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Indian Standard

METHODS OF TEST FOR SOILS

PART XXV DETERMINATION OF SILICA SESQUIOXIDE RATIO

(First Revision)

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Indian Standard

METHODS OF TEST FOR SOILS

PART XXV DETERMINATION OF SILICA SESQUIOXIDE RATIO

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part XXV) (First Revision) was adopted by the Indian Standards Institution on 24 December 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 With a view to establishing uniform procedures for the determination to different characteristics of soils and also for facilitating a comparative study of the results, the Indian Standards Institution is bringing out the Indian Standard Methods of test for soils (IS : 2720) which has been published in parts. This part covers method for determination of silica sesquioxide ratio. The silica sesquioxide ratio of clay is one of the fundamental properties of the soil. This is used as a guide in the mineralogical classification of soil. Usually clay minerals of high exchange capacity have also high silica sesquioxide ratio values while those of low exchange capacity have a low ratio. The ratio is determined on the clay fraction (particle size less than 0·002 mm) of the soil. This standard was first published in 1967. This revision covers improved method of initial treatment of the soil specimen for conducting this test.

0.3 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 (Part XXV) lays down the method for determining the silica sesquioxide ratio of soils.

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

2. APPARATUS

2.1 Glass Bottles — of 300, 500 and 1 000 ml capacity.

2.2 Cylinder — tall, wide mounted, 1 200 ml capacity.

2.3 Dishes, Porcelain

2.4 Buchner Funnel

2.5 Vacuum Trolley

2.6 Aspirator

2.7 Flask — measuring 100 and 250 ml.

2.8 Crucible with Lid

2.9 Tongs

2.10 Platinum Dish

2.11 Beaker — 400 and 800 ml capacity.

2.12 Muffle Furnace

2.13 Filter Paper — Whatman No. 42 and 50 or equivalent.

2.14 Reagents — The following reagents 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 results of analysis.

2.14.1 *Hydrochloric Acid*

2.14.2 *Sodium Hydroxide*

2.14.3 *Ammonium Chloride*

2.14.4 *Ammonia*

2.14.5 *Rosolic Acid*

2.14.6 *Fusion Mixture*

3. PROCEDURE

3.1 Initial Treatment of Soil Specimen — Ten grams of the dried clay substance be separated by centrifuging — 2 micron fraction. It should then be freed of exchangable cations by dialyses or with an exchange resin. Colloidal impurities and organic impurities be then oxidised with hydrogen peroxide. Later iron oxide be dissolved away with oxalic acid and clay fraction washed free of oxalate ions and dried. It should then be used for estimation of silica and aluminium oxide and iron oxide.

3.2 Estimation of Silica — About one gram of the dried clay accurately weighed shall be taken in a platinum dish and mixed with fusion mixture 5 to 6 times the weight of the clay. It shall then be ignited in the muffle furnace or any suitable arrangement (at about 900°C) and cooled. The dish shall then be placed in the 800-ml beaker filled with distilled water. A few millilitres of concentrated hydrochloric acid shall be added and the beaker covered with watch glass. After some time when the effervescence stops, the platinum dish shall be washed with distilled water into the beaker containing the dish with the ignited mass. The whole mass shall be evaporated to dryness on a sand bath till whole of the hydrochloric acid disappears. If necessary, the process, may be repeated to ensure complete baking or dehydration of silica. The evaporation shall be continued for another hour to remove the last traces of hydrochloric acid. Two hundred millilitre of distilled water shall be added and heated for at least another 10 minutes, filtered through Whatman filter paper No. 42 or equivalent and washed free from acid. The whole of silica along with filter paper shall be placed in a preweighed crucible. The crucible shall be placed in the muffle furnace for some time till the weight of crucible with its contents becomes constant, then cooled and weighed. The weight of silica shall be calculated by subtracting the empty weight of the crucible.

3.3 Estimation of Aluminium Oxide and Iron Oxide

3.3.1 The sesquioxide ($Fe_2O_3 + Al_2O_3$) in the crucible shall be fused with fusion mixture and then dissolved in hydrochloric acid. It shall be added to the filtrate obtained in **3.2.** About 5 ml of Bromine water shall be added and the contents shall be made to 250 ml. Half of it shall be taken for estimation of aluminium oxide and iron oxide. The other half shall be taken for the estimation of iron oxide only.

3.3.2 To the first half about four grams of ammonium chloride (NH_4Cl) and a few drops of rosolic acid solution shall be added and heated to boiling. A little paper pulp shall then be added and the solution made very slightly ammonical with dilute ammonia as shown by a faint pink colour of rosolic acid and finally filtered through Whatman filter

paper No. 42 or equivalent. The precipitates along with filter paper shall be placed in a weighed crucible which shall then be ignited in the muffle furnace or any other suitable arrangement. The final weight shall be noted. The total weight of aluminium oxide plus iron oxide shall be obtained by subtracting from the final weight, the weight of the empty crucible.

3.3.3 To the second half of the filtrate obtained in **3.3.1**, an excess of concentrated sodium hydroxide shall be added and boiled. The precipitate of iron hydroxide so formed shall be filtered. The aluminium hydroxide dissolves in sodium hydroxide. The precipitates shall be washed free from alkali by hot distilled water and dissolved in the minimum quantity of hydrochloric acid. Ammonium chloride (solid) shall be added and the solution heated and again allowed to cool. Excess of ammonium hydroxide solution shall then be added and precipitates so formed filtered, dried along with the filter paper and transferred to the pre-weighed crucible. The crucible shall be ignited in the muffle furnace or any other suitable arrangement, cooled, reweighed and the weight of iron oxide calculated. The difference between the weights of aluminium oxide plus iron oxide ($Al_2O_3 + Fe_2O_3$) and iron oxide gives the weight of aluminium oxide.

4. CALCULATIONS

4.1 The values of silica, iron and alumina shall be expressed as percentage of clay. Each value shall be divided by its molecular weight to obtain the gram molecular percentage as given below:

Gram molecular percentage of silica (SiO_2),

$$a = \frac{\text{Weight of } SiO_2}{\text{Weight of clay}} \times \frac{100}{60}$$

Gram molecular percentage of aluminium oxide (Al_2O_3),

$$b = \frac{\text{Weight of } Al_2O_3}{\text{Weight of clay}} \times \frac{100}{102}$$

Gram molecular percentage of iron oxide (Fe_2O_3),

$$c = \frac{\text{Weight of } Fe_2O_3}{\text{Weight of clay}} \times \frac{100}{159{\cdot}7}$$

The silica sesquioxide ratio is given by the following equation:

$$\frac{a}{b + c}$$

4.2 The average of three determinations shall be taken as the silica sesquioxide ratio of the soil sample.

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	$1\ N = 1\ kg.m/s^2$
Energy	joule	J	$1\ J = 1\ N.m$
Power	watt	W	$1\ W = 1\ J/s$
Flux	weber	Wb	$1\ Wb = 1\ V.s$
Flux density	tesla	T	$1\ T = 1\ Wb/m^2$
Frequency	hertz	Hz	$1\ Hz = 1\ c/s\ (s^{-1})$
Electric conductance	siemens	S	$1\ S = 1\ A/V$
Electromotive force	volt	V	$1\ V = 1\ W/A$
Pressure, stress	pascal	Pa	$1\ Pa = 1\ N/m^2$

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