

# ReWaRD

Version 2.5

## User Manual

RETAINING WALL DESIGN

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# Chapter 1

## Introduction

Welcome to ReWaRD®, the advanced retaining wall design program. ReWaRD gives you the power to design a wide range of embedded retaining walls in a variety of soil types, under an assortment of loading conditions.

ReWaRD is easy to learn and even easier to use. You'll find all the things you need to design a retaining wall are only a few mouse clicks away and can be put together in moments. ReWaRD's calculations are fast and its visual display is rich in detail and comprehensive in coverage.

This chapter of the *ReWaRD 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:

- Chapter 1     *Introduction*
- Chapter 2     *Installing and starting ReWaRD*
- Chapter 3     *Overview*
- Chapter 4     *Tutorial 1 – cantilever wall in sand*
- Chapter 5     *Tutorial 2 – propped wall in stiff clay*
- Chapter 6     *Tutorial 3 – cofferdam in mixed soils*
- Chapter 7     *The Stockyard*
- Chapter 8     *Workbooks*
- Chapter 9     *Producing reports*
- Chapter 10    *Customizing the program*
- Chapter 11    *Upgrading from previous versions*

## Conventions

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

This	Represents
<b>Bold</b>	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
<b>Item1 ▶ Item2</b>	An item on a cascading menu. Item1 is the name of an option on the main menu bar (such as <b>File</b> or <b>Window</b> ); and Item2 is the name of an option on the cascading menu that appears when you select Item1 (such as <b>New</b> or <b>Open</b> ). Thus, <b>File ▶ New</b> represents the New command from the File menu.
<i>italic</i>	Place holders for information you must provide. For example, if you are asked to type <i>filename</i> , 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 the ReWaRD manuals and the on-line help system.

### User manual

The *ReWaRD User Manual* (this book) explains how to install and use ReWaRD. It includes a n overview of the program, a tutorial, and separate chapters giving detailed information about ReWaRD's Stockyard and Workbooks.

### Reference manual

The *ReWaRD Reference Manual* gives detailed information about the calculations ReWaRD performs. The manual assumes you have a working knowledge of the geotechnical design of embedded retaining walls.

### ReWaRD's help system

ReWaRD's help system contains detailed information about 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 dialogue box
- Choose a command from the **Help** menu

If you need assistance with using on-line help, 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, ReWaRD 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.

## Technical support

Technical support for ReWaRD is available direct from Geocentrix or through your local distributor. If you require technical support, please contact Geocentrix by any of these means:

Voice: +44 (0)1737 373963

Fax: +44 (0)1737 373980

E-mail: [support@geocentrix.co.uk](mailto:support@geocentrix.co.uk)

Web: [www.geocentrix.co.uk](http://www.geocentrix.co.uk)

Please be at your computer and have your licence number ready when you call.

Alternatively, you can write to the following address:

ReWaRD Technical Support  
Geocentrix Ltd  
Scenic House  
54 Wilmot Way  
Banstead  
Surrey  
SM7 2PY  
United Kingdom

Please quote your licence number on all correspondence.

## Sales and marketing information

For sales and marketing information about ReWaRD, please contact ReWaRD Sales on the same numbers as above.



## Chapter 2

# Installing and starting ReWaRD

ReWaRD can be installed to run on Windows 95 or Windows NT. Although you can install the software on as many computers as you like, you will only be able to run the program on those computers to which you attach the supplied security key.

Before you begin installing your copy of ReWaRD, there are a few things you should check:

- Examine the contents of your ReWaRD package to check we have sent you everything listed below
- Make sure you have the necessary hardware and software to run ReWaRD

## What's in the ReWaRD package

The ReWaRD package includes the following items:

- *ReWaRD User Manual* (this document)
- *ReWaRD Reference Manual*
- Geocentrix Software CD
- One security key (dongle) for each copy of the program you have purchased
- Instructions for installing and running your copy of ReWaRD

## Hardware and software requirements

In order to run ReWaRD, you will need the following hardware and software:

- IBM®-compatible PC with an 80386- (or higher) processor
- Microsoft® Windows® 95 (or later) or Microsoft Windows NT 4 (or later)
- At least 30Mb free space on your hard disk for a complete installation
- CD-ROM drive
- Any printer supported by Windows
- A mouse or other pointing device supported by Windows

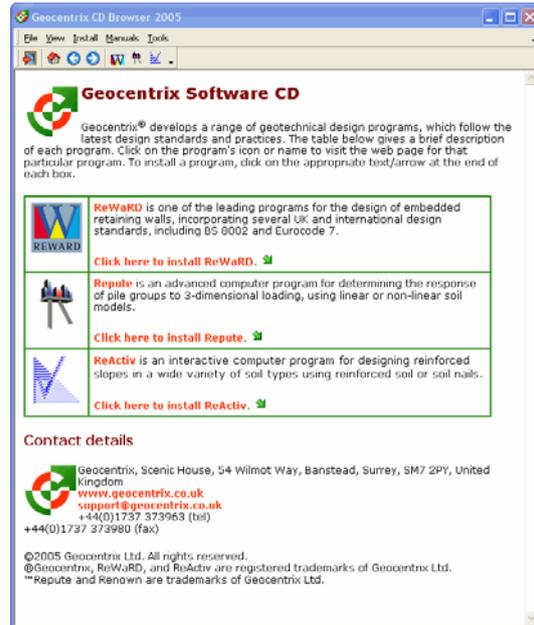
## Upgrading from an earlier version of ReWaRD

If you are upgrading your copy of ReWaRD from an earlier version, you should note the following:

- ReWaRD's setup program installs Version 2.5 in a different directory to Versions 1.x and 2.0 and hence will not overwrite your existing copy of ReWaRD
- JOB files created in ReWaRD 1.x can be imported into ReWaRD 2.5, where they will be converted into ReWaRD's new RWD format
- RWD files created in ReWaRD 2.0 can be opened in ReWaRD 2.5, where they will be updated without loss of information
- Documents created in ReWaRD 2.5 can be exported into ReWaRD 1.x's JOB format, although some information may be lost. The program will inform you when this happens
- Documents created in ReWaRD 2.5 cannot be read by ReWaRD 2.0

## To install ReWaRD

- Place the Geocentrix Software CD in your CD-ROM drive. The Browser (right) should automatically appear (if not, run **SETUP.EXE** from the CD's root folder).
- Click on the text "**Click here to install ReWaRD**" or the arrow  alongside it to run the ReWaRD Setup program. When asked "Do you want to run or save this file?" click **Run**. If a security warning appears, click **Run**.
- When the ReWaRD Setup welcome screen appears, click **Next**.
- Read and accept the License Agreement and click **Next**. Then review the Release Notes and click **Next**.
- Select the features you want to install, choose a product install path, and click **Next**.
- When you are ready to update your system, click **Next**. The ReWaRD Setup program will install the necessary files on your system.
- When setup is complete, click **Finish**. The HASP Device Driver setup program will then start, allowing you to install the drivers necessary for ReWaRD to communicate with its security key. Follow the on-screen instructions.
- When the HASP setup is complete, click **Finish**. If you ticked the **Run ReWaRD** button, ReWaRD will start automatically and display its Licence Registration Wizard.
- Enter your user information exactly as given on the program's packaging, make sure the supplied security key is attached to your computer, and click **Register** to run ReWaRD.



## To run ReWaRD

- From Windows' Start menu, click All Programs | Geocentrix | ReWaRD 2.5.

## To uninstall ReWaRD

- Exit ReWaRD.
- From Windows' Start menu, click All Programs | Geocentrix | Uninstall | Uninstall ReWaRD 2.5.
- Follow the instructions on-screen.

## Chapter 3 Overview

This chapter gives you an overview of ReWaRD's main features.

### Key features

ReWaRD's user interface revolves around two main views:

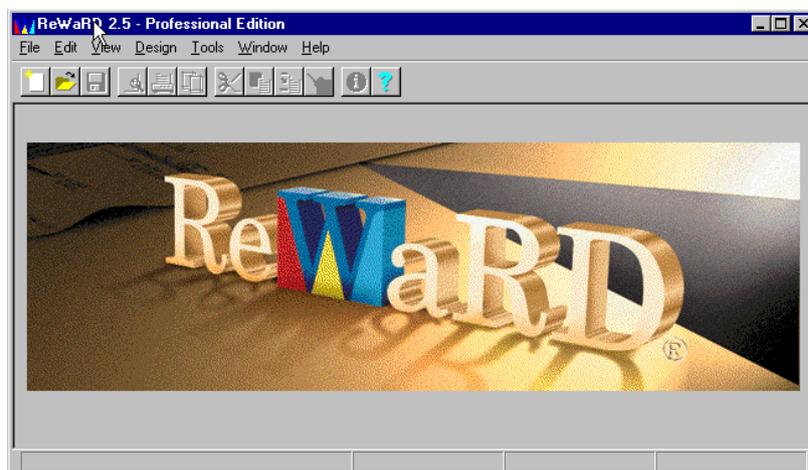
- The *Stockyard*, where you create, edit, and delete engineering objects
- *Workbooks*, where you define stages in the construction sequence and perform engineering calculations

In addition, ReWaRD has a number of tools and features which assist you in getting the best out of the Stockyard/Workbook interface:

- Wizards are provided to speed up frequently-performed tasks, such as creating a multi-propped construction sequence
- Context-sensitive dialogue boxes and property sheets help to simplify data-entry
- Data-validation prevents you from entering invalid parameters or choosing invalid options
- On-line help is provided at the click of a button

### The Desktop

ReWaRD's Desktop comprises the program's title bar, menu bar, toolbar, main work area, and status bar.



#### Title Bar

The Title Bar displays the name and version number of the program. The Control menu at the left-hand edge of the Title Bar provides commands for sizing, moving, or closing ReWaRD's main window. The row of buttons at the right-hand edge of the Title Bar provide quick ways of maximizing or minimizing and closing ReWaRD's main window.

#### Menu Bar

The Menu Bar provides groups of commands for manipulating files, editing and viewing objects, setting properties, choosing a design standard, performing calculations, running tools, arranging windows, and accessing on-line help.

Some items (**File**, **Edit**, **View**, **Design**, **Tools**, **Window**, and **Help**) appear on the Menu Bar at all times. Others (such as **Create**, **Properties**, and **Calculate**) appear when needed, depending on which view is active.

## Toolbar

The Toolbar provides buttons that help you perform certain tasks quickly, without using the menus. The Toolbar changes when you change the active view.

If you pause while passing the mouse pointer over a toolbar button, ReWaRD displays the name of that button. This makes it easier for you to recall what each button does.

## Main work area

The Desktop's main work area acts as a container for ReWaRD's Stockyard and Workbook views. When you create a new document or open an existing document, ReWaRD creates a Stockyard view for that document. You may then display as many Workbook views as you wish, subject only to the limits of your computer's memory.

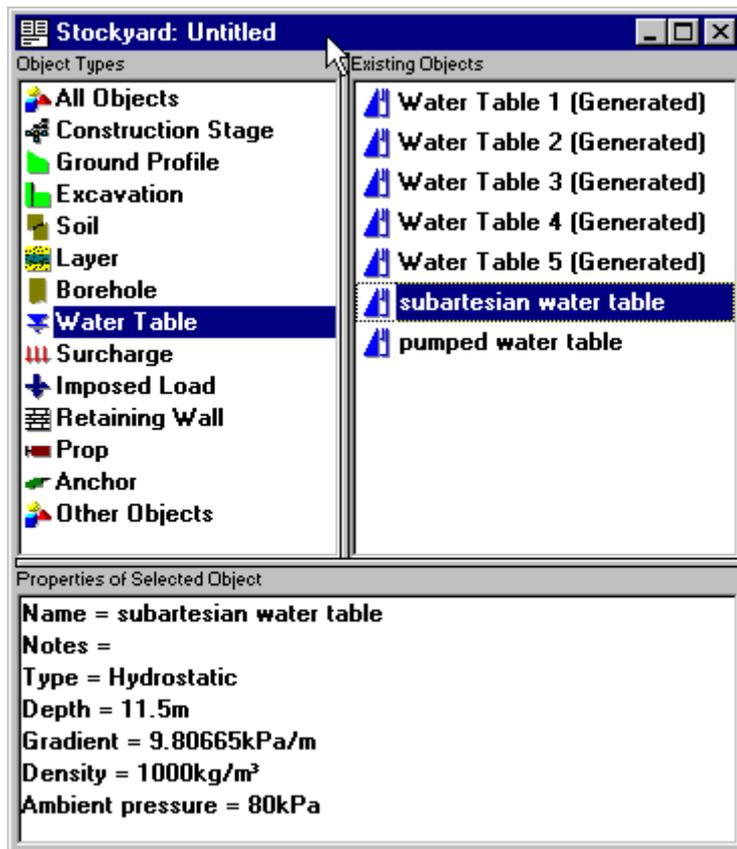
## Status Bar

The Status Bar displays summary information about the current document. The Status Bar changes when you change the active view. For example, when a Workbook's Drawing Board is selected, the Status Bar displays the (x, y) coordinate of the mouse pointer, which allows you to determine the location of any object on the Drawing Board.

When you select a menu command, the Status Bar displays a brief description of that command.

## The Stockyard

ReWaRD's Stockyard is where you create and manage the engineering objects you will need to define your retaining wall project. This is at the heart of ReWaRD's data entry system.

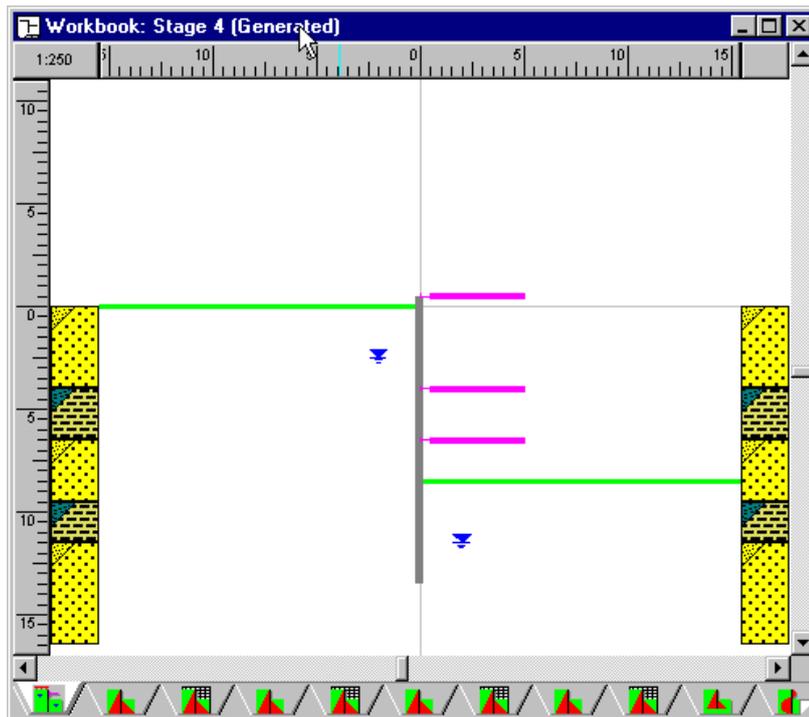


The Stockyard is divided into three panes which list the engineering objects you can create, the engineering objects you have already created, and the properties of those objects. Context-sensitive pop-up menus allow you to manipulate each object at the click of a button.

Chapter 7 describes the features of the Stockyard in detail and explains how you can use it to maximum effect in your design work.

## Workbooks

Although the Stockyard is where you create the engineering objects you need, ReWaRD's Workbooks are where you use them to create designs. Each Workbook encapsulates all the information that is relevant to a particular construction stage, whether it is part of a sequence of stages or one of several "what-if" scenarios.



ReWaRD's Workbooks are multi-paged windows containing a Drawing Board, several results and graph pages, and a messages page. The Drawing Board provides continuous visual feedback as you build each construction stage. By presenting the results of its calculations on separate pages, ReWaRD ensures that all the information you might want is readily available without you being overwhelmed with numbers.

Chapter 8 describes the capabilities of ReWaRD's Workbooks in detail and explains how you can use them to optimize your designs.

## Tools

ReWaRD provides a number of tools to increase your efficiency in using the program. You can see what tools are available to you by clicking on the **Tools** item on the menu bar.

## Startup-Wizard

The Start-up Wizard is designed to speed up your use of ReWaRD, by listing the four most common tasks that users perform when they first start the program.

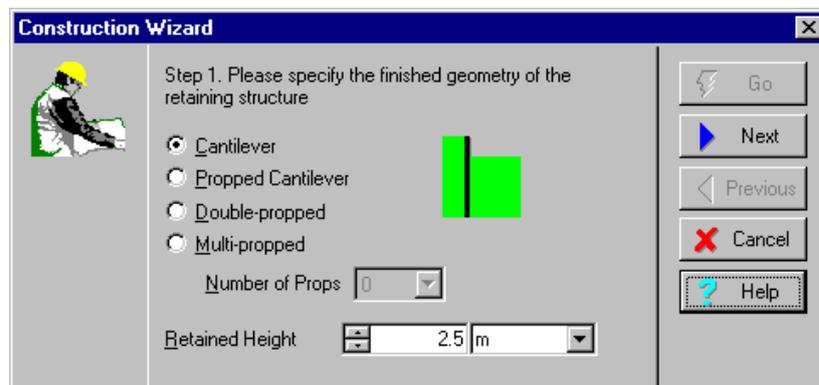


Select which option you want from those provided and click the Go button (alternatively, *double-click* on the desired option to select and go in one action).

The Start-up Wizard automatically appears each time you run ReWaRD. If you want to display the Start-up Wizard at any other time, choose the **Start-up Wizard** command from the **Tools** menu.

## Construction Wizard

The Construction Wizard helps you build up a multi-stage construction sequence by answering a few key questions. Once the Construction Wizard has built your multi-staged project, you can then edit it to meet your precise requirements.

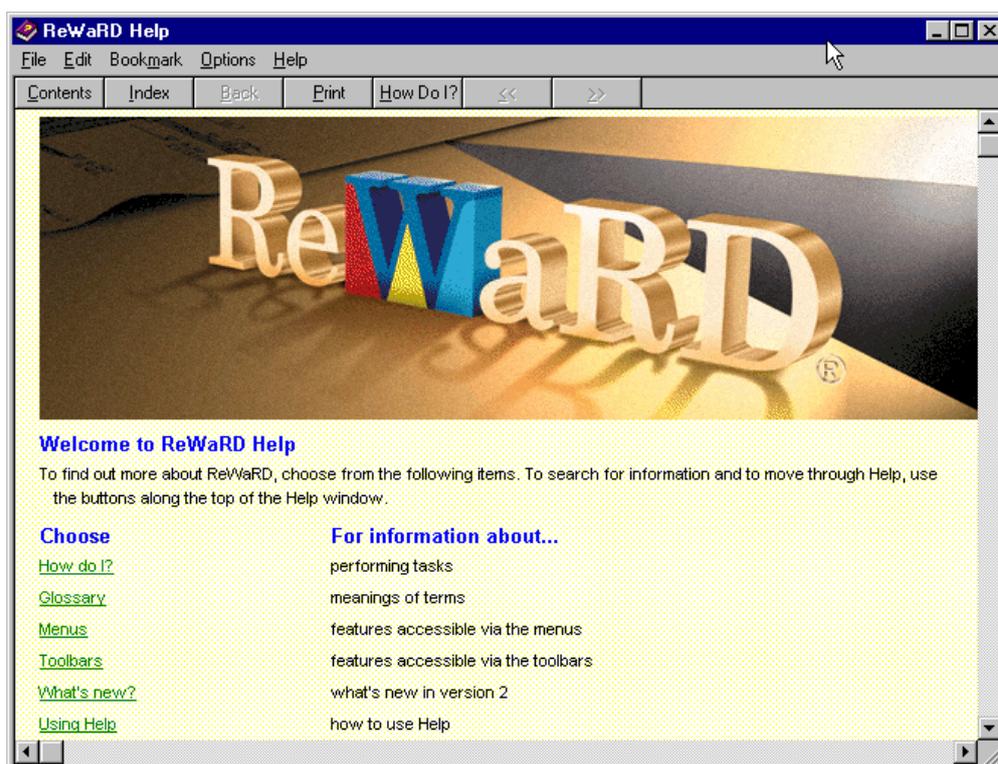


The tutorial in Chapter 4 shows you how to use the Construction Wizard.

To display the Construction Wizard, choose the **Construction Wizard** command from the **Tools** menu.

## On-line help

ReWaRD has one of the most comprehensive on-line help systems of any geotechnical engineering program. If you want to know how to use a particular dialogue box or want to discover what BS 8002 recommends for angles of wall friction, you will find the information you want in ReWaRD's help system.



## To open ReWaRD's on-line help

To open ReWaRD's on-line help:

- Press F1
- Click the Help button in a dialogue box
- Choose a command from the **Help** menu

## Chapter 4

# Tutorial 1 – cantilever wall in sand

This tutorial helps you to get started with ReWaRD, by designing a simple cantilever wall in sand. The tutorial shows you how to:

- Use ReWaRD's Construction Wizard
- Choose between the available design standards
- View the results of your calculations

### Worked example

The worked example involves the design of a wall to support a 4m excavation in sand.

The ground conditions at the site comprise 15m of dense sand ( $\gamma = 17 \text{ kN/m}^3$ ;  $\phi = 35^\circ$ ;  $c' = 0$ )<sup>1</sup>. The groundwater table is 15m below excavation level and hence the sand can be considered dry throughout.

A diaphragm wall 0.6m thick will be used to support the excavation in the long term. No props can be used.

You are required to calculate the wall's minimum depth of embedment and the maximum bending moment and shear force it must resist.

### Using the Construction Wizard to create a new project

If ReWaRD is not already running, double-click on the ReWaRD icon to load the program into your computer's memory. Once the "splash screen" has disappeared, ReWaRD displays its Start-up Wizard.



Select the option **Run the Construction Wizard** and click the **Go** button. ReWaRD's Construction Wizard appears on your screen.

The Construction Wizard asks you a number of questions about the retaining wall project you want to create and then generates a project according to your answers.

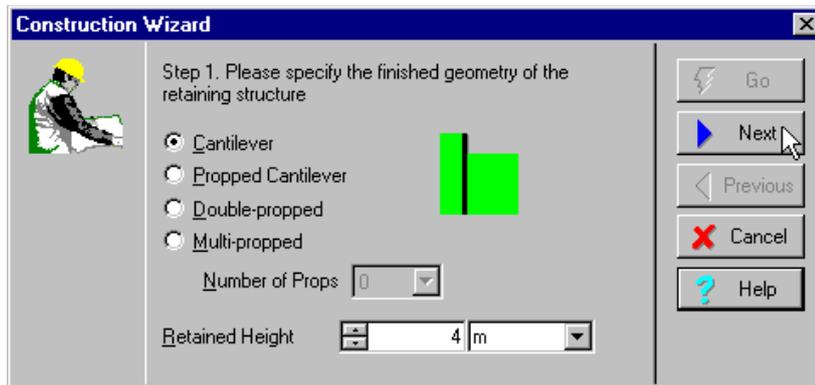
### Step 1

In Step 1, the Construction Wizard asks you to specify the finished geometry of

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<sup>1</sup> $\gamma$  = unsaturated unit weight;  $\phi$  = angle of shearing resistance; and  $c'$  = effective cohesion of the sand

the retaining structure.

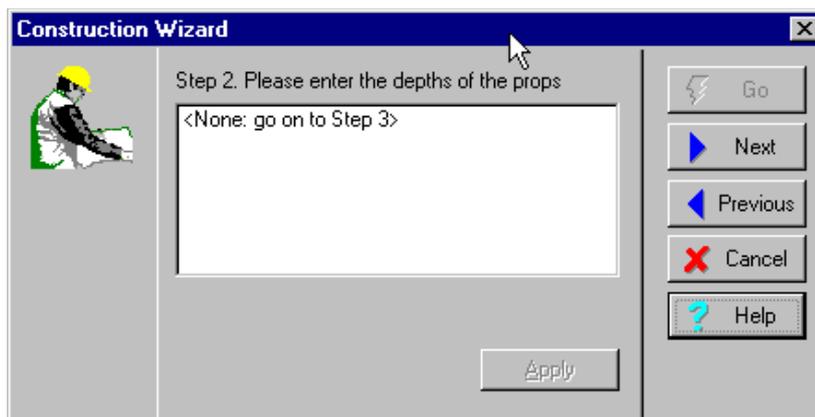


If not already selected, click on the **Cantilever** option. The number of props changes to 0 and the picture shows a cantilever wall.

Change the retained height to 4m and click **Next** to continue.

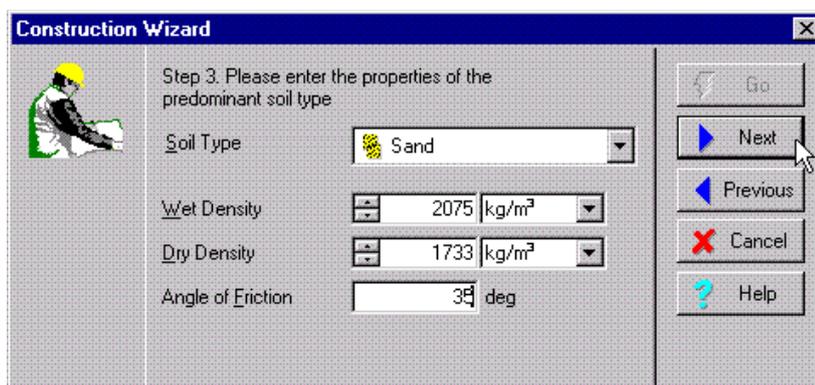
## Step 2

In Step 2, the Construction Wizard asks you to enter the depths of the props. Since there are no props in this worked example, click **Next** to continue.



## Step 3

In Step 3, the Construction Wizard asks you to enter the properties of the predominant soil type.



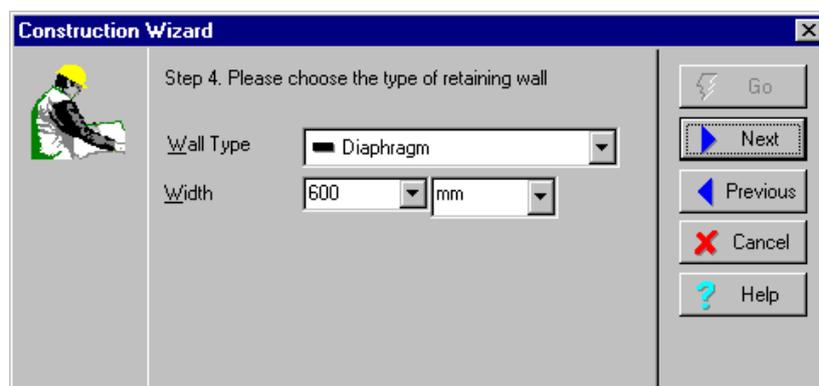
Select Sand from the **Soil Type** box; leave the wet density at its default value; and enter a dry density of 1733 kg/m<sup>3</sup> (which is equivalent to 17 kN/m<sup>3</sup>) and an angle of friction of 35°.

Although not shown, the Construction Wizard automatically sets the soil's effective cohesion to zero. (It doesn't matter what value you enter for the wet density, since this will not be used in this example.)

Click **Next** to continue.

## Step 4

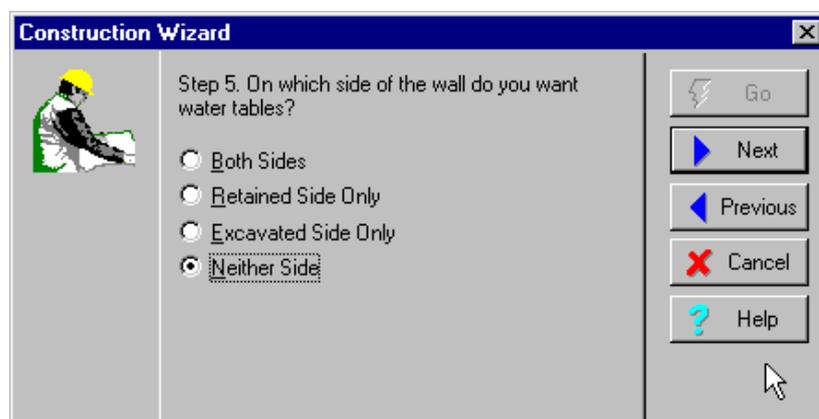
In Step 4, the Construction Wizard asks you to choose the type of retaining wall you want to use.



If it is not already selected, select Diaphragm from the **Wall Type** box and 600 mm in the **Width** box. Click **Next** to continue.

## Step 5

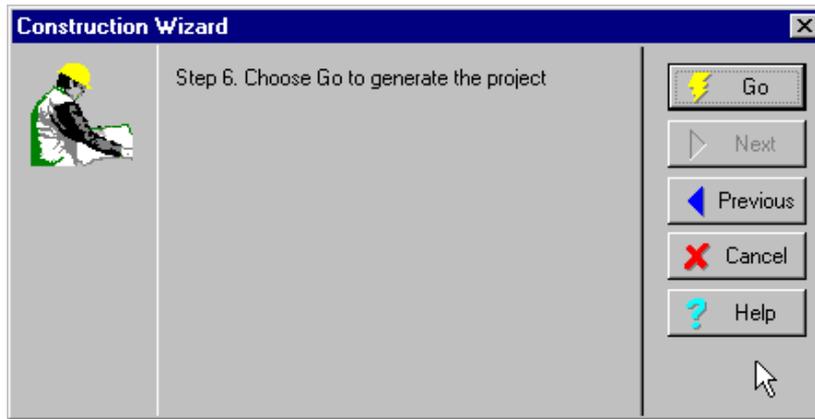
In Step 5, the Construction Wizard asks you on which side of the wall you want water tables.



Select **Neither Side** and click **Next** to continue.

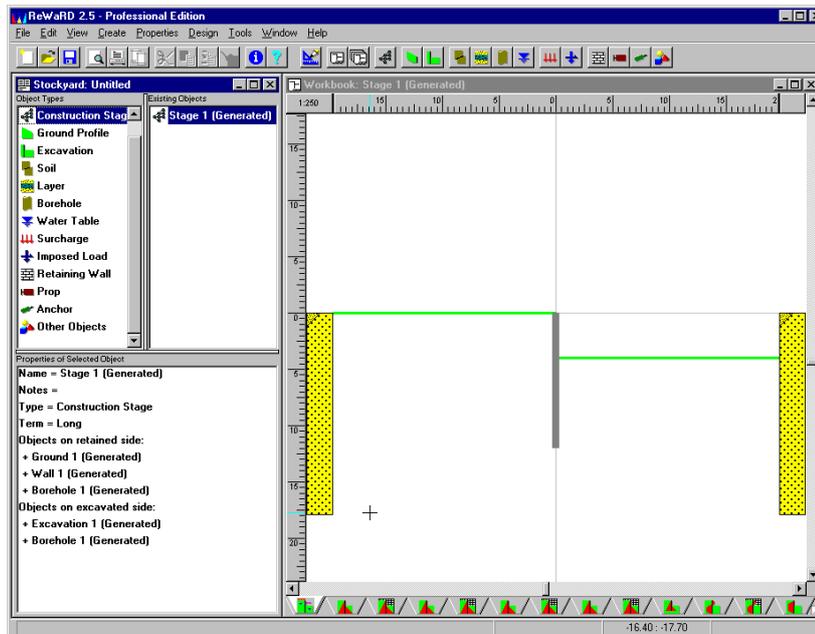
## Step 6

Step 6 is where you instruct the Construction Wizard to generate your project. If you want to review the information you have entered in Steps 1-5, you can do so by clicking on the **Previous** and **Next** buttons in succession.



When you are ready, click on **Go** to generate the project.

The Construction Wizard creates the engineering objects needed to define the project, fills its Stockyard with these objects, and then displays the Workbook associated with Construction Stage 1. At this moment, your screen should look something like this:



## What the Construction Wizard has done for you

ReWaRD's Construction Wizard has automated a lot of the tasks you would normally have to perform to setup a retaining wall project from scratch. It has created a total of seven engineering objects, which you can view by clicking on **All Objects** in the Stockyard's *Objects Type* pane:

- Horizontal ground surface
- Diaphragm wall 0.6m thick
- Sand with appropriate properties
- Drained layer containing the sand
- Borehole containing the layer
- Construction stage containing all the other objects
- Horizontal excavation at 4m depth

You can review the properties of these objects by clicking on them in turn and looking at the pane labelled *Properties of Selected Object*.

At this point, it is a good idea to save your work, which you can do by choosing the **Save As** command from the **File** menu (or by clicking on the Save button on the Toolbar). When the Save As dialogue box appears, choose the folder where you want to save the document, enter its filename as TUTORIAL1, and click **OK** (ReWaRD will automatically add the extension .RWD for you).

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 1, under the name STEP1 .RWD.

## Choosing a design standard

ReWaRD provides support for several UK and international design standards, as listed on the **Design** menu. When you select one of these standards, ReWaRD changes its configuration so that the calculations you perform are in accordance with it.

In this Tutorial, you will prepare calculations using two British design standards:

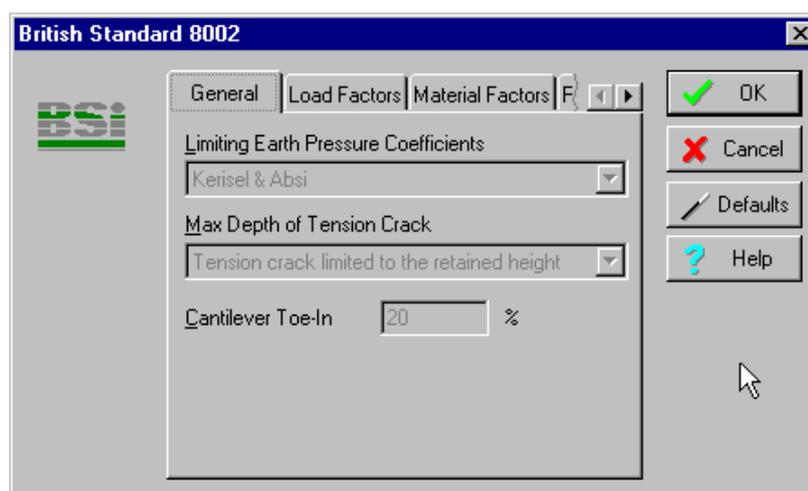
- BS 8002
- CIRIA 104



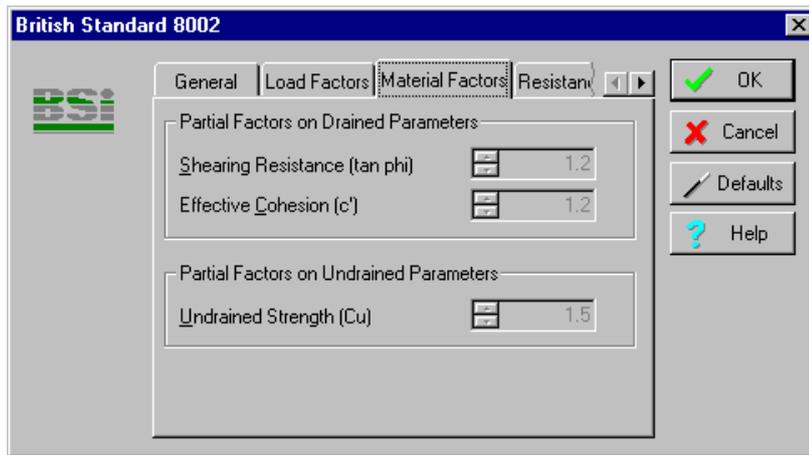
## Designing to BS 8002

If it is not already selected, select **BS 8002** from ReWaRD's **Design** menu. (The selected standard is shown ticked and greyed on this menu.)

You can review the settings for the selected standard by choosing the **Properties...** command from the **Design** menu. The following box appears for BS 8002:



Click on each of the tabs in turn to see what rules the program follows when it performs its calculations. In particular, note the partial factors that are applied to the soil's drained parameters.



On the Equilibrium page, note that equilibrium conditions are set to “At minimum safe embedment” (see the *ReWaRD Reference Manual* for further information about what this means). The significance of this will become apparent later in the tutorial.

Click **Cancel** to close this box when you have finished.

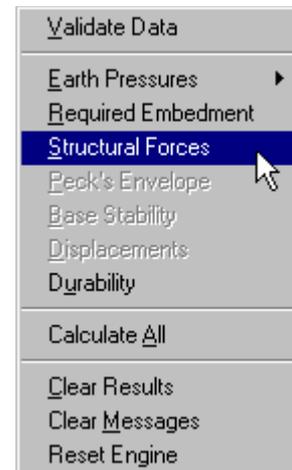
### Calculating structural forces

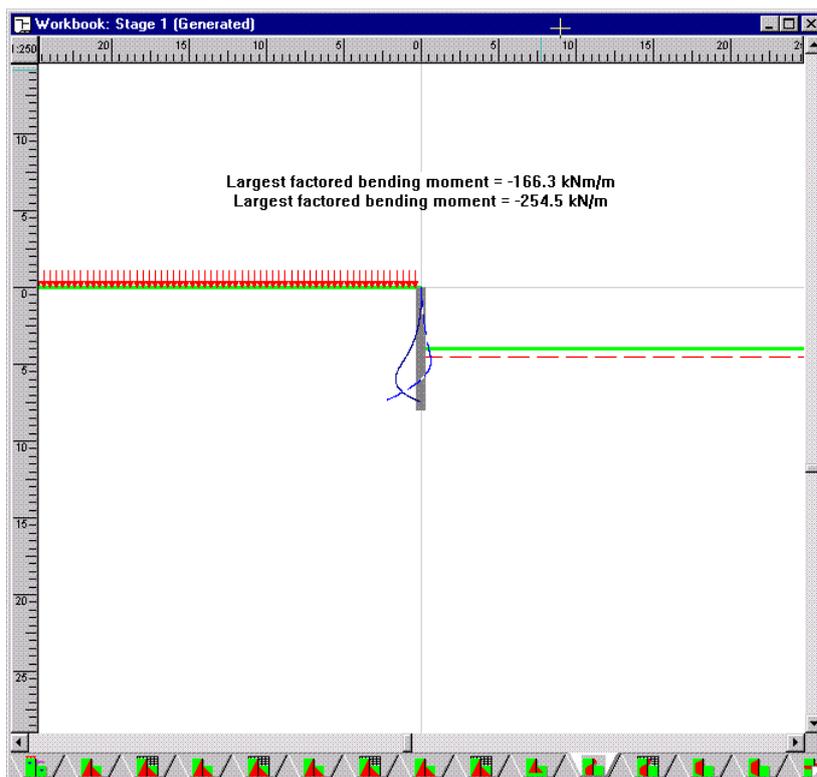
Once you have defined a valid construction stage and have selected the design standard you wish to use, you are ready to calculate structural forces in the wall:

- If necessary, click on the Workbook to make it active
- Choose the **Structural Forces** command on the Workbook’s **Calculate** menu
- (Or) Click on the Calculate Structural Forces button on the Workbook’s Toolbar

ReWaRD calculates earth pressures against the wall that are in equilibrium and match the condition given on the Equilibrium page of the Design Standard’s property box. In this case, earth pressures are calculated at the minimum safe embedment of the wall (i.e. in equilibrium with safety factors applied).

ReWaRD then uses these earth pressures to calculate the structural forces in the wall (see the *ReWaRD Reference Manual* for further details) and displays the structural forces on a picture of the construction stage.





Bending moments are shown by a dark blue solid line and shear forces by a light blue dashed line. Maximum values of each are noted on the diagram (these are design values – i.e. they already include appropriate safety factors, which in the case of BS 8002 are 1.0). The dashed red line on the right hand side of the picture indicates the unplanned excavation that ReWaRD has applied in accordance with BS 8002.

You can view the earth pressures used to calculate these structural forces by choosing the appropriate command from the Workbook's **View ► Earth Pressures** menu. You should choose the **At Minimum Safe Embedment** command (since these are the earth pressures used in this case).

The following diagram show the earth pressures obtained at the minimum safe embedment.



Note that the earth pressures on the excavated side of the wall do not begin at formation level – this is because BS 8002 requires a minimum unplanned excavation of 0.5m to be included in the calculations. (One of ReWaRD’s key benefits is that important details like this are automatically applied.)

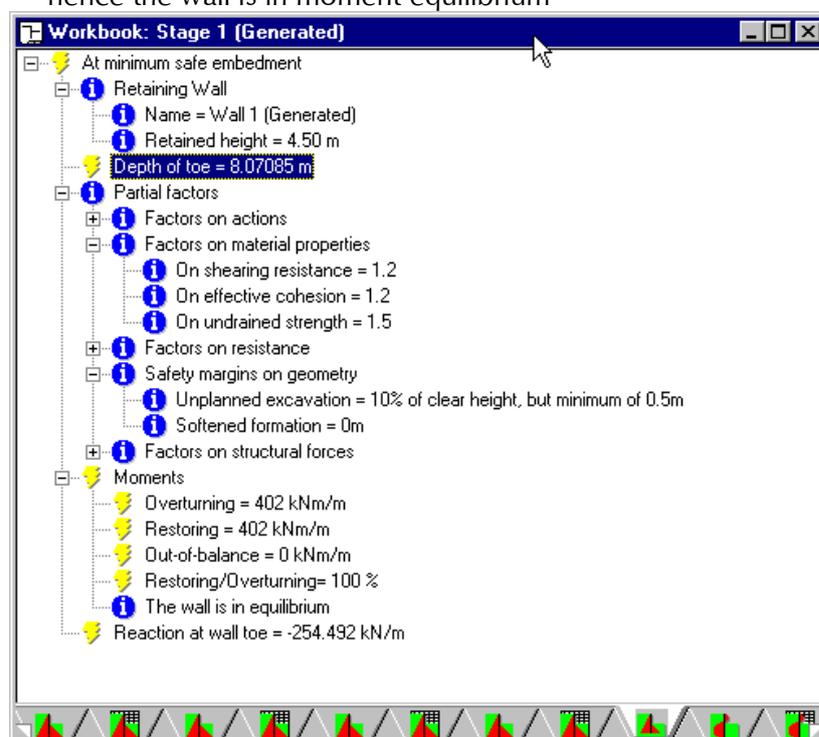
ReWaRD also provides the results of the earth pressure calculations in a table or spreadsheet. To view the earth pressures in this format, choose **Table** from the Workbook’s **View** menu. By default, ReWaRD displays the design pressures, as shown below.

	A	B	C	D	E	F	G
1	Depth	EarthPr	WaterPr	TotalPr	EarthPr	WaterPr	Tot
2	m	kPa	kPa	kPa	kPa	kPa	
3		Retained	Retained	Retained	Excavated	Excavated	Excavated
4	0.00	2.8	0.0	2.8	0.0	0.0	
5	4.50	23.8	0.0	23.8	0.0	0.0	
6	4.50	23.8	0.0	23.8	0.0	0.0	
7	4.77	25.1	0.0	25.1	25.1	0.0	
8	4.77	25.1	0.0	25.1	25.1	0.0	
9	7.48	37.7	0.0	37.7	272.7	0.0	2
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							

## Checking the required embedment

To calculate the required embedment of the wall, choose the **Required Embedment** command from the Workbook's **Calculate** menu. The results are displayed in a hierarchical tree view. By expanding some of the nodes (by clicking on the + signs), you can easily obtain whatever information you require from the calculations. For example, in the picture below, you can see that:

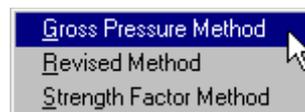
- The wall (whose unplanned retained height is 4.5m) requires a minimum toe depth of 8.1m
- Partial factors of 1.2 have been applied to the soil's coefficient of shearing resistance ( $\tan \phi$ ) and effective cohesion ( $c'$ )
- An unplanned excavation of 10% of the retained height or 0.5m (whichever is the greater) has been applied
- The overturning and restoring moments (402 kNm/m) are in balance and hence the wall is in moment equilibrium



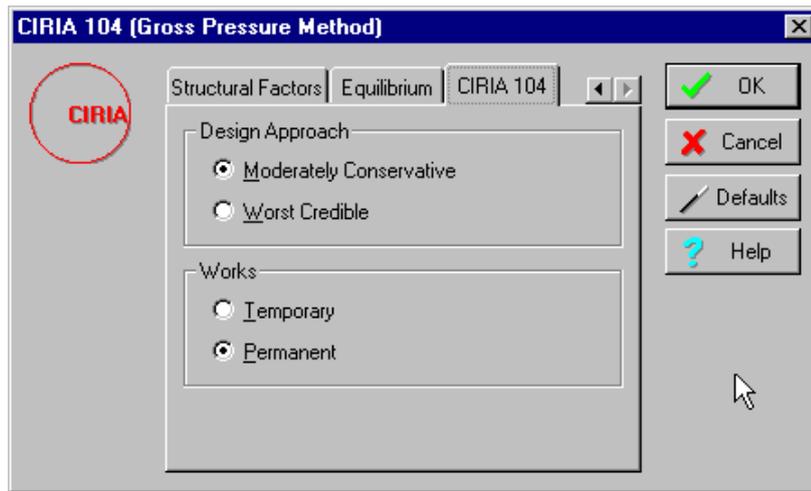
## Designing to CIRIA 104

You can obtain corresponding results using CIRIA 104 simply by changing the design standard and re-running the calculations:

- Select **CIRIA 104 ▶ Gross Pressure Method** from ReWaRD's **Design** menu



- Note that ReWaRD has cleared the previous results and invites you to calculate the required embedment again
- Review the settings for this standard by choosing the **Properties...** command from the **Design** menu
- On the Equilibrium page, note that the equilibrium conditions are set to "At Failure" (see the *ReWaRD Reference Manual* for further information about what this means)
- On the CIRIA 104 page, make sure that the design approach is set to Moderately Conservative and the Works to Permanent (again, see the *ReWaRD Reference Manual* for further information about these settings)



- Choose **OK** to save the design standard settings

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder `PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 1`, under the name `STEP2.RWD`.

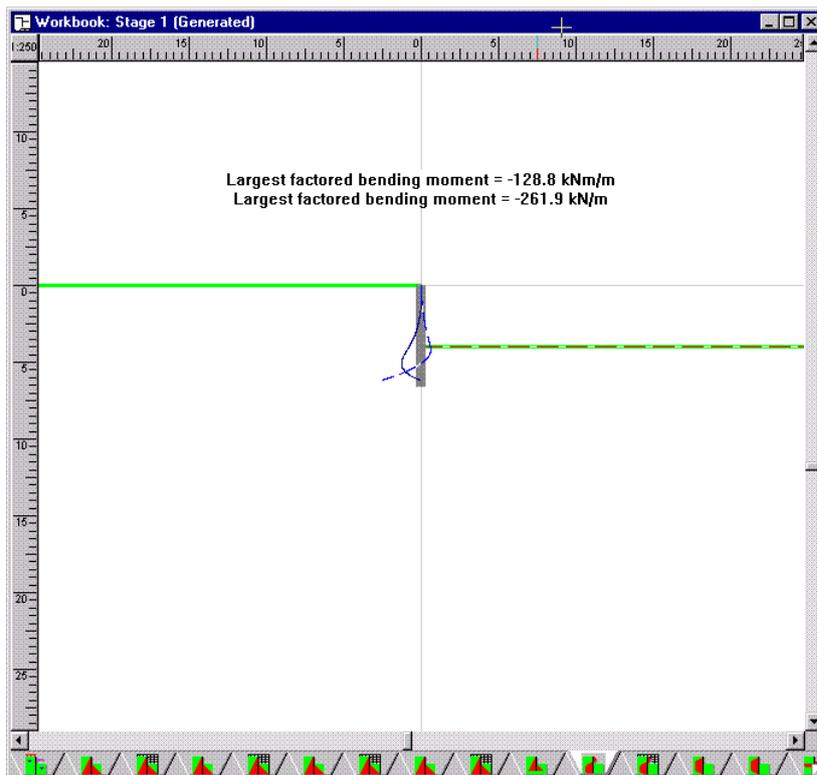
## Calculating structural forces

To calculate the structural forces in the wall:

- If necessary, click on the Workbook to make it active
- Choose the **Structural Forces** command on the Workbook's **Calculate** menu
- (Or) Click on the Calculate Structural Forces button on the Workbook's Toolbar

ReWaRD then calculates the embedment of the wall at failure (i.e. in equilibrium with *no* safety factors applied) and uses the earth pressures at this embedment to calculate the structural forces in the wall. (See the *ReWaRD Reference Manual* for further information.)

ReWaRD displays the structural forces pictorially:



The maximum bending moment in this case is 93 kNm/m and the maximum shear force is 210 kN/m. These are design values – i.e. they already include the appropriate safety factors (which in the case of CIRIA 104 are 1.5).

You can view the earth pressures used to calculate these structural forces by choosing the appropriate command from the Workbook’s **View ► Earth Pressures** menu. You should choose the **At Failure** command (since these are the earth pressures that CIRIA 104 recommends for calculating structural forces).

The following diagram shows the earth pressures obtained at failure.

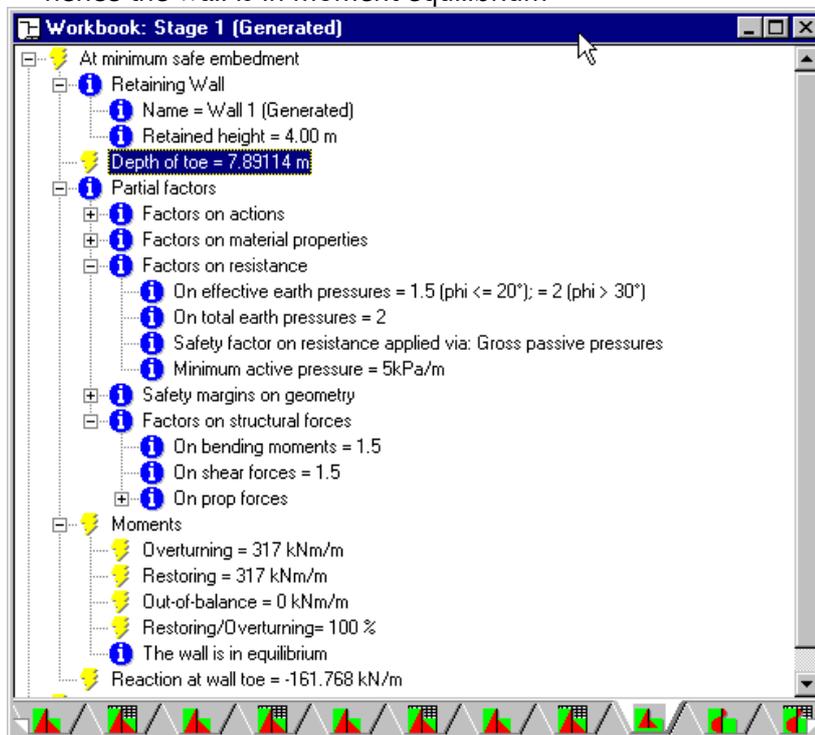


Note that the earth pressures on the excavated side of the wall *do* begin at formation level – this is because CIRIA 104 does not require a minimum unplanned excavation to be considered.

## Checking the required embedment

To calculate the required embedment of the wall, choose the **Required Embedment** command from the Workbook's **Calculate** menu. The results are displayed in a hierarchical tree view. By expanding the appropriate nodes, you can see that:

- The wall (whose retained height is 4.0m) requires a minimum toe depth of 7.9m
- Partial factors of 1.5-2.0 have been applied to the resisting effective pressures (i.e. passive pressures)
- Partial factors of 1.5 have been applied to the resulting bending moments and shear forces
- The overturning and restoring moments (317 kNm/m) are in balance and hence the wall is in moment equilibrium



## Conclusion

The results obtained using two different design standards are summarized below:

Result	BS 8002	CIRIA 104
Required embedment (m)	8.1	7.9
Maximum bending moment (kNm/m)	166	129
Maximum shear force (kN/m)	255	262

BS 8002 is more conservative than CIRIA 104 for this worked example, particularly in terms of bending moments. This is due mainly to the provision in BS 8002 of an unplanned excavation of 0.5m.

## What next?

Chapter 5 shows you how to build a project from scratch, using ReWaRD's drag-and-drop design features, and how to produce a printed report.

Chapter 6 takes you through the design of a more complicated structure – a multi-propped cofferdam in mixed soils – using the techniques introduced in Tutorials 1 and 2.



## Chapter 5

# Tutorial 2 – propped wall in stiff clay

This tutorial helps you to extend your knowledge of ReWaRD, by designing a propped wall in stiff clay. The tutorial shows you how to:

- Build a project from scratch, without using the Construction Wizard
- Drag engineering objects from the Stockyard and drop them onto a Workbook's Drawing Board
- Switch between short- and long-term stages (and hence drained and undrained calculations)
- Obtain a printout of your input and output data

### Worked example

The worked example is taken from CIRIA Report 104, *Design of retaining walls embedded in stiff clays*, by Padfield and Mair (1984). Appendix C of that document includes calculations for propped walls in stiff clay with and without seepage around the wall. Example C.2 involves the design of a wall to support an 8m excavation in stiff clay.

The ground conditions at the site comprise an unspecified thickness of stiff clay ( $\gamma = \gamma_s = 20 \text{ kN/m}^3$ ;  $\phi = 25^\circ$ ;  $c' = 0$ )<sup>2</sup>. Groundwater is at 1m below ground level on the retained side of the wall and at 1m below formation level on the excavated side.

The wall (type unspecified, but assumed herein to be secant piled) will form part of the temporary works and is supported by a prop at 2m below ground level.

You are required to calculate the wall's minimum depth of embedment; the maximum bending moment and shear force in the wall; and the force in the prop.

### Creating a new project from scratch

If ReWaRD is not already running, double-click on the ReWaRD icon to load the program into your computer's memory. Once the "splash screen" has disappeared, ReWaRD displays its Start-up Wizard. Select the option **Create a New Project** and click the **Go** button. ReWaRD's Stockyard appears on your screen.

Many of the following tasks can be performed in any order you choose.

### Creating a construction stage

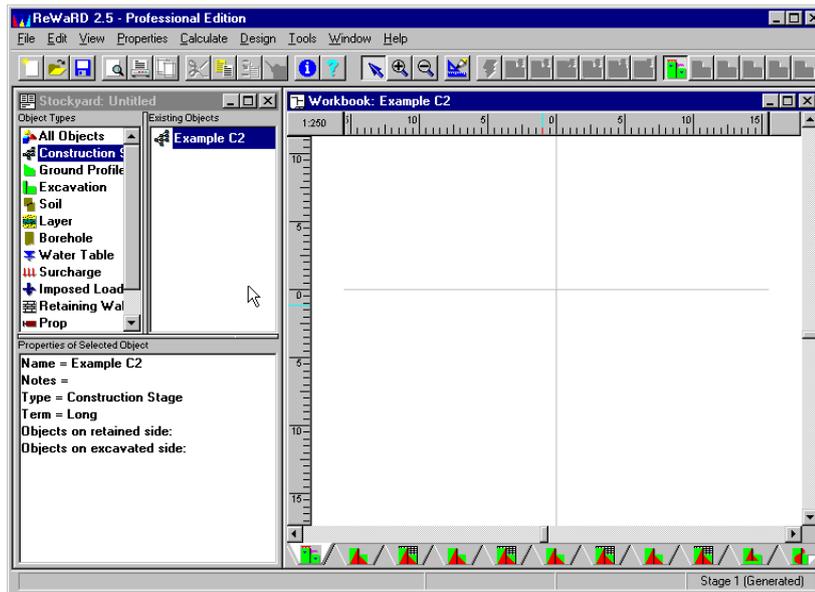
Start the new project by creating a Construction Stage. Choose **Construction Stage** on the Stockyard's **Create** menu and click the **OK** button in the dialogue box that appears.

ReWaRD creates a new Construction Stage and displays its property box. Change the name of the stage to *Example C2* and click **OK**.

ReWaRD saves the stage and then opens a new Workbook for you to add engineering objects to. At this point, your screen should look something like this:

---

<sup>2</sup> $\gamma$  and  $\gamma_s$  = unsaturated and saturated unit weights, respectively;  $\phi$  = angle of shearing resistance; and  $c'$  = effective cohesion of the clay

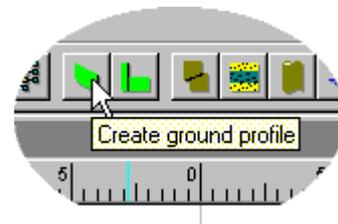


Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder `PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 2`, under the name `STEP1.RWD`.

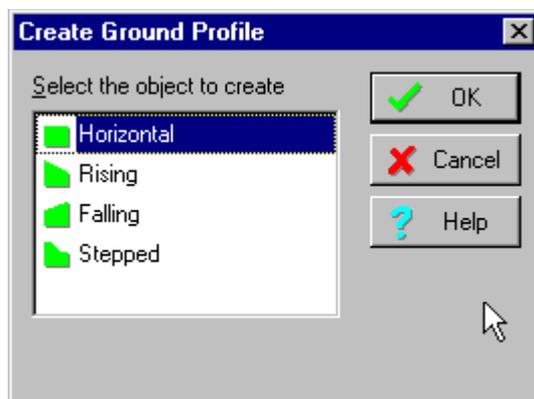
## Creating the ground geometry

Now define the geometry of the problem by creating a ground profile and an excavation. Click on the Stockyard to make it active.

Although you could create a ground profile via the Stockyard's **Create** menu as before, instead use one of the buttons on the Stockyard's Toolbar to do the same thing. You can locate which button to use by moving your mouse pointer over each button in turn until you find one whose tool-tip reads *Create ground profile* (see picture alongside).



When you click this button, the following box appears.



Choose Horizontal and click **OK**.

ReWaRD creates a new Horizontal Ground Profile and displays its property box. Since there are no properties to set for this object, just click **OK** to save it in the Stockyard.

To add the new ground profile to the construction stage:

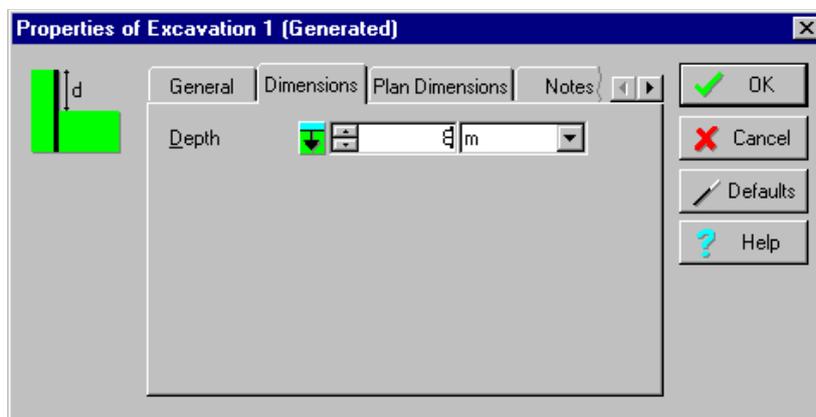
- Click on the words *Ground Profile 1* in the Stockyard's Existing Objects pane and – holding the left mouse button down – drag the object onto the Workbook's Drawing Board

- When you move your pointer over the Workbook, the cursor should change

from this:  to this: 

- When the cursor changes symbol, release your finger and the ground profile will be added to the construction stage

Repeat these instructions for a horizontal excavation, but change the depth of the excavation to 8m before **OK**-ing its property box.

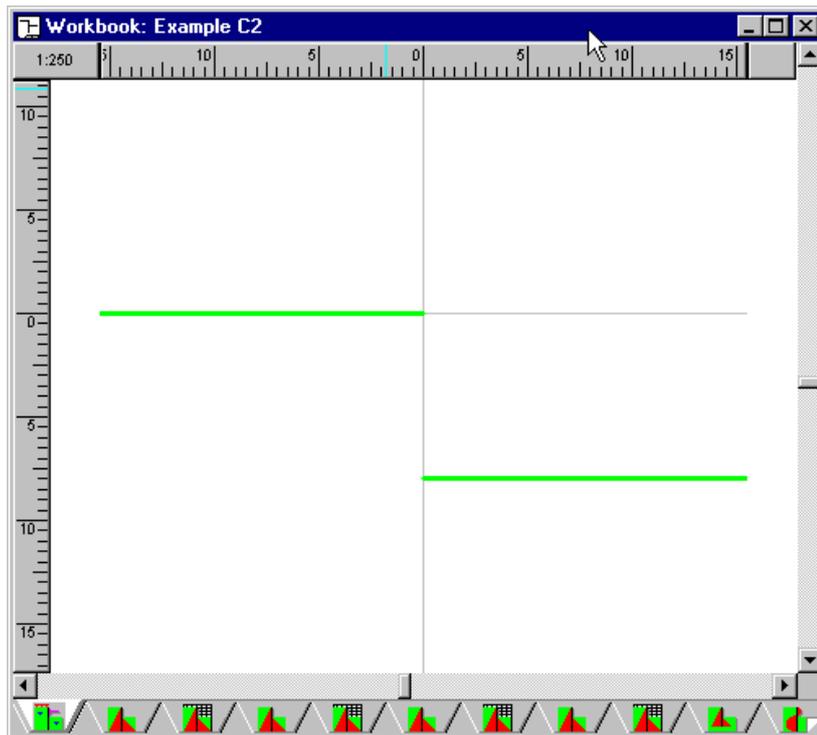


Note, in the picture above, the control with an arrow pointing downwards (to the left of the up-down spin buttons):

- When the arrow points down , the value entered in the left-hand box is considered a depth measured *downwards* from ground level
- When the arrow points up , the value entered in the box is considered to be a level measured *upwards* from Ordnance Datum (you can set ordnance datum via the **Ordnance Datum** command on the **Properties** menu)

If you click this button several times, you will see the value toggle between a depth of 8m depth and a level of –8m relative to Ordnance Datum.

When you have dragged *Excavation 1* onto the Workbook's Drawing Board, your construction stage should look something like this:



Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 2, under the name STEP2.RWD.

### Creating the wall

Although you could create the wall via the Stockyard's **Create** menu or Toolbar as before, instead try double-clicking on the words *Retaining Wall* in the Stockyard's Object Types pane. In the dialogue box that appears, select Secant Pile and choose **OK**.

ReWaRD creates a new Secant Pile Wall and displays its property box. Change the wall's toe depth to 20m and click **OK** to save the new wall. Then drag the wall onto the Workbook's Drawing Board.

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 2, under the name STEP3.RWD.

### Creating a soil column

Now it is time to define the soil column at the site. This involves creating three different objects:

- A soil, to represent the properties of the stiff clay
- A layer, to represent the geometry and drainage conditions
- A borehole, to represent the elevation and ordering of the

of that soil  
layers

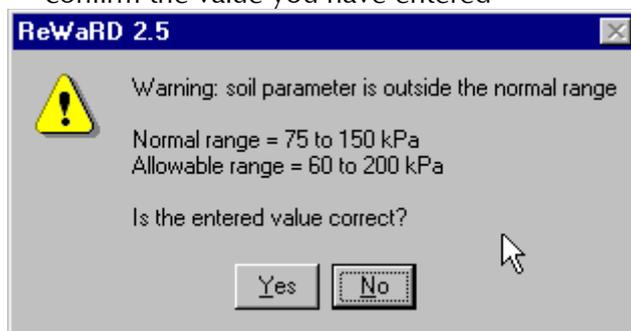
Although you could create the soil by using any of the methods described above, you can speed up the creation of objects still further by using one of the Stockyard's context menus, as follows:



- *Right-click* on the word *Soil* in the Stockyard’s Object Types pane
- Choose the command **New ► Clay** from the pop-up menu that appears

ReWaRD creates a new Clay Soil and displays its property box. Then set the following properties:

- On the General page, change the soil’s name to “Stiff clay”
- On the Classification page, change the soil’s classification to Unclassified/Stiff
- On the Density/Weight page, click on the **Unit Weight** button (if not already selected) and then change the soil’s saturated and unsaturated weights to 20 kN/m<sup>3</sup>
- On the Effective Stress page, change the soil’s angle of shearing resistance to 25° and its effective cohesion to zero (leave the Peak flag set and Poisson’s ratio unchanged)
- On the total stress page, change the soil’s undrained strength to 60 kPa. When you attempt to go to the Notes page, a warning message will appear telling you that the soil parameter is out of range (this being a stiff clay, ReWaRD expected you to enter a strength between 75 and 150 kPa). Answer Yes to confirm the value you have entered



- On the Notes page, enter any notes about this soil that you want to keep for future reference
- Finally, click on the **OK** button to confirm the soil’s properties

Now create an undrained layer in which to put the soil:

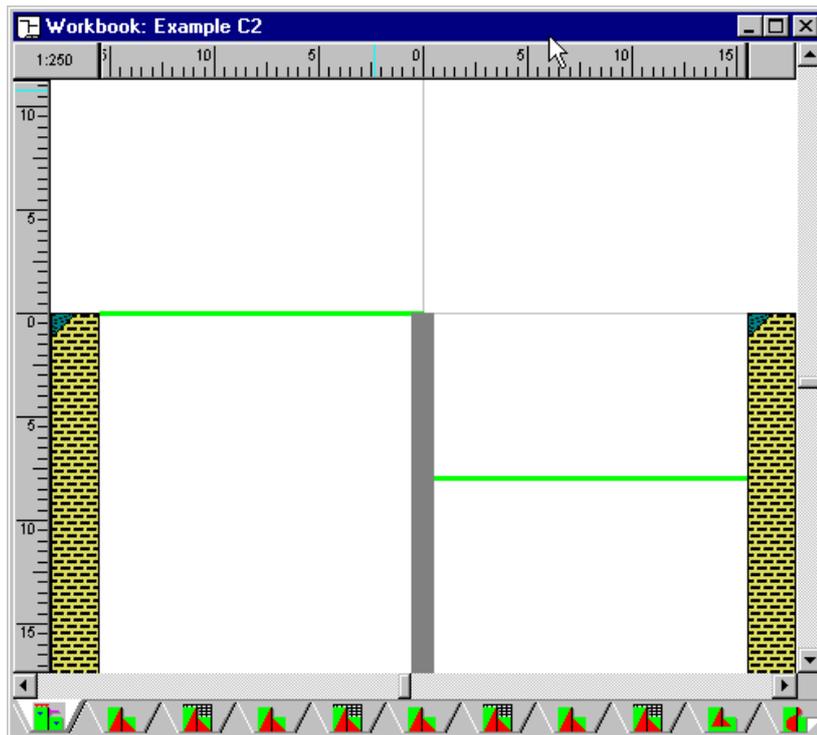
- *Right-click* on the word *Layer* in the Stockyard’s Object Types pane and choose **New ► Undrained** on the menu that appears
- ReWaRD creates a new Undrained Layer and displays its property box
- On the Properties page, change the soil to “Stiff clay” and the thickness to 30m
- Click on the **OK** button to confirm the layer’s properties

Now create a borehole in which to put the layer:

- *Right-click* on the word *Borehole* in the Stockyard’s Object Types pane and choose **New ► Borehole** on the menu that appears
- ReWaRD creates a new Borehole and displays its property box
- On the Layers page, select “Layer 1” in the **Available** box and click on the button with a single arrow pointing to the right (→). The layer moves from the **Available** box to the **Chosen** box
- Click on the **OK** button to confirm the borehole’s properties

Finally, drag the borehole onto the Workbook’s Drawing Board, where it automatically appears on both sides of the wall.

The Drawing Board now looks something like this:



Note the appearance of the soil column:

- The colour/pattern of the main part of the soil column represents the soil (in this case a clay)
- The colour/pattern of the corner piece represents the layer (in this case undrained)

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder `PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 2`, under the name `STEP4.RWD`.

### Adding the remaining objects

The remaining objects for you to create are two water tables (on either side of the wall) and a prop.

To add the first water table:

- *Right-click* on the words *Water Table* in the Stockyard's Object Types pane and choose **New ► Linear Seepage** on the menu that appears
- ReWaRD creates a new Linear Seepage Water Table and displays its property box
- On the Properties page, change the depth to 1m
- Click on the **OK** button to confirm the water table's properties
- Drag the water table onto the Workbook's Drawing Board, making sure that you drop in on the *retained* side of the wall (if you get this wrong, just drag the water table off the Drawing Board and drop it back into the Stockyard)

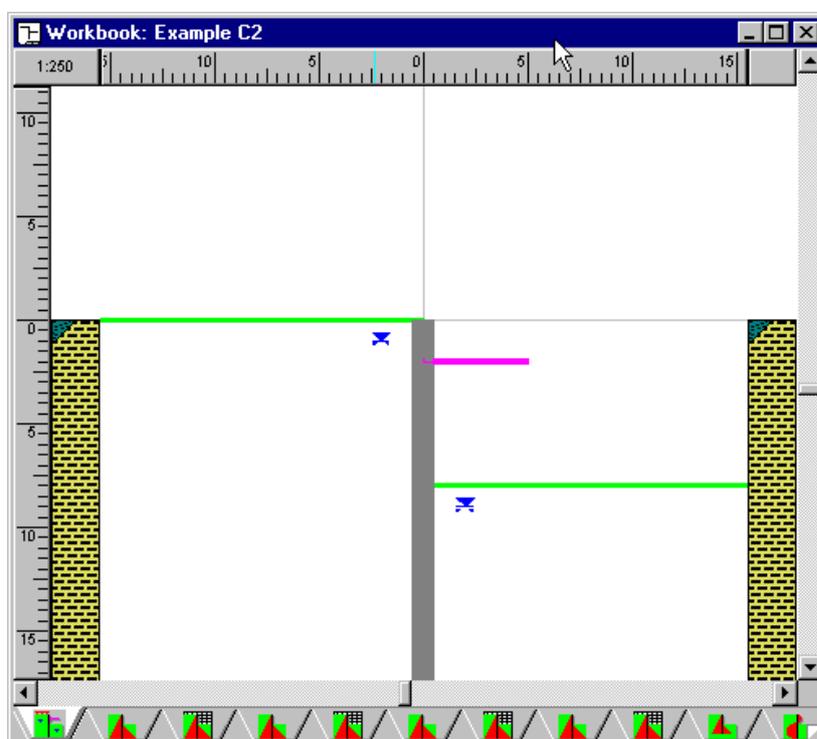
To add the second water table, repeat the instructions given above but change the depth to 9m and drop the water table on the *excavated* side of the wall.

To add the prop:

- *Right-click* on the word *Prop* in the Stockyard's Object Types pane and choose

- **New ► Horizontal** on the menu that appears
- ReWaRD creates a new Horizontal Prop and displays its property box
- On the Dimensions page, change the depth to 2m
- Click on the **OK** button to confirm the prop's properties
- Drag the prop onto the Workbook's Drawing Board

The Drawing Board now looks something like this:



Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 2, under the name STEP5.RWD.

## Designing to CIRIA 104

Tutorial 1 discussed ReWaRD's support for different UK and international design standards, so we will not dwell on these matters here. To select the appropriate design standard for this worked example:

- Select **CIRIA 104 ► Gross Pressure Method** from ReWaRD's **Design** menu
- On the CIRIA 104 page, make sure that the design approach is set to Moderately Conservative and set the Works to Temporary (see the *ReWaRD Reference Manual* for further information)
- Choose **OK** to save the settings

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 2, under the name STEP6.RWD.

## Calculating the required embedment

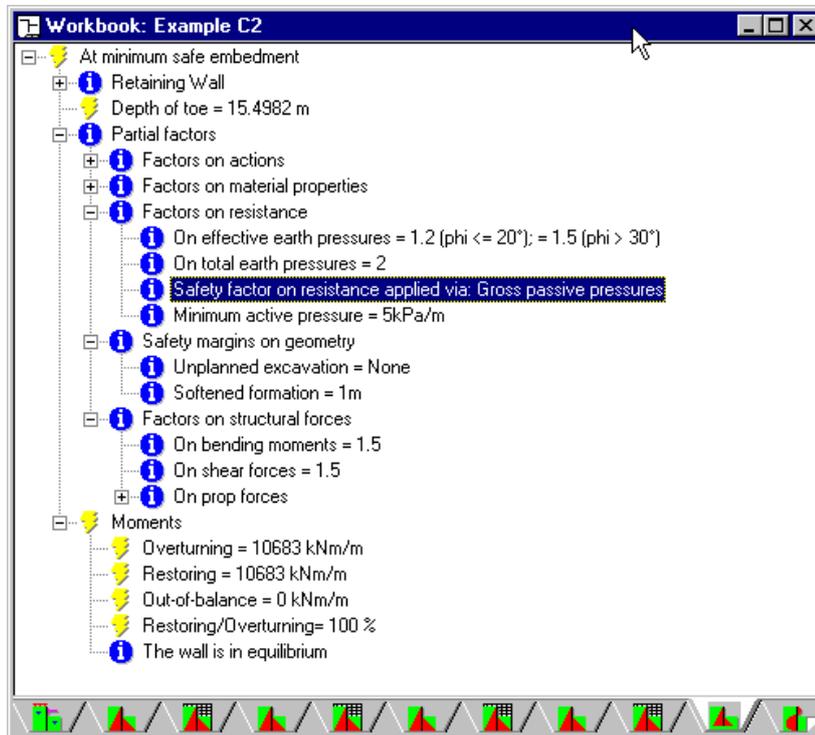
To calculate the required embedment of the wall:

- Choose the **Required Embedment** command on the Workbook's **Calculate**

menu

- (Or) Click on the Calculate Required Embedment button on the Workbook's Toolbar

ReWaRD calculates the embedment of the wall with the appropriate safety factors taken from CIRIA 104 and displays the results in a tree view:



The minimum safe embedment for this wall is 15.5m, based on a safety factor of 1.35 applied to the effective earth resistance (the 1.35 is obtained by interpolation between a value of 1.2 for  $\phi = 20^\circ$  and 1.5 for  $\phi = 30^\circ$  – the stiff clay in this example has  $\phi = 25^\circ$ ).

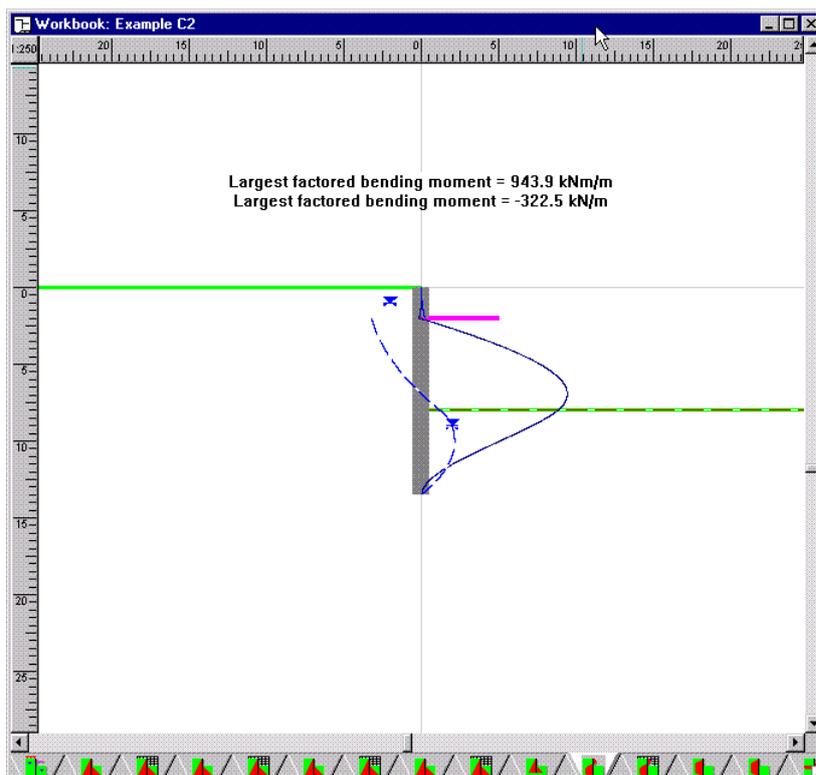
CIRIA 104, on page 136, gives a depth of embedment of approximately 7.5m for  $F_p = 1.35$ , making the toe depth 15.5m (as given by ReWaRD).

## Calculating structural forces

To calculate structural forces in the wall:

- Choose the **Structural Forces** command on the Workbook's **Calculate** menu
- (Or) Click on the Calculate Structural Forces button on the Workbook's Toolbar

ReWaRD calculates the embedment of the wall at failure (i.e. in equilibrium with *no* safety factors applied) and uses the earth pressures for this embedment to calculate the structural forces in the wall. (See the *ReWaRD Reference Manual* for further information.)



The maximum bending moment in this case is 944 kNm/m and the maximum shear force is 323 kN/m. These are design values – i.e. they already include the appropriate safety factors (which in the case of CIRIA 104 are 1.5).

If you switch to spreadsheet or table view, by choosing **Table** from the Workbook's **View** menu, you obtain the design prop force at 2m depth as 577 kN/m.

CIRIA 104, on page 137, gives the maximum *unfactored* bending moment as 627 kNm/m (corresponding to a design value of 940 kNm/m); the maximum unfactored shear force as 216 kN/m (corresponding to a design value of 324 kN/m); and the prop force as 232 kN/m (corresponding to a design value of 580 kN/m with a safety factor of 2.5). Thus CIRIA 104 and ReWaRD are in good agreement on these values (the slight differences are due to rounding errors in CIRIA 104's calculations).

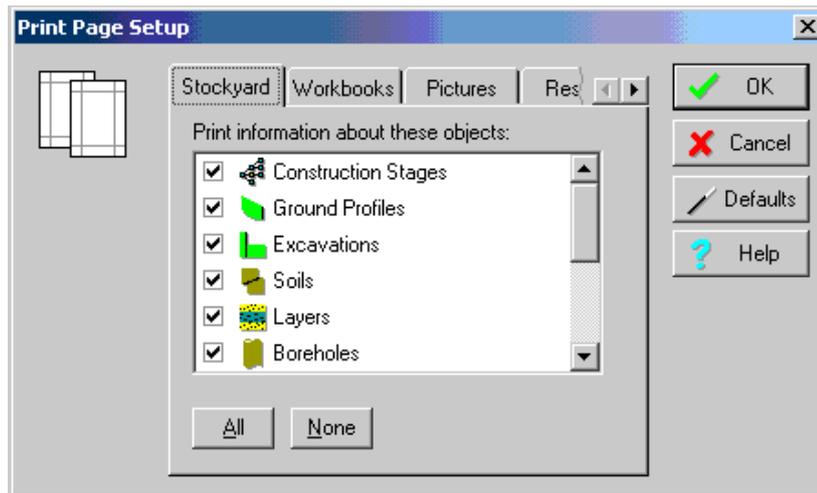
## Printing your results

At this point, you will want to obtain a hard copy of your result. ReWaRD allows you to select exactly what you want to appear on your printed output:

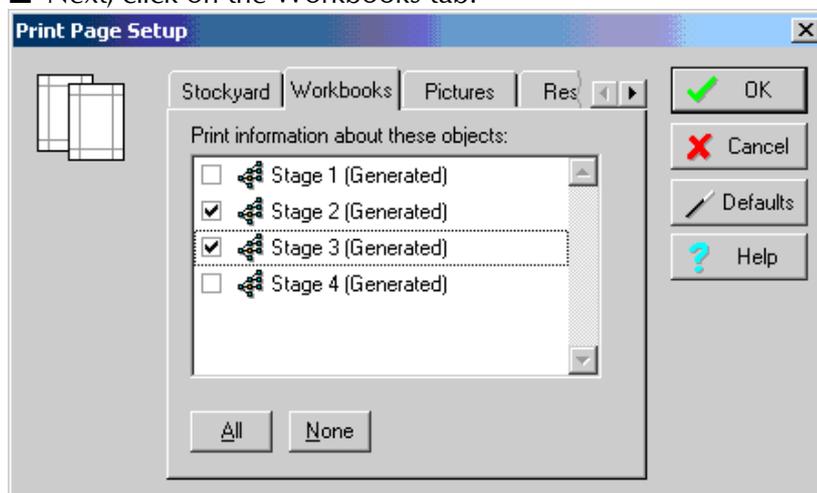
- You select which objects in the Stockyard should be printed (by default, all objects are selected)
- You select which Workbooks should be printed (by default, *no* Workbooks are selected)
- You select which results should be printed (by default all results for each selected Workbook are printed)

To override the default settings:

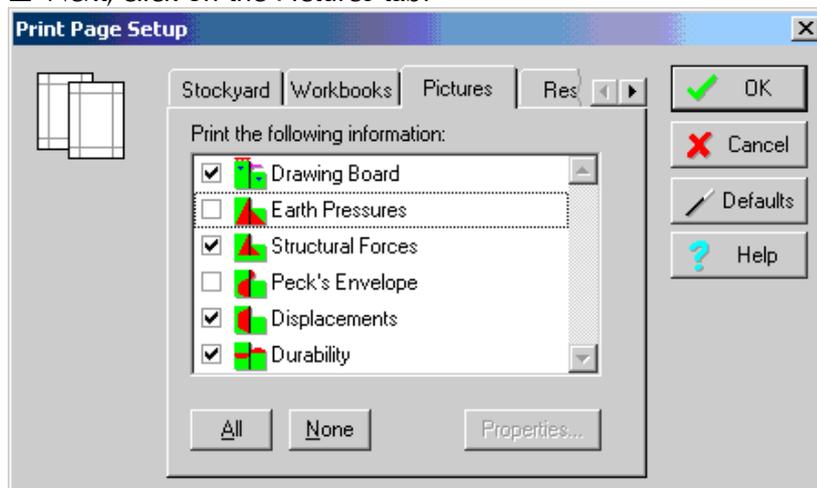
- Choose the **Page Setup** command from ReWaRD's **File** menu or the Page Setup button on ReWaRD's Toolbar. The following box appears:



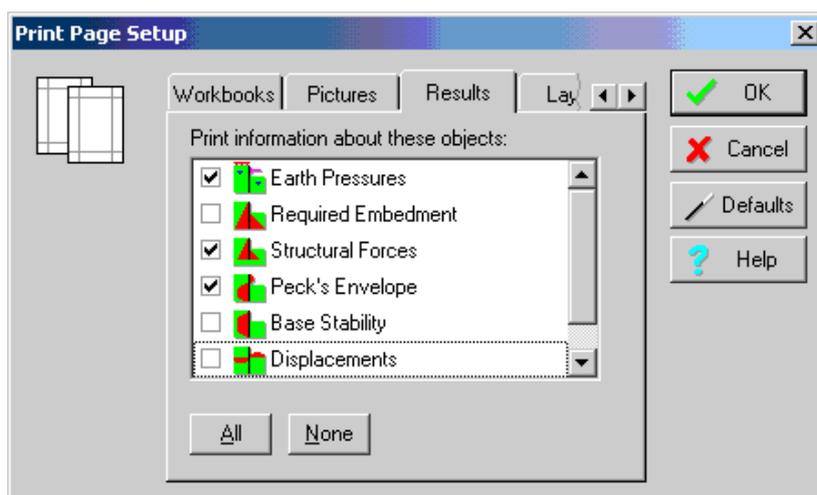
- Tick the engineering objects whose properties you want to print
- Un-tick those object you don't want to print
- Next, click on the Workbooks tab:



- Tick the stages for which you want to print results
- Un-tick those for which you don't want results
- Next, click on the Pictures tab:



- Tick the pictures you want to print
- Un-tick those you don't want to print
- Next, click on the Results tab:



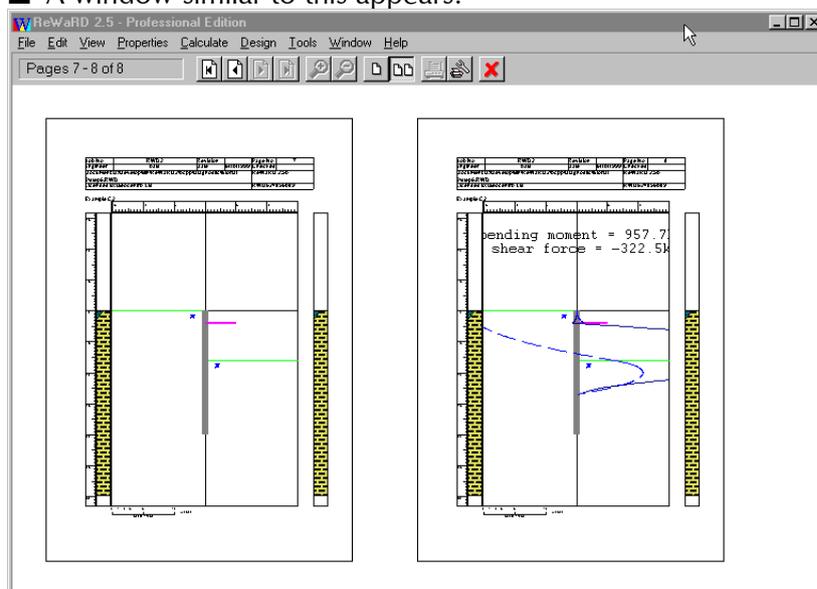
- Tick the results you want to print
- Un-tick those you don't want to print
- Finally, click the **OK** button to save your settings

To print the data:

- Choose the **Print...** command from ReWaRD's **File** menu or the Print button on ReWaRD's Toolbar
- Select whatever print options you require and click the **OK** button to begin printing

To can obtain a preview of the printed output:

- Choose the **Print Preview...** command from ReWaRD's **File** menu or the Print button on ReWaRD's Toolbar
- A window similar to this appears:



## What next?

Chapter 6 takes you through the design of a more complicated structure – a multi-propped cofferdam in mixed soils – using the techniques introduced in Tutorials 1 and 2.



## Chapter 6

### Tutorial 3 – cofferdam in mixed soils

This tutorial helps you to get to grips with ReWaRD's more advanced features, by building a multi-propped cofferdam in a mixed soil profile. The tutorial shows you how to:

- Change the engineering objects generated by ReWaRD's Construction Wizard
- Add new engineering objects as needed
- Choose between the available design standards
- Check the results of your calculations
- Customize the printed output

#### Worked example

The worked example is taken from CIRIA's Special Publication 95, *The design and construction of sheet-piled cofferdams*, by Williams and Waite (1993). Appendix B of that document describes the design of a sheet pile cofferdam used to support a sub-surface tank in a mixed soil profile.

The ground conditions at the site comprise:<sup>3</sup>

- 4m of sand and gravel ( $\gamma = 18$  and  $\gamma_s = 20.3\text{kN/m}^3$ ;  $\phi = 35^\circ$ ;  $c' = 0$ )
- 2.5m of firm clay ( $\gamma_s = 21\text{kN/m}^3$ ;  $C_u = 60\text{kPa}$ )
- 3m of silty sand ( $\gamma_s = 20.3\text{kN/m}^3$ ;  $\phi = 30^\circ$ ;  $c' = 0$ )
- 2m of soft/firm clay ( $\gamma_s = 20\text{kN/m}^3$ ;  $C_u = 40\text{kPa}$ )
- Medium coarse sand ( $\gamma_s = 20.3\text{kN/m}^3$ ;  $\phi = 35^\circ$ ;  $c' = 0$ )

The cofferdam will be open for less than 3 months and open to full excavation depth for no more than two weeks (hence a total stress analysis is appropriate).

Ground water level is 2.5m below ground surface. Water pressures in the medium coarse sand are sub-artesian, with a pressure head of 80kPa at the surface of the sand. A pumping system will be installed to lower the water pressures in the medium coarse sand by 80kPa throughout the depth of interest.

The permanent works are to be constructed on top of a base slab at a depth of 8m. A 0.5m thick drainage layer is to be placed beneath the base slab, so that the final formation is at a depth of 8.5m. The sheet piles will have an upstand of 1m.

The first frame will be installed at 0.5m above ground level and the excavation taken down to 5m before installing the second frame.

The second frame will be installed at a depth of 4m and the excavation taken down to 7.5m before installing the third frame.

The third frame will be installed at a depth of 6.5m.

The plan dimensions of the cofferdam are 17m by 12m.

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<sup>3</sup> $\gamma$  and  $\gamma_s$  = unsaturated and saturated unit weights, respectively;  $\phi$  = angle of friction;  $c'$  = effective cohesion; and  $C_u$  = undrained strength

## Using the Construction Wizard to create a new project

If ReWaRD is not already running, double-click on the ReWaRD icon to load the program into your computer's memory. Once the "splash screen" has disappeared, ReWaRD displays its Start-up Wizard. Select the option **Run the Construction Wizard** and click the **Go** button. ReWaRD's Construction Wizard appears on your screen.

The Construction Wizard asks you a number of questions about the retaining wall project you want to create and then generates a project according to your answers.

### Step 1 – specify the finished geometry

Click on the **Multi-propped** option. The number of props changes to 3 and the picture of the wall changes to a multi-propped wall.

Change the retained height to 8.5m and click **Next** to continue.

### Step 2 – enter the depths of the props

You want to place the first prop at 0.5m *above* ground level, but (as you will find if you attempt to do it) the Construction Wizard does not allow you to enter negative depths. Therefore, we will have to leave Prop 1 at ground level and change its depth later.

Select Prop 2 and change its depth to 4m, by entering 4 in the **Depth** box and clicking the **Apply** button. Then select Prop 3 and change its depth to 6.5m. Click **Next** to continue.

### Step 3 – enter the properties of the predominant soil type

In this example, the sand and gravel and the medium coarse sand have identical properties and hence it is appropriate to choose them as the "predominant soil type". You will add the other soils later.

Select Sand from the **Soil Type** box and enter a wet density of 2069kg/m<sup>3</sup> (which is equivalent to 20.3kN/m<sup>3</sup>), a dry density of 1766kg/m<sup>3</sup> (18kN/m<sup>3</sup>), and an angle of friction of 35°. (Although not shown, the Construction Wizard automatically sets the soil's effective cohesion to zero.) Click **Next** to continue.

### Step 4 – choose the type of retaining wall

If it is not already selected, select Sheet Pile from the **Wall Type** box; select Larssen from the **Range** box; and 16W from the **Section** box. Click **Next** to continue.

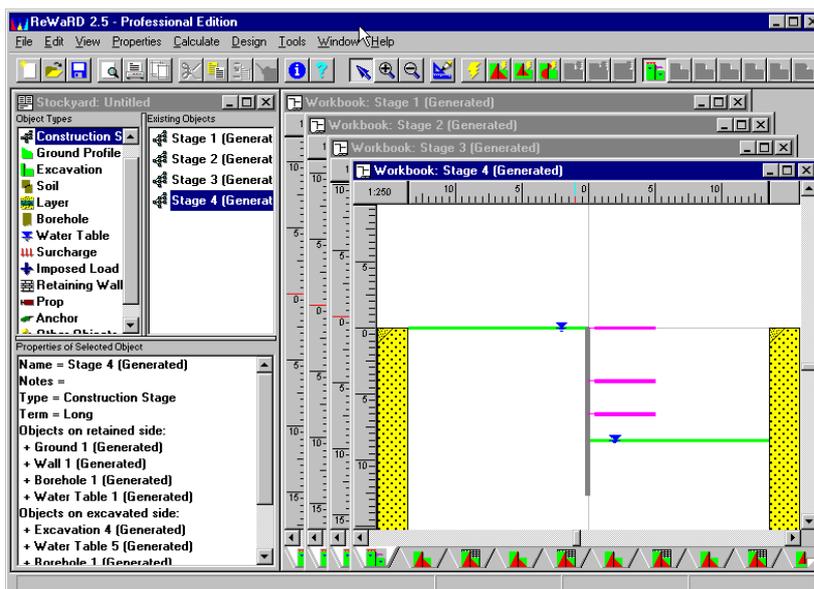
### Step 5 – where do you want water tables?

If it is not already selected, select the **Both Sides** option and click **Next** to continue.

### Step 6 – go!

When you are ready, click on **Go** to generate the project. The Construction Wizard creates a new document, fills its Stockyard with the objects needed to create your project, and then generates four construction stages and displays their associated Workbooks on the right hand side of the Stockyard.

At this point, your screen should look something like this:



Before proceeding further, save your work as TUTORIAL3 .

Provided you installed ReWARD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 3, under the name STEP1 .RWD.

## Modifying the project

ReWARD's Construction Wizard has automated a lot of the work you would normally have to do to create a multi-propped retaining wall project, but it has still left you with some things you need to change – and some you need to add – in order to model the worked example given in CIRIA SP95:

- The excavation depths must be checked (and, if necessary, changed)
- Other soil layers must be added
- The retaining wall must be given an upstand and the top prop moved up 0.5m
- Water tables must be moved and extra water tables added
- A surcharge must be added

## Changing the depths of the excavations

When it generated the project you are working on, ReWARD's Construction Wizard created three excavations at depths 0.5m below the level of each prop and a fourth at final formation level. You want to change some of these depths to match those given in CIRIA SP95.

To display a list of the excavations that the Construction Wizard has created for you, click on *Excavation* in the Stockyard's Object Types pane. ReWARD displays a list of the excavations in the Stockyard's Existing Objects pane.

Select Excavation 2 from the Existing Objects pane, right-click your mouse to display this object's context menu, and choose the command **Properties of Excavation 2 (Generated)...** ReWARD displays the property sheet for Excavation 2.

- On the Dimensions page, change the excavation's depth to 5.0m
- On the Plan Dimensions page, click on the **Has Plan Dimensions** box and

- enter a length of 17m and breadth of 12m
- Click **OK** to confirm the excavation's properties

Now select Excavation 3 from the Existing Objects pane and repeat the instructions given above, but change this excavation's depth to 7.5m.

Finally, select Excavation 4 from the Existing Objects pane and repeat the instructions given above (in this case there is no need to change the excavation's depth, since it is already 8.5m).

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 3, under the name STEP2.RWD.

## Adding the missing soils

To model the ground conditions at the site, we must first create a number of soils.

To display the soil that the Construction Wizard has already created for you, click on *Soil* in the Stockyard's Object Types pane. *Double-click* on the soil to display its property sheet, then:

- On the General page, change the soil's name to "Sand and gravel"
- On the Classification page, leave the soil's classification as Unclassified/Unspecified
- On the Density/Weight page, click on the **Unit Weight** button (if not already selected) and then change the soil's saturated weight to  $20.3 \text{ kN/m}^3$  and its unsaturated weight to  $18 \text{ kN/m}^3$ . Answer **Yes** to any warning messages asking you to confirm the values entered
- On the Effective Stress page, leave this soil's angle of friction as  $35^\circ$  and its effective cohesion as zero
- On the Notes page, enter any notes about this soil that you want to keep for future reference
- Finally, click **OK** to confirm the soil's properties

To create a new soil:

- *Right-click* on *Soil* in the Objects Types pane
- Choose **New ► Clay** on the pop-up menu that appears
- ReWaRD displays a property sheet for the newly created soil
- On the General page, change the soil's name to "Firm clay"
- On the Classification page, change its **State** to Firm
- On the Density/Weight page, change both weights to  $21 \text{ kN/m}^3$ . Answer **Yes** to any warning messages asking you to confirm the values entered
- On the Total Stress page, change the **Undrained Strength** to 60 kPa
- Finally, click **OK** to confirm the soil's properties

Now create two other soils with the following properties:

- Sand: name = "Silty sand"; class = Silty; saturated and unsaturated unit weights =  $20.3 \text{ kN/m}^3$ ; angle of shearing resistance =  $30^\circ$
- Clay: name = "Soft/firm clay"; state = Soft; both weights =  $20 \text{ kN/m}^3$ ; angle of shearing resistance =  $30^\circ$ ; undrained strength = 40 kPa

Finally, since the medium coarse sand has the same properties as the sand and gravel, create this soil by duplicating the latter:

- Select the sand and gravel in the Stockyard's Existing Objects pane
- Choose the **Duplicate** command from the **Edit** menu
- Double-click on the duplicate (which ReWaRD has named "Soil 1") to display its property sheet
- Change the soil's name to "Medium coarse sand"
- Click **OK** to confirm the soil's properties

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 3, under the name STEP3.RWD.

### Adding the missing layers

Now that all the necessary soils have been created, you can use these to define the layers at the site.

To display the layer that the Construction Wizard has created for you, click on *Layer* in the Stockyard's Object Types pane. *Double-click* on the layer to display its property sheet, then:

- On the General page, change the layer's name to "Layer 1"
- On the Properties page, change the layer's thickness to 4m and select "Sand and gravel" as the soil
- Click **OK** to confirm the layer's properties The soil columns on the Drawing Board of each Workbook change to reflect the new layer thickness

To create a new layer:

- *Right-click* on *Layer* in the Stockyard's Objects Types pane
- Choose **New ► Undrained** on the pop-up menu that appears
- ReWaRD displays a property sheet for the newly created layer
- On the Properties page, change the layer's thickness to 2.5m and select "Firm clay" as the soil (note how ReWaRD only displays those soils that can be treated as undrained)
- Click **OK** to confirm the layer's properties

Now create three other layers with the following properties:

- Drained: thickness = 3m; soil = "Silty sand"
- Undrained: thickness = 2m; soil = "Soft/firm clay"
- Drained: thickness = 5m; soil = "Medium coarse sand"

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 3, under the name STEP4.RWD.

### Amending the borehole

The Workbook's Drawing Board displays two soil columns, one on each side of the wall. ReWaRD's Construction Wizard has placed Borehole 1 (which currently contains Layer 1) in both of these soil columns. By adding Layers 2 to 5 to Borehole 1, you will get the same soil columns on both sides of the wall, not only in Stage 4, but in all the stages where Borehole 1 is used.

To demonstrate this, select Layers 2 to 5 in turn and drag them onto the Workbook's Drawing Board for Stage 4. (To drag a layer, click on its name in the

Stockyard's Existing Objects pane, hold the mouse button down and then move the mouse pointer across to the Workbook. The cursor will change shape from

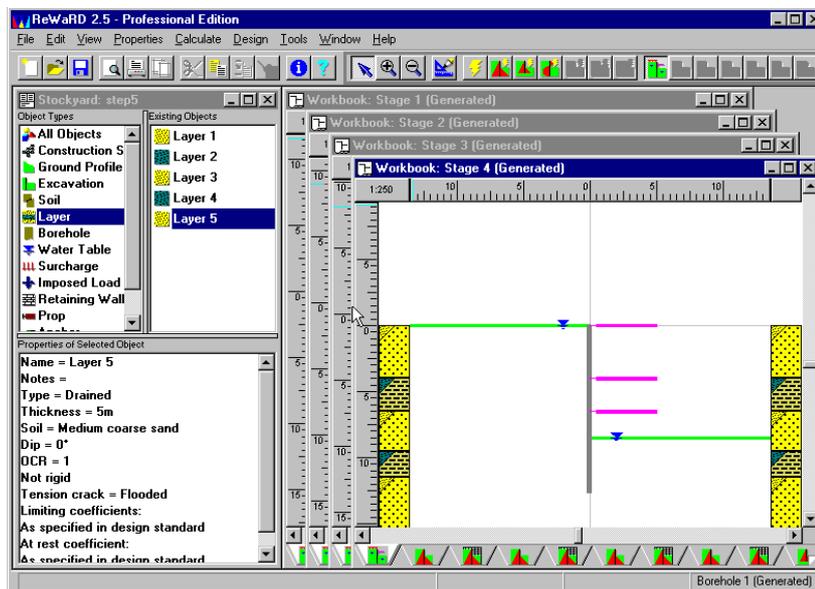


to as you do this.) When you let go of the mouse button, the layer

being dropped is added at the bottom of the borehole (so it is important that you do this in the right order!).

Be careful not to drop the layer onto or above either of the soil columns, since that will *insert* the layer into the appropriate borehole rather than append the layer at the bottom of the borehole. If you drop the layers on the middle of the Drawing Board, they automatically appear at the bottom of the borehole.

If you make a mistake, you can drag a layer out of the borehole and return it to the Stockyard in the same way.



When you have finished this, bring the Workbook for Stage 2 to the front of the screen by clicking on it or by choosing **Workbook: Stage 2 (Generated)** from ReWaRD's **Window** menu. Note that the soil columns for Stage 2 have been updated to correspond with those for Stage 4.

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 3, under the name STEP5.RWD.

### Extending the wall and moving the top prop

The next task is to provide the retaining wall with an upstand so that the top prop can be placed at 0.5m above ground level.

To display the wall that the Construction Wizard has created for you, click on *Retaining Wall* in the Stockyard's Object Types pane. *Double-click* on the wall to display its property sheet, then:

- On the Dimensions page, change the wall's height to 13.5m (this is the height assumed in CIRIA SP95) and its upstand to 0.5m (so its total height is 14m)
- Click **OK** to confirm the wall's properties. The Drawing Boards change to reflect the new wall dimensions

To display the props that the Construction Wizard has created for you, click on *Prop* in the Stockyard's Object Types pane. *Double-click* on Prop 1 to display its property sheet, then:

- On the Dimensions page, change the props's depth to -0.5m
- Click **OK** to confirm the prop's properties. The Drawing Boards change to reflect the new prop position

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 3, under the name STEP6.RWD.

## Changing and adding water tables

The next task is to model groundwater conditions at the site.

To display the water tables that the Construction Wizard has created for you, click on *Water Table* in the Stockyard's Object Types pane.

*Double-click* on "Water Table 1" to display its property sheet, then:

- On the Properties page, change the depth to 2.5m
- Click **OK** to confirm the water table's properties

*Double-click* on "Water Table 3" to display its property sheet, then:

- On the Properties page, change the depth to 5.0m (to bring it back into line with the changed excavation depth)
- Click **OK** to confirm the water table's properties

To create a new water table:

- *Right-click* on *Water table* in the Stockyard's Objects Types pane
- Choose **New ► Hydrostatic** on the pop-up menu that appears
- ReWaRD displays a property sheet for the newly created water table
- On the General page, change the water table's name to "Sub-artesian water table"
- On the Properties page, change the depth to 11.5m
- On the Connectivity page, un-check the option **Connected to Overlying Water Tables** and set the **Ambient Pressure** to 80kPa
- Click **OK** to confirm the water table's properties

Check that the Workbook for Stage 2 is still at the front of all the other Workbooks. Then select the sub-artesian water table in the Stockyard's Objects Pane and drag it onto the Stage 2's Drawing Board. (The cursor will change shape

from  to  as you do this.) When you let go of the mouse button, the water table appears on whichever side of the wall you let go of the mouse button. Repeat the exercise again, but drop the water table on the *other* side of the wall.

Now duplicate the sub-artesian water table, by selecting it from the Stockyard's Objects Pane and choosing the **Duplicate** command from the **Edit** menu. Then double-click on the duplicate (which ReWaRD has named "Water Table 1") to

display its property sheet:

- On the General page, change the water table's name to "Pumped water table" (this water table will be used to replace the sub-artesian water table from Stage 3 onwards)
- On the Connectivity page, set the **Ambient Pressure** to 0kPa
- Click **OK** to confirm the water table's properties

Bring the Workbook for Stage 3 to the front of the other Workbooks (by recourse to the **Windows** menu, if necessary) and drag the pumped water table onto both sides of the wall. Change the depth of Water Table 4 to 7.5m. Repeat for Stage 4.

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 3, under the name STEP7.RWD.

## Adding a surcharge

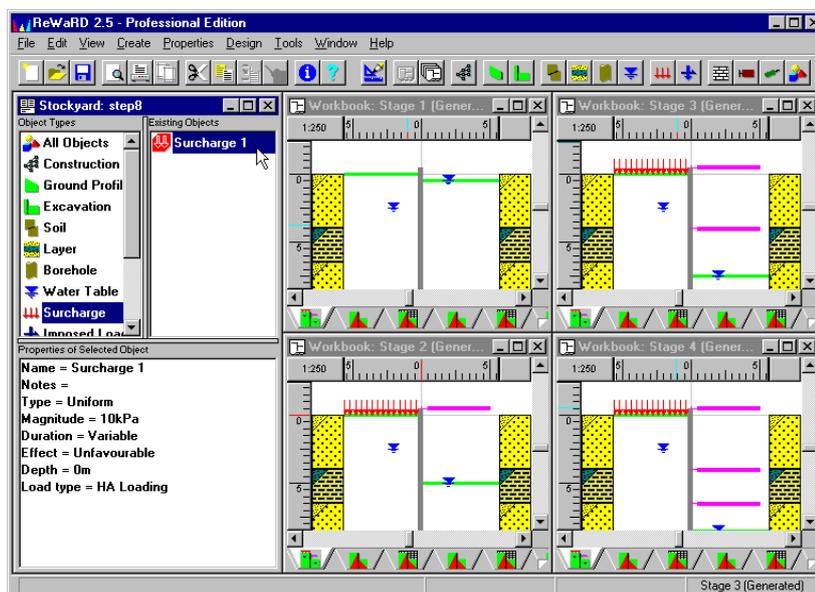
The final task is to add a surcharge at the top of the wall.

To create a new surcharge:

- *Right-click* on *Surcharge* in the Stockyard's Objects Types pane
- Choose **New ► Uniform** on the pop-up menu that appears
- ReWaRD displays a property sheet for the newly created surcharge
- (If necessary) On the Loading page, change the surcharge type to "HA Loading"
- Click **OK** to confirm the surcharge's properties

Now add the new surcharge to Stages 2-4 by choosing **Tile** from ReWaRD's **Windows** menu and then dragging the surcharge from the Stockyard's Existing Objects Pane and dropping it on the Drawing Board for each stage in turn. (The

cursor will change shape from  to  as you do this.) Be sure to drop the surcharge on the *retained* side of the wall.



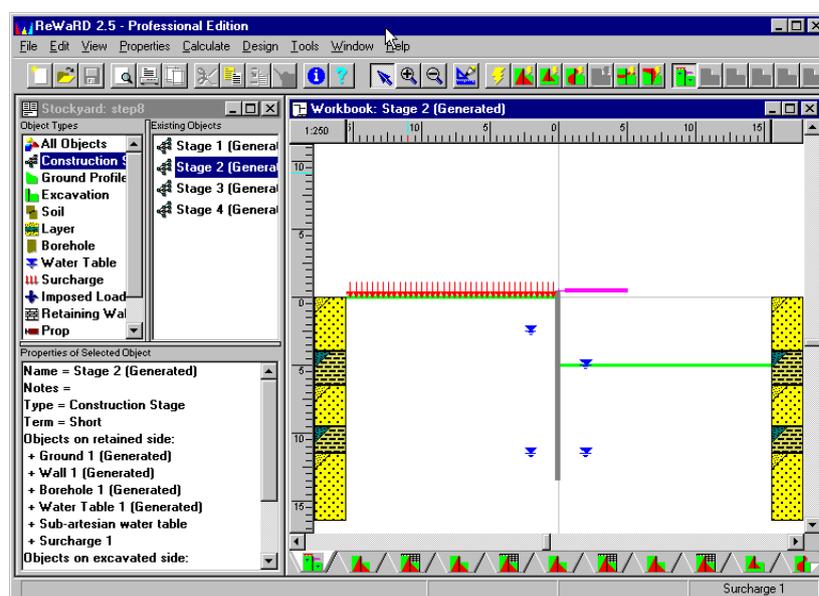
Provided you installed ReWaRD in its default folder, you will find a copy of this

worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 3, under the name STEP8.RWD.

## Designing the cofferdam: Stage 2

At this point, you are ready to start the design of the cofferdam. You may find it easier to close all the open workbooks and then re-open that for Stage 2 only. (This will leave your screen less cluttered.) To do this:

- Choose the **Close All ► Workbooks** command from ReWaRD's **Window** menu
- Choose **Construction Stage** from the Stockyard's **View** menu
- *Right-click* on Stage 2 in the Stockyard's Objects Pane and choose **Open Workbook**



## Selecting the design standard

In this Tutorial, you will work to the recommendations given in CIRIA Report 104, using the Gross Pressure Method. To select this standard, choose the **CIRIA 104 ► Gross Pressure Method** command from the **Design** menu.

You can review the settings for the selected standard by choosing the **Properties...** command from ReWaRD's **Design** menu. Click on each of the tabs in turn to see what rules the program follows when performing its calculations. When you reach the CIRIA 104 page, select the **Moderately Conservative** design approach and **Temporary Works** condition. When you have finished, click **OK** to close the dialogue box.

Provided you installed ReWaRD in its default folder, you will find a copy of this worked example in its current state in the folder PROGRAM FILES\GEOCENTRIX\REWARD\2.5\PROJECTS\TUTORIAL 3, under the name STEP9.RWD.

## Calculating earth pressures

The term "Earth pressures", used in its generic sense, includes:

- Pressures in the ground (vertical and horizontal effective stresses and pore water pressures)
- Pressures due to surcharges (vertical and horizontal)

- Other pressures acting on the retaining wall (such as the pressure from a water-filled tension crack)

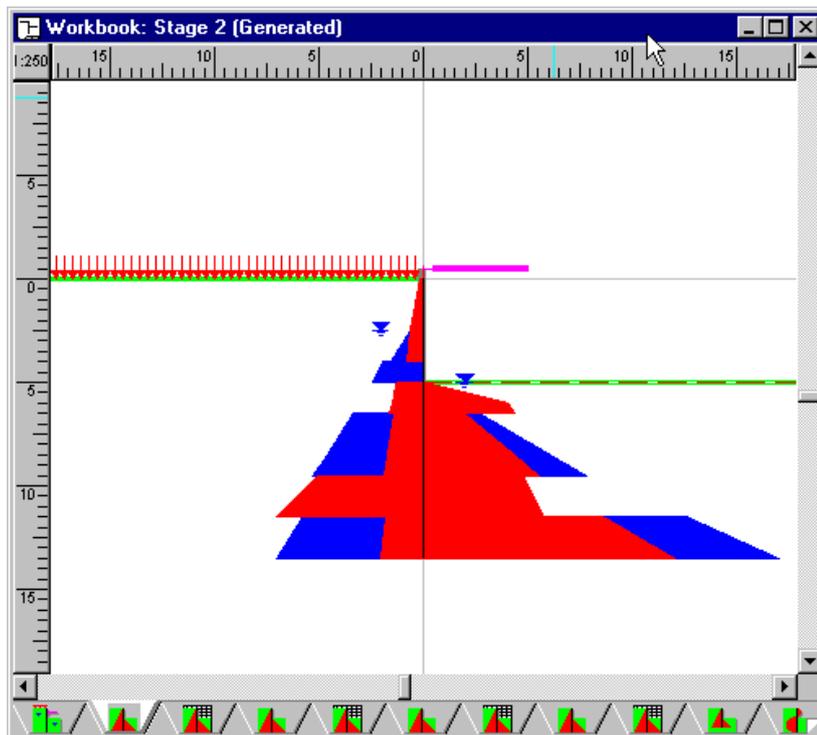
ReWaRD calculates each of these “earth pressures” according to well-established soil mechanics theory and automatically applies any safety factors required by the selected design standard. Full details of these calculations are given in the *ReWaRD Reference Manual*.

To perform the calculations, select the **Earth Pressures** pop-out menu from the Workbook’s **Calculate** menu (if necessary, click on the Workbook first to activate it). ReWaRD lists the various earth pressure conditions that it can calculate:

- As built
- At minimum safe embedment
- With enhanced safety factors
- At failure

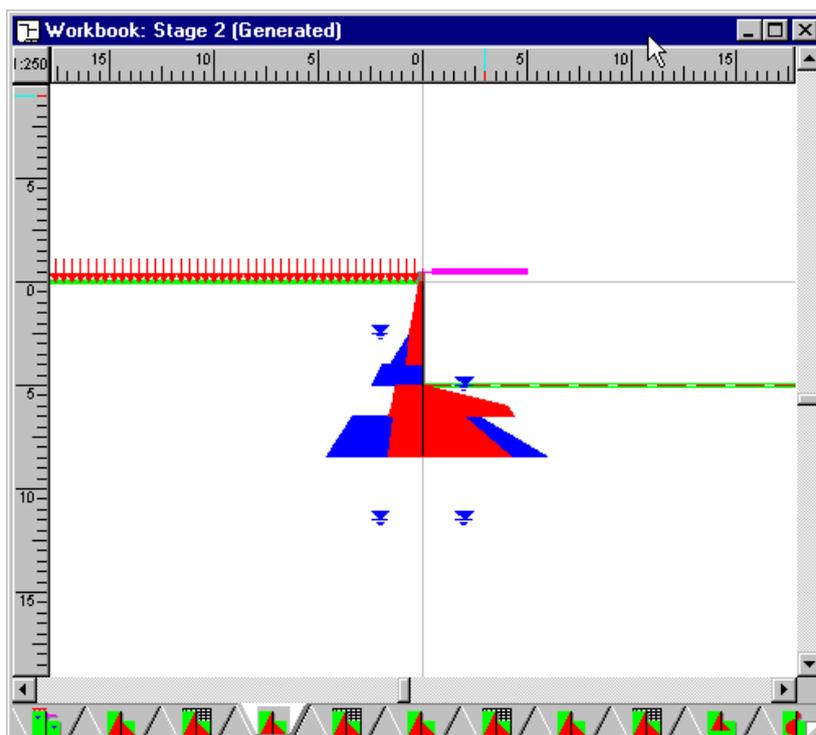
Choose the **All** command to calculate all four “flavours” of earth pressure.

ReWaRD displays the as built earth (red) and water (blue) pressures acting on both sides of the wall, superimposed on a picture of the construction stage.



Note how the earth and water pressures change with the various layers in the ground. Note also how the passive earth pressures drop to zero at formation level on the excavated side, owing to CIRIA 104's required for a 1m softened zone.

You can view the earth pressures calculated for the other conditions by choosing the appropriate command from the Workbook’s **View ► Earth Pressures** menu. The following diagram show the earth pressures obtained at the minimum safe embedment.



ReWaRD also provides the results of the earth pressure calculations in a table or spreadsheet. To view the results in this format, choose the **Table** command from the Workbook's **View** menu. ReWaRD displays the design pressures, as shown below.

	A	B	C	D	E	F	G
1	Depth	EarthPr	WaterPr	TotalPr	EarthPr	WaterPr	TotalPr
2	m	kPa	kPa	kPa	kPa	kPa	kPa
3		Ret	Ret	Ret	Exc	Exc	Exc
4	-0.50	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	2.26	0.00	2.26	0.00	0.00	0.00
7	2.45	12.28	0.00	12.28	0.00	0.00	0.00
8	2.45	12.28	0.00	12.28	0.00	0.00	0.00
9	2.50	12.50	0.00	12.50	0.00	0.00	0.00
10	2.50	12.50	0.00	12.50	0.00	0.00	0.00
11	2.51	12.52	0.07	12.58	0.00	0.00	0.00
12	2.51	12.52	0.07	12.58	0.00	0.00	0.00
13	4.00	16.01	14.71	30.72	0.00	0.00	0.00
14	4.00	0.00	39.23	39.23	0.00	0.00	0.00
15	5.00	0.00	49.03	49.03	0.00	0.00	0.00
16	5.00	25.00	0.00	25.00	0.00	0.00	0.00
17	5.16	25.79	0.00	25.79	12.89	0.00	12.89
18	5.16	25.79	0.00	25.79	12.89	0.00	12.89
19	6.00	30.00	0.00	30.00	81.91	0.00	81.91
20	6.00	30.00	0.00	30.00	81.91	0.00	81.91
21	6.50	32.50	0.00	32.50	87.16	0.00	87.16
22	6.50	27.82	39.23	67.05	38.84	14.71	53.55

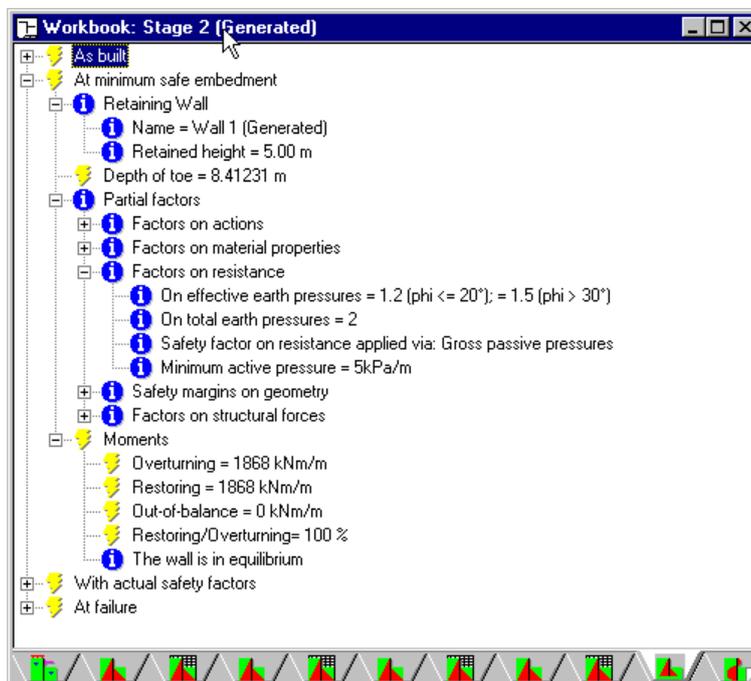
By default, ReWaRD displays the design pressures on the wall (see the *ReWaRD Reference Manual* for further information.) You can change what ReWaRD displays in the table by choosing one of the commands on the bottom half of the **View** ► **Earth Pressures** fly-out menu:

- All

- Coefficients
- Soils Stresses
- Surcharge Pressures
- Design Pressures
- Custom...

## Calculating required embedment

To determine whether the ground offers sufficient passive resistance to prevent the retaining wall from overturning, choose the **Required Embedment** command from the Workbook's **Calculate** menu. ReWaRD displays detailed information pertaining to the wall's stability, in a hierarchical tree view. If you expand various nodes (by clicking on the + signs) you get additional information about the wall's embedment, the safety factors used in the calculations, the calculated overturning and restoring moments, etc. The key piece of information in this view is the depth of the wall toe at the minimum safe embedment, which in this case is 8.4m (as shown below).



See the *ReWaRD Reference Manual* for an explanation of what the terms *as built*, *at minimum safe embedment*, *with maximum safety factors*, and *at failure* mean.

## Calculating structural forces

Structural forces include bending moments and shear forces acting in the retaining wall and forces in any props or anchors used to support it. Structural forces can only be calculated if the wall is in a condition of stable equilibrium. ReWaRD automatically adjusts the earth pressures acting on the wall in order to achieve equilibrium before calculating the structural forces. Full details of these calculations are given in the *ReWaRD Reference Manual*.

To calculate structural forces, choose the **Structural Forces** command from the Workbook's **Calculate** menu. ReWaRD displays the structural forces diagram, which shows the bending moments and shear forces acting on the wall. The maximum bending moment and shear force are also given.



ReWaRD also provides the results of the structural forces calculations in a table or spreadsheet. To view the results in this format, choose the **Table** command from the Workbook's **View** menu.

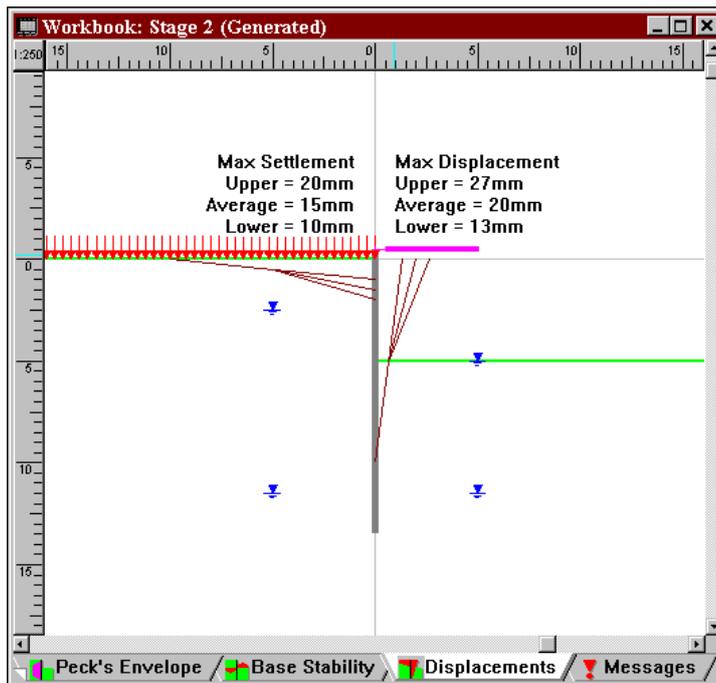
### Calculating displacements

ReWaRD calculates displacements using a database of measured movements of existing walls, which has been incorporated into the program. Full details of these calculations are given in the *ReWaRD Reference Manual*.

To calculate displacements, choose the **Displacements** command from the Workbook's **Calculate** menu. ReWaRD displays a box informing you that it generated 2 error/warning messages during the calculations. If you inspect the Messages View and look under the node labelled "Calculating displacements", you will see that ReWaRD cannot decide which profile to use to calculate displacements. This is because the stratified nature of the ground conditions makes it difficult for ReWaRD to select a predominant soil type (i.e. sand, stiff clay, or soft clay).

To proceed, you need to tell ReWaRD which soil you consider predominates. To do so, choose **Options...** from ReWaRD's **Design** menu and select the Displacements page. Un-tick the **Auto-Select** box, select **Sand**, and click the **OK** button.

This time, when you choose **Displacements** from the Workbook's **Calculate** menu, ReWaRD displays the following diagram. This is a graphical view of the settlement and horizontal movement envelopes predicted by the database. A summary of the maximum settlement and horizontal movement (both average and upper and lower bounds to the data) are also given.

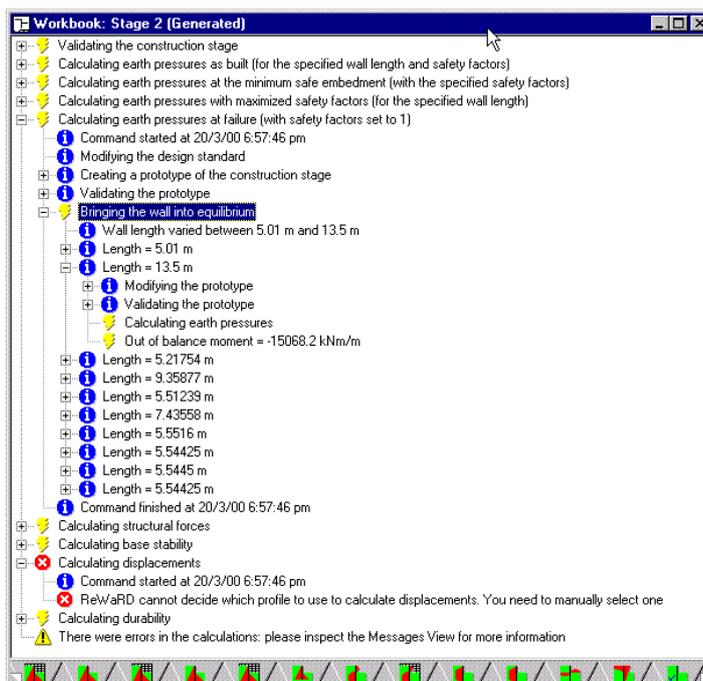


## Reviewing messages

ReWaRD provides an “audit trail” of the actions you take in each Workbook, including:

- A record of any objects added to or removed from the construction stage
- A record of the start and finish of any calculations you perform
- Any warning or error messages generated by the calculations

To review these messages, choose the **Messages** command from the Workbook’s **View** menu.



## Designing the cofferdam: other stages

Designing the cofferdam involves repeating the calculations you have performed for Stage 2 for the other stages in the construction sequence. ReWaRD

automatically adjusts its calculations to take account of the number of props or anchors that are used to support the retaining wall and any changes in ground conditions that you specify.

## What next?

Chapters 7 and 8 give more detailed information about ReWaRD's Stockyard and Workbooks. Here you will learn how to increase your efficiency in using ReWaRD's Integrated Design Environment.

When you have completed your design, you will want to obtain a printout of your results. Chapter 9 gives instructions for customizing ReWaRD's printing capabilities.

Once you become familiar with ReWaRD's capabilities, you will doubtless want to customize its many options. Chapter 10 explains how to do this.

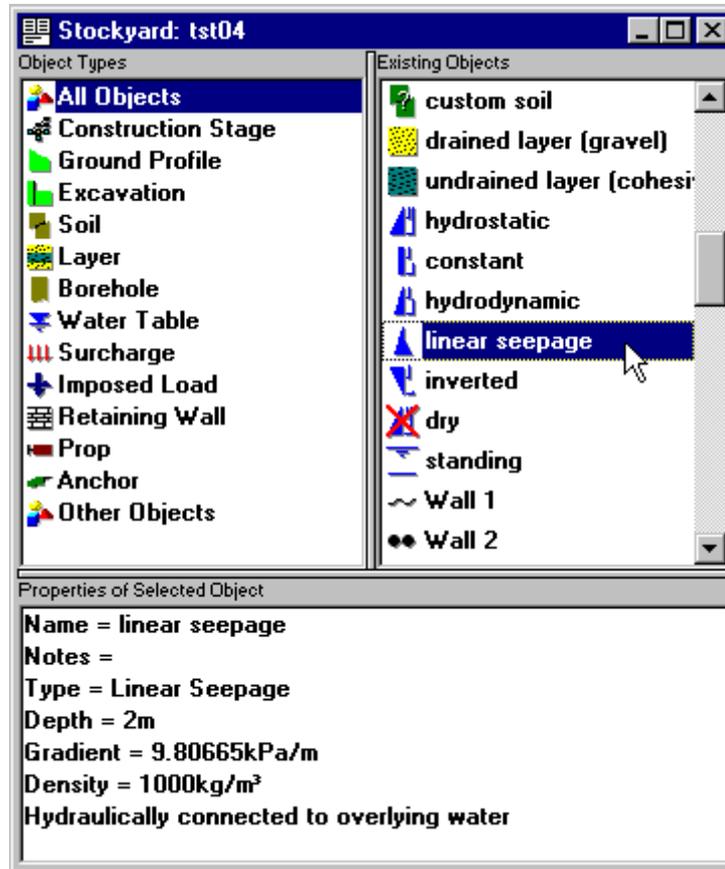
Chapter 11 has some useful information for those users who have upgraded to the current program from a previous version of ReWaRD.



## Chapter 7

# The Stockyard

ReWaRD's Stockyard allows you to create, edit, copy, paste, and duplicate engineering objects with the greatest of ease.



The Stockyard is divided into three separate *panes*, showing the *Object Types* (top left), *Existing Objects* (top right), and *Properties of Selected Object* (bottom). You can re-size each pane by dragging the divider bars left and right or up and down when the cursor changes to one of these symbols:



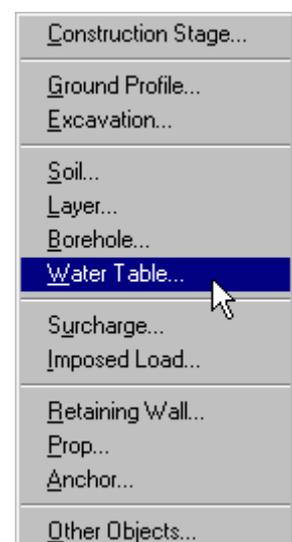
## Object types

The *Object Types* pane lists all the engineering objects you can create, ranging from ground profiles and excavations through to surcharges and imposed loads. The Object Types pane provides over 50 different engineering objects for you to use, each one uniquely identified by an easy-to-follow full colour symbol.



When you click on one of the items listed in the Object Types pane, the Existing Objects pane (see below) changes to show all the existing objects of that type.

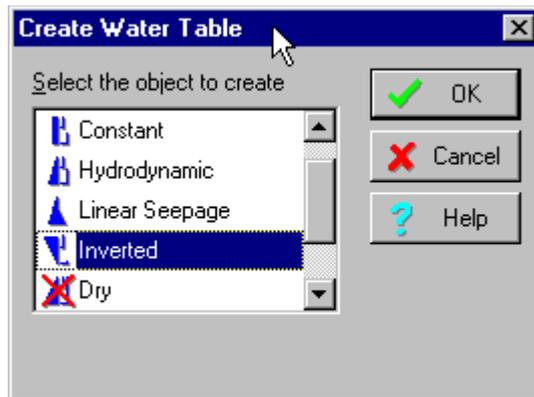
## To create a new object



To create a new object:

- Choose one of the commands on the Stockyard's **Create** menu (see the picture alongside)
- (Or) *Right*-click on an item in the Object Types pane and choose the **New ▶ Object...** command
- (Or) *Double*-click on an item in the Object Types pane
- (Or) Click on one of the buttons on the Stockyard's Toolbar

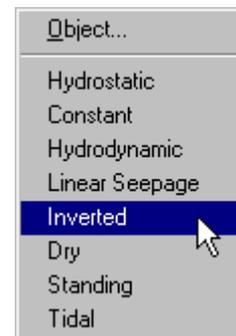
In each case, a box will appear from which you can choose which object to create.



Select the one you want and choose OK.

An alternative, and faster, way to achieve the above is to:

- *Right*-click on an item in the Object Types pane, click on **New**, and then choose which object to create from the fly-out menu that appears (see the picture alongside)



## Existing objects

The *Existing Objects* pane lists the engineering objects you have created. ReWaRD allows you to create an unlimited number of engineering objects.

When you click on one of the items listed in the Existing Objects pane, the Properties pane (see below) changes to show summary information for the selected object.

## To choose which objects appear in the Existing Objects pane

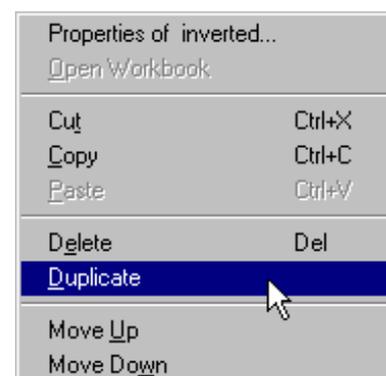
To choose which objects appear in the Existing Objects pane:

- Select one of the options on the Stockyard's
- View** menu
- Click on an item in the Object Types pane

## To edit an existing object

To edit the properties of an existing object:

- Click on the object and then choose the **Properties of <Name>...** command on the Stockyard's **Properties** menu (where <Name> is the name of the object)



- (Or) *Right*-click on the object and choose the **Properties of <Name>...** command on the pop-up menu that appears (see the picture alongside)
- (Or) *Double*-click on the object with the left mouse button

To cut, copy, paste, delete, duplicate, or move an existing object:

- Click on the object and choose one of the commands on the Stockyard's **Edit** menu
- (Or) *Right*-click on the object and choose one of the editing commands on the pop-up menu that appears (see picture above)
- (Or) Click on the object and press one of the shortcut keys (Ctrl+X to Cut, Ctrl+C to copy, Ctrl+V to paste, or Del to delete)
- (Or) Click on the object and then click on one of the editing buttons (cut, copy, or paste) on the Stockyard's Toolbar

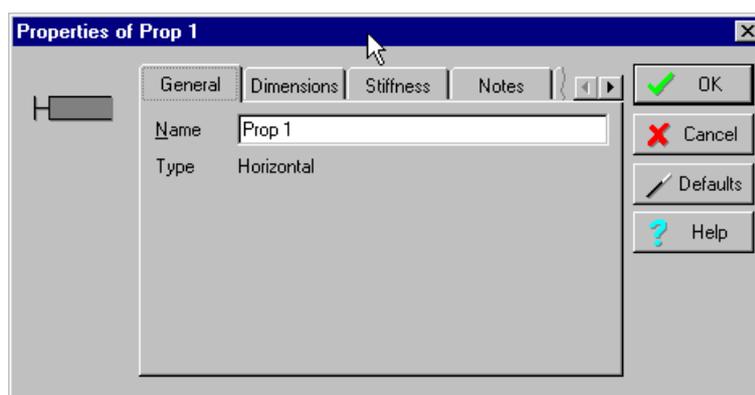
If a command cannot be applied to the selected object (e.g. the **Move Up** command is irrelevant to objects at the top of the Existing Objects pane), it is disabled (and its menu command and toolbar button are dimmed).

## Properties pane

The *Properties of Existing Object* pane gives a brief summary of the selected object's properties. A scroll bar appears in the Properties Pane if there is too much information to fit in the space available.

## Property boxes

Whenever you create a new object or edit the properties of an existing object, ReWaRD displays a property box so that you can enter whatever information the program needs to define that object. The property box "knows" what type of object you are creating or editing and only asks you for information that is relevant to that object. The following picture shows one of ReWaRD's object-oriented property boxes.



There are a number of features that are common to all of ReWaRD's property boxes. These include:

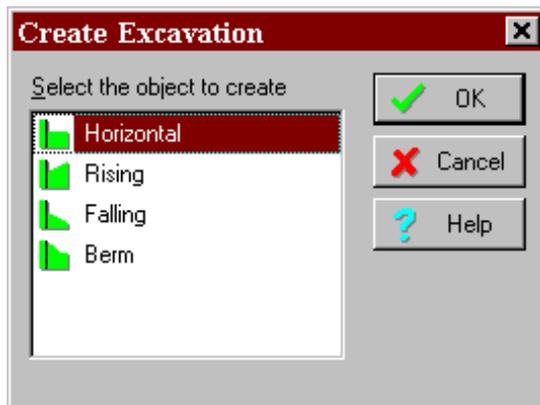
- The object's identifying icon, on the far left of the box
- On the General page, an edit control for entering the name of the object and some text indicating the type of object being created/edited
- One or more pages containing controls for entering the object's properties (e.g. in the picture above, Dimensions and Stiffness)
- On the Notes page, space for entering notes about this object for future reference
- On the Defaults page, buttons to allow you to save and reset the default

settings in Windows' Registry for this object type

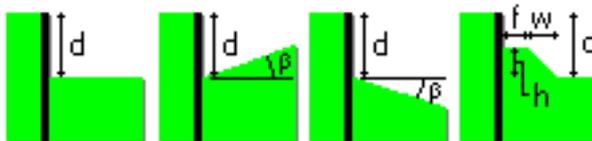
- **OK** and **Cancel** buttons
- A **Defaults** button, which allows you to load the default settings for this object type from Window's Registry
- A **Help** button for accessing the on-line help system

## Identifying icons

Each one of ReWaRD's 50+ engineering objects has a unique identifying icon which is displayed in the top left hand corner of that object's property box. A smaller (simplified) version of the icon is displayed in the Stockyard's Objects Pane alongside the name of the object and in the dialogue box that appears when you create an object of that type.



The icon helps you to identify each engineering object and (in its larger form) indicates dimensions or other properties that are needed to define that object. A selection of icons is shown below.



## Objects names

Each engineering object has a unique name which is used to identify it. ReWaRD automatically generates a default name (e.g. Prop 1, Retaining Wall 3, etc.) When you create an engineering object. You may change the name ReWaRD provides, provided you use a name that is not being used by any another object in the current document.

In practice, you will find it convenient to give certain objects (such as surcharges) meaningful names (such as "Load from footing", "Traffic loading", etc.).

## Defaults

ReWaRD provides default properties for most of the parameters that are needed to define your engineering objects. Chapter 9 explains how you can customize the default properties.

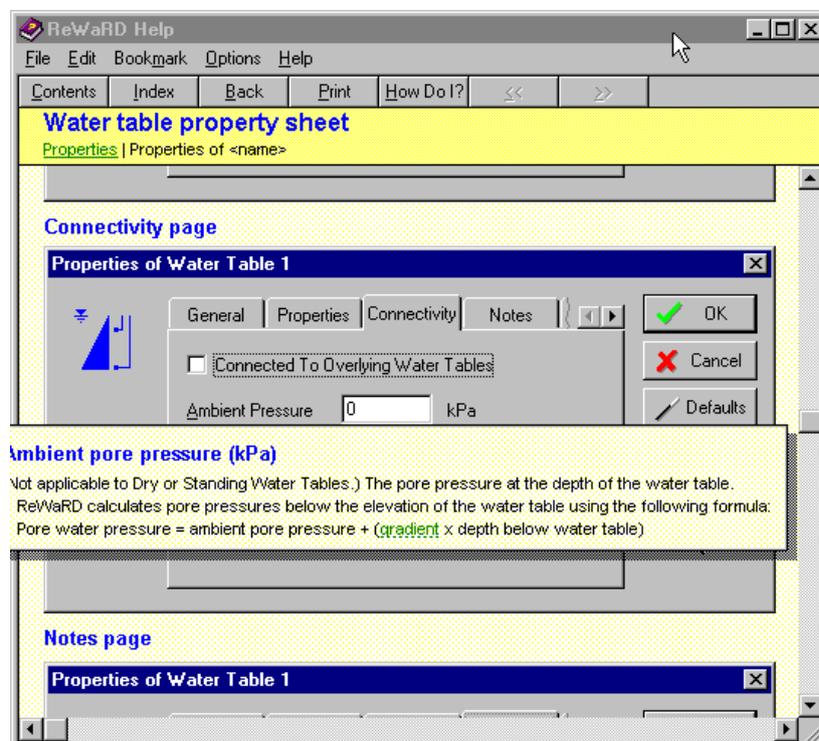
To change an object's properties to its default values:

- Click on the property box's **Defaults** button
- Press ALT-! on your keyboard

## Context-sensitive help

To obtain context-sensitive help for a particular property box:

- Click on the property box's Help button
- Press F1 on your keyboard



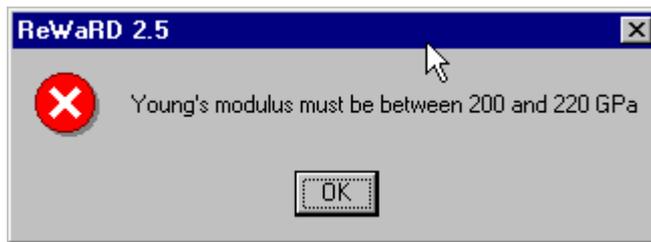
To find out what information you should enter into any particular control within the property box, just move the mouse cursor over that box within the help topic, whereupon the cursor will change to a hand. Click where the hand appears to display pop-up help for that control.

## Data validation

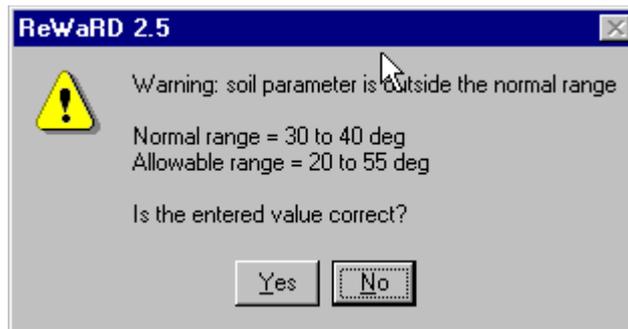
ReWaRD incorporates a comprehensive data-checking system that prevents you from entering invalid information for any engineering object. The data-checking system comprises:

- A keyboard filter to prevent you from entering invalid characters (such as entering a negative sign for a purely positive number)
- A range check to prevent you entering numbers that are too large (e.g. a wall length of 1000m) or too small (e.g. a wall length of 0m)
- A compatibility check to ensure that the values you enter are consistent with the object's other properties (e.g. a secant bored pile must have a horizontal spacing less than its diameter)
- A warning system to alert you to values that are unusually large or small – but nevertheless may still be valid

When ReWaRD detects an invalid value for a particular property, it displays an appropriate error message and won't allow you to continue until you have corrected the error.



When ReWaRD detects a value that is unusually large or small, it displays an appropriate warning message and asks you to confirm the value you have entered.



Choose **Yes** to confirm the value or **No** if you want to change it.

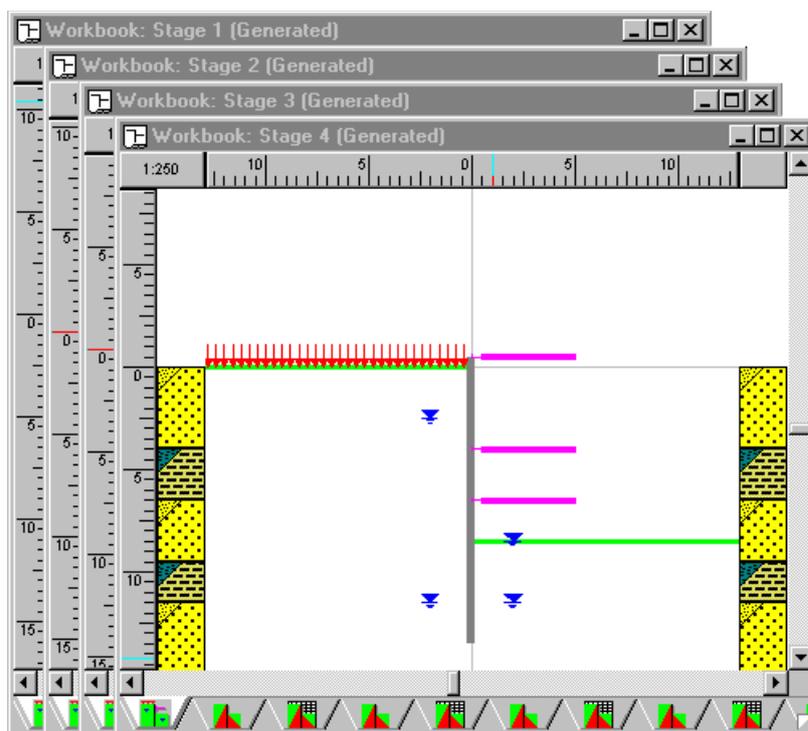
If you do not understand why a particular warning or error message is being triggered, click on the property box's Help button for further information.

## Chapter 8

# Workbooks

ReWaRD's Workbooks can be used to define or display:

- Separate stages in a construction sequence
- Alternative construction scenarios
- Different views of the same construction stage



Although each document can have only one Stockyard, it may have an unlimited number of Workbooks on display at any one time.

Each Workbook comprises a number of pages, as follows:

- The Drawing Board
- Results pages (presented either graphically or as a table)
- The Messages Page

You can display a particular page by:

- Choosing one of the commands on the Workbook's **View** menu
- Clicking on its tab at the bottom of the Workbook
- Clicking on any of the view buttons on the Workbook's Toolbar (the third and fourth rows of buttons in the picture alongside)



## The Drawing Board

The Drawing Board provides the main visual representation of a construction stage. It also acts as a powerful editing screen, as described in the section titled *Drag 'n' drop design* below.

The Drawing Board contains:

- Draggable rulers attached to its left and top edges
- Soil columns on either side of the wall

If you pause while passing the mouse pointer over a object displayed on the Drawing Board, ReWaRD displays the name of that object. This makes it easier for you to identify which object is which. Further, if you select an object in the Drawing Board, ReWaRD's Stockyard automatically displays the properties of that object for you to see.

## Drag 'n' drop design

One of ReWaRD's most powerful features is what we have termed *drag 'n' drop design*. This is the ability to build up a construction stage by dragging engineering objects from the Stockyard and dropping them onto a Workbook's Drawing Board. The Drawing Board's built-in intelligence ensures that your engineering objects only go where it is possible for them to go.

## To select an object

To select an engineering object:

- Click on the object with the left mouse button
- (Or) Press the TAB key repeatedly until the object is highlighted

ReWaRD indicates which object is selected by placing handles (i.e. small square rectangles) at its corners or ends.

The object that is selected when you click on one of the soils columns depends on which keys are pressed at the time:

- If the CTRL key is pressed, the layer is selected
- If the SHIFT key is pressed, the soil is selected
- If neither the CTRL or SHIFT keys are pressed, the borehole is selected

## To add an object to a Drawing Board

To add an object to a Drawing Board, click on it in the Stockyard's Existing Objects pane with the left mouse button *and hold the button down*. The cursor will change to a circle with a line across it. Then drag the mouse across to the Drawing Board and, when the cursor changes to a symbol with a + sign, release the mouse button.

The cursor indicates the type of object you are dragging and where you can drop it. For example:

-  signifies that the object (in this case, a retaining wall) *can* be dropped at the current location
-  signifies that the object *cannot* be dropped at the current location

What happens when you release the mouse button depends on what type of object you are dragging and where you drop it:

- Most objects automatically appear on the "correct" side of the wall at their specified depths
- Unless you drop them on one of the soil columns, layers are added to the

bottom of the boreholes on *both* sides of the wall (i.e. *underneath* any existing layers)

- If you drop a layer on a soil column, it appears immediately below the layer on which you drop it
- If you drop a layer *above* a soil column, it appears at ground level
- If you drop a soil onto an existing layer, the layer's soil type changes
- Water tables appear on whichever side of the wall you drop them on

## To remove an object from a Drawing Board

To remove an object from a Drawing Board, click on it with the left mouse button *and hold the button down*. Handles will appear to indicate that the object is selected and the cursor will change to a circle with a line across it. Then drag the mouse across to the Stockyard's Object's Pane and, when the cursor changes to a symbol representing the object, release the mouse button. The object will disappear from the Drawing Board.

## Editing an object

You can edit the properties of an existing object "in place" in a number of ways:

- By selecting the object and choosing the **Properties of <Name>...** command on the Workbook's **Properties** menu (where <Name> is the name of the object)
- (Or) By selecting the object, clicking the right-mouse button, and choosing the **Properties of <Name>...** command on the pop-up menu that appears (see the picture alongside)
- (Or) By *double*-clicking on the object with the left mouse button



Similarly, you can edit (i.e. cut, copy, paste, or delete) an object:

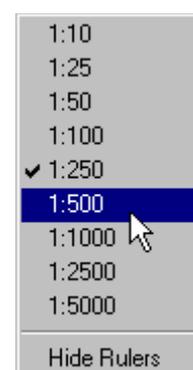
- By selecting the object and choosing one of the commands on the Workbook's **Edit** menu
- (Or) By selecting the object, clicking the right-mouse button, and choosing one of the editing commands on the pop-up menu that appears (see the picture above)
- (Or) By selecting the object and pressing one of the shortcut keys (Ctrl+X to Cut, Ctrl+C to copy, or Del to delete)
- (Or) By selecting the object and then clicking one of the editing buttons (cut or copy) on the Workbook's Toolbar

Note that when you cut or delete an object from a Drawing Board, it is only removed from the associated construction stage — it is *not* cut or deleted from the Stockyard.

## Changing the scale

You can change the scale of the drawing on the Drawing Board:

- By choosing the **Zoom In** or **Zoom Out** commands on the **Tools** menu and then clicking on the Drawing Board to change the scale up or down a level
- (Or) By clicking the **Zoom In** or **Zoom Out** buttons on the Workbooks' Toolbar and then clicking on the Drawing Board to change the scale up or down a level



- (Or) By right-clicking on one of the rulers and choosing the scale you want from those listed on the pop-up menu that appears (see the picture alongside)

When you choose one of the Zoom commands, ReWaRD goes into *Zoom mode* and will continue to alter the scale each time you click on the Drawing Board. You can cancel *Zoom mode*:

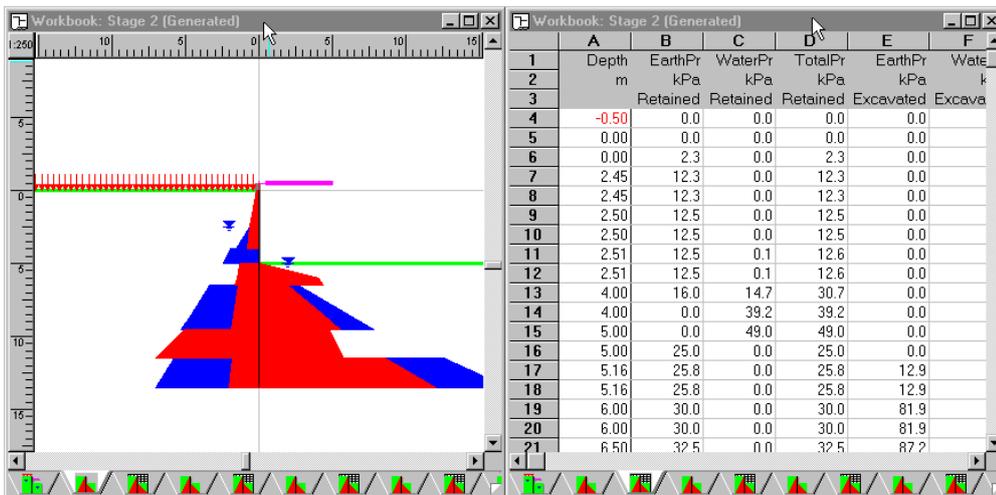
- By choosing the **Pointer** command on the **Tools** menu
- (Or) By clicking the **Pointer** button on the Workbooks' Toolbar

## Results pages

Each Workbook provides the results of your calculations on separate pages to ensure you are not overwhelmed with information. There are pages for:

- Earth pressures
- Required embedment
- Structural forces
- Peck's envelopes
- Displacements
- Base stability

Some pages display their results in one of two ways: either as a diagram or in a table of values.



You can switch between these views:

- By toggling between the **Picture** and **Table** commands on the Workbook's **View** menu
- (Or) By toggling between the **Picture** and **Table** buttons on the Workbook's Toolbar

## Customizing a page

You can customize each page's display by choosing the **Page...** command on the Workbook's **Properties** menu. This command is also available on the pop-up menu that appears when you right-click on a Workbook page.

Additionally, in the table-based pages, you can customize each column's display by choosing the **Properties of Column <Letter>...** command on the Workbook's **Properties** menu (where <Letter> is the column's letter, starting at A). This command is also available on the pop-up menu that appears when you right-click

on a table column.

## Choosing a layout

You can change to any one of a number of pre-defined layouts for ReWaRD's table pages by choosing the appropriate command from the Workbook's **View** menu. For example, to display as-built earth pressure coefficients:

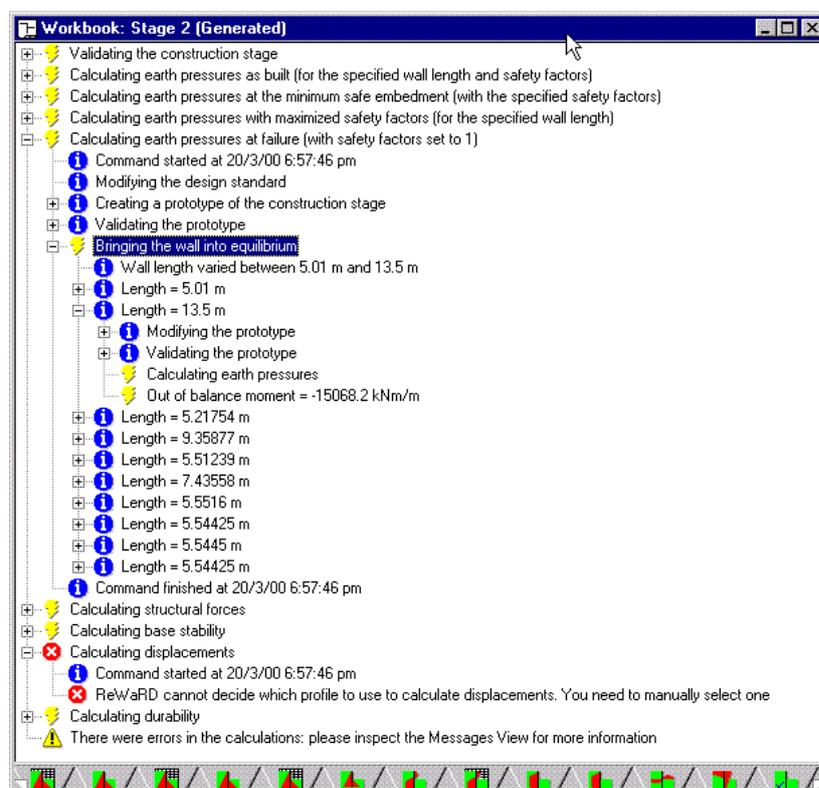
- First, calculate the earth pressures as built by choosing the **Earth Pressures ▶ As Built** command from the Workbook's **Calculate** menu
- Then, switch to table display by choosing the **Table** command from the Workbook's **View** menu
- Finally, display the earth pressure coefficients by choosing the **Earth Pressures ▶ Coefficients** command from the Workbook's **View** menu

You can also save the current layout for later re-use, by choosing the **Workbook ▶ Save Layout...** command from the Workbook's **Properties** menu. You can then restore the layout by choosing the **Workbook ▶ Restore Layout...** command. A selection of useful layouts are supplied with the program in the folder `PROGRAM FILES\GEOCENTRIX\REWARD\2.5\LAYOUTS` (they have the file extension `.RWL`).

You can restore a Workbook to its default layout by choosing the **Workbook ▶ Restore Default Layout** command from the Workbook's **Properties** menu.

## The Messages Page

ReWaRD uses the Messages Page to inform you of anything that occurs in its calculations that requires your attention or approval.



The messages ReWaRD displays fall into three main categories:

- Error messages, which explain why a particular calculation cannot be performed

- Warning messages, which explain what action ReWaRD has taken in response to an unusual or unsafe condition
- Informational messages, which provide additional information about the calculations that is not available on any of the other results pages

You can empty the messages window at any time by choosing the **Clear Messages** command from the Workbook's **Calculate** menu.

## Chapter 9

# Producing reports

ReWaRD allows you to customize the information in its printed reports, preview them on the screen before printing, and select exactly which pages you want to print.

### Selecting what appears in a report

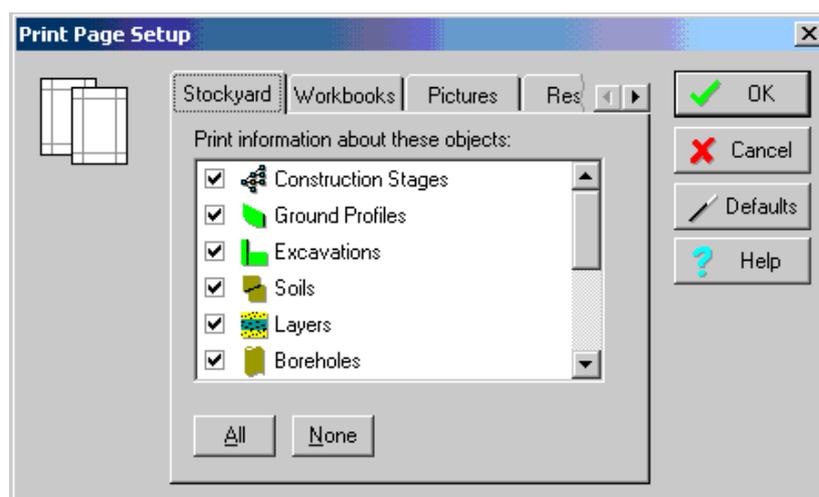
What appears in ReWaRD's printed reports depends on which options are selected in the Page Setup box. To display this box:

- Choose the **Page Setup** command on ReWaRD's **File** menu
- (Or) Click on the Page Setup button on the Toolbar

Each page within the Page Setup box covers a different part of the report.

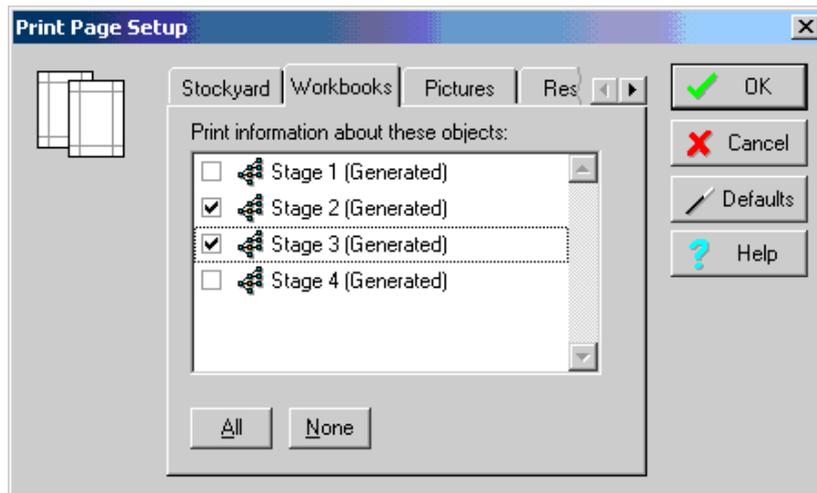
### Stockyard page

The Stockyard page allows you to select which engineering objects are included in the printed report (those which are ticked are included, those which are not are omitted).



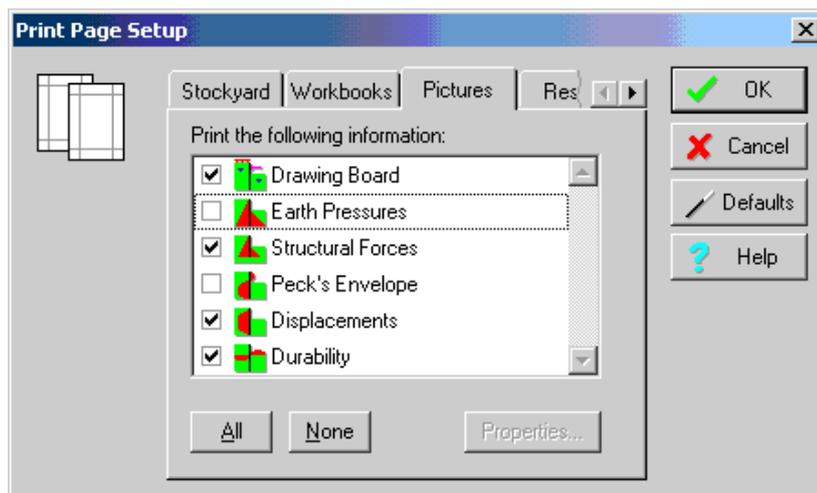
### Workbooks page

The Workbooks page shows a list of all the Construction Stages defined in the Stockyard. Each Construction Stage has a Workbook associated with it, which contains the results of the calculations you perform on that stage. For each Construction Stage you select on the Workbooks page, ReWaRD prints the corresponding results that are selected on the Results page (see below).



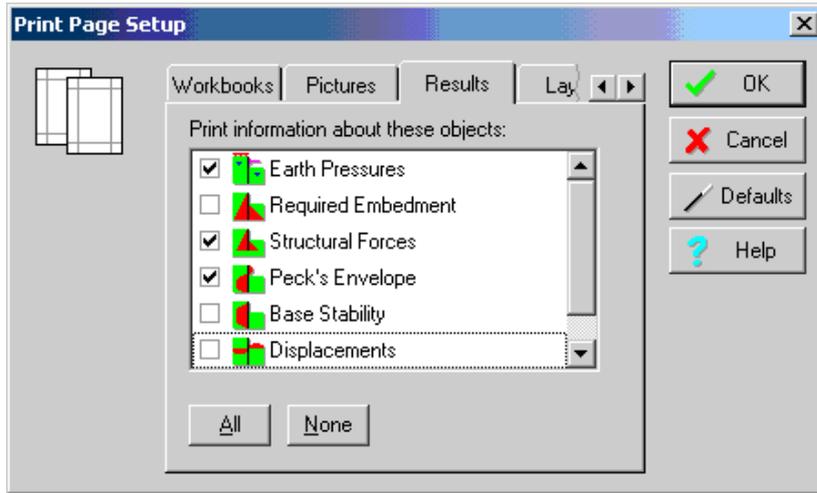
### Pictures page

The Pictures page shows the results for each Construction Stage that are available in picture format. For each Stage you select on the Workbooks page (see above), ReWaRD prints the pictures you select on the Pictures page. To customize the way the pictures are printed, select the specific picture whose printout you want to customize and click the Properties... button.



### Results page

The Results page shows the results for each Construction Stage that are available in tabular format. For each Stage you select on the Workbooks page (see above), ReWaRD prints the results that you select on the Results page.



### Layout page

The Layout page allows you to customize the size of the margins that appear around your report.

### Print preview

To see a preview of what will be printed when you choose ReWaRD's Print command:

- Choose the **Print Preview** command on ReWaRD's **File** menu
- (Or) Click on the Print Preview button on the Toolbar

The toolbar at the top of the print preview screen allows you to scroll forwards and backwards through the report, zoom in or out of the selected current page, view one or two pages at time, set the printer up, and (when you are ready to proceed) print the report.

Item	Type	Class	State	Other properties
Excavation 1	Excavation	Excavation 1	Excavation 1	Excavation 1
Excavation 2	Excavation	Excavation 2	Excavation 2	Excavation 2
Excavation 3	Excavation	Excavation 3	Excavation 3	Excavation 3
Excavation 4	Excavation	Excavation 4	Excavation 4	Excavation 4
Excavation 5	Excavation	Excavation 5	Excavation 5	Excavation 5

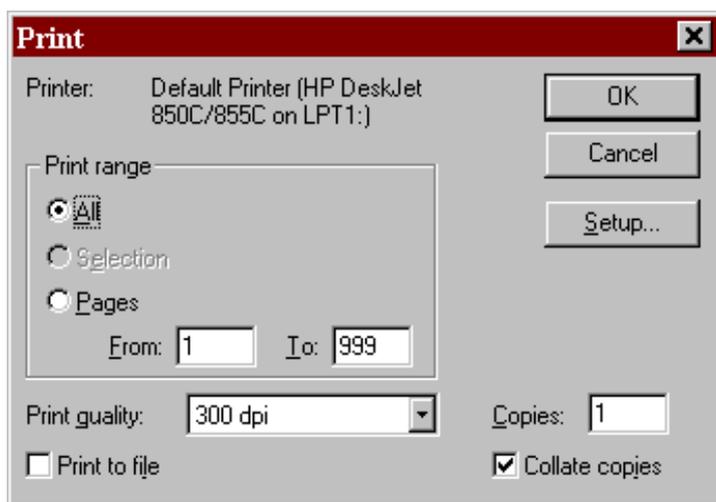
Item	Type	Class	State	Other properties
Page 1	Page	Page 1	Page 1	Page 1
Page 2	Page	Page 2	Page 2	Page 2
Page 3	Page	Page 3	Page 3	Page 3
Page 4	Page	Page 4	Page 4	Page 4
Page 5	Page	Page 5	Page 5	Page 5

### Printing

To print a report:

- Choose the **Print** command on ReWaRD's **File** menu
- (Or) Click on the Print button on the Toolbar

The Print box that appears allows you choose which pages you want to print, how many copies to print, whether to collate the pages, etc.



## Chapter 10

# Customizing the program

This chapter gives a brief explanation of how you can customize ReWaRD to suit your particular requirements. Further details can be found in ReWaRD's on-screen Help system.

### Windows' Registry

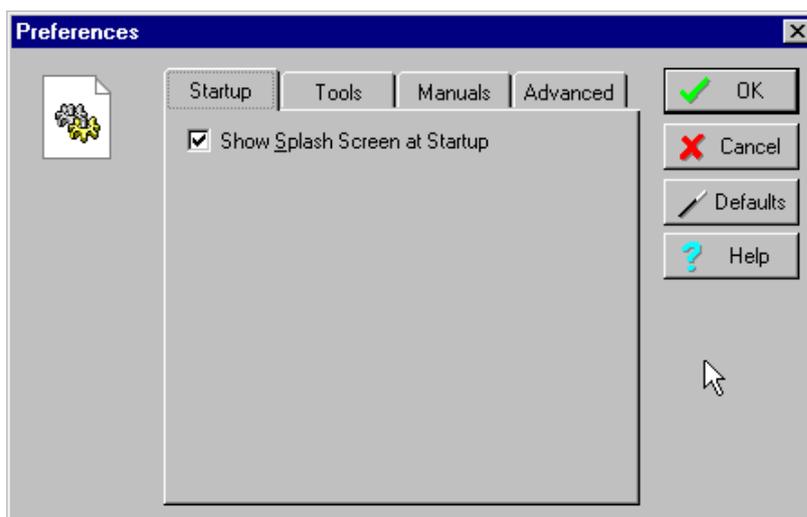
ReWaRD stores its default parameters in Windows' Registry under the key:

HKEY\_LOCAL\_MACHINE/SOFTWARE/Geocentrix/ReWaRD/2.5

Although you can edit these settings by hand if you wish, we strongly recommend that you alter the program's defaults via various controls that are provided throughout ReWaRD.

### Program-wide settings

You can change ReWaRD's program-wide settings by choosing the **Preferences...** command from the program's **Edit** menu. When you do so, the following box appears:



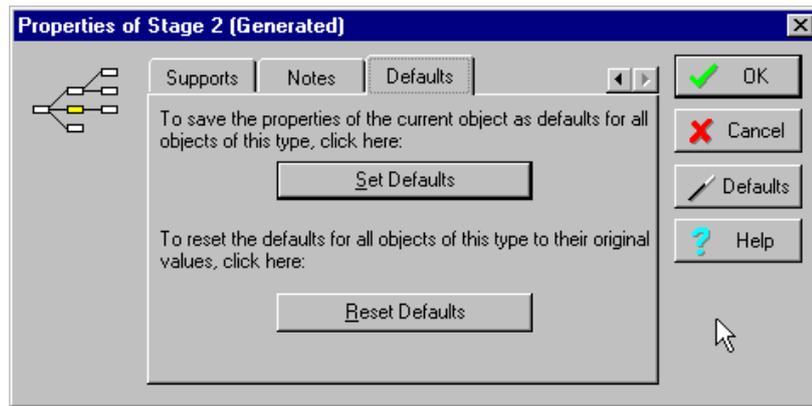
Change whichever settings you wish and click **OK** to confirm the changes.

Settings given on the Advanced page should only be altered on the advice of Geocentrix's Technical Support team.

### Defaults for engineering objects

When you edit any of the engineering objects that ReWaRD provides, you can call up default parameters for that object by clicking on the **Defaults** button on the right hand side of the object's property box. ReWaRD takes the default parameters from the Registry and enters them onto whichever page of the property box is visible (hidden pages are not affected). If a parameter does not have a default setting in the Registry, ReWaRD uses its *factory default* instead (see below).

You can set the default parameters for any engineering object by going to its Defaults page and clicking the **Set Defaults...** button.



The properties of the object that you are currently editing are then saved to the Registry for later recall.

You can reset the default parameters for any engineering object by clicking the **Reset Defaults...** button on the same page. The values stored in the Registry are replaced with *factory defaults*.

### Factory defaults

ReWaRD contains within its program code default parameters for all the engineering objects it provides. These default parameters are called *factory defaults* and are fully documented in ReWaRD's Help system.

# Chapter 11

## Upgrading from previous versions

This chapter provides a brief summary of the new features you'll find in ReWaRD version 2.5.

### What's new or improved in ReWaRD 2.5

Version 2.5 has many new or improved features compared with version 2.0:

- Number of pre-built engineering objects increased to 51
- Custom design standard greatly improved
- Validation on calculation now reported via the Workbook's Messages page
- Added earth pressure calculations at minimum safe embedment, with maximum safety factors, and at failure
- Wall friction, adhesion, undrained adhesion, and maximum undrained adhesion can be customized
- Improved implementation of the hinge method of calculating structural forces
- Added ability to specify object depths as height above Ordnance Datum
- Package includes British Steel's Electronic Piling Handbook
- Package includes British Steel's Electronic Piling Case Studies
- User and Reference Manuals provided in Adobe Acrobat format
- Stockyard and Workbooks are now synchronized (so that clicking on an object in the Workbook causes the Stockyard to automatically display its properties)
- Greatly improved Required Embedment, Base Stability, and Messages pages
- Added Durability calculation
- Added conversions to/from any fundamental engineering unit in the SI, CGS, or Imperial systems
- Default settings now stored in Windows' Registry and can be set or reset via the program
- Added Notes page to all engineering object property boxes
- Added ability to save projects as templates
- Added Preferences box
- Added links to Geocentrix's web site and software support web pages
- Improved the program's overall look and feel, including many user interface improvements
- Several bug fixes and other improvements to the program's operation
- Year 2000 compliance covering Levels 1-3 of the British Standards Institution's document *DISC PD2000-1*
- 32-bit application optimized for Windows 95/98/NT4

ReWaRD 2.5 can read files created in ReWaRD 2.0 with minor loss of data (you will be informed when this occurs) and can import files created in ReWaRD 1.x.

Neither ReWaRD 1.x nor ReWaRD 2.0 can read files created in ReWaRD 2.5.

### What's new or improved in ReWaRD 2.0

Version 2.0 introduced many new or improved features compared with version 1.x:

- Major overhaul of ReWaRD's user interface to make it quicker and even easier to use
- Completely new printing and graphing engines
- Implemented the following official and *de facto* design standards: Civil Engineering Code of Practice CP2; British Steel's Piling Handbook (6th

Edition); CIRIA Report 104; Hong Kong Geoguide 1 (2nd Edition); British Standard 8002; European pre-Standard ENV 1997 (Eurocode 7)

- Added **Print Preview** and **Page Setup** commands
- Added a recently-used file list to the **File** menu
- Provided pre-built templates as a quick way of building common design scenarios
- **Cut, Copy, and Paste** commands added to the Edit menu, allowing you to transfer engineering objects between different ReWaRD documents and to transfer the results of your calculations to any spreadsheet that can read Microsoft Excel files
- Start-up and Construction Wizards added to help novice users get started and experienced users become more efficient in their use of the program
- Commands added to the **Window** menu to enable you to open, close, minimize, and restore the various windows ReWaRD creates
- Introduced an integrated design environment, comprising the Stockyard (see Chapter 7) and Workbooks (Chapter 8)
- Added earth pressures calculations for king-post walls using Broms' method
- Added structural force calculations for multi-propped walls using the hinge method described in BS8002
- Equilibrium conditions could be determined by any one of three methods, using partial or lumped factors-of-safety
- Radical overhaul of ReWaRD's user interface
- Project Information box moved to the **Properties** menu
- Version 1.x's "Information Managers" replaced by Version 2.0's Stockyard. The **Ground** and **Structure** menus from Version 1.x replaced by the Stockyard's **View** and **Create** menus
- The ability to change the value of gravity was removed
- Version 1.x's Earth Pressures, Factors-of-Safety, Bending Moments, Prop Forces, and Displacements windows were replaced by Version 2.0's Workbooks.
- Various design options were brought together in Design Standards
- The results of base stability calculations were made available on a separate page of each Workbook
- Added automatic selection of Peck's envelope
- Added automatic selection of the displacement database
- Graphs were made an integral part of the program