EFFECT OF RICE HUSK ASH ON STRENGTH AND DURABILITY PARAMETER OF M-20 & M-40 CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT-A REVIEW

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Abstract: Construction activities are increasing rapidly, hence resulted in shortage of conventional construction materials. Mainly Coarse Aggregate, Crushed Sand and cement are used in the preparation of concrete. While the use of agricultural by-product i.e. rice husk ash can be used as a partial replacement with Cement. Due to the pozzolanic reactivity, rice husk ash (RHA) is employed as supplementary cementing material in concrete. The rice husk ash (RHA) contain near about 90 % of Silicon Dioxide (Sio2). By using rice husk ash in concrete, various properties of concrete can be improved. The addition of these admixtures also results in significant savings in energy and cost. The detailed experimental investigation is to study the effect of partial replacement of cement by Rice husk ash. In all 144 Specimen with M-20 & M-40 grade will be casted and tested. Properties like Slump Cone, Compressive strength, Tensile Strength, Flexural Strength and Durability Test for various amount of replacement of cement i.e. 10%, 15% and 20% with Rice Husk Ash for both the grades of concrete will be compared with that of conventional concrete which without Rice Husk Ash. The optimum level of replacement of Rice Husk Ash will be found out for both the grades of concrete. Cost analysis based on the result obtained will be determined and the reduction in cost of construction will be calculated.

***IndexTerms* - Rice Hush Ash, Compressive Strength, Flexural Strength, Durability.**

I. INTRODUCTION

Construction Industries is one of the largest industry worldwide which plays vital role in the economic as well social growth of the country. In India, creating quality concrete in the present climate does not depend solely on achieving a high strength property. It also depends on improving the durability of the concrete to sustain a longer life span and producing a greener concrete. By using industrial by-products such as rice husk ash as a mineral admixture and partially replacing Ordinary Portland Cement (OPC) in the concrete, the amount of greenhouse gas produced in making the concrete and the energy required to produce the concrete are reduced.

Concrete is the solid composite material and made up of suitable proportion of binding material, fine aggregate, Coarse aggregate and Water. And also it is mainly used to make driveways, patios, roads, bridges, and even entire buildings. The artificial stone called concrete is the most widely used building material. It is created by mixing aggregate, cement and water. In modern construction, we need advanced admixtures to be enhancing their properties of concrete. Which means to be mostly avoid the cracks, shrinkage, and also creep in the structures. Rice husk are the hard protective coverings of rice grains which are separated from the grains during milling process. Rice husk is an abundantly available waste material in all rice producing countries, and it contains about 30%–50% of organic carbon. In the course of a typical milling process, the husk are removed from the raw grain to reveal whole brown rice which upon further milling to remove the bran layer will yield white rice. Current rice production in the world is estimated to be 700 million tons. Rice husk constitutes about 20% of the weight of rice and its composition is as follows: cellulose (50%), lignin (25%–30%), silica (15%–20%), and moisture (10%–15%). Bulk density of rice husk is low and lies in the range 90–150 kg/m3. Sources of rice husk ash (RHA) will be in the rice growing regions of the world, as for example China, India, and the far-East countries.

RHA is the product of incineration of rice husk. Most of the evaporable components of rice husk are slowly lost during burning and the Primary residues are the silicates. The characteristics of the ash are dependent on (1) composition of the rice husks, (2) burning temperature, and (3) burning time. Every 100 kg of husks burnt in a boiler for example will yield about 25 kg of RHA. In certain areas, rice husk is used as a fuel for parboiling paddy in rice mills, whereas in some places it is field-burnt as a local fuel. However, the combustion of rice husks in such cases is far from complete and the partial burning also contributes to air pollution.

II. PROBLEM STATEMENT

Annually a huge amount of agricultural wastes are piled up or landfilled in rather productive lands, rendering the land useless. Rice husk Ash (RHA) is an agricultural waste product which can be which can be utilized in concrete as mineral admixture. Rice Hush Ash in Concrete could be helpful both for environmental and economic aspects in the construction industry. Similarly Cement is the principal raw material for the concrete production, manufacturing them leads to severe environmental pollution namely CO2 emissions. The emission of CO2 is estimated as 1 tons of CO2/1 tons of cement produced and globally 5–7% of CO2 emissions contribute to environmental degradation namely global warming etc. Ecological concerns have become increasingly important for the introduction of new materials and products. Rice Hush Ash has been reported to be a good supplementary cementitious material and hence it can used as partial replacement to cement which can help to reduce CO2 emissions.

III. Literature Review

Rupali Subhasmita Padhi, Rakesh Kumar Patra, Bibhuti Bhusan Mukharjee, Tanish Dey (2018), Influence of incorporation of rice husk ash and coarse recycled concrete aggregates on properties of concrete – The author researched on the utilization of concrete using rice husk ash in concrete to carry out the strength. The proportions used in this case were 5%, 10%, 15%, 20%, 25%, 30%, and 35% of rice husk ash and containing 10% of recycled aggregates. The cubes were casted and cured for 7, 28, and 90 days to determine the compressive strength, split tensile strength and flexural strength, modulus of elasticity. The author tried to determine all the mentioned strength while testing in laboratory. The results analyzed on experimenting the behavior of concrete satisfied the use of rice husk ash for 10-15%.

Kannan V (2018), Strength and durability performance of self-compacting concrete containing self-combusted rice husk ash and metakaolin-The author researched on carrying out the performance of concrete using rice husk ash a partial replacement with cement. The author analysed the behaviour of self-compacting concrete, by replacing of 0 to 30% of rice hush ash with the cement. Various tests were performed which are slump flow test, v-funnel test and L- box test for fresh state properties and for strength properties which are compressive and spilt tensile strength, for durability properties the rapid chloride penetration test were performed by the author. The study show that 15% rice husk ash, 10% Metakaolin and 10% Rice Hush ash + 10% Metakaolin blended SCC showed good result when compared to conventional concrete.

Blessen Skariah Thomas (2017), Green concrete partially comprised of rice husk ash as a supplementary cementitious material – A comprehensive review-The basic objective of this chapter is to get inside into the previous findings so that it will help to know the gap in earlier studies and to justify the research problem selected by me for the study purpose. The literature is reviewed on Green concrete partially comprised of rice husk ash as a supplementary cementitious material. The aim of this paper is utilization of rice husk ash as a supplementary cementitious material and the properties of such concrete at fresh and hardened stages. Almost 7% of the global carbon dioxide emissions, as the production of one ton of ordinary Portland cement releases approximately one ton of carbon dioxide. Rice husk is an agricultural waste, whose natural degradation is restricted due to the irregular abrasive surface and high siliceous composition. The tests were performed to determine the high strength and self-compacting concrete as it shows high strength, low shrinkage and permeability, high resistance to carbonation, chloride, sulphate and acidic environments. The author reveals the rice husk ash dependency which was basically depended on the material, time, duration of using RHA, and its temperature. All these properties will enhance the using of RHA in concrete to achieve better results than conventional concrete.

Huanghuang Huang, Xiaojian Gao, Hui Wang, Huan Ye (2017), Influence of rice husk ash on strength and permeability of ultra-high performance concrete-The main focus of the author in this study is to investigate the strength and permeability of the high performance concrete. The author used this admixture to determine the compressive strength and flexural strength at different curing ages. The author also presents the formation of concrete using rice husk ash with some proportions, thus measures the permeability by water absorption and chloride ion penetration test. Author mentioned the results achieved where on increasing load the permeability also increases. The compressive strength enhanced on using rice husk ash due to pore structure of concrete. Following below are the conclusions mentioned by the author: On increasing RHA the fluidity of fresh UHPC mixture decreases. The RHA enhances the compressive strength of concrete. The permeability of increases with the increase in vertical loading. The loading level is lower than 70% of ultimate strength, the RHA added sample presents a lower water absorption and chloride ion penetration

Elias Molaei Raisi, Javad Vaseghi Amiri, Mohammad Reza Davoodi (2018), Influence of rice husk ash on the fracture characteristics and brittleness of self-compacting concrete-The author researched on the characteristics of concrete by using rice husk ash as a partial replacement admixture with cement to make a new concrete mix to determine the fracture characteristics and brittleness of self-compacting concrete. The specimen prepared by using the proportions which are 0%, 5%, 10%, 15%, 20%. Author investigates on two main methods, the size effect method and the work of fracture method. Many of the characteristics were determined by the author in this study which are fracture toughness (KIC), fracture energies (Gf in SEM and GF in WFM), brittleness number (β), characteristic length (Lch) as well as effective length of fracture process zone (Cf), and critical crack-tip opening displacement (CTODC). The results achieved by the author in this study by replacing the rice husk ash with cement were satisfying as the effective length of fracture and fracture energy decreased with the increase RHA replacement ratio. Adding rice husk ash from 5 to 20% reduces the characteristic length to 14.9%, 20.8%, 27.0%, and 21.5%. Author determined the length of fracture process that decreases from 19.08mm to 12.39mm.

IV. Objective

- To compare the mechanical properties of concrete in the varying percentage of Rice husk ash, with conventional concrete.
- To check durability Parameters of Concrete with partial replacement of Cement with Rice Husk Ash.
- To perform a cost analysis based on the result obtained and to determine reduction in cost of construction.

V. Experimental Material

5.1 Cement

Cement is the major raw material used in construction Industry. Therefore, quality of cement must be checked before using it as a raw material

Table 5.1: Physical Properties of Cement

Sr. No	Name Of Test	Results	Method of Test	Limit As Per IS 269-2015
1	Fineness(By Dry Sieving)	5.20 %	IS 4031(Part-1)-1999-RA2013	-
2	Standard Consistency	30.00 %	IS 4031(Part-4)-1988-RA2014	-
3	Initial Setting Time	190 Min	IS 4031(Part-5)-1988-RA2014	Minimum 30 Min
4	Final Setting Time	290 Min	IS 4031(Part-5)-1988-RA2014	Maximum 600 Min
5	Specific Gravity	3.15	IS 4031(Part-11)-1988-RA2014	
6	Soundness by Le-Chatelier Method	1.1 mm	IS 4031(Part-3)-1988-RA2014	
7	Compressive Strength of Cement		IS 4031(Part-6)-1988-RA2014	
	3 Days	33.8 N/mm^2		Min 27 N/mm^2
	7 Days	44.9 N/mm^2		Min 37 N/mm^2
	28 Days	60.2 N/mm^2		Min 53 N/mm^2

5.2 Rice Hush Ash

The use of durability enhancing mineral admixtures or supplementary cementing materials has gained considerable importance as a key to long service life of concrete structures. There are many mineral admixtures that are used in way throughout the world but rice husk ash stands out as an eco-friendly, sustainable and durable option for concrete. This research attempts to bring out the effectiveness of rice husk ash as a versatile concrete admixture. Physical properties test and chemical result test are given below.

Table 5.2: Physical Properties of Rice Hush Ash

Sr. No	Name Of Test	Results	Method of Test	Limit As Per IS 3812 (Part-1) -2003
1	Standard Consistency	30.00 %	IS 1727 RA 2013	-
2	Initial Setting Time	195 Min	IS 1727 RA 2013	Minimum 30 Min
3	Final Setting Time	320 Min	IS 1727 RA 2013	Maximum 600 Min
4	Fineness 45 Micron Sieve	24.52 %		Max 34 %
5	Specific Gravity	2.28	IS 1727 RA 2013	
6	Compressive Strength		IS 1727 RA 2013	Not less than 80 % of the strength of corresponding plain cement mortar cube.
	7 Days	81.25 %		
	28 Days	82.63 %		

Table 5.3: Chemical results of Rice Hush Ash

Sr. No	Name Of Test	Results	Method of Test	Limit As Per IS 3812 (Part-1) -2003
1	Silicon Dioxide (Sio_2)	89.85 %	IS 1727 RA 2013	Min 35 %
2	Total Sulphur as sulphur trioxide (SO_3)	0.66 %	IS 1727 RA 2013	Max 3 %
3	Loss of Ignition	3.39 %	IS 1727 RA 2013	Max 5 %
4	Total Cloridesin % by Mass	0.013 %	IS 1727 RA 2014	Max 0.05 %

5.3 Aggregate

Aggregate plays an important role in construction. Aggregates influence, to a great extent, the load transfer capability of structure. Hence it is essential that they should be thoroughly tested before using for construction. Not only that aggregates should be strong and durable, they should also possess proper shape and size to make the structure act monolithically. All the aggregates are tested as per IS 2386: 1963 (RA 2016) and the result are as below.

Table 5.4: Sieve Analysis for 10mm Aggregate

Sieve Size (mm)	Weight Retained (gms)	Cum Weight Retained (gms)	Weight Retained %	Passing %	Limit as per IS : 383-1970 reaffirmed 2011 (Zone-II)
12.5	0.00	0.00	0.00	100.00	100
10	3025	3025	13.75	86.25	85-100
4.75	18093	21118	95.99	4.01	0-20
2.36	583	21701	98.64	1.36	0-5
PAN	299	22000	100	0.00	--
	22000gms				

Table 5.5: Sieve Analysis for 20mm Aggregate

Sieve Size (mm)	Weight Retained (gms)	Cum Weight Retained (gms)	Weight Retained %	Passing %	Limit as per IS : 383-1970 reaffirmed 2011 (Zone-II)
40	0.00	0.00	0.00	100	100
20	2995	2995	12.48	87.52	85-100
10	20297	23292	97.05	2.95	0-20
4.75	653	23945	99.77	0.23	0-5
PAN	55	24000	100		--
	24000gms				

Table 5.6: Test Result for 10mm and 20mm aggregate

Test	Result-10mm	Result-20mm	Unit
Specific Gravity	2.74	2.74	-
Aggregate Impact Value	14.21	13.52	%
LA Abrasion Value	19.12	18.32	%
D.L.B.D	1.48	1.48	g/cc
Water Absorption	1.68	1.52	%
Aggregate Crushing Value	18.02	17.63	%
Elongation Index	11.52	10.52	%
Flakiness index	11.69	11.69	%

5.4 Crushed Sand

Getting good quality of Crushed Sand which should be free from organic impurities. While adding the Crushed Sand to the mix, it should be in uniform size i.e. all the Crushed Sand particles should be fine. Crushed sand is tested as per IS 2386: 1963 (RA 2016) and the result are as below.

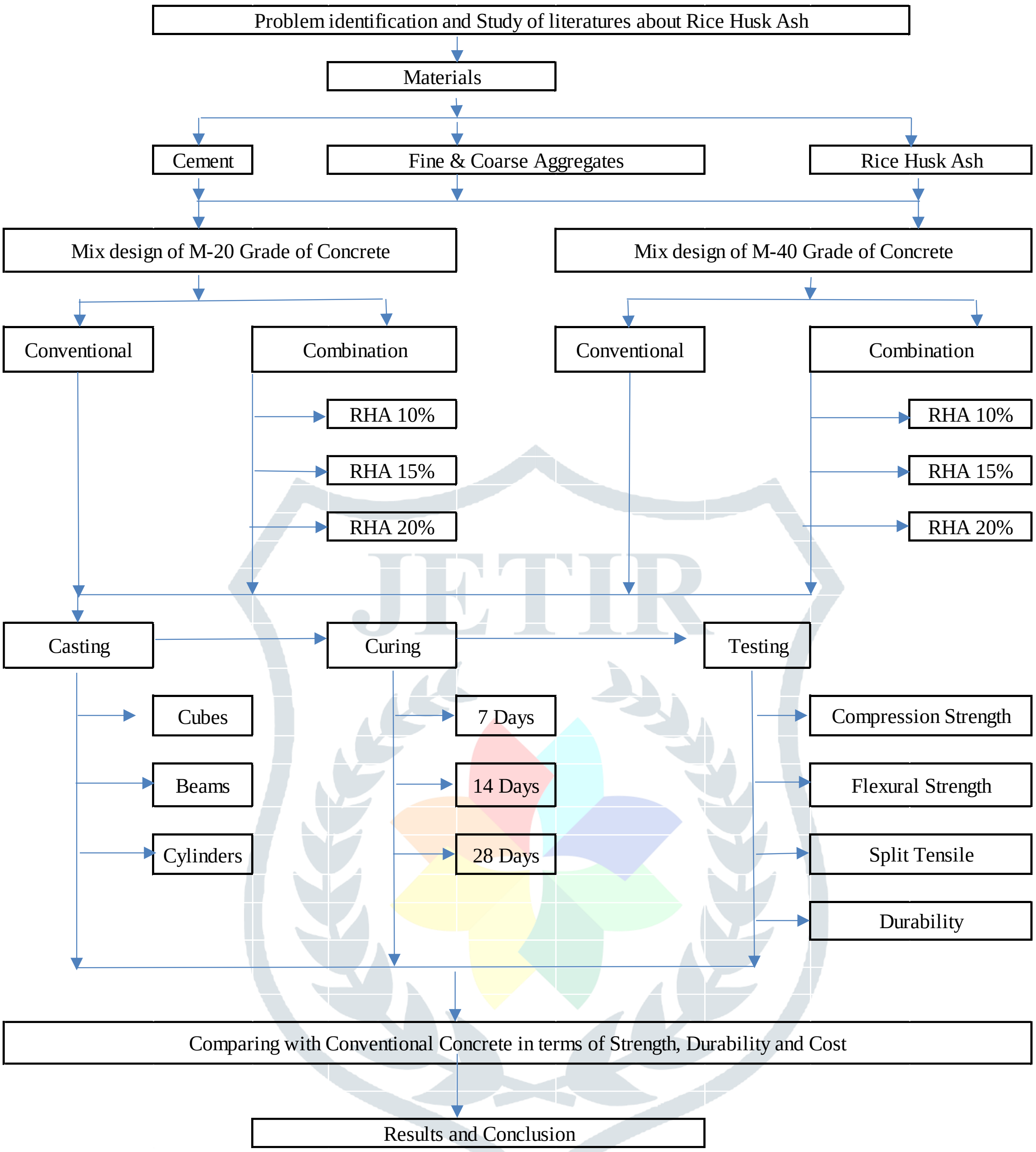
Table 5.7: Test Result for Crushed sand

Sieve Size (mm)	Weight Retained (gms)	Cum Weight Retained (gms)	Weight Retained %	Passing %	Limit as per IS : 383-1970 reaffirmed 2011 (Zone-I)
10	0.00	0.00	0.00	100	100
4.75	196	196	8.90	91.10	90-100
2.36	462	658	29.90	70.10	60-95
1.18	328	986	44.81	55.19	30-70
0.600	772	1758	79.90	20.10	15-34
0.300	190	1948	88.54	11.46	5-20
0.150	210	2158	98.09	1.91	0-20
PAN	42	2200	100		
	2200gms				

Table 5.8: Sieve Analysis for Crushed sand

Test	Result	Unit
Specific Gravity	2.74	-
D.L.B.D	1.48	g/cc
Water Absorption	1.52	%
Silt Content by Weight	5.14	%

VI. METHODOLOGY



VII. EXPECTED OUTCOMES/CONCLUSION

- Strength & Durability parameters will be increased.
- Cost optimization by using RHA.
- Contributing towards Sustainable development & also will be useful for the society service.

REFERENCES

[1] Rupali Subhasmita Padhi , Rakesh Kumar Patra , Bibhuti Bhusan Mukharjee , Tanish Dey -Influence of incorporation of rice husk ash and coarse recycled concrete aggregates on properties of concrete - Construction and Building Materials 173 (2018) 289–297.

[2] Elias Molaei Raisi, Javad Vaseghi Amiri, Mohammad Reza Davoodi - Influence of rice husk ash on the fracture characteristics and brittleness of self- compacting concrete - Reference: EFM 6047.

[3] Seyed Alireza Zareei, Farshad Ameri, Farzan Dorostkar, Mojtaba Ahmadi - Rice husk ash as a partial replacement of cement in high strength concrete containing micro silica: Evaluating durability and mechanical properties - Reference: CSCM 95.

[4] Josephin Alex, J. Dhanalakshmi, B. Ambedkar - Experimental investigation on rice husk ash as cement replacement on Concrete production - Construction and Building Materials 127 (2016) 353–362.

[5] Huanghuang Huang , Xiaojian Gao , Hui Wang , Huan Ye - Influence of rice husk ash on strength and permeability of ultra-high performance concrete - Construction and Building Materials 149 (2017) 621–628

[6] Mohammad Badrul Ahsan, Zahid Hossain - Supplemental use of rice husk ash (RHA) as a cementitious material in concrete Industry - Construction and Building Materials 178 (2018) 1–9

[7] Ravande Kishore, V.Bhikshma and P.Jeevana Prakash - Study on Strength Characteristics of High Strength Rice Husk Ash Concrete - Procedia Engineering 14 (2011) 2666–2672

[8] Kannan V - Strength and durability performance of self compacting concrete containing self- combusted rice husk ash and metakaolin - Construction and Building Materials 160 (2018) 169–179

[9] Sung-Hoon Kang, Sung-Gul Hong, Juhyuk Moon - The use of rice husk ash as reactive filler in ultra-high performance concrete -Cement and Concrete Research, 0008-8846/ © 2018 Elsevier Ltd. All rights reserved.

[10] Josephin Alex, J. Dhanalakshmi, B. Ambedkar - Experimental investigation on rice husk ash as cement replacement on concrete production - Construction and Building Materials 127 (2016) 353–362

[11] Ravande Kishore, V.Bhikshma and P.Jeevana Prakash - Study on Strength Characteristics of High Strength Rice Husk Ash Concrete - Procedia Engineering 14 (2011) 2666–2672

[12] Ravinder Kaur Sandhu , Rafat Siddique - Influence of rice husk ash (RHA) on the properties of self-compacting concrete: A review - Construction and Building Materials 153 (2017) 751–764

[13] Ha Thanh Le, Horst-Michael Ludwig - Effect of rice husk ash and other mineral admixtures on properties of self-compacting high performance concrete - Reference: JMADE 690

[14] Elias Molaei Raisi , Javad Vaseghi Amiri, Mohammad Reza Davoodi – Mechanical performance of self-compacting concrete incorporating rice husk ash - Construction and Building Materials 177 (2018) 148–157

[15] Blessen Skariah Thomas - Green concrete partially comprised of rice husk ash as a supplementary cementitious material – A Comprehensive review - Department of Civil Engineering, Providence College of Engineering, Chengannur, Kerala, India