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Study of Self Compacting Concrete - A Review

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Abstract – *Self Compacting Concrete is a distinctive concrete that can be placed and compacted under its own weight without any vibration effort. It also reduces difficulties of insertion of concrete in problematic condition, decreces time of placing of section and at a same time attains high strength and better durability. The different admixture like Ground granulated blast furnace slag, fly ash, lime stone powder, silica fumes, rice husk ash, glass powder etc. have proved effective for production of Self Compacting Concrete with satisfactory strength. This paper includes significant research on Self Compacting Concrete with regard to identification of mix proportion, fresh and mechanical properties along durability also been discussed.*

Key Words: Self Compacting Concrete, Super plasticizer, Durability, Strength, Viscosity modify agent, Filler material, Strength.

1. INTRODUCTION

Concrete is one of the flexible materials which are used worldwide. In 1980, Self Compacting Concrete first developed by Okmura at the Tokyo university. Self Compacting Concrete which can flow through crowded reinforcing bar without compaction and any experience of bleeding and segregation. The development of self-compacting concrete (SCC) also referred to as ‘‘Self-Consolidating Concrete’’ has recently been one of the most important developments in building industry. Super plasticizer is supplement to the concrete to attain such advanced properties demanding high slump. It has three essential fresh concrete properties filling ability, passing ability and segregation resistance. The demand of Self Compacting Concrete is growing rapidly due to many advantages like easier placing, faster construction time, reduced noise level, improved durability, reduction noise caused by casting, reduction in site manpower, thinner concrete section, safer working environment , better surface finishing.

Self Compacting Concrete doesn’t have any specific method of mix design so far and there are only method based on laboratory test which required more materials. Many investigators worked on the use of different admixtures in Self Compacting Concrete as limited replacement of cement. Testing was conducted in the laboratory on the samples casted by using different replacement materials to study the variation of properties of self-compacting concrete. The behaviour of concrete is studied under various replacement combinations of admixtures / waste materials with cement to examine the effect on various properties of Self Compacting Concrete.

2. REVIEW OF LITERATURE

Vijaya G. S, Dr. Vaishali G. Ghorpade, Dr. H. Sudarsana Rao(2018) gives outlines laboratory study on chloride resistance of waste plastic fiber reinforced self compacting concrete. Self compacting concrete mixes with varying percentages of waste plastic fibers like 0.0%, 0.25%, 0.5%, 0.75%, 1.00%, 1.1%, 1.2%, 1.3% and 1.4% were developed for M40 grade of concrete. The mix proportion was done by NANSU method. The result of fresh property test satisfies the limits specified by EFNARC. The cubes and cylinders were immersed in 5% magnesium chloride solution for a period of 30 days, 60days and 90 days. The degree of chloride attack is determined by evaluating the reduction in compressive strength split tensile strength and percentage loss of weight of specimen. From the test results it is observed that maximum compressive strength and split tensile strength were achieved for 1% of plastic fiber. The chloride content is determined by Argentometric titration method. [1]

Dinesh. A, Harini.S, Jasmine Jeba.P (2017) gives concrete is a mixture of cement, sand, gravel and water which dries hard and strong and is used as a material for building. Concrete has to be heavily vibrated for flow into very intricate forms or forms that have a lot of reinforcing bars. Hence to overcome these defects the self-compacting concrete is used. Self-compacting concrete is a flowing concrete mixture that is able to consolidate under its own weight. The self-compacting concrete flows easily at suitable speed into formwork without blocking through the reinforcement without being heavily vibrated. This project deals with the self- compacting concrete where the cement is partially replaced with fly-ash and silica fume. Here Ordinary Portland Cement is replaced with 5%, 10%, 15%, 20% and 25% of fly-ash and 2.5%, 5%, 7.5%, 10% and 12.5% of silica fume. From the experimental investigations, it is observed that there is increase in the fresh properties (workability) and increase in the hardened properties (split-tensile strength and compressive strength) for replacement of silica fume. [2]

Sumit Kumar, Gaurav Kumar (2016) gives that major advantage of this method is that SCC technology offers the opportunity to minimize or eliminate concrete placement problems in difficult conditions. The primary aim is to explore the feasibility of using SCC by examining its basic properties and durability characteristics i.e. water

absorption, shrinkage and sulfate resistance. An extensive literature survey was conducted to explore the present state of knowledge on the durability performance of self-consolidating concrete. However, because it usually requires a larger content of binder and chemical admixtures compared to ordinary concrete, its material cost is generally 20–50% higher, which has been a major hindrance to a wider implementation of its use. [3]

Nageswararao (2015) replaced the fine aggregate by crushed stone dust (CSD) and marble sludge powder (MSP) in various proportions in combination. Six mix deignswere 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. [4]

Prof. Shriram H. Mahure (2014) had studied about the fresh and hardened properties of self compacting concrete using Fly ash as partial replacement of cement in different percentages in addition to filler. The fresh properties have been determined by computing the Slump value, V-funnel value and L-box value and the hardened properties are determined by computing the Compressive strength, Flexural strength and Split tensile strength of the specimens. It is observed that the fresh properties of concrete shows an acceptable value up to 30% replacement of fly ash and also the hardened properties of concrete are significantly improved when compared to the conventional mix. [5]

Dhiyaneshwaran, S. (2013) investigates influence of using Viscosity Modifying Admixture (VMA) and Class F fly ash on Self-compacting Concrete (SCC). Mineral admixture fly ash at various six replacement levels (0%, 10%, 20%, 30%, 40% and 50%) was used with other constituents like cement, coarse and fine aggregate, water. Super plasticizer used was Glenium B233 as viscosity modifying agent and w/c ratio 0.45.The results obtained from experiments conducted on Self-compacting Concrete (SCC) produced with fly ash ranging from 0 % to 50 % developed compressive strength 30 MPa to 35.9 Mpa. From results, he concluded that up to 30% replacement of cement contents by fly ash exhibits noteworthy change in performance and better compressive strength. Increased replacement above 30% resulted in a decrease in strength. Therefore, 30% replacement of cement with fly ash could be considered as optimum. [6]

Mayur B. Vanjare, Shriram H. Mahure (2012) carried out an experimental study on to focus on the possibility of using waste material in a preparation of innovative concrete. One kind of waste was identified: Glass Powder (GP). The use of this waste (GP) was proposed in different percentage as an instead of cement for production of self-compacting concrete. The addition of glass powder in SCC mixes reduces the self-compatibility characteristics like filling ability, passing ability and segregation resistance. The flow value decreases by an average of 1.3%, 2.5% and 5.36% for glass powder replacements of 5%, 10% and 15% respectively. [7]

Anant patel (2011) had studied about the Compressive strength and Modulus of elasticity of self compacting concrete which contains admixtures and different content of cement and fly-ash. From the test results it is obtained that when water-powder ratio is lower, flow obtained for concrete is also lower. He observed that increase in cement content results in cohesive mix and high compressive strength of the specimens. He also concluded that modulus of elasticity of the concrete containing fly-ash is almost same as the modulus of elasticity of the conventional mix. Finally he observed that the effect of water-powder ratio, cement content and fly-ash plays a significant role in formation of self compacting concrete and its strength. [8]

Girish (2010) et al presented the results of an experimental investigation carried out to find out the influence of paste and powder content on self-compacting concrete mixtures. Tests were conducted on 63 mixes with water content varying from 175 l/m3 to 210 l/m3 with three different paste contents. Slump flow, V funnel and J-ring tests were carried out to examine the performance of SCC. The results indicated that the flow properties of SCC increased with an increase in the paste volume. As powder content of SCC increased, slump flow of fresh SCC increased almost linearly and in a significant manner. They concluded that paste plays an important role in the flow properties of fresh SCC in addition to water content. The passing ability as indicated by J-ring improved as the paste content increased. [9]

Erdogan Ozba (2008) carried out an investigating mix proportion of high strength self compacting concrete (HSSCC) by using Taguchi Method. The experiment shows the HSSCC by replacing the cement by fly ash in various stage by15%, 30% and 45%. It is used as a filler material and coarse aggregate is replaced by crushed lime stone and crushed sand. To improve the fresh property super plasticizer is used. For this experiment Eighteen (18) different mixeswere designed and tested for fresh and hardened properties of concrete. HSSCC is analysed by using the Taguchi's experiment design. In this method level of mix proportions are determined by Ultra Pulse Velocity (UPV).Various test are carried out for fresh and hardened concrete were Slump flow and V funnel test; UPV, compressive strength and split tensile tests. It was observed that design mix M10 (1:1.5:1.9) shows better improvement in compressive strength and M18 (1:2.1:1.8)in split tensile strength. The design mix confirming to M10 and M18 satisfies the high strength self compaction concrete. [10]

Andreas Leemann (2007) carried out a study on the effect of viscosity modifying agent (VMA) on mortar and concrete used to obtain the flow properties and the rheology is studied. Mainly VMA is used in the SCC to obtain the free flow without any segregation. Inorganic VMA micro silica (MS) and nano silica slurry (NA) and organic VMA high molecular ethylenoxide derivate (EO), Natural Polysaccharide (PS), starch derivate (ST) are used. These are combined with Super plasticizer (SP) for varying water binder ratios (w/b) are tested. While addition of VMA and SP shows the marginal difference in flow properties and rheology. The organic VMA MS and NS and the organic VMA to show a bigger gradient and VMA PS (0.4% and 0.8%) and ST a smaller gradient than the mix without VMA. PS causes the strongest increase of yield stress and MS the lowest. Combination of VMA and SP shows the improvement in compressive strength at the age of 28 days. Variation of w/b, the addition of SP and VMA all change flow properties and rheological properties in a different way. The in organic VMA cause an acceleration of hydration and higher compressive strength. [11]

Felekoglu (2005) has done research on effect of w/c ratio on the fresh and hardened properties of SCC. According to the author adjustment of w/c ratio and super plasticizer dosage is one of the key properties in proportioning of SCC mixtures. In this research, fine mixtures with different combinations of w/c ratio and super plasticizer dosage levels were investigated. The results of this research show that the optimum w/c ratio for producing SCC is in the range of 0.84-1.07 by volume. The ratio above and below this range may cause blocking or segregation of the mixture. [12]

Manu santhanam and Subramanyam (2004) discussed the existing research about various aspects of self-compacting concrete , including materials and mixture design , test methods , construction-related issues, and properties. They summarized that Self-Compacting Concrete is a recent development that shows potential for future applications. It meets the demands places by requirements of speed and quality in construction. [13]

Hajime Okamura and Masahiro Ouchi (2003) addressed the two major issues faced by the international community in using SCC, namely the absence of a proper mix design method and jovial testing method. They proposed a mix design method for SCC based on paste and mortar studies for super plasticizer compatibility followed by trail mixes. However, it was emphasized that the need to test the final product for passing ability, filling ability, and flow ability and segregation resistance was more relevant. [14]

Subramanian and Chattopadhyay (2002) described the results of trails carried out to arrive at an approximate mix proportioning of Self compacting concrete. Self-Compatibility was achieved for Water to Powder ratio ranging from 0.9 to 1.1 when Coarse Aggregate and Sand content were restricted to 46 % and 40% of the mortar volume respectively. [15]

Nan Su (2001) proposed a mix design method for self-compacting concrete. First, the amount of aggregates required was determined; the paste of binders was then filled into the voids of aggregates to ensure that the concrete thus obtained has flow-ability, self-compacting ability and other desired Self Compacting Concrete properties. The amount of aggregates, binders and mixing water, as well as type and dosage of super plasticizer to be used are the major factors influencing the properties of SCC. Slump flow, V-funnel, L-flow, U-box and compressive strength tests were carried out to examine the performance of SCC, and the results indicated that the proposed method could be used to produce successfully SCC of high quality. Compared to the method developed by the Japanese Ready-Mixed Concrete Association (JRMCA), this method is simpler, easier for implementation and less time- consuming, requires a smaller amount of binders and saves cost. [16]

Naik and Singh (1997) conducted tests on concretes containing between 15% and 25% by mass Class F and Class C fly ashes to evaluate compressive strength. The effects of moisture and temperature during curing were also examined. The results of the research showed that concretes containing Class C fly ash and were moist cured at 73°F (23°C) developed higher early age (1 to 14 days) compressive strengths than concretes with Class F fly ash. The long-term (90 days and greater) compressive strength of concretes containing fly ash was not significantly influenced by the class of fly ash. The air-cured concretes containing Class F fly ash did not develop strengths equivalent to air-cured normal concretes and air-cured concretes containing Class C fly ash developed relatively greater compressive strengths than air-cured concretes containing Class F fly ash. For concretes containing either class of fly ash, compressive strengths at 7 days increased with an increase in curing temperature. [17]

Nagataki, Fujiwara (1992) performed the slump flow test of SCC mix to find out whether the concrete mix is workable or not. They also performed the segregation test of SCC mix, by using locally available materials, the value ranging from 500-700 mm is considered as the slump required for a concrete to be self-compacted. [18]

3. CONCLUSIONS

Concrete is a combination of different materials in which all the properties have direct or indirect effect. Most of the researchers have carried out their investigational work to analyze the different set of concrete properties so it can be concluded that

- Self Compacting Concrete with mineral admixture exhibited satisfactory results in workability, because of small particle size and more surface area.

- Concept of self-compacting concrete has established itself as innovative material in the area of concrete technology.
- The procedure of mix design can be adopted for self compacting concrete for various applications based on experiences in identification of suitable mix proportion and self compacting concrete with mineral admixtures shows satisfactory results.
- Partial replacement of cement and fine aggregate with finer material exhibit self compacting concrete with low segregation potential.
- SCC with mineral admixture / waste materials can be successfully used in self-compacting concrete.

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