

# PROPERTIES OF SELF COMPACTING CONCRETE WITH BASALT FIBER AND MICRO SILICA

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## ABSTRACT

Fresh self-compacting concrete (SCC) flows into place and around obstruction under its own weight to fill the framework completely and self-compact, without any segregation and blocking. The elimination of the need for compaction leads to better quality concrete and substantial improvement of working conditions. SCC mixes generally have a much higher content of fine filters, including cement and produce excessively high compressive strength concrete. Now there is a need to have SCC with higher strength by adding some items which will improve its properties without affecting its workability. This investigation aims SCC of improved strength. We have also replaced cement with fly ash constantly in all the tests. Also for getting more strength W/C ratio of 0.32 was adopted and in order to maintain workability super plasticizer was used. Also we used different percentage of micro silica varying as 0, 5, 10, 15% replacement of cement and different percentage of basalt fiber varying as 0, 0.3, 0.9%. We used micro silica so that there is increase in compressive as well as flexural strength and basalt fiber for increase in flexural strength.

**Keywords:** Basalt Fiber, Fly Ash, Micro silica, Self Compacting Concrete,

## I. INTRODUCTION

Self-compacting concrete is defined as a concrete which is capable of self-consolidating without any external efforts like vibration, floating, poking etc. under its own weight. The mix is therefore required to have ability of passing, ability of filling and ability of being stable. SCC developed by Prof. Okamura and his team in Japan in the early nineties, has evolved as an innovative technology, capable of achieving the status of being an outstanding advancement in the sphere of concrete technology. Though the concept of self-compacting concrete was evolved initially in Japan around 1988, since then several research efforts have been made in developed countries such as Western Europe, Canada, Sweden and Netherlands.

Self-Compacting Concrete has been described as “The most revolutionary development in concrete construction for several decades”.

## II. CEMENT

The raw materials required for manufacture of Portland cement are calcareous materials such as limestone or chalk, and argillaceous material such as shale or clay. Cement factories are established where these raw materials are available in plenty. Cement factories have come up in many regions in India, eliminating the inconvenience of long distance transportation of raw and finished materials. The process of manufacture of

cement consists of grinding the raw materials, mixing them intimately in certain proportions depending upon their purity and composition and burning them in a kiln at temperature of about 1300 to 1500 C, at which temperature, the materials sinters and partially fuses to form modular shaped clinker. The clinker is cooled and ground to fine powder with addition of about 3 to 5 % of gypsum. The product formed by using this procedure is Portland cement.

### **Hydration of cement:**

Anhydrous cement does not bind fine and coarse aggregate. It acquires adhesive property when mixed with water. The chemical reactions take place between cement and water is referred as hydration of cement. The chemistry of concretes is essentially the chemistry of the reaction between cement and water. On account of hydration certain products are formed. These products are important because they have cement in or adhesive water. The quality, quantity, continuity, stability and rate of the hydration products are important. Anhydrous cement compounds when mixed with water, react with each other form hydrated compounds of very low solubility. The hydration of cement can be visualized in two ways. The first is “through solution” mechanism. In this the cement compounds dissolve to produce a supersaturated solution from which different hydrated products get precipitate. The second possibility in water attacks cement compounds in solid state converting the compounds into hydrated products starting from the surface and proceeding into interior of the compounds with time. It is probable that both “through solution” and “solid state” types of mechanism may occur during the course of reactions between cement and water.

### **Heat of hydration:**

The reaction of cement with water is exothermic. The reaction liberates a considerable quantity of heat. This liberation is called heat of hydration. This is clearly seen if freshly mixed cement is put in a vacuum flask and the temperature of mass is read at intervals. The study and control of the heat of hydration becomes important in construction of concrete dams and other mass concrete constructions. It has been observed that the temperature in the interior of large mass concrete constructions. It has been observed that temperature of interior of large mass is 50 C above the original temperature of the concrete mass at the time of placing and this high temperature is found to persist for prolonged period .

## **III. AGGREGATES:**

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. Concrete can be considered as two phase material for convenience; paste phase and aggregate phase. Having studied the paste phase of concrete in the earlier chapter, we shall now study aggregates and aggregate in this chapter. The study of aggregates can best be done under the following sub-headings:

Size, Shape, Strength, Texture, Specific gravity and bulk density, Sieve analysis, Moisture content, Durability, Grading.

## **IV. ADMIXTURES**

Admixtures are the materials other than the basic ingredients of concrete-cement, water and aggregates- added to the concrete mix immediately before or during mixing to modify one or more of the specific properties of

concrete in fresh or hardened state. The use of admixtures should offer an improvement not economically attainable by adjusting the proportion of cement and aggregates, and should not adversely affect any property of concrete.

Super-plasticizers are admixtures which are water reducing but significantly distinctly more so than the water reducing admixtures (Water reducing high range admixtures). There exist four main categories of Super plasticizers; Sulphonated melamine formed condensates, Sulphonated naphthalene formed Hyde condensates, modified lingo sulphonates and sulphonic acid. Based on sulphonate naphthalene or melamine formaldehyde condensates, vinyl polymers on poly carboxylate ethers.

## V. FLY ASH

Fly ash is finely divided residue resulting from combustion of powered coal and transported by the flue gases and collected by electrostatic precipitator. In UK it is referred as pulverized fuel ash (PFA). Fly ash is most widely used pozzolanic material all over world. Fly ash was first used in large scale in construction of Hungry Horse dam in America in the approximate amount of 30% by weight of cement. Later on it was used in Canyon and Ferry dams etc. In India, Fly ash was used in Rihand dam construction replacing cement unto 15% in recent time, the importance and use of fly ash in concrete has grown so much that it has almost become a common ingredient in concrete, particularly for making high strength and performance concrete.

## VI. BASALT FIBERS

Basalt Fiber or Fiber is a material made from extremely fine Fibers of basalt, which is composed of the mineral plagioclase, pyroxene, and olivine. Basalt Fiber is a relative newcomer to Fiber reinforced polymers (FRPs) and structural composites. It has a similar chemical composition as glass Fiber but has better strength characteristics, and unlike most glass Fibers is highly resistant to alkaline, acidic and salt attack making it a good candidate for concrete, bridge and shoreline structures. A hard, dense volcanic rock that can be found in most countries across the globe, basalt is an igneous rock, which means it began in a molten state. For many years, basalt has been used in casting processes to make tiles and slabs for architectural applications. Additionally, cast basalt liners for steel tubing exhibit very high abrasion resistance in industrial applications. In crushed form, basalt also finds use as aggregate in concrete. More recently, continuous Fibers extruded from naturally fire-resistant basalt have been investigated as a replacement for asbestos Fibers, in almost all of its applications. In the last decade, basalt has emerged as a contender in the Fiber reinforcement of composites.

## VII. MICRO SILICA

The term “microsilica” is the one normally used to describe the very fine powder, which is extracted from exhaust gases of silicon and ferrosilicon smelting furnaces and utilized in concrete to improve the properties of the concrete. Other terms for the same product are silica fume and condensed silica fume(CSF). The main purpose of incorporating the material in concrete is to make use of the very fine and reactive particles to produce a denser cement matrix. The microsilica particles have a pozzolanic reaction with calcium hydroxide from the hydration of the cement, thereby increasing the total product of hydration and reducing the amount of calcium

hydroxide. When properly used, microsilica increases the strength and reduces the permeability of the concrete providing a more durable and more sustainable product.

### **VIII. METHODOLOGY**

#### **Workability Measurement of SCC:**

Workability of SCC is higher than highest class of any normal concrete. Being of flowing nature, normal workability measurement methods are not suitable for SCC. The concrete is classified as Self Compacting Concrete only if it satisfies the following requirement.

- Filling ability
- Passing ability
- Segregation resistance

Many different test methods have been developed in attempts to characterize the properties of SCC. So far, no single method or combination of methods has achieved universal approval and most of them have their adherents. Similarly, no single method has been found which characterizes all the relevant workability aspects of Self Compacting Concrete, so each mix design should be tested by more than one test method for the different workability parameters.

### **IX. MIX DESIGN PROCEDURE:**

Mix design was done using the EFNARC guideline.

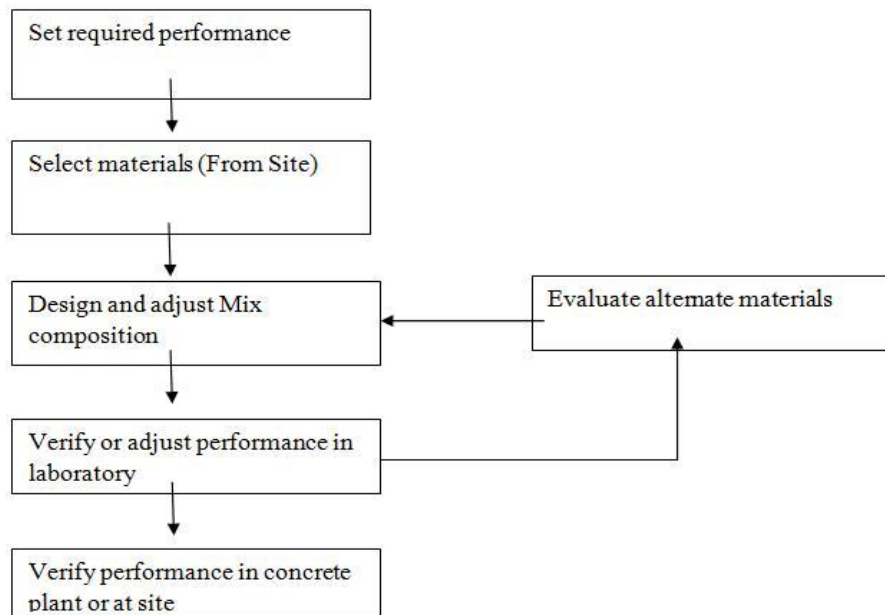


Chart No. 9.1 Chart Showing Mix Design Procedure

## X. RESULT OF WORKABILITY

RESULT OF WORKABILITY

SR. NO.	Test	0% Micro silica			5% Micro silica			10% Micro silica			15% Micro silica		
		0.0 BF	0.3 BF	0.9 BF	0.0 BF	0.3 BF	0.9 BF	0.0 BF	0.3 BF	0.9 BF	0.0 BF	0.3 BF	0.9 BF
1	Slump flow(mm)	755	745	705	750	745	700	745	725	705	735	710	685
2	V Funnel 0min.(S)	9.23	9.48	10.02	10.41	9.16	10.27	10.02	9.19	10.47	10.51	10.72	11.75
3	V Funnel 5min.(S)	10.05	10.71	11.3	11.56	11.33	12.66	12.16	11.44	13.18	12.64	13.57	14.51
4	L Box (h)	0.92	0.90	0.85	0.91	0.89	0.85	0.88	0.87	0.83	0.87	0.85	0.82
5	Super Plasticizer	0.7	1.1	1.7	0.8	1.0	1.75	0.85	1.05	1.8	0.9	1.1	1.8

Table no. 10.1 Table Showing Result of Workability

## XI. CONCLUSION

In present scenario there is a huge need of self compacting concrete where conventional way of compacting may not be always useful under different site condition. So instead of going for conventional concrete let us mix the concrete compacting on its own weight i.e. SCC

The present investigations show us the following things:

- We conducted the workability tests on the all the combinations and found that workability reduces with increase in percentage of micro silica.
- There was considerable decrease in workability with the increase in basalt fiber. It demanded comparatively more super plasticizer than micro silica and its dose got still higher when the combination of both was done.
- We found that compressive strength increases keepings 0% basalt fiber and varying percentage of micro silica and same vice versa.
- Hence we can say that for achieving more compressive strength combination of micro silica and basalt fiber can be considered. As we got the maximum compressive strength for maximum value of micro silica and basalt fiber we cannot comment about its optimum dose a it might increase or decrease with higher dose of micro silica and basalt fiber. Hence some more experimentation is required with more dosage in order to comment about its optimum dose. Flexural strength increase for increase in percentage of basalt fiber keeping 0% micro silica. Also we found than for 10 and 15% micro silica the strength was maximum for 0.3% basalt fiber i.e. 16.875N/mm<sup>2</sup> and 16.14N/mm<sup>2</sup> respectively.

## REFERENCES

- [1.] EFNARC” Specifications and guidelines for Self Compacting Concrete” February 2002.
- [2.] Shetty M.S. Concrete Technology, by S. Chand Publications.

- [3.] Chaohua Jiang, Ke Fan, Fei Wu, „Experimental study on the mechanical properties and microstructure of chopped basalt fibre reinforced concrete“  
Volume 58, June 2014,Pages 187–193
- [4.] Heba A. Mohamed,“ Effect of fly ash and silica fume on compressive strength of self-compacting concrete under different curing conditions“ Volume 2, Issue 2, June 2011, Pages 79–86.
- [5.] Nicolas Ali Libre, Mohammad Shekarchi,“ Mechanical and durability properties of self consolidating high performance concrete incorporating natural zeolite, silica fume and fly ash“ Volume 44, July 2013, Pages 175–184.
- [6.] R.V. Ranganatha, JagadishIVengalab,“ Influence of powder and paste on flow properties of SCC“ .
- [7.] FereshtehAlsadatSabet, Nicolas Ali Libre, Mohammad Shekarchi,  
“Mechanical and durability properties of self consolidating high performance concrete incorporating natural zeolite, silica fume and fly ash”.
- [8.] Mounir M. Kamala, Mohamed A. Safana, Zeinab A. Etman,“MechanicalI properties of self-compacted fiber concrete mixes“ .
- [9.] I.M. Nikbin, M.H.A. Beygi, M.T. Kazemi, J. VaseghiAmiri,“ Comparison of the Effects of Different Fibers on the Properties of Self-compacting Concrete”  
Materials & Design, Volume 59, July 2014, Pages 199-210.
- [10.] OzgurÇakır, Influence of silica fume onmechanical and physical properties of recycled aggregate concrete; HBRC Journal Available online 18 July 2014.