International Journal of Recent Advances in Multidisciplinary Topics
Volume 5, Issue 5, May 2024
https://www.ijramt.com | ISSN (Online): 2582-7839

Partial Replacement of Cement Using Rice Husk Ash and Eggshell Powder

B. Binduja[1*], Shehins Shihab[2], Ajay Ganesh[3], Ahsen Islahi[4], J. Assif Ali[5]
[1,2,3,4]UG Student, Department of Civil Engineering, Travancore Engineering College, Oyoor, Kollam, India
[5]Assistant Professor, Department of Civil Engineering, Travancore Engineering College, Oyoor, Kollam, India

***Abstract*: Concrete specimens are determined by replacing cement with rice husk ash and eggshell powder. This approach is part of sustainable construction practices where waste products are utilized to reduce the reliance on traditional materials like cement, which has a significant environmental impact due to its production process. Rice husk ash is a byproduct of rice milling and has pozzolanic properties, which can enhance the strength and durability of concrete when used as a partial replacement for cement. Eggshell powder, on the other hand, contains calcium carbonate, which can also contribute to the strength of concrete. When using waste products like rice husk ash and eggshell powder in concrete mixtures, it is important to conduct thorough testing to evaluate the mechanical properties of the resulting concrete. Compressive strength, split tensile strength, and flexural strength are key indicators of the performance of concrete in structural applications. The research study you mentioned seems to focus on investigating the effects of replacing cement with rice husk ash and eggshell powder on the mechanical properties of concrete. By incorporating these waste materials into concrete mixtures, the study aims to reduce the environmental impact of construction activities, lower construction costs, and promote sustainable building practices.**

***Keywords*: Rice husk ash, Eggshell powder.**

1. Introduction

Concrete has excellent compressive strength, which makes it suitable for supporting heavy loads and resisting compression forces. This property is crucial for structural elements like beams, columns, and foundations. Concrete is a durable material that can withstand harsh environmental conditions, such as exposure to moisture, chemicals, and temperature variations. Properly designed and cured concrete structures can have a long service life. Rice husk ash (RHA) has emerged as a promising material with the potential to address both the environmental impact of cement production and the utilization of agricultural waste. As a byproduct of rice milling, RHA offers a sustainable alternative to traditional cement components. Researchers have been conducting studies to explore the feasibility of incorporating RHA into concrete production as a supplementary cementitious material. By replacing a portion of cement with RHA, the overall carbon footprint of concrete production can be reduced while maintaining or even improving the performance of the material. In addition to its pozzolanic properties, RHA has been found to improve the workability of concrete mixes. The finer particles of RHA fill in the gaps between cement grains, resulting in a more cohesive and less porous concrete matrix. This can lead to better compaction during construction and improve the overall quality of the finished structure. Eggshell powder contains a high percentage of calcium carbonate, which can react with cement hydrates to enhance the strength and durability of concrete. The fine particles of eggshell powder can help improve the microstructure of concrete, leading to denser and more durable construction materials. Additionally, the use of eggshell powder in concrete production can contribute to reducing the overall carbon footprint of the construction industry. By exploring the potential of alternative materials like rice husk ash and eggshell powder in concrete production, researchers and industry professionals are paving the way for more sustainable construction practices.

A. Rice Husk Ash

Rice husk is a prevalent agricultural by product surrounding the paddy grain in rice-producing regions globally. With approximately 600 million tonnes of rice paddies harvested each year, about 20% of this yield consists of rice husk, totaling around 120 million tonnes annually. Unfortunately, many rice-producing countries resort to burning or discarding a significant portion of the husk generated during rice processing. When rice husk (RHA) is burned in open-air conditions, it results in the formation of rice husk ash (RHA). For every 1000kg of rice milled, approximately 220 kg (22%) of husk is produced, and when this husk is incinerated in boilers, it yields about 55 kg (25%) of RHA. The disposal of rice husk poses challenges during the rice refining process due to a lack of economic incentives, while its low density makes handling and transportation cumbersome. Rice husk ash (RHA) presents a significant environmental hazard, contributing to soil degradation and adversely impacting the surrounding areas where it is disposed of. The utilization of rice husk and its byproducts presents an opportunity for sustainable practices and resource optimization. By exploring innovative approaches and technologies, the challenges associated with rice husk disposal can be transformed into beneficial solutions that not only reduce environmental impact but also unlock economic value.

*Corresponding author: rajagopalsadasivan0@gmail.com

B. Eggshell Powder

The proposition of repurposing eggshells as a valuable resource underscores the importance of innovative waste management practices and sustainable utilization of natural materials. By harnessing the inherent properties of eggshells, we can not only mitigate environmental harm associated with biodegradable waste but also create new opportunities for economic growth and resource optimization. By exploring these innovative approaches to repurpose eggshells, it is possible to transform what was once considered waste into valuable resources that contribute to environmental sustainability and economic prosperity. Embracing the concept of converting eggshells into useful products aligns with the growing global trend of converting waste materials into income-generating assets, thus fostering a more circular and resource-efficient economy.

C. Objectives

The primary goals of this research are as follows,

1. To improve mechanical properties of concrete.
2. To cutting down the environmental pollutions.
3. To determine the percentage which gives maximum strength when compared to conventional concrete.
4. To determine the optimum replacement value of Rice husk ash, Eggshell powder for developing workable mix.

2. Methodology

The experimental investigation began with the identification of the process and the selection of suitable material. Experiment were carried out the on concrete by partial replacement cement with rice husk ash and eggshell powder. The replacement level of rice husk ash (10%,20%,30%), Eggshell powder (5%,!0%,15%) and the mix design were formulated. These results were compared with those of nominal concrete and to evaluate the behavior of the materials and workability tests such as slump cone and compaction factor tests were conducted. The casting and curing procedures were carried out to prepare specimens for mechanical testing. Mechanical tests, including compressive strength, flexural strength, split tensile test, and water absorption test, were conducted to assess the properties of the materials.

A. Workability Test

1) Slump test

The slump test is a standard test used to measure the consistency and workability of fresh concrete. The amount of slump indicates the concretes workability which is important for construction purposes**.**

2) Compaction factor test

The compacting factor test is designed primarily for the use in laboratory but it can also use in the field.it measures the degree of compaction achieved by concrete when it is compacted in a standard manner. The ratio of the compacted to the original volume gives the compaction factor, which indicates the workability of the concrete. The test is carried out as per IS 1199-1959**.**

Fc=partially compacted concrete/fully compacted concrete
Where
Fc=compaction factor

B. Compressive Strength Test

The dimension of specimen is 150x150x150.Tests shall be made at recognized ages of the test specimen in this project taken as 7 and 28 days. It is calculated by the equation using,

$$F=P/A$$

Where,
P= Maximum load applied (N)
F=Compressive strength (MPa)
A=Cross sectional area of the specimen (mm^2)

Fig. 1. Compressive strength test apparatus with specimen

C. Tensile Strength Test

Tensile strength is a measure of material ability to withstand a stretching force without breaking or deforming permanently. The dimension of cylindrical specimen of diameter of 150mm and length 300mm were prepared.

It is calculated by the equation using,

$$F= 2P/ (3.14\ DL)$$

Where,
P= Load at failure (N)
L= Length of the specimen (mm)
F= Tensile strength (MPa)
D= Diameter of specimen (mm)

Fig. 2. Split tensile strength test apparatus with specimen

D. Flexural Strength Test

The flexural strength test also known as modulus of rupture test measures a material ability to resist bending or breaking under applied force. The size of specimen is 100x100x500 mm were prepared. It is calculated by using,

$$F=PL/(bd^2)$$

Where,
P=Failure Load (N)
F=Flexural strength (MPa)
L=Effective span of beam
b=breadth of the specimen

Fig. 3. Flexural strength test apparatus with specimen

E. Durability Test

1) Water absorption test

The water absorption test for concrete involves determining the amount of water absorbed by concrete under specified conditions water absorption of the concrete is a crucial property that affects its durability and performance. The water absorption of concrete is typically measured by the weight of water absorbed by the concrete specimen over a specified period, often expressed as a percentage of the dry weight of the specimebn.it is calculate by the equation using,

$$W=(B-A/A)\ 100$$

B=Wet weight (kg)
A=Dry weight (kg)
W=water absorption

Fig. 4. Curing tank with specimen

3. Result and Discussion

A. Compressive Strength Test Result

Table 1

Percentage of replacement	Compressive strength (N/mm^2)	
	7 days	28 days
M1	24.43	37.38
M2	17.35	26.24
M3	11.17	20.72
M4	6.83	16.43

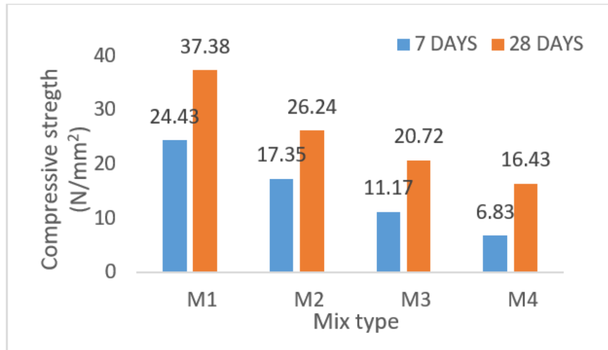

Fig. 5. Graph of compressive strength at 7 & 28 days

B. Split Tensile Strength Test Result

Table 2

Percentage of replacement	Split Tensile Strength (N/mm^2), 28 days
M1	2.13
M2	2.43
M3	2.15
M4	1.93

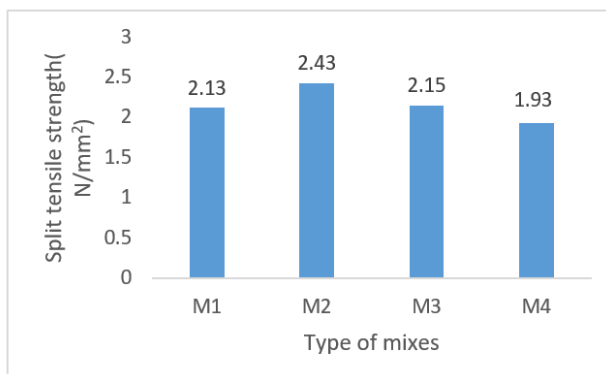

Fig. 6. Graph of tensile strength at 28 days

C. Flexural Strength Result

Table 3

Percentage of Replacement	Flexural Strength of Beam (N/mm^2), 28 days
M1	5.33
M2	5.65
M3	4.13
M4	3.42

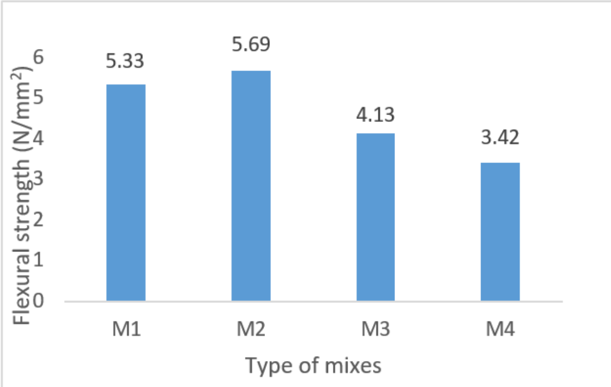

Fig. 7. Graph of flexural strength test at 28 days

D. *Durability Test Result*

Table 4
Water absorption test result for cube

Percentage of Replacement	Water absorption	
	7 days	28 days
M1	4.14	4.32
M2	4.21	5.15
M3	4.34	5.25
M4	5.38	5.54

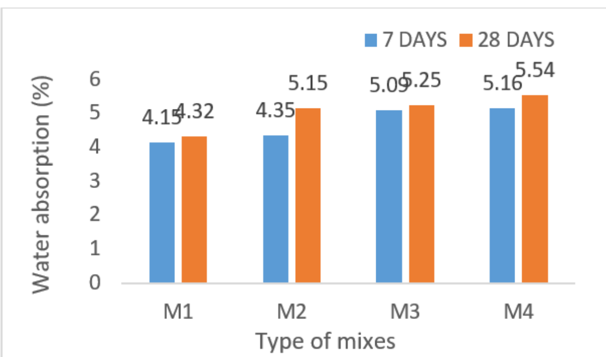

Fig. 8. Graph of water absorption of cubes specimen at 7 & 28 days

Table 5
Water absorption test for beam

Percentage of Replacement	Water absorption, 28 days
M1	6.27
M2	5.85
M3	7.84
M4	9.83

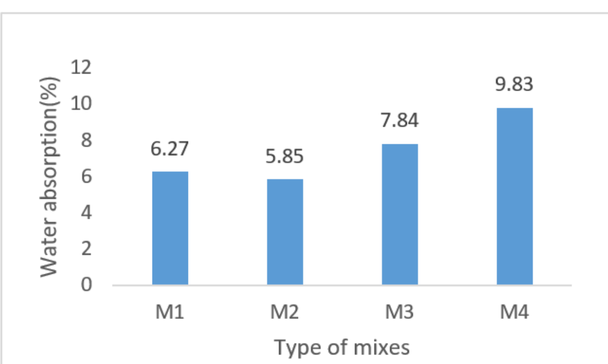

Fig. 9. Graph of water absorption of beam specimen at 28 days

Table 6
Water absorption test for cylinder

Percentage of replacement	Water absorption, 28 days
M1	5.73
M2	5.46
M3	6.23
M4	8.24

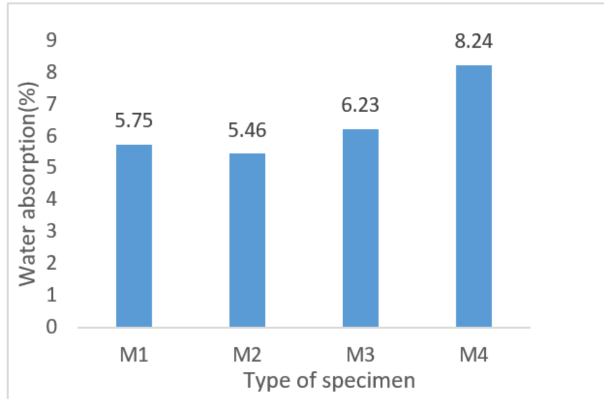

Fig. 10. Graph of water absorption of cylinder specimen at 28 days

4. Conclusion

The concrete mix with slump value of 147mm and a compaction factor of 0.93 is the concrete mix that offers the highest level of compaction according to the results. In the 7-day compressive strength test, M2 mix performed better than M25 initially but decreased over time compared to the control mix. For the 28-day compressive strength M2 mix had the highest strength initially but lower than the control mixes later. M4 mix showed the lowest strength, indicating negative effects of high cement replacement levels. In the 28-day split tensile strength test M2 mix performed better than M1 with increasing strength observed with higher percentages of rice husk ash eggshell powder replacements. In the 28-day flexural strength test. M2 mix outperformed the control mix, suggesting a balanced approach to cement replacement for optimum performance. Water absorption results indicated that materials absorbing more water had lower compressive flexural and spit tensile strengths. Higher cement replacement with rice husk ash and eggshell powder led to decreased strength due to increased water absorption.

References

[1] Muhammad Nasir Amin, Ritu Raj (2017), “Optimizing compressive strength prediction models for rice husk ash concrete with evolutionary machine intelligence techniques.”
[2] Khawaja Adeel Tariq, Samar Hussain (2018), “Effect of partial replacement of cement with rice husk ash on concrete properties.”
[3] Akila N, Dr.M.S Shobha, (2020):-International Journal of Engineering Research and Applications Partial Replacement of Rice Husk Ash and Egg Shell Powder for Cement on Normal Concrete.
[4] Nelson R, Mohit Gupta (2022), “Use of rice husk ash as a supplementary cementitious material in concrete mix for road pavements.”
[5] Karthik M. P, Anjana Santhakumar (2013), “Experimental Study on Rice Husk Ash in Concrete by Partial Replacement.”
[6] Nisar Ahmed Gabol, Aneel Kumar (2020), “Analysis of eggshell powder as a partial replacing material in Concrete.”
[7] Osama Zaid et al., (2019), “Experimental and analytical study of ultra-high-performance fiber-reinforced concrete modified with egg shell powder and nano-silica.”

[8] G.S. Harish Kumar (2012), “Assessment of the Strength of Concrete by Employing Eggshell Powder.”
[9] Ruta A. Gajjar, Jigar Zala (2017), “Utilization of eggshell powder and & GGBS in concrete.”
[10] B. N. Sangeetha (2018), “Effect of Rice Husk Ash and GGBS on Performance of Concrete.”