Asian Journal of Current Research

Volume 9, Issue 3, Page 143-148, 2024; Article no.AJOCR.12279
ISSN: 2456-804X

Exploring the Use of Rice Husk Ash in Concrete: Benefits and Applications

Ritesh Jain [a++*] and Satinder Kar Khattra [a#]

[a] *Department of Civil Engineering, PAU Ludhiana, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/ajocr/2024/v9i38799

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.ikprress.org/review-history/12279

Short Communication

Received: 21/05/2024
Accepted: 24/07/2024
Published: 31/07/2024

ABSTRACT

There are both economical and practical benefits to employing industrial and agricultural wastes in addition to more traditional building materials, despite the fact that their use has historically led to issues with pollution and waste management. Since the manufacture of one ton of ordinary Portland cement (OPC) produces nearly one ton of CO2, the demand for cement has surged in the last several decades, posing a serious ecological threat. The cement and building industries are linked to serious air pollution and harm to human health. As a result, governments and environmentalists have mandated the use of more environmentally friendly supplemental cementing materials in order to strictly regulate emission rates. Massive amounts of rice husk are harvested as a by-product material from the rice plant. The wastes have cheap transportation costs because they are typically easily accessible locally and have no commercial use. The woody coating that envelops the kernel or grain is called rice husk ash (RHA), and it is composed of two interlocking portions. Husk is a byproduct of yielding grain since it has to be manually removed by threshing or milling after rice is harvested. Wastes from the rice business, such as rice husks, are usually

---

[++] *Associate Professor;*
[#] *Assistant Professor;*
**Corresponding author: E-mail: ritesh5@pau.edu;*

***Cite as:** Jain, Ritesh, and Satinder Kar Khattra. 2024. "Exploring the Use of Rice Husk Ash in Concrete: Benefits and Applications". Asian Journal of Current Research 9 (3):143-48. https://doi.org/10.56557/ajocr/2024/v9i38799.*

disposed of in the open, harming the environment and providing no economic advantages. Research on the application of rice husk ash (RHA) in concrete is crucial due to its potential to enhance concrete properties and reduce environmental impact. The potential of RHA for waste management and the construction industry is demonstrated by a thorough examination of the potential benefits and applications of rice husk ash in concrete, supporting research studies as well as practical applications in building and environmental projects.

Keywords: Concrete; rice husk ash; pollution and strength.

1. INTRODUCTION

Industrial and agricultural wastes have historically led to issues with pollution and waste management. Nonetheless, there are benefits to using industrial and agricultural wastes in addition to more conventional building materials from a practical and financial standpoint. Since the wastes are readily available locally and typically have no commercial value, their transportation costs are low. The environment is protected and natural resources are conserved when waste materials are used in building. Several waste materials with pozzolanic qualities have been investigated for potential application in blended cements, such as fly ash, silica fume, volcanic ash, and corn cob.

Husk is a byproduct of yielding grain since it has to be manually removed by threshing or milling after rice is harvested. Wastes from the rice business, such as rice husks, are usually disposed of in the open, harming the environment and providing no economic advantages. The two overlapping portions of rice husk ash (RHA) are the woody coating that encases the grain or kernel.

The Food and Agriculture Organization (FAO) estimates that 482 million tons of rice were produced worldwide in 2016. Food Corporation of India estimates that 106,500 thousand metric tons of rice were produced annually in India in the 2016–2017 year. With a husk to paddy ratio of roughly 20% and an ash to husk ratio of 18%, 24.4 million tons of RHA are produced globally each year, with 21,300 thousand metric tonnes coming from India. This soluble silica, most likely in the form of silicate or monosilicate acid, enters the rice plant by its roots. It then travels to the plant's outer surface, where it concentrates through evaporation and polymerization to create a cellulose-silica membrane.

Pozzolanic materials, so named because they include reactive silica, are widely utilized in the manufacturing of concrete and cement. Pozzolans are also described as siliceous or siliceous and aluminous materials that, by themselves, have little to no cementitious value. However, when they are divided extremely finely and mixed with water, they chemically react with calcium hydroxide at room temperature to form compounds that do. As a result, this RHA has been utilized for many years to produce concrete all over the world.

RHA can be used instead of clay in the construction of bricks because it contains silicate, which combines with calcium hydroxide to form bonding chemicals. From an environmental perspective, the resulting RHA is an additional source of risk. Since there is less load demand for rural infrastructure, high-quality materials are not needed. Thus, attempts have been made to employ RHA as a building material given its cementitious character. This study used RHA generated from uncontrolled combustion, which is available from rice milling, where it is burned in an uncontrolled atmosphere.

This study examined the review on the effects of replacing fine aggregate with rice husk in terms of various aspects such as the workability, bulk density, and compressive strength of concrete in order to maximize the use of locally available materials.

2. PRESENT STATUS

Since the manufacture of one ton of ordinary Portland cement (OPC) produces nearly one ton of CO_2, the demand for cement has surged in the last several decades, posing a serious ecological threat. The cement and building industries are linked to serious air pollution and harm to human health. As a result, governments and environmentalists have mandated the use of more environmentally friendly supplemental cementing materials in order to strictly regulate emission rates. Massive amounts of rice husk are harvested as a by-product material from the rice plant. It is an organic waste product that creates problems when dumped because it has no useful purpose. Because of its high silica concentration, rice husk is suitable for use in OPC; when it is burned, it produces a high pozzolanic reactive rice husk ash (RHA), which is recyclable material based on renewable cement. There are many benefits to using RHA as mineral fillers in concrete, including improved technical properties and environmental cleanliness. RHA is also reasonably priced and widely available. Concrete composites that are strong, incredibly resistant to harsh environments, sustainable, and financially viable can be made with RHA. But the creation of environmentally friendly and sustainable concrete composites has also grown to be a major priority in the global building sectors.

3. LITERATURE REVIEW

Research on the characteristics, uses, and review processing of reactive silica derived from rice husk was conducted by Chandrasekhar in 2003. The waste material known as rice husk was widely accessible in all countries that produced rice. It was occasionally used as fuel in some areas to parboil rice in rice mills. In turn, the partially burned rice husk adds to further pollution in the environment. In addition to overcoming this, efforts have been made to develop ways to add value to these wastes by employing them as a secondary source of resources. About 20 percent of rice husk is made up of hydrated, amorphous silica. The silica changed into crystobalite, a crystalline form of silica, upon thermal treatment. On the other hand, amorphous silica with a large surface area, ultra-fine size, and high reactivity was created under controlled burning conditions. This micro-silica may be used to create sophisticated materials such as Mg2Si, SiC, Si3N4, and elemental Si. This rice husk silica was also used in high strength concrete as a silica fume alternative because of its high pozzolanic activity. It was also investigated whether this silica could be used as a filler in polymers. In addition to highlighting some findings from the authors' laboratory's processing and characterization of RHA and reactive silica derived from it, the current paper presented an attempt to compile and critically evaluate the research work completed thus far on the properties, processing, and applications of rice husk silica in various laboratories.

Chindaprasirt [1] Portland cement, fly ash, and rice husk ash mortar's ternary blend's strength, porosity, and resistance to corrosion. According to these findings, using a ternary combination of OPC, RHA, and FA results in mortars that are stronger than OPC mortar both at later ages and at low replacement levels with RHA and FA. When pozzolan is replaced at a low level of up to 20%, the porosity of the mortar decreases; when pozzolan is replaced at a 40% level, the porosity increases. However, the inclusion of both single pozzolan and the ternary blend of OPC, RHA, and FA considerably increased the mortar's resistance to chloride-induced corrosion as assessed by ACTIV. Compared to mortar containing a single pozzolan, ternary blend mortar has a greater corrosion resistance. The ternary blend of OPC, RHA, and FA was highly successful in accelerating mortar corrosion caused by chloride.

Givi [2] discussed properties of Mortar and Concrete Are Affected by Rice Husk Ash. The use of additional cementing elements has been a crucial component of high strength and high performance concrete mix design for the past ten years. These could be less energy and time-consuming to create, natural materials, byproducts, or industrial trash. Among the frequently utilized extra cementing ingredients were fly ash, rice husk ash (RHA), silica fume (SF), and ground granulated blast furnace slag (GGBFS). RHA is a by-product substance made of non-crystalline silicon dioxide with a high specific surface area and high pozzolanic reactivity that is created from the burning of rice husk. It was a pozzolanic material that was utilized in mortar and concrete, and it showed promise in enhancing the materials' durability and mechanical qualities. An overview of the research done on using RHA in concrete and mortar as a partial replacement for cement is given in this study. A study by Perez et al. [3] also reported on the mechanical, durable, and fresh qualities of concrete and mortar.

The potential for using rice husk ash as a building material in rural regions was investigated by Hossain et al. [4]. RHA, or rice husk ash, was an alternative building material for bricks and concrete that was produced through uncontrolled combustion. A significant amount of RHA is produced annually, which is concerning for the environment. RHA does, however, include silicate, which is a feature of pozzolanic materials. An attempt was made to use this RHA in place of clay for bricks and cement for concrete. The concrete and brick experimental findings were expressed in a normalized manner. Normalization was carried out using the control specimen—that is, a specimen devoid of RHA. remote residents are unable to use standard building materials due to financial constraints, but RHA, which was abandoned in a remote region, can provide an alternative. Based on the load requirement, the normalized figure can be used to determine the usable percentage of RHA. This study aimed to provide insight into the potential applications of RHA as a building material. This study was not intended to investigate the economic effects of RHA. A similar idea was given by Amran [5] and Siddika et al. [6].

Kadam [7] studied the effects of substituting sieved coal bottom ash for sand on the characteristics of concrete with a percentage change in cement. This paper presents the results of an experimental investigation on the effects of sieved coal bottom ash instead of natural sand on the properties of concrete at weight additions of 5%, 10%, 15%, 20%, 25%, and 30%. First, M-35 grade concrete was cast and tested using a predetermined ratio of 70% sieved coal bottom ash and 30% natural sand. The percentage changes in strength at 7, 28, 56, and 112 days were evaluated after testing on the sieved coal bottom ash concrete (compressive strength, split tensile strength, flexural strength, density, and water permeability). The results showed a significant increase in strength when 20% more cement was added with the weight of cement. The water cement ratio was kept at 0.45.

Rice husks were researched by Obilade [8] for use as fine particles in concrete. This study examines the effects of substituting rice husk for fine aggregate in terms of weight and volume on the workability, bulk density, and compressive strength of concrete. Sand was replaced with rice husk by volume and by weight, respectively. The replacement percentages were as follows: 0%, 5%, 10%, 15%, 20%, and 25%. The weight-to-volume mix ratio that was used was 1:2:4. The test for compacting factor was conducted on freshly laid concrete, and the test for compressive strength was conducted on 150 mm concrete cubes that had hardened after 7, 14, and 28 days of water curing. Similar findings by Chandraul [9] showed that when the fraction of sand replaced with rice husk increased, the Compacting Factor, Bulk Density, and Compressive Strength all dropped. When rice husk was used in place of sand in volume, the volume-batched concrete produced had a higher compacting factor than when sand was replaced by weight. In addition, the volume-batched concrete made by substituting rice husk for sand had greater bulk densities and compressive strengths than the concrete made by replacing weight. Additionally, the study showed that rice husk might potentially be used in place of fine aggregate when making structural concrete. For projects using rice husk, volume batching was advised to be used.

In 2017, Nambirajan [10] examined the effects of glass fiber and rice husk ash on cement characteristics, partially substituting quarry dust for fine aggregate. Cement, fine, coarse, and fiber mixtures were combined to create fiber-reinforced concrete, a composite material. Better fatigue strength, as well as higher static, dynamic, and compressive strengths, are displayed by fiber-reinforced concrete. The study examined the strength of fiber-reinforced concrete, utilizing quarry dust as fine aggregate and rice husk ash in place of some of the cement. By weight of cement, glass fiber was added in increments of 0.25% and 0.5%. Ordinary Portland Cement was substituted with 10%, 20%, and 30% weight of rice husk ash instead of cement. A 20% substitution of quarry dust for fine aggregate was made.

4. MANUFACTURING PROCESSES OF RHA CONCRETE COMPOSITES

RHA particles can be added to concrete to create RHA-based composites that are strong, extremely resistant to harsh conditions, sustainable, and financially viable (by keeping the guidelines as suggested by BIS codes) [11,12-17]. But the manufacturing of environmentally friendly and sustainable concrete composites has emerged as a major problem for the world's construction sectors. Thus, the source, clean manufacture, pozzolanic activity, and chemical makeup of RHA particles are reviewed in this key research. Three approaches can be used to study pozolanic activity: First, this ash is more active the more the addition of RHA alters the conductivity measurement of a saturated Ca(OH)2 solution. The only useful information obtained from this method is the degree of pozzolanic reactivity of the RHA; second, the rate at which Ca(OH)2 enters the pozzolanic reaction with RHA is measured [11]; and third, the strength of a paste made with RHA and pure Portland cement is compared.

5. CONCLUSIONS

A thorough analysis of the possible advantages and uses of rice husk ash in concrete, supporting academic study as well as real-world implementations in building and environmental initiatives illustrates the potential of RHA for waste management and the construction industry.

6. FUTURE PROSPECTS AND RECOMMENDATIONS

Because of its potential to improve concrete qualities and lessen environmental effect, research on the use of rice husk ash (RHA) in concrete is important. A review on this study indicates:

1. Use of RHA demonstrating a sharp rise in the volume of water needed for specimen preparation.
2. Compared to concrete mixes that contain rice husk ash, standard mixes require less water.
3. We can draw the conclusion that, to a limited extent, rice husk ash can be substituted for fine aggregate in situations where fine aggregate is lacking.
4. There are several new uses for RHA concretes that are worth investigating, such as the development of biomass-based RHA-based concretes as a unique class of lightweight fireproofing;

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chindaprasirt P, Rukzon S. Strength, porosity and corrosion resistance of ternary blend Portland cement, rice husk ash and fly ash mortar.Const & Buld Matr. 2008;22:1601–1606.
2. Givi A, Rashid SA, Aziz F, Salle. A Contribution of Rice Husk Ash to the Properties of Mortar and Concrete. Amrcn Sci. 2010;6:157-65.
3. Pérez SM, Díaz ES, Barboza-Cullqui D, García-Chumacero JM. Use of recycled concrete and rice husk ash for concrete: A review. Journal of Applied Research and Technology. 2024;22(1): 138-155.
4. Hossain T, Sarker KS, Basak C. Utilization potential of rice husk ash as a construction material in rural areas. Civ Engg. 2011; 2:175-88.
5. Amran M, Fediuk R, Murali G, Vatin N, Karelina M, Ozbakkaloglu T, Mishra J. Rice husk ash-based concrete composites: A critical review of their properties and applications. Crystals. 2021;11(2): 168.
6. Siddika A, Mamun MAA, Ali MH. Study on concrete with rice husk ash. Innovative Infrastructure Solutions. 2018;3:1-9.
7. Kadam MP, Patil YD. The Effect of sieved Coal Bottom Ash as a Sand Substitute on the Properties of Concrete with Percentage Variation in Cement. Cvl Engg & Arch. 2014;2:160-66.
8. Obilade. Use of rice husk ash as partial replacement for cement in concrete. Engg App Sci. 2014;5:11-16.
9. Chandraul K, Singh MK, Saxena AK, Arora TR. Experimental Study of RHA Concrete.Res App Sci & Engg Tech. 2015;3:77-82.
10. Nambirajan S. Effect of Rice Husk Ash and Glass Fibre on properties of Cement with Partial replacement of fineaggregate by Quarry Dust.Adv Res, Id & Innv Tech. 2017;3:407-16.
11. BIS: 10262-2009: Recommended guidelines for concrete mix design, Bureau of Indian Standard, New Delhi-2004
12. BIS: 1199-1959 (Reaffirmed 2004): Methods of Sampling and Analysis of Concrete, Bureau of Indian Standard, New Delhi-1999
13. BIS: 2386 (Part I)-1963 (Reaffirmed 2002): Methods of Test for Aggregates for Concrete, Bureau of Indian Standard, New Delhi-1963
14. BIS: 383-1970 (Reaffirmed 2002): Specification for Coarse and Fine Aggregates from Natural Sources for Concrete, Bureau of Indian Standard, New Delhi-1997
15. BIS: 456-2000 (Reaffirmed 2005) : Code of practice- plain and reinforced concrete, Bureau of Indian Standard, New Delhi-2000.

16. BIS: 516-1959 (Reaffirmed 2004): Methods of tests for strength of concrete, Bureau of Indian Standard, New Delhi-2004

17. BIS: 4031 (Part 4, 5&6)-1988: Methods of Physical Tests for Hydraulic Cement, Bureau of Indian Standard, New Delhi-1988

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.ikprress.org/review-history/12279