Geocomp

Technologies to manage risk for infrastructure

Resonant Column-Torsional Shear Testing Device

Entirely New and Better Approach to Resonant Column-Torsional Shear Testing

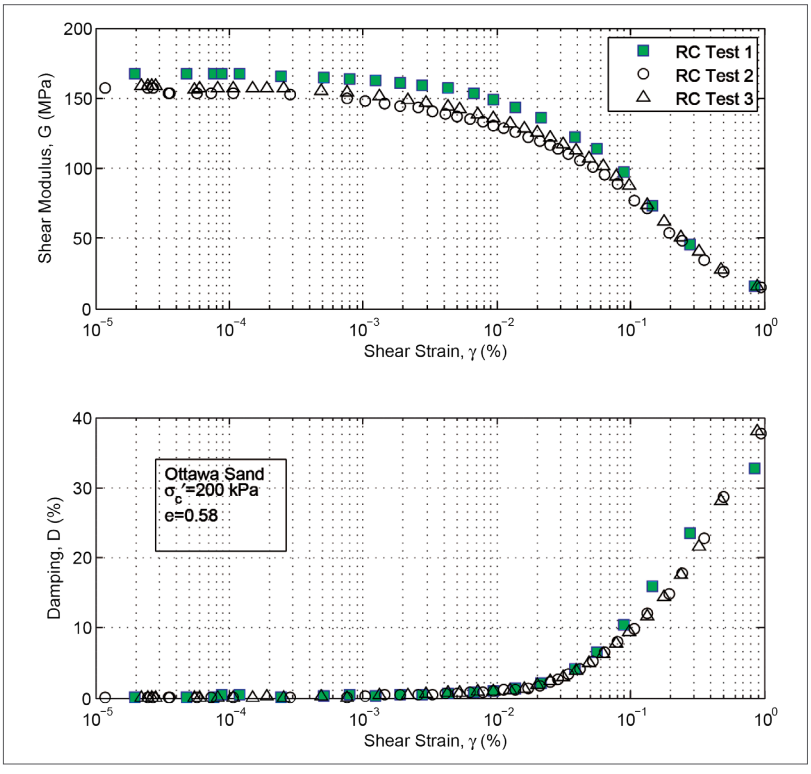
Geocomp's RC-TS pioneers a new approach to resonant column testing in which rotation of the top of the specimen is measured very precisely by two accelerometers and torque is measured directly at the base. Measured rotation and torque are used to directly calculate shear modulus and damping. This system eliminates errors associated with back EMF factors present in other devices.

The theory and design behind the Geocomp RC-TS is described in a paper published in the ASTM Geotechnical Testing Journal, *New Approach to Resonant Column Testing*.[1] This paper received ASTM's highest award, the Hogentogler Award, in 2013. The newly revised ASTM standard D4015 includes the new method.

[1] *Werden, S.K., Drnevich, V.P., Hall, J.R., Hankour, C., Conlee, C.T., and Marr, W.A. (2013). "New Approach to Resonant Column Testing." Geotechnical Testing Journal, 36(2), 20120122. ASTM International. doi:10.1520/GTJ20120122*

Unique Benefits

- Automated saturation and consolidation of specimens to in-situ stress conditions, including K_o consolidation
- Maintenance of prescribed stress conditions during RC and TS testing
- Run RC and TS for drained or undrained conditions
- Specify test conditions for multiple consolidation stress conditions to develop dependence of modulus and damping on stress levels using same specimen
- Run RC or TS on specimen from shear strains as low as 10^{-7} to as high as 10^{-1} in less than one minute with automated data reduction
- Run cyclic torsional shear tests for specified constant torsional shear stress amplitude, constant torsional shear strain amplitude, or input earthquake motion
- Run post-cyclic residual shear strength test in torsional mode
- Independently measure G_o and Poisson's Ratio with optional specially-designed piezo PnS sensors
- Self-calibration procedures built into the system



RC-TS Features

Option to perform torsional cyclic shear for studying cyclic strength and liquefaction

Option to independently measure low strain shear modulus and compression modulus with piezoelectric sensors

Option to measure post-liquefaction shear strength

Measures resonance frequency, damping ratio, and shear modulus in torsion

Fully-automated and unattended back-pressure saturation, consolidation, resonant column, torsional shear, and axial shear phases

Capable of performing:

- Torsional shear within a range of frequencies from 0.033 Hz up to 50 Hz with strain and up to 10 Hz
- Strain/stress-controlled and earthquake motion or user-defined irregular loading/strain tests
- Triaxial or stress path shear test after torsional shear or resonant column test

Integrated low-force (counter-balanced) lift mechanism for removing chamber

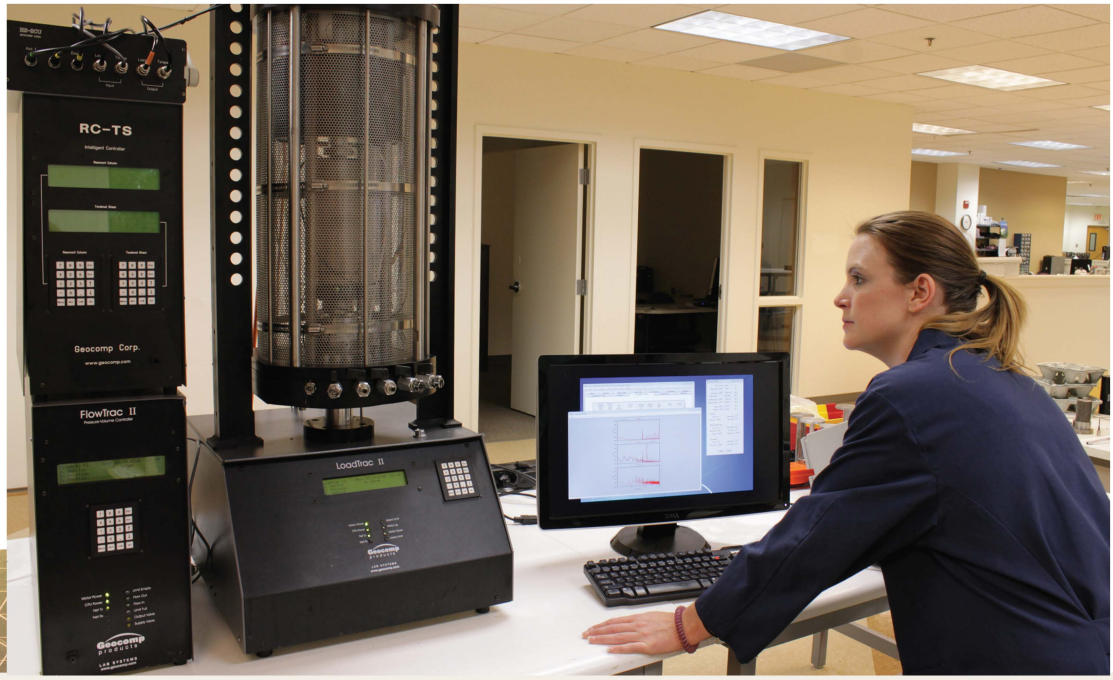
Complete protocol flexibility to intermix automated test phases

Sample Test Result (pictured at left)

- Dynamic properties of soil from 10^{-7} to 1 strains on one sample with RC only
- High repeatability

Applicable Test Standards:

- **ASTM D4015, D4767**
- **AASHTO T297**



Specifications

Specimen diameter: 71 mm (2.8 in)
Specimen length: Up to 152 mm (6 in)
Power: 208-240V, 50/60 Hz, 1 Phase
Chamber (cell) capacity: 1.4 MPa (200 psi)
LoadTrac load frame capacity:
45 kN (10,000 lb) with 76 mm (3.0 in) platen travel
FlowTrac control units for sample pressure:

- Pressure capacity: 1.4 MPa (200 psi) automated flow pump standard
- Volume capacity: 250 cc (15.3 in^3) standard; 750 cc (45.7 in^3) option available
- Flow range = 0.000006 cc/sec to 3 cc/sec ($3.7x10^{-7}$ in^3/sec to 0.18 in^3/sec)

Custom-precision, dual electro-pneumatic regulator for cell pressure:

- Pressure capacity 1.4 MPa (200 psi)
- Unlimited volume capacity

Torque capacity: 38N-m (350 lb-in) peak and 8 N-m (70 lb-in) continuous mode
Loading frequency: up to 800 Hz (RC); up to 50 Hz (TS)
Closed loop control mechanism: for saturation and up to 32 steps of isotropic/anisotropic and K_o consolidation
Monotonic testing capabilities: Consolidated, unconsolidated, drained, undrained triaxial, and stress path test up to 30% axial strain as a standard feature
Test control: via personal computer running Windows 7, 8, 10 with ArcNet network and Ethernet support
Sensors:

- Noise-free non-contact digital angular encoder with 1 x 10^{-5} rad resolution to measure rotation
- Combined stainless steel, pressure sealed and compensated, high linearity custom made biaxial torque sensor ±113 N-m (1000 lb-in) range with 0.0035 N-m (0.03098 lb-in) resolution and Axial load transducer with 9 kN (2 klb) capacity and 0.3 N (0.07 lb) resolution
- Internally and externally mounted dual accelerometers for rotation measurement in resonant column mode
- Two stainless steel pressure sensors, vented pressure sensor with a non-linearity of ±0.1 % of FS
- 76 mm (3.0 in) maximum range displacement transducer with long life $100x10^6$ movements, a linearity up to ±0.075%, and repeatability 0.002 mm ($7.9x10^{-5}$ in)

Data logging:

- DSP servo amplifier and PC-based secondary control loop including 16 bit data acquisition and digital I/O processing
- Four analog channels with signal conditioning and power supplies built-in
- Built-in 24 bit data acquisition and control reported to 16 bit

Calibration:

- One resonant column calibration rod (anodized aluminum)
- Independent check of G_o with piezo crystals

Safety Features:

- Limited angle actuator with mechanical limits for hard over-travel limits
- Soft over-travel limit
- Over-current, over-temperature protection in torque motor

Reporting:

- Reporting modulus and damping for each cyclic step and modulus reduction and damping increase for multiple step tests. Report also includes: peak-to-peak shear strain and stress versus cycle, shear stress versus shear strain, and pore pressure versus cycle.
- Complete tabular and graphical reporting for raw data and reduced data
- Support of data export to Excel spreadsheets

Options:

- P&S wave velocity measurement option using piezo electric P&S sensors
- Cosine pulse excitation; high-frequency programmable gain conditioning, acquisition, and filtering
- Automated travel time detection to remove human subjectivity in determining P wave and shear wave travel time

Geocomp Products

We design and manufacture automated laboratory testing systems and remote monitoring devices. We focus on creating products that help our clients accomplish their goals efficiently and quickly, whether it be in teaching, research, commercial, or other applications. We design our automated testing systems to help the user perform tests efficiently and quickly and produce high-quality results. Our remote monitoring systems are robust, versatile, and are easy to use in varying environmental settings. We serve numerous clients in over 140 countries. Join our many satisfied customers and make us your trusted source for remote monitoring equipment and automated laboratory testing systems.

Automated Laboratory Testing Product Line

Incremental Consolidation
Constant rate of consolidation including constant rate of strain, constant rate of loading, constant gradient, and constant excess pore pressure ratio
Triaxial: 1.4 to 6 inch diameter specimen
Stress Path Triaxial: 1.4 to 6 inch diameter specimen
Cyclic Triaxial: 1.4 to 6 inch diameter specimen
Direct and Residual Shear: 2.5, 6, and 12 inch specimen diameter
Direct Simple Shear and Cyclic Direct Simple Shear: 2.5, 4, and 12 inch diameter specimen
Resilient Modulus: 1.4 to 6 inch diameter specimen

Field Systems Product Line for Wireless Data Logger

iSite™: 4, 8, and 16 channel wireless data loggers
iSite™-HS: 8 channel Ethernet data logger with up to 1000Hz synchronized logging on each channel
iSite™-Noise: wireless noise monitoring with event record on MP3 format
iSiteCentral™: cloud-based, web monitoring of sensors and documents in real-time including apps and alerts

Geocomp's Innovative Resonant Column-Torsional Shear Testing Device

Geocomp's award-winning Resonant Column and Torsional Shear (RC-TS) testing system was developed in collaboration with Professor Vincent P. Drnevich of Purdue University and Professor John Hall of Worcester Polytechnic Institute. Geocomp's RC-TS allows the measurement of shear modulus and damping ratio for strains ranging between 10^{-7} to 10^{-1}.

The theory and design behind the Geocomp RC-TS is described in the Hogentogler award-winning paper published in the ASTM Geotechnical Testing Journal [Werden, S.K., Drnevich, V.P., Hall, J.R., Hankour, C., Conlee, C.T., and Marr, W.A. (2013). *New Approach to Resonant Column Testing,* Geotechnical Testing Journal, 36(2), 20120122, ASTM International. doi:10.1520/GTJ20120122.

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www.geocomp.com

125 NAGOG PARK, ACTON, MA 01720 [P] 978.635.0012

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