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Effect of Alccofine on Compressive Strength of SIFCON

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Abstract – *With this technology driven world, construction sector is also not unmarked. The use of new techniques and methodology in making construction more and more self efficient and reliable is the hot topic among various researchers now-a-days. To quench the thirst of strength, durability and hence sustainability, high strength and high performance concrete was once developed in order to fulfill the unanimous demands. The use of micro-fillers came into existence by this very concept only. This paper shows the results of using Alccofine, a type of micro-filler having particle size much finer than hydraulic materials like cement, fly ash and other type of fillers available. The optimization of Alccofine quantity by partial replacement of Cement was carried out experimentally and results showed the achievement of Ultra High Compressive Strength of the Slurry Infiltrated Fibrous Concrete. SIFCON is a special type of technique in which the fibers quantity can be increased upto 20 percent in concrete.*

Key Words: **Cement Replacement, High Performance Concrete, Fiber Reinforced Concrete, SIFCON, Micro-filler, Glass Slag, Alccofine, Ambuja Cement**

1. INTRODUCTION

With this technology driven world, construction sector is also not unmarked. The use of new techniques and methodology in making construction more and more self efficient and reliable is the hot topic among various researchers now-a-days. Cement the second most manufactured product in the planet contributes a major share of carbon dioxide into atmosphere. And the devastating effect of these harmful gases around is no longer secreted. Complete elimination of cement is yet to find so anything that can be used as partial replacement and can also act as binder while making concrete actually helps maintain sustainability. *To quench the thirst of strength, durability and hence sustainability, high strength and high performance concrete was once developed in order to fulfill the unanimous demands. The use of micro-fillers came into existence by this very concept only. Alccofine, a type of Glass Slag, has been developed recently by Counto Micro fine items Pvt. Ltd. in association with Ambuja Cement. It is a new-generation, ultrafine product whose basic raw material is slag of high glass content with high reactivity obtained through the process of controlled granulation.*

1.1 SIFCON

Slurry infiltrated Fiber concrete was first developed in 1979 by Lankard Materials Laboratory, Columbus, Ohio, USA, by incorporating large amounts of steel Fibers in steel Fiber reinforced cement-based composites **(Lankard 1984)** [01]. SIFCON is moderately new special type of high performance steel fiber-reinforced concrete (HPFRC). Efforts have been made to produce fiber reinforced concrete with fibers up to 6% but were affected by difficulties in placing and mixing of high volume of Fibers. to overcome this difficulty SIFCON came into existence. SIFCON is made by pre-placing quick discrete fibers in the moulds to its full ability or to the favored volume fraction, thus forming a network. The metal Fiber content can be as so much as 30 % by way of volume **(Lankard 1985)** [02]. SIFCON is one of the promising material which has a higher impact and blast resistance in various type of high performance fiber reinforced cementitious composites as computed by **(Tran et al. 2014)** [03]. The major differences between FRC and SIFCON, in addition to the clear change in Fiber volume fraction, lie in the absence of coarse aggregates in SIFCON which, if used, will restrict the infiltration of the slurry through the dense Fiber community.

2. Experimental Investigation

2.1 Material Used

Ordinary Portland cement of grade 53, confirmed to IS 12269:2013 , locally available fine sand of zone 3 having maximum size of 600 micron, micro-filler of high glass content, poly-carboxylate type superplasticizer for water reduction and to impart plasticity and both end hooked steel fibers has been used in the present investigation.

2.2 Mix Proportion

The mix proportion of Alccofine based slurry infiltrated fibrous concrete is given in the table 1. After various trail investigations water binder ratio was kept 0.25 with a superplasticizer dosage of 1.5 percent by weight, of binder. High range water reducer plasticizer was used in order to make the SIFCON mix workable even at this much low water binder ratio.

Table -1: Mix Proportion of SIFCON specimen

Sr. No.	Mix Proportion	Replacement with Alccofine	w/b Ratio	S.P
1	1:1	0%	0.25	1.5%
2	1:1	5%	0.25	1.5%
3	1:1	8%	0.25	1.5%
4	1:1	10%	0.25	1.5%
5	1:1	12%	0.25	1.5%

The above mix proportion provided in the table has been used for making of high cementitious slurry only. Out of these the higher compressive strength giving slurry has been chosen for further investigation that includes inclusion of fibers in the concrete.

2.3 Casting of Slurry Specimen

The cubes of size 70.6 mm were casted and tested for mortar strength initially. It follows the basic rule that greater the strength of mortar greater will be the strength of mix and ultimately concrete specimen made by the mix. The following were the results obtained after 28 days of normal curing of the slurry specimens.

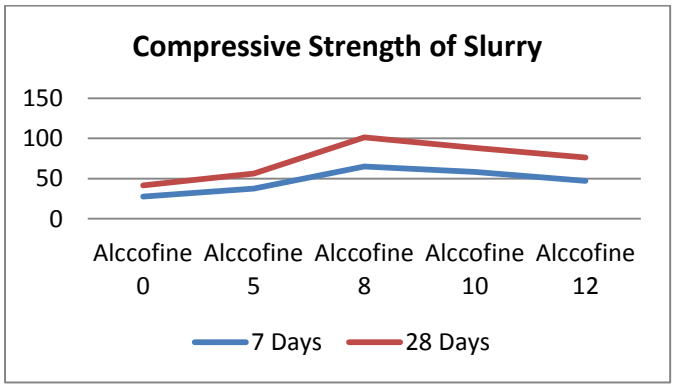

Chart -1: Compressive Strength of Slurry

From the graph it can be judged out that with the increase of Alccofine beyond 8 percent replacement by cement the compressive strength test results shows declination. Thus with the given constituent materials optimum replacement of 8 percent of cement by Alccofine has been chosen for further investigation on SIFCON.

2.3 Casting and Testing of SIFCON Specimen

The very first step in preparing the SIFCON specimen is to fill the mould with the desired quantity of fibers. No vibration is needed if the slurry is flowable enough to be easily poured into the mould filled with fibers. However if the quantity of fibers are large then external vibration will be required in order to ensure no voids during filling the slurry. The need of vibration also depends upon the aspect ratio and type of fibers being used.

From the investigation on slurry strength it has been found the optimum replacement of cement by Alccofine is 8 percent. And with the workability perspective 7 percent fibers by volume of mould has been used for SIFCON specimen.

Figure 1 - Separated Fibers

The fibers that were glued was firstly separated by hot water bath and is used as per the quantity depicted form the workability issues. After the moulds were being filled with steel fibers up to the required volume fraction, the slurry which was flowable enough to ensure complete infiltration into the mould filled with dense fiber network. The fibers were having aspect ratio of 80 with both end hooked, light vibration was needed in order to properly infiltrate the slurry in the mould. The dosage of superplasticizer (1.5% by weight of binder) used helped in maintaining the slurry into workable condition even after 2hrs from the time of mixing the ingredients together.

Figure 2 - Loading and Cracking of Cubes

Cube specimens of standardized size of 150 x 150 x 150 mm were casted with the desired quantity of fibers and are filled with the optimized slurry having maximum strength. Cubes were tested after the 7days and 28days of curing after wiping off the surface water.

3. CONCLUSIONS

The following are the results obtained from the compressive testing of the cubes as per IS: 516.

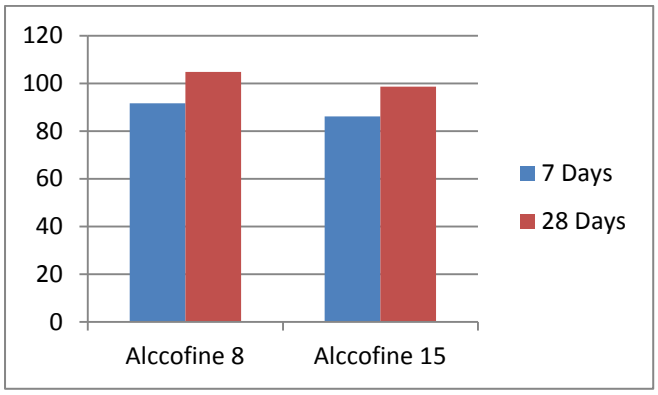

Chart -2: Compressive Strength test results on SIFCON

From the above chart it has been concluded that the optimized quantity of Alccofine to be added by replacing the cement with the given ingredients is 8 percent. Any further increment of the micro-filler will only leads to the decrease in the compressive strength of the cubes.

Although there is a decrease but with careful observation one can conclude that there is not much of the difference at the final stages. Thus Alccofine is also highly recommended for making of Ultra High Strength concrete by using SIFCON technique.

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