Integrated Data Entry Forms

User Guide - Version 8.12.1

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Entry forms are integrated into all Geotec graphic modules to enter, modify, delete and view data. Entry forms include calculations, validations, default values and automations. Entry forms are used to retrieve data based on various criteria via the Query mode.

The data is saved directly in the connected Geotec database, either a Microsoft Access (.mdb), SQLite (.db3), SQL Server or Oracle database.

1. Database

Geotec databases have a standardized structure of tables, fields, and relations between tables – no definition of tables or fields needs to be made by the user. The database structure can be in English or in French. The databases are generated via the DBM module.

To open the entry forms, the graphic module must be connected to a Geotec database (DB).

- Click or **File > Open DB** to open an Access or a db3 DB.

- Click or **File > Connect DB** to connect to an SQL Server or Oracle DB. Enter the username, password and login alias provided by your IT department.

The title bar displays the name of the module and the connected DB in square brackets such as: [DBMS: File] (DB Version - Language).

1.1. Data Hierarchy

The hierarchy structure of the database is presented in Figure 1.

- The **site** refers to the mandate for which borings are being carried out. It is defined by a unique number in the DB.

- The **boring** is defined by its number and its site number. The site-boring combination must be unique in the DB.

- **Samples**, **layers**, *in situ tests* and other data are all linked to the boring.

- **Lab tests** are defined by their site-boring-sample combination which must be unique in the DB.

- **Axes** are defined in the site to generate profile views.
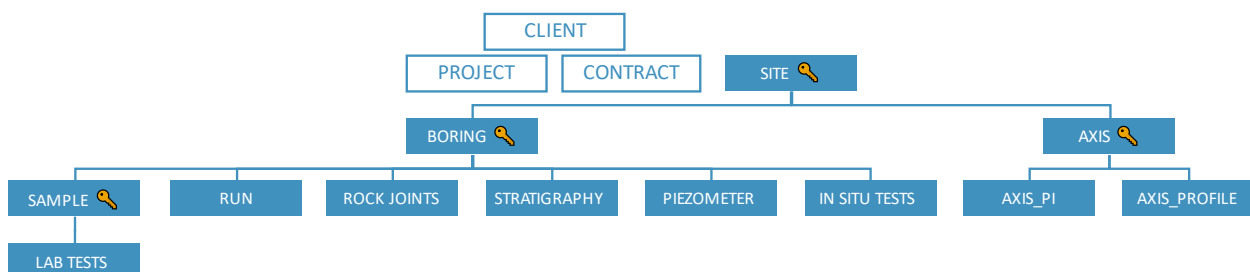
Figure 1 – Hierarchy structure of the Geotec database

2. Access the entry forms

Most of the buttons on the application toolbar of the graphic modules are linked to the data. They correspond to items from the Data menu and are described in this documentation.

2.1. Entry forms menu

Click the **Entry Forms Menu** button [icon] on the application toolbar or **Data > Entry > Entry Forms Menu**. A window opens, showing a button per entry form, all grouped by data type under the tabs **Description** (paragraph 6), **Rock** (paragraph 7), **In situ tests** (paragraph 8), **Lab tests** (paragraph 9) and **General** (paragraph 10). The four main entry forms, at the top of the database hierarchy, are described in paragraph 5.

When a query is made and data is retrieved, the name of each table containing data related to the query is displayed in red, to facilitate management.
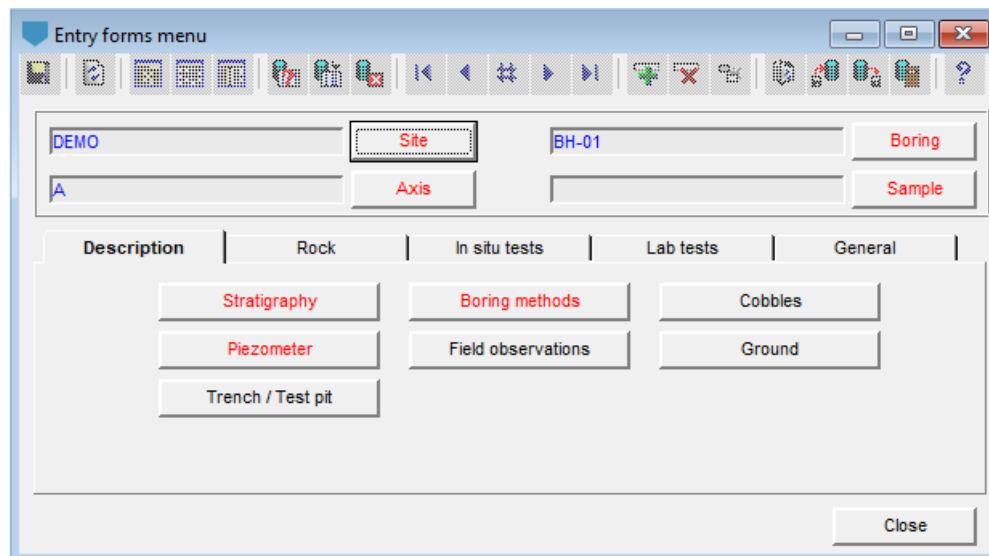
Figure 2 – Entry forms menu

2.2. Quick access buttons

Depending on the module, quick access buttons are available in the application toolbar to the left of the Menu button, or via **Data > Entry**. These buttons open the most common entry forms depending on the module. In Log, the quick access buttons [icons] are Site, Boring, Stratigraphy and Sample.

2.3. Interactive access

Depending on the module, the entry forms can also be opened by double-clicking in a graphic. Interactive editing is described in the documentation of each module.

- In Log, double-click in the header of the log report to open Boring, or in a column to open the corresponding form.

- In Lab, double-click in a graph to open the entry form whose data is displayed.

- In Pro, double-click in a data column to open the corresponding entry form.

- In Site, in 2D, double-click on a borehole symbol to open the Boring form, and on a line to open Axis. In 3D, double-click on a data column to open the corresponding form.

- In Time, double-click in a graph to open Piezometer.

2.4. Open Table

Any table or view of the database can be opened by clicking the **Open Table** button on the application toolbar or via **Data > Open Table**.

The **list** includes the **tables** and/or **views (queries)** of the database, depending on what is checked in **Include in the list**. The user can then choose the desired table or view from the list.

The user can select the **Display mode** for the entry form. The display modes can also be changed when the form is open (paragraph 3.2.3). Then, click **Open**.
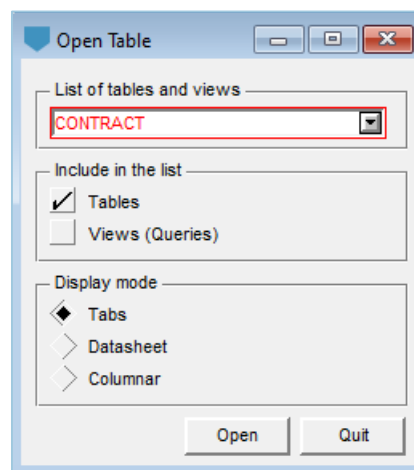
Figure 3 – Open Table

3. Characteristics of the entry forms

The entry forms all have the same characteristics. The Boring form is shown as an example for the following.

Figure 4 – Characteristics of the entry forms

3.1. Title bar of the entry forms

The title bar identifies the **table** associated to the entry form. The **number of records retrieved** via a query is indicated, as well as the position of the one currently displayed. The status is indicated:

- **New**: to insert a new record in the database.

- **Modified**: record modified but not yet saved. Modified values are displayed in red.

- **Saved**: existing and unmodified record.

3.2. Toolbar of the entry forms

When an entry form is open, the menu bar changes. It reflects actions specific to entry forms. Most menu items have a corresponding button in the toolbar of each form.

3.2.1. Save or cancel

Click the button 💾 or use **Action > Save** or the **[F10]** key to save any entry or modification in the database. By navigating between records, changes are automatically saved. After saving, the status indicated in the title bar changes to "Saved".

To cancel changes, use the **[Esc]** key or ❌ button and say **no** to the save request.

3.2.2. Refresh the graphic page

The graphic page is automatically refreshed with data when 🔁 is pressed. The button corresponds to **Action > Always Refresh.**

3.2.3. Display mode

Each entry form can be displayed in 3 different ways, depending on user preference.

- Click on ⬚ or use **Display > Tabs** to view with predefined tabs and groups of labels and fields.

- Click on ⬚ or use **Display > Datasheet** to see records as rows, and fields as columns. Columns can be resized by placing the cursor in the header between columns (the cursor becomes: ⬚) or moved by placing the cursor in the header of a column (the cursor becomes: ⬚). Columns can also be hidden by dragging the column header out of the entry form.

- Click on ⬚ or use **Display > Columnar** to see one record at a time, the 1st column listing the fields and the 2nd listing the values. Rows can be moved by placing the cursor on a row name (cursor becomes: ⬚).

3.2.4. Do a query

Use the buttons ⬚ , or the **Query** menu, or the **[F7]** and **[F8]** keys to do queries. See paragraph 11 for all details on **Simple queries and data retrieval.**

3.2.5. Navigate

When data is retrieved after a query or data entry, use the buttons ⬚ ⬚ ⬚ ⬚ ⬚ or **Record > First** to **Record > Last** to go to the first, previous, specific number, next or last record. The keys **[Ctrl]+[Home]** go to the first record, and **[Ctrl]+[End]** to the last. While navigating, any modification is automatically saved in the database.

In Datasheet display mode, you can also use the up and down arrows on the keyboard to navigate.

If the change in the current record has an impact on the graphic report, it will be refreshed, unless the option to **Refresh the graphic page** is not checked.

3.2.6. Insert

Click the button ⬚ or use **Record > Insert** or the **[F6]** key to insert a new record into the database. The status shown in the title bar changes to "New".

For some entry forms, basic data is entered directly when inserting a new record to speed up data entry, such as primary keys (Site No., Boring No.). This data can be modified.

In Datasheet display mode, you can also use the down arrow on the keyboard to insert a new record.

3.2.7. Delete

Click on the button ⬚ or use **Record > Delete** or the **[Shift]+[F6]** keys to delete the current record from the database. If it's a parent record to other records (e.g. boring containing samples), it is not possible to delete, except if data is from the same entry form (bottom table). To do cascade deletions, please use the DBM module.

In Datasheet display mode, you can also use the **[Delete]** key after selecting one or more rows.

A message indicating the number of records and the table involved asks to confirm the deletion. Click on No to cancel the deletion.

3.2.8. Duplicate

Click on the button or use **Record > Duplicate** or the **[F6]+[F4]** keys to duplicate the current record. A primary key is then suffixed by **_DUP**. This value will be modified by the user. Duplication does not involve dependent records.

The **Record > Copy Previous** option or the **[F4]** key is used to copy the previous record, if a new empty record has been inserted.

3.2.9. Layout

Click the button or use **Action > Layout** to open the configuration form to customize the current entry form. You can also click on the button located above the vertical scroll bar in Datasheet or Columnar mode or for secondary tables in Tabs mode. See paragraph 18.

3.2.10. Import external data

Click the button or use **Action > Import Data** to open the window to **Import external data**. See paragraph 16.

3.2.11. Export data

Click the button or use **Action > Export Data** to export data in CSV format. See paragraph 17.

3.2.12. Calculate

Click on the button or use **Action > Calculate** to open the calculation window (paragraph 4). The button is only active if a calculation exists in the form.

The calculations are described in the paragraph of each specific form.

3.2.13. Shortcuts

Click on the button or use **Help > Keyboard Shortcuts** to see the list of all shortcuts that can be used in the entry forms for various functions.

3.3. Generalities of the entry forms

3.3.1. Information about the field

The fields are predefined by Geotec. Use the **[F1]** key to open a pop-up with the NAME, TYPE, LENGTH of the field and IF REQUIRED. Hover over any field or header to display a tooltip describing the field and its unit or format.

3.3.2. Types of fields

Geotec fields are **numeric, alphanumeric** (text) or **dates.** Dates are entered as **yyyy-mm-dd hh:mi:ss** format in the entry forms. "**00**" replaces hours, minutes or seconds if not provided.

3.3.3. Field properties

Background and text colors identify each field's property.

- Key fields (required) – turquoise. The combination of keys defines a record as unique in the DB. Records must be entered hierarchically. Ex: a boring must be created before creating its samples. Keys can have up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- Required fields – turquoise. A few fields are not part of the primary keys but are nevertheless required.

- Disabled fields – grey. No value can be entered.

- Fixed fields – green. These values are calculated or used for calculations but are not saved in the DB. These are Aliases.

- Calculated fields – orange. These values are calculated and can be modified and saved in the DB.

3.3.4. Unit conversion

Depths can be entered in meters or feet, and lengths in meters, feet or inches, depending on the type of conversion defined. The selection of a unit conversion applies only to the <u>current form</u> and only applies to depth or length data that will be <u>entered or modified after the selection has been made</u>. The last unit conversion chosen in a form is selected by default the next time you open this form.

Use **Display > Conversions** to select the unit conversion for each entry form.
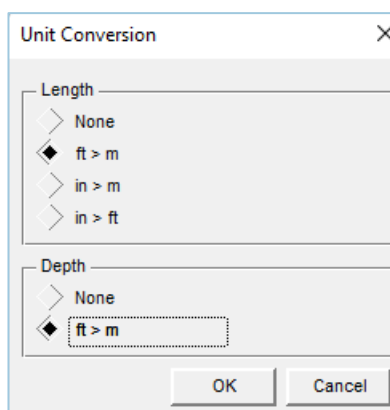
Figure 5 – Conversion of lengths and depths units

Possible conversions for lengths are:

- **None**   no conversion

- **ft > m**   enter the value in feet, it is converted to meters (x 0.3048) when leaving the field

- **in > m**   enter the value in inches, it is converted to meters (/ 12 x 0.3048) when leaving the field

- **in > ft**   enter the value in inches, it is converted to feet (/12) when leaving the field

Possible conversions for depths are:

- **None**   no conversion

- **ft > m**   enter the value in feet, it is converted to meters (x 0.3048) when leaving the field

When a conversion is applied, the fields involved become calculated fields, therefore in orange. The tooltip indicates in which unit the value should be entered.

3.3.5. Navigate between fields

To move from a field to another, use the **[Enter]** or **[Tab]** keys to go to the next field, or the **[Shift]+[Tab]** keys to go to the previous field. You can also use **Field > Previous** and **Field > Next.**

3.3.6. Duplicate a value

Use the **[F3]** key or **Field > Duplicate** to copy the value of the same field but from the previous record. This tool is very useful to quickly copy the same value in several records.

3.3.7. Text editor

All alphanumeric fields (texts) can be edited in a text editing window. Line breaks correspond to the "|" character of the forms. To open the text editor, use the keys **[Ctrl]+[E].**

3.3.8. Double-click

The double-click can be used in several fields to facilitate data entry.

- A double-click in a **key field** (turquoise background, such as site no, boring no, sample no, etc.) opens the parent table on the current record.

- A double-click in a field referring to **another table** opens the corresponding table (client no, contract no, sieving method no, etc.).

- A double-click in the **text fields** opens the Lists table if the type of selection is Default, Value, Description, + Value or + Description.

- A double-click in the **text fields** opens the text editor if the type of selection is Distinct or No list.

- A double-click in a **date** field opens a date editor.

- A double-click in a field named FILE_NAME or PHOTO_NO opens the Windows file selection.

3.3.9. Lists of values

Alphanumeric (text) fields can have a drop-down list, showing either the records defined in the LIST_ENG table (or LIST_FRE if Geotec is used in French) for the corresponding table and field, or the values entered for that same field in other records of the database.

Geotec   Sobek

The list is opened with the button ⬇ displayed to the right of each field, with the **[F9]** key or via **Field > List.**

The values of the LIST_ENG table (or LIST_FRE in French) can be edited via **Display > Predefined Lists** for the current table. It can also be opened by double-clicking in a field or via the **+ NEW** item in the list, for the current field. See paragraph 10.7.

The type of drop-down list for each field is defined with the **Customize entry forms (**Layout) (paragraph 18).

In Query mode (paragraph 11), the lists show all values for the current field in the records of the DB, as well as **is NULL** to search for records with no value in the current field.

3.3.10. Contextual menu

Click with the right button of the mouse in any field of the forms in Tabs mode, or on the header containing the field name in Datasheet or Columnar mode to open a contextual menu.
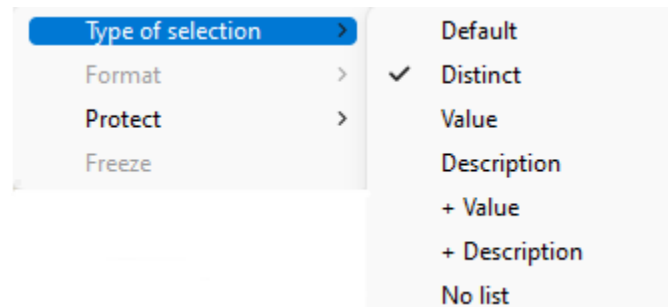
Figure 6 – Contextual menu of the entry forms

Type of selection defines the type of drop-down list to use. It can only be modified for Text fields. In some cases, such as primary keys and foreign keys, it is not possible to change the choice.

- **Default**. The list shows the records from the LIST_ENG table, and if there are none, the existing data from the database, for the current field.

- **Distinct**. The list shows the existing data in the database for the current field.

- **Value**. The list shows the values from the LIST_ENG table for the current field. Only one choice can be selected at a time.

- **Description**. The list shows the descriptions from the LIST_ENG table for the current field. Only one choice can be selected at a time.

- **+ Value**. The list is the same as for Value, but the choices are concatenated after each selection.

- **+ Description**. The list is the same as for Description, but the choices are concatenated after each selection.

- **No list**. No list is displayed.

Format is only active for numeric fields and dates. It is used to modify the format of the values in the form. The format in the database is not changed.

Protect is active except for key fields and required fields.

- **None**. The field is not protected against editing.

- **Partial**. The user can only select from the drop-down list.

- **Total.** The field cannot be edited.

Freeze is only active in Datasheet mode. It blocks the horizontal scrolling and keeps the columns to the left of the frozen one always fixed.

The changes are saved directly with the form customization, i.e. in REPORT_COL table (paragraph 18).

4.   Calculation window

When an entry form has a calculation function, the button 🖩 and **Action > Calculate** option are active. By selecting the option, a calculation window opens. Note that data must be retrieved (therefore in the entry form) to do calculations.
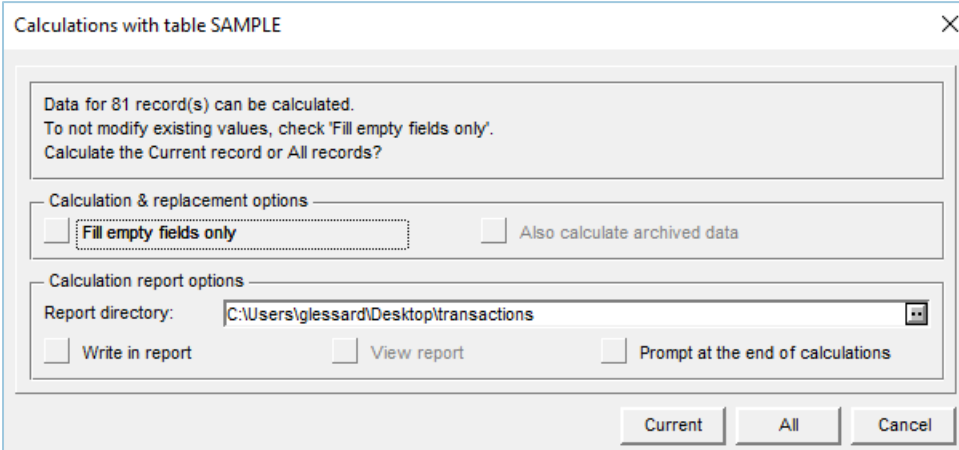
Figure 7 – Calculation window

- The **name of the table** involved is indicated in the title.

- If multiple records are retrieved, the user can choose to calculate the results for the **Current** one only, or for **All** records, the number being indicated in the first message. If only one is retrieved, only the Current button is active.

- For certain calculations (see the calculations detailed in the paragraph of each entry form), the user can choose to modify empty fields only, not existing values. To do this, check the **Fill empty fields only** box. Otherwise, the calculation modifies all existing values. When this option is not applicable in the calculation function, the box is disabled.

For example, for the calculation of stratigraphic descriptions, one may want to calculate only the records for which the descriptions are empty (that were not entered manually).

- If an archived site or boring exists in the database, the box **Also calculate archived data** is active. Check this option to calculate also data that are archived. Otherwise, the records are ignored.

  If you write in the report, the archived data are listed when calculations are not done because the option was not checked.

- The **Calculations report options** define the information presented to the user following the calculations.

  o By default, the **report directory** shows the directory of output files defined in the preferences. If it is modified here, it will also be modified in the preferences.

  o By checking **Write in report**, the daily report named Transactions_date.txt is updated with calculation information. Otherwise, the calculations are done but without a calculation report. Calculation information includes the number of records read and modified and the number of fields updated.

  o By checking **View report**, the daily report is shown on the form, with the text editor defined in the preferences (see the X3D documentation). This option is active only if "Write in report" is checked.

  o By checking **Prompt at the end of the calculations**, a window is displayed when calculations are done to show the number of records read and modified, and the number of fields updated.

- Other options may be displayed depending on the calculation.

5.   Main entry forms

Most of the Geotec data is related to four main tables, according to the data hierarchy (paragraph 1.1). In the Entry forms menu, these entry forms are opened via the 4 buttons at the top.

5.1. Site form

The form shows data from the SITE table of the Geotec database. It identifies and describes a site. It is the top of the hierarchical structure.

The **Limit <, Domain<** and **Map** buttons are active only in the **Site** module. They are used to define a polygonal limit or the domain directly with the mouse, and to edit the map. See the Site documentation.

- The **site number** is the key of the record. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

In the **Identification** tab…

- The **type of site** is alphanumeric with 3 characters and is used to categorize the site.

- The **municipal code** allows up to 10 digits. The list of **numbers** and **names of municipalities** defined in the MUNICIPALITY table is suggested (paragraph 10.6).

- The **geological province** where the site is located can be selected. It is only used for contamination calculations.

- The **client number** is alphanumeric with 20 characters. The list of **client numbers** and **names** defined in the CLIENT table is suggested (paragraph 10.2).

- The **project number** is alphanumeric with 20 characters. The list of **project numbers** and **names** defined in the PROJECT table is suggested (paragraph 10.3). It will be copied in its borings.

- The **contract number** is alphanumeric with 20 characters. The list of **contract numbers** and **names** defined in the CONTRACT table is suggested (paragraph 10.4). It will be copied in its borings

- The **region number** is alphanumeric with 20 characters. The list of **region numbers** and **descriptions** defined in the REGION table is suggested (paragraph 10.5).

- The **plan number** is alphanumeric with 40 characters. It is used to enter the number of the main plan in which the site appears.

- The **structure number** is alphanumeric with 20 characters.

- The **description** is alphanumeric with 255 characters to describe the site or the mandate.

In the **Location** tab…

- The position of the site's origin, i.e. its lower left corner, can be defined by its **easting** and **northing** (in meters), in the coordinate system, the NAD system and zone defined in the tab.

- The site **longitude** and **latitude** can be entered or calculated.

  They are used in the Google Maps tool integrated to the modules.

- The size of the site is defined with its **width** and **height**; in meters.

- The **location** of the site is alphanumeric with 255 characters.

- The **coordinate system** is either MTM or UTM. The information is needed for coordinate calculations.

- The **NAD** projection system is either NAD27 or NAD83. The information is needed for coordinate calculations.

- The **zone** where the site is located is entered. Automatically, it will be copied as the zone of its borings, but can be modified. The information is needed for coordinate calculations.

- The **angle** is the orientation of the site domain with respect to the geographic North. The angle is between 0 and 360 degrees.

In the **Management** tab...

- The **archiving code** is noted with character **A** for **'archived'**. When a site is archived, it is not possible to modify, delete or insert data.

- The **archiving date** is noted in the format *yyyy-mm-dd hh:mi:ss*.

- The person who archived the site (**archived by**) is alphanumeric with 40 characters.

- The **remark** on archiving is alphanumeric with 255 characters.

- A **cartographic file** can be associated to the site, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens. This cartographic file can be displayed in the **Pro** and **Site** modules.

  To save the file name with its full path, enable the option in the preferences. See the X3D documentation.

- The **unit** system is either SI (international system) and IM (imperial system). **By default, SI is used even if the field is empty.**

- **Grouping** is used to group sites together; with 5 characters.

- **Category** is used to enter a code to categorize the site, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

At the bottom of the form, a **list of tables linked** to SITE is available. The number in parentheses next to the table name indicates the number of records associated with the current site. By clicking on a table, the form opens either on the existing values, or in "new" mode. The list includes Axis, Boring, Client, Contract, Project and Regions.

5.1.1. Calculations

Geotec calculates the **longitude** and **latitude** of the site. The coordinate system and NAD must be defined for the site.

- If easting, northing and zone are entered, Geotec converts them to lat-lon.

- If the width and height are also entered, Geotec calculates the site center in meters while taking into account the angle, then converts into lat-lon.

- If easting, northing or zone is not entered, Geotec calculates the average of the longitudes and latitudes of the site's borings.

Figure 8 – Site entry form

5.2. Axis form

The form shows data from the AXIS table and its secondary tables AXIS_PI, AXIS_STRATA and AXIS_PROFILE of the Geotec database. It is used to define axes or cross-sections. It is in the hierarchical structure (Figure 1) just under SITE.

The **Points<** button is only active in the **Site** module. It is used to define the axis points directly with the mouse. See the Site documentation.

- The **site number** and the **axis number** together constitute the key of the records.

- The **site number** identifies the site of the axis. The drop-down list shows all sites defined in the SITE table.

- The **axis number** identifies the axis. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

In the **Identification** tab…

- The **type** of axis is a code of 3 characters maximum. The axis is generally a surveyed line (**LA**) or a seismic line (**LS**).

  In Pro, the profiles of seismic lines can be projected onto the main axis. Their type must be **LS** in order to be processed.

- **State** is a 1-character field indicating is the location of the axis is **P**lanned, **R**ealized or **V**alidated.

- **Chainage** is the chainage of the first point, in meters. The chainage is numeric.

- **Range** is the distance beyond which the borings are not projected on the profile views in the Pro module, in meters. It is a numeric value.

  If no distance is entered, **Pro** will use the distance set in the Pro options. If a distance is saved in the database, it overrides the option set in Pro.

- **Spacing** is used to enter the normal spacing between geophones measuring seismic velocities; in meters.

  Pro takes this distance into account when displaying profiles. If the distance between two measurements in the AXIS_PROFILE table is greater than the spacing, the profile is not drawn between these two measurements.

- The **phase** is alphanumeric with 20 characters with **Preliminary**, **Final** and **Revision** as choices.

- The **contract number** is alphanumeric with 20 characters. The list of **contract numbers** and **names** defined in the CONTRACT table is suggested (paragraph 10.4).

- The **contractor** who did the surveying is entered; with 40 characters.

- The **location** of the axis is alphanumeric with 80 characters.

- The **description** is alphanumeric with 255 characters to describe the axis.

In the **Management** tab...

- The **Realized by**, **Verified by**, and **Approved by** fields allow 40 characters.

- **Dates of survey**, **verification** and **approval** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- **Remark** is alphanumeric with 255 characters for other notes.

- **Transfer** is a 1-character code to classify records for their management.

5.2.1. Survey points

The **Survey points** tab at the bottom of the Axis form shows data from the AXIS_PI secondary table of the Geotec database. The tab is used to define the implementation points of the axes.

The control points of an axis can be the end points, the break points off the axis if it is a broken line, and/or the intersection points ("PI") for the tangents at the beginning and end of curved sections.

- The **site number**, the **axis number** and the **index** together constitute the key of the records.

- The **index (I)** is the sequence number of the control points. It is an integer.

- The **X** and **Y coordinates** of each point are then entered, in meters. Coordinates should be entered in the coordinate system, NAD system and zone defined in the site of the axis. These are double precision numbers with 3 decimal places. Values are required.

- The **radius of curvature (R)** is "0" if the axis is a broken line, and more than "0" if the point is a PI. The curvature direction is defined by the position of the control points around the current point.

- **Tag** is used to enter the identification of the point, or tag, with up to 20 characters. The tags mainly characterize the PI of a surveyed or seismic line.

- A **plan number** is used to enter the number of the reference plan containing the information. This number can be up to 40 characters long.

- **Transfer** is a 1-character code to classify records for their management.

5.2.2. Material for the strata

The **Material for the strata** tab at the bottom of the Axis form shows data from the AXIS_STRATA secondary table of the Geotec database. The tab is used to define the materials of the layers.

- The **site number**, the **axis number** and the **material** together constitute the key of the records.

- **Material** indicates the material type of the layer. The list of **materials** and their **description** defined in the MATERIAL table is suggested (paragraph 10.9).

- The mean seismic **velocity** for the material type is defined. The suggested unit is m/s.

5.2.3. Seismic lines

The **Seismic Lines** tab at the bottom of the Axis form shows data from the AXIS_PROFILE secondary table of the Geotec database. The tab is used to define a layer profile along a given axis and the measured seismic velocities.

- The **site number**, the **axis number**, the **material** and the **distance (D)** together constitute the <u>key</u> of the records.

- The **material** indicates the type of material of the layer for which the survey or seismic profile is done. The list shows the materials inserted in AXIS_STRATA for the same site and axis.

  In Pro and Site, the color used for the profiles is the one associated with the material defined in the MATERIAL table.

- The **distance (D)** contains the chainage of the profile point. Chainage is double precision with 3 decimal places.

- The **elevation (Z)** of each profile point is then entered; in meters. A value is required.

- The **X and Y coordinates** of each profile point can be entered, in meters. The coordinates are in the coordinate system, NAD system and area defined in the site of the axis.

- The **velocity** contains the seismic velocity recorded at each point for the layer represented by the type of material. The suggested unit is m/s.

- **Transfer** is a 1-character code to classify records for their management.

Figure 9 – Axis entry form

5.3. Boring form

The form shows data from the BORING table of the Geotec database. It identifies and describes a boring. It is in the hierarchical structure just under SITE (Figure 1).

The **Borings<** button is only active in the **Site** module. It is used to define the location of projected borings directly with the mouse. See the Site documentation.

- The **site number** and the **boring number** together constitute the key of the records.

- The **site number** identifies the site of the boring. The drop-down list shows all sites defined in the SITE table.

- The **boring number** identifies the boring. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

In the **Identification** tab…

- The boring **type** is a 2-character code to specify the nature of the boring. The default types present in the Geotec database are listed below. If the type is present in the lists table, its description is displayed in the field right of the **Type** field.

Table 1 – Default types of borings

Type	Description	Type	Description
CO	Cobra	TP	Test pit
CP	Piezocone	PZ	Stand alone piezometer
AT	Air track	QC	Quality control
GP	Guelph permeameter	AS	Auger sample hole
MA	Manual sampling	HA	Hand auger
PT	Dynamic penetration test	BH	Borehole
SP	Static penetrometer	TR	Trench

- **State** is a 1-character field indicating whether the boring is **P**lanned, **R**ealized, **V**alidated or **A**rchived. When a boring is archived, it is not possible to modify, delete or insert data.

- The **stop code** is a 1-character field indicating the reason for the end of boring, such as on **B**locks, at **D**etermined depth, **F**orced, **U**ndetermined, on probable **R**ock and **V**oluntary.

- The **reference** can contain a code indicating the reference elevation: the elevation of the natural terrain (**NG**) or the elevation of the drill floor (**FL**). The calculations are <u>always</u> made with the NG.

- The **ground level** at the location of the boring is entered; in meters. It is used in various elevation calculations. If the ground level is modified, the piezometric levels of the borehole can be recalculated.

- The **floor level** of the drill, for a borehole, is entered; in meters.

- The **total depth** of the boring is automatically incremented when data is entered in the other forms. It can also be changed manually.

- The **rock depth** is inserted automatically when the first rock layer (type R) is entered for the boring. It can also be changed manually.

- The **natural soil depth** is entered; in meters.

- The **sloughing depth** is entered; in meters.

- The boring **start** and **end dates** are in format *yyyy-mm-dd hh:mi:ss*.

- The **project number** is alphanumeric with 20 characters. The list of **project numbers** and **names** defined in the PROJECT table is suggested (paragraph 10.3). It was copied from the site if it was defined.

- The **contract number** is alphanumeric with 20 characters. The list of **contract numbers** and **names** defined in the CONTRACT table is suggested (paragraph 10.4). It was copied from the site if it was defined.

- A **parent boring** can be defined for the boring. The drop-down list shows all borings from the same site. Data from the boring and its parent can be displayed simultaneously in Log. See the Log documentation.

- **Remark** is alphanumeric with 255 characters for other notes.

- The **contractor** for drilling is entered; with 80 characters.

- The **dossier** number of the contractor is entered; with 40 characters.

- The **source** is used in the control of materials and indicates where the material was taken; with 20 characters.

- **Material** indicates the type of material for the control of materials, with 20 characters. The list of **materials** and their **description** defined in the MATERIAL table is suggested (paragraph 10.9).

In the **Location** tab…

- The **zone** where the boring is located is entered. It was copied from the site if it was defined. The information is required for coordinate calculations.

- The **easting** and **northing** of the boring can be entered or calculated, in meters, in the coordinate system and NAD defined in the site of the boring.

- **Longitude** and boring **latitude** can be entered or calculated.

  They are used in the Google Maps tool integrated to the modules.

- The **dip** of the boring (in degrees) is entered. It is used in various elevation calculations and in projections.

- The **azimuth** of the boring (in degrees) is entered. It is used in projections.

- The **reference** is alphanumeric with 40 characters to indicate the type of boring reference (for example: geodesic, arbitrary).

- The **plan number** is alphanumeric with 255 characters. It is used to enter the number of the main plan on which the boring is shown.

- The **boring** location is alphanumeric with 80 characters.

- The **axis number** is a string of 20 characters. The axes defined in the AXIS table are shown in the list. The **Pro** module shows the borings whose coordinates are defined. If a boring does not have coordinates but has an axis number, a chainage and possibly an offset, **Pro** will show this boring along the axis using the defined chainage and offset.

- The **chainage** and **offset** to the centerline determine the position of the boring relative to the axis. If an axis number is associated to the boring, the chainage and offset will apply for the representation of the boring along this axis specifically, <u>if the two coordinates of the boring are not defined</u>.

  According to geotechnical convention, if a boring is to the left of the axis line, its offset is negative. To determine the left and right of an axis line, look towards the increasing chainages.

In the **Equipment** tab…

- The **drill** used is entered; with 40 characters.

- The type of **hammer** used for driving the sampler is entered, with 40 characters.

- The **fall** height of the hammer is entered; the suggested unit is the meter.

- The **fluid** used for drilling is entered, with 40 characters.

- The list of **casings** is written, with 40 characters.

- The **diameter** of the main **casing** used is entered, in millimeters.

- The **corer** used for drilling is entered; with 40 characters.

- The **diameter** of the corer is entered, in millimeters.

- The **A/R** field is used to indicate whether the azimuth is apparent ("A") or real ("R").

- The type of **compass** is indicated by "0" if pivoting, or "1" if gyrating.

In the **Hydrogeology** tab…

- For the **groundwater**, up to 2 measurements can be entered with:

  o The **depth** of the water table; suggested unit is meter

  o The **measurement date,** in the format *yyyy-mm-dd hh:mi:ss*

  o The **casing depth** at the time of measurement (in meters)

  o The **stabilization** time, in hours

  o Five **remarks** of 2 characters can be added regarding the groundwater measurement.

- For **piezometric installations**:

  o Barometric correction can be applied for vibrating wire piezometers and water level dataloggers such as *Level Logger*.

    Select the **barometric station** to associate to the nest of piezometers installed in the boring. The list of **barometer numbers** defined in the BAROMETER table is suggested. Double-click in the field to open the Barometer table. See paragraphs 6.3.3 and 6.4 for the piezometer calculations and barometer definition, respectively.

    Enter a **default B1 value**. This value is used if there is no barometric pressure for the date of the piezometric level.

  o To display on the boring log the water depth on a specific date, enter a **Selected date** in the format *yyyy-mm-dd hh:mi:ss*. Otherwise, the latest reading date is used.

- A **non aqueous phase liquid** observed in the boring can be described with:

  o Its **depth**; suggested unit is meter

  o Its **measurement date**, in the format *yyyy-mm-dd hh:mi:ss*

  o The **type of contaminant**

  o The **thickness** of the non aqueous phase liquid; in millimeters.

In the **Management** tab...

- The **Driller**, **Technician**, **Compiled by**, **Verified by**, **Approved by**, and **Project manager** can have up to 40 characters.

- The **printing date** of the boring report is automatically inserted into the database by Log when the user prints a boring report.

- When a record belonging to the current boring is modified and saved, the **modification date** is updated.

- A **style file** associated to the boring can be defined, with 255 characters. This field is used by Log if the parameter is checked in the options of Log.

- A **photo** can be associated to the boring, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens. The photo can be displayed if an object in the style file is associated with this field in Log.

To save the photo with its full path, enable the option in the preferences. See the X3D documentation.

- A **photo description** can be entered, with 255 characters.

- The **scale** can be entered (number of meters on field per meter on paper). It will be used by Log in the boring display, if the parameter is checked in the options of Log

- The **precision on the level** allows you to enter the accuracy on the reading of the elevation of the boring which depends on the method of obtaining: GPS, surveying, etc.

- **Category** is used to enter a code to categorize the boring, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

In the **Validation** tab, there are fields added and described by the City of Montreal.

At the bottom of the form, a **list of descriptive tables** linked to BORING as well as a **list of in situ tests** is available. The number in parentheses next to the table name indicates the number of records associated with the current boring. By clicking on a table, the form opens either on the existing values, or in "new" mode.

The list of descriptive tables includes Casings (Boring methods), Cobbles, Ground, Observations, Piezometers, Rock Joints, Runs, Samples, Stratigraphy and Trench / Test pits.

The list of in situ tests includes Absorption, Cobra, Concentrations, Static Cone, Piezocone, Dynamic Cone, Geocamera, Lugeon, Permeability, Pressuremeter, Property values (Other properties) and Vane.

5.3.1. Calculations

Geotec calculates the **longitude** and **latitude** of the boring, or its **X** and **Y coordinates**. In both cases, the coordinate system and the NAD must be defined for the site of the boring. The user chooses which conversion to do in the Calculation window.

- By selecting to calculate longitudes and latitudes, Geotec uses the easting, northing and zone of the boring to convert into lat-lon.

- By selecting to calculate coordinates, Geotec uses the longitude and latitude to convert into easting, northing and zone.

Figure 10 – Boring entry form

5.4. Sample form

The form shows data from the SAMPLE table of the Geotec database. It is used to describe the samples taken along a borehole. It is in the hierarchical structure just under BORING. All laboratory tests will be linked to the defined samples.

- The **site number**, the **boring number** and the **sample number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring along which the sample was taken. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **depth increment** can be entered. A new sample will be positioned at a depth equal to the top depth of the previous sample plus the increment.

  Without an increment, sampling is considered continuous. A new sample will be positioned at a depth equal to the bottom depth of the previous sample.

- When adding samples, choose the **sample state via the radio buttons** or use the **same sampler** as the previous one.

  o If the box **Same sampler is checked,** the state, type and length of the previous sample are copied to the new one and the number is automatically incremented.

  o If the box **Same sampler is not checked,** all fields are inactive until the state is chosen. Choose between remolded, intact, core or grab. The type and length associated with the state are then entered and the number is automatically incremented.

- The **sample number** identifies the sample or subsample. Enter up to 19 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used. The number is copied to the **Parent** field, which is used only for subsamples.

  o The number of the first sample is suggested as 01. Modify it if desired.

  o The number of the samples added in the current boring is based on the previous sample (number and format). For example:

  With 002, the next will be 003. With GL-10, the next will be GL-11.

In the **Description** tab…

- The **State** field mirrors the top radio buttons. Depending on the **state** of the sample, some fields are disabled. A default type and length are associated with each state if radio buttons are used (not **Same sampler**). These can be specified by editing the drop-down list of the STATE field in the lists table.

  Values <u>must</u> be G, R, I and C. Descriptions are specified as: label, type, length (in meters). If the types and lengths are not specified, Geotec uses:

  R → Remoulded, SS, 0.6096
  I → Undisturbed, ST, 0.6096

C → Rock core, CR, 1.524

G → Grab, GB, 0.3048

The **state** is used in Log, Pro and Site to symbolized the samples.

- The sample **type** is a 3-character code to indicate the type of sampler used to take the sample. When a new sample is added, the type of the previous or the type associated to the state is suggested but can be modified. The default types present in the Geotec database are listed below.

Table 2 – Default types of samplers

Code	Sampler	Code	Sampler
AS	Auger sampler	SC	Split corer
CT	Corer tube	SS	Split spoon
CR	Diamond rock core	ST	Thin wall sampler (Shelby)
GB	Grab sample	TW	Thin wall sampler
MA	Manual	VI	Vibration
PS	Piston sampler	WC	Water content
QC	Quality control sample	WS	Wash sample

- The **top depth** of the sample is entered; in meters. When a new sample is added, the top depth is suggested by default, based on the depth increment.

- The sample **length** is either entered directly, or calculated by entering the bottom depth. When a new sample is added, the length of the previous one or the length associated with the state is suggested.

- The **bottom depth** of the sample is not a field of the database. It is calculated when the user enters the length. If the user enters a bottom depth for the sample, its length will be calculated.

- The **caliber** of the casing or corer is entered; with 10 characters.

- **N1** to **N6** are the number of blows per six inches; as integers.

- **N** is the standard penetration value; this value is the sum of **N2** and **N3**. The N value is shown automatically when N2 and N3 are entered; the user can modify it.

- A **remark on N** can be entered with 40 characters, typically to indicate a refusal length.

- **Driving energy** can then be entered, a numeric value.

- **Recovery length** is not a database field. By entering a value, the recovery (%) is automatically calculated.

- The **recovery** (in %) can be calculated from the length entered, or entered directly. If the **recovery is 0%,** Log, Pro and Site symbolize the sample state as 'Lost'.

- The cumulative **length** of pieces greater than 4 inches (RQD) is not a database field. By entering a value, the RQD is automatically calculated.

- The **RQD** (%) can be calculated from the length entered, or entered directly.

- Pocket penetrometer (**PP**) resistance is numeric, in kPa.

- **USCS** classification can be entered or calculated.

  If the USCS field is shown in Log, Pro or Site, the color of the material defined in the MATERIAL table or the pattern starting with U_ can be displayed. See the Log documentation.

- **Tests** is alphanumeric with 255 characters and is used to list other in-situ or laboratory tests done on the sample.

- **Chemical analyses** is alphanumeric with 255 characters and is used to list the chemical analyses done on the sample.

- The **description** of the sample can be done via the soil description matrix which opens via the icon ⊞. The matrix is described in paragraph 6.2. The description can also be entered manually, with 511 characters. A rock description matrix is for future development.

In the **Management** tab...

- The **sampling date** is in *yyyy-mm-dd hh:mi:ss* format.

- The sample **lab number** is alphanumeric with 20 characters maximum.

- The **duplicate number** is added, if desired, with 20 characters.

- The **intact tube number** can be entered, up to 10 characters.

- A **photo** can be associated to the sample, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the photo with its full path, enable the option in the preferences. See the X3D documentation.

- The **Sampled by, Compiled by** and **Verified by** fields are used to enter name of the technician, the person who compiled the information, and the inspector when the sample was taken.

- **Remark** is alphanumeric with 255 characters for additional details on the sample.

- When a modification to the sample is saved, the **modification date** is updated.

- **Transfer** is a 1-character code to classify records for their management.

- To estimate the exploitable height of a borrow pit, we have the **material** and its **top** and **bottom** depths. The list of **materials** and their **description** defined in the MATERIAL table is suggested. If the sample lies within a stratigraphic layer, the top and bottom depths of the layer are indicated.

  If the Material field is displayed in Log, Pro or Site, the color of the material defined in the MATERIAL table can be displayed.

- When the calculation is done (via the button 🖳 or using **Action > Calculate**), the **calculation date** is updated.

In the **Properties** tab...

- The percentage of **organic matter** and the concentration of **VOC** (volatile organic compounds) are 8-character and alphanumeric.

- The **olfactory** and **visual observations** are alphanumeric with 4 characters, to describe the organoleptic observations.

- **Rock properties** are obsolete fields and should be used via the RUN table (i.e. rock **strength**, degree of **fragmentation**, **number of joints**, **joint set number** and **weathering**).

At the bottom of the form, a **list of laboratory tests** is available. The number in parentheses next to the table name indicates if a test is associated to the current sample. By clicking on a table, the form opens either on the existing values, or in "new" mode.

The list of laboratory tests includes Concentrations, Consolidation, Density, Fall Cone (Swedish cone), Grain size analysis, Soil Relative Density, Consistency Limits, Proctor and Shear.

5.4.1. Sub-samples

Sub-samples are added to the current sample via the **Add a sub-sample** button.

- The **Add a sub-sample** button is active when positioned on:

  o A sample that has no subsample.

  o The last sub-sample of a sample, if the bottom depth of the sample has not been reached.

- By clicking on the button, the **number** of the first sub-sample is set to 'A'. The value can be modified but must have 1 character only. The number of subsequent sub-samples increments alphabetically.

  This number is concatenated to the number of the main sample (**parent**) and copied in the Sample field, e.g. 002A, GL-11C.

- The **top depth** of the sub-sample is suggested and can be changed. For the A, it is suggested as the top of the main sample. For the following, it is suggested as the bottom of the previous sub-sample.

- The **length** of the sub-sample is entered, or can be calculated by entering the bottom depth.

- The **bottom depth** of the sub-sample must be entered for the A. It is suggested for the following as the bottom of the main sample.

- The **description** of the sub-sample is done the same way as the main sample. Logically, if sub-samples are present, the main sample will not be described.

- Several fields are disabled for sub-samples (including N, recovery, RQD, etc.). All other fields can be entered as for samples.

5.4.2. Create a stratigraphic layer

Stratigraphic layers can be created from the samples. The button **Create a stratigraphic layer** is active when positioned on a sample or a sub-sample and its bottom depth is greater than the maximum bottom depth found in the STRATIGRAPHY TABLE for the current boring.

By clicking on the button, the description matrix opens and a new layer is proposed.

- The layer begins at the bottom depth of the previous layer, or at 0 if there is no layer yet.

- The layer ends:

  o At the top depth of the current sample or sub-sample **if its Description is empty**.

  o At the bottom depth of the current sample or sub-sample **if it has a Description**.

  o The bottom depth of the layer can be modified if necessary.

- The matrix shows a weighted average of the descriptive elements of all samples and sub-samples found between the top and bottom of the layer. The values can be modified. By clicking OK, the layer is saved.

5.4.3. Calculations

Geotec calculates the description of the sample or sub-sample based on the values selected in the matrix (paragraph 6.2). The user has the choice to modify all descriptions in the calculation, or only the records whose description is empty. To do this, check the box **Fill empty fields only**.

This makes it possible to quickly calculate the sample descriptions in English or French without having to reopen the matrix for each sample.

Figure 11 – Sample entry form

6. Entry forms for boring description

In the Entry forms menu, the entry forms for boring description are available via the buttons of the first tab. They include the stratigraphy description, installation of wells or piezometers, description of trenches, boring methods, and fields observations.

6.1. Stratigraphy form

The form shows data from the STRATIGRAPHY table of the Geotec database. It is used to describe the stratigraphy along a boring.

- The **site number**, the **boring number**, the **type of strata** and the **top depth** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring along which the stratigraphy is described. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **strata type** is a 1-character code, either S, R, T, E or U.

  o **Simplified** (type S): for soils. It is recommended to use the soil description matrix (paragraph 6.2).

  o **Rock** (type R): for rocks. The top depth of the first rock layer is copied into the ROCK_DEPTH field of the boring.

  o **Text** (type T): to display a remark at a specific depth without creating a layer.

  o **End of boring** (type E): to add a custom description explaining the end of boring conditions, which will be displayed at the bottom of the boring report.

- o **Unified** (type U): for future development, with selection of the unified classification.

- The **top depth** of the layer is required. By default, the top of the first layer is at 0 meter (or feet). The top of subsequent layers is equal to the bottom of their previous layer. These values can be modified.

- The **bottom depth** of the layer is entered, if applicable. The bottom depth is required for strata of type S, R and U.

- The **description** of the strata can be done via the soil description matrix which opens via the icon ⊞, for the layers of type **S**. The matrix is described in paragraph 6.2. The description can also be entered manually, with 511 characters. A rock description matrix is for future development.

- The **stratigraphic code** defines the materials of the layer. The use of the field varies depending on the selected strata type. The code is filled in automatically if materials are selected via the matrix (paragraph 6.2).

  - o **Type S** (simplified): this code is filled in automatically if the matrix is used. Up to 6 materials can be defined. The drop-down list shows the materials named *S_name* in the current patterns file (.ptn).

  - o **Type R** (rock): the user defines the dominant rock material. The drop-down list shows the materials named *R_name* in the current patterns file (.ptn). A large number of R-type patterns can be found in the geotec8.ptn patterns file.

  - o **Type T** (text): stratigraphic code is not used.

  - o **Type E** (end of borehole): to show that the boring stopped on rock, enter R in the stratigraphic code, which will display a rock symbol in the boring report. Otherwise, the code is not used.

  - o **Type U** (unified): the user defines the material of the layer according to USCS classification. The drop-down list shows the materials named *U_name* in the current patterns file (.ptn). The U-type materials found in the geotec8.ptn patterns file are listed below.

Table 3 – Unified classification

Symbol	Component	Symbol	Component
GP	Poorly-graded gravel	OL	Organic silt
GW	Well-graded gravel	MH	Highly plastic silt
SP	Poorly-graded sand	CH	Highly plastic clay
SW	Well-graded sand	OH	Organic clay
ML	Low plasticity silt	Pt	Peat
CL	Low plasticity clay		

The Log, Pro and Site modules will use the stratigraphic code and relative proportion, if applicable, to display stratigraphic symbols representing each layer.

- The **relative proportion** is filled in automatically if the soil matrix is used. It is used only for a type-S layer and can have a maximum of 6 digits. It indicates the relative proportion of each material defined in the stratigraphic code.

  - o 1: dominant material (> 35%)

- o   2: lower abundance material (20% to 35%)

- o   3: scarce material (10% to 20%)

- o   4: trace material (1% to 10%)

  For example, *silty sand, some clay, trace gravel* will be listed as:
  Code = SMCG and Proportion = 1234

  For other types, leave the field empty or put 1.

- The **top line** allows you to force a type of line at the top depth of the layer in the boring report.

  - o   **L0** removes the separator line

  - o   **L1** puts a solid line

  - o   **L2** puts a dotted line

  - o   **L3** puts a dashed line

- Layer **material** is alphanumeric with 20 characters. The list of **materials** and their **description** defined in the MATERIAL table is suggested (paragraph 10.9).

  If the Material field is displayed in Log, Pro or Site, the color of the material defined in the MATERIAL table can be displayed.

- The **wet density** of the layer is recorded, in kg/m^3. It can be used in the calculations of the vertical stress in the Piezocone form (paragraph 8.3).

- The **type of deposit** is a 2-character code.

- **Geological formation** is a 3-character code.

- **Geological group** is a 2-character code.

- **Properties 1 to 4** are additional 3-character codes to describe other properties of the layer, if needed.

- When a modification to the stratigraphy is saved, the **modification date** is updated.

- When the calculation is done (via the button 🖩 or using **Action > Calculate**), the **calculation date** is updated.

- The **priority** is an integer allowing to define the priority of the layer relative to the deposit sequence.

- **Transfer** is a 1-character code to classify records for their management.

6.1.1. Calculations

Geotec calculates the description of type-S layers based on the values selected in the matrix (paragraph 6.2), which includes the **stratigraphic code** and the **relative proportion**. The user has the choice to modify all descriptions in the calculation, or only the records whose description is empty. To do this, check the box **Fill empty fields only**.

This makes it possible to quickly calculate the layer descriptions in English or French without having to reopen the matrix for each layer.

Records of type E, T, U or R are not affected by the calculations.

Figure 12 – Stratigraphy entry form

6.2. Soil description matrix (samples and layers)

The **soil description matrix** is used to describe soils from samples and sub-samples (paragraph 5.4) and from stratigraphic layers (paragraph 6.1). It opens via the icon right of the Description field.

By selecting the descriptive elements, the **textual description** is automatically generated according to the following order. It is displayed in the middle of the matrix.

> **Category. Material (size), gradation, shape, color, oxidation, density / consistency, plasticity, moisture, calcareous. Structure. Presence (%) (list of debris). Inclusions. Evidence of contamination.**

The sample **number**, sub-sample **number**, or layer **depths** are shown at the top left of the matrix.

The **Copy from previous** button at the top copies the matrix information from the previous record as well as the description, if any manual edits were done.

Click **Cancel** to exit the matrix without keeping the changes. Click **OK** to exit the matrix and copy the generated description in the **Description** field of the table. It will replace a description that has already been entered.

Figure 13 – Soil description matrix

Category

The **category** is the main type of soil or rock. The category can be presented in boring reports in bold, italic, underlined and/or capital letters.

Materials

The materials can be selected at 2 places:

- Either via the radio buttons to indicate the proportions of clay, silt, sand and gravel.

  o The first material selected is set to 'Main'.

  o Only two materials can be selected as 'Main'; the third being automatically set to 'Adjective' for a maximum of 100% material.

  o To remove a material selection, touch the radio button again.

- Either via the drop-down list at the top right of the matrix. Only one can apply per sample or layer.

The codes corresponding to the materials selected (either from the drop-down list, the proportions table or the presences) are indicated in the field of the drop-down list, as information. Up to 6 materials can be selected. The proportions are also indicated next to the drop-down list, with the first digit corresponding to the first code, the second digit to the 2nd code, etc. Patterns associated to the **codes** and **proportions** are displayed in Log, Pro and Site. These values are saved in the CODE1 and PROP fields of the SAMPLE and/or STRATIGRAPHY tables.

- A main material (from the table or the drop-down list) has a proportion of 1 (> 35%)

- An adjective has a proportion of 2 (20-35%)

- 'Some' has a proportion of 3 (10-20%)

- 'Trace' or 'Presence' has a proportion of 4 (< 10%)

Primary and secondary materials may be presented in boring reports in bold, italic, underline and/or capital letters.

Presence (%) of cobbles, boulders and organic matter

You can add the percentage of cobbles, boulders and organic matter in the text field, as well as the maximum diameter. To see it in the description, check its box.

Debris

This is an 80-character field to list all debris. Check its box to see them in the description.

Color

The color can be entered, with 40 characters. It is included in the description.

Structure

The soil structure can be entered. It is included in the description. It can provide information about the geologic origin, the in-situ permeability, the contaminant pathways, etc.

Inclusions and contamination

Any inclusion or contamination can be indicated here, with 80 characters. These values are added at the end of the description.

Particle size

When sand is selected in the proportions table, the **Sand** item becomes active at the bottom of the matrix. Same thing with gravel. Up to 2 checkboxes can be selected. The particle size will be indicated in parentheses in the description.

Gradation

The gradation can be defined. One checkbox can be selected. It's included in the description.

Density or consistency

If we have a clay or a silty clay with no other main material, the **Consistency** item is present and up to 2 checkboxes can be selected. Otherwise, the **Density** item is present and up to 2 checkboxes can be selected. It is possible to force the use of Density or Consistency via the **Cohesionless / Cohesive button** at the top right.

If the N-value is entered in the sample definition, the corresponding density or consistency is automatically selected based on Table 4. The selection can be modified. The density or consistency range is included in the description.

Table 4 – Density or consistency based on N-value

N-value	Density
< 5	Very loose
5-10	Loose
11-30	Compact
31-50	Dense
> 50	Very dense

N-value	Consistency
< 3	Very soft
3-4	Soft
5-8	Firm
9-15	Stiff
16-30	Very stiff
> 30	Hard

Oxidation

The oxidation state can be defined. One checkbox can be selected. It's included in the description.

Plasticity

The plasticity can be defined. Up to 2 checkboxes can be selected. It's included in the description.

Particle shape

When gravel, cobbles or boulders is selected, the **Shape** item appears at the bottom of the matrix. Up to 2 checkboxes can be selected to describe the angularity. The particle shape is included in the description.

Moisture

The moisture can be defined. Up to 2 checkboxes can be selected. It's included in the description.

Calcareous

The calcareous state can be defined. Up to 2 checkboxes can be selected. It's included in the description.

6.3. Piezometer form

The form shows data from the PIEZOMETER table and its secondary tables PIEZOMETRIC_LEVEL and PIEZOMETER_SEAL of the Geotec database. It is used to define the characteristics of the piezometers, observation and pumping wells, as well as the different materials used for their installation and the piezometric levels recorded.

- The **site number**, the **boring number** and the **piezometer number** together constitute the key of the records.

- The **site** and **boring numbers** identify the boring where a well or piezometer(s) have been installed. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **piezometer number** identifies the piezometer. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The **installation code** is selected. The code's description is automatically copied into the field to its right, which can be edited. The drawing of the installation and the calculations vary according to the code selected.

  o **H** for Hydraulic or **T** for Open Tube

  o **S** for Sleeve or **R** for O'ring

  o **E** for Electric or **V** for vibrating wire

  o **P** for Pneumatic

  o **L** for water level datalogger such as *Level Logger*

- The **type of installation** is filled based on the code selected and can be modified. It is 80-character alphanumeric.

- The **serial number** of the piezometer installed is noted with 20 characters.

- A **maximum interval** between 2 measurements of piezometric levels **(in days)** can be imposed, for the Time module. When the number of days between two consecutive measurements is greater than the imposed interval, the curve will be interrupted between these two measurements. With a value of 0, no discontinuity is made.

- The type of **sealer** used is enter, with a maximum of 80 characters.

- The **Stop code** is a 1-character field indicating the reason the well / piezometer stopped being driven, such as **F**orced, **U**ndetermined and **V**oluntary.

- The **installation date** is noted in the format *yyyy-mm-dd hh:mi:ss*.

- When a modification to the installation is saved, the **modification date** is updated.

- When the calculation is done (via the button or using **Action > Calculate**), the **calculation date** is updated.

- The **screen code** is selected. The code's description is automatically copied into the field to its right, which can be edited. The drawing of the screen varies according to the code selected.

  o **C** for Casagrande (drawn as a rectangle)

  o **T** for Pierced Tube (drawn as a rectangle with horizontal lines)

  o **P** for Point (drawn by a rectangle and a triangular tip at the end)

- The **type of screen** is filled based on the code selected and can be modified. It is 80-character alphanumeric.

- **Opening** is the size of the openings in the screen; in millimeters.

- The screen **length** is entered; in meters. It is used in the drawing and calculations.

- The **bottom depth** of the screen is entered; in meters. It is used in the drawing and calculations.

- The screen **diameter** is entered, in millimeters.

- The **protector code** is selected. The code's description is automatically copied into the field to its right, which can be edited. The drawing of the protector varies according to the code selected.

  - **B** for protective box (drawn as a box around the tube)

  - **T** or other for protective casing (drawn as vertical rectangles surrounding the tube)

- The **type of protector** is filled based on the code selected and can be modified. It is 80-character alphanumeric.

- The **diameter** of the protector is entered, in millimetres.

- The **length** of the protector is entered; in meter. It is used in the drawing.

- The **top depth** of the protector is entered, in meters. A negative depth means that the top of the protector is above the natural ground. It is used in the drawing.

- The **cover** type is entered, with 80 characters. If a value is defined, the cover can be drawn at the top depth of the protector.

- The type of **upper cap** is entered, with 80 characters. If a value is defined, the upper cap can be drawn.

- The type of **lower cap** is entered, with 80 characters. If a value is defined, the lower cap can be drawn.

- **Remark** is alphanumeric with 255 characters for additional details on the installation.

- The **Inactive** checkbox can be checked to indicate that a piezometer is not longer being monitored.

- **Transfer** is a 1-character code to classify records for their management.

Open Tube

This section is present for all installation codes except P, E and V.

- The **tube diameter** is entered; in millimeters.

- **The depth** of **the top of the tube** is entered; in meters. If the tube is above ground, the top depth must be negative. It is used in the drawing and calculations.

Pumping chamber

This section is present for all installation codes except L, P, E and V.

- The **type** of pumping chamber is entered, with 80 characters.

- The **diameter** of the pumping chamber is in millimeters.

- The **length** of the pumping chamber is entered; in meters. It is used in the drawing.

Vibrating wire

This section is present for installation codes E and V.

- Choose to use the **linear** equation or the **polynomial** equation using the radio buttons. By default, the linear equation is chosen.

- Enter the **reading** at installation **R0** in reading units.

- Enter the **barometric pressure** at installation **B0** in kPa.

- Enter the **temperature** at installation **T0** in Celsius degrees.

- Enter the **thermal coefficient TC** in kPa / Celsius degree.

- For the linear equation, enter the **calibration factor CF** in kPa / reading units.

- For the polynomial equation, enter:

  o The **coefficient A** in kPa/reading units^2. The value in scientific format can be entered.

  o The **coefficient B** in kPa/reading unit.

  o The **coefficient C** is calculated automatically as $C = -(A \times 10^{-6} \times R_0{}^2 + B \times R_0)$

Level Logger

This section is present for installation code L.

- Enter the **distance between the probe** of the datalogger and the top of the tube, in meters. It is used in the drawing and calculations.

Pneumatic

This section is present for installation code P.

- Enter the **inertia correction factor**.

Figure 14 – Piezometer entry form

6.3.1. Piezometric levels

The **Piezometric levels** tab at the bottom of the Piezometer form shows data from the PIEZOMETRIC_LEVEL secondary table of the Geotec database. The tab is used to enter piezometric levels recorded for the current piezometer.

- The **site number**, the **boring number**, the **piezometer number** and the **measurement date** together constitute the <u>key</u> of the records.

- The **measurement date** is entered with format *yyyy-mm-dd hh:mi*:ss.

- The **reading** is entered and varies depending on the installation code.:

  o It is the depth of the water from the top of the tube; in meters, for all installation codes except L, P, E and V.

  o It is the reading on the dial, in reading units, for installation codes E and V.

  o It is the absolute pressure, in kPa, for installation code L.

  o It is the pressure, in kPa, for installation code P.

- **T1** is the **temperature** during the reading, in Celsius degrees.

- **B1** is the **barometric pressure** during the reading, in kPa.

- The **water pressure**, in kPa, is entered or calculated.

- The **piezometric level**, in meters, is entered or calculated.

- Five 2-character **remarks** can be added regarding the **measurement**.

- **Remark** is alphanumeric with 255 characters for additional details on the measurement.

- **Transfer** is a 1-character code to classify records for their management.

6.3.2. Seals

The **Seals** tab at the bottom of the Piezometer form shows data from the PIEZOMETER_SEAL secondary table of the Geotec database. The tab is used to define the materials used in the installation of the well or piezometers. The information applies to the current boring, not to a specific piezometer.

- The **site number**, the **boring number**, the **top** and **bottom depths** together constitute the <u>key</u> of the records.

- The **top** and **bottom depths** contain the top and bottom of each seal, lantern, or fill zone, in meters. Materials are listed in the table from deepest to shallowest.

  By default, the bottom of the first material is equal to the total depth of the boring. The bottom of the following materials is equal to the top of the previous. These values can be modified.

- The **code** designates the material(s) that will be drawn, based on the simplified classification. Up to 3 materials can be defined per code. The pattern used in the drawing will be S_CODE defined in the current patterns files (.ptn), or several superimposed if 2- or 3-letter codes are used (ex: code SG = pattern for sand + pattern for gravel).

- The **material** is automatically added as the code's description if it exists in LIST_ENG. It can be modified, with up to 40 characters.

- **Transfer** is a 1-character code to classify records for their management.

6.3.3. Calculations

Geotec calculates the atmospheric pressure B1, the water pressure and the water level based on inputs.

Atmospheric pressure B1

By associating a barometer to the boring where a vibrating wire piezometer or a water level datalogger such as a *Level Logger* is installed (see paragraph 5.3), Geotec inserts the barometric pressure B1 at the date and time of the piezometric measurement, or by doing a linear interpolation between the 2 nearest hours in the same day. If there is none, the default B1 value set for the boring is used.

Water pressure

The water pressure (P) at the screen depth is calculated. The dip and natural ground (NG) elevation are defined in the Boring entry form.

For hydraulic installations (all codes except P, V, E and L)

$$P = \left(depth_{bottom\ filter} - depth_{top\ tube} - reading\right) \times sin(dip) \times 9.806$$

For vibrating wire piezometers (code V and E)

Linear equation: $\qquad P_{uncorrected} = C_F \times (Reading - R_0)$

Polynomial equation: $\qquad P_{uncorrected} = A \times (Reading^2) + B \times Reading + C$

Temperature correction is applied if T0 and T1 are defined.

$$P = P_{uncorrected} - T_c \times (T_1 - T_0)$$

Barometric correction is applied if B0 and B1 are defined.

$$P = P_{uncorrected} - (B_1 - B_0)$$

The calculation of B1 with temperature and barometric pressure corrections is therefore:

Linear equation: $\qquad P = C_F \times (Reading - R_0) - T_c \times (T_1 - T_0) - (B_1 - B_0)$

Polynomial equation: $\qquad P = A \times (Reading^2) + B \times Reading + C - T_c \times (T_1 - T_0) - (B_1 - B_0)$

For water level dataloggers (code L)

$$P_{probe} = Reading - B_1$$

If distance$_{probe}$ > 0,

$$P = P_{probe} + \left(depth_{bottom\ filter} - depth_{top\ tube} - distance_{probe}\right) \times sin(dip) \times 9.806$$

For pneumatic piezometers (code P)

$$P = Reading - Inertia$$

Piezometric levels

The piezometric level is calculated according to the water pressure.

$$Level_{water} = NG - depth_{bottom\ filter} \times sin(dip) + P/9.806$$

6.4. Barometer form

The form shows data from the BAROMETER table and its secondary table BAROMETER_POINT of the Geotec database. It is used to record data from barometric stations to apply a barometric correction to data from vibrating wire piezometers and water level dataloggers such as *Level Loggers.*

The form is opened by double-clicking in the field **Barometric station** of the **Boring** form.

- The **barometer number** is the <u>key</u> of the record. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- If the barometer is a **vibrating wire,** check the box. The fields with initial readings L0, B0 and T0 as well as the calibration coefficients are activated. You can choose the calculations with the linear or polynomial equation.

- The **serial number** of the equipment is alphanumeric with 20 characters.

- The **installation date** is in *yyyy-mm-dd hh:mi:ss* format.

- The **location** of the barometric station is alphanumerci with 80 characters.

- **Remark** is alphanumeric with 255 characters for additional details about the barometer station.

- **Transfer** is a 1-character code to classify records for their management.

The table at the bottom of the Barometer form shows data from the BAROMETER_POINT secondary table of the Geotec database.

- The **barometer number** and the **reading date** together constitute the <u>key</u> of the records.

- The **reading date** (**BARO_DATE**) is in *yyyy-mm-dd hh:mi:ss* format. It is important to have the 2 digits for the hours, for example 04:15, 09:00, 15:30.

Standard barometer

- Enter the **reading** in kPa. This reading is copied into field B1.

- Enter the **temperature** but it is not used in the calculations.

Vibrating wire barometer

- Choose to use the **linear** equation or the **polynomial** equation by via radio buttons. By default, the linear equation is chosen.

- Enter the **reading** at installation **R0** in reading units.

- Enter the **barometric pressure** at installation **B0** in kPa.

- Enter the **temperature** at installation **T0** in Celsius degrees.

- Enter the **thermal coefficient TC** in kPa / Celsius degree.

- For the linear equation, enter the **calibration factor CF** in kPa / reading units.

- For the polynomial equation, enter:

- o   The **coefficient A** in kPa/reading units^2. The value in scientific format can be entered.

- o   The **coefficient B** in kPa/reading unit.

- o   The **coefficient C** is calculated automatically as $C = -(A \times 10^{-6} \times R_0{}^2 + B \times R_0)$

- Record the **reading** in reading units.

- Enter the **temperature** T1 in Celsius degrees.

6.4.1. Calculations

Geotec calculates the barometric pressure value B1 in kPa according to the inputs.

Standard barometer

$$B_1 = Reading$$

Vibrating wire barometer

Linear equation: $B_{1\ uncorrected} = C_F \times (Reading - R_0)$

Polynomial equation: $B_{1\ uncorrected} = A \times (Reading^2) + B \times Reading + C$

Temperature correction is added if T0 and T1 are defined.

$$B_1 = B_{1\ uncorrected} - T_C \times (T_1 - T_0)$$

If the barometer is not ventilated, the value B0 is added to it.

The calculation of B1 with temperature and barometric pressure corrections is therefore made with:

Linear equation: $B_1 = C_F \times (Reading - R_0) - T_C \times (T_1 - T_0) + B_0$

Polynomial equation: $B_1 = A \times (Reading^2) + B \times Reading + C - T_C \times (T_1 - T_0) + B_0$

Figure 15 – Barometer entry form

6.5. Trench / Test pit form

The form shows data from the TRENCH table of the Geotec database. It is used to describe test pits and/or trenches.

- The **site number** and the **boring number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the test pit or trench. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **length** and **width** of the trench are entered; in meters.

- The **azimuth** (orientation) of the trench is entered, between 0 and 360 degrees.

- The **stop code** is a 1-character field indicating the type of refusal during excavation, such as on **B**locks, at **D**etermined depth or on probable **R**ock.

- The **stripping thickness** and the **exploitable height** respectively indicate the thickness of the ground that was stripped before doing the boring, and the thickness of the exploitable material. The suggested unit is the meter. This information is useful in the analysis of borrow pits.

- The **estimated percentages** of **cobbles** and **boulders** found in the trench are entered. More details can be provided for the samples and / or layers via the matrix (paragraph 6.2)

- The **method** or excavation equipment is entered with 40 characters.

- A description of the **bucket** used can be entered with 40 characters.

- The wall **stability** can be described with 255 characters.

- A **description** of the excavation conditions is entered; with 255 characters.

- The **ground state** is a 40-character field, indicating for example, its moisture.

- The **woodland** density is a 40-character field.

- The **slope type** is a 40-character field, indicating for example, its incline.

- The **topography** is a 40-character field.

- The **surface soil** is a 40-character field.

- The **top** and **bottom depths** of the **oxidized zone** are entered, in meters.

- A **description** of the **oxidation conditions** is entered with 255 characters.

- The **depth** of two **water inflow** can be entered; the suggested unit is the meter.

- A **description** of the **water conditions** is entered; with 255 characters.

- A **photo** can be associated to the trench, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens. The photo can be displayed if an object in the style file is associated with this field in Log.

To save the photo with its full path, enable the option in the preferences. See the X3D documentation.

- A **photo description** can be entered, with 255 characters.

- The described **surface** of the trench is provided with 40 characters.

- A **photo description** can be added with 255 characters.

- The **remark** is alphanumeric with 255 characters to add details about the trench.

- **Transfer** is a 1-character code to classify records for their management.

Figure 16 – Trench / Test pit entry form

6.6. Boring methods form

The form shows data from the CASING table of the Geotec database. It is used to describe the boring methods used and their driving mode.

- The **site number**, the **boring number** and the **top depth** together constitute the key of the records.

- The **site** and **boring numbers** identify the boring. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **top** and **bottom depths** indicate between which depths the boring method is used, in meters. Both depths are required.

- The casing **caliber** is indicated with a 3-character abbreviation.

- **Driving mode** is a 1-character field indicating the driving mode used. The description of the driving mode is automatically copied to the Method field, which can be edited.

- The **type of drilling** is indicated with 40 characters.

- The **method of drilling** is indicated with 80 characters.

- The **remark** is alphanumeric with 255 characters for additional notes.

- **Transfer** is a 1-character code to classify records for their management.

Figure 17 – Boring methods entry form

6.7. Observation form

The form shows data from the OBSERVATION table of the Geotec database. It is used to indicate any remarks, note or observation done in the field. Typically, these observations are not geological.

- The **site number**, the **boring number** and the **top depth** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring for which there are field observations. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **depth** or **top depth** of the observation is entered, in meters.

- The **bottom depth** is entered, if the observation applies to an interval.

- The **remark** is added with 255 characters to describe the observation.

- **Transfer** is a 1-character code to classify records for their management.

Figure 18 – Observations entry form

6.8. Cobbles form (OBSOLETE)

WARNING: THE COBBLES FORM WILL BE REMOVED IN A FUTURE RELEASE. WE RECOMMEND USING THE MATRIX VIA THE SAMPLE AND/OR STRATIGRAPHY FORMS (PARAGRAPH 6.2).

The form shows data from the COBBLE table of the Geotec database. It is used to enter percentages of boulders and/or cobbles between two depths.

6.9. Ground form (OBSOLETE)

WARNING: THE GROUND FORM WILL BE REMOVED IN A FUTURE RELEASE. WE RECOMMEND USING THE TRENCH / TEST PIT FORM (PARAGRAPH 6.5).

The form shows data from the GROUND table of the Geotec database. It is used to enter the characteristics of the ground on which a borehole is located.

7. Entry forms for rock

In the Entry forms menu, the entry forms for rock description are available via the buttons of the second tab. They include the details about the rock joints and runs, information from the geocamera, the point load test and the uniaxial compression test.

7.1. Joints form

The form shows data from the ROCK_JOINT table of the Geotec database. It is used to describe the joints from a rock core or geocamera film as well as major structures.

- The **site number**, the **boring number** and the **depth** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the borehole where cores were taken, or in which a geocamera was installed. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The average **depth** of the joint, or the **top depth** of the major structure is entered, in meters.

The **Default parameters** button opens the Rock entry form to define default values for joint characterization, for runs and for RMR and Barton-Q calculation for each borehole. See paragraph 7.3.

If a major structure is present:

- The **length** of the major structure is entered, in meters, or can be calculated by entering the bottom depth.

- The **bottom depth** of the major structure is not a field of the database. It is calculated when the user enters the length. If the user enters a bottom depth for the structure, its length will be calculated.

- The type of major **structure** is then entered, with 6 characters. If the type is present in the table of lists (paragraph 0), its description is displayed next to the **Structure** field.

- The **number of joints** in the major structure is enter.

Geotec automatically calculates:

Nbr joints = nb of joints per meter of structure x length of structure

The number of joints per meter of structure can be defined in the default parameters (paragraph 7.3). The default value is 40.

Figure 19 – Joints entry form

If a joint is present:

- The type of **joint** is entered, with 10 characters maximum. If the type is present in the table of lists (paragraph 0), its description is displayed next to the **Type** field.

  If the type is empty, it is suggested by Geotec based on the separation selected.

  - If the **description** contains *vein* → VN for Vein

  - Healed → HJ for Healed Joint (or FL in French for Fracture Liée)

  - < 0.1 mm → CJ for Closed Joint (or FF for Fracture Fermée)

  - 0.1 to 1 mm → (PJ for Partially Opened Joint) (or FP for Fracture Partiellement Ouverte)

  - 1 to 5 mm or > 5 mm → (PJ for Opened joint) (of FO for Fracture Ouverte)

  In Log and Pro, a special display can be used for the joints with markers named J_TYPE. See the Log documentation.

- **Alpha** is the joint angle relative to the core axis; it's an integer between 0 and 90°.

- **Beta** is the azimuth of the joint relative to the core; it's an integer between 0 and 360°.

- **Dip** is the joint angle relative to a horizontal plane; it's an integer between 0 and 90°. It can be entered or calculated by Geotec. It is used in the stereonet and in the calculation of joint sets.

- **Direction** is the azimuth of the joint relative to the north; it's an integer between 0 and 360°. It can be entered or calculated by Geotec. It is used in the stereonet and in the calculation of joint sets.

The calculation theory of POND (Planes from Oriented, Navigated Drillcore) of Stanley and Hooper (2011) is used to calculate the dip and direction of joints based on the following angles:

      Azimuth of borehole (or 0 if not defined)
      Dip of borehole (or 90 if not defined)
      Joint Alpha angle
      Joint Beta angle
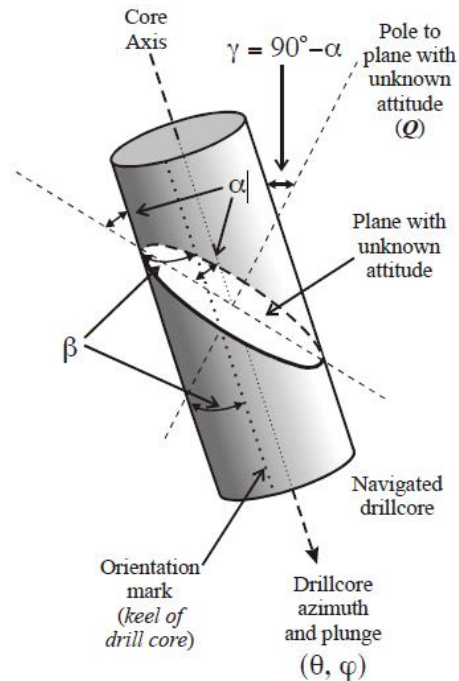
- The **set number** is alphanumeric. Joint sets are 1, 2, 3, 4, 5 or R (random). The joint set can be entered by the user or calculated by Geotec.

  To determine the joint set number, Geotec verified if its dip and direction are within the minimum and maximum dip and minimum and maximum direction of one of the joint sets defined for the borehole in the Default parameters (paragraph 7.3). The corresponding set number is assigned to the joint. If no set corresponds or if no joint sets was defined in the default parameters, the joint is random (R).

  The set number determined by Geotec is indicated right of the checkbox. If at least one joint set is defined in the parameters, the option **Replace with calculated set no** is active and is used to replace the field values by the ones calculated by Geotec.

The five next characteristics are used to determine the joint ratings for the RMR and Barton Q calculation. Default values are suggested. It is also possible to define the default parameters (paragraph 7.3) to use for the joints of the borehole.

- The **joint shape** is selected between 6 choices:

  o   Discontinuous → jw = 4

  o   Irregular → jw = 4

  o   Stepped → jw = 2.5

  o   Undulating (default value) → jw = 2

  o   Curved → jw = 1.5

  o   Planar → jw = 1

  The **jw** rating (Barton Q) is associated to each choice and used in the calculations.

- The **joint roughness** is selected between 6 choices:

  o Very rough → js = 2 and Ra4c = 6

  o Rough → js = 1.5 and Ra4c = 5

  o Slightly rough (default value) → js = 1.25 and Ra4c = 3

  o Smooth → js = 1.0 and Ra4c = 1

  o Polished → js = 0.75 and Ra4c = 0

  o Slickensided → js = 0.5 and Ra4c = 0

  The **js** rating (Barton Q) and the **Ra4c** rating (RMR) are associated to each choice and used in the calculations.

- The **joint separation** is selected between 5 choices:

  o Healed → Ra4b = 6 and Ja = 0.75

  o < 0.1 mm (default value) → Ra4b = 5

  o 0.1 to 1 mm → Ra4b = 4

  o 1 to 5 mm → Ra4b = 1

  o > 5 mm → Ra4b = 0

  o Enter the **joint aperture**, in mm.

  The **Ra4b** rating (RMR) is associated to each choice and used in the calculations.

- The **joint infilling** is selected between 5 choices:

  o None / stained → Ra4d = 6 and Ja = 1 (except if joint is healed, Ja = 0.75)

  o Cohesionless (default value) →
    o If separation is < 5 mm, Ra4d = 4
    o If separation is > 5 mm, Ra4d = 2 and Ja = 6
    o If separation is between 1 and 5 mm, Ja = 4
    o If separation is < 1 mm, Ja = 2

  o Hard cohesive →
    o If separation is < 5 mm, Ra4d = 4
    o If separation is > 5 mm, Ra4d = 2 and Ja = 10
    o If separation is between 1 and 5 mm, Ja = 6
    o If separation is < 1 mm, Ja = 3

  o Soft cohesive →
    o If separation is < 5 mm, Ra4d = 2
    o If separation is > 5 mm, Ra4d = 0 and Ja = 13
    o If separation is between 1 and 5 mm, Ja = 8
    o If separation is < 1 mm, Ja = 4

- o Swelling →
    - o If separation is < 5 mm, Ra4d = 2
    - o If separation is > 5 mm, Ra4d = 0 and Ja = 18
    - o If separation is between 1 and 5 mm, Ja = 10
    - o If separation is < 1 mm, Ja = 5
- o Enter the infilling material

The **Ja** rating (Barton Q) and **Ra4d** rating (RMR) are associated to the infilling and separation together and used in the calculations.

- The **joint weathering** is selected between 5 choices:

    - o None (default value) → Ra4e = 6
    - o Slight → Ra4e = 5
    - o Moderate → Ra4e = 3
    - o High → Ra4e = 1
    - o Decomposed → Ra4e = 0

    The **Ra4e** rating (RMR) is associated to each choice and used in the calculations.

The Rock Mass Rating parameters are calculated by Geotec or selected by the user.

- **Ra4a** is the joint continuity (persistence) rating. It is between 0 and 6. The persistence is defined by default as 1 to 3 m, but can be redefined for the borehole in the default parameters.

    - o For < 1 m → Ra4a = 6
    - o For 1 - 3 m → Ra4a = 4
    - o For 3 - 10 m → Ra4a = 2
    - o For 10 - 20 m → Ra4a = 1
    - o For > 20 m → Ra4a = 0

    If the persistence is based on roughness (see default parameters), Ra4a depends on Ra4c. For Ra4c = 5 → Ra4a = 4. For Ra4c = 3 → Ra4a = 2. Otherwise, Ra4c = Ra4a.

- **Ra4b** is the joint separation rating, based on **joint separation**. It is between 0 and 6.

- **Ra4c** is the joint roughness rating, based on **joint roughness**. It is between 0 and 6.

- **Ra4d** is the joint infilling rating, based on **joint infilling** and **separation**. It is between 0 and 6.

- **Ra4e** is the joint weathering rating, based on **joint alteration**. It is between 0 and 6.

- The **sum of the Ra4** is indicated for information, as: Ra4 = Ra4a + Ra4b + Ra4c + Ra4d + Ra4e.

- **Jcon** is the joint condition number (RMR 1989). It is used only if the user chooses the Jcon calculation method for Ra4 (paragraph 7.3).

    - o If the joint infilling is hard cohesive, soft cohesive or swelling

- o If separation is > 5 mm → Jcon = 0
- o If separation is from 1 to 5 mm <u>or</u> the joint roughness is slickensided → Jcon = 7
- o If separation is from 0.1 to 1 mm → Jcon = 14
  - o Otherwise…
    - o For a curved or planar joint …
      - o For a very rough joint → Jcon = 24 (cohesionless) or 26 (stained)
      - o For a rough or slightly rough joint → Jcon = 19 (cohesionless) or 24 (stained)
      - o For a polished or slickensided joint → Jcon = 14 (cohesionless) or 19 (stained)
    - o For a discontinuous, irregular, stepped or undulating joint …
      - o For a very rough joint → Jcon = 26 (cohesionless) or 30 (stained)
      - o For a rough or slightly rough joint → Jcon = 24 (cohesionless) or 26 (stained)
      - o For a polished or slickensided joint → Jcon = 19 (cohesionless) or 24 (stained)

- **Ra4** is the parameter evaluating the joint condition. It is between 0 and 30. Ra4 is either equal to the sum of Ra4a to Ra4e (default value), either equal to Jcon, or equal to the average of both. The calculation method can be redefined for the borehole in the default parameters (paragraph 7.3).

The Barton-Q parameters are calculated by Geotec or selected by the user.

- **Jr** is the joint roughness number. It is between 0.5 and 4.

  Jr can be calculated based on **Jr = jw * js** if the option is checked in the default parameters for the borehole (paragraph 7.3). The value of Jr is maximum 4.

  - o jw is the rating based on joint shape (between 1 and 4), and js is the rating based on joint roughness (between 0.5 and 2).

  If the option Jr = jw * js is not checked (default value), Jr is determined as follows.

  - o For a discontinuous, irregular or stepped joint → Jr = 4
  - o For an undulating or curved joint …
    - o For a very rough or rough joint → Jr = 3
    - o For a slightly rough or smooth joint → Jr = 2
    - o For a polished or slickensided joint → Jr = 1.5
  - o For a planar joint…
    - o For a very rough or rough joint → Jr = 1.5
    - o For a slightly rough or smooth joint → Jr = 1
    - o For a polished or slickensided joint → Jr = 0.5
  - o If the joint infilling is cohesionless, hard cohesive, soft cohesive or swelling <u>AND</u> the joint separation is > 5 mm → Jr = 1

- **Ja** is the joint alteration number, based on **joint infilling** and **separation**. It is between 0.75 and 20.

- **JRC** is the joint roughness coefficient, between 0.5 and 20. It is not used in the calculations.

  - o For a discontinuous, irregular or stepped joint → JRC = 20

- o For an undulating or curved joint …
  - o For a very rough or rough joint → JRC = 14
  - o For a slightly rough or smooth joint → JRC = 11
  - o For a polished or slickensided joint → JRC = 7
- o For a planar joint …
  - o For a very rough or rough joint → JRC = 2.5
  - o For a slightly rough or smooth joint → JRC = 1.5
  - o For a polished or slickensided joint → JRC = 0.5

- The joint or major structure **description** has 255 characters. If a geocamera file from WellCad, Dips or other software is imported into Geotec, the value in the **Description** field is analysed. The separation can be checked automatically based on the texts decoded:

  - o With *ealed*, *welded*, *lié* or *soudé*, Healed is checked.

  - o With *close* or *fermé*, < 0.1 mm is checked.

  - o With *part* or *slight*, 0.1 to 1 mm is checked.

  - o With *open* or *ouvert*, Geotec verifies the value in the Aperture field (mm).
    - o With an aperture greater than 5, >5 mm is checked.
    - o With an aperture greater than 1, 1 to 5 mm is checked.
    - o Otherwise, 0.1 to 1 mm is checked.

  - o For other descriptions, Geotec verifies the value in the Aperture field.
    - o With an aperture greater than 100 mm, so typically for major structures
      - o The structure length is calculated as: aperture / 1000
      - o The number of joints is calculated as: nbr of joints per meter of structure x structure length
      - o With *shear*, *fractur* or *cisail*, the structure is defined as FZ (fractured zone)
      - o With *broken*, *rempli* or *broy*, the structure is defined as BZ (broken zone)
    - o With an aperture greater than 5, >5 mm is checked.
    - o With an aperture greater than 1, 1 to 5 mm is checked.
    - o With an aperture greater than 0.1 mm, 0.1 to 1 mm is checked.
    - o Otherwise, the separation from the default parameters is checked.

- The joint or major structure **remark** has 255 characters. If a geocamera file from WellCad, Dips or other software is imported into Geotec, the value in the **Remark** field is analysed.

  The shape can be checked automatically based on the texts decoded:

  - o With *discontinu*, Discontinuous is checked.

  - o With *irregular* or *irréguli*, Irregular is checked.

  - o With *stepped* or *escalier*, Stepped is checked.

  - o With *undulat* or *ondul*, Undulating is checked.

- With *curve* or *courb*, Curved is checked.

- With *plan*, Planar is checked.

The roughness can be checked automatically based on the texts decoded:

- With *discontinu*, *very*, *v.* or *très*, Very rough is checked.

- With *slight*, *sl.* or *lég*, Slightly rough is checked.

- With *rough* or *rugueux*, Rough is checked.

- With *smooth*, *lisse* or *dou*, Smooth is checked.

- With *poli*, Polished is checked.

- With *slicken* or *strié*, Slickensided is checked.

- The name of the person who **logged** the information about the major structure or joint is entered, with 40 characters, as well as the **logging date** in format *yyyy-mm-dd hh:mi:ss*.

- **Transfer** is a 1-character code to classify records for their management. By putting an "X" in the Transfer field, the joint will not be displayed in the stereonet and will be ignored in the calculations of joint sets statistics.

In the **Stereonet** tab…

A stereonet is displayed in vector representation, showing all the joints of the current borehole, except those with an "X" in the Transfer field. Each joint is displayed according to its dip and direction.

- Dip: A dip of 0 is at the center of the stereonet, and a dip of 90 is on the outside.

- Direction: A direction of 0 is at the bottom of the stereonet. The direction increases clockwise. The direction of 90 is therefore at the left of the stereonet.

- For information, specific markers exist for healed joints (type HJ), closed joints (type CJ), partially opened joints (type PJ) and opened joints (type OJ). The other types are represented as a gray square.

- The definition of the joint sets in the default parameters of the borehole are shown as information.
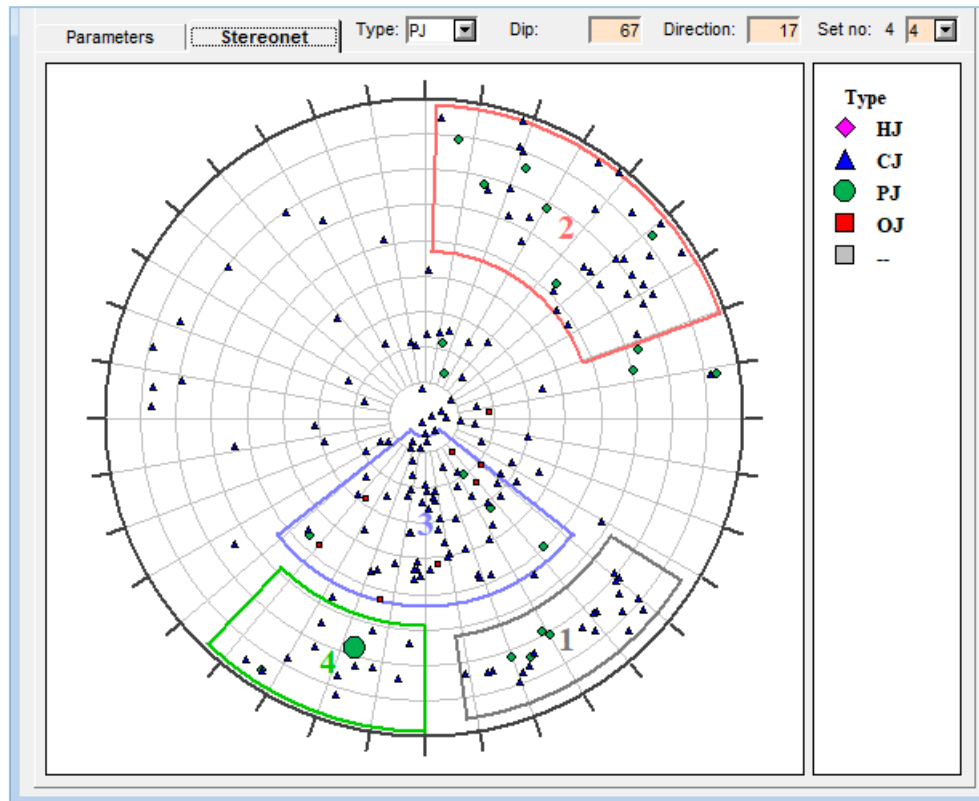
Figure 20 – Joints entry form - Stereonet

7.2. Run form

The form shows data from the RUN table and its secondary table RUN_SET of the Geotec database. It is used to describe the runs in the boreholes.

- The **site number**, the **boring number** and the **run number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the borehole where cores were taken. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **run number** can have up to 20 characters. The number of the first run is automatically suggested as 01, and the following ones are incremented.

The **Default parameters** button opens the Rock entry form to define default values for joint characterization, for runs and for RMR and Barton-Q calculation for each borehole. See paragraph 7.3.

Figure 21 – Run entry form

- The **top** and **bottom depths** of the run are required, in meters.

- The run **length** is not a field in the database. It is calculated when the user enters the bottom depth. If the user enters a length for the run, its bottom depth will be calculated.

- The **total core recovery TCR** can be calculated via its length, or inputted directly in %.

- The **solid core recovery SCR** can be calculated via its length, or inputted directly in %. The calculation of SCR can be done by Geotec based on the joints in the run, if the calculation method is checked in the default parameters (paragraph 7.3).

  o We use the diameter corresponding to the caliber entered in the CASING table (paragraph 6.6) at the depth of the run based on Table 7, or 50 mm if no caliber is found.

  o We ignore all joints whose separation of "0" (healed joint) or whose Transfer field is "X".

  o The pieces are calculated as the difference in depth of 2 consecutive joints minus the aperture of the first joint, while taking into account the top and bottom of the run for the first and last

joint (± 0.11 m on both extremities of the run). For a major structure, the piece is calculated as the structure length / (nbr joints + 1).

- o We add all pieces that are > diameter.

- o The SCR is the ratio of this length over the run length.

- The **Rock quality designation RQD** can be calculated via its length (sum of lengths > 10 cm), or inputted directly in %. The calculation of RQD can be done by Geotec based on the joints in the run, if the calculation method is checked in the default parameters (paragraph 7.3).

- o We ignore all joints whose separation of "0" (healed joint) or whose Transfer field is "X".

- o The pieces are calculated as the difference in depth of 2 consecutive joints minus the aperture of the first joint, while taking into account the top and bottom of the run for the first and last joint (± 0.11 m on both extremities of the run). For a major structure, the piece is calculated as the structure length / (nbr joints + 1).

- o We add all pieces that are > 10 cm.

- o The RQD is the ratio of this length over the run length.

- The **number of joints** in the run can be entered by the user or calculated by Geotec if the calculation method is checked in the default parameters (paragraph 7.3). Geotec calculates the number of joints defined in the ROCK_JOINT table between the top and bottom depth of the run, as well as the number of joints in major structures, if applicable.

- The average joint **spacing** (mm) is not a field of the database. It is calculated as:

$$\text{Spacing} = \text{run length} * 1000 / (\text{nbr of joints} + 1)$$

- The **rock code** defines the dominant rock material. The drop-down list shows the materials named *R_name* in the current patterns file (.ptn). A large number of R-type patterns can be found in the geotec8.ptn patterns file.

- The **geological formation** can be entered, with up to 40 characters.

- A **description** of the run is added, with 255 characters.

- The **Rock mass strength (RMS)** is used to calculate Ra1.

- o **UCT**: Geotec calculates the average of the UCS strength values from the UNIAXIAL_COMPRESSION table whose test depth is between the top and bottom of the run. The average is shown in the UCT field as information.

- o **PLT**: Geotec calculates the average of the equivalent UCS strength values from the POINT_LOAD table whose test depth is between the top and bottom of the run. The average is shown in the PLT field as information.

- o **RMS** can be entered by the user. Otherwise, Geotec uses:
  - o RMS = PLT if PLT is defined and UCT is not
  - o RMS = UCT if UCT is defined and PLT is not
  - o RMS = (PLT + UCT) /2 if both PLT and UCT are defined

- The **Intact rock strength index (**R0 to R6) is estimated based on the uniaxial compressive strength UCS. The default value is Medium strong, but can be redefined for the borehole in the default parameters. If RMS is not defined, Ra1 will be calculated based on the index selected.

  o Extremely weak (R0 - UCS between 0.25 and 1 MPa) → Ra1 = 0

  o Very weak (R1 - UCS between 1 and 5 MPa) → Ra1 = 1

  o Weak (R2 - UCS between 5 and 25 MPa) → Ra1 = 2

  o Medium strong (R3 - UCS between 25 and 50 MPa) → Ra1 = 4

  o Strong (R4 - UCS between 50 and 100 MPa) → Ra1 = 7

  o Very strong (R5 - UCS between 100 and 250 MPa) → Ra1 = 12

  o Extremely strong (R6 - UCS > 250 MPa) → Ra1 = 15

- The **percentage % of weak rock** varies between 0 and 100%.

- The **rock weathering** (W1 to W6) is selected between these 6 choices.

  o None (W1)

  o Slight (W2)

  o Moderate (W3)

  o High (W4)

  o Complete (W5)

  o Residual soil (W6)

The Rock Mass Rating parameters are calculated by Geotec or selected by the user.

- **Ra1** is the rating of intact rock strength, based on the RMS or the strength index R0 to R6. It is between 0 and 15.

  If RMS is defined, Ra1 is calculated with a linear interpolation between the following points:

RMS	0	1	5	25	50	100	250	10000
Ra1	0	0.5	1.5	3	5.5	9.5	15	15
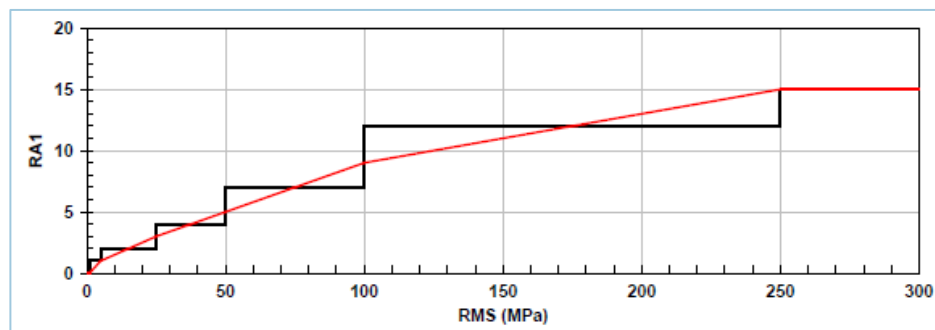
Figure 22 – Interpolation for calculation of Ra1 in Run entry form

Otherwise, Ra1 is calculated based on the R0 to R6 index as defined above.

- **Ra2** is the rating of RQD. It is between 3 and 20. It can be selected by the user from the drop-down list or calculated by Geotec with a linear interpolation between the following points:

RQD	0	10	25	50	75	90	100
Ra2	3	3	5.5	10.5	15	18.5	20
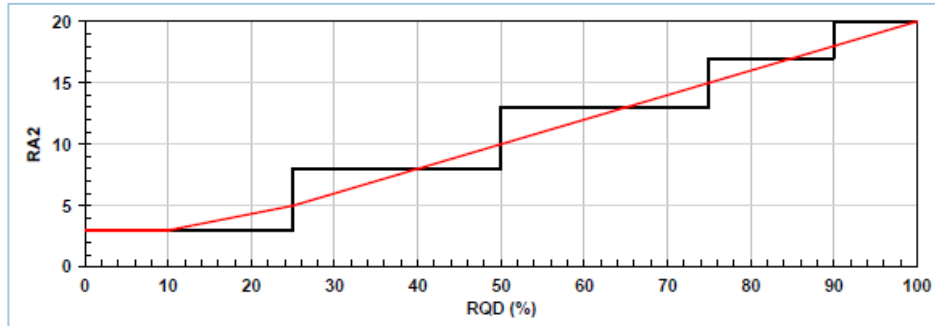
Figure 23 – Interpolation for calculation of Ra2 in Run entry form

- **Ra3** is the rating of average joint spacing. It is between 5 and 20. It can be selected by the user from the drop-down list or calculated by Geotec with a linear interpolation on logarithmic basis between the following points, where "s" is the average joint spacing.

s	1	10	60	200	600	2000	10000
Ra3	5	5	6.5	9	12.5	20	20
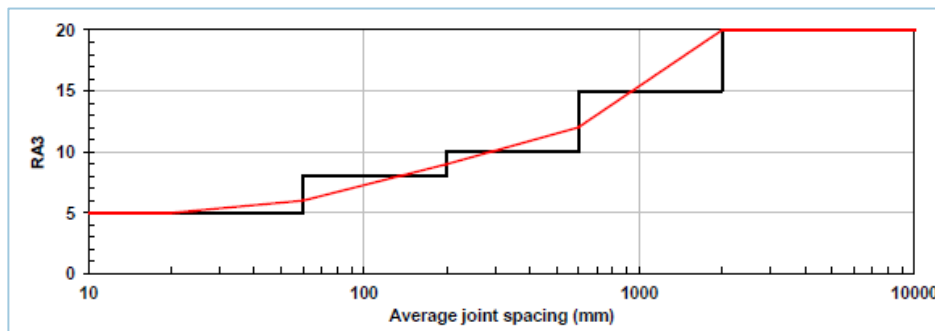
Figure 24 – Interpolation for calculation of Ra3 in Run entry form

- **Ra4** is the rating of joint condition. It is between 0 and 30.

  - Geotec calculates the average Ra4a, Ra4b, Ra4c, Ra4d and Ra4e of the joints for each set number (paragraph 7.2.1).

  - Ra4 for each set number is then calculated as indicated in paragraph 7.1 and is used to determine RMR for each set number.

  - Based on the selected RMR calculation criteria, Geotec uses the values of the run, including RMR, Ra1, Ra2, Ra3, Ra5 and Rb to recalculate Ra4.

- **Ra5** is the rating of groundwater conditions. It varies between 0 and 15. The default value is 15 but can be redefined for the borehole in the default parameters.

- **Rb** is the rating adjustment for joint orientations. It varies between 0 and -12. The default value is 0 but can be redefined for the borehole in the default parameters.

- The **RMR** is the rock mass rating and is between 0 and 100 %. RMR is automatically calculated as:

$$RMR = Ra1 + Ra2 + Ra3 + Ra4 + Ra5 + Rb$$

  o The RMR displayed in the entry form and saved in the database is calculated based on the criteria selected in the default parameters for the borehole. The criteria is indicated below the field Class.

  o Class: The class of rock quality is calculated for the RMR based on Table 5.

The Barton Q parameters are calculated by Geotec or selected by the user.

- **Jn** is the joint set number. It is between 0.5 and 20. It is calculated based on joint sets in the run.

  o For each joint set…

    If the number of joints in the run is ≥ than the minimum number of joints per run (6 or the value in the default parameters) <u>and</u> if the number of joints in the set is ≥ than the minimum number of joints per set (2 or the value in the default parameters), then the number of sets in increased by 1. A random set is not included in the total number.

  o Jn is then determined based on the number of sets obtained, the number of joints in the run and the presence of a Random set.

Nbr joints ≥ 20 * run length	→ Jn = 20
Nbr sets = 0 and Nbr joints = 0	→ Jn = 1
Nbr sets = 0 and Nbr joints > 0	→ Jn = 1
Nbr sets = 1 and no random	→ Jn = 2
Nbr sets = 1 and a random	→ Jn = 3
Nbr sets = 2 and no random	→ Jn = 4
Nbr sets = 2 and a random	→ Jn = 6
Nbr sets = 3 and no random	→ Jn = 9
Nbr sets = 3 and a random	→ Jn = 12
Nbr sets ≥ 4	→ Jn = 15

- **Jr** is the joint roughness number. It is between 0.5 and 4.

  o Geotec calculates the average Jr of the joints for each set number (paragraph 7.2.1) as well as the Jr associated to each calculation criteria of Barton-Q.

  o Based on the Barton-Q calculation criteria selected, the Jr associated to the criteria is displayed in the entry form and saved in the database.

- **Ja** is the joint alteration number, based on **joint infilling** and **separation**. It is between 0.75 and 20.

  o Geotec calculates the average Ja of the joints for each set number (paragraph 7.2.1).

  o Based on the Barton-Q calculation criteria selected, Geotec uses the values of run, including Q, RQD, Jn, Jr, Jw and SRF to recalculate Ja.

- **Jw** is the joint water reduction number. It varies between 0.05 and 1. The default value is 1 but can be redefined for the borehole in the default parameters.

- **SRF** is the stress reduction factor. It varies between 0.5 and 400. The default value is 1 but can be redefined for the borehole in the default parameters.

- **Jv** is the number of joints per cubic meter. It is displayed as information only.

$$J_v = \frac{(115 \times RQD)}{3.3}$$

- **Q** is the rock quality index and is between 0.001 and 1000. The Barton-Q is automatically calculated as:

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

where RQD is at least 10.

- o Q displayed in the entry form and saved in the database is based on the criteria selected in the default parameters for the borehole. The criteria is indicated below the field Class.

- o Class: The class of rock quality is calculated for the Barton-Q based on Table 6.

  - A **remark** about the run can be added with 255 characters.

- The name of the person who **described** the run is entered, with 40 characters, as well as the **logging date** in format *yyyy-mm-dd hh:mi:ss*.

- **Transfer** is a 1-character code to classify records for their management.

7.2.1. Joint sets statistics

The **Joints** tab at the bottom of the form shows data from the ROCK_JOINT table of the Geotec database. Automatically, all joints whose depth is between the top and bottom depths of the run are listed. Their values can be edited. The joints can be sorted by **depth** or by **set number** depending on the radio button selected.

The **Sets** tab at the bottom of the form shows data from the RUN_SET secondary table of the Geotec database.

The joint sets statistics are calculated by Geotec. If there is already existing data, the must be deleted with the button **Delete sets statistics** in order to be regenerated. A joint set is generated if at least 1 joint or major structure belongs to it in the run, including the R set. Any joint with "X" in its Transfer field is ignored in the calculations. Each set shows the average of all values of its joints as well as the Barton Q and RMR calculation.

In the **Stereonet** tab…

A stereonet is displayed in vector representation, showing all the joints of the current borehole, except those with an "X" in the Transfer field. Each joint is displayed according to its dip and direction.

- Dip: A dip of 0 is at the center of the stereonet, and a dip of 90 is on the outside.

- Direction: A direction of 0 is at the bottom of the stereonet. The direction increases clockwise. The direction of 90 is therefore at the left of the stereonet.

- The joints are displayed with a marker representing their type (paragraph 7.1).

- The definition of the joint sets in the default parameters of the borehole are shown as information.

The joint sets statistics show a summary of the values calculated in RUN_SET (Sets tab). The number of joints, RMR and Barton Q are shown for:

- Set numbers 1, 2, 3, 4, 5 and R if applicable

- Weighted average of sets → The number of joints per set is taken into account

- Average of sets → The number of joints per set is not taken into account, each set counts as 1 joint

- Minimum set value → The minimum RMR, the minimum Q and the number of joints of the associated set

- Maximum set value → The maximum RMR, the maximum Q and the number of joints of the associated set

- Dominant set → The values of the set with most joints
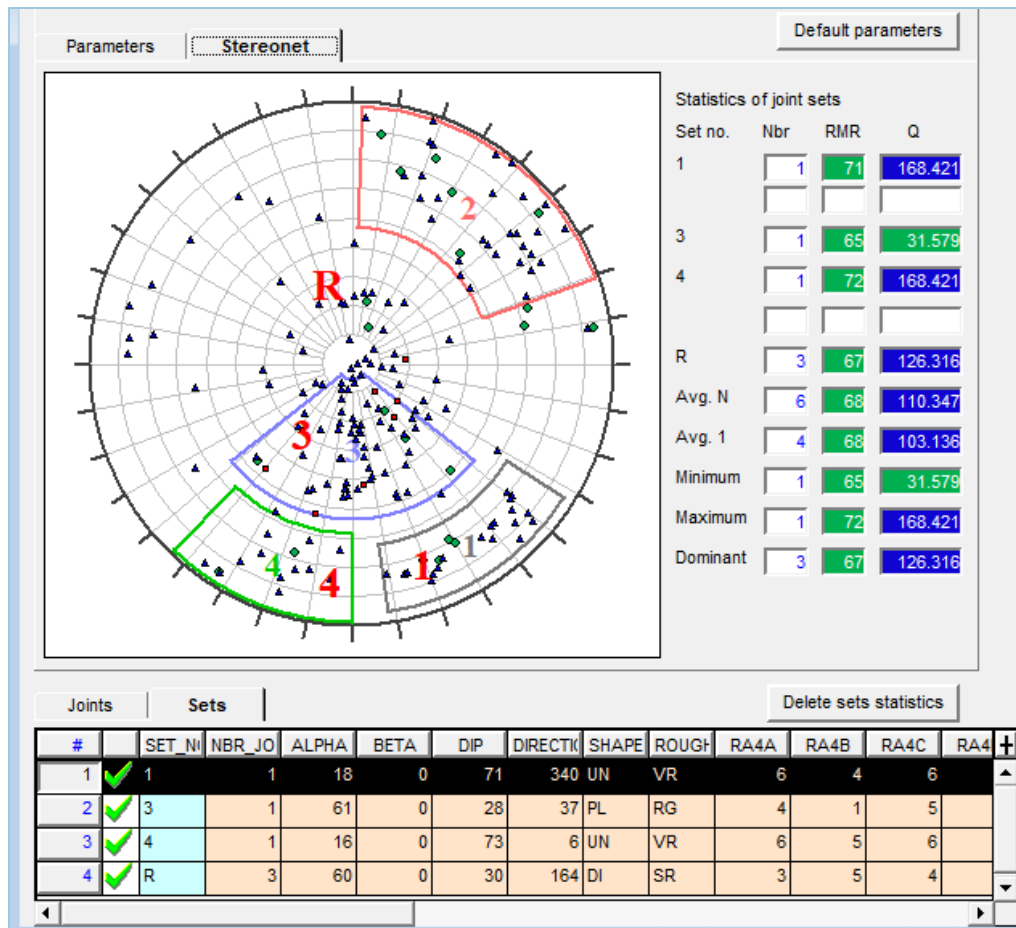
Figure 25 – Run entry form – Stereonet and joint sets statistics

The class of rock quality is calculated for the RMR and the Barton-Q based on Table 5 and Table 6 respectively. By defining a color for each class in the table of lists (for table RUN, fields Q_CLASS and RMR_CLASS), it will be used as the cell background color for each corresponding value.

Table 5 – Classes of rock quality (RMR)

RMR	81-100	61-80	41-60	21-40	0-20
Class	I	II	III	IV	V
Description	Very good	Good	Fair	Poor	Very poor

Table 6 – Classes of rock quality (Barton Q)

Q	> 400	100 < Q ≤ 400	40 < Q ≤ 100	10 < Q ≤ 40	4 < Q ≤ 10	1 < Q ≤ 4	0.1 < Q ≤ 1	0.01 < Q ≤ 0.1	≤ 0.01
Class	A1	A2	A3	B	C	D	E	F	G
Description	Exceptionally good	Extremely good	Very good	Good	Fair	Poor	Very poor	Extremely poor	Exceptionally poor

7.3. Default parameters form

The **Rock** entry form is opened via the **Default parameters** button in the Joints and Runs entry form. The form shows data from the ROCK table and its secondary table ROCK_SET of the Geotec database. It is used to define default values for joint characterization, for runs and for RMR and Barton-Q calculation for each borehole, as well as to establish the definition of joint sets. It is also used to define the calculation method with regards to joint distribution.

- The **site number** and the **boring number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the borehole for which default parameters are set, for the rock joints and runs. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

A number of joints can be defined for 3 default parameters of the borehole.

- **Nbr of joints per meter of structure**: by default, the value is 40 but can be modified. This value is used when calculating the number of joints in a major structure, as:

  Nbr joints = nb of joints per meter of structure x length of structure

- **Minimum nbr of joints per run**: by default, the value is 6 but can be modified between 1 and 20. This value is used for the Jn calculation.

- **Minimum nbr of joints per set**: by default, the value is 2 but can be modified between 1 and 10. This value is used for the Jn calculation.

Figure 26 – Entry form of default parameters for rock joints and runs

The five next characteristics are used to determine the joint ratings for the RMR and Barton Q calculation. Choose the default values to use for the rock joints of the borehole. Each characteristic is described in paragraph 7.1.

- The **joint shape** is selected between: Discontinuous, Irregular, Stepped, Undulating (suggested by default), Curved or Planar

- The **joint roughness** is selected between: Very rough, Rough, Slightly rough (suggested by default), Smooth, Polished or Slickensided

- The **joint separation** is selected between: Healed, < 0.1 mm (suggested by default), 0.1 to 1 mm, 1 to 5 mm or > 5 mm

- The **joint infilling** is selected between: None / stained, Cohesionless (suggested by default), Hard cohesive, Soft cohesive or Swelling

- The **joint weathering** is selected between: None (suggested by default), Slight, Moderate, High or Decomposed

The Rock Mass Rating parameters include default values for the joints, runs and calculation methods to use.

- **Persistence** is the joint continuity. The value will be used to calculate Ra4a. The persistence is selected between: Based on roughness, < 1 m, 1 to 3 m (default value), 3 to 10 m, 10 to 20 m or > 20m.

- **Ra4 calculation** is the method to use to determine Ra4, the parameter evaluating the joint condition. Ra4 is either equal to the sum of Ra4a to Ra4e (default value), either equal to Jcon, or equal to the average of both.

- **Ra5** is the rating of groundwater conditions. It varies between 0 and 15. The selected rating will be used by default for the runs of the borehole. Ra5 = 15 is suggested by default.

- **Rb** is the rating adjustment for joint orientations. It varies between 0 and -12. The selected rating will be used by default for the runs of the borehole. Rb = 0 is suggested by default.

- **Strength R** is the intact rock strength index R and varies between 0 and 6. It is estimated based on uniaxial compressive strength UCS. The default value is 3 (medium strong). The strength R will be selected by default for the runs of the borehole. It can be used in the calculation of Ra1.

- **RMR based on** is used to select the most important criteria for the calculation of RMR. However, the RMR calculated for all criteria is available in the statistics (Stereonet tab of the Run form). The default value is Weighted average of sets (choice 7).

The Barton Q parameters include default values for the runs and calculation methods to use.

- **Jw** is the joint water reduction number. It varies between 0.05 and 1. Jw selected will be used by default for the runs of the borehole. Jw = 1 is suggested by default.

- **SRF** is the stress reduction factor. It varies between 0.5 and 400. SRF selected will be used by default for the runs of the borehole. SRF = 1 is suggested by default.

- The checkbox **Jr = jw * js** indicated the calculation method of Jr. If the box is not checked (default option), Jr will be from the predefined choices based on shape and roughness. If the box is check, Jr will be the product of jw and js.

- **Q based on** is used to select the most important criteria for the calculation of Barton Q. However, the Q calculated for all criteria is available in the statistics (Stereonet tab of the Run form). The default value is Minimum set value (choice 9).

The management includes comments about the default parameters as well as the calculation method with regards to joint distribution.

- A **description** of the geological formation or other can be added, with 255 characters.

- The **remark** is added with 255 characters.

- **Transfer** is a 1-character code to classify records for their management.

- To **always use joint distribution to calculate the number of joints per run, the RQD and the SCR**, check their corresponding boxes. If the box is <u>not</u> checked, the parameter is calculated only if empty. It is not calculated if there is already a value.

    The calculation method for the number of joints, the RQD and the SCR is specific to the workstation. It is not associated to each borehole.

In the **Stereonet** tab…

A stereonet is displayed in vector representation, showing all the joints of the current borehole, except those with an "X" in the Transfer field. Each joint is displayed according to its dip and direction.

- A dip of 0 is at the center of the stereonet, and a dip of 90 is on the outside.

- A direction of 0 is at the bottom of the stereonet. The direction increases clockwise. The direction of 90 is therefore at the left of the stereonet.

- For information, specific markers exist for healed joints (type HJ), closed joints (type CJ), partially opened joints (type PJ) and opened joints (type OJ). The other types are represented as a gray square.

- The joint sets defined in the bottom table are also displayed in the stereonet. If a color is defined for the set number in the table of lists, it will be used for the set display (for table ROCK_SET, field SET_NO, value 1 to 5).

The table at the bottom of the Rock form shows data from the ROCK_SET secondary table of the Geotec database. This is where joint sets are defined. Geotec will use these definitions to determine to which set the joint belongs and to do joint sets statistics.

- The **site number**, the **boring number** and the **set number** together constitute the <u>key</u> of the records. A total of 5 sets can be defined.

- The minimum dip, maximum dip, minimum direction and maximum direction are used to define a set with 4 sides.

- The **minimum dip**, **maximum dip** and **minimum direction** are used to define a conical set.

    o The center of the cone is the "Minimum dip, Minimum direction" point.

    o The radius of the cone is equal to the maximum dip.

7.4. Geocamera form

The form shows data from the GEOCAMERA table of the Geotec database. It is used to define the geocamera images taken along a borehole.

- The **site number**, the **boring number**, the **type of image** and the **top depth** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the borehole where the geocamera was installed. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The type of image is a 2-character code, either AC for acoustic image, OP for optical image, 3D for three-dimensional image, or PH for photo.

- The **top** and **bottom depths** of the layer where the photo was taken are indicated, in meters.

- **Diameter** indicates the hole dimension; the suggested unit is the mm.

- The **file name** is entered, with a maximum of 255 characters. The file must be a **.bmp** extension. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

  The images can be displayed with the Log module.

- A **description** of the image can be added with up to 255 characters.

Figure 27 – Geocamera entry form

7.5. Point load form

The form shows data from the POINT_LOAD table of the Geotec database. It is used to enter the parameters and calculate the results of the point load test for a rock sample.

- The **site number**, the **boring number** and the **depth** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the borehole from which the core samples are taken for point load tests. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The top **depth** of the sample core is entered, in meters.

- Choose the **test type**.

  o **Diametral**: The core is placed horizontally between the platens

  o **Axial:** The core is placed vertically between the platens

  o **Prismatic**: The core is prismatic or irregular in shape and placed horizontally between the platens

- The **test number** can be entered, with 20 characters.

Diametrical Type: The ratio of core length over the core diameter should be greater than 1.

- Enter the **core diameter (d)**, in millimeters (mm).

    Geotec verifies if a caliber is entered in the CASING table at the depth of the test (paragraph 6.6). If yes, the corresponding diameter is entered, based on Table 7. If no caliber is found or does not correspond to the following list, 50 mm is suggested.

Table 7 – Caliber and corresponding diameter

Caliber	Diameter (mm)	Caliber	Diameter (mm)
PQ	85.0	HX	76.2
HQ	63.5	NX	54.7
NQ	47.6	BX	42.0
BQ	36.5	AXT	30.1
AQ	27.0	EXT	21.5
PQ3	83.0	XRT	18.7
HQ3	61.1		
NQ3	45.0		

- Enter the **core length (L)**, in millimeters (mm).

- The distance between the contact points (D), and the equivalent diameter (De) equal the diameter.

Axial type: The ratio of core length over the core diameter should be between 0.3 and 1.

- Enter the **core diameter (d)**, in millimeters (mm). It is suggested based on Table 7 as for the Diametral test. It equals the **core width (W).**

- Enter the **core length (L)**, in millimeters (mm).

- The distance between the contact points (D) equals the core length.

- The **equivalent diameter** is calculated as: $D_e = \sqrt{4 \times W \times D / \pi}$

Prismatic Type: This test is done on blocks of rock or irregular cores.

- Enter the **average core width (W)**, perpendicular to the direction of loading, in millimeters (mm).

- Enter the **core length (L),** in millimeters (mm).

- Enter the distance between the contact points (D).

- The **equivalent diameter** is calculated as: $D_e = \sqrt{4 \times W \times D / \pi}$

The test results are then entered or calculated.

- The **maximum load applied (P)** is the failure load, in kN.

- The **strength index (I$_s$)** is entered or calculated, in MPa.

- The **corrected strength index** for a 50 mm core **(I$_{s50}$)** is entered or calculated, in MPa.

- The **equivalent UCS value** is entered or calculated, in MPa.

- **Remark** is alphanumeric with 255 characters for additional comments.

- The **realized by** field takes a 40-character string.

- The **test date** is noted in the format *yyyy-mm-dd hh:mi:ss*.

- **Transfer** is a 1-character code to classify records for their management.

7.5.1. Calculations

In addition to the equivalent diameter, Geotec calculates the strength index I_s, the corrected strength index I_{s50} and the equivalent UCS.

Equivalent diameter: $$D_e = \sqrt{4 \times W \times D / \pi}$$

Strength index: $$I_s = \frac{P \times 1000}{D_e{}^2}$$

Corrected Strength index: $$I_{s50} = \frac{P \times 1000}{D_e{}^{1.5}\sqrt{50}}$$

UCS equivalent: $q_c = C \times I_{s50}$ where C varies with core diameter

C = 24.5 if d ≥ 60

C = 24 if d ≥ 54

C = 23 if d ≥ 50

C = 21 if d ≥ 42

C = 19 if d ≥ 30

C = 18 if d < 30

Figure 28 – Point load entry form

7.6. Uniaxial compression test form

The form shows data from the UNIAXIAL_COMPRESSION table of the Geotec database. It is used to enter the parameters and calculate the results of the uniaxial compression test for a rock sample.

- The **site number**, the **boring number** and the **depth** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the borehole from which the core samples are taken for uniaxial compression tests. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The top **depth** of the sample core is entered, in meters.

- The **test number** can be entered, with 20 characters.

- Enter the **core diameter (d)**, in millimeters (mm).

  Geotec verifies if a caliber is entered in the CASING table at the depth of the test (paragraph 6.6). If yes, the corresponding diameter is entered, based on Table 7. If no caliber is found or does not correspond to the following list, 50 mm is suggested.

- Enter the **core length (L)**, in millimeters (mm).

The test results are then entered or calculated.

- The **maximum load (P)** is the failure load, in kN.

- The **uniaxial compressive strength (UCS)** is entered or calculated, in MPa.

- **Remark** is alphanumeric with 255 characters for additional comments.

- The **realized by** field takes a 40-character string.

- The **test date** is noted in the format *yyyy-mm-dd hh:mi:ss*.

- **Transfer** is a 1-character code to classify records for their management.

7.6.1. Calculations

Geotec calculates the strength (UCS) in MPa as: $q_c = \frac{4 \times P \times 1000}{\pi d^2}$ where d is in millimeters and P is in kN.

Figure 29 – UCT (uniaxial compression test) entry form

8.   Entry forms for in-situ tests

In the Entry forms menu, the entry forms for in-situ tests are available via the buttons of the third tab.

8.1. Vane form

The form shows data from the VANE table and its secondary table VANE_POINT of the Geotec database. It is used to describe a vane test and the resistances measured.

- The **site number** and the **boring number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring where vane tests were done. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- Enter up to 40 characters in the fields **Realized by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Remark** is alphanumeric with 255 characters for additional details.

- The **vane number** has up to 20 characters.

- The **type of blade** indicates its dimensions, with 40 characters.

- The most recent **calibration date** is noted in the format *yyyy-mm-dd hh:mi:ss*.

- The **K calibration coefficient** of the apparatus is a numeric value.

- The top **depth** of the **clay** layer is recorded, in meters.

The table at the bottom of the Vane form shows data from the VANE_POINT secondary table of the Geotec database.

- The **site number**, the **boring number** and the **depth** together constitute the <u>key</u> of the records.

- The **depth** of the vane resistance measurement is entered, in meters.

- The **shear strength of unremoulded soil** (maximum shear strength SU) is numeric, in kPa.

- The **shear strength of remoulded soil** (residual shear strength SUR) is numeric, in kPa.

- **Sensitivity** to remoulding (**ST**) is the ratio of intact strength to remoulded strength. Sensitivity is calculated automatically when both strengths are entered. The user can modify it.

- **Remark** is alphanumeric with 255 characters for additional details on the test at the given depth.

- **Transfer** is a 1-character code to classify records for their management.

8.1.1. Calculations

Geotec calculates the sensitivity as Su / Sur if both values are entered.

Figure 30 – Vane entry form

8.2. Pressiometer form

The form shows data from the PRESSIOMETER table of the Geotec database. It is used to enter measurements done with a pressuremeter or dilatometer in a boring, whether for soils or rock.

- The **site number**, the **boring number** and the **depth** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring where the pressuremeter or dilatometer measurements were taken. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **depth** of the test is entered, in meters.

- A **test number** can be indicated, with 20 characters.

- The **test type** indicates the test used: Ménard-E (ME) or Ménard-G (MG) method.

- The **creep pressure** is in kPa. It defines the limit between the pseudo-elastic behavior and the plastic state.

- The **limit pressure** is in kPa. It is the pressure at which failure occurs.

- The Ménard **deformation** modulus is in kPa. It defines the pseudo-elastic behavior of the soil.

- **Remark** is alphanumeric with 255 characters for additional details on the test at the given depth.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

Figure 31 – Pressiometer entry form

8.3. Piezocone form (CPTU)

The form shows data from the CPTU table and its secondary tables CPTU_POINT, CPTU_ZONE and CPTU_SISMIC of the Geotec database. It is used to define piezocone penetration tests (CPTu) including calculation parameters, measurements, SBT interpretation and shear wave velocities (SCPTu).

Geotec calculates several parameters based on the theory of Robertson et al (1986) and Robertson (1990) and uses charts to predict the Soil Behavior Type (SBT). The methods used for the interpretation of the piezocone test and the empirical and theoretical equations used to determine the various properties as presented in paragraph 8.3.4.

Several fields are automatically filled when importing a .drf file. See section A4 of Appendix A – Importing *.drf files for piezocones - for more details.

- The **site number** and the **boring number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring where a piezocone penetration test was done. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

In the Identification tab…

- The **top** and **bottom depths** correspond to the start and end depths of the test, respectively, in meters. They are inserted automatically when importing a drf.

- The **groundwater depth** table is entered, in meters. It is copied from the BORING table when importing a drf. A depth of 0 is used by default if no value is entered.

- The **refusal type** is alphanumeric with 255 characters.

- **Remark** is alphanumeric with 255 characters for additional comments.

- The **acceptable** normalized cone resistance **qcn** is noted, in kPa.

- The **upper and lower depth limits** indicate the interval where the values are considered to comply.

- **Transfer** is a 1-character code to classify records for their management. Following the import of a drf, the value D is indicated.

In the Equipment tab…

- The number of the **probe** used has 40 characters. It is inserted automatically when importing a drf.

- The **tip** used has 40 characters.

- The cone **diameter** is indicated, in mm. The default value is 20 mm. The diameter is not used in the calculations.

- The **area ratio** for the cone is shown. The default value is 0.8.

- The **rate of penetration** of the cone is in mm/min. It can be used in the interpretation of the results.

- The **increment** between depth measurements is in mm. If a drf is imported, the increment is automatically defined as the smallest difference between 2 successive depths.

  For the log display, if the distance between two points is greater than 10x the increment, no line will be drawn between these points.

- The radio buttons **Total resistance qt** and **Tip resistance qc** indicate the field to use in the calculations. The corresponding field INPUT_QC is 0 for QT and 1 for QC.

  If a drf is imported, the input defined in the file or when importing is automatically selected.

  If data is entered in one of the two fields (QT or QC), the corresponding button is automatically selected.

- The radio buttons **Resistivity** and **Conductivity** indicate whether the input is conductivity (in mS/m) or resistivity (in ohm-m) if an RCPTu test was performed. The value of the INPUT_CO field is 0 for resistivity and 1 for conductivity.

- **Initial** and **final** piezocone **calibration constants** can be entered for:

  o The cone resistance qc (MPa)
  o The pressure head u2 (m)
  o The **friction fs** (kPa)
  o The probe temperature (volts)

In the Calculations tab, enter the parameters to use for the calculations.

- The **Nkt constant** is a cone factor generally between 10 and 20. The default value is 14.

- The **Nst constant** is a cone factor generally between 1 and 10. The default value is 3.08.

- The ratio of the undrained shear strength (su) over the preconsolidation pressure (pc) **Su/Pc** is between 0.1 and 0.5. The default value is 0.22.

If both Nkt and Nst are entered, they are used in the calculation. Otherwise, Su/Pc is used with the Nkt value.

- The **minimum value of Ic** to calculate su and pc is generally between 2 and 3. The default value is 2.6.

- The **minimum value of fs** to use in the calculation is entered. It can vary between 0 and 1 and the default value is 0.1. The value of fs min is used in calculations when FS is lower than fs min. If fs min is not defined, calculations are not done when FS is negative or 0.

- The **N exponent** is used to calculate Qtn. It is between 0.5 and 1. If no value is entered, N is calculated at each depth.

- **Cq max** is the maximum value of the stress normalization factor. The default value is 1.7.

- The **Dr constant** is for the calculation of the relative density. The default value is 350.

- The **minimum thickness** to create an SBT zone is entered, in meters. When the SBT values are the same over the minimum thickness or more, a zone is created. The default value is 0.1. The minimum value to calculate a zone is 0.001 meter.

- The **calculation method** for the SBT zones is selected from the following list. The SBT values are calculated from the 6 charts, but the zones in CPTU_ZONE will be for the selected method (paragraph 8.3.2).

    o   SBT_Rf

    o   SBT_Bq

    o   SBT_Ic

    o   SBTn_Fr

    o   SBTn_Bq

    o   SBTn_Ic

- The **type of density** to use in the vertical stress calculations is either **C**onstant, **P**rofile or **V**ariable. The default value is V (variable).

    o   **Constant** uses the densities entered in the Piezocone form, i.e. the wet density (above the water table) and the saturated density (below the water table). If either is not entered, Variable is used for the corresponding depths.

    o   **Profile** uses densities from the SBT Zones tab. If there are no values, the densities in the Stratigraphy form are used (paragraph 6.1). Otherwise, if a parent boring is defined with the piezocone, the densities in the Stratigraphy form of the parent boring are used. If no density is found for a specific depth, Variable is used for that depth.

    o   **Variable** uses the calculated density at each depth in the Piezocone Readings tab, with an Rf between 0.1 and 10.

- The **wet** and **saturated densities** are entered; in kg/m^3. They are used when the type of density selected is Constant. The default values are 1,900 and 2,000.

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- When a modification to the piezocone test is saved, the **modification date** is updated.

- When the calculation is done (via the button 🗄 or using **Action > Calculate**), the **calculation date** is updated.

Figure 32 – Piezocone entry form

8.3.1. Piezocone readings

The **Piezocone readings** tab at the bottom of the Piezocone form shows data from the CPTU_POINT secondary table of the Geotec database. The tab is used to record piezocone penetration resistance measurements and to calculate various parameters.

- The **site number**, the **boring number** and the **depth** together constitute the <u>key</u> of the records.

- The **depth** of the soil penetration resistance measurement is in meters.

- The **tip cone resistance QC** or the **cone resistance corrected for U2 (QT)** is in kPa. The other value will be calculated (paragraph 8.3.4). If the resistance is lower than 11 kPa (or 0.011 MPa), the parameters for this depth are not calculated.

- The **friction resistance FS** is entered, in kPa. If FS is lower than fs min defined in the Calculations tab, fs min is used in the calculations. If fs min is not defined, calculations are not done when FS is negative or 0.

  When importing a DRF or CSV file, FS values smaller than -999 are not imported (value set to null).

- The measured porewater pressure U2 is entered, in kPa.

- **IX** and **IY** are the **inclines** in the **X** and **Y directions** (in degrees).

- **Temp** is the temperature, in degrees.

- Electrical **conductivity** (in mS / m) or electrical **resistivity** (in ohm-m) is entered, if a RCPTu test was done. The other value will be calculated (paragraph 8.3.4).

- **Transfer** is a 1-character code to classify records for their management. Following the import of a drf, the value D is indicated.

- All other fields in the Piezocone readings tab are values calculated by Geotec. The parameters and equations are detailed in paragraph 8.3.4.

8.3.2. SBT zones

The **SBT zones** tab at the bottom of the Piezocone form shows data from the CPTU_ZONE secondary table of the Geotec database. The tab is used to enter or identify calculated SBT zones, based on the SBT method selected in the Calculations tab.

- The **site number**, the **boring number** and the **top depth** together constitute the <u>key</u> of the records.

- The **top** and **bottom depths** are those of the zone where SBT values are the same.

- The zone **description** has 255 characters. If the SBT zones are calculated, Geotec will use the equivalence of each SBT value, or just the value if the equivalence is not defined (paragraph 10.11).

- The **soil density D** of the zone is entered, in kg/m3. It is used in the vertical stress calculations when the type of density selected is Profile.

- The **SBT** (Soil Behavior Type) for the zone is calculated, based on the calculation method selected in the Calculations tab.

- **Category** is used to enter a code for the zone, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

8.3.3. Shear

The **Shear** tab at the bottom of the Piezocone form shows data from the CPTU_SISMIC secondary table of the Geotec database. The tab is used to enter the shear wave velocities measured with SCPTu piezocone tests.

- The **site number**, the **boring number** and the **top depth** together constitute the <u>key</u> of the records.

- The **top** and **bottom depths** are those of the interval in which the shear wave velocity was measured.

- The average shear wave velocity is in m/s.

- **Transfer** is a 1-character code to classify records for their management.

8.3.4. Calculations

Geotec calculates several soil properties based on the input data. The variables and equations used are as follows.

Variable	Definition	Value or Equation
Depth	Measurement depth	N/A
Water	Water table depth	N/A
FS	Friction resistance (kPa)	N/A
U2	Measured porewater pressure (kPa)	N/A

Nkt	Cone factor for SU calculation	14 by default
Nst	Cone factor for PC calculation	3.08 by default
Ic min	Minimum value of Ic to calculate su and pc	2.6 by default
a	Cone area ratio	0.8 by default
pa	Atmospheric pressure (kPa)	Approximated to 100 kPa
Cdr	Relative density calculation constant	350 by default
Resistivity	Electrical resistivity (ohm-m)	$Resistivity = 1000/conductivity$
conductivity	Electrical conductivity (mS/m)	$Conductivity = 1000/resistivity$
QT	Cone resistance corrected for U2 (kPa)	$QT = QC + U2 \times (1-a)$
QC	Tip cone resistance (kPa)	$QC = QT - U2 \times (1-a)$
QTA	Cone resistance divided by atmospheric pressure	$QTA = QT/pa$
RF	Friction ratio (%)	$RF = FS/QT \times 100\%$
I_{SBT}	SBT index for non-normalized SBT	$I_{SBT} = \sqrt{(3.47 - \log(QT/pa))^2 + (\log(RF) + 1.22)^2}$
U0	Hydrostatic pressure (kPa)	$U0 = (depth - water) \times 9.81$ or 0 if $depth < water$
D	Density (kg/m^3)	

	Constant	$D = Dwet$ if $depth < water$
		$D = Dsat$ if $depth > water$
	Profile	$D = D$ from cptu_zone, or
		$D = D$ from stratigraphy, or
		$D = D$ from stratigraphy for parent boring
	Variable	$D = (0.27 \times \log(RF) + 0.36 \times \log(QTA) + 1.236) \times 1000$
		With $0.1 \leq RF \leq 10$

γ	Unit weight (kN/m^3)	$\gamma = D/1000 \times 9.81$
TS	Total vertical stress (kPa)	$TS = \sum(\gamma \times \Delta depth)$
ES	Effective vertical stress (kPa)	$ES = TS - U0$
FR	Normalized friction ratio (%)	$FR = FS/(QT - TS) \times 100\%$
QTN	Normalized cone resistance	Iteration with n = 1 and finished when ($n_i - n_{i-1}$) < 0.01.
Ic	SBT index for normalized SBT	$QTN = (QT - TS)/ES$

n	Exponent to calculate stress	$I_c = \sqrt{(3.47 - log(QTN))^2 + (log(FR) + 1.22)^2}$
Cq	Correction factor for effective stress	$n = 0.381 \times Ic + 0.05 \times (ES/pa) - 0.15$ where $0.5 \leq n \leq 1$ $Cq = (pa/ES)^n$ $QTN = (QT - TS)/pa \times Cq$
Bq	Normalized excess porewater pressure	$Bq = (U2 - U0)/(QT - TS)$
α	Alpha constant	$\alpha = 10^{0.55 \times Ic + 1.68}$
VS	Shear wave velocity (m/s)	$VS = \sqrt{\alpha \times (QT - TS)/pa}$
VS1	Normalized shear wave velocity (m/s)	$VS1 = VS \times (pa/ES)^{0.25}$
G0	Initial shear modulus (MPa)	$G0 = D \times VS^2/1000000$
DR	Relative soil density (%)	$DR = \sqrt{QTN/Cdr} \times 100\%$
E	Young's modulus of elasticity (MPa)	$E = 0.8 \times G0$ If Ic < 2.6
N60	Number of blows per 0.3 m	$N60 = \dfrac{QC/pa}{8.5 \times (1 - Ic/4.6)}$
N160	Normalized number of blows per 0.3 m	$N160 = N60 \times Cq$
Nq	Bearing capacity factor	$Nq = QC/ES$
PHI (φ')	Friction angle (degrees)	$\varphi = \tan^{-1}\left(\dfrac{log(QC/ES) + 0.29}{2.68}\right) \times \dfrac{180}{\pi}$
SU	Undrained shear strength	$SU = (QT - TS)/Nkt$ If Ic > Ic min
PC	Preconsolidation pressure	$PC = (QT - TS)/Nst$ If Ic > Ic min
OCR	Overconsolidation ratio	$OCR = PC/ES$ If Ic > Ic min
ST	Sensitivity	$ST = \dfrac{100}{FR \times Nkt}$ If Ic > Ic min

SBT_RF — Soil Behavior Type (SBT) based on Qt-Rf chart

SBTN_FR — Normalized Soil Behavior Type (SBT) based on Qtn-Fr chart
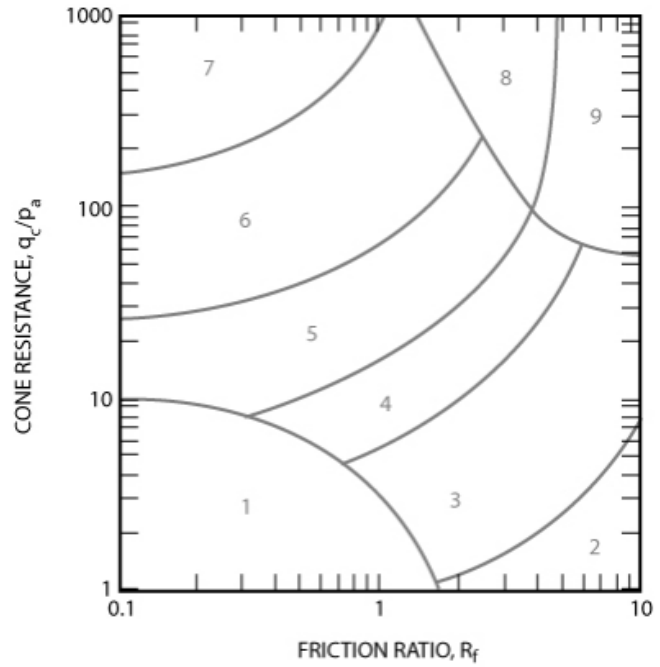
SBT_BQ — Soil Behavior Type (SBT) based on Qt-Bq chart

SBTN_BQ — Normalized Soil Behavior Type (SBT) based on Qtn-Bq chart
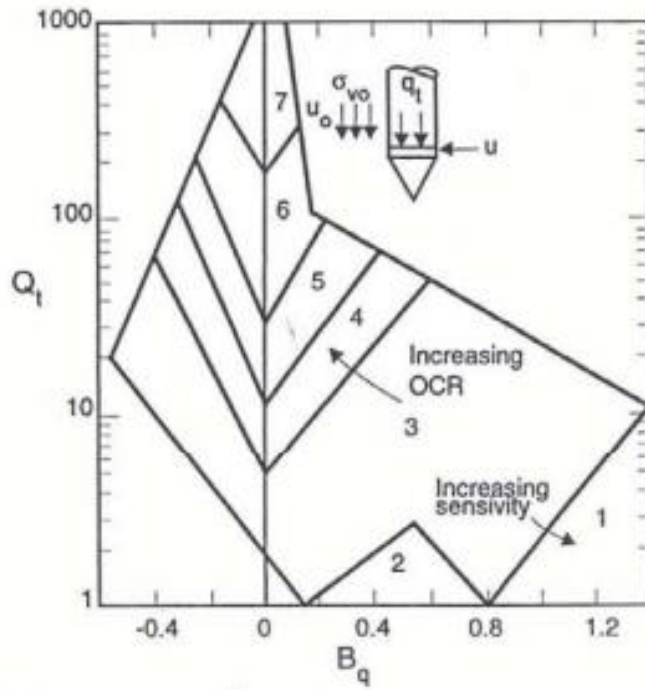
SBT_IC	Soil Behavior Type (SBT) based on I_{SBT} value	SBT = 7 if I_{SBT} or Ic < 1.31
		SBT = 6 if I_{SBT} or Ic < 2.05
		SBT = 5 if I_{SBT} or Ic < 2.60
SBTN_IC	Normalized Soil Behavior Type (SBT) based on Ic value	SBT = 4 if I_{SBT} or Ic < 2.95
		SBT = 3 if I_{SBT} or Ic < 3.6
		Otherwise, SBT = 2

8.4. Static cone form (OBSOLETE)

WARNING: THE STATIC CONE FORM WILL BE REMOVED IN A FUTURE RELEASE. WE RECOMMEND USING THE PIEZOCONE FORM (PARAGRAPH 8.3).

The form shows data from the CPT table and its secondary table CPT_POINT of the Geotec database. It is used to describe static cone penetration tests (CPT) and the measurements.

- The **site number** and the **boring number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring where a static cone penetration test was done. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- A **test number** can be added; with 20 characters maximum.

- The **maximum tip resistance** obtained during the test is entered; in kPa.

- The **maximum total resistance** obtained during the test is entered; in kPa.

- The penetration **velocity** for the rods into the soil is entered, in mm/min.

- The **tip diameter** is in mm.

- The **apical angle** is entered, in degrees.

- The **projected section** can be inputted.

- The **piston** and **sleeve areas** are entered, in cm^2.

- **Transfer** is a 1-character code to classify records for their management.

The table at the bottom of the Static cone form shows data from the CPT_POINT secondary table of the Geotec database.

- The **site number**, the **boring number** and the **depth** together constitute the <u>key</u> of the records.

- The **penetration depth** where the cone penetration resistance and the local lateral friction are determined is entered, in meters.

- The **tip resistance**, i.e. the strength necessary to drive the conic tip, is entered in kPa.

- The **total resistance** is entered in kPa.

- The **penetration resistance** of the cone **qc** is entered, in kPa.

- The **local lateral unit friction fs** is entered, in kPa.

- **Remark** is alphanumeric with 255 characters for additional details on the test at the given depth.

- **Transfer** is a 1-character code to classify records for their management.

8.5. Dynamic test form

The form shows data from the DPT table and its secondary table DPT_POINT of the Geotec database. It is used to define dynamic cone penetration tests.

- The **site number** and the **boring number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring where dynamic penetration tests were done. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- A **test number** can be added; with 20 characters maximum.

- The **hammer weight** is generally entered in kg.

- The **height of fall** is generally entered, in meters.

- The **depth increment** per measurement can be inputted. A default value of 0.3048 m (1 foot) is displayed. The increment is used when inserting new rows in the bottom table.

- **Transfer** is a 1-character code to classify records for their management.

The table at the bottom of the Dynamic test form shows data from the DPT_POINT secondary table of the Geotec database.

- The **site number**, the **boring number** and the **depth** together constitute the <u>key</u> of the records.

- The top **depth**, before the blows, is entered. If a **depth increment** is defined, each new depth will be automatically incremented by this value. If no increment is defined, the depth will be incremented by the difference between the 1st and 2nd depths entered.

- The **number of blows (NB)** necessary for the cone to penetrate from the current depth to the following is entered.

- **Remark** is alphanumeric with 255 characters for additional details on the test at the given depth.

- **Transfer** is a 1-character code to classify records for their management.

Figure 33 – Dynamic test entry form

8.6. Cobra form

The form shows data from the COBRA table and its secondary table COBRA_POINT of the Geotec database. It is used to define cobra tests.

- The **site number**, the **boring number** and the **test number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring where cobra tests were done. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **test number** has 20 characters maximum.

- The **diameters** of the **rods** and **tips** are entered; the suggested unit is the millimeter.

- The **refusal depth** indicates the depth where the cobra boring ended; the suggested unit is the meter.

- The **groundwater depth** indicates where the water is.

- **Remark** is alphanumeric with 255 characters for additional details on the test.

- **Transfer** is a 1-character code to classify records for their management.

The table at the bottom of the Cobra form shows data from the COBRA_POINT secondary table of the Geotec database.

- The **site number**, the **boring number**, the **test number** and the **depth** together constitute the <u>key</u> of the records.

- The top **depth** of a measurement of penetration time is entered; the suggested unit is the meter.

- **Time** is the elapsed time since the beginning of the test; the suggested unit is the second.

- **Rate** is the penetration rate, or the penetration time for 1 m; the unit is the second.

- **Transfer** is a 1-character code to classify records for their management.

Figure 34 – Cobra entry form

8.7. Other properties form

The form shows data from the PROPERTY_VALUE table of the Geotec database. It is used to enter values of various properties that do not have a specific entry form in Geotec. The properties are defined by the user in the Properties form (paragraph 10.8).

- The **site number**, the **boring number**, the **top depth** and the **property** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring for which various properties have been measured. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- If the property was measured on a **sample** or **sub-sample**, enter its **number**. If a number is entered, its top and bottom depth are automatically retrieved and displayed in the form.

- The **top and bottom depths** of the measurement, if applicable, are entered; the suggested unit is the meter. If the measurement applies to a sample / sub-sample, its depths are automatically indicated.

- **The property** defines what we are measuring. The property must have been defined in the Properties form (paragraph 10.8) before you can add measurements.

- Two numeric **values** can be entered for the property.

- A **remark** of 255 characters is used to add details or textual values.

- **Transfer** is a 1-character code to classify records for their management.

The values and remark can be entered via a table in the Sample form, which displays all properties whose measurement type is "3 – Sample", whose order is positive and that are not hidden (paragraph 10.8). When data is inserted via this table, the depths of the corresponding sample / sub-sample are automatically entered.

Property values can be displayed in the graphic modules, by entering the property in the Series cell of the curve of the PROPERTY_VALUE graph. See the documentations of Log, Pro and Site for more details.

8.7.1. Calculations

The calculation function retrieves the depths of the samples or sub-samples entered in the SAMPLE table and updates them in the PROPERTY_VALUE table. If values are linked to a depth, interval or run, nothing is calculated.

Figure 35 – Other properties entry form

8.8. Absorption form

The form shows data from the ABSORPTION table of the Geotec database. It is used to enter test results for water absorption of the rock measured between two depths.

- The **site number**, the **boring number**, the **test number** and the **top depth** together constitute the key of the records.

- The **site** and **boring numbers** identify the boring where the absorption measurements were taken. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **test number** has up to 20 characters.

- The **depths** of the **top** and **bottom** packers for the test are entered, in meters. The bottom depth is also required.

- The **absorption** measured is entered; the suggested unit is L/min/m.

- The **maximum pressure** used during the test is entered; in kPa.

- The **permeability** measured by the absorption test is entered; in m/s.

- **Remark** is alphanumeric with 255 characters.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

Figure 36 – Absorption entry form

8.9. Lugeon form

The form shows data from the LUGEON table of the Geotec database. It is used to enter results of Lugeon tests to determine the permeability of a geologic formation.

- The **site number**, the **boring number** and the **top depth** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring where the Lugeon test was done. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **depths** of the **top** and **bottom** packers for the test are entered, in meters. The bottom depth is also required.

- The average **water pressure** (MPa) is inputted for the 5 stages of water injection.

- The average **flow** (L/min) is inputted for the 5 stages of water injection.

- The water absorption in **Lugeon** units (L/min/m at a pressure of 1 MPa) is entered.

- The **permeability** measured by the Lugeon test is entered; in m/s.

- **Remark** is alphanumeric with 255 characters.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

Figure 37 – Lugeon entry form

8.10.   Permeability form

The form shows data from the PERMEABILITY table of the Geotec database. It is used to enter permeability measurements for a boring.

- The **site number**, the **boring number** and the **depth** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring where the permeability measurements were taken. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **depth** of the permeability measurement is entered; the suggested unit is the meter.

- The **length** of the measurement is entered; the suggested unit is the meter.

- The **type of test** used to determine the permeability is indicated, with 20 characters.

- The **permeability** measured by the test is entered; in m/s.

- **Remark** is alphanumeric with 255 characters.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

Figure 38 – Permeability entry form

8.11.   Tromino form

The form shows data from the TROMINO table of the Geotec database. It is used to enter results of tests done with the Tromino apparatus for geophysics.

- The **site number** and the **boring number** together constitute the <u>key</u> of the records.

- The **site** and **boring numbers** identify the boring where the Tromino test was done. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- The **frequency F0** is between 0 and 500 Hz.

- The **standard deviation** is numeric, in meters.

- The **confidence level** is a 2-character field indicating the quality of the measurement.

- The **region** of the reference graph is entered.

- The **estimated depth** of dense layer is entered, in meters.

- **Remark** is alphanumeric with 255 characters.

Figure 39 – Tromino entry form

9. Entry forms for laboratory tests

In the Entry forms menu, the entry forms laboratory tests are available via the buttons of the fourth tab. Four entry forms are for laboratory management, including the sieving methods used, the grain size requirements, the hydrometer calibrations and the lab equipment.

9.1. Grain size analysis form

The form shows data from the GRAIN_SIZE table and its secondary table GRAIN_SIZE_POINT of the Geotec database. The Hydrometer tab also shows data from the HYDROMETER table. The form is used to enter lab measurements and calculate the results of grain size analyses, including sieving and sedimentation.

- The **site number**, the **boring number** and the **sample number** together constitute the key of the records.

- The **site, boring and sample numbers** identify the sample on which the sieving analysis and, if applicable, sedimentation test was done.

  The drop-down list of sites shows all sites that have a least one sample defined in the SAMPLE table. The drop-down list of borings shows all borings that belong to the site selected and that have at least one sample defined in the SAMPLE table. The drop-down list of samples shows all samples defined in the SAMPLE table for the selected boring.

- The type of **material** analyzed can be selected from the list of materials and their description defined in the MATERIAL table (paragraph 10.9). Double-click in the field to open the corresponding form for editing.

By default, the material associated to the sample is suggested. If there is none, then the one associated to the boring of the sample is suggested. Otherwise, NIL is shown.

If a sieving method and / or a grain size requirement is associated to the material, they will be automatically displayed in the next 2 fields.

- The **sieving method** used in the lab is selected from the list showing all sieving methods defined (paragraph 9.11). Double-click in the field to open the corresponding form for editing.

  The weighing method (individual or cumulative), the balance number and the weighing unit (g, kg or lb) for the coarse, medium and fine fractions are automatically copied in the definition of the grain size. Also, the sieve diameters defined in the method are generated for the curve.

- A **grain size requirement** can be selected from the list showing all grain size requirements defined (paragraph 9.12). Double-click in the field to open the corresponding form for editing.

  The envelope can be displayed on the graphic report and the conformity of the curve will be verified by Geotec.

- The classification **standard** is entered with 20 characters. It is for future development.

The **Water content button** opens the limits entry form to define the natural water content measured on the sample. See paragraph 9.2 for details.

The **Stratigraphy button** opens the stratigraphy entry form to define the % of cobbles and boulders for the layer where the sample was taken. These percentages can be included in the correction of grain size curves in the Lab module. See paragraph 6.1 for the details on the layers and the documentation of Lab for the curve correction. The button may also be labelled Cobbles to open the cobbles entry form for the same purpose, but this option is obsolete and will be removed in a future release.

The **Combine button** is used to calculate grain size combinations. It can only be used in Lab. See the documentation of Lab.

The **USCS button** opens the calculation window. It is used to calculate the USCS value and insert it into the USCS field of the SAMPLE table for the corresponding sample. In the calculation window, you can choose to fill only the empty fields, not the existing values. To do this, check the box **Fill empty fields only**. Otherwise, the calculation overwrites existing USCS values. See the calculation details in section 9.1.1.1.

The **Description button** opens the calculation window. It is used to calculate the Description based on the grain size and insert it into the DESCRIPTION field of the SAMPLE table for the corresponding sample. In the calculation window, you can choose to fill only the empty fields, not the existing values. To do this, check the box **Fill empty fields only**. Otherwise, the calculation overwrites existing DESCRIPTION values. See the calculation details in section 9.1.1.1.

9.1.1. Results

The **Results** tab at the top of the entry form shows calculation results done by Geotec from lab measurements of sieving and sedimentation tests. By clicking on the Results tab, the same tab gets

activated at the bottom of the form to display the diameters and calculated passing percentages as well as the raw data, or to enter the diameters and passing percentages directly, without raw data. The tab at the bottom shows data from the GRAIN_SIZE_POINT secondary table of the Geotec database.

In Passing percentages…

- The fields **225 mm** to **0.002 mm** contain the passing percentages of the various sieves P_x, between 0 and 100%. They are calculated by Geotec via a linear interpolation on logarithmic basis, based on the points of the curve indicated in the bottom table.

   If the passing percentage of the largest diameter is between 95% and 100%, an extrapolation is done, if necessary, for the diameters greater than 0.075 mm – in other words, so the curve reaches 100%.

   An option is available in Lab to force the extrapolation for the diameters greater than 0.075 mm but smaller than the largest diameter – in other words, to bring the curve down to the silt. Otherwise, the curve is not extrapolated to small diameters.

- The **fineness module** is calculated by Geotec as:

$$fm = 10 - \frac{[P_{0.16}+P_{0.315}+P_{0.63}+P_{1.25}+P_{2.5}+P_5+P_{10}+P_{20}+P_{40}+P_{80}]}{100}$$

In Diameters and coefficients…

- The fields **D10**, **D30** and **D60** contain the diameters corresponding to 10%, 30% and 60% of the particles. They are calculated by Geotec via a linear interpolation on logarithmic basis, based on the points of the curve indicated in the bottom table.

   An option is available in Lab to force the extrapolation to calculate the diameters D_x smaller than the largest diameter of the curve. The diameters D_x are not extrapolated if they would be greater than the largest diameter of the curve. Without the option, the diameters D_x are not extrapolated.

- **Cu** is the uniformity coefficient. Cu is not a field of the database. It is calculated by Geotec as:

$$Cu = \frac{D_{60}}{D_{10}} \qquad \text{if } D_{10} > 0.001 \text{ and } D_{60} > 0.001 \text{ and } D_{60} < 1000$$

- **Cc** is the concavity coefficient. Cc is not a field of the database. It is calculated by Geotec as:

$$Cc = \frac{D_{30} \times D_{30}}{D_{10} \times D_{60}} \qquad \text{if } D_{10} > 0.001 \text{ and } D_{30} > 0.001 \text{ and } D_{60} > 0.001$$

- The fields **Silt**, **Sand**, **Gravel**, **Cobbles** and **Boulders** are not fields of the database. They are calculated by Geotec as:

$$Silt = P_{0.08} - P_{0.002}$$

If $P_{0.002}$ is NULL, it corresponds to the percentages of fine particles, because the percentage of clay is not known.

$$Sand = P_5 - P_{0.08}$$

$$Gravel = P_{80} - P_5$$

$$Cobbles = P_{225} - P_{80}$$

$$Boulders = 100 - P_{225}$$

The sample characterization shows the calculations based on the grain size analysis, as well as the data from the SAMPLE table, for information purposes, including:

- The **description** based on the grain size curve, calculated by Geotec.

- The **description** entered for the current sample.

- The **USCS** classification calculated by Geotec.

- The **USCS** classification of the current sample.

- **Category** is used to enter a code to categorize the test, with 20 characters. It is mainly used for grain size combinations. The value **CMB-xx** is entered in the record of a grain size used in a combination. See the documentation of Lab for details about combinations.

- The **category** of the current sample. It can be the type of soil indicated in the soil description matrix. It can also be the value **CMB-xx** which is entered in the record of a sample used in a combination.

- The **length of the grain size** is used for results of grain size combinations. The length is the sum of the lengths of all samples combined.

- The **length** of the current sample.

In Management…

- When the calculation is done (via the button or using **Action > Calculate**), the **calculation date** is updated.

- When a modification to the test is saved, the **modification date** is updated.

- The **smoothing** of the grain size curve can be fixed; however, offset values entered at specific points of the curve take precedence over the global smoothing. With a value of -1, no smoothing of the grain size curve is done and the offset values for each point of the curve are not taken into account.

  If no smoothing is defined in the Grain size table, the calculation is done with the smoothing defined in the options of Lab.

Figure 40 – Grain size entry form – Results

The table of the Results tab at the bottom of the form shows data from the GRAIN_SIZE_POINT secondary table of the Geotec database.

- The **site number**, the **boring number**, the **sample number** and the **diameter** together constitute the <u>key</u> of the records.

- The **diameter** of the sieves or particles is in millimeters; with a precision of 4 decimals. The diameters can be entered or generated automatically by selecting a sieving method.

- The % **passing** the sieve is either entered by the user, or copied during the calculation by Geotec of the results based on the raw data in the SIEVE_POINT (Sieving tab) and HYDROMETER_POINT (Hydrometer tab) tables.

- The **reading** is either the mass retained on the sieves (individual or cumulative) of the SIEVE_POINT table, or the hydrometer reading of the HYDROMETER_POINT table. These values are copies automatically.

- The **elapsed time**, in minutes, for the hydrometer test, is a raw data in the HYDROMETER_POINT table. The values are copies automatically.

- The **temperature** in degrees Celsius, for the hydrometer test, is a raw data in the HYDROMETER_POINT table. The values are copies automatically.

- The **reading correction**, for the hydrometer test, is a raw data in the HYDROMETER_POINT table if the composite correction was not used. The values are copies automatically.

- The **smoothing (Z)** is used for the smoothing of the grain size curve at the current point. It contains the offset around the point for the curve. With a value of -1, the curve goes through the point as a straight line – there is no smoothing. With a value of 0, the curve goes through the point with a rounded line; the greater the value, the more the curve is smoothed at the point. A smoothing coefficient for the whole curve can be defined in the Grain size table and / or in the options or Lab; see the documentation of Lab.

- **Transfer** is a 1-character code to classify records for their management. By putting "X" in the Transfer field, the point will not be displayed in the curve and not included in the calculations.

9.1.1.1   Calculations

The grain size **description** is determined from the materials and their proportions.

- Geotec calculates the percentages of materials.

  - The clay percentage is $P_{0.002}$

  - The silt percentage is $P_{0.08} - P_{0.002}$

  - The sand percentage is $P_5 - P_{0.08}$

  - The gravel percentage is $P_{80} - P_5$

  - The cobbles percentage is $P_{225} - P_{80}$

  - The boulders percentage is $100 - P_{225}$

- The proportions are then determined from the percentages of materials.

  - If percentage is < 1 %   → material not included
  - Otherwise, if percentage is < 10 %   → proportion 4 (trace)
  - Otherwise, if percentage is < 20 %   → proportion 3 (some)
  - Otherwise, if percentage is < 35 %   → proportion 2 (adjective)
  - Otherwise   → proportion 1 (main)

- The description is then generated based on the material and its proportion.

The **USCS** is calculated based on the grain size curve only if $P_{0.08}$ is less than 50 %. Otherwise, the limits test is used to calculate the USCS classification.

- By default, **coarse** is S. Is there more gravel than sand? $P_5 < (100 + P_{0.08})/2$?

  o   If yes, coarse is G.

  o   If no, coarse is S.

- By default, **fine** is M. If there most clay than silt? $P_{0.002} > P_{0.08}/2$ or $P_{0.002} > 50$?

  o   If yes, fine is C.

  o   If no, fine is M.

- For gravels, the **gradation** is W by default (if Cu or Cc is not defined). Geotec verifies Cu and CC.

  o   If Cu ≥ 4 and 1 ≤ Cc ≤ 3, gradation is W.

  o   Otherwise, if Cu > 0 and Cc > 0, gradation is P.

- For sands, the **gradation** is W by default (if Cu or Cc is not defined). Geotec verifies Cu and CC.

  o   If Cu ≥ 6 and 1 ≤ Cc ≤ 3, gradation is W.

  o   Otherwise, if Cu > 0 and Cc > 0, gradation is P.

- To create the USCS classification, Geotec verifies the percentage of fine particles.

  o   IF $P_{0.08} < 5$ %   → USCS = CoarseGradation
  like GW, GP, SW, SP

  o   Otherwise, if $P_{0.08} > 12$ %   → USCS = CoarseFine
  like GM, GC, SM, SC

  o   Otherwise   → USCS = CoarseGradation-CoarseFine
  like GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, SP-SC

9.1.2. Sieving

The **Sieving** tab at the top of the entry form is used to enter raw data for the sieving test done. By clicking on the Sieving tab, the same tab gets activated at the bottom of the form to enter the measurements for each sieve. The bottom tab shows the SIEVE_POINT temporary table.

In Management data…

- Enter up to 40 characters in the fields **Realized by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name or number of the **laboratory** where the test was done is noted, with 20 characters.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Remark** is alphanumeric with 255 characters for additional details.

The laboratory apparatus used for the sieving test are indicated. This ensures better monitoring in the event that an equipment is faulty.

- The **number of the balances** used for weighing for coarse, medium and fine fractions are indicated, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with BAL is suggested (paragraph 9.14).

  If balances are associates to the selected sieving method, their numbers are automatically entered.

The auxiliary water contents are <u>only</u> used for wet soils tests. If sieving is done on dry materials, leave these fields empty or indicate a water content of 0%. Otherwise, for the coarse (w_{stone}) and fine (w_{sand}) fractions, enter:

- The **tare number**, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with TARE is suggested (paragraph 9.14).

- The **tare mass**. If a mass is defined in the EQUIPMENT table for the selected tare, it will be displayed. The unit is the one defined for the sieving method.

- The **mass of the tare and wet soil**. The unit is the one defined for the sieving method.

- The **mass of the tare and dry soil**. The unit is the one defined for the sieving method.

- The **water content, in %.** It is calculated by Geotec or can be entered by the user.

$$w = \frac{mass_{tare\ wet\ soil} - mass_{tare\ dry\ soil}}{mass_{tare\ dry\ soil} - mass_{tare}} \times 100\%$$

Then, define the soil fractions, depending on the sieving method selected (paragraph 9.11).

- Enter the **maximum diameter** of the particles, if needed.

- For each quartering of the selected sieving method, so for the coarse (total), medium (gravel) and fine (sand) fractions:

  o The **maximum** and **minimum diameters** of the sieves are indicated.

  o Enter for **mass** to be sieved. The mass is of the wet soil. The unit is indicated next to the field, depending on the one defined for the sieving method.

    If the soil was already dried before weighing, do not indicate an auxiliary water content, or enter 0%.

  If just one or two quarterings are defined for the method, then only those defined will have diameters. The Mass field will be deactivated for non-defined quarterings.

- After washing:

  o Indicate the **tare number** used for the sand fraction, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with TARE is suggested (paragraph 9.14).

  o Indicate the **tare mass**. If a mass is defined in the EQUIPMENT table for the selected tare, it will be displayed. The mass is in grams.

  o Enter the **mass of the tare and dry sand, after washing**. If the tare mass is not indicated, enter the mass of the dry sand directly, in grams.

Figure 41 – Grain size entry form – Sieving

In the Sieving tab at the bottom of the entry form:

- The sieve diameters defined in the sieving method are generated automatically. For each sieve, indicate the cumulative or individual mass, depending on the type of weighing indicated in the sieving method. Indicate the mass measured in the pan to verify the acceptability of the test.

9.1.2.1 Calculations

The following calculations are done for the sieving test (top part of the entry form):

- The **dry mass** of the fine fraction (**sand**) is calculated as:

$$mass_{dry\ sand} = \frac{mass_{wet\ sand}}{1+\frac{w_{sand}}{100}}$$

- The **dry mass** of the medium fraction (**gravel**) is calculated as:

$$mass_{dry\ gravel} = \frac{mass_{wet\ gravel}-mass_{cum\ gravel}}{1+\frac{w_{sand}}{100}} + \frac{mass_{cum\ gravel}}{1+\frac{w_{stone}}{100}}$$

- Then the **water content of the medium fraction** is calculated as:

$$w_{gravel} = \frac{mass_{wet\ gravel} - mass_{dry\ gravel}}{mass_{dry\ gravel}} \times 100\%$$

- The **total dry mass** is calculated as:

$$mass_{dry\ total} = \frac{mass_{wet\ total} - mass_{cum\ stone}}{1 + \frac{w_{gravel}}{100}} + \frac{mass_{cum\ stone}}{1 + \frac{w_{stone}}{100}}$$

where:

w_{sand} is the auxiliary water content of the sand fraction (for wet soil test)

w_{stone} is the auxiliary water content of the stone fraction (for wet soil test)

w_{gravel} is the water content calculated for the mass used after the 1st quartering

$mass_{cum\ gravel}$ is the cumulated mass on the smallest diameter of the medium fraction

$mass_{cum\ stone}$ is the cumulated mass on the smallest diameter of the coarse fraction

The following calculations are done for each diameter of the sieving test (bottom part of the entry form). The results are shown as information in the disabled columns.

- The dry mass of sand, the dry mass of the medium fraction and to total dry mass are copied into the **Total dry mass** column, as information, for the diameters corresponding to the 3 fractions.

- The **individual mass** is either entered, or equal to the cumulative mass minus the previous cumulative mass.

- The **cumulative mass** is either entered, or equal to the sum of the individual mass and the previous cumulative mass.

- The **cumulative dry mass** is calculated as:

$$mass_{cum\ dry} = \frac{mass_{cum\ wet}}{1 + \frac{w_{stone}}{100}}$$

For the sand fraction, the dry mass equals the mass indicated. It is understood that the test is done with dry soil.

- The **% retained** on the sieve is calculated from the dry mass of the fraction indicated in the 1st column

$$\%\ retained = \frac{mass_{cum\ dry}}{mass_{dry\ fraction}}$$

- The **passing %** are calculated for each fraction as well as for the total.

  - For the coarse fraction: $\%\ passing_{total} = 100 - \%\ retained$

  - For the medium fraction:
    - $\%\ passing_{medium} = 100 - \%\ retained$
      The heading of this column indicates the minimum diameter of the coarse fraction.
    - $\%\ passing_{total} = \frac{\%\ passing_{last\ total} \times \%\ passing_{medium}}{100}$
      where $\%\ passing_{last\ total}$ is the total % passing the minimum diameter of the coarse fraction.

- o For the fine fraction:
  - o $\% \ passing_{fine} = 100 - \% \ retained$

    The heading of this column indicates the minimum diameter of the medium fraction.
  - o $\% \ passing_{medium} = \dfrac{\% \ passing_{last \ medium} \times \% \ passing_{fine}}{100}$

    where $\% \ passing_{last \ medium}$ is the medium % passing the minimum diameter of the medium fraction.
  - o $\% \ passing_{total} = \dfrac{\% \ passing_{last \ total} \times \% \ passing_{last \ medium} \times \% \ passing_{fine}}{100}$

- The **existing passing %** indicates the value saved in the database before the last calculations.

- If a grain size envelope is selected, the **minimum** and **maximum passing %** defined for the envelope are indicated at the corresponding diameters, and are concatenated in the column **Passing min-max**.

- The **compliance** at each diameter that has a requirement is verified by Geotec. If the passing % is less than the minimum requirement or more than the maximum requirement, the passing % is Non-Compliant (N.C.).

- For each fraction, the mass on the **pan** can be entered. The **loss percentage** is calculated for the **test validity** and shown in the Passing total column.

$$\% \ loss_{coarse} = \frac{mass_{total \ wet} - mass_{cum \ pan}}{mass_{total \ wet}} \times 100$$

$$\% \ loss_{medium} = \frac{mass_{gravel \ wet} - mass_{cum \ pan}}{mass_{gravel \ wet}} \times 100$$

$$\% \ loss_{fine} = \frac{mass_{sand \ washed} - mass_{cum \ pan}}{mass_{sand \ washed}} \times 100$$

where

$mass_{cum \ pan}$ is the cumulative mass on the pan for the fraction indicated

$mass_{sand \ washed}$ is the mass of dry sand after washing

The sieve diameter, reading (individual or cumulative mass) and total passing percentage are copied in table GRAIN_SIZE_POINT, visible in the Results tab at the bottom of the entry form.

9.1.3. Hydrometer

The **Hydrometer** tab at the top of the entry form shows data from the HYDROMETER table of the Geotec database. It is used to enter raw data for the hydrometer test done. The tab is displayed as soon as a GRAIN_SIZE record exists. By clicking on the Hydrometer tab, the same tab gets activated at the bottom of the form to enter the readings. The bottom tab shows the HYDROMETER_POINT temporary table.

In Management data…

- Enter up to 40 characters in the fields **Realized by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name or number of the **laboratory** where the test was done is noted, with 20 characters.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Remark** is alphanumeric with 255 characters for additional details.

The Dry mass calculation is used to determine the equivalent dry mass of the sample used for the hydrometer test.

- The **method** is selected from:

  - 1: moisture content (low water % after air-drying)

  - 2: water content (higher water %, often in clays)

  - 3: oven drying

- Enter the **tare number**, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with TARE is suggested (paragraph 9.14).

- Enter the **tare mass**, in grams. If a mass is defined in the EQUIPMENT table for the selected tare, it will be displayed.

- For methods 1 and 2

  - Enter the **mass of the tare and air-dried or wet soil**, in grams.

  - Enter the **mass of the tare and oven-dried soil**, in grams.

  - The **moisture content** or **water content** is entered or calculated by Geotec as:

$$w = \frac{mass_{tare\ wet\ soil} - mass_{tare\ dry\ soil}}{mass_{tare\ dry\ soil} - mass_{tare}} \times 100\%$$

- For method 3

  - Enter the **mass of the dispersing agent** used, in grams.

  - Enter the **mass of the tare and oven-dried soil** after the hydrometer test, in grams. The dispersing agent will also be included in the open-dried solution.

In Characteristics of sample

- The **specific gravity (Gs)** of the sample for the hydrometer test is 2.7 by default. It can be modified.

- The **sieve diameter** (mm) is selected from the drop-down list. The suggestions are between 5 mm and 0.08 mm. The 2mm sieve is generally used.

- The **passing sieve %** is read from the GRAIN_SIZE_POINT table (bottom Results tab) at the sieve indicated. If there is no passing percentage for the sieve, Geotec will use the passing % of the greater sieve.

- The **mass retained on 0.08 mm (mass$_{0.08}$)** can be entered, in grams.

- Enter the **total mass of the sample** for the test, air-dried or wet, in grams.

- The **equivalent dry mass of the sample**, in grams, is included in the calculations. It can be entered or calculated by Geotec.

  o For methods 1 and 2: $\quad mass_{dry} = \dfrac{mass_{total}}{(1+\frac{w}{100})}$

  o For method 3: $\quad mass_{dry} = mass_{tare\ dry\ soil} - mass_{tare} - mass_{dispersing}$

The laboratory apparatus used for the hydrometer test are indicated. This ensures better monitoring in the event that an equipment is faulty and is used to retrieve the specifications of some of the equipment used.

- The **hydrometer number** is indicated, with 20 characters. The list of hydrometers and their model (151H or 152H) defined in the HYDROMETER_CALIBRATION table is suggested (paragraph 9.13). By selecting a hydrometer, the standard elapsed time are displayed in the bottom table, from 30 seconds to 1440 minutes.

- The **bulb length (L$_{bulb}$)** of the hydrometer is entered, in cm. If it is defined in the HYDROMETER_CALIBRATION table for the selected hydrometer, it will be displayed. If the length is not entered, a value of 0 cm is used in the calculations.

- The **bulb volume (V$_{bulb}$)** of the hydrometer is entered, in ml. If it is defined in the HYDROMETER_CALIBRATION table for the selected hydrometer, it will be displayed. If the volume is not entered, a value of 0 ml is used in the calculations.

- **Coefficients A** and **B** of the **calibration curve** are entered **(Calib$_A$** et **Calib$_B$)**. If they are defined in the HYDROMETER_CALIBRATION table for the selected hydrometer, they will be displayed. If the coefficients are not entered, a coefficient A of -0.266 (151H) or -0.163 (152H) and a coefficient B of 16.3 are used in the calculations.

- **Coefficients A** and **B** of the **composite correction curve** are entered **(Comp$_A$** et **Comp$_B$)**. If they are defined in the HYDROMETER_CALIBRATION table for the selected hydrometer, they will be displayed. If a correction reading is taken rather than the calculation via the composite correction, enter 0 in both fields. If the coefficients are not entered, values of 0 are used in the calculations.

- The **density correction factor** is entered; the default value is 1. If it is defined in the HYDROMETER_CALIBRATION table for the selected hydrometer, it will be displayed.

- The **meniscus** is entered. For a 151H, the meniscus is 0.5 by default. For a 152H, the meniscus is 1 by default. This value will be added to the readings taken at the top of the meniscus (see calculations).

- The **number of the cylinder** used is indicated, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with CYL is suggested (paragraph 9.14).

- The **area A** (cm^2) and the **volume** (ml) of the cylinder are entered. If the area and / or the volume are defined in the EQUIPMENT table for the selected cylinder, they will be displayed. If the area is not entered, a value of 27 cm^2 is used in the calculations.

- The **number of the balance** used for weighing is indicated, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with BAL is suggested (paragraph 9.14).

In the Hydrometer tab at the bottom of the entry form:

- Adjust, if needed, the **elapsed time** at the time of reading, in minutes. If no reading is taken at a certain time, leave the row empty. It will not be saved.

- Enter the hydrometer **reading**. The reading is taken at the <u>top of the meniscus</u>. If the reading is done at the bottom of the meniscus, set the meniscus value to 0 and ensure that the calibration was also done with readings taken at the bottom of the meniscus.

- Enter the **temperature**, in degrees Celsius. It will be copied to the following row when entering the next reading.

- If the **reading correction** is done via a control solution instead of the composite correction (so coefficients A and B for the composite correction are at 0), enter the correction. It will be copied to the following row when entering the next reading.

#		Elapsed time min	Hydro-meter reading	Tempe-rature °C	Water viscosity poises	K	Reading correc-tion	Effective reading 151H	Effective depth cm	Equivalent diameter mm	Particle content %	Passing total %
1	✓	1.0	38.0	21.7	0.009618	0.01316	5.7	32.3	11.10	0.0439	49.71	45.07
2	✓	2.0	36.0	21.7	0.009618	0.01316	5.7	30.3	11.43	0.0315	46.63	42.27
3	✓	5.0	34.0	21.7	0.009618	0.01316	5.7	28.3	10.52	0.0191	43.55	39.48
4	✓	15.0	31.0	21.7	0.009618	0.01316	5.7	25.3	11.01	0.0113	38.93	35.29
5	✓	30.0	28.0	21.7	0.009618	0.01316	5.7	22.3	11.50	0.0081	34.30	31.10
6	✓	60.0	26.0	21.8	0.009595	0.01314	5.7	20.3	11.83	0.0058	31.29	28.37
7	✓	120.0	23.5	21.9	0.009573	0.01313	5.6	17.9	12.24	0.0042	27.51	24.94
8	✓	240.0	21.5	22.0	0.009550	0.01311	5.6	15.9	12.57	0.0030	24.50	22.22
9	✓	480.0	20.0	22.2	0.009505	0.01308	5.5	14.5	12.82	0.0021	22.34	20.25
10	✓	1440.0	17.5	21.7	0.009618	0.01316	5.7	11.8	13.23	0.0013	18.12	16.43

Figure 42 – Grain size entry form – Hydrometer

9.1.3.1 Calculations

The following calculations are done for the hydrometer test (top part of the form) and will be used in the calculations of the bottom table.

- The **passing 0.08 mm P$_{0.08}$** is read at the 0.08 mm sieve in the Results tab at the bottom of the entry form.

- The **passing 0.08 mm washed P$_{0.08\ washed}$** is calculated if there is a **mass retained on 0.08 mm**, as:

$$P_{0.08\ washed} = 100 - \frac{mass_{0.08}}{mass_{dry}} \times 100$$

The following calculations are done for each reading of the hydrometer test (bottom part of the entry form). The results are shown as information in the disabled columns.

- The **coefficient of viscosity η** of water, in poises:

$$\eta = 0.000005 \times temp \times temp - 0.000445 \times temp + 0.01692$$

- The **K factor** is a constant based on the temperature of the soil suspensions and the relative density of the soil particles.

$$K = \sqrt{\frac{30\eta}{980 \times (Gs-1)}}$$

- The **reading correction** is a raw data of the HYDROMETER_POINT table if the composite correction is not used. If the composite correction is used, the correction is calculated as:

$$corr = -Comp_A \times temp + Comp_B$$

- The **effective reading** corresponds to the reading with the composite correction applied:

$$reading_{eff} = reading - corr$$

- The **effective depth** is calculated with the calibration curve:

$$depth_{eff} = -Calib_A \times (reading + meniscus) + Calib_B + \frac{L_{bulb}}{2} - \frac{V_{bulb}}{2A}$$

If readings are taken between 2 minutes (at 30 seconds, 1 minute and 2 minutes), the hydrometer will not be removed from the solution. The last term of the equation ($\frac{V_{bulb}}{2A}$) is not subtracted for those readings.

- The **equivalent diameter of the particles D**, in millimeters, is calculated based on Stokes' law.

$$D = K \times \sqrt{\frac{depth_{eff}}{etime}} = \sqrt{\frac{30\eta}{980 \times (Gs-1)}} \times \frac{depth_{eff}}{etime}$$

- The **existing diameter** indicates the value saved in the database before the last calculations.

- The calculation of the **particle content Part** depends on the hydrometer model.

  For 151H:
$$Part = \frac{100}{mass_{dry}} \times reading_{eff} \times F \times \left(\frac{Gs}{Gs-1}\right)$$

For 152H: $$Part = \frac{100}{mass_{dry}} \times reading_{eff} \times F \times a \text{ where } a = 1.53 - (0.2 \times Gs)$$

- The **passing percentage P** is calculated with the passing % of the sieve diameter.

$$P = Part \times \frac{P_{sieve}}{100} \text{ where } P_{sieve} \text{ is } 100\% \text{ if it is not defined.}$$

If a mass retained on 0.08 mm is indicated,

$$P = Part \times \frac{P_{0.08}}{P_{0.08\ washed}}$$

- The **existing passing %** indicates the value saved in the database before the last calculations.

The elapsed time, the reading, the temperature, the reading correction (if read), the equivalent diameter and the passing percentage are copied in table GRAIN_SIZE_POINT, visible in the Results tab at the bottom of the entry form.

9.2. Limits form

The form shows data from the LIMITS table and its secondary table LIMITS_POINT of the Geotec database. It is used to enter lab measurements and calculate the results of water content and liquid and plastic limits tests.

- The **site number**, the **boring number** and the **sample number** together constitute the key of the records.

- The **site, boring and sample numbers** identify the sample on which the water content and / or limits test was done.

    The drop-down list of sites shows all sites that have a least one sample defined in the SAMPLE table. The drop-down list of borings shows all borings that belong to the site selected and that have at least one sample defined in the SAMPLE table. The drop-down list of samples shows all samples defined in the SAMPLE table for the selected boring.

The **USCS button** opens the calculation window. It is used to calculate the USCS value and insert it into the USCS field of the SAMPLE table for the corresponding sample. In the calculation window, you can choose to fill only the empty fields, not the existing values. To do this, check the box **Fill empty fields only**. Otherwise, the calculation overwrites existing USCS values. See the calculation details in the next section.

In Management data…

- Enter up to 40 characters in the fields **Realized by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name or number of the **laboratory** where the test was done is noted, with 20 characters.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Remark** is alphanumeric with 255 characters for additional details.

The laboratory apparatus used for the test are indicated. This ensures better monitoring in the event that an equipment is faulty.

- The **number of the balance** used for weighing is indicated, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with BAL is suggested (paragraph 9.14).

- The **number** of the **Casagrande apparatus** or of the **cone penetrometer**, depending on the test used, is indicated with 20 characters.

- The **type of liquid limit** indicates either S for Swedish cone or C for Casagrande. This field is automatically filled according to the bottom tab where the data is entered.

- A remark on the **preparation** of the sample can be added, with 80 characters.

The results can be directly entered by the user or calculated by Geotec based on the measurements in the bottom tables.

- The **natural water content** (WN) is in %.

- The **plastic limit** (WP) is in %.

- The **liquid limit** (WL) is in %.

- The **plasticity** (PI) and **liquidity** (LI) **index** are calculated automatically. These values are not saved in the database.

- The **shear strength** of the remolded soil can be entered, in kPa.

- **Non-plastic material** can be checked.

- The **USCS** classification is **calculated** by Geotec.

The sample characterization shows data from the SAMPLE table, for information purposes, including:

- The **description** entered for the current sample.

- The **USCS** classification of the current sample.

In Management...

- When the calculation is done (via the button or using **Action > Calculate**), the **calculation date** is updated.

- When a modification to the limits test is saved, the **modification date** is updated.

- **Transfer** is a 1-character code to classify records for their management.

The tabs at the bottom of the Limits form show data from the LIMITS_POINT secondary table of the Geotec database. The **All readings** tab shows all readings done for the current sample. The reading type

is shown as well as all fields of the table. The other tabs show only part of the fields, depending on the type of readings to be entered.

- The **site number**, the **boring number**, the **sample number**, the reading **type** and the point **index** together constitute the <u>key</u> of the records.

- The **reading type** is entered with the tab selected.

  - o **N** for natural water content
  - o **P** for plastic limit
  - o **C** for liquid limit with the Casagrande apparatus
  - o **S** for liquid limit with the Swedish cone

- The point **index (I_POINT)** is used to enter several points for the same test. It is an integer.

- Enter the **tare number**, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with TARE is suggested (paragraph 9.14).

- Enter the **tare mass**, in grams. If a mass is defined in the EQUIPMENT table for the selected tare, it will be displayed.

- Enter the **mass of the tare and wet soil**, in grams.

- Enter the **mass of the tare and dry soil**, in grams.

- The **water content W** is entered or calculated by Geotec.

- The **number of blows N** of the test is an integer. It is used only for the liquid limit test with the Casagrande apparatus.

- The **initial penetration reading P0** is in mm. It is only used for the Swedish cone liquid limit test.

- The 1st, 2nd, 3rd and 4th **penetration readings P1**, **P2**, **P3** and **P4** are in mm. They are used only for the Swedish cone liquid limit test.

- The **average reading P** is in mm. It can be entered or calculated by Geotec. It is only used for the Swedish cone liquid limit test.

- The drying **temperature** can be specified for liquid limit tests.

- The **drying mode** is a 2-character field indicating the control mode for water content. Typical codes would be WA (water addition), DA (air drying), DO (oven drying), DF (filtration drying), DP (drying with an absorbent plate).

- **Transfer** is a 1-character code to classify records for their management. By putting "X" in the Transfer field of one of the points, the point will not be included in the calculations.

Figure 43 – Limits entry form

9.2.1. Calculations

In the bottom table, Geotec calculates for each record

- of all tests, the water content w: $w = \dfrac{mass_{tare\ wet\ soil} - mass_{tare\ dry\ soil}}{mass_{tare\ dry\ soil} - mass_{tare}} \times 100\%$

- of the Swedish cone test, the average penetration: $P = average(Px - P0)$

The **natural water content WN** (%) is the average of the w of the "N" type records (water content) if there are several for the same sample.

The **plastic limit WP** (%) is the average of the w of the "P" type records (plastic limit) if there are several for the same sample.

The **liquid limit WL** (%) with the Casagrande apparatus depends if it's a one-point or multipoint test.

- 1-point method: $WL = w \times \left(\dfrac{N}{25}\right)^{0.121}$

- Multipoint method: Geotec plots a straight line of water content as a function of number of blows (logarithmic scale) and extrapolates to N = 25.

The **liquid limit WL** (%) with the Swedish cone depends if it's a one-point or multipoint test.

- 1-point method:
$$WL = \frac{20(w-15)}{P+10} + 15$$

- Multipoint method: Geotec plots a straight line of water content as a function of cone penetration (linear scale) and extrapolates to P = 10.

The **plasticity index** (%) is calculated as: $\quad PI = WP - WL$

The **liquidity index** is calculated as: $\quad LI = \frac{WN-WP}{WP-WL}$

The **USCS** is calculated using the Atterberg chart. Line A's equation is $PI = 0.73(WL - 20)$.

- If WL < 50

  - If PI > 7 and IP ≥ line A → UCSC = CL
  - Else if PI ≥ 4 and PI ≥ line A → UCSC = CL-ML
  - Else → UCSC = ML

- If WL ≥ 50

  - If PI ≥ line A → UCSC = CH
  - Else → UCSC = MH

9.3. Proctor form

The form shows data from the PROCTOR table and its secondary table PROCTOR_POINT of the Geotec database. It is used to enter lab measurements and calculate the results of Proctor tests for the determination of the water content – dry density relationship.

- The **site number**, the **boring number** and the **sample number** together constitute the <u>key</u> of the records.

- The **site, boring and sample numbers** identify the sample on which the compaction test was done.

  The drop-down list of sites shows all sites that have a least one sample defined in the SAMPLE table. The drop-down list of borings shows all borings that belong to the site selected and that have at least one sample defined in the SAMPLE table. The drop-down list of samples shows all samples defined in the SAMPLE table for the selected boring.

In Management data…

- Enter up to 40 characters in the fields **Realized by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name or number of the **laboratory** where the test was done is noted, with 20 characters.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Remark** is alphanumeric with 255 characters for additional details.

The laboratory apparatus used for the test are indicated. This ensures better monitoring in the event that an equipment is faulty and is used to retrieve some of the specifications.

- The **number of the balances** used for weighing for density (D) and for water content (WC) are indicated, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with BAL is suggested (paragraph 9.14).

- The **number of the rammer** used is indicated, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with RAM is suggested (paragraph 9.14).

- The **number of the mould** used is indicated, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with MOUL is suggested (paragraph 9.14).

The test parameters as well as the mould and sample characteristics are then defined.

- The **method** used is selected between **A**, **B**, **C** and **D**. For method A or B, the meshing will be set to 5 mm. For method C or D, the meshing will be 20 mm.

- The diameter of the cut-off sieve (**meshing**) is automatically displayed based on the method selected, but can be modified. The suggested values are 5 mm, 10 mm, 20 mm and 80 mm.

- The **passing %** is read from the grain size analysis done on the sample at the meshing indicated. The user can modify it or enter a passing % if a grain size analysis wasn't done.

- The **test type** is selected between **Standard** or **Modified**.

- The **rammer type** is selected between **Manual** or **Mechanical**.

- The **preparation** is selected between **Dry** or **Moist**.

- The purpose of the normalizing correction is to bring all points of the Proctor test on a common basis, as if they were all done with the same percentage of stones retained on the 5 mm sieve. The **normalizing correction at 5 mm sieve** can be based on the existing **grain size** of the sample, or on the **average of the stone contents**. The calculations are detailed in the next section.

- The mould **mass** (g) and **volume** (cm^3) are entered. If a mass and a volume are defined in the EQUIPMENT table for the selected mould, they will be displayed.

- The **apparent specific gravity** of sand is 2.7 by default and can be changed by the user.

- The **apparent specific gravity** of stone is 2.7 by default and can be changed by the user.

- The **bulk specific gravity** of stone is 2.7 by default and can be changed by the user.

- The **retained % on 5 mm** is calculated based on the selected normalizing correction at 5 mm sieve.

- The standard from which the **correction formula** used to correct the optimum water content and the maximum dry density as a function of the stone content of the total sample can be indicated. It is **ASTM-D4718**.

In Management...

- When the calculation is done (via the button 🖩 or using **Action > Calculate**), the **calculation date** is updated.

- When a modification to the Proctor test is saved, the **modification date** is updated.

- **Transfer** is a 1-character code to classify records for their management.

The results can be entered directly by the user or calculated by Geotec based on the measurements in the bottom table. The **Values measured in the test** are calculated based on the points of the compaction curve. The **Values corrected for stone** are corrected for stone content, if the passing % is less than 100%. See the calculation details in the next section.

- The **optimum water content** is in %.

- The **maximum dry density** is in kg/m^3. The unit weight will automatically be calculated.

- The **maximum dry unit weight** is not a field in the database. You can enter a value (in kN/m^3) and the maximum dry density will be automatically calculated.

- The **degree of saturation** is in %.

The table at the bottom of the Proctor form shows data from the PROCTOR_POINT secondary table of the Geotec database.

- The **site number**, the **boring number**, the **sample number** and the point **index** together constitute the <u>key</u> of the records.

- The **index (I_POINT)** defines the order of each point on the compaction curve. It is an integer.

- Enter the **tare number**, with 20 characters. The list of apparatus numbers defined in the EQUIPMENT table and whose category begins with TARE is suggested (paragraph 9.14).

- Enter the **tare mass**, in grams. If a mass is defined in the EQUIPMENT table for the selected tare, it will be displayed.

- Enter the **mass of the tare and wet soil**, in grams.

- Enter the **mass of the tare and dry soil**, in grams.

- Enter the **mass of the mould and wet soil**, in grams.

- If measured, enter the **mass retained on the 5 mm sieve** for the normalization, in grams.

- The **water content W$_{test}$** is entered or calculated by Geotec.

- The **density D$_{test}$** is entered or calculated by Geotec.

- The **retained % on the 5 mm sieve** is entered or calculated by Geotec.

- The **water content normalized at 5 mm W** is entered or calculated by Geotec based on % retained.

- The **density normalized at 5 mm D** is entered or calculated by Geotec based on % retained.

- **Smoothing (Z)** is used for the smoothing of the compaction curve at the current point. It contains the offset around the point for the curve. With a value of 0, the curve goes through the point; the greater the value, the more the curve is smoothed at the point. An offset can be set for the whole curve; see the documentation of Lab.

- **Transfer** is a 1-character code to classify records for their management. By putting "X" in the Transfer field, the point will not be displayed in the curve and not included in the calculations.

Figure 44 – Proctor entry form

9.3.1. Calculations

For each point of the curve, Geotec calculates:

- The **water content w$_{test}$**: $\qquad\qquad w_{test} = \frac{mass_{tare\ wet\ soil} - mass_{tare\ dry\ soil}}{mass_{tare\ dry\ soil} - mass_{tare}} \times 100\%$

- The **density d$_{test}$**: $\qquad\qquad\qquad d_{test} = \frac{mass_{mould\ soil} - mass_{mould}}{\frac{volume_{mould}}{1000} \times (1 + \frac{w_{test}}{100}))}$

- If a mass retained on 5 mm is entered, the **retained % on the 5 mm sieve** is:

$$retained_{5mm\ indiv} = \frac{mass_{retained}}{mass_{tare\ dry\ soil} - mass_{tare}} \times 100$$

For the complete test, Geotec calculates:

- The **passing %** which is read from the grain size analysis done on the sample at the meshing indicated.

- The **retained % on 5 mm** depends on the selected normalizing correction.

  With **grain size**: $\qquad\qquad\qquad retained_{5mm} = 100 \times \left(1 - \frac{passing_{5mm}}{passing_{meshing}}\right)$

  With **average stone contents**: $\qquad retained_{5mm} = average(retained_{5mm\ indiv})$

For each point of the curve, Geotec calculates the normalized water content and density.

- The normalizing correction: $\qquad corr = \frac{retained_{5mm}}{100} - \frac{retained_{5mm\ indiv}}{100}$

- The **water content W normalized at 5 mm**:

  if corr ≥ 0 $\qquad\quad w = w_{test} \times (1 - corr) + (0.8 \times corr)$

  if corr < 0 $\qquad\quad w = \frac{w_{test} + (0.8 \times corr)}{(1 + corr)}$

  If there is no retained % at 5 mm, the normalized water content equals the test water content.

- The **dry density D normalized at 5 mm**:

  if corr > 0 $\qquad\quad d = \frac{1}{\left(\frac{corr}{gs_{bulk} \times 1000}\right) + \frac{(1 - corr)}{d_{test}}}$

  if corr ≤ 0 $\qquad\quad d = d_{test} \times \frac{1 - |corr|}{1 - (\frac{|corr| \times d_{test}}{gs_{bulk} \times 1000})}$

  where gs$_{bulk}$ is the bulk specific gravity of stone.

  If there is no retained % at 5 mm, the normalized dry density equals the test dry density.

For the test, Geotec calculates the optimum point.

- The normalized points (w, d) are placed on a graph of dry density as a function of water content and the optimum point (w$_{opt\ test}$, d$_{max\ test}$) of the test is found by kriging.

- The density of water gw is defined at 1000 kg/m^3.

- The specific gravity of the soil gs is calculated as:

$$gs = retained_{5mm} \times \frac{gs_{app}}{100} + gs_{sand} \times \frac{100 - retained_{5mm}}{100}$$

where gs$_{app}$ is the apparent specific gravity of stone and gs$_{sand}$ is the apparent specific gravity of sand.

- The degree of saturation deg$_{sat\ test}$ is: $$deg_{sat\ test} = \frac{w_{opt\ test}}{(\frac{gw}{d_{max\ test}} - \frac{1}{gs})}$$

where w$_{opt\ test}$ is the optimum water content of the test and d$_{max\ test}$ is the maximum dry density of the test.

For the test, Geotec calculates the optimum point (w$_{opt}$, d$_{max}$) corrected for stone content, if applicable.

- If the % passing the meshing is less than 100%

$$d_{max} = \frac{1}{\left(\frac{1 - \frac{passing}{100}}{gs_{bulk} \times gw}\right) + \frac{\left(\frac{passing}{100}\right)}{d_{max\ test}}}$$

$$w_{opt} = w_{opt\ test} \times \frac{passing}{100} + 0.8 \times \frac{100 - passing}{100}$$

$$deg_{sat} = \frac{w_{opt}}{(\frac{gw}{d_{max}} - \frac{1}{gs})}$$

Otherwise, values are equal to the test optimum.

9.4. Consolidation form

The form shows data from the CONSOLIDATION table and its secondary table CONSOLIDATION_POINT of the Geotec database. It is used to define the parameters and results of the odometer consolidation and permeability test.

- The **site number**, the **boring number** and the **sample number** together constitute the <u>key</u> of the records.

- The **site, boring and sample numbers** identify the sample on which the consolidation / permeability test was done.

  The drop-down list of sites shows all sites that have a least one sample defined in the SAMPLE table. The drop-down list of borings shows all borings that belong to the site selected and that have at least one sample defined in the SAMPLE table. The drop-down list of samples shows all samples defined in the SAMPLE table for the selected boring.

- Enter up to 40 characters in the fields **Done by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name or number of the **laboratory** where the test was done is noted, with 20 characters.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Remark** is alphanumeric with 255 characters for additional details.

Enter the sample characteristics.

- **H0** is the initial height of the sample; the suggested unit is millimeters.

- **Gs** is the relative density.

- **K0** is the initial permeability; the suggested unit is m/s.

- **W0** is the initial natural water content, in %.

- The **degree of saturation** is then entered.

The void ratios are entered or calculated by Lab.

- **E0** is the void ratio at in-situ effective stress P0.

- **Ei** is the void ratio at effective stress of 9.81 kPa or entered for at the start of the test (MTQ).

- **Ec** is the void ratio at preconsolidation stress Pc.

- **Ef** is the void ratio at effective stress at the end of testing Pf.

Effective stresses are in kPa.

- **P0** is the in-situ effective soil stress. It is entered by the user.

- **Pf** is the effective stress at the end of testing. It is entered or calculated by Lab.

The results include the calculation method, the preconsolidation stresses and the indices.

- The **calculation method** is chosen between **Sobek** (simplified method) and **MTQ** (LC22-301 standard). By default, the Sobek method is chosen. Depending on the method, the values of PC and PC max differ as well as the Ei.

- **PC min** represents the lower limit of the preconsolidation stress (kPa). It is entered or calculated by Lab.

- **PC** represents the probable preconsolidation stress (kPa). It is entered or calculated by Lab.

- **PC max** represents the upper limit of the preconsolidation stress (kPa). It is entered or calculated by Lab.

- **CC** is the compression index. It is entered or calculated by Lab.

- **CCR** is the recompression index. It is entered or calculated by Lab

- **CV** is the consolidation coefficient for the probable preconsolidation stress (PC); the suggested unit is m^2/s. It is entered.

- **CK** is the permeability variation index. It is entered or calculated by Lab.

- When the calculation is done (via the button or using **Action > Calculate**), the **calculation date** is updated.

- When a modification to the consolidation test is saved, the **modification date** is updated.

The table at the bottom of the Consolidation form shows data from the CONSOLIDATION_POINT secondary table of the Geotec database.

- The **site number**, the **boring number**, the **sample number** and the point **index** together constitute the key of the records.

- The **index (I_POINT)** defines the order of each point on the consolidation curve. It is an integer.

- The **pressure (P)** is required. The suggested unit is kPa.

- The **void ratio (E)** is required.

- The **permeability (K)** can be entered if an odometer permeability test was done, in m/s.

- **CC** is the **compression index per loading**. CC is equal to the slope between a point (log P, e) and the previous. As soon as values of P and E are entered for a 2nd point, CC is calculated.

- **CV** contains the consolidation coefficient measured during loading to go from the previous pressure to pressure **P**. The suggested unit is the m^2/s.

- **Smoothing (Z)** is used for the smoothing of the consolidation curve at the current point. It contains the offset around the point for the curve. With a value of 0, the curve goes through the point; the greater the value, the more the curve is smoothed at the point. An offset can be set for the whole curve; see the documentation of Lab.

- **Transfer** is a 1-character code to classify records for their management. By putting "X" in the Transfer field, the point will not be displayed in the curve and not included in the calculations.

Figure 45 – Consolidation entry form

9.4.1. Calculations

The calculations are available only in the Lab module, using a style file that shows the consolidation curve. Figure 46 shows the points used in the calculations.

The Casagrande construction is used for the calculation and is shown in red. There are 200 points calculated at regular intervals (on logarithmic scale) for each curve. Lab finds the inflection point IP (where the second derivative is null) and the point of maximum curvature. We do not use the rebound curve if it is present, but it appears on the graph of consolidation tests.

- **E0** is the interpolated value on the Y axis at P0 stress, if entered.

- **Ei** is the interpolated value on the Y axis at a stress of 9.81 kPa. With the MTQ method, Ei is not calculated if a value is already entered.

- **Ec** is the interpolated value on the Y axis at Pc stress.

- **Ef** is the value interpolated on the Y axis at Pf stress (end of test).

- **Pf** is calculated as the maximum effective stress, before the rebound curve.

- **Pc min** is the intersection between the slope at IP and the horizontal from e0.

- With the **Sobek** method:

  o **Pc** is the intersection of the slope at the IP and the extension of the portion before the Pc.

  o **Pc max** is found with the construction of Casagrande. We take the bisector between the horizontal at the point of maximum curvature and the tangent at this same point. Pc max is the intersection between this bisector and the slope at the IP.

- With the **MTQ** method:

  o **Pc** is found with the construction of Casagrande. We take the bisector between the horizontal at the point of maximum curvature and the tangent at this same point. Pc is the intersection between this bisector and the slope at the IP (therefore equal to Pc max from the Sobek method).

  o **Pc max** is the stress at the divergence between the virgin consolidation curve and its upward extension (inflection point).

- **Cci** is the slope at the IP.

- **Ccr** is the slope between a point at 25% and another at 50% of the load in logarithmic mode.

- **Ck** is the slope of the least squares line passing through the points *(k, e) (permeability, void radio)*. By putting "X" in the Transfer field of one of the points, the point will not be displayed in the curve and not included in the calculation of Ck.
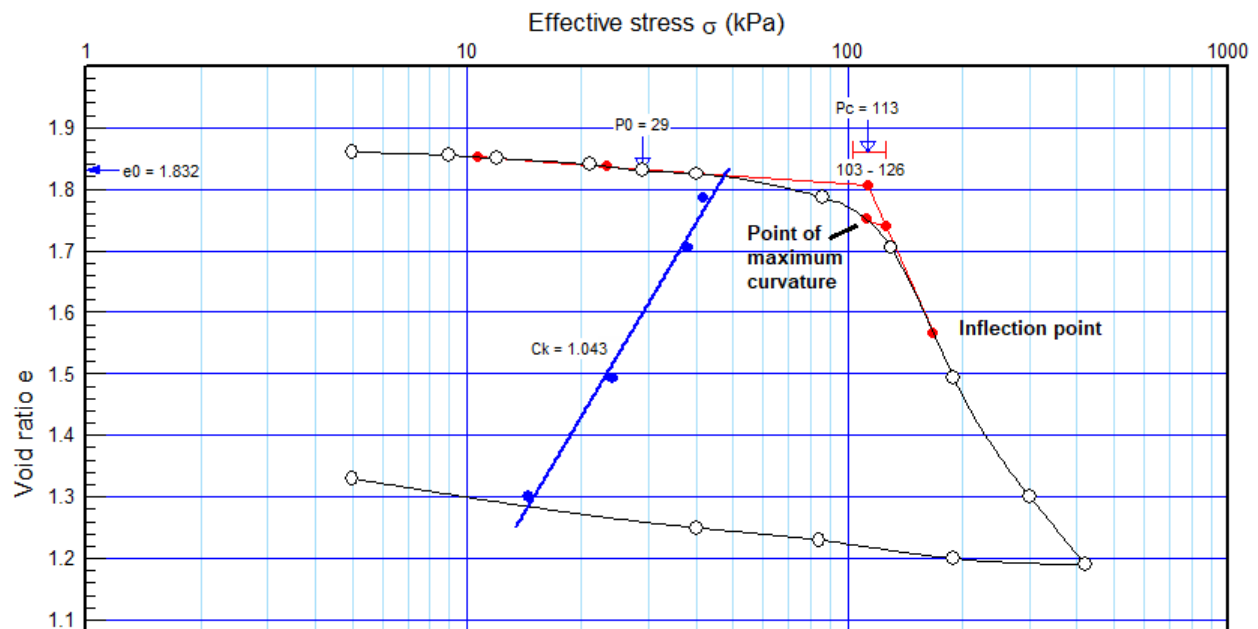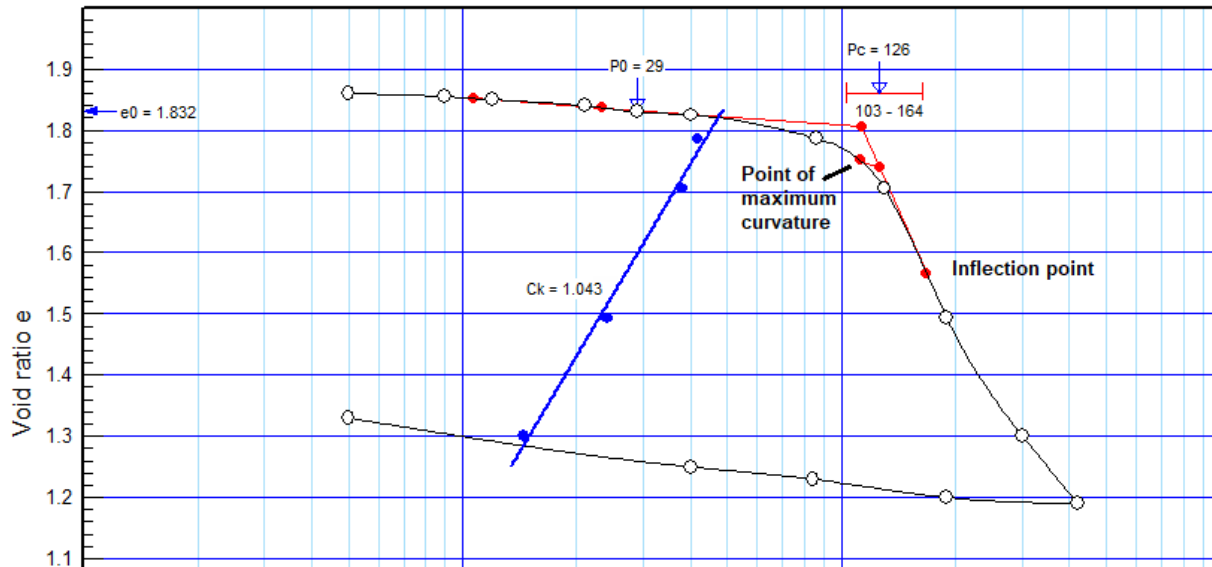
Figure 46 – Details of consolidation calculations – Sobek method (top) and MTQ (bottom)

9.5. Swedish cone form

The form shows data from the FALL_CONE table of the Geotec database. It is used to enter the shear strengths of an intact or remoulded soil determined by the fall cone test.

- The **site number**, the **boring number** and the **sample number** together constitute the key of the records.

- The **site, boring and sample numbers** identify the sample on which the fall cone test was done.

  The drop-down list of sites shows all sites that have a least one sample defined in the SAMPLE table. The drop-down list of borings shows all borings that belong to the site selected and that have at least one sample defined in the SAMPLE table. The drop-down list of samples shows all samples defined in the SAMPLE table for the selected boring.

In the Swedish cone tab…

- The shear strength of unremoulded soil (SU) is numeric, in kPa.

- The shear strength of the remolded soil (SUR) is numeric, in kPa.

- **Sensitivity** to remoulding (**ST**) is the ratio of intact strength to remoulded strength. Sensitivity is calculated automatically when both strengths are entered. The user can modify it.

- The **natural water content** of the sample can be entered, in %.

- **Remark** is alphanumeric with 255 characters for additional details.

In the Management tab…

- Enter up to 40 characters in the fields **Realized by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

9.5.1. Calculations

Geotec calculates the sensitivity as Su / Sur if both values are entered.

Figure 47 – Swedish cone entry form

9.6. Specific gravity form

The form shows data from the GS_SOIL table of the Geotec database. It is used to enter results of specific gravity tests.

- The **site number**, the **boring number** and the **sample number** together constitute the <u>key</u> of the records.

- The **site, boring and sample numbers** identify the sample on which the specific gravity test was done.

  The drop-down list of sites shows all sites that have a least one sample defined in the SAMPLE table. The drop-down list of borings shows all borings that belong to the site selected and that have at least one sample defined in the SAMPLE table. The drop-down list of samples shows all samples defined in the SAMPLE table for the selected boring.

In the Results tab…

- The **specific gravity of the sand fraction** is used to enter the test result. The diameter shown is 5 mm.

- The specific gravity of the fraction smaller than sand can then be entered.

- The **cut-off diameter** of this fraction is then entered (in mm).

- The radio buttons **Sand fraction** and **Fraction < 5 mm** will be used in a future development.

In the Management tab…

- Enter up to 40 characters in the fields **Realized by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

- **Remark** is alphanumeric with 255 characters for additional details.

Figure 48 – Specific gravity entry form

9.7. Density form

The form shows data from the DENSITY table of the Geotec database. It is used to enter measurements of unit weight or density for a sample.

- The **site number**, the **boring number**, the **sample number** and the **test type** together constitute the key of the records.

- The **site, boring and sample numbers** identify the sample on which the density test was done.

  The drop-down list of sites shows all sites that have a least one sample defined in the SAMPLE table. The drop-down list of borings shows all borings that belong to the site selected and that have at least one sample defined in the SAMPLE table. The drop-down list of samples shows all samples defined in the SAMPLE table for the selected boring.

- The **test type** is the one used to determine the density.

- The **wet density** measured by the test is entered; in kg/m^3.

- Enter up to 40 characters in the fields **Realized by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

- **Remark** is alphanumeric with 255 characters for additional details.

Figure 49 – Density entry form

9.8. Unconfined compression form

The form shows data from the UCS table of the Geotec database. It is used to enter the results of unconfined compressive strength tests for soil samples.

- The **site number**, the **boring number** and the **sample number** together constitute the key of the records.

- The **site, boring and sample numbers** identify the sample on which the unconfined compressive strength test was done.

  The drop-down list of sites shows all sites that have a least one sample defined in the SAMPLE table. The drop-down list of borings shows all borings that belong to the site selected and that have at least one sample defined in the SAMPLE table. The drop-down list of samples shows all samples defined in the SAMPLE table for the selected boring.

- The **height** of the test specimen is entered in mm.

- The **diameter** of the test specimen is entered in mm.

- The **mass** of the test specimen is entered in g.

- The **water content** of the test specimen is entered in %.

- The **dry density** of the test specimen is entered in g/cm^3.

- The material's **Young's modulus** is entered in MPa.

- The material's **Poisson's ratio** is entered.

- The **maximum load** at failure is entered, in N.

- The **deformation** is the decrease in height of the specimen due to compression, in mm.

- The **compressive strength** is entered, in MPa.

- The **failure type** is entered with a 2-character code.

- The **angle** of the **fracture plane** is in degrees.

- Enter up to 40 characters in the field **Tested by**.

- The **test date** is noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

- **Remark** is alphanumeric with 255 characters for additional details.

Figure 50 – Unconfined compression entry form

9.9. Shear strength form

The form shows data from the SHEAR table of the Geotec database. It is used to enter the characteristics and results of shear strength tests done on a sample.

the **Interpretation** button opens the interpretation of a group of shear strength tests.

- The **site number**, the **boring number** and the **sample number** together constitute the key of the records.

- The **site, boring and sample numbers** identify the sample on which the shear strength test was done.

  The drop-down list of sites shows all sites that have a least one sample defined in the SAMPLE table. The drop-down list of borings shows all borings that belong to the site selected and that have at least one sample defined in the SAMPLE table. The drop-down list of samples shows all samples defined in the SAMPLE table for the selected boring.

Under the Identification tab, we define the characteristics of the test and of the sample.

- The **test number** is can be entered; with 20 characters.

- The test **type** is entered. The proposed types are the consolidated drained test (CD), the consolidated undrained test (CU), the direct shear test (DIR) and the unconsolidated undrained test (UU). The description of the selected type is automatically displayed.

- **Sigma'3** is the lateral pressure, in kPa. This field is not used if the test type is "**UU**".

- The **loading rate** is entered, in mm/min.

- The **backpressure** is in kPa.

- The **rupture shape** can be selected. The description of the rupture shape is automatically displayed after selecting the code.

- The sample **unit weight** is entered, in kN/m^3.

- The sample **density** is in kg/m^3.

- **W0** is the initial water content of the sample, in %.

- **Wf (top)**, **Wf (middle)** and **Wf (bottom)** are the final water content at the top, middle and bottom of the sample, in %.

Under the Results tab…

- For **CD**, **CU** and **UU type tests**, the following values at the **peak** (maximum) and at the largest deformation are entered:

  o **q'** is the deviatoric effective stress (kPa)

  o **p'** is the mean effective stress (kPa)

  o **E** is the strain (%)

  o **u*** is the porewater pressure (kPa). Values of u* are not entered for CD and UU type tests.

- For **DIR type tests**, the following values are entered:

  o **Tau** is the shear stress (kPa)

  o **Sigma n'** is the normal effective stress (kPa)

Under the Management tab...

- Enter up to 40 characters in the fields **Done by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- The **group number** is used to enter an identification of 20 characters grouping the shear strength tests of same type and associated to the same site. The drop-down list shows the groups defined in the Interpretation form.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

Figure 51 – Shear strength entry form

9.9.1. Interpretation

The form shows data from the TRIAXIAL table of the Geotec database. It is used for the interpretation of a group of shear strength tests.

the **Shear strength** button opens the shear strength entry form.

- The **site number** and **group number** together constitute the <u>key</u> of the records.

- The **site number** identifies the sites. The drop-down list shows all sites defined in the SITE table.

- The **group number** identifies the group of interpretation. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The **test type** can be entered. The types are the same as in the Shear form. The description of the selected type is automatically displayed.

- **c** and **c'** are the cohesion and effective cohesion, respectively.

- **Phi** and **Phi'** are the total and effective friction angle, respectively.

- **Remark** contains a string of 255 characters to describe the group of tests.

Under the Management tab...

- Enter up to 40 characters in the fields **Done by** and **Verified by**.

- The **test date** and **verification date** are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The name of the **data file** can be entered, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file with its full path, enable the option in the preferences. See the X3D documentation.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

9.10. Concentrations form

The form shows data from the CONCENTRATION table of the Geotec database. It is used to enter concentrations of contaminants measured in-situ or via laboratory analyses. See the description of the Contaminants form in paragraph 10.10 which contains the criteria used for the calculations.

- The **site number**, the **boring number**, the **top depth** and the **contaminant** together constitute the key of the records.

- The **site** and **boring numbers** identify the boring in which concentrations were measured. The drop-down lists show all sites that have a least one boring defined in the BORING table, then all borings of the BORING table for the selected site.

- If the contaminant concentration was measured on a **sample** or **sub-sample**, enter its **number**. If a number is entered, its top and bottom depth are automatically retrieved and displayed in the form.

- The **group** of contaminants is defined. The list is from the CONTAMINANT table, but the user can enter another one with 50 characters maximum. The group is used to narrow the drop-down list of contaminants.

- The **contaminant** is the one for which concentrations were measured. The list from the CONTAMINANT table for the group selected is suggested, but the user can enter another one, with 40 characters maximum.

- The **top and bottom depths** of the measurement, if applicable, are entered; the suggested unit is the meter. If the measurement applies to a sample / sub-sample, its depths are automatically indicated.

- A **remark** of 255 characters is used to add details.

- The contaminant **concentration in soil** is entered. The measurement unit should be the one defined in the CONTAMINANT table for the same contaminant.

- If criteria A to C are defined in the CONTAMINANT table, the **contamination level in soil** is calculated. It is a 10-character field with these values, usually: A-, A, A-B, B, B-C, C and C+.

- The contaminant **concentration in water** is entered. The measurement unit should be the one defined in the CONTAMINANT table for the same contaminant.

- If criteria A to C are defined in the CONTAMINANT table, the **contamination level in water** is calculated. It is a 10-character field with these values, usually: A-, A, A-B, B, B-C, C and C+.

- **Alert** is used to enter an alert threshold of 5 characters.

- When a modification is saved, the **modification date** is updated.

- When the calculation is done (via the button or using **Action > Calculate**), the **calculation date** is updated.

- **Category** is used to enter a code to categorize the test, with 20 characters.

- **Transfer** is a 1-character code to classify records for their management.

9.10.1. Calculations

Geotec calculates the contamination level based on the concentration indicated in the entry form and criteria A to C defined in the CONTAMINANT table (paragraph 10.10) for the same geologic province as the one of the current site. If no province is defined for the site, it is compared to criteria from the B province. If the 3 contamination criteria are not defined for the contaminant, the calculation of the level is not done.

The calculation function also retrieves the depths of the samples or sub-samples entered in the SAMPLE table and updates them in the CONCENTRATION table. If the values are linked to a sample, this function is not launched.

Figure 52 – Concentrations entry form

9.11. Sieving methods form

The form shows data from the SIEVING_METHOD table and its secondary table SIEVES_SET of the Geotec database. It is used to define the sieving methods used in the laboratory and the associated sets of sieves. Sieving methods BNQ_2501-025 and LC_21-040 are automatically added to Geotec databases.

- The **sieving method number** is the <u>key</u> of the record. It typically corresponds to the number of the standard. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The **classification** norm is entered with 20 characters. It is for future development.

- The method **description** has 255 characters.

- Minimum limit, maximum limit, grain size description and concrete sand are for future development.

- For each method, up to 3 quarterings or groups of sieves can be defined as needed: the coarse fraction (Cobbles), medium fraction (Gravel) and fine fraction (Sand).

  o Indicate the **number of the scale** used for weighing.

  o Indicate whether the **weighing** is **individual** (each sieve separately) or **cumulative**.

  o Indicate the **unit of mass** (grams g, kilograms kg or pounds lb).

The table at the bottom of the Sieving methods form shows data from the SIEVES_SET secondary table of the Geotec database.

- The **sieving method number** and the **diameter** together form the <u>key</u> of the records.

- The sieve **diameter** is numerical. It can be entered or selected via the drop-down list which suggests Quebec standard sieves between 300 mm and 0.08 mm.

- The **fraction** is required. This is a 1-character field that indicates whether the sieve is associated with the coarse fraction (Q for Cobbles), the medium fraction (G for Gravel) or the fine fraction (S for Sand).

- The **sieve number** can be entered. The drop-down list suggests the sieves defined in the Laboratory Equipment form (paragraph 9.14).

Figure 53 – Sieving methods entry form

9.12. Grain size requirements form

The form is used to define grain size specifications that can be associated with the grain size tests and presented in the Lab module. The MG-20, MG-20B, MG-56 and MG-80 grain size specifications are automatically added to Geotec databases.

- The **Envelope** (or specification) is required. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The **description** of the specification can be entered.

In the bottom table, define the requirements for the grain size specifications.

- Indicate the **diameter** where a requirement applies. A list of common diameters is available.

- Enter the **minimum passing** and the **maximum passing** for each diameter.

Data entered in the Grain size requirements form are automatically saved in multiple tables.

- The SPEC site

- The boring whose number is the name of the specification and whose remark is the description of the specification

- The samples MIN and MAX in the boring

- A grain size curve associated to the MIN sample with the diameters and their MIN_PASSING

- A grain size curve associated to the MAX sample with the diameters and their MAX_PASSING

Figure 54 – Grain size requirements entry form

9.13.   Hydrometer calibrations

The form shows data from the HYDROMETER_CALIBRATION table of the Geotec database. It is used to specify the calibration factors for the hydrometers used by the laboratory. Calibration of the ASTM 151H and 152H hydrometers are automatically added to the Geotec databases for reference.

- The **hydrometer number** is the key of the record. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The hydrometer **model** is either 151H or 152H. The calibration and the calculations differ depending on the model chosen.

- The **calibration date** is noted in the format *yyyy-mm-dd hh:mi:ss*.

- The **length** of the **hydrometer bulb** is entered, in cm.

- The **volume** of the **hydrometer bulb** is entered, in cm^3.

- **Coefficients A** and **B** of the **calibration curve** are entered.

- **Coefficients A** and **B** of the **composite correction curve** are entered. If a correction reading is taken rather than the calculation via the composite correction, enter 0 in both fields.

- The **density correction factor** is entered; the default value is 1.

- A **description** of the hydrometer can be added with 255 characters.

Figure 55 – Hydrometer calibration entry form

9.13.1. Calibration curve

The calibration curve of a hydrometer establishes the relationship between the distance (cm) and the reading taken on the hydrometer. The reading is always taken <u>at the top of the meniscus</u> and adjusted in the calculations of the hydrometer test. Figure 56 show an example of calibration for measured depth, real depth, and effective depth as a function of reading.

The effective depth equation is: $H' = L_1 + \frac{L_B}{2} - \frac{V_B}{2A}$ where

- V_B is the volume of the bulb (cm³)

- A is the area of the sedimentation cylinder (cm²)

- L_B is the length of the bulb (cm)

- L_1 is the **measured depth** (blue curve) and corresponds to the distance from the reading mark on the hydrometer stem to the top of the hydrometer bulb.

- The **real depth H** (orange curve) corresponds to the distance from the reading mark on the hydrometer stem to the geometric center of the hydrometer bulb, or: $H = L_1 + \frac{L_B}{2}$

- The **effective depth H'** (gray curve) corresponds to the real depth corrected for water displacement resulting from the insertion of the hydrometer in the suspension, or: $H' = H - \frac{V_B}{2A}$

The different set of values can be used in the calibration but by entering or not the length and / or volume. Below are the coefficients to enter for calibration for the example of the figure.

- If **measured depth** is used, enter **coefficient A** (-0.167), **coefficient B** (10.6), **bulb volume** (64 cm³ in our example) and **bulb length** (14 cm).

- If **real depth** is used, enter **coefficient A** (-0.167), **coefficient B** (17.6), **bulb volume** (64 cm³ in our example) and **bulb length of 0** (already included in the calibration).

- If **effective depth** is used, enter **coefficient A** (-0.167), **coefficient B** (16.485), **bulb volume of 0** (already included in the calibration) and **bulb length of 0** (already included in the calibration).
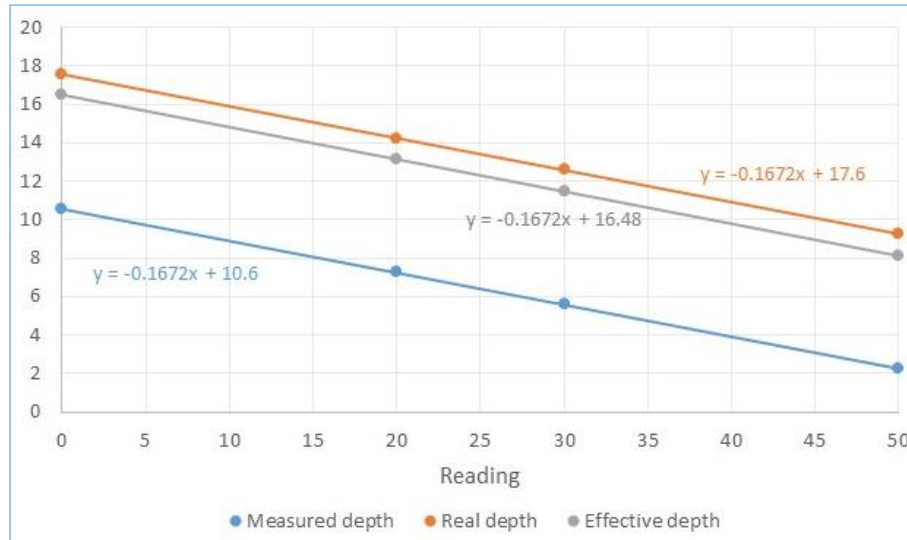
Figure 56 – Example of calibration curves

9.13.2. Composite calibration

1. Calculations of percentages of soil remaining in suspension are based on the use of distilled water. However, the use of a dispersing agent increases the specific gravity of the resulting liquid compared to that of distilled water.
2. Hydrometers are calibrated at 20°C. Temperature variation from this standard may produce inaccuracies in readings. The amount of inaccuracy increases as the variation from 20°C increases.
3. Hydrometers are graduated to be read at the bottom of the meniscus formed by the liquid on the stem. Since it is not possible to secure readings of soil suspensions at the bottom of the meniscus, readings should be taken at the top of the meniscus and a correction applied.

These three inaccuracies are included in the composite calibration.

Prepare a solution of distilled water and dispersing agent in the same proportion as will be used in the sedimentation tests. At 2 sufficiently different temperatures, read the hydrometer at the top of the meniscus. For a 151H, the correction is the difference between the reading and one. For a 152H, it is the difference between the reading and zero (1.0 or 0.0 being the reference readings at the bottom of the meniscus in a cylinder filled with distilled water at 20°C).

Create a graph of correction with temperature (Figure 57) and set a straight-line relationship with equation y = ax + b. With the example below, coefficient A would be -0.476 and coefficient B would be 16.071.
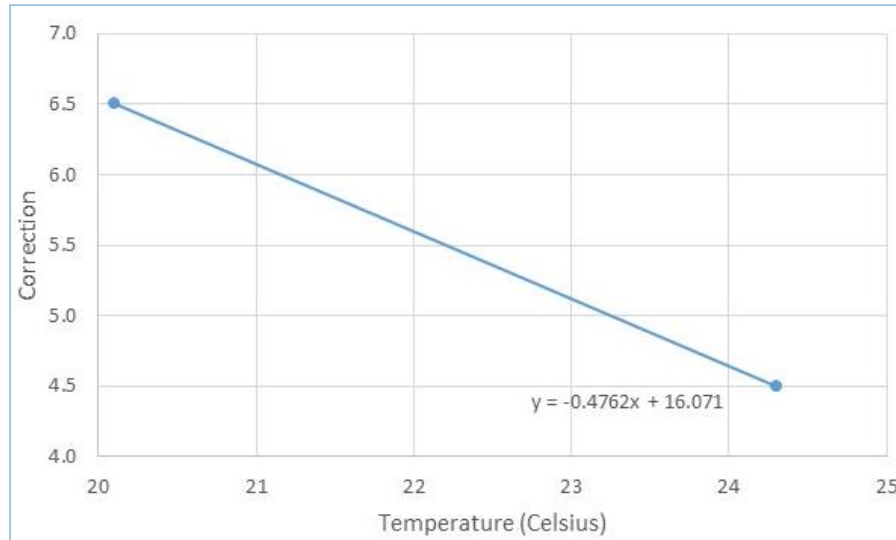
Figure 57 – Example of calibration of composite correction

9.13.3. Density correction factor

The correction factor F for density is used in the BNQ 2501-025 standard. Please refer to it. With a value of 1, the factor has no impact.

9.14. Lab equipment form

The form shows data from the EQUIPMENT table of the Geotec database. It is used to define the apparatus used in the laboratory and their information.

- The **category** and the **apparatus number** together constitute the <u>key</u> of the records.

- The **category** indicates the type of device. It is used to create a field-specific drop-down list in the entry forms. The following choices should be used:

  Balance, Cylinder, Rammer, Mould, Tare, Thermometer, Sieve

- The **apparatus number** identifies the equipment. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The **model** has 20 characters to specify the equipment model or sub-categorize equipment.

- The **calibration date** is noted in the format *yyyy-mm-dd hh:mi:ss*.

- The **mass**, **volume**, **area**, **height** and **diameter** are numeric fields and only apply to certain types of apparatus.

- The measurement **scale** of the apparatus is alphanumeric with 50 characters.

- The measurement **precision** of the apparatus is 50 character alphanumeric.

- An apparatus **description** can be added with 255 characters.

Figure 58 – Lab equipment entry form

10. General entry forms

The last tab of the Entry forms menu is General (paragraph 2.1). It is separated in entry forms for **administration** and for **predefined lists and other definitions**.

10.1. Employees form

The Employees form is for future development.

10.2. Clients form

The form shows data from the CLIENT table of the Geotec database. It is used to enter administration information about your clients. The list of **client numbers** and **names** defined in the CLIENT table is used in the Site, Projects and Contracts entry forms.

- The **client number** is the key of the record. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The **client's name** is a 80-character string.

- The **address** is entered with up to 255 characters.

- The **city**, the **province** and the **country** are 20-character strings.

- The **postal code** is a 10-character string.

- The **phone** and **fax** numbers have 20 characters.

- **Email** has 50 characters maximum, and **website** has 80.

- The client's **GST** and **PST numbers** can be entered with 10 characters.

- The **contact's name** for the client is entered, with 60 characters.

- The client's **logo file** can be selected, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens.

  To save the file name with its full path, enable the option in the preferences. See the X3D documentation.

- **Remark** is alphanumeric with 255 characters for additional details.

Figure 59 – Clients entry form

10.3. Projects form

The form shows data from the PROJECT table of the Geotec database. It is used to enter administration information about your projects. The list of **project numbers** and **names** defined in the PROJECT table is used in the Site and Boring entry forms.

- The **project number** is the <u>key</u> of the record. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- A **sub-project** can be added with 20 characters.

- The **project name** is an 80-character string.

- **The description** is alphanumeric with 255 characters for a complete description of the project.

- The **client number** for the project has 20 characters. The list of **client numbers** and **names** defined in the CLIENT table is suggested (paragraph 10.2).

- The **client's name** is automatically the one defined in the CLIENT table for the client number selected. The value is alphanumeric with 255 characters.

- The **dossier** is a general reference number; with 20 characters.

- The **start** and **end dates** of the project are noted in the format *yyyy-mm-dd hh:mi:ss*.

- The **phase**, **type** and **activity code** for the project are alphanumeric with 12 characters.

- The **ISO version**, **ISO procedure** and **ISO sequence** are alphanumeric with 12 characters.

Figure 60 – Projects entry form

10.4. Contracts form

The form shows data from the CONTRACT table of the Geotec database. It is used to enter administration information about your contracts. The list of **contract numbers** and **names** defined in the CONTRACT table is used in the Site and Boring entry forms.

- The **contract number** is the <u>key</u> of the record. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The general **contractor** doing the work for the contract is entered, with 80 characters.

- The **contract name** is a 255-character string.

- **The description** is alphanumeric with 255 characters for a complete description of the contract.

- The **client number** for the contract has 20 characters. The list of **client numbers** and **names** defined in the CLIENT table is suggested (paragraph 10.2).

- The **client's name** is automatically the one defined in the CLIENT table for the client number selected. The value is alphanumeric with 255 characters.

- The **start** and **end dates** of the contract are noted in the format *yyyy-mm-dd hh:mi:ss*.

Figure 61 – Contracts entry form

10.5. Regions form

The form shows data from the REGION table of the Geotec database. It is used to identify and describe a region and the limits of the domain it covers. The list of **region numbers** and **descriptions** defined in the REGION table is used in the Site entry form.

The **Domain<** and **Map** buttons are active only in the **Site** module. They are used to define the domain directly with the mouse, and to edit the map. See the Site documentation.

- The **region number** is the key of the record. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The region's domain is defined. The **minimum and maximum easting and northing** of the region are entered (in meters).

- The **angle** is the declination at the center of the region indicated on topographic maps, between -90 and 90 degrees. If the declination is West, the value is position; if the declination is East, the value is negative.

- The **zone** where the region is located is entered.

- The **NAD** projection system is either **NAD27** or **NAD83**.

- The coordinate system is either MTM or UTM.

- The region's domain can also be defined with the **East** and **West longitude** and **North** and **South latitude** of the region.

- The **longitude** and **latitude** of the region's center can be entered or calculated.

    They are used in the Google Maps tool integrated to the modules.

- The **description** is alphanumeric with 255 characters to add notes.

- A **cartographic file** can be associated to the region, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens. This cartographic file can be displayed in the **Site** module.

    To save the file name with its full path, enable the option in the preferences. See the X3D documentation.

- **Transfer** is a 1-character code to classify records for their management.

10.5.1. Calculations

Geotec calculates the **longitude** and **latitude** of the region's center. If X and Y min and max coordinates are entered, Geotec calculates their average and converts it to lat-lon. Otherwise, Geotec calculates the average of the longitudes and latitudes of the sites that have the region number defined.

Figure 62 – Regions entry form

10.6. Municipalities form

The form shows data from the MUNICIPALITY table of the Geotec database. It is used define the municipalities. The list of **municipality numbers** and **names** defined in the MUNICIPALITY table is used in the Site entry form.

The Tutorial.mdb database provided by Sobek contains the list of municipalities in Quebec based on the website DonneesQuebec.ca from 2022.

- The **name of the municipality** is a 100-character string. A value is required.

- The **municipal code** is the key of the record. Enter up to 10 digits.

- The **designation** shows the type of agglomeration: a village, a parish, a city, etc. with 20 characters.

- The **MTM zone** where the municipality is located is entered; this number varies between **3** and **10** inclusively in Quebec.

- **Easting** contains the value expressing the hundreds of thousands of X coordinates for the municipality.

- **Northing** contains the value expressing the millions and hundreds of thousands of Y coordinates for the municipality.

- The **area** is expressed in km^2.

- The **population** is then entered.

- The **number** and **name** of the **regional county municipality** (RCM) to which the municipality belongs are entered. The number is an integer; the name is a 50-character string.

- The **number** and **name** of the **administrative region** to which the municipality belongs are entered. The number is an integer; the name is a 50-character string.

Figure 63 – Municipalities entry form

10.7. Lists form (English and French)

The forms show data from the LIST_ENG (English) and LIST_FRE (French) tables of the Geotec database. The language corresponds to the language in which the software is used. The forms are used to define the drop-down lists of values used in the other entry forms of Geotec, <u>except</u> for fields whose type of drop-down list of "1: distinct" or "6: no list" (paragraph 18).

The Geotec database created by DBM contains more than 400 records. The user can modify them, add some and delete others. NOTE: If you modify the LIST_ENG table, the records are not automatically modified in the LIST_FRE table. If you use Geotec in both languages, verify their correspondence.

- The **table name**, **field name**, **value** and **description** together constitute the <u>key</u> of the record.

- The name of the Geotec **table** is identified.

- The name of table **field** is identified. The list suggests all fields of the selected table.

- The **value** is typically an abbreviation. It is the item chosen when the type of drop-down list is "2: value" or "4: + value" (paragraph 18). It is alphanumeric with 10 characters.

   o If there is no value to indicate, use the dot. In this case, the description will be used in the drop-down list.

   o To use ranges of numeric values, enter the minimum value followed by : and by the maximum value. You can associate a description, color and pattern to a range of values.

   For example, enter the value 0:20 in order for the associated color to be used for all values between 0 and 20 inclusively.

- The **description** is chosen when the type of drop-down list is "3: description" or "5: + description" (paragraph 18). It is alphanumeric with 255 characters.

- A **color** associated to the value is selected by double-clicking in the cell. This color is used for curves of type Color.

- A **pattern** associated to the value is selected by double-clicking in the cell. This pattern is used for curves of type Pattern.

- The **rank** is used to force a display order in the list. The items are displayed by numerical rank (from 0), followed by the items without a rank. The items with the same rank are displayed alphabetically.

The **% character** is supported as replacement character for the table and field names, to avoid repeating values used in different fields. For example, the remarks on the hydrogeology measurements in tables BORING and PIEZOMETRIC_LEVEL can be entered once only with % as table and MEASURE_REM% as field.

In the Geotec modules, the description of a value from the tables of lists can be displayed by using the **@@ characters**, except if an equivalence for this table, field and specific value is already defined In the EQUIVALENCE table (see paragraph 10.11) For example, @@BORING.TYPE will indicate *Test pit* if the value of the TYPE field of the BORING table is TP.

#		TNAME	CNAME	CVALUE	DESCR	RANK	COLOR	PATTERN
95	✓	SAMPLE	INCLUSIONS	.	Rootlets			
96	✓	SAMPLE	INCLUSIONS	.	Shell fragments			
97	✓	SAMPLE	INCLUSIONS	.	Wood			
98	✓	SAMPLE	OLF_OBS	1	None		15000804	
99	✓	SAMPLE	OLF_OBS	2	Light		4054597	
100	✓	SAMPLE	OLF_OBS	3	Medium		16776960	
101	✓	SAMPLE	OLF_OBS	4	Strong		16196382	
102	✓	SAMPLE	STATE	C	Core,CR,1.524			
103	✓	SAMPLE	STATE	G	Grab,GB,0.305			
104	✓	SAMPLE	STATE	I	Intact,ST,0.914			
105	✓	SAMPLE	STATE	P	Lost			
106	✓	SAMPLE	STATE	R	Remolded,SS,0.61			
107	✓	SAMPLE	STRUCTURE	.	Blocky			
108	✓	SAMPLE	STRUCTURE		Fissured			

Figure 64 – Lists entry form

10.8. Properties form

The form shows data from the PROPERTIES table of the Geotec database. It is used to define the various properties that do not have a specific table in Geotec. The list of **properties** defined in the PROPERTIES table is used in the Other properties entry form (paragraph 8.7).

- **Property** is the key of the record. You can enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- If the **Hide** box is checked, the property will not be displayed in the table in the Sample form. This checkebox is managed on each workstation separately.

- The property **units** is alphanumeric with 10 characters. It is indicated next to the property in the table of the Sample form.

- The **parent** property can be selected from all defined properties. It is for a future development.

- The **category** is alphanumeric with 10 characters and it used to group several properties in the same category.

- The **measurement type** indicates if the property is measured at a given depth (1), for a depth interval (2), on a sample (3) or on a run (4). The properties of type "3" are displayed in a table in the Sample form for facilitate the data entry, except those that are hidden or whose order is 0.

- The **type of drop-down list** for the remark of each property can be defined. In table LIST_ENG, the table name is PROPERTIES, the field name is the name of the property (ex: PROPERTIES and CONTAINER).

  - **0: Default**. The list shows the records from the LIST_ENG table, and if there are none, the existing data from the database, for the current field.

  - **1: Distinct**. The list shows the existing data in the database for the current field.

  - **2: Value**. The list shows the values from the LIST_ENG table for the current field. Only one choice can be selected at a time.

  - **3: Description**. The list shows the descriptions from the LIST_ENG table for the current field. Only one choice can be selected at a time.

  - **4: + Value**. The list is the same as for Value, but the choices are concatenated after each selection.

  - **5: + Description**. The list is the same as for Description, but the choices are concatenated after each selection.

  - **6: No list**. No list is displayed.

- **Order** is used to force a display order in the table of the Sample form, from smallest to largest number. To hide a property from the table in Sample form, set its rank to 0.

- The **format** of the numeric values can be modified for viewing – for example in scientific format, or without decimals.

- The **minimum** value is numeric. It is for a future development.

- The **maximum** value is numeric. It is for a future development.

- The **description** is alphanumeric with 255 characters to describe the property

- A **remark** can be added with 255 characters.

- The **name of the person** who **added** the property and the **date added** can be entered for better management.

- **Transfer** is a 1-character code to classify records for their management.

Figure 65 – Properties entry form

10.9. Materials form

The form shows data from the MATERIAL table of the Geotec database. It is used to define various materials and to associate a display color or automatisms for quality control. The list of **materials** and their **description** defined in the MATERIAL table is used in several Geotec forms.

- **Material** is the <u>key</u> of the record. You can enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The **color associated** to the material can be used in graphic reports. By double-clicking in the field, a color definition form opens to facilitate its selection.

- A default **sieving method** can be selected for the material via the drop-down list showing all sieving methods defined (paragraph 9.11).

- A default **grain size requirement** can be selected for the material via the drop-down list showing all grain size requirements defined (paragraph 9.12).

- The **reference test** and the **minimum required** are used to establish compliance during tests to determine in-situ densities. They will be used in a future development.

- The material **description** is alphanumeric with 255 characters.

Figure 66 – Materials entry form

10.10. Contaminant form

The form shows data from the CONTAMINANT table of the Geotec database. It is used to define contamination criteria for water and soils. The list of **contaminants** defined in the CONTAMINANT table is used in the Concentrations form (paragraph 9.10).

The Tutorial.mdb database provided by Sobek contains several contamination criteria based on previous lists from the MDDEP.

- The **contaminant** and the **geologic province** together constitute the <u>key</u> of the record.

- The **contaminant** is alphanumeric with 40 characters.

- The code for the **geologic province** has 1 character and is used to define criteria A of the contaminant.

- The **group** has 50 characters. It is used to narrow the drop-down list of contaminants in the Concentrations form.

- The **description** of up to 255 characters is used to add information.

The following four fields are for the soil contamination.

- **Measurement unit** is used to enter the unit of the contaminant concentrations in soil.

- **Criteria A to C** contain the contaminant concentrations corresponding to each criteria.

The following four fields are for the water contamination.

- **Measurement unit** is used to enter the unit of the contaminant concentrations in water.

- **Criteria A** contains the method's quantification limit.

- **Criteria B** contains the water consumption criterion.

- **Criteria C** contains the surface water and sewer criterion.

Figure 67 – Contaminants entry form
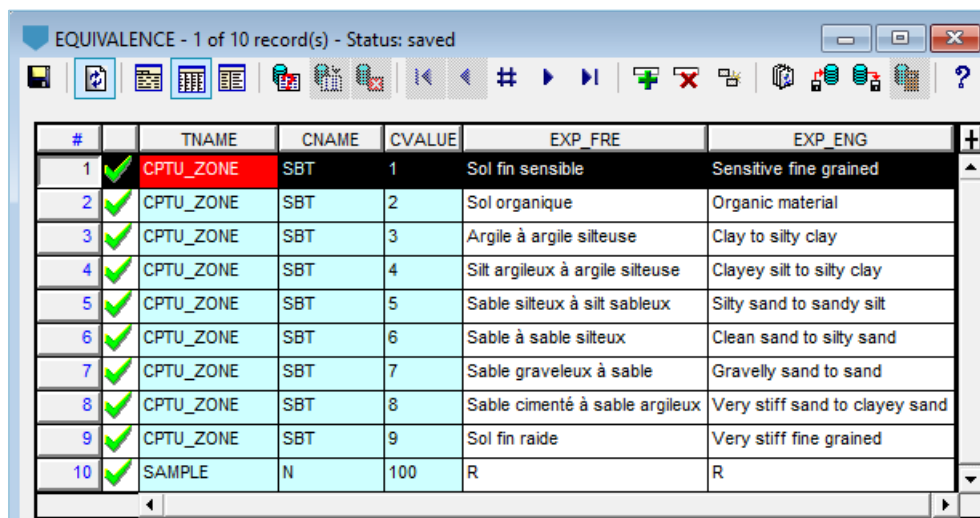
10.11. Equivalences forms

The forms show data from the EQUIVALENCE table of the Geotec database. The form is used to define expressions to display by the graphic modules instead of specific values.

- The **table name**, **field name** and **value** together constitute the <u>key</u> of the record.

- The name of the Geotec **table** is identified.

- The name of table **field** is identified. The list suggests all fields of the selected table.

- The **value** is what we define an equivalence for.

- The equivalent **expressions** in **French** and **English** are alphanumeric with 80 characters.

In the Geotec modules, you can display an expression equivalent to a value by using the @@ characters. For example, "R" will be displayed in a column showing the sample N values when N = 100.

The @@ characters can also be used to display the description of a value from the LIST_ENG or LIST_FRE table if no equivalence for this table, field and specific value exists (paragraph 10.7).

Figure 68 – Equivalences entry form

11. Simple queries and data retrieval

In all Geotec entry forms, queries can be done to retrieve data from the database using various criteria. The queries filter the records in the database in order to consult, modify, complete, print or delete them. Queries are done in three steps: 1 – open the Query mode; 2 – enter the filter criteria; 3 – execute the query.

Use the button ![icon] of the application toolbar, the **[F7]** key or **Data > Retrieval by > Simple Query** to open the default entry form of the module, for example Boring in Log and Axis in Pro. The form will be directly in Query Mode, indicated in the title bar and by the dark blue background color of the form.

The user can do a query in any entry form. Once the form is open (paragraph 2), use the **[F7]** key, the button of the entry form toolbar or **Query > Enter** to switch to Query mode (indicated in the title bar and by the dark blue background color of the form). Then, enter the criteria for the query. The filter values can be typed in directly or via more complex criteria.

- Use **[F7]** a 2nd time or use **Query > Last** to fill with the last criteria used.

- Use **%** to replace several characters. For example, BH% to retrieve borings whose number starts with BH, or 2022-04% to retrieve borings whose date is April 2022, or simply % to retrieve all records that have a value in the given field.

- Use **_** to replace just one character. For example, BH0_ to retrieve borings whose number has 4 characters and starts with BH0.

- Use **<** or **>** for numbers or dates. For example, >10 for greater than 10, or <2019-06-01 for before June 1st 2019.

- Use **IS NULL** to retrieve all records without a value in the given field.

- Use **!** (which means not LIKE) to exclude records from a query. The ! can be used for a specific value, or with the replacement characters. For example, !TP% to retrieve everything except borings starting with TP, or !%2015% to retrieve everything except borings with 2015 in their number.

- Use the drop-down lists to select a specific value in a field.

- In the drop-down lists, hold down the **[Ctrl]** or **[Shift]** key to select several non-consecutive or consecutive values, respectively. Then hit **[Enter]** or click outside the list to confirm the selection. The values will be displayed, separated by **;**. Multiple selections can indication exclusions. For example, !TP%;!%2014% to exclude all records starting with TP and those that have 2014 in their number.

Then, use the **[F8]** key, the button of the entry form toolbar or **Query > Execute** to execute the query. It will return all records from the database that correspond to the specified criteria and the status of the title bar will be Saved (paragraph 3.1). If no record corresponds, the entry form returns to New mode (to insert).

To cancel the query, use **[Ctrl]+[Q]** keys, the button of the entry form toolbar or **Query > Cancel**. The form returns to New mode (to insert).

The option **Query > View SQL** is active as soon as a query is done and show the SQL statement.

Figure 69 – Query mode

12. Customized queries (OBSOLETE)

WARNING: THE CUSTOMIZED QUERY FORM WILL BE REMOVED IN A FUTURE RELEASE. WE RECOMMEND USING SIMPLE QUERIES (PARAGRAPH 11).

Use the button of the application toolbar **Data > Retrieval by > Customized Query** to open the customized query form.

Figure 70 – Customized query form

12.1.   Creation of a condition

The creation of a condition is done in an empty row of the conditions table. The addition of a condition creates a new row in the conditions table.

12.1.1. Selective condition

By selective condition, we refer to a condition that has a chosen criterion in all its elements, with the eventual exception of **Null**. To create a selective condition, the steps are:

- Select a table from the database. Click in the cell of the **Table** column, then select the table in the scrolling list opened via the button, or directly type the table name.

  Selecting a table may automatically create join conditions (see paragraph 12.6).

- Select a field of the table in the cell of the **Field** column. This selection is done the same way as for the table; the scrolling list displays the fields from the selected table.

- Select an operator in the cell of the **Operator** column. This selection is done the same way as for the table and field.

  With the **Like** and **Not Like** operators, the "%" and "_" characters can be used in the value as a replacement character, as in a simple query (see paragraph 11). Do not confuse the **==** operator which is a join operator between two tables and the **=** operator which is the equality operator.

- Select one or many values, accordingly, in the cell of the **Value** column. If the operator is **=**, **Like** or **Not Like**, it is possible to choose several values, the separation character being "**;**".

  Hold down the **[Ctrl]** key and click on the desired values for non-consecutive values or use the **[Shift]** key for consecutive values, by clicking on the first and last value of the series.

  The list of the possible values in a condition depends on all other conditions defined in the table.

- Ask to retrieve the records that do not have a value in the field of the condition, by entering **Y** or **N** in the cell of the **Null** column. If the field chosen in the condition is not with required value, the **Null** cell contains **N** by default.

  Example: since borings are generally vertical, the DIP field will often contain no value, sometimes 90, and a value lower than 90 if the boring is not vertical. To retrieve only the vertical borings, the condition should be that the DIP field of the BORING table is equal to 90 degrees or empty, so with **Y** in the **Null** cell.

  Example: if the condition is on the CATEGORY field of the GRAIN_SIZE table with **Not Like** as the operator and «EX» as the value, the query will return all the records with a value other than EX in the CATEGORY field of the GRAIN_SIZE table. The records with no value in this field will only be retrieved if the condition contains **Y** in the **Null** cell.

12.1.2. Non-selective condition

A non-selective condition has one or many elements with no defined criteria.

- Example: If the user wants to retrieve the borings having a dip value entered in the database, whatever the value, and exclude the borings without a dip, he creates a condition on the DIP field of the BORING table using the "**<>**" operator, an impossible value, 370 for example, and **N** in the **Null** cell.

- Example: If the user wants to retrieve all the borings in which a piezometer is defined, he creates a condition in which he only selects the PIEZOMETER table and leaves empty the other elements of the condition. This condition is interpreted as a retrieval of the records of borings present in the PIEZOMETER table, without another specification.

12.2.   Modification of a condition

Modifying a condition is done by selecting a new element of this condition, the table, field, operator, value or presence of records with the empty field.

Changing an element in a condition erases all the elements in the cells to the right of the modified element. Therefore, changing the name of the table in a condition implies selecting a field from this table as well as the other elements of the condition.

Modifying a condition may lead to the deletion and/or addition of join conditions (see paragraph 12.6).

12.3.   Deletion of a condition

To select a condition, click in the grey cell on its left. A condition is selected when it is in reverse video. To delete a condition, select it and click on **Delete**.

Deleting a condition may lead to the deletion of join conditions (see paragraph 12.6).

12.4.   Insertion of a condition

Clicking on the **Insert** button inserts a new empty row in the conditions table. The new row is inserted at the top of the table if no condition was selected, or after the selected row. The user can then create a condition in the new row.

12.5.   Moving a condition

The user can move a condition in the table by selecting it and clicking on one of the buttons with an up and down red arrow, to move the condition up or down by one row in the table.

12.6.   Joint conditions

12.6.1. Automatic join conditions

The following example defines a join condition, more specifically an automatic junction condition.

To select all the borings from the "SMALL_DAM" site that have a piezometer, the user creates a condition on the SITE_NO field of the BORING table using the **=** or **Like** operator and the "SMALL_DAM" value. He then creates a new condition whose only criterion is the PIEZOMETER table. By selecting this table, two join conditions are automatically created. These conditions mean that the application must

locate all the borings identified by the pair SITE_NO - BORING_NO present in the BORING and PIEZOMETER tables.

For join conditions to be created automatically there must be a relationship between the tables of the conditions. In the previous example, the SITE_NO and BORING_NO fields in the PIEZOMETER table are not only part of the key of the PIEZOMETER table but also form an external key that links the PIEZOMETER table to the BORING table.

The elements of an automatically generated join condition cannot be modified but the condition can be deleted. This deletion may make the condition at the origin of the deleted join condition unnecessary (without any effect).

12.6.2. Join conditions entered by the user

This example explains when the user should create a join condition to specify the retrieval.

If the user wants to retrieve the borings that have the same category as at least one of their respective samples, he must create the following join condition.

4	SAMPLE	CATEGORY	==	BORING.CATEGORY	N

To create this join condition, the user creates a new condition on the table and field to compare, SAMPLE and CATEGORY in our example. He then selects the **==** operator. Choosing the value, "BORING.CATEGORY" in our example, is done via the scrolling list of the **Value** cell.

12.7. Viewing the SQL command

Clicking on the **SQL** button opens a tool tip showing the SQL command that will be launched with defined conditions.

12.8. Default conditions

Each application has specific default conditions. Selecting the **Default** value from the scrolling list associated to the **Name** field in the **Query** zone (see paragraph 12.10) replaces the content of the table with the default conditions of the application. The values entered as criteria for these conditions are the last values used.

For example, with **Log**, the default conditions are on the SITE_NO and BORING_NO fields of the BORING table.

12.9. Launch / cancellation of the query

To launch the data retrieval, click **OK** in the query editing window or press the **[F8]** key. The data found are then displayed in the graphs and objects defined in the style file used. Clicking on **Cancel** closes the query editing window without launching the data retrieval.

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12.10. Management of queries

The user can save a query in the database. A previously saved query can be selected, modified and deleted. The management of the queries are in the rectangle labelled **Query** in the editing window of the customized queries (Figure 70).

12.10.1. Selecting a query

To select a query in the database, click on the arrow button right of the query name field. In this list, the **Default** term is displayed first, followed by the saved queries in alphabetical order.

To choose a query from the list, click on its name. Then, the name of the selected query, its description and its conditions are displayed in the fields and table of the conditions editing window.

12.10.2. Saving a query

To be able to save the current query in the database, the name of the query must be different than **Default**, at least one of its conditions must have changed, or its description must have been edited. Then, click **Add**. If the name of the query already exists, it will be updated in the database. It is not possible to modify the **Default** query.

The name of the query is entered in the **Name** field of the **Query** zone. If a query is selected, the user can change its name. If the user provides a query name that already exists in the database, a message will notify the user and he must enter another one.

The **Description** field is used to enter a string of up to 255 characters to describe the query. It becomes active when a name other than **Default** is used. The button on the right of the **Description** field opens the text editing window.

12.10.3. Deleting a query

To delete a query, select it and click on the **Remove** button of the **Query** zone. The **Remove** button is not active for the **Default** query.

13. Google Maps

Use the button ⊞G of the application toolbar or **Data > Retrieval by > Google Maps** to open the Google Maps window to view the position of borings, sites and regions, as well as polygonal limits and axes depending on the module.

To use the tool:

1. Execute a simple query (paragraph 11), a query by limit (paragraph 14) or by group of records (paragraph 15), or a customized query (paragraph 12).
2. The longitudes and latitudes of the sites, borings and regions must have been defined or calculated in the database (paragraphs 5.1, 5.3 and 10.5 respectively).

3. For the calculations, the MTM or UTM coordinate system, the NAD 83 or 27 and the zone must be indicated for the sites in the SITE table so that the coordinate / longitude-latitudes conversions are done correctly.

When opening Google Maps, the map is positioned at the location of the data retrieved. By moving the map, any entity located inside the view is also displayed.

When data is displayed in Google Maps, place the cursor on an entity to display a tooltip with information about the entity. For borings, it includes the site and boring numbers, type, state, zone, northing, easting, ground elevation, rock depth, maximum depth, latitude and longitude. For sites and regions, it includes the site or region number, the zone, and the latitude and longitude of the site or region center.

Localisation

You can **center the map on a site** from the database, via the drop-down list that shows all sites whose longitude and latitude are defined or calculated.

The **latitude** and **longitude** of the **map center** are displayed. The user can modify the center manually or by moving the map with the mouse.

The **current zoom** varies between 1 (view of the Earth) to 21 (very close view). It can be set manually or changed with the mouse wheel.

Minimum zoom for display

The user can define the **minimum zoom for display the regions, sites and borings.** The entities will not be displayed on the map if the current zoom is smaller than the minimum zoom.

A minimum zoom can be defined for the markers indicating the location, as well as for the texts showing the entity number.

Data displayed

The five buttons open the drawing attributes window to define the appearance of the entities in Google Maps, including the marker (symbol) and the text for the identifications.

In the Pro and Site modules, the default attributes for the borings, axes and limits are those of curves #110 (Boring), #101 (Axis_Curve) and #120 (Limit) of the plan view. They can be modified as follows.

Regions and **Sites**:

- Define the marker and its diameter, and the font, its size and the text alignment.

- With **roadmap** and **terrain**, the marker and text are black.

- With **satellite** and **hybrid**, the color defined for the marker is used for the marker and the text.

Borings:

- Define the marker and its diameter, and the font, its size and the text alignment.

- o The marker for each boring is the one in the current markers file whose name is the concatenation of the type and state of the boring, for example, TP_R for a realized test pit.

- o If no corresponding marker is found, the one defined for **borings** is used.

- The **current boring** is always **red** (marker and text). It is the boring shown on the graphic page.

- The **retrieved borings** are always **blue** (marker and text). They are the borings retrieved in the query. The number of borings retrieved is indicated (including the current one).

- The **borings inside the domain** include all borings located in the domain of the map and visible at the current zoom. The total number is indicated.

  - o With **roadmap** and **terrain**, the marker and text are black.

  - o With **satellite** and **hybrid**, the color defined for the marker is used for the marker and the text.

Axes and **Limit**:

If the query is done via a polygonal limit or an axis, they will also be displayed in Google Maps.

- Define the marker, its diameter, and its color for the implementation points.

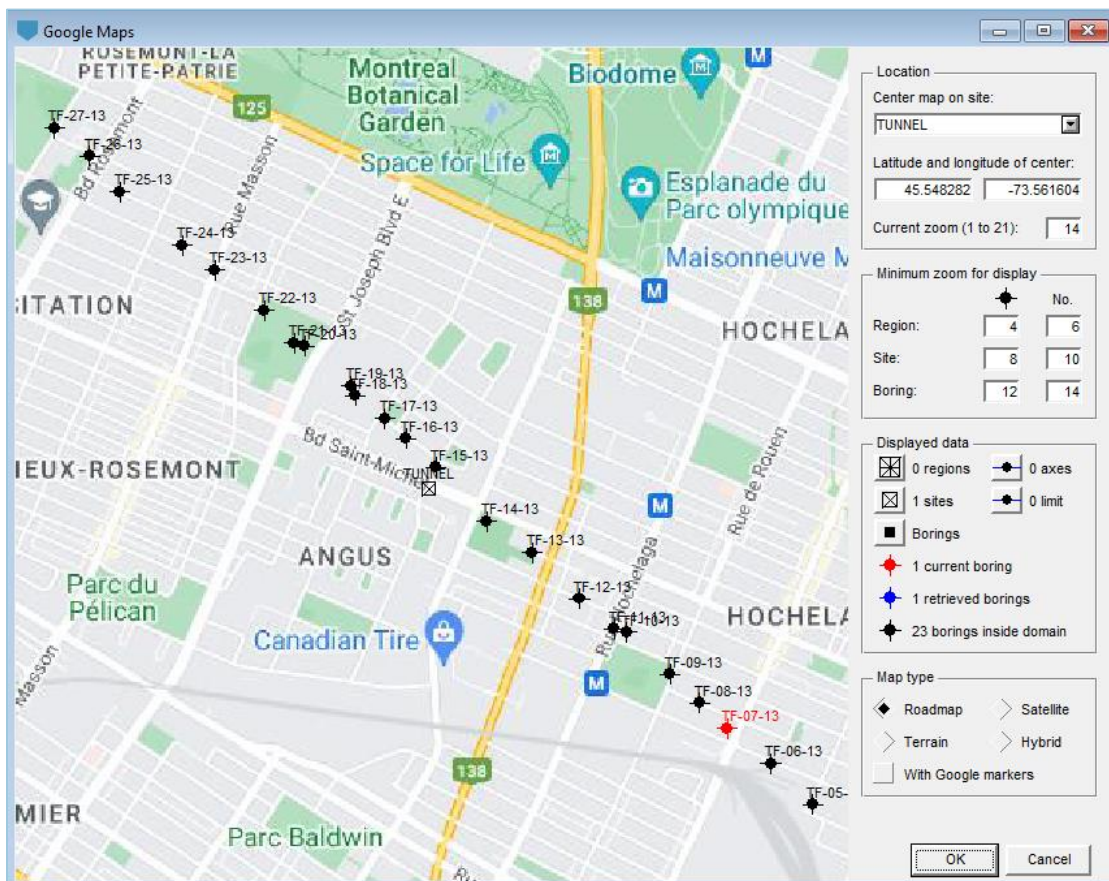- Define the line color and thickness representing the axis or the limit.

Figure 71 – Google Maps

Type of map

The standard map types can be selected for Google Maps: **Roadmap**, **Terrain**, **Satellite** and **Hybrid**.

13.1. Interactive editing

In Google Maps, do a right click with the mouse to display a contextual menu.
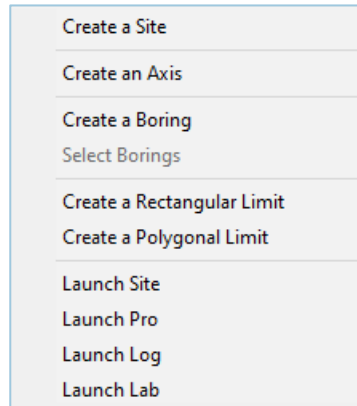
Figure 72 – Interactive editing in Google Maps

13.1.1. Create a site

By selecting **Create a Site**, the cursor becomes ╬. If the user wants to cancel right away, right click and select **Cancel**.

To create the site, click with the mouse at one corner of the new site, hold down and move the cursor to the diagonally opposite corner; a dotted line shows the area created. When the button of the mouse is released, the site entry form is displayed.

By default, the coordinate systems of the last site queried are used (MTM or UTM, NAD83 or NAD27). The X and Y coordinates of the bottom left corner, its longitude and latitude, the zone used for the calculation, as well as the width and height of the area are automatically entered.

The user enters the site number and any other information in the entry form, and saves the new site.

13.1.2. Create an axis

By selecting **Create an Axis**, the cursor becomes ✎. Click with the mouse at each point of the axis. A dotted line shows the movement of the cursor. When the last point of the axis is defined, right click and select **Cancel** to erase the axis being created, or **Terminate** to edit and save the new axis.

The axis entry form is then displayed and shows the coordinates of each point clicked. The axis points are converted to geodesic coordinates based on the systems defined in the site of the axis (MTM or UTM, NAD83 or NAD27).

The user enters the axis number and any relevant information in the entry form, and saves.

13.1.3. Create a boring

By selecting **Create a Boring**, the cursor becomes ✎. Click with the mouse at the location of the boring.

The boring entry form is then displayed and shows the coordinates of the added boring, based on the systems defined in the site of the boring (MTM or UTM, NAD83 or NAD27).

The user enters the boring number and any relevant information in the entry form, and saves.

13.1.4. Select borings

This option is disabled in Google Maps. It is active in the plan view of the Site module. Please refer to the Site documentation.

13.1.5. Create and modify a rectangular or polygonal limit

- By selecting **Create a rectangular limit**, the cursor becomes ╋. If the user wants to cancel right away, right click and select **Cancel**.

  Click with the mouse at one corner of the rectangular limit, hold down and move the cursor to the diagonally opposite corner; a dotted line shows the area created.

  When the button of the mouse is released, the limits entry form is displayed; the longitudes and latitudes of the 4 corners of the limit are automatically entered. The number of the current site is shown as limit number. The user can modify it, then save the new rectangular limit.

- By selecting **Create a polygonal limit**, the cursor becomes ✎. If the user wants to cancel right away, right click and select **Cancel**.

  Click with the mouse each point of the polygonal limit. A dotted line shows the movement of the cursor. When the last point of the polygonal limit is defined, right click and select **Terminate**.

  The limits entry form is then displayed; the longitudes and latitudes of each point of the limit are automatically entered. The number of the current site is shown as limit number. The user can modify it, then save the new polygonal limit.

Any rectangular or polygonal limit can be modified with the mouse. When the cursor is on a limit, it becomes +⁇. By right clicking, a contextual menu is displayed.

When **adding a point to the limit**, the cursor becomes ✎. The point will be added between the two points closest to the cursor. A message is displayed, showing the exact coordinates of the point. To stop the addition of points, right click and select **Terminate**.

When the cursor is on a point of the limit, the option **Delete this Point from Limit** is active. A message is displayed to confirm the deletion of the point.

When the cursor is on a point of the limit, it becomes +✥. By clicking on the point, it becomes ✋✥. Move the point to the desired position, and release the button of the mouse; a message is displayed to confirm the move.

14. Polygonal limits

Use the button ![icon] of the application toolbar or **Data > Retrieval by > Polygonal Limit** to open the entry form to define polygonal limits. The form will be directly in Query Mode, indicated in the title bar and by the dark blue background color of the form. See paragraph 11 for details about the queries.

The retrieval by limit is used to retrieve borings located within the coordinates of the limit.

1. Select the limit in the drop-down list.
2. Touch **[F8]** to execute the query.
3. The coordinates of the limit are displayed in the table and the corresponding borings are retrieved.

The form shows data from the LIM table and its secondary table LIM_POINTS of the Geotec database. It is used to define polygonal limits, a polygon or rectangle inside of which borings are located.

The **Rectangle <** and **Polygon <** buttons are active only in the **Site** module. They are used to define the limits directly with the mouse. See the Site documentation.

- The **limit number** is the key of the record. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

- The **reference** identifies the site where the limit applies. The drop-down list shows all sites defined in the SITE table. The coordinate system, NAD and zone of the reference site are used to convert between longitude / latitude and geodesic coordinates the entities and the map.

- A **cartographic file** can be associated to the limit, with a maximum of 255 characters. By clicking on the button right of the field, the Windows file selection screen opens, to select a .lim, .dxf or .xyz file. This cartographic file can be displayed in the **Pro** and **Site** modules.

    To save the file name with its full path, enable the option in the preferences. See the X3D documentation.

- The **description** contains a string of 255 characters to describe the limit.

The table at the bottom of the Polygonal limit form shows data from the LIM_POINT secondary table. The table is used to define each point of the limit.

- The **limit number** and the **index** together constitute the key of the records.

- The **index (I)** is the sequence number for the points of the limit, to determine the shape of the polygon. It is an integer.

- The **X** and **Y coordinates** of each point are then entered. Coordinates are either entered in meters in the coordinate system, NAD system and zone of the reference site, or in longitude / latitude. Values are required.

Figure 73 – Polygonal limits entry form

15.   Group of records

Use the button [icon] of the application toolbar or **Data > Retrieval by > Group of Records** to open the entry form to define groups of records. The form will be directly in Query Mode, indicated in the title bar and by the dark blue background color of the form. See paragraph 11 for details about the queries.

If data are already retrieved, the **Add** button will be active to create a new group of records.

1. Select the desired tab at the bottom of the form for the creation of the new group.
2. Click the **Add** button.
3. All records already retrieved will be shown in the bottom table, based on the tab selected.
4. Add a group number to save it in the database.

Otherwise, the retrieval by group of records is used to retrieve some records from the database, based on grouping criteria defined by the user.

1. Click on one of the 5 tabs at the bottom of the form, either to retrieve a group of Sites, of Axes, or Borings, of Samples or of Piezometers.
2. Then, Select the group number from the drop-down list.
3. Touch **[F8]** to execute the query.
4. The records from the group are displayed in the table and are retrieved.

The form shows data from the SEL table and its secondary tables SEL_SITE, SEL_AXIS, SEL_BORING, SEL_SAMPLE and SEL_PIEZO of the Geotec database. It is used to define groups of records based on user criteria. These groups can be retrieved via queries.

• The **group number** is the <u>key</u> of the record. Enter up to 20 characters with letters, numbers and symbols - _ ( ) . Accents and other special characters cannot be used.

• The **description** contains a string of 255 characters to describe the group of records.

- The **reference site and boring** is used mainly for groups of borings. It is used to define which boring will be the reference for the vertical alignment if several borings are superimposed on boring logs.

  The drop-down lists show all sites included in the group, then all borings of the selected site. You can also choose the reference site and boring by selecting a row of the table.

The tabs at the bottom of the Group of records form show data from the SEL_SITE, SEL_AXIS, SEL_BORING, SEL_SAMPLE and SEL_PIEZO secondary tables, respectively. The tabs are used to define to which type of entity the group applies.

The **group number** and the **columns present in the table** together constitute the key of the records.

Figure 74 – Group of records entry form

16. Import external data

You can import external data, typically CSV files, in a table of the database. Application files specific to a few tables can also be imported.

Click the button ⬛ of the application toolbar or **Data > Import Data** from the main window to open the import window. It can also be launched from the entry form toolbar (paragraph 3.2.10).

The format of the CSV files is detailed in paragraph 16.8.

16.1. Step 1: Select the table

If the import window was opened from an entry form, the **Table name** is inactive and indicates the current table. If it's opened from the main window, select from the drop-down list the table into which data will be imported.

16.2.   Step 2: Select the file or directory to insert

You can insert data from a single file, or from several files in the same directory at once. Click the desired checkbox, then click the **Browse** icon right of the Path field. A file selection or directory selection window opens to select the desired file or directory. It is also possible to use the drop-down list of the 9 last directories used via the **Path** field.

By selecting <u>a file</u>, its rows are automatically read and displayed in the tab **Content of selected file**. The file name and the total number of records read are shown in blue at the top of the tab.

By selecting <u>a directory</u>, the list of .csv files from that directory is displayed in the tab **List of files**.

The **Path** field gets updated with the path of the directory where the files are located.

16.3.   Step 3: Select the insertion and replacement options

When importing, all records whose keys do not exist in the database will be inserted. Additional insertion and replacement options can be selected.

- By checking the option **Create parent records**, records that are parent to the file data are created when importing if they don't already exist in the database. They will only be defined by their number. If the option is not checked and the parent records do not exist, the data will not be imported and an error message will be indicated in the report.

  Example: if a .csv file of samples is imported but the site and borings of the samples do not exist in the database, they will get created.

- By checking the option **Fill empty fields of existing records**, records are already present in the database will be updated with the file data, but only for their fields that were empty.

  Example: if a csv file contains the X and Y coordinates of borings already present in the database but whose fields EASTING and NORTHING are empty, these coordinates will be inserted.

- By checking the option **Replace different values of existing records**, records are already present in the database will be updated with the file data.

  If cells are empty in the .csv file, they will not affect existing values in the database.

  It is possible to delete values from the database. To do this, write **NULL** or **!** as value in the desired cells of the .csv file.

- If an archived site or boring exists in the database, the option **Also import into archived sites and borings** is active. Check this option to allow data to also be inserted into archived sites or borings. Otherwise, the records are skipped.

  In the transactions report, the archived data are listed if related records were not inserted because the option was not checked.
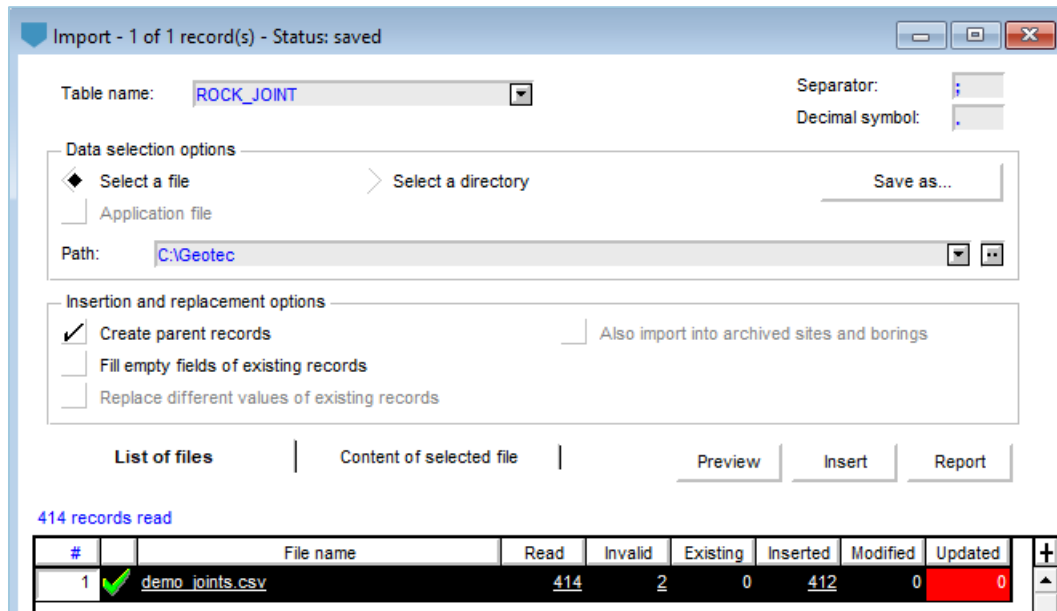
Figure 75 – Import external data

16.4.   Optional: Preview

The **Preview** button is used to see the results of the data import without executing it. In the **List of files** tab, check the desired file(s) via their cell to the right of their number and click **Preview**.

- The **Read** column indicates the number of valid records read in the file.

- The **Invalid** column indicates the number of records that do not have values for all keys of the table, or that have the same keys as another record.

- The **Existing** column indicates the number of records already existing in the database among those that are checked.

- The **Inserted** column indicates the number of records that will be inserted in the table.

- The **Modified** column indicates the number of records that will be modified in the table, in other words, a record where the value of at least one field will be modified. If options Fill empty fields or Replace different values are not checked, this column indicates 0.

- The **Updated** column indicates the number of fields that will be modified in the table, in other words, whose value will be modified. If options Fill empty fields or Replace different values are not checked, this column indicates 0.

All values greater than 0 are underlined. Double-click in a cell to open a file listing the corresponding records. Double-click on the file name to list the records of all columns. The file opens with the text editor selected in the preferences window. The file named **Preview_yyyy-mm-dd.txt** is saved in the directory of output files. It indicates:

- The date and time of the double-click

- The complete .csv file name

- The Geotec table involved

- The list of records based on the column clicked and their number in parentheses

16.5.   Optional: Data validation

To validate the content of a file from the **List of files**, check the desired file via the cell to the right of its number and click on **Content of selected file**. You can view the file data. If data is incorrect or incomplete, correct them here. Uncheck row(s) if you don't want to insert them.

You can resave the CSV file with the **Save as…** button. The new CSV file will include only the check rows and the corrected data, if applicable.

The **decimal symbol** and the **separator** are displayed for information only after reading the file.

16.6.   Step 4: Insert into the database

Click on the **Insert** button to save in the database using the insertion and replacement options. To insert data from multiple files, check the desired file(s) in the **List of files** tab before clicking on Insert. Then, the **List of files** indicates for each checked file:

- In **Read**, the number of valid records read in the file.

- In **Invalid**, the number of records that do not have values for all keys of the table, or that have the same keys as another record.

- In **Existing**, the number of records already existing in the database among those that are checked.

- In **Inserted**, the number of records inserted in the table.

- In **Modified**, the number of records modified in the table; in other words, the records where the value of at least one field was modified. This column applies only with options Fill empty fields and Replace different values.

- In **Updated**, the number of fields modified in the table; in other words, whose value was modified. This column applies only with options Fill empty fields and Replace different values.

After the import, a file opens with the text editor selected in the preferences window. The file named **Transactions_yyyy-mm-dd.txt** is saved in the directory of output files. It indicates the name and path of each file and the number of records read, invalid, existing, inserted, modified and replaced, if applicable, as well as the tables involved. Click on **Report** to reopen the transactions file.

16.7.   Application file

For the axis, piezocone and limits entry forms, it is possible to insert an application file with a specific structure. This option will then be active with the file extension indicated.

For the <u>piezocone</u> entry form, the **Application file** is a ***.drf** extension. By checking it, the option **Create parent records** is automatically checked. The *.drf file is used to automatically insert a lot of data in the CPTU and CPTU_POINT tables. See Appendix A – Importing *.drf files for piezocones.

For the <u>axes</u> entry form, the **Application file** is a *.prf extension (seismic profiles). By checking it, the option **Create parent records** is automatically checked. The *.prf file is used to insert profiles of stratigraphic layers along an axis and the measured seismic velocities. Please contact us if you need to exact format.

With the <u>limits</u> entry form, you can insert *.lim files generated via the Site module in SM2 mode.

16.8. Format of *.csv data files

The first row of a CSV file must contain the name of the fields to insert, as defined in the database. To know the exact name of the fields, use the **[F1]** key in the entry forms, or do a CSV data export beforehand (paragraph 17). From the 2nd row, put the values.

The CSV import verifies if the headings correspond to fields in the selected table. If yes, the values are read. If not, the column is ignored. **A column must exist for each primary key of a table**, otherwise the data cannot be inserted.

To delete data from the database, write **NULL** or **!** in the cell and check the option **Replace different** values. Table 8 shows how to delete the values from the GROUND_ELEV field for 7 borings.

Table 8 – Example of .csv to insert into the BORING table

SITE_NO	BORING_NO	EASTING	NORTHING	GROUND_ELEV
PETITE-DIGUE	TF-01	300000	5000000	!
PETITE-DIGUE	TF-02	300010	5000010	!
PETITE-DIGUE	TF-03	300020	5000020	!
SMALL-DAM	TP-01	300030	5000030	!
SMALL-DAM	TP-02	300040	5000040	!
SMALL-DAM	TP-03	300050	5000050	!
SMALL-DAM	TP-04	300060	5000060	!

Table 9 – Example of .csv to insert into the GRAIN_SIZE_POINT table

SITE_NO	BORING_NO	SAMPLE_NO	SIZE	PASSING
PETITE-DIGUE	PU-01	1	80	100
PETITE-DIGUE	PU-01	1	56	90
PETITE-DIGUE	PU-01	1	40	88.9
PETITE-DIGUE	PU-01	1	31.5	80
PETITE-DIGUE	PU-01	1	20	71
PETITE-DIGUE	PU-01	1	10	55
PETITE-DIGUE	PU-01	1	5	41.55

PETITE-DIGUE	PU-01	1	0.08	24.5
PETITE-DIGUE	PU-01	1	0.0351	13
PETITE-DIGUE	PU-01	2	80	98
PETITE-DIGUE	PU-01	2	56	87
PETITE-DIGUE	PU-01	2	40	68
PETITE-DIGUE	PU-01	2	31.5	51
PETITE-DIGUE	PU-01	2	20	41
PETITE-DIGUE	PU-01	2	10	27
PETITE-DIGUE	PU-01	2	5	25
PETITE-DIGUE	PU-01	2	0.08	8

17. Export data to CSV

To produce a CSV report with data from an entry form, click the button ▤➡ of the entry form toolbar, or use **Action > Export Data.** All data retrieved will be presented as rows in a CSV file. The heading of each column will be the field name.

If a customized format *name* other than Default is entered in the preferences window (see the documentation of X3D), the Layout used for the CSV report will be FORM_DEF_*name*. Otherwise, it will be FORM_DEF.

The Windows file saving screen opens on the directory of output files to save the file at the desired location.

18. Customize entry forms (Layout)

You can customize each entry form via the shortcuts in the forms (paragraph 3.2.9) or the contextual menu (paragraph 3.3.10). The Layout button 🔲 is also available in the application toolbar or via **Data > Layout** of the main window.

The layout window is used to customize the entry forms and the CSV files produced via the Export tool. The layout window is shown in Figure 76. A query can be done just like in the other entry forms to retrieve the layout of another entry form.

The first time an entry form is opened, a record for the table is created in REPORT and records in REPORT_COL, as the bottom of the layout form, the customize the fields of the entry form. **If a customized format *name* other than Default is entered in the preferences window (see the documentation of X3D), the Layout used for the CSV report will be FORM_DEF_*name*. Otherwise, it will be FORM_DEF.**

The changes done via the contextual menu or in Datasheet or Columnar display by moving a column, changing its dimensions or dragging it outside to hide it are saved in these 2 tables.

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The **Report parameters** section indicates that the reports produced are of CSV type. You can choose that the column headings of the CSV file be the field **name** or the field **title** defined in the bottom table. This option is used only if the report is produced via the Layout form. If the report is produced via the entry form, the heading is always the field name. See paragraph 17.
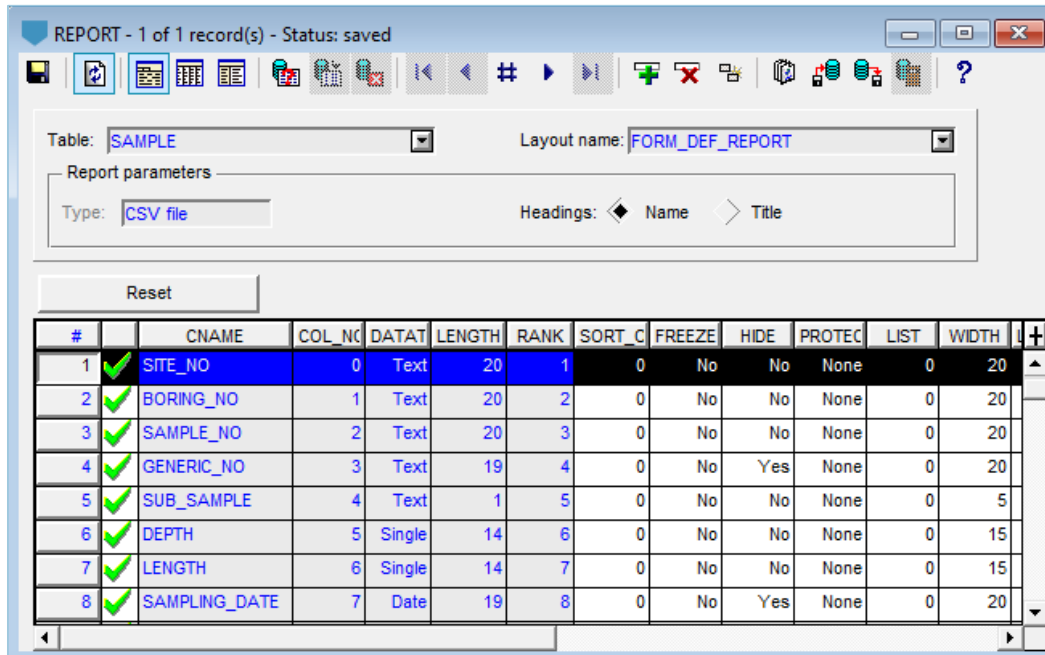
Figure 76 – Layout of entry forms and CSV reports

- **CNAME** contains the field names. The values cannot be modified.

- **COL_NO** contains the field number as defined in the database; the first field defined by # 0. The values cannot be modified.

- **DATATYPE** indicates the type of field (paragraph 3.3.2), as defined in the database. The values cannot be modified.

- **LENGTH** contains the maximum number of characters for the field. The values cannot be modified.

- **RANK** defined the order in which the columns or rows appear from left to right or top to bottom. To modify the order, select the row in the table by clicking its number in the first column and move to the desired place. The rank value will be automatically adjusted.

- **SORT_ORDER** is used to define the column(s) on which the data will be sorted after a query. **0** keeps the default sort. Otherwise, the data will be sorted by the field with **1** as order, then with **2**, etc. The data is always in ascending order.

- **FREEZE** allows to block horizontal scrolling and keep columns to the left of the frozen always fixed. Only one cell of the FREEZE column can be set to Yes. Double-click in the cell to switch from No to Yes and vice-versa.

- **HIDE** indicates if a field is visible or not in Datasheet and Columnar display. Double-click in the cell to switch from No to Yes and vice-versa.

- **PROTECT** indicates the protection against editing. It is active except for key fields and required fields. **None** indicates no protection. **Partial** indicates that the user can only select from a drop-down list. **Total** indicates that the field cannot be edited. Double-click in the cell to switch from one choice to another.

- **LIST** defined the type of drop-down list to use. It can only be modified for Text fields, except for primary keys and foreign keys.

  - **0: Default**. The list shows the records from the LIST_ENG table, and if there are none, the existing data from the database, for the current field.

  - **1: Distinct**. The list shows the existing data in the database for the current field.

  - **2: Value**. The list shows the values from the LIST_ENG table for the current field. Only one choice can be selected at a time.

  - **3: Description**. The list shows the descriptions from the LIST_ENG table for the current field. Only one choice can be selected at a time.

  - **4: + Value**. The list is the same as for Value, but the choices are concatenated after each selection.

  - **5: + Description**. The list is the same as for Description, but the choices are concatenated after each selection.

  - **6: No list**. No list is displayed.

- **WIDTH** shows in terms of number of characters the width of the columns in Datasheet mode. By default, the width is equal to 1 more than the length, but with 5 as minimum and 20 as maximum. The user can change the width. It is also modified when the user adjusts the column width with the mouse in Datasheet mode.

- **LINE_FEED** is used to force a word wrap on a value if it cannot be displayed fully in the cell in Datasheet mode. Double-click in the cell to switch from No to Yes and vice-versa.

- **FORMAT** is used only for numeric fields and dates. It is used to modify the format of the values in the entry form. The format in the database is not changed. A drop-down list suggests several formats depending on the type of data (numeric or date) but the user can enter others.

  - Either a **C** expression (%g, %.2f, %.0e, %s, etc.)

  - Either with a mask (999.99 for 2 decimals, 9.99e for scientific notation with 2 decimals, yyyy-mm-dd hh:mi for a date, etc.)

- **NULL_VALUE** is not used and will be deleted in a future version.

- **TITLE** is used to modify the name of the field heading in Datasheet and Columnar display. By default, the field name is entered.

- **DESCRIPTION** shows the tooltip message (paragraph 3.3.1). By default, the definition from the data dictionary is written. If the box **Custom description of the fields** of the preferences window is checked (see documentation of X3D), DESCRIPTION will be used. Otherwise, the tooltip shows the definition from the data dictionary in the language used in the module.

Select one or several rows of the bottom table and click on **Reset** to initialize to the default values.

19. References

19.1. Piezocone test

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19.2. Rock mechanics and rock tests

ASTM (2016) Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications. ASTM D 5731-16, West Conshohocken, PA.

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Palmström (2009) Combining the RMR, Q, and RMi Classification Systems. www.rockmass.net, 25p. Oslo, Norway.

19.3. Grain size analysis

MINISTÈRE DES TRANSPORTS DU QUÉBEC, LABORATOIRE DES CHAUSSÉES. LC 21–040 « Analyse granulométrique »

BUREAU DE NORMALISATION DU QUÉBEC. BNQ 2501-025 (2013) « Sols – Analyse granulométrique des sols inorganiques ».

ASTM (2002). Standard Test Method for Particle-Size Analysis of Soils. ASTM D 422-63 (Reapproved 2002), West Conshohocken, PA.

19.4. Water content and Atterberg limits

BUREAU DE NORMALISATION DU QUÉBEC. BNQ 2501-170 (2014) « Sols – Détermination de la teneur en eau ».

BUREAU DE NORMALISATION DU QUÉBEC. BNQ 2501-092 (2014) « Sols – Détermination de la limite de liquidité à l'aide d'un pénétromètre à cône et de la limite de plasticité ».

BUREAU DE NORMALISATION DU QUÉBEC. BNQ 2501-090 (2005) « Sols – Détermination de la limite de liquidité à l'aide de l'appareil de Casagrande et de la limite de plasticité ».

ASTM (2000) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. ASTM D 4318-00, West Conshohocken, PA.

19.5. Proctor test

ASTM (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort. ASTM D 698-07, West Conshohocken, PA.

ASTM (2012) Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort. ASTM D 1557-12, West Conshohocken, PA.

ASTM (2007) Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles. ASTM D 4718-87 (Reapproved 2007), West Conshohocken, PA.

BUREAU DE NORMALISATION DU QUÉBEC. BNQ 2501-250 (2013) « Sols – Détermination de la relation teneur en eau – masse volumique sèche – Essai avec énergie de compactage normale ».

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19.6. Consolidation test

MINISTÈRE DES TRANSPORTS DU QUÉBEC, LABORATOIRE DES CHAUSSÉES. LC 22–301 « Essai de consolidation à l'oedomètre »

MINISTÈRE DES TRANSPORTS DU QUÉBEC, LABORATOIRE DES CHAUSSÉES. LC 22–320 « Détermination du coefficient de perméabilité des sols à l'oedomètre (méthode à charge hydraulique variable) »

ASTM (1996) Standard Test Method for One-Dimensional Consolidation Properties of Soils. ASTM D 2435-96, West Conshohocken, PA.

Appendix A – Importing *.drf files for piezocones

For the <u>piezocone</u> form, the application file is a *.drf file. It is used to automatically insert a lot of data in the CPTU and CPTU_POINT tables.

A1. Converting a file from Excel to *.drf

The following steps explain how to convert an Excel file to the *.drf format. Below is an example of the beginning of a *.drf file:

XYZ 2014-11-29 12:15 Sobek Technologies
SITE PROBE a b BORING
1.63,295.83,42.6894,-2.781
1.64,642.19,36.1549,-2.693
1.65,867.01,32.1005,-2.535
1.66,1338.82,25.3348,-2.341

1. Validate the data in the Excel file by removing or correcting any error.

2. Only keep the DEPTH, QT or QC, FS and U2 columns, in this order.
    The values are in meters, then kPa, kPa, kPa. See paragraph A3 if the values are in different units.

3. For the 1st line, enter the following string in the first cell:
    XYZ yyyy-mm-dd hh:mi TECHNICIAN

    a. XYZ must be present to decode the file.

    b. The following value is the date and time of the test, in yyyy-mm-dd hh:mi format. If the exact time is not recorded, enter 00:00.

    c. The following value is the name or listing of the technicians.

4. For the second line, enter the following string in the first cell:
    SITE PROBE BORING

    a. SITE is the site number (project).

    b. PROBE must have 3 parts separated by spaces (ex: STD 20T AD122, or A B C).

    c. The last value is the boring number.

5. On line 3, add **qt** if QT is the input, **qc** if QC is the input. If no input is indicated and the values begin at line 3, a message will prompt the user to select QT or QC as the input during the import.

6. The values start at line 4, or at line 3 if the previous step is skipped.

7. Save this version of Excel, save as CSV file (Comma delimited or semi-colon delimited) and say Yes to the format change.

8. Open the CSV file with a text editor (notepad, etc.)

9. At the end of the first 3 lines, delete the 3 commas (or semi-colons) and save.

10. Rename the file extension from CSV to DRF. The values should all be separated by commas (or semi-colons).

A2.   Importing a *.drf file

You can import directly into Geotec the DEPTH, QT or QC, FS and U2 data from a .drf file. These data will be inserted into the fields that have the same name, in the CPTU_POINT table. You can then calculate several parameters and results.

1. Open the piezocone (CPTu) entry form.

2. Click on the **Import** icon 🖫 in the toolbar of the entry form.

3. Select the options **Application file** and **Create parent records** to create the site and boring automatically.

4. Select the *.drf file to import by clicking on the **Browse** button next to the **Path** field.

5. Click the **Data from current file** tab.

6. If the cone resistance input isn't specified in the .drf file, a message asks the user to select qt or qc. **This selection is saved for the following .drf files that will be imported without a specified input. To change your selection, close and reopen the piezocone form.**

7. Click on **Insert.**

It is possible to import several *.drf files at once with the option **Select a directory**, just like for CSV files (paragraph 16.2).

If values of QT or QC are smaller than 11 kPa or 0.011 MPa, data for these depths are not imported.

If values of FS are < -999, they are imported as NULL.

A3.   Data units for DEPTH, QT or QC, FS and U2

Geotec considers that the piezocone data are in meters in the 1st column (depth), and in kPa in columns 2 (cone resistance), 3 (friction) and 4 (porewater pressure).

It is possible to force another unit system for the last 3 columns by adding the following two lines after the last row of data:

==

Units: meters,MPa,kPa,m

The line starting with **Units** defines the unit system. This example indicates that in the 1st column, the data are in meters; in the 2nd, in MPa; in the 3rd, in kPa; and in the last, in meters.

The units must be separated by the same separator as the values, either the comma or the semi-colon.

When the unit indicated is MPa, the values are multiplied by 1000 to convert them to kPa when they are inserted into the database.

When the unit indicated is m, the values are multiplied by 9.81 to convert them to kPa when they are inserted into the database.

A4. Automatic updates done in the database upon import

When we import data from a .drf file, several values are inserted automatically into fields and tables of Geotec.

- If the SITE does not exist in the database, it will be created upon import if the option **Create parent records** is checked.

- If the BORING does not exist in the database, it will be created upon import if the option **Create parent records** is checked.

- The boring TYPE is set to CP (Piezocone) in the BORING table.

- The greatest depth read in the .drf file is inserted into the TOTAL_DEPTH field of the BORING table.

- The date and time are inserted into the DATE_START field of the BORING table.

- The name or list of technicians is inserted into the CARRIED_OUT_BY field of the BORING table.

- The value D is inserted into the T field of the CPTU, BORING and SITE tables when the records did not already exist in the database, to indicate an import by .drf file.

- If the CPTU does not exist in the database, it will be created upon import if the option **Create parent records** is checked.

- The smallest depth read in the .drf file is inserted into the DEPTH_FIRST field of the CPTU table.

- The greatest depth read in the .drf file is inserted into the DEPTH_LAST field of the CPTU table.

- The groundwater depth entered in the BORING table is inserted into the WATER_DEPTH field of the CPTU table.

- The default type of density is V (variable) in the D_TYPE field of the CPTU table.

- The probe is inserted in the PROBE field of the CPTU table.

- The DIAMETER of the cone is 20 mm by default.

- The AREA_RATIO of the cone is 0.8 by default.

- The increment between two values (in mm) read in the .drf file is inserted into the READING_STEP field of the CPTU table.

- The radio button for Total resistance qt or for Tip resistance qc is selected to indicate the input. The corresponding field INPUT_QC is 0 for QT, 1 for QC.

- The default calculation parameters are:
    - Nkt = 14
    - Nst = 3.08

- o Su/Pc = 0.22
- o Min Ic = 2.6
- o Cq max = 1.7
- o Dr constant = 350