INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

Lab Manual:

Transportation Engineering Laboratory (ACEB25)

Prepared by

B. Suresh (IARE10449)

Department Of Civil Engineering
Institute of Aeronautical Engineering

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Contents

INTRODUCTION

1.1 Introduction

Transportation engineering is the application of technology and scientific principles to the planning,design, operation and management of facilities. Traffic control refers to the traffic engineering, regulation, management and safety with an integrated approach in traffic system. This course gives an overview on Transportation engineering with respect to construction and maintenance of highways as per IRC standards. This course also focuses on designing new transportation systems and infrastructures, including highways. Further the course is useful to solve the complex problems related to the traffic management by collecting and evaluating the data such as traffic flow, density, speed and volume.

1.1.1 Student Responsibilities

The student is expected tocome prepared for each lab.Lab preparation includes understanding the labexperiment from the lab manual and reading the related textbook material.

Students have to write the allotted experiment for that particular week in the work sheets given and carry them to the Lab. In case of any questions or problems with the preparation, students can contact the Faculty Teaching the Lab course, but in a timely manner.

Students have to be in formal dress code, wear shoes and lab coat for the Laboratory Class.

After the demonstration of experiment by the faculty, student has to perform the experiment individually. They have to note down the observations in the observation Tables drawn in work sheets, do the calculations and analyze the results.

Active participation by each student in lab activities is expected. The student is expected to ask the Faculty any questions they may have related to the experiment.

The student should remain alert and use commonsense while performing the lab experiment.They are also responsible for keeping a professional and accurate record of the labexperiments in the files provided.

1.1.2 Responsibilities of Faculty Teaching the Lab Course

The Faculty shall be completely familiar with each labprior to the laboratory. He/She shall provide the students with details regarding the syllabus and safety review during the first week.Lab experiments should be checked in advance to make sure that everything is in working order.The Faculty should demonstrate and explain the experiment and answer any questions posed by the students.Faculty have to supervise the students while they perform the lab experiments. The Faculty is expected to evaluate the lab worksheets and grade them based on their practical skills and understanding of the experiment by taking Viva Voce. Evaluation of work sheets has to be done in a fair and timely manner to enable the students, for uploading them online through their CMS login within the stipulated time.

1.1.3 Laboratory In-charge Responsibilities

The Laboratory In-charge should ensure that the laboratory is properly equipped, i.e., the Faculty teaching the lab receive any equipment/components necessary to perform the experiments.He/She is responsible for ensuring that all the necessary equipment for the lab is available and in working condition. The Laboratory In-charge is responsible for resolving any problems that are identified by the teaching Faculty or the students.

1.1.4 Course Coordinator Responsibilities

The course coordinator is responsible fo rmaking any necessary corrections in Course Description and lab manual. He/She has to ensure that it is continually updated and available to the students in the CMS learning Portal.

1.2 Lab Policy and Grading

The student should understand the following policy:

ATTENDANCE: Attendance is mandatory as per the academic regulations.

LAB RECORD's: The student must:

1. Write the work sheets for the allotted experiment and keep them ready before the beginning of eachlab.
2. Keep all work in preparation of and obtained during lab.
3. Perform the experiment and record the observations in the worksheets.
4. Analyze the resultsand get the work sheets evaluated by the Faculty.
5. Upload the evaluated reports online from CMS LOGIN within the stipulated time.

Grading Policy:

The final grade of this course is awarded using the criterion detailed in the academic regulations. A large portion of the student's grade is determined in the comprehensive final exam of the Laboratory course (SEE PRACTICALS),resulting in a requirement of understanding the concepts and procedure of each lab experiment for successful completion of the lab course.

Pre-Requistes and Co-Requisties:

The lab course is to be taken during the samesemester as ACEB25, but receives a separate grade. Students are required to have completed ACEB03 with minimum passing grade or better grade in each.

1.3 Course Goals and Objectives

The Physics Laboratory course is designed as a foundation course to provide the student with the knowledge to understand the basic concepts in Physics which have lot of applications in the field of Engineering.

The experiments are designed to complement the concepts introduced in ACEB25. In addition, the student should learn how to record experimental results effectively and present these

results in a written report.

More explicitly, the class objectives are:

1. To gain proficiency in the use of common measuring instruments.
2. To enhance understanding of theoretical concepts including:
    - SPECIFIC GRAVITY
    - ABRASION AND ATTRITION
    - CRUSHING STRENGTH.
    - IMPACT STRENGTH.
    - SHAPE TESTS OF COARSE AGGREGATES
    - PENETRATION OF BITUMINOUS.
    - DUCTILITY OF BITUMINOUS
    - SOFTENING POINT OF BITUMEN
    - FLASH AND FIRE POINT TEST OF BITUMEN
    - NORMAL CONSISTENCY FINENESS OF CEMENT
    - INITIAL SETTING TIME AND FINAL SETTING TIME OF CEMENT
3. To develop communication skills through:
    - Verbal interchanges with the Faculty and other students.
    - Preparation of succinct but complete laboratory reports.
    - Maintenance of laboratory worksheets aspermanent, written descriptions of procedures, analysis and results.
4. To compare theoretical predictions with experimental results and to determine the source of any apparent errors.

1.4 Use of Laboratory Instruments

One of the major goals of this lab is to familiarize the student with the proper equipment andtechniques for conducting experiments. Some understanding of the lab instruments is necessaryto avoid personal or equipment damage.By understanding the device's purpose and following a fewsimple rules, costly mistakes can be avoided.

The following rules provide a guideline for instrument protection.

1.4.1 Instrument Protection Rules

1. New students must receive an orientation on lab operating procedures before working in a lab.
2. Students shall publish a safety checklist for equipment for which they are responsible.
3. Students must read the safety checklist for each piece of equipment before operating it.
4. Ensure you know the location of the emergency stop button before starting equipment.
5. Always depressurize accumulators or pneumatic reservoirs before working on fluid power apparatus.

6. Check the application pressure, system pressure, and component pressure before connecting a system to a pump or pressure source. The maximum operating pressures are listed on equipment labels or published on manufacturer websites.
7. Periodically check hoses for leakage, cracks, kinks, or breaks.
8. Test your equipment for leaks at low pressure before raising the pressure to the operating pressure.
9. All components shall operate within manufacturer's specifications.
10. Equipment shall incorporate an emergency stop or emergency return control, whichever provides maximum safety.
11. Emergency stops shall be readily accessible under all conditions of working and shall operate immediately.
12. Equipment shall be designed so that loss of electrical, pneumatic and/or hydraulic power shall not cause a hazard.
13. Pump inlet temperatures should not exceed 600C when maximum ambient temperatures exist.
14. Rotating parts shall be guarded to provide adequate protection against hazard.
15. Flexible hoses shall only be used where necessary. Their length shall be minimized and they shall be protected from abrasion. If failure causes a hazard, the hose shall be restrained or shielded.

1.5 Data Recording and Reports

1.5.1 The Laboratory Notebook:

Students must record their experimental values in the provided tables in this laboratory manual and reproduce them in the lab reports. Reports are integral to recording the methodology and results of an experiment. In engineering practice, the laboratory notebook serves as an invaluable reference to the technique used in the lab and is essential when trying to duplicate a result or write a report. Therefore, it is important to learn to keep accurate data. Make plots of data and sketches when these are appropriate in the recording and analysis of observations. Note that the data collected will be an accurate and permanent record of the data obtained during the experiment and the analysis of the results. You will need this record when you are ready to prepare a lab report.

1.5.2 The Laboratory Worksheets:

Reports are the primary means of communicating your experience and conclusions to other professionals. In this course you will use the lab report to inform your LTA about what you did and what you have learned from the experience. Engineering results are meaningless unless they can be communicated to others. You will be directed by your LTA to prepare a lab report on a few selected lab experiments during the semester. Your assignment might be different from your lab partner's assignment.
Your laboratory report should be clear and concise. The lab report shall be typed on a word processor. As a guide, use the format on the next page. Use tables, diagrams, sketches, and plots, as necessary to show what you did, what was observed, and what conclusions you can draw

from this. Even though you will work with one or more lab partners, your report will be the result of your individual effort in order to provide you with practice in technical communication.

CONCLUSIONS - The conclusion section should provide a take-home message summing up what has been learned from the experiment:

1. Briefly restate the purpose of the experiment (the question it was seeking to answer)
2. Identify the main findings (answer to the research question)
3. Note the main limitations that are relevant to the interpretation of the results
4. Summarise what the experiment has contributed to your understanding of the problem.

LAB-1 Introduction to Transportation Laboratory

2.1 Introduction

Transportation materials lab deals with testing of pavement material used for construction in day- to-day activities as per IS standards.

1. Identify the properties and behavior of highway material for different loading patterns in terms of crushing and impact loads
2. Demonstrate tests on transportation materials like aggregate, bitumen, sand etc. and check their strength and suitability
3. Understand the properties of cement by conducting setting time, specific gravity, and compressive strength tests.
4. Measure and calculate flakiness and elongation properties of coarse aggregates
5. From the calculated result we can justify the material properties which helps us to evaluate the pavement properties

2.2 Objective

To familiarize the students with the lab facilities, equipment, standard operating procedures, lab safety, and the course requirements.

2.3 Prelab Preparation:

Read the Introduction and Appendix A, of this manual.

2.4 Equipment needed

ACEB25 lab manual.(1 to 12 experiments list)

2.5 Procedure

1. Impact test determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent brittle-ductile transition. It is to determine whether the material is brittle or ductile in nature.
2. The strength of coarse aggregates is assessed by aggregates crushing test. The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of pavement, aggregate possessing low aggregate crushing value should be preferred.

3. Specific gravity test of aggregates is done to measure the strength or quality of the material while water absorption test determines the water holding capacity of the coarse and fine aggregates. The main objective of these test is to, measure the strength or quality of the material.

4. This attrition test is conducted to determine the resistance power of stone against the grinding action. This test is mainly conducted to find out the suitability of a particular action. This test is mainly conducted to find out the suitability of a particular stone for road construction.

5. Abrasion testing determines the relative quality, toughness, and durability of mineral aggregates subjected to impact and abrasion. Values derived from both the Micro Deval and the L.A. Abrasion tests offer information about the performance of aggregate in use.

6. The particle shape of aggregates is determined by the percentages of flaky and elongated particles contained in it. for concrete and construction of bituminous works the presence of flaky and elongated particles are not suitable and cause failures and breaking during heavy loads

7. It's basic principle, and the basic principle of the penetration test, was to determine the depth to which a truncated No. 2 sewing needle penetrated an asphalt sample under specified conditions of load, time, and temperature. In 1915, ASTM even went as far as specifying the brand of needle

8. The ductility test of bitumen sample is one of the important tests of bitumen to be conducted before road construction. Ductility measures the adhesive property of the bitumen too along with its elasticity.

9. The softening point helps in the determination of the temperature beyond which the bitumen is softened beyond a pre-specified softness. Hence, the softening point test of bitumen helps in knowing the maximum temperature to which the given bitumen can be exposed.

10. . Flash and fire point test of bitumen sample is one of the important tests of bitumen to be conducted before road construction. Flash and fire point measures the temperature at which the material is at risk of catching fire

11. . If Less water is added than required, Cement isn't properly hydrated and results in loss of strength. The Standard or Normal consistency for Ordinary Portland cement varies between 25-35water is added to cement.

12. . Initial setting time test is important for transportation, placing and compaction of cement concrete. Initial setting time duration is required to delay the process of hydration or hardening. Final setting time is the time when the paste completely loses its plasticity.

13. Every material has pores which may contain voids in it. If the cement is exposed to extreme moisture content due to bad weather conditions, then the specific gravity of cement may go up to 3.19. If the specific gravity is 3.19, then the pores in cement are filled with the moisture content

14. . The compressive strength test is done on cement when it is used as cement mortar and concrete. The strength of the binder (cement) therefore has a significant effect on the performance characteristics of the mixture of cement and sand and ensures the overall quality of the finished product

15. . Compressive strength can be defined as the capacity of concrete to withstand loads before failure. Of the many tests applied to the concrete, the compressive strength test is the most important, as it gives an idea about the characteristics of the concrete.

16. When moisture content is increased by adding more water, the sand particles pack near each other and the amount of bulking of sand is decreased. Thus, the dry sand and the sand completely flooded with water have practically the same volume.

2.6 Experimental Procedure:

The control unit is switched on and the speed control slowly rotated, increasing the governor speed until the center sleeve rises off the lower stop and aligns with the first division on the graduated scale. The sleeve position and speed are then recorded. Speed may be determined using hand tachometer on the spindle. The governor speed is then increased in steps to give suitable sleeve movements, and readings repeated at each stage throughout the range of sleeve movement possible.
The result may be plotted as curves of speed against sleeve position. Further tests are carried out changing the value of one variable at a time to produce a family or curves.

2.7 Operating Instructions:

For obtaining the graphs as mentioned above following instructions may be followed.

1. Make proper connections of the motor.
2. Increase the motor speed slowly and gradually.
3. Note the speed by tachometer and sleeve displacement on the scale provided.
4. Plot the graph of Crushing v/s Curing for Concrete block.
5. Plot the governor characteristic after doing the necessary calculations.

2.8 Precautions:

1. Do not keep the mains “ON” when trial iscomplete.
2. Increase the speed gradually.
3. Take the sleeve displacement reading when the pointer remainssteady.
4. See that at higher speed the load on sleeve does not hit the upper sleeve of the governor.
5. While closing the test bring the dimmer to zero position and then switch “OFF” the motor.

2.9 Results:

2.10 VIVA - Questions:

1. What is the different test on aggregates ?
2. State the different grades of bitumen.
3. Explain the term Impact and crushing?
4. What is the Bulking of a sand?
5. Define the Flash and fire of Bitumen.

LAB-2 AGGREGATE CRUSHING STRENGTH TEST

3.1 Introduction

Theory and Scope:
1. This is one of the major Mechanical properties required in a road stone. The test evaluates the ability of the Aggregates used in road construction to withstand the stresses induced by moving vehicles in the form of crushing. With this the aggregates should also provide sufficient resistance to crushing under the roller during construction and under rigid tyre rims of heavily loaded animal drawn vehicles.
2. The crushing strength or aggregate crushing value of a given road aggregate is found out as per IS-2386 Part- IV.
3. The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of pavement aggregate possessing low aggregate crushing value should be preferred.
4. The aggregate crushing value of the coarse aggregates used for cement concrete pavement at surface should not exceed 30

Aim:
To determine crushing strength of a given aggregate as per IS: 2386 part - IV

Apparatus:
- A steel cylinder of internal diameter 15.2 cm (Steel cylinder with open ends)
- A square base plate, plunger having a piston diameter of 15 cm.
- A cylindrical measure of internal diameter of 11.5 and height 18 cms.
- Steel tamping rod having diameter of 1.6 cms length 45 to 60 cms.
- Balance of capacity 3 kg with accuracy up to 1 gm.
- Compression testing machine capable of applying load of 40 tonnes at a loading rate tonnes per minute .

3.2 Objective

To study the Crushing strength of aggregates.

3.3 Prelab Preparation:

Study the working principle and construction of crushing Machine

3.4 Equipment needed

1. Steel cylinder.
2. Stop watch

3. weighing balance

4. **ElectricitySupply:** Single Phase, 220 V AC, 50 Hz 5-15 amp socket with earth connection, Bench Area Required: 1 m x 1m.

3.5 Theory;

The strength of coarse aggregates is assessed by aggregates crushing test. The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of pavement, aggregate possessing low aggregate crushing value should be preferred.

3.6 Procedure

1. The aggregate in surface-dry condition before testing and passing 12.5 mm sieve and retained on 10 mm sieve is selected.

2. The cylindrical measure is filled by the test sample of the aggregate in three layers of approximately equal depth, each layer being tamped 25 times by the rounded end of the tamping rod.

3. After the third layer is tamped, the aggregates at the top of the cylindrical measure are leveled off by using the tamping rod as a straight edge. Then the test sample is weighed. Let that be w1 gm.

4. Then the cylinder of test apparatus is kept on the base plate and one third of the sample from cylindrical measure is transferred into cylinder and tamped 25 times by rounded end of the tamping rod.

5. Similarly aggregate in three layers of approximately equal depth, each layer being tamped 25 times by rounded end of the tamping rod.

6. Then the cylinder with test sample and plunger in position is placed on compression testing machine.

7. Load is then applied through the plunger at a uniform rate of 4 tonnes per minute until the total load is 40 tonnes and the load is released.

8. Aggregates including the crushed position are removed from the cylinder and sieved on a 2.36mm IS Sieve and material which passes this sieve is collected and weighed. Let this be w2 gm.

9. The above step is repeated with second sample of the same aggregate. The two tests are made for the same specimen for taking an average value.

10. Total weight of dry sample taken is w1gm. weight of the portion of crushed material passing 2.36mm IS sieve be w2 gm. Then the aggregate crushing value is defined as the ratio of weight of fines passing the specified IS sieve to the total weight of the sample (w1). Aggregate crushing value = 100*w2/w1

3.7 Observation Table:

3.8 Calculations:

3.9 Probing Further Questions:

1. What is the use or application of the aggregate crushing test?
2. Define aggregate crushing value and how crushing strength test is carried out on cylindrical stone specimen explain.
3. What do you understand by the term "Ten percent Fines value"?

LAB-3 AGGREGATE IMPACT TEST

4.1 Introduction

Theory and Scope

Toughness is the property of a material to easiest impact. Due to moving loads the aggregates are subjected to pounding action or impact and there is possibility of stones breaking into smaller pieces. Therefore a test designed to evaluate the toughness of stones the resistance of the stones to fracture under repeated impacts may be called Impact test on aggregates. The test can also be carried on cylindrical stone specimen known as Page Impact test. The aggregate Impact test has been standardized by Indian Standard Institution. The aggregate impact test is conducted as per IS2386 Part IV.
The aggregate Impact value indicates a relative measure of the resistance of aggregate to a sudden shock or an Impact, which in some aggregates differs from its resistance to a slope compressive load in crushing test. A modified Impact test is also often carried out in the case of soft aggregates to find the wet Impact value after soaking the test sample. Various agencies have specified the maximum permissible aggregate Impact values for the different types of pavements. IRC has specified the following values. The maximum allowable aggregate Impact value for water bound Macadam; Sub-Base coarse 50% where as cement concrete used in base course is 45%. WBM base course with Bitumen surface in should be 40%. Bituminous Macadam base course should have A.I.V of 35%. All the surface courses should possess an A.I.V below 30%.

4.2 Aim

To determine the aggregate impact value of given aggregate as per I.S-2386 Part IV.

4.3 Objective

Impact test determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent brittle-ductile transition. It is to determine whether the material is brittle or ductile in nature.

4.4 Prelab Preparation:

Study about Impact strength of aggregate

4.5 Equipment needed

- Impact testing machine.
- Tamping rod.
- IS sieve set.

4.6 Description:

1. The impact test on aggregate is carried out to know the response of aggregates to different kinds of loads that the aggregates will be subjected to during their service life.
2. The need for impact value test is used to measure the toughness of aggregates which is nothing but the ability of aggregates to resist the sudden loading or impact loading.
3. Find out the impact resistance of aggregate is important because, during service life, the aggregates will be actually subjected to this type of load. For example, aggregates will be subjected to impact after speed breaker, or when the vehicle is moving on the undulating road, etc.
4. So, by AIV Test, we can find out the response of aggregates to sudden loading. If the result is satisfactory, we use those aggregates in pavement. If not, aggregates are rejected.

4.7 Procedure

1. The test sample consists of aggregates passing 12.5mm sieve and retained on 10mm sieve and dried in an oven for 4 hours at a temperature of 100 C to 110 C.
2. The aggregates are filled upto 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 it has a straight edge.
5. Then the entire aggregate sample in a measuring cylinder is weighted nearing to 0.01gm.
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 38cm 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 than removed from the cup and the whole of it is sieved on 2.366mm sieve until no significant amount passes. The fraction passing the sieve is weighed accurate to 0.1gm. Repeat the above steps with other fresh sample.
8. Let the original weight of the oven dry sample be w1gm and the weight of fraction passing 2.36mm I.S sieve be w2gm. Then aggregate Impact value is expressed as the formed in terms of the total weight of the sample.
   Aggregate Impact Value = 100 * W2/W1

4.8 observation:

S.no	sample	Trial 1	Trial 2	Trial 3

4.9 Precautions:

- Never run the apparatus if power supply is less than 180 volts & above than230volts.
- Increase the motor speed gradually.
- Experimental set up should be tight properly before conductingexperiment.
- Before starting the rotary switch, dimmer stat should be at zeroposition.

4.10 Results

4.11 Further Probing Experiments

1. How is aggregate Impact expressed?
2. What do you understand by dry and wet Impact value?
3. Aggregate Impact value of material A is 15 and that of B is 35. Which one is better for surface course?

LAB-4 SPECIFIC GRAVITY AND WATER ABSORPTION TEST

5.1 Introduction

Specific gravity and Water Absorption Test of Aggregates are major important tests to be performed on aggregate. These two parameters or properties of aggregate play an important role in the mix design of concrete. As we know that aggregate occupies 70 to 80% volume of concrete, its testing becomes essential before use.

As per IS: 2386 (Part III) – 1963 – (Indian Standard- Methods of Test for Aggregates for Concrete – Specific Gravity, Density, Voids, Absorption, and Bulking),

5.2 Objective

"Specific Gravity is defined as the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water." The specific gravity is usually showed the strength and quality of the material. The specific gravity of aggregates test is usually used for the identification of stones or aggregates. Aggregates with low specific gravity values are mostly weaker than those with higher specific gravity values.
Water absorption of aggregates is the % of water absorbed by an air–dried aggregate when immersed in water at 27°C for a period of 24 hours.

5.3 Equipment needed

- Wire basket. The wire basket used for the test is not more than 6.3mm mesh or it is also a perforated container of convenient size. It usually chromium–plated and done well polished. It has wire hangers that are not thicker than 1mm for hanging it from the balance. A basket has freely hanged this type of watertight container is used. The dry and soft absorbent clothes are used. (2nos.). Min. size of the clothes is 75X45cm. A tray is used for test Min. area not less than 650sqcm An airtight container is also used. The capacity o container is similar to the basket.

- Oven The oven use for the test is well ventilated or thermostatically control to maintain the temperature of oven up to 100*C to 110*C.

- Beaker and Balance. The balance used to measure the aggregate has sufficient capacity (3kg minimum). Accuracy of balance readable up to 0.5gm. The balance is such a type and its shape is also to permit the basket containing the sample to be hanging from the beam and weight in water.

5.4 Theory:

The water absorption test uses to find the water holding capacity of the aggregates. The water is absorbed by the aggregates or stones in their pores known as water absorption. Usually, water absorption gives an idea about the strength of the aggregates. That aggregate has more water absorption is usually unsuitable for the construction. There is a basic 3 method specified to find out the specific gravity of aggregates based on their sizes. The aggregates are larger than the 10mm (Basket method) The aggregates are between 10mm and 40mm (Basket method) The aggregates are smaller than 10mm (Pycnometer bottle)
Let us now consider four masses m1, m2, m3 and m4 revolving in planes 1, 2, 3 and 4 shown in fig. The relative angular positions of these masses are shown in the end view
Fig. The magnitude, angular position and position of the balancing mass m1in plane 1may be obtained as discussed below:

5.5 Procedure

Following the procedure used for specific gravity and water absorption test of aggregate

1. Take about 2 kg of an aggregate sample (Aggregate which has been artificially heated shall not be used).
2. The aggregates are thoroughly washed so, the finer particles of the dust are removed from their surface.
3. Then the washed aggregates are placed in the wire basket and immersed in the distilled water at a temperature between 22° C to 32° C with cover from the water surface at least 5 cm top of the basket.
4. The basket immersed in the water requires immediate removal of entrapped air. This entrapped air was removed by lifting the basket 25 mm above the base of the tank and allowing 25 drops at the rate of about 1 drop/sec. Then basket filled with aggregate is allowed to be immersed in water for a period of 24 hrs.
5. After 24 hours the basket and the aggregates are weighed in the water at a temperature of 22° C to 32° C. (W1)
6. Then the basket and the aggregates are taken out from the water and it allows to drain for a couple of minutes after these aggregates are removed from the basket and placed on the dry cloths.
7. After this the empty basket is again immersed in the water, apply 25 drops, and weighed in water. (W2)
8. The aggregates are placed on the dry cloth and are gently surface dried with a cloth if 1st cloth is not taken moisture then aggregates are transferred to the second one. After these aggregates are spread on the cloth and less exposed to the atmosphere away from direct sunlight or also away from the other source of the heat until it appears to be completely surface dried.
9. For accelerating the unheated air may be used after the first 10 minutes for those aggregates which are difficult to dry and weigh it. (W3)
10. Then the aggregates are placed in the shallow tray and put in the oven at a temperature of 100° C to 110° C for 24 hours.

11. After 24 hours the aggregates are removed from the oven and fill in the airtight container for the cooling of it and weighed. (W4)

5.6 Observation:

1. Weight of saturated aggregate sample suspended in wire basket = W1
2. Weight of basket suspended in water = W2
3. Weight of saturating aggregate in water = (W1-W2) = Ws
4. Weight of surface dry aggregate in air = W3
5. Weight of water equal volume of aggregate = (W3 – Ws)

Calculations:

1. Specific Gravity of Aggregate = Dry Wt. Of Aggregate / Wt. Of Equal Volume Water= W4 / (W3- Ws)
2. Apparent Specific Gravity = Dry. Wt. of Aggregate / Wt. Of the equal volume of water excluding air = W4 / (W4-Ws)
3. Water Absorption of Aggregate = % by weight of water absorbed in terms of oven-dried weight of aggregate = (W3 – W4) x 100) / W4
4. Specific gravity and water absorption of a coarse aggregate lab report are prepared after calculating the above values.
5. IS Reccomanded Values The specific gravity of coarse aggregate as per is code is 2.5 to 3.
6. The water absorption of aggregate ranges from 0.1 to 2%

5.7 Precautions:

- Never run the apparatus if power supply is less than 180 volts & above than230volts.
- Increase the motor speed gradually.
- Experimental set up should be tight properly before conductingexperiment.
- Before starting the rotary switch, dimmer stat should be at zeroposition.

5.8 Results

5.9 Further Probing Experiments

1. Specific Gravity of Coarse aggregate IS Code
2. what is the value of Specific Gravity of Coarse Aggregate?
3. Define bulking of sand
4. What are the effects of bulking of fine aggregates ?

LAB-5 ABRASION AND ATTRITION TEST OF COARSE AGGREGATES

6.1 Introduction

Abrasion Test is the measure of aggregate toughness and abrasion resistance such as crushing, degradation and disintegration. The percentage wear of the sample aggregates due to rubbing with steel balls is determined and is known as Los Angeles Abrasion Value.

6.2 Theory and Scope:

Abrasion is a measure of resistance to wear or hardness. It is an essentially property for road aggregates especially when used in wearing coarse. Due to the movements of traffic, the road stones used in the surfacing course are subjected to wearing actions at the top. When traffic moves on the road the soil particle (sand) which comes between the wheel and road surface causes abrasion on the road stone. The abrasion test on aggregate is found as per IS2386 part-IV. Abrasion tests on aggregates are generally carried out by any one of the following methods
1. Los Angeles abrasion test.
2. Deval abrasion test.
3. Dorry abrasion test.

Los Angeles Abrasion Test: -
The principle of Los Angeles abrasion test is to find thepercentage wear due to the relative rubbing action between the aggregates and steel balls used as abrasive charge pounding action of these balls also exist while conducting the test. Maximum Allowable Los Angeles Abrasion Values of Aggregates in Different Types of pavement layers as per Indian Road Congress (IRC) are:- For sub-base course a value of 60%. For base course such as WBM, Bituminous Macadam (B.M.), Built - Up spray grout base course and etc. value of 50%. For surface course such as WBM, BM, Bituminous Penetration Macadam, Built-Up spray grout binder course and etc. a value of 40%. If aggregates are used in surface course as bituminous carpet, bituminous surface dressing, single or two coats, cement concrete surface coarse and etc. a value of 35%. If aggregates are used for bituminous concrete, Cement concrete pavement as surface coarse than aggregate abrasion value of 30% maximum.
ATTRITION MACHINE: Conforming in all its essential characteristics to the design shown The machine shall consist of a vertical shaft with paddles attached at one end. The other end shall be attached to an electric motor capable of rotating the shaft at a speed of 390 ± 10rpm under load.

6.3 Objective

Abrasion test is carried out to test the hardness property of aggregates. The principle of Los Angeles abrasion test is to find the percentage wear due to relative rubbing action between the aggregate and steel balls used as abrasive charge.

An attrition test is a test carried out to measure the resistance of a granular material to wear. An example of a material subjected to an attrition test are stones used in road construction, indicating the resistance of the material to being broken down under road traffic.

6.4 Theory:

Samples for attrition are to be obtained from materials to be tested by use of a sample splitter or the method of quartering. The test sample shall be the end result of the sampling method and, when dry, should weigh between 490 and 520 g. Under no circumstances should an attempt be made to select samples of an exact predetermined mass.

6.5 Abrasion Test Procedure:

1. Clean and dry aggregate sample confirming to one of the grading A to G is used for the test.
2. Aggregates weighing 5Kg for grading A, B, C or D and 10Kg for grading's E, F or G may be taken as test specimen and placed in the cylinder.
3. The abrasive charge is also chosen in accordance with table no.1 and placed in the cylinder of the machine, and cover is fixed to make dust tight. The machine is rotated at a speed of 30 to 33 revolutions per minute.
4. The machine is rotated for 500 revolutions for grading's A, B, C and D, for grading's E, F and G, it shall be rotated for 1000 revolutions.
5. After the desired number of revolutions, the machine is stopped and the material is discharged from the machine taking care to take out entire stone dust.
6. Using a sieve of size larger than 1.70mm I.S sieve, the material is first separated into two parts and the finer position is taken out and sieved further on a 1.7mm I.S sieve.
7. Let the original weight of aggregate be w1gm, weight of aggregate retained on 1.70mm I.S sieve after the test be w2gm. Los Angeles abrasion value %= (w1-w2)/w1x100

6.6 Attrition Test Procedure

1. Ovens dry the test sample to constant mass. Weigh to the nearest 0.1 g and record the masses the original mass.
2. Set the Attrition test sample tank so that there is a clearance of 5 mm between the bottom of the attrition shaft and the bottom of the tank.
3. Place the test sample in the tank and add 175 ml of water and cover with the lid. Run the attrition machine at 390 rpm for 10 min.
4. Lower the tank, wash the material on the lid and paddles into the tank with a wash bottle and wash the sample onto a 75 µm sieve
5. Wash the sample over the 75 µm sieve as described in MTO Test Method LS-602 and oven dry the material retained to constant mass
6. Weigh the oven-dry sample to the nearest 0.1 g.

6.7 Calculations:

Calculate the percentage of deleterious material (loss by attrition and washing) as follows
A = (mass of pass 75 µm sieve)/ (Mass of original sample) x 100 Where: A = loss by attrition and washing, percent
W1= original mass of sample, g
W2 = mass of retained 75 µm sieve after washing, g

6.8 Results:

6.9 Further Probing Experiments

1. The abrasion value found from Los Angeles test for two aggregates A and B are 50% and 38% respectively. Which aggregate is harder? Why? For what types of constructions are these suitable?

2. Why Los Angeles abrasion test is considered superior to the other form of tests which are used to determine the hardness of aggregates?

3. Two materials have abrasion values 3 and 10 respectively. Which one is harder and why

LAB-6 SHAPE TESTS OF COARSE AGGREGATES

7.1 Introduction

An aggregate is classified as being elongated if it has a length (greatest dimension) of more than 1.8 of its mean sieve size. The elongation index of an aggregate sample is found by separating the elongated particles and expressing their mass as a percentage of the mass of the sample tested.

7.2 Theory and Scope:

The particle shape of aggregate is determined by the percentages of flaky and elongated particles contained in it. In case of gravel it is determined by its Angularity Number. Flakiness and Elongation tests are conducted on coarse aggregates to assess the shape of aggregates. Aggregates which are flaky or elongated are detrimental to the higher workability and stability of mixes. They are not conducive to good interlocking and hence the mixes with an excess of such particles are difficult to compact to the required degree. For base coarse and construction of bituminous and cement concrete types, the presence of flaky and elongated particles are considered undesirable as they may cause inherent weakness with probabilities of breaking down under heavy loads. Rounded aggregates are preferred in cement concrete road construction as the workability of concrete improves. Angular shape of particles are desirable for granular base coarse due to increased stability derived from the better interlocking when the shape of aggregates deviates more from the spherical shape, as in the case of angular, flaky and elongated aggregates, the void content in an aggregate of any specified size increases and hence the grain size distribution of the graded aggregates has to be suitably altered in order to obtain minimum voids in the dry mix or the highest dry density. It is determined according to the procedure laid down in IS-2386 (PART- I).

7.3 Flakiness Index:

The flakiness index of aggregates is the percentage by particles whose least dimension (thickness) is less than 3/5th (0.6) of their mean dimension. The test is not applicable to sizes smaller than 6.3mm.

7.4 Elongation Index:

The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than 1 and 4/5th times (1.8 times) their mean dimensions. The elongation test is not applicable to sizes smaller than 6.3mm

7.5 Angularity Number::

The angularity number of an aggregate is the amount by which the percentage voids exceeds 33 after being compacted in a prescribed manner. The minimum allowable combined index of aggregates used in surface course of pavement is30Aim: - To determine the flakiness Index of a given aggregates sample.

7.6 Equipment needed

The apparatus consists of a standard thickness gauge, I.S. sieves of sizes 63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 and 6.3mm and a balance to weigh the samples.

7.7 Flakiness 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 (w1gm).
3. In order to separate flaky materials, each fraction is then gauged for thickness on
4. Thickness gauge, or in bulk on sieve having elongated slots as specified in the table.
5. Then the amount of flaky material passing the gauge is weighed to an accuracy of at least 0.1% of test sample.
6. 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+... = wg 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+... =Wg is found.
7. 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 .

7.8 Elongation Procedure:

1. The sample is sieved through I.S-sieves 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 aggregates 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

6. sizes are found - W1, W2, W3, and the total weight of sample determined = W1+W2+W3+... = Wg. Also the weights of 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.

7. 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.

7.9 Further Probing Experiments

1. What is shape test on aggregate?

2. What are the tests on coarse aggregates?

3. Is sieve sizes for coarse aggregate?

4. Which of the following test is conducted to evaluate the shape property of aggregate?

5. What are the tests conducted on sand?

LAB-7 PENETRATION AND DUCTILITY TEST OF BITUMINOUS MATERIALS

8.1 Introduction

Penetration test of Bitumen determines the hardness or softness of bitumen by measuring the depth in millimeter to which a standard loaded needle will penetrate vertically in five seconds while the temperature of the bitumen sample is maintained at 25 C. This test is applied almost exclusively to bitumen and Ductility test of bitumen measures the amount by which the bitumen will stretch at a temperature below the softening point is determined. .

8.2 Objective

To determine the penetration and ductility test of bitumen.

8.3 Theory and Scope:

The consistencies of bituminous materials vary depending upon several factors such as constituents, temperature, etc. As temperature ranges between 25^{o} and 50^{o}C most of the paving bitumen grades remain in semi-solid or in plastic states and their viscosity is so high that they do not flow as liquid. Determination of absolute viscosity of bituminous material is not so simple. Therefore the consistency of these materials is determined by indirect methods. The consistency of bitumen is determined by penetration test which is a very simple test. Various types and grades of bituminous materials are available depending on their origin and refining process. The penetration test determines the consistency of these materials foe the purpose of grading them, by measuring the depth (in units of one tenth of a millimeter or one hundredth of a centimeter) to which a standard needle will penetrate vertically under specified conditions of standard load, duration and temperature. Thus the basic principle of the penetration test is the measurement of the penetration (in units of one tenth of a mm) of a standard needle in a bitumen sample maintained at 25C during five seconds, the total weight of the needle assembly being 100gm. The softer the bitumen, the greater will be the penetration. The test is conducted as per IS-1203 for paving bitumen.
A certain minimum ductility is necessary for a bitumen binder. This is because of the temperature changes in bituminous mixes and the repeated deformations that occur in flexible pavements due to the traffic loads. It is of significant importance that the binders form ductile thin films around the aggregates. The binder material which does not possess sufficient ductility would crack and thus provide previous pavement surface. This is in turn results in damaging effect to the pavement structure. The ductility is expressed as the distance in centimeters to which a standard briquette of bitumen can be stretched before the thread breaks. The test is standardized by the IS: 1208. The test is conducted at $27^{o}\pm0.5^{o}$C and a rate of pull of 50 ± 2.5 mm per minute.

8.4 Equipment needed

It consists of items like container, needle, water bath, penetrometer, stop watch etc. Container is 55mm in diameter and 35mm to 57mm height. The needle is provided With a shank approximately 3.0mm in diameter into which it is immovably fixed.

Briquette mould, (length - 75mm, distance between clips - 30mm, width at mouth of clips - 20mm, cross section at minimum width - 10mm x 10mm), Ductility machine with water bath and a pulling device at a pre calibrated rate, a putty knife, thermometer.

8.5 Penetration test Procedure:

1. The bitumen is softened to a paving consistency between 75 and 100C above the approximate temperature at which bitumen softens.
2. The sample material is thoroughly stirred to make it homogeneous and free from air bubbles and water.
3. The sample containers are cooled in atmosphere of temperature not lower than 13^{o}C for one hour. Then they are placed in temperature controlled water bath at a temperature of 25^{o}C for a period of one hour.
4. The weight of needle, shaft and additional weight are checked. The total weight of this assembly should be 100gm.
5. Using the adjusting screw, the needle assembly is lowered and the tip of the needle is made to just touch the top surface of the sample.
6. The needle assembly is clamped in this position. The contact of the tip of the needle is checked using the mirror placed on the rear of the needle.
7. The initial reading of the penetrometer dial is either adjusted to zero or the initial reading is noted.
8. Then the needle is released by pressing a button and a stop watch is started. The needle is released exactly for a period of 5.0secs.
9. At least 3 measurements are made on this sample by testing at distance of not less than 100mm apart.
10. The difference between the initial and final penetration readings are taken as the penetration value.

8.6 Ductility Test Procedure

1. The bitumen sample is method to a pouring temperature (75C to 100C) and poured into the mould assembly and placed on a brass plate, where a solution of glycerin or soap solution is applied at all surfaces of briquette mould exposed to bitumen.
2. After the sample is poured to the mould, thirty to forty minutes the entire assembly is placed in a water bath at 27^{o}C. Then the sample is removed from the water bath maintained at 27^{o}C and excess bitumen material is cutoff by leveling the surface using hot knife.

3. After trimming the specimen, the mould assembly containing sample is replaced in water bath maintained at 27^{o}C for 85 to 95 minutes. Then the sides of mould are removed and the clips are carefully booked on the machine without causing any initial strain. Two or more specimens may be prepared in the moulds and clipped to the machine so as to conduct these test simultaneously. The pointer is set to read zero.

4. The machine is started and the two clips are thus pulled apart horizontally. While the test is in operation, it is checked whether the sample is immersed in water at depth of at least 10mm. The distance at which the bitumen thread of each specimen breaks is recorded (in cm) to report as ductility value.

8.7 Results:

8.8 Further Probing Experiments

1. List the factors that affect the result of a ductility test.

2. What do you understand by the term repeatability and reproducibility?

3. Explain the significance of ductility test.

LAB-8 SOFTENING POINT OF BITUMEN MATERIALS

9.1 Introduction

The apparatus used to determine softening point of bitumen is RING AND BALL assembly. The softening point of various bitumen grades generally lies between 35°C to 70°C. Softening point of bitumen to be used for road construction at a place where the maximum temperature is 40°C should be greater than the 40°C.

9.2 Objective

Softening point test of bitumen is done to determine the consistency of bitumen. This test gives an idea of the temperature at which the bitumen attain certain viscosity.

9.3 Prelab Preparation:

Get complete discussion on softening point of bitumen test

9.4 Equipment needed

Ring and Ball apparatus, Water bath with stirrer, Thermometer, Glycerin, etc. Steel balls each of 9.5mm and weight of 2.5±0.08gm.

9.5 Theory and Scope

Bitumen does not suddenly change from solid to liquid state, but as the temperature increase, it gradually becomes soften until it flows readily. The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test. For bitumen it is usually determined by Ring and Ball apparatus. The test is conducted as per IS: 1205.

9.6 Procedure

1. Sample material is heated to a temperature between 75^{o} and 100^{o}C above the approximate softening point until it is completely fluid and is poured in heated rings placed on the metal plate.
2. To avoid sticking of the bitumen to metal plate, coating is done to this with a solution of glycerin and dextrin.
3. After cooling the rings in air for 30 minutes, the excess bitumen is trimmed and rings are placed in the support.

4. At this time the temperature of distilled water is kept at 5^{o}C. This temperature is maintained for 15 minutes after which the balls are placed in position.

5. Then the temperature of water is raised at uniform rate of 5^{o}C per minute with a controlled heating unit, until the bitumen softens and touches the bottom plate by sinking of balls. At least two observations are made. For material whose softening point is above 80^{o}C, glycerin is used for heating medium and the starting temperature is 35^{o}C instead of 5^{o}C.

6. The temperature at the instant when each of the ball and sample touches the bottom plate of support is recorded as softening point value.

9.7 Results

9.8 Further Probing Experiments

1. What are the factors which affect the ring and ball test results?

2. What is softening point?

3. If material A has softening point of 56 and B has 42 which binder is good and why?

LAB-9 FLASH AND FIRE POINT TEST OF BITUMEN MATERIALS

10.1 Introduction

Flash point and fire point gives a measure of the critical temperatures beyond which the bitumen should not be exposed to. Thus, these critical temperatures .

10.2 Objective

Bitumens are viscoelastic materials without sharply defined melting points; they gradually become softer and less viscous as the temperature rises. The softening point of bitumen can be determined through the use of a ring-and-ball apparatus immersed in distilled water (30 to 80°C) or USP glycerin (above 80 to 157°C).

10.3 Equipment needed

Pensky-Martens closed cup tester, thermometer, heating source, flame exposure.

10.4 Theory

Flash and Fire point test is a safety test conducted on a bituminous material so that it gives an indication of the critical temperature at and above where precautions should be taken to eliminate fire hazards during its applications. Bituminous materials leave out volatiles at high temperature depending upon their grade. These volatile vapors catch fire causing a flash. This condition is very hazardous and it is therefore essential to qualify this temperature for each bitumen grade, so that the paving engineers may restrict the mixing or application temperature well within the limits. Flash and Fire point test is conducted as per IS: 1209. As per IS: 1209 the definitions of flash and fire point are: Flash Point: "The flash point of a material is the lowest temperature at which the vapour of substance momentarily takes fire in the form of a flash under specified conditions of test". Fire Point: "The fire point is the lowest temperature at which the material gets ignited and burns under specified condition of test".

Importance

Flash point: It is the lowest temperature at which vapours of the material will ignite, given an ignition source. Fire point: The fire point of a fuel is the lowest temperature at which the vapour of that fuel will continue to burn for at least 5 seconds after ignition by an open flame.

Procedure

1. All parts of the cup are cleaned and dried thoroughly before the test is started.

2. The material is filled in the cup upto a mark. The lid is placed to close the cup in a closed system. All accessories including thermometer of the specified range are suitably fixed.

3. The bitumen sample is then heated. The test flame is lit and adjusted in such a way that the size of a bed is of 4mm diameter. The heating of sample is done at a rate of 5^{o} to 6^{o}C per minute. During heating the sample the stirring is done at a rate of approximately 60 revolutions per minute.

4. The test flame is applied at intervals depending upon the expected flash and fire points And corresponding temperatures at which the material shows the sign of flash and fire are noted

10.5 Result

10.6 Further Probing Experiments

1. Define flash and fire points.

2. What is the significance of flash and fire point test?

3. What are the parameter that affects the result of flash and fire point tests?

LAB-10 NORMAL CONSISTENCY OF FINENESS OF CEMENT

11.1 Introduction

The standard consistency of any cement is achieved when cement permits the Vicat plunger to penetrate to a point 33 to 35 mm from the bottom of the Vicat mould. First of all, take about 300 gm of cement into a tray and is mixed with a known percentage of water by weight of cement.

11.2 Objective

Objective of this test is to find the basic required quantity of water to form a cement paste as specified by IS Code 4031 (Part 4 – 1988) which the Vicat plunger will penetrate to 5-7mm point to the bottom of Vicat mould.

11.3 Equipment needed

Vicat apparatus with plunger, I.S. Sieve No. 9, measuring jar, weighing balance

11.4 Experimental Procedure

1. The vicat apparatus consists of a D- frame with movable rod. An indicator is attached to the movable rod, which gives the penetration on a vertical scale
2. A plunger of 10 mm diameter, 50 mm long is attached to the movable rod to find out normal consistency of cement.
3. Take 300 gm of cement sieved through I.S. Sieve No. 9 and add 30% by weight (90 ml) water to it. Mix water and cement on a non-porous surface thoroughly with in 3 to 4 minutes. .
4. The cement paste is filled in the vicat mould and top surface is leveled with a trowel. The filled up mould shall be placed along with its bottom non-porous plate on the base plate of the vicat apparatus centrally below the movable rod. The plunger is quickly released into the paste.
5. The settlement of plunger is noted. If the penetration is between 33 mm to 35 mm from top (or) 5 mm to 7 mm from the bottom, the water added is correct. If the penetration is less than required, the process is repeated with different percentages of water till the desired penetration is obtained.

11.5 Observation

The test should be performed away from vibrations and other disturbances. Care should be taken to maintain the specified temperature, humidity and the time of mixing so as to avoid setting of cement paste as per test requirement.

11.6 Precautions

1. The Test should be conducted at Room Temperature.
2. The humidity of the room should be + or – 65+
3. The whole process of mixing should be made on Glass Sheet.

11.7 Results:

11.8 Further Probing Experiments

1. What is normal or standard consistency of a cement paste?
2. What are the factors affecting the result of the test?
3. What do you understand by the term flash setting?