Resonant Column (GDSRCA)

Overview: The GDS Resonant Column Apparatus (GDSRCA) is a true fixed free resonant column where one end of a confined solid or hollow cylindrical soil specimen is excited and the other is fixed.

For many years the resonant column apparatus has been used in research and commercial laboratories to estimate values of the shear modulus, G, and damping ratio, D, for soil specimens across the small to medium strain range (< 1 %).

Key Features:	Benefits to the User:
Current driven actuator using a transconductance power amplifier:	The impedance of magnet / coil devices change with frequency. At higher frequencies, using a constant voltage amplifier the current would be seen to reduce. As the torque is directly proportional to current, the torque will also reduce and a non-linear torque input would affect results. This effect is removed in the GDSRCA by using a current driven power amplifier.
Designed to provide maximum rigidity:	Providing minimum losses and a more consistent frequency response. With no rigid support to the top cap, it is completely free vibrating.
Dedicated GDS RCA software is used for control and data acquisition of the RCA apparatus:	Simple automated tests ensures consistent results.
Low equipment damping:	The software switches the hardware to provide an 'open circuit' through the coils during free vibration decay, which prevents 'back' EMF generation and reduces equipment damping effects.
Electro-magnetic drive system:	Which incorporates precision wound coils and composite sintered neodymium iron boron (NdFeB) "rare-earth" magnets.
Internally mounted, counter-balanced accelerometer:	Used to measure vibratory response of the sample.
Internal cell:	To surround sample with water, to avoid air penetrating the membrane.

Tests that can be Performed:

Resonance in torsion, resonance in flexure, damping ratio in torsion, damping ratio in flexure and optional slow speed (<2Hz) torsional shear.

Upgrade Options:

Lifting frame for easy cell top removal, vertical bender elements (S and P wave), torsional shear upgrade using non-contacting proximetor transducer, high pressure upgrades from 1MPa (standard) to 2MPa or 3MPa, unsaturated testing (Method A), environmental temperature chamber (-20°C to +60°C).

Technical Specification:

Frequency Range (Hz):	0 to 350
Pressure Range (MPa):	1 standard, 2, 3 as upgrades
Sample Sizes (mm):	50, 70, 100

Product Features:

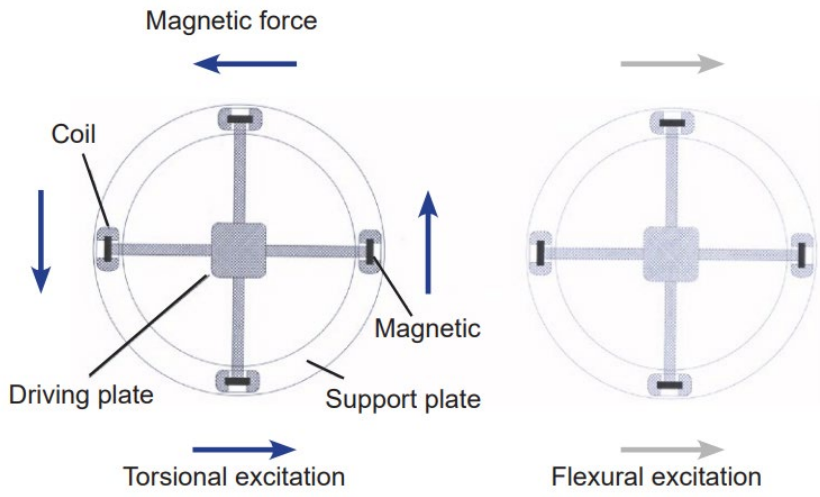
Torsional / flexural vibrations, damping by free vibration, state-of-the-art current-driven amplifier and calibration equipment.

Damping by Free Vibration

When performing damping ratio tests, the apparatus is designed to minimise the influence of equipment damping. During free vibration decay (after the power is normally shut off at resonance) back EMF is usually generated in the coils by the movement of the magnets. This causes large equipment damping errors. In the GDS resonant column the software switches the hardware to provide an open circuit through the coils during free vibration decay, which prevents back EMF generation. However, instantly turning coils to open circuit does give an instantaneous spike of back EMF that affects results, through GDS' R & D we have developed a system to attenuate this effect before it is significant.

Torsional / Flexural Vibrations

During torsional tests, four pairs of coils are connected in series so that a net torque is applied to the sample. To apply flexural vibrations, the coils are switched (automatically) so that only two magnets are used applying a horizontal force to the specimen hence inducing flexural excitation. This allows the same coil and magnet arrangement to be used in both flexural and torsional vibration.



State-of-the-art Current-driven Amplifier

RCA systems that GDS supplies are current driven using a transconductance power amplifier. This is due to the fact that the impedance of the RCA system changes with frequency. At higher frequencies, using a constant voltage, the current will be seen to reduce. As the torque is directly proportional to current, the torque will also reduce. This change to using a current driven power amplifier reflects the current thinking in the state-of-the-art resonant column testing throughout the world.

Calibration Equipment

To derive Io and Iy experimentally, a test is performed on a calibration bar to compute its resonant frequency in torsion and flexure respectively. This is achieved by calibrating the apparatus by substituting metal calibration bars in place of the specimen whose mechanical properties are known. The GDS RCA provides 3 calibration weights and 3 calibration bars of differing stiffness in order for Io and Iy to be calibrated by the end user.

Upgrade Options:

Cell Upgrade

Upgrades from the standard 1MPa RCA to 2MPa or 3MPa are available. The 3MPa cell is a replacement of the transparent outer cell top and transparent inner cell with stainless steel inner and outer cell.

Note: Lifting frame recommended for upgrades.

Lifting Frame

The lifting frame allows a user to safely remove the triaxial cell top by using a counterweight pulley system. The frame does not attach to the resonant column, so it can be easily moved to another piece of apparatus or stored away until it is needed.

Environmental Temperature Chamber (-20°C to +60°C)

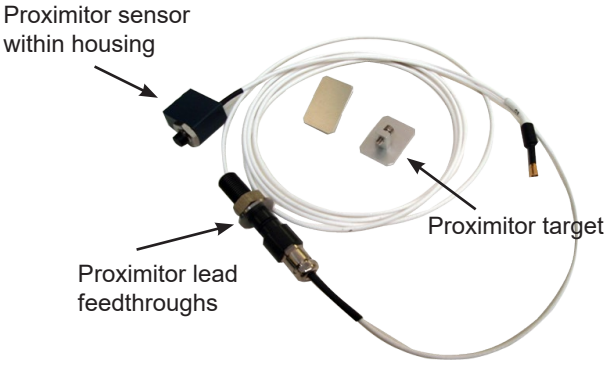
Temperature Control System for Heating and Cooling.
A climate controlled version for -20°C to +60°C is available.
The climate control system comprises of:

- Environmental chamber to buffer the cell from changes in atmospheric temperature.
- Inner cell mounted direct cooling system/heating coil.

Upgrade Options:

Torsional Shear Upgrade

Cyclic torsional shear tests may be performed in the GDSRCA through the addition of a high precision proximitor transducer system. Torsional shear tests enable the full cyclic stress-strain response of a test specimen to be recorded across the small strain range, using loading frequencies of 2 Hz and below. The axial strain and pore pressure response are also acquired during the torsional shear test.



Upgrade to Bender Element Testing

Any GDSRCA system may be upgraded to perform P and S wave bender element testing with the addition of the following items:

- Bender element pedestal with bender element insert.
- Bender element top-cap with bender element insert.
- Signal conditioning and high speed data acquisition unit (2 Megasamples/ second), which includes amplification of source and received signals (P and S-wave) with user controlled gain levels (via software).

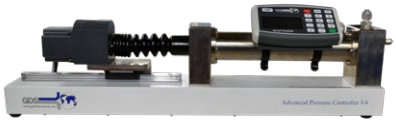
GDS Bender Element Analysis Tool (GDSBEAT):

The subjectivity and lack of satisfactory standards for interpreting shear wave travel times across the industry from bender element test data, has led GDS to develop a bender elements analysis tool. The tool allows the rapid, automated analysis of bender element tests to objectively estimate the shear wave travel time. The analysis tool is available to download from GDS' website.

Upgrade to Unsaturated Testing

The GDSRCA system may be upgraded to perform unsaturated triaxial testing:

• Method A: Adding a 1000cc Advanced Pressure/Volume Controller (for application of pore air pressure and measurement of air volume change).



Alternative Product: Hardin Oscillator

The Hardin Oscillator allows axial loads up to 2kN to be applied to a sample during resonance testing. The Hardin Oscillator standard cell pressure is 1MPa (With an optional upgrade to 20MPa) and can be supplied with a standard static actuator (5kN) or a GDS 50kN load frame for post resonance shearing. The cell has extra height to accommodate specimens up to 100mm.

See Hardin Oscillator datasheet for more information.

GDS RCA software

Is used for control and data acquisition of the RCA apparatus. The software allows testing to occur via a simple, user-friendly interface. The tests that may be performed using the

GDS RCA software are as follows:

- Resonance in torsion.
- Resonance in flexure.
- Damping Ratio in torsion.
- Damping Ratio in flexure.
- Slow speed (<2Hz) torsional shear

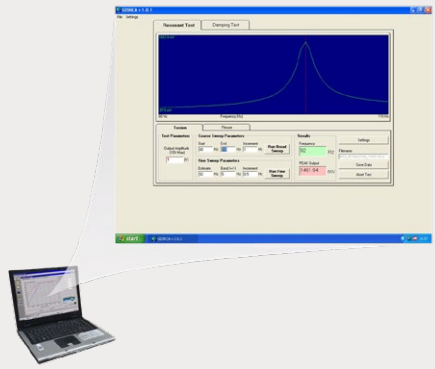


Fig 4. GDS RCA software resonance test data

GDSLAB Control Software

GDSLAB is the control and data acquisition software for geotechnical laboratory applications. GDSLAB starts with a core application known as the kernel. The GDSLAB kernel allows for data acquisition from your hardware, but no test control. Simply add the appropriate module or modules to complete the test suite functionality you require. GDSLAB is compatible with all existing GDS equipment and furthermore key hardware from other manufacturers.

GDSLAB has the ability to be configured to your hardware of choice, no matter how unique the arrangement. A text file (*.ini) or initialisation file is created that describes the hardware connectivity to the PC. The hardware layout is available in graphical format via the GDSLAB 'object display'. This makes setting up the devices and checking the connectivity extremely simple.

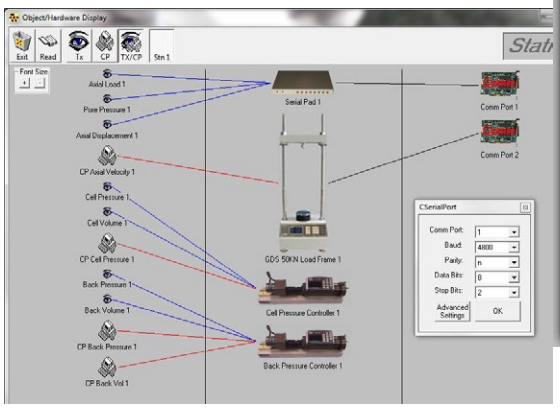


Fig 1. Show a typical set-up screen in GDSLAB

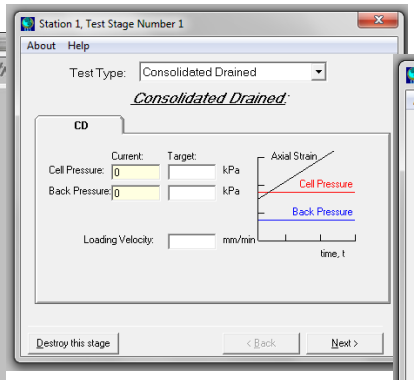


Fig 2. Show a typical station test stage set-up in GDSLAB

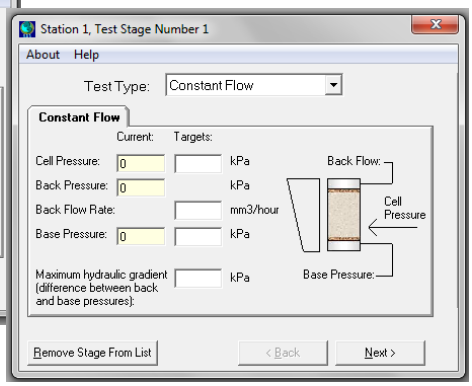


Fig 3. Show a typical station test stage set-up in GDSLAB

Required Operating System: Windows 7 SP1 or higher (We strongly recommend that Windows is fully up to date and running the latest Service Pack/ Version available). Recommended PC Specification: 2GHz processor, 4GB Ram, 64Bit Operating System and USB connectivity. Note: GDS software can run on lower spec PC's however; performance and processing of data may be affected.

Why Buy GDS?

GDS have supplied equipment to over 86% of the world's top 50 Universities:

GDS have supplied equipment to over 86% of the world's top 50 Universities who specialise in Civil & Structural Engineering, according to the "QS World University Ranking 2020" report.

GDS also work with many commercial laboratories including BGC Canada, Fugro, GEO, Geolabs, Geoteko, Golder Associates, Inpijn Blokpoel, Klohn Crippen, MEG Consulting, Multiconsult, Statens Vegvesen, NGI, Ramboll, Russell Geotechnical Innovations Ltd, SA Geolabs, SGS, Wiertsema and Partners to name a few.

Would you recommend GDS equipment to your colleague, friend or associate?

100% of our customers answered "YES"

Results from our post-delivery survey asked customers for feedback on their delivery, installation (if applicable), supporting documentation, apparatus and overall satisfaction with GDS. The survey ran for two years.

Made in the UK:

All GDS products are designed, manufactured and assembled in the UK at our offices in Hook. All products are quality assured before they are dispatched.

GDS are an ISO9001:2015 accredited company. The scope of this certificate applies to the approved quality administration systems relating to the "Manufacture of Laboratory and Field Testing Equipment".

Extended Warranties:

All GDS apparatus are covered by a 12 month manufacturers warranty. In addition to the standard warranty, GDS offer comprehensive extended warranties for 12, 24 and 36 months, for peace of mind against any repairs in the future. The extended warranties can be purchased at any time during the first 12 months of ownership.

GDS Training & Installation:

All installations & training are carried out by qualified engineers. A GDS engineer is assigned to each order throughout the sales process. They will quality assure the apparatus prior to shipping, if installation has been purchased, install the apparatus on the customers site & provide the training.

Technical Support:

GDS understand the need for ongoing after sales support, so much so that they have their own dedicated customer support centre. Alongside their support centre GDS use a variety of additional support methods including remote PC support, product helpsheets, video tutorials, email and telephone support.