Comparison of Compressive Strength by Partial Replacement of Sand Using Wood Powder and Rice Husk

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

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Section: 27A
Semester: Fall-2025

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DECLARATION

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

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TO

"OUR PARENTS & TEACHERS"

ACKNOWLEDGEMENTS

All glory and sincere appreciation are due to the all-powerful Allah, the most merciful and beneficent, for providing the opportunity and capacity to carry out this endeavor in a safe and acheful manner. His showers of blessings throughout our research work to complete the research successfully. We would like to express our deep and sincere gratitude to our research supervisor Rafi bin Shahadat, Department of Civil Engineering, Sonargaon University, for providing us with invaluable guidance throughout this research. As a guide, she supplied maximum aid concluding the project job. With her prior years of expertise and guidance, she directed us to come out with success through the most tough issues experienced by us. Her keen interest in the issue and good guidance were the sources of the author's inspiration. We want to express our sincere appreciation to our guides for their co-operation and constant civility toward us during the entire process. We also wish to acknowledge (Md. Robiullah's) instrumental help in locating pertinent materials, who patiently taught us his method for synthesizing a number of other laboratory techniques, and who worked closely with us to present this thesis. We sincerely would like to thank all instructor and staff of the Civil Engineering Department of Sonargaon University (SU), Dhaka, which contributed in various ways to the completion of this thesis. Finally, we want to express our sincere thanks to my family and friends for their everlasting encouragement, love, and support. Without their constant support, this project would not have been able to move further.

ABSTRACT

The rapid depletion of natural river sand and the increasing generation of agricultural and industrial waste have encouraged researchers to explore sustainable alternative materials in concrete production. This study investigates the effect of partial replacement of fine aggregate (sand) with wood powder and rice husk on the compressive strength of concrete. Concrete was prepared with partial replacement of sand at 0%, 5%, 10%, and 15% by wood powder and rice husk. A total of concrete specimens of size 100 mm diameter and 200 mm height cylinder were cast and tested for compressive strength at 7 and 28 days of curing in accordance with ASTM standards. Partial replacement of sand with wooden husk, the compressive strength improved at 5% replacement compared to the control mix. Partial replacement of sand with rice husk showed 10% rice husk replacement produced the highest compressive strength. This research presents an experimental study on the comparison of compressive strength of concrete by partial replacement of fine aggregate (sand) using wood powder and rice husk. The increasing demand for natural sand and the environmental issues associated with agricultural and industrial waste disposal have encouraged the use of alternative materials in concrete production. The 10% rice husk replacement exhibited the highest compressive strength among all mixes, achieving 3212.52 at 7 days and 3642.00 at 28 days. Concrete containing 5% wood powder showed improved compressive strength compared to the control mix, with values of 2773.44 at 7 days and 3375.42 at 28 days. A comparison between wood powder and rice husk indicates that rice husk performs better than wood powder as a partial replacement of sand. The maximum compressive strength was obtained with 10% rice husk replacement, particularly at 28 days of curing.

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CHAPTER 1
INTRODUCTION

1.1 Background and Motivations

Concrete is the most widely used construction material due to its strength, durability, and versatility. Fine aggregate (sand) is a major constituent of concrete. Rapid urbanization and infrastructure development have led to excessive extraction of natural sand, causing environmental degradation and scarcity. Therefore, the use of alternative materials as partial replacement of sand has become an important area of research.

Bangladesh and other developing countries generate significant amounts of wood powder and rice husk as by-products of agricultural and industrial activities. Utilizing these materials as partial replacements for sand in concrete can reduce environmental impact, lower material costs, and promote sustainable construction practices.

Wood powder and rice husk are industrial and agricultural waste materials abundantly available in Bangladesh. Improper disposal of these wastes causes environmental pollution. Utilizing them in concrete can reduce waste, conserve natural resources, and promote sustainable construction.

Figure 1.1 Wood Powder

Figure 1.2 Rice Husk

Figure1.3 Fine aggregate (sand)

1.2 Problem Statement

1) The rapid growth of the construction industry has led to an increasing demand for natural river sand, which has resulted in its scarcity and a continuous rise in cost. Excessive extraction of sand from riverbeds causes serious environmental problems such as riverbank erosion, lowering of groundwater levels, loss of aquatic habitats, and ecological imbalance.

2) At the same time, large quantities of industrial and agricultural wastes like wood powder and rice husk are generated every year. The disposal of these materials poses significant environmental challenges, as they are often dumped in open areas or burned, leading to land pollution and air quality deterioration.

3) Although wood powder and rice husk have potential to be used as partial replacement materials in concrete, there is a lack of sufficient and reliable comparative data regarding their effect on the compressive strength of concrete.

4) Therefore, a systematic study is necessary to evaluate and compare the compressive strength performance of concrete incorporating wood powder and rice husk as partial replacements for natural sand, aiming to promote sustainable construction practices while addressing environmental and material scarcity issues.

1.3 Objectives of the Study

The main objectives of this research are:

- To study the compressive strength of concrete with partial replacement of sand by wood powder
- To study the compressive strength of concrete with partial replacement of sand by rice husk
- To compare the strength performance of wood powder concrete and rice husk concrete with conventional concrete
- To identify the optimum replacement percentage

1.4 Scope of the Study

This study focuses on the experimental investigation of the compressive strength of concrete by partial replacement of fine aggregate (sand) using wood powder and rice husk. The scope of the study is outlined as follows:

1. compressive strength analysis of concrete using partial replacement of fine aggregate by wood powder and rice husk at 7- and 28-days curing periods The research is limited to ordinary Portland cement (OPC) concrete of a single grade mix design, prepared under controlled laboratory conditions.
2. Fine aggregate (natural sand) is partially replaced by wood powder and rice husk at selected replacement levels (such as 0%, 5%, 10%, and 15%) by weight of sand.
3. The study evaluates the compressive strength performance of concrete specimens at standard curing periods, primarily 7 days and 28 days.
4. The research emphasizes the comparative analysis between wood powder–modified concrete and rice husk–modified concrete to identify the more effective partial replacement material.
5. The study is confined to laboratory-scale experimentation and does not include field application or long-term structural performance evaluation.
6. Environmental and economic implications are discussed qualitatively, focusing on waste utilization and reduction of natural sand consumption, but detailed life-cycle assessment and cost analysis are beyond the scope of this research.

1.5 Significance of the Study

1) The findings of this study may contribute significantly to sustainable construction practices in several ways. First, by partially replacing natural sand with alternative materials such as wood powder and rice husk, the study helps reduce dependency on natural sand, whose excessive extraction leads to environmental degradation, riverbank erosion, and ecological imbalance. Reducing sand consumption also supports the conservation of natural resources for future generations.

2) Second, the effective utilization of waste materials like wood powder and rice husk addresses waste management challenges by diverting these by-products from open dumping or burning, which can cause environmental pollution. Incorporating such waste materials into concrete production promotes recycling, minimizes landfill usage, and supports the principles of a circular economy.

3) Finally, the use of locally available waste materials as partial sand replacements can provide cost-effective alternative construction materials. These materials are often inexpensive or readily available, which can lower overall material costs without significantly compromising the compressive strength and performance of concrete. As a result, this approach offers an economically viable and environmentally friendly solution for sustainable construction.

1.6 Organization of the thesis

This section has a brief description of the thesis outline. Of the thesis.

- Chapter 1: Introduction. This chapter provides the background and motivations of the research. The overall objectives and expected outcomes are also described in this chapter.
- Chapter 2: Literature Review. This chapter reviews the related works in the Compressive strength analysis with a special focus on Cementite's Materials.
- Chapter 3: Materials and Methodology. This chapter describes the methodology adopted to carry out the research.
- Chapter 4: Results and Discussion. This chapter describes the results of Sample testing and compression testing.
- Chapter 5: Conclusions and Future Work. This chapter summarizes the conclusions and major contributions of this study and provides recommendations for future studies.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The increasing demand for concrete in infrastructure development has resulted in excessive exploitation of natural river sand, leading to environmental degradation, ecological imbalance, and rising construction costs. At the same time, the disposal of agricultural and wood-based waste materials poses significant environmental challenges. Researchers have therefore focused on identifying sustainable alternatives to natural fine aggregates by utilizing waste materials such as rice husk, rice husk ash, sawdust, and wood powder in concrete production. This chapter reviews previous studies related to the use of rice husk and wood powder as partial replacements of fine aggregate, with particular emphasis on their effects on compressive strength, workability, durability, and sustainability.

2.2 Sustainability and Alternative Materials in Concrete

Sustainable construction practices emphasize the reduction of natural resource consumption and the reuse of industrial and agricultural waste materials in building materials. According to Mehta (2001), the incorporation of waste by-products in concrete can significantly reduce the environmental footprint of construction while maintaining acceptable mechanical performance. Similarly, Naik and Moriconi (2005) highlighted that the utilization of waste materials in concrete contributes to the conservation of natural aggregates and promotes eco-efficient construction.

Recent studies have demonstrated that partial replacement of fine aggregates with waste materials not only reduces landfill disposal but can also improve certain engineering properties of concrete, particularly at low replacement levels. However, the performance largely depends on the physical and chemical characteristics of the replacement material, such as particle size, shape, porosity, and water absorption capacity.

2.3 Rice Husk and Rice Husk Ash in Concrete

Rice husk is an agricultural by-product obtained during the milling of rice. It is lightweight, porous, and rich in silica, making it a potential pozzolanic material when properly processed. The controlled burning of rice husk produces rice husk ash (RHA), which contains a high percentage of amorphous silica.

Ganesan et al. (2008) investigated the use of rice husk ash as a supplementary cementitious material and reported that concrete containing up to 10% RHA exhibited improved compressive strength and durability due to enhanced pozzolanic reactions and pore refinement. Similarly, Zhang and Malhotra (1996) observed that RHA significantly improved the resistance of concrete to chloride penetration and chemical attack.

While most studies focus on rice husk ash as a cement replacement, some researchers have examined the use of raw rice husk as a partial replacement for fine aggregate. Habeeb and Mahmud (2010) reported that low percentages of rice husk improved workability and produced marginal increases in compressive strength due to better particle packing. However, higher replacement levels resulted in strength reduction because of increased porosity and weak interfacial bonding.

2.4 Wood Powder and Sawdust in Concrete

Wood powder and sawdust are by-products of timber processing industries and are characterized by low density, fibrous texture, and high water absorption capacity. Their incorporation in concrete has been studied primarily to produce lightweight and low-cost construction materials.

Udoeyo and Dashibil (2002) examined the use of sawdust ash as a partial replacement for cement and found that low replacement levels improved certain strength properties, while higher levels reduced compressive strength. Elinwa and Mahmood (2002) reported that untreated sawdust in concrete resulted in reduced strength due to the presence of organic compounds that interfere with cement hydration.

Bederina et al. (2007) studied the effect of wood waste as a fine aggregate replacement and concluded that the inclusion of wood particles reduced the density of concrete, making it suitable for non-structural and lightweight applications. However, the compressive strength decreased significantly at higher replacement levels due to increased void content and weak bonding between the cement paste and wood particles.

2.5 Effect on Workability and Water Absorption

Several researchers have reported that both rice husk and wood-based materials increase the water demand of concrete mixes. Their porous and fibrous nature leads to higher water absorption, which can adversely affect workability and strength if not properly controlled. Neville (2011) emphasized that materials with high absorption capacity require either pre-soaking or adjustment of the water–cement ratio to maintain consistent workability. Islam et al. (2016) observed that concrete mixes containing agricultural waste materials exhibited reduced slump values, indicating lower workability at higher replacement levels.

2.6 Durability and Long-Term Performance

Durability is a critical parameter in evaluating the suitability of alternative materials in concrete. Studies by Chindaprasirt et al. (2007) demonstrated that the incorporation of silica-rich agricultural waste materials improved resistance to sulfate attack and reduced permeability. However, the presence of untreated organic materials, such as raw wood powder, may increase the risk of biodegradation and long-term strength loss. Siddique (2008) suggested that proper treatment and controlled usage of waste materials are essential to ensure the long-term performance and durability of sustainable concrete.

2.7 Comparative Studies on Fine Aggregate Replacement

Comparative research has shown that the performance of alternative fine aggregates varies significantly depending on their chemical composition and physical properties. Agricultural waste materials rich in silica tend to exhibit better bonding characteristics and contribute to secondary hydration reactions, whereas organic fibrous materials primarily act as fillers and may weaken the cement matrix.

Corinaldesi et al. (2010) reported that fine aggregate replacement using lightweight and porous materials resulted in reduced compressive strength beyond an optimum replacement level, typically ranging between 5% and 15%. This finding aligns with the general trend observed in experimental studies involving rice husk and wood powder.

2.8 Research Gap and Justification of the Present Study

Although extensive research has been conducted on the use of rice husk ash as a cement replacement, limited studies are available on the direct comparison between raw rice husk and wood powder as partial replacements of fine aggregate. Furthermore, most existing studies focus on either agricultural or wood waste materials independently rather than providing a comparative performance analysis under identical mix design and curing conditions.

The present study addresses this research gap by experimentally evaluating and comparing the compressive strength performance of concrete containing rice husk and wood powder as partial replacements of natural sand at varying replacement levels. The findings aim to contribute to the development of sustainable and cost-effective construction materials suitable for practical applications.

2.9 Content

2.9.1 Wood Powder in Concrete

Wood powder, a waste material from sawmills, used to partially replace natural sand in concrete. Being lightweight and porous, wood powder reduces the density and generally lowers the compressive strength of concrete, especially at higher replacement levels. At low replacement percentages, it may be suitable for non-structural or lightweight applications. Its use promotes recycling of industrial waste and supports sustainable construction practices. Previous studies on the use of Wood powder as a partial replacement for fine aggregate. Effects of Wood powder on compressive strength, durability, and workability. Benefits of Wood powder as a low-cost and eco-friendly material. Limitations of using high percentages of Wood powder.

2.9.2 Rice Husk in Concrete

Rice husk is an agricultural waste material, used as a partial replacement of natural sand in concrete. Due to its lightweight and fibrous nature, rice husk affects the density and strength of concrete. At low replacement levels, rice husk may improve particle packing and contribute to acceptable compressive strength. However, higher replacement percentages generally reduce strength and workability. The use of rice husk helps in waste management and promotes sustainable construction practices. Previous studies on the use of Rice Husk as a partial replacement for fine aggregate. Effects of Rice Husk on compressive strength, durability, and workability. Benefits of Rice Husk as a low-cost and eco-friendly material. Limitations of using high percentages of Rice Husk.

CHAPTER 3
MATERIALS AND METHODOLOGY

3.1 Introduction

This chapter describes the materials used, mix design procedure, replacement percentages, specimen preparation, curing process, and testing methodology adopted to investigate the compressive strength of concrete with partial replacement of sand using wood powder and rice husk.

3.2 Methodology Overview

The materials used in this experimental investigation are described below. The methodology employed for investigating the compressive strength of concrete using Rice Husk Ash (RHA) and Red Clay (RC) involves a step-by-step experimental process. This study focuses on replacing sand with these materials at different levels (5%, 10%, and 15%) and testing their effect on concrete strength. The research includes the selection of materials, preparation of concrete mixes, casting of cylinders, curing, and compressive strength testing at 7 and 28 days. This section gives an overview of the main methods followed in the research to ensure reliable and repeatable results.

3.2.1 Cement

Ordinary Portland Cement (OPC) conforming to ASTM C150 was used throughout the study. The cement was fresh, free from lumps, and stored in a dry place to prevent moisture contamination.

Ordinary Portland Cement (OPC) was used as the main binding material. Cement is one of the most important components in concrete, as it reacts with water to form a hard and durable mass that binds the aggregates together. OPC was selected because it is widely available in Bangladesh and is commonly used in construction works. The cement used in this study was tested before use to confirm its quality.
Properties of Cement:

- Type: Ordinary Portland Cement (OPC)
- Color: Grey

Figure: 3.1 Ordinary Portland Cement

3.2.2 Fine Aggregate (Sand)

Natural river sand passing through a 4.75 mm sieve was used as fine aggregate. The sand was clean, dry, and free from organic impurities, clay, and silt.

Properties of Sand:

- Maximum size: 4.75 mm
- Specific gravity: 2.60
- Zone: Medium sand

Figure:3.2 Fine Aggregate

3.2.3 Coarse Aggregate (Stone Chips)

Crushed stone aggregates with a maximum nominal size of 20 mm were used. The aggregates were angular in shape, clean, and free from dust and deleterious materials.

Properties of Coarse Aggregate:

- Maximum size: 20 mm
- Specific gravity: 2.70
- Shape: Angular

Stone chips were the grading obtained through sieve analysis shows that the aggregate is well-graded and suitable for preparing concrete mixes for compressive strength testing.

Figure: 3.3 Coarse Aggregate

3.2.4 Wood Powder

Wood powder was collected from a local sawmill. The material was air-dried and sieved to remove oversized particles before use. Wood powder is a lightweight material with high water absorption capacity.

Characteristics of Wood Powder:

- Source: Local saw mill
- Color: Light brown
- Nature: Light weight, fibrous

Figure: 3.4 Wood Powder

3.2.5 Rice Husk

Rice husk was collected from a local rice mill. It was cleaned, dried, and sieved before use. Rice husk is an agricultural waste material that is abundantly available in Bangladesh.

Characteristics of Rice Husk:

- Source: Rice mill
- Color: Yellowish-brown
- Nature: Light weight and porous

Figure: 3.5 Rice Husk

3.2.6 Water

Clean potable water was used for mixing and curing. Water was used as a key component in the preparation of concrete mixes. Water used as per BNBC 2020 standards, water used for mixing and curing must be clean and free from harmful substances such as oils, acids, alkalis, salts, sugars, or organic materials that could adversely affect the quality of concrete or the reinforcement steel.

For this project, the water–cement ratio was maintained at 0.5 to ensure proper hydration of the cement and achieve the desired workability of the mix. This ratio was carefully selected to balance strength and durability while preventing issues such as excessive shrinkage or reduced compressive strength.

Figure: 3.6 Water Mixing

3.3 Procedure of making the Cylinder (Mix Design)

Concrete of was designed using a nominal mix proportion of:
1: 1.5: 3 (Cement: Sand: Coarse Aggregate)
The water–cement ratio was maintained at 0.50 for all mixes to ensure uniformity and comparability of results.

3.4 Replacement Percentages

Fine aggregate (sand) was partially replaced by wood powder and rice husk at four different percentages by weight:

- 0% (Control Mix)
- 5%
- 10%
- 15%

Mix Identification

Mix ID	Replacement Material	Percentage
CM	None	0%
WP5	Wood Powder	5%
WP10	Wood Powder	10%
WP15	Wood Powder	15%
RH5	Rice Husk	5%
RH10	Rice Husk	10%
RH15	Rice Husk	15%

Figure: 3.7 Replacement Percentages

3.5 Specimen Preparation

- Concrete was mixed manually
- Concrete Cylinder specimens of size 100 diameter and height 200 mm were prepared for compressive strength testing.
- Specimens were demolded after 24 hours

Figure: 3.8 Specimen Casting

3.5.1 Procedure (Specimen Casting)

- All materials were weighed accurately.
- Dry mixing of cement, sand, and coarse aggregate was carried out.
- Wood powder or rice husk was added according to the replacement percentage.
- Water was added gradually and mixing continued until a homogeneous mix was obtained.
- The fresh concrete was poured into cylinder molds in three layers.
- Each layer was compacted using a tamping rod.
- The top surface was leveled and finished smoothly.

3.6 Curing Process

After casting, the specimens were left undisturbed for 24 hours at room temperature. After demolding, the specimens were submerged in clean water for curing.

- Curing periods: 7 days and 28 days
- Curing method: Water curing

Proper curing was ensured to allow adequate hydration of cement. During the curing period, the water temperature was kept at room condition to ensure uniform hydration. Proper curing ensured the prevention of cracks, reduction of shrinkage, and development of sufficient strength in the concrete. After the curing period, the specimens were taken out of the tank, surface-dried, and prepared for compressive strength testing.

Figure: 3.9 Curing Process

3.7 Compressive Strength Test Procedure

After completing the curing period of 7 days, 21 days, and 28 days, the concrete cylinders were taken out from the curing tank. The surface water was wiped off and the specimens were allowed to dry for a short time before testing. The compressive strength test was carried out using a Compression Testing Machine (CTM). Each specimen was placed carefully in the machine between the upper and lower plates in a vertical position, ensuring that the load was applied uniformly along the axis of the cylinder. A gradual load was applied without shock, at a constant rate, until the specimen failed.

The compressive strength test was conducted in accordance with ASTM C39 using a compression testing machine (CTM).

Test Procedure:

1. The cube specimen was removed from water and wiped dry.
2. The specimen was placed centrally on the CTM platform.
3. Load was applied gradually and uniformly.
4. The maximum load at failure was recorded.

Figure: 3.10 Compressive Strength Testing

3.8 Data Collection

The obtained compressive strength values from different mixtures will be compiled and analyzed statistically. The effects of varying proportions of Wood powder, Rice Husk Ash (RHA) on the compressive strength will be studied. Comparative analysis will be conducted between the modified concrete mixes and the control mixes.

Figure: 3.11 Unite Weight of (Stone Chips)

Figure: 3.12 Unite Weight of (Sand)

3.9 Summary

This chapter presented the materials used, mix proportions, replacement levels, specimen preparation method, curing process, and compressive strength testing procedure adopted for the experimental investigation.

The "Results and Discussion" section stands as the culmination of empirical data. The materials and steps used in the research were described. Fine sand was partially replaced with wood powder and Rice Husk at 5%, 10%, and 15% ratios. Concrete cylinders were cast, cured in water, and then tested for compressive strength at 7 and 28 days.

The process also included proper preparation of materials, casting, curing, and testing to ensure reliable results. This methodology allows the study to clearly show how different waste materials affect the strength of concrete.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Introduction

This chapter shows the compressive strength results of conventional concrete and modified concrete mixes were recorded and tabulated.

4.2.1 Test Results

Table 4.1 Sieve Analysis Wood Powder

Sieve No	Materials Retained (gm)	% Materials Retained	Cumulative % Materials	% Finer
4	1	0.1	0.1	99.9
8	7	0.7	0.8	99.2
16	130	13	13.8	86.2
30	75	7.5	21.3	78.7
50	63	6.3	27.6	72.4
100	18	1.8	29.4	70.6
Pan	5			
			Total= 93	FM=0.93

Table 4.2 Unit Weight Wood Powder

Condition	Weight of Bucket (gm)	Weight of Bucket Materials (gm)	Weight of Materials (gm)	Volume of Bucket (m3)	Unit Weight, (kg/m3)	Average Unit Weight, (kg/m3)
Shoveling	4000	4536	536	0.00278	192	
Rodding	4000	4730	730	0.00278	262	249
Jiggling	4000	4517	817	0.00278	293	

Table 4.3 Specific Gravity Wood Powder

A= 27 gm, Oven Dry weight in Air A (gm)			
B= 657 gm, Weight of pycnometer filled with water to Calibration mark. B (gm)			
C= 654 gm, Weight of pycnometer with specimen and water to Calibration mark. C (gm)			
S= 50 gm, Weight of S.S.D sample in Air S (gm)			
Tests	Formula	Calculation	Result
Apparent Specific Gravity	A/(B+A-C)	27/(657+27-654)	0.9
Bulk Specific Gravity (Oven Dry Basis	A/(B+S-C)	27/(657+50-654)	0.5
Absorption Capacity, 0%	(S-A)/A*100	(50-27)/27*100	85.18
Bulk Specific Gravity (S.S Dry Basis	S/(B+S-C)	50/(657+50-654)	0.94

Table 4.4 Sieve Analysis Rice Husk

Sieve No	Materials Retained (gm)	% Materials Retained	Cumulative % Materials	% Finer
4	0	0	0	100
8	3	0.3	0.3	99.7
16	215	21.5	21.8	78.2
30	42	4.2	26	74
50	28	2.8	28.8	71.2
100	8	0.8	29.6	70.4
Pan	4			
			Total= 106	FM= 1.06

Table 4.5 Unit Weight Rice Husk

Condition	Weight of Bucket (gm)	Weight of Bucket Materials (gm)	Weight of Materials (gm)	Volume of Bucket (m3)	Unit Weight, (kg/m3)	Average Unit Weight, (kg/m3)
Shoveling	4000	4789	789	0.00278	289	
Rodding	4000	5036	1038	0.00278	372	358
Jiggling	4000	5147	1147	0.00278	412	

Table 4.6 Specific Gravity Rice Husk

A= 32 gm, Oven Dry weight in Air A (gm)			
B= 657 gm, Weight of pycnometer filled with water to Calibration mark. B (gm)			
C= 667 gm, Weight of pycnometer with specimen and water to Calibration mark. C (gm)			
S= 50 gm, Weight of S.S.D sample in Air S (gm)			
Tests	Formula	Calculation	Result
Apparent Specific Gravity	A/(B+A-C)	32/(657+32-667)	1.45
Bulk Specific Gravity (Oven Dry Basis	A/(B+S-C)	32/(657+50-667)	0.8
Absorption Capacity, 0%	(S-A)/A*100	(50-32)/32*100	56.25
Bulk Specific Gravity (S.S Dry Basis	S/(B+S-C)	50/(657+50-667)	1.25

Table 4.7 Sieve Analysis Sand

Sieve No	Materials Retained (gm)	% Materials Retained	Cumulative % Materials	% Finer
4	6	0.6	0.6	99.4
8	26	2.6	3.2	96.8
16	178	17.8	21	79
30	315	31.5	52.5	47.5
50	381	38.1	90.6	9.4
100	68	6.8	97.7	2.6
Pan	26			
		Total	265.6	
			FM= 2.65	

Table 4.8 Unit Weight Sand

Condition	Weight of Bucket (gm)	Weight of Bucket Materials (gm)	Weight of Materials (gm)	Volume of Bucket (m3)	Unit Weight, (kg/m3)	Average Unit Weight, (kg/m3)
Shoveling	4000	7985	3985	0.00278	1433	
Rodding	4000	8360	4360	0.00278	1568	1545
Jiggling	4000	8545	4545	0.00278	1634	

Table 4.9 Specific Gravity Sand

A= 280 gm, Oven Dry weight in Air A (gm)			
B= 656 gm, Weight of pycnometer filled with water to Calibration mark. B (gm)			
C= 832 gm, Weight of pycnometer with specimen and water to Calibration mark. C (gm)			
S= 291 gm, Weight of S.S.D sample in Air S (gm)			
Tests	Formula	Calculation	Result
Apparent Specific Gravity	A/(B+A-C)	280/(656+280-832)	2.69
Bulk Specific Gravity (Oven Dry Basis	A/(B+S-C)	280/(656+280-832)	2.48
Absorption Capacity, 0%	(S-A)/A*100	(291-280)/280*100	3.92
Bulk Specific Gravity (S.S Dry Basis	S/(B+A-C)	291/(656+291-832)	2.53

Table 4.10 Sieve Analysis Stone Chips

Sieve No	Materials Retained (gm)	% Materials Retained	Cumulative % Materials	% Finer
3/4	273	27.3	27.3	72.7
3/8	695	69.5	96.8	3.2
4	32	3.2	100	0
8	0	0	100	0
16	0	0	100	0
30	0	0	100	0
50	0	0	100	0
100	0	0	100	0
			Total= 724.1	FM= 7.24

Table 4.11 Unit Weight Stone Chips

Condition	Weight of Bucket (gm)	Weight of Bucket Materials (gm)	Weight of Materials (gm)	Volume of Bucket (m3)	Unit Weight, (kg/m3)	Average Unit Weight, (kg/m3)
Shoveling	4000	7769	3769	0.00278	1355	
Rodding	4000	8193	4193	0.00278	1508	1473
Jiggling	4000	8326	4326	0.00278	1556	

Table 4.12 Gravity Stone Chips

A= 1890 gm, Oven Dry weight of sample in Air, A (gm)			
B= 1915 gm, Weight of S.S.D sample in Air, B (gm)			
C= 1220 gm, Weight of S.S.D sample in Water, C (gm)			
Tests	Formula	Calculation	Result
Apparent Specific Gravity	A/(A-C)	1890/(1890-1220)	2.82
Bulk Specific Gravity (Oven Dry Basis	B/(B-C)	1915/(1915-1220)	2.75
Absorption Capacity, 0%	(B-C)/A*100	(1915-1220)/1890*100	36.77
Bulk Specific Gravity (S.S Dry Basis	A/(B-C)	1890/(1915-1290)	2.71

4.2.2 Compressive Strength Test Results

The compressive strength of concrete Cylinder was determined using a compression testing machine in accordance with ASTM C39. The average values of compressive strength obtained from testing are presented below.

Table 4.13 Compressive Strength of concrete at 7 days curing

Case	Cylinder Día =mm	Cylinder Height =mm	Cylinder Weight=gm	Load (KN)	Crushing Strength (PSI)	Average Crushing Strength (PSI)
%	102.70	206	4085	155	2714.23	2618.41
	102.00	206	4036	154	2733.86	
	102.90	205	4102	138	2407.16	
Rice husk 5%	103.00	206	4143	145	2524.35	2632.68
	102.30	206	3984	150	2647.26	
	102.80	206	4077	156	2726.43	
Rice husk 10%	103.20	205	4088	180	3121.54	3212.52
	103.00	205	4069	190	3307.77	
	103.20	205.5	3963	185	3208.25	
Rice husk 15%	102.90	206	3814	165	2878.12	2735.19
	102.70	206	3777	140	2451.56	
	102.00	206	3985	162	2875.88	
Wooden husk 5%	103.10	205	4058	160	2780.09	2773.44
	102.80	206	4143	145	2534.18	
	102.80	205	4088	172	3006.06	
Wooden husk 10%	102.70	206	4082	162	2836.81	2766.54
	103.00	206	3990	160	2785.49	
	102.40	206	4152	152	2677.31	
Wooden husk 15%	102.80	205	3992	133	2324.46	2525.67
	103.20	206	4030	151	2618.63	
	102.90	206	3977	151	2633.92	

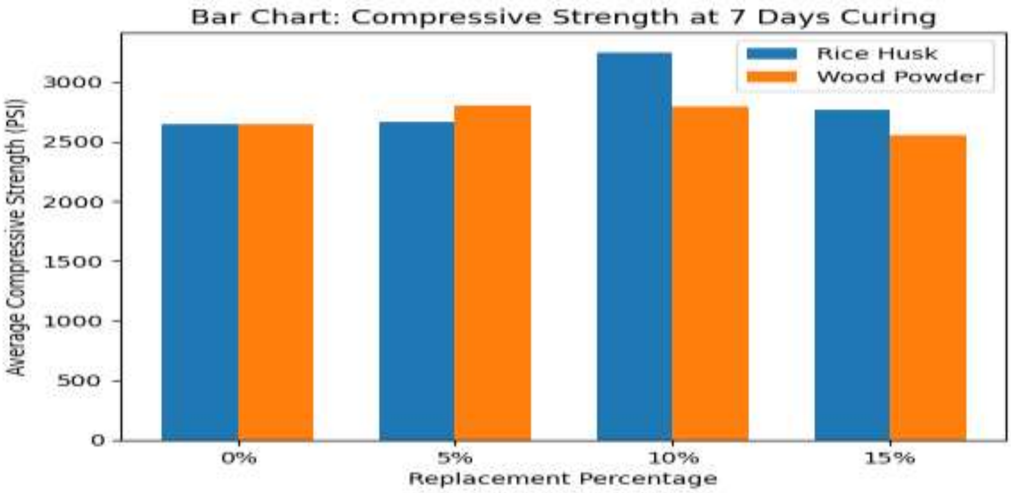

Figure: 4.1 Compare Compressive Strength 7 days

Table 4.14 Compressive Strength of concrete at 28 days curing

Case	Cylinder Día (mm)	Cylinder Height (mm)	Cylinder Weight(gm)	Load (KN)	Crushing Strength (PSI)	Average Crushing Strength (PSI)
%	102.10	206	4053	190	3366.34	
	102.70	205.6	4051	170	2976.90	3092.71
	101.90	207	4040	165	2934.89	
Rice husk 5%	102.10	205	4079	200	3543.52	
	101.40	206	4064	195	3502.79	3282.70
	102.70	205	4017	160	2801.79	
Rice husk 10%	103.00	206	3993	200	3481.86	
	102.10	205	3987	205	3632.10	3642.00
	102.30	206	4039	216	3812.05	
Rice husk 15%	102.40	206	3904	190	3346.64	
	103.10	206.5	4004	186	3231.85	3279.02
	102.40	205.7	3864	185	3258.57	
Wooden husk 5%	103.00	206	3972	191	3325.18	
	102.70	205	4154	190	3327.12	3375.42
	102.60	207	4020	198	3473.97	
Wooden husk 10%	103.00	206	3969	185	3220.72	
	101.90	206	4015	174	3094.97	3020.64
	102.10	205	4008	155	2746.22	
Wooden husk 15%	101.90	204	3964	170	3023.82	
	102.20	206	3907	166	2935.36	2813.22
	102.10	205	4072	140	2480.46	

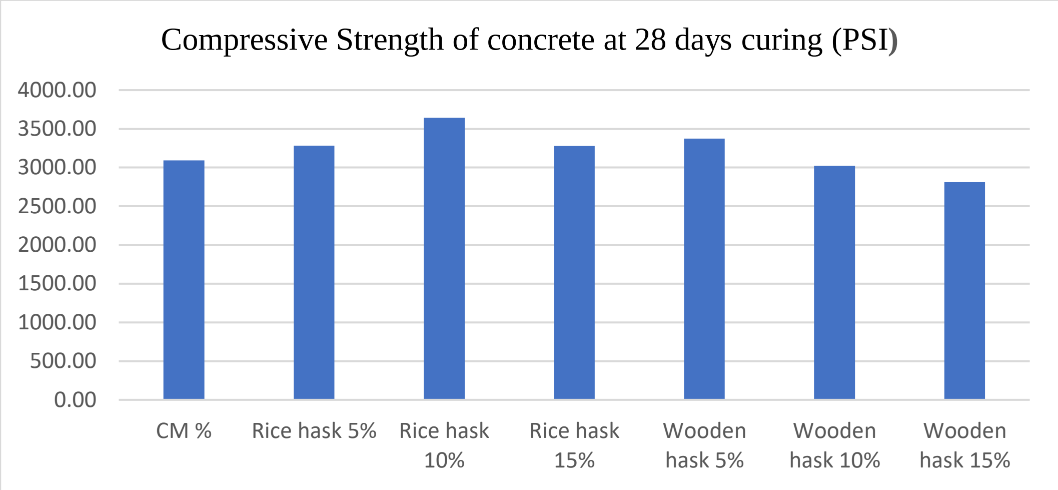

Figure: 4.2 Compare Compressive Strength 28 days

Table 4.15 Summary Compressive Strength Results

Mix ID	Replacement (%)	7 Days Strength	28 Days Strength
CM	0	2618.41	3092.71
Rice husk 5%	5	2632.68	3282.70
Rice husk 10%	10	3212.52	3642.00
Rice husk 15%	15	2735.19	3279.02
Wooden husk 5%	5	2773.44	3375.42
Wooden husk 10%	10	2766.54	3020.64
Wooden husk 15%	15	2525.67	2813.22

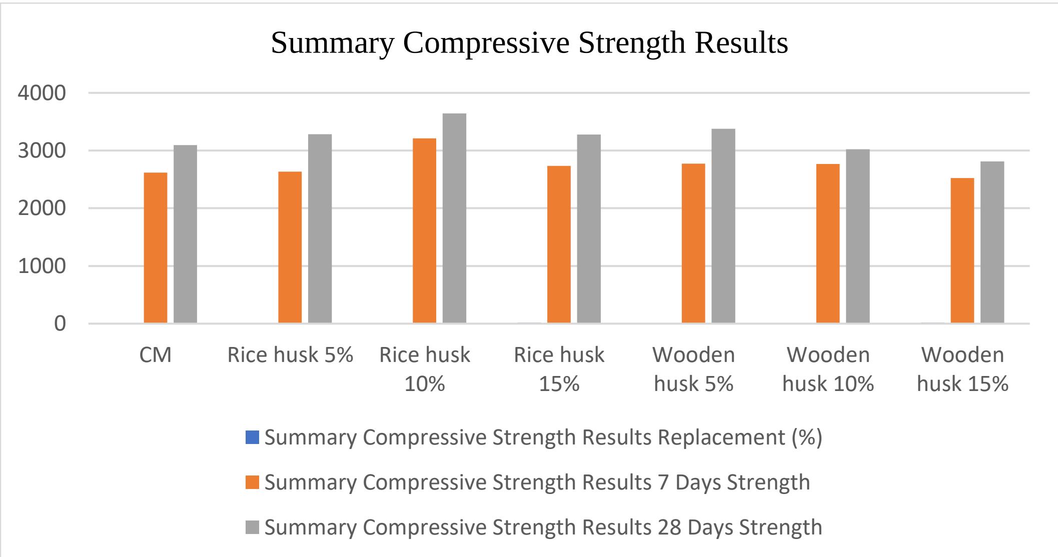

Figure: 4.3 Compressive Strength Results

4.3 Analysis of Compressive Strength Results

Table 4.2 presents the compressive strength results of concrete mixes with partial replacement of sand by wood powder and rice husk at 7 and 28 days of curing.

4.3.1 Control Mix (CM)

7 Days: 2618.41
28 Days: 3092.71
The control mix shows the normal strength development of conventional concrete and is used as a reference for comparison with the modified mixes.

4.3.2 Effect of Rice Husk Replacement

At 5% rice husk replacement, the compressive strength slightly increased compared to the control mix, indicating a positive contribution to the concrete matrix.
The 10% rice husk replacement exhibited the highest compressive strength among all mixes, achieving 3212.52 at 7 days and 3642.00 at 28 days. This improvement can be attributed to better particle packing and possible pozzolanic activity of rice husk, which enhances the cementitious matrix.
However, at 15% replacement, the compressive strength decreased compared to the 10% mix. The reduction may be due to excessive replacement of fine aggregate, leading to weaker bonding and increased porosity.

4.3.3 Effect of Wood powder Replacement

Concrete containing 5% wood powder showed improved compressive strength compared to the control mix, with values of 2773.44 at 7 days and 3375.42 at 28 days.
As the replacement level increased to 10% and 15%, a gradual reduction in compressive strength was observed. This reduction is likely caused by the fibrous nature and higher water absorption capacity of wood powder, which negatively affects the bond between cement paste and aggregates.

4.3.4 Comparative Performance of wood powder and rice husk

A comparison between wood powder and rice husk indicates that rice husk performs better than wood powder as a partial replacement of sand. The maximum compressive strength was obtained with 10% rice husk replacement, particularly at 28 days of curing.
Wood powder showed acceptable performance only at lower replacement levels, while higher percentages resulted in significant strength loss.

4.3.5 Summary

The optimum replacement level for rice husk is 10%.
The optimum replacement level for wood powder is 5%.
Compressive strength generally increases with curing age for all mixes.
Excessive replacement (15%) reduces compressive strength due to poor bonding and increased porosity.

CHAPTER 5
CONCLUSION AND FUTURE WORK

5.1 Conclusion

- This study investigated the effect of partial replacement of natural sand with wood powder and rice husk on the compressive strength of concrete. Based on the experimental results obtained at 7 days and 28 days of curing, the following conclusions can be drawn:

- Partial replacement of sand with rice husk showed a positive influence on compressive strength up to an optimum level. The 10% rice husk replacement produced the highest compressive strength at both 7 days and 28 days, outperforming the control mix.

- Beyond the optimum level, an increase in rice husk content led to a reduction in compressive strength. The decrease at 15% replacement is attributed to excessive substitution of fine aggregate, which resulted in poor bonding and increased porosity.

- In the case of wood powder replacement, the compressive strength improved at 5% replacement compared to the control mix. However, further increase in wooden husk content caused a noticeable reduction in strength.

- The reduction in strength for higher wood powder replacement levels is mainly due to the fibrous nature and high-water absorption capacity of wooden husk, which negatively affects the cement–aggregate bond.

- A comparative evaluation revealed that rice husk performed better than wood powder as a partial replacement of sand in concrete, particularly in terms of long-term compressive strength.

- The study confirms that agricultural and wood waste materials can be used in concrete to a limited extent, contributing to sustainable construction practices while maintaining acceptable strength levels.

5.2 Recommendations

Based on the findings of this study, the following recommendations are proposed:

1) Rice husk can be safely used up to 10% as a partial replacement of sand in concrete where improved compressive strength is required.

2) Wooden powder replacement should be limited to 5% to avoid significant loss in compressive strength.

3) Proper pre-treatment of wood powder and rice husk, such as washing and controlled drying, is recommended to reduce impurities and water absorption.

4) Future research should investigate the effects of these materials on other mechanical properties of concrete, such as tensile strength, flexural strength, and durability.

5) Long-term performance tests, including shrinkage, permeability, and resistance to chemical attack, should be conducted to evaluate the durability of modified concrete.

6) The use of wood powder and rice husk in concrete can help reduce environmental waste and natural sand consumption, promoting sustainable and eco-friendly construction.

7) Field trials and large-scale applications are recommended before implementing these materials in structural concrete.

5.3 Limitations of the Study

Despite achieving the objectives of this research, the study has several limitations that should be considered when interpreting the results:

1) The experimental investigation was limited only to the compressive strength of concrete. Other important mechanical properties such as split tensile strength, flexural strength, and modulus of elasticity were not evaluated.

2) The study considered only three replacement levels (5%, 10%, and 15%) for rice husk and wooden husk. Intermediate or lower replacement percentages were not examined, which may provide additional insight into optimal performance.

3) The curing period was limited to 7 days and 28 days. Long-term strength development beyond 28 days, such as 56 or 90 days, was not investigated.

4) Only one type of cement, sand, and aggregate was used. Variations in material properties from different sources may influence the performance of concrete containing wood powder and rice husk

5) The wood powder and rice husk used in this study were not subjected to advanced processing or chemical treatment, which could potentially improve their performance in concrete.

5.4 Future Scope of Research

Based on the findings and limitations of the present study, the following areas are suggested for future research:

1) Further studies should investigate the effect of wood powder and rice husk replacement on other mechanical properties of concrete, such as split tensile strength, flexural strength, impact resistance, and modulus of elasticity.

2) The influence of different replacement percentages, including smaller increments (e.g., 2.5%, 7.5%, and 12.5%), may be examined to determine more precise optimum replacement levels.

3) Future research may explore pre-treatment methods for wood powder and rice husk, such as grinding, chemical treatment, or thermal processing, to improve bonding and reduce water absorption.

4) Environmental and economic analyses, including life cycle assessment (LCA) and cost–benefit evaluation, should be performed to assess the sustainability of using agricultural and wood waste in concrete.

5) Large-scale field applications and structural performance studies are recommended to validate laboratory findings and assess real-life construction feasibility.

CHAPTER 6
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