Geocentrix

Repute 2.5

Quick-Start Guide

Intelligent pile design and analysis

Set in Optimum using Corel® WordPerfect® X7. Printed in the UK.

Acknowledgments

Repute 2.0 was developed with the generous support of Corus, Atkins, and Stent Foundations. Repute 2.x was designed and written by Dr Andrew Bond of Geocentrix, with the assistance of Ian Spencer of Honor Oak Systems.

PGroupN was designed and written by Dr Francesco Basile of Geomarc. Special recognition goes to the late Dr Ken Fleming of Cementation Foundations Skanska for his invaluable advice and support during the development of PGroupN.

The *Repute Quick-Start Guide* was written by Andrew Bond.

The following people assisted with the production of the program and its documentation: Jenny Bond, Francesco Basile, Romain Arnould, Joe Bond, Tom Bond, Halcrow Group, Jack Offord, and Claire Bond. The following generously gave their time during initial beta testing: Francesco Basile and Dave Rowbottom.

Revision history

Last revised 16th October 2020 (for version 2.5.9).

TABLE OF CONTENTS

INTRODUCING REPUTE 2.5

Repute® provides a rich set of capabilities for engineers to design/analyse:

- various types of single pile, using current and historical design standards (such as Eurocode 7 and BS 8004:2015)
- pile groups under generalized 3-dimensional loading, using linear of non-linear soil models

Repute considers single pile response using a variety of calculation methods for ultimate and serviceability limit states. Both traditional lumped factors-of-safety and modern partial factors can be applied in these calculations.

Repute analyses pile group behaviour using the boundary element method, employing the leading analytical program PGroupN (developed by and included under exclusive licence from Geomarc). PGroupN provides a complete 3D non-linear boundary element solution of the soil continuum, which overcomes limitations of traditional interaction-factor methods and gives more realistic predictions of deformations and the load distribution between piles.

What's new in Repute 2.5?

New features

- Multi-threaded boundary element engine, up to 100x faster than before
- Support for spun piles and micropiles
- Action Import Wizard
- Pile Group Import Wizard
- Ability to chose which sections and materials appear in the Stockyard
- Support for BS 8004:2015
- Direct support for rock within the boundary element analysis

Improved features

- Pile Group Wizard now supports a wider range of pile types
- Greater distinction between different calculations in Stockyard
- Updated Quick-Start Tutorial
- Support for using the program across wide area networks

- Numerous other minor improvements

Documentation

Repute is supplied with a detailed *Quick-start Guide*, comprehensive *User Manual*, and authoritative *Reference Manual*. The latest versions of these manuals (including any corrections and/or additions since the program's first release) are available in electronic (Adobe® Acrobat®) format from the Geocentrix website. (www.geocentrix.co.uk/repute and follow links to Repute's documentation).

Quick-Start guide (this booklet)

The *Repute 2.5 Quick-Start Guide* includes six tutorials that show you how to use the main features of Repute. Each tutorial provides step-by-step instructions on how to drive the program. There are three tutorials dealing with single pile design and three with pile group design. The tutorials increase in difficulty and are designed to be followed in order.

User manual

The *Repute 2.5 User Manual* explains how to use Repute. It provides a detailed description of the program's user interface and explains how to employ it to maximum effect.

Reference manual

The *Repute 2.5 Reference Manual* gives detailed information about the engineering theory that underpins Repute's calculations. The manual assumes you have a working knowledge of the geotechnical design of single piles and pile groups, but provides appropriate references for further study if you do not.

Help system

Repute's help system contains detailed information about the program, including most of the content of the *Quick-Start Guide*, *User Manual*, and *Reference Manual* – plus additional information that is not found in any of these documents.

Help appears in a separate window to Repute, allowing you to view the help topics while you continue to work with Repute itself. To open the help system:

- Press `F1`
- Click the Help button in any dialog box
- Click on the Help button on the right hand side of Repute's Ribbon

Software Re-Assurance™

Software Re-Assurance for Repute (including updates, upgrades, and technical support) is available direct from Geocentrix or through your local distributor. To obtain Re-Assurance, contact Geocentrix as follows:

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

Notes

Screenshots in this guide were produced on Windows 10 (your screen may differ). Not all options are available in every edition of Repute.

In this guide, '`[Docs]`' refers to the folder where the documents that ship with Repute were installed, typically here:

```
C:\Users\Public\Documents\Geocentrix\Repute\2.5
```

On Windows XP, replace:

```
C:\Users\Public\Documents
```

with:

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

TUTORIAL 1
H-PILE IN CLAY AND SAND

This tutorial demonstrates the basic features of Repute, through a worked example involving the analysis of a single H-pile installed in clay and sand:

- Ground conditions comprise 5 m of clay overlying 20 m of dense sand. The clay has unit weight of 20.5 kN/m^3, angle of shearing resistance of 23°, and undrained shear strength of 60 kPa. The sand has unit weight of 18 kN/m^3 and angle of shearing resistance of 35°.
- The foundation comprises a 305 x 305 x 110 H-pile of steel grade S275.
- A vertical load of 700 kN is to be applied to the pile.
- You want to determine the minimum length of pile needed to safely carry the applied action according to traditional UK practice.

This tutorial is written for users of the Standard, Enterprise, and Trial Editions of Repute only. Users of the Professional Edition should look at Tutorials 4-6.

Overview

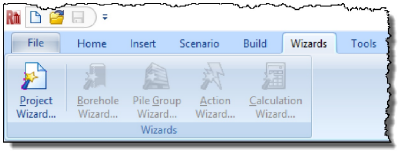
- In Step 1, you will use the Project Wizard to enter project information, select a design standard, and create scenarios to represent short- and long-term conditions.
- In Step 2, you will use the Borehole Wizard to create a borehole containing clay and sand layers.
- In Step 3, you will create an H-pile and specify its cross-section and steel grade.
- In Step 4, you will create the force applied to the pile.
- In Step 5, you will use the Calculation Wizard to create the calculations you want Repute to perform.
- In Step 6, you will perform the calculations and review the results.
- In Step 7, you will produce a report summarising the results of the calculations.
- In Step 8, you will close (and optionally save) the project.

If Repute is not already running, double-click on the Repute icon on Windows' Desktop to start the program. Once the splash screen has disappeared, Repute displays its Welcome page.

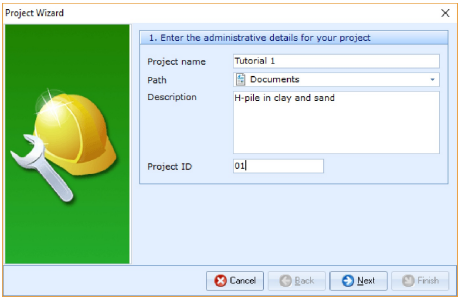
If you have an existing project open, click **Close** on the program's **File menu**. (You will be prompted to save your work if you have not already done so.)

Step 1 – create the project

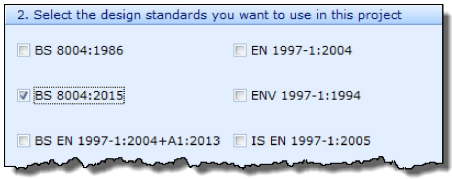
In Step 1, you will use the Project Wizard to enter project information, select a design standard, and create scenarios to represent short- and long-term conditions.



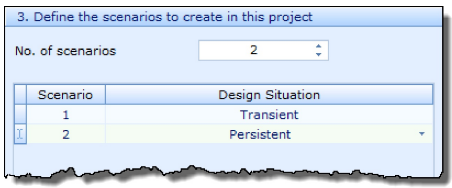
1. Open the Project Wizard by selecting the **Wizards** tab on Repute's ribbon and then clicking on the **Project Wizard** button.
2. When the Wizard appears, type "Tutorial 1" in the **Project name** box. Choose the folder where you want to save this project by using the **Path** control. (If you do not change the setting here, it will be saved in your Documents folder.)
3. Enter "H-pile in clay and sand" in the **Description** box and "01" in the **Project ID** box.



4. Click **Next** to display the next page (the standards that appear depend on which edition of Repute you are running). Select **BS 8004: 2015** by clicking on the relevant checkbox (a tick mark appears when a standard is selected).

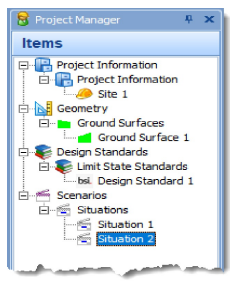


5. Click **Next** to display the next page. Increase the **Number of scenarios** to 2 and then change the **Design Situation** of Scenario 1 to "Transient" but leave Scenario 2 as "Persistent".



6. Click **Next** to display the final page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.

7. When you are ready, click **Finish** to generate the project. The Project Wizard then:



   - Creates Site 1, Ground Surface 1, Design Standard 1, and Situations 1-2
   - Adds Ground Surface 1 to Situations 1-2
   - Creates a new project named `Tutorial 1.rpx` with all these items

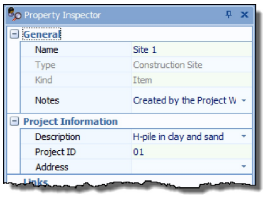
8. You can view these items by right-clicking anywhere inside the Project Manager to display its context menu and selecting the **Expand All** command. The Project Manager will then look as shown in the picture alongside.

9. To view the properties of any particular item, select the item you want to inspect in Repute's Project Manager (e.g. Site 1)

10. Display the Property Inspector for the item by:

    - Right-clicking on the item, to display its context menu, and clicking the **Properties...** command
    - *Or* ... Double-clicking on the item

11. Repute's Property Inspector will open and display the properties of the selected item. (For example, for Site 1 the description is shown as "H-pile in clay and sand" and the Project ID as "01".)

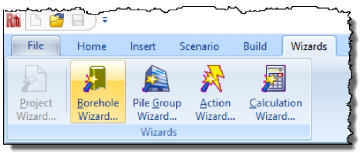


`[Docs]\Tutorials\Tutorial 1\Step 1.rpx` captures everything so far.

Step 2 – create the borehole

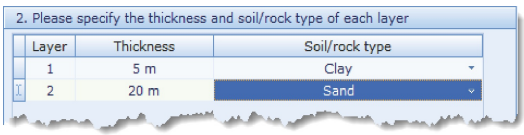
In Step 2, you will use the Borehole Wizard to create a borehole containing clay and sand layers.

1. Open the Borehole Wizard by selecting the **Wizards** tab on Repute's ribbon and then clicking on the **Borehole Wizard** button.

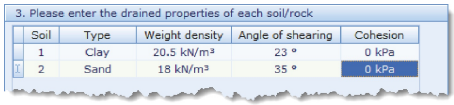


2. When the Wizard appears, increase the number of layers to 2.

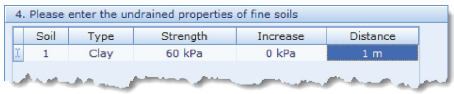
3. Click **Next** to display the next page. Change Layer 1's thickness to 5m and its soil type to "Clay". Change the thickness of Layer 2 to 20m but leave its soil type as "Sand".



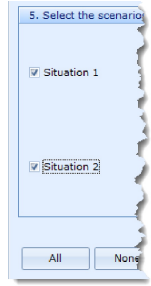
4. Click **Next** to display the next page. Change the **Weight density** (unit weight) of Soil 1 to 20.5 kN/m^3 and its **Angle of shearing** to 23°. Change the weight density of Soil 2 to 18 kN/m^3 and its angle of shearing to 35°. Leave the **Cohesion** of both soils unchanged.



5. Click **Next** to display the next page. Change the **Strength** of Soil 1 to 60 kPa. Leave all other properties unchanged. (Note that Soil 2 does not appear on this page, since it is a sand and so does not have undrained properties.)



6. Click **Next** to display the next page. Since the ground profile does not include rock, there is nothing to set on this page.
7. Click **Next** to display the next page. Click **All** to select both scenarios.
8. Click **Next** to display the next page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
9. When you are ready, click **Finish** to generate the borehole. The Borehole Wizard then:



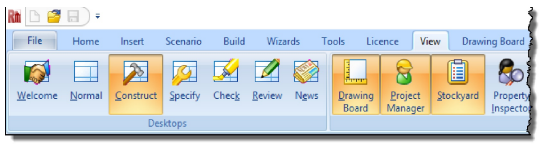
- Creates Soils 1-2, Layers 1-2, and Borehole 1
- Links Soil 1 to Layer 1
- Links Soil 2 to Layer 2
- Adds Layers 1-2 to Borehole 1

`[Docs]\Tutorials\Tutorial 1\Step 2.rpx` captures everything so far.

Step 3 – create the pile

In Step 3, you will create an H-pile and specify its cross-section and steel grade.

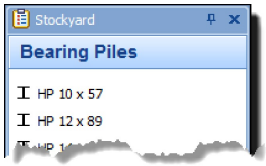
1. Open the Stockyard by selecting the **View** tab on Repute's ribbon and then clicking on the **Construct** button.



2. When the program has switched to its Construction Desktop (in which the Drawing Board, Project Manager, and Stockyard are displayed), right-click

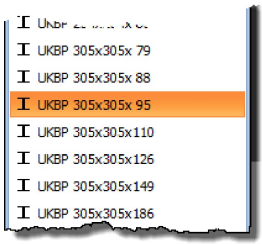
anywhere inside the Stockyard to display its context menu and select the **Bearing Piles** command. The Bearing Piles group will open.

3. Create the section by selecting the item labelled "UKBP 305x305x95", right-clicking to display its context menu, and then selecting the command **Create 'UKBP 305x305x95'**. The newly-created hot-rolled section will appear in the Project Manager (under Sections).



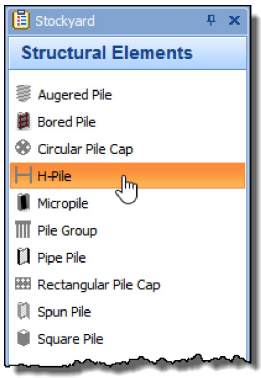
4. Next, right-click anywhere inside the Stockyard to display its context menu and select the **Steels** command. The Steels group will open.

5. Create the steel by holding the `Ctrl` key down and clicking on the item labelled "S275". (When the Ctrl key is pressed, Repute automatically creates any item that you select in the Stockyard. This saves you the effort of displaying the popup menu each time you want to create a new item.) The newly-created steel will appear in the Project Manager (under Materials).



6. Finally, click on the Stockyard's Structural Elements caption (near the bottom of the Stockyard). The Structural Elements panel will open.

7. Create the pile by holding the Ctrl key down and clicking on the item labelled "H-pile". The newly-created pile will appear in the Project Manager (under Structural Elements).

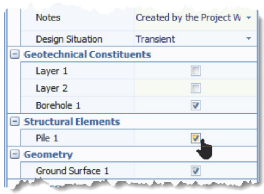


8. In the Project Manager, right-click on the newly-created pile ("Pile 1") to display its context menu and select the **Properties...** command. The Property Inspector will appear.

9. In the Property Inspector, change the **Material Name** (under Material Properties) from "Not specified" to "Steel 1". Then change the **Section Name** (under Section Properties) from "Not specified" to "Section 1". Leave all other properties of the pile unchanged.

10. Returning to the Project Manager, select Situation 1 (under Scenarios).

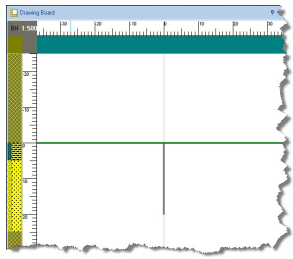
11. In the Property Inspector, place a tick next to Pile 1 (under Structural Elements) to add the



pile to this scenario. The Drawing Board will refresh.

12. Repeat the previous two instructions for Situation 2.
13. In this step, you have:
    - Created Section 1, Steel 1, and Pile 1
    - Linked Section 1 and Steel 1 to Pile 1
    - Added Pile 1 to Situations 1 and 2

The Drawing Board will now look something like this:



`[Docs]\Tutorials\Tutorial 1\Step 3.rpx` captures everything so far.

Step 4 – create the force

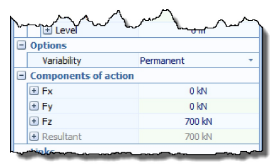
In Step 4, you will create the force applied to the pile.

1. Open the Stockyard's Actions panel by selecting the **Insert** tab on Repute's ribbon and then clicking on the **Action** button.

2. The Actions group will open in the Stockyard.

Hold the `Ctrl` key down and click on the item labelled "Force".

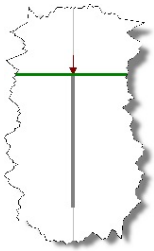
3. The newly-created force will appear in the Project Manager (under Actions).
4. In the Property Inspector, change the **Variability** of Force 1 (under Options) to "Permanent" and the value of **Fz** (under Components of Action) to 700 kN. The Resultant will automatically change to 700 kN.



5. Change the **Tether to ...** item to "Pile 1". This

will ensure that the force's plan position will always match the pile's plan position, even if the pile is moved.

6. In the Project Manager, select "Situation 1" (under Scenarios).
7. In the Property Inspector, place a tick next to Force 1 (under Actions) to add the action to this scenario. The Drawing Board will refresh and now look like this:



8. Repeat the previous two instructions for Situation 2.
9. In this step, you have:
   - Created Force 1
   - Added Force 1 to Situations 1 and 2

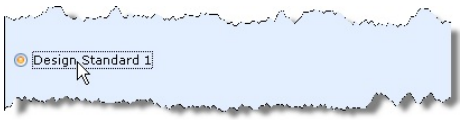
This file at `[Docs]\Tutorials\Tutorial 1\Step 4.rpx` captures everything so far.

Step 5 – create the calculations

In Step 5, you will use the Calculation Wizard to create the calculations you want to perform.

1. Open the **Calculation Wizard** by selecting the **Wizards** tab on Repute's ribbon and then clicking on the **Calculation Wizard** button.
2. When the Wizard appears, select "Longitudinal ULS". (The calculations that appear here depend on which edition of Repute you are running.)

3. Click **Next** to display the next page. Select "Design Standard 1" (this is the BS 8004:2015 design standard created in Step 1 of this tutorial).



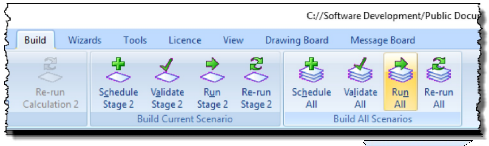
4. Click **Next** to display the next page. Click **All** to select both situations.
5. Click **Next** to display the final page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
6. When you are ready, click **Finish** to generate the calculations. The Calculation Wizard then:
   - Creates Calculations 1-2
   - Links Situation 1 to Calculation 1
   - Links Situation 2 to Calculation 2
   - Links Design Standard 1 to Calculations 1-2

`[Docs]\Tutorials\Tutorial 1\Step 5.rpx` captures everything so far.

Step 6 – perform and review the calculations

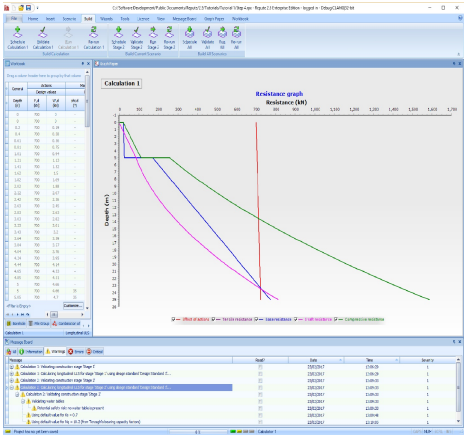
In Step 6, you will perform the calculations and review the results.

1. Run the calculation by selecting the **Build** tab on Repute's ribbon and then clicking on the **Run All** button.



2. Repute will perform all the calculations that you have specified (i.e. Calculations 1 and 2) and then change to its **Checking Desktop** (which displays the Workbook and Graph Paper). You can switch to this display at any time by clicking on the **Check** button on the **View** tab of Repute's ribbon.

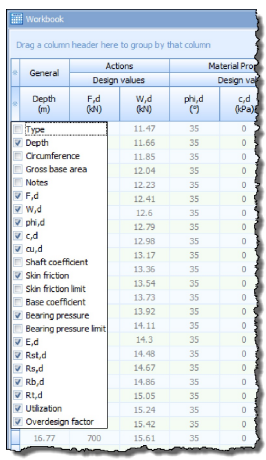
3. Your screen will now look something like this:



4. The **Graph Paper** (top right panel) shows:
   - effect of the actions *E* (the sum of the applied forces and the self-weight of the pile) increasing slightly with depth
   - separate components of shaft and base resistances, R_s and R_b
   - the total compressive resistance, $R_c = R_s + R_b$, exceeding the effect of actions ($E \leq R_c$) at a depth between 13.5 and 14.5 m (depending on which calculation is displayed)

5. The **Workbook** (top left panel) shows the same information, but in tabular format. The Workbook contains a lot more information than is initially shown. To display this additional information, click on the button labelled '*' in the top-left-hand corner of the Workbook (to the left of the heading 'Depth') and select the data you want to see.

6. To view the results of the second calculation, select Calculation 2 in the Project Manager. Repute will automatically update the Workbook and Graph Paper with this calculation's data. (To display the Project Manager, select the **View** tab on Repute's ribbon and then click on the **Project Manager** button.)

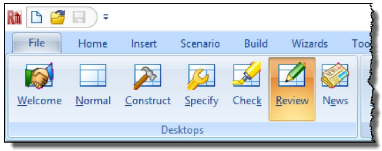


`[Docs]\Tutorials\Tutorial 1\Step 6.rpx` captures everything so far.

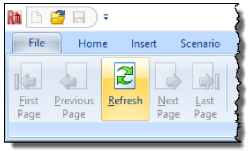
Step 7 – produce a report

In Step 7, you will produce a report summarising the calculations.

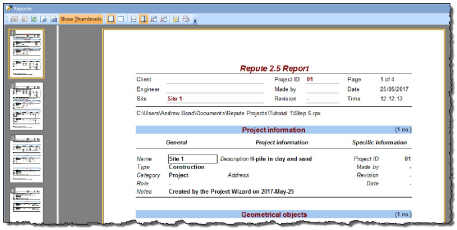
1. Display Repute's reporting tools by selecting the **View** tab on Repute's ribbon and then clicking on the **Review** button.



2. Next, create a report by selecting the **Reporter** tab on Repute's ribbon and clicking on the **Refresh** button.



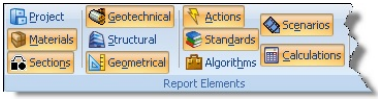
3. Repute will generate the requested report and display it, together with a set of thumbnails, in the Reporter.



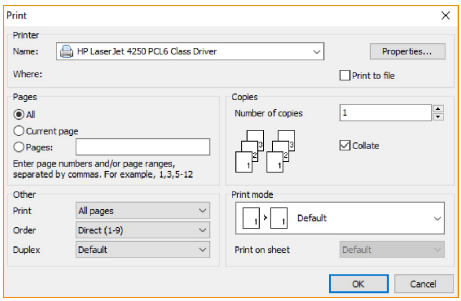
4. You can navigate around the report using the controls on the **Reporter** tab on Repute's ribbon: First Page, Previous Page, Next Page, and Last Page. You can jump to specific pages by clicking on the thumbnails on the left-hand side of the Reporter.

5. You can also re-size the report using the Fit Width, Fit Height, Zoom In, and Zoom Out controls.

6. You can choose what to include in your report by selecting or deselecting individual items in the **Report Elements** group, then clicking the **Refresh** button.



7. You can edit the report's layout using the **Modify** command (this is only available in the Enterprise Edition of the program).
8. You must close this window in order to return to Repute. You can do this by going to File and then selecting Exit.
9. Finally, you can output the report onto paper using the **Print** command and choosing from the options provided in the dialog box that appears on your screen. (Note: this is not available in the Trial Edition.)



Step 8 – close the project

In Step 8, you will close and – optionally – save the project. (Note: this is not available in the Trial Edition.)

1. Close the project by clicking on the **File** menu's **Close** command.
2. If you have made changes to the project since it was last saved, Repute will ask you if you want to save before proceeding. Answer **Yes** or **No** by clicking the appropriate button.
3. Repute will then (if requested) save and close the project.

`[Docs]\Tutorials\Tutorial 1\Tutorial 1.rpx`. captures everything in this tutorial.

What next?

Tutorial 2 shows you how to set up Fleming's hyperbolic analysis.

TUTORIAL 2
FLEMING'S HYPERBOLIC ANALYSIS

Tutorial 2 shows you how to construct a load vs displacement curve for a single pile, using Fleming's hyperbolic analysis, described in his 1992 Géotechnique paper "A new method for single pile settlement prediction and analysis" (see vol. 42, no. 3, pp 411-425). This tutorial demonstrates how to setup a calculation in Repute without using the program's built-in wizards, thereby showing you how versatile the program's user interface is.

The worked example is taken from Figure 6 in Fleming's paper, which is based upon from tests carried out at Wembley by Whitaker & Cooke. We are interested in replicating the load vs displacement curve given by Fleming's analysis.

- Ground conditions at the site are not given in the paper, so we will assume 25m of London Clay with an undrained strength of 100 kPa and an angle of shearing resistance of 23°.
- The pile studied is a 12.2 m long, 775 mm diameter bored pile made of concrete with Young's modulus equal to 19.5 GPa.
- A vertical load of 200 tonnes (approximately 2000 kN) is applied at the centre of the pile.
- The ultimate load that the pile can carry has been calculated (separately) as 1994 kN on the shaft and 1002 kN from the base. The soil modulus below the pile base is 33.125 MPa. Other parameters used by Fleming are the shaft flexibility factor (0.0017 or 0.17%) and effective column length factor (0.45).

This tutorial is written for users of the Standard, Enterprise, and Trial Editions of Repute only. Users of the Professional Edition should look at Tutorials 4-6.

Overview

- In Step 1, you will enter project information about the site and the Engineer.
- In Step 2, you will define the site's ground conditions.
- In Step 3, you will create a bored pile and specify its cross-section and concrete grade.
- In Step 4, you will create the force applied to the pile.
- In Step 5, you will sleeve the pile through the made ground.
- In Step 6, you will create the scenario and calculation and link various

items together.

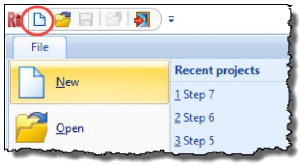
- In Step 7, you will perform the calculation and produce a report showing the relationship between load and displacement.
- In Step 8, you will close (and optionally save) the project.

If Repute is not already running, double-click on the Repute icon on Windows' Desktop to start the program. Once the splash screen has disappeared, Repute displays its Welcome page.

If you have an existing project open, click **Close** on the program's **Application menu**. You will be prompted to save your work if you have not already done so.

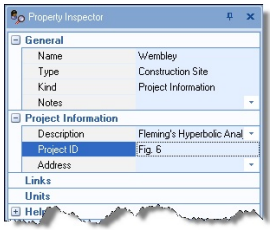
Step 1 – create the project information

In Step 1, you will enter project information about the site and the Engineer.



1. Click **New** on the program's **File** menu to create a blank project. Alternatively, click on the **New** button on the **Quick-access toolbar**, located on the right-hand side of Repute's icon in the tile bar.
2. Open the Stockyard's Project Information group by selecting the **Insert** tab on Repute's ribbon and then clicking on the **Project Information** button. The Project Information group will open in the Stockyard.

3. Hold the `Ctrl` key down and click on the item labelled "Construction Site". A newly-created site will appear in the Project Manager (under Project Information).
4. In the Project Manager, double-click on the newly-created site ("Site 1") to open its Property Inspector.



5. In the Property Inspector, change the **Name** to "Wembley".
6. Enter "Fleming's Hyperbolic Analysis" in the **Description** box and click OK to confirm what you have typed.
7. Enter "Fig. 6" in the **Project ID** box.
8. Returning to the Stockyard, create a Party by holding down the `Ctrl` key and clicking on the item labelled "Party". A newly-created party will appear in the

Project Manager (under Project Information) as “Party 1” and the Property Inspector will display its default properties.

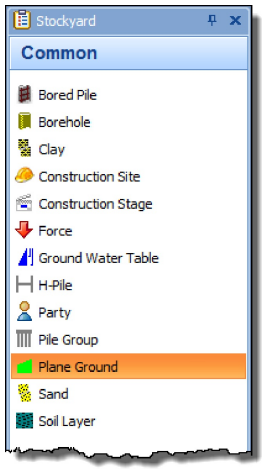
9. In the Property Inspector, change the **Name** of the newly-created party to “Whitaker and Cooke” and their role to “Engineer” (if not already selected).

`[Docs]\Tutorials\Tutorial 2\Step 1.rpx` captures everything so far.

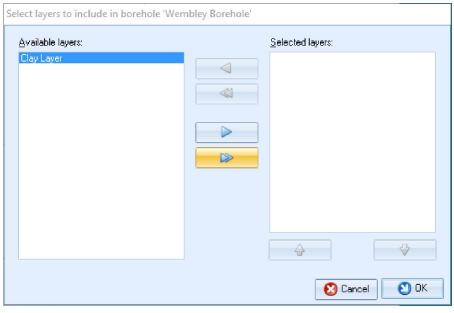
Step 2 – create the ground conditions

In Step 2, you will define the site’s ground conditions.

1. Returning to the Stockyard, click on the button labelled **Common** to open the Common group, where you will find (amongst other items) Plane Ground.
2. Hold the `Ctrl` key down and click on the item labelled “Plane Ground” to create it.
3. In the Property Inspector, change the **Name** “Ground Surface 1” to “Horizontal Ground” but leave the other (default) properties unchanged.
4. Back in the Stockyard, open the Grounds group so that you can create a Clay. You may need to click one of the small buttons at the bottom of the Stockyard to display this group. You can move the mouse over each button in turn to display a tooltip indicating which panels they control. Create the Clay by Ctrl-clicking on it.
5. In the Property Inspector, change the **Name** of the new Clay to “London Clay”, and enter the following properties: under the heading *Drained Strength*, **Angle of shearing resistance** = 23°; under *Undrained strength*, **Undrained strength** = 100 kPa.



6. In the Stockyard, open the Geotechnical Constituents group and create both a Soil Layer and a Borehole.
7. Select the layer in the Project Manager and then (in the Property Inspector) change its **Name** to “Clay Layer”, its **Thickness** to 25 m, and select “London Clay” in its **Soil** box, under the heading *Material*.
8. Now select the borehole in the Project Manager and the, in the Property Inspector, rename it “Wembley Borehole”. Next, press the **Select...** button.
9. In the dialog box that appears, click on the >> button to move “Clay Layer” from the **Available layers** box to the **Selected layers** box. Click **OK** to confirm the changes.

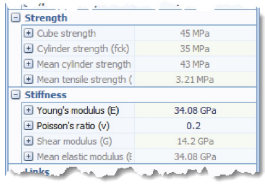


`[Docs]\Tutorials\Tutorial 2\Step 2.rpx` captures everything so far.

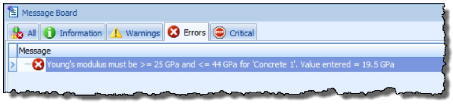
Step 3 – create the pile

In Step 3, you will create a bored pile and specify its cross-section and concrete grade.

1. Open the Concretes group in the Stockyard and create a concrete of grade C35/45.



2. In the Property Inspector, attempt to change the **Young's modulus (E)** of the new concrete to 19.5 GPa. When you press `ENTER`, the value will revert back to 34.08 GPa and the **Message Board** will open to reveal the error message "Young's modulus must be >= 25 GPa and <= 44 GPa for 'Concrete 1'. Value entered = 19.5 GPa". Since the value of Young's modulus used by Fleming is outside the allowable range for Grade Concrete, we need to use a Custom Concrete instead.



3. Back in the Concretes panel, create a Custom Concrete. Then set its **Young's modulus (E)** to 19.5 GPa (this should succeed) and change its **Name** to "Fleming's concrete".

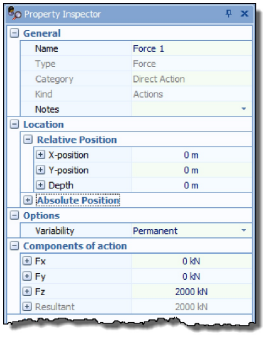
4. Because we no longer need the Grade Concrete, we can delete it from the project by right-clicking on 'Concrete 1' in the Project Manager and selecting **Edit > Delete**. When prompted, confirm that you want to delete 'Concrete 1 (Grade Concrete)'.

5. Open the Structural Elements group in the Stockyard and create a Bored Pile.
6. In the Property Inspector, change the **Length** of the new pile to 12.2 m and its **Shaft diameter** to 775 mm (its base diameter will automatically increase to 775 mm). Finally, select "Fleming's concrete" in the box **Material name**.

`[Docs]\Tutorials\Tutorial 2\Step 3.rpx` captures everything so far.

Step 4 – create the force

In Step 4, you will create the force applied to the pile.

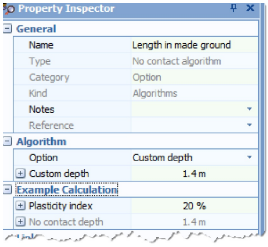


1. Open the Actions group in the Stockyard and create a Force.
2. In the Property Inspector, change the **Variability** (under **Options**) of the new force to "Permanent"
3. Change **Fz** (under **Components of action**) to 2000 kN, whereupon the **Resultant** will automatically change to 2000 kN.

`[Docs]\Tutorials\Tutorial 2\Step 4.rpx` captures everything so far.

Step 5 – sleeve the pile

In Step 5, you will sleeve the pile through the made ground.

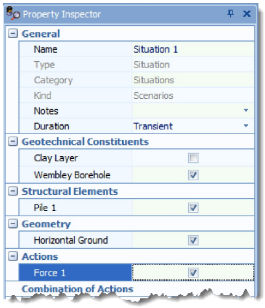


1. Open the Algorithms group in the Stockyard and create a No contact algorithm.
2. In the Property Inspector, change the **Name** of the new algorithm to "Length in made ground" and **Custom depth** to 1.4 m. The **Algorithm Option** will automatically change to "Custom depth". In the example calculation, the **No contact depth** will also change to 1.4 m (which is depth of ground that the calculation will ignore when calculating skin friction).

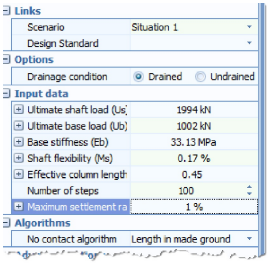
`[Docs]\Tutorials\Tutorial 2\Step 5.rpx` captures everything so far.

Step 6 – create the scenario and calculation

In Step 6, you will create the scenario and calculation and link various items together.



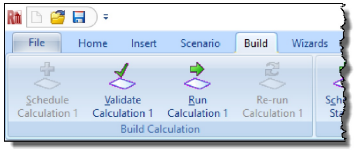
1. Open the Scenarios group in the Stockyard and create a Situation.
2. In the Property Inspector, change the scenario's **Duration** to "Transient". Then, tick the following items so that they appear in this scenario (as you do so, they will appear on the Drawing Board):
   - Wembley Borehole
   - Pile 1
   - Horizontal Ground
   - Force 1
3. Open the Calculations group in the Stockyard and create Fleming's Analysis.
4. In the Property Inspector, set the **Scenario** to "Situation 1" and the **No contact algorithm** to "Length in made ground".
5. Enter the following values for the calculation's other properties: **Ultimate shaft load (Us)** 1994 kN; **Ultimate base load (Ub)** 1002 kN; **Base stiffness (Eb)** 33.125 MPa; **Shaft flexibility (Ms)** 0.17%; and **Effective column length (Ke)** 0.45. These values are taken directly from Fleming's paper.
6. Finally, set the **Maximum settlement ratio** to 1%. This controls how much of the load vs displacement curve is generated. You want to go up to about 8 mm displacement, which is 1% of the pile diameter.



`[Docs]\Tutorials\Tutorial 2\Step 6.rpx` captures everything so far.

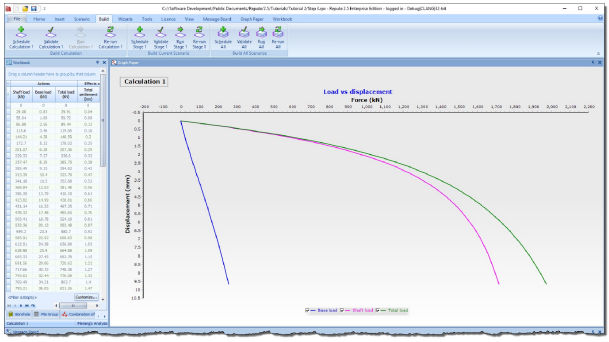
Step 7 – perform and review the calculation

In Step 7, you will perform the calculation and produce a report showing the relationship between load and displacement.



1. Run the calculation by selecting the **Build** tab on Repute's ribbon and then clicking on the button labelled **Run Calculation 1**.
2. Repute performs the calculation and then changes to its **Checking Desktop** (which displays the Workbook and Graph Paper).

3. Your screen will now look something like this:



4. The **Graph Paper** displays a graph which is almost identical to Figure 6 in Fleming's paper, showing:

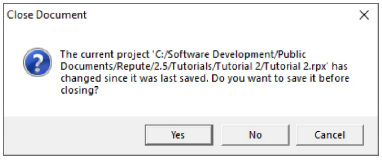
   - Base load vs displacement (in blue)
   - Shaft load vs displacement (in pink)
   - Total load vs displacement (in green)

5. You can view the data on which this graph is based in the **Workbook** (left).

Step 8 – close the project

In Step 8, you will close and – optionally – save the project. (Note: this is not available in the Trial Edition.)

1. Click on the program's **File** menu and click **Close**.
2. If you have made changes to the project since it was last saved, Repute will ask you if you want to save it before proceeding. Answer Yes or No by clicking the appropriate button.



3. Repute will then (if requested) save and close the project.

`[Docs]\Tutorials\Tutorial 2\Tutorial 2.rpx` captures the everything in this tutorial.

A Repute project which reproduces all nine hyperbolic analyses from of Fleming's paper can be found in `[Docs]\Examples\Fleming (1992).rpx`.

What's next?

Tutorial 3 shows you how to design a single pile in accordance with the requirements of Eurocode 7.

TUTORIAL 3
SINGLE PILE DESIGN TO EUROCODE 7

Tutorial 3 shows you how to design a single pile according to the requirements of Eurocode 7. The worked example is taken from Chapter 13 of the book "Decoding Eurocode 7" by Bond and Harris (2008), London: Taylor and Francis.

- Ground conditions comprise 8 m of medium strength sandy CLAY overlying medium dense gravelly SAND. The clay has characteristic undrained strength of 45 kPa and characteristic weight density of 18.5 kN/m^3. The sand a characteristic angle of shearing resistance of 36°, zero effective cohesion, and characteristic weight density of 20 kN/m^3. The sand's constant-volume angle of shearing-resistance is 33°.
- Groundwater at the site is at 1 m depth and skin friction above groundwater will be ignored.
- The pile studied is a 10 m long, 400 mm square pile made of concrete with characteristic weight density of 25 kN/m^3.
- Vertical loads of 650 kN (permanent) and 250 kN (variable) will be applied to the pile.
- You want to determine the minimum pile length required by Eurocode 7 according to the National Annexes published in Ireland and in the United Kingdom.

Full hand calculations for this example are given as Examples 13.1 and 13.2 in Bond and Harris (2008).

This tutorial is written for users of the Standard, Enterprise, and Trial Editions of Repute only. Users of the Professional Edition should look at Tutorials 4-6.

Overview

- In Step 1, you will use the Project Wizard to enter project information, select design standards, and create a scenario to represent short-term conditions.
- In Step 2, you will use the Borehole Wizard to create a borehole containing the clay and sand layers.
- In Step 3, you will add a water table to the scenario.
- In Step 4, you will create a pile and specify its cross-section and concrete grade.
- In Step 5, you will use the Action Wizard to create the forces applied to

the pile.

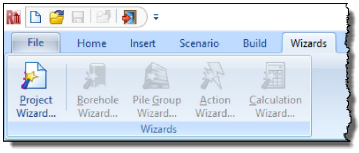
- In Step 6, you will use the Calculation Wizard to create a calculation and specify the design standard to use in that calculation.
- In Step 7, you will specify precise details of how you want the calculation to be performed.
- In Step 8, you will perform the calculations and review the results.
- In Step 9, you will create a second calculation, identical to the first but based on the UK National Annex to Eurocode 7.
- In Step 10, you will close (and optionally save) the project.

If Repute is not already running, double-click on the Repute icon on Windows' Desktop to start the program. Once the splash screen has disappeared, Repute displays its Welcome page.

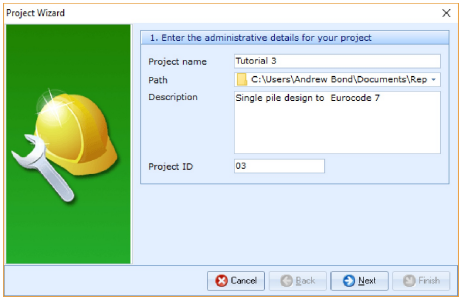
If you have an existing project open, click **Close** on the program's **File menu**. (You will be prompted to save your work if you have not already done so.)

Step 1 – create the project

In Step 1, you will use the Project Wizard to enter project information, select design standards, and create a scenario to represent short-term conditions.

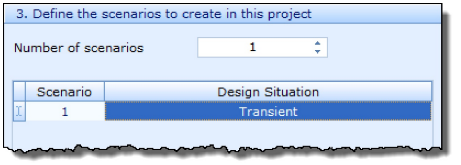


1. Open the Project Wizard by selecting the **Wizards** tab on Repute's ribbon and then clicking on the **Project Wizard** button.
2. When the Wizard appears, type "Tutorial 3" in the **Project name** box. Choose the folder where you want to save this project by using the **Path** control – for example, 'Repute Projects', which you could create using Windows' File Explorer. (If you do not change the setting here, it will be saved in your 'Documents' folder.)
3. Enter "Single pile design to Eurocode 7" in the **Description** box and "03" in the **Project ID** box.



4. Click **Next** to display the next page. The design standards that appear here depend on which edition of Repute you are running (the Enterprise Edition supports more design standards than the Standard and Professional editions).
5. Select BS EN 1997-1: 2004 and IS EN 1997-1:2005 by clicking on the relevant check-boxes (a tick mark appears next to a standard when it is selected).

6. Click **Next** to display the next page. Keep the **Number of scenarios** as 1, but change the **Design Situation** of Scenario 1 to "Transient".



7. Click **Next** to display the final page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
8. Click **Finish** to generate the project. The Project Wizard then:

- Creates Site 1, Ground Surface 1, Design Standards 1 and 2, and Situation 1
- Adds Ground Surface 1 to Situation 1
- Creates a new project named `Tutorial 3.rpx` with all these items

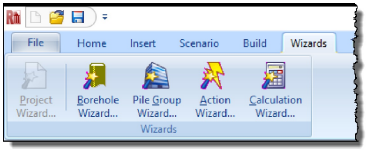
9. Finally, rename the design standards to make it easier to identify them later, as follows. Locate Design Standard 1 (under "Design Standards > Limit State Standards") in the **Project Manager**, right-click on it, and select **Properties**. The Property Inspector will appear. Change the **Name** of this standard to "EC7 with UK NA".
10. Repeat the previous step for Design Standard 2, renaming it "EC7 with Irish NA".

`[Docs]\Tutorials\Tutorial 3\Step 1.rpx` captures everything so far.

Step 2 – create the borehole

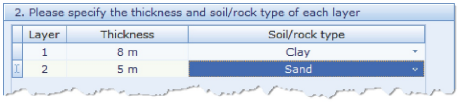
In Step 2, you will use the Borehole Wizard to create a borehole containing the clay and sand layers.

1. Open the Borehole Wizard by selecting the **Wizards** tab on Repute's ribbon and then clicking on the **Borehole Wizard** button.

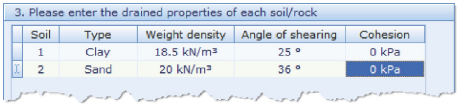


2. When the Wizard appears, increase the number of layers to 2.

3. Click **Next** to display the next page. Change Layer 1's **Thickness** to 8 m and its **Soil type** to "Clay". Change the thickness of Layer 2 to 5 m but leave its soil type as "Sand".

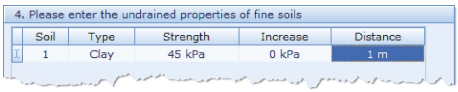


4. Click **Next** to display the next page. Change the **Weight density** of Soil 1 to 18.5 kN/m^3 but leave its other properties unchanged. Change the **Angle of shearing** of Soil 2 to 36° but leave its other properties unchanged.


3. Please enter the drained properties of each soil/rock

	Soil	Type	Weight density	Angle of shearing	Cohesion
	1	Clay	18.5 kN/m³	25 °	0 kPa
	2	Sand	20 kN/m³	36 °	0 kPa

5. Click **Next** to display the next page. Change the **Strength** of Soil 1 to 45 kPa. Leave all other properties unchanged. (Note that Soil 2 does not appear on this page, since sand is a fine soil and so does not have undrained properties.)


4. Please enter the undrained properties of fine soils

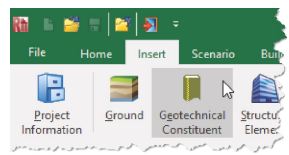
	Soil	Type	Strength	Increase	Distance
	1	Clay	45 kPa	0 kPa	1 m

6. Click **Next** to display the next page. Since the ground profile does not include rock, there is nothing to set on this page.
7. Click **Next** to display the next page. Place a tick in the checkbox for **Situation 1**.
8. Click **Next** to display the final page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
9. Click **Finish** to generate the borehole. The Borehole Wizard then:
   - Creates Soils 1 and 2, Layers 1 and 2, and Borehole 1
   - Links Soil 1 to Layer 1
   - Links Soil 2 to Layer 2
   - Adds Layers 1and 2 to Borehole 1

`[Docs]\Tutorials\Tutorial 3\Step 2.rpx` captures everything so far.

Step 3 – add a water table

In Step 3, you will add a water table to the scenario.



1. Open the Stockyard's Geotechnical Constituents panel by selecting the **Insert** tab on Repute's ribbon and then clicking on the **Geotechnical Constituents** button. The Geotechnical Constituents panel will open in the Stockyard.
2. Hold the `Ctrl` key down and click on the item labelled "Ground Water Table". The newly-created water table will appear in the Project Manager (under Geotechnical Constituents > Water Tables).
3. In the Property Inspector, change the **Depth** of Water Table 1 (which you will find under Location > Relative Position) to 1 m.

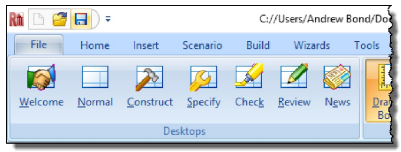
4. In the Project Manager, select “Situation 1” (under Scenarios > Situations).
5. In the Property Inspector, place a tick next to Water Table 1 (under Geotechnical Constituents) to add the water table to this scenario. The Drawing Board will refresh.
6. In this step, you have:
   - Created Water Table 1
   - Added Water Table 1 to Situation 1

`[Docs]\Tutorials\Tutorial 3\Step 3.rpx` captures everything so far.

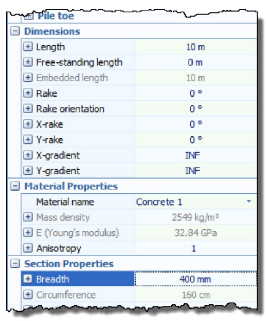
Step 4 – create the pile

In Step 4, you will create a pile and specify its cross-section and concrete grade.

1. Display Repute’s **Construct** desktop by selecting the **View** tab and clicking on the **Construct** button. The program will display the Drawing Board, Project Manager, and Stockyard.



2. Right-click anywhere inside the Stockyard to display its context menu and select the **Concretes** command. The Concretes group will open.
3. Create the concrete by holding the `Ctrl` key down and clicking on the item labelled “C30/37”. (When the `Ctrl` key is pressed, Repute automatically creates an instance of the item that is selected in the Stockyard.) The newly-created concrete will appear in the Project Manager (under Materials > Concretes).
4. Next, click on the Stockyard’s Structural Elements caption (near the bottom of the Stockyard). The Structural Elements group will open.
5. Create the pile by holding the `Ctrl` key down and clicking on the item labelled “Square Pile”. The newly-created pile will appear in the Project Manager (under Structural Elements).
6. In the Project Manager, right-click on the newly-created pile (“Pile 1”) and select **Properties...**. The Property Inspector will appear.
7. In the Property Inspector, change the **Material Name** (under Material Properties) from “Not specified” to “Concrete 1”. Then change the pile’s **Length** (under Dimensions) to 10 m and



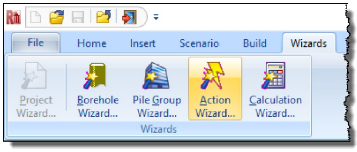
its **Breadth** (under Section Properties) to 400 mm. Leave all other properties of the pile unchanged.

8. Returning to the Project Manager, select Situation 1 (under Scenarios > Situation).
9. In the Property Inspector, place a tick next to Pile 1 (under Structural Elements) to add the pile to this scenario. The Drawing Board will refresh.
10. In this step, you have:
    - Created Concrete 1 and Pile 1
    - Linked Concrete 1 to Pile 1
    - Added Pile 1 to Situation 1

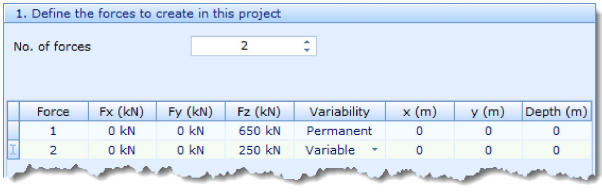
`[Docs]\Tutorials\Tutorial 3\Step 4.rpx` captures everything so far.

Step 5 – create the forces

In Step 5, you will use the Action Wizard to create the forces applied to the pile.

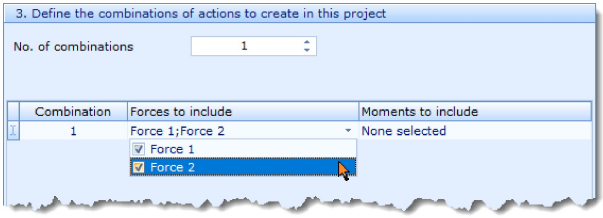


1. Open the **Action Wizard** by selecting the Wizards tab on Repute's ribbon and clicking on the **Action Wizard** button.
2. When the Wizard appears, increase the **No. of forces** to 2; "Force 1" and "Force 2" will be created.
3. Set the **Fz** value for Force 1 to 650 kN and change its **Variability** to "Permanent".
4. Then set the **Fz** value for Force 2 to 250 kN but keep its **Variability** as "Variable".



5. Click **Next** to display the next page. Since no moments are applied to the pile, leave the number of moments as 0.
6. Click **Next** to display the next page. Increase the **No. of combinations** to 1; "Combination 1" will be created. Under the column **Forces to include...**, tick

Force 1 and Force 2.



7. Click **Next** to display the last page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
8. Click **Finish** to generate the actions and their combination. The Actions Wizard will then:
   - Create Forces 1 and 2
   - Create Combination 1
   - Add Forces 1 and 2 to Combination 1
9. Returning to the **Project Manager**, select Situation 1 (under Scenarios > Situations).
10. Then, in the **Property Inspector**, place a tick next to Combination 1 (under Actions) to add the combination to this scenario. The Drawing Board will refresh.

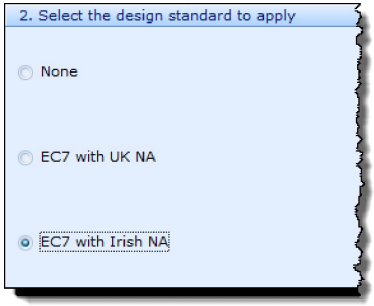
`[Docs]\Tutorials\Tutorial 3\Step 5.rpx` captures everything so far.

Step 6 – create the calculation

In Step 6, you will use the Calculation Wizard to create a calculation and specify the design standard to use in that calculation.

1. Open the **Calculation Wizard** by selecting the **Wizards** tab on Repute's ribbon and then clicking on the **Calculation Wizard** button.
2. When the Wizard appears, select "Longitudinal ULS". (The calculations that appear here depend on which edition of Repute you are running. The Enterprise Edition provides more calculations than the Standard and Professional editions.)

3. Click **Next** to display the next page. Select "EC7 with Irish NA".



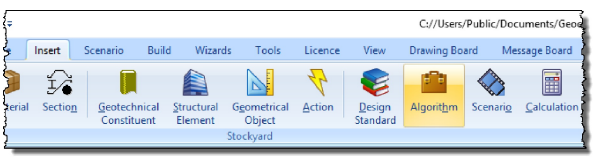
4. Click **Next** to display the next page. Place a tick in the checkbox next to **Situation 1**.
5. Click **Next** to display the final page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
6. When you are ready, click **Finish** to generate the first calculation. The Calculation Wizard then:
   - Creates Calculation 1
   - Links Situation 1 to Calculation 1
   - Links "EC7 with Irish NA" to Calculation 1

`[Docs]\Tutorials\Tutorial 3\Step 6.rpx` captures everything so far.

Step 7 – customize the calculation

In Step 7, you will specify precise details of how the calculation is to be performed, following the decisions made by Bond and Harris, 2008.

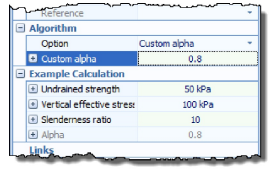
1. Open the Stockyard's Algorithms group by selecting the **Insert** tab on Repute's ribbon and then clicking on the **Algorithm** button.



2. Hold the `CTRL` key down and click on "No contact algorithm" in the Stockyard. Then, in the Property Inspector, change the **Name** of the new algorithm to "No skin friction" and enter "Ignore skin friction above water

table" in its **Notes** field. Enter a value of 1.0 m into the **Custom depth** box, whereupon the **Algorithm Option** will automatically change to "Custom depth".

3. Hold the CTRL key down and click on "Alpha" in the Stockyard. Change the **Name** of the new algorithm to "Alpha in clay" and enter "From US Army Corps of Engineers" in its **Notes** field. Enter a value of 0.8 into the **Custom alpha** box, whereupon the **Option** will automatically change to "Custom alpha".



4. Hold the CTRL key down and click on "Earth pressure coefficient" in the Stockyard. Change the **Name** of the new algorithm to "Ks in sand" and enter "= Nq/50" in its **Notes** field. Enter a value of 1.59 into the **Custom compression coefficient** box, whereupon the **Option** will automatically change to "Custom earth pressure coefficient".

5. Hold the CTRL key down and click on "Wall friction" in the Stockyard. Change the **Name** of the new algorithm to "Delta in sand" and enter "= constant volume angle of shearing resistance" in its **Notes** field. Enter a value of 33° into the **Custom friction value** box, whereupon the **Option** will automatically change to "Custom friction value".

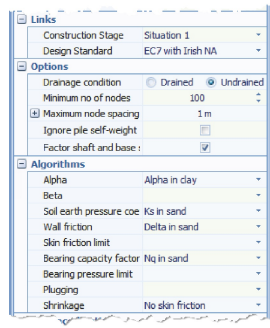
6. Hold the CTRL key down and click on "Bearing capacity algorithm" in the Stockyard. Change the **Name** of the new algorithm to "Nq in sand". Change the **Option** to Berezantzev. In the **Example Calculation** group, change the **Angle of shearing resistance** to 35° and the **Slenderness ratio** to 25. The value of **Nq** will update (to 47.23), while **Nc** is not specified (since Berezantzev's algorithms is only applicable to sands).

7. Select "Calculation 1" in the **Project Manager**.

8. In the **Property Inspector**, set a link to the bearing capacity algorithm you have just created by clicking on the down arrow to the right of the heading **Bearing Capacity Factor** and selecting 'Nq in sand'.

9. Repeat the previous instruction for the other algorithms you have created (i.e. Wall friction, Earth pressure coefficient, Alpha, and Shrinkage).

10. Also tick the **Undrained resistance** option to ensure that the calculation is based on total stresses in the clay.

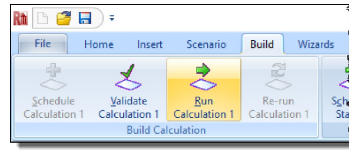


[Docs]\Tutorials\Tutorial 3\Step 7.rpx captures everything so far.

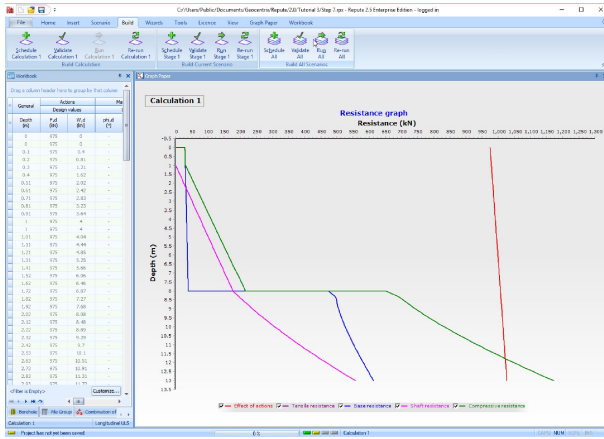
Step 8 – perform and review the calculations

In Step 8, you will perform the calculation and review the results.

1. Run the calculation by selecting the **Build** tab on Repute's ribbon and then clicking on the **Run Calculation 1** button.



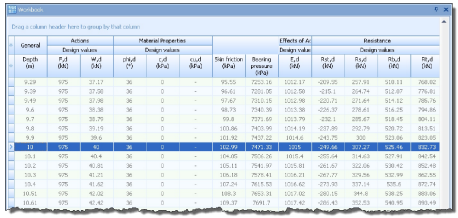
2. Repute will perform the specified calculation and then change to its **Check Desktop** (which displays the Workbook and Graph Paper). Your screen will now look something like:



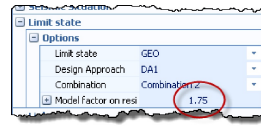
3. The **Graph Paper** (top right panel) shows the:

   - Effect of actions (E, equal to the sum of the applied forces and the self-weight of the pile) increasing with depth
   - Separate components of tensile resistance (R_t), base resistance (R_b), and shaft resistance (R_s) also increasing with depth
   - The total compressive resistance ($R_c = R_s + R_b$) exceeding the effect of actions ($E \leq R_c$) at a depth between 11 and 12 m

4. The **Workbook** (top left panel) shows the same information in tabular format. The Workbook contains a lot more information than is initially shown. To display this additional information, click on the button in the top-left-hand corner (labelled *) and select the data you want to see. The picture here show results for the depth 10 m.



5. The results calculated by Repute differ from those given in the book by Bond and Harris (2008), where a model factor on resistance of 1.5 was used (following the *draft* Irish National Annex). Instead, Repute uses the value 1.75 that appears in the published version of that Annex.



6. You can check this by selecting the **View** tab on Repute's ribbon and then clicking on the **Specify** button. Then, select 'EC7 with Irish NA' in the **Project Manager** to display its properties in the **Property Inspector**. Expand the category labelled **Options** (if necessary) and read the value for **Model factor on resistance**.

A Repute project that reproduces Bond and Harris's calculations can be found in `[Docs]\Examples\Bond and Harris (2008) Ex 13.1.rpx`.

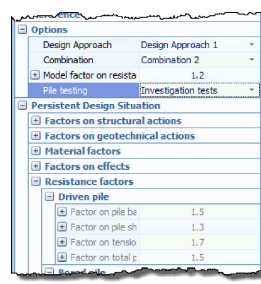
Step 9 – change the design standard

In Step 9, you will create a second calculation, identical to the first but based on the UK National Annex to Eurocode 7.

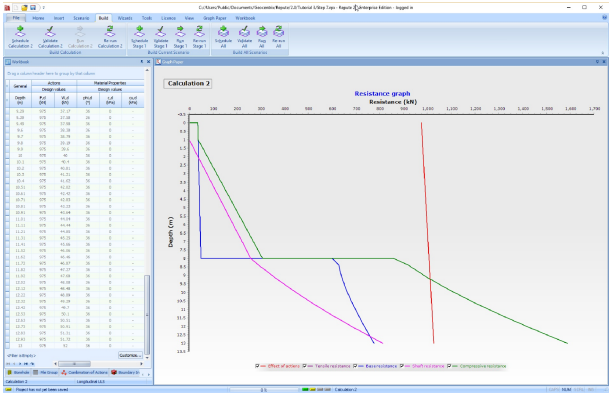
1. Returning to the **Project Manager**, create a copy of Calculation 1 by right-clicking on it (under 'Calculations') and selecting the **Edit > Duplicate** command.

2. With this calculation selected in the **Project Manager**, change its **Name** to 'Calculation 2' and its **Design Standard** to 'EC7 with UK NA'.

3. In the **Project Manager**, select the Design Standard 'EC7 with UK NA'. Then in the **Property Inspector**, set **Options > Pile testing** to 'Investigation tests'. The values of the model factor and the resistance factors will change. This setting is appropriate when the calculated resistance will be checked by static pile load tests taken to ultimate load.



4. Run the calculation by selecting the **Build** tab on Repute's ribbon and then clicking on the **Run 'Calculation 2'** button. (If this button is disabled or reads **Run 'Calculation 1'**, then go back to the Project Manager and select Calculation 2, then re-try.) Your screen will now look something like this:



Step 10 – close the project

In Step 10, you will close and – optionally – save the project. (Note: this is not available in the Trial Edition.)

1. Display the program's **File Menu** and close the project by clicking on **Close**.
2. If you have made changes to the project since it was last saved, Repute will ask you if you want to save before proceeding. Answer Yes or No by clicking the appropriate button.
3. Repute will then (if requested) save and close the project.

`[Docs]\Tutorials\Tutorial 3\Tutorial 3.rpx` captures everything in this tutorial.

What's next?

Tutorial 4 shows how the boundary element method can analyse a pile group.

TUTORIAL 4
PILE GROUP IN CLAY AND SAND

Tutorial 4 demonstrates how the boundary element method can be used to analyse a pile group. The worked example involves a group of four bored piles in stiff clay overlying dense sand:

- Ground conditions comprise 8m of stiff clay overlying dense sand. Both soils will be modelled as linear elastic materials.
- The stiff clay has a vertical Young's modulus of 40 MPa and a horizontal modulus of 20 MPa, with Poisson's ratio equal to 0.5.
- The dense sand has the same Young's modulus vertically and horizontally, equal to 50 + 10z MPa (where z is the depth below the top of the sand in metres), and Poisson's ratio equal to 0.3.
- The bored piles are installed on a 2 x 2 grid, at 3 m spacing (centre-to-centre). Each pile is 20 m long, 1050 mm in diameter, with a Young's modulus (vertically and horizontally) of 30 GPa.
- A characteristic vertical force of 12 MN (permanent), horizontal force of 1 MN (variable), and moment of 2 MNm (variable) are applied at the centre of the pile group.
- You want to determine the displacement and rotation of the pile cap under serviceability conditions.

This tutorial is written for users of the Professional, Enterprise, and Trial Editions of Repute only. Users of the Standard Edition should look at Tutorials 1-3.

Overview

- In Step 1, you will use the Project Wizard to enter project information and create a scenario to represent a persistent design situation.
- In Step 2, you will use the Pile Group Wizard to create a 2 x 2 pile group and specify the piles' properties.
- In Step 3, you will use the Borehole Wizard to create a borehole containing stiff clay and dense sand layers.
- In Step 4, you will enter the stiffness parameters for Soils 1 and 2.
- In Step 5, you will use the Action Wizard to create the actions applied to the pile group.
- In Step 6, you will use the Calculation Wizard to create the calculation you want Repute to perform.

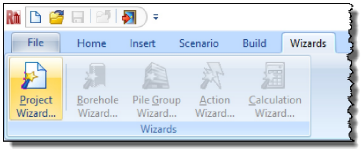
- In Step 7, you will perform the calculation and review the results.
- In Step 8, you will produce a report summarising the calculation.
- In Step 9, you will close and (optionally) save the project.

If Repute is not already running, double-click on the Repute icon on Windows' Desktop to start the program. Once the splash screen has disappeared, Repute displays its Welcome page.

If you have an existing project open, click **Close** on the program's **Application menu**. You will be prompted to save your work if you have not already done so.

Step 1 – create the project

In Step 1, you will use the Project Wizard to enter project information and create a scenario to represent the design situation to be analysed.



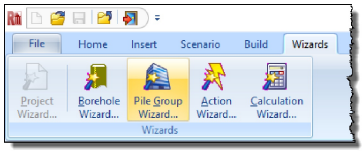
1. Open the Project Wizard by selecting the **Wizards** tab on Repute's ribbon and then clicking on the **Project Wizard** button.
2. When the Wizard appears, type "Tutorial 4" in the **Project name** box. Choose the folder where you want to save this project by using the **Path** control. If you do not change the setting here, the file will be saved in your Documents folder.
3. Enter "Pile group in clay and sand" in the **Description** box and "04" in the **Project ID** box.
4. Click **Next** to display the next page. Since we are not going to use a design standard, there is nothing to set on this page.
5. Click **Next** to display the next page. In the table, change the Design Situation of Situation 1 to "Persistent" (if it is not already set).
6. Click **Next** to display the final page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
7. When you are ready, click **Finish** to generate the project. The Project Wizard then:
   - Creates Site 1, Ground Surface 1, and Situation 1
   - Adds Ground Surface 1 to Situation 1
   - Creates a new project "`Tutorial 4.rpx`" with all of these items

`[Docs]\Tutorials\Tutorial 4\Step 1.rpx` captures everything so far.

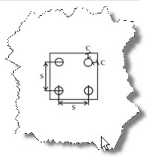
Step 2 – create the pile group

In Step 2, you will use the Pile Group Wizard to create a 2 x 2 pile group and specify the piles' properties.

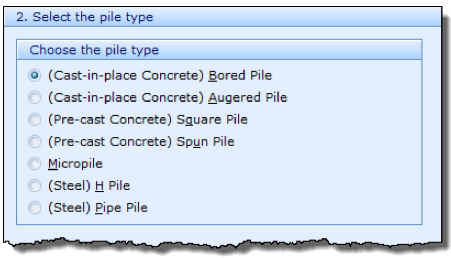
1. Open the **Pile Group Wizard** by selecting the Wizards tab on Repute's ribbon and clicking on the **Pile Group Wizard** button.



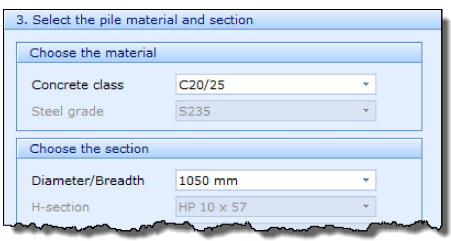
2. When the Wizard appears, choose the **Predefined** plan arrangement and change the **Total number of piles** to 4. The picture on the left-hand side of the Wizard will change to show you the default 2 x 2 pile arrangement. Change the **Spacing** between the piles to 3000 mm, but leave the **Cover** at its default value (150 mm).



3. Click **Next** to display the next page. Choose '(Cast-in-place Concrete) Bored Pile' as the **pile type**.

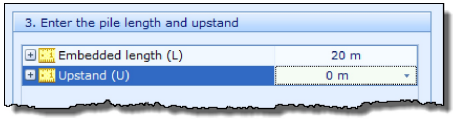


4. Click **Next** to display the next page. Change the **Concrete class** to C20/25 and the **Diameter/Breadth** to 1050 mm. (By default, this concrete has Young's modulus of 30 GPa but this is not shown.)

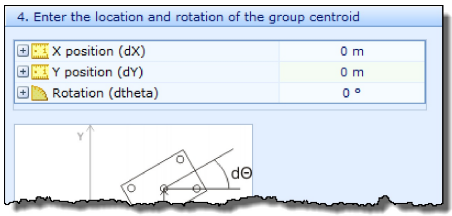


5. Click **Next** to display the next page. Change the **Embedded length (L)** to 20 m

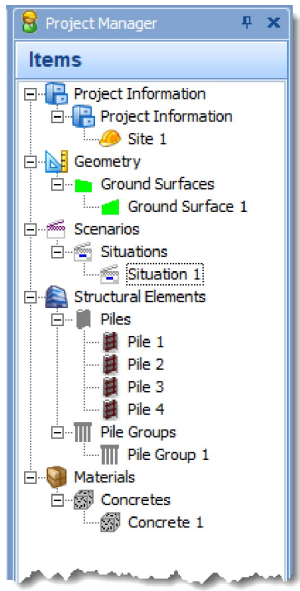
but leave the **Upstand (U)** as 0 m.



6. Click **Next** to display the next page. Leave all the values on this page as zero – this will position the pile group centrally in the co-ordinate system (and not rotated).



7. Click **Next** to display the next page. Tick "Situation 1" to add the pile group to the scenario.
8. Click **Next** to display the last page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
9. When you are ready, click **Finish** to generate the pile group. The Pile Group Wizard then:
    - Creates Piles 1-4
    - Creates Pile Group 1
    - Creates Concrete 1
    - Links Piles 1-4 to Concrete 1
    - Adds Piles 1-4 to Pile Group 1
    - Adds Pile Group 1 to Situation 1
10. Select Pile Group 1 in the Project Manager (under "Structural Elements > Pile Groups"), and double-click to show its properties.
11. Under the heading **Pile Cap,** enter 1.5 into the **Pile cap thickness** editor and press



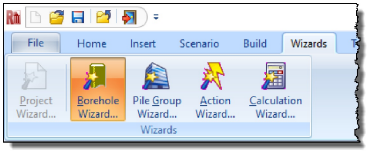
ENTER.

`[Docs]\Tutorials\Tutorial 4\Step 2.rpx` captures everything so far.

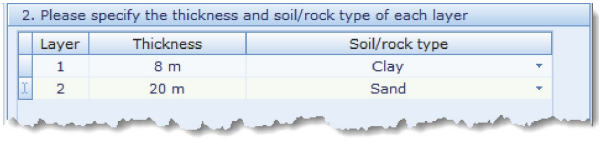
Step 3 – create the borehole

In Step 3, you will use the Borehole Wizard to create a borehole containing stiff clay and dense sand layers.

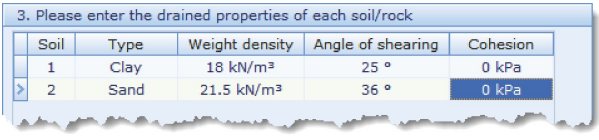
1. Open the **Borehole Wizard** by selecting the Wizards tab on Repute's ribbon and clicking on the **Borehole Wizard** button.



2. When the Wizard appears, increase the number of layers to 2.
3. Click **Next** to display the next page. Change the thickness of Layer 1 to 8 m and its type to "Clay". Change the thickness of Layer 2 to 20 m and its type to "Sand".



4. Click **Next** to display the next page. Change the weight density of Soil 1 to 18 kN/m^3 but leave its angle of shearing as 25°. Change the weight density of Soil 2 to 21.5 kN/m^3 and set its angle of shearing to 36°. Leave the cohesion of both soils unchanged at 0 kPa. Click **Next** to display the next page.

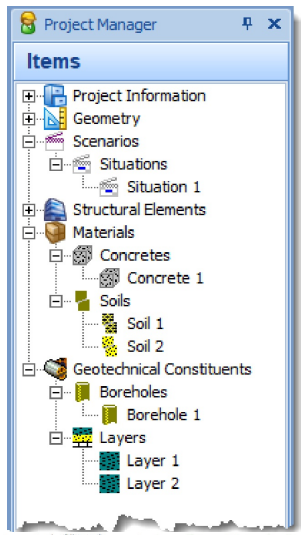


5. Change the undrained strength of Soil 1 to 100 kPa, its increase in strength to 500 kPa, and the distance over which the increase occurs to 8m.


4. Please enter the undrained properties of fine soils

	Soil	Type	Strength	Increase	Distance
1	1	Clay	100 kPa	500 kPa	8 m

6. Click **Next** to display the next page. Since the ground profile does not include rock, there is nothing to set on this page.
7. Click **Next** to display the next page. Tick "Situation 1" to add the borehole to the scenario.
8. Click **Next** to display the last page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
9. When you are ready, click **Finish** to generate the borehole. The Borehole Wizard then:
    - Creates Soils 1-2
    - Creates Layers 1-2
    - Creates Borehole 1
    - Links Soil 1 to Layer 1
    - Links Soil 2 to Layer 2
    - Adds Layers 1-2 to Borehole 1
    - Adds Borehole 1 to Situation 1

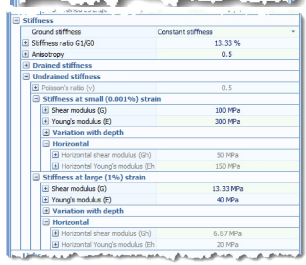


`[Docs]\Tutorials\Tutorial 4\Step 3.rpx` captures everything so far.

Step 4 – enter the soils' stiffness properties

In Step 4, you will enter the stiffness parameters for Soils 1 and 2.

1. Select Soil 1 in the Project Manager (under "Materials"), and double-click to show its properties.
2. Expand the heading **Stiffness > Undrained Young's modulus (Eu) > Large strain stiffness**. Under this heading, enter 40 into the **Undrained Young's modulus** editor and press ENTER.
3. The value of **Shear modulus (G)** will



automatically change to show 13.33 MPa, which you can see if you expand the heading **Stiffness > Shear modulus (G) > Large strain stiffness**.

4. The **Stiffness ratio G1/G0** will change to 13.33%, since the **Small strain stiffness > Shear modulus (G)** value is 100 MPa (= G_0) and G_1 = 13.33 MPa.

5. Near the bottom of the heading **Stiffness**, type 0.5 into the **Anisotropy** editor and press ENTER. The value of undrained **Horizontal Young's modulus (Eh)** will change to 20 MPa (i.e. 40 MPa x 0.5) and the value of **Horizontal shear modulus (Gh)** to 6.67 MPa (i.e. 13.33 MPa x 0.5).

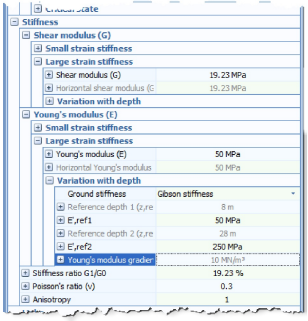
6. Next, select Soil 2 in the Project Manager. The Property Inspector will change to display its properties.

7. heading **General**, type 8 into the **Reference depth 1 (z,ref1)** editor and press ENTER (this is the top of the soil layer).

8. Type 28 into the **Reference depth 2 (z,ref2)** editor and press ENTER (this is the bottom of the soil layer).

9. Under the heading **Stiffness**, (if necessary) type 0.3 into the **Poisson's ratio (v)** editor and press ENTER. The other editors will show their default values.

10. Under the sub-heading **Young's modulus (E) > Large-strain stiffness**, type 50 into the **Young's modulus (E)** editor and press ENTER. The **Large strain stiffness > Shear modulus (G)** value will automatically change to show 19.23 MPa, corresponding to G = E / 2(1 + v).



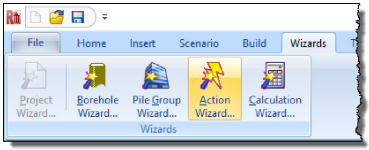
11. Double-click on the sub-heading **Variation with depth** (or single-click on the + button located to the left of it) and type 250 into the **E',ref2** editor and press ENTER. The **Stiffness > Ground Stiffness** editor will change to show "Gibson stiffness" and the value of **Young's modulus gradient (dE/dz)** will change to show 10 MN/m^3.

`[Docs]\Tutorials\Tutorial 4\Step 4.rpx` captures everything so far.

Step 5 – create forces and moments

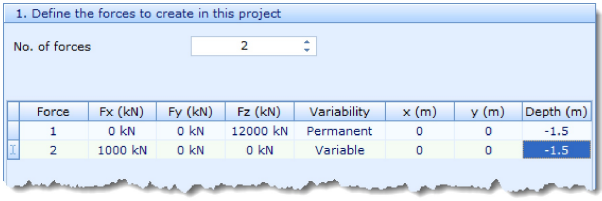
In Step 5, you will use the Action Wizard to create loads applied to the pile group.

1. Open the **Action Wizard** by selecting the Wizards tab on Repute's ribbon and clicking on the **Action Wizard** button.

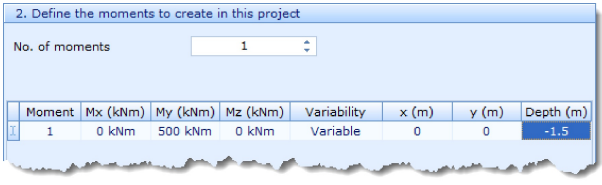


2. When the Wizard appears, increase the number of forces to 2; "Force 1" and "Force 2" will be created. Set the **Fz** value for Force 1 to 12000 kN, the **Fx** value of Force 2 to 1000 kN, and the **Fz** value of Force 2 to 0 kN. Change the **Variability** of Force 1 to "Permanent", but leave that for Force 2 as "Variable".

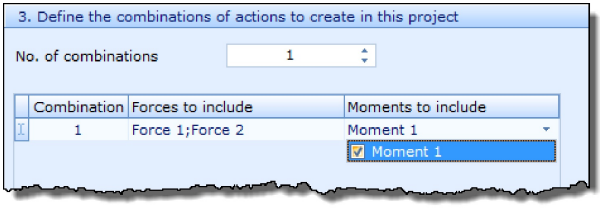
3. Change the **Depth** of both forces to –1.5 m.



4. Click **Next** to display the next page. Increase the number of moments to 1; "Moment 1" will be created. Set its **My** value to 500 kNm, leave its **Variability** as "Variable", and set its **Depth** value to –1.5 m.



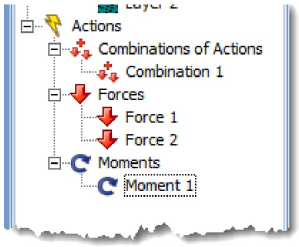
5. Click **Next** to display the next page. Increase the number of combinations to 1; "Combination 1" will be created. Under the column **Forces to include...**, tick Force 1 and Force 2. Under the column **Moments to include...**, tick Moment 1.



6. Click **Next** to display the last page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.

7. When you are ready, click **Finish** to generate the actions and their combination. The Actions Wizard then:

   - Creates Forces 1 and 2
   - Creates Moment 1
   - Creates Combination 1
   - Adds Forces 1 and 2 and Moment 1 to Combination 1



8. Going back to the **Project Manager**, select Situation 1 (under Scenarios > Situations).

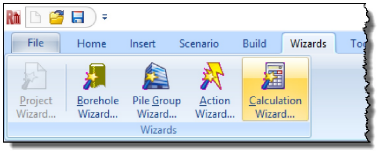
9. Then, in the **Property Inspector**, place a tick next to Combination 1 (under Actions) to add the combination to this scenario. The Drawing Board will automatically update.

`[Docs]\Tutorials\Tutorial 4\Step 5.rpx` captures everything so far.

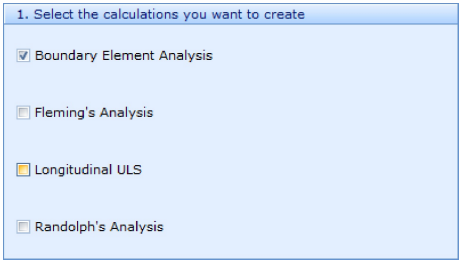
Step 6 – create the calculation

In Step 6, you will use the Calculation Wizard to create the calculation you want Repute to perform.

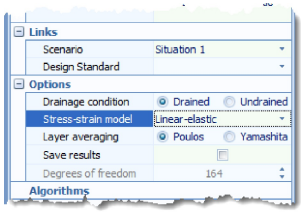
1. Open the **Calculation Wizard** by selecting the **Wizards** tab on Repute's ribbon and then clicking the **Calculation Wizard** button.



2. When the Wizard appears, select "Boundary Element Analysis". (The calculations that appear here depend on which edition of Repute you are running. The Enterprise Edition provides more calculations than the Standard and Professional editions.)



3. Click **Next** to display the next page. Since there are no standards to select from, there is nothing to do on this page.
4. Click **Next** to display the next page. Select "Situation 1" to link the boundary element analysis to that scenario.
5. Click **Next** to display the last page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
6. When you are ready, click **Finish** to generate the calculation. The Calculation Wizard then:
   - Creates Calculation 1
   - Links Calculation 1 to Situation 1
7. Select "Calculation 1" in the **Project Manager** (if it is not already selected).
8. In the **Property Inspector**, under the heading "Options" change the **Stress-strain model** to "Linear-elastic".

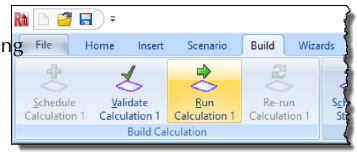


`[Docs]\Tutorials\Tutorial 4\Step 6.rpx` captures everything so far.

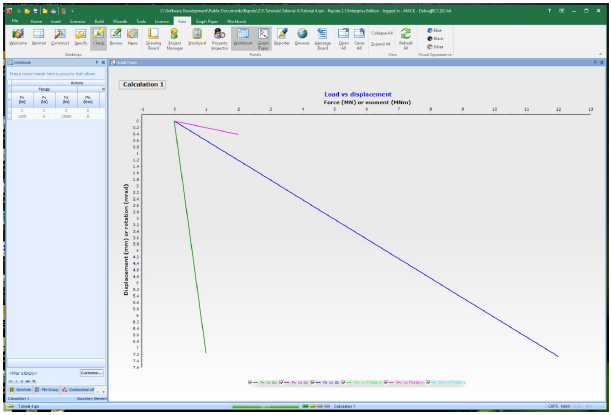
Step 7 – perform and review the calculation

In Step 7, you will perform the calculation and review the results.

1. Run the calculation by selecting the **Build** tab on Repute's ribbon and clicking on the **Run Calculation 1** button.



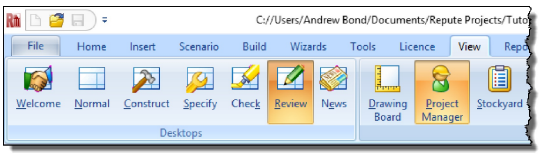
2. Repute will perform all the calculations that are linked to Situation 1 (in this case, just Calculation 1) and then change its display to show its Checking Desktop (which displays the Workbook, and Graph Paper). You can switch to this display at any time by clicking on the **Check** button on the **View** tab of Repute's ribbon.
3. Your screen will now look something like this:



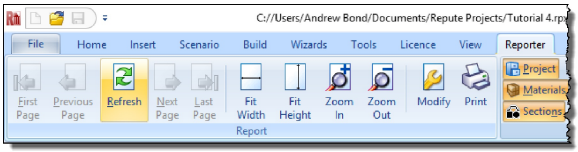
Step 8 – produce a report

In Step 8, you will produce a report summarising the calculation.

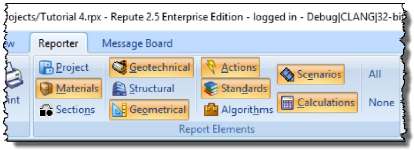
1. Switch to Repute's Review Desktop (which displays the Reporter and Project Manager) by selecting the **View** tab of Repute's ribbon and then clicking on the **Review** button.



2. Create the report by clicking on the **Refresh** button located at the top of the **Reporter**. Repute will generate the requested report and then show it. You can navigate around the report using the **First Page**, **Previous Page**, **Next Page**, and **Last Page** controls, also at the top of the **Reporter**.



3. You can choose which elements appear in the report by turning items on or off via the buttons in the Report Elements group on the **Reporter** tab.



4. Finally, you can print the report by clicking on **Print** button on the **Reporter** tab.[1]

Step 9 – close the project

In Step 9, you will close and (optionally) save the project.[2]

1. Display the program's **File Menu** and click **Close**.
2. If you have made changes to the project since it was last saved, Repute will ask you if you want to save it before proceeding. Answer Yes or No by clicking the appropriate button.
3. Repute will then (if requested) save and close the project.

`[Docs]\Tutorials\Tutorial 4\Tutorial 4.rpx` captures everything in this tutorial.

What's next?

Tutorial 5 shows you how to set up a non-linear boundary element analysis of a pile group in stiff clay overlying rock.

[1]You cannot print the project in the Trial Edition of Repute

[2]You cannot save the project in the Trial Edition of Repute

TUTORIAL 5
NON-LINEAR ANALYSIS OF PILE GROUP IN STIFF CLAY OVERLYING A RIGID LAYER

This tutorial demonstrates non-linear boundary element analysis of a pile group. It shows you how to:

- Specify a non-linear analysis
- Introduce a rigid layer into the calculations
- Produce a load-displacement graph for the pile cap
- Print the results of your calculations

The worked example involves the analysis of a group of 4 piles installed in stiff clay overlying a rgid layer.

- The ground conditions at the site comprise 35 m of stiff clay (Young's modulus 75 + 10z MPa vertically and half that horizontally, where z is the depth below the top of the layer; Poisson's ratio 0.5) overlying a rigid layer.
- A non-linear soil model will be used for the clay, with unit weight 19.8 kN/m^3, undrained strength 75 + 10z kPa, and adhesion factor 0.5.
- The water table is at the ground surface.
- The piles will be installed on a 2 x 2 grid, at 3 m spacing (centre-to--centre) along the edge of the grid. Each pile is 20 m long, 1.05 m in diameter, with a free-standing length of 0.5 m and Young's modulus of 30 GPa (both axially and laterally). This is the same pile group as was used in Step 2 of Tutorial 4.
- You are interested in the displacements and rotation of the pile cap under a combined vertical load of 20 MN, horizontal load of 2 MN, and moment of 3 MNm. The loads will be applied at the centre of the pile cap.
- Hyperbolic curve-fitting constants of 0.5 (for the shaft), 0.99 (for the base), and 0.9 (for lateral response) should be used.

This tutorial is written for users of the Professional, Enterprise, and Trial Editions of Repute only. Users of the Standard Edition should look at Tutorials 1-3.

Overview

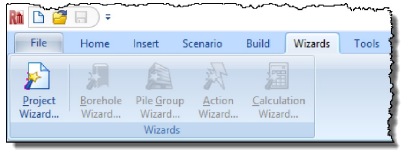
- In Step 1, you will use the Project Wizard to enter project information and create a scenario to represent the design situation to be analysed.
- In Step 2, you will create four piles and connect them together in a pile group.
- In Step 3, you will create a stiff clay and specify its properties.
- In Step 4, you will create a layer, borehole, and water table.
- In Step 5, you will create a force, moment, and combination of actions (to combine the force and moment).
- In Step 6, you will create the calculation that you want Repute to perform.
- In Step 7, you will perform the calculation.
- In Step 8, you will export results to a Microsoft Excel spreadsheet.
- In Step 9, you will close and (optionally) save the project.

If Repute is not already running, double-click on the Repute icon on Windows' Desktop to start the program. Once the splash screen has disappeared, Repute displays its Welcome page.

If you have an existing project open, click **Close** on the program's **File** menu. You will be prompted to save your work if you have not already done so.

Step 1 – create the project

In Step 1, you will use the Project Wizard to enter project information and create a scenario to represent the design situation to be analysed.



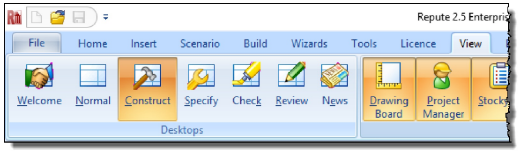
1. Open the Project Wizard by selecting the **Wizards** tab on Repute's ribbon and then clicking on the **Project Wizard** button.
2. When the Wizard appears, type "Tutorial 5" in the **Project name** box. Choose the folder where you want to save this project (for example,'Repute Projects') by using the **Path** control. (If you do not change the setting here, it will be saved in your Documents folder.)
3. Enter "Pile group in stiff clay overlying rigid layer" in the **Description** box.
4. Enter "05" in the **Project ID** box.

5. Click **Next** to display the next page. Since we are not going to use a design standard, there is nothing to set on this page.
6. Click **Next** to display the next page. Since the **Design Situation** of Situation 1 is already set to "Persistent", there is nothing to change on this page.
7. Click **Next** to display the final page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.
8. Click **Finish** to generate the project. The Project Wizard then creates a new project named `Tutorial 5.rpx` containing the following items:
   - Project Information: Site 1
   - Geometrical Objects: Ground Surface 1
   - Scenarios: Situation 1

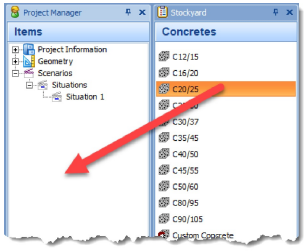
`[Docs]\Tutorials\Tutorial 5\Step 1.rpx` captures everything so far.

Step 2 – create the pile group

In Step 2, you will create four piles and connect them together in a pile group.



1. Switch to Repute's Construction Desktop by selecting the **View** tab on Repute's ribbon and clicking on the **Construct** button. (The Construction Desktop displays the Drawing Board, Project Manager, and Stockyard.)
2. Right-click anywhere in the **Stockyard** and select "Concretes" from the pop-up menu in order to open the Concretes group.
3. Then click on the item labelled "C20/25" and *keep the left mouse button pressed.*
4. Drag the cursor away from the **Stockyard** towards the **Project Manager**. The cursor will change to signal the dragging operation.
5. Finally, release the left mouse button when the cursor is located over the **Project Manager** to drop the concrete there, where it will appear as Concrete 1 (under the heading "Materials").
6. Back in the **Stockyard**, click on the heading

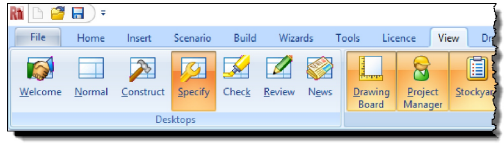


labelled “Structural Elements” to open the Structural Elements group.

7. Then click on the item labelled “Bored Pile” and drag it to the Project Manager, in the manner described above.

8. Repeat the previous instruction for “Pile Group”.

9. Switch to Repute’s Specification Desktop by selecting the **View** tab on Repute’s ribbon and clicking on the **Specify** button. (The Specification Desktop displays the Drawing Board, Project Manager, and Property Inspector.)



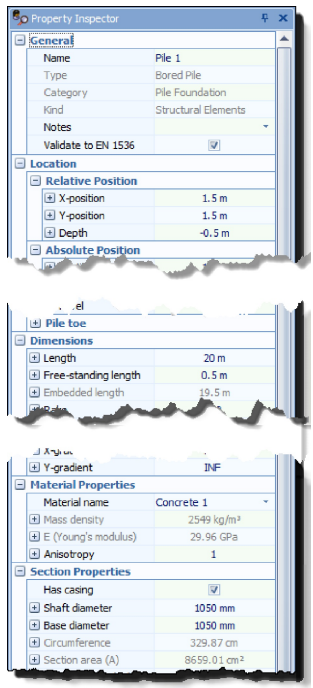
10. In the **Project Manager**, select Pile 1 (located under the heading “Structural Elements”). The **Property Inspector** will change to show its properties.

11. In the **Property Inspector**, under the heading “Location > Relative Position”, change the pile’s **X-position** and **Y-position** (both) to 1.5 m.

12. Under “Section Properties”, tick the box **Has casing** and change the pile’s **Shaft diameter** to 1050 mm. The pile’s **Base diameter** will change to 1050 mm as well.

13. Under “Material Properties”, select “Concrete 1” in the **Material name** box.

14. Finally, under “Dimensions”, change the pile’s **Length** to 20 m (if necessary) and its **Free-standing length** to 0.5 m.



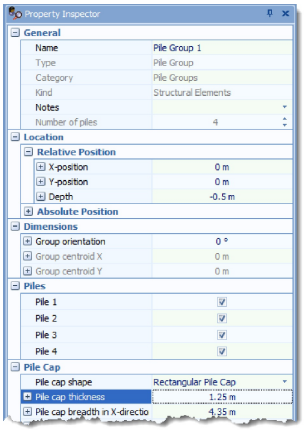
15. Next, duplicate Pile 1 by right-clicking on it in the **Project Manager** and selecting the **Edit > Duplicate** command. “Pile 1 - Copy” will appear in the Project Manager and its properties in the Property Inspector.

16. In the **Property Inspector**, change the **Name** of the new pile to “Pile 2” and its **X-position** to −1.5 m. Press ENTER to confirm the change in position. Leave all its other properties unchanged.

17. Duplicate Pile 2 by right-clicking on it in the **Project Manager** and selecting the **Edit >**

Duplicate command (or, quicker, by pressing CTRL+D).

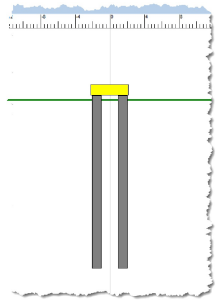
18. In the **Property Inspector**, change the **Name** of the new pile to "Pile 3" and its **Y-position** to −1.5 m and press ENTER. (Note, its X-position will also be −1.5 m.)
19. Finally, duplicate Pile 3, change its **Name** to "Pile 4", and its **X-position** to +1.5 m. (Its Y-position will be −1.5 m.)
20. In the **Project Manager**, select Pile Group 1.
21. In the **Property Inspector**, under the heading **Location > Absolute Position**, change the **Level** of the pile group to 0.5 m and press ENTER.
22. Place ticks next to all four piles and click the Resize button under the heading Pile Cap. The dimensions of the pile cap will change to reflect the piles' new positions.
23. Under the heading **Pile Cap,** change the **Pile cap thickness** to 1.25 m and press ENTER.
24. Lastly, select Situation 1 (under "Scenarios > Situations") in the **Project Manager** and tick "Pile Group 1" in the **Property Inspector** to add the pile group to the scenario.



25. In this step you have:

- Created Concrete 1, Pile 1, and Pile Group 1
- Linked Pile 1 to Concrete 1
- Duplicated Pile 1 to create Piles 2, 3, and 4 and changed their locations
- Added Piles 1-4 to Pile Group 1
- Adds Pile Group 1 to Situation 1

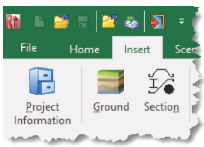
The Drawing Board will now look something like this. Note that the pile cap appears in yellow, since we have not specified a material to link to this element.



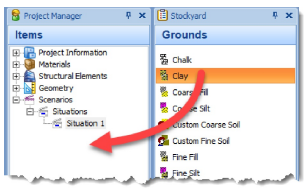
`[Docs]\Tutorials\Tutorial 5\Step 2.rpx` captures everything so far.

Step 3 – create the soil

In Step 3, you will create a stiff clay and specify its properties.



1. Open the **Stockyard**'s Grounds group by selecting the **Insert** tab on Repute's ribbon and clicking on the **Ground** button.
2. When the **Stockyard** appears, click on the item labelled "Clay" and *keep the left mouse button pressed*.
3. Drag the cursor away from the **Stockyard** towards the **Project Manager**. The cursor will change to signal you are dragging.



4. Finally, release the left mouse button when the cursor is located over the **Project Manager** to drop the clay there, where it will appear as Soil 1 (under the heading "Materials > Soils").
5. Next, open the **Property Inspector** for "Soil 1" by double-clicking on it within the **Project Manager**.
6. Under the heading **General**, type 35 into the **Reference depth 2 (z,ref2)** editor and press `ENTER` (this is the bottom of the soil layer).
7. Under the heading **Classification**, if necessary untick **Strict validation**.
8. Under the heading **Mass/weight densities,** change the clay's **Weight density** to 19.8 kN/m^3.

9. Under the heading **Strength > Undrained strength,** change the clay's **Undrained strength** to 75 kPa.

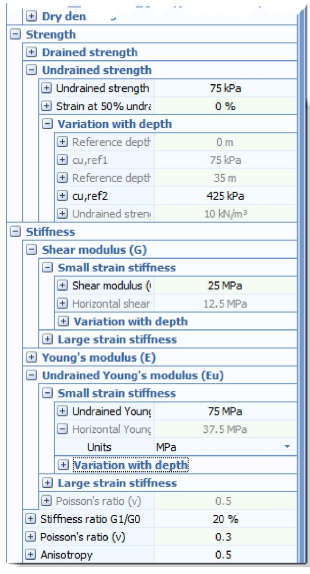
10. Double-click on the heading **Variation with depth** (or single-click on the + button located to the left of it). Enter 425 kPa into the box **cu,ref2**. The undrained strength gradient (dcu/dz) will change to 10 kN/m^3.

11. In the Property Inspector, near the bottom of the **Stiffness** group, type 0.5 into the **Anisotropy** editor and press ENTER.

12. Find the heading **Undrained Young's modulus (Eu) > Small strain stiffness**. Type 75 into the **Undrained Young's modulus (E)** editor and press ENTER. The value of E_u at large strain stiffness will automatically change to 15 MPa, keeping the **Stiffness ratio G1/G0** (and hence E_{u1}/E_{u1}) at its current value of 20%.

13. Since the soil's anisotropy was previously set to 0.5, the **Horizontal Young's modulus (Eh)** becomes 37.5 MPa (i.e. 75 MPa x 0.5).

14. Under the heading **Undrained Young's modulus (Eu) > Small strain stiffness**, double-click on the sub-heading **Variation with depth** (or single-click on the + button located to the left of it).

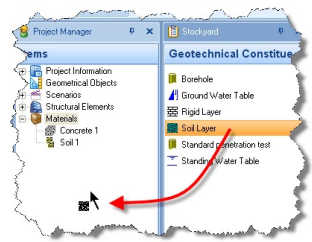


15. Enter 425 MPa into the **Eu,ref2** editor and press ENTER. The value of the **Young's modulus gradient (dE/dz)** will change to 10 MN/m^3.

`[Docs]\Tutorials\Tutorial 5\Step 3.rpx` captures everything so far.

Step 4 – create a layer, borehole, and water table

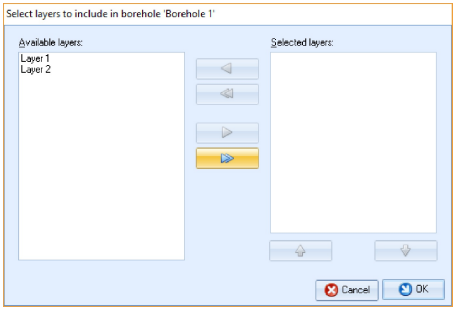
In Step 4, you will create a layer and borehole to hold the stiff clay and a water table (at ground surface).



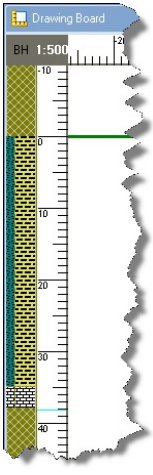
1. In the Stockyard, open the Geotechnical Constituents group and then create a Soil Layer, a Rigid Layer, a Borehole, and a Ground Water Table by dragging-and-dropping these items from the Stockyard to

the Project Manager.

2. Add the water table to the scenario by dragging it from the Project Manager to the Drawing Board.
3. Select Layer 1 in the Project Manager and then, in the Property Inspector, change its **Thickness** to 35 m and select "Soil 1" in its **Soil** box.
4. Now select Borehole 1 in the Project Manager and, in the Property Inspector, press the **Select...** button.
5. In the dialog box that appears, click on the >> button to move Layer 1 and Layer 2 from the **Available layers** box to the **Selected layers** box. Click **OK** to confirm the changes.



6. Select Situation 1 in the **Project Manager**.
7. Finally, in the **Property Inspector**, tick "Borehole 1" to add it to the scenario. The borehole will appear on the left-hand side of the **Drawing Board**.
8. In this Step you have manually:
   - Created Layers 1-2, Borehole 1, and Water Table 1
   - Added Water Table 1 to Situation 1
   - Linked Soil 1 to Layer 1
   - Added Layers 1-2 to Borehole 1
   - Added Borehole 1 to Situation 1

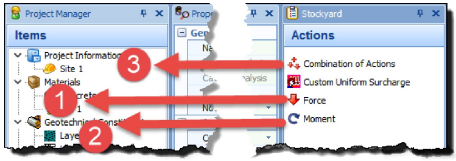


`[Docs]\Tutorials\Tutorial 5\Step 4.rpx` captures everything so far.

Step 5 – create forces and moments

In Step 5, you will create a force, moment, and combination of actions (to combine the force and moment).

1. In the **Stockyard**, open the Actions group and then create a Force, a Moment, and a Combination of Actions by dragging-and-dropping these items from the Stockyard to the Project Manager.



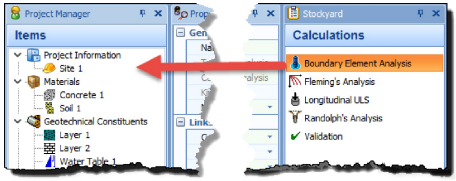
2. Select Force 1 in the **Project Manager**.
3. In the **Property Inspector**, change the force's **Level** (under the heading **Location > Absolute Position**) to 1.75 m, its **Fx** value to 2000 kN, and its **Fz** value to 20 000 kN. The **Depth** will change to –1.75 m and the **Resultant** to 20 099.75 kN as you do this. (The change in level is necessary to place the force on top of the pile cap.)
4. Select Moment 1 in the **Project Manager**.
5. In the **Property Inspector**, change the moment's **Level** to 1.75 m ut leave its **My** value as 500 kNm.
6. Select Combination 1 in the **Project Manager**.
7. In the **Property Inspector**, tick both Force 1 and Moment 1. Make a note of the **Fx**, **Fz**, and **My** values (these are resolved about the combination's current location). Then change the **Level** of Combination 1 to 1.75 m. The My value will change automatically as the lever arm of the forces has changed.
8. Select Situation 1 in the **Project Manager**.
9. Finally, in the **Property Inspector**, tick "Combination 1" to add it to the scenario. Arrows will appear on the **Drawing Board** above the pile group.
10. In this Step you have manually:
    - Created Force 1, Moment 1, and Combination 1
    - Added Force 1 and Moment 1 to Combination 1
    - Added Combination 1 to Situation 1

`[Docs]\Tutorials\Tutorial 5\Step 5.rpx` captures everything so far.

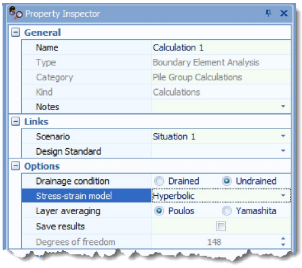
Step 6 – create the calculation

In Step 6, you will create the calculation you want Repute to perform.

1. In the **Stockyard**, open the Calculations group by right-clicking and selecting 'Calculations' from the pop-up menu.
2. Create a Boundary Element Analysis by dragging-and-dropping this item from the Stockyard to the Project Manager.



3. In the **Property Inspector**, under the heading *Links*, change the **Scenario** to "Situation 1". Then, under *Options*, change the **Drainage condition** to Undrained and the **Stress-strain model** to 'Hyperbolic'.
4. In this Step you have:
   - Created Calculation 1
   - Linked Situation 1 to Calculation 1

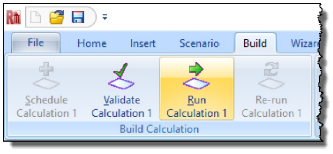


`[Docs]\Tutorials\Tutorial 5\Step 6.rpx` captures everything so far.

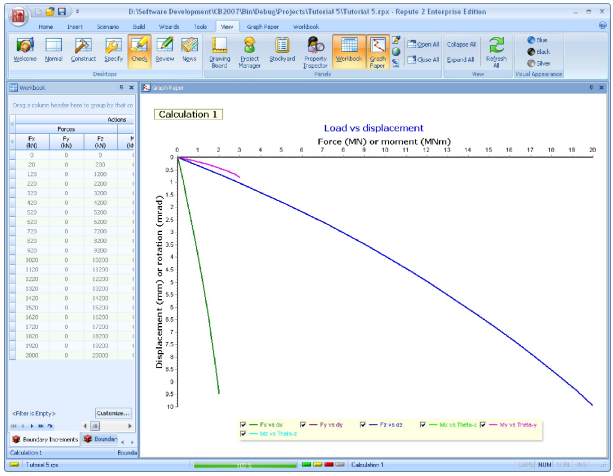
Step 7 – perform and review the calculation

In Step 7, you will perform the calculation.

1. Run the calculation by selecting the **Build** tab on Repute's ribbon and clicking on **Run Calculation 1**.
2. Repute will perform the calculation and then change its display to show its Checking Desktop (displaying the Workbook and Graph Paper panels). You can switch to this display at any time by clicking on the **Check** button on Repute's **View** tab.



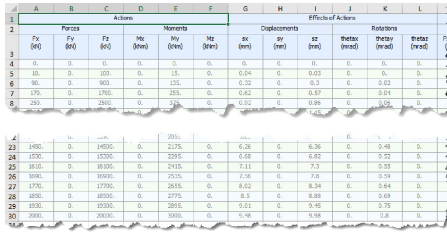
3. Your screen will now look something like this:



Step 8 – export the results

In Step 8, you will export results to a Microsoft Excel spreadsheet.

1. Right-click in the **Workbook** panel to reveal its context menu and select **Export**. Only the data that is currently displayed in the Workbook will be exported. To include other results, click on the Asterisk (*) in the top left corner of the Workbook's table and select the results you want to include.
2. Select the desired path for the file, enter its name, and then click on the **Save** button. This will save the data in an Excel spreadsheet (*.xls file).
3. You can then view the results by navigating to this folder using Windows' File Manager and opening the file in Excel. The results should look like the image below (if opened in Excel 2016).



Step 9 – close the project

In Step 9, you will close and – optionally – save the project. (Note: this is not available in the Trial Edition.)

1. Display the program's **File Menu** and click **Close**.
2. If you have made changes to the project since it was last saved, Repute will ask you if you want to save it before proceeding. Answer **Yes** or **No** by clicking the appropriate button.
3. Repute will then (if requested) save and close the project.

`[Docs]\Tutorials\Tutorial 5\Tutorial 5.rpx` captures everything in this tutorial.

What's next?

Tutorial 6 looks at the more complicated case of an asymmetric pile group under 3-dimensional loading.

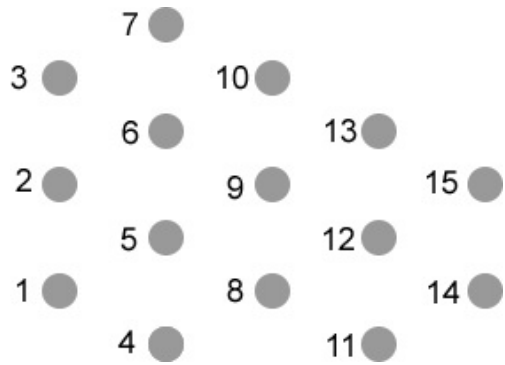
TUTORIAL 6
ASYMMETRIC PILE GROUP UNDER 3D LOADING

Tutorial 6 considers a more complicated project: that of an asymmetric pile group under general 3-dimensional loading. This tutorial shows you how to:

- Modify an existing project
- Change the location of individual piles within a pile group
- Specify 3D loading

The worked example involves the analysis of a group of 15 piles installed in stiff clay overlying dense sand.

- The ground conditions at the site are identical to those in Tutorial 5.
- The piles will be installed on an irregular grid, shown below. The spacing between adjacent rows is 3 m in the X-direction and 1.5 m in the Y.



- Each pile is 20 m long, 1 m in diameter, and has a Young's modulus of 30 GPa (both axially and laterally).
- You are interested in the displacements and rotation of the pile cap under a combined vertical load of 50 MN, horizontal loads of 10 MN (in the X-direction) and 7 MN (in the Y-direction), and moments of 5 MNm (in the XZ-plane) and 3 MNm (in the YZ-plane). The vertical load will be applied on the pile cap at the location of Pile 9.

This tutorial is written for users of the Professional, Enterprise, and Trial Editions of Repute only. Users of the Standard Edition should look at Tutorials 1-3.

Overview

- In Step 1, you will open and modify an existing project.
- In Step 2, you will delete the old pile group and then specify a new group.
- In Step 3, you will move the piles to their final (asymmetric) positions.
- In Step 4, you will modify the actions on the pile group.
- In Step 5, you will perform the calculation and review the results.
- In Step 6, you will close and (optionally) save the project.

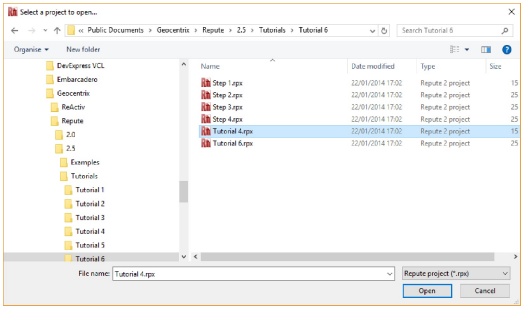
If Repute is not already running, double-click on the Repute icon on Windows' Desktop to start the program. Once the splash screen has disappeared, Repute displays its Welcome page.

If you have an existing project open, click **Close** on the program's **Application menu**. You will be prompted to save your work if you have not already done so.

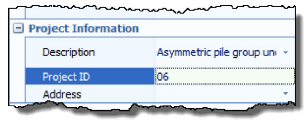
Step 1 – open and modify an existing project

In Step 1, you open an existing project and modify its project information.

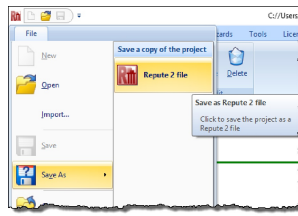
1. Click on the **File > Open** command and, in the dialog box that appears, navigate to the folder `[Docs]\Tutorials\Tutorial 6` and select the file `Tutorial 4.rpx` (this is a copy of the file that was saved at the end of Tutorial 4). Click on the **Open** button to open this project.



2. In the **Project Manager**, double-click on "Site 1" to display its properties in the **Property Inspector**. Then, in the Property Inspector, change the **Description** to "Asymmetric pile group under 3D loading" and the **Project ID** to "06".



3. Save the project under a different name, by clicking the **File > Save As** command and then clicking on **Repute 2 file**.



4. In the dialog box that appears, change the File name to "Tutorial 6" and click on the **Save** button to save the modified project with a new name. It will automatically be saved in the folder `[Docs]\Tutorials\Tutorial 6` unless you choose another location for it.

`[Docs]\Tutorials\Tutorial 6\Step 1.rpx` captures everything so far.

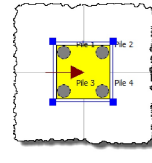
Step 2 – specify a new pile group

In Step 2, you will delete the old pile group and then specify a new group.

1. The pile group specified in Tutorial 4 was a 2 x 2 group. You can see this most easily by changing the orientation of the Drawing Board to plan view. To do this, right-click anywhere on the Drawing Board and select **Plan**. Alternatively, select the **Drawing Board** tab on Repute's ribbon and then click on the **Plan** button.

2. You may also find it easier to see the piles if you increase the Drawing Board's scale. To do this, right-click anywhere on the one of the rulers at the edge of the Drawing Board and select **1:100**. Alternatively, there are buttons on the **Drawing Board** tab (on Repute's ribbon) which allow you to manipulate the scale however you choose.

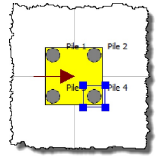
3. If you move the mouse over the drawing of the pile group in the **Drawing Board**, a balloon will appear showing its name (which is "Pile Group 1"). You can select this group by clicking on it, whereupon a blue selection rectangle will appear with square "handles" at each corner. "Pile Group 1" will automatically be highlighted in the Project Manager. You



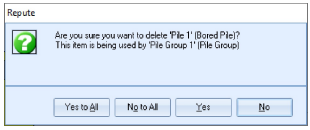
can display its properties in the Property Inspector by clicking on the Pile Group in the Project Manager.

4. De-select the pile group by holding the CTRL-key down and clicking on the drawing of the group. The handles will disappear and the Pile Group will be de-selected (and no longer highlighted) in the Project Manager.

5. If you now move the mouse over one of the piles within the group, a balloon will appear showing the pile's name (e.g. "Pile 4"). You can select this pile by clicking on it, whereupon a blue selection rectangle will appear with square "handles" at each corner. "Pile 4" will automatically be highlighted in the Project Manager and its properties displayed in the Property Inspector.



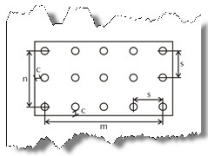
6. To delete all the piles from the project, hold the CTRL key down and select each pile in turn in the **Project Manager**. Then, right-click to display the Project Manager's pop-up menu, and select the **Edit > Delete** command. You will be reminded that Pile 1 is being used by Pile Group 1 and prompted to confirm its deletion. Click **Yes to All** to delete all the piles from the project. They will disappear from both the Project Manager and the Drawing Board.



7. Repeat the previous step for Pile Group 1 to delete it from the project.

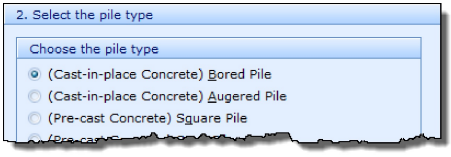
8. Open the **Pile Group Wizard** by selecting the Wizards tab on Repute's ribbon and clicking on the **Pile Group Wizard** button.

9. When the Wizard appears, choose the **Custom** plan arrangement and change the number of pile rows to **m** = 5 by **n** = 3. The picture on the left-hand side of the Wizard will change to show you a (generic) rectangular pile arrangement.

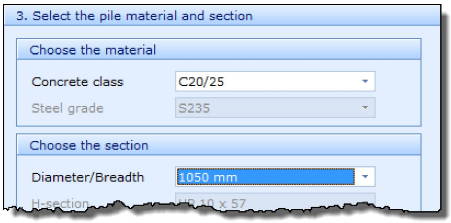


10. Change the **X Spacing** and **Y Spacing** to 3000 mm, but leave the **Cover** at its default value (150 mm).

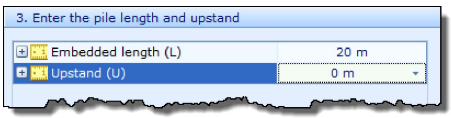
11. Click **Next** to display the next page. Choose '(Cast-in-place) Bored Pile' as the **pile type**.



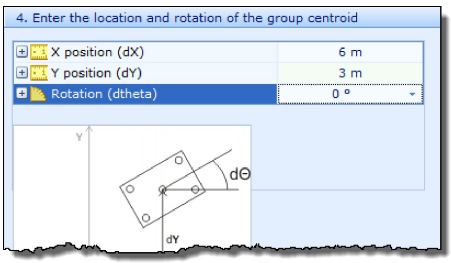
12. Click **Next** to display the next page. Change the **Concrete class** to C20/25 and the **Diameter/Breadth** to 1050 mm. By default, the concrete will be assigned a Young's modulus of 30 GPa.



13. Click **Next** to display the next page. Change the **Embedded length (L)** to 20 m but leave the **Upstand (U)** as 0 m.



14. Click **Next** to display the next page. Change the **X position (dX)** of the pile group's centroid to 6 m, its **Y position (dY)** to 3 m but leave its **Rotation (dθ)** as 0°. This will move the piles in the group close to their desired positions.



15. Click **Next** to display the next page. Tick "Situation 1" to add the pile group to the scenario.

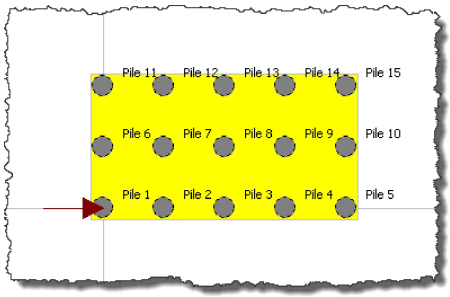
16. Click **Next** to display the last page. If you wish to review any of the settings you have made, click **Back** to return to the relevant page.

17. When you are ready, click **Finish** to generate the pile group. The Pile Group Wizard then:

    - Creates Piles 1-15

- Creates Pile Group 1
- Creates Concrete 2
- Links Piles 1-15 to Concrete 2
- Adds Piles 1-15 to Pile Group 1
- Adds Pile Group 1 to Situation 1

The Drawing Board will now look something like this:

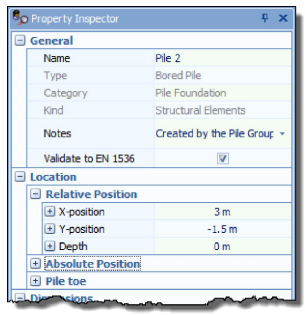


`[Docs]\Tutorials\Tutorial 6\Step 2.rpx` captures everything so far.

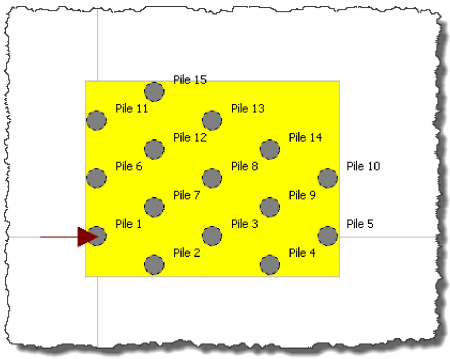
Step 3 – move the piles to their final positions

In Step 3, you will move the piles to their final (asymmetric) positions.

1. Select "Pile 2" in the **Project Manager** and then, in the **Property Inspector**, change its **Y-Position** to –1.5 m and press ENTER. The pile's position on the Drawing Board will change automatically.
2. Repeat the previous instruction for Pile 4.
3. Next, change the **Y-Position** of Piles 7 and 9 to +1.5 m; the **Y-Position** of Piles 12 and 14 to +4.5 m; and the **X-** and **Y-Position** of Pile 15 to +3.0 m and +7.5 m (respectively).



4. Select "Pile Group 1" in the **Project Manager**.
5. In the **Property Inspector**, under the heading *Pile Cap*, click on the **Resize** button to enlarge the pile cap. The Drawing Board will now look something like this:

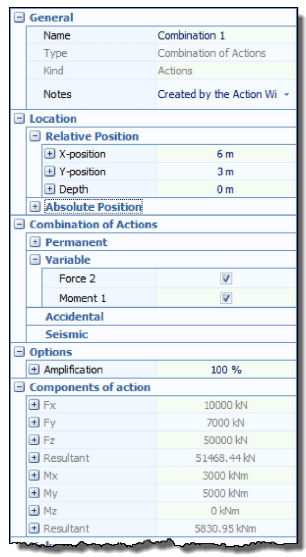


A copy of this step can be found at `[Docs]\Tutorials\Tutorial 6\Step 3.rpx`.

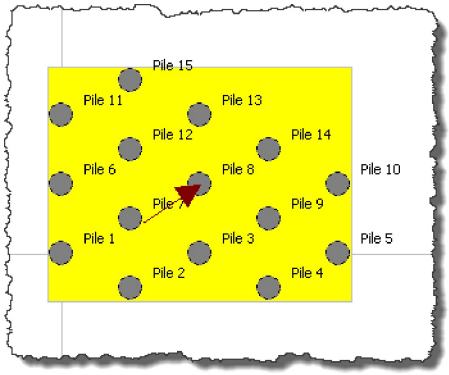
Step 4 – modify the loads

In Step 4, you modify the actions on the pile group.

1. Select "Force 1" in the **Project Manager** and then, in the **Property Inspector**, change **Fz** to 50000 kN, select "Pile 8" in the **Tether to ...** box, and change the **Depth** to 0 m.
2. Select "Force 2" and change its **Fx** to 10000 kN, **Fy** to 7000 kN, select "Pile 8" in the **Tether to ...** box, and change the **Depth** to 0 m. As you do this, the force's orientation and position will change automatically on the Drawing Board.
3. Select "Moment 1" and change its **Mx** to 3000 kNm, **My** to 5000 kNm, select "Pile 8" in the **Tether to ...** box, and change the **Depth** to 0 m.
4. Finally, select "Combination 1" and change its **X-position** to 6 m, **Y-position** to 3 m, and **Depth** to 0 m. Again, as you do this, the combination's orientation and position will change automatically and the various components of action displayed in the Property Inspector will also change.



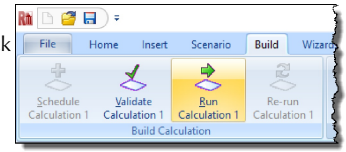
5. The Drawing Board will now look something like this:



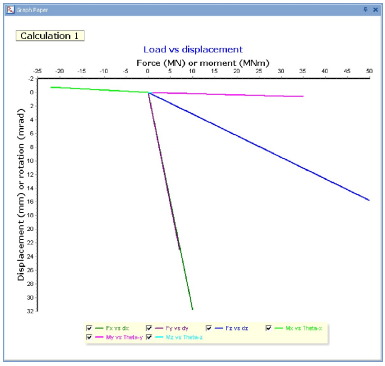
`[Docs]\Tutorials\Tutorial 6\Step 4.rpx` captures everything so far.

Step 5 – perform and review the calculation

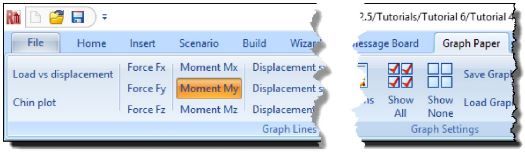
In Step 5, you will perform the calculation and review the results.



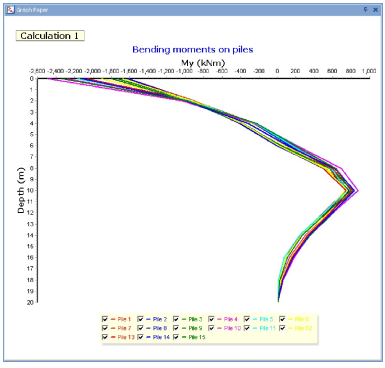
1. Select Calculation 1 in the **Project Manager** and then, on the **Build** tab, click on the button labelled **Run Calculation 1**.
2. Repute will perform the calculation and then change its display to show its Checking Desktop (which displays the Workbook and the Graph Paper). You can switch to this display at any time by clicking on the **Check** button on the **View** tab.
3. Your screen will now look something like this:



4. You can change the graph that appears on the screen by selecting the Graph Paper tab on Repute's ribbon and clicking on the any of the available graphs that are listed there.

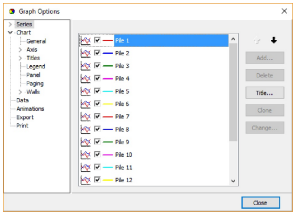


5. For example, if you click on the **Moment My** button, the graph will change to look something like this:



6. You can change the appearance of the graph by experimenting with the

extensive set of controls provided via its Options box. To display the Graph Options box, click on the Options button on the graph paper tab. Click on the help button to find instructions for using this box to customize your graph.



Step 6 – close the project

In Step 6, you will close and – optionally – save the project. (Note: this is not available in the Trial Edition.)

1. Display the program's **File Menu** and click **Close**.
2. If you have made changes to the project since it was last saved, Repute will ask you if you want to save it before proceeding. Answer Yes or No by clicking the appropriate button.
3. Repute will then (if requested) save and close the project.

`[Docs]\Tutorials\Tutorial 6\Tutorial 6.rpx` captures everything in this tutorial.

What's next?

Further information about the program's capabilities can be found in the *Repute 2.5 User Manual* and the program's built-in help system. Details of the theory that underpins the program's calculations can be found in the *Repute 2.5 Reference Manual*.

Further resources are available from the Geocentrix website:

www.geocentrix.co.uk/repute