A review on Experimental study on glass fiber reinforced self compacting concrete.

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1. Abstract: - In this review the experiments study of hardened properties of fresh self compacting concrete and glass fiber reinforced self compacting concrete are compared. Also the influence of glass fiber on fresh and hardened properties of self compacting concrete is investigated. The utilized of glass fiber in SCC improved mechanical properties and durability an hardened concrete mixture SCC compare the fresh properties (compressive strength, splitting tensile strength, modulus of rapture and modulus of elasticity) of SCC with varying glass fiber percentage % .and SCC with (Glass Fiber Reinforced Concrete) GFRC were prepared with a water cement ratio of 0.35 .it was found that addition of glass fiber to be slightly reduced the workability properties of SCC. Compressive strength and splitting tensile strength of SCC were found to be slightly higher than fresh SCC. Modulus of rapture and modulus of elasticity of SCC was found to be lower than fresh SCC. Addition of glass fiber in SCC had limited effect on compressive strength and modulus of elasticity but increased modulus of rapture and splitting strength significantly.

Key words: self compacting concrete, glass fiber, mechanical properties, fly ash, glass fiber reinforced concrete.

2. Introduction

SCC also referred to as self compacting concrete that is also to flow under its own weight and completely fill the framework, while maintaining homogeneity even in the presence of congested reinforcement and then consolidating without the need of vibration. It is able to gush under its own load, completely filling form work and achieve the full compaction, even in the occurrence of congested support. The hardened concrete is dense, uniform and has the same property and durability as standard vibrated concrete. Fill Completely in the frame work even in the presence of dense reinforce while maintaining homogeneity without the need for any additional compaction. Self-compacting concrete (SCC) was first proposed by Prof. Hajimi Okamura and Ozawa in Tokyo University Japan 1986. Glass fiber reinforced concrete was developed in the 1960's and rapidly established it's an efficient construction material with major benefit in efficiency, weight saving and durability.

It was developed to offset the growing shortage skilled labor. L&T construction took initiation to implement this technique in INDIA A as of the year 2000 SCC use for pre fabricate product precast members & ready mix concrete (cast - in- situ)] in JAPAN, USA, later on INDIA etc.

3. Literature Review

Ozawa *et al.* (1989) focused on the influence of mineral admixtures, like fly ash and blast furnace slag on the flowing ability and segregation resistance of self-compacting concrete. They found out that on partially replacement of OPC by fly ash and blast furnace slag the flowing ability of the concrete improved remarkably. He concluded that the best flowing ability and strength characteristics 10-20% of fly ash and 25-45% of slag cement by mass.

Domone and His-Wen (1997) performed a slump test for high workability concrete. A beneficial correlation between the slump values and flow was obtained from the laboratory test. It showed satisfying value of the slump flow.

Bui (2002) discussed a speedy method in order to test the resistance to segregation of Self-compacting concrete. Extensive test programmed of SCC with different water-binder ratios, paste volumes, combinations between coarse and fine aggregates and various types and contents of mineral admixtures was carried out. The test was helpful in concluding the method along with the apparatus used for examining the segregation resistance of SCC in both the directions (vertical and horizontal).

Xie (2002) presented the preparation technology of high strength self- compacting concrete (SCC) containing ultra pulverized fly ash (UPFA) and super plasticizer (SP).Various parameters of concrete were selected namely good workability, high mechanical properties and high durability and SCC was developed. There was low slump loss in the fresh SCC mixture. SCC containing UPFA and SP can be evaluated by the method of combining slump flow and L-box test. Slump flow was 600-750 mm. Flow velocity of L-box test was 35-80 mm/sec.

Lachemi and Hossain (2004) presented the research on the suitability of four types of Viscosity Modifying Agent (VMA) in producing SCC. Fresh and hardened properties of SCC were studied by adding different VMA to SCC. The deformability through restricted areas can be evaluated using v-funnel test. In this test, the funnel was filled completely with concrete and the bottom outlet was opened, allowing the concrete to flow out. The time of flow from the opening of outlet to the seizure of flow was recorded. Flow time can be associated with a low deformability due to high paste viscosity, higher inter particle friction or blockage of flow. Flow time should be below 6 sec for the concrete to be considered as SCC. All the mix performed well with no significant segregation and jamming of aggregate was noticed.

Cengiz (2005) used fly-ash with SCC in different proportional limit of 0%, 50% and 70% replacement of normal Portland cement (NPC). He investigated the strength properties of self compacted concrete prepared using HVFA (high volume fly ash). Concrete mixtures made with water-cementations material ratios ranged from 0.28 to 0.43 were cured at moist and dry curing conditions. He investigated the strength properties of the mix and developed a relationship between compressive strength and flexural tensile strength. The study proved that it is possible to convert an RCC (zero slump) concrete to a workable concrete with the use of suitable super plasticizer.

Ferrara (2006) evaluated the HLSCC for all the basic properties namely flow ability, segregation resistance ability and filling ability of fresh concrete. The tests of slump flow (for measuring of flow ability) and the time which is required to reach the 500 mm of slump flow (S) (for measuring of segregation resistance ability) of HLSCC satisfied the expected capacity level in all mixes, the time is noted which is required to completely flow through V-funnel (S) (for measuring of segregation resistance ability) only satisfied the level in most of the LC mixed concrete (mix no. 2-4) and one of mixed concrete (mix no. 6).

Kumar (2006) reported the history of SCC development and its basic principle, different testing methods to test high-flow ability, resistance against segregation, and passing ability. Different mix design methods using a variety of materials has been discussed in this paper, as the characteristics of materials and the mix proportion influences self-compact ability to a great extent, also its applications and its practical acceptance at the job site and its future prospects have also been discussed. Orpiment test was performed, the more dynamic flow of concrete in this test simulates better the behavior of a SCC mix when placed in practice compared with the Slump-flow variation. The Orpiment/J-ring combination test shows great promise as a method of assessing filling ability, passing ability and resistance to segregation.

Sahmaran (2007) presented a paper on study of fresh and mechanical properties of a fiber reinforced self-compacting concrete inculpating high-volume fly ash in mixtures containing fly ash. Fifty percent of cement by weight was replaced with fly ash. It was found that the slump flow diameters of all mixtures were in the range of 560-700 mm which was in acceptable range and the slump flow time was recorded to be less than 2.9 seconds.

Khatib (2008) investigated the properties of self-compacting concrete prepared by adding fly ash (FA). FA was used as a replacement for Portland Cement (PC). PC was replaced 0-80% by fly ash. For all the mixes water binder ratio was maintained as 0.36. Strength properties as well as the workability, shrinkage, absorption and ultrasonic pulse velocity were studied in this research. From the observations it was concluded that 40% replacement of FA resulted in strength of more than 65 N/mm2 at 56 days. On increasing the amount of fly ash the high absorption values were obtained and absorption of less than 2% was exhibited.

Grdić (2008) presented the properties of self compacting concrete, mixed with different types of additives: silica fume and fly ash. L-box test was used to assess the passing ability of SCC to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blockage. L- Box has arrangement and the dimensions by difference with the height of the horizontal section of the box, these three measurements are used to calculate the mean depth of concrete as h2 mm. The same procedure was used to calculate the depth of concrete immediately behind the gate h1 mm. The passing ability was calculated from the following equation: $Pa=h2/h1$ Where; Pa is the passing ability and the value of Pa ranged between 2-10 mm. h1 and h2 are the height in mm at near and far end of passing ability respectively.

Miao (2010) conducted a research on developing a SCC with cement replacement up to 80% in all the mixes and examining its fresh properties. Result show that the fly ash acts as a lubricant material; it does not react with super plasticizer and produce a repulsive force and the super plasticizer may only act on the cement. As a result, the larger the amount of fly ash contained, lesser the super plasticizer needed.

Hiba (2011) presented an experimental study on SCC with two cement contents; the work involved three types of mixes, the first considered different percentages of fly ash, the seconds used different percentages of silica fumes and the third used mixtures of fly ash and silica fume. It was concluded that higher the percentages of fly ash the higher the values of concrete compressive strength until 30% of FA, however the higher values of concrete compressive strength is obtained from mix containing 15% FA.

Ali Abd-Elhakam Aliabdo (2012) carried out an experimental study on polymer modified concrete self compacting concrete (PMSCC). Two different polymers, styrene butadiene rubber (SBR) and polyvinyl acetate (PVC) are used in this experiment in different dosage from 0%, 5%, 10% and 15% in the production PMSCC and was compared with traditional concrete and self compacting concrete. The filler material used in this experiment is Lime powder and Silica fume. To increase the flow properties super plasticizer namely, naphthalene and modified poly carboxylic ether were used for the production of SCC. The flow test is conducted on a constant 70 cm diameter of concrete for 12 different mix designs. The comparison is tested between

SBR and PVC in PMSCC and SCC. From the results it was observed that, at 90 days compressive strength of PMSCC is 25% higher than the self compacting concrete. Lime powder and Naphthalene based chemical admixture shows aboriginal improvement in compressive strength, mechanical properties and bond strength. The use of polymer decreases the degree of hydration of cement.

Kannan (2013) carried out an experiment of chloride and chemical resistance of self compacting concrete using Rice Husk Ash (RHA) and Meta kaolin (MK) as filler materials and replacement of cement. Seventeen different mixes for various proportions were designed including ordinary SCC and tested for suitability. The percentage replacement of RHA and MK adopted in this study were 5%, 10% 15%, 20%, 25% and 30% in separate and combined percentage replacement of RHA and MK were 5%, 10%, 15% and 20% with the addition of super plasticizer (SP). The fresh state is tested for all mix and the flow properties are observed. From the results it was observed that compressive strength increased at a replacement of 15% (RHA), 20% and 30% (MK) in combination of both. The durability test to determine the acid resistance is carried out by immersing the cube in H2SO4 solution, the result shows that there is a better improvement during individual replacement of RHA and MK at 25% and 5% respectively and 40% of combination of RHA and MK. The SEM analysis clearly states that there were no pores while RHA and MK are combined together.

Edwin Fernando (2014) carried out an experimental investigation on self compacting concrete by replacing the fly ash as a filler material and copper slag as fine aggregate at a percentage of 5%, 10%, 15%, 20% and 25%. Mix design is done as per EFNARC specification by keeping water cement ratio of 0.40 all mix and super plasticizer was used to increase the flow properties. The fresh and hardened properties of concrete was tested as per the standards and compared for normal SCC and SCC with partial replacement of fly ash and copper slag. The result shows a marginal improvement in the replacement of cement by fly ash up to 40%.

Nileena (2014) replaced the Ground Granulated Blast Furnace Slag and Granulated Blast Furnace Slag as filler material by the water cement ratio of 0.45. Six different mix proportions were prepared with a partial replacement of cement by GGBS at 30%, 40% and 50% and GBS at 30%, 40% and 50% as partial replacement of fine aggregate. . Super plasticizer is used to achieve the self compatibility. The standard tests for fresh and hardened concrete was carried out and it was observed that only a small increase in compressive strength was achieved for 20% partial replacement of GGBS and GBS. But, ultrasonic pulse velocity shows an excellent result that there is no crack or undulations inside the specimen.

Nageswararao (2015) replaced the fine aggregate by crushed stone dust (CSD) and marble sludge powder (MSP) in various proportions in combination. Six mix deigns were prepared by partial replacement of CSD and MSP at 0%, 20%, 40%, 60%, 80% and 100%. Super plasticizer is added in various ratios 0.35, 0.3 and 0.25 to obtain the flow properties. The fresh and hardened concrete (Compressive strength, Split tensile strength and Flexural strength) properties show good results at a partial replacement of MSP (60%) and CSD (40%) with lower water content. However, the durability results are not comparable with normal self compacting concrete. Self compacting concrete can be achieved by low water cement ratio with addition of super plasticizer.

Subhan ahmad (2016) compare to properties of NC and SCC then compressive and slitting tensile strength of SCC was found to be slightly higher than the corresponding properties of NC. Addition of 0.6%kg/m^3 of glass fiber slightly reduced the fresh properties of SCC. Glass fiber increased compressive strength and modulus of elasticity but increased slitting tensile strength and modulus of rupture by considerable amount.

4. Conclusion

The concept of self-compacting concrete has established itself as innovative material in the area of concrete technology.
The general procedure of mix design can be adopted for self compacting concrete for various applications based on experiences in identification of suitable mix proportion. The increase in fine material increases the suitability of self compacting concrete.
The partial replacement of cement and fine aggregate with finer material exhibit self compacting concrete with low segregation potential. Self compacting concrete with mineral admixtures shows satisfactory results.
The research focus on viscosity agent and the interaction with super plasticizer is worthwhile in self compacting concrete.

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