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Strength Assessment Of GGBS Based Polypropylene Fiber Reinforced Concrete Composites

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Abstract: **The objective of the investigation is to find the effects of concrete composites when cement is partially replaced with cement and when polypropylene fibers are added to the composites. The proportions of the mix design of the control mix are 1: 1.528: 2.7. The water-cement ratio used for the investigation was 0.45. The cement was replaced by GGBS for 0, 10, 20, 30 percentages for above mentioned replacements the polypropylene fibers were added for 0, 0.25, 0.5, 0.75 percentages. The cut length of polypropylene fibers used in the investigation is 12mm. This investigation gives the feasibility of use of polypropylene fibers on properties of concrete such as compressive strength, split tensile strength and flexural strength. The above test were conducted by varying both fiber content and GGBS content. The GGBS content was varied from 0 to 30 percent of cement content.**

Keywords: **polypropylene fibers, GGBS, compressive strength, split tensile strength, flexural strength.**

1. INTRODUCTION

Concrete is the material which is the second largest material poured to the earth. This is the reason it is gaining more and more importance. It is the vital element in development of infrastructure. Thus it is obvious that the more is the requirement the more is the research is carried on it. In concrete technology there are more aspects that increasingly gaining importance and research demand, but particularly talking about the fiber reinforced concrete, the fiber plays an important role. There are many types of fibers that are used in fiber reinforced concrete such as natural fibers and artificial fibers. Natural fibers such as coir, hay, jute etc and artificial fibers such as steel fibers, glass fibers, polypropylene fibers etc,. In polypropylene fiber reinforced concrete it can be seen that the concrete is not studied as the plastic industry has undergone drastic change. Upon studying the previous works that are carried out, it becomes obvious that they have used a primitive polypropylene fiber that is they have used collated fibrillated polypropylene. So in this work the strength behavior of GGBS based polypropylene fiber reinforced concrete composites is studied.

2. RESEARCH SIGNIFICANCE

Literature referred were about polypropylene fibers, GGBS, and M-sand. Drago[3] investigated on the shrinkage of high performance concrete reinforced with polypropylene fibers. Measurement of total shrinkage was done by using displacement transducer. They concluded that the reduction of shrinkage depends primarily on the volumetric content of fibers used and also on their state of moistening. The authors say that the workability of concrete added with dry polypropylene fibers was worse compared to concrete with moistened polypropylene fibers. Li Guo-zhong [5] investigated on mechanical properties of cement mortar containing polypropylene fibers and polymer emulsion. If the stress are too much, cracks are formed inside the cement mortar. Due to introduction of polypropylene fibers in motor, the bond stress will be formed on the interface between polypropylene fibers and the matrix, thus relaxes the stress concentrations. Nemkumar [6] investigated the influence of lenth, diameter and geometry of polypropylene fibers on control of cracking. They conducted experimental investigation by varying the above variables to understand their influence. They varied the

dosage from 0.1 to 0.3%. They conclude that the effectiveness of fiber increases as the volume of fiber increases. The fiber which performed well among other type of polypropylene fibers are F1 which was monofilament type, with thickness 3 denier, with length 12.5mm and having density 900 kg/m^3. A. Oner[1] conducted experiment to determine optimum level of GGBS on compressive strength of concrete. They concluded that the water to binder ratio decreased as the GGBS content increased for the same workability. They found the optimum dosage for maximum strength at about 55 – 59% of the total binder content. And after optimum dosage any further additions of GGBS, there is decrease in compressive strength. A. K. Mullick[2] compares manufactured sand with natural sand. Natural sand and manufactured sand have differences from geological process of sorting and shaping. The particle size distribution in manufactured sand tends to minimize voids. The compressive strength containing manufactured sand was higher than concrete containing river sand. It was clear that crushed stone can be used for satisfactory mixes as fine aggregate.

3. EXPERIMENTAL PROGRAMME

Initially, the basic tests for various components of concrete were performed. Sieve analysis, specific gravity, water absorption, bulk density tests were performed for fine aggregate and coarse aggregate. Fineness, initial and final setting time tests were performed for cement. After performing all the basic tests, the trial mixes were done for choosing the appropriate water to binder ratio. The water to binder ratio was kept constant throughout the investigation i.e. 0.45. In this investigation structural properties of polypropylene fiber reinforced concrete composites are determined.

4. MATERIAL USED

Preliminary test that were to be conducted for constituents of concrete were conducted. Before actual execution of investigation the test were conducted on cement, fine aggregates, coarse aggregates and GGBS. The properties of polypropylene fiber were obtained from the reliance industry from which it was procured. The test conducted and the test results are given

Table I. Results of materials used

Cement	
Standard consistency	30
Specific gravity	3.14
Fine aggregate (M-sand)	
Fineness modulus	2.95
Specific gravity	2.6
Water absorption	3.63%
Coarse aggregate	
Specific gravity	2.7
Water absorption	0.72%
Index of flakiness	14.86%
Index of elongation	12.79%
Impact value	15%
Crushing value	21.44%
Polypropylene fibers	
Shape	Triangular
Length	12mm
Diameter	25 – 40 microns
Specific gravity	0.9- 0.91
Ground granulated blast furnace slag	
Fineness	380
Specific gravity	2.87

5. DETAILS OF SPECIMEN

Mix design was done for a target strength of M30 by using cement grade of OPC 53. The mix proportion obtained by the mix design was 1:1.528:2.7. The water to cement ratio taken was 0.45. The fiber content and GGBS content was varied to study the properties of composites. The tests conducted on concrete were compressive strength, split tensile strength and flexural strength as per the Indian code standards.

Table II. Number of specimens

Test conducted	Size	numbers
Compressive strength	15*15*15 cms	3 for each
Split tensile strength	30*15ϕ	3
Flexural Strength	50*10*10 cms	3

The investigation involved totally 16 combinations of mix proportions including the control mix, varying the content of cement, GGBS and volume of fibres. The water to binder ratio was kept constant throughout the investigation. The water to binder used in my investigation was 0.45. The GGBS content was varied from 0 to 30 percent of cement content. The content of polypropylene fibres were varied from 0 to 0.75% of cement content. The following table gives the exact idea of proportions varied in the investigation.

Table III. Number of specimens

Combination name	GGBS in percentage	Fibre content in percentage by weight	Length of polypropylene fibres
0/0	0	0	Control mix
0/0.25	0	0.25	12mm
0/0.5	0	0.5	
0/0.75	0	0.75	
10/0	10	0	
10/0.25	10	0.25	
10/0.5	10	0.5	
10/0.75	10	0.75	
20/0	20	0	
20/0.25	20	0.25	
20/0.5	20	0.5	
20/0.75	20	0.75	
30/0	30	0	
30/0.25	30	0.25	
30/0.5	30	0.5	
30/0.75	30	0.75	

The 0/0 combination is control mix. The first number indicates the percentage of GGBS which is replaced for cement and second number indicates the volume of fiber content. For example 10/0.25 means 10 percent of GGBS is replaced for cement and 0.25% of polypropylene fibers is added.

6. RESULTS AND DISCUSSION

The properties of concrete which were studied are compressive strength, split tensile strength and flexural strength. The above mentioned test results of different concrete composites were compared with the control mix.

6.1 Compression test:

For each combination of concrete composites compression test was conducted for 7, 14 and 28 days. And for each test three trials were conducted and average of them were taken. The test results are tabulated and are given below. A chart showing the variation of strength of various combination of concrete composites are given below.

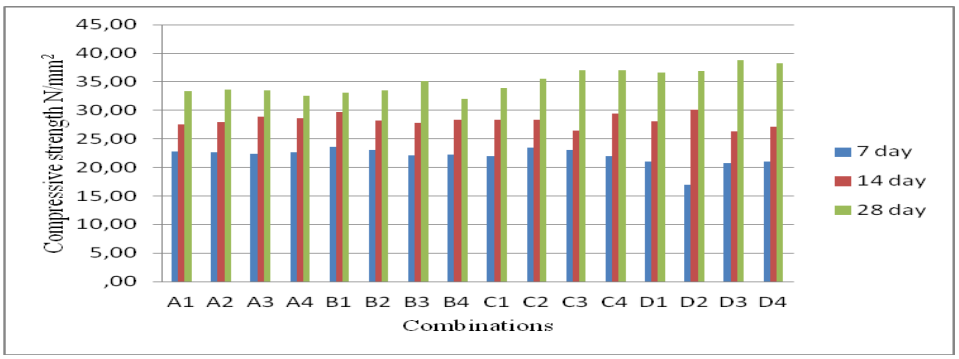

Fig.1: Compressive strength of different combinations.

Table IV. Results of compression test

Combination name	Compressive strength in N/mm^2		
	7 days	14 days	28 days
0/0	22.815	27.481	33.333
0/0.25	22.593	27.926	33.630
0/0.5	22.444	28.889	33.556
0/0.75	22.667	28.667	32.519
10/0	23.556	29.704	33.037
10/0.25	23.037	28.222	33.556
10/0.5	22.074	27.852	35.185
10/0.75	22.22	28.296	32.074
20/0	21.926	28.370	33.852
20/0.25	23.407	28.370	35.481
20/0.5	23.111	26.519	37.037
20/0.75	22.000	29.407	36.963
30/0	20.963	28.074	36.593
30/0.25	19.926	30.148	36.889
30/0.5	20.815	26.296	38.815
30/0.75	21.037	27.185	38.296

With 0 % of GGBS and varying content of fibers, it was seen that the addition of fibers had no effect on concrete composites. By observing the overall results we can say that the concrete strength was increased by addition of GGBS and not by the fibers. The maximum strength was obtained by the combination of 30/0.5.

6.2 Split tensile strength:

The split tensile strength of concrete composites was conducted only for 28 days. For each combination three trials were conducted. The test results of the split tensile strength is given in table 4. The variation of the split tensile strength with respect to different combination are given below.

Table V. Results of Split tensile and Flexural test

Combination name	Compressive strength in N/mm^2 for 28 days	
	Split tensile	Flexural
0/0	2.971	7.600
0/0.25	3.325	7.600
0/0.5	3.725	7.867
0/0.75	3.466	7.733
10/0	2.994	8.400
10/0.25	3.207	7.733
10/0.5	3.513	7.733
10/0.75	3.513	8.133
20/0	2.980	7.867
20/0.25	3.216	8.800
20/0.5	3.763	9.067
20/0.75	3.339	9.867
30/0	2.924	8.667
30/0.25	3.197	9.467
30/0.5	3.683	10.133
30/0.75	3.400	9.600

By observing the results of split tensile strength, it can be said that the split tensile strength has no dependence on the GGBS content. But as the volume of polypropylene fibers are increased there was increase in the split tensile strength of concrete composites.

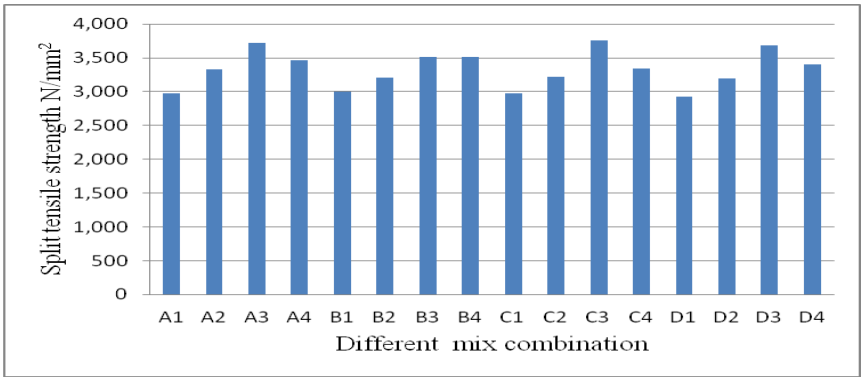

Fig.2: Split tensile Strength of different combinations.

6.3 Flexural Strength:

The flexural strength of concrete composites was conducted for 28 days. Beam specimens used in the investigation are 10*10*50 cms size. The test results are given in table 5. For each combination of concrete composites three trials were conducted and average of them were considered. The chart showing the variation of Flexural strength of different concrete composites are given below .

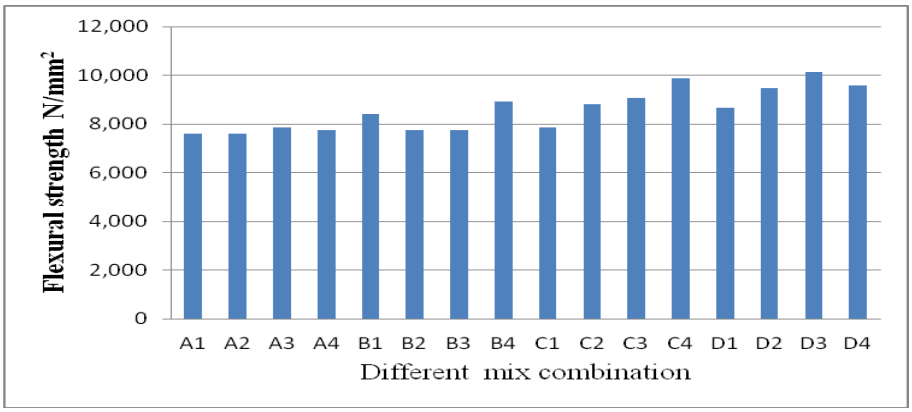

Fig.3: Flexural strength of different composites

By observing the results of flexural strength the variation on the chart tells that the strength dependence is not only by the fibers nor by GGBS. But we can say that the combination of both GGBS and polypropylene fibers contributes to Flexural strength. But the increase in the flexural strength is poorly considerable.

7. CONCLUSIONS

The test result of different concrete composites is compared to control mix and conclusions were made. The various conclusions drawn are given below,

- The addition of polypropylene fibres had very little effect on strength of concrete.
- Due to addition of polypropylene fibres, there was considerable increase in split tensile strength.
- The increase in strength of concrete composite combinations is due to GGBS and polypropylene fibres have little effect on it.
- Both GGBS and polypropylene fibres have no effect on flexural strength.
- The combination D3 has enhanced properties of concrete due to both combinations of GGBS and polypropylene fibres.
- The increase in split tensile strength is maximum for 0.5% of volume of polypropylene fibres.
- It was seen that as the fibre content increased above particular limit there was slight decrease in overall strength properties of concrete.

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