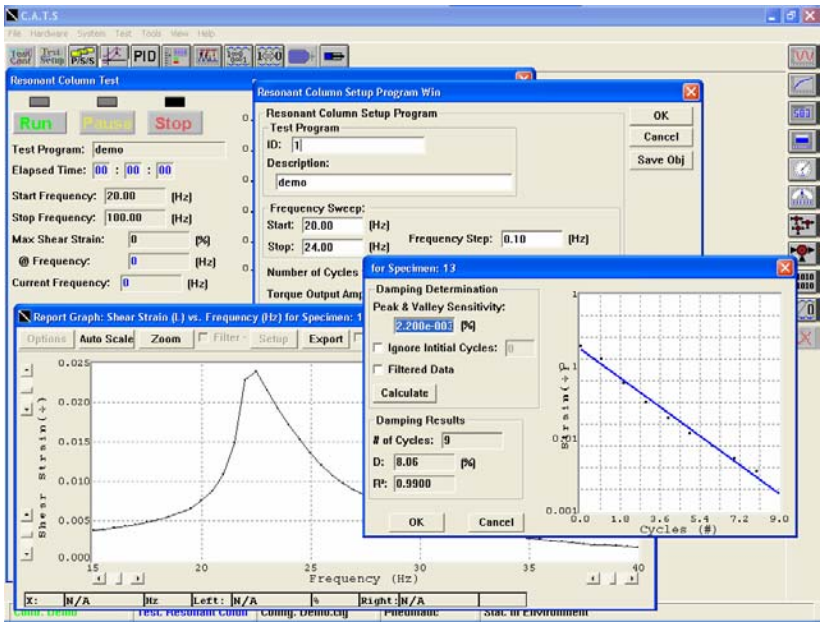
GCTS is committed to designing accurate testing systems by integrating innovative software engineering with advanced hardware. GCTS systems perform at the highest levels of reliability, providing efficient systems that satisfy customer needs and expectations.

GCTS TESTING SYSTEMS

TSH-100 and CATS-RC/TSH
Resonant Column/Torsional Shear Testing System and CATS Module



- **Automatic determination of resonant frequency and damping ratio from frequency sweep and free vibrations data**
- **Capable of performing modulus/damping resonant column and torsional tests on soils and asphalts (solid and hollow specimens)**
- **Floating drive and measurement system to allow for large angular & axial specimen deformations**
- **1,000 kPa (150 psi) maximum confining pressure - higher confining pressures available with stainless steel cell wall**
- **Platens with ultrasonic transducers for P- and S-wave velocity measurements are available as an option**
- **Standard systems available for 71-mm and 100-mm diameter specimens available. Other platens sizes are also available**
- **Does not require complicated electronics such as an oscilloscope or function generator**
- **Available upgrades of most resonant column systems to a computer-controlled system**

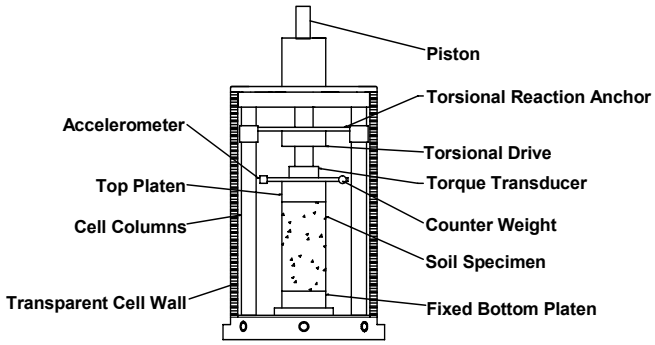
DESCRIPTION

The GCTS TSH-100 Resonant Column/Torsional Shear Testing system combines the features of both resonant column and torsional shear devices into one system so that the effects of soil parameters such as void ratio, confining pressure, strain amplitude, and number of load cycles on shear modulus and material damping can be evaluated. In fact, by utilizing all available options, this system is capable of the full spectrum of modulus measurement, ranging from ultra low strains to high strains with significant overlap.

For the resonant column test a torsional drive is used to vibrate the top of the soil specimen at frequencies up to 250 Hz in first-mode resonance while the bottom is fixed. Non-contacting rotational sensor and a torque transducer attached to the top platen monitor the torsional motion and torque directly. The non-contacting sensor is located on extended arms to amplify the rotational deformation providing a shear strain resolution of 10-6. An optional accelerometer can also be installed to measure large shear strains.

The GCTS System can also perform closed-loop torsional shear tests (stress or strain controlled) on the same soil specimen, either statically or dynamically at up to 20 Hz.

P.O Box 23686 Tempe AZ 85283 U.S.A. Tel: (480) 456-0110 Fax: (480) 456-4727 gcts.com



With this system, soil specimens can be tested under isotropic (hydrostatic) or anisotropic conditions. The driving and measuring system are mounted on a "floating" frame allowing large vertical specimen deformations throughout the complete test. Its unique configuration also allows for very large shear deformations of up to ±20°.

The GCTS CATS Resonant Column/Torsional Shear module is part of our 32-bit Windows software, CATS (Computer Aided Testing System), which is the most advanced geotechnical software available today. This software test module has greatly simplified the operation of instruments and conduction of the resonant column test by allowing the user to directly program test calculated parameters in the units of interest (such as strain) based on the specimen dimensions. These parameters are calculated in real time and are available for display, and/or graphing. Use of calculated test parameters directly eliminates complex and lengthy pre-calculations required in designing test programs. This allows the user to concentrate on the material behavior rather than on the electronics and equipment operation.

The resonant column test module has the ability to automatically calculate these specimen results for each tested specimen:

- Resonant Frequency (Hz)
- Maximum Shear Strain
- Shear Velocity (m/sec)
- Shear Modulus (MPa)
- Damping Ratio – Free Vibration Decay (%)
- Damping Ratio – Half Power Bandwidth (%)
- Predominant Frequency from Free Vibration Data FFT Analysis (Hz)
- Natural Frequency - from Resonant Frequency and Phase Shift (Hz)
- Natural Frequency - from Resonant Frequency and Free Vibration Decay (Hz)
- Natural Frequency - from FFT Frequency and Free Vibration Decay (Hz)

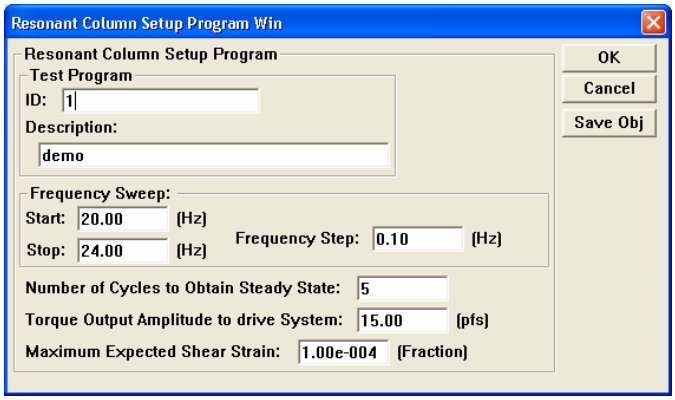
The module requires, at a minimum, that the accelerometer or proximitor(s) that is used for the shear deformation be measured electronically. The torque input for the software can either come from a torque sensor, or it can be a function of the output to the driving motor.

The resonant column test module contains three test inputs, which are calculated in real time, and they are as follows:

Table 1. Standard Calculated Inputs		
1	t	Torque
2	γ	Shear Strain
3	τ	Shear Stress

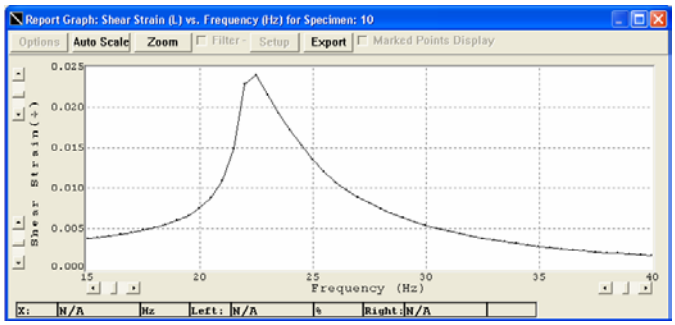
The shear strain, γ, is a real-time calculation using the curve fitted results of either the accelerometer or proximitor(s) inputs.

The resonant column module test program is easy to setup, where the user enters the starting frequency, the stop frequency, the frequency step, and few other parameters, and the software will conduct the test automatically without user intervention. This minimizes the number of cycles at each frequency preventing premature specimen degradation.

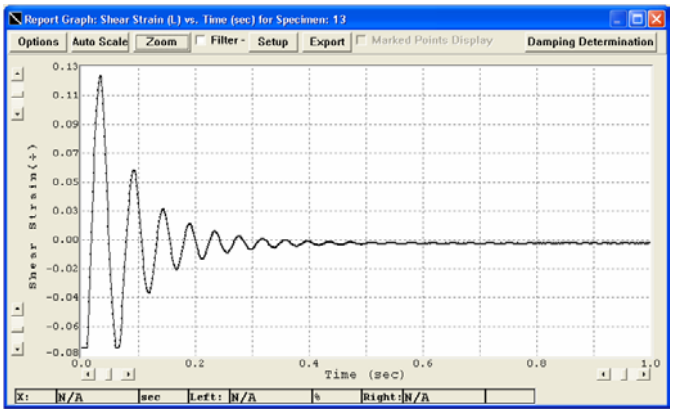


CATS Software Screen for RC Test Setup

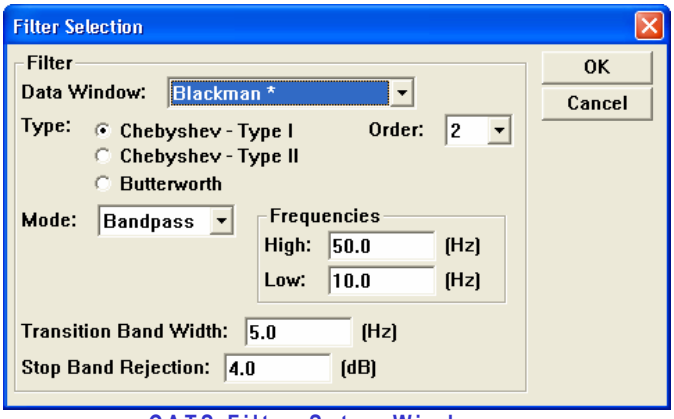
At the end of the test, the software calculates the specimen results and the user can see the frequency sweep on how the resonant frequency was determined.



CATS Sample Frequency Sweep



CATS Sample Free Vibrations Data

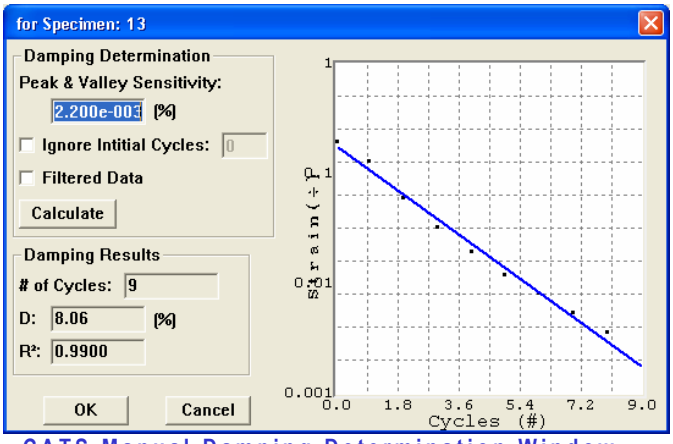


CATS Filter Setup Window

The user can also see the forced vibrations data of the specimen (at the resonant frequency), as well as the free vibrations data, from which one of the damping ratios is determined

Free Vibrations Damping Ratio Determination

If the user is not satisfied with how the Free Vibration Decay Damping Ratio was determined, the user can manually determine it using the damping Free Vibration Decay Damping Ratio Determination Window.



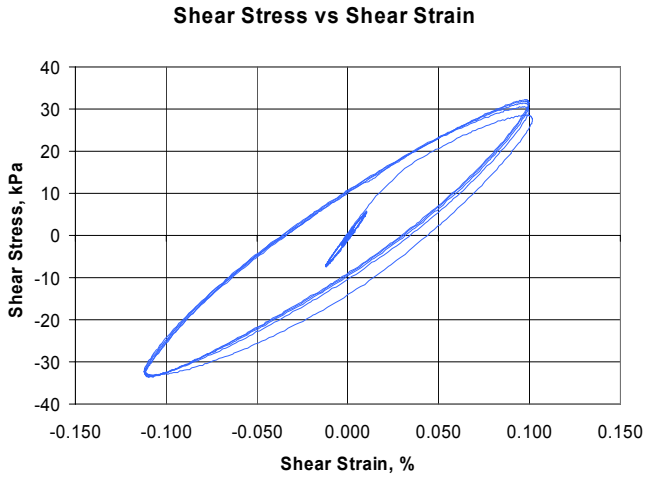
CATS Manual Damping Determination Window

Filtering

The user can also filter the free vibrations data in case some external noise of a certain frequency (such as AC power) proves to provide too much of an influence on the results. The user can view the FFT (Fast Fourier Transform) of the free vibration results, then optionally employ a filter in order to reduce the effects of this unwanted signal.

The resonant column module of the GCTS CATS software simplifies the usage of the resonant column/torsional shear apparatus by providing a convenient way to calculate the needed test parameters (shear strain, shear stress, etc.) just by entering in the specimen dimensions and system configuration. It also features an easy to setup test program which reduces the amount of time required for test setup. After a short period a testing the software automatically calculates the specimen results, which makes this software module an invaluable tool in resonant column/torsional shear testing.

Torsional Shear



SPECIFICATIONS