International Journal of Research in Engineering, Science and Management
Volume-1, Issue-10, October-2018
www.ijresm.com | ISSN (Online): 2581-5782

Rice Husk Ash as Partial Replacement Material of Cement in Concrete

S. Andavan[1], Ramesh Bhaskar[2], S. Purushotham Vara Prasad[3]
[1,2]*Associate Professor, Department of Civil Engineering, Saveetha School of Engineering, Chennai, India*
[3]*Student, Department of Civil Engineering, Saveetha School of Engineering, Chennai, India*

***Abstract*—This paper summarizes that in order to increase the demand of construction materials and need for providing a sustainable growth in construction field. For this objective, use of agricultural by product (rice husk ash) on the cement in order to mitigate the availability, affordability, quality and pollution issues. Solid cubes of size 150*150*150, cylinders and prisms of M20 grade were casted by three different levels of replacement of cement to RHA by weight at 0%, 10%, 20%. Specimens were made ready for testing after 7, and 28 days curing in water served as the control by IS methods. Testing was included for the strength (compressive, flexure and split tensile). The test results revealed that strength are slightly better than the standard concrete by satisfying the limits initiated endorsed by standard.**

***Index Terms*— Rice husk ash (RHA), Cement, Compression strength test, Split tensile Strength, flexural strength test, Cost**

I. Introduction

Concrete is identified as the source of a nation's infrastructure due to its economic progress and strength and indeed to the superiority of life. Over 5% of global CO2 emissions can be credited to Portland cement production. To reduce the limitations of cement (OPC), it can be partially replaced with green materials which have pozzolanic characteristics. Number of green materials has been studied for the replacement of cement partially like fly ash, ground nut shell ash, etc. which have been successful. The present paper focuses on the replacement of cement partially with Rice Husk India is one of the leading producers of Rice. Globally rice paddy of about 600 million tons is being produced, accounting for an annual production of 120 million tons Rice Husk. In most of the cases, the husk produced during the processing of the rice is either burnt or dumped as waste material. Rice husk ash contains 90%-95% of reactive silica. It is estimated that the world rice harvest is about 588 million tons per year and India is the second largest producer of rice in the world with a production of 132 million tons per year annually. Extensive research has been carried out on the use of amorphous silica in the manufacture of concrete. Most of these studies have been performed in order to find the effectiveness of RHA as a pozzolanic by concentrating on the amount of ash present in the mix and on the enhanced characteristics resulting from its use.

The present investigation focuses on assessment of the suitability of Rice husk ash a cementitious material by conducting various physical and chemical analysis and hence to understand the influence of RHA on concrete properties (fresh state and hardened state). It was also proposed to determine the optimum level for replacement of rice husk in maximum compressive strength and to understand the application of rice husk in concrete beams.

II. Materials

Ordinary Portland Cement (OPC) of 43 Grade was used to conduct the experimental work.

River sand, locally available and confirming to Zone II specification with respect to IS 383-1970 [13] was taken as fine aggregate and crushed stones of 20 mm nominal size was taken as coarse aggregate. To examine the suitability of rice husk ash as a replacement for cement, the various chemical and physical properties were carried out. These properties of RHA were compared with standard cement properties for assessing the correctness of RHA as a supplementary cementitious material.

Coarse aggregate, locally available and suitable size of aggregates are used in this project.

Traditionally, rice husk has been considered a waste material and as generally been disposed of by dumping or burning, although some has been used as a low-grade fuel. Nevertheless, RHA has been successfully used as a pozzolana in commercial production in a number of countries including India. RHA use in the civil construction field may be a viable solution to its disposal as waste on the environment. Interest in RHA utilization by the construction industry is not new. The process was investigated by Mehta [1977], who observed that it was possible to obtain ashes rich in silica (in crystalline or glassy state) depending on the combustion conditions. In the glassy silica case, highly pozzolanic ashes would be obtained, which would be adequate for partial substitution of Portland cement. Pozzolanic definition by ASTM C618 [1978] is a siliceous or siliceous and aluminous material which, in itself, possesses little or no cementitious value but which will, in finely divided form in the presence of moisture, react chemically with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties. RHA produced after burning of Rice husks (RH) has high reactivity and pozzolanic property. Chemical compositions of RHA are affected due to burning process and temperature. Silica content in the ash

increases with higher the burning temperature. As per study by Hwang and Wu [1989] RHA produced by burning rice husk between 600 and 700°C temperatures for 2 hours, contains 90-95% SiO2 , 1-3% K2O and <5% un burnt carbon. Under controlled burning condition in industrial furnace, conducted by Mehta [1992], RHA contains silica in amorphous and highly cellular form, with 50-1000 m^2/g surface area. So use of RHA with cement improves workability and stability, reduces heat evolution, thermal cracking and plastic shrinkage. This increases strength development, impermeability and durability by strengthening transition zone, modifying the pore-structure, blocking the large voids in the hydrated cement paste through pozzolanic reaction. RHA minimizes alkali-aggregate reaction, reduces expansion, refines pore structure and hinders diffusion of alkali ions to the surface of aggregate by micro porous structure. These properties are difficult to achieve by the use of pure Portland cement alone.

Recent study on the use of RHA as a construction material has been reported by Jayasankar et al. [2010], Nargale et al. [2012] and Sandesh et al. [2012], where the amount of replacement varies from 0 to 20% without varying the grade of ordinary Portland cement (OPC). The strength gained in concrete when OPC was partially replaced by a material processing pozzolanic property also depends upon the grades of OPC [Marthong, 2002]. Different grades of OPC are available depending on the respective country codal classification. Bureau of Indian Standard (BIS) normally classify three grades of OPC namely: 33, 43and 53, which are commonly used in construction industry. Indian Standard code of practice for plain and reinforced concrete [IS 456, 2000], recommends use of RHA in concrete but does not specify quantities. The possibility of using RHA as part replacement of OPC need to be investigate for confident used of these materials. The review of literature however, could not find any comparative study on the effect of concrete properties when cement of varying grades were partially replace by RHA are addressed together. Thus, in the present work a holistic approach was adopted to investigate the possibility of using RHA as a construction material. The contributions to strength gain, improvement in durability, water absorption and shrinkage are the main parameter of study.

III. Literature Review

Factors Influencing the Sulphate Resistance of Cement Concrete and Mortar, J. Prasad, D.K. Jain and A.K. Ahuja.

Prasad et al (2006) investigated on Cement concrete which continues to be the pre-eminent construction materials for use in any type of civil engineering structure He concluded in his investigation the blended cements, particularly are better in Sodium Sulphate environment. The blended cement mixes show more deterioration in Magnesium Sulphate exposure in compared to plain cement mixes. The Magnesium Sulphate environment is more severe than Sodium Sulphate environment. The performance of low water/binder ratio mixes is inferior in Sulphate resistance. The little initial air curing of mixes is beneficial for Sulphate resistance. He also stated that the deterioration of cement mixes increases with increase in the concentration of Sulphate. The presence of Chloride ions with Sulphate ions reduces the rate of Sulphate attack on cement mixes. The deterioration rate of mixes due to Sulphate attack is higher at high temperature with alternate wetting and drying cycles.

Effect of Rice Husk Ash (RHA) As Partial Replacement of Cement on Concrete Properties, C. Marthong.

In this paper, it discusses about Cement is widely noted to be most expensive constituents of concrete. The entire construction industry is in search of a suitable and effective the waste product that would considerably minimize the use of cements and ultimately reduces the construction cost. Rice husk ash (RHA) which has the pozzolanic properties is a way forward. The possibility of using RHA as a construction material need to be investigates. Three grades of ordinary Portland cement (OPC) namely; 33, 43 and 53 as classified by Bureau of Indian Standard (BIS) are commonly used in construction industry. A comparative study on effects of concrete properties when OPC of varying grades was partially replaced by RHA is discussed in this paper. Percentage replacement of OPC with RHA was 0, 10, 20, 30 and 40% respectively. The compressive strength, water absorption, shrinkage and durability of concrete were mainly studied. The study suggests that up to 20% replacement of OPC with RHA has the potential to be used as partial cement replacement, having good compressive strength performance and durability.

Rice Husk Derived Waste Materials As Partial Cement Replacement In Lightweight Concrete, Celso Yoji KawabataI; Holmer Savastano JuniorII; Joana Sousa-CoutinhoIII [2012].

In this study rice husk ash (RHA) and broiler bed ash from rice husk (BBA), two agricultural waste materials, have been assessed for use as partial cement replacement materials for application in lightweight concrete. Physical and chemical characteristics of RHA and BBA were first analysed. Three similar types of lightweight concrete were produced; a control type in which the binder was just CEMI cement (CTL) and two other types with 10% cement replacement with, respectively, RHA and BBA. All types of similar lightweight concrete were prepared to present the same workability by adjusting the amount of super plasticizer. Properties of concrete investigated were compressive and flexural strength at different ages, absorption by capillarity, resistivity and resistance to chloride ion penetration (CTH method) and accelerated carbonation. Test results obtained for 10% cement replacement level in lightweight concrete indicate that although the addition of BBA conducted to lower performance in terms of the degradation indicative tests, RHA led to the enhancement of mechanical properties, especially early strength and also fast ageing related results, further contributing to sustainable construction with energy saver lightweight concrete.

Durability Study on Compressive Strength of Concrete Using Rice Husk Ash as a Partial Replacement Using Magnesium

Sulphate Solution, V. V. S.Sarma, P. V. Rambabu, G.Venkata Ramarao.

The research work describes the feasibility of using the RHA waste in concrete production as a partial replacement of cement. This present work deals with the effect on strength and mechanical properties of cement concrete by using RHA. The utilization of RHA in concrete as a partial replacement of cement is gaining immense importance today, mainly on account of the improvement in the long term durability of concrete combined with ecological benefits. RHA collection systems have resulted in improving the consistency of RHA. The use of RHA in concrete as a supplementary cementatious material was tested as an alternative to traditional concrete. The cement has been replaced by rice husk ash accordingly in the range of 0%, 5%, 10%, 15%, and 20% by weight of cement for mix. Concrete mixtures were produced, tested and compared in terms of compressive strengths with the Conventional concrete. These tests were carried out to evaluate the mechanical properties for the test results of 7, 28, 60 days for compressive strengths in MgSO4 solution of 1%,3%,5% and also durability aspect rice husk ash concrete for sulphates attack was tested. The result indicates that the RHA improves concrete durability Use of Rice Husk Ash in Concrete: A Review, Amitkumar I. Gupta, Dr. Abhay S. Wayal.

Conventional building material like cement is both resource and energy-intensive material. Production of cement also emits CO2 in atmosphere. In order to decrease this environmental pollution and cost of conventional building materials, alternative materials like fly ash, ground granulated blast-furnace slag, metakaolin, rice husk ash (RHA) and silica fume is used because of their pozzolanic behavior. RHA which contains high silica content produced by controlled incineration of rice husk can be used as supplementary cementitious material (SCM) in concrete production since it exhibits high pozzolanic characteristics and contributes to strength and impermeability of concrete. This paper presents an overview of the work carried out on the use of RHA as partial replacement of cement in concrete and its effect on workability, compressive strength and chloride permeability of concrete.

Experimental Studies on Concrete with Rice Husk Ash as a Partial Replacement of Cement Using Magnesium Sulphate Solution, Rama Krishna Bolla, M. K. M. V. Ratnam.

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of RHA are generated in Rural and Small Scale Industries with an important impact on environment and humans. In recent years, many researchers have established that the use of supplementary cementitious materials (SCMs) like fly ash (FA), blast furnace slag, silica fume, metakaolin (MK), and rice husk ash (RHA), hypo sludge etc. can, not only improve the various properties of concrete - both in its fresh and hardened states, but also can contribute to economy in construction costs. This research work describes the feasibility of using the RHA waste in concrete production as a partial replacement of cement. This present work deals with the effect on strength and mechanical properties of cement concrete by using RHA. The utilization of RHA in concrete as a partial replacement of cement is gaining immense importance today, mainly on account of the improvement in the long term durability of concrete combined with ecological benefits. RHA collection systems have resulted in improving the consistency of RHA. The use of RHA in concrete as a supplementary cementatious material was tested as an alternative to traditional concrete. The cement has been replaced by rice husk ash accordingly in the range of 0%, 5%, 10%, 15%, and 20% by weight of cement for mix. Concrete mixtures were produced, tested and compared in terms of compressive strengths with the Conventional concrete. These tests were carried out to evaluate the mechanical properties for the test results of 7, 28, 60 days for compressive strengths in MgSO4 solution of 1%,3%,5% and also durability aspect rice husk ash concrete for sulphates attack was tested. The result indicates that the RHA improves concrete durability. The workability of concrete with increase in percentages of RHA is determined by Slump Cone test, Compaction Factor test and Vee-Bee test as these tests are suitable for mixes of low workability.

Study on Concrete with Partial Replacement of Cement by Rice Husk Ash, N Kaarthik Krishna, S Sandeep, K M Mini.

In this paper, Concrete is identified as the source of a nation's infrastructure due to its economic progress and strength, and indeed to the superiority of life. Over 5% of global CO2 emissions can be credited to Portland cement production. To reduce the limitations of cement (OPC), it can be partially replaced with green materials which have pozzolanic characteristics. Number of green materials has been studied for the replacement of cement partially like fly ash, ground nut shell ash, etc. which have been successful. The present paper focuses on the replacement of cement partially with Rice Husk Ash (RHA). India is one of the leading producers of Rice. Globally rice paddy of about 600 million tons is being produced, accounting for an annual production of 120 million tons Rice Husk. In most of the cases, the husk produced during the processing of the rice is either burnt or dumped as waste material. Rice husk ash contains 90%-95% of reactive silica. It is estimated that the world rice harvest is about 588 million tons per year and India is the second largest producer of rice in the world with a production of 132 million tons per year annually. Extensive research has been carried out on the use of amorphous silica in the manufacture of concrete. Most of these studies have been performed in order to find the effectiveness of RHA as a pozzolan by concentrating on the amount of ash present in the mix and on the enhanced characteristics resulting from its use.

Utilization of Rice Husk Ash in Concrete as Cement Replacement, Harshit Varshney.

Rice husk ash (RHA) is an agricultural based pozzolanic material, generated by rice mills in huge quantities. This paper

summarizes the experimental work of concrete in which ordinary Portland cement (OPC) cement were replaced by Rice husk ash (RHA). Partial replacement of OPC cement was carried out at 0% to 20% in steps of 5% and compared with 0% replacement. In this work different tests were performed as slump test, compaction factor, compression test and split tensile test to find the suitable percentage replacement of cement by RHA. Compression and split tests were performed for 7days and 28 days of curing and result shows some variation in both tests in every proportion. After performing tests, the results suggest that up to 15% replacement of RHA for cement is suitable for making concrete.

Due to the wide use of concrete the cost of building materials increasing very quickly in some parts of the world also in developing country like India so only the industries, business cooperation, government and few individual can afford it. This rising cost can however be reduced by use of alternative building materials that are locally available and cheap. Some industrial and agricultural waste products may be use as building material. There are different wastes available in large quantities that have properties to make concrete. Rice husk is one of them; Rice husk is a byproduct of agricultural waste generated in rice mills. During milling of paddy 80% weight found out as rice and remaining 20% weight received as husk. This husk is used as fuel in industries to generate steams and other purposes. This husk contains about 75 % organic fickle matter and the remaining 25 % of the weight of this husk is converted into ash during the firing process, this ash is known as rice husk ash (RHA). From the 20th century, there had been an increase in the economic consumption of mineral admixtures by the cement and concrete industries. The increasing demand for cement and concrete is conformed to by partial replacement of cement. Significant cost savings can result when by-products are used as a partial replacement for the energy acute Portland cement. The use of by-products also reduces the pollution and proved as an environmental friendly method of disposal of large quantities of waste materials that would otherwise pollute land, air and water. Typically RHA contains 80 – 90% of amorphous silica, 1-2 % Potassium oxide (K2O) and remaining being sunburn carbon. The RHA can be blended with ordinary Portland cement to produce concrete. In this present study, Ordinary Portland cement was replaced by rice husk ash at different percentage to find out the suitable percentage of rice husk ash with the help of compressive and split tensile strength. Effect of Partial Replacement of Cement by Fly Ash, Rice Husk Ash with Using Steel Fiber in Concrete, Kapil Lakr, Vaibhav Gupta.

In the ancient period, the construction work was largely carried out with the help of industry mudstone. Fly ash is a coal burned by product of the plant and rice hull ash is the by - product of burnt rice husk at a higher temperature from plant paper made fibres are commonly used today in the to improve the mechanical properties of the concrete. Especially synthetic (polypropylene, polyester, etc.) glass fibers, nylon, asbestos, carbon and steel used in concrete caused good results to improve many propertie s of the concrete. Considerable efforts have been taken worldwide using natural waste and bye - product cement as complementary to improve the properties of cement concrete. The envelope of the rice ash (RHA) and fly ash (FA) to the use of steel fibers is such materials. RHA's bye-product of the rice industry. rice hull ash is a highly reactive pozzolanic material produced by the controlled burning of rice hulls. FA is finely divided produced by coal power plant. Fly ash has similar properties to naturally occurring pozzolonic material. The detailed experimental investigation is done to study the effect of partial replacement of cement by FA, RHA with the use of steel fibers in concrete. This article began as a proportion of 30% and 0% RHA FA blend into the concrete by replacing the cement proportion taken last FA 15% and 15% RHA, with a gradual increase of the ORS 2.5 % and a gradual simultaneous reduction of 2.5% FA and improve the resistance of concrete steel fibres were added and the fibre volume fraction is 0%, 0.25%, 0.5%, 0.75% and 1.0% by volume in the proportion of 10% and 20% RHA FA. The purpose of this research is to study the effects of steel fibres on the handling, compression strength, bending tensile strength, tensile splitting strength, and acid resistance test, study the durability of fly ash of the rice hull ash in the concrete.

Partial Replacement of Cement by Rice Husk Ash, Ravi Bhushan, Sopan Gochhe, Harneet Singh, Bikram Prasad Bastola

This paper summarizes the feasibility of using partial rice husk ash on the cement in order to mitigate the availability, affordability, quality and pollution issues. Solid masonry blocks size 150*150*15 of M20 grade were casted 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), and 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.

In current worldwide markets and increasing accentuation on quality, requirement for concrete having high strength with affordable cost has increased numerous fold. Over the past decades, research on concrete has entered broad based areas of activities to enhance the concrete performance. The reason behind this is not only to the vast range of applications that concrete offers, but also due to its great affordability, strength, durability, and versatility. Numerous method has been applied and different kinds of concrete has been introduced like, Self - Compacting Concrete(SCC) was introduced that enhances the durability of the concrete, high strength concrete(HSS) was introduced that provide ultra-high strength. But such concrete is rarely available and high cost. The need to reduce the high cost of Ordinary Portland Cement with the desirable

characteristics some materials has to be modified. From the intensified research into locally available products and reduction in cost partial replacement of the OPC with rice husk ash is proven to be effective fulfilling requirement.

Pozzolanic definition by ASTM C618 [1978] is a siliceous or siliceous and aluminous material which, in itself, possesses little or no cementitious value but which will, in finely divided form in the presence of moisture, react chemically with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties.

Effect of Rice Husk Ash on Properties of Concrete, Makarand SureshKulkarni, Paresh GovindMirgal, Prajyot Prakash Bodhale, S. N. Tande

The optimized RHA, by controlled burn and/or grinding, has been used as a pozzolanic material in cement and concrete. Using it provides several advantages, such as improved strength and durability properties, and environmental benefits related to the disposal of waste materials and to reduced carbon dioxide emissions. Up to now, little research has been done to investigate the use of RHA as supplementary material in cement and concrete production in Vietnam. The main objective of this work is to study the suitability of the rice husk ash as a pozzolanic material for cement replacement in concrete. However it is expected that the use of rice husk ash in concrete improve the strength properties of concrete. Also it is an attempt made to develop the concrete using rice husk ash as a source material for partial replacement of cement, which satisfies the various structural properties of concrete like compressive strength. From the entire experimental work & studies it is concluded that mix M2 (M0+20%RHA) is the best combination among all mixes, which gives max, tensile, flexure & compression strength over normal concrete.

IV. Conclusion

To determine the various test results on hardened concrete design mix of M20 such as compressive, flexural and tensile and compared with the control mix of both river sand and M sand. There is gradual decrease in strength of test of 7 and 28 days. It can be used for light weight structures and also resists with sulphate attack.

References

[1] Bui D D, Hu J and Stroeven P 2005 Particle size effect on the strength of rice husk ash blended gap-graded portland cement concrete Cement & Concrete Composites 27 pp. 357– 366.
[2] Ganesan K, Rajagopal K and Thangavel K 2008 Rice husk ash blended cement: Assessment of optimal level of replacement for strength and permeability properties of concrete Construction and Building Materials 22 pp. 1675–1683.
[3] Gemma Rodriguez de Sensale 2006 Strength development of concrete with rice husk ash Cement & Concrete Composites 28 pp. 158-160
[4] Hwang Chao-Lung, Bui Le Anh-Tuan and Chen Chun-Tsun 2011 Effect of rice husk ash on the strength and durability characteristics of concrete Construction and Building Materials 25 pp. 3768–72
[5] Ravande K, Bhikshma V and Jeevana Prakash P 2011 Proc. Twelfth East Asia-Pacific Conf. on Structural Engineering and Construction — EASEC12 vol. 14 Study on strength characteristics of high strength rice husk ash concrete Procedia Engineering pp. 2666–72.
[6] Tashima M M, Carlos A R da Silva, Jorge Akasaki L and Michele Beniti B 2004 Proc. Conf. (Brazil) The possibility of adding the rice husk ash to the Concrete
[7] Rama Rao G V and Sheshagiri Rao M V 2003 High performance concrete with rice husk ash as mineral ad-mixture ICI Journal pp 17-22
[8] Ferraro R, Nanni A, Rajan K, Vempati R and Matta F 2010 Carbon neutral off-white rice husk ash as a partial white cement replacement Journal of Materials in Civil Engineering 22 pp. 1078-83 IConAMMA-2016 IOP Publishing IOP Conf. Series: Materials Science and Engineering 149 (2016) 012109 doi:10.1088/1757-899X/149/1/012109 10
[9] James J and Subba Rao M 1986 Reactivity of rice husk ash Cement and Concrete Research 16 pp 296-302
[10] Deepa G Nair, Jagadish K S and Alex Fraaij 2006 Reactive pozzolanas from rice husk ash: An alternative to cement for rural housing Cement and Concrete Research pp. 1062-71
[11] Rawaid Khan, Abdul Jabbar, Irshad Ahmada, Wajid Khana, Akhtar Naeem Khana and Jahangir Mirza 2012 Reduction in environmental problems using rice-husk ash in concrete Construction and Building Materials pp. 360–365
[12] Mini K M, Dheeraj Swamy B L P, Srinivas K, Narasinga Rao K and Vaibhav R 2014 Effect of silica fumes addition to carbon nanotubes based cement composites International Journal of earth sciences and engineering pp. 1829-1833
[13] Indian Standard 383 (1970) Specification for coarse and fine aggregates from natural sources for concrete
[14] Indian Standard 4031 (1988) Methods of physical tests for hydraulic cement Part 4: Determination of consistency of standard cement paste
[15] Indian Standard 4031 (1988) Methods of physical tests for hydraulic cement Part 5: Determination of initial and final setting times
[16] Indian Standard 1199 (1959) Methods of sampling and analysis of concrete
[17] Indian Standard 516 (1959) Methods of tests for strength of concrete
[18] Indian Standard 5816 (1999) Method of test splitting tensile strength of concrete.