International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 02 | Feb 2025 www.irjet.net p-ISSN: 2395-0072

"An Experimental Study on Partial Replacement of Cement by RHA and Sand by Rice Husk."

Maulya K T[1], Hemantha K M[2], Sinchana M D[3], Neha P[4], Manjunath H S[5]

[1,2,3,4] *Students, Department of Civil Engineering Rajeev institute of Technology, Hassan.*
[5] *Assistant Professor, Department of Civil Engineering Rajeev institute of Technology, Hassan.*

Abstract – This study explores the partial replacement of cement with rice husk ash (RHA) and sand with rice husk to address issues related to availability, cost, quality, and pollution. Solid masonry blocks of size 150x150x15 mm, with M25 grade, were produced by replacing 30% of cement with RHA by weight and substituting rice husk for sand at varying percentages (0%, 5%, 10%, 15%, 20%, 25%). Cubes were prepared for testing after curing in water for 3, 7, and 28 days, with the control group being standard concrete. The tests measured compressive strength and workability (using the slump cone test). The results showed that both workability and strength were slightly better than standard concrete, meeting the limits set by established standards.

Key Words: **Rice husk ash, Rice husk, Sand, Compressive strength, Slump Cone.**

1.INTRODUCTION

Cement is essential for India's infrastructure and construction sectors, with the country being the second-largest producer globally, producing over 500 million tons annually. Despite this, regions in India have faced cement shortages due to factors like rising demand from government infrastructure projects, raw material shortages, and logistical issues. In response, the industry is expanding production through new plants and projects while adopting new technologies to improve efficiency and reduce environmental impact. However, cement scarcity remains a challenge.

The construction industry heavily relies on cement and sand, but their high demand raises concerns about environmental and economic impacts. Cement production significantly contributes to carbon emissions, and excessive sand mining harms ecosystems. In light of these issues, alternatives like Rice Husk Ash (RHA) and rice husk have been explored to replace cement and sand. RHA, a by-product of rice milling, has pozzolanic properties that enhance concrete strength and durability while reducing the carbon footprint of cement. Similarly, rice husk can replace sand, mitigating sand scarcity and providing a solution to waste management.

This study aims to evaluate the effects of using RHA as a partial cement replacement and rice husk as a sand substitute in concrete, focusing on mechanical properties, durability, workability, and environmental impact. The research contributes to the development of sustainable concrete solutions that maintain performance standards while reducing environmental harm. By examining the optimal use of these materials, the study supports greener, eco-friendly construction practices.

1.1 Greenhouse Gases Emission - Cement industry

The cement industry is a major contributor to greenhouse gas emissions, including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), as well as air pollutants like particulate matter (PM), sulfur dioxide (SO2), and nitrogen oxides (NOx). It also releases toxic substances such as dioxins, heavy metals, and polycyclic aromatic hydrocarbons (PAHs). These emissions impact health, the environment, and the economy. The industry is working on reducing emissions through energy efficiency, alternative fuels, and control technologies.

1.2 Greenhouse Gases Emission - Sand mining

Sand used in construction can have several disadvantages, including environmental impact from over-mining, quality issues like impurities and improper grading, and structural problems from excessive use. It can also be costly, especially if transported from distant sources, and poses health risks due to dust and silica exposure. Sand is a non-renewable resource, and its overuse requires alternative materials like crushed stone or recycled options to minimize its impact.

2. Materials and Methodology

2.1 Cement

Ordinary Portland Cement (OPC) is the most widely used cement in construction. It is a fine powder made from calcium, silica, alumina, and iron, typically sourced from limestone, clay, and other materials.

2.2 Fine Aggregate

Fine aggregate is a type of aggregate used in concrete, consisting of particles smaller than 4.75 mm. It is usually made of sand, crushed stone, or recycled concrete and helps fill the voids in the concrete mix, enhance workability, and provide a smooth finish. Fine aggregates are classified based on their size, shape, and texture.

2.3 Coarse Aggregate

Coarse aggregates, including gravel, crushed stone, and recycled concrete, provide strength and stability in construction. They are sourced from natural deposits or produced by crushing larger rocks into smaller particles

2.4 Rice husk

Rice husk, a renewable by-product rich in silica, cellulose, and lignin, offers sustainable applications in construction, including partial replacement for cement and sand, while reducing waste and greenhouse gas emissions.

2.5 Rice husk ash

Rice Husk Ash (RHA), rich in silica, enhances concrete's strength, durability, and sustainability. As a pozzolanic material, RHA offers a sustainable, eco-friendly alternative to traditional cement, reducing environmental impact.

2.6 Water

Water is essential in concrete mixing, aiding cement hydration and improving workability. Using clean, potable water ensures strong, durable concrete, as impurities can negatively affect its properties and performance.

3. Methodology

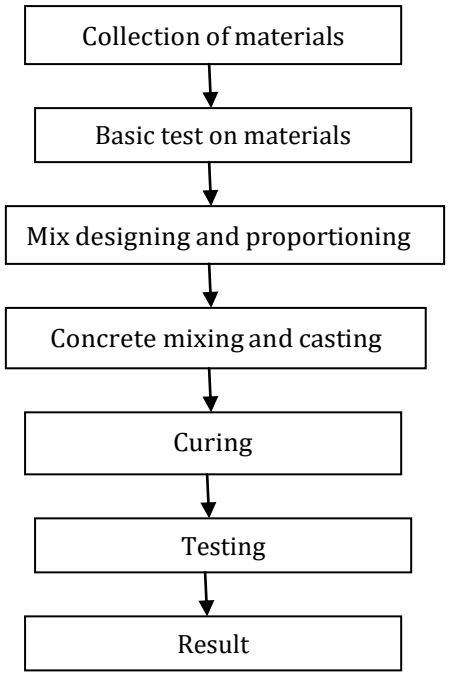

Table -1: Compressive strength

Compressive strength				
% of rice husk ash	% of rice husk	Days of curing	Compressive strength (KN)	Compressive strength (N/mm2)
0	0	3	165	7.3
		7	429	19.00
		28	657.8	29.23
30	5	3	175	7.7
		7	445	19.77
		28	679.8	30.21
30	10	3	153.9	6.84
		7	401.9	17.86
		28	614.6	27.31
30	15	3	139	6.1
		7	362	16.08
		28	518.6	23.04
30	20	3	113.8	5.05
		7	298.8	13.28
		28	485.4	20.37
30	25	3	92.4	4.10
		7	245.8	10.92
		28	393.2	17.47

The compressive strength test for concrete measures its ability to withstand loads that reduce its size. It involves applying a gradually increasing compressive load to a specimen until failure occurs, with the maximum load recorded. Dividing this load by the specimen's cross-sectional area gives the compressive strength, typically expressed in megapascals (MPa) or pounds per square inch (psi). This test is crucial for evaluating concrete quality and durability in construction, providing essential data for structural design and quality control. It plays a vital role in assessing the mechanical properties of materials used in the construction and engineering industries.

Table -2: Slump cone test

W/c ratio	% of RHA replaced (%)	% of rice husk replaced (%)	H1(mm)	H2 (mm)	Slump H1-H2 (mm)
0.45	0	0	300	224	76
0.45	30	5	300	227	73
0.45	30	10	300	230	70
0.45	30	15	300	234	66
0.45	30	20	300	238	62
0.45	30	25	300	241	59

H1 - Height of mould; H2 - Height of subsided concrete

The Slump Cone Test measures the workability of fresh concrete, assessing its consistency and flow. A cone-shaped mould is filled in three layers, each compacted with 25 strokes. After lifting the mould, the slump, or the distance the concrete settles, is measured. A zero slump indicates a stiff mix, while a high slump suggests a more workable but potentially segregating mix. Factors like water content, aggregate type, cement content, and temperature can influence the result. This test ensures accurate assessment of concrete workability, aiding proper placement, compaction, and finishing.

4. CONCLUSIONS

In this study investigating the partial replacement of cement and fine aggregate by rice husk ash and rice husk in concrete, the following conclusions can be drawn for the replacement of cement at 30% and fine aggregate at 0% ,5%, 10%, 15%, 20% and 25%.

- The workability of concrete is good for conventional concrete compared to replaced concrete.
- The compressive strength of concrete for 5% rice husk concrete is more (7.7 N/mm^2 for 3 days curing and 19.77 N/mm^2 for 7 days curing, 30.21 N/mm^2 for 28 days curing.) compared to conventional concrete (7.3 N/mm^2 for 3 days curing and 19.00 N/mm^2 for 7 days curing, 29.23 N/mm^2 for 28 days curing.)
- More than 5% replacement of rice husk, the compressive strength goes on decreasing.
- For replacement of 5% of rice husk and rice husk ash in concrete it gives more strength compare to conventional concrete.

REFERENCES

[1] "Rice Husk Ash in Concrete", Solomon Asrat Endale, Woubishet Zewdu Taffese, Duy-Hai Vo and Mitiku Damtie Yehualaw, Endale, S.A.; Taffese, W.Z.;Vo, D.-H.; Yehualaw, M.D. Rice HuskAsh in Concrete. Sustainability 2023,15, 137. https://doi.org/10.3390/su15010137 volume 15, Issue: 2023

[2] "Behaviour of Cement Concrete using Rice Husk As A Replacement of Fine Aggregate", Saritha Saju, ,Govind S Lal, Muhammed Ijas Ismail. Department of Civil Engineering, Mangalam College of Engineering Ettumanoor, India. International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Volume10, Issue 12- December-2022.

[3] "Rice Husk as Partial Replacement of Cement with Natural Fiber (Jute Fiber)", Ayan, International Journal of Research in Engineering and Science (IJRES). International Journal of Research in Engineering and Science (IJRES) ISSN (Online): 2320-9364, ISSN (Print): 2320-9356 Volume 10, Issue 3-2022.

[4] " REPLACEMENT OF CEMENT WITH RICE HUSK ASH IN CONCRETE" Md Sarfaraz. Department- Civil engineering Mewar University Chittorgarh Rajasthan India. International journal of research and analytical reviews, Volume 9, Issue 4 October 2022

[5] "EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF FINE AGGREGATE WITH RICE HUSK IN CONCRETE",A.Daniel Rex, S.Kirubakaran,M.Jegadeesan, P.Satheeskumar, Department Of Civil Engineering Christian Polytechnic College, Oddanchatram,Dindigu, International Journal of Scientific Research in Engineering and Management, Volume: 06 Issue: 08 August – 2022.

[6] "Eco-Friendly Study on Properties of Concrete by Partial Replacement of Cement by Rice Husk ash", Arivalagan S. Department of Civil Engineering Dr M.G.R. Educational and Research Institute Chennai-600095, Tamil Nadu,India.VOLUME 7, ISSUE 6, 2020.

[7] "Partial replacement of cement with rice husk ash in concrete production an exploratory cost-benefit analysis for low-income communities", Franco Muleya, Natasha,Muwila,Chipozya Kosta Tembo, International society for manufacturing, service and management engineering, Volume 13, Issue 3-2021.

[8] "Use of Rice Husk Ash as Partial Replacement of Cement in Sandcrete Blocks", Wajid Khan, Muhammad Fahim, Saeed Zaman, Sajjad Wali Khan, Yasir Irfan Badrashi, Fayaz Khan. Department of Civil Engineering, University of Engineering and Technology, Peshawar, Pakistan, Advances in Science and Technology Research Journal, Volume 15 , Issue: 2021.

[9] "Use of Rice Husks as partial replacement of coarse aggregates in concrete paving blocks", Mwalimu K. Musau, Douglas Shitanda, Michael Githinji , Caroline Mwende, Building and Civil Engineering Department, Machakos University- Kenya, European International Journal of Science and Technology ISSN: 2304-9693, Volume 9, Issue 31 July 2020.

[10] "Partial Replacement of Cement with Rice Husk Ash in Cement Concrete" Vashisht Patil, Prof. M. C. Paliwal Department of Civil and Environment Engineering, National Institute of Technical Teachers Training and Research, Bhopal, India, International Journal of Engineering Research & Technology (IJERT), Volume 9, Issue 12-December-2020.

[11] "PARTIAL REPLACEMENT OF CEMENT BY RICE HUSK ASH", Er. RAVI BHUSHAN1, SOPAN GOCHHE, ER. HARNEET SINGH, BIKRAM PRASAD BASTOLA, International Research Journal of Engineering and Technology (IRJET), Volume: 04, Issue: 10-Oct - 2017.

[12] "Rice husk ash as a partial replacement of cement in high strength concrete containing micro silica: Evaluating durability and mechanical properties", Seyed Alireza Zareeia,, Farshad Amerib, Farzan Dorostkarc, Mojtaba Ahmadic, Department of Civil Engineering, Khorasgan (Isfahan) Branch, Islamic Azad University, Isfahan, Iran. Case Studies in Construction Materials, Volume 10, issue: 15 May 2017.

[13] "Effect of Rice Husk Ash in Concrete as Cement and Fine Aggregate" Nithyambigai. G Assitant Professor Department of Civil Engineering SRM University, Ramapuram Chennai, Tamil Nadu, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181, Volume 4, Issue 05, May-2015.

[14] "Experimental Study On Rice Husk As Fine Aggregates In Concrete", Obilade, I.O. Department of Civil Engineering, Osun State Polytechnic, Iree, Nigeria, The International Journal Of Engineering And Science (IJES), Volume 3 Issue 09-14-2014.

[15] "Compressive Strength and Durability Properties of Rice Husk Ash Concrete" V. Ramasamy. KSCE Journal of Civil Engineering (2012) 16(1):93-102 DOI 10.1007/s12205-012-0779-2 Issue 2012.

[16] IS 10262-2019 and IS 456-2000 Recommended guidelines for Concrete Mix Design.

BIOGRAPHIES

Name: Ms. MAULYA K T
Department of Civil Engineering, Rajeev Institute of Technology Hassan
Email: maulyathammayya7@gmail.com

Name: Mr. HEMANTHA K M
Department of Civil Engineering, Rajeev Institute of Technology Hassan
Email: hemantha022002@gmail.com

Name: Ms. SINCHANA M D
Department of Civil Engineering, Rajeev Institute of Technology Hassan
Email:sinchanamdsinchanamd1@gmail.com

Name: Ms. NEHA P
Department of Civil Engineering, Rajeev Institute of Technology Hassan
Email:nehaprem83@gmail.com