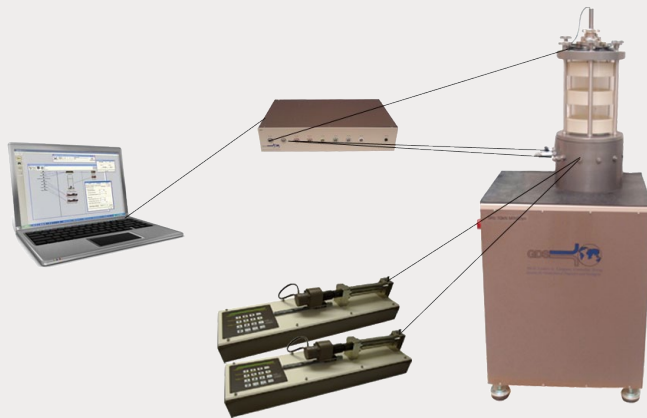## Advanced Dynamic Triaxial Testing System
(DYNTTS)

Overview: The Advanced Dynamic Triaxial Testing System (DYNTTS) is a high-end testing apparatus combining a triaxial cell with a dynamic actuator capable of applying load, deformation and stresses at up to 10Hz.

The axial axis is screw-driven from an integral base unit housing the motor drive. Axial force and axial deformation are applied through the base of the cell.

Standards:

ASTM D-3999   ASTM D-5311

Key Features:	Benefits to the User:
High accuracy electro-mechanical control:	The DYNTTS system is capable of very small strain static tests through to large strain dynamic tests.
Interchangeable load cells:	Allows user to accommodate very soft to very stiff soils with ranges of 1, 2, 4, 8, 10, 16, 25, 40 and 60kN.
In-built balanced ram (up to 5Hz systems):	Keeps cell pressure constant during cycling, meaning a dynamic pressure controller is not required (unless dynamic cycling of cell pressure is required).
Interchangeable pedestals and triaxial extension top caps:	Allows testing of 38, 50, 70 and 100mm diameter test specimens in the same cell.
Direct closed loop of axial displacement & axial force:	Accurate control in either axial displacement or axial force mode.
Adaptive Control as Standard:	Adaptive Control significantly improves the dynamic load control performance of an apparatus, leading to increased testing precision.

Tests that can be Performed:

Consolidated drained (CD), consolidated undrained (CU), consolidation (Triaxial), dynamic cyclic loading of samples under either load or strain, slow cyclic testing, quasi-satic (low speed/creep) tests, stress paths, K-Zero and user defined waveforms.

Upgrade Options:

Dynamic cell pressure, larger sample sizes up to 300mm diameter, higher cell pressure up to 5MPa, Bender element system (Vertical, Horizontal, S and P waves), Hall Effect Local Strain, LVDT local strain, unsaturated testing and temperature controlled testing.

Technical Specification:

Actuators:	High accuracy electromechanical
Axial Force Accuracy:	<0.1%
Axial Force Resolution:	16bit (i.e. <0.4N for 10kN load cell, <1.5N for 40kN load cell)
Axial Load (kN):	10, 25, 40 or 60
Displacement Range (mm):	100
Displacement Resolution:	0.20um
Operating Frequency (Hz):	2 (Standard), 5, 10
Pressure Range (MPa):	2 (Standard), upgradeable to 5
Speed of Measurement and Control:	5, 10kHz
Sample Sizes (mm):	38, 50, 70, 100 (other sizes available on request up to 300)

Systems Elements & Options

The fundamental system hardware elements are shown in Fig. 1 below. The actual hardware used may be chosen to suit your testing and budgetary requirements. The more common arrangements are as follows:

GDS Data Acquisition Digital Control System (GDSDCS)

The GDS dynamic systems are all based around the high speed GDS Digital Control System (GDSDCS) with closed-loop feedback of displacement and load.

With 16 bit data acquisition (A/D) and 16 bit control output (D/A), the GDSDCS runs at a control frequency of 10kHz per channel. This means that when running at 10Hz the system uses 1000 control points per cycle. When running at 1Hz, it uses 10000.

GDSLAB Software

The GDSLAB control and acquisition software is a highly developed, yet extremely flexible software platform. Starting with the Kernel module and the ability to perform data acquisition, additional modules are added for your testing requirements.

Pore Pressure (kPa)
Axial Strain (mm)
Load Cell (kN)

Load frame control

Cell pressure / volume

Back pressure / volume

Note: Connection via RS232 multiplexer (mux) or PC resident IEEE card (depending on device type chosen)

Pressure Volume / Controllers

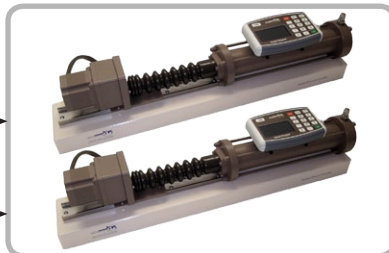The cell and back pressures can be controlled with either the...

- The Standard Pressure/Volume Controller (STDDPC) with pressure ranges from 1 to 4MPa, serial PC connectivity and 200cc volumetric capacity.
- Or, there is the Advanced Pressure / Volume Controller (ADVDPC) with pressure ranges of 2 to 4MPa, serial or IEEE PC connectivity and 200cc volumetric capacity, (ADVDPC 2MPa controller can be bought as a 1000cc volumetric capacity item).

Optional Electromechanical dynamic cell pressure actuator: The dynamic actuator allows cycling of cell pressure between two user chosen values. For example between 200kPa- 400kPa cycled a 1Hz, enabling dynamic stress path testing to be performed.
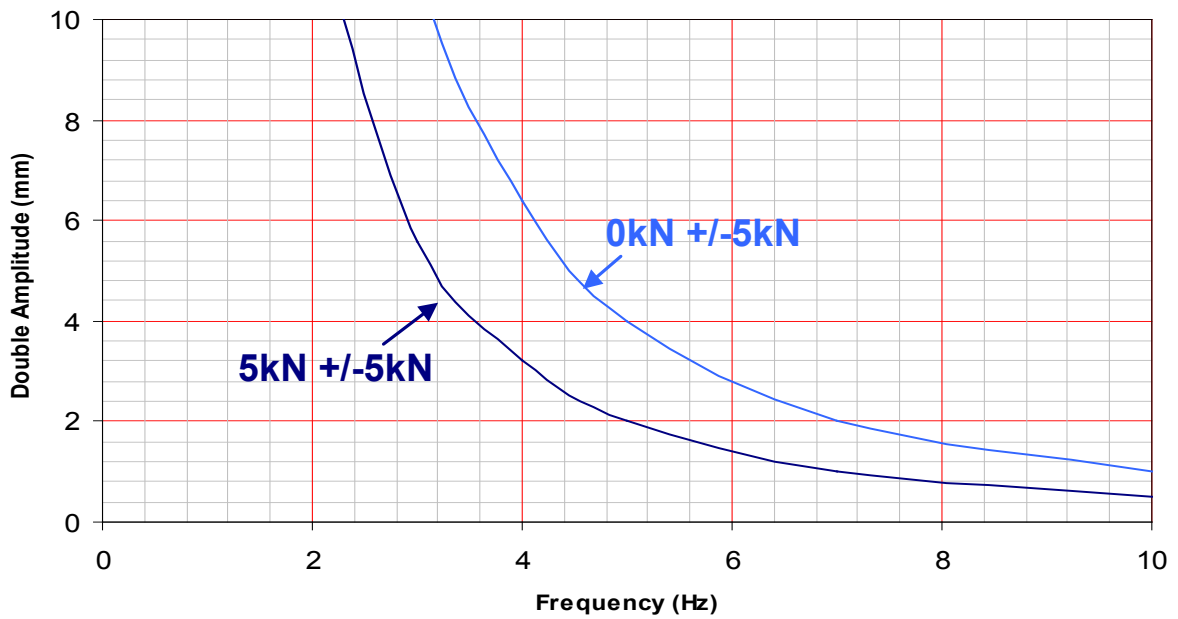
Frequency Range (Hz)

- 2, 5 & 10.

Load Range (kN)

- 10, 16, 20, 40 60.

Specimen Sizes (mm)

- 38, 50, 70, 100, 300, other sizes available upon request.

## Fig. 2 Typical system performance, showing frequency and amplitude

	With 5kN force datum		with zero kN force datum	
Frequency (Hz)	Amplitude (mm)	Double Amplitude (mm)	Amplitude (mm)	Double Amplitude (mm)
0.1	50	100	50	100
0.2	50	100	50	100
0.5	26.5	53	26.5	53
1	13.3	26.6	13.3	26.6
2	6	12	6	12
3	2.8	5.6	4.4	8.8
4	1.6	3.2	3.2	6.4
5	1	2	2	4
7	0.5	1	1	2
10	0.25	0.5	0.5	1

Fig. 3 Typical test results, showing displacement control at 1Hz

Axial displacement feedback control

Frequency (Hz):	1.00
Peak to peak (mm):	2.000
Radial stress (kPa):	200.0
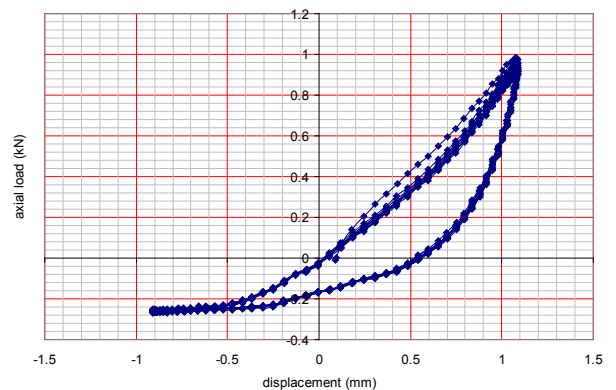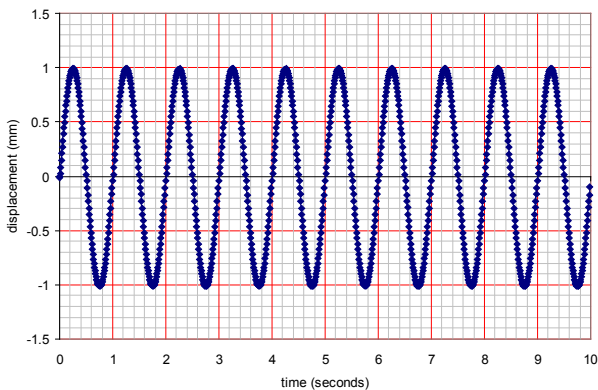
Adaptive Control - As Standard

Adaptive Control is a cutting edge technology that significantly improves the dynamic load control performance of an apparatus, leading to increased testing precision.

The GDS Adaptive Control firmware algorithm automatically adjusts the control gain values based on the observed specimen stiffness, removing the need for the user to enter a specimen stiffness value prior to the test. This has the additional advantage of ensuring specimen stiffness changes during a test are also dealt with correctly. When testing using an apparatus running GDS Adaptive Control, the firmware automatically optimises the control gains' values based on variations in soil stiffness as a cyclic test stage progresses, enabling a consistent loading amplitude to be applied to the test specimen. This marks a significant improvement over traditional PID closed-loop systems which, especially when testing multiple specimens of varying stiffness, require the user to re-tune the system before each dynamic cyclic test as well as risk under-performance when specimen stiffness changes during loading.
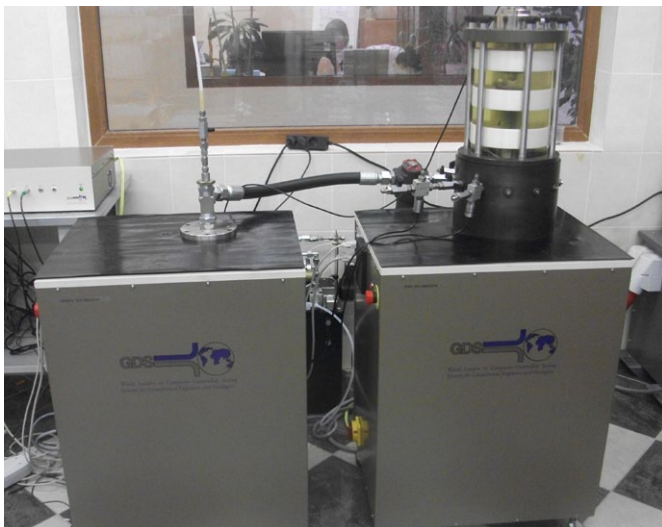
Adaptive Control

Upgrade Options:

Hall Effect local Strain, LVDT Local Strain, Unsaturated Testing, Bender Element System (Vertical, Horizontal, S and P waves) and Temperature Controlled Testing.

10H$_z$ DYNTTS System - Consists of two Actuators

1 x 10H$_z$ Dynamic Axial Loading Systems
1 x 10H$_z$ Dynamic Cell Pressure Controller

Upgrade to Local Strain Measurement

Any DYNTTS system may be upgraded to perform Local Strain measurement using either Hall Effect or LVDT transducers. Both device types enable axial and radial deformation to be measured directly on the test specimen via lightweight aluminium holders. Hall Effect transducers may be used in water up to 1700kPa.

LVDT transducers come in 2 versions:
- Low pressure (up to 3500 kPa) version for use in water.
- High pressure (up to 200 MPa) version for use in nonconducting oil.

Fig 4. LVDT transducers as shown on sample.

Upgrade to Unsaturated Testing

Any DYNTTS system may be upgraded to perform unsaturated triaxial testing with the addition of the following items:

- Unsaturated pedestal with high air entry porous stone.
- 1000cc digital air Pressure/volume controller (ADVDPC) for the application of pore air pressure and measurement of air volume change (see Fig. 5).
- Optional HKUST double cell (for more information on this please see the data sheet 'Unsaturated Triaxial Testing of Soil (UNSAT).
- Optional double walled cell.

For further information on unsaturated testing methods, please refer to the

Fig 5. Advanced Pressure Controller used in Unsaturated Testing

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:

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.
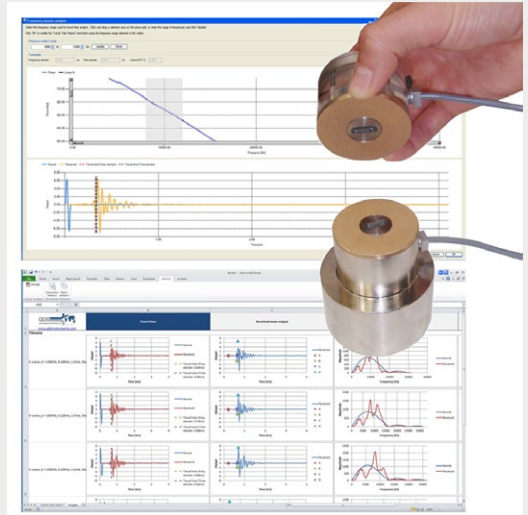
Fig. 6 Shows screenshots of the GDSBEAT software.

Tests that can be Performed:

Consolidated drained (CD), consolidated undrained (CU), consolidation (Triaxial), dynamic cyclic loading of samples under either load or strain, slow cyclic testing, quasi-satic (low speed/creep) tests, stress paths, K-Zero and user defined waveforms.

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.
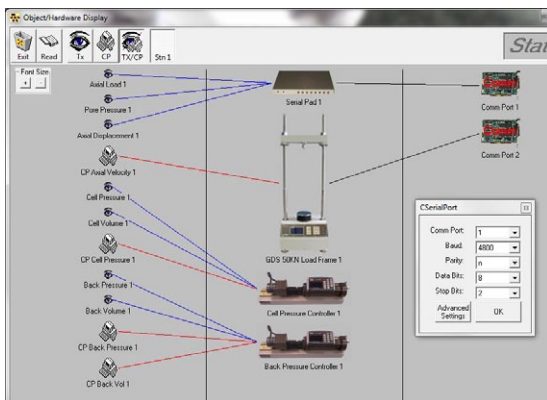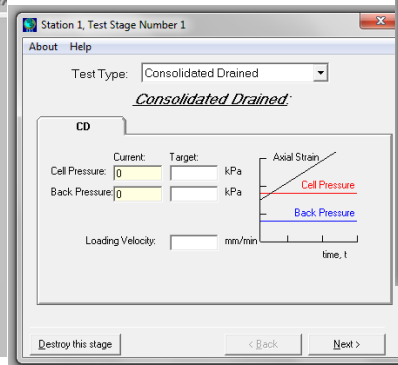
Fig. 7 Show a typical set-up screen in GDSLAB

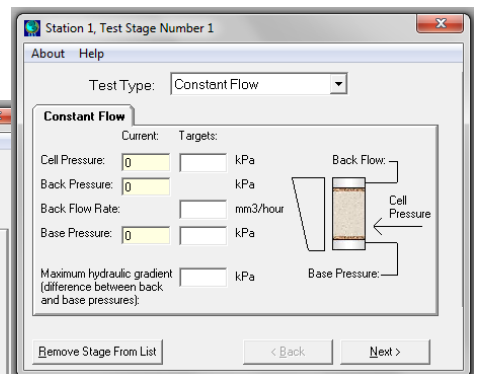Fig. 8 Show a typical station test stage set-up in GDSLAB

Fig. 9 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.

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.

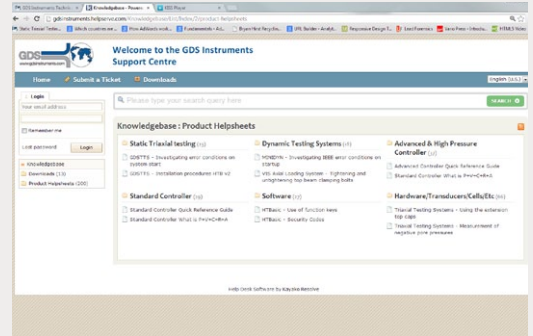Alongside their support centre GDS use a variety of additional support methods including...

Fig 10. 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.

THE QUEEN'S AWARDS FOR ENTERPRISE: INTERNATIONAL TRADE

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.

ISO 9001 REGISTERED FIRM

INTERNATIONAL ACCREDITATION BOARD

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.