Experimental Studies on Effect of Alccofine in Workability and Mechanical Properties of Steel Fiber Reinforced Concrete

[1]Ammu Baby, [2]Divya Sasi
[1]Student, [2]Assistant Professor
[1]Department of Civil Engineering,
[1]Mar Baselios Institute of Technology and Science, Nellimattom, Ernakulam, India

***Abstract* - In concrete, fibers are usually used to control cracking which are caused due to plastic shrinkage and drying shrinkage. Fibers also reduce the permeability of concrete and thereby reduce bleeding of water. Some types of fibers produce greater resistance to impact, abrasion, and shatter in concrete. Fibers which are too long tend to cause balling in the mix and create workability problems. Alccofine is a specially processed pozzolanic product with high reactivity based on slag of high glass content obtained through controlled granulation process. This pozzolanic material can be utilized for producing highly durable concrete composites. It provides reduced water demand for a given workability, owing to its ultra-fine particle size and unique chemistry. Experimental investigation will be carried out on determining the effect of alccofine on the mechanical properties and the workability of steel fiber reinforced concrete. For that steel fiber of length 5cm and 1mm diameter are added at percentages of 0.1, 0.25 and 0.5 by volume of concrete. And Alccofine is added at the rate of 5, 10, and 15 % by weight of cement. Experimental results show that Alccofine performs as a better workability agent as well as improves the strength of concrete.**

***Index Terms* - Fiber Reinforced Concrete, Steel Fibers, Alccofine, Workability, Compressive Strength, Tensile Strength, Flexural Strength.**

I. INTRODUCTION

For almost all constructions, the most widely used material is cement concrete. Approximately an equal amount of carbon dioxide is emitted into the atmosphere during cement production. Efforts have been taken over the past few years for improving the performance of concrete. It has been suggested that, cement replacement materials along with chemical and mineral admixtures can improve durability as well as the strength characteristics of concrete. It is the availability of mineral admixtures that marked opening to a new era for designing higher strength concrete mix. Admixtures are newly developed helps in lowering the water/ binder ratio to very low-levels without losing workability. The main advantage of mineral admixtures in concrete is reducing the cement content. It is economic and environmental benefits as well as means reducing the rise in temperature and improves the compressive strength at the same time.

The aim of this study is to evaluate the performance of concrete containing supplementary cementitious material Alccofine. Utilization of waste materials such as alccofine in construction industry reduces the technical and environmental problems of plants. And reduces the amount of solid waste besides decreases electricity costs and reduces greenhouse gas emissions associated with Portland clinker production, and also helps in conserving existing natural resources. Practical problems remain in field application, despite the benefits of alccofine. Due to the slow pozzolanic reactivity of alccofine, at early stages of aging, the strength of concrete containing high volume of alccofine as a partial cement replacement, is much lower than that of control concrete,. This Paper reports the results of an experimental investigation on determining the effect of alccofine on the mechanical properties and the workability of steel fiber reinforced concrete. Hence here in this investigation an attempt has been made on partial replacement of cement with alccofine along with incorporation of steel fibres with different percentages by volume of concrete.

II. EXPERIMENTAL PROGRAM

Experimental program has been planned to provide sufficient information for ascertaining the quality of Alccofine based fiber reinforced concrete. Study has been conducted to evaluate the behavior of Alccofine in workability and mechanical properties of steel fiber reinforced concrete.

Materials Used

The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

Cement

For the study, RAMCO Portland Pozzolana Cement (PPC) has been used.

Table 1 Properties of Cement

Specific gravity	3.125
Standard consistency	32%
Initial setting time	60 minutes
Final setting time	540 minutes

Steel Fiber

Type of Steel fibre used is hooked end one. The fiber is collected from Jeetmull Jaichandlal Private Limited, Chennai.

Table 2 Properties of Steel Fiber

Specific gravity	7.85
Length	50mm
Diameter	1mm

Coarse Aggregate

Aggregates retained on 4.75mm sieve are used. Aggregate size selected is 20mm, which is clean and free of surface dust and fines. Coarse aggregate was collected from a local quarry.

Table 3 Properties of Coarse Aggregate

Specific gravity	2.73
Crushing value	37.53%
Impact value	34.44%
Abrasion value	45.8%
Flakiness index	6.13%
Elongation index	28.32%

Fine Aggregate

Aggregate passing through 4.75mm IS sieve is used. Manufactured Sand (M- Sand) from local quarry is collected for the experimental purpose. Specific gravity of fine aggregate = 2.73

Alccofine

Alccofine is a pozzolanic material which can be utilized for produce highly durable concrete structures. It is a specially processed product obtained through the process of controlled granulation, which is based on slag of high glass content with higher reactivity. ALCCOFINE 1203 is used. It is collected from Ambuja cements.

Table 4 Chemical Composition of Alccofine

CaO	61-64 %
SO_3	2-2.4 %
SiO_2	21-23 %
Al_2O_3	5-5.6 %
Fe_2O_3	3.8-4.4 %
MgO	0.8-1.4 %

III. MIX DESIGN

The mix design is carried out as per IS 10262:2009. M30 grade concrete is selected for the study.

Table 5 Mix Proportion for $1m^3$ M30 Concrete

Material	Weight (kg/m^3)
Cement	437.78
Fine aggregate	783.37
Coarse aggregate	1025.79
Water	197

IV. EXPERIMENTAL PROCESS

The following moulds were used to cast concrete specimens for various studies.

1) Slump test was conducted for determining the fresh properties of concrete.
2) 150mm x 150mm x 150mm moulds were used to cast cubes for determining the compressive strength of concrete
3) 300mm height x 150 mm diameter moulds were used to cast cylinders to determine the split tensile strength
4) 100mm x 100mm x 500mm moulds were used to cast beams to determine the flexural strength of the concrete

Table 6 Nomenclature

SF	Steel Fiber
AF	Alccofine

Fresh Properties of Concrete

Slump test was conducted using slump cone.

Table 7 Fresh Properties of Concrete

Specimen	Slump(mm)
Normal Concrete	80
0.10% SF	80
0.25% SF	70
0.50% SF	60
0.5% SF+05% AF	70
0.5% SF+10% AF	90
0.5% SF+15% AF	110

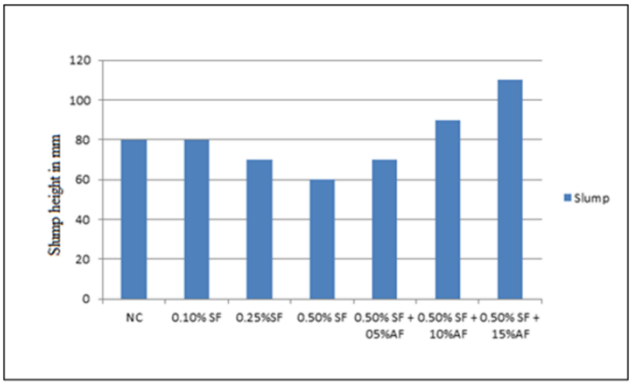

Figure 1 Fresh Property of Concrete (Slump Value in mm)

Hardened Properties of concrete

Hardened properties of concrete in this study include, the compressive strength, split tensile strength and the flexural strength.

Compressive strength

The compressive strength test was conducted as per IS 516 – 1959 on three cubes using a compression testing machine.

Table 8 Compressive Strength of Concrete

Specimen	Compressive strength (N/mm^2)	
	7 days	28 days
Normal Concrete	22.32	34.34
0.10% SF	22.41	34.71
0.25% SF	23.14	35.62
0.50% SF	25.01	36.35
0.5% SF+05% AF	25.96	37.52
0.5% SF+10% AF	26.33	39.50
0.5% SF+15% AF	24.85	28.88

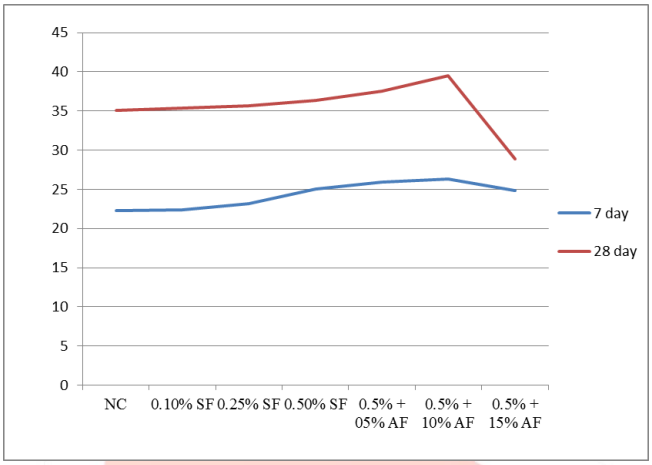

Figure 2 Compressive strength of concrete (in N/mm^2)

Split tensile strength

The test method deals with the determination of the splitting tensile strength of cylindrical concrete specimens. In this method a diametral compressive force is applied along the length of a cylindrical specimen.

Table 9 Split Tensile Strength of Concrete

Specimen	Split Tensile strength (N/mm^2)	
	7 days	28 days
Normal Concrete	1.60	2.40
0.10% SF	1.89	2.60
0.25% SF	1.93	2.90
0.50% SF	2.11	3.12
0.5% SF+05% AF	2.20	3.16
0.5% SF+10% AF	2.57	3.25
0.5% SF+15% AF	2.46	2.92

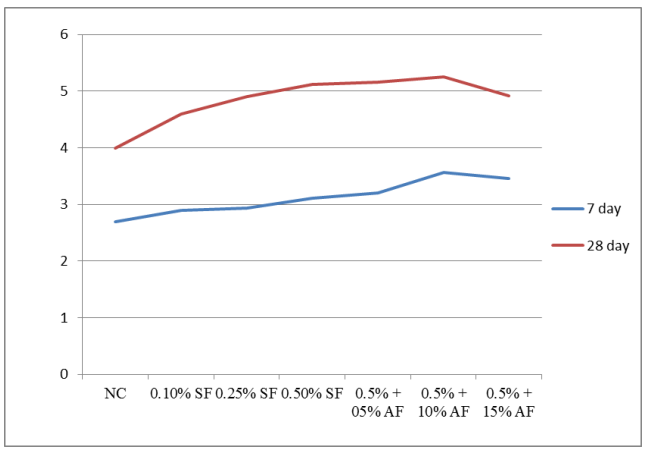

Figure 3 Split Tensile strength of concrete (in N/mm2)

Flexural strength

This test method covers the determination of the flexural strength of concrete using a simple beam with two-point loading. Test was conducted in two point bending test machine.

Table 10 Flexural Strength of Concrete

Specimen	Flexural strength (N/mm2)	
	7 days	28 days
Normal Concrete	4	5.63
0.10% SF	5.6	6.5
0.25% SF	5.6	6.5
0.50% SF	5.8	6.9
0.5% SF+05% AF	6.0	7.0
0.5% SF+10% AF	6.4	7.2
0.5% SF+15% AF	5.9	6.7

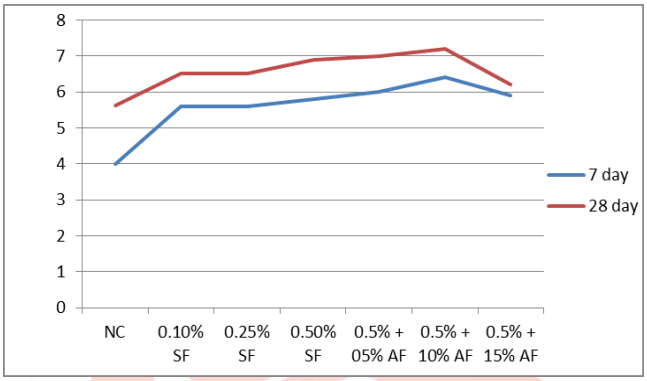

Figure 4 Flexural Strength of Concrete in N/mm^2

Comparison of test results

Maximum values of compressive strength, split tensile strength and flexural strength of various compositions of concrete are compared in 28 day strength.

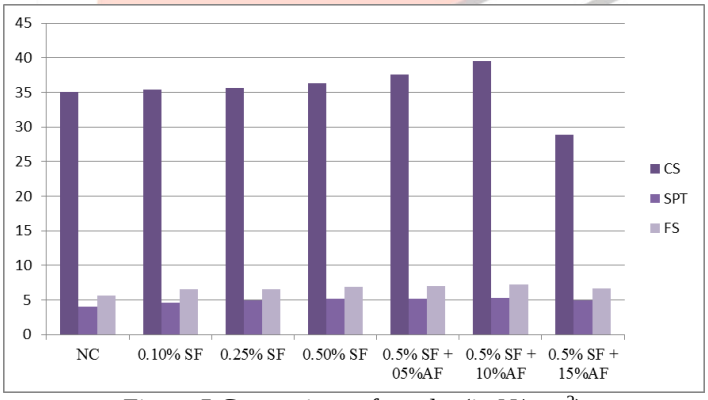

Figure 5 Comparison of results (in N/mm^2)

V. CONCLUSIONS

Results show that, introduction of Alccofine will improve workability as well as mechanical properties of steel fiber reinforced concrete.

- Workability reduces on introduction of steel fibers to normal concrete
- Addition of Alccofine shows immense improvement in workability of steel fiber reinforced concrete
- Compressive strength, split tensile strength and flexural strength shows maximum value in the combination 0.5%SF + 10%AF
- It can be inferred that optimum value of cement replacement with Alccofine lies in the range of 10% - 15%
- Alccofine behaves as a good admixture in strength improvement as well as in workability

Drawback on mixing of steel fiber reinforced concrete in mixer is that steel fibers show a tendency to stick on to the interior of concrete mixer. Introduction of too much steel fiber make concrete non-workable, uneconomical and threat in safety for handlers. Climatic conditions may affect the fresh properties as well as hardened properties of concrete.

VI. ACKNOWLEDGMENT

The author wish to thank Asst. Prof.. Divya Sasi, Asst. Prof. Manju George, Prof. Shiney Varghese, Prof. Dr. K.M. Lovely. And also wish to thank beloved parents, friends and staff members of Institute. This work was supported in part by a grant from Mar Baselios Institute of Technology and Science, Nellimattom.

REFERENCES

[1] Ansari U.S., Chaudhri I.M., Ghuge N.P., Phatangre R.R., Concrete With ALCCOFINE & Fly Ash An Economical & Environment Friendly Approach, International Journal of Modern Trends in Engineering and Research, (2015).

[2] Siddharth P Upadhyay, Prof. M.A.Jamnu, Effect On Compressive Strength Of High Performance Concrete Incorporating Alccofine And Fly Ash, Journal Of International Academic Research For Multidisciplinary, Volume 2, (2014).

[3] Dr. Mohid Hamraj, Experimental Study On Binary Blended High Strength Steel Fibre reinforced Concrete Using Alccofine As Mineral Admixture, International Journal Of Science, Engineering And Technology, Volume 2, (2014).

[4] Abhijitsinh Parmar, Dhaval M Patel, Dron Chaudhari, Harpalsinh Raol, Effect of Alccofine and Fly Ash Addition on the Durability of High Performance Concrete, International Journal of Engineering Research & Technology, Volume 3, (2014)

[5] Praveen Nayak S, H. S. Narashimhan, Raghunandan V.Kadaba Hardened Properties of Concretes made with Micro Silica and Alccofine-A Performance Optimization based Comparative Study, International Journal of Engineering Research and Development, Volume 10, (2014).

[6] Mahammedtofik Y. Patel, Prof. A.R.Darji, Prof. B.M.Purohit, Study on Mechanical properties of High Performance Concrete with Alccofine and Waste Glass Powder, International Journal for Scientific Research & Development, Voume 2, (2014).

[7] Mo.Tofik Y. Patel1 Siddharth P Upadhyay, Prof. A.R. Darji, Prof. M.A. Jamnu, To Study On Effect Of High Performance Concrete With Alccofine And Waste Glass Powder, International Journal for Scientific Research & Development, Volume. 2, (2014).

[8] Saurav, Ashok Kumar Gupta Experimental study of strength relationship of concrete cube and concrete cylinder using ultrafine slag Alccofine, International Journal of Scientific & Engineering Research, Volume 5, (2014).

[9] Jinay M. Pandya, Prof. B. M. Purohit, Experimental Study on the Mechanical Properties of Concrete Incorporating PET Fibers, International Journal for Scientific Research & Development, Volume 2, (2014).

[10] M.S. Pawar, A. C. Saoji, Effect of Alccofine on Self Compacting Concrete, The International Journal Of Engineering And Science, Volume 3 (2013).

[11] Suthar Sunil B, Dr. (Smt.) B. K. Shah , Study On Strength Development Of High Strength Concrete Containing Alccofine And Fly-Ash, Indian Journal Of Research, Volume 2, (2013)

[12] Yatin H Patel, P.J.Patel, Prof. Jignesh M Patel, Dr. H S Patel, Study On Durability of High Performance Concrete With Alccofine And Fly Ash, International Journal of Advanced Engineering Research And Studies, Volume 2, (2013).

[13] Abhijitsinh Parmar, Dhaval M Patel, Experimental Study on High Performance Concrete by Using Alccofine and FlyAsh - Hard Concrete Properties, International Journal of Engineering Research & Technology, Volume 2, (2013)

[14] K. S. Kulkarni, S. C. Yaragal and K. S. Babu Narayan, Effect of Elevated Temperatures On Mechanical Properties Of Microcement Based High Performance Concrete, International Journal of Applied Engineering and Technology, Volume 1, (2011)

[15] Anumol V. Basheer, Ahsana Fathima , Anju Dominic, Experimental Investigation On Slurry Infiltrated Fiber Concrete (Sifcon) With Alccofine, International Journal of Engineering Research-Online, Volume 3, (2015)

[16] Nivin Philip, D. Neeraja, Mechanical Properties of High Performance Concrete with Admixtures and Steel Fibre, ARPN Journal of Engineering and Applied Sciences, Volume 10, (2015)

[17] IS 456-2000, "Indian Standard Code of Practice for Plain and Reinforced Concrete, (fourth Revision)", Bureau of Indian Standard, New Delhi, 2000

[18] IS 10262-1982, "Indian Standard Recommended Guidelines for Concrete Mix Design", Bureau of Indian Standard, New Delhi, 1983

[19] IS 383, "Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete," Bureau of Indian Standards, New Delhi, 1970

[20] IS 516 (Reaffirmed 1999), "Method of Test for Strength of Concrete." BIS New Delhi, 1959, pp. 1-25.

[21] IS 2386 (Part 1), 1963, "Methods of test for Aggregates for Concrete, Part l, Particle size and Shape", Bureau of Indian Standard, New Delhi, 1963

[22] IS 2386 (Part 3), 1963,"Methods of Test for Aggregates for Concrete, Part Ill, Specific Gravity, Density, Voids, Absorption And Bulking", Bureau of Indian Standard, New Delhi, 1963.

[23] IS 2386 (Part 4), 1963,"Methods of Test for Aggregates for Concrete, Part IV, Mechanical Properties", Bureau of Indian Standard, New Delhi, 1963