
GEO-SIM: A VIRTUAL LABORATORY TEST SIMULATOR FOR GEOTECHNICAL ENGINEERING EDUCATION



Dayakar Penumadu: Department of Civil and Environmental Engineering, University of Tennessee, Knoxville, TN, USA



Amit Prashant: Department of Civil Engineering, Indian institute of Technology, Kanpur, UP, INDIA



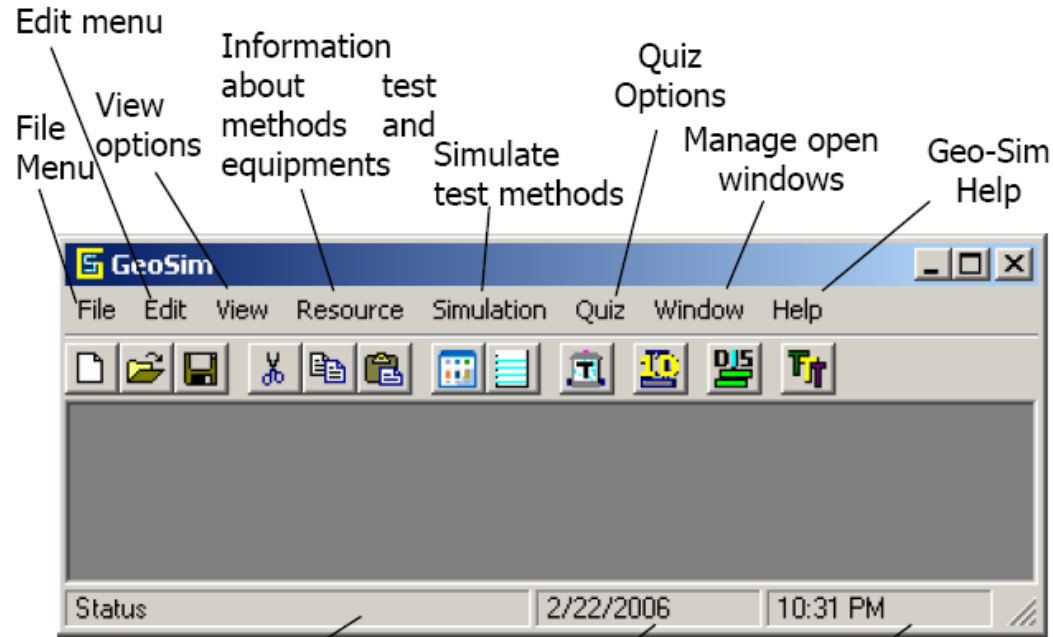
David J. Frost: Department of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, GA, USA

Acknowledgements: Financial support from the National Science Foundation (NSF) through grants EEC-0296187 is gratefully acknowledged. Any opinions, findings, and conclusions or recommendations expressed in this material are those of authors and do not necessarily reflect the views of NSF.

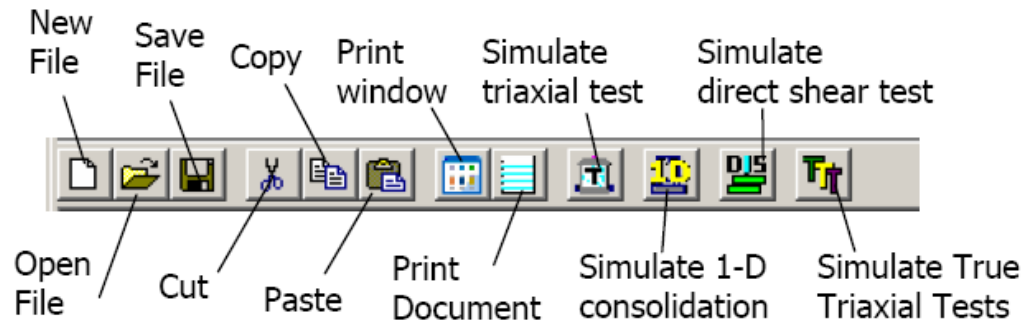
Concept of Virtual Laboratory Testing

- The objective of this research is to develop a multimedia software (Geo-Sim) for performing virtual laboratory experiments to complement and extend the existing laboratory course component related to soil behavior. The virtual experiments are proposed as an addition to the limited real experiments performed within the existing curriculum.
- The Geo-Sim test simulator has been developed in several independent modules consisting of different laboratory simulations. The modules for triaxial compression tests with various specimen boundary conditions, one-dimensional consolidation tests with both incremental load and constant rate of strain method, and direct shear test have been completed. The software supports WINDOWS platforms with multimedia capabilities.

Geo-Sim: Main Window

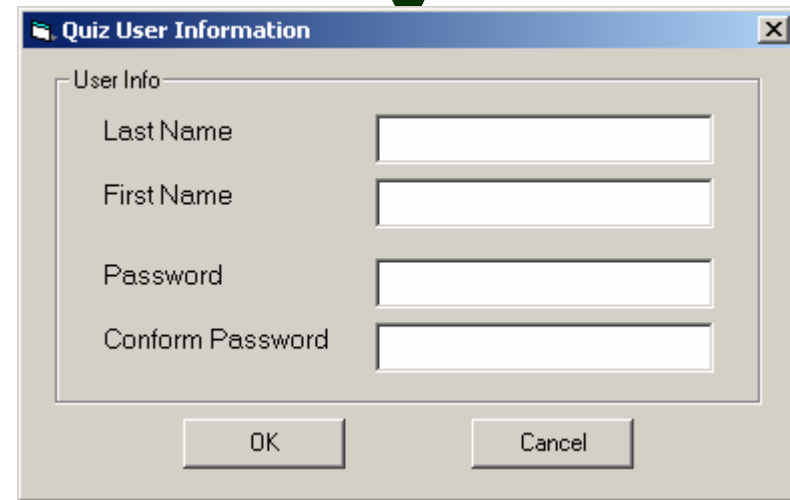
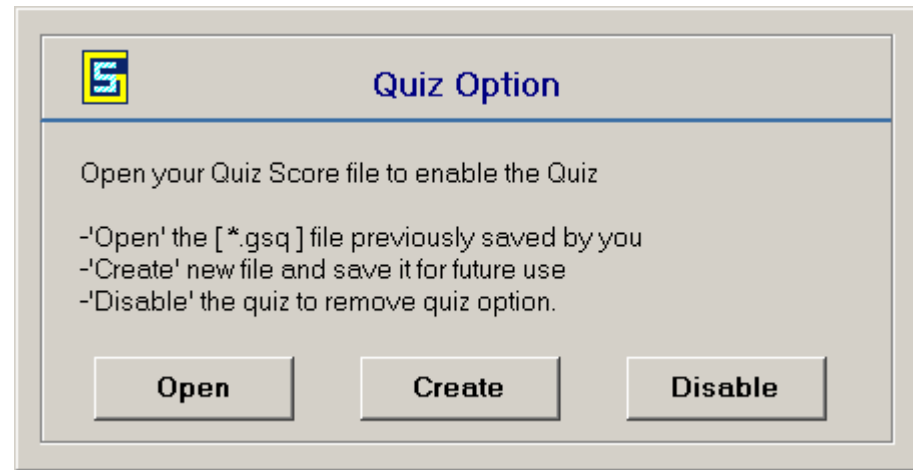


Labels for the main window interface:
 Edit menu, File Menu, View options, Information about test methods and equipments, Simulate test methods, Quiz Options, Manage open windows, Geo-Sim Help, Status Bar, Date, Time



Quiz Option:

- ❑ Quiz scores are tracked in a Geo-Sim Quiz File (*.gsq file).
- ❑ You can “create” this file by providing the your name and a password for file security.
- ❑ The created file can be used in multiple Geo-Sim sessions by pressing the “Open” button and providing the password. So, **remember** the password when you create the file.
- ❑ Send the file to the instructor once the required segments are completed.



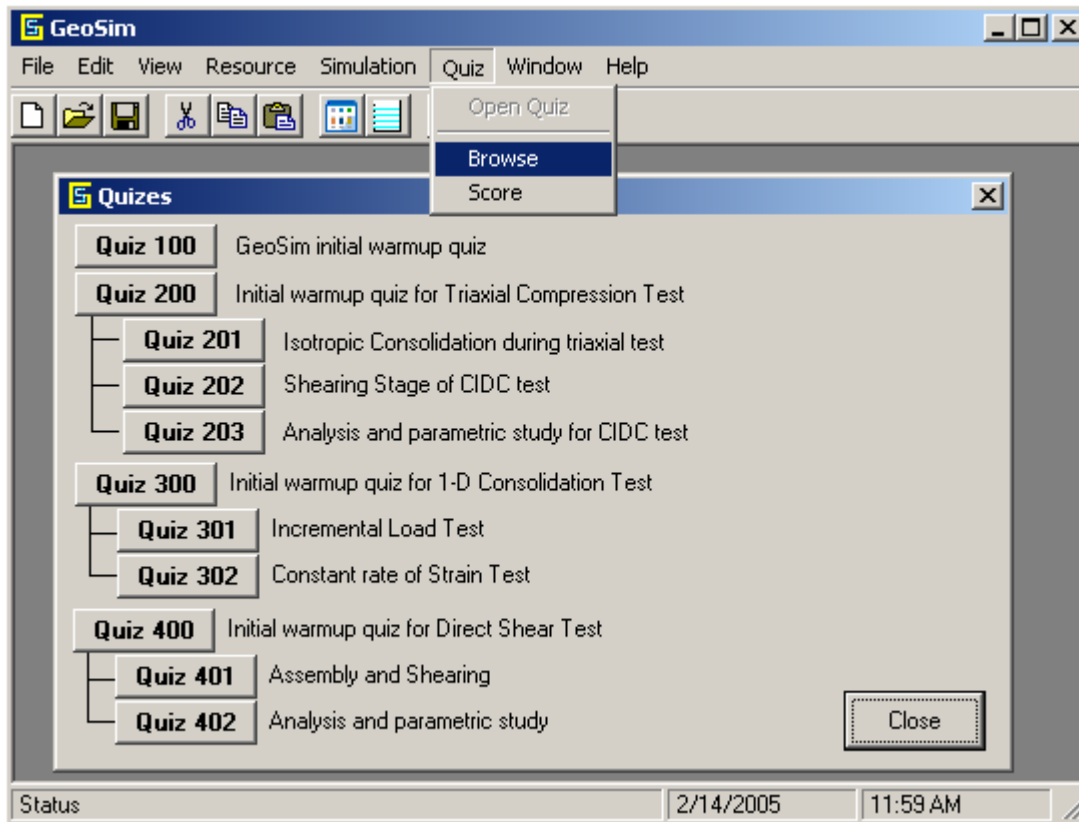
Quiz Applet

The screenshot shows a quiz applet window titled "Quiz - 100". The interface includes a header bar with the title, a row of question numbers (1-5) where '1' is selected, a "Skip Quiz" button, and a calculator icon. The main area contains a question text and four multiple-choice options (A, B, C, D). The bottom bar contains navigation buttons: "Done", "Read Topic", "Clear Selection", "Previous", and "Next".

Annotations with arrows point to the following elements:

- Quiz ID**: Points to the "Quiz - 100" title bar.
- Question number**: Points to the row of question numbers (1-5).
- Question**: Points to the question text area.
- Multiple choice answers**: Points to the list of radio button options (A, B, C, D).
- Close the Quiz and record score**: Points to the "Done" button.
- Relevant help topic**: Points to the "Read Topic" button.
- Clear selected answer on this page**: Points to the "Clear Selection" button.
- Navigation through questions**: Points to the "Previous" and "Next" buttons.
- Invoke Calculator**: Points to the calculator icon.
- Skip Quiz and discard scoring for this quiz session**: Points to the "Skip Quiz" button.

Quiz Menu



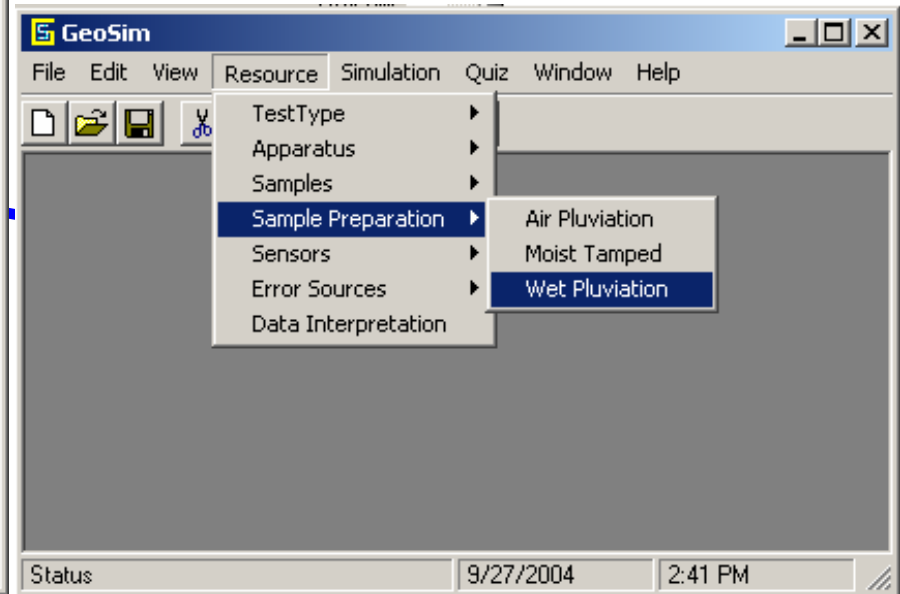
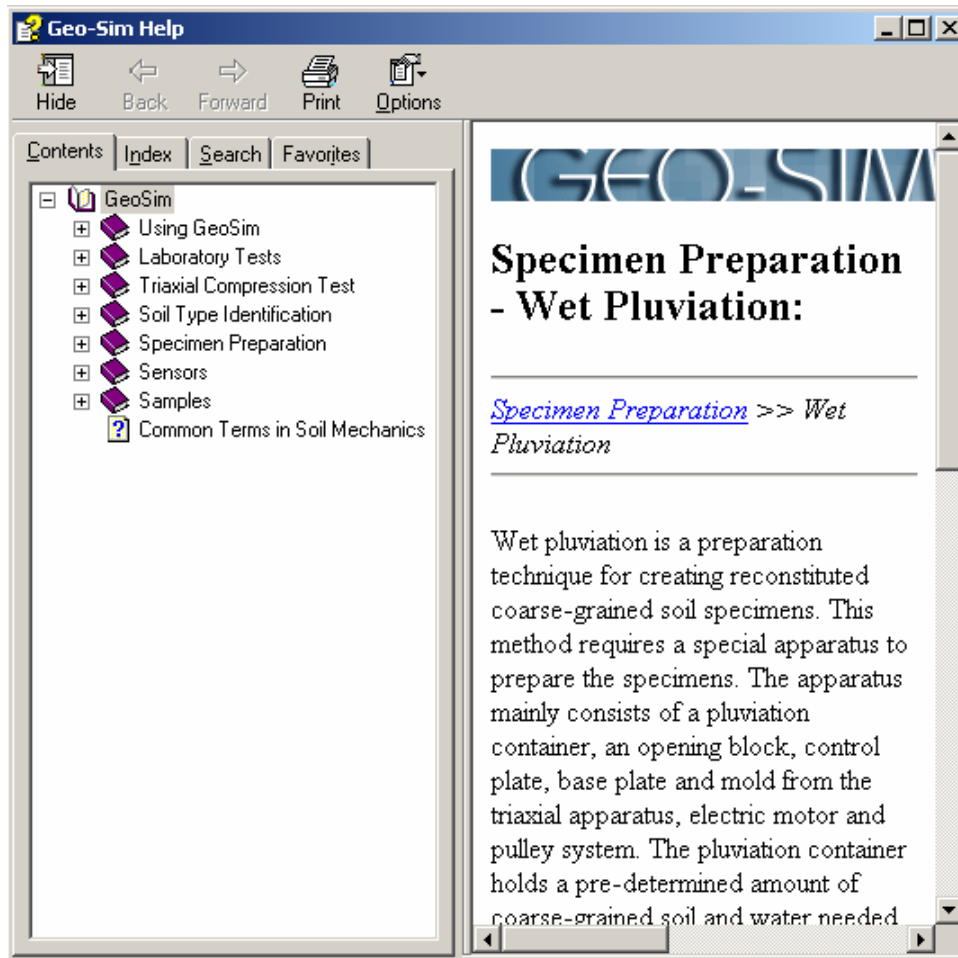
GeoSim Quiz Score Sheet
User's Name: amit prashant

	Asked Questions	Attempted Questions	Correct Answers	Quiz Score
warmup quiz	5	0	0	0 / 50
Triaxial Compression Test	5	0	0	0 / 50
consolidation during triaxial test	5	3	1	10 / 50
Stage of Triaxial test	5	5	5	50 / 50
study for Triaxial test	5	5	2	20 / 50
Stage of Triaxial test	1	0	0	0 / 50
ing stage of Triaxial test	1	0	0	0 / 50
or Triaxial test	1	0	0	0 / 50
1-D ConsolidationTest	5	2	2	20 / 50
Incremental Load Test	5	3	3	30 / 50
Constant rate of Strain Test	5	2	2	20 / 50
Simulating CRS Test	1	0	0	0 / 50
warmup quiz for Direct Shear	5	1	1	10 / 50
quiz on Direct Shear Test	5	2	2	20 / 50
quiz on parametric study of Direct Shear Test	5	1	1	10 / 50
Simulating Direct Shear Test	1	1	1	50 / 50
Parametric study for Direct Shear Test	1	1	1	50 / 50

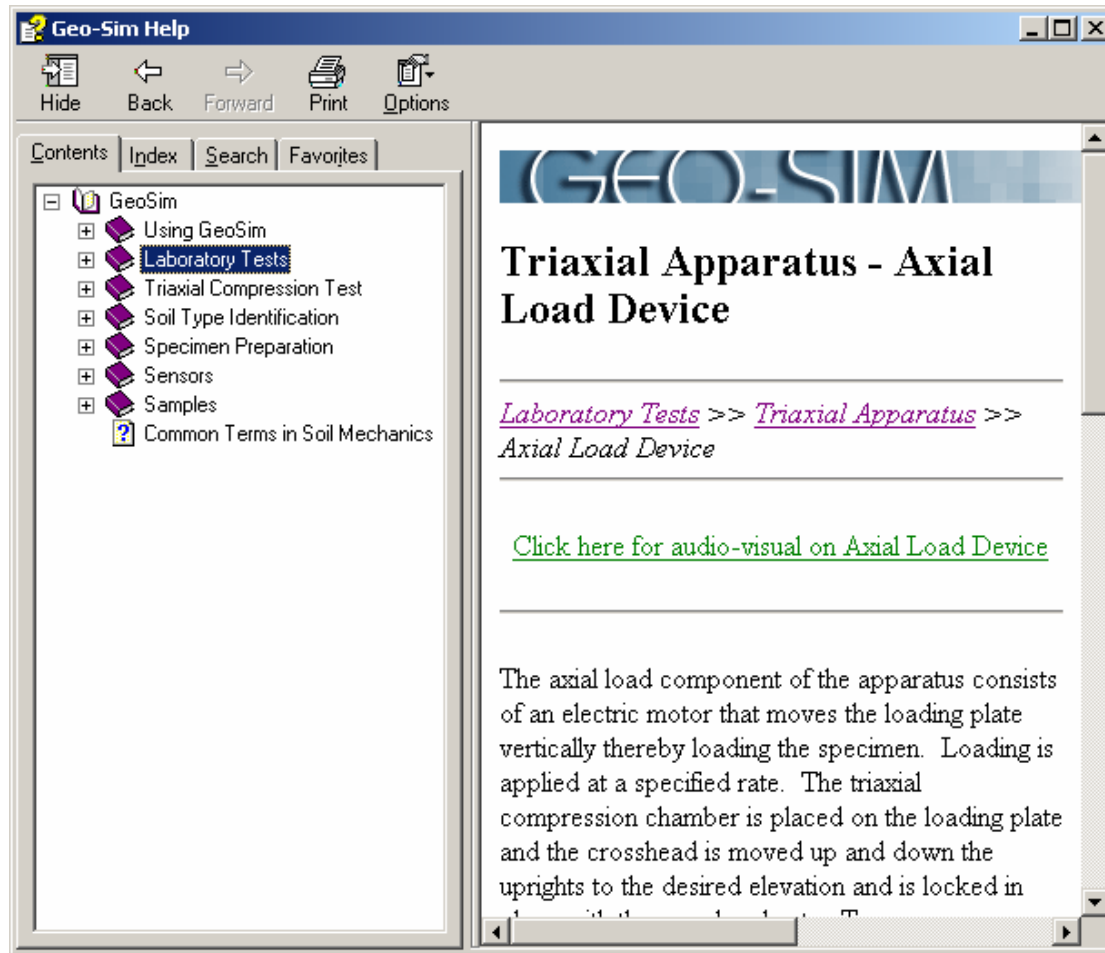
Final Score = 290 / 900

Resources

- Background Material (such as Soil Classification)
- Testing Equipment and its Components
- Sampling techniques
- Sensors
- Test Procedures
- Error Sources and Limitations
- Data Analysis
- Audio-visual resources

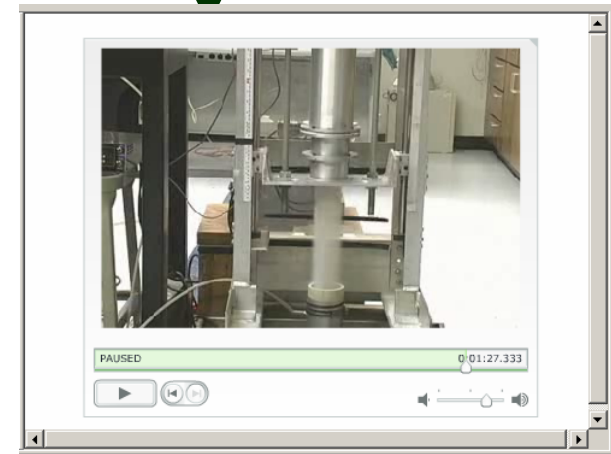


Exploring Help Files




Alternate navigation for specific topic

Links for audio-visuals related to the topic



Triaxial Test Selection

❑ Click **Simulation** menu on main menu bar and select **Triaxial Test**.

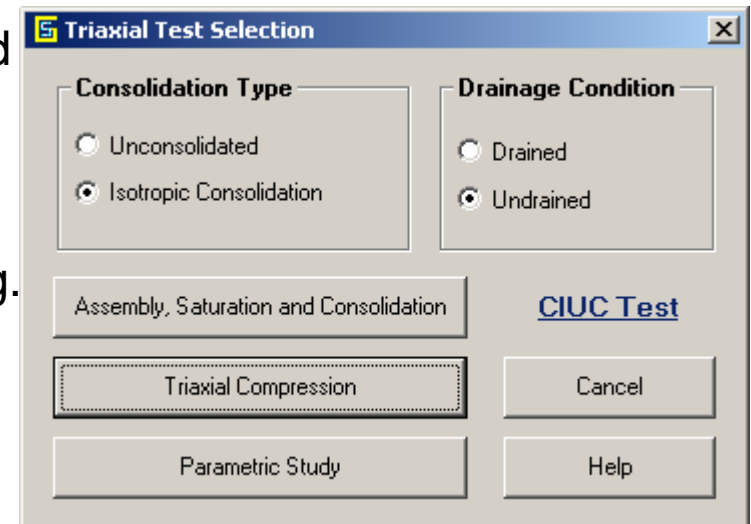
OR, click on the menu icon . You will see this window popped up.

❑ Select the drainage conditions during shearing.

Consolidation type is isotropic.

drained – isotropic → CIDC test

undrained – isotropic → CIUC test



❑ Click on one of three buttons on left to perform corresponding simulations

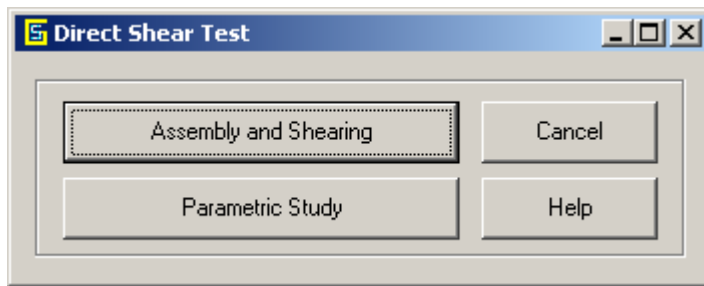
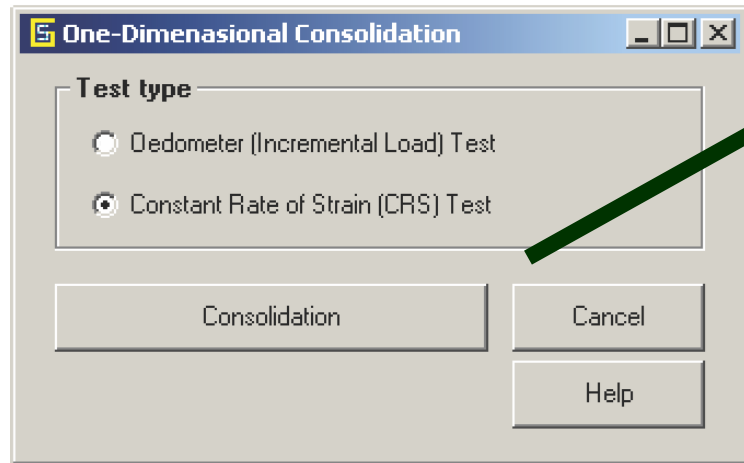
➤ **Saturation and Consolidation**: Simulate the preshear stage of triaxial testing.

➤ **Triaxial Compression**: Simulate triaxial shearing for various soil types

➤ **Parametric Study**: Study the influence of various parameters (such as effective confining stress) on soil behavior.

1-D Consolidation and Direct Shear Test

Simulation Modules for 1-D Consolidation and Direct shear test have been developed using the same pattern as of Triaxial module.



One-Dimensional Consolidation

CRS consolidation test: Singapore Marine Clay

No.	Eff. Sigma(v) kPa	Void ratio e
1	10.273	2.0826
2	12.572	2.071
3	15.806	2.0594
4	19.872	2.0478
5	25.323	2.0304
6	32.705	1.9725
7	42.241	1.9261
8	53.106	1.868
9	66.767	1.797
10	79.54	1.7116
11	92.238	1.6362
12	105.534	1.5609
13	120.741	1.4797
14	138.21	1.3928
15	171.363	1.3232
16	198.722	1.2536
18	293.654	1.1667
19	349.832	1.1029

Constant Rate of Strain 1-D Consolidation Test

Direct Shear Test

Direct Shear Test: Bass Strait Sand

No.	H Disp (mm)	Shear Stress (kPa)	V Disp (mm)
1	0.223	19.3	0
2	0.446	38.1	-0.001
3	0.639	55.3	-0.001
4	0.907	76.6	-0.009
5	1.1	91.9	-0.012
6	1.338	103.3	-0.013
7	1.532	113.2	-0.013
8	1.755	124.5	-0.012
9	1.978	131.9	-0.012
10	2.201	137.4	-0.012
11	2.409	141.3	-0.011
12	2.601	145.3	-0.009
13	2.84	148.3	-0.009
14	3.048	150.2	-0.008
15	3.271	151.2	-0.008
16	3.48	151.7	-0.004
17	3.688	152.7	0
18	3.911	153.7	0.002
19	4.119	153.2	0.009
20	4.342	152.7	0.018
21	4.595	153.2	0.022
22	4.803	153.2	0.034
23	5.026	153.2	0.042
24	5.249	153.7	0.051
25	5.472	153.7	0.062
26	5.695	154.2	0.076
27	5.918	154.2	0.084
28	6.022	154.2	0.088
29	6.216	154.2	0.094
30	6.409	154.2	0.095
31	6.602	154.2	0.097

Direct Shear Test