

**Direct Digital Shear Apparatus  
SL372**

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User Guide  
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## Direct Digital Shearbox

Digital direct shear box, floor mounted with carriage assembly and load hanger with 10:1 lever loading device.

- Microprocessor controlled digital stepper motor
- Control via the digital display with keyboard
- Return datum facility
- Fully steplessly variable speed over the range of 0.00001 to 9.99999mm/minute
- RS232 port
- Forward/reverse travel limit switches
- Will accept either analogue or digital measuring devices

### Introduction:

In all soil stability, problems such as the analysis and design of foundations of retaining walls and embankments, knowledge of the strength of the soil involved is required. The Direct Shear Test is one of the tests for measurement of shear strength of soil.

The Direct Digital Shear Apparatus meets the general requirements of BS1377 and has a normal load capacity of 8kg/sq. cm when the loads are applied through lever and 1.6kg/sq. cm when the loads are applied directly. The following tests can be performed with this apparatus.

- I) Immediated, Undrained or quick
- II) Consolidated Quick or Consolidated Undrained
- III) Slow or Drained
- IV) Residual Shear Strength Test

Description:

The shear box complete with bottom and top plates, porous stones gripper plates, plain or perforated, and a water jacket is mounted on a loading unit. The shear box housing can be attached to the lead screw and the top half of the shear box to the Proving Ring through Universal adaptors. The Shear Box is made in two halves. The top half slides over the lower half and is fitted with a loading U-arm that can be connected to the Proving Ring. The two boxes are pinned together with two removable pins. Three shear clearance adjustment screws are provided, with the help of three screws, the upper half of the shear box is raised above the lower half. The bottom plate supporting the test specimen rests on pins in the sides of the lower half of the shear box. Two pairs of gripper plates are provided, one pair plain & the other pair perforated. The top-loading pad has a recess for a steel ball which can be inserted and on which the loading yoke rests. The normal load can be applied to the specimen either directly or through a loading steel ball. The pins are to be removed after the loading plate is placed over the specimen in the box. The water jacket rests on two ball roller strips, which are held between v-grooves and a flat surface on the underside of the water jacket and matching grooves on strips, which are fixed firmly to the channel of the frame.

The Water Jacket with Shear Box is attached to the lead screw through a Universal bearing and the u-arm is attached to the Proving Ring.

The other end of the Proving Ring is held by means of the abutment screw.

The consolidation dial gauge rests on the top cross head of the loading yoke and the strain Dial Gauge rests against an anvil fixed on the water jacket.

The loading unit consists of a frame on which the water jacket rests. A bracket is mounted on the frame for fixing the Strain Dial Gauge. The Consolidation Dial Gauge is held by a clamp supported by a clamp rod. The normal loads are applied to the specimen either directly through counter balanced loading yoke or through a loading yoke connected to a counter balanced detachable lever yoke and the lever being counter balanced by a weight. The loading lever has ratio of 1:10 and is supported on knife-edge and grooves, the fulcrum being the knife-edge on the capstan. After counter balancing, for levelling and for lowering or raising the loading yoke, the

capstan is used. The weights are placed on the hanger. These weights have been marked to indicate the normal stress on the specimen when placed on the hanger during lever loading. In the case of direct loading, these indicated values have to be divided by 10.

A counter weight is used to counter balance the loading system. The weight can be moved till the lever loading system is balanced and locked with the help of the two locking nuts. In the case of direct loading system, the detachable lever is removed and the hanger is suspended on the bracket and by moving the counter weight nearer the fulcrum, the loading system is balanced.

The shear load application is through the advancement of a load screw, which is secured against rotation by a sliding key. The thrust piece can be attached to the u-arm, which is fixed to the top half of the shear box. The thick walled portion of the water jacket rests against the lead screw. A load measuring proving ring of appropriate capacity is held between the thrust piece and a lead screw, which passes through the abutment bracket.

Setting up (A) for  
Lever Loading:-

Mount the frame on a level base. Position the lever on the groove provided on the lower arm with the knife-edge on the capstan coming on the groove in the lever. Place the loading hanger on the lever. Counter balance the loading lever by adjusting the counter weight and lock the counter weight. Then counter balance the whole of the loading system, loading lever, yoke and hanger by adjusting the counter weight. Once this is done, lock the counter weight in position with the help of lock nuts.

(B) for Direct  
Loading:-

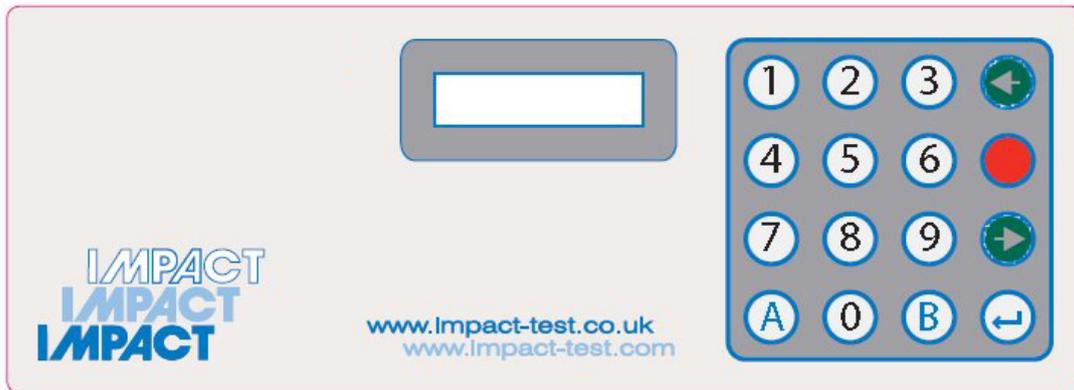
USE THE KEYPAD For setting the rate of movement of the lead screw (rate of deformation) for a shear test.

Specimen Preparation, Undisturbed:- undisturbed sample is necessary when the strength of cohesive soil in its natural state is required. Trim the larger mass of soil down to the required size, or clean the specimen cutter and force it into the ground till the sample slightly protrudes out of the cutter. Remove the cutter with sample by under digging and trim it flush at both ends.

Specimen Preparation Remoulded:- When the soil is to be disturbed and compacted, as on embankment, determine the strength from remoulded specimen. Press the specimen cutter into the larger mould in which the soil is compacted to the required dry density at the required moisture content. Alternatively, mix just sufficient water to the weighed amount of soil, which, when compacted to required volume yield a sample of required density and moisture content.

Compact the wet soil, directly in the specimen cutter after allowing some time of uniform distribution if moisture content. Do not compact the wet soil in the shear box as the cross grooved plate is rested on pins and they are likely to get damaged.

Non-cohesive soils may be tamped in the shear box itself with the base plate, gripper plate or porous stone in place at the bottom of the box, as required.



### Setting the Test Speed

Test Speeds are set using the numeric keypad. The position of the decimal point is fixed on the display, and as such does not need to be entered using the Numeric Keypad. To preset a speed of, for example 2.54000 mm/minute, enter 0254 on the numeric keypad. The speed will be entered on the bottom row of the display. After entering the preset speed, press the ENTER (ENT) key to set the Test Speed, which will now be shown on the top row of the display.

The A and B buttons on the keypad may be used to set any speed that is used on a regular basis.

To set the button speed enter the digits on the keypad as above and then press either button A or B to store that particular speed to that button.

Speeds in excess of 9.99999mm/minute should not be entered.

### Keypad Operation

Press the LEFT key to start the ram moving leftward at the test speed displayed. It will continue moving upward until the left limit is reached or the STOP key is pressed.

To position the ram quickly, the LEFT key is held pressed. After 2 seconds, the ram speed will accelerate to 50mm/minute. When the LEFT key is released, the speed will revert to 5mm/minute.

Press the STOP key to halt ram travel at any time.

Press RIGHT to return the ram. It will travel at the last set LEFT speed and continue until the right Limit is reached, or STOP is pressed. To change the RIGHT speed, enter a new value using the keypad or press either the A or B button to use a pre-set speed.

## Limit Switches

When the Forward limit on the carriage assembly is encountered, the SL372 will only permit a Backward command. When the Backward limit is encountered, only a Forward command is permitted.

When the Forward and Backward Limit micro-switches mounted on the carriage assembly are connected into the SL372. The limit logic is: -

### LEFT AND RIGHT

Upper Limit encountered. STOP machine... Permit a Backward command

Lower Limit encountered. STOP machine... Permit a Forward command

## Test Procedure:-

(I) Immediate undrained or quick tests:- Transfer the specimen to the shear box with a gentle push. Place the top grid, porous stone and top plate one after another and rest the loading yoke on the top plate. Use the solid metal grid at the bottom to prevent the escape of pore water. If the specimen is to be saturated, fill the container with water. Raise the upper part of the box relative to the lower part slightly by screwing - in the shear clearance screws and then withdraw the screws completely.

Note:- For most soils, a clearance of approximately one millimetre between the two halves would be satisfactory. Remove the two pins holding the two halves together before applying the shear load.

Apply the shear load at a constant rate of deformation of 1.25mm/min. For any strain-controlled test, take set of readings every 15 seconds for the first 2 minutes and then at different time intervals. Continue the test to a horizontal displacement of approximately 20% of the length of the specimen unless a constant shear force is obtained earlier.

Note down the reading of the Load Ring at the time of failure. At the time of failure the reading starts to decrease after reaching a maximum. Repeat the above procedure for different specimens moulded from the same sample at different normal loads.

(II) Consolidated quick or consolidated undrained test:- Apply the load and allow the specimen to consolidate under this normal load. (If the normal load is of large intensity, it has to be applied in steps). Note down during the test the consolidation dial gauge readings at suitable intervals of time. This gives compression V/s time relationship. When the sample is completely consolidated under the applied normal load the shear stress is applied such that there is no volume change or change in moisture content.

(III) Slow or drained tests:- Apply the normal load and allow the specimen to consolidate under this normal load. Note down during the test the consolidation dial gauge readings at suitable intervals of time as in a consolidation test. This gives compression V/s time relationship. This may be used to evaluate the coefficient of consolidation by usual curve fitting methods. When sample is completely consolidated, the shear stress is applied at a strain rate so as to ensure that at least (or on scope is left for the development of pore pressure et al). Theoretical formulas suggested by Gibson & Henkel and other investigators may be made use of in the selection of strain-rate for drained tests.

(IV) Residual shear strength test:- this test is carried out after the failure of the specimen in the slow or drained test. After recording the maximum load taken by the specimen in the direct shear test, the switch on the machine is operated in the reverse direction so that the shearing load on the specimen is completely released. Then the load is applied in the reverse direction and the maximum reading of the proving ring recorded.

(V) Results:- Plot a curve of the shearing resistance V/s normal stress. Find out the apparent cohesion and the angle of shearing resistance from the graph.

Application of  
Shear:-

For applying shear loads to the specimen after preparing it as above, proceed as follows:-

1. Pull the sliding key to release the lead screw.
2. Select the strain rate required and set the strain on the keypad
3. Screw the clearance adjustment screws down till it comes in contact with the lower half of the shear box and then a half turn further so that the upper half of the shear box is just raised above the lower half. Unscrew the adjustment screws well above the lower face of the upper half of the shear box and lock.
4. Remove the locating pins which keep the two halves of the shear box together.
5. Note all readings of dial gauges and Load Ring.
6. Switch the motor on the 'Forward' and start reading when the Load Ring shows that shear load is being applied.

Maintenance:-

- I) Clean the apparatus after use and keep the lead screws lubricated with light grease and the rest with thin oil. Keep any exposed metal parts covered with grease to prevent corrosion when not in use.
- II) Dial gauges and Load Ring should be removed from the machine when the test is over and stored safely.