JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

EXPERIMENTAL STUDYE ON MECHANICAL PROPERTIES OF RICE HUSK ASH CONCRETE WITH DIFFERENT WATER CEMENT RATIOS

Dr.Gul Muhammad[1]*, Dr.Abdul Aziz Ansari[2], Ali Haider[3]

[1*]Department of Civil Engineering, College of Engineering & Technology , Ziauddin University, Karachi,07540, Sindh, Pakistan. gul.muhammad@zu.edu.pk
[2] Department of Civil Engineering, College of Engineering & Technology, Ziauddin University, Karachi,07540, Sindh, Pakistan. aziz.ansari@zu.edu.pk
[3] Undergraduate Student Department of Civil Engineering, College of Engineering & TechnologyZiauddinUniversity,EducationCity,Karachi,07540,Sindh, Pakistan. ali.14553@zu.edu.pk
*

Abstract
The development of concrete technology can lessen the amount of energy and natural resources consumed, as well as the environmental impact of pollutants. A considerable amount of rice husk ash is currently produced when rice husk is burned as fuel in rice mills to provide steam for the boiling process of rice grains. This has a negative impact on the surrounding population as well as the environment. The inclusion of additional cementitious elements, such as rice husk ash, has been shown by numerous studies in recent years to not only enhance the various properties of concrete, but also to lower building costs. The viability of partially replacing cement in the manufacturing of concrete with percentage amount of rice husk ash is described in this research study. In this study, rice husk ash was used in place of cement in the amount of 10% with various water cement ratios, which are 0.45, 0.48, and 0.50% by weight of cement for rice husk ash concrete mixtures. These mixtures were then tested and compared with conventional (base) concrete in terms of compressive strength and split tensile strength. For a period of 28 days. According to test results, with addition of rice husk ash with different water cement (W/C) ratio 0.45, 0.48, or 0.50 improves the compressive and split tensile strength by up to 10.09%., 10.77% at W/C ratio of 0.48 and 0.45 in comparison to regular concrete.

***Keywords*:** Rice husk ash, concrete, water cement ratio, strength test, cement

1. INTRODUCTION

A byproduct of milling rice, rice husk ash (RHA) can be used to concrete as an additional cementitious element. In general, RHA was used to describe an agricultural by-product that was produced under controlled circumstances by burning husk at temperatures lower than 800 °C. The procedure yields roughly 25% ash, which is extremely pozzolanic since it contains 85% to 90% amorphous silica and roughly 5% alumina. In the past it has been revealed that the cellular RHA particles in concrete with RHA had an absorptive quality, which meant that more water was needed for the same consistency. It provides an environmentally approachable technique of improving the workability, strength, and toughness of concrete [1]. A study on cement concrete, which is still the best building material to employ in any kind of civil engineering structure [12]. Mixtures with a low water/binder ratio perform worse when it comes to sulphate resistance. Sulphate resistance benefits from the small amount of initial air curing that mixes undergo. At high temperatures and with alternating cycles of wetting and drying, the rate of deterioration of mixes caused by sulphate attack is increased.[12].

There are two methods to burn rice husk: purposefully and accidentally. In open heap communities, rice husk was first burned to ash at temperatures ranging from 300 to 450 degrees Celsius. Uncontrolled burning of the husk below 500 °C did not complete the ignition, and a significant amount of unburned carbon was discovered in the ensuing ash. A key consideration in the design of concrete mixes is the W/C ratio, which has a major impact on the porosity, density, and strength of the hardened concrete as well as controlling the hydration process in rice husk ash concrete. the highest strength was attained by the concrete with 15% RHA and 85% OPC of total binding material[2]. In the past the usage of rice husk ash mainly 10% RHA-replaced cement shows superior strength above control concrete at all ages [15]. there is a 57.2, 56.02, and 55.04 percentage increase in tensile strength for 10, 15%, and 20% of cement replacement by RHA, respectively [16].The ordinary port land (OPC) cement concrete has a lower compressive strength than concrete with up to 30% RHA added to the cement concrete [17]. In the previous studies it has noticed that for every sample, the split tensile strength and compressive strength rise at the same time. plain concrete had superior strength for both RHA replacements. Furthermore, the cost of additional cementitious material may be lowered by roughly 40% when RHA is used [18]. The concrete workability, split tensile strength, flexural strength, and compressive strength of RHA concrete that has been partially replaced with cement.[9].RHA may

be able to offset the issue of recycling large amounts of husk waste that would otherwise be landfilled because of ignorance of its potential economic benefits. Here, RHA was procured locally from Lengan, an Isfahan-based company. After that, it was burned for five hours at 600 °C in a laboratory mill[8]. The percentage of RHA in concrete grew to 20%, there was a notable decrease in new concrete's workability and an increase in the material's compressive and cracking tensile strengths [13]. At 30% RHA, the maximum decline was found to be roughly 28% of the typical shrinkage that occurs in concrete after 90 days[13].The use of magnesium sulfate solution to partially substitute rice husk ash on the compressive strength and durability of concrete have significant effect[15]. Rise husk ash has been added at different percentages by weight of cement for the mixture and the outcomes show that the RHA increased the durability of the concrete. [15]. The RHA's significant pozzolanic activity is due to its huge specific surface area and non-crystalline silica. Research on the concrete subjected to sulfate and the sulfate attack significantly affects the concrete's microstructure and engineering qualities [10]. The compressive strength of a few commercial sand concrete blocks. Firewood was used to create Rice Husk Ash (RHA) to ensure that the constituent elements of ordinary Portland Cement (OPC) Rice Husk Ash (RHA) hollow sand concrete blocks were suitable for block making the ash concentration of OPC/RHA paste causes the setting times to increase[11]. A number of variables affect the mechanical qualities of rice husk ash concrete (RHAC), one of which is the (W/C) ratio, which is crucial for establishing the hydration process and ultimate concrete strength. Therefore, this study is focused to examine and analyze the mechanical properties of natural fiber in general and rice husk Ash content 10% in particular as a reinforcing material with different percentages of water cement (W/C) ratio to construct the concrete cylinders and concrete cubes. The analysis will be carried out through experimentation testing in laboratory.

2. Materials and Methods

Cement concrete stabilized with 10% addition of rice husk ash (RHA) was used as the base material for this investigation with the addition of different amount of water cement ratio percentages. RHA, is an agro-based waste material that is widely available worldwide particularly in nations that cultivate rice, like Pakistan, India, Bangladesh and other words. About 200 kg of rice husk can be produced from one ton of paddy rice, and when this husk burns, about 40 kg of ash is produced. The different stages of rice husk stocks are shown in Figure 1.



(a) Rice Husk



(b) Rice Husk Ash



(c) Rice Husk Ash storage

Figure 1.Stocking of different Stages of Rice Husk

The most popular type of cement, known as ordinary Portland cement, or OPC, is utilized as a binder ingredient in this investigation. In composite materials like cement concrete, aggregates play a crucial role as reinforcement, enhancing the overall strength of the material. The OPC and aggregate used in this investigation are shown in Figure 2.



OPC cement



Aggregates

Figure 2. OPC cement & Aggregates

According to a previous study, RHA has significant pozzolanic activities because to the fineness features, high specific surface area, and presence of amorphous silica. The usual chemical configuration and physical characteristics of RHA as shown in Table 1. Chemical proportion of RHA

Table 1. Chemical proportion of RHA

Chemical Properties	Constituents (Weight, %)
SiO2	78-86
Al2O3	0.1-2.0
Fe2O3	0.16-1.85
CaO	0.55-4.81
MgO	0.35-4.5
SO3	0.24-1.18
Na2O	1-1.14
K20	2.54-3.68
Loss in ignition	4-8.55

Table 2. Physical properties of RHA

Specific Gravity (gm/cm3)	2-2.23
Fineness passing 45 µm (%)	70-99
Setting Time (minutes)	(Initial 190-200) (Final 260-265)
Compressive Strength (N/mm2)	(28Days 25-28)

The ASTM C39/C39M and C496 protocol is adopted for performing the compressive strength and split tensile strength test of concrete cube and cylinder. Based on the amount of RHA (rice husk ash) utilized in the concrete, the specimens are split into four batches. RHA (rice husk ash) dosage is expressed as a percentage of cement weight. Concrete's characteristics and behavior are highly dependent on a variety of factors. Therefore, it is essential to establish the parameters of the study before starting any experimental investigations. The information about the batches of samplings cast and tested is displayed in Table 3.

Table 3. Details of the Batches of Specimens Cast and Tested

S.NO	Batch	RHA %	W/C Ratio
1	B – 1	0%	0.50
2	B – 2	10%	0.45
3	B – 3	10%	0.48
4	B - 4	10%	0.50

3. EXPERIMENTAL SETUP

Concrete quality is tested in the lab using the Compression Testing Machine (CTM) equipment. Concrete cubes and cylinders are tested using the CTM machine.to assess compressive strength and split cylinder tensile strength of the concrete as shown in Figure 3.

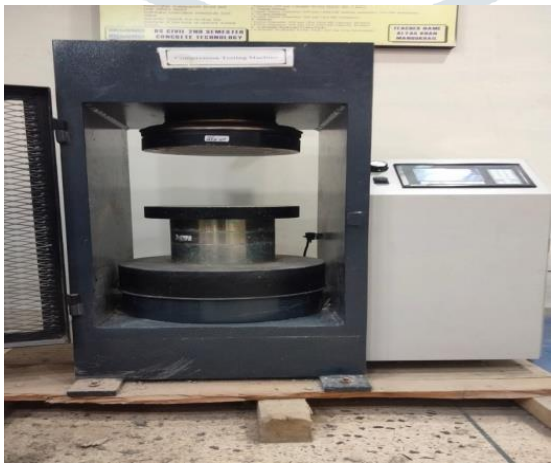


Figure 3. Compression Testing Machine (CTM)

The Figure 4 and Figure 5 show the pictorial view of concrete testing in the lab before and after the testing of concrete cubes and concrete cylinders respectively.




The Pictorial view of cube before testing in CTM | The Pictorial view of cube during testing in CTM

Figure 4. Concrete Cubes before and after testing during compressive strength testing




Pictorial view of cylinder before testing in CTM | Pictorial view of cylinder during testing in CTM

Figure 5. Concrete cylinders before and after testing during split tensile strength testing

4. Sample Preparation

For the shape and size of specimen the following standard-size specimens as shown in Figure 6 were casted, cured then tested throughout the investigation. Cubes Standard-sized 100 mm x 100 mm x 100 mm cubes were casted then cured it for 28 days before testing of compressive strength test. Cylinders Standard-sized (150 x 300 mm) were casted then cured it for 28 days before testing of split tensile strength test.




Dimensional view of cube specimen | Dimensional view of Cylinder specimen

Figure 6. Pictorial View of Cube and Cylinder

The cement is mixed with aggregates and 10% rice husk content by weight with addition of specified amount of water cement (W/C) ratio. The strengthening occurs throughout the hardening phase, which can last for several days or weeks. The mixing, pouring and curing of the concrete are shown in Figure 7 .





(a) Mixing and pouring of concrete | (b) Curing process

Figure 7. Mixing with pouring and curing of concrete samples

Table 4. Mix proportion for RHA (Rice Husk Ash) concrete for cube

Materials	Control Mix	RHA 10%	RHA 10%	RHA 10%

Cement (Kg)	1.17	1.05	1.05	1.05
RHA (Rice Husk Ash) (kg)	0	0.117	0.117	0.117
Fine Aggregates (kg)	2.31	2.31	2.31	2.31
Coarse Aggregates (kg)	4.62	4.62	4.62	4.62
Water (kg)	0.60	0.53	0.56	0.6
W/C	0.50	0.45	0.48	0.50

Table 5. Mix proportion for RHA (Rice Husk Ash) concrete for cylinder

Materials	Control Mix	RHA 10%	RHA 10%	RHA 10%
Cement	1.90	1.71	1.71	1.71
RHA (Rice Husk Ash)	0	0.190	0.190	0.190
Fine Aggregates (Kg)	3.42	3.42	3.42	3.42
Coarse Aggregates(Kg)	6.84	6.84	6.84	6.84
Water (kg)	0.95	0.855	0.912	0.95
W/C	0.50	0.45	0.48	0.50

5. RESULTS AND DISSCUSSION

5.1 Influence of water cement (w/c) ratio on compressive strength of normal concrete and reinforced concrete

The effect of water cement ratio on compressive strength of normal concrete and concrete reinforced with 10% RHA are elaborated in Table 6. After 28 days of curing compared to the control mix's compressive strength (concrete without rice husk ash), the compressive strength of concrete containing 10% RHA as a partial replacement of cement with varying w/c ratios of 0.45, 0.48, and 0.50 increased by 10.09%, 9.35%, and 9.5% respectively.it has been shown in Figure 8 the w/c ratio at 0.45 shows better improvement in both normal and reinforced concrete.

Table 6. Compressive strength of normal & reinforced concrete with different water cement Ratio

Water cement Ratio	Average Compressive Strength (N/mm^2)			% variation in compressive strength of 10% of RHA concrete as compared to Normal concrete
	Normal Concrete	Concrete with 10% of RHA	Strength improvement with RHA addition	
0.50	27.58	30.2	2.62	9.5
0.48	29.6	32.37	2.77	9.35
0.45	30.2	33.25	3.05	10.09

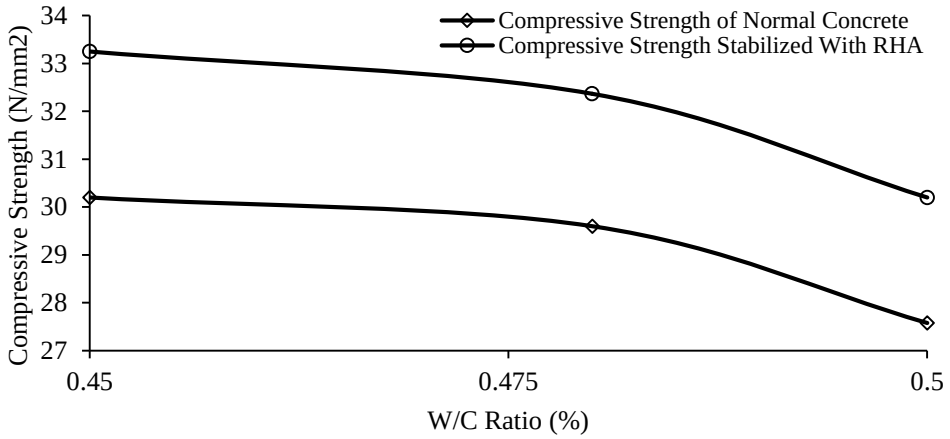


Figure 8. Compressive strength of Normal and Stabilized Concrete

5.2 Influence of water cement (w/c) ratio on split tensile strength of normal concrete and reinforced concrete

The effect of water cement ratio on split tensile strength of normal concrete and concrete reinforced with 10% RHA are elaborated in Table 7. After 28 days of curing compared to the control mix's compressive strength (concrete without rice husk ash), the split tensile strength of concrete containing 10% RHA as a partial replacement of cement with varying w/c ratios of 0.45, 0.48, and 0.50 increased by 9.57%, 10.77%, and 7.43% respectively.it has been shown in Figure 9Figure **8** the w/c ratio at 0.48 shows better improvement in reinforced concrete only while the normal concrete shows the improvement on w/c ratio at 0.45.

Table 7. Split Tensile strength of normal & reinforced concrete with different water cement Ratio

Water cement Ratio	Average Split Tensile Strength (N/mm^2)			% variation in Split tensile strength of 10% of RHA concrete as compared to Normal concrete
	Normal Concrete	Concrete with 10% of RHA	Strength improvement with RHA addition	
0.50	2.96	3.18	0.22	7.43
0.48	2.97	3.29	0.32	10.77
0.45	3.03	3.32	0.29	9.57

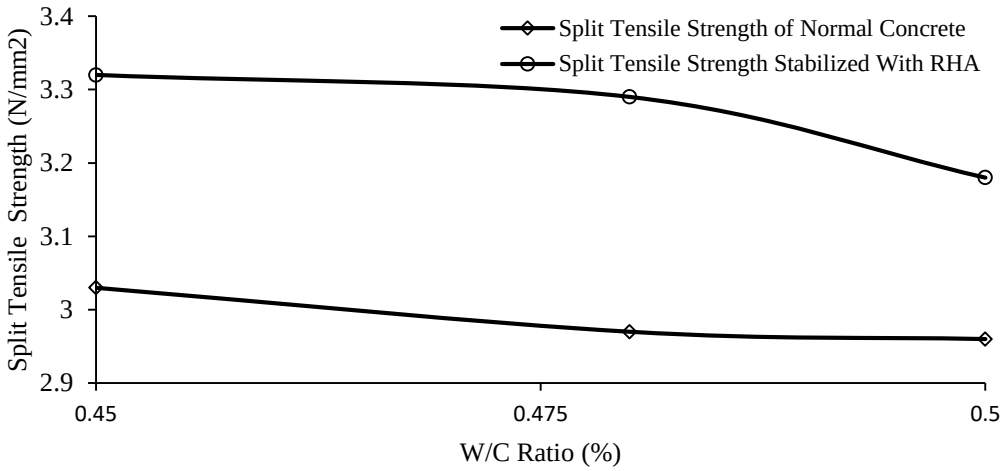


Figure 9. Split Tensile Strength of Normal and Stabilized Concrete

6. CONCLUSION

It is possible to conclude that at 28 days of curing the highest increase in concrete's compressive strength with a 10% partial replacement of cement is 10.09% concrete with a 0.45 W/c ratio and the highest improvement in split tensile strength of concrete with a 10% partial replacement of cement is 10.77% concrete with a 0.48 W/c ratio.

The approach seems to be effective when taking into account the hidden costs of environmental preservation and the intangible cost of the RHA (rice husk ash) disposal problem. The main issues with RHA (rice husk ash) disposal can be resolved with RHA (Rice Husk Ash) concrete, which also reduces the need for cement, which uses a lot of energy and natural resources.

7. Acknowledgments

The authors are thankful to the Civil Engineering Department of College of Engineering and Technology, Ziauddin University Karachi for providing financial support and testing facility.

8. Declaration of Conflict

There are no conflicts between the authors of this research paper.

REFERENCES

[1] Fapohunda, C., et al., A review of some agricultural wastes in Nigeria for sustainability in the production of structural concrete. 2021. 18(2): p. 76-87.

[2] Mohamad, N., et al., Environmental impact of cement production and Solutions: A review. Materials Today: Proceedings, 2022. 48: p. 741-746.

[3] Seyed Alireza Zareeia, F., FarzanDorostkarc, MojtabaAhmadic "Rice husk ash as a partial replacement of cement in high strength concrete containing micro silica: Evaluating durability and mechanical properties". Sustainability, 2017(15May 2017).

[4] Ayesha Siddika, M.A.A.M.M.H.A., Study on concrete with rice husk ash. 2018. Volume 3.

[5] Jan Skalny, J.M.a.I.O., Consequences of sulphate attack onconcrete. 2002.

[6] Abdullahi, E.B.O.a.M., the Use of Rice Husk Ash in Low-Cost Sandcrete Block Production. Leonardo Electronic Journal of Practices and Technologies ISSN 1583-1078, 2006(January-June 2006.): p. 58-7.

[7] J. Parsad, D.K., Jain and A.K Ahuja, Factors Influencing the Sulphate Resistance of cement concrete and morter. 2006.

[8] S. I. Khassaf, A.T.J., F.K. Mahdi, Investigation the Properties of Concrete Containing Rice Husk Ash to Reduction the Seepage in Canals. International journal of scientific & technology research, 2007. Volume 3(ISSUE 4, ISSN 2277-8616, April2007).

[9] V.V.S Sarmaetal, P.V.R.G.V., Durability study on Compressive strength using rice husk ash as a partial replacement using magnesium sulphate solution. International Journal of Engineering Research and Development, 2014. Volume 10(ISSUE 5 (May 2014)): p. PP43-47.

[10] Ramezanianpour, A. A., P. Pourbeik, M. Mahdikhani, and F. Moodi. "Mechanical Properties and Durability of Concretes Containing Rice Husk Ash as Supplementary Cementing Material." In 2nd International Conference on Sustainable Construction Materials and Technologies. 2010.

[11] Alex, Josephin, J. Dhanalakshmi, and B. Ambedkar. "Experimental investigation on rice husk ash as cement replacement on concrete production." Construction and Building Materials 127 (2016): 353-362.

[12] Ganesan, K., K. Rajagopal, and K. Thangavel. "Rice husk ash blended cement: Assessment of optimal level of replacement for strength and permeability properties of concrete." Construction and building materials 22, no. 8 (2008): 1675-1683

[13] Mayooran, Selvaraja, Singarajah Ragavan, and Navaratnarajah Sathiparan. "Comparative study on open air burnt low-and high-carbon rice husk ash as partial cement replacement in cement block production." Journal of Building Engineering 13 (2017): 137-145.