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Experimental Investigation of Partial Replacement of Cement with Rise Husk and Steel Fiber in the Concrete Mix

M. Tamizharasan[1*], R. Haripraba[2], P. Ragunathapandian[3]
[1]*M.E. Student, Arulmigu Meenakshi Amman College of Engineering, Vadamavandal, India*
[2]*Assistant Professor, Arulmigu Meenakshi Amman College of Engineering, Vadamavandal, India*
[3]*Professor, Arulmigu Meenakshi Amman College of Engineering, Vadamavandal, India*

***Abstract*: Concrete is well known is a heterogeneous mix of cement, water and aggregates. Globally concrete is the backbone for the development of infrastructure, buildings, industrial structures, bridges and highways etc. In today's situation concrete needs special combinations of performance and uniformity requirements that cannot be always achieved by using conventional constituents and normal mixing. It is weak in tension, has limited ductility and little resistance to cracking. Mineral admixtures such as fly ash, silica fume, blast furnace slag, rice husk ash, are finely divided siliceous materials and are added to concrete as a partial replacement for cement. The addition of these admixtures also results in significant savings in energy and cost. The detailed experimental investigation is doing to study the effect of partial replacement of cement by Rice husk ash with using Steel fiber in concrete. Thus, the present research study includes the experimental investigation of concrete by adding rice husk ash with using steel fiber different proportion in M30 grade of concrete.**

***Keywords*: rice husk ash, steel fiber.**

1. Introduction

Globally concrete is the backbone for the development of infrastructure, buildings, industrial structures, bridges and highways etc. In today's situation concrete needs special combinations of performance and uniformity requirements that cannot be always achieved by using conventional constituents and normal mixing. Rice husk is an agricultural residue which accounts for 20% of the 649.7 million tons of rice produced annually worldwide. Burning the husk under controlled temperature below 800 °C can produce ash with silica mainly in amorphous form. Today inspired from the ancient application of techniques artificial fibers are commonly used now a day in order to improve the mechanical properties of concrete. The main objective of the project is to find out alternative materials for road pavements to meet the demands of bitumen for the upcoming years, to provide adequate serviceability at minimum cost, to make the eco-friendly roads with safety, and speed for the flow of traffic. In this investigation, an attempt has to be made to determine the feasibility of industrial waste products such as Steel Slag and Rice Husk Ash use in base layer of concrete road pavements.

2. Literature Review

Following are the critical literature reviews on various papers based on experimental research work on use of Rice Husk Ash and Steel Fibre into the concrete.

Hossain et al. (2011). He found that addition of rice husk ash in cement increases its normal consistency and setting times. It has also been found that addition of rice husk ash in brick does not affect its shape and size.

Krishna et al. (2012). He stated that applications of Rice Husk Ash as repair mortars, coatings and soil stabilization. Rice Husk Ash contributes significantly to a green building.

Mohod et al. (2012), found that the workability of steel fibre reinforced concrete gets reduced as the percentage of steel fibres increases. Compressive strength and flexural strength of concrete goes on increasing with the increase in fibre content.

Deotale et al. (2012), stated that rice husk ash concrete low workability and fly ash concrete high workability also increasing fiber content reduced workability.

Kumar et al. (2014), found that addition of Rice Husk Ash at 25% decreases the compressive strength and inclusion of polypropylene fibres into concrete mixes increases the compressive strength at 0.5% fibres content as compared to the control mix

3. Materials Used

A. Cement

Ordinary Portland cement (53 Grade) was used for casting all the specimens The type of cement affects the rate of hydration, so that the strengths at 21 early ages can be considerably influenced by the particular cement used. It is also important to ensure compatibility of the chemical and mineral admixtures with cement. Properties of cement physical properties of the cement in the present experimental work are given in table 1.

*Corresponding author: tamizharasan.m17@gmail.com

Table 1
Physical properties of cement

S.No.	Property	Values
1	Fineness of cement	220 m^2/kg
2	Specific gravity	3.1
3	Normal consistency	34%
4	Setting Time	
	• Initial setting time	55 mins
	• Final setting time	7 hours
5	Compressive strength	
	• 3 days	30 N/mm^2
	• 7 days	48 N/mm^2
	• 28 days	55 N/mm^2

B. *Fine Aggregate*

River sand from local sources was used as the fine aggregate. The specific gravity of sand is 2.68. Properties of Fine Aggregate Physical properties of the fine aggregate used in the present work are given in table 2.

Table 2
Physical properties of fine aggregate

S.No.	Property	Values
1	Specific gravity	2.75
2	Bulk density	
	• Loose state	14.66 KN/mm^3
	• Compacted state	18.54 KN/mm^3
3	Water Absorption	0.7%
4	Flakiness index	16.75%
5	Elongation index	24%
6	Crushing value	25%
7	Impact value	15%
8	Fineness modulus	3.45

C. *Water*

Potable fresh water, which is free from concentration of acid and organic substances was used for mixing the concrete.

D. *Coarse Aggregate*

Crushed granite aggregate with specific gravity of 2.7 and passing through 20 mm sieve and retained on 10 mm was used for casting all specimens. Several investigations concluded that maximum size of coarse aggregate should be restricted in strength of the composite. In addition to cement paste aggregate ratio, aggregate type has a great influence on concrete dimensional stability.

Table 3
Physical properties of coarse aggregate

S.No.	Property	Values
1	Specific Gravity	2.75
2	Bulk Density	
	• Loose state	17.8 KN/m^3
	• Compacted state	18.65 KN/m^3
3	Grading of sand	Zone – II

E. *Rice Husks*

Rice husks are the hard protective coverings of rice grains which are separated from the grains during milling process. Rice husk is an abundantly available waste material in all rice producing countries, and it contains about 30%–50% of organic carbon. In the course of a typical milling process, the husks are removed from the raw grain to reveal whole brown rice which upon further milling to remove the bran layer will yield white rice. Current rice production in the world is estimated to be 700 million tons. Rice husk constitutes about 20% of the weight of rice and its composition is as follows: cellulose (50%), lignin (25%–30%), silica (15%–20%), and moisture (10%–15%).

Table 4

S.No.	Property	Values
1	Fineness of cement	220m^2/kg
2	Specific gravity	2.35
3	Bulk density	90-150 kg/m3

F. *Mix Design*

Stipulation for proportioning:
Grade designation: M30
Type of cement: OPC 53 grade
Max nominal size of aggregate: 20mm
Min cement content:280 kg/m^3
Max water cement ratio: 0.45
Workability: 100mm
Exposure condition: Extreme (plain)
Method of concrete placing: Manual

- Degree of supervision: Good
- Type of aggregate: Crushed angular
- Max cement content: 410 kg/m^3
- Chemical ad mixture: Nil

Test data for material

- Cement used: opc 53 grade
- Specific gravity of cement: 3.00
- Chemical admixture: Nil

Specific gravity of:

1. Fine aggregate: 2.45
2. Coarse aggregate: 2.81

Water absorption:

1. Fine aggregate: 1%
2. Coarse aggregate: 0.52%

Free (surface) moisture:

1. Fine aggregate: Nil
2. Coarse aggregate: Nil

Sieve analysis:

1. Fine aggregate: Conforming to grading zone 1
2. Coarse aggregate: –

Material required for m^3:

- Cement = 424.5 kg/m^3
- Water = 191 litre
- Fine aggregate = 702.78 kg/m^3
- Coarse aggregate = 1178 kg/m^3

4. Result and Analysis

The experimental findings on various design mixtures are discussed in these section compressive strength tests, split tensile strength and flexural strength tests are all included in the results. In this investigation cubes, beam and cylinders of each 18 specimens of each, where cast and evaluated over the course of 7 days, 14 days and 28 days. The compression and finding are addressed in more detail in the following sections.

Table 5
Compressive strength test results for different proportion of rice husk with steel fiber

S.No.	% of Rice Husk with and Steel Fiber	Compressive Strength (MPa)		
		7 Days	14 Days	28 Days
1	0%	25	28.56	35
2	5%	22	25	32.5
3	10%	20	23.5	32
4	15%	18.56	21.65	30
5	20%	17.58	19.25	29

Table 6
Flexural strength results for different proportions of rise husk with steel fiber

S.No.	% of Rice husk with steel fiber	Flexural Strength (MPa)		
		7days	14days	28days
1.	0%	3.8	3.55	5.1
2.	5%	5.5	5.85	6.85
3.	10%	4.75	5.7	6.40
4.	15%	4.21	5.23	5.73
5.	20%	3.75	4.23	4.45

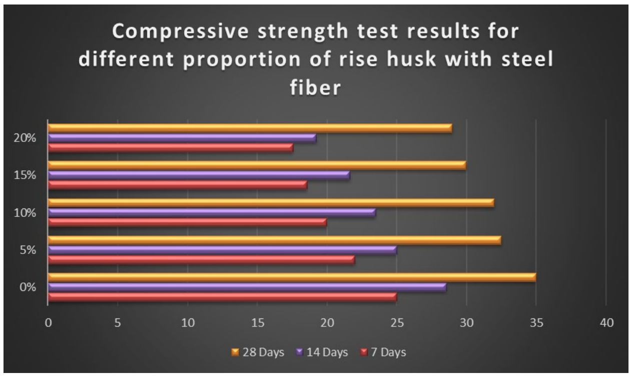

Fig. 1. Compressive strength test results for different proportion of rice husk with steel fiber

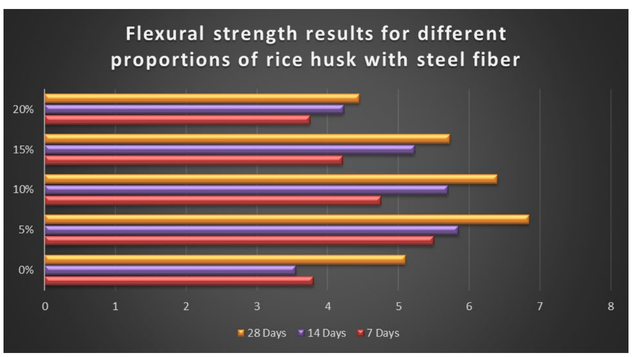

Fig. 2. Flexural strength results for different proportions of rise husk with steel fiber

5. Conclusion

From above experimental test, following conclusions are drawn:

1) Compressive strength of concrete increases after Replacement of Cement by Rice Husk Ash and Addition of Steel Fibre in it.
2) Compressive strength increases as increase in Rice Husk Ash content up to 15% replacement, further increase in Rice Husk Ash content shows decrease in compressive strength of concrete.
3) For M30 grade concrete, optimum mix is B2 and C2 with 15% replacement of Rice Husk Ash and Addition of Steel Fibre.
4) For M30 grade concrete there was 23.31% maximum increase of replacement of Rice Husk Ash and Addition of FCSF compressive strength as compared with standard A M30 mix and 19.30% maximum increase of replacement of Rice Husk Ash and Addition of HESF compressive strength as compared with standard A M30 mix.

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