AN EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH FLYASH AND ALCCOFINE IN CONCRETE

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Abstract: Concrete structures have become very common in civil construction with the growing technology in concrete world and urbanisation there is lot of requirements of raw material. Due to scarcity of non-renewable resources, concrete making materials are required to be preserved, so there is utmost necessity of using supplementary waste materials in concrete. The waste materials like fly ash, silica fume, lime stone quarry fine, blast furnace slag etc can be used as replacement of cement to address the issue of environmental pollution.

In present study an attempt has been made to investigate the strength and split tensile strength of concrete by partially replacing cement by fly ash in different proportions. To supplement the loss in strength of concrete due to addition of fly ash at higher percentage levels, another cementations material alccofine as partial replacement of fly ash had seen used to prepare binary and ternary mixes respectively.

The results obtained in present study showed that there is marked improvement in compressive strength and split tensile strength of concrete with addition of fly ash and alccofine both.

Keywords: Compressive strength, Fly ash, Alccofine, Split tensile strength, Concrete.

1. INTRODUCTION

Concrete is by far the most widely used construction material today. The versatility and flexibility in concrete, its high compressive strength and the discovery of the reinforcing and pre-stressing techniques which help to make up for its load tensile strength have contributed largely to its widespread use. We can rightly say we are in age of concrete. But nowadays due to rapid growth in construction cement is very costly. Also due to large growth in industrialization there is a large amount of wastes generated, which is hazardous to environment and living beings. To overcome above problems wastes generated can be used as alternative materials. The search for alternative binders, or cement replacement materials, has been carried out for decades. Research has been conducted on the use of fly ash, volcanic ash, volcanic pumice, pulverized-fuel ash, blast slag and silica fume as cement replacement material. Fly ash and others are pozzolanic materials because of their reaction with lime liberated during the hydration of cement. The main aim of this study is to get the economical and eco-friendly High Strength Concrete (HSC) by using Fly ash and alccofine as a partial replacement for cement.

2. LITERATURE REVIEW

Arivazhagan (2011) conducted a peculiar study on the environmental benefit with fly-ash stated that there is increases in crop yields and nutrient uptake due to release of major secondary and micro nutrients from fly-ash applied in the soil during crop growth. Basically fly-ash has slightly acidic in pH and its effect is more pronounced in soils having high pH.

Jayesh kumar Pitroda (2012) It is shown in this paper that this research work describes the feasibility of using the thermal industry waste in concrete production as partial replacement of cement. The use of fly-ash in concrete formulations as a supplementary cementitious material was tested as an alternative to traditional concrete. The cement has been replaced by fly-ash accordingly in the range of 0% (without fly ash), 10%, 20%, 30% & 40% by weight of cement for M-25 and M-40 mix. Concrete mixtures were produced, tested and compared in terms of compressive and split strength with the conventional concrete. These tests were carried out to evaluate the mechanical properties for the test results for compressive strength up to 28 days and split strength for 56 days are taken.

Swaroop (2013) In his presentation the study is mainly confined to evaluation of changesin both compressive strength and weight reduced in five different mixes of M30 Grade namely conventional aggregate concrete (CAC), concrete made by replacing 20% of Cement by fly-ash (FAC1), concrete made by replacing 40% of cement by fly ash(FAC2), concrete made by replacing 20% replacement of cement by GGBS (GAC1) and concrete made by replacing 40% replacement of cement by (GAC2). The effect of 1% H2SO4 and sea water of those concrete mixes are determined by immersing these cubes for 7 days, 28 days, 60 days in above solutions and the respective changes in both compressive strength and weight reduction had observed and upto a major extent we can conclude concretes made by that fly-ash and GGBS had good strength and durable properties comparison to conventional aggregate in severe environment.

Harison et al (2014) conducted a peculiar study on the utilization of materials which can fulfill the expectations of the construction industry in different areas. In this study cement has been replaced by fly-ash accordingly in the range of 0%,10%,20%,30%,40%,50%,60%by weight of cement for M-25 mix with 0.46 water cement ratio. Concrete mixtures were produced, tested and compared in terms of compressive strength. It was observed that 20% of replacement of Portland pozzolana cement (PPC) by fly-ash strength is increased marginally (1.9% to 3.2%) at 28 days and 56 days respectively. It was observed that up to 30% replacement of PPC by fly-ash strength is almost equal to the referral concrete after 56 days. PPC gained strength after 56days curing because of slow hydration process.

Kraiwood Kiattikomal , et al reported that for class-f flyash it was the fineness , not to the chemical composition that has significant effect on compressive strength of mortars .The mortars with finer fly ash gained higher compressive strength than those with the coarser ones.

P. Kumar mehta referred to the work of Malhotra.v.m and his colleagues according to which fly ash used in large volume imparts excellent workability to concrete at a water content 10 to 20 percentage lower than that for concrete without the flyash and further reductions in water content can be achieved with better aggregate grading and with the help of super plasticizing admixtures.

Siddharth P Upadhyay, Prof. M.A.Jamnu Studied **"**Effect of compressive strength of high performance concrete incorporating alccofine and fly ash". In this Paper the Compressive strength of high performance concrete with there placement of cement with Alccofine and Fly ash, and also with natural sand to manufactured sand. The concrete specimens were cured on normal moist curing under normal atmospheric temperature. The compressive strength was determined at 3, 7 and 28 days. The addition of Alccofine shows an early strength gaining property and that of Fly ash shows long term strength. The ternary system that is Ordinary Portland cement fly ash Alccofine concrete was found to increase the compressive strength of concrete on all age when compared to concrete made with fly ash and Alccofine alone. An experimental program has been designed to provide results of Alccofine and fly ash with manufactured sand based high performance concrete. To check the performance of Alccofine and fly ash with manufactured sand based concrete have been studied in this investigation.

Saurabh Gupta, Dr. Sanjay Sharma, Er. Devinder Sharma Studied "Astudy on alccofine a supplementary cementitious material" This can be used as a SCM due to its ultrafine size and high content of calcium oxide (Cao), Alccofine1203 is essential in terms of reducing heat of hydration and strength at all stages whereas Alccofine 1101 can be used as a grouting purpose. For determining the effect of ALCCOFINE 1203 on the workability, water requirement and HRWR dosages, three trials of concrete mixes were prepared, based on the following mix design methodology- Results are taken from study carried by Counto Micro Fine Products PVT. LTD.

The author concludes that-The Alccofine being use as mineral admixture in a concrete mix increase the initial strength of the concrete than the ordinary concrete. The concrete possesses high workability and retain the workability for sufficient time. Alccofine is easy to use and can be added directly with cement, ultrafine particle of Alccofine provide better and smooth surface finish. For high strength concrete the cost of the concrete mix prepared with Alccofine is lesser than the concrete without Alccofine. It also lowers the water/binder ratio.

3. MATERIAL DESCRIPTION

This section deals with the mix design procedure adopted for Control concrete and the studies carried out on properties of various materials used throughout the experimental work. Also the details of method of Casting and Testing of specimens are explained.

A. Cement:

The cement powder, when mixed with water, forms a paste. This paste acts like glue and holds or bonds the aggregates together. There are many types of cements. Each type of cement will produce concrete with different properties. The most common types of cement are OPC &(Blended cements) BC.

Figure.1 Cement

B. Ordinary Portland cement chemistry:

The cement used for normal concrete construction. It has adhesive and cohesive properties so as to render it to form a good bond with other materials. It solidifies when mixed with water. It is the most active binding medium and is perhaps the most scientifically controlled component in concrete, cement is obtained by burning a mixture of the siliceous, argillaceous and calcareous materials in a definite proportion.

The temperature to which the mixture must be burnt is about 1400°C. The clinker so obtained is cooled and powdered to the required fineness. The product so obtained is "cement". It consists of different properties are obtained by mixing the above components in different proportions along with small percentages of other chemicals. Portland cement is the most important type of cement is widely used.

The OPC was classified into three grades, namely 33grade, 43 grade and 53 grade depending upon the strength of the cement at 28 days when tested as per IS 4031-1988. If the 28 days strength is not less than 33N/mm^{2,} it is called 33 grade cement, if the strength is not less than 43N/mm^2, it is called 43 grade cement, and if the strength is not less than 53N/mm^2, it is called 53 grade cement. But the actual strength obtained by these cements at the factory are much higher than BIS specifications.

Table: 1 Components of Portland cement

Oxide	**Percent, content**
Lime (CaO)	60 to 67
Silica (SiO2)	17 to 25
Alumina (Al2O3)	3 to 8
Iron oxide (Fe2O3)	0.5 to 6
Magnesia (MgO)	0.1 to 4
Alkalies (K2O,Na2O)	0.4 to 1.3
Sulphur (SO3)	1.2 to 3

Cement is a complicated mixture of chemical compound, ordinary Portland cement contains the following compounds

Tri calcium silicate (CaO)3SiO2denoted by C3S.

Di calcium silicate (CaO)2SiO2 denoted by C2S.

Tri calcium aluminate (CaO)3Al2O3 denoted by C3A.

Tetra calcium alumino ferrite (CaO)4Al2O3 denoted by C4AF.

About 70% to 80% of cement is contributed by C3S and C2S which are responsible for the strength of cement. These compounds provide to cement the property to resist the attacks of acids and alkalies and make the cement durable.

C2S has the property of hydrating rapidly and is responsible to provide not only early strength but also ultimate strength.

C2S has the property of hydrating less rapidly and provides the strength after duration of 7 days.

C3A gets hydrated rapidly and is found responsible to provide early strength but is found to slightly retard the ultimate strength. This compound is susceptible to be attacked by alkalies and salts.

C4AF appears to be redundant compound not known to provide any strength and is at times considered an undesirable compound which gets in to cement.

Aggregates:

Aggregates are the important constituents in concrete. They give body to concrete, reduce shrinkage and effect economy. Earlier, aggregates

C. Classification:

Aggregates can be classified based on their sizes as:

Coarse aggregate (C.A)

Fine aggregate (F.A)

The size of the fine aggregates shall not exceed 4.75mm IS Sieve. Aggregates of size more than 4.75mm are called as coarse aggregates. Generally, aggregates used in concrete may be of sand, gravel, crushed stone, broken brick, furnace slag etc., for reinforced concrete only sand, gravel and crushed rock should be used as aggregates. Aggregates pieces should be preferably approaching cubical or spherical shapes instead of being elongated thin and low coefficient of expansion. Lime stone aggregates should not be used for fire resisting concrete. Over burnt broken brick, blast furnace slags are the proper materials to be used for this work. Sand or gravel obtained from the bends of deep rivers with slow motion is likely to consist of clay and silt coating. Hence, these should not be used without properly washing them, for reinforced work.

1. Coarse aggregates:

Fine and coarse aggregates make up the bulk of a concrete mixture. The presence of aggregate greatly increases the robustness of concrete above that of cement, which otherwise is a brittle material and thus concrete is a true composite material. Locally available crushed coarse aggregate was used. Sieve analysis of the coarse aggregate was carried out in the laboratory.

Figure 2: Coarse aggregates

The deleterious substances that should be limited in aggregate are clay lumps, wood, coal, chert, silt, rock dust (material finer than 75 microns), and organic material, unsound and friable particles.

Table: 2 Grading limits for coarse Aggregates IS: 383

IS Sieve	**% PASSING FOR GRADED AGGREGATES**		
Designation	**40mm**	**20mm**	**10mm**
40mm	95-100	100	100
20mm	30-70	95-100	100
10mm	10-35	25-55	40-85
4.75mm	0-5	0-10	0-10

Bulking of sand:

The free moisture content in fine aggregate results in bulking of volume. Free moisture forms a around each particle this film of moisture exerts what is known as surface tension which keeps the neighbouring particles away from it. Similarly, the force exerted by surface tension keeps every particles away from each other. Therefore, no point of contact is possible between the particles.

This causes bulking of the volume. The bulking increases with increase in moisture content up to a certain limit beyond that the further increases in the moisture content representing saturation point, the fine aggregate shows no bulking.

The extent of bulking can be estimated by conducting a simple field test. A sample of moist fine aggregate is filled into a measuring cylinder. Note down the level, say h1. Pour water into the measuring cylinder and completely inundate the sand and shake it. Since, the volume of saturated sand is same as that of dry sand; the inundated sand completely offsets the bulking effect. Note down the level of sand as h2. Then h1-h2 shows bulking of sand.

Tests on Coarse Aggregate:

The following tests are conducted on coarse aggregate:-

Fineness modulus test

Specific gravity of coarse aggregate

A) Fineness modulus test:

Aggregates most of which retained on IS: 4.75mm sieve are known as coarse aggregate. Sieve analysis is carried out for the determination of coarse aggregate by sieving. In sieve analysis of fine aggregate sieves of size 80mm, 40mm, 20mm, 12.5mm, 10mm, 4.75mm confirming to IS :460-1962 shall be used.

The sample shall be brought to an air dry condition before weighing and sieving. The air dry sample shall be weighed successively on the appropriate sieves starting with the largest size. Each sieve shall be shaken separately over a clean tray for a period of not less than 2 minutes.

The shaking is done with a varied motion backwards and forwards, left and right, circular clock wise and with frequent jarring so that the material is kept moving over the surface of sieve in frequently changing directions.

Find the percentage weights retained on each sieve. Fineness modulus = (∑F+500)/100= (105.7 + 500)/16.

Alccofine:

Alccofine is a new generation micro fine concrete material of practical size much finer than other hydraulic materials like cement, fly ash, silica etc. being manufactured in India. It is used for high Strength Concrete which is important in respect of workability as well as strength. It is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. It is grey in colour. The computed blain value based on particle size distribution (PSD) is around 12000cm2/gm and thus is ultra-fine material. The alccofine used in present study was procured from Ambuja Cement Ltd. and the properties provided by the manufacturer are listed in table 2

There are two types of Alccofine: -

1 Alccofine 1203: - It is an alccofine with low calcium silicate. Alccofine 1200 series is of 1201, 1202, 1203 which represents fine, micro fine, ultrafine particle size respectively. Alccofine 1203 is a slag based SCM having ultra-fineness with optimized particle size distribution. Alccofine 1203 provides reduced water demand for a given workability, even up to 70% replacement level as per requirement of concrete performance.

2 Alccofine1101:- It is an Alccofine with high calcium silicate. It is a micro finer cementitiousgrouting material for soil stabilization and rock anchoring. The performance of Alccofine is superior to all other admixtures used in India. Due to high calcium oxide (Cao) content.

Table 3: Chemical and physical analysis of alccofine

Chemical analysis	Mass%	Physical analysis	range
CaO	30-34	Bulk density	600-700 Kg/m^2
Al2O3	18-25	Surface area	12000 Cm^2/gm
Fe2O3	0.8-3.0	Particle shape	irregular
SO3	0.1-0.4	Particle size(D10)	<2mm
MgO	6-10	D50	<5mm
SiO2	30-36	D90	<9mm

Water:

Water is an important ingredient of concrete, and a properly designed concrete mixture, typically with 15 to 25% water by volume, will possess the desired workability for fresh concrete and the required durability and strength for hardened concrete. The roles of water have been discussed earlier and are known as hydration and workability. The total amount of water in concrete and the water-to-cement ratio may be the most critical factors in the production of good-quality concrete. Too much water reduces concrete strength, while too little makes the concrete Unworkable. Because concrete must be both strong and workable, a careful selection of the cement-to-water ratio and total amount of water are required when making concrete (Popovics, 1992).

Mixing water:

Water can exist in a solid form as ice, a liquid form as water, or a gaseous form as vapour.

Mixing water is the free water encountered in freshly mixed concrete. It has three main functions:

It reacts with the cement powder, thus producing hydration products;

It acts as a lubricant, contributing to the workability of the fresh mixture; and (3) It secures the necessary space in the paste for the development of hydration products. The amount of water added for adequate workability is always greater than that needed for complete hydration of the cement in practice. Unlike other raw materials, the raw water supply varies significantly in quality, both from one geographical region to another and from season to season. Water derived from an upland surface source, for instance, usually has a low content of dissolved solids and is relatively soft, but has a high concentration of organic contamination, much of it colloidal. By contrast, water from an underground source generally has a high content of dissolved solids and a high hardness level but a low organic content.

Excessive impurities in mixing water not only may affect setting time and concrete strength, but also may cause efflorescence, staining, corrosion of reinforcement, volume instability, and reduced durability.

There is a simple rule concerning the acceptability of mixing water: if water is potable, that is, fit for human consumption, with the exception of certain mineral waters and water containing sugar, it is also suitable for concrete making.

4. DETAILS OF CONCRETE MIX

Design of concrete mixes involves determination of the proportions of the given constituents namely, cement, water, coarse aggregate and fine aggregate. Workability is specified as the important property of concrete in the fresh state. For hardened state compressive strength and durability will be considered. In this chapter the details of concrete mixes are discussed. In the present work M30 grade of concrete were carried out.

Methods of concrete mix design:

The mix design methods being followed in different countries are mostly based on empirical relationships, charts and graphs developed from extensive experimental investigations methods are in practice.

Following methods are in practice:

ACI Mix design method

USBR Mix design method

British Mix design method

Mix design method according to Indian standard

Since ACI Mix design method is an originator for all other methods, including Indian standard method, wherein every table and charts are fully borrowed from ACI, we follow the Mix design method in practice according to Indian standard code.

Concrete mix design:

The important criteria kept in view while designing the concrete mix are strength, durability and workability of concrete. The mix proportions were carried theoretically based on IS recommendations.

Materials used:

53-grade OPC is used throughout the investigation. Locally available sand is used as fine aggregates and crushed granite stone with maximum 20mm is used as coarse aggregates are used for mixing the concrete and curing the specimens.

Requirements of Mix Design:

The requirements which form the basis of selection and proportioning of mix ingredients are:

The minimum compressive strength required from structural consideration
The adequate workability necessary for full compaction with the compacting equipment available.

Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular site conditions.

Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

Factors to be considered in Mix Design (As per SP23-1982):

The design of concrete mix will be based on the following factors.

Grade of concrete: This gives the characteristic strength requirements of concrete. Depending upon the level of quality control available at the site, the concrete mix has to be designed for a target mean strength which is higher than the characteristic strength.

Type of cement: The type of cement is important mainly through its influence on the rate of development of compressive strength of concrete as well as durability under aggressive environments ordinary Portland cement (OPC) and Portland Pozzolona cement (PPC) are Permitted to use in reinforced concrete construction.

Note: In the designation of a concrete mix M refers to the mix and the number to the specified characteristic compressive strength of 15 cm cube at 28 days curing expressed in N/mm^2. MI5 and less grades of concrete may be used for lean concrete bases and simple foundation for masonry walls. Grades of concrete lower than M20 shall not be used in reinforced concrete structure as per IS 456-2000.

*Maximum nominal size of aggregate***:** It is found that larger the size of aggregate, smaller is the cement requirement for a particular water cement ratio. Aggregates having a maximum nominal size of 20mm or smaller are generally considered satisfactory.
*Minimum water cement ratio***:** The minimum w/c ratio for a specified strength depends on the type of cement.

Mix Proportion Designations**:**
The common method of expressing the proportions of ingredients of a concrete is in the terms of parts or ratios of cement, fine and coarse aggregates. For e.g., a concrete mix of proportions 1:2:4 means that the mix contains one part of cement, two parts of fine aggregate and four parts of coarse aggregate. The proportions are either by volume or by mass. The water-cement ratio is usually expressed in mass.

5. EXPERMENTAL WORK

The cement and sand were first added and mixed thoroughly in the dry state until homogeneity was achieved. The dry coarse aggregate were added to the mixture and again mixed thoroughly. Water was slowly added and mixed thoroughly for 3 min. After mixing all the ingredients, concrete specimens were cast using steel moulds and compacted with a table vibrator in three layers. For each mix, six 150*150*150 mm cubes and cylinders of 150mm diameter and 300mm length were produced for measurement of the compressive strength and split tensile strength respectively.

Figure 3: Casting of Specimens

A. Fly ash concrete mix:
The design mix for M30 grade of concrete was prepared by partially replacing cement with five different percentages by weight of fly ash (0%, 5%,10%,15%, & 20%). The mix proportion for fly ash concrete mix is as follows.

Table 4: weight of materials for M30 Grades of concrete with varying percentages fly ash

Mix	Materials by weight		
	% of fly ash	Cement (kg/m^3)	Fly ash(kg/m^3)
	0	438	0
	5	416.1	21.9
M30	10	394.2	43.8
	15	372.3	65.7
	20	350.4	87.6

B. Casting of specimen with fly ash andalccofine :
The design mix for M30 grade of concrete was prepared by partially replacing cement with 15% fly ash and four different percentages by weight of alccofine (8%, 10%, 12%, and 14%). The mix proportion for M30 Grade of concrete with varying percentages of fly ash and alccofine is as follows

Table 5 : weight of materials M30 grade of concrete with varying percentage of fly ash and alccofine

MIX	Material by weight				
	% of fly ash	%of alccofine	Cement (kg)	Fly ash(kg)	Alccofine(kg)
		8	332.26		35.04
M30	15	10	328.5	65.7	43.8
		12	319.74		52.56
		14	310.98		61.3

C. Curing of Concrete:

Concrete derives its strength by the hydration of the cement particles. The hydration of cement is not a momentary action but a process continuing for long time. Of course, the rate of hydration is fast to start with, but continues over a long time at a decreasing rate. The quantity of the product of hydration and consequently the amount of gel formed depends upon the extent of hydration.

Figure 4: Specimen during curing

Curing can also be described as keeping the concrete moist and warm enough so that the hydration of cement can continue. Concrete, while hydrating releases high heat of hydration. This heat is harmful from the point of view of volume stability. If the heat generated is removed by some means the adverse effect due to the generation of heat can be reduced. This can be done by thorough water curing.

6. RESULTS AND DISCUSSION

This section deals with the observation of the results from the various tests conducted on concrete for use as reducing the quantities concrete. The results are compared with the control of different

Concrete mixes for the various percentage replacement levels of cement with Fly ash and alccofine. The strength characteristics of concrete containing Fly ash and alccofine are discussed in this chapter. Tests were performed on hard concrete cured under Standard laboratory conditions, and compressive and spilt tensile strengths were observed at Curing ages of 7, 28, days.

A. Compressive Strength of Concrete:

The main function of the concrete in structure is mainly to resist the compressive forces. When a plain concrete member is subjected to compression, the failure of the member takes Place, in its vertical plane along the diagonal. The vertical cracks occur due to lateral tensile Strain. A flow in the concrete, which is in the form of micro crack along the vertical axis of the member will take place on the application of axial compression load and propagate Further due to the lateral tensile strain.

B. Test procedure and results for compressive strengths:

Test specimens of size 150×150×150 mm were prepared for testing the compressive Strength of both controlled as well as fly ash and alccofine based concrete. The Modified mixture with varying percentage of fly ash and alccofine as a partial replacement of cement were prepared and cast into cubes. Compressive strength test results at curing ages of 7 and 28 days for control mix as well as for the modified mixes are shown in the Table **6**. For testing in compression, no cushioning material was placed between the specimen and the plates of the machine.

The load was applied axially without shock till the specimen was crushed. Fig 5 shows the test setup for the compressive strength. Three specimens for each mix were tested and the corresponding values were observed and average values were taken for discussion. Table 6 Shows the variation of compressive strength with varying percentage replacement of cement with fly ash and alccofine. Variations with both materials being used as replacements of cement by fly ash and alccofine in the concrete.

Figure 5: Test setup for the compressive strength

Table 6: Test For the setup Compressive Strength

Mix design	Concrete mix with % of fly Ash	7days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
Conventional mix	**0**	25.36	32.09	38.23
M30	**5**	20.36	22.03	22.9
	10	22.67	23.6	24.9
	15	25	26.7	29
	20	24.4	25.06	26.04
	25	21.11	21.9	23.4

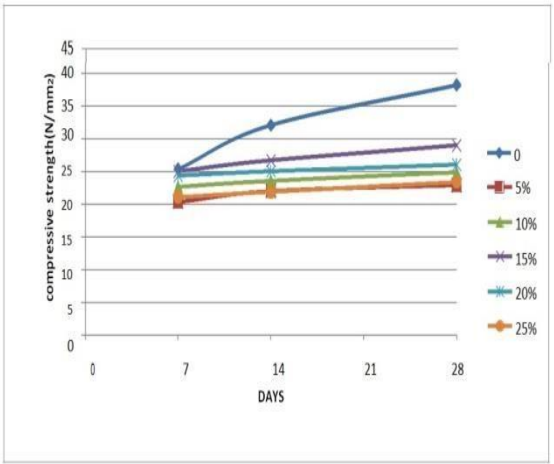

Figure 6 : Compressive strength graph of fly ash

Figure 7 : Compressive strength graph of fly ash and alccofine

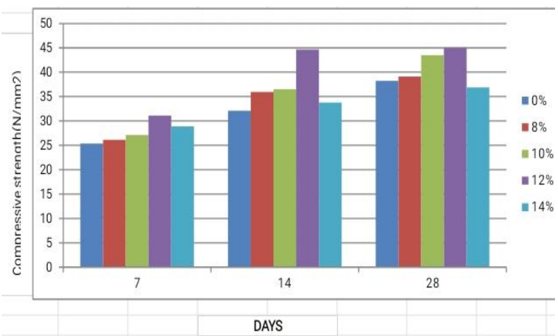

Table 7: Compressive Strength Test Result: By using fly ash and alccofine

Mix design	Concrete mix		7days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
	% Fly ash	% Alccofine			
Convention mix	0	0	25.36	32.09	38.23
M30	15	8	26.13	35.95	39.11
		10	27.11	36.5	43.5
		12	31.11	44.66	45
		14	28.88	33.77	36.88

C. Compressive strength graph:

Compressive strength test graphs of fly ash and alccofine:

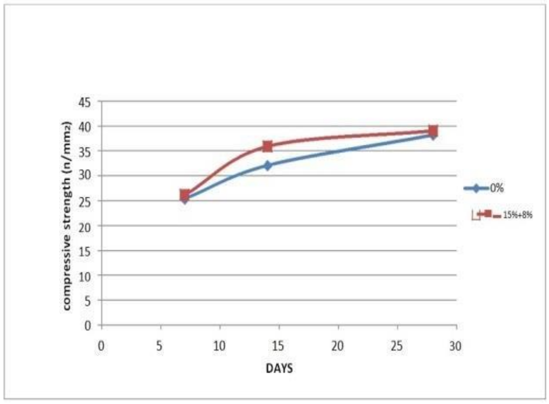

Figure 8 : Comparison between conventional and 15% fly ash and 8% alccofine

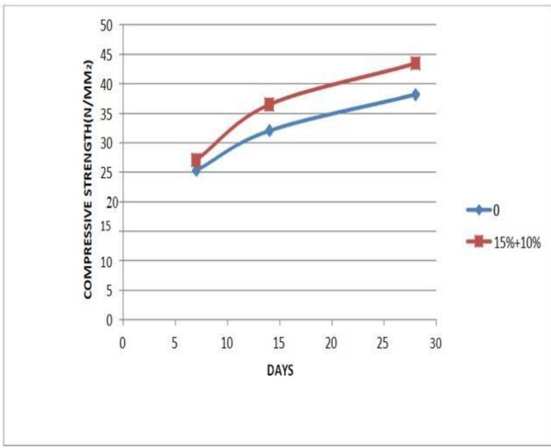

Figure 9: Comparision between conventional and 15%fly ash and 10% alccofine

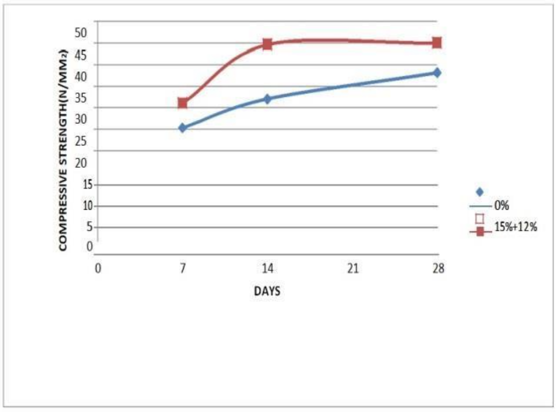

Figure 10 : Comparision between conventional and 15% fly ash and 12% alccofine

D. Split Tensile Test

The concrete mix is prepared for M30 grade and cement is replaced by fly ash and alccofine as certain percentage. The Split Tensile Test is done graphs which shows the 7 days,14 days and 28days strength of the concrete mix, graph also says, there is increase in strength as compared to conventional concrete.

Figure 11: Test setup for Split Tensile Test

Mix design	Concrete mix		7days (N/mm2)	14days (N/mm2)	28days (N/mm2)
	% Flyash	% Alccofine			
Conventionl mix	0	0	20.28	25.67	30.58
M30	15	8	20.9	28.76	31.28
		10	21.68	29.2	34.8
		12	24.88	35.72	36
		14	23.1	27.01	29.5

Table -18 Split tensile test results

Split tensile test graphs of fly ash and alccofine

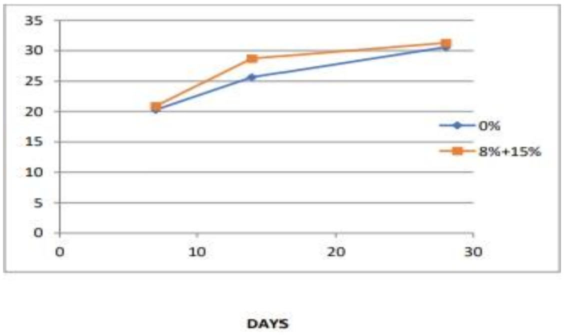

Figure 13 : Comparison between conventional and 15% flyash and 8%alccofine

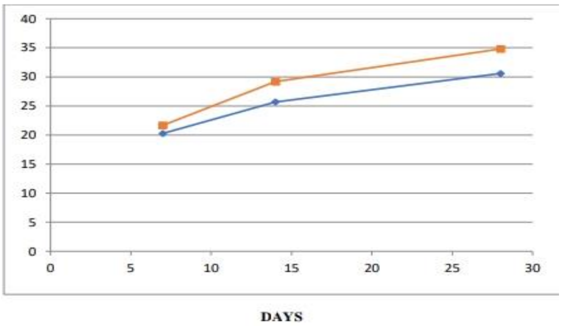

Figure 14: Comparision between conventional and 15%fly ash and 10%alccofine

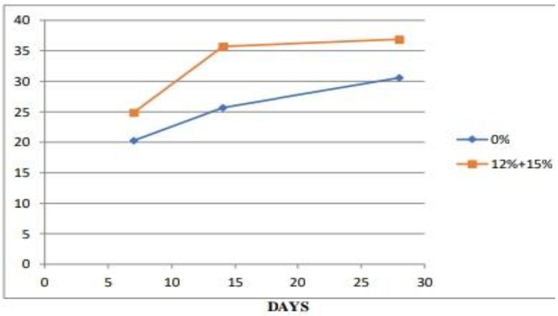

Figure 15 :Comparision between conventional 15%fly ash and 12%alccofine

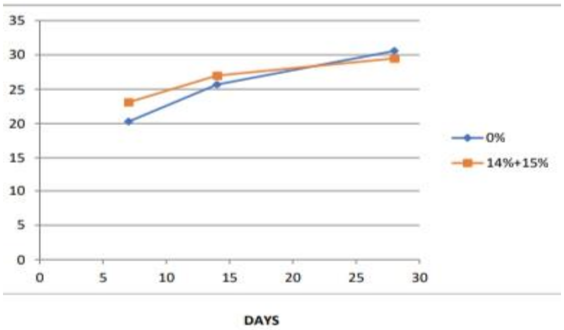

Figure 16 : Comparison between conventional and 15% fly ash and 14%alccofine

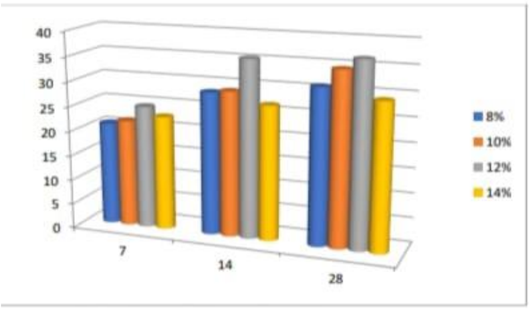

Figure 17: Split Tensile Test graph

CONCLUSION:

The following conclusion was drawn from the above AN EXPERIMENTAL study:

The following conclusions can be made from the results of compressive strengths and from the analysis of the graph

1. The optimum percentage of compressive strength of concrete for 28days with 15%cement replaced with fly ash is found maximum strength of **29 N/mm^2**
2. The maximum compressive strength of M30 grade concrete for 7 days is **31.11 Mpa** by partial replacement of cement by 12% alccofine and 15% flyash.
3. The maximum compressive strength of M30 grade concrete for 14 days is **44.66 Mpa** by partial replacement of cement by 12% alccofine and 15% flyash.
4. The maximum compressive strength of M30 grade concrete for 28 days is **45 Mpa** by partial replacement of cement by 12% alccofine and 15% flyash.
5. The maximum split tensile strength of M30 grade concrete for 7 days **24.88 Mpa** by partial replacement of cement by Alccofine 12% and flyash 15%.
6. The maximum split tensile strength of M30 grade concrete for 14 days **35.72 Mpa** by partial replacement of cement by Alccofine 12% and flyash 15%.
7. The maximum split tensile strength of M30 grade concrete for 28 days **36 Mpa** by partial replacement of cement by Alccofine 12% and flyash 15%.

REFERENCES

1. Indian standard code recommended by the method of concrete mix design (IS:10262-2009)

2. Abhishek sachdeva ,V.Rajeshkumar - Replacement of Portland cement with alccofine.Vol-6 , Issue- iii , march 2018.

3. Jigar saiya , Ankit Tiwari , Seema Jagtap - AN EXPERIMENTAL investigation on effect of alccofine with flyash and GGBS on high performance concrete. Vol-5, Issue- iii, march 2018.

4. Mehrajud din sofi ,Tapeshwar , Nadeem GulsarShahmir – AN EXPERIMENTAL investigation of blended cement with significant use of flyash and alccofine. Vol-5, Issue-iii, march 2018.

5. Surendra kumar, Mr.Rohitkumar – Behaviour of high performance concrete using alccofine and flyash. Vol-5, Issue-x, june 2018.

6. Mahim Mathur, Asish Mathur – Performance of concrete by partial replacement of alccofine 1203. Issue-2018.

7.M.S.KrishnaHygrive, I.Siva Kishore, KJB Chari – comparative study on compressive strength of concrete using flyash. Vol-8, Issue –iv, april 2017, pp.1737,1745.

8.ManojKumar.J, Divya.P, - AN EXPERIMENTAL study on partial replacement of cement using alccofine. Vol-116, 2017.

9.P.R.Kalyan Chakravarthy and R.Rathan Raj – Analysis on compressive strength of concrete with partial replacement of cement with alccofine. Vol-12, Issue-viii, april-2017.

10. India Lidoo, Sanjeev naval – Design of high performance of concrete M100 using mineral admixture. April-2017.

11. JagadeshVirupakshi Patil – Partial replacement of cement by flyash in concrete mix design. Vol-4, Issue-ii, nov-2017.

12. M. Vijaya Sekhar reddy, K.Ashalatha – Studies on eco-friendly concrete by partial replacement of cement with alccofine and fine flyash. Vol;-2, Issue-v, march 2016.

13. Vinod Goud, Niraj Soni – Partial replacement of cement with flyash in concrete and its effects. Vol-6, Issue-x, oct 2016.

14.U.S.Ansari – Concrete with alccofine and flyash an economical and enviroanment friendly approach. March 2015.

15.Ghuge N.P, Chaudhri, Phatangre.R.R – High performance concrete with partial replacement of cement by alccofine and flyash. Vol-5, Issue-ii, april-june 2015.