Strengthening of Silica Fume of Workability and Compressive Strength of Concrete

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Abstract*—Now-a-days, there is a great need to reduce the cost of the building materials and hence,the cost of construction so that the "dream of a shelter"to every citizen of our country could be achieved at an affordable cost.The cost for the construction of buildings could be reduced considerably by utilizing industrial by-products wherever possible in the buildings. . This project presents the results of an experimental investigation carried out to find the suitability of addition of silica fume in M_{20} grade concrete. Two grades of Portland pozzolana Cement (PPC) were used in the M_{20} grade concrete, namely PPC. Silica fume, which is non-metallic and non-hazardous waste material obtained during the production of elemental silicon or alloys containing silicon in electric arc furnace, is used in this project. The main parameter investigated in this study is the addition of silica fume in varying dosages of 0%, 2.5%, 5%, 7.5%, 10%, 12.5% in M_{20} grade concrete with a water-cement ratio of 0.5. Concrete cube specimens were cast for M_{20} grade concrete using various dosages of silica fumeas indicated above and tested at the age of 7, 14 and 28 days. The investigation revealed that the addition of silica fume develop the compressive strength, sufficient for construction purposes. The results for concrete indicated that Workability decreased significantly as silica fume percentage increases compared with the normal concrete without addition of silica fume.

***Index Terms*—silica fume, pozzolan, compressive strength**

I. INTRODUCTION

Portland Pozzolana Cement structures has Concrete (PPC) no due alternative is to is one it's a of widely structural the in main the used stability ingredients civil construction construction and used strength. Material for the industry. The production for Ordinary various Unfortunately, of concrete types Portland of and production of cement involves emission of large amounts of carbon- dioxide gas into the atmosphere, a major contributor for green house effect and the global warming, hence it is inevitable either to search for another material or partly addition it by some other material.

1.2 Silica Fume

Silica Fume is most commonly used supplementary materials used in the development of High Performance Concrete. Addition of silica fume to concrete has many advantages like high strength, durability and reduction in addition cement production. The optimum silica fumes replacement percentage for obtaining maximum 28 – day's strength of concrete ranged from 10 to 20 %.Silica fume (SF) is a byproduct of the smelting process in the silicon and ferrosilicon industry. It is also known as micro silica, condensed silica fume, volatilized silica or silica dust. Silica fume color is either premium white or grey. Because of its extreme fineness and high silica content, silica fume is a highly effective pozzolanic material. Silica fume is used in concrete to improve its properties. Silica fume is a by-product of producing silicon metal or ferrosilicon alloys in smelters using electric arc furnaces importance to the concrete industry

This research aim to:

- To study the strengthening of silica fume on workability and compressive strength of concrete

II. MATERIALS AND METHOD

2.1 Cement

Portland Pozzolana cement of confirming to IS: 1489- 1991 was used for the present experimental investigation. To produce high performance concrete, the utilization of high strength cements is necessary. It is also important to ensure compatibility of the chemical and mineral admixtures with cement

Table 1 Chemical Properties of PPC

s.no	Characteristics	Required value
1	Total loss on ignition (% by mass)	Not more than 5.0
2	Magnesia (% by mass)	Not more than 6.0
3	Insoluble residue (% by mass)	Not more than x + 4(1000 – x)/ 100
4	Sulphuric anhydride %	Not more than 3.5%
5	Total chloride content %	Not more than 0.10%

2.1 Fine aggregate

M-Sand is the only alternative to River Sand used for Concrete Strength compared it causes less damage to the environment as compared to river sand. Better quality control since manufactured in a controlled Environment River sand is not available so we're using M-Sand. Locally available sand passing through 4.34 mm sieve with specific gravity of 2.80, which falls under grading zone1 were used for the entire investigation

2.2 Coarse Aggregate

Coarse aggregates consist of aggregates larger than fine aggregates and their sizes vary from 2.0 to 4.75mm. These tend to improve quality and bond characteristics and generally results in a higher flexural strength of concrete. It alsohelps in reducing shrinkage. These aggregates occupy 70-80% of volume of the concrete. It is having specific gravity of 2.92 and it is subjected to the sieve analysis the maximum size of large is 150mm

S.NO	DESCRIPTION	RIVER SAND
1	Specific gravity	2.62
2	Fineness modulus	4.79
3	Effective size	0.36
4	Uniformity co- efficeient	1.92
5	Void ratio	0.376
6	Moisture content %	25
7	Bulking effect	47%

Table 2 Properties of fine Aggregates

S.NO	DESCRIPTION	COARSE SAND
1	Specific gravity	2.92
2	Fineness modulus	3.46
3	Effective size	2.67
4	Uniformity co- efficeient	1.92
5	Void ratio	0.953
6	Impact value	18.5
7	Percentage of wear	14.1
8	Crushing value	21.75%

Table 3 Properties of Coarse Aggregates

2.3 Silica fume

Silica fume, also referred to as micro silica or condensed silica fume,is another material that is used as an artificial pozzolanic admixture. Silica fume (SF) is a byproduct of the smelting process in the silicon and ferrosilicon industry. The reduction of high-purity quartz to silicon at temperatures up to 2,000º C produces SiO2 vapours, which oxidizes and condense in the low temperature zone to tiny particles consisting of non-crystalline silica. Byproducts of the production of silicon metal and the ferrosilicon alloys having silicon contents of 75% or more contain 85-95% non-crystalline silica.

The by-product of the production of ferrosilicon alloy having 50% silicon has much lower silica content and is less pozzolanic. It can be used in proportions of 0%, 2.5%, 5% ,0.75%,10% and12.5% of the cement content Silicafume specific gravity -2.2

Figure 1 (a) Silica fume

2.4Methodology

- Collection of materials
- Testing of materials to study their properties.
- Mix design to obtain a mix of required strength.

- Estimating the number of specimens to be cast perform the experiments
- Casting specimen – cubes
- Testing of specimens – 7^{th} ,14^{th} and 28^{th} days tests to be performed.
- Representing the results obtained by plotting suitable graphs.

2.5 Mix design

Step by step detailed procedure for concrete Mix design of M_{20} grade as perIS-10262:2009 and IS456:2000

- Step:1 Calculate the target mean compressive strength at 28 days
- Target mean compressive strength=Characteristic strength + 1.65 x StandardDeviation =26.60 N/mm²
- Step:2 Selection of maximum water cement ratio
- The maximum water- cement ratio should be selected as per table 5 of IS-456:2000Maximum atadopted water – cement ratio=0.5
- Step:3 Estimation of entrapped air for the maximum size of aggregate used the air content is estimated.er – cement ratio=0.55
- Step:4 Selection of water Content and Fine to total aggregate ratio
  Maximum water content for 20 mm aggregate and a slump value of 25 to50mm =186 But in our problem the value of slump is 75mm so we need alter the water content Estimated water content =186 + (3/100) x 186 =191.58 litres
- Step:5 Calculation of cement content the cement content per unit volume of concrete is computed sing Table 5 of IS:456: 2000 300kg/m Maximum cement content = 450kg/m³
- Step:6 Cement, Fine and coarse aggregates needed for M_{20} Grade Concrete

s.no	Materials	Quality
1	Cement	383.16 kg
2	Fine Aggregate	869 kg
3	Coarse Aggregate	1066 kg
4	Water	191.58 lit

Therefore, mix design Ratio of M20 Grade Concrete by Weight isCement: FA: CA=1:2.26:2.78

2.6 Workability Tests

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of wort.

Figure 2 Slump Cone Test

2.7 Compressive Strength Test

The main aim is to determine the compressive strength of concrete specimen. the test specimens, cubical in shape, are of size 150x150x150mm compression tests are made at recognized (28 days) ages of the test specimens. specimens cured in water are tested immediately on removal from water and while they are still in wet condition. The bearing surfaces of the testing machine are wiped clean and the cubes are placed in the compression testing machine in such a manner that the load is applied to opposite sides of the cubes as cast.

Figure.3 Compressive Strength test

Figure.4 Test concrete sample

III. RESULT AND DISCUSSIONS

This chapter explain the tests carried on concrete and Materials using in concrete. The analysis of test results studied in detailed. In the cubes will be casted with the study on mechanical behavior of addition of cement by silica fume for finding the optimum strength. The load will be applied till collapse for crack patterns and propagations. Mathematical modeling will be carried out for better understanding.

MATERIALS TESTING RESULTS

S.N	DESCRIPTION	Trail-1	Trail-2
1	Wt of Density bottle (W1), kg	0.025	0.0250
2	Wt of Density bottle + Fine aggregate(W2),kg	0.0760	0.0790
3	Wt of Density bottle +Water + Fine aggregate(W3),kg	0.1115	0.1124
4	Wt of Density bottle +Water (W4),kg	0.0750	0.0770
5	Specific gravity	3.5	2.90

Result: Specific gravity of Cement = 3.2

- SPECIFIC GRAVITY OF CEMENT FOR GRADE PPC53

Result: Specific gravity of Cement = 3.08

- SPECIFIC GRAVITY OF FINEAGGREGATE (FOR M-SAND)

Result: Specific gravity of Fine aggregate (M-Sand) = 2.80

- FINESS MODULUS OF FINE AGGREGATES

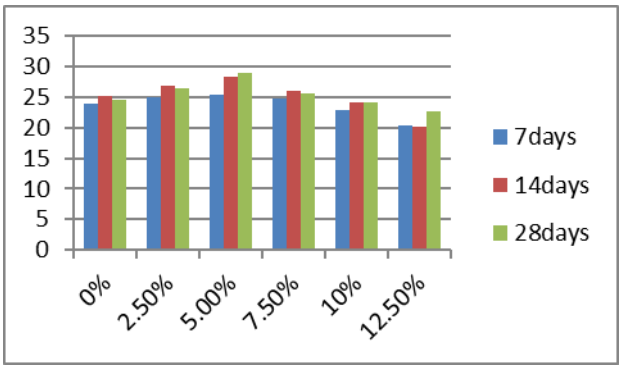
Result: Fineness modulus of Fine aggregate = 3.8076

- SPECIFIC GRAVITY OF COARSE AGGREGATE

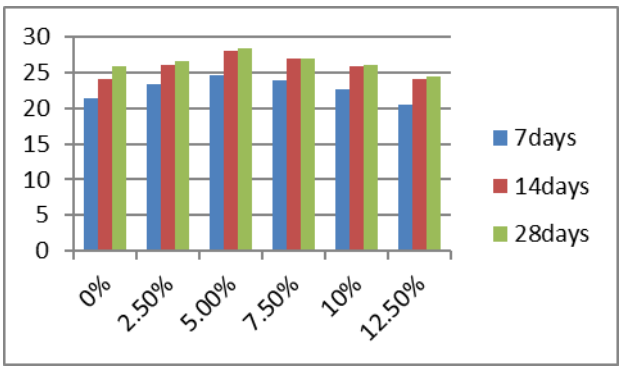
Result: Specific gravity of coarse aggregate (M-Sand) = 2.81

- FINESSMODULUSOFCOARSEAGGREGTES (20mm Size)

Result: Fineness modulus of coarse aggregate = 3.022



Graph 6.4.1 Test Results on Compressive Strength of Concrete PPC 43



Graph 6.4.1 Test Results on Compressive Strength of Concrete PPC 53

CONCULUSION

Now-a-days, there is a great need to reduce the cost of the building materials so that the *"dream of a shelter"* to every citizen of our country could be achieved atan affordable cost. The cost of construction of buildings could be reduced considerably by utilizing industrial by-products wherever possible in the buildings. This project presents the results of an experimental investigation carried out to find the suitability of addition of silica fume in M_{20} grade concrete. Two grades of Portland Pozzolana Cement (PPC) were used in the M_{20} grade concrete, namely 43 and 53 Grade OPC. Silica fume, which is non-metallicand non-hazardous waste material obtained during the production of elemental silicon or alloys containing silicon in electric arc furnace, is used in this project. The main parameter investigated in this study is the addition of silica fume in varying dosages of 0%, 2.5%, 5%, 7.5%, 10%, 12.5% in M_{20} grade concrete with a water-cement ratio of 0.5. Concrete cube specimens(150 x 150 x 150 mm)were cast for M20 grade concrete using various dosages of silica fume as indicated above and tested at the age of 7, 14 and 28 days. The

investigation revealed that the addition of silica fume develop the compressive strength, sufficient for construction purposes. The results for concrete indicated that Workability decreased significantly as silica fume percentage increases compared with the normal concrete without addition of silica fume.It was found that the addition of silica fume improves the compressive strength of concrete up to 5% addition. Beyond that level, the addition of silica fume do not show considerable improvement. Hence, silica fume can be added up to 5% to improve the strength properties of concrete.

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