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A Comparative Study of Strength Properties of Paver Blocks with Partial Replacement of Cement by Fly Ash and Rice Husk Ash

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ABSTRACT: Concrete pavements are gaining popularity in recent times; manufacture of pavements is done basically with cement as cementitious material. This has resulted in large usage of cement. Also there is lot of production & availability of Fly ash and Rice husk ash. An attempt is made to replace cement by Fly ash and Rice husk ash to check the workability and strength property. Chapter 1 deals with Introduction, Related work is made in Chapter 2 and Objectives are listed in Chapter 3, Chapter 4 deals with materials used and their properties, Mix design and Methodology of Casting. Experimental results are presented in Chapter 5, Conclusions and Scope of further study is deals in Chapter 6.

KEYWORDS: Fly ash, Rice husk ash, Paver blocks, Compressive strength.

I. INTRODUCTION

1.1 General

Now days the environment resources are depleting due to Industries, mining etc among them Construction Company is also a vast polluters of the environment they also emit greenhouse gases as well as acidifying gases into the atmosphere. In 2010, OPC being produced in 3300 million tonnes annually over the globe. This is equivalent to 7% of worldwide carbon pollution Caused by humans. The emissions from the Cement plant have a significant impact on the environment and must be managed. Dust, Sulphur dioxide (SO₂), Nitrogen oxides, and Carbon dioxide (CO₂) are some of the gases emitted during the Cement making process.

In concrete one of the major ingredient is Cement and it is used in building and Civil engineering projects. Every year, approximately 1 tonne of concrete is produced in the Cement industry for every human being on earth. Cement manufacturing necessitates a significant amount of resources, power, and heat. The manufacture of Cement generates a large amount of Solid waste as well as gaseous pollutants. Cement production takes long time to manufacture and is a complicated operation. The manufacture of OPC led in the release of greenhouse gases such as Carbon dioxide (CO₂).

1.2 Paver blocks

After China, India is the world's second-largest paver manufacturer. The Indian Paver Block Industry is largely unorganized, with a huge number of small-scale producers competing against one another on a territorial basis. When it comes to the importance of Paver stones, there is a lot of curiosity about them. Paver blocks are often used in pathways, parking lots, and parks, and they are simple to install because to their interlocking design. They are also simple to clean, maintain, and repair.

1.3 Fly ash (FA)

Fly ash is the fine residue left over after pulverised coal is burned in electric and steam power plants. India's primary source of electricity generation is thermal power plants. There is still a long way to go, and we will have to rely on conventional coal-fired thermal power plants for a while longer (50-100 years). According to an approximate estimate, India produces about 115 million tonnes of FA each year. Just 40 million tonnes of Fly ash are employed in a number of engineering projects per year.



1.4 Rice husk ash (RHA)

Rice husk ash is a kind of farming waste produced in enormous amounts. RHA has been discovered to be Super pozzolanic. RHA is made by burning Rice husk for around 2 hours at temperature ranging from 600 to 700°C.

II. LITERATURE REVIEW

O.D. Atoyebi, et.al. [2020]: Here the researcher prepared dog bone shaped blocks With 1:4 mix ratio where 1 stands for Cement and 4 for quarry dust. after preparing moulds there were kept for curing for about 7, 14, 21, 28 and 56 days respectively and here the researcher mainly focused on Curing aspects so he adopted various curing methods such as earth curing, sprinkler curing, pond curing, open air curing, hot water air curing, membrane curing etc from the results obtained the researchers says that ponding curing is giving best results followed by sprinkling, membrane, open air curing for 56 days.

Sachin Kuckian, et.al. [2020]: In this report, they mainly concentrated on using Fly ash as a supplementary cementitious material by 0 %, 5 %, 10 %, 15 %, 20 %, 25 %, 30 %, and 35 % respectively. Here the most of the experiments are done on compressive strength. With a W/C ratio of 0.5, M30 grade Mix configuration was used, as per IS 10262:20009 and IS 456:2000. Paver blocks of 60 and 80 mm thickness were prepared separately. Pavers are tested for 7 and 28 days respectively. Basis of the findings of an experiments, the researcher concludes that replacing FA by up to 20% results in a greater Compressive strengths, i.e. for a 60mm thickness, a Compressive strength of 78.60 N/mm² is achieved, and for an 80mm thickness, a Compressive strength of 49.95 N/mm².

Truptimala Pattnaik, et.al. [2018]: The author employed Fly ash and Glass powder in this case. As an alternative to cement, and author replaced it by 0%, 10%, 20%, 30%, 40% respectively, Author choosed M40 Mix with a proportion of 1:2:3 and adopted W/C ratio of 0.4 for making zigzag Paver blocks of thickness 80 mm and plan area of 31,250 mm². And they were tested for Mechanical properties, Water absorption and Abrasion resistance test were conducted for 7, 28, and 56 days respectively, Here author concluded that substituting 20% of a cement with an similar amounts of fly ash and glass powder resulted in greater compressive and flexural strength. An author goes on to say that by proper utilizing waste materials as cement will eliminate the adverse environmental impact of dumping Fly ash and Waste glass over a ground.

ER. Atul thakur, et.al. [2017]: The Author employed RHA as an alternative to cement, for preparing Paver blocks. and the author partially replaced Cement with Rice husk ash by 0%, 15%, 20%, 25%, 30%, 35%, & 45% respectively, and prepared Paver blocks that were checked for Compressive strength, Water absorption, and Abrasion test According to the findings of the experiments, the specimens Compressive strengths reduces with an increment in Rice husk ash (RHA) content. And specimen's Abrasive resistance declines as the composition of Rice husk ash raised (RHA). And author also came to the Conclusion that Rice husk ash (RHA) based Paver blocks are a Cost-effective and environmentally safe.

III. OBJECTIVES

The following are the objectives of the present experimental work:

1. To Develop a Paver block Mix design that conforms to code IRC:SP:63-2018.
2. To Compare the Results of Fresh properties like Slump cone and Compaction factor tests Of Fly ash Paver blocks with the Rice husk ash Paver blocks.
3. To obtain the Results of Fresh properties like Slump cone and Compaction factor tests, on Combined Fly ash and Rice husk ash Paver blocks.
4. To Compare the Results of properties like Compressive strength and Water absorption of Fly ash Paver blocks with the Rice husk ash Paver blocks.
5. To obtain the Results of properties like Compressive strength and Water absorption, on Combined Fly ash and Rice husk ash Paver blocks.
6. To utilize Wastes like Fly ash and Rice husk ash in Producing Paver blocks.

IV. MATERIALS AND METHODOLOGY

4.1 Materials

Cement, Fly ash, M-Sand, Coarse aggregate, Rice husk ash and Water are needed for making of Paver blocks. And the materials are tested for respective physical parameters as per IS Standards. And the tested parameters will be helpful for obtaining the Mix design.

4.1.1 Cement:

In this experiment, all types of Paver blocks were made with 43 grade Ordinary Portland Cement (OPC) from the ULTRATECH CEMENT brand. And here Fresh, Lump-free Cement was used. The physical testing of cement was carried out in accordance with IS 8112:2013.

Sl.No.	Properties	Test results	As per standards IS 8112:2013
1	Specific gravity	3.03	-
2	Fineness passing 45 μ sieve	91%	-
3	Standard consistency	32%	-
4	Soundness	0.5 mm	Less than 10 mm
5	Setting time		
	Initial setting time	40 minutes	30 minutes (Minimum)
	Final setting time	240 minutes	600 minutes (Maximum)
6	Compressive strength(MPa)		
	7 Days	28.08 MPa	23 MPa
	28 Days	47.17 MPa	43 MPa
7	Bulk density	2.12 g/cm ³	-

4.1.2 M-Sand:

M-Sand is one of the alternative resources to compensate River sand. And it is majorly obtained from the quarries, one of the benefits of utilizing M-Sand is that it is dust-free, and it can be easily regulated to achieve the required size. And manufactured sand of size less than 4.75mm is used for this Project work and M-Sand is locally procured.

Sl.No.	Properties	Test values
1	Water absorption	1.20%
2	Fineness modulus	2.56
3	Grading zone	II
4	Specific gravity	2.64

4.1.3 Coarse aggregates:

Locally available Coarse aggregate of size 10mm down aggregate are used in the present work.

Sl.No.	Properties	Test values
1	Specific gravity	2.70
2	Impact value	16.80%
3	Crushing value	18.37
4	Water absorption	0.32%
5	Fineness modulus	2.33



4.1.4 Fly ash (FA):

Fly ash is collected from PMK Concrete products in this Project, which is located in Yakkegundi, Shivamogga road, Harihar, Davangere.

Table 4.4: Physical properties of Fly ash

Sl.No.	Properties	Test values
1	Fineness passing 45µ sieve	95%
2	Specific gravity	2.30
3	Specific gravity	1.97 g/cm ³
4	Compressive strength (MPa)	
	7 Days	27.08 MPa
	28 Days	48.14 MPa

4.1.5 Rice husk ash (RHA):

For this project Mattihalli Dryers rice mill offered Rice husk ash, which is located in Bamboo bazaar road, Davangere.

Table 4.5: Physical properties of Rice husk ash

Sl.No.	Properties	Test values
1	Fineness passing 45µ sieve	93%
2	Specific gravity	2.00
3	Specific gravity	1.85 g/cm ³
4	Compressive strength (MPa)	
	7 Days	25.72 MPa
	28 Days	45.09 MPa

4.1.6 Water:

For the making of Paver blocks and the curing of specimens, portable tap water was utilized.

4.2 Mix design

Code IRC:SP:63-2018 is used to generate the Mix design. and here M30 grade concrete and W/C ratio of 0.36 is adopted. Here 2 different trial mixes were designed among them one of the best mix design is selected for the experiment work. And finally the following mix design is adopted for the experimental work 1:2.78:1.9 and this mix is used for making of various combinations of Paver blocks and the concrete mix is tested for

1. Compressive strength test

Table 4.6: Designation of Concrete Mixes

Mix Designation M30	Description
M0	GRADE M30 CONTROL CONCRETE
M1	95% CEMENT+5% FA
M2	90% CEMENT+10% FA
M3	85% CEMENT+15% FA
M4	80% CEMENT+20% FA
M5	95% CEMENT+5% RHA
M6	90% CEMENT+10% RHA
M7	85% CEMENT+15% RHA
M8	80% CEMENT+20% RHA
M9	90% CEMENT+5% FA+5% RHA



M10	80% CEMENT+10% FA+10% RHA
M11	70% CEMENT+15% FA+15% RHA
M12	60% CEMENT+20% FA+20% RHA

V. EXPERIMENTAL RESULTS

Table 5.1: A Table indicating Overall Compressive strength Test Results of Fly ash Paver blocks

Mix Designation	% of FA	Compressive Strength (N/mm ²)	
		7 Days	28 Days
M0	0%	36.26	51.20
M1	5%	37.97	52.90
M2	10%	38.40	55.04
M3	15%	40.96	58.88
M4	20%	37.12	52.05

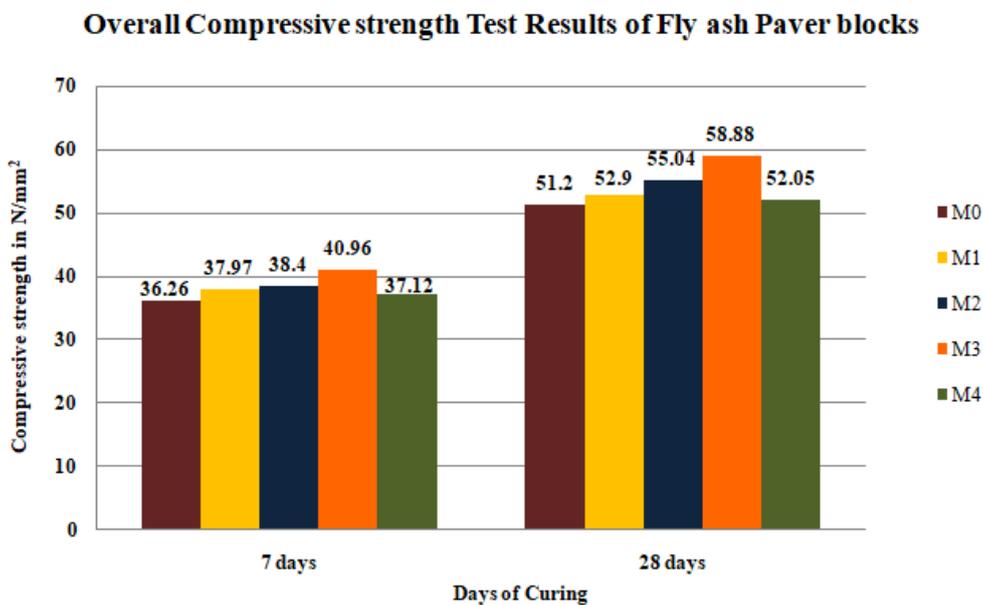


Figure 5.1: Overall Compressive strength Test Results of Fly ash Paver blocks



Table 5.2: A Table indicating Overall Compressive strength Test Results of Rice husk ash Paver blocks

Mix Designation	% of RHA	Compressive Strength (N/mm ²)	
		7 Days	28 Days
M0	0%	36.26	51.20
M5	5%	37.54	53.33
M6	10%	38.82	56.32
M7	15%	33.70	49.49
M8	20%	31.57	46.93

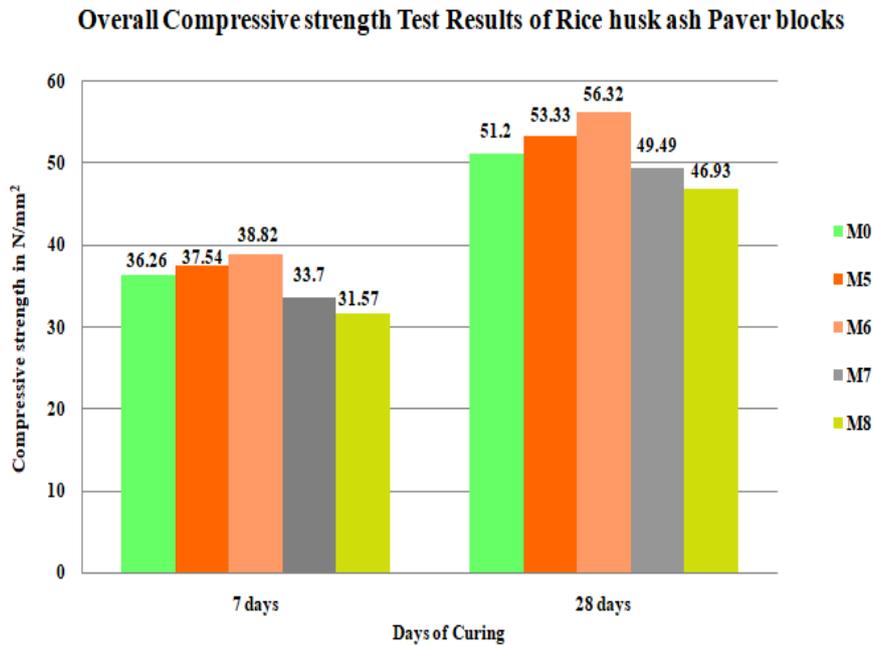


Figure 5.2: Overall Compressive strength Test Results of Rice husk ash Paver blocks

Table 5.3: A Comparative Table of Compressive strength Test b/w Fly ash v/s Rice husk ash Paver blocks

Mix Designation	Mix Designation	% of FA	% of RHA	Compressive strength Test Results of FA		Compressive strength Test Results of RHA	
				7 Days	28 Days	7 Days	28 Days
M0	M0	0%	0%	36.26	51.20	36.26	51.20
M1	M5	5%	5%	37.97	52.90	37.54	53.33
M2	M6	10%	10%	38.40	55.04	38.82	56.32
M3	M7	15%	15%	40.96	58.88	33.70	49.49
M4	M8	20%	20%	37.12	52.05	31.57	46.93

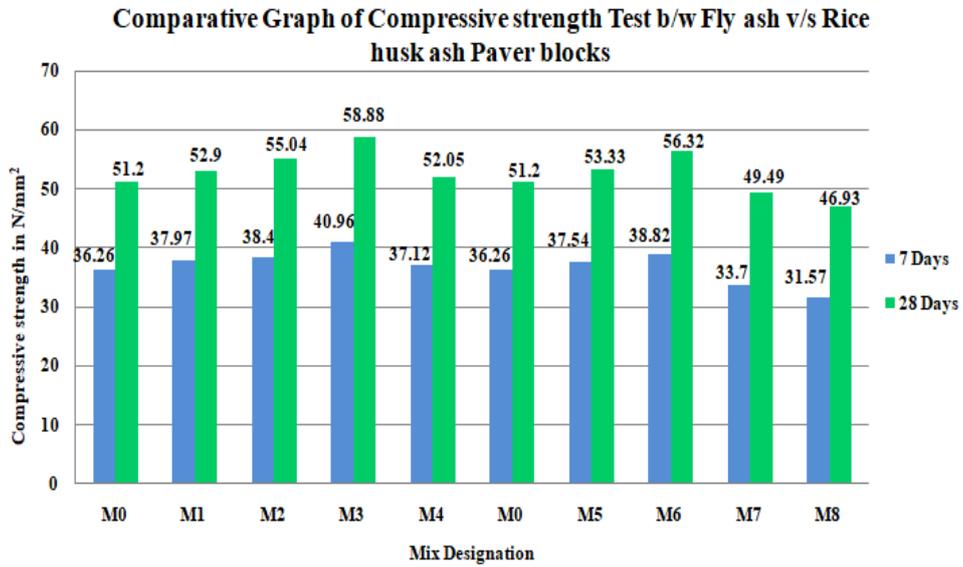


Figure 5.3: Comparative Graph of Compressive strength Test b/w FA v/s RHA Paver blocks

Table 5.4: A Table indicating Overall Compressive strength Test Results of Combined Fly ash + Rice husk ash Paver blocks

Mix Designation	% of FA	% of RHA	Compressive Strength (N/mm ²)	
			7 Days	28 Days
M0	0%	0%	36.26	51.20
M9	5%	5%	28.16	43.09
M10	10%	10%	30.72	46.08
M11	15%	15%	27.73	40.10
M12	20%	20%	24.32	37.12

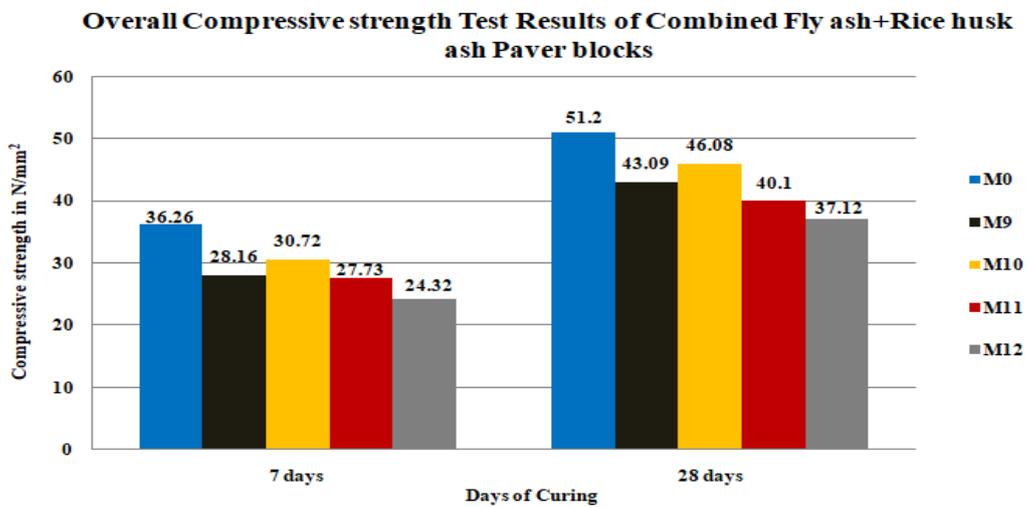


Figure 5.4: Overall Compressive strength Test Results of Rice husk ash Paver blocks



VI. CONCLUSION

1. Compressive strength with Fly ash addition at 15% as given good results.
2. Compressive strength with replacement of cement by Rice husk ash has not shown remarkable improvement, but cement with 10% replacement by RHA can be adopted.
3. The blocks with Cement replacement by both FA and RHA will not improve the strength properties.
4. Scope of studies
Following further studies can be carried out
 1. Impact test
 2. Effect of Temperature variation

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