



Experimental Study On Performance Of Concrete By Partial Replacement Of Cement With Alccofine

¹Mohammed Hasan Niyaz Ahammed,²Anusuri. Uma Maheswari

¹P.G. Student, ²Associate Professor & HOD

^{1,2}Department of Civil Engineering,

^{1,2} Chaitanya Engineering College, Kommadi, Visakhapatnam, A.P.

Abstract: Concrete is third most widely used material in world and cement is major ingredient of it. One ton cement production cause emission of one ton of CO₂ gas which is harmful to environment. ALCCOFINE is a new generation supplementary cementitious material (SCM) with a built-in high tech content which can be used as cement replacement. In this thesis, it is proposed to study the Alccofine based high performance concrete with various proportions. M60 grade of concrete is planned to study by their mechanical properties such as compressive strength, flexural strength and compared with conventional concrete. Cement is replaced with Alccofine with percentages varying from 5% to 20% at an interval of 5%. For all the tests, standard experiments are followed to determine the properties as per Indian standards. The results are presented and discussed.

Index Terms – Alccofine, Compressive strength, Flexural strength, Split Tensile strength

I. INTRODUCTION

Cement, fine aggregate, water, and coarse aggregate are the usual ingredients of concrete, a composite material. When aggregate, dry cement, and water are combined to create Portland cement concrete (and other hydraulic cement concrete), they make a fluid bulk that can be shaped with ease. Cement, water, and other chemicals combine chemically to generate a hard matrix that holds all the components together to create a multipurpose, long-lasting substance that resembles stone.

Following studies on the effects of concrete on the environment and sustainability as the global trend that is driving the construction industry, various strategies for lowering the consumption of Portland cement, natural aggregates, and drinking water must be developed. Using a lot of industrial waste in place of aggregates and Portland cement is a sustainable way to handle this issue. Flyash is added along with other admixtures to provide greater workability and strength in order to correct it. Alccofine 1203 is one such additive among them.

Alccofine is easy to use and it can be added directly with cement. The ultrafine particle of Alccofine provides better and smooth surface finish. As well as cost is concerned, for high strength concrete the cost of concrete mix prepared with alccofine is less than the concrete without Alccofine. The advantage of Alccofine other than strength is that it also lowers the water/binder ratio. Alccofine material increases the strength both in compression and flexure to a large extent.

II. LITERATURE REVIEW

[1] S.C. Boobalan, V. Aswin Srivatsav, A. Mohamed Thanseer Nisath, A. Pratheesh Babu, V. Gayathri, "A comprehensive review on strength properties for making Alccofine based high performance concrete"

This paper gives the comprehensive review on the strength properties for making the Alccofine based High Performance Concrete. Various researchers were conducted for incorporating the Alccofine materials with various proportions in High Performance Concrete. Alccofine materials cause concrete to attain high strength at an early stage and has higher durability and workability when compared to regular mix of concrete. Alccofine 1203 is a micro fine mineral additive for concrete and mortars for lowering water demand, and also reduces the heat of hydration, improving the strength and durability parameters of concretes at various ages. This paper has analysed the various research publications for making the efficient Alccofine based High Performance Concrete. Major advantage of Alccofine is low calcium silicate material, which enhances pH of the concrete to protect against corrosion, faster removal of shuttering, better pump ability of concrete and improved durability and reduced permeability of concrete.

[2] G.Srinivasan, "Study on alccofine (1203) based high performance concrete"

In this present scenario of construction practice, new materials are being used as additive to the High Performance Concrete. Alccofine 1203 is one of such additive which proposed to use, in order to increase the compressive strength and durability of concrete. Alccofine 1203 is primarily composed of low calcium silicates which is processed and obtained through controlled particle size distribution (PSD). When compared to cement, the particle size distribution and specific gravity of Alccofine 1203 is higher and lower respectively, thus making more suitable as an additive to cement. In this thesis, it is proposed to study the Alccofine based high performance concrete with various proportions. M50 grade of concrete is planned to study by their mechanical properties such as compressive strength, flexural strength, elastic modulus of concrete and other durability properties. For all the tests, standard experiments are followed to determine the properties as per Indian standards. The results are presented and discussed. It is observed that 10% Alccofine added with the cement is giving increase in strength.

[3] Malvika Gautam, Dr. Hemant Sood, "Effect of Alccofine on strength characteristics of Concrete of different grades-A Review"

In the present paper, the effect of alccofine on properties of concrete has been studied. The main aim of this study is to evaluate the strength or we can say high performance of concrete containing supplementary cementitious materials (SCM) such as Alccofine. In this paper literatures of various researchers who have researched on durability of high performance concrete with Alccofine are reviewed. Because of the demands in the construction industry, the necessity of high performance concrete is also increased. Over the past few years, the efforts which are made for improving the performance of concrete suggest that cement replacement materials along with the minerals and chemical admixtures can improve the strength and durability characteristics of concrete. The alccofine material is pozzolanic material which is becoming popular in the construction industry and has brought technical revolution in the field of Civil Engineering. For high strength, Alccofine is a new generation micro fine concrete material and which is important in respect of workability as well as strength. Also Alccofine is easy to use and it can be added directly with cement. The ultrafine particle of Alccofine provides better and smooth surface finish. As well as cost is concerned, for high strength concrete the cost of concrete mix prepared with alccofine is less than the concrete without Alccofine. The advantage of Alccofine other than strength is that it also lowers the water/binder ratio. Alccofine material increases the strength both in compression and flexure to a large extent.

[4] Saurav, Ashok Kumar Gupta Studied "Experimental study of strength relationship of concrete cube and concrete cylinder using ultrafine slag Alccofine"

In this study cement was replaced with Alccofine and fly ash and also manufactured sand was used in place of natural sand. The concrete specimens were cured under normal atmospheric temperature for 3, 7, 28 days and after curing strength characteristics were observed. The alccofine shows an early strength and fly ash shows long term strength. The maximum compressive strength was achieved by using 10% of Alccofine and fly ash 30%. The strength gained up to 3 days was good, between 3 to 7 days' strength gained was excellent and 7 to 28 days the strength gain was comparatively slow or less. Alccofine increases the filling ability, passing ability and resistance to segregation. If cost is compared, the cost of Alccofine is cheaper than cement hence it is also economic with higher strength.

III. MATERIALS USED

Cement : It is mainly used as a binder material in concrete which is used for construction that sets, hardens to other materials bind together. OPC (ordinary Portland cement) of 53 grade is used conforming to IS: 12269-1987. The tests on cement are carried out as per Indian Standards.

Alccofine: It is a low calcium silicate material which improves the workability and compressive strength due to granulation and high glass content. ALCCOFINE1203 is a specially processed product based on high glass content with high reactivity obtained through the process of controlled granulation. The raw materials are composed primary of low calcium silicates.

Fine Aggregate: Fine Aggregate (FA) sand of particle size less than 4.75 mm size & confirming to zone-II as per IS 383:2016 code is used. Good river bank sand in the absence of any earthy matter and organic matter. Particles are angular in shape passing 4.75mm and retaining on 150 micron standard sieve. The river sand is used as fine aggregate conforming to the requirements of IS: 383-2016.

Coarse Aggregate: Is obtained by crushing various types of granites, schist, crystalline and lime stone and good quality sand stones. Concrete made with sand stone aggregate give trouble due to cracking because of high degree of shrinkage. Uniformly well graded coarse aggregate of 20 mm size conforming to IS 383:2016 code is used.

Water: The water used for preparing concrete mix and for curing should be clean and free from hazardous impurities such as salts, acids, alkali, oil and organic materials confirming to IS 456:2000 code. The pH of the water used should be in the range of 6–8.

IV. PHYSICAL PROPERTIES OF MATERIALS

The properties of cement are consistency-32%, setting time- 58mins (initial), 410 mins (final), fineness-4%, soundness-2mm, specific gravity-3.15. The properties of fine aggregate are specific gravity-2.65, water absorption-1.20%, grading zone-II, fineness modulus-2.90. The properties of coarse aggregate are specific gravity-2.88, fineness modulus-7.65.

V. TESTS ON HARDENED CONCRETE

5.1 Slump Cone Test

Slump cone test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction. The slump test is the most simple workability test for concrete, involves low cost and provides immediate results.

5.2 Compressive Strength Test

This test was conducted as per IS 516-1959. The cubes of standard size 150x150x150mm and cylinders 150x300mm were used to find the compressive strength of concrete. Specimens were placed on the bearing surface of compression testing machine, of capacity 100tones without eccentricity and a uniform rate of loading of 550 Kg/cm² per minute was applied till the failure of the cube. The maximum load was noted and the compressive strength was calculated. The compressive strength is represented in N/mm². The Mathematical representation of compressive strength $\sigma_c = P/A$.

5.3 Split Tensile Strength Test

This test was performed on Universal Testing Machine (UTM). The test is carried out at the loading rate of 1 kN/s specified IS: 5816 - 1999. The magnitude of tensile stress acting uniformly to the line of action of applied loading is given by formula: $f_{ct} = 2P/\pi dl$.

5.4 Flexural Strength Test

This test was performed on universal testing machine (UTM) as shown in figure. The test is carried out at the loading rate of 70 kN/min. The magnitude of flexural stress acting uniformly to the line of action of applied loading is given by formula $f_b = Pl/bd^2$.

VI. RESULTS & DISCUSSIONS

Table 1 Slump Cone Test Results

Alccofine (%) Replacement	Slump Value (mm)
0	92
5	100
10	105
15	110
20	112

Table 2 Compressive Strength Test Results

Grade of Concrete	% of Cement Replaced with Alccofine	Mix Designation	Compressive Strength (N/mm ²)	
			7 Days	28 Days
M60	0	A ₀	47.35	70.00
	5	A ₅	46.50	68.90
	10	A ₁₀	48.00	73.50
	15	A ₁₅	50.00	82.00
	20	A ₂₀	46.45	77.25

Table 3 Split Tensile Strength Test Results

Grade of Concrete	% of Cement Replaced with Alccofine	Mix Designation	Split Tensile Strength (N/mm ²)	
			7 Days	28 Days
M60	0	A ₀	5.21	5.95
	5	A ₅	5.33	6.12
	10	A ₁₀	5.90	6.80
	15	A ₁₅	7.11	8.05
	20	A ₂₀	6.66	7.40

Table 4 Flexural Strength Test Results

Grade of Concrete	% of Cement Replaced with Alccofine	Mix Designation	Split Tensile Strength (N/mm ²)	
			7 Days	28 Days
M60	0	A ₀	4.75	5.60
	5	A ₅	5.89	6.30
	10	A ₁₀	6.05	7.20
	15	A ₁₅	7.15	8.20
	20	A ₂₀	6.29	7.95

VII. CONCLUSIONS

- 1) From the experimental results, the optimum replacement of cement by the Alccofine is 15 % of the volume of the cement.
- 2) The strength development of Alccofine based concrete is greater than all other concrete at all age of curing.
- 3) From the experimental results, when compressive strength compare to control mix, the A15 mix is improved by 4.76 % at 28 days curing.
- 4) From the experimental results, when split tensile strength compare to control mix, the A15 mix is 12.5 % improved at 28 days curing.
- 5) From the experimental results, when flexural strength compare to control mix, the A15 mix is 22.2 % improved at 28 days curing.
- 6) It is clearly known that the Alccofine material increases the strength only at the addition of 10% replacement of cement.
- 7) If the percentage level of Alccofine is increased beyond that level it acts as a filler material and yields good workability to the concrete.
- 8) A marginal improvement can be seen in both flexural and split tensile strength results also, this indicates that there are no negative advantages of using alccofine in concrete.
- 9) Alccofine replaced at 15% levels has contributed to the higher strength values.
- 10) Alccofine Replacement at 15% was found to be an optimal dosage for hydration and strength gain in accordance with codal provisions. However, the 10% and 20% partial replacements act as filler material during the concrete's bonding phase.

REFERENCES

- [1] S.C. Boobalan, V. Aswin Srivatsav, A. Mohamed Thanseer Nisath, A. Pratheesh Babu, V. Gayathri , “A comprehensive review on strength properties for making Alccofine based high performance concrete”, Materials Today: Proceedings, pp:4810-4812, Feb-2021.
- [2] G.Srinivasan, “Study on alccofine (1203) based high performance concrete”, IOP Conference Series: Materials Science and Engineering, pp: 01-12, 2020.
- [3] P. Narasimha Reddy and J. Ahmed Naqash “Effect of Alccofine on Mechanical and Durability Index Properties of Green Concrete”, IJE TRANSACTIONS C: Aspects Vol. 32, No. 6, (June 2019) 813-819
- [4] R Suganya and Latha Maheshwari, “Experimental Investigation on Alccofine Concrete” Vol. 8 Issue 04, April2019, International Journal of Engineering Research & Technology (IJERT), 2019.
- [5] Mahim Mathur, Ashish Mathur “Performance of Concrete by Partial Replacement of Alccofine -1203” International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 RTCEC - 2018 Conference Proceedings.
- [6] Ankit Nainwal, Akshay C, Jaibeer Bhandari, “Comparison between Simple Concrete Cubes and Alccofine Mixed Concrete Cubes (M20 Grade)”, IJSRE Volume 05 Issue 2017, Page 6857-6871.
- [7] Malvika Gautam, Dr. Hemant Sood, “Effect of Alccofine on strength characteristics of Concrete of different grades-A Review”, International Research Journal of Engineering and Technology (IRJET) e- Vol 04, Issue: 05 , May -2017.