International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 08 | Aug -2017 www.irjet.net p-ISSN: 2395-0072

Study on Alccofine based High Strength Self-compacting Fibrous Concrete- A review

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Abstract - In recent years, fibers has been widely utilized for strengthening concrete structures due to its high tensile and compressive properties. In this paper, an introduction is given on the properties and different fibers used for structural applications. Moreover, a brief review is given on the papers and future development of fibers used for strengthening structures. The use of steel and synthetic fibers improves the strengthening properties of concrete. In this paper review has been done on self-compacting concrete and the effect of different types of fibres on the rheological properties

Key Words*: self-compacting concrete; fibres;alccofine.*

1. INTRODUCTION

Concrete is the most frequently and widely used construction material on the planet. Global consumption of concrete per capita is approximately two tonnes per year. In India, since last decade mega construction projects have been successfully implemented and executed by using concrete. The type and quality of concrete being used have undergone varied transformation, from its increasing strength to escalating performance of concrete. Enhancing the concrete properties (fresh & hardened) is continuously one of the main necessities for construction of structures. High strength concretes having compressive strength ranging from 50 MPa up to 130 MPa has been used around the world in tall buildings and bridges with long spans or buildings in aggressive environmental conditions. The major advancement in the concrete technology includes increasing the strength of concrete, increasing the performance of concrete and introduces self-compact ability in concrete. These transformations of concrete are discussed briefly as follows:

1.1 High Strength and High Performance Concrete

The concrete having characteristic cube strength between 60 and 100 N/mm^2 is called the high strength concrete. High strength can be achieved by making optimum use of basic ingredients that constitute the normal strength concrete with controlled water-cement ratio and minerals admixtures for its development.

High performance strictly relates to a concrete that has been developed to have good specific characteristics, such as high resistance to chloride ingress or high abrasion resistance. It was observed during the past decades, that it is not only strength of the concrete that is important, but also other parameters of concrete like long term mechanical properties, low permeability, placement, compaction, early age strength, volume stability and service life in severe environment.

1.2 FIBROUS CONCRETE

A Fiber Reinforced Concrete (FRC) is a composite material consisting of randomly distributed fiber in a cement matrix which can be synthetic, natural, steel, etc. FRC is normally prepared with high cement content and low water content. Cost effective materials are needed today by the construction industry for increasing the strength of concrete structures. Normal concrete is fails suddenly but the addition of fibres improves ductility of concrete and its post-cracking load carrying capacity.

1.3 Self-Compacting Concrete

SCC is an innovative concrete that flow under its own weight and does not require vibration as conventional concrete needs vibration immediately after it is placed to eliminate entrapped air. It is at the same time cohesive enough to be handled without segregation or bleeding. In conventional concrete, compaction is done with the vibrators and the assurance of quality is compromised in complex structures due to lack of workmanship. Insufficient compaction considerably reduces the ultimate performance of concrete i.e. strength of concrete and the permeability of concrete, which in turns reduces the durability of concrete structures. Vibration also causes health problems in worker like HAVS (Hand Arm Vibration Syndrome), etc.

The introduction of SCC technology allows the improvement in concrete construction methods for increased and improved results. The need of this type of concrete was introduced by Okamura in 1986. The fundamental research

on the workability of self-compacting concrete had been done by Ozawa and Maekawa at University of Tokyo in 1989. For the concrete to be self-compacted concrete it should have pass EFNARC Guidelines those are: passing ability, filling ability and segregation resistance.

BENEFITS OF SCC

- Reducing labour cost and decreasing construction time
- Improved durability
- Improved filling ability of congested structural members
- Better surface finish
- Better safety working environment and reducing the noise pollution
- Even in the hardened state SSC has higher modulus of elasticity for effective reinforcement.
- Minimum cover is not required (neither rust nor corrode).
- Ideal aspect ratio i.e. relation between Fiber dia and length, which makes them outstanding for early-age performance.

1.4 Fibrous Reinforced Self-compacting Concrete

The advantages linked to the addition of steel fibres to concrete mixtures can be combined with the benefits of the self-compacting capability of concrete, with the outlet of steel fibre reinforced concrete mixtures showing self-compacting ability. The resulted outlet is nominated by Self-Compacting Fibrous Concrete (SCFC) and, when compared to usual concretes, gives technical profits in terms of costs/benefits ratio.

1.4.1 APPLICATIONS OF FIBROUS REINFORCED SELF-COMPACTING CONCRETE

- Runway, Aircraft Parking, and Pavements.
- Dams and Hydraulic Structure
- Tunnel Lining and Slope Stabilization
- Walls ,Thin Shell, Pipes, and Manholes
- Precast Concrete and Products
- Warehouse / Industrial
- Residential

1.5 USE OF MINERAL ADMIXTURES IN HSCC

HSCC have the capability to consume a large amount of industrial by-products or waste as cementitious material. Mineral admixtures like silica fumes, fly ash, limestone powder and GGBFS have been used for the development of SCC. Use of these materials in SCC enhances properties in fresh and in hardened state.

1.6 ALCCOFINE

Alccofine is a new generation, micro fine material of particle size much finer than other hydraulic materials like cement, fly ash etc. manufactured in India. It has unique characteristics to enhance 'performance of concrete' in fresh and hardened stages. It can be used as practical substitute for Silica Fume.

2. Review of Research work carried out by Different Researchers

HamoonFathi; et al [1] carried out a study to investigate the effect of replacing aggregates with waste glass (at percentage 30, 50, 70 and 100) and mechanical properties of concrete containing glass and fibres were examined. . Also polypropylene fibre was added at different percentages (0%, 0.1% and 1.5%) to the concrete. It was observed that slump get reduced on adding glass and fibre, compressive strength reduced on adding glass, but use of fibres improves the tensile strength.

Apoorva Chandak and Nitin Agrawal et al 2016 [2] in their work on development of fibre reinforced self-compacting concrete using hybrid fibres (sisal and banana) reported that on keeping the fibre content b/w 0.3% to 0.5% . The water/cement ratio was kept at 0.4 and admixture content was 1 %.Lower slump value of SCFRC than conventional concrete was obtained. Increase in tensile and compressive strength was found with addition of fibres. SCFRC shows great resistance to the cracks than conventional concrete and with this it is feasible to produce low cost sustainable self-compacting fibre reinforced concrete.

Qi Cao; et al 2016 [3] evaluated the effect of fibre on self-compacting concrete. Workability of fresh concrete, mechanical properties and shrinkage of hardened concrete were determined. Steel fibre volume fraction used was 0.25%, 0.5% and 0.75% of the total volume of concrete; volume fraction polypropylene fibre was 0.10%. Investigation indicated that workability decreases with the increased percentage of fibres in concrete. The strength of self-compacting concrete improves with the addition of fibres.

Mr.Manohar K N; et al 2015 [4] the glass fibre reinforced self-compacting concrete (GFRSCC) was produced in this work by combining self-compacting concrete and glass fibres. The workability and strength studies on glass fibre reinforced self-compacting concrete of grade M40 with fly ash and silica fume was studied by them.

M.Adams Joe1; et al 2015 [5] studied and quoted that a maximum of 50% GGBS were able to be used as a mineral admixture without affecting the self-compact ability. This paper covers the SCC by replacing certain percentage of

cement and adding some percentage of lime. Self compactability is retained upto 40% of replacement of cement with GGBS. All hardened properties of SCC were observed to decrease with increase in content of GGBS.

Yatin H Patel; et al. 2014 [6] carried out research to evaluate the performance of concrete (HPC) containing supplementary cementitious materials such as Fly ash &Alccofine. Alccofine and Fly ash are pozzolanic materials and can be utilized to produce highly durable concrete composites. It was observed that concrete incorporating Alccofine and fly ash have higher compressive strength and Alccofine enhanced the durability of concretes and reduced the chloride diffusion.

Mounir M. Kamal; et al. 2014 [7] carried out a research with the main objective of determining the optimum content of fibres (steel and polypropylene fibres) used in SCC. . These results showed that the optimal dosage of steel and polypropylene fibre was 0.75% and 1.0% of the cement content, respectively. The 28 days compressive strength was increased by 13% after using the polypropylene fibres. Usage of the steel fibres increased the 28 day compressive strength by 37% independent of the fibre content compared to the control self-compacted concrete mix without fibre addition. The impact resistance in terms of the number of drops needed to cause the fracture of test specimens was increased by 22% and 67% when polypropylene and steel fibres were used, respectively.

Sunil Suthar et al 2013 [8] studied the effect of Alccofine and Fly ash addition on the Mechanical properties of High performance Concrete. The addition of 8% AL to different FA replacements has a high compressive strength than 10% SF. The optimum and high strength concrete can be obtained with 8% AL and 20% FA.

Pawar1 M. S. 2013 [9] studied the effect of the use of the Alccofine powder to increase the amount of the fines and hence achieve self – compatibility was also discussed in this study. It focuses on comparison of the properties of SCC with fly ash and Alccofine to that of standard one with fly ash. Fresh Properties and harden Properties of SCCs with 10% Alccofine are superior to SCCs with 5% and 15% of Alccofine.

S. Devinder et al [10] used Foundry Slag as partial replacement for fine aggregates and Alccofine as partial replacement of cement. M100 grade was used with water/binder ratio 0.239. Foundry slag (0 to 50%) and alccofine(15%) were used for casting concrete specimens and tested for compressive strength, tensile strength and flexural strength at 7, 14, 28, 56 and 90 days. Replacement of fine aggregates with up to 45% of FD showed an increase in CS, FS and TS at all ages but showed a decrease in these properties with 50% of FD. Results suggested that reasonably high strength concrete can be designed by substituting fine aggregates with 10% to 45% of foundry slag and partial replacement of cement with 15% of Alccofine.

S. Devinder et al [11] studied Prediction of High Strength of Concrete Using Waste Foundry Slag and Alccofine by comparing strength properties with Ultrasonic Pulse Velocity and Rebound Number and found that the correlation between strength properties and NDT properties were excellent.

S. Devinder et al [12] carried out Comparative Studies on Mechanical Properties of High Strength Concrete Using Foundry Slag and Alccofine and found that co-relation between these properties were excellent.

K. Ashish et al [13] carried out study on Waste Iron Slag and Alccofine as a Substitute Material for Fine Aggregate and Cement used in Concrete and found that use of Alccofine enhances the strength properties and makes the concrete for use in earthquake prone areas**.**

3. Conclusion

1. The addition of Alccofine in SCC mixes increases the self compatability characteristic like filling ability, passing ability and .resistance to segregation.
2. An early strength gaining property was found on the addition of Alccofine.
3. The higher strength grades concrete can be developed by using Alccofine and will enhance the hardened as well as performance of the concrete.
4. Use of steel and other fibres helps in enhancing tensile and flexural strength of the concrete.
5. Ductility of concrete and its post-cracking load carrying capacity was improved through addition of Fibre.
6. Development of cracks could be reduced by using the steel fibre.

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