COMBINED EFFECT OF WATER CEMENT RATIO AND FLY ASH ON CONCRETE BY 25% REPLACEMENT.

By

Md. Zony Ahmed

Jalil Kotowal

Md. Morsalin hosen

Md. Jahurul islam

Shanjida khatun

A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering



Department of Civil Engineering
Sonargaon University
147/I, Green Road, Dhaka-1215, Bangladesh

Section: 17B

Semester: Fall -2022

Combined effect of water cement ratio and fly ash on concrete by 25% replacement.

By

Md. Zony Ahmed	BCE1902017109
Jalil Kotowal	BCE1901016059
Md. Morsalin Hosen	BCE1902017122
Md. Jahurul islam	BCE1902017072
Shanjida khatun	BCE1902017096

Supervisor

Afia Zahin Nita Hossain

Lecturer, Department of Civil Engineering, Sonargaon University.

A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

Department of Civil Engineering

Sonargaon University

147/I, Green Road, Dhaka-1215, Bangladesh

Section: 17B

Semester: Fall-2022

BOARD OF EXAMINERS

The thesis titled "**Combined Effect Of Water Cement Ratio And Fly Ash On Concrete By 25% Replacement.**" submitted by Md. Zony Ahmed (BCE1902017109), Jalil Kotowal (BCE1901016059), Md. Morsalin Hosen (BCE1902017122), Md. Jahurul Islam (BCE1902017072), Shanjida Khatun (BCE1902017096) Student No.: 05, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering on Date-of-Defense 20.01.2023.

……

1. Chairman

Afia Zahin Nita Hossain
Lecturer, Department of Civil
Engineering, Sonargaon University

……

2. Internal / External Member — Member

……

3. Internal / External Member — Member

DECLARATION

It is hereby declared that this thesis/project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

STUDENT NAME	STUDENT ID.	SIGNATURE
Md. Zony Ahmed	BCE1902017109	
Jalil Kotowal	BCE1901016059	
Md. Morsalin Hosen	BCE1902017122	
Md. Jahurul Islam	BCE1902017072	
Shanjida Khatun	BCE1902017096	

Dedicated

To

"First and foremost, thank Allah, the Almighty for endowing his immense blessing that helped us in each step of our progress towards the successful completion of our research work. We dedicate this thesis to our parents"

ACKNOWLEDGEMENTS

All praise to Allah. We are grateful to almighty Allah for giving strength and courage that we have completed the thesis successfully.

We would like to express our heartiest gratitude and profound indebtedness to many people who have helped us in completing this study. First and foremost, our deepest gratitude goes to our advisor, Afia Zahin Nita Hossain, Lecturer, Department of Civil Engineering, Sonargaon University, Dhaka. Her excellent supervision, continuous guidance, constructive suggestions and encouragement made the tedious thesis work such easier to endure. Her active interest, proper guidance and valuable advice were the source of our inspiration.

The authors are particularly grateful to our Honorable sir, Associate Professor Lutfor Rahman, Department Head, Department of Civil Engineering, Sonargaon University, Dhaka, for his valuable suggestion and co-operation.

Finally, we would also like to convey thanks to all the teachers of Department of Civil Engineering, Sonargaon University (SU), Dhaka for their valuable instructions at different stages of this research. We are grateful to all the stuff of concrete and strength of materials laboratory for their sincere cooperation during laboratory works.

ABSTRACT

Fly ash (FA) is burning coal product which is used as supplementary cementitious materials (SCM) as the conjunction with cement. The use of FA is considered by its pozzolanic properties i.e. SiO2, Al2O3 and CaO to hardened concrete. The potential of FA as SCM has been well-known over the globe but that significant utilization has to be studied based on its compound's characteristics and pozzolanic activity. For this case, the amount of FA is added 25% by mass of total cementitious material, concrete with fly ash (NFA) and another blended without FA as normal concrete (NC) made of ordinary Portland cement. This amount is indicated as dosage in moderate to high volume of FA classification. In this Study, the detailed experimental investigation was done to study the effect of partial replacement of cement by Fly Ash (FA) in combine proportion 25% FA mix in concrete by replacement of cement. The tests on hardened concrete were destructive in nature which includes compressive test on cube for size (100 x 200 mm) at 7,14, and 28 days of curing as per IS: 516 (1959), The work presented in this study reports the effects on the behavior of concrete produced from cement with combination of FA on the mechanical properties of concrete such as compressive strength, flexural strength, and split tensile strength. Investigation reported that compressive strength increases by 30.15% in compared with targeted strength and reduces by 8.73% compared with control concrete at 28 days. Partial replacement of FA reduces the environmental effects, produces economical and eco-friendly concrete.

NOTATIONS

ACI	= American Concrete Institute
ASTM	= American Society for Testing and Materials
KN	= Kilonewton
mm	= Millimeter
MPa	= Mega Pascal (N/mm^2)
P	= Axial load
F.M	= Fineness Modulus
f'_c	= Compressive strength of cylindrical specimen of concrete at 28 days
W/C ratio	= Water/Cement Ratio
C.C	= Cement Content
Pcf	= Pound per cubic feet.
psi	= Pound per square inch
Ksi	= Kip per square inch
A.E	= Air Entrance
N.A.E	= Non Air Entrance
E_c	= Modulus of Elasticity of concrete

TABLE OF CONTENT

ABSTRACT……..…….…….....7

LIST OF FIGURES……..…….……10

LIST OF TABLES……..…….……..11

CHAPTER 1……..……12

INTRODUCTION……..……...12

1.1 Background and Motivations…….……...……...12
1.2 Research Objectives and Overview……..……..…….……14
1.3 Organization of the thesis……...…….……14

CHAPTER 2……..……15

Literature Review ……..……...…….……15

2.1 Introduction……..…….....15
2.2 Literature Review Overview……..…….……15
2.3 Summary……..……17

CHAPTER 3……..……18

Methodology……...…..……18

3.1 Introduction……...…..……18
3.2 Methodology Overview……...……..……21
3.3Summary……..……...……..……27
CHAPTER 4……..……28

Result and Discussion……...……28

4.1
Introduction……..…….……28
4.2 Specific Aim 1 ……..……..……28
4.3 Summary……..……40

CHAPTER 5……..……41

5.1 Conclusions……..……41

5.2 Limitations and Recommendations for Future……...……41

REFERENCES……...……....……42

LIST OF FIGURES

Fig 3.4 : Fly Ash……..…….. 20

Fig3.5(a) Coarse Aggregate……..……20

Fig3.5(b) Coarse Aggregate……..……20

Fig3.7a(1): Balance……..……..……...…21

Fig3.7a(2): Cement Paste……..……..…...……...21

Fig3.7(b) Normal Consistency measurement by Vicat's Apparatus……..……...……22

Fig3.7c(1) Sand filter By hand……..……..…...……...23

Fig3.7c(2): Weight 500g Sample……..……..…..…….23

Fig3.7d(1): Mixing water with the fine aggregate…….……..……..……..……25

Fig3.7d(2): Pycnometer with sample……..……...……..…...…….25

Fig3.7e(1): Determined weight in water……..……..26

Fig3.7e(2): Determined weight at room temp……...……...……..26

Fig3.7f(1): Aggregate measurement……..…….…..…….……27

Fig3.7f(2): Concrete Mixing.……...…….……..……..27

Fig3.7f(3): Cylinder Marking…….....……..……...….27

Fig3.7f(4): Cylinder Curing…….……...……..…….……27

Fig3.7f(5): Dia Measurement…..……..…….……27

Fig3.7f): Compressive strength……...……..…….……27

Fig4.1(a): Normal consistency graph……..…….……..29

Figure4.1c(1) : Grain size distribution curve of Coarse aggregate (Stone chips)…….32

Figure4.1c(2): Grain size distribution curve of fine aggregate……..…….……34

LIST OF TABLES

Table.4.1 Physical properties of Cement with mixed fly ash ……..26

Table:4.1(c) Gradation of Stone Chips ……..…….29

Table4.1(c): Gradation of Fine aggregate (Sylhet sand) ……..…….……...…...30

Table4.1 (d): Specific Gravity of Fine Aggregate ……..…….……....32

Table4.1 (d): Specific Gravity of Fine Aggregate ……..……...……...33

Table4.1(e): Specific Gravity of Coarse Aggregate …….……...……33

Table4.1(i): For 100% Cement (Compressive Strength in 7 days) ……..…...……34

Table4.1(i): For 100% Cement (Compressive Strength in 7 days) …….……34

Table4.1(ii): For 100% Cement (Compressive Strength in 14 days) ……..……..…...…..35

Table4.1(ii): For 100% Cement (Compressive Strength in 14 days) ……..……34

Table4.1(i): For 100% Cement (Compressive Strength in 28 days) …….……..36

Table4.1(i): For 100% Cement (Compressive Strength in 28 days) ……..…….……36

CHAPTER 1
INTRODUCTION

1.1 Background and Motivations

Concrete is the most widely used construction material in the modern world. Concrete includes large amount of natural resources as aggregates and cement with water. Cement production consumes huge energy and causes about 7% of total green house gas emission in the world (Malhotra 2002). Furthermore, the raw materials processing phases in the factory releases dust, noises, greenhouse gases especially carbon dioxide that contaminates the environment and aggravates the climate change. These uninvited environmental issues cause distress to the lifestyle of mankind. Therefore, enhancing the manufacturing technology of cement plant for cleaner production is one of the resolutions to this issue. Approach of using industrial waste as supplementary cementitious material or cement free concrete also would reduce dependency on cement demand. Hence, utilization of supplementary cementitious materials such as fly ash, slag and silica fume is being researched extensively over the last few decades to enhance durability and sustainability of concrete. But using fly ash in concrete has various positive effects on the environment, making it environmentally benign. It saves the cement requirement for the same strength thus saving of raw materials such as limestone, coal etc. required for manufacture of cement. Fly ash (FA) is a coal combustion residual which appears as a by-product from processing combustion in steam generator of industrial thermal power plants. The amount of FA is enormously cause serious problems which is related to the environment pollution (Andrew R M, 2019). Globally increasing day by day, the current annual production of fly ash worldwide is estimated around 600 million tons cases which is factories pulverized the FA in each year. (Ahmaruzzaman M, 2010) Presently in Bangladesh, it is estimated that 1.3 million cubic feet of fly ash is produced per annum for dumping from thermal power plants alone, and is estimated to reach an alarming crescendo of 9.5 million cubic feet by 2018 The environmental degradation due to dumping of fly ash aggravates the situation. In fact, the problem is now successfully solved to use a pollutant of FA as a replacement of cement. Currently, fly ash is a byproduct of coal being burned in power plants and is used to enhance the mechanical characteristics of concrete. In the past, FA was typically employed in concrete at levels between 10% and 25% of the cementitious

materials' mass, but this still relies on the pozzolanic activity. When applications of FA in concrete were initiated, early strength was taken into consider without considering the low heat generation. The effects of fly ash on the time of setting depends on the characteristics and amounts of fly ash used. However, some Class C materials are reported to reduce the time of setting and others have no effect. The rate at which such strength is developed and the level of such strength depends on the characteristics of the fly ash, the cement used, the proportions of fly ash to cement, and the curing regimen. The use of this concrete was also considered to support the durability by increasing its mechanical properties. The addition of fly ash in both the ways are beneficial but the second method gives the freedom and flexibility to the engineer/user for changing the variation of percentage addition of fly ash. According to the "National Precast Concrete Association," fly ash can be added up to 70% by weight of cement for mass concreting projects like dams and retaining walls, as well as 15 to 35% by weight of fly ash for regular concrete work. Due to a very low water content, superplasticizer may occasionally be required to achieve workability. Several researchers have successfully created the ideal FA concrete composition utilizing admixtures and locally available ingredients. It is mainly considered to the proportion of FA on the concrete mixture. This is highlighted, with a given slump, FA concrete consolidates better than conventional PC. In addition, FA also advances the cohesiveness and lessen the segregation. Concrete is normally proportioned to achieve a certain minimum strength at specified age, 14-day, 28-day (typical age of the concrete) and 56-day. The early-age strength is decreased as the level of replacement increased. The FA must be managed at each age of strength, and curing quality control must be offered, in order to preserve the development over the long term. Several researchers in the past investigated the effect of mineral and chemical admixtures on the properties of the concrete adopting different theories. Success in utilizing other alternative material which production consumes lesser natural resources, economic and has lesser harm to the nature to act as binder in concrete would contribute to sustainable and healthier environment for future generation. Thus, cement is an expensive material more than FA and has a particular impact on environmental pollution, the main objective of this study is to consider alternatives to cement.

1.2 Research Objectives and Overview

Effect on concrete depend upon properties of ingredients and their relative proportion. Addition of mineral in concrete mixes, while designing of mixes has become increasingly complex. This is due to the chemical composition and pozzolanic properties of admixtures. complexity will be experimentally studied in this research. The study will investigate the effect over the various properties of concrete with use of mineral admixtures. Based on mechanism & combination the main objectives of this study are-

1. To compare the strength between fly ash mixed concrete and normal concrete by cement replacement.

2. To identify the difference in workability and durability between fly ash mixed concrete and normal concrete and setting time measure between FAC and similar concrete without fly ash.

1.3. Significance of the Study:

Fly ash utilization, especially in concrete, has significant environmental benefits including: increasing the life of concrete roads and structures by improving concrete durability, net reduction in energy use and greenhouse gas and other adverse air emissions when fly ash is used to replace or displace. To establish sustainable and healthier environment for future generation by removing stack of fly ash, it has many benefits and improves concrete performance in both the fresh and hardened state. Fly ash use in concrete improves the workability of plastic concrete, and the strength and durability of hardened concrete. Cement is costly material, so the partial replacements of these materials by fly ash reduces the cost of concrete. The most important significance is reduced permeability to water and aggressive chemical. Because the pores in properly cured concrete formed with fly ash are smaller, the final product is denser. Which increases strength and reduces permeability.

CHAPTER 2
Literature Review

2.1 INTRODUCTION

Concrete is a stone like material obtained by permitting a carefully proportioned mixture of cement, sand, aggregate and water to harden in forms of the shape and dimension of the desired structure. The bulk of the material consists of fine and course aggregate. Cement and water interact chemically to bind the aggregate particle into a solid mass. Additional water, over and above that needed for this chemical reaction, is necessary to give the mixture the workability that enables it to fill the forms and surround the embedded reinforcement steel prior to hardening. Concrete in a wide range of properties can be obtained by appropriate adjustment of the proportions of the constituent materials. These properties depend to a very substantial degree on the proportion of the mix, on the thoroughness with which the various constituents are intermixed, and on the condition of humidity and temperatures in which the mix is maintained from the moment it is placed in the forms until it is fully hardened. The process of controlling this condition is known as curing. To protect against the unintentional production of substandard concrete, a high degree of skillful control and supervision is necessary throughout the process, from the proportioning by weight of the individual components, through mixing and placing, until the completion.

This chapter includes overview of some previous work. Some isolated work had been carried out in the past in different countries and some information is available about our study. In those studies all of them were used crushed stone aggregate as coarse aggregate.

2.2 LITERATURE REVIEW

A review of literature reveals that the study reported by Satish H. Sathawane et. al / Procedia Engineering 51 (2013) 35 – 44 for the use of Combine Effect of Rice Husk Ash and Fly Ash on Concrete by 30% Cement Replacement. In their study, detailed experimental investigation was done to study the effect of partial replacement of cement by Fly Ash (FA) and Rice Husk Ash

(RHA). It is discovered that fly ash and rice husk ash are superior to other auxiliary materials like slag and silica fume. Due to RHA's low specific gravity, which results in a decrease in mass per unit volume, its addition lessens the structure's dead load.

The comparison of results of compressive strength using cube specimen of M25 grade of concrete for different percentage of cement, RHA and FA. Target strength of M25 concrete was 32.1 Mpa, but convention concrete gives 45.78Mpa compressive strength at 28 days of curing. Comparative work shows maximum compressive strength obtained at combination of 22.5% FA and 7.5% RHA which was less than strength of control concrete but greater than target strength. It was observed that 30.15% strength was increase as compared to target strength and 8.73% strength decreases as compared to control concrete at 28 days of curing

And flexural tensile strength using beam specimens of M25 grade of concrete. Beams were tested after 28 days of curing for Flexural Strength. It was observed that maximum flexural strength was obtained at combination of 22.5% FA and 7.5% RHA and strength was increase by 4.57% as compared to control concrete at 28 days of curing.

Another review of literature reveals that the study reported by abdulhalim KaraGin and Murat DoLruyol (2014) for the use of An Experimental Study on Strength and Durability for Utilization of Fly Ash in Concrete Mix. In this study the variation of strength and durability for concrete exposed to aggressive environment, sulfate attacks have been examined. It has been noted that, in case of sulfate attacks, at early stages fly ash concrete as composite materials shows weak strength properties with respect to those of plain concrete. However, it was observed that over time the FA concrete gains strength more rapidly. Namely, the strength difference reduced to a ratio of about 1% at the end of 5-month period. Since fly ash ties up free lime which leads to less bleed voids, it leads a considerable reduction of permeability to water and sulfate as aggressive chemical. Moreover, in case of sulfate attacks the experimental results show that uses of %20 FA (fly ash) as replacement of Portland cement cause a slight difference in strength properties of concrete samples. Economic benefit can be achieved by using fly ash as a pozzolanic addition in the concrete mixture.

Another review of literature exhibits the study reported by, M. M. ISLAM1 , M. T. ALAM1 , M. S. ISLAM1(2017) for the use of Use of Supplementary Cementitious Materials in Concrete: Bangladesh Perspective. This paper presents an experimental investigation carried out to study the effects of supplementary cementitious materials such as GGBFS and fly ash as partial replacement of cement on strength development of concrete. Because The emission of greenhouse gases from the production of raw materials of concrete is an important issue in construction sector. Cement is the prime constituents of structural concrete and it produces approximately 7% of global man made CO2. Cement was partially replaced with six percentages (0%, 10%, 20%, 30%, 40% and 50%) of GGBFS and fly ash by weight. Based on the results of this experimental investigation on different GGBF slag and fly ash concretes made with different cement replacement level for various curing period up to 180 days. Rate of gain in strength at early age of curing for both GGBF slag and fly ash concrete is observed to be lower as compared to OPC concrete upto 28 days. GGBF Slag and fly ash concrete mix having cement replacement levels up to 40% shows higher compressive as well as tensile strength as compared to OPC concrete. The optimum amount of GGBF slag in the concrete is observed to be 30% of cement. After 180 days curing, GGBF slag concretes with 30% cement replacement shows 19% higher compressive strength than OPC concrete. The corresponding increase in tensile strength is reported to be 22%. The optimum fly ash content is also observed to be 30% of cement. After 180 days of curing, fly ash concretes with 30% cement replacement shows 15% higher compressive strength than OPC concrete. The corresponding increase in tensile strength is reported to be around 18%. Use of GGBF slag or fly ash as a replacement of cement provides lower impact on environment by reducing CO2 emission in cement industry and judicious use of resources.

CHAPTER 3
Methodology

3.1 Introduction

This chapter includes different types of experimental data required to determine the properties of various ingredients of concrete, processes of manufacture of concrete, and tests to determine the properties of fresh and hardened concrete. In this chapter we have to determine the gradation of coarse aggregate, specific gravity, absorption capacity and unit weight of coarse aggregate and also determine the different properties of fine aggregate and binding materials, which is presented below. Fly ash is used in concrete either as an admixture at the concrete mixer or as an ingredient in blended cement. The physical and chemical properties of FA and OPC were first investigated. The compressive strength, split tensile strength, and flexural strength of concrete were used to study the impact of FA on its physical characteristics. Cylindrical specimens with varying the water cement ratio, maximum size of coarse aggregate (stone aggregate) and mixing ratios were prepared, then cured the specimen in water at normal temperature for 14, 21and 28 days tested. There are total number of 18 cylindrical specimens were tested and the modulus of elasticity was determined from the corresponding stress strain diagram.

The working methodology of the study is as follows:

i. Selection of materials.
ii. Preparation of concrete ingredients.
iii. Casting of concrete cylinders.
iv. Testing the specimen.
v. Result and discussion.
vi. Conclusion and recommendation.

3.2 Cement

The cement used was Pozzolana Portland cement (PPC) with a specific gravity of 3.12. Initial and final setting time of the cement was 42 min and 5hour 25 min. Normal consistency of the cement was 28%.

3.3 WATER

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. In this study potable water from tap was used in the mixture of concrete.

3.4 Fly Ash

Asphalt mixing plant of Mechanical circle Dhaka South City Corporation is situated at Dhalpur Jatrabari in Dhaka. Wood and Gas are used as fuel in the plant. Firewood is collected from different places of the country including Chattogram. There are three layers of unusable fly ash from fuel wood namely top layer, middle layer and bottom layer. The top layer is the first class fly ash which is the most smooth and good quality. It looks like cement. The middle layer is the second class fly ash which is less smooth and normal quality than the top layer. And the bottom layer is the third class fly ash which is relatively less smooth and normal quality than the middle layer. When fly ash is made from fuel, it is too hot to use. It takes 5 -7 days for it to cool down. After cooling it is sifted through quality sieve. About 95 -99 percent fly ash is obtained by running the top layer. About 70 -80 percent fly ash is obtained by running the middle layer. About 50 -60 percent fly ash is obtained by running the bottom layer which is usable. We have used top layer fly ash in lab tests for replacement which is the best quality



Fig 3.4 : Fly Ash.

3.5 PROPERTIES OF COARSE AGGREGATE

The aggregate most of which are retained on the 4.75mm sieve and contain only that much of fine material as is permitted by the specifications are termed coarse aggregate. In this study stone chips had been used as coarse aggregate



Fig3.5(a) Coarse Aggregate



Fig3.5(b) Coarse Aggregate

3.6 TESTS FOR FINE AGGREGATE

Fine aggregate is the aggregate most of which passes through No. 4 sieve (4.75mm opening) and contain only that much coarser material as is permitted by the specification. It should be clean and free from organic substances and size should be uniformly distributed.. The fine aggregate that

had been used in this study was Sylhet sand only. The following tests were employed to determine the properties of fine aggregate.

3.7 **Experimental program**

(a). Normal Consistency:

First we measured 650gm of cement with a balance apparatus and put it on the mixed plate and within 30 sec we made a paste with a certain amount of water (which is 22%-30% of cement). In the context of Bangladesh, Normal consistency of most cement 25% +, so we started with 25%. a paste was made with 162.5gm of water in 30 seconds. A ball was made with a little more cement than was needed to fill the ring, and passed from one hand to the other hand 6 times, maintaining a distance of 6". The ball of paste was inserted with the large end keeping the constricted diameter of the ring in the palm and the excess part was removed. The ring with cement paste is placed under the plunger rod and the plunger rod touches the upper surface of the paste and tighten the set screw. Then we set the movable indicator (10 mm Diameter) to the upper zero mark of the scale and for take an initial reading release the rod immediately. This must not exceed 30 sec after release the rod. The apparatus was free of all vibrations during the test. The paste of normal consistency when the rod settles to a point 10 1 mm below the original surface in 30 sec after being released.



Fig3.7a (1): Balance.



Fig3.7a (2): Cement Paste.

(b). Initial setting Time & Final setting Time:

After getting the normal consistency, we rested the paste with the ring for 30 min for first penetration. we kept Center the paste confined in the ring, resting on the plate, under the 1-mm needle, which brought in contact with the surface of the paste, and we tightened the set-screw. Then we set the movable indicator (1 mm needle) to the upper zero mark of the scale, or take an initial reading, and release the rod immediately. This must not exceed 30 sec after completion of mixing. And the same way, after 45min, 60min take the reading we determine the initial setting time through the graph. The needle must not be visibly sunk into the paste for the final setting time to occur, or the first penetration measure must not leave a complete circular impression on the specimen surface. Verified the final set by taking two more penetration readings in various places on the specimen surface. it was Replaced the needle with the annular attachment in the Vicat's apparatus. When the attachment fails to leave an impression on the test block surface after gently pressing the needle against it, the cement will be deemed to have fully set.



Fig3.7(b) Normal Consistency Measurement by Vicat's Apparatus.

(C). Sieve Analysis of Fine and Coarse Aggregate:

We dried the sample at a temperature 110 ± 50c than took a weight 500g sample from it. If particles are lumped, break that sample into its individual particles with the fingers or wooden hammer. We try to break into individual particles with fingers. Determine the mass of sample accurately Weighted (gm) and sieves are stacked in order, with the largest aperture size at the top, and the

smallest at the bottom (4 no. – 8 no. – 16 no – 30 no. – 50 no. – 100 no. – PAN) . A receiver (Pan) was placed under all of the sieves to collect samples. The sample is placed over the sieve and the lid is attached. it can be filtered by two methods, one by hand and the other by a shaker machine. We filtered the sand by hand. After 2.5 minutes we stopped the sieve shaker and measure the mass of each sieve and retained material. Weight to each sieve and the pan with the sand retained on them. Total sample was 500gm. Than 100% passing a 4 no., 8 No. and 16 no. sieve. when at least 0.6 % retained at (#30) sieve 3 gm, than 43.4% retained at (#50) sieve 217 gm , 50.2% retained at (#100) sieve 251 gm, than 5.2% retained at pan 26 gm. A table was prepared and all the data were calculated which is shown in the results and discussion chapter.



Fig3.7c (1) Sand filter By hand.



Fig3.7c (2): Weight 500g Sample

(d). Specific Gravity of Fine Aggregate:

Procedure: We sampled about one kilogram of aggregate. We dried the sample to constant weight at 110 +5 °C, allowed it to cool a comfortable transfer temperature, covered it with water and added 6% moisture to the fine aggregate and left it for 24 hours. We carefully removed excess water to avoid damage. We spread the sample on a flat non- absorbent surface exposed to a gentle current of air and shook it frequently to dry. We continued this procedure until the sample was free flowing. Cone test for surface moisture: we placed a portion of the particularly dry fine aggregate loosely in the mold and piled the excess material on top of the mold with cloth fingers holding the mold. With the drop we lightly tamped the fine aggregate into the mold and allowed the tamper to

fall freely under gravitational attraction on the drop. We adjusted the initial height to the new surface height after each drop and distributed the drops over the surface. We removed the loose sand from the base and lifted mold vertically. Fine aggregate retained the shape of the mold due to surface wet ability. We continued drying with constant stirring and checking at frequent intervals until the mold release sand clumps sagged. When fine aggregate slumps slightly it indicated that a surface has reached a dry state. The first trial of surface moisture testing indicated no surface moisture; it was dry before the surface reached dry conditions. In this case we thoroughly mixed a few ml of water with the fine aggregate and allowed the sample to stand in a covered container for 30 minutes. Then we restarted the drying process at frequent intervals for drying conditions on the surface.

Test on sample: Partially we filled the Pycnometer with water, quickly prepared 500 gm of saturated surface dry fine aggregate in the Pycnometer and filled with additional water to about 90% holding capacity. We rolled the Pycnometer to remove all air bubbles, were upside down and immersed in circulating water adjusted to a temperature of 23+1.7°C and brought the water level in the Pycnometer to the calibrated capacity. We determined the total weight of water in the Pycnometer sample. We weighted the Pycnometer filled to its calibration capacity with weighing water by cooling it in air for one hour from dry to constant weight at 110°C.



Fig3.7d(1): Mixing water with the fine aggregate.



Fig3.7d(2): Pycnometer with sample

(e). Specific Gravity of Coarse Aggregate:

Procedure: Sampling, We thoroughly mixed the aggregate sample and reduced its approximate volume. We rejected a 4.75 mm (No-4) sieve and thoroughly washed the sieve to remove other coatings from the surface. After sieving through 4.75 mm (No- 4) sieving 2.36 mm (No- 8) we used for remaining fine material.

Experimental procedure: We dried the test sample at 110+5°C and cooled it with air. 37.5 mm (1.5 in) size for test specimens or larger size was comfortable to handle until cooled. Then we immersed the aggregate in water and kept at room temperature for 15 to 19 hours. Then we removed the test sample from the water and rolled it on a large absorbent cloth until all was visible. We used a moving air stream to help dry the individual larger particles. We weighed the test sample to the overall pore saturated while the operating surface of the sample was drying and recorded all subsequent weights to the nearest 0.5 gm. We determined its weight in water at 23+1.7°C which had a density of 997 +2kg/m3.We shacked the container to remove all trapped air before weighing. We dried the test sample to constant weight at 110+5°C air cooled to room temperature for 1 to 3 hours which is comfortable to handle.



Fig3.7e (1): Weight Determined of coarse aggregate in water



Fig3.7e (2): Weight Determined of coarse aggregate at room temp.

(f). Compressive Strength Test

To test compressive strength we selected concrete grade M15 (1:2:4) as this ratio is commonly used in Bangladesh. For 7 days, 14 days and 28 days to test compressive strength we needed a minimum of 9 concrete cylinder and if we replace cement by fly ash we need 9 more, for this total 18 cylinder we measure course aggregate and fine aggregate. We prepared concrete by adding 55% water for cement concrete and 70% water for fly ash mixed concrete, and three layers of concrete were poured into (8"*4") size mold and each layer was compacted by tamping 25 times with 16mm diameter rod. Thus when the cylinder is filled with concrete, the surface is compacted well. When the work is done, after 24 hours at normal temperature we take it out of the mold and immersed in water.



Fig3.7f (1): Aggregate measurement.



Fig3.7f(2): Concrete Mixing



Fig3.7f(3): Cylinder Marking



Fig3.7f(4): Cylinder Curing.

We removed the cylinders from the water 24 hours before to take 7 days strength. Then we measured the diameter and height of the cylinders. The value of strength was obtained by plotting along cylinder height in space for compressive spaceman of UTM machine. Similarly 14 days and 28 days strength values are determined.

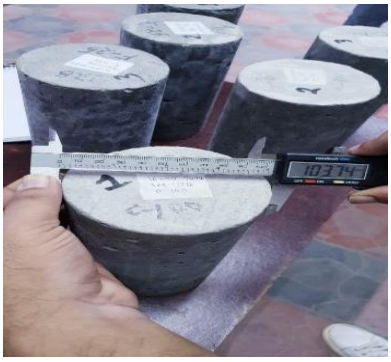


Fig3.7(5): Dia Measurement.



Fig3.7(6): Compressive strength.

CHAPTER 4
Results and Discussion

4.1 INTRODUCTION

This chapter includes the Compare compressive strength between Fly ash mixed concrete and without fly ash mixed concrete. The specimens were tested in the laboratory and the load was applied by the Universal Testing Machine. Sizes of cylinders (4"× 8") and total 18 number were casted and tested at 14, 21 and 28 days curing period respectively for determine the compressive strength of concrete. The test results are presented in graphical and tabular form and discuss under different category

Table.4.1 Physical properties of Cement with mixed fly ash

No.	Test Conducted	Test Result	Requirement as per IS:3812 Part
1	CONSISTANCY %	40.2	------
2	SPECIFIC GRAVITY (gm/cc)	00.0	------
3	SETTING TIME		
	Initial(min.)	55min	
	Final (min)	7hour10min	-----
3	COMPRESSIVE STRENGTH (N/Sq.mm)		
	1) 7 DAYS	5.42Mpa	
	2) 14 DAYS	6.65Mpa	Not less than 80%of cement at 28 days.
	3) 28 DAYS	7.71Mpa	

(a). Normal consistency: The water content of a paste has a marked effect upon the time of set as well as other properties. Bringing the cement paste to a standard condition of wetness, called 'normal consistency' regulates the water content. For finding out initial setting time, final setting time and soundness of cement, normal consistency has to be used. The normal consistency of a cement paste is defined as that consistency which will permit a Vicat's plunger having 10 mm diameter and 50 mm length to penetrate to a depth of 10 mm from the top of the mold. The test method conforms to the standard specification of **ASTM C187**.(2011).The usual range of values being between 22 to 30 percent by weight of dry cement. The normal consistency of the cement obtained after testing which has shown in Table. We use shah cement special which has a normal consistency of 28%. The consistency of cement means 28% water requirement to start the chemical reaction between water and cement. This test helps to identify the minimum water required to make the cement paste. Finding out standard consistency of cement is essential because the amount of water added in cement affect the setting time of cement If Less water is added than required, Cement isn't properly hydrated and results in loss of strength.

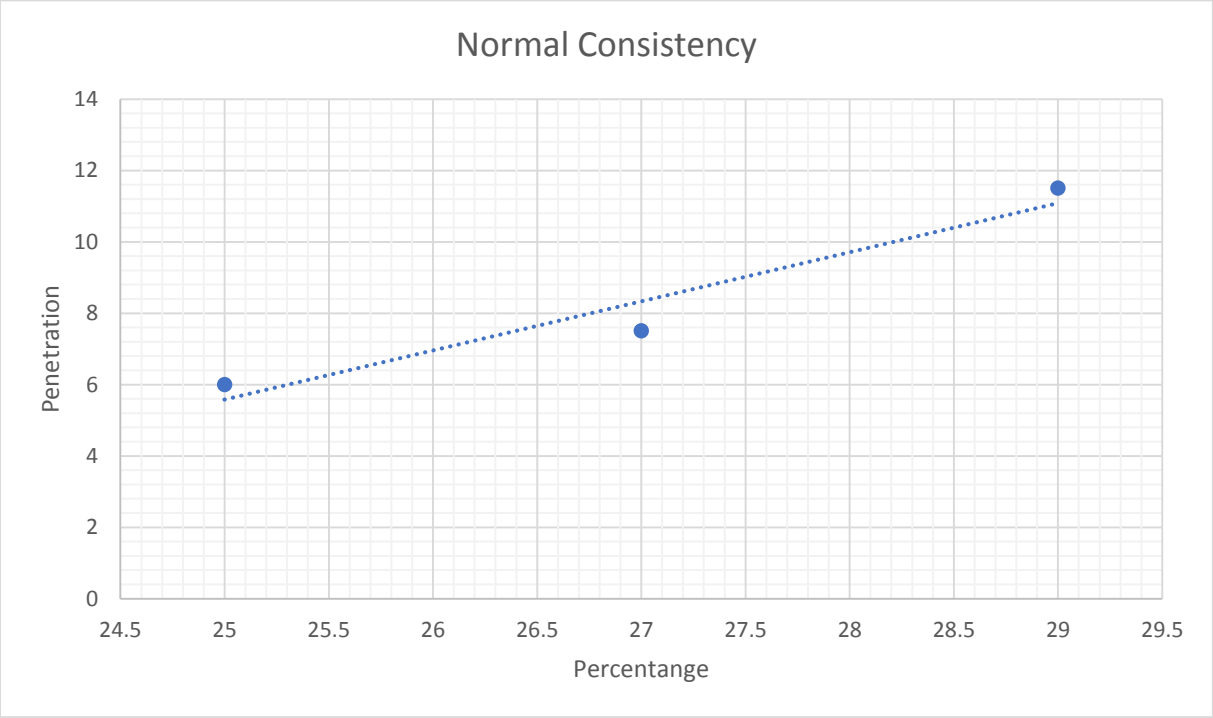


Fig4.1(a): Normal consistency graph

b). Initial setting time & Final setting time: Cement, when mixed with water, forms slurry which gradually becomes less plastic with the passage of time and finally a hard mass is obtained. In this process, a stage is reached when the cement paste is sufficiently rigid to withstand a definite amount of pressure. Cement, at this stage is said to have set and the time required to reach this stage is termed "setting time". An arbitrary division has been made for the setting time of cement as initial setting time and final setting time. It is difficult to draw a rigid line between these two arbitrary divisions. A soft plastic paste of cement and water gradually becomes less plastic and finally becomes stiff and hard. For convenience, initial setting time is regarded as the time elapsed between the moments that the water is added to the cement, to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the moment that the water is added to the cement and the time when the paste has completely lost his plasticity and has attained sufficient firmness to resist certain definite pressure. The setting time of cement give an indication of how long the cement will remain workable when used in a concrete mix. Setting should not be confused with hardening, which refers to the gain in mechanical strength after the certain degree of resistance to the penetration of a special attachment pressed into it. The test method conforms to the standard specification of **ASTM C191** (2008). The initial and final setting time for the cement used for this study which has shown in Table.

(c). Sieve Analysis of Fine and Coarse Aggregate:

For Coarse Aggregate:

The sieve analysis is conducted to determine the particle size distribution and fineness modulus of fine aggregate called gradation. The fineness modulus is a numerical index of fineness, giving some idea of the mean size of the particle present in the entire body of the aggregate. The determination of the fineness modulus consists in dividing a sample of aggregate into fractions of different sizes by sieving through a set of standard sieves taken in order of size, with larger sieve on the top. Each fraction contains particle between definite limits. The limits are being the opening size of standard sieves. The materials retained on each sieve after sieving represent the fraction of

aggregate coarser than the sieve in question than finer than the sieve above. The sum of cumulative percentages retained on the sieves divided by 100 give the fineness modulus.

The particle size distribution of an aggregate as determined by sieve analysis is termed grading of the aggregate. If all the particles of an aggregate are of uniform size, the compacted mass will contain more voids, whereas an aggregate comprising particle of various sizes will give a mass containing lesser voids. The particle size distribution of a mass of aggregate should be such that the smaller particles fill the voids between the larger particles. The proper grading of an aggregate produces dense concrete. It is, therefore, essential that the coarse and fine aggregate be well graded to produce quality concrete. The grading of aggregate is expressed in terms of percentage by weight retained on or passing through a series of the ASTM sieves taken in order like fineness modulus test. No.100, No.50, No.30, No.16, No.8, No.4, 3/8", 3/4", 1.50" and larger, increasing in the ratio of 2 to 1 are used.

In sieve analysis of coarse aggregate a stack of sieve of size 150µm (No.100), 300µm(No.50), 600 µm(No.30), 1.18 mm(No.16), 2.36mm(No.8), 4.75mm (No.4), 9.5mm(3/8 in.), 19.0mm(3/4 in.), 37.5mm(1.50 in.)

The test method for sieve analysis of coarse aggregate conforms to the standard specification of **ASTM C136**.(2006) . The test data and result of sieve analysis of coarse aggregate as shown in Table4.1c. And the graphical presentation of coarse aggregate is also as shown in fig

Table:4.1(c) Gradation of Stone Chips

Sieve Number	Material Retained (gm)	%Material Retained	Cumulative % Retained	% Finer	FM
3 in	0	0	0	100.00	2.50
3/2 in	0	0	0	100.00	
3/4 in	502g	50.2%	50.2	49.8	
3/8 in	491g	49.1%	99.3	0.7	
#4	7g	0.7%	100	0	
Total	1000g				

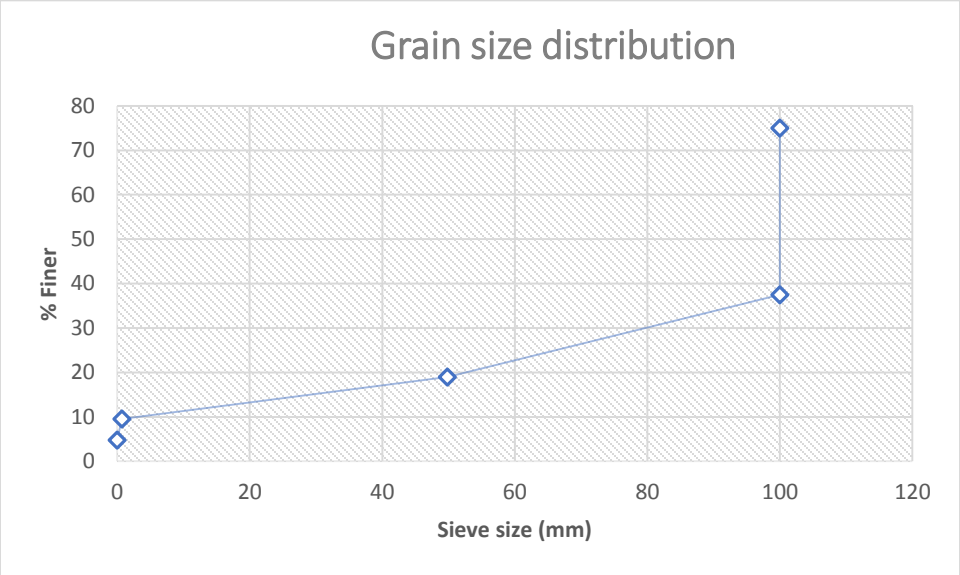


Fig4.1c(1): Grain size distribution

and coarse aggregates smaller than 38.1 mm range from 6.75 to 8.00. As the sizes of coarse aggregate increases then the compressive strength will also increase with constant water to cement ratio (w/c -0.5 and Mix proportion 1:2:4) The workability of concrete get improved after increasing larger sizes of aggregates in concrete.

For Fine Aggregate

Gradation of fine aggregate is performed following the same procedure of coarse aggregate. The test method conforms to the standard specification of **ASTM C136**.(2006).The Fineness Modulus(F.M) of fine aggregate used in this study which has shown in Table.

Table4.1(c): Gradation of Fine aggregate.

Sieve Number	Sieve Opening (mm)	Sieve (gm) Material Retained (gm)	% Material Retained	Cumulative % Retained	% Finer	FM
#4	4.75	0	0	0	100.00	2.40
#8	2.36	0	0	0	100.00	
#16	1.18	0	0	0	100.00	
#30	0.60	3 gm	0.60%	0.66	99.34	
#50	0.30	217 gm	43.66%	44.32	55.68	
#100	0.15	251 gm	50.50%	94.82	5.18	
Pan		26 gm	5.24%	100.00	0.00	
Total		497gm	100%			

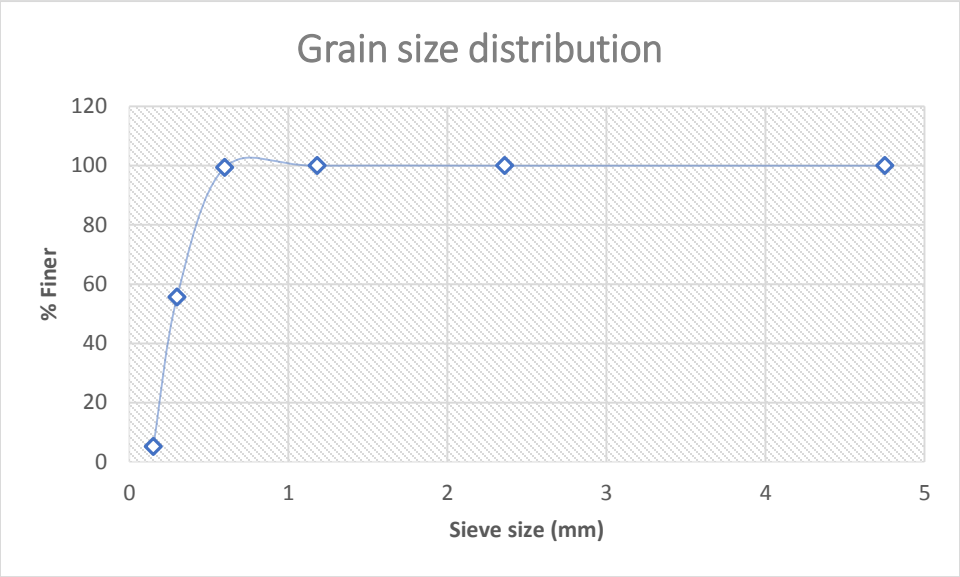


Figure4.1c(2): Grain size distribution curve of fine aggregate

Fine aggregates range **from an FM of 2.00 to 4.00**

Fine sand	2.2 mm – 2.6mm
Medium sand	2.6 mm – 2.9 mm
Coarse sand	2.9 mm – 3.2 mm

Fineness modulus allows to effectively predict the amount of water they'll need to mix the concrete. It also paints an accurate picture of the concrete's workability, which is measured in terms of slump value. Generally speaking, the higher the fineness modulus, the higher the slump value or in other words the stiffer the concrete will be.

(d). Specific Gravity of Fine Aggregate: Aggregates generally contain pore, both permeable and impermeable, for which specific gravity has to be carefully defined. With this specific gravity of each constituent known, its weight can be converted into solid volume and this is also required in calculating the compacting factor in connection with the workability measurements. This test

method covers the determination of bulk specific gravity, apparent specific gravity and water absorption of fine aggregate. This test conforms to the standard specification of **ASTM C128**.(2012).

Bulk specific gravity is defined as the ratio of the weight of the aggregate (SSD or Oven dry) to the weight of water occupying a volume equal to that of the solid excluding the impermeable pores.

Apparent specific gravity is the ratio of the weight of the aggregate dried in an oven at 100 to 110^0C for 24 hours to the weight of water occupied a volume equal to that of the solid including the impermeable pores.

Total internal moisture content of an aggregate in the saturated surface dry condition may be termed as "absorption capacity", although it is sometimes referred to simply absorption. Absorption values are used to calculate the change in the weight of an aggregate due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition. The values of absorption capacity and specific gravity of fine aggregate used in this study which has shown in Table.

Calculation:

Bulk specific gravity = A/ (B+S-C)

Absorption capacity = (S-A)/A×100

Where,

A =Weight of oven dry specimen in air

B =Weight of pycnometer filled with water

S =Weight of the SSD specimen

C = Weight of pycnometer filled with specimen and water to calibration mark.

Table4.1 (d): Specific Gravity of Fine Aggregate

Wt. of OD Sand, A (gm)	Wt. of Pycnometer + Water, B (gm)	Wt. of Pycnometer + Water + Sand, C (gm)	Wt. of SSD Sand, S (gm)	Bulk Sp. Gr. (OD)	Bulk Sp. Gr. (SSD)	App. Sp. Gr.	Absorption (%)
300g	653g	839g	316g	2.31	2.43	2.63	5.33%

(e). Specific Gravity of Coarse Aggregate: The specific gravity of coarse aggregate was calculated as follows:

Bulk sp. gravity (OD) = A /B-C

Bulk sp. gravity (SSD) = B/ B-C

Apparent sp. gravity = A /A-C

Absorption (%) = (B-A /A) x100

Table4.1(e): **Specific Gravity of Coarse Aggregate**

Wt. of OD CA, A (gm)	Wt. of SSD CA, B (gm)	Wt. of CA in Water, C (gm)	Bulk Sp. Gr. (OD)	Bulk Sp. Gr. (SSD)	App. Sp. Gr.	Absorption (%)
1605g	1825g	1150g	2.38	2.70	3.53	13.71%

(f). Compressive Strength Test: The mechanical strength of hardened cement is the property of the materials, which is perhaps the most important one for its structural use. Strength tests are not made on a neat cement paste because of difficulties of molding and testing with consequent large variations in results. The strength of cement is usually determined from test on mortar made with cement. The compressive and tensile strength of cement used in this study which has shown in Table

The compressive strength was calculated as follows: Compressive strength (MPa) = Failure load / cross sectional area

Strength of concrete increases with age.

Table4.1f(i): Compressive Strength in 7 days for 100% cement

Weight	Height	Diameter	Load	Compressive strength, CS=F/A
4.017	205mm	103.75mm	80KN	9.46Mpa
4.020	205mm	102.88mm	72KN	8.66Mpa
4.012	207mm	103.37mm	70KN	8.34Mpa

Average compressive strength= 8.82Mpa

Table4.1f(ii): Compressive Strength in 7 days for 25% replace cement

Weight	Height	Diameter	Load	Compressive strength, CS=F/A
3.807	207	101.50	41KN	5.07Mpa
3.767	205	101.50	45KN	5.56Mpa
3.918	205	103.13	47KN	5.62Mpa

Average compressive strength= 5.42Mpa

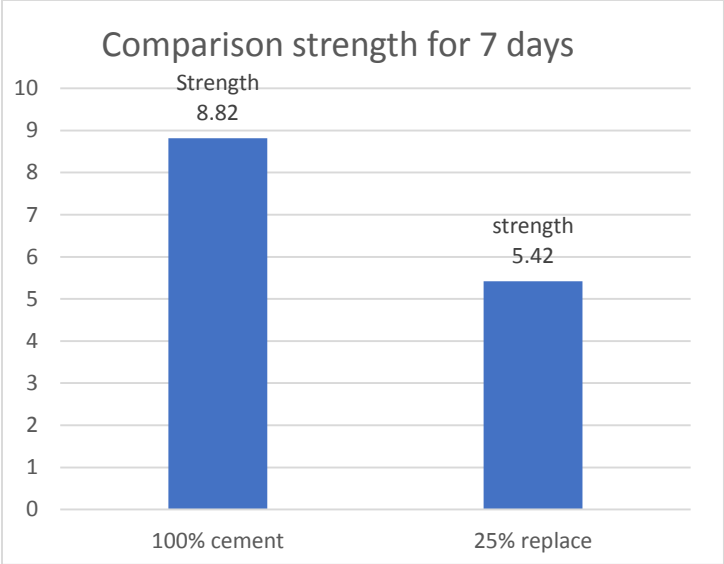


Fig4.1f(I & ii): Comparison strength for 7 days

Table4.1f(iii): Compressive Strength in 14 days for 100% Cement

Weight	Height	Diameter	Load	Compressive strength
3.993	205mm	103.75mm	95KN	11.24Mpa
3.986	205mm	102.88mm	94KN	11.31Mpa
3.899	207mm	103.37mm	94KN	11.20Mpa

Average compressive strength= 11.25Mpa

Table4.1f(iv): Compressive Strength in 14 days for 25% replace cement

Weight	Height	Diameter	Load	Compressive strength
3.818	207	101.50	55KN	6.80Mpa
3.754	205	101.50	55KN	6.80Mpa
3.906	205	103.13	53KN	6.34Mpa

Average compressive strength= 6.65Mpa

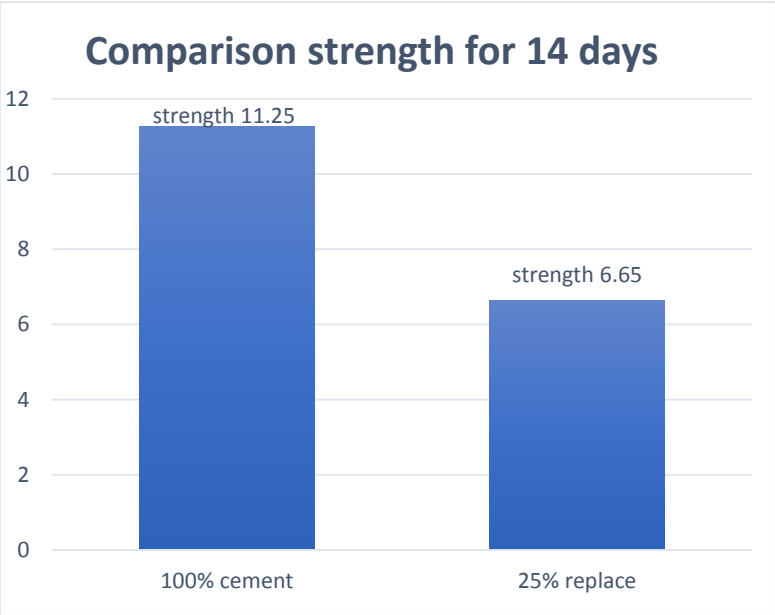


Fig4.1f(iii & iv): Comparison strength for 14

Table4.1f(v): Compressive Strength in 28 days for 100% Cement

Weight	Height	Diameter	Load	Compressive strength
3.982	205mm	103.75mm	117KN	13.84Mpa
3.973	205mm	102.88mm	114KN	13.71Mpa
3.881	207mm	103.37mm	108KN	12.87Mpa

Average compressive strength= 13.47Mpa

Table4.1f(vi): Compressive Strength in 28 days for 25% replace cement

Weight	Height	Diameter	Load	Compressive strength
3.800	207	101.50	65KN	8.03Mpa
3.741	205	101.50	64KN	7.91Mpa
3.891	205	103.13	60KN	7.18Mpa

Average compressive strength= 7.71Mpa

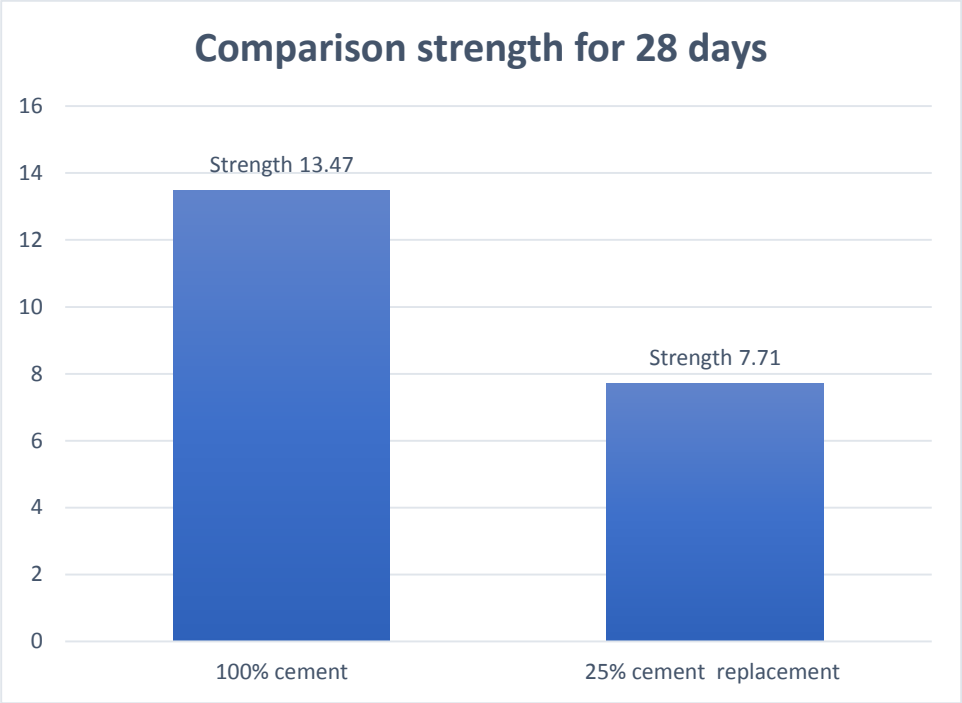


Fig4.1f (v & vi): Comparison strength for 28 days

By using concrete grade M15(1:2:4) the minimum compressive strength will be 15Mpa in 28 days. Compressive strength achieved by concrete at 7days is about 65% and at 14 days is about 90% of the target strength. Considering that, our compressive strength was close. By replacing 25% fly ash the strength decreased by 50%, which means that the plant fly ash we used did not have good cementitious properties. And the amount of water was not equal for both process could also be a reason. Or it is possible to increase the strength by reducing the percentage further.

CHAPTER 5
Conclusions and Future Works

5.1 Conclusions

Fly ash is found to be superior to other supplementary materials like slag, and silica fume. FA used in this study is efficient as a pozzolanic material; it is reach in amorphous silica. Due to low specific gravity of FA which leads to reduction in mass per unit volume, thus adding it reduces the dead load on the structure. Used of Fly ash helps in reducing the environment pollution during the disposal of excess Fly ash. Cement is costly material, so the partial replacements of these materials by fly ash reduces the cost of concrete. Based on the results presented above, the following conclusions can be drawn:-

1. Compressive strength increases with the reduce in the percentage of Fly ash replacement of Cement in Concrete for mix proportions.
2. The maximum 28 days compressive strength was obtained with combination of 7.71Mpa Fly ash mix in all combinations which was less than targeted strength.
3. The maximum 07 days flexural strength was obtained with combination of 5.42Mpa fly ash.
4. The percentage of water cement ratio is reliant on quantity of FA used in concrete. Because FA is a highly porous material.
5. The workability of concrete had been found to be decrease with FA in concrete.

5.2 Limitations and Recommendations for Future Works:

On the basis of the present study, following recommendations are suggested for further study.

a. Test may perform 56 days and 96 days compressive strength for concrete.

b. Test may perform different percentage of fly ash and water cement ratio.

c. Admixture can be used to change the performance of stone aggregate concrete.

d. Cube specimen may also be studied.

e. Size of specimen may also be reduced.

References

[1] Andrew R M, 2019 Global CO2 emissions from cement production, 1928-2018 Earth Syst. Sci. Data 11, 4 p. 1675–1710.

[2] Ahmaruzzaman M. A review on the utilization of fly ash. Prog Energy Combust Sci 2010;36(3):327–63.

[3] Alsayed S H and Amjad M A, 1996 Strength, Water Absorption and Porosity of Concrete Incorporating Natural and Crushed Aggregate J. King Saud Univ. - Eng. Sci. 8, 1 p. 109–119

[4] Specification S, 2002 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use p. 1–3

[5] M. M. ISLAM1 , M. T. ALAM1 , M. S. ISLAM1, 9 - 11 February 2017, Use of Supplementary Cementitious Materials in Concrete: Bangladesh Perspective.

[6] Satish H. Sathawane, Vikrant S. Vairagade, and Kavita S Kene, 51 (2013) 35 – 44, Combine Effect of Rice Husk Ash and Fly Ash on Concrete by 30% Cement Replacement.

[7] Abdulhalim KaraGin, Murat DoLruyol , 22 May 2014; An Experimental Study on Strength and Durability for Utilization of Fly Ash in Concrete Mix.

[8] Naraindas Bheel, Shanker Lal Meghwar , Sohail Ahmed Abbasi , Lal Chand Marwari , Jabbar Ahmed Mugeri , Rameez Ali Abbasi, Vol. 4, No. 10, October, 2018, Effect of Rice Husk Ash and Water-Cement Ratio on Strength of Concrete.

[9] E Susanti , H Istiono , I Komara , D Pertiwi , Y Septiarsilia , F K Syahputra, 1010 (2021) 012035, Effect of fly ash to water-cement ratio on the characterization of the concrete strength.

[10] P. Nath, P. Sarker, 14 (2011) 1149–1156, Effect of Fly Ash on the Durability Properties of High Strength Concrete.

[11] Alvin Harison , Vikas Srivastava,Arpan Herber, Volume 2, Issue 8 January 2014, Effect of Fly Ash on Compressive Strength of Portland Pozzolona Cement Concrete.

[12] C.Marthong, T.P.Agrawal, Vol. 2, Issue4, July-August 2012, pp.1986-1991, Effect of Fly Ash Additive on Concrete Properties.