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Indian Standard

METHODS OF TEST FOR STABILIZED SOILS

PART V DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH OF STABILIZED SOILS

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Indian Standard

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Indian Standard

METHODS OF TEST FOR STABILIZED SOILS

PART V DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH OF STABILIZED SOILS

0. FOREWORD

0.1 This Indian Standard (Part V) was adopted by the Indian Standards Institution on 25 September 1970, after the draft finalized by the Soil Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Soil stabilization is the alteration of any property of a soil to improve its engineering performance. There are several methods of stabilization and these may be broadly on the basis of treatment given to the soil (for example, dewatering and compaction), process involved (for example, thermal and electrical) and on additives employed (for example asphalt and cement). The choice of a particular method depends on the characteristics of the problem on hand. For studying in the laboratory, the methods and effects of stabilization, certain standard methods of test for the evaluation of properties of stabilized soils and their analysis are required. The required standards on methods of test for stabilized soils are being published in parts. This part (Part V) lays down the method for the determination of unconfined compressive strength of stabilized soil.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in this field in this country. This has beer met by basing the standard on BS 1924 : 1967 'Methods of test for stabilized soils' published by the British Standards Institution.

0.4 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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

SECTION A TEST FOR FINE AND MEDIUM GRAINED STABILIZED SOIL

1. SCOPE

1.1 This standard (Part V) covers the determination of the unconfined compressive strength of stabilized soil specimens made with fine and medium grained soils. It covers the preparation and testing of cylindrical specimens prepared to a pre-determined dry density or with a constant compactive effort. The method in which the specimens are prepared to a constant dry density is preferred and should be used whenever possible.

2. GROUPING OF SOIL

2.1 For the purpose of this standard, soils shall be grouped as follows:

a) *Fine-Grained Soils* — Not less than about 90 percent of the soil passing a 2·36-mm IS Sieve.

b) *Medium-Grained Soils* — Not less than about 90 percent of the soil passing a 20-mm IS Sieve.

c) *Coarse-Grained Soils* — Not less than about 90 percent of the soil passing a 40-mm IS Sieve.

3. APPARATUS

3.1 For specimens compacted to a pre-determined dry density.

3.1.1 *4·75-mm and 20-mm IS Test Sieves* — For fine and medium-grained soils respectively.

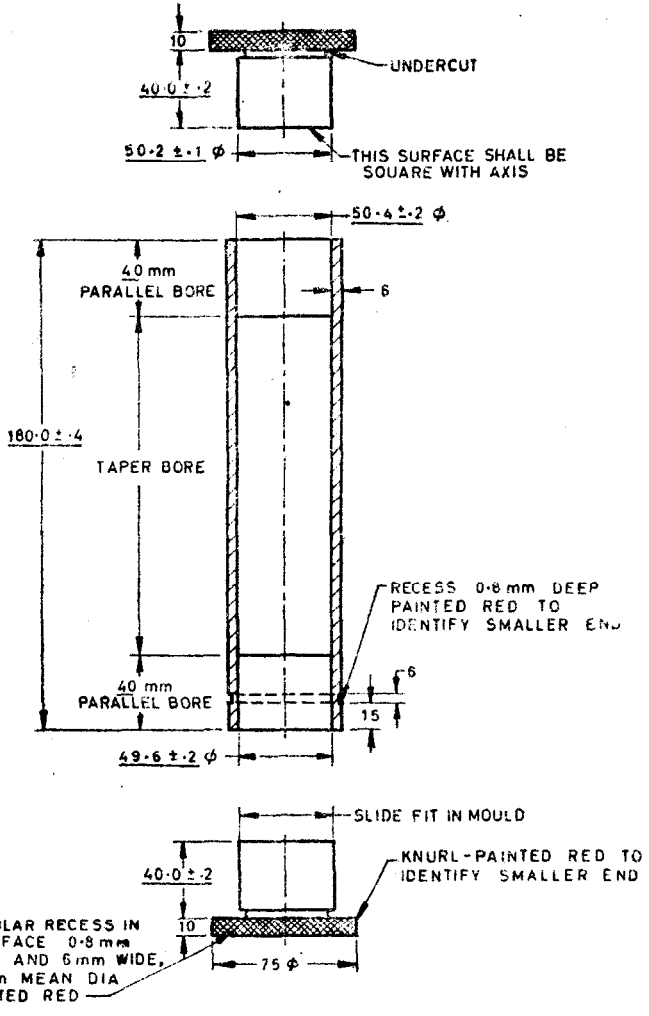
3.1.2 *Balance* — readable and accurate to 1 g.

3.1.3 *Tapered Moulds* — each having two steel plugs of dimensions shown in Fig. 1 and 3 for the preparation of specimens of the following dimensions (*see* Note 1):

a) For fine-grained soils 100 mm high × 50 mm mean diameter (*see* Fig. 1).

b) For medium-grained soils 200 mm high × 100 mm mean diameter (*see* Fig. 3).

3.1.4 Ejecting plungers and displacing collars for use with the above moulds of dimensions shown in Fig. 2 and 4.

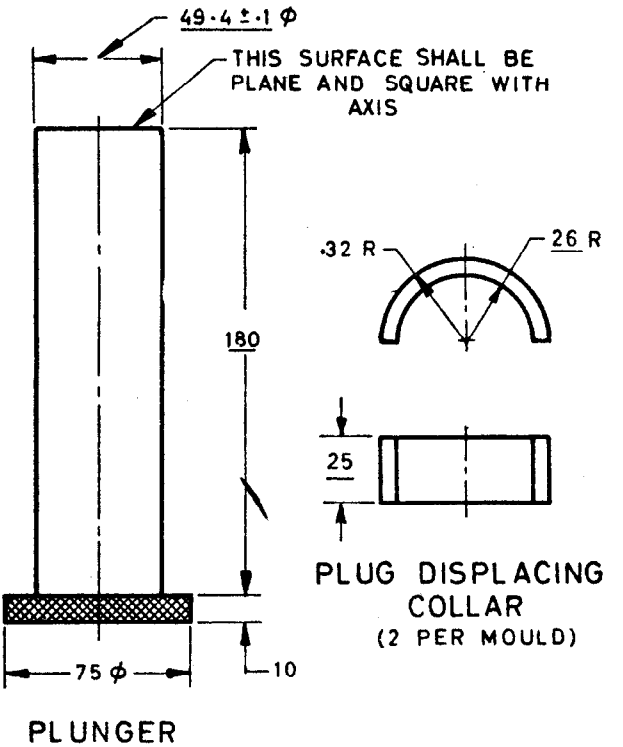


NOTE 1 — All surfaces should be smooth and free from tool marks.
NOTE 2 — *Material* — mild steel.

This design has been found satisfactory, but alternative designs may be employed, provided that the essential requirements are fulfilled. Essential dimensions are underlined.

All dimensions in millimetres.

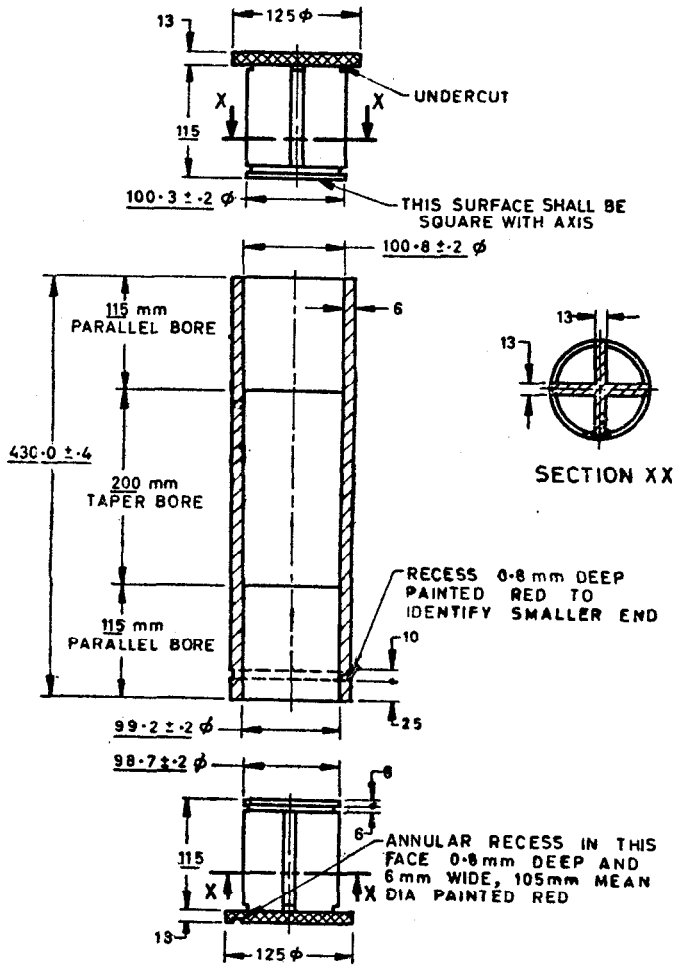
FIG. 1 TAPERED CYLINDRICAL MOULD WITH PLUGS FOR PREPARATION OF SPECIMENS FOR THE UNCONFINED COMPRESSIVE STRENGTH TEST (FINE-GRAINED STABILIZED SOIL)



This design has been found satisfactory, but alternative designs may be employed, provided that the essential requirements are fulfilled. Essential dimensions are underlined.

All dimensions in millimetres.

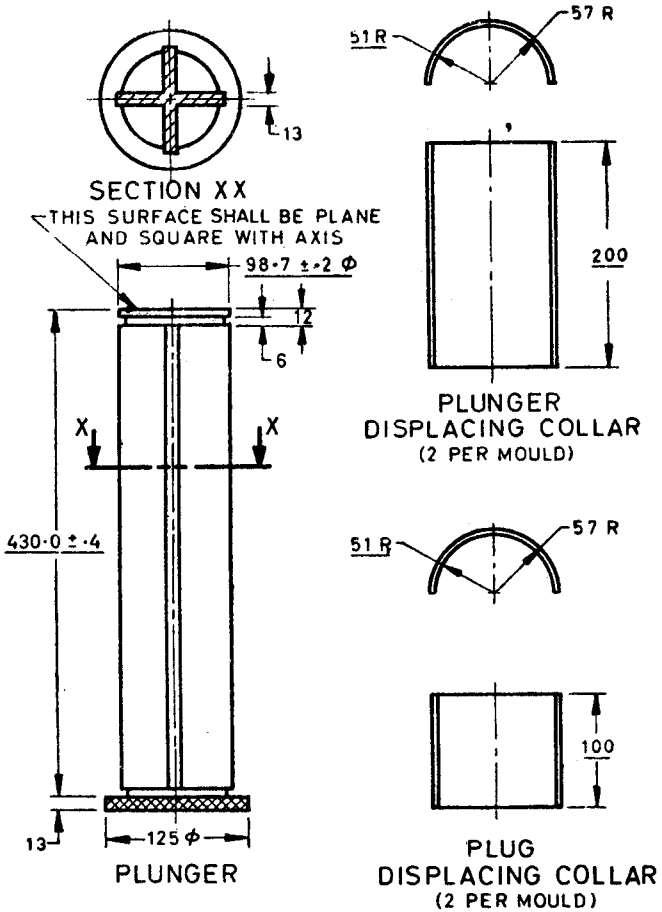
FIG. 2 PLUNGER AND DISPLACING COLLAR FOR USE WITH TAPERED CYLINDRICAL MOULD SHOWN IN FIG. 1



This design has been found satisfactory, but alternative designs may be employed, provided that the essential requirements are fulfilled. Essential dimensions are underlined.

All dimensions in millimetres.

FIG. 3 TAPERED CYLINDRICAL MOULD WITH PLUGS FOR PREPARATION OF SPECIMEN FOR THE UNCONFINED COMPRESSIVE STRENGTH TEST (MEDIUM-GRAINED STABILIZED SOIL)



This design has been found satisfactory, but alternative designs may be employed, provided that the essential requirements are fulfilled. Essential dimensions are underlined.

All dimensions in millimetres.

FIG. 4 PLUNGER AND DISPLACING COLLAR FOR USE WITH TAPERED CYLINDRICAL MOULD SHOWN IN FIG. 3

3.1.5 *Compression Testing Machine of the Lever, Self Indicating or Proving Ring Type* — Capable of exerting a load up to 5 tonnes for fine-grained soil specimens and 50 tonnes for medium-grained soil specimens, and of providing a uniform rate of deformation in the test specimen of approximately 1·25 mm/min.

In addition to the equipment specified in **3.1.5**, use may be made of a jack and frame or other mechanical device to force the plugs into the mould and so avoid the use of a compression testing machine for this purpose.

3.1.6 *Steel Tamping Rod* — 6 to 12 mm diameter and of suitable length.

3.1.7 *Device* — for moisture content determination in accordance with IS : 4332 (Part II)-1967*.

3.1.8 *Hide- or Copper-Faced Hammer* — a suitable weight being 2 kg.

3.1.9 *Metal Funnel or Scoop* — to fit the neck of the moulds.

3.1.10 *Calipers* — readable and accurate to 0·25 mm with an opening not less than 100 mm or 200 mm when testing fine- or medium-grained soils respectively.

3.2 For specimens compacted to a constant compactive effort, additional apparatus given in **3.2.1** to **3.2.3** is required.

3.2.1 *Metal Rammer* — 50 mm diameter having a weight of 2·6 kg and a controlled drop of 310 mm.

3.2.2 *Palette Knife* — a convenient size is one having a blade 200 mm long and 30 mm wide.

3.2.3 *Straight Edge* — for example, a steel strip 300 mm long, 25 mm wide and 3 mm thick, with one bevelled edge.

4. MATERIAL

4.1 Paraffin wax or other suitable wax for coating the test specimen to maintain it at its specified moisture content.

5. PREPARATION OF SPECIMEN

5.1 For specimens compacted to a pre-determined dry density.

5.1.1 *Compaction Using Compression Device* — Using only material passing the 4·75-mm IS test sieve for fine-grained soils, and only material passing the 20-mm IS test sieve for medium-grained soils, the stabilized soil shall be prepared as described in IS : 4332 (Part I) - 1967†.

*Methods of test for stabilized soils: Part II Determination of moisture content of stabilized soils mixtures.

†Methods of test for stabilized soils: Part I Method of sampling and preparation of stabilized soils for testing.

The weight of the stabilized soil (W_1) required for moulding into a specimen of the required dry density shall be calculated in accordance with the mould used. In the case of soils stabilized with a solid stabilizer, for example, cement, this weight shall be calculated from the formulæ:

For fine-grained soils (100 × 50 mm moulds):

$$W_1 = \left(V_f + \frac{V_f m}{100} \right) \gamma_d g = (196 + 1{\cdot}96\,m)\,\gamma_d g$$

For medium-grained soils (200 mm × 100 mm moulds):

$$W_1 \left(V_m + \frac{V_m m}{100} \right) \gamma_d g = (1\,570 + 15{\cdot}7m)\,\gamma_d g$$

where

V_f = volume of mould for fine-grained soils in cm³,

m = the moisture content of the soils plus stabilizer in percent,

γ_d = density of dry soil plus stabilizer in g/cm³, and

V_m = volume of mould for medium-grained soils in cm³.

The appropriate weight of material shall be placed in the mould into which, using a displacing collar, the lower plug has been inserted to a distance of 15 mm. During filling, the stabilized soil shall be tamped gently and uniformly so that the upper plug can be inserted at a distance of 15 mm. The upper plug should be inserted and the mould assembly placed in the compression device or testing machine. After removal of the displacing collars, pressure shall be applied to the plugs until the flanges are in contact with the barrel of the mould. After the pressure has been maintained for about $\frac{1}{2}$ minute, the load shall be released and the mould removed from the press. The plugs shall then be removed from the mould. The plunger shall then be inserted into the end of the mould having the smaller diameter and the specimen released from the taper by gentle hammering or pressure. The specimen shall then be removed from the mould and weighed to the nearest 1 g (W_2) (*see* Note 2).

5.1.2 *Compaction Using Hammer*—The procedure shall be as in **5.1.1** except that the specimen shall be compacted by driving home the end plugs, with a hide- or copper-faced hammer.

5.2 For Specimens Compacted with Constant Compactive Effort—Using only material passing the 4·75-mm IS test sieve for fine-grained soils, and only material passing the 20-mm IS test sieve for medium-grained soils, the stabilized soil shall be prepared as described in IS:4332 (Part I)-1967*.

*Methods of test for stabilized soils: Part I Method of sampling and preparation of stabilized soils for testing.

5.2.1 *For Fine-Grained Soils* — The appropriate plug shall be inserted into the bottom of the mould (that is the larger diameter uppermost) and a quantity of the material sufficient to give a specimen length of 100-115 mm after compaction (that is about 450 g) shall be added to the mould, being tamped uniformly and gently with the tamping rod during the operation.

The other plug shall be inserted into the mould, and the soil shall be compacted by 15 blows of the rammer dropped from a height of 310 mm into the plug (this plug should not have been driven fully home at this stage; if it has, then there is insufficient material in the mould). The mould containing the specimen shall then be inverted and the uppermost plug replaced by the plunger. The soil shall then be further compacted by 15 blows from the rammer applied to the plunger.

The compacted specimen shall be rejected for subsequent testing if its length exceeds 115 mm.

The plunger shall then be inserted into the end of the mould having the smaller diameter and the specimen released from the taper by gentle hammering or pressure. The specimen shall then be removed from the mould and weighed to the nearest 1 g (W_2) (*see* Note 2).

5.2.2 *For Medium-Grained Soils* — The appropriate plug shall be inserted into the bottom of the mould (that is the larger diameter uppermost) and a quantity of material sufficient to give a specimen of 200-215 mm after compaction (that is about 3·5 kg) shall be compacted into the mould in six equal layers, each layer being given 25 blows of the rammer dropped from a height of 310 mm above the stabilized soil. The blows shall be uniformly distributed over the surface of each layer, which shall be scarified with the palette knife before the next layer is added. The compacted specimen shall be rejected for subsequent testing if its length exceeds 215 mm.

The plunger shall then be inserted into the end of the mould having the smaller diameter and the specimen released from the taper by gently hammering or pressure. Any length in excess of 200 mm shall be extruded beyond the mould. This length is gauged by placing the 200 mm long displacing collars on the plunger. The face of the specimen shall be carefully levelled off to the end of the mould using the straight edge, and any irregularities shall be filled with fine material from the same sample. The specimen shall then be removed from the mould and weighed to the nearest 1 g (W_2) (*see* Note 2).

6. CURING

6.1 The specimen shall be completely coated with paraffin wax or other suitable wax or otherwise suitably protected by methods such as wrapping in polyethene to maintain it at its specified moisture content (*see* Note 3),

care being taken not to leave holes in the wax film and to complete the coating as quickly as possible to prevent the absorption of wax, and it shall then be weighed to the nearest 1 g (W_3). It shall subsequently be stored for a period (*see* Note 4), the length of which will depend on the process and type of stabilizer employed, under conditions in which it is protected from mechanical damage and kept at a temperature of 27 ± 2°C (*see* Note 5).

After the curing period and before testing, the specimen shall again be weighed to the nearest 1 g (W_4). Any 100 mm high × 50 mm diameter specimen which has lost more than 2 g in weight and any 200 mm high × 100 mm diameter specimen which has lost more than 5 g in weight during the curing period shall be discarded.

7. TEST PROCEDURE

7.1 After weighing, the wax shall be removed from the end of the specimen and, if desired, from the sides, care being taken to avoid damaging the soil surface.

7.2 The length of the specimen (L) shall be measured to the nearest 0·25 mm by means of the calipers, and recorded.

7.2.1 The specimen shall then be placed centrally on the lower platen of the compression testing machine and the load shall be applied to the ends of the specimen. The load shall be applied so that the rate of deformation is uniform approximately 1·25 mm/min. The maximum load exerted by the machine during the test shall be recorded P kg.

7.3 The moisture content shall be determined in accordance with IS:4332 (Part II)-1967* on a representative sample of fragments taken from the interior of the specimen, and recorded.

8. CALCULATIONS

8.1 The unconfined compressive strength (p) of the specimen shall be calculated from the formulæ:

a) For fine-grained soils

$$p = P/A_f = P/1\,963 \text{ MN/m}^2$$

b) For medium-grained soils

$$p = P/A_m = P/7\,854 \text{ MN/m}^2$$

where

P = maximum recorded load, N (*see* **7.2.1**),

*Methods of test for stabilized soils: Part II Determination of moisture content of stabilized soil mixtures.

A_f = cross sectional area of specimen for fine-grained soil (mm^2), and

A_m = cross sectional area of specimen for medium-grained soils (mm^2).

8.2 In the case of soils stabilized with solid stabilizer, the weight of the dry solids/cm^3 [dry soil plus stabilizer density (γ_d)] in the specimen shall be calculated from the formulæ:

a) For fine-grained soils

$$\gamma_d = \frac{100\,W_2}{A_f L\,(100+m)} = \frac{100\,W_2}{19{\cdot}63\,L\,(100+m)}\ g/cm^3$$

b) For medium-grained soils

$$\gamma_d = \frac{100\,W_2}{A_m L\,(100+m)} = \frac{100\,W_2}{78{\cdot}54\,L\,(100+m)}\ g/cm^3$$

where

W_2 = weight of specimen before coating with wax in g;

A_f = cross-sectional area of specimen for fine-grained soil (cm^2);

A_m = cross sectional area of specimen for medium grained soils (cm^2);

L = length of specimen (cm); and

m = moisture content of the soil plus stabilizer after curing, in percent.

9. REPORTING OF RESULTS

9.1 The unconfined compressive strength of the specimen shall be reported as follows:

a) Values of compressive strength up to 2 MN/m^2 (20 kg/cm^2) report to the nearest 0·05 MN/m^2 (0·5 kg/cm^2).

b) Values of compressive strength above 2 MN/m^2 (20 kg/cm^2) report to the nearest 0·1 MN/m^2 (1 kg/cm^2).

9.2 The report shall include relevant details of the size and shape of the specimen and the composition of the stabilized soil mixture, the dry soil or dry soil plus stabilizer density, the moisture content as determined in **7.3**, the methods of compaction and curing and the curing period and temperature.

NOTE 1 — The standard has been written on the basis of internally-tapered moulds being used. Although these have the advantage that they are very convenient in use, split moulds with parallel bores may also be employed. The moulds should be lightly coated with suitable oil before use.

NOTE 2 — *Removal of specimen from mould* — When dealing with cohesive mixtures of stabilized soil it is possible to remove the specimen from the mould immediately after preparation. However, with non-cohesive soils mixed with stabilizers capable of developing cohesion, it may be advantageous to allow the specimen to remain in the mould for some time, for example, 24 hours.

NOTE 3 — Coating with wax has been specified as this has been found to be the best method of maintaining the moisture content of the specimen at a constant value of and is very simple to carry out. To simplify its removal from the specimen, the wax should be used as cool as possible.

NOTE 4 — *Period of storage* — With many stabilizing agents, the strength of the stabilized soil increases with storage. In such cases, tests should be made on specimens that have been stored for various periods to determine whether or not the strength is increasing satisfactorily. With cement-stabilized specimens, suitable periods of storage are 3,7,14 and 28 days.

In certain circumstances, however, it will be convenient to obtain a simple assessment of the quality of the stabilized mixture as rapidly as possible. In such cases, tests should be made on specimens that have been stored for a single fixed period, the time chosen depending on the process of stabilization under consideration. With cement stabilized specimens, this period should normally be seven days.

NOTE 5 — The tolerance on the curing temperature of $\pm$ 2°C is essential for all laboratory work and for preliminary testing to ascertain the cement content required. For site conditions where strength tests are being made only for quality control purposes, however, the tolerance may be relaxed to $\pm$ 5°C. If this is done the maximum and minimum curing temperatures should be ascertained and reported with the results.

SECTION B TEST FOR MEDIUM AND COARSE GRAINED STABILIZED SOIL

10. SCOPE

10.1 This method covers the determination of the unconfined compressive strength of stabilized soil specimens made with medium-and coarse-grained soils. It covers the preparation and testing of cubical specimens prepared to a pre-determined dry density, with a constant compactive effort or by compaction to refusal. The method in which the specimens are prepared to a pre-determined dry density is preferred and should be used whenever possible.

11. GROUPING OF SOIL

11.1 For the purpose of this standard, soils shall be grouped as follows:

a) *Fine-grained soils* — Not less than about 90 percent of the soil passing a 2·36-mm IS Sieve.

b) *Medium-grained soils* — Not less than about 90 percent of the soil passing a 20-mm IS Sieve.

c) *Coarse-grained soils*—Not less than about 90 percent of the soil passing a 40-mm IS Sieve.

12. APPARATUS

12.1 For all methods of compaction.

a) 20-mm and 40-mm IS test sieve for medium- and coarse-grained soils respectively.

b) *Balance*—readable and accurate to 1 g.

c) *Steel or Cast Iron Moulds*—suitable for casting 150 mm cubes.

The mould shall be strong enough to prevent distortion and constructed in such a manner as to facilitate removal of the specimen without damage. The mould shall be so machined that when it is assembled ready for use the dimensions and internal surfaces are accurately within the following limits:

The height of the mould and the distance between the opposite faces shall be 150 ± 0·2 mm. The angle between adjacent interior faces and between interior faces and top and bottom planes of the mould shall be 90 ± 0·5°. The interior faces of the mould shall be plane surfaces with a permissible variation of 0·03 mm. Each mould shall be provided with a baseplate having a plane surface. The baseplate shall be attached to the mould with robust clamps.

The parts of the mould shall be lightly oiled before assembly, and when assembled shall be positively and rigidly held together during filling and subsequent handling of the filled mould.

d) *Plasterer's Steel Trowel*

e) *Curing Tins*—160 × 160 × 155 mm deep with well-fitting lids, and suitable sealing tape.

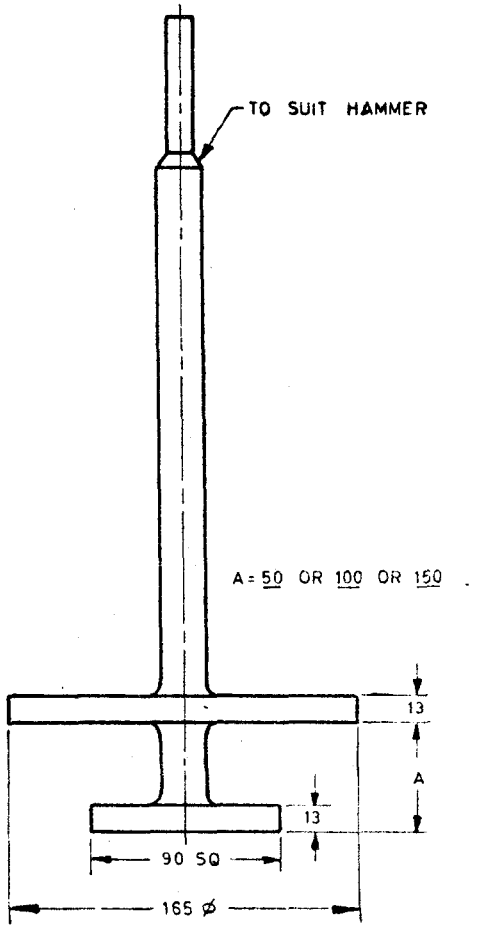
f) *Compression Testing Machine of the Lever, Self-Indicating or Proving Ring Type*—capable of exerting sufficient load for the tests and of providing a uniform rate of increase of stress in the test specimen of approximately 35 kgf/cm²/min.

g) *Palette Knife*—a convenient size is one having a blade 200 mm long and 30 mm wide.

h) *Flat Metal Plates*—measuring approximately 200 mm × 200 mm × 3 mm for preventing loss of moisture from top of cube mould.

j) *Apparatus*—for moisture content determination in accordance with IS:4332 (Part II)-1967*.

*Methods of test for stabilized soils: Part II Determination of moisture content of stabilized soils mixtures.



This design has been found satisfactory, but alternative designs may be employed, provided that the essential requirements are fulfilled. Essential dimensions are underlined.

All dimensions in millimetres.

FIG. 5 TAMPER WITH SPACING COLLAR, FOR USE WITH A VIBRATING HAMMER, FOR PREPARATION OF SPECIMENS MADE UP TO A PRE-DETERMINED DRY DENSITY FOR THE UNCONFINED COMPRESSIVE STRENGTH TEST (MEDIUM AND COARSE-GRAINED STABILIZED SOILS)

12.2 For Specimens Compacted to a Pre-determined Dry Density — The following additional apparatus is required:

a) *Suitable Electric or Pneumatic Vibrating Hammer*

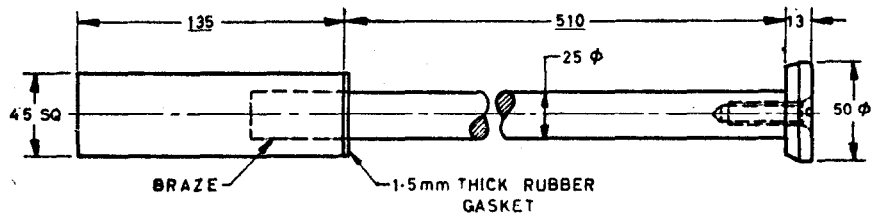
b) *Square or Rectangular Tamper* — preferably square, of approximately 8 000 mm² area for use with the vibrating hammer having a collar rigidly and accurately attached to its shank so that the tamper foot is prevented from entering the mould further than 50 mm (*see* Fig. 5).

c) As in (b) but with entry into the mould limited to 100 mm.

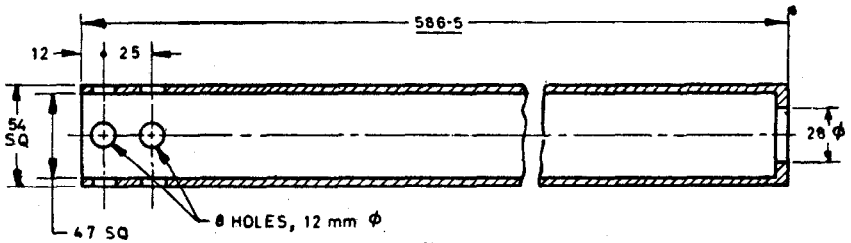
d) As in (b) but with entry into the mould limited to 150 mm.

12.3 For Specimens Compacted to a Constant Compactive Effort — The following additional apparatus is required:

a) *Metal Rammer* — having a 45 mm × 45 mm square faces a weight of 4·89 kg and a controlled drop of 450 mm (*see* Fig. 6).



RAMMER



GUIDE

This design has been found satisfactory, but alternative designs may be employed, provided that the essential requirements are fulfilled. Essential dimensions are underlined.

NOTE — *Rammer* — Adjust to make total weight 4·89 kg. Guide length of travel of rammer 450 mm.

All dimensions in millimetres.

FIG. 6 RAMMER FOR PREPARATION OF SPECIMENS COMPACTED TO A CONSTANT COMPACTIVE EFFORT FOR THE UNCONFINED COMPRESSIVE STRENGTH TEST (MEDIUM AND COARSE-GRAINED STABILIZED SOIL)

b) *Straightedge* — for example a steel strip 300 mm long, 25 mm wide and 3 mm thick, with one bevelled edge.

12.4 For Specimens Compacted to Refusal — The following additional apparatus is required:

a) *Electric Pneumatic Vibrating Hammer*

b) *Square or Rectangular Tamper* — preferably square of approximately 8 000 mm² area for use with the vibrating hammer.

c) *Straightedge* — for example, a steel strip 300 mm long 25 mm wide and 3 mm thick, with one bevelled edge.

13. PREPARATION OF SPECIMEN

13.1 For Specimens Compacted to a Pre-determined Dry Density — Using only material passing the 20-mm IS Test Sieve for medium-grained soils, and only material passing the 40-mm IS Test Sieve for coarse-grained soils, the stabilized soil shall be prepared as described in IS : 4332 (Part II)-1967*.

The weight of stabilized soil (W_1) required for moulding into a specimen of the required dry density shall be calculated from the formula:

For soils stabilized with a solid stabilizer:

$$W_1 = \left(V + \frac{V}{100} m \right) \gamma_d g = (3\,375 + 33{\cdot}75\,m)\,\gamma_d g$$

where

V = volume of the mould in cm³,

m = moisture content of the soil plus stabilizer in percent, and

γ_d = density of dry soil plus stabilizer in g/cm³.

The material (W_1) shall be divided into three equal parts by weight. One of the parts shall be placed in an assembled mould and the surface levelled off. Using a tamper fitted with a collar at the 10 cm mark and a vibrating hammer, the material shall be compacted uniformly until the collar comes into contact with the upper surface of the mould. The surface of the layer shall be scarified with the palette knife before adding the next layer, which shall be compacted in similar manner to the first layer, but using a tamper fitted with a collar at the 5 cm position. A 150 mm cube mould, less baseplate shall then be placed squarely on top of the mould, the compacted surface scarified with the palette knife, and the final layer added using the tamper with the collar at the 150 mm position. The upper mould shall then be removed and the surface of the specimen

*Methods of test for stabilized soils : Part II Determination of moisture content of stabilized soil mixtures.

carefully levelled off to the end of the mould using the trowel and vibrating tamper, care being taken not to spill any loose material during this final operation. The mould containing the specimen shall then be covered with a metal plate and stored at a temperature of 27±2°C (*see* Note 1) until the following day when the specimen shall be removed from the mould for further curing. The specimen shall then be weighed to the nearest 1 g (W_2).

13.2 For Specimen Compacted to a Constant Compactive Effort—Using only material passing the 20-mm IS Test Sieve for medium-grained soils, and only material passing the 40-mm IS Test Sieve for coarse-grained soils, the stabilized soil shall be prepared as described in IS:4332(Part I)-1967*.

13.2.1 The mould shall be assembled on its baseplate, and another mould, less baseplate, placed squarely on top. A quantity of stabilized soil sufficient to give a specimen of 150 to 165 mm depth after compaction (that is about 8 kg) shall be compacted into the mould in three equal layers, each layer being given 35 blows of the rammer dropped from a height of 450 mm above the stabilized soil. The blows shall be uniformly distributed over the surface of each layer, which shall be scarified with the palette knife before the next layer is added. The compacted specimen shall be rejected for subsequent testing if its height exceeds 165 mm.

13.2.2 After removing the upper mould, excess material shall be struck off level with the top of the lower mould by means of a straightedge, and any irregularities shall be filled with fine material from the same sample. The mould containing the specimen shall then be covered with a metal plate and stored at a temperature of 27 ± 2°C (*see* Note 1) until the following day when the specimen shall be removed from the mould for further curing. The specimen shall then be weighed to the nearest 1 g (W_4).

13.3 For Specimen Compacted to Refusal—Using only material passing the 20-mm IS Test Sieve for medium-grained soils and only material passing the 40-mm IS Test Sieve for coarse-grained soils, the stabilized soil shall be prepared as described in IS:4332(Part I)-1967*.

13.3.1 The mould shall be assembled on its baseplate and another mould, less baseplate, placed squarely on top. A quantity of stabilized soil sufficient to give a specimen of 150 to 165 mm depth after compaction (that is about 8 kg) shall be compacted into the mould in three equal layers, each layer being compacted with a tamper fitted to a vibrating hammer

*Methods of test for stabilized soils : Part I Method of sampling and preparation of stabilized soils for testing.

until it is judged that no further compaction is possible. Each layer shall be scarified with the palette knife before the next layer is added. The compacted specimen shall be rejected for subsequent testing if its height exceeds 165 mm.

13.3.2 After removing the upper mould, excess material shall be struck off, level with the top of the lower mould by means of a straight edge, and any irregularities in the surface shall be filled with material from the same sample. The mould containing the specimen shall then be covered with a metal plate and stored at a temperature of 27 ± 2°C (*see* Note 1) until the following day when the specimen shall be removed from the mould for further curing. The specimen shall then be weighed to the nearest 1 g (W_2).

14. CURING

14.1 The curing tin shall be placed over the specimen, and the tin and specimen then inverted. The lid shall then be placed in position and sealed with suitable tape (*see* Note 2). The tin containing the specimen shall then be weighed to the nearest 1 g (W_2). It shall subsequently be stored for a period (*see* Note 3), the length of which will depend on the process and type of stabilizer employed, at a temperature of 27 ± 2°C (*see* Note 1).

14.2 After the curing period, and before testing, the tin containing the specimen shall again be weighed to the nearest 1 g (W_4). Any specimen that has lost more than 10 g in weight during the storage period shall be discarded.

15. TEST PROCEDURE

a) After weighing, the specimen shall be removed from the tin.

b) The specimen shall then be placed centrally on the lower platen of the compression testing machine in such a manner that the load shall be applied to opposite sides of the cube as cast, that is, not to the top and bottom. The load shall be applied without shock and increased continuously at a rate of approximately 35 kgf/cm²/min until the resistance of the cube to the increasing load breaks down and no greater load can be sustained. The maximum load exerted by the machine can be recorded (P kg).

c) The moisture content shall be determined in accordance with IS:4332(Part II)-1967* on a representative sample of fragments taken from the interior of the specimen and recorded.

*Methods of test for stabilized soils : Part II Determination of moisture content of stabilized soil mixtures.

16. CALCULATIONS

a) The unconfined compressive strength (p) of the specimen shall be calculated from the formula:

$$p = P/A \text{ MN/m}^2 = P/22\,500 \text{ MN/m}^2$$

where

P = maximum recorded load, N, and

A = area of cross section of specimen in mm^2.

b) In the case of soils stabilized with a solid stabilizer, the weight of dry solids per cubic foot (dry soil plus stabilizer density (γ_d) in the specimen shall be calculated from the formula:

$$\gamma_d = \frac{100\,W_2}{V(100+m^1)} \text{ g/cm}^3 = \frac{100W_2}{3\,375\,(100+m^1)} \text{ g/cm}^3$$

where

W_2 = weight of specimen after removal from the mould in g,

V = volume of mould in cm^3, and

m^1 = moisture content of soil plus stabilizer after curing in percent.

17. REPORTING OF RESULTS

17.1 The unconfined compressive strength of the specimen shall be reported as follows:

a) Values of compressive strength up to 3·5 MN/m^2 (35 kg/cm^2), report to the nearest 0·1 MN/m^2 (1 kg/m^2).

b) Values of compressive strength above 3·5 MN/m^2 (35 kg/cm^2), report to the nearest 0·15 MN/m^2 (1·5 kg/m^2).

17.2 The report shall include relevant details of the size and shape of the specimen and the composition of the stabilized soil mixture, the dry soil or dry soil plus stabilizer density, the moisture content as determined in **15** (c), the methods of compaction and curing and the curing period and temperature.

NOTE 1 — The tolerance on the curing temperature of ± 2°C is essential for all laboratory work and in preliminary testing to ascertain the cement content required. For site conditions where strength tests are being made only for quality control purposes, however, the tolerance may be relaxed to ± 5°C. If this is done the maximum and minimum temperatures shall be ascertained and reported with the results.

NOTE 2 — Storage in a sealed tin has been specified in the case of cubes as this has been found to be the best method of maintaining the moisture content at a constant value and is very simple to carry out.

This method of curing, at constant moisture content, has been found to be suitable for stabilization with cement or lime but with other stabilizers, guidance on a suitable method of curing should be sought from the manufacturers of the stabilizers.

NOTE 3 — *Period of storage* — With many stabilizing agents, the strength of the stabilized soil increases with storage. In such cases, tests should be made on specimens that have been stored for various periods, to determine whether or not the strength is increasing satisfactorily. With cement-stabilized specimens, suitable periods of storage are 3,7,14 and 28 days.

In certain circumstances, however, it will be convenient to obtain a simple assessment of the quality of the stabilized mixture as rapidly as possible. In such cases, tests should be made on specimens that have been stored for a single fixed period, the time chosen depending on the process of stabilization under consideration. With cement-stabilized specimens, this period should normally be seven days.

With other stabilizers, guidance on a suitable period of storage should be sought from the manufacturers of the stabilizers.

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