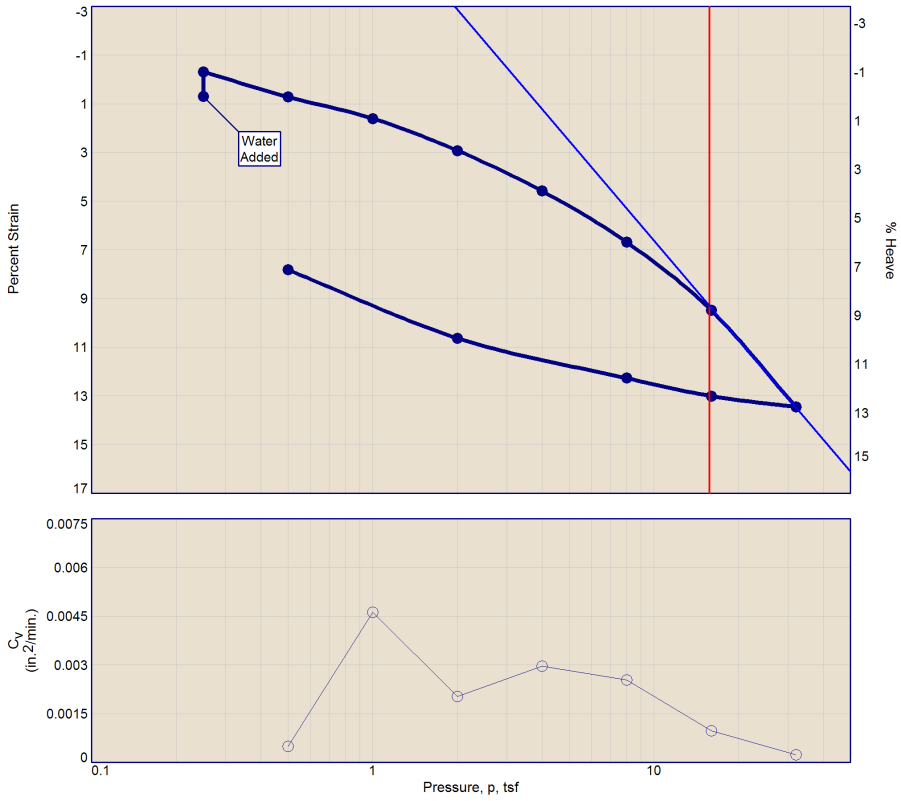
GEOSYSTEM® CONS
Version 4

Software for Swell and Consolidation Test Data Reduction

CONSOLIDATION TEST REPORT



SUMMARY OF TEST RESULTS

	DRY DENSITY (pcf)	MOISTURE CONTENT, (%)	SATURATION (%)	VOID RATIO	SPECIFIC GRAVITY	OVERBURDEN (pcf)	P_C (pcf)	C_C	SWELL PRESS. (pcf)
INITIAL	71.2	19.6	38.2	1.414	2.752	2	16	0.33	0
FINAL		18.9	42.4	1.225					

Source of Sample: Boring B-2 **Depth:** 0-2.5' **Sample Number:** S-1
Material Description: Dark Brown Sandy Lean Clay w/ Organics & Rubble **USCS:** CL **AASHTO:** A-6(11)
Remarks:

ALV ENGINEERS

Client: County of Berthoud
Project: Berthoud County Landfill Expansion
Project No.: P91003-24 **Figure**

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Contents

1. Introduction

CONS reduces and reports data from a one-dimensional consolidation of swell test. Calculations are compliant with ASTM D2435 and D4546 (Methods "A" and "B") and AASHTO analog standards.

⇒ If you're upgrading from an earlier GEOSYSTEM program, check this web page for a quick rundown of the new features included in the latest release.

1.1 Tutorial

If you're just starting out with the software, consider taking the program's thirty minute tutorial:

1. Start your GEOSYSTEM package.
2. Select Project > Open, navigate to **`C:\Users\Public\Documents\GEOSYSTEM`** if you've installed the software locally, or navigate to the program's installation directory if you've installed it on a network share.
3. You should find a GEOSYSTEM project file called **`DEMO`**: double-click on it.
4. The software will display the contents of the DEMO project. On the left side of the screen is a yellow box listing the material sources from which the DEMO project's testing samples were taken: click on either **`Boring B-4`** or **`B-4`**.
5. On the right side of the screen you should see a list of samples taken from Boring B-4: find the data entry card for sample **`S-4`** and click on CONS at the bottom of that card.
6. Select Help > Tutorial, and the program will begin displaying a series of yellow tutorial cards at the bottom of the data entry window.

1.2 Contacting Technical Support

If you have any questions on installing or operating our software, please feel free to contact GEOSYSTEM technical support. We do not charge for support, though we can only help with software that we are currently selling (we cannot answer questions about older versions our programs). You can contact us through our support page at http://www.geosystemsoftware.com/support.htm .

⇒ If you think that the program's calculated results "don't look quite right", please give us something more to work with: do the calculations by hand and fax your calculations to +1 970/223-8788 prior to submitting a support question.

2. Configuration

CONS features a number of configurable options for data entry, test results calculation and report generation. Before typing in your first test set you should make sure that the package is correctly configured for your specific testing and reporting standards. To do this, select Options > CONS Setup.

⇒ Note that these settings affect every test entered into the current project file.

2.1 Data Entry Options

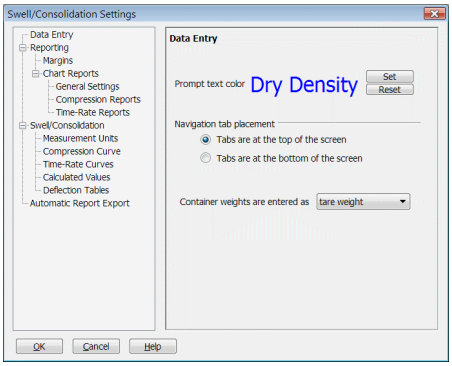


Figure 2.1: Data Entry Settings

Selecting Options > CONS Setup then clicking on **Data Entry** in the navigation list at the dialog's left side provides you with the following options:

Prompt text color

Sets the color of all data entry prompts. Click **Set** to select a color or **Reset** to restore the program's default color.

Navigation tab placement

Navigation tabs allow you to change from one window to another (for example, between the test data entry window and the report preview window). The tabs look like this: 

Navigation tabs may be placed at either the top or the bottom of the screen by selecting one of the **Navigation tab placement** options.

Container weights are entered as

CONS can be set up to keep a list of container IDs and associated weights – when entering moisture content data, instead of entering the container weight you can enter the container ID and the program will look up the associated weight. To do this, select **Tare ID** in this box then enter your list of container IDs and weights into the program's container database (Options > Container List).

2.2 Loading Frame Deflections

Loading frame deform when subjected to increasing stresses. ASTM D2435 requires that a table of loading frame deflections be generated for the various loading pressures utilized in a consolidation test; readings are taken using a non-deformable disk in place of the sample (optionally with filter paper if it will be used in the actual test). When the actual consolidation test is performed test readings are adjusted to account for the measured deflections.

CONS maintains a database of deflection tables; when you start entering a new consolidation test you can select a table from this database and have the program adjust your test's readings according to the list of deflections from this table. To add your own deflection table to the database, select Options > CONS Setup then click on **Deflection Tables** in the left-hand navigation panel.

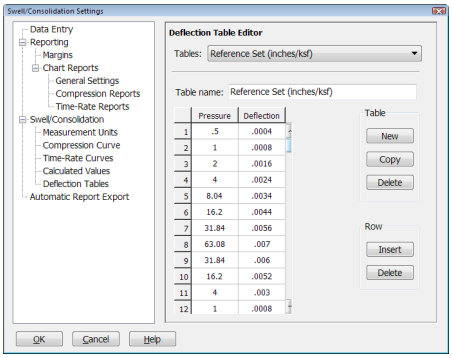


Figure 2.2: Deflection Table Editor

1. Click on the **New** button in the **Table** box on the right side of the dialog.
2. At the **Table name** prompt, enter a unique ID for your deflection table (i.e., one that's not already used for one of the deflection tables currently stored in the program's database).
3. After you've entered your table name, pressing Enter brings you to the deflection readings grid. For each deflection reading that you've taken, enter the pressure and corresponding deflection dial reading.

   ⇒ ***CONS*** assumes that the dial gauge is zeroed prior to the start of the calibration procedure.

   ⇒ Use the same measurement units for your deflections as will be used for entering the consolidation test data.

   ⇒ All deflection readings should be positive. If your dial gauge decreases in readings with compression, you still need to enter the reading as a positive amount of deflection.

   ⇒ Deflection table pressures should be in the same units that will be used to enter your test pressures.

⇒ If an unload and/or reload cycle was included as a part of the calibration the table will feature multiple entries for the same loading pressure (one for the initial loading, one for the unload, then another for the reload, etc.). When ***CONS*** applies the table to your consolidation test it determines which calibration entry will be used for a given loading increment based upon whether or not the increment was an initial loading cycle, an unloading cycle, or a subsequent reloading cycle.

⇒ The loading increment immediately prior to a water-added cycle and the water-added cycle itself share the same loading pressure and deflection. Enter a pressure/deflection line for the loading increment immediately prior to the water-added cycle, but do not enter a line for the actual water-added cycle.

2.3 Reporting Options

The following subsections cover settings that affect the program's printed reports.

2.3.1 Printout Margins

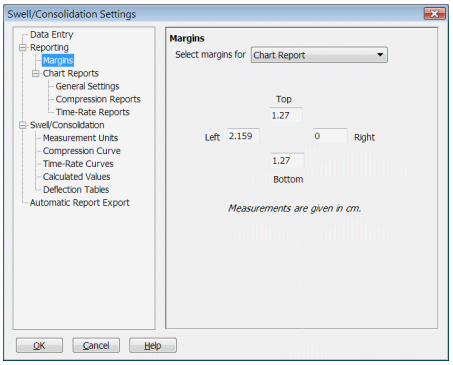


Figure 2.3: Setting the Report Margins

The **Margins** selection on the Setup dialog (Options > CONS Setup then click on **Margins** in the navigation list at the dialog's left side) allows you to select the whitespace used at the top, bottom, left and right sides of chart and summary reports.

⇒ The measurement units (inches or cms.) used for specifying margins are determined by the Regional settings in the Windows Control Panel.

2.3.2 General Chart Report Options

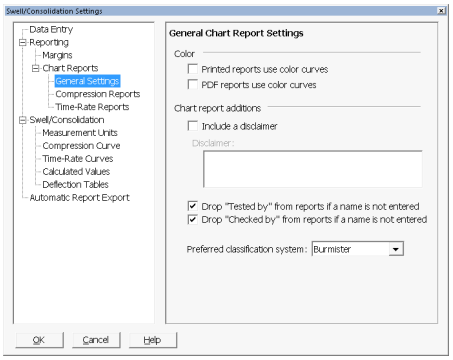


Figure 2.4: General Chart Report Settings

The basic appearance of the chart reports generated by ***CONS*** can be customized by selecting Options > CONS Setup and then clicking on **General Settings** underneath **Chart Reports** in the navigation list at the dialog's left side.

⇒ The software also includes separate report settings pages for options that are specific to compression reports and specific to time-rate reports.

Printed reports use color curves

If selected, curves plotted on chart reports are shown in a program-selected color.

PDF reports use color curves

Determines whether chart reports exported as .PDF files show curves in program-selected colors.

Include a disclaimer

If selected, a disclaimer is printed down the left margin of chart reports. The disclaimer is listed in the Disclaimer field directly below the checkbox, and may be modified after checking the **Include a disclaimer** box.

Drop "Tested by" from reports if a name is not entered

The Sample Info. window includes a data entry field titled **Tested by**. This field, along with the **Drop "Tested by" from reports if a name is not entered** checkbox on the program's setup dialog affects the appearance of chart reports:

- If you do not fill in the **Tested by** data entry field and **Drop "Tested by" from reports if a name is not entered** is *not checked*, "Tested by" will appear below chart report's bottom margin, along with an area for a signature.
- If you do not fill in the **Tested by** data entry field and **Drop "Tested by" from reports if a name is not entered** is *checked*, "Tested by" will NOT appear below chart report's bottom margin.
- If the **Tested by** data entry field is filled in: "Tested by" will appear below chart report's bottom margin, followed by the name entered into the **Tested by** data entry field.

Drop "Checked by" from reports if a name is not entered

Is similar to **Drop tested by**... discussed above. Leaving this box unchecked and leaving the **Checked by** data entry field blank provides an area below chart reports' bottom border for the report's reviewer to sign the page.

Preferred classification system

While not currently used in stock ***CONS*** report forms, the software has the capability to include a single user-selected soil classification (USCS, AASHTO, etc.) on a custom report format. The **Preferred classification system** box selects which classification would be included on the report.

2.3.3 Compression Curve Report Options

Selecting Options > CONS Setup then clicking on **Compression Reports** underneath **Chart Reports** in the left-hand navigation panel gives you a list of settings that control the appearance of compression curve chart reports.

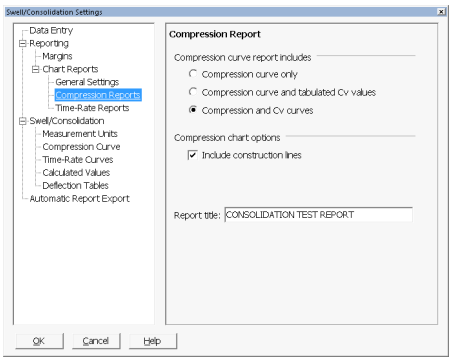


Figure 2.5: Compression Report Settings Options

Compression report includes

You can include a graph of C_v vs. $\log_{10}(pressure)$ or a table of C_v results underneath the compression chart by selecting the **Compression and Cv curves** or **Compression curve and tabulated Cv values** options, respectively. Select the **Compression curve only** option to omit all time-rate data from the compression report.

⇒ Neither the C_v table nor the C_v graph will be plotted unless time-rate data have been entered for several loading increments.

⇒ By design, values on the C_v vs. $\log_{10}(pressure)$ *do not* plot at the pressures corresponding to their loading increments. ASTM D 2435 specifies (in 13.2.6.3 of the 2011 standard revision) that the C_v values be plotted vs. the log of the *average* applied during increment. (See the standard's Note 23 for the committee's rationale.)

Include construction lines

If you select this option ***CONS*** will include the C_c and P_c construction lines on compression curve reports.

Report title

The chart report title is a single line of text shown at the top of the compression chart report. Typically the title reads, e.g., **`Swell/Consolidation Test Report`**.

2.3.4 Time-Rate Curve Report Options

Selecting Options > CONS Setup then clicking on **Time-Rate Reports** underneath **Chart Reports** in the left-hand navigation panel gives you a list of settings that control the appearance of deformation vs. $\log_{10}(time)$ or vs. $\sqrt{time}$ chart reports.

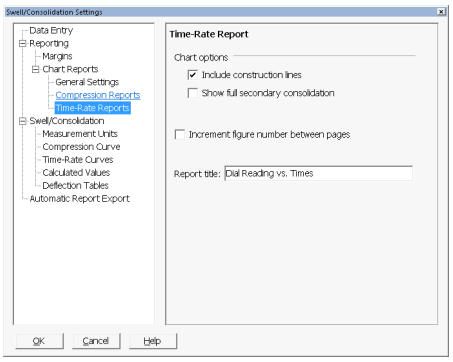


Figure 2.6: Time-Rate Report Settings Options

Include construction lines

If you select this option ***CONS*** will include the C_v construction lines on the time-rate charts.

Show full secondary consolidation

The primary consolidation portion of many $\sqrt{time}$ curves occupies only the left 10 or 20 % of the time-rate graph, which makes it difficult to accurately place the C_v construction. Unchecking the **Show full secondary consolidation** box expands the primary portion of the time-rate curve to occupy the entire width of the chart.

⇒ This option only takes effect when time-rate curves are plotted on chart reports. The on-screen curve display always shows the full chart.

Report title

The chart report title is a single line of text shown at the top of the time-rate chart report pages. Typically the title reads, e.g., **`Dial Reading vs. Time`**.

2.3.5 Automatically Exporting Reports

CONS can automatically export versions of its test reports into a selected hard disk subdirectory. This feature can be used to maintain an archival copy of a project's reports (which is useful because it's always better to store your data in as many formats as is possible if you want to be able

to review your results many years down the road), or, if your webserver's directories are available from your local network, you can make your test reports web-accessible by configuring ***CONS*** to automatically store copies of each test report in a webserver directory.

⇒ If your webserver is not accessible from your local network, you can use the GEOSYSTEM Bindery program to export your test reports to the web and notify your clients via e-mail that new reports are available for review. The program can also fax and e-mail your reports directly to clients.

For more information, please see www.geosystemsoftware.com/bindery .

If you select Options > CONS Setup then click on **Automatic Report Export** in the left-hand navigation panel, you'll be presented with the following dialog and options:

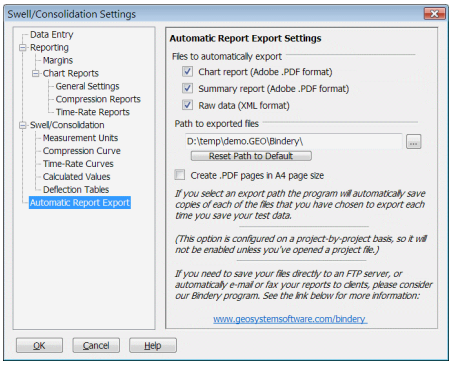


Figure 2.7: Automatic Report Export Dialog

Chart report (Adobe .PDF format)

If this option is checked, ***CONS*** will automatically export the test's chart report in a format readable by Adobe Acrobat Reader.

Summary report (Adobe .PDF format)

If this option is selected, ***CONS*** automatically exports the test's summary report into an Adobe Acrobat .PDF file.

Raw data (XML format)

If this option is selected, ***CONS*** exports an XML file listing the test's data and calculated results.

Path to exported files

This is the file path to where you want to store your exported files. If the path does not exist, the program will offer to create it for you when you click on the dialog's **OK** button.

Reset Path to Default

This sets the **Path to exported files** to be a directory called "Bindery" stored *inside* your project's data file folder, which is useful if you want to export your reports as an archival copy of your data.

Create .PDF pages in A4 page size

If this box is *not* checked, ***CONS*** will export your reports as letter-sized (8.5" x 11.0") pages; if the box *is* checked, the .PDF reports will be created as A4-sized (210mm. x 297mm.) pages.

⇒ ***CONS*** starts the test report exporting process when you select Save and Exit or when you click on the program's close button. This may delay the program for a few seconds while exiting.

2.4 Measurement Units Settings

Selecting Options > CONS Setup then clicking on **Measurement Units** in the left-hand navigation panel allows you to select the units used to enter and report your testing data and results.

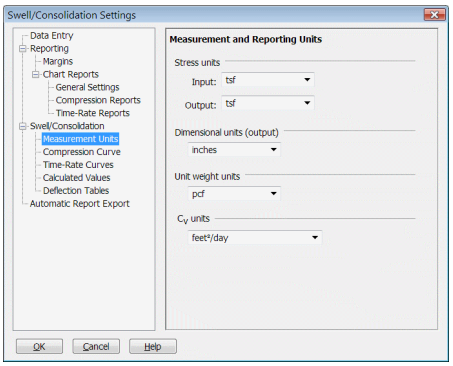


Figure 2.8: Measurement Units Selections

Stress units

Use the **Input** and **Output** selection boxes to specify the units used when recording the test's loading pressures and the units to be used when reporting those pressures on chart reports. (The program will automatically convert between the input and output units.)

Dimensional units (output)

Use this selection to specify the units used for reporting sample dimensions and test readings. (The software uses the project's dimension units setting – specified by selecting Project > Dimension Units immediately after opening the project – to determine the input dimensional units for swell/consolidation test data.)

Unit weight units

Selects the units used for reporting the calculated dry density in the Sample Info. window.

C_v units

Selects the units to be used for reporting time-rate C_v values.

2.5 Compression Curve Options

There are several options that govern the general appearance of plotted compression curves (other settings control compression report *plotting*). To modify these settings, select Options > CONS Setup then click on **Compression Curves** in the left-hand navigation panel.

Start the compression curve at

You can choose between plotting your compression curves starting at the left edge of the chart (and ordinate equal to either e_0, zero percent strain or zero deflection) or starting at the first test point.

ASTM D4546 compatibility

If this option is chosen, swell curves will include a right-hand scale indicating percent heave and the **Heave %** will be reported on selected compression curve chart reports instead of **Swell %**.

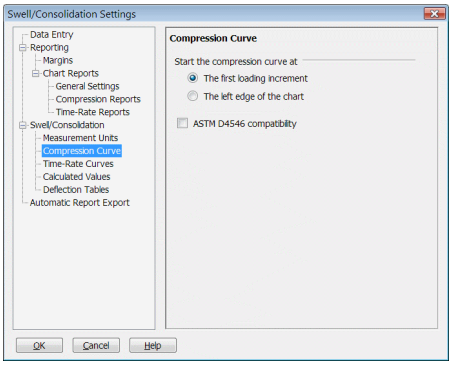


Figure 2.9: Compression Curve Sieve Settings Dialog

⇒ See this for instructions on selecting between plotting a void ratio, percent change or deformation curve.

2.6 Time-Rate Curve Options

The software has a couple of settings that govern time-rate curves in general (other settings control time-rate chart *plotting*). To modify these settings, select Options > CONS Setup then click on **Time-Rate Curves** in the left-hand navigation panel.

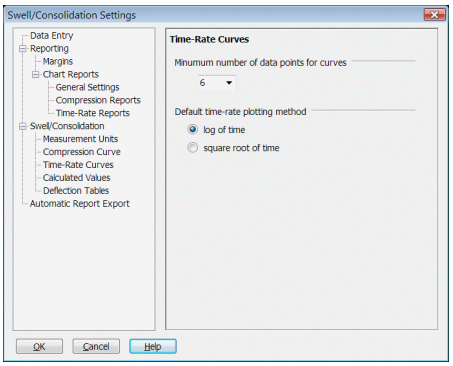


Figure 2.10: Time Rate Curve Settings Dialog

Minimum number of data points for curves

CONS needs at least four data points to calculate C_v results for a loading increment, but you can enforce your own data standard by changing this option.

Default time-rate plotting method

Given enough data points for a loading increment ***CONS*** displays either a $\sqrt{time}$ or $\log_{10}(time)$ chart in the bottom-left of the screen. The **Default time-rate plotting method** setting determines which graph is shown.

⇒ Once ***CONS*** makes its initial selection for an increment you can still swap between the two chart types by clicking on the button in the time-rate chart display's top-right corner.

2.7 Calculated Results Options

Selecting Options > CONS Setup then clicking on **Calculated Values** in the left-hand navigation panel gives you a list of settings that affect the way the program performs a couple of calculations.

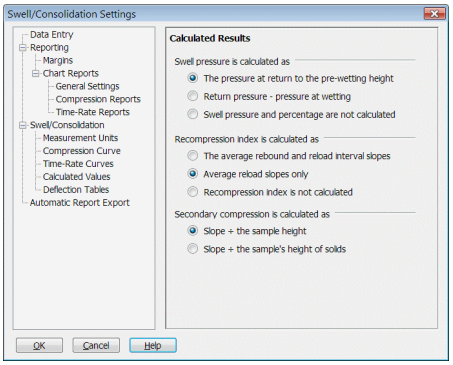


Figure 2.11: Calculated Results Options

Swell pressure is calculated as

Various sources give the swell pressure calculation as either simply the pressure required to reduce the swelled sample height back to its pre-wetting height, or that pressure *minus* the pressure at wetting. This option allows you to choose between the two methods. (**Swell pressure and percentage are not calculated** prevents the program from reporting either values on the data summary or the chart report.)

Recompression index is calculated as

Again, there are two definitions for recompression index: the average of the slopes of the compression curve reload intervals, or the average of the slopes of both the unload and reload intervals. Use this option to select the desired calculation method.

Secondary compression is calculated as

C_α, the $\sqrt{time}$ coefficient of secondary consolidation, can be reported as either the slope of the secondary compression portion of the curve divided by the height of the sample, or by the height of solids (the later option of course requires entry of a specific gravity value.

3. Entering Test Data

Data entry for a swell or consolidation test is split into a number of separate steps:

- Sample and test background information, which covers basic information about the test and the sample tested.
- Loading increment readings data entry.
  - A *loading increment* encompasses all of the readings taken while specific pressure was applied to the sample. The term's used generically to refer to load, unload and reload intervals.
- Review and adjust time-rate curve constructions.
- Review and adjust the compression curve constructions.
- Preview and print the final test reports.

Begin your test entry by clicking on the underlined CONS at the bottom of a GDM sample data card.

3.1 Sample and Test Information

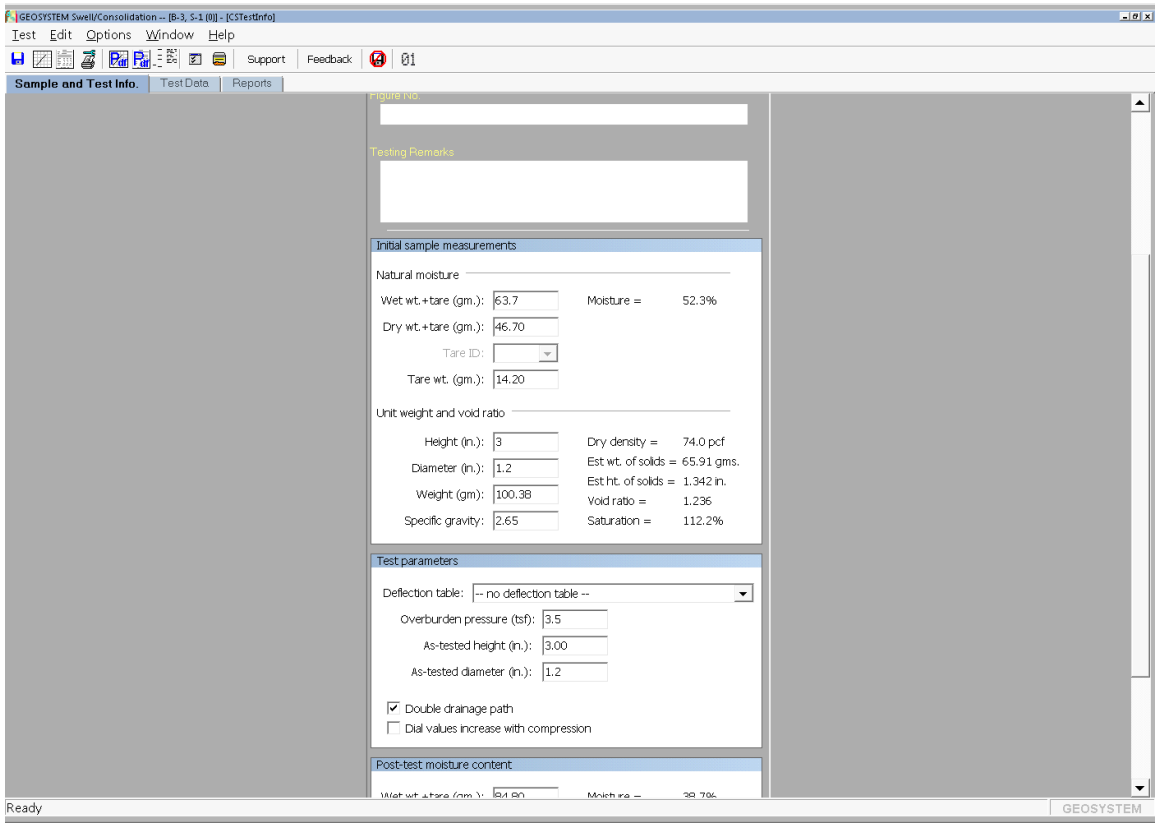


Figure 3.1: Sample Info. Window

The swell/consolidation initial data entry window covers basic information about the test and the sample tested. This window is displayed by clicking on the **Sample Info.** navigation tab, or by selecting Window > Sample and Test Info..

3.1.1 Background Sample and Test Information

The top portion of the window is devoted to background information on the sample and the test – the material description, classification, who ran the test, remarks on the test procedure, etc. Some of these items may be automatically filled in by other data reduction modules: For example, if you've licensed ***LabSuite*** or ***CLSuite*** the sample's USCS classification is automatically calculated if you've entered sieve and Atterberg testing data. Leave these fields blank; after you've completed data entry for the lab tests, the missing information will be automatically filled in.

Also note that because ***CONS*** supports a number of different report formats, the information requested on the top portion of the Sample Info. window may vary according to which report format is selected; e.g., some formats may include a place for listing the sample's USCS classification, while others may omit this information.

⇒ You can select from the program's different report forms with the **Report form** toolbar at the top of the report preview window (Window > Reports).

⇒ Regarding the **Tested by** and **Checked by** fields: If you fill in either of these fields, the information that you enter will be shown below the border of the test's chart report. If you do not fill in one of these fields, the corresponding "Tested By"/"Checked By" text may either a) be removed from the bottom of the chart chart report, or b) still be included, with an empty space for a signature, depending upon the **Drop "Tested by" from reports if a name is not entered** and **Drop "Checked by" from reports if a name is not entered** configuration selections.

Regarding the **Material description** field: ***CONS*** normally uses the material description that you entered into the **Material Description** field on the Data Manager window (that's the window with the numbered sample cards where you entered the sample's number, depth, etc.). However, if you're entering boring log data, the material description at the depth where you took your lab. test sample may only be something like:

```
grades to slightly silty
```

with the full stratigraphy description entered at some depth above the lab. test sample. If this is the case, you can either override the default description or click on the link that reads **Click here to select from a list of material descriptions**: this drops down a box listing all of the material descriptions entered into the current source folder. Double-click on one of the descriptions to select it.

3.1.2 Initial sample measurements

Natural moisture

The natural moisture content is used to calculate the sample's *unit weight*, which is in turn used in void ratio calculations. If void ratio results are not required, or if you elect to determine the final moisture content of the sample, you can skip entering natural moisture content data.

Height
Diameter

These fields are the height and diameter of the sample *used to calculate the soil's unit weight*.

Weight

This is the weight (technically, the *mass*) of the unit weight sample at in situ moisture content.

Specific gravity

The specific gravity value is optional, but the software will not be able to calculate void ratio results without it.

3.1.3 Test parameters

Deflection table

If you have a table of loading frame deflections at various pressures, you can enter your table using the program's deflection table editor, then select your deflection table by ID from the **Deflection table** box. As you continue on to enter loads, the software will use your chosen deflection table to adjust the readings you enter based upon the deflection for the load that you've given in the loading table.

Deflection tables are optional: if you haven't entered a table appropriate for the test, select **`– no deflection table –`**.

Overburden pressure

This is an optional parameter used to indicate the pressure exerted by the overburden material on the sample. If entered, the pressure is used by the program in recompression index calculations. Leave the field blank if a value is not available.

As-tested height
As-tested diameter

This are the height and diameter of the trimmed sample in the consolidometer, ready for the application of the initial loading pressure.

Double drainage path

Check this box if a porous stone was used on both faces of the test sample.

Dial values increase with compression

Check this box if your dial gauge increases in value as your sample is compressed. Conversely, leave this box unchecked if your dial readings *decrease* as the sample is compressed.

3.1.4 Post-test moisture contents

Wet wt.+tare (gm.), Dry wt.+tare (gm.), Tare (gm.) and Tare ID

The post-test wet and dry sample weights are optional results that can be entered as a double-check of the program's calculated dry sample weight (which is derived from the calculated unit weight and the mold volume).

Use final solids weight instead of estimated initial weight

If the unit weight (as calculated from the natural moisture content) appears incorrect, the program can be forced to utilize the post-test dry weight in place of the calculated unit weight by checking this box.

3.1.5 Reporting options

Chart report includes

A full chart report can feature either:

- A single page showing compression curve data along with an optional table of C_v results or a chart of C_v vs. $\log_{10}(pressure)$.
- The compression curve data page plus pages showing time-rate charts for any loading increments for which you've entered valid time-rate data.
- Time-rate pages only (i.e., no compression curve page).

Use the **Chart report includes** option to pick which pages are generated for the current test.

Data summary includes

If you took time-rate data for your test you can include the time-rate readings and and optional chart of reading vs. $\log_{10}(time)$ or $\sqrt{time}$ on the data summary report:

- Selecting the **Tabulated time-rate readings** option adds a table of time-rate data for each loading increment to the data summary.
- The **Cv chart and tabulated time-rate readings** option adds a time-rate chart to each loading increment's time-rate readings table (if enough readings have been entered to allow the program to produce the chart).
- **No time-rate information** produces a summary only final deformations for each increment.

3.2 Entering Test Readings

Selecting Window > Readings and Charts displays the test readings and chart preview window.

Swell/Consolidation tests are composed of *loading increments*; i.e., loading pressures along with a minimum of two time/dial reading pairs.

In addition, intermediate time and dial readings may be entered for some or all of the test's loading increments if you want to have the program plot time-rate charts and calculate C_v values.

Begin entering data for a loading increment by specifying the loading pressure in the **Pressure:** box.

⇒ If the **Pressure:** box doesn't show the correct units, select Options > CONS Setup, click on "Measurement Units" underneath "Swell/Consolidation" in the left-hand navigation panel, then select the correct units from the **Input** box underneath **Stress units**.

After typing the increment's pressure, press Enter to jump to the readings grid.

3.2.1 Test Readings

Use the readings grid to enter pairs of elapsed time/dial readings taken for the current loading increment. You need to fill at least two rows of the grid:

⇒ The first grid row will always list an initial time of **0** (or the time on the clock at the beginning of the loading increment if you're using the clock time option) and the dial reading immediately prior to the application of the loading pressure. For 2nd and subsequent loads, the program automatically fills in the dial reading for the first row with the final dial reading from the previous loading increment. This is almost always the correct choice.

⇒ If you don't need to chart or perform time-rate calculations on the increment you can enter a final time (or **F** for "final") on the second row, along with the reading on the dial at the end of the loading increment (i.e., immediately before the next pressure is applied, or the final dial reading before the test termination).

⇒ If you do need a time-rate chart and C_v value for the increment, you'll need to enter a minimum of three additional time/dial reading pairs after the initial pair. (Note that the software has a **Minimum number of data points for curves** setting that governs the actual number of readings that you'll need to enter before ***CONS*** will plot a time-rate chart for the increment.)

⇒ You can insert and delete rows of data by right-clicking on a row and selecting the "Insert Row" and "Delete Row..." options from the popup menu.

⇒ The program assumes that dial readings were taken in inches if your project's dimension units (specified by selecting Project > Dimension Units immediately after opening the project) are feet and inches. Dial readings should be in centimeters if the project's dimension units are SI.

Dial readings may be entered with a precision of up to .00001 inches or centimeters. Since it can get tedious to enter, e.g., **0.00** for every reading when your readings are all less than 0.01, the program includes an automatic dial divisor option via the **Dial divisor** selection box directly below the test readings grid. With the appropriate divisor, you can enter, e.g., **23** instead of **0.0023**. (In this example the proper dial divisor would be **10,000**.)

When you enter a new dial value ***CONS*** divides your value by the number listed in the **Dial divisor** box. The result of this division is shown on the test readings grid. If you double-click on a reading you've already entered ***CONS*** reverses the calculation.

When you're finished entering data for the increment, to start a new increment click on the "Next loading increment" button (see Figure 3.2) or press Enter in the test readings grid without entering anything in the current row's elapsed time column.

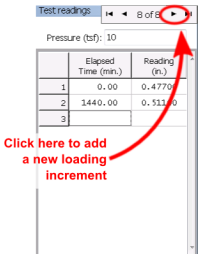


Figure 3.2: Next Loading Increment Button

3.2.2 Saturation Cycles

Saturation, or *water-added* or swell cycles are entered as two loading increments. The first increment contains the readings at the swell pressure, *up to the saturation time.* After entering the final time/reading pair before saturation, start a second loading increment. Enter the same pressure, or **`w`** or **`s`** into the **Pressure:** box, then enter the post-saturation time/dial readings.

3.2.3 Revising Test Readings Data

You can review the data for an already-entered loading increment by either a) clicking on the loading increment navigation buttons, or b) by clicking on the marker corresponding to the loading increment on the compression curve display.

4. Time-Rate Curves

If you enter enough test readings for the current loading increment ***CONS*** displays a chart of dial readings vs. $\log_{10}(time)$ or vs. $\sqrt{time}$ in the lower left section of the screen. In this panel you can select whether the current chart ($\log_{10}(time)$ or $\sqrt{time}$) is included in the final chart reports by checking the corresponding chart's **Report** box, or leave both $\log_{10}(time)$ and $\sqrt{time}$ box unchecked if you find that the loading increment's readings are not amenable to plotting a reasonable time-rate curve.

Both $\log_{10}(time)$ and $\sqrt{time}$ charts also have *construction lines* used to calculate C_v; while these lines are automatically placed by the program as you enter your time-rate data, they are user-adjustable.

⇒ Please treat the program's construction line placement as an initial guess. Each line's placement should be carefully reviewed before printing your final reports.

You can toggle between the $\log_{10}(time)$ and $\sqrt{time}$ charts by clicking on the switch to $\log(time)$ and switch to $\sqrt{(time)}$ buttons. Unlike in previous versions of the software, toggling between the charts *does not* reset any construction line adjustments you may have made. It also does not affect whether the chart is plotted on the final reports – the **Report** check box displayed to the right of each chart selects whether the chart gets plotted on the time-rate chart reports.

4.1 Log(time) Construction Adjustment

To calculate C_v from a $\log_{10}(time)$ plot a line must be placed tangent to the steepest portion of the time-rate curve (called the *primary construction line*), and a second line is placed through the final readings that represent a straight-line trend (called the *secondary construction line*). The intersection of these two lines represents D_{100}

CONS estimates the initial placement of these lines based upon the mathematical model used to plot the curve. You can adjust this placement by dragging the line endpoints with your mouse, *while holding the left mouse button down*.

The D_0 calculation requires an additional construction consisting of two vertical lines labeled $\mathbf{t_0}$ and $\mathbf{4t_0}$. These lines represent a time ratio of 1 to 4 on the curve: D_0 is taken as the dial reading at time "t" minus the difference between the dial readings at "4t" and "t". Again, the location of the construction can be adjusted by dragging the $\mathbf{t_0}$ line with your mouse while holding the left mouse button down.

⇒ The time interval construction will only appear if the $\mathbf{D_0}$ **is** selection is **`Construction`**. If you select **`Initial dial`**, ***CONS*** will use the actual dial reading at time = 0 as D_0 instead of using a construction line to estimate the D_0 value.

⇒ Additionally, this construction will not be shown (and the **D_0 is** selection will be set to **`Initial dial`**) if the software cannot determine a placement for the **t_0** and **$4t_0$** lines that satisfies two requirements (per ASTM D2435):

- **t_0** must be placed between 25 and 50 % of the total loading increment deformation.
- **$4t_0$** must be located at less than 50 % of the total loading increment deformation.

4.2 Square-Root(time) Construction Adjustment

Calculation of C_v from a $\sqrt{time}$ chart requires placement of a line tangent to the steepest portion of the time-rate curve, then a second line starting at the same left endpoint as the first but with a slope of 1.15 times the first. Finally a third, vertical, construction line is initially placed at the intersection of the second line with the curve. This line indicates the curve's T_{90} point.

All three lines can be adjusted by dragging on their endpoints with the mouse while holding down the left mouse button.

⇒ The **C_v percentage** box causes the program to calculate C_v at a different percentage of primary consolidation than the default value of 90 %.

5. The Compression Curve

After you've entered a couple of loading increments the software displays a graph of percent change, void ratio or deformation vs. $\log_{10}(pressure)$ in the top-left portion of the screen. You can use this display to adjust the construction lines used to determine preconsolidation pressure (P_c) and the compression index (C_c), change the type of data used on the chart (percent change, void ratio or deformation, and D_{100} or final dial reading) and modify the chart's scales.

⇒ If your curve appears upside down, you've probably made the wrong Dial values increase with compression check box selection.

⇒ You can review the test data for any point on the compression curve by clicking on the point.

5.1 Selecting the Compression Curve Type

The **Curve is** box at the right of the compression curve box selects between plotting the compression curve as $\log_{10}(pressure)$ vs. either void ratio, percent strain or deformation.

⇒ The **`Void ratio`** selection will be disabled if you haven't entered enough data to calculate void ratios.

5.2 Using D100 Values to Plot the Compression Curve

If you've taken time-rate data for some of your loading increments you can have the program use the deformation/void ratio/percent strain value calculated at D_{100} for these: increments as the point that the compression curve passes through instead of the result at the increments' final dial reading. (Doing so ignores the effects of secondary consolidation on the curve.) Loading increments without time-rate data (those for which a D_{100} value could not be calculated) would still be marked at the deformation/void ratio/percent strain value produced by their final dial reading.

⇒ To use D_{100} values, click on the **Use D100 values** check box.

5.2.1 Construction Line Adjustment

The compression curve chart features two construction lines:

A blue line
This line is used to determine the compression index (C_c). It should be adjusted to be tangent to the steep, linear portion of the compression curve.

A vertical red line
This line is used to determine the P_c value. It should be adjusted left or rightwards until it intersects the point of maximum curvature on the compression curve.

⇒ Please note that the intersection of the red line with the compression curve does not directly indicate the preconsolidation pressure. Rather, ***CONS*** uses this intersection as one of two parameters (along with the construction line tangent to the steep, linear curve portion) to Casagrande's graphical method of estimating preconsolidation pressure.

Both construction lines can be adjusted by dragging on their endpoints with the mouse while holding down the left mouse button. If you don't like the result, you can reset the construction line placement by clicking on the **Reset Constructions** button.

⇒ As with the construction lines used to calculate time-rate C_v results, please treat the program's compression curve construction line placement as preliminary estimations. Each line's placement should be carefully reviewed before printing your final reports.

6. Reporting Your Data

CONS features three methods for reporting your data:

XML Files

XML files contain a listing of both your raw testing data as well as various values calculated by the software such as C_c, C_r, etc. XML files are saved on-disk and may be viewed by a web browser or by versions of Microsoft Excel. This is an ideal format for e-mailing testing data and results to your clients in a format that incorporates both a means of presentation (through a web browser) as well as a means of manipulating the raw data (through a spreadsheet).

Data Summary Reports

Summary reports list the raw data taken from your test. They may be sent to a printer or saved on disk.

Chart Reports

CONS *chart reports* differ from data summary reports in that the former prominently features charts (compression, C_v vs. $\log_{10}(pressure)$ and time-rate), while data summary reports feature raw testing data (with small optional time-rate charts). ***CONS*** has two general types of chart reports: the *compression report*, which, in addition to a chart of void ratio/deformation/% strain vs. $\log_{10}(pressure)$ can also optionally include a table of C_v values or a chart of C_v vs. $\log_{10}(pressure)$, and the *time-rate report*, which includes charts of dial reading vs. $\log_{10}(time)$ or $\sqrt{time}$.

⇒ Another difference between chart and summary reports is that ***CONS*** ships with several different chart reports from which you can select, while there's only one format for the summary report.

⇒ Chart and summary reports can be saved to a file in .PDF, .EMF, .PNG or .DXF format.

⇒ Through the Windows clipboard, you can also export chart reports to programs that can paste pictures into their documents (such as word processors or paint programs). To do this, select Edit > Copy Entire Test: once on the Windows clipboard, you can paste the chart into, for example, a word processing document by starting the word processor and selecting Edit > Paste.

6.1 Previewing Reports

Chart reports and data summary reports may be reviewed and printed by selecting Window > Reports, or by clicking on the **Reports** navigation tab. From this window you can:

- Select a different format for printing the compression and/or time-rate chart reports.
- Preview and print chart and summary reports.

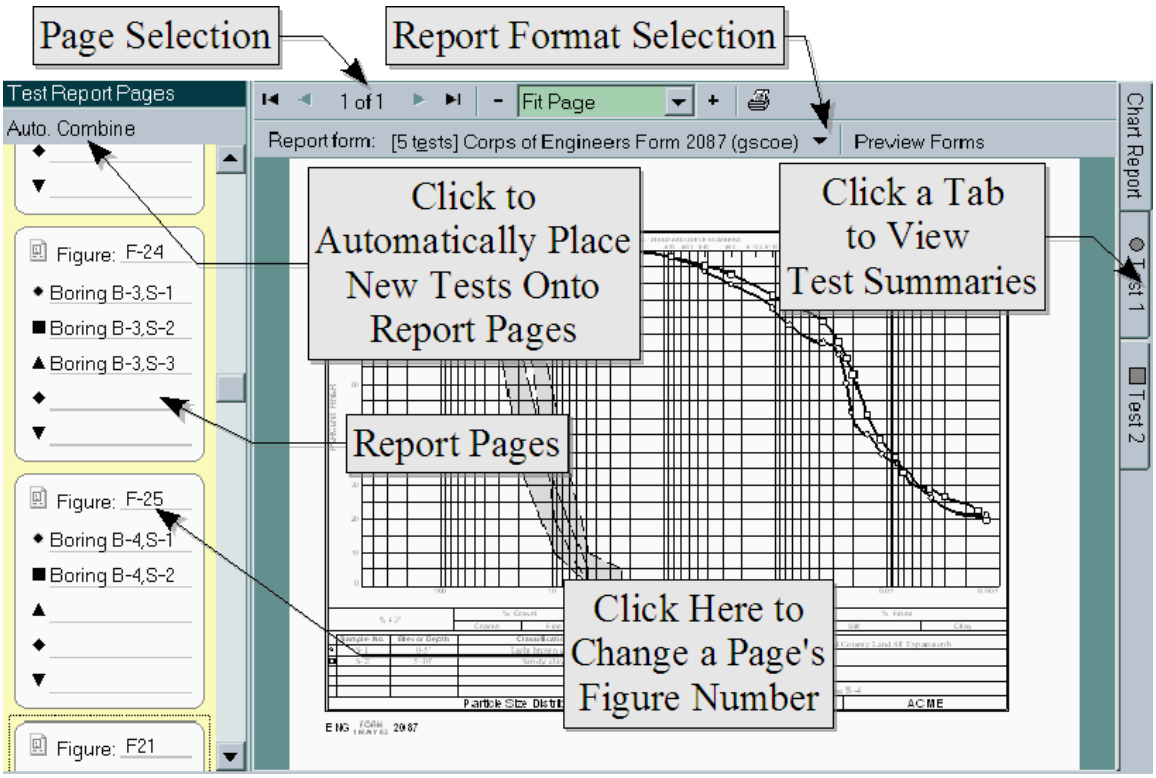


Figure 6.1: The Report Preview Window

Following is a list of actions that you can take from this window:

You can change the format of the report pages

The software ships with many different chart report formats that you can use for printing your test data. (You can view samples of all of the program's report formats by clicking on the **Preview Forms** button.) To select a new report format, click on the button shown in the following figure:

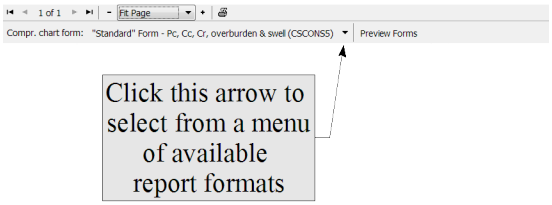


Figure 6.2: Selecting a Chart Report Form

⇒ Note that there are two different chart reports: the compression curve chart report and the time-rate curve chart report. Each report has its own set of formats. To select the format for your time-rate curve reports, advance to the 2nd page of the preview, which (if you've chosen the **`Compression & Time-Rate Report Pages`** **Chart report includes** option) will be the first page of the time-rate chart portion of the report. You can then select a different time-rate report format.

You can review the test's data summary report

To do this, click on the tab labeled **Summary** on the right-hand side of the window.

You can print out the report

Click on the button.

6.2 Data Summary Reports

Data summary reports list the raw data taken from a single consolidation test (e.g., specimen weights, test readings, etc.). You can print a summary report or export it to a file by selecting Test > Output Data Summary Report.

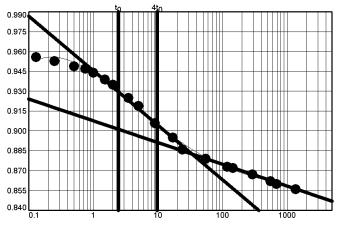
Pressure: 10.00 tsf — **TEST READINGS** — **Load No. 1**

No.	Elapsed Time	Dial Reading
1	0	1.00000
2	1	0.96400

Void Ratio = 1.209 **Compression =** 1.2%

Pressure: 25.00 tsf — **TEST READINGS** — **Load No. 2**

No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0	0.96400	11	9	0.90600
2	.13	0.95600	12	17	0.89500
3	.25	0.95300	13	24	0.88600
4	.5	0.94900	14	55	0.87900
5	.75	0.94700	15	119	0.87300
6	1	0.94400	16	145	0.87200
7	1.5	0.93900	17	292	0.86700
8	2	0.93500	18	551	0.86200
9	3.5	0.92500	19	685	0.86000
10	5	0.91900	20	1349	0.85600



Void Ratio = 1.128 **Compression =** 4.8%

D_0 = 0.9538 **D_{50} =** 0.9181 **D_{100} =** 0.8824 **C_v at 4.62 min. =** 0.903 ft.^{2}/day **C_α =** 0.016

Pressure: 50.00 tsf — **TEST READINGS** — **Load No. 3**

No.	Elapsed Time	Dial Reading
1	0	0.85600
2	1440	0.74100

Void Ratio = 1.043 **Compression =** 8.6%

Pressure: 100.00 tsf — **TEST READINGS** — **Load No. 4**

No.	Elapsed Time	Dial Reading
1	0	0.74100
2	1440	0.61400

Void Ratio = 0.948 **Compression =** 12.9%

Pressure: 10.00 tsf — **TEST READINGS** — **Load No. 5**

No.	Elapsed Time	Dial Reading
1	0	0.61400
2	1440	0.62900

Void Ratio = 0.959 **Compression =** 12.4%

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Figure 6.3: Sample Summary Report Page

6.3 Exporting Reports To Files

You can save ***CONS***'s testing data summary and chart reports for posting to a web server or for e-mailing to clients. The program supports several different export formats:

- **Adobe Acrobat .PDF:** Universal format for Internet document distribution. Requires the Adobe Reader program to display the files.
- **AutoCAD .DXF:** Format for interchange among CAD programs.
- **Windows Metafile (.EMF):** These files can be inserted as a picture into a word processing document or manipulated with a vector-drawing program such as Adobe Illustrator.
- **Portable Network Graphics (.PNG)** and **JPEG File (.JPG):** These files are "bitmap" files that can be inserted into word processing documents or edited with a raster-drawing program such as Windows Paint or Photoshop.

To save a chart or summary report as a file, select either Test > Output Data Summary Report or Test > Output Chart Report, then, from the **Output to** box on the next dialog, select one of the file formats outlined above.

If you've chosen the **Adobe Acrobat .PDF File**, **Windows Metafile (.EMF)**, **Portable Network Graphics (.PNG)** or **JPEG File (.JPG):** options you'll see the following dialog:

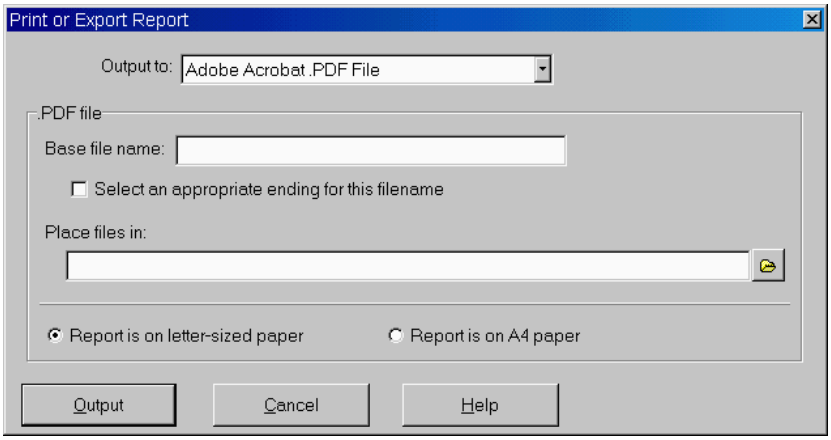

Figure 6.4: .PDF, .EMF, .PNG and .JPG Output Settings Dialog

.DXF files are somewhat more complicated: if you select the **AutoCAD .DXF File** you'll see this dialog:

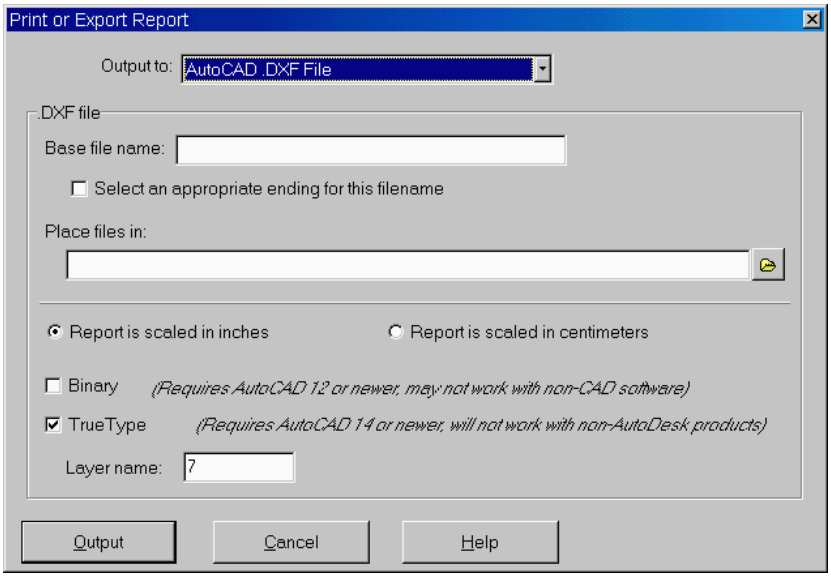

Figure 6.5: .DXF Output Settings Dialog

There are a number of options available for selecting where and how the reports are generated:

Base file name

When the program creates a file from one page your report (for .DXF, .EMF, .PNG and .JPEG files), or from your *entire* report (for .PDF files), the file's name will start with whatever is entered into this field.

Select an appropriate ending for this filename

Without this option, the names of the files created will be whatever you have selected as the **Base file name**. Checking the **Select an appropriate ending for this filename** box alters how the program names the report files: the sample number and/or sampling location is added to the **Base file name**, followed by the test type (i.e., "CS") and either "ChartReport" or "TestData". For example, with the **Select an appropriate ending for this filename** box checked, the program may create .PDF files with names like:

```
P92321 Sample S-4 Boring B-3 GS TestData.PDF
P92321 Sample S-1 Test Pit TP-2 GS ChartReport.PDF
```

etc.

⇒ With **Base file name** and **Select an appropriate ending for this filename** you can come up with some useful file naming variations. For example, you could leave **Select an appropriate ending for this filename** unchecked and enter the sample number/location as part of the **Base file name** - of course, this means that when you export the next report, you'd have to change the **Base file name** to reflect the new sample number.

As another example, if you have created a hard disk subdirectory just to hold .PDF files from a certain project, you may not need to include the project

number as part of each .PDF file name: instead of being called, for example, **`P92321 Sample S-4 Boring B-3.`**
(P92321 being the project number), by leaving the **Base file name** field blank you can get export files with names like **`Sample S-4_Boring B-3.PDF`**

Place files in
Sets the directory where your exported files will be placed.

Report is on letter-sized paper ***(.PDF, .EMF and .PNG files only)***
Report is on A4 paper ***(.PDF, .EMF and .PNG files only)***
Selects the paper size to be used for the exported report image.

Report is scaled in inches ***(.DXF files only)***
Report is scaled in centimeters ***(.DXF files only)***
Reports exported as CAD files either measure either 10 units vertically (when scaled in inches) or 25.4 units vertically (when scaled in centimeters). This selection does not affect the report's appearance; rather, it just affects the coordinates given to each line and piece of text on the report. (As such, the selection is only important when the exported report is to be edited by an illustration or CAD program.)

Binary ***(.DXF files only)***
Binary .DXF files will be smaller (by 25 to 50 percent) and open faster in AutoCAD. The reports will appear the same when viewed in a CAD program no matter if this option is selected or not. Note that very few illustration programs will read binary .DXF report files.

TrueType ***(.DXF files only)***
If this option is unselected, .DXF report files use a monospaced font (**`similar to this`**) for everything on the form, meaning that .DXF reports are less attractive than their printed counterparts. The TrueType option allows you to generate .DXF files that look exactly like the printed versions – however, TrueType .DXF files are only supported on AutoCAD versions 14 and newer; additionally, many other drawing and CAD programs do not support TrueType files.

Layer name ***(.DXF files only)***
Specifies the name of the CAD drawing layer on which your report will be drawn. Layer names may be any combination of alphabetic and numeric characters – however, many CAD programs cannot handle layer names that include spaces. (**`MYLAYER`** is OK, **`MY LAYER`** is not.) Since your chosen layer name will be repeated throughout the .DXF report files, the shorter you make the name the smaller in size your .DXF files will become.

6.4 Exporting XML Files

The XML file format provides a means of exporting your testing data and calculated test results into a format readable by a web browser and by newer Excel spreadsheet programs (XP or later). This

makes XML files a natural method for posting testing results to a Web or FTP site or for e-mailing directly to clients.

To export an XML file, select Test > Export XML File

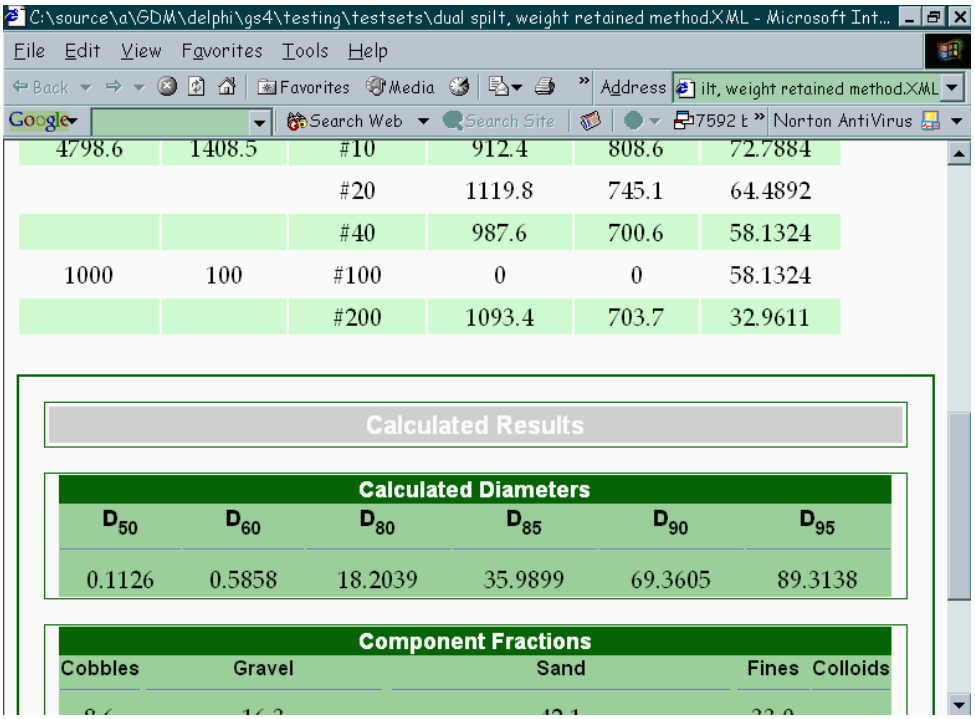

Figure 6.6: Portion of an XML Report Viewed in Internet Explorer

6.5 Listing the Results From Multiple Tests

The GEOSYSTEM Data Summary and Export tool may be used to summarize the results of multiple lab. tests. Several stock configuration files can be used by selecting Tools > Data Summary and Export from the GDM or LOGDRAFT menu, then selecting File > Recall Existing Configuration and selecting one of the listed configuration files.

⇒ To list swell/consolidation test results, select **CCSSUMMARY1.LFG** or **CCSSUMMARY2.LFG**.

⇒ If you've purchased LOGDRAFT, you can use the configuration files to view an on-screen list of the tests performed for a project: From the LOGDRAFT screen, select Project > Browse and choose one of the listed configuration files.

6.5.1 Test Results Calculated by the Program

As an alternative to using the stock **`CSSummary1.LFG`** and **CSSummary2.LFG** summary and export files, you can also create your own summaries with data values calculated by the program. These values (or "variables") can also be referenced in boring logs created with the GEOSYSTEM LOGDRAFT program.

The following table lists the names of all of the calculated results provided by ***CONS*** and gives a short description of each:

Table 6.1: Calculated Test Results for Summaries and Boring Logs

Item Name	Description
CC	Compression index
PP	Preconsolidation pressure
CR	Recompression index
CS	Swell index
E0	Initial void ratio
EM	Void ratio at maximum past effective stress
CSNMI	Test sample initial water content
CS_DENS	Test sample unit weight
INIT_SAT	Test sample initial saturation
CSMF	Post-test final moisture
EO	Void ratio at overburden
EF	Final void ratio
FINAL_SAT	Final saturation
OCR	Overconsolidation ratio
OVER	Overburden pressure
CVALL	Cv test results (all loads)
SWELL	Percent swell
SWELL_PRESS	Swell pressure
DIDCONS	Consolidation test performed
DIDSWELL	Swell test performed

7. Importing from Data Acquisition Files

While ***CONS*** can't directly import readings from digital dial hardware, it *can* import files created by data acquisition software provided by hardware manufactures to read data from their equipment. Support is included for importing files created by the following manufacturers and equipment lines:

Durham Geo Slope
ELE-Soiltest
Geocomp Lab Systems
GeoTAC
Geotest Instrument Corporation
Hogentogler GeoStar®
Humboldt

Table 7.1: Supported Manufacturers' File Formats as of May, 2015

(See the current list here .)

You can import data acquisition files one at a time or import multiple files at once. To start the process, begin by entering your sample and test information, then select Test > Import Data Acquisition File. ***CONS*** responds by showing a file selection dialog:

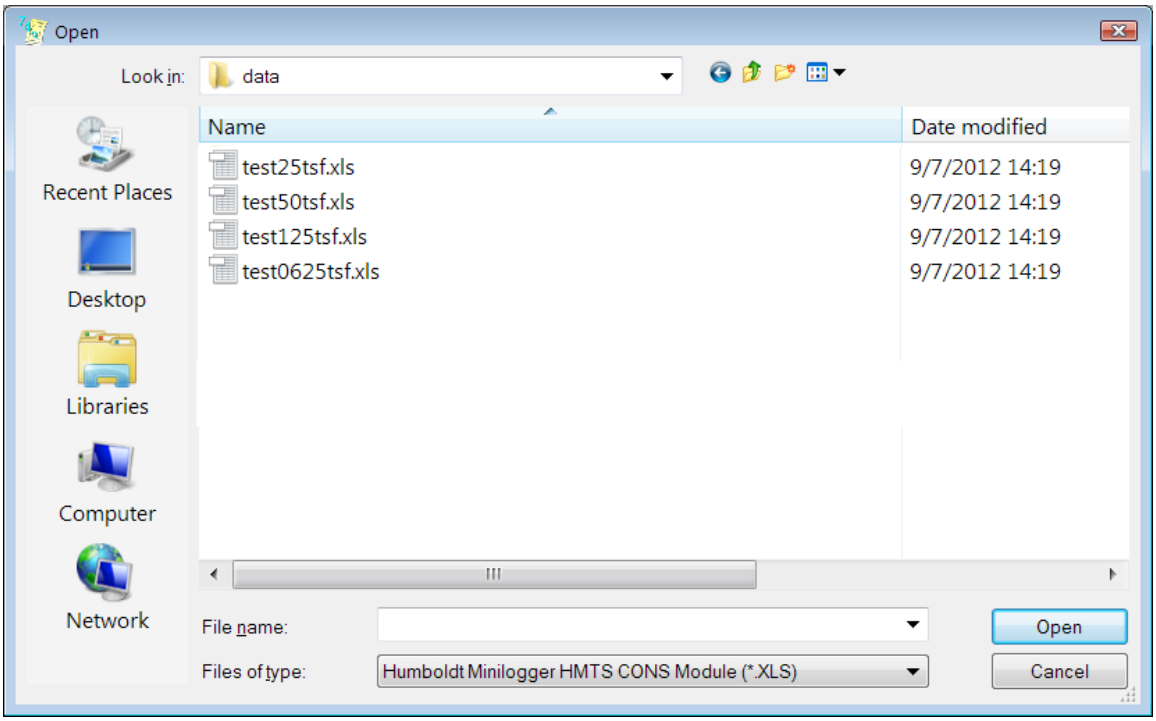

Figure 7.1: Data Acquisition File Selection Dialog

⇒ Before selecting file(s) to import, make sure to change the **Files of type** selection to reflect your file format.

For data acquisition file formats the do not hold an entire test in a single file (i.e., each loading increment's worth of data is stored in a different file), *you can select multiple files for importing simultaneously*. To do this, hold your Ctrl key down as you click on each file to be imported. When you've selected all the test's files, click on the **Open** button to continue.

After you click the **Open** button, one of two things will happen:

- *The program will return you to the test data entry screen, where you can review your newly-imported data.* (Make sure to check the program's construction line placement for each newly-imported loading increment, along with the compression curve construction line placement.) This action happens only if you imported a single data file, and the file includes information on the pressures used for each imported loading increment.
- *The software will display a dialog where you can associate a pressure with each imported loading increment, as well as re-order the imported increments.* (The re-ordering option is useful if you import multiple files.) This dialog is discussed in the following section.

7.1 Filling In Missing Information

After you've selected one or more data acquisition files for importing, ***CONS*** will display a dialog where you can do three tasks:

Specify the pressure used at each of the imported loading increments.
Many data acquisition file formats do not include the applied pressure as a part of the test data stored in the file.

Re-order the imported loading increments.
If you import multiple files simultaneously the order in which they're import is random, so you may need to shuffle the imported loading increments to reflect your testing order.

Cancel the import of one or more loading increments.
If you accidentally chose the wrong data acquisition file to be imported, you can remove it from the "to be imported" list here.

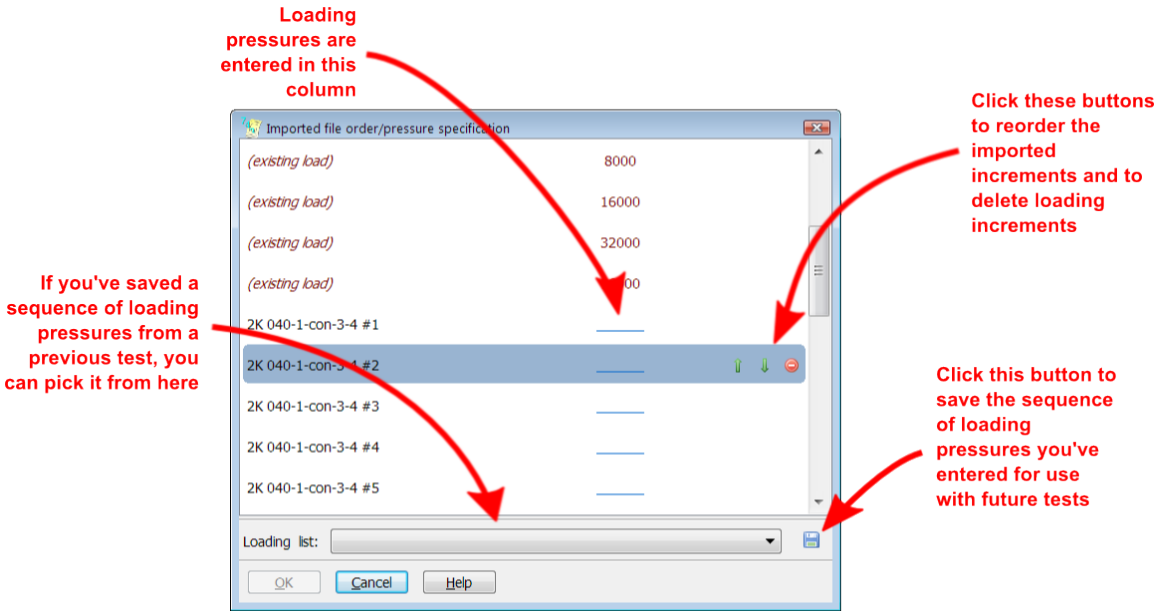

Figure 7.2: Data Acquisition Import Loading Pressure and File Ordering Dialog

Figure 7.2 shows a screen capture of the dialog after a file (**`2K 040-1-con-3-4`**) was selected for appending to an existing set of loading increments (the **`8000`**, **`16000`**, **`32000`** and the obscured **`16000`** column entries). The underlines represent imported loading increments for which a loading pressure must be specified (because the imported file lacked information on the pressures applied during the increments).

To specify the pressures used on each loading increment:

1. Begin by clicking on the topmost underline: The program will allow you to enter a loading pressure for that increment.
2. Pressing Enter after you've typed the pressure will take you down to the next loading increment, where you can enter the next increment's pressure.
3. Continue this until you've entered all of the missing loading pressures.

⇒ After you've entered a particular sequence of loading pressures you can save it and apply it to future imports. To do this, click on the button at the right of the **Loading list** selection box. The next time you import data from a test that used the same loading pressure sequence you can pick the sequence in the **Loading list** box and the program will fill in the current import's missing loading pressures.

If you've selected more than one file to import, the order in which the program lists loading increments imported from the files will be random. Since the order in which these increments are listed reflects the order that they'll be shown in the tests's compression curve, you need to make sure this order is correct before clicking on the dialog's **OK** button.

To reorder the sequence of loading increments being imported:

1. Click on a row listing one of the loading increments to be moved. The program will highlight the row and show two or three icons on the right side of the row (a downward and/or upwards pointing arrow and a red "delete" icon).
2. Click on the ↓ or ↑ icons to shift the increment into its proper position.
3. Repeat the procedure for the rest of the imported increments.

⇒ When you're appending a series of imported files to the end of a ***CONS*** file that already has data the program will not let you move an imported loading increment above the an increment that was already in the ***CONS*** file.

Sometimes you'll discover that you've chosen the wrong file for importing. If this is the case you'll need to remove the file's loading increments from the import list.

To remove one or more loading increments from the import list:

1. Click on a loading increment to be removed.
2. Click on the ● icon at the right edge of the row.
3. Repeat the process for any other increments to be removed.

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