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A REVIEW ON DURABILITY PROPERTIES OF SELF COMPACTING CONCRETE

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Abstract: This review paper includes the literature reviews related to durability properties of self compacting concrete. Concrete structure generally made without compaction but it is necessary to be compact to achieve desire strength and workability. This lead to produce self compacting concrete. Generally SCC is a fluid mixture suitable for placing in structures with congested reinforcement without vibration. To produce self compacted concrete is difficult because it is not economic and it requires producing in huge amount. This paper investigates the concrete (SCC) with different amounts of chemical and mineral admixture. In addition to compressive strength, the durability properties of SCC mixes were determined by means of Initial surface absorption test (ISAT), capillary suction test, rapid chloride penetration test, carbonation , sulphate attack, alkali-silica reaction, water permeability test. The test results indicated that the durability properties of the mixes appeared to be very dependent on the type and amount of the mineral and chemical admixture used.

Keywords: Self compacting concrete, Admixture, durability.

I. INTRODUCTION

One of the basic infrastructural facilities that man needs for good living is shelter. However, the increasing cost of conventional construction materials has made it difficult to meet the shelter requirements of the teeming population of developing countries. SCC is basically a concrete which is capable of flowing into the form work, without segregation and bleeding, reduces manpower, better finishes, easier placement, better durability, thinner concrete sections, lesser noise levels, no vibration, safer working environment, to fill uniformly and completely every corner of it by its own weight without any application of vibration or other mechanism during placing of concrete. Due to many advantages like faster construction, reduction in site for thinner concrete sections, improved durability, suitability for congested reinforcement; this concrete becomes popular in civil engineering construction. It is a sensitive mix, strongly dependent on the composition and characteristics of its constituents. It consists of the same components as of conventionally vibrated concrete,which are cement, aggregates and water, with the addition of chemical and mineral admixtures in different proportions. In SCC, the aggregates contribute 60-70% of the total volume. Stability and flow ability of SCC is achieved by increasing the solid fraction of paste phase of concrete that can be achieved by employment of some admixtures, that improves the hardened and especially durability properties of the concrete. European Federation of natural trade associations representing producers and applicators

of specialist building products (EFNARC) has drawn up specifications and guidelines for self compacting concrete to provide a framework for design and use of high quality SCC.

II. LITERATURE SURVEY

Ansari, Chaudhri, Ghuge N.P and Phatangre (2015) conducted an investigation on replacing cement by supplementary cementitious materials like alccofine and fly ash for M70 grade of concrete. In this research the compressive strength of concrete with alccofine, fly ash and the results are compared with normal concrete. From this investigation they observed partially replacing cement by alccofine the strength of concrete increased by 20%. It was found that alccofine is less expensive than cement and so it achieved higher strength then ordinary concrete, so it is recommended by them in Indian construction industry.

Amrutha et al.(2011) has made five SCC mixes with high volume fly ash and results are compared for the durability performance with the normal vibrated concrete of similar strength. Self compacting concrete mixes with high volumes of fly ash were assessed by accelerated chloride permeability tests (RCPT) after different periods of curing. Based on the results, at 28 days curing, the RCPT values were less than 1000 coulombs and for normally vibrated concrete the current is in the range of 1800 to 2000 coulombs by which the range is considered as low to moderate, as per ASTM C1202 [23]. It has been concluded that in aggressive and chloride rich environment SCC mixes with high volume fly ash performed well. The Chlorides infiltrate into cement by dispersion along the water movement pores. For such dispersion, the imperviousness is enhanced by redefining the pore structure of the solid. Also the response of tricalcium aluminates with fly ash makes SCC more impermeable.

Bodogiannis et.al (2014) examined the durability of metakaolin based self-compacting concrete. In this study concrete was prepared by repacking cement with metakaolin. The properties such as open porosity, sorptivity, water and gas permeability and chloride permeability were evaluated in their study against control mix. Fresh properties of SCC such as slump flow value, V funnel and L box permeability test etc were evaluated. The effect of metakaolin as a replacement material had an enhanced effect in the chloride penetration resistance and it did not enhance surface water permeability.

Berry and Malhotra (1986) impervious concrete is more durable. Joshi and Lohtia (1997) [14] stated that durability of concrete is improved when the concrete is impermeable. Water content, aggregate grading, cementitious materials and curing are the factors that influence the permeability of concrete. The pozzolanic property of fly ash makes it react chemically with calcium hydroxide and water to produce CSH gel and the risk of leaching is considerably reduced. Considerable pore refinement takes place due to the presence of fly ash .Due to pozzolanic reaction between Portland cement paste and fly ash, the expansive pores changeover to fine pore, because of which the penetrability in cementitious frameworks decreases.

Bremner and Thomas (2004) of ACI Committee 232, 2004 reported that durability of concrete is enriched when fly ash is an ingredient in concrete as the permeability is reduced because of no attack by aggressive agents. Oxygen permeability, hydraulic permeability and chloride permeability are the three major indexes for permeability evaluation. The various methods for estimating the permeability of concrete are mentioned in various codes AASHTO T259 [16], ACI 228.2R-98 [17], API RP 27 [18], ASTM C1202 [19]

Dhiyaneshwaran.S, Ramanthan.P, Baskar.I, venkatasubramani.R (2013) had investigated about the workability and durability characteristics of self-compacting concrete containing Viscosity modifying admixture and class F fly-ash. In this investigation, SCC was made by usual ingredients such as cement, fine aggregate, Coarse aggregate, water and mineral admixture at Fly – ash at various replacement levels (10%, 20%, 30%, 40%, 50%). The workability of the concrete is determined by conducting slump flow, V-funnel, L-box and U-box tests and the durability of the concrete is computed using acid resistance, sulphate attack and saturated water absorption test. He concluded that

30% replacement of fly-ash is optimum. He observed that fresh properties, mechanical properties and the durability properties of the concrete have been improved compared to the convention mix of the concrete.

Divya chopra et al (2015) carried out a study on strength, permeability and micro structure of self-compacting concrete containing Rise Husk Ash. The cement is replaced by Rice husk ash (RHA) as supplementary cementitious material. SCC was tested for fresh and hardened state for four different mixes. The rice husk ash is replaced by cement by varying percentages from 0, 10, 15 and 20. To improve the workability high range water reducer super plasticizer is used up to 25% without loss of workability. By the replacement of 15% RHA shows good workability and up to 33% of strength increased. The replacement increased to 20% the strength decreased but 20% RHA mix shows increase in porosity, but it is still less than the control mix. In this study porosity decreased with increases in age. This is basically due to large formation of C-S-H gel, dense structure is formed, so porosity decreased. From XRD and SEM analysis shows the formation of C-S-H gel at the replacement of 15% RHA concrete helps increase in compressive strength. Pores and cracking were at maximum for the control mix. The most dense structure was observed for 15% replacement with RHA which resulted in the highest compressive strength for the mix.

Dinakar et al. 2013 have conducted studies on fresh and hardened properties of fly ash replaced self-compacting concrete by replacing fly ash up to 70%. They have also made studies on durability properties namely chloride permeability, water absorption and water penetration depth. It is concluded that initial absorption value exhibited by self compacting concrete with fly ash was 3% but it has increased for self-compacting concrete with high volumes of fly ash. Further the penetration depths reported were higher at 50 and 70 %replacement levels.

Gayathri.K, Ravichandran.K and Saravanan.J, (2016) had investigated about the performance of alccofine replacing the cement in concrete at 5%, 10%, 15% and 20%. It is found that 15% replacement of cement by alccofine is yielding good strength when compared to other mix percentages and by increasing the percentage of alccofine in concrete as replacement of cement, the value of cementing efficiency increases.

Kannan et al (2013) carried out an experiment of chloride and chemical resistance of self compacting concrete using Rice Husk Ash (RHA) and Metakaolin (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.

Iyappan. M (2014) had investigated about the fresh and hardened properties of self-compacting concrete in which the Portland cement is partially replaced with nano silica. In addition, the durability properties of the concrete like acid resistance using HCL were also examined with three different percentages of nano-silica. He concluded that 2% and 4% replacement of nano silica results in improved hardened properties where as 6% replacement of nano silica results in reduction in hardened properties of concrete. He also obtained that 4% replacement of nano silica results in better acid resistance of the concrete.

Malhotra and Mehta (2002) reported that the permeability of high volume fly ash (HVFA) concrete is less than normal conventional concrete with a water cement ratio of 0.4.

Papayianni et al., (2011) has experimented Self compacted concrete by replacing cement with calcareous fly ash in various proportions up to 50%. The assessment of durability in terms of shrinkage has been carried out. The High calcium fly ash SCC mixes have shown low early shrinkage deformation when compared with mixes without fly ash. It has also been concluded that the fly ash incorporation in SCC mixes have shown reduced early shrinkage deformations in terms of autogenous and plastic.

Pathak and Siddique (2012) have made studies by using fly ash as replacement in concrete and the specimens are cured at the temperature varying from 100 to 300°C. Rapid chloride penetration Test (RCPT) was carried out at 28, 91 and 365 days and the permeability of chloride ion reduced to 1000 to 2000 coulomb after 28 days for SCC mixes with fly ash. Usually with the rise in temperature the self-compacting concrete becomes permeable, but is stable up to 100°C.

Rafat Siddique (2013) investigated about the strength and durability properties of Self-Compacting concrete which is obtained by partially replacing natural sand with waste foundry sand (WFS). He replaced the Natural sand with WFS by 0%, 10%, 15% and 20% in terms of weight. He studied the fresh properties of concrete before computing the strength parameters. Compressive strength and split tensile strength test were obtained at the age of 7, 28, and 56 days and to determine the durability of the concrete, sulphate resistance was evaluated at the age of 7, 28 and 56 days and Rapid Chloride Permeability test was conducted at age of 28 days. Test results have shown that there is increase in compressive strength and split tensile strength of self-compacting concrete and also the durability properties have been improved by incorporating waste foundry sand as a replacement of Natural sand.

Srivastava et al (2012) carried an experiment of addition of silica fume as a filler material to concrete in various stages. Cement is partially replaced by silica fume in varying proportions as per the mix design. The addition of silica fume increases workability, strength and durability, as well as resistance to cracks are improved. It was observed that there is an increase in compressive strength from 6% to 57% during partial replacement of cement by silica fume. Addition of silica fume improves the bond strength of concrete; however, modulus of elasticity of silica fume in concrete shows a similar result to that of conventional self compacting concrete.

Turk et al.(2013) experimented and investigated the carbonation depth of fly ash SCC, vibrated normal concrete and SCC with only cement. The carbonation resistance of Self compacting concrete with high volume of fly ash was higher than that of normal concrete. The carbonation resistance of Self compacting concrete with fly ash specimens decreased with the increase of silica fume and fly ash content.

Yatin H Patel, P.J.Patel, Prof. Jignesh M Patel and Dr. H S Patel, S(2013) had done experimental investigation on durability properties of concrete by replacing cement with alccofine and fly ash. From the investigation they concluded that concrete incorporating alccofine and fly ash have better compressive strength compared to normal concrete. It is found that Alccofine improved the durability of concrete and decreased the chloride diffusion. It is determined that during accelerated electrolytic corrosion test loss of weight for steel in alccofine is much less, so in alccofine regular cover is sufficient to prevent steel from corrosion because of its pore filling and pore refining of particle.

III. CONCLUSION

Self-compacting concrete is the only type of concrete where the vibration effect is ignored, thus making the environment protection near the construction site and also reduce the exposure of workers to vibration. The advantage of SCC makes it desirable all over the world. Seventeen review papers on the usage of industrial waste products in the self-compacting concrete had been discussed. From the review, it is concluded that the industrial waste products can be effectively used as a replacement material in self-compacting concrete. It is also understood that different products exhibits different properties at the fresh and hardened state. It is also clearly evident that the

durability characteristics of the concrete are significantly improved with the partial replacement of materials.

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