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Strength Performance of Concrete Containing Rice Husk Ash as Cement Replacement in Presence of Polypropylene Fiber

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ABSTRACT

This study focuses on the utilization of Rice Husk Ash (RHA) as partial replacement of Ordinary Portland Cement (OPC) in concrete in addition with Polypropylene (PP) fiber. The main goal of this study was to decrease dependence on OPC and address environmental waste generated through rice mills. This study considered concrete cubes prepared through 1:2:4 ration with 0.50 water-cement ratio with and without RHA and PP fibers. The water curing was done for 7 and 28 days, with three specimens for each proportion, and the average value was considered as the result. It was observed that the compressive strength of M2 concrete which containing 10% RHA was noticed 7% higher than the control mix concrete and declared as 10% RHA as optimum dosage. Next, the performance in terms of compressive strength of concrete containing optimum dosage of RHA in presence of PP fibers of three different lengths were also evaluated and found that the 0.1% of PP fiber of 0.5 inches length gives the 25% higher strength performance as compared to the control mix and 17% higher than the concrete containing 10% RHA only at the age of 28days. Hence, this study concluded that the replacing OPC cement with 10% RHA produces satisfactory strength performance and incorporation of PP fiber gives better strength performances.

Keywords:
Rice Husk Ash, Polypropylene Fibre, Cement Replacement, Concrete, Waste Materials

1. Introduction

In the construction industry, cement and aggregates serve as the foundational elements. Construction becomes impractical without these crucial components. In today's advanced society, the increasing demand for natural aggregates significantly impacts natural resources and environmental preservation, as the materials used in cement and aggregates are naturally occurring [1] [2]. Given this circumstance, it is imperative to safeguard natural resources and promote the utilization of waste materials in construction [3] [4]. Additionally, the world is confronted with a pressing issue concerning the disposal and repurposing of waste materials, with thousands of tons generated globally on daily basis [5] [6]. Besides that, Rice is cultivated across over a hundred countries globally, covering an extensive land area of approximately 158 million hectares, yielding an annual production of nearly 700 million tons of milled rice. The majority, around 90%, of this rice output, total about 640 million tons, originates from Asia. In the case of Pakistan, rice production stands at around 10 million tons [4]. On the other side, Polypropylene fiber is an industrial derivative sourced from hydrocarbons, specifically petroleum oil. The process begins by extracting the propylene monomer from crude oil in gaseous form, and through chain-growth polymerization, polypropylene is produced. This lightweight fiber

serves as reinforcement in concrete, effectively resisting crack formation [7]. Therefore, in this study, waste materials such as RHA taken into consideration which is readily available and discarded material. Consequently, the research explores the utilization of RHA as substitute for cement in presence of propylene fiber.

2. **Materials and Methodology**

This study considered cement, fine aggregates, coarse aggregates, waste marble powder, rice husk ash, propylene fiber, and water. Fine aggregate (sand) that was passed through a 4.75mm sieve and coarse aggregate passed from 19mm sieve was used. Rice husk was obtained from nearby Rice Mills, and processed through open burning to produce rice husk ash (RHA) for partial cement replacement. Propylene (PP) fiber was purchased through supplier.

The standard concrete cubes of 150mm size were prepared and total 42 samples were casted as shown in Table 1. The concrete mix ratio of 1:2:4 with 0.5 water-cement ratio used. These samples were cured in water for 7 and 28 days, with three specimens for each proportion, and the average value considered as the test result.

Table 1. Number of samples prepared for the study

Mix code	Cement %	Coarse aggregate %	Fine aggregate %	Replacement material %		Compressive strength	
				RHA%	0.1% PP	7 Days	28 Days
M0	100	100	100	0	-	3	3
M1	95	100	100	5	-	3	3
M2	90	100	100	10	-	3	3
M3	85	100	100	15	-	3	3
M4	90	100	100	10	0.5”	3	3
M5	90	100	100	10	1”	3	3
M6	90	100	100	10	1.5”	3	3
Total Number of Samples						42	

3. **Results and Discussion**

The compressive strength test was performed, and the outcomes are illustrated in the subsequent table, displaying the fluctuation in compressive strength corresponding to variations in the percentage of RHA. The values have been standardized based on the outcomes of the 0% RHA mix. The compressive strength of RHA concrete and normal concrete at 7 and 28 days appears to be comparable to some extent. In overall assessment, it is evident that a modest dosage rate (10% addition of RHA) notably enhances the concrete's compressive strength. Nevertheless, an increase in the percentage of RHA leads to a decline in the strength of the concrete. Similar findings were also reported in the previous studies [4]. Detailed results are provided in Table 2 and presented in Fig. 1.

Table 2. **Compressive Strength of concrete at 7 and 28days**

Mix ID	Length of PP fiber (inches)	PP Fiber %	OPC	RHA%	Compressive strength @7days (MPa)	Compressive strength @28days (MPa)
M0	-	-	100	0	16.95	26.4
M1			95	5	17.3	26.5
M2			90	10	18.3	28.2
M3			85	15	16.8	26.9
M4	0.5	0.1	90	10	21.3	33.1
M5	1				19.3	30.1
M6	1.5				19	29

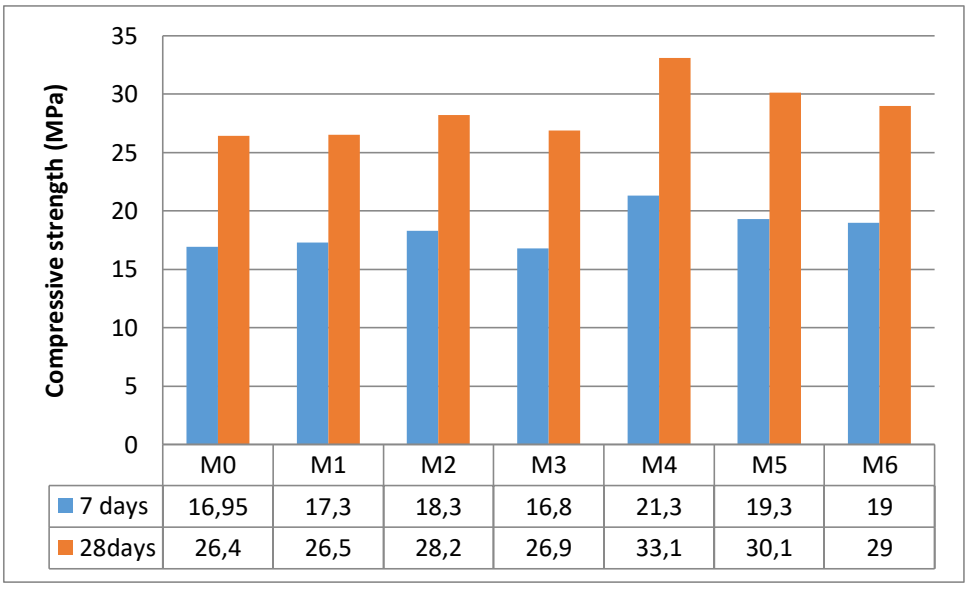

Figure 1. Compressive strength of concrete containing RHA and PP fiber

However, the compressive strength of M2 mix which containing 10% RHA was noticed 7% higher than the control mix concrete at 28days and declared as 10% RHA as optimum dosage. Next, the performance in terms of compressive strength of concrete containing optimum dosage of RHA in presence of PP fibers of three different lengths were also evaluated and found that the 0.1% of PP fiber of 0.5 inches length gives the 25% higher strength performance as compared to the control mix and 17% higher than the concrete containing 10% RHA only at the age of 28days.

3. **Results and Discussion**

Based on the experimental findings following outcomes were noticed,

- The strength performance of concrete containing 10% RHA was increased 8% as compared to the control mix concrete at the age of 7days.
- The strength performance of concrete containing 10% RHA was increased 7% as compared to the control mix concrete at the age of 28days.
- The strength performance of concrete containing 10% RHA with 0.1% of 0.5 inches length was increased 25% as compared to the control mix concrete at the age of 7days.

- The strength performance of concrete containing 10% RHA with 0.1% of 0.5 inches length was increased 25% as compared to the control mix concrete at the age of 28days.

Hence, this study concluded that the replacing OPC cement with 10% RHA produces satisfactory strength performance and incorporation of PP fiber gives better strength performances.

3. **Acknowledgement**

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