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MATTEST
Engineering Services LLP

Fine Aggregate Testing

Website : mattestlab.com

E-mail : rvmattest@gmail.com

Vishal Raiyani
(M.Tech)

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

STANDARD: IS: 2386 (Part 1) -1996

- This standard covers the procedure for the determination of Particle size distribution of Fine & Coarse and all-in-aggregates by sieving or screening.

APPARATUS

1. Sieves- Sieves (Conforming to IS:460-1962) of size 40mm, 20mm, 12.5mm, 10mm, 4.75mm, 2.36mm, 1.18mm, 600micron, 300micron & 150micron.
2. The balance or scale shall be such that it is readable and accurate to 0.1 percent of weight of the test sample.
3. Sieve shaker.

TEST SAMPLE

- The weight of the sample available shall not be less than the weight given in the table below. The sample for sieving shall be prepared from the larger sample either by quartering or by means of sample divider.

Maximum Size present in Substantial proportions (mm)	Minimum weight of sample required for quartering (Kg)
20	25
10	6
6.3	3

- Minimum weight of sample required for Sieve analysis after Quartering shall be as follows.

Maximum Size present in Substantial proportions (mm)	Minimum weight of sample required for Sieve analysis (Kg)
20	2.0
10	0.5
4.75	0.2

PROCEDURE

- Bring the sample to an air-dry condition before weighing and sieving.
- Weigh the air-dry sample and sieve successfully on the appropriate sieves starting with the largest.
- Each sieve shall be shaken separately over a clean tray until not more than a trace passes, but in any case, for a period of not less than 2 minutes.
- Shake with a varied motion so that the material is kept moving over sieve surface in frequently changing directions.

- Light brushing of the underside of sieve with a soft brush may be used to clear the sieve openings.
- On completion of sieving the material retained on each sieve together with any material cleaned from the mesh, shall be weighed.
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-- End of SOP –

DETERMINATION OF BULK DENSITY

STANDARD: IS: 2386 (Part 3) -1996

- This standard covers the method of test deals with the procedure for determining unit weight or bulk density of aggregates.

APPARATUS/EQUIPMENT

1. Balance sensitive to 0.5% of the wt. of Sample to be weighed.
2. Cylinder Metal Measure of capacity 3l for Fine Aggregate and 15l for Coarse Aggregate.
3. Tamping rod of 16mm diameter with 60 cm long rounded at one end.

PROCEDURE

- Take representative sample of aggregate as required for the test according to maximum size of aggregate and the container required from Table below.
- Determine the empty weight (M_1) and the volume (V) of the cylinder at 27 °C.

Size of containers for bulk density

Size of largest	Nominal capacity	Inside diameter cm	Inside Height cm	Thickness of metal in mm
Under 4.75	3	15	17	3.15
Over 4.75 to 40	15	25	30	4.00
Over 40	30	35	31	5.00

COMPACTED WEIGHT

- Fill the container in three equal layers, each layer being subjected to 25 strokes with the rounded end of the tamping rod.
- Struck off the surplus aggregate using the tamping rod as a straight edge and weight (M_2).

LOOSE WEIGHT

- Over flow the container by pouring the material from a height of not exceeding 5 cm above the top of the cylinder.
- Struck off the surplus aggregate using the tamping rod as a straight edge and weigh (M_3).

-- End of SOP --

DETERMINATION OF SPECIFIC GRAVITY AND WATER ABSORPTION

STANDARD: 2386 (Part 3) -1996

- This standard covers the method for the determining the specific gravity, apparent specific gravity and water absorption of aggregates for fine aggregates.

DEFINITION:

- Specific gravity is the ratio of the mass of a given volume of the substance to the mass of an equal volume of water.

APPARATUS:

1. Balance of capacity not less than 3 kg with accuracy of 0.5 gm
2. Oven to maintain a temperature of 100 to 110 °C.
3. Pycnometer of about 1 Lit capacity
4. Tray for drying the sample

PROCEDURE:

- Take about 1 kg of sample for aggregate up-to 10mm size and 500gm for aggregate less than 4.75mm size.
- Keep the sample to be tested in water for 24 ± ½ hour and remove the entrapped air by gentle agitation.
- The water should be carefully drained and sample is to be placed in metal tray and must be surfaced dried by applying warm air and uniform drying should be achieved.
- The saturated surface dry sample weighted as A.
- Take the empty pycnometer bottle and fill it with distilled water such that the surface of the water in the hole is flat and free from entrapped air.
- The pycnometer shall be dried on the outside and weighed as B.
- After completion of above step empty the pycnometer and dry it.

- Now, place the aggregate in the Pycnometer and fill it with distilled water and entrapped air shall be eliminated by gently rotating the Pycnometer.
- The pycnometer shall be topped up with distilled water so that the surface of the water in the hole is flat. The pycnometer shall be dried on the outside and weighed as C.
- The sample kept in the tray should be kept in oven for 24 ± ½ hour at 110 °C.
- Take the sample from the oven and cool it to room temperature.
- Note down the weight of aggregate (D).

CALCULATION

I. Specific Gravity = $\boldsymbol{D/[A-(C-B)]}$

II. Water Absorption (%) = $\frac{\boldsymbol{A-D}}{\boldsymbol{D}} * \mathbf{100}$

- Here,
  C = Total weight of Sample + Water + Pycnometer.
  B = Weight of Pycnometer + Water.
  A = Saturated Surface Dry weight of aggregate.
  D = Oven Dry weight after 24 hours.

PRECAUTION

- The difference in temperature of the water in the pycnometer during the first and second weighing shall not exceed 2 °C.

-- End of SOP --

DETERMINATION OF MATERIALS FINER THAN 75-MICRON (FINE AGG)

STANDARD: IS: 2386 (Part 1) -1963

- This standard covers the method of test deals with the procedure for determining the total quantity of material finer than 75-micron IS sieve in aggregates by washing.

APPARATUS

- The apparatus required for the test is as follows:
- The balance or scale shall be of sufficient capacity and sensitivity and shall have an accuracy of 0.1 percent of the weight of test sample.
- Sieves-A nest of two sieves, the lower being 75-micron IS Sieve and the upper approximately 1.18 mm IS Sieve.
- Container-A pan or vessel of a size sufficient to contain the sample covered with water and to permit of vigorous agitation without loss of any part of the sample of water.
- Oven-An oven of sufficient size capable of maintaining a uniform temperature of 110 ± 5 °C.

TEST SAMPLE:

- The weight of sample available shall not be less than the weight.

Maximum Nominal Size of Aggregates (mm)	Approximate minimum weight of sample (gm)
4.75	500
10.0	2000
20.0	2500
40 or over	5000

PROCEDURE:

- The test sample shall be dried to constant weight at a temperature of 110± 5 °C and weighed to the nearest 0.1 percent.
- The dried and weighed sample shall be placed in the container and sufficient water is added to cover it. Then the contents of the container are agitated vigorously.

- The agitation shall be sufficiently vigorous such that the coarse particles are separated and the fine particles are brought into the suspension.
- The water (mixed with fine particles) shall be poured over the nested sieves arranged with the coarser sieve at the top.
- All materials retained on the both the sieves shall be container containing coarser particles.
- Steps 3, 4 & 5 are repeated till the wash water looks clear. Care should be taken such that no materials retained on the sieve get lost.
- The retained materials should be dried to a constant weight at a temperature not exceeding 110 °C and weighed to the nearest 0.1 percent.

-- End of SOP –

DETERMINATION OF SOUNDNESS OF AGGREGATES

STANDARD: IS: 2386 (Part V) -1963

- This standard covers the method of test deals with the procedure for determining the soundness of aggregates.

APPARATUS

- Sieves of size 80mm, 63mm, 50mm, 40mm, 31.50mm, 25mm, 20mm, 16mm, 12.50mm, 10mm, 8mm, 4.75mm, 4mm, 2.36mm, 1.18mm, 600microns, 300microns and 150 microns with square openings conforming to IS:460-1962.
- Containers for immersing the samples shall be perforated so as to permit free access of the solution from the sample and drainage of the solution from the sample without loss of aggregate.
- Arrangements shall also be available to ensure that the volume of the solution in which samples are to be immersed shall be at least five times the volume of the sample immersed at any one time.
- Balance of capacity 500 gm sensitivity to 0.01 gm.
- Balance of capacity 10 kg sensitivity to 1 gm.
- Thermostatically controlled oven capable of being maintained at 105to 110 °C.
- The rate of evaporation, at this range of temperature shall be at least25gm/hour for four hours which period the doors of the oven kept closed.

SODIUM SULPHATE SOLUTION

- Prepare saturated solution of sodium sulphate technical grade, conforming to IS:255- 1950 or an equivalent grade of the salt of either the a hydrous (Na_2SO_4) or the crystalline ($Na_2SO_4.10\ H_2O$) form in water at temperature of 25 to 30 °C.
- For making of the solution, 420gms of a hydrous salt or 1300 gm of decahydrate salt per liter of water are sufficient for saturation at 28 °C.
- The mixer shall be thoroughly stirred during the addition of salt and the solution shall be stirred at frequent intervals until used.

- The solution shall be cooled to a temperature of 27±2 °C and maintained at that temperature for at least 48 hours before use.
- Salt cakes if any shall be broken and specific gravity of the solution shall be determined.
- When used, the solution shall have specific gravity of 1.151 to1.174.
- Discolored solution shall be discarded, or filtered and checked again for specific gravity.

Fine Aggregates

- An aggregate passing 4.75 mm IS Sieve shall be considered as fine aggregates.
- Sample shall be of such size that it will yield not less than 100 gm of each of the sizes shown in Table 1.

Coarse Aggregates

- Aggregates of size more than 4.75 mm shall be considered as coarse aggregates.
- Sample shall be of such size that it will yield not less than following amounts of different sizes mentioned in table below which shall be available in amounts of 5% or more.

Table 1

Passing IS sieve	Retained on IS sieve
600 microns	300 microns
1.18 mm	600 microns
2.36 mm	1.18 mm
4.75 mm	2.36 mm

Table 2

10 mmto4.75 mm	300 gms
20 mmto10 mm	1000gms
12.5 mm to10 mm	33%
20 mm to12.5 mm	67%
40 mm to 20 mm	1500 gms
25 mm to 20 mm	33%
40 mm to 25 mm	67%
63 mm to 40 mm	3000 gms
50 mm to 40 mm	50 %
63 mm to 50 mm	50 %
80mm and larger sizes by 20mm spread in sieve size, each fraction	3000 gms

All in Aggregates

- Separate all in aggregates in to two major fractions such as smaller than 4.75 and coarser than 4.75.
- The former shall be dealt as fine aggregates and the latter as coarse aggregates.

Preparation of Test Sample Fine Aggregates

- Thoroughly, wash fine aggregates on 300 microns IS sieve and dry to constant weight at 105°C to 110°C & separate in to different sizes through the sieves mention in **Table 2.**

Coarse Aggregates

- Thoroughly wash and dry aggregates to a constant weight in an oven at temperature of 105 °C to 110 °C.
- Separate in to desired fraction by sieving through the sieves mention in **Table:2.**
- Weight the required size of fraction and place in to separate containers.
- In the case of fraction coarser than 20 mm the number of particles shall also be counted.

PROCEDURE

Storage of Sample in Solution

- Immerse the samples in the prepared solution of sodium sulphate for not less than 16hrs nor more than 18hrs in such a manner that solution covers the sample to a depth of at least 15 mm.
- Cover the containers to reduce the evaporation & to prevent accidental condition of extraneous substances.
- The temperature in the solution shall be maintained within 27 $\pm$ 1 °C throughout the immersion period.
- After the immersion period remove the aggregates from the solution and permit to drain for 15 $\pm$ 5 minutes and place in the oven at a temperature of 105 to 110°C until it attains a constant weight.
- During this period remove the aggregates from the oven cool to room temperature and weigh at intervals not less than 4 hours nor more than 18hours.

- Constant weight may consider to have been achieved when two successive weights for any one sample shall not differ by more than 0.1gram for fine aggregates and 1gram for coarse aggregates.
- After the constant weight has been achieved remove the aggregates from the oven and cool to room temperature.
- Again, immerse the aggregates in solution for next cycle and repeat the same procedure as described above.
- The number of cycles to be conducted shall be as per specifications.
- After the completion of the final cycle cool the sample and wash the sample free from sulphate.
- This may be determined when there is no more reaction of the washed water with barium chloride. (When there is no white precipitation when barium chloride is added to washed water, it can be said that there is no sulphate with washed water)
- Dry each faction of sample in an oven at a temperature of 105 to 110 °C to constant weight and weigh.
- Sieve the fine aggregates over the same sieve on which it was retained before the test.
- Sieve the coarse aggregates over the sieves of sizes shown in Table 3 for appropriate size of particle.

Table 3

Size of aggregates	Sieve Size used to determine loss
63 to 40 mm	31.50 mm
40 to 20mm	16 mm
20 to 10mm	8 mm
10to 4.75 mm	4 mm

- Exam in visually each size of aggregates to see if the any evidence of excessive splitting, crumbling or disintegration of the grains.
- Conduct a combined sieve analysis of all the material subject to the above test to note the variation from the original grain size an analysis of the sample.

-- End of SOP --

DETERMINATION OF SILT CONTENT (FINE AGG)

STANDARD: CPWD-SPECIFICATIONS 91-92 (APPENDIX-D)

- This standard method of test covers an approximate method of estimating whether organic compounds are present in natural sand in sufficient quantities to be harmful, and hence is intended to show whether further tests are necessary or desirable.

APPARATUS

- The apparatus required for the test is as follows:
- The balance or scale shall be of sufficient capacity and sensitivity and shall have an accuracy of 0.1 percent of the weight of test sample.
- Container-A 200ml measuring cylinder of a size sufficient to contain the sample covered with water and to permit of vigorous agitation without loss of any part of the sample of water.

TEST SAMPLE:

- The weight of sample available shall not be less than 300gm.

PROCEDURE:

- A sample of sand to be tested shall be placed without drying in a 200 ml measuring cylinder.
- The volume of sample shall be such that it fills the cylinder up to 100ml mark.
- The clean water shall be added up to 150ml mark.
- Dissolve the little salt in the proportion one tea spoon to half a litre.
- The mixture shall be shaken vigorously, the last few shakes being sidewise direction to level off the sand and the contents allowed to settle for 3 hours.
- The height of silt visible as settled layer above the sand shall be expressed as a percentage of the height of sand below.
- The sand containing more than the above allowable percentage of silt, shall be washed so as to bring the silt contents within allowable limits.

-- End of SOP --