



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 5Hz.

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.

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 multiple 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.

Technical Specification:

Operating Frequency:	5Hz	5Hz	5Hz	5Hz	5Hz
Load Range:	10kN	40kN	40kN	40kN	60kN
Cell Pressure Range:	2MPa	2MPa	2MPa	4MPa	1MPa
Sample Size (Diameter):	up to 100mm	up to 100mm	up to 150mm	up to 100mm	up to 300mm

Actuators:	High accuracy electromechanical
Axial Force Accuracy:	<0.1%
Axial Force Resolution:	24bit (i.e. <0.4N for 10kN load cell, <1.5N for 40kN load cell)
Axial Load (kN):	10, 40 or 60
Displacement Range (mm) & Resolution:	100 & 0.20um
Operating Frequency (Hz):	5Hz
Cell Pressure Range (Static):	2MPa (standard), optional 4MPa upgrade available with max sample size 100mm
Cell Pressure Range (Dynamic):	Optional dynamic cell pressure 1000kPa/200cc
Sample Sizes (mm):	38, 39.1, 50, 61.8, 70, 100, 101, 150 or 300

Optional Extras:

Vertical Bender Elements	50, 70, 100, 150mm
Horizontal Bender Elements	50, 70, 100mm
LVDT Local Strain Transducers	50, 70, 100mm
Hall Effect Local Strain Transducers	38, 50, 70, 100mm
Mid Plane Pore Pressure & Suction Probe	up to 100mm
Lifting Frame	Available
Unsaturated Testing	50, 70, 100mm
Temperature Control	-10°C to +60°C, -20°C to +65°C, -20°C to +85°C (For 5Hz / 40kN / 4MPa only)
Permeability Upgrade	Available
Dynamic Cell Pressure Control	5Hz / 1MPa

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:

GDSLAB Software

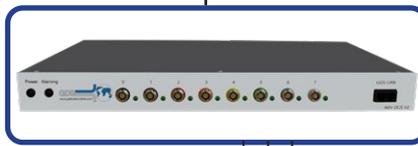
The GDSLAB control and acquisition software is a highly developed, yet extremely flexible software platform. Starting with the Kernel module and the ability to perform data acquisition, additional modules are added for your testing requirements.



Note: Connection via USB

ADVDCS v2 Acquisition Pad

The ADVDCS v2 is based around a modern, high speed, 32 bit processing core and has eight simultaneous sampling 24 bit universal analogue input channels, enabling any transducer in the GDS range to be connected. High speed digital bus technology allows real-time streaming of transducer data making it ideal for high speed data acquisition. The ADVDCS v2 supports full digital control of servo motor and hydraulic actuators allowing accurate, precise and noise free control of actuators.



Pore Pressure (kPa)

Axial Strain (mm)

Load Cell (kN)

Load frame control

Cell pressure / volume

Back pressure / volume



Pressure Volume / Controllers

The cell and back pressures can be controlled with either one of the below:

- The Standard Pressure/Volume Controller (STDDPC) with pressure ranges from 1 to 4MPa, serial PC connectivity and 200cc volumetric capacity.
- The Advanced Pressure / Volume Controller (ADVDPV) with pressure ranges of 2 to 4MPa, USB connectivity and 200cc volumetric capacity, (ADVDPV 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. The maximum pressure of this actuator is 1MPa.

Frequency Range (Hz)

- 5

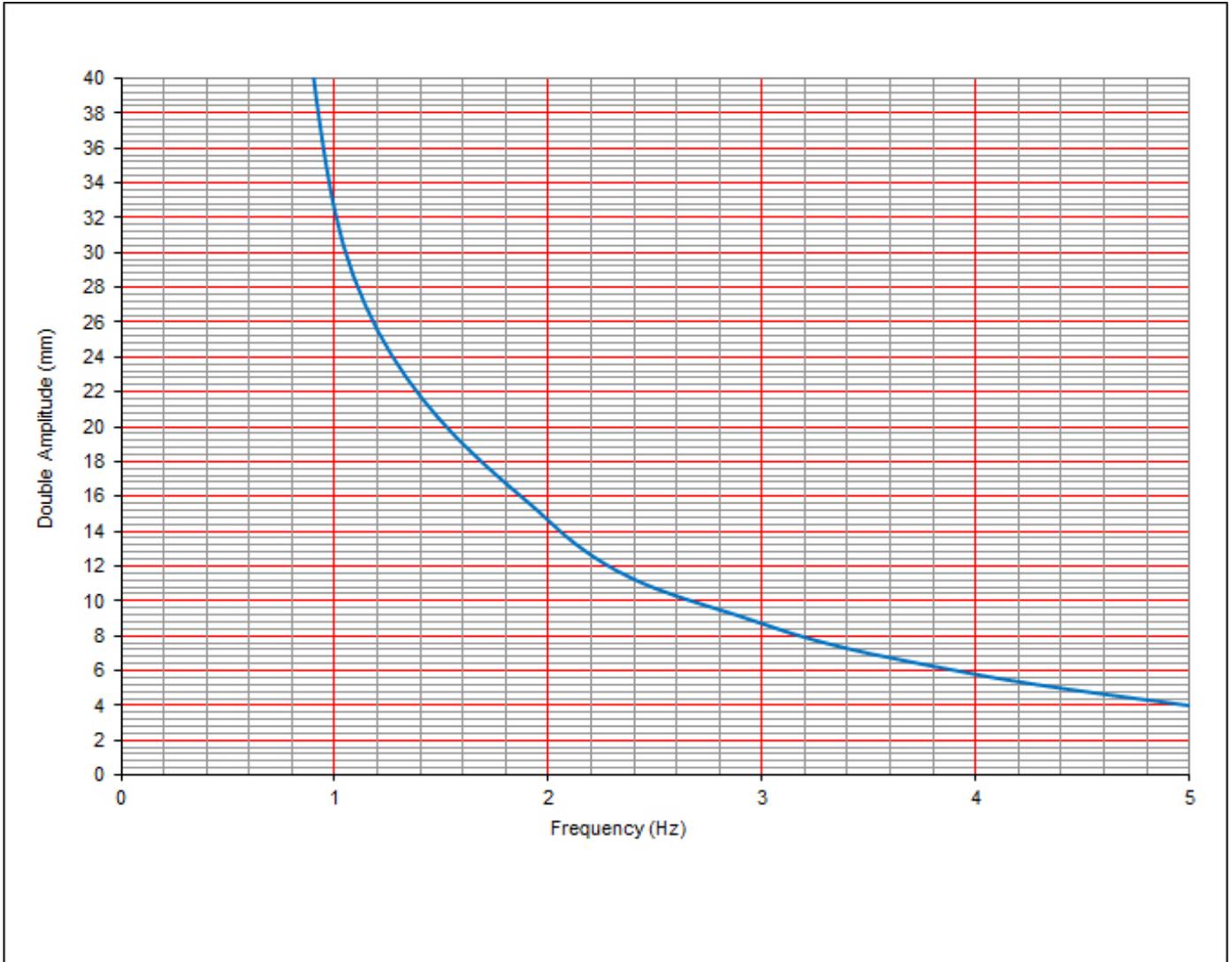
Load Range (kN)

- 10, 40 or 60.

Specimen Sizes (mm)

- up to 300mm (dependent on chosen operating frequency)

Typical System Behaviour Showing Frequency and Amplitude for 5Hz/10kN System



Frequency (Hz)	5Hz - Double Amplitude (mm)
0.1	100.0
0.2	100.0
0.5	100.0
1	32.3
2	14.6
3	8.7
4	5.8
5	4.0

Note:

- Performance curves for a sinusoidal waveform under displacement control with a datum of 0kN.
- At a load of 5kN the achievable amplitude may be reduced by up to 50% as a guide.
- Under load control at typical failure behaviour where the resultant displacement curve to achieve the load waveform is no longer a smooth sinusoid, the achievable amplitude may be reduced by up to 30% as a guide.

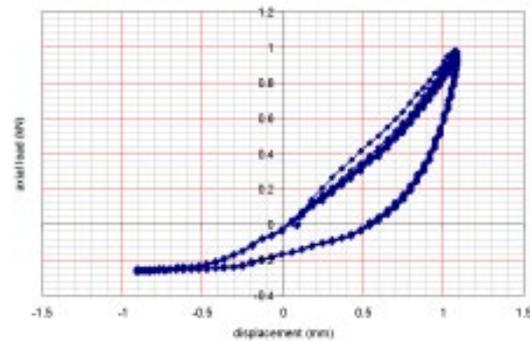
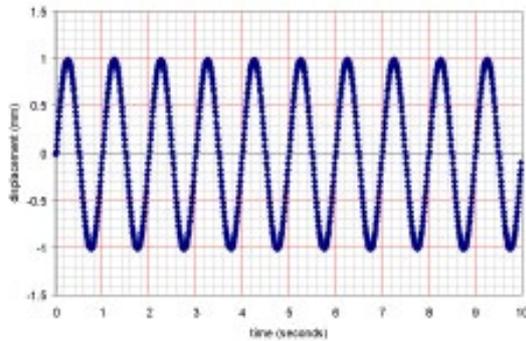
Typical Test Results Showing Displacement Control at 1Hz

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**

Temperature Controlled Testing

The DYN TTTS may be upgraded to include a temperature control system, enabling the dynamic cyclic response of soil to be observed and quantified when placed under frozen and/or heated conditions

It is possible to have a range of -10°C to $+60^{\circ}\text{C}$ or -20°C to $+85^{\circ}\text{C}$, depending on the required range. The heater and chiller units used have a resolution of 0.01°C with a bath stability of $\pm 0.05^{\circ}\text{C}$, this stability & resolution is not necessarily reflected in the cell.

The control solutions consist of heating and cooling hardware, or heating hardware only. Gaseous back pressures, such as carbon dioxide or nitrogen, may also be applied within the temperature controlled systems.



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 tool allows the rapid, automated analysis of bender element tests to objectively estimate the shear wave travel time. The analysis tool is available

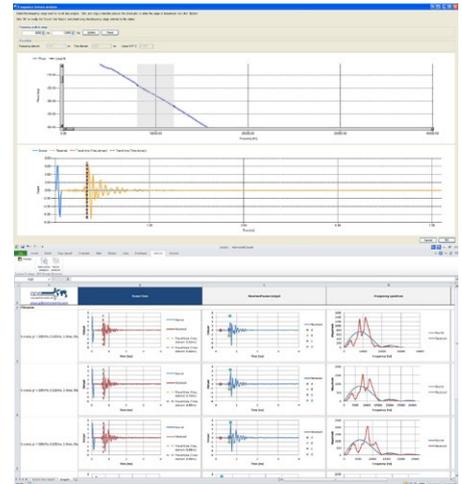


Fig. 4 Screenshots of the GDSBEAT

Upgrade to Unsaturated Testing

Any DYNNTTS system may be upgraded to perform unsaturated triaxial testing with the addition of, unsaturated pedestal with high air entry porous stone a 1000cc digital air Pressure/volume controller (ADVDPCC) for the application of pore air pressure and measurement of air volume change. Optional HKUST double cell or a double walled cell are available.

Upgrade to Local Strain Measurement

Any DYNNTTS 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.

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.

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.

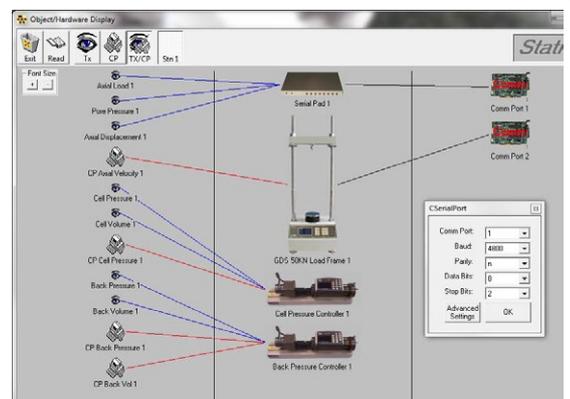


Fig. 5 A typical set-up screen in GDSLAB



Optional Lifting Frame

The Advanced Dynamic Triaxial Testing System now has the option of a lifting frame. The pulley driven lifting frame attaches to the apparatus and allows easy access to the sample.

The lifting frame is suitable for cells up to 150mm in size, weighing up to 150kg.



ADVDCS v2 Acquisition Pad Used with DYNPTS

Overview: The ADVDCS v2 is a modern high speed digital control and acquisition system developed especially for geotechnical testing, and is the premier device in the GDS range, typically supplied with our most advanced dynamic test and control systems. The ADVDCS v2 has been fully

designed and developed by GDS' in-house engineering team.

The ADVDCS v2 is based around a modern, high speed, 32 bit processing core and has eight simultaneous sampling 24 bit universal analogue input channels, enabling any transducer in the GDS range to be connected. High speed digital bus technology allows real-time streaming of transducer data making it ideal for high speed data acquisition. The ADVDCS v2 supports full digital control of servo motor and hydraulic actuators allowing accurate, precise and noise free control of actuators.

The ADVDCS v2 is the direct result of GDS research into high accuracy dynamic control, and contains machine learning algorithms that adapt in real-time to dynamic changes in sample compliance thereby delivering excellent control over the full machine performance envelope.

Technical Specification:

Connection to PC:	USB
Acquisition Channels:	8 Analogue + 1 Quadrature Decoder
Control Channels:	2 (Analogue or digital)
Multi Box Capability:	x4
Max Number of Channels:	Up to 32 analogue + 4 quadrature channels with synchronised data acquisition
Sample Rate:	5kHz
Resolution:	24 bit, 16,777,216
Gain Ranges:	8 (User defined in software)
Description:	Advanced level solution for the highest performance of dynamic acquisition & control
Voltage Resolution:	~ 0.000001 mVolts (1 nanovolt)
Voltage Input Type:	Fully Differential, Balanced Precision Inputs with Integrated Signal Conditioning
Transducer Excitation Voltage:	Differential, Fixed Precision +/-5V, Independent (not Ganged), Ratiometric Excitation
Number of Input Ranges:	8 Independently Selectable Ranges Per Channel from (-10...+10mV) to (-10...+10V)
Excitation Current Sense:	Yes - can monitor transducer currents - alerts user of disconnected transducers
Excitation/Transducer Fault Detection:	Overvoltage, Overcurrent, Absent Transducer
Excitation Fault Tolerance:	Independent Per Channel, if any channel is shorted the other channels will continue to operate normally
Current Input Mode:	Yes - Via resistor fitted in cable termination (different ranges possible)
Differential Measurement Range:	-10mV...+10mV up to -10V...+10V for balanced differential signals
Transducer Calibration:	Linear, polynomial and custom transducer calibration
Virtual Transducers:	Up to 32 virtual transducers (e.g. strain, compliance, calculated values)
Data Acquisition Options:	Digital filtering for noise reduction
Digital Control:	1 kHz 32-bit floating point control loop
Analogue Control:	Control of both digital and analogue motor drives possible
Compliance Estimation:	Real time specimen compliance estimation
Adaptive Control:	Adaptive load and stress control
Custom Waveforms:	Custom waveform control with a maximum of 16000 points per waveform
Sample Docking:	Automatic sample docking
Display and Monitoring:	Data acquisition in GDSLab via USB interface, High resolution real time graphs
Software:	GDSLAB
System Characteristics:	200 MHz dual core ARM Cortex-M4 CPU, 32-bit architecture, On-board flash memory, 480 Mbit/s USB connection
Minimum System Requirements:	OS: Windows 7 or later, CPU: 1.5 GHz or higher, Memory: 2 GB, USB 2.0

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.

TOP 50

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".

40 YEARS OF
BRITISH
INNOVATION 

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.

