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Effect of Pozzolanic Materials on Fiber Reinforced Concrete

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Abstract: Different materials like rice husk ash, Ground granulated blast furnace slag, silica fume to obtain the desired needs in this project. Also X-ray diffraction test was conducted on different pozzolanic material used to analyse their content ingredients. I used synthetic fiber (i.e Recronfiber) 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 I used different percentage of silica fume with the replacement of cement keeping constant fiber content and concrete was casted. In this study it was used two types of cement, Portland slag cement(PSC) and Ordinary Portland cement(OPC).I have conducted consistency of cement by Vicat apparatus, the workability by Slump cone, compressive strength test by cube test, splitting test, flexural test etc. Finally porosity and Permeability test conducted.
Keywords: Fiber reinforced concrete, FRC, Pozzolanic materials, etc.

I. INTRODUCTION

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. 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 concreteas 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.

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cement materials, water, aggregate and sometimes admixtures inrequired 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 a

nd 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 south-ward journey; a journey that seems to have gained momentum on its path to self– destruction.

Problem Statement

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 lead to 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 order of M60 to M120 are commonly used. Concrete of the order of M200 and above are a possibility in the laboratory conditions.

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 draw backs, 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.

II. MATERIALS AND PROPERTIES

1) *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.

Table 1. Table Label 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
K2O	0.30

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 SiO2 content and can be used as a concrete admixture. Rice husk ash exhibits high pozzolanic characteristics and contributes to high strength and high impermeability of concrete.

Table 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
P2O5	0.34

3) 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 is subjected to 2000 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.

Table 2. 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

4) *Super Plasticizer:* There are two types of admixtures i.e Mineral admixtures and Chemical admixtures.
Mineral admixtures: Silica fume, Ground granulated blast furnace slag, Rice husk ash, Fly ash Chemical admixture:
a) Accelerating admixture
b) Retarding admixture
c) Water-reducing admixture
d) Air entering admixture
5) *Ordinary Port Land Cement (Opc):* is the basic Portland cement and is best suited for use in general concrete construction. It is of three types, 33 grade, 43 grade, 53 grade. One of the important benefits 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.
a) Aggregate properties greatly influence the behaviour of concrete, since they occupy about 80% of the total volume of concrete. The aggregate are classified as: Fine aggregate, Coarse aggregate Fine aggregate are material passing through an IS sieve that is less than 4.75mm gauge beyond which they are known as coarse aggregate. Coarse aggregate form the main matrix of the concrete, where as fine aggregate form the filler matrix between the coarse aggregate. The most important function of the fine aggregate is to provide workability and uniformity in the mixture. The fine aggregate also helps the cement paste to hold the coarse aggregate particle in suspension.
b) Fiber materials: According to terminology adopted by the American Concrete Institute (ACI) Committee 544, Fiber Reinforced Concrete, there are four categories of FRC based on fiber material type. These are Steel Fiber Reinforced Concrete, Glass Fiber Reinforced Concrete, Sinthetic Fiber Reinforced Concrete, including carbon fibers; and Natural Fiber Reinforced Concrete.
c) Recron Fiber: Recron Fibrefill is India's only hollow Fibre specially designed for filling and insulation purpose. Made with technology from DuPont, USA, Recron Fibrefill adheres to world-class quality standards to provide maximum comfort, durability.

III. MATERIALS USED

A. *Cement*

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

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

Table 3.1. Properties of Portland slag cement:

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

Table 3.2. Properties of Ordinary Portland cement:

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

B. 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 3.3. Properties of fine aggregate:

Properties	Results Obtained
Specific gravity	2.65
Water absorption	0.6%
Fineness modulus	2.47

C. 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 3.4. Properties of coarse aggregate:

Properties	Results Obtained
Specific gravity	2.67
Water absorption	0.4%
Fineness modulus	4.01

D. Fibers

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

E. 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 was used. Specific gravity test was conducted using Le-Chatelier apparatus and found to be 2.77.

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 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.

F. 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.

IV. RESULTS AND DISCUSSION

TABLE 5.1. 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

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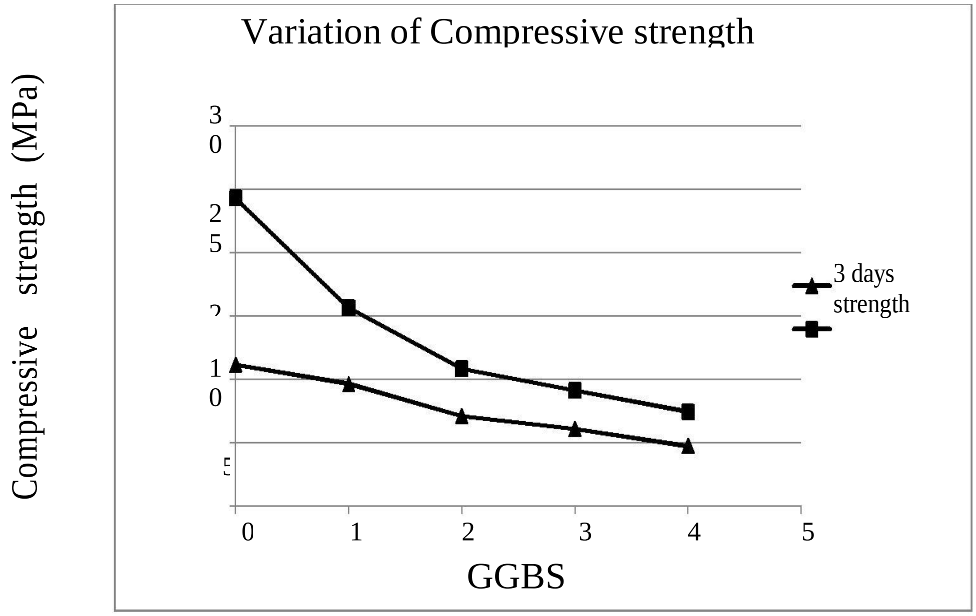
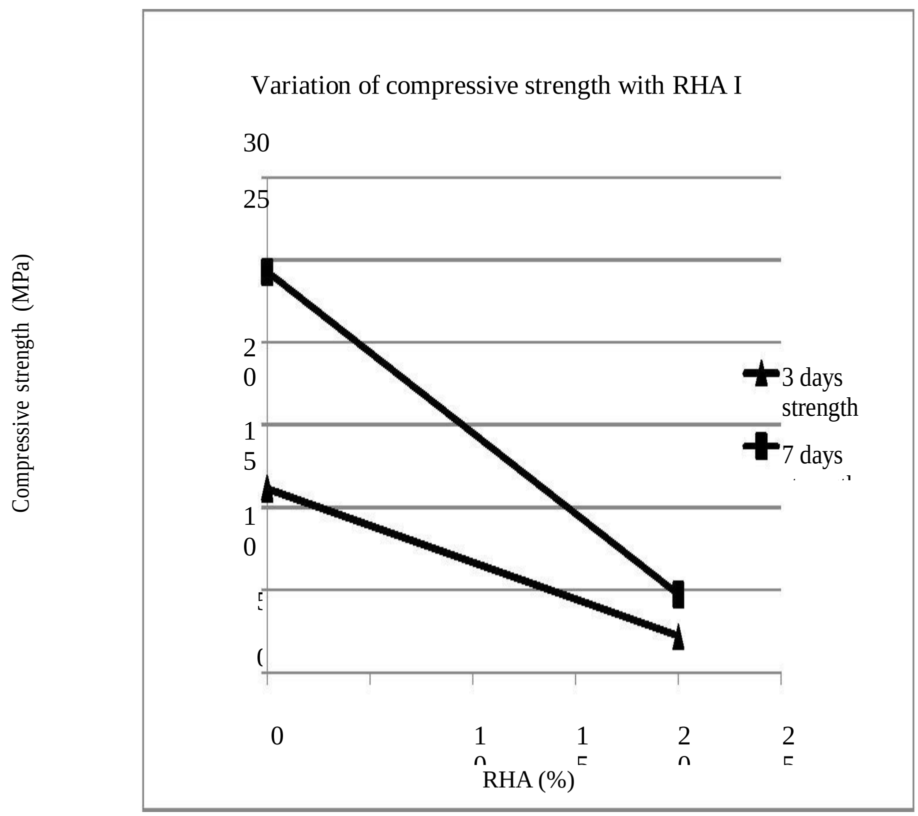


Fig. 5.1 . Variation of Compressive strength of mortar with different GGBS %

Table 5.2. Effect of RHA on Compressive strength of cement:

% of cement replaced byRHA	3 days strength (MPa)	7 days strength (MPa)
0	11.176	24.31
20% (RHA I)	2.23	4.74
20% (RHA II)	3.65	7.45



V. CONCLUSION

1) Use of GGBS as cement replacement increases consistency. Although fineness greatlyinfluenced on proper pozzolanic reaction still GGBS passing 75 micron sieve notgiving good strength of mortar. Using GGBS more than 10% in Portland slag cementthe strength reducing rapidly.
2) With replacement of cement with RHA the consistency increases. Use of RHA whichburned properly in controlled temperature improves the strength of mortar. But use ofRHA not giving satisfactory strength result.
3) With the use of superplasticizer it possible to get a mix with low water to cement ratioto get the desired strength.
4) In case of Portland slag cement with the use of Recronfiber , the 28 days compressivestrength at 0.2% fiber content the result obtained is maximum. The 28 days splittingtensile and flexural strength also increases about 5% at 0.2% fiber content to that ofnormal concrete. Further if fiber percentage increases then it was seen a great loss inthe strength.
5) 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%.
6) Ordinary Portland cement gives good compressive strength result as compared to Portland slag cement in case of mix with SF and 0.2% Recron.

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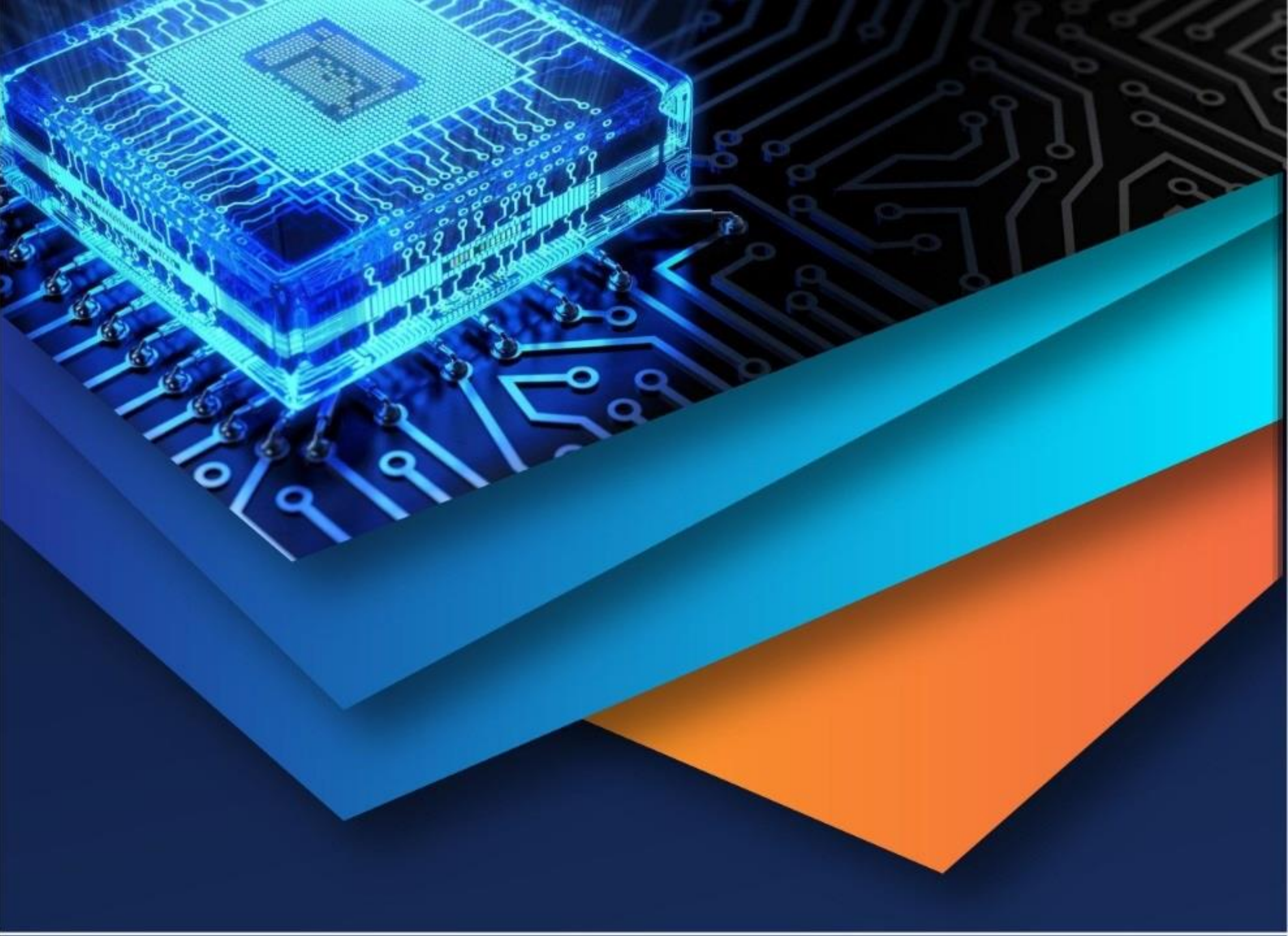

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