A Study on Strength Properties of Concrete with Rice Husk Ash and silica fume with addition of Glass Fiber

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Abstract -*Concrete is being widely used for the construction of most of the buildings, bridges, etc throughout the world. A huge quantity of concrete is required to meet out this infrastructure development. Fast depleting natural resources, huge consumption of energy, and environmental hazards involved in the production of cement has inspired for searching the substitution by other material with similar material, especially in developing countries. Cement is widely noted to be most expensive constituents of concrete. The objective of is study is to investigate the strength properties of concrete in ordinary Portland cement by rice husk ash and silica respectively. The composite matrix that is obtained by combining cement, Rice Husk ash, aggregates and fibers is known as "Rice Husk ash Fiber reinforced concrete". The fiber in the cement Rice Husk ash based matrix acts as crack-arresters, which restrict the growth of micro cracks and prevent these from enlarging under load. The experimental work has carried out to study the effects of cement has been replaced by rice husk ash (RHA) 10%, silica fume 10% in common (weight of cement) and glass fiber in the range of 0.5%, 1.0%, 1.5% and 2.0% for M-25 mix. The compressive strength at 3 days, 7days and 28 days have been obtained with normal curing condition. A maximum increase in compressive strength of 32.3Mpa with 10% of RHA replacement, 10% of silica fume and glass fiber 1% was observed. The compressive strengths of concrete is reduced as the percentage of glass fiber replacement is increased beyond 2.0%.*

***Key Words*:**Rice husk ash, Glass Fiber, cementitious material, Compressive Strength, split strength

1. INTRODUCTION

Ordinary Portland Cement (OPC) is becoming an energy exhaustive and pricey constituent in the production of concrete, which is the most widely used construction material [5]. The need to reduce the high cost of Ordinary Portland Cement in order to provide accommodation for the populace has intensified research into the use of some locally available materials that could be used as partial replacement for Ordinary Portland Cement [11]. Concrete properties can be improved by the use of industrial and domestic wastes such as fly ash, rice husk ash, blast furnace slag, timber ash, steel fiber, glass fiber and plastic wastes. These wastes can be found as natural materials, by-products or industrial wastes [2]. It can contribute about 20% of its weight to Rice Husk [1]. Rice husk ash (RHA), an agricultural waste, is classified as "a highly active pozzolan" because it contains a very high amount of amorphous silica and a large surface area. It is estimated that 1,000kg of rice grain produce 200kg of rice husk; after rice husk is burnt, about 20 percent of the rice husk or 40 Kg would become RHA Rice husk ash (RHA) is a general term describing all types of ash produced from burning rice husks. In practice, the type of ash obtained varies considerably according to the burning technique. At 550°C – 800°C amorphous ash is formed and at temperatures greater than this, crystalline ash is formed [7].The pozzolanic and cementitious reaction associated with RHA reduces the free lime present in the cement paste, decreases the permeability of the system, improves overall resistance to CO2 attack and enhances resistance to corrosion of steel in concrete [13]. The partial replacement of cement by RHA will result in lower energy consumption associated with the production of cement [13]. RHA has two roles in concrete manufacture as a substitute for cement, reducing the cost and weight of concrete in the production of low cost building blocks. Glass fiber has high tensile strength (2 – 4 GPa) and elastic modulus (70 – 80 GPa) but has brittle stress-strain characteristics (2.5 – 4.8% elongation at break) and low creep at room temperature. Claims have been made that up to 5% glass fiber by volume has been used successfully in sand-cement mortar without balling. Glass-fiber products exposed to outdoor environment have shown a loss of strength and ductility [2]. Inspired from the ancient application of glass fibers are commonly used nowadays in order to improve the strength properties of concrete. Especially Synthetic glass, nylon, asbestos, carbon and steel fibers used in concrete caused good results to improve numerous concrete properties [3].

2. MATERIALS

The Ordinary Portland cement of 53-grade was used in this study conforming to IS: 12269-1987 [18]. The river sand is used as fine aggregate conforming to the requirements of IS: 383-1970 [17]. Coarse aggregate obtained from local quarry units has been used for this study conforming to IS: 383-1970 [17]. Rice Husk Ash used in the present experimental study was obtained from Tindivanam, Tamil nadu. Specifications, Physical Properties of this RHA given in Table1. The specific gravity of silica fume is 2.2. It consists of 0.1 to 1 micron sized fine, smooth spherical glassy particles with fineness of 20m^2/gm conforming to ASTM C1240-1999 standards. The water used for experiments was potable water conforming as per IS: 456-2000. Glass fibres are made of silicon oxide with addition of small amounts of other oxides. Glass fibres are characteristic for their high strength, good temperature and corrosion resistance, and low price [2]. Alkali resistant E-glass fibres of 12mm length, 0.014mm nominal diameter, specific gravity of 1.9 and density of 2650 kg/m3 were used.

3.METHODOLOGY

M25 grade concrete mixes of RHA 10%, silica fume 10% in common (by weight) replacement of cement and glass fiber in the range of 0.5%, 1.0%, 1.5% and 2.0% with w/c ratio of 0.40 (IS 10262-2009) were prepared. The mixes were designated in accordance with IS: 10262-2009 [16]. A total of 45 concrete cubes and 45 concrete cylinders were casted for the different percentages of replacement of cement. The specimens were demoulded after 24 hours and curing was done for different age of testing. They were tested for their strength properties on 3, 7 and 28 day. It is used to determine the workability of fresh concrete. The apparatus used for slump test are: slump cone and tamping rod.

Table -1: Workability Test

Sl. No	% of Glass fibre	Slump Test (mm)
1	0	68
2	0.5	65
3	1	69
4	1.5	63
5	2	61

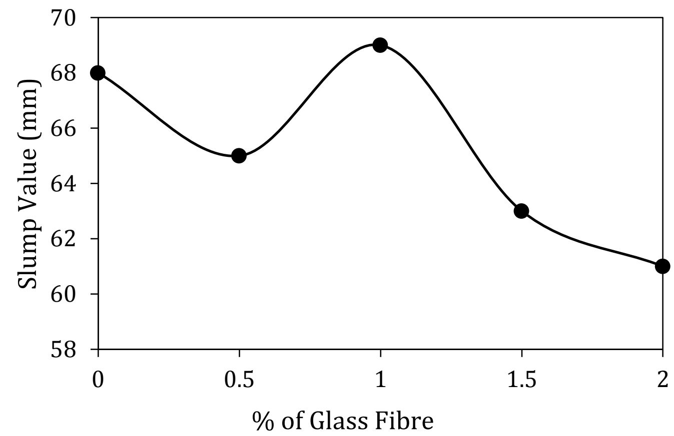

Chart -1: Workability Test

Table -2: Compressive Strength of cube on 3, 7 and 28 Days

% of RHA	% of Glass fiber	Compressive Strength (N/mm2)		
		3 days	7 days	28 days
10%	0	15.54	22.5	30.9
	0.5%	16.2	23.5	31.5
	1%	17.2	24.2	32.3
	1.5%	14.3	20	29.4
	2%	12.5	16	26.5

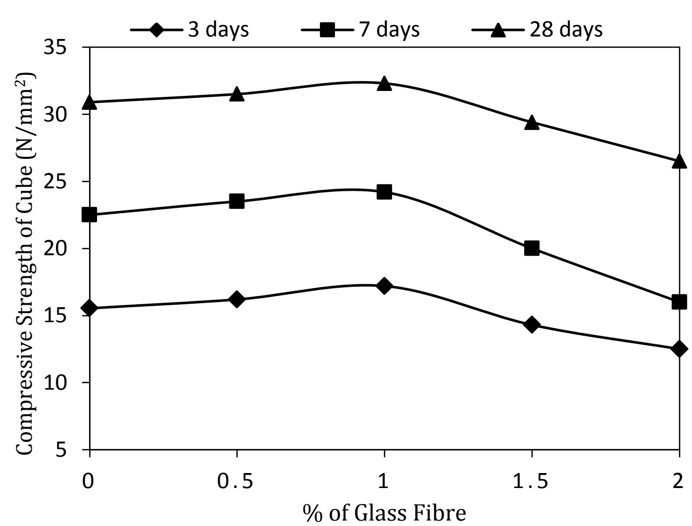

Chart -2: Comparison of Compressive Strength of cube on 3, 7 and 28 Days

Table -3: Split tensile Strength of cylinder on 3, 7 and 28 Days

% of RHA	% of Glass fiber	Split tensile Strength (N/mm2)		
		3 days	7 days	28 days
10%	0	1.54	2.87	4.13
	0.5%	1.14	2.39	3.34
	1%	1.26	2.54	3.54
	1.5%	1.05	2.09	3.05
	2%	1.02	2.02	3.0

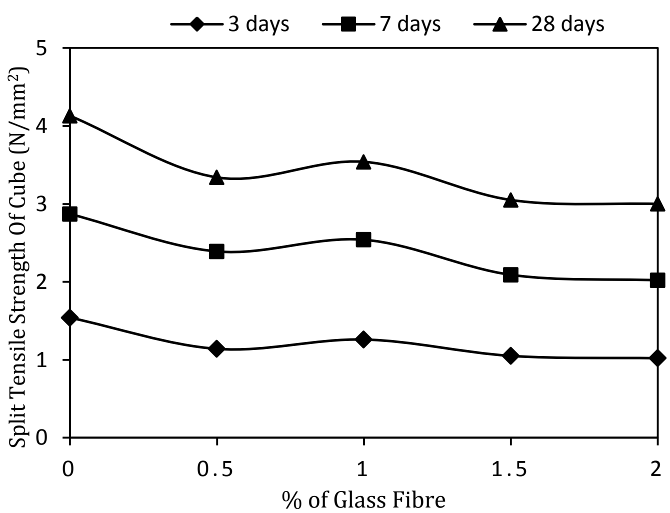

Chart -3: Comparison of Split tensile Strength of cylinder on 3, 7 and 28 Days

4.0 RESULTS AND DISCUSSION.

The compressive and split tensile strength of M25 grade concrete mix for RHA 10%, silica fume 10% and different percentage of glass fibre as shown in Table 2 and Table 3. The results for various percentages are discussed below.

1. For M25 concrete the compressive strength at the end of 3, 7 and 28days for 0.5% of additional of glass fibre the compressive strength showed an increasing value of 16.2, 23.5 and 31.5N/mm2 as shown in Table 2.
2. A similar trend of increasing value was observed when the glass fibre is increased to 1% and 1.5% the maximum value obtained at the end of 28days for 1% and 1.5% was 32.3 and 29.4N/mm2 at the end of 28days as shown in Chart 2.
3. A gradually increase of 0.5% of glass fibre (2%) showed a decreasing trend in the compressive strength at the end of 3, 7 and 28 days. The compressive strength observed at the end of 28days for 2% of glass fibre is 26.5N/mm2.
4. Split tensile strength at the end of 3, 7 and 28days for 0.5% of additional of glass fibre the Split tensile strength showed and decreasing value of 1.14, 2.39 and 3.34N/mm2 as shown in Table 3.
5. A similar trend of decreasing value was observed when the glass fibre is increased to 1% and 1.5% the maximum value obtained at the end of 28days for 1%, 1.5% and 2% was 3.54, 3.05 and 3.0N/mm2 as shown in Chart 3.

5.0 Conclusions:

For M25 grade concrete the maximum compressive strength was found to be 1% of glass fibre and RHA 10%, silica fume 10% by weight. Also the strength achieved by the glass fibre is comparable to the conventional M25 grade of concrete. The split tensile strength with 1% showed a decreasing value with 1% of glass fibre when compare to conventional concrete. This highlights that the glass fibre with 1% showed a better performance with respect to its strength properties.

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