THE IMPACT OF INCORPORATING EGGSHELLS IN CONCRETE ON ITS PERFORMANCE

Submitted By

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DECLARATION

I hereby declare that, this thesis has been done by under the supervision of **J. M. Raisul Islam Shohag, Lecture, Department of Civil Engineering, Daffodil International University.** I also declare that neither this work has not been submitted elsewhere for any purpose (except for publication).

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Dedicated to

Our Teachers, Parents And Family

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LIST OF ABBREVIATIONS

ESW = Eggshell Waste

FA = Fly Ash

ASTM = American Society for Testing and Materials.

ACI =American Concrete Institute.

S.S.D. = Saturated Surface Dry

RAC = Recycle Aggregate Concrete

O.D. =Oven Dry

FA = Fine Aggregate

CA = Coarse Aggregate

W/C= Water Cement ratio

F.M. - Fineness Modulus

MPa =Mega Pascal (N/mm^2)

Psi = Pound per square inch

KN= Kilo Newton

Kg= Kilogram

mm =Millimeter

cm = Centimeter

CR=Crumb Rubber

CRC = Crumb Rubber Concrete

UTM = Universal Testing Machine

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ABSTRACT

The use of natural eggshells as an additive in concrete has gained attention in recent years due to its potential to improve the performance of the material. The eggshells, which are rich in calcium carbonate, can enhance the mechanical and durability properties of concrete, making it a more sustainable and environmentally friendly construction material. With growing concerns about the environmental impact of traditional building materials, the use of eggshells in concrete offers a promising solution for improving the sustainability of the construction industry. This study aims to explore the effect of eggshell addition on concrete performance, including its impact on strength, durability, setting time, and cost. The results of this research will provide valuable insights into the potential of eggshells as a sustainable alternative to traditional concrete materials. Investigating the impact of adding natural eggshells to concrete mixture on its properties such as compressive strength, split tensile strength, with the aim of determining the potential of eggshells as a supplementary material in improving the performance of concrete. The concrete specimens were prepared with varying percentages of eggshells (4%, 8%, 12%, and 16%) and tested for compressive strength and split tensile strength after 28 days of curing. The results of the study showed that the addition of eggshells to the concrete mixture had a positive effect on its compressive and split tensile strength. The compressive strength of the concrete increased with increasing eggshell content up to 8% and then decreased at higher percentages. The split tensile strength of the concrete also increased with increasing eggshell content. The study concludes that the use of natural eggshells as a supplementary material has the potential to enhance the performance of concrete. The optimal percentage of eggshells for maximum improvement in concrete performance was found to be 8%.

Keywords: Concrete, Eggshell, Split Tensile Strength, Compressive Strength

CHAPTER-1
INTRODUCTION

1.1 Basic Concept

Natural eggshells used to concrete mixtures have drawn interest because of their potential to improve concrete performance. When added to the concrete mix, eggshells, which are made of calcium carbonate, provide a number of advantages. First off, using eggshells minimizes the quantity of synthetic elements needed to make concrete, making it a more environmentally friendly and long-lasting building material. Eggshells also aid in reducing concrete's porosity, increasing its toughness and weather resistance. According to studies, adding eggshells to concrete significantly boosts the compressive strength of the material. Additionally, eggshells can help concrete be more fire resistant. This is due to the fact that calcium carbonate releases carbon dioxide when heated, which aids in containing the spread of fire. The carbon footprint of making concrete can be decreased by partially substituting natural eggshells for Portland cement. Eggshells added to concrete can also increase workability, making it simpler to mold and mound the material into the shapes that are required. The use of natural eggshells as an addition in concrete is a potential discovery that is worthwhile investigating due to its many advantages. The use of eggshells in concrete also leads to improved mechanical properties, making it more resistant to cracks and abrasions. The calcium carbonate in eggshells can also react with other components in the concrete mixture, leading to a denser and more cohesive structure. The use of eggshells in concrete can result in lower costs, as it reduces the need for expensive synthetic materials and additives. Furthermore, the eggshells can act as a natural source of calcium, improving the overall health and quality of the concrete. Research has also shown that the addition of eggshells to concrete can increase its resistance to acid and alkaline attack, further enhancing its durability. The use of eggshells in concrete can also lead to improved thermal insulation, helping to regulate the temperature of buildings and structures. The natural eggshells are a renewable resource that can be sourced locally, reducing the environmental impact of concrete production. With its numerous benefits, the use of eggshells in concrete is an innovative solution that has the potential to revolutionize the construction industry. In summary, the impact of employing natural eggshells on the performance of concrete is a promising finding that warrants more study and investigation. Eggshells are a worthwhile component to take into consideration since they have the potential to improve the strength, dependability, and sustainability of concrete. The addition of natural eggshells to concrete is a step in the direction of a greener and more sustainable future for the building sector. The use of eggshells in concrete is a straightforward and economical option that has the potential to make a big difference because of its many benefits. We may take a step towards a more sustainable and environmentally friendly future for the building sector by investigating the usage of natural eggshells in concrete.

1.2 Background of Study

One of the most used building materials in the world, concrete has a big environmental effect during manufacture. Traditional concrete production uses a lot of energy and synthetic elements, which might be harmful to the environment and contribute to climate change. In order to lessen the environmental effect of concrete manufacturing while also enhancing its performance, there has been an increase in interest in investigating alternate approaches in recent years. One of the most promising developments in this area is the use of natural eggshells as a supplement in concrete mixture. The eggshells are made of calcium carbonate, which is a common ingredient in many construction materials. The idea behind using eggshells as a supplement in concrete is to reduce the amount of synthetic materials required and to improve the overall performance of the concrete. This can be achieved by incorporating the calcium carbonate from the eggshells into the concrete mixture, which contributes to its strength and durability.

Natural eggshells in concrete provide a variety of possible advantages. First off, by using fewer synthetic ingredients and additives, it lessens the environmental effect of producing concrete. Second, it enhances concrete's performance by boosting compressive strength, lowering porosity, and enhancing resistance to weathering and fire. In addition, using eggshells can reduce the entire cost of producing concrete, making it a cost-effective choice. Natural eggshells in concrete represent a fascinating field of study that merits additional investigation due to the possible advantages.

1.3 Scope of the study

Evaluation of the effects of eggshell addition to the concrete mixture is the main objective of the study on the usage of natural eggshells and concrete performance. The major goal is to ascertain the degree to which eggshells can enhance concrete's compressive strength, durability, and resistance to fire and weathering. This will be accomplished through laboratory tests in which various eggshell addition rates to concrete mixes will be examined for their physical and mechanical characteristics.

In addition to evaluating the performance of concrete with eggshells, the study will also assess the sustainability benefits of using eggshells as an additive. This will include an evaluation of the carbon footprint of concrete production with eggshells, as well as an analysis of the potential costs savings associated with using this alternative solution.

The study will also consider the scalability of using eggshells in concrete production, including the availability of eggshells as a resource, and the practicality of using eggshells in large-scale construction projects. By considering these factors, the study will provide a comprehensive evaluation of the potential of using natural eggshells in concrete.

1.4 Objectives

The objectives of this study are as follows; -

i. To determine the compressive strength of concrete with addition to recyclable waste material.
ii. To determine the split tensile strength of concrete with addition to recyclable waste material.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Due to worries about the environmental effect of standard building materials, the use of natural materials as a supplement to these materials has grown in popularity in recent years. Eggshells, a byproduct of the food industry and a plentiful natural resource, are one such example. The goal of this study of the literature is to look at the research that has already been done on how adding eggshells to concrete affects its strength, durability, and sustainability. The review will also explore any challenges or limitations associated with using eggshells as a supplement to concrete and identify areas for further research. The use of eggshells as a supplement to concrete has gained attention as a potential solution to both waste management and sustainability issues. Eggshells are composed primarily of calcium carbonate, which is also a major component of cement. When added to concrete, eggshells are believed to improve its performance by contributing to the formation of calcium silicate hydrate, the primary binder in concrete. However, the effectiveness of eggshells as a supplement to concrete is still a subject of debate, and further research is needed to fully understand their impact.

The literature study will take into account research that have looked at the microstructure, durability, and physical and mechanical characteristics of concrete that contains eggshells. The evaluation will also look at any potential environmental advantages or disadvantages of utilizing eggshells in place of concrete. This will be accomplished by examining the energy use, emissions, and any effects on the material's lifetime related to the manufacture of concrete incorporating eggshells.

A research was conducted in Indonesia to study the effect of using eggshell waste as a substitute for cement in self-compacting concrete (SCC). The research used an experimental method and compared the compressive and tensile strength values of SCC with 0%, 2.5%, 7.5%, 12.5%, and 17.5% variations of eggshell waste. The results showed that eggshell substitution increased the compressive strength of the SCC, although not optimally, and also increased the tensile strength compared to normal SCC [1].

Eggshell powder is a bio-waste material that can cause health hazards and environmental pollution when disposed of in landfills. Replacing cement with eggshell powder in concrete can help minimize these negative effects and ensure the sustainability of building materials. Four different replacement ratios (0%, 4%, 8%, 16%) were tested, and the results showed that the sportively decreased with up to a 4% replacement, but increased with higher replacement ratios. This may be due to the eggshell powder acting as a better inert filler at lower replacement ratios, reducing capillary pores and increasing the impermeability of the concrete structure [2].

Overall, the goal of the literature study is to offer a thorough knowledge of how adding eggshells to concrete can affect how well it performs. The findings of this study will encourage the usage of eggshells as a good substitute for conventional building materials and aid in the development of sustainable construction materials.

2.2 Literature Review

To examine the effect of adding eggshells on the properties of concrete. Eggshells was collected, cleaned, and added to plain concrete in different percentages (4%, 8%, 12%, and 16%) to evaluate its impact on the compressive and split tensile strength of the concrete. The results showed that the highest compressive and split tensile strength was achieved when the concrete was 4% eggshells, respectively. It also improved the tension strength of concrete [3].

This paper focuses on improving the strength of concrete by adding eggshells. Results showed that the compressive and split tensile strength of concrete improved with 4% addition of eggshells. The paper provides a summary of the improvement in the mechanical performance of concrete with steel fiber reinforcement [4].

This paper explores the use of eggshell powder (ESP) obtained from bakeries and fast-food restaurants as a filler, cement, and fine aggregate in concrete. ESP has high amounts of calcium and is combined with pozzolanic materials like fly ash to improve concrete properties and reduce environmental pollution. The modulus of elasticity also decreased with high levels of replacement. The specific gravity of ESP was lower than that of cement, but the durability and water absorption of concrete improved with the addition of ESP [5].

The cement industry contributes to air pollution and greenhouse gas emissions by releasing CO2 during the conversion of calcium carbonate to calcium oxide. In this study, sugarcane bagasse ash (SCBA) and Nano eggshell powder (NEP) were added to cement in different percentages to reduce the cement content in high-strength concrete (HSC). 16 HSC mixtures were experimented with, including SCBA and NEP, and their fresh and hardened properties were evaluated. EDX and SEM analyses were conducted to analyze the microstructure of SCBA, NEP, and HSC concrete. This suggests that using SCBA and NEP as cementitious materials can help reduce cement content and potentially mitigate the environmental impact of the cement industry [6].

The paper investigates the use of micro-sized eggshell powder as a partial replacement for cement in concrete. Four replacement percentages were tested and the effects on workability, compressive strength, flexural strength, water absorption, and acid attack were analyzed. The results showed that eggshell powder improved workability and mechanical properties but had a negative effect on durability. 4% replacement was found to be the optimum percentage for both compressive and flexural strength. Overall, the study suggests that eggshell powder has potential as an alternative material to replace cement in concrete [7].

This study explores the effects of partially replacing cement with egg shell powder in lightweight foamed concrete. The aim is to reduce environmental waste and carbon emissions while promoting the application of lightweight foamed concrete. The study investigates engineering properties such as workability, stability, compressive and split tensile strength, water absorption, and sorptivity at various replacement levels of 0%, 2.5%, 5%, 7.5%, and 10% by mass. Results show that egg shell powder can be used as a partial cement replacement material for masonry units up to a 5% replacement level, improving compressive and flexural strength while reducing spread diameter, stability, and sorptivity [8].

This passage discusses the use of eggshell powder as a substitute material for cement in the production of sustainable concrete. Eggshell powder is a viable option as it improves disposal of eggshells, has a high calcium content, and improves hardened properties and resistance to water penetration and carbonation. It is also an accelerator to the hydration process. However, eggshell powder shows weakness in chloride and sulphate environments. Although there are many studies on the material, research on the durability properties of eggshell powder in concrete should be increased [9].

Different weight percentages of cement were replaced with eggshell ash, and the properties studied include workability, compressive and flexural strengths, water absorption, dry density, and thermal conductivity. Results show that the optimum replacement ratio is 15%, as it improves compressive and flexural strength by about 14.7% and 6.5%, respectively, at 28 days age. The use of eggshell ash also leads to a reduction in water absorption and thermal conductivity, and a decrease in the amount of cement used in the mixture, thus supporting natural resources' sustainability and reducing emitted gases [10].

The study investigated the use of eggshell powder as a replacement for cement in concrete to improve its mechanical properties. The eggshells were heated and ground, and tests were performed on concrete samples with 0%, 4%, 8%, 12% and 16% eggshell replacement at 7, 14, and 28 days. Results showed that a 10% eggshell replacement caused a 1% increase in compressive strength, 21% decrease in water absorption, and 90% increase in electrical resistance, while a 20% replacement caused a 17% decrease in compressive strength but still resulted in decreased corrosion. The study suggests that using eggshells as a cement substitute can lead to improved quality and a safer environment [11].

This paper reviews the use of eggshell powder as a cement replacement in concrete to produce sustainable and green concrete. The paper discusses the chemical compound of eggshells, production techniques, and properties of eggshell concrete (ESC). Results from various studies indicate that ESC has advantages such as improved hardened properties, reduced setting time, and increased resistance to water penetration and carbonation. However, ESC shows weakness in chloride and sulphate environments. The paper concludes that while significant research has been done on the material, more research is needed to investigate the durability properties of ESC [12].

This study investigated the use of ultra-fine eggshell powder (UFESP) as a partial replacement for cement in Self-Compacting Concrete (SCC) at different weight percentages (0-25% with 5% increments). The study found that the addition of UFESP up to 15% improved the compressive strength of SCC, but at higher percentages, the strength decreased. The fresh properties of all mixtures met the requirements for SCC, but the dry density decreased as UFESP content increased. The study suggests that UFESP can be a viable material for sustainable construction, but further research is needed to optimize its use in concrete [13].

The addition of different types of mineral admixtures can influence the material's overall behavior. To optimize the material's performance, an experimental study was conducted on six sets of HPFRC specimens with varying fiber volume content and types of mineral addition. The study evaluated the material's behavior in compression, flexural tension, and shrinkage properties, and the results showed that the addition of high fiber volume content and Algerian blast furnace slag into the mix resulted in a high-performing HPFRC material suitable for use in practice [14].

CHAPTER 3

METHODOLOGY

3.1 Introduction

A study on the effect of using natural eggshell addition on concrete performance would typically provide background information on the topic, including the rationale for investigating this issue and the potential benefits of using eggshells as a supplementary cementation material. The introduction would also state the research question and objectives of the study, as well as provide an overview of the methodology that will be used to investigate the effect of eggshell addition on concrete performance. The introduction may also discuss relevant previous studies and the contribution that the current study makes to the field of concrete technology.(1) natural eggshells and grinding them into a fine powder, (2) measuring the correct proportions of eggshell powder to be added to the concrete mix, (3) mixing the eggshell powder with the cement, aggregates, and water to produce the concrete mixture, (4) casting and curing the concrete specimens, (5) testing the concrete specimens for various properties such as compressive strength, flexural strength, and water absorption and (6) analyzing the results to determine the effect of eggshell addition on the concrete performance.

The study may also include measures like controlling variables like curing conditions and the kind of cement used, carrying out multiple trials to average out any inconsistencies, and comparing the results to earlier studies on related topics in order to ensure the validity of the results. A microstructural examination utilizing methods like scanning electron microscopy or x-ray diffraction may also be included in the study to further understand the process by which eggshells alter concrete qualities. Overall, to correctly establish the impact of natural eggshell addition on concrete performance, the approach for this sort of study should be well-planned, rigorous, and controlled.

3.2 Grade 15 Concrete

Grade 15 concrete refers to a standard of concrete strength, where "grade" refers to the compressive strength of the concrete mixture in pounds per square inch (psi) also known as M15 concrete. A concrete mix with a compressive strength of 2175 psi is referred to as "Grade 15 concrete". The mixture ratio of grade 15 concrete 1:2:4. Where 1 cement, 2 sand and 4 aggerate. It is important to note that the actual compressive strength of concrete may vary depending on several factors such as the curing conditions, water-cement ratio, type and amount of aggregate, and curing time. The use of grade 15 concrete is suitable for applications that require high strength such as bridges, high-rise buildings, and heavy-duty industrial structures.

3.3 Ingredients

3.3.1 Cement

For the experiment, we utilized Portland Composite Cement (PCC) from the brand SHAH Cement, which can be easily obtained from local markets in Bangladesh. A total of 95 kilograms of cement was used in the experiment.

Figure 3.3.1: Cement

3.3.2 Coarse Aggregate

The processing method utilized will determine the size of the coarse aggregates used in the experiment. The coarse aggregate in the experimental trial had a nominal size of 20 mm. Crushed stone made up the coarse aggregate, and there were 15.43 cubic feet of it in total.

Figure 3.3.2: Coarse Aggregate

3.3.3 Fine Aggregate

We have completed the experiment with exceptional quality sand, and Sylhet Sand is among the top options available to us. The reason we opted for Sylhet Sand is due to its remarkable strength-bearing capabilities We collected sand from Ashulia.

Figure 3.3.3: Fine Aggregate

3.3.4 Water

To ensure the quality of the experiment, it was imperative to use pure water free from any impurities. Therefore, water was sourced from a local, uncontaminated source. In order to guarantee that the water was free from pollutants such as dust, it was collected carefully and thoroughly screened. A total of 20.84 liters of this clean water was utilized in the experiment.

Figure 3.3.4: Water

3.3.5 Eggshell

The use of high-quality, powdered eggshells was crucial to the success of the experiment. By collecting them from Ashulia in their powdered form, we were able to ensure that the eggshells would perform optimally in the experiment. The fine powder form of the eggshells allowed for even distribution and easy mixing with the other materials, which was important for the accuracy of the results.

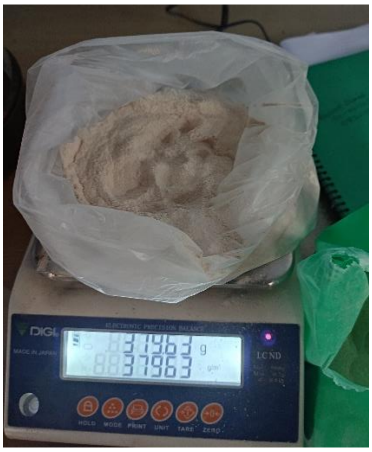

Figure 3.3.5: Eggshell

3.4 Recyclable waste materials

Eggshells are a natural waste material that is produced in large quantities daily, making them an abundant and readily available resource. They are made of calcium carbonate, which is a strong and durable material, making them an attractive alternative to synthetic materials in various industrial and construction applications.

Eggshells are often used as a material in concrete, improving its strength and crack resistance. They are also used in the production of lightweight construction materials, such as lightweight concrete blocks, tiles, and mortar. Eggshells are a sustainable material as they reduce the need for virgin materials and contribute to reducing waste in landfills.

Eggshells are also made entirely of biodegradable material, making them safe for the environment to dispose of correctly and ecologically beneficial. Eggshells are a low-energy substitute for synthetic materials, thus using them in building and industrial applications can help reduce carbon emissions.

3.5 Slump Test

To perform a slump test, you will need a slump cone, a tamping rod, and a level surface. The purpose of this test is to evaluate the cohesiveness and workability of freshly poured concrete.

Here are the steps to perform the test:

- Set up the apparatus: Gather the slump cone, tamping rod, and level surface for the experiment.
- Fill the cone: Using fresh concrete, fill the slump cone and compact it with 25 strokes of the tamping rod.
- Remove the cone: Carefully lift the cone vertically, keeping the base in contact with the concrete surface.
- Measure the slump: Measure the difference between the height of the concrete in the mold and the height of the remaining concrete in the cone. This distance is referred to as the "slump." Record your results.

The slump test provides valuable information about the consistency of the concrete mixture, indicating whether it was mixed properly or not.

 

Figure 3.5.1: Slump Test

3.6 Compressive Strength Test

The compressive strength test is a common test that determines the compressive strength of a material. This test is used to determine the maximum load that a material can withstand before it fails. The test is performed on cylindrical specimens of the material, usually with a diameter to height ratio of 2:1 (8”:4”). The following steps describe the procedure for a compressive strength test:

- **Sample preparation:** Obtain cylindrical samples of the material and make sure that they are of the correct size and shape. The samples should be smooth and free from cracks, voids, and other defects.
- **Loading the specimen:** Mount the cylindrical sample in the Universal Testing Machine (UTM), making sure that it is centered and aligned with the compression axis. Apply the load to the specimen at a constant rate of strain until it fails.

- **Measuring the load and deformation:** Measure the load and deformation of the specimen during the test. This can be done using load cells and displacement transducers, which are connected to the testing machine.
- **Calculation of compressive strength:** The compressive strength of the material is calculated by dividing the maximum load at failure by the cross-sectional area of the specimen.
- **Data analysis**: Analyze the data obtained from the test to determine the compressive strength of the material and to study its behavior under load. This information can be used to design structures and components that are made of the material.

It is important to note that the compressive strength test should be performed under controlled conditions, with the temperature and moisture content of the samples maintained within specified limits

Figure 3.6.1: Compressive Strength Test

3.7 Split Tensile Test

The split tensile test is a method used to determine the tensile strength of concrete. It measures the maximum compressive stress that concrete can endure before it fails. The steps involved in a split tensile test are as follows:

Specimen preparation: Cylindrical concrete specimens of a specified size and shape are made and cured for a specified period of time. The surface of the concrete specimens is smoothed and polished to ensure a uniform surface.

Loading arrangement: The specimen is placed in the UTM and gripped at its two ends. The grips must be placed in such a way as to create a split in the specimen along its axis.

Load application: The UTM applies a tensile load to the specimen at a constant rate of deformation. The load and deformation of the specimen are continuously recorded during the test.

Recording of results: The load and deformation of the specimen are continuously recorded during the test.

Failure analysis: The point of failure of the specimen is noted, and the maximum load and corresponding deformation are recorded.

Calculation of tensile strength: The tensile strength of the concrete is calculated by dividing the maximum load applied to the specimen by its cross-sectional area. The resulting value is the tensile strength of the concrete.

It's important to note that the procedure may vary slightly based on the specific type of UTM and testing standards used. However, the basic steps are generally the same.

CHAPTER 4

RESULT & DISCUSSION

4.1 Introduction

Cement, sand, stone chips, water, and eggshell were just a few of the several materials used in the study. To make sure they were of high quality and relevance, the cement, sand, and stone chips were purchased from a local supplier. After being formed into cylinder forms, the concrete samples underwent a curing procedure for 7, 14, and 28 days. In the experiment, steel fibers were added in varying amounts, starting at 0% and increasing by 4% and 8% to a maximum of 16%. The purpose of this experiment was to determine how different eggshell percentages affected the characteristics of the concrete.

4.2 Calculation of Compressive Strength

To measure the compressive strength of concrete, a Universal Testing Machine (UTM) is utilized to test a cylinder.

Table 4.2-1: Determination of Compressive Strength of cylindrical Concrete at 7 days

SL NO.	Concrete Mix	% of Egg Shell	Maximum Load Recorded (KN)	Compressive Strength (MPa)
1	M15	0%	52	6.62
2	M15	4%	64	8.14
3	M15	8%	54.33	6.91
4	M15	12%	64	8.14
5	M15	16%	63	8.02

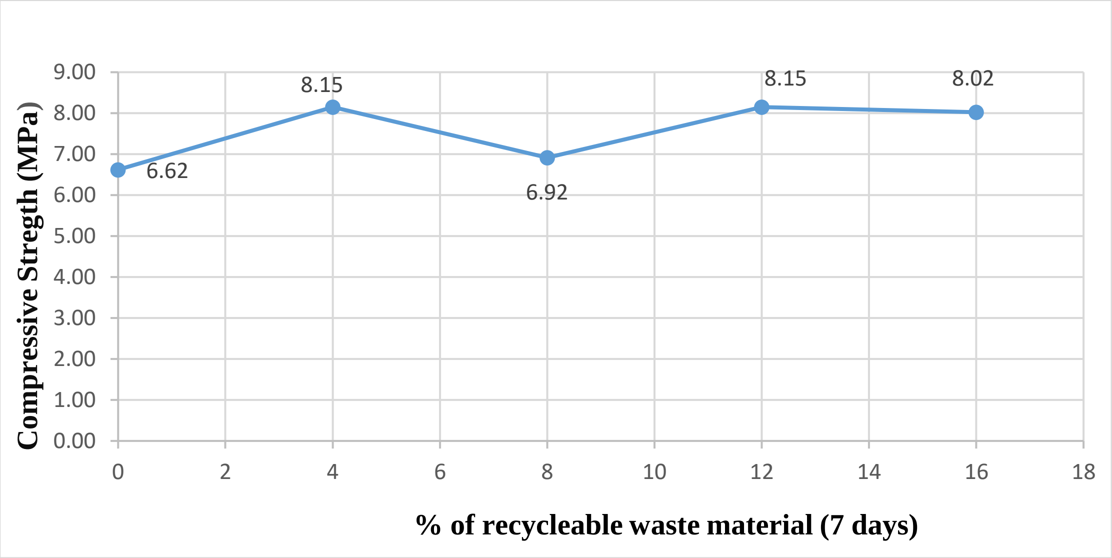

Figure 4.2.1: Graphical of Compressive Strength of Cylindrical with respect to % of Cyclable Waste Material

Table 4.2-2: Determination of Compressive Strength of cylindrical Concrete at 14 days

SL NO.	Concrete Mix	% of Egg Shell	Maximum Load Recorded (KN)	Compressive Strength (MPa)
1	M15	0%	60	7.64
2	M15	4%	81.66	10.40
3	M15	8%	82.33	10.48
4	M15	12%	66.66	8.49
5	M15	16%	65	8.28

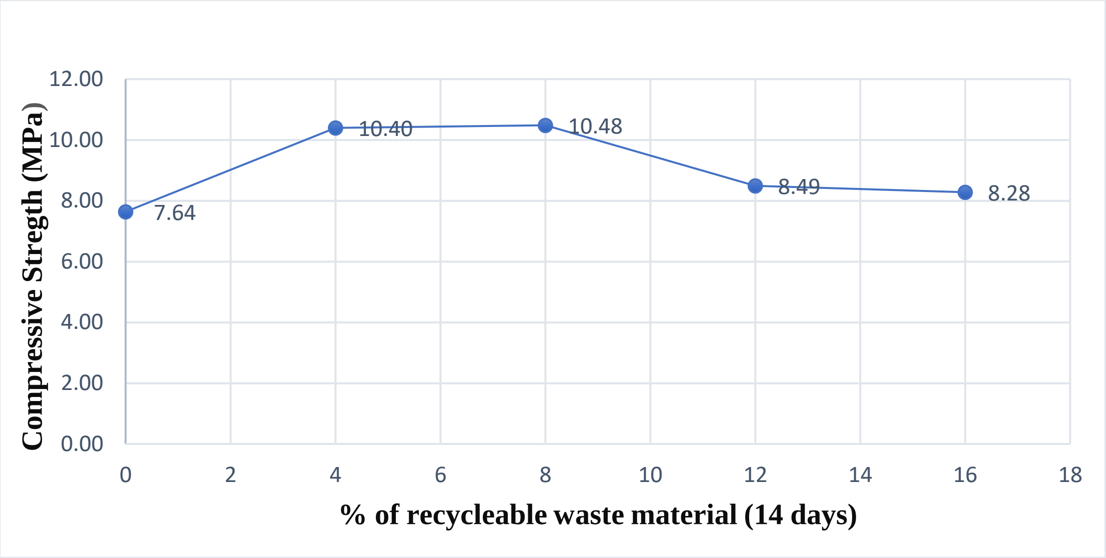

Figure 4.2.2: Graphical of Compressive Strength of Cylindrical with respect to % of Cyclable Waste Material

Table 4.2-3: Determination of Compressive Strength of cylindrical Concrete at 28 days

SL NO.	Concrete Mix	% of Egg Shell	Maximum Load Recorded (KN)	Compressive Strength (MPa)
1	M15	0%	64.5	8.21
2	M15	4%	76.66	9.76
3	M15	8%	91.67	11.67
4	M15	12%	85	10.82
5	M15	16%	91.66	11.67

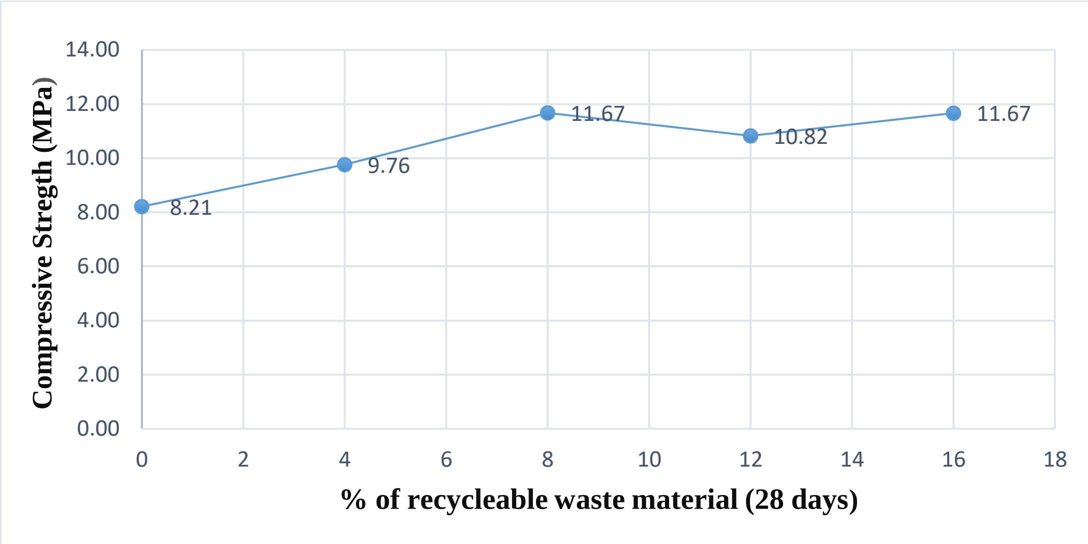

Figure 4.2.3: Graphical of Compressive Strength of Cylindrical with respect to % of Cyclable Waste Material

4.3 Calculation of Split Tensile Strength

To measure the split tensile strength of concrete, a Universal Testing Machine (UTM) is utilized to test a cylinder.

Table 4.3-1: Determination of Split Tensile Strength of cylindrical Concrete at 7 days

SL NO.	Concrete Mix	% of Egg Shell	Maximum Load Recorded (KN)	Split Tensile Strength (MPa)
1	M15	0%	37	1.18
2	M15	4%	53	1.69
3	M15	8%	52.66	1.73
4	M15	12%	51.33	2.04
5	M15	16%	45.33	2.01

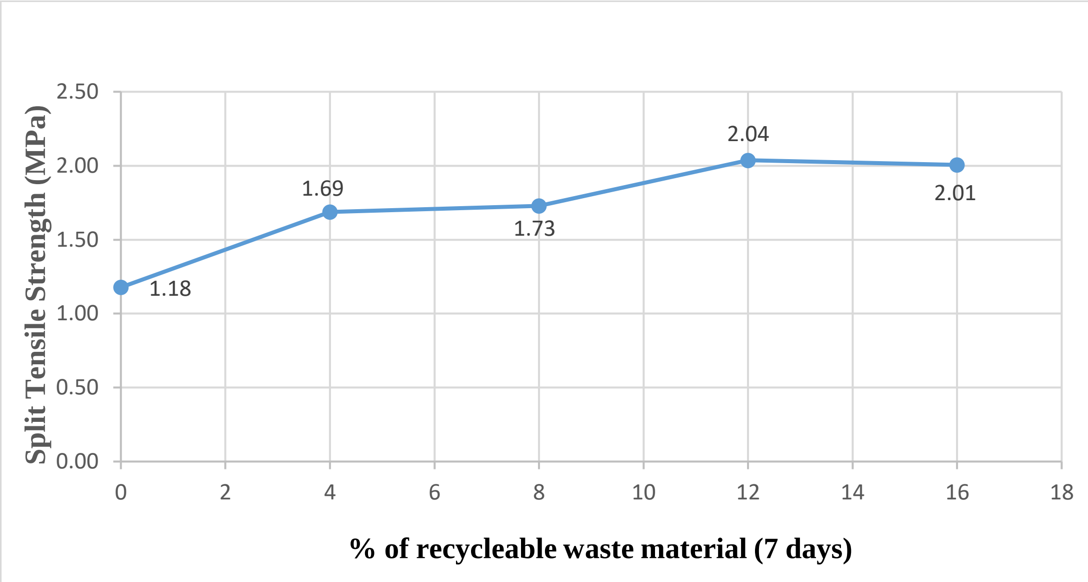

Figure 4.3.1: Graphical of Split Tensile Strength of Cylindrical with respect to % of Cyclable Waste Material

Table 4.3-2: Determination of Split Tensile Strength of cylindrical Concrete at 14 days

SL NO.	Concrete Mix	% of Egg Shell	Maximum Load Recorded (KN)	Split Tensile Strength (MPa)
1	M15	0%	51	1.45
2	M15	4%	70	2.10
3	M15	8%	64.16	2.62
4	M15	12%	56	2.12
5	M15	16%	32.5	2.07

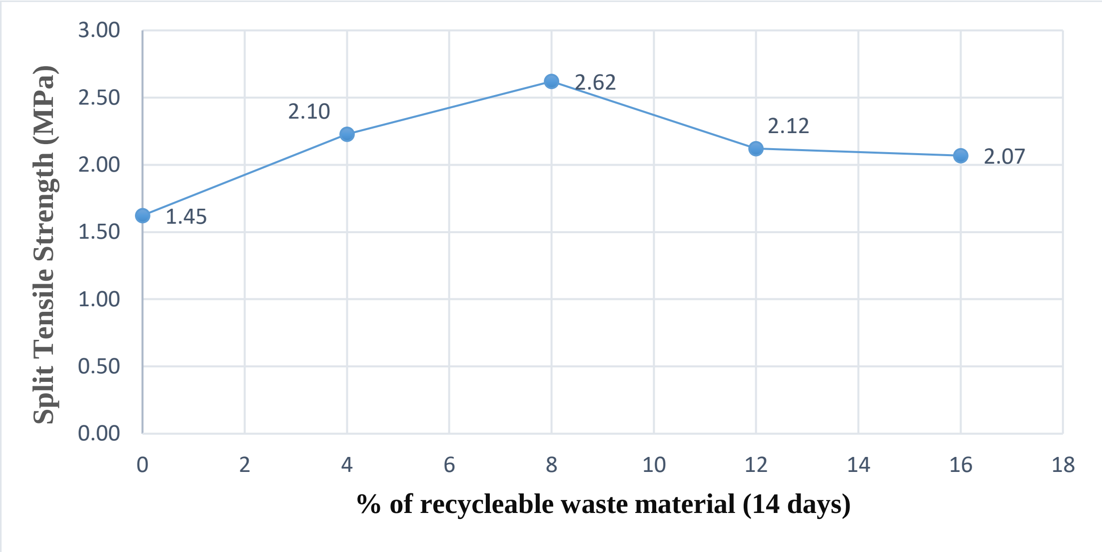

Figure 4.3.2: Graphical of Split Tensile Strength of Cylindrical with respect to % of Cyclable Waste Material

Table 4.3-3: Determination of Split Tensile Strength of cylindrical Concrete at 28 days

SL NO.	Concrete Mix	% of Egg Shell	Maximum Load Recorded (KN)	Split Tensile Strength (Mpa)
1	M15	0%	45.7	1.62
2	M15	4%	65.83	2.23
3	M15	8%	70	2.92
4	M15	12%	65	2.71
5	M15	16%	60	2.92

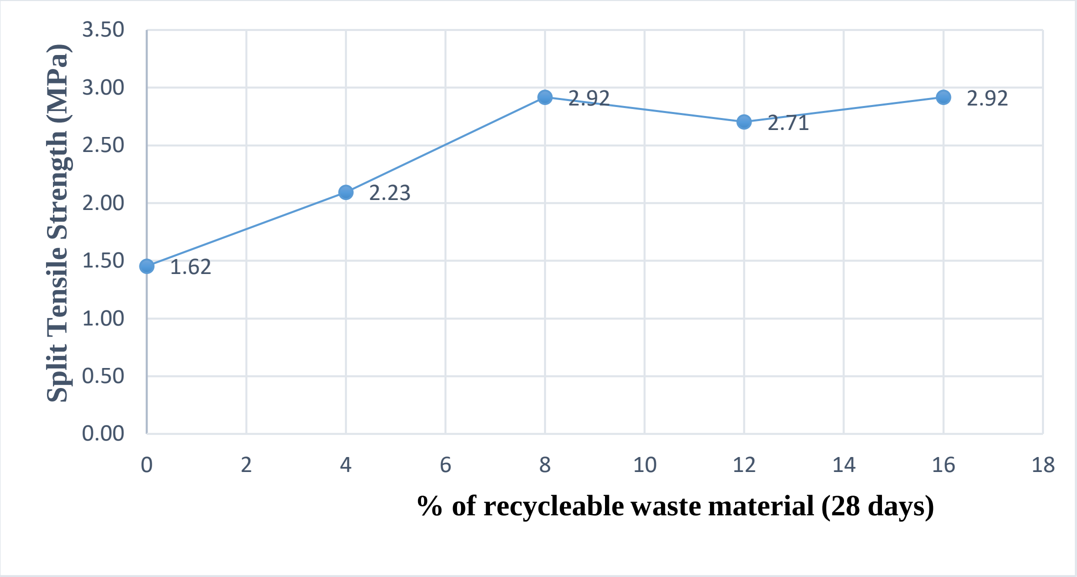

Figure 4.3.3: Graphical of Split Tensile Strength of Cylindrical with respect to % of Cyclable Waste Material

4.4 Comparison between compressive and split tensile strength

The graph displays a comparison of the compressive strength and split tensile strength at 7, 14, and 28 days.

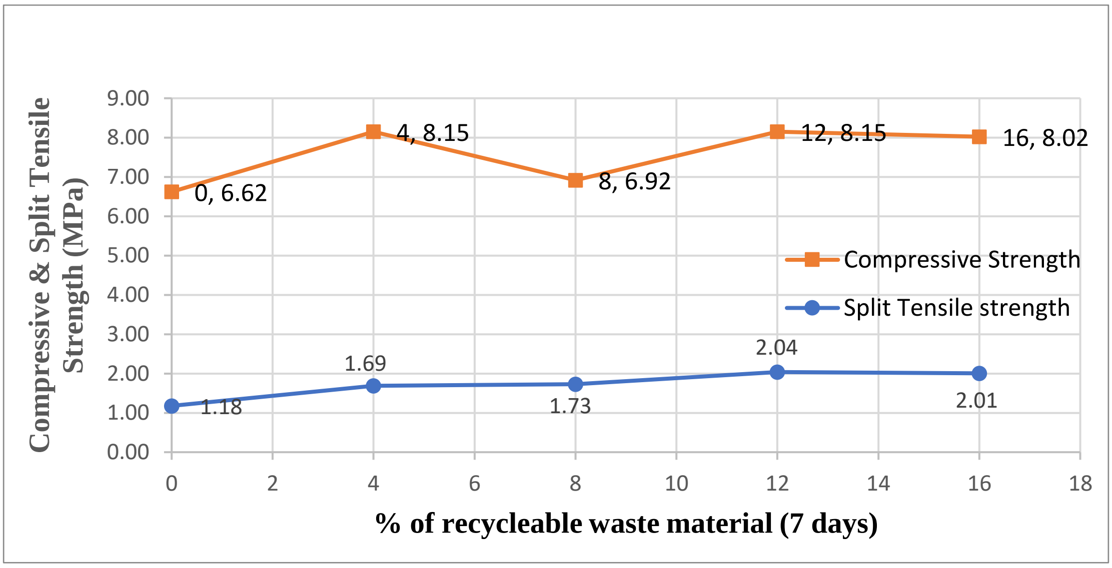

Figure 4.4.1: Comparison between Compressive and Split Tensile Strength of 7 Days

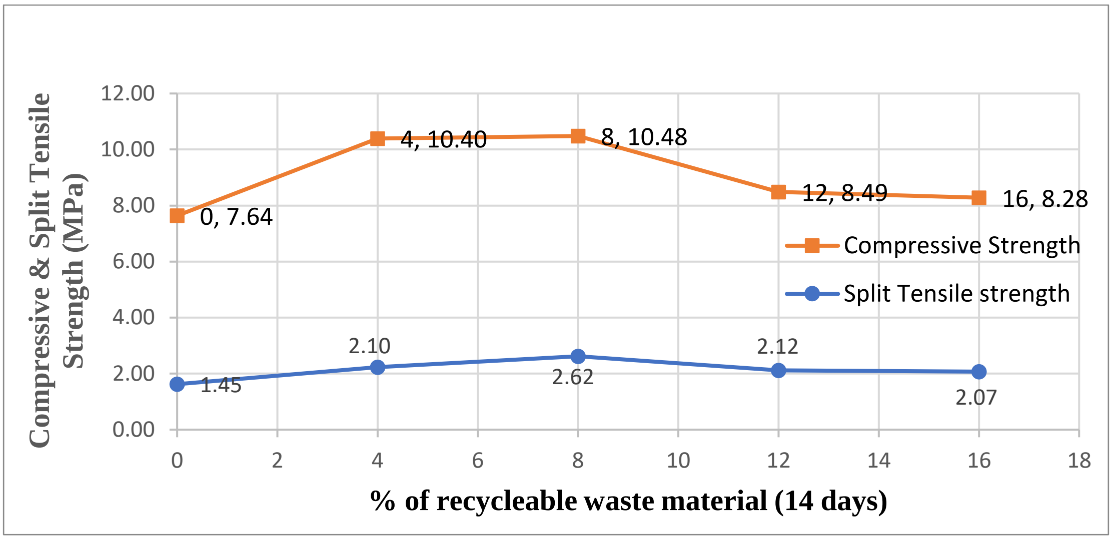

Figure 4.4.2: Comparison between Compressive and Split Tensile Strength of 14 Days

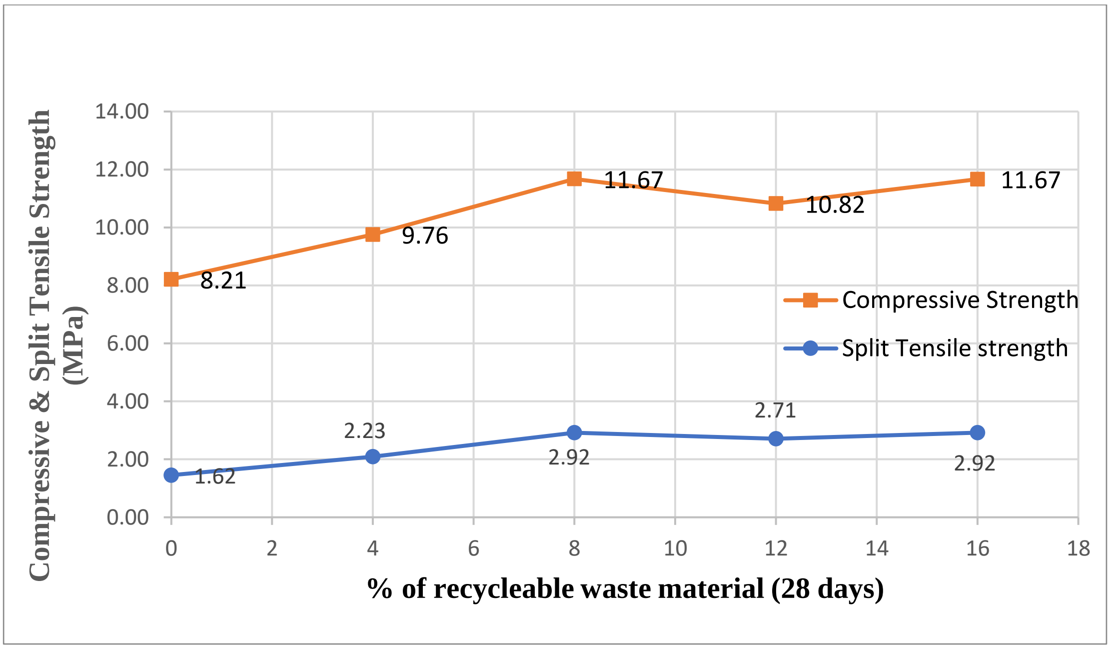

Figure 4.4.3: Comparison between Compressive and Split Tensile Strength of 28 Days

4.5 Discussion

Comparing M15 concrete with 0% eggshell to concrete with 4% eggshell after a 7-day curing time reveals an improvement in compressive strength of 8.15 MPa in the latter case. Compressive strength drops by 6.92 MPa when eggshell content is raised to 8%. The compressive strength decreases by 8.02 MPa with eggshell content increasing to 16% and 8.15 MPa with eggshell content increasing to 12%.

A comparison between M15 concrete with 0% eggshell compressive strength of 7.64 MPa and concrete with 4% eggshell after a 14-days curing period shows an increase in compressive strength of 10.40 MPa. When the eggshell percentage is increased to 8%, the compressive strength increases by 10.48 MPa. However, when the percentage of eggshell is further increased to 12%, there is a reduction in compressive strength of 8.49 MPa, and with 16% eggshell, there is a reduction of 8.28 MPa.

The compressive strength of M15 concrete with 0% eggshell increased from 8.21 MPa to 9.76 MPa after 28 days of curing, according to a comparison with concrete with 4% eggshell. The compressive strength rises by 11.67 MPa when the eggshell content is raised to 8%. However, the compressive strength decreases by 10.82 MPa when the eggshell percentage is raised to 12%, and it increases by 11.67 MPa when it reaches 16% eggshell.

A comparison between M15 concrete with 0% eggshell split tensile strength of 1.18 MPa and concrete with 4% eggshell after a 7-days curing period shows an increase in split tensile strength of 1.69 MPa. When the eggshell percentage is increased to 8%, the split tensile strength increases by 1.75 MPa. However, when the percentage of eggshell is further increased to 12%, there split tensile strength increases of 2.04 MPa, and with 16% eggshell, there is a reduction of 2.01 MPa.

A study of the split tensile strength of M15 concrete with 0% eggshell and M15 concrete with 4% eggshell after a 14-day curing time reveals a 2.23 MPa improvement in split tensile strength. The split tensile strength rises by 2.62 MPa when the eggshell percentage is raised to 8%. However, the split tensile strength improves by 2.12 MPa when the eggshell percentage is further raised to 12%, and it decreases by 2.07 MPa when it is raised to 16%.

A comparison between M15 concrete with 0% eggshell split tensile strength of 1.62 MPa and concrete with 4% eggshell after a 28-days curing period shows an increase in split tensile strength of 2.23 MPa. When the eggshell percentage is increased to 8%, the split tensile strength increases by 2.92 MPa. However, when the percentage of eggshell is further increased to 12%, there is a reduction of 2.71 MPa, and with 16% eggshell, there split tensile strength increases of 2.92 MPa.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

In a number of research investigations, eggshells have been used as an addition in concrete. Eggshells may be added to concrete mixes to increase the concrete's performance in a number of ways, according to research.

Utilizing eggshells in concrete has several advantages, one of which is that it can improve the concrete's compressive strength. Eggshells' high calcium content can react with cement in concrete to create calcium silicate hydrate, which increases the concrete's strength.

Another benefit of using eggshells in concrete is that it can improve the durability of the concrete. Eggshells contain organic compounds that can fill the pores in the concrete, making it more resistant to water absorption and reducing the risk of cracking and damage due to freeze-thaw cycles.

Additionally, the use of eggshells in concrete can also contribute to sustainability by reducing waste. Eggshells are a common waste product that can be diverted from landfills and used in concrete production.

5.2 Conclusion

In conclusion, eggshells can increase the strength, longevity, and sustainability of concrete by being added 4% to 8% in concrete mixes. The ideal eggshell processing ratio and ratio of eggshells are currently being determined in order to maximize performance in concrete. For adding 8% Eggshells, we got Compressive strength in 7, 14, and 28 days 6.92, 10.48, and 11.67 on the other hand Split Tensile strength 1.73, 2.62, and 2.92. That means if we use 4% to 8% of Eggshells, we’ll get the maximum strength.

5.3 Recommendation

It is advised that eggshells be used in concrete in practical applications, particularly in places where there is a lot of eggshell waste. It's important to inform engineers and contractors of both the advantages and disadvantages of employing eggshells in concrete mixes.

- The use of high-quality sand and distilled water in the mixture can enhance the strength of the resulting product.
- Choosing to use ready-mix concrete can lead to the production of a final product with high strength.
- Incorporating eggshells 4% to 8% in concrete ratio of 1:1.5:3 will provide additional improvement in strength.
- In addition to eggshells, other recyclable materials such as human hair, plastic particles, and steel fibers can also be used for experimentation in concrete. These materials can potentially provide reinforcement and improve the properties of the resulting concrete mixture.

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Appendix

Figure 5.2.1: Cement

Figure 5.2.2: Sand

Figure 5.2.3: Aggregate

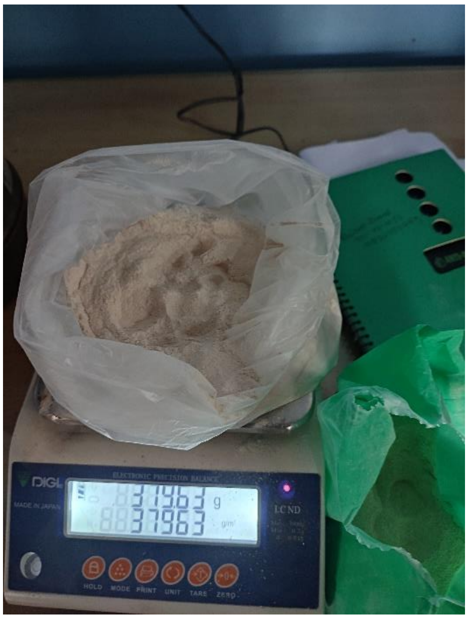

Figure 5.2.2: Crushed Eggshell

Figure 5.2.3: Water

Figure 5.2.6: Mixing Eggshell

Figure 5.2.7: Mixture Preparing

Figure 5.2.8: Slump Test

Figure5.2.4: Mould Preparing

THE END