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Use of Silica Fume by Replacing Cement Partially

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Abstract : *The main objective of this paper to give a vast information related silica fume and how it effects the properties of concrete by using it indifferent percentages such as 5% 7.5 % 10% 15% 20% 30% and how it reduces the cost of construction. After the 7 14 and 28 days of testing is done by replacing the cement with 5% 7.5 % 10% 15% 20% 30% of silica fume the compressive strength starts to increase up to the replacement of 20 % then it starts to decrease after increase in percentage. The strength of cube at 30% replacement of silica fume is less as compared to 15 and 20%. Therefore we conclude that excess replacement of cement by silica fume decrease the strength of concrete. Hence we found that the maximum strength has occurred at 20%. Also the partial replacement of cement by silica fume increases the durability against the acid attack at certain percentage this is due to the presence of silica in silica fume which reacts with calcium hydroxide and thus reduces the acid attack .*

Keywords – *Compressive strength, Calcium Hydroxide, Concrete, durability, Silica Fume.*

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I. Introduction

Concrete is a construction material which is widely used for different types of structures due to its stability and strength and is made by mixture of coarse aggregate. It forms like a mass of stone on hardening. It is versatile and strong construction material. The initial hardening reaction occurs within a few hours. For full hardness and strength concrete takes few weeks and can continuously gain strength over many years. It is also used to create hard surfaces which contribute to surface runoff that may cause soil erosion flooding and water pollution. Thus concrete is one of the most powerful tool for proper flood control by making dams diversions and deflection of flood waters mud flows. At low stress levels the elasticity of concrete is relatively constant but starts decreasing at higher stress levels as matrix cracking develop. Silica fume ids a by-product of silicon metal or Ferro silicon alloys. Due of its physical and chemical properties it is very reactive. It is widely used in concrete. Concrete which contains silica fume can have very high strength and durability as compared to normal concrete. Silica fume is very effective pozzolanic material due to its extreme fineness and high silica content. Addition of silica fume also reduces the permeability of concrete to chloride ions which protects the reinforcement from corrosion.

II. Literature Review

The properties of silica fume both in case of fresh and hardened silica fume concrete are significantly affected as compared to normal concrete. Studies and experiments have indicated that silica fumes presence make concrete more cohesive and less prone to segregation performance of water demand, setting of time plastic shrinkage varies respectively from concretes without silica fume. There have been very mechanical enhancements of concrete in case of compressive strength tensile strength, elastic modulus as well as fracture toughness.

Mathew *et al.* (2012) studied that effect of silica fume when added to concrete. The optimum silica fume replacement percentage for obtaining maximum 28 days strength of concrete ranged from 10 to 20 %. Cement replacement up to 10 % with silica fume leads to increase in compressive strength, for m30 grade of concrete.

Srivastava *et al.* (2014) concluded the following points from the research carried out on use of silica fume; (1) the addition of silica fume reduces workability. However, in some cases it improves the workability, (2) Silica fume inclusion increases the compressive strength of concrete significantly (6-57%). The increase depends upon the replacement level. (3) The addition of silica fume improves the bond strength of concrete.

Mittal *et al.* (2015) studied the change in the properties of concrete as follows when different silica fume percentage was used. It has been found that micro silica increases the workability of the fresh concrete up

to a certain limit of micro silica (upto20%) as cement replacement. Compressive strength was also increased on addition of micro silica.

Lone *et al*. (2019) studied the effect of silica fume on the strength parameters of concrete when used in self compacting concrete. It was concluded that all the strength parameters presented a positive result when used upto 30% and after that the results showed the decrease in strength parameters.

III. Methodology And Results

Various tests were carried out to execute this project. Among the tests the results of the slump test, compressive strength tests are discussed in this section.

Slump Test: Slump test is the most commonly used method of measuring consistency/ workability of concrete which can be employed either in laboratory or at site if work. Three samples of concrete were considered for this test and the results obtained are presented in the Table below.

SLUMP TEST RESULTS

Sample	Water Cement Ratio	Slump Value(mm)
1	0.38	83
2	0.40	91
3	0.42	105

The results clearly indicated that the slump values were in between 80-110.

Compressive Strength Test: The test was carried out conforming to IS 516-1959 to obtain compressive strength of concrete at the age of 7, 14 and 28 days. The cubes were tested by using Compressive Testing Machine (CTM) of capacity 2000KN. Three cubes with identification mark such as OA were tested each under different loading and their compressive strength was checked separately for each cube. In each testing done for different percentage of silica fume usage three different cubes were taken separately. The compressive strength is up to 27.65 N/mm2 and 31.3 N/mm2 at 7, 14 and 28 days during the replacement by 20%. The maximum compressive strength is observed at 20% replacement of silica fume. There is a significant improvement in the compressive strength of concrete because of the high pozzolanic nature of the silica fume and its void filling ability. For each compressive strength test designating 7, 14, 28 day strength with replacement of 5%, 10, 15%, 20%, and 30%, the results of compressive strength are shown below:

Compressive Strength of concrete cubes after 7, 14 and 28 days

Identification Mark	C. strength of cube (N/mm^2) After 7 days	Silica fume	Average Comp. strength (N/mm^2)	C. strength of cube (N/mm^2) After 14 days	Average Comp. strength (N/mm^2)	C. strength of cube (N/mm^2) After 28 days	Average Comp. strength (N/mm^2)
0A	17.47	Standard	17.15	20.97	20.48	25.04	24.79
0A	16.46	-		20.1		24.44	
0A	17.52	-		17.52		24.89	
5A	20.90	5%	20.86	22.50	22.48	25.97	25.92
5A	20.86	-		22.47		25.87	
5A	20.82	-		22.45		25.93	
10A	25.30	10%	25.24	26.82	26.81	28.94	28.95
10A	25.24	-		26.80		28.86	
10A	25.19	-		26.79		28.81	
15A	26.71	15%	26.69	27.65	26.64	30.35	30.32
15A	26.66	-		27.60		30.32	
15A	26.70	-		27.67		30.30	
20A	27.85	20%	27.65	28.85	28.53	32.04	31.3
20A	27.80	-		28.75		31.04	
20A	27.68	-		28.68		30.62	
30A	12.80	30%	12.84	16.66	16.56	22.34	21.51
30A	12.81	-		16.56		21.95	
30A	12.92	-		16.46		20.25	

IV. Conclusion

On the basis of the investigation, the following conclusions have been made**:-**

- With the increase of silica fume percentage the compressive strength of concrete decreases.
- The maximum compressive strength is observed at 20% replacement of cement by silica fume.
- The compressive strength is up to 27.65 N/mm2 and 31.3 N/mm2 at 7, 14 and 28 days during the replacement by 20% respectively.
- Replacement of cement by silica fume is found to have increased the durability against acid attack at certain percentage.

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