



Siliguri Institute of Technology
Civil Engineering Department

Laboratory Work Book for Soil Mechanics Laboratory
(CE(PC)594)

NAME: ARBISHEN CHAKI

ROLL NO.: 110D0310040

REGISTRATION NO.: 013203 OF 2010-20

SEMESTER/YEAR: 5th/3rd

Siliguri Institute of Technology

Civil Engineering Department

Laboratory Work Book for Soil Mechanics Laboratory (CE(PC)594)

Title Sheet

Experiment No : 01

Experiment Name : Determination of Natural moisture Content

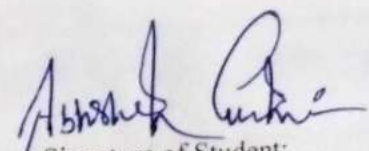
Date of Experiment : 07/12/20

Submission Date : 23/12/20

Student Name : ABHISHEK CHAKI

Roll No. : 21903310040

Semester/Year : 5th / 3rd Year


Signature of Student:

by oven drying method -

*** Objective:** — The object of this test is to determine the Water Content of a Soil Sample in the laboratory by oven drying. This experiment forms an essential part of many other laboratory experiments.

*** Apparatus:** —

SL. No.	Name of the Equipments Used
1.	Non-Corrosible airtight Containers.
2.	Balance of Sufficient Sensitivity to weigh Soil Samples to an accuracy of 0.04 Percent of the Weight of the Solid taken for the test. For Fine Grained Soils the balance should have an accuracy of 0.01 g & for Coarse sand it should have an accuracy of 0.1 g.
3.	DESICATOR with any suitable desiccating agent.
4.	Thermostatically Controlled oven, with interior of non-corroding.
5.	Material to maintain temperature between 105°C to 110°C

Teacher's Signature & Date :

*** Theory :-** The natural moisture content also called the water content is defined as the ratio of the weight of the water present in the soil sample to the weight of the solids in a given mass of soil. This ratio is expressed as the percentage.

*** Procedure :-**

- (i) Clean the container and weigh it with lid (w_1)
- (ii) Put the desired quantity of the moist soil sample in the container and replace the lid. Take the weight w_2 .
- (iii) Keep the container in the oven with lid removed and maintain the temperature of the oven between 105°C to 110°C for about 16 to 24 hrs.
- (iv) Take out the container, replace the lid and cool it in the desiccators. Find the weight w_3 of the container with lid and dried soil sample.

*** Data and observation sheet -**

Determination No.	1	2	3
1. Container. no.	01	02	03
2. w_1 : of container (w_1) g.	6.7	6.5	6.5
3. w_2 : of container + wet soil (w_2) g.	9.3	10.1	10.3
4. w_3 : of container + dry soil (w_3) g.	8.7	9.2	9.5
5. w_4 : of dry soil ($w_3 - w_1$) g.	2	2.3	3
6. w_5 : of water ($w_2 - w_3$) g.	0.6	0.9	0.8
7. Moisture Content.	30	39.13	26.66
$W = (w_2 - w_3) / (w_3 - w_1) \times 100\%$			

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NOTE

Experiment Name :

Page No. 03

•% Result :— Moisture Content, $W = \frac{(30 + 39.13 + 26.6)}{3}$
 $= 36.22\%$

— Abhinav Kumar
—————
(11001319040)

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Laboratory Work Book for Soil Mechanics Laboratory (CE(PC)594)

Title Sheet

Experiment No : 02

Experiment Name : Determination of Liquid Limit

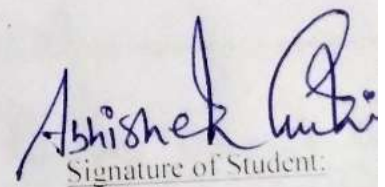
Date of Experiment : 14/12/20

Submission Date : 20/12/20

Student Name : ABHISHEK CHAKI

Roll No. : 119 0131 0040

Semester/Year : 5th / 3rd.


Signature of Student:

❖ Object :- To find the upper & lower limits, namely the liquid limit of the sample of soil as per IS: 2720 (Part 5) - 1985. These limits are helpful in classifying clayey soils.

❖ Apparatus :-

Sr. No.	Name of the Equipments Used.
1.	Mechanical Liquid Limit device - It shall conform to IS 9250-1987
2.	Grooving tool:- it shall conform to IS 9250-1987
3.	Porcelain Evaporating dish:- About 12 to 15 cm in diameter.
4.	Flat glass plate:- 10 mm thick and about 15 cm square diameter
5.	Spatula:- Flexible, with the blade about 8 cm long and 2 cm wide for mixing soil and water in the Porcelain evaporating dish.
6.	Balance:- Sensitive to 0.01 g
7.	Oven:- Thermodynamically controlled with interior of non-corroding material to maintain the temperature between 105°C and 110°C
8.	Wash bottle or Beaker:- Containing distilled water.
9.	Containers - air tight and non-corrodible for determination of moisture content.

❖ Theory :- It is the minimum water content at which the soil flows under its own weight. With reference to Casagrande's Liquid Limit device.

Teacher's Signature & Date :

It is defined as the moisture content at which a soil mass cut by a grooving tool of standard dimension will glow together for a distance of $1/2$ inch. Under the impact of 25 blows.

*** Procedure :-** About 120g of the soil sample passing 425 micron IS sieve shall be mixed thoroughly with distilled water in the evaporating dish to form a uniform paste. The paste shall have a consistency that will require 30 to 35 drops of the cup to cause the desired closure of the standard groove. In the case of clayey soils, the soil paste shall be left to stand for a sufficient time (24 hrs) so as to ensure uniform distribution of moisture throughout the soil mass. The soil in the cup shall be divided by six strokes of the grooving tool along the diameter through the centre line of the cam follower so that a clean, sharp groove of the proper dimension is formed. The cup shall be lifted and dropped by timing the clock at the rate of 2 revolutions per second until the two halves of the soil cake come in contact with bottom of the groove along a distance of about 12mm. This length shall be measured with end of the grooving tool or a ruler. The number of drops required to cause the groove close for the length of 12mm shall be recorded. A representative slice of soil approximately the width of the spatula, extending from about edge to

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edge of the soil cake at right angle to the surface and including that portion of the surface in which the soil flowed together, shall be taken for moisture content determination. Repeat the experiment with samples of soil with three more additional moisture contents so as to get one number of blows ranging from 10 to 40.

* Data & Observation Sheet :-

Determination No.	1	2	3
1. Container No.	I	II	III
2. Wt. of Container (gms)	20.18	21.37	24.28
3. Wt. of Container + wet Soil	38.24	36.10	40.14
4. Wt. of Container + Dry Soil.	33.51	32.46	36.43
5. Wt. of Water	4.72	3.64	3.71
6. Wt. of dry Soil.	13.34	11.09	12.15
7. Water Content % (Weight of Water / Weight of Dry Soil) $\times 100\%$	35.38	32.82	30.52
8. No. of Blows (N)	17	23	27

* Results :- Liquid Limit of Soil Sample = _____

Teacher's Signature & Date :

- Abhishek Kumar
(21901319040)

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Laboratory Work Book for Soil Mechanics Laboratory (CE(PC)594)

Title Sheet

Experiment No : 03

Experiment Name : Determination of Plastic Limit of Soil

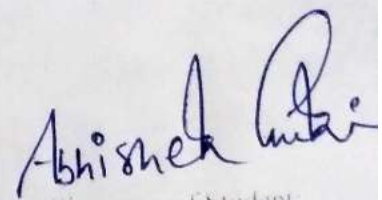
Date of Experiment : 21/12/20

Submission Date : 28/12/20

Student Name : ABHISHEK CHAKI

Roll No. : 11901319040

Semester/Year : 5th / 3rd


Signature of Student

Determination of Plastic Limit

* Object :- To determine the Plastic Limit of a Soil Sample.

* Apparatus :-

S. No.	Name of the Equipments Used.
1.	Potter's rubber rolling disk about 200mm diameter of a flat glass plate, 450 mm square and 10mm thick.
2.	Ground glass plate, about 200mm x 150mm.
3.	Metallic rod, 3mm dia & 100 mm long.
4.	Oven.
5.	Spatula.
6.	Moisture Content Can.

* Theory :- The Plastic Limit of a soil is the water content of the soil below which it ceases to be plastic it begins to crumble when rolled into 3mm thread dia.

* Procedure :-

1. Take about 300g air dried soil from a thoroughly mixed sample of the soil passing 425 μ sieve.
2. Mix the plastic soil mass for some time for maturing.
3. Take about 80g of plastic soil. The soil then rolling with fingers on a glass plate. The rate of rolling should be about 80 to 100 stroke per minute to form a thread of 3mm diameter.

4. If the diameter of the thread becomes less than 3mm without cracks, it shows that the water content is more than Plastic Limit.

5. Collect the pieces of the crumble soil thread in a moisture content container.

6. Repeat the procedure at least twice with fresh samples of Plastic Soil each time.

* Data & Observation sheet :-

Determination No.	1.	2.	3.
1. Container No.	I	II	III
2. Wt. of Container	26.10	21.86	23.91
3. Wt. of Container + Wet Soil.	33.20	34.74	30.15
4. Wt. of Container + dry Soil.	31.20	32.51	29.06
5. Wt. of Water.	1.00	2.23	1.09
6. Wt. of dry Soil.	5.10	10.65	5.15
7. Water Content %	21.37	20.94	21.17
$= (\text{Weight of Water} / \text{Weight of dry Soil}) \times 100\%$			

* Result :-

Plastic Limit of the Soil Sample = **21.16%**

- Abhishek Guleri

(11001319040)

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Title Sheet

Experiment No : 04

Experiment Name : Determination of Shrinkage Limit of a Soil Sample

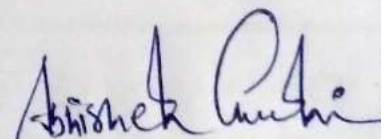
Date of Experiment : 04/01/2020

Submission Date : 11/01/2020

Student Name : ABHISHEK CHAKI

Roll No. : 1990131 9090

Semester/Year : 5th / 3rd Year



Signature of Student:

Determination of Shrinkage Limit of a Soil Sample

Objective: — To determine the shrinkage limit of a sample of the remolded soil.

Apparatus: —

Sl. No.	Name of the Equipments used
1.	Shrinkage dish, having a slot bottom 45mm diameter.
2.	Two loose evaporating dishes about 120mm diameter, with a pour out and slot bottom.
3.	One small measuring dish, 60mm diameter.
4.	Two glass plate, one plain and one with pores, 75x75x3mm
5.	Glass cup, 50mm diameter and 25mm high.
6.	IS Sieve 425 μ .
7.	Oven.
8.	Desiccator
9.	Weighing balance, accuracy 0.01g
10.	Measuring.

Theory: The shrinkage limit is the water content of the soil when the water is just sufficient to fill all the pores of the soil, and the soil is just saturated.

It can be determined from the relation.

$$W_s = \left[(M_1 - M_s) - (V_1 - V_2) P_w \right] / M_s \times 100.$$

Where M_1 = Initial wet mass,

V_1 = Initial volume.

M_s = Dry mass.

V_2 = Volume after drying.

* Procedure :-

- 1) Take a sample of mass about 100g from thoroughly mixed soil passing 425 μ sieve.
- 2) Take about 30g of the soil sample in a loose evaporating dish. mix it with distilled water to make a creamy paste which can be easily worked without entrapping the air bubbles.
- 3) Take the shrinkage dish, clean it and determine its mass.
- 4) Fill mercury in the shrinkage dish. Remove the excess mercury.
- 5) Transfer the mercury of the shrinkage dish to a mercury weighing dish and determine the mass of the mercury to an accuracy of 0.1g.
- 6) Coat the inside of the shrinkage dish with a thin layer of silicon grease.
- 7) Add more soil paste and continue the tapping till the shrinkage dish completely filled and excess soil paste projects out about its edge.

- 8) Dry the Soil in the shrinkage dish in air until the colour of the Paste turns from dark to light then dry the Paste in the oven 105° - 110° to constant mass.
- 9) Roll the dry Paste in a desiccator. Remove the dry Paste from the desiccator after cooling and weighing the shrinkage dish with the dry Paste to determine the dry mass of the Soil.
- 10) Place the glass cup in a glass evaporating dish and fill with mercury. Remove the excess mercury by pressing the glass plate with porous sinter over the top of the cup.
- 11) Take out the dry Paste of the soil shrinkage dish and immerse it in that glass cup full of mercury.
- 12) Collect the mercury displaced by the dry Paste in the evaporating dish, and transfer it to the measuring dish. Determine the mass of the mercury to an accuracy of 0.1 mg. The Volume of the dry Paste (V_d) is equal to the mass of the mercury divided by the S.G. density of mercury.
- 13) Repeat the test at least 3 times.

* Calculations

S.No.	Determination No.	1	2	3
1.	mass of Empty measuring dish.	7.56	7.75	7.67
		78.12		
2.	mass of measuring dish, with equal to Volume of the shrinkage dish.	78.12	78.01	78.16
		57.30	55.70	56.35
3.	mass of measuring = (2.1)			
4.	Volume of shrinkage dish, $V_1 = (3) / 13.6$	49.74	47.53	48.68
5.	mass of Empty shrinkage dish.	70.56	70.26	70.49
6.	mass of shrinkage + wet Soil.	41.81	46.53	44.86
7.	mass of shrinkage dish = dry Soil.	537	548	540
8.	mass of wet Soil $m_s = (6-5)$	529	540	532
9.	mass of measuring displayed by Pan	38.9	39.7	35
10.	mass of measuring displayed by Pan	31.6	31.3	31
11.	Volume of dry Pan, $V_2 = (10) / 13.6$	23.2	23.0	2

* Result

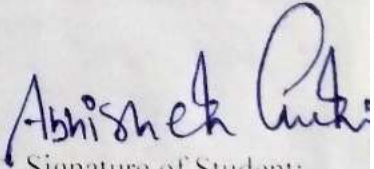
$$\text{Shrinkage limit} = \frac{[m_1 - m_s] - (V_1 - V_2) \rho_w \times 100}{m_s} = 11.5$$

- Abhishek Tunki

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Title Sheet

Experiment No : 05
Experiment Name : Specific Gravity of Soil.
Date of Experiment : 11/01/21
Submission Date : 18/01/21
Student Name : ABHISHEK CHAKI.
Roll No. : 11903319040
Semester/Year : 5th / 3rd.


Signature of Student:

* Object :- The object of the test is to determine the specific gravity of soil fraction passing 4.75mm IS sieve by pycnometer.

* Apparatus :-

Sl. No.	Name of the equipments used.
1.	Pycnometer of about 500ml capacity with the conical brass cap screwed at its top.
2.	Balance sensitive to 1g
3.	Deaired distilled water & Glass rod.

* Theory :- Specific gravity is the ratio of the weight in air of a given volume of the soil particles to the weight in air of equal volume of distilled water at 4°C. It is an important factor which is used in computing other soil properties.

* Procedure :-

- clean the pycnometer and dry it. Find the weight (W_1) of the pycnometer brass cap and washer accurate to 1mg.
- Take about 200 to 400g oven dried soil and put it on the pycnometer. weigh the pycnometer plus soil (W_2)
- Fill the pycnometer to half to half its height with distilled water, and mix it thoroughly with glass rod.

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Replace the screw top and fill the Pycnometer slush with hole in the conical cap by the Pycnometer soon outside and weight it (w_3)

(iv) Empty the Pycnometer, clean it thoroughly and fill it with distilled water, to the hole of the conical cap and weight it (w_4)

(v) Repeat step 2 to 4 for two more determinations of specific gravity.

* Data & Observation Sheet :-

Determination No.	1	2	3
Weight of Pycnometer (w_1) g	640		
Weight of Pyc + Soil (w_2) g	740		
Weight of Pyc + Soil + Water (w_3) g	1540		
Weight of Pyc + Water (w_4) g	1480		

* Calculation :- The specific gravity is calculated as follows

$$G = \frac{w_2 - w_1}{[(w_2 - w_1) - (w_3 - w_4)]}$$

$$G = \frac{740 - 640}{[(740 - 640) - (1540 - 1480)]} = 2.5$$

* Specific gravity of the given soil (G) = **2.5**

- Abhishek Chakraborty
 (11001310040)

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Laboratory Work Book for Soil Mechanics Laboratory (CE(PC)594)

Title Sheet

Experiment No : 06

Experiment Name : Grain Size Analysis

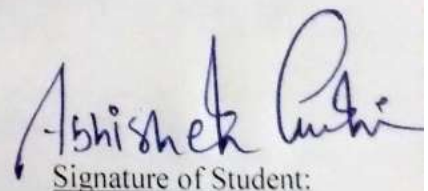
Date of Experiment : 18/01/21

Submission Date : 27/01/21

Student Name : ABHISHEK CHAKI

Roll No. : 11900319040

Semester/Year : 5th / 3rd.


Signature of Student:

✱ Aim:— To determine the Particle size distribution of a Soil by Sieving.

✱ Apparatus:—

Sl No.	Name of the Equipments Used.
1.	Set sieves 2mm, 75µ, 60µ, 425µ, 212µ, 150µ & 75µ
2.	Set of Coarse sieves 100mm, 80mm, 40mm, 20mm, 10mm & 4.75mm
3.	Weighing Balance with accuracy of 0.1% of the mass of Sample.
4.	Oven.
5.	Mechanical Shaker.
6.	Trays.
7.	Mortar with a Rubber Covered Pestle.
8.	Brushes.
9.	Rissoles.

✱ Theory:— The Soil is Sieved through a set of IS Sieve. The material retained on different sieves is determined the Percentage of material retained on any Sieve given by

$$P_n = \frac{M_n}{M} \times 100$$

where, M_n = mass of Soil retained on sieve n .

and, M = Total mass of the Soil sample.

Teacher's Signature & Date :

The Cumulative Percentage of material retained,

$$C_n = P_1 + P_2 + P_3 + \dots + P_n$$

Where, P_1, P_2 , etc are Percentage retained on sieves 1, 2, etc. which are coarser than sieve size n .

The Percentage finer than sieve n .

$$N_n = 100 - C_n$$

✱ Procedure :

1. Take the required of the sample. Sieve it through a 4.75mm IS sieve. Take the soil fraction retained on 4.75mm IS sieve for the Coarse sieve analysis (Part I) and that passing through the sieve as analysis (Part II).
2. Sieve the sample through the set Coarse Sieves by hand. While the sample while sieving through each sieve. The material retained on the sieves may be rubbed with the rubber pestle in the mortar.
3. Determine the mass of the material retained on each sieve.
4. Calculate the Percentage of soil retained on each sieve on the sieve on the basis of the total mass of the sample taken in step (1).
5. Determine the Percentage passing through each sieve.

* Part - II. Fine Analysis :-

6. Take the Portion of the soil passing through 4.75mm IS sieve oven dry it at 105° to 110°C weight it to 0.1% of the total mass.

7. Sieve the soil through the most of the fine sieves. The sieves should be against so that the sample falls in regular motion over the sieves. However, no particles should be pushed through the sieve.

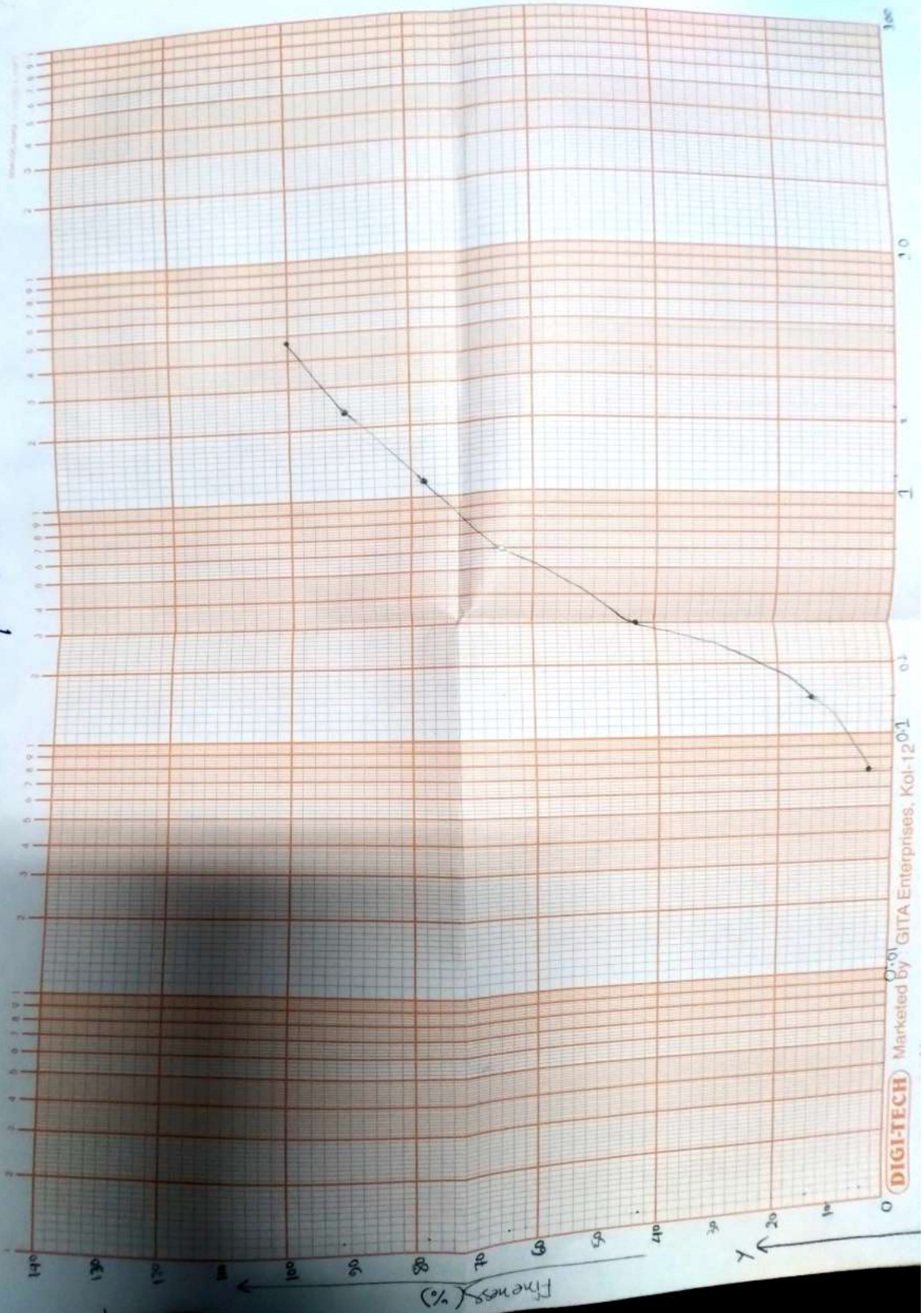
8. Take the material retained on various sieves in a mortar. Rub it with the rubber Paddle, but do not try to break individual particles.

9. Resize the material through the next of sieves.

10. A minimum 10 minutes of shaking is retained is a mechanical sieve shaker is used.

11. Determine the Percentage retained, cumulative Percentage retained, and the Percentage fines, based on the total mass taken in step (1)

Abhishek Chakraborty / 10050319040



Experiment Name :

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* Calculation :

Total mass of sample = 5000 gm

Sieve Size(mm)	Retained (gm)	Wt. Retained	% of WT Retained	% Passing.
80	0	0	0	100
40	875	875	17.5	82.5
20	805	1680	33.6	66.4
12.5	550	2230	44.6	55.4
10	225	2455	49.1	50.9
4.75	605	3060	61.2	38.8
2.36	280	3340	66.8	33.2
1.18	605	3945	78.9	21.1
0.6	610	4555	91.1	8.9
0.3	310	4865	97.3	2.7
0.15	110	4975	99.5	0.5
0.075	20	4995	99.9	0.1
Pan	5	5000	100	0
Total	5000			

- Ashish Kumar

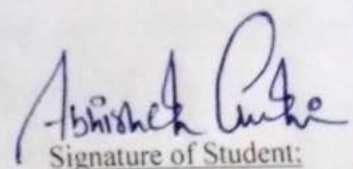
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Teacher's Signature & Date :

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Laboratory Work Book for Soil Mechanics Laboratory (CE(PC)594)

Title Sheet

Experiment No : 07
Experiment Name : Core Area Method
Date of Experiment : 25/01/21
Submission Date : 06/02/21
Student Name : ABHISHEK CHAKI
Roll No. : 11903319040
Semester/Year : 3rd Year / 5th Sem


Signature of Student:

Determination of Field density

and dry Unit Weight by

Cone Cutted method

EXP No. _____

Date : _____

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* Aim : — To determine the dry density of Soil in Place by Cone-cutted.

* Apparatus : —

SL. No.	Name of the Equipments Used.
1.	Cylindrical Cone Cutted of steel, 130 mm long & 100 mm initial diameter with wall thickness of 3 mm beveled at one end.
2.	Steel dolly 25 cm high and 10 cm internal diameter with wall thickness 7.5 mm. fitted with a lip to enable it to be on top of the Cone cutted.
3.	Steel Hammer.
4.	Palette Knife.
5.	Steel Rule.
6.	Balance accurate to 10g.
7.	Spade or Pick axe or excavating tool.
8.	Container for water content determination.

* Theory : — A cylindrical Cone Cutted is a seamless steel tube. For determination of the dry density of the Soil. The dry density of Soil obtained as—

$$\rho_d = \gamma / (1+w) = (M/V) / (1+w)$$

Where, m = mass of wet Soil; V = Initial Volume of Cone cutted; w = Water Content.

- * Procedure :-**
- 1) Measure the inside dimensions of Core Cutter and calculate its Volume. Find the mass of Core Cutter.
 - 2) Expose the small area, about 30cm square to be tested and level it.
 - 3) Dig out the contained soil from the surrounding soil and allow some soil to project from the lower end of the cutter.
 - 4) Find the mass of cutter full of soil.
 - 5) Keep some representative specimen of soil for water content determination.
 - 6) Repeat the test at least two or three locations nearby and get the average dry density.

*** Calculations :-**

Sl. No.	Determination No.	1.	2.	3.
1.	Mass of Core Cutter + Wet Soil (g)	2652		
2.	Mass of Core Cutter (g)	974		
3.	Mass of Wet Soil (g)	1678		
4.	Volume of Core Cutter (ml)	1021		
5.	Bulk density (g/cm ³)	1.64		
6.	Container No.	A		
7.	Mass of Container + Wet Soil (g)			
8.	Mass of Container + Dry Soil (g)			
9.	Mass of Empty Container (g)			
10.	Mass of dry Soil (g)			
11.	Mass of Water (g)			
12.	Water Content (%)	12.43		
13.	Dry Density $\rho_d = \gamma / (1+w)$ (g/cm ³)	1.46		

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* Result ———
mm

The Dry Density of the soil sample is $= 1.46 \text{ g/cm}^3$

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Title Sheet

Experiment No : 08

Experiment Name : Sand Replacement

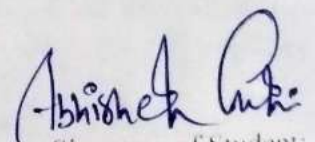
Date of Experiment : 08/02/21

Submission Date : 15/02/21

Student Name : ABHISHEK CHAKI

Roll No. : 11901319040

Semester/Year : 5th / 3rd


Signature of Student:

Determination of Field Density and dry Unit Weight By Sand Replacement Method

Experiment Name :

Page No. (01)

❖ Object :- To determine the dry density of soil in place using Sand Pouring Cylinder.

❖ APPARATUS :-

SL No.	Name of the Equipments Used
1.	Sand Pouring Cylinder of 3048, Capacity mounted above a pouring Cone and separated by a shutter cover plate.
2.	Tools for excavating holes, suitable tools, such as shaper tools to make a level surface.
3.	Cylindrical Calibrating Containers with an internal diameter of 100mm and an internal depth 150mm.
4.	Balance to weigh up to an accuracy of 1kg.
5.	Metal Containers to collect excavated soil.
6.	Metal tray hole with 100mm diameter or hole at the centre.
7.	Glass Plate about 450 St. mm and 10mm thick.
8.	clean, uniformly graded natural Sand passing 75mm IS sieve and retained on the 600 μ IS Sieve.
9.	Suitable non-corrodible air tight Containers
10.	Thermostatically controlled oven with an interior non-corroding material the temperature between 105°C to 110°C
11.	A desiccator with a desiccating agent.

Teacher's Signature & Date :

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✱ Theory :- This method has a major limitation in the case of soils containing coarse-grained particles such as gravel, stones and cobbles. Under such circumstances, field density test by sand replacement method is advantageous, as the presence of coarse grained particles will adversely affect the test results.

The basic principle of sand replacement method is to measure the in-situ volume of hole from which the material was excavated from the weight of sand with known density filling in the hole.

✱ Procedure :-

A) Calibration of the Cylinder :- 1.) Fill the sand pouring cylinder with clean sand so that the level of the sand in the cylinder is within 10mm from the top. Find out the initial weight of the cylinder plus sand (W_1) and the weight should be maintained constant throughout the test so which the calibration is used.

2.) Allow the sand of volume equal to that of the calibration to descend to the bottom of the cylinder by opening the shutter, close the shutter and place the cylinder on the glass plate. Open the cylinder and weight of the cylinder (W_2) gives the weight of sand filling cone position. Put the sand back to its position to same initial wt constant.

Teacher's Signature & Date :

B. Determination of Bulk density of Soil :-

- 1.) Determine the volume (V) of the Calibrating Container by Filling Water to the brim. Check this volume by Calculating from the measured internal dimensions of the Container.
- 2.) Place the Sand Pouring Cylinder concentrically on the top of the Calibrating Container, after being filled to constant mass (M_1). Open the shutter and permit the sand to run into Container. When no further movement of sand takes place and find the mass nearest to (M_2)

C. Determination of dry density of Soil in Place :-

- 1.) Exposed about 450 sq. mm area of the soil to be tested and trim it down to level surface. Keep the tray on the level surface and excavate soil in the tray. Find the mass of the excavated soil (M).
- 2.) Remove the tray and place the sand pouring cylinder, so that the base of the cylinder concentrically covers the hole. The cylinder should have a constant mass (M_1). Open the shutter and permit the sand to run into the hole. Close the shutter when no further movement of the sand is seen. Remove the cylinder and determine its mass (M_2).
- 3.) Keep a representative sample of the excavated soil for water content determination.

* Calculations :-

Table-1: Determination of Bulk Density of Sand in the Calibrating Container.

SL No.	Determination No.	Readings
1.	Mass of Sand + Cylinder before Pouring (M_1)g	2310
2.	Mass of Sand in cylinder after Pouring in Cone (M_2)g.	11040
3.	Mean mass of Sand in Cone (M_c) ($M_1 - M_2$)g	8890
4.	Mass of cylinder + Sand after Pouring in Calibrating Container (M_4)	8840
5.	Mean mass of Sand in calibrating Container (M_{ee}) ($M_1 - M_4 - M_c$)	1750
6.	Volume of Sand in Calibrating Container (V_c) (cm^3)	1671
7.	Bulk Density of Sand ρ (M_{ee}/V_c) g/ cm^3	1980

Table-2: Determination of in situ Bulk Density and Dry Density:

Experiment Name :

Sl No.	Determination	Reading
1.	mass of Sand + cylinder before pouring (w_1) or	11040
2.	mass of Sand in cylinder after filling the least the test hole (w_2) or	450
3.	mass of Sand filling the test hole (w_3) ($w_1 - w_2 - m_c$) or	9120
4.	mass of soil in test hole (m_s) or	1470
5.	Volume of Soil in the test hole (V_h) (w_3 / ρ) cm^3	980
6.	In situ density of the Soil in the test hole (m_s / V_h) (g/cm^3)	1470

* Result - The Dry Density of the soil is = 1500 kg/m³

- Ashish Kumar
(11001310040)



Siliguri Institute of Technology

Civil Engineering Department

**Laboratory Work Book for ENVIRONMENTAL ENGINEERING
(CE791)**

NAME: - DEBOJYOTI MANTRI

ROLL NO: -11901317027

REGISTRATION NO: -171190110186 OF 2017-2018

SEMESTER/YEAR: -7TH SEMESTER, 4TH YEAR

Siliguri Institute of Technology
Civil Engineering Department
Laboratory Work Book for ENVIRONMENTAL ENGINEERING(CE791)

Title Sheet

Experiment No : CE 791/4
Experiment Name : pH METER - Determination of pH of samples.
Date of Experiment : 03 - DECEMBER - 2020
Submission Date : 06 - DECEMBER - 2020
Student Name : Debojyoti Mahtoi.
Roll No. : 11901317027
Semester/Year : 7th Semester, 4th Year, 2020-21

Debojyoti Mahtoi
Signature of Student:

Experiment No. CE 791/4

NAME →

pH METER - DETERMINATION OF pH OF SAMPLES.

AIM →

To determine the pH (Hydrogen ion) in the given sample.

PRINCIPLE →

The pH is determined by measurement of the electromotive force of a cell comprising an indicator electrode (an electrode responsive to hydrogen ions such as glass electrode) immersed in the test solution and a reference electrode or a combined electrode. The contact between the test solution and the reference electrode is usually achieved by means of a liquid junction. The emf of this cell measured with pH meter. This is a high impedance electrometer calibrated in terms of pH.

APPARATUS →

1. pH meter.
2. Standard buffer solution of known pH.
3. Distilled water.
4. Samples.

REAGENTS ->

Calibrate the electrode system against standard buffer solutions of known pH. Buffer tablets having pH 4.0, 7.0, and 9.2 are available.

pH 4, pH 7, pH 9.2 BUFFER SOLUTIONS ->

Dissolve buffer tablet of pH 4 in 10 ml of distilled water to get pH 4 buffer solution. Similarly other buffer solutions can be prepared by dissolving corresponding buffer tablets.

PROCEDURE ->

1. Switch on the instrument.
2. Wash probe and blot using tissue paper.
3. Check - Temp = 30° Switch the buttons to pH and Stand by at the bottom.
4. Take Buffer pH - 4 and insert the probe. Press Stand by to Read.
5. Adjust the Cal control to read 4. Wait for 1 min.
6. Press to stand by, wash probe and blot using tissue paper.
7. Take Buffer pH - 9.2 and insert the probe, press Stand by to read.
8. After the Instrument shows 9.2, press to stand by, wash probe and using tissue paper.
9. Take one sample, insert the probe, press read, measure pH.

OBSERVATIONS AND CALCULATIONS -7

Sl. No	Temp. of Sample ($^{\circ}\text{C}$)	pH value	Remarks
1.	30 $^{\circ}\text{C}$	6.1	Acidic
2.	30 $^{\circ}\text{C}$	5.7	Acidic

10. Press to stand by, wash probe and blot using tissue paper and repeat the same for other sample.
11. Finally, wash probe and blot using tissue paper, dip in distilled water.

NOTE →

$\text{pH} = 7$ indicates Neutral pH

$\text{pH} < 7$ indicates Acidic pH

$\text{pH} > 7$ indicates Alkaline pH

RESULT →

pH of the taken sample is = Acidic

Siliguri Institute of Technology

Civil Engineering Department

Laboratory Work Book for ENVIRONMENTAL ENGINEERING(CE791)

Title Sheet

Experiment No : CE 791/3

Experiment Name : DETERMINATION OF SOLIDS

Date of Experiment : 10 - DECEMBER - 2020

Submission Date : 15 - DECEMBER - 2020

Student Name : Debojyoti Mantei

Roll No. : 11901317027

Semester/Year : 7th Semester, 4th Year, 2020-21

Debojyoti Mantei.
Signature of Student:

Experiment No CE 791/3

NAME → DETERMINATION OF SOLIDS :- TOTAL SOLIDS,
SUSPENDED SOLIDS AND DISSOLVED SOLIDS.

AIM → To determine the total suspended solids, total dissolved solids and total solids of given sample.

PRINCIPLE →

Determination of total solids is made by evaporating and drying of a measured sample in an oven at 105°C for a period of 1 hour. Since water for portable use contains small amount of suspended matter, it is usual to filter a sample of water and determine solids in filtrate by the foregoing method. The difference between total solids in unfiltered and filtered samples is taken as measure of the suspended solids is also classified as volatile or organic solids and fixed or inorganic solids.

APPARATUS →

1. Standard beaker.
2. Conical flask.
3. Filter paper.
4. Digital Balance.
5. Oven.
6. Evaporating Dish.

Teacher's Signature

PROCEDURE ->SUSPENDED SOLIDS ->

1. Take 25ml of sample in beaker
2. Note the weight of properly dried filter paper (W_1)
3. Properly fold and place the filter paper on the Erlenmeyer flask
4. Pour the sample through and filter it completely
5. Transfer the filter paper to an oven at 105°C for one hour
6. Note the weight of dried filter paper (W_2)
7. The difference between the above 2 weight gives the suspended solids (W_3).

Total Suspended Solids = $(W_3 \times 1000) / \text{ml of sample taken.}$

DISSOLVED SOLIDS ->

1. Filter a known quantity of water in filter paper.
2. Take the empty dish and clean it thoroughly, make it perfectly dry.
Take the weight of the empty dish W_1 gm.
3. Take a known quantity of the filtered water sample in the dish
4. Heat the dish till the entire liquid evaporate and the dry residues remain at the bottom.
5. Take the weight of dish after 20 minutes cooling and weight it - W_2 gm.

Total Dissolved Solids = $[(W_2 - W_1) \times 1000] / \text{ml of sample taken.}$

Teacher's Signature

TOTAL SOLIDS ->

Add suspended solids and dissolved solids which gives total solids.

RESULT ->

1. Total suspended solids in the sample ->

$$[(0.1 \times 10^6) / 25] = 4000 \text{ ppm.}$$

2. Total Dissolved solids in the sample ->

$$[(0.2 \times 10^6) / 5] = 40000 \text{ ppm.}$$

3. Total solids in the sample ->

$$\begin{aligned} &4000 + 40000 \\ &= 44000 \text{ ppm} \end{aligned}$$

Siliguri Institute of Technology

Civil Engineering Department

Laboratory Work Book for ENVIRONMENTAL ENGINEERING(CE791)

Title Sheet

Experiment No : CE 791/7

Experiment Name : DETERMINATION OF HARDNESS OF SAMPLES.

Date of Experiment : 17 - DECEMBER - 2020

Submission Date : 21 - DECEMBER - 2020

Student Name : Debojyoti Maitra

Roll No. : 11901317027

Semester/Year : 7th Semester, 4th Year, 2020-21

Debojyoti Maitra
Signature of Student:

Experiment No. CF 791/7

AIM -> To determine the hardness of given sample by EDTA method.

PRINCIPLE ->

EDTA and its sodium salt form a compound when added to a solution of certain metal cations. If a small amount of dye such as Eriochrome black T is added to an aqueous solution containing small calcium and magnesium ions at a pH of 10 ± 0.50 the solution become wine red. If EDTA is added then Ca and Mg will be complexed. When all these two ions are completed the solution will turn blue. This is the end point of titration. The higher the pH sharper the end point, however above pH 10, there is a danger of precipitation of Calcium Carbonate and Magnesium hydroxide.

Hence, the pH is fixed at 10 ± 0.50

APPARATUS ->

1. Burette.
2. Pipette.
3. Conical flask.

REAGENTS ->

EDTA solution 0.01 M

PROCEDURE ->

1. Take 20ml well mixed sample in Erlenmeyer flask.
2. Add 1 to 2ml buffer solution so as to bring the pH to 10 ± 0.50 .
3. Add 2 drops Eriochrome black T indicator solution. The solution changes in colour.
4. Titrate against standard EDTA till colour turns blue. Note down the volume (V)

OBSERVATIONS AND CALCULATIONS -7

S.L.No.	Sample No.	Volume of Sample (V)	Initial burette reading (ml)	Final burette reading (ml)	Volume of EDTA (ml)	Hardness (mg/l)
1.	1	20 ml	20 ml	20.2 ml	0.2	10

$$\text{Hardness as } \text{CaCO}_3 = (V_1 \times S \times 1000) / V \text{ mg/l}$$

where; V_1 = ml of titrant used

S = mg of CaCO_3 equivalent to 1ml of EDTA solution = 1mg CaCO_3

V = volume of sample

$$= [(0.2 \times 1 \times 1000) / 20] = 10 \text{ mg/l}$$

RESULT ->

$$\text{Hardness as } \text{CaCO}_3 = 10 \text{ (mg/l)}$$

Siliguri Institute of Technology
Civil Engineering Department
Laboratory Work Book for ENVIRONMENTAL ENGINEERING(CE791)

Title Sheet

Experiment No : CE791/1
Experiment Name : DETERMINATION OF TURBIDITY (NTU)
Date of Experiment : 24 - DECEMBER - 2020
Submission Date : 02 - JANUARY - 2021
Student Name : Debojyoti Mante
Roll No. : 11901317027
Semester/Year : 7th Semester, 4th Year, 2020-21

Debojyoti Mante.
Signature of Student:

Experiment No. CE 791/1

NAME → Determination of TURBIDITY (NTU).

AIM → To determine the turbidity of the given samples.

PRINCIPLE →

Turbidity can be measured either by its effects on the transmission of light which is termed as turbidimetry or its effects on the scattering of light which termed as Nephelometry. Turbidimetry can be used for sample with moderate turbidity and Nephelometer for sample with low turbidity. Higher the intensity of scattered light higher the turbidity.

APPARATUS →

1. Nephelometric Turbidimeter.
2. Cuvettes to takes the samples for measurements.

REAGENTS →

- Solution (1) dissolves 1 g hydrazine sulphate in distilled water and dilute to 100ml in volumetric flask.
- Solution (2) dissolves 10 g hexamine LR grade in distilled water and dilute to 100ml in volumetric flask.
- In 100ml volumetric flask, mix 12.5ml solution (1) and 12.5ml solution (2). Let them stand for 24 hrs at 25°C dilute to mark and mix. The turbidity of the suspension is 1000 NTU.

PROCEDURE ->

1. Switch on the instrument and keep it on for some time.
2. Select appropriate range depending upon the expected turbidity of the sample.
3. Set zero of the instrument with turbidity free water using a blank solution and adjust 000 with set zero knob
4. Now in another test tube take standard suspension just prepared as above for 0-200 NTU solution as standard.
5. Take its measurements and set the display to the value of the standard suspension with the calibrate knob.

RESULT ->

Tap water = 0.69 NTU

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Laboratory Work Book for ENVIRONMENTAL ENGINEERING(CE791)

Title Sheet

Experiment No : CE 791/10

Experiment Name : DETERMINATION OF OPTIMUM DOSAGE
OF ALUM

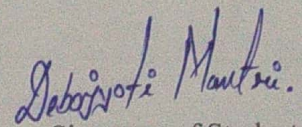
Date of Experiment : 11 - JANUARY - 2021

Submission Date : 14 - JANUARY - 2021

Student Name : Debojyoti Mantei

Roll No. : 11901317027

Semester/Year : 7th Semester, 4th Year, 2020 - 21


Signature of Student:

Experiment No. CE 791/10.

NAME → Determination of OPTIMUM DOSAGE of ALUM (Jar test apparatus).

AIM → To determine the optimum alum dosage of the given samples of water.

PRINCIPLE →

Metal salts hydrolyse in presence of the natural alkalinity to form metal hydroxides. The multivalent cations can reduce the Zeta-potential. The metal hydroxides are good adsorbents and hence remove the suspended particles by entrapping them.

APPARATUS →

Jar Test Apparatus.

REAGENTS →

Standard Alum / Ferricous / Ferric Salt Solution :- Prepare standard chemical solution such that 1L of solution contains 14.28 gm. of salt in the solution.

PROCEDURE →

1. Measure initial turbidity of the sample.
2. Measure 1 lit. of the water to be tested into a series of glass jars.
3. Attach to stirring device (Jar test Apparatus)

Teacher's Signature

4. Add progressive volumes of the chemical solution to each of the jars covering the range of chemical dosage expected of 0.25ml, 0.5ml, 0.75ml, 1ml, 1.25ml, 1.5ml
5. Mix rapidly each sample for 1 minute @ 60-80 rpm
6. Reduce the speed to about 30 rpm and mix for 15 mins
7. Allow the flocs to settle for 30 minutes

RESULT ->

Selected optimum dosage = x (say) ml/l = 1.5 mg/l

Strength of alum solution = 14.28 gm/l = 14.28 mg/ml

Optimum dosage, mg/l = 14.28 mg/ml $\times x$ ml/l = (14.28 $\times$ 1.5) mg/l

$$= 14.28 x \text{ mg/l.}$$

$$= (14.28 \times 1.5) \text{ mg/l}$$

$$= 21.42 \text{ mg/l}$$

Siliguri Institute of Technology
Civil Engineering Department
Laboratory Work Book for ENVIRONMENTAL ENGINEERING(CE791)

Title Sheet

Experiment No : CE 791/6

Experiment Name : DETERMINATION OF ALKALINITY OF A GIVEN SAMPLE

Date of Experiment : 18 - JANUARY - 2021

Submission Date : 20 - JANUARY - 2021

Student Name : DEBOJYOTI MANTRA

Roll No. : 11901317027

Semester/Year : 7th Semester, 4th Year, 2020-21

Debojyoti Mantra
Signature of Student:

Experiment No $\rightarrow$ CE 791/6

NAME $\rightarrow$ Determination of ALKALINITY of a given Sample

AIM $\rightarrow$ To determine the amount of alkalinity present in the given sample

APPARATUS $\rightarrow$

1. Burette with Burette stand and porcelain tile
2. Pipettes with elongated tips
3. Conical flask
4. Measuring cylinders
5. Beakers
6. Dropper
7. Stirrer

REAGENTS $\rightarrow$

1. Standard 0.02N Sulphuric acid
2. Phenolphthalein indicator
3. Methyl orange indicator

REAGENTS PREPARATION $\rightarrow$

2) Std. acid of 0.02N

Prepare 0.1N HCl solution by diluting 9ml of conc. HCl to 1 litre in distilled water. Standardize this with 0.1N Sodium Carbonate solution. Prepare 0.02N HCl solution by diluting 20ml of 0.1N HCl to 1 litre in distilled water.

Teacher's Signature

[OR]

Place 7-ml conc H_2SO_4 in a 250 ml jar and make up to the mark with carbon dioxide free distilled water. Standardize it against 0.1N sodium carbonate solution using methyl orange as the indicator [End pt. is the appearance of faint orange colour]. This will give 1N standardize sulphuric acid dilute 20 ml of 1N standardize sulphuric acid to 1000 ml in a volumetric flask with carbon dioxide free distilled water to give 0.02N standard acid. 1ml of exactly 0.02N acid = 1.0mg of $CaCO_3$

(Either H_2SO_4)

Sodium Carbonate solution 0.1N

Dissolve 0.53gm anhydrous sodium carbonate in distilled water and make up to 100ml.

b) Phenolphthalein indicator

Add 1 gm of phenolphthalein in 200 ml distilled water and dissolve it. Add 0.02N sodium hydroxide solution dropwise until a faint pink colour appears. (0.4gm NaOH dissolved in 100 ml distilled water gives 0.02N NaOH)

c) Methyl orange indicator

Add 0.1gm of methyl orange in 200 ml of distilled water. Heat until it gets dissolved and filter it.

Teacher's Signature

OBSERVATIONS AND CALCULATIONS →

Table - 1:- Determination of phenolphthalein Alkalinity →

Sample No and Source	Volume of Sample (ml)	Burette Reading		Volume of Sulphuric acid (ml)	phenolphthalein alkalinity (mg/L as CaCO_3)
		Initial (ml)	Final (ml)		
1	100	3.1	3.7	0.6	6

PROCEDURE →

Phenolphthalein alkalinity (P) →

1. Take 20ml of water sample in conical flask. (If the sample contains any chlorine. Dechlorinate by the addition of 1 drop 0.1 N Sodium thiosulphate soln.)
2. Add 1 or 2 drops of phenolphthalein indicator until the colour becomes pink
3. Titrate against std. acid till colour just disappears.

Total alkalinity (T) →

1. Add 1 or 2 drops of methyl ^{orange} indicator to the same solution in which phenolphthalein alkalinity has been determined. The colour becomes yellowish.
2. Titrate against std. acid till the colour changes to pale pink
3. Repeat the titrate for concordant values.

Table - 2 :- Determination of Methyl Orange -7

Sample No. and Source	Volume of Sample (ml)	Burette Reading (ml)		Volume of Sulphuric acid (ml)	Total Alkalinity (mg/l as CaCO_3)
		Initial	Final		
<u>1</u>	<u>100</u>	<u>3.7</u>	<u>6.4</u>	<u>2.7</u>	<u>27</u>

CALCULATION →Phenolphthalein alkalinity (as CaCO_3) mg/l =

$$(\text{Vol. of Std. acid in ml} \times 1000) / \text{Vol. of Sample taken in ml}$$

(For phenolphthalein end point)

$$= [(0.6 \times 1000) / 100] = 6$$

$$(\text{as } \text{CaCO}_3) \text{ mg/l} = (\text{Vol. of Std. acid in ml} \times 1000) / \text{Vol. of Sample taken in ml}$$

(For methyl orange end pt.)

$$= [(2.7 \times 1000) / 100] = 27$$

∴ Total alkalinity

$$= 6 + 27 = 33 \text{ (mg/l)}$$

RESULT →Hydroxyl alkalinity = mg/l Carbonate alkalinity = mg/l Bicarbonate alkalinity = mg/l Total alkalinity = mg/l

Teacher's Signature

Siliguri Institute of Technology
Civil Engineering Department
Laboratory Work Book for ENVIRONMENTAL ENGINEERING(CE791)

Title Sheet

Experiment No : CE 791/11

Experiment Name : DETERMINATION OF RESIDUAL
CHLORINE

Date of Experiment : 25 - JANUARY - 2021

Submission Date : 03 - FEBRUARY - 2021

Student Name : DEBOJYOTI MANTRI

Roll No. : 11901317027

Semester/Year : 7th Semester, 4th Year, 2020-21

Debojyoti Mantri.
Signature of Student:

Experiment No. CE. 791/11

Name $\rightarrow$ Determination of RESIDUAL CHLORINE.

AIM $\rightarrow$

To determine the amount of free residual chlorine present in the given sample by iodometric method.

PRINCIPLE $\rightarrow$

Chlorine will liberate free Iodine from Potassium Iodide solution at pH 8 or less. The liberated Iodine is titrated against standard Sodium thiosulphate with starch as indicator

APPARATUS $\rightarrow$

- Burette with stand
- Pipette
- Conical flask
- Measuring jar

CHEMICAL REQUIRED $\rightarrow$

1. Sodium thiosulphate
2. Potassium iodide
3. Conc. HCL
4. Starch.

REAGENTS PREPARATION $\rightarrow$

Standard sodium thiosulphate solution (0.05N)

Dissolve 3.1 gm of sodium thiosulphate in 250 ml of distilled water. For preservation add 2 drops of chloroform

Standard potassium iodide solution (0.1)N

Dissolve 4.15 gm of potassium iodide in 250 ml of distilled water.

Starch indicator

Dissolve 1 gm starch in 1 litre distilled water to make a thin paste. Pour this paste in about 100 ml boiling distilled water and boil for 2 min and cool.

PROCEDURE ->

- (A) Take 250 ml conical flask and add to it 10 ml of potassium iodide solution.
- (B) Add to it 100 ml of sample.
- (C) Shake vigorously and add to it 10 ml of distilled water.
- (D) Add 2 ml of conc HCl.
- (E) Add 1 or more starch until the colour becomes blue.
- (F) Titrate against sodium thiosulphate solution until the blue colour just disappears.

OBSERVATIONS AND CALCULATIONS →

Sl. No	Burette reading (ml) Initial	Burette reading (ml) Final	Volume of the given sample (ml)	Indicator	End point
<u>1</u>	<u>10</u>	<u>12</u>	<u>2</u>	Starch	Disappearance of deep blue color.

CALCULATION →

$$1000 \text{ ml of } 1N \text{ Sodium thiosulphate} = 35.45 \text{ gms of chlorine} \\ (\text{free residual chlorine mg/l}) = \frac{(35.45 \times V_2 \times N \times 1000)}{V_1}$$

V_1 = Volume of sample in ml

V_2 = Volume of Sodium thiosulphate

N = normality of Sodium thiosulphate (0.05)

RESULT →

The amount of free residual chlorine present in the given sample = mg/l

Siliguri Institute of Technology
Civil Engineering Department
Laboratory Work Book for ENVIRONMENTAL ENGINEERING(CE791)

Title Sheet

Experiment No : CE 791 / 2
Experiment Name : DETERMINATION OF COLOR IN WATER
Date of Experiment : 04 - FEBRUARY - 2021
Submission Date : 09 - FEBRUARY - 2021
Student Name : DEBOJYOTI MANTRI
Roll No. : 11901317027
Semester/Year : 7th Semester, 4th Year, 2020-21

Debojyoti Mantri
Signature of Student:

Experiment No $\rightarrow$ CE 791/2

NAME $\rightarrow$ Determination of color in water.

AIM $\rightarrow$ To determine the color in water.

APPARATUS $\rightarrow$

1. Color Disk
2. Filtration system including Filter paper, funnel, holder, beaker etc.

REAGENTS $\rightarrow$

1. Standard potassium chloro-platinate solution.

PROCEDURE $\rightarrow$

1. Prepare standard samples having color within a specific range by mixing different concentration of standard potassium chloro-platinate solution with distilled water. Using these samples to prepare a color calibration curve (Absorbance vs color concentration) for the spectrophotometer.
2. Take 50ml of filtered test sample in a beaker. Take 50ml distilled water in another beaker. Use this sample as blank.
3. Set the spectrophotometer to determine color concentration of the sample.
4. Put the blank sample inside the spectrophotometer cell and

Teacher's Signature

OBSERVATIONS AND CALCULATIONS →

Sample No	Source of Sample	Temperature of Sample ($^{\circ}\text{C}$)	Color (pt-co)
1	Tap water	25 $^{\circ}\text{C}$	1.45

Set the reading "Zero".

5. Bring out the blank sample and place the test sample inside the spectrophotometer.

6. After a while the display will show the color concentration of the sample.

RESULT →



Siliguri Institute of Technology

Civil Engineering Department

Laboratory Work Book for Transportation Engineering Laboratory

(CE(PC)596)

NAME: Soumik Datta

ROLL NO.: 11901319039

REGISTRATION NO.:

SEMESTER/YEAR: 5th (3rd Year)

Siliguri Institute of Technology
Civil Engineering Department
Laboratory Work Book for Transportation Engineering Laboratory
(CE(PC)596)

Title Sheet

Experiment No : 1

Experiment Name : Aggregate Impact value

Date of Experiment :

Submission Date :

Student Name : Soumik Dutta

Roll No. : 11901319039

Semester/Year : 5th / 3rd

Signature of Student:

Aggregate impa

No.

AGGREGATES

Page No. /

Date. /

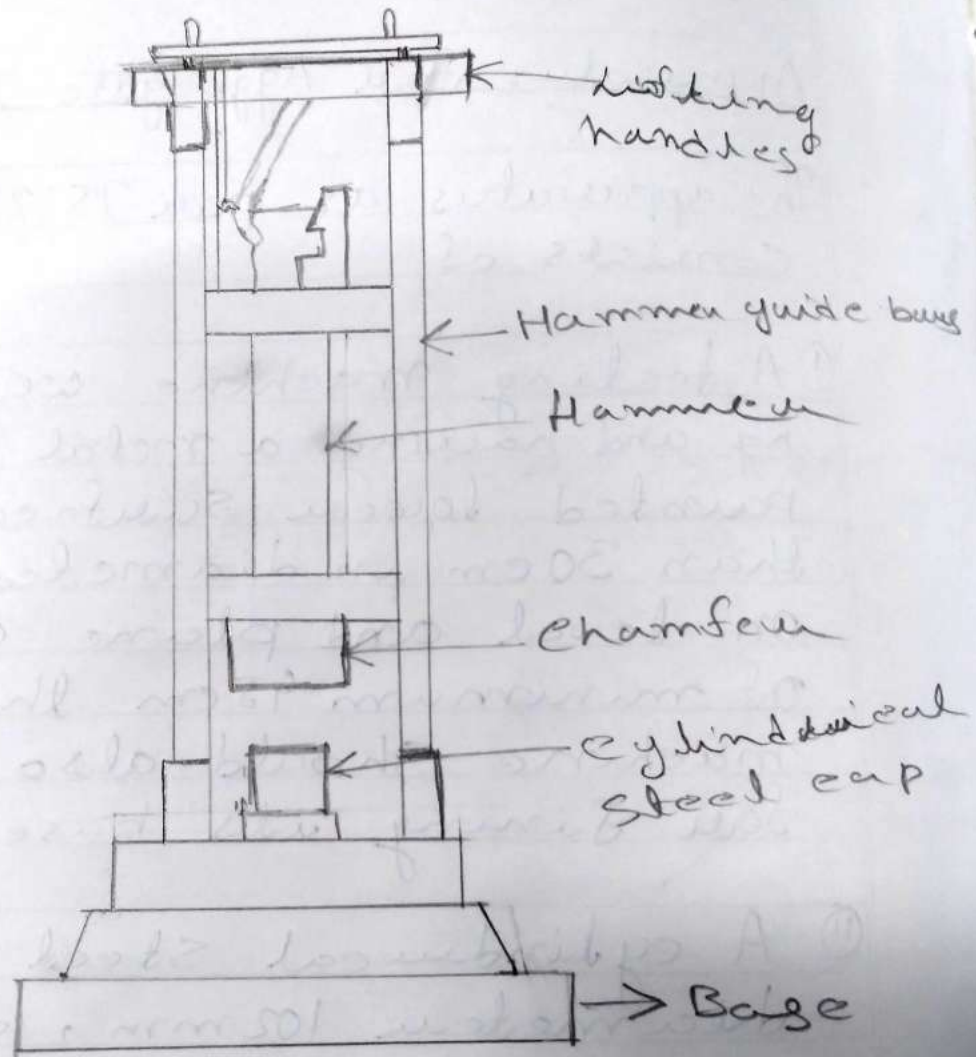
AGGREGATE IMPACT VALUE ON COARSE

Aim: To determine the impact value of aggregate.

Apparatus for Aggregate Impact Test:

The apparatus as per IS: 2386 (Part IV) - 1963 consists of:

- (i) A testing machine weighing 45 to 60 kg and having a metal base with a painted lower surface of not less than 30 cm in diameter. It is supported on level and plane concrete floor of minimum 45 cm thickness. The machine should also have provisions for fixing its base.
- (ii) A cylindrical steel cup of internal diameter 102 mm, depth 50 mm and minimum thickness 6.3 mm.
- (iii) A metal hammer on top weighing 13.5 to 14.0 kg the lower end being cylindrical in shape, 50 mm long 100.0 mm in diameter with a 2 mm chamfer at the lower



Aggregate Impact Testing Machine

edge and case hardened. The hammer should slide freely between guides and be concentric with the cup. Free fall of hammer should be within 380 ± 5 mm.

- ⑭ A cylindrical metal measure having internal diameter 75 mm and depth 50 mm for measuring aggregates.
- ⑮ Tamping rod 10 mm in diameter and 230 mm long, rounded at one end.
- ⑯ A balance of capacity not less than 500 g readable and accurate up to 0.1 g.

Theory of Aggregate Impact Test:-

The property of a material to resist impact is known as toughness. Due to movement of vehicles on the road the aggregates should therefore have sufficient toughness.

Teacher's Signature

to resist their disintegration due to impact.

This characteristic is measured by impact value test.

The aggregate impact value is a measure of resistance to sudden impact or shock, which may differ from its resistance to gradually applied compressive load.

Procedure of Aggregate Impact test:-

The test sample consists of aggregates sized 10.0 mm 12.5 mm. Aggregates may be dried by heating at 100-110°C for a period of 4 hours and cooled.

① Sieve the material through 12.5 mm and 10.0 mm IS Sieves. The aggregates passing through 12.5 mm Sieve and retained on 10.0 mm Sieve comprises the test material.

② Pour the aggregates to fill about just $\frac{1}{3}$ rd depth of measuring cylinder.

- (iii) Compact the material by giving 25 gentle blows with the rounded end of the tamping rod.
- (iv) Add two more layers in similar manner, so that cylinder is full.
- (v) Strike off the surplus aggregates.
- (vi) Determine the net weight of the aggregates to the nearest gram (w).
- (vii) Bring the impact machine to rest without wedging or packing up on the lower plate, block or floor, so that it is rigid and the hammer guide columns are vertical.
- (viii) Fix the cap firmly in position on the base of machine and place whole of the test sample in it and compact by giving 25 gentle strokes.

Teacher's Signature

with tamping rod.

(ix) Raise the hammer ~~its~~ until its lower face is 380 mm above the surface of aggregate sample in the cup and allow it to fall freely on the aggregate sample. Give 15 such blows at an interval of not less than one second between successive falls.

(x) Remove the crushed aggregate from the cup and sieve it through 2.36 mm IS Sieves until no further significant amount passes in one minute. Weigh the fraction passing the sieve to an accuracy of 1 gm. Also, weigh the fraction retained in the sieve.

Compute the aggregate impact value. The mean of two observations rounded to nearest whole number is reported as the Aggregate Impact value.

Observations of Impact Test:-

Observations	Sample 1	Sample 2
Total weight of dry Sample (W_1 gm)	366	350
Weight of portion passing 2.36mm sieve (W_2 gm)	50	48
Aggregate impact value (Percent) = $W_2/W_1 \times 100$	13.66%	13.71%
Mean =	13.68%	

Sample calculation:-

Observation	Sample 1	Sample 2
Total weight of dry sample (W_1 gm)		
Weight of portion passing 2.36mm sieve (W_2 gm)		
Aggregate Impact value (Percent) = $W_2/W_1 \times 100$		

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Mean =

Result of Impact test:-

Aggregate Impact Value: 13.88%

Recommended Aggregate Impact Test Values

Classification of aggregates using Aggregate Impact Value is as given below:-

Aggregate Impact Value	Classification
< 20%	Exceptionally Strong
10-20%	Strong
20-30%	Satisfactory for

Teacher's Signature

>35%

Weak form road
surfacing.

Specified limits of Percent aggregate impact value for different types of road construction by Indian Roads Congress is given below.

SI NO	Type of Pavement	Aggregate impact value not more than.
1	Wearing course	
a	Bituminous surface dressing	
b	Penetration macadam	30
c	Bituminous carpet concrete	
d	Cement concrete	
2	Bitumen bound macadam base course	35
3	WBM base course with bitumen surfacing	40
4	Cement concrete base course	45

Siliguri Institute of Technology
Civil Engineering Department
Laboratory Work Book for Transportation Engineering Laboratory
(CE(PC)596)

Title Sheet

Experiment No : 2

Experiment Name : Flakimers Index and elongation Index test

Date of Experiment : 03/12/20

Submission Date :

Student Name : Soumik Dutta

Roll No. : 11901319039

Semester/Year : 5th/3rd

Signature of Student:

FLAKINESS INDEX AND ELONGATION INDEX OF COARSE AGGREGATES.

Page No. /

Date. /

- AIM: ① To determine the elongation index of the given aggregates
② To determine the flakiness index of the given aggregates

Apparatus:- The apparatus for the Shape tests consists of the following

- ① A standard thickness gauge
- ② A standard length gauge
- ③ IS Sieves of sizes 63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 and 6.3 mm
- ④ A balance of capacity 5 kg readable and accurate up to 1 gm

Theory:- The particle shape of aggregates is determined by the percentages of flaky and elongated particles contained in it. For base courses and construction of bituminous and cement concrete types, the presence of flaky and elongated particles are considered undesirable as these cause inherent weakness with the possibilities of breaking

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down under heavy loads. The evaluation of shape of the particles, particularly with reference to flakiness and elongation is necessary.

Procedure:- ① Sieve the sample through the 15 sieves (as specified in the table)

② Take a minimum of 200 pieces of each fraction to be tested and weigh them.

③ In order to separate the flaky materials, gauge each

④ Weigh the flaky material passing the gauge to an accuracy of at least 0.1 percent of the test sample.

⑤ In order to separate the elongated materials, gauge each fraction for length on a length gauge.

⑥ Weigh the elongated material retained on the gauge to an accuracy of at least 0.1 percent of the test sample.

Size of aggregates		Weight of fraction consisting of at least 200 pieces	Thickness gauge size, mm	Weight of aggregate in each fraction passing through gauge mm	Length in each fraction retaining on length gauge, mm	Length of aggregate in each fraction retaining on length gauge, mm
Passing through IS sieve mm	Retained on IS sieve mm					
1	2	3	4	5	6	7
63	50	w ₁	23.90	x ₁	-	-
50	40	w ₂	27.00	x ₂	81.00	y ₁
40	31.5	w ₃	19.50	x ₃	58.00	-
31.5	25	w ₄	19.95	x ₄	40.5	y ₂
25	20	w ₅	13.50	x ₅	32.4	y ₃
20	16	w ₆	10.80	x ₆	25.5	y ₄
16	12.5	w ₇	8.55	x ₇	20.2	y ₅
12.5	10	w ₈	9.75	x ₈	1.47	y ₆
10	6.3	w ₉	2.89	x ₉	0	y ₇
		w		x =		

Observation:-

$$\text{Flakiness index} = \frac{(x_1 + x_2 + \dots)}{(w_1 + w_2 + \dots)} \times 100$$

$$\text{Elongation index} = \frac{(y_1 + y_2 + \dots)}{(w_1 + w_2 + \dots)} \times 100$$

Result

1) Flakiness index =

2) Elongation index =

Sample Calculations

Size of aggregate		Weight of aggregate		Weight of aggregate		Weight of aggregate in each
Passing through IS Sieve mm	Retained on IS Sieve mm	Weight of specimen consisting of at least 200 pieces	Thickness of gauge, mm	Surface area of specimen passing thickness gauge, mm	Length of gauge, mm	Section retained on length gauge, mm
1	2	3	4	5	6	7
63	50	$W_1 = 0$	23.90	$X_1 = 0$	-	-
50	40	$W_2 = 0$	27.00	$X_2 = 0$	81.00	$Y_1 = 0$
40	31.5	$W_3 = 6$	19.50	$X_3 = 0$	58.00	$Y_2 = 6$
31.5	25	$W_4 = 6$	19.95	$X_4 = 0$	-	-
25	20	$W_5 = 2562$	13.50	$X_5 = 235$	40.21	$Y_3 = 159$
20	16	$W_6 = 1653$	10.80	$X_6 = 216$	32.4	$Y_4 = 135$
16	12.5	$W_7 = 854$	8.55	$X_7 = 135$	25.5	$Y_5 = 195$
12.5	10	$W_8 = 462$	6.75	$X_8 = 169$	20.2	$Y_6 = 142$
10	6.3	$W_9 = 263$	4.89	$X_9 = 63$	14.7	$Y_7 = 69$
Total		$W = 5794$		$X = 818$		$Y = 695$

Result :-

① Flakiness Index = 14.12%

② Elongation Index = 12.00%

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Civil Engineering Department

Laboratory Work Book for Transportation Engineering Laboratory

(CE(PC)596)

Title Sheet

Experiment No : 3

Experiment Name : Los angle abrasion value test

Date of Experiment : 22/12/20

Submission Date : 29/12/20

Student Name : Soumik Dutta

Roll No. : 11901319099

Semester/Year : 5th / 3rd

Signature of S

Los Angeles Abrasion Value Test

Page No. /

Date. /

Aim:- To determine the Los Angeles abrasion value of the aggregate and assess the suitability of aggregates to be used in the different road pavements.

Introduction:- Due to the movement of traffic, the road stones used in the subdrainage course are subject to wearing action at the top.

Resistance to wear or hardness is an essential property of road aggregates, especially when used in wearing course. These road stones should be hard enough to resist the abrasion due to traffic. When fast moving traffic fitted with pneumatic tyres to move on the road, the soil particles pass between the wheel and road surface causes abrasion.

Abrasion test on aggregate are generally carried out by any of the following methods

1. Los Angeles abrasion test

2. Deval's abrasion test

3. Dummey's abrasion test

Of these, the Los Angeles abrasion test is most commonly adopted as the test values of aggregates have been correlated with the performance of studies.

Los Angeles Abrasion Test

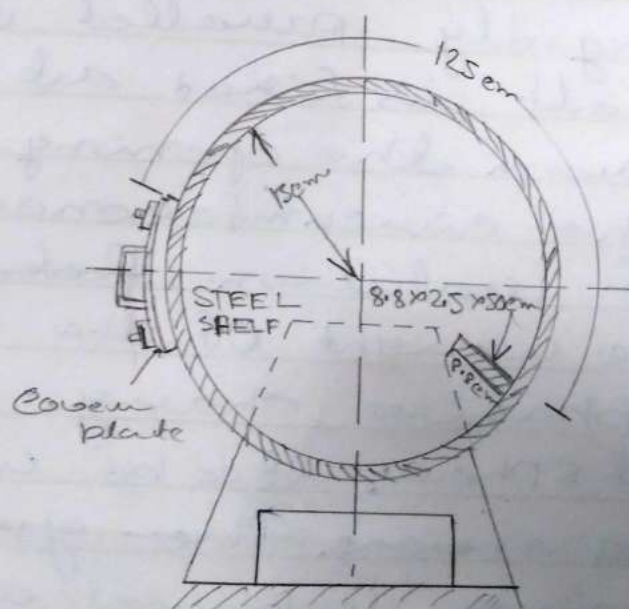
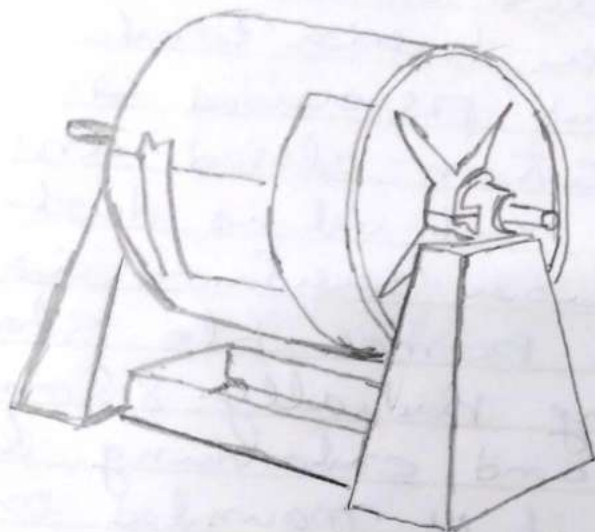
Theory:-

The principle of Los Angeles abrasion test is to find the percentage wear due to relative rubbing action between aggregates and steel ball used as an abrasive charge. The pounding action of these balls all exists while conducting the test. Los Angeles abrasion test has been standardized by the ASTM, AASHTO and ~~Tenn~~ also by the ISI. The specification of Los Angeles abrasion values is also available for various types of pavement construction.

Apparatus:- The apparatus consists of a Los Angeles machine and sieves.

Los Angeles machine consists of a hollow steel cylinder closed at both ends having an inside diameter 30 cm and an inside length of 50 cm mounted on stub shafts about which it rotates on a horizontal axis. An opening is provided in such a way that when closed and lined by bolts and nut, it is dust-tight and the innermost surface is perfect cylindrical. A removable steel shell projecting radially 8.8 cm into the cylinder and extending to the full length of it is mounted on the innermost surface of the cylinder rigidly parallel to the axis. The shell is lined at a distance of 1.5 cm from the opening, measured along the circumference in the direction of rotation, ~~Refer~~ Abrasive chart. The weight of the sphere used as it abrasive charge and the number of spheres to be used are specified depending. The grading and abrasive charge to be used are given in the table with 1.7 mm opening - the new one.

9



CROSS SECTION

Los Angeles Abusion Machine

Date. / /

Grading	Weight in grams of each test sample in the size range, mm (Passing and retained on square holes)										Abrasive Change	
	80-63	63-50	50-40	40-25	25-20	20-12.5	12.5-10	10-6.3	6.3-4.75	4.75-2.36	No. of Spheres	Weight of change
A	-			1250	1250	1250	1250				12	5000 ± 25
B	-					2500	2500				12	4884 ± 25
C	-							2500	2500		8	3330 ± 25
D	-								5000		6	2500 ± 15
E	2500x	2500x	5000x								12	5000 ± 25
F			5000x	5000x							12	5000 ± 25
G				5000x	5000x						12	5000 ± 25

Procedure: Clean aggregates dried in an oven at 105-110°C to constant weight. Conforming to any one of the grading A, to G as per table 1. is used for the test. The grading or gradations used in the test should be nearest to may be taken as a test specimen and placed in the cylinder. The cover is then fixed dust-tight. The machine is rotated at a speed of 30 to 33 revolutions per minute. The machine is rotated for 500 revolution for gradations A, B, C, and D four gradations

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E, F and G it shall be rotated for 1,000 revolutions. The machine should be balanced and driven in such a way as to maintain uniform peripheral speed.

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. Using a sieve of a size larger than 1.70 mm IS size, the material is first separated into it parts and the finer portion is taken out and sieved further on a 1.7 mm IS sieve. The portion of material coarser than 1.7 mm size is washed and dried in an oven at 105 to 110°C to constant weight and weighed correct to one gram.

OBSERVATION SHEET

Table 2. Result of Los Angeles abrasion test

① Type of aggregate =

② Number of spheres used =

③ Number of revolutions =

④ Gradation =

⑤ Weight of charge =

⑥ Speed of rotation =

Test values and calculation	Test Number	Average
	1	2
Weight of Specimen, W_1 g =	5000	
Weight of Specimen after Abrasion test, retained on 1.70 mm test sieve		
W_2 g =	2650	
Los Angeles abrasion value = Percentage wear = $\frac{W_1 - W_2}{W_1} \times 100$	47.00%	

Calculation:-

The difference between the original and final weight of the sample represents the actual wear that has taken place and the value is expressed as a percentage of the original weight of the sample and is reported as the Percentage wear.

Let the original weight of agg = W_1 gm
Weight of agg retained on 1.70 mm sieve after the test =

Loss in weight due to wear test = $(W_1 - W_2)$

Los Angeles Abrasive Value: Percentage wear
= $\frac{W_1 - W_2}{W_1} \times 100$

Sample calculation

OBSERVATION SHEET

Table 3 Result of Los Angeles abrasion test

- ① Type of agg = B
- ② Number of Spheres used = 11
- ③ Number of revolutions = 500
- ④ Gradung = B
- ⑤ Weight change = 4599 gm
- ⑥ Speed of rotation = 33 rpm

Test Values and calculation	Test Number		Average
	1	2	
Weight of Specimen W_1 =	5000	5000	5000
Weight of Specimen after abrasion test retained on 1.70 mm test sieve, W_2 =	3708	3668	3608
Los Angeles abrasion value = Percentage wear	25.84%	26.64%	26.24%
$\frac{W_1 - W_2}{W_1} \times 100$			

calculation:- The above Los Angeles Abrasion value of the aggregate is within the MORTAR Specification to be used in any pavement layer.

Result:- The result of Los Angeles abrasion test is expressed as a % wear and the

Average value of two tests may be reported as the Los Angeles abrasion value.

Los Angeles Abrasion Value = _____ %

TABLE 4: - Max Allowable Los Angeles Abrasion values of Agg in Different types of Pavement Layer.

SINO	Type of Pavement Layer	Los Angeles Abrasion value max %
1	(i) WBM Sub-base, WBM, WMM and CRM base courses	40
	(ii) Bituminous Penetration macadam Built up spray grade base course	
	(iii) Bituminous Precursor base / binder course	
2	(i) Dense-graded BM & binder course	35
	(ii) Cement concrete pavement	
3	(i) Bituminous carpet Surface course	40
	(ii) Bituminous Surface dressing single or two coats	
4	(i) Close graded bituminous Surfaced mixed seal surfacing	30
	(ii) Bituminous concrete Surface course	

Siliguri Institute of Technology

Civil Engineering Department

Laboratory Work Book for Transportation Engineering Laboratory

(CE(PC)596)

Title Sheet

Experiment No : 57

Experiment Name : Aggregate crushing value test

Date of Experiment :

Submission Date :

Student Name : Soumik Dutta

Roll No. : 11901319039

Semester/Year : 5th/3rd

Signature of Student

AGGREGATE CRUSHING VALUE TEST

Page No. /

Date. /

- AIM:-
- To determine the aggregate crushing value of the aggregate
 - To assess the suitability of the aggregates to be used in different road pavements.

Introduction:- The aggregates used in roads and pavement construction must be strong enough to withstand crushing under wheel and traffic. Aggregate crushing value test on the resistance of an aggregate crushing value is a numerical index of the strength of the aggregate and it is used in construction of roads and pavement. ~~Course~~ agg crushing value is the percentage of the crushed material obtained when test aggregates are subjected to a specified load under standardized condition.

Principle:- The aggregate crushing value gives relative measure of the resistance of an aggregates to crushing under a gradually applied compressive load. Crushing value is a measure of strength of the aggregates the aggregate should

therefore have minimum crushing value.

Apparatus:- ① A steel cylinder 15cm dia with plunger and base plate

② A straight metal tamping rod 16mm dia and 45 to 60cm long rounded at one end

③ A balance of capacity 3kg readable and accurate to one gram.

④ IS sieves of sizes 12.5mm, 10mm and 2.36mm

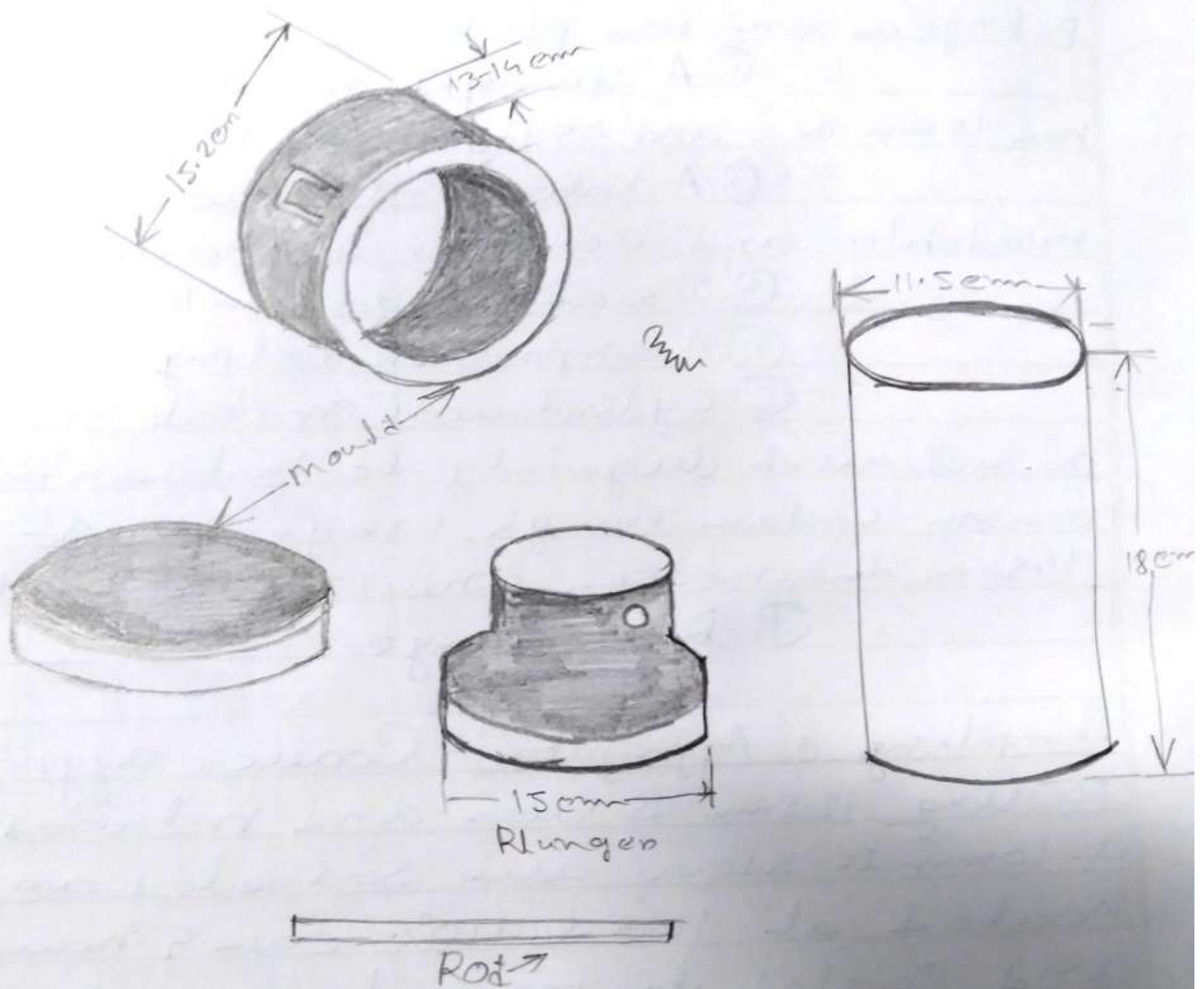
⑤ A compression testing machine.

⑥ Cylindrical metal measure of sufficient rigidity to retain its form under rough usage and of 11.5cm diameter and 18cm height.

⑦ Dial gauge.

Sampling of Aggregates:- Coarse aggregate passing 12.5mm IS sieve and retained on a 10mm IS sieve are selected and heated at 100 to 110°C for 9 hours and cooled to room temperature.

The quantity of aggregate shall be such that the depth of material in the cylinder, after tamping shall be 10cm. This conveniently by filling the cylinder

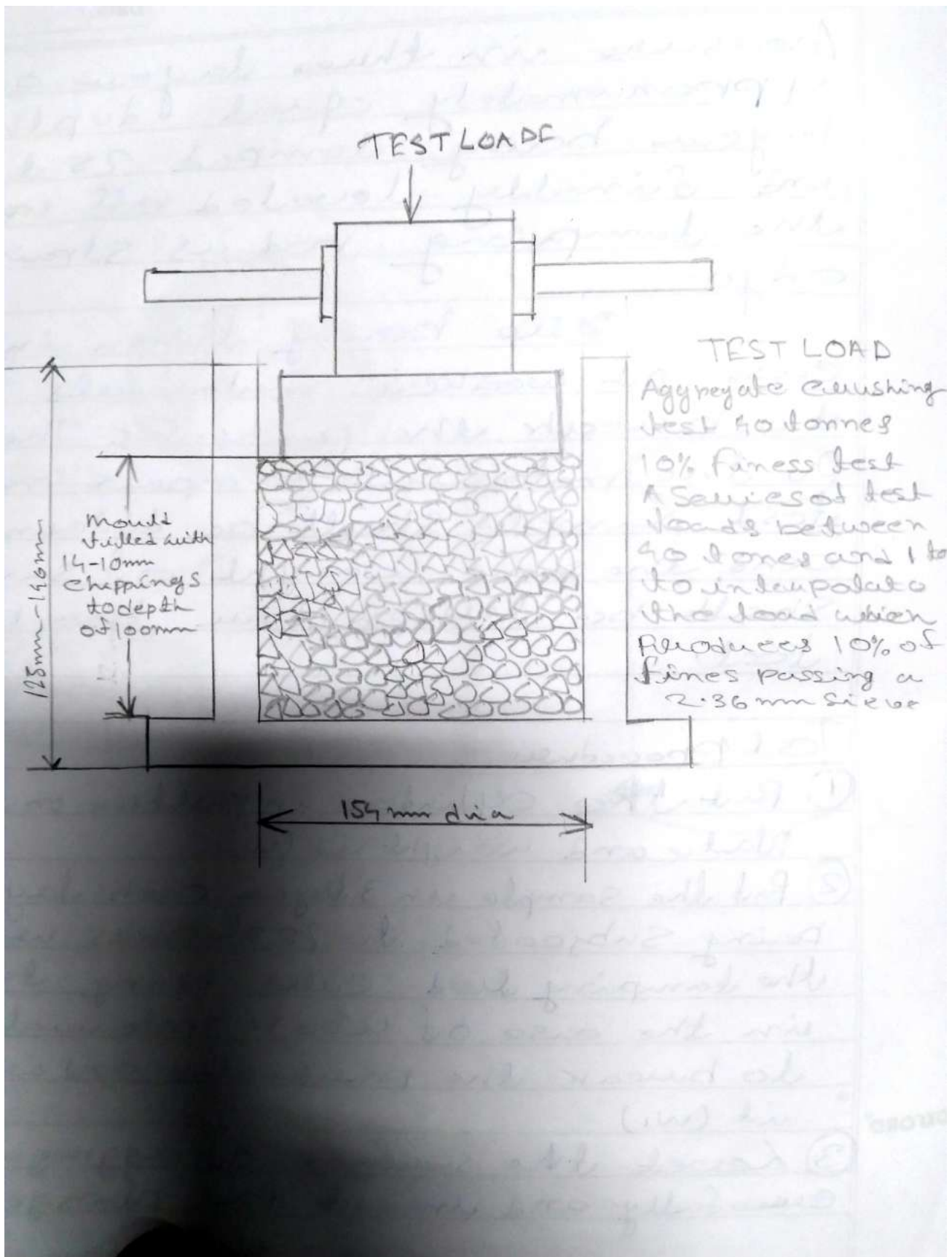


measures in three layers of approximately equal depth, each layer being tamped 25 times and finally leveled off using the tamping rod as straight edge.

care being taken in the case of weaker materials not to break the particles. The weight of the material comprising the test sample shall be determined and the same weight of sample shall be taken for the repeat test.

Test procedure:-

- ① Put ~~the~~ cylinder in position on the base plate and weight it (w)
- ② Put the sample in 3 layers each layer being subjected to 25 strokes using the tamping rod. Care being taken in the case of weak materials not to break the particles and weight it (w_1)
- ③ Level the surface of aggregate carefully and insert the plunger



that it rests horizontally on the surface. care being taken to ensure that the plunger does not jam in the cylinder.

4. Place the cylinder with plunger on the loading platform of the compression testing machine.
5. Apply load at a uniform rate so that a total load of 90T is applied in 10 minutes.
6. Release the load and remove the material from the cylinder.
7. Sieve the material with 2.36mm IS sieve care being taken to avoid loss of fines.
8. Weigh the fraction passing through the IS sieve (W_2).

Calculation: The ratio of weight of fines found to the weight of total sample in each test shall be expressed as a percentage the result being rounded to the first decimal place.

Aggregate Crushing Value = $(W_2 \times 100) / (W_1 - W)$
 W_2 = weight of fraction passing through the appropriate sieve

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$W_1 - W =$ Weight of surface dry sample
 The mean of two results to nearest whole number is the aggregate crushing value

Sample data

Sample Number	Total wt of dry sample W_1	Wt. of fines passing 2.36 mm IS sieve W_2	Aggregate crushing value $= W_2 / W_1 \times 100\%$	Average Aggregate crushing value
	g			
1	3500	340	$\frac{340}{3500} \times 100 = 9.71\%$	9.42
2	3500	320	$\frac{320}{3500} \times 100 = 9.14\%$	

Calculation! - This agg. can be used in any pavement layer based on the crushing value result following the ~~the~~ MORTG & H Specification.

Result - The agg crushing value of the sample is _____.

Siliguri Institute of Technology

Civil Engineering Department

Laboratory Work Book for Transportation Engineering Laboratory

(CE(PC)596)

Title Sheet

Experiment No : 5

Experiment Name : Standard Penetration test for bitumen

Date of Experiment : 15/01/21

Submission Date :

Student Name : Soumik Dutta

Roll No. : 11901319039

Semester/Year : 5th / 3rd

Signature of Student:

No.

STANDARD PENETRATION TEST FOR BITUMEN

Page No.	
Date.	

AIM:- To determine the penetration of bitumen

Apparatus:- The apparatus required for the penetration test are as follow.

- Penetration Apparatus
- Needle
- Container
- Water Bath
- Thermometer for Water Bath
- Stopwatch

Theory:- In this test we examine the consistency of a sample of bitumen by determining the distance in tenths of a millimeter that a standard needle penetrates time and temperature. This is the most widely used method of measuring the consistency of a bituminous material at a given temperature. It is a means of classification rather than a measure of quality.

Procedure for Bitumen Penetration Test.

① Preparation of test Specimen:-

1. Soften the material to a pouring consistency at a temperature not more than 60°C for latex and 90°C for

Softening point still it is homogeneous and free from air bubbles and water.

i) Pour the melt into the container to a depth at least 10mm in excess of the expected penetration. Protect the sample from dust at a temperature between 15° to 30°C for one hour. Then place it along with the transfer dish in the water bath at $25^{\circ} \pm 0.1^{\circ}\text{C}$ unless otherwise stated.

ii) Fill the transfer dish with water from the water bath to depth sufficient to cover the container completely. Place the penetration apparatus.

iii) Clean the needle with benzene dry it and load with the weight. The total moving load required is $100 \pm 0.25\text{ gms}$, including the weight of the needle, carrier and superimposed weight.

iv) Adjust the needle to contact the surface of the sample. protected by the surface of the bituminous material.

Sample calculation:

Actual test temperature = 25°C

Penetration dial reading	Test 1	Test 2	Test 3	Average
a) Initial	190	180	185	185
b) Final	140	144	139	141
Penetration value = (a) - (b)	50	36	46	44

(b) Test

- ① Make the pointer of the dial to read zero or note the initial dial reading
- ② The needle is released by pressing a button and a stop watch is started. The needle is released exactly for a period of 5.0 Sec
- ③ Adjust the penetration machine to measure the distance penetrated
- ④ Make at least 3 readings at point on the surface of the sample not less than 10mm apart and not less than 10mm from the side of the dish. After each test return the sample and transfer dish to the water bath and wash the needle clean with benzene and dry it

Report:-

The average penetration value of 3 tests of a given bitumen sample is reported mean penetration value = 99

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Civil Engineering Department

Laboratory Work Book for Transportation Engineering Laboratory

(CE(PC)596)

Title Sheet

Experiment No : 6

Experiment Name : specific gravity and water absorption test of Aggregate

Date of Experiment : 10/2/21

Submission Date :

Student Name : Soumik Dutta

Roll No. : 11901319039

Semester/Year : 5th/3rd

Signature of Student:

No.

SPECIFIC GRAVITY AND WATER ABSORPTION TESTS OF AGGREGATES.

Page No. /

Date. /

AIM:- To determine the Specific gravity and water absorption of the given aggregate.

Introduction:- The Specific gravity of an aggregate is considered to be a measure of strength or quality of the material.

Aggregates having low specific gravity are generally weaker than with than those with high specific gravity. This property helps a general identification of aggregates.

Water absorption also gives an idea on the internal structure of aggregate. Aggregates having more absorption are more porous in nature and are generally considered unsuitable for good construction, unless found to be acceptable based on strength, Impact and hardness tests.

Apparent Specific gravity is the ratio of the weight in air of a given volume of the water impermeable portion of a

Pourable material at a stated temperature to the weight in air of an equal volume of distilled water at a stated temperature.

Bulk specific gravity is the ratio of the mass of volume of material at a stated temperature to the mass of an equal volume of distilled water at a stated temperature.

Apparatus

The apparatus required for these tests are

1. A balance of at least 3kg capacity with a accuracy to 0.5g.

2. An oven to maintain a temperature range of 100 to 110°C

3. A wire basket of not more than 6.3mm mesh on a perforated container of convenient size with three wire hangers for suspending it from the balance

4. A container for filling water and suspending the wire basket in it

5. An airtight container of

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capacity similar to that of basket, a shallow tray and two dry absorbent clothes.

6. Pycnometer of 100ml for aggregates finer than 63 mm and specific gravity bottle.

Procedure for aggregate coarser than 63mm.

1. About 2kg of aggregate sample is taken, washed to remove fine and then placed in the wire basket. The wire basket is then immersed in water which is at temperature of 22°C to 32°C .
2. Immediately after immersion the entrapped air is removed from the sample by lifting the basket 25 mm above the base of the tank and allowing it to drop 25 times at a rate of about one drop per second.
3. The basket with aggregate are kept completely immersed in water for a period of 24 ± 0.5 hours.

1) Agg engr than 6.3mm / Table-1

SI NO	Details	Observed values
1.	Weight of saturated Aggregate and basket in water: w_1 g	
2.	Weight of basket in water: w_2 g	
3.	Weight of saturated Aggregate in air: w_3 g	
4.	Weight of oven dry aggregate in air: w_4 g	
5.	Apparent specific gravity: $w_4 / [w_4 - (w_1 - w_2)]$	
6.	Bulk specific gravity: $w_4 / [w_3 - (w_1 - w_2)]$	
7.	Water Absorption: $[(w_3 - w_4) \times 100] / w_4$	

Sample observation and calculation Table-2

SI NO	Details	Observed values
1.	Weight of saturated Agg and basket in water: w_1 g	
2.	Weight of basket in water: w_2 g	
3.	Weight of Saturated Agg in air: w_3 g	
4.	Weight of oven dry Agg in air: w_4 g	
5.	Apparent Specific Gravity: $w_4 / [w_4 - (w_1 - w_2)]$	
6.	Bulk specific Gravity: $w_4 / [w_3 - (w_1 - w_2)]$	
7.	Water Absorption: $[(w_3 - w_4) \times 100] / w_4$	

2. Aggregate of size finer than 6.3mm Table-3

SI NO	Details	Observed values
1	Weight of Pycnometer in air: w_1 g	
2	Weight of Agg and pycnometer: w_2 g	
3	Weight of Agg Pycnometer and water: w_3 g	
4	Weight of water and pycnometer in air: w_4 g	
5	Apparent Specific Gravity: $(w_2 - w_1) / [(w_4 - w_1) - (w_3 - w_2)]$	

Sample observation and calculation Table-4

SI NO	Details	Observed values
1	Weight of pycnometer in air: w_1 g	
2	Weight of Agg and pycnometer: w_2 g	
3	Weight of Agg pycnometer and water: w_3 g	
4	Weight of water and pycnometer in air: w_4 g	
5	Apparent Specific gravity: $(w_2 - w_1) / [(w_4 - w_1) - (w_3 - w_2)]$	

4. Immediately after immersion the entrapped air is removed from the sample by shaking pycnometer, placing a finger on the hole at the top of the sealed pycnometer.
5. Now the pycnometer is completely filled up with water till hole at the top, and after confirming that there is no more entrapped air in it, it is weighed.
6. The contents of the pycnometer are discharged and it is cleaned.
7. Water is filled up to the top of the pycnometer, without any entrapped air. It is then weighed.

Results:- (For 1 Aggregate coarser than 6.3 mm)

Bulk Specific Gravity = _____

Apparent Specific Gravity = _____

Water Absorption = _____ %

Result B:- (For 2 Aggregate ~~coarser than~~ of size finer than 6.3 mm)

Apparent Specific Gravity = _____