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Use of Rice Husk Ash and Fly Ash in Rigid Pavement as Pertial Replacement to Cement: A Review

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ABSTRACT

The cement industry has been known to contribute significantly to environmental problems, particularly in terms of CO2 emissions. Therefore, researchers and scientists are exploring the use of alternative binders such as fly ash and rice husk ash (RHA) to reduce the environmental impact of cement production. This project aims to investigate the potential of utilizing fly ash and RHA as a partial replacement for cement in concrete mixes. Research has shown that using fly ash and RHA can produce concrete with superior performance characteristics and lower environmental impact compared to normal concrete. Furthermore, it can also help reduce the cost of concrete construction while decreasing greenhouse gas emissions. By utilizing these sustainable materials, we can reduce waste disposal to landfills, improve the construction industry, and promote a healthier planet.

Key words –Cement , agricultural waste, rice husk ash, fly ash, concrete, performance characteristics

1. INTRODUCTION

Cement is a widely used construction material and researchers are exploring ways to utilize industrial and agricultural waste as a raw material, which would not only be cost-effective but also reduce environmental pollution. Rice husk is a major by-product of the rice processing industry in many parts of the world, especially in developing countries, and is mostly dumped into water streams or landfills, causing environmental pollution. Rice husk ash (RHA) is a non-crystalline silicon dioxide with high pozzolanic reactivity, which can be utilized as a partial replacement for cement in concrete. Fly ash is another by-product obtained from coal combustion and consists of silicon dioxide, aluminium oxide and calcium oxide, which can also be used in concrete. This work aims to address the environmental problems caused by the disposal of these by-products to landfills and reduce carbon dioxide emissions, which contribute to global warming. Utilizing waste and by-products in construction provides numerous benefits, such as reducing the emission of carbon dioxide which is a major environmental concern caused by cement production, minimizing the amount of waste entering landfills without proper disposal, and reducing the exploitation of natural resources. In this study, the effects of rice husk ash. (RHA) and fly ash on various parameters of concrete will be investigated to produce an economical concrete for rigid pavements. Partial replacement of cement with RHA and fly ash is expected to result in equivalent flexural strength of concrete, which is crucial for concrete pavement. The mechanical properties of concrete will be evaluated by partially replacing different percentages of RHA and fly ash by weight of cement for a control mix of M40 grade concrete

The main aim of this study was to investigate the potential use of rice husk ash and fly ash as cement substitutes in order to reduce the environmental impact of cement production. Specific goals of the research included characterizing the physical and chemical composition of these materials, examining their effect on the properties of fresh concrete, determining the optimal percentage of ash to be used in mix proportion for M40 grade concrete, and evaluating the impact on the mechanical properties of concrete when ordinary Portland cement is replaced with rice husk ash and fly ash.

2. LITERATURE REVIEW

Kumar et al. (2016) had done the replacement partially in the proportion of 0% ,20% and its effect on workability of concrete made with rice husk ash were investigated for the 20% rice husk ash replacement, the hardened properties such as compressive strength observed were good as compare to 0 % RHA. The compressive strength test was conducted at 0 % and 20 % rice husk ash replacement and the highest compressive strength at 20 % RHA replacement as compared to 0% RHA replacement at 14 ,21 and 28 days. At all the bond substitution levels of Rice husk fiery debris; there is slow increment in compressive quality from 3 days to 7 days. However there was huge expansion in compressive quality from 7 days to 28 days took after by slow increment from 28 days.

Vignesh and Suriya Prakash (2016) have done the study to investigate the mechanical properties of concrete with different replacement levels of Pozzolana Portland cement by rice husk ash. The cement has been replaced by rice husk ash (RHA) accordingly in the range of 2%, 4%,6%,8%,16% by weight of cement in common for M40 mix. The compressive strength at 7days and 28 days have been obtained with normal curing condition. Replacement of Rice husk ash (0%,2%,4%,6%,8% and 16%) was done for M40 grade of concrete. The test results showed that the replacement of cement by Rice Husk Ash up to 8% by weight had considerably increased the physical and mechanical properties of concrete. By use of this agricultural waste, the construction cost reduced by 30%.

Bhushan et al. (2017) They have done the experiment by casting Solid masonry blocks size 150*150*150 of M20 grade by replacement of cement to RHA by weight at 0%,5%,10%,15%,20%,25%. Cubes were made ready for testing after 7, and 28 days curing in water served as the control. Testing was included for the strength (compressive, flexure and split tensile), workability (water binding ratio and setting time), costing analysis. The test results revealed that the workability and strength are slightly better than the standard concrete by satisfying the limits initiated endorsed by standard. The reduction on cost by 3.08% relative to the initial values. The flexure strength of rice husk ash concrete was increased for 5% with 3.59% and 10% with 1.79% with respect to conventional concrete. After that there was continuously decrease in strength of mixes 15%, 20%, 25% with 21.79%, 49.88%, 59.55% respectively with respect to conventional mix. Rice husk ash can be added to cement concrete as partial replacement of cement up to 10% without any significant reduction in any of the property of concrete.

Hiwase et al. (2018) have done the experiment bythe percentage replacements of Ordinary Portland cement (OPC) with Rice Husk Ash (RHA) by 0%, 2.5%, 5%, 7.5%, 10%, 12.5%,15%. The concrete used in this Experimental work was made using Binder (Cement and RHA), Sand and Gravel. The concrete mix proportion was 1:1.5:3 by weight. The Compressive Strength of Cubes were tested for the duration period of 3 days,7 days and 28 days after curing respectively. Compressive strength of concrete is gradually decreasing when the cement is replaced by RHA. With a percent increase in cement by RHA there was decrease in gain of early strength with time in concrete Specific gravity for cement was 3.145 and RHA was 2.22 and thus it can be said that RHA was lighter than cement. Initial and Final setting time of Cement with RHA combination was found out to lie within appropriate range. The substitution of Rice Husk Ash can be used up to 10% for best results in producing plain concrete for concrete structures. The workability of concrete had been found to be decreased with increase RHA in concrete.

Joshi et al. (2019) In this experiment cement was partially replaced by rice husk ash by 10% and weight of cement and compared it with normal concrete by using the grade M30 at the 3day, 7day, 28 day. As the rice husk ash was a waste material, it reduced the cost of construction. The optimum replacement level of RHA was found to be 0-15% for M30 grade of concrete . The replacement of cement with RHA is much lower than that of cement. The slump values of the concrete reduced as the percentage of RHA increased. By using this Rice husk ash in concrete as replacement the emission of greenhouse gases can be decreased to a greater extent. As a result, there were greater possibility to gain more number of carbon credits.

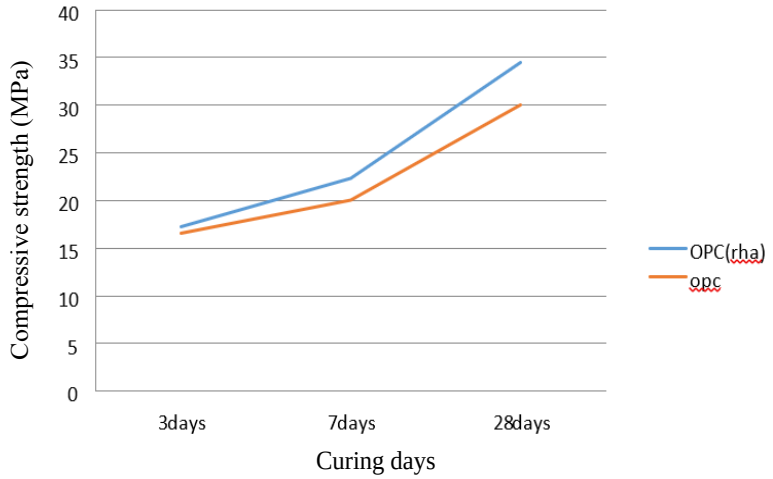

Fig 1. Compressive strength of cube samples (Joshi et al., 2019)

Rathi et al. (2020) In this study evaluates the performance of geopolymer concrete made with partial replacement of cement with rice husk ash and fly ash for rigid pavement applications. The results showed that the geopolymer concrete with 20% replacement of cement exhibited higher compressive strength, flexural strength, and split tensile strength compared to conventional concrete.

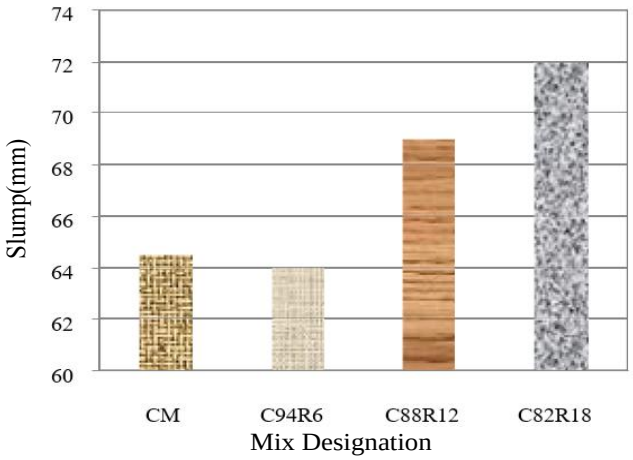

Fig 2. Slump test results (Rathi et al., 2020)

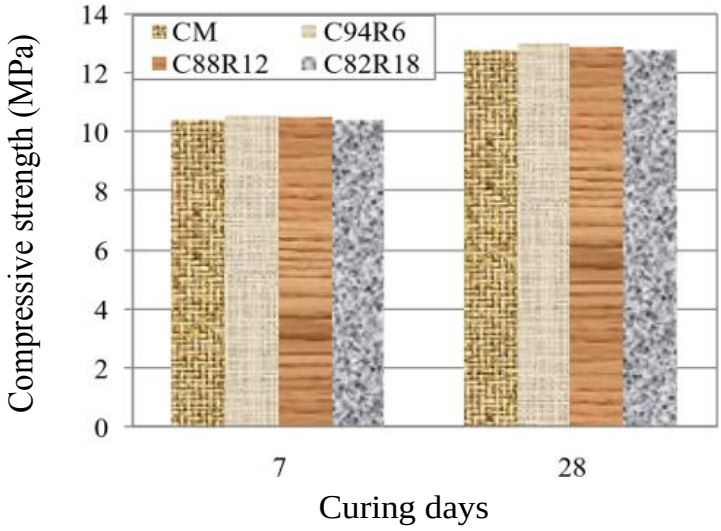

Fig 3. Compressive strength results (Rathi et al., 2020)

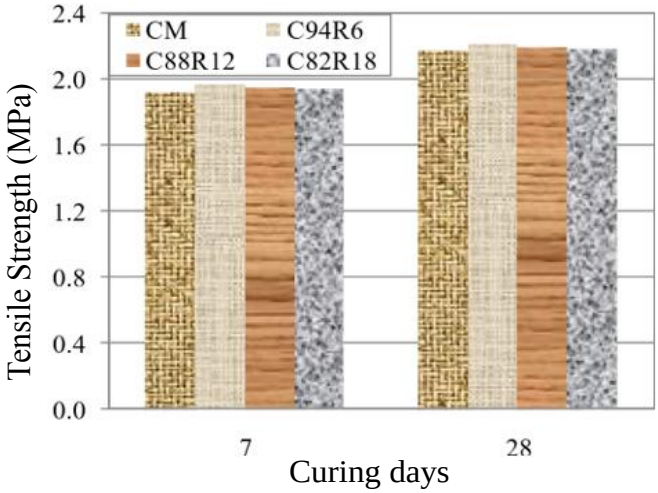

Fig 4. Splitting tensile strength (Rathi et al., 2020)

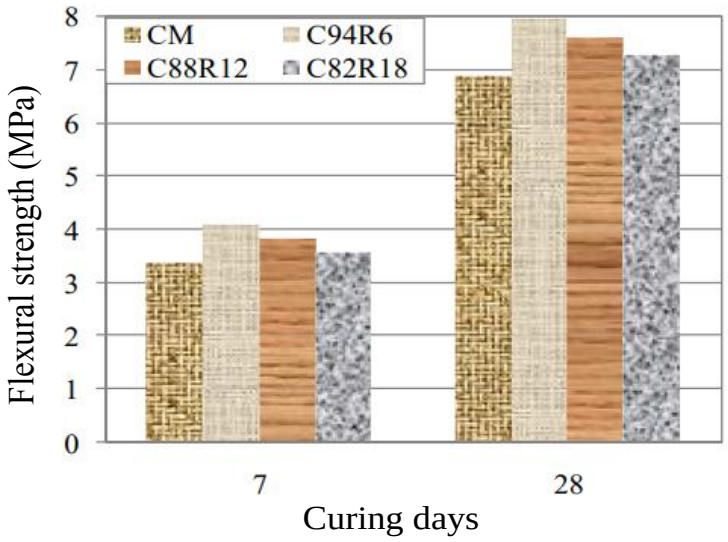

Fig 5. Flexural strength (Rathi et al., 2020)

Gupta et al. (2021) In this study investigates the strength and durability of concrete with partial replacement of cement by rice husk ash and fly ash for rigid pavement. The results showed that the use of rice husk ash and fly ash as partial replacement of cement improved the strength and durability properties of concrete for rigid pavement.

Singh et al. (2022) In this study evaluates the performance of concrete with partial replacement of cement by rice husk ash and fly ash for rigid pavement. The results showed that the concrete with 10% replacement of cement with rice husk ash and 20% replacement of cement with fly ash exhibited higher compressive strength and split tensile strength compared to conventional concrete.

Singh et al. (2022) In this study compares the strength and durability of concrete with partial replacement of cement by rice husk ash and fly ash for rigid pavement. The results showed that the concrete with 15% replacement of cement with rice husk ash and 10% replacement of cement with fly ash exhibited higher compressive strength, split tensile strength, and flexural strength compared to conventional concrete.

3. CONCLUSION

The conclusion of the study on the use of rice husk ash and fly ash as partial replacement to cement in rigid pavement is that it is a viable option that can significantly improve the performance and sustainability of concrete. The use of these alternative materials in concrete mixes resulted in concrete with comparable or even superior strength and durability properties compared to conventional concrete. Moreover, the incorporation of rice husk ash and fly ash helped to reduce the carbon footprint of concrete, which is crucial in the context of increasing environmental concerns.

Based on the literature survey it is concluded that

1. The use of rice husk ash (RHA) as a replacement for cement in concrete can offer several benefits, including cost reduction and a potential decrease in greenhouse gas emissions. The study found that the optimum replacement level of RHA for M40 grade of concrete is 15%, which means that up to 15% of cement can be replaced with RHA without compromising the strength of the concrete.
2. One advantage of using RHA in concrete is that it is a waste material that would otherwise be discarded, which reduces the overall cost of construction. Additionally, by using RHA in concrete, the emission of greenhouse gases can be decreased, which can lead to the possibility of gaining more carbon credits.
3. However, it is important to note that as the percentage of RHA in the concrete mix increases, the slump values of the concrete may decrease. Slump refers to the measure of the consistency of the concrete, and a lower slump value indicates that the concrete is less workable and may be more difficult to place and finish.
4. Similarly, the addition of fly ash in Ordinary Portland Cement (OPC) concrete as a partial replacement of OPC can also offer benefits such as reducing the cost of construction and decreasing greenhouse gas emissions. The study found that up to 20% of OPC can be replaced with fly ash without compromising the compressive strength, flexural strength, and split tensile strength of the concrete.

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