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FRESH AND MECHANICAL PROPERTIES OF SELF-COMPACTING CONCRETE CONTAINING FLY ASH AND RICE HUSK ASH

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Abstract - *Self-compacting concrete (SCC), a new type of concrete with high performance (HPC) have been first introduced in Japan in 1986. Fresh prepared self-compacting concrete (SCC) flows freely into formwork of each corner with having obstructions without any blocking and segregation under its own weight without any tamping or vibration. Self-compacting concrete (SCC) usually requires fine fillers and chemical admixtures. This study investigates the rheological properties, compressive and flexural strengths of self-compacting concrete containing fly ash, individually and in combination with rice husk ash as mineral additives with partial replacement of cement. Rice husk ash (RHA) has helps to improve the pore-structure of the interfacial transition zone (ITZ) between the cement paste and the aggregate in self compacting concrete. In this study the cement is replaced by rice husk ash (RHA) up to 25%. This paper presents a study on the fresh and hardened properties of fly ash (FA) based self-compacting concrete (SCC) and the combination of fly ash (FA) with rice husk ash (RHA) based self-compacting concrete (SCC) The scope of this study is to utilize the available benefits of rice husk ash in self-compacting concrete research was to determine the usefulness of Rice and the cost of materials will be decreased by reducing the cement content by utilizing locally available waste material like rice husk ash(RHA).*

Key Words: ***Self-compacting concrete, Rice husk ash, Fly ash, Rheological properties.***

1. INTRODUCTION

Self-Compacting Concrete is a special type of concrete which provides greater workability, strength, durability and it resists segregation and it have passing ability. There are different names for this concrete, self-blend or self-consolidating concrete, self-leveling concrete and rheoplastic concrete. This concrete was first introduced in Japan by Professor Okamura in 1986. To attain high performance and durable concrete structure more workers needed and special type of equipments required like vibratory equipment required for compaction. Only one method for making of durable concrete structure is by producing SCC which can be compacted without any skilled workers and vibrating equipments.

The main reason to achieve this special type of concrete is to reduce manpower in site, faster construction, easier placing, and to reduce noise level in site. Conventional concrete structure without vibration is carried out by using tremie this is used only for under water concrete structure but the main aim to introduce modern type of self compacting concrete to give high performance, better reliable, and uniform quality. Specifications and guide lines for Self Compacting Concrete is given in EFNARC 2002 which helps to select mix proportion to provide frame work for mix design, list of test methods for fresh concrete and typical acceptance criteria, check list, troubleshooting guide etc….

Indian scenario

In India, during last decade Self-Compacting Concrete were developed and used by attempting the laboratories and field tests according to the European guidelines. This 'modern' Self Compacting Concrete is used in large quantity for Delhi Metro Project about 10000m^3 for making dome, tunnel lining, column casting etc... Rich content fly ash self compacting concrete is introduced by Hindustan Construction Company for making domes, wall in turbine building for the construction of Power plant in Rajastan.

Mineral admixtures are commonly used for Self-Compacting Concrete as a finer material, these mineral are used as a both reactive and inert additives to improve the performance and workability, quality of concrete and to reduce heat of hydration.

The mineral additives are used to meet the special rheological requirements of Self-Compacting Concrete, flyash, silica fume, ggbs, ground blast furnace slag, ground glass filler, rice husk ash and stone powder, etc...

- **Fly Ash:**

In India, total 75 thermal power stations or plants produce about 100-170 million tonne of fly ash per year and it is estimated that the total generation of fly ash 300 million by 2020. The utilization of fly ash is only 5% by construction industries. In 2015 the union ministry of Environment and Forests (MoEF) has decided to utilization fly ash is mandatory in construction industries.

All plants utilizing over 40% of area for dispose flyash. Utilization of flyash in concrete is now increased like common ingredient in concrete for producing high strength and high performance concrete. By utilizing this ash not only produces better properties for concrete but also helps to reduce the impact on environment by disposal.

- **Rice Husk Ash:**

This is waste industrial material which is produced by burning rice husk in mills. This rice husk is burned about at 500^0 C to 800^0 C and it is estimated that 1000kg of rice grains produces about 200 to 250 kg of rice husk after burning this rice husk produces rice husk ash around 25% to 30%. This rice husk ash is utilize as filler or pozzalanic materials for Self Compacting Concrete it gives greater strength but reduces workability to restore workability New Generation plasticizers are used.

- **New Generation Plasticizers:**

This is also called as Next generation Superplasticizers or Hyperplasticizer or high-range water-reducing admixture (HRWRA). For Self Compacting Concrete Polycarboxylate ethers chemical based superplasticizer is more effective than Modified Lignosulfonates which is naphthalene or melamine chemical based superplasticizer.

2. MATERIALS

A. Cement: Commonly used Ordinary Portland cement of 43 Grade was used.

B. Rice husk ash: Locally available Rice husk ash has taken from rice mill, Raichur which is burned at a temperature of 6000 C. specific gravity of 2.13, normal consistency is 26%.

C. Fly ash: Locally available Fly ash (Class F) is used and it is collected from "Raichur Thermal Power plant or Station (RTPS), Karnataka, India

D. Admixtures: Polycarboxylate ether (PCE) based new generation superplasticizer; SIKA" s ViscoCrete 10R3superplasticizer is used.

3. MIX TEST METHODS FOR SCC

The mix design steps, method and procedure for self compacting concrete is different as steps adopted for normal concrete mix and it is based in Indian standard 10262-2008, but self-compacting concrete is based on EUROPEAN specification and guidelines given in „EFNARC 2002". A SCC mix powder content of 550 kg/m3 designed is by fixing 0.36 water/binder ratio by weight with 35% coarse aggregate content of concrete volume. Cement has been replaced in two ways, the first way is replaced with 30% fly ash (Class F) and other way is fly ash blended with rice husk ash, in 30% fly ash replacement of 5 10%, 15%, 20% and 25% of rice husk-ash by percentage weight of total binder or powder content. The coarse aggregates are used with 60:40 blending by percent of weight of total aggregate. In this different mixes with coarse aggregate of sizes 10mm and 12.5mm are used. New generation super plasticizer was used as 2% of air content is fixed by volume of concrete.

I. Self-compacting concrete with fly ash

M1 – 70%OPC + 30% FA

II. Combination of fly ash and rice husk ash based self-compacting concrete

M2 – 70%OPC + 25%FA + 5%RHA

M3 – 70%OPC + 20%FA + 10%RHA

M4 – 70%OPC + 15%FA + 15%RHA

M5 – 70%OPC + 10% FA + 20%RHA

M6 – 70%OPC + 5%FA + 25%RHA

3.1 TESTS

Following are the two stages of tests are carried for self-compacting concrete

A. Rheological or Fresh state tests

- Slump flow test , T50 Slum flow , 'L" box, U- box, V – funnel

B. Mechanical properties tests

- Compressive strength And Flexural strength

Table 1*:* Acceptance criteria for rheological properties of Self-compacting Concrete (As per EFNARC 2002)

Sl. No		1	2	3	4	5
Method		Slump Flow	T50 Flow	L-box	U-box	V - funnel
Unit		Mm	Sec	(h2/h1)	(h2-h1)	Sec
Typical	**Min**	650	2	0.8	0	6
Range	**Max**	800	5	1.0	30	12

B. Mechanical Properties

Compressive strength:

The compressive strength for different relative mixes of cubes at 7, 14 and 28th days of M1, M2, M3, M4, M5 and M6 concrete mixes have been observed for Fly ash (FA) based Self-compacting concrete (SCC), and combination of Fly ash (FA) ash and rice husk ash based concrete. Each batch consists of 9 cubes for compressive strength and it is calculated by taking average of three samples of each batch of SCC.

TABLE 2 Compressive Strength test results at different curing ages

Mix ID	Description	Compressive strength (MPa)		
		Days		
		7	14	28
M1	70%OPC + 30% FA	18.11	24.55	32.70
M2	70%OPC + 25%FA + 5%RHA	19.27	28.34	33.52
M3	70%OPC + 20%FA + 10%RHA	22.02	28.89	33.94
M4	70%OPC + 15%FA + 15%RHA	22.41	30.11	36.50
M5	70%OPC + 10%FA + 20%RHA	24.12	30.33	37.43
M6	70%OPC + 5%FA + 25%RHA	25.13	31.13	37.28

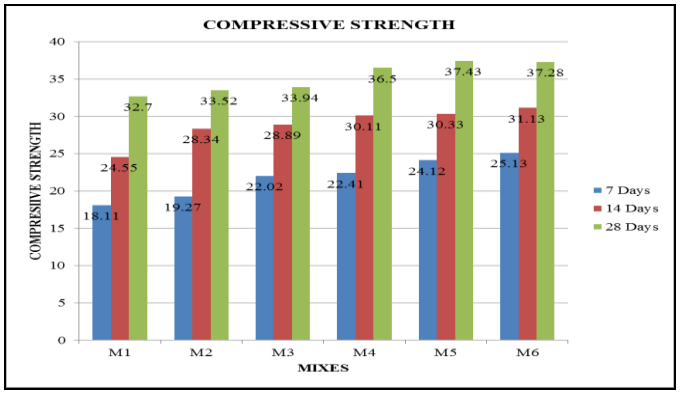

Chart -1: Compressive Strength test results at different curing ages

From the experimental results obtained, has been observed and noted that the compressive strength of concrete increased with increase in the proportion of replacement of rice husk ash by decreasing in the level of fly ash.

The maximum compressive strength obtained for a mix M5 prepared with 30 percentage partial replacement of cement with fly ash and rice husk ash (10 percent FA and 20 percent RHA), compressive strength for 30 percent replacement of cement with cement the fly ash is less as compare to mix M6 (5 percent FA and 25 percent RHA). This results the increase in this shows the strength development due to the amorphous silica content in RHA.

Flexural strength:

The flexural strength of concrete for different mixes of beams t 7th, 14th and 28th days for fly ash (FA) based self compacting concrete and blended fly ash and rice-husk ash based self compacting concrete. This Flexural strength test has been conducted by casting beams. The complete test results of flexural strength for controlled concrete is given in Table-3

Mix ID	Description	Flexural strength (MPa)		
		Days		
		7	14	28
M1	70%OPC + 30% FA	1.68	3.16	4.54
M2	70%OPC + 25%FA + 5%RHA	1.79	3.18	4.73
M3	70%OPC + 20%FA + 10%RHA	2.80	3.83	4.60
M4	70%OPC + 15%FA + 15%RHA	2.98	3.99	4.97
M5	70%OPC + 10%FA + 20%RHA	2.92	4.12	5.14
M6	70%OPC + 5%FA + 25%RHA	3.12	4.27	5.09

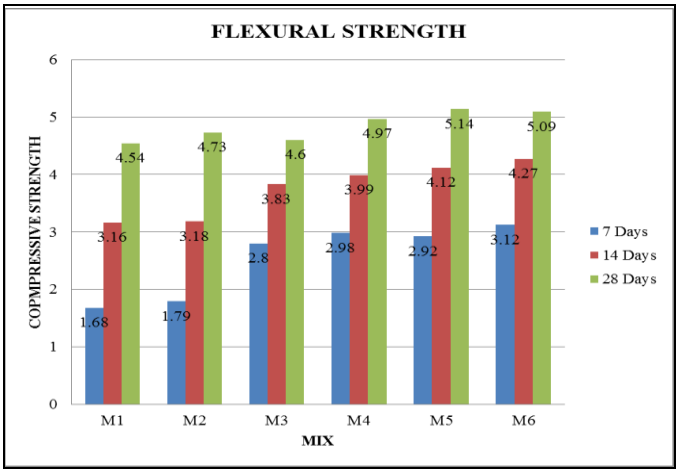

Chart-2 :Flexural strength test results at different curing ages

The flexural strength of beam is observed by subjecting to two points loads. M6 was obtained greater strength that of control concrete. For other different mixes of SCC there is only a little difference with adjusted control concrete. It has been noted and observed that the flexural strength of self compacting concrete (SCC) increased with an increase in partial replacement of cement with 5 percent of fly ash and 25 percent of rice husk ash. The higher flexural strength has been obtained due to the improvement in pore structure.

3. CONCLUSIONS

Based on the experimental results of this investigation, it has been observed that the use of fly ash and rice husk in SCC mixes reduces the possibility of bleeding and segregation, it also increases the passing ability and it helps to fill the complete form work having with good filling ability of concrete. Rice hsk ash improves the microstructure of concrete. The major findings of the study are:-

- Rice husk ash can be used as a filler or binder up to 25% replacement of cement and 30% with two additives that is fly ash and rice husk ash (FA/RHA).
- Use of RHA containing more amorphous silica is helpful in flow ability and segregation control.
- The required rheological properties of SCC are obtained with 30% replacement of cement with FH from RHA.
- As compared to FA based SCC (M1), the combination of FA and RHA based SCC (M2-M6) obtained more compressive strength. Compressive strength increases by increase in percent of RHA.
- The compressive strength of concrete containing rice husk ash for 28 days is 37 MPA or more of all mixes, this result shows normal range of compressive strength can easily achieved by utilizing rice husk ash to produce good properties for SCC
- The flexural strength for all mixes for 28 days produce comparable strengths as the control mix. But SCC containing RHA have more flexural strength.
- This study promotes the use of RHA, which is otherwise considered as waste material. Hence the RHA based SCC is a sustainable material for future construction works.

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