INVESTIGATION WITH SILICA FUME & POLYPROPYLENE FIBRE ON PROPERTIES OF CONCRETE

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Abstract— The aim of the study was to investigate the effects of binder systems containing different levels of silica fume and polypropylene fibre on properties of concrete. In this programme test specimens of Cubes of size 100 mm x 100 mm x 100 mm, beam with 6000 mm x 100 mm x 100 mm will prepared using the standard moulds. The samples are cast using the two different combinations as control concrete, with silica fume and polypropylene fibre. A total of 96 specimens will cast for testing the properties such as compressive strength & 48 specimens will cast for testing the properties such as tensile strength and 48 specimens will cast for testing the properties such as flexural strength. Different percentages of silica fume and polypropylene fibre with constant water cement ratio are casted. The concrete mixes are 0%, 6%, 10%, 15% Silica fume with partial replacement of cement and 0%, 0.2%, 0.3%, 0.5% of polypropylene fibre in addition. Cubes were kept in water tank for curing up to 7 and 28 days and beams along with some cubes for tensile test kept in water tank for curing for 28days. The results were compared with the varying percentage of silica fume and polypropylene fibre.

IndexTerms— Silica Fume, Polypropylene Fibre, Compressive Strength,Spilt Tensile Test, Flexural Test (keywords)

I. INTRODUCTION

Concrete is a composite construction material made primarily with aggregate, cement, and water, admixture. There are many formulations of concrete, which provide varied properties, and concrete is the most used man-made product in the world. Concrete is widely used for making architectural structures, foundations, brick/block bridges/overpasses, walls, motorways/roads, pavements, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences and poles and even boats. Concrete can be formulated with high compressive strength, but always has lower tensile strength. For this reason it is usually reinforced with materials that are strong in tension (often steel).

In recent years significant attention has been given to the use of the Pozzolan silica fume as a concrete property-enhancing material, as a partial replacement for Portland cement, or both. Silica fume has also been referred to as silica dust, condensed silica fume, microsilica, and fumed silica.

The initial interest in the use of silica fume was mainly caused by the strict enforcement of air-pollution control measures in various countries to stop release of the material into the atmosphere. More recently, the availability of High Range Water-Reducing Admixtures (HRWRA) has opened up new possibilities for the use of silica fume as part of the cementing material in concrete to produce very high strengths or very high levels of durability or both. As with other concrete constituent materials, potential users of silica fume should develop their own laboratory data for the particular type and brand of cement, aggregates, and chemical admixtures to be used with the silica fume. This testing may be supplemented by observations of silica-fume concrete in the field and by testing of cores taken from such concrete.

Polypropylene (PP) is a versatile and widely used polymer, Polypropylene (PP) resins are a general class of thermoplastics produced from propylene gas. Propylene gas is derived from the cracking of natural gas feedstock's or petroleum by-products. Polypropylene (PP) fibers belong to the newest generation of large-scale, manufactured chemical fibers, having the fourth largest volume in production after polyesters, polyamides and acrylics. The amount of polypropylene fibers recommended by most manufacturers for use in paving mixtures and most other mixtures is 0.1 percent by volume of concrete (0.889 to 0.949 kg per cubic meter). The aim of the study was to investigate the effects of binder systems containing different levels of silica fume on fresh and mechanical properties of concrete. The work focused on concrete mixes having a fixed water/cement ratio. The percentages of silica fume that replaced cement in this research were 0%, 6%, 10% and 15%. Apart from measuring the workability of fresh concrete, the mechanical properties evaluated were: development of compressive strength; secant modulus of elasticity; strain due to creep, shrinkage, swelling and moisture movement. Also using fiber with some specific length and three volume fractions of 0% , 0.2%, 0.3% and 0.5% are used.

II. EXPERIMENTAL PROGRAM & SETUP

In this Chapter, the test results are presented and discussed. The test results cover the compressive strength, flexural strength, tensile strength . The main aim of this experimentation is to study the effect of partial replacement of cement by silica fume and addition of polypropylene fibre on the properties of concrete. The experimental programme is divided in four phases.

a) Concrete mix design as per IS 10262-2009 for M20 grade of concrete partial replacement of cement by silica fume and addition of polypropylene fibre with varying percentages.
b) Casting of cubes and beams.
c) Curing of cubes and beams for 7 days and 28 days
d) Testing of all beam specimens with single point loading for flexural strength and tensile , compressive strength for all cubes. Each test result plotted in the Figures or given in the Tables is the mean value of results obtained from at least three specimens.

MIX DESIGN

Concrete mix design as per IS 10262-2009 for M20 grade of concrete. Silica fume after partial replacement of cement and addition of polypropylene fibre with varying percentages.

Mix Description (SF% + PP%)	Cement (Kg/m^3)	Sand (Kg/m^3)	Aggregate (Kg/m^3)	Water (Lit.)	SF (Kg/m^3)	PP (Kg/m^3)
0 + 0	383	735	1103	192	-	-
0 + 0.2	383	735	1103	192	-	15.7
0 + 0.3	383	735	1103	192	-	23.55
0 + 0.5	383	735	1103	192	-	39.25
6 + 0	360.02	735	1103	192	22.98	-
6 + 0.2	360.02	735	1103	192	22.98	15.7
6 + 0.3	360.02	735	1103	192	22.98	23.55
6 + 0.5	360.02	735	1103	192	22.98	39.25
10 + 0	344.7	735	1103	192	38.3	-
10 + 0.2	344.7	735	1103	192	38.3	15.7
10 + 0.3	344.7	735	1103	192	38.3	23.55
10 + 0.5	344.7	735	1103	192	38.3	39.25
15 + 0	325.55	735	1103	192	57.45	-
15 + 0.2	325.55	735	1103	192	57.45	15.7
15 + 0.3	325.55	735	1103	192	57.45	23.55
15 +0.5	325.55	735	1103	192	57.45	39.25

III. RESULTS

In this project the test were taken on concrete to determine compressive strength, tensile strength, flexural strength. The strength is calculated by using compressive testing machine for compressive strength and UTM for flexural strength of beams. It is as follows:

Compressive Strength:

The result of compressive strength were plotted in below Table 3.1 and shown in fig. 3.1. Result indicate that if we replace silica fume by 0%, 6%, 10% & 15% and increase percentage of Polypropylene as 0%, 0.2%, 0.3%, 0.5% will give us a good results and help to increase compressive strength of concrete.

Compressive Strength s = P/A

Table 3.1 Average Compressive strength of various types of concrete at different ages

Mix Description (SF% + PP%)	**Average Compressive Strength (N/mm^2)**	
	7 Days	**28 Days**
0 + 0	26.11	35.88
0 + 0.2	29.44	37.86
0 + 0.3	30.48	40.83
0 + 0.5	23.47	31.44
6 + 0	24.25	32.33
6 + 0.2	30.01	34.35
6 + 0.3	36.44	37.55
6 + 0.5	34.88	38.22
10 + 0	31.15	32.33
10 + 0.2	31.80	33.25
10 + 0.3	37.28	41.11
10 + 0.5	29.55	36.88
15 + 0	28.23	35.33
15 + 0.2	26.21	34.23
15 + 0.3	27.13	33.29
15 +0.5	22.66	32.25

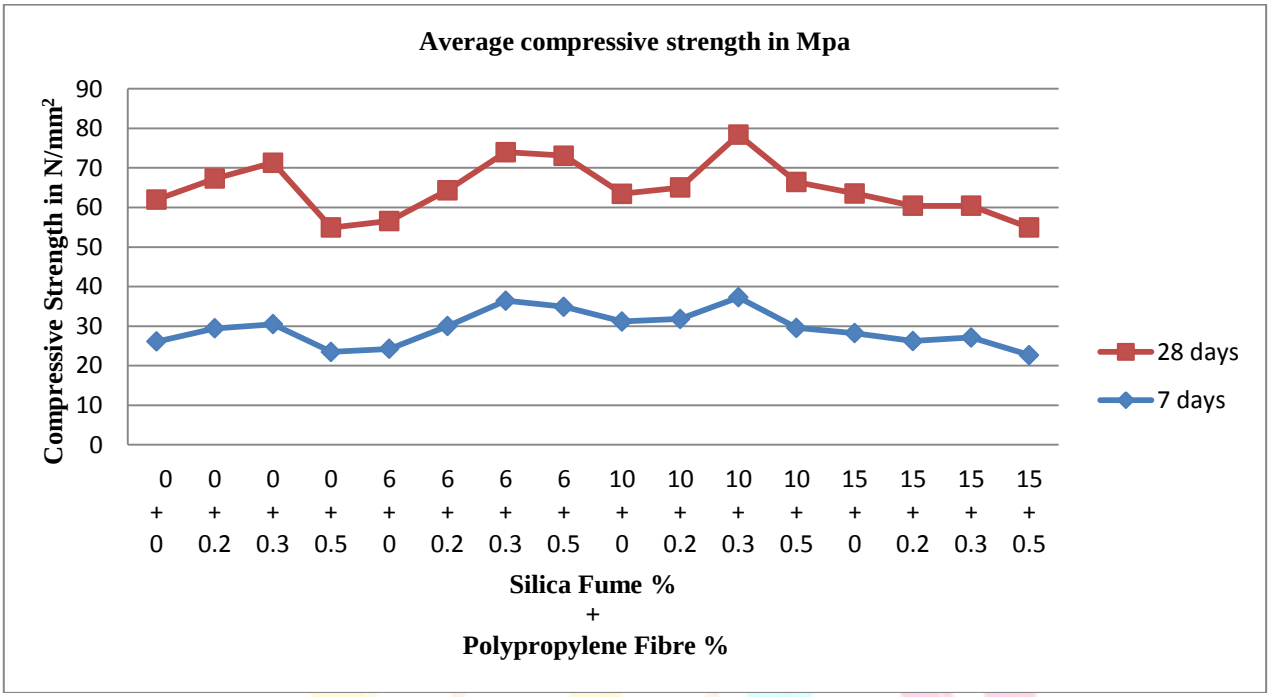

Fig. 3.1 Graphical representation of Compressive Strength

Split Tensile Strength

The result of tensile strength were plotted in below Table 3.2 and shown in fig. 3.2. Result indicate that if we replace silica fume by 0%, 6%, 10% & 15% and increase percentage of Polypropylene as 0%, 0.2%, 0.3%, 0.5% will give us a good results and help to increase tensile strength of concrete.

Split Tensile Strength $\sigma sp = 0.5187\ P / S^2$

Table 3.2 Average Spilt Tensile strength of various types of concrete

Mix Description (SF% + PP%)	Average Spilt Tensile strength (N/mm^2)
	28 Days
0 + 0	1.88
0 + 0.2	2.79
0 + 0.3	2.97
0 + 0.5	2.43
6 + 0	2.17
6 + 0.2	2.23
6 + 0.3	2.59
6 + 0.5	2.80
10 + 0	2.92
10 + 0.2	3.85
10 + 0.3	3.20
10 + 0.5	2.20
15 + 0	2.35
15 + 0.2	2.85
15 + 0.3	2.45
15 +0.5	2.15

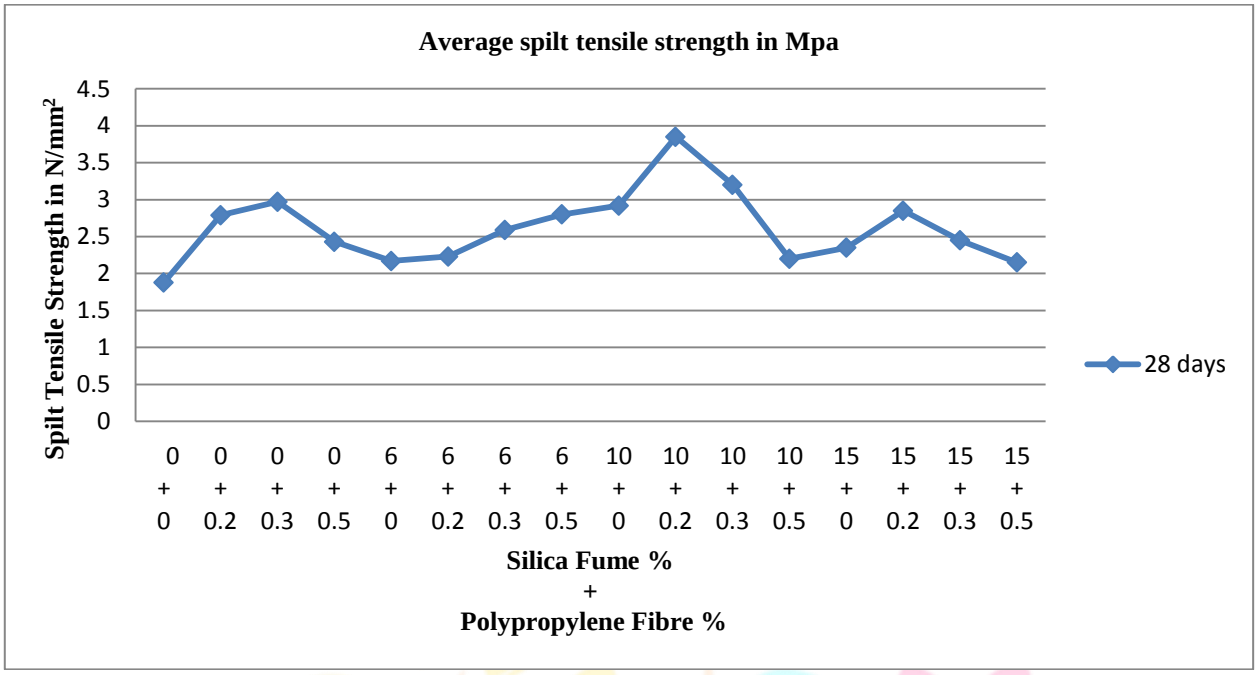

Fig. 3.2 Graphical Representation of Spilt Tensile Strength

Flexural Strength

The result of tensile strength were plotted in below Table 3.3 and shown in fig.3.3. Result indicate that if we replace silica fume by 0%, 6%, 10% & 15% and increase percentage of Polypropylene as 0%, 0.2%, 0.3%, 0.5% will give us a good results and help to increase flexural strength of concrete. Testing of all beam specimens with single point loading for flexural strength . The flexural strength of the specimens were calculated by the following equation :-

Flexural Strength $f = PL/bd^2$

Table 3.3 Average Flexural strength of various types of concrete

Mix Description (SF% + PP%)	Average Flexural strength (N/mm^2)
	28 Days
0 + 0	4.65
0 + 0.2	4.82
0 + 0.3	5.58
0 + 0.5	3.07
6 + 0	3.12
6 + 0.2	3.59
6 + 0.3	3.86
6 + 0.5	3.15
10 + 0	5.34
10 + 0.2	5.73
10 + 0.3	7.11
10 + 0.5	4.29
15 + 0	5.23
15 + 0.2	4.78
15 + 0.3	4.26
15 +0.5	3.08

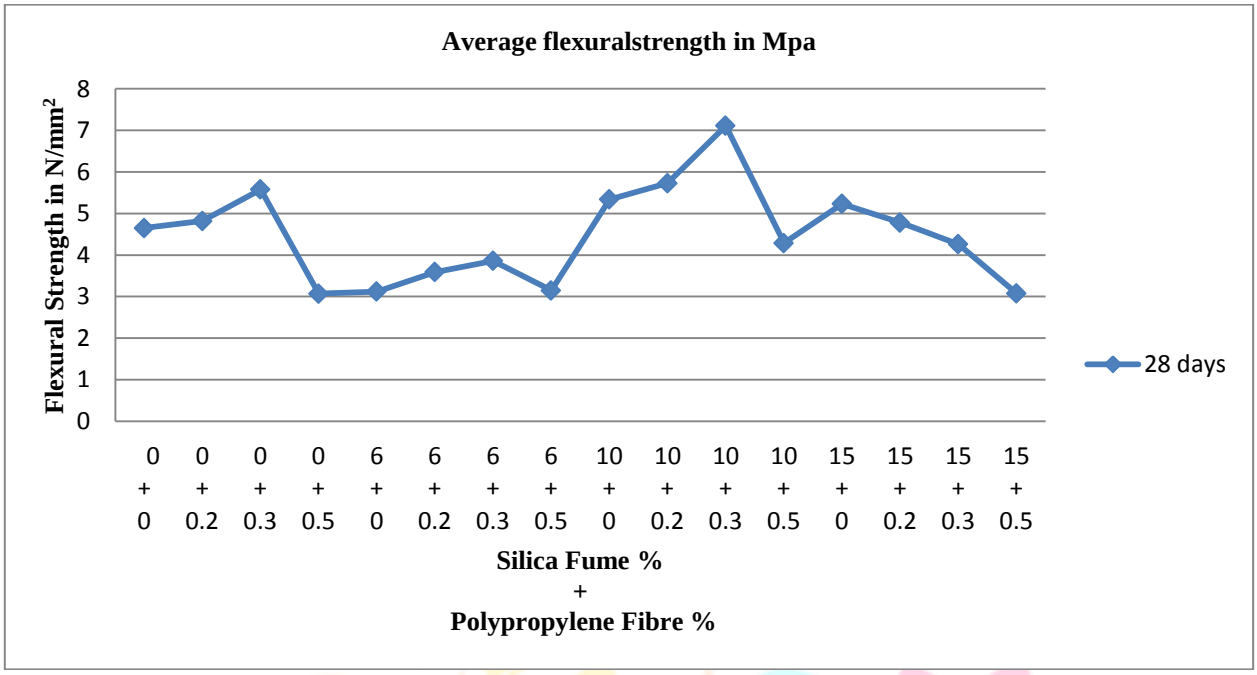

Fig. 3.3 Graphical Representation of Flexural Strength

IV. CONCLUSIONS

Based on the results and observations made in this experiment. The following conclusions are drawn:

- The silica fume and polypropylene generally improves tensile strength, flexural strength. The quantum of increase in the individual properties depends upon addition level.
- The gain in compressive strength is improved depending upon the addition of polypropylene.
- Plain concrete is a brittle material and fails suddenly. Addition of Silica fume & Polypropylene to concrete changes its brittle mode of failure into a more ductile one and improves the concrete ductility.
- Due to the use of silica fume as partially replacement to cement it gives more smooth surface than plain cement concrete.
- The compressive strength, tensile strength and flexural strength of concrete increases with Polypropylene & fly ash content. It is true up to 10% Silica fume and 0.3% Polypropylene combination if we add more than that strength starts reducing. Therefore it always preferable to use Silica fume and Polypropylene together with 10% + 0.3% combination of addition and it gives us better result.

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