

GCTS is committed to designing accurate testing systems by integrating innovative software engineering with advanced hardware. GCTS systems perform at the highest levels of reliability, providing efficient systems that satisfy customer needs and expectations.

► **RDS-300**
Rock Direct Shear System



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- **Closed-Loop Servo Control System**
- **500 kN Normal Load & 300 kN Shear Load Capacities**
- **Adjustable Locking Mechanism to Prevent Rotation of Top Box in any one Direction, two Directions, or None**
- **Accepts Specimens with up to Ø150 mm (6") & up to 150 mm high**
- **Software for Automatic Performance of Direct Shear Tests Including Normal Stiffness Control**
- **Unconfined or Triaxial Tests with Optional Hardware**
- **Also Available Large-Scale Test Systems for Shear Loads of up to 1,000 kN (100 ton) & Specimen Sizes up to 300 mm Diameter or Side.**

DESCRIPTION

The GCTS Rock Direct Shear System is a versatile “turn-key” system for determining shear strength of a wide range of intact or jointed rock specimens. The rock specimen configurations include cylindrical cores, cubes, prisms, and rock fragments.

This system features state-of-the-art, electro-hydraulic, closed-loop digital servo control of shear and normal loads for test automation. The system includes automatic data acquisition and real-time graphics with very precise sensors and 16-bit resolution. The GCTS system is easily programmable to measure residual shear strength during or after any number of cycles specified by the user.

The GCTS software calculates automatically the corrected specimen area, the normal and shear stresses, shear deformation, and the average normal deformation. Loads, stresses or deformations for both the shear and normal



Shear Box

actuators can be directly prescribed to perform advanced tests. The hydraulic servo control of the normal load has a very low compliance that enables the precise performance of tests such as Normal Stiffness Control test, where the normal deformation is controlled as a function of the prescribed stiffness to simulate actual compressibility of a ground shear plane. The rotation of top shear box can be restricted forcing the shear plane to remain constant. Rotation restrictions can be made on either one or both axes (pitch or roll). Alternatively, the top shear box can be set free to rotate while four LVDTs describe the shear plane inclination.

The low friction linear bearings on the base guide the horizontal movement of the shear box. The rigid frame around the shear box provides high overall stiffness to the system.

Sample rings with pre-grouted specimens can be easily mounted in the shear box allowing for simultaneous preparation of multiple specimens (using optional sample rings). This avoids waiting for curing, and therefore, ideal for production testing.



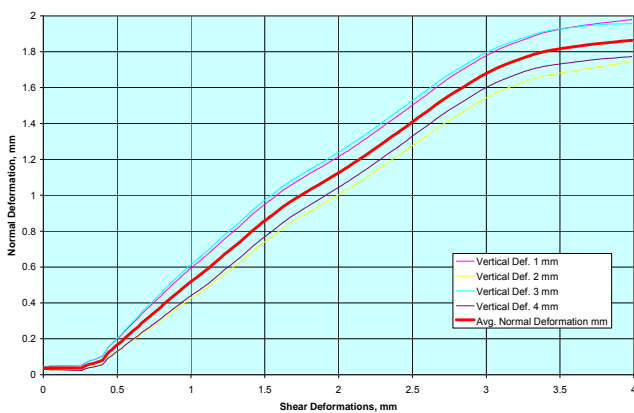
Specimen Rings

GCTS offer specimen rings with different inside diameters up to 150 mm. Ring holders can also be ordered for different initial shear gaps. The standard shear gap is 10 mm.

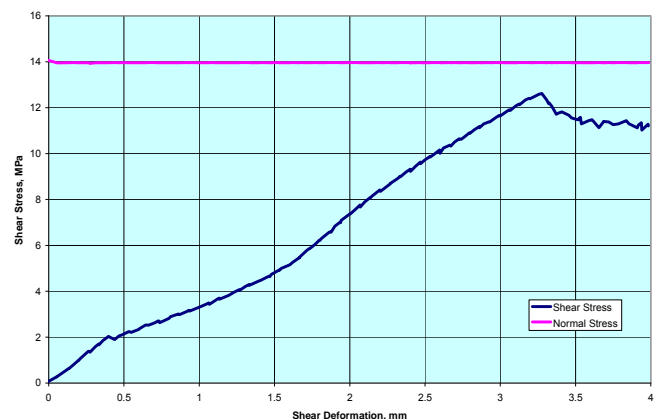
This system can also be provided with an optional triaxial cell, unconfined loading platens, indirect loading tension (Brazilian) platens, etc. to perform most of the laboratory mechanical tests required for rocks.



Direct Shear System with Triaxial Cell Option



Normal Deformation vs. Shear Deformation



Normal & Shear Stress vs. Shear Deformation

SPECIFICATIONS

1) RDS-300 ROCK DIRECT SHEAR SYSTEM

1.1) Compression Frame 500 kN (100 kips)

Four-column vertical standing assemble with 1,000 kN/mm (5,700,000 lbs./inch) frame stiffness: Clearance between platens: 600 mm. Clearance between columns: 410 mm. Includes 100 mm swivel platen with HRC 45 hardness.

1.2) Direct Shear Apparatus

Top shear box with horizontal translation fixed and bottom shear box mounted on sliding bearings to minimize horizontal friction. Includes adjustable locking mechanism to prevent rotation of the top box in any one direction, two directions, or none (fixed so that no shear plane rotations are allowed).

1.3) Rock Specimen Shear Rings

Top and bottom 150 mm inside diameter sample rings for rock specimens up to 150 mm high for testing cylindrical cores, cubes, prisms, and rock fragments. Tight fit in direct shear box.

1.4) Electro-Hydraulic Shear Load Actuator

Double acting (pull/push) hydraulic loader with ± 300 kN (± 30 ton) load capacity, ± 50 mm stroke and a 19-LPM electro-hydraulic servo valve for closed-loop control of shear load or shear displacement.

1.5) Electro-Hydraulic Normal Load Actuator

Hydraulic loader with 300 kN (30 ton) load capacity, 100 mm stroke and a 19-LPM electro-hydraulic servo valve for closed-loop control of normal load or normal displacement.

1.6) Transducers

Sensors to automatically measure Shear and Normal Loads, and Shear and Normal Deformations.

- One (1) Load sensor 300 kN range for shear load.
- One (1) Load sensor 250 kN range for normal load.
- Two (2) Deformation sensors 100 mm range for shear and normal deformation.
- Four (4) Deformation sensors 12 mm range for normal box deformation.

1.7) SCON-2000: Digital Servo Controller and Acquisition System

Microprocessor based digital servo controller, function generator, data acquisition, and digital I/O unit. Advanced servo control from any system sensor with "on-the-fly bump-less" transfer switching between any connected transducer or calculated input.

- 850 MHz micro-processor with 64 MB RAM and 64 MB solid state disk.
- 6 kHz maximum loop rate (200 kHz conversion rate between channels).
- Adaptive digital servo control.
- 16-bit resolution.
- Sample and Hold
- Accepts up to 24 DSB-111 universal signal conditioning boards.
- Accepts up to 8 control channels (DSB-121 and DSB-122 boards).
- 8 digital inputs and 8 digital outputs
- 48-bit digital counter.
- Watchdog timer to detect control program status for automatic interlock shutdown.
- Ethernet and RS-232 Communications.

1.8) DSB-111 Universal Signal Conditioning Boards (8 each)

Includes 8 universal signal conditioning boards for load cells, LVDTs, pressure transducers, or other analog input signals. Each module includes digital (computer) controlled offset and gain.

- 16-bit resolution.
- Adjustable offset range: ± 5 volts.
- Adjustable gain range: 1 to 1000 in 4000 steps
- ± 5 volt DC excitation
- 5 Volt RMS @ 3kHz AC excitation
- 6-pole anti-alias filter with 0-50 Hz flat response with less than 0.009

dB ripple and more than 60 dB attenuation at frequencies larger than 500 Hz

- Allows user to change or configure system with different type sensors

1.9) DSB-122 Servo Amplifier Boards (2 each)

Includes 2 servo amplifier boards to drive servo valves for the digital control of the shear and normal load/deformations. 16-bit resolution and 325 mA maximum output servo amplifier board to drive servo valves. Each board includes null, gain, dither amplitude, dither frequency, and current limit adjustments.

1.10) WIN-CATS Control Software

32-bit Windows 98/2000/NT/XP software for advanced digital servo control from any system sensor or calculated channel with "on-the-fly" bump-less transfer. Includes calculated channels for stress, strain, etc. and user defined equations. Digital servo controller.

- Third degree polynomial conversions from sensor output in real time
- Ability to define user defined inputs as a function of other inputs and correct by another input via a third degree polynomial to view or control in real time
- Configurable unit library to automatically perform unit conversions
- Linear, log, and semi-log plotting capability with user specified plot parameters
- Unlimited user configurable view tools (meters, gages, bars, etc.)
- Signal analysis option that will give FFT of any system signal
- Advanced PID control with adaptive control
- Peak/Valley compensation on system control
- Stabilization by any associated input in control, not only the feedback control sensor

1.11) WIN-DSH Direct Shear Software

Direct Shear Test Module to automatically perform conventional direct shear tests as well as residual and incremental tests. Includes shear stress or shear deformation control, normal stress, normal deformation, real-time graphical display of test progress with auto-zoom, automatic SI or English unit conversion, automatic specimen area corrections, and presentation ready graphical output. Also includes normal load/deformation computer control to perform constant normal stiffness tests where the normal load is a function of a prescribed stiffness to simulate actual compressibility of a ground shear plane.

1.12) Computer System

IBM-PC compatible computer and software to control and execute the test automatically with the following specifications: Pentium IV processor, 512 MB RAM, 40 GB Hard, CD/RW ROM drive, 17" SVGA color monitor, and mouse.

1.13) Electro-Hydraulic Pump System

19 LPM, 10 HP, 20 MPa variable volume constant pressure pump. 150 liter reservoir, oil temperature indicator, filter, pressure gage, valves, thermal and low fluid level shut off protection, heat exchanger, 10 m long hydraulic hoses, accumulator, filler strainer, drain port and motor starter. Includes computer on/off controls and oil temperature and level sensors for computer diagnostics and interlocks. Voltage: 208, 230, 380 or 460 V / 50 or 60 Hz / 3-phase (please specify electrical power at time of ordering).

OPTIONS

2) Extra Set of 150-mm Specimen Inside Rings

Top and bottom 150 mm inside diameter sample rings for rock specimens up to 150 mm high for testing cylindrical cores, cubes, prisms, and rock fragments. Allows preparing a second specimen while the testing equipment is testing another specimen. Tight fit in direct shear box.

3) Extra Set of 100-mm Specimen Inside Rings

Top and bottom 100 mm inside diameter sample rings for rock specimens up to 100 mm high for testing cylindrical cores, cubes, prisms, and rock fragments. Allows preparing a second specimen

while the testing equipment is testing another specimen. Tight fit in direct shear box.

4) HTRX-70 High Pressure Triaxial Cell

4.1) Triaxial Cell

Stainless steel construction triaxial cell, 70 MPa (10,000 psi) confining pressure capacity and 1,000 kN axial load capacity. Accepts samples with a diameter from 25 mm to 65 mm and with a length of 2 times the diameter. Supplied with 10 electrical feed-through connectors for in-vessel instrumentation. Includes loading piston with spherical seating, cell and pore fluid connectors, and one set of spare seals. Accepts axial and circumferential measurement device. Fits inside the DSH-300 compression frame.

4.2) Software

Triaxial test module to automatically perform conventional triaxial static tests as well as other advanced tests such as Stress-Path, Ko-loading, etc. Includes procedures for servo controlling the radial strain for post failure behavior tests.

5) Triaxial Platens for EX, AX, BX, NX, HQ, or HX Diameter

Set of platens for triaxial testing. Includes top and bottom platen made of hardened steel with a Rockwell hardness of no less than HRC58 and grounded surface with flatness better than 0.005 mm. Meets ISRM specifications. Please indicate desired size at time of ordering.

6) Unconfined platens for EX, AX, BX, NX, HQ, or HX Diameter

Set of platens for unconfined testing. Includes top and bottom platen made of hardened steel with a Rockwell hardness of no less than HRC58 and grounded surface with flatness better than 0.005 mm. Meets ISRM specifications. Please indicate desired size at time of ordering.

7) Axial & Circumferential Measurement Device for High Pressure Triaxial Cell

For the measurement of axial and radial strains inside the triaxial cell. One (1) set of upper and lower LVDT holder rings for two deformation sensors positioned at 180 degrees to measure average axial strain. Accommodates specimens from $\text{Æ}50$ to 65 mm.

- One (1) circumferential roller assembly and LVDT holder to measure arc changes. Accommodates specimens with a diameter from 50 mm to 65 mm.
- Three (3) LVDT ± 2.5 mm range.
- Three (3) DSB-111 Universal Signal Conditioning Boards.

8) Air Operated Confining or Back (pore) Pressure Pump

Air operated hydraulic pressure pump, 70 MPa (10,000 psi) pressure capacity for confining or back (pore) pressure application to triaxial cell. Requires 700 kPa (100 psi) air pressure supply.

9) Pressure Intensifiers and Volume Change System for Cell or Back (Pore) Pressure Computer Control

This option allows the performance of more advanced tests such as the stress/strain path as well as permeability and hydraulic fracture tests. (Note: Two intensifiers are recommended for a complete triaxial system with cell and pore pressure servo control).

9.1) Pressure Intensifier

Pressure intensifier system for independent control of the cell or back (pore) pressure to 70 MPa (10,000 psi) and 280 cc stroke capacity. Closed-loop digital servo control of pressure or flow with "bumpless" transfer. Capable of measuring volume change under pressure control or pressure change under flow control. Required to perform Ko-consolidation test. Includes 11 LPM servo valve, pressure gauge, and fluid fill reservoir.

9.2) Transducers

Transducers to measure pore pressure and pore volume change:

- One (1) LVDT 250.0 mm range.
- One (1) pressure Trans. 70 MPa range.

10) P & S Ultrasonic Velocity Measurement System

- Signal Conditioning and Pulse Generation.
Digitally controlled pulser and receiver including anti-alias filter. 10 MHz Bandwidth receiver. User selectable pulse energy amplitude. Pulse raise time less than 5 nano-seconds.
- High Speed Acquisition board
20 MHz acquisition rate with 12 bit resolution digitizing board. Includes system cables.
- Computer Interface & Data Acquisition
16 single ended or 8 differential analog inputs with 200 Hz anti-alias filter. 12-bit resolution, ± 10 volt, A/D data acquisition board with 16 single ended or 8 differential A/D channels and shielded cables (100 kHz sampling rate). 2 D/A channels for P & S wave velocity output to an external acquisition or control system. Includes system cables.
- Ultrasonic Velocity & Data Acquisition Controller
Digital signal processing and signal enhancement software for automatic ultrasonic velocity measurements including wave form stacking, filtering, and spectral analysis. Acquisition software with engineering unit displays and graphs of up to 16 channels. Automatic P & S velocity measurements programmable by time or input signal level change. Output data compatible with Excel or other programs. Includes Pentium processor and 15" color monitor.
- P & S Wave Dual Selector Switch
Computer controlled selector switch for the automatic selection of P or S pulser and receiver transducers.

11) Ultrasonic Transducers for Triaxial Testing

Set of compression mode and shear mode transducer platens for EX, AX, BX, NX, HQ, or HX diameter specimens with 200 kHz frequency crystals (1 MHz crystal also available) for GCTS Triaxial cell. Shear wave transducers built with 4 shear crystals each. Platens can be used with selected specimen diameters only. Please specify diameter at the time of ordering.

12) Installation & Training

Installation assistance and training at customer facility (3 days). Includes airfare, lodging, food, etc.

WARRANTY

One (1) year parts and labor.

SHIPPING

Approximated Volume of Standard System: 6 m³
Approximated Weight of Standard System: 2,400 kg.