GCTS is committed to designing accurate testing systems by integrating innovative software engineering with advanced hardware. GCTS systems perform at the highest levels of reliability, providing efficient systems that satisfy customer needs and expectations.

**CATS-TRX-ROCKS**

Triaxial Software Module

- Designed for performing rock triaxial tests
- Automatic ram-specimen touch-down with programmed initial contact stress
- Display and/or control calculated parameters in any desired unit
- Isotropic and Anisotropic Consolidation
- Static and Dynamic Loading with Stress/Strain path control
- Ko Strain Path
- Post-failure behavior
- Easy to setup and conduct Triaxial tests
- Export data to Excel or other Windows programs
- Automatic Mohr-Coulomb model fitting
- Compatible with most Rock Triaxial test Systems

**DESCRIPTION**

The GCTS CATS Triaxial module is part of our 32bit Windows software, CATS (Computer Aided Testing System), the most advanced Geotechnical software available today. Conducting Triaxial tests have been greatly simplified in this module by the incorporation of direct user programming of test calculated parameters in the units of interest (stress, strain, etc.) based on the specimen dimensions. These parameters are calculated in real time and are available for display, graph and/or control. Using calculated test parameters directly eliminates complex and lengthy pre-calculations to design test programs. This allows the user to concentrate on the material behavior rather than on the electronics and equipment operation. Data can be readily exported into other Windows programs such as Excel. The software offers a vast unit selection for displaying each parameter even allowing mixing different unit systems. Unit management is completely automatic.
The Triaxial test module has the ability to automatically control all of the three test axes: Axial Actuator, Cell pressure, Pore Pressure. The advanced controls for the loading frame, cell pressure, pore pressure, and chamber temperature offered by CATS testing software provide for a very precise and synchronized execution of the prescribed test commands.

In addition to the parameters read directly from the system sensors, the Triaxial test module contains 20 test inputs as listed in table 1. These parameters are calculated in real time and are available for monitoring and/or control. There are user selectable methods to calculate the strains: $\varepsilon_a$, $\varepsilon_r$, and $\varepsilon_v$, which can either be from a direct input, or calculated as a function of the other strains. $\varepsilon_a$ can be measured from the frame axial deformation, or it can be measured using the gauge axial deformation input. $\varepsilon_r$ can be measured from a Radial, Diametric, or Circumferential device or it can be back-calculated as a function of the other strains. $\varepsilon_v$ can be a direct internal (pore) or external (cell volume) measurement, or it can be a function of $\varepsilon_a$ and $\varepsilon_r$. All the above parameters are automatically calculated from specimen dimensions and test system setup. Just by answering a few questions, this program provides the right calculations for all the field parameters.

### Table 1. Standard Calculated Inputs

1. $\varepsilon_a$ - Axial Strain  
2. $\varepsilon_r$ - Radial Strain  
3. $\varepsilon_v$ - Volumetric Strain  
4. $\varepsilon_{oct}$ - Octahedral Strain  
5. $\gamma$ - Shear Strain  
6. $A_c$ - Corrected Area  
7. $\sigma_d$ - Deviator Stress  
8. $\sigma_a$ - Axial Stress  
9. $\sigma_a'$ - Axial Effective Stress  
10. $\sigma_c'$ - Cell Effective Pressure  
11. $p$ Cambridge Mohr Parameter Stress  
12. $p'$ Cambridge Mohr Parameter Effective Stress  
13. $p$ MIT Mohr Parameter Stress  
14. $p'$ MIT Mohr Parameter Effective Stress  
15. $q$ Mohr Parameter Stress  
16. $t_{oct}$ - Octahedral Shear Stress  
17. $U_{ex}$ - Excess Pore Pressure  
18. $\mu$ - Poisson’s Ratio  
19. $E_t$ - Tangent Young’s Modulus  
20. $E_s$ - Secant Young’s Modulus

This software module includes a procedure to automatically lower the loading piston until it contacts the specimen by first moving under deformation control until an axial load is detected and then changing to stress control to reach a prescribed seating stress.

The software corrects $\sigma_d$ - Deviator Stress for the loading piston uplift forces generated by the confining pressure. Controlling the $\sigma_d$ directly prevents the loading piston from loosing contact with the specimen when changing the confining pressure (manually or programmed). The stresses are calculated with respect to the corrected area, not the original area, so the “true” stresses are calculated and/or controlled in real time.

The CATS TRX-ROCK software program provides a default data acquisition procedure but it can be overridden by providing the user selectable acquisition rates. Data can be acquired by time, level crossing, or both.

The Rock Triaxial Module is actually made up of 4 independent Stages: Consolidation, Static Loading, Dynamic Loading, and Universal. A test program can be composed of up to 100 stages in any order or repeated as many times as required.

With the ability to zero deformations and update specimen dimensions at the end of any stage, the user can also perform multi-stage testing using one specimen and one test program.

CATS TRX-ROCKS allows the user to configure the computer screen with virtually an infinite number of displays and graphs. The user can select from several different tools to display on real time any of the test sensor outputs or calculated parameters. In addition, user configurable charts and plots can be designed and displayed on real time to graph any test parameter while performing any tests. Screen designs can be saved to be re-used at a later time.
CONSOLIDATION

The Consolidation stage features Isotropic and Anisotropic consolidation. The stage also features a Time to Apply Consolidation Stress selection, so the consolidation stress can be applied in a ramp format, instead of being instantaneous.

This stage also features the ability to manually change the stress/strain rates during testing, for all three axes.

The user can leave the Data Acquisition selection to be automatic, whereas the software selects the parameters, or the user can manually prescribe the Data Acquisition parameters.

STATIC LOADING

The Static Loading stage is an easy to setup static loading stage where control of all of the three test axes can be established, with either the constant or ramp functions. Any test parameter, measured or calculated, can be selected for control allowing for the performance of sophisticated tests. Smooth or “bump less” control transfers from one parameter to another in the middle of a test are also possible eliminating any sample disturbance during this transfer. In this way, a test can be programmed to start with stress control, then switch to axial or radial strain control, to obtain better loading rates as well as to slow down during specimen failure. This control options are available for all three axes, axial actuator, cell pressure, and pore pressure. In this fashion, the loading ram can be easily programmed to apply axial strains at a constant rate while the confining pressure is programmed to maintain zero radial strain (Ko test).

DYNAMIC LOADING

The Dynamic Loading stage is an easy to setup cyclic stage where control of all three axes can be established, with the traditional Sine, Triangular, and Square dynamic waveforms (Constant waveform is available for the Cell Pressure and Back Pressure axes). Controlling the axial stress (as oppose to the axial load) and Peak and Valley compensation ensures the precision of the programmed waveform amplitude even after the specimen undergoes significant deformations or stiffness degradation. More advanced waveforms can be applied using the Universal software module.
UNIVERSAL

The Universal module can be used when the standard modules do not offer the required test program.

This Universal module provides the user complete control of all the available hardware (load frame, cell pressure, cell temperature, etc.). This module offers several pre-programmed waveforms such as ramp, sine, triangular, square, random, etc. where the frequencies and amplitudes can be specified as constants or variable from cycle to cycle. In addition, a “playback” feature allows the user to program any user generated profile for any of the control axes. All of the triaxial test calculated parameters are also available for logging and/or control within the Universal module. See the CATS software brochure for more information about the Universal test module.

REPORT GENERATION

The CATS TRX-ROCK program provides the user an easy and fast report generation where individual test results can be plotted in many different formats. It also allows for the combination of test results to calculate the friction and cohesion intercept (for peak and residual values). Graphs and plots can be directly exported to any Windows program such as Word for an easy and fast report preparation.

In addition, all of the saved test data and calculated parameters including Mohr circles can be directly exported into Excel for further analysis and report generation. The friction angle and cohesion intercept are automatically calculated using all available test specimens for a particular sample. The software calculates these parameters from peak and residual conditions as well as for total and effective stresses. The program also allows the user to select which specimens are used in the calculation. Even though, the Mohr circles and other result graphs can be printed or directly exported to programs such as Word, CATS TRX-ROCK allows you to export all the graph data including the Mohr circles (as data vectors) into Excel for a more customized and professional report presentation.