Study of Compressive Strength of Concrete with Steel Fiber and Silica Fume

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Abstract— The present study involves the use of steel fiber in M-35 grade of concrete with mineral admixture (silica fume) which helps in increasing compressive strength. The effect of steel fiber on compressive strength by varying the percentage by weight of cement in additional form 1%, 2% and 3%. And then also mixed mineral admixture (silica fume) at constant rate 10% by weight of cement. The tests were performed according to Bureau of Indian standards (IS: 2770 (Part I). it was found that addition of steel fiber in concrete they give variation in strength.

Key words: Portland Pozzolana Cement (PPC), Silica Fume, Steel Fiber, Compressive Strength, Compressive Testing Machine

I. INTRODUCTION

In the world, concrete is most widely used construction material they are made in any form and shape. The strength and durability of concrete can be changed by making appropriate changes in its ingredient like cementation material, aggregate and water and by adding some special ingredient like silica fume and steel fiber. They are produced better strength in concrete. The presence of micro cracks in the mortar aggregate produce weakness in concrete they can be removed by inclusion of silica fume with steel fiber. They are composite material can be introduced into its resist crack growth.

The steel fiber is resisting the axial compressive force in the cube form so they produce better compressive strength in concrete. Silica fume is known to produce a high strength concrete and is used in two different ways as a cement replacement, in order to reduce the cement content (usually for economic reasons) and as an additive to improve concrete properties (in both fresh and hardened states).in general, the character and performance of fiber concrete changes with varying concrete formulation as well as the fiber material type.

The fiber can be imagined as an aggregate with an extreme deviation in shape from the rounded smooth aggregate. The fibers interlock and entangle around aggregate particles and considerably reduce the workability, while the mix becomes more cohesive and less prone to segregation. The fibers are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all direction. Fiber helps to improve the compressive strength.

A. Material Used

Material used in the study was cement (PPC), fine aggregate (river sand passing through 4.75 mm), coarse aggregate (crushed granite stone 60% passing through 20mm and 40% passing through 10mm), Silica Fume, Steel Fiber, and Water. The Table no. 1 and table no. 2 gives the physicals and chemicals properties of silica fume. A brief description of the material used in this research work is presented below.

1) Cement

For making concrete PPC grade cement (ACC) was used.

2) Fine Aggregates

The fine aggregates used in this investigation is Narmada River sand passing through 4.75 mm sieve with specific gravity of 2.62. The grading zone of fine aggregates is zone II as per Indian standard specification.

3) Coarse Aggregates

Machine crushed broken stone angular in shape was used as coarse aggregates. There are two fraction of coarse aggregates was used. The size of coarse aggregates 20mm with specific gravity of 2.82, and size of coarse aggregates 10mm of specific gravity 2.82.

4) Water

Ordinary clean portable water free from suspended particles and chemical substances is used for both mixing and curing of concrete.

5) Advantages of Using Silica Fume and Steel Fiber

- High early compressive strength, High tensile, flexural strength.
- Very low permeability to chloride and water intrusion.
- Enhanced durability and increased toughness.
- Increased abrasion resistance on decks, floors, overlays and marine structure.
- Superior resistance to chemical attack from chlorides, acids, nitrates and sulfates and life cycle
- Cost efficiencies.
- Higher bond strength, high electrical resistivity and low permeability.

S.NO.	Main Element	Percentage %
1	Particle size	**<1 µm**
2	Bulk Density	**610**
3	Moisture content	**0.85**
4	Specific Gravity	**2.22**
5	Fineness M2/kg	**17000-20000**

Table 1: Typical physical properties of silica fume

S. No.	Main Element	Percentage %
1	Silicon (% as SiO2	>85
2	Aluminum (% as Al2O3)	<1
3	Iron (% as Fe2O3)	<1
4	Calcium (% as CaO)	<1
5	Magnesium (% as MgO)	<1
6	Sodium (% as Na2O)	<1
7	Potassium (% as K2O)	<1
8	Chloride (% as Cl)	<0.3
9	Loss on ignition (%)	<3.19
10	Sulfate (% as SO4)	<0.3

Table 2: Typical Chemical properties of silica fume

II. TEST SPECIMEN DETAILS

Experiments were conducted on cubes. The cube specimen of dimensions 150mm x 150mm x150 mm are used. The ingredient used in concrete was PPC (ACC), Local River sand confirming to zone II (specific gravity 2.62) and clean portable water. Design mixes of M-35 were used to prepare the specimens. Cement was partially replaced by 10% of Silica Fume by weight and also added1%, 2% and 3% of Steel Fiber by weight of cement.

III. EXPERIMENTAL RESULTS AND DISCUSSION

For cube specimen total one set of cubes A (A1, A2, A3, A4) were tested for their compressive strength for different proportion of steel fiber and constant rate of silica fume such as A set for M35 (0%,1%,2%,3% of steel fiber with replaced 10% silica fume) respectively. It was observed that the specimen set A (A4) has maximum compressive strength in 28 days.

IV. RESULTS

The compressive strength values at 7 and 28 days of curing are shown in Table no.3 and Table no.4.There is an increase in compressive strength of sets A. All other concrete mixes containing silica fume and steel fiber show a variation in strength with the increase in steel fiber content.

Grade		M35	
Days		28days	
% of Steel fiber with Silica fume	Cube sets	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0%	A1	31.5	31.5
		31.1	
		32	
1%	A2	34.22	33.78
		33.8	
		33.33	
2%	A3	35.11	34.66
		34.22	
		34.66	
3%	A4	36.9	35.41
		35.11	
		34.22	

Table 3: Result of Compressive strength testing for 7 days with 10% of silica fume showing in Table no.3

Grade		M35	
Days		28days	
% of Steel fiber with Silica fume	Cube sets	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0%	A1	41.8	43.84
		43.5	
		46.22	
1%	A2	47.11	47.40
		48	
		47.11	
2%	A3	48	48.15
		50.22	
		46.22	
3%	A4	50.7	49.34
		48	
		49.33	

Table 4: Result of Compressive strength Testing for 28 days with 10% of silica fume showing in Table no.4-

V. DISCUSSION ON RESULTS

Table shows the results of comprehensive strength experimental investigation on the behavior of axially loaded specimen's i.e. compressive strength specimen strengthened with replacing10 percentage of silica fume and add to different percentage of steel fiber. Form the result for 7 days and 28 days, specimen sets A (A1, A2, A3, A4) are given the effective results compare to conventional method cube for compressive test. The all cube results in graph from in below.

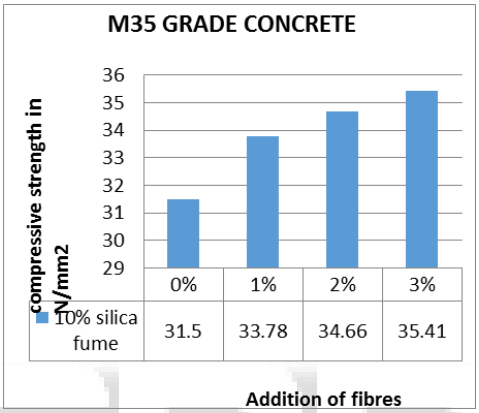

Fig. 1: Showing the variation of the compressive strength in M 35 grade concrete

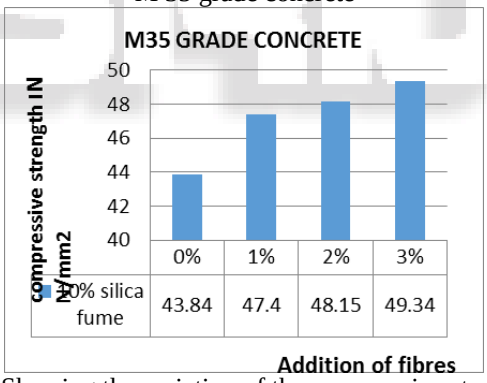

Fig. 2: Showing the variation of the compressive strength in M 35 grade concrte

VI. CONCLUSIONS

Form the series of test conducted on the concrete specimens with fixed percentage of silica fume and different percentage of steel fibers.

The following conclusion is drawn;

A. Compressive Strength Results for 7 Days

- Sets A2 increase the strength 7.23% compare to conventional concrete sets A1.
- Sets A3 increase the strength 10.03% compare to conventional concrete sets A1.
- Sets A4 increase the strength 12.41% compare to conventional concrete sets A1.

B. Compressive Strength Results for 28 Days

- Sets A2 increase the strength 8.12% compare to conventional concrete sets A1.
- Sets A3 increase the strength 9.83% compare to conventional concrete sets A1.
- Sets A4 increase the strength 12.54% compare to conventional concrete sets A1.

From the study it can be concluded that the specimen can be used with silica fume and steel fiber to increase their strength to a great extent. The 10% silica fume specimens to increase the results with different percentages of steel fibers. This material may be used in RCC compression members and pre-stress concrete. Fiber reinforced composite material are becoming more frequently used in civil engineering construction.

C. The Major Effects Due to Silica Fume Additions

- Improve strength of concrete at all ages at optimum cement replacement levels. The strength development of concretes with silica fumes differently depending on the content of silica fume and on the curing condition, as well as binder characteristics.
- Reduction heat of hydration, and also reduced water permeability of concrete.
- Improved sulphate resistance of concrete.

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