LITERATURE REVIEW ON ROLE OF VMA IN CONCRETE

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Abstract: Concrete is a family of binding material, fine aggregate, coarse aggregate and water. Concrete is normally used in the frame structure. But there is some limitation like self-compaction, surface finishes, maintains strength at congested area. Due to this limitation we are trying to make self- compacting concrete with the use of mineral admixture. SCC is concrete that can be placed and compacted under its own weight without any vibration effort, assuring complete filling of formwork even when access is hindered by narrow gaps between reinforcement bars. The primary objective of this study is to make use of Ground granulated blast furnace slag (GGBS) as a replacement of cement and understand its effects on the fresh properties, compressive strength weathering. The study also intended to quantify the amount of Ground granulated blast furnace slag (GGBS) to be added to the concrete according to the value of concrete properties Measured. The workability of self-compacted concrete is increased as content of GGBS increased. Compressive strength of SCC with GGBS is increased up to 10% replacement of cement with GGBS.

Index Terms: Ground granulated blast furnace slag (GGBS), SCC (self-compacted concrete), super plasticizer, viscosity modify agent.

I. INTRODUCTION

Present-day self-compacting concrete can be classified as an advanced construction material. As the name suggests, it does not require to be vibrated to achieve full compaction. This offers many benefits and advantages over conventional concrete. These include an improved quality of concrete and reduction of on-site repairs, faster construction times, lower overall costs, facilitation of introduction of automation into concrete construction. An important improvement of health and safety is also achieved through elimination of handling of vibrators and a substantial reduction of environmental noise loading on and around a site. The composition of SCC mixes includes substantial proportions of fine-grained inorganic materials and this gives possibilities for utilization of mineral admixtures, which are currently waste products with no practical applications.

II. LITERATURE REVIEW

Bertil Persson (2001) carried out an experimental and numerical study on mechanical properties, such as strength, elastic modulus, creep and shrinkage of self-compacting concrete and the corresponding properties of normal compacting concrete. The study included eight mix proportions of sealed or air-cured specimens with water binder ratio (w/b) varying between 0.24 and 0.80. Fifty percent of the mixes were SCC and rests were NCC. The age at loading of the concretes in the creep studies varied between 2 and 90 days. Strength and relative humidity were also found. The results indicated that elastic modulus, creep and shrinkage of SCC did not differ significantly from the corresponding properties of NCC. [1]

Nan Su et al (2001) proposed a new mix design method for self-compacting concrete. First, the amount of aggregates required was determined, and 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 SCC 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. [2]**.**

Bouzoubaa and Lachemi (2001) carried out an experimental investigation to evaluate the performance of SCC made with high volumes of fly ash. Nine SCC mixtures and one control concrete were made during the study. The content of the cementations materials was maintained constant (400 kg/m3), while the water/cementations material ratios ranged from 0.35 to 0.45. The self-compacting mixtures had a cement replacement of 40%, 50%, and 60% by Class F fly ash. Tests were carried out on all mixtures to obtain the properties of fresh concrete in terms of viscosity and stability. The mechanical properties of hardened concrete such as compressive strength and drying shrinkage were also determined. The SCC mixes developed 28-day compressive strength ranging from 26 to 48 MPa. They reported that economical SCC mixes could be successfully developed by incorporating high volumes of Class F fly ash. [3]

Sri Ravindra rajah (2003) et al made an attempt to increase the stability of fresh concrete (cohesiveness) using increased amount of fine materials in the mixes. They reported about the development of self-compacting concrete with reduced segregation potential. The systematic experimental approach showed that partial replacement of coarse and fine aggregate with finer materials could produce self-compacting concrete with low segregation potential as assessed by the V-Funnel test. The results of bleeding test and strength development with age were highlighted by them. The results showed that fly ash could be used successfully in producing self-compacting high-strength concrete with reduced segregation potential. It was also reported that fly ash in self-compacting concrete helps in improving the strength beyond 28 days. Self-Compacting Concrete. [4]

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. [5]

Paratibha Aggarwal (2008) et al presented a procedure for the design of self-compacting concrete mixes based on an experimental investigation. At the water/powder ratio of 1.180 to 1.215, slump flow test, V-funnel test and L-box test results were found to be satisfactory, i.e. passing ability; filling ability and segregation resistance are well within the limits. SCC was developed without using VMA in this study. Further, compressive strength at the ages of 7, 28, and 90 days was also determined. By using the OPC 43 grade, normal strength of 25 MPa to 33 MPa at 28-days was obtained, keeping the cement content around 350 kg/m3 to 414 kg/m3. [6]

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. [7]

E. Todorova, G. Chernev, G. Chernev. The aim of the "influence of metakaolinite and stone flour on the properties of self-compacting concrete" was the manufacture and characterization of mixture for self-compacting concrete with participation of powder additives (metakaolinite and stone flour) and super plasticizers (viscocrete 5370 and viscocrete 5800). The influence of chemical admixtures and powder additives on concrete properties was made by the different methods: sorption ability; sᴇᴍ; ftir and potential. Physical and mechanical properties as compressive strength; spreading and fluidity were measured. Tests for mechanical and physical properties of self-compacting concrete established, that the best appropriate mixtures were these with metakaolinite and 1,25 % Viscocrete 5370, with stone flour and admixture of 1,2 % Viscocrete 5370 and Viscocrete 5800. The strength pressure reaches 71 MPa, 65, 1 MPa and 63, 3 MPa, respectively. SEM micrographs proved evenly distribution of fine fraction in concrete mixture. Metakaolinite and stone flour showed excellent values for each test using for investigation properties of prepared mixtures. They improve the characteristics of self-compacting concrete. Better results showed mixtures with higher content of powder materials and super plasticizers. [8]

Cristian Druta (2003) carried out an experimental study on to compare the Splitting Tensile Strength and Compressive Strength values of self-compacting and normal concrete specimens and to examine the bonding between the coarse aggregate and the cement paste using the Scanning Electron Microscope. In this experiment used mineral admixes Blast Furnace Slag, Fly Ash and Silica Fume and chemical admixes Super plasticizers and Viscosity-Modifying Admixtures, It has been verified, by using the slump flow and U-tube tests, that self-compacting concrete (SCC) achieved consistency and self-compatibility under its own weight, without any external vibration or compaction. Also, because of the special admixtures used, SCC has achieved a density between 2400 and 2500 kg/m3, which was greater than that of normal concrete, 2370-2321 kg/m3.Self-compacting concrete can be obtained in such a way, by adding chemical and mineral admixtures, so that its splitting tensile and compressive strengths are higher than those of normal vibrated concrete. An average increase in compressive strength of 60% has been obtained for SCC, whereas 30% was the increase in splitting tensile strength. Also, due to the use of chemical and mineral admixtures, self-compacting concrete has shown smaller interface micro cracks than normal concrete, fact which led to a better bonding between aggregate and cement paste and to an increase in splitting tensile and compressive strengths. A measure of the better bonding was the greater percentage of the fractured aggregate in SCC (20-25%) compared to the 10% for normal concrete. [9]

Subramanian and Chattopadhyay (2002) are research and development engineers at the ECC Division of Larsen & Toubro Ltd (L&T), Chennai, India. They have over 10 years of experience on development of self-compacting concrete, underwater concrete with ant wash out admixtures and proportioning of special concrete mixtures. Their research was concentrated on several trials carried out to arrive at an approximate mix proportion of self-compacting concrete, which would give the procedure for the selection of a viscosity modifying agent, a compatible super plasticizer and the determination of their dosages. The Portland cement was partially replaced with fly ash and blast furnace slag, in the same percentages as Ozawa (1989) has done before and the maximum coarse aggregate size did not Exceed. The two researchers were trying to determine different course and fine aggregate contents from those developed by Okamura. The coarse aggregate content was varied, along with water-powder (cement, fly ash and slag) ratio, being 50%, 48% and 46% of the solid volume. The U-tube trials were repeated for different water-powder ratios ranging from 0.3 to 0.7 in steps of 0.10. On the basis of these trials, it was discovered that self-compatibility could be achieved when the coarse aggregate content was restricted to 46 percent instead of 50 percent tried by Okamura (1997). In the next series of experiments, the coarse aggregate content was fixed at 46 percent and the sand content in the mortar portion was varied from 36 percent to 44 percent on a solid volume basis in steps of 2 percent. Again, the water-powder ratio was varied from 0.3 to 0.7 and based on the U-tube trials a sand content of 42 percent was selected. In order to show the necessity of using a viscosity-modifying agent along with a super plasticizer, to reduce the segregation and bleeding, the mixture proportion developed by the two researchers was used to cast a few trial specimens. In these trials, viscosity-modifying agent was not used. The cast specimens were heavily reinforced slabs having 2400x600x80 mm and no vibration or any other method of compaction was used. However, careful qualitative observations revealed that the proportions needed to be delicately adjusted within narrow limits to eliminate bleeding as well as settlement of coarse aggregate. It was difficult to obtain a mixture that was at the same time fluid but did not bleed. This led to the conclusion that slight changes in water content or granulometry of aggregate may result either in a mixture with inadequate flowing ability, or alternatively one with a tendency for coarse aggregate to segregate. Therefore, it became necessary to incorporate a viscosity-modifying agent in the concrete mixture. Viscosity-modifying agents can be a natural polymer such as guar gum, a semi-synthetic polymer such as hydroxyl propyl methyl cellulose, or water-soluble polysaccharides, including those derived from a microbial source such as welan gum. Experiments involving three types of gums were being carried out by the two researchers. One commonly used thickener in cement- based systems, namely hydroxyl propyl methyl cellulose (HPMC), a low-priced gum known as guar gum and a special product called welan gum were selected for studying their suitability for use in self-compacting concrete. On a first consideration, a1l these qualified as viscosity modifying agents. However, some of these substances, with the exception of welan gum, had shortcomings. Guar gum had to be made into a suspension in water after heating to 60˚C and stirring for about one hour. This solution lost its suspending power after twelve hours. HPMC was not compatible with the naphthalene formaldehyde super plasticizer and entrained excessive air, causing a reduction in strength (Fig.1) Welan gum is suitable for use in self-compacting concrete because it combines with most types of super plasticizer and has superior suspending power, compare to guar gum and hydroxy propylmethy cellulose (HPMC). In order to arrive at an acceptable combination of dosages of welan gum and superlasticizer, Subramanian and Chattopadhyay (2002) ran several tests related to the tendency of the concrete to bleed and its ability to pass the U-tube test. They discovered that with a combination corresponding to 0.1 percent of welan gum and 0.53 percent by weight of water acrylic copolymer type super plasticizer, a satisfactory self-compacting mixture could be obtained. [10]

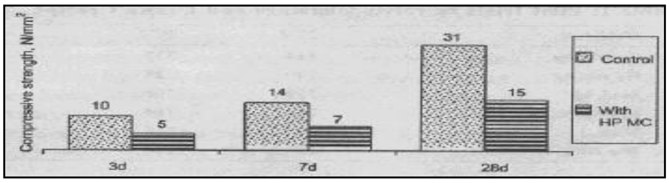

Fig.1 Compressive strength of SCC with and without HPMC (Subramanian and Chattopadhyay, 2002).

Surabhi.C.S, Mini Soman, Syam Prakash.V Carried out an experimental study on cement content in the SCC mix is replaced with various percentage of limestone powder and the fresh and hardened properties were studied. It is observed that limestone powder can be effectively used as a mineral additive in SCC. Then conclude that result the 7 day and 28 day compressive strength increases with increase in content of limestone powder up to 20%. The improvement in compressive strength at 28 day is about 20% for a replacement of 20% of cement with limestone powder. But further addition of limestone powder reduces the strength. All the hardened properties like cylinder compressive strength, split tensile strength, flexural strength and modulus of elasticity improves with the addition of limestone powder. [11]

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. [12]

Suraj N. Shah., Shweta S. Sutar, Yogesh Bhagwat carried out an experimental study on to find out the effect of addition of red mud, which is a waste product from the aluminium industries, and foundry waste sand, which is a waste product from foundry, on the properties of self-compacting concrete containing two admixtures and experimentation combinations of admixtures which is taken Super plasticizer & VMA. It can be concluded that maximum compressive strength of self-compacting concrete with the combination of admixtures (SP+VMA) may be obtained by adding 2% foundry waste sand which is a waste material of ferrous industry (foundry). [13]

N. Bouzouba and M. Lachemi carried out an experimental study on producing and evaluating SCC made with high-volumes of fly ash is presented. The high-volume fly ash self-compacting concretes (except one) have a slump flow in the range of 500 to 700 mm, a flow time ranging from 3 to 7 seconds, a segregation index ranging from 1.9 to 14%, and bleed water ranging from0.025 to 0.129 mL/cm2. The temperature rise of the self-compacting concrete was 5 to 10

C lower than that of the control concrete, and the setting times of the self-compacting concrete were 3 to 4 hours longer than those of the control concrete. The self-compacting concrete developed compressive strengths ranging from 15 to 31 MPa and from 26 to 48 MPa, at 7 and 28 days, respectively. [14]

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. [15]

R.V(2003) found that use of fine fly ash for obtaining Self compacting concrete resulted in an increase of the 28 day Compressive Strength Concrete by about 38%. Self-compacting concrete was achieved when volume of paste was between 0.43 and 0.45. [16]

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. [17]

Hardik Upadhyay carried out an experimental study on different mix design methods using a variety of materials has been discussed, as the characteristics of materials and the mix proportion influences self- compatibility to a great extent. It can be a boon considering improvement in concrete quality, significant advances towards automation and concrete construction processes, shortened construction time, lower construction cost and much improvement in working conditions as it reduces noise pollution. Properties of self-compacting concrete with different types of additives [18]

Zoran Grdic (2008) carried out an experimental study on present's properties of self-compacting concrete, mixed with different types additives: fly ash, silica fume, hydraulic lime and a mixture of fly ash and hydraulic lime. Due to test results, the addition of fly ash to the mixture containing hydraulic lime is quite beneficial, bringing a substantial improvement of the behaviour of SCC FAHL concrete. Also, this mixture has smaller filling capacity and fluidity than other mixtures. [19]

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. [20]

Safiuddin (2008) et al. observed that drying shrinkage occurs when concrete hardens and dries out at the early age. It induces potential flow channels in the form of micro-cracks. These cracks provide the access to deleterious agents, and thus affect the durability of concrete. The drying shrinkage of SCC does not differ very much from that of normal concrete. Several studies reported that it could be even lower in SCC. In general, the reduced coarse aggregate content and the increased amount of cementing material are expected to cause more drying shrinkage in SCC. But the porosity also affects the drying shrinkage of concrete. As the porosity is reduced in SCC, it compensates the negative effects of aggregate and binder on drying shrinkage. In addition, the drying shrinkage tends to decrease in SCC since a very small amount of free water is available in the system. Also, SCC has minimum empty voids on concrete surface that are largely responsible for drying shrinkage. [21]

Felekoglu et al. (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. [22]

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. [23]

III. CONCLUSION

To increase the stability of fresh concrete (cohesiveness) using increased amount of fine materials in the mixes. To development of self-compacting concrete with reduced segregation potential. The systematic experimental approach showed that partial replacement of coarse and fine aggregate with finer materials could produce self-compacting concrete with low segregation potential as assessed by the V-Funnel test. 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. If we add the mineral admixture replacement for we can have a better workable concrete. It has been verified, by using the slump flow, T50 cm slump flow J-ring test, L-box test and U-tube tests, that self-compacting concrete (SCC) achieved consistency and self-compatibility under its own weight, without any external vibration or compaction. SCC with mineral admixture exhibited satisfactory results in workability, because of small particle size and more surface area.

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