Cyclic simple shear

Dynamic shear test apparatus for soil behaviour prediction under dynamic conditions

MAIN FEATURES

- **5 kN** horizontal and vertical actuators
- **5 kN** load cells fitted in-line with actuators, 1 N accuracy
- **constant diameter** test performance
- possibility of **constant height** shear test
- possibility of **constant stress** test
- possibility of **constant rate of strain** test
- operating frequency up **to 10 Hz** (depending on test conditions)

GENERAL DESCRIPTION

The cyclic simple shear apparatus is generally used for research in the dynamic field of soil behaviour, and can quite easily simulate many different field loading conditions, for example:
- **Stability** under seismic events on submerged slopes of the continental shelf characterised by layered clays
- **Degradation** of shear stress in cohesive soils under cyclic loading
- Evaluation of the **liquefaction parameters** of non-cohesive soils under cyclic loading

The cyclic simple shear is a plane strain device. The shear strain is induced by horizontal movement at the bottom of the sample relative to the top. The diameter of the sample remains constant, therefore any change in volume can only be as a result of vertical movement of the top platen.

The system is designed to allow a sample to be consolidated and then sheared under constant volume conditions (simulating an undrained shear of a saturated specimen).

Sample

The standard sample is 70 mm diameter. The test can also be performed on 50 mm diameter samples using the conversion kit 31-WF7500/1.
The sample is positioned on a pedestal, with a top cap the same as used for triaxial testing, and is supported laterally by a rubber membrane secured with O-rings. To maintain a constant diameter throughout the test the sample is restrained by a series of slip rings.

Shear stage

During shearing the rings slide across each other as shown in picture 3 above, while keeping the diameter constant. The vertical height of the sample is maintained constant by the vertical actuator under closed-loop control with feedback from the vertical displacement transducer. The change in vertical stress required to achieve constant height is assumed to be equal to the change in pore pressure.

Below is a general description of the main system components:

Base system

The system consists of a simple shear load frame fitted with an air receiver with servo-valves for controlling vertical and horizontal load/displacement. It incorporates a control and data acquisition system as described below, with two 5 kN actuators. The system is housed within a cabinet. The horizontal and vertical actuators are fixed to the frame, which supplies the reaction to the forces applied. Each actuator has an internal displacement transducer, which relays the actuator piston position back to the computer. This is very important when setting up a sample; it allows you to set enough travel for the test duration. The sample is set up in the machine, which has a rigidly fixed top half and a moving bottom half. The top half houses the 50mm diameter vertical ram. This is housed in a linear bearing to allow vertical movement and prevent horizontal movement. The bottom half is mounted on roller bearings as in a standard shear box.

DATA SHEET

Integrated Multi-Axis Control System
The IMACS is a compact self-contained unit that provides all critical control, timing and data acquisition functions for the test and the transducers. It is linked to a personal computer through a USB communications link.
The data acquisition module has 13 normalised (±10 V range) transducer input channels. These channels are digitised by accurate, high speed 20 bit (A/D) converters for data analysis and presentation. The control module has two channels for feedback control. One is dedicated to the vertical actuator for load/displacement, the second is for the horizontal actuator for load/displacement. The feedback control module and the data acquisition module have their own dedicated high speed USB 10 Mbit/s or RS232 interface. This allows uninterrupted, simultaneous communication, giving increased speed of cooperation and flexibility.
Supervised by the PC, the IMACS automatically controls the operation of loading
for individual types of test. The IMACS directly controls the servo-valve to apply the requested loading rate or waveform. While the specimen is being subjected to loading forces, the IMACS captures data from the transducers and transfers these, via the USB or RS232 link, to the PC for processing, display and storage.

Load cells
These two 5 kN load cells are fitted in-line with the horizontal and vertical actuators.
The load cells are fitted with a calibration module, allowing the transducers to be changed or moved within the data acquisition system without the need to recalibrate them. Accurate to 1 N.

Displacement transducer
This ± 15 mm displacement transducer is built into the actuator. It measures the actuator piston position and can also be used as the control transducer for the cyclic strain test.

Vertical displacement transducer
This transducer is calibrated over ± 2.5 mm for controlling the sample height. Accurate to 1 µm.

In-line signal conditioning
This normalises all the transducer outputs, allowing transducers to be moved from channel to channel without having to recalibrate.

The system includes the following:

- Cyclic simple shear machine with horizontal and vertical actuators 5 kN capacity
- Accessories for sample preparation
- Force and displacement transducers
- Control system and data acquisition
- Software and PC

TECHNICAL SPECIFICATIONS

Main frame: floor mounted, steel box frame including integral double acting horizontal and vertical pneumatic actuators, each with an +/-15 mm internal displacement transducer (Accuracy: 1µm) . The top cap is fixed and the pedestal is mounted on roller bearings.

Sample size: 70 mm dia. (50 mm with conversion kit)

Maximum load: ± 5 kN vertical and horizontal

Operating frequency: up to 10 Hz (depending on test conditions)

Overall dimensions: 1200x1500x700 mm (hxlxw)

Electrical specification: 240 or 110 V, 50-60 Hz, 1 ph.

Weight approx.: 350 kg

ORDERING INFO

31-WF7500
Cyclic Simple Shear Apparatus PC controlled, with IMACS, Fitted in cabinet, including adapters for 70mm Samples 110V-220V 60Hz-50Hz 1ph

31-WF7500/1
50mm dia. sample accessories including pedestal and top cap

ACCESSORIES

31-WF7500/1
50mm dia. sample accessories including pedestal and top cap

86-D2015/A
Air compressor, 10 bar max. pressure, 200 l capacity, 5.5 kW.
400 V, 50 Hz, 3 ph. (220 V, 60 Hz model available on request)

86-D2019
Air treatment unit for the dehumidification of air, comprehending: air dryer, particle filter 5M, oil filter 0.01 M. 230 V, 50-60 Hz, 1 ph

ADDITIONAL INFORMATION

SOFTWARE

Consolidation stage
The consolidation stage is simply the application of a static axial loading stress to the specimen while the lateral loading (shear) axis is held stationary. Axial stress and specimen

displacements (axial and lateral) data are measured over time and logged by the system. Logged data is also displayed to the operator in the form of charts and tables as the test stage proceeds. The consolidation stage is manually terminated by the operator once consolidation of the specimen is determined to be complete.

Cyclic simple shear stage
This stage of the test applies a lateral cyclic shear force, or optionally a displacement, to the specimen, while the axial axis is either maintained at the specified stress, or optionally, the specimen height is maintained. Both axial and lateral force and specimen displacements together with shear induced pore pressure are measured for each loading cycle. Measured data is obtained from 50 sample points captured over the cycle period. This data is displayed to the operator in the form of wave shapes, charts and tables and also logged

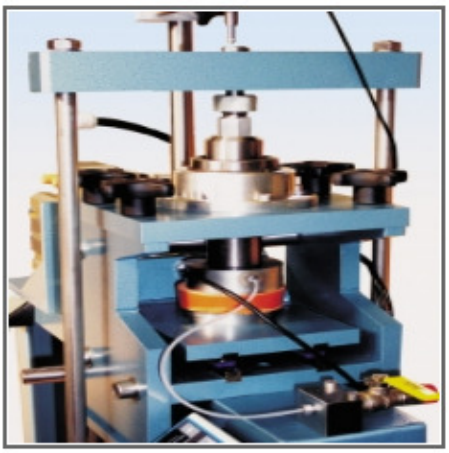
by the system to an archive data file. The loading cycle shape is operator selectable from predefined functions but may also be a user generated shape.

Linear displacement shear stage

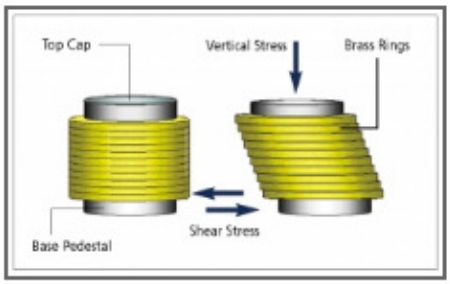
The linear displacement shear stage of the test applies a rate of lateral shear displacement

to the specimen. Both axial and lateral force and specimen displacement together with shear induced pore pressure are measured for each loading cycle. Measured data is displayed to the operator in the form of charts and tables and also logged by the system to an archive-data file.

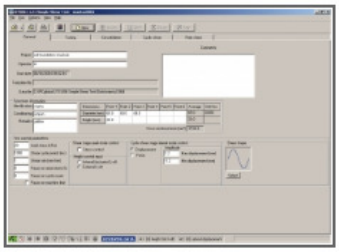
Cyclic simple shear 31-WF7500



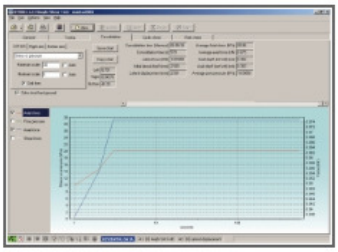
Sample in the cyclic simple shear 31-WF7500



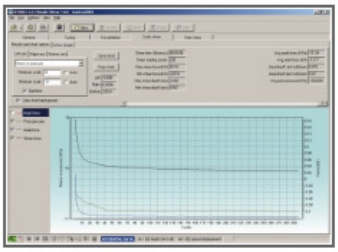
Scheme of the sample in the Cyclic simple shear 31-W7500



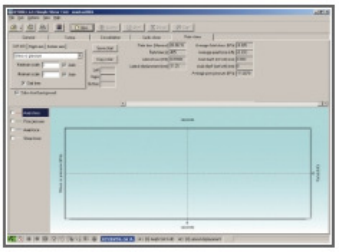
Set up parameters: This stage of the software allows you to select the type of test parameters you wish to carry out for example: Consolidation stage force pressure Shear stage axial mode to be controlled in stress or constant height. Shear stage lateral mode to be controlled in force or displacement with choice of wave shape. Shear rate speed. Test



Consolidation: This stage shows the consolidation forces being applied to the sample. -- Graph displays Axial stress against time. Induced pore pressure against time. Axial force against time. Shear force against time.



Cyclic shear: This stage shows the dynamic forces/ displacements being applied to the sample. -- Graph displays Axial stress against time. Induced pore pressure against cycles. Axial force against time. Shear force against time.



Rate shear: This stage shows the rate shear being applied to the sample. -- Graph displays: Axial stress against time. Induced pore pressure against time. Axial force against time. Shear force against time.