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BUREAU OF INDIAN STANDARDS

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भारतीय मानक ***मसौदा***

डोलोमाइट, चूनापत्थर और अन्य संबद्ध सामग्रियों के नमूने लेने की पद्धतियां

(आई एस 2109 का *दूसरा पुनरीक्षण* **)**

Draft *Indian Standard*

SAMPLING OF DOLOMITE, LIMESTONE AND OTHER ALLIED MATERIALS INCLUDING PYROXINITE AND OLIFLUX - METHODS

(*Second Revision of* IS 2109)

ICS 77.100

Ores and Feed Stock for Iron and Steel Industry Sectional Committee, MTD 13	Last date for receipt of comments: 17 November 2023

FOREWORD

(*Formal clauses to be added later*)

The standard was originally published in 1962 and subsequently revised in 1982. This revision has been brought out to bring the standard in the latest style and format of the Indian Standards.

In addition, the following changes have been made:

a) Reference clause is added;
b) Modification in clause 3 and 4;
c) Lot size, sub-lots and incremental sizes are increased;
d) Scoop dimensions are modified; and
e) Clause 11, reporting of test results is updated.

In the formulation of this standard, due consideration has been given to international standards and practices prevailing in different countries. For this purpose, guidance has been obtained from the following standards issued by the International Organizations for Standardization:

ISO 3082 : 2017 Iron ores — Sampling and sample preparation procedures

This standard contains clauses **9.1** which call for agreement between the purchaser and the manufactures.

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 : 2022 'Rules for rounding off numerical values (*Second Revision*)'. A 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

SAMPLING OF DOLOMITE, LIMESTONE AND OTHER ALLIED MATERIALS INCLUDING PYROXINITE AND OLIFLUX - METHODS

(*First Revision*)

1 SCOPE

1.1 This standard lays down the procedure to be followed in collecting and preparing samples from a lot in order to determine size distribution, moisture content and chemical analysis of dolomite, limestone and other allied materials including pyroxinite and oliflux in the lot. It gives detailed procedures for sampling from stationary stock piles, wagons, trucks, conveyors and shipholds.

1.2 This standard also includes a method for estimating and reporting the quality characteristics of dolomite, limestone and other allied materials supplied in bulk.

2 REFERENCE

The following Indian Standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
IS 460	Test Sieves — Specifications
Part 1 : 2020	Wire cloth test sieve (*fourth revision*)
Part 2 : 2020	Perforated plate test sieve (*fourth revision*)
Part 3 : 2020	Methods of Examination of Apertures of Test Sieves (*fourth revision*)
IS 1548 : 1981	Manual on basic principles of lot sampling (s*econd revision*)

3 TERMINOLOGY

The word 'dolomite' in this standard shall mean limestone and other allied materials including pyroxinite and oliflux also for brevity. For the purpose of this standard, the following definitions shall apply.

3.1 Run of Mine — Dolomite consisting of all sizes up to 200 mm.

3.2 Crushed and Screened — Dolomite of sizes not more than 120 mm in case of nominal top size is 10 - 120 mm and sizes not more than 50 mm in case of nominal top size is 0 - 50 mm obtained after crushing and screening.

3.3 Consignment — The quantity of dolomite delivered at one time.

3.4 Lot — The quantity of dolomite indicated to be of the same category and offered for inspection at one time. A lot may consist of whole or a part of the quantity ordered for.

3.5 Sub-lot — The quantity of dolomite in each of the portions into which a lot is divided for the purpose of sampling.

3.6 Increment — The quantity of dolomite obtained by a sampling device at one time from a lot or sub-lot.

3.7 Unit Sample —The quantity of dolomite collected at one point in sectional sampling or at one time from the conveyor.

3.8 Gross Sample — Sample as collected from a sub-lot, that is, the quantity of material consisting of one or several increments or unit samples taken from a sub-lot.

3.9 Size Sample — The sample taken for the determination of the size distribution of the lot or sub-lot.

3.10 Moisture Sample — The sample drawn from a lot/sub-lot exclusively for the use of the moisture determination.

3.11 Laboratory Sample — The quantity of material obtained by reducing a gross sample following a specified procedure, intended for laboratory testing.

3.12 Composite Sample (for the lot) — The quantity of material obtained by mixing together proportionate quantities of material from each of the laboratory sample representing sub-lots into which a lot has been divided.

3.13 Dolomite — It is an anhydrous carbonate mineral composed of calcium magnesium carbonate, ideally $CaMg(CO_3)_2$.

3.14 Limestone — It is a sedimentary rock composed principally of calcium carbonate (calcite) $CaCO_3$.

3.15 Nominal Top Size — Particle size expressed by the smallest aperture size of the test sieve of square opening complying to relevant parts of IS 460 such that no more than 5 % by mass of material is retained on the sieve.

4 SAMPLING FROM STOCK PILE

The stationary stock pile varies largely in volume, particularly in height. Hence it is quite difficult to obtain samples from stationary stock piles, therefore is normally not recommended. Sampling of stock piles should preferably be done when the material is in motion by the methods described in **4.1**, by the former method. However, in case it becomes very much necessary to draw sample from stationary stock pile, any of the method described in **4.2** may be adopted. For the procedures given in **4.2**, the top surface of the stock pile to be sampled shall be flat and even over the entire stock pile as far as possible.

4.1 Sampling during Formation or Dismantling of Stock Piles

4.1.1 Quantity of dolomite to be loaded into or unloaded from a stock pile shall be considered as consisting of a number of sub-lots of approximately equal mass as specified in Table 1.

TABLE 1 NUMBER OF SUB- LOTS
(*Clauses* 4.1.1, 4.2.1.1, 5.1, 6 *and* 7.1)

MASS OF THE LOT (IN TONNES) (1)	NUMBER OF SUB- LOTS (2)
Up to 1 000	2
1001 to 3 000	3
3 001 to 6 000	4
6 001 to 20000	5
20 001 to 30000	6
30 001 to 70 000	8
70 001 to 100 000	10
100 001 to 150 000	15
150 000 and above	15 + (1 for every 10000 tons)

4.1.1.1 From the quantity of dolomite constituting a sub-lot, the number of increments specified in Table 2, depending on the category of dolomite, shall be collected at regular intervals spaced over the whole period of loading or unloading. The increments, each of mass specified in Table 2, shall be collected with the help of suitable scoop (Fig. 1) or baskets of equivalent capacity.

NOTE — While sampling run of mine dolomite, if a lump of size, over 200 mm is encountered at any point, the lump shall be picked up as it is (without breaking into pieces), to be accounted for in the size determination as given under **8.4.1** and in the reduction of gross sample as given under **9.2**.

TABLE 2 MASS OF THE INCREMENTS AND UNIT SAMPLES
(Clauses 4.1.1.1, 4.2.1.2, 5.2, 5.3, 6 and 7.2)

SL NO.	INCREMENTS	RUN OF MINE	CRUSHED AND SCREEND (Nominal Top Size 120mm)	CRUSHED AND SCREEND (Nominal Top Size 50mm)
(1)	(2)	(3)	(4)	(5)
i)	Increment mass (kg)	8	8	4
ii)	Number of increment	50	50	40
iii)	Mass of gross samples (kg)	400	400	160
iv)	Number of unit samples	10	10	4
v)	Mass of unit sample(kg)	40	40	40

4.1.2 *Gross Samples*

4.2 Sampling from Stationary Stock pile All the increments collected from the same sub-lot shall be combined together to constitute a gross sample.

4.2.1 *Sub-lots*

The quantity of dolomite in the stock pile shall be approximately estimated and shall be divided into a number of sub-lots of approximately equal mass as per Table 1. The dolomite surface in the sub-lot shall be levelled, before sampling. Each sub-lot shall be sampled either by sectional sampling (*see* **4.2.1.1**) or by trench sampling (*see* **4.2.1.2**).

4.2.1.1 *Sectional sampling*

The number of unit samples to be collected from a sub-lot shall be as given in Table 2. For collecting those unit samples, an equal number of points shall be located on the central longitudinal line of the dolomite surface in the stock piles.

On the surface of each of the stock pile on which a point has been located a circle of diameter three times the maximum particle size of dolomite shall be marked at the selected point and over the area of the circle the entire section of the dolomite, from top to bottom shall be collected in stages. This can be done by reaching initially up to a depth of 50 cm and then covering the hole so formed, by a plate for removing the metering lying on the sides of the hole. After removing the plate, further depth can be reached in the same manner. This procedure is repeated till the bottom of the stock pile is reached.

4.2.1.2 *Trench sampling*

The gross samples shall be made up of the number of increments as specified in Table 2. These increments shall be taken from the- stock pile in the following manner:

The number of increments shall be equally distributed over the entire stock pile and along a randomly chosen line on the surface, a trench shall be cut right down to the ground level leaving a space of 30 cm in width to provide for walking space. From the trenches so cut, the requisite number of increments shall be collected with the help of a suitable sampling scoop (*see* Fig. 1) at various points spread over the two exposed sides of the trenches. In, case of larger stock piles, in addition to the trenches so formed, the sides of the stock piles may also be opened to expose the material at place where the trench does not expose the material inside.

4.2.2 The gross sample for each sub-lot shall be formed by combining all the unit samples or increments collected from stock piles.

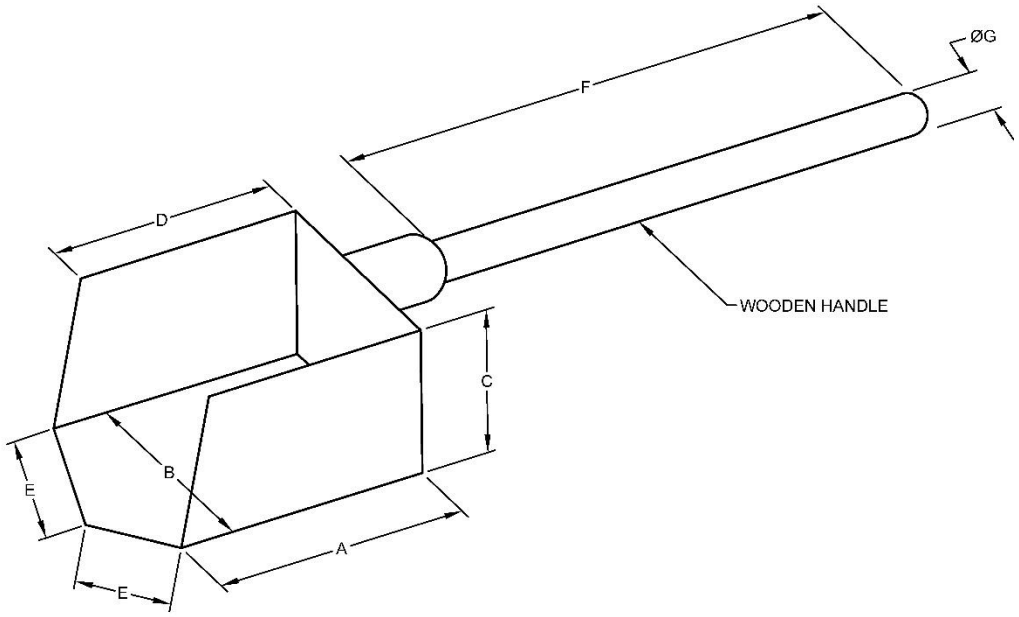

FIG. 1 SAMPLING SCOOP

NOMINAL CAPACITY OF THE SCOOP	DIMENSIONS OF THE SAMPLING SCOOP IN mm						
	A	B	C	D	E	F	G
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
8 kg (Lump and sized)	200	240	150	175	115	440	40
4kg (Calibrate and fines)	175	150	120	100	65	350	30

5 SAMPLING FROM WAGONS AND TRUCKS

Representative samples of dolomite may be collected either during loading or unloading of wagons or trucks, i.e. when the material is in motion or from loaded wagons or trucks. As far as possible, sampling during motion is to be preferred.

5.1 Sub-lots

For the purpose of sampling, all the wagons or trucks in the lot shall be divided into a number of sub-lots of approximately equal mass as specified in Table 1.

5.2 Sampling during Loading or Unloading

For sampling of dolomite during the course of loading or unloading, the number of increments to be collected from each sub-lot and the mass of the increment shall be as given in Table 2 depending

on the category of the material. In case of wagons, at least 25 percent of the total number of wagons in a sub-lot, subject to a minimum of 5 wagons shall be selected at random and the required number of increments shall be evenly distributed at equal intervals, over the selected wagons, in case the sub-lot consists of 5 or less number of wagons, all of them shall be subjected to sampling and the number of increments shall be equally distributed. In the case of trucks, at least 50 percent of the trucks in a sub-lot subject to a minimum of 10 trucks shall be selected at random and the required number of increments shall be evenly distributed. In case the sub-lot size is less than l0 trucks, all of them shall be subjected to sampling. The increments may be collected with the help of sampling scoop (Fig. 1) or suitable basket of equivalent capacity. When the dolomite is received from a single source it is sufficient to sample 25 percent of the trucks subject to a minimum of five.

5.3 Sectional Sampling

For the purpose of sampling from loaded wagons, the method of sectional sampling shall be adopted. The number of unit samples to be collected from each sub-lot shall be in accordance Table 2. For collecting these unit samples, an equal number of points shall be located on the central and longitudinal lines of the dolomite surface of all the wagons in the lot. At each point, a unit sample shall be collected as indicated in **4.2.1.1.** Sectional sampling from trucks is to be avoided as far as possible and sampling has to be carried out only during the loading or unloading of trucks.

6 SAMPLING DURING LOADING/UNLOADING OF SHIPS

The quantity of dolomite in a lot shall be divided into a number of sub-lots of approximately equal mass as specified in Table 1. Sampling has to be carried out only when the material is loaded into or unloaded from a ship hold. The number of increments as given in Table 2 shall be taken at regular intervals of time.

7. SAMPLING FROM CONVEYORS

7.1 Sub-lots

For the purpose of sampling a, lot, while it is being discharged over a conveyor, shall be divided into a number of sub-lots of approximately equal mass as specified in Table 1. This can be done by dividing the total duration of movement of dolomite into a number of equal intervals corresponding to the number of sub-lots, keeping also in view the rate of discharge.

The material moved in each of such intervals will form a sub-lot. A representative gross sample shall be drawn from each of the sub-lots and shall be kept separately. Thus there will be as many gross samples as the number of sub-lots into which the lot has been divided.

7.2 The number of increments to be taken from a sub-lot is given in Table 2 and depends on the category of dolomite. The number shall be evenly distributed over the sub-lot. The increment shall be drawn with the help of a suitable sampling scoop (*see* Fig. 1) at regular intervals.

7.3 Taking Increments at Discharge Points

When the material is in motion, the most reliable means of taking such increments is to sample at a point where it discharges from the belt. The best possible increment is one which cuts across entirely the falling stream of the material by means of a suitable receptacle passed from one side

of a stream to the other without allowing the material to overflow the receptacle. The stream should be sampled systematically by taking material from all portions.

7.4 Sampling by Stopped Belt Method

If it is practicable to stop the conveyor belt periodically, larger quantity of dolomite constituting unit sample may be drawn from the belt so as to avoid frequent stoppage of the belt and interruption of the flow of material. The mass of each unit sample shall be not less than 40 kg and it shall be collected from the full width and thickness of stream. The number of unit samples as given in Table 2 shall be equally spread over the entire sub-lot.

8 DETERMINATION OF SIZE DISTRIBUTION

8.1 The size distribution of dolomite in a lot shall normally be estimated as given below:

a) Over 200 mm;

b) Over 150 mm and up to 200 mm;

c) Over 50 mm and up to 150 mm;

d) Over 10 mm and up to 50 mm;

e) Over 1 mm and up to 10 mm; and

f) 1 mm and below.

If necessary, dolomite of other sizes may also be estimated.

8.2 In the determination of size distribution sieves of suitable sizes. As specified in IS 460 (Part 2) shall be used wherever possible. The standard test sieve will, after period of time, become less accurate. The sieve shall, therefore, be periodically checked according to IS 460 (Part 3) and the correction factor to be applied to the result shall be determined.

8.3 Gross Samples Constituted by Aggregating Unit Samples

Each gross sample shall be screened successively through selected sieves (*see* **8.1**) and the quantity retained on each of the sieves, as also that passing through the smallest sieve, shall be weighed separately and recorded.

8.3.1 Size distribution for the lot shall be estimated as follows:

a) Over 200 mm, percent $= \frac{a_1+a_2+\cdots}{m_{1+}m_{2+\ldots}} \times 100$

b) Over 150 mm, and up to 200 mm, percent $= \frac{b_1+b_2+\cdots}{m_1+m_{2+\ldots.}} \times 100$

c) Over 50 mm, and up to 150 mm, percent $= \frac{c_1+c_2+\cdots}{m_1+m_2+\cdots} \times 100$

d) Over 10 mm, and up to 50 mm, percent $= \frac{d_1+d_2+\cdots}{m_1+m_2+\cdots} \times 100$

e) Over 1 mm, and up to 10 mm, percent $= \frac{e_1+e_2+\cdots}{m_1+m_2+\cdots} \times 100$

f) 1 mm and below percent $= \frac{f_1+f_2+}{m_1+m_2+} \times 100$

Where,

m_1, m_2……are the masses of the different gross sample or unite sample;

a_1, a_2……are the corresponding masses of dolomite of size exceeding 200 mm;

b_1, b_2……are the corresponding masses of dolomite of size over 150 mm, and up to 200 mm;

c_1, c_2……are the corresponding masses of dolomite of size over 50 mm, and up to 150 mm;

d_1, d_2……are the corresponding masses of dolomite of size over 10 mm, and up to 50 mm;

e_1, e_2……. are the corresponding masses of dolomite of size over 1 mm, and up to 10 mm; and

f_1, f_2 ……are the corresponding masses of dolomite of size over 1 mm, and below.

NOTE — Percentage of material of any other desired sire shall be calculated on similar lines.

8.3 *Gross Samples Constituted by Aggregating Increments*

Where the gross samples do not contain any lump over 200 mm the procedure detailed in **8.2** and **8.2.1** shall be followed for estimating the size distribution in the lot, the percentage of material over 200 mm being nil.

8.4 Where the gross samples contain some lumps over 200 mm, the portion of the gross samples excluding such lumps shall be treated as in **8.2**.

8.4.1 The size distribution for the lot shall be estimated as follows:

a) Over 200 mm, percent $= \frac{4n}{(4n)+m_1'+m_2'+\ \ldots\ldots\ldots\ldots} \times 100$

b) Over 150 mm, and Up to 200 mm, percent $= \frac{b_1+b_2+\cdots\ldots\ldots\ldots\ldots\ldots\ldots}{(4n)+m_1'+m_2'+\ \ldots\ldots\ldots\ldots} \times 100$

c) Over 50 mm, and Up to 150 mm, percent $= \frac{c_1+c_2+\cdots\ldots\ldots\ldots\ldots\ldots}{(4n)+m_1'+m_2'+\ldots\ldots\ldots} \times 100$

d) Over 10 mm, and, Up to 50 mm, percent $= \frac{d_1+d_2+\cdots\ldots\ldots\ldots\ldots\ldots}{(4n)+m_1'+m_2'+\ldots\ldots\ldots} \times 100$

e) Over 1 mm, and Up to 10 mm, percent $= \frac{e_1+e_2+\cdots\ldots\ldots\ldots\ldots\ldots}{(4n)+m_1'+m_2'+\ldots\ldots\ldots} \times 100$

f) 1 mm, and below, percent $= \frac{f_1+f_2+\cdots\ldots\ldots\ldots\ldots\ldots}{(4n)+m_1'+m_2'+\ldots\ldots\ldots} \times 100$

Where,

m_1', m_2'……..are the masses (in kg) of the different gross samples excluding lumps over 200 mm,

n is the total number of lumps over 200 mm in all the gross samples, and
$b_1, b_2 \ldots\ldots\ldots\ldots; \ c_1, c_2 \ldots\ldots\ldots\ldots\ldots; \ d_1, d_2$…….; are as defined in **8.2**

NOTE — Mass of each lump is taken to be equivalent to one increment, that is, 4 kg.

9 REDUCTION OF A GROSS SAMPLE

9.1 Moisture Sample

Each of the gross samples shall be sent first for size determination and only after that the sample preparation shall be carried out. For moisture determination, moisture sample of 20 to 25 kg shall be taken from each gross sample in not less than 5 increments after crushing the material to -10 mm size by mechanical or manual means. From this 20 to 25 kg material, two or more samples of 1 kg each shall be drawn for moisture determination.

NOTE — If needed, separate moisture samples may be drawn from the sub-lot by any other procedure, as agreed to between the purchaser and the supplier.

9.2 Preparation of Samples for Chemical Analysis

Dolomite in each gross sample shall be first crushed in a jaw crusher, roll crusher or manually using a hammer or pounder and a suitable steel plate, till the material in gross sample is of -10 mm size. Duplicate moisture samples of 1 kg each may be collected at this stage, if not already done. The rest of the material shall be mixed well and reduced, to 20 kg which shall then be further processed in stages as detailed in Fig. 2, to prepare the laboratory samples for chemical analysis. For reduction at various stages one of the methods detailed in **9.2.1** to **9.2.3** shall be followed. The mass of each laboratory sample shall be at least 200 g.

NOTE — The lumps obtained while collecting the increments (see **4.1.1.1**) shall be crushed separately and one scoopful for each lump (approximately 4 kg for run of mine ore) shall be taken along with the materials of other sizes in the gross sample for reduction as detailed in **9.2**.

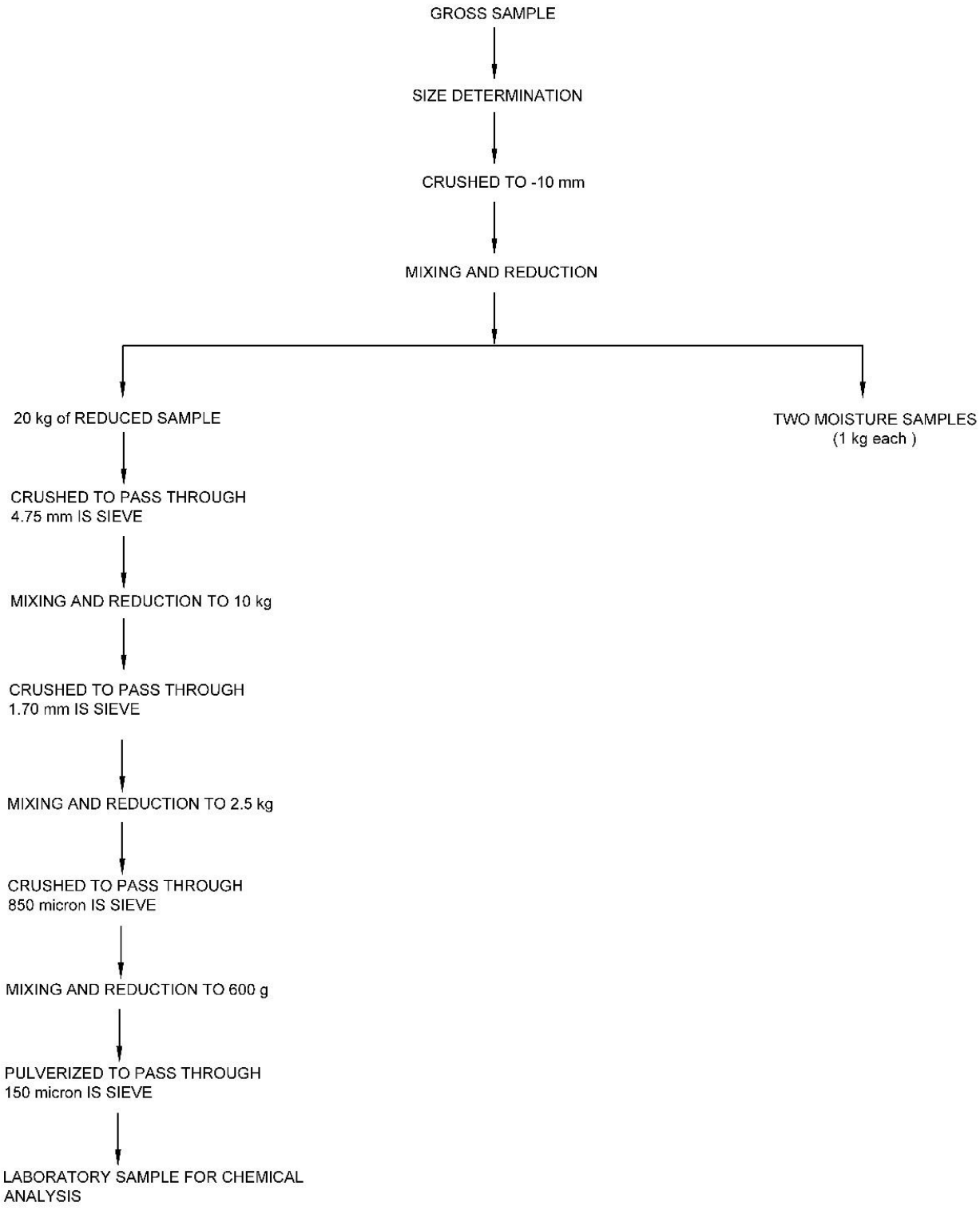

FIG.2 STAGES OF REDUCING A GROSS SAMPLE

NOTE — Step 850 micron may be bypassed in case mechanical sample preparation.

9.2.1 *Reduction by Riffle Divider*

After each crushing, the material shall be well mixed and poured into the riffle. This process shall be repeated using rifles of different sizes according to the size of the crushed material.

9.2.2 *Coning and Quartering Method*

In this method the crushed dolomite shall be well mixed and then scooped into a cone-shaped pile. Care shall be taken to drop each scoopful over the same spot to ensure even distribution of lumps and fines on all sides of the cone.

After the cone is formed it shall be flattened by pressing the top of the cone with the smooth surface of the scoop. Then, it is cut into quarters by two lines which intersect at right angle at the center of the base of the cone. The bulk of the sample is reduced to half by rejecting any two diagonally opposite quarters.

9.2.3 *Increment Reduction Method*

The division of the gross sample (after being crushed to 10 mm) by the manual increment division method (*see* Fig. 3) shall be carried out according to the following procedure. It is advisable to have at least 20 increments under this method.

The size of the increment shall be as specified in Table 3.

a) Spread the crushed sample on a smooth, flat and non-moisture absorbing plate, into a uniform flat rectangle of dimensions $a \times b$ mm.
b) Divide the rectangle into five equal parts lengthwise and four equal parts breadthwise (for 20 increments) as given in Fig. 3.
c) From each of the 20 parts so obtained, equal quantities, not less than that specified in Table 3, shall be collected with the help of a suitable scoop and combined together to form the reduced sample.

In the above procedure the scoop shall be inserted to the bottom of the sample layer and if necessary a bumper plate may be inserted in front of the scoop to facilitate the operation

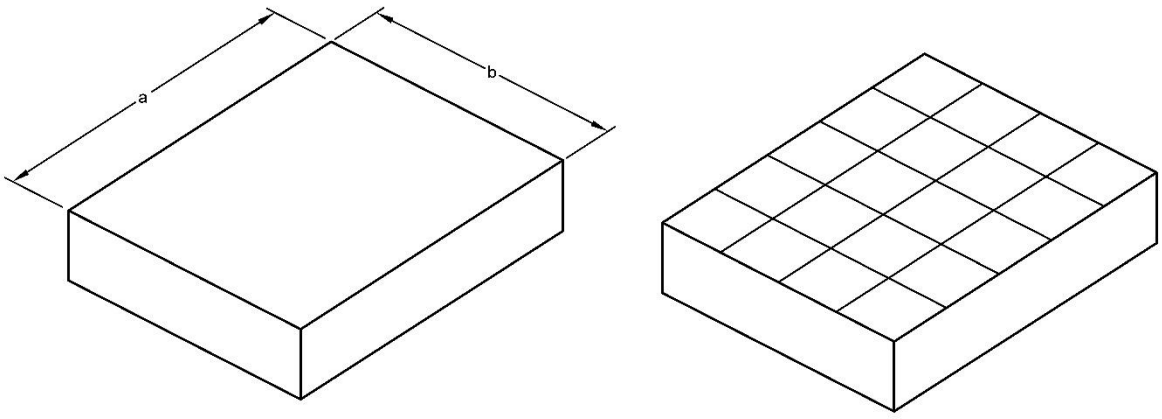

FIG.3 MANUAL INCREMENT DIVISION METHOD

TABLE 3 SIZE OF INCREMENTS IN MANUAL INCREMENT DIVISION METHOD
(*Clause* 9.2.3)

Sl No.	SIZE OF MATERIAL	THICKNESS OF LAYER	QUANTITY TO BE ONTAINED AT ONE TIME FROM EACH PART
	(1)	(2)	(3)
	(mm)	(mm)	(g)
i)	10	30 to 40	250
ii)	4.75	25 to 35	150
iii)	1.70	15 to 25	40
iv)	0.85	10 to 20	25
v)	0.15	5 to 10	5

10 NUMBER OF TESTS

10.1 Moisture Determination

All the moisture samples representing different sub-lots in a lot shall be tested individually for moisture content.

If needed, moisture determination shall be carried out in duplicate for each gross sample, to avoid change in moisture content, the moisture determination shall be done as quickly as possible.

10.2 Laboratory Samples for Chemical Analysis

All the laboratory samples shall be tested individually for important characteristics. For the remaining characteristics, a composite sample prepared by mixing equal or proportionate quantities of dolomite from each of the laboratory samples shall be analyzed. Unless otherwise agreed to between the purchaser and the supplier, the following schedule of testing should be followed:

Chemical Constituents

Individual laboratory sample to be analyzed for:

a) Calcium Oxide
b) Silica
c) Loss On Ignition

A composite sample to be analyzed for:

a) Aluminum
b) Magnesium oxide
c) Ferric Oxide
d) Carbon Dioxide

11 REPORTING

11.1 Reporting of Moisture Content

The result obtained from i^{th} sub-lot shall be denoted by ' x_i '. In case duplicate test results are obtained for i^{th} sub-lot, average of these two results shall be denoted by $\bar{x}_i$. The overall moisture content of dolomite in the lot shall be calculated by the following formula:

$$\text{Average moisture content} = \frac{\sum m_i \times x_i}{\sum m_i}$$

Where,

m_i, is the mass of the i^{th} sub-lot and symbol $\sum$ stands for summation over all i's.

11.2 Chemical Analysis

11.2.1 For those characteristics, where composite samples have been tested, only one test result will be available and that result shall be reported as the value of that characteristic for the lot sampled.

11.2.2 When two laboratory samples have been analyzed individually from a lot, the average of the two available test results shall be reported as the value of the characteristic for the lot sampled. The individual test results shall also be reported to give an indication of the range of variation in quality.

11.2.3 When three or more laboratory samples have been analyzed individually from a lot the following procedure shall be followed to assess the average quality and limits of variation.

Let $x_1, x_2, \ldots\ldots\ldots\ldots\ldots x_n$ be the results of analyzing n laboratory samples for a particular characteristic.

Calculate,

$$\text{Average } (\bar{x}) = \frac{x_1+x_2+x_3+\cdots+x_n}{n}, \text{ if sub-lots are of approximately equal mass}$$

Or

$$\text{Weighted average } (\bar{x}) = \frac{w_1x_1+w_2x_2+w_3x_3+\cdots+wnx_n}{w_1+w_2+w_3+\cdots+w_n},$$

Where,

w_1, w_2, w_3…. w_n are the mass of the sub-lots.

Range (R) = difference between the maximum and minimum of the values (when n is less than 10).

Or

Range (R) = the average value of ranges. When the number of sub-lots n is equal to 10 or more, the corresponding results on laboratory samples (10 or more) should be constituted into two groups in order of their occurrence. For each group, range (R) should be calculated and the average value (R) of the R's should be used in the subsequent clause.

The average level of the characteristics in the lot shall be reported equal to (x).

The limits of variation in the average level of the lot at 95 percent probability shall be reported as ($\bar{x} \pm hR$), where h is a factor, the value of which depends upon the number of laboratory samples analyzed. The appropriate value of the factor h is given below:

Number of Laboratory Samples analyzed	Value of Factor h
3	1.30
4	0.72
5	0.51
6	0.40
7	0.33
8	0.29
10	0.31
12	0.25
15	0.24
16	0.19
18	0.17
21	0.17
27	0.13
NOTE — If the number of laboratory samples are different from those given above, it is recommended to obtain the factor 'h' for determining confidence limits for the average, using samples standard derivation from Table 5 of IS 1548.	