



### 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.

From the resonant frequency, small strain stiffness can be found. GDSRCA's are used by advanced commercial laboratories and Universities for performing research.

#### Key Features:

#### Benefits to the User:

RCA systems that GDS supplies are current driven using a transconductance power amplifier:	This is because 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 and no rigid support to the top cap so it is completely free vibrating.
Dedicated GDS RCA software is used for control and data acquisition of the RCA apparatus:	Simple automated tests.
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:

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

#### Upgrade Options:

Lifting frame for easy cell top removal, vertical bender elements (S and P wave), unsaturated RCA testing pedestals, torsional shear upgrade using non-contacting proximitor transducer, high pressure upgrades from 1MPa (standard) to 2MPa, 3MPa or 25MPa, anisotropic test upgrade (hanging weights), gas hydrate upgrade option, unsaturated testing (Method A and B), option for environmental temperature chamber (-20 degs C to +40 degs C), an axial loading actuator and frame and a Hardin Oscillator type actuator with axial force actuator.

#### Technical Specification:

Frequency Range (Hz):	300
Pressure Range (MPa):	1 standard, 2, 3 and 25 as upgrades
Sample Sizes (mm):	50, 70, optionally 100

**Product Features:**

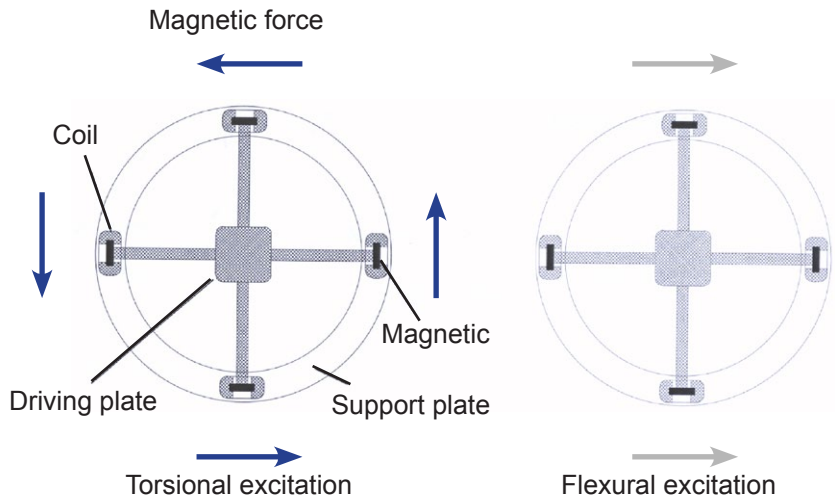
Damping by free vibration, torsional / flexural vibrations, state-of-the-art current-driven amplifier and calibration equipment.

**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  $I_0$  and  $I_y$  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  $I_0$  and  $I_y$  to be calibrated by the end user.



**Upgrade Options:**

**High Pressure Upgrades**

Upgrades from the standard 1MPa RCA to 2MPa, 3MPa or 25MPa are available. The 25MPa cell is a replacement of the transparent outer cell top and transparent inner cell windows with stainless steel Inner and outer cell.

*Note: Lifting frame available for high pressure 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.



**Gas Hydrate**

An upgrade of a standard RCA to a gas hydrate system is available please contact us direct for more information.

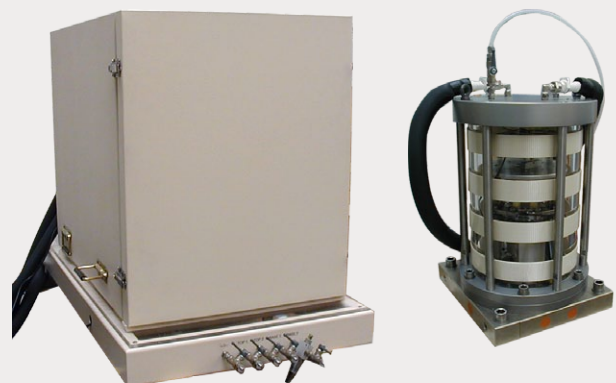


**Environmental Temperature Chamber (-10 degs C to +65 degs C)**

Temperature Control System for Heating and Cooling.

A climate controlled version for -10°C to +65 °C is available (See Fig. 10 below). The climate control system comprises of:

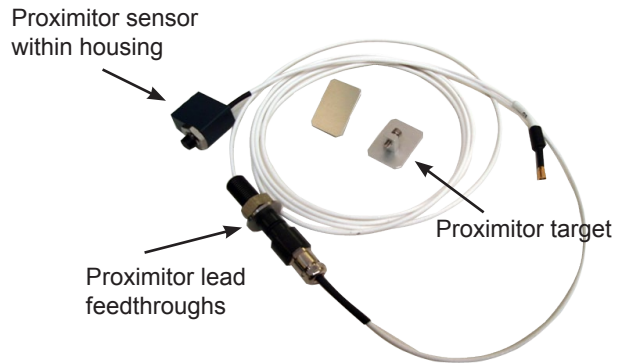
- Environmental chamber to buffer the cell from changes in atmospheric temperature.
- Inner cell mounted direct cooling system/heating coil.
- It is recommended that this system be used with a separate water bath.



**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 GDSTAS 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.
- High-speed data acquisition card.
- Signal conditioning unit which includes amplification of source and received signals (P and S-wave) with user controlled gain levels (via software).



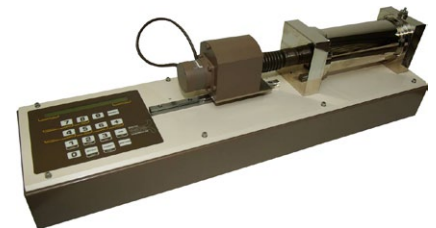
**GDS Bender Element Analysis Tool (GDSBEAT):**

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**

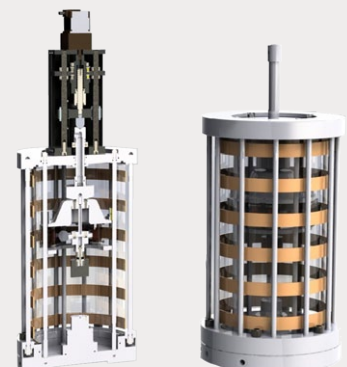
The GDSRCA system may be upgraded to perform unsaturated triaxial testing:

- 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 significant axial loads to be applied to a sample during resonance testing. The hardin oscillator cell is for pressures up to 1MPa and can be supplied with a standard static actuator or a GDS ELDYN system. The cell has extra height to accommodate specimens up to 100mm and comes with special low friction seals and linear bearing making it ideal for dynamic testing.



### Tests that can be Performed:

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

### 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.

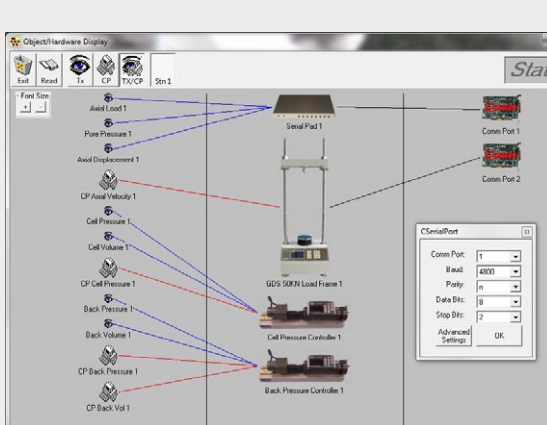


Fig 1. Show a typical set-up screen in GDSLAB

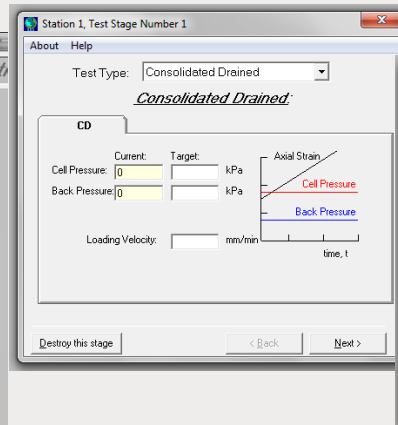


Fig 2. Show a typical station test stage set-up in GDSLAB

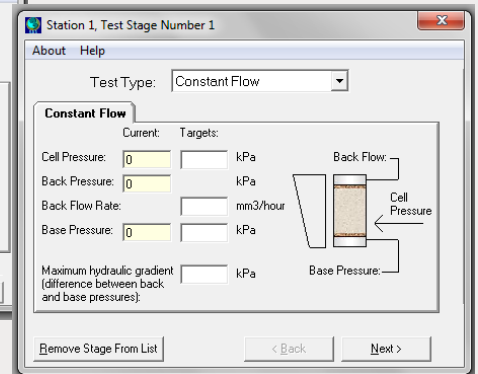


Fig 3. Show a typical station test stage set-up in GDSLAB

Operating System: Windows XP SP3 or higher (We recommend that whichever version of Windows you are running, that it is up to date with the latest Service Pack). PC Spec Hardware: 1GHz (minimum) / 1GB Ram (minimum): CD Rom.

### 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

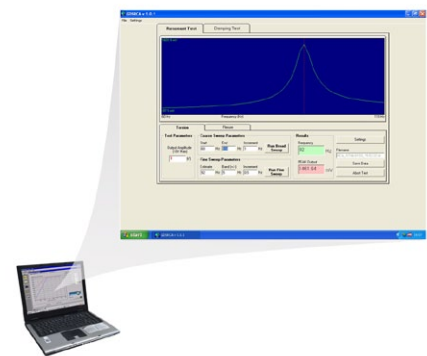


Fig 4. GDS RCA software resonance test data

## Why Buy GDS?

### Technical Support:

GDS provide comprehensive on-site product training and installation. GDS understand the need for ongoing after sales support, so much so that they have their own dedicated customer support centre. The support centre allows the user to log queries, download helpsheets and get the latest information on product updates. The site is fully searchable and provides a great resource to customers.

Alongside their support centre GDS use a variety of additional support methods including...

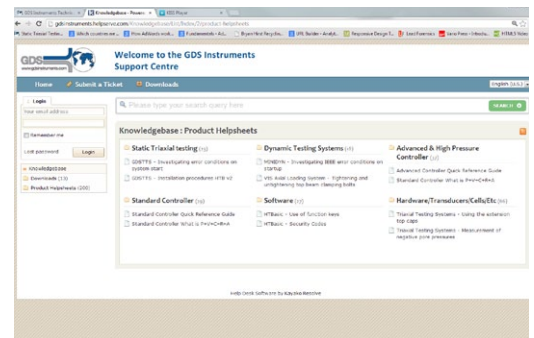


Fig 5. GDS online customer support centre.

- **Remote PC Support:** Remote PC support works by GDS providing a secure link to a customers PC, thereby allowing GDS to take control. Once in control of the PC, GDS can help with any problems associated to software, installation, testing etc.
- **Product Helpsheets:** The helpsheets are the GDS FAQ documents. They cover a multitude of hardware and software questions and are free to download from our online support centre.
- **YouTube Channel:** GDS YouTube channel holds both software and hardware video's aimed to give you better understanding of how the products work.
- **Email & Telephone Support:** If you prefer you can email requests to support@gdsinstruments.com where they will be automatically added to the support system and then allocated to a support engineer.

### GDS Awarded Queens Award for Enterprise in International Trade:

GDS have been presented with the most prestigious corporate award made in the UK – The Queen's Award for Enterprise in the International Trade category. GDS are delighted to have won the award which has been given to GDS for increasing overseas trade by 190% over six years of continuous sustained growth, and for selling over 85% of their production overseas. GDS have achieved this through a combination of continuous product development, understanding customer's requirements and a company wide dedication to customer support.



### Made in the UK:

All GDS products are designed, manufactured and assembled in the UK at our offices in Hook. Quality assurance is taken of all products before they are dispatched.



GDS are an ISO9001:2000 accredited company. The scope of this certificate applies to the approved quality administration systems relating to the "Manufacture of Laboratory and Field Testing Equipment".



Due to continued development, specifications may change without notice. See the GDS website for the full product range & to visit our Geotechnical Learning Zone.