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SPECIFICATION FOR COARSE AND FINE AGGREGATES FROM NATURAL SOURCES FOR CONCRETE

(Second Revision)

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

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Indian Standard

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Indian Standard

SPECIFICATION FOR COARSE AND FINE AGGREGATES FROM NATURAL SOURCES FOR CONCRETE

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 25 September 1970, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 This standard was first published in 1952 and subsequently revised in 1963. The present revision of the standard has been taken up to incorporate the modification necessary in the light of experience gained in its use and also to bring it in line with the latest thinking on the subject.

0.2.1 The requirements for aggregates for mass concrete have been included and it is proposed to withdraw IS : 515-1959* when this standard is printed.

0.3 The limiting values for the permissible deleterious materials in the aggregates, aggregate abrasion value and soundness test for aggregates have been revised. Recommendations have been included for the size of aggregates for mass concrete. The four grading zones for fine aggregates as specified in the earlier version of the standard have not been changed. These four grading zones become progressively finer from Grading Zone I to Grading Zone IV (*see* Table 4). The fine aggregates within each of these grading zones are suitable for making concrete, but to make concrete of high strength and durability, the mix proportions should be chosen according to the grading characteristics of the fine aggregates used; the ratio of fine to coarse aggregate being reduced as the fine aggregate becomes finer from Grading Zones I to IV. In particular, the correct design of the mix becomes increasingly important as the grading of the fine aggregate approaches the coarse outer limit of Grading Zone I or the fine outer limit of Grading Zone IV, and the suitability of a given fine aggregate grading may, in some circumstances, depend on the grading and shape of the coarse aggregate. It is sometimes found that a fine aggregate which lies in one grading zone and near the border of another does not

*Since withdrawn

remain consistently in one zone but fluctuates between the two. It is therefore, desirable to choose a suitable ratio of fine to coarse aggregate proportions of the concrete to allow some fluctuations in the grading zone of the fine aggregate.

0.3.1 The four grading zones indicated in this standard are meant to cover the use of the natural sands available in the country. It is, however, necessary to appreciate the limitations in either using a very coarse sand or a very fine sand and the need to make suitable changes in the mix design.

0.4 Investigations have shown that the bulk density is affected by the size of the container used to determine it. Secondly there is an increasing tendency to batch concrete by weight rather than by volume. Hence as in 1963 version of the standard, the provisions regarding bulk density have not been included.

0.5 Whilst the requirements specified in this standard generally meet the normal requirements for most of the concrete works, there might be special cases where certain requirements other than those specified in the standard might have to be specified; in such case, such special requirements, the test required and the limits for such tests may be specified by the purchaser.

0.6 Indian Standards Methods of test for aggregates for concrete [IS:2386 (Part I)-1963 to IS:2386 (Part VIII)-1963] are necessary adjuncts to this standard. For sampling of aggregates, reference may be made to IS:2430-1969.

0.7 This standard contains clauses **3.2.1**, **3.4**, **3.5**, **6.2**, **6.3** and **6.4** which call for agreement between purchaser and supplier and requires the supplier to furnish technical information as given in Appendix A.

0.8 Titles of standards referred to in the various clauses of this standard are given in Appendix B.

0.9 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.

1. SCOPE

1.1 This standard covers the requirements for aggregates, crushed or uncrushed, derived from natural sources, such as river terraces and riverbeds, glacial deposits, rocks, boulders and gravels, for use in the production of concrete for normal structural purposes including mass concrete works.

1. SCOPE

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2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

NOTE — A comprehensive standard covering glossary of terms relating to aggregates for concrete is under preparation. The standard when published will include the definitions covered under **2.1** to **2.3**.

2.1 Fine Aggregate — Aggregate most of which passes 4·75-mm IS Sieve and contains only so much coarser material as permitted in **4.3**.

2.1.1 *Natural Sand* — Fine aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies.

2.1.2 *Crushed Stone Sand* — Fine aggregate produced by crushing hard stone.

2.1.3 *Crushed Gravel Sand* — Fine aggregate produced by crushing natural gravel.

2.2 Coarse Aggregate — Aggregate most of which is retained on 4·75-mm IS Sieve and containing only so much finer material as is permitted for the various types described in this standard.

NOTE — Coarse aggregate may be described as:

a) uncrushed gravel or stone which results from natural disintegration of rock,

b) crushed gravel or stone when it results from crushing of gravel or hard stone, and

c) partially crushed gravel or stone when it is a product of the blending of (a) and (b).

2.3 All-in-Aggregate — Material composed of fine aggregate and coarse aggregate.

3. QUALITY OF AGGREGATES

3.1 General — Aggregate shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or combination thereof. They shall be hard, strong, dense, durable, clear and free from veins and adherent coating; and free from injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. As far as possible, flaky, scoriaceous and elongated pieces should be avoided.

3.2 Deleterious Materials — Aggregates shall not contain any harmful material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of the concrete. Aggregates to be used for reinforced concrete shall not contain any material liable to attack the steel reinforcement. Aggregates which are chemically reactive with alkalies of cement are harmful as cracking of concrete may take place.

NOTE — Aggregates petrographically similar to known reactive types or aggregates which, on the basis of service history or laboratory experiments, are suspected to have reactive tendency should be avoided or used only with cements of low alkalies [not more than 0·6 percent as sodium oxide (Na_2O)], after detailed laboratory studies. Use of pozzolanic cement and certain pozzolanic admixtures may be helpful in controlling alkali aggregate reaction.

3.2.1 *Limits of Deleterious Materials* — The maximum quantity of deleterious materials shall not exceed the limits specified in Table 1 when tested in accordance with IS : 2386-1963. However, the engineer-in-charge at his discretion, may relax some of the limits as a result of some further tests and evidence of satisfactory performance of the aggregates.

3.3 Aggregate Crushing Value — The aggregate crushing value, when determined in accordance with IS : 2386 (Part IV)-1963 shall not exceed 45 percent for aggregate used for concrete other than for wearing surfaces, and 30 percent for concrete for wearing surfaces, such as runways, roads and pavements.

3.4 Aggregates Impact Value — As an alternative to **3.3** the aggregate impact value may be determined in accordance with the method specified in IS : 2386 (Part IV)-1963. The aggregate impact value shall not exceed 45 percent by weight for aggregates used for concrete other than for wearing surfaces and 30 percent by weight for concrete for wearing surfaces, such as runways, roads and pavements.

3.5 Aggregate Abrasion Value — Unless otherwise agreed to between the purchaser and the supplier, the abrasion value of aggregates, when tested in accordance with the method specified in IS : 2386 (Part IV)-1963 using Los Angeles machine, shall not exceed the following values:

a) For aggregates to be used in concrete for wearing surfaces	30 percent
b) For aggregates to be used in other concrete	50 percent

3.6 Soundness of Aggregate — For concrete liable to be exposed the action of frost, coarse and fine aggregates shall pass a sodium or magnesium sulphate accelerated soundness test specified in IS : 2386 (Part V)-1963, the limits being set by agreement between the purchaser and the supplier,

except that aggregates failing in the accelerated soundness test may be used if they pass a specified freezing and thawing test satisfactory to the user.

NOTE — As a general guide, it may be taken that the average loss of weight after 5 cycles shall not exceed the following:

a) For fine aggregate	10 percent when tested with sodium sulphate (Na_2SO_4), and
	15 percent when tested with magnesium sulphate ($MgSO_4$)
b) For coarse aggregate	12 percent when tested with sodium sulphate (Na_2SO_4), and
	18 percent when tested with magnesium sulphate ($MgSO_4$)

4. SIZE AND GRADING OF AGGREGATES

4.1 Single-Sized Coarse Aggregates — Coarse aggregates shall be supplied in the nominal sizes given in Table 2. For any one of the nominal sizes, the proportion of other sizes, as determined by the method described in IS:2386 (Part I)-1963 shall also be in accordance with Table 2.

4.1.1 *Coarse Aggregate for Mass Concrete* — Coarse aggregate for mass concrete works shall be in the sizes specified in Table 3.

4.2 Graded Aggregates — Graded coarse aggregates may be supplied in the nominal sizes given in Table 2.

4.3 Fine Aggregates — The grading of fine aggregates, when determined as described in IS:2386 (Part I)-1963 shall be within the limits given in Table 4 and shall be described as fine aggregates, Grading Zones I, II, III and IV. Where the grading falls outside the limits of any particular grading zone of sieves other than 600-micron IS Sieve by a total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600-micron IS Sieve or to percentage passing any other sieve size on the coarse limit of Grading Zone I or the finer limit of Grading Zone IV.

4.4 All-in-Aggregates — If combined aggregates are available they need not be separated into fine and coarse, but necessary adjustments may be made in the grading by the addition of single-sized aggregates. The grading of the all-in-aggregate, when analyzed, as described in IS:2386 (Part I)-1963 shall be in accordance with Table 5.

TABLE 1 LIMITS OF DELETERIOUS MATERIALS

(*Clause* 3.2.1)

Sl No.	Deleterious Substance	Method of Test	Fine Aggregate Percentage by Weight, *Max*		Coarse Aggregate Percentage by Weight, *Max*	
			Uncrushed	Crushed	Uncrushed	Crushed
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Coal and lignite	IS : 2386 (Part II)-1963	1·00	1·00	1·00	1·00
ii)	Clay lumps	do	1·00	1·00	1·00	1·00
iii)	Materials finer than 75-μ IS Sieve	IS : 2386 (Part I)-1963	3·00	15·00	3·00	3·00
iv)	Soft fragments	IS : 2386 (Part II)-1963	—	—	3·00	—
v)	Shale	do	1·00	—	—	—
vi)	Total of percentages of all deleterious materials (except mica) including Sl No. (i) to (v) for col 4, 6 and 7 and Sl No. (i) and (ii) for col 5 only	—	5·00	2·00	5·00	5·00

Note 1 — The presence of mica in the fine aggregate has been found to red considerably the durability and compressive strength of concrete and further investi tions are underway to determine the extent of the deleterious effect of mica. I advisable, therefore, to investigate the mica content of fine aggregate and m suitable allowances for the possible reduction in the strength of concrete or mortar.

Note 2 — The aggregate shall not contain harmful organic impurities [tested accordance with IS : 2386 (Part II)-1963] in sufficient quantities to affect adver the strength or durability of concrete. A fine aggregate which fails in the test organic impurities may be used, provided that, when tested for the effect of org impurities on the strength of mortar, the relative strength at 7 and 28 days, reporte accordance with 7 of IS : 2386 (Part VI)-1963 is not less than 95 percent.

TABLE 2 COARSE AGGREGATES

(*Clauses* 4.1 *and* 4.2)

IS Sieve Designation	Percentage Passing for Single-Sized Aggregate of Nominal Size						Percentage Passing for Graded Aggregate of Nominal Size			
	63 mm	40 mm	20 mm	16 mm	12·5 mm	10 mm	40 mm	20 mm	16 mm	12·5 mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
80 mm	100	—	—	—	—	—	100	—	—	—
63 mm	85 to 100	100	—	—	—	—	—	—	—	—
40 mm	0 to 30	85 to 100	100	—	—	—	95 to 100	100	—	—
20 mm	0 to 5	0 to 20	85 to 100	100	—	—	30 to 70	95 to 100	100	100
16 mm	—	—	—	85 to 100	100	—	—	—	90 to 100	—
12·5 mm	—	—	—	—	85 to 100	100	—	—	—	90 to 100
10 mm	0 to 5	0 to 5	0 to 20	0 to 30	0 to 45	85 to 100	10 to 35	25 to 55	30 to 70	40 to 85
4·75 mm	—	—	0 to 5	0 to 5	0 to 10	0 to 20	0 to 5	0 to 10	0 to 10	0 to 10
2·36 mm	—	—	—	—	—	0 to 5	—	—	—	—

TABLE 3 SIZES OF COARSE AGGREGATES FOR MASS CONCRETE

(*Clause* 4.1.1)

CLASS AND SIZE	IS SIEVE DESIGNATION	PERCENTAGE PASSING
Very large, 150 to 80 mm	160 mm*	90 to 100
	80 mm	0 to 10
Large, 80 to 40 mm	80 mm	90 to 100
	40 mm	0 to 10
Medium, 40 to 20 mm	40 mm	90 to 100
	20 mm	0 to 10
Small, 20 to 4·75 mm	20 mm	90 to 100
	4·75 mm	0 to 10
	2·36 mm	0 to 2

*There being no IS Sieve having an aperture larger than 100 mm a perforated plate complying with IS : 2405-1963 and having a square aperture of 160 mm may be used.

5. SAMPLING AND TESTING

5.1 Sampling — The method of sampling shall be in accordance with IS : 2430-1969. The amount of material required for each test shall be as specified in the relevant method of test given in IS : 2386 (Part I)-1963 to IS : 2386 (Part VIII)-1963.

5.2 All tests shall be carried out as described in IS : 2386 (Part I)-1963 to IS : 2386 (Part VIII)-1963. Unless otherwise stated in the enquiry or order, duplicate tests shall be made in all cases and the results of both tests reported.

5.2.1 In the case of all-in-aggregates, for purposes of tests to verify its compliance with the requirements given in Table 1, and when necessary for such other tests as required by the purchaser, the aggregates shall be first separated into two fractions, one finer than 4·75-mm IS Sieve and the other coarser than 4·75-mm IS Sieve, and the appropriate tests shall be made on samples from each component, the former being tested as fine aggregate and the latter as coarse aggregate.

5.2.2 If further confirmation as to the satisfactory nature of an aggregate is required, tests may be made in accordance with **2** and **5** of IS : 516-1959 with a view to comparing the properties of the concrete made with the aggregate under consideration with those of concrete made with an aggregate of known quality.

TABLE 4 FINE AGGREGATES

(*Clause* 4.3)

IS Sieve Designation	Percentage Passing for			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4·75 mm	90-100	90-100	90-100	95-100
2·36 mm	60-95	75-100	85-100	95-100
1·18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

NOTE 1 — For crushed stone sands, the dermissible limit on 150-micron IS Sieve is increased to 20 percent. This does not affect the 5 percent allowance permitted in **4.3** applying to other sieve sizes.

NOTE 2 — Fine aggregate complying with the requirements of any grading zone in this table is suitable for concrete but the quality of concrete produced will depend upon a number of factors including proportions.

NOTE 3 — Where concrete of high strength and good durability is required, fine aggregate conforming to any one of the four grading zones may be used, but the concrete mix should be properly designed. As the fine aggregate grading becomes progressively finer, that is, from Grading Zones I to IV, the ratio of fine aggregate to coarse aggregate should be progressively reduced. The most suitable fine to coarse ratio to be used for any particular mix will, however, depend upon the actual grading, particle shape and surface texture of both fine and coarse aggregates.

NOTE 4 — It is recommended that fine aggregate conforming to Grading Zone IV should not be used in reinforced concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

TABLE 5 ALL-IN-AGGREGATE GRADING

(*Clause* 4.4)

IS Sieve Designation	Percentage Passing for All-in-Aggregate of	
	40 mm Nominal Size	20 mm Nominal Size
80 mm	100	
40 mm	95 to 100	100
20 mm	45 to 75	95 to 100
4·75 mm	25 to 45	30 to 50
600 micron	8 to 30	10 to 35
150 micron	0 to 6	0 to 6

6. SUPPLIER'S CERTIFICATE AND COST OF TESTS

6.1 The supplier shall satisfy himself that the material complies with the requirements of this standard and, if requested, shall supply a certificate to this effect to the purchaser.

6.2 If the purchaser requires independent tests to be made, the sample for such tests shall be taken before or immediately after delivery, according to the option of the purchaser, and the tests carried out in accordance with this standard and on the written instructions of the purchaser.

6.3 The supplier shall supply free of charge the material required for tests.

6.4 The cost of the tests carried out under **6.2** shall be borne by:

a) the supplier, if the results show that the material does not comply with this standard; and

b) the purchaser, if the results show that the material complies with this standard.

APPENDIX A

(Clause 0.8)

INFORMATION TO BE FURNISHED BY THE SUPPLIER

A-1. DETAILS OF INFORMATION

A-1.1 When requested by the purchaser or his representative, the supplier shall provide the following particulars:

a) Source of supply, that is, precise location of source from where the materials were obtained;

b) Trade group of principal rock type present (*see* Appendix C);

c) Physical characteristics (*see* Appendix C);

d) Presence of reactive minerals; and

e) Service history, if any.

A-1.2 Subject to prior agreement, the supplier shall furnish such of the following additional information, when required by the purchaser:

a) Specific gravity,

b) Bulk density,

c) Moisture content,

d) Absorption value,

e) Aggregate crushing value or aggregate impact value,

f) Abrasion value,

g) Flakiness-index,

h) Elongation-index,

j) Presence of deleterious materials,

k) Potential reactivity of aggregate, and

m) Soundness of aggregate.

APPENDIX B

(*Clause* 0.9)

TITLES OF REFERRED STANDARDS

IS:2-1960 Rules for rounding off numerical values (*revised*)

IS:515-1959 Specification for natural and manufactured aggregates for use in mass concrete

IS:516-1959 Methods of test for strength of concrete

IS:2386 Methods of test for aggregates for concrete:

(Part I)-1963 Particle size and shape

(Part II)-1963 Estimation of deleterious materials and organic impurities

(Part III)-1963 Specific gravity, density, voids, absorption and bulking

(Part IV)-1963 Mechanical properties

(Part V)-1963 Soundness

(Part VI)-1963 Measuring mortar making properties of fine aggregate

* Since withdrawn

(Part VII)-1963 Alkali aggregate reactivity

(Part VIII)-1963 Petrographic examination

IS:2405-1963 Wire cloth and perforated plates for industrial sieves

IS:2430-1969 Methods for sampling of aggregates for concrete

APPENDIX C

(*Clause* A-1.1)

DESCRIPTION AND PHYSICAL CHARACTERISTICS OF AGGREGATES FOR CONCRETE

C-1. GENERAL HEADINGS

C-1.1 To enable detailed reports on aggregates to be framed on a comparable basis, the following general headings under which the appropriate information may be given are suggested as a guide:

a) *Trade Group* — For example, granite, limestone and sandstone (*see* **C-2.1**);

b) *Petrological Name and Description* — The correct petrological name should be used and should be accompanied by a brief description of such properties as hardness, colour, grain, imperfections, etc;

c) *Description of the Bulk* — The degree of cleanliness, that is, freedom from dust, should be stated and reference made to the presence of any pieces not representative of the bulk, such as elongated or flaky pieces;

d) *Particle Shape* — *See* **C-3**; and

e) *Surface Texture* — *See* **C-3**.

C-2. NOMENCLATURE OF ROCK

C-2.0 The technical nomenclature of rocks is an extensive one and for practical purposes it is sufficient to group together with those rocks having certain petrological characteristics in common. Accordingly, the list of trade groups given in **C-2.1** is adopted for the convenience of producers and users of stone.

C-2.1 Trade Groups of Rocks Used as Concrete Aggregate

Names of trade groups: Granite, Gabbro, Aplite, Dolerite, Rhyolite, Basalt, Sandstone, Limestone, Granulite, Gneiss, Schist and Marble

C-2.1.1 *List of Rocks Placed Under the Appropriate Trade Groups* — The correct identification of a rock and its placing under the appropriate trade group shall be left to the decision of the Geological Survey of India or any competent geologist.

IGNEOUS ROCKS

Granite Group

Granite
Granophyre
Granodiorite
Diorite
Syenite

Gabbro Group

Gabbro
Norite
Anorthosite
Peridotite
Pyroxenite
Epidiorite

Aplite Group

Aplite
Porphyry
Quartz reef

Dolerite Group

Dolerite
Lamprophyre

Rhyolite Group

Rhyolite
Trachyte
Felsite
Pumicite

Basalt Group

Andesite
Basalt

SEDIMENTARY ROCKS

Sandstone Group

Sandstone
Quartzite
Arkose
Graywacke
Grit

Limestone Group

Limestone
Dolomite

METAMORPHIC ROCKS

Granulite and Gneiss Groups

Granite gneiss
Composite gneiss
Amphibolite
Granulite

Schist Group

Slate
Phyllite
Schist

Marble Group

Marble
Crystalline
Limestone

C-3. PARTICLE SHAPE AND SURFACE TEXTURE

C-3.1 The external characteristics of any mixture of mineral aggregate include a wide variety of physical shape, colour and surface condition. In order to avoid lengthy descriptions, it may be convenient to apply to distinctive group types of aggregates some general term which could be adopted.

C-3.2 The simple system shown in Tables 6 and 7 has, therefore, been devised and is put forward in the hope that it will facilitate defining the essential features of both particle shape and surface characteristics.

C-3.3 Surface characteristics have been classified under five headings or groups. The grouping is broad; it does not purport to be a precise petrographical classification but is based upon a visual examination of hand specimens. With certain materials, however, it may be necessary to use a combined description with more than one group number for an adequate description of the surface texture, for example, crushed gravel, 1 and 2; oolites 3 and 5.

TABLE 6 PARTICLE SHAPE

(*Clause* C-3.2)

CLASSIFICATION	DESCRIPTION	ILLUSTRATIONS OF CHARACTERISTIC SPECIMENS	EXAMPLE
(1)	(2)	(3)	(4)
Rounded	Fully water worn or completely shaped by attrition	Fig. 1	River or seashore gravels; desert, seashore and windblown sands
Irregular or partly rounded	Naturally irregular, or partly shaped by attrition, and having rounded edges	Fig. 2	Pit sands and gravels; land or dug flints; cuboid rock
Angular	Possessing well-defined edges formed at the inter-section of roughly planar faces	Fig. 3	Crushed rocks of all types; talus; screes
Flaky	Material, usually angular, of which the thickness is small relative to the width and/or length	Fig. 4	Laminated rocks

TABLE 7 SURFACE CHARACTERISTICS OF AGGREGATES

(*Clause* C-3.2)

GROUP	SURFACE TEXTURE	EXAMPLE
1	Glassy	Black flint
2	Smooth	Chert, slate, marble, some rhyolite
3	Granular	Sandstone, oolites
4	Crystalline	Fine: Basalt, trachyte, keratophyre
		Medium: Dolerite, granophyre, granulite, microgranite, some limestones, many dolomites
		Coarse: Gabbro, gneiss, granite, granodiorite, syenite
5	Honey combed and porous	Scoriae, pumice, trass

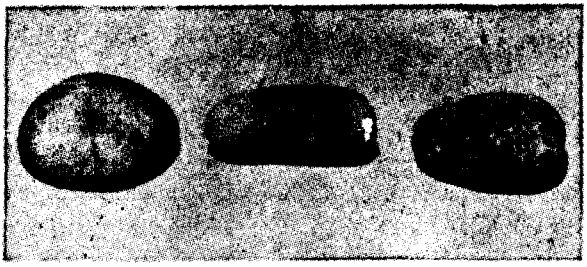

FIG. 1 PARTICLE SHAPE: ROUNDED

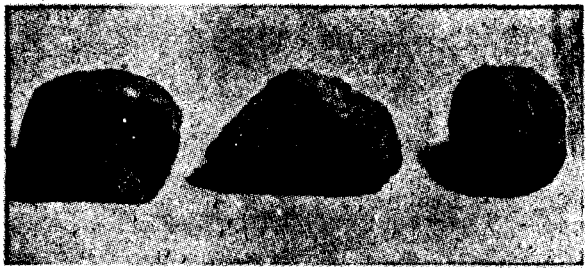

FIG. 2 PARTICLE SHAPE: IRREGULAR

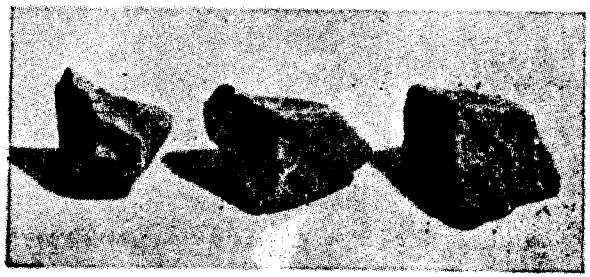

FIG. 3 PARTICLE SHAPE: ANGULAR

FIG. 4 PARTICLE SHAPE: FLAKY

(*Continued from page* 2)

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