Compressive Strength Behavior of Concrete Using Coconut Shell as a Partial Replacement of Coarse Aggregate

Md. Yousuf Ali

Shamvhu Kumar Shill

Md. Khademul Islam

Md. Shafiul Alam

Tripti Kirtania

Department of Civil Engineering
Sonargaon University (SU)
147/I, Green Road, Dhaka – 1215

December, 2019

Compressive Strength Behavior of Concrete Using Coconut Shell as a Partial Replacement of Coarse Aggregate

A

Thesis Submitted to the Department of Civil Engineering of Sonargaon (SU) in Partial Fulfillment of the Requirements for the Degree

Of

Bachelor of Science in Civil Engineering

Submitted By

Md. Yousuf Ali
BCE – 1602008007

Shamvhu Kumar Shill
BCE – 1601007250

Md. Khademul Islam
BCE – 1602008086

Md. Shafiul Alam
BCE – 1601007249

Tripti Kirtania
BCE – 1502005214

Supervisor
Md. Harun Ar Rashid
Lecturer, Department of Civil Engineering,
Sonargaon University (SU)

DEDICATION

We would like to dedicate our research work to our parents, without whom nothing would be possible.

Sonargaon University (SU)

Department of Civil Engineering

LETTER OF TRANSMITTAL

May 20, 2019

To

Md. Harun Ar Rashid
Lecturer,
Department of Civil Engineering,
Sonargaon University (SU).
147/I, Green Road, Tejgaon, Dhaka – 1215, Bangladesh.

Subject: Submission of Project Report.

Sir,
This is our great pleasure that we are submitting here with the project report of "**Compressive Strength Behavior of Concrete Using Coconut Shell as a Partial Replacement of Coarse Aggregate**". It is an important topic. The project report has been done according to the requirement and guidelines of the Sonargaon University (SU).

We Hope that this report will certainly help you in evaluating our project report on "**Compressive Strength Behavior of Concrete Using Coconut Shell as a Partial Replacement of Coarse Aggregate"** We would be very glad to provide any assistance in interpreting any part of the paper, whenever necessary.

Thanking You

Sincerely Yours

DECLARATION

This is to declare that the material presented in the report has been carried out by us and has not previously been submitted to any University / College / Organization for any academic qualification.

We hereby ensure that the work has been presented does not breach existing copyright.

We undertake to indemnify the university against any loss or damage arising from breach of the foregoing obligation.

Thank You

Sincerely Yours

Group Batch

1. ……………………

   Md. Yousuf Ali

   ID – BCE 1602008007

2. ……………………….

   Shamvhu Kumar Shill

   ID – BCE 1601007250

3. ………………………

   Md. Khademul Islam

   ID - BCE 1602008086

4. ……………………

   Md. Shafiul Alam

   ID - BCE 1601007249

5. …………………..

   Tripti Kirtania

   ID – BCE 1502005214

Department of Civil Engineering
Sonargaon University (SU)

Sonargaon University (SU)

RECOMMENDATION LETTER FROM THESIS SUPERVISOR

The thesis entitled "**Compressive Strength Behavior of Concrete Using Coconut Shell as a Partial Replacement of Coarse Aggregate"** Performed and submitted by Md. Yousuf Ali, Shamvhu Kumar Shill, Md. Khademul Islam, Md. Shafiul Alam and Tripti Kirtania for partial fulfillment of the requirement of the degree of B.Sc in Civil Engineering from the Sonargaon University (SU).

This project work has been carried out under my guidance and is a record of the successful work.

Supervisor

MD. Harun Ar Rashid
Lecturer,
Department of Civil Engineering,
Sonargaon University (SU).
147/I, Green Road, Tejgaon, Dhaka – 1215, Bangladesh.

Department of Civil Engineering
Sonargaon University (SU)

Sonargaon University (SU)

CERTIFICATE OF ACCEPTANCE OF THE THESIS

This is to certify that the project paper on "**Compressive Strength Behavior of Concrete Using Coconut Shell as a Partial Replacement of Coarse Aggregate"** is the confide record of project work done by Md. Yousuf Ali, Shamvhu Kumar Shill, Md. Khademul Islam, Md. Shafiul Alam and Tripti Kirtania for partial fulfillment of the requirement of the degree of B.Sc in Civil Engineering from the Sonargaon University (SU).

This project work has been carried out under my guidance and is a record of the successful work.

Supervisor

MD. Harun Ar Rashid
Lecturer,
Department of Civil Engineering,
Sonargaon University (SU).
147/I, Green Road, Tejgaon, Dhaka – 1215, Bangladesh.

ACKNOWLEDGEMENT

All praises and profound gratitude to the almighty Allah who is the most beneficent and the most merciful for allowing great opportunity and ability to bring this effort to fruition safety and peacefully.

First of all, we would like to express our sincere gratitude to our supervisor **Md. Harun Ar Rashid** for his throughout patience, guidance, valuable advices and help to complete the research work.

We would like to place on record our deep sense of gratitude to our guides for their cooperation and unfailing courtesy to us at every stage.

We sincerely would like to thank all instructors and staffs of the Civil Engineering Department of Sonargaon University (SU), Dhaka, which contributed in various ways to the completion of this thesis.

Finally, we would like to express our deepest gratitude to our entire group member whose support and manual labor contributed in various ways for the completion of this thesis work.

Authors
Sonargaon University (SU)

ABSTRACT

The high cost of conventional building materials is a major factor affecting housing delivery in the world. This has necessitated research into alternative materials of construction. In this study, coconut shell is used as light aggregate in concrete. The properties of coconut shell and coconut shell aggregate concrete is examined and the use of coconut shell aggregate in construction is tested. The project paper aims at analyzing flexural and compressive strength characteristics of with partial replacement using M20 grade concrete. The project also aims to show that Coconut shell aggregate is a potential construction material and simultaneously reduce the environment problem of solid. Cylinder is casted, tested and their physical and mechanical properties are determined. The main objective is to encourage the use of these 'seemingly' waste products as construction materials in low-cost housing. Another aim is to reduce the cost of new construction work and reduce solid waste by reusing the coconut waste. Coconut shell Aggregate (CSA) is a viable alternative to natural aggregate which helps in the preservation of the environment. Coconut shell aggregate was made by crushing the waste of coconut. Two types of concrete mixtures were tested: concrete made entirely with natural aggregate (NAC) as a control concrete and one type of concrete made with coconut shell coarse aggregate (0%, 4%, 8% and 12% replacement of coarse coconut shell aggregate). Thirty six (36) specimens were made for the testing of the basic properties of hardened concrete. To determine the compressive strength of the concrete, cylinders were tested in SU lab by destructing the cylinders with the help of Universal Testing Machine (UTM). From the analytical results, we got the highest average compressive strength for 4% of demolished coconut shell waste as coarse aggregate in the concrete cylinder Compared with fresh coarse aggregate concrete. But when increased the percentage of coconut shell of coarse aggregate the strength was decreased. And it also shows that the compressive strength of specimens is maximum after 28 days curing compared with 7 & 14 days.

NOTATIONS

f_c'	=	The 28 days compressive strength of cylinder specimen of concrete.
$f'_{c_{sv}}$	=	28 days compressive strength of concrete made with stone chips plus certain ratio of coconut shell aggregate in MPa.
W_a	=	Water absorption of concrete made with stone chips plus a certain ratio of coconut shell aggregate in (%)
W'_a	=	water absorption of concrete made with stone chips in % When x = 0, Then Wa = W´a
X	=	Percent of replacement.
F.M.	=	Fineness modulus.
Mpa	=	Mega Pascal.
Psi	=	Pound per square inch.
S.S.D.	=	Saturated Surface Dry.
W/C	=	Water Cement ratio.
CS	=	Coconut Shell.

TABLE OF CONTENTS

Page no.

LIST OF THE TABLES

LIST OF THE FIGURES

CHAPTER I
INTRODUCTION

1.1 General

With the development of world, the construction field also developed. Now a day different types of waste materials are using construction. In developed countries many industries companies they have identify many natural light weight aggregate. The use of waste materials is important role in reduction of cost of construction and results in solid waste management. In this paper coconut shell waste materials in used in the construction. Concrete is a composite materials composed of course aggregate. Coconut shell is one of the waste materials can be used as aggregate in concrete and which is easily available in all countries like INDIA, AFRICA, USA etc. the coconut shell is light weight aggregate and more suitable for construction because toughness of coconut shell is high and which is easily available.

Infrastructure development across the world created demand for construction materials. Concrete is the premier civil engineering construction material. Concrete manufacturing involve consumption of ingredients, aggregates, water and admixture(s). Among all the ingredients, aggregates form the major part. Two billion tons of aggregate are produced each year the United States. Production is expected to increase to more than 2.5 billion tons per by the year 2020. Similarly, the consumption of the primary aggregate was 110 million tons in U.K in the year 1960 and reached nearly 275 million tons by 2006. Use of natural aggregate in such a rate leads to a question about the preservation of natural aggregates sources. In addition, operations associated with aggregate extraction and processing are the principal causes of environmental concerns. In light of this, in the contemporary civil engineering construction, using alternative materials in place of natural aggregate concrete production makes concrete as sustainable and environmentally friendly construction material. Different alternative waste materials and industrial byproducts such as fly ash, bottom ash, recycled aggregates, foundry sand, china clay sand, crumb rubber, glass were replaced with aggregate and investigated properties of the concretes. Apart from above mentioned waste materials and industrial byproducts, few studies identified that coconut shells, the agricultural by product can also be used as aggregate in concrete. According to a report, coconut is grown in more than 86 countries worldwide, with a total production of 54 billion nuts per annum. India occupies the premier position in the world with an annual production of 13 billion nuts, followed by Indonesia and the Philippines. Limited research has been conducted on mechanical properties of concrete with coconut shells as aggregate replacement. However, further research is needed for better understanding of the behavior of coconut shells as aggregate in concrete. Furthermore, there is no study available in the literature on the transport properties which determine durability of the concrete. Thus, the aim of this work is to provide more data on the strengths coconut shell concretes at different coconuts shells (CS) replacements and study the transport properties of concrete with CS as coarse aggregate replacement. Furthermore, in this study, the effect of fly ash as cement replacement and aggregate replacement on properties of the CS replaced concrete was also investigation.

The high demand for concrete in the construction using normal weight aggregates such as gravel and granite drastically reduces the natural stone deposits and this has damaged the environment thereby causing ecological imbalance, there is a need to explore and to find out suitable replacement material to substitute the natural stone. In development countries, many natural materials like Pumice, Scoria and Volcanic debris and manmade materials like expanded blast-furnace slag, vermiculite and clinker are used in construction works as substitutes for natural stone aggregates. In India, commercial use of non-conventional aggregates in concrete construction has not yet started.

India is the third largest producer of concrete products in the world. Coconut trees are widely cultivated in the southern states of India, especially Kerala. Kerala got its name itself derived from a word, “kera” meaning coconut tree. Kerala is densely populated state and most of its population uses coconut or it’s byproducts in their daily activities. Coconut shells thus get accumulated in the mainland without being degraded for around 100 to 120 years. Disposal of these coconut shells is therefore a serious environmental issue. In this juncture, the study on use of coconut shells as a substitute or replacement for coarse aggregates in concrete is gaining importance in terms of possible reduction of waste products in the environment and finding a sustainable alternative for non renewable natural stone aggregates.

1.2 Background of the Study

In this study, coconut shell is used as light weight aggregate in concrete. The properties of coconut shell and coconut shell aggregate concrete is examined and the use of coconut shell aggregate in construction is tested. Moisture content and water absorption were 4.20% and 24% respectively and these values are more compared to conventional aggregate. Coconut shell exhibits more resistance against crushing, impact and abrasion not in a free sugar form, does not affect the setting and strength of concrete. Hydration test on coconut shell fines with cement indicates that the inhibitory index for coconut shell fines with cement can be classified as low and no pre-treatment is required. Coconut shell-cement ratio has been optimized to satisfy the criteria of structural light weight concrete. Long term investigation up to 365 days on compressive strength of coconut shell aggregate concrete for three different curing conditions, namely, laboratory curing (full water immersion W1), simulation of the practical curing (Site curing W2) and air-dry (no curing W3) has been carried out. The increase in the pulse velocity and the compressive strength of coconut shell aggregate concrete is more in practical curing (W2) followed by full water curing (W1). Biological decay was not evident as the coconut shell aggregate concrete cubes gained strength even after 365 days. The continual increase in strength indicates that the coconut shell aggregate does not deteriorate once coconut shell aggregates are encapsulated into the concrete matrix. In a short term study, at 28days, properties of coconut shell aggregate concrete namely flexural strength, splitting tensile strength, impact resistance and elastic modulus were determined and a comparison made with control concrete. Long term investigation up to 365 days showed that the experimental bond strength of coconut shell aggregate concrete was much higher than the design bond strength as stipulated by IS 456 and BS 8110 under all types of curing compared to conventional aggregate. Density of coconut shell is in the range of 550-650 kg/m3 and these are within the specified limits for light weight aggregate. There is no need to treat the coconut shell before use as an aggregate except for water absorption. The presence of sugar content in the coconut shell, as long as it is conditions. The durability properties of concrete shell aggregate concrete are comparable to other conventional light weight concretes.

The flexural behavior of reinforced coconut shell aggregate concrete beams was comparable to control concrete and that of other light weight concretes. Beams with low reinforcement ratios satisfied all the serviceability VIII requirements as per IS 456 BS 8110. Beams with shear links failed in flexure mode, while beams without shear links failed in diagonal shear modes. No horizontal cracks were observed at the level of the reinforcement, which indicates that there were no occurrences of bond failure. When coconut shell aggregate concrete is subjected to 100°C for 4 Hrs and 200°C for 2Hrs, its residual strengths are 18 N/mm2, respectively. These values satisfy the criteria of structural light weight concrete strength as per ASTM C 330. Coconut shell aggregate concrete can offer 2 hours fire resistance and therefore it may be classified under type 3 constructions.

Lightweight aggregate concrete (LWAC) is an important and versatile material in modern construction. It is grained popularity due to its lower density and superior thermal insulation properties. Many architects, engineers and contractors recognize the inherent economics and advantages offered by this material, as evidence by the many impressive lightweight concrete (LWC) structures found throughout the world. Lightweight concrete has strengths comparable to normal concrete; yet is typically 25-35% lighter. Structural LCW offers design flexibility and cost savings due to self weight reduction, improved seismic structural response and lower foundation costs. Lightweight concrete pre-cast elements offer reduced transportation and placement costs. The main characteristic of lightweight aggregate is its high porosity, which results in a low specific gravity. Although commercially available lightweight aggregate has been used widely for manufacture of LWC, more environmental and economical benefits can be achieved if waste materials can be used as lightweight aggregates in concrete. In view of the escalating environmental problems, the use of aggregates from by-products and/or solid waste materials from different industries is highly desirable. In recent years, researchers have also paid more attention to some agriculture wastes for use as building material in construction.

1.3 Objectives of the Study:

The objectives of this study are given below**:**

a) To determine the compressive strength of concrete made with coconut shell using coarse aggregate (0%, 4%, 8% and 12% partial replacement of stone chips by coconut shell aggregate as a coarse aggregate) after 7, 14 & 28 days of curing.

1.4 Research Outline

The working research outline in this study is as follows:

a) Properly selection of materials.

b) Conventional concrete is prepared using Portland cement, water, sand and stone chips at the ratio according to ACI mix design.

c) Preparation of concrete using coconut shell aggregates replacing of fresh stone chips.

d) Slump test of the concrete mix.

e) Curing of concrete.

f) Testing of specimens.

g) Result & Analysis.

h) Conclusion and recommendation

1.5 Scope of the Study

a) The demolished coconut shell waste can be reused as coarse aggregate in new construction, like
b) Can be used for constructing gutters, pavements etc.
c) Low priorities low-rise buildings.
d) Large pieces of crushed aggregate can be used for building revetments which in turn is very useful in controlling soil erosion.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Concrete is an artificial material similar in appearance and properties to some natural lime stone rock. It is a man made composite, the major constituent being natural aggregate such as gravel, or crushed rock, sand and fine particles of cement powder all mixed with water. The concrete as time goes on through a process of hydration of the cement paste, producing a required strength to withstand the load. The use of coconut shell as coarse aggregate in concrete has never been a usual practice among the average citizens, particularly in areas where light weight concrete is required for non-load bearing walls, non-structural floors, and strip footings. Although coarse aggregate usually take about 50% of the overall self weight of concrete. The cost of construction materials is increasing day by day because of high demand, scarcity of raw materials, and high price of energy. From the standpoint of energy saving and conservation of natural resources, the use of alternative constituents in construction materials is now a global concern. For this, the extensive research and development works towards exploring new ingredients are required for producing sustainable and environment friendly construction materials. The recycling of solid wastes in civil engineering applications has undergone considerable development over a very long time. The utilization of fly ash, blast furnace slag, recycled aggregates, red mud, Kraft pulp production residue, waste tea etc., in construction materials shows some examples of the success of research in the area. Similarly, the recycling of hazardous wastes for use in construction materials and the environmental impact of such practices has been studied for many years. Coconut is grown in more than 93 countries. South East Asia is regarded as the origin of coconut. India is the third largest, having cultivation on an area of about 1.78 million hectares. Annual production is about 7562 million nuts with an average of 5295 nuts per hectare. The coconut industry in India accounts for over a quarter of the world's total coconut oil output and is set to grow further with the global increase in demand. However, it is also than main contributor to the nation's population problem as a solid waste in the form of shells, which involves an annual production of approximately 3.18 million tones. Coconut shell represents more than 60% of the domestic waste volume. Coconut shell, which presents serious disposal problems for local environment, is an abundantly available agricultural waste from local coconut industries. In developing countries where abundant agricultural and industrial wastes are discharged, these wastes can be used as potential material or replacement material in the construction industry. This will have the double advantage of reduction in the cost of construction material and also as a means of disposal of waste.

J.P. RIES (2011) studied that Lightweight Aggregate (LWA) plays important role in today's towards sustainable concrete, Lightweight aggregates contributes to sustainable development by lowering transportation requirements, optimizing structural efficiency that results in a reduction in the amount of overall building material being used, conserving energy, Reducing labor demands and increasing the survive life of structural concrete.

AMARNATH YERRMALLA (2012) et al studied the strength of coconut shell (CS) replacement and different and study the transport properties of concrete with CS as coarse aggregate replacement. They concluded that

a) Increase in CS percentage decreased densities of the concrete.
b) CS percentage increased the 7 days strength gain also increased with corresponding 28 days curing strength.

VISHWAS P.KULKARNI (2013) studied that aggregate provide volume at low cost, comprising 66 percent to 78 percent of the concrete. Conventional coarse aggregate namely gravel and fine aggregate is sand in concrete will be used as control. While natural material is coconut shell as coarse aggregate will be investigate to replace the aggregate in concrete.

GOPAL CHARAN BEHERA, RANJAN KUMAR BEHERA presented the comparative cost analysis and strength characteristics of concrete produced using crushed coconut shell as substitutes for conventional coarse aggregate. The main objective was to encourage the use of coconut shell waste as construction materials in low-cost housing.

2.2 Use of concrete waste in

A research effort has been done to match society's need for safe and economic disposal of waste materials. The use of waste materials saves natural resources and dumping spaces, and helps to maintain a clean environment. The current concrete construction practice is thought unsuitable because, not only it is consuming enormous quantities of stone, sand and drinking water, but also two billion tons a year of Portland cement, which releases green-house gases leading to global warming. Experiments has been conducted for waste materials like- rubber tyre, e-waste, coconut shell, blast furnace slag, waste plastic, demolished concrete constituents, waste water etc. construction waste recycle plants are now installed in various countries but they are party solution to the waste problems.

2.3 Coconut shell as coarse aggregate

Coconut shell is used as light weight aggregate in concrete. Coconut shells are by-products of coconut oil production. Coconut shells are used in the production of activated carbon due to hardness and high carbon content. Various researchers have investigated the use of coconut shells and their derivatives in civil engineering construction. Cost reduction of 40% can be achieved if coconut shells are used to replace gravel in concrete. This study was conducted to investigate the properties of as well concrete using coconut shells as replacement for crushed granite and to access the potential use of coconut shell concrete as a structural material as contribute to knowledge on the use of waste materials in construction. Coconut shell is one of the most important natural fillers produced in tropical countries like Malaysia, Indonesia, Thailand, and Srilanka. Many works have been devoted to use of other natural fillers in composites in the recent past years and coconut shell filler is a potential candidate for the development of new composites because they have strength and modulus properties along with the added advantage of high lining content. The high lining content makes the composites made with these filler more weather resistant and hence more suitable for application as construction materials. Coconut shell flour is also extensively used to make products like furnishing materials, rope etc. The shells also absorb less moisture due to its low cellulose content the report focuses on studying the effectiveness of coconut shell particles as a source of natural materials for reinforcing epoxy resins towards their flexural properties. The coconut shell also has exceptional properties. It has a specific gravity of 1.2, which is about twice the density of hardwood. It is at least twice as hard as hardwood and is also very rich in energy. The hardness of coconut shell is comparable to lower strength aluminum alloys, making it one of the hardest organic materials produced in nature. It can be ground into 50-micron chips to potentially be used as reinforcement for engineering plastic. Chopped glass fibers are conventionally used as reinforcement to increase strength and stiffness and reduce cost in polymeric composites. Ground coconut shell is not as hard as glass, but it should bond much better to the matrix, since the bond interface will be.

Organic to organic, rather than organic to silicon oxide. We are currently studying this option. Because of its high mass density, coconut shells also have a high energy-density.

CHAPTER III
MATERIALS AND METHODOLOGY

3.1 Introduction

This chapter includes the experiments required to determine the properties of coconut shell aggregate and the properties of ingredient of concrete, processes of manufacture of concrete, and tests to determine the properties of fresh & hardened concrete.

3.2 The Properties of Ingredients of Concrete

Following are the commonly used ingredients in concrete

(a) Aggregate

(i) Fine aggregate

(ii) Coarse aggregate

(b) Binding Materials

(c) Water

3.2.1 Aggregate

Aggregates are the inert materials that are mixed in fixed proportions with a Binding Material to produce concrete. Aggregate is important that the aggregate have good strength, durability and weather resistance, that its surface be free from impurities such as loam, silt and organic matter which may weakened the bond with the cement paste, and that no unfavorable chemical reaction take place between it and the cement.

Aggregate can be classified on the basis of size as

- Fine aggregate
- Coarse aggregate

Fig. 3.1: Fine Aggregate, Coarse Aggregate & Coconut Shell Aggregate.

3.2.1.1 Test for Fine Aggregate

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8-inch sieve. The fine aggregate that had been used in this study was locally available Syhlet sand.

The following tests are employed to determine the properties of fine aggregate:

3.2.1.1.1 Sieve Analysis of Fine Aggregate

Sieve analysis of fine aggregate is used to determine the particle size distribution & fineness modulus of fine aggregate.

The particle size of an aggregate as determine by sieve analysis is termed grading of aggregate.

The test method for sieve analysis of fine aggregate conforms to the ASTM standard requirements of specification C136.

The value of F. M. of Sylhet Sand is given in the Table 3.1.

3.2.1.1.2 Specific Gravity and Water Absorption Capacity of Fine Aggregate

The test method for specific gravity and water absorption capacity covers the determination of bulk specific gravity, apparent specific gravity and water absorption of fine aggregate.

In this test study Saturated surface dry aggregate had been used to determine the specific gravity of fine aggregate.

The test method for specific gravity and water absorption capacity conforms to the ASTM standard requirements of specification C128-97.

Calculation

Bulk sp. gr. =A/ (B+S-C)

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.

Percent of absorption capacity =(S-A)/A*100

The values of specific gravity of combined sand and water absorption capacity is given in the Table 3.1

Table 3.1: Properties of Fine aggregate (Sylhet sand)

Properties	**Value**
Fineness Modulus	2.56
Water Absorption Capacity (%)	0.92
Specific Gravity	2.35

3.2.1.2 Test for Coarse Aggregate

Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. Generally stone chips are used as coarse aggregate. We also used coconut shell waste as coarse aggregate.

3.2.1.2.1 Sieve Analysis of Coarse Aggregate

The test method for sieve analysis of fine aggregate conforms to the ASTM standard requirements of specification C136.

The value of F.M. stone aggregate is given in the Table 3.2

3.2.1.2.2 Specific Gravity and Absorption Capacity

The test method for specific gravity and absorption capacity of coarse aggregate conforms to the ASTM standard requirements of specification C127.

Calculation

The bulk specific gravity (SSD basis) =B/(B-C)

Percentage of absorption = (B-A)/A*100

A =weight of oven dry test sample in air

B= weight of saturated surface dry test sample in air

C= weight of saturated test sample in water.

The values of specific gravity and absorption capacity of recycled aggregate, stone chips and stone aggregate are given in the Table 3.2

Table 3.2: Properties of coarse aggregates

Common properties	**Stone Aggregate**
Dry rodded unit weight (Kg/m^3)	2.670
Absorption capacity (%)	1.21
Bulk specific gravity (S.S.D)	2.57
F.M.	8.03

3.2.2 Cement

A cementing material is one which has the adhesive and cohesive properties necessary to bond inert aggregates into a solid mass of adequate strength, durability. For making structural concrete, so called hydraulic cements are used exclusively. Water is needed for the chemical process (hydration) in which the cement powder sets and hardens into solid mass. Various hydraulic cement have been developed, Portland cements, this was first patented in England in 1824, is by far the most common. In hydraulic cement that hardens by interacting with water and forms water resisting compound when it receives its final sets. It is highly durable and compressive strength in mortar and concrete. Its specific gravity ranges from 3.12 to 3.16 and weight 1208 $\mathrm{Kg/m^3}$ (94 $\mathrm{lb/ft^3}$). Its measured fineness by particles size ranges from 10 microns to 50 microns. The specific gravity of cement used in this study was 3.15. The FRESH BRAND CEMENT is manufactured by MEGHNA CEMENT LTD BY BASHUNDHARA GROUP was used in this study.

Fig. 3.2: Cement.

3.2.3 Water

Water is essential in the production of concrete in order to precipitate chemical with the cement, to wet the aggregate, and to lubricate the mixture for easy workability. Since the quality of water affect the strength it is necessary to go into the purely of water. In this study drinking water has been used in mixing of concrete.

3.3 Concrete Mix Design

Most of the available mix design methods are based on empirical relationships, charts and graphs developed from extensive experimental investigations.

In this study ACI mix design method has been used. This method if based on the fact that for a given maximum size of coarse aggregate, the water content determines the workability of mix. Using the steps of ACI method of mix proportioning, the mix proportion was found 1:1.5:3.

3.4 Process of Casting

Production of quality of concrete requires meticulous care exercised at every stage of manufacture of concrete. The various stages of casting of test specimens are:

a) Batching
b) Mixing
c) Slump Test
d) Compacting
e) Curing
f) Finishing

3.4.1 Batching

Weigh batching is the correct method of measuring the materials. For important concrete, invariably, weight batching system is should be adopted.
In this study weight batching has been used for measuring the materials.

3.4.2 Mixing

In this study concrete mixing had been done by the tilting type mixer. Speed of the mixer was of about 15-20 revolution per minute. Mixing time was 5-6 minute. The mixing of concrete is shown in Figure 3.1.

Fig. 3.3: Mixing of concrete in the study.

3.4.3 Slump Test

The concrete slump test is used for the measurement of a property of fresh concrete. The test is a pragmatic test that measures the workability of fresh concrete. More precisely, it measures consistency between batches. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test is used to ensure uniformity for different batches of similar concrete under field conditions, and to ascertain the effects of plasticizers on their introduction. The slump test result is a measure of the behavior of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete.

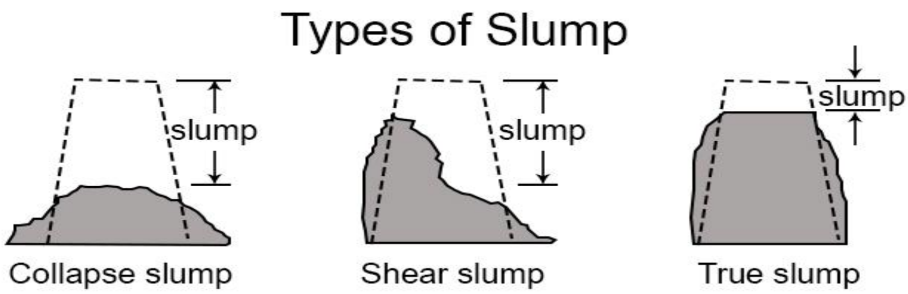

Fig. 3.4: Types of Slump.

The slumped concrete takes various shapes, and according to the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump. If a shear or collapse, slump is achieved, a fresh sample should be taken and the test repeated. A collapse slump is an indication of too wet a mix. Only a true slump is of any use in the test. A collapse slump will generally mean that the mix is too wet or that it is a high workability mix, for which slump test is not appropriate. Very dry mixes; having slump 0 - 25 mm arc used in road making, low workability mixes; having slump 10 - 40 mm are used for foundations with light reinforcement, medium workability mixes having slump 50 - 90 for normal reinforced concrete placed with vibration, high workability concrete, slump > 100 mm.

Fig. 3.5: Slump Test.

3.4.4 Compaction of Concrete

Compaction of concrete is the process adopted for expelling the entrapped air from the concrete. In the process of placing and mixing of concrete, air is likely to get entrapped in the concrete. If this air in not remove fully, the concrete losses strength considerably.

Fig. 3.6: Compaction of Concrete.

3.4.5 Curing of Concrete

Fresh concrete gains strength the most rapidly during the first few days and weeks. Structural design is generally based on the 28-days strength, about 70 percent of which is reached at the end of the 1st week after placing. The final concrete strength depends greatly on the condition of moisture and temperature during this initial period.

3.4.6 Methods of Curing

The best method of water curing is immersion of specimens in water because it satisfies all the requirements of curing namely promotion of hydration, elimination of shrinkage and absorption of the heat of hydration. In the study, the specimen was submerged in water for 28 days.

Fig. 3.7: Curing of cylinder.

3.5 Tests of the Specimens of Concrete

Testing of harden concrete plays an important role in controlling and confirming the quality of cement concrete work. Following tests have been commonly used to determine the properties of hardened concrete:

Fig. 3.8: Specimens of Concrete.

3.5.1 Compressive Strength of Concrete:

Strength of harden concrete measured by the compressive strength test. The compression strength of concrete is a measure of the concrete's ability to resist loads which tend to compress it. The compressive strength of concrete is measured by crushing cylindrical concrete specimens in compression testing machine. The compressive strength of concrete can be calculated by the failure load divided with the cross sectional area resisting the load and reported in Mega Pascal (MPa) in SI units. Concrete's compressive strength requirements can vary from 2500 psi (17 MPa) for residential concrete to 4000 psi (28 MPa) and higher in commercial structures. Higher strengths up to and exceeding 10,000 psi (70 MPa) are specified for certain applications. Compressive strength results are primarily used to determine that the concrete mixture as delivered on site meets the requirements of the specified strength, fc', in the job specification. Cylinders tested for acceptance and quality control are made and cured in accordance with procedures described for standard-cured specimens in ASTM C-31, Standard Practice for Making and Curing Concrete Test Specimens in the Field. For estimating the in place concrete strength, ASTM C-31 provides procedures for field-cured specimens. Cylindrical specimens are tested in accordance with ASTM C-39, standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. A test result is the average of at least two standard-cured strength Specimens made from the same concrete batch and tested at the same age. In most cases strength requirements for concrete are at 28 days. Design engineers use the specified strength to design structural elements. This specified strength is incorporated in the job contract documents. The concrete mixture is designed to produce an average strength fc' higher than the specified strength such that the risk of not complying with the strength specification is minimized. To comply with the strength requirements of a job specification, the following acceptance criteria apply:

- The average of three consecutive tests should equal or exceed the specified strength
- No single strength test should fall below fc' by more than 500 psi (3.45MPa) or by more than 0.10 f*c*' when fc' is more than 5000 psi (35 Mpa).

It is important to understand that an individual test falling below fc' does not necessarily constitute a failure to meet specification requirements. When the average of strength tests on a job are at the required average strength fc', the probability that individual strength tests will be less than the specified strength is about 4% and this is accounted for in the acceptance criteria. When strength test results indicate that the concrete delivered fails to meet the requirements of the specification, it is important to recognize that the failure of concrete may be due to the testing procedure. This is especially true if the fabrication; handling, curing and testing of the cylinders are not conducted in accordance with standard procedures.

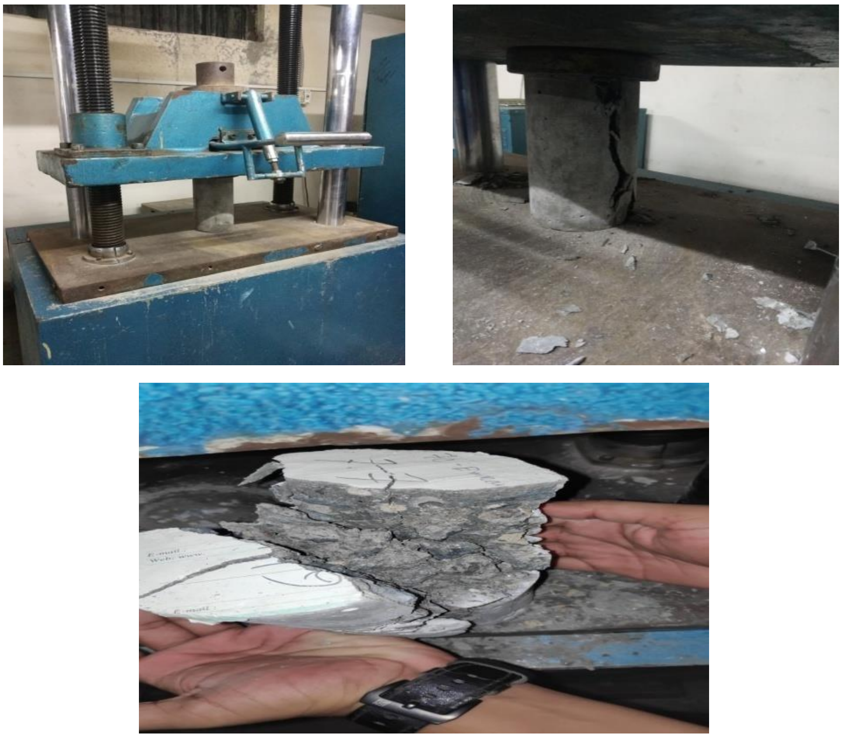

Fig. 3.9: Compressive strength test of specimen.

3.5.2 Water Absorption Properties

Water absorption of concrete using various composition of coconut shell aggregate content as a function of soaking time *t*. The water absorption rate is very fast for composition of the concrete. Water absorption increases gradually with the addition of reused aggregate.

Fig. 3.10: Water Absorption of specimen.

CHAPTER IV
RESULTS AND DISCUSSIONS

4.1 Introduction

Natural resources in Bangladesh are limited but anticipated rapidity of infrastructure development is quite fast. The changed development scenario of the country further indicates towards maximizing the land use through demolishing old low-rise structures with the high-rise ones. Recycling of demolished concrete can save the environment further by efficient and cost effective management of generated solid wastes. To perform this study in total 63 standard cylinder specimens were tested. These were tested to determine the compressive strength, water absorption and density of concrete. To get the actual value we tested after 7 days, 21 days and 28 days curing.

4.2 Test Results:

Here is the compressive strength test result of our specimens.

[Cylinder size (4” x 8”) & Mixing Ratio (1:1.5:3)]

Table 4.1: After 7 days curing Compressive strength of specimens obtained by replacement of stone chips by coconut shell as a coarse aggregate.

Mixing Percentage (%)		Area (Sq.mm)	Load (KN)	Strength (Mpa)	Average Strength
0%	Sample- 1	8103.21	165	20.36	19.79
	Sample- 2	8103.21	155	19.13	
	Sample- 3	8103.21	161	19.87	
4%	Sample- 1	8103.21	155	19.12	19.45
	Sample- 2	8103.21	158	19.50	
	Sample- 3	8103.21	160	19.74	
8%	Sample- 1	8103.21	125	15.42	14.19
	Sample- 2	8103.21	115	14.19	
	Sample- 3	8103.21	105	12.96	
12%	Sample- 1	8103.21	140	17.28	13.99
	Sample- 2	8103.21	90	11.11	
	Sample- 3	8103.21	110	13.57	

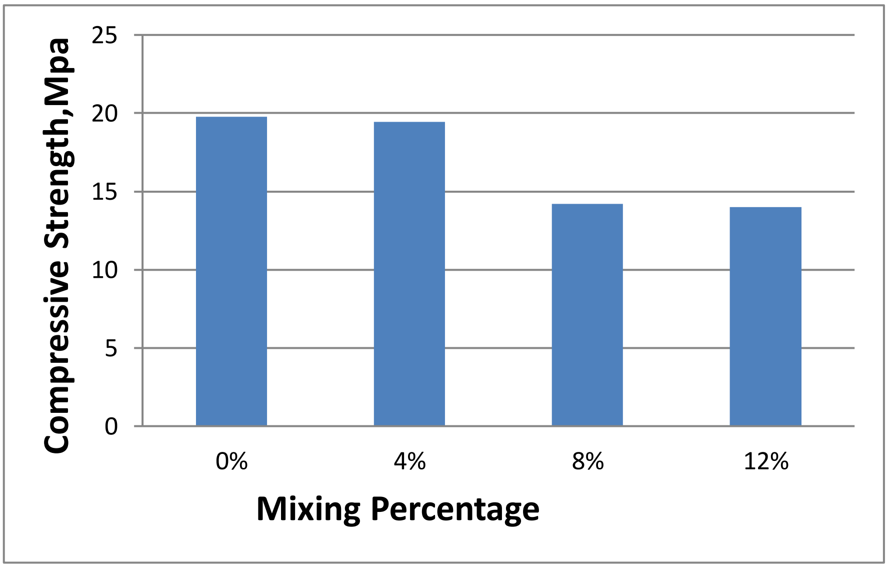

Fig. 4.1: Compressive strength of specimens after 7 days of curing

When we put the value of compressive strength on graph after 7 days curing, it shows that strength is linearly decreasing with increase of percentage of coconut shell. We get better strength for 4% of reused material.

Table 4.2: After 14 days curing Compressive strength of specimens obtained by replacement of stone chips by coconut shell as a coarse aggregate.

Mixing Percentage (%)		Area (Sq.mm)	Load (KN)	Strength (Mpa)	Average Strength
0%	Sample- 1	8103.21	167	20.61	20.90
	Sample- 2	8103.21	186	22.95	
	Sample- 3	8103.21	155	19.13	
4%	Sample- 1	8103.21	125	15.42	15.79
	Sample- 2	8103.21	127	15.67	
	Sample- 3	8103.21	132	16.29	
8%	Sample- 1	8103.21	120	14.81	14.19
	Sample- 2	8103.21	115	14.19	
	Sample- 3	8103.21	110	13.57	
12%	Sample- 1	8103.21	85	10.49	10.9
	Sample- 2	8103.21	98	12.09	
	Sample- 3	8103.21	82	10.12	

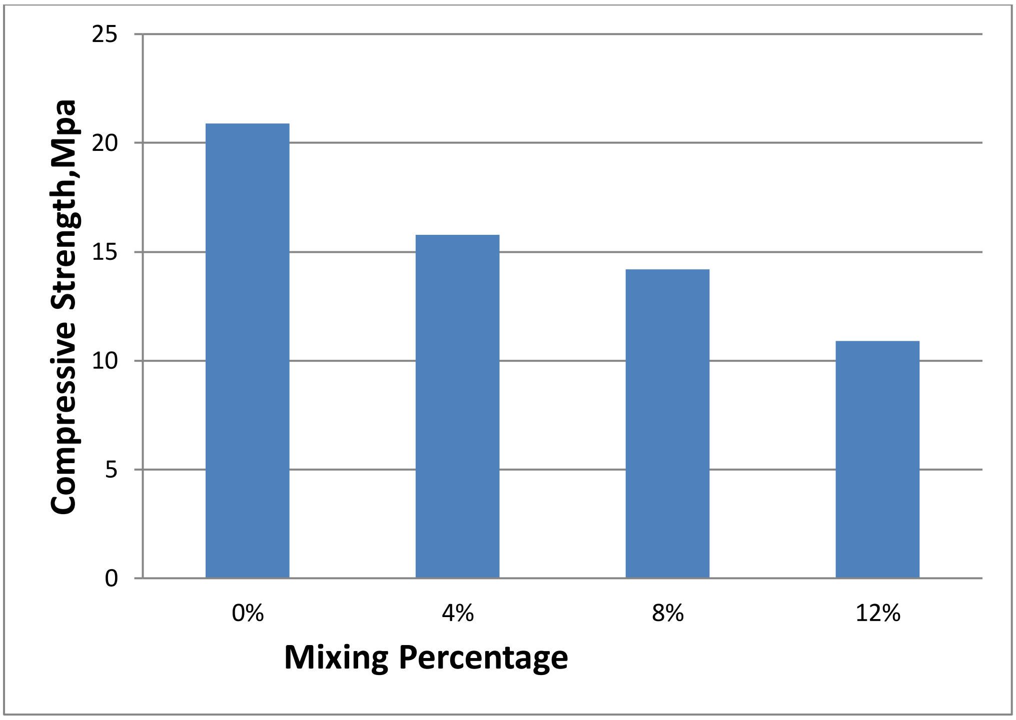

Fig. 4.2: Compressive strength of specimens after 14 days of curing

It is clear from the above figure that the compressive strength after 14days curing, strength is linearly decreasing with the percentage of replacement of stone chips by coconut shell. After 14 days curing again we get better strength for 4% of coconut shell aggregate.

Table 4.3: After 28 days curing Compressive strength of specimens obtained by replacement of stone chips by coconut shell as a coarse aggregate.

Mixing Percentage (%)		**Area (Sq.mm)**	**Load (KN)**	**Strength (Mpa)**	**Average Strength**
0%	Sample- 1	8103.21	230	28.38	26.94
	Sample- 2	8103.21	235	28.99	
	Sample- 3	8103.21	190	23.45	
4%	Sample- 1	8103.21	165	20.36	20.36
	Sample- 2	8103.21	170	20.98	
	Sample- 3	8103.21	160	19.74	
8%	Sample- 1	8103.21	130	16.04	17.48
	Sample- 2	8103.21	150	18.51	
	Sample- 3	8103.21	145	17.89	
12%	Sample- 1	8103.21	107	13.20	12.63
	Sample- 2	8103.21	95	11.72	
	Sample- 3	8103.21	105	12.96	

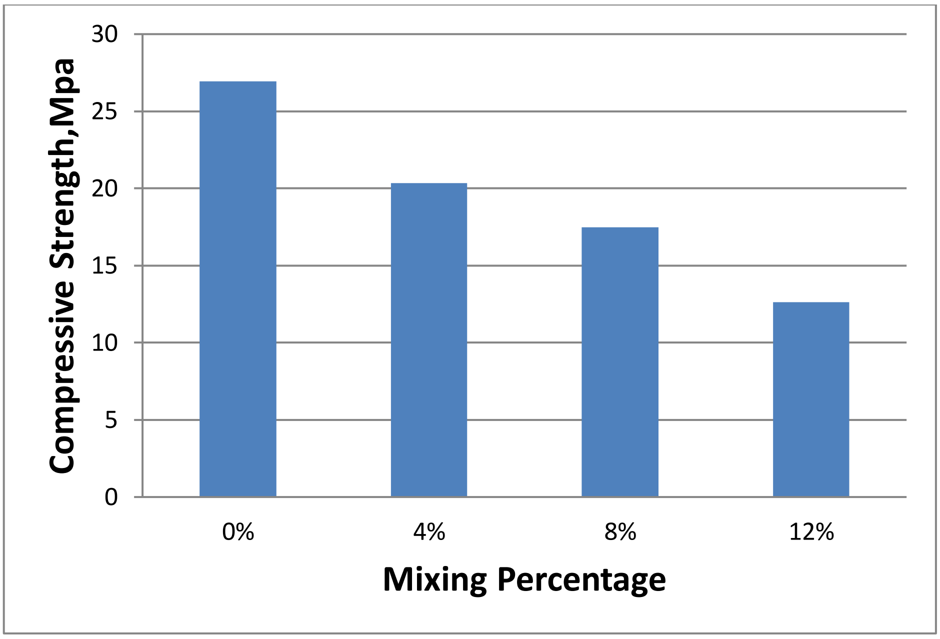

Fig. 4.3: Compressive strength of specimens after 28 days of curing

After 28 days of curing graph shows that 4% of coconut shell aggregate is allows on the top of other. We can say that 4% of replacement of stone chips by coconut shell aggregate would give the better strength if we cured the specimen more.

Table 4.4: The properties of slump test of Specimens obtained by volumetric replacement of stone chips by coconut shell aggregate as a coarse aggregate.

Mixing Percentage (%)	Sample	Slump (mm)	Average Slump (mm)
0%	Cured for 7 days	50	47.33
	Cured for 14 days	52	
	Cured for 28 days	40	
4%	Cured for 7 days	47	45.00
	Cured for 14 days	45	
	Cured for 28 days	43	
8%	Cured for 7 days	42	40.00
	Cured for 14 days	41	
	Cured for 28 days	37	
12%	Cured for 7 days	37	36.00
	Cured for 14 days	32	
	Cured for 28 days	39	

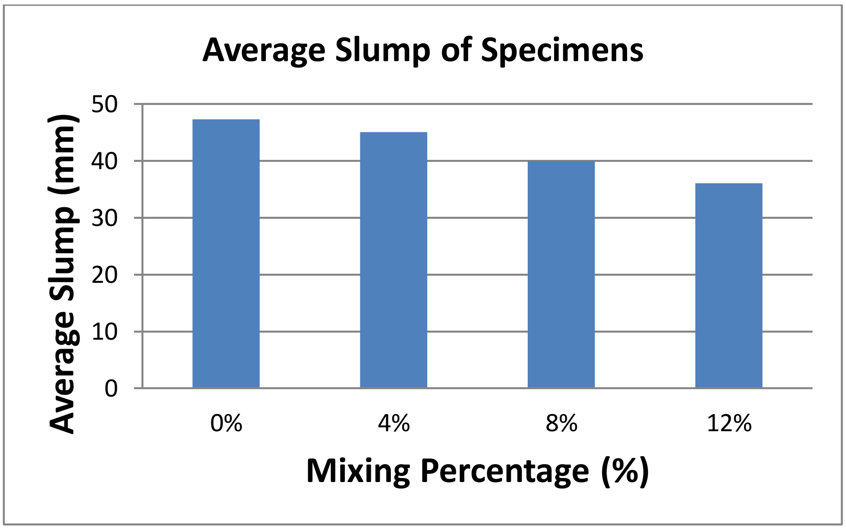

Fig. 4.4: Slump VS mixing percent of coconut shell aggregate as coarse aggregate.

Figure shows that, average slum value of specimens varied with the mixing percentage of coconut shell aggregate.

Table 4.5: The properties of water absorption of concrete obtained by volumetric replacement of stone chips by coconut shell aggregate as a coarse aggregate.

Mixing Percentage (%)	Sample	Dry wt. (Kg)	Wet wt. (Kg)	Water (Kg)	% of Water absorb	Average % of Water absorb
0%	Cured for 7 days	4.14	4.26	0.12	2.82	3.19
	Cured for 14 days	3.99	4.13	0.14	3.39	
	Cured for 28 days	4.03	4.17	0.14	3.36	
4%	Cured for 7 days	3.96	4.06	0.10	2.46	3.30
	Cured for 14 days	3.92	4.09	0.17	4.16	
	Cured for 28 days	3.85	3.98	0.13	3.27	
8%	Cured for 7 days	4.16	4.25	0.09	2.12	3.27
	Cured for 14 days	3.95	4.12	0.17	4.13	
	Cured for 28 days	4.05	4.2	0.15	3.57	
12%	Cured for 7 days	3.83	3.98	0.15	3.77	3.96
	Cured for 14 days	4.03	4.21	0.18	4.28	
	Cured for 28 days	4.02	4.18	0.16	3.83	

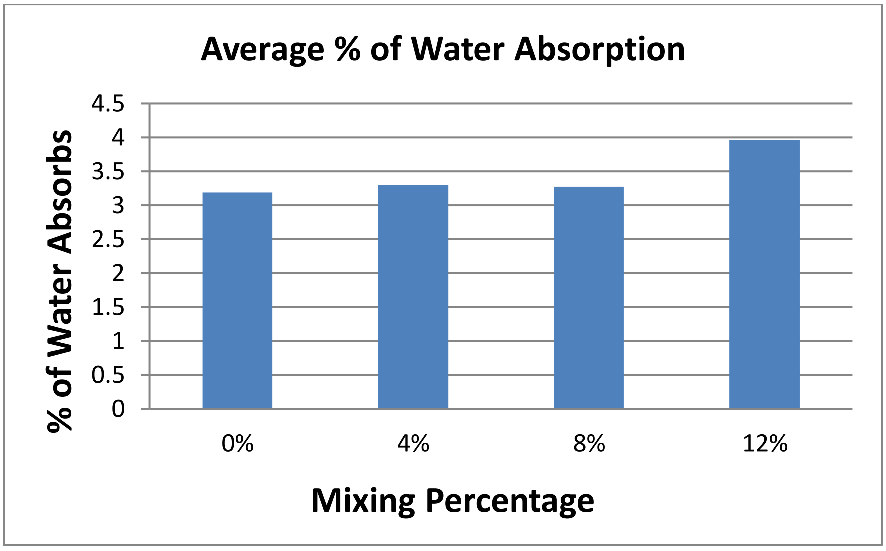

Fig. 4.5: Percentage of water absorbs VS mixing percent of coconut shell aggregate as coarse aggregate.

4.3 Discussion

This paper investigates the possibility of recycling of demolished coconut as coarse aggregate. For this, coconut shell were collected from a site of Dhaka city and crushed into coarse aggregate. About 36 concrete cylinders were made using coconut shell aggregate with water content ratio 0.45. Test item include slump, Water Absorption, Compressive strength. The average compressive strength of coconut shell aggregate concrete has been found in between 15.44 Mpa (2238.8 psi) to 16.82 Mpa (2439.38 psi). The result indicates that coconut shell aggregate can be used for new construction work. Destructive tests were performed by "The Universal Testing Machine". Loading was 4KN/sec applied by the Universal Testing Machine over the specimens.

From the above discussion, it can be said that may be this kind of the coconut shell concrete having that kind of compressive strength can be used in low priorities construction work which needs lower compressive strength than other construction work.

The result also shows that the compressive strength of specimens is maximum after 28 days curing compared with 7 & 21 days. The coconut shell coarse aggregate can be used in new low rise building, which helps reducing the cost budgets and also reduce the solid waste. By reducing the solid waste it will also save our Environment.

CHAPTER V
CONCLUSION AND RECOMMENDATIONS

5.1 General

This chapter was set out to represent the conclusion of this project. Lastly, some testing, investigations and studies were also recommended after the conclusion, to further the strength characteristics of coconut shell aggregates concrete for the application in high strength concrete.

5.2 Conclusions

On the basis of our comparative analysis of test results of the basic properties of concrete with different percentages of coarse coconut shell aggregate content (0%, 4%, 8% and 12%), the following conclusions are made.

(i). By analyze the compressive strength of concrete made with coconut shell coarse aggregate (0%, 4%, 8% and 12% replacement of stone chips by coconut shell as a coarse aggregate). We get the highest compressive strength for 4% of coconut shell aggregate concrete between all other percentages, compare with fresh coarse aggregate concrete. The compressive strength decreases gradually with the percent increase of coconut shell coarse aggregate.

According to these test results, the performance of 4% of coconut shell coarse aggregate concrete is mainly satisfactory.

5.4 Recommendations for Further Studies

In every stage of tests, it may happen some human error, Machine calibration error and environmental error that make some variation in results. Following are the recommendations for further studies,

(i). Coconut shells as partial replacement of coarse aggregates effectively executed in areas where coconut shell is present in abundant quantity.

(ii). Provisions should be made to convert coconut into suitable aggregate form on a large scale in order to make the concrete industry more sustainable.

(iii). Flexural strength can also be determined by casting CS concrete cube specimens.

(iv). Durability factor can be determined by carrying some durability test on the CS cube specimens.

(v). Lightweight self compacting concrete can be produced using the coconut shell aggregate.

(vi). CSC can be tried in pavements and floors since CS aggregate has high resistance to wear.

(vii). We tested for the mixing percentage of coconut shell coarse aggregate 4%, 8% & 12%. In further studies more percentage can be tested.

(viii). Here we test the compressive strength after 7 days, 14 days and 28 days curing, got higher strength for 28 days curing. In further studies, curing can be done for more days. Compressive strength can be checked by increasing the curing time.

(ix). More tests like Temperature Measurement, Bulk Density and Yield, etc can be performed for more accurate and effective results.

(x). Use some admixture such as MUHU makes concrete admixture. It is use for coconut shell concrete the high strength of the compressive strength test.

REFERENCE

- I.S 516-1959, Indian Standard: METHODS OF TESTS FOR SRENGTH OF COCONUTE.

- I.S 456-2000 Indian Standard: PLAIN AND REINFORCED CONCRETE-CODE OF PRACTICE.

- https://www.wikipedia.com
- https://www.scribd.com
- https://shodhganga.inflibnet.com
- https://www.liquisearch.com
- S.K. DUGGAL
- https://www.eaasjournal.org/survey/userfiles/files/v3i307%20civil%20engineering.pdf
- K. Gunasekaran, "Utilization of Coconut Shell as Coarse Aggregate in the Development of Light Concrete" , Thesis-SRM University, 2011.
- Majid Ali and NawawiChouw, "Coir Fiber and Rope Reinforced Concrete Beam under Dynamic Loading", Thesis- University of Auckland, NewZealand, 2009.
- Dewanshu Ahlawat and L.G Kalurkar, "Strength Properties of Coconut Shell Concrete" International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 7, 2012, pp. 20-24, ISSN Print: 0976-6308, ISSN Online: 0976-6316.

- Adeyemi AY.,(1998)," An investigation into the suitability of coconut shells as aggregate in concrete production" , Journal of Environment, Design and Management.

- J. P. Ries, J. Speck, (2010), "Lightweight aggregate optimizes the sustainability of concrete", concrete sustainability conference, national ready mixed concrete Association.

- Gunasekaran K, Kumar PS, (2008), "Developing lightweight concrete using Agricultural and Industrial Solid Wastes" , Proceedings of Innovative World of Concrete' 08, 4th International Conference & Exhibition + ICI Silver Jubilee celebration.

- Amarnath Yerrmala Ramachandrudu C, properties of concrete with coconut Shells as Aggregate Replacement, International Journal of Engineering Inventions, vol. 1, Issue 6, October 2012.

- Vishwas P.Kulkarni, Sanjay kumar B. Gaikwad, “Comparative study on coconut shell aggregate with conventional concrete”, IJIET, Volume 2, Issue 12, June 2013, pp 67-70
- Gopal Charan Behera, Ranjan Kumar Behera, Coconut Shell as Coarse Aggregate, International Journal of Engineering Research & Technology (IJERT), vol.2, Issue 6, June-2013.
- Manindar Kaur, Manpreet Kaur, “ A Review on utilization of coconut shell as coarse aggregate in mass concrete”, IJAER, Vol 7, No. 11, (2012)