An Experimental Study on Strength of Concrete Containing Crumb Rubber with Alccofine

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***Abstract*- Concrete is one of the most widely used construction material throughout the world. So each constituents of concrete like aggregate, cement etc. are vital materials needed for the construction industry. In order to fulfill the insufficient of aggregates, have to use some alternative materials like Alccofine, Crumb Rubber etc. which are recycled or waste materials. In this study concrete mix designs are prepared by using IS method (for M30 grade of concrete). Furthermore, this study examined the properties of concrete by partially replacing the cement by Alccofine and fine aggregate by Crumb Rubber (CR) by varying weight percentages of Alccofine(5%, 10%, 15%) and CR (2%, 4%, 6%, 8%) respectively. A comparison study was also performed on mechanical properties like compressive strength and flexural strength of conventional concrete with partially replaced concrete.**

***Index Terms* - Crumb Rubber, Alccofine, Compressive Strength, Flexural Strength.**

I. INTRODUCTION

Concrete is a versatile construction material and is extensively used in civil engineering practice. Now a day the use of concrete is very large and the constituent materials of concrete are reduced. In order to overcome such situations have to partially replace those constituents by using alternative materials [10]. In India number of waste materials is produced by different manufacturing companies, thermal power plant, municipal solid wastes and other wastes [3]. Currently waste materials resulting from various physical and chemical processes are most important challenge in the industrial and developing countries [4]. One of the non-recyclable materials enters the environment is automotive used tyres. Burning is a choice for their decomposition; however the gases exhausted from the burning tyres results in pollutions [5]. Based on different investigations, another way is using the tyres in concrete. This may cause a decrease in the mechanical properties of concrete which will be compensated by adding Alccofine to rubber containing concrete in varying percentages [2].

Crumb rubber is a material produced by shredding and commutating used tires [6]. Waste tyre rubber is a promising material in the construction industry due to its light weight, elasticity, energy absorption, sound and heat insulating properties [9]. An emerging use is the production of concrete, in which tyre rubber particles partially replace the natural aggregates. This has the additional advantage of saving in natural aggregates used in the production of concrete [5].

Alccofine is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation [8].Owing to its unique chemistry and ultra-fine particle size, Alccofine provides requirement of concrete performance. Alccofine can also be utilized as a high range water reducer to improve compressive and flexural Strength or as a super workability aid to improve flow [1]. Alccofine is known to produce a high strength concrete and is used in two different ways as a cement replacement, in order to reduce the cement content and as an additive to improve concrete properties [7].

The objective of the study is to determine the mechanical properties of concrete containing crumb rubber with alccofine.

II. EXPERIMENTAL PROGRAMME

An experimental investigation was carried out to develop rubber concrete with varying percentages of Alccofine to observe those influences on mechanical properties in concrete.

Materials Used

i). *Cement*: Ordinary Portland Cement of 53 grade conforming to IS 12269-1987 (Dalmia brand) was used in this experiment. Various experiments were conducted to find the initial and final setting time.

ii). *Coarse Aggregate*: Coarse aggregate is chemically stable material in concrete, used in construction, including sand, gravel, crushed stone, slag etc. Coarse aggregate of nominal size 20mm was used. Coarse aggregates consist of one or a combination of gravels or crushed stone with most of which is retained on 4.75mm IS sieve. As per IS: 2386(part1)-1963 various tests like sieve analysis and specific gravity were conducted.

iii). *Fine Aggregate*: Fine Aggregates are mainly passing through 4.75mm IS sieve. As per IS: 2386(part3)-1963 various tests like sieve analysis and specific gravity were conducted.

iv). *Water*: Portable water in the laboratory confirming to the requirements of water for concreting as per IS 456:2000 was used for casting and curing of specimens.

v). *Super Plasticizer*: Rheobuild 981 with specific gravity 1.21 was used as super plasticizer. This was obtained from BASF Construction Chemicals (India) Pvt. Ltd.

vi). *Crumb Rubber:* It is collected from local source was used for replacing fine aggregates with varying percentages. The waste tire crumb rubber particles used to replace fine aggregate in concrete of size passing through 1.18 mm IS sieve and retaining on 600µ IS sieve.

vii). *Alccofine 1203:* It is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation, which is shown in **Figure 1.** Alccofine 1203 collected from Ambuja Cement Private Limited, Goa.

Fig.1 Alccofine

Mix Design

The mix design is carried out as per IS 10262:2009. The grade of concrete adopted for this study is M30. Mix proportions for M30 grade are tabulated in **Table 1.**

Table 1 Mix Proportions for M30 Concrete

Materials	Quantity (kg/m^3)
Cement	375.24
Fine Aggregate	884
Coarse Aggregate	1101.05
Water	157.6
Admixture	3.75

Testing Procedure

Concrete test specimen consists of 150x150x150mm cubes and100x100x500 beams were prepared for conducting compressive strength and flexural strength test. The prepared specimens are kept for curing for 7 days and 28 days. Specimens were taken from the mould after 7days, 28 days and dried at room temperature. Then the respective specimens are tested for both 7 days and 28 days to obtain the compressive strength and flexural strength of concrete. Test setup for compressive strength and split tensile strength respectively shown in **Figure 2.**

Fig. 2 Test setup for compressive strength and flexural strength

III. RESULT AND DISCUSSION

Compressive Strength Test

From the experiments, the result obtained shows that the performance of rubber concrete in compressive strength is quite encouraging up to 2% and then gradually decreases with increase in Crumb Rubber percentage which is graphically shown in **Figure 3.**This reduction of compressive strength is due to weakness of bond between the cement matrix and crumb rubber when compared with the sand. The variation of compressive strength with varying percentage of Alccofine and constant percentage of

Crumb Rubber as graphically shown in **Figure 4**. Results obtained from the compressive strength testing are tabulated in **Table 2** and **Table 3**.

Table 2 Compressive Strength of concrete with varying percentage of Crumb Rubber

Cube designation Crumb Rubber (%)	Compressive strength (N/mm^2)	
	7 days	28 days
0	21.77	33
2	22.66	34
4	19.55	30.51
6	17.92	26.74
8	13.55	20.32

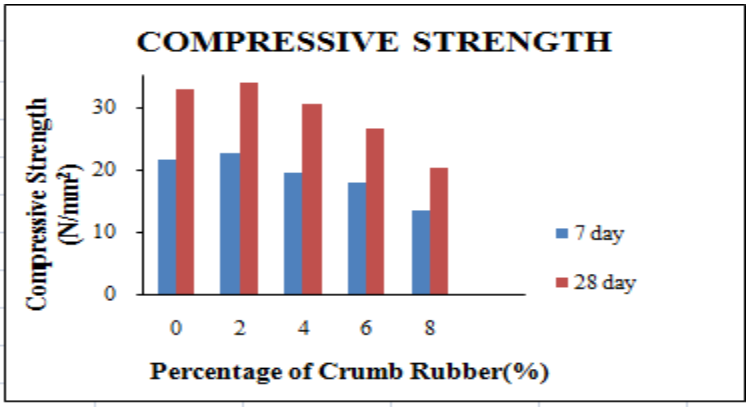

Fig.3 Compressive Strength of Concrete with varying percentages of Crumb Rubber

Table 3 Compressive Strength of rubber concrete with varying percentage of Alccofine

Cube designation (%)	Compressive strength (N/mm^2)	
	7 day	28 day
8%CR	13.55	20.32
8%CR+5%AL	17.11	25.67
8%+10%AL	18.22	27.33
8%CR+15%AL	22.66	34

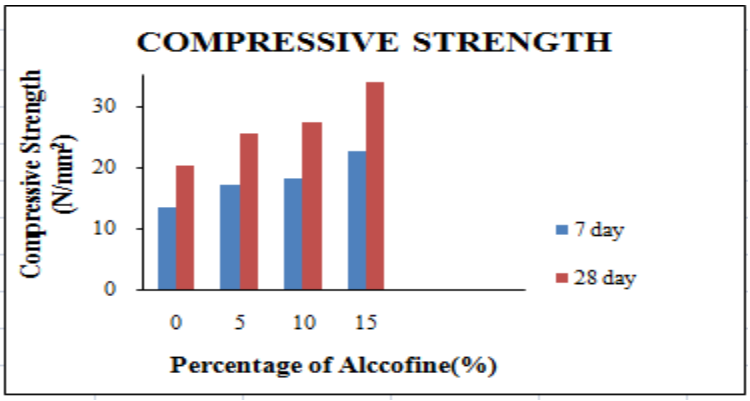

Fig.4 Compressive Strength of Rubber Concrete with varying percentages of Alccofine

Flexural Strength Test

The performance in flexural strength of rubber concrete is quite encouraging up to 2% and then it gradually decreases with increase in the crumb rubber percentages which is graphically shown in **Figure 5**. This is due to non polar action of the rubber particles which attract air and repels water. The variation of flexural strength with varying percentage of Alccofine and constant percentage of Crumb Rubber as shown in **Figure 6**. Results obtained from the flexural strength testing are tabulated in **Table 4** and **Table 5**.

Table 4 Flexural Strength of concrete with varying percentage of Crumb Rubber

Beam designation Crumb Rubber (%)	Flexural strength (N/mm^2)	
	7 day	28 day
0	4	7
2	4.875	7.31
4	3.55	5.25
6	4.5	6.75
8	3.25	4.875

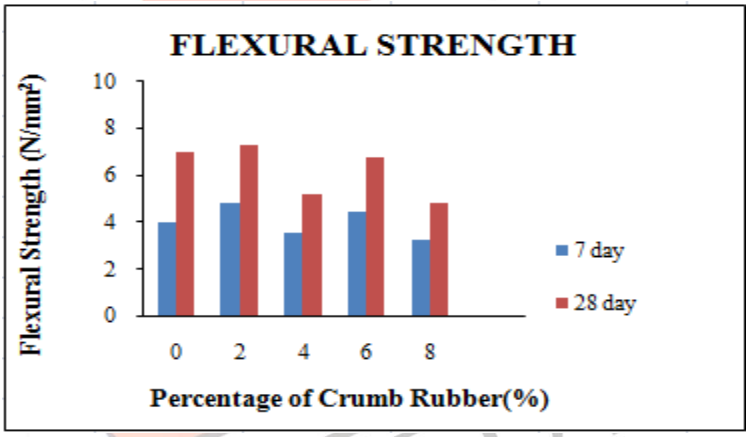

Fig. 5 Flexural Strength of Concrete with varying percentages of Crumb Rubber

Table 5 Flexural Strength of rubber concrete with varying percentage of Alccofine

Beam designation (%)	Flexural Strength (N/mm^2)	
	7 day	28 day
8%CR	3.25	4.875
8%CR+5%AL	3.9	5.85
8%+10%AL	4.5	6.75
8%CR+15%AL	5.5	8.25

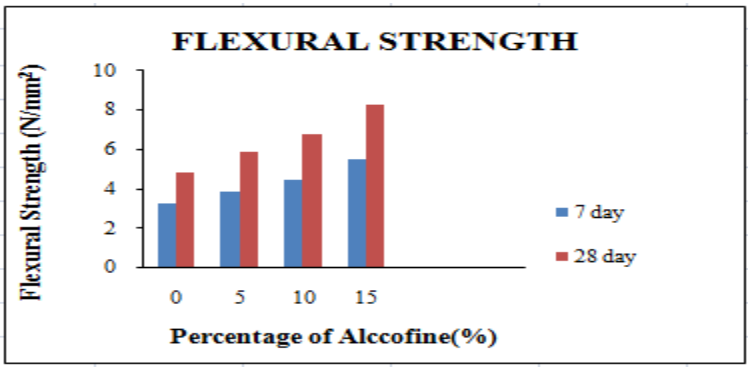

Fig. 6 Flexural Strength of Rubber Concrete with varying percentages of Alccofine

IV. CONCLUSION

This study examines the compressive and flexural behavior of the concrete when it is partially replaced with Crumb Rubber and Alccofine. The following conclusions can be drawn from experimental results:

- The compressive strength of rubber concrete with alccofine was greater than that of control mix. This is due to the high pozzolanic reaction of alccofine.
- Flexural strength of hardened concrete gradually increases as the percentage of alccofine increases and the maximum value obtained is at 15%. This is due to the ultrafine particle size and its high void filling ability.
- The relative cost of Alccofine is cheaper than cement so for better strength of concrete it should be promoted in construction industry.

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