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Study of Fly Ash, Rice Husk Ash and Marble Powder as Partial Replacement to Cement in Concrete

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Abstract : Now days, the waste rice husk from rice mill, marble powder from tile industry and fly ash from steam power plant are necessary to utilize as partial replacement of cement for concrete production. Large scale production of cement required consumption of raw materials and energy as well as emissions to air which posse's environmental threat in various areas of country. Apart from the environmental threat, there still exists the problem of shortage in many areas. Therefore, substitute material for concrete needs to be considered. The paper aims to analyze the compressive strength of concrete cubes and flexural strength of concrete beams made from partially replaced cement, sand, and coarse aggregate. This research study adopted in laboratory on 48 total specimens of grade M25 concrete cubes of size 150x150x150mm and concrte beams of size 100x100x500mm were casted. Out of the 48 concrete specimens cast, 6 each were made out 10%, 20%, and 30 % replacement of fly ash, rice husk ash and marble powder to cement in concrete. It was found that the compressive strength and flexural strength of concrete made from the mixture of 20 % partially replaced cement, sand and coarse aggregate was similar than the concrete made from without replaced cement , sand and coarse aggregate.
Keywords : Fly ash, Rice husk ash, Marble powder, Compressive strength, Flexural strength.

Introduction

Concrete is a mixture of cement, sand, aggregates and water. The properties of concrete could also be enhanced by using admixture in concrete. The mixture of paste and aggregates is that the simplest sort of concrete. The specified properties of concrete are often achieved by adding ash, rice husk, and marble powder in concrete. The standard of paste is set by the character of concrete. The right proportioning, mixing and compacting of the ingredients develops the strong and sturdy concrete. The environmental problems are generated due to the disposal of waste in environment directly. So, there's got to reuse waste as admixture in concrete. These industrial wastes are dumped within the nearby land and thus the natural fertility of the soil is spoiled.

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Literature Survey

Jayeshkumar Pitroda et al. (2012) studied the compressive strength of concrete reduces when cement replaced by fly ash up to certain limit. Jayesh Patel and MA Jammu (2014) concluded that the compressive strength of cubes are increased with addition of 10% waste marble dust and 5% rice husk ash by weight of cement. Makarand Kulkarni et al. (2014) concluded that the placing and finishing of concrete easier after addition of 20% rice husk ash in concrete. Mangesh Mhatre et al. (2014) studied utilization of fly ash and rice husk ash concrete decreases compressive strength with increase in water cement ratio and compaction factor. Monika Dhaka (2013) improved the strength and quality of concrete by replacing sand using 50% marble powder and 50% quarry rock dust. The compressive strength of concrete is decreased and workability is increased when 50% marble powder is used in concrete. Piyush Raikwar and Vandana Tare (2014) concluded that use of rice husk ash and marble powder solves the problem of disposal by using in concrete. The optimum content of rice husk ash and marble is found to be 16% and 5% respectively. The cost per km of two lanes was Rs. 29, 98,096 for optimum content of rice husk ash and marble in concrete as cost of controlled concrete was Rs 37, 32,273. Rohit Siwach et al. (2015) studied that up to 20% replacement of cement by fly ash in concrete for 0.40 w/c ratios have higher compressive strength than minimum required as per MoRT and H specification. Also, up to 20% replacement of cement by rice husk ash in all water cement ratio have lesser compressive strength than minimum required as per MoRT and H specification.

From literature survey, it is concluded that, there is no study conducted on partial replacement of cement by fly ash, rice husk ash and marble powder.

Material Used

Cement

Cement is most expensive component of cement concrete. It is responsible for about 60% costs of materials. It is a binding medium for discrete ingredients. In this work, 53 grade Ordinary Portland Cement (OPC) satisfying the specifications provided in the IS: 12269- 1997 manufactured by Birla Shakti Cement was used which shows physical properties of cement in Table 1.

Table 1: Physical properties of cement

Fineness(m^2/kg)	269 m^2/kg
Compressive strength after 3 days	35.20
Compressive strength after 28 days	56.40
Initial setting time	170 minutes
Final setting time	280 minutes
Soundness	1.0

Fly Ash (FA)

The ash is manufactured in thermal plant as a finely divided mineral residue. This ash could also be utilized in concrete as mineral admixture. The physical properties of ash collected from Govind Milk Production, Phaltan are given Table 2.

Table 2: Physical properties of fly ash

Fineness(m^2/kg)	320 m^2/kg
Lime reactivity	4.5 Mpa
Moisture content	0.5 %
Soundness	0.8 %
Compressive strength after 28 days	80 %

Rice Husk Ash (RHA)

The rice husk ash may be a by-product obtained from the rice mills industries. In India, large amount of rice husk ash is developed which has high reactivity and pozzolonic property. The use specific quantity isn't defined in IS 456- 2000 but it recommends use of RHA in concrete.

Marble Powder (MP)

The 25% of marble powder is produced during the cutting and polishing of marble blocks. Around 7,000,000 tons of marble have been delivered on the planet. Today, disposal of marble powder is the ecological issue in marble business.

Fine Aggregate

Locally available sand was used as fine aggregate of size 4.75mm. The IS 383-1970 is used to perform the sieve analysis of sand as given in Table 3.

Table 3: Sieve analysis of sand

IS sieve sizes	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Percentage Retained	Cumulative Percentage Passed
4.75 mm	16	1.6	1.6	98.4
2.36 mm	182.5	19.85	18.25	80.15
1.18 mm	354.5	55.3	35.45	44.7
600 micron	124	76.7	12.4	32.3
300 micron	268	94.5	26.8	5.5
150 micron	40	98.5	4	1.5
75 micron	15	100	1.5	0

Coarse Aggregate

The aggregate of size 20mm was used as coarse aggregate. The specific gravity and water absorption was 2.68 and 2.11 % respectively. The IS 2386-1963 is used to perform the sieve analysis of coarse aggregate as given in Table 3.

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Table 4: Sieve analysis of coarse aggregate

IS sieve sizes	Weight Retained (Kg)	Cumulative Weight Retained (Kg)	Cumulative Percentage Retained	Cumulative Percentage Passed
20 mm	1.845	36.9	36.9	63.1
12.5 mm	2.960	96.1	59.2	3.9
10 mm	0.195	100	3.9	0
4.75 mm	-	100	-	0
2.36 mm	-	100	-	0
600 micron	-	100	-	0
300 micron	-	100	-	0
150 micron	-	100	-	0

Water

Portable water is generally considered satisfactory for mixing concrete.

Concrete Mix Design

In this study M25 concrete is used. The concrete mix design for controlled concrete is done by using IS 10262:2009 are given in Table 5.

Table 5: Mix design and Mix proportion

Ingredients in kg/m^3	**Controlled Concrete (0 %)**	**FA+RHA+MP (10%)**	**FA+RHA+MP (20%)**	**FA+RHA+MP (30%)**
Cement	413.33	371.99	330.66	289.33
Fly Ash	0	28.93	57.87	86.89
Rice Husk Ash	0	8.27	16.53	24.81
Marble Powder	0	4.13	8.26	12.39
Fine Aggregate	669.68	669.68	669.68	669.68
Coarse Aggregate	1153.18	1153.18	1153.18	1153.18
Water	186	186	186	186
W/C ratio	0.45	0.45	0.45	0.45

Experimental Procedure

Batching and Mixing

The weight batching is adopted for accuracy and all the ingredients of concrete were properly mixed by using mix proportion obtained from mix designed for M25 grade concrete.

Casting and Curing

The moulds were properly cleaned with oil. The mix was placed in three layers, each layer was compacted with 25 blows using the tamping rod and after that specimens were placed over vibrating machine for the compaction. After 24 hours, specimens were removed and placed into the curing tank. The mould size for cube and beam were 150x150x150 mm and 100x100x500 mm respectively. The concrete casting and molding are shown in figure 1.

Figure 1: Concrete casting and molding

Testing of Specimens

The specimens of concrete were taken outside the curing tank after 7 and 28 days of curing. The specimens were allowed to dry under the laboratory condition. The load slowly applied without shock and constantly till the specimen fails. The maximum load recorded and noted down. Readings of controlled concrete specimens, 10% cement replaced concrete specimens, 20% cement replaced concrete specimens and 30% cement replaced concrete specimens were taken after curing period of 7 and 28 days. Parameters measured during the testing are axial compressive load and deflection. The specimens tested for compressive strength, split tensile strength and flexural strength.

Results and Discussion

The specimens of concrete cube and beam were tested in Compression Testing Machine (capacity 2000 kN) and Universal Testing Machine (capacity 1000 kN) respectively. An average of three specimens was tested for each strength result.

Compressive Strength

The compressive strength of cube specimens is shown in Table 6 and figure 2.

Table 6: Compressive strength of different types of concrete

Control Mix (M25)	Controlled Concrete (0 %)	FA+RHA+MP (10%)	FA+RHA+MP (20%)	FA+RHA+MP (30%)
	Compressive Strength in N/mm^2 7 days			
	23.91	23.16	21.80	15.18
	Compressive Strength in N/mm^2 28 days			
	39.99	42.49	29.73	24.31

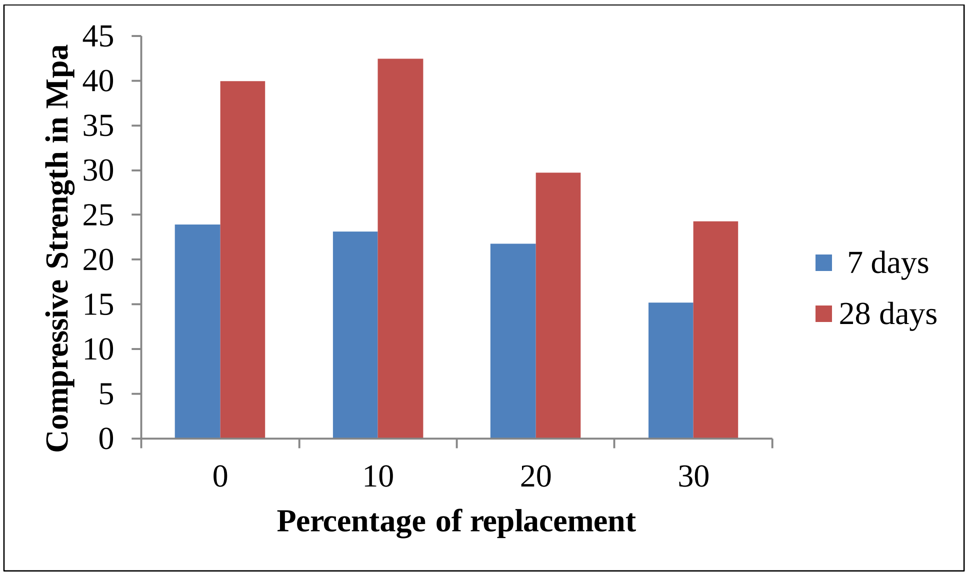

Figure 2: Compressive strength Vs percentage of replacement

Flexural Strength

The flexural strength of beam specimens is shown in Table 7 and figure 3.

Table 7: Flexural strength of different types of concrete

Control Mix (M25)	Controlled Concrete (0 %)	FA+RHA+MP (10%)	FA+RHA+MP (20%)	FA+RHA+MP (30%)
	Flexural Strength in N/mm^2 7 days			
	3.45	3.24	2.72	1.6
	Flexural Strength in N/mm^2 28 days			
	5.29	5.06	3.57	2.97

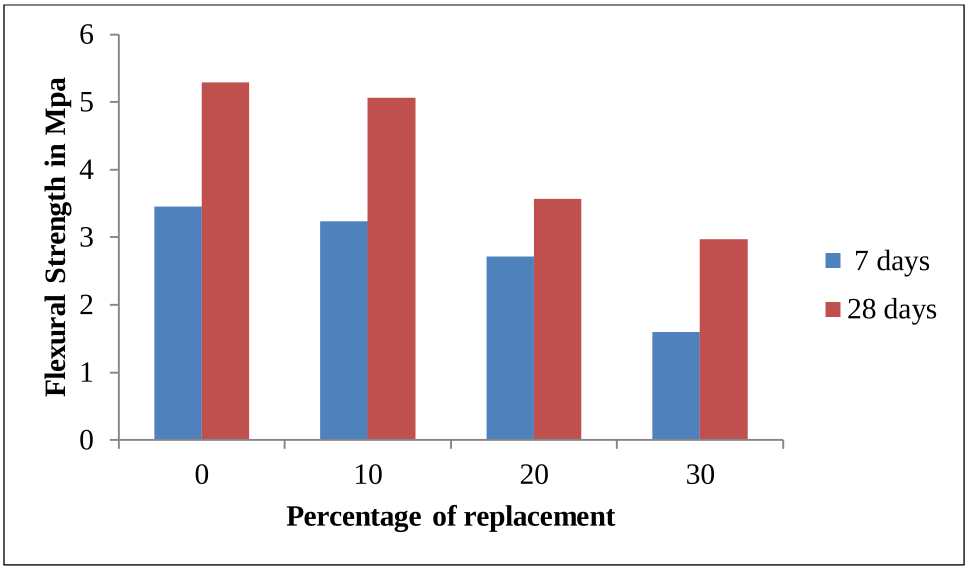

Figure 3: Flexural strength Vs percentage of replacement

Conclusion

The following conclusions are drawn on the basis of experimental results:

1. Compressive strength increased when cement is replaced by 10% of fly ash, rice husk ash and marble powder as compare to control mix concrete.
2. Flexural strength is slightly less as compare to control mix concrete when cement is replaced by 10% of fly ash, rice husk ash and marble powder.
3. Compressive and flexural strength increases when percentage of fly ash increases as compare to rice husk ash and marble powder.
4. The rice husk ash and marble powder is cost effective as compare to silica fumes.
5. The maximum replacement of cement is 20% of fly ash, rice husk ash and marble powder when compared with minimum strength required.
6. The use of supplementary cementing material as fly ash, rice husk ash and marble powder in concrete pavement roads of less traffic load is economical and eco-friendly.

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