Influence of Rice Husk Ash on the Strength Properties of Engineered Cementitious Composites

K. B. Shoba, P. Asha

*Abstract— The main objective of this study is to investigate the mechanical properties of engineered cementitious composites with different levels of ordinary portland cement of Grade 53 by adding Rice Husk Ash and Polypropylene fibres of different percentages. In order to achieve target mix, Chryso Optima S682(HRWR based admixture) has been incorporated with a dosage level of 3%. Cubes of 50mm*50mm*50mm, Cylinders of 75mm*150mm and prisms of 360mm*75mm*50mm were cast and evaluated. The compressive strength of 7, 14 and 28 days have been obtained. Outcomes pertaining to the mechanical properties of rice husk ash at 28 days were quite encouraging and the optimum percentage of rice husk ash was found to be 5% in engineered cementitious composites*

Keywords: Rice Husk Ash, Strength Characteristics, Levels of replacement.

1. INTRODUCTION

One of the waste materials in the world lies in the rice growing regions which is known as Rice Hull or Husk. The utilization of rice husk ash will reduce the energy consumed when adopted by the production of cement. Henceforth Rice Husk will be considered as an agro based product in which it can be used as an alternative material for cement without sacrificing the strength and durability. Basically rice husk ash is obtained by burning rice husk which is considered as the product from rice milling and used when igniting raw clay bricks in the kilns. Also it was adopted for the purpose of cooking which was then replaced by liquefied petroleum gas. As rice husk ashes have trifling protein content it cannot be taken into consideration for the purpose of animal feeding. It was estimated that 2000 kilograms of rice grains produce 400 kilograms of rice husk and after it gets burnt, about 20% of that would get converted into rice husk ash. Rice husk ash comprises of 80 to 85% of silica where seem to be very much reactive, depending the leading temperature of the incineration. However, Portland rice husk ash cements containing up to 50% ash by weight possessed compressive strengths which be reasonably greater than the control portland cements even at the early age of 7 days. Cements containing RHA gives excellent resistance toward organic and mineral acids which are in diluted form. The demand of water for obtaining normal consistency tend in the direction of elevate with increased ash content of the blended cements, yet this could be corrected by incorporating water reducing admixtures.

Revised Manuscript Received on December 22, 2018.

K. B. Shoba, Research Scholar, Department of Civil Engineering, St. Peter's Institute of Higher Education & Research, Avadi, Chennai, Tamilnadu, India.(Email: shoba.royalcivil1@gmail.com)

P. Asha, Professor, Department of Civil Engineering, St. Peter's Institute of Higher Education & Research, Avadi, Chennai, Tamil Nadu, India. (E-mail: ashap1905@gmail.com)

2. LITERATURE REVIEW

Hossain et al. (2011) determined that the addition of rice husk ash in cement increases its normal consistency and setting time. He also added that the addition of rice husk ash in bricks does not create an impact in its size and shape.

Shende et al. (2012) exhibited that compressive strength, split tensile strength and flexural strength seem to be high when adding 3% of fibres when compared to 0%, 1% and 2% of fibres

K.B.Shoba et al. (July 2018) Study on replacement of cement by micro silica (20 %) along with (1.5 %) of polypropylene fiber in ECC Matrix.

Krishna et al. (2012) enunciated that rice husk ash is fond of applications as repair mortars, stabilizing the soil. It also contributes significantly to strengthen green building concept.

Deotale et al. (2012) found that concrete containing rice husk ash possess low workability when compared with concrete containing fly ash. When on adding fibre, it explored decrease in workability

Akeke et al. (2013) observed that, experimental study on flexural strength indicates that a marginal increase when replacing 10% to 25% of rice husk ash. Especially for structural concrete replacing 10% of rice husk ash seem to be effective

Nair et al. (2013) studied with the aim of adding the rice husks ash in concrete results in increase in compressive strength as well as flexural strength. Also it revealed decrease in density when compared with conventional concrete

Kulkarni et al. (2014) concluded that the concrete becomes cohesive and plastic when incorporating rice husk ash thus allowing the same for easier placing and finishing of concrete. He also added that highest compressive strength, split tensile and flexural strength had been attained when rice husk ash of 20% have been added.

Khatri et al. (2014) took on experiments pertaining to rice husk ash on cubic strength of concrete cubes. It was found that the concrete cubes are sensitive with the replacement levels of 5% and 15% of rice husk ash by ordinary Portland cement. He also added that the cubic strength rapidly increases about 30% at 7 days and 50% at 28 days when on adding super plasticizers

*Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication*

ayalekshmi et al. (2014) proposed that the optimum replacement of waste materials in concrete along with the addition of polypropylene fibres provides improved results when compared with conventional concrete and that proved to be economical also.

Meddah et al. (2015) suggested that choosing the aspect ratio of fibre in the range of 80 will be appropriate for toughness performance. Multiple toughness indices say 110 and 130 improved with increasing fibre length to the maximum of 40 mm.

3. RESEARCH SIGNIFICANCE

The main goal of this experimental investigation is to determine strength and characteristics of engineered cementitious composites containing rice husk ash in partial replacement of cement in terms of 5%, 10%, 15%, 20% and 25% respectively and the addition of polypropylene fibres at 0.5%, 1%, 1.5% and 2% respectively. In total, 26 different ECC specimens containing high range water reducing admixture were cast for the purpose of investigation

4. EXPERIMENTAL PROGRAM

4.1 Materials and Mix Proportions

In this study, ingredients used for producing the mixture includes Ordinary Portland Cement of grade 53, M-sand, Rice husk ash having specific gravity of 2.27, water, polypropylene fibres and a high range new generation water reducing admixture. The physo-chemical properties of these materials are shown in Table 1, 2,3,4,5 and the mix proportions are shown in Table 6. The mixtures are prepared using mini-mixer by a constant water-binder ratio of 0.3.

Table.1 Physical Properties of 53 grade OPC

S. No	*Test Conducted*	*Results*
1	**Fineness**	276.4 m^2/kg
2	**Initial setting time**	180min
3	**Final setting time**	265min
4	**Soundness by Le- Chatelier Method**	1.0mm
5	**Compressive Strength**	
5 a	***3 days***	31.5MPa
5 b	***28 days***	53.0MPa

Table.2 Physical Properties of M-Sand

S. No	*Description*	*Results*
1	**Un-compacted bulk density**	1.43 kg / lit
2	**Compacted bulk density**	1.64 kg/ lit
3	**Specific gravity**	2.54
4	**Water Absorption**	2.50 %

S. No	*Physical Properties*	*Results*
1	**Shape Texture**	Irregular
2	**Color**	Grey
3	**Size of the particle**	<45 microns
4	**Mineralogy**	Non Crystalline
5	**Specific Gravity**	2.27
6	**Odour**	Odourless
7	**Appearance**	Very fine

Table.3 Physical Properties of Rice Husk Ash

S. No	*Chemical Properties*	*Results*
1	**SiO_2**	86.95%
2	**Al_2O_3, Fe_2O_3**	0.23%, 0.12%
3	**CaO, MgO, K_2O, Na_2O**	0.3%,0.2%,2.15%, 0.1%

Table.4 Chemical Properties of Rice Husk Ash

S. No	*Description*	*Results*
1	**Length of fibre (mm)**	3.50
2	**Density (g/cc) & Color**	0.91 & White
3	**Diameter of fibre (μm)**	38
4	**Tensile Strength**	>500 MPa
5	**Elongation Rate**	>15%
6	**Melting & Burning point**	180°&>360°

Table.5 Properties of Polypropylene Fibre

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication

Table.6 Mix Proportions of Test Specimens

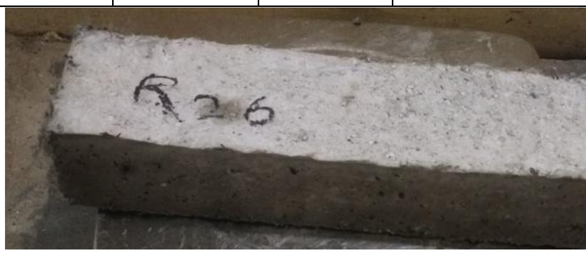
S. No	Mix ID	Cement (kg/m^3)	Rice Husk Ash (kg/m^3)	M. Sand (kg/m^3)	HRWR (%)	w/c Ratio	Addition of Polypropylene Fibre (%)
1	RHA0,F0	850	0	544	3	0.3	0
2	RHA5,F0	807.5					
3	RHA10,F0	765					
4	RHA15,F0	722.5					
5	RHA20,F0	680					
6	RHA25,F0	849.75					
7	RHA5,F0.5	807.75	42.5				0.5
8	RHA10,F0.5	765	85				
9	RHA15,F0.5	722.5	127.5				
10	RHA20,F0.5	680	170				
11	RHA25,F0.5	637.5	212.5				
12	RHA5,F1	807.5	42.5				1
13	RHA10,F1	765	85				
14	RHA15,F1	722.5	127.5				
15	RHA20,F1	680	170				
16	RHA25,F1	637.5	212.5				
17	RHA5,F1.5	807.5	42.5				1.5
18	RHA10,F1.5	765	85				
19	RHA15,F1.5	722.5	127.5				
20	RHA20,F1.5	680	170				
21	RHA25,F1.5	637.5	212.5				
22	RHA5,F2	807.5	42.5				2
23	RHA10,F2	765	85				
24	RHA15,F2	722.5	127.5				
25	RHA20,F2	680	170				
26	RHA25,F2	637.5	212.5				

4.2 Mixing and casting of specimens

Cube moulds of 50mm*50mm*50mm, cylindrical specimens of 75mm*150mm and coupon specimens of 360mm*75mm*50mm are considered for conducting tests on 26 different specimens. The solid ingredients including cement, rice husk ash, and manufactured sand are first mixed for a period of 30 seconds in Hobart mixer machine with a capacity of 7 litres Thereafter water and high range water reducing admixture in stipulated dosage levels are added to the dry mix and blend well for about 120 seconds. Polypropylene fibres are then added thereafter into the mortar mix and continued to blend until the fibre gets evenly distributed. Then the mixture is cast and demoulded after 24 hours. After that, the specimens are cured in curing tank to satisfy different curing intervals to assess for mechanical property.

(a)

(b)



(c)

Fig.1 Casting of Cube, Cylinder and Beam Specimens

Fig. 2 Testing of flexure specimens.

5. RESULTS & DISCUSSION

5.1 Compressive Performance for Rice Husk Ash in ECC

The mortar specimens be positioned in the compression testing machine having 2 tonne capacity. The load was applied significantly till the resistance of the specimen towards increasing load can be sustained. The variation in strength potencies with respect to 26 different mix identities defined to exhibit the best outcome in the mechanical properties of ECC are shown in Fig.3, 4&5 respectively. It have been observed that the compressive strength has attained to a maximum value of 49.24 MPa when on replacing rice husk ash of 5 % by cement and adding 0.5% of polypropylene fibres, The compressive strength decreases when the replacement levels for rice husk ash and polypropylene fibres were increased.

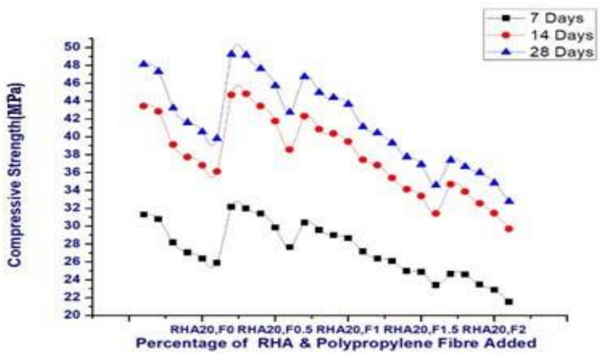


Fig.3 Compressive strength for test specimens at 7, 14 & 28days

5.2 Split tensile Performance of Rice Husk Ash in ECC

The cylindrical specimens were placed in horizontal axis adhering with wooden strips which is carefully positioned along the upper and lower plane of loading for the specimen. Load was applied and improved continuously considering a supposed rate commencing from 1.2 MPa until fracture. With respect to the result outcomes, it was observed that the split tensile had attained at maximum value of 4.73 MPa when replacing rice husk ash of 5 % by cement and adding 0.5% of polypropylene fibres whereas for 15%, 20% and 25% the strength notably decreased to 4.28 MPa, 3.93 MPa and 3.7 MPa thereby the strength detained setting a benchmark of 3.18 MPa when rice husk ash of 25% and fibres of 2% were added.

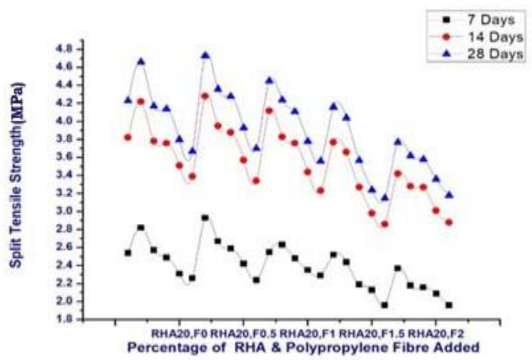


Fig.4 Split tensile strength for test specimens at 7, 14 &28 days

5.3 Flexural Performance of Rice Husk Ash in ECC

The specimens be placed in the testing machine and load is applied going on the uppermost surface where the centroid axis with awareness aligned with the axis of the loading equipment. The load be continued linearly until fracture attained. The test results revealed that the flexural strength rapidly improved to a maximum range of 7.37 MPa. When replaced with 15%, 20% and 25%, flexural strength decreased to 7.16 MPa, 6.89 MPa and 6.44 MPa.

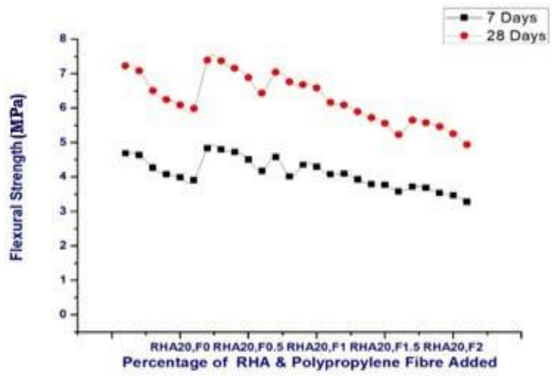


Fig.5 Flexural strength for test specimens at 7,14 & 28 days

6. CONCLUSIONS

With respect to the above experimental study, the following conclusions were drawn.

- Rice husk ash in engineered cementitious composites exhibits low workability when on blending and to counter the outcome of, high range water reducing admixture have been used to maintain the rheoplastic properties.
- The reliability of Rice husk ash and Polypropylene fibre in engineered cementitious composites pertaining to different mix identities had been investigated with the intention of improving their sustainability index.
- The maximum replacement level of rice husk ash and addition of polypropylene fibres in engineered cementitious composites shall be considered as 5 % and 0.5% based on the research hypothesis.

REFERENCES

1. Abdelaziz Meddah, Larbi Belagraa, Miloud Beddar., Effect of the fibre geometry on the flexural properties of reinforced refractory concrete, 7th Scientific technical conference material problems in civil engineering, Volume 3, 2015, pp 185-192
2. Deepa G.Nair, K.Sivaraman and Job Thomas., "Mechanical Properties of RHA- High strength concrete", American Journal of Engineering Research (AJER), Volume 3, pp 14-19
3. K.B.Shoba and P.Asha"Study On Engineered Cementitious Composites Using Micro Silica & Polypropylene Fibre", International Journal of Civil Engineering and Technology (IJCIET), Volume 9, Issue 7, (July 2018)

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

4. R.S. Deotale, S.H.Sathawane, A.R. Narde., "Effect of Partial Replacement of Cement by Fly Ash, Rice Husk Ash using fibre in concrete, International Journal of Scientific & Engineering Research, Volume 3, Issue 6, June 2012, pp1-9
5. Godwin. A. Akeke, Maurice E.Ephraim, Akobo I.Z.S and Joseph O.Ukpata., "Structural properties of Rice Husk Ash concrete", International Journal of Engineering and Applied Sciences, May 2013, Volume 3, pp 57-62
6. R.N. Krishna, "Rice Husk ash – An Ideal admixture for concrete in aggressive environments", 37th Conference on our world in concrete & structures: 29-31 August 2012, Singapore article Online Id: 100037026
7. P. Padma Rao, A. Pradhan Kumar, B. Bhaskar Singh, A study on use of rice husk ash in concrete, IJEAR, Volume 4 Issue Spl-2, Jan-June 2014, pp 75-81
8. Sankar Jegadesh J.S & S.Jeyalekshmi., "Study on properties of concrete with colour adsorbed fly ash, rice husk ash, steel slag and polypropylene fibres", International Journal of Civil Engineering (IJCE), Volume 3, Issue 3, May 2014, pp 9-18
9. A.M Shende, A.M Pande, M. Gulfam Pathan., "Experimental study on fibre reinforced concrete for M-40 Grade", International Refereed Journal of Engineering and Science (IRJES) Volume 1, Issue 1, September 2012, pp 43-48
10. Shubha Khatri., "Impact of Admixture and Rice Husk Ash in Concrete Mix Design", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 11, Issue 1, Ver 4, February 2014, pp 13-17
11. Tanvir Hossain, Shuronjit Kumar Sarker, B.C. Basak.,Utilization potential of rice husk ash a construction material in rural areas, Journal of Civil Engineering (IEB), 39 (2), November 2011, pp 175-188.