



K-REA

B. USER MANUAL

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B.1. General preview

B.1.1. Presentation of K-REA

K-REA is a Windows®-based software enabling to design retaining walls, using the subgrade reaction method.

The Windows® format allows for a user-friendly interface and a really easy data input. Moreover, the schematic display of each construction phase makes it easy to check the project data.

You may define soil and wall properties, as well as construction phases, directly from the main window.

The main functions or actions available in K-REA are listed below and grouped into different categories:

The general options of a project include:

- units (homogeneous either to MN, kN or t);
- water weight;
- orientation of the vertical axis, in order to work either with depths or with levels;
- calculation options (number of iterations and steps);
- output options (graphics, language, limiting/mobilised earth resistance ratio);
- option to take anchors buckling into account.

Soil and wall properties include:

- geometrical and geotechnical properties of the soil layers;
- groundwater level for each soil layer;
- parameters related to the subgrade reaction calculation method, using wizards for the coefficients k_0 (Jaky), k_a , k_p (Kérisel and Absi, Coulomb or Rankine), c_a , c_p (Caquot) and k_h (Balay, Schmitt or Chadeisson);
- product of inertia of the wall, depending on the wall type (diaphragm wall, spaced or jointed piles, sheet-pile wall). Wizards are available;
- cylindrical rigidity in the case of a circular wall. Wizards are available;
- The option to change the wall width (default width is one linear meter).

The actions available to define the construction stages include:

- Caquot, Boussinesq and Graux surcharges (which can be later modified or removed) either on uphill or downhill sides;
- Horizontal loads, external moments or rotation springs to be applied directly onto the wall;
- Excavations, changes of the waterlevel, application of Caquot surcharges at the excavation level, either on uphill or downhill sides;
- Excavations with berms;
- Sheeting installation;
- Simulation of a discontinuous wall (with its effect on earth pressures), and of the sheeting installation;
- Fill (downhill or uphill) with application of a Caquot surcharge;

- Installation and removal of anchors (struts, prestressed anchors), or modification the anchors stiffness and prestress force;
- Modification of the overall product of inertia on parts of the wall;
- Wall extension upwards ("wall raising");
- Modification of soil properties (independently for each layer, downhill and/or uphill): active/passive earth pressure coefficients, subgrade reaction coefficients, ...);
- Hydraulic gradients uphill or downhill;
- Definition of a maximum passive pressure in order to simulate a maximal resistance for the wall.

The main options, soil properties and wall properties are available from the main menu, and are displayed in dialogue boxes. Once they have been validated, they are displayed on the graphical representation of the project in the main window.

Actions, such as struts installation, excavations or surcharges, are available in the action selection zone in the main window. Their graphical representation is also displayed in the main window after validation.

Finally, both calculation and results display can be requested from the main window.

All these steps are detailed in this part of the manual.

The mechanical properties of the actions available in K-REA are detailed in Part C – Technical manual.

Examples and tutorials are presented in Part D – Tutorials and examples.

K-REA DATA FILES ARE SAVED AS .P20 FILES AND RESULTS FILES ARE SAVED AS .REA FILES.

B.1.2. Quick start

1. Start K-REA by clicking either the **Start** menu shortcut or the desktop shortcut.
2. Select **New Project**.
3. Set the dimensions and options for the project by selecting the **Data** menu, then **Title and Options**. Fill in the text boxes and validate.
4. Set the soil layers properties by selecting the **Data** menu, then **Soil layers**.
5. Set the wall properties by selecting the **Data** menu then **Retaining wall** (available only after input of the soil properties).
6. Apply the actions for the initial phase if any: select them in the action selection zone, define their properties, and **Validate** them so that they are displayed on the graphical representation in the main window.
7. Click on **Add** in the staged construction management zone. Apply the actions for the new calculation phase, define their properties using the action selection zone, and **Validate** them.
8. Repeat this procedure until the final phase is reached.
9. Run the calculation by clicking on the **Calculation** button below the action selection zone (the calculations can also be run after definition of each phase depending on the user's habits).
10. Finally, click on the **Results** button in the action selection zone to open the detailed results window.

B.1.3. Recommendations and notes

↪ K-REA is intended to be used with anchors located in the soil on the right side of the wall, and struts located on the left side of the wall. So **the main excavation must be located on the left of the wall (downhill side)**. This does not prevent a temporary excavation level deeper on the right side than on the left side of the wall.

↪ The **Caquot surcharge**, **Maximal pressure** and **Reduced pressure** actions can only be applied in the initial phase. Consequently, these actions can only be applied once, and their parameters are valid for the whole staged construction of the project. The Maximal pressure action can never be modified. On the contrary, the Reduced pressure action can be cancelled by sheeting installation, and the Caquot surcharge action is automatically cancelled on a given side when applying an excavation or fill on this very same side.

↪ Some actions have to be preceded by an Excavation-Water action. These are: **Sheeting installation**, excavation with **Berm** and **Hydraulic gradient**. Apply an Excavation-Water action first, then, in the same phase, apply one of the three actions listed before. In the action parameters zone, the following instructions should appear:

Excavation-Water or **Excavation Water** or **Excavation-Water**
Berm **Sheeting installation** **Hydraulic gradient**

↪ When fills are installed, they are taken into account with $p_i = k_i \cdot \sigma_v'$. Successive fills can be defined in successive phases.

↪ The **Sheeting installation** action (for soldier-pile walls) is valid only if the **Reduced pressure** action has been defined in the initial phase.

↪ When installing anchors, the "gap" in the shear forces is equal to the value of the prestress forces. Zero prestress forces may account for continuity in the shear forces diagram.

↪ Anchors and other forces applied to the wall can be superposed at the same point of the wall and can all be considered as elementary forces acting onto the wall. The total number of each type of anchor cannot exceed 50 for the whole project.

↪ If the elementary wall width is different from 1 m, do not forget to input all the values that depend on this elementary wall width proportionally to it. Such values can be: the wall properties (EI , R_c), the stiffness of struts or anchors (K), exterior forces applied to the wall (P , M , R), reduced pressure coefficients...

The results displayed by K-REA are also proportional to the elementary wall width.

B.2. Main window

The main window in K-REA enables to reach all features necessary to set up a project. The secondary windows are the data input dialogue boxes, the wizards windows, and the results window.

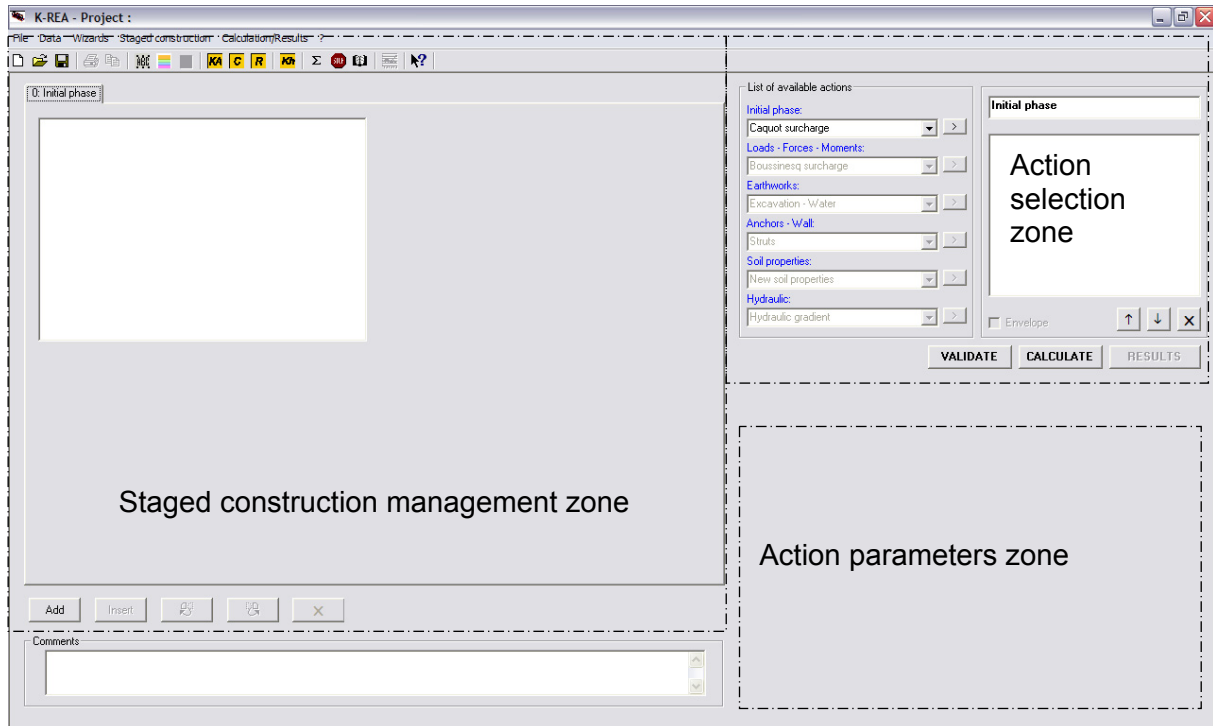


Figure B 1: Main window

The main window includes:

- The menu bar;
- Buttons, on the button bar and in the window itself;
- The staged construction management zone;
- A comments zone;
- The action selection zone;
- The action parameters zone (not shown on figure B 1).

The following chapters detail how to use each part of the main window.

B.2.1. Main menu



The main menu options are available by left-clicking on their label.

B.2.1.1. File menu

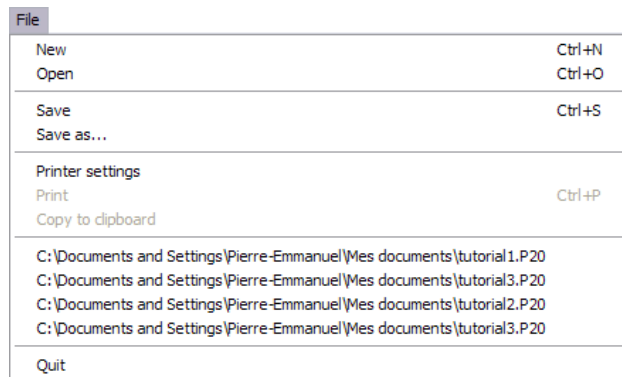


Figure B 2: File Menu

This menu enables to reach different options related to file management and printing. It also enables to quit the program. The sub-menus are described hereafter:

- **New:** enables to start a new K-REA project.
- **Open:** enables to open a file explorer and select an existing project. K-REA data files are .P20 files.
- **Save:** saves the project data into the active file (selected at first by the user). The names given to K-REA project files should be compatible with the Windows® writing formats.
- **Save as:** saves the project data into another file (the user is requested to provide a new filename).
- **Printer settings:** enables to set the printing options (choice of the printer, number of copies, colour or black&white).
- **Print:** opens the printing dialogue box.
- **Copy to clipboard:** copies a screenshot of the data or of the results in order to paste them afterwards into another Windows® file.
- **Recent files:** this part of the file menu displays shortcuts to the last four files opened in K-REA. These recent files are available only if they have not been moved or erased.
- **Quit:** enables to quit K-REA.

B.2.1.2. Data menu

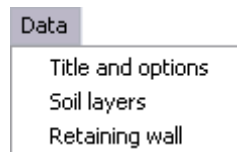


Figure B 3: Data menu

This menu enables to display the project data dialogue boxes. These data include: the general options for the project, the soil layers properties, and those of the wall. Chapter B.3. Data provides detailed explanations about the data in K-REA.

- **Title and Options:** enables to display the corresponding dialogue box, to type in a title for the project, and to set its general options (units, calculation step, number of iterations per phase, buckling option, etc.).
- **Soil layers:** enables to set the soil properties (weights, specific properties, subgrade reaction coefficients, etc.).
- **Retaining wall:** enables to set the wall properties (dimensions, properties, etc.).

IN ORDER TO DEFINE A NEW PROJECT PROPERLY, IT IS NECESSARY TO BROWSE SUCCESSIVELY ALL OPTIONS IN THIS MENU.

B.2.1.3. Wizards menu

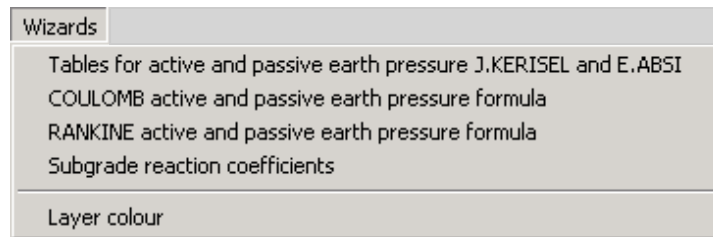


Figure B 4: Wizards menu

This menu enables to display the different dialogue boxes for wizards. They provide help to define the active/passive earth pressure coefficients or subgrade reaction coefficients. The use and contents of the wizards dialogue boxes are described in chapter B.4. Wizards.

- **Tables for active and passive earth pressure by KERISEL and ABSI:** enables to calculate the active/passive earth pressure coefficients, reading the J. Kérisel and E. Absi charts [1].
- **COULOMB Active and passive earth pressure formula:** calculates the active and passive earth pressure coefficients using the Coulomb formula [2].
- **RANKINE Active and passive earth pressure formula:** calculates the active and passive earth pressure coefficients using the Rankine formula [2].
- **Subgrade reaction coefficients:** enables to calculate the subgrade reaction coefficients using the Balay or Schmitt formulae, or the Chadeisson charts [3] [4] [5].
- **Layers colours:** opens the soil properties dialogue box. Double-click on the colour rectangle for a given soil layer in order to open the dialogue box for layers colours.

B.2.1.4. Staged construction menu

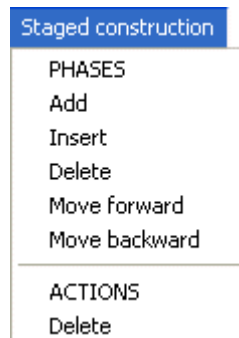


Figure B 5: Staged construction menu

This menu enables to manage the phases of the project, and the actions for each stage.

PHASES

- **Add:** creates a new calculation phase after the existing ones.
- **Insert:** inserts a new calculation phase before the selected phase.
- **Delete:** deletes the selected calculation phase.
- **Move forward:** enables to change the phases order by moving the selected phase forward.
- **Move back:** enables to change the phases order by moving the selected phase backward.

These changes appear in the staged construction management zone (refer to chapter B.2.3.1).

ACTIONS

- **Delete:** deletes the selected action in the current phase.

These modifications appear in the action selection zone (refer to chapter B.2.3.2).

B.2.1.5. Calculation/Results menu

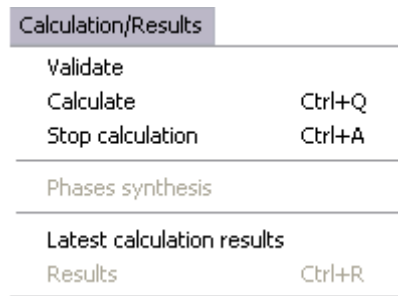


Figure B 6: Calculation/Results menu

This menu enables to manage the calculations and results display.

- **Validate:** saves the current values for the input data in the action parameters window and displays the data on the graphical representation.
- **Calculate:** runs the calculation.
- **Stop calculation:** stops the calculation.
- **Phases synthesis:** displays the graphical representation as well as a summary of the actions parameters for all the project phases.
- **Latest calculation results:** displays the latest calculation results, if they still exist (in the same directory). Beware: if the project data have been modified since the latest calculation, the displayed results will not correspond to the new data anymore.
- **Results:** opens a window with the detailed results per phase (curves or tables) as well as the envelope curves and the data summary.

The **Phases synthesis** and **Results** windows are introduced in chapters B.8.2 and B.6.2.

B.2.1.6. Help menu



Figure B 7: Help menu

This last menu enables to reach the help sub-menus and the software information.






- **Help:** enables to reach the help menu.
- **About:** provides software information (for example the version of the software).
- **TERRASOL website:** this is a link to the TERRASOL website.

B.2.2. Shortcuts




B.2.2.1. Buttons bar

The shortcut buttons are displayed on this bar. They enable to reach the features previously described:





File menu buttons:

-  creates a new project;
-  opens an existing file using the file explorer;
-  saves the changes in the current project;
-  opens the printing dialogue box;
-  copies data or results to the clipboard.





Data menu buttons:

-  opens the Title and Options dialogue box;
-  opens the Soil layers dialogue box;
-  opens the Retaining wall dialogue box.


Wizards menu buttons:

-  wizard for KERISEL and ABSI active and passive earth pressure coefficients;
-  wizard for COULOMB active and passive earth pressure coefficients;
-  wizard for RANKINE active and passive earth pressure coefficients;
-  wizard for subgrade reaction coefficients.

Calculation/Results menu buttons:

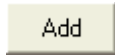
-  performs the calculation;
-  stops the calculation;
-  displays the results;
-  displays the latest calculation results.

Other buttons:

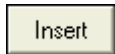
-  Online help.

B.2.2.2. Main window buttons

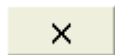
The buttons at the bottom of the staged construction management zone are shortcuts for the **Staged construction menu, PHASES sub-menu** (Add, Insert, Delete, Move forward et Move back commands).



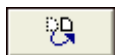
creates a new calculation phase after the existing ones.



inserts a new calculation phase before the selected phase.



Delete: deletes an existing calculation phase.



Move forward: enables to change the phases order by moving the selected phase forward.



Move back: enables to change the phases order by moving the selected phase backward.

The buttons under the staged construction management zone are shortcuts for the **Staged construction menu, ACTION sub-menu** (Delete).

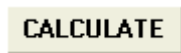


Delete: deletes the selected action in the current phase.

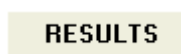
The buttons at the bottom of the action selection zone are shortcuts for the **Calculation/Results menu** (Validate, Calculation or Results commands).



saves the input data and displays the data on the graphical representation.



performs the calculation.



opens the results window.

B.2.2.3. Keyboard shortcuts

Keyboard shortcuts are another way to reach the features of K-REA directly. Here is the list of the keyboard shortcuts.

- **Ctrl+N**: Creates a new project;
- **Ctrl+O**: Opens an existing file using the file explorer;
- **Ctrl+S**: Saves the current file;
- **Ctrl+P**: Opens the printing wizard dialogue box;
- **Ctrl+Q**: Runs the calculation;
- **Ctrl+A**: Stops the calculation;
- **Ctrl+R**: Opens the results window.

These shortcuts are indicated in the corresponding sub-menus.

B.2.3. Project management zones

B.2.3.1. Staged construction management zone

The following figure shows the staged construction management zone located on the left of the main window. This zone enables to create and manage the different calculation phases.

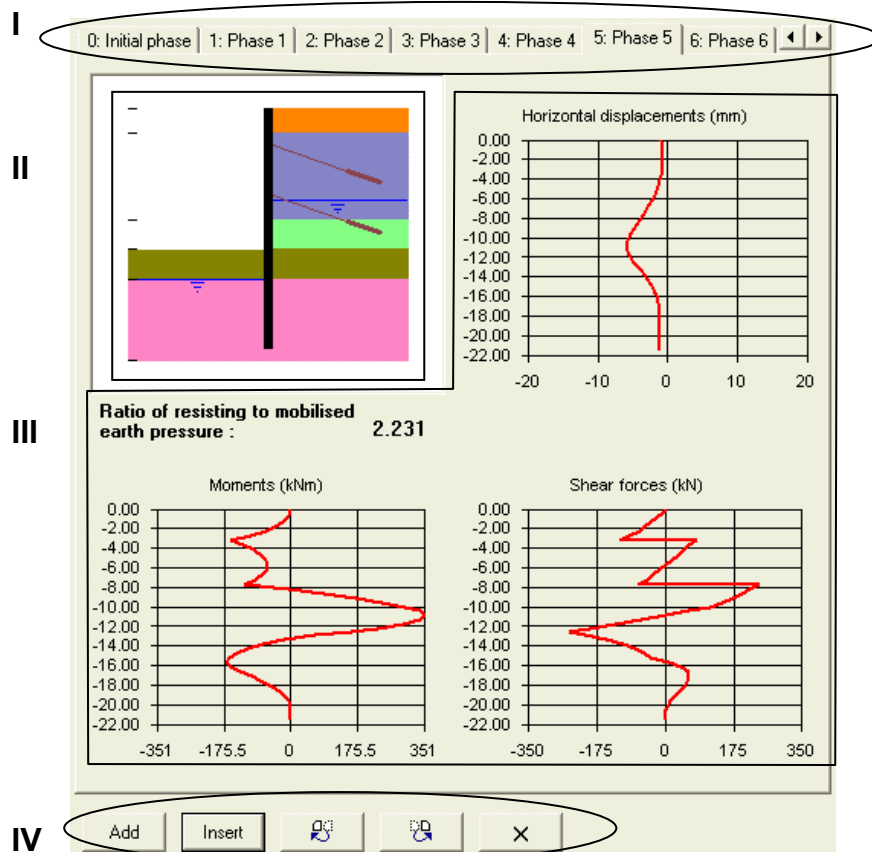


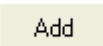
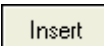
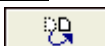

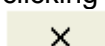
Figure B 8: Staged construction management zone, consisting in 4 zones

In **zone I**, tabs will be added when creating new calculation phases. It is possible to browse through the different phases of the project by clicking on the phase tabs.

In **zone II**, the soil layers, wall and all validated actions for the current phase will be displayed on the graphical representation.

After the calculation, the main results are displayed as curves in **zone III**. These are the displacements, shearing forces and moments. If the option was selected in the “Title and options” dialogue box, the limited/mobilised earth resistance ratio will also be displayed.

The shortcuts buttons in **zone IV** (staged construction management zone) enable to:

- create a new phase by clicking on 
- insert a new calculation phase by clicking on 
- move a phase forward or backward by clicking on  or 
- delete an existing phase by clicking on 

Note 1: the curves can be enlarged by double-clicking them, so that they fill all the staged construction management zone. It is then possible to click on a point of the curve to display its properties at the bottom of the main window. Right-clicking on these curves enables to reach the popup menu (refer to chapter B.6.2.3). Double-clicking on the curve again enables to bring the curve back to its initial size.

Note 2: in **zone II**, the graphical representation of the soil layers, wall and actions is scaled only vertically, not horizontally. This is just a schematic sketch, not a true-scale cross-section. Do not trust the length of an anchor, for example, nor the wideness of a berm or that of a surcharge.

B.2.3.2. Action selection zone

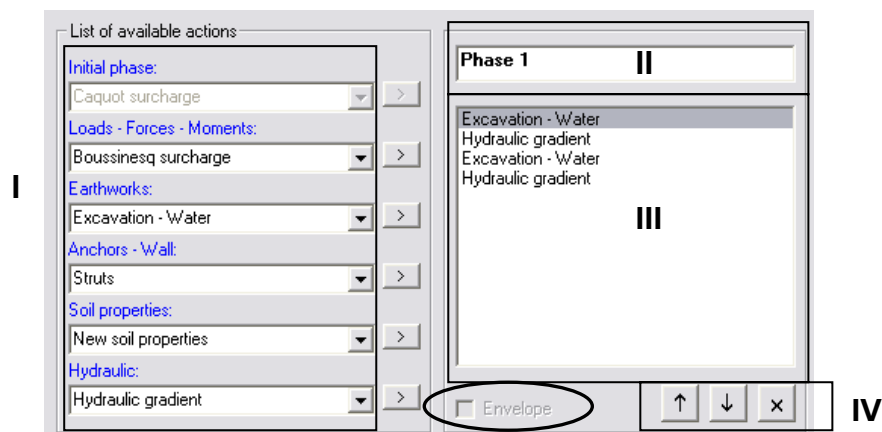


Figure B 9: Action selection zone divided into four zones

The action selection zone appears in the upper-right corner of the main window. It enables to define actions for the selected calculation phase.

In K-REA, the actions represent temporary or permanent loads applied onto the ground or the wall. They also enable to define earthworks (the program will calculate the corresponding effects onto the wall).

These actions are grouped into different categories:

- **Initial phase:** includes 3 types of actions available only in the initial phase: Caquot surcharge, reduced pressure and maximal pressure. These actions can be applied only once and remain valid during the whole project.
- **Loads-Forces-Moments:** includes 2 types of surcharges applied onto the ground (Boussinesq and Graux surcharges), 2 types of loads applied directly onto the wall (Couple and horizontal load), as well as linear forces.
- **Earthworks:** includes the variations of the groundlevel due to simple excavations, excavations with berms or with sheeting installation, and to fills.
- **Anchors-Wall:** includes 3 types of anchors (struts, anchors and rotation springs). Several anchors can be placed at the same point on the wall. This category includes 2 types of wall modifications as well (modification of the wall stiffness and extension of the wall upwards).

- **Soil layers:** this category includes an action that enables to modify the properties of the soil layers (each property can be changed individually in a phase).
- **Hydraulic:** this category includes one single action, which is the definition of a hydraulic gradient.

The categories are displayed in blue in **zone I** (action selection zone).

Zone I includes a listbox for each category, so that you can browse through all actions types available for each category.

The following table summarises all available actions:

Actions selection	
	↳ Initial phase
	↳ Caquot surcharge
	↳ Reduced pressure
	↳ Maximal pressure
	↳ Loads-Forces-Moments
	↳ Boussinesq surcharge
	↳ Graux surcharge
	↳ Moments
	↳ Horizontal load on the wall
	↳ Linear force
	↳ Earthworks
	↳ Excavation-Water
	↳ Fill
	↳ Berm
	↳ Sheetting installation (soldier-pile wall)
	↳ Anchors-Wall
	↳ Struts
	↳ Anchors
	↳ Rotation spring
	↳ Modification of the wall bending stiffness
	↳ Wall raising
	↳ Soil properties
	↳ New soil properties (modification of existing ones)
	↳ Hydraulic
	↳ Hydraulic gradient

To select an action, click on the scrolling arrow of the desired listbox, and select the proper action.

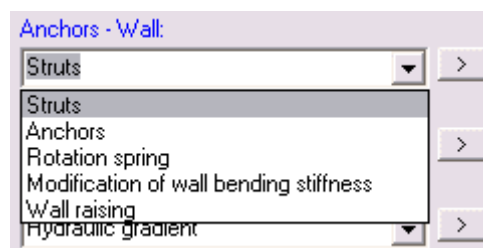



Figure B 10: Selection of the Struts action

Then click on the transfer button  next to the listbox in order to transfer the action into the list of applied actions for the current phase (**zone III**).

The corresponding action parameters zone is then displayed, right under the action selection zone. The parameters for the selected action should be defined. This specific zone is described in the next chapter.

All actions in a phase are listed in the order in which they have been defined, in **zone III**.

The mechanical properties of these actions are described in part C – Technical manual.

The current phase is the one displayed in **zone II**. It is possible to rename each phase by replacing the default title in **zone II** with a new name.

The “**Envelope**” checkbox enables to define the phases which will be used by the program to calculate the envelope curves. For example:

- If no “**Envelope**” box is checked in the phase tabs, only one envelope curve will be shown. This default curve includes the maximal displacements, shear forces and moments calculated for all phases.
- If a project includes five phases plus the initial phase, and if the “**Envelope**” box is checked in phase 3, two envelope curves will be available: one with the maximal displacements, shear forces and moments for phases 1 to 3, and the other curve with those maximal data for phases 4 to 5.

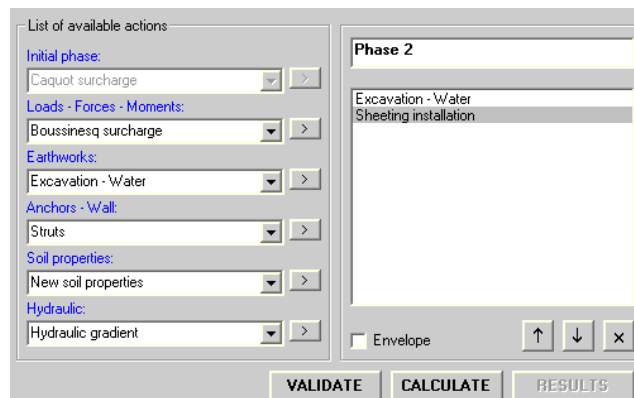


Figure B 11: Action selection zone

B.2.3.3. Action parameters zone

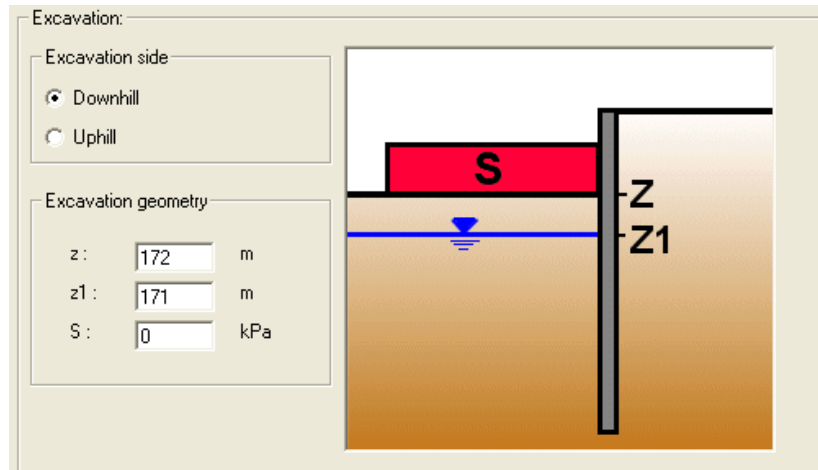


Figure B 12: Action parameters zone (example of an excavation with modification of the waterlevel)

The action parameters zone appears in the lower right corner of the main window, right under the action selection zone.

Each action in K-REA is associated with a specific set of action parameters. In general, the action parameters zone is divided into two parts. The left part enables for the data input and the right part shows a schematic diagram that illustrates the action parameters.

Figure B 12 shows the parameters zone corresponding to the “excavation-water” action. The checkboxes and edit boxes appear in white. The example illustrates a “simple” excavation at level 172 m with a water table at 171 m and no surcharge applied on the bottom of the excavation.

Parameters for all actions are described in Part C – Technical manual.

B.2.3.4. Comments zone

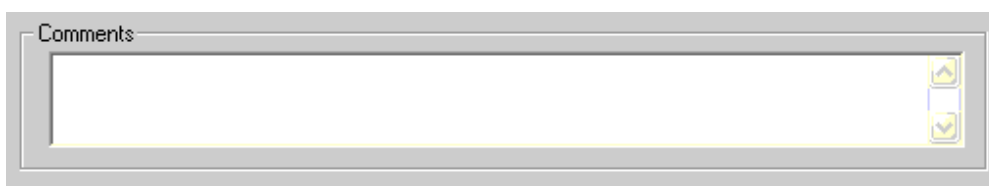


Figure B 13: Comments zone

The comments zone is located right under the staged construction management zone. This zone enables to type in comments for the current phase. These comments are then displayed in the results window as well as in the results synthesis.

B.3. Data menu

B.3.1. Title and options

This dialogue box can be displayed by clicking on the **Data** menu, then on **Title and options**. It is used to define the general options of each project.

Figure B 14: Title and Options dialogue box

The checkboxes, radio buttons and data input boxes are white and can be edited.

This dialogue box is divided into the following zones:

- **Title/Project number:** this zone is used to type in a title for the project (the content of this box has no impact on the calculation).
- **Units:** you may work in (MN, MPa, m) or (kN, kPa, m) or (t,t/m²,m). The selected units system is valid for the whole project (data input and output). The units display depends on the selected units system, but there is no data conversion, except for the water weight, which is automatically converted. (kN ,kPa, m) units and a water weight equal to 10kN/m³ are the default values.
- **Definition of the project in:** this option is used to select whether the vertical axis is directed upwards (“levels” option) or downwards (“depths” option). This orientation is valid for the whole project and can never be changed. “Depths” is the default choice.
- **Calculation options:** it is possible to take anchors buckling into account, simply by checking the corresponding box (“add anchors buckling in moments calculation”⁽¹⁾). It is not the default option. It is also possible to change the Number of iterations per phase (default value is 10), as well as the Calculation step, equivalent to the elementary division along the wall for calculations (default value is 0,5 m).

Note: the suitable range for the calculation step is between the wall thickness and a value that would limit the number of wall elements to 30.

⁽¹⁾: the buckling option is associated to the anchor action and enables to take the vertical force created by the anchor into account in the moments calculation.

- **Curves display:** checking the box “same scale for curves” makes sure that curves for all phases will have the same scale. This is the default option.
- **Output display:** checking the box “Display ratio limited/mobilised earth resistance” ensures that this ratio is displayed on the main screen, in the results window and on the printouts. This is the default choice.
- **Language for output:** this choice enables to select the language for printouts.

B.3.2. Soil layers

This dialogue box is displayed when clicking on the **Data menu** and then **Soil layers**. It enables to define all soil properties for each soil layer. All those properties are used in the calculation.

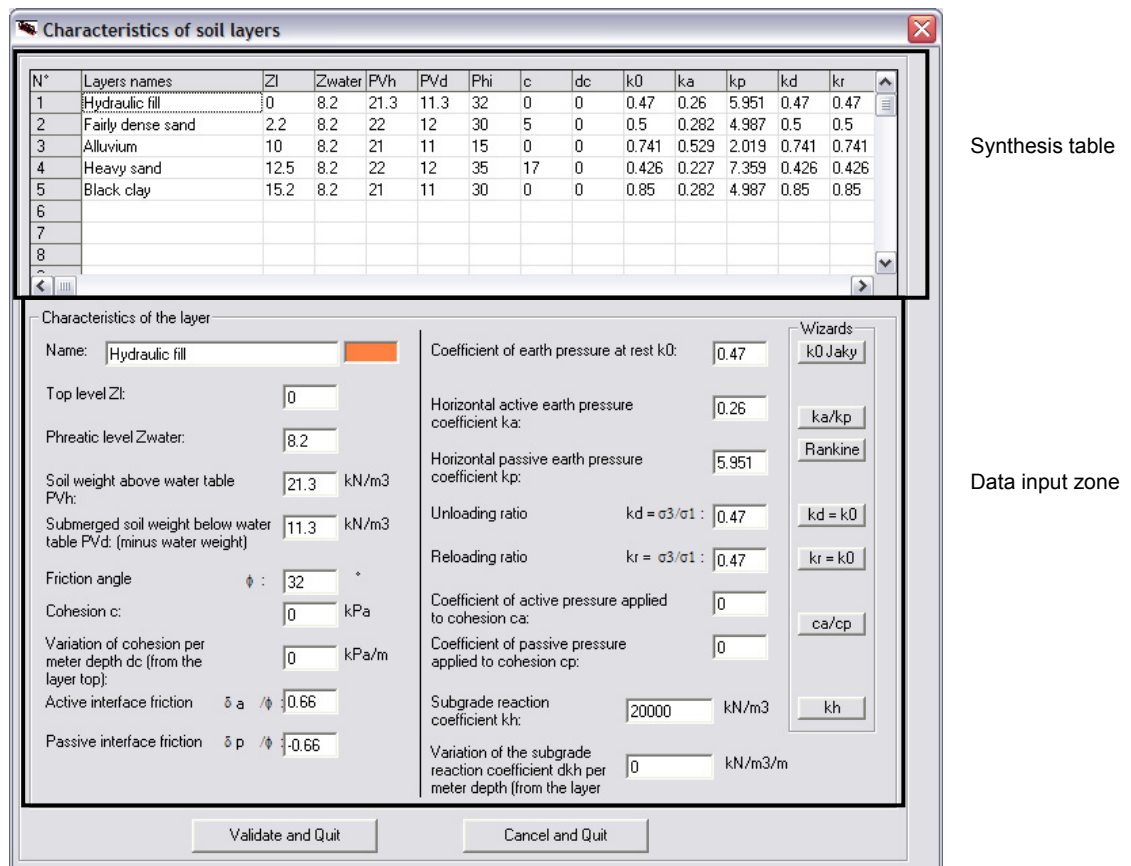


Figure B 15: Soil layers dialogue box

This dialogue box is divided into two parts. The upper part includes a synthesis table, which displays the data and enables to select a layer. The bottom part is the input zone, which enables to define or change the properties for the layer currently selected in the table.

The input data is automatically validated when clicking again in the synthesis table.

In the data input zone, the properties for each layer should be fully defined, starting from the upper layer:

- The name of the soil layer;
- **Z_c**: top level of the layer (m);
- **Z_{water}**: groundwater level (the default value is that of the previous layer) (m);
- **PV_h**: soil weight (above water level) (MN/m³, kN/m³, t/m³);
- **PV_d**: submerged soil weight (below water level) (MN/m³, kN/m³, t/m³);
- **Phi**: internal friction angle (°);
- **c**: cohesion (MPa, kPa, t/m²);
- **dc**: variation of the cohesion per meter depth (MPa/m, kPa/m, t/m²/m);
- **δ_a/φ**: active interface friction;
- **δ_p/φ**: passive interface friction;

- k_0 : coefficient of earth pressure at rest;
- k_a : horizontal active earth pressure coefficient;
- k_p : horizontal passive earth pressure coefficient;
- k_d : unloading ratio;
- k_r : reloading ratio;
- c_a : coefficient of active pressure applied to cohesion;
- c_p : coefficient of passive pressure applied to cohesion;
- k_h : subgrade reaction coefficient (MN/m³, kN/m³, t/m³);
- dk_h : variation of the subgrade reaction coefficient per meter depth (MN/m³/m, kN/m³/m, t/m³/m).

Note 1: the unloading and reloading ratios enable to take the unloading and reloading effect on the variation of horizontal forces that soils apply onto the wall: initial pressure at zero displacement and plasticity levels are modified (refer to chapter C.4.3.).

$k_d = k_r = k_0$ if soil consolidation is not taken into account.

If the material is perfectly elastic then $k_d = \frac{\nu}{1-\nu}$ with ν = Poisson ratio.

If the material is incompressible, then $\nu = 0.5$ and $k_d = 1$. This is the case when solicitations are applied too quickly for an efficient draining, or when soils are largely overconsolidated.

The paper [5] in the bibliography suggests a formula for the calculation of k_d (depending on the OCR value).

In general, by symmetry, $k_r = k_d$.

Note 2: wizards for the various coefficients are available using the buttons on the dialogue box.

There are 4 automatic wizards (no need to enter new parameters):

- The **k0 Jaky** wizard calculates k_0 using the Jaky formula: $k_0 = 1 - \sin \varphi$, and displays the value in the corresponding edit box.
- The **Rankine** wizard calculates the values of k_a and k_p using the Rankine formulas, and displays them in the corresponding edit boxes. The formulas are:

$$k_a = \tan^2\left(\frac{\pi}{4} - \frac{\varphi}{2}\right) \text{ and } k_p = \tan^2\left(\frac{\pi}{4} + \frac{\varphi}{2}\right).$$

- The **$k_d = k_0$** wizard copies the value of k_0 into the k_d box automatically.
- The **$k_r = k_0$** wizard copies the value of k_0 into the k_r box automatically.

There are also 2 wizards with dialogue boxes:

- The **k_a/k_p** wizard calculates the active/passive pressure coefficients using one of the three following methods: Kérisel & Absi tables, Coulomb formula or Rankine formulas.

- The c_a/c_p wizard calculates the active/passive pressure coefficients applied to cohesion using the Caquot formulas and the value of the friction angle. The formulas used are:

$$c_a = \frac{1}{\tan \varphi} \left[\frac{\cos \delta_a - \sin \varphi \cos \alpha}{1 + \sin \varphi} e^{-(\alpha - \delta_a) \tan \varphi} \cos \delta_a - 1 \right] \text{ and}$$

$$c_p = \frac{1}{\tan \varphi} \left[\frac{\cos \delta_p + \sin \varphi \cos \alpha}{1 - \sin \varphi} e^{(\alpha + \delta_p) \tan \varphi} \cos \delta_p - 1 \right] \text{ with } \sin \alpha = \frac{\sin \delta}{\sin \varphi}$$

For both latest wizards, the values of the interface frictions should be defined, except if these frictions were defined in the main soil properties and are equal to one of the following values: {0.99 ;0.75 ;0.66 ;0.50 ;0.33 ;0.00 ;-0.33 ;-0.50 ;-0.66 ;-0.75 ; -0.99}. In that case they are retrieved automatically.

Those two wizards are described more precisely in chapter B.4. Wizards.

WIZARDS ARE ONLY A HELP FOR THE USER, THEY ARE NOT A COMPULSORY STEP IN A PROJECT. THE USER IS RESPONSIBLE FOR THEIR USE.

Finally, the soil layers dialogue box includes two more buttons. The **Cancel** button cancels the changes and closes the dialogue box whereas the **Validate and Quit** button saves the modified data and closes the dialogue box.

Note 3: clicking on the X button in the title bar of the window closes the dialogue box without saving the changes (the X button is equivalent to the **Cancel** button).

B.3.3. Retaining wall

This dialogue box is opened when clicking on the **Data** menu, then on **Retaining wall**. It enables to define the wall properties that will be used during the calculation.

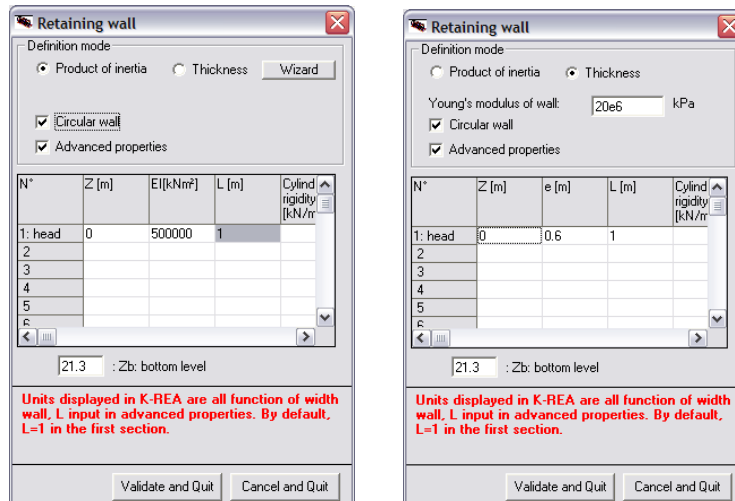


Figure B 16: Retaining wall dialogue box

The wall can be defined in two different ways: either using its **Product of inertia**, or using its **Thickness** and Young's modulus. The choice is made using the radio buttons in the upper part of the dialogue box.

Two additional options may be selected using checkboxes. The **Circular wall** option enables to display an additional column in the table below, in order to set the **cylindrical rigidity** of such a circular wall.

The **Advanced properties** option enables to display and define the elementary wall width **L**. This value is set to 1 m by default.



The elementary wall width is taken as a reference for the whole project. All the input data should depend on this value.

In order to define the wall properties, select and fill in the cells of the input table, as well as the edit box below the table. The different parameters are:

- **The Young's modulus of the wall:** to be defined if the wall is defined using its thickness (MPa, kPa, t/m²);
- **Z:** top level of the wall (m);
- **EI:** product of inertia of the wall (as a function of the elementary width), to be defined if requested to do so (MN.m², kN.m², t.m²);
- **e:** thickness of the wall, to be defined if requested to do so (m);
- **Cylindrical rigidity:** to be defined if the wall is circular (MN/m³, kN/m³, t/m³);
- **L:** elementary wall width, either per linear meter; or per element (panel width for example). The default value is 1 m (input and calculations per linear meter). In case this value has to be changed, make sure that the advanced properties box is checked.
Note: if various sections of the wall have different widths, it is recommended to work per linear meter for all sections and for the whole project.
- **Z_p:** bottom level of the wall (m).

Note 1:

- Here is the formula for the EI product, for a concrete rectangular section of diaphragm wall:

$$EI = E_{concrete} * \frac{L * e^3}{12}$$

$E_{concrete}$ = concrete Young's modulus (MPa, kPa, t/m²)
e = wall thickness (m)
L = wall elementary width (m)

- Formula for the cylindrical rigidity, for a concrete diaphragm wall, with $e \ll R$:

$$R_c = \frac{E_{concrete} * e}{R^2}$$

$E_{concrete}$ = concrete Young's modulus (MPa, kPa, t/m²)
e = wall thickness (m)
R = curvature radius (m)

- Formula for the EI product for a discontinuous wall (soldier-pile wall). For a soldier-pile wall, only the piles rigidity is usually taken into account:

$$EI = \frac{(EI)_{pile}}{d} * L$$

d = spacing between piles axis (m)
L = wall elementary width (m)

Note 2: a **Wizard** is available to calculate the product of inertia and the cylindrical rigidity per linear meter, depending on the type of wall (diaphragm wall, spaced or jointed piles, and sheet-pile wall). Refer to chapter B.4.3. Wizards for further information.

WIZARDS ARE ONLY A HELP FOR THE USER, THEY ARE NOT A COMPULSORY STEP IN A PROJECT. THE USER IS RESPONSIBLE FOR THEIR USE.

B.4. Wizards

The wizards proposed in the Wizards menu are independent from the project, and can thus be used at any time.

WIZARDS ARE ONLY A HELP FOR THE USER, THEY ARE NOT A COMPULSORY STEP IN A PROJECT. THE USER IS RESPONSIBLE FOR THEIR USE.

B.4.1. Wizards for the active and passive earth pressure coefficients

B.4.1.1. Tables for active and passive earth pressure, according to KERISEL and ABSI

This wizard is the exact reproduction of the work by Kérisel and Absi, published by "Les Presses de l'École Nationale des Ponts et Chaussées", under the title "Tables de pression et butée des terres de Kerisel et Absi" (Tables for active and passive earth pressure by Kérisel and Absi) [1].

This wizard consists in a dialogue box as shown below:

The dialog box contains the following elements:

- Input fields:**
 - λ : Angle between the wall OB and the vertical: 0
 - ϕ : Friction angle: 30
 - β : Angle between the ground surface OA and the horizontal: 0
 - δ : Angle between the lateral earth pressure and the normal of the wall: 0
 - β/ϕ' : 0.00
 - δ/ϕ' : 0.00
 - Selected value (inclined): 3.000
 - Selected value (horizontal): 3.000
- Type of tables listbox:** Passive earth pressure - weighted cohesionless soil, no surcharge
- Table of earth pressure coefficients:**

Lambda\Phi	10	15	20	25	30	35	40	45
50°								
45°								
40°								1.040
35°					1.020	1.120	1.240	1.350
30°			1.070	1.160	1.280	1.420	1.560	1.750
25°	1.050	1.150	1.260	1.400	1.560	1.740	1.950	2.200
20°	1.160	1.290	1.450	1.620	1.840	2.100	2.400	2.700
15°	1.240	1.420	1.610	1.850	2.150	2.450	2.900	3.400
10°	1.310	1.520	1.760	2.050	2.400	2.850	3.400	4.100
5°	1.370	1.610	1.900	2.250	2.700	3.300	4.000	4.900
0°	1.420	1.700	2.050	2.450	3.000	3.700	4.600	5.800
-5°	1.460	1.780	2.150	2.550	3.300	4.200	5.300	7.000
-10°	1.490	1.840	2.300	2.900	3.600	4.700	6.200	8.300
-15°	1.520	1.910	2.400	3.100	4.000	5.300	7.100	10.000
-20°	1.530	1.960	2.550	3.300	4.400	6.000	8.300	12.000
-25°	1.540	2.000	2.650	3.500	4.800	6.700	9.600	14.500
-30°	1.530	2.050	2.750	3.800	5.300	7.600	11.200	17.500
-35°	1.510	2.050	2.850	4.000	5.700	8.500	13.100	21.500
-40°	1.480	2.050	2.950	4.200	6.300	9.600	15.400	26.000
-45°	1.440	2.100	3.000	4.500	6.900	11.000	18.000	32.000
-50°	1.390	2.050	3.100	4.700	7.500	12.200	21.500	40.000
-55°	1.340	2.050	3.100	5.000	8.200	14.000	25.000	50.000
-60°	1.250	2.000	3.200	5.300	8.900	15.800	30.000	60.000
-65°	1.180	1.940	3.200	5.500	9.700	18.000	35.000	76.000
-70°	1.090	1.870	3.300	5.800	10.600	20.500	42.000	95.000
-75°		1.780	3.200	6.100	11.600	23.500	50.000	118.000
-80°		1.670	3.200	6.300	12.700	26.500	60.000	150.000
-85°		1.550	3.200	6.600	14.000	31.000	72.000	188.000
-90°		1.400	3.100	6.900	15.300	35.000	86.000	240.000
- Diagram:** A schematic diagram of a retaining wall OB, ground surface OA, and lateral earth pressure P. Angles λ , β , and δ are indicated.

Figure B 17: Tables for active and passive earth pressures by Kerisel and Absi

1) Select the table type you want to use in the listbox in the upper right part of the window

- Passive earth pressure, weighted cohesionless soil, no surcharge;
- Active earth pressure, weighted cohesionless soil, no surcharge;
- Weightless cohesionless soil, with surcharge.

2) Fill in the requested data in the data input zone located in the upper left corner of the window:

- λ : angle between the wall and the vertical (default value is 0°);
- φ' : friction angle ($^\circ$);
- β : angle between the ground surface and the horizontal line, defined using the β/φ' ratio suggested in the list ($^\circ$);
- δ : angle between the lateral earth pressure and the normal to the wall, defined using the δ/φ' ratio suggested in the list ($^\circ$);
- α : angle between the surcharge and the ground surface ($^\circ$);
- Ω : angle between the ground surface and the wall ($= \frac{\pi}{2} + \beta - \lambda$) ($^\circ$).

The value in the table corresponding to these data is highlighted in grey, and displayed below the input data (with an additional value corresponding to its projection on the horizontal axis, which will be used during the calculations).

This value can be transferred to the corresponding K-REA edit boxes, using the **Transfer** button. To close the wizard, click Quit.

Important note 1: In K-REA, the transfer button works only for values calculated using vertical walls! Values calculated with non-vertical walls can be viewed, but cannot be used in the calculations.

Note 2: K-REA uses a linear interpolation to determine values between those indicated in the table cells.

Note 3: the wizard automatically retrieves the value of the friction angle from the soil layers dialogue box. It also retrieves the values of interface angles from the soil layers dialogue box, if these values are among:

- {1,00 ; 0,66 ; 0,00 ; -0,66 ; -1,00} δ_a/φ' for active pressures;
- {0,66 ; 0,5 ; 0,33 ; 0,00 ; -0,33 ; -0,5 ; -0,66 ; -1,00} δ_p/φ' for passive pressures.

B.4.1.2. COULOMB active and passive earth pressures formulas

This wizard displays the results calculated using the Coulomb formulas (refer to "*Techniques de l'ingénieur*"; *Construction*; C242; "*Ouvrages de soutènement, pression et butée*", by F. Schlosser [2]):

$$k_a = \frac{\cos^2(\lambda - \phi)}{\cos(\lambda + \delta) * \left[1 + \sqrt{\frac{\sin(\phi + \delta) * \sin(\phi - \beta)}{\cos(\lambda + \delta) * \cos(\lambda - \beta)}} \right]^2}$$

$$k_p = \frac{\cos^2(\lambda + \phi)}{\cos(\lambda + \delta) * \left[1 - \sqrt{\frac{\sin(\phi - \delta) * \sin(\phi + \beta)}{\cos(\lambda + \delta) * \cos(\lambda - \beta)}} \right]^2}$$

The wizard shows up in a dialogue box, as shown below:

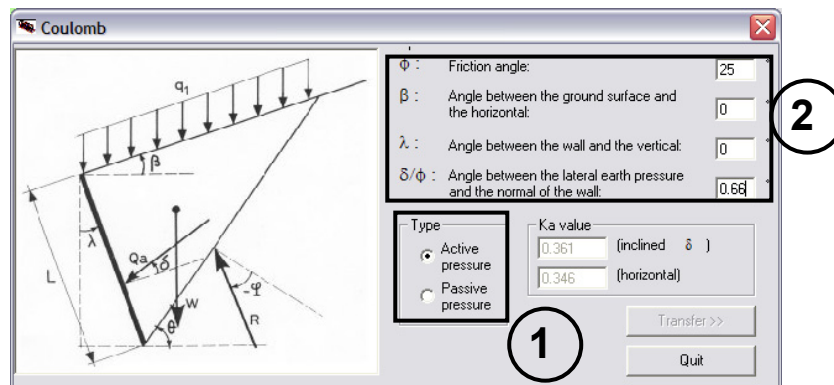


Figure B 18: Calculation using the Coulomb method

1) Select the calculation type:

- Active pressure;
- Passive pressure.

2) Input the requested data:

- φ : friction angle ($^{\circ}$);
- β : angle between the ground surface and the horizontal axis ($^{\circ}$);
- λ : angle between the wall and the vertical axis (default value is 0) ($^{\circ}$);
- δ/φ : interface friction ratio.

The resulting values are displayed in the lower right corner of the window (inclined value and horizontal projection).

These values can be transferred to K-REA edit boxes by using the **Transfer** button. Click on **Quit** to close the wizard.

Important note 1: In K-REA, the transfer button works only for values calculated using vertical walls! Values calculated with non-vertical walls can be viewed, but cannot be used in the calculations.

Note 2: the wizard automatically retrieves the value of the friction angle from the soil layers dialogue box. It also retrieves the values of interface angles from the soil layers dialogue box, if these values are included in the range from -1.00 to 1.00.

B.4.1.3. RANKINE active and passive earth pressures formulas

This wizard displays the results given by the Rankine formulas for a retaining wall (refer to "Techniques de l'ingénieur"; Construction; C242; "Ouvrages de soutènement, pression et butée" by F. Schlosser [2]):

$$k_a = \left[\frac{\cos \beta - \sqrt{\cos^2 \beta - \cos^2 \varphi}}{\cos \beta + \sqrt{\cos^2 \beta - \cos^2 \varphi}} \right] \cos \beta$$

$$k_p = \left[\frac{\cos \beta + \sqrt{\cos^2 \beta - \cos^2 \varphi}}{\cos \beta - \sqrt{\cos^2 \beta - \cos^2 \varphi}} \right] \cos \beta$$

The screenshot below illustrates the wizard dialogue box:



Figure B 19: Calculation using the Rankine method

Input the inclination of the slope β and the internal friction angle ϕ . Both passive and active coefficients are immediately calculated and displayed in the boxes in the lower part of the dialogue box.

Note: the wizard automatically retrieves the value of the friction angle from the soil layers properties.

These values can also be transferred to the data input boxes, using the **Transfer** button. Click on **Quit** to close the wizard.

B.4.2. Subgrade reaction wizard

This wizard proposes three different methods to estimate the subgrade reaction coefficient: Balay formula [3], Schmitt formula [4], and Chadeisson curves [5].

The wizard consists in a dialogue box divided into three parts. Three radio buttons in the upper part enable to choose one of the three available methods. The values calculated using each of these methods are shown under their title, in blue. The middle part of the window is the data input zone. The lower part is used to display the results and comments.

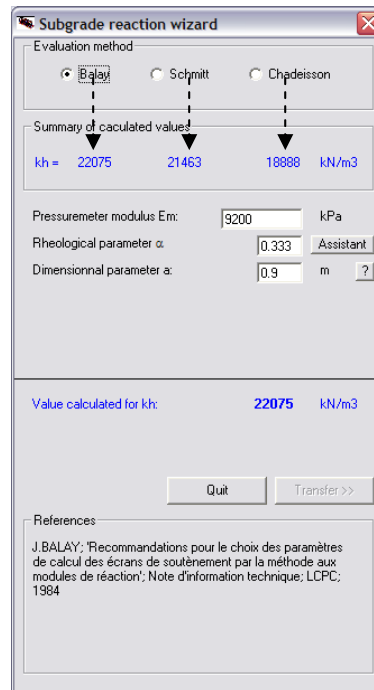


Figure B 20: Calculation of the subgrade reaction coefficients, using the Balay method

The display of values calculated using the different methods allows the user to decide which value he wants to use for the calculations.

B.4.2.1. BALAY formula

The Balay formula was published in “*Recommandations pour le choix des paramètres de calcul des écrans de soutènement par la méthode aux modules de réaction*” [3]:

$$k_h = \frac{E_m}{\left(\frac{\alpha * a}{2}\right) + 0.133 * (9 * a)^\alpha}$$

The requested parameters are:

- **E_m**: pressuremeter modulus (MPa, kPa, t/m²) ;
- **α**: rheological parameter;
Note: this parameter can also be calculated using a sub-wizard.
- **a**: dimensional parameter (m).
Note: a picture is available to help estimating this parameter.

The rheological parameter wizard is also a dialogue box, and it is based on reference [6]:

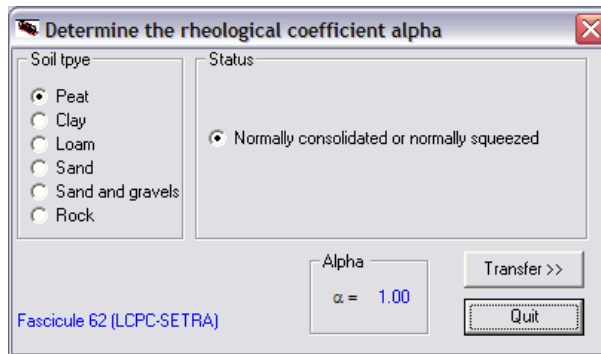


Figure B 21: Rheological parameter wizard

B.4.2.2. SCHMITT formula

The Schmitt calculation method is explained in a series of papers in the *Revue Française de Géotechnique* (French geotechnical review) n° 71 and 74 [4]. It is based on the following formula:

$$k_h = \frac{2.1 * \left(\frac{E_m}{\alpha} \right)^{\frac{4}{3}}}{(EI)^{\frac{1}{3}}}$$

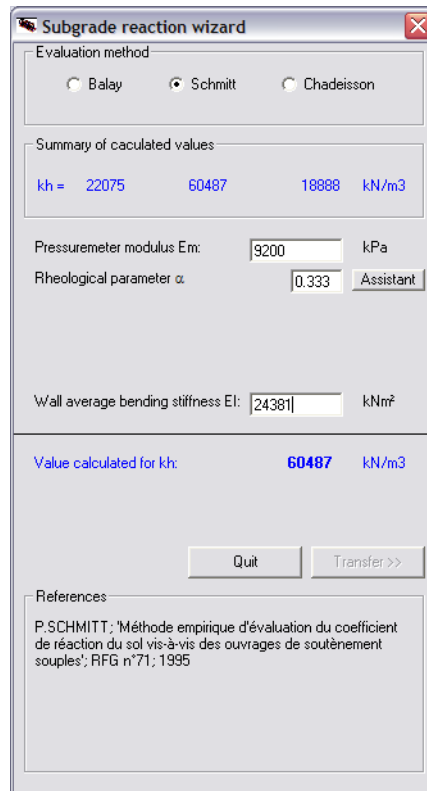


Figure B 22: Calculation of the subgrade reaction coefficient using the Schmitt formula

B.4.2.3. CHADEISSON curves

The Chadeisson curves were published in a paper by A. Monnet, “*Module de réaction, coefficient de décompression, au sujet des paramètres utilisés dans la méthode de calcul élasto-plastique*”, published in *Revue Française de Géotechnique* n° 65 [5].

The curves are displayed and the proper value is retrieved automatically depending on the values input for the cohesion and the friction angle. It is also possible to check those values directly on the curves.

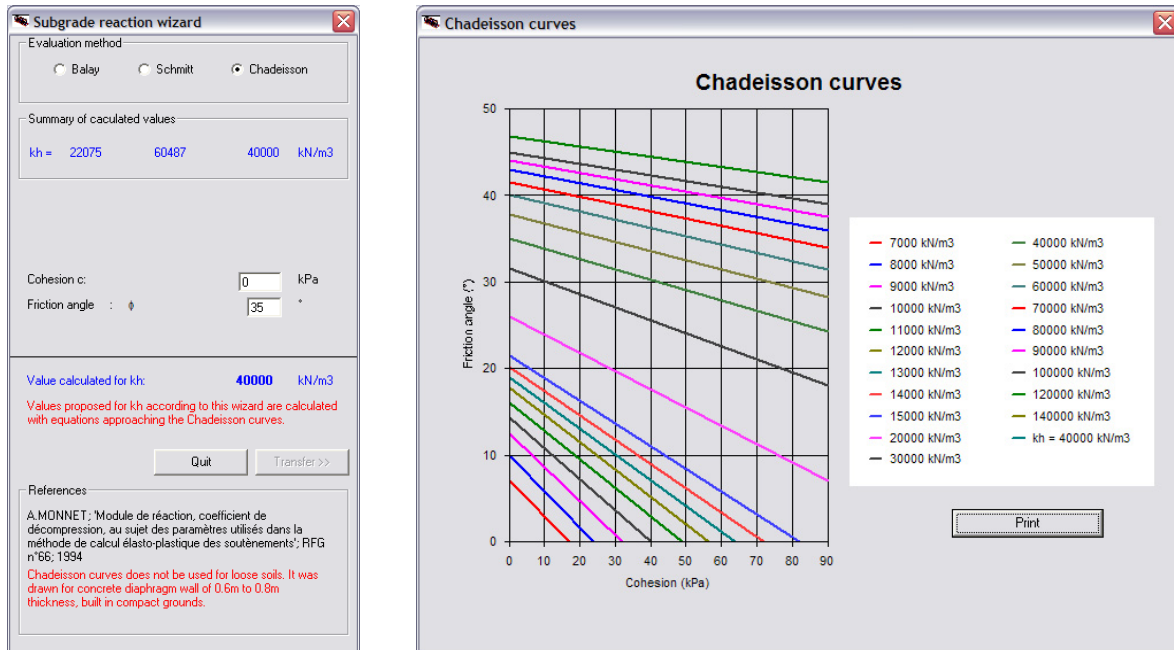


Figure B 23: Chadeisson curves

Note: The curves have been reproduced approximately. There may be a slight difference between the curves that appear in the wizard window and the Chadeisson curves that can be found in papers.

B.4.3. EI and Rc wizard

This wizard helps to estimate EI and R_c values, for three different types of walls: diaphragm walls (circular or not), piles and sheet-piles. The wizard can be reached from the retaining wall dialogue box (**Data, Retaining wall**).

Specific parameters should be entered for each type of wall. EI estimations are displayed in blue.

The dialogue box is closed automatically when the values are transferred using the transfer button **Transfer >>**. Otherwise, click the **X** button located in the title bar of the window to close it.

B.4.3.1. Diaphragm walls

This wizard enables to calculate the EI product as well as the cylindrical rigidity R_c for a continuous wall.

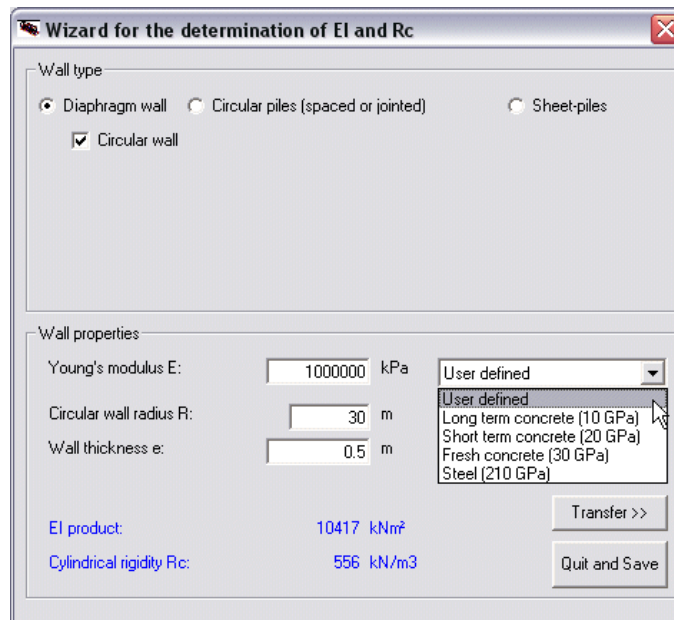


Figure B 24: Calculation of the EI product for a diaphragm wall

Three values should be defined:

- **E**: concrete Young's modulus (it can be chosen from the listbox) (MPa, kPa, t/m²);
- **e**: wall thickness (m);
- **R_c**: radius of the circular wall when the wall is circular (MN/m³, kN/m³, t/m³).

These values can be transferred to the main dialogue box by using the **Transfer** button. Click **Quit and Save** to close the wizard.

Note: the rigidity values are given per linear meter. It is necessary to correct them if the elementary wall width is not equal to 1 m (refer to chapter 3.3).

The software calculates:
$$EI = E_{concrete} * \frac{1 * e^3}{12} \text{ et } R_c = \frac{Ee}{R^2} \quad \text{for } L=1 \text{ m}$$

B.4.3.2. Spaced or jointed piles

This wizard enables to calculate the EI product (given per linear meter) for spaced or jointed piles. These piles can be made of concrete, steel or a combination of both materials.

Select “circular piles (spaced or jointed)” as shown on the screenshot below:

Figure B 25: Calculation of the EI product for a circular pile

Three values should be defined:

- **E**: concrete Young's modulus (MPa, kPa, t/m²);
- **e_h**: spacing between piles (m);
- **d**: piles diameter (m).

The software calculates

$$EI = \frac{\pi d^4}{64 e_h} E_{concrete}$$

In order to calculate the EI product for steel piles, select “Circular piles (spaced or jointed)”, then “steel sections”, as shown below:

Figure B 26: calculation of the EI product for steel circular piles

You should select a type of steel section. Use the “steel section” listbox to choose among the following categories:

- Specific steel section: enables to set an inertia that is not available in the list;
- Hollow circular steel section: enables to calculate the inertia of hollow circular sections, using their external diameter and their thickness;
- IPE, IPE A, IPE O: I-shaped European ARCELOR beams;
- IPN: normal European ARCELOR beams;
- HE AA, HE A, HE B, HE M: European wide wings ARCELOR beams;
- HL: European very wide wings ARCELOR beams;
- HD: ARCELOR column-beams;
- HP: ARCELOR pile-beams;
- TUBEUROP diameter/thickness: hollow and circular TUBEUROP sections;
- TUBES STAD diameter/thickness: hollow and circular TUBES STAD sections.

*This list of suppliers is not exhaustive.



Input the complementary requested data when needed, and do not forget to define the spacing between sections axis.

The software calculates

$$EI = \frac{I_{steel}}{e_h} E_{steel}$$

Note: use the **Transfer >>** button.

In order to calculate the inertia of a pile made of both steel and concrete, click “Circular piles (spaced or jointed)” then “steel sections” as shown thereafter:

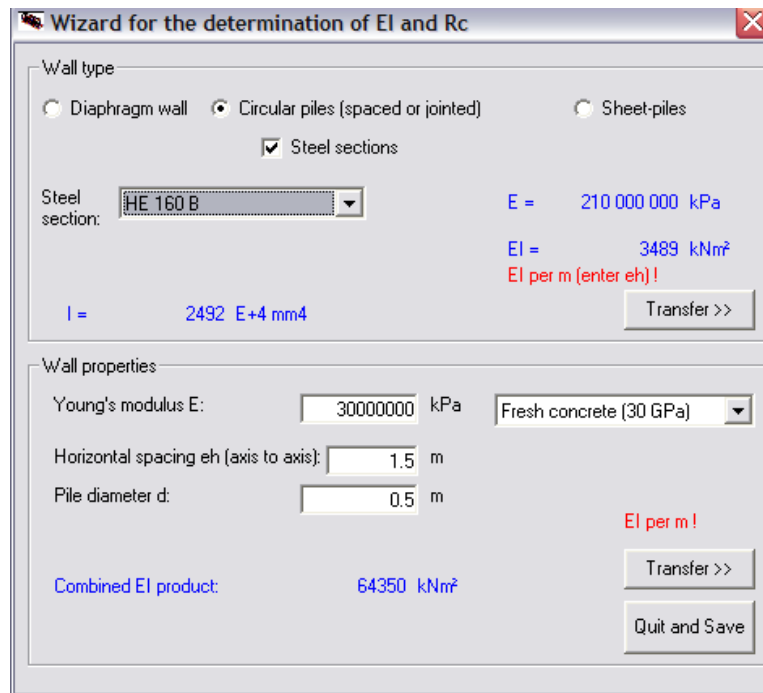


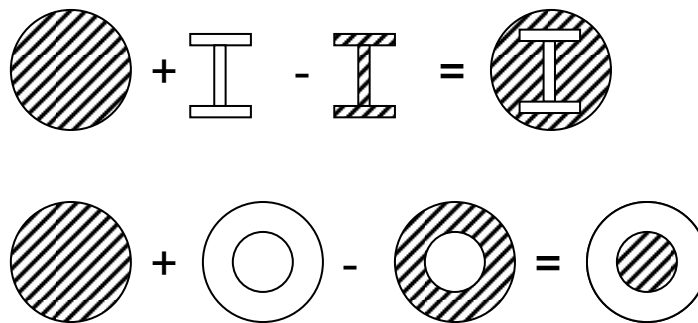
Figure B 27: Calculation of the EI product for mixed walls

Fill in both the steel section parameters and the concrete parameters.

The software calculates:

$$EI = \frac{\pi d^4}{64 e_h} E_{concrete} + \frac{I_{section}}{e_h} E_{section} - \frac{I_{section}}{e_h} E_{concrete}$$

This formula applies to different section geometries:



Note 1: use the **Transfer >>** button.

Note 2: the rigidity values are given per linear meter. It is necessary to correct them if the elementary wall width is not equal to 1 m (refer to chapter 3.3).

B.4.3.3. Sheet-pile walls

This wizard enables to calculate the product of inertia of sheet-pile walls (given per linear meter), taking corrosion into account.

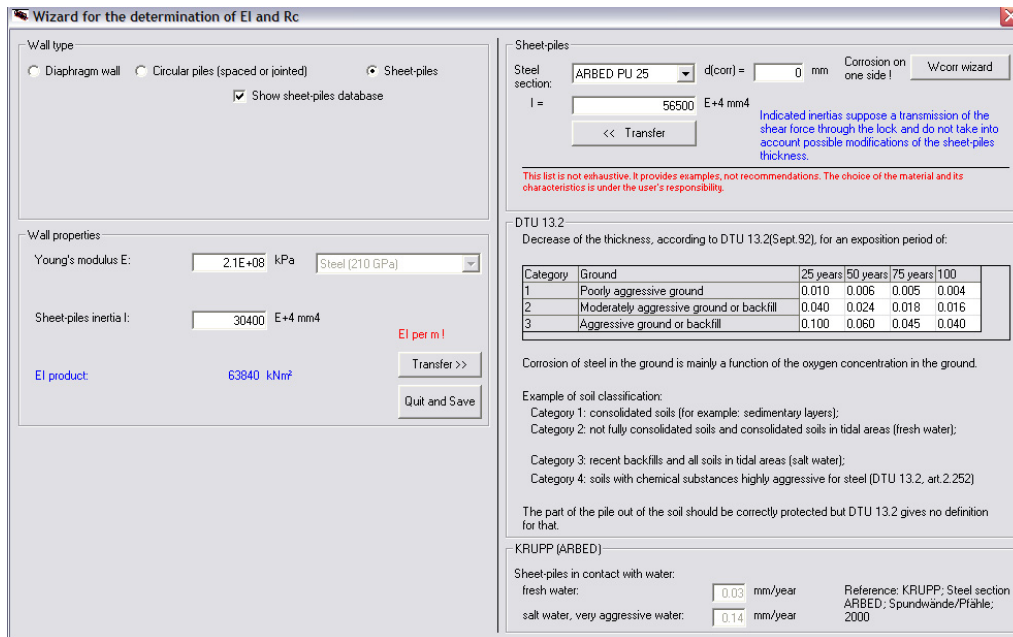


Figure B 28: Sheet-piles database

Two values should be defined:

- **E**: concrete Young's modulus (MPa, kPa, t/m²);
- **I**: inertia of the sheet-piles in 10⁴ mm⁴ (a database may be used).

Note: the rigidity values are given per linear meter. It is necessary to correct them if the elementary wall width is not equal to 1 m (refer to chapter 3.3).

B.5. Staged construction

When the soil and the wall properties have been defined, the staged construction must be described.

Each phase can include one or several actions. It is fully up to the user to decide and define the actions for each phase, but be aware that the staged construction management can have an influence on the results, due to the interactions between different actions. In order to make sure that the actions combinations are correct, refer to part C of the manual (Technical manual), and check the properties for each action.

By default, K-REA always creates a first phase named “Initial phase” as illustrated on the figure below:

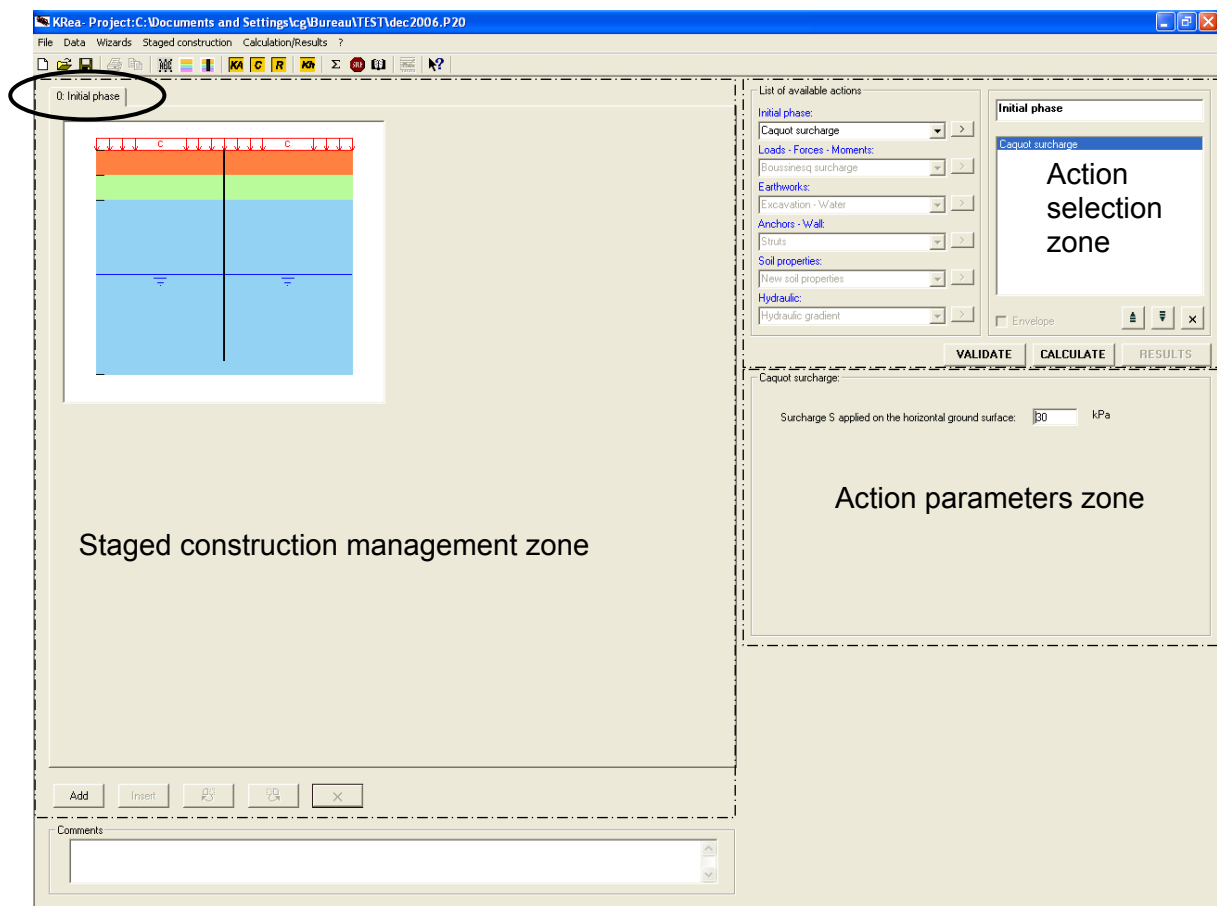
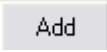


Figure B 29: Initial phase

In this first phase, three actions are available. They can be applied only in this phase and only once. Those are the actions: “Caquot surcharge” (uniformly distributed on both sides of the wall), “Reduced pressure” and “Maximal pressure”. The use of the action selection zone is described in the chapter B.2.3.2. and the meaning of the actions is given in the part C – Technical manual. If actions are applied in the initial phase, they will be displayed on the graphical representation of the staged construction management zone after their validation.

In order to create Phase 1, click on the  button in the staged construction management zone. This action creates a new tab named “Phase 1” and the schematic profile

of the soil layers remains the same. But after each validation of an action, the profile of the project is modified to take into account this action.

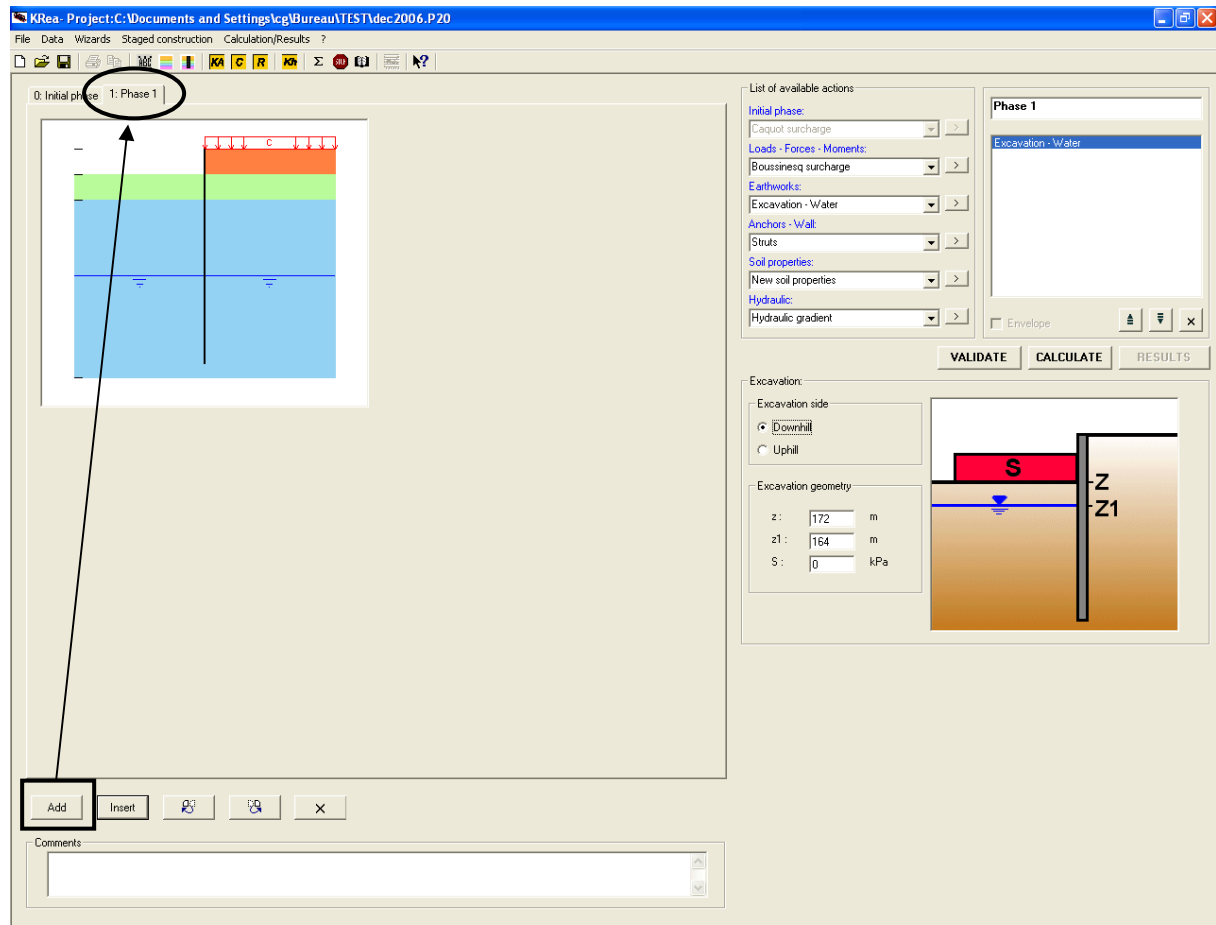


Figure B 30: Phase 1



Each time new phases will be added, corresponding tabs will appear next to the existing tabs. The tabs of the staged construction management zone allow an easy and quick browsing between the calculation phases of the project by a simple click on each tab.

The handling of the action selection and action parameters zones, in order to define the actions for a phase, are described in chapters B.2.3.2 et B.2.3.3. respectively. The whole actions are detailed individually in part C – Technical manual.

B.6. Calculation and results

B.6.1. Calculation

In K-REA, there are three different ways to run the calculation:

- Click on the shortcut button  located in the action selection zone;
- Click on the calculation button  in the buttons bar;
- Or select the **Calculation/Results** menu and then **Calculation**.

The calculation can be performed at any time (in the initial phase, in the current phase, in the final phase), as long as all the data for the soil layers and for the wall have been fully defined.

It enables to obtain the values of displacements, moments and shear forces in the wall, or else the values of the pressures in the soil on both sides of the wall, etc.

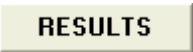

B.6.2. Results

After the calculation, the curves for displacements, shear forces and moments appear in the staged construction management zone, in the current phase tab.

It is possible to view additional curves and tables when opening the results window.

The results window is a separate window, using the same tab-navigation system as the main window.

There are three ways to open this window:

- click on the button  in the action selection zone;
- click on the shortcut button  in the buttons bar;
- or select **Calculation/Results** and then the **Results** sub-menu.

In the results window, a warning appears in case the calculation did not converge (which means that the maximal number of iterations defined in the general options of the project was reached).

By default, when opening the results window, the first tab is activated. This is the “Data” tab (reminder of the input data):

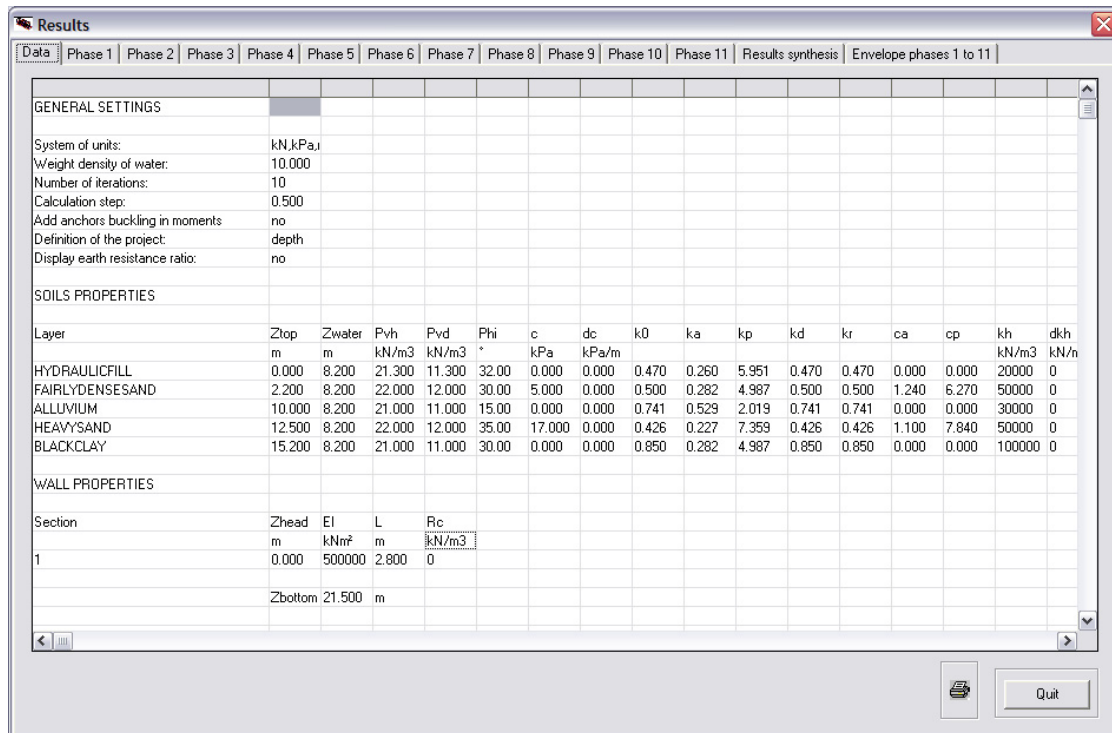


Figure B 31: Results window, Data tab

This tab summarises all the data relating to the soil layers, the wall and the selected options (like buckling for example), as well as the actions defined for the initial phase if any (reduced pressure, Caquot surcharge or maximal pressure).

In the phases tabs, the curves for displacements, moments, shear forces and earth pressures are displayed (“curves” is the default display option).

The phases tabs are divided into **five zones**:

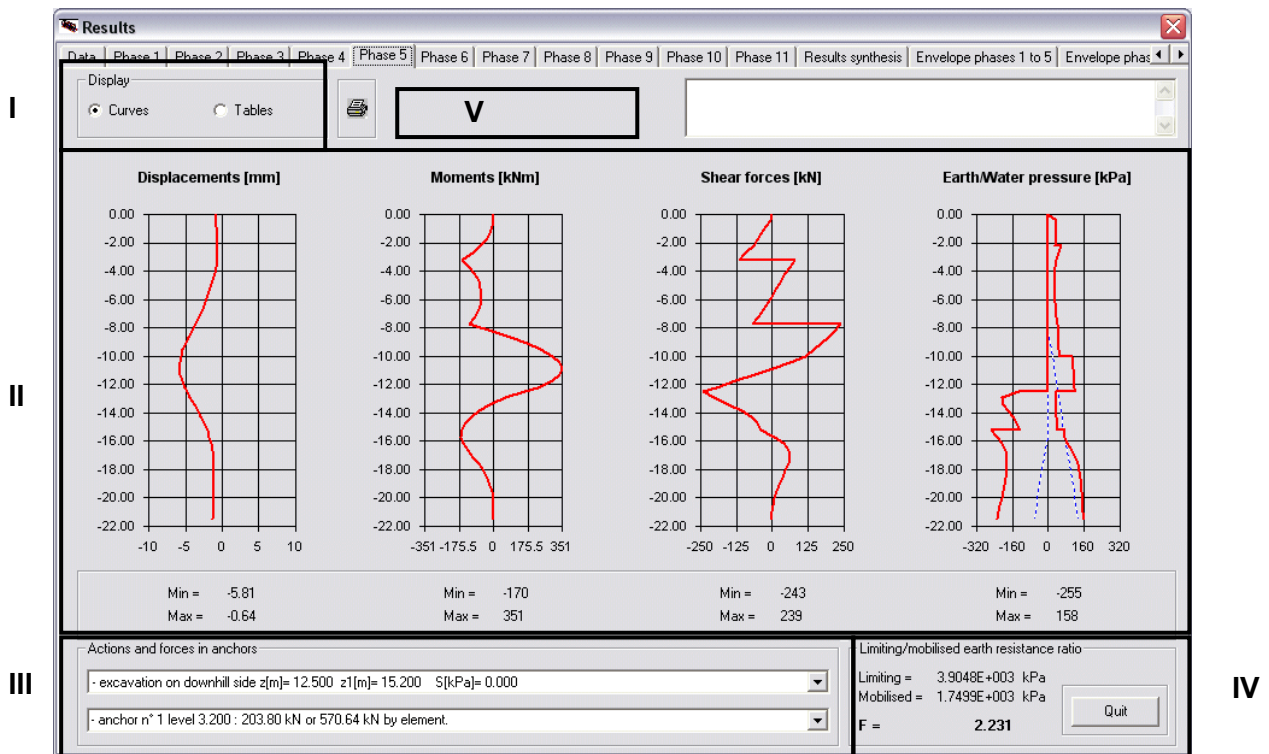


Figure B 32: Graphical results display for phase 2

Zone I. The first zone is the display selection zone. It enables to shift between curves and tables.

Zone II. The second zone is devoted to the curves display:

- the **displacements** displayed in millimeters ;
- the **moments** displayed in the units system chosen for the project;
- the **shear forces** displayed the units system chosen for the project;
- the **earth and water pressures**, red curves for the earth pressures and blue dotted curves for the water pressures. Negative pressures are those applied onto the left side of the wall (downhill side), and positive pressures are those applied onto the right side of the wall (uphill side).

The minimal and maximal values for each curve are displayed below the curves.

Zone III. The third zone is located in the lower left corner of the window, and contains two listboxes:

- The first list includes the actions defined for the current phase and their parameters. It also indicates the convergence status of the calculation for this phase.
- The second list displays the longitudinal forces in the anchors for the current phase. If the anchors wizard was used to define the project, the forces and the maximal resistance for each anchor will also be displayed.

Zone IV. If the option “Display ratio limiting/mobilised earth resistance” was checked in the project settings, this ratio is displayed in this zone.

Zone V. This zone is dedicated to warning messages. Such messages appear when the calculation did not converge, when an anchor works in compression, or when a strut works in traction (if the convention “main excavation on downhill side”, i.e. on the left to the wall, is respected).

When the “tables” display option is checked, only zone II changes, as shown below:

LEVEL	rotation	displacement	moment	shear force	status	status	earth pressure	earth pressure	water pressure	water pressure	vertical pressure
[m]	[rad]	[mm]	[kNm]	[kN]	DOWN.	UPHILL	DOWN.	UPHILL	DOWN.	UPHILL	DOWN.
0.000	0.00099	-3.94	0.00	0.00	excav.	passive	0.00	0.00	0.00	0.00	0.00
0.440	0.00098	-3.51	-2.43	-16.60	excav.	elast.	0.00	26.90	0.00	0.00	0.00
0.880	0.00098	-3.07	-17.20	-50.90	excav.	elast.	0.00	28.80	0.00	0.00	0.00
1.320	0.00095	-2.65	-47.50	-87.40	excav.	elast.	0.00	30.50	0.00	0.00	0.00
1.760	0.00088	-2.25	-94.40	-126.00	excav.	elast.	0.00	31.90	0.00	0.00	0.00
2.200	0.00077	-1.88	-158.00	-166.00	excav.	elast.	0.00	32.60	0.00	0.00	0.00
2.200	0.00077	-1.88	-158.00	-166.00	excav.	elast.	0.00	58.10	0.00	0.00	0.00
2.700	0.00056	-1.54	-261.00	-243.00	excav.	elast.	0.00	53.20	0.00	0.00	0.00
3.200	0.00023	-1.34	-400.00	-311.00	excav.	elast.	0.00	42.80	0.00	0.00	0.00
3.200			-400.00	228.00							
3.700	-0.00012	-1.31	-300.00	175.00	excav.	elast.	0.00	32.90	0.00	0.00	0.00
4.200	-0.00038	-1.44	-225.00	125.00	excav.	elast.	0.00	37.80	0.00	0.00	0.00
4.700	-0.00058	-1.68	-176.00	70.30	excav.	elast.	0.00	40.80	0.00	0.00	0.00
5.200	-0.00075	-2.01	-155.00	13.30	excav.	elast.	0.00	40.60	0.00	0.00	0.00
5.700	-0.00090	-2.42	-162.00	-40.10	excav.	elast.	0.00	35.70	0.00	0.00	0.00
6.200	-0.00108	-2.92	-194.00	-87.40	excav.	active	0.00	31.80	0.00	0.00	0.00
6.700	-0.00130	-3.51	-249.00	-134.00	excav.	active	0.00	34.90	0.00	0.00	0.00
7.200	-0.00159	-4.23	-329.00	-185.00	excav.	active	0.00	38.00	0.00	0.00	0.00
7.700	-0.00197	-5.12	-435.00	-241.00	excav.	active	0.00	41.10	0.00	0.00	0.00
7.700			-435.00	653.00							
8.200	-0.00225	-6.19	-123.00	593.00	excav.	active	0.00	44.20	0.00	0.00	0.00

Figure B 33: Tables for results of phase 5

The title bar on top of the table includes information about the columns (results type, side of the wall (downhill or uphill, units system)).

A thorough description of the columns is given hereafter:

- **Depth or level:** position of calculation points (nodes) along the wall, in depths or in levels (depending on the choice for the project). The calculation step is the maximal distance between two nodes. But the distance between two nodes can be smaller than that, because the program includes nodes at the interfaces between soil layers and at the anchors heads (1 node for each anchor and 2 nodes for each soil interface).
- **Rotation:** rotation for the structure at the calculation node, when forces are equilibrated.
- **Displacement:** displacement of the structure at the calculation node, when forces are equilibrated.

Note: the rotation is positive from uphill to downhill and displacements are positive from downhill to uphill.

- **Moment:** moment calculated at the calculation nodes.
- **Shear force:** shear force calculated at the calculation nodes.

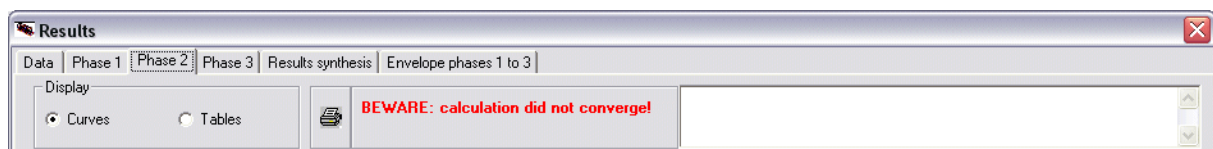
Note: the moments and shear forces calculated by K-REA are function of the elementary wall width.

- **Status:** soil status at each node, according to the following rule:
 - Excavation: excavation uphill or downhill;
 - Separation: no more contact between the soil and the wall (=negative pressure);
 - Active: active pressure on the wall;
 - Elastic: elastic soil facing the wall;
 - Passive: passive pressure on the wall.
- **Earth pressure:** effective horizontal earth pressure. It is calculated by multiplying the relevant earth pressure coefficient with the vertical earth pressure.
- **Water pressure:** water pressure calculated for each node using the water weight.
- **Vertical pressure:** sum of all effective vertical pressures at each node.
- **Limiting active pressure:** limiting active pressure.
- **Limiting passive pressure:** limiting passive pressure.
- **Vault pressure:** pressure resulting from the vault effect. It is calculated by multiplying the displacement with the cylindrical rigidity. In a circular wall, the compression is equal to this pressure, multiplied with the wall radius. The vault pressure is equal to zero if the wall is plane.

Note: an “effective” pressure means a soil pressure that doesn’t take into account the water pressure.

The status and earth pressures are all given in two columns. The first column (downhill) corresponds to the forces applied onto the left side of the wall, and the second column (uphill) corresponds to the forces onto the right side of the wall.

The **calculation convergence** depends on the status of the wall elements (nodes). If the status of all wall elements remains the same from one calculation step to the next one, then it is assumed that convergence is reached.



Note: when an action in a given phase has no influence on the wall displacements, the program will detect a “non-convergence”, because the results will be the same for all nodes from one phase to the other. But this “non-convergence” does not mean that the calculation really failed to converge within the maximum number of iterations (a common example is the installation of a strut as a single action in a given phase: the non-convergence warning will be displayed, but it’s no problem in this case).

The “synthesis table” tab displays a table that summarises the main results calculated for the different phases:

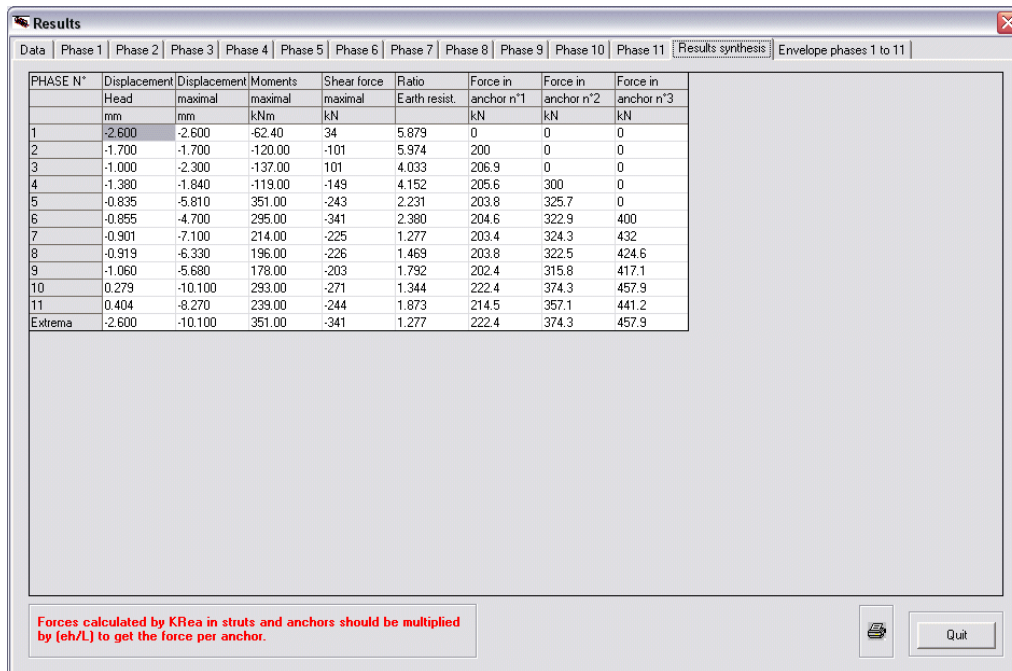


Figure B 34: Synthesis table

The last tabs in the window enable to view the envelope curves for displacements, moments and shear forces. The available envelopes depend on the envelope options selected during the phases definition:

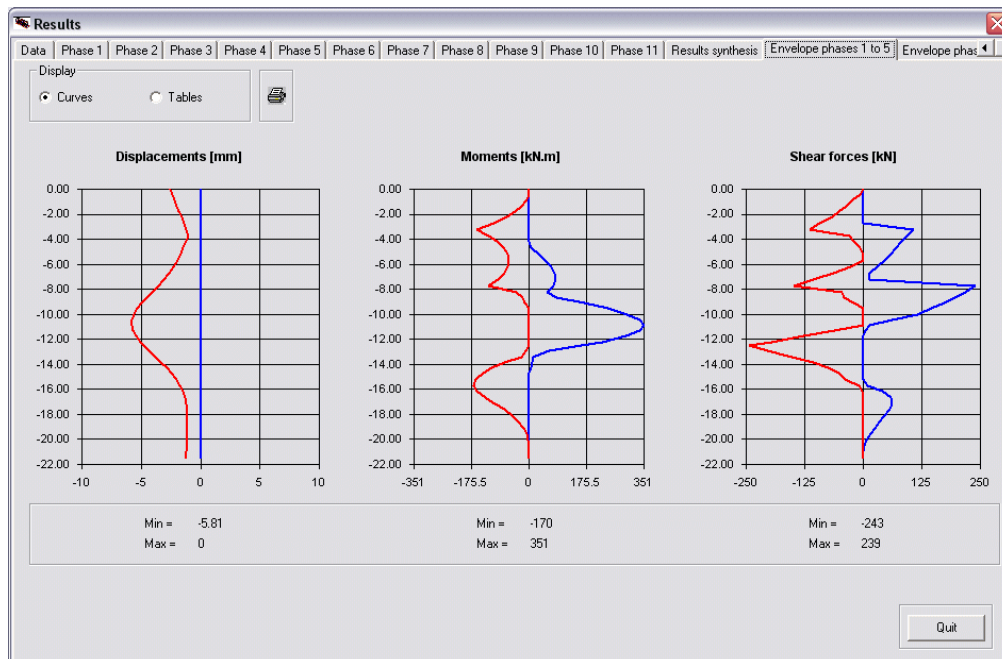



Figure B 35: Envelope curves for phases 1 to 5

These last tabs look like the phases tabs: you can select to display envelopes as curves or tables.

Note: Two buttons are always displayed in the tabs. The “print” shortcut button  enables to open the printing wizard. The button **Quit** enables to close the results window.

B.7. Display options

B.7.1. Layers colours

This wizard can be opened by selecting the **Wizard** menu and then **Layers colours**. The soil layers dialogue box appears. Double-click on the colour to be modified, in order to open the colours wizard.

This wizard enables to change the default colour assigned to each soil layer. These new colours will be considered as the new default settings for all projects with K-REA.

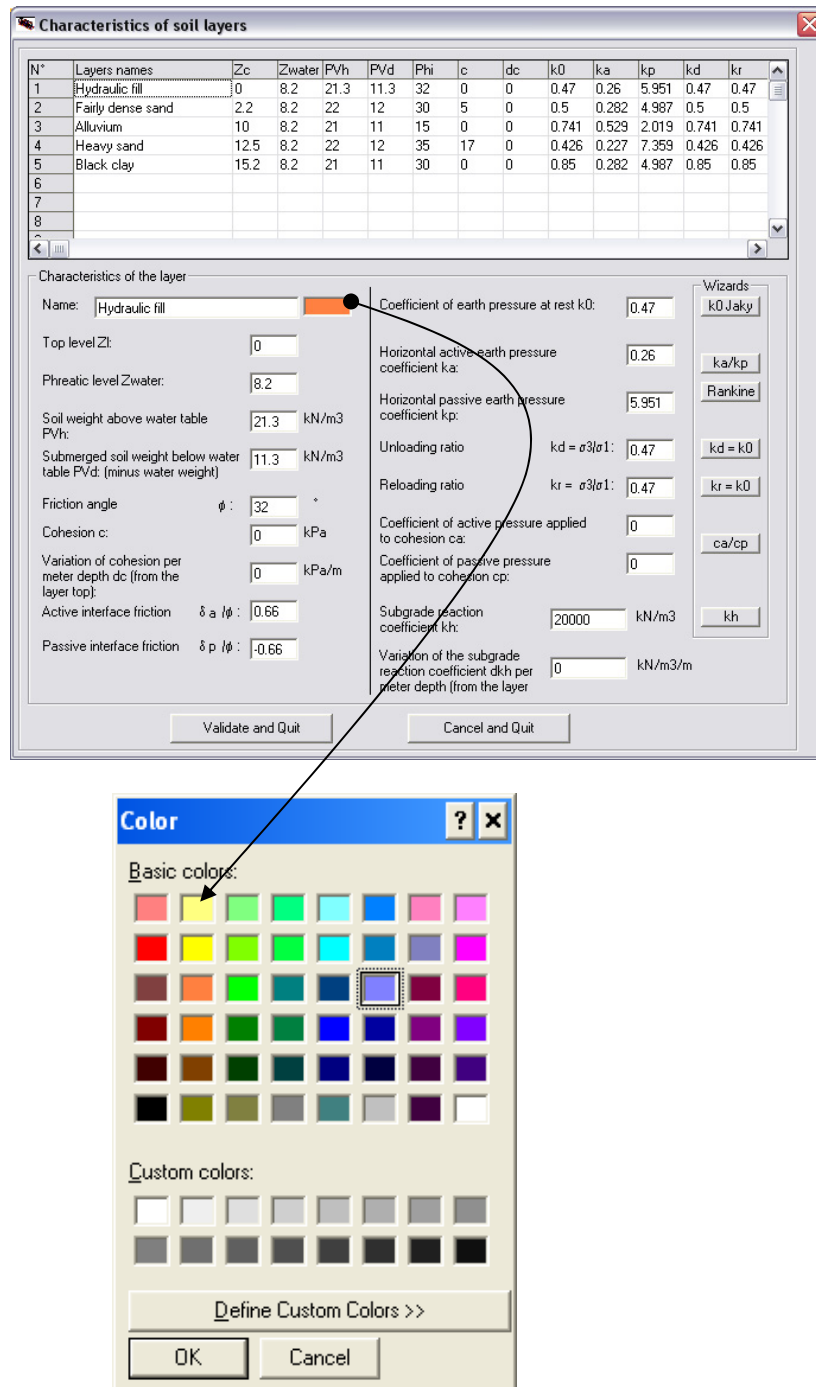


Figure B 36: Colour wizard for the soil layers

B.7.2. Popup menus

These menus are not permanently displayed in the main window of K-REA. They can be displayed by a right-click on some K-REA objects.

B.7.2.1. Popup dialogue box for the graphical display settings in the main window

This dialogue box appears after a right-click on the graphical representation in the main window.

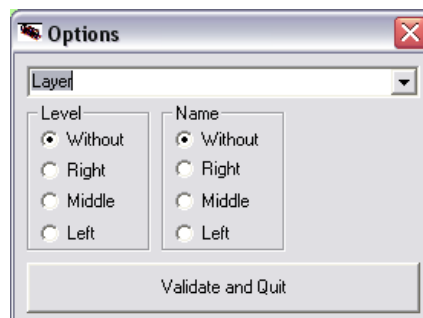


Figure B 37: Popup dialogue box for the graphical display in the main window

It enables to change the display settings: display of the levels of the soil layers interfaces, of the anchors, surcharges, excavations, fills, etc. on the graphical representation of the project. It also enables to display the values of the surcharges or the names of the soil layers.

The listbox in the upper part of this dialogue box enables to select which display setting you want to change. The radiobuttons available in the dialogue box depend on this choice.

Here are examples of this dialogue box:

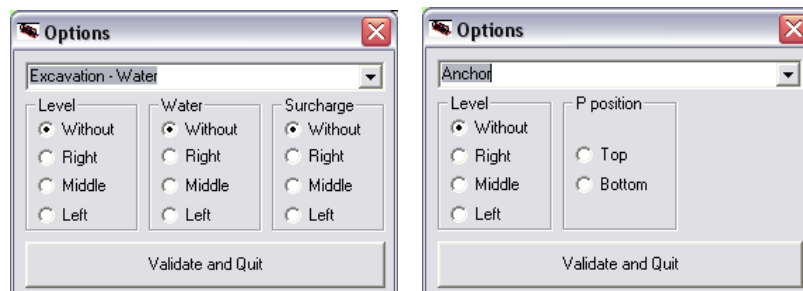


Figure B 38: Additional examples of the popup dialogue box

Use the radio buttons to define your new display settings, and click on **Validate and Quit**. The new settings will be taken into account on the graphical representation, and the dialogue box will be closed automatically.

B.7.2.2. Popup menu in the synthesis tables

This menu appears when the synthesis tables for the soil layers or the wall are right-clicked.

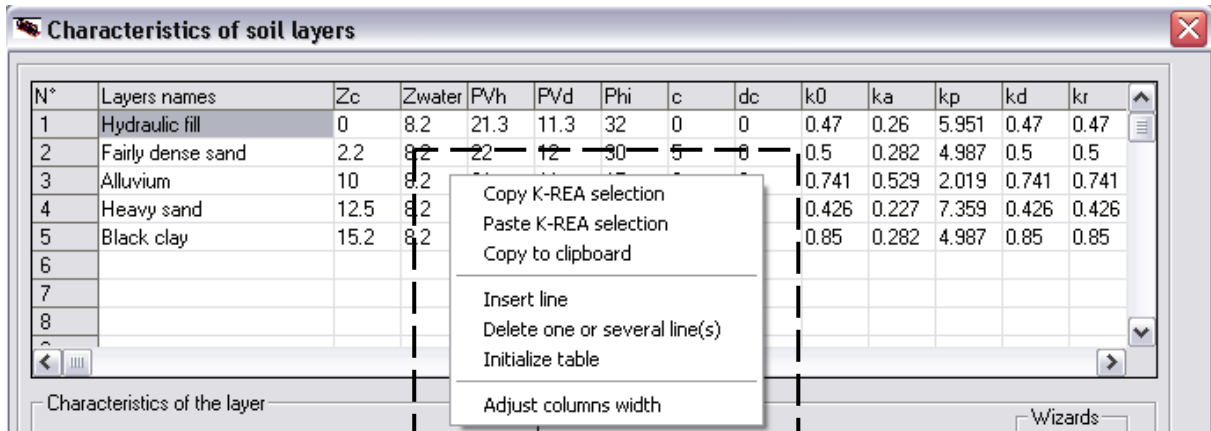


Figure B 39: Right-click menu in the soil layers table

Here are the available options:

- **Copy K-REA selection:** copies the selected values (one line for example) into the clipboard.
- **Paste K-REA selection:** pastes the copied values into the table.
- **Copy to clipboard:** copies the synthesis table to clipboard, so that it can be later pasted into another document.
- **Insert line:** creates an empty line above the selected line.
- **Delete one or several line(s):** deletes the selected line(s).
- **Initialize table:** erases all values in the table.
- **Adjust columns width:** optimizes the columns width.

B.7.2.3. Popup menu in the results window

Each table or curve in the results window can be right-clicked to display this popup menu.

Example: popup menu on a results curve

Left-click on a curve to select it.

Right-click on the same curve to display the popup menu. The following options are available:

- **Copy:** enables to copy the curve to the clipboard.
- **Curves format:** enables to change the curve settings (line thickness, line style).

- **Background colour:** enables to change the background colour of the curve.

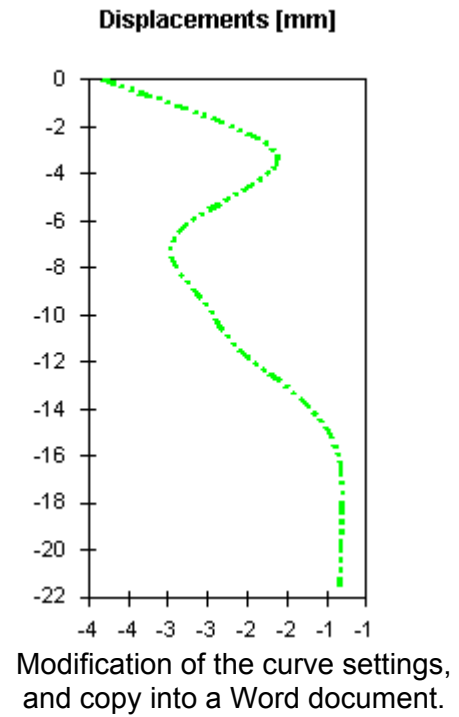
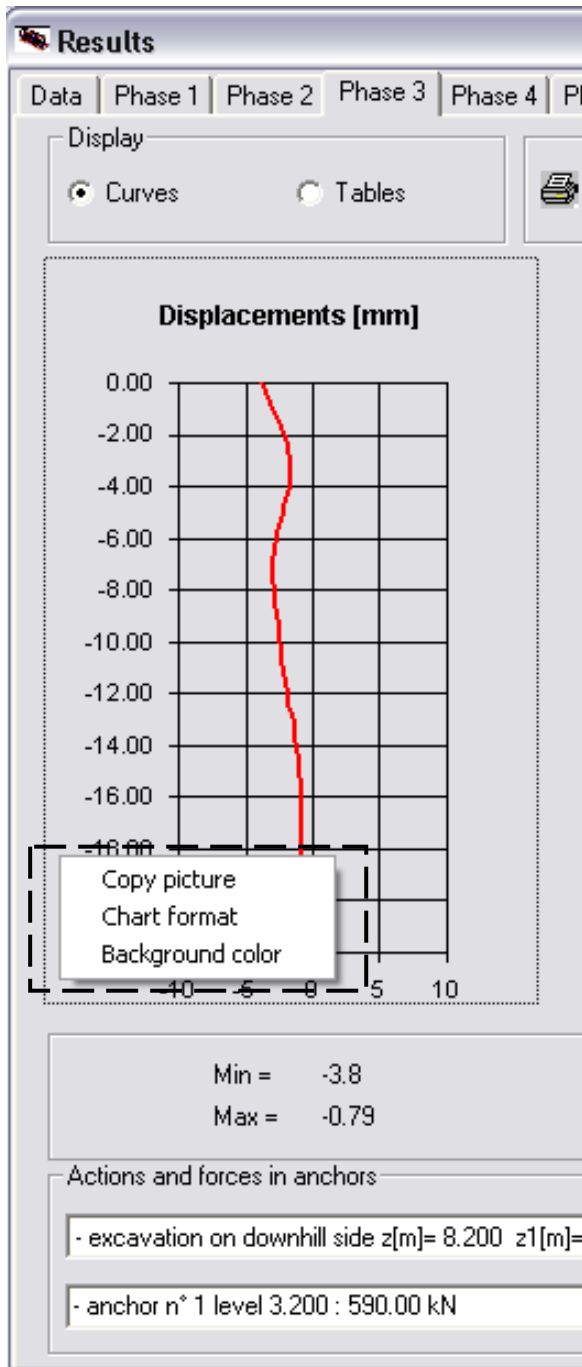


Figure B 40: Popup menu on the curves

Example: popup menu on a results table

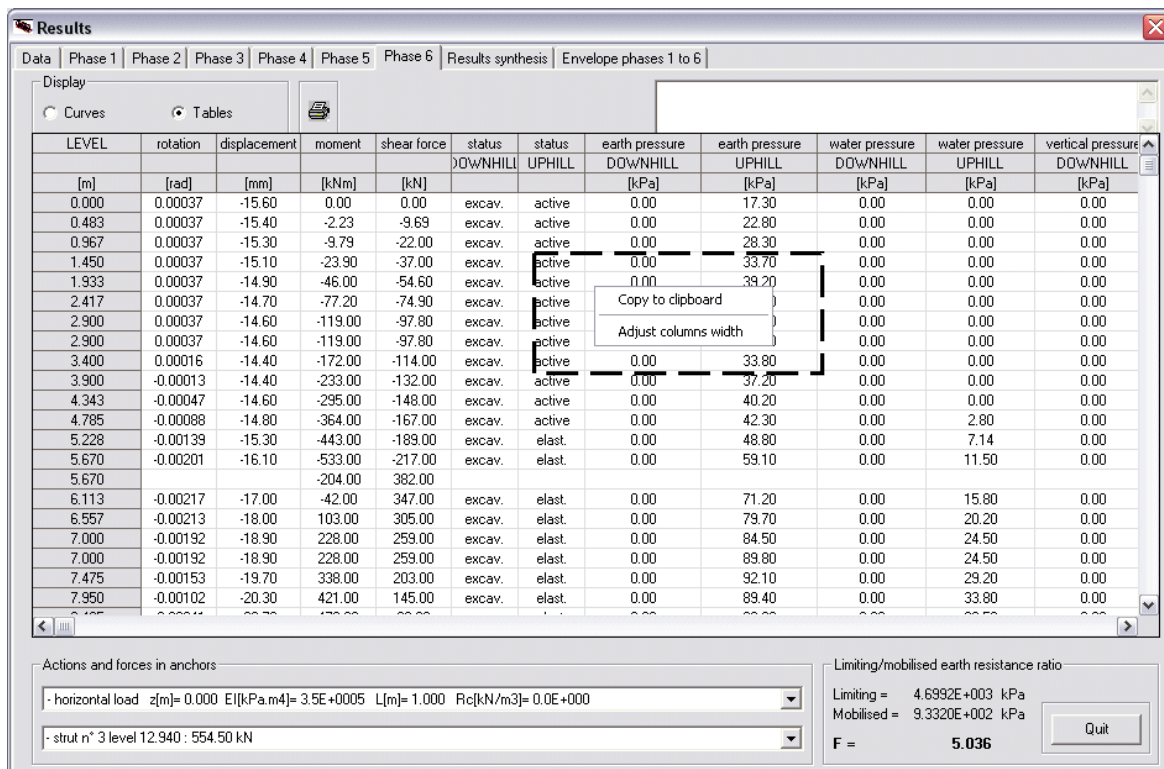


Figure B 41: Popup menu on a results table

Right-click on the table to display the popup menu. The following options are available:

- **Copy to clipboard:** enables to copy the selected table to the clipboard, so that it can be pasted into another document (Excel, Word, etc...).
- **Adjust column width:** enables to reduce the columns width as much as possible.

All these popup menus enable to customize your results display in K-REA.

B.8. Printing

B.8.1. Printing wizard

The printing wizard can be opened with the shortcut button  or with the menu **File, Print**.

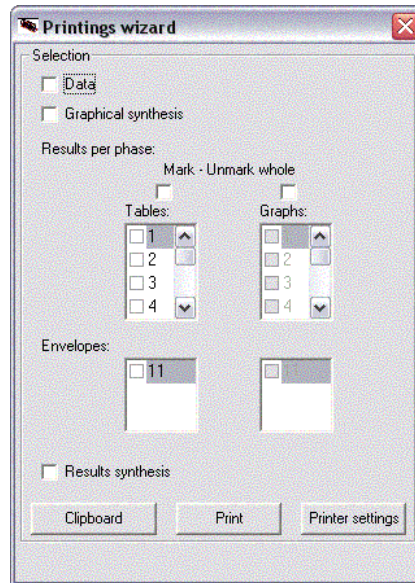
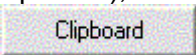


Figure B 42: Printing wizard

The printing wizard enables to select which elements should be printed:

- **Data:** prints the first tab of the results window.
- **Graphical synthesis:** prints the phases synthesis (see next page).
- **Results per phase:** prints the output for the selected phases. All phases can also be selected at once. It is possible to edit tables and/or curves.
- **Results synthesis:** prints the results synthesis.
- **Envelopes:** prints the envelope curves and/or tables.

These elements can be copied into the clipboard (rather than printed), in order to paste them later into another document. In that case, click on the button .

Note 1: the results window must be opened before printing the curves.

Note 2: the tables to be copied to the clipboard have to be selected using the mouse.

B.8.2. Phases synthesis (graphical synthesis)

This command enables to print or copy a graphical synthesis of the project to the clipboard. It includes the schematic representation of the project for each phase, as well as the list of actions selected for each phase and their parameters.


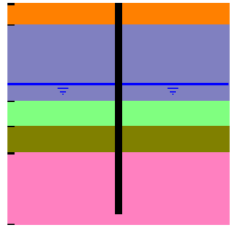
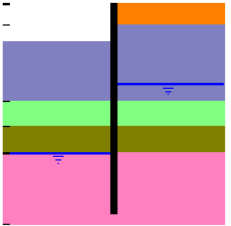
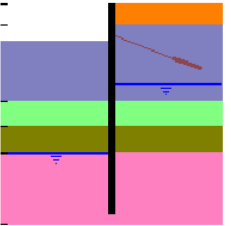
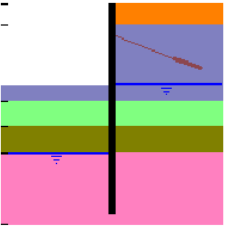

 v.2.2.0 du 30.11.2006	PROJECT 00921594		
Paroi moulée : 0,82 m d'épaisseur et 3 lits de tirants			
STAGED CONSTRUCTION			
INITIAL PHASE	PHASE 1	PHASE 2	PHASE 3
			
	- excavation (downhill) : z [m] = 3.700 z1 [m] = 15.200	- installation of anchor : n°1 z [m] = 3.200 K [kN/m] = 13380 P [kN] = 200 alpha [°] = 20.00	- excavation (downhill) : z [m] = 8.200 z1 [m] = 15.200
	Calculated by: TERRASOL		

Figure B 43: Phases synthesis

BIBLIOGRAPHY

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