

Soil Mechanics

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27 | Direct/Residual shear

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Wykeham Farrance is one of the longest established manufacturing companies in the world of Geotechnical Testing Systems. It has always been synonymous with high technology and quality. A close working relationship with several premier Universities in Europe ensures a flow of new ideas for development of new testing techniques and systems. WYKEHAM FARRANCE was originally formed in 1941 by Geoff Wykeham and Geoff Farrance. The original company is now part of the CONTROLS GROUP as the Soil Mechanics Division.

The consolidation test determines the rate and magnitude of consolidation of a soil specimen restrained laterally and subjected to a number of successive increments of vertical loads. We propose Front loading oedometers, the ACE, Automatic computerized oedometer and other similar goods.

The Direct/Residual shear test covers the determination of the consolidated drained shear strength of a soil material in direct shear. Various models are available to satisfy all requirements.

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Front Loading Oedometer

Standards

BS 1377:5 | ASTM D2435 | ASTM D3877 |
ASTM D4546 | AASHTO T216 |
NF P94-090-1 | NF P94-091 |
UNE 103-405 | UNE 103-602

26-WF0302

Front loading oedometer

The oedometer consolidation test determines the rate and magnitude of consolidation of a soil specimen restrained laterally and subjected to a number of successive vertical load increments.

The oedometer apparatus has a rigid aluminium alloy frame which avoids distortion under load. The lever arm assembly is supported in precision self-aligning bearings. Consolidation cells, dial gauge/displacement transducer, weight sets and bench are not included and have to be ordered separately. See Accessories.

Technical specifications

- Max loading (using 11:1 lever arm ratio): 1848 kg, corresponding to 9.061 MPa (92.40 kgf/cm²) on a 20 cm² specimen (50.47 mm diameter)
- Overall dimensions: 500 x 200 x 750 mm (height without hanger x width x length)
- Weight: 21 kg (approx.)



Slotted steel weights

Accessories

Weight sets

26-WF0230/C2

Weight set, 64 kg in total, comprising: 2 x 0.25, 1 x 0.5, 1 x 1, 1 x 2, 1 x 4 and 7 x 8 kg weights.



Three oedometers (26-WF0302) complete with cells and electronic displacement transducers ⁽¹⁾ (30-WF6207), mounted on a consolidation bench (26-WF0312) and connected to the Geodatalog and PC (not included)

⁽¹⁾ As an alternative to the standard dial gauges.

26-WF0230/D2

Weight set, 80 kg in total, comprising: 2 x 0.25, 3 x 0.5, 1 x 1, 1 x 2, 3 x 5 and 6 x 10 kg weights.

Single slotted weights

See pages...

Mechanical (analogue) Measuring device

30-WF6401

Dial gauge, 10 mm travel, 0.002 mm resolution.

Permeability attachment

26-WF0338/A

Permeability attachment with 50 ml graduated burette. Complete with clamps, stand and rubber hose for connection to the cell. Weight 4 kg.

Consolidation bench

26-WF0312

Bench for up to three oedometers. Weight 30 kg

Electronic measuring devices

30-WF6207

Linear potentiometric transducer, 10 mm travel.

Note: in case displacement transducer is supplied complete with data acquisition system, then a traceable calibration certificate on request.

Data acquisition and processing system

Note: For more information on the Geodatalog, see page. . . .

30-WF6016/T1

Consolidation Geo-Analysis template conforming, to BS 1377:5.

30-WF6016/T8

Consolidation Geo-Analysis template conforming, to ASTM D2435.

main features

- > Rigid aluminium alloy frame
- > 3 lever arm position: 9:1, 10:1, 11:1. Max loading 1848 kg
- > Can be fitted with traditional dial gauge or linear transducer for connection to the Geodatalog data acquisition and processing system



26-WF0338/A fitted to the 26-WF0302 with cell 26-WF0320



Exploded view of consolidation cell 26-WF0320

Consolidation cells and spare parts

Suitable for both fixed ring oedometer consolidation and falling head permeability tests. The cell is constructed of aluminium and comes complete with all the parts illustrated in the exploded view.



Code	Specimen Dimensions (dxh) mm	Specimen area cm ²	Cell dim. (dxh) mm	Weight kg	Calibration disc, code 26-	Upper porous disc code 26-	Lower porous disc code 26-	Cutting ring code 26-
<u>26-WF0320</u>	50.47 x 20	20.00	139 x74	1.3	<u>WF0320/9</u>	<u>WF0320/4</u>	<u>WF0325/10</u>	<u>WF0320/3</u>
<u>26-WF0321</u>	63.50 x 20	31.67	139 x74	1.3	<u>WF0321/9</u>	<u>WF0321/4</u>	<u>WF0326/10</u>	<u>WF0321/3</u>
<u>26-WF0325</u>	71.40 x 20	40.00	139 x74	1.3	<u>WF0325/9</u>	<u>WF0325/4</u>	<u>WF0325/10</u>	<u>WF0325/3</u>
<u>26-WF0326</u>	75.00 x 20	44.16	139 x74	1.3	<u>WF0326/9</u>	<u>WF0326/4</u>	<u>WF0326/10</u>	<u>WF0326/3</u>
<u>26-WF0335</u>	112.80 x 25	100.00	200 x74	3.0	<u>WF0335/9</u>	<u>WF0335/4</u>	<u>WF0335/10</u>	<u>WF0335/3</u>

Weight application guide

This information is intended to make it easy to select the weight set that is appropriate for the cell size, the beam ratio and the maximum load applied.

Cell model	26-WF0320 Beam ratio 1:10	26-WF0321 Beam ratio 1:11	26-WF0325 Beam ratio 1:10	26-WF0326 Beam ratio 1:9	26-WF0335 Beam ratio 1:10
For max. pressure	32 kg/cm ² 64 kg/cm ²	20 t/ft ² 40 t/ft ²	16 kg/cm ² 32 kg/cm ²	16 kg/cm ² 32 kg/cm ²	8 kg/cm ² 16 kg/cm ²
Weight set 26-WF	0230/C2 0230/C2	0230/C2 0230/C2	0230/C2 0230/C2	0230/D2 0230/D2	0230/D2 0230/D2
Add. weight 27-WF	- 8 x 0275/A	- 8 x 0275/A	- 8 x 0275/A	- 8 x 0277/A	- 8 x 0277/A
Total weight kg	64 128	64 128	64 128	80 160	80 160

Typical consolidation configurations

Standard, with analogue dial gauge

Code	Quantity	Description
26-WF0302	1	Front loading oedometer
26-WF032 X ⁽¹⁾	1	Consolidation cell
26-WF0230/C2	1	Weight set, 64 kg in total
30-WF6401	1	Dial gauge, 10 mm x 0.002 mm divisions
26-WF0312	1	Consolidation bench for up to 3 oedometers

⁽¹⁾ To be selected

With digital data acquisition and processing

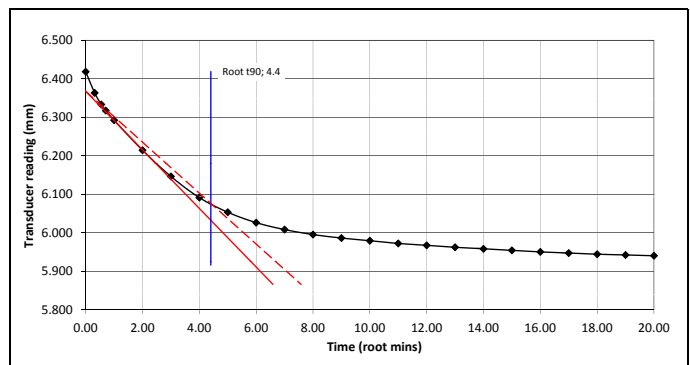
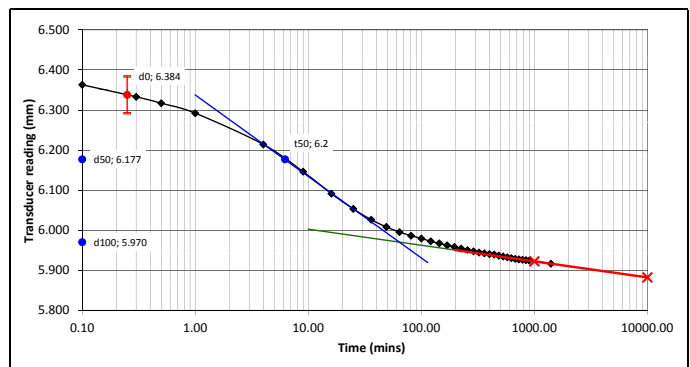
Code	Quantity	Description
26-WF0302	1	Front loading oedometer
26-WF032 X ⁽¹⁾	1	Consolidation cell
26-WF0230/C2	1	Weight set, 64 kg in total
30-WF6207	1	Linear potentiometric transducer, 10 mm travel
30-WF6042	1	Transducer extension cable, 6 m long
82-P9008/ELT	1	Set of four cables
30-WF6008	1	Geodatalog, 8-channel data acquisition system
30-WF6016/T1 30-WF6016/T8	1	Geo-Analysis template to BS or Geo-Analysis template to ASTM
26-WF0312	1	Consolidation bench for up to 3 oedometers

⁽¹⁾ To be selected

DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS USING INCREMENTAL LOADING
Tested in accordance with ASTM Designation: D 2435
TEST DATA

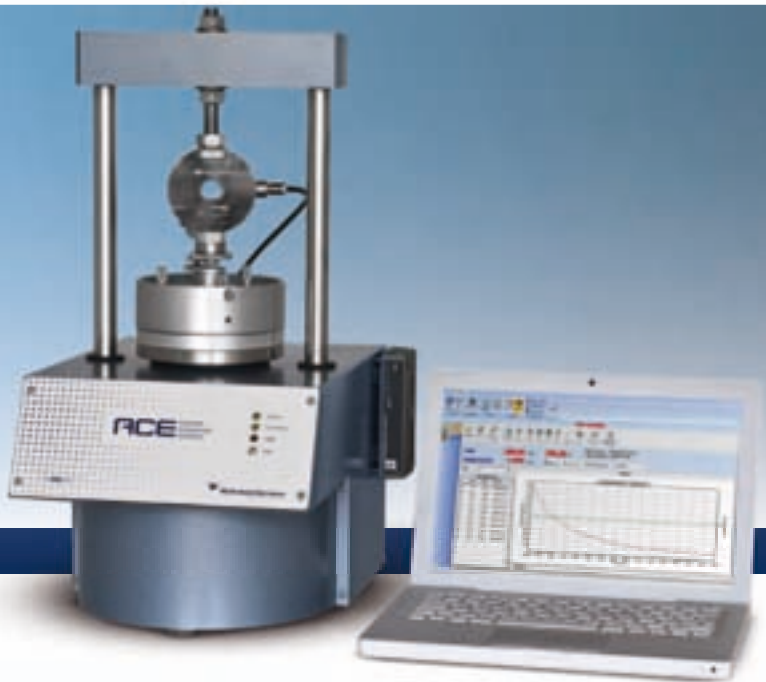
Project location	EXAMPLE	Specimen number	3A
Project reference	12345	Specimen depth (m)	1.5
Borehole number	BH2		

Increment number 5 - Loading Vertical stress (kPa) 1280 Mass (kg) 25.70



ACE

ACE Automatic Computerized Oedometer

**Standards**

BS 1377:5 | ASTM D2435 | ASTM D3877 | ASTM D4546 | AASHTO T216 |
NF P94-090-1 | NF P94-091 | UNE 103-405 | UNE 103-602

26-WF3120**Automatic Computerized Oedometer**

110-240 V, 50-60 Hz, 1 ph.

The oedometer consolidation test is used to determine the rate and magnitude of consolidation of a soil specimen restrained laterally and subjected to a number of successive increments of vertical load.

The ACE (Automatic Computerized oEdometer) consists of a small and compact load frame housing two coaxial pneumatic cylinders: the smaller one for low loads and the other for higher loads, with automatic switching from one to the other when needed. There are two analogue channels: one for the displacement transducer and the other for the load cell with closed-loop feedback, which controls application of the required pressure using a high precision pneumatic servo-actuator. Test parameters are pre-programmed and saved in the ACE software by the operator, including the test end, which

can be programmed on a time or increment basis. The software can control up to 60 ACE units from a single PC, giving the operator the choice of controlling single or multiple units.

Once the software is installed (mandatory) with the first ACE unit, it is possible to extend the control of further units just by enabling the communication without additional interventions and costs. An IP address is given to each unit for the LAN communication: system modularity is ensured for subsequent integrations.

ACE software allows to set up, save and recall different load/unload sequences: for each of them applied pressure steps, recording mode, time of application, swelling control and secondary consolidation rate limit can be defined by the user.

Besides the traditional time limit control for transition from one step of pressure to another, further automatic controls are included in the software with great

main features

- > Fully automatic PC-controlled test execution
- > Three conditions for the automatic switch to the next step are available: time, swelling, rate of secondary consolidation.
- > Testing can continue 24 hours a day, 7 days a week without interruption giving greater throughput of tests with a considerable cost decrease
- > Automated loading eliminates negative factors such as operator error and manual handling of dead weights
- > 15 kN maximum loading capacity, 10 mm travel displacement transducer
- > Real-time data and graph display
- > Single ACE software installation controls up to 60 units
- > Test management software supplied including calibration facility
- > High speed LAN network communication



Detail of load cell and displacement transducer

advantage to the users, as:

- Swelling control: if the specimen under test tends to expand, a swelling limit can be pre-set: in case the pre set limit is exceeded, the system will automatically skip to the next loading step.
- Secondary consolidation rate control: the system will automatically skip to next loading step if the secondary consolidation rate is lower than a pre-set limit.

Test results are recorded and displayed in real time and calculations are performed automatically. Test data can be processed using the proper Geo-Analysis

Templates conforming to BS or ASTM Standards.

The frame can accept all standard consolidation cells, from 50.47 to 112.80mm diameter.

Consolidation cells, Geo-Analysis templates and test software are not included. See Accessories. PC is not included.

Technical specifications

- Maximum vertical force: 15 kN - 30 kN available on request
- Load cell capacity: 15 kN
- Displacement transducer: 10 mm maximum travel
- Maximum air pressure supply: 10 bar. (If the air pressure source is not available in the laboratory, our air compressor model 86-D2015, 50 l capacity may be used.
- Specimen size: from 50.47 to 112.80 mm diameter using our consolidation cells. See Accessories.
- Software: can control up to 60 ACE units (not included, see Accessories)
- PC connection: LAN cable (included)
- Measurement accuracy: better than 1%
- Overall dimensions: 280 x 300 x 600mm (w x dx h)
- Weight approx.: 25 kg (approx.)



AUTOLAB



Modularity concept: up to 60 ACE units can be connected to the same PC via LAN and controlled by the same software 26-WF3120/SOF.

Accessories

Test software

26-WF3120/SOF

ACE automatic computerized oedometer test software

Consolidation cells (see page 47)

Permeability accessory (optional)

26-WF0338/B

Permeability attachment with 50 ml graduated burette.

Geo-Analysis templates for data processing

30-WF6016/T1

Consolidation Geo-Analysis template conforming to BS1377:5 Standard.

30-WF6016/T8

Consolidation Geo-Analysis template conforming to ASTM D2435 Standard.

Hub

26-WF4645

LAN Hub with 8 ports for Wykeham Farrance devices. LAN cable from hub to PC is included.

Air supply

See page 571

Software:

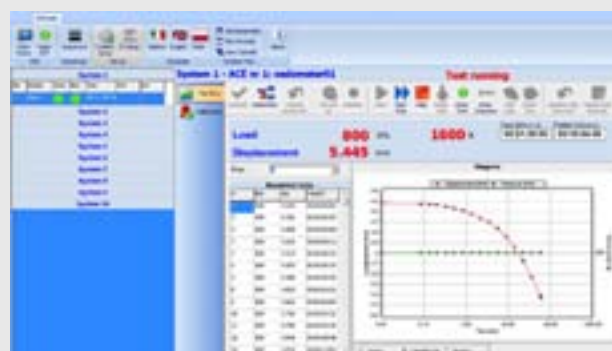
ACE software operates as interface for all testing processes: the possibility to pre-set all test conditions and let each oedometer unit to work independently and to perform the whole test automatically is the great advantage of ACE testing system, ensured by the dedicated software developed by the geotechnical experts.



Calibration and verification facilities for force and displacement transducers are included in the software. Txt files are automatically generated for calibration reports. Each system is factory calibrated but verifications have to be ensured by the users at least once a year



The screenshot above shows an example of test sequences setting, where swelling monitoring and control option is activated.



For each step, test data are displayed in real time and recorded according to the pre-set logging mode. Testing unit status is continuously displayed and time scale can be switched immediately from linear to logarithmic and square root.

Hydraulic Consolidation Cells

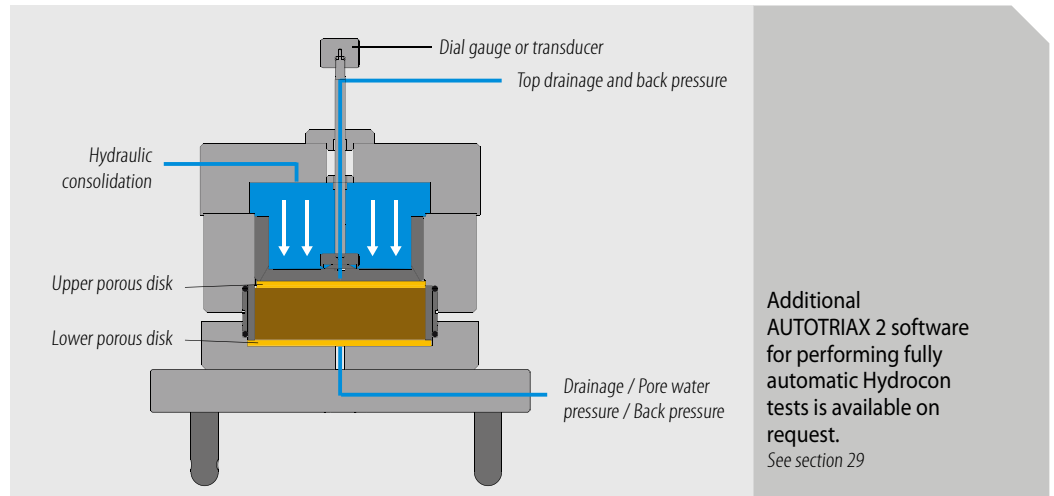
Standards BS 1377:6

26-WF0345

Hydrocon, hydraulic consolidation cell for 100 mm diameter samples



The Hydrocon hydraulic consolidation apparatus is used to determine the magnitudes and rates of consolidation of soil specimens of relatively low permeability by hydraulic pressure. This type of cell overcomes the complexity usually associated with hydraulic oedometers and allows more information to be gathered from the soil sample. Pore water pressure is measured using a pressure transducer and vertical settlement using a linear strain transducer (or a dial gauge). As the Hydrocon is a confined consolidation system, it is possible to measure both pore and back pressure during testing. The coefficient of consolidation can be directly computed from pore pressure dissipation tests. In addition it is possible to make an accurate permeability measurement by generating a vertical flow of water through the sample. The complete test apparatus includes the Hydrocon cell, pressure



Additional AUTOTRIAX 2 software for performing fully automatic Hydrocon tests is available on request. See section 29

system, water de-airing system and measuring system (manual, or electronic with the Geodatalog data acquisition system. See the table showing the configuration of a complete system.)

The Hydrocon is also available for testing unsaturated samples. See model 26-WF0346.

Technical specifications

- Manufactured from anodized light alloy, complete with three valves, one porous base disc and one top loading porous disc. Three support legs for stability.
- Suitable for 100 mm diameter soil samples
- Maximum working pressure: 3500 kPa
- Overall dimensions: 260 x 450 mm (diameter x height)
- Weight: 10 kg (approx.)

Accessories

See the table configuration of a complete testing system.



28-WF4330 with 28-WF4330/2

Typical configuration of a complete system

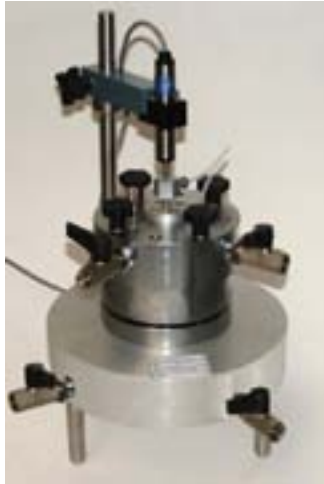
Manual or electronic option, with pore and back pressure facilities

Code	Description	Q.ty
26-WF0345	Hydrocon, hydraulic consolidation cell	1
Pressure system		
28-WF4330	Triaxial panel, two way	1
28-WF4330/2	Digital pressure gauge for 28-WF4330	1
28-WF4320	Bladder air/water interface	2
28-WF4320/1	Spare bladder for 28-WF4320	1
86-D2015	Laboratory air compressor	1
28-WF2016/2	Air filter for 86-D2015 air compressor	1
28-WF4191	Nylon tubing, OD 8 mm / ID 6 mm, 10 m coil	1
Water de-airing system		
28-WF4220/A	De-airing tank, 7 l capacity	1
86-D2005	Air drying unit	1
86-D0819	Silica gel desiccator, 1 kg bottle	2
86-D2001	Vacuum pump	1
86-D2064	Rubber tubes	2
28-WF4225	Valve panel for de-airing tank	1
Measuring system - manual option		
30-WF6401	Dial gauge, 10 mm travel, 0.002 mm subdivisions	1
28-WF6300	Pressure transducer, 0-10 bar	1
28-WF6310	De-airing block	1
28-WF4450	Digital readout unit for pore press. measurement	1
28-WF4400	Double burette volume change apparatus	1
28-WF4400/1	Red dye hydrocarbon soluble pack for 500 ml	1
Measuring system - electronic option		
30-WF6207	Linear displacement transducer, 10 mm travel	1
28-WF6300	Pressure transducer, 0-10 bar	1
28-WF6310	De-airing block	1
28-WF4410	Automatic volume change apparatus	1
30-WF6044	Transducer extension cable, 12 m	3
82-P9008/ELT	Set of four cables	1
30-WF6008	Geodatalog 8-channel data acquisition unit	1
30-WF6016/T12	Hydrocon consolidation Geo-Analysis template	1

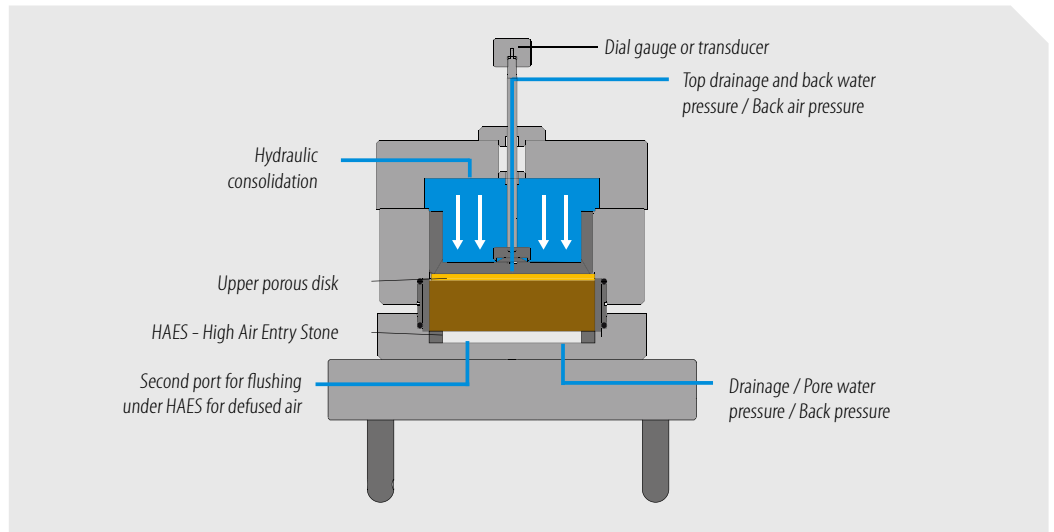
26-WF0346

Hydrocon SWCC consolidation cell

for 100 mm diameter unsaturated samples.



The Hydrocon SWCC consolidation apparatus is used to determine the magnitude and rate of settlement and pressure of unsaturated soil specimens. Because of the low permeability of some materials, performing a drying and wetting stage can take several weeks. The Hydrocon SWCC cell is a flexible soil testing apparatus capable of applying uniaxial pressures of up to 3500 kPa to a 100 mm diameter specimen. Its base is fitted with a High Air Entry Stone (HAES) which enables a soil/water characteristic suction curve to be obtained. This type of stone allows water to pass through but not air so that the soil matrix potential can be controlled at various values: 1, 2, 5, 10 and 15 bar. During a test it is possible to load the soil specimen in such a way that the overburden pressure in the field is recreated, whilst measuring the chamber and pore water pressure using a pressure transducer and the vertical settlement using a linear strain transducer.



As the Hydrocon SWCC is a confined consolidation system, it is possible to measure both pore and back pressure during testing and to make accurate permeability measurements.

For a complete system, see the table showing a typical test set configuration.

Technical specifications

- Same as 26-WF0345, but complete with four valves, compensator ring and 2 bar High Air Entry Stone sealed on aluminium ring.

Accessories

26-WF0346/1B

1 bar High Air Entry Stone for 100 mm diameter samples.

26-WF0346/2B

2 bar High Air Entry Stone for 100 mm diameter samples.

26-WF0346/5B

5 bar High Air Entry Stone for 100 mm diameter samples

26-WF0346/10B

10 bar High Air Entry Stone for 100 mm diameter samples

26-WF0346/15B

15 bar High Air Entry Stone for 100 mm diameter samples

Typical configuration of a complete system

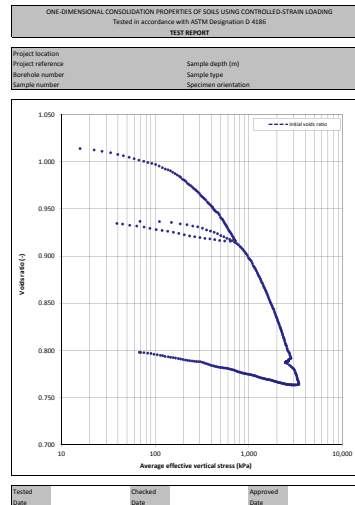
Code	Description	Q.ty
26-WF0346	Hydrocon, SWCC hydraulic consolidation cell with 2 bar High Air Entry Stone and compensator ring	1
Pressure system		
28-WF4331	Triaxial panel, three way	1
28-WF4330/2	Digital pressure gauge for 28-WF4331	1
28-WF4320	Bladder air/water interface, 1000 kPa maximum	2
28-WF4320/1	Spare bladder for 28-WF4320	1
86-D2015	Laboratory air compressor	1
28-WF2016/2	Air filter for 86-D2015 air compressor	1
28-WF4191	Nylon tubing, OD 8 mm / ID 6 mm, 10 m coil	1
Water de-airing system		
same as indicated on page 50		
Measuring system - electronic option		
30-WF6207	Linear displacement transducer, 10mm travel	1
28-WF6300	Pressure transducer 0-10 bar	3
28-WF6310	De-airing block	3
28-WF4410	Automatic volume change apparatus	1
30-WF6044	Transducer extension cable, 12 m	5
82-P9008/ELT	Set of four cables	2
30-WF6008	Geodatalog 8, data acquisition unit	1
30-WF6016/T13	Hydrocon SWCC Geo-Analysis Template	1
Alternative Pressure system for pressures up to 3500 kPa		
28-WF4312	Oil and water constant pressure system, 3500 kPa	1
28-WF4302/1	High viscosity oil, 5 kg	1
28-WF4191	Nylon tubing, OD 8 mm / ID 6 mm, 10 m coil	1
28-WF4050/1	Normal action coupling for fitting lines to cell	1
28-WF6302	Pressure transducer 0-35 bar	3

Continuous consolidation cell

Standards ASTM D4186

26-WF0360

Continuous consolidation cell (CRS)



Additional AUTOTRIAX 2 software for performing fully automatic CRS (constant rate of strain) tests is available on request. See section 29

main features

- > Continuous monitoring of test data (vertical load, pore pressure, vertical compression) and detailed plotting of the consolidation curve
- > Relatively short time to perform the test: less than half the time of an incremental loading consolidation test
- > More accurate and reliable evaluation of consolidation and compressibility parameters
- > Particularly suitable for cohesive saturated soils

Technical specifications

- Specimen size: 63.5 x 25.4 mm (diameter x height)
- Maximum working pressure: 800 kPa
- Maximum vertical load: 50 kN
- Overall dimensions: 240 x 410 mm (approx.) (diameter x height)
- Weight: 10 kg (approx.)

Accessories

See table for Configuration of a complete test system.



Typical Configuration of a complete system

Code	Description	Q.ty
26-WF0360	Continuous consolidation cell	1
26-WF0360/1	Cutting ring	1
28-WF0490	Nylon tubing, OD 6 mm / ID4 mm, 20 m coil	1
28-WF0490/1	Flaring tool	1
28-WF4330	Triaxial panel, two way	1
28-WF4330/2	Digital pressure gauge for 28-WF4330	1
28-WF4320	Bladder air/water interface	2
28-WF4320/1	Spare bladder for 28-WF4320	1
28-WF4005	Triaxial load frame, 50 kN capacity	1
30-WF4459	De-airing block	1
28-WF6301	Pressure transducer, 0-20 bar	1
30-WF6207	Linear transducer, 10 mm travel	1
30-WF0375/T	Load cell, 50 kN capacity	1
28-WF4220/A	De-airing tank, 7 l capacity	1
86-D2001	Vacuum pump	1
86-D2064	Rubber tubes	2
86-D2005	Air drying unit	1
86-D0819	Silica gel desiccator, 1 kg bottle	2
28-WF4225	Valve panel for de-airing tank	1
86-D2015	Laboratory air compressor	1
28-WF2016/2	Air filter for 86-D2015 air compressor	1
28-WF4191	Nylon tubing, OD 8 mm/ID 6 mm, 10 m	1
82-P9008/ELT	Set of four cables	1
30-WF6008	Geodatalog, 8-channels data acquisition unit	1
30-WF6016/T6	CRS Geo-Analysis template	1
30-WF6044	Transducer extension cable, 12 m	3

The purpose of the Constant Rate of Strain (CRS) oedometer test is to determine the magnitude and rate of consolidation of a soil restrained laterally, drained axially from the top and subjected to controlled-strain loading.

The 26-WF0360 continuous consolidation cell is used to perform this test, with other equipment such as a triaxial load frame, pressure system, data acquisition and processing components and other accessories required to complete the system. See configuration of a complete system.

The cell features a double chamber for two different and independent water pressure systems, with pore pressure measured at the base of the specimen by a pressure transducer and drainage connected to the top of the specimen.

Direct/residual shear testing machines

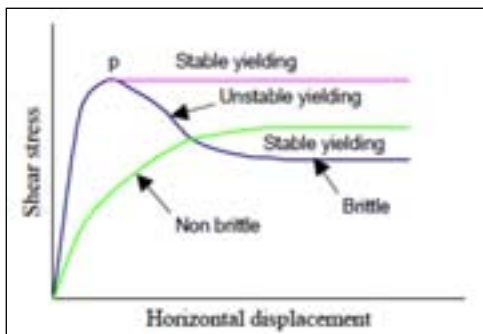
Standards

ASTM D3080 | AASHTO T236 | BS 1377:7 | NF P94 071-1/2 | CEN-ISO/TS 7982-10

If a failure occurs in the ground (for example for deep excavations performed without retaining structures), a slip circle surface is generally created within the soil. After a first immediate general failure, the soil will stabilize, since the soil can still offer a residual strength. Different laboratory testing methods have been developed and standardized:

Direct shear tests

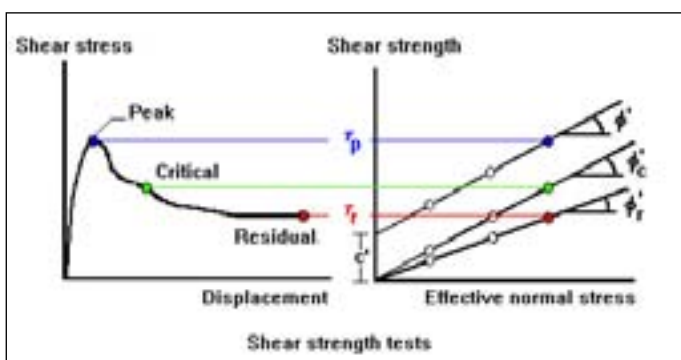
In the traditional direct shear test the soil specimen (either undisturbed, remoulded or compacted) is placed in a rigid metal box and subjected to a normal constant stress. The metal box consists of two halves that can slide horizontally each other and will apply an increasing horizontal force to the lower part of the specimen while the upper part is reacting against the shearing action. From the measurement of this shearing action the shear strength of the soil is calculated.



Direct/residual shear test with cycles

(forward & reverse)

The main limitation of the conventional shear box is that it is not possible to apply the shearing action for large displacement of the soil specimen by repeating several times the shearing action on the same surface of the specimen already subjected to the shearing action of the traditional direct shear test. This type of test is standardized as multi-reversal direct shear.



Both tests can be performed, at different level of automation, with all our Shear testing machines:

DIGISHEAR

27-WF2060 DIGISHEAR,
with digital control and display of speed (see page 54)

AUTOSHEAR

27-WF2160 AUTOSHEAR,
with digital speed control and data acquisition control system (see page 56)

SHEARMATIC

27-WF2180 SHEARMATIC,
digital automatic version with pneumatic automatic loading by a closed-loop control system (see page 58)

SHEARMATIC 300

27-WF2304 SHEARMATIC 300
digital automatic version 100 kN cap. with shear box assembly for 300 mm square samples. (see page 60)

Residual shear tests by the ring shear apparatus

Standards

ASTM D6467 | BS 1377:7

The ring shear apparatus, also known as Bromhead Apparatus, has been developed to overcome the main disadvantage of the multi-reversal shear test, where the shearing action is reversed, causing the continuous re-orientation of the soil particles.

In the ring shear apparatus the specimen is annular shaped and subjected to an unlimited rotational displacement from the lower part, while the upper part is reacting against a couple of load rings or load cells. The main advantages of this test is that large displacements make reliable the measurement of the residual strength of a soil specimen, where the area of contact on the shear plane is maintained constant. The disadvantage is that the specimen is tested only under remoulded conditions.

This test can be performed with the following machine:

TORSHEAR

27-WF2202 TORSHEAR
Bromhead ring shear apparatus. (see page 62)

DIGISHEAR**Direct/residual Shear Machine****Standards**

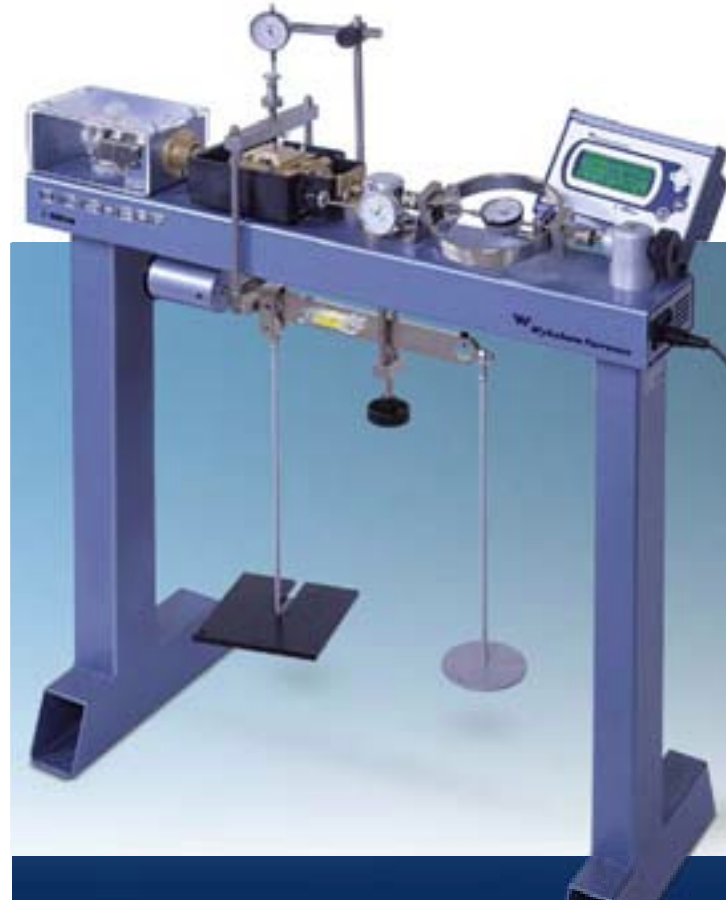
ASTM D3080 | AASHTO T236 | BS 1377:7 |
NF P094 071-1/2 | CEN-ISO/TS 7982-10

27-WF2060**DIGISHEAR, direct/residual shear machine**

Digital control and display of speed.
110-240 V, 50-60 Hz, 1 ph.

The DIGISHEAR machine, with digital control and display of speed, is driven by a high resolution stepper motor and worm reduction unit and can accommodate all standard-sized specimens up to 10 cm square and 10 cm diameter. Vertical load is applied directly to the specimen via a loading yoke and weight hanger, and can be increased by using the counterbalanced lever-arm loading hanger which amplifies the load by a factor of 10. The loading yoke can hold up to 50 kg of weights so that the total load on the specimen can reach 500 N, or 5000 N when the lever-arm hanger is used.

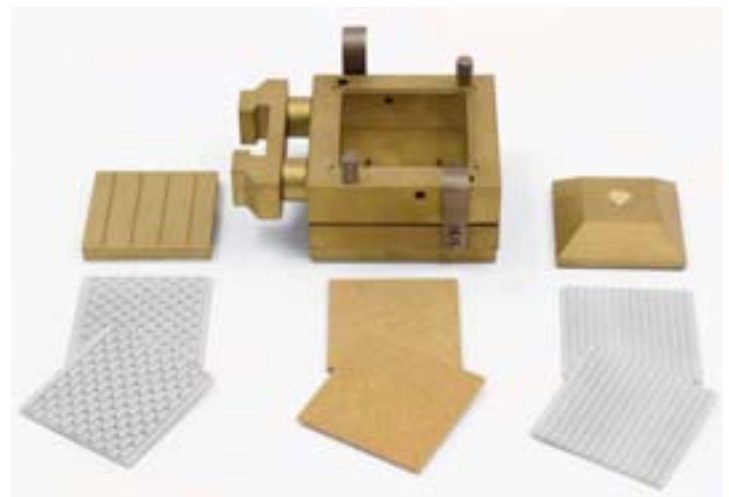
The machine is supplied without a shear box assembly, slotted steel weights and load/displacement measurement apparatus, which can be analogue (load ring and dial gauges), or electronic with data acquisition and processing (load cell, displacement transducers and data acquisition system). All these items have to be selected and ordered separately - see Accessories.

**main features**

- > Reversible stepping motor for residual strength testing
- > Infinitely variable speed drive from 0.00001 to 9.99999 mm/min
- > Compact ergonomic design
- > Safety device to prevent overload and overtravel
- > Can be fitted with mechanical (analogue) measuring equipment, or electronic with data acquisition and processing

Technical specifications

- Speed range: adjustable from 0.00001 to 9.99999 mm/min (preset via firmware)
- Maximum shear force: 5000 N
- Maximum vertical load: 500 N or 5000 N using 10:1 lever-arm device
- Speed drive ratio: stepper motor 1/10000 resolution
- Horizontal travel: preset via firmware up to 20 mm
- Displacement limits: controlled by optical safety switch
- Digital display: 4-row / 20-character LCD. Easy to operate with the membrane keyboard
- Specimen sizes: 60 and 100 mm square; 50, 60, 63.5 and 100 mm diameter
- Overall dimensions: 953 x 387 x 1180 mm (w x d x h)
- Weight: 120 kg (approx.)



Shear box

Accessories

Shear box assemblies

These shear box assemblies are designed to be used with our 27-WF2060 Digishear, 27-WF2160 Autoshear and 27-WF2180 Shearmatic shear testing machines.

The box is manufactured from brass and is designed to confine the specimen whilst permitting free drainage of the surrounding water. The complete assembly consists of a square box with a rigid-walled round or square hole, with a loading pad, base plate, 2 plain grid plates, 2 perforated grid plates and 2 porous plates.

Weight: from 2.5 to 4 kg (approx.)

27-WF0215/B

Shear box assembly for 60 mm square specimens.

27-WF0216/B

Shear box assembly for 100 mm square specimens.

27-WF0217/B

Shear box assembly for 50 mm diameter specimens.

27-WF0218/B

Shear box assembly for 60 mm diameter specimens.

27-WF0219/B

Shear box assembly for 63.5 mm diameter specimens.

27-WF0222/B

Shear box assembly for 100 mm diameter specimens.

Mechanical (analogue) measuring devices

27-WF1002/ST

Load ring, 2000 N capacity, with adapter, or, alternatively:



27-WF1002/ST
Load ring with adapter

Accessories for shear box assemblies

Box code, 27-	WF0215/B	WF0216/B	WF0217/B	WF0218/B	WF0219/B	WF0222/B
Sample cutter*	<u>WF0215/B7</u>	<u>WF0216/B7</u>	<u>WF0217/B7</u>	<u>WF0218/B7</u>	<u>WF0219/B7</u>	<u>WF0222/B7</u>
Extrusion dolly*	<u>WF0215/8</u>	<u>WF0216/8</u>	<u>WF0217/8</u>	<u>WF0218/8</u>	<u>WF0219/8</u>	<u>WF0222/8</u>

Spare parts for shear box assemblies

Box code, 27-	WF0215/B	WF0216/B	WF0217/B	WF0218/B	WF0219/B	WF0222/B
Loading pad	<u>WF0215/B2</u>	<u>WF0216/B2</u>	<u>WF0217/B2</u>	<u>WF0218/B2</u>	<u>WF0219/B2</u>	<u>WF0222/B2</u>
Base plate	<u>WF0215/B3</u>	<u>WF0216/B3</u>	<u>WF0217/B3</u>	<u>WF0218/B3</u>	<u>WF0219/B3</u>	<u>WF0222/B3</u>
Porous plate**	<u>WF0215/4</u>	<u>WF0216/4</u>	<u>WF0217/4</u>	<u>WF0218/4</u>	<u>WF0219/4</u>	<u>WF0222/4</u>
Plain grid plate**	<u>WF0215/B5</u>	<u>WF0216/B5</u>	<u>WF0217/B5</u>	<u>WF0218/B5</u>	<u>WF0219/B5</u>	<u>WF0222/B5</u>
Perforated grid plate**	<u>WF0215/B6</u>	<u>WF0216/B6</u>	<u>WF0217/B6</u>	<u>WF0218/B6</u>	<u>WF0219/B6</u>	<u>WF0222/B6</u>

* Not supplied with the shear box. They must be order separately.

** Two pieces are supplied with each shear box

27-WF1003/ST

Load ring, 5000 N capacity, with adapter.

30-WF6401

Dial gauge for measuring vertical deformation, 10 mm travel, 0.002 mm resolution.

30-WF6402

Dial gauge for measuring horizontal deformation, 30 mm travel, 0.01 mm resolution.

Electronic measuring devices

27-WF0377/ST

Load cell, 5 kN cap., complete with adapters

30-WF6207

Linear potentiometric transducer, 10 mm travel, for vertical deformation, complete with mounting block

30-WF6208

Linear potentiometric transducer, 25 mm travel, for horizontal displacement, complete with mounting block

Note: in case displacement transducers and load cell are supplied complete with data acquisition system, then a traceable calibration certificate is available on request.

Data acquisition and processing system

Note For more information on the Geodatalog, see page 108

30-WF6016/T2

Direct and residual shear Geo-Analysis template BS

30-WF6016/T9

Direct and residual shear Geo-Analysis template ASTM

Weight sets

27-WF0230/C3

Weight set, 37.5 kg in total, comprising: 2 x 0.25, 2 x 0.5, 2 x 1, 3 x 2, 3 x 4 and 2 x 8 kg weights.

27-WF0230/C4

Weight set, 34 kg in total, comprising: 2 x 1, 1 x 2 and 3 x 10 kg weights. (additional)

Single slotted weights

27-WF0270/A

Slotted steel weight, 0.25 kg ± 3 g.

27-WF0271/A

Slotted steel weight 0.5 kg ± 3 g.

27-WF0272/A

Slotted steel weight, 1 kg ± 5 g.

27-WF0273/A

Slotted steel weight, 2 kg ± 5 g.

27-WF0274/A

Slotted steel weight, 4 kg ± 5 g.

27-WF0275/A

Slotted steel weight, 8 kg ± 10 g.

27-WF0276/A

Slotted steel weight, 5 kg ± 5 g.

27-WF0277/A

Slotted steel weight, 10 kg ± 10 g.



Slotted steel weights

AUTOSHEAR

Direct/residual Shear Machine

**main features**

- > Microprocessor-controlled drive system
- > Large 240 x 128-pixel display
- > Test speed, direction and cycles (up to 10) programmable using the keyboard
- > Rapid approach and automatic positioning
- > Infinitely variable speed from 0.00001 to 11.00000 mm/min
- > Possibility to set different speed and direction (forward and reverse) in the residual shear test
- > Three analogue channels: one for load cell, and two for displacement transducers, 130,000-point resolution
- > Different protocols for downloading data to PC through RS-232 serial port
- > Standard load ring and dial gauges also compatible for manual recording

Standards

ASTM D3080 | AASHTO T236 | BS 1377:7 | NF P094 071-1/2 | CEN-ISO/TS 7982-10

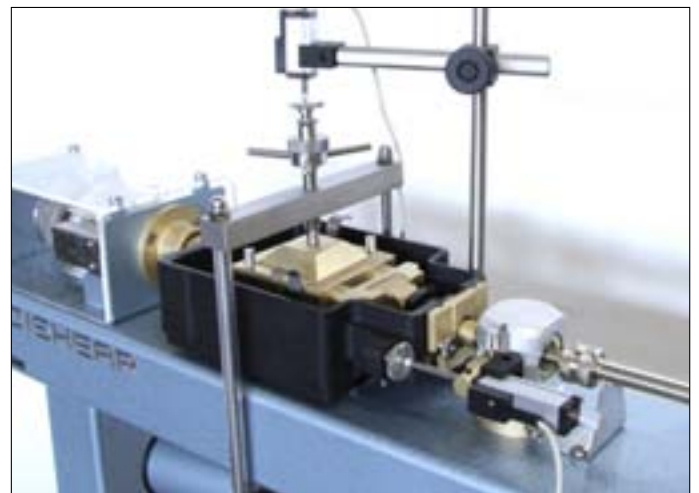
27-WF2160**AUTOSHEAR, direct/residual shear machine**

digital control of speed and data acquisition control system.

110-240 V, 50-60 Hz, 1 ph.

The AUTOSHEAR machine is controlled by a microprocessor system which reads and processes horizontal force and displacement readings and manages the motor and safety limits via a closed-loop control system. The unit provides the following important features:

- Automatic running of tests
- Closed-loop control of test speed
- Large, monochromatic, 240 x 128-pixel graphic display for viewing and recording data in real time
- Different calibration functions (linear and polynomial)
- Language selection
- Travel and cycles programmable using a 10 button membrane keyboard with 4 specific interactive icons
- Continuous monitoring and display of horizontal force, vertical and horizontal displacement
- Maximum horizontal displacement limit (20 mm) controlled by mechanical and optical safety switch
- Different recording modes, including linear, exponential (square root) and logarithmic
- High capacity data memory (up to 1000 lines of data)
- RAM memory with battery back-up with clock/calendar, operative even when the unit is switched off



Detail of shear box carriage made of high resistance techno-polymeric material

The design of the horizontal loading system provides rigid linear alignment of the loading ram, shear box and force measurement system, ensuring that the horizontal shearing force is transmitted along the shearing plane of the specimen.

Techno-polymeric material of excellent quality and high resistance has been used for the carriage of the shear box. It offers excellent resistance to corrosion and wear and tear, and it is resistant to all chemicals found in soil specimens. The carriage is lightweight and easy to clean.

The machine is supplied without load cell, transducers for horizontal and vertical displacement, shear box assembly and weights. All these items have to be ordered separately - see Accessories.

The machine can also be fitted with mechanical (analogue) measuring devices.

The microprocessor control system allows the machine to work as an automatic stand-alone unit: the test measurements (force and displacement) are directly displayed and stored in the unit memory according to pre-set recording modes. The PC is only required once the test is completed, to download the test data via the RS-232 port. The data can be processed using the Direct and residual shear Geo-Analysis templates - see Accessories.

Technical specifications

- Speed range: 0.00001 – 11.00000 mm (preset via firmware)
- Maximum shear force: 5000 N
- Maximum vertical load: 500 N or 5000 N using 10:1 lever-arm device
- Speed drive ratio: stepper motor 1/10000 resolution
- Horizontal travel: preset via firmware up to 20 mm
- Displacement limits: controlled by optical safety switch
- Maximum shear cycles: up to 10 (forward and reverse)
- Digital: large 240 x 128 pixel display
- Specimen sizes: 60 and 100 mm square; 50, 60, 63.5 and 100 mm diameter
- Overall dimensions: 953 x 387 x 1180 mm (w x d x h)
- Weight: 120 kg (approx.)

Accessories

Electronic measuring devices

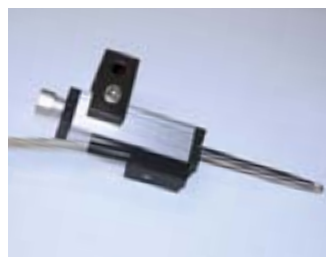
27-WF0377/ST

Load cell, 5 kN capacity, complete with adapters.



30-WF6207

Linear potentiometric transducer, 10 mm travel for vertical deformation, complete with mounting block.



30-WF6208

Linear potentiometric transducer, 25 mm travel for horizontal displacement, complete with mounting block.

Note: Traceable calibration certificate is available on request.

Data processing software

30-WF6016/T2

Direct and residual shear Geo-Analysis templates conforming to BS 1377:7.

30-WF6016/T9

Direct shear Geo-Analysis template conforming to ASTM D3080.

Shear box assemblies

For a general description and related accessories and spares, see page 55

Weight set

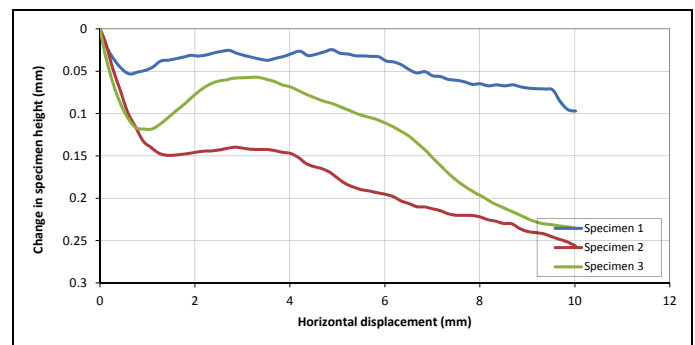
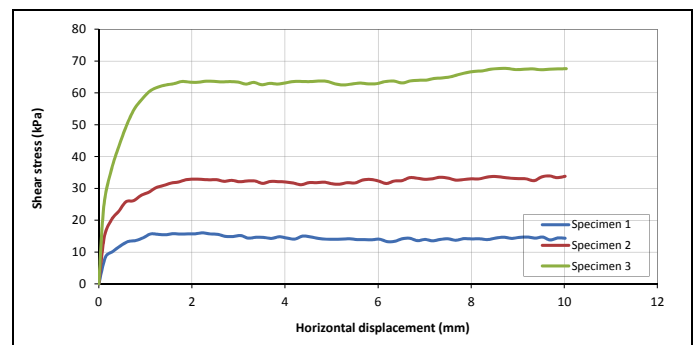
See page 55

Mechanical (analogue) measuring devices

See page 55

DETERMINATION OF SHEAR STRENGTH BY DIRECT SHEAR (in the small shearbox apparatus)
Set of single stage tests - tested in accordance with BS 1377:1990:Part 7: Clause 4 (procedure 4.5.4)
TEST REPORT - SHEARING

Project location	<i>EXAMPLE</i>		
Project reference	12345	Sample depth	0.50
Borehole number	BH1	Sample type	Compacted cohesionless
Sample number	2A	Specimen orientation	N/A



Tested	JKW	Checked	Approved
Date	30/01/2013	Date	Date

Example of a direct shear test processed with the 30-WF6016/T2 Geo-Analysis template (BS standard): the top plot shows shear stress versus horizontal displacement; the bottom plot shows change in specimen height versus horizontal displacement

SHEARMATIC

Direct/residual Shear Machine

**main features**

- > Automatic pneumatic application of pre-set consolidation steps (up to 50)
- > Automatic test management from consolidation to failure
- > No dead weights or lever-arm required
- > Infinitely variable speed from 0.00001 to 11.00000 mm/min
- > Linear connection between shear box, drive unit and load cell for transmission of the horizontal force along the shearing plane, instead of the classic "swan neck"
- > High-resistance techno-polymeric carriage
- > Possibility to set different speeds and travel (forward and reverse) in the residual shear tests
- > Each single step of vertical pressure can be applied instantaneously or by means of a linear ramp over a pre-set time interval

Standards

ASTM D3080 | AASHTO T236 | BS 1377:7 | NF P094 071-1/2 | CEN-ISO/TS 7982-10

27-WF2180**SHEARMATIC Automatic direct/residual shear machine**

with programmable pneumatic loading. 110-240 V, 50-60 Hz, 1 ph.

This microprocessor-based advanced model is a stand-alone machine, driven by a high-resolution stepper motor with epicyclical reduction gear with reduced backlash. A pneumatic closed-loop system with a high-performance pressure regulator is incorporated for the automatic application of vertical pressure, with the main advantage that manual loading of dead weights is eliminated.

Techno-polymeric material of high quality and resistance has been used for the carriage of the shear box. It offers excellent resistance to corrosion and wear and tear, and it is resistant to all chemicals found in soil specimens. The carriage is light-weight and easy to clean. The microprocessor system reads and processes the force, vertical pressure and displacement readings, and manages the motor, the pressure valve, the safety system and the test steps through the closed-loop system. It has a scratchproof membrane keyboard and a large monochromatic graphic display.

The machine is supplied complete with the following electronic transducers:

- ± 5 kN capacity load cell, bi-directional type (compression and tension), nominal sensitivity 2 mV/V, accuracy $\pm 0.03\%$
- 10 mm displacement transducer, 1 kOhm nominal resistance, $\pm 0.25\%$ linearity, 0.002 mm repeatability
- 25 mm displacement transducer, 1 kOhm nominal resistance, $\pm 0.25\%$ linearity, 0.002 mm repeatability
- 1000 kPa pressure transducer, 0.1 kPa accuracy, nominal sensitivity 2 mV/V

Note The Shear box assemblies have to be selected and ordered separately. The machine requires a compressed air supply of 10 bar maximum pressure. For a suitable air compressor, laboratory model, see Accessories.

The **Shearmatic** unit, along with the **ACE** Automatic oedometer and **Autotriax 2**, Automatic Triaxial test system, makes up a unique equipment for providing complete automation of a Consolidation, Shear and Triaxial Soil Mechanics laboratory.

The unit provides the following important features:

Automatic test termination:

- When a pre-set horizontal load or displacement is reached
- After a pre-set duration of the shear stage (from 1 minute to about 7 days)

Safety micro switch:

- Optical for zero and end of travel
- Mechanical for maximum horizontal displacement

Application of vertical load:

- Pneumatic piston with a high-resolution regulator, motor-driven via Automax electronic board with closed-loop control via a 10 bar pressure transducer

Input channels:

- One for a load cell transducer with 130,000-point resolution
- Two for potentiometric displacement transducers

3 calibration modes for transducers:

- 1st step linear
- 2nd degree polynomial
- Up to 10 steps linearization

Data recording:

- Consolidation stage: vertical pressure and displacement
- Shear stage: horizontal force and displacement; vertical pressure and displacement

Recording mode:

- Linear, exponential (square root) and logarithmic
- At pre-set intervals of recorded data

Recorded data capacity:

- 2000 lines of data

Blocks of memory:

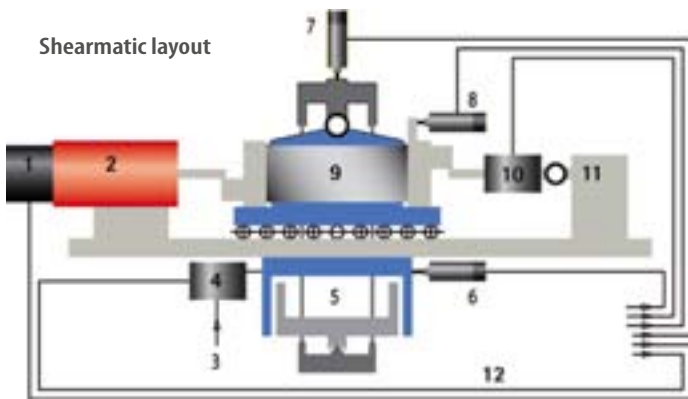
- Up to 25

Communication protocol:

- Selectable via RS-232 serial port:
- ASCII for use with Windows Hyper Terminal or CONTROLS for use with 82-Q0800/TRM



AUTOLAB



- | | |
|--|---------------------------------------|
| 1. Stepper motor | 7. Vertical displacement transducer |
| 2. Horizontal loading assembly | 8. Horizontal displacement transducer |
| 3. Compressed air supply | 9. Shear box |
| 4. Proportional valve to control the vertical load | 10. Load cell |
| 5. Vertical loading assembly | 11. Machine frame |
| 6. Vertical load air pressure transducer | 12. Control console |

Technical specifications

- Motor: high-accuracy stepper motor 1/10000 resolution
- Test speed: infinitely variable from 0.00001 to 11.00000 mm/min
- Maximum horizontal force: 5 kN
- Maximum vertical force: 8 kN = 800 kPa on a 100x100 mm square specimen
- Maximum shear cycles: 10 (forward and reverse)
- Maximum travel: 20 mm
- Maximum air pressure supply: 10 bar
- Maximum working air pressure: 8 bar
- RS-232 serial port
- Overall dimensions: 973 x 421 x 427 mm (wxdxh)
- Weight: 100 kg (approx.)

Accessories

Shear box assemblies
See page 55

Air compressors

86-D2015

Laboratory air compressor, 10 bar maximum pressure, 50 litre capacity, 230 V, 50 Hz, 1 ph.

86-D2015/Z

As above but 110 V, 60 Hz, 1 ph.

86-D2015/Y

As above but 220 V, 60 Hz, 1 ph.

28-WF2016/2

Air filter/water trap for air compressor.

Data processing software

30-WF6016/T2

Direct and residual shear Geo-Analysis templates conforming to BS 1377:7.

30-WF6016/T9

Direct shear Geo-Analysis template conforming to ASTM D3080.

Serial communication box

27-WF2180/LINK

4 channels serial communication box (4 input and 1 output) for the multi-connection of up to 4 shear testing machine to PC for data downloading.

Note: it's required when more than one unit are connected to a single PC

Example of a direct shear test processed with the 30-WF6016/T9 Geo-Analysis template (ASTM standard): the top plot shows the consolidation (vertical deformation versus time); the bottom plot shows the shearing (shear stress versus relative lateral displacement).

Set up of the consolidation steps

- Each row of this table represents a pressure step which is defined by:
- Initial pressure (set point) that is equal to the pressure of the previous step
 - Final pressure (target) will be reached automatically at a constant rate
 - Pre-set time to pass from initial to final pressure
- For example, rows 3 and 4 of this table mean that:
- The pressure will be increased instantaneously (time = 0) from 100 to 300 kPa
 - The pressure of 300 kPa will be maintained for the time of consolidation (in this case 500 minutes).

SET. PT	TARGET	TIME	EN
0000	0100	00000	Yes
0100	0100	01000	Yes
0100	0300	00000	Yes
0300	0300	05000	No
0000	0000	00000	No
0000	0300	00000	No
0300	0300	00000	No
0300	0300	00000	No

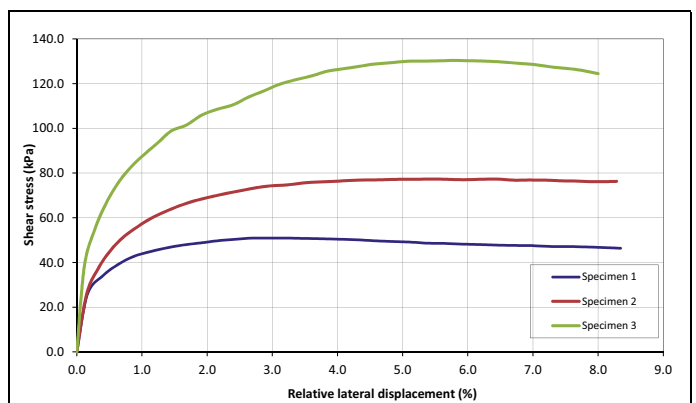
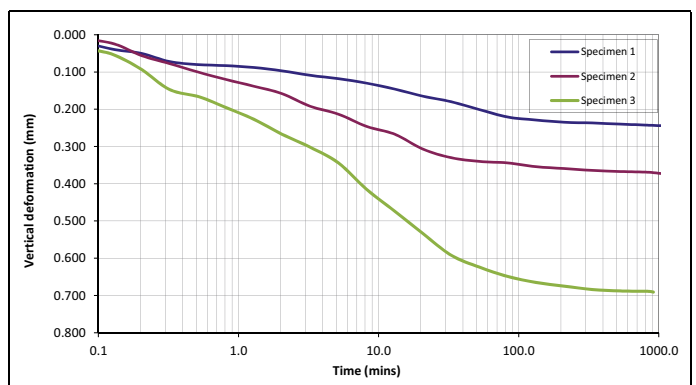
Direct shear test

- This screen shows the status of and information about the test, and displays real-time values of:
- Horizontal force
 - Vertical pressure (maintained constant)
 - Horizontal displacement
 - Vertical displacement

Test name	CONSOLID. + DIRECT
Load cell	[kN]: 0.00778
Pressure	[kPa]: 0001
Horiz. displac.	[mm]: 0.000
Vert. displac.	[mm]: 00.000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
Tested in accordance with ASTM Designation: D 3080
TEST REPORT

Project location	Specimen number
Project reference	Specimen depth (m)
Borehole number	



SHEARMATIC 300

Large Shear testing machine

AUTOLAB

**main features**

- > Ideal for testing shale, industrial slag, brick rubble, and colliery spoils
- > Sample size 150 and 300 mm square
- > 100 kN vertical pressure and horizontal force
- > Infinitely variable speed control from 0.00001 to 11.00000 mm/min
- > Automatic hydraulic application of pre-set consolidation steps (up to 50)
- > Automatic test management from consolidation to failure.
- > Linear connection between shear box, drive unit and load cell for transmission of the horizontal force along the shearing plane
- > Possibility to set different speeds and travel (forward and reverse) in the residual shear tests
- > Each single step of axial force can be applied instantaneously or by means of a linear ramp over a pre-set time interval

**Standards**

ASTM D3080 | AASHTO T236 | BS 1377:7 | NF P094 071-1/2 | CEN-ISO/TS 7982-10

27-WF2304**SHEARMATIC 300, large automatic shear box apparatus**

100 kN capacity, with shear box assembly for 300 mm square samples. 230 V, 50 Hz, 1 ph.

27-WF2304/Z

As above but 110 V, 60 Hz, 1 ph

The SHEARMATIC 300 automatic machine is ideal for soil and other materials that contain large particles of up to 20 mm largest dimension. Sample sizes up to 300 mm square can be tested, with inserts also allowing the testing of smaller sample sizes

Vertical pressure for consolidating the sample is applied and controlled by an automatically programmable closed-loop hydraulic system and horizontal deformation is driven by a high-resolution stepper motor. The machine is entirely managed by the software of a microprocessor unit that reads and processes the force, vertical pressure and displacement readings, and manages the motor, the vertical hydraulic loading system and the test steps, through closed-loop systems. The user interface is a ten-key scratchproof membrane keyboard with large monochromatic graphic display.

The machine works as an automatic stand-alone unit: the test measurements (horizontal and vertical force and displacement) are directly displayed and stored in the unit's memory according to the pre-set recording modes. The PC is only required once the test is completed, to download the test data via the RS-232 port. The data can be processed using the 30-WF6016/T2 or 30-WF6016/T9 Direct and residual shear Geo-Analysis templates - see Accessories.

By using a large sample it is possible to gain a more representative indication of shear strength. Furthermore, the large shear box can be used to obtain the angle of friction between many materials. Particular applications include the construction of earth dams and other embankment work.

The machine includes a shear box, one 100 kN load cell and two linear potentiometric transducers, 100 and 50 mm travel, with mounting brackets.

**Technical specifications**

- Sample size: up to 300 mm square. Can be reduced to 150 mm using 27-WF2304/1 150 mm sample insert. See Accessories.
- Shear and vertical force: 100 kN
- Speed range: infinitely variable from 0.00001 to 11.00000 mm/min
- Maximum travel: 75 mm
- Consolidation steps: up to 50
- Data acquisition: RS-232 serial port for use with Direct and residual Geo-Analysis templates (see Accessories).
- Power rating: 2000 W
- Overall dimensions: 1470 x 758 x 1570 mm approx. (w x d x h)
- Weight: 800 kg (approx.)

Accessories**27-WF2304/1**

150 mm square sample insert for 300 mm shearbox.

Data processing software**30-WF6016/T2**

Direct and residual shear Geo-Analysis templates conforming to BS 1377:7.

30-WF6016/T9

Direct shear Geo-Analysis template conforming to ASTM D3080.

Consolidation bench

27-WF0226

Consolidation bench for shear boxes

Where only one direct shear machine is available, this bench can be used to maintain constant loads on up to three shear box specimens, in order to reduce the testing time when more than one sample has to be tested.

It consists of a steel frame with three locating plates, three loading yokes and weight hangers, and three lever-arm loading hangers which can be used to extend the range of applied pressure by 10:1. The frame can hold up to 3 shear boxes and requires displacement transducers or dial gauges to measure the settlement and a set of weights to apply the load. It is suitable for all standard shear boxes, 27-WF0215/B to 27-WF0222/B (not included).



Technical specifications

- 3 loading yokes and hangers
- 3 lever-arm loading devices with a load amplification ratio of 10:1
- Holds up to 3 shear boxes
- Dimensions: 2310 x 500 x 1215 mm (w x d x h)
- Weight: 120 kg (approx.)

Accessories

Mechanical (analogue) measuring devices

30-WF6401

Dial gauge, 10 mm travel, 0.002 mm resolution:

Electronic measuring devices

30-WF6207

Linear potentiometric transducer, 10 mm travel.

Data acquisition and processing system

Note For more information on the Geodatalog and Geo-Analysis templates, see page 108

Weight sets/Slotted steel weights

See page 55

Laboratory Vane Apparatus

Standards

ASTM D4648 | BS 1377:7

27-WF1730

Laboratory vane apparatus

The laboratory vane apparatus is based on an original concept of the Transport and Road Research Laboratory of the United Kingdom. It can be used with a wide range of vane sizes, although as standard, it is sold with the 12.7 mm square vane and a set of four calibrated springs. The test can be performed directly on the sample or on a sample contained in a sampling tube. In this case the 27-WF1736 attachment for 38 and 100 mm diameter sampling tubes should be used - see Accessories.

- A motorizing unit is also available
- Weight: 11 kg (approx.)

Accessories

Alternative vanes

27-WF1732

Vane 25.4 x 25.4 mm.

27-WF1733

Vane 12.7 x 25.4 mm.

27-WF1734

Vane 12.7 x 19.0 mm.

Sampling tube holding attachment.

27-WF1736

Attachment to hold sample tubes of 38 and 100 mm diameter.



27-WF1736

Motorizing attachments

27-WF1730/2

Motorizing attachment to convert 27-WF1730 apparatus, including drive belt, pulley set and fixing studs. Testing speed 6 to 12°/min, conforming to BS 1377:7. 240 V, 50 Hz, 1 ph.

27-WF1730/2Y

As above but 220 V, 60 Hz, 1 ph.



main features

- > Manual or motorized versions available
- > Lightweight, compact and portable, ideal for site or main laboratory
- > Convenient and rapid method of determining shear strength of soft soils



27-WF1730/2

27-WF1730/3

Motorizing attachment to convert 27-WF1730 apparatus, including drive belt, pulley set and fixing studs. Testing speed 60 to 90°/min, conforming to ASTM D4648. 240 V, 50 Hz, 1 ph.

27-WF1730/3Y

As above but 220 V, 60 Hz, 1 ph.

27-WF1730/4

As above but 110 V, 60 Hz, 1 ph.

Spares

27-WF1731

Spare vane 12.7 x 12.7 mm.

27-WF1735

Spare set of four calibrated springs.

TORSHEAR**Ring Shear Apparatus****main features**

- > Microprocessor controlled drive system
- > Speed range adjustable from 0.001 to 180°/min
- > Rapid approach without any limit of rotation
- > Two measurement options: mechanical with load rings and dial gauge, and electronic with data acquisition, using load cells, displacement transducer and Geodatalog data acquisition system

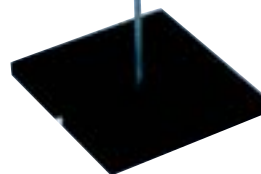
27-WF2202 with accessories
for electronic measurement option

Standards ASTM D6467 | BS 1377:7

27-WF2202

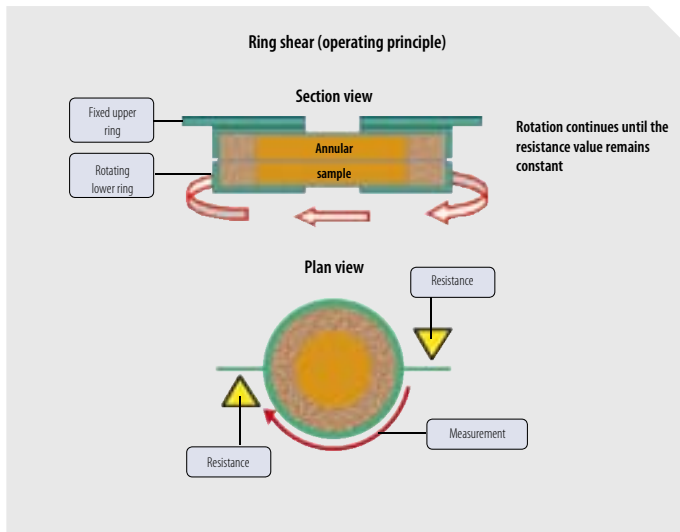
TORSHEAR, Bromhead ring shear apparatus.

110-240V, 50-60Hz, 1ph.

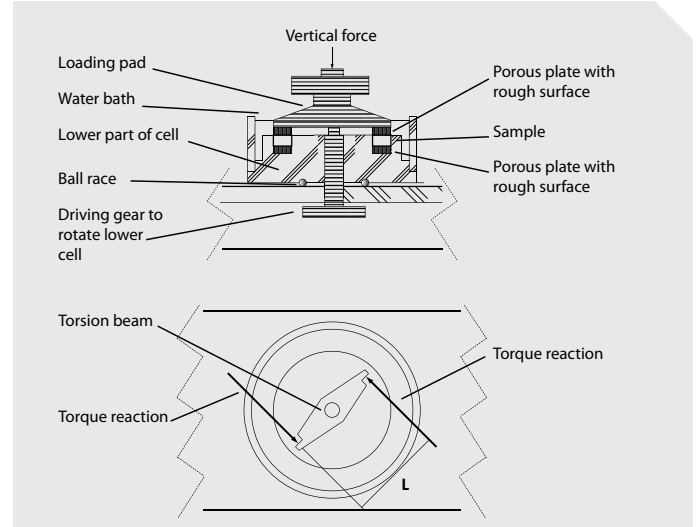


The TORSHEAR machine is dedicated to the determination of the residual shear strength. The residual shear strength of soils is sometimes also termed the ultimate shear strength. This is the strength of soil when it is sheared to large displacements, for example along the failure plane of a landslide or in a fault zone.

A remoulded specimen is used to determine the residual shear properties of the soil. A slip surface is formed in the test specimen as part of the test procedure. It can also be useful to know what sort of value the residual shear strength of an intact soil can have, because this (when taken in conjunction with the peak shear strength of the same soil) indicates its brittleness or susceptibility to progressive failure. Soils with high brittleness need to be used with caution, in engineering works such as embankments, or if they cannot be removed, for example in a natural slope. In the unfortunate event of a slope failure occurring, the general scale of displacement will depend on the magnitude of the brittleness.



Typical arrangement of ring shear apparatus



The TORSHEAR apparatus tests the residual shear strength of re-moulded soil samples. The main advantage of this method, when compared to using a shearbox apparatus, is that the shearing is continuous with a constant area. This method allows the field conditions to be recreated in the laboratory, giving very accurate residual shear strength values.



Detail of linear potentiometric transducer with mounting block

The sample is loaded vertically between two porous stones by a counterbalanced lever arm loading system with a ratio of 10:1. The base of the cell and lower platen are rotated by means of a variable speed motor, while rotation of the upper part of the cell is restrained by a pair of matching load rings or load cells which measure the torque transmitted to the sample.

The settlement of the upper platen during consolidation and shear can be monitored using a sensitive dial gauge or linear transducer mounted on the top of the loading yoke. A linear transducer and strain gauge load cells

can be connected to the GEODATALOG for data acquisition and processing See Accessories.

Using the waterproof membrane keyboard and the LCD 4-row / 20-character display, it is possible to set the speed in degrees/min and position the sample using the fast approach function. The test can be stopped using the keyboard or by setting a time or rotation limit.

Dial gauges or linear transducers, load rings or cells and weights are not included and have to be ordered separately - see Accessories.

Technical specifications

- Speed range: 0.001 to 180°/min
- Maximum shear stress: 500 kPa
- Maximum vertical stress: 1000 kPa (lever ratio 10:1)
- Specimen dimensions: area 40 cm² (internal diameter 70 mm, external diameter 100 mm), thickness 5 mm
- Power rating: 570 W
- Overall dimensions: 770 x 400 x 750 mm (excluding lever) (w x d x h)
- Weight: 72.5 kg (approx.)

Accessories

Electronic measuring devices

27-WF2202/3

Pair of load cells, 1 kN capacity, with adapters.

30-WF6207

Linear potentiometric transducer, 10 mm travel, complete with mounting block.

Note: in case displacement transducers and load cell are supplied complete with data acquisition system, then a traceable calibration certificate is available on request.

Data acquisition and processing system

Note For more information on the Geodatalog, see page 108

30-WF6016/T3

Ring shear Geo-Analysis template conforming to BS 1377:7.

30-WF6016/T16

Ring shear Geo-Analysis template conforming to ASTM 6467.

Mechanical (analogue) measuring devices

27-WF2202/1

Pair of matched load rings, 1 kN capacity.

30-WF6401

Dial gauge 10 mm travel, 0.002 mm resolution.

Weights for vertical load

27-WF2202/2

Set of slotted steel weights, total 50 kg.

Stand (optional)

27-WF2202/4

Metal stand for 27-WF2202 apparatus.

Spares

27-WF2202/5

Pair of porous stones.

Soil Mechanics

28 | Triaxial testing

29 | Automatic triaxial testing

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The triaxial tests are performed to determine the stress-strain relation of a soil specimen subjected to different strain levels and drainage conditions. We propose various models of triaxial load frames, triaxial cells and all related accessories. Section 29 concerns the AUTOTRIAX 2, Automatic triaxial system, the advanced apparatus to control up to six independent systems and the section 30 concerns the Data acquisition systems for geotechnical tests.

28 Triaxial testing

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29 AUTOTRIAX 2

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30 Data acquisition system

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Introduction

Investigation of stress-strain relationships in soil is usually carried out with triaxial tests where undisturbed, remoulded or compacted specimens are subjected to different stress level sand drainage conditions to simulate as closely as possible the different situations that can occur in the subsoil on site and the possible effects of construction, excavations, embankments, landslides, etc.

This section contains descriptions of different testing solutions and details of the equipment required to carry out the various types of triaxial test in manual, semi-automatic or automatic mode.

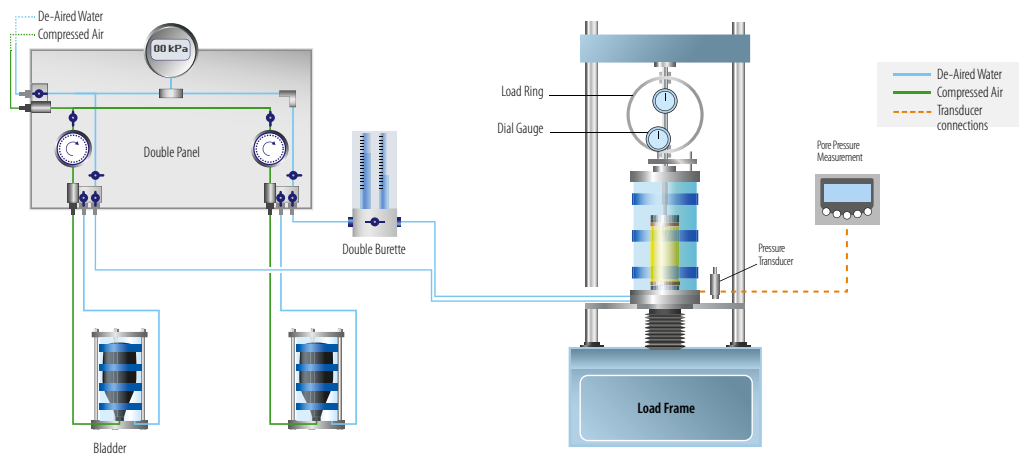
A summary table is presented below in order to help the user to select the right equipment, from basic manual systems up to fully automatic advanced solutions.

Test mode	Applications	Standards	Test equipment required
Manual with analogue measurement system	Total stress: UU (Unconsolidated Undrained) Effective stress: CU, CD (Consolidated Undrained, Consolidated Drained) Permeability	ASTM 2850 / 4767 / D7181 / D5084 BS 1377:6 / 7 / 8 CEN-ISO/TSI 17892-8 / 9 / 11 NF P94 070 /P94 074	<ul style="list-style-type: none"> • Triaxial load frame • Analogue measuring system:..... <ul style="list-style-type: none"> - Axial strain dial gauge - Load measuring ring - Pore water pressure - Double burette measuring volume change • Triaxial cell with accessories (standard or banded)..... • Pressure system..... • De-airing system • Geo-Analysis processing templates
Manual with electronic measurement system	As above plus: Unsaturated	ASTM 2850 / 4767 / D7181 / D5084 BS 1377:6 / 7 / 8 CEN-ISO/TSI 17892-8 / 9 / 11 NF P94 070 /P94 074	<ul style="list-style-type: none"> • Triaxial load frame • Electronic measuring system:..... <ul style="list-style-type: none"> - Displacement transducer - External / submersible load cell - Pore pressure transducer - Volume change device • Triaxial cell with accessories (standard, banded or double-wall unsaturated cell)..... • Pressure system..... • De-airing system • Data acquisition system • Geo-Analysis processing templates
Automatic (PC- controlled) with digital measurement system AUTOTRIAX-2	As above plus: Stress path	ASTM 2850 / 4767 / D7181 / D5084 BS 1377:6 / 7 / 8 CEN-ISO/TSI 17892-8 / 9 / 11 NF P94 070 /P94 074	<ul style="list-style-type: none"> • Triaxial load frame • Digital measuring system:..... <ul style="list-style-type: none"> - Displacement transducer - External / submersible load cell - Pore pressure transducer • Triaxial cell with accessories (standard, banded or double-wallunsaturated cell)..... • Pressure/volume controller..... • De-airing system • Data acquisition and control units..... • Triaxial test automatic controland processing software

Page

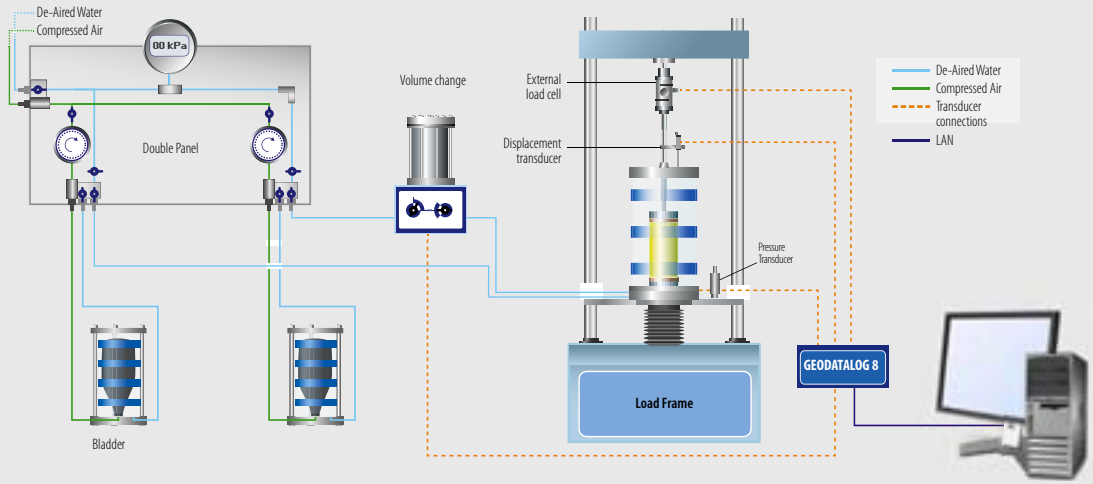
General system layout schematic

70
86



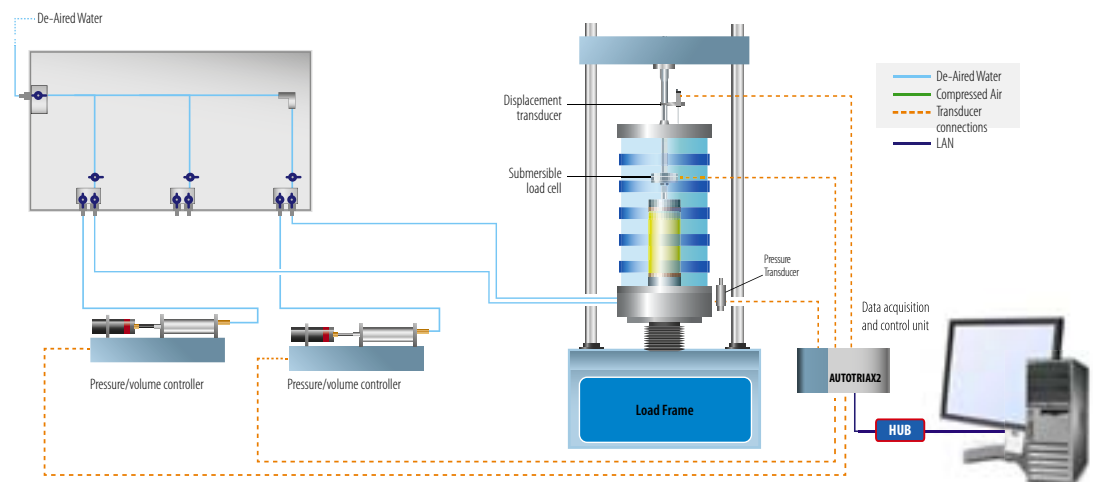
78/80
82
84
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78/80/84
82
84
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70
88



78/80/84
100
84
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102

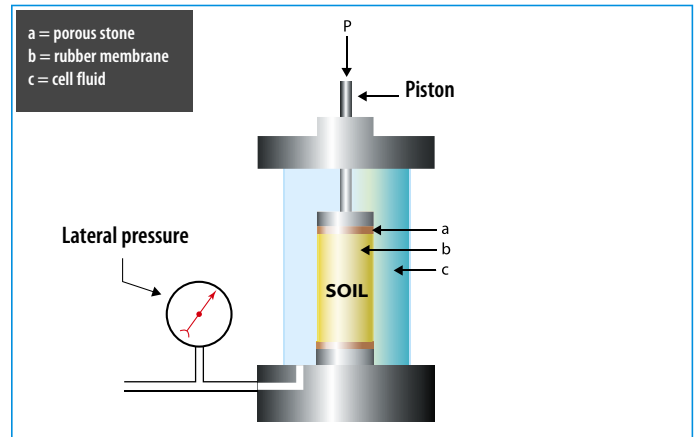
Types of triaxial test: test descriptions

Total stress - Unconsolidated Undrained (UU) test

ASTM D2850, BS 1377:7, CEN-150/TS17892-8, NF P94 070, NF P94 074

With this method the shear strength is measured in terms of total stress. The soil specimen is not allowed to consolidate and maintains its original structure and water content, so that its compressive strength depends only on the level of geostatic stress in the field.

Tests are often carried out on three specimens from the same sample, each subjected to a different confining pressure. Provided that the soil is fully saturated, the shear strength will be the same for each test and is known as "undrained shear strength".

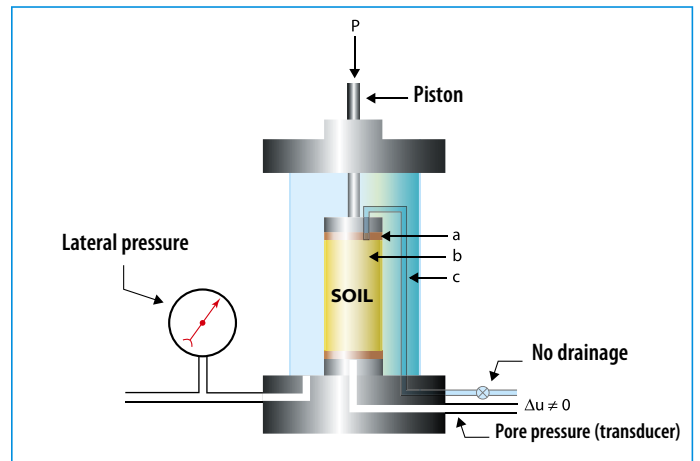


Effective stress - Consolidated Undrained (CU) test

ASTM D4767, BS 1377:8, CEN-150/TS17892-9, NF P94 070, NF P94 074

With this test method the shear strength is measured in terms of effective stress. The specimen is saturated and allowed to consolidate (i.e. to change its structure and water content) at the required confining pressure. At the end of consolidation, the specimen is subjected to a controlled application of load, during which no drainage is allowed and pore pressure is measured. The effective stresses are calculated as the difference between the total stress and the pore pressure.

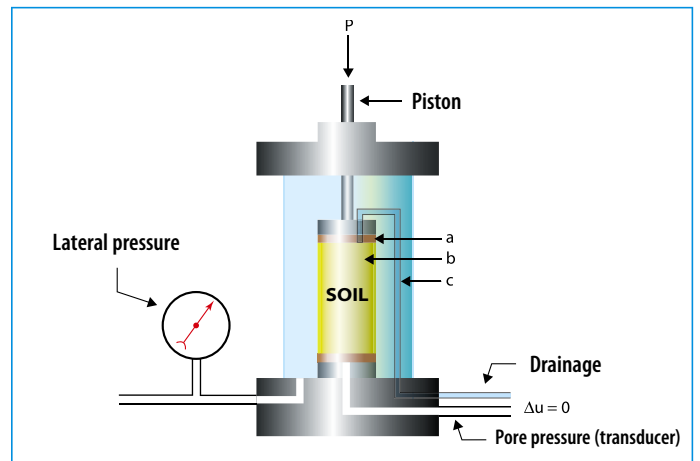
Since the shear strength is affected by the effective stresses, by testing a set of three specimens at different confining pressures, it is possible to define the failure envelope according to Coulomb's model and define the parameters c' and ϕ' .



Effective stress - Consolidated Drained (CD) test

ASTM D7181, BS 1377:8, CEN-150/TS17892-9, NF P94 070, NF P94 074

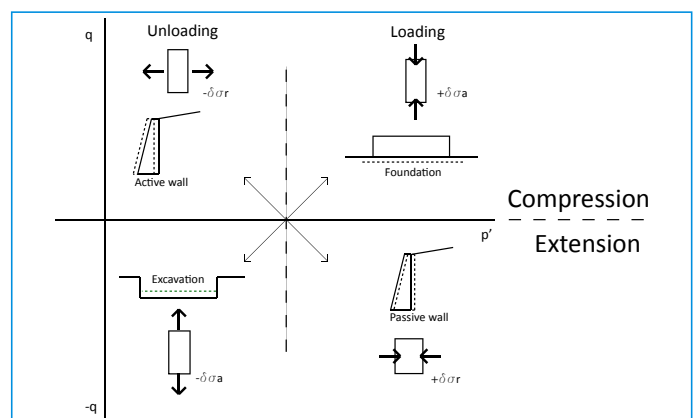
This test method is the same as the CU test except that the failure stage is carried out very slowly to prevent any change in the pore pressure inside the specimen, which is allowed to drain. Calculation of the total and effective stresses and failure envelope are also the same as for the CU.



Stress path test

Events on site such as excavation, construction or natural occurrences can produce changes in the magnitude and ratio of the principal stresses (major and minor). In a stress path test the horizontal and vertical pressures applied to the specimen are managed independently, which allows the behaviour of a soil subjected to anisotropic loading and unloading to be replicated and measured in the laboratory.

This test can only be accurately and reliably performed with an automatic servo-controlled closed-loop system.

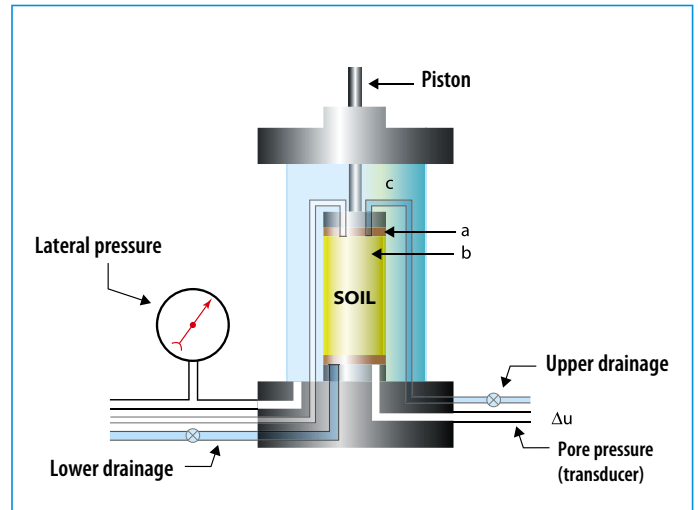


Permeability test in a triaxial cell

ASTM D5084, BS 1377:6,CEN-ISO/TS17892-11

The triaxial permeability test involves saturating and consolidating the specimen to the required effective stress in the same way as for a CD or CU test, but instead of a failure stage, water is allowed to flow through the specimen under a pre-defined difference of pressure and the rate of flow is measured. From this measurement the soil permeability is calculated.

Three independent pressure systems are used for the test; for the confining pressure, the drainage line to the top of the specimen and the drainage line to the base of the specimen.



Unsaturated soil test

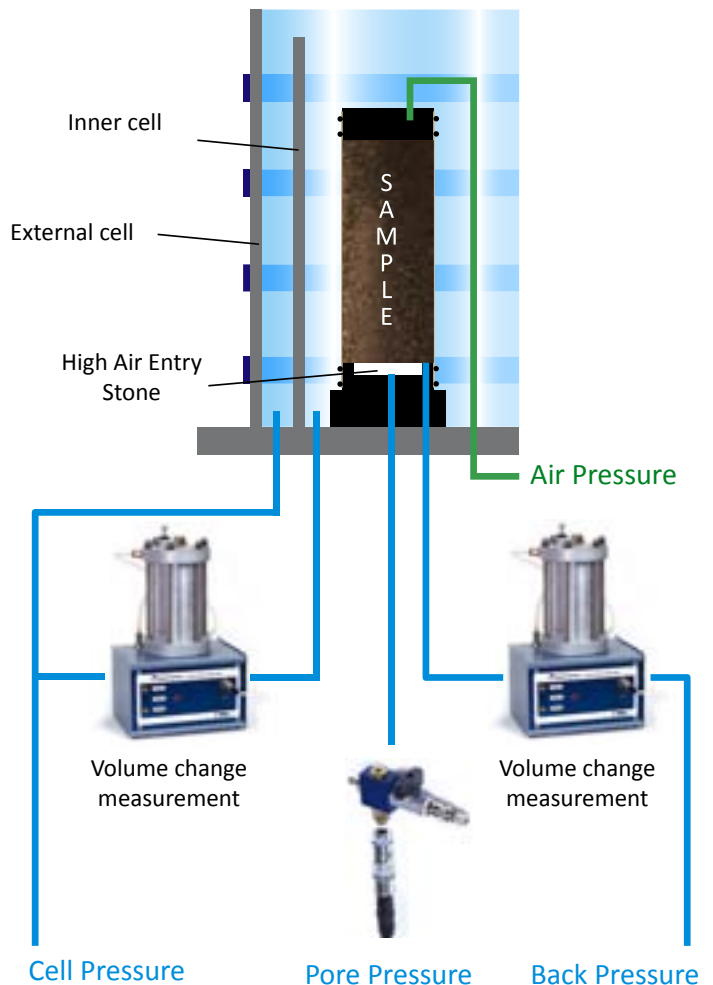
An unsaturated testing system is used when effective stress testing is required that recreates in-situ conditions of specimens that exist in a naturally unsaturated state (for example soil that is higher than the water table).

In an unsaturated soil, the voids between soil particles are filled with both air and water, and surface tension forces create a negative pore water pressure (or suction) which pulls the soil particles together and increases the strength of the soil. Saturating the soil (replacing the air in the voids with water) results in a positive pore water pressure which pushes the soil particles apart and reduces the overall strength. Because of this, it is not desirable to saturate unsaturated or partially saturated material, but neither can it be tested using conventional triaxial systems because the negative suction causes problems with the equipment.

The solution to this problem is to use what is known as the axis translation method, which involves applying an air pressure via the top cap (in the same way as a water back pressure in a saturated test). This raises the pressure inside the sample to a positive value which, in turn, applies a positive pressure to the porous stone and to the pore water pressure transducer.

A special triaxial cell is used for the test, with a double wall which allows the total change in sample volume to be measured, and a high air entry stone in the base pedestal that allows water to pass but not air.

Using the axis translation method with the double-wall cell allows effective stress testing to be carried out on unsaturated material.



TRITECH

Triaxial load frames



28-WF4005



28-WF4010

common main features

28-WF4005, 28-WF4005/4C, 28-WF4010 and 28-WF4010/4C

- > Designed for soil testing laboratories to perform UU, CU, CD and stress path* (compression/extension) tests
- > Suitable for automatic PC-controlled triaxial testing (see AUTORIAX 2 system)*
- > Allows dynamic tests to be performed when fitted with a suitable actuator (see Dynatriax system)*
- > Maximum compression capacity: 50 kN or 100 kN
- > Speed range from 0.00001 to 99.99999 mm/min
- > Maximum sample diameter (for triaxial testing): 150 mm
- > The quality of the design avoids vibrations that may affect the specimen or measurements accuracy
- > Ideal solution for advanced and research laboratories that require high productivity and high quality testing
- > High-contrast 4 x 20-character display with 6-key membrane keyboard*
- > Very wide variable speed range suitable to perform also unconfined, CBR and Marshall tests

* Only for model without built in data acquisition

Standards

BS 598 | BS 1377: 4 | BS 1377:7 | BS 1377:8 | ASTM D1559 | ASTM D1883 | ASTM D2166 | ASTM D2850 | ASTM D4767 | ASTM D5581 | ASTM D6927 | ASTM D7181 | NF P94 070 | NF P94 074 | NF P94-078 | NF P98-251 | CEN- ISO/TS 17892-9 | CEN- ISO/TS 17892-8 | EN 12697-34 | EN 13286-47

WYKEHAM FARRANCE's electro-mechanical TRITECH machines are the original high-performance load frames for triaxial tests. Introduced by the company over 50 years ago, they have undergone continuous development and are the ideal solution for advanced and research laboratories that want to perform high quality tests at high levels of productivity. Based on heavy duty triaxial load frames, with advanced electronics and high quality components, these frames are the top of the range currently available for triaxial testing on soils. The load frames are built around a robust twin chromed-column structure, ensuring extremely high rigidity. The loading platen is made from stainless steel.

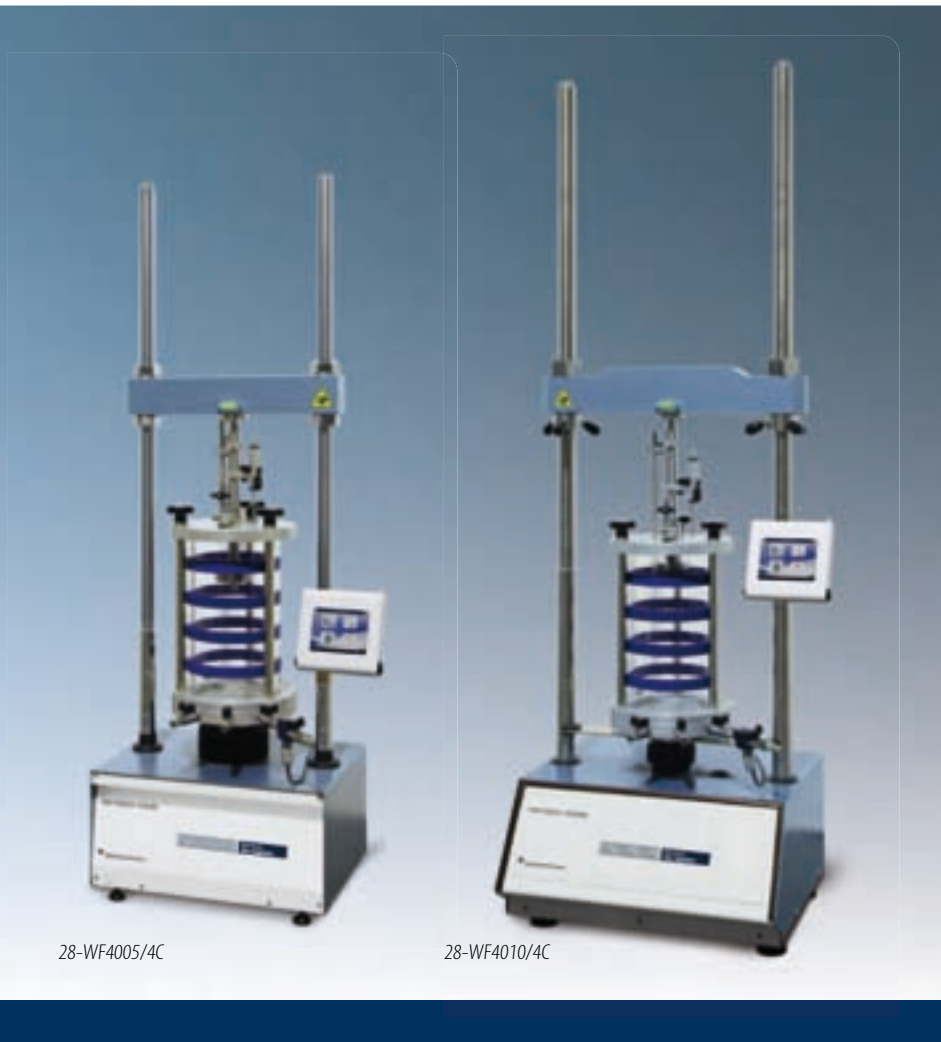
Four models are available depending on the max capacity and if equipped or not with a built-in data acquisition.

28-WF4005 and 28-WF4010, 50 and 100 kN cap.

The models 28-WF4005 - 50 kN capacity and 28-WF4010 - 100 kN capacity can be used either as parts of a computer-controlled automatic testing system or as high-performance units under manual control with an external data acquisition. In manual mode the user-friendly keyboard on the front panel allows to manage all the frame's functions, including rapid approach facility that reduces test set-up time. For efficient use the last settings are stored and automatically recalled after switch on and micro switches prevent over-travel problems.

In the Automatic PC-controlled triaxial systems the frame is driv-

en through the RS 232 serial port, in order to operate under load or displacement closed loop control. These two models can also be equipped with a pneumatic actuator to perform both static and dynamic testing.



28-WF4005/4C

28-WF4010/4C

additional features

28-WF4005/4C and 28-WF4010/4C

(models with 4 built-in channels data acquisition)

- > Data acquisition by 4 in-built channels
- > Double control mode including machine and data acquisition via local touch screen display or from remote PC (not included) and software (included)
- > USB port to connect a memory stick (included with the machine) for test data storage
- > Effective sampling rate up to 50 / sec
- > LAN communication
- > Automatic test start and stop according preset conditions
- > Wide 5.7" waterproof touch screen color graphic display allowing machine control, live on screen data plot and tabulation
- > Local and remote transducers calibration through the dedicated software
- > Graphical and Numerical display of readings.

**28-WF4005/4C,
28-WF4010/4C,
50 and 100 kN cap.,
4 channels built-in data
acquisition.**

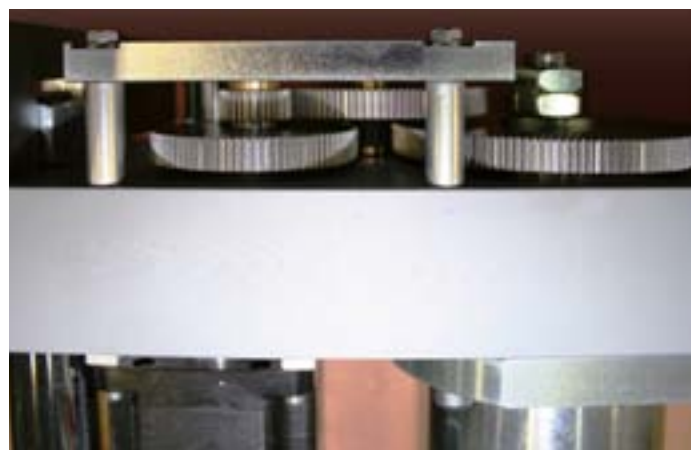
The models 28-WF 4005/4C – 50 kN capacity and 28-WF4010/4C – 100 kN capacity are fitted with 4 built-in channels and data acquisition, to be used either in stand-alone mode or connected to a PC. These load frames are equipped with a wide user friendly touch screen display, side mounted and very ergonomic allowing local control of the main functions and data acquisition.

In each model the panel and display are protected from water and dust by a waterproof membrane.

The touch screen display is extremely versatile to start, pause and stop the test, to set up data recording mode, to show live readings of the transducers in real time and to perform calibrations.

In addition a LAN connection and a dedicated software (included with the machine) allows remote control from the PC.

In remote control mode the software allows the user to control the main functions via PC as well as to calibrate the channels with linear, polynomial and multi-coefficient calibration mode, and to display the readings (figures and plots).



Detail of the Trittech legendary gearbox. The system is designed to minimize the vibration and allow smooth transmission

TRITECH

Triaxial load frames (continued)

Models	28-WF4005	28-WF4010	28-WF4005/4C	28-WF4010/4C
4 built-in channels	-	-	✓	✓
Maximum sample diameter, mm	150	150	150	150
Minimum testing speed, mm/min	0.00001	0.00001	0.00001	0.00001
Maximum testing speed, mm/min	99.99999	99.99999	99.99999	99.99999
Maximum compression force, kN	50	100	50	100
Maximum tensile force, kN	5	5	5	5
Minimum vertical clearance, mm	335	390	335	390
Maximum vertical clearance, mm	1100	1140	1100	1140
Horizontal clearance, mm	364	498	364	498
Platen diameter, mm	158	158	158	158
Platen travel, mm	100	100	100	100
Dimensions, mm (h x w x d) (approx.)	1460 x 505 x 380	1830 x 600 x 520	1460 x 655 x 380	1830 x 750 x 520
Power, W	600	680	600	680
Weight, kg (approx.)	98	120	98	120



Detail of the adjustable 5.7" touchscreen color graphic display

Ordering information

28-WF4005

TRITECH50, Triaxial load frame 50 kN, 220-110 V / 50-60 Hz / 1 ph

28-WF4010

TRITECH100, Triaxial load frame 100 kN, 220-110 V / 50-60 Hz / 1 ph

28-WF4005/4C

TRITECH50 – 4 channels, Triaxial load frame 50 kN with 4 built-in data acquisition channels, 220-110 V / 50-60 Hz / 1 ph

28-WF4010/4C

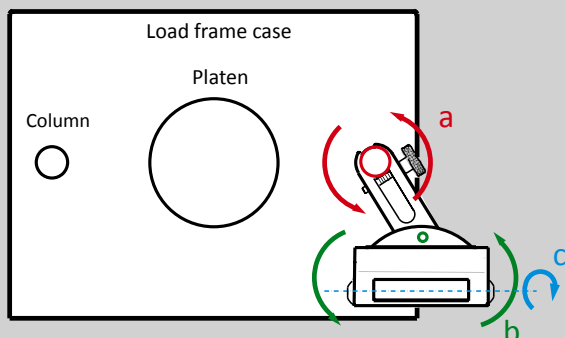
TRITECH100 – 4 channels, Triaxial load frame 100 kN with 4 built-in data acquisition channels, 220-110 V / 50-60 Hz / 1 ph

Accessories

A complete range of parts and accessories is available from WYKHAM FARRANCE to configure these machines for any typical triaxial soil testing application.

Triaxial cells	see page 75, 78
Measurement instruments	see page 86, 88
Pressure systems	see page 82
Water de-airing system	see page 84
Data acquisition and processing	see pag 108

Note: see our web site for the list of accessories to perform CBR, Marshall and Unconfined tests with TRITECH



The touchscreen controller is mounted on an ergonomic, multi-jointed support that allows its position to be adjusted in four different ways:

- changing the height of the support
- rotating the support (a)
- swiveling the touchscreen (b)
- tilting the touchscreen (c)

TRIAX

Triaxial Load frames



28-WF4001

28-WF4001/4C

Standards

BS 598 | BS 1377: 4 | BS 1377:7 | BS 1377:8 | ASTM D1559 | ASTM D1883 | ASTM D2166 | ASTM D2850 | ASTM D4767 | ASTM D5581 | ASTM D6927 | ASTM D7181 | NF P94 070 | NF P94 074 | NF P94-078 | NF P98-251 | CEN- ISO/TS 17892-9 | CEN- ISO/TS 17892-8 | EN 12697-34 | EN 13286-47

WYKEHAM FARRANCE's electro-mechanical TRIAX machines have been specifically designed for triaxial applications and are ideal for commercial laboratories that need a versatile machine capable of performing a wide range of tests. The load frame is built around a robust twin chromed-column structure, ensuring extremely high rigidity up to 50 kN.

Two versions are available: both 50 kN capacity, with or without built-in data acquisition:

28-WF4001

The model 28-WF4001 requires an external data acquisition unit or can be fitted with analogical measurement system.

In manual mode, the user-friendly keyboard on the front

panel allows to manage all the frame's functions, including rapid approach facility that reduces test set-up time. For efficient use the last settings are stored and automatically recalled after switch on and micro switches prevent over-travel problems

28-WF4001/4C

The model 28-WF4001/4C is fitted with 4 built-in channels and data acquisition, to be used either in stand-alone mode or connected to a PC.

This load frame is equipped with a wide user friendly touch screen display, side mounted and very ergonomic allowing local control of the main func-

tions and data acquisition.

The panel and display are protected from water and dust by a waterproof membrane. The touch screen display is identical to that one fitted to the 28-WF4005/4C model.

common main features

28-WF 4001 and 28-WF4001/4C models

- > Designed for soil testing laboratories to perform UU, CU and CD triaxial tests on samples from 38 to 70 mm dia.
- > Also suitable for a wide range of other tests such as unconfined, CBR and Marshall tests
- > Maximum load frame capacity: 50 kN
- > Speed range from 0.00001 to 50.8 mm/min
- > Large High-contrast 4 x 20-character display and 6-keys membrane keyboard*
- > Maximum sample diameter (for triaxial testing): 70 mm
- > Ideal solution for small laboratories that need a very versatile machine suitable to perform a wide range of tests

** Only for model without built in data acquisition*

additional features

28-WF4001/4C

(model with 4 built-in channels data acquisition)

- > Double control mode including machine and data acquisition via local touch screen display or from remote PC (not included) and software (included)
- > USB port to connect a memory stick (included with the machine) for test data storage
- > Effective sampling rate up to 50 / sec
- > LAN communication
- > Automatic test start and stop according preset conditions
- > Wide 5.7" waterproof touch screen color graphic display allowing machine control, live on screen data plot and tabulation
- > Local and remote transducers calibration through the dedicated software
- > Graphical and Numerical display of readings.

TRIAx

Triaxial Load frames (continued)

Model	28-WF4001	28-WF4001/4C
4 built-in channels		✓
Maximum sample diameter, mm	70	70
Minimum testing speed, mm/min	0.00001	0.00001
Maximum testing speed, mm/min	50.8	50.8
Maximum load frame capacity, kN	50	50
Minimum vertical clearance, mm	390	390
Maximum vertical clearance, mm	725	725
Horizontal clearance, mm	380	380
Platen diameter, mm	158	158
Platen travel, mm	100	100
Dimensions, mm (h x w x d) (approx.)	1250 x 495 x 495	1250 x 645 x 495
Power, W	600	600
Weight, kg (approx.)	90	90



Ordering information

28-WF4001

TRIAx, Triaxial load frame 50 kN, 220-110 V / 50-60 Hz / 1 ph

28-WF4001/4C

TRIAx – 4 channels, Triaxial load frame 50 kN, 220-110 V / 50-60 Hz / 1 ph

Accessories

A complete range of parts and accessories is available from WYKEHAM FARRANCE to configure these machines for any typical triaxial soil testing application.

Triaxial cells	see page 75, 78
Measurement instruments	see page 86, 88
Pressure system	see page 82
Water de-airing systems	see page 84
Data acquisition and processing	see page 108

Note: see our web site for the list of accessories to perform CBR, Marshall and Unconfined tests with TRIAX

Banded triaxial cells and accessories

Standards

ASTM D2850 | ASTM D4767 | ASTM 7181 | BS 1377:8 | BS 1377:9 | CEN-ISO/TS 17892-8-9 | NF P94 070 | NF P94 074

The cell essentially consists of a transparent chamber which is banded to prevent excessive expansion during the test.

The design of the cell ensures vertical alignment of the loading ram by clamping the Perspex wall separately from the cell top.

The cell has to be completed with a pedestal, top cap (standard or vacuum) and other accessories conforming to the specimen size. The cells can be fitted not only with accessories of the nominal size, but also with those of smaller sizes (e.g. the 28-WF4070 70 mm cell can be adapted to test specimens with diameters of 38 and 50 mm). 28-WF4070 to 28-WF4150 cells can be fitted with an upgrading kit so that tests can be performed using local strain transducers and bender elements.

See Upgrading options.

- Maximum working pressure of 2000 kPa or 3500 kPa (28-WF4070 model only)
- Separate cell chamber clamping prevents over stressing chamber and ensures correct alignment
- Light alloy construction with stainless steel ram and O-ring seal
- Built-in ram clamp
- Includes rod and rest for strain dial gauge or displacement transducer
- Five on/off no-volume-change valves fitted as standard
- For samples with diameters of 38, 50, 70, 100 and 150 mm
- Chamber height is suitable for submersible load cells
- Rapid assembly design
- Designed to accommodate a specimen with a height twice its diameter
- Models 28-WF4070, 28-WF4100 and 28-WF4150 can be used to perform stress path and dynamic testing, using a vacuum attachment with the appropriate pedestal and top cap
- Models 28-WF4070, 28-WF4100 and 28-WF4150 can be upgraded with an advanced kit to make them compatible with local strain transducers and bender elements

Specifications

Product code 28-	WF4050	WF4070	WF4100	WF4150
Nominal sample diameter, mm	50	70	100	150
Sample diameter range, mm	38 to 50	38 to 70	38 to 100	38 to 150
Maximum working pressure, kPa	2000	3500	2000	2000
Maximum cell height, mm	410	550	600	710
Cell diameter, mm (inc. valves)	350	400	440	520
Weight, kg (approx.)	7	18	21	40
No. of inlet points	5 (for top drainage/back pressure, cell pressure and base drainage/pore pressure)			
Attachment for vacuum top cap for extension tests	—	✓	✓	✓
Upgrading option for use of local strain transducers and bender elements	—	✓ 28-WF 4070/ADV	✓ 28-WF 4100/ADV	✓ 28-WF 4150/ADV
Effective stress/Total stress testing	✓	✓	✓	✓
Stress path testing	—	✓	✓	✓
Dynamic testing	—	✓	✓	✓

Ordering information

28-WF4050

Banded triaxial cell for samples up to 50 mm diameter.

28-WF4070

Banded triaxial cell for samples up to 70 mm diameter.

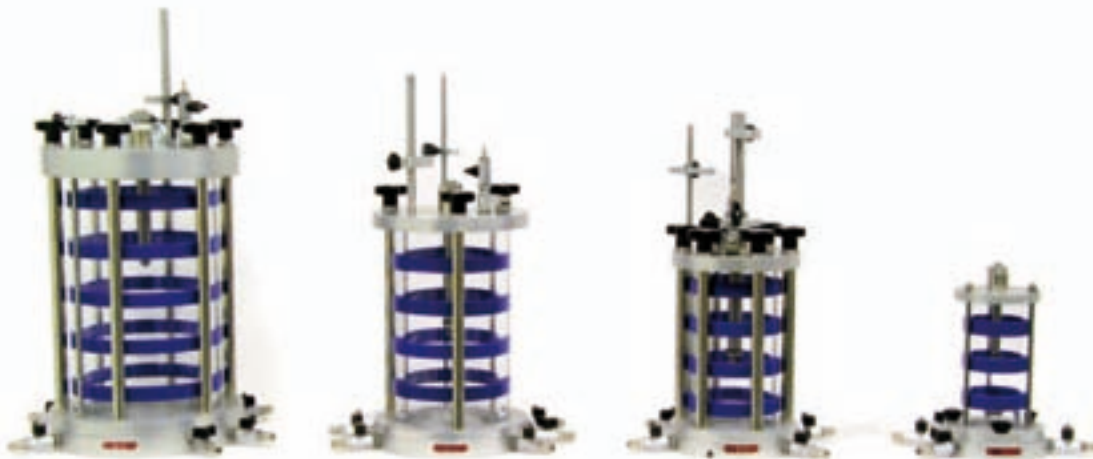
28-WF4100

Banded triaxial cell for samples up to 100 mm diameter.

28-WF4150

Banded triaxial cell for samples up to 150 mm diameter.

Note: Pedestals, top caps, porous discs, rubber membranes, O-rings etc. are not included - see Accessories



28-WF4150, 28-WF4100, 28-WF4070 and 28-WF4050

Accessories

Triaxial cell pedestals

Each cell has to be fitted with a pedestal corresponding to the size of the specimens to be tested. Using specific adaptive pedestals it is possible to test specimens with different diameters in the same triaxial cell - see the table below.

Diameter, mm	Banded triaxial cell product code			
	28-WF4050	28-WF4070	28-WF4100	28-WF4150
38	<u>28-WF4031/5</u>	<u>28-WF4031/7</u>	<u>28-WF4031/10</u>	<u>28-WF4031/15</u>
50	<u>28-WF4051/5</u>	<u>28-WF4051/7</u>	<u>28-WF4051/10</u>	<u>28-WF4051/15</u>
70	-	<u>28-WF4071/7</u>	<u>28-WF4071/10</u>	<u>28-WF4071/15</u>
100	-	-	<u>28-WF4101/10</u>	<u>28-WF4101/15</u>
150	-	-	-	<u>28-WF4151/15</u>



Triaxial cell and sample accessories

Diameter, mm	38	50	70	100	150
Top cap	<u>28-WF4032/A</u>	<u>28-WF4052/A</u>	<u>28-WF4072/A</u>	<u>28-WF4102/A</u>	<u>28-WF4152/A</u>
Vacuum top cap	<u>28-WF4032/AV</u>	<u>28-WF4052/AV</u>	<u>28-WF4072/AV</u>	<u>28-WF4102/AV</u>	<u>28-WF4152/AV</u>
Base disc	<u>28-WF4033</u>	<u>28-WF4053</u>	<u>28-WF4073</u>	<u>28-WF4103</u>	<u>28-WF4153</u>
Porous discs (2)	<u>28-WF4034</u>	<u>28-WF4054</u>	<u>28-WF4074</u>	<u>28-WF4104</u>	<u>28-WF4154</u>
Membranes (pack of 10)	<u>28-WF4035</u>	<u>28-WF4055</u>	<u>28-WF4075</u>	<u>28-WF4105</u>	<u>28-WF4155</u>
O-rings (pack of 10)	<u>28-WF4036</u>	<u>28-WF4056</u>	<u>28-WF4076</u>	<u>28-WF4106</u>	<u>28-WF4156</u>
Membrane stretcher	<u>28-WF4031/A</u>	<u>28-WF4051/A</u>	<u>28-WF4071/A</u>	<u>28-WF4101/A</u>	<u>28-WF4151/A</u>
O-ring placing tool	<u>28-WF4031/B</u>	<u>28-WF4051/B</u>	<u>28-WF4071/B</u>	<u>28-WF4101/B</u>	<u>28-WF4151/B</u>
Two-part split former	<u>28-WF4031/C</u>	<u>28-WF4051/C</u>	<u>28-WF4071/C</u>	<u>28-WF4101/C</u>	<u>28-WF4151/C</u>
Two-part split mould	<u>28-WF4031/D</u>	<u>28-WF4051/D</u>	<u>28-WF4071/D</u>	<u>28-WF4101/D</u>	<u>28-WF4151/D</u>
Lateral filter drains (pack of 50)	<u>28-WF4031/E</u>	<u>28-WF4051/E</u>	<u>28-WF4071/E</u>	<u>28-WF4101/E</u>	<u>28-WF4151/E</u>
Filter discs(pack of 100)	<u>28-WF4031/F</u>	<u>28-WF4051/F</u>	<u>28-WF4071/F</u>	<u>28-WF4101/F</u>	<u>28-WF4151/F</u>
Hand sampler	<u>28-WF4031/G</u>	<u>28-WF4051/G</u>	<u>28-WF4071/G</u>	<u>28-WF4101/G</u>	-
Two-part split former with vacuum attachment	<u>28-WF4031/H</u>	<u>28-WF4051/H</u>	<u>28-WF4071/H</u>	<u>28-WF4101/H</u>	<u>28-WF4151/H</u>

28-WF4005/E

Extension test accessory for connecting the load cell ram to the cross bar of the load frame. This accessory must be used with a submersible load cell and a vacuum top cap.



Pedestals 28-WF4071/7, 28-WF4051/7 and 28-WF4031/7

Triaxial cell and sample preparation accessories



Two-part split mould with vacuum attachment
28-WF4101/H



Upgrading kits 28-WF4150/ADV, 28-WF4100/ADV, 28-WF4070/ADV

Upgrading options

Upgrading kits are available that allow local strain transducers and bender elements to be used inside the banded cells. An access ring is provided that fits between the cell base and the cell body with holes for the cables to go through. Watertight plugs are included to seal the unused holes.

28-WF4070/ADV

Advanced upgrading kit for triaxial cell WF4070 allowing use of local strain transducers and bender elements.

28-WF4100/ADV

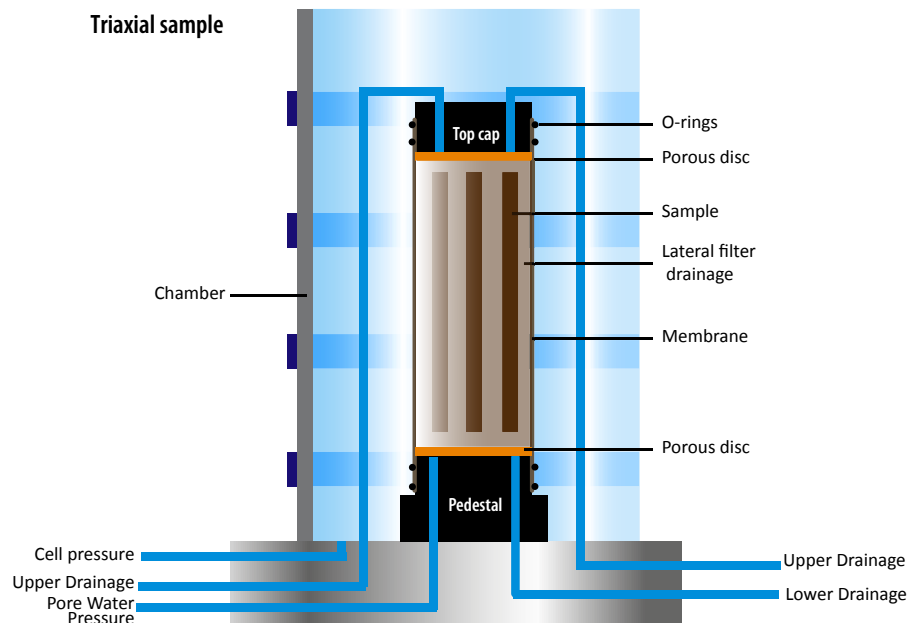
As above but for triaxial cell WF4100.

28-WF4150/ADV

As above but for triaxial cell WF4150.



Banded triaxial cells fitted with upgrading kits for using local strain transducers and bender elements



Standard triaxial cells and accessories

These cells essentially consist of a transparent polycarbonate chamber which has a top plate with a piston assembly fitted into it and a double flange base fitted to the bottom. Three (or six) simple thumbscrews are used to clamp the upper part of the cell to the base, which makes assembly and disassembly a very quick and simple operation. The base of the cell has four inlet points for top drainage/back pressure, cell pressure and base drainage/pore water pressure. Two of these are supplied with special no-volume-change valves.

Pedestals, top caps, porous discs, rubber membranes and O-rings are not included and have to be ordered separately - see Accessories.

Specifications

Product code	28-WF0410/A	28-WF0411/A	28-WF0416/A
Nominal sample diameter, mm	50	70	100
Sample diameter range, mm	35 to 50	35 to 70	70 to 100
Maximum working pressure, kPa	1700	1700	1700
Maximum cell height, mm	450	500	560
Cell diameter, mm (inc. valves)	270	310	340
Weight, kg (approx.)	5	8	15
No. of inlet points	4* (for top drainage/back pressure, cell pressure and base drainage/pore pressure)		
Effective stress/Total stress testing	✓	✓	✓

* Two valves are already included, the other two must be ordered separately.

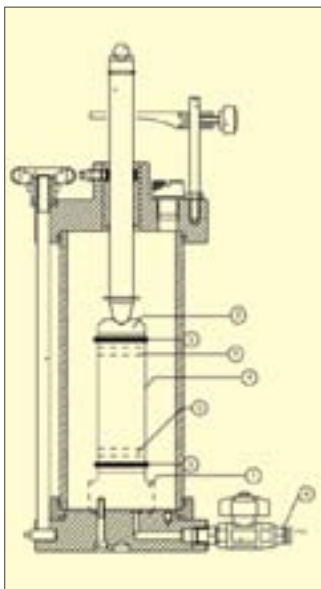


28-WF0416/A, 28-WF0411/A, 28-WF0410/A



Legend

- 1. Pedestal.** Used to adapt the triaxial cell base for different sample sizes. Supplied complete with a solid disc for tests without drainage.
- 2. Top cap.** Used to spread the load evenly over the whole cross-sectional area of the sample when drainage to the top of the sample is required. Includes a nylon tube and connector for the drainage line.
- 3. Porous disc.** Acts as a filter ensuring that the passage of water into and out of the sample is evenly spread over the whole cross-sectional area. Two are required - one for the top of the sample and one for the base.
- 4. Rubber membrane.** Provides a protective waterproof barrier around the sample. Made of rubber latex and supplied in packs of 10.
- 5. O-rings.** Used to seal the membrane against the pedestal and the top cap at either end of the sample. Supplied in packs of 10.
- 6. Membrane stretcher.** Used to the membrane open so it can be easily placed over the specimen without any disturbance.
- 7. Filter paper drains.** Used as side drains when specimens have low permeability. They are particularly useful when saturating clays before consolidation and shearing. Pack of 50.
- 8. Split sand former.** A specially designed piece of equipment for use when preparing non-cohesive soils which otherwise could not be mounted in a triaxial cell.
- 9. Drainage burette.** 10 ml capacity burette used to prepare non-cohesive specimens by applying a negative pressure to the base of the specimen and for measuring drainage into and out of the specimen when testing with the specimen open to the atmosphere. Supplied with connections for triaxial cell.
- 10. O-ring placing tool.** Used for applying the O-rings with the minimum disturbance to the sample.
- 11. No-volume change valve.** Identical to the two valves supplied with the triaxial cells and used for opening and closing the base drainage line when measuring pore pressure or fitting the drainage burette.
- 12. Split mould.** Used for trimming the ends of undisturbed soil specimens.



Ordering information

28-WF0410/A

Standard triaxial cell for 35, 38 and 50 mm diameter samples.

28-WF0411/A

Standard triaxial cell for 35, 38, 50 and 70 mm diameter samples.

28-WF0416/A

Standard triaxial cell for 70 and 100 mm diameter samples.

- 1 Base adapter
- 2 Porous top cap
- 3 Porous disc
- 4 Rubber membrane
- 5 Sealing rings
- 6 No-volume change valve

Triaxial cell pedestals

Each cell has to be fitted with a pedestal corresponding to the size of the specimens to be tested. Using specific adaptive pedestals it is possible to test specimens with different diameters in the same triaxial cell - see the table below. All pedestals are permeable, with holes for base drainage/pore pressure measurement, and are supplied complete with a solid disc for use in undrained tests.

Diameter, mm	Standard triaxial cell product code		
	28-WF0410/A	28-WF0411/A	28-WF0416/A
35	28-WF0410/A1	28-WF0411/A1	-
38	28-WF0410/A2	28-WF0411/A2	-
50	28-WF0410/A3	28-WF0411/A3	-
70	-	28-WF0411/A4	28-WF0416/A1
100	-	-	28-WF0416/A2



Hand sampler comprising cutter, wooden dolly and receiver

Triaxial cell and sample accessories

Diameter, mm	35	38	50	70	100
Top cap	28-WF0420/A3	28-WF0422/A3	28-WF0425/A3	28-WF0428/A3	28-WF0432/A3
Porous discs (2)	28-WF0420/A4	28-WF4034	28-WF4054	28-WF4074	28-WF4104
Membranes (pack of 10)	28-WF0420/A5	28-WF4035	28-WF4055	28-WF4075	28-WF4105
O-rings (pack of 10)	28-WF0420/7	28-WF4036	28-WF4056	28-WF4076	28-WF4106
Membrane stretcher	28-WF0420/8	28-WF4031/A	28-WF4051/A	28-WF4071/A	28-WF4101/A
O-ring placing tool	28-WF0420/10	28-WF4031/B	28-WF4051/B	28-WF4071/B	28-WF4101/B
Two-part split former	28-WF0420/A6	28-WF0422/A6	28-WF0425/A6	28-WF0428/A6	28-WF0432/A6
Two-part split mould	28-WF0420/13	28-WF4031/D	28-WF4051/D	28-WF4071/D	28-WF4101/D
Lateral filter drains (pack of 50)	28-WF0420/A9	28-WF4031/E	28-WF4051/E	28-WF4071/E	28-WF4101/E
Drainage burette	28-WF0420/11	28-WF0420/11	28-WF0420/11	28-WF0420/11	28-WF0432/11 ¹
Filter discs (pack of 100)	-	28-WF4031/F	28-WF4051/F	28-WF4071/F	28-WF4101/F
Hand sampler	28-WF0420/9	28-WF4031/G	28-WF4051/G	28-WF4071/G	28-WF4101/G

¹ 50 ml model.

Other accessories

28-WF4005/39

Platen adapter to fit standard triaxial cell onto TRITECH50 and TRITECH100 frames.

86-D0845

Water-repellent grease, 1 kg box.

28-WF0420/15

Greaser for triaxial cells.

28-WF0490/1

Flaring tool.

28-WF0490

Nylon tubing, OD6 mm x ID 4 mm, 20 m.

28-WF0420/12

No-volume-change valve.

Double-wall triaxial cells for unsaturated tests

In traditional triaxial systems, where saturated samples are tested, the change in specimen volume is measured simply by monitoring how much water enters or leaves the sample using a volume change transducer. When testing unsaturated samples however, this is not possible since volume change measurements are complicated by the compressibility of the air in the voids.

If an increase of confining pressure is applied to an unsaturated sample, a movement of water out of the sample will occur but an additional change in size will result from the compression of the air in the voids.

Correct determination of volume change requires both the volume of water leaving the sample and the total volume change of the sample to be measured.

For detailed information visit our web site...

Beside is shown the double-wall triaxial cell, with inner wall made from glass, complete with access ring for transducer cables. The cell has to be completed with a base pedestal with High-Air Entry Stone.

Two models are available:

Product code	28-WF4170	28-WF4171
Nominal sample diameter, mm	70	100
Sample diameter range, mm	50 to 70	50 to 100
Maximum working pressure, kPa	2000	2000
Maximum cell height [mm]	690	795
Cell diameter, mm (inc. valves)	478	535
Weight, kg (approx.)	30	50
No. of inlet points	5 (for top drainage/back pressure, cell pressure and base drainage/pore pressure)	
Attachment for vacuum top cap for extension tests	Included	

Axis translation method with High Air Entry Stone (HAES): operating principle.

One of the problems with testing a sample with high suction (negative pore water pressure) is that it will suck the water from the porous stone on the base pedestal and cause cavitation in the pore water pressure measuring system.

To prevent this happening the porous disc has been replaced with a high air entry stone. These stones allow water to pass through but air at pressures below the rating of the stone cannot pass. For example, a 5 bar stone will not allow air at pressures under 5 bar to pass through. The stone is cemented into an anodised aluminium ring which fits into a recess in the pedestal with an o-ring seal to prevent water passing around the outside of the stone.



28-WF4170

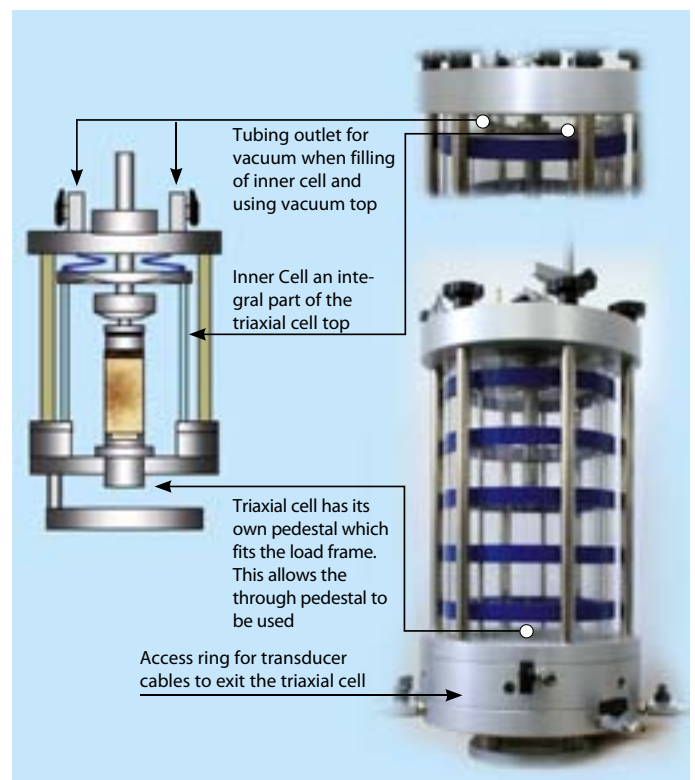
Ordering information

28-WF4170

Double-wall triaxial cell for unsaturated tests on 70 mm diameter soil samples, complete with 6 ports for transducer cables

28-WF4171

Double-wall triaxial cell for unsaturated tests on 100 mm diameter soil samples, complete with 6 ports for transducer cables.



Accessories

Double-wall triaxial cell unsaturated pedestal

Pedestal set for unsaturated cell, comprising pedestal, 2 bar High Air Entry Stone sealed into an aluminium ring and a height compensation ring. Using specific adaptive pedestals it is possible to test specimens with different diameters in the same triaxial cell – see the table below.

Diameter, mm	Double-wall triaxial cell product code	
	28-WF4170	28-WF4171
50	28-WF4170/50	28-WF4171/50
70	28-WF4170/70	28-WF4171/70
100	-	28-WF4171/100

High Air Entry Stones (HAES)

A 2 bar capacity HAES is included with the pedestals as standard but it can be easily replaced with stones of other capacities for 50, 70 and 100 mm diameter pedestals – see the table below.

Maximum air pressure	Pedestal diameter		
	50 mm	70 mm	100 mm
1 bar	28-WF4150/1B	28-WF4170/1B	28-WF4171/1B
2 bar	28-WF4150/2B	28-WF4170/2B	28-WF4171/2B
5 bar	28-WF4150/5B	28-WF4170/5B	28-WF4171/5B
10 bar	28-WF4150/10B	28-WF4170/10B	28-WF4171/10B
15 bar	28-WF4150/15B	28-WF4170/15B	28-WF4171/15B

For top cap and accessories see page 76

Spare parts

Pedestal diameter, mm	50	70	100
Aluminium plate for testing saturated samples	28-WF4150/3	28-WF4170/3	28-WF4171/3
Aluminium retaining ring	28-WF4150/4	28-WF4170/4	28-WF4171/4
Base pedestal	28-WF4150/5	28-WF4170/5	28-WF4171/5

Components of pedestal set for unsaturated cell

- 1 Pedestal set for unsaturated test
- 2 High air Entry stone (HEAS) sealed on aluminium ring
- 3 Aluminium compensation ring
- 4 Aluminium plate for saturated soil test
- 5 Porous stone for saturated soil test



Typical configuration of a system to perform triaxial tests on unsaturated samples 70 mm dia. with the axis translation method with the double wall cell 28-WF4170

Product code	Description	Q.ty
28-WF4170	Double-wall triaxial cell for 70 mm diameter samples	1
28-WF4170/70	Pedestal with HAES for 70 mm diameter samples	1
28-WF4072/A	Top cap for 70 mm diameter samples	1
28-WF4005	Tritech triaxial testing machine, 50 kN capacity	1
86-D2015	Air compressor, 50 L	1
28-WF2016/2	Air filter/water trap for air compressor	1
28-WF4220/A	De-airing tank, 7 L	1
86-D2001	Vacuum pump	1
86-D2005	Air drying unit	1
86-D2064	Rubber tube for vacuum	2
86-D0819	Silica gel dessicant with indicator	1
28-WF4225	Valve panel for de-airing tank	1
28-WF4331	Pressure control panel, 3 lines	1
28-WF4330/2	Digital gauge for 28-WF4331	1
28-WF4320	Bladder air/water cylinder	2
28-WF4191	Nylon tubing 6x 8 mm diameter, 10 m	2
28-WF6353	Submersible load cell, 5 kN capacity	1
30-WF6208	Displacement transducer, 25 mm travel	1
28-WF6221	Mounting bracket for 25 mm diameter cell ram	1
28-WF6300	Pressure transducers, 10 bar	2
28-WF6310	De-airing block	2
28-WF4410	Automatic volume change apparatus	2
30-WF6008	Geodatalog 8-channels datalogger	1
82-P9008/ELT	Set of four cables	2
30-WF6042	Transducer extension cables	6

Pressure systems

We produce three different systems for providing water at controlled pressures to triaxial systems:

- **Oil/Water pressure apparatus**, suitable for pressures up to 1700 kPa and 3500 kPa
- **Air/Water pressure system**, consisting essentially of a distribution panel with air/water bladder cylinders and an air compressor, suitable for pressures up to 1000 kPa
- **Hydromatic** stand-alone pressure/volume controller

Each system has to be completed with the De-airing water system. See page 84

Oil/Water pressure apparatus



main features

- > Generates and automatically controls the set pressure up to a maximum of 3500 kPa (500 p.s.i.) within $\pm 0.5\%$
- > Very stable over long periods
- > Required pressure set using precision hand wheel control
- > Stepless pressure increments
- > No weights or calibration required

This apparatus provides an infinitely variable constant pressure using an adjustable spring type dead weight pressure feedback system connected in-line with a pump and an oil/water interchange vessel.

The apparatus comprises: hydraulic pump, honed piston/spring assembly, cylindrical oil/water interchange vessel, pressure gauge, valves and 2 kg of oil.

The 28-WF4334 water distribution panel can be used to simplify the process of refilling the water in the vessel - see Accessories.

Two versions are available:

- 28-WF4302 / 28-WF4304 for pressures up to 1700 kPa
- 28-WF4312 / 28-WF4314 for pressures up to 3500 kPa

Dimensions: 310 x 300 x 400 mm

Weight: 16 kg (approx.)

Ordering information

28-WF4302

Oil and water constant pressure apparatus for pressures up to 1700 kPa. 230 V, 50 - 60 Hz, 1 ph.

28-WF4304

As above but 110 V, 60 Hz, 1 ph.

28-WF4312

Oil and water constant pressure apparatus for pressures up to 3500 kPa. 230 V, 50 - 60 Hz, 1 ph.

28-WF4314

As above but 110 V, 60 Hz, 1 ph.

Accessories and spares

28-WF4334

Three-line water distribution panel for triaxial systems.

Dimensions: 520 x 400 x 100 mm

Weight: 3.5 kg (approx.)

28-WF4302/1

High viscosity oil, 5 kg.

28-WF4191

Nylon tubing ID 6 mm x OD 8 mm, 10 m length.

Hydromatic stand-alone pressure/volume controller

main features

- > Application of pressure up to 3500 kPa for triaxial or permeability tests
- > Recording and display of pressure and volume change measurements in real time
- > Temporary or continuous connection to PC for data downloading with different protocols through RS 232
- > Possibility to set pressure ramp and cycles
- > Easy connection to any kind of system



Technical specifications

- Output pressure: up to 3500 kPa
- Pressure accuracy: $\pm 0.1\%$ of full scale
- Volume accuracy: 0.1 cm^3
- Resolution: 131000 divisions
- Volumetric capacity: 250 cm^3
- Data downloading: via RS 232
- Overall dimensions: 250 x 220 x 150 mm
- Weight: 7 kg (approx.)

Ordering information

28-WF4300/A

Hydromatic stand-alone pressure/volume controller. 110-240 V, 50-60 Hz, 1 ph.

Accessories

28-WF4334

Three-line water distribution panel for triaxial systems.

Dimensions: 520 x 400 x 100 mm

Weight: 3.5 kg (approx.)

Air/Water pressure system

This system basically comprises a distribution panel, air/water bladder cylinders (one per required pressure line) and an air compressor.

Pressure distribution panels

Two models are available: 28-WF4330 for two pressure lines and 28-WF4331 for three pressure lines. They include precision air regulators, pressure outlets and quick release fittings.

They have to be fitted with a digital gauge (see Accessories, model 28-WF4330/2).

Dimensions/weight:

28-WF4330: 510 x 454 x 184 mm /10 kg (approx.)

28-WF4331: 690 x 454 x 184 mm /15 kg (approx.)

Air/water bladder cylinder

The air/water bladder cylinders are used to deliver pressurized water up to 1000 kPa to triaxial cells via the pressure distribution panels. The main advantages of using this apparatus are:

- High degree of accuracy
- Extremely simple to operate
- Future expansion of system very easy and relatively low cost
- Bladder enables the use of de-aired water
- Large reservoir to cope with long term tests and large samples

The cell, made of a transparent acrylic tube flanged between two light alloy disc with a rubber membrane fitted inside, can operate continuously at pressures up to 1000 kPa. The unit acts as a reservoir/interface between the compressed air (used as a pressure source) and the water (used as the pressurizing medium in the triaxial cell). The cylinders have to be used with a 28-WF4330 or 28-WF4331 two or three line distribution panel depending on the application.

Dimensions: 178 mm diameter x 410 mm height

Weight: 5.8 kg (approx.)

Air compressor

The air compressor requires air filter/water trap and has the following specifications:

- Max. pressure: 1000 kPa
- Continuous working pressure: 800 kPa
- Reservoir capacity: 50 liters
- Max air delivery: 234 L/min
- Power rating: 1500 W

Dimensions: 985 x 395 x 820 mm (w x d x h)

Weight: 62 kg (approx.)

Ordering information

28-WF4330

Two-line pressure distribution panel, complete with air regulators and pressure outlets.

28-WF4331

Three-line pressure distribution panel, complete with air regulators and pressure outlets.

28-WF4320

Air/water pressure bladder cylinder.

86-D2015

Laboratory air compressor, 10 bar maximum pressure, 50 L capacity. 230 V, 50 Hz, 1 ph.

86-D2015/Y

As above but 220 V, 60 Hz, 1 ph.

86-D2015/Z

As above but 110 V, 60 Hz, 1 ph.

28-WF2016/2

Water trap for air compressor.

Accessories and spares

28-WF4330/2

Digital pressure gauge, 1 kPa resolution.

28-WF4330/2C

As above but, with traceable calibration certificate.

28-WF4330/3

Spare air pressure regulator, 150 psi (1000 kPa), with fittings for OD 8 mm tubing.

28-WF4191

Nylon tubing, ID 6 mm x OD 8 mm, 10 m length.

28-WF0490

Nylon tubing, ID 4 mm x OD 6 mm, 20 m length.

28-WF4320/1

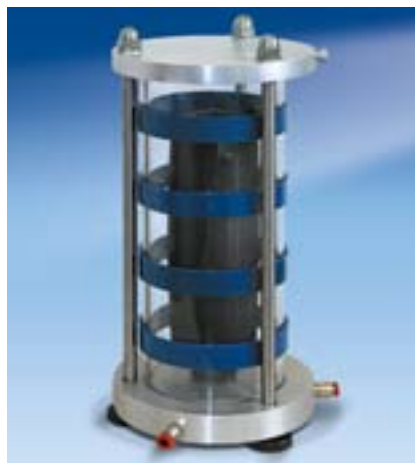
Spare rubber membrane for 28-WF4320 air/water bladder cylinder



28-WF4330 with digital pressure gauge 28-WF4330/2



28-WF4331 with digital pressure gauge 28-WF4330/2



28-WF4320



86-D2015

Water de-airing system

De-airing the water, that will be used to fill triaxial cells, pressure systems and volume change measurement apparatus, is essential for properly saturating soil specimens.

The system comprises the following:

- A de-airing tank (two versions are available with 7 or 23 L capacity)
- Vacuum pump with air drying unit
- Valve panel
- Tubing and accessories

During operation, the vacuum pump is connected to the air outlet of the tank the vacuum draws the air out of the water.



De-airing tanks

The tanks consist of a transparent acrylic cylinder fitted with a water spray inlet, an air outlet, a water outlet and a metal stand which can be wall-mounted at a suitable level to fill the triaxial system by gravity.

Two models are available:

- 28-WF4220/A, 7 litre capacity
Overall dimensions: 579 x 200 x 209 mm
Weight: 6.4 kg (approx.)
- 28-WF4221/A, 23 litre capacity
Overall dimensions: 619 x 320 x 311 mm
Weight: 12 kg (approx.)



28-WF4220/A

Vacuum pump, air drying unit and accessories

Our vacuum pump 86-D2001 has to be used with the air drying unit (86-D2005) filled with silica gel desiccant (86-D0819). This is recommended to avoid/limit water vapour mixing with the oil in the pump, which, in significant concentrations, may cause serious damage to the pump. When the pump will be used intensively, use of the outlet mist filter (86-D2001/3) is also recommended, which collects any oil vapour issuing from the oil reservoir during operation.

Specifications

86-D2001 Vacuum pump

- Free air displacement: 75 L/min
- Ultimate vacuum: 0.1 mbar
- Power: 180 W
- Dimensions: 300 x 150 x 240 mm (approx.)
- Weight: 8.5 kg (approx.)

86-D2005 Air drying unit

- Plastic frame with acrylic cylinder
- Dessicant capacity: 500 g (approx.)
- Overall dimensions: 185 mm diameter x 300 mm
- Weight: 1 kg (empty, approx.)

86-D2001/3 Outlet mist filter (optional)

- Weight: 0.7 kg (approx.)



86-D2001 Vacuum pump with 86-D2005 Air drying unit filled with 86-D0819 Silica gel desiccant



Vacuum pump 86-D2001 fitted with outlet mist filter 86-D2001/3

Valve panel

For connecting the de-airing tank to the vacuum pump. Includes water tap connection and two de-aired water outlets.

Dimensions: 510 x 200 x 30 mm

Weight: 3 kg (approx.)



28-WF4225

Ordering information

28-WF4220/A

De-airing tank, 7 litre capacity.

28-WF4221/A

De-airing tank, 23 litre capacity.

86-D2001

Vacuum pump. 230 V, 50 - 60 Hz, 1 ph.

86-D2064

Rubber tube for vacuum pump.

86-D2005

Air drying unit.

86-D0819

Silica gel desiccant, 1 kg.

28-WF4225

Valve panel.

Analogue measurement for triaxial systems

Load rings for triaxial frames

Load rings can be directly connected to the adapter fitted to the cross-head of triaxial frames. Using the 28-WF1049 connector (see Accessories) they can be adapted for use with our complete range of triaxial cells. Supplied complete with calibration chart.

Specifications

- High resolution dial gauge, 0.001 mm
- Dimensions:
182 mm diameter x 214 mm height
- Weight: 1.2 to 2.2 kg (approx.)

Ordering information

28-WF6450

Load ring, 1 kN capacity.

28-WF6451

Load ring, 2 kN capacity.

28-WF6452

Load ring, 5 kN capacity.

28-WF6453

Load ring, 10 kN capacity.

Accessories

28-WF1049

Connector for triaxial cells.

28-WF1048

Adaptor to connect load rings to the cross beam of WF load frame to CBR and Marshall test

82-T1000/9

Adaptor has to be used to connect WF load ring with Multispeed



Load ring with 28-WF1049 connector (fitted to the lower end)

Axial strain dial indicators

50 mm dial diameter, clockwise rotation. Supplied complete with rear mounts for connection to load rings. Two models are available: 30 and 50 mm travel.

Weight: 200 g (approx.)

Specifications

- High resolution dial gauge, 0.01 mm
- Accuracy: $\pm 1\%$
- Dimensions: 182 mm diameter x 214 mm height
- Weight: 1.2 to 2.2 kg (approx.)

Ordering information

29-WF6402

Dial gauge, 30 mm travel, 0.01 mm subdivisions.

29-WF6403

Dial gauge, 50 mm travel, 0.01 mm subdivisions.



28-WF6402

Double burette volume change apparatus

This apparatus has two measurement tubes consisting of a 25 ml burette mounted internally and an acrylic tube externally. The burette tubes are connected directly to a reversing valve system, which is used to reverse the direction of travel of the interface in the measurement tubes without affecting the direction of flow of water to or from the triaxial cell. The unit also includes a by-pass valve system when volume change measurement is not required. Burettes are calibrated to Class A.

Dimensions: 130 x 682 x 87 mm

Weight: 3 kg (approx.)



28-WF4400

Ordering information

28-WF4400

Double burette volume change apparatus.

Accessories

28-WF4400/1

Red dye hydrocarbon soluble pack for 500 ml.

Pore water pressure measurement

Pore pressure can be precisely measured using a pressure transducer connected to the triaxial cell via a de-airing block (28-WF6310 for the banded triaxial cells or 28-WF4459 for the standard triaxial cells). For triaxial tests with manual data recording, the transducer (e.g. our model 28-WF6300) can be plugged into the 28-WF4450 readout unit, eliminating the need for a data acquisition system.

Triple channel digital readout unit for pore pressure measurement

This digital pressure gauge consists of a long-term steady analogue section and a 16-bit A/D converter which guarantees 65,000 internal divisions. The unit has internal batteries, which is assisted by the AUTO-POWER-OFF function that activates if no change in readings is detected during any 30 minute period. The unit is fitted with a multiplexer selector switch.

Pressure transducers

Used for the measurement of pore pressure in conventional testing systems and also cell and back pressure in the automatic and dynamic testing systems.



Pressure transducer 28-WF6300 connected to the de-airing block 28-WF4459 for standard triaxial cells



Pressure transducer 28-WF6300 connected to the de-airing block 28-WF6310 for banded triaxial cells.

main features

- > Programmable in Imperial or metric units
- > Battery powered
- > Peak function (positive and negative)



Technical specifications

- Display: 4 x 20 characters
- Measuring units (programmable): mbar, bar, MPa, kPa, psi
- Accuracy: ± 0.2 % full scale
- Scanning rate: 50 readings per second
- Dimensions: 120 x 130 x 75 mm (w x d x h)
- Weight: 1 kg (approx.)

Ordering information

28-WF4450

Triple channel digital readout unit for pore pressure measurement. Battery powered. 110 - 220, 50 - 60 Hz, 1 ph.

Technical specifications

- Input voltage: 0-10V DC
- Output voltage: 100 mV to full scale
- Nominal sensitivity: 1.5 to 3 mV/V
- Resolution: infinite
- Accuracy: better than 0.1 kPa
- Weight: 150 g (approx.)

Note: the transducers have to be connected to triaxial cells using a suitable de-airing block - see Accessories

Ordering information

28-WF6300

Pressure transducer, 1000 kPa

28-WF6301

Pressure transducer, 2000 kPa

28-WF6302

Pressure transducer, 3500 kPa

Accessories

28-WF6310

De-airing block for connecting a pressure transducer to a banded triaxial cell.

28-WF4459

De-airing block for connecting a pressure transducer to a standard triaxial cell.

Electronic measurement for triaxial systems

External load cells

Used to measure the axial force applied to a specimen in a triaxial cell. Supplied complete with a connector for attaching to the crosshead of our triaxial load frames.



External load cell

Technical specifications

- Nominal sensitivity: 2mV/V
- Accuracy: better than 0.2%
- Dimensions (cell only)

3.5, 10, 25, 50 kN models

57 mm diameter x 80 mm height

100 kN model 82 mm diameter x 110 mm height

- Weight (approx.):

3.5, 10, 25, 50 kN models 2 kg approx

100 kN models: 5 kg approx

- Connecting thread:

3.5, 10, 25, 50 kN models female M20 x 1.5

100 kN model female M30 x 2

Ordering information

28-WF0370/T

External load cell, 3.5 kN capacity.

28-WF0373/T

External load cell, 10 kN capacity.

28-WF0374/T

External load cell, 25 kN capacity.

28-WF0375/T

External load cell, 50 kN capacity.

28-WF0376/T

External load cell, 100 kN capacity.

Note: in case the load cell is supplied complete with data acquisition system, then a traceable calibration certificate is available on request. For ordering info, add suffix 'C' to the relevant product code (e.g. 28-WF0370/TC)

Submersible load cells

Submersible (internal) load cells have been designed to work inside the triaxial cells. They have a low hysteresis and very good linearity together with a substantial overload safety feature and are supplied complete with rams to suit Banded triaxial cells 28-WF4050 to 28-WF4150 (Load cells with a 15.5 mm diameter ram fit the 28-WF4050 cell, whilst the 25 mm diameter ram fits all the other cell models).

Different models are produced for dynamic testing which are practically identical to the standard models except for the way they connect to the triaxial system.

Technical specifications

- Overload capacity: 200%
- Rate output: 2mV/V
- Excitation voltage: 10V DC
- Non linearity: $\pm 0.05\%$ full scale
- Hysteresis: 0.05% full scale
- Deflection at full load: 0.05 mm
- Maximum side force without effect: 50% full scale
- Compensated temperature range: 0 to 50°C
- Diameter: 75 mm
- Height (excluding ram): 50 mm
- Weight (excluding ram and extension kit): 850 g



Submersible load cell

The table below shows which triaxial cells the different models of submersible load cells are compatible with and the diameters of the fitted rams.

Load cell product code	Capacity (kN)	Compatible triaxial cells	Ram diameter (mm)
<u>28-WF6350</u>	1.0	28-WF4050	15.5
<u>28-WF6352</u>	5.0		
<u>28-WF6354</u>	10.0		
<u>28-WF6351</u>	1.0	28-WF4070, 28-WF4100, 28-WF4150 28-WF4170, 28-WF4171	25.0
<u>28-WF6353</u>	5.0		
<u>28-WF6355</u>	10.0		
<u>28-WF6356</u>	25.0		

Ordering information

28-WF6350

Submersible load cell, 1 kN capacity, complete with 15.5 mm diameter ram and extension kit for small samples.

28-WF6351

As above but with 25 mm diameter ram.

28-WF6352

Submersible load cell, 5 kN capacity, complete with 15.5 mm diameter ram and extension kit for small samples.

28-WF6353

As above but with 25 mm diameter ram.

28-WF6354

Submersible load cell, 10 kN capacity, complete with 15.5 mm diameter ram and extension kit for small samples.

28-WF6355

As above but with 25 mm diameter ram.

28-WF6356

Submersible load cell, 25 kN capacity, complete with 25 mm diameter ram and extension kit for small samples.

Note: in case the submersible is supplied complete with data acquisition system, then a traceable calibration certificate is available on request. For ordering, add the suffix 'C' to the relevant product code (e.g. 28-WF6350/C).



For data acquisition see our data logger see page 108

Axial displacement transducers and mounting brackets

Linear potentiometric transducers are used with various types of testing equipment, such as consolidation apparatus, shear testing machines and conventional triaxial testing systems, to measure sample deformation.



30-WF6209

Technical specifications

- Potentiometric transducers
- Input voltage: 10V DC
- Output: from 0 to 10V DC
- Repeatability: better than 0.002 mm
- Accuracy: better than 0.002 mm
- Connector: 6 pin

All the above transducers are supplied with a mounting block but have to be completed with the appropriate mounting bracket for connection to triaxial cells. See Accessories.

Ordering information

30-WF6207

Linear potentiometric transducer, 10 mm travel.

30-WF6208

Linear potentiometric transducer, 25 mm travel.

30-WF6209

Linear potentiometric transducer, 50 mm travel.

30-WF6210

Linear potentiometric transducer, 100 mm travel.

Note: in case the displacement transducer is supplied complete with data acquisition system, then a traceable calibration certificate is available on request. For ordering, add the suffix 'C' to the relevant product code (e.g. 30-WF6208/C).

Accessories

28-WF6220

Mounting bracket to fit 28-WF4050 banded triaxial cell (15.5 mm ram diameter).

28-WF6221

Mounting bracket to fit 28-WF4070, 28-WF4100 and 28-WF4150 banded triaxial cells (25 mm ram diameter).

28-WF1048/T

Mounting bracket to fit 28-WF0410/A, 28-WF0411/A and 28-WF0416/A standard triaxial cells.



30-WF6221



30-WF1048/T

Volume change apparatus

This apparatus, when connected to a suitable display or data acquisition system, measures change in sample volume by providing an electrical signal directly proportional to the volume of water flowing through the unit. The apparatus comprises a piston connected to a 25 mm linear potentiometric transducer, sealed against a precision-machined calibration chamber so that the linear movement of the piston is exactly proportional to the volume of water in the calibration chamber. The apparatus has a front control panel with a reversing valve system to measure the water flow in both directions.

Technical specifications

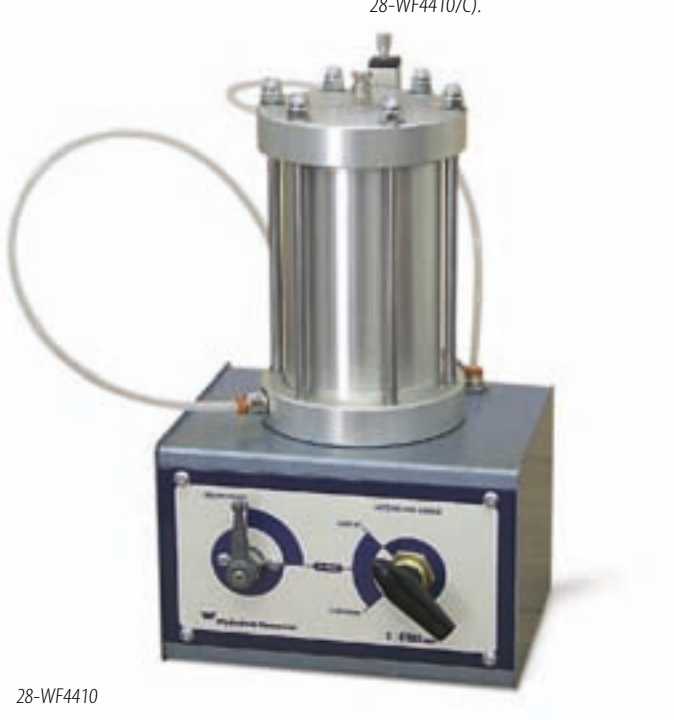
- Basic capacity: 100 cm³
- Transducer input: up to 12V DC
- Accuracy: ± 0.1 ml
- Dimensions: 260 x 280 x 400 (w x d x h)
- Weight: 5 kg (approx.)

Ordering information

28-WF4410

Automatic volume change apparatus.

Note: in case the volume change is supplied complete with data acquisition system, then a traceable calibration certificate is available on request. For ordering, add the suffix 'C' to the relevant product code (e.g. 28-WF4410/C).



28-WF4410

Pressure transducers

See pag 87



Note: in case pressure transducer is supplied complete with data acquisition system, then a traceable calibration certificate is available on request. For ordering, add the suffix 'C' to the relevant product code (e.g. 28-WF6300/C).

Measurement of the maximum shear modulus (G_{max})

Bender elements

Bender elements allow to measure the maximum shear modulus (G_{max}) of a soil sample and from this data to evaluate the stiffness of a soil. G_{max} is generally associated with shear strain levels of about 0.001% and is a key parameter in small strain dynamic analyses, such as those to predict soil behavior or soil structure interaction during earthquakes, explosion or machine and traffic vibrations.

The piezoceramic bender element is an electro-mechanical transducer, which is capable of converting mechanical energy (movement) either to or from electrical energy. The single bender element consists of two thin piezoceramic plates, which are rigidly bonded together with conducting surfaces between them and on the outsides.

The polarization of the ceramic material in each plate and the electrical connections are such that when a driving voltage is applied to the element, one plate elongates and the other shortens. The net result is a bending displacement, which is greater in magnitude than the length change in either of the two layers.

On the other hand, when the bender element is forced to bend, one layer will go into tension and the other into compression: this will result in an electrical signal, which can be measured.

In the soil application the bender elements are encapsulated and mounted into inserts, which are fixed into the pedestal and top cap of a triaxial cell. They protrude edge-first into the soil specimen as cantilevered. When excited the bender element bends from side to side pushing the soil in a direction perpendicular to the length of the element and thus having a large coupling factor with the soil. This produces a shear wave, which propagates parallel to the length of the element into the soil sample. On the other end of the soil sample another bender element is forced to bend and produces an electrical signal that can be measured.

Theory on shear wave propagation in an elastic body tells us that the value of the shear modulus G_{max} of the soil from measurement of shear wave velocity V_s is given by:

$$G_{max} = \rho \cdot (V_s)^2$$

where ρ is the mass density of the soil sample. The system consists of a transmitter, which is energized to produce the shear waves through the soil sample, and the receiver that receive the electrical signal.

The travel time of the shear wave from the transmitter to the receiver is determined via a specific software that allows the user to quickly and easily calculate the shear wave velocity.

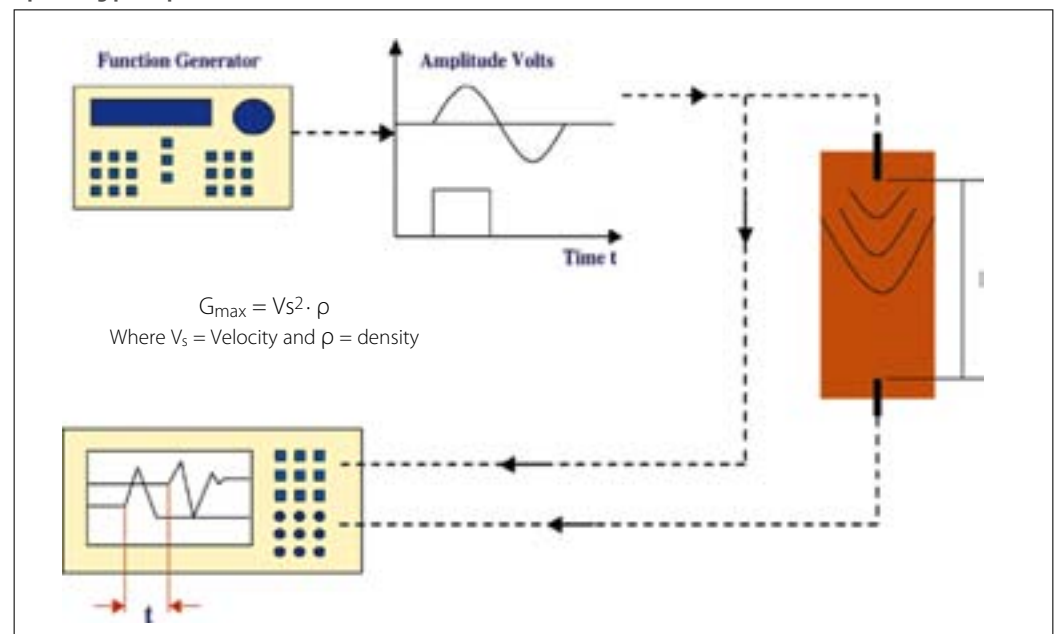
The complete power and measuring system 28-WF4190 includes:

- Waveform generator
- Analogic PC interface with virtual oscilloscope software
- Connecting cables
- Personal Computer is not included



Bender element with vacuum top cap and base pedestal

Operating principle



Ordering information

Models for compression testing only

28-WF4057/B

Bender elements, 50 mm top cap and base pedestal, for 70 mm diameter cell.

28-WF4077/B

Bender elements, 70 mm top cap and base pedestal, for 70 mm diameter cell.

28-WF4077/B1

Bender elements, 70 mm top cap and base pedestal, for 100 mm diameter cell.

28-WF4107/B

Bender elements, 100 mm top cap and base pedestal, for 100 mm diameter cell.

28-WF4157/B

Bender elements, 150 mm top cap and base pedestal, for 150 mm diameter cell.

Models for extension and compression testing (vacuum type)

28-WF4058/B

Bender element, 50 mm vacuum top cap and base pedestal for 70 mm diameter cell.

28-WF4078/B

Bender element, 70 mm vacuum top cap and base pedestal, for 70 mm diameter cell.

28-WF4078/B1

Bender element, 70 mm vacuum top cap and base pedestal, for 100 mm diameter cell.

28-WF4108/B

Bender element, 100 mm vacuum top cap and base pedestal, for 100 mm diameter cell.

28-WF4158/B

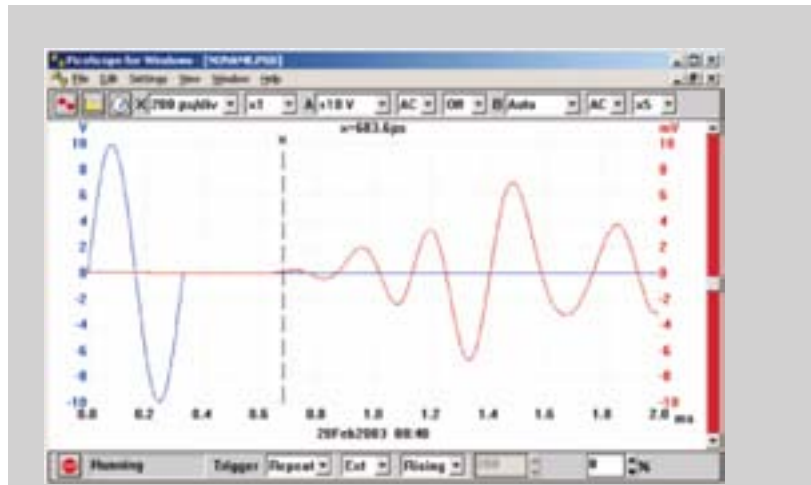
Bender element, 150 mm vacuum top cap and base pedestal, for 150 mm diameter cell.

Accessories

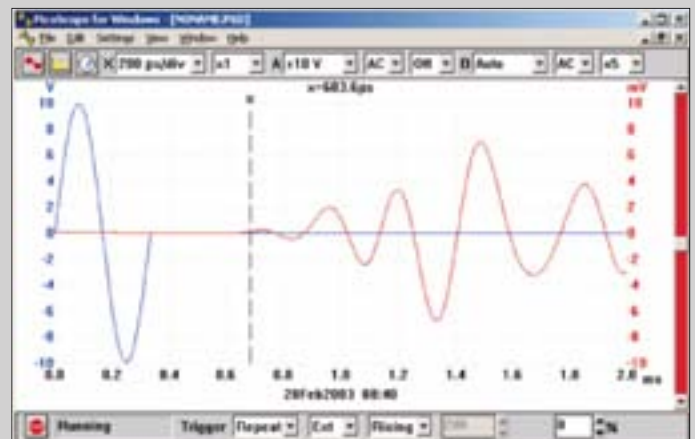
28-WF4190

Power and measuring system. 110-230 V, 50-60 Hz, 1 ph.

The bender elements have to be powered by a wave form signal generator. The output signal is converted into digital and transmitted to a PC via an interface and processed with the virtual oscilloscope software. The complete system includes waveform generator, analogic-PC interface with virtual oscilloscope software and connecting cables. PC not included.



Bender elements test results on clay. Frequency set at 3 kHz



Frequency set at 3 kHz



Banded triaxial cell 28-WF4070 fitted with upgrading kit 28-WF4070/ADV for using bender element and local strain transducers



28-WF4190

Local strain measurement in triaxial testing

main features

- > Suitable for specimen diameters from 38 to 150 mm
- > Maximum working pressure of 3500 kPa
- > Light and compact construction with reduced dimensions
- > For use with Banded triaxial cells fitted with suitable upgrading kits and Double-wall triaxial cells
- > Vertical and radial deformation measured directly on the triaxial test specimen
- > Suitable for static and dynamic data acquisition by triaxial systems



Local strain transducers

In conventional triaxial testing the stiffness of a soil specimen is determined by external measurement of displacement. Such measurements are subject to errors caused by deflections of the loading system and bedding of the porous stone onto the ends of the specimen.

Local vertical and radial strain transducers avoid these problems by providing the opportunity to measure the deformation, with high accuracy, directly on the triaxial test specimen.

Local strain transducers are supplied in a kit which includes one radial and two vertical transducers suitable for 38, 50, 70, 100 and 150 mm specimen diameters. Mounting accessories such as radial belt, mounting brackets and jig are also included.

All the models are supplied with dedicated in-line interface suitable for static or dynamic test, see the ordering information.

For more detailed information concerning the operating principle visit our web site



Transducers mounted on a sample

Technical specifications

- Input voltage: 10 V
- Output voltage (ratiometric):
± 350mV (radial); ± 950mV (vertical)
- Accuracy (average):
better than ± 0.5% FRO
- Temperature coefficient: ± 0.02/FRO/°C
- Weight: from 9 to 95 g (approx.)

Ordering information

Models for static testing

28-WF4039/KM

Local strain transducer kit for 38 mm diameter samples with two vertical and one radial miniature "on-specimen" transducers, radial belt, axial fixing pads and plugs.

28-WF4059/KM

As above but for 50 mm diameter samples.

28-WF4079/KM

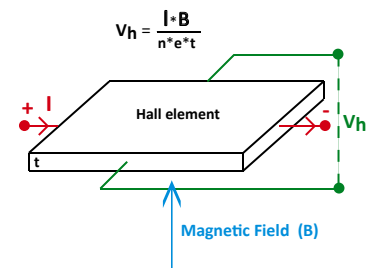
As above but for 70 mm diameter samples.

28-WF4109/KM

As above but for 100 mm diameter samples.

28-WF4159/KM

As above but for 150 mm diameter samples.



V_h : Hall voltage; B : Magnetic field; I : current across the plate length; e : elementary charge; t : thickness of the plate; n : charge carrier density

Models for dynamic testing (in the Dynamic triaxial system)

28-WF4039/KN

Local strain transducer kit for 38 mm diameter samples with two vertical and one radial miniature "on-specimen" transducers, radial belt, axial fixing pads and plugs.

28-WF4059/KN

As above but for 50 mm diameter samples.

28-WF4079/KN

As above but for 70 mm diameter samples.

28-WF4109/KN

As above but for 100 mm diameter samples.

28-WF4159/KN

As above but for 150 mm diameter samples.

Note: all the transducers mentioned above can be supplied, on request, with a traceable calibration certificate. For ordering, add the suffix 'C' to the relevant product code (e.g. 28-WF4039/KMC).

Calibration device for On-sample transducers (see page 111)

Specimen consolidation

main features

- > Allows simultaneous anisotropic consolidation of three triaxial specimens
- > Reduces the testing time when only one triaxial compression machine is available
- > Fits triaxial cells for specimens up to 100 mm diameter
- > Ergonomic design for better use of space in the laboratory
- > Suitable for other makes of triaxial cell (with little adjustment)



28-WF0493 with triaxial cells, dial gauges, beam loading devices and weights

Standards

ASTM D4767 | D7181 | BS 1377:8 | CEN-ISO/TS 17892-9

28-WF0493

Three-place consolidation bench for triaxial cells.

This apparatus has been designed to reduce the testing time for triaxial tests when only one compression machine is available. With this equipment it is possible to perform the consolidation stage of three triaxial specimens at the same time for CU and CD tests under anisotropic conditions. The apparatus consists of a steel bench complete with three load frames and centering platens, which fit any of our triaxial cells for specimens from 35 to 100 mm diameter. Each consolidation frame can be equipped with a beam loading device to reduce the number of dead weights required for anisotropic consolidation (see Accessories). Weights can be placed on both the centre hanger and on the lever hanger.

The apparatus has to be completed with vertical displacement gauges or transducers (which connect to data acquisition and processing systems for soil mechanics), and slotted weights and pressure system for cell and back pressure.

Overall dimensions: 1300 x 800 x 970 mm (w x d x h)
 Weight: 145 kg (approx.)

Accessories

Slotted weights

28-WF0493/1

Set of weights for specimens from 35 to 70 mm diameter.

Each set, suitable for a single frame with a Beam loading device 28-WF0493/3, comprises:

- 4 x 250 g Slotted steel weights
- 4 x 500 g Slotted steel weights
- 4 x 1 kg Slotted steel weights
- 4 x 2 kg Slotted steel weights
- 4 x 4 kg Slotted steel weights

28-WF0493/2

Additional set of weights for specimens up to 100 mm diameter.

Each set, suitable for a single frame with a Beam loading device 28-WF0493/3, can be used in addition to the 28-WF0493/1 weight set for anisotropic consolidation of large specimens. The set consists of four 8 kg slotted steel weights.

Beam loading device

28-WF0493/3

Beam loading device, 10:1 ratio.

Used to amplify the vertical load to be applied to the specimen. The lever is supplied with a screw jack support with handle.

Three units must be ordered for one 28-WF0493

Dial gauges and displacement transducers for measuring axial displacement

These devices should be selected according to the specimen size and type of measurement system: either analogue with dial gauges or electronic with displacement transducers connected to suitable data acquisition equipment.

30-WF6402

Dial gauge, 30x0.01 mm.

30-WF6403

Dial gauge, 50x0.01 mm.

30-WF6208

Vertical displacement transducer, 25 mm travel.

30-WF6209

Vertical displacement transducer, 50 mm travel.

30-WF1048/T

Mounting bracket for dial gauges and displacement transducers.

Locking device

28-WF0410/A4

Piston locking device to hold the piston and top cap in place on the specimen. Only for triaxial cells 28-WF0410/A, 28-WF0411/A and 28-WF0416/A - the device is not necessary with the other triaxial cells.



Detail of the 28-WF0493/3 beam loading device and slotted steel weights

28-WF0493. Detail of the upper frame with the top screw for levelling and adjusting the position of the cross head to fit different triaxial cells.



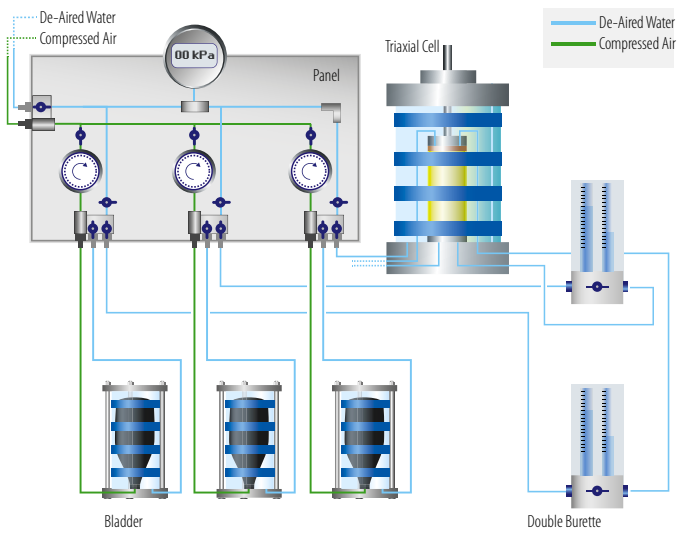
Determination of permeability of normal and contaminated soil samples

Standards

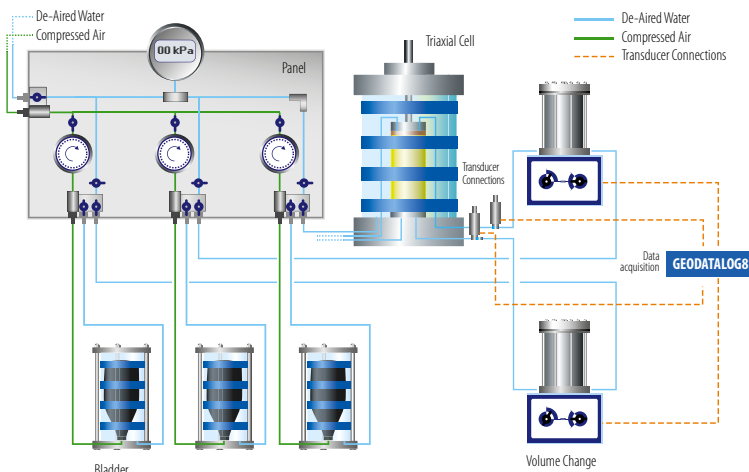
ASTM D5084 | BS 1377:6 | CEN-ISO/TS 17892:11

The permeability test is designed for measuring the hydraulic conductivity (coefficient of permeability) of water saturated porous materials. It can be performed using any of our triaxial cells, using the accessories described in the configuration table below. In cases where soil samples are contaminated, the special stainless steel cell 28-WF0194/B with toxic interface chamber 28-WF0194/3 should be used instead of triaxial cell.

Permeability tests in triaxial cell



Permeability tests in triaxial cell with data acquisition



Permeability testing system for water-saturated porous materials

The system consists of a number of standard testing items which are listed in the following table and described else where in this catalogue.

The table below gives a typical list of the parts and accessories required for a system performing triaxial permeability tests on 70 mm diameter samples*.

Code	Description	Q.ty
28-WF4070	Banded triaxial cell for 70 mm diameter samples	1
28-WF4071/7	Pedestal for 70 mm diameter samples	1
28-WF4072/A	Top cap for 70 mm diameter samples, with drainage leads	1
28-WF4074	Pair of porous discs for 70 mm diameter samples	1
28-WF4075	Rubber membranes (10 pieces) for 70 mm diameter samples	1
28-WF4076	O-rings (10 pieces) for 70 mm diameter samples	1
28-WF4071/A	Membrane stretcher for 70 mm diameter samples	1
28-WF4071/B	O-ring placing tool for 70 mm diameter samples	1
28-WF4071/C	Two-part split mould for 70 mm diameter samples	1
28-WF4071/D	Two-part split former for 70 mm diameter samples	1
28-WF4071/F	Filter discs (100 pieces) for 70 mm diameter samples	1
28-WF4071/G	Hand sampler for 70 mm diameter samples	1
28-WF6300	Pressure transducer, 1000 kPa	2
28-WF6310	De-airing block	2
28-WF6008	Geodatalog 8, data acquisition unit	1
82-P9008/ELT	Set of four cables	1
28-WF4331	Triaxial panel for three pressure lines	1
28-WF4330/2	Digital pressure gauge	1
28-WF4320	Air/water bladder cylinder	3
28-WF4410	Volume change apparatus	2
28-WF4221/A	De-airing tank, 23 litre capacity	1
28-WF2001	Vacuum pump	1
86-D2005	Air drying unit	1
86-D0819	Silica gel with indicator, 1000 g	1
86-D2064	Rubber tube for vacuum	2
28-WF4225	Valve panel for de-airing tank	1
86-D2015	Air compressor	1
28-WF2016/2	Water trap for air compressor	1
28-WF4191	Nylon tube ID 6 x OD 8 mm, 20 m	2

* Obviously the test can be performed with other sample diameters by substituting the items that are sample size dependent with those of the required size.

Permeability cell for contaminated soil samples

This model is used for contaminated soil samples. Made entirely of stainless steel, it has to be used with the toxic interface chamber to avoid toxic permeants from entering the control panel. This also prevents contact of air with the permeant so that no toxic or corrosive vapors can escape into the laboratory.

The cell can be fitted with accessories for 70 and 100 mm diameter samples.

Ordering information

28-WF0194/B

Permeability cell with stainless steel valves for use with contaminated soils.
 Dimensions: 300 mm diameter x 355 mm height (approx.)
 Weight: 5 kg (approx.)

28-WF0194/3

Toxic interface chamber.
 Weight: 3 kg (approx.)



Toxic interface 28-WF0194/3



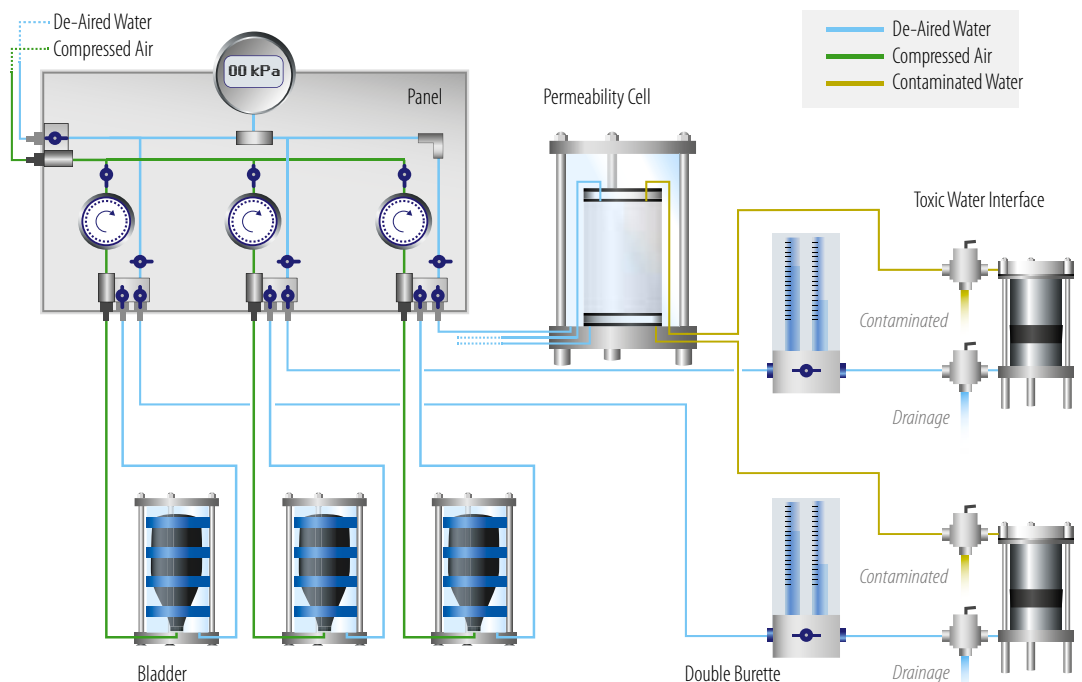
28-WF0194/B

Accessories

Top caps, base pedestals and sample accessories

Diameter sample	70 mm	100 mm
Top cap and base pedestal for contaminated materials	28-WF0194/B1	28-WF0194/B2
Porous discs	28-WF4074	28-WF4104
Membranes	28-WF4075	28-WF4105
O-rings	28-WF4076	28-WF4106
O-ring placing tool	28-WF4071/B	28-WF4101/B
Membrane stretcher	28-WF4071/A	28-WF4101/A
Two part split former	28-WF4071/D	28-WF4101/D
Hand sampler	28-WF4071/G	28-WF4101/G

Permeability tests in triaxial cell with contaminated water



AUTOTRIAX²**Automatic triaxial tests system****main features**

- > Automatic execution of up to 6 independent triaxial tests from start to finish with only one PC
- > Type of tests: total and effective stress, stress path, K_0 , permeability and unsaturated soils
- > High-speed PC closed loop control for continuous monitoring and instantaneous reaction of systems components
- > User-friendly software for remote control and test procedure
- > Ideal solution for high demands laboratories which requires high productivity and reliability
- > Space efficiency design
- > No need of air compressor (with exception of unsaturated soils tests)

Typical AUTOTRIAX 2 configuration for effective stress and stress path

AUTOTRIAX²

The optimization of advanced technologies for high efficiency triaxial tests

Standards

BS 1377:7 | ASTM D2850 | ASTM D4767 | BS 1377:8 | BS 1377:6 | ASTM D7181

The AUTOTRIAX 2 is an advanced triaxial testing system that can automatically perform up to 6 entire and independent tests at the same time, from start to finish, without any human intervention.

AUTOTRIAX 2 can perform different kinds of triaxial tests such as:

- Total and effective stress tests:
 - UU (unconsolidated undrained) BS and ASTM standards
 - CU (consolidated undrained) BS and ASTM standards
 - CD (consolidated drained) BS and ASTM standards
- Stress path tests following MIT and Cambridge methods;
- K_0 anisotropic volume controlled tests;
- Permeability tests in triaxial cells according to BS and ASTM standards
- Unsaturated soil testing with control of matric suction using the axis translation method.

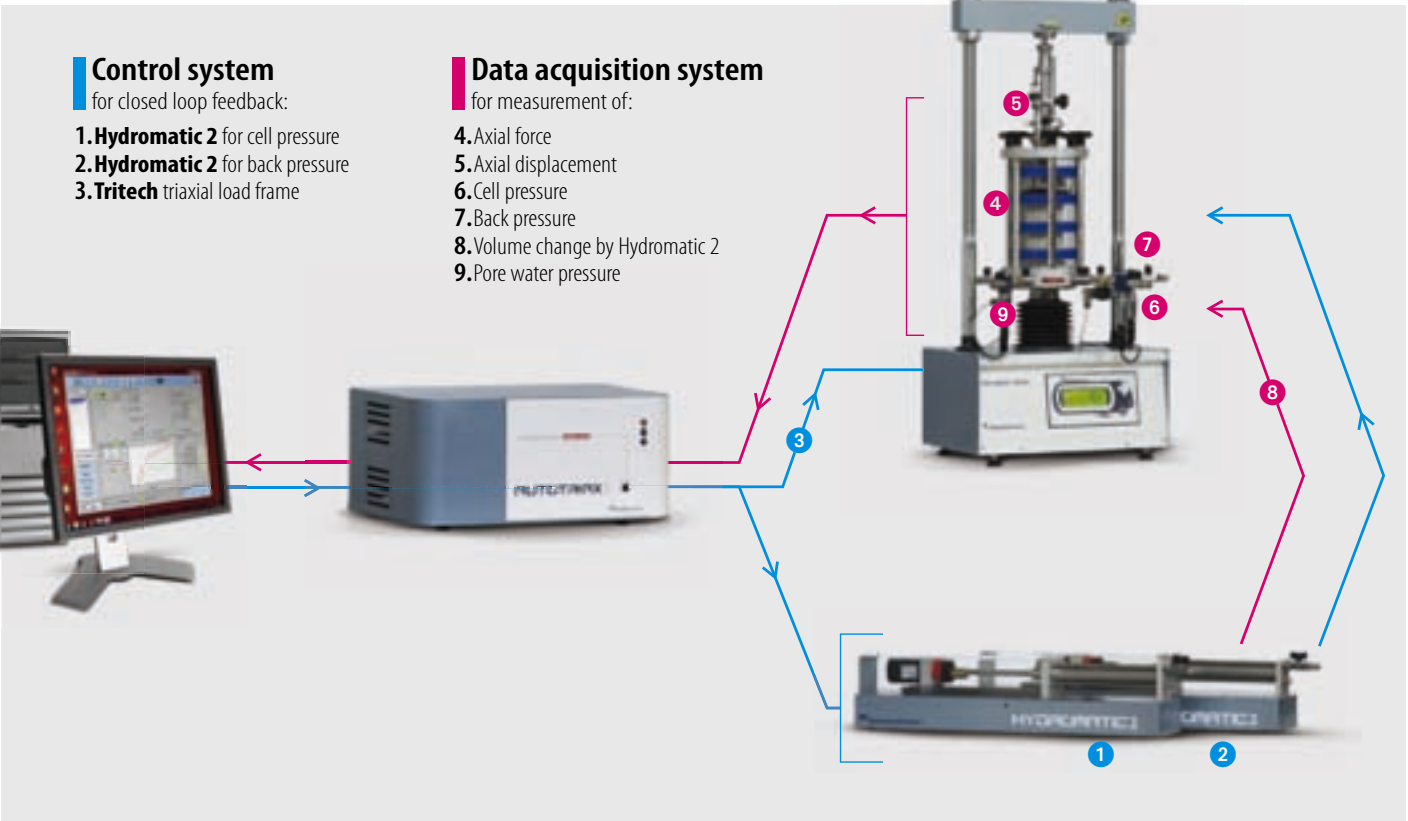
A typical automatic triaxial configuration comprises:

- Load frame and triaxial cell with accessories: a suitable model can be selected from our range (see triaxial load frames and triaxial cells banded or standard) or, alternatively, existing machines and cells can be used, after compatibility check with our specialists;
- Data acquisition and control unit connected to a PC (using a LAN network);
- Hydromatic 2 pressure/volume controllers with automatic open/close valves: the pressure controllers can reach up to 3500 kPa and have a volume capacity of 250 cc;
- Triaxial test automatic control and processing software.

The AUTOTRIAX 2 configurations can be extended and expanded in subsequent steps in order to control further tests by adding the relevant components. These operations can be easily made on site by simply configuring the user-friendly software, like a plug-and-play system.

The closed-loop feedback control system monitors the component status continuously in order to react to any change in the parameters pre-set for each test stage.

More than 30 system configurations are available. A practical guide for the most typical and common configurations limited to the part required for the main components is shown at pag 107



Data acquisition and Control Unit



main features

- > It manages pressure/volume controller, load frames, cell and back pressures, solenoid valves and transducers
- > Transmits data and information between the software and all the active components
- > Calibration data of connected transducers are saved in the firmware of the units
- > Four different versions are available to offer maximum flexibility
- > Can be stacked vertically reducing the footprint on the work bench
- > The modular design concept allows easy extension of the system

These are the brains of the AUTOTRIAX 2 system, transmitting data and information between the software and all the active components such as the pressure controllers and Trittech triaxial load frame. The units are produced in four different versions to offer maximum flexibility. They can be stacked vertically, making them very space-efficient, and power connectors of multiple units can be daisy-chained together, allowing them all to be run from a single mains socket. Transducer calibrations are saved directly in the firmware of the units.

29-WFD1A2

Master unit

A Master unit is always required, whatever combination of systems you want to put together. It has four active control channels for connecting the transducers that are needed for feedback to the software (for controlling vertical load or displacement and cell and back pressure) and eight passive channels for connecting a pore pressure transducer plus any other additional transducers, including local strain measuring devices. The Trittech compression frame, Hydromatic 2 pressure/volume controllers and solenoid valves (for opening and closing the pressure lines) also connect to the unit.

One Master unit is all that is needed for a single standard effective stress system.

Connections:

- 2 Hydromatic pressure/volume controllers
- 1 Trittech compression frame
- 12 transducers
- 2 solenoid valves

29-WFD0A1

Pressure extension unit

Used in addition to a Master unit, this extension unit provides control for one extra pressure system, with connections for a pressure transducer, solenoid valve and Hydromatic 2 pressure/volume controller, plus three spare passive transducer channels. It could be used, for example, in a system running permeability tests where three controlled pressures are required.

Connections:

- 1 Hydromatic pressure/volume controller
- 4 transducers
- 1 solenoid valve

29-WFD0A3

Triple pressure extension unit

Used in addition to a Master unit, this extension unit provides control for three extra pressure systems, with connections for three pressure transducers, solenoid valves and Hydromatic 2 pressure/volume controllers, plus nine spare passive transducer channels.

Connections:

- 3 Hydromatic pressure/volume controllers
- 12 transducers
- 3 solenoid valves

29-WFD0A1/UNS

Pressure extension unit for unsaturated test module only

Used in addition to a Master unit, this extension unit provides control for one air pressure system, with connections for a pressure transducer, solenoid valve and Servoflow Air pressure controller. There is also a connection for an Automatic Volume Change device to measure the change in cell volume, plus two spare passive transducer channels.

Connections:

- 1 Servoflow
- 4 transducers
- 1 solenoid valve
- 1 Automatic Volume Change device



Master unit 29-WFD1A2 rear panel



29-WFD1A2 + 29-WFD0A1 stacked vertically reducing the footprint on the work bench

Specifications

- Analogue/digital converter: 16-bit
- Additional transducer gain ranges: +/- 20 mV and +/-10 V
- Ethernet connection to PC: 100 Mb
- Dimensions: WFD1A2 or WFD0A3: W 330 x D 240 x H 144 mm, WFD0A1 or WFD0A1/UNS W 330 x D 240 x H 70mm
- Weight: 6 kg (29-WFD1A2/29-WFD0A3) 4 kg (29-WFD1A1/29-WFD0A1/UNS)
- Power supply: 110-240 V 50/60 Hz, 1ph

Note: the sensors connected to these units can be supplied, on request, complete with a traceable calibration certificate

Ordering information

- 29-WFD1A2**
AUTOTRIAX 2 Data acquisition and control unit: Master unit
- 29-WFD0A3**
AUTOTRIAX 2 Data acquisition and control unit: Triple pressure extension unit
- 29-WFD0A1**
AUTOTRIAX 2 Data acquisition and control unit: Pressure extension unit
- 29-WFD0A1/UNS**
AUTOTRIAX 2 Data acquisition and control unit: Air pressure extension unit for unsaturated testing

Accessories

- 29-WF4645/COMP**
High specification desktop PC with LCD monitor. Operating system MS Windows preinstalled. 8 port LAN HUB converter for AUTOTRIAX 2 connection. 110-240V/50-60Hz/1Ph
- 26-WF4645**
LAN Hub with 8 ports for Wykeham Farrance devices.



29-WFD0A1/UNS Pressure extension unit for unsaturated test

Pressure and volume controller



HYDRAMATIC 2

29-WF4502/B

Hydromatic 2 pressure/volume controller

Hydromatic 2 is used to generate water pressure in and around the test specimen. It is driven by a stepper motor, which enables the unit to measure volume change. The unit consists of a hydraulic piston, driven by a ball-screw and gearbox, mounted on a ball-slide, and is managed under closed-loop control by the Data acquisition and control unit. A 3500 kPa capacity pressure transducer and its de-airing block are included. The status of the unit is monitored by the AUTOTRIAX 2 software and safety microswitches are installed to prevent over-travel beyond mechanical limits or capacity.

Each Hydromatic 2, also includes a solenoid valve which is installed on the triaxial cell base to open and close the pressure lines. They are powered and controlled by the Data acquisition and control units.

For a standard effective stress system, two Hydromatic 2 units are required one for cell pressure and one for back pressure.

Specifications

- Output pressure: 3500 kPa
- Volume capacity: 250 cc
- Pressure resolution: 0.1 kPa
- Volume resolution: 0.001 cc
- Pressure accuracy: 0.1% of full scale
- Closed-loop control of pressure: regulated to 0.1 kPa
- Closed-loop control of volume: regulated to 0.001 cc
- Dimensions: W 740 x D 140 x H 160 mm
- Weight: 5 kg
- Power supply: 110-240 V 50/60 Hz, 1 ph
- Solenoid valve speed: < 10 mm/s

Accessories

29-WF4334

Water distribution panel for automatic triaxial testing

29-WF4191

Nylon tubing 6 mm bore x 8 mm outside diameter, 10 m length

29-WF6302/A

Pressure transducer 3500 kPa capacity for pore water pressure

29-WF6310

De-airing block for connecting a pressure transducer to a banded triaxial cell



Hydromatic 2 29-WF4502/B includes pressure transducer, de-airing block and on/off valve.



Water distribution panel 29-WF4334

Air pressure controller and water volume change for unsaturated testing

29-WF4511

Servoflow air pressure controller

(for unsaturated testing module only)



Servoflow for unsaturated testing 29-WF4511

The Servoflow is an electro-pneumatic pressure controller that generates air pressures of up to 1000 kPa for one pressure line. Managed under closed-loop control by the Data acquisition and control unit that it is connected to, it consists of a chassis housing an electronic pressure regulator. The regulator reduces the supply air pressure to a regulated output which is directly proportional to an electrical input signal received from the control unit. In the AUTOTRIAX 2, the Servoflow is used to provide air pressure to the sample for unsaturated soils testing systems, based on the axis translation method.

Specifications

- Servoflow air pressure controller**
- Output pressure: 1000 kPa
 - Pressure resolution: 0.1 kPa
 - Pressure accuracy: 0.1% of full scale
 - Closed-loop control of pressure: regulated to 0.1 kPa
 - Dimensions: W 225 x D 210 x H 140 mm
 - Weight: 5 kg
 - Power supply: 110-240 V, 50/60 Hz, 1ph

29-WF4412

Automatic Volume Change apparatus

measuring the volume change of an unsaturated soil sample in the double wall triaxial cell.

(for unsaturated test module only)



Volume change apparatus for unsaturated testing 29-WF4412

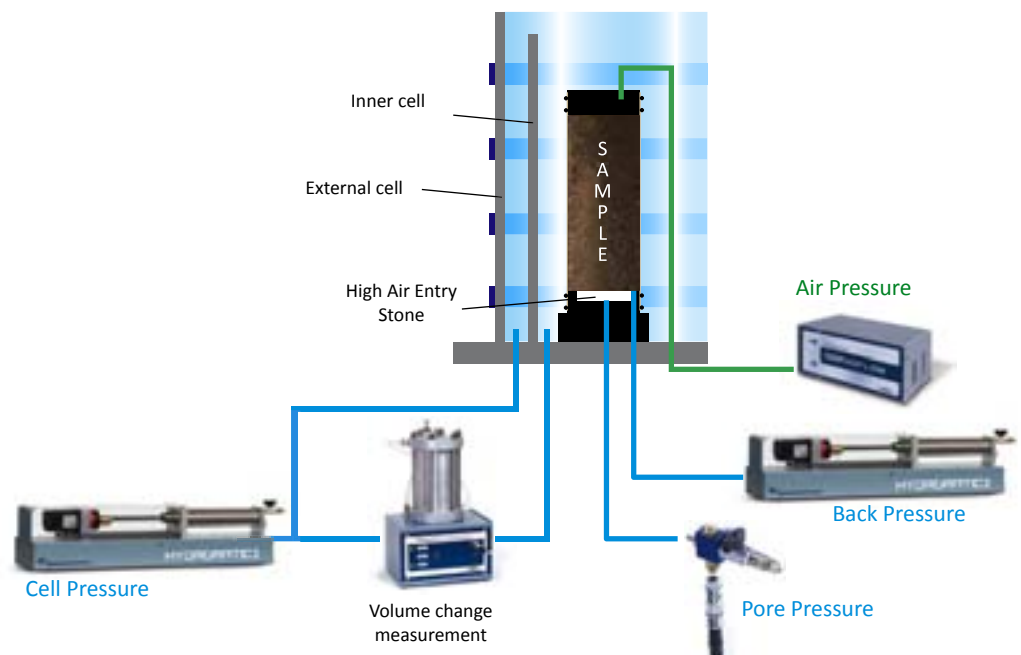
The device is used for unsaturated soils testing with the double wall triaxial cell to measure the volume change of the soil sample.

The design is based on the standard volume change device with integral solenoid valves that allow the flow direction and bypass functions to be controlled by the pressure extension unit - unsaturated. The device has a physical capacity of 100 cc but due to the automatic switching, it can measure volume change continuously. It is powered directly by the pressure extension unit - unsaturated and has LEDs on the front panel to show the flow status.

Specifications

Automatic Volume Change

- Capacity: 100 cc
- Accuracy: 0.1 cc
- Maximum operating pressure: 2000 kPa
- Dimensions: W 280 x H 400 x D 260 mm
- Weight: 9 kg
- Power supply: 24 V DC direct from the pressure expansion unit - unsaturated.



AUTOTRIAX 2 – Schematic layout for unsaturated test using axis translation method

Triaxial test automatic control and processing software



main features

- > Comprehensive and user-friendly interface between the operator and the testing systems
- > Up to 6 independent triaxial systems can be run at the same time from a single computer or multiple computers
- > Real-time display of all the transducers and calculated data for all live tests, with plots of measured and calculated data, selectable by the user.
- > Automatic control in real time of standard and non-standard tests (e.g. stress path tests)
- > Calibration and verification procedures for all the transducers
- > User-defined range limits and limit alarms for all the sensors and controllers
- > Data processing and reporting facility with customisable language

The AUTOTRIAX 2 software is a comprehensive and user-friendly interface between the operator and the testing system. Installed on a PC communicating with the system over a fast Ethernet connection, the software can be used to configure the system(s), calibrate transducers, specify test parameters, set system limits and control the system during a test, either manually or automatically. Due to the flexibility of the software, each triaxial system can either have its own, dedicated PC, or multiple systems can be run from one PC.

Three different software are available:

- **Device Management Software**
- **Test software**
- **Template for data processing**

Device Management Software

- This base software is supplied as standard with the AUTOTRIAX 2 system
- Designed for setting up the configuration and allocation of the components of each triaxial system
- Up to 11 points of calibration can be recorded with automatic polynomial best fitting (up to 7th order)
- The calibration data of different transducers can be stored for the same channel and easily recalled when connected
- Full scale limits can be set for all the transducers and pressure/volume controllers to prevent over-travel and possible damage
- Management of Hydromatic 2 pressure/volume controllers and Trittech compression frames outside of testing procedures (e.g. controller tuning, water refilling of pressure controllers)



System Select panel showing two triaxial systems are available, with one shared Trittech compression frame, one system is suitable for permeability test

Test software

Test software comprehends different modules.

All the test modules include the following basic features:

- Input of project, sample and test details and parameters
- Set up of test sequences, including selection of automatic or manual control
- Real-time data for all transducers are displayed throughout the test, as well as all calculated stresses, strains, ratios, volume change etc. Updated specimen dimensions are displayed at the end of each stage
- Graphical test data can be displayed on four separate user-definable graphs, each with up to six data series
- Manual control panel to control the solenoid valves, Hydromatic 2 and Tritech units before starting the test
- Transducer readings and zero-set options displayed in large font on a separate panel, enabling the user to easily view the readings from a distance
- Review option to look at data and graphs for tests already completed during a live test
- Data processing and reporting conforming to the relevant standards by quickly and easily importing test data into the Microsoft Excel® AUTOTRIAX 2 triaxial template
- Test pause option (automatic or by the user) for conditioning/refilling the Hydromatic 2 pressure/volume controllers
- Simultaneous and independent control of axial stress (displacement or load controlled), cell pressure, back pressure, base pressure (in the Permeability Module) and air pressure (in the Unsaturated Soils Module)
- Alarm display when travel or capacity limits of the system components are reached
- Set up of additional limits to stop or to hold the stress/strain conditions during the test

EFFECTIVE and TOTAL STRESS

This software module, supplied as standard, includes manual or automatic control of saturation, consolidation and shear stage, according to ASTM and BS Standards:

Saturation (ASTM D4767, ASTM D7181, BS 1377:Part 8)

Under manual control, three different options for running the stage are available:

- Increments of cell pressure only
- Increments of cell and back pressure
- Simultaneous ramps of cell and back pressure

Alternatively, automatic control can be selected to run the complete stage according to BS1377:8 Clause 5.3, BS1377:8 Clause 5.4 or ASTM 4767/7181.

Data monitoring and processing consists of:

- Multiple plot options including: cell pressure vs. pore pressure / B values; cell, back and pore pressure vs. time; volume change vs. time
- Summary table and plot of all the saturation steps performed

Consolidation (ASTM D4767, ASTM D7181, BS 1377:Part 8)

Automatic or manual isotropic consolidation with cell and back pressure targets set by the user.

Data monitoring and processing consists of:

- Multiple plot options including: volume change and pore pressure dissipation vs. time
- Graphical fitting methods, according to the relevant standards, for the evaluation of the end of consolidation
- Data processing of T50/T100 to calculate speed for monotonic as for BS / ASTM.

CU/CD test monotonic shear (ASTM D4767, ASTM D7181, BS 1377:Part 8)

Automatic or manual shear stage (drained / undrained) using calculated or user-defined rate of strain and failure criteria in compression or extension⁽²⁾

Data monitoring and processing consists of:

- Multiple plot options including: deviator stress, volume change, pore pressure vs. axial strain; MIT or Cambridge stress path

UU test monotonic shear (ASTM D2850, BS 1377:Part 7)

Automatic or manual undrained shear stage in compression, with rate of strain and cell pressure input.



Device Settings screenshot for Hydromatic 2 pressure/volume data acquisition and control device showing settings for the four channels

Triaxial test automatic control and processing software (continued)

STRESS PATH MODULE ⁽¹⁾⁽²⁾

This optional software module is for the automatic or manual control of stress path stages, with independent control of axial and radial stresses. The module can be used together with the standard stages of saturation, isotropic consolidation and monotonic shear provided by the Effective Stress Test Module to carry out what is generally known as stress path testing. This package includes the following:

- Total stress ramps
- Back pressure ramps
- MIT stress ramps to target values of s and t
- Cambridge stress ramps to target values of p and q
- Ramps to target change in axial displacement/strain
- Ramps to target volume change
- User-defined independent ramps / hold of deviator stress, cell pressure and back pressure

Data monitoring and processing consists of:

- Multiple plot options including: total and effective stress, volume change, pore pressure vs. axial strain; MIT or Cambridge stress path

K_0 MODULE ⁽¹⁾⁽²⁾

This optional software module is for the automatic or manual control of K_0 stages, with closed-loop control of the cross-sectional area of the soil sample. The module can be used together with the standard test stages of saturation, isotropic consolidation and monotonic shear provided by the Effective Stress Test Module. This package includes the following:

- Axial stress ramps with closed-loop control of radial stress to maintain the K_0 conditions
- Radial stress ramps with closed-loop control of axial stress to maintain the K_0 conditions
- K_0 conditions, controlled via the continuous monitoring of volumetric strain and axial strain
- K_0 conditions, controlled via the continuous direct measurement of the sample diameter by a local radial strain "on-sample" transducer

PERMEABILITY MODULE ⁽¹⁾

This optional software module is for the automatic or manual control of triaxial permeability stages in accordance with BS1377:Part 6 and ASTM D55084-10 methods A and D. The module is used together with the standard test stages of saturation and isotropic consolidation provided by the Effective Stress Test Module to carry out triaxial permeability tests. This package includes the following:

- control and measurement of base pressure
- measurement of permeability under a constant hydraulic gradient
- measurement of permeability under a constant rate of flow

Data monitoring and processing consists of:

- Multiple plot options including: change of volume / mean flow rate vs. time
- Evaluation tools to calculate in real time the permeability from the mean flow plot

UNSATURATED SOIL MODULE ⁽¹⁾

This optional software module is for the automatic or manual control of specific stages for unsaturated soils.

The module is used together with the standard test stages of saturation, isotropic consolidation and monotonic shear provided by the Effective Stress Test Module to carry triaxial testing on unsaturated soils. Stress path stages can also be performed when the Stress Path Module has been purchased. This package includes the following:

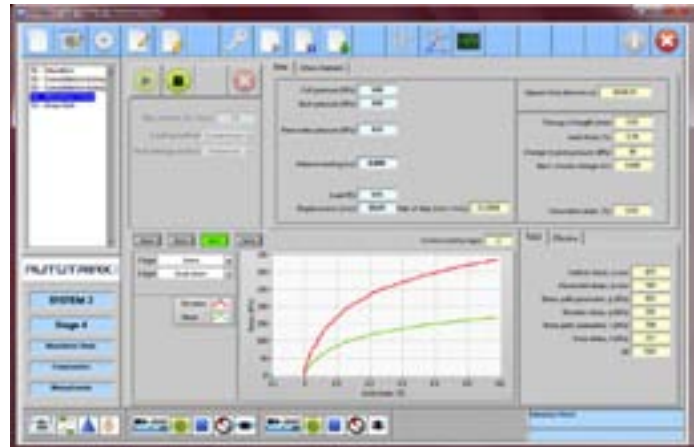
- control and measurement of air pressure
- control of matric suction during consolidation, monotonic shear and stress path stages
- measurement of pore pressure using the axis translation method
- SWCC (soil water characteristics curve) test stage

Data monitoring and processing consists of:

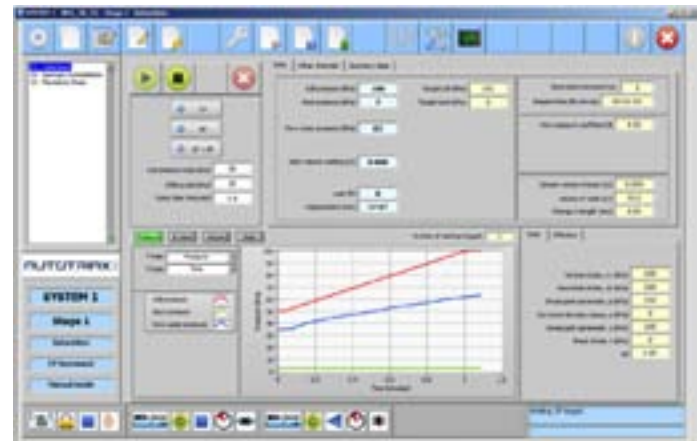
- Multiple plot options including: matric suction/pressures vs. strain; matric suction vs. moisture content
- Display of all unsaturated related stresses throughout the test

⁽¹⁾ An additional license must be purchased to unlock this module

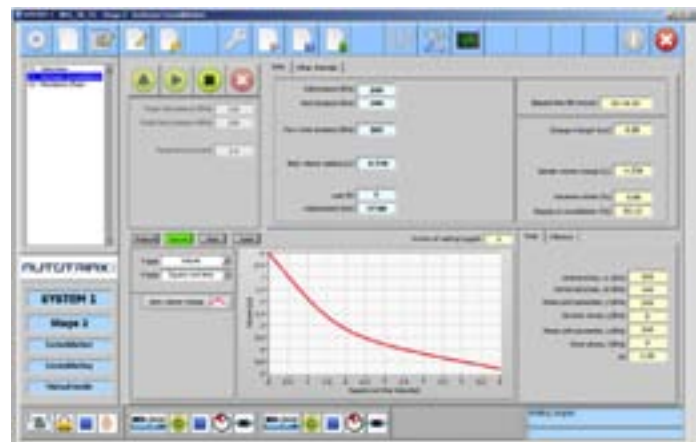
⁽²⁾ A vacuum top cap and submersible load cell must be used for tests with stages in extension



Deviator and shear stress plotted against axial strain during a monotonic shear stage



A saturation cell pressure increment with the graph showing the pore water pressure responding as the cell pressure is increased to the target.



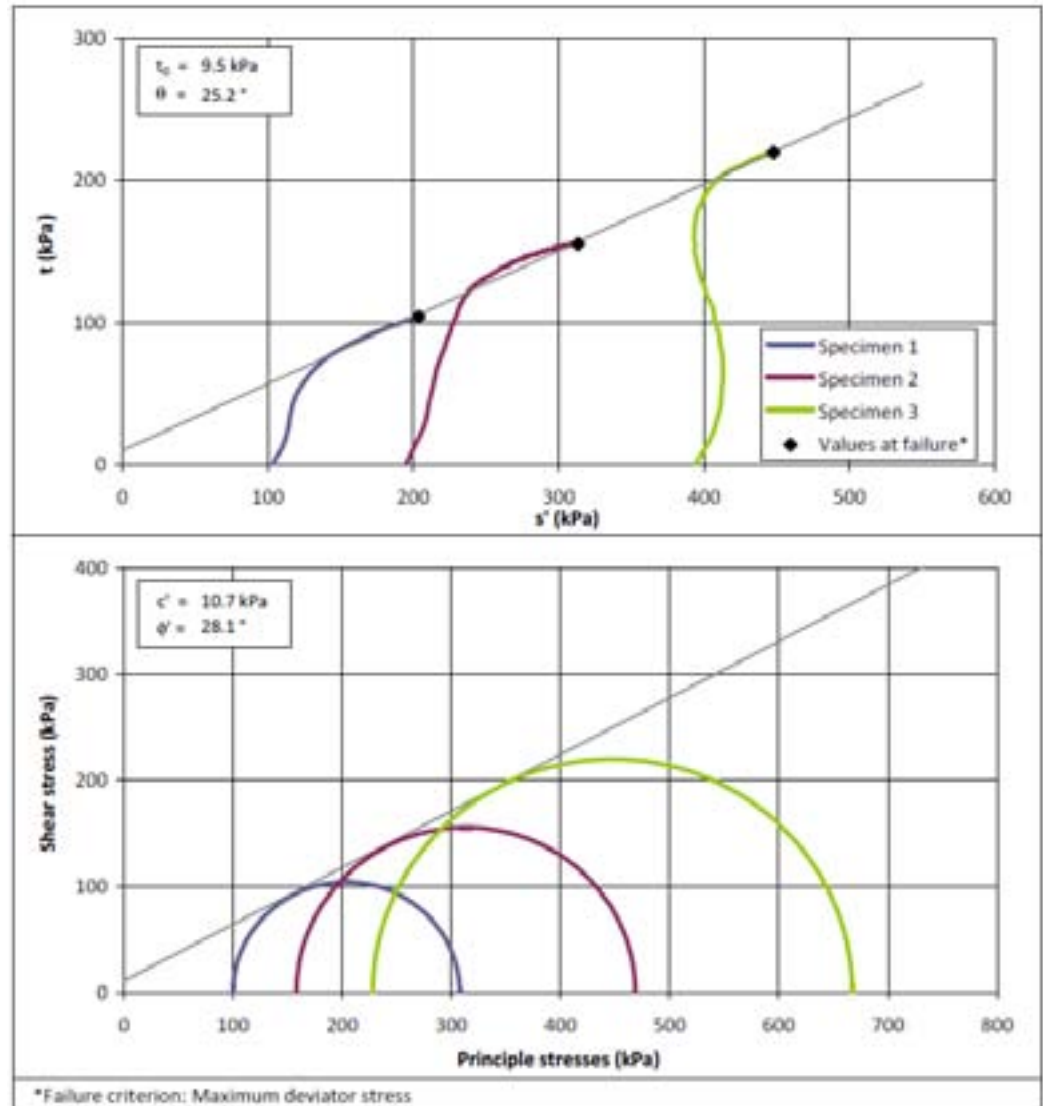
An isotropic consolidation stage in progress with volume change plotted against square root time on the graph

Template For Data Processing

The Triaxial Template is Excel®-based data processing software that has been specially designed for the AUTOTRIAX 2 testing system. Data for the entire test is imported at the click of a button, with individual worksheets created and completed automatically for each stage of the test. Test reports are generated conforming to the selected standard and can be printed.

- Automatic data importing
- Processing and reporting of results to BS or ASTM standards
- Includes presentation of Mohr circles and failure envelope with manipulation tools
- Triaxial permeability results can be post-processed to calculate the permeability value
- Possibility to plot a combined stress path graph of total and effective Cambridge and MIT stress path parameters over the whole test
- Can process multiple types of test*:
 - Unconsolidated Undrained (UU) triaxial - single, set of 3 or multistage
 - Consolidated Undrained triaxial (CU) - single, set of 3 or multistage
 - Consolidated Drained triaxial (CD) - single, set of 3 or multistage
- Triaxial permeability
- CU and CD tests with any type of stage can be processed:
 - Saturation
 - Isotropic consolidation
 - Monotonic shear
 - Unsaturated (soil/water curve)
 - Stress path
 - K_0

*The types of test that can be processed depend on which modules of the AUTOTRIAX 2 software are licensed



Typical data processing using template for AUTOTRIAX 2

Ordering Information

29-WFD1A2/SW1

Effective stress (CU / CD / UU) base test software with manual and automatic performance of saturation, consolidation and shear stages to ASTM and BS

29-WFD1A2/SW2

Activation code for Stress path test module with manual and automatic performance of stress path stages

29-WFD1A2/SW3

Activation code for K_0 test module with manual and automatic performance of K_0 stages

29-WFD1A2/SW4

Activation code for Unsaturated test module including manual and automatic modes for testing using the axis translation method

29-WFD1A2/SW5

Activation code for Permeability test module with manual and automatic performance of constant rate of flow and constant hydraulic gradient permeability stages

29-WFD1A2/TM

Triaxial Excel® Template for data processing software that has been specially designed for the AUTOTRIAX 2 testing system.

Automatic CRS and Hydrocon

Additional Autotriax 2 software for performing CRS (Constant Rate of Strain) and Hydraulic consolidation are available on request

Typical configurations

AUTOTRIAX 2

Automatic triaxial system to perform
Effective stress - Stress path - K_0 tests



AUTOTRIAX 2

Automatic triaxial system to perform
Effective stress - Stress path - K_0 - Permeability tests



AUTOTRIAX 2

Automatic triaxial system to perform
Unsaturated tests



Typical configurations (continued)

The following summary table is intended as a practical guide for the most typical and common configurations, limited to the part required for the main components, to cover different type of triaxial tests. However, due to the high flexibility of the system, many other configurations not included in the table here below, can be managed, according to the requirements of the user. To use the table below, first select the type of test starting from the left, then select the number of frames and triaxial cells

that will be managed simultaneously; then continue on the same row to find the main hardware components and software packages. If a single frame is dedicated to a single triaxial cell, the test can be controlled automatically from start to end. If a single frame is shared with several triaxial cells, the system can manage automatically saturation and isotropic consolidation simultaneously on the different triaxial cells.

The system shall be completed with the following components:

- Triaxial load frame, see TRITECH model page 70
- Banded triaxial cells and accessories, see page 75
- Sensors: Displacement transducer, pressure transducers, load cells, see page 87, 89
- Pressure system and water distribution panel see page 82

- De-airing water system see page 84

If additional measurements are required, the system can be upgraded with the following:

- Local strain measurements see page 92
- Bender elements see page 90

AUTOLAB



Test					Frame	TX cell								Software				
E	S	K _c	P	U			WFD1A2	WFD0A1	WFD0A3	WFD0A1/UNS	WF4502/B	WF4511	WF4412	SW1	SW2	SW3	SW4	SW5
•	•				1	1	1				2			•	•			
•	•	•			1	1	1				2			•	•	•		
•	•	•	•		1	1	1	1			3			•	•	•		•
•	•	•		•	1	1	1			1	2	1	1	•	•	•	•	
•	•	•	•	•	1	1	1	1		1	3	1	1	•	•	•	•	•
•					1*	3	1	1	1		6			•				
•			•		1*	3	1	2	1		7			•				•
•					1*	6	1	1	3		12			•				
•			•		1*	6	1	2	3		13			•				•
•	•				3	3	3				6			•	•			
•	•		•		3	3	3	1			7			•	•			•
•	•	•			6	6	6				12			•	•	•		
•	•		•		6	6	6	1			13			•	•			•
•	•			•	6	6	6			1	12	1	1	•	•		•	

Key:

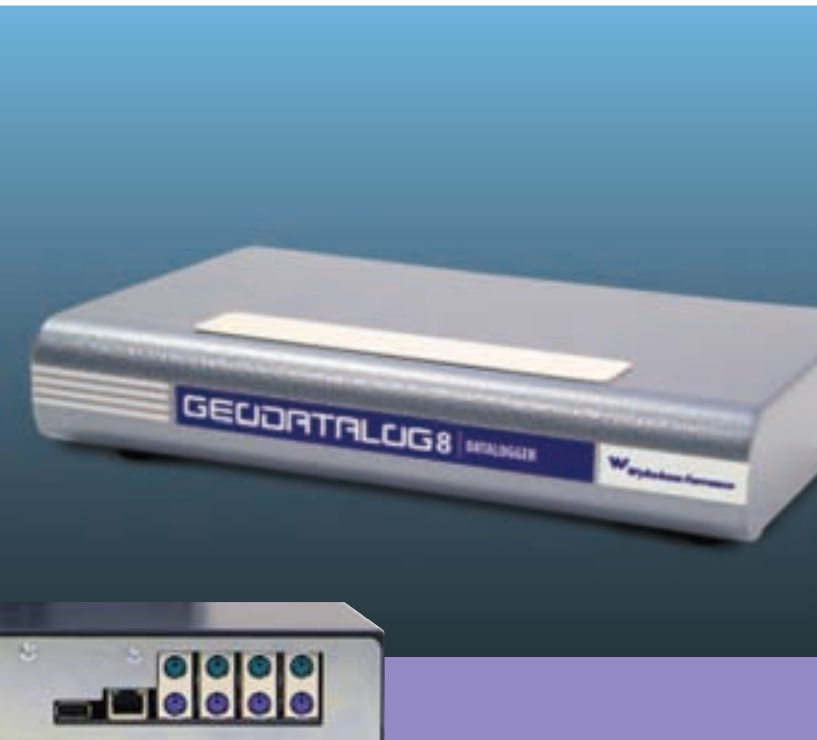
- E:** Total/effective stress according to BS and ASTM standards
- S:** Stress path (vacuum top cap and submersible load cell are required for tests with stages in extension)
- K_c:** K_c consolidation (vacuum top cap and submersible load cell are required for tests with stages in extensions)
- P:** Permeability (the items indicated in the table are intended to perform permeability tests in one cell)
- U:** Unsaturated (the test requires the double-wall triaxial cell; the items indicated in the table are intended to perform unsaturated test in one cell)

**Note: in these configurations it is not possible to follow strictly the ASTM standards in the consolidation stage, where the axial compression of the specimen should be recorded continuously (ref. ASTM D4767 point 8.3.4). To perform this measurement in a fully automatic mode, a dedicated load frame for each triaxial cell fitted with submersible load cell and vacuum top cap is required.*

Up to 6 independent systems are controller by the same PC



GEODATALOG 8



main features

- > 8 independent input channels
- > Up to 8 instruments can work in a network creating a modular system with up to 64 independent channels.
- > LAN / Ethernet connection to PC via dedicated software
- > Compatible with load cells, pressure transducers, strain gauges, LDT / LVDT / potentiometric displacement transducers.
- > Effective resolution: 131000 points
- > Sampling rate up to 500 readings per second per channel
- > Numerical and graphical display of readings via PC software
- > The transducers can be grouped and combined by the user for matching different applications.
- > Possibility to perform various tests (e.g. shear, consolidation, triaxial, ...) in parallel, each one having independent clock, channels and logging mode

30-WF6008

Geodatalog 8

Multipurpose datalogger, with dedicated software

GEODATALOG 8 is a multipurpose data logger which works directly connected to a PC. Data are automatically transferred to PC in real time for live monitoring of the tests.

GEODATALOG 8 records and monitors in real time the measurements requested for Soil Mechanics testing, in particular:

- Consolidation - Shear - Triaxial - Many others

It is compatible gauge load cells, pressure transducers, linear LDT transducers, LVDT conditioned transducers, with strain, potentiometric displacement transducers.

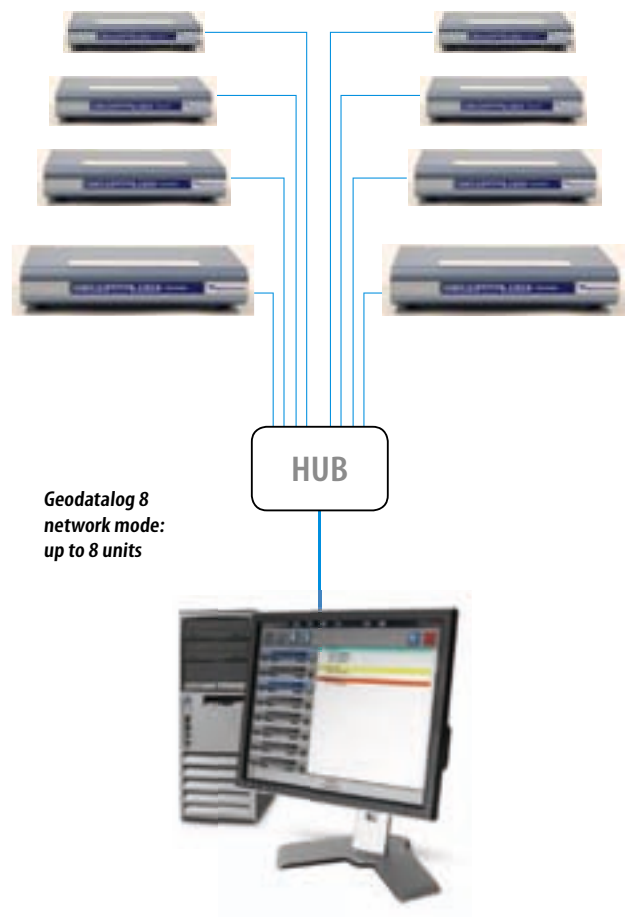
GEODATALOG 8 is conceived with a modular and flexible concept: up to 8 instruments can form a network (using a hub model 26-WF4645) and then create a modular system with up to 64 independent channels.

It is supplied complete with general purpose DATACOMM 2 PC software allowing remote calibration of the channels, and fully comprehensive data management.

GEODATALOG 8 should be always proposed complete with at least one set of 4 Lumberg-to-PS2 adaptor cables (see model 82-P9008/ELT).

Technical specification

- Requires connected PC
- Number of channels: 8
- Network mode: Up to 8 units
- Sampling rate: Up to 500 readings/second per channel
- Effective resolution: 131000 points
- Communication port: LAN / Ethernet
- Excitation (VEXC): from 1V to 10V for each couple of channels (up to 4)
- Datalogger input: 0-10V; 0-20 mA
- Software: Included, DATACOMM 2
- Dimensions approx lxdxh [mm]:
- 290 x 195 x 61
- Weight approx [kg]: 1.6 kg
- Power supply: 110-220V, 50-60 Hz, 1ph





DATACOMM 2 software combines the active channels into customizable groups by the operator. Data acquisition for each group is an independent task which can be started / stopped automatically with specific acquisition and logging mode.

ASCII format data export is available for combination with our Geo-Analysis-Templates suitable for post-processing and printout of test certificates according to the most important international Standards . See data processing



DATACOMM 2 - Channels configuration. The transducers can be grouped and combined by the user for matching different applications.

Accessories

Electronic measurement device

See pag 88

Cable

82-P9008/ELT

Set of four cables for connecting sensors to DATALOG8 (82-P9008) and GEODATALOG8 (30-WF6008)

Extension cable

30-WF6042

Transducer extension cable, 6 m length

30-WF6044

Transducer extension cable, 12 m length

Lan Hub

26-WF4645

LAN Hub with 8 ports for Wykeham Farrance devices.

Data processing: Geo-Analysis Templates

Sixteen templates for different tests and Standards have been developed specifically for processing test data recorded by the DATACOMM 2 software. The templates are MS Excel® based programs with easy-to-use functions for importing data files, calculating results, producing test reports that conforms to the relevant international Standards.

Geo-Analysis Templates

Test	Standard	Ordering information	
Consolidation	Incremental loading	BS 1377:5, ASTM D2435	30-WF6016/T1 30-WF6016/T8
	CRS	ASTM D4186	30-WF6016/T6
	Hydraulic consolidation	BS 1377:6	30-WF6016/T12
	SWCC -Hydraulic consolidation	-	30-WF6016/T13
Shear	Direct/residual	BS 1377:7 ASTM D3080	30-WF6016/T2 30-WF6016/T9
	Ring	BS 1377:7 ASTM D6467	30-WF6016/T3 30-WF6016/T16
	Triaxial	Effective stress	BS 1377:8 ASTM D4767 - D7181
Total stress		BS 1377:7	30-WF6016/T5
		ASTM D2850	30-WF6016/T10
Other tests	Permeability	BS 1377:6	30-WF6016/T14
	CBR	BS 1377:4	30-WF6016/T7
	Unconfined	ASTM D2166	30-WF6016/T15

Other templates are available for processing data gathered with different type of tests

Calibration equipment for the geotechnical laboratory

Any laboratory needs to verify periodically the calibrations of their electronic measuring systems, in order to produce reliable and accurate results. Equipment for calibrating force, displacement, volume change and pressure measuring devices are described in this section.

Force Measurement

For calibration of force measuring devices we propose the following load cells fitted with digital readout unit, supplied complete with ACCREDIA calibration certificate according to EN ISO 376.

Load cells

30-WF0372/SIT

5 kN load cell complete with ACCREDIA calibration certificate* and stainless steel loading seat.



30-WF0372/SIT or
30-WF0373/SIT
with stainless steel
loading seat



30-WF0373/SIT

50 kN load cell complete with ACCREDIA calibration certificate* and stainless steel loading seat.

* In order to issue the calibration certificate, the load cells must be ordered complete with the digital readout unit.

Technical specifications

- Linearity: $\leq 0.03\%$
- Hysteresis: $\leq 0.03\%$
- Repeatability: $\leq 0.01\%$

Digital readout unit

30-WF6601

Digital readout unit for load cells**.



30-WF6601 digital readout unit

Technical specifications

- Accuracy: $\leq 0.02\%$
- Standard resolution: $(2\text{mV/V}) \pm 25000$ div.
- Internal resolution: ± 32000 div.
- Zero and peak functions
- Auto power off function.
- Supplied with four 1.5 V AA size alkaline batteries.
- Typical battery life 1 year.

** One digital readout unit can be used for both load cells

Pressure Measurement

Pressure calibrations are performed with a digital pressure gauge, similar to model 30-WF6601, supplied complete with ACCREDIA calibration certificate.

30-WF6305/SIT

50 bar digital pressure gauge complete with ACCREDIA calibration certificate.

Technical specifications

- Linearity and hysteresis: $\leq 0.05\%$
- Internal resolution: 65000 div.
- Zero and peak function
- Auto power off function.
- Supplied with four 1.5 V AA size alkaline batteries.



30-WF6305/SIT digital pressure gauge

Volume Change

Calibration of the volume change apparatus can be simply performed by weighing the water coming out of the device, using any digital balance with 0.01 g resolution, e.g. model 11-D0630/06

Displacement Measurement

Calibration of displacement measuring devices can be performed with either the analogue or digital micrometer 25 and 50 mm travel respectively, 0.001 mm resolution. They are both available, optionally, with a traceable calibration certificate.

Both types of micrometer basically consist of a stainless steel frame with two brackets: one for the transducer and the other for the micrometer gauge head. The bracket can hold transducers with nominal diameters of 8, 12, 19 and 22 mm, or 18 mm square.

Technical specification

Product code	30-WF0652	30-WF0653
Type	Analogue/mechanical	Digital
Maximum travel, mm	25	50
Resolution, mm	0.001	0.001
Dimensions, mm (w x d x h)	260 x 60 x 100	300 x 60 x 107
Weight, kg (approx.)	0.6	1.5

30-WF0652

Analogue micrometer, 25 mm travel x 0.001 mm resolution.

30-WF0652/C

As above with traceable certificate

30-WF0653

Digital micrometer, 50 mm travel x 0.001 mm resolution.

30-WF0653/C

As above with ACCREDIA certificate

Local Strain Measurement

These transducers are used to measure local strain in triaxial testing. The calibration is performed with a special device that can also be used for standard linear displacement transducers with up to 50 mm travel.

The set includes:

- Frame capable of positioning the micrometer horizontally and vertically
- Adaptors for both vertical and radial local strain transducers
- Holders for transducers with nominal diameters of 8, 12, 19 and 22 mm, or 18 mm square.

Technical specifications

- Max travel: 50 mm
- Resolution: 0,001 mm
- Dimensions: 260 x 60 x 100 mm (w x d x h)
- Weight: 1.5 kg (approx.)



30-WF0653/K

Calibration device for local strain transducers and standard linear displacement transducers up to 50 mm travel.

30-WF0653/KC

As above with ACCREDIA certificate



30-WF0652 analogue micrometer



30-WF0653 digital micrometer

Soil Mechanics

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The response of soils to cyclic loading is determined mostly by the mechanical properties of the soil. There are several types of geotechnical engineering problems associated with dynamic loading, some examples include: wave propagation, machine vibrations, seismic loading, liquefaction and transient cyclic loading. We can provide several different systems to investigate these events: Dynamic triaxial, FACT, Resonant column/torsional shear and Cyclic simple shear.

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