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Literature Review on Effect of Admixtures on Durability of Self-Compacting Concrete

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***Abstract*: SCC or Self Compacting Concrete is the most innovative type of concrete which is made in recent days. The concept of SCC has been introduced by PR. OKUMARA at OUCHI UNIVERSITY, in early 80's. SCC does not require any external vibration for its compaction, and it can flow on its own weight. There are several research work has been done on the durability of SCC, in this research the fresh properties of M50 design mix SCC is going to be observed according to EFNARC guideline. And the mix design is done by IS10262:2009 by replacing cement by Fly ash, and Calcite at various proportions.**

***Keywords*: EFNARC, Self-Compacting Concrete, Fly ash, Calcite**

1. Introduction

Cement concrete has clearly emerged as the material of choice for the construction of a large number and variety of structures in the world today. Durability is important criteria for the design of concrete structure. Any deficiency in durability could make the structure unfit for the intended purpose. If the structure is not durable then the strength of structure reduces with the age due to deterioration of concrete and reinforcement due to surrounding environment. To have a sustainable concrete structure, durability is key. Use of inappropriate materials, poor construction practices, curing and mix designs, results in concrete structures often showing serious premature deterioration. Calcite is a carbonate mineral and the most stable polymorph of calcium carbonate (CaCO3). Calcite is stable in hardened cementitious materials because of alkaline environment of the materials. They can help to durability some extent by filling pores of the materials. However, acids react with carbonates and generally form salt, water and carbon dioxide. Moreover, calcite helps to carbonation mechanism and dissolves hydration products of cement. By dissolving of cement hydration products (CH) corrosion risk occurs because of reduction of pH and impairing of passive layer on reinforcement. Fly ash is a byproduct from burning pulverized coal in electric power generating plants. The decrease in free lime and the resulting increase in cementitious compounds, combined with the reduction in permeability enhance concrete durability.

2. Literature review

M. Lachemi et. al. (Mar. 2001) They made nine SCC mixtures and one control concrete were investigated in this study. The content of the cementitious materials was maintained constant (400 kg/m3), while the water/cementitious 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 concretes such as compressive strength and drying shrinkage were also determined. The self-compacting concretes developed a 28-day compressive strengths ranging from 26 to 48 MPa. The results show that an economical self-compacting concrete could be successfully developed by incorporating high-volumes of Class F fly ash.

Hajimi Okamura and Masahiro Ouchi (2003) for the making self-compacting concrete a standard concrete the various investigation for establishing a rotational mixdesign method and self-compatibility testing methods have been carried out. Since they concluded that when self-compacting concrete becomes so widely used that it is seen as the, "standard concrete", rather than a, "special concrete". And they succeeded in creating durable and reliable concrete structures.

N R Gaywala& D B Raijiwala (2006) was done on "Self-Compacting Concrete: A Concrete of Next Decade" Journal of Engineering Research and Studies. The specimens were casted by M25 grade of concrete. They studied the effect of different proportion of Fly Ash (15%, 25%, 35%, 45%, and 55%) in concrete. The maximum compressive strength, split tensile strength, flexural strength & pull out strength for self-compacting concrete can be obtained by addition of 15% of fly ash in mix as compared to addition of 25%, 35%, 45% and 55% cement replacement by fly ash.SCC gives good durability properties as compared to the ordinary concrete

P.L. Domone (2007) collected data from more than 70 recent studies then analyzed co-related and compared the hardened mechanical properties of self-compacting concrete (SCC) normally vibrated concrete (NVC). Results showed that limestone powder, added in SCC, contributes significantly to strength at ages up to at least 28 days. The analysis has shown that sufficient data have been obtained to give confidence in the

general behavior of SCC.

Burak Felekoglu (2007) have worked on the use of a quarry dust limestone powder in self-compacting paste and investigated its concrete applications. He divided his work in two parts- 1. The physical and mechanical properties of cement pastes incorporating quarry waste limestone powder (QLP) and a powder produced by direct grinding of limestone (PLP) were compared. 2. Performance of quarry waste limestone powder in SCC applications were tested and discussed. It was found that normal strength SCC (~30MPa) mixtures that contain approximately 300–310 kg of cement per cubic meter can be successfully prepared by employing high amounts of QLP. Higher strength classes of SCCs (~45–50MPa) can be achieved but the cement dosage should be increased (i.e. 470 kg/m3).

Selvamony Cet al (2009) was done on "Development of High Strength Self-Compacted Self-Curing Concrete with Mineral admixtures" International Journal on Design and Manufacturing Technologies. In this study, the effect of replacing the cement, coarse aggregate and fine aggregate by limestone powder (LP) with silica fume, quarry dust and clinkers respectively and their combinations of various proportions on the properties of SCC has been compared. Silica fume was observed to improve the mechanical properties of SCC, while lime stone powder along with quarry dust affected mechanical properties of SCC adversely. From the test result a maximum of 8% of lime stone powder with silica fume, 30% of quarry dust and 14 % of clinkers was able to be used as a mineral admixture without affecting the self compact ability.

Salim Barbhuiya (2011) studied the use of an alternative material i.e. dolomite powder, instead of limestone powder, for the production of SCC. For this he prepared five concrete mixes with different proportions of fly ash and dolomite powder (Mix 1 100% FA, Mix 2 75%FA + 25%DP, Mix 3 50%FA + 50%DP, Mix 4 25%FA + 75%DP, Mix 5 100%DP), each having the same water cement ratio of 0.38 were tested in this study. He concluded that it is possible to manufacture self-compacting concrete using fly ash and dolomite powder with acceptable fresh and hardened properties.

Nitish chalhotra (2011) This research consist of i) Development of suitable mix for self-compacting concrete that would satisfy the requirement of the plastic state. ii) Casting of concrete sample and testing them for compressive strength, shrinkage, water absorption, sulphate resistance and sorptivity. He use M25 grade of concrete. The conclusion he got for 35% fly ash for replacement to the properties observe were good as compare to 15% & 25% fly ash replacement. Hence if increase the fly ash replacement it better workable concrete. An increase of about 24% strength at 28 days and 30% at 56 days was observe with the decrease of fly ash content for 35%fly ash to 15% fly ash.35%fly ash replacement shoes 2 time less shrinkage in 20 days than that of 0% fly ash. Increase the amount of fly ash result seen the systematic reduction in sorptivity. Concrete mix with high pest contain are bound to have higher absorption value than concrete with lower paste contain as observe 35% fly ash replacement shoes higher absorption i.e. 2.7% at the age of 28 days and 2.59% at the age of 56 days than 15% fly ash replacement.

Vanjare & Shriram H. Mahure (2012) were described "Experimental Investigation on Self-Compacting Concrete Using Glass Powder" International Journal of Engineering Research and Applications. The specimens were casted by M20, M25, and M30 grade of concrete. They studied the effect of different proportion of Glass Powder (5%, 10%, and 15%) in concrete. 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. The average reduction in compressive strength for all grades was around 6%, 15% and 20% for glass powder contents of 5%, 10% and 15% respectively. The average reduction in flexural strengths for all grades was around 2%, 3.7% and 6.75% for glass powder contents of 5%, 10% and 15% respectively.

Dhiyaneshwaran, S. Ramanathan, P. Baskar, and Venkatasubramani (2013) studied the workability and durability characteristics of Self-Compacting Concrete (SCC) with Viscosity Modifying Admixture (VMA), and containing Class F fly ash. The mix design for SCC was arrived as per the Guidelines of European Federation of National Associations Representing for Concrete (EFNARC). In this investigation, SCC was made by usual ingredients such as cement; fine aggregate, coarse aggregate, water and mineral admixture fly ash at various replacement levels (10%, 20%, 30%, 40% and 50%). The super plasticizer used was Glenium B233 and the viscosity modifying agent used was Glenium Stream 2. The experiments are carried out by adopting a water-powder ratio of 0.45. Workability of the fresh concrete is determined by using tests such as: slump flow, T50, V-funnel, L-Box and U-box tests. The durability of concrete is tested by acid resistance, sulphate attack and saturated water absorption at the age of 28, 56 and 90 days.

Ramanathan P et al (2013) was done on "Study on Durability Characteristics of Self-Compacting Concrete with Fly Ash" Jordan Journal of Civil Engineering. They studied the effect of different proportion of Fly Ash (10%, 20%, 30%, 40% and 50%).The durability of concrete is tested by acid resistance, sulphate attack and saturated water absorption at the age of 28, 56 and 90 days. From the test result 30% replacement of fly ash, the fresh properties observed were good as compared to 10%, 20%, 40% and 50% fly ash replacement. Saturated water absorption percentage decreases with the increase in fly ash. For 30%replacement of fly ash, the lower water absorption level is a good. Compressive strength loss decrease with the increase in fly ash in concrete.

Ahmed Fathi et al (2013) was done on "Study The Effectiveness of the Different Pozzolanic Material on Self-Compacting Concrete" ARPN Journal of Engineering and Applied Sciences. This paper presents the study on the effect of fly ash (FA), silica fume (SF) and microwave incinerated Fly Ash (MIRHA) as cement replacement material (CRM) on the

mechanical and fresh properties of self-compacting Concrete (SCC). The result showed that the MIRHA needed more water as compared to SF to achieve the similar fresh properties, similarly concrete with 5% SF showed about 9.70% higher compressive strength after 90 days, 5.10 MPa high tensile strength and 10.12 MPa flexural strength when compared with other mixes. 5% SF and 30% FA mixes showed highest compressive strength as compared to the control mix. Whereas all CRM mixes resulted in high flexural strength, which was due to the negligible bleeding and high cohesiveness. Silica fume requires less water demand as compared to MIRHA for achieving the similar fresh properties.

K. Sathish Kumar and S. Dilli Babu (2015) Self-Compacting Concrete is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. One of the disadvantages of self-compacting concrete is its cost, associated with the use of high volumes of Portland cement and use of chemical admixtures. One alternative to reduce the cost of self-compacting concrete is the use of mineral admixtures such as fly ash, ground granulated blast furnace slag and micro silica, which is finely, divided materials added to concrete during mixture procedure. When these mineral admixtures replace a part of the Portland cement, the cost of self-compacting concrete will be reduced especially if the mineral admixtures are waste or industrial by-product. Moreover, the use of mineral admixtures in the production of self-compacting concrete not only provides economic benefits but also reduces heat of hydration. The incorporation of mineral admixtures also eliminates the need for viscosity-enhancing chemical admixtures. The lower water content of the concrete leads to higher durability, in addition to better mechanical integrity of the structure. This paper presents an experimental investigation on strength aspects like compressive, flexural and split tensile strength of self-compacting concrete containing different mineral admixtures and workability tests for different mineral admixtures are carried out. About 15% fly ash and 5% micro silica are used as a partial replacement for cement.

KS Johnsirani & A jagannathan (2015) This paper presents durability study on self-compacting concrete (SCC) with various partial replacements of fly ash, silica fume and combination of both fly ash and silica fume. The slump, V-funnel and L-Box test are carried out on the fresh SCC and in harden concrete compressive strength and split tensile strength values are determined. Attempts have been made to investigate the suitability of various replacements and also to study the durability properties such acid resistance, sulphate attack, alkaline attack, sorptivity, chloride permeability of SCC.

3. Conclusion on literature review

- Use of supplementary cementious materials that is, fly ash with an aim to achieve better workability with the saving in cementious material.
- Optimum dose of chemical admixture varies with the type of the chemical admixtures as well as type of cement and w/c ratio.
- As w/c ratio decreases, the optimum dose of admixture expressed as percentage of cement in concrete mix increases.
- Addition of super plasticizer along with 10% fly ash of cement content accelerates the compressive strength of Self- Compacting Concrete.
- Self-compacting concrete require considerable amount of powder content and fines for its cohesiveness and ability to flow without bleeding and segregation.
- By replacing the certain amount of mineral admixture with cement in self compacting concrete it increase strength, workability, durability.
- Use of fly ash with calcite in self compacting concrete reduces the carbon dioxide content.
- Self-compacting concrete is eco-friendly and cost effective with use of mineral admixture.

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