9. DELETERIOUS CONTENT OF AGGREGATES.
(IS : 2386 – PART – 2)

I. DETERMINATION OF CLAY LUMPS:

Apparatus:

1) Balance – sensitive to 0.001 g, 2) Containers – size and shape that will permit the spreading of the sample on the bottom in a thin layer, 3) Sieves – conforming to IS : 460-1962.

Sampling:

Samples shall be obtained by quartering or by the use of a sampler, from a representative sample selected from the material to be tested. They shall be handled in such a manner as to avoid breaking up clay lumps, which may be present. Samples shall be dried to constant weight at a temperature not exceeding 110^0C.

Samples of fine aggregate shall consist of particles coarser than 1.18 mm IS sieve and shall weigh not less than 100 g.

Samples of coarse aggregate shall be separated into different sizes using 4.75mm, 10mm, 20mm and 40mm IS sieves. The weight of the sample for different sizes shall be not less than those indicated below:

Size of Particles Making Up the Samples (mm)	Weight of Sample Min.(g)
4.75 to 10	1000
10 to 20	2000
20 to 40	3000
Over 40	5000

In the case of mixtures of fine and coarse aggregates, the material shall be separated into two sizes on 4.75mm IS sieve, and the samples of fine and coarse aggregates shall be prepared as described above.

Procedure:

The sample shall be spread in a thin layer on the bottom of the container and examined for clay lumps. Any particles, which can be broken into finely divided particles with the fingers, shall be classified as clay lumps. After all discernible clay lumps have been broken, the residue from the clay lumps shall be removed by the use of sieves indicated below:

Size of Particles Making up the Sample	Size of Sieve for Sieving Residue of Clay Lumps
Fine aggregate (retained on 1.18mm IS sieve)	850 - micron
4.75 to 10 mm	2.36 mm
10 mm to 20 mm	4.75 mm
20 mm to 40 mm	4.75 mm
Over 40 mm	4.75 mm

Calculations:

The percentage of clay lumps shall be calculated to the nearest 0.1 percent in accordance with the following formula:

$$L = \frac{(W - R)}{W} \times 100$$

Where, L = percentage of clay lumps.
W = weight of sample.
R = weight of sample after removal of clay lumps.

II. DETERMINATION OF CLAY, FINE SILT AND FINE DUST.

Apparatus:

1) A watertight screw-topped glass jar of dimensions similar to a 1-kg fruit-preserving jar, 2) A device for rotating the jar about its axis, with this axis horizontal, at a speed of 80 +/- 20 rev/min, 3) A sedimentation pipette of the Andreason type of approximately 25 ml capacity. This consists mainly of a pipette fitted at the top with a two way tap and held rigidly in a clamp which can be raised or lowered as required, and which is fitted with a scale from which the changes in height of the pipette can be read, 4) A 1000 ml measuring cylinder, 5) A scale or balance of capacity not less than 10 kg, readable and accurate to one gram, 6) A scale or balance of capacity not less than 250 g, readable and accurate to 0.001 g, 7) A well ventilated oven, thermostatically controlled, to maintain a temperature of 100 to 110^0C.

Chemicals:

A solution containing 8 g of sodium oxalate per litre of distilled water shall be taken. For use, this stock solution is diluted with distilled water to one tenth (that is 100 ml diluted with distilled water to one litre).

Test sample:

The sample for test shall be prepared from the main sample taking particular care that the test sample contains a correct proportion of the finer material. The amount of sample taken for test shall be in accordance with below table.

Maximum size present in substantial proportions (mm)	Approximate weight of sample for test (kg)
63 to 25	6
20 to 12.5	1
10 to 6.3	0.5
4.75 or smaller	0.3

All in aggregates shall be separated into fine and coarse fractions by sieving on a 4.75 mm IS sieve and the two samples so obtained shall be tested separately.

Procedure:

Method for fine aggregate: Approximately 300 g of the sample in the air dry condition, passing the 4.75 mm IS sieve, shall be weighed and placed in the screw topped glass jar, together with 300 ml of the diluted sodium oxalate solution. The rubber washer and cap shall be fixed, care being taken to ensure water tightness. The jar shall then be rotated about its long axis, with this axis horizontal, at a speed of 80 +/- 20 rev/min for a period of 15 minutes. At the end of 15 minutes, the suspension shall be poured into the 1000 ml measuring cylinder and the residue washed by gentle swirling and decantation of successive 150 ml portions of sodium oxalate solution, the washings being added to the cylinder until the volume is made up to 1000 ml. The determination shall be completed as described below.

Method for coarse aggregate: The weighed sample shall be placed in a suitable container, covered with a measured volume of sodium oxalate solution (0.8 g per litre), agitated vigorously to remove all adherent fine material and the liquid suspension transferred to the 1000 ml measuring cylinder. This process shall be repeated as necessary until all clayey material has been transferred to the cylinder. The volume shall be made up to 1000 ml with sodium oxalate solution and the determination completed as described below.

The suspension in the measuring cylinder shall be thoroughly mixed by inversion and the tube and contents immediately placed in position under the pipette. The pipette shall then be gently lowered until the tip touches the surface of the liquid, and then lowered a further 10 cm into the liquid. Three minutes after placing the tube in position, the pipette and the bore of tap shall be filled by opening and applying gentle suction. A small surplus may be drawn up into the bulb between tap and tube, but this shall be allowed to run away and any solid matter shall be washed out with distilled water from top end. The pipette shall then be removed from the measuring cylinder and its contents run into a weighed container, any adherent solids being washed into the container by distilled water

from top end. The contents of the container shall be dried at 100 to 110^0C to constant weight, cooled and weighed.

Calculations: The proportion of fine silt and clay or fine dust shall then be calculated from the following formula:

$$\text{Percentage of clay and fine silt or fine dust} = \frac{100}{W1}\left(\frac{1000W2}{V} - 0.8\right)$$

Where, W1 = weight in g of the original sample.
W2 = weight in g of the dried residue.
V = volume in ml of the pipette
0.8 = weight in g of sodium oxalate in one litre of the diluted solution.

III.DETERMINATION OF LIGHT-WEIGHT PIECES.

Apparatus:
1) Balances – for weighing fine aggregates, a balance having a capacity of not less than 500 g, sensitive to at least 0.1 g; for weighing coarse aggregates, a balance having a capacity of not less than 5000 g, sensitive to at least 1 g.
2) Containers – containers suitable for drying the aggregate sample, and containers suitable for holding the heavy liquid during the sink-float separation.
3) Skimmer – a piece of 300-micron sieve cloth of suitable size and shape for separating the floating pieces from the heavy liquid.
4) Hot-plate or oven.
Heavy liquid: The heavy liquid shall consist of a mixture of carbon tetrachloride, and 1, 1, 2, 2-tetrabromoethane, bromoform, and monobromobenzene, or bromoform and benzene, in such proportions that the desired specific gravity will be obtained. Bromotrichloromethane may be used as a heavy liquid having a specific gravity of 2.00. The specific gravity shall be maintained within +/- 0.01 of the specified value at all times during the test.

The approximate volumes of materials to be combined to produce a mixture of the desired specific gravity may be computed from the following specific gravities of the different liquids:

Liquid	Specific gravity
1,1,2,2-tetrabromoethane	2.97
Benzene	0.88
Bromoform	2.88
Carbon tetrachloride	1.58
Monobromobenzene	1.49

For determining coal and lignite, the heavy liquid used shall have a specific gravity of 2.00 +/- 0.01.

Test Sample: The minimum size of test sample shall be as follows:

Maximum size of aggregate (mm)	Minimum weight of sample (grms)
6.3 (fine aggregate)	200
20	3000
40	5000
80	10000

Procedure:

1) Fine aggregate: Allow the dried sample of fine aggregate to cool to room temperature and then sieve over a 300-micron IS sieve until less than one percent of the retained material passes the sieve in one minute of continuous sieving. Weigh the material coarser than the 300-micron IS sieve to the nearest 0.1 g; then introduce it into the heavy liquid in a suitable container, the volume of liquid being at least three times the absolute volume of the aggregate. Pour the liquid off into a second container; passing it through the skimmer and taking care that only the floating pieces are poured off with the liquid and that none of the sand is decanted onto the skimmer. Return to the first container the liquid that has been collected in the second container and, after further agitation of the sample by stirring, repeat the decanting process just described until the sample is free of floating pieces. Wash the decanted pieces contained on the skimmer in carbon tetrachloride, until the heavy liquid is removed, and then dry. The pieces will dry very quickly, but may be placed in an oven at 105^0C for a few minutes if desired. Brush the dry decanted pieces from the skimmer onto the balance pan and determine the weight to the nearest 0.1 g.

2) Coarse aggregate: Allow the dried sample of coarse aggregate to cool to room temperature and sieve over a 4.75 mm IS sieve. Weigh the material coarser than the 4.75 mm IS sieve to the nearest 1 g; then introduce it into the heavy liquid in a suitable container, the volume of the liquid being at least three times the absolute volume of the aggregate. Using the skimmer, remove the pieces that rise to the surface, and save them. Repeatedly agitate the remaining pieces and remove the floating pieces until no additional pieces rise to the surface. Wash the decanted pieces in carbon tetrachloride until all of the heavy liquid is removed, and allow to dry. Determine the weight of the decanted pieces to the nearest 1-gram.

Calculations: Calculate the percentage of lightweight pieces as follows:

For fine aggregate:

$$L = \frac{W1}{W2} \times 100$$

For coarse aggregate:

$$L = \frac{W1}{W3} \times 100$$

Where, L = percentage of lightweight pieces.
W1 = dry weight in g, of decanted pieces.
W2 = dry weight in g, of portion of sample coarser than 300-micron IS sieve.
W3 = dry weight in g, of portion of sample coarser than 4.75 mm IS sieve.

IV. DETERMINATION OF SOFT PARTICLES.

Apparatus: The apparatus shall consist of a brass rod, having a Rockwell hardness of 65 RHB to 75 RHB. A brass rod of about 1.6mm diameter and of proper hardness inserted into the wood shaft of an ordinary lead pencil is a convient tool for field or laboratory use.

Test Sample: Aggregates for the test shall consist of material from which the sizes finer than the 10mm IS sieve have been removed. The sample tested shall be of such size that it will yield not less than the following amount of the different sizes, which shall be available in amounts of 10 percent or more:

Sieve size (mm)	Sample Weight (grms)
10 to 12.5	200
12.5 to 20	600
20 to 25	1500
25 to 40	4500
40 to 50	12000

Procedure:
Each particle of aggregate under test shall be scratched with the brass rod with a small amount of pressure (about 1 kg). Particles are considered to be soft if during the scratching process, a groove is made in them without deposition of metal from the brass rod or if separate particles are detached from the rock mass.

Calculations: The report shall include the following information.
a) Weight and number of particles of each size of each sample tested with the brass rod.
b) Weight and number of particles of each size of each sample classified as soft in the test.
c) Percentage of test sample classified as soft by weight and by number of particles.
d) Weighed average percentage of soft particles calculated from percentage in item (c) and based on the grading of sample of aggregate received for testing.