Experimental Study of Concrete using Silica Fume

Akshatha K. B[1]

[1]Research Scholar @ Kurunji Venkataramana Gowda College of Engineering, Department of Civil Engineering, Sullia, Dakshina Kannada, Karnataka, India

---

Abstract - *Increase in the consumption of materials required in the production of concrete has lead to depletion of materials. Silica fume can be mixed with concrete to improve the strength and durability of the concrete. In this present investigation an attempt has been made to determine the effect of SF and steel bars on M-45 grade concrete. The experimental investigation involved addition of silica fume is varied as 5%, 7.5%, 10% and 12.5% by weight of the cement. The steel fibres of aspect ratio 35 are also added to improve the tensile strength of the concrete. The addition of steel fibre is varied as 0.5%, 0.75% and 1% by volume fraction. The characteristics of the fresh concrete are carried out to find the workability of the concrete. The hardened properties of the concrete such as compressive strength, flexural strength, tensile strength and modulus of elasticity were carried out to determine the effect of silica fume and steel fibre. The addition of 7.5% SF and 0.75% hooked end steel fibre was found to be optimum.*

***Key Words*: Hooked End Steel fibre, Compressive Strength, Tensile Strength, Flexural Strength, Modulus of elasticity.**

1. INTRODUCTION

The concrete is a cement based material, which has become most popular and widely used in construction field such as Highways, flyovers, building, dams etc., It is composite material made up of cement, crushed stone, sand, water and admixtures. The nature of the concrete is very good in compression but weak in tension and also it is characterized by brittle in nature. There are different types of binders which are used in preparation of concrete. In most of the construction work Portland cement used as a binder. Now-a-days the consumption of concrete increased exponentially and structure without concrete cannot be imagined. Usually normal concrete has some drawbacks like, weak in bond, low tensile strength, and limited ductility and allow strain at cracks (Manoj Kumar et al, 2015). Durability of concrete mainly depends upon the climatic condition, which may likely to damage the concrete structures. To enhance the life against such problems, it is necessary to improve the mechanical properties of the concrete. To achieve this, engineers are looking for new generation of concrete.

2. MATERIALS AND METHODOLOGY

2.1 Cement

It is very fine powder with adhesive properties and acts as binder material in the concrete matrix. Ordinary Portland cement of 43 grade cement was used in this study. The basic tests were carried out in accordance with relevant IS codes.

2.2 Silica Fume

Silica fume is also called as micro silica and it is used as pozzolonic admixture or mineral admixture in concrete. In the present investigation, the silica fume used was procured from "CORNISHE Silica fume" from Manjeshwar techno traders, Yeyyadi, Mangalore Karnataka, India.

2.2 Aggregates

Aggregates are the secondary component to the concrete. Aggregate below 20mm down size are used for concrete mix. Well graded aggregates which minimize the voids in concrete and hence it requires minimum cement paste to fill the voids. There are two types of aggregates mainly depending upon their size i.e. fine aggregate and coarse aggregates which has been used in our study.

2.3 Super Plasticizer

It is a chemical admixture other than the water, aggregate or cement which is added to the concrete along with water during mixing. The chemical admixture will affect the setting and Harding characteristic for cement paste. "Conplast SP430" super plasticizer was used for this project which is supplied by FOSROC.

2.4 Methodology

The mix design for the M45 grade of concrete was carried out based on the guidelines given in IS 10262-2009 and IS 456-2000. The target slump was selected as 100 and water cement ratio of 0.4 was kept constant. After many trials, based on strength and workability, the final mix proportion for control mix of 1:1.68:2.79: 0.4 with cement content 410kg/m^3 was selected. To study the effect of silica fume in the concrete mix, various mixes were proposed with varied proportions of silica fume and an experiment was conducted for about 56 days.

3. RESULT AND DISCUSSION

3.1 Slump Test

The effect of silica fume addition to the concrete as cement replacement on workability characteristic is shown in Fig 4.1graphically. As the percentage of silica fume increases from 0% to 12.5% the slump decreases from 100 to 72mm. The reduction in slump is attributed to the particles size, surface area and size of silica fume particle which is very much lesser than cement particles and it requires more water than cement alone for a given slump. Figure 1 shows the slump test performed for the fresh concrete.

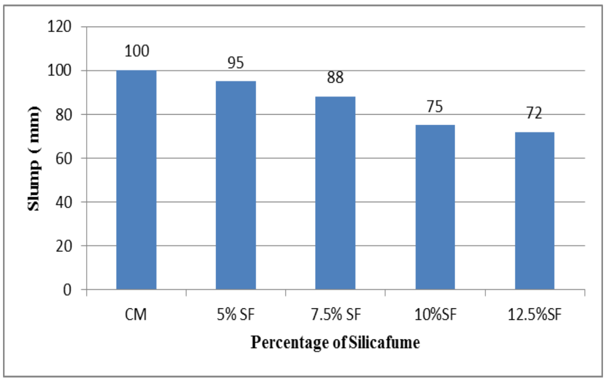

Figure 1: Slump Result of Silica Fume Variation

3.2 Density

The density test is conducted to know the compactness of the concrete. It is mainly depends upon the compaction of the concrete. From the Figure 2 it is observed that the density obtained for control mix is 25.46 kN/m^3. The addition of silica fume is tends to reduce the density of the concrete. The density obtained for 5% silica fume i.e., 25.36 kN/m^3, 7.5% addition of silica fume i.e., 25.33 kN/m^3, 10% silica fume i.e., 25.32 kN/m^3 and 12.5% replacement of silica fume i.e., 25.10 kN/m^3.

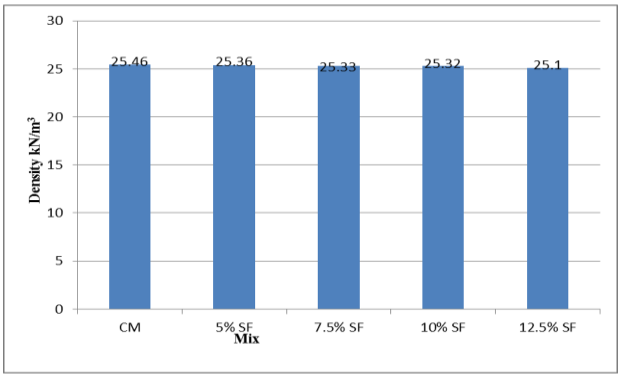

Figure 2: Slump Result of Silica Fume Variation

3.3 Compression Strength

Figure 3 graphically represents the variation of compressive strength of the concrete. It can be observed that percentage of silica fume increases the compressive strength is also increase. The compressive strength for 5% to 12.5% silica fume test was done at the age of 7, 28 and 56 days. The compressive strength for control mix was 43.76 N/mm2, 49.70 N/mm^2 and 63.53 N/mm^2 for 7, 28 and 56 days. For 5% replacement of silica fume the strength was increased 32.49%, 16.68% and 7.06%. For 7.5% replacement strength was about 14.87%, 40.74% and 15.47%, 10% replacement 11.49%, 0.6% and 3.49% and 13.27%, 20.38% and 17.04% for 12.5% replacement with silica fume.

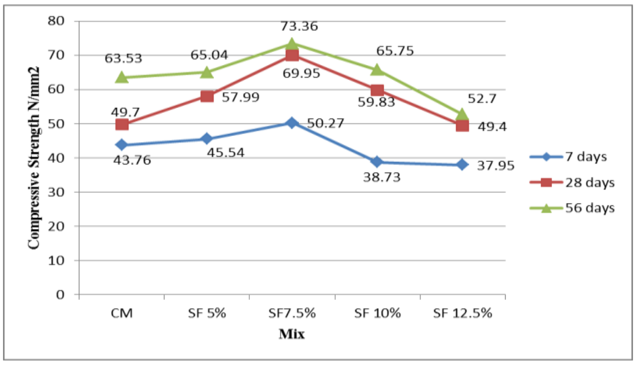

Figure 3: Compressive strength of Silica Fume variation

3.4 Split Tensile Strength

Figure 4 graphically represents the effect of silica fume on split tensile strength. Addition of silica fume on concrete slightly increases in the tensile strength of the concrete, because it enhances the mechanical properties of concrete. In this study percentage of silica fume was varied from 0%, 5%, 7.5%, 10% and 12.5%. As the percentage of silica fume increases the tensile strength increases up to 7.5% replacement but after that the strength was decreased. For 7.5% replacement 5.2 N/mm^2 and for 12.5% replacement the tensile strength was about 3.8 N/mm^2.

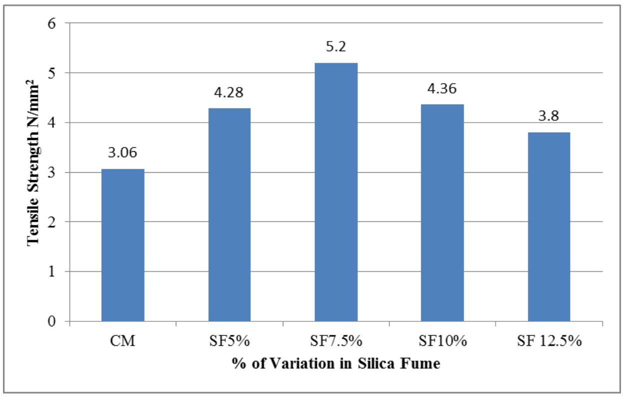

Figure 4: Effect of Silica Fume on Split Tensile Strength Concrete

3.5 Flexural strength of concrete

Figure 5 graphically represents the variation of flexural strength by adding of silica fume. Silica fume was added with percentage of 0%, 5%, 7.5%, 10% and 12.5% as a cement replacement. Flexural strength of conventional mix is 4.4N/mm^2, 5% of silica fume was added to the concrete mix the strength was about 3.8N/mm^2 which is less than control mix, but as the addition of silica fume increases flexural strength was increases up to 10% the value is about 4.55N/mm^2 and 3.73N/mm^2 for 12.5% replacement of silica fume.

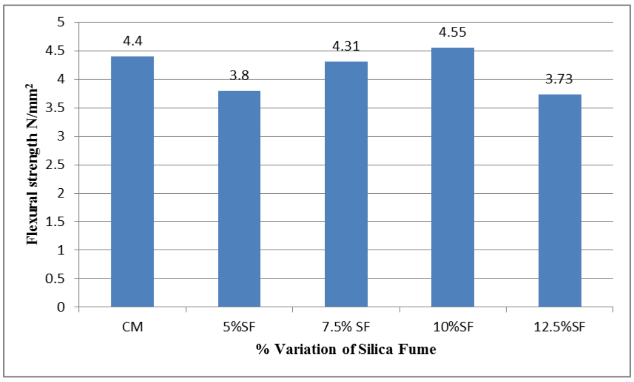

Figure 5: Effect of Silica Fume on Flexural Strength

3.6 Silica Fume variations on Modulus of Elasticity

Figure 6 shows the modulus of elasticity of silica fume concrete. The MOE for control mix was 33125 N/mm^2. Addition of silica fume on concrete marginally increases in the Modulus of elasticity which is similar to the control mix. The silica fume was added up to a percentage of about 5% to 12.5%. 7.5% silica fume replacement on cement obtained value i.e., 38500 N/mm^2, and further increases in percentage of silica fume i.e., 12.5% replacement obtained 35830 N/mm^2.

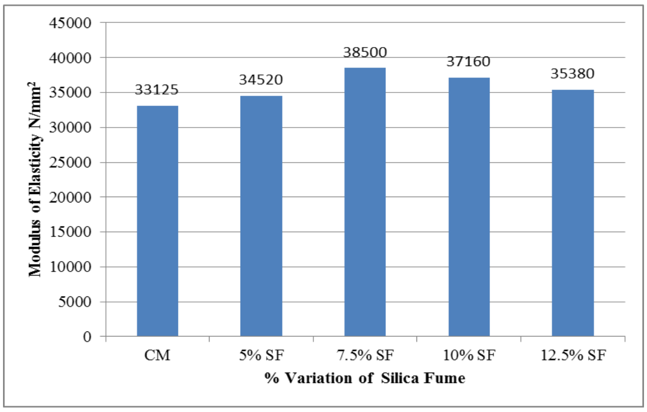

Figure 6 Effect of Silica fume on Modulus of Elasticity

4. CONCLUSION

The addition of silica fume to the concrete tends to decrease the workability of normal concrete. The density of the concrete with silica fume is similar to the normal concrete. But the use of steel fibers enhanced the density. The compressive strength of concrete gets enhanced with the use of silica fume. The split tensile strength and flexural strength is also found with similar variation when silica fume was used. There is no particular trend of variation in modulus of elasticity of normal and silica fume concrete.

REFERENCES

1. Amudhavalli N K, Jeena M., (2012), "Effect of Silica Fume on Strength and Durability parameters of Concrete", International Journal of Engineering Sciences and Emerging Technologies, ISSN: 2231-6604, Vol.3, Issue-1, Pp 28-35.
2. Dilip S R and Amitava S., (2012), "Effect of Partial Replacement of Cement by Silica Fume on Hardened Concrete", International journal of Emerging Technology and Advanced Engineering, ISSN: 2250-2459, Vol.2, Issue 8.
3. Dasari V R and Prashant Y P., (2012), "Combined Effect of Silica Fume and Steel Fiber on Mechanical Properties on Standard Grade of Concrete and Their Interrelations", International Journal of Advanced Engineering Technology, ISSN: 0976-3945 Vol.3, Issue 1, Pp 361-366.
4. Milind V M., (2012)," Performance of Steel Fiber Reinforced Concrete", International Journal of Engineering and Science, ISSN: 2278-4721, Vol.1, Issue 12, Pp 01-04.
5. Muhaned A and Shallal R A., (2007), "Strength and Elasticity of Steel Fiber Reinforced Concrete at High Temperature", Journal of Engineering and Development, ISSN: 1813-7822, Vol.11, No.2.
6. Shiva K B., (2012),"Effect of Addition of Steel Fibers on Strength and Durability of High Performance Concrete", Journal of Engineering Research and Studies, ISSN: 0976-7916, Vol.3, Issue 3.
7. Misba G, Alsana B and Javed A N., (2014)," Study of Modulus of Elasticity of Steel Fiber Reinforced Concrete", International Journal of Engineering and Advanced Technology, ISSN: 2249-8958, Vol.3, Issue 4.
8. Prashant Y P., Nagarnaik P B and Pande A M., (2011),"Performance of Steel Fiber on Standard Strength Concrete in Compression", International Journal of Civil and Structural Engineering, ISSN: 0976-4399, Vol.2.
9. Konapure C G and Dasari V S., (2015)," Effect on Steel Fiber Reinforced Concrete with Silica Fume for High Grade", International Journal of Engineering and Innovative Technology, ISSN: 2277-3754, Vol.4, Issue11.
10. Job T and Ananth R., (2007),"Mechanical Properties of Steel Fiber-Reinforced Concrete", Journal of Material in Civil Engineering.

BIOGRAPHY

Akshatha K. B,
M.Tech (Construction Technology)
Kurunji Venkataramana Gowda College of Engineering, Sullia, Dakshina Kannada, Karnataka, India .