ISSN 2277 – 5528
Impact Factor- 3.145

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & MANAGEMENT

A STUDY ON CONCRETE PROPERTIES BY PARTIAL REPLACEMENT OF CEMENT BY FLY ASH, ALCCOFINE

Tushar Shirke*[1], Ajay Shinde*[2], Yogesh Thorat*[3], Amit Kawade*[4], Aakash Gadekar*[5] and Pradip Sonawane*[6]

*[1, *2, *3, *4, *5]Student, Department of Civil Engineering, Jai Hind Polytechnic, Pune, India
*[6]Assistant Professor, Department of Civil Engineering, Jai Hind Polytechnic, Kuran, India

ABSTRACT

The aim of this study is to evaluate the performance of concrete by partial replacement of cement by fly ash, Alccofine. Pozzolanic materials like Fly ash and Alccofine that can be used for producing highly durable and good quality concrete. In this study cement is partially replaced by Alccofine and Fly ash for M20 gread of concrete. The compressive strength of OPC concrete is increased replacing cement by Alccofine upto 20% of alccofine after that there is reduction in compressive strength. The compressive strength is test on 3, 7 and 28 days. The replacement of Alccofine is shows that early strength is gain. That of show Fly ash shows that long term strength.

Study shows the basic properties of Fly ash and Alccofine. Any adverse effect is does not caused on properties of fresh concrete by partially replacement. Due to this results shows that concrete giving good strength with partial replacement of Alccofine and Fly ash. As well as Alccofine and Fly ash is the good filler material in concrete. Thus,it is suitable to use Alccofine and Fly ash partially replaced with cement.

Keywords: *Fly ash, Alccofine, Compressive strength, Heat of hydration*, Economy.

I. INTRODUCTION

This paper is focus on partially replacement of cement with Alccofine and Fly ash. A most number of papers available with replacement of cement with fly ash in this paper strength of concrete is investigate along with cost comparison between OPC concrete and concrete with Alccofine and Fly ash.The replacement of Alccofine and Fly ash increases the durability, strength, chemical attack resistance of concrete.

Cement concrete is probably the most extensively used construction material in the world. The reason for its extensive use is that it provides good workability and can be molded in any shape. Plain cement concrete is the most widely used material for construction of various structures. However, it suffers from numerous drawbacks such as, low tensile strength, brittleness, unstable crack propagation and low fracture resistance etc. Quest for knowledge has not remained static. It could be from sheer inquisitiveness in the human nature in general or out of our needs. Researchers, scientists and technologists throughout the age have worked for advancement of knowledge. Researchers develop some idea and apply it to our advantage or to satisfy specific needs develop the appropriate equipment, material or technology. The field of concrete has no exception.

In the last 30 years, there is rapid development in the area of cement, concrete technology and also in the admixtures like pozzolanic admixture etc, Which can improve the performance characteristics of concrete and hence the construction industry demands the right type and right quality of concrete for the right application by which durability of structure can improved.

Concrete is one which satisfies the performance criteria which can be defined in terms of strength, durability, permeability, shrinkage etc. due to virtue of this concrete, it can be used in many important applications like in the construction of power plants, roads, buildings, bridges etc. In the production of concrete, use of admixture like pozzolanic admixture is attempted which makes the concrete less permeable and durable. There are rapid research and developments in various types of admixture including pozzolanic admixtures by the applications of which the performance characteristics of concrete can be further improved at lesser cost.

Plain concrete possess a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in the concrete and poor tensile strength is due to the propagation of such micro cracks,

ISSN 2277 – 5528
Impact Factor- 3.145

eventually leading to brittle fracture of the concrete. In plain concrete and similar brittle material, structural cracks develop even before loading, particularly due to drying shrinkage or other causes of volume change. The width of these initial cracks seldom exceeds a few microns, but their other two dimensions may be of higher magnitude.

When loaded, the micro cracks propagate and open up and owing to the effect of stress concentration, additional cracks form in places of minor defects. The structural cracks proceed slowly or by tiny jumps because they are retarded by various obstacles, changes of direction in bypassing the more resistant grains in matrix. The development of such micro cracks is the main cause of inelastic deformations in concrete.

It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties. This type of concrete is known as fiber reinforced concrete. Hence fiber reinforced concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers.

In the construction of important structures, the pozzolannic admixture preferred was silica fume; its cost however, was point of concern to the concrete technologist. Alccofine 1203 is a specially processed product based on the 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 select ingredients results in controlled particle size distribution. The computed blain value based on PSD is around 12000sq.cm/gm. and is truly ultra-fine.

II. OBJECTIVES

The objective of this study is to investigate the behavior of fresh Concrete partial replacement of cement with Fly ash and Alccofine and investigate following properties.

- To study the compressive strength of concrete by partial replacement of Alccofine and Fly ash.
- To investigate workability of fresh concrete.
- To compare the properties of concrete with partly replacement of Alccofine and Fly ash.
- To investigate replacement is economical or not.

III. ADVANTAGS OF USE OF ALCCOFINE AND FLY ASH

Following are main advantages of Fly ash and Alccofine while use in concrete.

1. Use of alccofine and Fly ash as partial replacement of cement is Eco-friendly drive.
2. Alccofine is acts as filler material as well as bonding agent as it show bonding property also.
3. Use of fly ash in concrete can save the thermal industry disposal costs and produced a ‘greener’ concrete for construction.
4. Alccofine and pond ash can be use to form various higher concrete grades.
5. The cement content can be reduced a lot by increasing te Fly ash and Alccofine content to make it more economical and also we can achive designed strength.
6. Partially replacement of cement is does not change original strength of concrete.
7. When Fly ash used in brick construction the compressive strength of brick is increases with increasing in lime content.

IV. LIMITATIONS OF USE OF ALCCOFINE AND FLY ASH

Following are limitations of Alccofine and Fly ash while use in concrete.

1. The CaO content is less in Alccofine and Fly ash so as to plastisizer property is less.
2. The water absorption of Fly ash is more soas to it can not used in large proportion of replacement.
3. Replacement of Alccofine and Fly ash is suitable for mass concreting work like dam construction.
4. Skilled supervision is required while adding Alccofine and Fly ash.
5. Fly ash and Alccofine are not easily available.

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V. METHEDOLOGY

For developing concrete mix, it is important to select proper ingredients, evaluate their properties and understand the interaction among different materials. Concrete will normally contain not only Portland Cement, Aggregate and Water, but also Supplementary Cementing Materials.

1. Cement.
2. Sand (fine aggregates).
3. Coarse Aggregates.
4. Water.
5. Alccofine.
6. Fly ash.

Physical properties of cement

Table 1- Cement Properties

Sr. No.	**Description of Test**	**Results**	**As per IS: 12269-1987**
01	Fineness of cement (residue on IS sieve No. 9)	3 %	> 10%
02	Specific gravity	3.06	3.15
03	Standard consistency of cement	31 %	-
04	Setting time of cement a) Initial setting time b) Final setting time	35minute 458minute	> 30 minute < 600 minute
05	Soundness test of cement (with Le-Chatelier's mould)	6 mm	10 mm
06	Compressive strength of cement: a) 3 days b) 7 days	44.70 N/mm^2 54.47 N/mm^2	> 27 N/mm^2 > 37 N/mm^2

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Physical properties of sand (fine aggregates)

Table 2- Physical properties of Fine Aggregate (sand).

Sr. No	Property	Results
1.	Particle Shape, Size	Round, 4.75mm down
2.	Fineness Modulus	2.82
3.	Silt content	3%
4.	Specific Gravity	2.62
5.	Water absorption	1%
6.	Bulking of sand	4.12%
7.	Bulk density	1786 Kg/m^3
8.	Surface moisture	Nil

Physical properties of coarse aggregates

Table 3- Physical Properties of Coarse Aggregate.

Sr. No	Properties	Results
1.	Particle Shape, Size	Angular, 20mm,10mm down
2.	Fineness Modulus of 20mm aggregates	7.4
3.	Specific Gravity	2.67
4.	Water absorption	0.5%
5.	Bulk density of 20mm aggregates	1603 Kg/ mm^3
6.	Bulk density of 10mm aggregates	1585 Kg/mm^3
7.	Surface moisture	Nil

Water

Water is important ingredient of concrete which plays important role inheat of hydration process. The minimum water content required in concrete is 38% of weight of cement. The 15% water required for filling gel pours and 23% water is required for generation of heat of hydration process. The minimum waer content in concrete which results the increase in compressive strength of concrete.

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Alccofine

Alccofine 1203 is a specially processed product besed on slag of high glass content with high reactivity obtain through the process of controlled granulation. Alccofine plays important role in concrete to reducing the water demand as well as it increase compressive strength and workability of OPC concrete. It also fills pours remain between cement particles.

- IS 12089:1987 – Specification for granulated slag for the manufacture of portland slag cement.
- IS 456:2000 (Clause no.5.2.2) – Plain and reinforced concrete code of practice.
- ASTM C 989 99 – Standard specification for ground granulated blast furnace slag for use in concrete and mortar.

Chemical properties of alccofine

Table 4- Distinctive chemical composition

Chemical Analysis	Mass %
CaO	32-34
Al_2O_3	18-20
Fe_2O_3	1.8-2
SO_3	0.3-0.7
MgO	8-10
SiO_2	33-35

Physical properties of alccofine

Table 5- Distinctive physical composition

Physical analysis	Range
Bulk Density	600-700 kg/m3
Surface Area	12000 cm2/gm
Particle shape	Irregular
Particle Size	-
d10	< 2 µ
d50	< 5µ
d90	< 9 µ

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VI. EXPERIMENTAL WORK

Aim of experimental work

The primary aim of this experimental program is to study the effect of partially replacement of Alccofine and Fly ash content on the properties of concrete. Alccofine and Fly ash is used as mineral admixture and effect of different amount of on the strength and durability related properties are studied. In this experimental program the strength parameters of concrete with 13% replacement of alccofine and Fly ash with cement are studied. The concrete mix selected for this is M20.

Investigation of concrete properties

Comparative study of effect of Alccofine and fly ash on OPC concrete is done by Compressive strength test.

Casting of concrete specimens

Cube mould of 150 x 150 x 150 mm are used for casting the specimens for compressive strength.

Batching

The measurement of materials for making concrete is known as batching. There are two method of batching.

(I) Volume batching (II) Weigh batching.

(II) Weight batching

Strictly speaking, weigh batching is the correct method of measuring the materials. For important concrete, invariably, weigh batching system should be adopted of weight system in batching, facilitates accuracy, flexibility and simplicity. Different types of weigh batchers are available. The particular type of weigh batchers to be used depends upon the nature of the job.

Cement, sand, coarse aggregate (20mm) and Mineral admixture Alccofine and Fly ash measured with Digital balance. The water is measured with measuring cylinder of capacity 1 liter and measuring jar of capacity 1000ml, 2000 ml

Mixing of concrete

The ingredients were thoroughly mixed over a clean concrete surface.

1. The sand and aggregates were measured accurately and were mixed in dry state for normal concrete.
2. Whereas for alccofine concrete, first measured quantity of cement and required percentage of alccofine (e.g. 13%) by weight of cement, were mixed thoroughly and then added to dry mix of aggregates.
3. The dry concrete mix is then thoroughly and uniformly mixed till uniform and homogeneous mixing of alccofine in dry mix is observed.
4. Care is taken to avoid the balling of concrete.
5. The water is then spread over the concrete mix and remixed thoroughly again for few minutes.

The fresh concrete is placed in the moulds by trowel. It is ensured that the representative volume is filled evenly in all the specimens to avoid segregation, accumulation of aggregates etc. While placing concrete, the compaction in vertical position is given to avoid gaps in moulds.

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Placing and compaction of concrete

The fresh concrete is placed in the moulds by trowel. It is ensured that the representative volume is filled evenly in all the specimens to avoid segregation, accumulation of aggregates etc. While placing concrete, the compaction in vertical position is given to avoid gaps in moulds.

The interior surface and the base of the moulds were lightly oiled before placing the concrete in the mould. Mould was filled with concrete in three equal layers, approximately one third height of specimen. Each layer was compacted using 16mm diameter temping rod with 25 strokes. The strokes were distributed uniformly throughout the layer, and then the mould was fully compacted by giving the vibration on the vibration table. Sufficient care was taken to see that concrete was properly filled in corners and the edges of the mould.

Finishing of concrete

As soon as the air bubbles stopped to rise, the top surface of the mould was finished with trowel by applying little pressure.

Care is taken not to add any extra cement, water or cement mortar for achieving good surface finish. The additional concrete is chopped off from top surface of the mould for avoiding over sizes etc. The density of fresh concrete is taken with the help of weigh balance. Identification marks are given on the specimens by embossing over the surface after initial drying.

Curing of spacimen

After 24 hours specimens were opened and they were kept in curing tank filled with water for a curing of required period. All these specimens were properly grouped according to their coding so that removal of the specimen from their place for testing work could be conveniently done in a proper sequence. The elements were left undisturbed for a whole period of curing.

Test setup of cube specimen for compressive strength testing

For the compression test, the cubes are placed in machine in such a manner that the load is applied on the Forces perpendicular to the direction of cast. In compression testing machine, the top surface of machine is fixed and load is applied on the bottom surface of specimen. The rate of loading is gradual and failure (crushing) load is noted. Also the failure pattern is observed precisely.

VII. TEST RESULTS AND DISCUSSION

The results obtained by carrying out the tests on the cubes made with mix proportions decided earlier are as stated below:

3days compressive strength

Table 6- compressive strength with Alccofine

Sr. No	Alccofine (%)	Compressive Load (KN)	C/S Area (mm^2)	Compressive Strength (N/mm^2)	Avg. Compressive Strength (N/mm^2)
1	13%	234	22500	10.4	
2	13%	233	22500	10.35	9.90
3	13%	202	22500	8.97	

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7days compressive strength

Table 7- compressive strength with Alccofine

Sr. No	Alccofine (%)	Compressive Load (KN)	C/S Area (mm^2)	Compressive Strength (N/ mm^2)	Avg. Compressive Strength (N/ mm^2)
1	13%	364	22500	16.17	
2	13%	374	22500	16.62	16.59
3	13%	382	22500	16.97	

28days compressive strength

Table 8- compressive strength with Alccofine

Sr. No	Alccofine (%)	Compressive Load (KN)	C/S Area (mm^2)	Compressive Strength (N/ mm^2)	Avg. Compressive Strength (N/ mm^2)
1	13%	620	22500	27.55	
2	13%	605	22500	26.88	27.25
3	13%	615	22500	27.33	

3days compressive strength

Table 9- compressive strength with Fly ash

Sr. No	Alccofine (%)	Compressive Load (KN)	C/S Area (mm^2)	Compressive Strength (N/ mm^2)	Avg. Compressive Strength (N/ mm^2)
1	13%	182	22500	8.08	
2	13%	188	22500	8.35	8.35
3	13%	194	22500	8.62	

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7days compressive strength

Table 10- compressive strength with Fiy ash

Sr. No	Alccofine (%)	Compressive Load (KN)	C/S Area (mm^2)	Compressive Strength (N/ mm^2)	Avg. Compressive Strength (N/ mm^2)
1	13%	320	22500	14.22	
2	13%	308	22500	13.68	14.01
3	13%	318	22500	14.13	

28days compressive strength

Table 11- compressive strength with Fly ash

Sr. No	Alccofine (%)	Compressive Load (KN)	C/S Area (mm^2)	Compressive Strength (N/ mm^2)	Avg. Compressive Strength (N/ mm^2)
1	13%	520	22500	23.11	
2	13%	540	22500	24	23.91
3	13%	554	22500	24.62	

3days compressive strength

Table 12- compressive strength with OPC

Sr. No	Alccofine (%)	Compressive Load (KN)	C/S Area (mm^2)	Compressive Strength (N/ mm^2)	Avg. Compressive Strength (N/ mm^2)
1	13%	162	22500	7.20	
2	13%	168	22500	7.46	7.46
3	13%	174	22500	7.73	

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7days compressive strength

Table 13- compressive strength with OPC

Sr. No	Alccofine (%)	Compressive Load (KN)	C/S Area (mm^2)	Compressive Strength (N/ mm^2)	Avg. Compressive Strength (N/ mm^2)
1	13%	276	22500	12.26	
2	13%	278	22500	12.35	12.38
3	13%	282	22500	12.53	

28days compressive strength

Table 14- compressive strength with OPC

Sr. No	Alccofine (%)	Compressive Load (KN)	C/S Area (mm^2)	Compressive Strength (N/ mm^2)	Avg. Compressive Strength (N/ mm^2)
1	13%	475	22500	21.11	
2	13%	490	22500	21.78	21.33
3	13%	475	22500	21.11	

VIII. CONCLUSION

1. Indian Standard method is easy method for the mix design M20 grade concrete.
2. Fly ash shows more water absorption .
3. 20% of Alccofine and Fly ash replacement found to be the optimum amount in order to get favorable strength.
4. The compressive strength of concrete with Alccofine and Fly ash increases with increased curing period.
5. Replacement of Alccofine and Fly ash is Eco-friendly, economical.
6. Replacement of Alccofine and fly ash it is suitable for mass concreting work.
7. The use of Alccofine results in hydrated cement matrix to comprise of very small pores.
8. The replacement of Alccofine is more effective for recycle aggregate.
9. The replacement of Alccofine and Fly ash which helps to gains earlier strength of concrete.

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10. Denseness of concrete is increases by replacement of Alccofine and Fly ash which results the increase in durability.
11. The maximum strength is achieved by partial replacement of Alccofine in OPC concrete.

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