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Pozzolanas Effect 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 large-scale 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.

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 can be 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.

1.2. HIGH PERFORMANCE CONCRETE:

In recent years, the terminology "High-Performance Concrete" has been introduced into the construction industry. The American Concrete Institute (ACI) defines high-performance concrete as concrete meeting special combinations of performance and uniformity requirements that cannot always be achieved routinely when using conventional constituents and normal mixing, placing and curing practices. A commentary to the definition states that a high-performance concrete is one in which certain characteristics are developed for a particular application and environment. Examples of characteristics that may be considered critical for an application are:

- Ease of placement
- Compaction without segregation
- Early age strength
- Long-term mechanical properties
- Permeability
- Density
- Heat of hydration
- Toughness
- Volume stability
- Long life in severe environments
-

Because many characteristics of high-performance concrete are interrelated, a change in one usually results in changes in one or more of the other characteristics. A high-performance concrete is something more than is achieved on a routine basis and involves a specification that often requires the concrete to meet several criteria.

REVIEW OF LITERATURE

2.1. Introduction:

As our aim is to develop concrete which does not only concern on the strength of concrete, it also having many other aspects to be satisfied like less porous, capillary absorption, durability. So for this we need to go for the addition of pozzolanic materials along with superplasticizer with having low water cement ratio. The use of silica fume is many, which is having good pozolanic activity and is a good material for the production high performance concrete. Also now a days one of the great application in various structural field is fiber reinforced concrete, which is getting popularity because of its positive effect on various properties of concrete.

MATERIALS & PROPERTIES:

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 be used as pozzolanic material.

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 increase in slag content and also on the fineness of slag. This is because of the surface configuration and 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.

EXPERIMENTAL PROGRAMMES:

4.1. OUTLINE OF PRESENT WORK:

Rice husk ash is a product confirming to engineering requirements in terms of physical and chemical properties. So in our present study we are going to put our great diligence in study of RHA which can be made as a partial cement replacing material simultaneously achieving required strength testing on mortar cubes. GGBS is a non-metallic product essentially consists of silicates and alumino silicates of calcium and other bases. The four major factors, which influence the hydraulic activity of slag, are glass content, chemical composition, mineralogical composition and fineness.

Cement:

For the experiment following two types cements were used,
(a) Portland Slag Cement
(b) Ordinary Portland cement (53 grade)

The chemical composition and different properties are shown below.
Fineness – 340 m^2/kg
Specific gravity- 2.96
Initial setting time - 120 min
Final setting time – 240 min

Table 4.1. Properties of Portland slag cement:

Specific gravity	2.96
Initial setting time (min)	125
Final setting time (min)	235

Table 4.2. Properties of Ordinary Portland cement:

Specific gravity	3.1
Initial setting time (min)	90
Final setting time (min)	190

Fine aggregate:

In this study it was used the sand of Zone-II, known from the sieve analysis using different sieve sizes (10mm, 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, 150µ) adopting IS 383:1963.

Table 4.3. Properties of fine aggregate:

Properties	Results Obtained
Specific Gravity	2.65
Water absorption	0.6%
Fineness Modulus	2.47

Coarse aggregate:

The coarse aggregate used here with having maximum size is 20mm. We used the IS 383:1970 to find out the proportion of mix of coarse aggregate, with 60% 10mm size and 40% 20mm.

Table 4.4. Properties of coarse aggregate:

Specific gravity	2.67
Water absorption	0.4%
Fineness modulus	4.01

Fiber:

In this project work it was used Recron fiber. It is a type of synthetic fiber. In different weight fraction (0.0%, 0.1%, 0.2%, 0.3%) to concrete it was used.

Ground granulated blast furnace slag (GGBS):

As pozzolanic activity greatly depends on fineness, so GGBS passing through 75 micron whose fineness of order of 275-550 m^2/kg was used. Specific gravity test was conducted using Le-Chatelier apparatus and found to be 2.77. X-Ray diffraction test was conducted shown below in figure no. 4.1.

Rice husk ash:

In this study we have used two types of Rice husk Ash. First type which was low burned having greater percentages of carbon (which is having negative impact on strength development), so looking black and

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second type is looking white because it was being burnt in higer temperature. Here in second type of RHA the percentage of carbon is low. The specific gravity test was carried out using Le- Chatelier apparatus and found to be 2.21 for RHA– I and 2.20 for RHA-II. X-Ray diffraction test was carried out shown below in fig no. 4. 2 and fig no. 4.3.

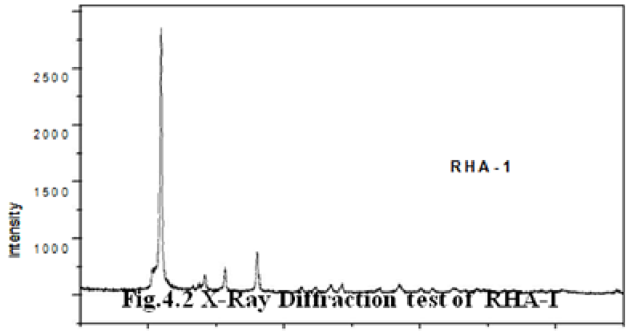


Fig.4.2 X-Ray Diffraction test of RHA-I

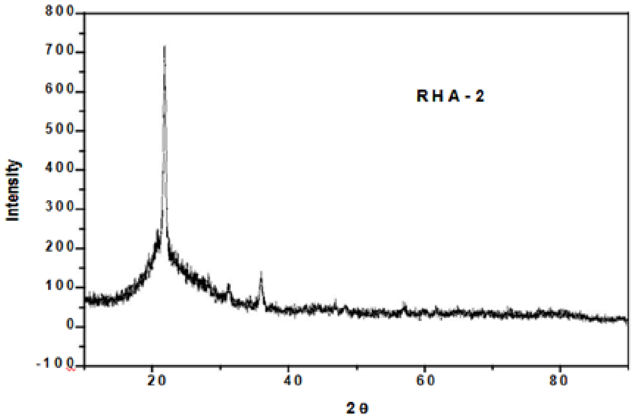


Fig. 4.3 X-Ray Diffraction test of RHA-II

Silica fume:

Silica fume is used in different percentage (0%, 10%, 20%, 30%) with the replacement of cement for its greater pozzolanic activity along with fiber. The specific gravity of silica fume was found out using Le-Chatelier apparatus and found to be Specific gravity- 2.36. X-Ray diffraction test was conducted shown below in figure no. 4.4.

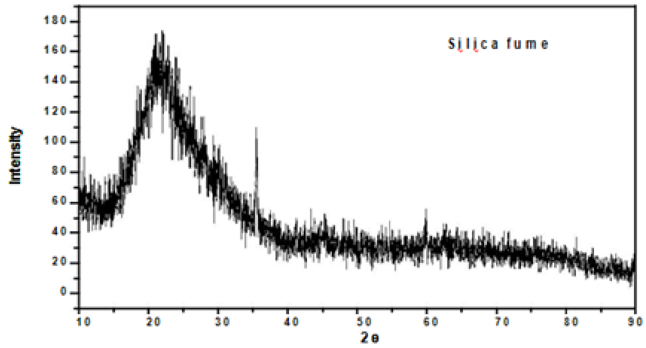


Fig. 4.4 X-Ray Diffraction test of silica fume

4.2.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 45° with 2θ equal to 90° and different graphs are obtained, which were analysed using “X-pert High Score” software.

4.3.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.

4.3.1 TEST RESULT:

Table 4.5. Effect of GGBS in normal consistency of cement:

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

Firstly with Portland slag cement the effect of fiber and SF on strength of concrete are shown below then using OPC.

Fig. 4.10 Determination of compressive strength of cube

Fig. 4.11 Determination of splitting tensile strength of cylinder

Fig. 4.12 Determination of Flexural strength of prism

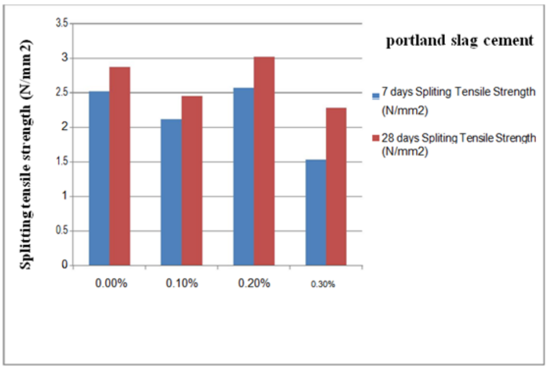
4.4.1 TEST RESULT:

Table 4.9. Effect of Recron fiber on Compressive strength using slag cement:

Fiber content (%)	7 days compressive strength (N/mm^2)	28 days compressive strength (N/mm^2)
0.0	29.036	37.77
0.1	24.63	27.4067
0.2	26.43	32.148
0.3	17.2	25.48

Table 4.10. Effect of recron fiber on Splitting Tensile Strength using slag cement:

Fiber content (%)	7 days splitting tensile strength (N/mm^2)	28 days splitting tensile strength (N/mm^2)
0.0	2.523	2.873
0.1	2.12	2.452
0.2	2.569	3.018
0.3	1.533	2.280



Fiber percentage (%)

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Fig. 4.14 Effect of Recron fiber on splitting tensile strength

4.4.2. 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 different percentage 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.

4.5. CAPILLARY AND POROSITY TEST:

Capillary and porosity test was conducted on specimens prepared with fiber and (fiber + silica fume) of Portland slag cement to observe the amount of water absorption and voids percentage present within the casted concrete.

Capillary test:

In case of capillary test cube specimen cured for 28 days were tested. Firstly the specimens were dried in oven at about 105^{0}C until constant mass was obtained. Specimens were cooled down to room temperature for 6hr. The sides of the specimen were coated with paraffin to achieve unidirectional flow.

The specimens were exposed to water on one face by placing it on slightly raised seat (about 5 mm) on a pan filled with water. The water on the pan was maintained about 5mm above the base of the specimen during the experiment as shown in the figure below. The weight of the specimen was measured at regular 30 minutes interval up to 2hr 30 min to get the little absorption variation of water. The capillary absorption coefficient (k) was calculated by using formula:

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where,
W = Amount of water absorbed in gm
A = Cross sectional area in cm^2 contact with water t = Time in seconds
The experimental set up is shown below,

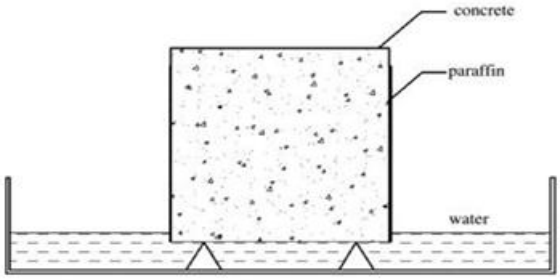

Fig. 4.23 Experimental set up for capillary absorption test

Firstly cubes with different percentage of fibers (0.0%,0.1%, 0.2%, 0.3%) are tested then secondly cubes of different silica fume percentage (10%, 20%, 30%) with constant 0.2% fiber were tested. All the specimens of Portland slag cement. The value of capillary absorption coefficient (k) was determined for different mixes.

Fig. 4.24 Capillary absorption test of cubes

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

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. As the replacement of cement with different percentages with Silica fume increases the consistency increases. 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. So it is inculcated that 0.2% Recron fiber and 20% SF is the optimum combination to achive the desired need. 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.

The splitting tensile strength increases about 15% at 10% SF and constant 0.2% Recron fiber, then decreases with increasing the SF percentage. Flexural strength is not giving good indication and goes on decreasing and it is about 40% decrement as the SF percentage increases to 30%. Ordinary Portland cement gives good compressive strength result as compared to Portland slag cement in case of mix with SF and 0.2% Recron. The capillary absorption coefficient (k) with decreases great sign as SF percentage increases at constant fiber percentage i.e 0.2%. At 20% SF content the k value decreases progressively with 70% reduction that to without SF content concrete. The porosity value also decreases as the SF value increases from 0-30% in Recron fiber reinforced concrete.

5.2. SCOPE OF FURTHER WORK:

The research work on pozzolanic materials and fiber along with pozzolan as is still limited. But it promises a great scope for future studies. Following aspects are considered for future study and investigation; Percentage and actual fineness of GGBS require as partial cement replacement for good strength development. Use of RHA as cement replacement with properly burned in controlled temperature and grinded which may lead proper strength development. Replacing cement with different percentage of silica fume to judge the optimum percentage of silica fume to be used to get better strength result. Research on Recron fiber and silica fume with greater fineness as a partial cement replacing material, by which we can minimise the cost and at the same time achieve the durability and strength for the production of High Performance Concrete. It requires a proper mixing propertions for the development of high strength, high performance concrete which may not be possible manually. So it needs some global optimisation techniques to develop the desire result with greater accuracy and time saving.

REFERENCES:

1. Pierre-Claude Aitcin, “Developement in the application of high performance concrete”,

Construction and Building Material, Vol. 9. No. 1, 1995, 13-17

2. Andrzej Ajdukiewicz and Wojciech Radomski, “Trends in the Polish research on high-performance concrete”, Cement and Concrete Composite, Vol. 24, 2002, 243-251

3. Pierre-Claude Aitcin, “The durability characteristics of high performance concrete”, Cement & Concrete Composite, Vol. 25, 2003, 409-420

4. Moayad N Al-Khalaf and Hana A Yousif, “Use of Rice husk ash in concrete”, The International Journal of Cement Composites and Lightweight Concrete, Vol. 6, November 4 1984.

5. Muhammad Soaib Ismail and A. M. Waliuddin, “Effect of rice husk ash on high strength concrete”, Construction and Building Material, Vol. 10. No. 7, 1996, 521-526

6. Gemma Rodriguez de Sensale, “Strength development of concrete with rice-husk ash”, Cement & Concrete Composite, Vol. 28, 2006,158-160

7. A Oner & S Akyuz, “An experimental study on optimum usage of GGBS for the compressive strength of concrete”, Cement & Concrete Composite, Vol. 29, 2007, 505-514.

8. Caijun Shi and Jueshi Qian, “High performance cementing materials from industrial slags”, Resourses Conservation & Recyclin, Vol. 29, 2000, 195-207

9. K Ganesh Babu and V. Sree Rama Kumar, “Efficiency of GGBS in Concrete”, Cement and Concrete Research, Vol. 30, 2000, 1031-1036.

10. M. Collepardi, “Admixtures used to enhance placing characteristics of concrete”, Cement & Concrete Composite, Vol. 20, 1998, 103-112

11. I. Papayianni , G. Tsohos, N. Oikonomou, P. Mavria, “Influence of superplasticizer type and mix design parameters on the performance of them in concrete mixtures”, Cement & Concrete Composite, Vol. 27, 2005, 217-222 .

12. Ronald F. Zollo, “Fiber-reinforced Concrete: an Overview after 30 Years of Development”, Cement & Concrete Composite, Vol. 19, 1997, 107-122.

13. A. M Alhozaimy, P Soroushian & F Mirza, “Mechanical Properties of Polypropylene Fiber Reinforced Concrete and the Effects of Pozzolanic Materials, Cement & Concrete Composite, Vol. 18, 1996, 85-92.

14. Janusz Potrzebowski, “The splitting test applied to steel fiber reinforced concrete”, The International Journal of Cement Composites and Lightweight Concrete, Vol. 5, No. 1, February 1983

15. S. Bhanja, B. Sengupta, “Modified water–cement ratio law for silica fume concretes”, Cement and Concrete Research, Vol. 33, 2003, 447-450.

6.2. APPENDIX:

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Fig. Concrete Mixer

Fig. Slump test apparatus

Fig.Vibrating machine

Fig. X-RD Machine

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