Development of Self Compacting Concrete Using Natural Materials: A Review

Katam Sambasiva Rao[1], Dr. Dineshkumar Gopalakrishnan[2]
[1](M.Tech Student, Dept. of civil engineering, Vaagdevi College of Engineering (Autonomous), Warangal, India)
[2](Assistant professor, Dept. of civil engineering, Vaagdevi College of Engineering (Autonomous), Warangal, India)
[1]Corresponding Author: sambrao.aee@gmail.com

To Cite this Article
Katam Sambasiva Rao, Dr. Dineshkumar Gopalakrishnan, "Development of self compacting concrete using natural materials: A review", Journal of Science and Technology, Vol. 06, Issue 02, March-April 2021, pp105-108

Article Info
Received: 04-11-2020 Revised: 11-02-2021 Accepted: 15-02-2021 Published: 23-02-2021

Abstract: *The world is heading towards an era of thinnest components of structures for having more spacious designing. This can be accomplished using the modern invention of Rheodynamic concrete also termed as self compacting concrete. To improve passing ability and fluidity of Self compacting concrete, the mix requires high powder content, high range VMA (Viscosity Modifying Agent) & super plasticizer, lesser quantity of coarse aggregate is engulfed in comparison to traditional concrete to fill in congested areas. In this phase of the technology, it is innovative to minimize the waste produced by the Industries; one such way to minimize this wastage is by utilizing these materials for construction activities. This review focuses on the possible ways of using these waste materials in self compacting concrete without degrading its properties such as flow ability, fluidity, and workability and segregation resistivity giving rise to the concept of green concrete.*

Keywords: *SCC (self compacting concrete), Industrial waste, passing ability, fibers, strength*

I. Introduction

The faster adoptability of skyscrapers has led to drastic changes in the designing, planning and way of Construction at site. Due to dense population and inappropriate availability of land the structures components are thinned for providing more carpet area. Due to the thinner components, congestion in the alignment of reinforcement occurs. These challenges gave rise to new form of concrete known as self compacting concrete or Rheodynamic concrete. It has the ability to fill formwork and sheath reinforcing bars through action of gravity while preserving similitude. To do so self compacting concrete uses fewer quotas of coarse aggregates and high potion of superplasticizer. The segregation resistance and firmness of the mix is obtained by using high fines content. The implications of self compacting concrete in construction have shown advancements in both designing and durability of buildings. The property of self compacting concrete to fill even the congested areas thanks to its fluidity has proven beneficial in many aspects of designing.

Many products are discharged by industries in the form of industrial waste; these products can be utilized in the mix design of self compacting concrete in the following ways:

1. By partially replacing the binding content i.e. cements.
2. Using as admixture to modify the properties.
3. To reduce the conventional aggregates quantity.

Additions in the form of admixtures [3]:

As per the reactive capacity with water the additions are classified as Type I & Type II.

1. Mineral fillers with promising finish such as lime stone powder/granite powder generally accepted to increase the paste volume when passing through the 125 micron sieve.
2. As per control requirement of bleed, 0.1μm size silica flume and 1μm size Micro silica is used as additive.

Similarly there are multiple additives like Metakaolin, Air cooled slag, ground glass etc., are available to suit the field requirements.

Source and quantum generation of some of the well-known industrial wastes given by Government of India is tabulated below [4].

Table no 1: Industrial waste list provided by Government of India [4]

Source and Quantum of generation of some major industrial waste

S. No	Name	Quantity (million tonnes per annum)	Source/Origin
1.	Steel and Blast furnace	35.0	Conversion of pig iron to steel and manufacture of Iron
2.	Brine mud	0.02	Caustic soda industry
3.	Copper slag	0.0164	By product from smelting of copper
4.	Fly ash	70.0	Coal based thermal power plants
5.	Kiln dust	1.6	Cement plants
6.	Lime sludge	3.0	Sugar, paper, fertilizer tanneries, soda ash, calcium carbide industries
7.	Mica scraper waste	0.005	Mica mining areas
8.	Phosphogypsum	4.5	Phosphoric acid plant, Ammonium phosphate
9.	Red mud/ Bauxite	3.0	Mining and extraction of alumina from Bauxite
10.	Coal washery dust	3.0	Coal mines
11.	Iron tailing	11.25	Iron Ore
12.	Lime stone wastes	50.0	Lime stone quarry

(Source : National Waste Management Council- Ministry of Environment & Forests-1990/1999)

Utilization of these materials can minimize the Carbon foot print as well as economical concrete can be achieved.

In parallel to industrial wastes natural materials (pumice stone, earthen materials, mycelium, hemp fibers, basalt powder, basalt fibers etc.,) are also available which can be used for producing light weight and green self compacting concrete.

II. Literature Review

METAKOALIN AND KILN DUST [7]

The objective of this review was to study the properties of SCC. The study shows a description about compressive strength value, flexural strength value and split strength value upon the addition of METAKOALIN (MK) AND KILN DUST (CKD) for different time periods. The study concludes that as long as the traditional Portland cement is replaced with proper proportions of MK & CKD, the endurance of composition will be complemented to more abiding concrete. It has been reported by the study that competitive self compacting concrete can be achieved from restoring up to 50% of OPC with CKD; a hermetic SCC can be produced by using 20% MK.

GLASS POWDER [6]

This review's aim was to provide an experimental study on SCC using GLASS POWDER. The study shows the variations observed in the mix upon the addition of glass powder in different proportions. The review indicates that there is a decrease in the flow value of the mix with increase in glass powder content, indicating a decrease in deformability of the mix, there was an increase in relative flow time, which was studied by finding the V-Funnel time, upon the addition of glass powder showing an increase in viscosity of the mixture. There was also a decrement in the l-box value on adding glass powder. A decrement in the compressive strength had been observed to vary inversely proportional to the proportion of the glass powder in the mix.

PUMICE STONE AND STYROFOAM SPRAY [1]

In this case study pumice stone with Styrofoam was used to produce light weight concrete. the porous nature of the pumice stone comes in handy for forming light weight concrete. It has been shown that the light weight aggregates present in the mix reduce the dead load but decrease the concrete strength. the study mentioned that usage of pumice stone demises the strength parameters of concrete limiting the usage of lightweight concrete for separation walls.

MYCELIUM COMPOSITES [2]

The prescribed study, details about the innovative usage of mushroom materials in building materials such as bricks. The study states that mushroom composites are a class of viable biomaterials grown from fungal mycelium. Agriculture waste products such as cotton hulls are used in this process. The resulting sturdy organic compatible material can be used in many applications such as building materials, thermal insulating materials and packaging materials. In the study they were able to produce a mycelium brick with fewer loads bearing capacity which could be used for light weight constructions.

SILICA FUME AND QUARRY DUST [8]

The objective of this paper was to study the properties of SCC upon addition of silica fumes and quarry dust. The review categorized silica fumes as a supplementary Cementous material possessing excellent pozzolanic properties. The study mentioned that the strength decreases upon the addition of quarry dust and silica fumes, the compressive strength of SCC mixture containing silica fumes was greater compared to the Self Compacting Concrete mixture containing quarry dust. According to the report, the split tensile strength test showed the same tenor as that of compressive strength test i.e. increases with a decrease in W/c ratio. The report stated that upon the addition of silica fumes there was an enhancement in mechanical properties of SCC due to its pozzolanic properties, also that it contributed in increasing the strength of SCC. The inclusion of silica fumes and quarry dust in SCC provides us the flexibility of managing its strength depending upon our needs.

ULTRAFINE NATURAL STEATITE [9]

This investigation focusses on attributes of SCC upon usage of ultrafine natural steatite as a supplement for cement. The study showcased its properties by performing the L-box experiment, it was concluded that the addition of ultrafine natural steatite in substitution to cement increased water demand by reducing the height ratio. Upon conducting the V-funnel test it was stated that the flow timing increases almost increases linearly. It has also been mentioned that the addition of UFNSP has an impact on the workability i.e. decrease in slump (increases spreading time) due to increase in UFNSP content. Upon elemental mapping the 56 days specimen it was found that the magnesium and silicate were mapped, which shows diffusion over surface thereby helping in formation of denser structures.

FLY ASH- EFFECT OF SUPERPLASTICIZER AND HARDENING OF SCC [12]

This research paper enlists the attributes of SCC with Fly ash. The study undertook various tests such as slump, compaction factor, unit weight and compressive strength containing 10% fly ash and varying the proportion of superplasticizer. An increment in both slump and compaction factor was noted using 10% of fly ash and increasing the proportion of superplasticizer from 0.25 to 0.35 percentage. Superplasticizer along with 10% fly ash additive shows acceleration in the compressive strength, establishes the uniformity and homogeneity of SCC and also provides a marginal reduction in weight of the concrete. This mixture turns out to be ecofriendly and requires no vibration resulting to no voice pollution. The study also mentions about future investigative opportunities in this aspect of the usage of fly ash that its hardening properties could also be studied using the L-box test and V-funnel test.

FLY ASH, SILICATE FUMES AND CONPLAST SP430 [5]

The objective of this journal was to experiment the usage of materials like Fly Ash, Silicate Fumes and Conplast SP430. Conplast SP430 is a sulphonated naphthalene polymer also known as brown liquid, it has been deliberately made for reducing the water proportion in the concrete mix without losing its workability. The study concluded that there was a decrease in compressive strength with increment in fly ash percentage and an increase in compressive strength was observed with increase in the percentage of silica fumes. The same trend was encountered for the tensile strength of the SCC. Even though the usage of fly ash decreases the strength whereas silica fumes increase the strength of the mix as a replacement to cement, they were encouraged as they play a momentous role in abating the economical hazards.

VEGETABLE AND SYNTHETIC FIBERS [10]

The aim of this investigation is to achieve SCC using vegetable and synthetic fibers as additives without stirring its mechanical and physical properties. The study states that the addition of fibers leads to delay in spreading of cracks increase in flexural as well as tensile strength, increment in toughness of hardened concrete. Further observations show that the inclusions of fibers give rise to more water requirement as the fibers tend to absorb water. After preliminary studies it was stated that the amount of water and superplasticizer differs from one fiber to another. The results showed that the fibers which they chose (plant fibers, DISS fiber, ALFA fiber, Date palm fiber,) showed a negative effect on workability and self-compacting attributes of self compacting concrete. The insertion of fibers in the concrete creates a space between the concrete particles which is considered adequate to avoid riving in concrete at temperature rise. The evolution of workability of SCC bundles decreases over time, especially in confined areas.

MARINE ALGAE [11]

The study experiments the properties of marine algae and use them as mixing material for concrete. the study states that the marine algae control chemical reactions of cement, avoid voids and decrease the permeability of the concrete. It was reported that addition of marine algae increases compressive, tensile and flexural strength of the concrete depending upon the number of days of curing. The beams made with marine algae concrete showed lesser deflection for a specific load compared to a normal concrete beam. It has been concluded that the usage of 8% mixture of marine algae concrete gives superior results. The usage of marine algae concrete is beneficial in many ways as it eco- friendly there by reducing the carbon foot print. Recent advancements in the usage of bio degradable materials in concrete can be used as supply to give better results in marine algae concrete.

III. Conclusion and Summary

An overview of various research papers and manuals has been presented in this paper. It is necessary to study further on these areas so that economically promised green SCC and light weight SCC can be produced with the use of industrial wastes and naturally available alterative materials keeping the facts of carbon foot print.

References

[1]. Arpit Sharma, Manali Sehrawat, Kamaldeep Singh and Madhur Saraf "floating concrete by using light weight aggregates" International Journal of Current Research Vol. 9, Issue, 05, pp.49842-49845, May, 2017.

[2]. Santhosh b s, bhavana d r, rakesh m g "mycelium composites: an emerging green building material" International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 06 | June 2018

[3]. "Wrd handbook chapter no. 3 self compacting concrete" Maharashtra Engineering Research Institute, water resource department, nashik-04 April 2019

[4]. "INDUSTRIAL SOLID WASTE", http://cpheeo.gov.in by GOI

[5]. Dinesh. A, Harini.S, Jasmine Jeba.P, Jincy.J, Shagufta Javed "experimental study on self compacting concrete" IJERST DOI: 10.5281/zenodo.345692

[6]. Mayur B. Vanjare, Shriram H. Mahure "Experimental Investigation on Self Compacting Concrete Using Glass Powder" (IJERA) Vol. 2, Issue 3, May-Jun 2012, pp.1488-1492

[7]. Chandrakant u. Mehetre, pradnya p. Urade, shriram h. Mahure & k. Ravi "comparative study of properties of self compacting concrete with metakaolin and cement kiln dust as mineral admixtures" IJRET Vol. 2, Issue 4, Apr 2014, 37-52

[8]. Ms. Priyanka p. Naik, prof. M. R. Vyawahare "comparative study of effect of silica fume and quarry dust on strength of self compacting concrete" (ijera) vol. 3, issue 3, may-jun 2013, pp.1497-1500

[9]. P. Kumar, K. Sudalaimani, and M. Shanmugasundaram "An Investigation on Self-Compacting Concrete Using Ultrafine Natural Steatite Powder as Replacement to Cement" Hindawi Advances in Materials Science and Engineering Volume 2017, Article ID 8949041

[10]. A.Belkadi, S.Aggoun, C.Amouri, A.Geuttala, H.Houari "experimental investigation on the properties and performance of self compacting concrete with vegetable and synthetic fibers" . Proceedings of the 7th International Conference on Mechanics and Material design Albuferia/Portugal 11-15 June 2017 Publ.INEGI/FEUP (2017).

[11]. R. Ramasubramani, R. Praveen and K. S. Sathyanarayanan "study on the strength properties of marine algae concrete".RASAYAN.J.Chem Vol. 9 | No. 4 |706 - 715 | October - December | 2016

[12]. S. M. Dumne "Effect of Superplasticizer on Fresh and Hardened Properties of Self-Compacting Concrete Containing Fly Ash" American Journal of Engineering Research (AJER) Volume-03, Issue-03, pp-205-211