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EFFECT OF POZZOLANAS ON FIBER REINFORCED CONCRETE

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ABSTRACT

High-performance concrete is defined as concrete that meets special combinations of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing, and curing practices. Ever since the term high-performance concrete was introduced into the industry, it had widely used in largescale concrete construction that demands high strength, high flowability, and high durability. A high-strength concrete is always a high-performance concrete, but a high-performance concrete is not always a high-strength concrete. Durable concrete Specifying a high-strength concrete does not ensure that a durable concrete will be achieved. It is very difficult to get a product which simultaneously fulfill all of the properties. So the different pozzolanic materials like Ground Granulated Blast furnace Slag (GGBS), silica fume, Rice husk ash, Fly ash, High Reactive Metakaolin, are some of the pozzolanic materials which can be used in concrete as partial replacement of cement, which are very essential ingredients to produce high performance concrete. So we have performed XRD tests of these above mentioned materials to know the variation of different constituent within it. Also it is very important to maintain the water cement ratio within the minimal range, for that we have to use the water reducing admixture i.e superplasticizer, which plays an important role for the production of high performance concrete. So we herein the project have tested on different materials like rice husk ash, Ground granulated blast furnace slag, silica fume to obtain the desired needs. Also X-ray diffraction test was conducted on different pozzolanic material used to analyse their content ingredients. We used synthetic fiber (i.e Recron fibe) in different percentage i.e 0.0%, 0.1%, 0.2%, 0.3% to that of total weight of concrete and casting was done. Finally we used different percentage of silica fume with the replacement of cement keeping constant fiber content and concrete was casted. In our study it was used two types of cement, Portland slag cement and ordinary Portland cement. We prepared mortar, cubes, cylinder, prism and finally compressive test, splitting test, flexural test are conducted. Finally porosity and permeability test conducted. Also to obtain such performances that cannot be obtained from conventional concrete and by the current method, a large number of trial mixes are required to select the desired combination of materials that meets special performance. KEYWORDS: Effect, Pozzolanas, Fiber, Reinforced, Concrete

KEYWORDS: Forces, Displacemen, Floating, Pile, Different, Analytical, Method

1.1. INTRODUCTION

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementitious materials, water, aggregate and sometimes admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material which canbe moulded into any shape hardens into a rock-like mass known as concrete. The hardening is because of chemical reaction between water and cement, which continues for long period leading to stronger with age. The utility and elegance as well as the durability of concrete structures, built during the first half of the last century with ordinary portland cement (OPC) and plain round bars of mild steel, the easy availability of the constituent materials (whatever may be their qualities) of concrete and the knowledge that virtually any combination of the constituents leads to a mass of concrete have bred contempt. Strength was emphasized without a thought on the durability of structures. As a consequence of the liberties taken, the durability of concrete and concrete structures is on a southward journey; a journey that seemsto have gained momentum on its path to self– destruction. This is particularly true of concrete structures which were constructed since 1970 or thereabout by which time (a) the use of high strength rebars with surface deformations (HSD) started becoming common, (b) significant changes in the constituents and properties of cement were initiated, and (c) engineers started using supplementary cementitious materials and admixtures in concrete, often without adequate consideration.

The setback in the health of newly constructed concrete structures prompted the most direct and unquestionable evidence of the last two/three decades on the service life performance of our constructions and the resulting challenge that confronts us is the alarming and unacceptable rate at which our infrastructure systems all over the world are suffering from deterioration when exposed to real environments.

The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and the global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact.

Fly ash, Ground Granulated Blast furnace Slag, Rice husk ash, High Reactive Metakaolin, silica fume are some of the pozzolanic materials which can be used in concrete as partial replacement of cement. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacements and the results are encouraging. The strength, durability and other characteristic of concrete depends on the properties of its ingredients, proportion of mix, method of compaction and other controls during placing and curing.

With the passage of time to meet the demand, there was a continual quest in human being for the development of high strength and durable concrete. The history of high strength concrete is about 35 years old, in late 1960s the invention of water reducing admixtures leadto the high strength precast products and structural elements in beam were cast in situ using high strength concrete. Since then the technology has come of age and concrete of the orderof M60 to M120 are commonly used. Concrete of the order of M200 and above are a possibility in the laboratory conditions. The definition of high strength concretes is continually developing. In the 1950s 34N was considered high strength, and in the 1960s compressive strengths of up to 52N were being used commercially. More recently, compressive strengths approaching 138N have been used in cast-in-place buildings. The advent of prestressed concrete technology has given impetus for making concrete of high strength. In India high strength concrete is used in prestressed concrete bridges of strength from 35 MPa to 45 MPa. Presently (in 2000) Concrete strength of 75 MPa is being used forthe first time in one of the flyover at Mumbai. Also in construction of containment Dome at Kaiga power project used HPC of 60MPa with silica fume as one of the constituent.

The reasons for these demands are many, but as engineers, we need to think about the durability aspects of the structures using these materials. With long term durability aspectskept aside we have been able to fulfil the needs. The concrete of these properties will have a peculiar Rheological behaviour.

Now a day the construction industry turning towards pre-cast elements and requirement of post-tensioning has made the requirement of the high strength of concrete invariable and the engineers had to overcome these drawbacks, which to a great extent we have been able to do. The construction today is to achieve savings in construction work. This has now turned into one of the basic requirement of concreting process.

2.1. EARLIER RESEARCHES

Some of the early research works had done using different pozzolanic materials with the replacement of cement using superplasticizer for the development high performance concrete. Also the development in the field of fiber reinforced concrete along with pozzolanas. So below an over view of different studies has been represented.

Aitcin[1] (1995) cited on development in the application of high performance concrete. Over the last few years, the compressive strength of some of the concrete used has increased dramatically. In 1988, a 120 MPa concrete was delivered on site, while, until relatively recently, 40 MPa was considered indicative of high strength. The spectacular increase in compressive strength is directly related to a number of recent technological developments, in particular the discovery of the extraordinary dispersing action of superplasticizers with which flowing concretes can be made with about the same mixing water that is actually required to hydrate all the cement particles or even less. The reductionin water/cement ratio results in a hydrated cement paste with a microstructure so dense and strong that coarse aggregate can become the concrete's weakest constituent. Silica fume, a highly reactive pozzolana, considerably enhances the paste/aggregate interface and minimizes debonding. Lastly, the use of supplementary cementitious materials, such as fly ash and especially slag, helps solve slump loss problems which become critical at low w/c ratios.

Ajdukiewicz and Radomski[2] (2002) delve into Trends in the Polish research on high- performance concrete. They analysed the main trends in the research on high- performance concrete (HPC) in Poland. There they sighted on some examples of the relevant investigations. The fundamental engineering and economical problems concerning the

structural applications of HPC in Poland are presented as well as the needs justifying the increased use of this material are briefly described.

Aitcin[3] (2003) studied on the durability characteristics of high performance concrete. He examined durability problems of ordinary concrete can be associated with the severity of the environment and the use of inappropriate high water/binder ratios. High- performance concrete that have a water/binder ratio between 0.30 and 0.40 are usually more durable than ordinary concrete not only because they are less porous, but also because their capillary and pore networks are somewhat disconnected due to the development of self-desiccation. In high-performance concrete (HPC), the penetration of aggressive agents is quite difficult and only superficial. However, self-desiccation can be very harmful if it is not controlled during the early phase of the development of hydration reaction, therefore, HPC must be cured quite differently from ordinary concrete. Field experience in the North Sea and in Canada has shown that HPCs, when they are properly designed and cured, perform satisfactorily in very harsh environments. However, the fire resistance of HPC is not as good as that of ordinary concrete but not as bad as is sometimes written in a few pessimisticreports. Concrete, whatever its type, remains a safe material, from a fire resistance point of view, when compared to other building materials.

Al-Khalaf and A. Yousif [4] (1984) examined on use of RHA in concrete. They studied the actual range of temperature require to burn rice husk in order to get the desired pozzolanic product, use of rice husk as partial replacement of cement on compressive strength and volume changes of different mixes. And showed that up to 40% replacement can be made with no significant change in compressive strength compared with the control mix. He tested on mortar cube, by testing on 50 mm cubes. In his investigation alsohe deduced that the most convenient and economical burning conditions required to convert rice husks into a homogenous and well burnt ash is at 500^0 C for 2 hours. Also for a given grinding time, there is a considerable reduction in the specific surface area of RHA as burning temperature increases. For mortar mix with constant RHA content, the water requirement decreases as the fineness of the ash increases. The minimum pozzolanic activity can be obtained, when the ash has a specific surface of about 11,500 cm^2/gm. The strength of cement-RHA mortar approaches the strength of the corresponding plain mortar when the specific surface of RHA about 17000cm^2/gm. For 1:2 and 1:3 mortar mixes of standard consistency the maximum percentage of rice husk ash that can be replaced by weight of cement without 60 days strength being less than that of plain mortar was 30% and 40 % respectively. Also he found

higher the percentage or RHA, higher is the volume change characteristic corresponding to plain mortar.

Ismail and waliuddin[5] (1996) had worked on effect of rice husk ash on high strength concrete. They studied the effect of rice husk ash (RHA) passing 200 and 325 micron sieves with l0-30% replacement of cement on the strength of HSC. The RHA was obtained by burning rice husk, an agro-waste material which is abundantly available in the developing countries. A total of 200 test specimens casted and tested at 3,7,28 and 150 days. Compressive and split tensile strengths of the test specimens.Cube strength over 70 MPa was obtained without any replacement of cement by RHA. Test results indicated that strength of HSC decreased when cement was partially replaced by RHA for maintaining same level of workability. They observed that optimum replacement of cement by RHA was 10-20%, and even from crystalline form of RHA good result may be obtained by fine grinding.

De Sensale[6] (2006) studied on strength development of concrete using rice husk ash. This paper presents a study on the development of compressive strength up to 91 days of concretes with rice-husk ash (RHA), in which residual RHA from a rice paddy milling industry in Uruguay and RHA produced by controlled incineration from the USA were usedfor comparison. Two different replacement percentages of cement by RHA, 10% and 20%,and three different water/cementicious material ratios (0.50, 0.40 and 0.32), were used. The results are compared with those of the concrete without RHA, with splitting tensile strength and air permeability. It is concluded that residual RHA provides a positive effect on the compressive strength at early ages, but the long term behavior of the concretes with RHA produced by controlled incineration was more significant. Results of splitting tensile and air permeability reveal the significance of the filler and pozzolanic effect for the concretes with residual RHA and RHA produced by controlled incineration.

Oner A and Akyuz S [7] (2007) studied on optimum level of ground granulated blast furnace slag (GGBS) on compressive strength of concrete. In their study GGBS was added according to the partial replacement method in all mixtures. A total of 32 mixtures were prepared in four groups according to their binder content. Eight mixes were prepared as control mixtures with 175, 210, 245 and 280 kg/m3 cement content in order to calculate the Bolomey and Feret coefficients (KB, KF). For each group 175, 210, 245 and 280 kg/m3 dosages were determined as initial dosages, which were obtained by removing 30 percent ofthe cement content of control concretes with 250, 300, 350, and 400 kg/m3 dosages. Test concretes were obtained by adding GGBS to concretes in an amount equivalent to approximately 0%, 15%, 30%, 50%, 70%, 90% and 110% of cement contents of control concretes with 250, 300, 350 and 400 kg/m3 dosages. All specimens were moist cured for 7,14, 28, 63, 119, 180 and 365 days before compressive strength testing. The test results proved that the compressive strength of concrete mixtures containing GGBS increases as the amount of GGBS increase. After an optimum point, at around 55% of the total binder content, the addition of GGBS does not improve the compressive strength. This can be explained by the presence of unreacted GGBS, acting as a filler material in the paste

2.2. SCOPE AND OBJECTIVE OF PRESENT WORK

The objective of the present work is to develope concrete with good strength, less porous, less capillatrity so that durablility will be reached. For this purpose it requires the use of different pozzolanic materials like rice husk ash, ground granulated blast furnace slag, silica fume along with fiber. So the experimental programme to be undertaken;

- To determine the mix proportion with rice husk ash, ground granulated blast furnace slag and silica fume with fiber to achieve the desire needs.
- To determine the water/ binder ratio, so that design mix having proper workability and strength.
- To investigate different basic properties of concrete such as compressive strength, splitting tensile strength, flexural strength etc and comparing the results of different proportioning.
- Determination of porosity and capillary of different proportioned concrete.

2.3 MATERIALS & PROPERTIES

2.3.1 GROUND GRANULATED BLAST FURNACE SLAG:

Ground Granulated Blastfurnace slag (GGBS) is a by-product for manufacture of pig iron and obtained through rapid cooling by water or quenching molten slag. Here the molten slag is produced which is instantaneously tapped and quenched by water. This rapid quenching of molten slag facilitates formation of "Granulated slag". Ground Granulated Blast furnace Slag (GGBS) is processed from Granulated slag. If slag is properly processed then it develops hydraulic property and it can effectively be used as a pozzolanic material. However, if slag is slowly air cooled then it is hydraulically inert and such crystallized slag cannot beused as pozzolanic material. Though the use of GGBS in the form of Portland slag cement isnot uncommon in India, experience of using GGBS as partial replacement of cement in concrete in India is scanty. GGBS essentially consists of silicates and alumino silicates of calcium and other bases that is developed in a molten condition simultaneously with iron in a blast furnace. The chemical composition of oxides in GGBS is similar to that of Portland cement but the proportions varies.

The four major factors, which influence the hydraulic activity of slag, are glass content, chemical composition, mineralogical composition and fineness. The glass content of GGBS affects the hydraulic property, chemical composition determines the alkalinity of the slag and the structure of glass. The compressive strength of concrete varies with the fineness of GGBS. Ground granulated blast furnace slag now a days mostly used in India. Recently for marine out fall work at Bandra, Mumbai. It has used to replace cement to about 70%. So it has become more popular now a day.

Table 3.1. Chemical composition (%) of GGBS:

SiO_2	39.18
Al_2O_3	10.18
Fe_2O_3	2.02
CaO	32.82
MgO	8.52
Na_2O	1.14
K_2O	0.30

Performance of Ground Granulated Blast furnace Slag in Concrete:

The replacement of cement with GGBS will reduce the unit water content necessary to obtain the same slump. This reduction of water content is more pronounced with increasein slag content and also on the fineness of slag. This is because of the surface configurationand particle shape of slag being different than cement particle. Surface hydration of slag is slightly slower than that of cement. Reduction of bleeding is not significant with slag of 4000 cm^2/g fineness but significant when slag fineness of 6000 cm^2/g and above.

Advantages of using GGBS:

- Reduce heat of hydration

- Refinement of pore structures
- Reduce permeability to the external agencies
- Increase resistance to chemical attack.

Reaction Mechanism of Ground Granulated Blast furnace Slag:

Although GGBS is a hydraulically latent material, in presence of lime contributed from cement, a secondary reaction involving glass (Calcium Alumino Silicates) components sets in. As a consequence of this, cementitious compounds are formed. They are categorizedas secondary C-S-H gel. The interaction of GGBS and Cement in presence of water is described as below:

Product of hydration of OPC

OPC(C_3S/C_2S) + H_2O ————————> C-S-H + CH

Product of hydration of GGBS

GGBS(C_2AS/C_2MS) + H_2O ——————> C-S-H + SiO_2

Reaction of pozzolanic material

SiO_2+ CH + H_2O —————————————>C-S-H

The generation of secondary gel results in formation of additional C-S-H, a principal binding material. This is the main attribute of GGBS, which contributes to the strength and durability of the structure. The diagrammatic representation of secondary gel formation is shown below.

2.3.2 RICE HUSK ASH

Rice husk ash is obtained by burning rice husk in a controlled manner without causing environmental pollution. When it is properly brunt it has high SiO_2 content and can be usedas a concrete admixture. Rice husk ash exhibits high pozzolanic characteristics and contributes to high strength and high impermeability of concrete. Rice husk ash essential consists of amorphous or non crystalline silica with about 85- 90% cellular particle, 5% carbon and 2% K_2O. The specific surface of RHA is between 40000-100000 m^2/kg.

India produces about 122 million ton of paddy every day. Each ton of paddy produces about 40 kg of RHA. There is a good potential to make use of RHA as a valuable pozzolanic material to give almost the same properties as that of microsilica. In USA highly pozzolanic rice husk ash is patented under the trade name of Agrosilicaand is marketed.it is having superpozzolanic property when used in small quantity i.e. 10% by weight of cement and it greatly enhances the workability and impermeability of concrete.

Table 3.2. Chemical composition (%) of RHA:

SiO_2	85.88
K_2O	4.10
SO_3	1.24
CaO	1.12
Na_2O	1.15
MgO	0.46
Al_2O_3	0.47
Fe_2O_3	0.18
P_2O_5	0.34

2.3.3 SILICA FUME:

Silica fume also referred as microsilica or condensed silica fume is another material that is used as an artificial pozzolanic admixture. It is a product resulting from reduction of high purity quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy. When quartz are subjected to 2000^0C reduction takes place and SiO vapours get into fuels. In the course of exit, oxidation takes place and the product is condensed in low temperature zones. In the course of exit, Silica fume rises as an oxidised vapour, oxidation takes place and the product is condensed in low temperature zones. When the silica is condensed, it attains non-crystalline state with ultra fine particle size. The super fine particles are collected through the filters. It cools, condenses and is collected in bags. It is further processed to remove impurities and to control particle size. Condensed silica fumeis essential silicon dioxide (SiO_2) more than 90 percent in non crystalline form. Since it is an airborne material like fly ash, it has spherical shape. It is extremely fine with particle size less than 1 micron and with an average diameter of about 0.1 micron, about 100 times smaller than average cement particles. Silica fume has specific surface area of about 20,000m^2/kg, as against 230 to 300 m^2/kg. The use of silica fume in conjunction with superplasticizer has been back bone of modern high performance concrete. High fineness, uniformity, high pozzolanic activity and compatibility with other ingredients are of primary importance in selection of mineral admixture. As Silica fume has the minimum fineness of 15,000 m^2/ kg, whereas the fumed Silica has the fineness of 190,000 m^2/g which is 6 to 7 times finer than Silica fume. Finer the particle of pozzolano, higher will be the modulus of elasticity, which enhances the durability characteristics of the High performance concrete. Application of high performance concrete (HPC) has got momentum in various fields of construction globally in the near past. High performance concrete is being practised in the fields like construction of nuclear reactors, runways at airport, railway sleepers, cooling towers, silos, chimneys and all kinds of bridges. Considerable amount of development has been made in the field of High performance concrete and high strength concrete can be obtained using silica fume as a mineral admixture. Silica fume has been used for one of the fly over at Mumbai, India with concrete strength of 75 MPa.

Table 3.3. Chemical composition of silica fumes in %:

SiO_2	93
Al_2O_3	0.4
CaO	1.2
Fe_2O_3	0.2
MgO	1.2
Na_2O	0.1
K_2O	1.1
SO_3	0.3

Advantages of Silica fume:

- High strength concrete made with silica fume provides high abrasion/corrosion resistance.
- Silica fume influences the rheological properties of fresh concrete, the strength, porosity and durability of hardened mass.
- Silica fume concrete with low water content is highly resistant to penetration of chloride ions.
- The extreme fineness of silica fume allows it to fill or pack the microscopic voids between cement particle and especially in the voids at the surface of the aggregate particleswhere the cement particles cannot fully cover the surface of the aggregate and fill the available space.

2.3.4 SUPERPLASTICIZER

There are two types of admixtures i.e Mineral admixtures and Chemical admixtures.

1) *Mineral admixtures:*

- Silica fume
- Ground granulated blast furnace slag
- Rice husk ash

- Fly ash

***2)** Chemical admixture:*

- Accelerating admixture
- Retarding admixture
- Water-reducing admixture
- Air entering admixture
- Super- plasticizing admixture

Super plasticizing admixture:

A substance which imparts very high workability with a large decrease in water content (at least 20%) for a given workability. A high range water reducing admixture (HRWRA) is also reffered as Superplasticizer, which is capable of reducing water content by about 20 to 40 percent has been developed. These can be added to concrete mix having a low- to-normal slump and water cement ratio to produce high slump flowing concrete. The effect of superplasticizers lasts only for 30to 60 minutes, depending on composition and dosage andis followed by rapid loss in workability.

One of the important factors that govern the issue water–cement ratio during the manufacture of concrete, lower the water-cement ratio lower will be the capillary pores and hence lower permeability and enhanced durability.

Although Superplasticizer are essential to produce a truly high performance concrete (HPC) characterised by low water-cement ratio and workability level without high cement content. Concrete are being produced with w/c ratio of as low as 0.25 or even 0.20 enabled the production of highly durable high performance concrete. The workability also increases with an increase in the maximum size of aggregate. But smaller size aggregate provides larger surface area for bonding with the mortar matrix, which increases the compressivestrength. For concrete with higher w/c ratio use of larger size aggregate is beneficial.

2.3.5 CEMENT

Cement is a material that has cohesive and adhesive properties in the presence of water. Such cements are called hydraulic cements. These consist primarily of silicates and aluminates of lime obtained from limestone and clay. There are different types of cement, outof that I have used two types i.e,

2.3.6 Ordinary Portland cement

2.3.7 Portland slag cement

Ordinary port land cement (OPC) is the basic Portland cement and is best suited for use in general concrete construction. It is of three type, 33 grade, 43 grade, 53 grade. One of the important benefit is the faster rate of development of strength. Portland slag cement is obtained by mixing Portland cement clinker, gypsum and granulated blast furnace slag in suitable proportion and grinding the mixture to get a thorough and intimate mixture between the constituents. This type of cement can be used for all purposes just like OPC. It has lower heat of evolution and is more durable and can be used in mass concrete production.

Table 3.4. Specification of Recron:

Denie r	1.5d
Cut length	6mm,12mm,24mm
Tensile strength	About 6000 kg/cm^2
Melting point	➢ 250^o C
Dispersion	Excellent
Acid resistance	Excellent
Alkali resistance	good

3. RESULTS AND DISCUSSION OF XRD TEST

XRD was conducted on RHA-I, RHA-2, GGBSS and Silica fume, to idealize the different chemical composition of these pozzolanic material. Test was performed at an angle 45o with 2θ equal to 90o and different graphs are obtained, which were analysed using “X-pert High Score” software.

In case of GGBS from the graph it is inculcated that compound purely in amorphous form. Here we got the formation of Mg2Al2O4 corresponding to no. 74-1133 and Mg2SiO4 with no.74-1680. From the XRD graphs of RHA-I and RHA-II obtained from X-pert High Score software, it was visualised that RHA-I (black type) somehow is in crystalline form as compared to RHA-II (white type). But in both the form of rice husk ash we found crystabalite low temperature silica type with no. 76-0939 as to that of software. The graph shows silica fume also is in amorphous state with having compound SiO2 and CaO with nos. 03-0865 and 80-2146 respectively in the software used

.

3.1 EFFECT OF GGBS AND RHA ON PROPERTIES OF CEMENT

To know the properties of GGBS and RHA on mortar we performed different tests

- Consistency test
- Compressive strength

The amount of water required to produce a standard cement paste to resist a specified pressure is known as normal or standard consistency. In other word it is the limit of water required at which the cement paste resist the penetration of standard plunger (1 mm diameter) under a standard loading up to a distance of 5-7 mm from the base of Vicat apparatus. The consistency of cement depends on its type and fineness. More water is required in cement with higher fineness value. The water quantity was calculated by [(P/4) + 3] % of 800 gm. Consistency test was performed with both GGBS and rice husk ash of different percentage content. That is GGBS with 0, 10, 20, 30, 40 % and RHA with 0, 10, 20, 30 %. Then mortars

of standard size were casted with different percentage of GGBS (0%, 10%, 20%, 30%, 40%) and RHA (0% and 20%) with the replacement of cement. Portland slag cement and sand of zone- II was used in this experiment. Then compression test was conducted of mortars in Compression testing machine.

Table 4.5 Effect of GGBS in normal consistency of cement:

% of cement replacedby GGBS (%)	**Consistency (%)**
0	**31.0**
10	**32.0**
20	**33.0**
30	**34.5**
40	**36.5**

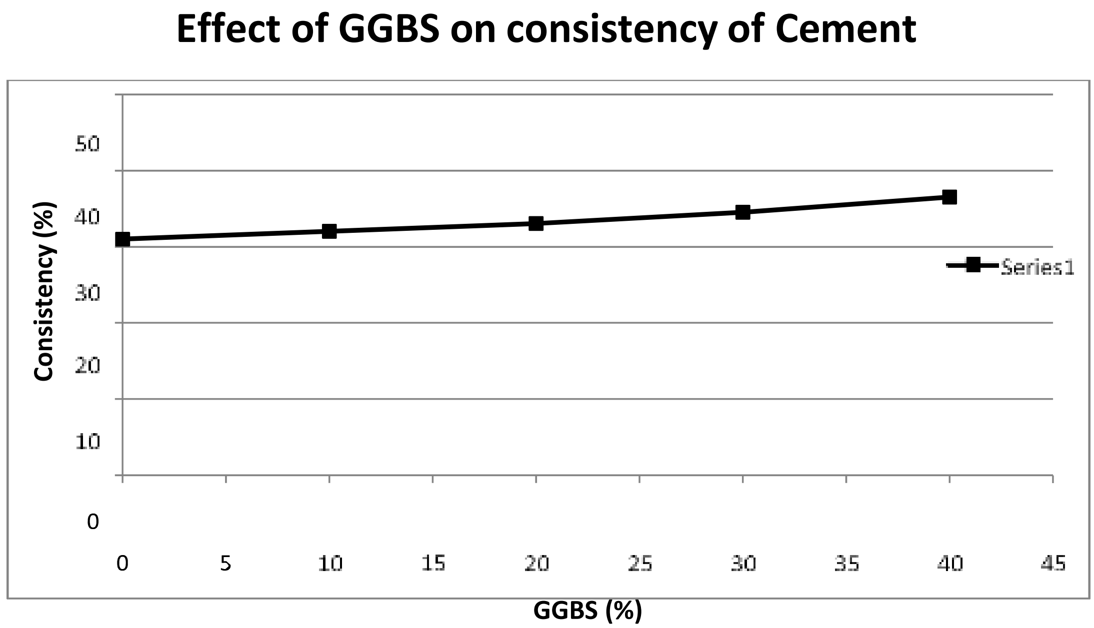

Fig. 4.5 Variation of Consistency of cement containing different % ofGGBS

Table 4.6. Effect of GGBS on Compressive strength of cement:

% of GGBS with cement replacement	3 days strength (MPa)	7 days strength (MPa)
0	11.176	24.31
10	9.66	15.63
20	7.117	10.85
30	6.10	9.15
40	4.74	7.46

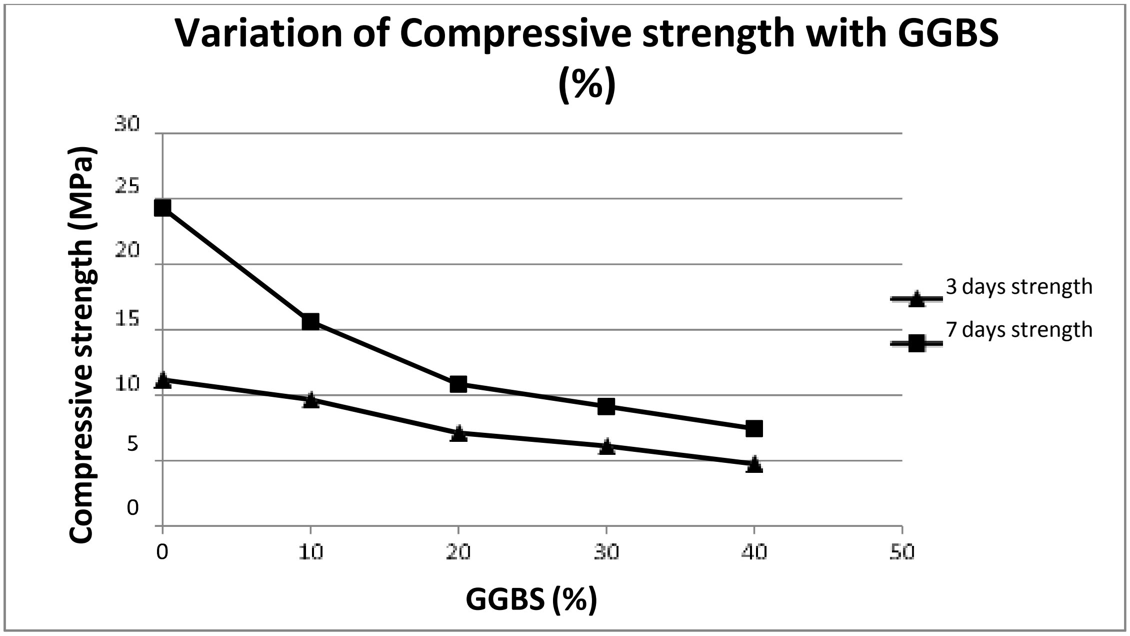

Fig. 4.6 . Variation of Compressive strength of mortar with different GGBS %

Table 4.7. Effect of RHA on Normal Consistency of cement:

% of cement replaced by RHA	**Consistency (%)**
0	**31.0**
10	**45.0**
20	**48.0**
30	**52.0**

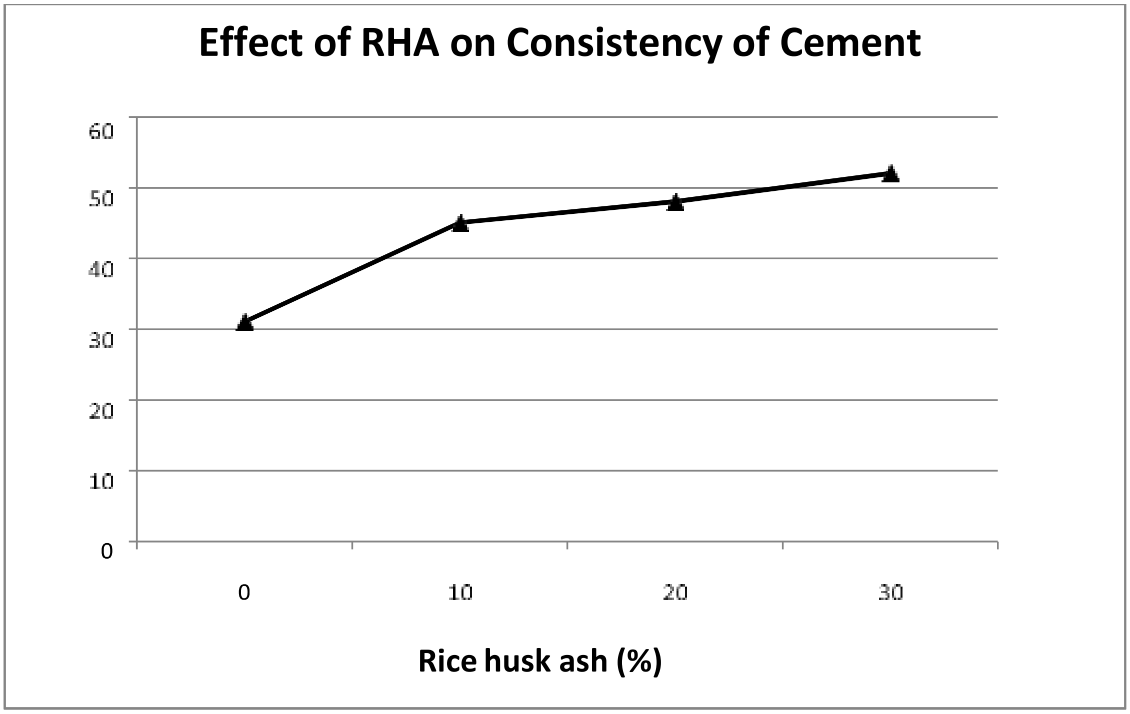

Fig. 4.7 Variation in Consistency of cement with different % of RHA

4. DISCUSSION

Consistency of cement depends upon its fineness. Though silica fume having greater fineness than cement and greater surface area so the consistency increases greatly, when silica fume percentage increases compare to plain cement. It was observed that normal consistency increases about 45% when silica fume percentage increases from 0% to 30%.

In case of Portland slag cement it was observed that using Recron fiber from 0.0% to 0.1% the compressive strength is not incresed, but as the fiber percentage was increased from 0.1% to 0.2% the compressive strength was increased and on further increament of fibre content the strength reduces. The 28 days compressive strength of concrete is higher at with 0.2% fiber compared to other fibre composition but lower than unreinforced concrete. In addition to fiber silica fume was used as a partial replacement to cement. The differentpercentage of silica fume such as 10%, 20%, 30% replacement was used with 0.2% Recron fiber. The 20% replacement of slag cement with of silica fume gave maximum strength compared to other percentages of replacement, whereas the strength is higer with 30%replacement of silica fume in case of ordinary Portland cement.

In case of Portland slag cement it was observed that addition of Recron fiber from 0.0% to 0.1% the splitting tensile strength decreases. But as the fiber percentage was increased that to 0.2% the 28 days splitting tensile strength is about 5% more than that of concrete without fiber. and with further addition of fiber the strength reduces. At 20% silica fume replacement to cement at 0.2% fiber content strength again increases about 12% more than that of normal concrete and maximum to other percentage of replacement, where as in case of ordinary Portland cement the tensile strength at 28 days is 15% more than normal concrete at 10% silica fume replacement and 0.2% fiber. The strength reduces gradually on other percentages of silica fume.

Flexural strength using Recron fiber from 0.0% to 0.1% is reducing. As the fiber percentage increases from 0.1%-0.2% the flexural strength is increasing about 5% and as further increasing the fiber content the strength decreases. In case of silica fume replacement at 0.2% fiber content the flexural strength gives positive outcome. At 20% silica fume there is higer strength about 10% more than normal concrete, which is the maximum strength than other percentages of silica fume replacement. In case of ordinary Portland cement keeping 0.2% fiber content and varying silica fume percent (10%, 20%, 30%) it was observed that the 28 days flexural strength decreases as the of silica fume percentage increases. The strength decreases about 40% at 30% silica fume replacement than normal concrete.

5. CONCLUSION

In this present study with the stipulated time and laboratory set up an afford has been taken to enlighten the use of so called pozzolanic material like ground granulated blast furnace slag, rice husk and silica fume in fiber reinforced concrete in accordance to their proficiency. It was concluded that,

5.1.1 Use of GGBS as cement replacement increases consistency. Although fineness greatly influenced on proper pozzolanic reaction still GGBS passing 75 micron sieve not giving good strength of mortar. Using GGBS more than 10% in Portland slag cement the strength reducing rapidly.

5.1.2 With replacement of cement with RHA the consistency increases. Use of RHA which burned properly in controlled temperature improves the strength of mortar. But use of RHA not giving satisfactory strength result.

5.1.3 With the use of superplasticizer it possible to get a mix with low water to cement ratio to get the desired strength.

5.1.4 In case of Portland slag cement with the use of Recron fiber , the 28 days compressive strength at 0.2% fiber content the result obtained is maximum. The 28 days splitting tensile and flexural strength also increases about 5% at 0.2% fiber content to that of normal concrete. Further if fiber percentage increases then it was seen a great loss in the strength.

5.1.5 As the replacement of cement with different percentages with Silica fume increases the consistency increases.

5.1.6 With Portland slag cement keeping 0.2% Recron fiber constant and varying silica fume percentage the compressive, splitting tensile, flexural strength affected remarkably. Using 20% silica fume with 0.2% fiber percentage the 28 days compressive strength increases 7% more than concrete with 0.2% fiber only. 28days split tensile and flexural strength increases further, about 12% and 10% that of normal concrete.

5.1.7 So it is inculcated that 0.2% Recron fiber and 20% SF is the optimum combination to achive the desired need.

5.1.8 In case of OPC the compressive strength is increasing as the percentage of silica fume increases from 0-30% and 0.2% Recron fiber and it is about 20% more than strength of normal concrete with OPC.

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