International Journal of Scientific Research & Engineering Trends
Volume 5, Issue 4, July-Aug-2019, ISSN (Online): 2395-566X

Experimental Investigation on Properties of Concrete Using Silica Fume and Met kaolin as Partial Replacement of Cement

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***Abstract*- This experimental investigation is carried out to study the different strength characteristics of concrete with partial replacement of cement with Silica Fume and Metabolic. In this investigation cement of M25 grade of concrete is replaced with Silica Fume and Metakolin in different percentage as 5%, 10% and 15%. Experimental analysis of addition of Silica Fume and Metakolin in concrete has been done. Strength of concrete was determined by performing compression test (150mm x 150mm x 150mm) size cube, split tensile test (150mm diameter and 300mm length cylinders) and flexural strength (100mm x 100mmx 500mm) size beam.**

Keywords-Silica fume, Met kaolin, Partial Replacement, Compressive strength, Tensile strength, Flexural strength.

I. INTRODUCTION

Concrete is one of the most extensively used construction materials in the world, with two billion tons placed worldwide each year. Concrete can generally be produced of locally available materials, can be cast into a wide variety of structural configurations and requires minimum maintenance during service. In its production and use, no poisonous substances are emitted. The found in abundant all over the world. The only ecological disadvantage of concrete is the emission of carbon-di-oxide (Co2) gas during production of cement clinker, have brought about pressure to reduce the cement consumption through the use of supplementary materials.

Supplementary cementitious materials (SCM's) are finely ground solid materials that are used to replace part of cement in concrete mixtures, these materials react chemically with hydrating to form a modified paste microstructure. In addition to their positive environmental impact, SCM's may possess pozzolanic or latent hydraulic reactivity or a combination of these. The term Pozzolan refers to siliceous materials which in finely divided form and in the presence of water will react chemically with calcium hydroxide (CH) to form cementitious compounds.

II. METHODOLOGY

This study is research laboratory oriented.

1. The materials are collected from a specific location and properties are studied.
2. Using these properties, mix design of M25 grade concrete is carried out with suitable w/c ratio.
3. To study the compressive strength, split tensile strength and flexural strength of concrete cubes, cylinders and beams were casted and tested in laboratory.
4. Concrete cubes 150 x 150 x 150 mm were casted and tested at 7, 14, and 28 days confirming IS: 516 – 1959 and compressive strength is reported. Concrete cylinders having diameter 150 mm and height 300 mm were casted and tested at 28 days as per IS: 5816-1999 and split tensile strength is reported. Concrete beams of size 100 x 100 x 500 mm were casted and tested for 28 days as per IS: 516 - 1959 and flexural strength is reported.
5. Conclusions are drawn based on test results.

III. MATERIAL USED

1. Cement

Ordinary port land cement of birla super brand of 53 grade confirming to IS: 12269-1987 was used in present study.

2. Fine Aggregate

The sand used for this experimental work was locally procured and passing through 4.75mm sieve with specific gravity 2.80.

3. Coarse Aggregate

Crushed aggregate of maximum size 20mm & minimum 10mm are used in the present study. Its specific gravity is 2.85.

4. Water

In this experimental work for mixing theconcrete and for curing the concrete specimen ordinary potable tap water available at laboratory was used.

5. Slica Fume

Silica Fume used was confirming to ASTM C (1240-2000) and was supplied by Nakoda Enterprises, Indore. Silica Fume is used as partial replacement of cement.

6. Metakaolin

Metakaolin is another pozzolanic material which is manufactured from selected kaolins, after refinement and calcination under specific conditions. Metakaolin used 25 kg bag which is manufactured by Specialty Minerals LTD, Baroda.

IV.TEST CONDUCTED

Universal Testing Machine (UTM) was used to carry test on concrete mix. Tests were carried out for finding the compressive and flexural strength. A standard test procedure is followed for each test and performance of concrete mix is studied.

1. Compressive Strength Test

For compressive strength test, cube specimens of dimensions 150 mm x 150 mm x150 mm were cast for M25 grade of concrete. The compressive strength test was carried out conforming to IS 516-1959 to obtain compressive strength for M25 grade of concretes.

2. Flexural Strength Test

Flexural strength test was conducted on beam specimens under two point loading as per I.S.516-1959, over an effective span of 600 mm divide into three equal parts. The average ultimate flexural tensile stress was determined from the failure flexural loads

3. Split Tensile Strength Test

This test is conducted in a 200 tones capacity of the compression-testing machine by placing the cylindrical specimen of the concrete, so that its axis is horizontal between the plates of the testing machine.

V. RESULTS AND DISCUSSIONS

1. Compressive Strength Test

Compressive strength test usually gives an overall picture ofthe quality of concrete because strength is directly related tothe structure of the hydrated cement paste. Compressive strength tests were performed on the cube specimens at the ages of 7, 14 and 28days.

2. Effect of Partial Replacement Silica Fume And Metakaolin With Steel Fibers At 7 Days On Compressive Strength

The cube compressive strength was observed as 19.2 N/mm^2 for 10% SF and 10 % Met kaolin and there is an increase of strength by 18.15 % when compared to control specimen.

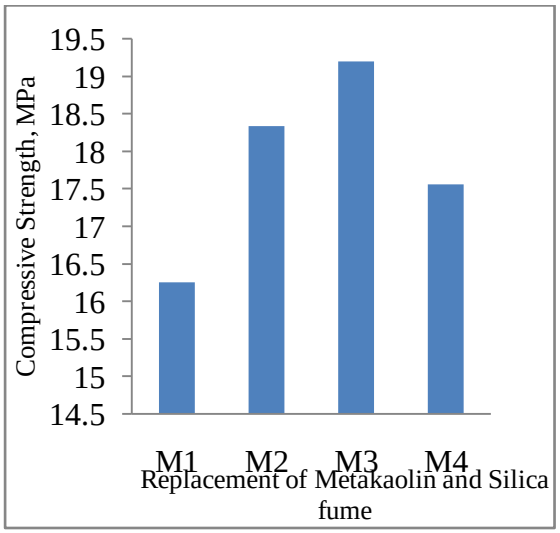

Fig. 9Compressive Strength of M25 grade concrete at 7 days curing.

3. Effect of Silica Fume and Metakaolin at 14 Days On Compressive Strength

The cube compressive strength was observed as 24.46 N/mm^2 for 10% SF, 10 % Met kaolin there is an increase of strength by 8.18 % when compared to control specimen.

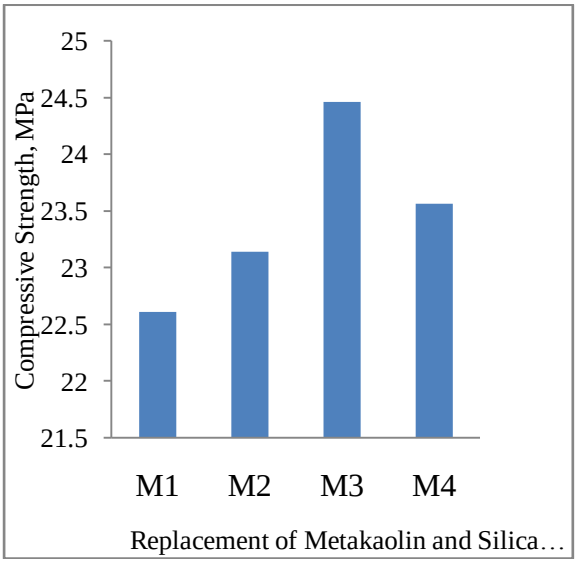

Fig. 10 Compressive Strength of M25 grade concrete at 14 days curing.

4. Effect of Silica Fume and Metakaolin With Steel Fibers At 28 Days On Compressive Strength

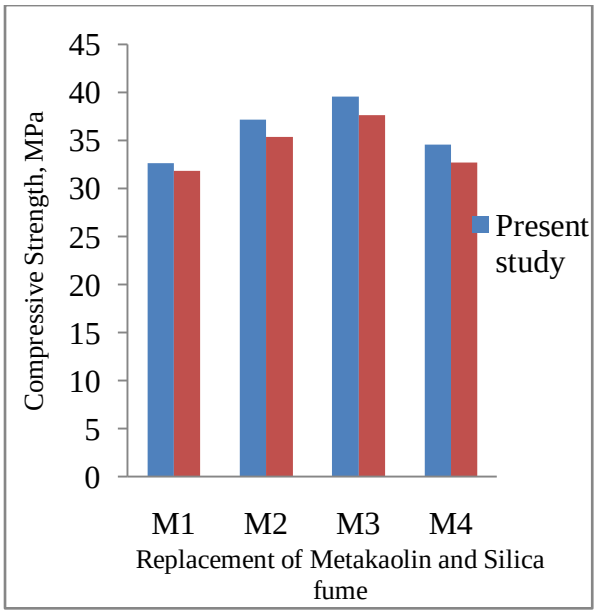

Fig. 11Compressive Strength of M25 grade concrete at 28 days curing

The maximum values of compressive strength at 10% SF and 10 % Metakaolinare 39.52 N/mm^2. Also shows the validation of our results of compressive strength of concrete mix at 28 days. It shows slightly higher value than the results obtained by satyendra et al (2015).

4. Flexural Strength Test Result

The Flexural strength decreases as shown in Table 4.2. The Percentage increase in the Flexural strength of M25 grade of concrete with 10% of Silica Fume and 10% of Metakaolin is 3.16 %. The variation of Flexural Strength of M25 Grade of concrete for control mix as shown in Fig. 12.

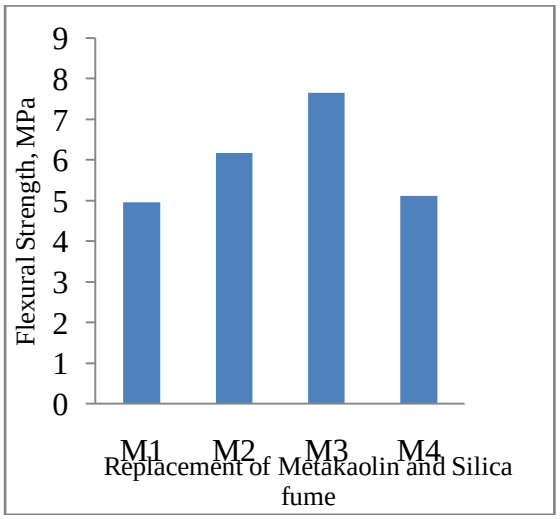

Fig.12 Flexural Strength of M25 grade at 28 days curing

5. Split Tensile Strength Test Result

The Concrete with 10 % of Silica Fume and 10% of Metakaolin possesses higher Split Tensile Strength i.e. 8.97 MPa when compared to all other proportions and with further increase in the content of Metakaolin, The split tensile strength decreases.

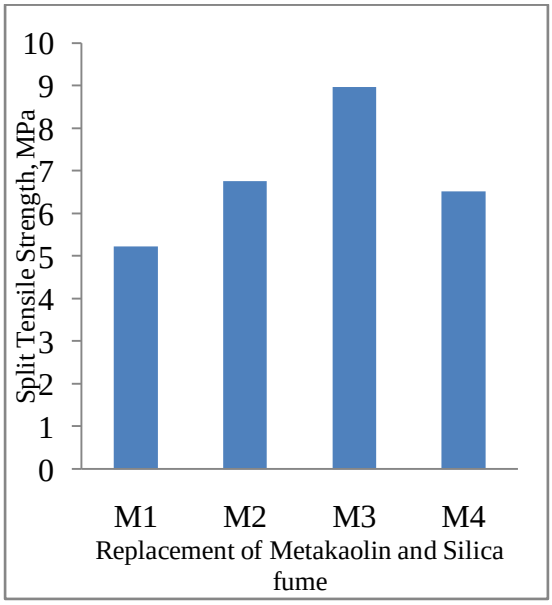

Fig.13 Split Tensile Strength of M25 grade at 28 days curing.

6. Cost Analysis

Material estimation includes costs for water, cement, natural sand, silica fume, metakolin and coarse aggregate for a particular design mix. According to the mix design calculation we achieved the weight of water, cement, natural sand, silica fume, metakolin and coarse aggregate

for concrete. As the water is largely available in India, its costs can therefore be neglected. Current study shows that replacement of cement using silica fume and metakolin can be made as much as 10 %. Analysis of the cost of concrete with and without silica fume and metakaolin for M25 grade is shown in fig. 14.

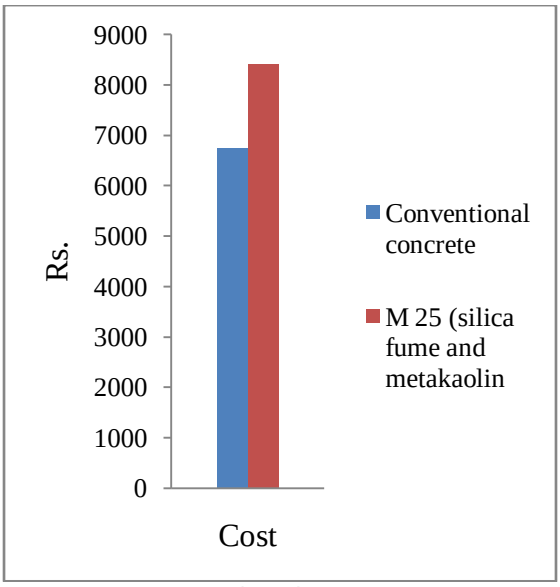

Fig. 14: Cost Comparison

VI. CONCLUSION

The purpose of introducing Silica fume and Metakaolin by partial replacing cement is to increase strength and performance of the concrete. And also strength and durability properties of concrete can be enhanced by introducing the steel fibres. The following conclusions could be drawn from the present investigation.

1. Addition of admixtures to the concrete increases the strength of high performance concrete.
2. The compressive strength of high performed concrete at 7 days, 14 days and 28 days of curing with 5%, 10% and 15% of Silica fume and Metakaolin has been increased by 18.15 %, 8.18 % and 24.08 % and it is 19.2, 24.46 and 39.52 N/mm^2.
3. From the obtained results, 10% of silica fume and 10 % of metakaolin can be taken as the optimum dosage, which can be used for giving maximum possible strength at the age of 28 days.
4. The percentage increase in flexural strength at 28 days of 10% of silica fume and 10 % of metakaolinis 3.16%.
5. From the experimental results, the optimum percentage recommended as 10% of silica fume and 10% of metakaolin for achieving maximum benefits in flexural strength.
6. From the test of split tensile strength of M25 grade of control concrete is 5.23 MPa. The split tensile strength of concrete increases with all the proportions of Metakaolin (5%, 10% & 15%) and Silica Fume (5%, 10% & 15%). The concrete with 10 % of Silica Fume and 10% of Metakaolin possesses higher Split Tensile Strength i.e. 8.97 MPa.When compared to all other proportions and with further increase in the content of Metakaolin. The split tensile strength decreases.

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