(Reaffirmed 1997)

Indian Standard
METHOD OF LOAD TEST ON SOILS
(Second Revision)

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(*Continued from page* 1)

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(*Continued on page* 12)

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0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 30 November 1982, after the draft finalized by the Soil Engineering and Rock Mechanics Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Visual examination of the soil exposed in suitably located trial pits at the site, combined with the already established data for different types of soils is commonly used for deciding on the safe bearing capacity. While this procedure may be adequate for light or less important structures under normal conditions, relevant laboratory tests or field tests are essential in the case of unusual soil types and for all heavy and important structures. This standard covers plate load test method for determination of ultimate bearing capacity of soil in place which assumes that soil strata is reasonably uniform. The load test included in the standard is also used to find modulus subgrade reaction useful in the design of raft foundation and in the design of pavements.

0.3 Plate load test, though useful in obtaining the necessary information about the soil with particular reference to design of foundation has some limitations. The test results reflect only the character of the soil located within a depth of less than twice the width of the bearing plate. Since the foundations are generally larger than the test plates, the settlement and shear resistance will depend on the properties of a much thicker stratum. Moreover this method does not give the ultimate settlements particularly in case of cohesive soils. Thus the results of the test are likely to be misleading, if the character of the soil changes at shallow depths, which is not uncommon. A satisfactory load test should, therefore, include adequate soil exploration (*see* IS : 1892-1979*) with due attention being paid to any weaker stratum below the level of the footing.

0.4 Another limitations is the concerning of the effect of size of foundation. For clayey soils the bearing capacity (from shear consideration) for a larger foundation is almost the same as that for the smaller test plate.

*Code of practice for sub-surface investigation for foundations (*first revision*).

But in dense sandy soils the bearing capacity increases with the size of the foundation. Thus tests with smaller size plate tend to give conservative values in dense sandy soils. It may, therefore, be necessary to test with plates of at least three sizes and the bearing capacity results extrapolated for the size of the actual foundation (minimum dimensions in the case of rectangular footings).

0.5 This standard was first published in 1962 and subsequently revised in 1971. In the present revision, the use of apparatus has been generalized and also specific sizes of plates have been mentioned for the different types of soils, besides incorporating zero correction which was present in 1971 version and prescribing log log scale for cohesionless and partially cohesive soils.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard lays down the method for conducting load test for estimation of bearing capacity of soils and its settlement.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 2809-1972† and IS : 6403-1981‡ shall apply.

3. APPARATU

3.1 Loading platform truss of sufficient size and properly designed members so as to estimate load reaction for conducting the test shall be used. The typical set up used for gravity loading is given in Fig. 1, for reaction loading in Fig. 2 and for loading truss in Fig. 3.

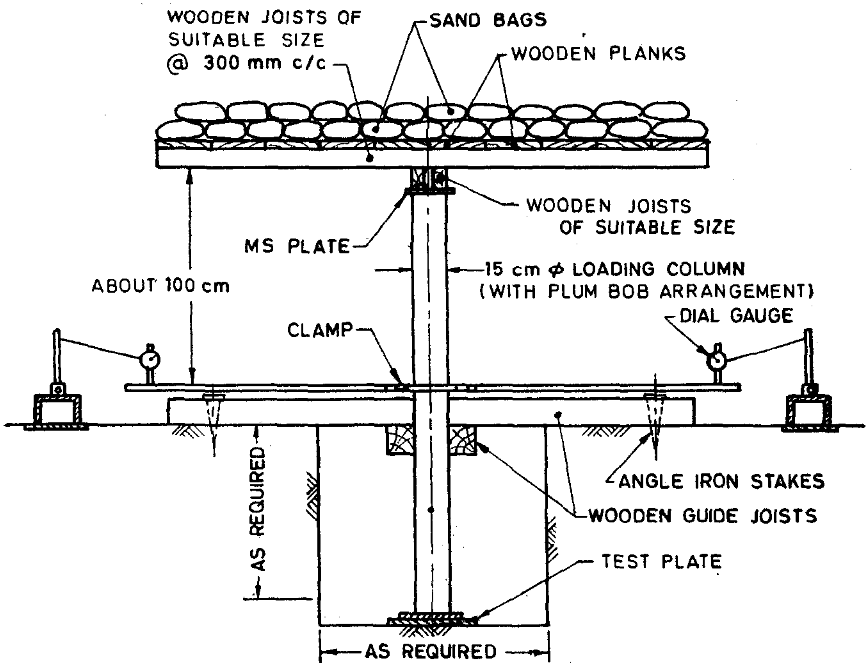
3.2 Hydraulic jack of required capacity with properly calibrated load measuring device, such as pressure gauge, electronic load cell, or proving ring shall be used.

3.3 Bearing Plates — Circular or square bearing plates of mild steel, not less than 25 mm in thickness and varying in size from 300 to 750 mm

*Rules for rounding off numerical values (*revised*).

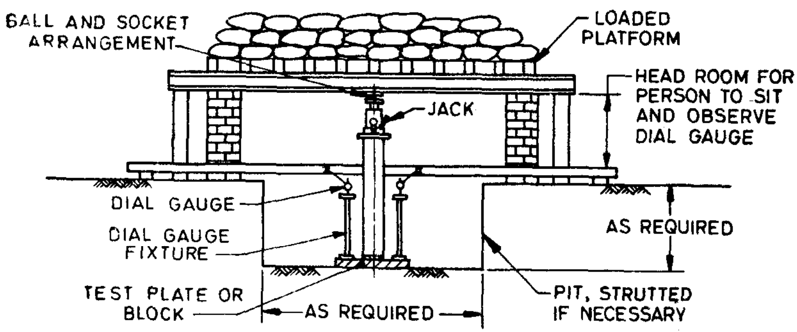
†Glossary of terms and symbols relating to soil engineering (*first revision*).

‡Code of practice for determintaion of allowable bearing pressure on shallow foundations (*first revision*).



NOTE — *Clamp could also be at lower level.*

FIG. 1 TYPICAL SET UP FOR GRAVITY LOADING PLATFORM



NOTE — Dial gauge fixture may be on the form clamp also.

FIG. 2 TYPICAL SET UP FOR REACTION LOADING PLATFORM

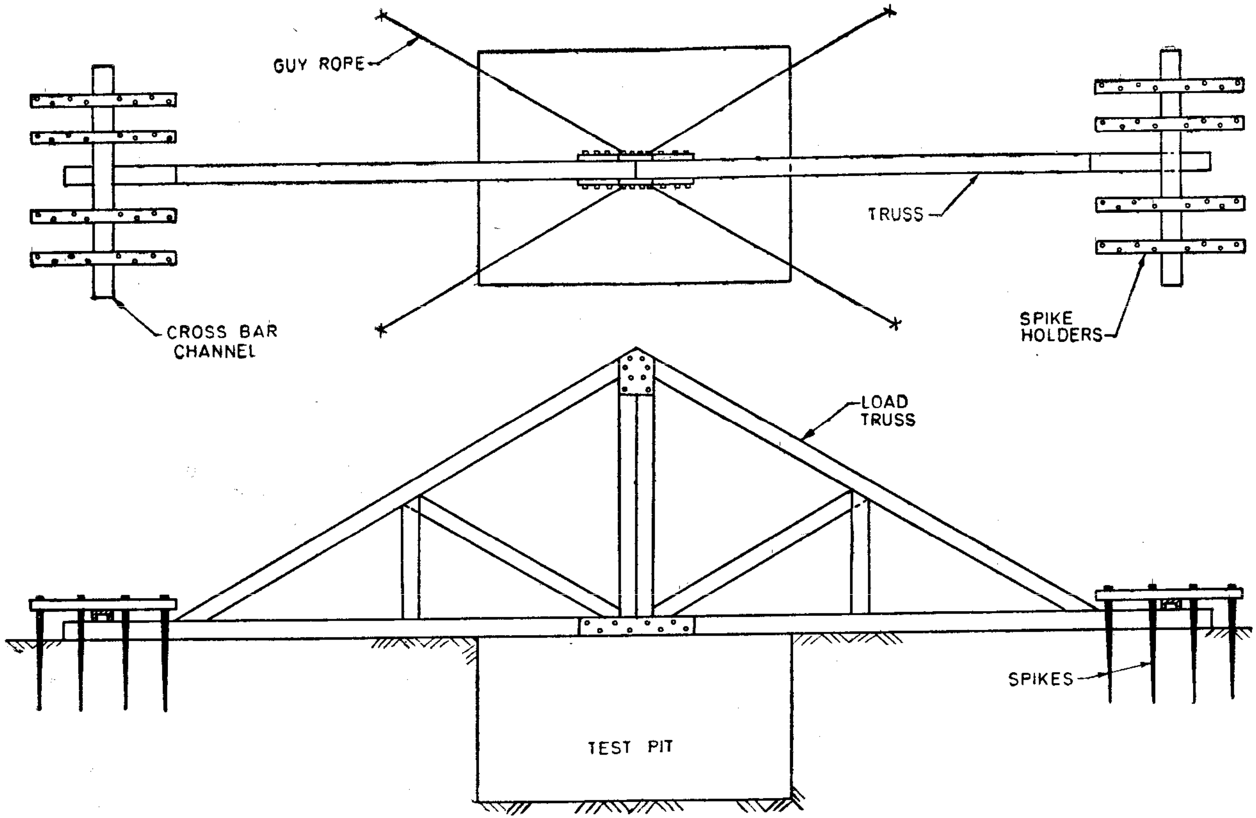
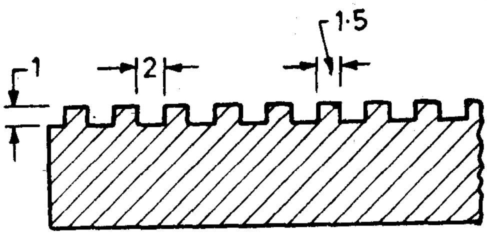


Fig. 3 Typical Set Up for Loading Truss

with chequered or grooved bottom (*see* Fig. 4), provided with handles for convenient setting and centre marked. As an alternative, cast in-situ or precast concrete blocks may be used with depths not less than two-third the width.



All dimensions in millimetres.

FIG. 4 DETAILS OF CHEQUERS OR GROOVES

3.4 Settlement Recording Device — Dial gauges with 25 mm travel, capable of measuring settlement to an accuracy of 0·01 mm.

3.5 Datum Beam or Rod — Beam or rod of sufficient strength capable of maintaining straightness when fitted on two independent supports fitted with arms or magnetic bases for holding dial gauges.

3.6 Miscellaneous Apparatus — A ball and socket arrangement, loading columns, steel shims, wooden blocks, collar, reaction girder with cradles for independent fitting to the reaction platform as necessary to the particular set up.

4. PROCEDURE

4.1 Selection of Location — The locations for load test shall be based on exploratory borings, and unless otherwise desired, shall be conducted at an elevation of the proposed foundation level under the worst estimated conditions. In case the water table is within the depth equal to the width of the test plate, the test shall be conducted at water table level. In case water table is higher than the test level, it shall be lowered to the test level and maintained by pumping through a sump, away from the test plate, however, for the soils like cohesionless silt and fine sand which cannot be drained by pumping from the sump, the test level shall also be water table level.

4.2 Test Pit — The pits, usually at the foundation level, having in general normally of width equal to five times the test plate or block, shall have a carefully levelled and cleaned bottom at the foundation level; protected against disturbance or changes in natural formation.

4.3 Dead Load — The dead load of all equipment used, such as ball and socket, steel plate, loading column, jack, etc, shall be recorded prior to application of load increment.

4.4 Size and Shape of Plate — Except in case of road problems and circular footings, square plates may be adopted. For clayey and silty soils and for loose to medium dense sandy soils with $N < 15$, a 450 mm square plate or concrete blocks shall be used. In the case of dense sandy or gravelly soils ($15 < N < 30$) three plates of sizes 300 mm to 750 mm shall be used depending upon practical considerations of reaction loading and maximum grain size. The side of the plate shall be at least four times the maximum size of the soil particles present at the test location.

NOTE — N is the standard penetration resistance value determined in accordance with IS : 2131-1981*.

4.5 Test Arrangement

4.5.1 The loading platform shall be supported by suitable means at least 2·5 m from the test area with a height of 1 m or more above the bottom of the pit to provide sufficient working space. No support of loading platform should be located within a distance of 3·5 times size of test plate from its centre.

4.5.2 The test plate shall be placed over a fine sand layer of maximum thickness 5 mm, so that the centre of plate coincides with the centre of reaction girder/beam, with the help of a plumb and bob and horizontally levelled by a spirit level to avoid eccentric loading. The hydraulic jack should be centrally placed over the plate with the loading column in between the jack and reaction beam so as to transfer load to the plate. A ball and socket arrangement shall be inserted to keep the direction of the load vertical throughout the test. A minimum seating pressure of 70 g/cm^2 shall be applied and removed before starting the load test.

4.5.3 The two supports of the reference beam or datum rod shall be placed over firm ground, fixed with minimum two dial gauges resting at diametrically opposite ends of the plates. The dial gauges shall be so arranged that settlement is measured continuously without any resetting in between.

4.6 Load Increments — Apply the load to soil in cumulative equal increments up to 1 kg/cm^2 or one-fifth of the estimated ultimate bearing capacity, whichever is less. The load is applied without impact, fluctuation or eccentricity and in case of hydraulic jack load is measured over the pressure gauge, attached to the pumping unit kept over the pit, away from the testing plate through extending pressure pipes.

4.7 Settlement and Observation — Settlements should be observed for each increment of load after an interval of 1, 2·25, 4, 6·25, 9, 16 and

*Method for standard penetration test for soils (*first revision*).

25 min and thereafter at hourly intervals to the nearest 0·02 mm. In case of clayey soils the 'time settlement' curve shall be plotted at each load stage and load shall be increased to the next stage either when the curve indicates that the settlement has exceeded 70 to 80 percent of the probable ultimate settlement at that stage or at the end of 24 hour period. For soils other than clayey soils each load increment shall be kept for not less than one hour or up to a time when the rate of settlement gets appreciably reduced to a value of 0·02 mm/min. The next increment of load shall then be applied and the observations repeated. The test shall be continued till, a settlement of 25 mm under normal circumstances or 50 mm in special cases such as dense gravel, gravel and sand mixture, is obtained or till failure occurs, whichever is earlier. Alternatively where settlement does not reach 25 mm, the test should be continued to at least two times the estimated design pressure. If needed, rebound observations may be taken while releasing the load.

5. DETERMINATION OF ULTIMATE BEARING CAPACITY/ SAFE BEARING PRESSURE/SETTLEMENT

5.1 Shape of the Load/Settlement Curve — A load settlement curve shall be plotted out to arithmetic scale. From this load settlement curve the zero correction which is given by the inter-section of the early straight lines or the nearly straightline part of the curves with zero deadline shall be determined and subtracted from the settlement readings to allow for the perfect seating of the bearing plate and other causes.

5.1.1 Four typical curves are shown in Fig. 5. Curve *A* is typical for loose to medium cohesionless soil; it is a straightline in the earlier stages but flattens out after some time, but there is no clear point of failure Curve *B* is for cohesive soil; it may not be quite straight in the early part and leans towards settlement axis as the settlement increases. For partially cohesive soils curve *C* possessing the characteristics of both the curves *A* and *B* is obtained while curve *D* is purely for dense cohesionless soils.

5.2 From the corrected load settlement curves no difficulty should be experienced in arriving at the ultimate bearing capacity in case of dense cohesionless soils or cohesive soils (*see* Fig. 5, curves *D* and *B*) as the failure is well defined. But in the case of Curves *A* and *C* where yield point is not well defined settlements shall be plotted as abcissa against corresponding load intensities as ordinate, both to logarithmic scales (*see* Fig. 6), which give two straightlines, the inter-section of which shall be considered as yield value of soil.

5.3 From Fig. 5 the safe bearing pressure for medium and dense sands could be read, corresponding to a settlement (S_p), which shall be

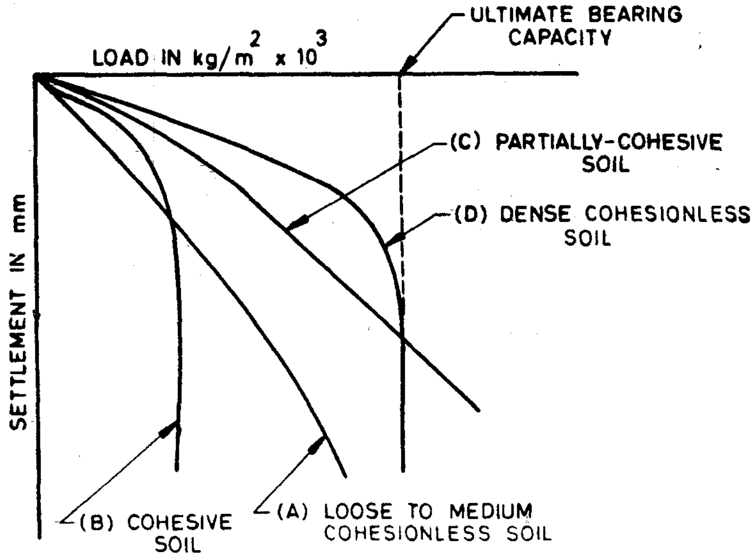


FIG. 5 LOAD SETTLEMENT CURVES

calculated as under (S_f taken as permissible settlement of footing (*see* IS : 1904-1978*):

$$S_f = S_p \left[\frac{B (B_p + 0{\cdot}3)}{B_p (B + 0{\cdot}3)} \right]^2$$

where

B = the size of footing in m,
B_p = size of test plate in m,
S_p = settlement of test plate in m, and
S_f = settlement of footing in m.

From this formula total settlement of footing (S_f) is calculated taking S_p as observed total settlement of plate.

6. REPORT

6.1 The continuous listing of all time, load and settlement data, for each test shall be recorded with details of test elevation, natural water table, profile of test pit, size of bearing plate and irregularity, if any, in routine procedure.

6.2 It is necessary to excavate soil below the test plate to a depth equal to twice the dimension of the plate so as to examine and record the sub-soil profile.

*Code of practice for structural safety of buildings: Shallow foundations (*second revision*).

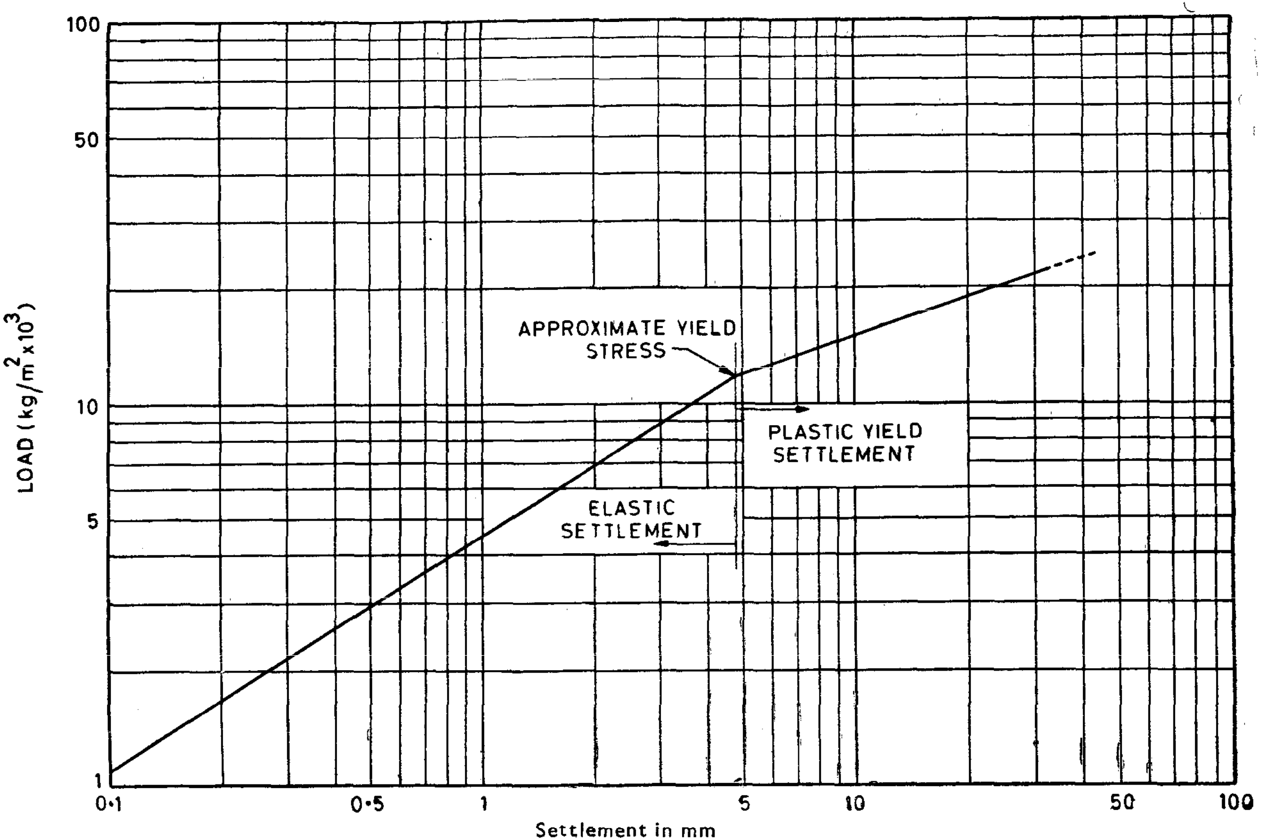


Fig. 6 Load Settlement Curve
(Log-Log Scale)

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