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Experimental Study on Metakaolin and Rice Hush Ash Based Geopolymer Concrete

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Abstract: *The use of modern-day cement in construction industries produces two billion tons of CO; emission annually into the atmosphere, which makes it the thirds largest man-made sources of CO; emission. Although the use of Portland cement is still unavoidable, many efforts are being made in order to reduce the use of Portland cement in concrete. The significant advantage of this concrete in utilization of waste material such as rice hush ash from neyveli lignite plant and metakaolin which is highly reactive metastable clay is essentially anhydrous aluminosilicate obtained from calcining kaolin to 650°C-700°C.The present study is aimed to prepare rice hush ash and metakaolin based geopolymer. Concrete with sodium hydroxide molarity 8, 10, 12 & 14M and sodium silicate as activator solution. Curing mode was adopted, ambient curing instead of heat curing various. The ratio of Na-SiO,/ NaOH as 2.5, with liquid binder ratio 0.5 was used. Naphthalene based superplasticizer was used to improve the workability in all geopolymer mixes. Strength properties such as compressive strength test, split tensile test, flexural strength, modulus of elasticity was developed, test results depict that the high calcium rice hush ash geopolymer concrete with metakaolin blend replacement of 75% were marginally higher in NaOH concentration of 12M.*

I.INTRODUCTION

Portland cement concrete is a mixture of Portland cement aggregates, and water. Concrete is the most often used construction material. The worldwide consumption of concrete was estimated to be about

8.8 billion tons per year. Due to increase in infrastructure developments, the demand for concrete would increase in the of future.

The production of cement is increasing about 3% annually, the production of one ton of cement liberates about 0.7 tons of CO; to the atmosphere, as he results of de-carbonation of limestone in the kiln during manufacturing of cement and the combustion of fossil fuels.

The contribution of Portland cement production worldwide to the greenhouse gas emission is estimated to be about 1.35 billion tons annually or about 7% of the total greenhouse gas emissions to the earth's atmosphere. Cement is also among the most energy intensive construction materials, after aluminum and steel. By the year 2017, the world cement consumption rate is expected to reach about 2 billion tones, meaning that about 1.4 tones CO_2 will be released. In order to address the environmental effect associated with Portland cement, there is a need to use other binders to make concrete.

One of the efforts of producing more environmentally friendly concretes is to replace the Portland cement in concrete with the pozzolanic materials like rice hush ash, rice husk ash, GGBS, metakaolin, bottom ash etc.

II. MATERIALS AND PROPERTIES

2.1. Metakaolin

Metakaolin is refined kaolin clay that is fired (calcined) under carefully controlled conditions to create an amorphous aluminosilicate that is reactive in concrete. Kaolin is mined and crushed, it is separated from sand, refined to remove impurities and stored in store. kaolin is fed into rotary kiln to produce metakaolin is obtained from the calcinations of kaolinite clays at temperatures.

Metakaolin is an artificial pozzolanic material obtained by the calcination of kaolinite clays over a specific temperature range. It is a material with pozzolanic properties and can be added to lime mortar mixes to provide improved mechanical and water behaviour characteristics for use in conservation mortars. For this application cement mortars are inadequate, due to their excessive brittleness, low plasticity and high elastic modules and high content insoluble salts.

2.2. Fine Aggregate

Concrete's primary component, aggregate, gives the material volume. Since it is chemically inert, it gives concrete strength and longevity. M-sand that passes through a 4.75mm screen is used as fine aggregate. The parameters of fine aggregates tested.

2.3. Coarse Aggregate

As coarse aggregate, natural crushed stone with a 20mm minimum particle size was employed. The test results for the coarse aggregates

2.4. Rice hush ash

Rice dust is formed during the processing of rice grain at a rice-processing plant as a resultof the discharge upon the receipt of raw rice from vehicles, removal of impurities, sorting by size, during separation of membranes, crushing, grinding, polishing, moving grain along the elevators and conveyors, etc., i.e., during all technological operations of the rice groats production.

High dust concentration in the air is one of the main adverse factors, resulting in environmental pollution and occupational diseases. Prolonged breathing in the dusty air causes heavy damage to human health. Dust with a diameter greater than 10 microns causes irritation of the upper respiratorytract.

III.DESIGN METHODOLOGY

3.1. Mix Design

Based on the limited part research on geopolymer pastes available as the true and the experience grained during the preliminary experimental work following ranges were selected for theconstituents of the mixtures used.

Ratio of activator solution -to-metakaolin by mass in the range of 0.5.

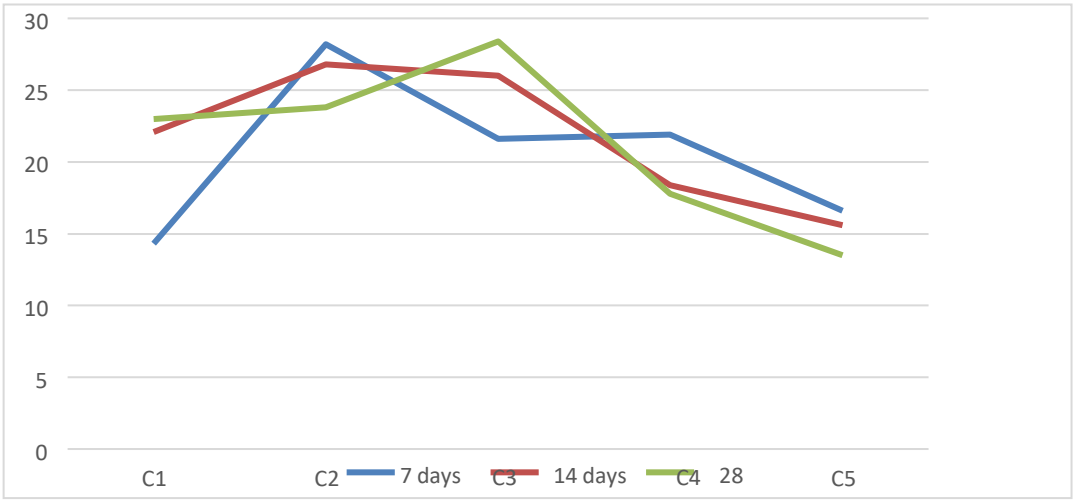
Table 6. Mix Proportion Per Cube meter

S.NO	Cube Type	Concrete Design Mix Proportion(ByWeight)				
		Metakaolin (kg)	Rah (kg)	F.A (kg)	C.A (kg)	W/C ratio
1.	C1	0.75	0.75	2.25	4.5	0.42
2.	C2	1.0	0.5	2.25	4.5	0.42
3.	C3	1.25	0.25	2.25	4.5	0.42

Mix Proportion per Cube meter

Cube ID	Description
C1	50%(metakaolin)+50%(Rha)
C2	60%(metakaolin)+40%(Rha)
C3	75%(metakaolin)+25%(Rha)

3.2. Results and Discussions



X-Axis: % of Metakaolin & Rice hush ash, Y-Axis: Compressive Strength(Mpa)

3.2.1. Compressive strength test

The most frequent test on concrete is the compressive strength test because it is a measure of the desirable characteristics of concrete that are quantitatively connected to its compressive strength.Compressive Testing Machine (CTM) with a 2000 kN capacity was used to measure compressivestrength. Concrete's compressive strength was evaluated using cube specimens of 150 mm by 150mm by 150 mm. The test was conducted by sandwiching a specimen between a CTM's loading surfaces, then applying load until the specimen broke. For each proportion, three test specimens were cast, and the compressive strength was measured under each set of test conditions. The average value was taken into account. Below are three specimens' average compressive strengthsat ages 7, 14, and 28 days for each category.

IV.SUMMARY AND CONCLUSION

A study on high calcium rice hush ash and metakaolin based geopolymer was attempted to find its viability in concrete. Preliminary study on the geopolymer was carried out by studying various molar concentration of NaOH. Based on the compressive strength of high calcium rice hush ash metakaolin based geopolymer trial mixes are carried out replacement of rice hush ash by metakaolin in25%,50%,75% & 100% by mortar cubes of varying molarity 8M, 10M, 12M & 14M.

compressive strength increases when molarity increases from 8 to 12M in high calcium rice hush ash geopolymer mortar then decreases in 14M. Maximum compressive strength 21.69 N/mm² was attained in 12M ofNaOH & Na:SiO, ratio2.5, with liquid binder ratio 0.5 and 75% replacement of metakaolin with rice hush ash in mortar cubes..

Hardened properties of high calcium rice hush ash geopolymer concrete achieved marginally higher value when molarity of NaOH 12M & 75% replacement of metakaolin.

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