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Dynamic Triaxial Testing of Soil

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Electro-mechanical and Pneumatic systems

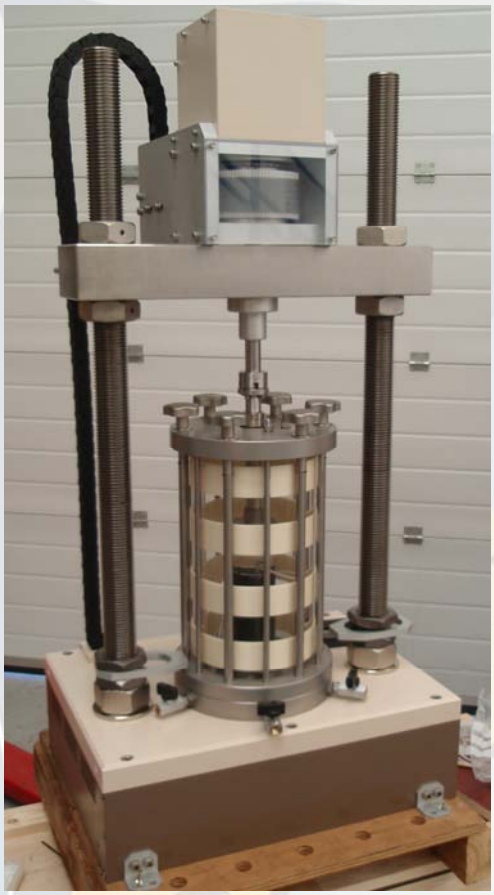
When specifying a dynamic triaxial testing system there are three common types of axial actuator to choose from; Pneumatic, Electro-mechanical or Hydraulic. Care should be taken to choose the type of actuator suitable for the intended purpose as each type of actuator can be suitable for a specific type of testing. For a number of years the standard actuator type for the lowest cost entry into dynamic triaxial testing has been pneumatic. Pneumatic actuators traditionally provided very cost effective but low quality systems for triaxial testing. Pneumatic systems are soft and difficult to control accurately because they are based on compressed air pressure. Using air pressure as a driving force is not an ideal solution because it relies on moving large quantities of air in and out of the actuator so unless testing very stiff samples it is difficult to achieve meaningful results at testing frequencies greater than 1Hz.

Electro-mechanical testing systems provide highly accurate and reliable testing solutions. While these systems have traditionally only been available to well funded research institutions recently GDS has released the new ELDyn system which is more cost-effective (even surpassing pneumatic systems in terms of economy) while still providing the benefits of this type of actuator. Electro-mechanical actuators provide a much more stable platform to carry out high quality testing. The increased accuracy of control and stability over pneumatic systems means that they are ideally suited to high quality, dynamic research testing as well as highly accurate creep and small strain testing. Whole life costs for electro-mechanical systems are also generally lower as a large air compressor is not required to be running continuously due to air losses in the actuator. Electro-mechanical systems draw only the required power directly from the mains to achieve the required test.

Tuning methods should also be considered where load controlled tests are required. The benefits of computer controlled tuning should be considered relative to old fashioned manual/pneumatic systems.

Specifications can be very misleading when systems are being specified for dynamic triaxial testing. A common misconception is that the control valve frequency (often specified as 70Hz) is the maximum operating frequency that the system can reliably test samples at. This is NOT the case. While 70Hz 'testing' may be achievable on an extremelly stiff sample of steel, when a soft or 'normal' soil is tested the achievable amplitude with pneumatic systems tends to render the maximum working frequency down to sub 1Hz (often sub 0.2Hz).

ELDyn Triaxial Frame and Cell



System ease of use is one of the great triumphs with an electromechanical system. An ELDyn system for example can be used confidently with the minimum amount of training, therefore ensuring the knowledge of the system can be efficiently passed between users.

The laboratory environment should also be considered. The large air compressors required to run dynamic pneumatic systems continuously are very noisy, not particularly energy efficient as well as being large in size. Electro-mechanical systems only require a mains electricity supply and so are much quieter in the laboratory.

Hydraulic systems are generally used for either higher loads (greater than 50kN) and where testing frequencies greater then 10Hz are required, as such they are not considered in this document.

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GDS Electro-mechanical systems

Two Electro-mechanical systems are available from GDS to dynamic triaxial testing; ELDyn and DYNTTS. The benefits of each system are detailed below:

ELDyn – Entry Level

ELDyn is designed to supersede pneumatic systems and provide a stable and safe platform for research and teaching.

- Standard 5kN. Optional 10kN upgrade.
- Full amplitude at rated frequency (1.5mm @ 5Hz so 3mm peak to peak)
- Can be used in parallel with a traditional loadframe to achieve 50kN static shearing tests
- Price competitive to Pneumatic systems
- Low maintenance
- Low lifetime costs, energy efficient
- Self contained Bench-top Mounted load frame system
- Can be used with optional bender elements, local strain transducers, local pore pressure transducer or for Unsaturated testing.

DYNTTS – Advanced

This system is designed for top level research highly precise research.

- Standard 10kN optionally up to 60kN Dynamic loading
- Full amplitude at rated frequency (2mm @ 5Hz so 4mm peak to peak)
- Cell pressures up to 64MPa
- Balanced ram for models up to 5Hz
- Dynamic cell pressure option
- Built in transducer access ring
- Full amplitude at rated frequency
- Price competitive to Pneumatic systems
- Floor standing compact unit
- User defined waveforms
- Can be used with optional bender elements, local strain transducers, local pore pressure transducer or for Unsaturated testing.

Headline specification comparison for Dynamic Triaxial Testing systems:

	Traditional Pneumatic	GDS- ELDyn	GDS - DYNTTS
Available Dynamic Load Ranges	Normally 5kN	5 or 10kN	10, 16, 20, 40 or 60kN
Usable Frequency Range	Usually 1Hz 2Hz with reduced control accuracy	5Hz	Static, 2, 5 or 10Hz
Maximum static axial load	50kN Using traditional Triaxial Frame for static shearing	50kN Using traditional Triaxial Frame for static shearing	As specified under dynamic loading
Maximum displacement amplitude at rated frequency	0.01mm @ 70Hz	2mm @ 5Hz	Dependent on requirements
Balanced Ram – Used to keep cell pressure constant during axial cycling	Not available – relies on air filled cell	Not available – relies on air filled cell	<5Hz - Included >5Hz uses dynamic cell pressure control
Able to cycle around Zero Deviator load efficiently?	NO	YES	YES
Good For Small Strain Testing?	NO	YES	YES
Good For Creep Testing?	NO	YES	YES
Require external High power air compressor?	YES	NO	NO

For further information on these systems please contact GDS or consult the datasheets available from:
ELDyn: http://www.gdsinstruments.com/products/eldyn.htm
DYNTTS: http://www.gdsinstruments.com/products/dyntts.htm

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