TRIAXIAL STRESS MEASUREMENT TEST (UU-CU-CD TESTS)

Product Code

Triaxial Test Systems, 220-240 V 50-60 Hz

Standards

ASTM D2850, D4767, D7181; AASHTO T-297;
BS 1377-7, BS 1377-8

UU Only Triaxial Test Configuration

Determining the mechanical properties of soils is a very important step to design foundations, embankments and other soil structures.

Building constructions, excavations, tunnelling and similar applications have several effects on the subsoil structures and these effects are successfully simulated with Triaxial Tests where the stress-strain relation of undisturbed soil specimen are investigated by subjecting the soil sample to different stress levels and drainage conditions.

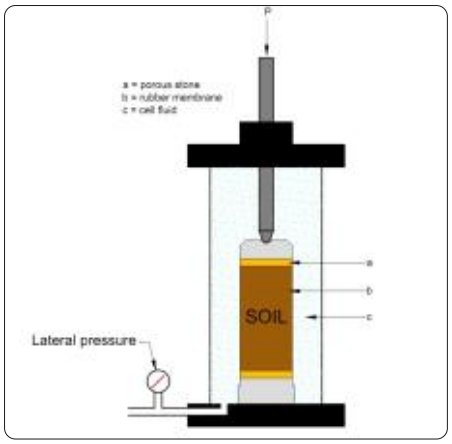
The UTEST Triaxial Test System provides automated triaxial compression tests on cylindrical undisturbed and remolded soil samples. Unconsolidated undrained (UU), consolidated drained (CD) and consolidated undrained (CU) compression tests can be automatically run, controlled and reported using this apparatus.

Unconsolidated Undrained (UU) Test

For the UU test , the specimens (assumed to be saturated prior to test) are subjected to a confining fluid pressure in a triaxial chamber. Once the specimen is inside the triaxial cell, the cell pressure is increased to a predetermined value by rotating the knob, and the specimen is brought to failure by increasing the vertical stress by applying a constant rate of axial strain. Saturation and consolidation are not permitted to keep the original structure and water content of sample untouched. Pore pressures are not measured during this test and therefore the results can only be interpreted in terms of total stress.

These tests are generally carried out on three specimens of the same sample subjected to different confining stresses.

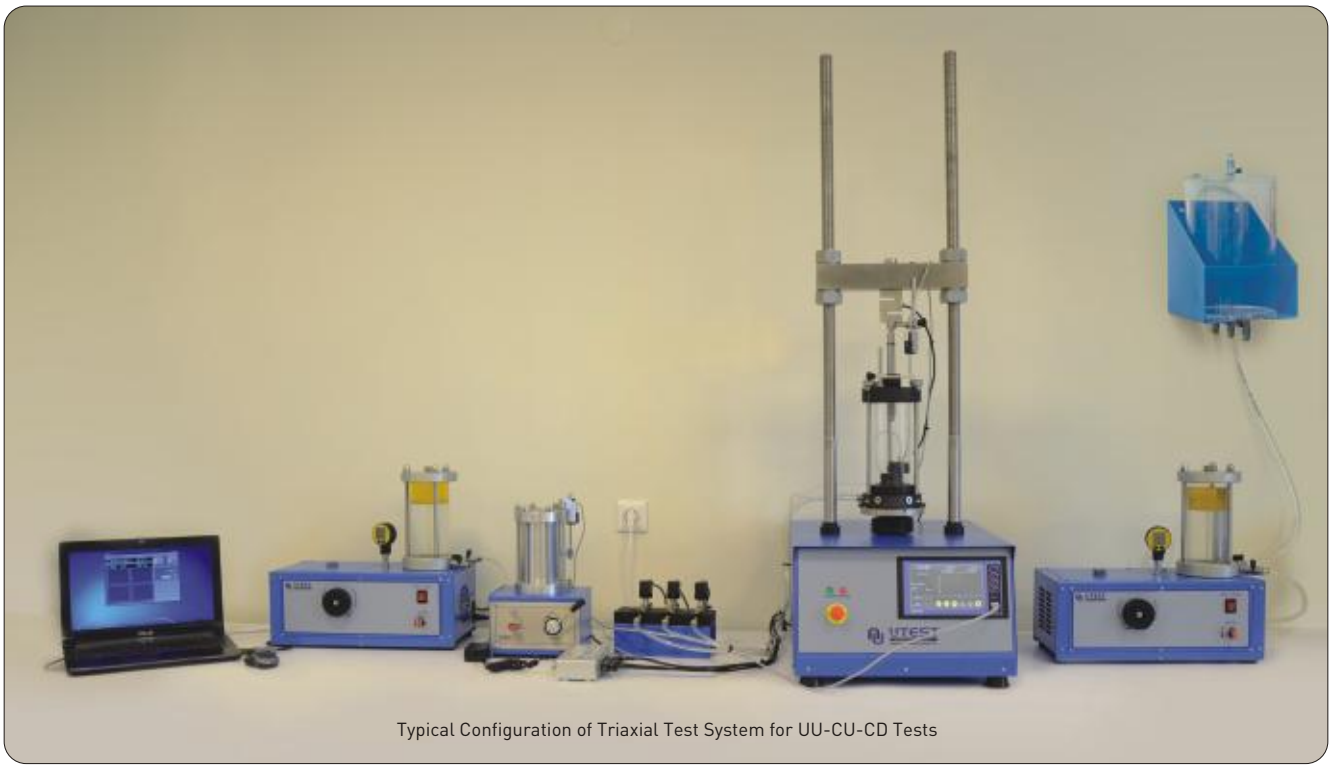
Since all specimens are supposedly saturated the shear strength are similar for all tests. The results of the test are plotted as curves of principal stres difference against strain. For conditions of maximum principal stress difference (taken as failure) Mohr circles are plotted in terms of total stress. The average undrained shear strength should be noted, and the failure envelope drawn tangential to the Mohr circles in order to find the "undrained cohesion intercept" and undrained "angle of shearing resistance".



TRIAXIAL STRESS MEASUREMENT TEST (UU-CU-CD TESTS)

Consolidated Undrained (CU) Test & Consolidated Drained (CD) Test

Peak effective strength parameters (c' and ϕ') may be determined either from the results of consolidated undrained (CU) triaxial compression tests with pore pressure measurement, or from consolidated drained (CD) triaxial compression tests. The consolidated undrained/ drained triaxial compression tests are normally performed in several stages, involving the successive saturation, consolidation and shearing of each of three specimens.



Typical Configuration of Triaxial Test System for UU-CU-CD Tests

Saturation is carried out in order to ensure that the pore fluid in the specimen does not contain free air. Saturation is normally carried out by leaving the specimens to swell against an elevated back pressure. Back pressure (which is simply an imposed pore pressure) is applied through a volume change gauge to the top of the specimen, while a cell pressure of slightly higher value is also applied. Both cell pressure and back pressure are normally increased in increments, allowing time for equalization at each stage. The degree of saturation can be expressed in terms of Skempton's pore pressure parameter (Skempton, 1954):

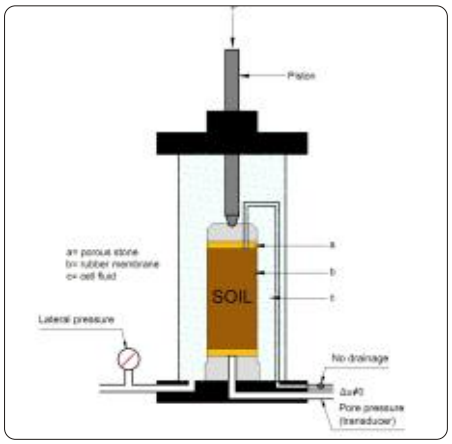
$$B = \frac{\Delta u}{\Delta \sigma_3}$$

where Δu is equal to change in pore pressure for an applied cell pressure change of Δσ3. For an ideally saturated soil B is equal to unity. It is recommended by several standard test methods that a value of B greater than, or equal to, 0.95 must be achieved before the specimen may be considered as fully saturated and the consolidation stage started. The consolidation stage of an effective stress triaxial test is carried out for two reasons. First, three specimens are tested and consolidated at three different effective pressures, in order to give specimens of different strengths which will produce widely spaced effective stress Mohr circles. Secondly, the results of consolidation are used to determine the minimum time to failure in the shear stage. The effective consolidation pressures (i.e. cell pressure minus back pressure) will normally be increased by a factor of two between each specimen, with the middle pressure approximating to the vertical effective stress in the ground. When the consolidation cell pressure and back pressure are applied to the specimen, readings of volume change are made using a volume change device in the back pressure line. Pore pressure is measured at the specimen base, with drainage to the back pressure line taking place through a porous stone covering the top of the specimen. The coefficient of consolidation of the clay can be determined by plotting volume change as a function of the square root of time. Theoretical considerations indicate that the first 50% of volume loss during consolidation should show as a straight line on this plot. This straight line is extended down to cut the horizontal line representing 100% consolidation, and the time intercept at this point (termed "t_{100}" by Bishop and Henkel) can be used to obtain the coefficient of consolidation.

TRIAXIAL STRESS MEASUREMENT TEST (UU-CU-CD TESTS)

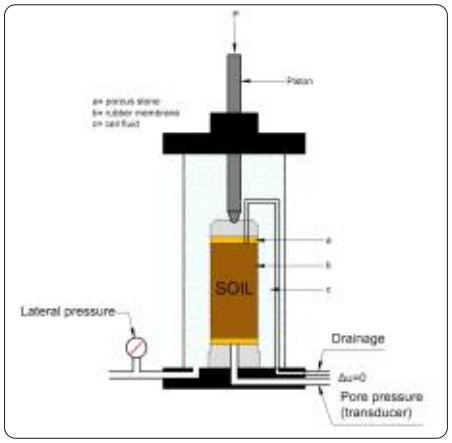
Consolidated Undrained (CU) Test:

Once consolidation is complete, the specimen is to be isolated from the back pressure and the rate of vertical movement of the compression machine platen set according to result of consolidation.. During the shear stage the vertical stress is increased by the loading ram, and measurements are made at regular intervals of deformation, ram load and pore pressure. These are converted to graphs of principal stress difference (σ1- σ3) and pore pressure as a function of strain, and failure is normally taken as the point of maximum principal stress difference. The effective stress Mohr circles are plotted for the failure conditions of the three specimens which has been subjected to different consolidation level, and the gradient and intercept of a straight line drawn tangential to these circles defines the effective strength parameters c' and ϕ'.



Consolidated Drained (CD) Test:

The consolidated drained triaxial compression test, with volume change measurement during shear is carried out in a similar sequence to the consolidated undrained test, but during shear the back pressure remains connected to the specimen which is loaded sufficiently slowly to avoid the development of excess pore pressures. The shear stage of a drained triaxial test can be expected to take between 7 and 15 times longer than that of an undrained test with pore pressure measurement. Once shearing is complete, the results are presented as graphs of principal stress difference and volume change as a function of strain, and the failure Mohr circles are plotted to give the drained failure envelope defined by the parameters cd' and φd' .



Triaxial CD-CU-UU equipment is computer controlled, test values can be transferred to computer and data processing can be made with Triaxial software on Windows operating system. All data can be used on Excel programs.

The load data and axial displacement data are transfered and recorded through BC 100 Unit to the software. Three pressure data (cell pressure, back pressure and pore pressure) from triaxial cell and volume change data transfered and recorded through the unilogger to the software.

Typical configuration of system for different tests (UU-CU-CD)			
Product Code	Description	UU	UU-CU-CD
UTM-0108	Multiplex Universal Electromechanic Test Machine*	1	1
UTGM-0010	Load Cell 5 kN	1	1
UTS-0400 UTS-0401	Triaxial Cell**	1	1
UTS-0405	Block with One Connection Line for Triaxial Test Cells	1	-
UTS-0406	Block with 3 Connection Lines for Traxial Test Cells	-	1
UTGM-0110	Pressure Transducer	1	3
UTS-0408	Oil and Water Constant Pressure System	1	2
UTS-0415	Automatic Volume Change Unit	-	1
UTG-0320	Static Unilogger 4 Channels	-	1
UTS-0416	Software to Perform UU Triaxial Tests	1	1
UTS-0417	Software to Perform CU-CD Triaxial Tests	-	1
UTS-1330 and UTGP-1140	De-Airing Water Tank, 7 L. and Hose	1	1

* Supplied complete with UTGM-0025 50 kN Load Cell, UTGM-0062 25 mm Linear Potentiometric Transducer and UTC-4930 BC 100 Data Acquisition and Control Unit.

** Choose the suitable cell for the specimen size (UTS-0400: 38-50 mm dia. samples / UTS-0401: 70-100 mm dia. samples). For cell accessories and sample prepatarion accessories see page 7.

Optional Apparatus for De-Airing Water see page 9.

TRIAXIAL STRESS MEASUREMENT TEST (UU-CU-CD TESTS)

Multiplex Universal Electromechanic Test Machine

The UTM-0108 Multiplex Universal Electromechanic Test Machine is a Servo Controlled Multiplex Machine supplied complete with UTGM-0025 50 kN Load Cell, UTGM-0062 25 mm Linear Potentiometric Transducer and UTC-4930 BC 100 Data Acquisition and Control Unit. 5 kN Loadcell should be ordered separately for Triaxial Tests.

The Frame capacity is 50 kN. This versatile digital loading frame features a microprocessor controlled drive system with an advanced servo motor enabling the operator to easily set any test speed via the membrane keyboard. The keyboard comprises adjustment buttons such as "start", "increase", "automatic", "manual", "down", "up". The testing speed can be set between 0,00001 mm/min to 51mm/min. The test automatically stops when load and displacement is reached to 99% value of the set measuring range. Visit Our website (Products/Universal/Multiplex Machines) for UTM-0108 details .

Load and displacement values are collected by BC 100 and transferred to PC for further processing with the UTS-0416 UU and UTS-0417 CU-CD Software.

Dimensions	550x650x1100 mm
Weight (approx.)	95 kg
Power	750 W

UTGM-0042 with UTGM-0062

UTM-0108

BC 100 Unit

BC100 TFT unit is designed to control the machine and processing of data from load-cells, pressure transducers or displacement transducers which are fitted to the machine.

All the operations of BC100 are controlled from the front panel consisting of a 800x480 pixel 65535 color resistive touch screen display and function keys 4 analogue channels are provided for load-cells, pressure transducers or displacement transducers.

BC100 has easy to use menu options. It displays all menu option listings simultaneously, allowing the operator to access the required option in a seemless manner to activate the option or enter a numeric value to set the test parameters.The BC100 digital graphic display is able to draw realtime "Load vs. Time", "Load vs. Displacement" or "Stress vs. Time" graphics.

BC100 unit offers many addition unique features. You can save more than 10000 test results in its internal memory. BC100 unit has support for various off-the-shelf USB printers, supporting both inkjet and laser printers(ask for compatible models). Thanks to its built-in internet protocol suite, every aspect of BC100 device can be controlled remotely from anywhere around the world.

MAIN FEAUTURES

- Can make test with displacement or load control.
- Real time display of test graph.
- CPU card with 32-bit ARM RISC architecture
- One analog channel for high capacity load cell, one analog channel for low capacity load cell, one analog channel for displacement transducer and one analog channel for cell pressure (only for UU tests)
- Programmable digital gain adjustment for load-cell, pressure transducers, strain-gauge based sensors, potentiometric sensors, voltage and current transmitters
- 1/256000 points resolution per channel
- 10 data per second sample rate for each channel
- Ethernet connecting for computer interface
- 800x480 resolution 65535 color TFT-LCD industrial touchscreen
- 4 main function keys
- Multi-language support
- 3 different unit system selection; kN, Ton and lbf
- Real-time clock and date
- Test result visualization and memory management interface
- Remote connection through ethernet
- USB flash disc for importing test results and for firmware
- USB printer support for inkjet and laser printers (ask for compatible models)
- Camera support for real-time video recording during test (ask for compatible models)
- Free of charge PC software for the test control and advanced report generation

TRIAXIAL STRESS MEASUREMENT TEST (UU-CU-CD TESTS)

Data Acquisition & PC Software

The CU-CD triaxial test is a complicated test needs load data, diplacement data 3 pressure data from triaxial cell and volume change data. Load data and displacement data are transfered and recorded through BC 100 Unit to the software. 3 pressure data from triaxial cell and volume change data transfered and recorded through the unilogger to the software.

The UTEST software for CD-CU tests is compatible with UTEST UTG-0320 datalogger and BC 100 unit. UTEST unilogger can be connected to PC by RS232 port. All channel gains can be set manually and accuracy of the reading can be increased.

Triaxial Software is a modular software that when a new test wanted to do, it directs the user step by step. First the software wants to input initial measurements such as diameter, heigth, sample weigth etc. On this stage the user decides CU or CD test will be done and enters cell pressure increment steps, back pressure differential pressure and effective stress that will be used on consolidation.

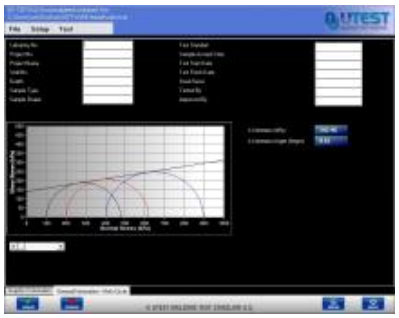
After the initialization is completed, the user goes to Saturation Cell Pressure increment stage. Cell presure must be incremented to the pressure entered at initialization stage. During this stage the software calculates B and pore pressure and submits their graph respect to time. When B value saturates this stage must be ended. Generally value of B would not reach to 0.95, therefore a back presuure increment stage must be implemented. On the saturation back pressure increment stage, prior to the start of this stage software commands what back pressure must be applied respect to initial settings. The software draws volume change and pore pressure data during this stage.

Saturation stages can be done recursively at most of 10 cycles. The relevant data of each stage is written to respective files for further investigation and report facilities. When the saturation is completed the consolidation stage can be implemented.On this stage the software commands to adjust both cell and back pressure to apply effective stress. On the consolidation stage Volume change,pore pressure and pore pressure disssipation percent is drawn as graphs. When the stage is completed, the next stage will be shear stage of CU or CD. The software suggest the shear speed respect to the results found on consolidation stage. Axial displacement and force must be tared prior to the start of shearing.

On the shear stage deviator stress, pore pressure, σ' versus σ'3 and s' versus t' graphs are drawn. 4 different test specimen can be configured in same file. All the results are used for drawing mohr circles. The data is evaluated with respect to specimen shear end condition. This condition can be selected as constant pore pressure, constant volume change effective prime deviator ratio etc. With the final measurements one set of data is closed.

The raw data can be exported to Microsoft Excel. Without using Microsoft Excel environment all reports can be printout which includes summary of each stage with relevant graphs.

UTG-0320



TRIAXIAL STRESS MEASUREMENT TEST (UU-CU-CD TESTS)

Triaxial Cells

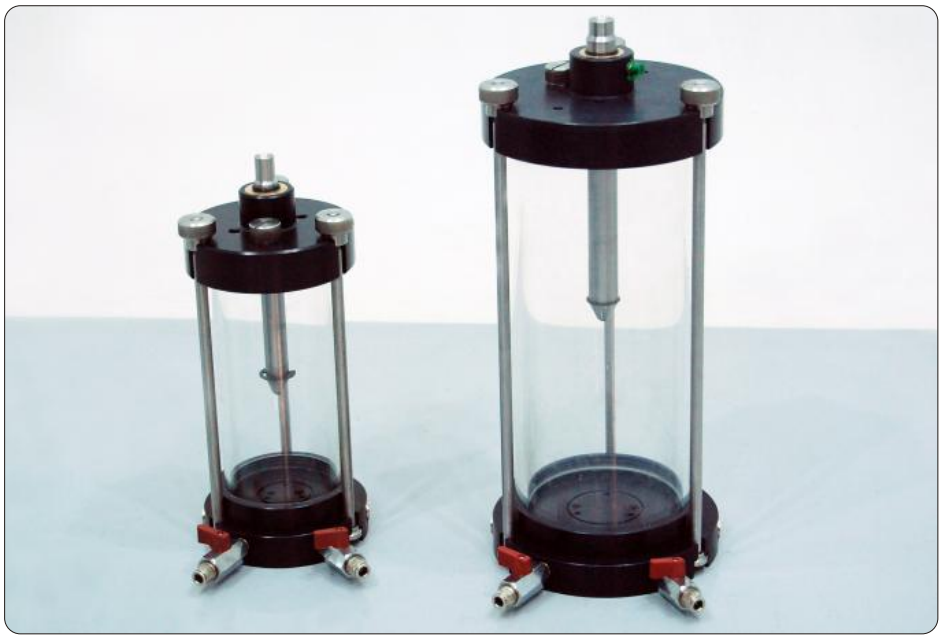
UTS-0400 Standard Triaxial cell for 38 and 50 mm dia. samples
UTS-0401 Standard Triaxial cell for 70 and 100 mm dia. samples

The cell has been designed and treated to minimize corrosion. Particular attention has been paid to the quality of finish between the piston and the head. Final assembly includes the fitting of an O-ring seal and the use of a special lubricant to reduce friction to a minimum and eliminate water leakage. The piston load capacity is designed to accept high axial loads which may be present during the final stages of a test.

Each cell has five take-off positions drilled in the base for top drainage/back pressure, pore water pressure and bottom drainage. Three no volume change valves and anvil for displacement transducer are supplied complete with the cell. Each cell will accept a range of base adaptors and various accessories for testing a wide range of specimens.

The cell capacity is designed to tolerate confining pressures as high as 1700 kPa which is enough for simulating most in-situ conditions.

For cell accessories and sample prepatarion accessories see next page.



UTS-0400 UTS-0401

	UTS-0400	UTS-0401
Dimensions	160X160X400 mm	210X210X550 mm
Weight (approx.)	4.5 kg	12 kg

TRIAXIAL STRESS MEASUREMENT TEST (UU-CU-CD TESTS)

Cell Accessories

Sample Diameter(mm)	38	50	70	100	UU Test	CU CD Test
Base Adaptor	UTS-0420	UTS-0450	UTS-0470	UTS-0500	YES	YES
Porous Top Cap	UTS-0421	UTS-0451	UTS-0471	UTS-0501	YES	YES
Nylon Tubing for Drainage	UTS-0422	UTS-0452	UTS-0472	UTS-0502	--	YES
Pair of Porous Discs	UTS-0423	UTS-0453	UTS-0473	UTS-0503	--	YES
Rubber Membrane	UTS-0424	UTS-0454	UTS-0474	UTS-0504	YES	YES
Membrane Placing Tool (Strecher)	UTS-0425	UTS-0455	UTS-0475	UTS-0505	YES	YES
0 Ring(10 pcs.)	UTS-0426	UTS-0456	UTS-0476	UTS-0506	YES	YES
0 Ring Placing Tool	UTS-0427	UTS-0457	UTS-0477	UTS-0507	YES	YES
Leteral Filter Paper(50 pcs.)	UTS-0428	UTS-0458	UTS-0478	UTS-0508	--	YES
Filter Paper Discs(100 pcs.)	UTS-0429	UTS-0459	UTS-0479	UTS-0509	--	YES
Plastic Discs (2pcs)	UTS-0430	UTS-0460	UTS-0480	UTS-0510	YES	--

Sample Preparation Accessories

Sample Diameter(mm)	38	50	70	100
Split Sand Former	UTS-0431	UTS-0461	UTS-0481	UTS-0511
Split Mould	UTS-0432	UTS-0462	UTS-0482	UTS-0512
Cutter	UTS-0436	UTS-0466	UTS-0486	UTS-0516
Aluminium Dolly	UTS-0437	UTS-0467	UTS-0487	UTS-0517

TRIAXIAL STRESS MEASUREMENT TEST (UU-CU-CD TESTS)

Oil and Water Constant Pressure System

Product Code

UTS-0408 Oil and Water Constant Pressure Unit, 1700 kPa
220-240V, 50-60Hz, 1ph
UTS-0409 Digital Pressure Gauge, 1700 kPa (250 psi)
UTGM-0110 Pressure Transducer, 2000 kPa

The Oil and Water Constant Pressure Unit is extremely versatile and can be used in conjunction with a wide range of test equipment. The unit provides continuous variable pressure up to 1700 kPa. Pressure is increased or decreased simply by turning a control wheel.

The Unit is used for providing cell/back pressure in triaxial tests. The apparatus is supplied without a gauge for those customers who have suitable pressure monitoring equipment.

As optional equipment for monitoring the pressure of the unit;

- The Digital Pressure Gauge (UTS-0409) or
- The pressure transducer(UTGM-0110) which can be used with UTEST BC100 TFT Unit on the Multiplex Universal Electromechanic Test Machine (UTM-0108) for only UU test or
- The pressure transducer(UTGM-0110) which should be used with the datalogger (UTG-0320) for CU-CD tests

can be used and prefered optional equpment should be ordered separately.

The machine features a clear hydraulic/water interface reservoir and up to 1 liter capacity of water is available under pressure. Supplied complete with 2 liters of No.46 regular hydraulic oil.

UTS-0408 with UTS-0409

Product Code	Dimensions	Weight	Power
UTS-0408	300X250X250 mm	7.5 kg	35 W
UTS-0409	150X150X100 mm	0.6 kg	

Volume Change Measurement

Product Code

UTS-0415 Automatic Volume Change Unit

The Unit consists of a piston connected to a 25 mm travel linear transducer which is 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 creates an electrical signal proportional to the volume of water flowing through the unit. By connecting it to the data acquisition system the measured volume change will be used by software during the test and in final report.

Capacity : 100 cm^3
Transducer Input : up to 12 V DC
Accuracy : ± 0.1 ml

Dimensions	260x260x400 mm
Weight (approx.)	5 kg


UTS-0415

Pressure Transducer and Block for Triaxial Test Cells

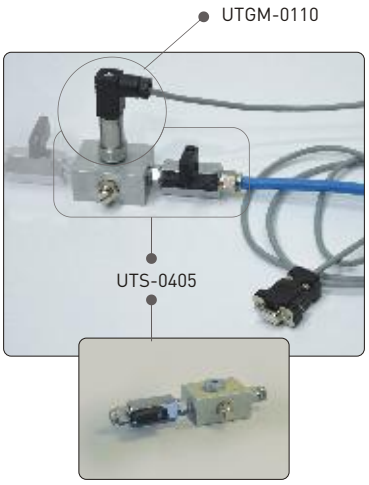
Product Code

UTGM-0110	Pressure Transducer, 2000 kPa
UTS-0405	Blockwith One Connection Line for Triaxial Test
UTS-0406	Block with Three Connection Lines for Triaxial Test

The Pressure Transducer is used for the measurement of cell or back or pore pressure of water in triaxial test systems and also should be used with an UTEST BC100 TFT Unit (UTC-4930) or a datalogger (UTG-0320)

The Block for triaxial test cells are used for connection of the pressure transducers and de-airing in the water hoses.


UTS-0406



De-Airing Water

Product Code

UTS-0418	De-Airing Water Apparatus, 230V, 50Hz, 1ph
UTS-1330	De-Airing Water Tank, 7 L.
UTGE-3580	Vacuum Control and Water Connection Panel with Regulator and Vacum Gage Manometer
UTGE-3585	Connection Panel for Vacuum and Water with Vacuum Gage Manometer
UTGE-3505	Vacuum Pump 51 L/min. Capacity, 220-240 V 50-60 Hz
UTGG-2015	Filter Flask 2000 ml
UTGE-3570	Air Drying Unit / Water Trap, Vacuum Type
UTGP-1140	Plastic Hose, Ø8mm, 6m

The UTS-0418 De-Airing Water Apparatus is a compact and self-contained equipment which can de-air water quickly and efficiently down to levels of dissolved oxygen acceptable for geotechnical test methods.The apparatus used in conjunction with the de-airing tank (UTS-1330). Air is removed from the water by a vacuum system. De-airing tank should be ordered separately.


UTS-0418


UTS-1330

TRIAXIAL STRESS MEASUREMENT TEST (UU-CU-CD TESTS)

The first option for de-airing water;

- De-Airing Water Apparatus UTS-0418
- De-Airing Water Tank(UTS-1330)
- Vacuum Control and Water Connection Panel with Regulator and Vacum Gage Manometer(UTGE-3580) or Connection Panel for Vacuum and Water with Vacuum Gage(UTGE-3585) (These panels are optional)
- Plastic Hose (UTGP-1140)

The second option for de-airing water;

- Vacuum Pump (UTGE-3505),
- Filter Flask (UTGG-2015) or Air Drying Unit / Water Trap (UTGE-3570)
- De-Airing Water Tank (UTS-1330)
- Vacuum Control and Water Connection Panel with Regulator and Vacum Gage Manometer (UTGE-3580) or Connection Panel for Vacuum and Water with Vacuum Gage(UTGE-3585) (These panels are optional)
- Plastic Hose (UTGP-1140)

By using UTGE-3580 Vacuum Control and Water Connection Panel, vacum pressure degree can be regulate.

By using UTGE-3585 Connection Panel for Vacuum and Water with Vacuum Gage Manometer and UTGE-3580 Vacuum Control and Water Connection Panel with Regulator, de-aring water equipment can be used without repeated assembling the hoses.

Product Code	Dimensions	Weight (approx.)
UTS-0418	465x240x340 mm	15 kg
UTGE-3580	450x150x500 mm	7 kg
UTS-1330	250x250x250 mm	2.7 kg
UTGG-1442	120x120x220 mm	0.5 kg
UTGE-3505	300x150x240 mm	8.5 kg
UTGE-3570	70x80x170 mm	0,5 kg

UTGE-3580

UTGE-3585

UTGE-3570