

User Guide

CLASROCK32

Classification of Rock

Masses

geo&soft[®]
international

Geo Soft di ing. G. Scioldo

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Chapter 1 - Introduction to the program

Introduction to the program

Rock mass classification systems constitute an integral part of empirical mine and tunnel design.

They are traditionally used to group areas of similar geomechanical characteristics, to provide guidelines of stability performance and to select appropriate support. The primary objective of all classification systems is to quantify the intrinsic properties of the rock mass based on past experience.

Despite a plethora of empirical classification systems, only two systems are commonly used for mine and tunnel design. The first system is the Norwegian Geotechnical Institute's Q system, Barton et al. (1974) and the Rock Mass Rating System (RMR), proposed by Bieniawski (1973). The RMR and Q systems have evolved over time to better reflect the perceived influence of various rock mass factors on excavation stability.

CLASROCK thus allows the classification of a rock mass using the RMR and Q methods.

The RMR classification system, Bieniawski (1989), was developed for characterizing the rock mass and for providing a design tool for tunneling. The system has evolved due to a better understanding of the importance of the different parameters and increased experience.

The parameters needed to determine the Bieniawski index are:

- resistance to monoaxial compression of the rock, which should be intact, C_0 , this can also be determined through the resistance index with an indentation test.
- quality of the rock through the modified percent recovery index (RQD)
- spacing of the discontinuities
- condition of discontinuities (nature of layer contact, filling, degree of separation)
- water flow
- orientation of the discontinuities in relation to the direction of excavation

A numerical value should be given to each of these parameters. The sum of these values yields the class of the RMR index. There are 5 classes, from I to V.

- class I - excellent
- class II - good
- class III - reasonable
- class IV - poor
- class V - very poor

The Q classification system was developed by Barton, Lien and Lunde (1974), primarily for tunnel design work. It expresses rock quality, Q, as a function of 6 independent parameters:

$$Q = \frac{RQD}{J_n} \cdot \frac{J_r}{J_a} \cdot \frac{J_w}{SRF}$$

where:

- RQD: the modified percent recovery index
- number of joint sets (Joint Set Number (J_n)): a numerical coefficient defined as a function of the number of natural joint sets present in the rock mass ($J_n = 0.5$ for a massive rock; $J_n = 20$ for an intensely fractured rock)
- roughness of the joint surfaces most unfavourable to excavation (Joint Roughness Number (J_r)): roughness index and waviness of the surfaces of discontinuity ($J_r = 0.5$ for a smooth and flat surface; $J_r = 3$ for a rough and irregular surface)
- degree of alteration of the joints and the eventual presence of filling material (Joint Alteration Number (J_a)): index of alteration of the surfaces of discontinuity ($J_a = 0.75$ for a hard surface and tight discontinuities; $J_a = 13-20$ for a joint filled with clay)
- eventual presence of water (Joint Water Reduction Factor (J_w)): reduction coefficient used to take into account the presence of water ($J_w = 0.05-0.10$ when there are large flows of water and water under pressure; $J_w = 1$ under absence of water)
- stress conditions (Stress Reduction Factor (SRF)): reduction coefficient in order to take into account the tension (SRF = 1.5-2.5 in massive rocks, SRF 10-20 in presence of zones of weakness and for rock characterised by swelling phenomena)

It has been suggested that RQD/ J_n reflects block size, J_r/J_a reflects friction angle and J_w /SRF reflects effective stress conditions. The main advantage to the Q classification system is that it is relatively sensitive to minor variations in rock properties. The descriptions used to assess joint conditions are relatively rigorous and leave less room for subjectivity, compared to other classification systems.

Based on the value assumed by Q the rock will fall in one of the following nine quality classes:

- exceptionally poor
- extremely poor
- very poor
- poor
- discrete
- good
- very good
- extremely good
- exceptionally good

Chapter 2 - System requirements and program installation

System requirements

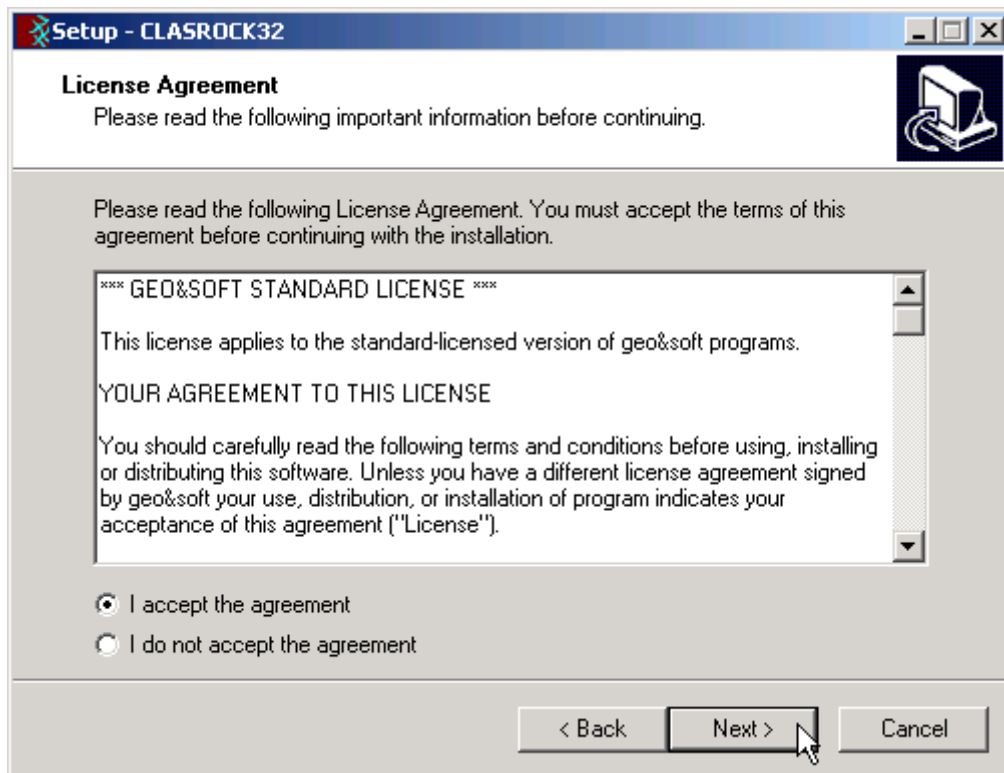
- Pentium® class processor
- Microsoft® Windows® 95 OSR 2.0, Windows 98, Windows Me, Windows NT®* 4.0 with Service Pack 5 or 6, Windows 2000, or Windows XP
- 64 MB of RAM (128 MB recommended)
- 100 MB of available hard-disk space
- CD-ROM drive
- A printer driver **must** be installed, even if the printer itself is not connected to the PC.

Program installation

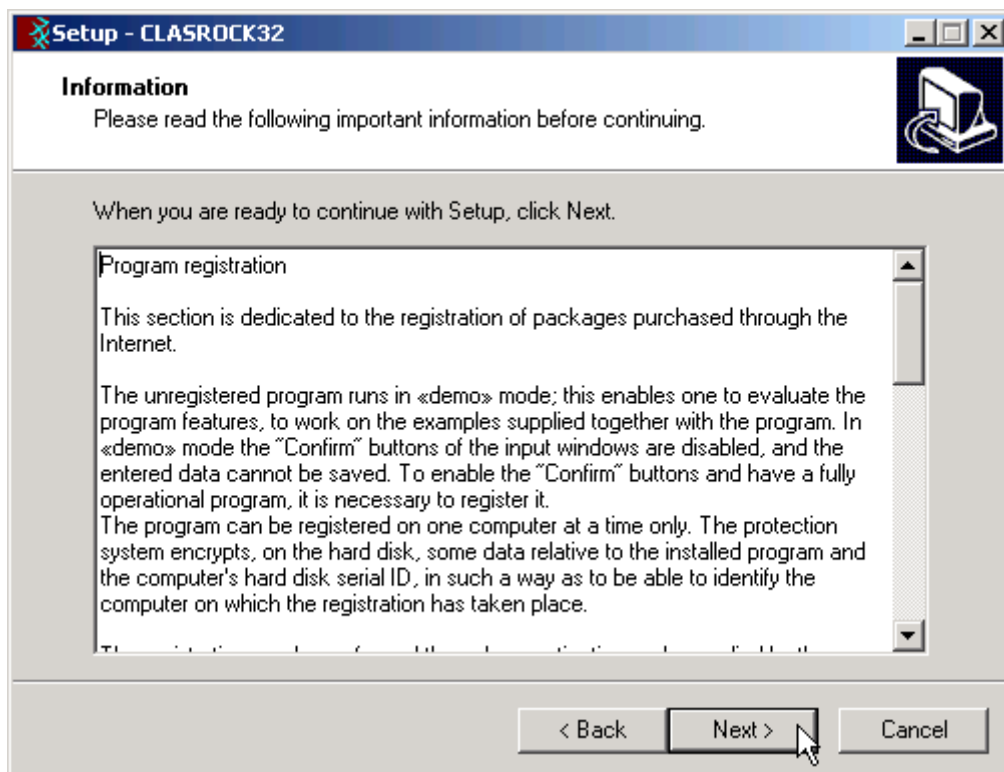
To install the CLASROCK program, run **CLASROCK32SETUP.EXE** from the CD-ROM or from the folder where you downloaded and saved the setup program.



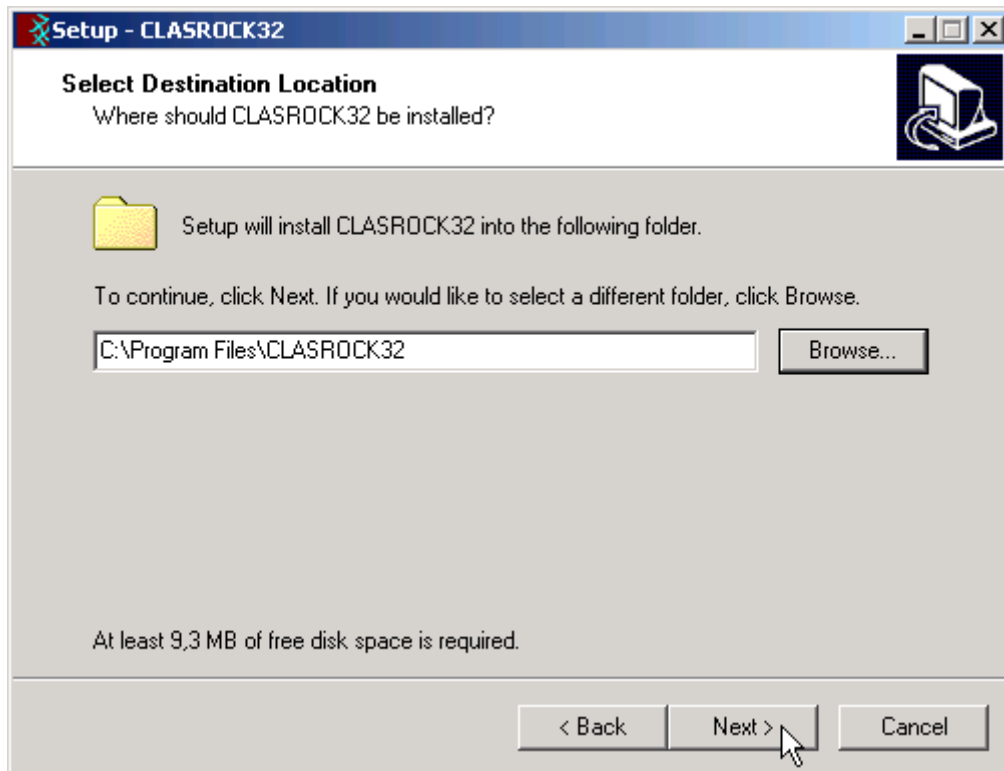
Press the **NEXT** button to start the installation.



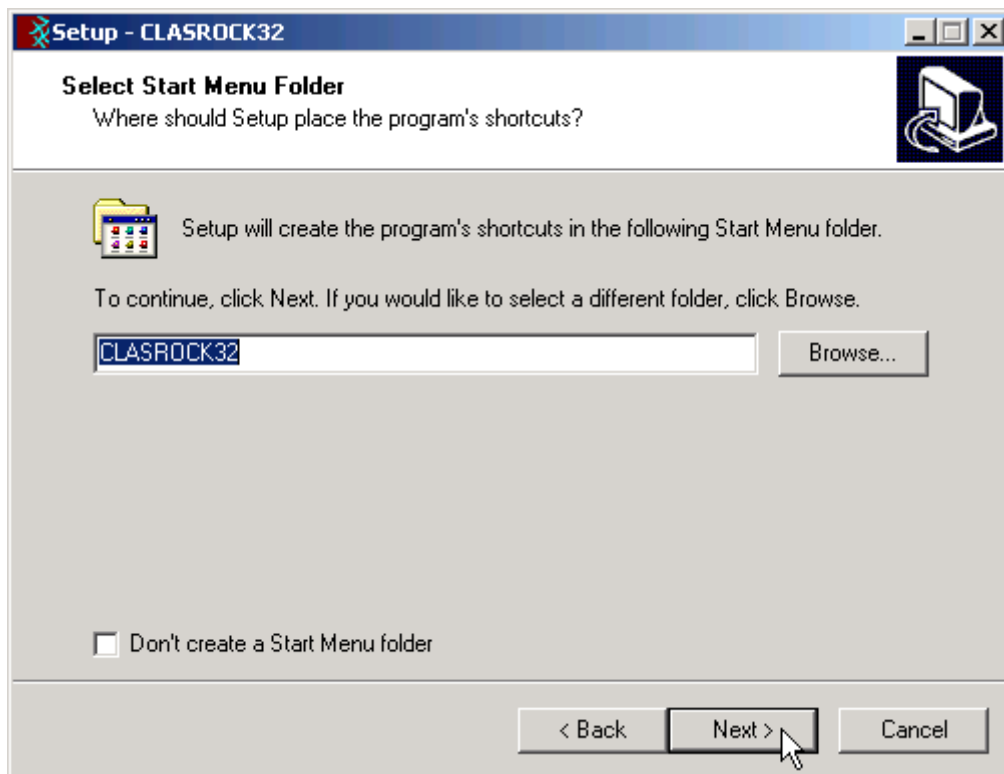
Carefully read the License Agreement and press the **NEXT** button.



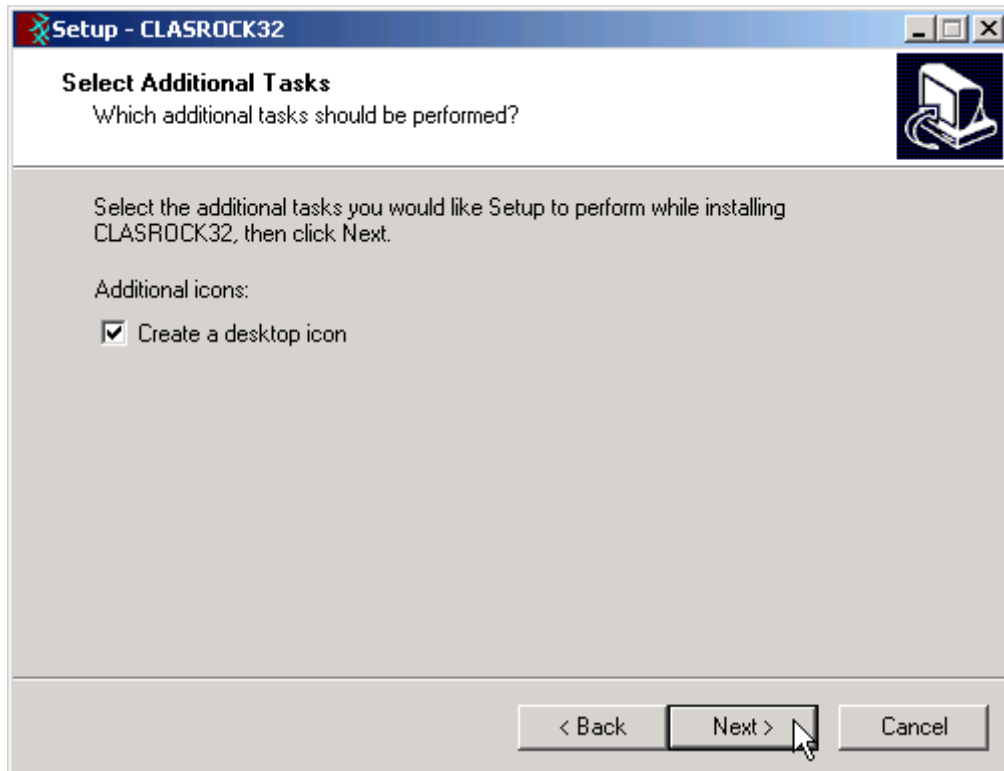
Carefully read the informations about the registration of the software and press the **NEXT** button.



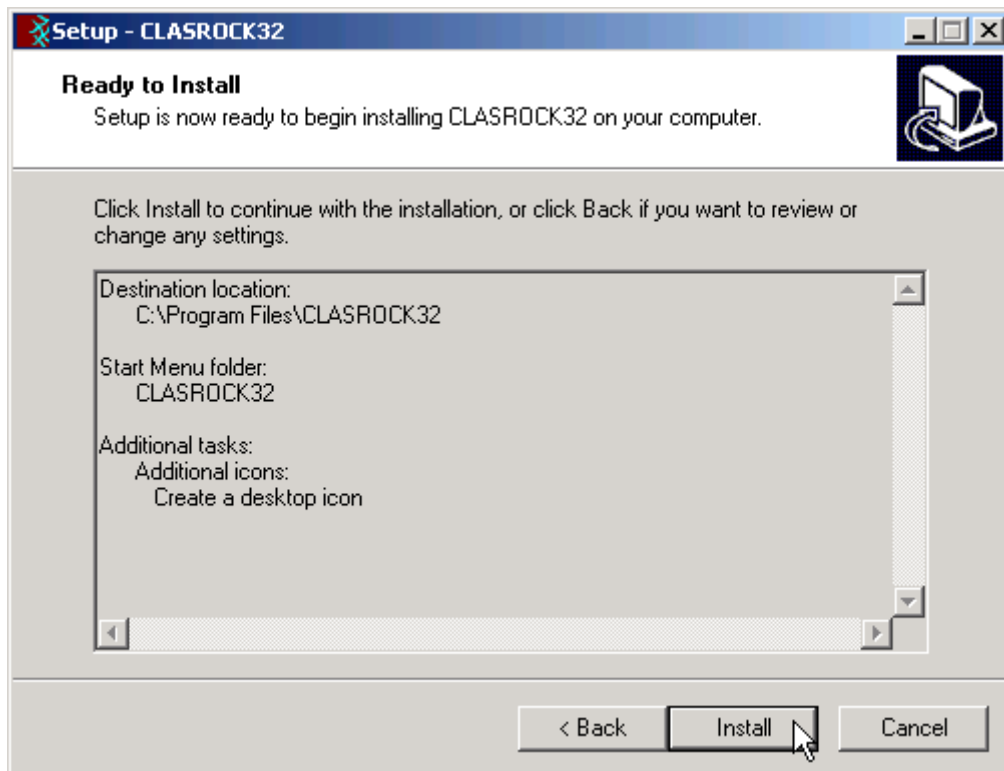
Select the folder where the **CLASROCK32** directory would be created and press the **NEXT** button.



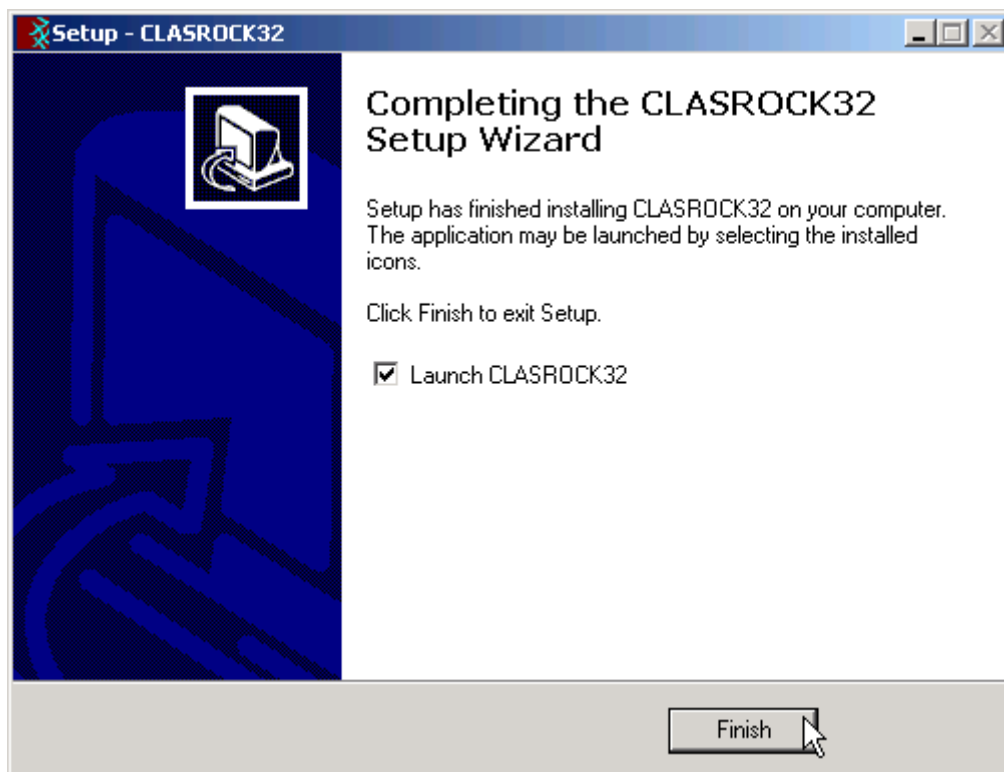
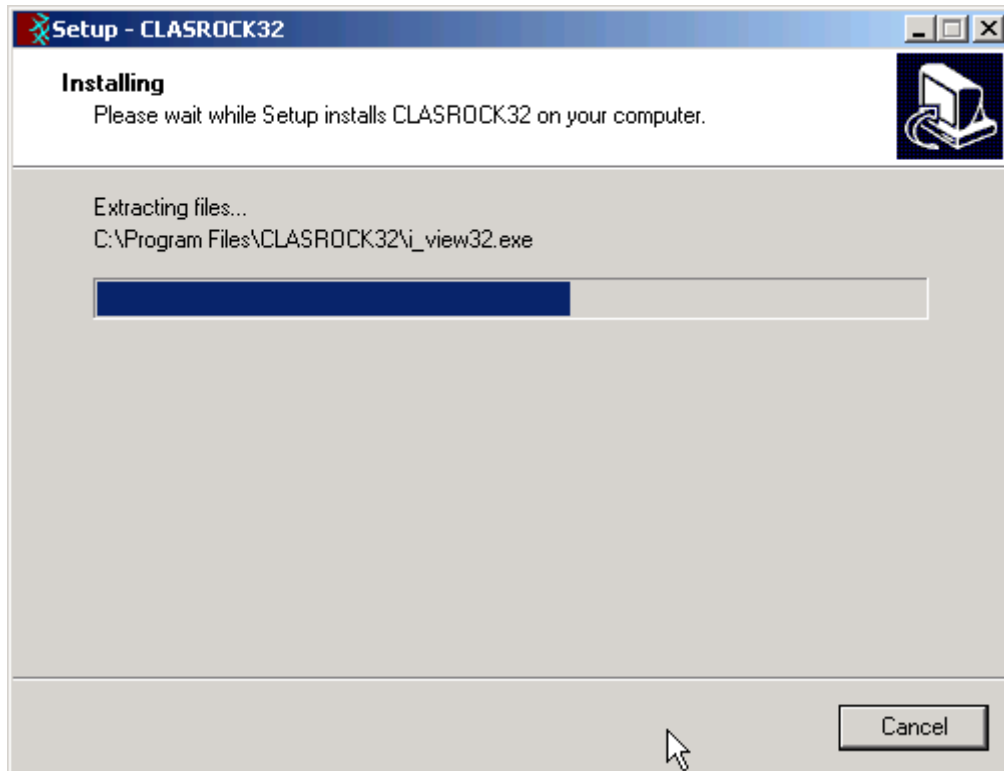
Press the **NEXT** button to create the **CLASROCK32** group in the Start menu.



Choose if you want an icon to be created on your desktop, or not.



Press the **INSTALL** button to continue the installation procedure ...



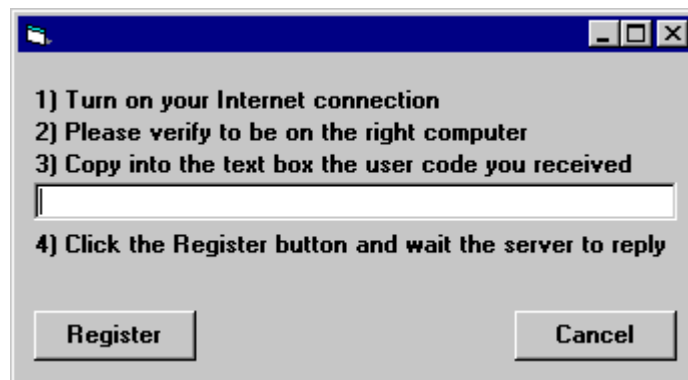
Once completed the installation, press the **END** button to exit the setup procedure and to start **CLASROCK32**.

CLASROCK32 can be run by clicking the **Start** button, then selecting the **CLASROCK32** group in the **Programs** menu, and clicking **CLASROCK32**.

Chapter 3 - The program protection

Program registration

This section is dedicated to the registration of packages purchased through the Internet.



The unregistered program runs in «demo» mode; this enables one to evaluate the program features, working on the examples supplied together with the program. In «demo» mode the «Confirm» buttons of the input windows are disabled, and the entered data cannot be saved. To enable the «Confirm» buttons, and have a fully operational program, it is necessary to register it.

The program can be registered on one computer only at a time. The protection system encrypts, on the hard disk, some data relative to the installed program and to the computer hard disk serial ID, in such a way as to be able to identify the computer on which the registration has taken place.

The registration can be performed, by the manufacturer or supplier, with an **activation code**.

We would like to stress that the encrypted protection data on the hard disk are bound in a unique way to the hard disk itself: subsequently, one can no longer use the activation code to install the program on other computers.

Let us describe the procedure for the registration of the software:

1. select the **Registration** command from the Help menu.
2. turn on your Internet connection
3. copy into the box the activation code you received
4. click the <Registration> button and wait the server to replay

Chapter 4 - How to update the program

Procedure for updating the program

We believe that the best advertising is a client who shows to the colleagues a state-of-the-art product, so we have always made available the free updates of our packages.

Now a new service is available for free: **AutoUpdater** automatically searches and downloads the new components from our web site **www.geoandsoft.com**, saving the older versions in a backup folder.

If you prefer, you still can download the updated full setup from our web site, of course.

To download the updated components with AutoUpdater, follow this procedure:



1. Start the program
2. Click the "**Update**" button at the bottom of the first window.
3. Wait for the program to verify if some updated component is available on our servers. If the program finds new components, it shows the list: each component has a check box which allows to choose if a single component has to be downloaded, or not. AutoUpdater automatically checks the boxes of the components whose download is suggested, and leaves unchecked the files which could have been modified by the user, like the colour configuration files.
4. Select the files you want to download and click the "**Update**" button.
5. Once the files have been installed, AutoUpdater runs the updated program.

AutoUpdater can also be configured to automatically start at each run of the program. Simply check the “update at startup” check box, and AutoUpdater will automatically search for new components each time the program is run.



Autoupdating requirements and troubleshooting

The autoupdating procedure requires an active Internet connection.

The search for new components is directly performed by the program, while the download is performed by AutoUpdater: for this reason, both the main program and AutoUpdater need the right to access to the Internet.

All the autoupdating procedures use the HTTP protocol, port 80, and automatically recognize if a proxy server is used on the local network to access the Internet.

If you experience some problems with the autoupdating procedure, they may be due to a FIREWALL: ask your System Administrator to give the right to access the Internet to the executable of the program (*32.exe) and to the AutoUpdater.exe module, in the program folder. No “act as a server” right is needed.

If particularly hard security rules disallow giving those access rights, remember you can download the updated full setup, from our web site, through your web browser.

Chapter 5 - User Interface

Usage Notations

Some typographical notations and keyboard formats are used in this manual to help locate and interpret information more easily.

Bold print is used to indicate command names and related options. Characters appearing in bold print should be typed exactly as printed, including spaces.

Words written in *italics* indicate a request for information.

CAPITAL letters are used to indicate computer, printer, directory, and file names.

User Interface and Data Entering

The user interface is designed to be easy to use and powerful and is supported by complete on-line help. This help contains practical hints and the theoretical background, where applicable. It should reduce the requirement of frequently consulting the printed manuals.

All the commands are located inside a menu bar. Each menu contains a list of commands that one can select with the mouse or the keyboard. The arrangement of the menus, designed with ergonomic criteria, follows the logical order of the operations, inhibiting the access to further operations until all the necessary data have been entered.

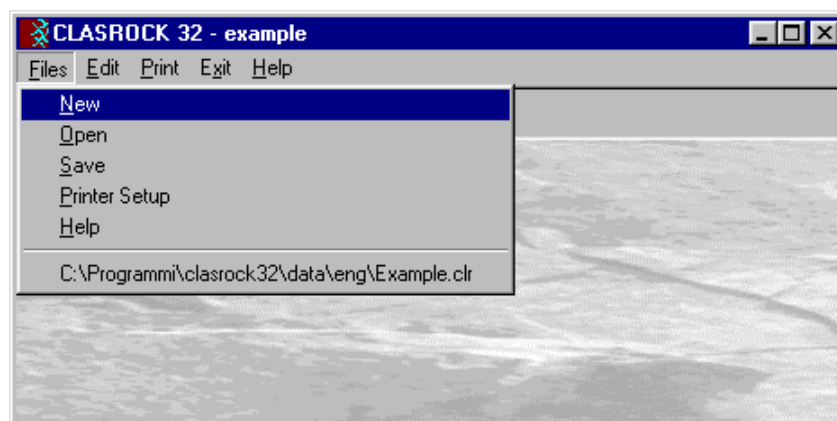
The interface layout is maintained in all of our programs, to simplify, as much as possible, the transition from one program to another to avoid having to learn different commands and procedures for similar functions (such as entering data or managing files).

Let us examine the general components that are available in the user interface of geo&soft programs.

User Interface: Menu Bar and Menus

The Menu Bar manages the access to all the program commands. The goal of the menu design is to offer an ergonomic, simple, and understandable arrangement of the commands.

The menus used to perform a complete operation are normally ordered left to right and top to bottom. When possible, the following scheme is used: definition of the name of the project, entering the required data, performing the calculation, and generating the output as a preview or final print.



The programs automatically disable some menus or commands when the execution of such menus or

commands is not yet feasible. Typical examples are: a calculation menu is disabled when not all the data needed for the calculation have been completely entered, or a print menu is disabled if not all the calculations have been executed.

To choose a command from a menu, use the following procedures:

- ☞ Point the menu that is to be activated, click the left button of the mouse, then point the command to be activated, and click the left button of the mouse again. If one does not wish to select any command from the menu that is open, exit the area of the menu before releasing the mouse button.

The Input Dialogue Windows

The different menu commands can perform an immediate action, or display a dialogue window in order to input or edit the various data sets.

When a dialogue window is visible, all the actions that do not pertain to it are ignored. Hence, it is necessary to close the dialogue window to resume the normal use of the program.

Some fundamental tools are used inside the dialogue windows: data fields such as text and list boxes, and buttons.

The text boxes are used to input numerical values and text strings. Most of the editing keys (HOME, END, INS, DEL, etc.) can be used inside these fields. If one sees a small arrow pointing down on the right side of the data field, one has a list box.

To scroll the list box and select an item, do as follows:

- ☞ click the arrow, and then click the item to be selected.

There are three buttons in the dialogue window:

- <Ok> - this button saves the entered information and goes on to the next phase.
- <Cancel> - this button closes the Dialogue window without saving the just entered data, or without executing the command.
- <Help> - this opens a window that contains general information on how to use the dialogue windows.

To use the buttons:

- ☞ click the button

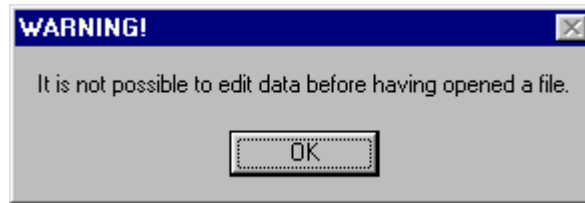
To edit the data inside the dialogue window, use the following keys:

- TAB - moves the cursor to the next field; when the cursor is inside the last visible field the cursor goes to the first control button of the Dialogue window. To return to the previous field, press SHIFT+TAB.
- ENTER - moves the cursor to the next field. If the cursor is positioned on one of the window buttons, the corresponding command is executed.
- BACKSPACE - cancels the last character that has been entered.
- DEL - cancels the character to the right of the cursor.
- ESC - closes the Dialogue window without saving the entered values or without executing the command. The <Cancel> button will do the same.
- UP ARROW/ DOWN ARROW - these are used in multiple fields, or those fields that have a list box.
- LEFT ARROW/ RIGHT ARROW - moves the cursor to the previous or next field.
- HOME - moves the cursor to the beginning of the field.
- END - moves the cursor to the end of the field.

A yellow box with a short text that explains the meaning of the value to be entered, can be seen in the lower part of the window. If the text is not completely visible, click the yellow box to read the complete text.

Message Windows

The function of these windows is to give information to the user concerning the system status, as in the case of an error due to an improper use of the program.



Help On Line

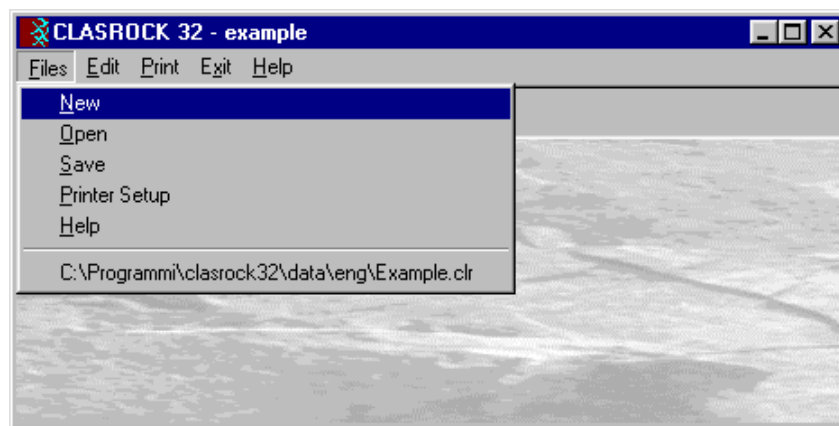
A complete Help On Line is available. It is possible to ask for information or suggestions related to the commands or the use of the program. In order to access the help on line, proceed as follows:

1. Position the cursor on a field of a dialogue window and press F1.
2. Use the Summary from the Help menu.

Chapter 6 - Commands

Files Menu

In order to operate with this program, it is necessary to open a project; this can be a new project or an already existing one.



New Command

To open a new file:

- choose the New command from the menu by first clicking the Files menu item and then on the New command.

Open Command

To open an existing file:

- choose the Open command from the menu by first clicking the Files menu item and then on the Open command. Type the name of the file in the File Name field and confirm.

The name of the file in use will be reported in the title bar of the main window.

The name of the file should not contain spaces and/or punctuation marks. It is not necessary to indicate any extension, since the extension ".CLR" is automatically added: for example, given the name "TEST01", the file name "TEST01.CLR" will be internally used by the program.

Save Command

To save a file:

- choose the Save command from the menu by first clicking the Files menu item and then on the Save command. Select a directory, if necessary, and type the name of the file in the File Name field and confirm.

Printer Setup Command

When selecting this command, one calls the printer configuration dialogue window. Here one can verify and modify the default printer setup or select another printer from the list of the installed ones.

Edit Menu

This menu is used to enter and edit the input data used for the rock mass classification.



Bieniawski Parameters Command

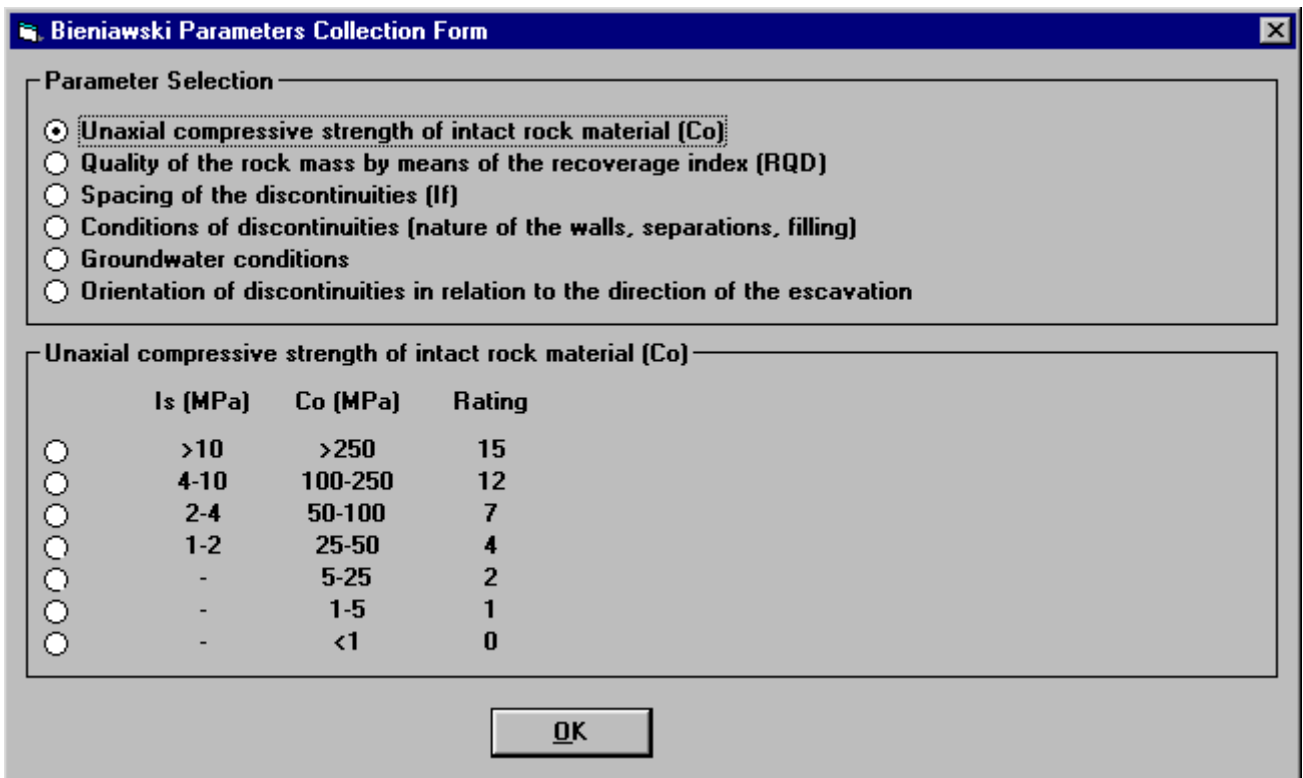
This enables one to enter and edit the parameters required for Bieniawski’s RMR classification.

The "Bieniawski Parameters Collection Form" Dialogue Box

The “Bieniawski Parameters Collection Form” is divided into two frames: the list of the parameters is shown in the first frame, the options related to each parameter are listed in the second one.

The input is performed by choosing one of the available options for each parameter. If one of the parameters is skipped, the lower rating option is assigned by default.

The Bieniawski parameters are:



Resistance C_o (Rock intact)

I_s (MPa)	C_o (MPa)	Rating
> 10	> 250	15
4 - 10	100 - 250	12
2 - 4	50 - 100	7
1 - 2	25 - 50	4
-	5 - 25	2
-	1 - 5	1
-	<1	0

For resistances $C_o < 25$ MPa it is suggested to use uniaxial compression resistance tests.

Rock Quality Designation

RQD	Rating
90% - 100%	20
75% - 90%	17
50% - 75%	13
25% - 50%	8
<25%	3

Spacing

I_f	Rating
> 2 m	20
0.6 - 2 m	15
200 - 600 mm	10
60 - 200 mm	8
<60 mm	5

Condition of the discontinuities

Condition	Rating
Very rough discontinuities, not continuous, not separated, hard end faces	30
Slightly rough discontinuities, separation < 1 mm, hard end faces	25
Slightly rough discontinuities, separation < 1 mm, soft end faces	20
Smooth discontinuities (SLK) or filling < 5 mm thickness or open joints 1 - 5 mm and continuous	10
Filling of weak resistance > 5 mm thickness or open joints > 5 mm and continuous	0

Water flows

Flow per 10 linear metres	Water pressure in discontinuities s_1 max.	General conditions	Rating
0	0.0	dry	15
< 10 l/min	<0.1	dump	10
10 - 25 l/min	0.1 - 0.2	wet	7
25 - 125 l/min	0.2 - 0.5	dripping	4
> 125 l/min	> 0.5	problems due to water flows	0

Please note that the water flows should be determined in each known exposure and, when measurements are available, these should be confronted with s_1 : when measurements are absent $s_1 = g Z$

Orientation of the discontinuities in relation to the direction of excavation

Orientation	Rating for Tunnels	Rating for Foundations	Rating for Slopes
very advantageous	0	0	0
advantageous	-2	-2	-5
discreet	-5	-7	-25
not favourable	-10	-15	-50
decidedly not favourable	-12	-25	-60

For tunnels the following values can be used for reference:

Direction perpendicular to the tunnel axis: digging in the direction of the inclination

Inclination:	<20°	20° - 45°	45° - 90°
	poor	favourable	quite favourable

Direction perpendicular to the tunnel axis: digging against the direction of the inclination

Inclination:	<20°	20° - 45°	45° - 90°
	poor	unfavourable	poor

Direction parallel to the tunnel axis

Inclination	<20°	20° - 45°	45° - 90°
	poor	unfavourable	quite unfavourable

For a dip between 0° e 20°, the effect is unfavourable in any direction

Subdivision in classes of the rock mass

class	I	II	III	IV	V
description	excellent	good	reasonable	poor	very poor
total numerical coefficient	81-100	61-80	41-60	21-40	<20

At the end of the analysis, the program calculates the GSI index (Geological strenght index) using the expression: **GSI = RMR₈₉ - 5**

Where RMR₈₉ is obtained by placing the rating of the parameter on the water presence to 15, and the parameter of correction on the direction of the joints to zero.

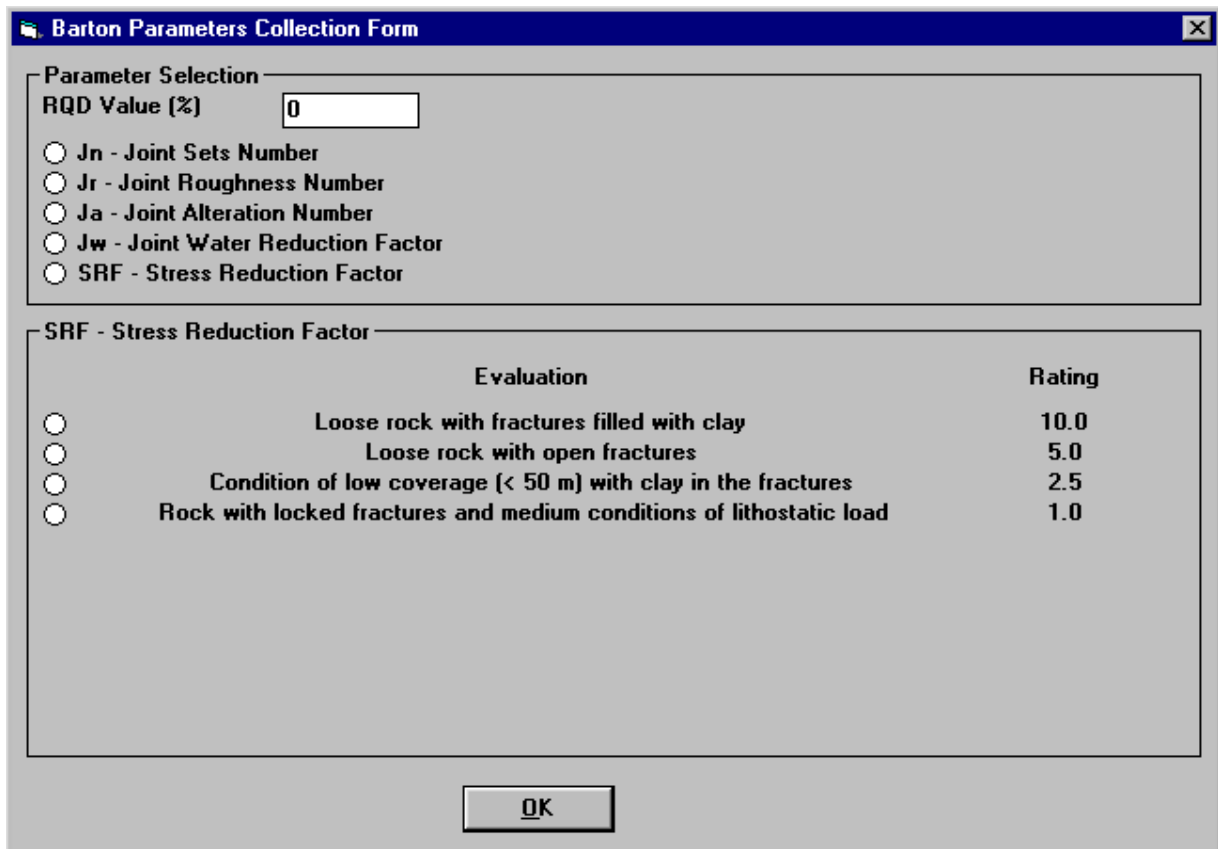
Barton Parameters Command

This enables one to enter and edit the parameters required for the Barton Q classification.

The " Barton Parameters Collection Form" Dialogue Box

The "Parameters Collection Form" is divided into two frames: the list of the parameters is shown in the first frame, the options related to each parameter are listed in the second one.

The input is performed by choosing one of the available options for each parameter. If one of the parameters is skipped, the lower rating option is assigned by default. The Barton parameters are:



The parameters proposed by Barton are as follows:

RQD - Rock Quality Designation

RQD	Evaluation
0 – 25	very poor
25 - 50	poor
50 - 75	discrete
75 - 90	good
90 - 100	excellent

For the evaluation of the Q index, for values of RQD \leq 10 one uses RQD = 10.

Joint Set Number

Rock mass	Jn
Massive - few joints	0.5
One system of joints	2
Two systems of joints	4
Three systems of joints	9
Four or more systems of joints	15
Rock badly fractured	20

Joint Roughness Number

Rock mass	Jr
Discontinuous joints	30
Rough and wavy	25
Flat and wavy	20
Rough and flat	10
Smooth and flat	5
Discontinuity with filling	5

Stress Reduction Factor

Rock mass	SRF
Loose rock with fractures filled with clay	10.0
Loose rock with open fractures	5.0
Condition with little covering (< 50 m) with clay in fractures	2.5
Rock with closed fractures and average lithostatic load conditions	1.0

Joint Alteration Number

Rock mass	Ja
Without filling	0.75
only oxidised	1.0
Silty coating	3.0
Argillaceous coating	4.0
Sand or kataclastic breccia	4.0
Hard clay < 5 mm	6.0
Soft clay < 5 mm	8.0
Swelling clay < 5 mm	12.0
Hard clay > 5 mm	10.0
Soft clay > 5 mm	15.0
Swelling clay > 5 mm	20

Joint Water Reduction Factor

Hydraulic conditions	Jw
Dry	1.0
Medium flow rates	0.66
High flow rates (joints without filling)	0.5
High flow rates (joints with washed-out filling)	0.33
High flow rates (joints with filling and discontinuous flow)	0.15
High flow rates (joints with filling and continuous high flows)	0.075

Quality of the rock mass (Q)

Class	Value of Q
exceptionally poor	<0.01
extremely poor	0.01-0.10
very poor	0.10-1.00
poor	1.00-4.00
discrete	4.00-10.0
good	10.0-40.0
very good	40.0-100.0
extremely good	100.0-400.0
exceptionally good	400.0-1000.0

Titles Command

This command enables one to enter and edit one title and up to five sub-titles.

TITLES

Main title

Subtitle 1

Subtitle 2

Subtitle 3

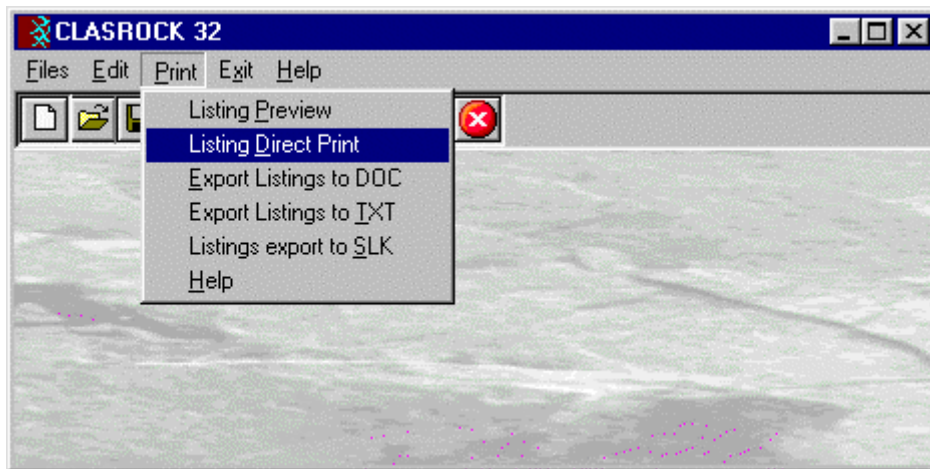
Subtitle 4

Subtitle 5

It is possible to introduce up to six titles, the first of which will result in larger characters.

Print Menu

This menu allows one to print the results of the classification.



Listing Preview Command

With this command, it is possible to preview the listings of the calculation results. The listings cannot be changed in the preview window.

The scroll bar, the UP arrow and DOWN arrow keys, or the PAGE UP e PAGE DOWN keys can be used to scroll the page. To exit press ESC or double-click any point of the window.

Listing Direct Print Command

With this command, it is possible to directly send the listings of the calculation results to the printer.

Listing Export to DOC

With this command, it is possible to export the listings of the calculation results into the DOC format (Microsoft Word 97 compatible).

The program creates a file with the same name as the current project but with the ".DOC" extension; the file is saved in the same directory as the data files.

The file is automatically opened if the program finds the Microsoft Word executable.

Listing Export to TXT

With this command, it is possible to export the listings of the calculation results into the TXT format (Microsoft Notepad compatible).

The program creates a file, with the same name as the current project but with the ".TXT" extension; the file is saved in the same directory as the data files.

The file is automatically opened if the program finds the Microsoft Notepad executable.

Listing Export to SLK

With this command, it is possible to export the listings of the calculation results into the SLK format (Microsoft Excel 97 compatible).

The program creates a file, with the same name as the current project but with the ".SLK" extension; the file is saved in the same directory as the data files.

The file is automatically opened if the program finds the Microsoft Excel executable.

Exit Menu

This command allows one to exit from the program. If some data have been added or modified the program asks the user to save the file.