TAGORE INSTITUTE OF ENGINEERING AND TECHNOLOGY

Deviyakurichi-636112, Attur (TK), Salem (DT). Website: www.tagoreiet.ac.in

(Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai)

Accredited by NAAC

Department of Civil Engineering

II Year- III Semester – Civil Engineering

CE8311 CONSTRUCTION MATERIALS LABORATORY

LAB MANUAL

Academic Year 2020-2021

(2017 Regulation)

Department of Civil Engineering

To learn the principles and procedures of testing Concrete and Highway materials and to get hands on experience by conducting the tests and evolving inferences.

List of Experiments

I. Test on Fine Aggregates

1. Grading of fine aggregates

2. Test for specific gravity and test for bulk density

3. Compacted and loose bulk density of fine aggregate

II. Test on Coarse Aggregate

1. Determination of impact value of coarse aggregate

2. Determination of elongation index

3. Determination of flakiness index

4. Determination of aggregate crushing value of coarse aggregate

III. Test on concrete

1. Test for Slump

2. Test for Compaction factor

3. Test for Compressive strength - Cube & Cylinder

4. Test for Flexural strength

IV. Test on Bricks and Blocks

1. Test for compressive strength of bricks and blocks

2. Test for Water absorption of bricks and blocks

3. Determination of Efflorescence of bricks

4. Test on tiles

1. The students will have the required knowledge in the area of testing of construction materials and components
of construction elements experimentally.

COURSE OUTCOMES

CONTENTS

Expt. No.01 DETERMINATION OF FINENESS MODULUS OF FINE AGGREGATE

Aim:
To determine fineness modulus of fine aggregate and classifications based on IS: 383-1970.
Apparatus Required:
1. Test Sieves conforming to IS: 460-1962.
2. Specification of 4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300micron, 150 micron.
3. Weigh Balance
4. Gauging Trowel
5. Stop Watch
Procedure:

1. The sample shall be brought to an air-dry condition before weighing and sieving.
2. The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest.
3. Material shall not be forced through the sieve by hand pressure.
4. Lumps of fine material, if present, may be broken by gentle pressure with fingers against the side of the sieve.
5. Light brushing with a fine camel hair brush may be used on the 150-micron and 75-micron IS Sieves to
prevent aggregation of powder and blinding of apertures.
6. On completion of sieving, the material retained on each sieve, together with any material cleaned from the
mesh, shall be weighed.

Observation and Calculation

Weight of empty tray = kg
Weight of tray + fine aggregate = kg
Weight of fine aggregate = kg

IS Sieve Weight Retained on Sieve

Percentage of Weight Retained (%)

Percentage of Weight Passing (%)

Cumulative Percentage of Passing (%)

4.75 mm
2.36 mm
1.18 mm
600
micron

300
micron
Total

Fineness modulus = F/100

Result:
The fineness modulus of fine aggregate is _.
Outcome:
At the end of the experiment, student acquires knowledge in the determination of the fineness modulus of given aggregate.
Viva - voce

1. Fine Aggregates should pass through which IS sieve?
2. How many types of fine aggregates are there based on source?
3. What is the fineness modulus value of fine sand?
4. Which of the materials can be used as fine aggregates?
5. What is the specific gravity for sand?
6. In the ratio 1:4:8, which number indicates quantity of fine aggregates?
7. Which size coarse aggregate is ideal for use in concrete mix?
8. Which of the following sand type is excellent for use in mortar and concrete work?
9. What is sand composed of?
10. Which IS code gives the grading of sand?

Applications

1. To calculate the fineness of sand which is used in the construction fields.
2. Used for calculation of Mix design of concrete for construction.

Expt. No.02 DETERMINATION OF SPECIFIC GRAVITYOF FINE

AGGREGATE

Aim:
To determine specific gravity of fine aggregate
Apparatus Required:
1. Pycnometer (either a Pycnometer jar with conical top or a stoppered bottle having a capacity of at least
50ml)
2. 4.75mm sieve
3. Weighing balance
4. Oven
5. Glass rod
6. Distilled water
Theory:
Specific gravity G is defined as the ratio of the weight of an equal volume of soil solids at a given temperature to the weight of an equal volume of distilled water at that temperature, both weights being taken in air. The Indian Standard specifies 27oC as the standard temperature for reporting the specific gravity.
Procedure:
1. Clean and dry the Pycnometer
2. Weigh the empty Pycnometer with its cap (W1)
3. Take about 200gmof oven dried soil passing through 4.75mm sieve into the Pycnometer and weigh again (W2)
4. Add sufficient de-aired water to cover the soil and screw on the cap
5. Shake the Pycnometer well and remove entrapped air if any
6. Fill the Pycnometer with water completely
7. Dry the Pycnometer from outside and weigh it (W3)
8. Clean the Pycnometer by washing thoroughly
9. Fill the cleaned Pycnometer completely with water up to its top with cap screw on
10. Weigh the Pycnometer after drying it on the outside thoroughly (W4)
11. Repeat the procedure for three samples and obtain the average value of specific gravity.

Observation and Calculation
Calculate the specific gravity of the soil, as follows,
Specific gravity = GS = (W2- W1)
(W4- W1)(W3- W2)

Where,
Weight of empty Pyconometer, W1 =
Weight of Pyconometer + soil sample, W2 =
Weight of Pyconometer + soil sample + water, W3 =
Weight of Pyconometer + water, W4 =

Result:
The specific gravity of the test sample =
Outcome:
Gained knowledge related to various properties of soil (Specific gravity).

Viva - voce
1. What is soil mechanics?
2. What are main types of soils?
3. What is empirical correlation between PSD and permeability?
4. What is meant by degree of saturation?
5. What are the principles of direct shear test?
6. What is the effect of pore pressure on shear strength of soil?
7. How will you find the shear strength of cohesion less soil?
8. What are the types of shear tests based on drainage?
9. What is meant by shear strength and failure envelope?
10. What are the shear strength parameters?
11. What is cohesion and stress path?
12. What is angle of internal friction?
13. What are the various methods of determination of shear strength in the laboratory?
14. What is the differential equation of deflection of a bent beam?
15. What are the disadvantages of direct shear test?
16. What are the types of tri-axial test based on drainage conditions?
17. What is meant by plastic index, saturated mass density?
18. Distinguish between relative density, relative compaction.

Applications
1. To calculate the weight properties of soil like void ratio, degree of saturation and density properties.
2. Used for calculation of Mix design of concrete for construction.

Expt. No.03 DETERMINATION OF COMPACTED AND LOOSE BULK DENSITY OF FINE AGGREGATE

Aim:
To determine compacted and loose bulk density of fine aggregate

Apparatus Required:
1. Weighing balance
2. Cylindrical metal measure
3. Tamping rod
Procedure for Compacted Bulk Density
1. Measure the volume of the cylindrical metal measure by pouring water into the metal measure and record the volume "V" in litre.
2. Fill the cylindrical metal measure about one-third full with thoroughly mixed aggregate and tamp it 25 times using tamping bar.
3. Add another layer of one-third volume of aggregate in the metal measure and give another 25 strokes of tamping bar.
4. Finally fill aggregate in the metal measure to over-flowing and tamp it 25 times.
5. Remove the surplus aggregate using the tamping rod as a straightedge.
6. Determine the weight of the aggregate in the measure and record that weight "W" in kg.
Procedure for Loose Bulk Density
1. Measure the volume of the cylindrical metal measure by pouring water into the metal measure and record the volume "V" in litre.
2. Fill the cylindrical measure to overflowing by means of a shovel or scoop, the aggregate being discharged from a height not exceeding 5 cm above the top of the measure
3. Level the top surface of the aggregate in the metal measure, with a straightedge or tamping bar.
4. Determine the weight of the aggregate in the measure and record the weight "W" in kg.

Observation and Calculation
Calculation for Compacted Bulk Density
Compacted unit weight or bulk density = W/V
Where,
W = Weight of compacted aggregate in cylindrical metal measure, kg
V = Volume of cylindrical metal measure, litre

Calculation For Loose Bulk Density
Loose unit weight or bulk density = W/V
Where,
W = Weight of loose aggregate in cylindrical metal measure, kg
V = Volume of cylindrical metal measure, litre

Result:

The compacted bulk density of the given sample =
The compacted bulk density of the given sample =

Outcome:
Gained knowledge related to various properties of soil (Bulk density).

Viva - voce
1. What is unconsolidated undrained condition?
2. What is consolidated undrained condition?
3. What is the main cause of slope failure?
4. What are the factors affecting permeability tests?
5. What is meant by effective stress?
6. What is meant by angle of repose of soil?
7. Explain coulomb's law.
8. What are the merits and demerits of direct shear test?
9. What are the different types of failure of a triaxcal compression test specimen?
10. What do you mean by stress-path?
11. What is peak shear strength? West out the factors it depends on?
12. What is Rohr's circle? What are the characteristics of Rohr's circle?
13. What are the type of triaxial test?
14. What are the advantages of triaxial test?
15. What is compaction of the soil?
16. What is the Relationship between the Dry Density - Water Content?
17. What is meant by voids line?
18. How to differentiate finite slope and infinite slope?
19. How do u explain factor of safety of an infinite slope in case of cohesion less soil?

Applications
1. It is used to find out the densities of soils at various field condition.
2. It is also used for determining moisture content of soil.

Expt. No.04 DETERMINATION OF IMPACT VALUE OF COARSE AGGREGATE

Aim:

To determine the aggregate impact value of given aggregate

Apparatus Required:

1. Impact testing machine: The machine consists of a metal base. A detachable cylindrical steel cup of internal diameter 10.2 cm and depth 5 cm. A metal hammer of weight between 13.5 to 14 kg, 10 cm in diameter and 5 cm long. An arrangement for raising the hammer and allow it to fall freely between vertical guides from a height of 38 cm on the test sample in the cup

2. A cylindrical metal measure having 7.5 cm and depth of 5 cm for measuring aggregates

3. A tamping rod of circular cross section, 1 cm in diameter and 23 cm long, rounded at one end

4. IS sieve of sizes 12.5 mm, 10 mm and 2.36 mm

5. Balance of capacity not less than 500 gm to weigh accurate up to 0.01 gm

Procedure:

1. The test sample consists of aggregates passing 12.5 mm sieve and retained on 10 mm sieve and dried
in an oven for 4 hours at a temperature of 1000 C to 1100C

2. The aggregates are filled up to about 1/3 full in the cylindrical measure and tamped 25 times with
rounded end of the tamping rod

3. The rest of the cylindrical measure is filled by two layers and each layer being tamped 25 times

4. The overflow of aggregates in cylindrically measure is cut off by tamping rod using its straight edge

5. Then the entire aggregate sample in a measuring cylinder is weighted nearing to 0.01 gm

6. The aggregates from the cylindrical measure are carefully transferred into the cup which is firmly fixed in position on the base plate of machine. Then it is tamped 25 times

7. The hammer is raised until its lower face is 38 cm above the upper surface of aggregates in the cup and allowed to fall freely on the aggregates. The test sample is subjected to a total of 15 such blows each being delivered at an interval of not less than one second. The crushed aggregate is then removed from the cup and the whole of it is sieved on 2.36mm sieve until no significant amount passes. The fraction passing the sieve is weighed accurate to 0.1 gm

8. Repeat the above steps with other fresh sample

9. Let the original weight of the oven dry sample be w1 gm and the weight of fraction passing 2.36 mm IS
sieve be w2 gm. Then aggregate impact value is expressed as the % of fines formed in terms of the total

Observation and Calculation

Sl.No. Details of Sample Trail 1 Trail 2 Average

1 Total Weight of aggregate sample filling the cylinder measure = W1 g
2 Weight of aggregate passing 2.36mm sieve after the test = W2 g
3 Weight of aggregate retained 2.36mm sieve after the test = W3 g
4 (W1 -W2 +W3)
5 Aggregate Impact Value = (W2 / W1) * 100 Percent

Result:
The mean aggregate impact value is _%.
Outcome:
At the end of the experiment, student acquires knowledge in the determination of the aggregate impact value of given aggregate.

Viva–voce
1. What is impact load?
2. What are materials used for impact test?
3. What is aggregate?
4. What are the tests conducted for aggregate?
5. What is abrasion?
6. What is sieve analysis?
7. What is attrition?
8. What is the different size of sieve available for aggregate test?
9. What is specific gravity?
10. What is void ratio?
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Application
1. The purpose of an impact test is to determine the ability of the material to absorb energy during a collision.
2. This energy may be used to determine the toughness, impact strength, fracture resistance, impact resistance or fracture resistance of the material depending on the test that was performed and the characteristic that is to be determined.
3. These values are important for the selection of materials that will be used in applications that require the material to undergo very rapid loading processes such as in vehicular collisions.

Expt. No. 05 SHAPE TEST (ELONGATION INDEX)

Aim:

To determine the Elongation index of the given aggregate sample

Apparatus Required:

1. Length gauge

2. IS sieve

Procedure:

1. The sample is sieved through IS Sieve specified in the table. A minimum of 200 aggregate pieces of each fraction is taken and weighed

2. Each fraction is thus gauged individually for length in a length gauge. The gauge length is used should be those specified in the table for the appropriate material

3. The pieces of aggregate from each fraction tested which could not pass through the specified gauge length with its long side are elongated particles and they are collected separately to find the total weight of aggregate retained on the length gauge from each fraction

4. The total amount of elongated material retained by the length gauge is weighed to an accuracy of at least 0.1% of the weight of the test sample

5. The weight of each fraction of aggregate passing and retained on specified sieves sizes are found – W1, W2, W3, ... and the total weight of sample determined =W1+ W2+W3+.....= W gm. Also the weights of the material from each fraction retained on the specified gauge length are found = x1, x2, x3..... and the total weight retained determined = x1+x2+x3+.....= X gm

6. The elongation index is the total weight of the material retained on the various length gauges, expressed as a percentage of the total weight of the sample gauged

$$\text{Elongation index} = \frac{(x1 + x2 + x3 + ...)}{(W1 + W2 + W3 + ...)} \times 100$$

Observation and Calculation

Size of aggregate

Length gauge

Weight of the fraction consisting of atleast 200 pieces in gm

Weight of aggregates in each fraction retained on length gauge gm Passing through IS sieve mm Retained on IS sieve mm

63 50 -
50 40 81
40 25 58.50
31.5 25 -
25 20 40.5
20 16 32.4
16 12.5 25.6
12.5 10 20.2
10 6.3 14.7

Result:
The elongation index of a given sample of aggregate is %
Outcome:
At the end of the experiment, student acquires knowledge in the determination of elongation
index of the given aggregate sample.

Viva - voce

1. What is Elongation index
2. What are the types of stones used for coarse aggregate?
3. What do you understand by the term repeatability and reproducibility?
4. What are all the size of sieves used
5. Explain the term viscosity.
6. What are the uses of coarse aggregate in concrete
7. What are the precautions to be taken during viscosity test using orifice viscometer?
8. What is the significance of flow value in Marshall Test?
9. What is filler?

Applications
This test is used to determine the particle shape of the aggregate and each particle shape being preferred under specific conditions.

Expt. No. 06 SHAPE TEST (FLAKINESS INDEX)

Aim:
To determine the flakiness index of the given aggregate sample
Apparatus Required:
1. The apparatus consist of a standard thickness gauge
2. IS Sieve of size 63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 and 6.3
3. Balance to weight the samples
Procedure:
1. The sample is sieved with the sieves mentioned in the table
2. A minimum of 200 pieces of each fraction to be tested are taken and weighed (W1 gm)
3. In order to separate flaky materials, each fraction is then gauged for thickness on thickness gauge, or
in bulk on sieve having elongated slots as specified in the table
4. Then the amount of flaky materials passing the gauge is weighed to an accuracy of atleast 0.1% of test
sample
5. Let the weight of the flaky materials passing the gauge be W1gm. Similarly the weights of the fractions
passing and retained on the specified sieves be W1, W2, W3, etc, are weighed and the total weight
W1+W2+W3+... = W gm is found. Also the weights of the materials passing each of the specified
thickness gauge are found =W1, W2, W3.... And the total weight of the material passing the different
thickness gauges = W1+W2+W3... = W gm is found
6. Then the flakiness index is the total weight of the flaky material passing the various thickness gauges
expressed as a percentage of the total weight of the sample gauged

$$\text{Flakiness index} = \frac{(w1 + w2 + w3 + ...)}{(W1 + W2 + W3 + ...)} \times 100$$

Size of aggregate

Thickness gauge
(0.6 times the
mean sieve) mm

Weight of the
fraction consisting
of atleast 200
pieces in gm

Weight of aggregates in each fraction passing on thickness gauge gm

Passing through IS sieve mm

Retained on IS sieve mm

63 50 33.90
50 40 27.00
40 25 19.50
31.5 25 16.50
25 20 13.50
20 16 10.80
16 12.5 8.55
12.5 10 6.75
10 6.3 4.89

Result:
The flakiness index of a given sample of aggregate is %
Outcome:
At the end of the experiment, student acquires knowledge in the determination of the flakiness index of the given aggregate sample.

Viva - voce
1. Define – Flash and fire points
2. What is the significance of flash and fire point test?
3. What are the parameters that affect the result of flash and fire point tests?
4. Define – Specific gravity
5. What is the use of finding specific gravity?
6. What are the factors affecting specific gravity test?
7. What are the applications of penetration test?
8. What are the precautions to be taken while conducting a penetration test?
9. What are the factors which affect the ring and ball test results?
10. What is softening point?

Applications
This test is used to determine the particle shape of the aggregate and each particle shape being preferred under specific conditions.

Expt. No. 07 DETERMINATION OF AGGREGATE CRUSHING VALUE OF COARSE AGGREGATE

Aim:
To determine crushing value of course aggregate

Apparatus required:
1. A 15-cm diameter open-ended steel cylinder, with plunger and base-plate, of the general form and dimensions.
2. Straight metal tamping rod.
3. A balance of capacity 3 Kg.
4. IS Sieves of sizes 12.5, 10 and 2.36 mm.
5. Cylindrical metal measure of sufficient rigidity to retain its form under rough usage and of the following internal dimensions: Diameter 11.5 cm and Height 18.0 cm.

Procedure:
1. The material for the standard test shall consist of aggregate passing a 12.5 mm IS Sieve and retained on a 10 mm IS Sieve, and shall be thoroughly separated on these sieves before testing.
2. The aggregate shall be tested in a surface-dry condition. If dried by heating, the period of drying shall not exceed four hours, the temperature shall be 100 to 110°C and th aggregate shall be cooled to room temperature before testing.
3. The appropriate quantity may be found conveniently by filling the cylindrical measure in three layers of approximately equal depth, each layer being tamped 25 times with the rounded end of the tamping rod and finally leveled off, using the tamping rod as a straight-edge.
4. The weight of material comprising the test sample shall be determined (Weight A) and the same weight of sample shall be taken for the repeat test.
5. The apparatus, with the test sample and plunger in position, shall then be placed between the platens of the testing machine and loaded at as uniform a rate as possible so that the total load is reached in 10 minutes. The total load shall be 400 kN.
6. The load shall be released and the whole of the material removed from the cylinder and sieved on a 2.36 mm IS Sieve for the standard test. The fraction passing the sieve shall be weighed (Weight B).