

# A REVIEW ON UTILIZATION OF PLASTIC GRANULES AND ALCCOFINE IN SELF-COMPACTING CONCRETE

Fiona Alias<sup>1</sup>, Tellma John<sup>2</sup>

<sup>1</sup>PG student, Civil Engineering Department, Toc H Institute of Science and Technology, Kerala, India

<sup>2</sup>Assistant Professor, Civil Engineering Department, Toc H Institute of Science and Technology, Kerala, India

\*\*\*

**Abstract** - Self-Compacting Concrete (SCC) has been one of the reliable alternatives practiced in the construction of congested reinforced concrete structure. It can fill all the void spaces, passes through any obstruction by its own weight and does not require any external vibration. Modern application of self-Compacting Concrete is focused on high performance, better and more reliable and uniform quantity. Plastic granules is used as a replacement of fine aggregate and which reduces the dead load of the structure, overall cost, in turn reduces the pollution. Alccofine is a new generation, micro fine material of particle size and is much finer than other hydraulic materials like cement, fly ash, silica etc. as a result this material increases both compression and flexural strength. The work is aimed at the utilization of Plastic granules which indirectly facilitate waste reduction, maintaining the ecological balance and thus reduces the consumption of aggregates.

**Key Words:** Self-Compacting Concrete, Alccofine, Plastic granules

## 1. INTRODUCTION

Self-compacting concrete is a highly flowable type of concrete that spreads into the form without the need for mechanical vibration. Self-compacting concrete is a non-segregating concrete that is placed by means of its own weight. Supplementary cementitious materials (SCM) are finely ground solid materials that are used to replace a portion of the cement in a concrete mixture. These supplementary materials may be naturally occurring, manufactured or man-made waste. Alccofine is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. The replacement of fine aggregate in the mixture with low cost, recycled plastic granules which reduces the dead load of the structure, overall cost, in turn reduces the pollution. The use of plastic waste as a natural aggregate substitute in concrete is a relatively recent concept. One of the first significant reviews on the use of waste plastic in concrete focused on the advantages and financial benefits of such use, besides their physical and mechanical properties.-

### 1.1 Plastic Granules

The word "plastic" means substances which have plasticity and accordingly anything that is formed in a soft state and

used in a solid state can be called a plastic. Plastics can be separated into two types. The first type is thermoplastic, which can be melted for recycling in the plastic industry. These plastics are polyethylene, polypropylene, polyamide, polyoxymethylene, polytetrafluoroethylene and polyethylene terephthalate. The second type is thermosetting plastic. This plastic cannot be melted by heating because the molecular chains are bonded firmly with meshed crosslink. These plastic types are known as phenolic, melamine, unsaturated polyester, epoxy resin, silicone, and polyurethane. At present, these plastic wastes are disposed by either burning or burying which causes several environmental issues.

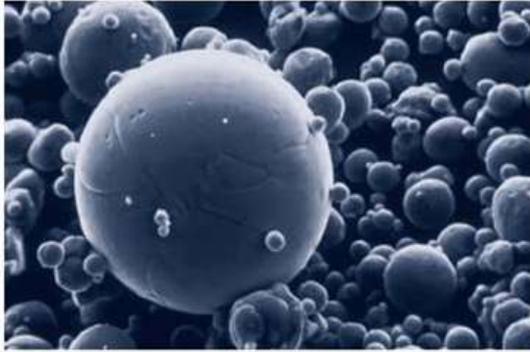
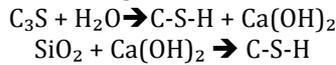
The use of plastic waste as a natural aggregate substitute in concrete is a relatively recent concept. One of the first significant reviews on the use of waste plastic in concrete focused on the advantages and financial benefits of such use, besides their physical and mechanical properties. And more over use of plastic as aggregate gives a solution to the problems encountered with the quarrying of natural aggregate.

### 1.2 Alccofine

Alccofine is a specially processed product based on high glass content with high reactivity obtained through the process of controlled granulation. It is a micro fine material of particle size much finer than other hydraulic materials like cement, fly ash, silica etc. being manufactured in India. Alccofine has unique characteristics to enhance performance of concrete in both fresh as well as hardened stages due to its optimized particle size distribution. When this material is mixed with water, they react chemically to form a strong rigid mass that binds aggregate particles together to make concrete. Specific gravity of alccofine is 2.9. Alccofine is pozzolanic material which is becoming popular in the construction industry and has brought many developments in the field of Civil Engineering. The Figure 1 shows the nano particle form of Alccofine.

For high strength, Alccofine is a new generation micro fine concrete material and which is important in respect of workability as well as strength. It can be added directly with cement and are easy to handle. The ultrafine particle of Alccofine provides smooth surface finish. The most important advantages of Alccofine is its strength

improvement and lower the water/binder ratio. Compression and flexure can be increased to a large extent with the addition of Alccofine. Alccofine also consumes by product calcium hydroxide from the hydration of cement to form additional C-S-H gel which is similar to pozzolans.



**Fig 1:** Nano particle form of Alccofine

## 2. LITERATURE REVIEW

In recent years, many studies were conducted by various researchers on environmental friendly concrete materials. Plastic granules and Alccofine are two such materials that can be used in the construction industry. The goal which is expected from the paper is to study the properties of concrete with Plastic granules and Alccofine to make a strong and durable low cost and eco-friendly concrete.

### 2.1 Self-Compacting Concrete with Plastic Granules

Aboutaleb D., et.al (2013), conducted study on the use and recycling of plastic wastes in the formulation of the self-compacting mortars as a fine aggregate instead of sand given the non-availability of natural resources such as sand. The sand is substituted with the plastic waste at dosages (0%, 10%, 20%, 30% and 50% by weight of the sand). The physical (bulk density, porosity, water absorption and ultrasonic pulse velocity testing) and mechanical (bulk compressive and flexural strength) properties of SCMs were evaluated and a complementary study on micro-structural of the interface of cementitious matrix and plastic waste. The results shows that the self-compacting concrete have good flow (flowability at the implemented), fluidity is significantly improved by the presence of these waste and the results of mechanical test showed that the compressive strength at 28 days of self-compacting mortar containing up to 50% of plastic waste was acceptable for lightweight mortars with the bulk density 1.5 kg/m<sup>3</sup>. Reduction in the compressive strength was between 15% and 33% for mortar containing 20-50% plastic waste.

Hama M. S.(2017), et.al (2013), this paper investigate the effect of using plastic waste as partial replacement of fine aggregate, on the fresh characteristics of self-compacting concrete (SSC). For this purpose, different self-compacting concrete mixes were designed at constant water-to-binder ratio of 0.32 and 520 kg/m<sup>3</sup> of binder content. Class F fly ash was used as partial replacement of cement (30% by weight of cement). The six designated plastic waste contents of 0, 2.5, 5, 7.5, 10, and 12.5% and three different sized Plastic wastes (fine plastic wastes, coarse plastic wastes, and mixed plastic waste) were considered as experimental parameters. The workability properties of self-compacting concrete mixtures were performed regarding to slump flow diameter, T50 slump flow time, V-funnel flow time, L-box height ratio, and L-box T20 and T40 flow times. The 28-day compressive strengths of self-compacting concretes were also measured. The experimental results of this work are showed that the plastic waste with the sizes and contents that used in this work can be used successfully as a fine aggregate in self-compacting concrete.

Milehsara D. S., et.al (2017), studied the combined effects of waste Polyethylene Terephthalate (PET) particles and pozzolanic materials on the rheological, mechanical and durability properties of self-compacting concrete (SCC) are evaluated. The replacement ratios of fine aggregates with the same weight of waste PET aggregates are 5, 10 and 15 weight percent (wt.%). Moreover, the replacement ratio of cement with the same weight of silica fume and fly ash is 10 and 30 wt.%, respectively. The workability of SCC containing waste PET particles was determined using slump flow, V-funnel and L-box tests. Mechanical (compressive, tensile and flexural strengths and modulus of elasticity), rheological (L-Box, slump flow and V-funnel) and durability (water absorption and electrical resistance) properties are assessed. The results show that waste PET particles can be reused as aggregates in SCCs. Use of waste PET in SCC decreases compressive, tensile and flexural strengths. However, pozzolanic materials (fly ash and silica fume) compensate the loss of strength caused by adding PET.

Al-Hadithia A. I. et.al (2019), investigated the mechanical properties and impact behaviour of PET fiber reinforced self-compacting concrete (SCC). PET fibers from waste plastic were added to SCC with an aspect ratio of 28. One reference concrete mix, from which all other mixes were developed, was used to produce eight SCC mixers containing different volumetric ratios of plastic fibers percentages (0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5%, 1.75%, and 2%). Experiments showed that the inclusion of PET fibers in SCC results in an increase in compressive and flexural strengths. The behavior of SCC slabs under impact loading was studied. A significant improvement was found in the resistance to impact load and energy absorption capacity of slabs containing PET fibers. The increment in the time of max deflection for the concrete mixes containing PET fibers increased significantly, thereby

indicating the enhanced capacity of SCC to absorb further energy under low velocity impact. This improvement in the behavior of SCC under impact by the inclusion of PET fibers may lead to further applications of this type of concrete in sustainable structures.

Daraei A. et.al (2019), studied on the mechanical, fracture and durability characteristics of self-compacting high-strength concrete (SCHSC) containing recycled polypropylene plastic particles (RPPP) with and without silica fume (SF). The first set of mixtures included binary cementitious blends of 20% fly ash (FA) and 80% Portland cement (PC). However, the second series of the mixtures incorporated ternary cementitious blends of 20% FA, 10% SF and 70% PC. To produce the concretes, medium size aggregate was replaced with RPPP at five designated percentages of 0%, 10%, 20%, 30% and 40% by volume in both sets of concretes. The test results showed that the use of RPPP significantly improved the fracture and ductility properties, whereas aggravated other measured properties of SCHSCs. However, with the addition of SF all mechanical and durability characteristics remarkably enhanced. The results also demonstrated that SCHSC with compressive strength higher than 70 MPa at 90 days was produced by using RPPP content up to 40% replacement level by total medium aggregate volume, and 10% SF.

## 2.2 Self Compacting Concrete with Alccofine

Pawar M. S., et.al (2013), in this paper, the study focuses on comparison of the properties of SCC with flyash and Alccofine to that of standard one with flyash. The main variable is proportion of Alccofine keeping cement, flyash, water, coarse aggregate, fine aggregate and super plasticizer contents constant. In the experimental procedure of SCC, alccofine were added in 0%, 5%, 10% and 15%. From the results of considered parameters, it is observed that 10% replacement of cement with alccofine showed better performance in case of strength parameters such as compressive and split tensile strength.

Aggarwal Y., et.al (2015), studied on the effect of Alccofine on fresh and hardened properties of Self Compacting concrete. Five various mixes of SCC were designed keeping fly ash content constant as 25% and varying the percentage of alccofine as 0%, 2.5%, 5%, 7.5% and 10% by weight of cement. Total power content was kept constant as 550kg/m<sup>3</sup>. The study investigates the performance of concrete in term of self compactibility parameters (Slump flow, V-funnel, L-box and U-box), compressive strength and water absorption. The results indicate that replacements with alccofine positively affect both fresh and hardened properties of self-compacting concrete. The compressive strength at 28 days was found to increase by 31.6 % at 10% replacement with alccofine. Water absorption at 28 days decreased with increase of alccofine content for all mixes.

Anto J., et.al (2017), investigated the properties of self compacting concrete with Micro Steel Fibers and Alccofine. In this study first the properties of a normal SCC M30 mix was evaluated. Then mixes with 5%, 10%, and 15% replacement of cement with Alccofine was prepared and optimum percentage was determined by studying the fresh and mechanical properties and comparing it with Normal SCC mix. Optimum percentage was selected as 10%. By studying the compressive strength of different mixes it was observed that all SCC with both Alccofine and Micro steel fibre gave high strength than normal SCC mix. When comparing the Split tensile strength also SCC with Alccofine and Micro steel fibre gave highest result. Flexural strength also gives satisfactory results.

Mini K.M., et.al (2018), conducted study on strength and durability studies of SCC incorporating silica fume and ultra-fine GGBS (alccofine). In the experimental procedure of SCC, silica fume and alccofine were added in 0%, 5%, 10% and 15% individually. Fresh state properties comprised of flow ability, segregation resistance and passing ability, whereas hardened state properties consist of compressive strength at 7th, 28th, 56th and 90th day and split tensile strength at 28th day were analysed and studied. Durability tests such as water absorption, unrestrained shrinkage, resistance to acid attack, resistance to sulphate attack, sorptivity, rapid chloride permeability test and exposure to various environmental circumstances were also conducted. From the results of considered parameters, it is observed that maximum strength for alccofine and silica fumes incorporated SCC was obtained at 10% replacement.

Kala T.F., et.al (2018), study concluded that alccofine and GGBS combination can be used in the SCC as the strength enhancer. SCC being a high performance concrete after the addition of alccofine, produces a high performance and high strength concrete. Mix design for SCC was carried out by Nan-Su method which is considered as a simple mix design and the dosage of super plasticizer will be determined by trial and error as substantial result of characteristics of fresh and hardened concrete and effect of alccofine (5%, 10%, 15% and 20% by volume) by keeping the GGBS percentage constant (30%) on rheological properties and strength properties were investigated. The outcome implies that the workability of SCC with 5% and 10% alccofine by volume of concrete leads to decline of other rheological properties given by codal provisions (EFNARC). In contrast, the improvement in properties of concrete like compressive strength from 36.6 to 42.9 N/mm<sup>2</sup>, splitting tensile strength from 3.8 to 7.9 N/mm<sup>2</sup> and flexural strength from 4.9 to 8.3 N/mm<sup>2</sup> at 28 days was observed with increase in alccofine dosage. It is observed that maximum strength for alccofine and GGBS incorporated SCC was obtained at 10% and 30% replacement. Finally the conclusion has been drawn that alccofine and GGBS combination can be used in the SCC as the strength enhancer.

### 3. CONCLUSION

This paper presents a review on the effect of Plastic granules and Alccofine on the properties of self compacting concrete. By using PET granules it is observed that it resist to impact load and it also increases energy absorption capacity. Based on the literature, the use of waste PET granules in concrete or mortar has a potential to reduce the dead load of concrete. Thus it can reduce the earthquake risk of a building, and it could be helpful in the design of an earthquake resistant building. It also helps in the reduction of usage of natural resources, disposal of wastes, prevention of environmental pollution, and then saves energy. Alccofine is a pozzolanic material that can be used to replace cement to increase the strength parameters of concrete like compressive strength, splitting tensile strength and flexural strength. From the literature review, the optimum value of alccofine obtained as 10%. Addition of optimum percentage of alccofine increases compressive strength, splitting tensile strength and flexural strength. Also by the addition of alccofine improves the workability, filling ability, passing ability, flowability, and pumpability properties. Also reduces the segregation and bleeding due to its optimized particle size distribution.

### REFERENCES

- [1] Aboutaleb D., Maallem M., Safi B. and Saidi M., The use of plastic waste as fine aggregate in the self-compacting mortars: Effect on physical and mechanical properties, *Journal of Construction And Building Materials*, Volume 43, 2013, PP 436-442
- [2] Aggarwal P., Aggarwal Y. and Khatana S. R., Effect of Alccofine on Fresh and Hardened Properties of Self Compacting concrete, *National Conference on Technological Innovations for Sustainable Infrastructure*, 13-14 March, 2015
- [3] Al-Hadithia A. I., Moslehb W. K. and Noamana A. T., Mechanical properties and impact behavior of PET fiber reinforced self-compacting concrete (SCC), *Composite Structures*, Volume 224, 2019, PP 1-12
- [4] Anto J. and Baby B., Study of properties of self compacting concrete with micro steel fibers and Alccofine, *International Research Journal of Advanced Engineering and Science*, Volume 2, 2017, Issue 2, PP 83-87
- [5] Chakravarthy P. R. K. and Raj R. R., Analysis on compressive strength of concrete with partial replacement of cement with alccofine, *ARPN Journal of Engineering and Applied Sciences*, Volume 12, 2017, PP 2392-2395
- [6] Daraei A., Faraj R. H. and Sherwani A. F. H., Mechanical, fracture and durability properties of self-compacting high strength concrete containing recycled polypropylene plastic particles, *Journal of Building Engineering*, Vol 25, 2019, PP 2352-2364
- [7] Hama M. S. and Hilal N. N., Fresh properties of self-compacting concrete with plastic waste as partial replacement of sand, *International Journal of Sustainable Built Environment*, Vol 6, 2016, PP 299-308
- [8] Kala F.T. and Kavitha S., Evaluation of Strength Behavior of Self-Compacting Concrete using Alccofine and GGBS as Partial Replacement of Cement, *Indian Journal of Science and Technology*, Vol 9(22), 2016
- [9] Milehsara D. S., Nik S. A., Omran L. O. and Sadrmomtazi A., The combined effects of waste PET particles and pozzolanic materials on the properties of self-compacting concrete, *Journal of Cleaner Production*, 2015, PP 1-17
- [10] Mini K. M. and Mohan A., Strength and durability studies of SCC incorporating silica fume and ultra-fine GGBS, *Journal of Construction And Building Materials*, Vol 171, 2018, PP 919-928
- [11] Pawar M. S. and Saoji A. C., Effect of Alccofine on Self Compacting Concrete, *The International Journal Of Engineering And Science (IJES)*, Volume 2, 2013, Issue 6, PP 05-09