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Indian Railways
Centre for Advanced Maintenance Technology

(केवल कार्यालयीन उपयोग हेतु /
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Requirements of Fine 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 passes 4.75 mm IS Sieve and containing only so much coarser material as permitted when grading of fine aggregates determined as described in IS 2386 (Part 1) shall be within the limits given in Table 9 of IS 383-2016 and shall be described as fine aggregate, Grading Zones I, II, III and IV.

Fine Aggregates from natural sources may be –

(i) Natural Sand (Uncrushed sand) from natural disintegration of rocks,
(ii) Crushed Sand – Crushed stone sand & crushed gravel sand,
(iii) Mixed Sand produced by blending natural sand and crushed stone sand or crushed gravel sand in suitable proportions.

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

<table>
<tr><th>SN</th><th>Material / Test</th><th>Method of Test, Ref to</th><th>Permissible Limits/ Variations</th></tr>
<tr><td>1</td><td>Gradation test</td><td>IS 2386 (Part 1)</td><td>As per table below</td></tr>
<tr><td>A</td><td colspan="3">Fine Aggregates – (Table 9 of IS 383:2016)
The grading of fine aggregates shall be within limits given table below.
<table>
<tr><th rowspan="2">SN</th><th rowspan="2">IS Sieve Designation</th><th colspan="4">Percentage passing</th></tr>
<tr><th>Grading Zone I</th><th>Grading Zone II</th><th>Grading Zone III</th><th>Grading Zone IV</th></tr>
<tr><td>1</td><td>10 mm</td><td>100</td><td>100</td><td>100</td><td>100</td></tr>
<tr><td>2</td><td>4.75 mm</td><td>90-100</td><td>90-100</td><td>90-100</td><td>95-100</td></tr>
<tr><td>3</td><td>2.36 mm</td><td>60-95</td><td>75-100</td><td>85-100</td><td>85-100</td></tr>
<tr><td>4</td><td>1.18 mm</td><td>30-70</td><td>55-90</td><td>75-100</td><td>90-100</td></tr>
<tr><td>5</td><td>600 µm</td><td>15-34</td><td>35-59</td><td>60-79</td><td>80-100</td></tr>
<tr><td>6</td><td>300 µm</td><td>5-20</td><td>8-30</td><td>12-40</td><td>15-50</td></tr>
<tr><td>7</td><td>150 µm</td><td>0-10</td><td>0-10</td><td>0-10</td><td>0-10</td></tr>
</table>
Note:
1 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 particular sieve size, (subject to cumulative amount of 10 percent), it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing 600 µm IS Sieve or to percentage passing any other sieve size on the coarse limit of Grading Zone I or finer limit of Grading Zone IV.
2. For crushed stone sands, the permissible limit on 150 µm IS Sieve is increased to 20 percent. This doesn't affect the 5 percent allowance permitted in Note 1 above.
3. 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.</td></tr>
</table>

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** (*Table 2 of IS :383:2016*)				
	Limits of Deleterious Materials – Fine Aggregates				
	SN	Deleterious Substance	Test Procedure, Ref Code	Fine 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)	3.0	15.0 (For crushed sand) 12.0 (For mixed sand)
	(iv)	Shale	Presence and extent of shales shall be determined by petrography at the time of selection and change of source.	1.0	-
	(v)	Total of percentage of all deleterious materials (except mica) including SN (i) to (iv)	-	5.0	2.0
A	(vi)	Mica, percent by mass (Where no tests for strength & durability are conducted)	-	1.0	1.0
	(vii)	Mica (muscovite type), percent by mass Mica (for both muscovite and biotite), percent, maximum by mass [Where tests are conducted to ensure adequate workability, satisfactory strength, permeability and abrasion (for wearing surfaces)]	-	3.0 5.0	3.0 5.0
	(viii)	Total of percentage of all deleterious materials (including mica) including SN (i) to (iv) and (vi) or (vii)	-	8.0	5.0
3	**Tests for Soundness** (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 10% when tested with sodium sulphate (Na_2SO_4), and 15% when tested with magnesium sulphate ($MgSO_4$)	
4	**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.	

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SN	Material / Test	Method of Test, Ref to	Permissible Limits/ Variations
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
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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