EFFECT OF GLASS FIBER ON ALCCOFINE MIX CONCRETE

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Abstract— As a construction material, concrete is the largest production of all other materials. Concrete is a composite material composed of aggregate bonded together with fluid cement which hardens overtime. Efforts for improving the performance of concrete over the past few years suggest that cement replacement materials can be utilized to produce high strength concrete. The aim of this experimental study is to evaluate the performance of concrete containing supplementary materials such as alccofine and glass fiber. Glass fibers are added to concrete to impart energy absorption, toughness and impact resistant property and these in turn improve the fracture and fatigue property of concrete. An optimum of alccofine was determined experimentally. Later fibers were added in three percentages and the variations in the result were found out. Result indicated that with the increase in glass fiber content, there was an increase in compressive strength, split tensile strength and flexural strength.

Index Terms—Alccofine, glass fiber, compressive strength, split tensile strength, flexural strength, slump test, cement

1 INTRODUCTION

Concrete is one of the mainly used materials throughout the globe in the various fields, which basically consists of cement, sand and crushed quarry stones which are locally and naturally available. Sand and crushed stone are used as a filler material in concrete and cement is used for bonding and strength parameter of the concrete. Therefore, the concrete is used extensively all over the world. It has many disadvantages. That is for the production of one tone of concrete nearly one tone of CO_2 is released, which effect the environment [1]. Nowadays, efforts for improving the characteristics of concrete over the past few years suggest that cement replacement materials along with chemical admixtures can improve the durability and corrosion characteristics of concrete. Alternative concretes are needed to reduce the significant environmental impact of Ordinary Portland Cement concrete construction.

A new material ALCCOFINE 1203 has been introduced now in industry. It is a supplementary cementitious material suitably replaces cement in concrete. ALCCOFINE 1203 is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation[2].

A paper by Prasanna T. M. (2015), studied on replacement of cement with alccofine in various percentages and the result indicated that, after 10% of alccofine replacement, strength was decreased. Fig 1 shows the image of Alccofine 1203.

Fig. 1 Alccofine 1203

Fiber reinforced cement or concrete is a relatively new composite material in which fibers are introduced in the matrix as micro reinforcement, so as to improve the tensile, cracking and other properties of concrete. Using fiber in the concrete increased the flexural strength of the concrete and ensures concrete to exhibit ductile. behavior. Fibers generally reduce the workability of concrete, but the presence of ultra fine material helps in counteracting the workability. Fig 2 shows the image of glass fiber [3], [4], [5].

2 EXPERIMENTAL PROGRAMS

Experimental program has been designed to provide properties of cement, fine aggregate and coarse aggregate, which were tested in laboratory. Properties of alccofine and glass fiber were provided by manufactures.

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2.1 Cement

Ordinary Portland Cement 53 grade cement was used for investigation. Table 1 gives the properties of cement. It is confirmed to IS 4031-1968 and IS 12269-2013.

TABLE 1
Properties of cement

Sl. No.	Properties	Obtained value
1	Fineness	5 %
2	Specific gravity	3.15
3	Standard consistency	29 %
4	Initial setting time	45 Minutes
5	Final setting time	330 Minutes
6	Compressive strength (3 days)	17.93 MPa
7	Compressive strength (7 days)	27.23 MPa
8	Compressive strength (28 days)	32.7 MPa

2.2 Fine and Coarse aggregate

Confirming IS 383 – 1987 have been used. Table 2 and 3 shows the properties of fine and coarse aggregate respectively. Fine aggregate used was of zone II and was having a specific gravity and fineness modulus of 2.7 and 2.99 respectively.

Coarse aggregate used was of specific gravity, 2.82 and fineness modulus, 6.31. Aggregate crushing value obtained was 32.42%.

2.3 Alccofine 1203

Alccofine have used conforming to ASTM C989-99. Physical and chemical properties are tabulated in table 2 and 3 respectively.

TABLE 2
Physical properties of alccofine

Sl No.	Properties	Magnitude
1	Fineness	>12000 cm^2/gm
2	Bulk Density	600 – 700 kg/m^3
3	Particle shape	Irregular
4	Particle Size, d_{10}	<2µ
5	Particle Size, d_{50}	<5µ
6	Particle Size, d_{90}	<9µ

TABLE 3
Chemical properties of alccofine

Sl No.	Compound	Range
1	CaO	32% - 34%
2	SO_3	0.3% - 0.7%
3	SiO_2	33% - 35%
4	Al_2O_3	18% - 20%
5	Fe_2O_3	1.8% - 2%
6	MgO	8% - 10%

2.4 Glass fiber

AE type glass fibers were used. Table 4 shows the properties f lass fiber.

Fig. 2Glass fiber

TABLE 4
Properties of glass fiber

Sl No.	Properties	Magnitude
1	Diameter	12µm
2	Specific gravity	2.60
3	Failure strain	3.0%
4	Elasticity	80GPa
5	Tensile strength	2.5GPa

2.5 Mix design and proportion

In the present study M30 grade concrete mix design as per IS: 10262 (2009) was carried out. The concrete mix proportion was 1:2.01:3.57. Water cement ratio was 0.45. For 1 m^3 concrete, 360 kg of cement, 723.28 kg of fine aggregate and 1286.26 kg of coarse aggregate were used. To improve the workability, super plasticizer were used and water content was reduced to 162 l/m^3.

3 EXPERIMENTAL PROCESS

The specimen of size 150mm×150mm×150mm was used to test the compressive strength of cubes for 7 day and 28 day and specimen of size 150 mm diameter and 300 mm height was used to test split tensile strength at 28 day. Size of flexural strength test at 28 day specimen was 100mm × 100mm × 500mm and length of 400 mm. Alccofine varies from 0% to 12%. Further glass fiber was added in three percentages (1%, 1.5% and 2%) to 12% alccofine mix and variations in properties were investigated. Specimens were tested in automatic compression testing machine for compression strength test and split tensile strength. Fig 3 shows the automatic compression testing machine. Flexural strength was tested in flexural testing machine.

Fig 3. Automatic compression testing machine

4 RESULTS AND DISCUSSIONS

4.1 Slump test

Result from slump test showed that as the alccofine was increased from 0% to 10%, there was an increase from 92 m to 114 mm. But further addition decreased the slump to 111 mm. Also addition of fibers decreased the slump. Table 5 shows the slump result

Table 5

Slump value of all the mixes

Sl No.	% of alccofine (%)	% of glass fiber (%)	Slump (mm)
1	0	0	92
2	4	0	100
3	6	0	104
4	8	0	109
5	10	0	114
6	12	0	111
7	12	1	106
8	12	1.5	100
9	12	2	95

4.2 Compressive strength

The result obtained for different percentage of alccofine is showed in fig 4. Compressive strength was increased for alccofine 0% to 10%. Fig 5 shows the variation in compressive strength, when glass fibers were added.

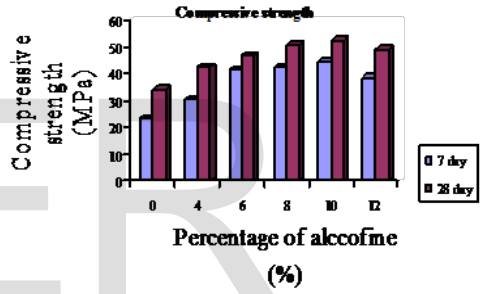

Fig 4. Variation in compressive strength for different percentages of alccofine

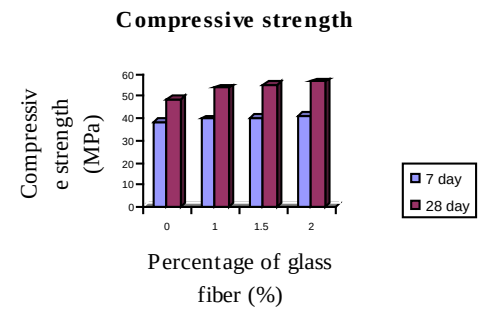

Fig 5. Compressive strength variation when glass fibers were added

4.3 Split tensile strength

Result obtained for different percentages of alccofine are shown in fig 6. Fig 7 indicates the variation in strength when glass fibers were added to 12% alccofine mix.

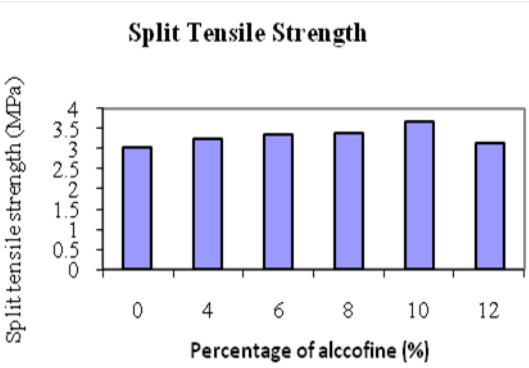

Fig 6.Split tensile strength for different percentages of alccofine

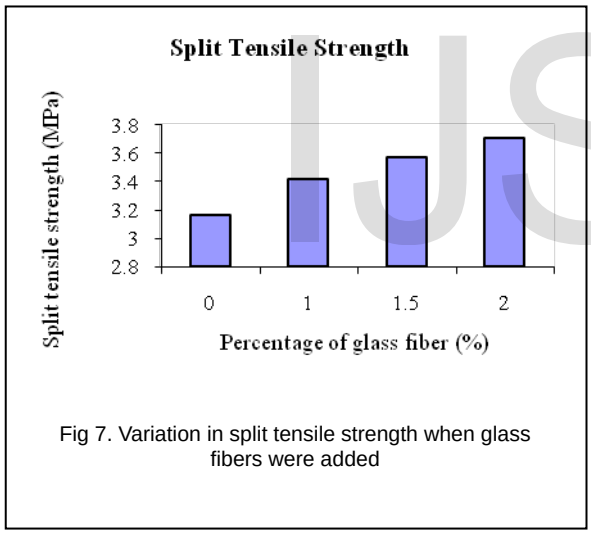

Fig 7. Variation in split tensile strength when glass fibers were added

4.4 Flexural strength

Fig 8 and fig 9 shows the result obtained for flexural strength for different percentages of alccofine and for different percentages of glass fiber respectively.

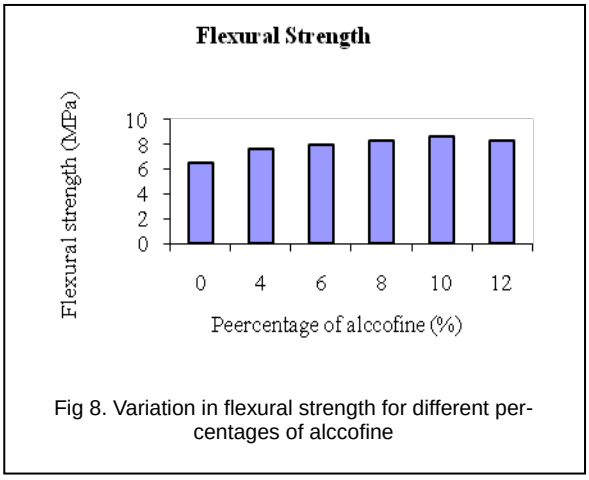

Fig 8. Variation in flexural strength for different percentages of alccofine

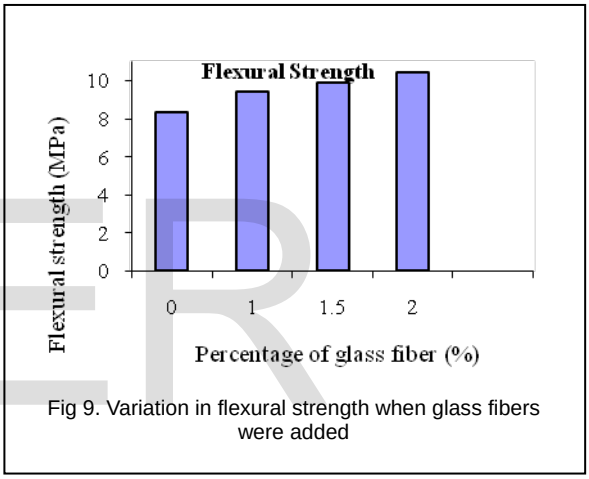

Fig 9. Variation in flexural strength when glass fibers were added

5 Conclusions

Alccofine increases the compressive strength, split tensile strength and flexural strength of concrete. Addition of alccofine increased the workability of concrete till 10 % of alccofine replacement. Optimum percentage of alccofine was found to be 10 %. Alccofine is an early strength gaining material. Maximum percentage increase for compressive (7 day and 28 day), split and flexural strength was 90.89 %, 51.79 %, 20.29 % and 32.92 % respectively.

Addition of glass fiber (1 %, 1.5 % and 2 % by weight of cement) increased the compressive strength slightly but there was a considerable increase in split tensile strength and flexural strength. But the addition of glass fiber decreased the workability. This is due to the non uniform distribution of fibers in concrete. This can be improved by increasing the water cement ratio or by addition of super plasticizer. Maximum percentage increase of compressive strength, split tensile strength and flexural strength when glass fiber was added were 7.62 %, 9.98 %, 17.41 % and 24.85 % respectively. Glass fibers also reduced the formation of cracks in concrete.

The results of the present study show that:

[1] Alccofine increases the workability till 10 % of replacement of cement.

[2] Alccofine is an early strength gaining material.

[3] Replacement of cement till 10 % of alccofine will help in attaining high strength concrete.

[4]Glass fibers reduce the workability but it can be counteracted by the addition of super plasticizers.

[5] Addition of glass fiber increases the fracture toughness of concrete.

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