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Study of geopolymer concrete of rice husk ash and Fuller's Earth

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ABSTRACT

The production of Cement which is the main ingredient of concrete causes major pollution of green house gases. Now a days major initiative is being taken to produce geopolymer concrete which is more economical and environment friendly. This article expounds the study of geopolymer concrete made from Fullers Earth, Rice Husk Ash, Quick Lime and Solution obtained from heating RHA in 20 N NaOH solution. 24 cubes of concrete having dimensions of 150 mm^2 were prepared by mixing Fullers Earth, Rice Husk Ash in different proportions with Quick Lime and coarse and fine aggregate in solution obtained after heating Rice Husk Ash in 20N NaOH solution. The casted specimens were cured at 40 ^oC for 28 days in the curing tank. It was seen that the compressive strength increases with the increase in percentage of Rice Husk Ash but addition of more than 30% Rice Husk Ash brings down the compressive strength of the geopolymer concrete. The mixture of 30% Rice Husk Ash and 60% Fullers Earth gives maximum compressive strength of 30N/mm^2. Thus the focal objective of preparing a cementless concrete has been achieved by the exploitation of naturally available Fullers Earth (FE) and the agricultural waste Rice Husk Ash (RHA).

Key words: *Fullers Earth, Cementless concrete, Geopolymer concrete, Rice Husk Ash.*

Introduction

Cementing materials of different forms have been used by ancient Greece and Rome and the Portland cement made its appearance in 1756. This very production of Portland cement brought a renaissance in the field of architecture but with this it also increased green house gases in our environment (Andrew, 2018; Lloyd and Rangan, 2010; Vora *et al.*, 2013; Joseph *et al*, 2012).

To minimize global warming researchers have taken initiative to develop geopolymers as complete replacement for cement. The emerging technology of geopolymer has reduced about 80% of carbon dioxide emission into atmosphere. In this process the materials rich in aluminium and silicon is reacted with alkaline solution which initiates geopolymenrization process by producing materials which acts as binding agents. In this research the ingredients chosen for preparing geopolymer are FE and RHA along with quick lime and solution obtained from heating RHA in 20 N NaOH solution. FE is a clay used in ancient times for making light weight bricks (Alden, 2010; Alkaya and Esener, 2011; Mirza, *et al.*, 2009). FE contains high percent of aluminium and silicon which acts as good binding agents. On the other hand about 4 tonnes of RHA is produced each year in India. RHA finds much use in developing geopolymers due to its high silica content (Ismail and Waliuddin, 1996). This research is an initiative to develop materials for construction from low cost materials which are already in nature or is disposed as waste. Thus this study will not only make use of waste material but will also minimize the use of cement in construction industries.

Materials and Method

Materials used in this work are

Fullers Earth (FE): FE was obtained from nearby store. The material was powdered and was subjected to qualitative and quantitative estimation.

Rice Husk: Rice Husk was obtained from paddy field. Rice Husk obtained was subjected to heat treatment in furnace at 600 °C and was cooled and kept in desiccator for further use. A part of RHA was taken in a beaker into which 20N solution of NaOH was poured. This solution was refluxed for one hour and the brown colored viscous solution so obtained was filtered and used as activating solution.

Coarse and fine aggregate and commercial grade sodium hydroxide pellets (97.4% purity) and calcium oxide (99% purity) were also used for this study.

A total of 24 concrete cubes of size 150 mm×150 mm×150 mm are casted using different proportions of FE and RHA along with 5% calcium oxide, 5% of aggregate and activating solution. Before casting, the inner surface of the mould is coated with a thin layer of oil in order to help the demoulding process. The cubes were filled with concrete in three layers. After filling the cube with each layer tamping was done with a rod for homogenizing each layer and compaction of the concrete. Once the cube was filled, the surface was made in flush by using trowel and covered with a damp jute cloth and left at 30 °C for 24 hours. Then the samples cubes were cured in the curing tank at 40 °C for 28 days and were then tested for compression strength.

Results and Discussion

FE and RHA when mixed in different proportions with calcium oxide and activating solution forms a hard and tough structure after curing. Qualitative and quantitative estimation of FE and RHA shows the presence of 45% Al_2O_3 and 23% SiO_2 in FE and 82% SiO_2 in RHA. The tough structure is estimated to be formed by the polymerization of Aluminium and Silicon in alkaline media.

Eight sets of slurry prepared with different proportions of FE and RHA when subjected to test for compressive strength showed that the increasing percentage of RHA increases the compressive strength but on further increasing the percentage of RHA above 30% decreases the strength. The increase in compressive strength may be attributed with the increase in Silicon and Aluminium bonding as RHA is rich in SiO_2 while decrease in strength may be due to decrease in Al_2O_3 content procured from FE. Table 1 depicts the average compressive strength obtained from the 8 sets of cured cubes. The compressive strength shows the formation of M30 grade concrete by using 25% to 30% of RHA.

Table 1. Average Compressive Strength of Geo-concrete cubes with varying percentage of RHA and FE

Cube	Sets	% RHA	%FE	Average Compressive Strength (N/mm²)
1	I	5	85	15.65
2				
3				
4	II	10	80	19.43
5				
6				
7	III	15	75	24.97
8				
9				
10	IV	20	70	28.44
11				
12				
13	V	25	65	30.12
14				
15				
16	VI	30	60	31.23
17				
18				
19	VII	35	55	26.10
20				
21				
22	VIII	40	50	24.84
23				
24				

Conclusion

In this research article the compressive strength of geopolymer based concrete increases on increasing the percentage of RHA upto 30%. This has been attributed by the fact that in this ratio the feasibility of geopolymerisation increases which leads to increased compressive strength. Thus this work is a successful attempt of developing a low cost and ecofriendly geopolymer based concrete.

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