EVALUATION OF FLEXURAL PROPERTY OF CEMENT CONCRETE PAVEMENT CONTAINING M SAND AS FINE AGGREGATE AND RICE HUSK ASH AS PARTIAL REPLACEMENT OF CEMENT

Sagar [1], Sachin Patil [2], Trupti G Mural [3], Shripooja.K.V[4], S.Mohan Reddy[5], Syed Amer Ali[6]
1,2 Assistant Professor, Civil Engineering Department, Rao Bahadur Y Mahabaleshwarappa Engineering College, Ballari-583104.
3,4,5,6UG students, Civil Engineering Department, Rao Bahadur Y Mahabaleshwarappa Engineering College, Ballari-583104.

Abstract : Over 5% of global CO2 emissions can be attributed to Portland cement production. Demand for cement continues to grow. The emissions caused by annual increases in production exceed gains to reduce emissions through manufacturing efficiencies and cleaner fuels. And also increase in the cost of conventional building materials and to provide a sustainable growth; the construction field has prompted the designers and developers to look for 'alternative materials' for the possible use in civil engineering constructions. For this objective, the use of industrial waste products and agricultural byproducts are very constructive. These industrial wastes and agricultural byproducts such as Fly Ash, Rice Husk Ash, Silica Fume, and Slag etc can be used as cementing materials because of their pozzolanic behavior, which otherwise require large tracts of lands for dumping. Large amounts of wastes obtained as byproducts from many of the industries can be the main sources of such alternate materials. The world rice harvest is estimated at 588 million tons per year and India is second largest producer of rice in the world with annual production of 132 million tons per year. This paper presents the details of an experimental investigation carried out to use Rice Husk Ash as a partial replacement to Cement and use of M sand as a complete replacement of natural sand in Concrete in an attempt to investigate the flexural strength of concrete. For control concrete, IS method of mix design is adopted and considering this a basis, mix design for replacement method has been made. Four different replacement levels of Rice Husk Ash namely 5%, 10%, 15% and 20% are chosen for the study to utilize Rice Husk ash and M sand in the production of Concrete. Beams of 100 x 100 x 500 mm were cast, cured for 7 days and 28 days and then tested to record the Flexural strengths to compare with control concrete to check the suitability for concrete pavements. The results have been analyzed and useful conclusions have been drawn.

***IndexTerms* - M Sand, Rice Husk Ash, pavement**

I. INTRODUCTION

Increasing demand of the building materials had come into concern of public and related industries. The issue is not only the chronic shortage of building materials but also the great impact to environment. Government and cement industry had developed several strategies to overcome this issue. One of it is to reuse the by-product generated from agricultural and industrial production activities. Examples for the agro-waste generated from agricultural sources are rice husk, jute fibre, coconut husk and etc. (Maduwar, Ralegaonkar & Mandavgane, 2012). These agro-wastes can be remade into sustainable building materials. Reuse of such agro-waste is not only overcome the pollution to environment, shortage of building materials but also the disposal problem of agro-waste. Malaysia has a great potential to reuse the agro-waste to reduce the environmental issues generated from the cement industry and agro-waste and achieve the objective of sustainable development.

Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. Manufactured sand is produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm. Manufactured sand is an alternative for river sand.

Due to fast growing construction industry, the demand for sand has increased tremendously, causing a deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost.

Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed. The utilization of M-Sand is not only economical but also reduces the environmental pollution.

The experimental investigation examines the physical properties of concrete at the age of 7 and 28 days of curing. The experimental tests are Flexural strength test at 7 and 28 days of curing.

Crusher dust and Rice Husk Ash are the two prominent industrial wastes, which are producing in huge quantities. In the recent times application of these two industrial wastes, have been gaining importance. In the present study, various percentages of crusher dust were added to Rice Husk Ash and tests like compaction, strength tests were performed. From the test results, Revanth Kumar.P et.al (2016) identified that increasing percentage of crusher dust increases strength values. 30% replacement of Rice Husk Ash by crusher dust can be used as geotechnical construction material.

G.A. Habeeb et.al (2009) reports an experimental investigation on the influence of Rice Husk Ash (RHA) Average Particle Size (APS) on the mechanical properties and drying shrinkage of the produced RHA blended concrete. Locally produced RHA with three deferent APS (i.e., 31.3, 18.3, and 11.5 µm, respectively) were used to replace cement by 20 % of its weight. Mixture proportioning was performed to produce high workability RHA mixture (200-240 mm slump) with target strength of 40 MPa. Incorporation of RHA in concrete resulted in increased water demand, for the mechanical properties, inclusion of RHA provided similar or enhanced mechanical properties when compared to the control Ordinary Portland Cement (OPC) mixture, with finer RHA giving better improvement. Fine RHA exhibited the highest shrinkage value due to the effect of microfine particles which increases its shrinkage values considerably.

Gemma Rodríguez de Sensale et.al (2006) presents a study on the development of compressive strength up to 91 days of concretes with rice-husk ash (RHA), in which residual RHA from a rice paddy milling industry in Uruguay and RHA produced by controlled incineration from the USA were used for comparison. Two different replacement percentages of cement by RHA, 10% and 20%, and three different water/cementicious material ratios (0.50, 0.40 and 0.32), were used. The results are compared with those of the concrete without RHA, with splitting tensile strength and air permeability. It is concluded that residual RHA provides a positive effect on the compressive strength at early ages, but the long term behavior of the concretes with RHA produced by controlled incineration was more significant. Results of splitting tensile and air permeability reveal the significance of the filler and pozzolanic effect for the concretes with residual RHA and RHA produced by controlled incineration..

II. MATERIALS USED

The details of various materials used in this investigation are given in the following sections.

2.1. Cement Used

Ordinary Portland cement of 43 grade of Ultratech brand conforming to IS: 12269 standards was used in this investigation. The specific gravity of the cement was 3.10. The initial and final setting times were found as 60 minutes and 270 minutes respectively.

2.2. Fine Aggregate Used

M-sand is used as a Fine aggregate which were collected in an around Ballari conforming IS 383-1970 passing 4.75 mm and are with the following properties

Table 1: Physical properties of Fine Aggregate

Sl. No.	Characteristics	Test results	Recommended values	IS Standards
1	Specific gravity	2.77	2.5-2.9	IS 383-1970
2	Fineness modulus	3.079	2-4	IS 383-1970
3	Bulk density	1580	1520-1680	IS 2386-3-1963

2.3. Coarse-aggregate Used

Crushed granite aggregate available from local sources has been used. To obtain a reasonably good grading, 76% of the 12mm size aggregates and 24% of 20 mm size aggregates are used in the production of concrete. The specific gravity of coarse aggregate is 2.69.

2.4. Water Used

Potable fresh water available from local sources was used for mixing and curing of mixes.

2.5. Rice Husk Ash

Properties of RHA is as follows

Table 2: Chemical Composition of Rice Husk Ash

SL.NO	Chemical Compound	Abbreviation	Percentage (%)
1	Silica	SiO_2	67.2
2	Aluminium Oxide	AL_2O_3	5.98
3	Ferric Oxide	Fe_2O_3	2.08
4	Calcium oxide	CaO	2.72
5	Magnesium Oxide	MgO	2.36
6	Sodium Oxide	Na_2O	0.91
7	Potassium oxide	K_2O	3.65
8	Loss on ignition	L.O.I	13.9
9	Sulphide Oxide	SO_3	1.01

III. Methodology

The main aim of the experimental program is to study the Flexural property of concrete. Cement is partially replaced with Rice Husk Ash in the proportion of 0%(Referance mix), 5%, 10%, 15% and 20% by weight. Fine aggregate which are used in the project were completely replaced by M sand which is denoted by 100%.

The materials (Cement, CA and FA) are weighed and dry mixed thoroughly after the measured amount of water for Water cement ratio of 0.5 is added and the material is mixed thoroughly until it becomes uniform. Replacement of cement by RHA from 0% to 20% by weight is done and M sand is used as Fine Aggregate. Concrete produced are filled in 100mm× 100mm × 500mm moulds. After 24 hours of casting, the specimens are de-molded and kept for curing.

The specimens were tested at different ages (7 and 28 days of curing) for flexural strength in accordance with Bureau of Indian Standards. For each trail, 3 beams were cast and tested at the age of 7 and 28 days. The average values of flexural strength were adopted in each case.

IV. Discussions of Test Results

4.1.Effect of age on flexural strength of concrete w.r.t different % replacement of rice husk ash:

Table 1 represents tabulated values of the compressive strength of Rice husk ash concrete w.r.t age

Table.1 Flexural strength of Rice husk ash concrete w.r.t age

Percentage of RHA	**Flexural strength (Mpa)**	
	7days	**28days**
0% RHA	6.00	7.10
5% RHA	6.20	7.38
10% RHA	6.71	8.86
15% RHA	6.06	7.35
20% RHA	5.60	6.21

Figure 1 represents the Effect of age on flexural strength of concrete w.r.t different % replacement of rice huskash

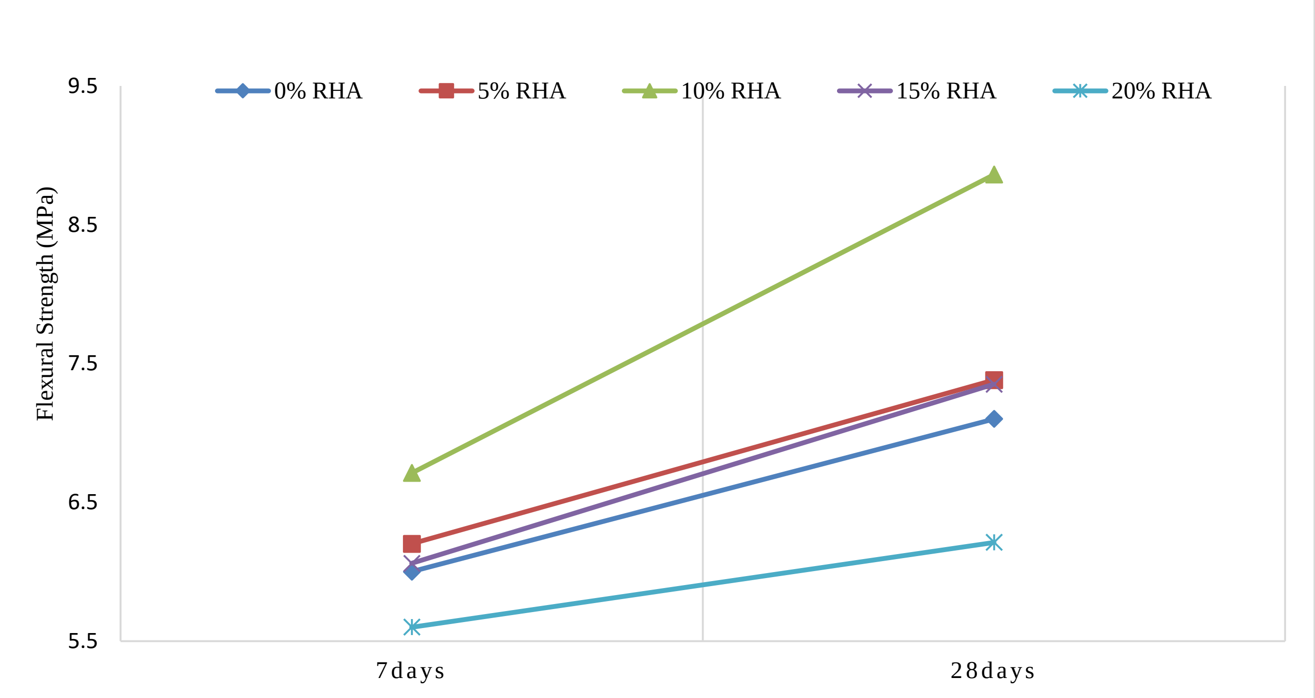

Fig.1 Effect of age on flexural strength of concrete w.r.t different % replacement of rice husk ash.

From this figure, it can be observed that the flexural strength increases for all the percentages of replacement of Rice Husk Ash from 7days to 28days, but the early strength gain is maximum for 10% replacement of cement by Rice Husk Ash and it increases by 24.27% for 28days. The early strength gain is minimum for 20% replacement of cement by Rice Husk Ash, and it increases by only by 9.82% for 28days. It can also be observed that the replacement of river sand by M sand yields good results compared to the ordinary concrete w.r.t age of concrete. The interfacial transition zone of concrete becomes stronger because of the pozzolanic products given out by Rice Husk Ash that helps in improving the bonding between cement mortar and aggregate. However, the flexural strength of concrete reduces for other percentages of Rice Husk Ash.

4.2. Effect of percentage replacement of Rice Husk Ash on the Flexural strength of concrete:

The variation of flexural strength (after 28 days curing) with varying percentage of Rice Husk Ash are presented in Figure. 2

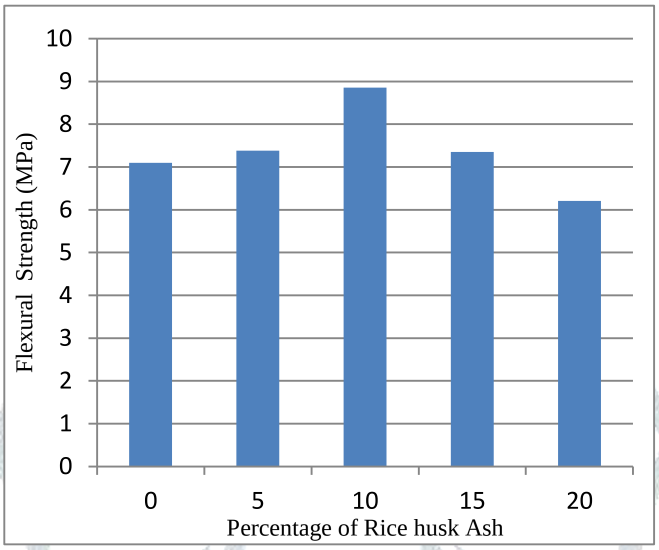

Fig.2 The variation of flexural strength (after 28 days curing) with varying percentage of Rice Husk Ash

From this figure, it can be observed that the flexural strength increases with increase in percentage of Rice Husk Ash, this is due to the higher fineness of Rice Husk Ash which might have allowed the Rice Husk Ash particles to increase the reaction with $Ca(OH)_2$ to give more calcium silicate hydrate (C-S-H) resulted in higher compressive strength. This is true for 5% and 10% replacement of cement by Rice Husk Ash. Further with every increase in Rice Husk Ash replacement by 5%, it resulted in the decrease of flexural strength. The maximum flexural strength was achieved for 10% replacement of cement by Rice Husk Ash and was decreased by 6.72% and by 14.44% with every 5% increase in Rice Husk Ash respectively. It can also be observed that the replacement of river sand by M sand yields good results compared to ordinary concrete along with replacement of cement by Rice Husk Ash. As the percentage replacement of Rice husk ash increases, there was also a gradual increase in the flexural strength of Rice husk ash concrete up to nearly 10% replacement and then it decreases.

V. Conclusions

The present investigation establishes the superiority concrete produced with partial replacement of cement by Rice Husk ash to stand well compared to ordinary concrete. The important conclusions of the present paper are summarized below.

1. The flexural strength of the concrete with partial replacement of rice husk ash increases with increasing the percentage of rice husk ash to some extent.
2. 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. This will result in the reduction in the cost of concrete to some extent.
3. The early strength gain is maximum for 10% replacement of cement by Rice Husk Ash.
4. It can also be observed that the replacement of river sand by M sand yields good results compared to ordinary concrete.
5. It can also be observed that the partial replacement of cement by rice husk ash and replacement of river sand by M sand yields good results compared to ordinary concrete which is ideal for concrete pavement.
6. Rice husk ash is environment polluting material and is best supplementary material for cement replacement as it is easily available in rice producing areas.
7. By using this Rice husk ash in concrete as the replacement the emission of greenhouse gases can be decreased to a greater extent. As a result, there is a greater possibility to gain number of carbon credits.
8. The technical and economic advantages of incorporating Rice Husk Ash in concrete should be exploited by the construction and rice industries, more so for the rice growing nations of Asia.

References

[1] M. Okamura, H. Ouchi, Self compacting concrete, J. Adv. Concr. Technol. 1 (2003) 5–15.
[2] K. Kartini, Effects of Silica in Rice Husk Ash (RHA) in producing High Strength Concrete, … of Engineering and …, vol. 2, no. 12, pp. 1951–1956, 2012.
[3] B. Lagerblad, Mechanism of carbonation, in Proceedings of the 18th International Baustofftagung Ibausil, 12–15 September (2011).

[4] W. Nocun-Wczelik, G. Lój, Effect of finely dispersed limestone additives of different origin on cement hydration kinetics and cement hardening, 13th International Congress on the Chemistry of Cement. (2011) 1–7.

[5] J.T.C. Mauricio López, Effect of natural pozzolans on porosity and pore connectivity of concrete with time, Rev. Ingeniería Constr. 25 (3) (2010) 419–431.

[6] M.S. Meddah, A. Tagnit-Hamou, Pore structure of concrete with mineral admixtures and its effect on self-desiccation shrinkage, ACI Mater. J. 106 (3) (2009) 241–250.

[7] A.P. Saciloto, A.L.G. Gastaldini, G.C. Isaia, T.F. Hoppe, F. Missau, Influence of the use of rice husk ash on the electrical resistivity of concrete: a technical and economic feasibility study, Constr. Build. Mater. 23 (2009) 3411–3419.

[8] M. Safiuddin, J.S. West, K.A. Soudki, Hardened properties of self-consolidating high performance concrete including rice husk ash, Cem. Concr. Compos. 32 (9) (2010) 708–717.

[9] T.F. Hoppe, A.L.G. Gastaldini, G.C. Isaia, A.P. Saciloto, F. Missau, Influence of curing time on the chloride penetration resistance of concrete containing rice husk ash: a technical and economical feasibility study, Cem. Concr. Compos. 32 (2010) 783–793.

[10] D.D. Bui, J. Hu, P. Stroeven, Particle size effect on the strength of rice husk ash blended gap-graded Portland cement concrete, Cem. Concr. Compos. 27 (3) (2005) 357–366.