BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Civil Engineering

Course no: CE-202

MATERIALS SESSIONAL

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

Experiment No: 01

Experiment Name:

Determination of Normal Consistency of Cement Using Vicat's Apparatus.

Date of performance: 19.11.13

Date of submission: 21.01.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

Roll No.

Objective :-

The objective of this experiment is to determine the normal consistancy of cement using Vicat's apparatus.

Theory :

In order to make a cement paste of desired wetness it is necessary to mix adequate quantity of water with dry cement. The amount of water content which will produce a cement paste of standard consistance is termed as normal consistancy of that cement. In this experiment normal consistancy is determined by Vicat's apparatus by measuring the depth of penetration in cement paste of a 10 m.m diameter plunger under it's own weight. A graph is drawn between penetration of plunger vs water content. Then from the graph normal consistancy of cement is determined.

Apparatus :

1. Vicat's Apparatus
2. Mixing machine or mixer
3. Balance
4. Glass graduates
5. Small Trowel
6. Stop watch

Experiment No. 01

Determination of Normal Consistency of Cement Using Vicat's Apparatus

Type of cement = OPC (Ordinary Portland Cement)
Wt. of cement, W_1 (gm) = 650 gm
Water Temperature (°C) =
Room Temperature (°C) = 26°C

No of observation	1	2	3	4	5	6
Percentage of water taken, W_2	24.5	24	23.5	25	25.5	
Weight of water added, gm = $W_1 \times W_2/100$	159.25	156	152.75	162.5	165.75	
Depth of plunger penetration, mm	12.5	7	4	13	17	

Result:

The normal consistency of thecement sample is = 24.425 %

Signature of Class Teachers

Student Name: Sudipta Roy

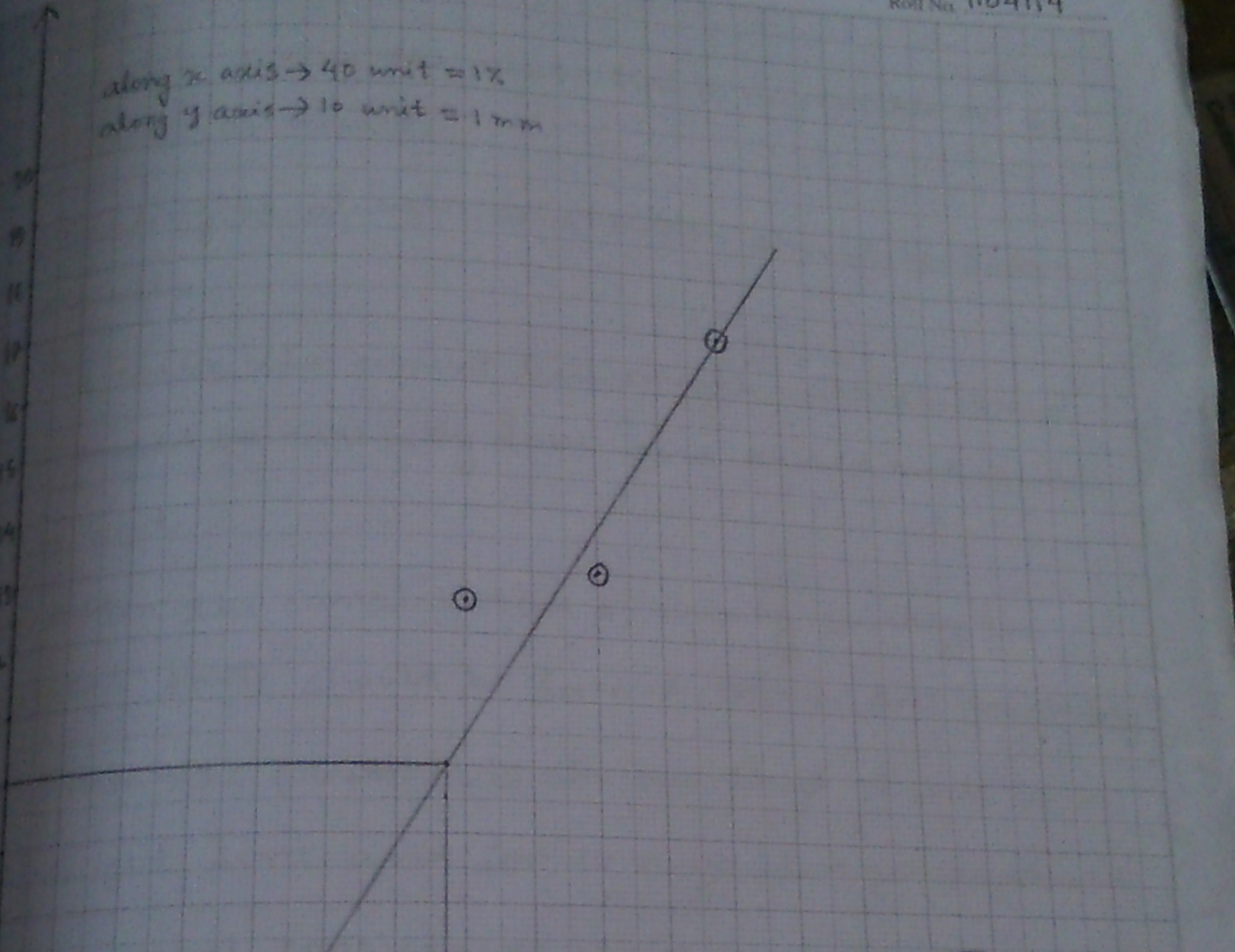
Student No : 1104114

Sec & Group: B_2 , Group -3

Date: 19.11.13

Roll No. 1104114

along x axis → 40 unit = 1%
along y axis → 10 unit = 1 mm



Plunger penetration vs water percentage graph

Discussion:

i) Variation during the penetration is responsible for the variation of result.

ii) Reading of plunger penetration should be taken caresully.

iii) To make the cement ball smooth with the trowel, it should be care-fully done and should not compress the paste.

iv) After the completation of mixing quickly the cemerit paste should be formed into a ball immediately.

v) From the graph it is obvious that it will be a straight line and for 10 m.m plunger penetration the normal consistancy is 24.425% which is in the range of (22-30)%.

Assignment:-

1.8: What is the importance of determining normal consistancy of cement?

Ans: Normal consistancy is very importance for testing the quality of cement which is a standard measure of plasticity of a cement paste and also the abilidty of a cement paste to flow and hence measure of workabilidty of the cement.

2.8: With finer cement particle size, would more or less water be required to achieve the normal consistency? Briefly explain.

Ans: With finer cement particide size, more water should be required to achieve the normal consistency of cement. Because the surface area of finer particle of cement is more than any other sized particle and that's why it absorbs more water than particle and that's why it absorbs more water than other sized particle. So, finer cement particle needs more water.

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

Experiment No: 02

Experiment Name:

Determination of Initial Setting Time of Cement Using Vicat's Apparatus.

Date of performance: 21.01.14

Date of submission: 28.01.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

objective:

The objective of this experiment is to determine the initial setting time of cement Using Vicat's Apparatus.

Theory:

One of the most important properties of cement is its setting time. It is defined by two parameters - initial setting time and final setting time. Initial setting time indicates the bleginning of solidification or beginning of losing plasticity. It is defined as the period elapsed between the time when the water is added to the cement and the time at which the paste attains a certain degree of hardness. To determine the initial setting time of cement, cement paste is tested with 1-m.m diameter needle of the Vicat's Apparatus. According to the specification under ASTM C191 initial setting time is the time elapsed between addition of water to form cement paste and when the 1m.m needle of the Vicat's Apparatus moves ~~26~~ 25 m.m penetration into the paste and final setting time is reached when the needle does not sink visibly into the paste.

Apparatus:

1. Vicat's Apparatus,
2. Mixing machine or Mixer,
3. Balance,
4. Glass graduates,
5. Small trowell,
6. Stop watch.

Experiment No. 02

Determination of Initial Setting Time of Cement Using Vicat's Apparatus

Type of cement = OPC

Wt. of cement, W_1 (gm) = 650 gm

Normal consistency of the cement NC, % = 25%

Water to be added to the cement, gm = $W_1 \times NC / 100$ = 162.5 gm

No of observation	1	2	3	4	5	6	7	8	9	10
Elapsed time, min	30	60	90	120	150	160	162			
Depth of needle penetration, mm	38	38	38	38	33	27	18			

Result:

The initial setting time of the cement sample is = 161 min

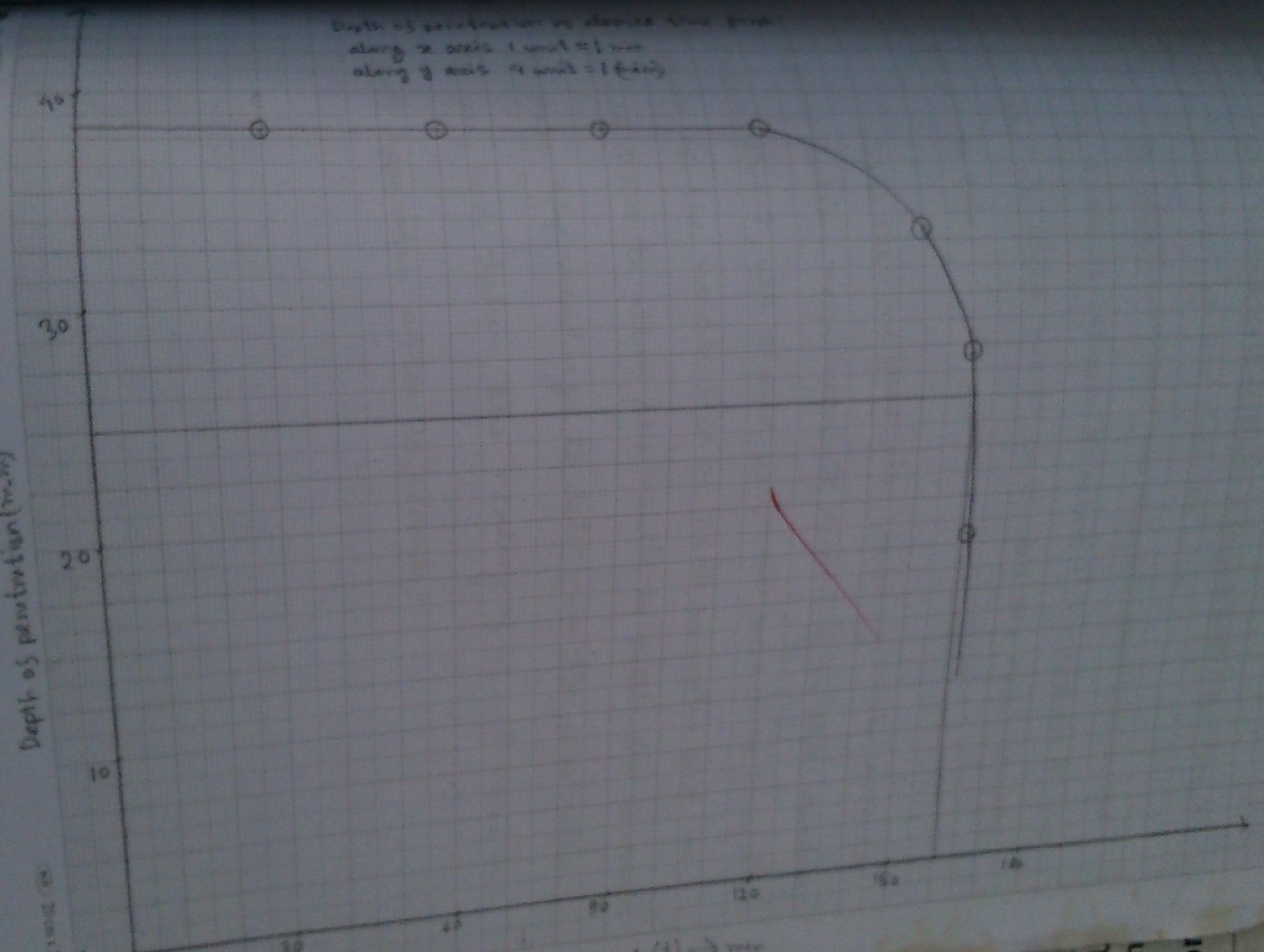
Signature of Class Teachers

Student Name: Sudipta Roy

Student No.: 1104114

Sec & Group: B_2 (group-3)

Date: 21.01.14


Depth of penetration(m-m)
10
20
30
40
40
80
120
160

Discussion:

The initial setting time of cement paste according to ASTM C150 is not less than 45 mins.

In this experiment we obtained that the initial setting time is 161 minutes which is more than 45 mins. So, the observed result fulfilled the requirements of ASTM C150.

This test method also conforms to the ASTM C191 specification requirements. According to this standard requirement, we should penetrate needle of 1 mm dia, which is the needle size of Vicat's Apparatus and we should have to allow the needle to settle for 30 seconds to take the readings to determine the penetration. So, we had taken the reading of penetration of Vicat's Apparatus after 30 seconds.

Assignment Questions:

Q 1) Describe the factors affecting the initial setting time of a cement.

⇒ The factors that affect the initial setting time of cement are temparature, humidity, fineness of cement and cement composition.

Setting time is more at low temparature. It decreases with temparature, but above 30°C, a reverse effect may be observed.

Setting time increases with an increase in humidity as water cannot evaporate easily.

Setting time is affected by percentage of C_3S, C_3A and Gypsam in the cement. In case of low or no gypsam, even a lower percentage of C_3A may cause flash set reducing setting time.

setting time decreases with increase in the fineness. With an increase in the fineness, the surface area per unit mass of cement increases. Since hydration occurs at surface, so, the rate of hydration increases and setting time decreases.

Q.2) Compare the functions of C_3S and ~~C_3A~~ ~~C_4A~~ C_2S in setting time of cement.

⇒ Setting time of cement occurs primarily due to hydration to the of reactions of C_3S and C_2S. C_3S undergoes hydration similarly C_2S except it produces more $Ca(OH)_2$, heat and have a greater reaction rate. The principal hydration product is ~~$C_3H_2S_3$~~ $C_3S_2H_3$, calcium silicate hydrate which acts as a glue gel binder. C_3S

produces 502 kJ/kg which is almost double to that of C_2S. Cement containing more C_3S sets faster than cement containing more C_2S. This evolved heat is used in the setting of cement. C_3S hydrates and hardens rapidly and is largely responsible for initial set and early strength whereas C_2S hydrates and hardens slowly and it's largely responsible for strength increases beyond one week.

Q.3) Distinguish between 'hardening' and 'setting'.

⇒ The term 'setting' is used to describe the stiffing of the cement paste. Setting of the cement refers to changes of cement paste from fluid to rigid state.

The term 'hardening' refers to the gain of strength of a set cement paste, although during setting the cement paste acquires some strength.

Hardening of cement occurs after the cement has set.

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BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

Experiment No: 03

Experiment Name:

Determination of Compressive Strength of Hydraulic Cement Mortars

Date of performance: 21.01.14

Date of submission: 25.02.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

Objective:

The objective of this experiment is to determine the compressive strength of hydraulic cement mortars.

Theory:

Compressive strength of cement is considered as the most significant quality of the material in the structure. Hardened cement is capable to withstand some specific amount of stress. This ultimate stress is called strength of the cement mortar. If the stress is compressive, then it is called compressive strength. This strength can be affected by a number of factors including - water-cement ratio, cement-fine aggregate ratio, type and grading of fine aggregate, manner of mixing, curing conditions, size and shape of specimen, moisture content at the time of test, loading condition and age cement gains strength over time. Cement mortar strength is not directly related to concrete strength. It is only considered as quality control measure. The experiment will be conducted for few days. This compressive strength indicates the ability to bear required load. So this experiment is very important. As per ASTM C150 for OPC minimum compressive strength should be

Experiment No. 03

Determination of Compressive Strength of Hydraulic Cement Mortars

Type of cement = OPC

Wt. of cement, W_1 (gm) = 700 gm

Water – cement ratio, WC = 0.485

Water to be added to the cement, gm = $W_1 \times WC$ = 339.5 gm

Size of the specimen, (inch) = 2 in x 2 in x 2 in

Date of casting cement mortar = 21.01.14

Calibration equation of testing machine: $Y = mX + c$

$Y = 0.993X - 4.495$ (for 7, 14 day test)

$Y = 1.004X - 8.635$ (for 28 day test)

Results:

Sl No.	Specimen Age, days	Observed Maximum Load (X), KN	Actual Calibrated Maximum Load (Y), KN	Maximum Load (Z), lb = Y * 224.0	Specimen Loading Area (A), inch²	Compressive Strength, psi = Z/A	Average Compressive Strength, psi
1	7	83	77.924	17454.975	4	4363.74	
2		95	89.84	20124.16	4	5031.04	4640
3		86	80.903	18122.272	4	4530.57	
4	14	91	85.868	19234.432	4	4808.61	
5		88	82.889	18567.136	4	4641.78	4850
6		96	90.833	20346.592	4	5086.65	
7	28	119	110.841	24828.384	4	6207.10	
8		103	94.777	21230.048	4	5307.51	5630
9		104.5	96.283	21567.392	4	5391.85	

Signature of Class Teachers

Student Name: Sudipta Roy

Student No.: 1104114

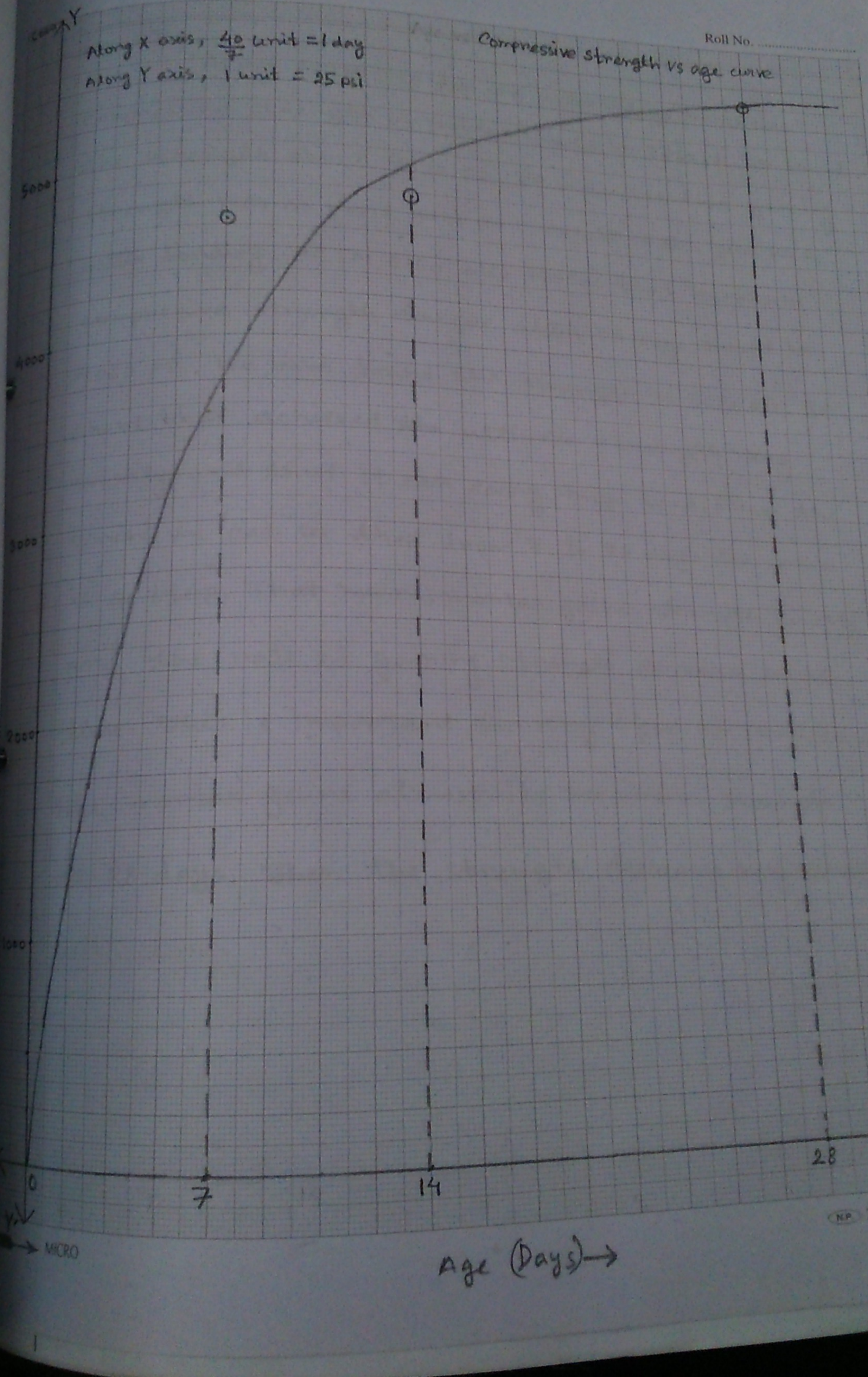
Sec & Group: B_2 Group-1

Roll No. .....

Along X axis, $\frac{40}{7}$ unit = 1 day

Along Y axis, 1 unit = 25 psi

Compressive strength vs age curve



Discussions:

As per ASTM C150 for OPC after 7 days minimum compressive strength of mortar should be 2760 psi. We found the strength about 4640 psi. It indicates that gaining strength was so rapid and as a result it can give us a better bonding. ASTM C150 also states that minimum compressive strength for OPC after 28 days should be 4060 psi. We have found the strength as 5630 psi. It shows that achieved the ultimate strength very quickly and thus it can carry huge load. From the graph we can see that from 7 to 28 days the curve is so steep. That means, mortar gains strength quickly and the rate of gaining strength decreases with time. This is important for any type of structure. The mortar gains almost its maximum strength at 28 days. Then the strength decreases very slowly with time.

Assignment Questions:-

1) What is the significance of determining compressive strength of cement mortar rather than determining on neat cement paste ?

Ans: Compressive strength is not determined on neat cement paste because of difficulties in moulding and testing with consequent large variation of result. Besides, individual cement paste can not bear the minimum strength. So, compressive strength of cement mortar is determined.

2) Why it is necessary to store the mortar specimen in saturated lime water ?

Ans: In saturated lime water, there remains a lot of lime around the mortar specimens. As a result, lime inside the mortar does not come out to the water. If we keep the mortar for curing in limeless water then inner lime will come out to the water and hydration reaction will not properly conducted.

3) Why the failure load obtained from testing machine need to be calibrated ? How it is done.

Ans: After a certain period because of mechanical decay the machine losses its power. As a result, a gap between the actual load and observed load is created. So, we need to calibrate the machine after a certain time at regular basis.

For calibration, first the known load and then the observed load are plotted in a graph paper. Then a linear relationship obtained between two loads. If we input the observed load in the calibration equation, then we will get the actual calibrated load.

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

Experiment No: 04

Experiment Name:

Determination of Soundness of Cement by Expansion of Cement Mortar bars

Date of performance: 28.01.14

Date of submission: 25.02.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

Assignment Questions and Answers:

1) what are the factors may responsible for soundness of cement? Which constituents are responsible for the expansion of the mortar bar measured in laboratory test?

Ans: Dist factors are responsible for unsoundness of cement. It is due to the presence of excess lime. It can also be happened due to inadequate burning or insufficiency in fineness of grinding or through mixing of raw materials. In addition to these, too high propertion of magnesium or calcium sulfate may cause unsoundness.

The constituents responsible for the expansion of the mortar bar are gypsam, lime, magnesium and calcium sulfate. After completing hydration reaction, if these constituents exist expansion of mortar bar is happened.

2) What is the effect of fineness of fly ash on expansion of the mortars?

Ans: For the presence of fly ash in cement, the hydration reaction becomes so fast in the outer part, but this reaction does not so fast in the inner part. As a result the internal reaction gets delayed. Thus the chemical agents like lime, sulfate salt reacts with water and makes the cement concrete unsound. Thus, too much fineness increases the expansion of mortars.

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BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

xperiment No: 05

xperiment Name:

Determination of Fineness of Cement by Air
rmeability Apparatus.

ate of performance: 28.01.14

ate of submission: 11.02.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

Objective:

The objective of this experiment is to determine the fineness of cement by Air Permeability Appratus.

Theory:

The fineness of cement can be defined as the measure of size of particles of cement or in simple form "Specific Surface of cement". The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gaining strength and also on a rate of heat evolution. The disadvantages of fine grinding is that it is susceptible to air set and early deterioration.

The air permeability specific surface testing method is widely used for measurement of the fineness of hydraulic cement. The specific surface is either expressed as mass specific surface (m^2/kg) or volume specific surface (m^2/m^3). As per ASTM specification C150 the fineness of ordinary portland cement should not be less than 280 m^2/kg

According to the ASTM specification C204 the determination of fineness of cement by air permiability method is done using Blaine Air permeability Apparatus. The test method

involves air flow through a prepared bed of cement by application of specification pressure and permeability of cement is measured using empirical equation on the basis of its relation ship with air flow rate.

Apparatus:

1) Blaine's air permeability apparatus
2) Stop watch.

Experiment No. 05

Determination of Fineness of Cement by Air Permeability Apparatus

7

Density of the cement, ρ (g/cm³) = 3.15 g/c.m³

Calibrated bulk volume of cement bed, V (cm³) = 1.806 cm³

Standard porosity of the bed, ϵ_s = 0.509

Time interval of manometer drop for the standard, T_s (sec) = 107.5 s

Specific surface of the standard sample, S_s (cm²/gm) = 348.3 m²/kg

Wt of Cell+ Disk + Filter Papers (W_1), gm	Wt of Cell+ Disk+ Filter Papers + Cement up to calibrated volume, (W_2), gm	Wt of Cement up to calibrated volume, (W), gm	Porosity of cement, $\epsilon = 1 - \frac{W}{\rho V}$	Time interval of manometer drop for the test (T), sec	Specific surface of the test sample (S), (cm²/gm)
101.10	104.27	3.17	0.4427	146	~~282~~

Results :

Fineness of the test sample = 282 (m²/kg)

28.1

Signature of Class Teachers

Student Name: Sudipta Roy

Student No.: 1104114

Sec & Group: B2 Gr-3

Date : 28.01.14

1104114

Discussion :-

As per ASTM specification C150 the fineness of ordinary portland cement should not be less than 280 m^2/Kg In this test, the value we get for this cement is 282 m^2/Kg. So, from this test we can say the portland cement is of required specific surface or fineness.

Assignment Question :-

1. What are the effects of the change in cement particle fineness? What is the significance if the cement is too fine?

⇒ The fineness of cement particle has an important effect on the rate of hydration and hence on the rate of gaining strength and also on a rate of heat evolution. Besides finer cement offers a greater surface area for hydration and hence faster the development of strength. Finer cement particle also increase the drying shrinkage of concrete.

If the cement is too fine, it is susceptible to air set and early deterioration.

2. What are the methods of determining fineness of cement in the lab?

⇒ The methods are:

i) Sering
ii) Turbidity meter
iii) Air permeability meter.

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BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

Experiment No: 06

Experiment Name:

Determination of Compressive Strength of Concrete

Using Cylindrical and Cube Specimens

Date of performance: 11.02.14

Date of submission: 25.03.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

Objective:

The objective of this experiment is to determine the compressive strength of cement concrete using cylindrical and cube specimens.

Theory:

The compressive strength of concrete can be considered as the most significant test of concrete as it is used more often in compression than in any other way. The compressive strength of concrete is the most common performance measured used by the engineers in designing building and other structures. Due to having almost no tensile strength, concrete is never used without some form of reinforcement. Its compressive strength depends upon many factors including the quality and proportions of the ingredients, size and shape of test specimens, mixing method, use of admixtures, molding, sampling method, age of testing and curing environment. The w/c (water-cement) ratio is the single most important indicator of strength, which is minimum 0.3 by weight to ensure that the water comes into contact with all cement and practically the value is 0.4 to 0.6 to achieve a workable consistency. The test is done either using cylindrical specimens or using cube

Specimens, are cylindrical concrete specimens are tested in accordance to ASTM specification for compressive strength determination of concrete using cubic specimens is performed according to BS1881. This test methods covers determination of compressive strength of concrete specimen having a unit weight in excess of 50 lb/ft³.

Apparatus:

i) Cylindrical and cube molds
ii) Weighing machine
iii) Metal buckets
iv) Scoop
v) Compacting bar or vibrator
vi) Concrete mixer
vii) Slump testing mold
viii) Sampling tray
ix) Compression testing machine

Experiment No. 06

Determination of Compressive Strength of Concrete Using Cylindrical and Cube Specimens

Type of Coarse Aggregate :
Proportion – Cement : Fine Aggregate : Coarse Aggregate = 1:2:4
Calibration equation of compression testing machine = $Y = 0.989X - 103.1$ (for cylinder)
$Y = 1.003X - 0.431$ (for 0-50 ton) (for cube)

Table for Cylindrical Concrete Specimen:

Gr. No.	SL No.	Age in days	Specimen Designation	Water Cement Ratio	Specimen Area, sq.inch (sq.mm)	Calibrated Maximum Load, lb (kN)	Crushing Strength, psi (MPa)	Average Crushing Strength, psi (MPa)	Type of Failure
1	1	7		0.5	12.68	12115.04	950	950	mortar
	2				12.76	11893.504	930		mortar
	3				12.45	12115.04	970		mortar
	1	14			12.41	16324.224	1310	1310	mortar
	2				12.41	16319.296	1310		mortar
	3				12.41	16102.688	1300		mortar
	1	28			12.43	18982.656	1520	1620	mortar
	2				12.45	20518.624	1640		mortar
	3				12.56	21419.552	1700		mortar
2	1	7		0.45	12.48	13665.799	1090	1100	mortar
	2				12.50	13222.72	1060		mortar
	3				12.51	14329.28	1140		mortar
	1	14			12.48	17874.97	1430	1380	mortar
	2				12.47	17431.904	1400		mortar
	3				12.47	16324.224	1300		combined
	1	28			12.37	21198.016	1720	1700	combined
	2				12.43	20754.94	1670		combined
	3				12.47	21419.552	1720		combined
3	1	7		0.4	12.57	10785.84	850	940	mortar
	2				12.49	12336.576	990		mortar
	3				12.69	12182.237	960		mortar
	1	14			12.45	15064.732	1210	1230	mortar
	2				12.49	15986.967	1280		mortar
	3				12.47	14840.51	1190		combined
	1	28			12.46	17742.256	1430	1460	mortar
	2				12.47	16169.149	1300		combined
	3				12.46	20378.332	1640		mortar

Table for cube specimen continued to next page....

Table for Concrete Cubes:

Gr. No.	Sl. No.	Age in days	Specimen Designation	Water Cement Ratio	Specimen Area, sq.inch (sq.mm)	Calibrated Maximum Load, lb (kN)	Crushing Strength, psi (MPa)	Average Crushing Strength, psi (MPa)	Type of Failure
1	1	7		0.5	36.36	51314	1410	1350	mortar
	2				36.63	47302	1290		mortar
	1	14			36.09	89428	2480	2140	mortar
	2				36.28	65356	1800		mortar
	1	28			36.99	77392	2130	2250	combined
	2				36.18	85446	2370		combined
2	1	7		0.45	36.33	59338	1670	1360	mortar
	2				36.61	39278	1080		mortar
	1	14			36.43	79398	2170	2140	mortar
	2				36.59	77392	2110		explosive
	1	28			36.37	97452	2670	2610	combined
	2				36.58	93440	2550		combined
3	1	7		0.4	36.795	43290	1180	1180	mortar
	2				36.867	43290	1170		mortar
	1	14			36.53	70130	1920	1850	mortar
	2				36.47	64550	1770		explosive
	1	28			36.40	75386	2070	2040	combined
	2				36.34	73380	2010		combined

Signature of Class Teachers

Student Name: Sudipta Roy

Student No.: 1104114

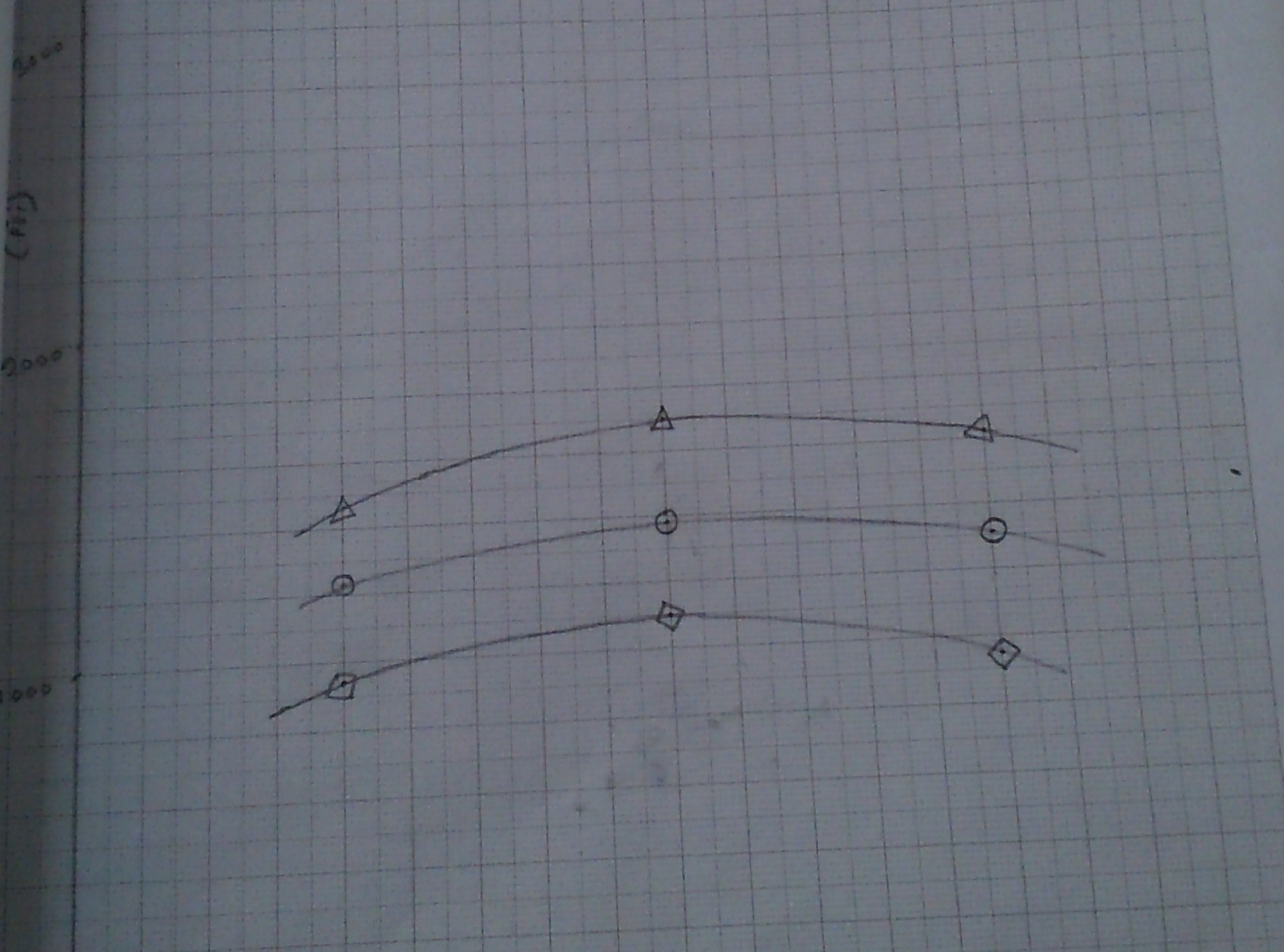
Sec & Group: B2(G-2)

Date : 25.03.14

Roll No. 1104114

Compressive strength vs w/c graph (cylinder)

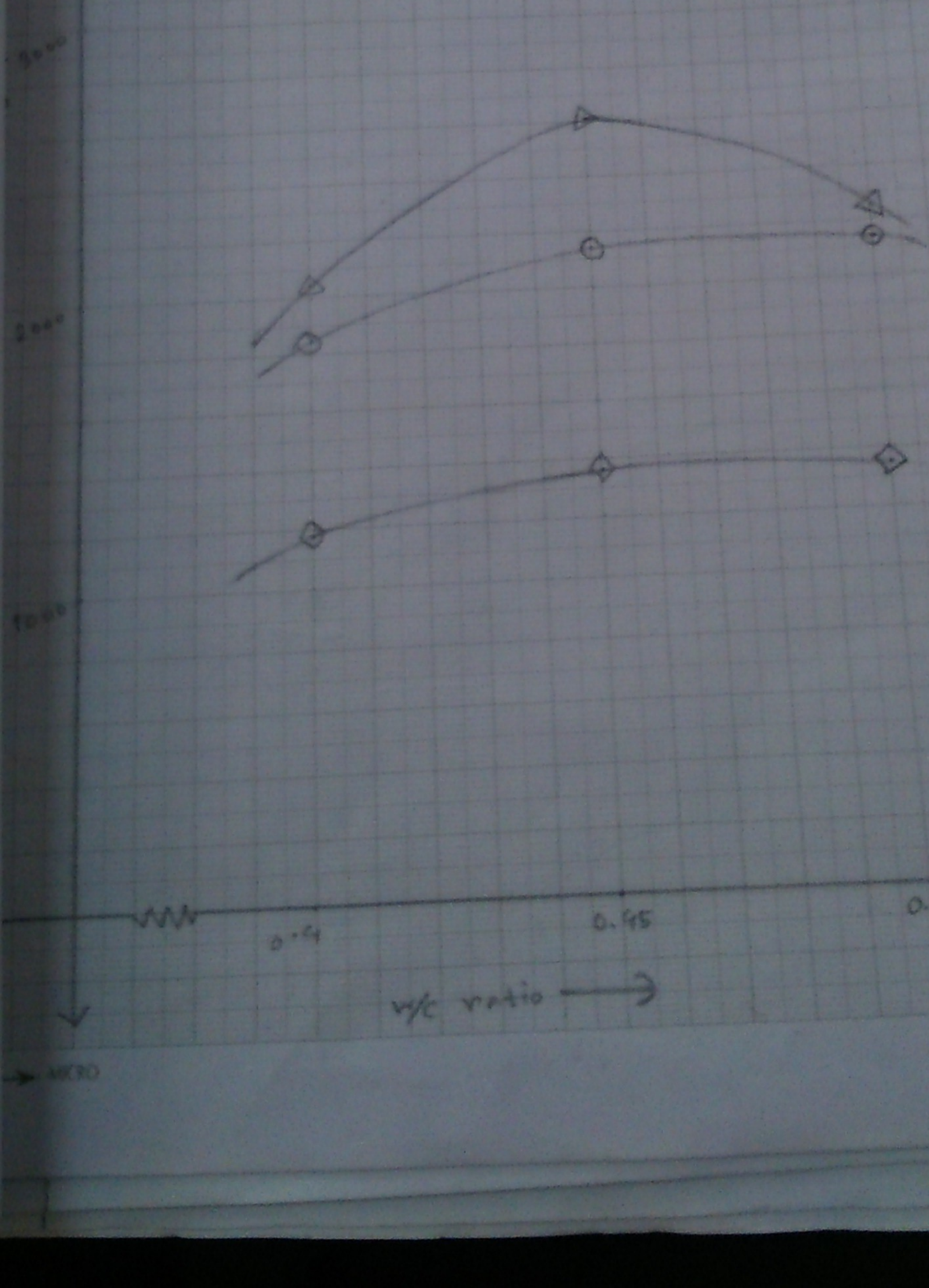
□ → 7 day
○ → 14 day
△ → 28 day



Roll No. 11041114

Compressive strength Vs
w/c ratio graph
(cube)

○ — 7 days
○ — 14 days
△ — 28 days



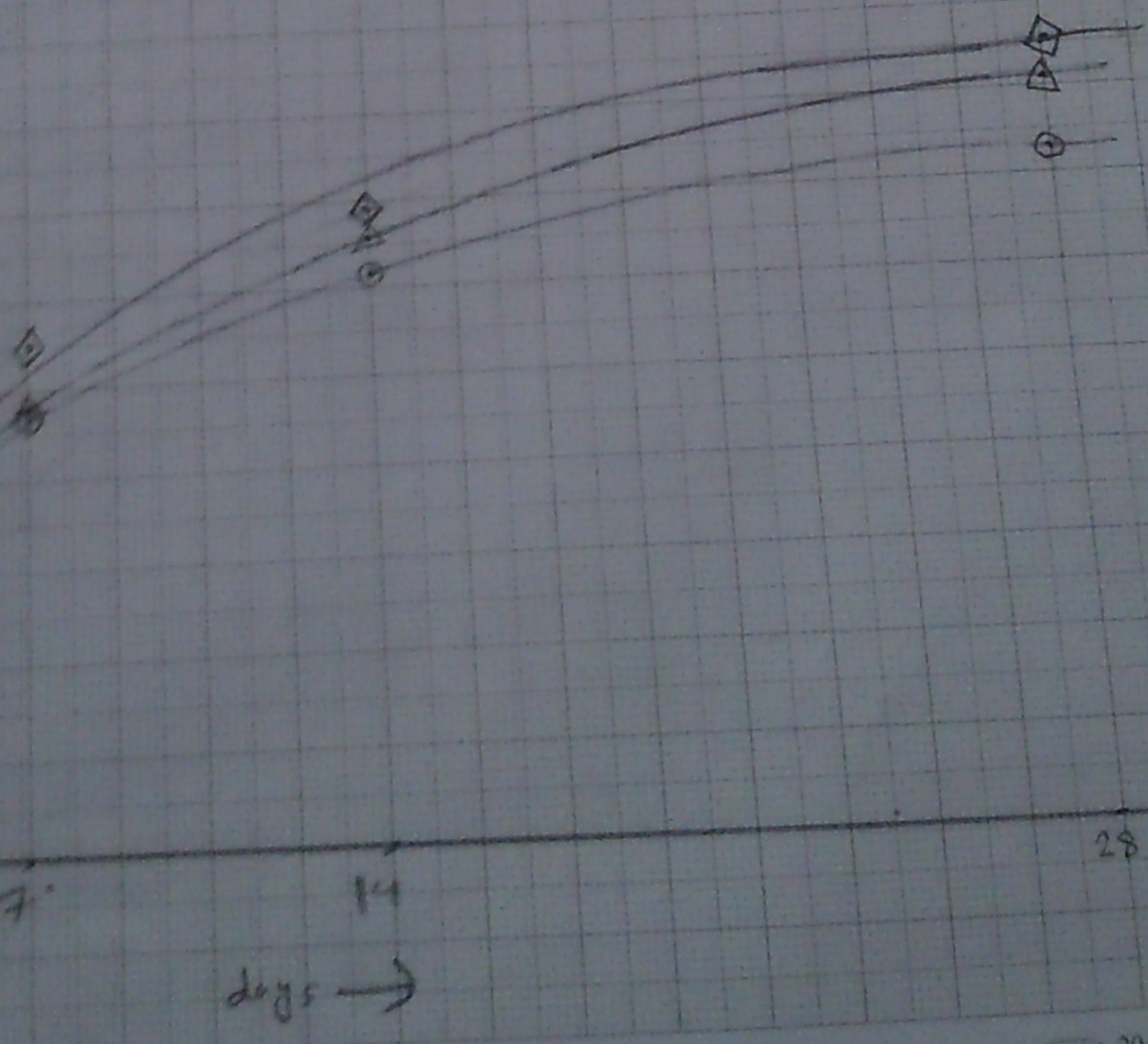
(size) 20 cm x 25 c

→ micro

Roll No. 1104114

Compressive strength vs
days graph (cylinder)

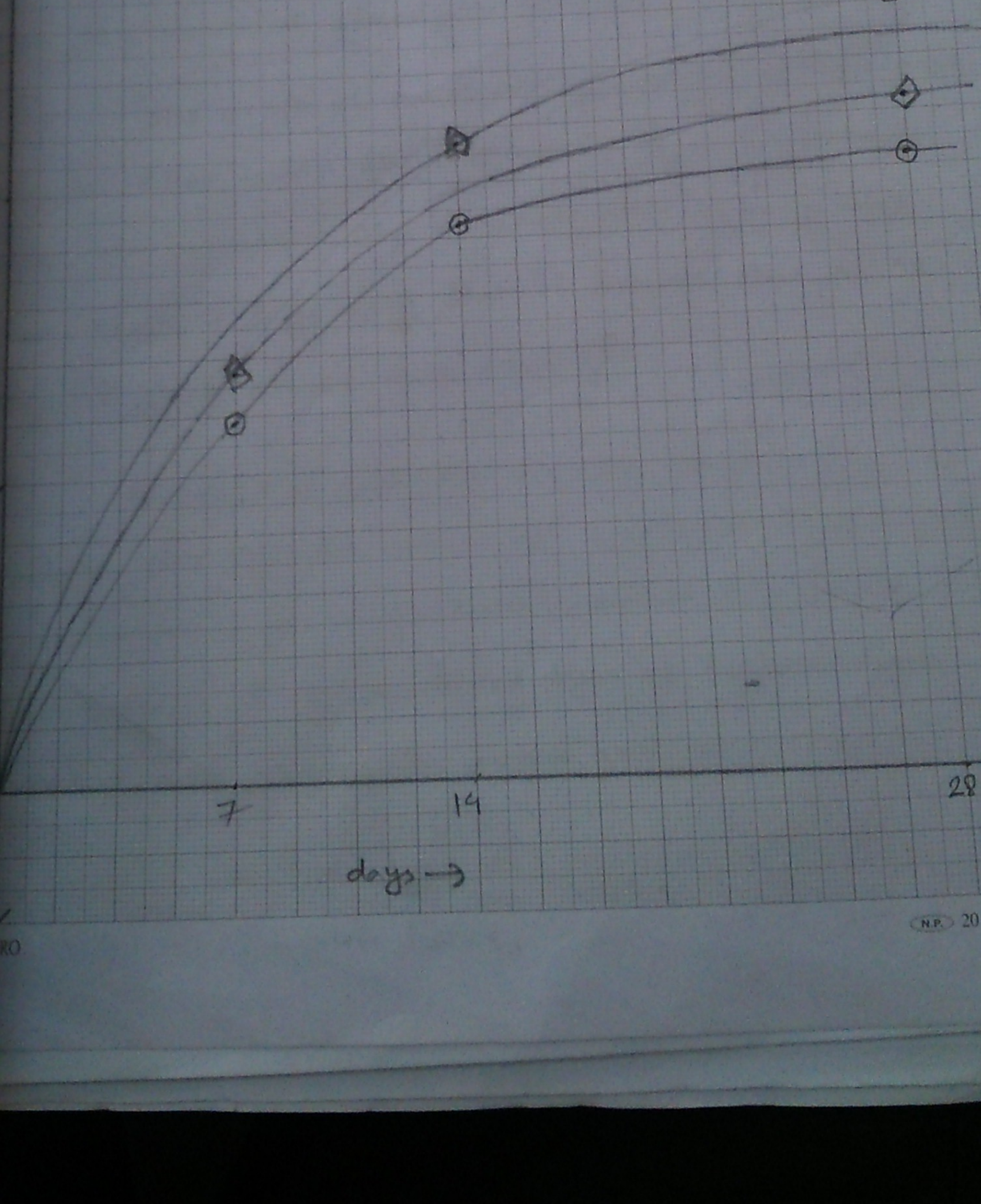
△ → 0.45
○ → 0.4
△ - 0.5



Roll No. 1104 114

Compressive strength vs day (cube)

○ → 0.4
△ → 0.45
◇ – 0.5



N.P. 20 cm x 25 cm

Discussion:

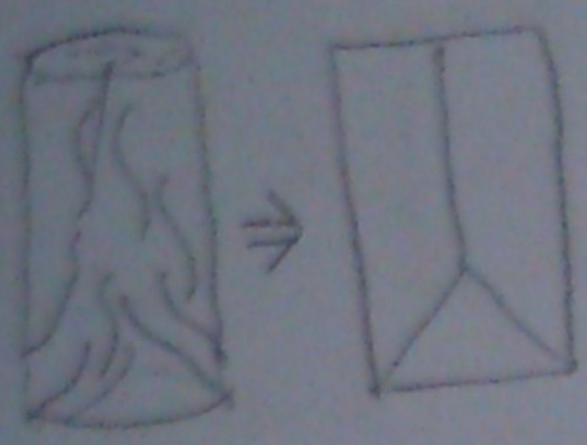
From the experiment, after plotting the graph of compressive strength vs w/c ratio, we see that the the compressive strength is highest at the middle portion of the graph. But we know that with the increase of w-c ratio the compressive strength decreases. Here, for 0.4 water cement ratio, there may be some technical or other fault. That's why we have not get the expected strength for 0.4 w-c ratio.

The graph of compressive strength vs time(days) denotes that with the increase of time compressive strength increases. The increasing rate is very high for first 7 days and then it becomes slow. At 28 day it gains almost full strength.

In case of failure we can mainly see two types of failure for cylinder and cube, mortar and combined. In mortar type of failure, mortar only break and comes out. In combined type of failure, both mortar and aggregates break and comes out.

The fracture type the cylinder and cube specimen are drawn here:

7 days:-



Cylinder-1
Core and split
(mortar)

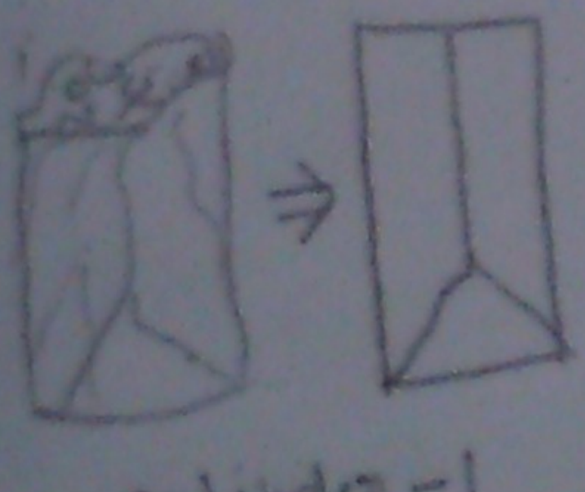
Cylinder-2
Columnar
(mortar)

cylinder-3
Core and split
(mortar)

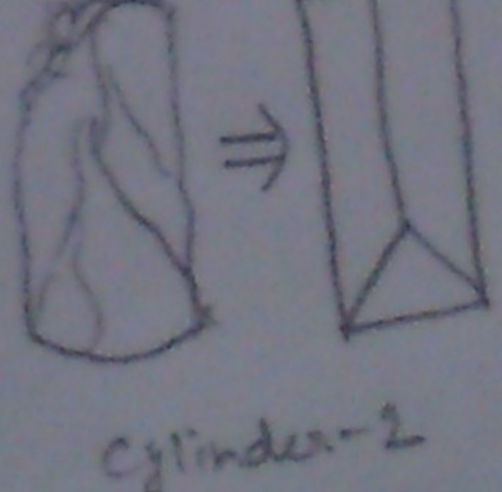
Cube-1
Core
(mortar failure)

Cube-2
Shear
(mortar)

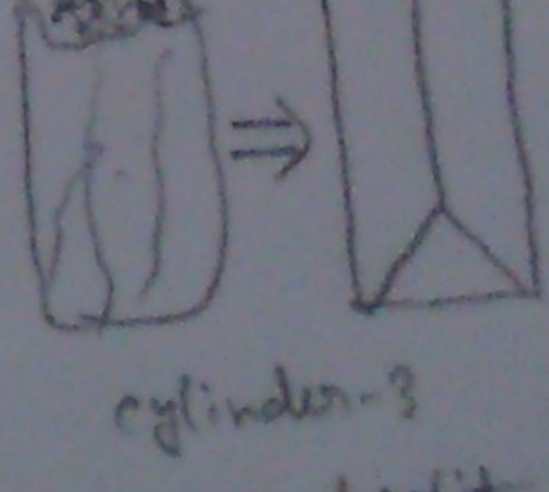
14 days:-



Cylinder-1
Core and split
(mortar)



Cylinder-2
Core and split
(mortar)

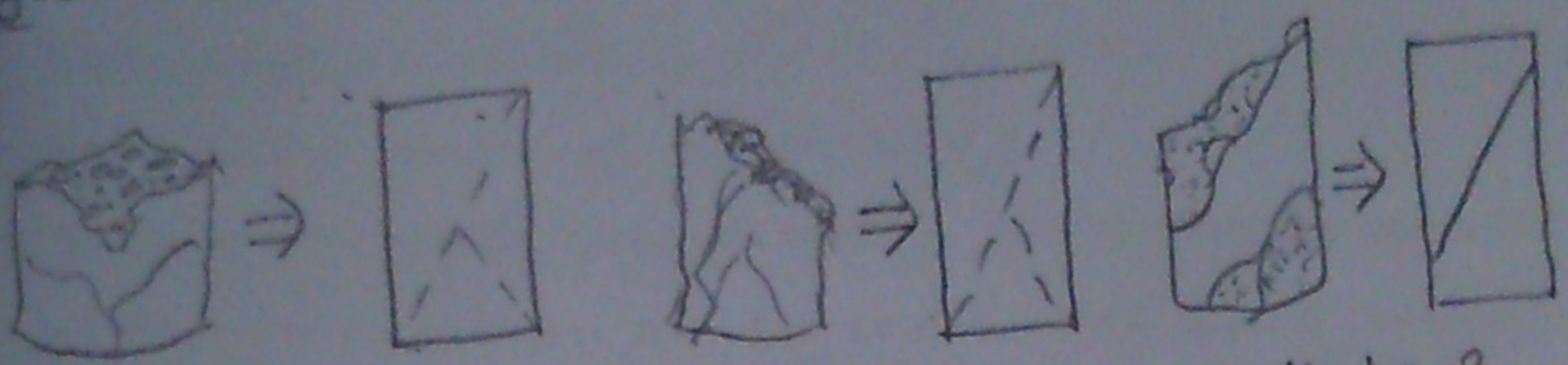


Cylinder-3
Core and split
(Combined)

Cube-1
Shear (mortar)

Cube-2
explosive

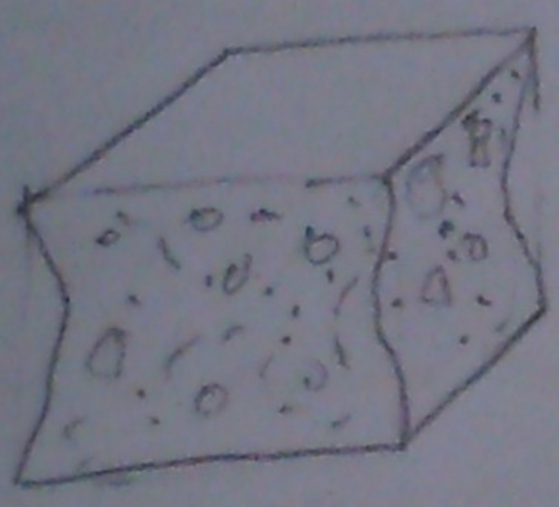
28 days:-



cylinder-1
cone and shear
(combined)

cylinder-2
cone and shear
(combined)

cylinder-3
shear
(combined)



cube-1
Shear
(combined)

cube-2
cone
(combined)

Assignment Questions:-

1. How the compressive strength of concrete can be related to water-cement ratio of concrete?

Ans: A minimum water cement ratio is needed to ensure the hydration reaction of concrete. At this water-cement ratio the strength of concrete will be higher. But if the the w/c is increase gradually, after a certain level it will decrease the compressive strength.

2. Why it is necessary to slump test? How it can be related to workability?

Ans: Slump test is necessary to measure workability. A minimum slump value is needed to determine workability i.e how much time one will get and easiness will be found to place it and its ability to reach the difficult places such as joints that holds the structure. If the slump value is low, the workability is low and workability increases with slump value.

3. Why compressive strength of concrete using cube specimen gives higher value than that from cylindrical specimen?

Ans: (i) Cylinder is more slender than cube. Cylinder buckles earlier than cube at a given load.

(ii) L/D ratio of cube is smaller than cylinder. So it can take more load.

(iii) In cube the load is given perpendicular to the fibre arrangement but in cylinder the load is given parallel to the fibre arrangement. If the load is given perpendic to fibre arrangement it can take more load.

9) What is the effect of l/d ratio on compressive strength of concrete?

Ans: As l/d ratio decreases, slenderness also decreases. So, a body having a lesser l/d ratio can take more load than body having higher l/d ratio. As a result compressive strength will higher for smaller l/d value.

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

Experiment No: 07

Experiment Name:

Testing and Sampling of Bricks for Compressive Strength, Efflorescence and absorption

Date of performance: 04.03.14

Date of submission: 25.03.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

Objective:

The objective of this experiment is to test and sampling of bricks for compressive strength, efflorescence, and absorption.

Theory:

Brick is artificially prepared one of the most widely used units in masonry construction. According to the characteristics of good brick, they should be uniform in color, size and shape and also should be sound, compact and free from crack or other flaws such as air bubbles, stone nodules etc. The minimum compressive strength of 1st class bricks should not be less than 2500 psi and when immersed in water for 24 hours absorption should be 15 to 20% of dry weight, because the strength decreases by about 25% when soaked in water. The weight of each brick should be in the range of 6 to 7 lbs. Efflorescence, usually a harmless phenomenon, is a white crystalline unattractive deposit that forms on or near the surface of concrete, masonry and cement based materials. In rare cases, excessive efflorescence, within the pores of the material can cause expansion that may disrupt the surface. If it is on the surface it provides a serious disfigu

while if it is beneath the surface it may lead to disruption and spalling of the surface layer.
In this test the determination of compressive strength, absorption and efflorescense bricks are carried out under the specifications of ASTM c67.

Apparatus:

i) Capping mold,
ii) Testing machine,
iii) Trays and containers,

Experiment No. 7

Testing and Sampling of Bricks for Compressive Strength, Efflorescence and Absorption

Type of Brick : Pressed
Class of Brick:
Frog Mark: NBM

Calibration equation, $Y = 1.018X - 20$ (0-850 kN)

Compressive Strength:

Sl. No.	Specimen Length, mm	Specimen Width, mm	Specimen Area, mm²	Maximum Load, kN (Calibrated)	Crushing Strength, psi	Average Crushing Strength, psi
1	118.8333	108.1667	12853.80591	397.38	4483.89	2900
2	119.8333	112.6667	13501.22246	173.42	1862.98	
3	110.8333	110.5	12247.07965	195.82	2319.025	
4	106.3333	112.3333	11944.77099	226.36	2748.55	
5	116.8333	110.3333	12890.60354	273.18	3073.67	

Absorption Capacity:

Sl. No.	SSD Weight, gm	Oven Dry Weight, gm	Weight of Soaked water, gm	Absorption Capacity, %	Average Absorption Capacity,%
1.	1343	1161	182	15.67	18.48
2.	1548	1301	247	18.98	
3.	1542	1302	240	18.43	
4.	1729	1460	269	18.42	
5.	1347	1114	233	20.91	

Efflorescence:

Pair No.	Observation
1	Efflorescenced
2	Efflorescenced
3	Efflorescenced
4	Efflorescenced
5	Efflorescenced

Student Name: Sudipta Roy

Signature of Class Teachers

Student No.: 1104114

Sec & Group: B_2 (G-1)

(1 GPa = 145037.73

Discussion:

From ASTM the minimum compressive strength of 1st class brick should not be less than 2500 psi. From experiment result the compressive strength of brick specimen is almost 2900 psi, which is far more than that. It shows that the specimen bricks are 1st class brick.

1st class brick should not absorb more than 1/6th of their own weight. The specimen bricks absorbs 18% water in average. So the water absorption capacity is almost 1st class.

Good bricks should not contain any efflorescence but from the test, we got that the specimens are slightly efflorescenced.

Assignment Questions :-

1. Why capping is needed ? What should be the basic properties of a capping material ?

Ans: Capping is used to ensure a plane surface area over the brick and to ensure a uniform distribution of applied load.

The capping material should have strength and elastic properties similar to those of the concrete in the specimen. This is required so that there is no enhanced tendency to splitting and also to achieve a reasonably uniform stress distribution over the surface of specimen. The capping material should not be weaker than the concrete in the specimen. However, if the cap is too strong, here will be apparent increase in strength of concrete due to large lateral restraint produced by strong cap.

2. How absorption capacity affects the compressive strength of brick?

Ans: If absorption capacity is high than the brick can absorb more water. That means it's interparticular distances are relatively larger. So, it's density is low and hence its strength is also low. So, the greater amount of absorption capacity is the less amount of strength.

3. What are the possible effects of efflorescense in construction How it can be controlled?

Ans: The initial occurance of efflorescence is primarily considered as the asthetic defect. However, if the fundamental cause is left uncorrected. Continued efflorescence can become a functional defect and effect the integrity and safety of a direct adhered facet.

The primary danger is potential bond failure resulting from continued depletion of calcium and subsequent loss of strength of cementitious adhesive and underlying cementitious components.

If no moisture reaches the sulphates, then they can't be rendered into solution and migrate to the surface where the water will evaporate and hence will cause efflorescence. So, to prevent any water from penetrating into the masonry wall good architectural details and qualify masonry construction are needed.

Designing with over hanging eaves, copings and flashings and attention to landscaping and sprinklers will reduce the chances of water entering the wall. In addition specifying tooled, compacted mortar joints (concave or 'v' type) will also reduce the potential for water infiltration.

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BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

Experiment No: 08

Experiment Name:

Sieve Analysis of Fine and Coarse Aggregate.

Date of performance: 04.03.14

Date of submission: 11.03.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

Objective:

The objective of this experiment is to determine the fineness modulas by sieve analysis of fine and coarse aggregate.

Theory:

The sieve analysis, commonly known as the gradation test is a basic essential test for all aggregate technicians. The sieve analysis determines the gradation i.e the distribution of aggregate particles, by size, within a given sample in order to determine compliance with design, production control requirements and verification specifications.

Aggregate gradation is also useful for the determination of some index values related to particle size distribution such as - fineness modulas (FM). To characterize the overall coarseness or fineness of an aggregate, a concept of fineness modulas is developed. The fineness modulas is defined as the empherical factor obtained by adding on each of the ASTM standard sieves and dividing this sum arbitrarily by 100.

$$FM = \frac{\Sigma \text{Cumulative \% retained on the standard sieves upto No. 100}}{100}$$

(Sieve opening (mm))

Apparatus:

(i) Balance or Scale

(ii) Sieves

(iii) Mechanical sieve shaker

Experiment No. 08

Sieve Analysis of Fine and Coarse Aggregate

Sieve Analysis for Fine Aggregate

Weight of aggregate:

Sieve No.	Sieve Opening, mm	Material Retained, gm	Percent of Material Retained	Cumulative % Retained	Percent Finer
No. 4	4.75	0	0	0	100
No. 8	2.36	15.4	3.08	3.08	96.92
No. 16	1.18	74.9	14.99	18.07	81.93
No. 30	0.6	212.2	42.47	60.54	39.46
No. 40					
No. 50	0.3	150.5	30.12	90.66	9.34
No. 100	0.15	38.1	7.62	98.28	1.72
No. 200					
Pan		8.6	1.72	100	0
Total		499.7			

Result:

$$\text{Fineness Modulus, FM} = \frac{\sum \text{cumulative \% retained on the standard sieves upto no.100}}{100}$$

$$= \frac{0+3.08+18.07+60.54+90.66+98.28}{100}$$

$$= 2.71$$

4.3

continued to next page.....

Data table for coarse aggregate

Sieve Analysis for Coarse Aggregate

Weight of aggregate:

Sieve No.	Sieve Opening, mm	Material Retained, gm	Percent of Material Retained	Cumulative % Retained	Percent Finer
~~1"~~ 1"	25.33	0	0	0	100
~~1.5"~~ 3/4"	19	2803	28.06	28.06	71.94
~~3/4"~~ 1/2"	12.67	4913	49.18	77.24	22.76
3/8"	9.5	1676	16.78	94.02	5.98
No. 4	4.75	598	5.99	100	0
No. 8	2.36	0	0	100	0
No. 16	1.18	0	0	100	0
No.30	0.6	0	0	100	0
No.50	0.3	0	0	100	0
No.100	0.15	0	0	100	0
PAN					
Total		9990			

Result:

$$\text{Fineness Modulus, FM} = \frac{\sum \text{cumulative \% retained on the standard sieves upto no.100}}{100}$$

$$= \frac{28.06+94.02+100+100+100+100+100+100}{100}$$

$$= 7.22$$

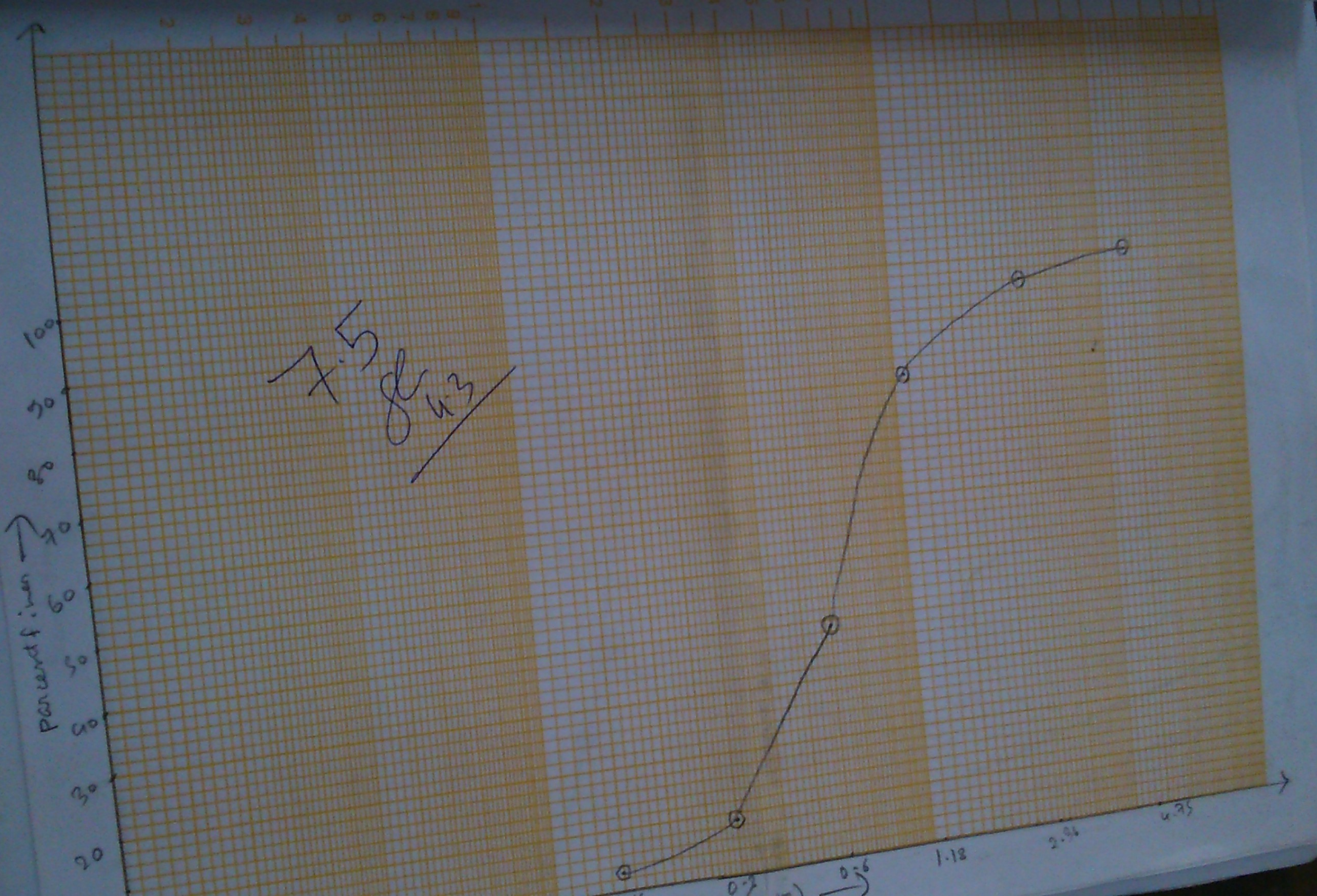
Signature of Class Teachers

Student Name: Sudipta Roy

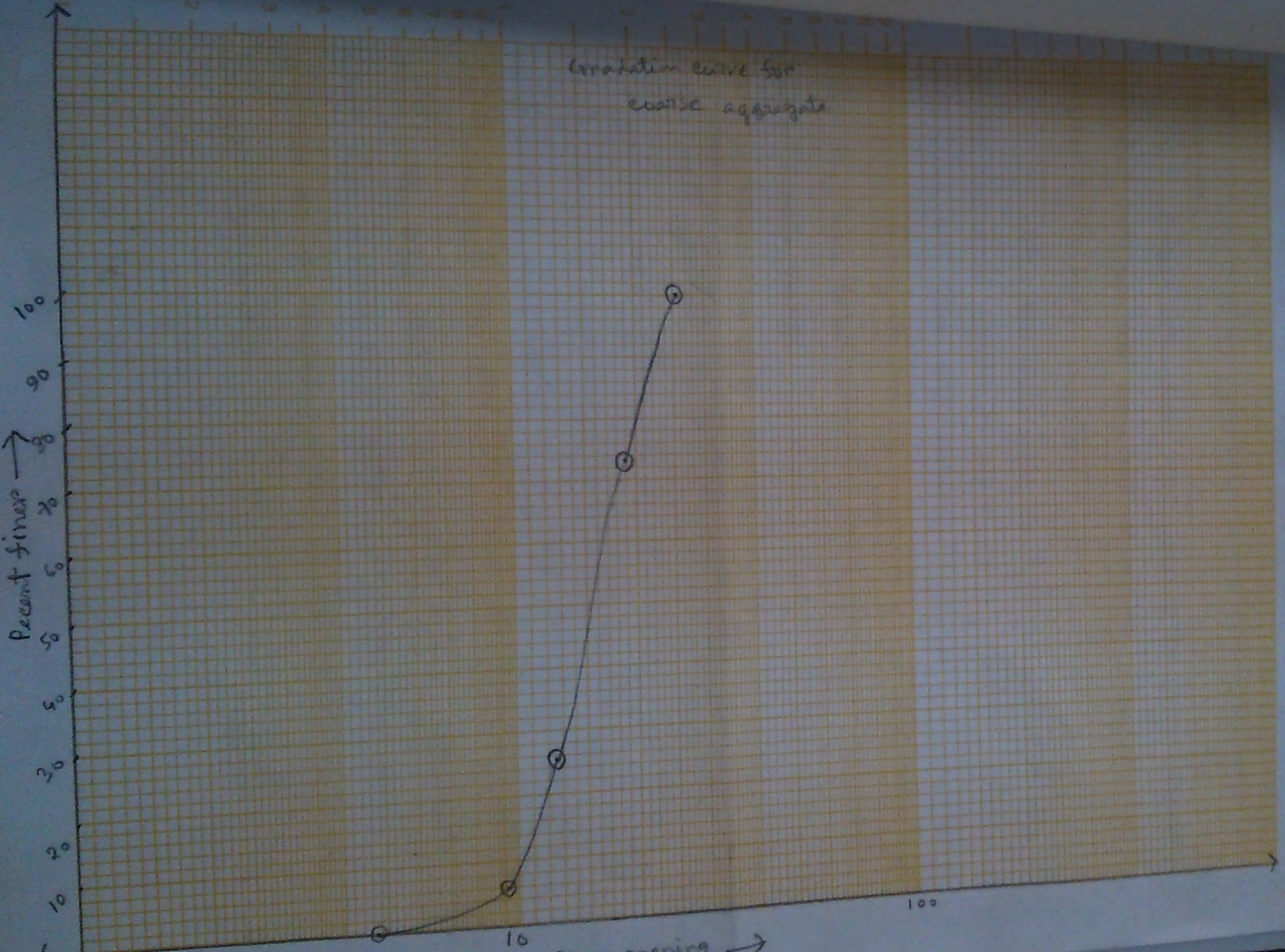
Student No.: 1104114

Sec & Group: B_2 Group-1

Date: 04.03.14



20
30
40
50
60
70
80
90
100
1.18
2.36
4.75



Gradation curve for
coarse aggregate
Percent finer →
10
20
30
40
50
60
70
80
90
100
10
100

Discussion:

Proper standard sieves should be used for gradation test. But we can use some non-standard sieve also for greater distribution variation.

After the full sieve analysis is conducted the initial material should be equal to the total material retained after test. 0.3% variation may be allowed. Here for fine aggregate test we took 500 gm of aggregates and after test the total weight is 499.7 gm. which is inside the allowable range.

From the graph it is found that the aggregates are well graded. As this test is for finding the FM of fine aggregates, it's obvious from calculation that fineness modulus is relatively low in comparison with coarse aggregate as in case of fine aggregate we have got the FM 2.71 and for coarse aggregate it is 7.22. The coarse aggregate curve represents that the coarse aggregate specimens are open graded as a small percent of materials is in the small size range

Assignment Questions & Answers:

Q. 1) How aggregate gradation can affect the compressive strength of concrete?

Ans: Dense and well graded aggregate are desirable for making concrete, as the space between longer particles is effectively filled by smaller particles to produce a well-packed structure. In uniform grading only a few sized dominate the bulk material and the aggregates are not effectively packed. In gap graded particles, segragation is a great problem. So particles do not get compacted perfectly. And open graded particles do not provide well compressive strength, because of air voids between the larger particles.

Q. 2) What is the importance of Fineness Modulus?

Ans: Fineness modulus is necessary to characterize the overall coarseness or fineness of aggregate.

Q. 3) What are the applications of open and dense graded aggregate?

Ans: OPen graded mixes are typically used as wearing courses or underlying drainage layers and also used in concrete pavement. Dense graded aggregates are used in HMA and PCC mix designs in US. It may be used as a base material for concrete pavers, asphalt drive ways, asphalt walk ways, road base for interlocking walls, open graded bases are preferred because of storage and treatment benefits.

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

Experiment No: 09

Experiment Name:

Determination of Specific Gravity and Absorption of

Fine and Coarse Aggregate

Date of performance: 11.03.14

Date of submission: 25.03.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

Objective:

The objective of this experiment is to determine the Specific Gravity and Absorption of fine and course aggregates.

Theory:

The measured water absorption rate and specific gravity of aggregates is routinely used in design and construction. The presence of permeable and impermeable pores in aggregates is very important for desiring of specific gravity of aggregates. With this SG is known, its weight can be converted into solid volume and hence a theoretical yield of concrete per unit volume can be calculated.

In portland cement concrete the specific gravity is used in calculating the percentage of voids and the solid volume of aggregates in computation of yield. The absorption is important in determining the net water-cement ratio in the concrete mix. Knowing the SG of aggregates is also critical to the construction of water filtration system, slope stabilization projects, railway bedding and many other applications. The specific gravity and absorption of coarse and fine aggregate are determined according to the specification AASHTO T84 (for fine) and AASHTO T85 (for coarse aggregate).

Depending on presence of moisture within the pores in aggregate and moisture on the surface aggregate condition can be defined into four catagories:

When aggregate is dried in oven at 110±5°C for 24 hrs no moisture left in the pores the condition is called O.D. When aggregate is dried in air for 24 hrs some moisture remains in the permeable pores and it is called Air dry condition. When the permeable voids of aggregate are filled with water, but no water is present on the exposed surface it is called Saturated surface Dry (SSD) condition. And when the permeable voids of aggregate are filled with water, in addition to that an excess layer of bound water is also present on exposed surface it is called moist condition.

Bulk specific Gravity (O-D), S_d = $\frac{\text{Oven dry wt of aggregate}}{\text{wt of water occupying equal volume including permeable pores}}$

Bulk specific Gravity (SSD), S_s = $\frac{\text{SSD weight of aggregate}}{\text{wt of occupying equal volume including permeable pores}}$

Apparent Specific Gravity (O-D), Sa = $\frac{\text{O-D weight of aggregate}}{\text{wt of water occupying equal volume excluding permeable pores}}$

Absorption is the increase in the weight of aggregate due to water being absorbed into the permeable pores of the material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass.

Apparatus:

i) Balance
ii) Pycnometer
iii) Mold
iv) Tamper
v) Sample container
vi) Sieves
vii) Water tank

Experiment No. 09

Determination of Specific Gravity and Absorption of Fine and Coarse Aggregate

For Fine Aggregate

Room Temperature, °C = 26°C

Water Temperature, °C = 23°C

S.S.D. Wt of Sample (S) in gm	Wt. of Empty Pycnom. (P), gm	Wt. of Pycnom. + Water (B), gm	Wt. of Pycnom. +Sample + Water (C), gm	Capacity of Pycnom. (V= B-P), gm	Wt. of Water Added (W = C-S -P), gm	Wt. of Moist Sample (F), gm	Wt. of Oven-Dry Sample (A), gm	Wt. of Air-Dry Sample (H), gm
500	138.4	1295.9	1608.6	1057.5	870.2	629.5	487	491

Results :

Parameters	Formulae	Calculations	Results
Apparent Specific Gravity, S_a	$\frac{A}{(V-W)-(S-A)}$	$\frac{487}{(1057.5-870.2)-(500-487)}$	2.794
Bulk Specific Gravity (O-D Basis), S_d	$\frac{A}{V-W}$	$\frac{487}{1057.5-870.2}$	2.60
Bulk Specific Gravity (S.S.D. Basis), S_s	$\frac{S}{V-W}$	$\frac{500}{1057.5-870.2}$	2.669
Absorption Capacity (D) in %	$\frac{S-A}{A}\times 100$	$\frac{500-487}{487}\times 100\%$	2.67%
Percentage of Free Moisture (M)	$\frac{F-S}{S}\times 100$	$\frac{629.5-500}{500}\times 100\%$	25.9%
Percentage of Effective Absorption S.S.D. Basis (D_e)	$\frac{S-H}{S}\times 100$	$\frac{500-491}{500}\times 100\%$	1.8%

Table for coarse aggregate continued to next page....

For Coarse Aggregate

Room Temperature, °C = 26°C

Water Temperature, °C = 25°C

Wt. of Basket in Air (B), lb / kg	Wt. of Basket in Water (E), lb / kg	Wt. of Basket+ SSD Sample (F), lb / kg	Wt. of Basket+ Sample in Water (G), lb / kg	S.S.D. Wt of Sample (S = F-B), lb / kg	Wt of S.S.D. Sample in Water (C = G-E), lb / kg	Wt. of Oven Dry Sample (A), lb / kg	Wt. of Air Dry Sample (H), lb / kg
0.576	0.508	4.000	2.636	3.424	2.128	3.399	3.405

Results :

Parameters	Formulae	Calculations	Results
Apparent Specific Gravity, S_a	$\frac{A}{A-C}$	$\frac{3.399}{3.399-2.128}$	2.67
Bulk Specific Gravity (O-D Basis). S_d	$\frac{A}{S-C}$	$\frac{3.399}{3.424-2.128}$	2.62
Bulk Specific Gravity (S.S.D. Basis). S_s	$\frac{S}{S-C}$	$\frac{3.424}{3.424-2.128}$	2.641
Absorption Capacity (D) in %	$\frac{S-A}{A} \times 100$	$\frac{3.424-3.399}{3.399} \times 100\%$	0.7%
Percentage of Effective Absorption S.S.D. Basis (D_e)	$\frac{S-H}{S} \times 100$	$\frac{3.424-3.405}{3.424} \times 100\%$	0.55%

Signature of Class Teachers

Student Name: Sudipta Roy

Student No.: 1164114

Sec & Group: B2 Gr-2

Date: 11.02.14

Discussion:

The specimen aggregate collapses fully in core test, so, we can tell the FA has in SSD condition.

While mixing the FA with water in the pycnometer we have to roll it so that no voids are there. There can be an error in determining the specific gravity, as to settle down the particles time is needed, but we are not letting the apparatus to rest, it may not give exact value.

The course materials are tried to turn in SSD condition from moist condition as far as possible, but some aggregates may be in mist condition.

Here, in the result in both cases we see $ASG > BSG(SSD) > BSG(OD)$. So, the result is almost ok we can say.

Assignment Question:

1. How Bulk specific gravity (O-D), bulk specific gravity (SSD) and apparent specific gravity (O-D) can be correlated? Which one is greater and why, explain.

Ans: In BSG (O-D), the over dry weight of a unit volume of aggregate at a stated temparature is taken. But in BSG (SSD) the SPSD weight of a unit volume of aggregate is taken. In both cases the weight of water is taken including permeable pores of that volume. As SSD weight is greater than O-D, so BSG (SSD) is greater. In apparent specific gravity (ASG) the aggregates are of O-D weight and the weight of water is taken excluding pores. As, the volume of the exluding pores have a greater impact on ASG than taking the O-D weight of aggregates, rather than SSD weight, the ASG is greatest. So, we can compare them like it ASG > BSG (SSD) > BSG (OD).

2. What difficulties arise in the use of aggregates which absorb water? How are they overcome (a) in the laboratory and (b) on the job?

Ans: If aggregate absorb too much water, it will reduce the amount of water available for hydration or conversly at the aggregate is very weight, it will add excess water to cement mix. This may weaken

the hardened concrete. The mix has too much water will not be adhesive and may separate and bleed.

2. Why core test is done for fine aggregate? discuss the procedure.

Ans: core test is done for fine aggregate to test whether the aggregates are in moist or SSD condition.

To do this the core is placed with the large diameter down on a glass plate. Now, it is filled overflowing with drying sand. The aggregates are lightly tamp into the mold with 25 light drops of tamper. Then the loose sands are removed and the mold is carefully lifted vertically. if surface moisture is present, the fine aggregate will retain the molded shape, when it achieves an SSD condition, the sand will slump.

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Course No: CE-202

Course Title: Materials Sessional

Experiment No: 10

Experiment Name:

Determination of Unit Weight and Voids in Fine and Coarse Aggregate

Date of performance: 18.03.14

Date of submission: 25.03.14

Name: Sudipta Roy

Student No: 1104114

Section: B_2

Level: 2

Term: 1

Session: 2011-12

Objective:

The objective of this experiment is to determine the unit weight & voids in fine and coarse aggregate.

Theory:

The weight of aggregate in a unit volume is required to be determined for design of concrete structures. Unit weight measures the volume that graded aggregate and the voids between them will occupy in concrete. The void content between particles affects the amount of cement paste required for the mix. Angular aggregates increase the void content larger size of well-graded aggregate is dependent on a number of parameter - moisture in aggregate, degree of compaction, aggregate gradation etc.

Unit weight values of aggregates are necessary for use for many methods of selecting proportions for concrete mixtures. They may also be used for determining mass/volume relationships for conversions and calculating the percentages of voids in aggregates. Voids within particles, either permeable or non-permeable are not included in voids as determined by this test method. The

unit weight and voids in aggregates is measured in accordance to ASTM C29.

For generally determination of unit weight and voids three different procedures are followed:

a) Shoveling procedure - used for determination of unit weight in loose condition.

b) Rodding procedure - used for determination of compacted unit weight of aggregates having a nominal maximum size of 1.5 in (37.5 mm) or less and

c) Jiggling procedure - used for determination of compacted unit weight of aggregates having a nominal maximum size greater than 1.5 in (37.5 mm) and not exceeding 6 in (150 mm).

Apparatus:

i) Balance,
ii) Tamping rod,
iii) Calibration equipment,
iv) Measure,

Experiment No. 10

Determination of Unit Weight & Voids in Fine and Coarse Aggregate

Type of Aggregate	Procedure used	Wt. of Measure T, lb	Wt. of Measure + Material G, lb	Wt. of Material G-T, lb	Average Wt. of Material, lb	Density of Water, lb/ft³	Volume of Measure V, ft³	Unit Weight M, lb/ft³	Bulk Specific gravity (O-D), S	% Void
FA	Shoveling	5.78	14.91	9.13	9.13	62.274	0.097	94.12	2.60	42%
	Rodding	5.78	15.37	9.59	9.59			98.87		39%
	Jiggling	5.78	15.74	9.96	9.96			102.68		37%
CA	Shoveling	0	43.83	43.83	43.83		0.49	89.45	2.619	45%
	Rodding	0	48.04	48.04	48.04			98.04		40%
	Jiggling	0	49.71	49.71	49.71			101.45		38%

Signature of Class Teachers

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Sec & Group: B2 (G-1)

Discussion:

In the lab all the procedure of compaction such as shovelling, Rodding, Jigging have been done according to ASTM C29.

The result may vary for the data taken from previous experiment (BSG(OD)).

The unit weight and voids depend on the gradation of fine and coarse aggregate.

Assignment Questions:

i) What are the significance of measuring unit weight and voids in aggregate?

Ans:

Unit weight and voids in aggregate is important for selecting proportions for concrete mixtures. They may also be used for determining mass volume relationships for conversions and calculating percentage of voids in aggregate. Voids within particles, either permeable or impermeable are not included in voids are determined by this.

ii) Why rodding procedure of for determination of unit weight in aggregates is not preferable for higher size aggregate?

Ans:

Because in higher size aggregate the void is also high, so rodding procedure cannot be effective there, Jiggling procedure is more effective here.

iii) What would be the effect upon the unit weight if damp fine aggregate is used.

Ans: If damp fine aggregate is used, water will provide extra weight but no extra volume. Water will occupy the particle space between aggregates. As a result, percentage of void will decrease and unit weight will increase.
