Experimental Investigation on Steel Fiber Reinforced Self Compacting Concrete

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Abstract— Concrete are the most important materials used in construction industries where the external forces more than the design loads mainly the lateral forces which leads to the deformation and produce cracks in the joints of the structural member. The usage of cement has been increased more over the world results in the air pollution which leads to the ozone depletion. Self-Compacting Concrete gets dense and compacted due to its own self-weight. The ingredients used for SCC are 53 grade Ordinary Portland Cement, Fine Aggregate, Coarse Aggregate, Super Plasticizer, Class-F Fly ash from thermal power plant, Viscosity modifying agent.

In the present experimental investigation, the main concentration is focused on to study the basic properties of cement, fly ash, fine aggregate, coarse aggregate, super plasticizer and viscosity modifying agent. Then the mix design is carried out for M30 grade concrete of SCC by European method for various fiber proportions. And also, fresh & hardened concrete properties such as slump flow, V-Funnel, L-box, U-box test carried out for self-compacting concrete.

Index Terms— SCC, fly ash, super plasticizer, deformation, properties.

I. INTRODUCTION

Concrete are the most important materials used in construction industries where the external forces more than the design loads mainly the lateral forces which leads to the deformation and produce cracks in the joints of the structural member. The usage of cement has been increased more over the world results in the air pollution which leads to the ozone depletion. Self-Compacting Concrete gets dense and compacted due to its own self-weight. The ingredients used for SCC are 53 grade Ordinary Portland Cement, Fine Aggregate, Coarse Aggregate, Super Plasticizer, Class-F Fly ash from thermal power plant, Viscosity modifying agent.

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II. APPLICATION AREAS OF SCC

SCC may be used in pre-cast applications or for concrete placed on site. It can be manufactured in a site batching plant or in a ready mix concrete plant and delivered to site by truck. It can then be placed either by pumping or pouring into horizontal or vertical structures. In designing the mix, the size and the form of the structure, the dimension and density of reinforcement and cover should be taken in consideration. These aspects will all influence the specific requirements for the SCC.

Due to the flowing characteristics of SCC it may be difficult to cast to a fall unless contained in a form. SCC has made it possible to cast concrete structures of a quality that was not possible with the

existing concrete technology.

III. STUDY ON MATERIALS

A. FINE AGGREGATE

The sand used for experimental program was locally procured and conforming to zone II. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm. The fine aggregate were tested as per Indian Standard Specification IS: 383 – 1970.

B. COARSE AGGREGATE

Aggregates typically constitute 70 – 80 % weight of Concrete; hence, aggregate types and sizes play an essential role in modifying the concrete properties. The maximum size of aggregate is generally limited to 20 mm. Aggregate of size 10 mm is desirable for structure having congested reinforcement. Well graded cubical or rounded aggregates are desirable. Aggregates should be of uniform quality with respect to shape and grading. The maximum 15 mm size was selected to reduce difficulties of producing, mixing and placing concretes and to prevent segregation of aggregates in fresh concretes.

C. CEMENT

Cement can be defined as material having adhesive and cohesive properties which make it capable of bonding material fragments into a compact mass. Cement is the most important ingredient in concrete. Different brands of cement have been found to posses different strength development characteristics and rheological behavior due to the variation in compound composition and fineness. In this experimental study ordinary Portland Cement conforming to IS: 8112-1989 was used.

D. FLYASH

Flyash consists of fine, Powdery particles that are predominantly spherical in shape, either solid or hollow, and most glassy in nature. Class F flyash as per IS 3812 – 2000 is used.

E. SUPER PLASTICIZERS

A number of studies have been conducted on the use of different types of super plasticizers with or without viscosity modifying agents in self compacting concrete. These studies seem to indicate those that super plasticizers that work on the principle of ‘steric hindrance’ require a lower dosage compared to those based on ‘electrostatic repulsion’. Stated in other words, acrylic copolymers (AC) and polycarboxylate ethers (PCE) are effective at lower dosages compared to sulfonated condensates of melamine (SMF) or naphthalene (SNF) formaldehyde. At present, SNF-based admixture is priced lower (in India) than that based on AC and PCE. In our project, we use Glenium 8233, polycarboxylate ether based super plasticizer.

Glenium sky 8233 is an admixture of a new generation based on modified polycarboxylic ether. The product has been primarily developed for applications in high performance concrete

where the highest durability and performance is required. GLENIUM sky 8233 is free of chloride and low alkali. It is compatible with all types of cements.

F. VISCOSITY MODIFYING AGENTS

The conventional method of improving the stability of flowing SCC is to increase the fines content by using a large amount of filter, reactive or inert. Of late, however, attempts are being made to reduce the fines content (and paste content) to the level of normal concrete (in doing so, reducing the potential for creep and shrinkage) and use viscosity modifying agents (VMAs) to improve the stability. Current research shows that SCC produced with low powder content and VMA had similar fresh concrete properties as SCC with high powder contents produced without VMA.

VMAs have been in use for a long time. They were mainly used for underwater concreting in the past, but are now also used in self-compacting concrete. Most VMAs have polysaccharides as active ingredient, some starches could also be appropriate for control of viscosity in SCC.

The sequence of addition of VMA and super plasticizer into the concrete mixture is important. If VMA is added before the super plasticizer, it swells in water and it becomes difficult to produce flowing concrete. To avoid this problem, VMA should be added after the super plasticizer has come into contact with the cement particles. Another method of addition is to disperse the super plasticizer in mixing water and then add VMA to this mixture. In this project, we use Matrix 2 a Viscosity modifying agent.

G. WATER

Water is the most important and least expensive ingredient of concrete. It acts as lubricant for fine and coarse aggregate and acts chemically with cement to form binding paste. The quantity water should be sufficient for hydration and suitable for workability. Normal portable water is used for mixing of concrete.

H. STEEL FIBERS

The steel fibers used in the project are of steel fiber of 60 mm in length and 0.75 mm in thickness

5. MIX PROPORTIONS

The desired properties of concrete can be obtained by using the ingredients in a certain proportion. Thus determining the relative amounts of materials is known as mix design. Thus it can be defined as the process of selecting suitable ingredients of concrete and determining their relative quantities for producing the concrete of desired properties strength, durability and consistency, etc., as economical as possible.

IV. EXPERIMENTAL INVESTIGATION

A. PREPARATION OF SELF COMPACTING CONCRETE

The ingredients of Self Compacting concrete are Cement, Fly ash, Coarse aggregate, Fine

aggregate, Super plasticizer, viscosity modifying agent and water. Here the cement is replaced by class-F flyash by 20% of its weight. The size of coarse aggregate is 10 mm to 12 mm is used. The quantity of super plasticizer is 0.8 lit per 100 kg of cement and the quantity of viscosity modifying agents is 0.4 lit per 100 kg of cement.

The ingredients are weighted and now ready for mixing. First dry mix is prepared than 80% of total quantity of water is added. After two minutes mixing remaining 20% of water is added with a super plasticizer and viscosity modifying agent. Now we obtain self-compacting concrete.

B. TESTS ON FRESH CONCRETE

1. Slump flow & T_{50} test
2. V- funnel test & V- funnel at T_5 minutes
3. L- box test
4. U- box test

WORKABILITY TEST RESULTS FOR SCC

S.No	Workability Test Methods	Minimum	Maximum	SCC
1	Slump flow (mm)	600	800	700
2	T_{50} cm Slump flow (sec)	2	5	2
3	V-funnel test (sec)	6	12	7
4	V-funnel test at T_5 min (sec)	0	+3	5
5	U – Box test (sec)	0	30	40
6	L – Box test (H_2/H_1)	0.8	1	0.89

CHARECTERISTIC COMPRESSIVE STRENGTH

S.No	TYPE OF CONCRETE	7^{th} DAY TEST RESULT (N/mm^2)	14^{th} DAY TEST RESULT (N/mm^2)
1	Conventional Concrete	22	29
2	SCC 1	20	27
3	SCC With Steel Fiber 1%	24	29
4	SCC With Steel Fiber 2%	25	32

CHARECTERISTIC SPLIT-TENSILE STRENGTH

S.No	TYPE OF CONCRETE	7th DAY TEST RESULT (N/mm^2)	14th DAY TEST RESULT (N/mm^2)
1	Conventional Concrete	2.7	2.87
2	SCC 1	2.6	2.8
3	SCC With Steel Fiber 1%	2.86	2.97
4	SCC With Steel Fiber 2%	3.12	3.24

V. CONCLUSION

The basic Properties of materials were tested and results tabulated. The Self Compacting Concrete mix proportions are determined by various trial and error method of SCC. In this Project the used two admixtures such as super plasticizers and viscosity modifying agent. The Self Compacting Concrete is achieved by Cement, Flyash, Coarse aggregate, Fine Aggregate, Super plasticizer, Viscosity modifying agent and water. The fresh concrete tests are conducted to find the workability. The fresh concrete tests like L box, V funnel, U Box and slump flow tests were conducted and results were tabulated.

The future work to evaluate the various strength properties of self compacting concrete and optimum dosage of flyash as replacement of cement. Then the various test specimens like cube, Cylinder casted and used to find the strength. Then the comparative study will be carried out between conventional concrete and SCC.

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