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Effect of Binary Blending of RHA and GGBS on Fresh and Hardened Properties of Concrete

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Abstract - *It might be a good choice to reduce the CO_2 emission by using various types of supplementary cementing materials (SCMs), like as Rice Husk Ash (RHA) and Ground Granulated Blast Furnace Slag (GGBS), as a cement replacement in the final concrete product. By reducing the use of Portland cement in concrete product, we can reduce the impact of CO2 emissions in our environment. In the present research, it was proposed to study of binary blending of waste materials (RHA and GGBS) as partial replacement of cement in respect of strength when it is exposed to water for different period (7 Days, 28 Days and 56 days). The optimum compressive strength of specimen has been found 43 N/mm² at GGBS 15% and RHA 3%)*

Key Words Rice Husk Ash (RHA) and Ground Granulated Blast Furnace Slag (GGBS), Binary Blending

1. INTRODUCTION

Rice Husk Ash (RHA) has not been extensively studied in geopolymer application. The RHA is a waste by-product generated from rice milling plants produced by burning of Rice Husk under the controlled temperature. The main component of the RHA is amorphous silicon oxide (83–98%) with a minor quantity of CaO, MgO, K_2O, Al_2O_3, Fe_2O_3 and Na2O. The global production of paddy rice in 2014 was about 741.3 million tons (MT) as per the Food and Agricultural Organization (FAO) report. Therefore, the rice industries will remain sustainable in future and hence higher will be the amount of rice agricultural wastes. India produces about 30 million tons of Rice Husk waste per year. Concrete containing rice husk offer superior durability properties compared to concrete with other admixtures. Several studies have been carried out so far to investigate the effect of GGBS, Rice Husk Ash and plastic Waste on strength and durability of concrete separately which have been reported in subsequent chapter accordingly. However, as per best of the author's knowledge no research has been carried out on combined effect of GGBS, Rice Husk Ash and Plastic waste on compressive strength of concrete.

1.1 Rice husk ash

Naresh et al (2016) Development of High strength Concrete using Rice husk ash and Slag: Hectic industrial activities are envisaged by India and the other developing and under developing countries aiming in this twenty first century, for gigantic improvement in Civil Engineering. India presently is facing problems due to pushing up the cost of construction materials. Already a partial substitution of fly-ash was used for ordinary Portland cement. High strength and high performance concrete are being widely used all over the world. Most of the applications of high strength concrete have been found in high rise buildings, long span bridges etc. The potential of rice husk ash as a cement replacement material is well established. Earlier researches showed an improvement in mechanical properties of high strength concrete with finely ground RHA as a partial cement replacement material. One of the agro-based wastes in our country is rice-husk. Some progress has been made to convert this rice-husk to ash by incineration and use it as a partial substitute replacement for the ordinary portland cement. Rice-husk ash contains 85-95% silica when open burnt and ground to a fineness of 16000Sq-cm/gm. Some investigations were reported on using rice-husk ash concretes and were shown to be good when comparable with concretes with no replacements. Another such mineral admixture is GGBS, confirming to IS12089 which is also a bi-product of iron manufacture industry. Due to its highly cementitious nature, when ground to cement fineness, hydrates like cement. The ground granulated blast furnace slag is a waste product from the iron manufacturing industry, which may be used as partial replacement of cement in concrete due to its inherent cementing properties. An experimental study was conducted on compressive Split tensile and flexural strength of concrete prepared with Ordinary Portland Cement, partially replaced by Rice husk ash and ground granulated blast furnace slag in different proportions varying from 0% to 25%.

1.2 Ground Granulated Blast Furnace Slag (GGBS)

Neeladharan et al (2019) adopted various method has been employed in the Stabilization of soil and to enhance the property of the soil. In the present study. The author has tried to improve the properties of the soil by incorporating local Fly ash and ground granulated blast furnace slag (GGBS). The outcome of the experimental studies was to minimize the cost of conventional material such as cement and lime. It was observed that the by incorporating Fly ash and GGBS in the soil by 15% the the soil changes from CH group to ML group increase of shear strength of soil (according to IS 1498-1970).

Kaviya et al (2017) investigated that the behavior of M35 concrete by partially replacing the cement by Ground granulated blast furnace slag (GGBS). Ground-granulated blast-furnace slag (GGBS) was obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. In order to form a form durable concrete structures in combination with ordinary Portland-cement and/or other pozzalanic materials GGBS was used. Cubes and Cylinders has been tested for its Compressive and split tensile strength after 7 and 28 days of curing. It was observed that the replacement percentages of cement by GGBS used are 30, 40 and 50. Water cement ratio adopted in this work was 0.46. The optimum replacement of Ground granulated blast furnace slag to cement is 30 percentages for M35 grade has been observed in the present experimental investigation.

Shalaka and Jadhav (2020), found that the results of an experimental investigations accomplish to find the suitability of GGBS in production of concrete.M20 grade of Concrete has been prepared by using 43 grade of OPC and GGBS has been mixed . The OPC has been replaced by GGBS. The replacement levels were 0%, 20%, 30% & 40% (by weight of cement) for GGBS. And replacing fine aggregate with 0%, 20%, 30% & 40% crusher dust.

2. MATERIAL AND METHODS

Concrete mix of M25 grade (i.e. concrete having 28days cube strength of 25 MPa as per IS: 456-2000) had been used in this investigation. The mix was designed as per SP-: 23-1982 and IS: 10262-1982. For better distribution of plastic waste in concrete, the fine aggregate was kept to be about 50 percent of the total aggregate. The resulting mix proportion of cement : fine aggregate : coarse aggregate was taken as 1 : 1.89 : 2.17 with a water-cement ratio of 0.49. The cement content was kept 400 kg/m^3 against the minimum cement content requirement of 380 kg/m^3 corresponding to the aggregate of 20 mm maximum size.

A. Cement

Ordinary Portland Cement of Birla grade 43 brand obtained from a single batch was used throughout this investigation. The physical and chemical properties of OPC as determined are given in Table 3.1. The cement satisfied the requirement of IS: 269- 1976. Physical properties of the cement were tested in laboratory in accordance with IS: 4031-1968. The chemical composition of cement was determined as per the procedure laid down in IS: 4032-1985. From chemical analysis, the percentage of various compounds, present in cement and as calculated from Bogue's equation (Neville 1977) were C3S = 54.1%, C2S = 16.6% , C3A = 10.8% and C4AF = 9.1%.

B. GGBS

Blast-furnaces operate at temperatures of about 1,500°C and are fed with a carefully controlled mixture of iron ore, coke and limestone. The iron ore is reduced to iron and the remaining materials form a slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid and if it is to be used for the manufacture of GGBS it has to be rapidly quenched in large volumes of water. The quenching optimises the cementitious properties and produces granules similar to coarse sand. This 'granulated' slag is then dried and ground to a fine powder. Although normally designated as 'GGBS' in the UK, it can also be referred to as 'GGBFS' or 'slag cement'. GGBS was obtained from M/s Vadraj Cement Limited, India.

Fig -1: GGBS

C. Rice husk ash

Rice husks are the hard protective coverings of rice grains which are separated from the grains during milling process. Rice husk is an abundantly available waste material in all rice producing countries, and it contains about 30%–50% of organic carbon. In the course of a typical milling process, the husks are removed from the raw grain to reveal whole brown rice which upon further milling to remove the bran layer will yield white rice. Current rice production in the world is estimated to be 700 million tons. Rice husk constitutes about 20% of the weight of rice and its composition is as follows: cellulose (50%), lignin (25%–30%), silica (15%–20%), and moisture (10%–15%). Bulk density of rice husk is low and lies in the range 90–150 kg/m3.

Rice husk has been procured from the GBS organic. The properties of the rice husk ash have been shown in the fig. 2.

Fig -2: Rice Husk Ask

D. Testing of Specimen

The cubes were tested for determining the compressive strength at the ages of 07, 28, and 56 days. The specimens taken were kept out of water and the solutions, as the case may be, on the day of testing and were put on gunny bags in open air for about two hours to attain the surface dry conditions before testing. The cubes were tested on 2000 kN 'AIMIL' compression testing machine (Fig. 3.) in accordance with the procedure laid down in IS: 516-1981. The average value of five specimens have considered for results.

Fig -3: Compression Testing

3. RESULTS AND DISCUSSIONS

The binary replacement of cement with RHA and GGBS has been done. The RHA has been varied from 3 -15 % with the range of 3%. The GGBS has been varied from 5-30% with the range of 5%. The compressive strength of the specimen has been determined at different age of 7, 28 and 56 days as shown in the Table 4.2. From the figs 4.1 -4.5, it is clear that the compressive strength of the concrete specimens have been increases as the age of the specimen increases at different percentage of RHA.

A. Workabilty

The workability of the concrete mix has been determined by slump test. The workability of different mix has been shown in the Table 4.1.

Table -1: Workability of Different Design Mix

RHA Content (%)	Slump (mm)
0	**96**
5	**90**
10	**85**
15	**79**
GGBS Content (%)	Slump (mm)
0	**96**
10	**97**
20	**99**
30	**98**

From the fig 4 , it has been found that the age of 7days with RHA 3% and for varying GGBS from 5-30% the compressive strength of the specimens increases up to 54%. At the age of 28 days with RHA 3% and for varying GGBS from 5-30% the compressive strength of the specimens increases up to 66%. At the age of 56 days with RHA 3% and for varying GGBS from 5-30% the compressive strength of the specimens increases up to 36%.

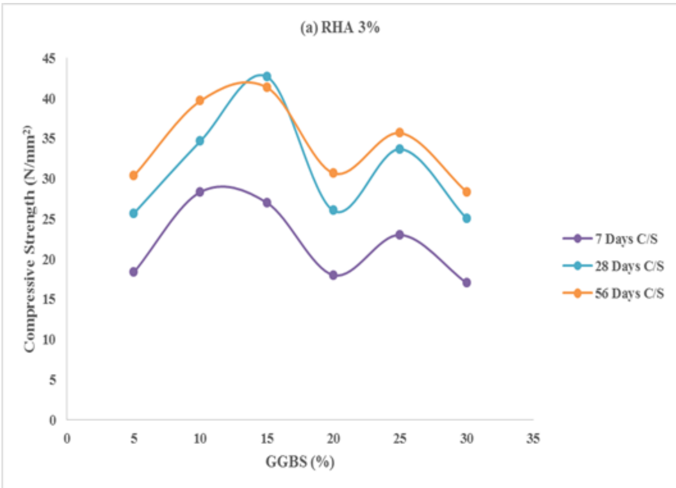

Fig -4: Variation of Compressive strength with respect to GGBS (%) at 3% RHA

The Variation of Water absorption has been investigated for different RHA % at different ages 7 , 28, 56, 90, 180, 270, and 365 days. The percentage of GGBS has been varied from 5-30%. From the fig.5 it has been observed that the variation of water absorption with respect of variation of GGBS is nonlinear. However, the maximum water absorption was found 6.92 % at 30%.

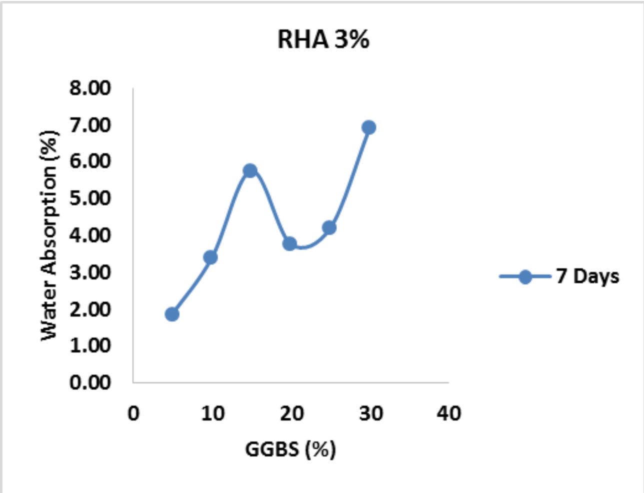

Fig -5: Variation of Water Absorption with respect to GGBS %, at 7 days and RHA 3%

From the Fig. 6, It is evident that the variation of density of concrete decreases with respect to the percentage of GGBS. The variation of the density is linear. However the maximum density is found to be at 5% of GGBS and Minimum density of the concrete is found to be minimum at 30 %.

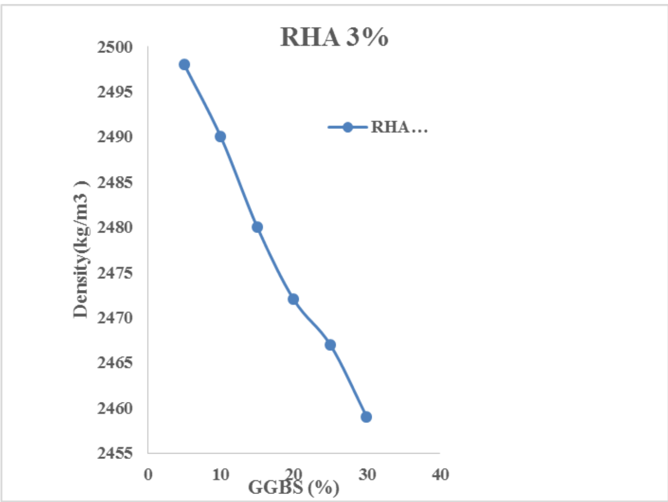

Fig -6: Variation of Density with respect to GGBS at RHA 3 %

4. CONCLUSION

In the present research, it was proposed to study of binary blending of waste materials (RHA and GGBS) as partial replacement of cement in respect of strength when it is exposed to water for different period (7 Days, 28 Days and 56 days). The optimum compressive strength of specimen has been found 43 N/mm2 at GGBS 15% and RHA 3%. It has been found that effect of water absorption is found nonlinear however the variation of density is found deceasing linearly.

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