SO-Log

Version 1.2.8960.0

Scientific Manual

This software is developed by Soil Office Software Group in order to generate boring logs as a means to summarize and report several tests performed within a geotechnical engineering project.

Soil Office

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1 INTRODUCTION

1-1 SOIL OFFICE

"Soil Office" is a developer of geotechnical engineering software since 2013. Our main objective is to develop functional and user friendly software, capable of performing precise calculations. The following software is currently considered:

- SO-Foundation: Bearing capacity of shallow foundations
- SO-Lab: Soil mechanics laboratory tests and boring logs including:
    - SO-Sieve: Sieve analysis, Hydrometer & Atterberg limits
    - SO-Shear: Direct shear
    - SO-Unconfined: Unconfined compression
    - SO-Triaxial: Triaxial compression
    - SO-Consolidation: One-dimensional consolidation
    - SO-Log: Geotechnical engineering boring logs

Feel free to contact us regarding any criticism, recommendation or additional information.

1-2 SO-LOG

"SO-Log" generates boring logs as a means to summarize and report several tests performed within a geotechnical engineering project.

Borings and samples are introduced in the first place and afterwards, final results regarding laboratory and field tests can easily be assigned. Just after the layering is applied, boring logs are accessible in a variety of landscape and portrait formats. To sum up, lots of smart capabilities are implemented including automatic layering, data entry validation, compatibility check, etc. leading to maximum accuracy outputs.

1-3 SOFTWARE CAPABILITIES

Multiple smart options are available in order ease data entry, increase output accuracy, etc. Some of them are listed below:

1-3-1 GENERAL FEATURES

- Supports "Metric", "SI", "English [ksf]" and "English [psi]" units.
- User is informed about the common ranges regarding input parameters.
- Data compatibility and accuracy is constantly checked and a list of errors is presented.

- 9 landscape and portrait templates are available for enhanced presentation of geotechnical laboratory and field tests results.
- Log depth per page may be individually altered regarding landscape and portrait formats.
- Exporting boring logs to XPS and PDF formats.
- Saving files with a minimal size.

1-3-2 PENETRATION TESTS

- SPT (Standard Penetration Test) and DP (Dynamic Probing) tests can be defined in boreholes and test pits, respectively.
- DP tests are convertible to SPT using a custom energy coefficient.
- By user's will, test results could be limited to 50 and 30 (or 32 depending on the project settings) in coarse-grained and fine-grained soils, respectively.
- Determination of relative density in coarse-grained and consistency in fine-grained soils.

1-3-3 SMART LAYERING

- Automatic layering considering the following criteria:

  - Soil Classification according to USCS
  - Organic fines
  - Cobbles and boulders
  - Percentage of different particles (gravel, sand and fines)

- For each depth range, if the mentioned layering criteria are not violated, best choices for filling the "USCS" and "Description" columns are recommended by the software.

2 SOFTWARE INTERFACE

2-1 GENERAL

❖ <u>Menus</u>

After running SO-Log, the following menus are visible on the top ribbon:

File menu: Contains commands relating to the handling of files, such as creating a new project, save, etc.
Save & Check: Saves the project in the first place and afterwards, checks the accuracy and compatibility of data within the whole project. A list of errors is presented in the end.
Settings: Program settings are determined through this menu.
Help: Contains the following:

- **Scientific manual:** Describes functionality of different parts of the software.
- **Index:** Contains indexed help topics.

License: The permit to use the software and information on the client.
About: Contains general information.

- **SO-Log:** Brief description about the current software and its version.
- **Soil Office:** Introducing Soil Office Software Group.

Units: Switches between the available unit systems.

❖ <u>Tabs</u>

The principal software functionalities are achieved through the following tabs located beneath the top ribbon:

Main: The main tab containing information on the project, borings and samples.
Input: Results regarding laboratory and field tests are assigned via this tab.
Layers: Layering is done through this tab using the automatic option or manually.
Export: Boring logs can be exported using each of the 9 available templates (landscape and portrait).

2-2 DETAILS ON MENUS

2-2-1 **FILE MENU**

This menu is consisted of the following:

New: Creation of a new project.
Open: Opens a previously defined project.
Save: Saves project (with *.sol extension).
Save & Check: Saves the project in the first place and afterwards, checks the accuracy and compatibility of data within the whole project. A list of errors is presented in the end. Errors specified by this option are of secondary type, which are completely described in chapter 3.

Save as: Saves project with a different name.
Sample projects: Sample projects in order to demonstrate software features and easily work with it.
Close: Closes project.
Exit: Closes project and exits SO-Log.

2-2-2 **SETTINGS**

This menu is consisted of the following:

Company logo: The desired logo could be introduced and is printed on all of the software's outputs. By clicking on the "Remove" button, the default logo would replace the current.
Depth per page: Log depth per page can be individually specified in landscape and portrait formats.
Marking divisions: Major and minor depth divisions.
Sort output logs by: Depending on the user's choice, output logs are sorted by alphabetic or data input order.
Fine-grained soils are …: Criterion for the determination of a "hard" fine-grained soil based on SPT result is specified.

2-3 DETAILS ON TABS

2-3-1 **MAIN**

2-3-1-1 PROJECT INFORMATION

Basic project information including name, client, location and code are entered in this section. A separate field is also dedicated for notes. The user can specify the project location on the map and the coordinates will be shown in the corresponding field. Project address is also presented by activating the "Reverse geocoding" option and the user may accept it or not.

2-3-1-2 TABLE OF BORINGS

Project borings are identified through this table. The input parameters are listed below:

> Boring method: Whenever the boring is machine-drilled and the method is not included in the available options or the user prefers it not to be specified, the "-" option can be used.
> Name: Boring name.
> Depth: Boring depth.
> Elev.: Ground elevation at top of boring.
> GWT: Depth to water table measured from boring top (Ground Water Table).
> Note: Notes regarding the boring such as weather conditions including recent rain or other events that could affect subsurface conditions.
> Export: Defines whether the boring is included in the output or not. This option is active by default.
> Contractor: Name of the drilling contractor.
> Start date: Start date of drilling.
> Finish date: Finish date of drilling.

The up and down arrows located on the right side of the table, are for the purpose of altering the order of the borings.

2-3-1-3 TABLE OF SAMPLES

Samples obtained within each of the borings are introduced in this table. The input parameters are listed below:

> Depth: Sample depth.
> Sample category: Sample category including "Disturbed", "Undisturbed" and "Rock core".
> Sample type: Varies by boring method and sample category. "-" may be used if empty for any reason.
> Color: Sample color. Some colors are available by default and others can be defined by the user.
> Code: Sample code.
> Note: Notes regarding sample or its extrusion process.

2-3-2 **INPUT**

All of the test results in a project are defined through this tab. By user's will tables corresponding to laboratory tests, field tests or both can be viewed. Note that **depths where the field tests are performed and the sample depths in the borings, are completely separate.**

2-3-2-1 FIELD TESTS

All of the tests mentioned in this section except SPT are only available in tests pits, therefore disabled in boreholes (machine-drilled borings). "Depth" and "USCS" are test depth and soil classification according to Unified system, respectively.

❖ SPT/DP

SPT and DP tests are defined via this section and are performed in boreholes and test pits, respectively. Table columns are as follows:

> Test refusal: this choice being selected means that the test was refused due to incomplete penetration during each of the steps, leading the test to be stopped.
> Value: contains test result. Depending on the test to be fully performed or refused, the unit is "blows" or "centimeters / inches", respectively.
> Unit: test result unit.
> Result: final test result which varies depending on the test type (SPT or DP) and the chosen settings. These settings are described later.
> Relative density / Consistency: if the layers are correctly defined in a boring, relative density in coarse-grained and consistency in fine-grained soils will be specified considering SPT (converted DP) results.

Choices affecting final test result:

– Convert DP results to equivalent SPT: By choosing this option–which is available in test pits–DP results are converted to equivalent SPT using the energy coefficient. The energy coefficient is located above the table and equals 0.3125 by default.
– Limit test results to 50: SPT or converted DP results are limited to 50.
– Limit fine-grained soils' results to 30/32: This option is available whenever the layers are fully and correctly defined in all borings or in other words, fine-grained and coarse-grained soils are thoroughly defined within the project borings. Using this option, SPT or converted DP results in fine-grained soils are limited to 30 or 32 whichever is chosen through the software settings. Soils with SPT results equal to or higher than 30 are considered "hard" by default.

❖ <u>Insitu soil density</u>

Contains insitu soil density tests.

γ_w: wet unit weight.
w: moisture content.
γ_d: dry unit weight.

Note: Whenever density and moisture content are measured both in field and laboratory, field test results are in priority to show up in outputs.

❖ <u>Insitu direct shear</u>

Insitu direct shear test with the following parameters:

Test type: test type is either "Slow" or "Fast".
ϕ: internal friction angle.
c: cohesion.

❖ <u>PLT</u>

Stands for "Plate Loading Test" and solely determines whether a test is performed or not.

2-3-2-2 <u>LABORATORY TESTS</u>

All of the tests mentioned within this section are related to predefined samples in the project borings. "Depth" and "USCS" are sample depth and soil classification according to Unified system, respectively.

2-3-2-2-1 <u>INDEX</u>

Index tests consist of USCS (Unified Soil Classification System), soil density, specific gravity and compaction.

❖ <u>USCS</u>

USCS is determined using particle size distribution (including sieve analysis and hydrometer) and Atterberg limits tests. The following parameters are used in the table:

> *Peat*: is active whenever soil is of "peat" type. Activating this option, results in deactivation of others.
> *Organic*: defines the existence of organic fines.
> *Particle size analysis*: the following refer to various particles' percentages and their distribution:

>> *Visual*: is used whenever visual examination is performed on the sample. All of the possible choices are filtered due to the Atterberg limits and can be chosen by the user.
>> *Hydrometer*: is used whenever hydrometer test is performed and thus clay and silt percentages may be individually determined. This option is disabled by default.
>> *G*: percentage of gravel.
>> *S*: percentage of sand.
>> *M*: percentage of silt.
>> *C*: percentage of clay.
>> *W/P*: gradation type. "W" for well-graded and "P" for poorly-graded.
>> *Cobble*: particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) U.S. standard sieve.
>> *Boulder*: particles of rock that will not pass a 12-in. (300-mm) square opening.

Atterberg limits: the following refer to Atterberg limits tests:

Visual: is used whenever visual examination is performed on the sample. 5 available choices are ML, CL-ML, CL, CH and MH.

NP: stands for "Nonplastic" and refers to situation where either the liquid limit or plastic limit test could not be determined, or if the plastic limit is equal to or greater than the liquid limit.

LL: Liquid Limit.

PL: Plastic Limit.

PI: Plasticity Index.

USCS: Unified Soil Classification System.

Description: Sample description according to USCS. In order to easily check and compare various sample descriptions, abbreviated descriptions (according to ASTM D2487) are initially presented in brackets.

❖ Soil density

Soil density and moisture content are assigned in this table. At least one of the 2 parameters, wet unit weight or moisture content, have to be specified for each sample. Availability of both recent parameters, results in the dry unit weight to be automatically calculated and presented.

γ_w: wet unit weight.

w: moisture content.

γ_d: dry unit weight.

❖ Specific gravity

G_s: Specific gravity of soil solids.

❖ Compaction

This table relates to compaction tests. Entering the test results is not necessary, but if done, both maximum dry unit weight and optimum moisture content have to be specified.

γ_{dmax}: maximum dry unit weight.

w_{opt}: optimum moisture content.

2-3-2-2-2 <u>STRENGTH</u>

Soil strength tests including direct shear, unconfined compression and triaxial compression tests.

❖ <u>Direct shear</u>

Input parameters are as follows:

> Test type: test type is either "Slow" or "Fast".
> ϕ: internal friction angle.
> c: cohesion.

❖ <u>Unconfined compression</u>

Unconfined compression tests with the following parameters:

> q_u: unconfined compressive strength
> c_u: undrained shear strength (using Tresca failure criterion) equal to one half of the unconfined compressive strength $\left(\frac{1}{2}\,q_u\right)$

❖ <u>Triaxial compression</u>

Triaxial compression tests with the following parameters:

> Test type: test type which could be "UU" (Unconsolidated Undrained), "CU" (Consolidated Undrained) or "CD" (Consolidated Drained).
> ϕ_{UU} , ϕ_{CU} & ϕ_{CD}: internal friction angle in UU, CU and CD tests, respectively.
> c_{UU} , c_{CU} & c_{CD}: cohesion in UU, CU and CD tests, respectively.

As can be seen, ϕ and c can be individually defined regarding each test type. Note that in CU tests, CD parameters could also be defined.

2-3-2-2-3 COMPRESSION

❖ Consolidation

C_c: coefficient of compression.
C_s: coefficient of swelling.
P'_c: effective preconsolidation pressure.

It is not compulsory for P'_c to be defined.

2-3-2-2-4 PERMEABILITY

❖ Permeability

Permeability tests are defined in this table. Corresponding test results are not included in any of the available formats and therefore not necessary to be defined.

K: permeability.

2-3-2-2-5 CHEMICAL

❖ Chemical

Using this table, chemical tests of all types could be defined. There is no need to specify chemical test results of any type.

2-3-3 **LAYERS**

Smart layering capabilities are one of the major features of the current software. Layering may be manually or automatically (using 2 different criteria) specified.

❖ Automatic layering

In this method, a new layer is introduced wherever each of the following criteria is altered:

1- Cobble.
2- Boulder.
3- Organic: is related to the existence of organic fines in the soil sample. Note that whenever fines' weight is equal to or less than 12 [%] of total sample weight, although USCS and description do not change by this criterion, a new layer will still be defined as this criteria is altered.
4- USCS: is the main layering criterion.
5- USCS + Percentage of different particles: Changes in various particles' percentages (gravel, sand and fines) lead to different descriptions in soils with the same USCS code. Considering this criterion, minor layers are introduced wherever descriptions are altered within samples sharing the same USCS code. For instance, unlike the USCS criterion, "*Lean CLAY*" and "*Lean CLAY with Sand*" are considered as two different layers.

Automatic layering could be performed using the following 2 methods:

- USCS: This method considers the first 4 criteria mentioned above. Description is presented based on the average sample in each layer. The average values regarding each of the particles' percentages are calculated within the layer and considered as the average sample. Therefore, this method is disabled in borings with at least one visually examined sample.
- USCS + Percentage of different particles: Choosing this option results in the addition of the fifth criterion to the "USCS" method. This method is always available and performs a more precise layering.

Note: The layers suggested by the software can easily be edited by the user.

❖ <u>Manual layering</u>

In the manual method, the user can define depth range, USCS and description. After USCS is selected, the user may choose from a list of possible descriptions presented by the software. These descriptions can be altered by user's will.

The 5 layering criteria mentioned before are continuously being checked and the user is informed about the software's recommendations (whenever available) regarding each of the columns "USCS" and "Description". These are introduced on top of all other choices, starting with Rec. (standing for "Recommended").

Note: Due to some simplifications and idealizations in the process of layering performed by users, checking the accuracy of layers and specially the descriptions is up to the user. Warnings and errors are specified by the software and do not prevent the user to export outputs logs. Chapter 3 fully describes error types in SO-Log.

2-3-4 **EXPORT**

This tab is dedicated to exporting output logs. 9 landscape and portrait templates are available for enhanced presentation of geotechnical laboratory and field tests results. Full details regarding each template and the exported parameters are presented in a table. Supplementary legends available in 2 landscape and portrait formats could be attached to the output logs by selecting the corresponding choice.

3 ERRORS

Possible errors in the software are divided to primary and secondary errors which are described in the current chapter.

3-1 PRIMARY ERRORS

Whenever wrong or illogical data are entered, the corresponding cells' colors are altered and a message is shown in the bottom ribbon to guide the user. The utilized colors are described below:

1- **Red:** The cell is empty or of the wrong data type.
2- **Orange:** The entered valued is not acceptable.
3- **Green:** Calculations may be performed, but the cell value seems to be illogical.

Project data cannot be saved while primary errors (except green type) exist.

3-2 SECONDARY ERRORS

Unlike primary errors, secondary errors do not apply any limitations on saving project data and are mostly encountered when changes in some data, cause some others to be inaccurate or incompatible. These errors are of 3 types; compatibility, depth and value with the following advantages:

− Software does not crash.
− Incompatible or inaccurate data are not exported.
− All errors regarding each input data are individually specified.

❖ Compatibility errors

Identifies incompatibility among input data which might be due to the following:

- Sample category or type is incompatible with boring method (machine-drilled or test pit).
- SPT or DP tests are defined in test pits or boreholes, respectively.
- Insitu soil density, insitu direct shear or PLT tests are defined in boreholes.
- At least one of the layering criteria (cobble, boulder, organic and USCS) are overridden within a layer's depth range.

The first 3 mentioned above, are due to changes in boring type (machine-drilled and test pit) and all secondary errors of these types are not exported in the output logs. The last one is due to wrong layers being defined by the user. Some users apply some simplifications or idealizations while

defining the layers, therefor **the existence of any secondary errors in the layering, does not prevent the software from exporting output logs.**

❖ Depth errors

Identify errors due to depth values and consist of:

- Sample depth in laboratory test or test depth in field test is greater than boring depth.
- Final depth of the specified layering is not equal to boring depth.

❖ Value errors

Value errors show that the input value is inaccurate or not within the acceptable range. At the moment, this type of error is only encountered when altering each of the DP test parameters (penetration per step or energy coefficient) causes some previously defined results to be inaccurate.

Note:

1- By clicking on the error types located beneath the tables, a message is shown and the user is informed about the probable cause or causes of the errors.
2- Using "Save & Check", a list of all secondary errors is generated and the accuracy of project data is automatically checked. By clicking on any of the specified errors in the list, the corresponding section is shown to apply corrections.

4 CONTACT US

Feel free to contact us regarding any criticism, recommendation or additional information.

1- Visit https://www.soiloffice.com/ContactUs
2- Send an e-mail to info@soiloffice.com
3- Call (+98) 912 313 4107 – Emad Zargaran.
   (Also available on WhatsApp)
4- Call "Emad.Zargaran" via Skype.

5 LIST OF SYMBOLS

Symbol	Description
c	cohesion
c_u	undrained shear strength (using Tresca failure criterion) equal to one half of the unconfined compressive strength
c_{UU} , c_{CU} & c_{CD}	cohesion in UU, CU and CD tests, respectively
C	percentage of clay
C_c	coefficient of compression
C_s	coefficient of swelling
CD	Consolidated Drained
CU	Consolidated Undrained
$Elev.$	ground elevation at top of boring
G	percentage of gravel
G_s	specific gravity of soil solids
GWT	depth to water table measured from boring top (Ground Water Table)
K	permeability
LL	Liquid Limit
M	percentage of silt
N_{DP}	number of blows in DP test (Dynamic Probing)
N_{SPT}	number of blows in SPT test (Standard Penetration Test)
NP	Nonplastic
P'_c	effective preconsolidation pressure
PI	Plasticity Index
PL	Plastic Limit
PLT	Plate Loading Test
q_u	unconfined compressive strength
S	percentage of sand
$USCS$	Unified Soil Classification System
UU	Unconsolidated Undrained
w	moisture content
w_{opt}	optimum moisture content
W/P	gradation type. "W" for well-graded and "P" for poorly-graded
ϕ	internal friction angle
ϕ_{UU} , ϕ_{CU} & ϕ_{CD}	internal friction angle in UU, CU and CD tests, respectively
γ_d	dry unit weight
γ_{dmax}	maximum dry unit weight
γ_w	wet unit weight