

An Experimental Investigation of Glass Fibre on Bottom Ash Based Concrete

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ABSTRACT: Concrete is an artificial material which has wider applications in the construction industry. Recent trends in concrete technology are to improve the workability, strength and resistance to smaller cracks in the concrete and also to utilize the waste by-products from other processes. Bottom ash is a hazardous by-product from coal based thermal power plants which causes several adverse effects to the environment if it is not properly disposed. Therefore in this study, fine aggregate is replaced with bottom ash and glass fibre is used for increasing the flexural strength and strain capacity of the concrete. The study was conducted to evaluate the strength characteristics of glass fibre and bottom ash on concrete. The concrete mix design was done for M30 grade concrete. Mix was prepared for different combinations (0%, 25%, 35%, 50% and 100%) replacement of sand by bottom ash with 0.3% of glass fibre. The specimen such as cubes of 150 x 150 x 150 mm in size and cylinder of 150 x 300 mm in size, beam of 1000 x 100 x 200 mm in size are casted and the properties such as compressive strength, split tensile strength & flexural strength has been analysed and it has been compared with control mix for the duration of 7 and 28 days.

KEYWORDS: Bottom ash, glass fibre, M30, mechanical properties.

I. INTRODUCTION

Concrete, an unavoidable construction material is a mix of cement, sand, coarse aggregate and water. Plain cement concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Addition of small closely spaced and uniformly dispersed fibres to concrete, acts as crack arresters and substantially improves the static and dynamic properties of plain concrete [1]. The fibres of short length and small diameters can be used in high strength concrete to convert its brittle nature to a ductile one. The fibres used can be of steel, polypropylene, nylon, glass or carbon [2]. Each of the above mentioned fibre has its own characteristic properties and limitations. Glass fibre is one of the strongest and most commonly used structural materials have shown strength up to 6896 MPa and commercial grades range from 3448 – 4830 MPa.

In India, over 70% of electricity generated in India, is by combustion of fossil fuels, out of which nearly 61% is produced by coal-fired plants. This results in the production of roughly 100 ton of ash. About 20% of total ash content of the coal fed in the boilers and is known as Bottom Ash [3]. Most of the ash has to be disposed of either dry, or wet to an open area available near the plant or by grounding both the fly ash and bottom ash and mixing it with water and pumping into artificial lagoon or dumping yards. This causes the pollution in water bodies and loss of Productive land. In recent years the utilization of such hazardous materials in concrete is increasing day by day to avoid its effect to the environment. Thus the experimental investigations were carried out to study the effect of use of bottom ash as a replacement of fine aggregate in concrete. And also the glass fibres were used to increase its strength properties.

II. MATERIAL USED AND THEIR PROPERTIES

The experiments were carried throughout by using the materials like Cement (OPC grade 53), fine aggregate confirmed to IS 383-1970, coarse aggregate as per IS: 2386 (Part – III), water conforms IS 3025 (Part 22, 23), bottom ash and glass fibre. The initial tests were conducted on the materials and their properties are given in table-1.

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Vol. 5, Issue 3, March 2016

III. EXPERIMENTAL INVESTIGATIONS

In the design mix of the concrete, the results on materials properties were considered and the mix proportions were identified as given in table-2. The bottom ash is varying from 0 to 100% and the glass fibre was taken 0.3% in each proportions. Also the mix proportion without the glass fibre was chosen for each % bottom ash concrete for the purpose of comparison of the strength properties. The suitable specimens were casted for each mix proportion (as per the table-3) and strength properties were examined by conducting the various tests like compressive strength, split tensile strength & flexural strength on 7 and 28 days of the curing period.

Table-1: Strength properties of the materials used			
Material & their properties	value	Material & their properties	value
Cement		Fine Aggregate	
Standard consistency	33%	Specific Gravity	2.64
Initial setting time	30mins	Fineness modulus	3.05
Strength	54.08N/mm ²	Water absorption	0.25%
Fineness	6%	Coarse Aggregate	
Soundness	2mm	Specific Gravity	2.63
Specific gravity	3.1	Fineness modulus	7.28
Glass fiber		Maximum size	20mm
Length of Fibre	6mm	Water absorption	1.86%
Diameter	12µm	Bottom ash	
Specific gravity	2.60	Specific Gravity	2.7
Failure strain	3%	Maximum size	0.5-2mm
Elasticity	80GPa	Plasticity	None
Tensile strength	2.5GPa	Water absorption	0.8-2%

Table-2: Mix proportion of concrete (M30 grade)						
Bottom ash (BA) as fine aggregate	%	0	25	35	50	100
Cement	kg/m ³	432.55	432.55	432.55	432.55	432.55
Fine Aggregate	kg/m ³	536.55	402.41	348.76	268.28	0
Coarse Aggregate	kg/m ³	1195.49	1195.49	1195.49	1195.49	1195.49
Bottom Ash	kg/m ³	0	134.14	187.79	268.27	536.55
Glass Fiber	kg/m ³	1.298	1.298	1.298	1.298	1.298
Water	liters	187.12	187.12	187.12	187.12	187.12

Table-3: Test specimens		
Test	Mould	size
Compression strength	Cube	150 x 150 x 150 mm
Split tensile strength	Cylinder	150 mm dia. x 300 mm in length
Beam flexural strength	Steel Prism	1000 x 100 x 200 mm

IV. RESULTS AND DISCUSSION

The compressive strength of the test specimens were examined on 7 & 28 days and it was found to be gradual decrease in the strength when increasing the bottom ash percentage. The values are tabulated in table-4 and the graphical representation of compressive strength of concrete at 7 and 28 days are given in figure-1 and figure-2 respectively.

International Journal of Innovative Research in Science, Engineering and Technology

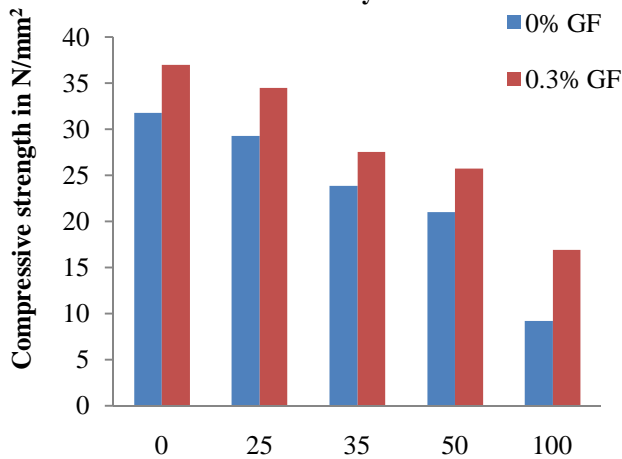
(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

% of Bottom ash (BA) as fine aggregate	Glass Fiber (%)	Compression Strength in N/mm ²	
		At 7 days	At 28 days
0	0	31.72	35.93
	0.3	36.91	40.24
25	0	29.25	34.83
	0.3	34.46	38.32
35	0	23.85	33.92
	0.3	27.48	37.22
50	0	20.98	36.7
	0.3	25.68	36.9
100	0	9.2	11.52
	0.3	16.9	25.4

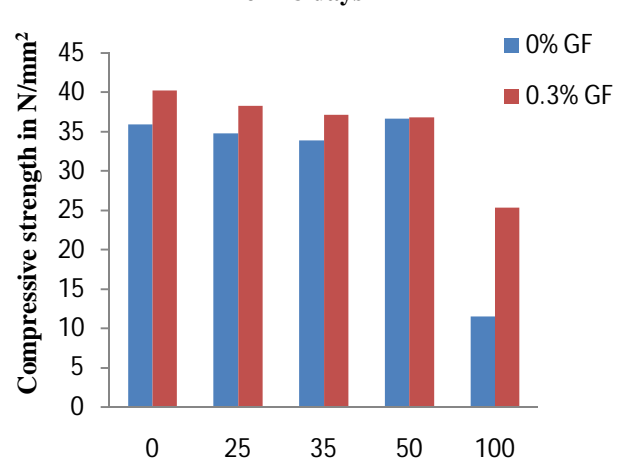
% of Bottom ash (BA) as fine aggregate	Glass Fiber (%)	Compression Strength in N/mm ²	
		At 7 days	At 28 days
0	0	2.15	2.15
	0.3	2.53	2.53
25	0	2.01	2.01
	0.3	2.48	2.48
35	0	1.92	1.92
	0.3	2.32	2.32
50	0	1.90	1.90
	0.3	2.24	2.24
100	0	1.27	1.27
	0.3	1.61	1.61

Fig-1: Compression strength of concrete on 7 days



% replacement of sand by Bottom ash (BA)

Fig-2: Compression strength of concrete on 28 days



% replacement of sand by Bottom ash (BA)

The test results for the split tensile strength of the concrete are given in table-5 and by the figure-3 & 4 for 7 & 28 days respectively. From the result it was identified that the split tensile strength of the concrete with glass fibre is more than the without glass fibre specimens. From the figure-5 and table-6, it was identified that the flexural strength of the concrete up to 50% bottom ash usage with 0.3% glass fibre is more when compared to the conventional concrete.

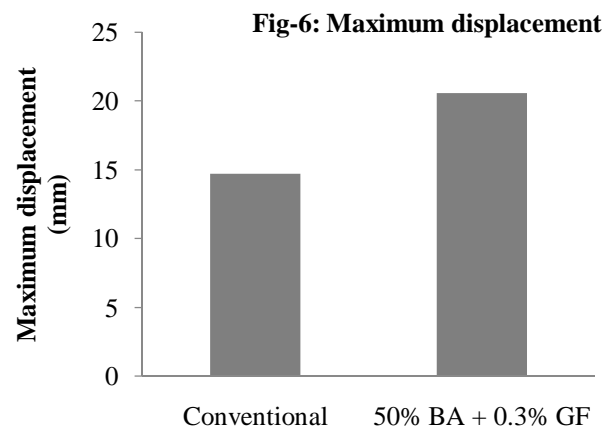
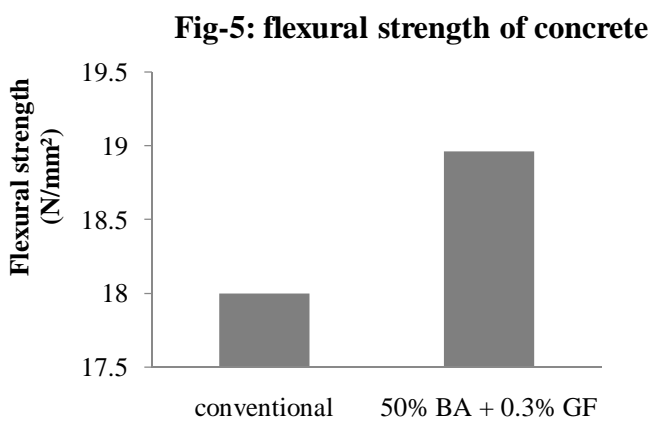
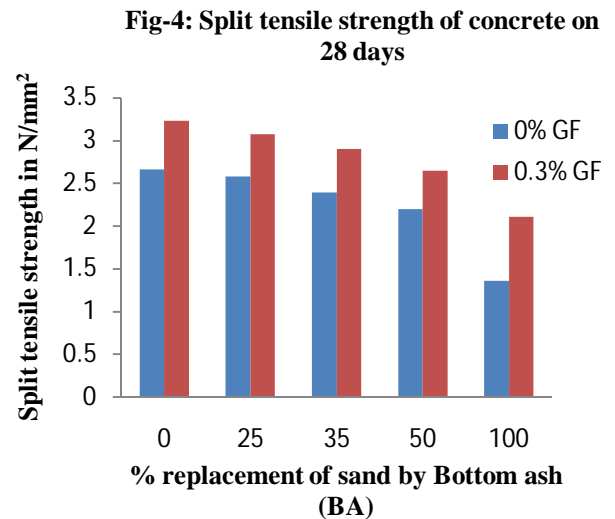
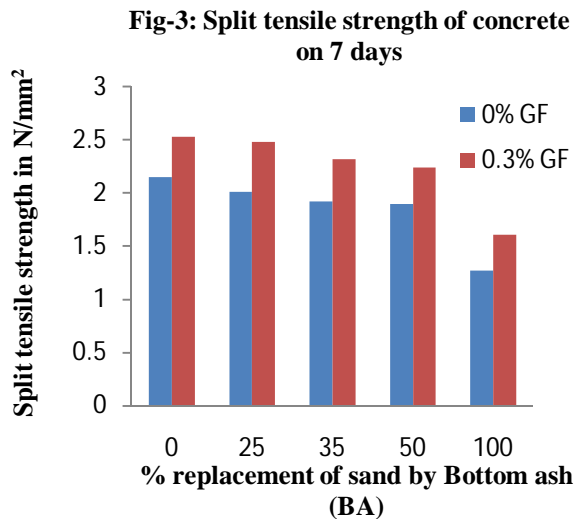


Table-6: Beam flexural strength of concrete

Specimen	PeakLoad (kN)	Flexural strength (N/mm ²)	Young's modulus (N/mm ²)	Max Bending Moment (kNm)	Maximum displacement (mm)
Conventional	68.60	18.00	20180	11.43	14.73
50 %Bottom ash + 0.3 % Glass fibre	72.25	18.96	20480	12.04	20.56

V. CONCLUSION

The study was conducted to evaluate the strength characteristics of glass fibre and bottom ash on concrete. The concrete mix design was done for M30 grade concrete. Mix was prepared for different combinations (0%, 25%, 35%, 50%, and 100% replacement of sand by bottom ash) with (0.3% of glass fibre).The specimen such as cubes of 150 x 150 x 150 mm in size and cylinder of 150 x 300 mm in size are casted and evaluate the properties such as compressive strength, split tensile strength & flexural beam strength has been analysed and it has been compared with control mix

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Vol. 5, Issue 3, March 2016

for the duration of 7 and 28 days. The 7 day cube compressive strength results showed that the strength of concrete reduced with increase in bottom ash. But at 28 days the strength of concrete with 50% replacement of bottom ash was almost equal to that of the control mix. Addition of 0.3% of glass fibre shows an increase in compressive for 0%, 25%, 35%, 50% and 100% replacement of bottom ash respectively. Increase in bottom ash shows a slight but noticeable increase in 7 day split tensile strength. But at 28 days the strength gain when compared to the controlled mix was not good. 50% bottom ash with 0.3% glass fibre showed the maximum 7 day and 28 day split tensile strength. From the above it is clear that 50% replacement of bottom ash with 0.3% glass fibre is the most efficient mix. By using the bottom ash as a replacement for Fine aggregate we can reduce land, water as well as air pollution and make the earth a better place to live in.

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