



HCA-600
Large Scale Dynamic Hollow Cylinder Testing System



1
2
3
4
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6
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8
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10
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12
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16
17
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20
21

- **Dynamic and Static Hollow Cylinder Apparatus capable of applying synchronized loading at frequencies up to 10 Hz (25 Hz single axis maximum frequency).**
- **Test large specimens 300 mm Outside Diameter & 150 mm Inside Diameter . Platens for solid 300 mm or smaller Diameter specimens also available.**
- **1,000 N-m torque and ± 300 kN axial load capacity.**
- **Independent digital servo control of axial load, torque, cell, inner and back pressures.**
- **Hydraulic servo controlled.**
- **Optional unsaturated soils testing system package.**
- **Complete "turn-key" system.**

DESCRIPTION

The purpose of any soil mechanics apparatus in a laboratory is to duplicate the in-situ conditions. However, none of these apparatus can control the rotation of the principal stress-strain directions. Axis-symmetric triaxial tests cannot model these conditions (principal stresses can only be 0° or 90°) and conventional shear tests rotate the axis associated to the major principal stress but without the possibility of monitoring stress conditions.

Advanced material characterization requires a testing device capable of controlling the rotation of principal stress directions. The GCTS Hollow Cylinder Apparatus (HCA) is capable of imposing three dimensional stress states, and it can rotate the principal stress directions. This apparatus, one can apply and control independently the principal stresses σ_1 , σ_2 and σ_3 and the rotation angle of σ_1 with the vertical direction.

Direct digital servo control of axial load, torque, confining pressure, internal pressure, and back pressure are achievable using the GCTS Dynamic Hollow Cylinder Testing System for performing "true triaxial" tests. This system is capable of simulating most field stress/strain path tests (static or dynamic) including plane strain, simple shear, and small shear strains. Other possible tests include: measurement of dynamic shear strength & deformation, liquefaction potential, shear modulus and damping ratio. The system is versatile in allowing the user to design custom procedures with operating frequencies of up to 25 Hz.



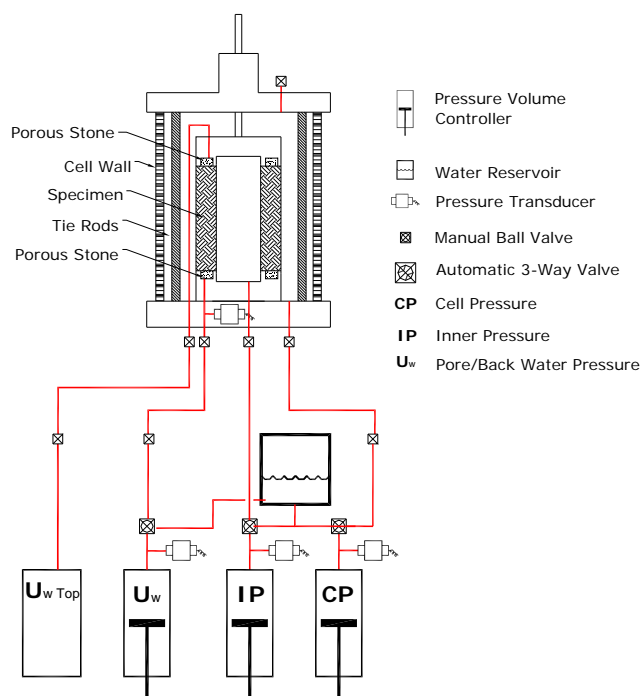
The HCA-600 is operated with our fully integrated SCON-2000 digital signal conditioning/controller and the state-of-the-art CATS-HCA, true 32-bit, Windows XP software. Conducting Hollow Cylinder tests have been greatly simplified by the incorporation of direct user programming of test calculated parameters in the units of interest (stress, strain, etc.) based on the specimen dimensions. Up to 20 test parameters such as principal stresses, rotation angle of principal stresses, octahedral stresses and strains, etc. are automatically defined and corrected taking into account such things as piston uplift force from

confining pressure application and changes in specimen area during the test. These parameters are calculated in real time and are available for display, graph and/or control. In addition, CATS software allows you to define user defined parameters to obtain multiple sensor averages or corrections as a function of other inputs. 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.

The system software advises the user on how to perform testing tasks and also reminds the user of important steps that may need to be executed (such as opening or closing a valve at required test stages). The program helps the user to select proper testing parameters and provides the necessary information to automatically execute the test. The Graphical User Interface with context sensitive on-line help and intuitive color windows help minimize the learning time and enables laboratory personnel to conduct more sophisticated testing programs at an economical price. The system manages all the instrumentation and continuously monitors sensor outputs to accurately account for uplift pressures acting on the loading piston, area changes, deformation and volume change sensor setup, re-positioning, etc. This system includes a load frame that is relatively lightweight but highly stable and has a small tabletop footprint. The load frame consists of two large, stainless steel threaded columns with a hard-anodized aluminum cross head beam and a large, thick bottom plate for stability. The bottom plate is threaded for the two upright columns and for hold-down bolts to secure the triaxial cell. The stainless steel nuts on the frame columns can be used to easily adjust the height of the crosshead beam to accommodate variable specimen or cell heights. These frames can be configured with different flow capacity servo valves to obtain the required cyclic amplitudes. Performance charts printed below show the cyclic response of the standard and optional servo valves.

The triaxial cell included with the HCA-600 system is constructed of stainless steel. The standard unit features a see-through Plexiglas external cell wall. All the standard GCTS triaxial cells can accommodate smaller diameter specimens using optional platens. These triaxial cells accept specimens with a length of 2 to 2.5 times the outside diameter.

The standard HCA-600 includes three pressure/volume controllers for applying the outer cell, inner cell and back pressures. Each pressure/volume controller is housed inside a metal cabinet with casters that also include a 20 liter fluid reservoir, precise analog gages, automatic ball valves, flow indicators, etc. making them very convenient and easy to operate. Pressure gauges provide a visual verification of confining and pore pressures. Convenient "quick-connect" fittings allow for easy connection of pressure lines and filling/draining the fluid reservoirs. Sight tubes are also available to show the available amount of fluid in each fluid circuit.



Each pressure/volume controller intensifier has a pressure transducer and LVDT connected to them allowing for the servo control as a function of pressure, fluid volume control, or any other measured or calculated test parameter. With both pressure/volume controllers, advance tests such as stress/strain path, K_0 , permeability, etc. can be easily performed. GCTS Pressure/Volume pumps use servo hydraulic controls that offer a fast reaction time and can apply synchronized cyclic axial and lateral stresses at high frequencies.

The embedded microprocessor is capable of performing all test functions even if the Windows computer crashes. It provides automatic dynamic control mode switching between any connected transducer or calculated parameter ("bump-less transfer"). This controller also conditions all transducers used for triaxial testing and provides real time linearization of any input using high-order polynomials. This digital controller is capable of updating the control loop at up to 6 kHz required to control the loads for high frequency dynamic tests. The SCON-2000 has several adaptive compensation techniques to improve the control precision without user intervention. Controlling the actual axial stress (as opposed to the axial load) and use of the Peak and Valley compensation ensures the precision of the programmed waveform amplitude even after the specimen undergoes significant deformations or stiffness degradation. This is an important feature in order to maintain the desired cyclic amplitudes throughout the entire test.

Our system includes a 150,000 per second sampling rate with 16-bit (0.0015%) resolution and "sample-and-hold" Digital-to-Analog (A/D) Converter. The sample-and-hold ensures that the converted values from all attached sensors (load cells, deformation, etc.) represent a single instant in time eliminating any data skew from delays in the A/D converter. GCTS

hardware-software interface includes both an analog anti-alias filter for high frequencies and a digital filter for lower frequencies. This configuration produces a very stable and precise signal measurement and control system as required to perform dynamic torsional/triaxial tests.

Any desired unit can be used for display or report test parameters and even allowing combining different unit systems. GCTS software also offers compatibility with network systems for monitoring or sending your test data directly to any computer connected to your network. Using a Windows network system in your lab facilitates transferring of your test data directly into other Windows programs such as Word or Excel for report generation as well as to easily backup your important test results.



Specimen preparation equipment is available for different specimen geometries and heights of 2 up to 2.25 times the specimen outside diameter.

Different options can be specified with the GCTS Hollow Cylinder Apparatus such as internal small strain gages and unsaturated soil testing capabilities. The unsaturated soil testing option includes direct strain measurements (inside and outside diameter as well as axial and angular strains).

