भारतीय मानक

मृदा कणों का वितरण और उनके द्वारा भूमि में पानी रोकना — ज्ञात करने की विधि

Indian Standard

AGGREGATE SIZE DISTRIBUTION AND WATER STABILITY OF SOIL AGGREGATES — METHOD FOR DETERMINATION

ICS 13.080

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

April 2000 **Price Group 2**

Soil Quality and Improvement Sectional Committee, FAD 27

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Soil Quality and Improvement Sectional Committee had been approved by the Food and Agriculture Division Council.

Soil mass consists of mainly sand, silt and clay fractions. However, these primary soil particles do not exist as such, but are bound together in varying degrees into larger secondary units termed 'aggregates' by cementing materials such as organic matter and its by-products. The size distribution of these aggregates determines the physical environment of soil for root growth and its proliferation and consequently crop production potential. The binding forces between the primary soil particles and their ability to withstand the impact of dispersive forces such as kinetic energy of rain, water and wind determines the aggregate stability. Scientists have developed a technique for simulating the impact of dispersion forces in laboratory to quantify the degree and extent of aggregation and its stability.

In the preparation of this standard, help have been derived from the following publications:

Baver, L.D. and H.F. Rhoades (1932). Aggregate analysis as an aid in the study of soil structure relationships. Journal of American Society of Agronomy, 24:920-930.

Emerson, W.W. (1967), Australian Journal of Soil Research 5:47.

Tiulin, A.F. (1928). Questions on soil structure II aggregate analysis as a method for determining soil structure. Report 2, pp. 77-122, Perm. Agriculture Experimental Station. Division of Agricultural Chemicals.

Yoder, R.E. (1936). A direct method of aggregate analysis and a study of the physical nature of erosion losses. Journal of American Society of Agronomy, 28:337-351.

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 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

AGGREGATE SIZE DISTRIBUTION AND WATER STABILITY OF SOIL AGGREGATES — METHOD FOR DETERMINATION

1 SCOPE

This Indian Standard specifies methods for the determination of aggregate size distribution and water stability of soil aggregates.

2 QUALITY OF REAGENTS

Unless specified otherwise, pure chemicals and distilled water (*see* IS 1070) shall be employed in tests.

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

3 PRINCIPLE

The air-dried soil sample is passed through a nest of sieves having different pore sizes to grade the aggregates into various sizes. The percentage distribution of dry aggregate is determined. A composite soil sample having the same percent distribution as the dry aggregates is shaken in water in similar nest of sieves to determine the aggregate stability. The aggregate stability or degree and extent of aggregation of fine material is calculated on the basis of soil retained on each sieve after deducting the appropriate sand fraction.

4 APPARATUS

4.1 Sampling Ring

20 cm diameter and 10 cm height.

4.2 Nest of Sieves

20 cm diameter and 5 cm height; provided with screens, top lid and bottom pan. The screens shall have 25.0, 10.0, 5.0 (4), 2.0 (10), 1.0 (18), 0.5 (35) and 0.25 (60) mm round openings/pores.

4.3 Mechanical Rotary Sieve Shaker

4.4 Aluminium Box

4.5 Spade

4.6 Brush

4.7 Yoder Type Mechanical Oscillator

Powered by a gear reduction motor having amplitude of oscillation 3.8 cm and frequency of oscillation 30-35 cycles per minute.

4.8 Buchner Funnels

15 cm diameter, with rubber stoppers.

4.9 Vacuum Flasks

1 000 ml.

4.10 Suction Pump or Aspirator

4.11 Perforated Cans and Sand Bath

5 REAGENTS

5.1 Sodium Hexametaphosphate Solution

5 percent (*m*/*v*).

5.2 Sodium Hydroxide Solution

4 percent (*m*/*v*).

6 COLLECTION OF SOIL SAMPLE

6.1 From Tilled Surface Layer

Sample is collected from the surface layer of a tilled field with the help of a ring. The ring shall be placed on the tilled soil and pressed it until in level with the surface. Loose soil within the ring shall be removed and collected in a polyethylene bag.

6.2 From Untilled Subsurface Soil

The soil up to root zone depth and boundaries of each soil horizon or distinct layers demarketed with the help of a sharp-edged knife. Collect the bulk samples (2 kg) layer or horizonwise in plastic bags, by making wedged shaped cuts with the help of a spade, shovel or hand-hoe. Label samples as described in **5.1**.

6.3 Labelling

One label indicating the depth and soil profile is placed inside the bag (**4.1** and **4.2**) and the other label on the outside of the bag.

6.4 Drying

The samples are air dried, if necessary.

7 PROCEDURE

7.1 Dry Aggregate Analysis

7.1.1 Spread the soil sample on a sheet of paper and subsample it by 'Quartering'. Form a cone of the mixed soil material in the centre of the mixing sheet with care to make it symmetrical with respect to fine and coarse soil material. Flatten the cone and divide through the centre with a flat metal spatula or a metal sheet, one half being moved to the side quantitatively. Divide each half into further halves, the four quarters being separated into separate piles or quarters. Weigh 100 g of sub-samples from two of these quarters and use for clod size and aggregate analysis as duplicates.

7.1.2 Transfer the weighed sample to the top sieve of the nest of sieves. Cover the top sieve with the lid and sieve on the rotary shaker for 10 min. Collect the soil retained on each screen in the pre-weighed aluminium box with the help of a small brush. Weigh each can separately. If the percentage of dry aggregates on 5 mm sieve exceeds 25 percent by mass of the total sample, transfer these aggregates to a nest of sieves with 25.0, 10.0 and 5.0 mm sieves along with a pan. Cover the top sieve containing the aggregates with a lid and replace the nest of sieves on the rotary shaker and shake for 10 min. Determine the percent distribution of dry aggregates retained on each sieve. Carry out a duplicate determination.

7.1.3 Dry the duplicate 100 g sample in an oven for 24 h at 105°C and calculate the oven-dry weight of the soil sample.

7.1.4 *Calculation*

$$\text{Weight of aggregates in each size group } (A) = (\text{Weight of aggregates} + \text{Can}) - \text{Weight of Can}$$

Percentage distribution of aggregates in each size group = A × 100

$$\text{Oven dry weight of aggregates, percent by mass} = \frac{\text{Air dry weight} \times 100}{100 + \text{Moisture content, percent by mass}}$$

7.2 Wet Aggregate Analysis

7.2.1 Prepare four composite 100 g soil samples, having the same composition as determined in dry aggregate analysis, from the soil retained on each sieve during dry aggregate analysis. Place a set of duplicate samples in an air-oven for the determination of moisture content and another set of duplicate samples in perforated cans on sand-bath for saturation. Transfer the saturated soil (except fine textured soil) to the top sieve of the nest of sieves and spread with the help of a glass rod and a slow jet of water. Remove the bottom pan and attach the nest of sieves to the Yoder type sieve shaker. Fill the drum with salt-free water at 20-25°C to a level somewhat below that of the screen in the top sieve of the nest of sieves, when the sieves are in the highest position. Then lower the nest of sieves to wet the soil for 10 min. Bring the nest of sieves to the initial position and adjust the level of water so that the screen in the top sieve is just covered with water in its highest position. Switch on the mechanical oscillator for 10 min. Remove the nest of sieves from the water and allow it to drain. Transfer the soil resting on each sieve with a stream of distilled water into a Buchner funnel having a pre-weighed filter paper into an aluminium can and dry at 105°C for 24 h. Weigh the soil nearest to 0.01 g.

7.2.2 Transfer the oven dry soil aggregates from all the cans of a set into a dispersion cup. Add dispersing agent (10 ml of 5 percent sodium hexametaphosphate solution for calcium saturated soil or 10 ml of 4 percent sodium hydroxide solution for acid soil), and enough distilled water to fill the cup within 3.8 cm of the rim. Stir the suspension for 10 min. Wash the suspension on an identical set of sieves as used previously by means of a stream of tap water. Oven-dry the sand remaining on each screen and weigh in the same manner as detailed earlier. Calculate the percent distribution of soil particles (aggregates and sand) and sand particles retained on each sieve.

7.2.3 *Calculation*

Size distribution of soil particles (aggregates + sand)

Soil particles in each size group, percent by mass

$$= \frac{\text{Oven dry weight of aggregates and sand in each size group}}{\text{Oven dry weight of soil sample}} \times 100$$

Size distribution of sand particles

$$\text{Sand in each size group, percent by mass} = \frac{\text{Oven dry weight of sand in each size group}}{\text{Oven dry size weight of soil sample}} \times 100$$

NOTE — The cumulative percentage of sand retained on each screen after dispersion to be calculated as done for soil particles.

8 EXPRESSION OF AGGREGATION

8.1 State of Aggregation

It shall be the percentage of aggregates greater than 0.1 mm.

8.2 Aggregation Index

8.2.1 Prepare a graph of cumulative percentage of soil particles *versus* the sieve sizes. A curve will then result going through the point (0 mm, 0 percent) and (8 mm, 100 percent), showing the distribution of soil particles.

8.2.2 Plot the cumulative percentage of the sand against the sieve sizes on the graph prepared in **8.2.1** and determine the area enclosed between the curves.

NOTE — If 1 mm (size class) represents 1 unit of the abscissa and 10 percent 1 unit of the ordinate; a square unit shall represent 0.1 mm of the mean diameter. Multiplying the area, therefore with 0.1 mm gives the mean diameter of the sample in millimetre in each case. The difference between the mean diameter of the soil particles and the dispersed sample gives the aggregation index.

8.3 Mean Weight Diameter

From the weight of the soil particles (aggregates + sand) in each size group, calculate its proportion to total sample weight, and then the mean weight diameter from the relationship:

Geometric Mean Diameter (GMD)

$$\text{GMD} - \exp\left[\frac{\left(W_i \log X_i\right)}{W_i}\right]$$

where

W_i = weight, in g, of aggregate in a size class with an average diameter x_i;

x_i = mean diameter, in mm, of each size fraction;

w_i = total weight, in g, of the sample; and

n = number of size fractions.

8.4 Stability Index of Soils

8.4.1 Prepare a graph of the percent distributions of soil particles and primary particles by plotting the percentages on the ordinate, and particle sizes on the abscissa, starting with the point 8 mm, 0 percent.

8.4.2 Mark the point of intersection. The positive difference between the sum of percentages of soil particles and primary particles on either size of the intersection is the stability index.

$$\text{Stability index} = E_a - E_m \text{ or } E_n - E_b$$

where

E_a = sum of the percentage of the soil particles;

E_m = sum of the percentage of primary particles, to the left of the intersection;

E_n = sum of the percentage of primary particles; and

E_b = sum of the percentage of soil particles to the right of the intersection.

8.5 Aggregate Stability (AS), Percent by Mass/ Degree of Aggregation/Structural Coefficient (SC) of Soil

It shall be the percentage of the material less than 0.1 mm which have combined to form water stable aggregates greater than 0.10 mm in diameter.

$$\text{AS/SC, percent} = \frac{\text{Weight of soil particles} > 0.10}{\text{Oven dry weight of soil sample}} - \frac{\text{Weight of sand} > 0.10}{\text{Weight of sand} > 0.10} \times 100$$

Bureau of Indian Standards

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