An Equipment for Linearly Rising Loads

by

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Introduction

FOR carrying out tests on models made of concrete or steel or other constructional materials some provision is required for the application of continuously increasing load as well as for recording the resulting deformation. In such situations, generally Universal Testing Machines with inbuilt automatic recording device are employed. The capacity of such a machine is too high (of the order of tons) and less sensitive for small model tests in soil laboratories. For the usual laboratory models of, footings of different shapes, static cone tests, small model piles, etc., suitable machines of capacity of a few hundreds of kg with a sensitivity of 1 kg or less, for the application of gradually increasing load are not available. As such small increments of loads either by dead loads or with the help of jacks coupled with measuring devices are applied to the models. Loading the models by increments is a step-loading procedure and it is difficult to apply dead loads such that no jerks take place. In other methods like jacking, the load on the model gets partly released following a deformation of the soil and due to sinking of the model into the soil. Hence, it requires constant attention of the operator to keep the load to a specified magnitude.

Any equipment which meets the requirements for the tests in soil laboratory should

(1) be simple and easy to fabricate and operate

(2) give smooth and very gradually increasing load on the model irrespective of the resulting deformation or settlement

(3) be sensitive with some flexiblity in capacity

(4) record automatically the load-settlement or load-penetration diagram

(5) have provision to apply different rates of loading

(6) be relatively cheap and

(7) be completely of indigenous material.

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Development of the Apparatus

A new apparatus has been fabricated fulfilling the above requirements. The apparatus (Figure 1 and Figure 2) consists mainly of a load supporting beam, carriage, load moving unit, load transferring spindle, recording unit, and a platform for the soil mould to be placed.

The Load Supporting Beam : It (1)* spans between the (7.5 cm × 5 cm I section about 160 cm long) immovable hinged support (8) and the loading spindle (15) and it is provided with ball bearings at the hinge for free rotation of the beam. It supports the carriage (2) along with the loads and carries an adjustable hanger (5) and a sliding weight (3) of small magnitude beyond the hinged support for balancing the lever with the counter weights. The ball (24) seated over the spindle can easily adjust itself to the position, in a prolonged groove provided under the spindle end of the beam, whenever the beam is lowered as the loading spindle slides downwards.

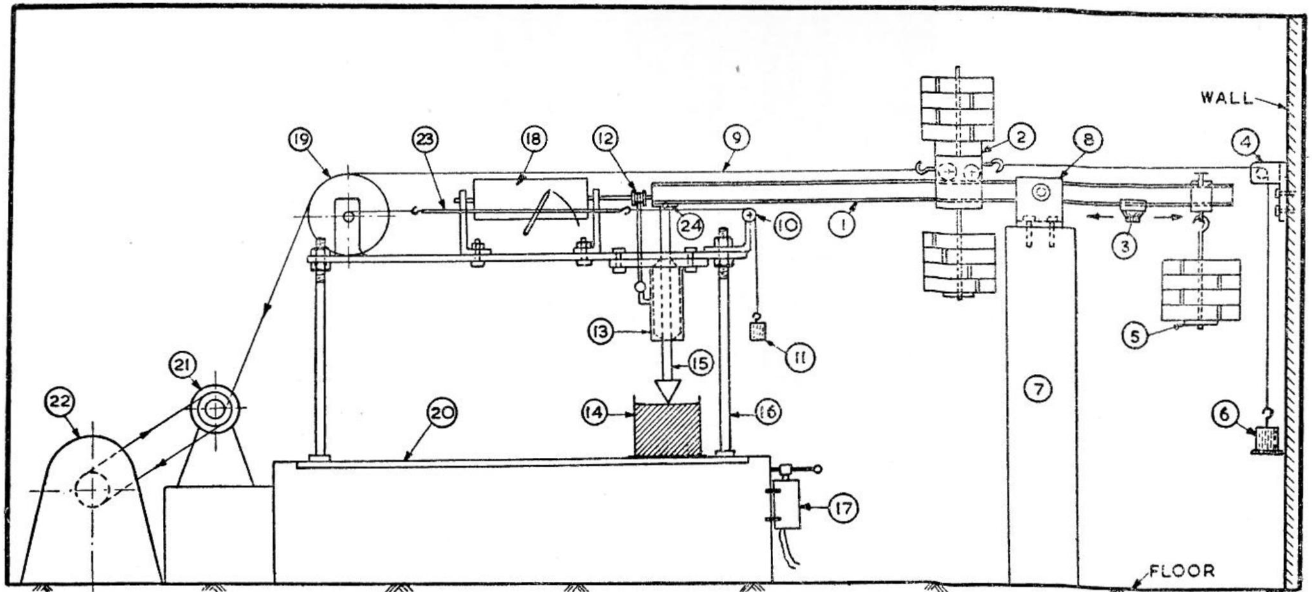
The Carriage : The carriage (2) is a hollow metallic box for carrying the dead loads. It is free to move smoothly over the beam as the ball bearings provided act as wheels. When the loads are placed over the carriage the centre of gravity of the whole assembly comes very near to the beam surface, on which the ball bearings move, avoiding eccentric pull on the loads and hence oscillations are avoided. The carriage is moved by a motor through a flexible cable interconnecting them over a rolling disc (19). A small weight (6) attached to the back of the carriage keeps the motion steady without any jerks.

The Load moving Unit : It consists of a motor 0.5 H.P. (22), a gear box and a stop down pulley (21). The interconnections are as shown in Figure 1 (9, 19, 21, 22). With the above arrangement the movement of the carriage can be obtained at any desired constant rate out of twenty variations possible, (5 gears and 4 steps on the pulley). The reverse switch (17) of the motor helps to bring the carriage back with the help of the small weight (16) attached to the carriage.

The Load transferring Spindle (15) : with a seating arrangement for a ball on the head, it is the key piece of apparatus to which the model to be tested is attached towards the bottom end. A frictionless guide (13) supports the spindle laterally as it slides vertically. Initially when the beam along with the carriage loads is balanced by counter-weights, the reaction that comes on to the spindle is zero and gradually increases to some value as the carriage moves forward. By changing the magnitude of loads on the carriage it is possible to change the intensity of rate of loading as well as the maximum load.

The recording Unit : It (18) consists of a well machined drum, free to rotate on its axis and properly supported by L-shaped legs. It is provided with a pencil holder which can move along the axis of the drum. The movements of the spindle and the carriage are transferred to the drum and the pencil, respectively, through the flexible thread connections

* The numbers in the brackets refer to the details of Figure 1.



Legend :

1. Loading beam (I–section) 2. Carriage with ball bearing 3. Sliding weight for finer adjustment 4. Pulley with support. 5. Counter weight with hanger and locking arrangement 6. Pull back weight to keep the motion steady 7. Masonry support. 8. Hinged support with ball bearings 9. Thin flexible rope 10. Pulley with support 11. Small counter weight 12. Fixed pulley on the axis of drum 13. Guide for loading spindle 14. Mould with compacted soil 15. Loading spindle with cone attached 16. 25mm dia. pillar supports—4 Nos. 17. Reversible switch. 18. Recording drum 19. Step pulley, type–disc, with supports. 20. Base plate with platform 21. Intermediate step pulley 22. Motor with gear box 23. Sliding rod with pencil 24. Ball seating.

FIGURE 1 : Schematic diagram of the equipment.

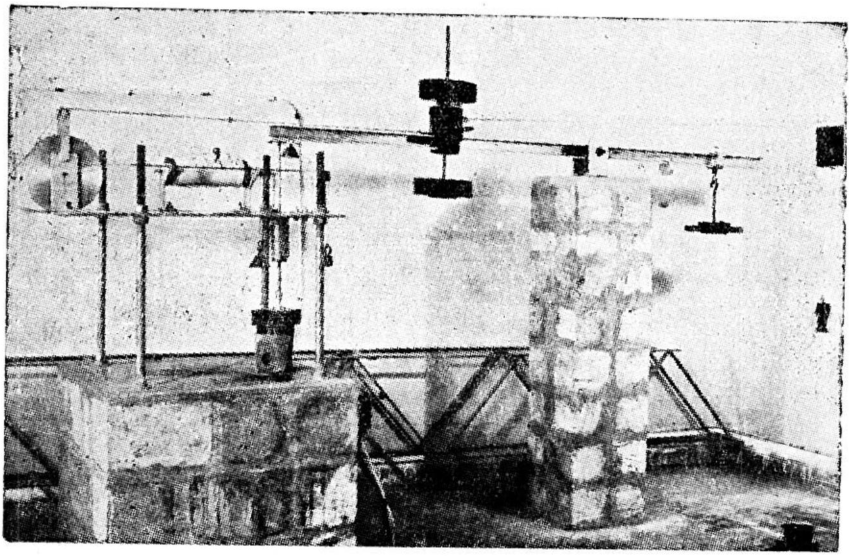


FIGURE 2 : Photograph showing the view of the equipment.

as shown (12, 23). As the load moves by a certain distance, the pencil moves by a fraction of that length over the drum and this forms the load axis. As the spindle with its attached model moves down under the load, the drum rotates correspondingly resulting in the movement shown to a magnified scale, and this forms the settlement or penetration axis. Thus, the load versus settlement or penetration diagram, is automatically recorded.

Working Platform : The platform (20) is mainly a base plate fixed at a convenient height for working. Four numbers of 2.5 cm diameter ; 60 cm long rods (16) welded at the four corners of the base plate form the supporting pillars of the top plate on which the recording unit (18), rolling disc (19) and the guide for the spindle (13), etc., are mounted. The top plate can be levelled with the help of nuts on the four corner supports. The elevation of the top plate is so adjusted that the top of the rolling disc and the carriage nose are at the same level so that no component of the pulling force comes on the spindle as the connecting cable is pulled. The platform mainly serves as a place to keep the soil mould below the loading spindle and the model.

Test Procedure : (*a*) The soil mould is prepared and kept ready for testing.

(*b*) The carriage is loaded with approximately double the estimated maximum load and counterbalanced with additional weights and finer adjustment is done with sliding weight (3).

(*c*) The model to be tested is screwed on the bottom end of the loading spindle.

(*d*) A graph sheet is attached to the drum and pencil is kept in position.

(*e*) The soil mould is kept on the platform under the loading spindle and the spindle is lowered till the model just touches the soil.

(*f*) The motor and the gear box are adjusted to the required speed.

(*g*) The motor is started and the experiment is carried out.

(*h*) When the carriage with the loads reaches its extreme position the motor is stopped.

(*i*) The carriage with the loads is brought back by reversing the motor with the help of reverse switch (17) and pull-back weight (6).

(*j*) The soil mould is removed and the graph sheet is detached.

(*k*) The details of the test like, density, moisture content, model tested, rate of loading, etc., are noted on the graph sheet.

Scale Factors : If W is the load on the lever weight of carriage + the loads placed, the load transferred **on** the testing model W_m is theoretically

$$W_m = W \times \frac{\text{length of travel of the carriage}}{\text{length of the lever arm}}.$$

With a view to account for the frictional losses at the hinge and in the guide for the loading spindle, the actual load transferred is measured with the help of proving ring placed below the spindle for different values of W and the load transfer ratio is obtained as an average of about half dozen values. Having known the actual load on the model and length of the diagram on the graph along the load axis the scale of graph is obtained. The scale along the settlement axis is the ratio of the perimeter of the drum (18) to the perimeter of the small pulley (12) and this scale which is constant for all diagrams happens to be 5.09 (magnified scale) in this case.

A set of load-penetration curves for static cone tests, obtained from the apparatus is shown in Figure 3. Similarly it is found to give fine performance in a good number of similar model tests.

Advantages

(1) It is a stress-controlled apparatus useful to get constant rate of loading.

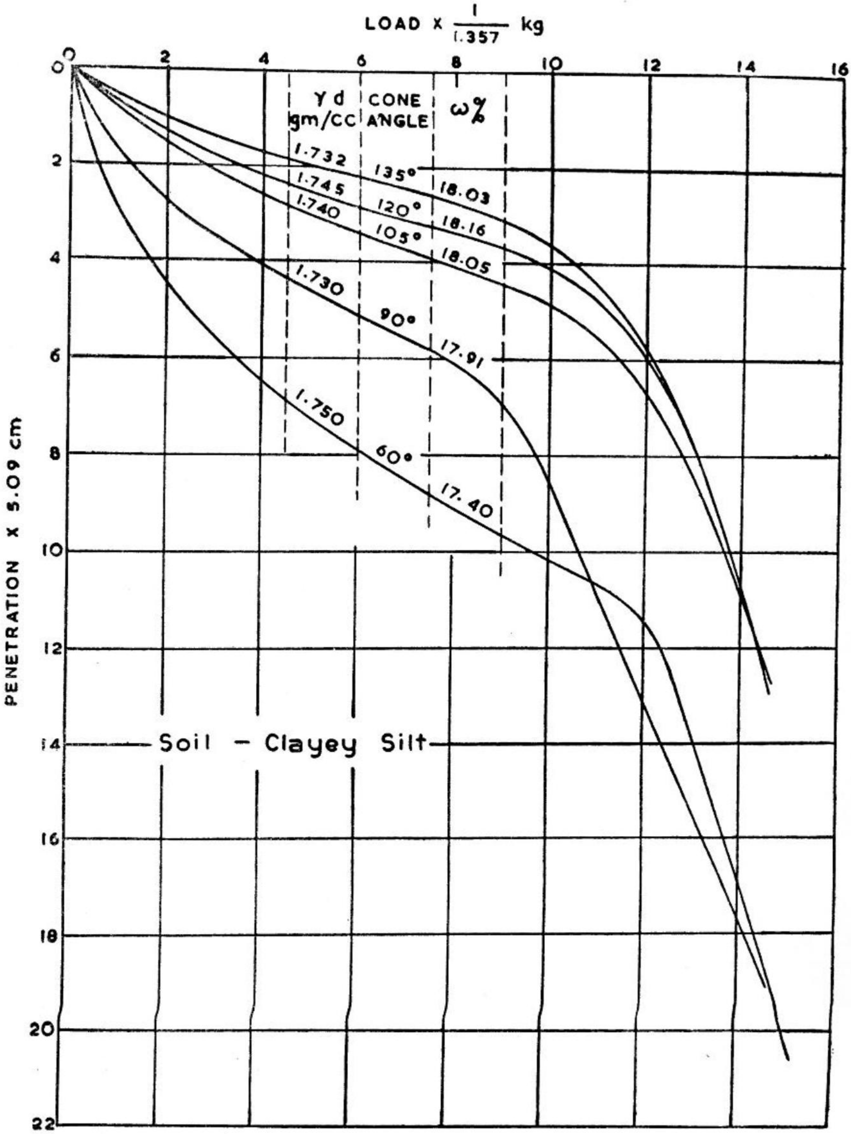


FIGURE 3 : Load penetration curves for static cone tests.

(2) It gives automatically the load-settlement/load-penetration diagrams.

(3) By varying the load on the carriage it is possible to get any rate of loading as well as a change in maximum load within a

certain range. Hence, it is quite suitable to work with varying sizes of models.

Acknowledgement

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Reference

VENKATANARAYANA, P. (1970): "An Investigation on Cone Penetration Tests". *Ph. D. Thesis*, Indian Institute of Technology, Kharagpur, August 1970.