iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3200

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Replacement of Portland cement with Alccofine: A Review

Abhishek Sachdeva[1], V. Rajesh Kumar[2]
[1] *Research Scholar, Civil Engineering Department, Lovely Professional University, Phagwara*
[2]*Professor, Civil Engineering Department, Lovely Professional University, Phagwara*

Abstract: ***Concrete is most widely used man made construction material in the world. Manufacturing of cement for concrete involves large amount of carbon dioxide emissions into the atmosphere, a major contributor for green house effect and global warming. Thus it becomes necessary to discover a substitute material for cement in concrete. A lot of Supplementary Cementitious Materials (SCM's) like fly ash, silica fumes, slag powder etc. have been identified in the past and also have been effectively used as a partial replacement to cement in the production of concrete. Boom in the infrastructure development is further demanding the production of High Performance Concrete (HPC) along with the eco- friendly and sustainable concrete. The production of high strength and durable eco-friendly concrete leads to the use of a new generation ultrafine supplementary cementitious material Alccofine as a partial replacement of cement in concrete. This new ultrafine pozzolonic material has become popular in the construction industry and has brought a revolution in the field of civil engineering. This paper presents an overview of published literatures by various researchers who have aimed to replace cement with Alccofine in the production of concrete. A significant improvement in the properties of concrete at fresh and hardened stage has been observed by the partial replacement of cement with Alccofine in concrete.***

Keywords: ***Concrete, Cement, Alccofine, Supplementary Cementitious Materials (SCM's), High Performance Concrete (HPC)***

I. INTRODUCTION

The production and use of concrete had led to a wide range of environmental and social consequences. A major component of concrete is cement, which is one of the primary producers of carbon dioxide gas. The production of Portland cement contributed 7% to global anthropogenic CO_2 emissions, largely due to the sintering of limestone and clay at 1,500 °C. Growth in the infrastructure development and advancement in the concrete technology has further led to the evolution of High Performance Concrete (HPC). HPC is becoming more popular now-a-days and is highly accepted in the construction industry. HPC may be defined as the concrete that possesses high workability, high strength and high durability. High cement/binder factors and very low water/cement ratios are the two main characteristics of High Performance Concrete. A concrete with high cement/binder content and very low W/C ratios results in the poor workability and workability retention. Due to these weaknesses, high dosages of high range water reducing agents (HRWR) are used in concrete resulting in cohesive and thixotropic, sticky mixes which are equally difficult to place and compact fully and efficiently. These problem indicate that there is probably a critical limit for the water content below which high HRWR dosage become not only essential but also unhelpful and undesirable, and often even harmful from a durability point of view. Unlike other Supplementary Cementitious Materials (SCM's), Silica fume and Alccofine are by-products from the industries, where their engineering values are well controlled. Therefore, using Silica fume and Alccofine in concrete should promise advantage as compared to other SCM's. Silica Fume is generally proposed as the appropriate cement extender where high strength, low permeability are the prime requirements. Though silica fume is known to improve durability, its addition in concrete is often negated by the increase water and/or admixture dosage required to improve the workability and handling properties of the fresh concrete. This promotes the use of Alccofine in concrete which itself can be used as HRWR and improves the properties of the concrete at fresh and hardened stage resulting in production of high performance eco- friendly concrete.

Alccofine 1203 is a new generation, ultrafine, low calcium silicate product, manufactured in India. It has distinct characteristics to enhance 'performance of concrete' in fresh and hardened stages. Alccofine 1203 is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. The raw materials are composed primary of low calcium silicates. The processing with other selected ingredients results in controlled particle size distribution (PSD). The computed blain value based on PSD is around 12000 cm^2/gm and is truly fine [1]. Due to its unique chemical composition and ultrafine particle size, Alccofine 1203 performs in superior manner than all other mineral admixtures used in concrete within India. Because of these properties of Alccofine, it is attracted to be used as partial replacement of cement in concrete. Recently, research

works has been focused on the partial replacement of cement with Alccofine in concrete, therefore fresh and hardened properties of concrete containing Alccofine has been reviewed.

II. BENEFITS AND APPLICATIONS OF ALCCOFINE

A. Technical Benefits at Fresh Stage

1) Improves workability retention
2) Improves flow ability
3) Improves rheology
4) Reduces segregation
5) Reduces heat of hydration

B. Technical Benefits at Hardened Stage

1) Improves strength at all ages
2) Improves durability
3) Improves resistance to Alkali Silica Reaction
4) Improves resistance to chemical attack
5) Lowers permeability

C. Fields of Applications

1) RCC residential, commercial structures
2) High rise structures with challenging situations to pump the concrete with ease
3) Temperature controlled mass concrete for raft and pile foundations
4) Aluminum / tunnel form work with high flow or self-compacting concrete
5) High performance concrete with extremely low water to binder ratio
6) Shotcrete with improved cohesion and faster initial strength gain
7) Precast concrete elements for tunnels, bridge, segmental construction, hollow core slabs, commercial precast units
8) Post tension / pre stressed concrete slab
9) Construction grouts, plasters, repair mortars

III.REVIEW OF LITRATURE

Sunil Suthar, B.K. Shah and P.J. Patel [2] planned an experimental program for M-70 grade of concrete which aimed to evaluate the compressive strength and Flexural Strength of Concrete. High Performance Concrete was made by partial replacement of cement by alccofine, fly ash, silica fume. In this study, Class F fly ash was used in various proportions of 20% to 35%, alccofine 4% to 14% and silica fume 4% to 14% by weight of cement. Percentage of fly ash varied from 20%, 25% and 30% in total binder content (cement + fly ash) of 600 kg/m^3. Alccofine and Silica fume in 4% to 14% by weight of binder content was added to the mix separately. It was concluded that the slump value for all the Alccofine mixes was better than that of the silica fume mixes. Alccofine increased the particle packing density and strength of concrete. High compressive strength was achieved with the incorporation of 8% of Alccofine to the different Fly ash replacements as compared to the 10% of Silica fume. Alccofine concrete mixtures had high compressive strength than all other silica-fume concrete mixes. The optimum and high strength concrete was recorded with 8% Alccofine and 20% Fly ash.

Deval Soni, Suhasini Kulkarni and Vilin Parekh [3] studied the performance of high performance concretes (HPC) containing supplementary cementitious materials. The main aim of the investigation program was first to prepare the high strength concrete of grade M80 with locally available ingredients and then to study the effects of different proportions of Alccofine and fly ash in the mix to find optimum range of Alccofine and fly ash content in the mix. Alccofine and fly ash was added by weight of cement as a replacement. . The total binder content (Cement + Fly ash + Alccofine) was kept 582 kg. All the trial mixes were made with 76% of cement content. Percentage replacement of Alccofine with binder content was 6% to 10% by mass and that of Fly ash was 14% to 18%. After the detailed investigation, it was concluded that Alccofine has better performance as compare to other slag materials and microsilica. Alccofine improves the workability of concrete. By increasing or trying various dosages of Alccofine and fly ash as a replacement to cement, the better results were obtained with 8% of Alccofine and 16% of Fly ash. Alccofine helps to increase both the compressive and flexural strength upto 8%.

Praveen Nayak S, H.S. Narashimhan and Raghunandan V.Kabada [4] investigated the hardened properties of concrete by using micro silica and alccofine in varied proportions. The main parameters investigated in this study was addition of micro silica and alccofine, by keeping maximum cement content 450kg constant and water content constant 144 kg for all mixes. The slump of concrete was practically kept around 100 ± 10mm for all the concrete mixes considered in this study. Both Micro Silica as well as Alccofine was added to concrete mixes in the following incremental proportions as addition to cement content, namely by 0.0, 3.34, 6.68, 10.02, 13.36 and 16.70% respectively. From the analysis of result, it was observed that the compressive strength, flexural strength, splitting tensile strength and impact strength test results for both micro silica and alccofine when added to concrete, exhibit maximum values of each property at around 13.36% addition level beyond which, further addition tends to reduce the performance of concrete with respect to mentioned properties. Compressive strength and Flexural strength was higher for Alccofine concrete mixtures as compared to that of micro silica mixtures. The optimized content of both micro silica and Alccofine was found to be at around 13.36% addition level based on the study.

Mohd. Hamraj [5] worked on the partial replacement of cement with Alccofine 1203 along with incorporation of crimped steel fibres of two aspect ratios with different percentages of the volume concrete. The durability properties of binary blended steel fibre reinforced concrete with Alccofine 1203 as mineral admixture by incorporating crimped steel fibres of different aspect ratios were studied. Also, the residual compressive strength and percentage weight loss of binary blended steel fibre reinforced concrete were determined. To fulfil the objectives of the present investigation, M50 grade concrete was taken as reference concrete. Initially five trail mixes were conducted with M50 grade concrete with partial replacement of cement with different percentages of Alccofine 1203 i.e., 5%, 10%, 15% and 20% and the dosage of Alccofine was optimized. After the optimization of Alccofine, the steel fibre reinforced concrete mixes were casted with different fibre content and aspect ratio. From this investigation, it was concluded that 15% cement replacement with Alccofine gave optimum strength and workability for Binary Blended Concrete. The workability of steel fibre reinforced concrete mixes was improved with the partial replacement of cement with Alccofine. The compressive strength of ordinary portland cement concrete and steel fibre reinforced conctrete mixes increased with the 15% replacement of cement with Alccofine and steel fibres of higher content and of higher aspect ratio. The binary blended concrete showed more resistance to acid attack. It was also found that 15% replacement of cement with Alccofine was more durable when compared to normal concrete after exposure to acid attack.

Sivakumar Durairaj and Hemalatha T [6] aimed to reduce the amount of cement used in the concrete, without compromising in the characterization and properties of the concrete. An experimental program was established to fulfil the objective in which M 50 grade of concrete with 10 percent replacement of alccofine and control mix of the same were utilized. The grade of concrete chosen was M50. The modified concrete mix was designed with 10% partial replacement of cement by weight in control mix. From the results, it was concluded that better workability and higher consistency was achieved by incorporating 10 % alccofine in concrete. With the inclusion of Alccofine as a partial replacement to cement in the concrete, it is possible to obtain a consistent mix, as the high surface area of Alccofines improves the rheology of fresh concrete. Also, there is a significant improvement in the mechanical properties of the concrete with the inclusion of Alccofine. The improvement is more obvious for higher concrete grade. The use of Alccofine results in hydrated cement matrix to comprise of very small pores. Permeability of concrete is reduced significantly for Alccofine mix. Due to the reduced permeability, chloride penetration into the concrete is reduced. This marked a significant improvement in the durability aspect of the concrete.

Rajesh Kumar S, Amiya K Samanta and Dilip K. Singha Roy [7] experimentally analyzed the mechanical properties of Alccofine 1203 which is a specially processed product based on high glass content with high reactivity obtained through the process of controlled granulation, on high strength concrete of grade M60. Cement was replaced by Alccofine by 5%, 10%, 15% and 20%. From the experimental analysis it was concluded that cement replacement by 10% of Alccofine gives higher values as compared with the other replacement levels. Alccofine increases the strength of concrete only at 10% replacement level of cement. If the percentage level of cement replacement with Alccofine is increased beyond 10 %, it will act as a filler material and yields good workability to the concrete.

Davinder Sharma, Sanjay Sharma and Ajay Goyal [8] analyzed the the strength development of concrete using Foundry Slag (FD) as partial replacement for conventional fine aggregates and Alccofine (AF) as partial replacement of cement. A study was planned in which M100 grade of concrete was designed using water/binder ratio 0.239. In this mix, conventional fine aggregates were replaced with varying percentage of Foundry slag from 0% to 50% along with the optimum percentage of 15% Alccofine as a partial replacement to cement. The specimens were casted and tested for compressive strength(CS), tensile strength(TS) and flexural strength(FS) development at the age of 7, 14, 28, 56 and 90 days. From the results, it was concluded that Alccofine (AF), a commercially available product in combination with Foundry slag (FD) can be used to replace PPC and FA respectively to produce

high strength concrete and thereby reducing the impact on environment by saving the natural resources. Reasonably high strength concrete mix can be designed by substituting fine aggregate with 10% to 45% of FD and partial replacement of cement with 15% of Alccofine. Optimum dosage of Alccofine due to its ultra fineness and optimized particle size distribution has resulted in developing higher early age strength. The hydration and pozzolonic reaction of Alccofine improved the pore structure of concrete. Replacement of fine aggregates with Foundry slag up to 45% reduced the permeability of concrete and showed that the concrete permeability decreased with the increase in FD content, age and strength.

A Narinder Reddy and T Menna [9] planned an experimental investigation in which concrete mixes of M30 grade with replacement of cement by 0%, 5%, 10%, 15%, 20% and 25% by weight of Fly ash were prepared. They were subjected to compression test so as to select the optimum replacement percentage of FA. Keeping this optimum percentage of FA as constant, additional replacement of cement with Alccofine was done varying its replacement in the range of 8%, 10%, 12% and 14%. The mix with 15% Fly ash replacement of cement has shown the maximum strength. Hence, it was concluded that the optimum percentage of replacement of cement by Fly ash could be taken as 15%.The results of compression tests on Eco-Friendly Concrete (EFC) with Alccofine and Fly ash combinations at different ages showed the superior values as compared to control concrete. In the investigation, the highest compression strength was achieved by the combination of FA - Alccofine at 15% - 10% respectively, also it gave maximum strength values in split tensile and flexural strength. Addition of replacement materials leads to eco-friendly and sustainable concrete and at the same time results in the reduction of overall cost of manufacture of EFC.

IV. CONCLUSION

A. Alccofine is proved to be a superior Supplementary Cementitious Material as compared with other materials enhancing the workability, strength and durability of concretre. Optimum dosage of Alccofine may be considered as 15%.

B. Alccofine reduces the requirement of High Range Water Reducer (HRWR) in concrete. Alccofine itself can be used as HRWR to improve compressive strength and workability of concrete.

C. Alccofine improves workability of concrete. For Alccofine, the water demand is reduced to achieve the specific slump value. This decrease in water demand is due to the presence of the high glass content which has water repelling properties.

D. Due to the presence of inbuilt CaO content, Alccofine triggers both the primary and the pozzolonic reactions resulting in the formation of additional C-S-H gel. This results in the formation of dense pore structure and ultimately higher strength gain.

E. Hydration and pozzolonic reactions of the Alccofine mixtures improved the pore structure of concrete. Because of its finer pore structure and chemical stability, Alccofine in concrete is substantially more resistant to chloride diffusion. Thus, it reduces the penetration of chlorides in concrete and protects embedded steel from corrosion resulting in the improved durability of concrete.

V. ACKNOWLEDGMENT

I express my deep gratitude to Dr. V. Rajesh Kumar, Dean and Professor, Civil Engineering Department, Lovely Professional University, Phagwara, for providing me stimulating guidance, continuous encouragement and support throughout the research work. On a personal note, I would like to thank my family and friends who have always supported and encouraged me a lot.

REFERENCES

[1] "Alccofine – Micro Materials," Counto Micro fine Products Pvt. Ltd. (A joint venture with ambuja cement ltd and alcon developers)

[2] S. Suthar, B.K. Shah, and P.J. Patel, "Study on effect of Alccofine & Fly ash addition on the Mechanical properties of High performance Concrete,"International Journal for Scientific Research & Development, Vol. 1 (3), pp. 464-467, 2013.

[3] D. Soni, S. Kulkarni, and V Parekh, "Experiment Study on High Performance Concrete With Mixing of Alccofine and Flyash," Indian Journal of Research, Vol. 3 (4), pp. 84-86, 2013.

[4] P. Nayak, H.S. Narashimhan, and R.V. kadaba , "Hardened Properties of Concrete made With Micro Silica and Alccofine – A Performance Optimization based Comparative Study," International Journal of Engineering Research and Development, Vol. 10 (8), pp. 1-9, 2014.

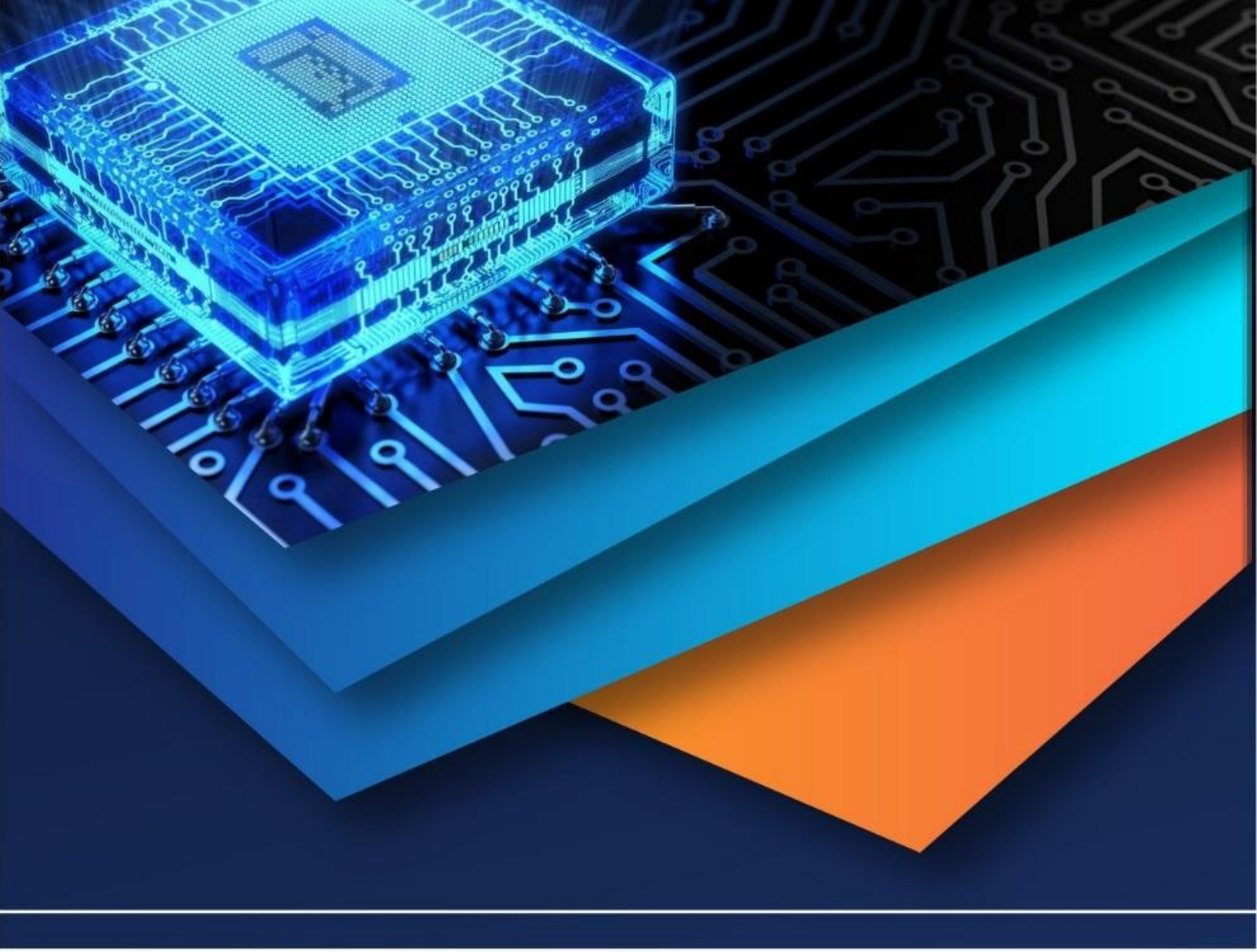
[5] M. Hamraj, "Experimetal Study on Binary Blended High Strength Steel Fibre- reinforced Concrete using Alccofine as Mineral Admixture," International Journal of Science, Engineering and Technology Research, Vol. 2 (8), pp. 56-62, 2014.

[6] S. Durairaj, T. Hemalatha, N. Shakthi, T. Shobana, and C. Soundarya, "Durability and Mechanical Characterization of Concrete Using Alccofines," International Journal of Applied Engineering Research, Vol. 10 (15) pp. 178-182, 2015.

[7] R. Kumar S, Amiya K. Samanta, and Dilip K. Singha Roy, "An experimental Study on the mechanical properties of Alccofine based high grade concrete," International Journal of Multidisciplinary Research and Development, Vol. 2 (10), pp. 218-224, 2015.

[8] D. Sharma, S. Sharma, and A. Goyal, "Utilization of Waste Foundry Slag and Alccofine for Developing High Strength Concrete,"International Journal of Electrochemical Sciences, Vol. 11, pp. 3190-3205, 2016.

[9] A. Narinder Reddy, and T. Meena, "An Experimental investigation on mechanical behaviour of Eco-friendly Concrete," IOP conference Series: Materials Science and Engineering, Vol. 263, pp. 1-9, 2017.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY