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DRAW OUT OPTIMUM CONTENT OF RICE HUSK ASH FOR SELF-COMPACTING CONCRETE

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Abstract — *concrete is used as main material in construction. Cement is main ingredient in concrete, due to high demand of cement additional pozzolana required to partial replacement of cement for economical production of concrete. Mechanical experiments of RHA blended Portland cement concretes revealed that in addition to the pozzolanic reactivity of RHA (chemical aspect), the particle grading (physical aspect) of cement and RHA mixtures also exerted significant influences on the blending efficiency. Self-compacting concrete (SCC) is one of the most significant advances in concrete technology in the last two and half decades. SCC was developed to ensure adequate compaction through self-consolidation and facilitate placement of concrete in structures with congested reinforcement and in restricted areas. The present work aims with the study of rheological properties of optimum content of RHA in SCC and compressive strength of different proportion of rice husk ash as 0%, 5%, 10%, 15% and 20%.*

Keywords- *self-compacting concrete (SCC), rice husk ash (RHA), super plasticizer (SP), viscosity modified agent (VMA), rheology.*

I. INTRODUCTION

In Japan, in early eighties, premature deterioration of concrete structures were detected almost everywhere in the country. The main cause of the deterioration was recognized as inadequate compaction. In addition, the gradual reduction in the number of skilled workers in Japan's construction industry led to a reduction in the quality of construction work. As a solution for these social and technical requirements, the concept of SCC was proposed by Prof Okamura at Tokyo University in 1988. He gave the first prototype of SCC using materials already in the market. Later studies to develop SCC, including a fundamental study on the workability of concrete, were carried out by Ozawa and Maekawa. SCC has now been taken up with enthusiasm across Europe and other parts of the world, in both site and precast concrete work. Practical application has been backed up by research on its physical and mechanical characteristics of SCC. Early SCC relied on very high contents of cementations paste, the mixes required specialized and well-controlled placing methods to avoid segregation, but the high contents of cement paste made them prone to shrinkage and high heat generation. The overall costs were very high and applications therefore remained very limited. After series of advancements it is no longer a material consisting of cement, aggregates, water and admixtures. As already mentioned it is now an engineered material with several constituents.

RHA is obtained by burning rice husks, which are generated in the rice milling industry as agricultural wastes during the processing of paddy rice. In rice producing countries, about 120 million metric tons of rice husks are available annually for disposal. The majority of this amount is generated in China, India, Indonesia, and Bangladesh. When this agro-waste is incinerated, crystalline or non-crystalline (amorphous) RHA can be obtained depending on the burning time and temperature. The uncontrolled incineration at high temperature (>800 _C) produces crystalline RHA, which possesses a poor pozzolanic property. Conversely, the controlled incineration of rice husks between 500 and 800 _C results in non-crystalline RHA, which possesses a very high content of amorphous silica. Due to a high silica content, the amorphous RHA is highly pozzolanic, and therefore more suitable than crystalline RHA for use in concrete. This type of RHA has been successfully used to produce high strength and high performance concretes with a good workability. However, limited research has been conducted to produce SCC with RHA, while investigating its possible effects on the workability or flowing ability of this special concrete. Generally, the role of RHA on the flowing ability of SCC should be investigated by testing fresh concrete. But it is often very difficult and time-consuming to study a wide range of variables in the case of concrete because of numerous trial mixtures having relatively a large batch size. In addition, it is not cost-effective due to the loss of materials and labor. As an alternative, the mortar formulated from SCC can be tested to study the potential effects of RHA on the flowing ability of fresh concrete.

The role of RHA in SCC is the same as that in any other concretes. In concrete, the RHA mainly serves as a micro filler, viscosity modifier. The RHA particles can fill the voids their smaller size. However, the micro filling ability of RHA is not as effective as metakaoline. This is because the RHA particles are much larger than the metakaoline particles. The

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typical median particle size of RHA is about 7 µm. While that of the cement and silica fume is 13 µm. Although RHA is not very fine in particle size, it behaves as a very reactive pozzolanic material because of its extreme surface fineness and high silica content.

II. MATERIAL AND ITS PROPERTIES

3.1 Cement

All type of cement conforming Indian Standard are suitable for the self-compacting concrete here in this experimental work OPC 53 grade is used conforming IS: 12269-2004.

"Table 1 physical properties of cement"

Sr no.	Properties	results	units	Limit as per IS
1	Initial setting time	35	Minutes	>30
2	Final setting time	225	Minutes	<600
3	Specific gravity	3.12	NA	<3.15
4	Compressive strength after 28 days	55	Mpa	>53

3.2 Aggregate

Aggregates in self compacting concrete should not be more than 20 mm as per European guideline 2005 so here in study 10mm and 20mm aggregate were used in proportion of 60% and 40 % respectively. Sieve analysis was done for the conforming size for both 20mm and 10 mm coarse aggregate and found all corrects as per IS code. Course aggregate were tested for specific gravity, free surface moisture, and water absorption as per IS IS: 2386 (Part III). Fine aggregate is most important ingredients of the concrete which fill the space between other materials the fine aggregate were used, tested for the specific gravity, free surface moisture, water absorption, silt content and sieve analysis. Each test was done on three sample of the materials the results are as per below table II

"Table 2 physical propertied of aggregate"

Sr no.	Properties	results	
		Fine aggregate	Course aggregate
1	Sieve analysis	Conforming zone II	Satisfied
2	Specific gravity	2.5	2.65
3	Free surface moisture	1%	0.5%
4	Water absorption	1.5%	0.68%
5	Silt content	1.2%	NA

3.3 Water

Ordinary tap water was used for mixing as well as curing of the specimen

3.4 Rice husk ash

Rice husk ash is blackish in color and very fine material which fill the space between the other ingredients, in addition to that it give good resistance to segregation which is most important criteria for SCC. Three specimen where tested for the specific gravity and found as 1.96.

3.5 Admixture

Glenium sky was used as high water reducer agent (HWRA), which reduce the water up to 20% of total and stream 2 was used as a viscosity modified agent. These both admixture were from BASF Company.

III. MARSH CONE TEST FOR PASSING ABILITY OF MORTAR AND FOR THE OPTIMUM CONTENT OF THE SUPER PLASTICIZER

The Marsh funnel is a simple device for measuring viscosity by observing the time it takes a known volume of liquid to flow from a cone through a short tube. It is standardized for use by mud engineers to check the quality of drilling mud. Other cones with different geometries and orifice arrangements are called flow cones, but have the same operating principle. For water cement ratio 0.35, 0.40 and 0.45 proportion mix was taken as 90% cement and 10% RHA was thoroughly mix. The slurry was made by the use of mortar mixer and 0.5 to 2% super plasticizer was added by weight.

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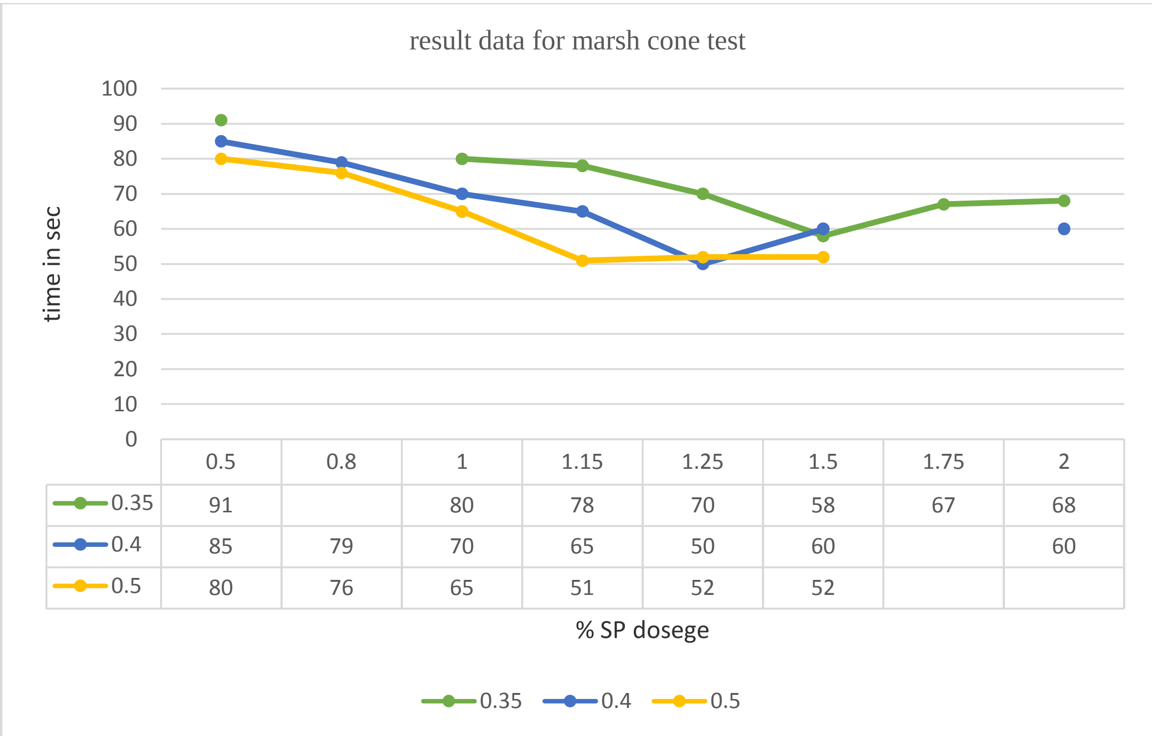
The slurry was screened by the 2.36 mm sieve.

"Figure 1 Mortar mixture" *"Figure 2 BASF SP"* *"Figure 3 marsh cone"*



	0.5	0.8	1	1.15	1.25	1.5	1.75	2
0.35	91		80	78	70	58	67	68
0.4	85	79	70	65	50	60		60
0.5	80	76	65	51	52	52		

"Figure 4 time Vs. Super plasticizer dosage"

IV. MIX DESIGN FOR OPTIMUM CONTENT

The design of mixtures including the variables and constraints are presented and discussed in this chapter. In addition, this chapter presents the design approach, describes different types of mixes, and gives their primary and adjusted mixture proportions and the dosages of chemical admixtures such as high-range water reducer (HRWR).
The variables and constraints for different concrete mixtures are shown in Table 4.2. The major design variables for the concrete mixtures were W/B ratio or binder (cement plus RHA) content, RHA content. The other the dosages of HRWR,

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and the mixing time of concrete. The dosages of HRWR were varied for different concrete mixtures. The HRWR dosages were mainly dependent of the W/B ratio or binder content and RHA content used.

The concrete mixtures were designed using the W/B ratios of 0.35, 0.40 and 0.45 to achieve the target compressive strength. The RHA was used in concrete mixtures as a supplementary cementing material substituting 0 to 20% of cement by weight.

"Table 3 mix proportion for the SCC"

Mix	Cement (kg/m3)	RHA (kg/m3)	CA (kg/m3)	FA (kg/m3)	Water (kg/m3)	SP (kg/m3)	W/B
CO0.35	451.43	0	1197.93	611.56	163.18	6.78	0.35
0.35RHA5	471.57	25.00	593.88	1163.31	163.03	7.45	
0.35RHA10	446.57	50.00	589.47	1154.66	162.99	7.45	
0.35RHA15	422.57	74.00	585.93	1147.74	162.96	7.45	
0.35RHA20	397.57	99.00	581.51	1139.08	162.92	7.45	
CO0.40	395	0	1227.23	654.48	163.44	4.94	0.40
0.40RHA5	412.50	22.00	1193.14	636.30	163.29	5.44	
0.40RHA10	391.50	43.00	1176.10	627.21	163.22	5.44	
0.40RHA15	369.50	65.00	1176.10	627.21	163.22	5.44	
0.40RHA20	347.50	87.00	1176.10	627.21	163.22	5.44	
CO0.45	351.12	0	1224.84	682.01	163.57	4.04	0.45
0.45RHA5	367.23	19.00	1208.06	672.66	163.5	4.45	
0.45RHA10	347.23	39.00	1191.28	663.32	163.42	4.45	
0.45RHA15	328.23	58.00	1191.28	663.32	163.42	4.45	
0.45RHA20	309.23	77.00	1174.50	653.98	163.35	4.45	

V. RESULTS AND DISCUSSION

The concrete mixtures were designed using the W/B ratios of 0.35, 0.40 and 0.45 to achieve the target compressive strength. The RHA was used in concrete mixtures as a supplementary cementing material substituting 0 to 20% of cement by weight.

The concrete mixtures were designated based on the W/B ratio, RHA content with the help of IS 10262 and EFNARC guidelines concrete mix proportioning.

Base on following point mix design was made.

- Maximum size of aggregate is 20mm
- Total powder content (380-600 kg) per cubic meter.
- Coarse aggregate content normally 28 to 35 per cent by volume of the mix (750-1000kg/m3).
- Typically water content does not exceed 210 liter/m3.
- Content balances the volume of the other constituents, typically 48 – 55% of total aggregate weight.
- For water/binder ratio 0.35, 0.40, 0.45 the SP dosage was 1.5%, 1.25%, 1.15% respectively.
- 10mm and 20mm aggregate were used for the design in 60% and 40 % used respectively.

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A) Rheological test for SCC

"Table 4 Acceptance criteria for Self-compacting Concrete"

Sr no.	Properties	test	unit	Typical range
1	Filling ability	Slump flow	mm	650-800
		T50 slump flow	Sec	2-5
		V-funnel	Sec	6-12
2	Passing ability	L-box	(H1/H2)	0.8-1
		U-box	(H1-H2) mm	0-30
		J-ring (height)	mm	0-10
3	Segregation resistance	V-funnel at T5minuts	sec	0 to +3

"Figure 5 U- Box"

"Figure 6 V-Funnel"

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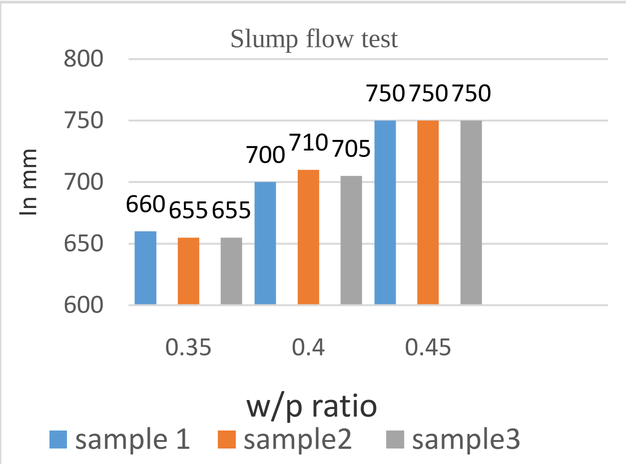
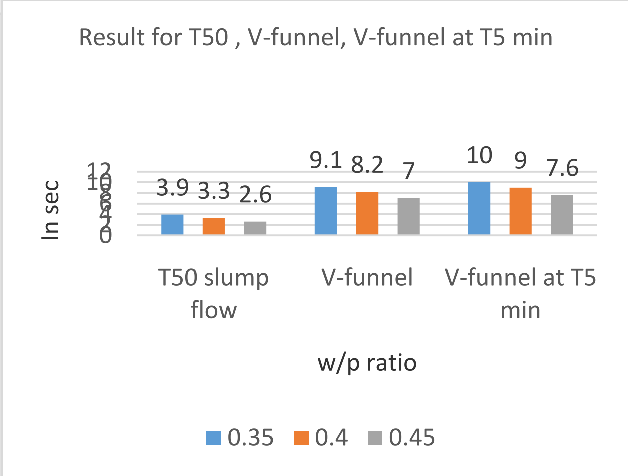
"Figure 7 L-Box"

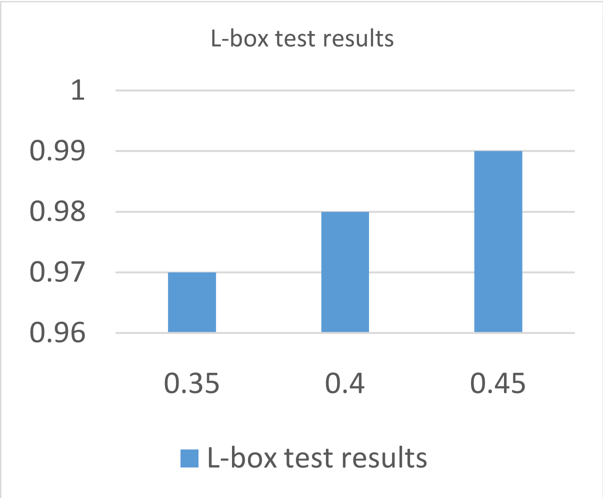
"Figure 8 J-Ring"



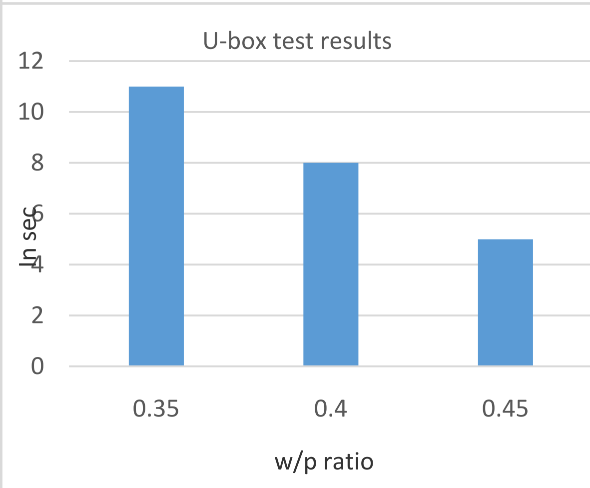
"Figure 9 results for slump flow test"



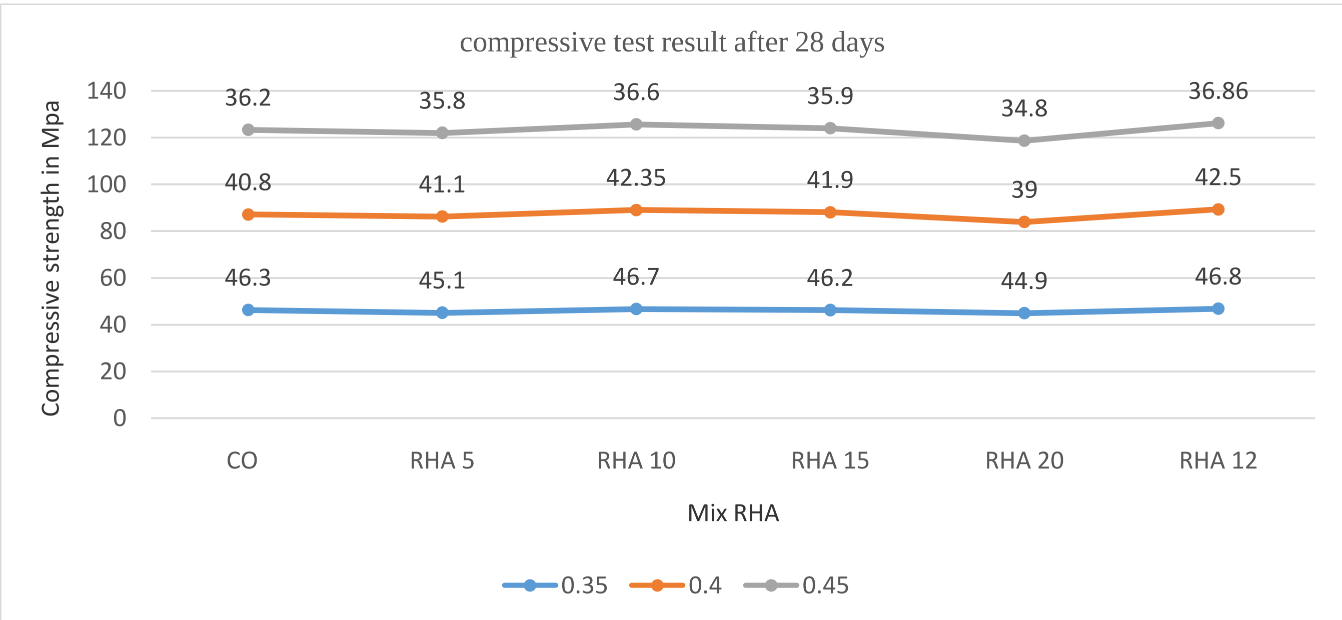
"Figure 10 results for T50, V-Funnel, V-funnel at T5min"



"Figure 11 results for L-box"



"Figure 12 results for U-box"



"Figure 12 compressive strength after 28 days"

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"Figure 13, 14 compressive test machine"

VI. CONCLUSION

The optimum content for the RHA mix self-compacting concrete is as 12% for the given properties of the ingredients. For mix design all the criteria given in the European code should be satisfied. Extreme care should be taken for the quality control, no deleterious material should be there in mix. As the rice husk ash is the agricultural byproduct, it can be conclude from the literature review that the use of rice husk ash in self-compacting concrete increase the mechanical properties as well as durability properties with respect to ordinary self-compacting concrete in addition to effective cost reduction by replacement of the cement to rice husk ash by weight. Water/cement ration is inversely proportional to the strength of the concrete

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