NovoSPT

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About

NovoSPT

NovoSPT is a computer program for interpretation of Standard Penetration Test (SPT/ DCPT) and correlating blow counts (N) to soil properties based on more than 300 correlations. It is gINT, Excel and Microsoft Access database compatible and provides several reporting and additional features. Please keep your software up-to-date by visiting the program's *web page*.

Although all efforts have been undertaken to ensure that this software is of the highest possible quality and that the results obtained are correct, the authors do not warrant the functions contained in the program will meet your requirements or that the operation of the program will be uninterrupted or error-free. The authors are not responsible and assume no liability for any results or any use made thereof, nor for any damages or litigation that may result from the use of the software for any purpose. All results to be verified independently by user.

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Vancouver, Canada

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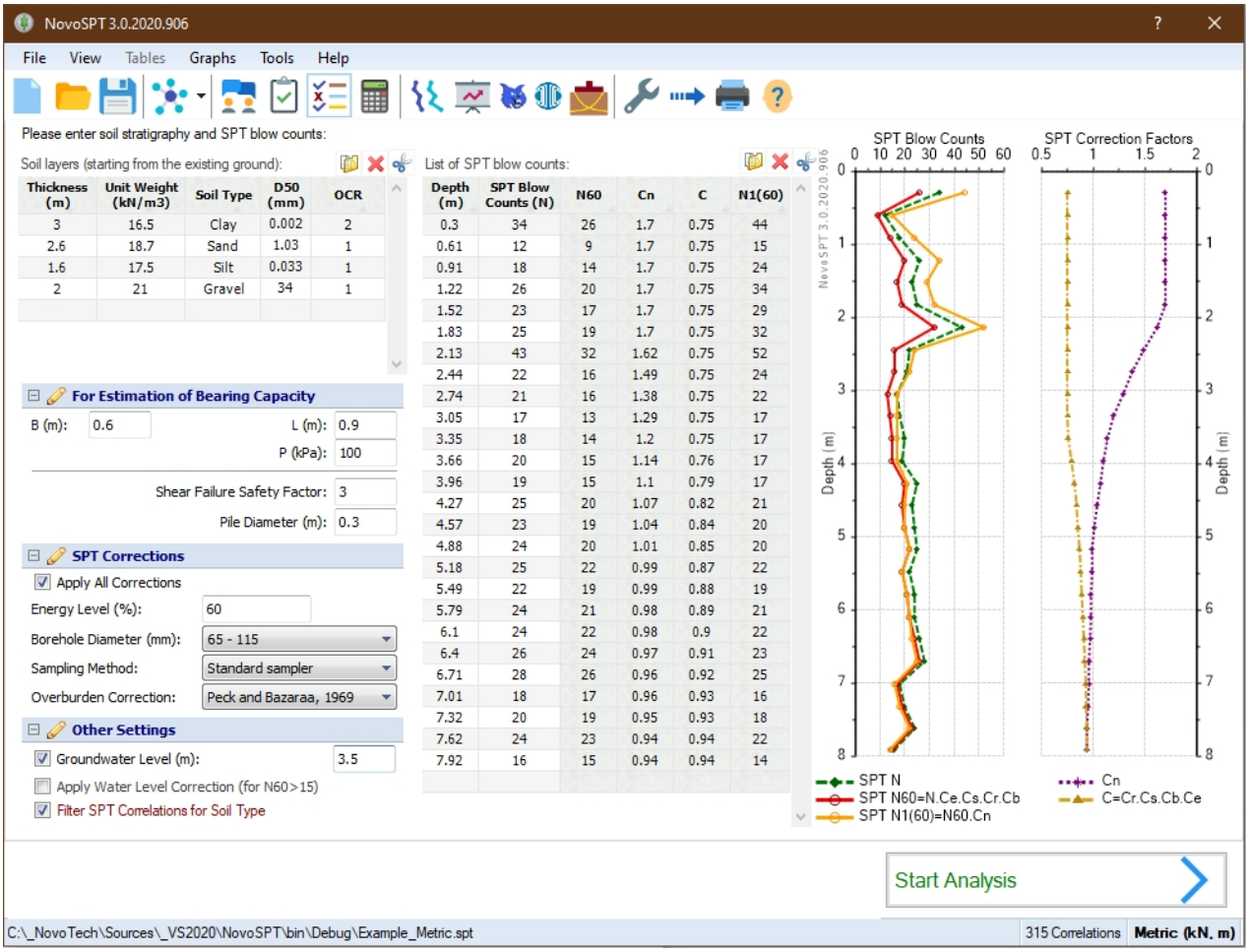
Getting Started ...

When starting a new analysis with NovoSPT, take the following steps:

Step 1: enter subsurface soil layers and SPT blow counts in the corresponding tables, as shown below. Notice the plots on the right -hand side of the page are updated as you enter data (see more here).

Step 2: enter input data for the size of the shallow and pile foundations, enter groundwater conditions and choose SPT correction methods (*see more here*).

Step 3: when data entry is over, click on 'Start Analysis' button. This will take to the next page, where you can choose the soil parameter to correlate, and the depth at which correlations are needed (see more here).



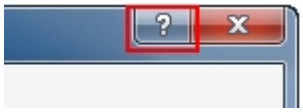
please note that:

- By *clicking on any chart* you will have access to several options for printing and exporting the chart
- The ? sign at the top-right corner of each page, opens up the corresponding help page
- Analysis files are saved with *.SPT extension and the complete file path is shown at the bottom of the page

Using Help

Activating Help

Help button is placed at the top-right corner of all pages, as shown on this screenshot. In order to get the help content associated with the page, please click on this button.



Units System

This version of NovoSPT supports the following unit systems:

- Metric units (kg, m, cm)
- US CUstomary units (lb, ft, in)

You can set the unit system on the preferences page.

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Data Entry

All data entry in NovoSPT is performed in **Input Data** tab. This data can be categorized into the following groups:

Shallow Footing: This data is used for calculating bearing capacity of shallow footings based on shear failure or settlement criteria (based on method). Footing size and load as well as safety factor against shear failure should be specified. Please notice that depth of footing (Df) is considered to be the depth (Z) selected by user on SPT table.

» Results are presented in "Correlated Soil Properties" tab when "Bearing capacity of footings on sand (qa)" items is selected from the list.

Pile Foundation: Diameter of the pile should be specified in order to estimate the friction and end bearing of the piles based on SPT blow counts. Please notice that pile length is considered to be the depth (Z) selected by user on SPT table.

» Results are presented in "Correlated Soil Properties" tab when "Bearing capacity of piles" items is selected from the list.

SPT Corrections: The following corrections should be applied on SPT number (N) to obtain N_{60} and $N1_{(60)}$ numbers:

- Energy level: this will adjust the SPT equipment energy to standard 60% energy. This correction factor is named **Ce** in NovoSPT.
- Borehole diameter: size of the borehole affects the SPT blow counts. This correction factor is named **Cb** in NovoSPT.
- Sampling method: some SPT samplers have a liner. This will affect the SPT blow counts and its correction factor is called **Cs** in NovoSPT.
- Rod length: this correction factor is called **Cr** and depends on length of SPT rods which is approximately equal to the depth of the test. NovoSPT Adds 1 metre (to account for the distance between the anvil and ground surface) to the total test depth when calculating **Cr**:

If $L < 4$ m $\Rightarrow$ Cr=0.7

If 4 m $< L < 6$ m $\Rightarrow$ Cr=0.85

If 6 m $< L < 10$ m $\Rightarrow$ Cr=0.95

If $L > 10$ m $\Rightarrow$ Cr=1.0

- Overburden stress: this corrections is usually called as "depth correction factor" or **Cn** and depends on overburden stress due to soil, at the test depth.

Please choose your favorite method for each correction factor. The following formula is used to calculate the correction factors at each depth:

$C=Ce.Cb.Cs.Cr \quad N_{60}=C.N \quad N1_{(60)}=Cn.N_{60}$

All the above-mentioned factors as well as N_{60} and $N1_{(60)}$ are plotted versus depth and presented on screen.

» Results for Cn corrections are presented in "Correlated Soil Properties" tab when "Overburden correction factor (cn)" items is selected from the list.

Settings: The groundwater level affects the calculation of effective

overburden stress (σ'_V) used in the correlations. In addition, user can choose to apply the water level correction on SPT blow counts, as proposed by Terzaghi. This correction is recommended for N≥15 in silty sands:

$N_{cor}=15+0.5(N_{60}-15)$

Another important point when using the correlations is 'applicability' of each correlation to soil type. For example if at depth of 3.4 meters where correlations are required, the soil type is generally "clay", a shear wave velocity correlation which is derived in "sand" would not be reliable and can provide somewhat wrong values. Some other soil parameters such as undrained shear strength are even meaningless for "sand" and "gravel" soil types. To filter the correlations based on each layer's soil type, click on "Show only applicable correlations". To read more details about this new feature, please read this page.

» Please notice that NovoSPT can provide correlations, either at a specific depth or along depth of the borehole. All correlations regarding a specific depth are presented in "Correlated Soil Properties" tab and user should specify the depth at which, correlations are to be calculated. To do this, please click on the desired depth at SPT data table and notice to the change in Depth and N60 fields on bottom-left of the page.

Soil Layers: This data is used to calculate the effective and total overburden stress at each depth where correlations are required. Please pick the soil type for each layer from the dropdown list (clay/silt/sand/gravel) and avoid details descriptions such as "sandy clay with gravel", etc. This soil type is used by NovoSPT when correlations are to be filtered based on soil type.

Some SPT correlations depend on OCR and D_{50} of the soil. These parameters should be specified for each soil layer.

» This data can be entered manually or maybe imported from a text file or from gINT database.

SPT data: In this table please enter raw data gathered from SPT test. The first two columns of this table include depth and SPT blow counts (N) and the other columns are automatically calculated during data entry. While this data is being entered, SPT plots are updated and present both SPT blow counts and correction factors along depth of borehole.

» This data can be entered manually or maybe imported from a text file or from gINT database.

Note: Never enter zero for a SPT test depth; it may lead to calculation errors. This is due to dependency of most Cn methods to σ_V which will be zero at Z=0.

Clearing Tables

For clearing all data entered in a table, simply press  button on top-right side of the table.

Shallow Footings Bearing Capacity and Settlement

If you want to estimate the bearing pressure and settlement of foundation based on SPT blow counts, enter corresponding data. For most of these calculations, average of N_{60}or $N1_{(60)}$ should be calculated for a depth ranging from 0.5B to 2B underneath the footing. So make sure that you have entered enough data within this depth range. You may also click on Tools ▸ Bearing Capacity Analysis menu to use NovoSPT's comprehensive analyses tool.

B: Footing width

L: Footing Length

Df: Depth of embedment for the footing (will be equal to the depth selected by user - see below)

P: Stress below the footing

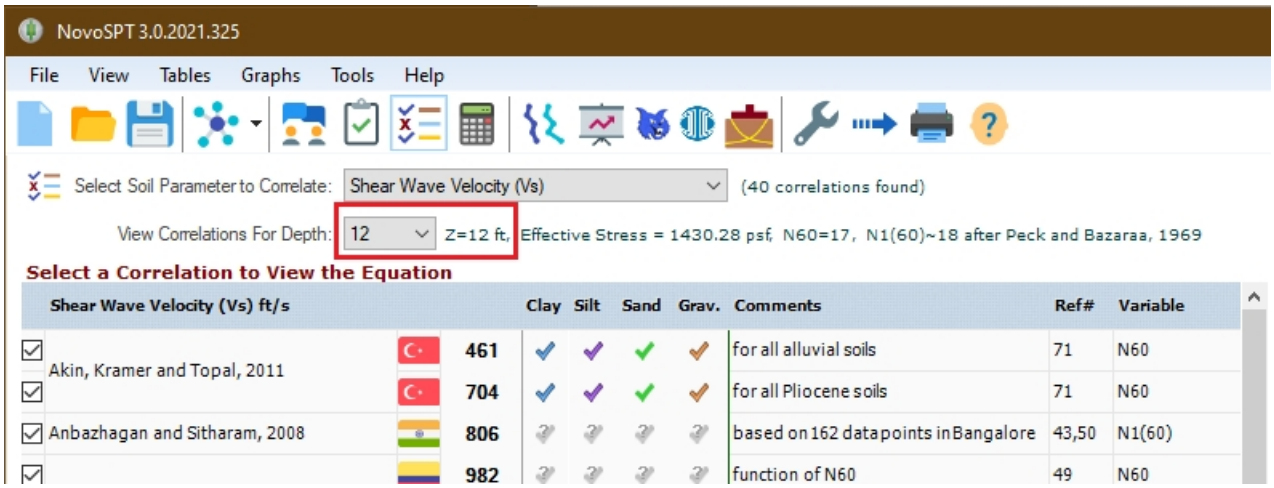
SPT Graph

Once you enter SPT versus depth data, and press Start Analysis button at the bottom-right corner of the screen, SPT graph is updated and un-corrected as well as corrected SPT numbers are plotted versus depth. Another graph shows the variation of SPT correction factors against depth. Click on each graph to zoom, print or export to other formats.

IMPORTANT

Selecting the depth (on SPT table) for which you would like to see the correlations

When data entry is finished, simply click on the row in the SPT table at which depth you need the correlations. For example, the following screenshot shows that depth Z=12 ft is selected and all correlations will be provided at this depth (read more about filtering correlations).



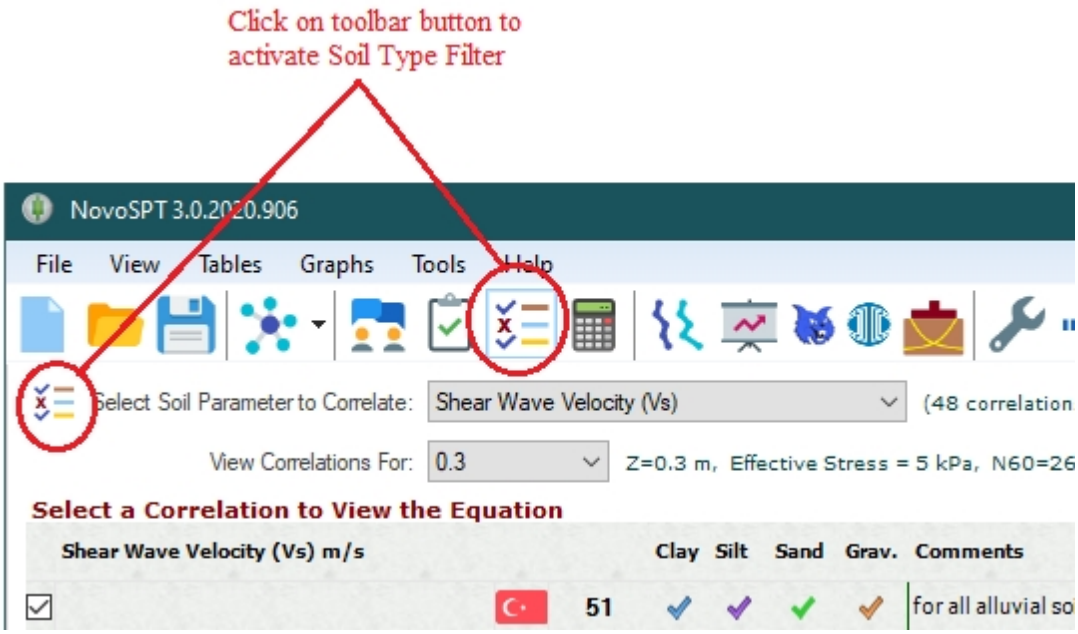
Toolbar & Menu

Most of the commonly used commands in NovoSPT are placed in toolbars. For other commands use menu bar. In each form, to read the user manual (Help) content for that page, click on **?** button on top-right corner of the page.

Soil Type Filtering

This feature can be activated by selecting "Filter SPT Correlations for Soil Type" checkbox on the input tab. If this option is activated, the corresponding button on the toolbar will be highlighted.

SPT correlations are typically derived based on case studies or field tests in a specific soil types. As a result, most of the SPT correlations are only valid for one or two soil types. In NovoSPT database of correlations, the applicable soil types are specified for each correlation:



The header of the correlations table specifies 4 different soil types:

Blue checkmark: correlation is valid for clay

Purple checkmark: correlation is valid for silt

Green checkmark: correlation is valid for sand

Brown checkmark: correlation is valid for gravel

Gray checkmark: the author has not clearly specified the soil types for this correlation. In this case, NovoSPT assumes that the correlation would be applicable to all soil types.

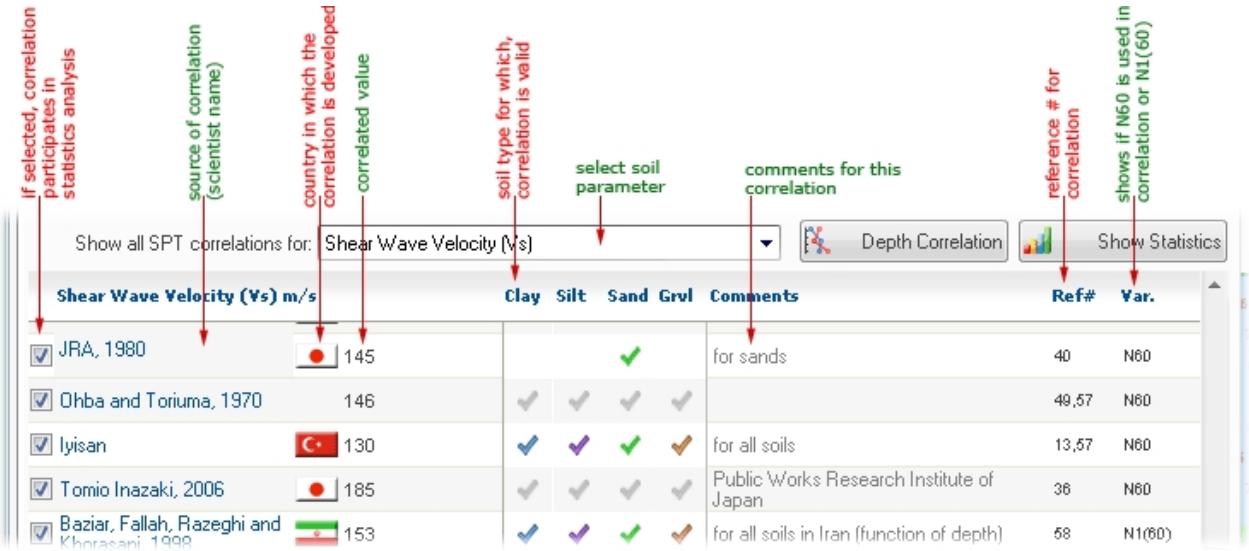
Why using the 'soil type filter'?

Although not applying the soil type filter, provides you with more correlations, it should be noted that not all of the correlations are valid for all soil types. For example, in a sand layer with a SPT blow counts of N_{60}=12, NovoSPT may provide a value for undrained shear strength (Su) at this depth if soil type filter is off (because you have asked the program not to check the soil type). You can prevent this confusion by selecting the soil type filter, and simply concentrate on those correlations that are valid for the actual soil type at that specific depth.

Since user has specified the soil layers in input form, the program can easily filter the applicable correlations during the analysis. If soil type filter is active, the filter icon will be highlighted on the toolbar and it will be shown above the correlations table (see screenshot above).

Correlated results

When data entry in NovoSPT is completed, pressing Start Analysis button will show the correlated results. NovoSPT uses more than 300 correlation correlations to prepare these results. For each soil parameter (e.g. "Relative Density Dr"), all available correlations are summarized in a table describing the reference, parameter value, and comments regarding each correlation used. The following screenshot describes parts of the correlation table:



Each method may be turn on/off by using the checkbox in the first column and will be added/removed from the statistics chart.

To view the statistics of all correlation for selected soil parameter, click on Show Statistics button (read more). If correlation of selected soil parameter in depth of borehole is required, click on Depth Correlation button (read more).

How to Copy Table Contents

If necessary, you can simply copy data within each table by selecting the target rows (by holding left mouse button down and selecting the rows), and then pressing CTRL+C. Thereafter, pressing CTRL+V in any other editor in Windows, pastes the data.

How to Export the Results Table to Microsoft Excel

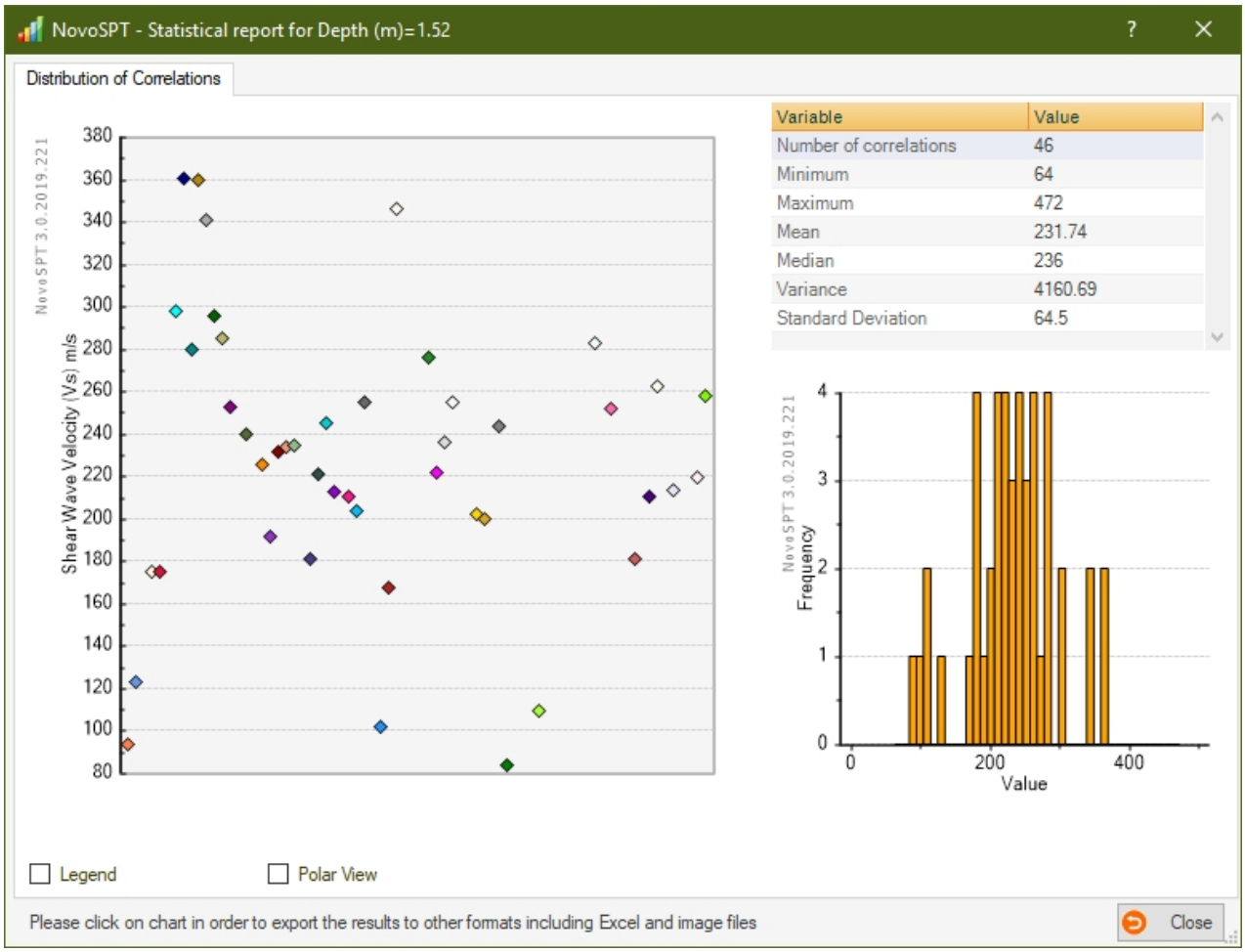
Click on the table, and then select Tables ▸ Save As MS Excel ... menu. Choose the file name and path in the dialog and the table will be saved as an Excel file.

Visualization of Correlated Values

To better visualize the results of a specific soil property, a graph is presented on statistical chart. This graph shows scatter of the results for each soil parameter and helps user to compare those values and pick the most reasonable range for that parameter. Please notice that for those formulas which provide a range for the parameter, the corresponding value in graph is shown as a vertical bar representing the minimum and maximum recommended range. To view additional information, move the mouse over each point on the graph to get more information about the method.

Statistical report

To better visualize the results of a specific soil property, a graph is presented on statistical chart. This graph shows scatter of the results for each soil parameter and helps user to compare those values and pick the most reasonable range for that parameter. Please notice that for those correlations that provide a range for the soil parameter, the value is shown as a vertical bar on the graph. To view additional information, move the mouse over each point on the graph to get more information about the correlation.

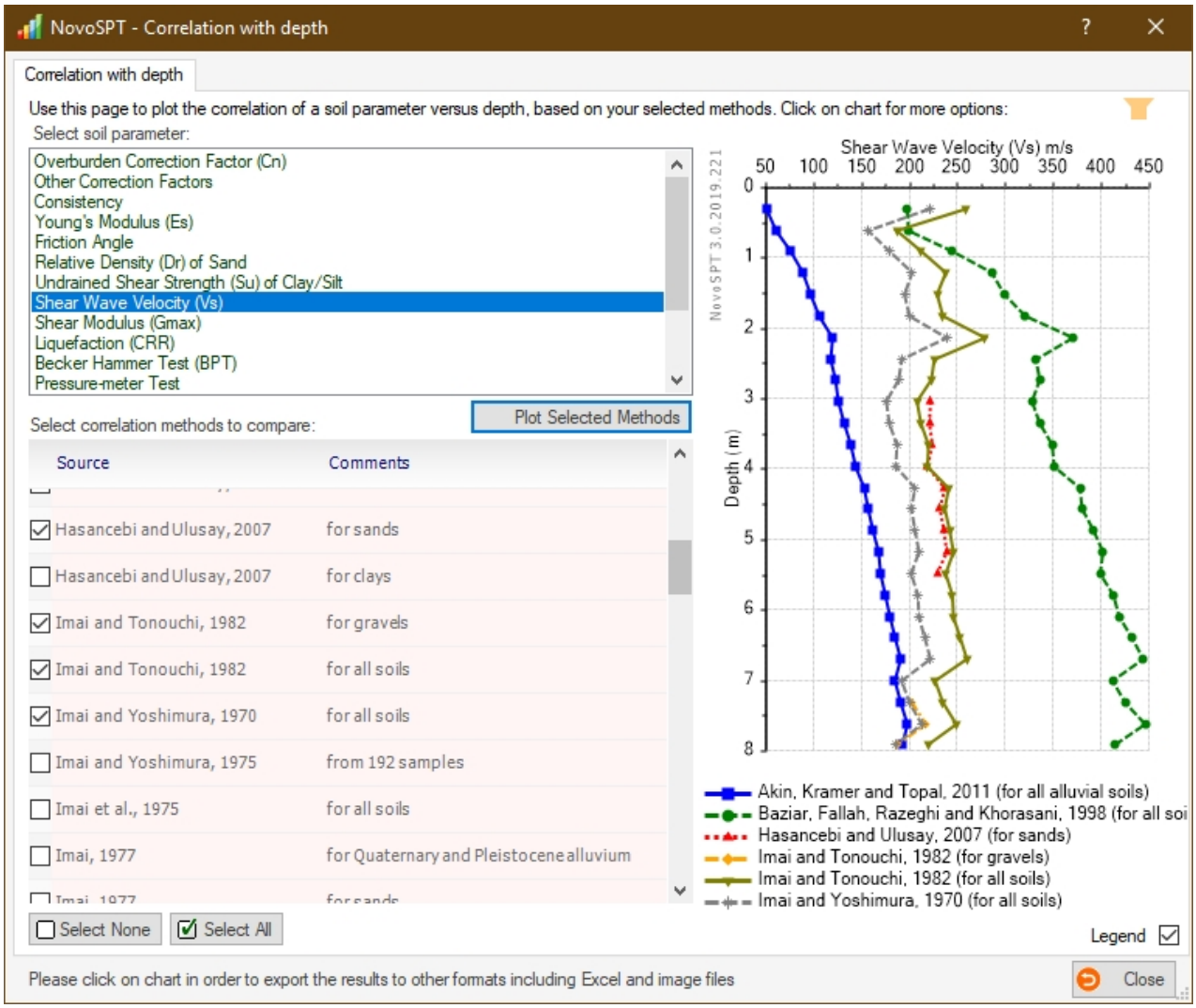


Click on each chart to open the chart in Chart Presentation Tool and you can export and print the data into other formats.

Correlation with depth

This feature is designed to plot the variation of a soil parameter in depth of a borehole based on SPT blow counts, and is accessible from View→Correlation versus depth of the borehole menu. Follow these steps to obtain the correlation in depth of borehole:

1. Select the desired soil parameter (shear wave velocity is selected in the following screenshot)
2. Select the correlations from the list (four of the selected methods can be seen in the screenshot)
3. Click on Plot Selected Methods button and wait for the graph to be updated
4. If necessary, remove or include more methods from the list and repeat step 3



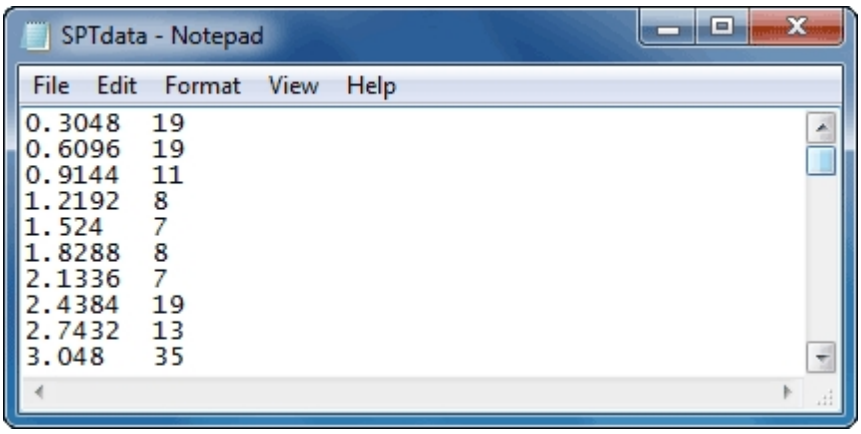
For example, in the above screenshot, 6 methods are selected and plotted along the depth of the borehole.

Note : Please notice that in this example, the funnel icon on top-right corner of the page indicates the *soil type filter* is ON. This means that only those correlations which are derived for the same soil type will be listed at each depth. Soil type at a depth is obtained from soil layers input data.

Import from text file

In case that there are large number of records for soil layers and/or SPT data, user may import data from Text files (*.txt) using button above the tables . The Text file should have the following format:

one record per line and two numbers on each line separated by comma or tab. For instance, if your SPT data is stored in a Text file, it looks like the following:



where, 0.3048,0.6096,0.9144,etc are depths and 19,19,11,etc are corresponding blow counts per foot (N). Text files can be easily generated using Windows **Notepad** or by exporting your data from spreadsheet applications such as Microsoft Excel into text format. For soil layers text file, each line consists of layer *thickness*, its *unit weight* , *soil type* , *D50* and *OCR* separated by comma.

Note: Importing from text file is typically used when you have several rows of data; if your geotechnical model is simple, just enter them in the tables manually.

Importing Data from gINT Files

NovoSPT also supports import from gINT files. Read more about this feature *here* to find out how you can import gINT files directly into NovoSPT.

Import from gINT

Please see the online help for this item.

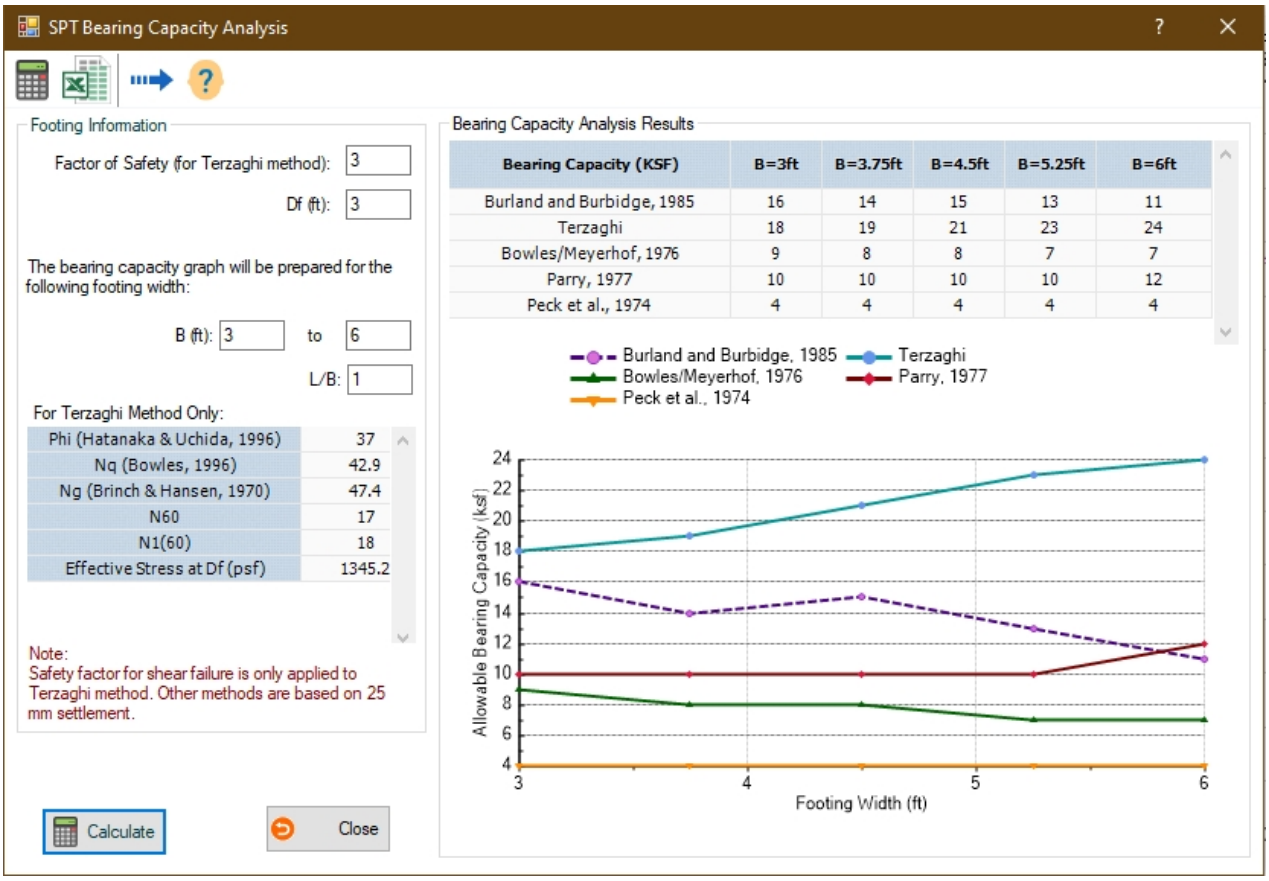
Exporting Tables and Graphs

Please see the online help for this item.

Graph Presentation Tool

Please see the online help for this item.

Bearing Capacity



Meyerhof, 1976 (based on 25mm settlement)

The allowable bearing capacity based on the SPT test according to Meyerhof is:

$$qa=N_{60}.Kd/F1 \qquad B\leq F4$$

$$qa=N_{60}.Kd/F2.\{(B+F3)/B\}^2 \qquad B>F4$$

where $Kd=1+D/(3B)\leq 1.33$ and F1 to F4 are defined as below for SI units:

$$F1=0.05\ ,\ F2=0.08\ ,\ F3=0.3\ ,\ F4=1.2\ m$$

and N_{60} is the average SPT blow counts from 0.5B above to 2B below the foundation level.

Parry, 1977 (based on 25mm settlement)

The allowable bearing capacity according to Parry for cohesionless soil is:

$$qa=30N_{60} \qquad Df\leq B$$

Where N_{60} is the average SPT blow counts below 0.75B underneath the footing.

Burland and Burbidge, 1985 (based on 25 mm settlement)

They collected more than 200 records of structures founded on sands and gravels. They started with the premise that the settlement could be represented by an equation of the form:

$$qa=2540.N_{60}^{1.4}/(10^T.B^{0.75})$$

where N60 is the average SPT blow counts to a depth of $B^{0.75}$ below footing and T~2.23

Peck, 1974

The following formula is used in NovoSPT for this method:

$$qa=10.6N_{1(60)}$$

General Terzaghi Formula

The following Terzaghi equation is used for indirect estimation of bearing capacity of shallow footing on cohesionless soil:

$$q_{ult} = (\bar{q}N_q) + (0.5\gamma BN_\gamma)$$

where:

q = is the overburden stress at foundation level (Df).

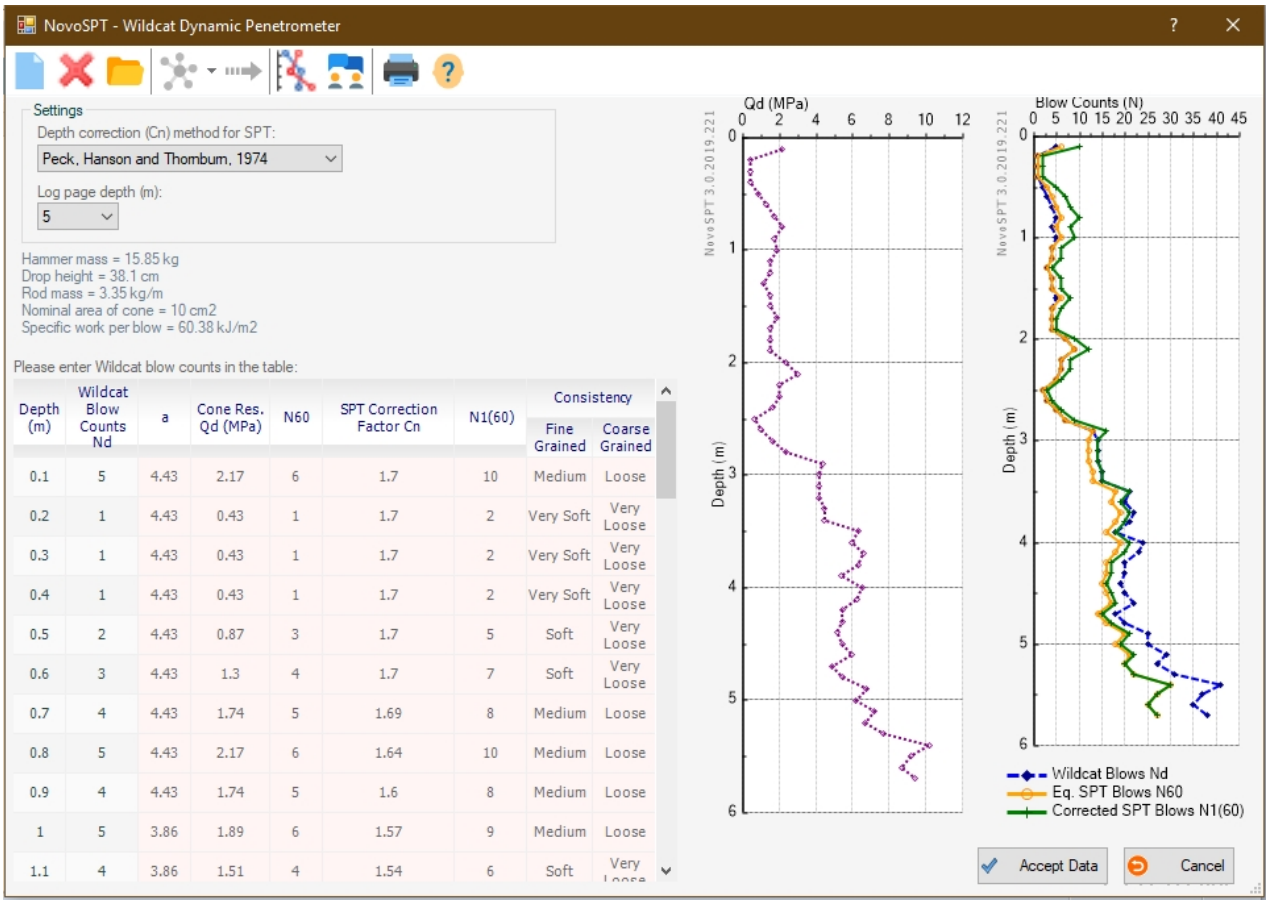
$N_q = e^{[\pi.\tan(\phi)]}\ [\tan(\pi/4+\phi/2)]^2$ Bowles 1996

$N_\gamma = 1.5(N_q-1).\tan(\phi)$ Brinch & Hansen 1970

ϕ = friction angle correlated from the equation proposed by Hatanaka and Uchida, 1996 based on SPT at foundation level

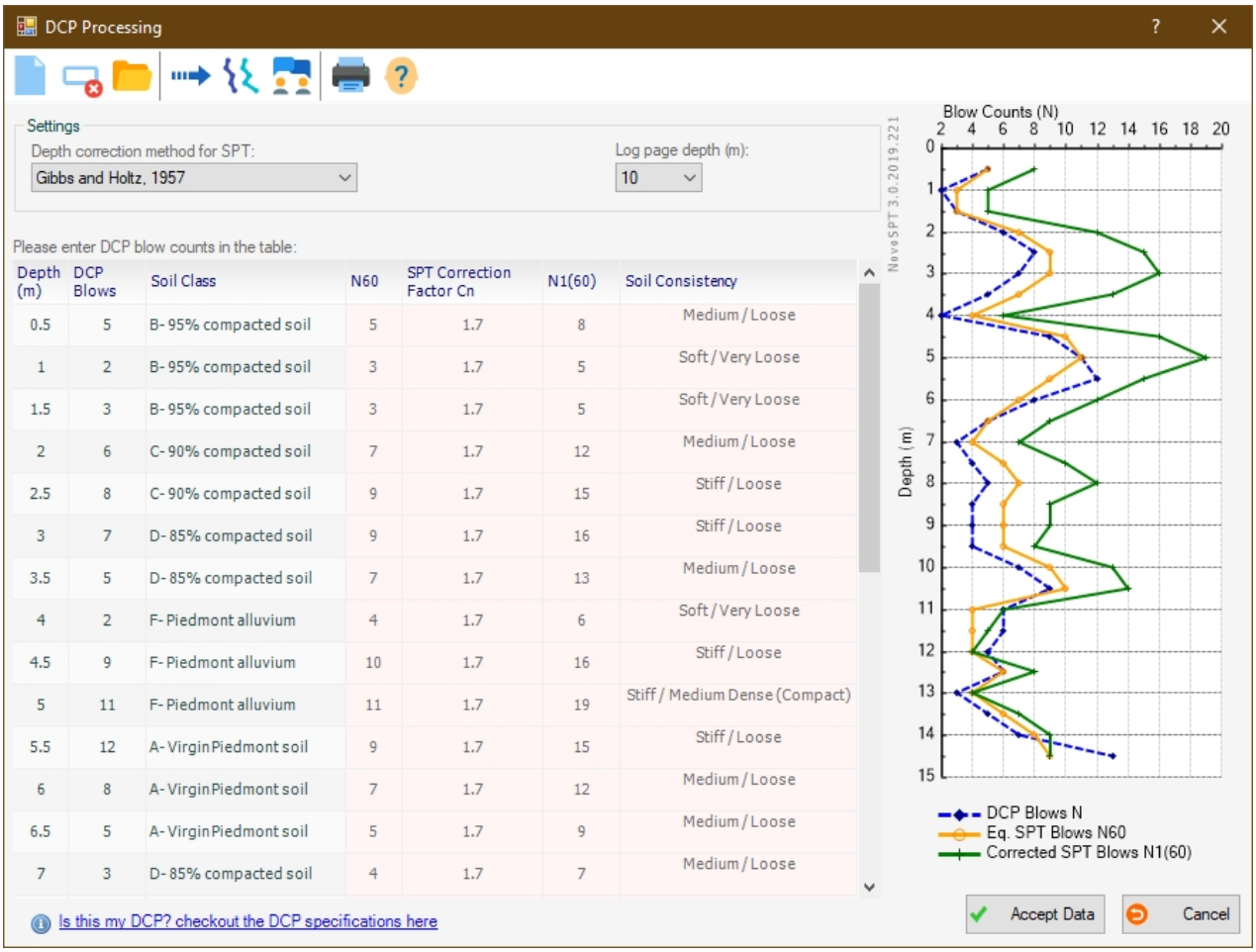
WildCat Penetrometer Module

If you use WildCat Dynamic Penetrometer (produced by Triggs company in the US), this module helps you process and correlate Wildcat blow counts to equivalent SPT blow counts. Please enter depth of test and corresponding WildCat blow counts in first 2 columns of the table. The other parameters including equivalent SPT blow counts will be calculated immediately. To transfer the correlated N_{60} obtained from Wildcat, to the NovoSPT main page click on Accept Data button.

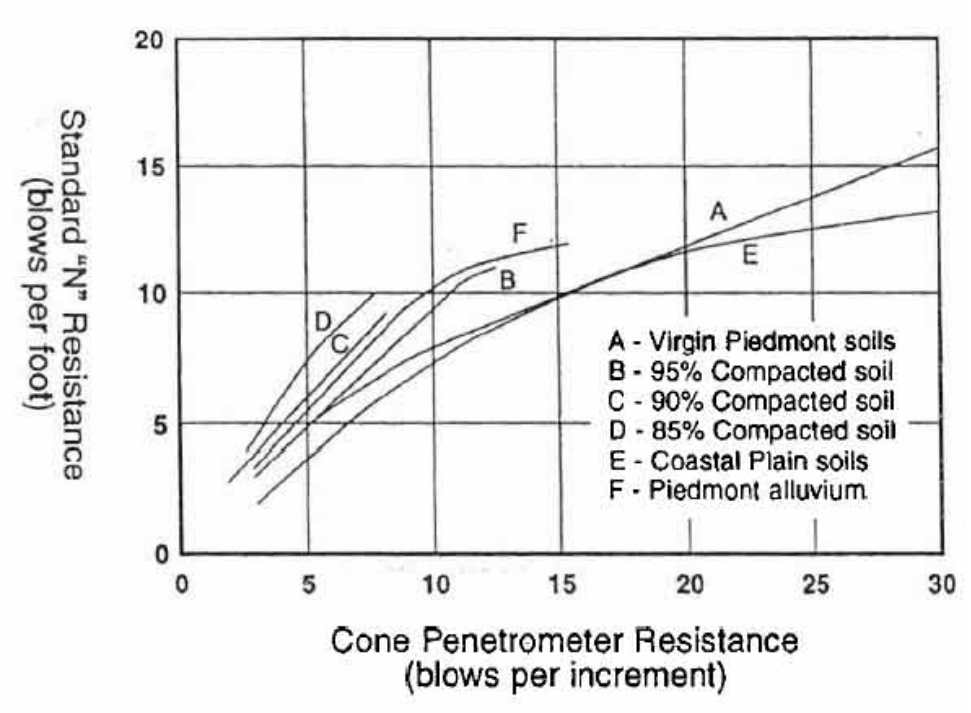


DCP Module

If you use DCP (produced by Durham Geo Slope company in US), this module helps you process and correlate DCP blow counts to equivalent SPT blow counts. Please enter depth and corresponding DCP blow counts as well as soil class (A to F) in the first 3 columns of the table. The other parameters including equivalent N_{60} and $N_{1(60)}$ will be calculated immediately. To transfer the correlated N_{60} obtained from DCP to the NovoSPT main page click on Accept Data button.



The following chart presents the correlations between DCP blows per increment and standard SPT blow counts for different soil types.



For the complete reference please read this paper:

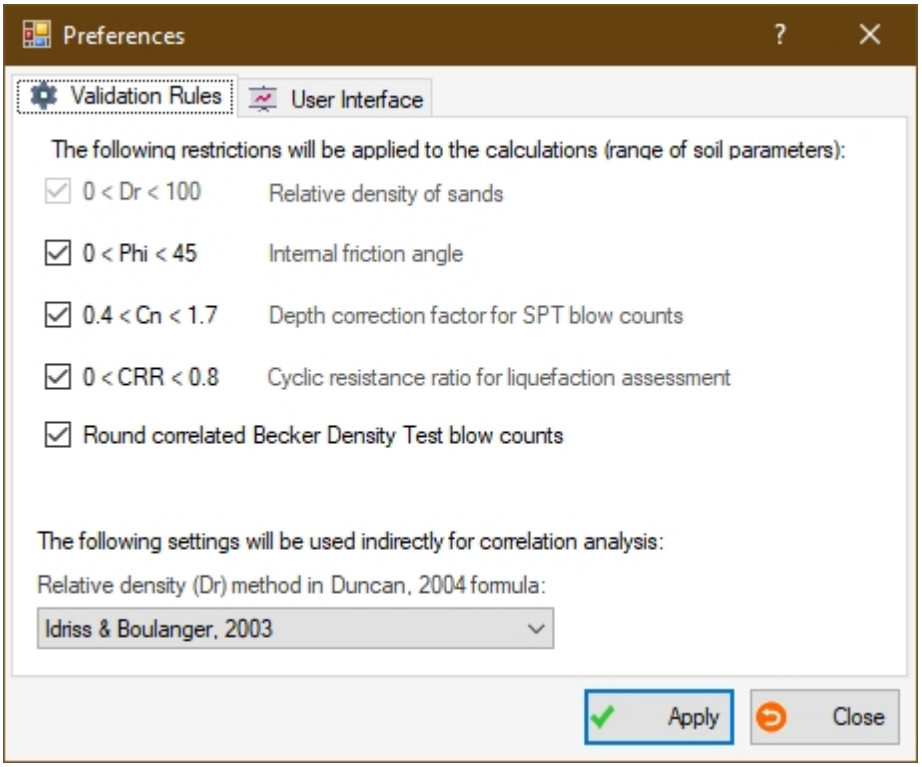
ASTM Special Technical Publication #399: Dynamic Cone for Shallow In-Situ Penetration Testing

by: George F. Sowers and Charles S. Hodges *Download link for user manual (Durham)*

Preferences

Validation Rules tab

The main aim for this tab is to control the valid ranges of output values, since some correlations produce invalid values like sand relative density more than 100 percent or friction angle more than 45 degrees. As it is shown on right, if the checkbox for "0 < Phi < 45" -for instance- is removed, no checking will be carried out on calculated Φ value. We highly recommend to keep all options selected. You can also specify the relative density calculation method used in Duncan (2004) formulae.

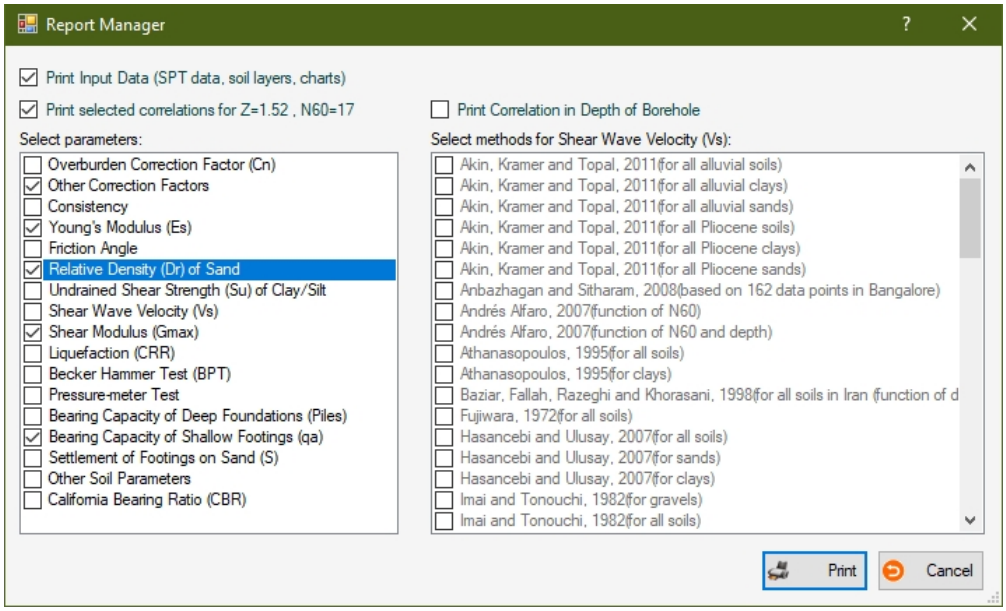


User Interface tab

Use this tab to choose the input / output units system. By selecting Show help button on top-right corner of all forms, a question mark *(?) button* will appear on top-right corner of forms, by clicking on it, help page for that page will pops up.

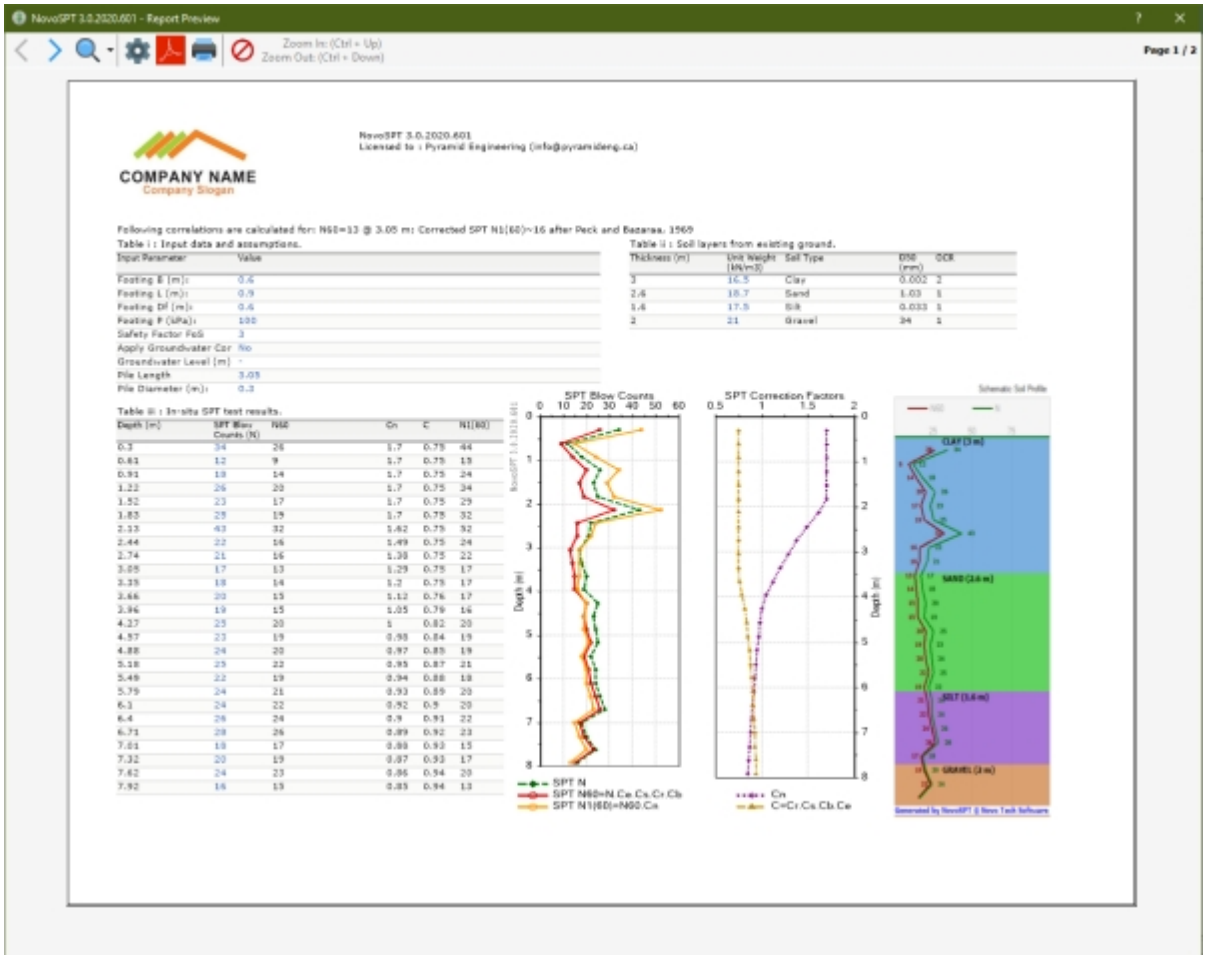
Reporting

To prepare the reports after completing the calculations, simply click on File→Report menu. This will bring up the report manager page, where you can choose the tables and graphs which should be included in the report:



By pressing Print button All selected tables and graphs will be summarized in the report. The print preview page will appear and allows user to change the page setup, send the print and zoom on the report. Toolbar buttons are described in the screenshot below:

Function	Shortcut
Zoom In	Ctrl+Up
Zoom Out	Ctrl+Down
Previous Page	Page Up
Next Page	Page Down



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