EXPLORING RICE HUSK ASH AS A REPLACEMENT FOR CEMENT IN CONCRETE PRODUCTION

Submitted By

Rowshan Rays Chowdhury
Md Jahid Hasan Akash

A Thesis Submitted to the Department of Civil Engineering, Daffodil International University is a Partial Fulfillment of the Requirement for the award of the Degree of
Bachelor of Science in Civil Engineering

Department of Civil Engineering

Daffodil International University

January 2025

EXPLORING RICE HUSK ASH AS A REPLACEMENT FOR CEMENT IN CONCRETE PRODUCTION

<u>Submitted by:</u>

Rowshan Rays Chowdhury
Id: 201- 47-318

Md Jahid Hasan Akash
Id: 201- 47-329

Department of Civil Engineering

Daffodil International University

<u>Supervised by:</u>

Ahad Ullah

Senior Lecturer

Department of Civil Engineering

Daffodil International University

A Thesis Submitted to the Department of Civil Engineering, Daffodil International University in partial fulfillment of the requirements for the award of the Degree of

Bachelor of Science in Civil Engineering

Department of Civil Engineering

Daffodil International University

January 2025

CERTIFICATION

We would like to say that the thesis paper on **"Exploring rice husk ash as a replacement for cement in concrete production"** was **written by Rowshan Rays Chowdhury with ID: 201-47-318 and Md Jahid Hasan Akash with ID: 201-47-329.** Their Project Paper is an excellent work. To my knowledge, it is original.

Signature of the Candidate-1

Rowshan Rays Chowdhury

201-47-318

Signature of the Candidate-2

Md Jahid Hasan Akash

201-47-329

Signature of the Supervisor

Ahad Ullah

Senior Lecturer,

Department of Civil Engineering

Faculty of Engineering

Daffodil International University

The project and thesis **" Exploring rice husk ash as a replacement for cement in concrete production " Submitted by Rowshan Rays Chowdhury with ID: 201-47-318 and Md Jahid Hasan Akash with ID: 201-47-329,** Session: Spring 2020, has been accepted as satisfactory. This work fulfill, in part, the requirements for the Bachelor of Science in Civil Engineering degree. The presentation of the work was held in January 2025**.**

BOARD OF EXAMINERS

Ahad Ullah — Supervisor
Senior Lecturer
Department of CE, DIU

Dr. Mohammad Hannan Mahamud Khan — Chairman
Associate Professor & Head
Department of CE, DIU

Md. Masud Alom — Member-01
Assistant Professor
Department of CE, DIU

Saurav Barua — Member 02
Assistant Professor
Department of CE, DIU

Md. Tanimul Haque — External Member
Executive Engineer,Roads and Highway
Department,Dhaka

LIST OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHS

LIST OF ABBREVIATIONS

ASTM	American Society of Testing Materials
OPC	Ordinary Portland Cement
PCC	Portland Composite Cement
RHA	Rice Husk Ash
FM	Fineness Modulus
CA	Coarse Aggregate
FA	Fine Aggregate
W/C	Water to Cement Ratio
CS	Compressive Strength
UTM	Universal Testing Machine
PSI	Pounds Per Square Inch

DEDICATION

WE DEDICATED THIS TO OUR FAMILY

ACKNOWLEDGEMENT

First, We are thankful to the almighty Allah for easily completing our thesis.

We further thank our supervisor, **Ahad Ullah, Senior Lecturer, Department of Civil Engineering, Daffodil International University**, for helping us with his valuable expertise and time. He guided us very well in this research from the beginning.

We are also thankful to the faculty members of our department for their valuable comments and helpful input. We will be forever grateful to our family and friends. We have love and gratitude from the bottom of our hearts for them. With whose help our academic journey has been successful.

ABSTRACT

This study explores the use of Rice Husk Ash (RHA) as a partial cement replacement in concrete to enhance sustainability and reduce the environmental impact of cement production. RHA, a by-product of rice milling, is rich in silica and exhibits pozzolanic properties, making it a potential replacement for improving concrete performance. Concrete mixes were prepared with varying RHA proportions (0%, 2%, 4%, 6%, 8%, 10%, 12%, and 14%) to evaluate the effects on compressive strength, workability, and durability. Nevertheless, a large amount of cement is used in the manufacturing of conventional concrete, which greatly increases carbon emissions. Sustainable construction methods must minimize cement use while preserving mechanical performance. The most effective combination was found to be an 8% inclusion of RHA, which increased compressive strength by the control mix while maintaining enough porosity for efficient water permeability. Higher percentage mixtures, especially those containing above 8% such as 10%, 12% and 14% resulted in decreased mechanical performance. This study shows that adding 8% RHA to concrete improves its mechanical qualities and lessens the environmental impact of cement-based construction, providing a sustainable option for contemporary urban infrastructure. This research shows how best to use it and its correct ratio can be used if desired. Which is effective in an environment. After the test, it can be said that the 8% ratio is the most balanced.

CHAPTER ONE
INTRODUCTION

1.1 General

Concrete is a fundamental material in construction, known for its strength and versatility. However, the environmental impact of cement production, which contributes significantly to global CO_2 emissions, has led to a growing interest in sustainable alternatives. One promising solution is the use of industrial by-products, such as Rice Husk Ash (RHA), as a replacement in concrete. RHA, a by-product of rice milling, is rich in silica (SiO_2) and possesses pozzolanic properties, making it suitable for improving the strength, durability, and workability of concrete.

This thesis explores the potential of utilizing RHA as a supplementary material in concrete. It examines the effects on concrete properties such as compressive strength, workability, and durability, while also considering its environmental benefits. By replacing a portion of cement with RHA, the study aims to reduce the carbon footprint of concrete production, offering a sustainable alternative. The research evaluates the optimal usage of RHA in concrete, contributing to the advancement of eco-friendly construction practices.

Figure 1.1 Rice Husk Ash

1.2 Background

Concrete, a widely used construction material, primarily consists of cement, water, fine and coarse aggregates. Cement is the most critical component of concrete, providing its binding property. However, cement production is a major contributor to global carbon dioxide (CO_2) emissions, accounting for approximately 7%-8% of total emissions. This significant environmental impact has prompted researchers (Asep Nandiyanto, 2022) and the construction industry to seek sustainable alternatives.

Rice husk ash (RHA), a by-product of rice milling, is an abundant agricultural waste material. Rice husks make up about 20% of the weight of harvested rice, and when burned, they produce ash that is rich in silica content. Properly processed RHA exhibits pozzolanic properties, making it a potential supplementary cementitious material (SCM) for use in concrete. Incorporating RHA not only addresses the disposal issues of rice husks but also reduces the reliance on cement, providing a dual benefit for sustainability.

Agricultural materials like Rice Husk Ash (RHA) offer effective ways to improve the strength and durability of concrete while preserving permeability. RHA, which is made by burning rice husks, has been demonstrated to increase concrete applications' compressive strength and durability since it is high in silica. By recycling waste materials, their incorporation not only improves mechanical characteristics but also advances sustainability. The beneficial effects of combining RHA on mechanical properties at different mix proportions (2%, 4%, 6%, 8%, 10%, 12% and 14%) will be examined in this study because it is comparatively unknown how this material works in concrete.

1.3 Problem Statement

Cement production has a high environmental cost, with significant energy consumption and CO_2 emissions. Simultaneously, the improper disposal of agricultural residues like rice husks poses a waste management challenge, particularly in rice-producing countries. While RHA has shown promise as a concrete replacement in laboratory studies, its practical implications at varying replacement levels need detailed investigation to determine the optimal use.

1.4 Rational

This research is driven by the dual benefits of using RHA: reducing reliance on cement, thereby lowering CO_2 emissions, and utilizing agricultural waste to create a sustainable construction material. The use of RHA aligns with global efforts to promote sustainable development, circular economy principles, and eco-friendly construction practices.

By evaluating the effects of RHA at varying replacement levels (0% to 14%), this study seeks to identify the optimal proportion that balances performance, cost-effectiveness, and environmental benefits. The findings will provide valuable insights for the construction industry, particularly in rice-producing regions where RHA is readily available, enabling more sustainable building practices and effective waste management solutions.

1.5 Objective

- To evaluate the feasibility of using rice husk ash (RHA) as a replacement for cement in concrete compressive strength.

1.6 Significance of the Study

This research focuses on the experimental evaluation of RHA as a partial cement replacement in concrete. Concrete mixes are prepared and tested with RHA replacing cement in increments of 2%, up to 14%. Key performance metrics include compressive strength, workability measured using the slump test, and durability (assessed through water absorption).

The study aims to determine whether RHA can serve as a sustainable alternative to cement in construction, reducing the carbon footprint and addressing waste management concerns. Additionally, the findings will contribute to the growing body of knowledge on sustainable construction materials, particularly in rice-producing regions where RHA is readily available.

CHAPTER TWO
LITERATURE REVIEW

2.1 Cement Production

The production of cement is a multi-step process that starts with the extraction and processing of essential raw materials, namely clay and limestone. These ingredients are burned to about 1450°C in a kiln to create clinker, which is subsequently ground up and combined with gypsum to create cement. The basic materials (Figure 2.1 *Cement Factory*) are transformed (Figure 2.2) into compounds like tricalcium silicate and dicalcium silicate in the kiln, which are necessary for the strength and longevity of cement. The construction industry relies heavily on the cement industry to supply necessary materials for the building of infrastructure. development.

Figure 2.1 Cement Factory

Figure 2.2 Carbon Emission

2.2 Rice Husk Ash (RHA) in Concrete

RHA is a silica-rich byproduct of milling rice. The natural qualities of this material have been extensively researched for their potential to replace cement in concrete, as they can improve the mix's durability and compressive strength.

2.3 Combined Effects of RHA in Concrete

Incorporating Rice Husk Ash (RHA) in concrete enhances compressive strength, durability, and resistance to chemical attacks while reducing permeability. Despite reduced workability, it improves sustainability by lowering cement usage and repurposing agricultural waste. RHA offers an eco-friendly, cost-effective solution, balancing performance and environmental benefits, especially in rice-producing regions.

2.4 Rice Husk Ash (RHA) and Cement

An elevated pervious concrete pavement material for roads is presented in this research. Pervious concrete can be made stronger by adding silica fume (SF), superplasticizer (SP), and smaller aggregates. With a base layer and a surface layer, the composite material reaches a flexural strength of 6 MPa and a compressive strength of 50 MPa. It is appropriate for both pedestrian walkways and car routes due to its exceptional water permeability, abrasion resistance, and durability against freezing and thawing. When compared to conventional pervious concrete, this eco-friendly pavement performs better. (Yang, 2003)

Fly ash, a by-product of burning coal in thermal power plants can be used with or without binders in the construction of roads, especially embankments. Usually, the embankments are built in a trapezoidal pattern. Because fly ash has a great potential to reduce the use of natural materials and promote sustainability and resource efficiency in infrastructure projects, this study highlights the significance of using fly ash in road construction, despite the fact that large quantities of this material are frequently left unused. (Seslija, 2015)

This paper investigates the effects of open and interconnected porosity on pervious concrete performance. It was discovered that whereas open porosity and the water/cement (w/c) ratio jointly affect compressive strength, interconnected porosity controls water permeability. In pervious concrete, the balance between porosity, permeability, and strength is greatly impacted by changes in the w/c ratio and paste volume. The results highlight the necessity of controlling porosity in no-fines pervious concrete to maximize permeability and strength. (Li, 2020)

When one ton of ordinary Portland cement (OPC) is produced, almost the same amount of CO2 is released into the atmosphere, hence the growing demand for cement has resulted in serious environmental problems and accounts for 8% of emissions worldwide. There have been suggestions for the use of environmentally friendly supplementary materials as a result of worries about air pollution and health hazards. A workable answer is provided by rice husk, a byproduct of rice farming. Rice husk ash (RHA), a highly pozzolanic substance appropriate for OPC, is created when it burns. RHA reduces environmental impact while enhancing strength, durability, and sustainability in concrete. The manufacture, characteristics, and prospects for developing more environmentally friendly, sustainable concrete composites for eco-friendly buildings are covered in this overview of RHA. (Amran, 2021)

Using reused concrete aggregate (RCA) and metallic additions as partial replacements for naturally occurring coarse aggregate (NCA) and Portland cement, this study intends to improve the environmental sustainability and cost-effectiveness of PC, a material that is commonly used to produce permeable pavements. 10%, 25%, 50%, and 100% of RCA were substituted for NCA, and the cement was replaced with pumice (10%, 25%, 50%), and nano-clay (1-3%). The effects of waste plastic fiber (WPF), steel fiber (STF), and macro-fiber (MF) on PC characteristics were also evaluated in this study. The findings demonstrated that whereas RCA enhanced permeability and void content, it lowered density and strength. At ninety days, pumice enhanced long-term mechanical characteristics while decreasing early-age strength. Nano-clay reduced permeability slightly while increasing strength. Using 1% STF resulted in a 78.9% increase in 180-day strength, outperforming MF and WPF in flexural strength improvement. The investigation came to the conclusion that without sacrificing long-term performance, RCA, pumice, nano-clay, and fibers used in certain dosages can greatly reduce NCA and cement use (Mehrabi, 2021).

Because of its porous structure and high content of amorphous silica, rice husk ash (RHA), which is produced when rice husk is burned, is a useful supplemental cementitious material (SCM) with strong pozzolanic activity and internal curing qualities. The physicochemical properties of RHA are reviewed in this work along with how it affects cement-based materials in terms of hydration, strength, resistance to sulfate and chloride penetration, carbonation, and shrinkage. By means of macro-particle diffusion processes and micro-particle dissolution, RHA improves cement hydration. Generally speaking, a RHA percentage of 10–14% is ideal for enhancing cement performance. Comprehending the mechanisms of action of RHA can facilitate its sustainable application in cementitious materials (Wang, 2021).

An environmentally beneficial pavement material that lowers surface runoff from cities is called pervious concrete. However, because of its low flexural strength and excessive porosity, which can lead to cracking, its use is restricted to low-traffic locations. The permeability, strength, and flexural performance of pervious concrete with different geogrid layers, geogrid placements, and coarse aggregate sizes are assessed in this study. According to test results, geogrids' ideal placement improves their compressive strength and permeability. According to flexural testing, geogrids increase the concrete's toughness, flexural strength, and deformability; the greatest outcomes are obtained when the geogrids are positioned between one-third and two-thirds of the beam's length. While larger aggregates (10–15 mm) enhanced post-cracking performance, smaller aggregates (5–10 mm) boosted flexural strength (Meng, 2021).

Due to urbanization and industrialization, there is an increasing need for cementitious composites, which puts pressure on natural resources and increases the difficulty of managing agricultural waste. This study investigates the use of biomass ashes as partial cement substitutes, namely rice husk ash (RHA), bamboo leaf ash (BLA), sugarcane bagasse ash (SCBA), wood waste ash (WWA), and palm oil fuel ash (POFA). According to the analysis, workability may be maintained by substituting RHA, BLA, WWA, and POFA for 5–10% of cement and SCBA for 5–20%. To preserve mechanical properties, replacement rates should be 5–15% for RHA, 5–10% for BLA, 5–30% for SCBA, 5–10% for WWA, and 5-20% for POFA. These results encourage sustainable practices in agriculture and building by making efficient use of trash. (Danish, 2023)

The purpose of this study is to examine how different coconut fiber and coconut shell compositions affect the mechanical characteristics of porous concrete that is intended to avoid flooding. distinct ratios of coconut shell to fiber were used to make five distinct concrete mixtures: 10.00/0.00, 7.50/0.50, 5.00/1.00, 2.50/1.50, and 0.00/2.00. The porous concrete samples underwent tests of compression and water absorption. The added materials had a substantial impact on compressive strength as well as water absorption capacity, according to the results. The ideal mixture had a water absorption rate of 0.196% and a compressive strength of 156.1 N/s. It contained 2 g of coconut fiber and no coconut shells. This research demonstrates the potential of integrating coconut fiber and shells in porous concrete as a sustainable approach to flood prevention and waste reduction. (Nandiyanto,2023)

This study looks at how the content of rice husk affects the characteristics of porous concrete. Samples with 1.5%, 3%, 4.5%, 6%, and 7.5% rice husk content were created by drying, sieving, and mixing rice husks with cement, water, and gravel. Tests for water permeability and compressive strength were conducted. Because of their high silica content, higher rice husk percentages led to improved compressive strength. 1.5% rice husk had the highest density (2.167 g/cm³), while 7.5% had the lowest density (1.978 g/cm³). Water passage was 100% for the 1.5% and 3% samples and 0% for the 4.5%, 6%, and 7.5% samples. The 1.5% variant had the lowest water absorption (0.307%) and the 7.5% variant had the greatest (1.657%). This study demonstrates how rice husk can be used as a sustainable aggregate to improve the performance of porous concrete (Nandiyanto, 2022).

Summary: The combined impacts of rice husk ash (RHA) on the characteristics of concrete are investigated in this work. While RHA, a pozzolanic substance, improves the microstructure of concrete to increase strength and longevity. The compressive strength, of several concrete compositions with varying concentrations of RHA was evaluated. The best blend of RHA, according to the results, greatly enhances the mechanical qualities of concrete, making it a more sustainable building material. This study emphasizes how using agricultural by-products can improve concrete performance and encourage environmentally friendly construction methods.

CHAPTER THREE
METHODOLOGY

3.1 General

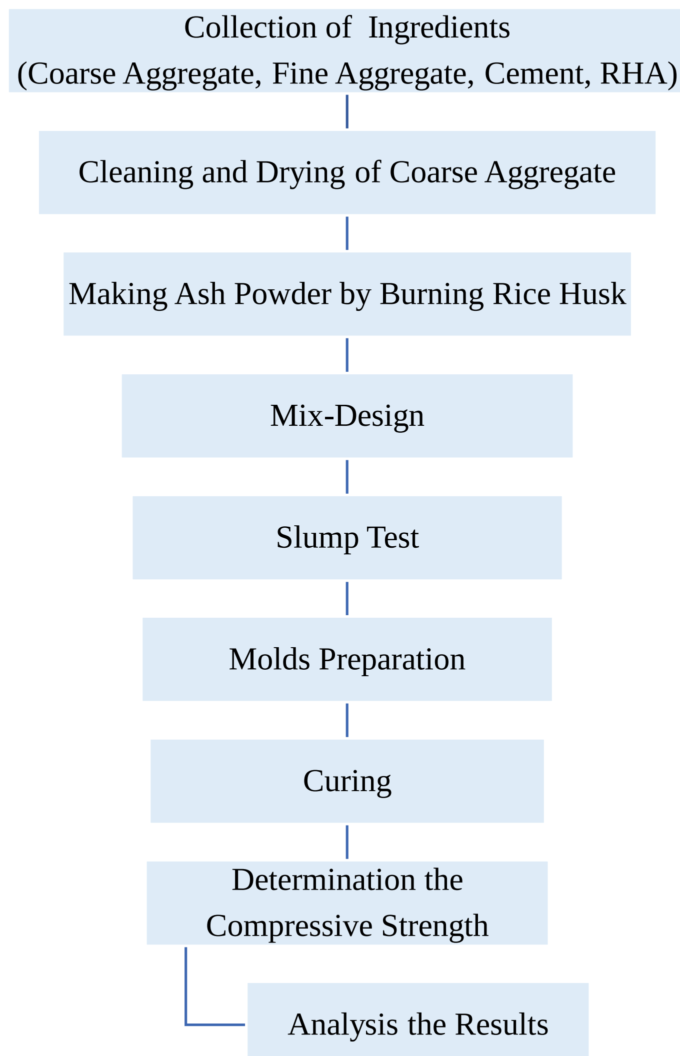
This chapter outlines the precise steps to form a cylinder using cement, sand, stone, and rice husk. A synopsis of the methodology is as follows:

1. Use the current technologies for testing.

2. Displaying the material estimate.

3. Create 48 molds in total.

4. Assess the methodology's resilience.



3.2 Current State of Methodology

The current methodology involves replacing cement with Rice Husk Ash (RHA) at varying percentages (0%-14%) in concrete mixes. Standardized tests measure compressive strength, workability, and durability. Key methods include the slump test for workability, compression testing for strength at 7 and 28 days, and durability assessments like water absorption and sulfate resistance analysis. This chapter explains how the entire process is done.

3.3 Environmental Analysis of the Properties

The environmental analysis in this study focuses on assessing the sustainability benefits of incorporating Rice Husk Ash (RHA) into concrete. By replacing a portion of cement with RHA, the study evaluates the reduction in CO_2 emissions associated with cement production. RHA, as a by-product of rice milling, reduces agricultural waste disposal problems, promoting waste-to-resource utilization. Additionally, the study examines the environmental impact of concrete's durability. Concrete with RHA is expected to demonstrate improved resistance to chemical attacks and reduced permeability, leading to longer-lasting structures and reduced maintenance needs. This enhances the overall lifecycle performance of concrete, contributing to sustainable construction practices. The analysis includes an evaluation of the potential for large-scale adoption of RHA, considering both environmental and economic factors.

3.4 Collection of Ingredients

For the test, we'll need a few materials, for example, RHA, Cement, Coarse aggregate (¾ Down Grade Stone) and Fine aggregate (Select Sand), which we could pick up locally.

3.4.1 Rice Husk Ash (RHA)

It is usually found in Rice Mill. So, we took 10 kg of it. The price of which is Tk 11 per kg.

Figure 3.1 Collecting of Rice Husk

Figure 3.2 Using Sunlight to Dry Rice Husk

3.4.2 Cement Bag

Portland composite Cement (PCC) (Figure 3.3) Cement is required for our experiment. Which can be found at any local store. The quality of cement should be kept in mind.

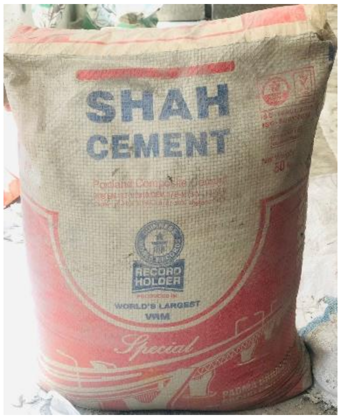


Figure 3.3 Portland Composite Cement

3.4.3 Collection of Coarse Aggregate

A good quality stone (Coarse aggregate) is required for this test. A 3/4 downgrade stone (Figure 3.4) is chosen for this. This stone can be found anywhere. We collected it from a place in Gabtali, Dhaka. Which was within our means.

Figure 3.4 A grade ¾ Down Stone

3.4.4 Absorption of Water

You need to be aware of water usage. Pure water is needed to make the mold and wet it. Care should be taken to ensure that no chemical substances are present in the water.

3.4.5 Properties of Sand

Selected sand (Figure 3.5) was used for this test. Also used dry volume of sand. Where its FM is 3.02.

Figure 3.5 Select Sand

3.5 Drying and Burning Process of Rice Husk

We put these Rice Husks in the field for 24 hours to dry. After that, We burn them and make them into a fine powder. To guarantee consistency in the finished product, the blending procedure was carried out repeatedly until a uniform particle size was reached.

Figure 3.6 The Drying Process of Rich Husk

Figure 3.7 Burning Process of Rich Husk

3.6 Instruments

We need some instruments like

1. Tamping Rod, Trowel, Shovel, Brush

2. Water Jar, Steel Bowl

3. Oven

4. Weight Machine, Measuring Tape

5. Slump, Sieves

3.7 Procedure

1. RHA comprised 2%, 4%, 6%, 8%, 10%, 12% and 14% of the cement in the ratio of **1:1.5:3** cement, sand, and stone mixture used in this experiment.

2. 2.2-liter water is used for each 6 molds.

3. We first allowed the rice husks to dry in the sun to ensure that no moisture was present. After drying, we burned them at approximately 400 degrees Celsius until we obtained ash. After that, we selected the powders using a sieve.

4. The concrete slump test is essential for evaluating the quality and workability of the mixture. Initially, we conducted this test on mixed materials. Upon passing the test, we then combine the materials and prepare to pour them into the mold. It's important to secure the mold in position before adding the mixture. The pouring process will occur in three stages, with side vibration applied during the first and final stages. We will follow this systematic approach to ensure that there are no voids or honeycombing within the concrete, as these defects could compromise its load-bearing capacity. Each cylinder will be formed using the same method.

Figure 3.8 Burn Rich Husk

Figure 3.9 Rice Husk Ash

Figure 3.10 Coarse Aggregate

Figure 3.11 Sieve Analysis

Figure 3.12 Fine Aggregate

Figure 3.13 Portland Composite Cement

Figure 3.14 Preparation for Concrete Mixing

Figure 3.15 Mix Concrete

Figure 3.16 Slump Test

Figure 3.17 Compaction using Tamping Rod

Figure 3.18 Settlement Time

Figure 3.19 Curing Molds

3.8 Test of Molds

To test the strength of the cylinders, compressive tests are necessary. These tests evaluate the mechanical characteristics, applicability, and performance of materials for various structural and engineering applications. They provide insights into the composition, design, and quality of a building or structure. For this purpose, a Universal Testing Machine (UTM) is required. The test is conducted by applying compression weights to the cylinders.

3.9 Compressive Strength Test of Concrete

1. After curing, remove all specimens from the water and dry them. If it is wet then the test result can’t be found accurately.

2. Specimen Placement: Align the mold horizontally in the testing machine, ensuring the flat sides are level and the mortar face is facing upward. Make sure it is clean and center the specimen on the base plate and opposing sides will bear the load.

3. Loading Procedure: Apply a constant load at a rate of 14 KN/mm^2 until failure, recording both the peak and final loads.

4. Data should be recorded in a table.

Figure 3.20 Compressive Strength Test of Mold

Figure 3.21 Axial splitting

Figure 3.22 Compressive Strength at UTM

Comment of Failure: Axial splitting cracks form parallel to the load axis under compression, often from overloading or imperfections. structures are need proper design, reinforcement, and inspection to prevent failure.

CHAPTER FOUR
RESULT AND DISCUSSION

4.1 General

This chapter outlines the different findings, results from the experiments, and additional tests conducted during the investigation. We created a total of 54 cylinders using 9 different ratios, with 6 molds for each ratio. During the 7- and 28-day tests, 3 molds were broken. After the curing period, the molds were removed and allowed to dry for a full day before testing to ensure optimal results. All cylinders were of uniform size and we will compute the average values from the tests performed.

4.2 Data Table

This part shows all the necessary data tables for this test.

4.2.1 Sieve Analysis Data of Coarse and Fine Aggregate

We have sieve analysis for Coarse Aggregate and Fine Aggregate.

Sieve analysis for Coarse Aggregate (CA)

Table 1 Coarse Aggregate

Sieve Size	Weight Retained(g)	% Retained	Wt. Retained% of Cumulative	% Finer
25	0	0	0	100
19	2495	50.60	50.60	49.4
9.5	286	5.80	56.40	43.6
4.75	1205	24.43	80.83	19.17
2.36	172	3.48	84.31	15.69
1.18	310	6.23	90.54	9.46
0.6	290	5.88	96.42	3.6
0.3	120	2.5	98.92	1.08
0.15	53	1.08	100	0
Total	4931	100	658.02	

According to the data table of Coarse Aggregate, we get FM = 6.58 and it’s standard.

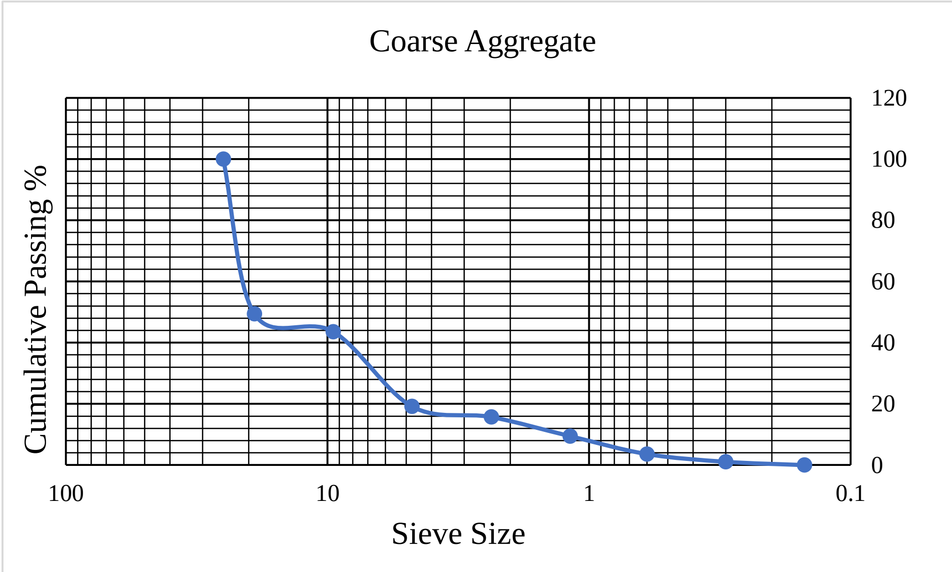


Figure: 1 Coarse Aggregate

Table 2 Fine Aggregate

Sieve Size	**Weight Retained(g)**	**% Retained**	**Wt. Retained% of Cumulative**	**% Finer**
4	49.3	2.63	2.63	100
8	92	4.91	7.54	97.37
16	342	18.25	25.79	92.46
30	823	43.93	69.72	74.21
50	504	27	96.72	30.28
100	63	3.36	100	3.28
Total	1873.3	100	302	

According to the data table of Fine Aggregate, we get FM = 3.02 and it’s standard.

Figure: 2 Fine Aggregate

4.2.2 Compressive Strength Test

We have done 0%, 2%, 4%, 6%, 8%, 10%, 12% and 14% of replacing mix ratio with concrete. Here all data is given.

Table 3 Compressive Strength without Rice Husk Ash

Day	Ratio	Area(in^2)	Crushing Load (lb.)	Compressing Strength (psi)	Average Compressing Strength (psi)
7	0%	12	39566.56	3297.21	3365.90
			40465.8	3372.15	
			41140.23	3428.35	
28	0%		43163.52	3596.96	3640.67
			43613.14	3634.42	
			44287.57	3690.63	

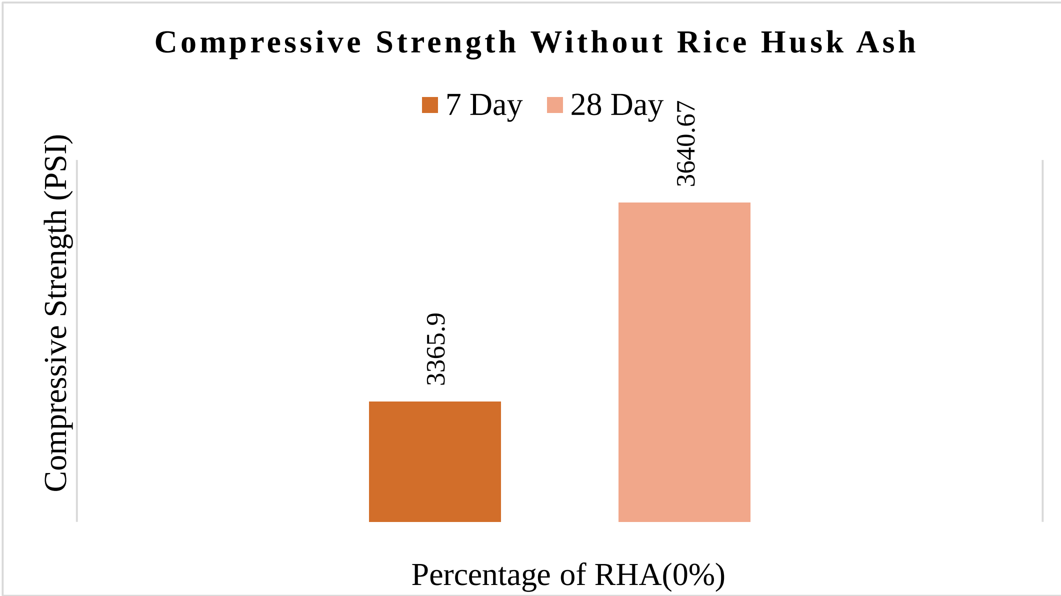


Figure: 3 Compressive Strength Without Rice Husk Ash

Comment: This bar graph depicts the percentage of 0 (%) compressive strength test results. There are two various results on separate dates. When the 7-day test happened, the strength was found to be 3365.90 psi another hand we got 3640.67 psi in 28 days. which is appreciable.

Table 4 Compressive Strength with 2% Rice Husk Ash

Day	Ratio	Area(in^2)	Crushing Load (lb.)	Compressing Strength (psi)	Average Compressing Strength (psi)
7	2%	12	37222.27	2909.78	2960.73
			37992.89	3066.07	
			38892.13	3141.01	
28	2%		41814.66	3084.55	3053.41
			38442.51	3003.54	
			40465.8	3072.15	

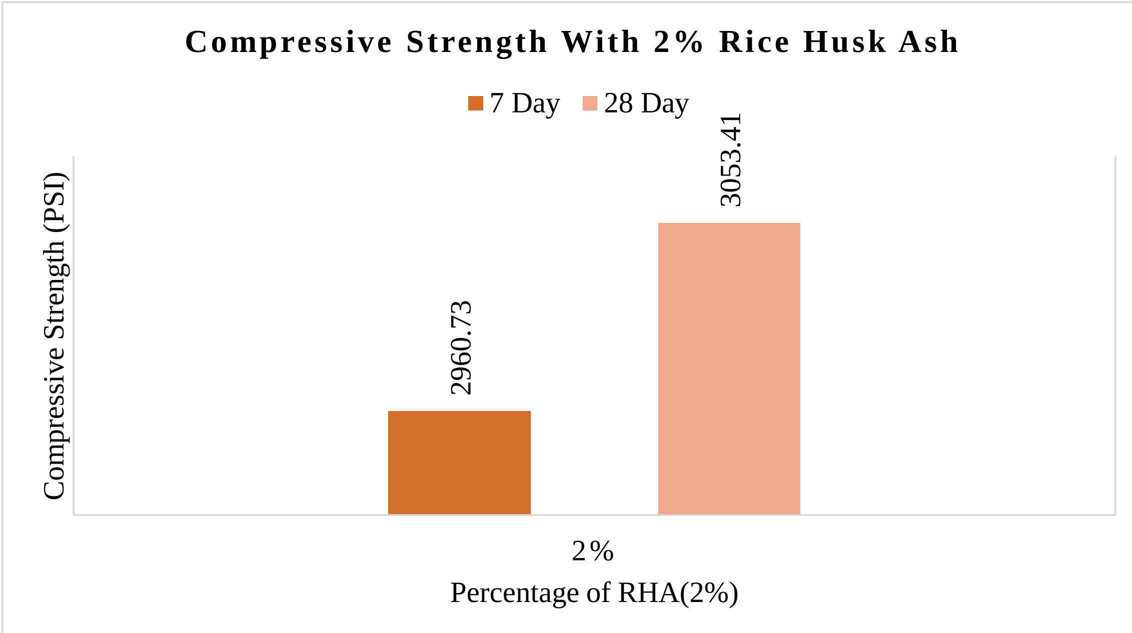


Figure: 4 Compressive Strength with 2% Rice Husk Ash

Comment: This bar graph depicts the percentage of 2 (%) compressive strength test results. There are two various results on separate dates. When the 7-day test happened, the strength was found to be 2960.73 psi another hand we got 3053.41 psi in 28 days. which is appreciable.

Table 5 Compressive Strength with 4% Rice Husk Ash

Day	Ratio	Area(in^2)	Crushing Load (lb.)	Compressing Strength (psi)	Average Compressing Strength (psi)
7	4%	12	35744.79	2978.73	3053.66
			35969.6	2997.46	
			38217.7	3184.80	
28	4%		34845.55	2903.79	3184.80
			44287.57	3690.63	
			35519.98	2959.99	

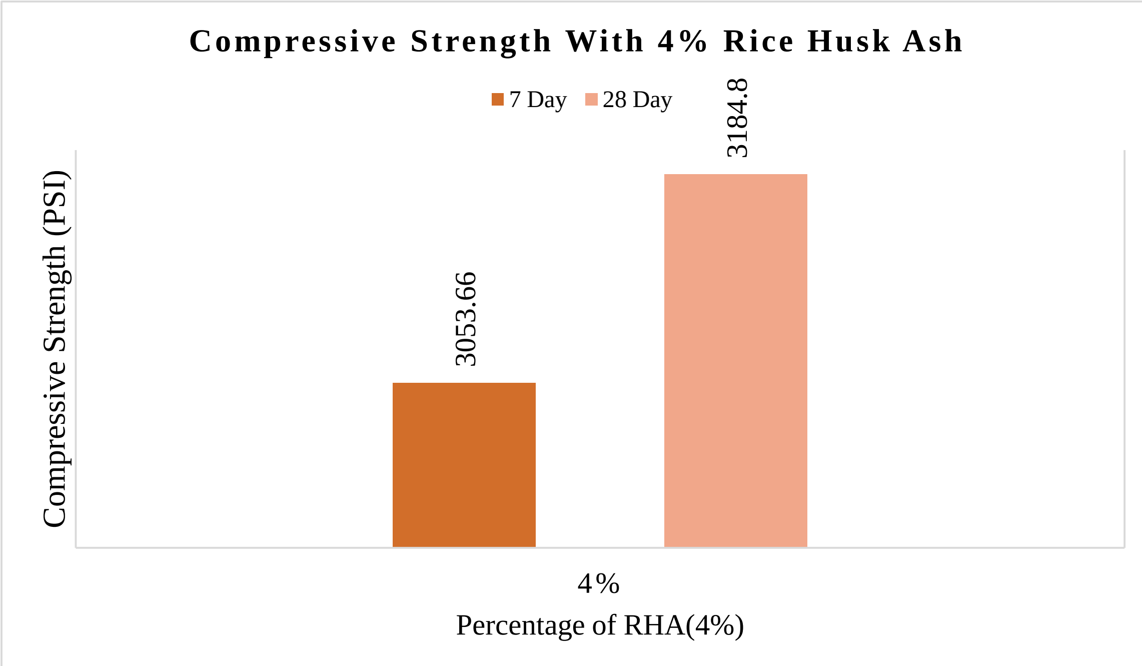


Figure: 5 Compressive Strength with 4% Rice Husk Ash

Comment: This bar graph depicts the percentage of 4 (%) compressive strength test results. There are two various results on separate dates. When the 7-day test happened, the strength was found to be 3053.66 psi another hand we got 3184.84 psi in 28 days. which is appreciable.

Table 6 Compressive Strength with 6% Rice Husk Ash

Day	Ratio	Area(in^2)	Crushing Load (lb.)	Compressing Strength (psi)	Average Compressing Strength (psi)
7	6%	12	39791.37	3315.94	3178.56
			36419.22	3034.93	
			38217.7	3184.80	
28	6%		42713.9	3559.49	3284.72
			40465.8	3372.15	
			35070.36	2922.53	

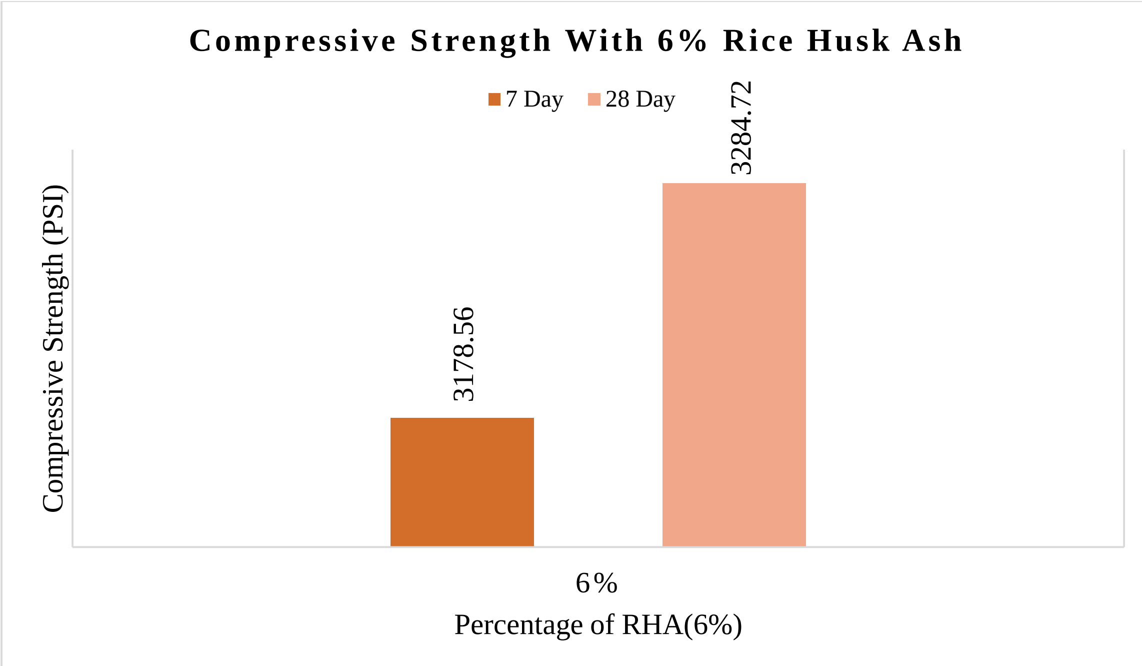


Figure: 6 Compressive Strength with 6% Rice Husk Ash

Comment: This bar graph depicts the percentage of 6 (%) compressive strength test results. There are two various results on separate dates. When the 7-day test happened, the strength was found to be 3178.56 psi another hand we got 3284.72 psi in 28 days, which is appreciable.

Table 7 Compressive Strength with 8% Rice Husk Ash

Day	Ratio	Area(in^2)	Crushing Load (lb.)	Compressing Strength (psi)	Average Compressing Strength (psi)
7	8%	12	44737.19	3561.87	3233.73
			40465.80	3221.79	
			36644.03	2917.51	
28	8%		40240.99	3203.90	3454.84
			43837.95	3490.28	
			46086.05	3669.27	

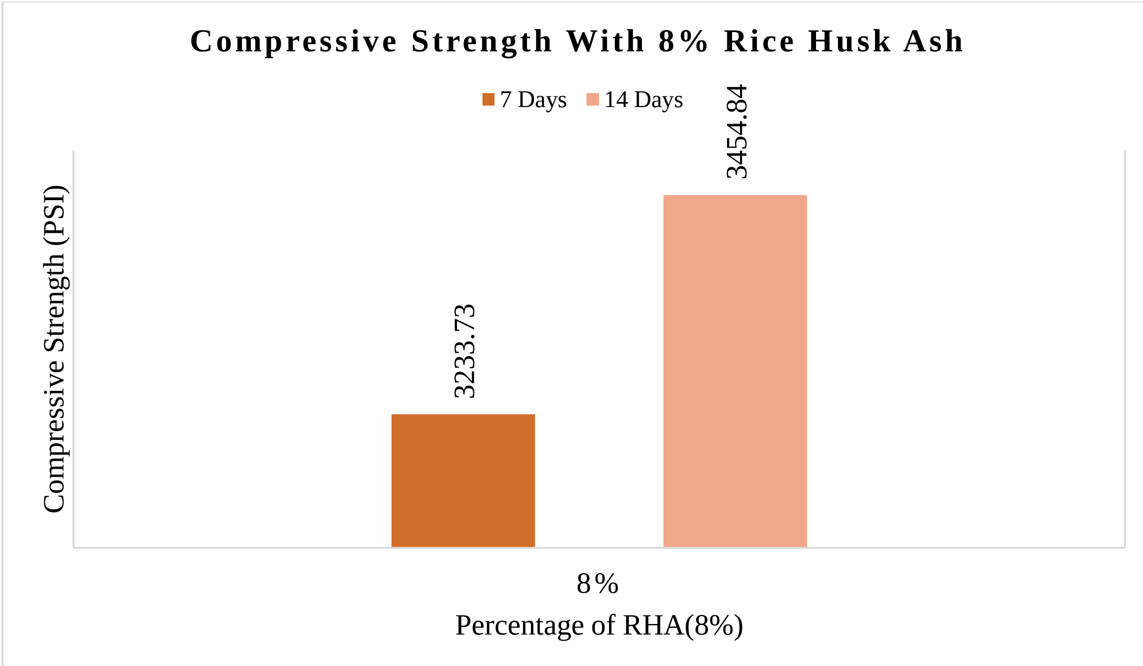


Figure: 7 Compressive Strength with 8% Rice Husk Ash

Comment: This bar graph depicts the percentage of 8 (%) compressive strength test results. There are two various results on separate dates. When the 7-day test happened, the strength was found to be 3233.73 psi another hand we got 3454.48 psi in 28 days. which is appreciable.

Table 8 Compressive Strength with 10 % Rice Husk Ash

Day	Ratio	Area(in^2)	Crushing Load (lb.)	Compressing Strength (psi)	Average Compressing Strength (psi)
7	10%	12	34845.55	2974.32	3092.89
			35969.6	3063.82	
			38442.51	3160.70	
28	10%		35969.6	3154.730	3239.36
			37768.08	3297.46	
			41140.23	3365.09	

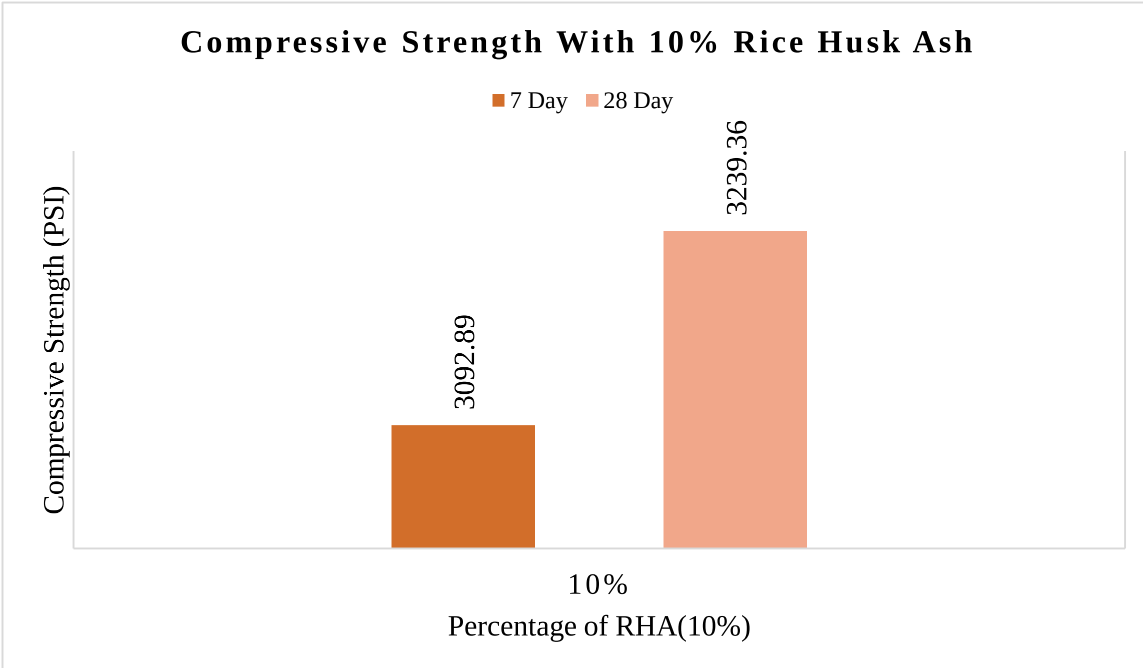


Figure: 8 Compressive Strength with 10% Rice Husk Ash

Comment: This bar graph depicts the percentage of 10 (%) compressive strength test results. There are two various results on separate dates. When the 7-day test happened, the strength was found to be 3092.89 psi another hand we got 3239.36 psi in 28 days. which is appreciable.

Table 9 Compressive Strength with 12% Rice Husk Ash

Day	Ratio	Area(in^2)	Crushing Load (lb.)	Compressing Strength (psi)	Average Compressing Strength (psi)
7	12%	12	34845.55	2765.519841	2967.72
			42264.28	3354.307937	
			35070.36	2783.361905	
28	12%		38892.13	3086.676984	3169.93
			40465.8	3211.571429	
			40465.8	3211.571429	

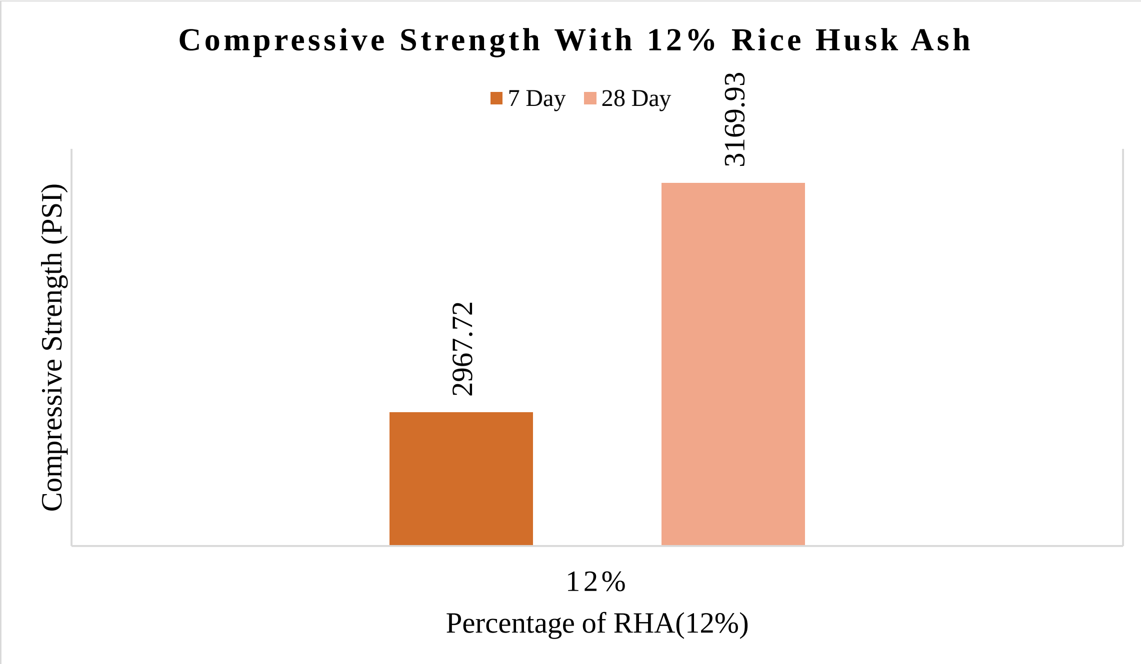


Figure: 9 Compressive Strength with 12% Rice Husk Ash

Comment: This bar graph depicts the percentage of 12 (%) compressive strength test results. There are two various results on separate dates. When the 7-day test happened, the strength was found to be 2967.72 psi another hand we got 3169.93 psi in 28 days. which is appreciable.

Table 10 Compressive Strength with 14% Rice Husk Ash

Day	Ratio	Area(in^2)	Crushing Load (lb.)	Compressing Strength (psi)	Average Compressing Strength (psi)
7	14%	12	32597.45	2587.09	2819.04
			35744.79	2836.88	
			38217.7	3033.15	
28	14%		35070.36	2783.36	2937.99
			37318.46	2961.78	
			38667.32	3068.83	

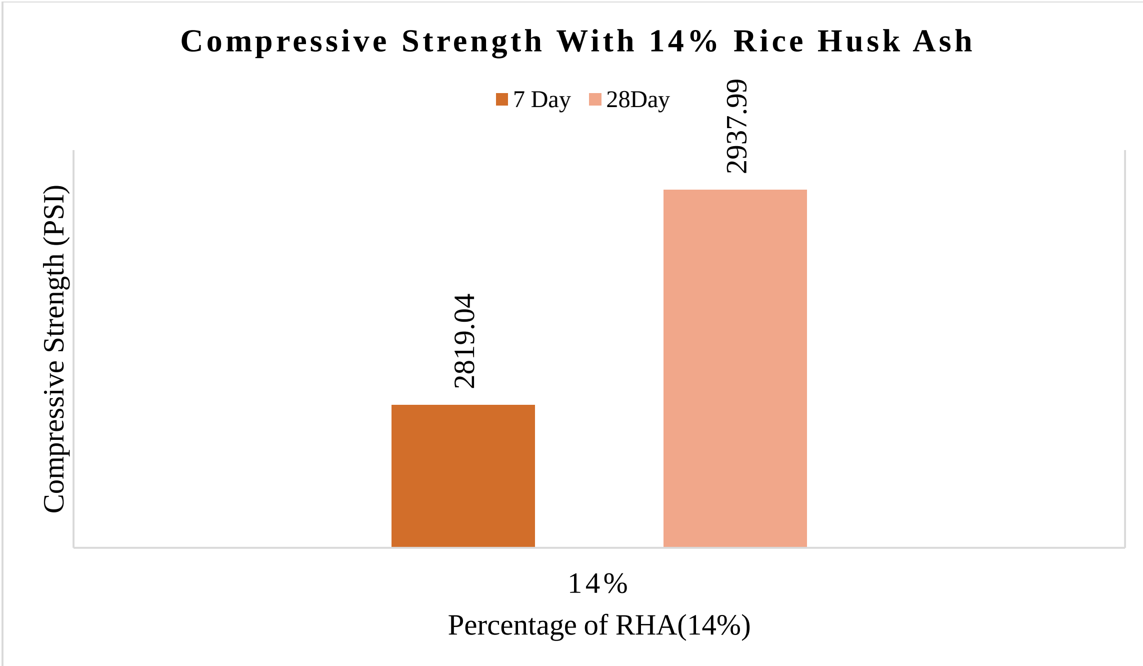


Figure: 10 Compressive Strength with 14% Rice Husk Ash

Comment: This bar graph depicts the percentage of 14 (%) compressive strength test results. There are two various results on separate dates. When the 7-day test happened, the strength was found to be 2819.04 psi another hand we got 2937.99 psi in 28 days, which is appreciable.

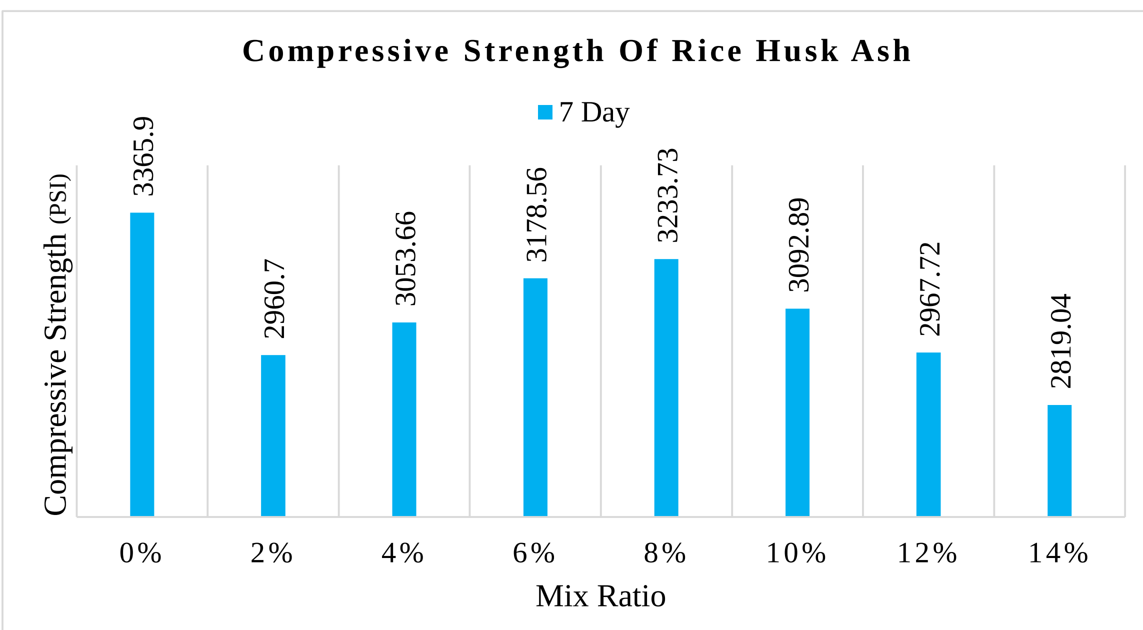


Figure: 21 Compressive Strength of Rice Husk Ash 07 days

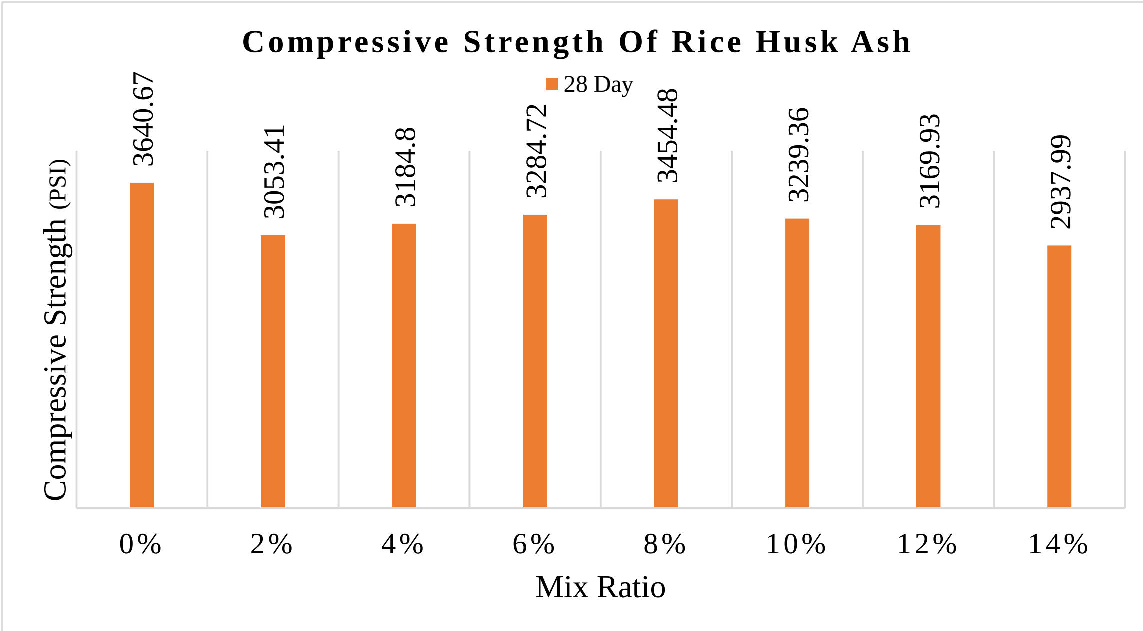


Figure: 12 Compressive Strength of Rice Husk Ash 28 days

Comment: This bar graph depicts the replacement percentage of 2%, 4%, 6%, 8%, 10%, 12% and 14% RHA compressive strength test results. There are various results on the 28-day test. When the 28-day test happened, the maximum strength was found to be 3454.48 psi on the other hand we got 3640.67 psi for 0% replacement concrete, which is appreciable.

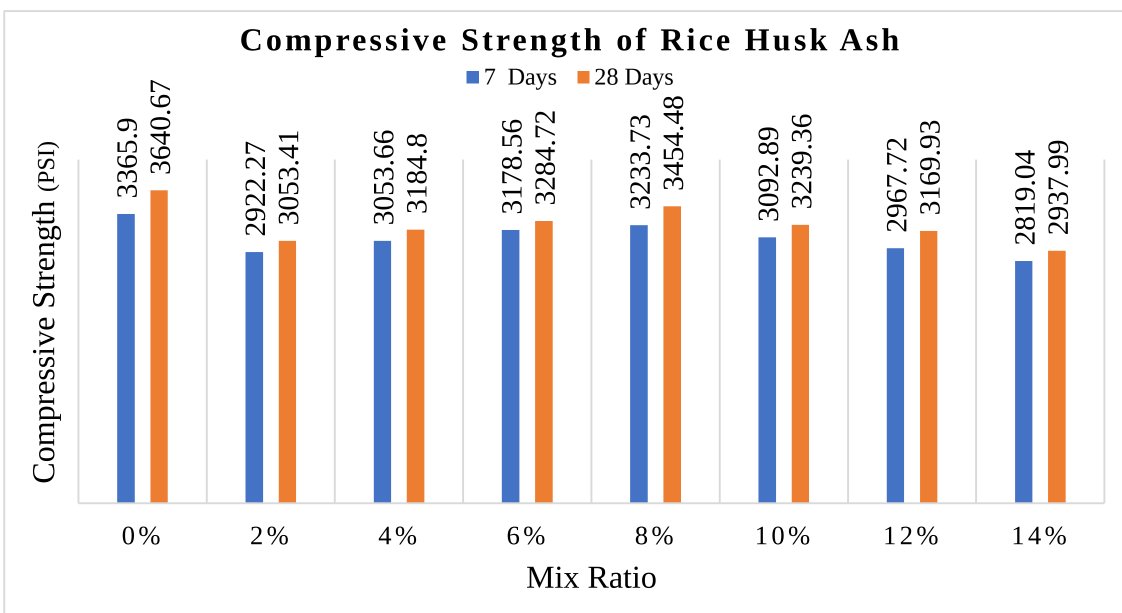


Figure: 13 Compressive Strength of Rice Husk Ash

Figure: 14 Comparison Between Normal and Best Mixture Concrete

Comment: This bar graph depicts the replacement percentage of 0% and 8%, of RHA compressive strength test results. There are various results on the 28-day test. When the 28-day test happened, the maximum strength was found to be 3454.48 psi on the other hand we got 3640.67 psi for 0% replacecement concrete, which is appreciable.

Summary: Using 8% Rice Husk Ash in concrete enhances compressive strength, maintains water permeability, reduces cement usage and offers sustainable urban infrastructure.

CHAPTER 05
CONCLUSION & RECOMMENDATION

5.1 Conclusion

The experimental results revealed that concrete mixes with 8% RHA exhibited improved compressive strength and maintained sufficient porosity for water permeability, making it a viable option for sustainable construction practices. Higher proportions of RHA, while still beneficial, resulted in a slight decrease in mechanical performance, highlighting the importance of identifying the optimal mix ratio.

1. The study found that incorporating 8% Rice Husk Ash (RHA) into concrete provides the best balance with compressive strength

2. It highlights the use of RHA as a sustainable alternative to traditional cement, contributing to reduced carbon emissions.

5.2 Recommendation

1. For further research, it is recommended to conduct long-term studies to evaluate the durability and performance of concrete with RHA under various environmental conditions, including different weather patterns and load applications.

2. Future investigations should explore a wider range of mix ratios, potentially incorporating additional agricultural by-products, to identify alternative optimal combinations that enhance performance while maintaining sustainability.

3. Pilot projects should be initiated to assess the real-world applicability of the optimized mix in urban infrastructure, focusing on practical aspects such as installation techniques, maintenance needs.

4. Establishing industry standards and guidelines for the use of agricultural waste materials in concrete production would facilitate wider adoption and ensure consistent quality and performance in construction practices.

5. Engaging stakeholders in the construction industry through workshops and training sessions on the benefits and methods of using RHA can promote sustainable practice and encourage innovative approaches to material use.

References

Amran, M. (2021). Rice Husk Ash-Based Concrete Composites: A Critical Review of Their Properties and Applications. *Crystal*. *Volume11,16811*(2); https://doi.org/10.3390/cryst11020168

Asep Nandiyanto, S. A. (2022). The EFFECT OF THE ADDITION OF COCONUT FIBERS AND COCONUT SHELLS ON THE MECHANICAL CHARACTERISTICS OF POROUS CONCRETE. *Journal of Engineering Science and Technology*. Volume35, Pages26-35, https://doi.org/ 10.1016/j.istruc.2021.10.092

Danish, A. (2023). Valorization of biomass ashes in the production of cementitious composites: A comprehensive review of properties and performance. *sciencedirect*. Volume.405,133244https://doi.o/10.1016 /j.conbuildmat.2023.133244

Li, L. G. (2020). Pervious concrete: effects of porosity on permeability and strength. *ICE Virtual Library*. Volume 73, pp. 69-79 https://doi.org/10.1680/jmacr.19.0019

Mehrabi, P. (2021). Effect of pumice powder and nano-clay on the strength and permeability of fiber-reinforced pervious concrete incorporating recycled concrete aggregate. *sciencedirect.com*.

Meng, X. (2021). Flexural Performance and Toughness Characteristics of Geogrid-Reinforced Pervious Concrete with Different Aggregate Sizes. *MDPI*.

Nandiyanto. (2022). THE EFFECT OF RICE HUSK COMPOSITION ON POROUS CONCRETE PERFORMANCE. *Journal of Engineering Science and Technology*.

Nandiyanto, A. B. (2023). THE EFFECT OF THE ADDITION OF COCONUT FIBERS AND COCONUT SHELLS ON THE MECHANICAL CHARACTERISTICS OF POROUS CONCRETE. *Journal of Engineering Science and Technology*.

Seslija, M. (2015). Construction of Road Embankment with Waste Materials. *scientific.net*.

Wang, J. (2021). Action mechanism of rice husk ash and the effect on main performances of cement-based materials: A review. *sciencedirect*.

Yang, J. (2003). Experimental study on properties of pervious concrete pavement materials. *sciencedirect*.

APPENDIX

1. Calculation the FM of Fine Aggregate (FA) and Coarse Aggregate (CA)

For Fine Aggregate, FM = $\frac{\text{Total weight of retained\% cumulative}}{100} = \frac{582.02}{100}$ = 6.58

For Coarse Aggregate, FM = $\frac{\text{Total weight of retained\% cumulative}}{100} = \frac{302}{100}$ = 3.02

2. Cylinder Volume(V)

Cylinder height = 8 inch, Dia = 4 inch

Volume, V=$\frac{\pi}{4}D^2$h = $\frac{\pi}{4}4^2 8$

=100.55 in^3 =0.058 cft

For 6 molds, we need volume, V= 6×0.058 cft = 0.348 cft

Shrinkage factor $= 1.05 \times 1.5$ cft = 0.348*1.5

= 0.522 cft

3. Find the mix ratio

We got,

Cement: Sand: Aggregate

= 1:1.5:3

Volume, V = 0.522 cft

4. Calculation per ratio

Mix ratio = Cement: FA: CA

=1:1.5:3

Volume = 0.522cft

For Cement

= $0.522 \times \frac{1}{5.5} = 0.094$ cft = $3.83 \approx 3.4$ kg

For FA, we got

= $0.522 \times \frac{1.5}{1+1.5+3} = 0.522 \times \frac{1.5}{5.5} = 0.142$cft

= $0.142 \times 45.3 = 6.44 \approx 6.5$ kg

For CA

$= 0.522\times \frac{3}{1+1.5+3} = 0.522 \times \frac{3}{5.5} = 0.284$

$= 0.284 \times 43 = 12.2$ kg ≈ 12 kg

5. Total volume for cylinder

Ratios we have replaced are - 0%, 2%, 4%, 6%, 8%, 10%, 12%, 14%

Total RHA for 2% = $\frac{2}{100} \times 3.4\times 1000 = 68$g

and Cement for 2% = (3.4-0.068) = 3.33 kg

Total RHA for 4% = $\frac{4}{100} \times 3.4\times 1000 = 136$g

and Cement for 4% = (3.4-0.136) = 3.26 kg

Total RHA $=\frac{6}{100} \times 3.4\times 1000 = 204$g

and Cement for 6% = (3.4-0.204) = 3.2 kg

Total RHA $=\frac{8}{100} \times 3.4\times 1000 = 272$g

and Cement for 8% = (3.4-0.272) = 3.1 kg

Total RHA for 10% $=\frac{10}{100} \times 3.4\times 1000 = 340$g

and Cement for 10% = (3.4-0.34) = 3.06 kg

Total RHA for 12% $=\frac{12}{100} \times 3.4\times 1000 = 408$g

and Cement for 12% = (3.4-0.408) = 3 kg

Total RHA for 14% $=\frac{14}{100} \times 3.4\times 1000 = 476$g

and Cement for 14% = (3.4-0.476) = 2.9kg

6. Calculation of Compressive strength

For compressive strength,

We use a sample which area is,

$A=\frac{\pi}{4} d^2 = \frac{\pi}{4} 4^2 = 12 \text{ in}^2$

Crushing Load P = 36222.27lb.

Compressing Strength,

$F = \frac{P}{A} = \frac{37222.27}{12}$ psi = 3209.78 psi

We calculate all samples by following this.