Electromechanical Dynamic Cyclic Simple Shear Confined (EMDCSS-CON)

The GDS Electromechanical Dynamic Cyclic Simple Shear Confined (EMDCSS-CON) is the premier device for simple shear testing. It is capable of carrying out dynamic cyclic tests ranging from small strain (0.005% shear strain amplitude) to large strain (10% shear strain amplitude), as well as a large range of extremely accurate quasi-static testing. This is the ultimate choice for a no-compromise simple shear machine with the greatest range of testing capabilities.

The EMDCSS-CON is supplied with a built in frame (as shown in the picture) allowing system components to be optimally positioned.

Key Features:	Benefits to the User:
Confining Pressure:	Enables full effective stress control of test specimen. Saturation, b-check, shear and true drained and undrained simple shear can be performed. The EMDCSS-CON also enables simple shear to be performed in controlled unsaturated conditions.
Active height control:	Allows for the more basic fixed height based constant volume tests to be performed, as per those specified in ASTM D-6528.
Shear Loadcell:	Designed so shear forces are measured in front of the linear guides so that frictional errors are eliminated.
Low friction coated retaining rings:	Special low friction coated retaining rings are provided to ensure the soil specimen is laterally confined, ensuring a constant cross section (k-zero condition), when performing fixed height/ volume tests.
Digitally controlled electromechanical actuators:	Electro-mechanical actuators can carry out tests up to 1mm at 5Hz, with greater accuracies than comparable pneumatic actuators. Single phase mains powered means no external noisy power pack or compressor is required, as opposed to pneumatic/hydraulic systems. Our new generation digitally controlled systems allow for even higher fidelity control with both improved resolution and maximum speed.
High quality linear guides:	200mm bearing length cross-rollers are used for high accuracy high load capacity linear guidance that not only provides stability to ensuring minimal rotation of the topcap during shearing, but does so with minimal friction. This enables testing to be true simple shear with minimal end platen rotation no matter what load conditions are applied.
Machine stiffness and top cap fixity:	The EMDCSS-CON machine has been designed from the ground up with stiffness in mind to offer even higher levels of intrinsic stiffness and topcap fixity than our original EMDCSS. Vertical compliance has particularly been focused on, which is critical for high quality DSS testing.
Advanced Control System:	The EMDCSS-CON uses the same advanced control system as its sister machine the EMDCSS. Overhauled in late 2018, this utilises state of the art digital motor control which, allows position reading and control to 0.000015mm (0.015micron). The new ADVDCS control system also includes a sophisticated compliance model for adaptive control as the sample stiffness changes during a test.

Technical Specification:

Dimensions:	Standalone: 1390mm x 480mm x 870mm. Desktop: 800mm x 480mm x 870mm
Displacement Range:	Axial = ± 25mm, Shear = ± 15mm: Accuracy = <0.1% FSO (In practice, axial range is ± 50mm to aid sample placement, however measured stroke is ± 2.5mm)
Displacement Resolution:	24 bit (i.e. ± 20mm = <0.6µm, ± 15mm = ± <0.5µm, ± 2.5mm = <0.1µm)
Load Range (kN):	5
Confining Pressure (MPa):	2
Operating Frequency (Hz):	0 (static) to 5
Power:	240V or 110V 50/60Hz 1 ph
Sample Sizes (mm):	50, 66, 70, 100
Weight: Standalone / Desktop:	300kg (Includes controllers / data acquisition box) / 245kg (Unit only)

Optional Extras:

Vertical Bender Elemetns	66mm

EMDCSS-CON System Set-up

Load Frame:

- 0 to 5Hz Operating Frequency
- 5kN Load Range

Schneider Motor Control:

- +20mm Shear displacement
- +40mm Axial displacement

Power:

- 240V or 110V / 50/60Hz / Single phase

GDSLAB Control & Acquisition Software

Note: Connection via USB interface to PC.

Local LVDT's:

- ± 2.5mm Axial LVDT
- ± 10mm Horizontal LVDT

Data Logger:

- Dual axis dynamic control unit
- Advanced 24 bit 8-channel data logger
- Control frequency of up to 1000 points per cycle
- LEMO plug connector type

Transducers:

- Vertical & Horizontal Axis Load Cell
- Pore & Cell Pressure Transducers
- Horizontal and Axial LVDT's
- Pneumatic Control

Pressure Control System:

- 2MPa Pneumatic Cell Pressure
- 2MPa Advanced / Standard Back Pressure Controller

Tests that can be Performed: Guaranteed to meet new ASTM D-6528 standards and NORSOK compliant. Cyclic simple shear tests are the main use for these systems as well as static/monotonic simple shear, multi-stage testing, low speed/creep tests, user defined waveform testing (independent waveforms can be used on each axis), consolidation and constant normal stiffness testing.

Upgrade Options: P and S wave measurements with Bender Element system, transducer local calibration kit and unsaturated testing.

How does it work?

In most simple shear tests a cylindrical soil specimen is laterally confined by low friction coated retaining rings, ensuring a constant cross sectional area. Vertical displacement is kept constant by using dynamic active height control and the sample is allowed to drain whilst shear force loading is applied, therefore constant volume conditions are enforced.

In the EMDCSS-CON the sample is confined inside a pressure chamber and so it is possible to fully saturate the sample and run true effective stress controlled undrained tests with fixed height, axial load or constant normal stiffness conditions; to run saturated tests while laterally restrained using confinement rings; or using a combination of true undrained conditions and lateral confinement.

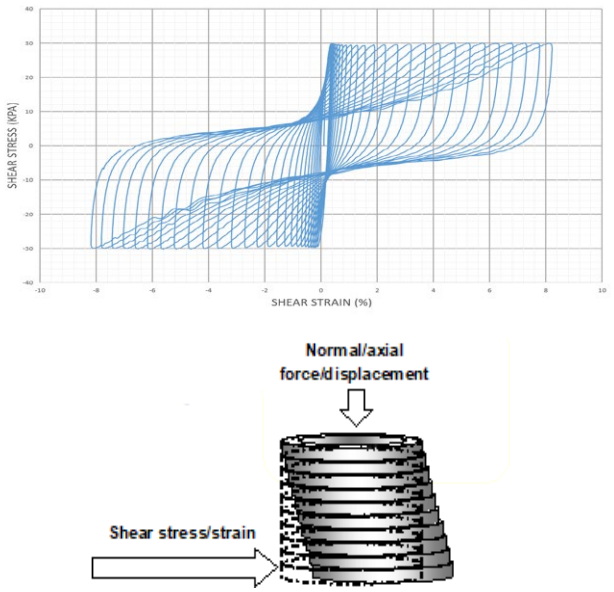


Fig. 1 Typical Graph shear stress (kPa) v shear strain (%) and sample schematic during sample shear.

The EMDCSS-CON apparatus allows for a smooth and continuous rotation through 90 degrees of the principal stress directions. The ability to simulate principle stress rotation is common to many geotechnical problems, including earthquake loading. The simple shear device allows direct investigation of the shear stress v. shear strain in drained and undrained situations (see graph Fig. 1). The simple shear test is used for undersea structures, landslips and earthquake performance studies. In addition, the dynamic cyclic capability allows investigation of damping ratio and liquefaction, also under the conditions of simple shear.

Super-stiff frame construction:

The GDS EMDCSS-CON system has been designed to yield the ultimate in performance for simple shear tests and to remove compromises that exist in other simple shear systems. The EMDCSS-CON has been designed to be as stiff as possible. This is an important feature for a simple shear system; the quality of results is governed by the topcap and pedestal guidance. Even if the pedestal guidance system is near perfect, if the system compliance is too high, the results will be compromised as the topcap movement will affect the result of the test.

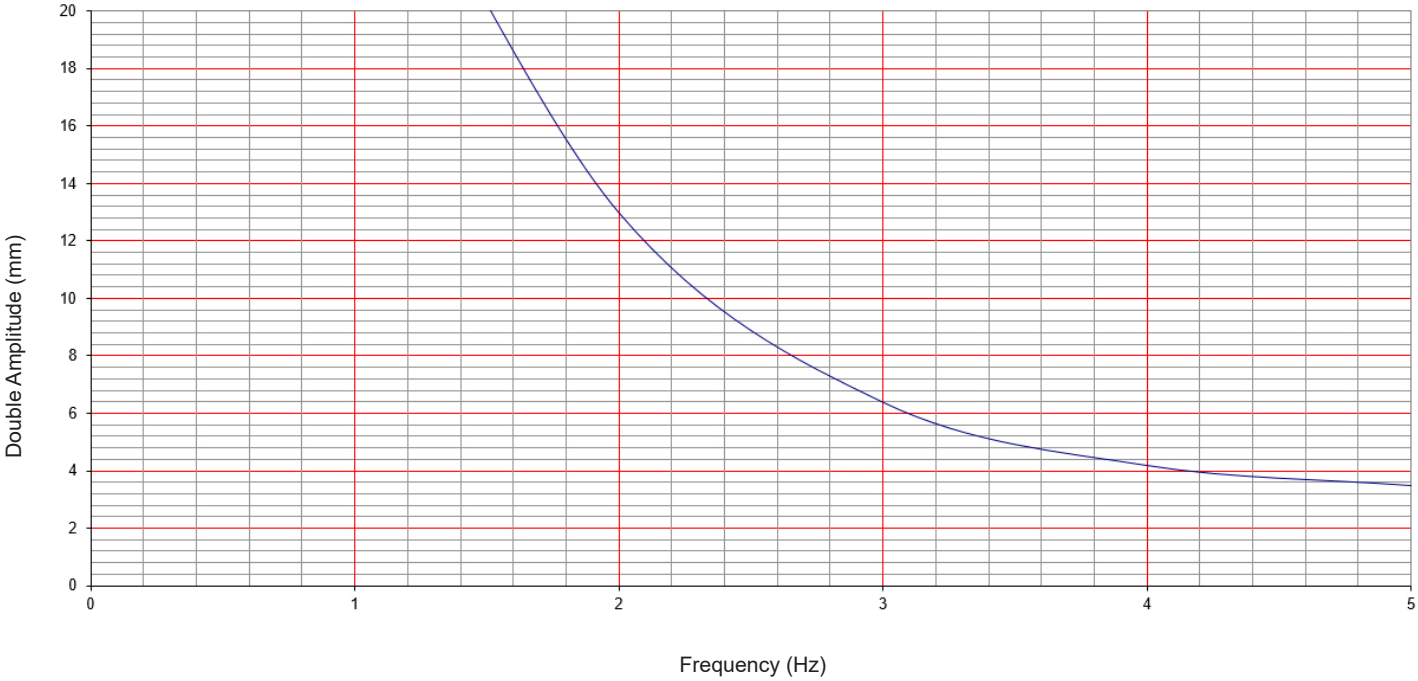
The EMDCSS-CON achieves the high degree of stiffness by utilising a deep support beam to mount the linear guides and two stainless steel pillars at the front of the machine to further brace the system. The linear guides that are used are heavily over rated for the loads the system will be subjected to. Again, this increases the stiffness of the system.

Vacuum Sample Prep Kits as standard

The sample former offered by GDS allows set up of non-cohesive samples with ease. The mould fits around the confining rings, and using a vacuum pump, pulls the membrane tight against the rings, allowing for the sample to be easily and correctly prepared. The mould is available in all sample sizes for the EMDCSS-CON.

Fig. 2 Shear forces being applied to the specimen

Typical system performance, showing frequency and amplitude (shear axis)



Frequency (Hz)	With zero kN force datum	
	Amplitude (mm)	Double Amplitude (mm)
0.1	15	30
0.2	15	30
0.5	15	30
1	14	28
2	6.5	13
3	3.2	6.4
4	2.1	4.2
5	1.75	3.5

Example Test Results

Typical results from a dynamic simple shear test are shown below. These tests were performed at 1Hz on a well graded sand. The pore pressure build up can be clearly seen in Fig.4 (as calculated from normal stress drop-off), with failure occurring around the 10th cycle. At this point the shear strain rapidly increases in amplitude to significant levels, while continuing to maintain the targeted shear stresses (Fig. 5 & 6). Finally, the measured drop off in vertical stress during cyclic testing from the constant volume system is seen in Fig. 7.

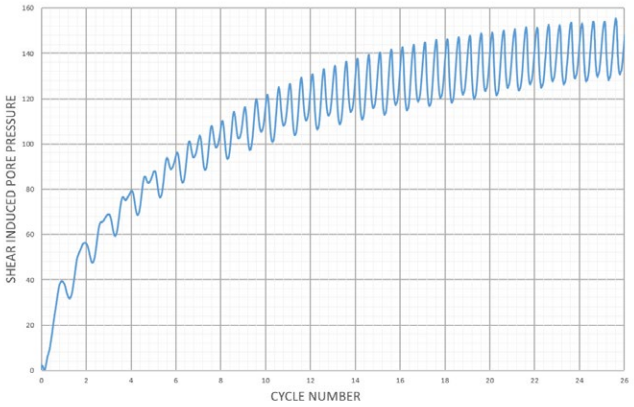


Fig. 4 Equivalent pore water pressure build up

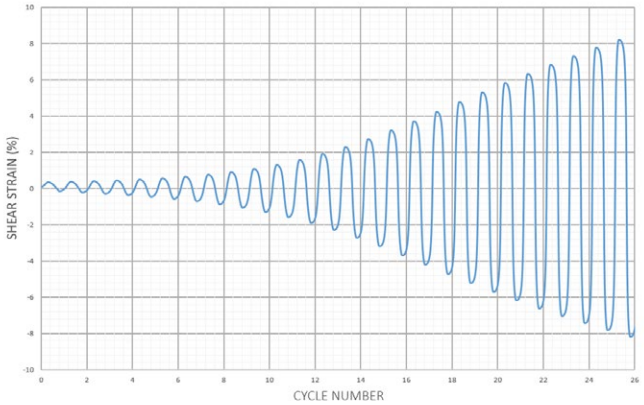


Fig. 5 Shear strain build up to failure

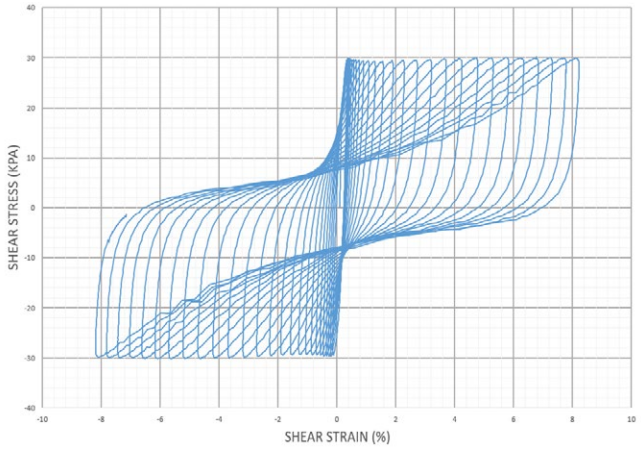


Fig. 6 Shear stress vs shear strain

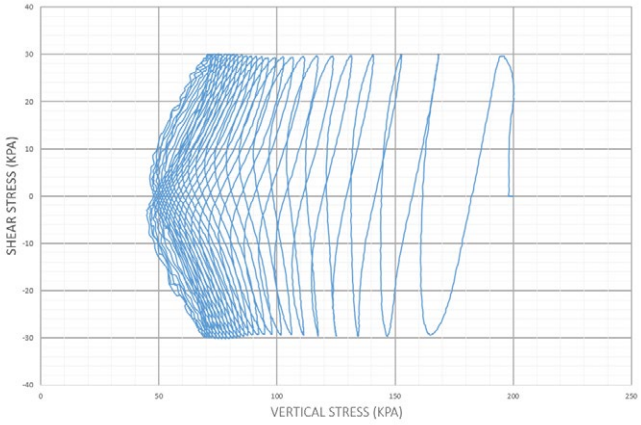


Fig. 7 Shear stress vs vertical stress

GDS shear force load cell

The GDS shear force load cell is designed specifically for the direct measurement of shear forces being applied to the specimen. Located between the topcap and the vertical actuator, the shear force load cell eliminates errors due to friction and system, which could otherwise be recorded in the results of the test.

Bender Element Option

Bender elements can be implemented in all sizes of pedestal and top-cap within the EMDCSS-CON range. Due to the short sample height (20mm), a high data acquisition rate is required because the travel time is extremely short. If we assume the velocity of the soil is 400m/s (for example) and the soil is 20mm high, the travel time over the 20mm would be 0.00005 seconds or 0.05 milliseconds. The GDS bender element system acquires data simultaneously at 2 Mega samples/second which gives a read interval resolution of 0.0005ms, therefore 100 samples would be acquired over the total travel time which is adequate for the velocity to be determined. Acquisition speeds any slower than 2 Mega samples/second would start introducing resolution errors.

Shear Local Strain LVDT

The EMDCSS-CON topcap can be modified to allow a local LVDT to be used with the system, adding an additional shear strain measurement. The LVDT is mounted on a bracket connected directly to the topcap. This then measures a flattened surface off the pedestal. The transducer connects into the data acquisition unit of the EMDCSS-CON (DCS). The LVDT upgrade is available for all sample sizes.

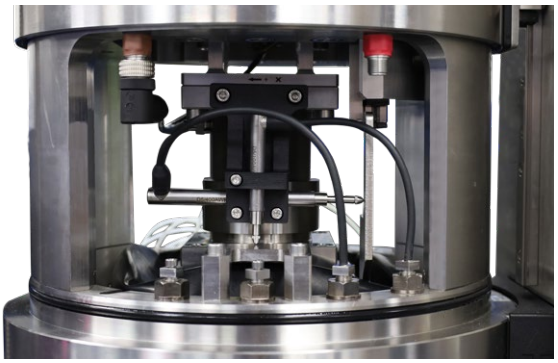


Fig. 8 Local shear LVDT location on topcap

Unsaturated Testing

The EMDCSS-CON can be upgraded to perform unsaturated testing with the addition of an air pressure source and unsat pedestal. We would typically recommend using our Unsat Method A approach for this apparatus. A GDS pneumatic controller can be provided as an air source, see fig 9.

Fig. 9 GDS Pneumatic Controller

GDSLAB control 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 only, additional modules may be chosen for your testing requirements. Some currently available modules are as follows:

- Simple Shear (Static and Dynamic)
- Advanced loading tests
- Unsaturated testing

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 (see Fig. 10).

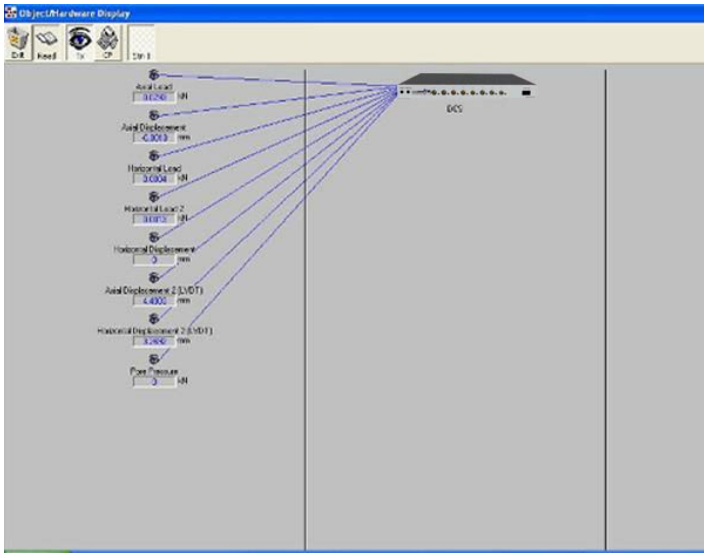


Fig. 10 The graphical interface for the ADVDCS V2 box controlling the EMDCSS-CON

GDSLAB dynamic simple shear test module

- Is a simple-to-use user interface for running dynamic cyclic loading and simple shear tests
- Provides sinusoidal cyclic control of axial displacement or axial force and shear displacement or shear force
- Allows a complete cycle of data to be saved every N cycles where the value of N is defined by the user
- Controls data displayed in real-time
- Saves up to 1000 points per cycle
- Has built-in standard waveforms: sinusoidal, triangular, square, havesine.
- Has user defined waveforms using 1000 point ASCII file.

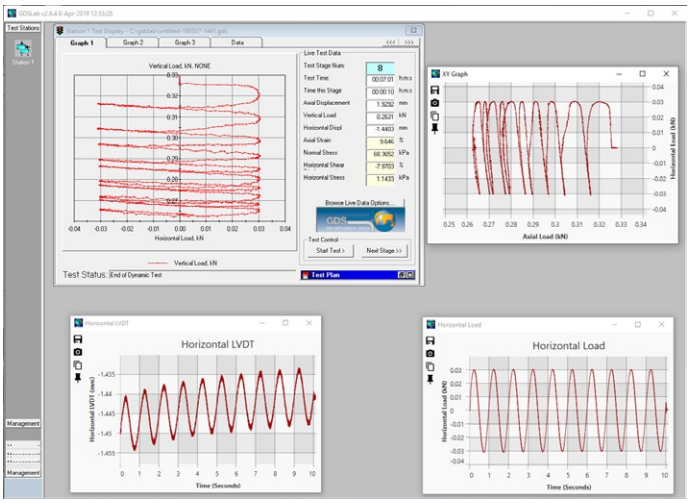


Fig. 11 shows GDS simple shear test module using the new ADVDCS V2 control systems.

ADVDCS v2 Acquisition Pad Used with EMDCSS-CON

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

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.

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.