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A Study on Properties of Concrete Containing Micro Fine GGBS with Polypropylene Fiber

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Abstract— **In this study development of concrete by making an efficient concrete mix design blending with mineral admixtures on micro fine GGBS for higher grade concreteand with addition of various percentages of polypropylene fiber (0%, 0.5%, 1%, 1.5%& 2%) in concrete has been undertaken. Development of efficient concrete mix design plays an important & vital role in producing eco-economical concrete. This study represents the effect of presence of mineral admixture micro fine GGBSand polypropylene fiber in concrete.**

GGBS partially replaced by cement in concrete for evaluating the workability and strength of concrete along with flexural & split tensile strength. This study has been done by varying 10% GGBS on partial replacementand with addition of various percentages of polypropylene fiber (0%, 0.5%, 1%, 1.5%& 2%) in concrete. About twenty-four trial mix, control mix and other variation mix were developed for M25 &M30 grade of concrete.

Index Terms— **concrete, compressive strength, mix design, GGBS, workability, flexural strength**

I. INTRODUCTION

Concrete is the composition of coarse aggregate, fine aggregate, cement, sand and water. It may also have admixtures and other additives. It is the most popular building material in the world and used from prolong time. In concrete, aggregate is the major component after cement. The yearly production of cement is nearly 3 billion tons. The construction industry relies heavily on cement for production of concrete. Nearly 7% of the global CO_2 emission is contributed by cement industries. Reducing the consumption of cement in the concrete will thus reduce the emission. Its great adaptability and relative economy in filling wide range of needs has made it a competitive building material. The demand of concrete for today's infrastructural expansion is increasing gradually.

Since the plain, unreinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. Sometimes concrete structures have to survive in adverse conditions under chemical attacks like chloride attack, sulphate attack and acid attack. These chemical attacks affect the durability of concrete structure. For hardened reinforced concrete chloride attack is considered as a cause for corrosion. Chemicals percolate through the cracks developed in the concrete structures and corrode the reinforcement provided in the concrete and thus the deterioration of structure starts and the durability of structure get affected.

The use of fibres in concrete is from ancient times; to increase the tensile strength and flexure strength of concrete various researchers investigate the effect of fibres on various properties of concrete. Since then Fibres such as steel, glass, carbon and polypropylene are use in concrete. Addition of fibre in concrete also influences its brittle behaviour and ductility.

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II. METHODOLOGY

For this study the following raw materialsare being used:

1. Coarse aggregate- The aggregates of nominal size of 20mm were used. The aggregates were purchased locally and tested for specific gravity and gradation using sieve analysis as per the Indian Standards.

2. Fineaggregate/sand-River sand was obtained from local sources. On this sand, Sieve Analysis and specific gravity tests were carried out.
3. Cement-OrdinaryPortlandCementofgrade43 (OPC43)wasobtainedlocally
4. GGBS- GGBS is an environmentally friendly product and made from a by-product of iron manufacturing. It is a high quality, low CO_2 material. Because GGBS has low embodied CO_2, it allows designing concrete mixes for sustainable construction. The manufacture of GGBS requires less than 20% of the energy and produces less than 10% of theCO_2 emissions compared to Portland cement production. Chemical composition of GGBS are Cao 40%, Silica 35%, Alumina 13%, Magnesia 8%.
5. Polypropylene fibres- The PPF is as available in various forms as fibrillated bundles, mono filaments or microfilaments. The fibrillated polypropylene fibers are formed by expansion of a plastic film, which is separated into strips and then slit. In monofilament fibers, the addition of buttons at the ends of the fibers increases the pull out load.
   Polypropylene fibers are formed from synthetic resin built up by the polymerization of propylene. Polypropylene toughness, flexibility, light weight, and heat resistance. Polypropylene fibers of aspect ratio i.e. l/d ratio 250 and specific gravity 0.954 is used.

III. TEST AND RESULTS

3.1 Workability of Concrete

3.1.1 Slump Test

Table No. 3.1 Slump for Control mix of M25 & M30 Grade

S. No.	Control Mix	Slump (mm)
1	M25	75
2	M30	90

Table No. 3.2 Slump with 10% GGBS and Polypropylene Fiber

S. No.	Polypropylene fibre %	Slump (mm)	
		M25	M30
1	0.0	70	80
2	0.5	68	78
3	1.0	64	75
4	1.5	61	72
5	2.0	59	70

3.2 Compressive Strength Test

Compressive strength of concrete is utmost property of concrete. Cubes of dimensions 150×150×150 mm were cast and testes for compressive strength on compression testing machine.

Table 3.3 Compressive Strength of M25 grade

PolypropyleneFibre %	Compressive Strength(N/mm^2)		
	7Days	14 Days	28 Days
0.0	16.09	21.46	26.82
0.5	17.95	23.78	29.93
1.0	20.52	26.94	33.64
1.5	21.24	27.85	34.82
2.0	18.17	22.24	27.70

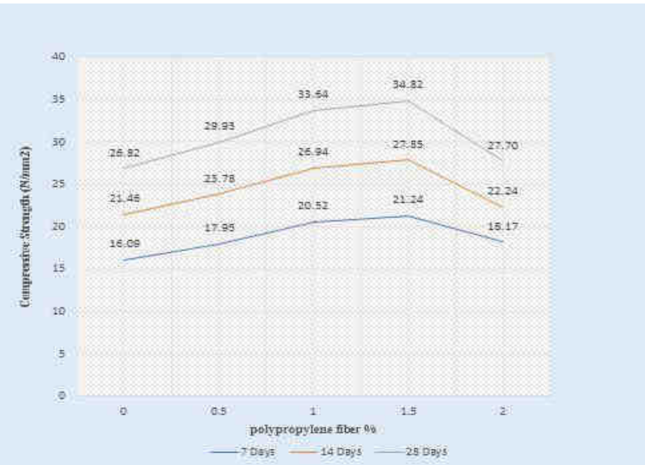

Fig A. Comparative Compressive Strength of M25 Grade

Table 3.4 Compressive strength of M30 grade

Polypropylene Fiber%	Compressive Strength(N/mm^2)		
	7 Days	14 Days	28 Days
0.0	19.60	26.50	32.67
0.5	20.41	26.12	33.47
1.0	21.50	28.46	35.84
1.5	22.80	29.47	36.79
2.0	21.71	28.76	35.60

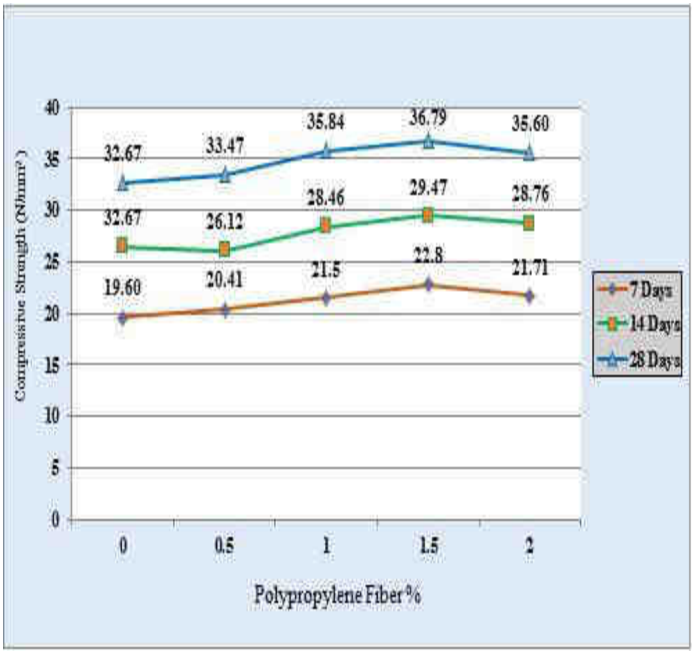

Fig B.Comparative Compressive Strength of M30 Grade

3.3 Split Tensile Strength of Concrete

Concrete is weak in tension so the testing of cylinder specimen for tensile strength is required. Cylinders of dimension 150mm (dia.) and 300mm (length) were cast and tested for split tensile strength on universal testing machine.

Table 3.5 Splitting Tensile Strength of M25 grade

PolypropyleneFiber %	Splitting Tensile Strength(N/mm^2)		
	7 Days	14 Days	28 Days
0.0	1.38	1.79	2.24
0.5	1.49	1.94	2.41
1.0	1.66	2.18	2.73
1.5	2.02	2.58	3.26
2.0	1.39	1.77	2.27

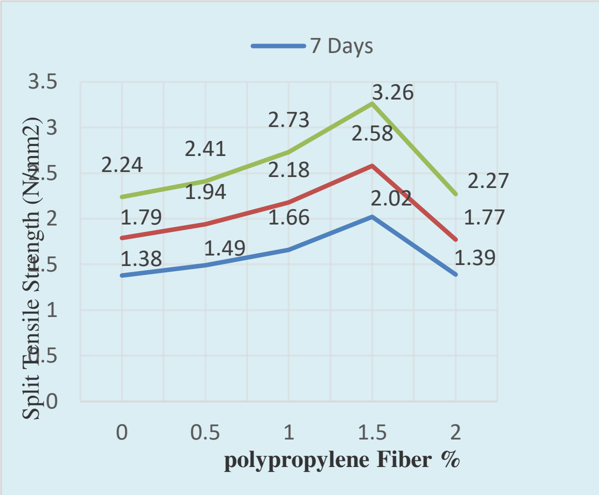

Fig C. Comparative Splitting Tensile Strength of M25 Grade

Table 3.6 Splitting Tensile Strength of M30 grade

PolypropyleneFiber%	Splitting Tensile Strength(N/mm^2)		
	7 Days	14 Days	28 Days
0.0	1.99	2.97	3.33
0.5	2.42	3.33	3.97
1.0	2.51	3.48	4.12
1.5	2.22	3.29	3.64
2.0	2.04	3.06	3.41

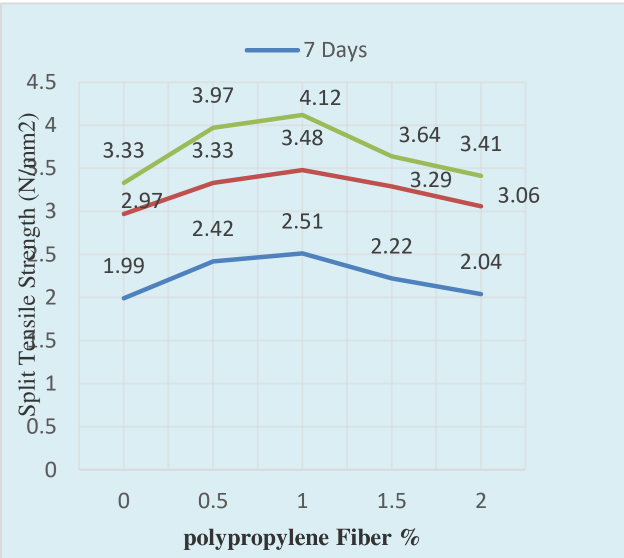

Fig. D. Comparative Splitting Tensile Strength of M30 Grade

3.4 Flexural Strength of Concrete

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. For flexural strength test beams of dimensions 150×150×500 mm were cast and tested on flexural testing machine.

Table 4.7 Flexural Strength of M25 grade

PolypropyleneFiber %	Flexural Strength (N/mm^2)	
	7 Days	28 Days
0.0	1.58	2.6
0.5	1.76	2.9
1.0	2.01	3.3
1.5	2.07	3.4
2.0	1.67	2.7

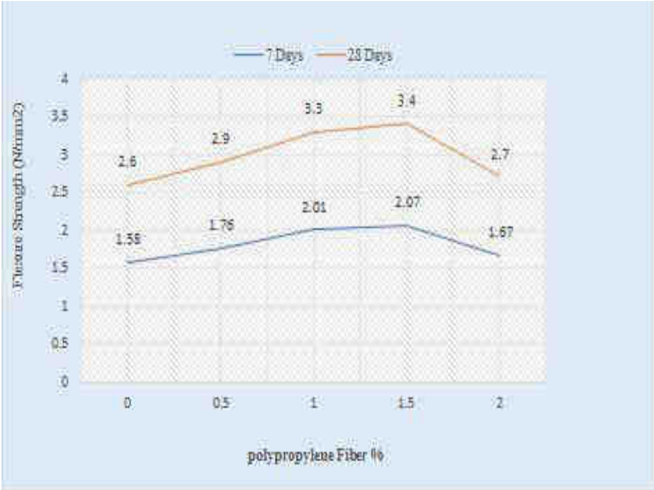

Fig E. Comparative Flexural Strength of M25 Grade

Table 3.8 Flexural Strength of M30 grade

PolypropyleneFiber %	Flexural Strength (N/mm^2)	
	7 Days	28 Days
0.0	1.64	2.70
0.5	1.81`	2.97
1.0	2.06	3.38
1.5	1.98	3.26
2.0	1.93	3.12

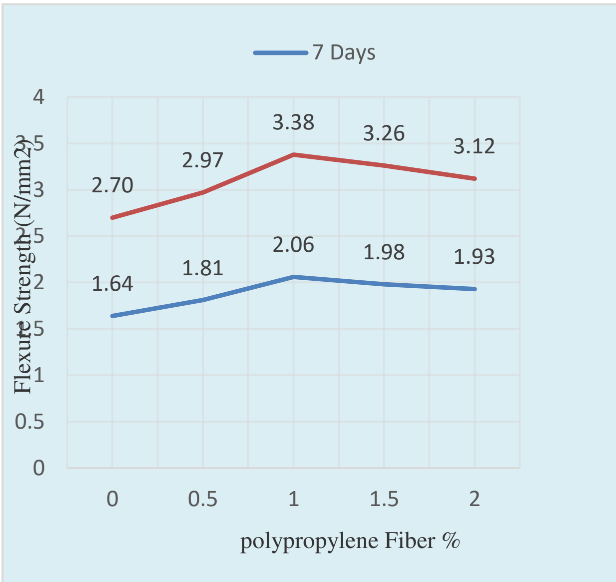

Fig F. Comparative Flexural Strength of M30 Grade

IV. CONCLUSION

As per research done in the area of strength properties based analysis of modified concrete to investigate and find out current challenges and scope of work in the area. After the research, three issues were found in the work which were based on experimental approach.

4.1 General Experimentation Result

In the research work these Experimental Scenarios were considered during experimentation.

- Accomplish Compressive strength test, split tensile test and flexural strength on concrete of grade M25 & M30 having different Percentage (0%, 0.5%, 1.0%, 1.5% and 2.0%) of Polypropylene Fiber and 10% of GGBS.
- To determine durability of concrete in terms of moisture loss in percentage for both M25 & M30.

V. RESULTS

In this experiment, Mix-Design of M25 &M-30 grade concrete; reference IS 10262: 2009, having water-cement ratio 0.45 is considered. Percentage of Polypropylenefiber (0% to 2%) is added in concrete along with GGBS which was partial replacement of cement by 10%. Total 30 specimens of Steel Fiber Reinforced Concrete were cast with great precision and were cured for 7, 14 days and 28 days. During concreting/casting of cubes, slump test on fresh concrete was conducted for verification of workability with above percentage (%) addition of Polypropylenefiber i.e. (0% to 2%). After completion of maturity period of concrete Compressive strength test, split tensile test and flexural strength test and durability tests were conducted on all the specimens with respective date of casting. From the study following observations were made with respect to above stated tests conducted –

A. FOR M25 CONCRETE

1. **Compressive Strength:**

The compressive strength increased as the percentage (%) of Polypropylene fiber was increased from 0% to 1.5% & maximum strength was achieved at 1.5% of Polypropylene Fibre. After 1.5% of PPF compressive strength started decreasing for both 14 days & 28 days concrete strength. It was concluded that optimum percentage increase in compressive strength of concrete was at 29.82% after 28 days of curing .

2. **Split Tensile Strength:**

The minimum split tensile strength was obtained at 0% addition of PPF while optimum split tensile strength was obtained at 1.5% addition of PPF at 14 and 28 days of curing. It was concluded that optimum percentage increment in split tensile strength of concrete was 45.53% at 28 days of curing respectively.

3. **Flexure Strength:**

It was noted that flexural strength of concrete increase gradually with addition of polypropylenefiber and minimum flexural strength was obtained at 0% while optimum flexural strength was obtained at 1.5% addition of PPF at 14 and 28 days of curing respectively.

It was concluded that optimum percentage increment in flexural strength of concrete was 30.76% at 28 days curing respectively.

4. **Durability**:

It was concluded that the percent loss of weight of cube specimens for resistance against acid attack was found to be -

- For GGBS10% at 90 days - 0.92 %
- For GGBS 10% and PPF 0.5% to 2.0% at 90 days found increasing - 0.95 to 1.73 %

The results revealed that the percent loss of weight of cube specimens for resistance against alkali attack was found to be

- For GGBS10% at 90 days - 0.26%
- For GGBS 10% and SF 0.5% to 2.0% at 90 days found increasing - 0.31 to 0.51 %

B. FOR M30 CONCRETE

1. **Compressive Strength:**

The results revealed that minimum compressive strength was obtained at 0% addition of polypropylenefiber while optimum compressive strength was obtained at 1.5% addition of steelfiber for both 14 days and 28 days curing period of cubes. It was concluded that optimum percentage increment in compressive strength of concrete was 12.61% at 28 days of curing respectively.

2. **Split Tensile Strength:**

The results revealed that minimum split tensile strength was obtained at 0% addition of polypropylenefiber while optimum split tensile strength was obtained at 1.0% addition of polypropylenefiber at 14 and 28 days curing of cubes.

It was concluded that optimum percentage increment in split tensile strength of concrete was 23.72% at 28 days of curing respectively.

3. **Flexure Strength:**

It was noted that minimum flexural strength was obtained at 0% while optimum flexural strength was obtained at 1.0% addition of polypropylene fiber at 14 and 28 days or curing respectively.

It was observed that optimum percentage increment in flexural strength of concrete was 25.18 % at 28 days curing.

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