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Effect of Rice Husk Ash on Properties of Concrete Using Steel and Polyester Fibres

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Abstract:

India is a major rice producing country and the husk generated during millings is mostly used as fuel in the boilers for processing paddy, producing energy through direct combustion and/or by gasification.

About 20 million tonnes of Rice Husk & 4 million tonnes of RHA is produced annually and is a great environmental threat, causing damage to the land and the surrounding area in which it is dumped. In the conversion of Rice Husks to ash, the combustion process removes the organic matter and leaves silica rich residue. on its mechanical properties has been studied. Samples with 10% RHA replacing the cement have been tested. The main aim of this project is to study the mechanical properties of concrete including steel and polyester fibres of M25 grade with 0.5%, 1% and

1.5% by volume of concrete. In this study I'm using steel fibres of length 25mm and diameter 0.6mm leading to aspect ratio of 50. The polyester fibres of length 12mm and 20-40 microns in diameter are used in this project.

Keywords: - fibre reinforced concrete, steel, polyester, compressive strength, split-tensile strength, flexural strength, Rice husk ash,

1. Introduction

Concrete is the most versatile construction material which is adequately strong, durable, and impermeable. Amongst the constituents of the concrete, cement is the most expensive component and its demand is continuously increasing throughout the globe. Hence, in order to control the cost of construction, it becomes essential to use industrial wastes, mineral admixtures and other cementious materials for catering to the increasing demand of cement. Not only industrial wastes but also agricultural wastes like Rice Husk Ash (RHA) also be supplemented with cement for the production of concrete which will not only make concrete economical but may also improve its properties like workability, impermeability, durability, reinforcement corrosion, etc,. For sustainable development of cement and concrete industry, it is imperative that increased usage of supplementary cementing materials be encouraged.

2.Materials

2.1 Cement

Ordinary Portland cement of 53 grades was used in the present study. Cement is a binder, a substance used in construction that sets and hardens and can bind other materials together. The most important types of cement are used as a component in the production of

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mortar in masonry, and of concrete, which is a combination of cement and an aggregate to form a strong building material. One of the important benefits is the faster rate of development of strength. In this project I have used OPC 53 grade cement. Specific gravity of cement was 3.15.

Chemical composition of cement,

Oxide Composition	OPC	RHA
SiO_2	20.99	88.32
Al_2O_3	6.19	0.46
Fe_2O_3	3.86	0.67
CaO	65.96	0.67
MgO	0.22	0.44
Na_2O_3	0.17	0.12
K_2O	0.60	2.91

Physical properties of cement,

S.NO	PARTICULARS	RESULTS
1	Specific Gravity	3.15
2	Initial setting time	30 min
3	Final setting time	600 min
4	Fineness	225 m^2/kg

2.2 Aggregates

The importance of using the right type and quality of aggregates cannot be overemphasized. The fine and coarse aggregates generally occupy 60% to 75% of the concrete volume (70% to 85% by mass) and strongly influence the concrete‘s freshly mixed and hardened properties, mixture proportions, and economy. Specific gravity of fine aggregate was calculated as 2.6 and specific gravity of coarse aggregate was found to be 2.74.

2.3 Rice Husk Ash

Rice milling generates a by product know as husk. This surrounds the paddy grain. During milling of paddy about 78 % of weight is received as rice, broken rice and bran .Rest 22 % of the weight of paddy is received as husk. In this paper RHA of 10% replacement for cement is used.

2.4 Steel fibres

Steel Fibres are generally distributed throughout a given cross section whereas reinforcing bars or wires are placed only where required. Steel fibres are relatively short and closely spaced as compared with continuous reinforcing bars of wires. Steel fibres of 0.5% of replacement of cement are used in this paper. Steel fibres having aspect ratio of 50.

2.5 Polyester fibres

Polyester is a category of polymer whose monomer contains the ester functional group. The most common polyester for fibre purposes is poly (ethylene terephthalate), or simply PET. This is also the polymer used for many soft drink bottles and it is becoming increasingly common to recycle them after use by remelting the PET and extruding it as fibre. This saves valuable petroleum raw materials, reduces energy consumption, and eliminates solid waste sent to landfills. Specific gravity of polyester fibres is 1.38.

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3.Experimental Procedure

3.1 Mix Proportioning and casting of specimens,

In this paper the mix design is done for M25 normal concrete and fibre reinforced concrete wit replacement of cement by 10% RHA and 0.5% steel, 0.5%-1.5% of polyester fibres with water cement ratio of 0.45.

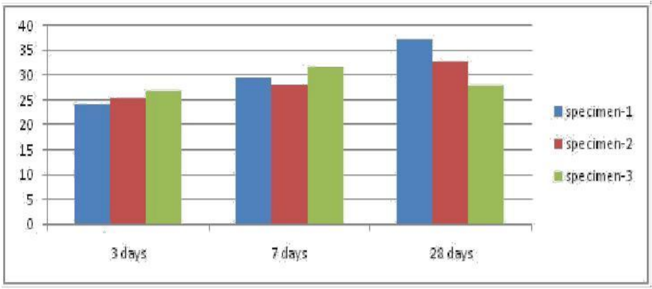
3.2 Mix proportioning for normal concrete,

Mix	Water (Litres/m³)	Cement (Kg/m³)	Fine Aggregate (Kg/m³)	Coarse Aggregate (Kg/m³)
M25	175	388.88	636.2447	1245.2217

Testing results,

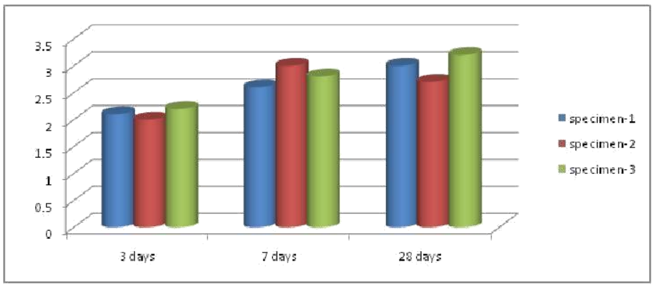
For cubes of compressive strength,

Days	Specimen	Compressive strength (N/mm²)	Average compressive strength (N/mm²)
3 days	Specimen-1	24.1	25.4
	Specimen-2	25.5	
	Specimen-3	26.7	
7 days	Specimen-1	29.4	29.6
	Specimen-2	28.1	
	Specimen-3	31.5	
28 days	Specimen-1	37.4	32.6
	Specimen-2	32.7	
	Specimen-3	27.8	



For cylinders of split tensile strength,

Days	Specimen	Split tensile strength (N/mm²)	Average split tensile strength (N/mm²)
3 days	Specimen-1	2.1	2.1
	Specimen-2	2.0	
	Specimen-3	2.2	
7 days	Specimen-1	2.6	2.8
	Specimen2	3.0	
	Specimen-3	2.8	
28 days	Specimen-1	3.0	3.0
	Specimen-2	2.7	
	Specimen-3	3.2	



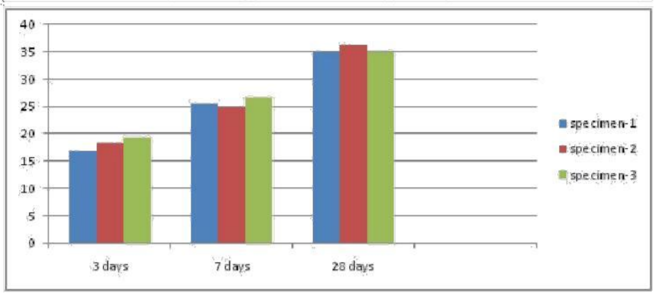
3.3 Mix proportioning for fibre reinforced concrete, a) For 10% RHA, 0.5% steel, 0.5% polyester fibres,

Mix	Water	Cement	Fine aggregate	Coarse aggregate	Steel	Polyester
M25	175 litres/m³	350 Kg/m³	633.33 Kg/m³	1240.1103	1.75 Kg/m³	3.5 Kg/m³

Testing results,

For cubes of compressive strength,

Days	Specimen	Compressive strength (N/mm²)	Average compressive strength (N/mm²)
3 days	Specimen-1	16.8	18.1
	Specimen-2	18.2	
	Specimen-3	19.3	
7 days	Specimen-1	25.5	25.6
	Specimen-2	24.9	
	Specimen-3	26.6	
28 days	Specimen-1	35.0	35.4
	Specimen-2	36.4	
	Specimen-3	35.0	



For cylinders of split tensile strength,

Days	Specimen	Split tensile strength (N/mm²)	Average split tensile strength (N/mm²)
3 days	Specimen-1	2.4	2.4
	Specimen-2	2.3	
	Specimen-3	2.6	
7 days	Specimen-1	2.9	2.9
	Specimen2	3.0	
	Specimen-3	2.9	
28 days	Specimen-1	3.1	3.1
	Specimen-2	2.9	
	Specimen-3	3.3	

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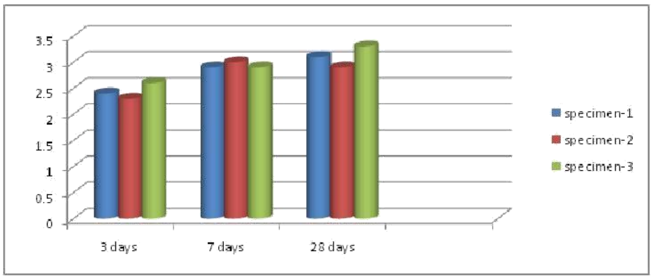
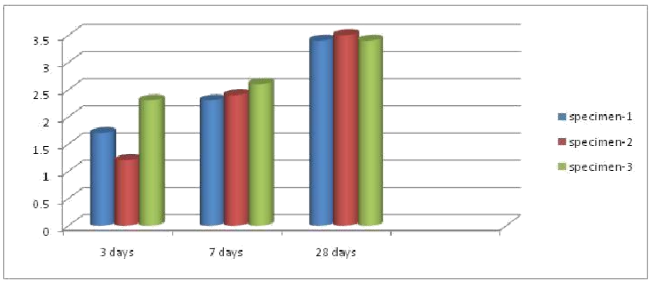




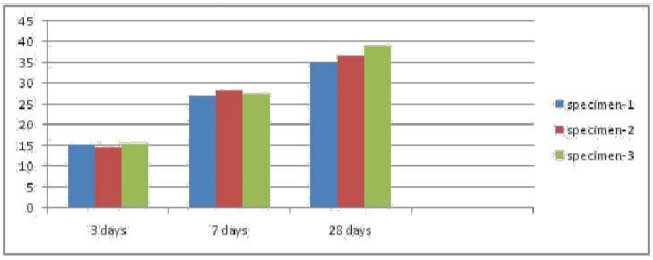
b) For 10% RHA, 0.5% steel, 1.0% polyester fibres,

Mix proportions,

Mix	Water	Cement	Fine aggregate	Coarse aggregate	Steel	Polyester
M25	175 Litre/m^3	350 Kg/m^3	633.724 Kg/m^3	1240.2884 Kg/m^3	1.75 Kg/m^3	3.5 Kg/m^3

For cubes of compressive strength,

Days	Specimen	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
3 days	Specimen-1	15.2	18.1
	Specimen-2	14.6	
	Specimen-3	15.4	
7 days	Specimen-1	26.9	25.6
	Specimen-2	28.3	
	Specimen-3	27.6	
28 days	Specimen-1	34.9	36.9
	Specimen-2	36.8	
	Specimen-3	39.0	



For cylinders of split tensile strength,

Days	Specimen	Split tensile strength (N/mm^2)	Average split tensile strength (N/mm^2)
3 days	Specimen-1	1.7	1.7
	Specimen-2	1.2	
	Specimen-3	2.3	
7 days	Specimen-1	2.3	2.4
	Specimen2	2.4	
	Specimen-3	2.6	
28 days	Specimen-1	3.4	3.4
	Specimen-2	3.5	
	Specimen-3	3.4	

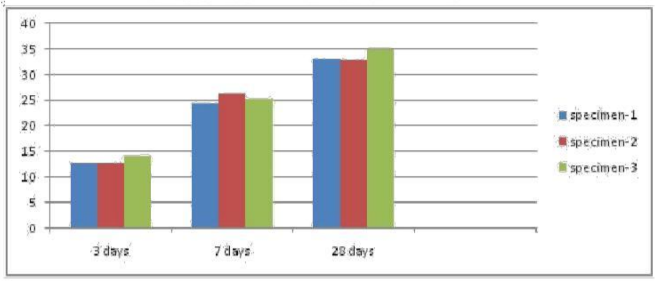
c) For 10% RHA, 0.5% steel, 1.5% polyester fibres,

Mix proportions,

Mix	Water	Cement	Fine aggregate	Coarse aggregate	Steel	Polyester
M25	175 Litres/m^3	350 Kg/m^3	633.633 Kg/m^3	1240.1103 Kg/m^3	1.75 Kg/m^3	5.25 Kg/m^3

For cubes of compressive strength,

Days	Specimen	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
3 days	Specimen-1	12.7	13.2
	Specimen-2	12.7	
	Specimen-3	14.2	
7 days	Specimen-1	24.5	25.4
	Specimen-2	26.4	
	Specimen-3	25.3	
28 days	Specimen-1	33.0	33.5
	Specimen-2	32.8	
	Specimen-3	34.9	



For cylinders of split tensile strength,

Days	Specimen	Split tensile strength (N/mm^2)	Average split tensile strength (N/mm^2)
3 days	Specimen-1	1.8	1.9
	Specimen-2	1.8	
	Specimen-3	2.0	
7 days	Specimen-1	2.0	2.1
	Specimen2	2.1	
	Specimen-3	2.1	
28 days	Specimen-1	2.8	2.6
	Specimen-2	2.3	
	Specimen-3	2.6	

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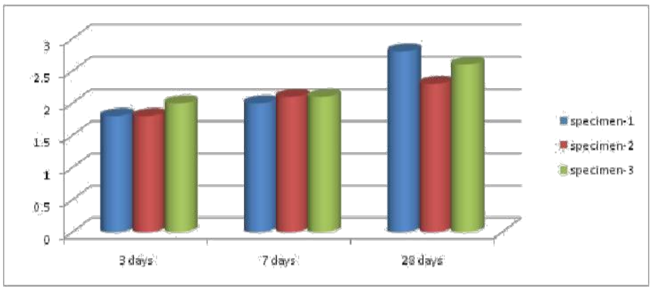


COMPARISON OF STRENGTHS FOR NORMAL CONCRETE AND FIBRE REINFORCED CONCRETE:

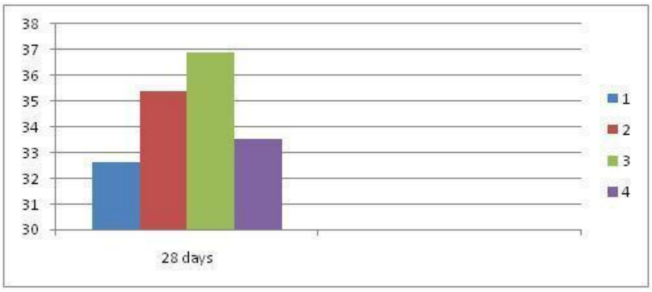
Strength variation for

1) Normal concrete,

2) 10% Rice Husk Ash, 0.5% steel fibres, 0.5% polyester fibres,

3) 10% Rice Husk Ash, 0.5% steel fibres, 1.0% polyester fibres,

4) 10% Rice Husk Ash, 0.5% steel fibres, 1.5% polyester fibres for 28 days of Compressive strength is shown in fig below,



It is observed that the compressive strength at 28 days is increased by 8.59% for 10% RHA, 0.5% steel fibres and 0.5% polyester fibres and increased by 13.20% for 10% RHA, 0.5% steel fibres and 1% polyester fibres and increased by 2.77% for 10% RHA, 0.5% steel fibres and 1.5% polyester fibres respectively when compared with the normal concrete.

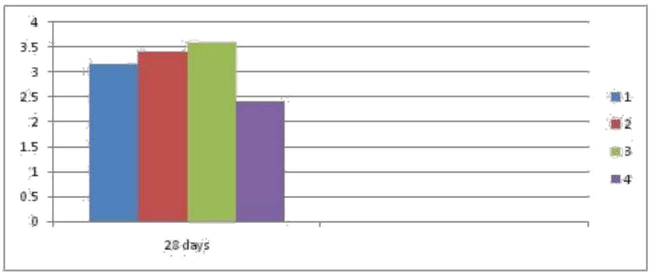
Strength variation for

1) Normal concrete,

2) 10% Rice Husk Ash, 0.5% steel fibres, 0.5% polyester fibres,

3) 10% Rice Husk Ash, 0.5% steel fibres, 1.0% polyester fibres,

4) 10% Rice Husk Ash, 0.5% steel fibres, 1.5% polyester fibres for 28 days of Flexural strength is shown in fig below,



It is observed that the flexural strength at 28 days is increased by 7.94% for 10% RHA, 0.5% steel fibres and 0.5% polyester fibres and increased by 14.29% for 10% RHA, 0.5% steel fibres and 1% polyester fibres and decreased by 23.81% for 10% RHA, 0.5% steel fibres, and 1.5% polyester fibres respectively when compared with the normal concrete.

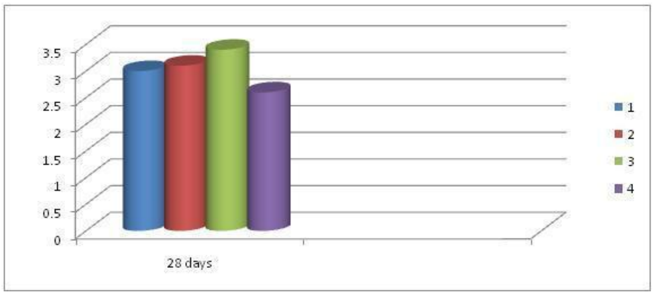
Strength variation for

1) Normal concrete,

2) 10% Rice Husk Ash, 0.5% steel fibres, 0.5% polyester fibres,

3) 10% Rice Husk Ash, 0.5% steel fibres, 1.0% polyester fibres,

4) 10% Rice Husk Ash, 0.5% steel fibres, 1.5% polyester fibres for 28 days of split tensile strength is shown in fig below,



It is observed that the split tensile strength at 28 days is increased by 3.34% for 10% RHA, 0.5% steel fibres and 0.5% polyester fibres and increased by 13.33% for 10% RHA, 0.5% steel fibres and 1% polyester fibres and decreased by 13.34% for 10% RHA, 0.5% steel fibres, and 1.5% polyester fibres respectively when compared with the normal concrete.

So, finally concluded that, for 10% Rice Husk Ash, 0.5% steel fibres and 1.0% polyester fibres the maximum strength will occur for compressive, flexural, split tensile strengths.

4. Conclusion

In the present investigation for M25 grade concrete, it can be concluded that the cement can be replaced up to 10% with RHA mixed with steel fibres and polyester fibres with equivalent or higher compressive strength to that of the control specimen. The main reason for this is that RHA acts as a filer material and it takes considerable time to enhance its hydration reaction with cement so by using 10% of RHA we get a fair compressive strength. Thus, RHA, which creates health hazards and environmental imbalance, can be blended with cement up to 10% RHA as a cement replacement material in construction. This reduction in strength on the introduction of plastic fibres can be attributed to improper bond between the cement-sand matrix and plastic fibres which further weakness the transition zone between the aggregate phase and the hydrated cement paste.

It is observed that from the literature review that the use of steel fibres especially crimped fibres are more advantageous as they enhance the overall mechanical properties of plain concrete than other fibres.

In this present research work, it is concluded that strength of the concrete slightly increases compared with the normal concrete by using steel and polyester fibres replacement of Rice Husk Ash.

1. In this present study cement is replaced by 10% RHA and simultaneously with steel and polyester fibres. It is concluded that by replacing 10% RHA and 0.5% steel 0.5% polyester the compressive strength increased by 8.59%, the flexural strength increased by 7.94%, split tensile strength increased by 3.34%, comparing with the normal concrete.

2. It is concluded that for 10% RHA and 0.5% steel, 1.0% polyester fibres the compressive strength increased by 13.20%, the flexural strength increased by 14.29%, split tensile strength increased by 13.33%, when compared with normal concrete.

3. It is finally concluded that, for 10% RHA, 0.5% steel and 1.5% polyester fibres the compressive strength slightly increased by 2.77%, the flexural strength decreased by 2.12%, split tensile strength decreased by 13.34%, when compared with the normal concrete.

So, finally we concluded that, for 10% Rice Husk Ash, 0.5% steel fibres and 1.0% polyester fibres the maximum strength will be achieved in compression, tension, flexure for compressive, flexural, split tensile strengths.

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