International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

Experimental Study on Partial Replacement of Ordinary Portland Cement(OPC) with Alccofine-1203

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Abstract - *Now-a-days enormous development occurred in the field of concrete technology. Many researchers have carried out several studies to investigate the possible utilization of broad range of supplementary cementitious materials as partial replacement of Portland cement. The use of supplementary cementitious materials in the production of concrete can result in major saving of cost and energy. It also helps to improve the strength and durability properties of concrete. The present investigation is carried out to study the effect of alccofine-1203 as partial replacement of cement on compressive strength, flexural strength and split tensile strength of concrete. The replacement levels of Alccofine-1203 are selected as 5% , 10% and 15% by weight of cement. The effect of cement,Alccofine and glass fibre has been checked by adding 2% Polypropylene glass fibre in 15% of split tensile strength. From the results,it is observed that the compressive strength , flexural strength and split tensile strength were increased with increase in replacement levels of alccofine.*

***Key Words*: Concrete , Alccofine-1203, Polypropylene glass fibre, Compressive Strength, Flexural Strength, Split tensile Strength.**

1. INTRODUCTION

Concrete is an artificial material in which the aggregates are bonded together by the cement when mixed with water. With the advancement of technology and increased in applications of concrete and mortars, the strength, workability, durability and other characteristics of ordinary concrete can be made suitable for any situation. For this, definite proportions of cement, water, fine aggregate, coarse aggregate, mineral admixtures and chemical admixtures are required.

Alccofine 1203 performs superior manner than all other mineral admixture used in concrete within India. Due to its CaO content, Alccofine 1203 triggers two way reactions during hydration.

- Primary reaction of cement hydration

Pozzolanic reaction : Alccofine 1203 also consumes by product calcium hydroxide from the hydration of cement to form additional C-S-H gel, similar to pozzolans.

Alccofine 1203 can also be used as high range water reducer to improve compressive strength or as a super workability aid to improve flow. Alccofine 1203 can be ideally used as

- Lower the water/binding ratio
- Use of more cost-effective admixture dosage
- A combination of above

1.1 Characteristics and properties

Alccofine 1203 has got the unique chemical composition mainly of CaO (31-33%) and SiO_2 (33-35%). Physically the product is unique with regard to its particle size distribution.

S. No.	Chemical Analysis	Mass (%)	Physical Analysis	Range
1.	CaO	32-34	Bulk Density	600-700 kg/m^3
2.	Al_2O_3	18-20	Surface Area	12000 cm^2/gm
3.	Fe_2O_3	1.8-2	Particle Shape	Irregular
4.	SO_3	0.3-0.7	Particle Size, d_{10}	<2µ
5.	MgO	8-10	Particle Size, d_{50}	<5 µ
6.	SiO_2	33-35	Particle Size, d_{50}	<9 µ

Table 1: Chemical and Physical composition

2. LITERATURE REVIEW

Alccofine 1203 is a cementitious supplementary material which has its own advantages. Many researchers have used this material as a partial replacement with cement which results in good workability, strength properties and durability. The use of Alccofine 1203 has also resulted in the strength gain, reduced the segregation, improved the cohesiveness and lowers the heat of hydration. Due to the higher lime content in the Alccofine 1203, corrosion issues have been reduced.

An attempt has been made to study the Basic Strength Properties by using Alccofine 1203 as mineral admixture along with addition of polypropylene glass fibres.

3. EXPERIMENTAL PROGRAM

An experimental study is conducted on Alccofine 1203 partially mixed with cement concrete along with addition of Polypropylene glass fibres.Normal grade of concrete of M20 mix with various percentages of Alccofine 1203 by replacing cement. The inherent high pozzolanic reactivity of Alccofine 1203 adds to the strength factor when mixed with cement concrete partially replacing cement even at higher strengths. Experimental study is carried out to investigate both the fresh and hardened concrete properties of concrete.

3.1 Materials Used

Main constituents of the concrete which cement, fine aggregate, coarse aggregate, Alccofine 1203 along with Polypropylene glass fibres have been procured from outside. The materials used in the present programme are shown below:

3.1 .1 Cement

Locally available Ordinary Portland Cement of 53 grade of ultra-tech brand conforming to ISI standards has been procured, and following tests have been carried out according IS: 8112 - 1989

S.No.	Physical Property	Test Results of OPC (53 grade)
1.	Initial Setting time	30 min
2.	Final Setting time	10Hours
3.	Fineness	8%
4.	Specific Gravity	2.03

Table 2: Physical properties of 53 grade OPC

3.1.2 Fine aggregate

The locally available natural river sand conforming to grading zone-II IS 383-19100 has been used as Fine aggregate. Following tests have been carried out as per the procedure given in IS 383(1970)

S.No.	Properties of aggregates	Test results of Fine aggregates
1.	Bulk Density	0
2.	Fineness Modulus	2.43
3.	Specific Gravity	2.29

Table 3: Tests on Fine Aggregate(FA)

3.1 .3 Coarse aggregate

Machine crushed granite confirming to IS 383-19100[23] consisting 20mm maximum size of aggregates has been obtained from the local quarry. It has been tested for physical and mechanical properties such as specific gravity, sieve analysis and the results have been shown in the Table 4

S.No.	Properties of aggregates	Test results of Fine aggregates
1.	Loose Density	1235kg/m3
2.	Rooded Density	1325kg/m3

Table 4: Tests on Coarse Aggregate(CA)

3.1.4 Water

Potable water has been used in this experimental program for mixing and curing.

3.2 Mix design

Mix design is defined as process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economic as possible.

3.2.1 Mix design of M30 grade concrete

In the present investigation M30 grade of concrete has been considered. The mix of concrete is designed as per the guidelines given in IS 456:2000 and IS 10262-2007, subsequently mixes were prepared with a partial replacement of cement by Alccofine-1203 of 0%, 5%, 10%, 15% by weight of cement for Cubes, Cylinders and beams.

3.3 Preparation of Test Specimens

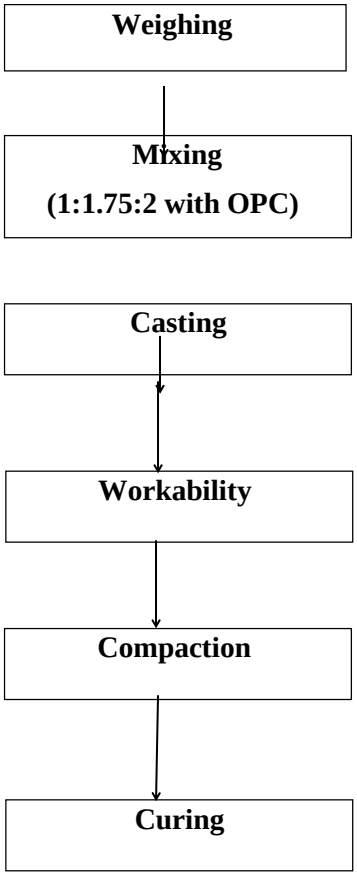

Fig 1: Flow chart of Work flow

Concrete cubes specimens of 150 mm x 150 mm x 150 mm size, Concrete cylinder specimens of 150mm x 300mm and concrete beam specimens of 150 mm x150 mm x 700 mm size were casted to evaluate the variation in compressive strength, split tensile strength and flexural strength respectively. After casting, the concrete specimens were kept in the moulds for 24 hours. The specimens were then demoulded and moist cured in a curing tank till the age of 28 days.

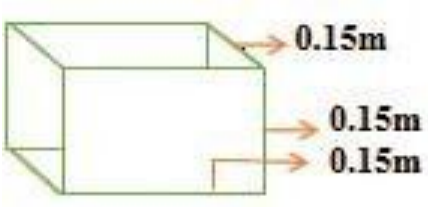

Fig 2: Schematic diagram of Cube setup

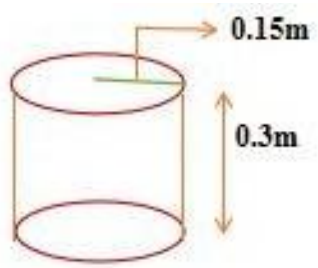

Fig3: Schematic diagram of Cylinder setup

Fig 4: Schematic diagram of Beam setup

3.4 Test Methods

3.4.1 Compressive strength test

The mixed proportion for compressive strength test is as shown below

	Conven -tional mix	5%	10%	15%
Cement	2.916kg	2.76kg	2.61kg	2.466kg
Alccofine	-	150gm	300gm	450gm
FA	5.103kg	5.103kg	5.103kg	5.103kg
CA	5.832kg	5.832kg	5.832kg	5.832kg
Water	1L 450ml	1L 450ml	1L 450ml	1L 450ml

Table 5: mix proportion for compressive strength

The compressive strength test is conducted on cube specimens at the age of 7 and 28 days in a compression testing machine. For each concrete mix containing different percentages of Alccofine-1203, two cubes were tested and the average value of compressive strength was determined.The performance of different concrete mixes was evaluated by determining reduction in compressive strength. The increase in

compressive strength was determined using the following relationship:

$$\text{Increase in compressive strength} = \frac{(A-B)}{A} \times 100$$

Where, A is the average strength of specimens made with ordinary Portland cement (MPa) and B is the average strength of specimens made with ordinary Portland cement and different replacement levels of Alccofine-1203 (MPa).

Fig 5: UTM machine

Fig 6: casted specimen

3.4.2 Split Tensile Strength test

The mixed proportion for Split tensile strength test is as shown below:

	Conven -tional mix	5%	10%	15%
Cement	2.2896kg	2.50kg	2.36kg	2.23kg
Alccofine	-	135gm	265gm	395gm
FA	4.678kg	4.678kg	4.678kg	4.678kg
CA	5.266kg	5.266kg	5.266kg	5.266kg
Water	1L 330ml	1L 330ml	1L 330ml	1L 330ml

Table 6: mix proportion for Split tensile strength

The Split tensile strength test is conducted in a 200 tonnes capacity of the compression-testing machine by placing the cylindrical specimen of the concrete, so that its axis is horizontal between the plates of the testing machine. Narrow strips of the packing material i.e., mild steel plates is placed at the top and bottom surface of cylinder in the horizontal position to receive compressive stress .The load was applied uniformly at a constant rate until failure by Split along the vertical diameter takes place. Load at which the specimen failed is recorded and the Split tensile stress is obtained using the formula based on Indian standard.The following relation is used to find out the split tensile strength of the concrete

$$F_t = \frac{2P}{\pi DL}$$

Where: P = compressive load on the cylinder

L= length of the cylinder,

D=diameter of the cylinder

Fig 7: casted specimen

3.4.3 Flexural Strength test

The mixed proportion for Flexural strength test is as shown below:

	Conven -tional mix	5%	10%	15%
Cement	6.35kg	6.9kg	6.53kg	6.17kg
Alccofine	-	365gm	725gm	1.08kg
FA	12.6kg	12.6kg	12.6kg	12.6kg
CA	14kg	14kg	14kg	14kg
Water	3L 630ml	3L 630ml	3L 630ml	3L 630ml

Table 7: mix proportion for Flexural Strength

The flexural strength test was conducted on beam specimens at the age of 7 and 28 days in accordance with

Indian Standard.Flexural strength is expressed in terms of modulus of rupture, which is the maximum stress at the extreme fibres in bending.For each concrete mix

containing different percentages of Alccofine-1203 the average value of flexural strength was determined.

Modulus of rupture was calculated for the maximum load taken by the member as:

Modulus of rupture, $f_b = \frac{pl}{bd^2}$ for a > 133 mm

$f_b = \frac{3pa}{bd^2}$ for a < 133 mm

where P is the maximum load applied to the specimen (Kg), l is the span on which the specimen is supported (cm), bis the measured width of specimen (cm), d is the measured depth of specimen (cm), a is the distance between the line of fracture and the nearer support measured on the center line of the tension side of specimen (cm).

Fig 8: Casted specimen

Fig 9: Curing of Specimens

4. RESULTS

4.1 Compressive Strength

The compressive strength values of the different concrete mixes made from ordinary Portland cement and ordinary Portland cement replaced by different percentages of Alccofine-1203 are shown in Table 8.The percentage increase in compressive strength at different replacement levels of Alccofine-1203 is shown in Fig 10.

Sl.no	Mix (days)	Alccofine-1203	Cube Compressive strength(N/mm^2)
1	7	0%	34.7
		5%	38.25
		10%	42.3
		15%	43.9
2	28	0%	49.5
		5%	51.5
		10%	55.6
		15%	58.1

Table 8: Compressive Strength values

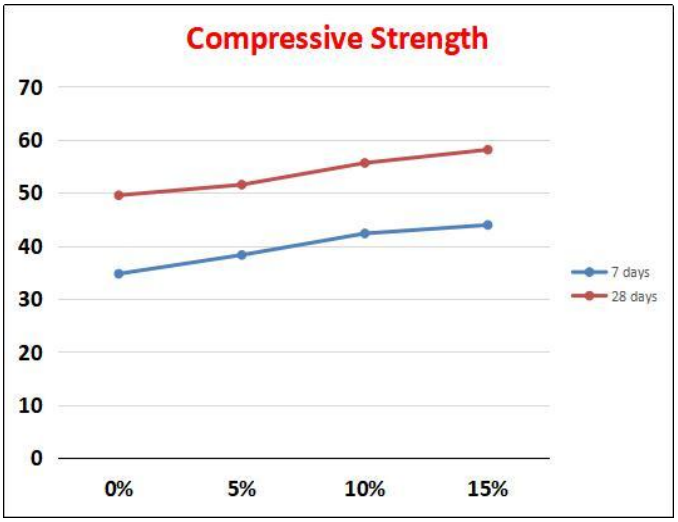

Fig 10: Compressive Strength

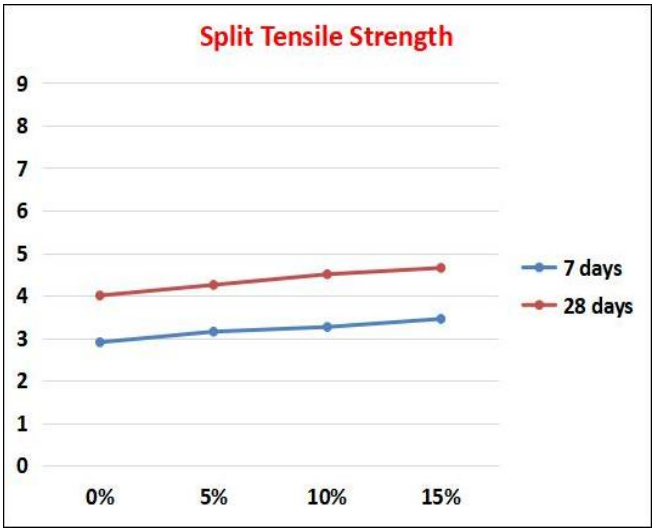

Fig 11: Split Tensile Strength

4.2 Split tensile strength

The Split tensile strength strength values of the different concrete mixes made from ordinary Portland cement and ordinary Portland cement replaced by different percentages of Alccofine-1203 are shown in Table 9.

Sl.no	Mix (days)	Alccofine -1203	Cylinder
			Split Tensile strength(N/mm^2)
1	7	0%	2.90
		5%	3.15
		10%	3.26
		15%	3.45
2	28	0%	4.0
		5%	4.25
		10%	4.50
		15%	4.65

Table 9: Split Tensile Strength values

4.3 Flexural Strength

The Flexural strength values of the different concrete mixes made from ordinary Portland cement and ordinary Portland cement replaced by different percentages of Alccofine-1203 are shown in Table 10.

Sl. no	Mix (days)	Alccofine-1203	Beam
			Flexural strength (N/mm^2)
1	28	0%	5.40
		5%	5.55
		10%	5.85
		15% (without glass fibre)	6.03
		15% (with glass fibre)	20.21

Table 10: Flexural Strength

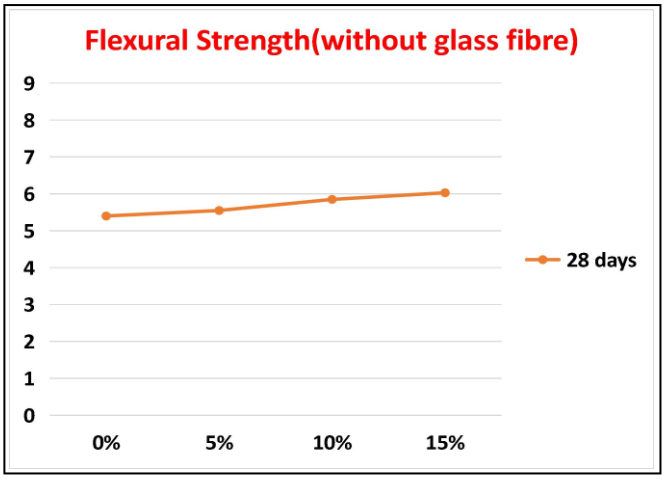

Fig 12: Flexural Strength(without glass fibre)

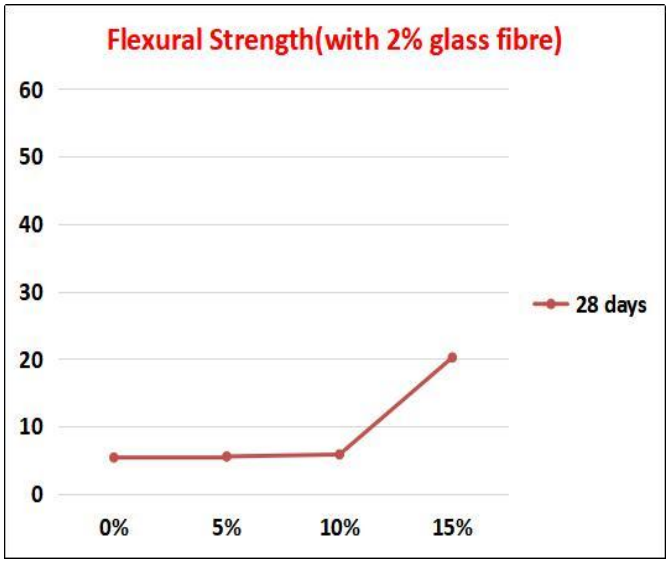

Fig 13: Flexural Strength(with2% glass fibre)

5. CONCLUSIONS

The main objective of this study is to analyze the performance of addition of commercially available Alccofine-1203 as an additive in cementitious materials to improve the properties of conventional concrete and to enhance the flexibility to resist cracking and spalling of concrete structures.The above conclusions were obtained as a result and performance for the tests conducted.The experimental tests unconcealed that the strength properties of concrete improved with the addition of 15% Alccofine-1203 to the concrete.

1. 15% of cement replacement with Alccofine-1203 gave desired workability for binary blended concrete without usage of super plasticizer.Hence BBC consisted of 85% OPC and 15% Alccofine- 1203(binary blending).

2. By adding 2% of fibre in 15% of Alccofine-1203 it observe that the flexural strength in without glass fibre specimen is less when compared to with fibre specimen.

It was observed that cracking resistance of the concrete specimens improved to a greater extent and the specimens were intact with each other even after the failure of specimen under loading thus making it a non brittle failure.

ACKNOWLEDGEMENT

We are thankful to **Dr.Mohammed Masood**,Principal, ISLEC for his encouragement through out the project.We would also like to express our heartfelt thanks to **Ms.K.Naanchari,** Head of Civil Engineering Department, ISLEC for her help and unending cooperation with us during completion of this work.

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