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A review on mechanical and rheological properties of self compacting concrete with glass and carbon fibre

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Abstract

Fibre-reinforced self-compacting concrete is a new building material that combines positive characteristics of workability of self-compacting concrete (SCC) with enhanced characteristics of hardened concrete due to fibre addition. Self-compacting concrete is a state of the art technology actively used all over the world in the construction field. In this paper give a brief overview on the mechanical and rheological properties of self compacting concrete with glass and carbon fibre.

Keywords: Fibre Reinforced (FC), Self Compacting Concrete (SCC), Glass and Carbon Fibre, Fibre Reinforced Self Compacting Concrete (FRSCC).

Introduction

Self-compacting concrete (SCC) is a flow-able concrete mixture that is provided with viscosity by adding various types of admixtures with impart the fluidity to the composite. The highly fluid nature of this concrete makes it adaptable for putting it in difficult conditions and in sections with complicated reinforcement. SCC is a highly flow-able type of concrete that need not required mechanical vibration to be placed as such normal concrete. SCC is non-segregating concrete that is moved with fluidity under gravitation and also, the addition of super-plasticizers and viscosity modifier are added to concrete to make it that way [1]. SCC inhibits segregation by the use of mineral fibres which help in holding the components together and so that all has equivalent viscosity and does not separate under the gravitation and hence, it helps in the thorough movement of the concrete [2]. Self-consolidating concrete is needs to be placed in its own weight, Flow-ability should be high enough to makes it flow under its own weight. It is necessary to meet this kind of requirement. Self-compacting concrete has higher strength when compared to the vibrated concrete of the same proportion and hence it is more convenient in providing a better interface between aggregates and the cement. Also, Self-Compacting concrete can be placed taller than the 5 meters height and at very rapid pace than the conventional concrete.

Carbon fibres have low density, high thermal conductivity, good chemical stability and exceptional abrasion resistance, and can be used to decrease or reduce cracking and shrinkage. These fibers increase some structural properties like tensile and flexural strengths, flexural toughness and impact resistance [3]. Carbon fibers also help to improve freeze-thaw durability and dry shrinkage. The adding of carbon fibers decreases the electrical resistance. Type of Carbon fiber:- Different type of Carbon fibre, according to properties and application.

Glass fibres are formed by the process in which molten glass is drawn in the form of filaments. The 204 filaments are drawn simultaneously and cooled, once solidified they are together on a drum into a strand containing 204 filaments. The

treatment of filaments is done with a sizing which shields the filaments against weather and abrasion effects prior to winding. Different types of glass fibres are there such as C-glass, E-glass, S-glass, AR-glass etc. Are manufactured having different properties and specific applications. E-glass, AR-glass, S-glass fibres are fibres used for structural reinforcement owing to alkali resistance. E-glass fibre is most used and least expensive of all. Glass fibre occur primarily in two forms (1) Continuous fibres (2) Discontinuous or chopped fibres. Advantages of glass fibres are that they are low cost, high strength, easy and safe handling, and rapid and uniform dispersion facilitating homogeneous mixes which in turn produce durable concrete. Disadvantages are poor abrasion resistance causing reduced usable strength. Glass fibres possess poor adhesion to specific polymer matrix materials and poor adhesion in humid environments.

Self-compacting concrete benefits

SCC has been frequently used in bridges and precast sections because of its flowing nature. The Akashi-Kaikyo Suspension Bridge is an example where self-compacting concrete is used. In this project, the SCC was mixed on-site and placed with the help of piping system and placed at 200 m far from where it is prepared. The project was completed early by at-least 2 years. It is further useful in the following

- Drilled shafts
- Columns
- Earth retaining systems

Using self-compacting concrete produces several benefits and advantages over regular concrete. Some of those benefits are:

- Improved construction.
- Labour reduction.
- Bond to reinforcing steel.
- Improved structural Integrity.
- Accelerates project schedules.
- Reduces skilled labour.
- Complex formation.
- Reduces equipment wear.
- Minimizes voids.
- Produces superior surface finishes.
- Superior strength and durability.
- Easier pumping procedure.
- Rapid placement of concrete
- Less noise pollution of vibrators
- Produces a uniform surface.
- Gives Architects to design complex shapes

- Used in long and deep sections.
- Gives variety in placement techniques

Literature Review

Mohammed et. al. 2020 [4], investigate an experimental study of fiber reinforced self compacting concrete (SCC) containing basalt fibers (BFs) and polypropylene fibers (PF). The mechanical properties of SCC reinforced with basalt fiber and polypropylene fibers were investigated in this study. The influence of basalt fibers (BFs) and polypropylene fibers (PF) with different contents on the compressive strength, flexural strength, splitting tensile strength and stress-strain curve of SCC were investigated. Basalt fibers with an aspect ratio 48 and polypropylene fibers with an aspect ratio 60. Percentage of fibers considered are 0.5percent, 1percent and 1.5percent of concrete mix. Ratio of volume of hybridization of fibers includes 1is to1, 1is to3 and 3 is to1(Polypropylene fiber is to Basalt fiber) for the above percentage of fibers.

Cholker et. al. 2019 [5], present the study performed on mechanical and durability properties of SCC concrete reinforced with carbon fibers. SCC mix used in present study is reinforced with carbon fibers from 0.5% to 2.5% by weight of cement. Different tests, namely slump flow, V-funnel, L-box and U-box test were conducted to check the rheological properties of freshly mixed SCC. Results obtained for all the mixes were within prescribed limits by EFNARC. The durability and mechanical properties of hardened concrete were studied to check different strengths. In mechanical properties, compressive strength was observed to increase when fiber dosage was up to 1% by weight of cement and later decreases as the dosage of fibers was increased from 1.5% to 2.5% by weight of cement. Split tensile strength, flexural strength was observed to be increasing for increasing dosage of carbon fibers. The durability of concrete also increased as fiber dosage.

Murugan, et al, 2017 [6], finds that the fibrous reinforced concrete reduces the workability but it is well under guidelines of the European federation. The strength increases when the glass fibre content is up to 0.6%. It also enhances the strength by preventing crack propagation in the concrete. Additional increase in strength is seen while & day and 28 days testing. the flexural and the bending strength is also enhanced with the fibre aggregate bonding. However fresh concrete test slump flow test is not up to the mark but within permissible limits.

Dinesh, et. al. 2017 [7], the properties of the Self compacting concrete with admixtures and evaluated. Self-compacting concrete (SCC) is a flow able concrete mixture that is provided with viscosity by adding various types of admixtures with impart the fluidity to the composite. The highly fluid nature of this concrete makes it adaptable for putting it in difficult conditions and in sections with complicated reinforcement. SCC is a highly flow able type of concrete that need not required mechanical vibration to be placed as such normal concrete. SCC is non-segregating concrete that is moved with fluidity under gravitation and also, the addition of super-plasticizers and viscosity modifier are added to concrete to make it that way. SCC inhibits segregation by the use of mineral fibres which help in holding the components together and so that all should have equivalent viscosity and does not separate under the gravitation and hence, it helps in the through

movement of the concrete. Self-consolidating concrete is needs to be placed in its own weight, Flow ability should be high enough to makes it flow under its own weight. it is necessary to meet this kind of requirement.

Sugathan et. al. 2017 [8], studied self-compacting concrete with sisal fibres and results are discussed in this paper. Sisal fibres are agriculture material sand is used in the experiment because of its ability to stretch. These fibres are known to improve the ductility of the SCC and are used of size 12mm in length and .12mm in diameter. All others properties including J test, L Test, and other hardened properties fall under the normal category. The sisal fibres are therefore helpful in improving the properties of the concrete. Segregation by the use of hybrid fibres helps in holding the components together and so that all have equivalent viscosity and does not separate under the gravitation. SCC inhibits segregation by the use of sisal fibres which help in holding the components together and so that all have equivalent viscosity and does not separate under the gravitation and hence, it helps in the through movement of the concrete.

Mirza et. al. 2016 [9], studied the Self Compacting concrete with various combination of the SCC mixes with fly ash and polypropene. However, the findings of the experiment out as expected with reduced workability and T600 and T400 are measured and all regular characteristics are studied with the normal SCC test procedures and Differences are measured and evaluated. The observed flow is from 610 to 700 mm which is slightly lower than the normal SCC mixture clearly shows the lowering in the workability which tends to be till 750 he obtained less workability and strength and the fibre flow ability. The viscosity of the SCC examined is inversely proportional to super plasticizer content incorporated, up to a saturation point where the viscosity remains fixed.

Haddadou, et. al. 2015 [10], studied the properties of the SCC with Polypropene and steel fibres and discussed the technological problems associated with the uneven distribution of the fibres in SCC., in this form the strength of the concrete increases significantly also with the help of the fibre and their long transverse placement can increase the flexural strength of the beam in accordance to the direction of the movement of concrete and thus the placement of fibres in concrete henceforth plays a very important role in the Self compacting concrete. However, the workability reduces as compared to the normal one and hence the super plasticizers are needed in more quantity. The flow-ability and passing tests clearly showed in the experiment that there is need of more water controlling plasticizer are needed. They discovered that all the properties improved when steel fibres are added to the self-compacting concrete except for the workability and thus promoting the use of steel fibres considering its advantage. All the other properties remain indicted with the SCC with additional fibres but not the workability which somehow needs to be checked.

Brundha et. al. 2015 [11], studied the properties of the SCC with Poly-propene and steel fibres and discussed the technological problems associated with the uneven distribution of the fibres in SCC., in this form the strength of the concrete increases significantly also with the help of the fibre and their long transverse placement can increase the flexural strength of the beam in accordance to the direction of the movement of concrete and thus the placement of fibres in concrete henceforth plays a very important role in the Self compacting concrete. However, the workability reduces as compared to the normal one and hence the super plasticizers are needed in more quantity. The flow-ability and passing tests clearly showed in the experiment that there is need of more water controlling plasticizer are needed. They discovered

that all the properties improved when steel fibres are added to the self-compacting concrete except for the workability and thus promoting the use of steel fibres considering its advantage. All the other properties remain intacted with the SCC with additional fibres but not the workability which somehow needs to be checked. The studied the acid attacks on SCC fibres in dilute HCL which results in the decrease of the strength of the concrete.

Conclusion

In this paper present the study and brief review on mechanical and rheological properties of self compacting concrete with glass and carbon fibre. The main strength are:

- The use of various agro-industrial wastes in SCC has positive effect on fresh and hardened properties.
- The mechanical behaviour was greatly affected by the inclusion of the fibres and thus finally improves the quality of the concrete, concrete inhomogeneity as a result of the fibres bad distribution that is rarely randomly oriented within the concrete can affects its binding.
- Experiments shows that it is possible to maintain SCC characteristics while using fibre reinforcement
- It is possible to produce medium strength, high strength and even ultra-high strength good quality of SCC using the wastes
- SCC inhibits segregation by the use of mineral fibres which help in holding the components together and so they that all have equivalent viscosity and does not separate under the gravitation and hence, it helps in the through movement of the concrete.

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