = \frac{W_i + VLoad_i - u_i\, \partial x_i - \dfrac{C_i\, \partial x_i \tan \theta_i}{F}}{\cos \theta_i \left(1 + \left(\dfrac{\tan\theta_i \tan \phi_i}{F} \right) \right)}$$

Figure 16: Forces considered in simplified Bishop´s method of slices.

The following formula defines the safety-factor:

$$F = \frac{R \sum_{i=1}^{N\,Slices} C_i\, ArcL_i + tan\, \emptyset_i \left(\frac{W_i + VLoad_i - u_i\, \partial x_i - \frac{C_i\, \partial x_i\, tan\, \theta_i}{F}}{cos\, \theta_i \left(1 + \left(\frac{tan\theta_i\, tan\, \emptyset_i}{F}\right)\right)} \right)}{\sum_{i=1}^{N\,Slices} \left(\sum_{j=1}^{N\,parts} Area_j\, dens_j\, horisontal\, arm_j + \sum_{k=1}^{N\,Loads} AreaLoad_k\, Moment\, arm_k \right)}$$

The formula for the safety-factor contains F on both sides. Because of that F has to be solved iteratively.
It is worth mentioning that also with the Bishop's method it is possible to get negative effective stresses. If that happens the effective stress is assumed to be zero.
The simplified Bishop method is according to literature giving more accurate results than the Swedish/ordinary method of slices. Read for example the article “Investigations on the accuracy of the simplified Bishop method” written by D.Y Zhu and published in “Landslides and Engineered Slopes – Chen et al. (eds) © 2008 Taylor & Francis Group, London, ISBN 978-0-415-41196-7 “. This article is free to download. The example in the article is slightly unclear but the example input file “Zhu left faced” is a close copy of the article example.
For those interested there are numerous articles that compare the simplified Bishop method of slices with other methods. See for example the article “Comparison on Factor of Safety using Different Method of Analysis for Slope Stability” published by Journal of Applied Engineering Design & Simulation (Volume 1 Issue 1 (September 2021) DOI 10.24191/jaeds.v1i1.28
eISSN 2805-5756). Also this article is free to download and the input file “Malaysian example” (see below) contains an input file mimicking the example in the article.
In my opinion, the difference between simplified Bishop and the more rigorous (Spencer, Morgenstern - Price, …) is small as long as the failure arc can be assumed as a circle. If there are doubts regarding the calculated safety factor I would move over to finite element software such as Plaxis or Flac.

Limitations

The only thing that limits regarding number of lines or number of center's to walk through is the memory in your computer (or iPhone). Normally there should be no problems independently of what you set up to solve.

Line limitations

Soil lines and water lines can not be vertical. This should be no problem because you can use approximately vertical lines by using a small difference in x1 and x2 instead of zero difference. Areaload lines can be vertical (same x1 and x2) which will give a horizontal load and zero vertical load.

Soil lines are not allowed to overlap. If the program detects overlapping Soil lines it will demand removal of the overlap.

Lines can cross but it is hard to find a reason for crossing of Soil lines. If the program detects Soil line crossings it will warn and ask for a control.

Search square limitations

Two things are important when setting up the search square.
If the search square is placed inside the soil the results will be unpredictable.
If a centre is located under the beginning or end of the failure arc parts of the failure arc will be curved with overhang at the top. In that case the program will for a right facing slope define the arc start based on the leftmost soil line crossing with the failure arc available (see Figure 17 below). A left facing slope will define the arc end as the maximum available crossing between soil line and the arc.

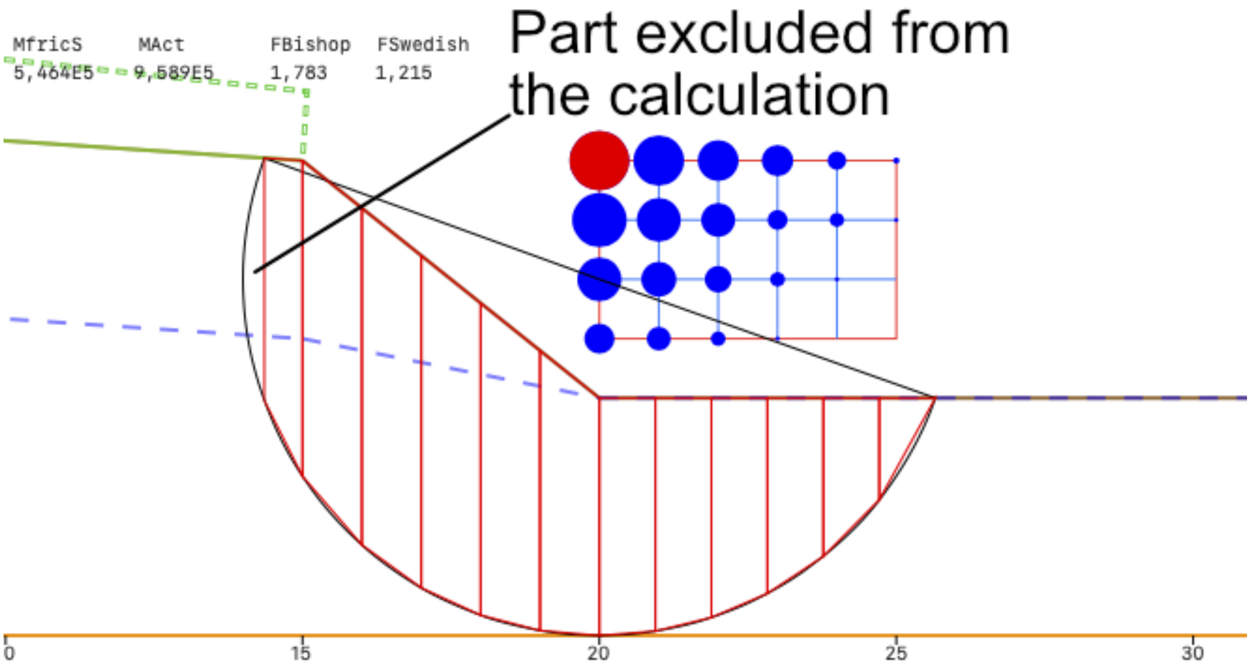


Figure 17: Arc centre under the start point of the failure arc (from file "Bad search example").

Examples

Example 1: Simple Example explaining the Detail output in the TextWindow.

Example files can be downloaded from psiconsab.se.
The following example demonstrates the use of the **Detail** command under the **Results** menu (**Detail** button in the GraphWindow screen on an iPhone).The slope set up consists of seven lines. Three soil lines, three water-lines and one area load line. Nstrim is set to one to get a simple output with minimum number of slices. If you open the file "Example 1" (on Mac chose **Open input** under the **File** menu or the **down arrow** on an iPhone). After opening the file choose **InPutWindow** under the **Windows** menu (press the go back button in the upper left corner and press the button "Input" on an iPhone). Scan through it with the tab, up arrow and down arrow keys ("F" and "B" buttons on an iPhone). You can also scan through the different lines with the control on the right side.

When you have examined the slope problem set up click on the **cancel** button and you will leave the InputWindow with the input data unchanged. Chose **Run slope** command from the **Results** menu (on an iPhone press the **GraphWindow** button followed by pressing the **Run slope** button) and the following screen will show (except for comments):

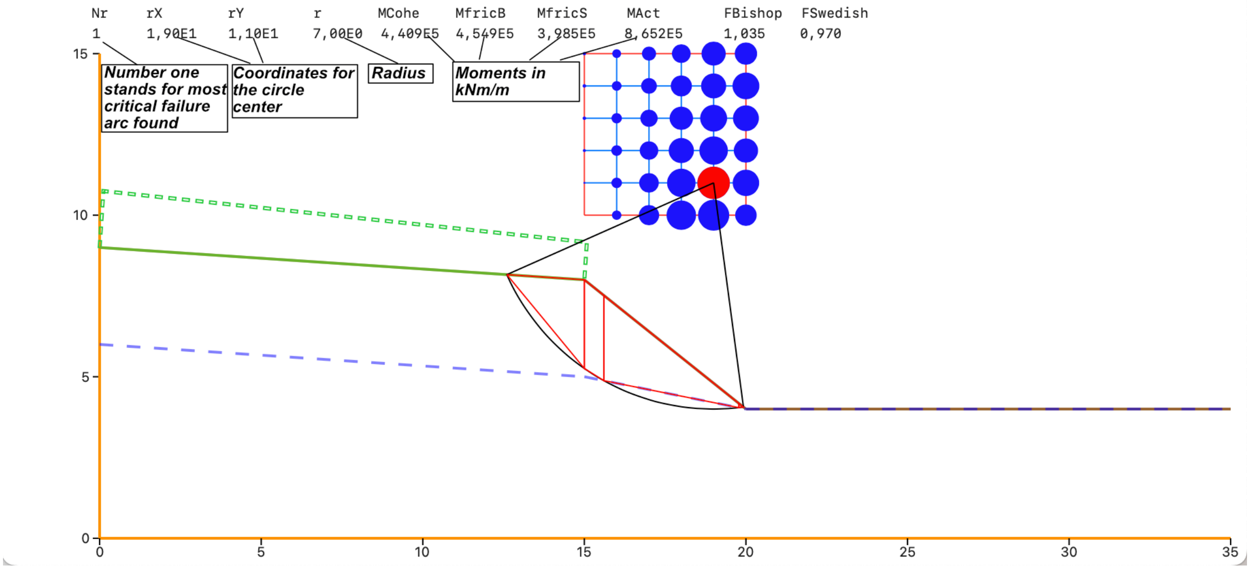


Figure 18: The Graphics display when the Run Slope or Detail command is executed.

Step through some of the results with the next command under the Results menu.
Go to **Window** menu and chose **InputWindow** (on an iPhone go back with the **back button** in the upper left corner and go to input screen with the **Input** button). Change nStrim to 10. Click OK and then execute **Run slope**. In the TextWindow there now will be data written from two calculations, one with nStrim = 1 and one with nStrim = 10. Below some explaining of the data from the nStrim = 10 output.

Let's start explaining from the beginning.
The first line tells the filename.
Next is “Search data” followed by “Lines definition”. Notice that the information under "Lines definition " has different meaning depending on the line type. For the AreaLoad and water lines, friction and density has no meaning and the C and Δc should be translated into applicable parameters (see the previous explained line types).
After the above input information the specific slope is examined.
First data about the failure arc is written, which directly after a **Run slope** command, is the failure arc with the lowest simplified Bishop safety factor. If you step on to another failure arc and execute the **Detail** command the data for that failure arc will be printed into the TextWindow. The Startx and Starty coordinates tells where the failure arc starts to the left. EndX and EndY tells where it ends on the right side.
After that comes detailed information about each slice. Let's take a special look at slice 4.

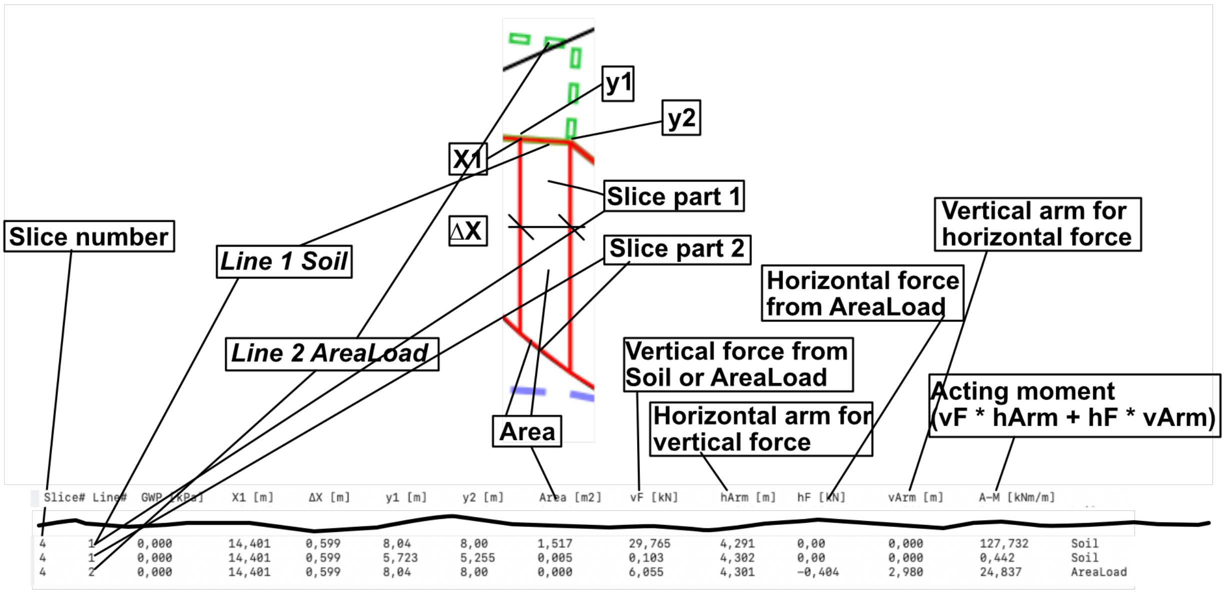


Figure 19: Explanation of output for slice 4 with line 1 governing the material properties. The slice contains slice part 1 and slice part 2 and AreaLoad from line 2. Text output from Example 1 but with nStrim = 10.

After this presentation of each slice and slice part in the calculation comes “Effect of slices” which is a summary of each slice. This summary contains the following data for each slice:
Slice#: Slice number (one (1) is the most left).
Wi [kN/m]: Vertical force from soil in the slice.
VPAL [kN/m]: Vertical force from Area Loads in the slice.
ui [kPa]: Water pressure at the bottom of the slice (contact with the analysed failure arc).
N’S [kN/m]: Effective force at the bottom of the slice calculated according to Swedish method of slices.
N’SB [kN/m]: Effective force at the bottom of the slice calculated according to simplified Bishop method of slices.
Alfa [°]: Angle of failure arc at the bottom and centre of the slice.
Δx [m]: Width of the slice.
CSL [m]: The curved length of the slice contact with the failure arc
MC [kNm|m]: Slice contribution to the cohesion resisting moment.
MFS [kNm|m]: Slice contribution to the frictional resisting moment calculated according to Swedish method of slices.
MFSB [kNm|m]: Slice contribution to the frictional resisting moment calculated according to simplified Bishop method of slices.
MAL [kNm|m]: Slice contribution to acting moments from area loads.
MSoil [kNm|m]: Slice contribution to acting moments from the soil weight.

The last part is a summary of the actual failure arc (self explanatory) and some statistics from the full run after execution of the **Run slope** command.

Free Water-surface

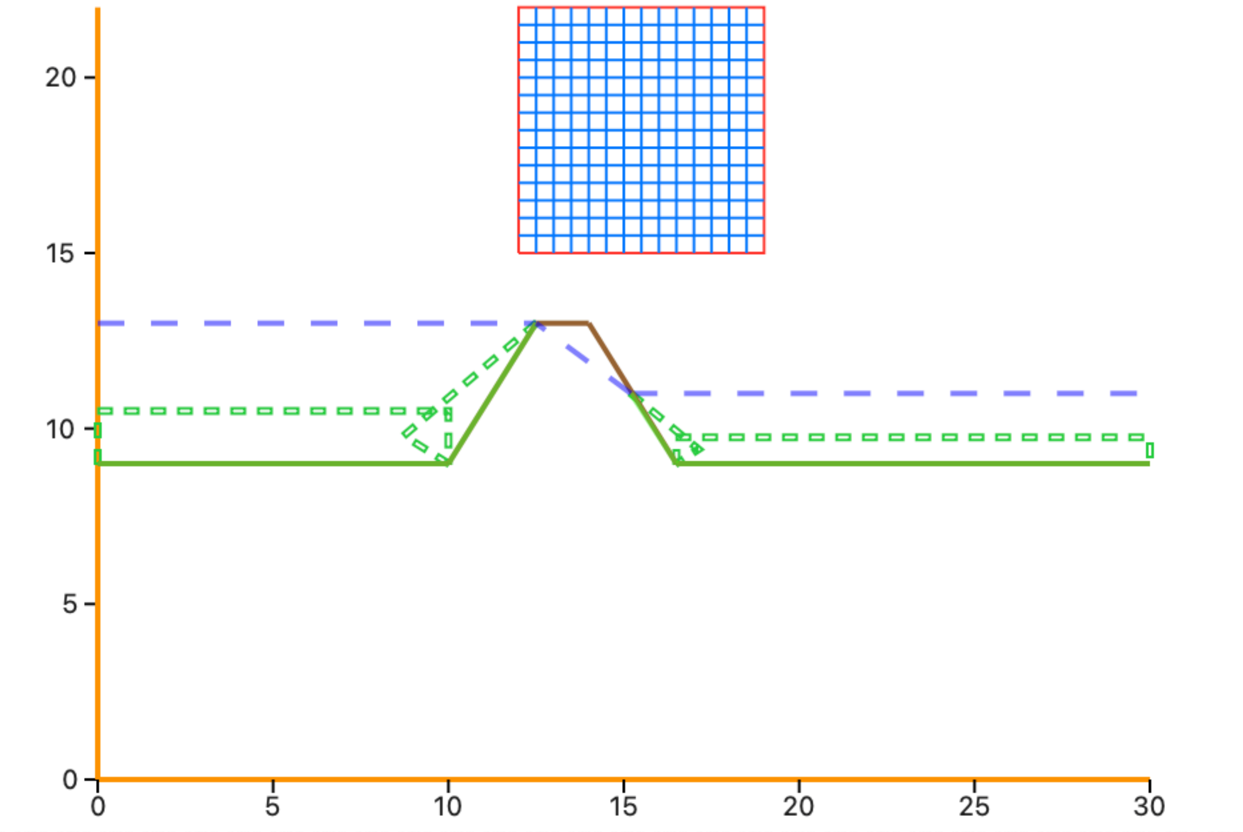


Figure 20: Example of how to deal with free water surfaces.

This example is more realistic and demonstrates how to use waterlines. The file “Free water surfaces” contains the following input:

```
Input file name: "Free water surfaces.txt"
List of input data:
Search data:
xStart      yStart      xEnd        yEnd        xStep       yStep       rXStart     rYStart     rStep       nStrm
12,0        15,0        19,0        22,0        0,50        0,50        12,5        11,0        0,2         10

Lines definition:
Line#       x1 [m]      y1 [m]      x2 [m]      y2 [m]      C [kPa]     cΔ [kPa/m]  Fric [°]    D [kg/m3]   LineType
1           0,00        13,00       12,50       13,00       0,00        0,00        0,00        0           Water
2           0,00        9,00        10,00       9,00        5,00        0,00        32,00       1 900       Soil
3           0,00        9,00        10,00       9,00        40,00       40,00       0,00        0           AreaLoad
4           10,00       9,00        12,50       13,00       5,00        0,00        32,00       1 900       Soil
5           10,00       9,00        12,50       13,00       40,00       0,00        0,00        0           AreaLoad
6           12,50       13,00       14,00       13,00       5,00        0,00        32,00       1 900       Soil
7           15,20       11,00       30,00       11,00       0,00        0,00        0,00        0           Water
8           14,00       13,00       16,50       9,00        5,00        0,00        32,00       1 900       Soil
9           16,50       9,00        30,00       9,00        5,00        0,00        32,00       1 900       Soil
10          15,20       11,00       16,50       9,00        0,00        20,00       0,00        0           AreaLoad
11          16,50       9,00        30,00       9,00        20,00       20,00       0,00        0           AreaLoad
12          15,20       11,00       12,50       13,00       0,00        0,00        0,00        0           Water
```

All the AreaLoads are only present to simulate the force from the free water to the soil-water boundary. Execute command Run slope under the Results menu and examine the textwindow. In the old days with a macintosh SE/30 the execution time was more than 10 minutes. Now lesser than a couple of seconds depending on machine. Not everything becomes better with time but at least computers are quicker. Don't be chocked when you find the following line in the TextWindow:

`Number of double slopes encountered: ---------------------------------------- 36`

The program has found out that some failure arcs has two or more separate parts and runs through the free water. These slopes will also be handled in the analyse where the parts are calculated one by one.

Nr	rX	rY	r	MCohe	MfricB	MfricS	MAct	FBishop	FSwedish
1	1,90E1	1,90E1	1,03E1	2,878E5	4,156E5	3,602E5	7,537E5	0,933	0,860

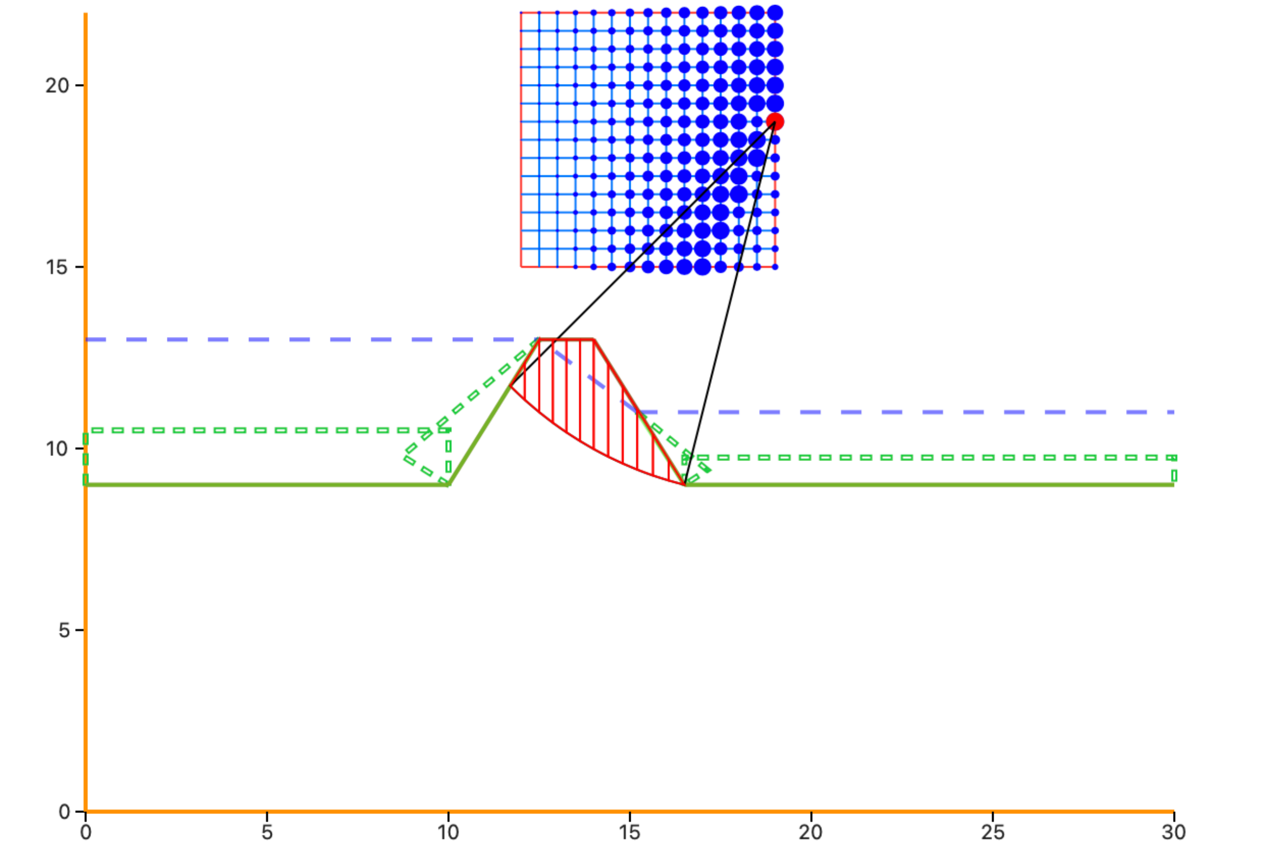


Figure 21: Display of critical center's. The red dot represents the most critical centre found. The bigger dot the more critical centre. The used search square seems to be a little bit to much to the left and probably a bit low.

As it seems we have put our search square a little bit to much to the left and maybe a bit low. Scan through some of the calculated slopes. Notice that many of the failure arcs goes through the or close to the footing of the slope. This is not a surprise. It seems unnecessary to calculate all the slopes under the footing. Let's try to adjust and dense the search square and concentrate the calculations to the footing. Go to the **InputWindow** (**Input** screen on iPhone). Set the first line in the dialog window as follows:

xStrt	yStrt	xEnd	yEnd	xStep	yStep	rXstrt	rYstrt	rStep	nStr...		
18,5	17,5	20,0	19,5	0,1	0,1	16,5	9,0	0,0	10	Ok	Cancel

rStep set to zero (0) forces the program to calculate only the first slope for each centre (there is nothing to increment R with). This will shorten the calculation time dramatically. Press the OK button and run the calculation. The Following picture will show:

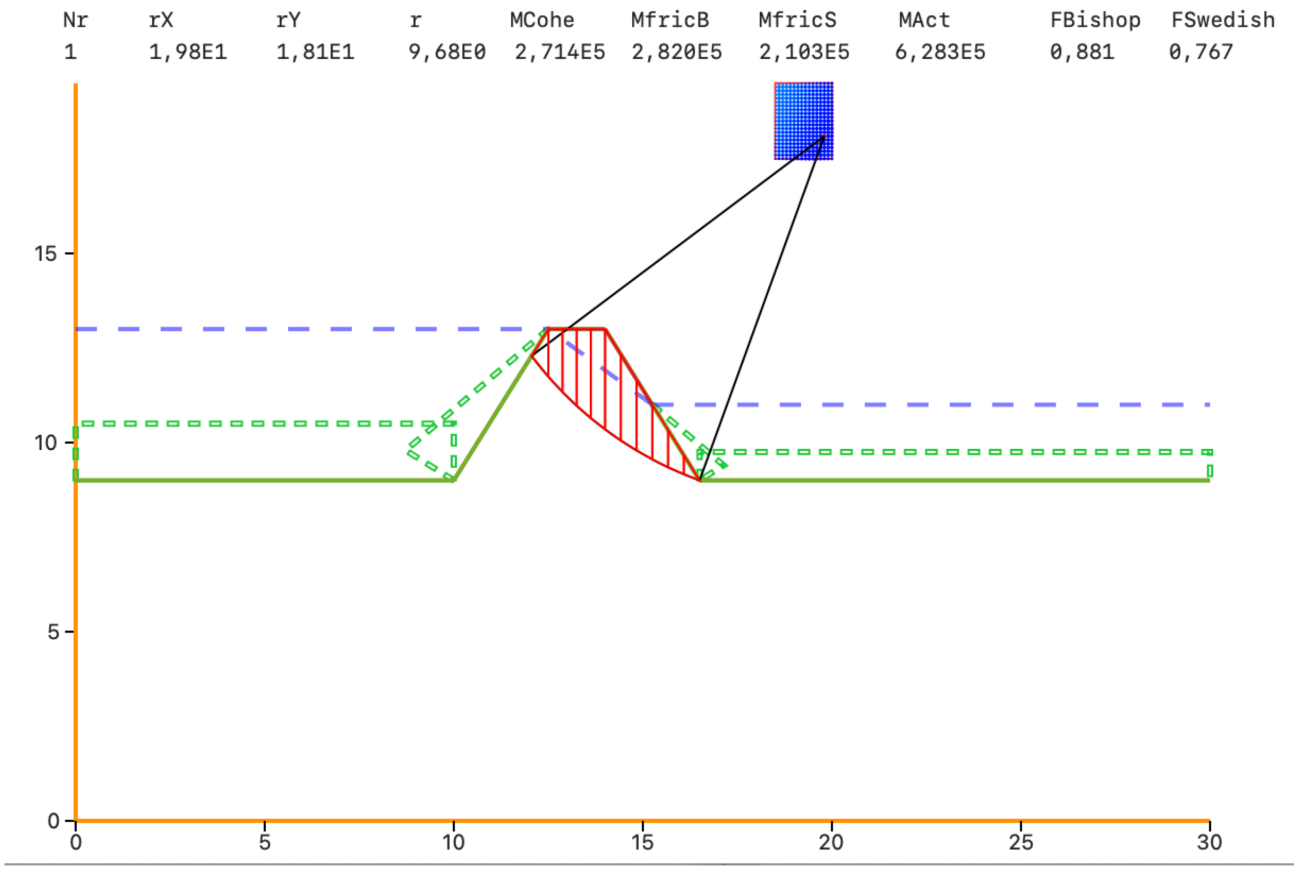


Figure 22: Display of critical center's. Second try. Seems to be OK.

Malaysian example

This example comes from the article “Comparison on Factor of Safety using Different Method of Analysis for Slope Stability” published by Journal of Applied Engineering Design & Simulation (Volume 1 Issue 1 (September 2021) DOI 10.24191/jaeds.v1i1.28 eISSN 2805-5756). The article compares simplified Bishop with Spencer and Morgenstern-Price using the software SLOPE/W and some hand calculations. Sadly there are no exact input data available showing the case studied so the input file “Malaysian example” is not an exact match but probably relatively near. Independently the results from SlopeStab (and SlopeStabi) gives results very close to the results in the article.

Some more useful hints

The font that are used in the TextWindow is a mono spaced system font. If you want to transfer text from the TextWindow to a word-processor be sure to set the font in the pasted text to a mono spaced font. If you want to load the data into Apple Numbers its a bit tricky. Smart way is to first replace all triple space with double space in a word processor and after that replace all double space with a tab.

Pictures in the clipboard are .pdf’s so they can easily be pasted into most word processors and layout apps.

If the soil in the problem has no frictional properties then you (theoretically) get the same result independently of used number of slices (set nSrim to 1)

Structure of input files

The input files are simple text files. Since soil line properties was updated December 2023 the original format was changed (the text SlopeStab was changed to SlopeStab2 and the soil line property Δc was added). The updated software, version 1.1.5 or newer, can read the old files but the old software (1.1.1 to 1.1.4) can not read the new files. The new files are structured as follows:

Line 1 : SlopeStab2
Line 2 : xStrt
Line 3 : yStrt
Line 4 : xEnd
Line 5 : yEnd
Line 6 : xStep
Line 7 : yStep
Line 8 : rXstrt
Line 9 : rYstrt
Line 10: rStep
Line 11: nStrim
Line 12: number of lines
Line 13: x1
Line 14: y1
Line 15: x2
Line 16: y2
Line 17: cohesion [c kPa]
Line 18: cohesion change with depth [Δc kPa/m]
Line 19: internal friction angle [fric °]
Line 20: density [d kg/m3]
Line 21: Line type
Line 13 to 21 repeated for all lines
Final line: “File name”