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Indian Railways
Centre for Advanced Maintenance Technology

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Requirements of Course Aggregate from Natural Sources as per IS 383-2016

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Aggregates are important components for making concrete and properties of concrete are substantially affected by various characteristics of the aggregates used. 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 are termed as coarse aggregates. Coarse aggregate from natural sources 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);

The physical and chemical requirements for coarse aggregates, for use in production of concrete are tabulated as under:

SN	Material / Test	Method of Test, Ref to	Permissible Limits/ Variations
1	**Gradation test**	IS 2386 (Part 1)	As per table below

Coarse Aggregates –

(i) Graded coarse aggregates may be supplied in the nominal sizes given in table below. *(Table 7 of IS 383:2016)*

SN	IS Sieve Designation	Percentage passing for single-sized Aggregate of Nominal size						Percentage passing for Graded Aggregate of Nominal size			
		63mm	40mm	20mm	16mm	12.5mm	10mm	40mm	20mm	16mm	12.5mm
1	80mm	100	-	-	-	-	-	100	-	-	-
2	63mm	85- 100	100	-	-	-	-	-	-	-	-
3	40mm	0-30	85-100	100	-	-	-	90-100	100	-	-
4	20mm	0-5	0-20	85-100	100	-	-	30-70	90-100	100	100
5	16mm	-	-	-	85-100	100	-	-	-	90-100	-
6	12.5mm	-	-	-	-	85-100	100	-	-	-	90-100
7	10mm	0-5	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
8	4.75mm	-	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
9	2.36mm	-	-	-	-	-	0-5	-	-	-	-

(ii) Coarse aggregate for mass concrete works shall be in sizes specified in table below. *(Table 8 of IS 383:2016)*

SN	Class and Size	IS Sieve Designation	Percentage Passing
A	1 Very large, 150 mm to 80 mm	160 mm	90-100
		80 mm	0-10
	2 Large, 80 mm to 40 mm	80 mm	90-100
		40 mm	0-10
	3 Medium, 40 mm to 20 mm	40 mm	90-100
		20 mm	0-10
	4 Small, 20 mm to 4.75 mm	20 mm	90-100
		4.75 mm	0-10
		2.36 mm	0-0.2

(iii) All-in-Aggregate: Material composed of fine aggregate and coarse aggregate. Grading shall be in accordance with sizes specified in table below. *(Table 10 of IS 383:2016)*

SN	IS Sieve Designation	Percentage passing for All-in-Aggregate of	
		40mm Nominal Size	20mm Nominal Size
1	80mm	100	-
2	40mm	95 to 100	100
3	20mm	45 to 75	95 to 100
4	4.75mm	25 to 45	30 to 50
5	600µm	8 to 30	10 to 35
6	150µm	0 to 6	0 to 6

DISCLAIMER: *The information contained in this pamphlet does not supersede any existing provisions laid down in RDSO & Railway Board instructions. This document is not statutory & instructions given in it are for the purpose of guidance only.*

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SN	Material / Test	Method of Test, Ref to	Permissible Limits/ Variations
2	**Test for Deleterious Materials**		
A	**Limits of Deleterious Materials –** As per table below *(Table 2 of IS :383:2016)*		
	SN / Deleterious Substance	Test Procedure, Ref Code	Coarse Aggregate Percentage by Mass, Max: Uncrushed / Crushed
	(i) Coal & lignite	IS 2386 (Part 2)	1.0 / 1.0
	(ii) Clay lumps	IS 2386 (Part 2)	1.0 / 1.0
	(iii) Materials finer than 75 micron IS sieve	IS 2386 (Part 1)	1.0 / 1.0
	(iv) Soft fragments	IS 2386 (Part 2)	3.0 / -
	(v) Total of percentage of all deleterious materials (including SN (i) to (iv) for uncrushed/crushed coarse aggregate	-	5.0 / 2.0
3	**Combined Flakiness & Elongation index**	IS 2386 (Part 1)	≯ 40% for uncrushed or crushed aggregate.
4	**Tests for Mechanical Properties** *(Cl. 5.4 of IS :383:2016)*		
A	Aggregate Crushing Value/ Ten Percent Fines Value	IS 2386 (Part 4)	≯ 30 for aggregates to be used in concrete for wearing surfaces, (such as runways, roads, pavements, tunnel lining carrying water, spillways and stilling basins). > 30 for aggregates to be used in concrete other than for wearing surfaces, then the test for 'ten percent fines' should be conducted and the maximum load for the ten percent fines should be 50KN.
B	Aggregate Impact Value (As an alternative to Aggregate Crushing Value/ Ten Percent Fines Value)	IS 2386 (Part 4)	≯ 30 for aggregates to be used in concrete for wearing surfaces, (such as runways, roads, pavements, tunnel lining carrying water, spillways and stilling basins). ≯ 45 for aggregates to be used in concrete other than for wearing surfaces.
	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.		
C	Aggregate Abrasion Value	IS 2386 (Part 4) using Los Angeles Machine	≯ 30 for aggregates to be used in concrete for wearing surfaces, (such as runways, roads, pavements, tunnel lining carrying water, spillways and stilling basins). ≯50 for aggregates to be used in concrete other than for wearing surfaces
5	**Test for Soundness of Aggregate** (Only for concrete liable to be exposed to the action of frost)		
A	Sodium or magnesium sulphate accelerated soundness test	IS 2386 (Part 5)	The limits to set by agreement between the purchaser and supplier. However, as a general guide, it may be taken that the average loss of mass after 5 cycles shall not exceed 12% when tested with sodium sulphate (Na_2SO_4), and 18% when tested with magnesium sulphate ($MgSO_4$)
6	**Alkali Aggregate Reaction –** 1. 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. 2. 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. 3. Petrographic analysis of aggregate should be carried out to find out the strained quartz percentage, undulatory extinction angle and its mineral composition before conducting these tests.		
A	Chemical Method [This method (for determination of potential reactivity) is not found to be suitable for slowly reactive aggregates or for aggregate containing carbonates or magnesium silicates, such as antigorite]	IS 2386 (Part 7)	If test results indicate deleterious or potentially deleterious character, the aggregate should be tested using mortar bar method to verify the potential for expansion in concrete.
B	Mortar Bar Method		
	Using 38 degree C temp regime (Not suitable for slowly reactive aggregate)	IS 2386 (Part 7)	0.05 % at 90 days & 0.1 % at 180 days
	Using 60 degree C temp regime (for slowly reactive aggregates)		0.05 % at 90 days & 0.06 % at 180 days

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SN	Material / Test	Method of Test, Ref to	Permissible Limits/ Variations
C	Accelerated mortar bar method (The test is found to be specially suitable for slowly reactive aggregate)	IS 2386 (Part 7)	Expansion < 0.10 % at 16 days after casting - Indicative of innocuous behavior in most cases. 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 absence of field performance data, mitigative measures should be taken.
			Expansion > 0.20 % at 16 days after casting - Indicative of potentially deleterious expansion
			Expansion between 0.10% & 0.20% at 16 days after casting - Includes both aggregate that are known to be innocuous and deleterious in field performance. - It may be useful to support this test with test by mortar bar method at 38°C and 60°C, as applicable.

INFORMATION TO BE FURNISHED BY THE SUPPLIER

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, in case of aggregates from natural sources;
c) Physical characteristics, in case of aggregates from natural sources;
d) Presence of reactive minerals;
e) Service history, if any, the name of projects where used and the performance including in recently completed projects.

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