AN OVERVIEW ON THE DEVELOPMENT AND THE RESEARCH WORK ON SELF COMPACTING CONCRETE.

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Abstract - *Concrete is the construction material which have been used from early times. The materials which are used for buildings, industries and for other purposes should be environmental friendly during usage. Self-compacting concrete is the most innovative type concrete in the recent days. Self-compacting concrete (SCC) does not require any type of vibration during its placement and compaction. The concrete is able to keep moving under its own weight through any type of formwork without any external compaction and even the concrete can flow through congested reinforcement. The amazing thing about SCC is that though it is not a conventional concrete but in its hardened state it is dense homogeneous and has same durability aspects as the normally vibrated concrete. To get the properties of fresh concrete for SCC mineral and chemical admixtures are added. An overview paper is presented based on research work of SCC through this decade. The test data says that the mechanical properties of SCC depend on several things like the strength of concrete, type of cement, type of aggregate, type of admixture, water-cement ratio and the mix proportions on which the properties of concrete changes)*

Key Words: SELF-COMPACTING CONCRETE,NAN SU, METAKAOLINE,W/C RATIO, VISCOSITY MODIFYING AGENT, FLY ASH, POZZOCRETE, SILICA FUME, WORKABILITY.

1. INTRODUCTION

SCC is made of the same materials which are used for conventional concrete. But in addition, viscosity modifying admixture and high range superplasticizer are mixed with the concrete paste to give it high workability and flow ability on its own weight which is the main criteria for self-compacting concrete. The consumption of cement (powder) quantity of SCC is very high and the ratio of fine aggregates to coarse aggregates is very high. To increase the cement (powder) quantity fine fillers such as fly ash, metakaolin, GGBS, rice husk, Pozzo Crete 60 and many another type of pozzolonic materials are mixed with cement.

2. LITERATURE REVIEW

T.Jeevetha1, Dr. S.Krishnamoorthi, G.S.Rampradheep (2014) [1] they studied the behavior or the performance of SCC varying the content of micro silica as the partial replacement of cement. It has been studied that both the fresh and hardened properties of concrete improves with the application of micro silica. The trial mixes are formed based on the EFNARC specifications. 5%, 10% Micro silica is used as cement replacement. The workability properties of the mix are evaluated by workability tests slump flow test, V-funnel. L-Box tests. In the study, the performance of concrete mix with micro silica, superplasticizer, and VMA is evaluated. It was found that the compressive strength of M40 cubes with w/c ratio less than 0.35 at 5% micro silica gives higher result. They used Ordinary Portland Cement of 53 grade (Zuari Cement) (500kg/m3-600kg/m3), river sand conforming to grading zone II of IS 383-1970, fine aggregate of specific gravity 2.53, coarse aggregate of nominal size 12.5 mm and specific gravity 2.35, micro silica having the specific gravity 2.2, Glenium Stream 2 as viscosity modifying admixtures. After doing the several trial mixes they concluded that the workability decreases with increase in the percentage of micro silica. It was concluded that at 5% replacement (powder content of 530kg/m3) of micro silica the mix shows good workability and compressive strength

U. N. SHAH & C. D. MODHERA (2014) [2] they studied the fresh properties of SCC by replacing the content of cement by fly ash and varying the percentage of fly ash. Slump flow, slump flow T50cm time, L box passing ratio test, V-funnel test was done to EFNARC standards to study the fresh properties of SCC. They used standard 53 grade ordinary Portland cement with specific gravity 3.14, processed class F fly ash of specific gravity 2.3, crushed course aggregates of 10 mm downsize with specific gravity 2.8 and bulk density of 1450kg/m3 and locally available river sand of specific gravity 2.7 and bulk density 1800kg/m3 of zone II, Polycarboxylate polymers based superplasticizer to reduce the w/c ratio, water soluble VMA is used to improve the viscosity of the mix. Based on the tests they concluded that Slump increased as the percent of fly ash increased. L box ratio is increased as the fly ash increased. V-funnel passing time reduce as the fly ash percentage increased. The addition of fly ash increases the workability of the concrete, which enable to reduce the water to binder ratio for the same workability.

K.S. Johns ran, Dr. A. Jagannathan (2015) [3] they studied experimental investigations on self-compacting concrete by replacing the cementitious materials by percentage of fly ash, silica fume and both fly ash and silica fume. They also replaced the natural sand by quarry dust. They carried out the slump, V-funnel and L-Box on fresh SCC and compressive strength test, split tensile strength test on the hardened SCC to study the properties of both fresh and hardened SCC samples. The specifications of the materials they use for their studies are ordinary Portland cement with fineness (retained on 90-μm sieve) 8%, normal consistency 28%, initial setting time 75 minutes, final setting time 215 minutes, specific gravity 3.15, the compressive strength at 7 and 28 days respectively 20.6Mpa and 51.2Mpa. Class F-type fly ash with specific gravity 2.12, silica fume, and river sand as fine aggregates with maximum size 4.75 mm specific gravity 2.56 and fineness modulus 3.1, and coarse aggregates are crushed stones with 12 mm maximum size with specific gravity 2.7, fineness modulus 7.69, crushing value 17.40 and impact value 12.50. Superplasticizer based on viscosity modified polycarboxylates are used to improve the workability of the mix, whose specific gravity is 1.14 and ph 8. Quarry dust of maximum size 1.18 mm and specific gravity 2.4. They adopted first mix design method for SCC by Okamura and Ozawa (1995). After doing the experiments they concluded that the addition of Silica Fume and fly ash decreases the demand of HRWRA in SCC Mixes. Replacement of cement by 5%, 10%, 15% and 20% Silica Fume in SCC and Replacement of cement by 10%, 20% and 30% Fly Ash in SCC, the superplasticizer cum retarder demands may be decreased when compared with Controlled SCC. The compressive Strength and Split Tensile Strength result show that the 20% replacement of Fly Ash, 15% replacement of Silica Fume and combination of 10% Fly Ash and 15% Silica Fume gives maximum Compressive Strength and Split Tensile Strength. And finally, the 100% replacement of river sand by Quarry Dust result shows that increase in compressive strength of 28% when to compare to 100% sand and increase in Split Tensile strength of 23.68% when to compare to 100% sand.

H.J.H. Brouwers, H.J. Radix (2005) [4] they studied about the experiments and theoretical aspects of self-compacting concrete. They discussed about the features of ''Japanese and Chinese Methods'' where the mixes are consist of slag cement, coarse aggregates(4–16 mm), sands of (0– 1, 0–2 and 0–4 mm) and a polycarboxylic ether type superplasticizer, and the particle size distribution follows grading line as presented by Andreasen and Andersen.

N R Gaywala, D B Raijiwala (2011) [5] they discussed the different hardened properties of self-compacting concrete with OPC, fly ash from Birla glass, Kosamba, Gujarat, as a binder material in concrete for design mix. And the hardened properties are compared with an M25 grade of concrete. They used crushed stones as coarse aggregate passing through 12.5 mm IS sieve but retained on 10 mm sieve, fine aggregates of maximum size 4.75 mm, the cement of 525kg/m3, and high-performance superplasticizer named GLENIUM SKY 78. After performing all the tests they concluded that maximum compressive strength, flexural strength, pull out strength, tensile strength attained at 15% fly ash mixing with cement, and a concrete mix with 35% fly ash gives nearer result in compressive strength, flexural strength, pull out strength, tensile strength in comparison with M25 mix.

Paratibha Aggarwal, Yogesh Aggarwal, S M Gupta, R Siddiqu (2005) [6] they discussed on the existing research works about SCC and materials and mixture design, test methods such as Vfunnel test, L-Box test, J-ring etc., Tribological behavior of SCC, performance of SCC for underwater applications, in basement walls, columns, beams etc., fresh concrete properties, performance of SCC mixtures using an "artificial neural network", developed models that can be used as economical tools which reduced the number of mix trials for SCC and can be used to generate future results using other material. On the review, they concluded that Workability parameters, the properties of SCC in the hardened state are similar to those of conventional concrete, high strengths, and adequate durability can be obtained using SCC. SCC has better internal frost resistance as compared to normal concrete. Different design methodologies like ANN, factorial design method etc. for SCC have been suggested to develop models that can be used as economical tools for the optimized design of SCC mixtures with desired properties.

P, Jeeva. S, Dhinesh.A, Manoj Kumar. R, Subramanian. M (2013) [7] they studied a review on the development of self-compacting concrete with mineral admixture silica fume. Silica fume is added at 10%, 12.5%, and 15% of cement weight. They have performed slump test, v funnel test, J-ring test, L-box test and U-box test on the fresh properties of SCC, and some NDT tests on the hardened properties of SCC ultrasonic pulse velocity test and compressive strength test by rebound hammer test. They suggested not to use more than 6% silica fume in the concrete mix, and SCC gives resistance against corrosion, freeze-thaw actions, and sulfate attack due to reduced porosity.

Kennouche .S, Zelizer .A, Benmounah .A, Hami .B, Mahdad .M, Bernoulli .H and Bijou .S (2013) [8] they studied the various properties of SCC mixing silica fume in 15% weight of the cement, Portland cement of two different type, polycarboxylates and plynaphtalen two types of admixtures, 3/8 mm and 8/15 mm aggregates are used coarse and fine sand of fineness modulus 3.2 and 1 are used and French association of civil engineering's recommendations are used for the mix design. After performing the tests for both the fresh and hardened concrete they concluded that fixing the dosage of silica fume at 15% the fresh properties of SCC has given a good result, but the mechanical properties show that the compressive strength is higher 25 Mpa which shows very low porosity, which is because of silica fume as filler material, they studied that the viscosity of the cement paste is inversely proportional to the percentage of superplasticizer.

Biswadeep Bharali (2015) [9] he studied about the fresh and hardened properties of SCC where Ground Granulated Blast Furnace Slag and Fly Ash was used as the filler material for cement with a various percentage for M30 concrete. They carried their strength test, flexural strength, and split tensile strength on the samples where the cement is replaced by 30% GGBS (Ground Granulated Blast Furnace Slag), 20% both GGBS and FA (Fly Ash), 40% of GGBS, 15% both GGBS and FA, 40% of FA, and 30% fly ash and Superplasticizer GLENIUM B233. After all the tests he concluded that FA has the ability to reduce the content or demand of admixture, it has been observed that 30% replacement of cement by FA gives a slump of 710 mm which is best compared to all the specimens, it also improves the fresh concrete properties, but when the cement is replaced by 40% GGBS the slump flow test value decreased compared to the test value of cement replaced by FA, it shows that concrete with 30% GGBS gives compressive strength 39 Mpa which nearer to the SCC (100%) cement 41.2 Mpa, the test result suggested that a concrete with 60% OPC, 20% FA, 20% GGBS has compressive strength 34.9 Mpa and flexural strength 7.0 Mpa.

Pramukh Ganapathy (2014) [10] he studied on the possibilities of using industrial by-products like Ground Granulated Blast Furnace Slag, and Silica Fume in the preparation of SCC. They proposed these powders as the replacement of cement in the production of SCC following Nan Su et al. method of mix design. They used 43 grade ordinary Portland cement with fineness 2940cm2/gm, normal consistency 29%, initial setting time 64 minutes, final setting time 192 minutes, specific gravity 3.12, and compressive strength 45.86 Mpa at 28 days. They used GGBS and SF with consistency 36% and 106% respectively, and specific gravity is 2.83,2.14 respectively. Fine aggregates with specific gravity 2.64, fineness modulus 2.91 confirming zone II, and coarse aggregates with maximum size 12 mm and specific gravity 2.65, Cera Hyper plasticizer had been used as Superplasticizer. After doing the mixing proportion and tests on both fresh and hardened properties they concluded that SCC mixes by GGBS and SF both satisfied the norms of the fresh properties of SCC based on EFNARC guidelines, so the method proposed by Nan Su et al is workable for adopting SCC using industrial by-products. SCC based on SF shows low strength, the optimum amount of GGBS is 30% to the total powder content (Dinakar P et al. 2013) but the experiment shows that 66.8% of GGBS to the total powder content shows satisfactory result for M25 grade concrete, some research paper suggested that 80% of GGBS can be used to achieve strength 30Mpa, it is assumed that strength of gain of GGBS mixed designs maybe due to the higher pozzolonic action of GGBS than SF.

K.S. Johns ran, Dr. A. Jagannathan, R. Dinesh Kumar (2013) [11] they represents an experimental study on SCC where the fine aggregate is replaced by quarry dust at 0%, 25%, 50%, 75%, 100%, and mixed with mineral admixtures like Fly Ash, Silica Fume, and chemical admixtures Superplasticizer is used. They did their tests on 45 no of cubes and 45 no of cylinders. They have carried out these tests to find a suitable percentage of quarry dust as a sand replacement, and the influence of proportion of superplasticizer in SCC to get the highest compressive strength. They used ordinary Portland cement of 53 grade with fineness 8%, normal consistency 28%, and initial setting time 75 minutes, final setting time 215 minutes and compressive strength 51.2 Mpa at 28 days, Fly Ash of class F with specific gravity 2.12, silica fume and CONAL-PCE 8860 superplasticizer. After conducting the tests they concluded that mineral admixtures improved the properties of SCC in fresh state without using VMA, such kind of SP are known as new generation SP which reduces the cost of VMA, at 0.34 w/c ratio SCC with 0%, 25%, and 50% replacement by quarry dust shows better result in passing ability, flowing ability, and segregation resisting ability, the SCC with 25% quarry dust replacement gives maximum compressive and tensile strength of 34.62 Mpa, 2.36 Mpa.

Er.Ranjodh Singh, Er.Rohin Kaushik, Er.Gurniwaz Singh (2013) [12] they had tried to achieve SCC with high fluidity and cohesiveness by replacing the fine aggregates with brick dust and marble powder, both are waste materials in industry and harmful to the environment so they tried to use these byproducts to replace the fine aggregates in SCC. They used OPC 43 grade cement, with 37% standard consistency and 3.15 specific gravity, fine and coarse aggregates both with specific gravity 2.65 and fineness modulus 2.2 and 7.87 respectively. After conducting the tests they concluded that SCC can be obtained using both brick dust and marble powder, concrete with 25% marble dust possessed well-hardened properties, under certain conditions both marble dust and brick dust increase the strength of SCC.

N.ANAND, G.PRINCE ARULRA (2014) [13] they discussed the behavior of SCC under elevated temperatures 27ºC to 900ºC under hot conditions. The specimens were heated using the electrical furnace, and the mechanical properties of SCC are tested on heated sample and normal samples of concrete. Conducting all the tests they came to the conclusion that SCC mixes of grade M25, M30, M35, and M40 shows decrease of compressive strength by 70.60%, 75.31%, 78.57%, and 81.76% at 900ºC temperature compared to the specimen at normal temperature, tensile strength of concrete mixes are found to be decreased by 75.36%, 77.52%, 79.35% and 80.22% respectively for M25, M30, M35, and M40, where the flexural strength decreased by 78.40%, 79.02%, 78.47% and 78.43% for M25, M30, M35, M40 at 900ºC compared to the other specimens at normal temperature, it was observed that the mechanical properties of SCC decrease with the increase in temperature, the strength increases with increase of cement grade but it was too marginal.

Aravinth S. N. (2014) [14] he tried to develop high strength self-compacting concrete of M60 with ordinary Portland cement 53 grade, silica fume, and superplasticizer GLENIUM B233 and tried to achieve SCC by trial mixes. He worked on EFNARC -2005 guidelines. After conducting the test for both fresh and hardened properties of SCC he concluded that reduction of w/p ratio (water powder ratio) increases the compressive strength, optimum dosage of chemical admixture is 1.5%-2%, below 1.5% of SP would affect the workability and over dosage would affect setting time, dosage of SP would vary linearly with the weight of cementitious materials, water content should be selected carefully before adding VMA because rheological behavior is more sensitive to water, results shows that concrete with 15-17.5% silica fume gives compressive strength 60.75 Mpa to 70.92 Mpa for w/p ratio 0.368 to 0.334.

N. Bouzoubaâ and M. Lachemib (2001) [15] they had studied an experimental program on SCC made with a high volume of fly ash. They performed their studies on 9 SCC samples and one control concrete. They had used 400kg/m3 cementitious material, with water-cementitious material ratio 0.35 to 0.45, SCC mixes are made by replacing cement 40, 50 and 60% of Class F fly ash, sulphonated, naphthalene-formaldehyde superplasticizer and a synthetic resin type air-entraining additives were used, they used coarse aggregates of maximum size 19mm, their studies showed that it is possible SCC with high volumes of class F fly ash, they studied that the slum flow of SCC using high volume of class F fly ash varies between 500 to 700 mm, flow time of 3 to 7 minutes, segregation was 1.9 to 14%, and water bleeded from 0.025 to 0.129 mL/cm2, temperature rise of SCC is 5 to 10 ºC lower than ordinary concrete, and setting time is 3 to 4 hours longer than ordinary concrete, and SCC gained 15 to 31 Mpa, and 26 to 48 Mpa at 7 and 28 days, and it was observed that SCC with 50% class F fly ash replacement gives 35 Mpa compressive strength with water-cementitious ratio 0.45 which cost is similar to normal M35 concrete.

Monika Dhaka, Dr. S.K. Verma (2014) [16] as durability of concrete largely depends upon its permeability, so they studied on the permeability test on some SCC mixes giving them different exposure condition, the SCC test mixes are exposed to different conditions like lab environment, heat cool cycles, and wet-dry cycles, then the results are compared with the specimen which is kept at room temperature to estimate the durability parameters, they had used OPC 43 grade, coarse and fine aggregates with specific gravity 2.7 and 2.6 and with fineness modulus 3.7 and 2.11 respectively, Structure 202 as superplasticizer, Guru Gobind Singh Thermal Power Plant, Ropar (Punjab)'s fly ash had been used as filler material. After making the samples and performing permeability tests they concluded that water permeability coefficient in case of wet dry exposure was less than the specimens which are exposed to normal condition, values of water permeability coefficient for normal and heat cool exposure are same almost, average water permeability coefficient, normal SCC was found 4.011 x 10-12 m/s, whereas value of water permeability coefficient for wet-dry and heat-cool exposure was found 1.742 x 10-12 m/s and 3.443 x 10-12 m/s respectively, where according to ACI 301-89 the maximum permeability coefficient is 15 x 10-12 m/s.

O. Babalola (2015) [17] they studied the comparison between the rheological properties and compressive strength analysis of SCC and normal conventional concrete, they used ordinary Portland cement (32.5 grade), fine river sand, coarse aggregates (20-25mm), Conplast SP430 Superplasticizer are used for the mix, taking W/C ratio 0.5, after mixing and doing all the tests they concluded that rheological properties of SCC and conventional concrete are different, water-cement ratio influence the strength properties of SCC as it does for conventional concrete, but its effect on the plastic properties of SCC is negligible compared to conventional concrete, compressive strength of a well-mixed SCC is in the range of 85% to 95% of conventional concrete, and greater compressive strength is achieved at 90 days or beyond.

Nileena M S, Praveen Mathew (2014) [18] they studied the effect of replacement of cement with GGBS and replacement of fine aggregates with GBS, to obtain SCC they had used ordinary Portland cement 53 grade, with a w/c ratio of 0.45, cement and fine aggregates are replaced by 30%, 40%, and 50% of GGBS and GBS respectively, they had done various tests flexure strength test, tensile strength test compressive strength test, ultrasonic pulse velocity test, elastic modulus test. They estimated the ingredients by Nan Su method and followed EFNARC guidelines, conducting all the tests they concluded that there was a small difference in the compressive strength of the SCC mix by GGBS as cement replacement and GBS as sand replacement, no change in flexural strength, only significant difference in elastic modulus was found, using both GGBS and GBS has negative aspect on the hardened properties of SCC.

Mallesh.M, Sharanabasava, Reena.K, Madhukaran (2015) [19] they followed the mixed design method by Nan Su for SCC, calculated all the materials required for SCC, by changing the Nan Su's coefficient and w/c ratio tried to achieve M25 SCC, they used OPC 43 grade cement, fine aggregates of 2.61 specific gravity and fineness modulus 2.98, coarse aggregates with 2.68 specific gravity, AUROMIX-400 as superplasticizer, on the basis of Nan Su's it was suggested that for M25 SCC mix the coefficient is 12 and w/c ratio is 0.55, which follows this proportions:

(1) Max size of aggregate = 10 mm
(2) The volume ratio of fine aggregates to total aggregates=S/a= 54% (50% to 57%)
(3) Sp. gravity of Cement (Gc) = 3.12
(4) Sp. the gravity of CA (Gg) = 2.68
(5) Bulk density of CA (Wgl) = 1265 Kg / m3
(6) Sp. the gravity of FA (Gs) = 2.61
(7) Bulk density of FA (Wgl) = 1595 Kg / m3
(8) Sp. the gravity of Fly ash (Gf) = 2.1
(9) Sp. gravity of water (Gw) = 1.0
(10) Packing factor (PF) = 1.04
(11) Super Plasticizer dosage= 0.80% (Auromix-400 Fosroc Constructive Solutions)
(12) Air content (Va) = 1.5 %
(13) Designed compressive strength (psi) FC = 25 Mpa

They concluded that as the Nan Su's coefficient increases w/c ratio increases to satisfy the SCC properties, as the coefficient increases the compressive strength increases for both 7 and 28 days.

Salem Alsanusi (2013) [20] he studied on the development of a suitable SCC mix as the effect of water to cement ratio, limestone, silica fume, which satisfy the plastic state properties of SCC, and castings of concrete cubes and testing of them for the compressive strength test, he suggested that not more than 6% silica fume by mass of cement should be used to get high compressive strength.

Mallesh M., Praveen S, Reena K, H. Eramma (2015) [21] they worked on a mix design procedure of M35 proposed by Nan Su, who was used to calculate the material required for SCC by changing Nan Su's coefficient and water cement ratio to get M35 grade concrete, in the SCC they used OPC 43 grade and fly ash as the filler material, they followed Nan Su's mix design steps. After doing all the tests they concluded that for Nan-Su's coefficient 7,8,9,10,11 for M35 grade SCC it achieved expected results for 7-days & 28-days compressive strength and got the required strength of about 43.25 Mpa for M35 grade of self-compacting concrete for Nan-Su's coefficient 10,w/c ratio, super plasticizer dosage 0.8

Prof. Kishor S. Sable, Prof. Madhuri K. Rathi (2012) [22] they have performed a research work in the comparison of shear and torsion of SCC and NCC with and without fibers with different aspect ratio. It has been observed that SFRSCCs have a slump flow of 660-715 mm, time of flow ranging from 2.89 to 5 sec, V-funnel flow in the ranging from 7.2 to 12.59 sec, T5minutes ranges from and 9.02 to 16.21 sec, a L-Box ratio ranging from 0.821 to 0.948 and a J-Ring test value ranging from 2 to 7 mm, SCC developed shear strengths ranging from 3.56 to 7.29 kN at the end of 28 days and the NCC developed shear strengths ranging from 3.11 to 6.62 kN at the end of 28 days. SCC developed moment strengths ranging from 2.35 to 4.82 kNm at the end of 28 days and the NCC developed moment strengths ranging from 2.05 to 4.38 kNm at the end of 28 days. SCC developed torsional strengths ranging from 20.50 to 34.76 kNm at the end of 28 days and the NCC developed torsional strengths ranging from 18.62 to 29.68 kNm at the end of 28 days. There is a decrease in the strength with a decrease in an aspect ratio of same fiber type. The straight fibers having less strength as compared with hook end and crimped fibers because of their shape. Due to the shape, it is obvious that the hook end and crimped fiber having a good bond and anchorage in the matrix resulting in more strength.

Lightweight concretes are successfully applied in the building construction due to their low specific weight in comparison with high strength concrete, high thermal insulation, high durability, A.A. Maghsoudi, Sh. Mohamadpour, M. Maghsoudi (2011) [23] they tried to develop SCLWC (self-compacting light weight concrete) with light weight aggregates "Light expand clay aggregate (Leca)", they used type II Portland cement, with specific gravity 3.15 and 10% silica fume, poly-carboxylic-ether (PCE) used as superplasticizer, After doing the tests on the fresh and hardened properties of SCLWC they concluded that using Leca and cement content 400 to 500 kg/m3 it is possible to produce lightweight self-compacting concrete with specific weight less than 1900 kg/m3, it gives compressive strength 20.8 Mpa to 28.5 Mpa within 28 days, the disadvantages of Leca aggregates are that they have low compressive strength so the compressive strength of concrete using Leca aggregates is low than normal concrete, the value of maximum strain in SCLWC lies between 0.0024 and 0.0022.

Mahavir Singh Rawat (2015) [24] he studied on fresh and hardened properties of self-compacting concrete where the OPC is partially replaced by 10% sugarcane bagasse ash, he used Conplast SP430-SRV as the super plasticizer, he observed that only two of his sample passed the fresh property tests of SCC, and concluded that the compressive and tensile strength both decrease with the increase of Sugarcane Bagasse Ash percentage with respect to cement.

Deepa Balakrishnan S., Paulose K.C. (2013) [25] they did their study on SCC made by high volume Fly Ash at 12.5%, 18.75%, 25%, 37.5% of the cement, and 6.25%, 12.5%, and 25% of cement replaced by dolomite powder, and the compressive strength are studied at the age of 7, 28, and 90 days with w/c ratio 0.33, from the experimental studies it has been observed that use of Fly Ash in SCC reduces the possibility of bleeding and segregation, increases the passing and filling ability of concrete, where the dolomite powder imparts viscosity to concrete and improves its segregation resistance, it has been observed that better physical and mechanical properties can be achieved by replacement of cement by fly ash from 12.5% to 18.75%, SCC can be made using dolomite powder instead of VMA, better fresh properties of SCC can be achieved using dolomite powder from 6.25% to 12.5% replacement of cement, the best SCC is obtained by using 37.5% fly ash, fine aggregates to 55% of total aggregates, OPC 53 grade, and w/c ratio 0.33.

Manjur A.Shendure, Mohit Uphade & Gagan Chajjed (2015) [26] they studied the effect on the fresh properties of concrete using neutralized red mud, as red mud is a waste product made from Bayer process of alumina production and a threat to environment, they tried to use this byproduct to make high performance concrete from durability aspect, their studies and experiments shows that 35% of fly ash and 15% neutralized red mud gives more compressive strength than 30% fly ash and 15% neutralized red mud, and 40% fly ash and 15% neutralized red mud, SCC with 35% fly ash and 0% NRM (neutralized red mud) gives minimum strength against normal concrete but achieved target strength, so they concluded that SCC with 35% fly ash and 15% NRM gives SCC with all fresh and hardened properties.

A Rajathi and G Portchejian (2014) [27] they studied on the effect of glass powder on the properties of SCC by mixing it with various proportions with cement which is a byproduct, they used OPC 53 grade with specific gravity 3.15, fine aggregates and coarse aggregates with specific gravity and fineness modulus 2.59, 3.1, and 2.61, and 7.69 respectively, and glass powder with specific gravity 2.11 and size less than 150μm and sieved in 75μm, going through the experiments they concluded they the flow ability of the SCC decreases 1.35%, 2.2%, and 4.36% on the application of 5%,10% and 15% of glass powder respectively, where the V funnel time increased by 6.21%, 15%, and 22.54% on the application of 5%,10% and 15% of glass powder respectively (it indicates higher viscosity of fluids), L-box also observed to decrease 1.5%, 3.2%, 5% on the application of 5%,10% and 15% of glass powder respectively, compressive strength also decreased 6%, 15% and 20% on the application of 5%,10% and 15%.

DEEPTHY RAJAGOPAL & MATHEWS M PAUL (2014) [28] they studied on the durability aspect of SCC using manufactured sand, fly ash as additive, Master Glenium

Sky 8233 as chemical admixture, used for M35 mix, and then sulphate attack and chloride attack of the specimens were determined, they used OPC 53 grade, manufactured sand as fine aggregates with specific gravity 2.65, coarse aggregates of 12.5 mm and 6 mm sized are used, and the test result suggested that compressive strength of cubes decreases which are immersed in sodium chloride solution as the strength of the solution increases and same for magnesium sulphate solution,.

Reena K, Mallesh M (2014) [29] they studied on the mix design procedure for M20 proposed by Nan Su, by changing Nan Su's coefficient for cement content {that is C=nfc} (C=cement content, fc= compressive strength, n= Nan Su's coefficient) and water cement ratio, they used OPC 43 grade cement, it has been observed that for Nan Su's coefficient 11, that is C=11fc for M20 grade concrete, which satisfied all the requirements by EFNARC, it has been observed from the tests that increase in Nan Su's coefficient also increase the water content to satisfy the requirements of SCC, it increase the cement content also as an effect the strength also increases, it decreases the quantity of filler material per m3 as the filler materials did not participate in aspect of strength the strength get increased, fine aggregate and coarse aggregates are independent of Nan Su's coefficient and water content, Nan Su's coefficient can be used for lower grade SCC.

M. Iyappan Dr. A. Jagannathan (2014) [30] they on the benefits of SCC made with nano silica, nano silica is used as the partial replacement of OPC, they used 0%, 2%, 4%, and 6% of nano silica, it is observed that using 2% nano silica increases split tensile strength compressive, flexural, and about 13.09%,11.93%, 10.51%, respectively, compressive, flexural, and split tensile strength are increased by 4% nano silica about 18.88%,16.01%,23%, but 6% nano silica decrease compressive, flexural, and split tensile strength about 0.4%,1.29%,14.4% compared with 4% addition of nano silica in SCC respectively.

3. CONCLUSIONS

SCC is a modern type of concrete which can be placed and compacted fully without any external force or we can say vibration. All the 30 case studies suggested that we can achieve SCC by using industrial by products as the filler materials like GGBS, Fly ash, Silica fume, Neutralized Red Mud, Glass powder, dolomite powder as cement replacements and quarry dust, Leca, manufactured sand as fine aggregates. As SCC does not require any vibration and can be made by industrials by products it is environmental friendly, as it does not require any vibration the cost for VMA or chemical admixtures can be balanced. It is also observed that there is no standardized tests or limits for SCC, though it has Nan Su method or EFNARC guidelines, etc. but there is no Standardized guideline in Indian province for SCC so there is a scope for further studies remain in making any standardized guideline for SCC in India, and also there is a scope remain in making high strength self-compacting concrete by using by products or Nano silica

3. REFERENCES

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