Wykeham Farrance

31-WF8500

WF RESONANT COLUMN

For the determination of:

- **RC test**
- shear wave velocity
- secant shear modulus G
- damping ratio D
- ratio from free-vibrations
- **TSS test**
- secant shear modulus from stress-strain response
- damping ratio from hysteresis loops
- **Automatic calculation of:**
- Resonant Frequency
- Shear wave velocity
- Shear modulus
- Shear strain
- Damping ratio from half power bandwidth
- Damping ratio from free vibration decay

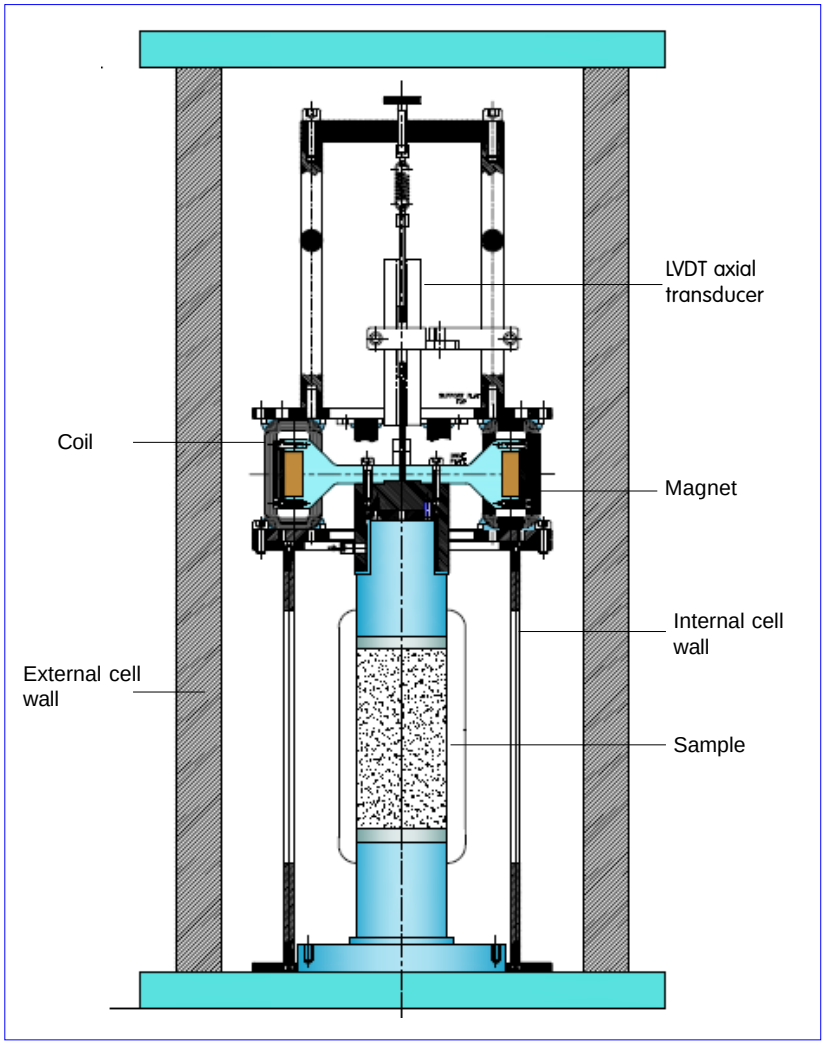
Reference Standard:
ASTM D4015-2000

MAIN FEATURES

- Combined Resonant Column / Torsional Simple Shear device
- Automatic detection of fundamental frequency
- RC: damping ratio from half power bandwidth and from free vibration data
- TSS: damping ratio from hysteresis loops
- Internal floating frame for large angular and axial deformation
- Confining pressure up to 1 MPa
- Suitable for 70 mm dia. specimen (or 50mm on request)
- Integrated signal generator and oscilloscope

31 RESONANT COLUMN (RC)/TORSIONAL SIMPLE SHEAR (TSS) TESTING SYSTEM

OPERATING PRINCIPLE



RESONANT COLUMN combines the features of both resonant column and torsional shear into a single unit including the current driven motor to apply torsional load to sample, a series of transducers with signal conditioning, a cell and back pressure electro-pneumatic control system and a data logger.
In the Resonant Column test a cylindrical soil specimen is restrained at the bottom and dynamically excited at the top. The torsional force at the top is generated using an electrical motor constituted by eight drive coils encircling four magnets attached to a drive plate. The generated frequency is up to 250 Hz. The fundamental mode of vibration is found from the maximum amplitude of motion; from the resonant frequency, shear wave velocity and shear wave modulus are calculated using elasticity theory. The corresponding shear strain is evaluated from the motion amplitude. Material damping can be determined from the half power bandwidth or from a free-vibration decay curve, which is generated by shutting off the driving power.
In the Torsional Simple Shear test the soil specimen is deformed cyclically at a low frequency (a maximum of 10 Hz), continuously monitoring torque and deformation. From the torque-deformation curves, a relationship between average shear stress and average shear strain is obtained, which in turn provides the shear modulus and the damping ratio.

TEST STAGES

Saturation stage

During saturation stage a small amount of cell and back pressures are applied in steps, with a consequent dissolution of the air contained in the intergaranular spaces. A control system generate the cell and back pressures using air/water interfaces. Cell, back and pore pressures are measured by pressure transducers 1000kPa cap, 0.1 kPa accuracy. Volume change is measured using high sensitivity differential pressure transducer.

Consolidation stage

The sample is subjected to the same back pressure used during the last saturation step while the cell pressure depends on the effective stress required in the next steps. When pore water pressure and volume changes are completely dissipated the consolidation stage ends.
During this stage the axial strain is measured using a LVDT transducer ± 12.5 mm travel, 0,2% class.

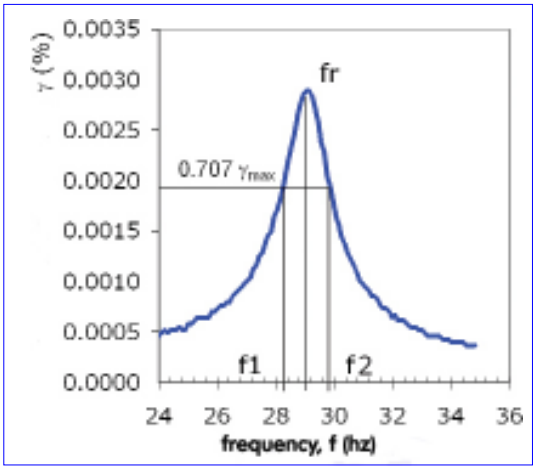
RC and TSS tests are usually performed in undrained conditions, closing the drainage channels and measuring changes in the pore water pressure.

Resonant Column test (RC)

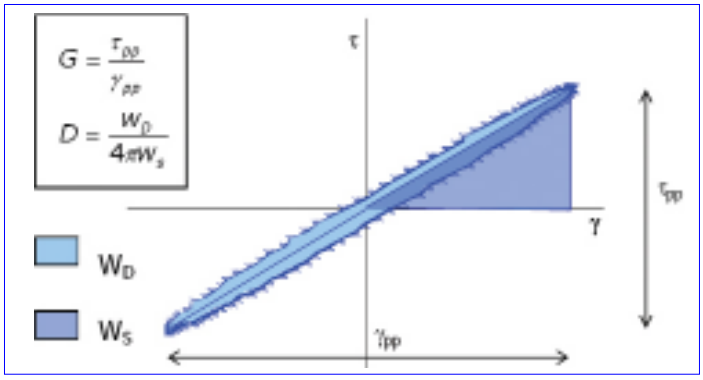
A signal generator supplies a sinusoidal voltage to the driving amplifier and a proportional current to the coils attached to the cell body. The magnetic field in the coils interacts with the magnets attached to the driving plate, that in turn conveys a torsional oscillation to the top of the specimen. As the frequency of the input signal varies, the dynamic response of the specimen results in a varying motion amplitude. The amplitude is captured either by an accelerometer attached to the driving plate and by proximity displacement transducers measuring the relative movement of the driving plate relative to the coils.

The frequency that maximizes the motion of the top of the specimen is associated to the first-mode resonance and is found applying an input signal with a frequency sweep. The secant shear modulus of the soil can be evaluated from the resonant frequency. The damping ratio can be evaluated either from the complete frequency response of the soil specimen ("half power band width"), or from a free-vibration decay curve that is generated by shutting off the driving power.

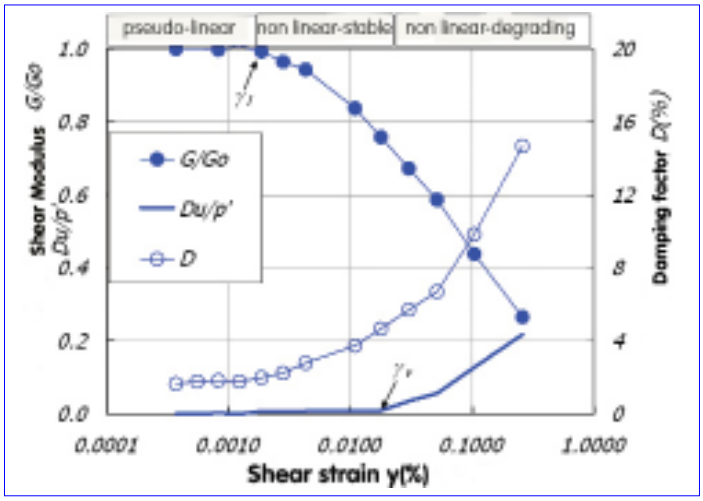
At a given consolidation effective stress, RC tests are repeated several times, increasing progressively the amplitude of the input voltage, thus obtaining the secant shear modulus and the damping ratio corresponding to increasing shear strain values.



RC: Resonant Column test



TSS: Determination of the shear modulus and damping factor

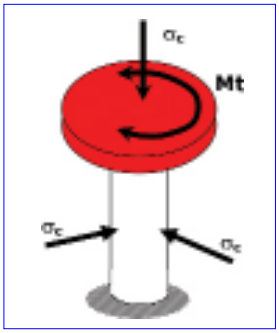


TSS : Strain level and mechanical behavior of the soil sample in simple cyclic shear condition

Torsional Simple Shear test (TSS)

A sinusoidal current is applied to the coils in a quasi-static condition and the motion of the top of the specimen is monitored using the proximity displacement transducers. The input current (proportional to the shear stress) and the corresponding torsional rotation (proportional to the shear strain) are simultaneously recorded. The shear modulus of the soil is determined from the average slope of the stress-strain loops, while material damping is related to the area of the hysteresis loop.

At a given consolidation effective stress, TSS tests are repeated several times, increasing progressively the amplitude of the input voltage, thus obtaining the secant shear modulus and the damping ratio corresponding to increasing values of the shear strain.



TSS: Schematic stress representation

31 RESONANT COLUMN (RC)/TORSIONAL SIMPLE SHEAR (TSS) TESTING SYSTEM

General specifications

Includes items:
- aluminium cell with stainless steel columns and acrylic transparent cylinder with 170 mm int. dia. x 200 mm ext. dia., including channels for bottom drainage;
- test accessories for 70 mm (or 50 mm) dia. specimens;
- internal floating frame for assembling the electrical motor that applies the torsional loads; this motor has four NeFeB 10 x 25 x 40 mm magnets and eight coils.
- main control box including:
  - o power supply
  - o current amplifier
  - o 8 channels signal conditioning unit
  - o USB data acquisition and signal generation board
  - o two electro-pneumatic converters for cell & back pressure
- sensor kit containing:
  - o axial LVDT transducer
  - o differential transducer for volume change measurement
  - o three Pressure transducers
  - o two Eddy current displacement sensors (with miniaturised driving system)
- dual burettes assembly for volume measurement and pneumatic auxiliary items
- PC and software

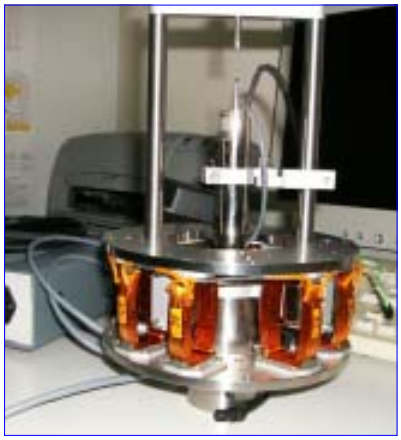
Maximum torque: 1 Nm
Maximum angular deformation: 10°
Maximum Cell and back pressure: 1 MPa.

Excitation frequency
- Dynamic (RC) 1-250 Hz
- Cyclic (TS) from 0 to 50 Hz maximum

Optional sensor:
- MEMS accelerometer

Optional calibration Kit:
- N°2 calibration bars kit + N°2 calibration weights

31-WF8500 system.
Controls panel.



31-WF8500 system.
Detail of the electrical motor.

Ordering information

Code	Description	Q.ty
31-WF8500	RESONANT COLUMN combined resonant column/torsional shear device for the automatic determination of damping ratio from half power bandwith and free vibration decay method.	1
28-WF2016/A	Air Compressor 10 bar 145 psi maximum working pressure, Output 10.2 cfm, 100 L receiver. 230 V/50 Hz/1 ph	1
28-WF2016/2	Water Trap for Air/Water assembly	1
28-WF4221	De airing tank, 23 lt capacity	1
28-WF2001	Portable vacuum pump. 220-240 V/50-60 Hz/1 Ph	1
28-WF2064	Rubber tube dia 6,5 x 12,5 mm, 2 m long for vacuum	1
28-WF0491/2	Water trap	1
28-WF4225	Valve panel for use with de-airing tank	1
31-WF8500/1	Calibration kit including 2 bars and 2 weights	1

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CONTROLS S.R.L. is certified to ISO 9001:2008

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