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METHOD OF TEST FOR SOILS

PART 26 DETERMINATION OF pH VALUE

(Second Revision)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Indian Standard

METHOD OF TEST FOR SOILS

PART 26 DETERMINATION OF pH VALUE

(Second Revision)

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Indian Standard

METHOD OF TEST FOR SOILS

PART 26 DETERMINATION OF *p*H VALUE*(Second Revision)*

0. FOREWORD

0.1 This Indian Standard (Part 26) (Second Revision) was adopted by the Bureau of Indian Standards on 30 June 1987, after the draft finalized by the Soil Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 With a view to establishing uniform producers for the determination of different characteristics of soils and also for facilitating a comparative study of the results, the Bureau of Indian Standards has brought out Indian Standard methods of test for soils (IS : 2720) which have been published in parts. This part covers the method for determination of *p*H value.

0.3 The acidic or alkaline characteristics of a soil sample can be quantitatively expressed by means of the hydrogen ion-activity commonly designated as *p*H, which is conveniently expressed by the following:

$$pH = - \log_{10} (H^+) = \log_{10} \frac{1}{H^+}$$

wherein, H^+ is the hydrogen ion-concentration in moles/litre.

In pure water, at 25°C, $H^+ = 1.00 \times 10^{-7}$ and thus *p*H = 7.00. This value corresponds to exact neutrality. At this temperature, acidic solutions have *p*H values less than 7 ($H^+ 10^{-7}$) and alkaline solutions have *p*H values greater than 7 ($H^+ 10^{-7}$).

0.4 Two methods, namely, electrometric method (standard method) and colorimetric method are commonly used to determine *p*H values of soil-water solutions. The *p*H is measured electrometrically by means of an electrode assembly consisting of one glass electrode and one calomel reference electrode with a saturated potassium chloride solution. Potassium chloride is used for the salt bridge because of the fact that the transference of the K^+ and Cl^- ions takes place at the rate in true solution. The *p*H

determination by this method is based on the assumption that the potential recorded is totally due to the potential difference across the glass membrane brought about the difference in H^+ ion activity, between solutions inside and outside the glass electrode. The outside solution is hydrochloric acid.

0.5 The colorimetric method can be considered as approximate but rapid. A colorimetric pH indicator is an organic dye, the colour of which is controlled by the hydrogen ion activity in solution. This method is useful for determination of soil pH , both in the laboratory as well as in the field.

0.6 Several factors are known to affect the pH value of a particular soil sample. Prominent amongst these are soil-water ratio, soluble salts concentration, carbon dioxide pressure, exchangeable cations and temperature. With the dilution of soil suspension, its pH increases. Increase in salt concentration in general, decreases the pH . A definite relationship exists between carbon dioxide pressure of soil air and pH , for example, the pH of calcareous soils is reduced in proportion to the logarithm of carbon dioxide pressure of soil air. In alkaline soils, the pH is principally influenced by exchangeable cations. With increase in temperature, pH decreases. The evaluation factors associated with soil pH shall thus be based on the full consideration of the soil constituents and not on pH value alone.

0.7 The hydrogen-ion concentration of soil water solution is of interest in problems involving grouting in weak rocks, soil stabilisation processes using lime and resinuous materials, corrosion of metals in contact with soils and reclamation of marine soils. The pH value also helps in interpreting some of the soil chemical tests.

0.8 This standard was first published in 1967 and revised in 1973. In this revision, procedures have been elaborated and pro forma for presentation of result have been added. The references in respect of equipments have been updated.

0.9 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*.

1. SCOPE

1.1 This standard (Part 26) lays down the procedure for the determination of pH value of soil suspension.

*Rules for rounding off numerical values (revised).

2. ELECTROMETRIC METHOD (STANDARD METHOD)

2.1 Apparatus

2.1.1 pH Meter — Direct reading type conforming to IS : 2711-1979*, with glass electrode and a calomal reference electrode or any other suitable electrode.

2.1.2 Balance (Analytical) — sensitive to 0.001 g.

2.1.3 Three 100-ml Glass Beakers — with covering glasses and stirring rods.

2.1.4 Two 500-ml Volumetric Flask.

2.1.5 Wash Bottle — containing distilled water.

2.1.6 Mortar with Rubber Covered Pestle.

NOTE — The glass apparatus used should be such that it is not affected by alkali.

2.2 Buffer Solutions — The buffer solutions given in 2.2.1 and 2.2.2 shall be used for the test. Unless specified otherwise, pure chemicals (see Note) shall be used in tests.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the result of analysis.

2.2.1 Buffer Solution pH 4.0 (at 25°C) — Dissolve 5.106 g of potassium hydrogen phthalate in distilled water and dilute to 500 ml with distilled water.

2.2.2 Buffer Solution pH 9.2 (at 25°C) — Dissolve 9.54 g of sodium tetraborate (borax) in distilled water and dilute to 500 ml.

NOTE 1 — Special care should be taken for preparation of buffer, particularly for alkaline buffer, when the distilled water used should be free from carbon dioxide.

NOTE 2 — The date of preparation of the buffer solutions should be indicated on the bottles. The buffer solutions shall be stored in well stoppered bottles. These solutions are susceptible to mould growth and hence may deteriorate in storage. Hence it is advisable either to use freshly prepared solution or to add toluene or a crystal of thymol to the solution prior to storing.

2.3 Soil Specimen — The soil sample received from the field shall be prepared in accordance with IS : 2720 (Part 1)-1983†. All aggregations of particles shall be broken down so that, if the samples were sieved on a 425-micron IS Sieve, discrete particles would be retained. The sample, after having been broken up, shall be thoroughly mixed and then subdivided either by quartering or by riffing until a representative sub-sample is obtained.

*Specification for direct reading pH meters (third revision).

†Methods of test for soils: Part 1 Preparation of dry soil sample for various tests (second revision).

2.4 Procedure — 30 g of the soil from the sample, prepared as in 2.3, shall be taken in a 100-ml beaker. 75 ml of distilled water (see Note) shall be added to it. The suspension shall be stirred for a few seconds. The beaker shall then be covered with a cover glass and allowed to stand for one hour, with occasional stirring. It shall be again stirred well immediately before testing.

NOTE — The distilled water used should be aerated by bubbling air through it for some time.

2.4.1 The pH meter shall be calibrated by means of the standard buffer solutions following the procedure recommended by the manufacturer. The electrodes shall be washed with distilled water dried with the help of an ordinary filter paper and then immersed in the soil suspension. Two or three readings of the pH of the soil suspension shall be made with brief stirring in between each reading. The reading should agree within ± 0.05 pH units (the pH readings of the soil suspension should reach a constant value in about one minute. No readings should be taken until the pH meter has reached equilibrium). The electrodes shall be removed from the suspension immediately and washed with distilled water. The calibration of the pH meter shall be again checked with one of the standard buffer solutions. If the instrument is out of adjustment by more than 0.05 pH units, it shall be set to the correct adjustment till consistent readings are obtained (when not in use, the electrodes shall be left standing in a beaker of distilled water).

2.5 Record of Observations

2.5.1 The data sheet to record the observations of electrometric method is given in Appendix A.

2.6 Calculations

2.6.1 No calculations are needed as the pH meter directly provides pH values.

2.7 Presentation of Results

2.7.1 The pH value of the soil suspension shall be reported to the nearest 0.1 pH units as indicated on data sheet. It should be mentioned that the above test was carried out by the electrometric method.

3. COLORIMETRIC METHODS (SUBSIDIARY METHODS)

3.1 Universal Indicator Method

3.1.0 This method gives a rough idea (to an accuracy of about 0.5) about the pH value of the soil and should be used where exact pH is not required.

3.1.1 Preparation of Universal Indicator — Dissolve in 100 ml of alcohol the following (in given order):

- a) 0.06 g of methyl yellow,
- b) 0.04 g of methyl red,
- c) 0.08 g of bromothymol blue,
- d) 0.10 g of thymol blue, and
- e) 0.02 g of phenolphthalein.

Titrate the solution to yellow colour with 0.1 N sodium hydroxide solution. The indicator gives the colour value as given below:

pH 1 Cherry red	pH 6 Yellow
pH 2 Rose	pH 7 Yellow green
pH 3 Red orange	pH 8 Green
pH 4 Orange red	pH 9 Blue green
pH 5 Orange	pH 10 Blue

3.1.2 Procedure — 20 g of soil from the representative soil sample should be taken in a 100-ml beaker. To it 50 ml of distilled water (see Note under 2.4) should be added, stirred for 10 min continuously and allowed to stand for an hour (see Note), 20 ml of the clear solution should be then pipetted out and to it 2 or 3 drops of universal indicator should be added into a clean test tube solution gently shaken. The colour of the solution should then be compared with standard charts from which pH should be directly read. While comparing the colour of the solution with that of the chart care should be taken to avoid the effect of reflection and shadow.

NOTE — In order to accelerate the settlement of soil particle so that a clear solution is obtained for the pH test, barium sulphate should be added. The ratio of weight of barium sulphate and soil should be 1/3, 1 and 3 for sand, silt and clay respectively.

3.2 Indicator Paper Method

3.2.1 Indicator Papers — Supplied in booklets or as rolled tape carrying the colour chart and of range as follows:

Bromocresol green	: Phenolphthalein
Bromothymol blue	: Thymol blue
Chlorophenol red	: Thymolphthalein
Methyl orange	: Titan yellow (Clayton yellow)
Methyl red	

3.2.2 Procedure — 20 g of soil from the representative soil sample should be taken in a 100-ml beaker. To it 50 ml of distilled water (*see* Note under 2.4) should be added, stirred for 10 min continuously and allowed to stand for an hour (*see* Note under 3.1.2). 20 ml of the clear solution should be then pipetted out into a clean test tube. The leaf of the indicator paper or a strip should be dipped into this solution. The colour of the moistened indicator paper should be compared with those provided with the indicator paper. The pH of the solution should be designated as the number written on a particular colour shade with which the colour of the moistened indicator paper matches closely.

3.3 Record of Observations

3.3.1 The data sheet to record the observations of colorimetric methods is given in Appendix B and Appendix C.

3.4 Calculations — Interpretations.

3.4.1 The comparison of the colour of the solution prepared with the standard chart provides the pH value.

3.5 Presentation of Results

3.5.1 The results of pH shall be reported in terms of number as indicated in Appendix B and Appendix C.

APPENDIX A

(Clause 2.5.1)

DETERMINATION OF pH

Electrometric Method (Standard Method)

Project _____

Test No. _____

Sample No. _____

Date _____

Soil Identification _____

Tested by _____

Temperature _____

Sample Passing

Sieve No. _____

pH meter reading, pH scale

Remark:

APPENDIX B

(Clause 3.3.1)

SOIL MECHANICS LABORATORY

DETERMINATION OF pH

Colorimetric Method (Universal Indicator)

Project _____

Test No. _____

Sample No. _____

Date _____

Soil Identification _____

Tested by _____

Temperature _____

Sample Passing

Sieve No. _____

Colour value	
pH	

Remark:

APPENDIX C

(Clause 3.3.1)

SOIL MECHANICS LABORATORY

DETERMINATION OF pH

Colorimetric Method (Indicator Paper)

Project _____

Test No. _____

Sample No. _____

Date _____

Soil Identification _____

Tested by _____

Temperature _____

Sample passing

Sieve No. _____

Matching range, pH	
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Remark:

(Continued from page 2)

Soil Testing Procedures Subcommittee, BDC 23 : 3

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