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Experimental Investigation on the Performance of Silicafume and Rice Husk Ash in Concrete Under Thermoshock

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Abstract:
Fire is still one of the most serious potential threats to any structure or building.RCC structures are unlikely to catch fire, but if they do, the consequences are severe.The rapid water cooling of the fire creates a thermal gradient across the concrete.Thermal shock occurs in concrete as a result of this.The overarching goal of this study is to investigate the performance of silica fume and Rice Husk Ash in concrete in terms of thermo shock resistance in terms of strength and durability parameters.

Keywords **—Silica fume, Rice Husk Ash, compressive strength when subjected to thermo shock at temperature of 1000^{o}C**

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I. INTRODUCTION

Concrete's fire performance has historically been taken for granted due to its non-combustible nature and ability to function as a thermal barrier, preventing heat and fire spread.The results of testing to "standard" fire exposures have been used to develop design criteria, which are typically expressed in terms of required reinforcement cover.However, the general applicability and usefulness of this approach may be questioned because heating regimes in real-world fires may differ significantly.Initial heating rates, in particular, can be faster, and all real fires have a distinct "cooling phase" both of these conditions are recognised as imposing additional stresses on in situ structures that may be highly restrained.As a result, there are still significant gaps in our understanding of the true behaviour of concrete structures in fire. And while fires in RCC structures are uncommon, the consequences are severe if they do occur.

II. NEED FOR THE PRESENT STUDY

It is well established that the microstructure, porosity and permeability properties of Portland Cement Concrete containing Silicafume and RHA are different from those of Portland Cement Concrete without Silicafume and RHA. It is therefore, expected that strength and durability properties of Silicafume concrete follow mechanisms different from conventional concrete. Research on the strength and durability aspects of High-Performance Concrete with particular emphasis on Silicafume concrete has been ongoing for several years. One particular area of interest has been the resistance of Silicafume and rice husk ash blended cement concrete to thermoshockperformance are very scarce in India.

This study focuses on the question of whether Silicafume and Rice Husk Ash concrete can be resistant to thermoshock when compared to conventional concrete without SF & RHA. The percentage of SF & RHA is varied in this present study to find the optimum content of the mix which has more thermal stability.

III. OBJECTIVES AND SCOPE OF THE INVESTIGATION

The primary objective of this investigation is to investigate experimentally, the effect of thermoshock on compressive strength, bond strengthof Silicafume and Rice Husk added concrete and also the behaviour of reinforced concrete beam and exterior beam column joints after thermoshock.

A. *To optimize the percentage of silicafume in concrete for resisting thermoshock at 1000°C temperature.*

B. *To optimize the percentage of Rice Husk Ash in concrete for resisting thermoshock at 1000°C temperature.*

C. *Four concrete mixtures were produced for comparative study with a water- cement ratio of 0.35 and Super Plasticizer 0.15. They are designated as Ordinary Portland Cement Concrete (OPCC), Silica Fume Concrete (SFC), Rice Husk Ash Concrete (RHAC), and Silica Fume Rice Husk Ash (SFRHAC)*

D. *The control mixture, OPC, was prepared without any silica fume and Rice Husk ash. Silica fume concrete (SFC) was produced using 0 to 15% SF by weight of cement. Similarly, Rice Husk ash concrete (RHAC) was prepared including 0 to 15% RHA as a partial replacement of cement. In addition, silica fume- Rice Husk Ash concrete (SFRHAC) was produced using 0 to 15% SF and RHA in place of equal amount of cement by weight.*

TABLE I
MIX PROPORTIONS OF CONCRETE MIXES

S.N	Symbols	Binder			FA	CA	Super Plasticizer	Water
		Cement	Silica fume	RHA				
1	OC00	1	--	--	1.5	2.25	0.15	0.35
2	SFC05	0.95	0.05	--	1.5	2.25	0.15	0.35
3	SFC10	0.90	0.10	--	1.5	2.25	0.15	0.35
4	SFC15	0.85	0.15	--	1.5	2.25	0.15	0.35
5	RHAC05	0.95	--	0.05	1.5	2.25	0.15	0.35
6	RHAC10	0.90	--	0.10	1.5	2.25	0.15	0.35
7	RHAC15	0.85	--	0.15	1.5	2.25	0.15	0.35
8	SFRHAC 05	0.95	0.025	0.025	1.5	2.25	0.15	0.35
9	SFRHAC 10	0.90	0.05	0.05	1.5	2.25	0.15	0.35
x	SFRHAC 15	0.85	0.075	0.075	1.5	2.25	0.15	0.35

IV. EXPERIMENTAL INVESTIGATION

COMPRESSION TEST The compression test was conducted as per IS 516 - 1959 on compression testing machine and the compressive strength was found out for all specimens.

Fig. 1.Compressive Strength Testing

PULL OUT TEST The pull out test was conducted as per IS 2770 - 1967 and the bond strength was found out for all specimens.

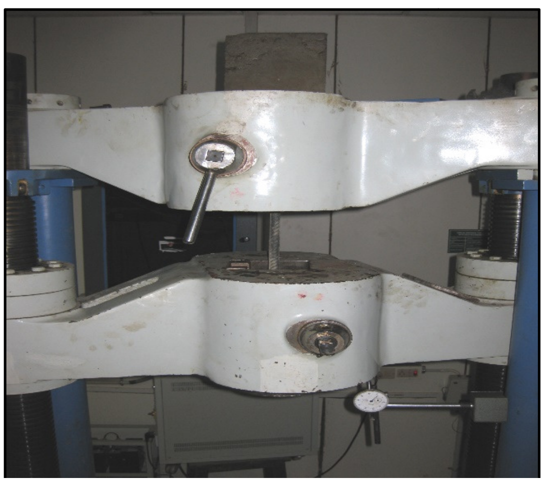

Fig. 2. Pull-out Test

Temperature Distribution in Concrete Cube Specimen under Fire of 1000°C from all Four Sides

A temperature of 1000°C was given to the surface of concrete from four sides and the temperature distribution across the concrete cube specimen of 150mm size and the values of compressive strength is taken and recorded for the both cases.

There is a possibility of cracking due to the thermal stresses at a lower temperature due to the differential temperature on the surface and inner core of concrete during heating and also due to thermoshock by sudden cooling.

Fig. 3. Thermal Test Machine

V. RESULTS AND DISCUSSION

TABLE II
COMPRESSIVE STRENGTH OF SILICA FUME CONCRETE AFTER THERMOSHOCK

Sl. No.	Mix	Age in Days	Compressive Strength in N/mm^2	
			Ambient Temperature	1000°C
1.	SFC00	28	41.10	12.70
2.	SFC05	28	50.40	25.25
3.	SFC10	28	52.50	29.19
4.	SFC15	28	52.25	23.62

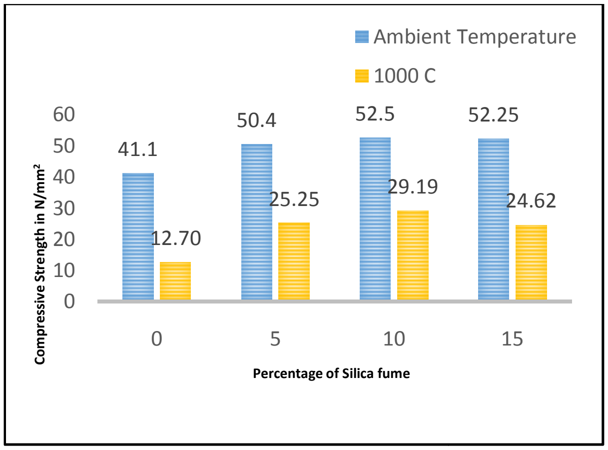

Fig. 4. S.F Concrete compressive Strength Comparison

TABLE III
COMPRESSIVE STRENGTH OF RICE HUSK ASH CONCRETE AFTER THERMOSHOCK

Sl.No.	Mix	Age in days	Compressive Strength in N/mm^2	
			Ambient Temperature	1000 °C
1.	RHAC00	28	41.10	12.70
2.	RHAC05	28	42.10	17.10
3.	RHAC10	28	43.20	19.80
4.	RHAC15	28	45.60	18.10

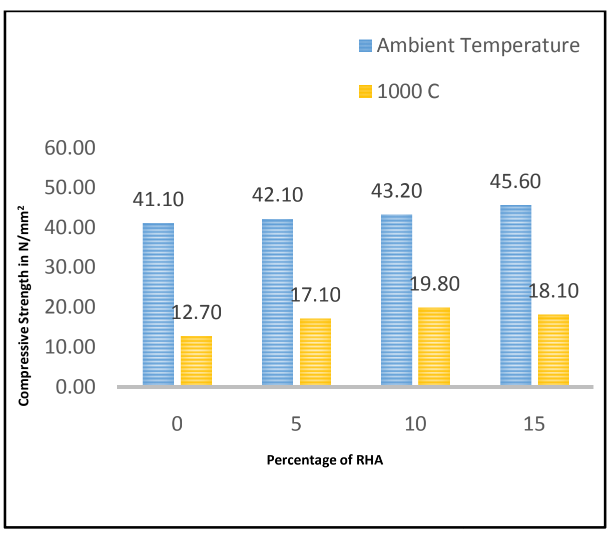

Fig. 5. RHA Concrete Compressive Strength Comparison

TABLEIV
COMPRESSIVE STRENGTH OF SF & RHA CONCRETE AFTER THERMOSHOCK

Sl.No.	Mix	Age in days	Compressive Strength in N/mm^2	
			Ambient Temperature	1000 ° C
1.	SFRHAC00	28	41.10	12.70
2.	SFRHAC05	28	45.20	20.10
3.	SFRHAC10	28	48.90	26.10
4.	SFRHAC15	28	50.20	22.90

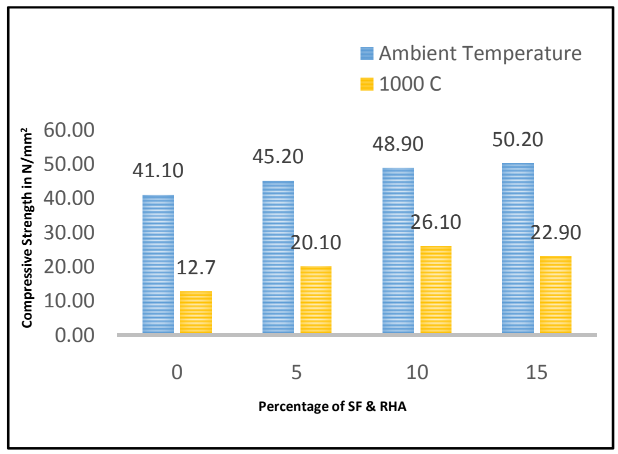

Fig. 6. SF & RHA Concrete Compressive Strength Comparison

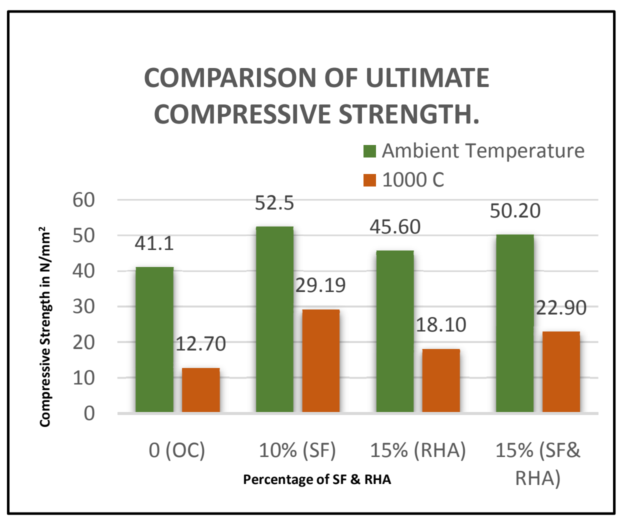

Fig. 7.Comparison of Ultimate Compressive Strength

TABLE V
BOND STRENGTH OF SILICA FUME CONCRETE AFTER THERMOSHOCK

Sl. No.	Type of Concrete Mix	Bond Strength N/mm^2	
		Ambient Temperature	1000^{o}C
1.	SFC00	6.12	1.00
2.	SFC05	7.18	1.43
3.	SFC10	7.42	1.43
4.	SFC15	9.11	2.30

VI.CONCLUSIONS FROM THE EXPERIMENTAL INVESTIGATION.

The following conclusions were reached from the experimental part of this investigation

- The loss of strength at lower temperature is due to the dehydration and air void formation, pore pressure and thermal stress. The major loss of strength at 1000^{o}C is because of the dehydroxylation of calcium hydroxide and decomposition of hydrated products.
- Concrete with 15% Silicafume shows a greater percentage loss in strength when compared to Concrete with 10% Silicafume, due to the formation of Silicafume agglomerates with a radial pattern of cracks extended into cement paste.
- Concrete specimens made with 10% Silicafume possess the highest compressive strength values at temperatures as more amount of Calcium Silicate Hydrate is formed with stronger binding forces between paste and aggregate and a sufficient thermal stability.Thus, the Silicafume improves the interfacial transition zone by consuming Portlandite.
- Silica fume provided better stability and good flow properties than Rice Husk Ash.
- Silica fume contributed to produce the highest level of compressive strength, and Bond Strength due to pronounced physical and chemical effects.
- Due to its low pozzolanic activity and inadequate micro filling ability, Rice Husk ash did not improve the characteristics of concrete as much as Silica fume.
- Because of the presence of silica fume, the combined usage of silica fume and RHA increased the characteristics of concrete.
- The small amount of RHA was ineffective on its own, but it worked well with silica fume to produce high-performance concrete.

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