Geocentrix

ReActiv 2

User Manual

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Acknowledgments

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The ReActiv User Manual written by Andrew Bond and Romain Arnould (formerly at GCG).

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Table of contents

Acknowledgments 2
Revision history 2
Table of contents 3

Introduction. 5
About this book 5
Conventions 6
Where to go for help 7
ReActiv's help system 7
Software Re-Assurance™ 7
Sales and marketing information 8
Documentation 8

Overview. 9
Job View 9
Slope 10
Soil column 10
Water regime 10
Surcharge 11
Datum line 11
Rulers 11
Managers 12
Mechanisms View 12
Reinforcement View 13
Toolbar 14
Status Bar 14
Soils 14
Soil Manager 15
Soil classification system and database 16
The selected soil 16
Design parameters 16
Slopes 17
Stability of upper slopes/crests 17
Water regimes 18
Parallel water regime 18
Horizontal water regime 18
Parabolic water regime 18
Reinforcements 19
Reinforcement Manager 19

Design strength 20
Design factors 20
Calculation options 21
Interwedge friction factor 21
Project information 22
Printing 22
Print 22
Print preview 23
Customizing the program 24

Calculating mechanisms.. 25
Mechanisms View 25
Mechanism types 26
Distribution of reinforcement force 27
Baseline 28
Invalid mechanisms 28
Calculating single mechanisms 29
Calculating grid mechanisms 30
Minimum and maximum co-ordinates 31
Number of lines 31
Spacing 31
Automatic grid 32
Default grid 32
Critical mechanisms 33
Search algorithm 33
Calculating the T_{max} mechanism 34
Searching for T_{max} 34
Search algorithms 34
Calculating the T_{ob} mechanism 35
Searching for T_{ob} 35
Search algorithm 35

Calculating the required reinforcement.. 36
Reinforcement View 36
Calculating the required reinforcement 37
Minimizing the length of soil nails 37
Providing an additional layer at the top of the slope 38
Setting a the vertical spacing between the layers 38
Tension on Wedge 1 or 2 39

Introduction

Welcome to ReActiv®, the reinforced slope design program. ReActiv is an interactive program that helps you to design reinforced slopes in a variety of different soil types, using reinforced soil or soil nails.

This chapter of the *ReActiv User Manual* outlines the contents of this book, explains the conventions that are used herein, and tells you what to do if you need help using the program.

About this book

This *User Manual* is divided into the following chapters:

- *Introduction*
- *Overview*
- *Calculating mechanisms*
- *Calculating the required reinforcement*

Conventions

To help you locate and interpret information easily, the *ReActiv User Manual* uses the following typographical conventions.

This	Represents
Bold	Items on a menu or in a list-box; the text on a button or next to an edit control; or the label of a group box.
Item1 > Item2	An item on a cascading menu. Item1 is the name of an option on the main menu bar (such as **File** or **Window**); and Item2 is the name of an option on the cascading menu that appears when you select Item1 (such as **New** or **Open**). Thus, **File > New** represents the New command from the File menu.
italic	Placeholders for information you must provide. For example, if you are asked to type *filename*, you should type the actual name for a file instead of the word shown in italics. Italic type also signals a new term. An explanation immediately follows the italicized term.
`monospaced`	Anything you must type on the keyboard.
CAPITALS	Directory names, filenames, and acronyms.
KEY1+KEY2	An instruction to press and hold down key 1 before pressing key 2. For example, "ALT+ESC" means press and hold down the ALT key before pressing the ESC key. Then release both keys.
KEY1, KEY2	An instruction to press and release key 1 before pressing key 2. For example, "ALT, F" means press and release the ALT key before pressing and releasing the F key.

Where to go for help

Your first source of help and information should be this manual and the ReActiv's extensive help system.

ReActiv's help system

ReActiv's help system contains detailed information about all aspects of the program. Help appears in a separate window with its own controls. Help topics that explain how to accomplish a task appear in windows that you can leave displayed while you follow the procedure.

To open the help system:

- Press `F1`
- Click the **Help** button in any dialog box
- Choose a command from the **Help** menu

If you need assistance with using the help system, choose the **How To Use Help** command from the **Help** menu.
Tooltips
If you pause while passing the mouse pointer over an object, such as a toolbar button, ReActiv displays the name of that object. This feature, called *tooltips*, makes it easier for you to identify what you see and to find what you need.

Software Re-Assurance™

Software Re-assurance for ReActiv (including updates, upgrades, and technical support) is available direct from Geocentrix. If you require Re-Assurance, please contact Geocentrix as follows:

ReActiv Technical Support Geocentrix Ltd Scenic House, 54 Wilmot Way Banstead, Surrey SM7 2PY, United Kingdom Please quote your licence number and on all correspondence	T: +44 (0)1737 373963 E: support@geocentrix.co.uk W: www.geocentrix.co.uk/support Please be at your computer and have your licence number ready when you call

Sales and marketing information

For sales and marketing information about ReActiv, please visit

http://www.geocentrix.co.uk/reactiv/index.html

or contact ReActiv Sales on the same numbers as above.

Documentation

The latest version of this *User Manual* (including any corrections and/or additions since the program's first release) are available in electronic (Adobe® Acrobat®) format from the Geocentrix website (www.geocentrix.co.uk/reactiv) and follow links to ReActiv's documentation.

Notes

The screenshots in this guide were produced on Windows 10. Your screen may differ, depending on the version of Windows on which you run ReActiv. Not all options are available in every edition of ReActiv.

In this guide, '[Documents]' refers to the folder where your ReActiv projects are saved. For Windows 10 this is:

C:\Users\Public\Documents\Geocentrix\ReActiv\2.0

On Windows XP, replace:

C:\Users\Public\Documents

with:

C:\Documents and Settings\All Users\Shared Documents

Overview

This chapter of the *ReActiv User Manual* provides an overview of ReActiv. It describes the main features of the program and the most commonly used commands.

ReActiv implements and extends the design method given in the UK Highways Agency's Advice Note HA68 on *Design methods for the reinforcement of highway slopes by reinforced soil and soil nailing techniques* (1994), which can be found in the HA's *Design manual for roads and bridges*, Volume 4 *Geotechnics and drainage*, Section 1 *Earthworks*, Part 4. For brevity, this document is referred to herein as the *Advice Note*. Chapter 8 explains the background theory and assumptions behind the Advice Note.

ReActiv divides the display of information about your reinforced slope problem between three main views:

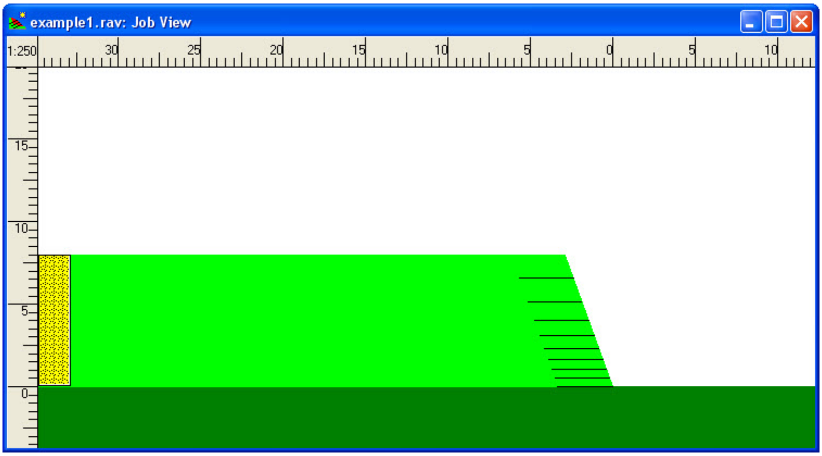
- The *Job View* — allows you to define the problem that you want to analyse
- The *Mechanisms View* — displays the results of calculations using the two-part wedge mechanism
- The *Reinforcement View* — gives a preliminary layout of the reinforcement that will be required

Each of these views is displayed in its own window, which fits inside ReActiv's *Frame Window*. The Frame Window serves as a desktop on which all other views and windows are arranged.

The following sections describe the various views and windows in turn.

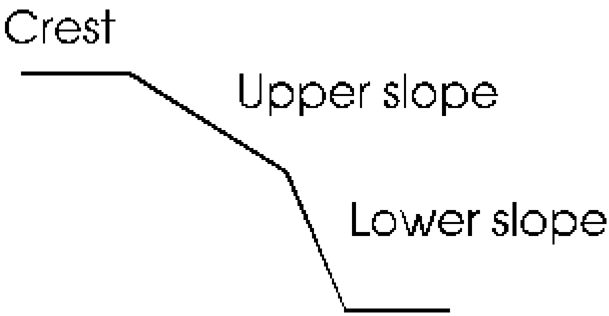
Job View

The Job View is place where you enter information that defines your reinforced slope problem. ReActiv provides you with continuous feedback as you enter this information, by displaying an up-to-date picture of the slope being analysed, including the soil column, water table, and any surcharge applied to the slope.



Slope

The slope is shown at the centre of the Job View and is drawn to a true scale. The names given to various parts of the slope are indicated below.



Soil column

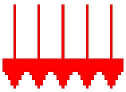
The *Selected Soil* (see page 16) is shown by the soil column near the left hand edge of the Job View. The symbol used to represent the Selected Soil depends on its classification.

The soil column is drawn to a true vertical scale.

Water regime

The slope's water regime is represented by Bishop's pore pressure parameter (r_u). The current value of r_u is displayed underneath the slope's baseline.

Surcharge



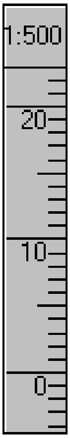
Surcharges are shown by (red) down-pointing arrows. They can be applied to the horizontal crest of *One-* or *Two-part* slopes or to the sloping crest of *Infinite* slopes. They cannot be applied to the lower part of any slope or the upper part of a *Two-part* slope.

The magnitude of the surcharge appears above the surcharge symbol.

Datum line

If the appropriate option on the **View** menu is selected, a datum line is drawn vertically through the toe of the slope. The datum line is coloured grey.

Rulers



Heights above ground level can be measured using the vertical ruler that appears along the left hand edge of the Job View (if the appropriate option on the **View** menu is selected). Similarly, horizontal distances can be measured using the horizontal ruler that appears along the top edge of the Job View.

You can change the scale of the rulers (and hence the size of the drawing in the Job View) by:

- Positioning the mouse pointer over one of the rulers and then clicking the right mouse button. A pop-up menu appears. Choose the scale you want from those listed
- Choosing one of the scales on the **View** menu
- Choosing **Zoom In** or **Zoom Out** on the **View** menu to change the scale to its next level up or down
- Clicking on the **Zoom In** or **Zoom Out** buttons on the Toolbar

The scales that ReActiv provides are:

- 1:50
- 1:100
- 1:250

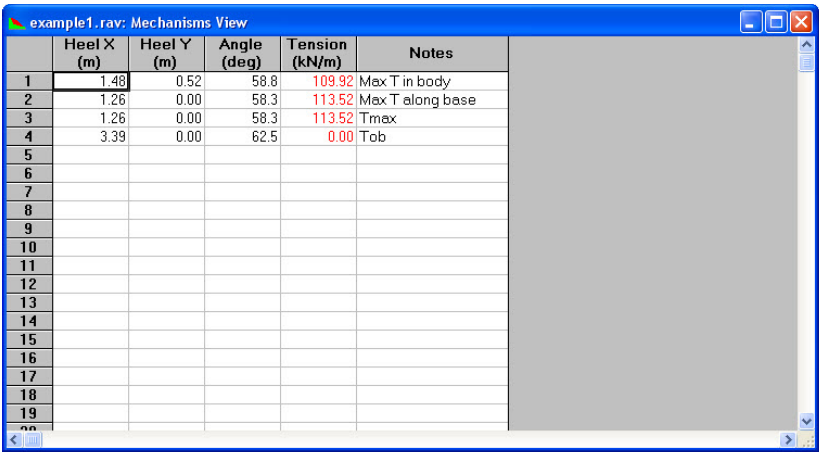
- 1:500

Managers

ReActiv's Managers are floating dialog boxes that allow you to add, edit, and delete objects with a minimum of effort. Each Manager displays a list of all the objects of a particular type you have defined. See page 15 for further information about ReActiv's Soil Manager and page 19 for ReActiv's Reinforcement Manager.

Mechanisms View

The Mechanisms View displays the results of your calculations using the two-part wedge mechanism described in Chapter 2.



	Heel X (m)	Heel Y (m)	Angle (deg)	Tension (kN/m)	Notes
1	1.48	0.52	58.8	109.92	Max T in body
2	1.26	0.00	58.3	113.52	Max T along base
3	1.26	0.00	58.3	113.52	Tmax
4	3.39	0.00	62.5	0.00	Tob
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					

The purpose of the calculations is to find the largest out-of-balance force that must be resisted by the reinforcement in order to stabilize the slope. ReActiv allows you to calculate:

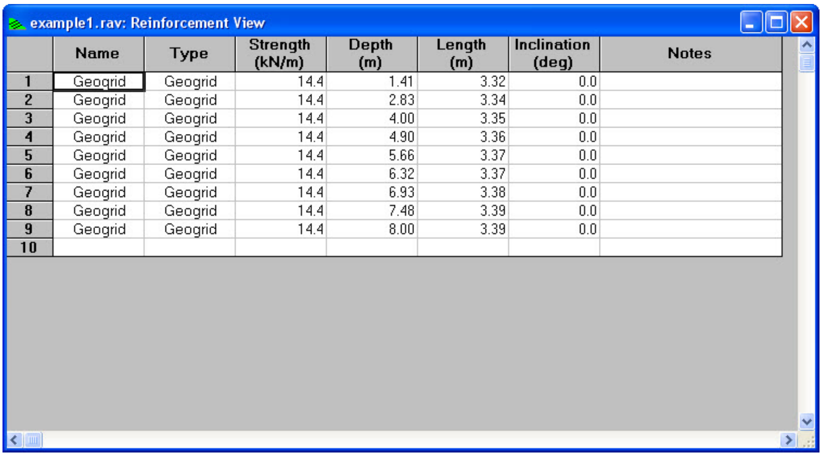
- The out-of-balance force (T) for an individual mechanism
- The largest out-of-balance force for the fan of mechanisms that emanates from each point on a search grid
- The greatest out-of-balance force of any mechanism in the slope (the T_{max}-mechanism) — see Chapter 7
- The basal mechanism that has an out-of-balance force of zero (the T_{ob}-mechanism) — see Chapter 7

The Mechanisms View displays the results of these calculations in a spreadsheet containing, for each mechanism:

- The X- and Y- coordinate of the mechanism's heel
- The angle of the upper wedge
- The out-of-balance force
- Notes indicating the type of mechanism (see Chapter 7), whether the mechanism is a critical mechanism (see Chapter 7), the T_{max}, or the T_{ob} mechanism
- (Optionally) The type of mechanism (see Chapter 7)

Reinforcement View

The Reinforcement View displays the reinforcement layout required to stabilize the slope.



	Name	Type	Strength (kN/m)	Depth (m)	Length (m)	Inclination (deg)	Notes
1	Geogrid	Geogrid	14.4	1.41	3.32	0.0	
2	Geogrid	Geogrid	14.4	2.83	3.34	0.0	
3	Geogrid	Geogrid	14.4	4.00	3.35	0.0	
4	Geogrid	Geogrid	14.4	4.90	3.36	0.0	
5	Geogrid	Geogrid	14.4	5.66	3.37	0.0	
6	Geogrid	Geogrid	14.4	6.32	3.37	0.0	
7	Geogrid	Geogrid	14.4	6.93	3.38	0.0	
8	Geogrid	Geogrid	14.4	7.48	3.39	0.0	
9	Geogrid	Geogrid	14.4	8.00	3.39	0.0	
10							

The suggested layout is suitable for preliminary design. The procedure for establishing a final design is discussed in Chapter 9.

For each layer of reinforcement in the suggested layout, ReActiv displays:

- The name of the reinforcement
- The reinforcement type (Geotextile, Geogrid, Soil Nails or User-defined)

- The strength of the reinforcement
- The depth of the layer
- The length of the reinforcement
- The reinforcement's inclination
- Notes giving special information relevant to that layer (for example, in the case of soil nails, the horizontal spacing of the nails)

Toolbar

The Toolbar provides mouse-users with quick access to commonly used menu commands.

To find out what each button does, refer to ReActiv's help system or place the mouse pointer over each button in turn and read the tooltip (description) that appears after a short delay.

Status Bar

The Status Bar provides a summary of the key information that you will require when working in each of ReActiv's views.

The Status Bar changes as you move from one view to another and reflects the information that you have entered into the program.

The Status Bar also provides an explanation of menu commands as you scroll through them and descriptions of what the buttons on the Toolbar do as you move the mouse pointer over them.

Soils

ReActiv implements seven types of soil:

- Gravel
- Sand
- Silt

- Clay
- Fill
- Chalk
- Custom

Soil Manager

ReActiv's *Soil Manager* makes it easy to add, edit, and delete soils. The Soil Manager is a floating dialog box that remains on top of all other windows until you choose to close it. The Soil Manager displays the names of every soil that has been created in the current job, and provides buttons that duplicate commands on the **Soil** menu.

If it is not already showing, you can display the Soil Manager by:

- Ticking **View > Soil Manager** on the Job View's menu bar
- Clicking on the Soil Manager button on the Toolbar

You can close the Soil Manager by:

- Unticking **View | Soil Manager** on the Job View's menu bar
- Clicking on the Soil Manager button on the Toolbar
- Choosing the **Close** command from the Soil Manager's control menu

You can move the Soil Manager around the screen in the usual ways, by dragging its title bar with the mouse or by choosing the **Move** command from the Soil Manager's control menu and then using the appropriate cursor keys.

Soil classification system and database

ReActiv uses the information you provide about a soil's classification to check the parameters that you enter via the Soil Properties dialog box.

ReActiv uses the Soil Classification System that was introduced in ReWaRD®, our retaining wall research and design program. The Soil Classification System provides a comprehensive and systematic description of commonly-encountered soil types and is linked to an extensive database of peak and critical state soil parameters.

In the Soil Classification System, each soil is classified according to three main descriptors:

- Group
- *Class* (depends on Group)
- *State* (depends on Group and Class)

Chapter 13 lists the various Groups, Classes, and States that ReActiv recognizes and compares them with established soil classification systems.

The selected soil

Although you may define the properties of more than one soil, only one soil is used by the program at any one time. This soil is known as the *Selected Soil*.

You may choose the *Selected Soil* by choosing **Slope | Selected Soil...** from the Job View's menu bar. Select one of the soils listed in the listbox and click the **OK** button, ReActiv re-draws the soil column (if displayed) to reflect the soil you have selected.

Design parameters

When ReActiv performs its calculations, it uses *design* values of the key soil parameters rather than characteristic values. The design value of the soil's angle of shearing resistance (ϕ) is given by:

$$\phi_{design} = \tan^{-1}\left(\frac{\tan\phi}{F_\phi}\right)$$

and the design value of the soil's effective cohesion (c′) is given by:

$$c'_{design} = \frac{c'}{F_c}$$

If you specify critical state parameters, ReActiv sets the partial factors in these equations to 1.0.

Slopes

ReActiv implements three types of slope:

- One-part
- Two-part
- Infinite

Stability of upper slopes/crests

The upper slope of Two-part slopes and the sloping crest of Infinite slopes are potentially unstable when:

$$\tan i \geq \left(1 - r_u\right)\tan\phi$$

where r_u is Bishop's pore pressure parameter, and ϕ is the soil's angle of shearing resistance. The angle i is given by:

- For Two-part slopes, the angle of the upper slope
- For Infinite slopes, the crest angle

ReActiv checks for potential instability of the upper slope or sloping crest when it validates the parameters you enter into the slope's property box. However, even if the slope is unstable, ReActiv allows you calculate the reinforcement required to stabilize the *lower* slope on the assumption that you will analyse the stability of the upper slope/sloping crest as a separate exercise. If you do this using ReActiv, then you should treat the reinforced lower slope as a competent foundation to the upper slope/sloping crest.

Water regimes

ReActiv implements four types of water regime:

- Parallel
- Horizontal
- Parabolic
- Custom

For water regimes other than custom, ReActiv calculates Bishop's pore pressure parameter (r_u) for you, using the formula given by Mitchell (1983), *Earth structures engineering*, Allen & Unwin Inc., Boston, p128.

Parallel water regime

For parallel water regimes, Bishop's pore pressure parameter (r_u) is given by:

$$r_u = \left(\frac{\gamma_w}{\gamma}\right)\cos^2\beta$$

where γ_w is the unit weight of water; γ is the unit weight of the *selected soil* (see page 16); and β is the angle of the lower slope.

Horizontal water regime

For horizontal water regimes, Bishop's pore pressure parameter (r_u) is given by:

$$r_u = \left(\frac{\gamma_w}{\gamma}\right)$$

where γ_w and γ are defined above.

Parabolic water regime

For parabolic water regimes, Bishop's pore pressure parameter (r_u) is given by:

$$r_u = \left(\frac{\gamma_w}{\gamma}\right)\cos\beta$$

where γ_w, γ, and β are defined above.

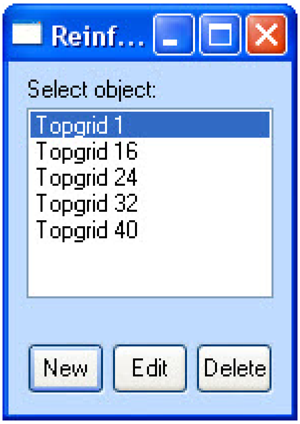
Reinforcements

ReActiv implements four types of reinforcement:

- Geotextiles
- Geogrids
- Soil nails
- Custom

Reinforcement Manager

ReActiv's *Reinforcement Manager* makes it easy to add, edit, and delete reinforcements. The Reinforcement Manager is a floating dialog box that remains on top of all other windows until you choose to close it. The Reinforcement Manager displays the names of every reinforcement that has been created in the current job.



If it is not already showing, you can display the Reinforcement Manager by:

- Ticking **View > Reinforcement Manager** on the Job View's menu bar
- Clicking on the Reinforcement Manager button on the Toolbar

You can close the Reinforcement Manager by:

- Unticking **View > Reinforcement Manager** on the Job View's menu bar
- Clicking on the Reinforcement Manager button on the Toolbar

- Choosing the **Close** command from the Reinforcement Manager's control menu

Design strength

The design strength (P_{des}) that you enter into ReActiv is the long-term factored design strength of the reinforcement per unit width of slope (in kN/m).

According to the Advice Note, the design strength should be derived from the *unfactored* long-term characteristic strength of the reinforcement (P_c) by applying a set of partial safety factors as follows:

$$P_{design} = \frac{P_c}{f_d f_e f_m}$$

where f_d is a factor-of-safety against mechanical damage before and during installation; f_e is a factor-of-safety against environmental (chemical and biological) effects during the reinforcement's design life; and f_m is a factor-of-safety to cover uncertainties in material strength (including extrapolation of data).

Values for P_c, f_d, f_e, and f_m may be taken from the BBA certificate or manufacturer's literature for the reinforcement.

Further guidance is available in the CIRIA Special Publication 123, *Soil reinforcement with geotextiles*, by RA Jewell (1996).

Design factors

ReActiv requires you to specify certain *design factors* that govern the base-sliding and pullout resistance of the reinforcement. The *direct-shear factor* is used in calculations which involve sliding of soil over the surface of the reinforcement, whereas the *bearing factor* is used in calculations involving local bearing failure on the ribs of geogrids or custom reinforcement.

Geotextiles

ReActiv uses the direct-shear factor to calculate the resistance that a geotextile provides against base-sliding and also — since pullout failure of a geotextile involves sliding along both its sides — its pullout resistance.

Geogrids

ReActiv uses the direct-shear factor to calculate the resistance that a geogrid provides against base-sliding.

Since pullout failure of a geogrid involves local bearing failure on the front edges of its ribs, ReActiv uses the bearing factor — and not the direct-shear factor — to calculate a geogrid's pullout resistance.

Soil nails

ReActiv uses the direct-shear factor to calculate the resistance that soil nails provide against base-sliding and also — since pullout failure of soil nails involves sliding along their circumference — their pullout resistance.

Custom reinforcement

Since you may want to specify certain types of geogrid as custom reinforcement (perhaps to get around ReActiv's validation checks), ReActiv uses the bearing factor — and not the direct-shear factor — to calculate the pullout resistance of custom reinforcement. This allows you to control the base-sliding and pullout calculations independently of each other.

Calculation options

Interwedge friction factor

The angle of friction (ϕ_{12}) that acts on the boundary between Wedges 1 and 2 (see Chapter 9) is given by:

$$\phi_{12} = f_{iwf} \; phiui$$

where ϕ is the angle of shearing resistance of the soil and f_{iwf} is the *interwedge friction factor*. ReActiv allows you to enter interwedge friction factors between 0 and 1.

Setting f_{iwf} = 0 leads to conservative designs but has the advantage that the equations used to calculate the out-of-balance force can be simplified, thereby eliminating the need to decide on which wedge the reinforcement force acts (see Chapter 9 for further discussion of this point).

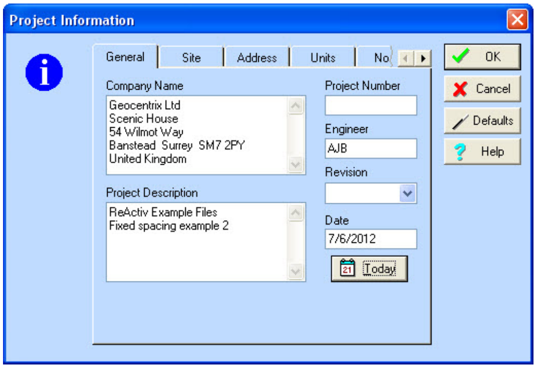
When you want to minimize the conservatism in your design, you can enter a non-zero value of f_{iwf}. The out-of-balance force then depends on which wedge the reinforcement force acts (see Chapter 9).

Setting f_{iwf} = 0.5 and assuming that all the reinforcement force acts on Wedge 2 provides a reasonable upper bound to results obtained using Caquot and Kerisel's charts and other methods (see Chapter 11). The agreement is less reasonable for small slope angles.

Project information

ReActiv allows you to store project information in each file, so that you can keep a record of the purpose and progress of your calculations.

The Project Information dialog box provides controls for entering your company's name and address, the project description and number, the engineer's initials, a revision letter and date, and notes about the current job.



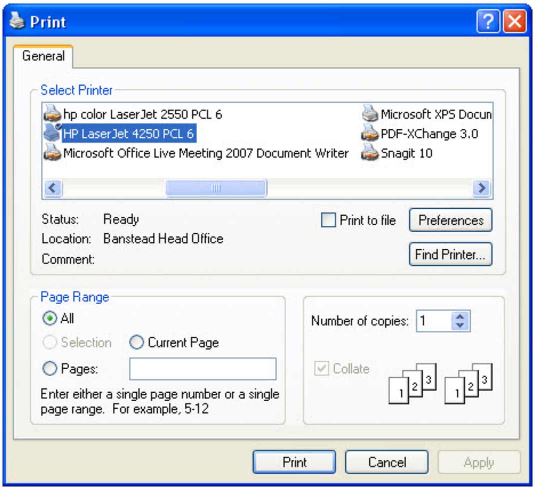
Choose **Edit > Project Info...** to display the Project Information box.

Printing

ReActiv allows you to print your input and output data on a wide variety of printers and to obtain a preview of the printout on your computer screen.

Print

The Print dialog box allows you to select various options for controlling what gets printed and where it gets printed.



You can display the Print dialog box by:

- Choosing **File > Print...** from the menu bar
- Clicking on the Print button on the Button Bar

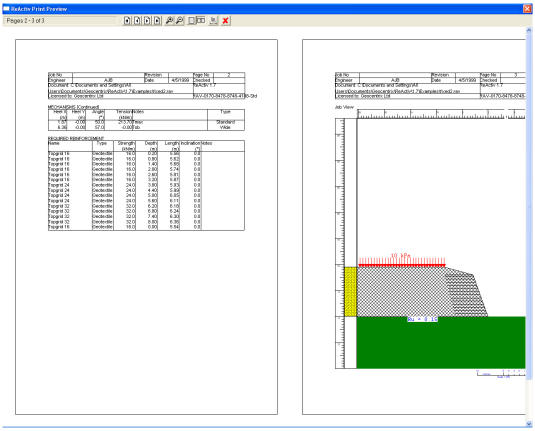
The currently selected printer is displayed at the top of the dialog box. You can change the properties of the printer by choosing the **Properties...** button.

Print preview

ReActiv provides a print preview facility, which allows you to see what will appear on the printed page. This preview facility is extremely useful if you only want to print a part of your input or output data, since it allows you to find out on which page the required data will appear.

You can display the Print Preview window by:

- Choosing **File > Print Preview...** from the menu bar
- Clicking on the Print Preview button on the Button Bar



Customizing the program

You can customize many of the default parameters that ReActiv provides in each dialog box, by holding down the `CTRL` key and then clicking on the **Defaults** button. ReActiv saves the values given in the dialog box in Windows' Registry, for later recall.

For further information, consult ReActiv's help system.

Calculating mechanisms

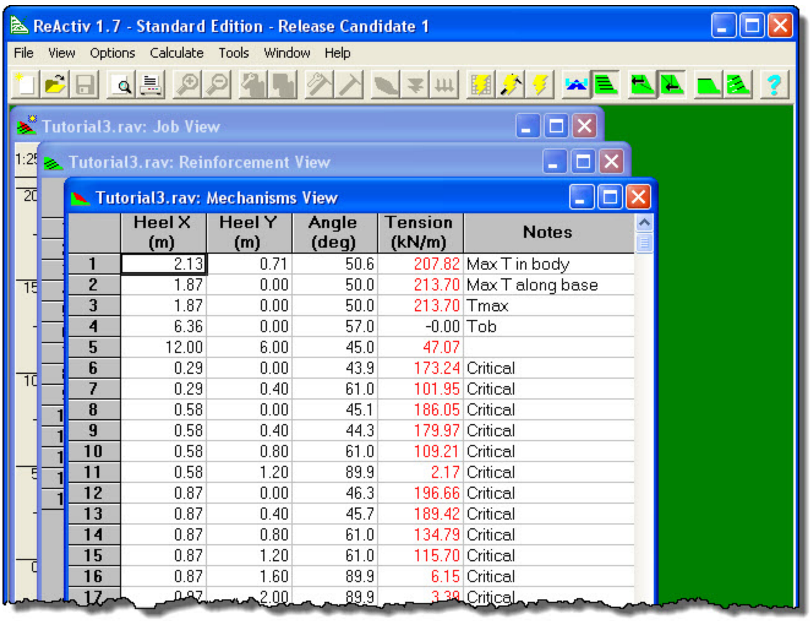
ReActiv performs calculations based on limit equilibrium analysis of the two-part wedge mechanism described in Chapter 9.

ReActiv allows you to calculate the out-of-balance force for a single mechanism or for a series of mechanisms set out on a grid. The program will also search automatically for the mechanism that has the largest out-of-balance force (the T_{max} mechanism) and the basal mechanism that has a zero out-of-balance force (the T_{ob} mechanism). ReActiv uses these two mechanisms to determine the reinforcement required to stabilize the slope (see Chapter 8).

The results of the calculations are displayed in the Mechanisms View, where they can be inspected.

Mechanisms View

ReActiv displays the results of any stability calculations that you ask it to perform in its Mechanisms View. This View is automatically created when you choose any of the available options on the **Calculate** menu.



The Mechanisms View displays the results of the calculations in a spreadsheet containing, for each mechanism:

- The X- and Y- coordinate of the mechanism's heel
- The angle of the upper wedge (θ_1)
- The out-of-balance force or tension
- Notes indicating whether the mechanism is a critical mechanism, the T_{max} mechanism, or the T_{ob} mechanism
- (Optionally) The mechanism's type (defined below)

Mechanism types

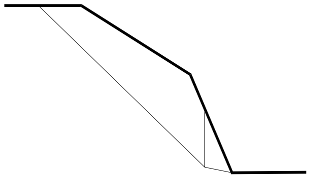
A mechanism's *type* depends on the positions of:

- The outcrop of Wedge 1
- The interwedge boundary

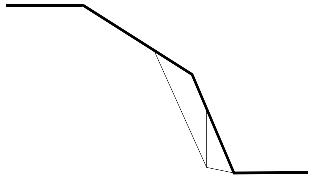
There are four possible mechanisms, as indicated in the following table.

Mechanism type	**Wedge 1 outcrops at...**	**Interwedge boundary outcrops at...**
Standard	Crest or upper slope	Lower slope
Narrow	Lower slope	Lower slope
Wide	Crest or upper slope	Upper slope
Extra-wide	Crest	Crest

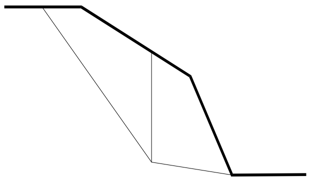
The following diagrams illustrate the various mechanism types:



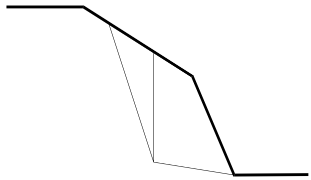
Standard



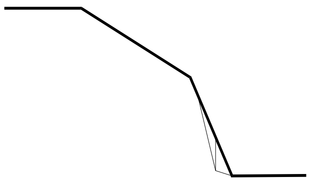
Standard



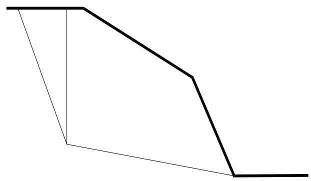
Wide



Wide



Narrow



Extra-Wide

Distribution of reinforcement force

As discussed in Chapter 8, ReActiv provides two methods of calculating the reinforcement force required to stabilize a mechanism. In the first method, it is assumed that the reinforcement force acts solely on Wedge 1; and, in the second method, it is assumed that the reinforcement force acts solely on Wedge 2.

You specify which method you want to use by selecting the appropriate options on the **Options** menu:

- Tension on Wedge 1 selects the calculation method in which the reinforcement force acts solely on Wedge 1

- **Tension on Wedge 2** selects the calculation method in which the reinforcement force acts solely on Wedge 2

When you display the **Options** menu, a tick mark is shown next to the currently selected option. By default, ReActiv puts all the reinforcement force on Wedge 2.

The assumption made about where the reinforcement force acts is irrelevant when the reinforcement is horizontal ($\delta = 0$) and its interwedge friction factor (f_{iwf}) is zero, since the value of zeta (ζ) given in Chapter 9 is always equal to one.

In all other cases, however, it is necessary to choose between the two methods provided. For most practical cases, it is reasonable to assume that the reinforcement force acts on Wedge 2 (although this may not be so for small slope angles when the interwedge factor is > 0 — see Chapter 9).

It can be shown for *inclined* reinforcement that placing all the reinforcement force on Wedge 1 is always conservative. (Note that the design charts given in Table 4.1 of the Advice Note are based on this assumption.) However, applying all the reinforcement force on Wedge 1 can be unnecessarily conservative for steeply inclined soil nails (e.g. with angles of inclination > 10°). As discussed in Chapter 9, the alternative assumption that all the reinforcement force acts on Wedge 2 gives reasonable design results provided the interwedge friction factor is less than or equal to 0.5 and, for this reason, by default the program assumes all the reinforcement force acts on Wedge 2.

Baseline

The *baseline* is a line that passes through the toe of the slope at an angle δ to the horizontal (where δ is the angle of inclination of the reinforcement, measured anticlockwise). For geogrids and geotextiles, δ is always zero; for soil nails and User-defined reinforcement, δ may be greater than or equal to zero.

Invalid mechanisms

Invalid mechanisms are those whose:

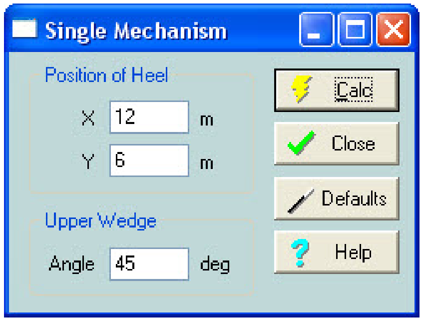
- Heel position (X, Y) is outside the slope
- Heel position is below the lowest layer of reinforcements (i.e. the *baseline*, defined below)
- Upper angle (θ_1) is less than or equal to its lower angle (θ_2) or greater than $90° - \delta$

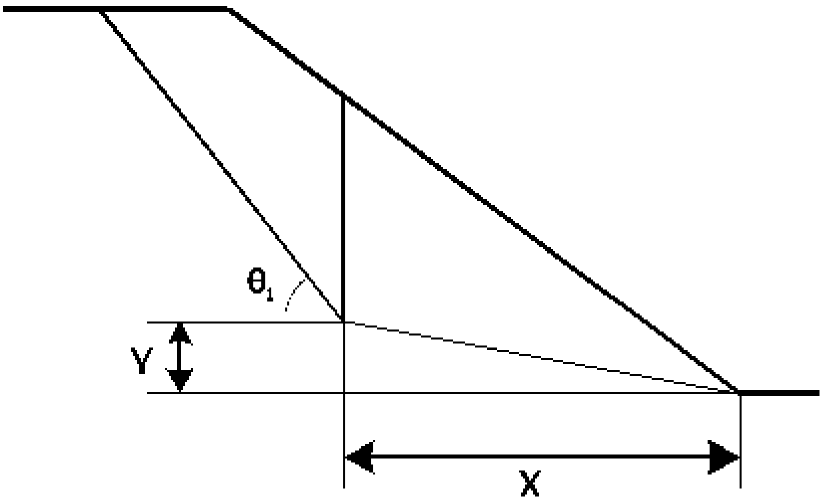
ReActiv displays the following error message if you attempt to calculate the out-of-balance force for an invalid mechanism.

Calculating single mechanisms

You can calculate the out-of-balance force (T) for a single mechanism by choosing **Calculate > Single Mechanism...** from the menu bar. If it has not already done so, ReActiv creates the Mechanisms Window and then displays the dialog box shown.

The Single Mechanism box is a floating dialog box that allows you to calculate the out-of-balance force for a single mechanism. You specify the X- and Y-coordinates of the mechanism's heel and the angle that the upper wedge (Wedge 1) makes to the horizontal (θ_1) by entering appropriate values into the **X**, **Y**, and **Angle** edit boxes.



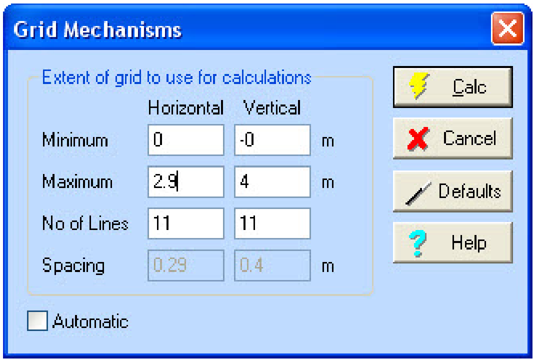


When you choose the **Calc** button, ReActiv first of all checks whether the specified mechanism is valid (see below) and — if it is — then:

- Calculates the out-of-balance force for that mechanism (which could be positive or negative)
- Appends the result of the calculation to the list of mechanisms displayed in the Mechanisms View

Calculating grid mechanisms

You can calculate the out-of-balance force (T) for a series of mechanisms by choosing **Calculate > Grid Mechanisms...** from the menu bar. If it has not already done so, ReActiv creates the Mechanisms View and then displays the dialog box shown.



The Grid Mechanisms box allows you to specify a series of uniformly spaced gridlines, along which the program will perform successive calculations in order to find the *critical mechanism* (see page 33) at each intersection point on the grid. Only the critical mechanism for each grid point is displayed in the Mechanisms View.

You do not need to use ReActiv's grid feature in order to find the T_{max} or T_{ob} mechanisms, since these are calculated for you automatically when you choose **Calculate > Tmax** or **Calculate > Tob** from the menu bar.

When you choose the **Calc** button, ReActiv does the following:

- Displays a dialog box which keeps you informed as to the progress of the calculations
- Performs a search for the most critical mechanism at each intersection point on the grid and (when it has found it) displays that mechanism in the Mechanisms View
- Updates the progress bar as each critical mechanism is found
- Allows you to cancel the remaining calculations by choosing the **Cancel** button

- Removes the dialogue box once all the calculations have been performed

Minimum and maximum co-ordinates

The starting and ending co-ordinates of the horizontal and vertical gridlines are given in their respective **Minimum** and **Maximum** boxes. To alter the given values:

- Turn off the check mark in the **Automatic** box
- Enter your own values in the **Minimum** and **Maximum** boxes

To restore the original values in the **Minimum** and **Maximum** boxes:

- Turn on the check mark in the **Automatic** box

Number of lines

The number of gridlines in the horizontal and vertical directions are given in their respective **No of Lines** boxes. To alter the given values:

- Turn off the check mark in the **Automatic** box
- Enter your own values in the **No of Lines** boxes

To restore the original values in the **No of Lines** boxes:

- Turn on the check mark in the **Automatic** box

When the number of gridlines in any direction is one, its maximum co-ordinate is reset to its minimum, its **Maximum** box is disabled, and its **Spacing** box is hidden.

Spacing

ReActiv automatically calculates the spacing of the gridlines in each direction from the appropriate minimum and maximum co-ordinates and number of lines. The spacing is calculated from:

$$Spacing = \frac{Maximum - Minimum}{No.\ of\ lines - 1}$$

Automatic grid

When the **Automatic** box is checked, ReActiv selects the most suitable grid for multiple calculations by setting the grid co-ordinates and number of lines as follows:

For the horizontal gridlines:

- Minimum co-ordinate = breadth of lower slope times the tangent of the reinforcement's angle of inclination
- Maximum co-ordinate = height of slope / 2
- No of lines = 11

For the vertical gridlines:

- Minimum co-ordinate = 0m
- Maximum co-ordinate = breadth of lower slope (i.e. H/tan β)
- No of lines = 11

Default grid

When you choose the **Default** button in the Grid Mechanisms box, ReActiv puts the following default parameters in the appropriate edit boxes.

For the horizontal gridlines:

- Minimum co-ordinate = R_y^{min} times H
- Maximum co-ordinate = R_y^{max} times H

where H is the total height of the slope (to its crest).

For the vertical gridlines:

- Minimum co-ordinate = R_x^{min} times B
- Maximum = R_x^{max} times B

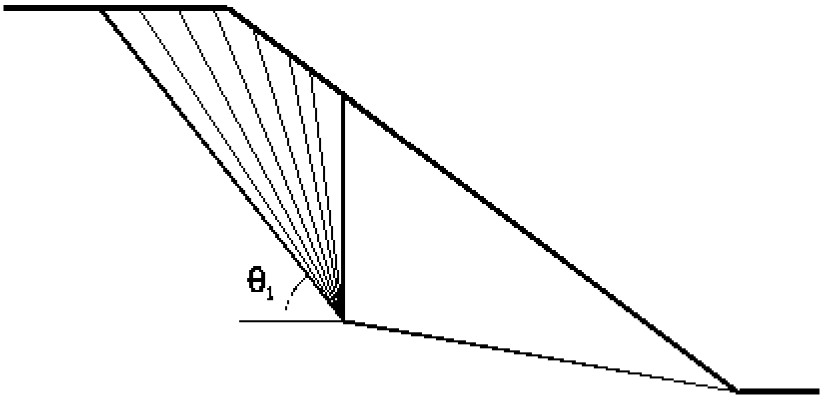
where B is the breadth of the slope.

The various min. and max. ratios are taken from Window's Registry. If you don't override the factory-supplied defaults, ReActiv uses the following values:

- $R_y^{min} = 0$
- $R_y^{max} = 0.5$
- $R_x^{min} = 0$
- $R_x^{max} = 1.0$

Critical mechanisms

For each point on the grid there is a fan of mechanisms, each with a different upper wedge angle (θ_1) and out-of-balance force (T). The *critical mechanism* is the one that has the largest value of out-of-balance force (where $\partial T/\partial\theta_1 = 0$).



Search algorithm

ReActiv searches for the critical mechanism within each fan using a variant of the *Golden Section Search* algorithm, known as *Brent's Method*. Brent's Method uses a technique called *inverse parabolic interpolation* to find the minimum (or maximum) of a one-dimensional function. A full description of the method is given by Press *et al*. (1992), *Numerical recipes in C (2nd edition)*, Cambridge University Press, pp397-402.

ReActiv indicates those mechanisms which are critical mechanisms by displaying the word "Critical" in the **Notes** column of the Mechanisms View.

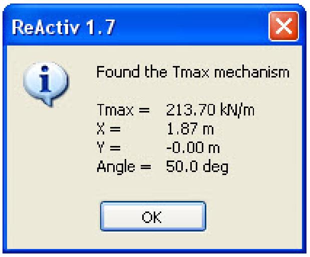
Calculating the T_{max} mechanism

You can find the largest out-of-balance force (T_{max}) of any mechanism in the slope by choosing **Calculate > Tmax** from the menu bar. If it has not already done so, ReActiv creates the Mechanisms View and then begins searching for the T_{max} mechanism.

Searching for T_{max}

The steps that ReActiv follows in searching for the T_{max} mechanism are as follows:

- First, ReActiv displays a dialog box that keeps you informed about the progress of the calculations (the number displayed in the progress bar is the number of X, Y co-ordinates that have been considered in the search)
- Second, ReActiv performs a search for the critical mechanism (see page 33) that has the largest out-of-balance force *anywhere in the slope* (you can cancel the search for T_{max} at any time by choosing the **Cancel** button in the dialog box)
- Third, ReActiv repeats the search from a new starting point, in order to ensure that its has not accidentally picked up a local maximum
- Fourth, ReActiv searches along the baseline for the mechanism with the largest out-of-balance force
- Fifth, ReActiv compares the body mechanism with the baseline mechanism, and sets the T_{max} mechanism to be the one with the larger out-of-balance force.
- Finally, ReActiv displays the result in a dialog box.



When you click the **OK** button, ReActiv dismisses this box and adds the T_{max} mechanism to the Mechanisms View. ReActiv marks the T_{max} mechanism with the word "Tmax" in the **Notes** column of the Mechanisms View.

Search algorithms

The search for T_{max} in the body of the slope is performed using the *Downhill Simplex Method* to find the minimum/ maximum of a two-dimensional function. A full description of the method is given by Press *et al.* (1992), *Numerical recipes in*

C (2nd edition), Cambridge University Press, pp408-412.

The search for T_{max} along the baseline of the slope is performed using *Brent's Method* (see page 33).

Calculating the T_{ob} mechanism

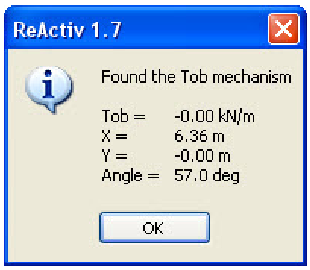
You can find the critical baseline mechanism that requires precisely zero reinforcement force to establish its equilibrium (i.e. the T_{ob} mechanism) by choosing **Calculate > Tob** from the menu bar. If it has not already done so, ReActiv creates the Mechanisms View and then begins searching for the T_{ob} mechanism.

Searching for T_{ob}

The steps that ReActiv follows in searching for the T_{ob} mechanism are as follows:

- First, ReActiv searches along the baseline for the mechanism with the largest out-of-balance force
- Second, ReActiv searches outwards from this point along the baseline for the critical mechanism that has zero out-of-balance force

When it has found the T_{ob} mechanism, ReActiv displays the result in a dialog box.



When you choose the **OK** button, ReActiv dismisses this box and adds the T_{ob} mechanism to the Mechanisms View. ReActiv marks the T_{ob} mechanism with the word "Tob" in the **Notes** column of the Mechanisms View.

Search algorithm

ReActiv searches for the T_{ob} mechanism using the method due to van Wijngaarden *et al*., as improved by Brent. A full description of the method is given by Press *et al.* (1992), *Numerical recipes in C (2nd edition)*, Cambridge University Press, pp359-362. The baseline T_{max} mechanism is used in the initial bracketing of T_{ob}, hence the need to search for the baseline T_{max} first.

Calculating the required reinforcement

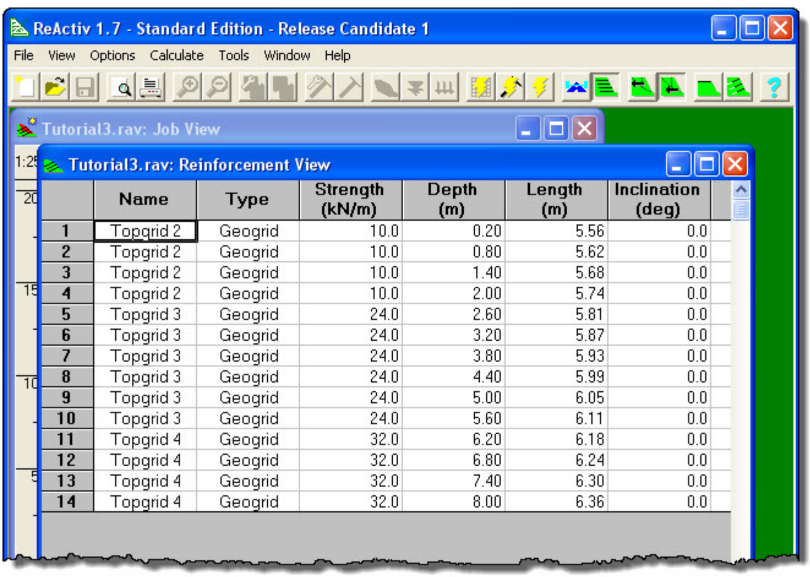
ReActiv determines the reinforcement required to stabilize a given slope based on the results of the T_{max} and T_{ob} calculations described in Chapter 7.

ReActiv allows you to calculate the number of reinforcement layers required, their optimum spacing, and their length. ReActiv also allows you to save on reinforcement when using soil nails by decreasing the horizontal spacing of the top row of nails. You can also choose to provide an extra layer of reinforcement at the top of the slope, set a fixed vertical spacing between the layers of reinforcement or change the wedge on which the tension is applied.

The required reinforcement layers are listed in the Reinforcement View and displayed on the slope in the Job View.

Reinforcement View

ReActiv displays the required reinforcement layout in its Reinforcement View. This View is automatically created when you choose **Calculate > Reinforcement** from the menu bar.



	Name	Type	Strength (kN/m)	Depth (m)	Length (m)	Inclination (deg)
1	Topgrid 2	Geogrid	10.0	0.20	5.56	0.0
2	Topgrid 2	Geogrid	10.0	0.80	5.62	0.0
3	Topgrid 2	Geogrid	10.0	1.40	5.68	0.0
4	Topgrid 2	Geogrid	10.0	2.00	5.74	0.0
5	Topgrid 3	Geogrid	24.0	2.60	5.81	0.0
6	Topgrid 3	Geogrid	24.0	3.20	5.87	0.0
7	Topgrid 3	Geogrid	24.0	3.80	5.93	0.0
8	Topgrid 3	Geogrid	24.0	4.40	5.99	0.0
9	Topgrid 3	Geogrid	24.0	5.00	6.05	0.0
10	Topgrid 3	Geogrid	24.0	5.60	6.11	0.0
11	Topgrid 4	Geogrid	32.0	6.20	6.18	0.0
12	Topgrid 4	Geogrid	32.0	6.80	6.24	0.0
13	Topgrid 4	Geogrid	32.0	7.40	6.30	0.0
14	Topgrid 4	Geogrid	32.0	8.00	6.36	0.0

The Reinforcement View displays the required reinforcement in a spreadsheet and gives, for each layer:

- The name of the reinforcement
- Its type
- Its strength
- The depth of the layer
- Its length
- Its inclination to the horizontal
- Notes giving special information relevant to that layer (for example, in the case of soil nails, their horizontal spacing)

Calculating the required reinforcement

When you choose the **Calculate > Reinforcement** command, ReActiv performs a number of calculations that culminate in the required reinforcement being displayed in the Reinforcement View. These calculations are described in full in Chapter 9 but, for convenience, are summarized below.

- First, a search is made for the T_{max} mechanism (if it has not already been found)
- Second, a search is made for the T_{ob} mechanism (if it has not already been found)
- Third, the total number of reinforcement layers (n) is calculated
- Fourth, the depth to the first layer of reinforcement (z_1) is calculated
- Fifth, the pullout length of the first layer (L_{e1}) is calculated
- Sixth, the depths of the remaining layers are calculated
- Finally, the lengths of these layers are calculated

Minimizing the length of soil nails

The Advice Note describes a method of reducing the length of soil nails by decreasing the horizontal spacing of the first layer of nails and adjusting the length of the other layers accordingly. The method is described in Chapter 9.

To minimize the length of soil nails, choose the **Reduce Nail Lengths** option from the **Options** menu in the Reinforcement View or click on the **Reduce Nail Lengths** button on the Toolbar. ReActiv will then automatically reduce the horizontal spacing of the top layer of nails when you next calculate the reinforcement. The actual spacing adopted in the calculations is displayed in the **Notes** column of the Reinforcement View.

Providing an additional layer at the top of the slope

When ReActiv optimizes the depths of the reinforcement layers, it places the first layer of reinforcement at some depth below the top of the slope. Because of this, there is the potential, particularly for Two-part or Infinite slopes, for the soil above the first layer to be unstable. This instability can be avoided:

- In the case of geotextiles and geogrids, by providing a "wrap-around" front face
- In the case of soil nails, by providing a mesh and shotcrete front face

In the absence of measures such as these to support the soil above the first layer, it may be necessary to provide an extra layer of reinforcement at the top of the slope. You can instruct ReActiv to provide this extra layer of reinforcement by selecting the **Extra Layer At Top** command from the Reinforcement View's **Options** menu or by clicking on the **Extra Layer At Top** button on the Toolbar. A tick mark is displayed next to this option when it is selected.

ReActiv asks you whether you want to provide an extra layer at the top of the slope whenever both of the following conditions are met:

- The angle between the reinforcement and the upper slope of crest is greater than or equal to 10°
- The **Extra Layer At Top** option is not already selected Reinforcement View

Setting a the vertical spacing between the layers

When **HA68/94** is selected on the **Options** menu, ReActiv calculates the vertical spacing between reinforcement layers according to the optimised procedure given in HA68 (see Chapter 9).

When the **Fixed Vertical Spacing** option is chosen on the **Options** menu, ReActiv places the layers at a fixed spacing (which you specify), but allows more than one strength of reinforcement to be used. At each depth, the program automatically selects the weakest layer that it can use to provide stability. The reinforcement layers that the program uses and the spacing between them can be set via the **Reinforcement Used...** command on the **Options** menu.

Tension on Wedge 1 or 2

ReActiv automatically specifies Wedge 2 as the wedge on which the tensions are to be applied. However, the program allows you to change it if you wish to.

To change the wedge on which the tensions are applied, choose the **Tension on Wedge 1** option or the **Tension on Wedge 2** option from the **Options** menu in the Menu bar; alternatively, click on the **Tension on Wedge 1** button or on the **Tension on Wedge 2** button on the Toolbar.