Indian Standard

COARSE AND FINE AGGREGATE FOR CONCRETE — SPECIFICATION

(Third Revision)

1 SCOPE

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, and manufactured aggregates produced from other than natural sources, for use in the production of concrete for normal structural purposes including mass concrete works.

2 REFERENCES

The standards listed below 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*
2386	Methods of test for aggregates for concrete:
(Part 1) : 1963	Particle size and shape
(Part 2) : 1963	Estimation of deleterious materials and organic impurities
(Part 3) : 1963	Specific gravity, density, voids, absorption and bulking
(Part 4) : 1963	Mechanical properties
(Part 5) : 1963	Soundness
(Part 6) : 1963	Measuring mortar making properties of fine aggregate
(Part 7) : 1963	Alkali aggregate reactivity
(Part 8) : 1963	Petrographic examination
2430 : 1986	Methods for sampling of aggregates for concrete (*first revision*)
4032 : 1985	Method of chemical analysis of hydraulic cement (*first revision*)
4905 : 1968	Methods for random sampling
6461 (Part 1) : 1972	Glossary of terms relating to cement concrete: Part 1 Concrete aggregates
9198 : 1979	Specification for compaction rammer for soil testing
9669 : 1980	Specification for CBR moulds and its accessories
14959 (Part 2) : 2001	Method of Test determination of water soluble and acid soluble chlorides in mortar and concrete: Part 2 Hardened mortar and concrete

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 6461 (Part 1) and the following shall apply.

3.1 Fine Aggregate — Aggregate most of which passes 4.75 mm IS Sieve and contains only so much coarser material as permitted in **6.3**.

3.1.1 *Natural Sand* — Fine aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies. This may also be called as uncrushed sand.

3.1.2 *Crushed Sand*

3.1.2.1 *Crushed stone sand* — Fine aggregate produced by crushing hard stone.

3.1.2.2 *Crushed gravel sand* — Fine aggregate produced by crushing natural gravel.

3.1.3 *Mixed Sand* — Fine aggregate produced by blending natural sand and crushed stone sand or crushed gravel sand in suitable proportions.

3.1.4 *Manufactured Fine Aggregate (Manufactured Sand)* — Fine aggregate manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing.

NOTE — Manufactured fine aggregate may be Recycled Concrete Aggregate (RCA) (*see* Annex A).

3.2 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,

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);

d) manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. Manufactured coarse aggregate may be Recycled Concrete Aggregate (RCA) or Recycled Aggregate (RA) (*see* Annex A).

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

4 CLASSIFICATION

The aggregate shall be classified as given in **4.1** and **4.2**. In case of mixed sand (*see* **3.1.3**), the manufacturer/ supplier should supply the individual sands to be mixed at site, at the time of batching.

4.1 Aggregates from Natural Sources

These shall be coarse and fine aggregates as defined in **3.1.1, 3.1.2, 3.1.3** and **3.2** [*see also* Note under **3.2**(a), (b) and (c)]

4.2 Manufactured Aggregates and Extent of Utilization

4.2.1 These shall be coarse and fine aggregates as defined in **3.1.4** and **3.2** [*see also* Note under **3.2**(d)].

The manufactured aggregates shall be permitted with their extent of utilization as percent of total mass of fine or coarse aggregate as the case may be, as indicated in Table 1 against each, for use in plain and reinforced concrete and lean concrete.

4.2.2 Manufactured aggregates shall not be permitted for use in prestressed concrete.

5 QUALITY OF AGGREGATE

5.1 General

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

5.2 Deleterious Materials

Aggregate shall not contain any harmful material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, free lime, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregate to be used for reinforced concrete shall not contain any material liable to attack the steel reinforcement.

5.2.1 *Limits of Deleterious Materials*

The maximum quantity of deleterious materials shall not exceed the limits specified in Table 2. 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.

Table 1 Extent of Utilization
(*Clause* 4.2.1)

Sl No.	Type of Aggregate	Maximum Utilization		
		Plain Concrete Percent	Reinforced Concrete Percent	Lean Concrete (Less than M15 Grade) Percent
(1)	(2)	(3)	(4)	(5)
i) Coarse aggregate:				
	a) Iron slag aggregate	50	25	100
	b) Steel slag aggregate	25	Nil	100
	c) Recycled concrete aggregate[1)] (RCA) (*See* Note 1)	25	20 (Only upto M25 Grade)	100
	d) Recycled aggregate[1)] (RA)	Nil	Nil	100
	e) Bottom ash from Thermal Power Plants	Nil	Nil	25
ii) Fine aggregate:				
	a) Iron slag aggregate	50	25	100
	b) Steel slag aggregate	25	Nil	100
	c) Copper slag aggregate	40	35	50
	d) Recycled concrete aggregate[1)] (RCA) (*See* Note 1)	25	20 (Only upto M25 Grade)	100

[1)] *See* **A-3** for brief information on recycled aggregates (RA) and recycled concrete aggregates (RCA).

NOTES

1 It is desirable to source the recycled concrete aggregates from sites being redeveloped for use in the same site.

2 In any given structure, only one type of manufactured coarse aggregate and one type of manufactured fine aggregate shall be used.

3 The increase in density of concrete due to use of copper slag and steel slag aggregates need to be taken into consideration in the design of structures.

4 While using manufactured aggregate as part replacement for natural aggregate, it should be ensured that the final grading meets the requirements specified in Table 7, Table 8 and Table 9.

Table 2 Limits of Deleterious Materials
(*Clause* 5.2.1)

Sl No.	Deleterious Substance	Method of Test, Ref to	Fine Aggregate Percentage by Mass, *Max*			Coarse Aggregate Percentage by Mass, *Max*		
			Uncrushed	Crushed/ Mixed	Manufactured	Uncrushed	Crushed	Manufactured
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Coal and lignite	IS 2386 (Part 2)	1.00	1.00	1.00	1.00	1.00	1.00
ii)	Clay lumps	IS 2386 (Part 2)	1.00	1.00	1.00	1.00	1.00	1.00
iii)	Materials finer than 75 µm IS Sieve	IS 2386 (Part 1)	3.00	15.00 (for crushed sand) 12.00 (for mixed sand) *see* Note 1)	10.00	1.00	1.00	1.00
iv)	Soft fragments	IS 2386 (Part 2)	—	—	—	3.00	—	3.00
v)	Shale	(*see* Note 2)	1.00	—	1.00	—	—	—
vi)	Total of percentages of all deleterious materials (except mica) including Sl No. (i) to (v) for col 4, 7 and 8 and Sl No. (i) and (ii) for col 5, 6 and 9	—	5.00	2.00	2.00	5.00	2.00	2.00

NOTES

1 The sands used for blending in mixed sand shall individually also satisfy the requirements of Table 2. The uncrushed sand used for blending shall not have material finer than 75 µm more than 3.00 percent.

2 When the clay stones are harder, platy and fissile, they are known as shales. The presence and extent of shales shall be determined by petrograpy at the time of selection and change of source.

3 The presence of mica in the fine aggregate has been found to affect adversely the workability, strength, abrasion resistance and durability of concrete. Where no tests for strength and durability are conducted, the mica in the fine aggregate may be limited to 1.00 percent by mass. Where tests are conducted to ensure adequate workability, satisfactory strength, permeability and abrasion (for wearing surfaces), the mica up to 3.00 percent by mass for muscovite type shall be permitted. In case of presence of both muscovite and biotite mica, the permissible limit shall be 5.00 percent, maximum by mass. This is subject to total deleterious materials (including mica) being limited to 8.00 percent by mass for col 4 and 5.00 percent for col 5.

Till a method is included in IS 2386 (Part 2), for determination of mica content, suitable methodology may be used for the same. Normally, petrographic density separation and wind blowing methods can be used.

4 The aggregate shall not contain harmful organic impurities [tested in accordance with IS 2386 (Part 2)] in sufficient quantities to affect adversely the strength or durability of concrete. A fine aggregate which fails in the testing of organic impurities may be used, provided that, when tested for the effect of organic impurities on the strength of mortar, the relative strength at 7 and 28 days, reported in accordance with IS 2386 (Part 6) is not less than 95 percent.

5.3 Combined Flakiness and Elongation Index

Flakiness and elongation shall be determined in accordance with IS 2386 (Part 1) on the same sample. After carrying out the flakiness index test, the flaky material shall be removed from the sample and the remaining portion shall be used for carrying out elongation index. Indices so worked out shall be added numerically to give combined flakiness and elongation index. The combined flakiness and elongation index so obtained shall not exceed 40 percent for uncrushed or crushed aggregate. However, the engineer-in-charge at his discretion may relax the limit keeping in view the requirement, and availability of aggregates and performance based on tests on concrete.

5.4 Mechanical Properties

5.4.1 *Aggregate Crushing Value/Ten Percent Fines Value*

The aggregate crushing value/ten percent fines value, when determined in accordance with IS 2386 (Part 4) shall be as follows:

a) For aggregates to be used in concrete for wearing surfaces, (such as runways, roads, pavements, tunnel lining carrying water, spillways and stilling basins) : 30 percent, *Max*

b) For aggregates to be used in concrete other than for wearing surfaces : In case the aggregate crushing value exceeds 30 percent, then the test for 'ten percent fines' should be conducted and the minimum load for the ten percent fines should be 50 kN

5.4.2 *Aggregates Impact Value*

As an alternative to **5.4.1**, the aggregate impact value may be determined in accordance with the method specified in IS 2386 (Part 4). The aggregate impact value shall not exceed the following values:

a) For aggregates to be used in concrete for wearing surfaces, (such as runways, roads, pavements, tunnel lining carrying water, spillways and stilling basins) : 30 percent

b) For aggregates to be used in concrete other than for wearing surfaces : 45 percent

NOTE — For concrete of grades M 65 and above, stronger aggregates are required and hence the maximum aggregate crushing value and aggregate impact value shall not exceed 22 percent.

5.4.3 *Aggregate Abrasion Value*

The aggregate abrasion value, when determined in accordance with IS 2386 (Part 4) using Los Angeles machine, shall not exceed the following values:

a) For aggregates to be used in concrete for wearing surfaces, (such as runways, roads, pavements, spillways, tunnel lining carrying water and stilling basins) : 30 percent

b) For aggregates to be used in concrete other than for wearing surfaces : 50 percent

5.5 Soundness of Aggregate

5.5.1 For concrete liable to be exposed to the action of frost, the coarse and fine aggregates shall pass a sodium or magnesium sulphate accelerated soundness test specified in IS 2386 (Part 5), the limits being set by agreement between the purchaser and the supplier.

NOTE — As a general guide, it may be taken that the average loss of mass 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 testing 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 ($MgSO_4$)

5.5.2 For slag aggregates, following additional tests shall be carried out:

a) *Iron unsoundness* — When chemical analysis of aggregates shows that the ferrous oxide content is equal to or more than 3.0 percent, and sulphur content is equal to or more than 1.0 percent, the aggregate shall be tested for iron unsoundness. The iron unsoundness of the slag aggregate when tested as per the procedure given in Annex D, shall not exceed 1 percent.

b) *Volumetric expansion ratio* — It shall not be more than 2.0 percent. The procedure shall be as given in Annex E.

c) *Unsoundness due to free lime* — Prior to use of iron slag (for production of aggregates) from a new source or when significant changes in furnace chemistry occur in an existing source which may result in the presence of free lime, the potential for pop-out formation shall be assessed by determining the free-lime content of the slag by petrographic examination or quantitative x-ray diffractometry on a representative sample.

If the number of particles containing free lime exceeds 1 in 20, then weathering of the slag stockpile (in moist condition or at/near saturated surface dry condition) represented by the test sample shall be continued until further testing shows that the level has fallen below 1 in 20.

5.6 Alkali Aggregate Reaction

Some aggregates containing particular varieties of silica may be susceptible to attack by alkalies (Na_2O and K_2O) originating from cement and other sources, producing an expansive reaction which can cause cracking and disruption of concrete. Damage to concrete from this reaction will normally only occur when all the following are present together:

a) A high moisture level within the concrete.

b) A cement with high alkali content, or another source of alkali.

c) Aggregate containing an alkali reactive constituent.

NOTE — The aggregates containing more than 20 percent strained quartz and undulatory extinction angle greater than 15°, causing deleterious reaction and also possibly showing presence of microcrystalline quartz is known as slowly reactive aggregates.

The aggregate shall comply with the requirements as follows, when tested in accordance with IS 2386 (Part 7):

1) *Chemical method* — The aggregate when tested in accordance with the chemical method, shall conform to the requirement as specified in IS 2386 (Part 7). If test results indicate deleterious or potentially deleterious character, the aggregate should be tested using mortar bar method as specified in IS 2386 (Part 7) to verify the potential for expansion in concrete. This chemical method (for determination of potential reactivity) however, is not found to be suitable for slowly reactive aggregates or for aggregate containing carbonates (limestone aggregates) or magnesium silicates, such as antigorite (serpentine). Therefore, petrographic analysis of aggregates shall be carried out to find out the strained quartz percentage, undulatory extinction angle and its mineral composition before conducting the test.
2) *Mortar bar method*
   i) *Using 38°C temperature regime* — The permissible limits for mortar bar expansion at 38°C shall be 0.05 percent at 90 days and 0.10 percent at 180 days. For slowly reactive aggregates (as explained in NOTE above) mortar bar method using temperature regime of 38°C shall not be used for determination of potential reactivity. Such slowly reactive aggregates shall be tested using 60°C temperature regime. Therefore, petrographic analysis of aggregates shall be carried out to find out the strained quartz percentage, undulatory extinction angle and its mineral composition before conducting the test.
   ii) *Using 60°C temperature regime* — The permissible limit mortar bar expansion at 60°C shall be 0.05 percent at 90 days and 0.06 percent at 180 days for slowly reactive aggregates.
3) *Accelerated mortar bar method* — The accelerated mortar bar test shall be carried out at 80°C using 1N NaOH. The test is found to be specially suitable for slowly reactive aggregate. The criteria for this test is as under:
   i) Expansions of less than 0.10 percent at 16 days after casting are indicative of innocuous behavior in most cases (*see* Note).

      NOTE — Some granitic gneisses and metabasalts have been found to be deleteriously expansive in field performance even though their expansion in this test was less than 0.10 percent at 16 days after casting. With such aggregate, it is recommended that prior field performance be investigated. In the absence of field performance data, mitigative measures should be taken.
   ii) Expansions of more than 0.20 percent at 16 days after casting are indicative of potentially deleterious expansion [*see* **4.2.2** of IS 2386 (Part 7)].
   iii) Expansions between 0.10 and 0.20 percent at 16 days after casting include both aggregate that are known to be innocuous and deleterious in field performance. For these aggregate, it is particularly important to develop supplemental information as described in **4.2.2** of IS 2386 (Part 7). In such a situation, it may also be useful to take comparator reading until 28 days. It may be useful to support this test with test by mortar bar method at 38°C and 60°C, as applicable.

In few locations in the country, dolomitic and limestone aggregates are encountered. In such cases, concrete prism test shall be preferred over mortar bar test. The test should cover the determination by measurement of length change of concrete prisms, the susceptibility of cement-aggregate combinations to expansive alkali-carbonate reaction involving hydroxide ions associated with alkalis (sodium and potassium) and certain calcitic dolomites and dolomitic limestones. Till this test is included in IS 2386 (Part 7), specialist literature may be referred for the test and applicable requirement.

5.7 Manufactured aggregates shall meet the additional requirements as given in Table 3, Table 4, Table 5 and Table 6.

Table 3 Additional Requirements for all Manufactured Aggregates

(*Clause* 5.7)

Sl No. (1)	Characteristic (2)	Requirement (3)
i)	Total alkali content as Na_2O equivalent, percent, *Max*	0.3
ii)	Total sulphate content as SO_3, percent, *Max*	0.5
iii)	Acid soluble chloride content, percent, *Max*	0.04
iv)	Water absorption, percent, *Max*	5 (*see* Note 1)
v)	Specific gravity	2.1 to 3.2 (*see* Notes 2 and 3)

NOTES

1 For recycled concrete aggregate and recycled aggregate, higher water absorption up to 10 percent may be permitted subject to pre-wetting (saturation) of aggregates before batching and mixing.

2 The limits are intended for use of aggregate in normal weight concrete.

3 Copper slag having higher specific gravity (up to 3.8) shall be permitted for part replacement of aggregates in accordance with **4.2.1**, such that the average specific gravity of the fine aggregate is not more than 3.2.

Table 4 Additional Requirements for Iron and Steel Slag Aggregates
(*Clause* 5.7)

Sl No. (1)	Characteristic (2)	Requirement (3)
i)	Calcium oxide as CaO, percent, *Max*	45.0
ii)	Total sulphur as S, percent, *Max*	2.0
iii)	Total iron as FeO, percent, *Max*	3.0

NOTE — Stockpiling of slag aggregate: Crushed slag aggregate should be stockpiled in moist condition at or near the saturated surface dry (SSD) condition before use, with the moisture condition being maintained by sprinkling with water.

Table 5 Additional Requirements for Electric Furnace Oxidation Slag Coarse Aggregate
(*Clause* 5.7)

Sl No. (1)	Characteristic (2)	Requirement (3)
i)	Calcium oxide as CaO, percent, *Max*	40
ii)	Magnesium oxide as MgO, percent, *Max*	10
iii)	Total iron as FeO, percent, *Max*	50
iv)	Basicity as CaO/SiO_2, percent, *Max*	2

Table 6 Additional Requirements for Copper Slag Aggregate
(*Clause* 5.7)

Sl No. (1)	Characteristic (2)	Requirement (3)
i)	Calcium oxide as CaO , percent, *Max*	12.0
ii)	Total sulphur as S, percent, *Max*	2.0
iii)	Total iron as FeO, percent, *Max*	70
iv)	Chlorine as NaCl, percent, *Max*	0.03

6 SIZE AND GRADING OF AGGREGATES

6.1 Single-Sized Coarse Aggregates

Coarse aggregates shall be supplied in the nominal sizes given in Table 7. For any one of the nominal sizes, the proportion of other sizes, as determined by the method described in IS 2386 (Part 1) shall also be in accordance with Table 7.

6.1.1 *Coarse Aggregate for Mass Concrete*

Coarse aggregate for mass concrete works shall be in the sizes specified in Table 8.

6.2 Graded Coarse Aggregates

Graded coarse aggregates may be supplied in the nominal sizes given in Table 7.

6.3 Fine Aggregate

The grading of fine aggregate, when determined as described in IS 2386 (Part 1) shall be within the limits given in Table 9 and shall be described as fine aggregate, Grading Zones I, II, III and IV. Where the grading falls outside the limits of any particular grading zone of sieves other than 600 µm IS Sieve by an amount not exceeding 5 percent for a particular sieve size, (subject to a cumulative amount of 10 percent), it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 µm 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.

6.4 All-in-Aggregate

If combined aggregates are available they need not be separated into fine and coarse. The grading of the all-in-aggregate, when analyzed, as described in IS 2386 (Part 1) shall be in accordance with Table 10. Necessary adjustments may be made in the grading by the addition of single-sized aggregates

7 SAMPLING AND TESTING

7.1 Sampling

The method of sampling shall be in accordance with

Table 7 Coarse Aggregates
(*Clauses* 6.1 *and* 6.2)

Sl No.	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)	(12)
i)	80 mm	100	-	-	-	-	-	100	-	-	-
ii)	63 mm	85 to 100	100	-	-	-	-	-	-	-	-
iii)	40 mm	0 to 30	85 to 100	100	-	-	-	90 to 100	100	-	-
iv)	20 mm	0 to 5	0 to 20	85 to 100	100	-	-	30 to 70	90 to 100	100	100
v)	16 mm	-	-	-	85 to 100	100	-	-	-	90 to 100	-
vi)	12.5 mm	-	-	-	-	85 to 100	100	-	-	-	90 to 100
vii)	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
viii)	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
ix)	2.36 mm	-	-	-	-	-	0 to 5	-	-	-	-

Table 8 Sizes of Coarse Aggregates for Mass Concrete

(*Clause* 6.1.1)

Sl No. (1)	Class and Size (2)	IS Sieve Designation (3)	Percentage Passing (4)
i)	Very large, 150 to 80 mm	160 mm	90 to 100
		80 mm	0 to 10
ii)	Large, 80 to 40 mm	80 mm	90 to 100
		40 mm	0 to 10
iii)	Medium, 40 to 20 mm	40 mm	90 to 100
		20 mm	0 to 10
iv)	Small, 20 to 4.75 mm	20 mm	90 to 100
		4.75 mm	0 to 10
		2.36 mm	0 to 0.2

Table 9 Fine Aggregates

(*Clause* 6.3)

Sl No.	IS Sieve Designation	Percentage Passing			
		Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
(1)	(2)	(3)	(4)	(5)	(6)
i)	10 mm	100	100	100	100
ii)	4.75 mm	90-100	90-100	90-100	95-100
iii)	2.36 mm	60-95	75-100	85-100	95-100
iv)	1.18 mm	30-70	55-90	75-100	90-100
v)	600 µm	15-34	35-59	60-79	80-100
vi)	300 µm	5-20	8-30	12-40	15-50
vii)	150 µm	0-10	0-10	0-10	0-15

NOTES

1 For crushed stone sands, the permissible limit on 150 µm IS Sieve is increased to 20 percent. This does not affect the 5 percent allowance permitted in **6.3** applying to other sieve sizes.

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.

3 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.

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.

IS 2430. The amount of material required for each test shall be as specified in the relevant method of test given in IS 2386 (Part 1) to IS 2386 (Part 8).

7.2 Chemical tests like alkalies (Na_2O equivalent), sulphate (SO_3), calcium oxide, sulphur (S), iron (FeO), magnesium oxide (MgO), silica (SiO_2) and chlorine (NaCl), can be carried out as per IS 4032 and water soluble chloride test can be carried out as per IS 14959 (Part 2). All other tests shall be carried out as described in IS 2386 (Part 1) to IS 2386 (Part 8) and in this standard.

7.2.1 In the case of all-in-aggregate, for the purpose of tests to verify its compliance with the requirements given in Table 2, and when necessary for such other tests as required by the purchaser, the aggregate 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.

Table 10 All-in-Aggregate Grading

(*Clause* 6.4)

Sl No.	IS Sieve Designation	Percentage Passing for All-in-Aggregate of	
		40 mm Nominal Size	20 mm Nominal Size
(1)	(2)	(3)	(4)
i)	80 mm	100	—
ii)	40 mm	95 to 100	100
iii)	20 mm	45 to 75	95 to 100
iv)	4.75 mm	25 to 45	30 to 50
v)	600 µm	8 to 30	10 to 35
vi)	150 µm	0 to 6	0 to 6

8 SUPPLIER'S CERTIFICATE AND COST OF TESTS

8.1 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.

8.2 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.

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

8.4 The cost of the tests carried out under **8.2** 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.

9 DELIVERY

9.1 Supplies of aggregate may be made in bulk in suitable quantities mutually agreed upon between the purchaser and the supplier. Where so required by the purchaser, the aggregate may be supplied in bags (jute, jute-laminated, polyethylene lined or as may be mutually agreed between the purchaser and the supplier) bearing the net quantity (may be 25 kg, 50 kg, 300 kg,

600 kg or as agreed to between the purchaser and the supplier). The tolerance on the quantity of aggregate in each bag or consignment shall be as per **9.2** unless mutually agreed upon between the purchaser and the supplier.

9.2 Tolerance Requirements for the Quantity of Aggregate Packed in Bags

9.2.1 The average of net quantity of aggregate packed in bags at the plant in a sample shall be equal to or more than 25 kg, 50 kg, 300 kg, 600 kg, etc, as applicable. The number of bags in a sample shall be as given below:

Batch Size	*Sample Size*
100 to 150	20
151 to 280	32
281 to 500	50
501 to 1 200	80
1 201 to 3 200	125
3 201 and over	200

The bags in a sample shall be selected at random (*see* IS 4905).

9.2.2 The number of bags in a sample showing a minus error greater than 2 percent of the specified net quantity shall be not more than 5 percent of the bags in the sample. Also the minus error in none of such bags in the sample shall exceed 4 percent of the specified net quantity of aggregate in the bag.

9.2.3 In case of a wagon or truck load of 5 to 25 t, the overall tolerance on net quantity of aggregate shall be 0 to + 0.5 percent.

10 MARKING

10.1 Each consignment/bag of aggregate shall be legibly and indelibly marked with the following information:

a) Manufacturer's name and his registered trade-mark, if any;
b) Net quantity, in kg;
c) Words 'Use no Hooks' on the bags;
d) Batch/control unit number;
e) Address of the manufacturer;
f) Month and year of consignment/packing;
g) Type of aggregate, such as 'Coarse Aggregate' or 'Fine Aggregate';
h) In case the aggregates are from natural sources, the words 'Natural Aggregate';
j) In case of aggregates from other than natural sources, the type of coarse/fine aggregate (*see* Table 1);
k) In case of coarse aggregate, the nominal size along with the words, 'Single Sized' or 'Graded', as the case may be; and
m) In case of fine aggregate, the grading zone.

10.2 Similar information shall be provided in the delivery advices accompanying the shipment of aggregate in bulk (*see* **10.3**).

10.3 BIS Certification Marking

The aggregate may also be marked with the Standard Mark.

10.3.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.