International Journal of Advance Research in Engineering, Science & Technology(IJAREST),
ISSN(O):2393-9877, ISSN(P): 2394-2444,
Volume 2,Issue 5, May- 2015, Impact Factor:2.125

ASSESSMENT OF IMPROVEMENT IN PROPERTIES OF PLAIN CEMENT CONCRETE BY USING BASALT FIBRE

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Abstract

Concrete is widely used material in the construction industry for building structures that are ordinary to those that involve highly specialized jobs. Experimental work was carried out to gather information about the properties of plain cement concrete with chopped basalt fibres. Basalt fibres have been used by varying its percentage by weight of cement as 0.65%, 1% and 1.3% for various grades of concrete from M20, M25, M30, M35, M40 to cover the largest contribution to the construction industry using ordinary concrete as also substantially large component of the same using standard concrete.

Effect of basalt fibre on properties of concrete like workability, compressive strength, split tensile strength and flexural strength has been studied. Optimum fibre percentages for various grades of concrete from view point of maximizing compressive strength have been calculated by using curve fitting approach. The drawback in the form of additional expenses to be incurred can be compensated by reduction in the material cost.

Keywords- *Basalt fibre, split tensile strength, compressive strength, flexural strength, standard concrete, high strength concrete.*

I. INTRODUCTION

Once the health risks associated with asbestos were discovered, there was a need to find a replacement for the substance in concrete and other building materials. By the 1960s, steel, glass (GFRC) and synthetic fibers such as polypropylene fibers were used in concrete. Research into new fiber-reinforced concretes continues till today.

Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented.

Basalt fibre is inorganic fibre originate from basalt rock. It is environmentally friendly, it has no chemical reactions that may damage health or the environment, non-combustible and non-explosive. It has a better resistance to the acid and alkaline solutions. Basalt fiber has excellent properties like high modulus, high strength, corrosion resistance, and it retains its strength at high temperature also which made civil engineering community to develop it further for different application purposes.

In line with matter whispered in the above article, a researcher may go for with enhancement of various properties by introducing different types of materials considering results of connected research as regards the same or may propose the totally new material to be introduced or may propose new methodology to be used or may propose a change in the material proportions that have already been tried or try yet another combination of any of above. Alternatively, a researcher may also go for an ad-hoc proportion or change proportions of materials to be introduced with a certain logical deduction or even may propose a combination of above for certain range of concrete strength/grades etc. and assess the change in various parameters or properties of concrete with pre-decided proportions. This paper is based on the intermediate results.

In this research work, the latter approach has been resorted to. The objective of this research work is to study the change in properties of concrete like workability, compressive strength, split tensile strength and flexural strength. The use of basalt fibre is proposed in concretes of various grades ranging from M20 to M40 and by varying the basalt fibre percentage by weight of cement in the concrete the change in various properties was assessed.

II. EXPERIMENTAL PROGRAMME

The chopped basalt fibres were used for the purpose of this dissertation work. The length of the individual fibre is 6mm. Fibre of 0%, 0.65%, 1% and 1.3% by the weight of the cement were suggested in this study. The binder consists of ordinary Portland cement. The coarse aggregate used was 20mm maximum size. Naturally available fine aggregate were used for the study wok. The basalt fibre was randomly oriented in the mix.

For fresh concrete, the standard slump cone test was conducted according to the IS: 1199-1959 for all mixes immediately after the mix was completed. Cubic samples 150 x150 x 150 mm were used for compressive strength. The concrete cube specimen were taken out from the tank, their surfaces were dried of excess water, cleaned and kept in the laboratory for a few minutes to obtain saturated dry surfaces specimens. Then their weight and dimensions were measured and noted.

The specimens were tested at various ages i.e. 3 days, 7 days and 28 days (3 cubes at each age) for compressive strength. Control mix details are listed in the table 1 below

Table-1 Mix details

Contents				
Grade	Cement kg/m^3	Water kg/m^3	FA kg/m^3	CA kg/m^3
M20	394	197	709	1053
M25	410	197	704	1045
M30	425	197	699	1038
M35	470	197	684	1016
M40	526	197	665	988

The split tensile specimens were tested at the age of 7 days and 28 days. The flexural specimens were tested at the age of 7 days.

III. RESULTS AND DISCUSSIONS

3.1. Slump of the fresh concrete

Table-2 Slump in mm

Grade	Fibre reinforced concrete strength in MPa		
	0.65%	1%	1.3%
M20	125	70	50
M25	115	65	50
M30	80	60	45
M35	70	50	40
M40	35	20	20

Increasing the percentage of fibre (by weight of cement) leads to a decrease in slump. This is mainly due to the fact that fibres restrain the flow ability of fresh concrete and results in a decrease in workability.

3.2. Strength of the concrete

3.2.1. Compressive strength

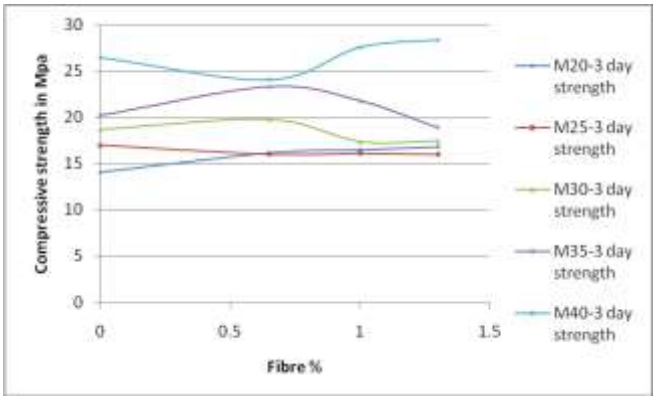
Table 3- Compressive strength at the age of 3 days

Grade	Plain Concrete	Fibre reinforced concrete strength in MPa		
	0	0.65%	1%	1.30%
M20	14.06	16.19	16.52	16.85
M25	16.96	16.04	16.11	16.02
M30	18.7	19.77	17.38	17.45
M35	20.24	23.3	21.8	18.9
M40	26.49	24.1	27.6	28.4

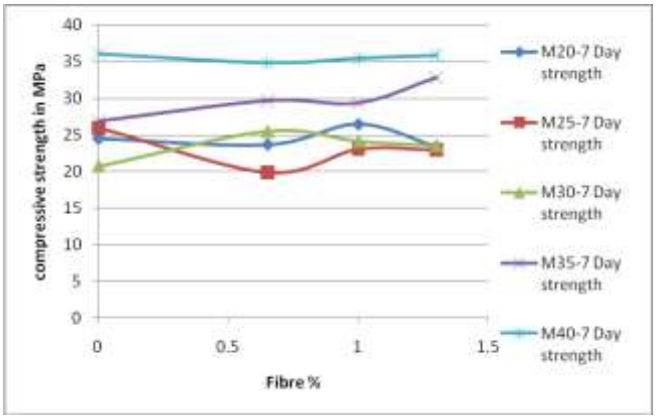
Table 4- Compressive strength at the age of 7 days

Grade	Plain Concrete	Fibre reinforced concrete strength in MPa		
	0	0.65	1	1.3
M20	24.4991	23.68	26.49	23.41
M25	25.9076	19.81	23.01	22.89
M30	20.7422	25.52	24.15	23.56
M35	26.8598	29.64	29.33	32.81
M40	36.1346	34.83	35.49	35.91

Results of 3 days and 7 days indicate the increase in the compressive strength at various fibre percentages added for almost all grades of concrete.



Graph-1 Compressive strength Vs fibre % at the age of 3 days

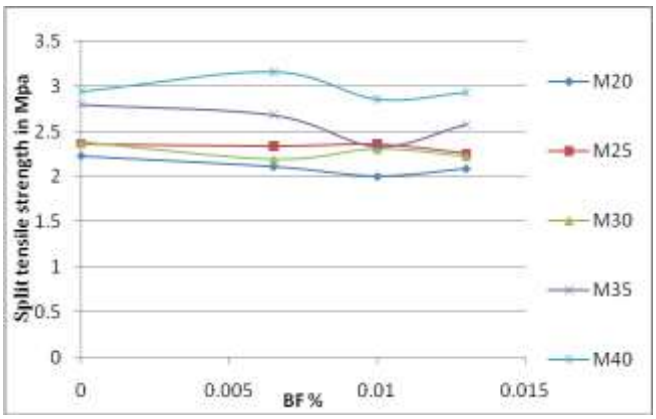


Graph-2 Compressive strength Vs fibre % at the age of 7 days

3.2.2. Split tensile strength

Table-5.Split tensile strength at the age of 7 days

Grade	Plain Concrete	Fibre reinforced concrete strength in MPa		
	0	0.65%	1%	1.30%
M20	2.23	2.110665	2.003174	2.089288
M25	2.36353	2.341137	2.360817	2.258985
M30	2.377147	2.191919	2.30581	2.223446
M35	2.797603	2.682171	2.336999	2.580808
M40	2.94	3.156988	2.854123	2.929528



Graph-3 Split tensile strength Vs fibre % at the age of 7 days

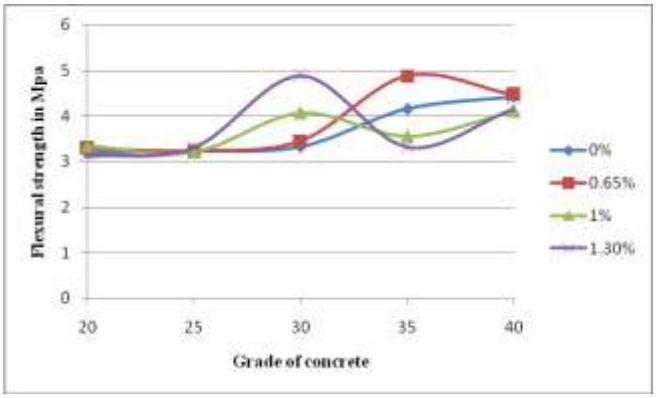
Graph-3 reveals that the split tensile strength, at the age of 7 days, increases with the addition of basalt fibre for high strength concrete whereas marginal change was observed for standard grades of concrete.

3.3.3 Flexural strength

Flexural test were conducted on beam specimen size of 150mm x 150 mm x 700 mm on universal testing machine.

Table 6- Flexural strength at the age of 7 days

Grade	Plain Concrete	Fibre reinforced concrete strength in MPa		
	0	0.65%	1%	1.3%
M20	3.195203	3.292144	3.34427	3.121551
M25	3.232951	3.247208	3.206562	3.307482
M30	3.330079	3.452873	4.069068	4.88823
M35	4.157316	4.876957	3.556032	3.318171
M40	4.436987	4.472994	4.108394	4.165174



Graph-4 Flexural strength Vs grade of concrete for various fibre % at the age of 7 days

For all practical purposes additional BF does not help to increase the flexural strength of BFRC irrespective of fibre content as compared with PCC for grades M20 and M25. M30 shows an improvement in flexural strength when it is converted to BFRC by addition of fibres and the same increases as the fibre content increases. M35 exhibits increase in flexural strength only for low fibre content studied i.e. 0.65% and in rest all cases it reduces as compared with PCC.

IV. CONCLUSION

1. Increase in fibre percent leads to the reduction in workability of concrete as fibre affects the flowing property of concrete.
2. Barring an exception almost for all grades, compressive strength increases with addition of fibre content.
3. The split tensile strength, at the age of 7 days, increases with the addition of basalt fibre for high strength concrete and remains same for all remaining grades.
4. Flexural strength increases for M35 grade at 0.65% fibre addition. For M30, increase in strength was observed as the fibre percent increases.

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