Feasibility of using Rice Husk Ash as Partial Replacement for Concrete

I.B. Ologunagba[1], A.S. Daramola[2], A.O. Aliu[3]

[1,2,3] *Civil Engineering Department, Rufus Giwa Polytechnic, PMB 1019, Owo, Ondo State.*

Abstract: *This study examined the feasibility of using rice husk ash as partial replacement for concrete. Concrete cubes tested comprise the Control and Specimen. The percentage of replacement in the specimen cubes varied from 5 to 20 in a mix of 1:2:4. Various tests considered and the results showed that rice husk ash replacement has better performance on the compressive strength of the concrete when the added percentage is not more than 10%, while observation showed that the application of rice husk ash has a reduced density when compared with the Control.*

Key words: *Rice Husk Ash, Compressive strength, Concrete, Density, Mix ratio, Control.*

1. INTRODUCTION

Concrete as a construction material in engineering has gained lots of popularity since its invention by the Romans. Concrete is a mass of sand, gravel, crushed rock, or other aggregate bonded together by a hardened paste of hydraulic cement and water. When properly proportioned, mixed, and consolidated, these ingredients form a workable mass which can be placed into a form of desired size and shape. The water present reacts with the cement to convert the concrete to a hard and durable product. (Kamran, 2013)

The increased use of concrete for major constructions like buildings and roads tends to increase the demand for its constituents materials (cement, sand and gravel). The high cost of concrete materials is increasing rapidly and therefore there is need for an alternative material that is cheaper and readily available that will also give a similar or better strength when used for concrete.

Rice Husk Ash (produced from rice husk with combustion technique) was introduced into concrete for its feasibility as partial replacement of cement in this research.

Rice-Husk Ash (RHA) can either substitute for some of the cement in a mortar or it can be mixed with quicklime to make a hydraulic, cement-free mortar. RHA may be used as a substitute for expensive cement to provide mortars possessing a range of strengths. (Allen, 2008)

Rice husk is used for biogas production in some countries while others consider it a waste and often dispose by open air combustion.

This research is aimed at making a better use of rice husk ash which is being considered a waste and mostly air burned in our locality as a means of disposal.

II. EXPERIMENTAL INVESTIGATION

The experimental investigation consists of testing 40 concrete cubes of mix ratio 1:2:4. The variables considered are (i)Concrete without rice husk (control) (ii) Concrete with 5% cement content replaced by rice husk (iii) Concrete with 10% of cement content replaced by rice husk (iv) Concrete with 15% of cement content replaced by rice husk (v) Concrete with 20% of cement content replaced by rice husk.

III. MATERIALS

The materials used are Ordinary Portland cement, rice husk ash, sand, granite and water.

A. ***Cement:*** Cement can be described as a material with adhesive and cohesive properties which make it capable of bonding mineral fragment into a compact whole and solid in the presence of water. For constructional purposes, the term cement is restricted to the bonding material used with aggregates, bricks, building blocks etc. This type of cement is usually principally constituted of compounds of lime, clay and magnesium, building in civil engineering is concerned with calcareous cement. It is made by heating limestone and clay or other suitable

raw materials together to form a clinker rich in calcium sulphate which regulates the rate of setting when the cement is mixed with the water.

B. ***Aggregates:*** Aggregates are hard inert filler materials mixed with a binding material like cement lime or mud in the preparation of mortar or concrete. Aggregates occupy 70 – 75% of the total volume of a mass of concrete and therefore, the properties of concrete are to a large extent dependent on the properties of the aggregates in them. The aggregate used are local aggregates (Gravel and pit sand for coarse and fine aggregate respectively).

C. ***Rice Husk Ash:*** Rice husk is an agro-waste material which is produced in about 100 million of tons. Approximately, 20 Kg of rice husk are obtained for 100 Kg of rice. Rice husks contain organic substances and 20% of inorganic material. Rice husk ash (RHA) is obtained by the combustion of rice husk. The most important property of RHA that determines pozzolanic activity is the amorphous phase content. (Mauro, 2012) Rice chaff is realized during the process of threshing and shelling operations, which is aimed at removing the grains from the protecting casting. These operations can be carried out by hand or by use of threshing machine. The threshing of rice by hand (manually) entails the beating of small bunches by hand, 6 to 8 times against a hard-surface (stones, metal drum,). If the cereals have been harvested when sufficiently ripe and the grain is dry, it detaches itself easily with a little fraction scattered around.

IV. RESEARCH METHODOLOGY

The concrete mix was carried out according to BS 1881 procedure. The proportion mix ratio of 1:2:4 of coarse aggregate, sand and replacement binder (rice-husk ash) were thoroughly mixed in clean surface using a shovel until an homogenous or suitable consistency was reached. The ash from rice husk was obtained from rice grinding machine operator and after burning, the residue was taken to the laboratory for sieving with sieve size 212 µm. The cubes were cast and cured at room temperature with water for 28 days. Rice husk ash replaces

ordinary Port-land cement at 5%, 10%, 15% and 20% by weight of cement. Concrete with no RHA present serves as the control experiment. The mix ratio used was 1:2:4 (binder, sand and granite) with water to binder ratio of 0.44.

Slump and compacting factor tests were carried out to check the effect of Rice Husk Ash

on the workability of fresh concrete. The tests were carried out in accordance with the requirements of BS 1881:

Part 102 (1983) for slump test and BS 1881: Part 103 (1983) for compacting factor test. Specimen preparation for compressive strength test was performed using 150mm cube steel moulds. The specimens were cast in three layers, each layer being tamped with 25 strokes of the tamping rod spread uniformly over the cross section of the mould.

The top of each mould was smoothened and leveled and the outside surfaces cleaned. The moulds and their contents were kept in the curing room at temperature and relative humidity 90% for 24hours.

De-molding of the cubes took place after 24hours and the specimens were transferred into water bath in the curing room. Compressive strength was determined at curing age 7,14,21 and 28 days. The compressive strength was determined using compression machine.

V. Results and Discussions

Rice Husk Ash was used in the production of normal weight concrete. Figure 1 Shows the Effect of percentage variation of Rice Husk Ash on the compressive strength.

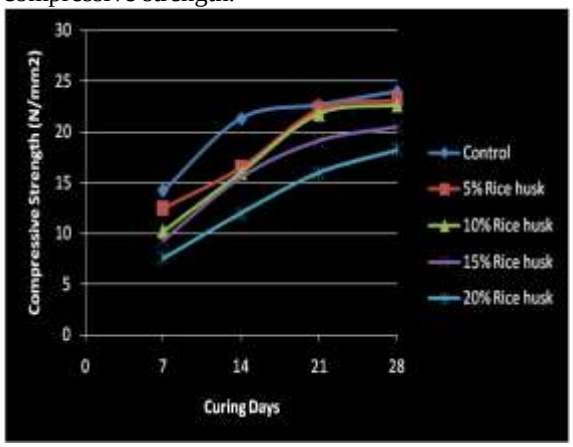

Figure 1: Chart showing the effect of Rice Husk Ash replacement percentage with corresponding compressive strength of the concrete

From the result, Rice Husk Ash replacement has better performance when the added percentage is not more than 10%. However, with 15% rice husk, there is reduction in strength when compared with the control but the strength is still within acceptable value of 20N/mm^2 at the 28th day for construction.

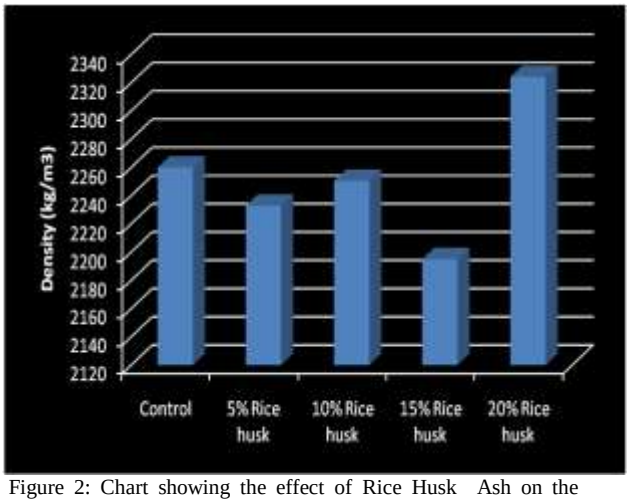

Figure 2: Chart showing the effect of Rice Husk Ash on the Density of concrete.

Figure 2 shows the effect of rice husk ash on the density of concrete. Density is a measure of concrete's solidity, acceptable density for normal concrete is 2240kg/m^3 – 2400kg/m^3. It was observed that application of rice husk ash has a reduced density when compared with the control except the 20% which has a higher density but a reduced strength. The change in density upon application of rice husk is still within the acceptable density for normal concrete.

VI.CONCLUSION

Rice husk ash a good material that can supplement cement to some extent but the rice husk ash is permissible to 15% replacement of cement. However, 10% has a good strength which can be applied for normal concrete without adverse effect or reduced strength but the water/binder ratio must be adhered to as 0.44 water/binder ratio has appreciable and acceptable strength for normal concrete. The locally available rice husk ash can be of significant use in construction industry rather than the open air burning means of disposal which has harmful effect on the people and environment at large.. The use of rice husk ash for concreting will reduce the cost of producing concrete when implemented. There has been no issue of hazardous emission generated from this material when used for construction and it will also help in providing clean and safe environment.

REFERENCES

[1] Al-Dulaijan S.U, Maslehuddin M. et al (2002) Effect of Aggregate Quality on the Properties of Concrete. The 6th Saudi Engineering Conference, KFUPM, Dhahran, December 2002 Vol. 3. 125

[2]Aliu Adekunle.O & Daramola A.S. (2013) Optimisation for the Use of Rice Husk Ash and Sawdust As Alternative Binder For ConcreteThe International Journal Of Engineering And Science (IJES) Volume2 Issue 10 Pages 39-42 ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

[3]Allen M. L. The Manufacture of a Cement Extender from Rice-Husks using a Basket-Burner Prince of Songkla University,Thailand.

[4] Kamran M. Nemati (2013) Aggregates for Concrete, Chapter 5 - Civil Engineering www.ce.memphis.edu/1101/notes/concrete/PCA_manual/Chap05.pdf

[5] Kett, I (2010) Engineered concrete : mix design and test methods (Concrete technology series) ISBN 0-8493-2277-4 (alk. paper) 1. Concrete.2. Portland cement.3. Concrete--Testing.I. Title.II. Series. 2010 by CRC Press LLC

[6] Love T.W. (1973) Construction Manual: Concrete & Formwork illustrated Published by Craftsman Book Company ISBN 0910460035, 9780910460033 169 pages

[7] Neville A.M. (1996) Properties of concrete. Wiley & Sons, 1996 ISBN 0470235276, 9780470235270 844 pages

[8] Opeyemi D.A. Ogunsakin V.L, Aliu A.O., Makinde O.O, Daramola A.S., Olabisi W. (2011). The suitability and performance of palm kernel shell as a substitute for coarse aggregates in the production of concrete. International Journal of Engineering Vol.5, No.2 (2011) 81 -87

[9] Opeyemi D. A. & Makinde O. O. (2012) The Suitability of Partial Replacement of Cement with Rice Husk Ash and Bone Powder in Concrete Structures International Journal of Emerging Technology and Advanced Engineering ISSN 2250-2459, Volume 2, Issue 9, September 2012

[10] Paul T. (2000) "Materials and Methods For Corrosion Control of Reinforced and Prestressed Concrete Structures in New Construction" US Department of Transportation, Research, Development, and Technology http://www.fhwa.dot.gov/publications/research/infrastructure/structures/00081.pdf

[11] Smith, M. R. & Colhs, L. (eds) 2001. Aggregates: Sand, gravel and crushed rock aggregates for construction purposes. Geological Society, London, Engineering Geology Special Publications, 17.

[12] Suresh N. (2012) "Workability of concrete" http://elearning.vtu.ac.in/16/ENotes/ConcreteTechnology/unit3-NS.pdf

[13] Yaqub* M., Imran Bukhari (2006). Effect Of Size Of Coarse Aggregate On Compressive Strength Of High Strength Concerts 31st Conference On Our World In Concrete & Structures: 16 – 17 August 2006, Singapore.

[14] Yusuf S. & Adejo B. (2011) Suitability Of The Use Of Rice Husk In Concrete Journal of Sciences and Multidisciplinary Research Volume 3, March 2011

[15] Zongjin Li (2011) Advanced concrete technology John Wiley & Sons, Inc. ISBN: 978-0-470-90243-1. 624 pages. January 2011

[16] Mauro M.T et al.."The Possibility Of Adding The Rice Husk Ash (Rha) To The Concrete." http://congress.cimne.upc.es/rilem04/adm in/files/filepaper/p282.pdf