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EXPERIMENTAL STUDY OF ULTRAFINE CALCIUM CARBONATE POWDER AND FLYASH IN CONCRETE

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ABSTRACT

The use of calcium carbonate and fly ash in concrete has not been a common practice due to number of reasons. Recently after the technological developments fly ash is been used in preparing the concrete. A wide variety of RMC's mow use fly ash in preparing concrete. The use of fly ash and calcium carbonate in concrete lead to many environmental benefits as the waste material can be used in concrete and hence no issues of dumping waste into the environment. It proves economical as the cost of concrete is reduced. In my study the use of calcium carbonate and fly ash in concrete was taken and cement of grade OPC 43 was used. The cement was replaced in concentrations of 5%, 10%, 15%, 20%, 25%, 30% by fly ash ash and calcium carbonate simultaneously. The optimum concentration of fly ash , calcium carbonate and mixture of fly ash and calcium carbonate was 20%, 15%, 10% F.A 5% CC simultaneously.

Keyword: *compressive strength, fly ash (F.A), calcium carbonate (CC), concrete.*

I. INTRODUCTION

In 21st century there have been lots of developments in various fields and the construction field is one of them. In today's era it is necessary to produce very high strength concrete for short and long term considerations. The challenge is to produce high quality concrete without actually affecting its cementitious properties. The bigger challenge for mix proportioning of such concrete has two folds:

- The concrete having high early strength of almost 30mpa or more after one or two days with the use of cementitious materials is required to be achieved. In order to produce such concrete it requires large amount of cement quantity but the maximum cement quantity that can be used as per IS-456 has been restricted to 450 N/mm^2 in view of the durability of concrete.
- In some construction applications such as high rise buildings, girders, bridges etc the strength of 50mpa or more at the end of 28 days or 56 days is required. This can be done either by providing large quantities of cement which will be highly uneconomical or by using fly ash with super plasticizers. But again we will not be able to achieve high early strength of 30mpa or more after 1 or 2 days.

So in order to obtain the high early strength at the initial age of 2-3 days the use of silica in concrete can help the cause but again it can be very costly considering the Indian market. Therefore, there is a need to investigate some other alternative materials which can help in obtaining these objectives. The material should be such that it does not have any negative effect on the properties of concrete and most importantly on the strength of concrete. After due analysis on the Indian market it has been found that many commercial products of calcium carbonate powder with various finenesses' is available. Hence, there is a need to investigate the performance of calcium carbonate with cement. Earlier there was no use of calcium carbonate in India due to various reasons which include non-availability of the limestone powder for commercial purposes and difference in the Indian origin cements. But now due to recent advancements in terms of technology which has been adopted by a number of manufacturers, the Indian cements have hugely improved. The aim of this paper is to find the effect of calcium carbonate powder and fly ash on fresh and hardened properties of concrete

II. LITERATURE REVIEW

2.1. This paper [1] published by **Hukma Ram and Sitaram Jat,** Experimental Study of Ultrafine Calcium Carbonate Powder and Fly Ash in Concrete (February 2011) was studied. They concluded that:

- When vaporlite 90 t along with fly ash is used in concrete the early strength is high and at an optimum proportion of vaporlite 90 t which is 1% of the weight of cement, strength obtained is maximum.
- If the 56 days strength of controlled mix and the mix containing 15% fly-ash and 1% vaporlite is compared, it is almost equal.
- On adding fly ash in some percentage of the weight of cement along with 1% of vapor lite the early strength of 2 days has almost doubled as compared to those mixes which contain same percentage of fly ash only. Thus, the results show that the increase in early strength of concrete is almost 100% at some optimum percentage of vaporlite along with fly-ash. There is no adverse effect of addition of vaporlite on the long term strength of concrete. Thus, the addition of vaporlite along with fly ash in making high strength concrete can be beneficial and economical.

2.2. This paper [2] published by **Dr. B. Madhusudhana Reddy, D.Pavankumar and Prof. C. Sashi dhar (march 2015**) presents the effect of calcium carbonate (CaCO3) on blended cement concrete (BCC). The BCC was prepared with CaCO3 concentrations of 0.025, 0.075, 0.1, 0.2, and 0.3g/l by adding in de ionized water. In addition to this, control specimen was prepared with deionized water (withoutCaCO3) for the purpose of comparison. The setting times and compressive strength were evaluated for 28 and 90 days apart from studying rapid chloride ion permeability. The results show that as CaCO3 concentration increases there is retarding in initial and final setting of blended cement (BC). The compressive strength of BCC increases as the concentration of CaCO3 goes up at both 28 and 90 days. There is no significant change in compressive strengths of BCC. It was also observed that chloride ion permeability has decreased with an increase in the concentration of the CaCO3.

2.3 This paper [3] published **by Siddam reddy, Anil Kumar Reddy, Dr. K. Chandrasekhar Reddy (May 2015)** presents the Effect Of Fly Ash On Strength And Durability Parameters Of Concrete**.** They concluded that Consistency of cement depends upon its fineness. Fly ash is having greater fineness than cement so the consistency increases greatly, when fly ash percentage increases. The normal consistency increases about 40% when fly ash percentage increases from 0% to 20% and workability was also increased. The optimum 7 and 28-day compressive strength have been obtained in the range of 20 % fly ash replacement level. Increase in split tensile strength beyond 20% fly ash replacement, fly ash seems to have a more pronounced effect on flexural strength than split tensile strength. When compared to other mix the loss in weight percentage was found to be reduced by 3.99 to 2.84 and compressive strength was reduced when the cement was replaced by 0% to 20% of fly ash.

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III. OBJECTIVES

The objectives of this study are:

- Tto study the effects of using ultrafine as cement replacing filler on the performance of concrete.
- To determine the effects of replacing part of cement with ultrafine calcium carbonate powder and fly ash on concrete performance such as workability and strength.
- To conduct compressive strength test.
- To provide economical construction material.
- Provide safeguard to the environment by utilizing waste properly.
- Effective use of the waste materials
- To study the properties of concrete i.e. compressive strength and workability when these materials are added
- Compressive Strength gain and loss of concrete by using these waste cementitious materials

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IV. MATERIALS USED

4.1 Fine aggregates: - The fine aggregates used was Badarpur Sand of ZONE II.

4.2 Coarse aggregates: - the aggregates used were 20 mm aggregates passing the criteria as per IS-383-1970

4.3 Cement: Cement used was:-OPC 43 Grade. (J K LAXMI)

4.4 Flyash: The fly ash which we have been used in our project was an ordinary fly ash locally available in Magicrete RMC plant Gurgaon.

4.5 Calcium carbonate: Calcium carbonate was obtained locally from an RMC plant.

V. CONCRETE MIX DESIGN for M-20

Table 1: DESIGN STIPULATIONS

Grade of Concrete	M-20
Type of Cement	OPC 53 Grade
Minimum Nominal Size of Aggregate	20mm
Workability	75-100mm
Exposure conditions	mild
Method of concrete placing	normal
Degree of supervision	good
Specific gravity of cement	3.10
Specific gravity of coarse aggregates	2.70
Specific gravity of fine aggregates	2.56
Sieve analysis	ZONE 2(IS 383-1970)

Table 2: DESIGN CALCULATIONS

	WATER	**CEMENT**	**SAND**	**AGGREGATE**
VOLUME	197.16(kg/m^3)	394.32(kg/m^3)	669.52(kg/m^3)	1159.61(kg/m^3)
RATIO	0.50	1	1.698	2.94

VI. EXPERIMENTAL INVESTIGATION

6.1. Workability of concrete

TABLE 6: Slump of fresh concrete of different mix proportions

TYPE OF MIX	SLUMP (mm)
Controlled mix	95
95% cement,5%FA	97
S90% cement,10%FA	98
85% cement,15%FA	101
80% cement,20%FA	104
75% cement,25%FA	106
70% cement,30%FA	110

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95% cement,5%CC	93
90% cement,10%CC	97
85% cement,15%CC	100
80% cement20%CC	105
75% cement,25%CC	107
70% cement,30%CC	109
90% cement, 5%FA,5%CC	100
85% cement, 10%FA,5%CC	103
80% cement, 15%FA,5%CC	109
75% cement, 20%FA,5%CC	115

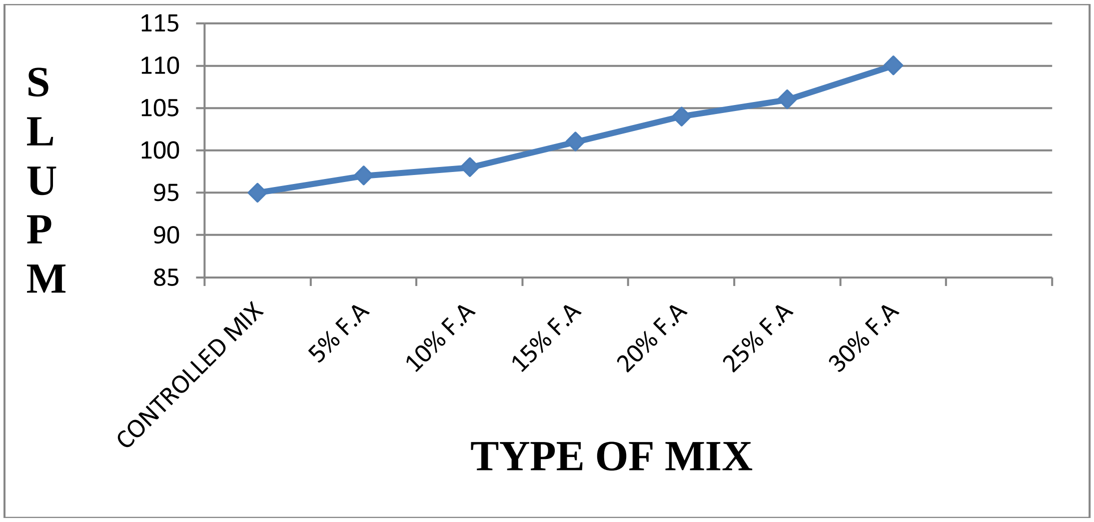

FIG 1: Slump of concrete containing Fly Ash

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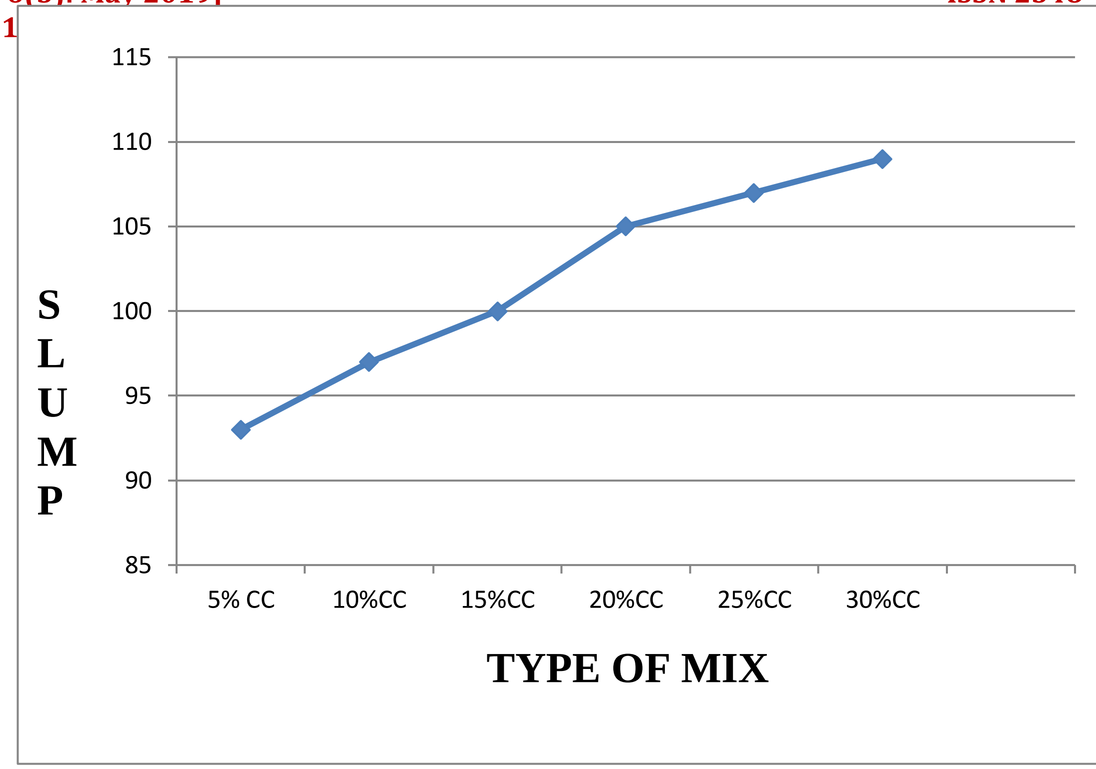

FIG 2: Slump of concrete containing calcium carbonate

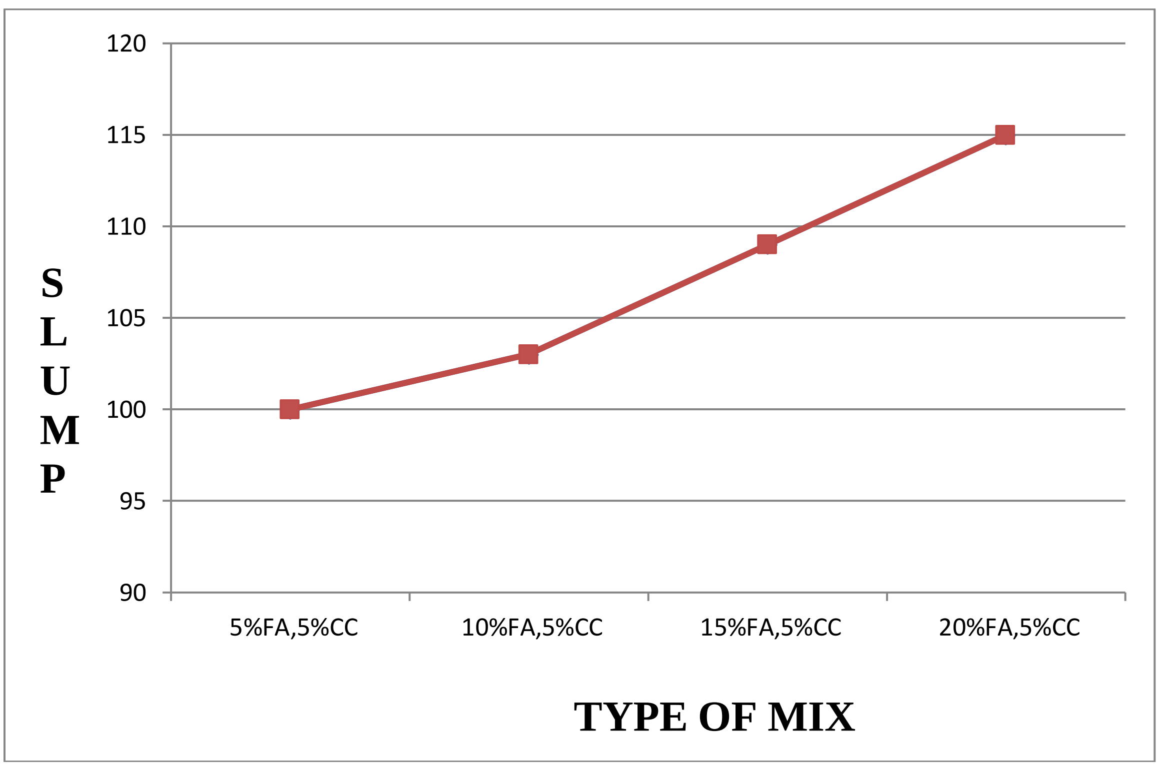

FIG 3: Slump of concrete containing calcium carbonate and fly ash

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6.2. Compressive strength of concrete

TABLE 7: 7 Days compressive strength

TYPE OF MIX	LOAD (KN)	COMPRESSIVE STRENGTH (N/mm^2)
Controlled mix	340	15.11
95% cement,5%FA	290	12.88
90% cement,10%FA	280	12.44
85% cement,15%FA	260	11.55
80% cement,20%FA	250	11.11
75% cement,25%FA	210	9.33
70% cement,30%FA	180	8
95% cement,5%CC	300	13.33
90% cement,10%CC	310	13.77
85% cement,15%CC	320	14.22
80% cement20%CC	280	12.44
75% cement,25%CC	240	10.66
70% cement,30%CC	210	9.33
90% cement, 5%FA,5%CC	310	13.77
85% cement, 10%FA,5%CC	330	14.66
80% cement, 15%FA,5%CC	270	12
75% cement, 20%FA,5%CC	220	9.77

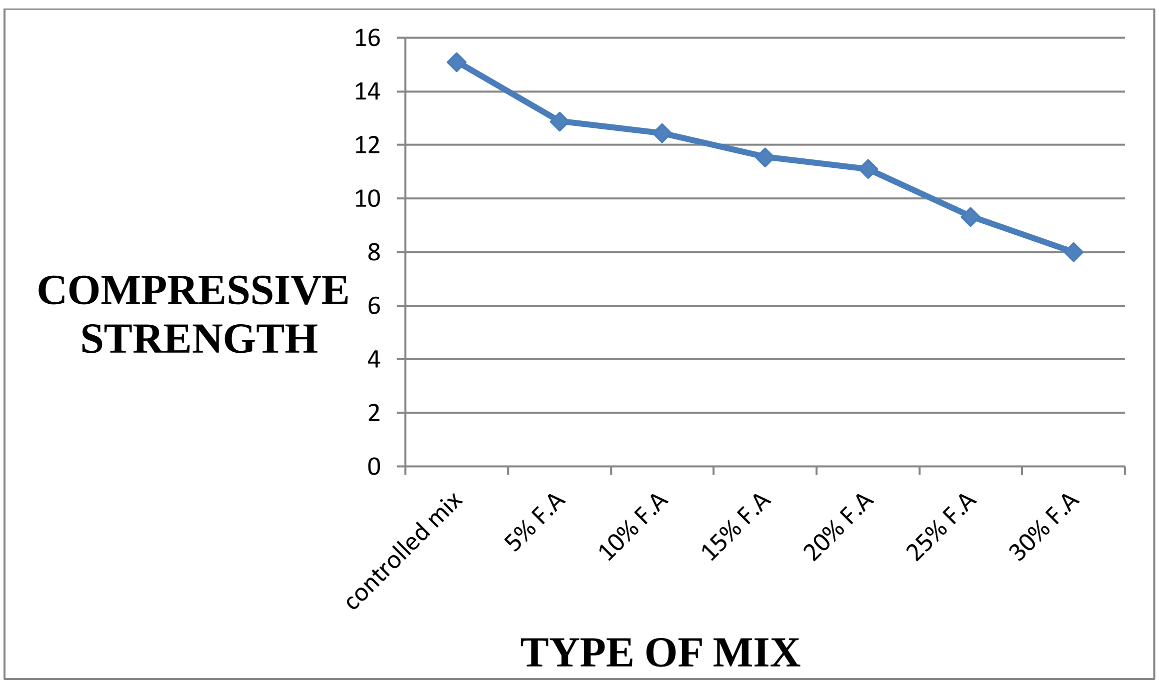

FIG 4: 7 Days compressive strength of F.A concrete

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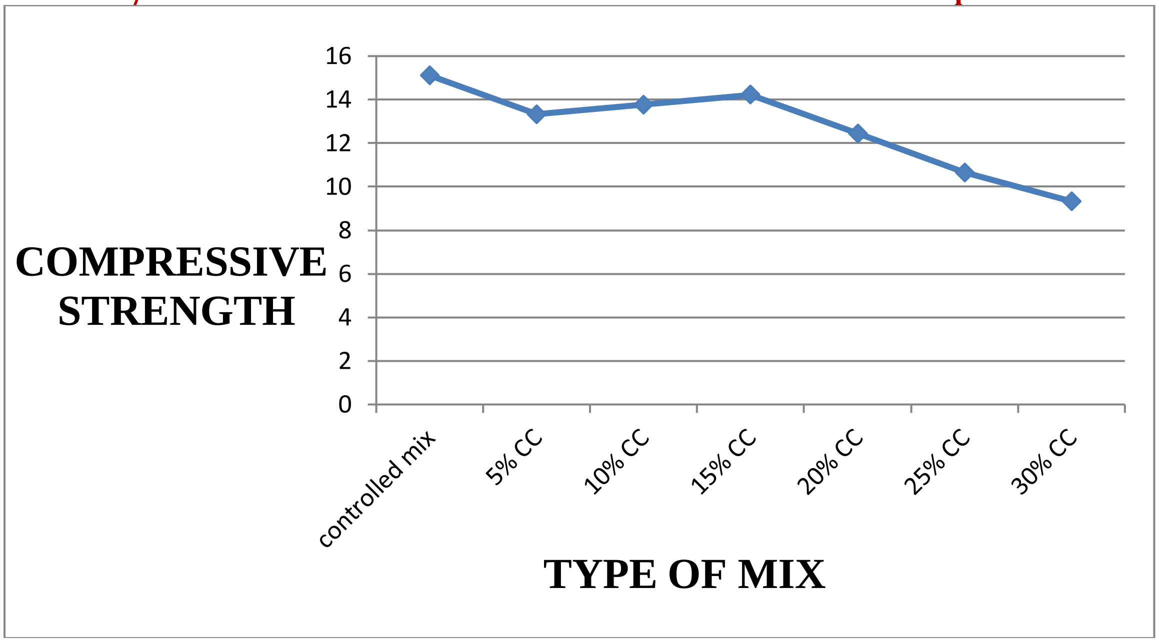

FIG 5:7 Days compressive strength OF CC concrete

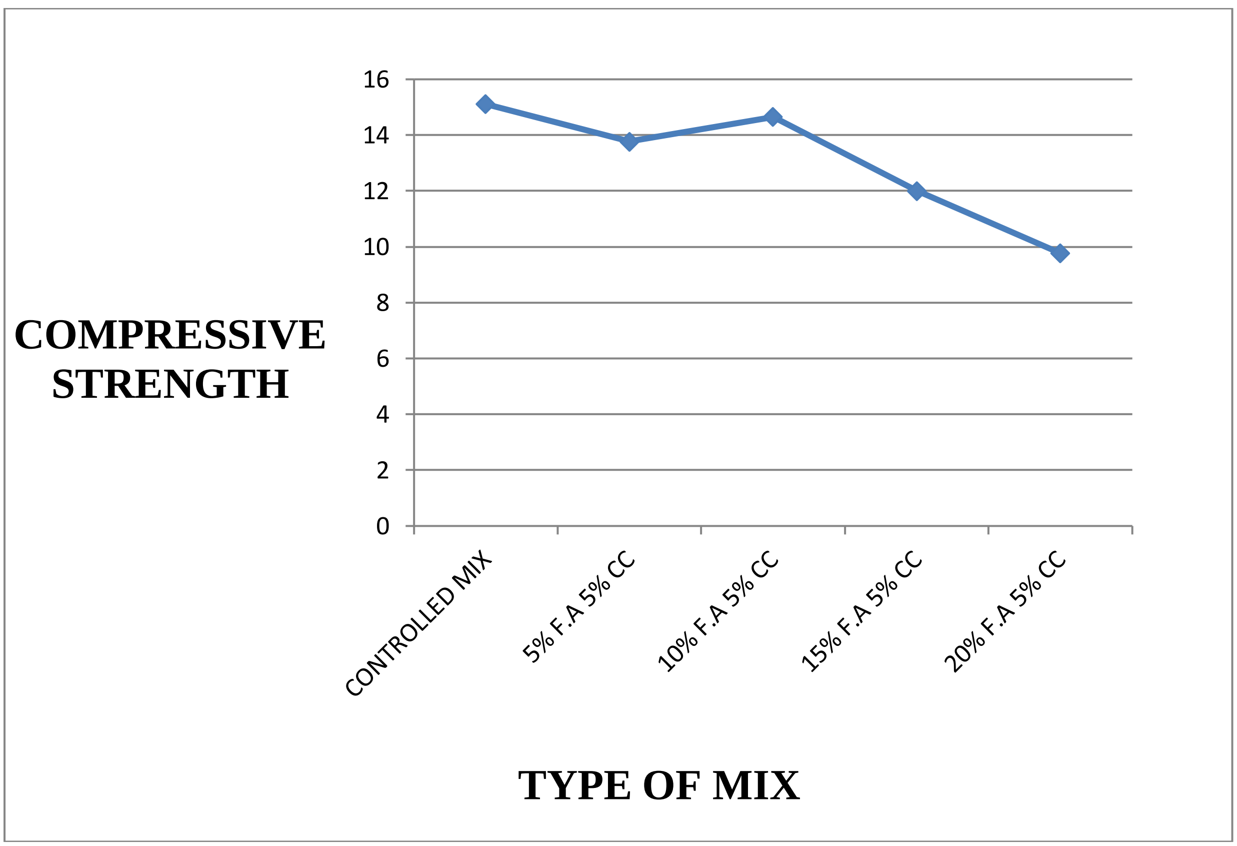

FIG 5: 7 Days compressive strength of F.A and CC concrete

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TABLE 8: 28 DAYS COMPRESSIVE STRENGTH

TYPE OF MIX	LOAD (KN)	COMPRESSIVE STRENGTH (N/mm^2)
Controlled mix	500	22.22
95% cement,5%FA	400	17.62
90% cement,10%FA	410	18.22
85% cement,15%FA	430	19.11
80% cement,20%FA	440	19.55
75% cement,25%FA	380	16.88
70% cement,30%FA	300	13.33
95% cement,5%CC	400	17.77
90% cement,10%CC	420	18.66
85% cement,15%CC	450	20
80% cement20%CC	370	16.44
75% cement,25%CC	340	15.11
70% cement,30%CC	300	13.33
90% cement, 5%FA,5%CC	410	18.22
85% cement, 10%FA,5%CC	430	19.11
80% cement, 15%FA,5%CC	380	16.88
75% cement, 20%FA,5%CC	340	15.11

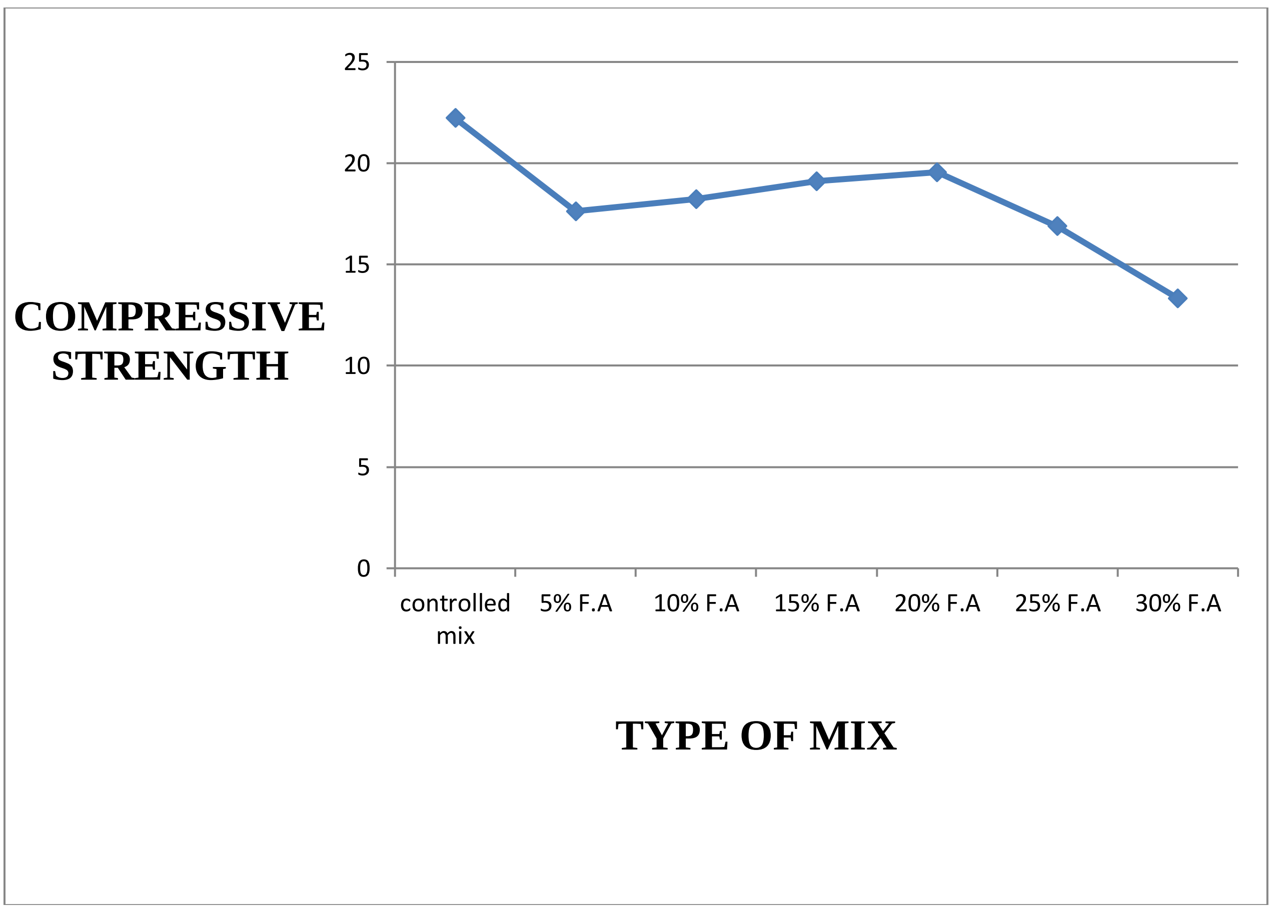

FIG 6: 28 Days compressive strength of F.A concrete

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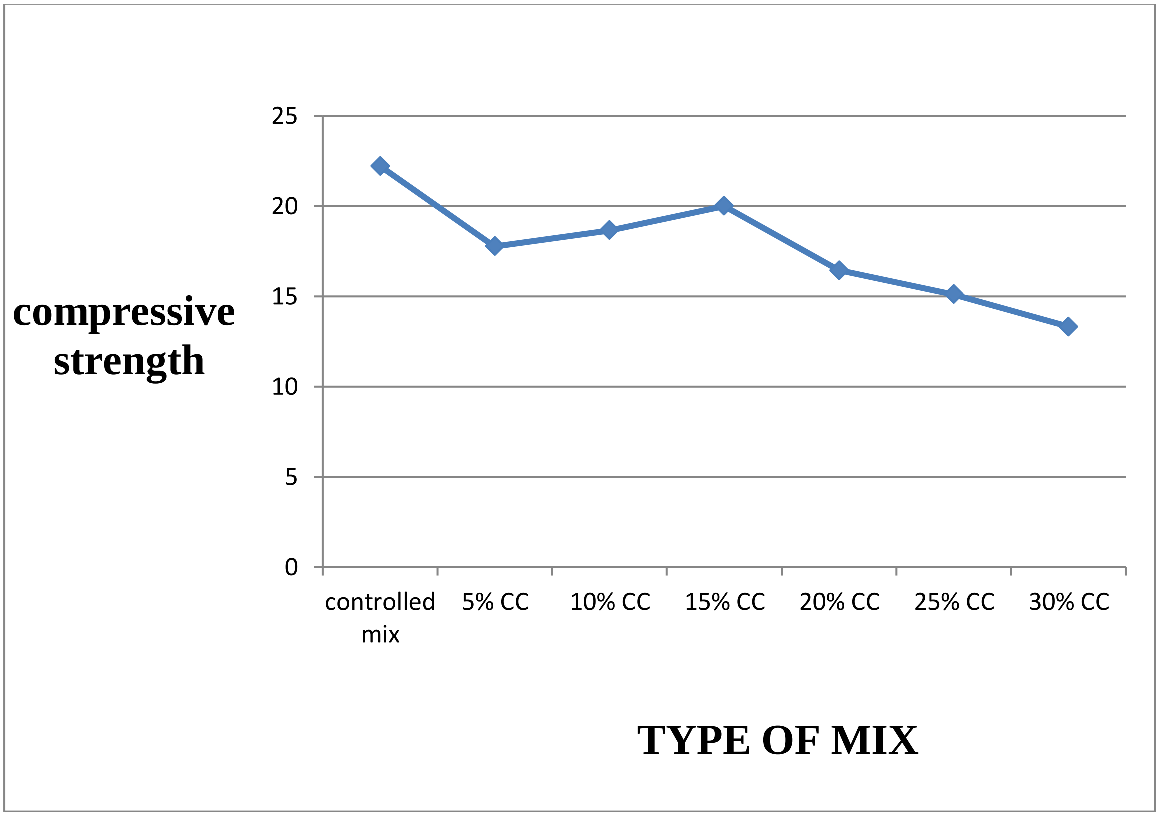

Fig 7: 28 Days compressive strength of CC concrete

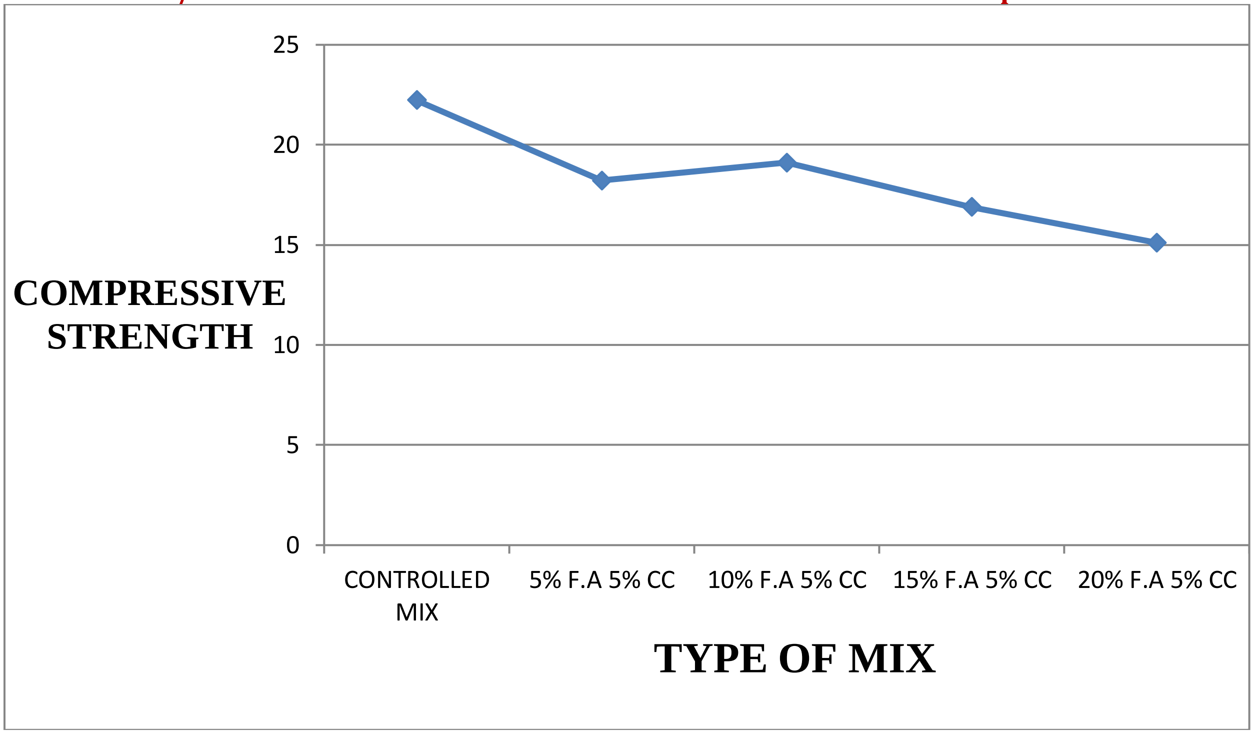

FIG 8: 28 Days compressive strength s of F.A and CC concrete

VII. CONCLUSIONS

- The water consumption can be reduced as the fly ash and calcium carbonate increases workability.
- The consumption of cement can be reduced by the use of calcium carbonate and fly ash in concrete.
- Fly ash can be used up to proportions of 20% replacement of cement.
- The calcium carbonate can be used up to proportions of 15 % replacement of cement.
- The compressive strength of concrete containing fly ash increases with time up to 20% replacement of cement.
- The compressive strength of concrete containing calcium carbonate increases up to 15% replacement of cement.
- Together fly ash and calcium carbonate can be used for replacing cement up to 10 % & 5% respectively. Up to this proportion the strength increases with time and after this begins to decrease. The compressive strength of concrete containing calcium carbonate is more than the concrete containing fly ash after 7 days.
- The compressive strength of concrete containing calcium carbonate is more than the concrete containing fly ash up to certain proportion after 28 days.
- The compressive strength of concrete containing fly ash and concrete increases with increase in proportions of fly ash and calcium carbonate up to certain proportions.
- After 28 days the compressive strength first increases and then decreases for concrete containing both fly ash and calcium carbonate.
- The workability of concrete increases when fly ash and calcium carbonate are used simultaneously.
- When fly ash and calcium carbonate are used together in concrete the workability also increases.
- Together fly ash and calcium carbonate can be used for replacing cement up to 10 % & 5% respectively up to this proportion the compressive strength keeps on increasing.

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