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EFFECT OF MINERAL ADMIXTURES IN CONCRETE

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ABSTRACT: The main focus of the present study is to analyse the effect of partial replacement of cement with minerals on the properties of concrete. In view of global warming, Cement industry is a major contributor in the emission of CO2 and the use of high level of energy resources in the production of cement leads to depletion of natural resources. In this present study, an attempt has been made to utilise the use of industrial and agricultural byproduct waste as a mineral admixture in concrete for partial replacement of cement that shall reduce waste landfill sites and pollution as well as minimize the consumption of natural resources. Among these industrial by-product are Fly Ash (FA), Silica Fume (SF), Rice Husk Ash (RHA) and Granulated blast furnace slag (BFS) for making the concrete there by reducing the CO2 emission.

These mineral admixtures, commonly used in structural concrete, were studied here to assess their effect on the fresh and hardened properties of concrete. The materials were catageroised for their chemical composition, crystalline, density, fineness, specific surface area, and particle size distribution were investigated.

The experimental results obtained were interpreted for a comparative analysis. The results obtained have been compared with those of control concrete made with Ordinary portland cement (OPC). Mineral admixtures are used today in almost all concrete mixtures to improve concrete fresh and hardened properties. In this study, four mineral admixtures were investigated: namely, silica fume (SF), Fly ash (FA), Blast-furnace slag (BFS) and Rice Husk Ash (RHA).The objective of this study is to assess the effects of commonly used mineral admixtures on the concrete properties.

I. INTRODUCTION

1.1 GENERAL

It is an undeniable fact that concrete is the most widely used man made construction material in the world today, and will remain so for the next few decades. Concrete is primarily comprised of portland cement, aggregates and water.The popularity of concrete is due to the abundance of raw material, excellence in strength and durability, low manufacturing and maintenance costs, versatility in forming various shapes and its unlimited structural applications in combination with steel reinforcement. A material other than water, aggregates, and hydraulic cements used as an ingredient of concrete or mortar and added to the batch immediately before or during mixing is called as Admixture. These admixtures used are of two types ; Chemical Admixtures and Mineral Admixtures which are added in concrete to improve the quality of concrete. Currently, a large number of mineral admixtures which are waste products of other industries are being used in making quality concrete.

This led to the thought of reduction of cement consumption and to intensification of research in exploring the possibility of enhancing strength and durability through the use of mineral admixtures.Moreover, effect of mineral admixtures on the durability and on the mechanical properties of concrete remained a focus of interest.

The amount of Portland cement replaced with the pozzolanic materials depends not only on the physical and chemical properties of the pozzolanic materials, but also on the characteristics of the Portland cement and pozzolan. It is also necessary to ensure compatibility of the mineral admixtures with cement.

1.2 MINERAL ADMIXTURES

A mineral admixture is a pozzolan which is defined as a “siliceous or aluminous material that in itself possesses little or no cementitious value but will, in finely divided form and in the presence of water, chemically react to form compounds possessing cementitious properties. In addition to cost-reduction benefits, addition of mineral admixtures can decrease concrete permeability, increase ultimate strength, and provide improved resistance to aggressive environments upto certain limit.

1.3 DIFFERENT MINERAL ADMIXTURES

Mineral admixtures include fly ash (FA), silica fume (SF), rice husk ash (RHA), Granulated blast furnace slag (BFS) which possess certain charecteristics through which they influence the properties of concrete differently.

Mineral admixtures are rich in silica and alumina. Fly ash (FA), Silica fume (SF), Blast furnace slag (BFS) are the by-products of industrial waste,while Rice husk ash (RHA) is the by-product of agricultural waste.

On the basis of reactivity, these mineral admixtures are classified into low reactive mineral admixtures Like FA, BFS and highly reactive mineral admixtures like SF, RHA, etc.

1.4FLY ASH (FA)

Fly Ash is produced in a finely divided residual pozzolanic material obtained from the combustion of powdered coal in electric generating plant when coal is burnt during power generation about 1600oC (2912oF). It mostly consists of solid spherical glass particles. In India nearly 70 million tons of fly ash is being produced every year while a very small quantity is used in manufacturing of cement. It is an eco-friendly product. In practical its dosage is limited to 35% by weight of the total cement material.

1.5SILICA FUME
Silica Fume is a by-product obtained after reducing high-purity quartz with coal in electric arc furnace by heating up to 2000oC (3632oF) during the production of silicon. By oxidation and condensation very fine spherical particles of Silica Fume are obtained which are highly reactive. Silica fume is another artificial pozzolanic mineral admixture. It consists of small spherical particles of amorphous silica which improves workability and makes the mix more mobile, yet cohesive also reduces freeze and thaw effect.

1.6GRANULATED BLAST FURNACE SLAG
Granulated blast furnace slag (GBS) or Blast furnace slag (BFS) contains silicates and alumino-silicates of calcium and is a by-product of iron manufactured in a blast furnace. There are two techniques, granulation and pelletization, through which GBS and BFS are produced. In granulation technique, molten slag is forced over a weir into high pressure water jets which rapidly cools the slag as granules diameter in size to form GBS; however, in pelletization technique, molten slag is poured into cold water rotating drum. The fins inside the rotating drum throw molten slag in the air towards the walls of the drum where water is sprayed to cool it rapidly which when blended with ordinary portland cement gives extraordinary properties to concrete as well as mortar.

1.7 RICE HUSK ASH
Rice husk is produced in millions of tons per year as a waste material in agricultural and industrial processes.RHA is produced by slow burning of rice husk in a controlled manner at a temperature between 500oC and 700oC (932oF to 1292oF). India produces about 122 million tons of paddy every year. About burning 20- 25% of the total husk becomes as "RICE HUSK ASH". Each ton of paddy produces about 40 Kg of rice husk ash. When properly burnt, it has high silica content and can be used as an admixture in mortar and concrete.

1.8OBJECTIVES
The main objectives of this research work are following:
To know the different mechanical properties of concrete by different replacement levels of FA, SF, GBS and RHA such as;

- Workability
- Permeability
- Durability
- Compressive strength
- Resistance of concrete to corrosion

- To optimize the quantity of fly ash, silica fume, granulated blast furnace slag and rice husk ash to replace the quantity of OPC and study the variation in the different properties of concrete.
- To find the optimum mix proportions for the high quality concrete with proper selection of admixtures considering the efficiency of mineral admixtures.
- To boost up the confidence of user to use ternary blend cement system by providing more information and additional data.
- To develop ternary blended concrete grade by conducting investigations on fresh concrete properties such as workability, air content and setting time and hardened properties such as compressive strength, acid resistance acid resistance,water absorption by varying percentage of FA, SF, GBS and RHA.
- To achieve these objectives, it is proposed to carry out the research work in eleven trials in following three phase as per standard test procedures:

II. RESEARCH METHODOLOGY

In order to meet the above objectives the following methodology isadopted. An attempt will be made to find theoptimum mix proportion of the admixture in place of cement after studying the above literature review.
Various mix trials were performed and various tests were carried out to found the optimum mix for the concrete will be identified. Also the material tests were carried out. Keeping the above in mind the fresh concrete tests such as slump test, compaction test and hardened concrete tests such as water absorption, acid resistance, compressive strength test and permeability test are also planned to be carried out.
A simple concrete mix proportioning system have been proposed. The coarse and fine aggregate contents are fixed, also the water / powder ratio and sand is fixed. Only the cement content and mineral admixtures content is varying. The mix design and concreting procedure is as follows:

- The fine aggregates as well as coarse aggregate content (all particleslarger than 4.75 mm and smaller than maximum size of aggregate is20mm) is fixed in the range of 45 to 50% of the concrete volume.
- The sand content (all particles size b/w 0.125-4.75 mm is fixed in the range of 20 to 25% of the concrete volume.
- The W/ B ratio is 0.45 (by weight), depending on the properties of the powder.
- The fly ash, Silica fume, Granulated Blast Furnace Slag and Rice Husk Ash percentages are determined through trial mixes, so as toensure the properties of concrete using fresh properties tests andhardened concrete tests.
- Percentage of the above mineral admixtures used are FA (35%), SF (25%), GBS (25%) and RHA (22%).

III. MATERIAL TESTING

The materials used in this experiment were locally available as a blinding agent, river sand as fine aggregates, crushed coarse aggregates and portable tab water was used for mixing and curing throughout the entire work.

3.1 CEMENT
Cement is the most important ingredient in concrete.Different brands of cement have been found to possess different strength development characteristics and

rheological behaviour due to the variations in the compound compositions and fineness.Here it was decided to use cement from a single supplier. Use 43 Grade of Cement of ordinary Portland Cement (OPC). Ordinary Portland Cement (OPC) is available in three grades namely 33, 43 and 53 grades.

3.1.1 Chemical Properties of Cement

S. No.	INGREDIENTS	CONTENT
01	Lime	60-67 %
02	Silica	17-25 %
03	Alumina	3-8 %
04	Iron Oxide	0.5-6 %
05	Mangnesia	0.1-4 %
06	Alkalies	0.4-1.3 %
07	Sulphur	1-3 %

Table 3.1.1Chemical Composition of Cement

3.1.2 Physical Properties of Cement

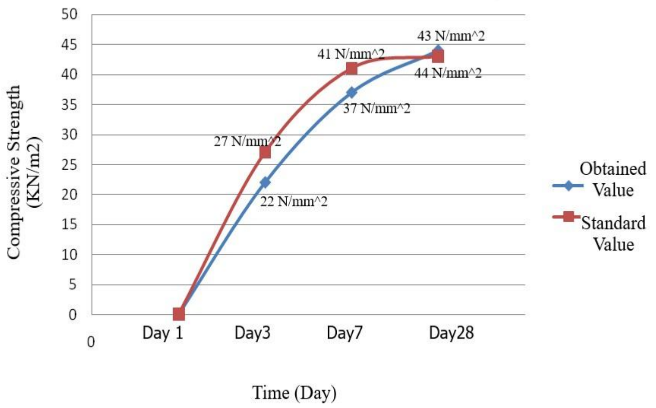
S.No.	Characteristics	Values Obtained	Standard Values
01	Normal Consistency	28%	35%
02	Initial Setting Time	44 min.	Not <30 minutes
03	Final Setting Time	269 min.	Not ≥ 600 minutes
04	Fineness	6.1 %	<10

Table 3.1.2 Physical properties of cement

3.1.3 Compressive strength test

S. No	Time (Days)	Strenth Obtained	Standard Strenth
1	3 days	22 N/mm^2	27 N/mm^2
2	7 days	37 N/mm^2	41 N/mm^2
3	28 days	44 N/mm^2	43 N/mm^2

Table 3.1.3 Compressive strength-Cement: Sand(1:3)



Graph B/W Compressive Strenth Vs Time(Days)

3.2 SAND

The sand used for the experimental programme was locally. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm. The sand was sieved through a set of sieves to obtain sieve analysis and properties and is presented in Table 3.2 (a) and Table 3.2 (b)

3.2(a). SIEVE ANALYSIS

Table 3.2(a)- Sieve analysis of Sand

Sr. No.	Sieve size	Mass retained	Percentage Retained	Cumulative percentage Retained	Percent passing
01	4.75mm	10 g	0.48	0.48	99.50
02.	2.36mm	80 g	3.8	4.28	95.70
03.	1.70 mm	275 g	13.3	17.58	82.42
03.	1.18mm	145 g	7.02	24.6	75.40
04.	150 µm	1509 g	73.07	97.67	2.33
05.	PAN	46 g	2.20	99.87	00
Sum		**2065**			

Total weight taken =1000gm, Therefore Fineness Modulus of sand =2.06

Thus the sand belonged to grading zone III.

3.2(b)PHYSICAL PROPERTIES

Sr. No.	Characteristics	Value
01.	Bulk density	1.5 kg/m^3
02.	Fineness modulus	2.06 m^2/g
03.	Water absorption	0.79%
04.	Grade zone (Based on percentage passing)	Zone III

Table 3.2(b) - Physical Properties of sand

3.3COARSE AGGREGATE

Aggregates are important consitituents of concrete. Aggregates occupy 45 to 50 percent of volume of the concrete. Basically there are two types of aggregates, the fine aggregate and the coarse aggregate.

The material which is retained on IS sieve no. 4.75 is termed as a coarse aggregate. The crushed stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The results of various tests conducted on coarse aggregate are given in Table 3.3

3.3 SIEVE ANALYSIS

Sr. No.	Sieve Size	Mass Retained in gm	Percentage Retained	Cumulative % Retained	Percent passing
01.	20mm	0	0	0	100
02.	16mm	1815	45.43	45.43	54.57
03.	12.5mm	1915	47.93	93.36	6.64
03.	4.75mm	250	6.25	99.61	0.39
04.	PAN	15	0.37	99.98	00

Table 3.3 - Sieve Analysis of Coarse Aggregate

Total Weight taken =3000gm
Fineness Modulus of Coarse Aggregate= (183.3+500)/ 100
= 6.8

3.4WATER

Water is the readily available most important component of concrete. The hydration of cement can take place only in the presence of water. It contributes to attain good concrete properties by lubricating the cement (binder), fine and coarse aggregates.

3.4.1 PHYSICAL QUALITY OF WATER

Water intended for use in concrete should be clean, fresh and free of deleterious substances. Water containing harmful substances such as silts, suspended particles, organic matter, oil, or sugar can unfavorably affect the strength and setting properties of cement and disrupt the affinity between aggregate and cement paste. Therefore, the suitability of water should be examined before use.In general, the potable or drinkable water is safe for use in concrete.

3.4.2 CHEMICAL QUALITY OF WATER

The mixing water should be chemically safe. The pH of mixing water should be in the range of 6.0 to 8.0. It should not contain high amount of dissolved solids, chlorides, alkalis, carbonates, bicarbonates, sulfates, and other salts, which can interfere with the performance of concrete and can affect the strength and setting properties of cement adversely. Therefore, when the suitability of water is questionable, it must be tested prior to use in concrete.

Properties	Obtained values
Ph	0.6-8.0
Dissolved salts, mg/l	290
Suspended particles	Nil
Chlorides, mg/l	20

Table 3.4.2 Chemical Properties of Water

IV. EXPERIMENTS AND MIX PROPORTION

4.1 CONCRET GRADE M25 = (1:1:2)

4.1.1 CONVENTIONAL CONCRETE CUBE (M_{CC})

Wet volume of concrete for 1cube = 0.15×0.15×0.15
= 0.003375m^3
Dry volume = Wet volume × 1.54
Cement $= \frac{1}{4} \times 1.54 = 0.385m= 0.385 \times 1440 = 554$kg
= 1870 gm / Cube
Sand $= \frac{1}{4} \times 1.54 = 0.385m^3 = 0.385 \times 1600 = 616$kg
= 2080 gm / Cube
Coarse Aggregatess $= \frac{2}{4} \times 1.54 = 0.77m^3 = 0.77 \times 1680 = 1293$ kg
= 4360 gm / Cube
Take W/Cratio = 0.45
Thereore water = 0.45×1.87
= 840gm

S.No.	Ingredients	Weight(gm)
01	Cement	1870
02	Sand	2080
03	Aggregates	4360
04	Water	840

Table 4.1.1 Conventional Concrete Ingredients and their weight(s)

4.2 CUBES With MINERAL ADMIXTURES

4.2.1Trial I[st] With FLY ASH (M_1)
Fly Ash Content= 35% = 655 gm
Cement= $\frac{1}{4} \times 1.54 \times 0.65 \times 1440 \times 0.003375$
= 1215 gm

4.2.2 Trial 2[nd] With SILICA FUME (M_2)
Silica Fume Content = 25% = 465 gm
Cement = $\frac{1}{4} \times 1.54 \times 0.75 \times 1440 \times 0.003375$
= 1405 gm

4.2.3 Trial3[rd]WithGRANULATED BLAST FURNACE SLAG (M_3)
Granulated Blast Furnace Slag Content = 25% = 465 gm
Cement= $\frac{1}{4} \times 1.54 \times 0.65 \times 1440 \times 0.003375$
= 1405 gm

4.2.4 Trial 4[th] With RICE HUSK ASH (M_4)
Rice Husk Ash Content = 22% = 410 gm
Cement = $\frac{1}{4} \times 1.54 \times 0.78 \times 1440 \times 0.003375$
= 1460 gm

4.2.5 Trial5[th]With FLY ASH + SILICA FUME(M_5)
Fly Ash + Silica Fume = 40% = 750 gm
Fly Ash Content = 25% = 468 gm
Silica Fume Content= 15% = 280 gm
Cement = $\frac{1}{4} \times 1.54 \times 0.60 \times 1440 \times 0.003375 = 1120$ gm

4.2.6 Trial 6[th] WithFLY ASH + BLAST FURNACE SLAG (M_6)
Fly Ash + Blast Furnace Slag = 30% = 560 gm
Fly Ash Content = 20% = 375 gm
Blast Furnace Slag = 10% = 185 gm
Cement = $\frac{1}{4} \times 1.54 \times 0.70 \times 1440 \times 0.003375$
= 1310 gm

4.2.7 Trial7[th] With FLY ASH + RICE HUSK ASH (M_7)
Fly Ash + Rice Husk Ash = 25% = 470 gm
Fly Ash Content = 15% = 280 gm
Rice Husk Ash = 10% = 190 gm
Cement $= \frac{1}{4} \times 1.54 \times 0.75 \times 1440 \times 0.003375$
= 1400 gm

4.2.8 Trial8[th]With SILICA FUME + BLAST FURNACE

SLAG (M_8)
Silica Fume + Blast Furnace Slag = 30% = 560 gm
Silica Fume Content = 15% = 280 gm
Blast Furnace Slag Content = 15% = 280 gm
Cement $=\frac{1}{4}\times 1.54 \times 0.70 \times 1440 \times 0.003375$
= 1310 gm

4.2.9 Trial9th With SILICA FUME + RICE HUSK ASH (M_9)
Silica Fume + Rice Husk Ash = 20% = 370 gm
Silica Fume Content = 10% = 185 gm
Rice Husk Ash Content = 10% = 185 gm
Cement= $\frac{1}{4}\times 1.54 \times 0.80 \times 1440 \times 0.003375$
= 1500 gm

4.2.10 Trial10th With BLAST FURNACE SLAG + RICE HUSK ASH (M_{10})
Blast Furnace Slag + Rice Husk Ash = 15% = 280 gm
Blast Furnace Slag Content = 10% = 185 gm
Rice Husk Ash Content = 5% = 95 gm
Cement $=\frac{1}{4}\times 1.54 \times 0.85 \times 1440 \times 0.003375$ = 1590 gm

4.2.11 Trial11th With FA+SF+GBS+RHA (M_{11})
FA+SF+GBS+RHA =30% = 560 gm
FA Content = 10% = 185 gm
SF Content = 10% = 185 gm
GBS Content = 5% = 95 gm
RHA Content = 5% = 95 gm
Cement $= \frac{1}{4}\times 1.54 \times 0.70 \times 1440 \times 0.003375$ = 1310 gm

MIX	CEMENT (gm)	FLY ASH (gm)	SILICA FUME (gm)	Granulated BLAST FURNACE (gm)	RICE HUSK ASH (gm)
C/C	1870	-	-	-	-
M_1	1215	655	-	-	-
M_2	1405	-	465	-	-
M_3	1405	-	-	465	-
M_4	1460	-	-	-	410
M_5	1120	468	280	-	-
M_6	1310	375	-	185	-
M_7	1400	280	-	-	190
M_8	1310	-	280	280	-
M_9	1500	-	185	-	185
M_{10}	1590	-	-	185	185
M_{11}	1310	185	185	95	95

V. TESTING OF SPECIMEN AND RESULTS

5.1 SLUMP CONE TEST

The slump test is the most commonly used method. Consistency is a term very closely related to workability. It is describes the state of fresh concrete where the maximum size of the aggregate does not exceed 20 mm. The slump test is suitable for slumps of medium to high workability, slump in the range of 25 – 125 mm. It refers to the ease with which the concrete flows. It is used to indicate the degree of wetness. Workability of concrete is mainly affected by consistency i.e. wetter mixes will be more workable than drier mixes, but concrete of the same consistency may vary in workability. The apparatus used for conducting the slump test consists of slump cone with handles and foot pieces. The size of the slump cone is 20-cm diameter base, 10 cm diameter top and 30 cm height. Foot pieces can be fixed to the clamps on the base plate. The base plate has lifting handle for easy transportation. One graduated steel tamping rod 16 mm diameter x 600 mm long rounded at one end graduated in mm. The internal surface of the mould is thoroughly cleaned and free from moisture and adherence of any old set concrete before commencing the test. The mould should be placed on smooth surface. Oil is applying on internal surface of the mould and applies the smooth surface where the mould is placed.

5.2 COMPACTION FACTOR TEST

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test. This test gives behaviour of concrete under the action of external forces. If measures the compactability of concrete, by measuring the amount of compaction. This test is suitable for mixes having medium and low workabilities i.e. compaction factor in between 0.91 to 0.81. The apparatus, which is commercially available, consist of a rigid frame that supports two conical hoppers vertically aligned above each other and mounted above a cylinder. The top hopper is slightly larger than the bottom hopper, while the cylinder is smaller in volume than both hoppers. To perform the test, the top hopper is filled with concrete but not compacted. The door on the bottom of the top hopper is opened and the concrete is allowed to drop into the lower hopper. Once all of the concrete has fallen from the top hopper, the door on the lower hopper is opened to allow the concrete to fall to the bottom cylinder. A tamping rod can be used to force especially cohesive concretes through the hoppers. The excess concrete is carefully struck off the top of the cylinder and the mass of the concrete in the cylinder is recorded. This mass is compared to the mass of fully compacted concrete in the same cylinder achieved with hand rodding or vibration. The compaction factor is defined as the ratio of the mass of the concrete compacted in the compaction factor apparatus to the mass of the fully compacted concrete. A larger apparatus is available for concretes with maximum aggregate sizes of up to 40 mm. The compaction factor test gives more information (that is, about compactability) than the slump test.

S. No	Trial No.	CONCRETE MIX TRIAL WITH CEMENT	SLUMP VALUE (mm)	COMPACTION FACTOR
01	00	CONVENTIONAL CONCRETE	110	0.95
02	01	M_1 FLY ASH (35%)	92	0.92
03	02	M_2SILICA FUME (25%)	90	0.91
04	03	M_3 GRANULATED BLAST FURNACE (25%)	90	0.91
05	04	M_4 RICE HUSK ASH (22%)	85	0.85
06	05	M_5 FLY ASH + SILICA FUME = (40%)	95	0.81
07	06	M_6 FLY ASH + GBS = (30%)	95	0.90
08	07	M_7FLY ASH + RHA = (25%)	90	0.90
09	08	M_8 SILICA FUME + GBS = (30%)	95	0.92
10	09	M_9 SILICA FUME + RHA = (20%)	90	0.85
11	10	M_{10} GBS+RHA=(15%)	90	0.88
12	11	M_{11} FLY ASH+SF+GBS+RHA = (30%)	105	0.93

5.3 COMPRESSIVE STRENGTH TEST OF CONCRETE CUBES
The compressive strength of concrete is given in terms of the characteristic compressive strength of 150 mm size cubes tested at 28 days (fck) below which not more than 5% of the test results are expected to fall. To calculate the compressive strength of concrete cubes the machine having capacity of 300tone was used. By this single test one judge that whether Concreting has been done properly or not. These specimens were tested by compression testing machine after 7, 14 & 28 days curing@ 140 Kg/cm per min. till the Specimens starts breaking.Calculations: Compressive strength = Maximum load/ Area (N/mm^2)

S. No.	Trial No.	CONCRETE MIX TRIAL WITH CEMENT	$\frac{LOAD}{AREA} \times 100$	COMP. STRENTH
01	00	CONVENTIONAL CONCRETE	$\frac{676}{3375} \times 100$	20.03
02	01	M_1 FLY ASH = (35%)	$\frac{585}{3375} \times 100$	17.23
03	02	M_2SILICA FUME = (25%)	$\frac{573}{3375} \times 100$	17.00
04	03	M_3GBS = (25%)	$\frac{575}{3375} \times 100$	17.00
05	04	M_4 RICE HUSK ASH = (22%)	$\frac{505}{3375} \times 100$	15.01
06	05	M_5 FLY ASH + SF = (40%)	$\frac{605}{3375} \times 100$	18.03
07	06	M_6 FLY ASH + GBS = (30%)	$\frac{605}{3375} \times 100$	18.03
08	07	M_7FLY ASH + RHA = (25%)	$\frac{600}{3375} \times 100$	17.95
09	08	M_8 SILICA FUME + GBS = (30%)	$\frac{610}{3375} \times 100$	18.00
10	09	M_9 SILICA FUME + RHA = (20%)	$\frac{640}{3375} \times 100$	19.00
11	10	M_{10} GBS+RHA = (15%)	$\frac{540}{3375} \times 100$	16.00
12	11	M_{11} FA+SF+GBS+RHA = (30%)	$\frac{670}{3375} \times 100$	19.85

5.4 ACID RESISTANCE TEST
The acid resistance tests were carried out on 150 mm size cube specimens at the age of 28 days curing. The cube specimens were weighed and immersed in water diluted with one percent by weight of sulphuric acid for 45 days continuously. Then the specimens were taken out from the acid diluted water and the surfaces of the cubes were cleaned. Then the weight and the compressive strengths of the specimens were found out and the average percentage of loss of weight and compressive strengths were calculated.

5.5 ALKALINITY MEASUREMENT
The pH values of the aqueous solution prepared from the powder sample of various concrete mixes with the w/b ratio of 0.45. The influence of silica fume, fly ash, blast furnace slag and rice husk ash on the pH value of concrete mixes and the variation of pH value with different percentage of silica fume, fly ash, blast furnace slag and rice husk ash. The pH values at the age of 28 days for mixes with w/c ratio of 0.45 without SF, FA, GBS and RHA was 13.57. The pH value for HPC mixes was less when compared to concrete mix without silica fume and was in the range of 13.18 to 13.41 at the w/b ratio of 0.45.The same trend was observed in silica fume with fly ash, GBS with FA concrete mixes at the w/b ratio of 0.45.

VI. ANALYSIS
Replacement of OPC by FA in concrete often improves workability, the water reduction associated with fine mineral powders is not a mechanical effect, but the result of dispersion and deflocculation similar to the effect of organic admixtures. The most significant benefit of FA is the reduction in water content which can be achieved with a given concrete workability. The workability and pumpability of concrete mixture is enhanced by decreasing the friction between aggregate particles, and this is generally achieved by increasing the paste content of the mixture Fly ash reduces bleeding capacity of a fresh concrete. It makes concrete more impermeable and denser as compared to Portland cement. The rate at which concrete sets during the first few hours after mixing is expressed as the initial and final setting time. Replacing of OPC by slag on an equal weight to weight basis in a concrete generally leads to a small increase in powder volume in the mix, which may be one reason why there is only a small increase in the workability. Another reason for improvement in workability could be due to slag that has a surface texture that is much smoother than that of cement. In reality, however, the influence of slag on the workability of concrete is not clear, especially when measuring workability by standard methods such as the slump test, compaction factor test. When OPC is replaced with SF, the strength increases with respect to control mix. The results of compressive strength of concrete using ternary cement blends indicate that the compressive strength with respect to control mix is higher up to certain percentage replacement level (optimal replacement level) of OPC with SF+FA for all w/c ratios and then becomes lower with further increase in percentage replacement level.
RHA is highly reactive at early ages and gives better early strength. If the silica fume is combined along with the fly ash and granulated blast furnace slag for the production of high quality concrete.Hence, in this study an attempt has been made to study the effect of addition of silica fume in the combinations of fly ash, granulated blast furnace slag and rice husk ash towards the strength, durability and other characteristics of concrete.

VII. SCOPE OF PRESENT STUDY
Research work has been carried out to study the mechanical properties of concrete by replacing ordinary portland cement by 35%, 25%, 25% and 22%FA, SF, GBS and RHA respectively by conducting various test on workability, water absorption, compressive strength. The structural behavior of concrete with FA, SF, GBS and RHA is also to be studied in order to utilize it in the building construction.
The choice of the quantity and stage of use of these mineraladmixtures is very important for the strength and durability of concrete. Silica fume have high early compressive strength whencompared to fly ash. Since the pozzolanic reaction proceedsslowly, the initial strength of fly ash concrete tends to be lower than that ofconcrete without

fly ash and concrete develops greater strength at later age.The addition of fly ash improves the workability but retards the setting timeof the concrete, whereas addition of silica fume and granulated furnace blast to concreterequires super plasticizer to improve the workability especially at low watercement ratio.

The need for the present study arises from the requirement to improve the overall utilization of these four mineral admixtures in correct proportions in concrete structures particularly in aggressive environment depending upon the requirements. The effect of those four mineral admixtures towards the enhancement of the strength and durability of concrete needs to be researched. A simple mix design procedure is also to be developed for high quality concrete considering the efficiency of fourmineral admixtures. From an economical and environmental point of view, strengthening of existing structures in most cases is a better alternative than demolishing and subsequent rebuilding. With this background the objectives of the present study is to find the optimum mix proportions for the high quality concrete with proper selection of admixtures.

VIII. CONCLUSION

The effect of different percentage replacement levels on the test results of mechanical properties are discussed in this Chapter. It concluded that if the cement content of control mixes at the above w/c ratio is kept constant, higher percentage of OPC can be replaced with FA+SF+GBS+RHA to get strength comparable to respective control mix by lowering w/p ratio of the mix. If strength at early age is desirable, the OPC replacement level in concrete using ternary blend system is limited to 30% with combination of 10% FA, 10% SF, 5% GBS and 5% RHA. If early strength is not the barrier, it is possible to achieve the same 28-days strength of concrete by adopting a mix with lower w/p ratio and higher replacement level of OPC with SF+FA+GBS+RHA, instead of adopting a mix with higher w/p ratio and lower replacement level..

The percentage replacement of FA upto 35%, SF upto 25%, GBS upto 25% and RHA upto 22% does not affect the relationship between accelerated curing strength and normal cured strength of concrete using binary mixes of OPC+FA, OPC+SF, OPC+GBS, OPC+RHA, OPC+FA+SF, OPC+FA+GBS, OPC+FA+RHA, OPC+SF+GBS, OPC+SF+RHA, OPC+GBS+RHA and OPC+FA+SF+GBS+RHA respectively at 7-day and 28-day.Relationship changes for mixes containing replacement level of 35% or more. It shows that type of binders and replacement levels do not affect significantly the relationships between accelerated curing strength and 7-day and 28-day normal cured strength of concrete.

Ternary blend cement system of OPC+FA+SF is a better choice than OPC concrete in terms of durability properties and corrosion resistance even in cracked condition. Mostly all tested durability properties show improvement with increase in the amount of FA and SF up to certain level of replacement. Further increase in replacement level show impoverishment in durability properties but mostly they are better than durability properties of control mixes.

The overall conclusions of this study are that blend cement system of OPC+FA+SF+GBS+RHA comprise a better choice than OPC concrete upto a certain percentage of cement replacement due to superior mechanical properties and durability, better corrosion resistance, economic reasons and being environmental friendly. If early strength is not the barrier, it is possible to achieve the same 28-days strength of concrete by adopting a mix with lower w/p ratio and higher replacement level of OPC with SF+FA+GBS+RHA, instead of adopting a mix with higher w/c ratio and lower replacement level. The resultant concrete also have lower permeability than OPC concrete even at replacement level of 30%.

The workability of concrete with microfiller mineral admixtures (low to moderate reactive pozzolan) greatly depends on the particle size, specific surface area, particle shape, and replacement level. In general, smaller the particle size and higher the specific surface of mineral admixture increases the water demands of concrete. The low to moderatere activity and filler effect help to maintain the workability and sometimes increase the workability.

Heat of hydration increases with the use of chemically active mineral admixtures and decreases with the use of microfiller mineral admixtures.In general, setting time of concrete decreases with the increase in replacement levels of chemically active mineral admixtures (SF) and increases with the increase of microfiller mineral admixtures. All mineral admixtures studied reduce bleeding in concrete with correct proportion of all ingredients.Based on Chapelle test, the reactivity of mineral admixtures is of the order: SF > FA > GBS>RHA.

Smaller particle size and higher specific surface area of mineral admixtures are favourable to produce highly dense and impermeable concrete; however, they cause low workability and more water.

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