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RESEARCH ARTICLE OPEN ACCESS

Effect Of NaOH Molarity On The Compressive Strength Of Sugarcane Ash Based Geopolymer Mortar.

Keerthana R, Nandu Anil, Pavithra M Shaji, Ubais K, Prof. Divya S Nair
(Student of Department of Civil Engineering Kidangoor, Kottayam-83, Kerala
(Student of Department of Civil Engineering Kidangoor, Kottayam-83, Kerala
(Student of Department of Civil Engineering Kidangoor, Kottayam-83, Kerala
(Student of Department of Civil Engineering Kidangoor, Kottayam-83, Kerala
(Assistant Professor of Department of Civil Engineering, College of Engineering Kidangoor, Kottayam- 83

ABSTRACT
Geopolymer mortar is an environment friendly and promising alternative to cement mortar. Research were going in the field of geopolymer cement, geopolymer mortar and also geopolymer concrete. For the preparation of geopolymer mortar an activator solution and a source material is needed. Any material which is rich in silica and alumina can be used as a source material. Sodium silicate and sodium hydroxide or potassium silicate and potassium hydroxide is used as activator solution. Flyash, GGBFS, silica fume, sugarcane baggase ash etc are used as source materials. This source material and alkaline solution react together to produce the geopolymer mortar. One of the important physical property of concrete is its compressive strength. In this experimental research the effect of molarity of solution on the compressive strength of geopolymer mortar were studied. Also the effect of curing (ambient curing and oven drying) on compressive strength were also studied.
Keywords— Geopolymer, Sugarcane baggase ash, Flyash.

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I. INTRODUCTION

The demand for Portland cement is rising, which increases CO2 emissions into the environment and contributes to global warming. Portland Pozzolana Cement (PPC) cement is currently the most popular type. There are several factors contributing to the pollution caused by Portland Pozzolana Cement. Cement is the primary component used to make concrete in the construction industry. However, a substantial number of raw materials are needed to produce cement. Burning lime stone produces carbon dioxide (CO2) gas, which is released into the atmosphere during cement manufacturing. When cement is produced, CO2 emissions come from two different places. The greatest source is burning fossil fuels to run the rotary kiln, and another is burning limestone chemically. Due to an increase in demand for cement, there is also an increase in cement output, which contributes to environmental degradation and global warming. Cement production peaked in 1995 at 1.5 billion tonnes, and it continued to rise, reaching 2.2 billion tonnes in 2010. One tonne of CO2 is released into the environment during the manufacturing of one tonne of cement. CO2 is the only greenhouse gas that contributes to 65 percent of all global warming. In 1979, it was found out that by-product materials like fly ash may be utilised to react with an alkaline liquid to create binders. In order to combat the problems with global warming, a number of initiatives are being made to complement the usage of Portland cement. The sodium hydroxide and sodium silicates that make upthe alkaline solution are inexpensive and widely accessible in the area. Therefore, fly ash and alkaline solution can totally replace cement since fly ash is typically inert and behaves like cement when it combines with an alkali, creating a geopolymer. An inorganic polymer with little weight is called geopolymer. In order to create geopolymer mortar, elements containing aluminate and silicate, like fly ash or slag from the production of iron and metal, must be chemically reacted. It can serve as a viable replacement for regular Portland cement (OPC). The word "geopolymer" comes from the fact that the primary raw materials utilised in the manufacture of silicon-based polymers are minerals thatform rocks in the earth. Viktor Glukovsky of Kiev, USSR, created concrete materials in the 1950s that were initially referred to as "soil silicate concretes" and "soil cements," but since Joseph Davidovits introduced the geopolymer concept in 1991, the terminology and definitions of "geopolymer" have grown more varied and frequently conflicting[3]. Professor Joseph Davidovits conducted research on fireproof polymers in the late 1970s and created the word "geopolymer" to characterise a class of alkali-activated aluminosilicate binders. Thus, the production of geopolymer using kaolinite and calcined kaolinite has garnered interest on a global scale. Geopolymer technology has great promise for use in the concrete industry as an alternative to Portland cement as a binder. The geopolymer technology has the potential to drastically reduce the CO2 emissions to the atmosphere that the cement industry is responsible for in terms of global warming. Since fly ash is a by-product of thermal power plants and has excellent cementitious characteristics, the fly ash-based geopolymer is extremely environmentally benign. Although geopolymer can be made from industrial waste, it didn't require as much energy to make as Portland cement. The production of geopolymers may result in a reduction in greenhouse gas emissions. An all-natural component that includes silica (Si) and alumina makes up the majority of the components of geopolymer (Al). Sugarcane baggase ash is rich in silica and contains considerable amount of alumina too[1]. The polymerization process proceeds quickly between 60 and 90 degrees Celsius. And the polymerization bond depends on silica and alumina. Following the reaction of these fundamental components, alkali activator solvents such NaOH and Sodium Silicate, with a NaOH concentration of approximately 8–14 M, were used. Bagasse ash waste from sugarcane is the main component used in this geopolymer research. We attempt to investigate the effect of NaOH molarities and curing methods on the compressive strength of geopolymer mortar and the potential benefits of incorporating a locally accessible industrial waste like sugarcane bagasse ash into it because geopolymer has become one of the most contentious topics of discussion in the construction industry in recent years due to the increase in the amount of global greenhouse gases.

II. SCOPE OF THE PROJECT

- Availability of cheap and eco-friendly alternative for Portland cement.
- Consumption of locally available industrial waste (bagasse ash) and thereby reducing theindustrial waste deposition.
- Reduction in CO2 emission and thereby reducing the global warming.
- Increased compressive strength.

III. OBJECTIVES

- To determine the optimum ratio of sugarcane bagasse ash and fly ash (60:40,70:30, 80:20,90:10).
- To determine the effect of NaOH molarity on compressive strength of optimum mix.
- To determine the effect of curing on compression strength –oven drying & ambient curing.

IV. METHODOLOGY

A. COLLECTION OF MATERIALS

Flyash, sugarcane bagasse ash, sodium hydroxide, sodium silicate, and fine aggregate make up the components of geopolymer mortar. Fly ash, a byproduct obtained from thermal power plants is widely available. The sodium hydroxide and sodium silicates that make up the alkaline solution are inexpensive and widely accessible in the area. Sugarcane bagasse ash was gathered from the jaggery mill

B. DETERMINATION OF MIX PROPORTION

Trial and error is used because there are no IS code specifications for the mix design of geopolymer mortar. To determine the mix proportion, flyash and sugarcane bagasse ash were combined in the following ratios: 60:40, 70:30, 80:20, and 90:10, respectively[4].

C. PREPARATION OF TEST SAMPLES OF DIFFERENT NaOH MOLARITIES

The impact of various NaOH molarities on the mortar is discovered once the mix proportion is established. For this reason, eight sample cubes with dimensions of 70.6mm x 70.6mm x 70.6mm are constructed, three of each of the following sizes: 8M, 10M, 12M, and 14M.

D. MIXING, CASTING AND CURING

The alkaline solution are prepared and is kept for 24 hours then the flyash and alkaline solution are blended in the designated ratio for 5 minutes. Later, sand is added and stirred for an additional five minutes. Steel moulds measuring 70.6mmX70.6mmX70.6mm were used to cast the mortar samples and then compression test is carried out.

E.TESTING OF COMPRESSIVE STRENGTH OF SAMPLES

Mortar cubes were prepared and tested using Universal Testing Machine (UTM). The remaining sets of 8M, 10M, 12M, and 14M are treated to ambient curing, while one set is dried in an oven. The oven was set to cure the mortar mixture in the moulds at a temperature of 80°C. UTM with a loading capacity of 40T is used for compression strength measurements.

V. OPTIMUM MIX RATIO

The alkaline solution are prepared and is kept for 24 hours then the flyash and alkaline solution are blended in the designated ratio for 5 minutes. Using sieve analysis the M-sand selected for the experiment is found belonging to zone-1 , later sand is added and

stirred for an additional five minutes. Steel moulds measuring 70.6mmX70.6mmX70.6mm were used to cast the mortar samples. The mortar is then manually compressed using a cylindrical plunger after being filled in a mould in two layers. Geopolymer mortar samples are cast, let to cool to room temperature under atmospheric pressure and unrestricted humidity for an hour, and then cured for 24 hours at 80 °C in an oven. The ratio of flyash to bagasse ash was varied in the following orders: 60:40, 70:30, 80:20, and 90:10, respectively, to determine the mix percentage.
The cube specimen with a 70:30 ratio was found to have the highest compressive strength, hence 70:30 was determined to be the ideal ratio for bagasse ash to flyash

VI. COMPRESSIVE STRENGTH TEST

In this experimental work, four different mixtures with the same content of fly ash (592g) and baggase ash (254g) was prepared to study the influence of sodium hydroxide concentration on the compressive strength of geopolymer mortar[2].

Four levels of sodium hydroxide concentration i.e. 8 M, 10 M, 12 M and 14 M were used. Activation of aluminosilicate based materials with alkalis generally requires heat curing for the formation of alkali-activated binders. Mortar specimens were cured in the oven at 80°C for a period of 24 hours to complete geopolymerisation reaction.

Initially, the alkaline solutions were prepared a day prior to the casting of mortar cubes. The necessary molarity of NaOH solution is made and it is then combined in 1:1 ratio with sodium silicate. The weight of NaOH pellets required in one litre of water for the preparation NaOH solution of different molarity is shown in Table 2. The NaOH flakes were diluted by using tap water and left at ambient temperature for 24 h to reduce the excessive heat generation. Later, the calculated quantity of alkali liquid was added gradually and mixed thoroughly. Cube specimens of 70.6 mm X 70.6 mm X 70.6 mm in size were cast by using fly ash and baggase ash as binders along with m-sand in required quantities as given in Table 3.

VII. TEST RESULTS

The test is done on geopolymer mortar cubes in compressive strength testing machine to determine its compressive strength after the age of 1 days and 28 days for oven dried and ambiently cured samples respectively.

A. OVEN DRIED SAMPLES

Cube specimens of 70.6 mm X 70.6 mm X 70.6 mm in size were cast by using fly ash and baggase ash as binders along with m-sand in required quantities. Mortar cubes are then placed in oven for 24 hours for heat curing at 80°C. Heat cured samples were then taken out [Fig 6.1] and compressive strength test was carried out. The results obtained in the test is shown in Table 4. It can be seen that the compressive strength of geopolymer mortar with 8M NaOH concentration cured at 80°C has been found to be in the range of 13.5 N/mm² to 14.5 N/mm² and the maximum compressive strength was obtained for mortar with 14M NaOH concentration , ranging between 24 N/mm² to 24.5 N/mm². It can be observed that for oven dried samples the compressive strength increases with increase in NaOH molarities.

SAMPLE	COMPRESSIVE STRENGTH (N/mm²)
8M	13.84
	14.24
	14.14
10M	19.46
	20.06
	19.76
12M	22.36
	22.06
	21.66
14M	24.07
	23.77
	24.47

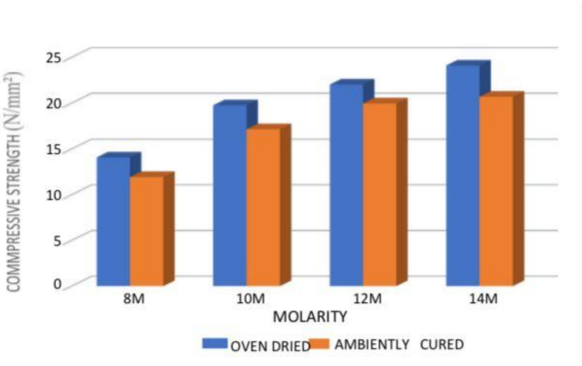
B. AMBIENTLY CURED SAMPLES

The remaining mortar cube specimens are subjected to ambient curing for 28 days in room temperature. Ambiently cured samples after 28 days [Fig 6.2] is subjected to compressive strength test . The results obtained in the test is shown in Table 5. The compressive strength of geopolymer mortar with 8M NaOH concentration has been found to be in the range of 11.5 N/mm² to 12.5 N/mm² and the maximum compressive strength was obtained for mortar with 14M NaOH concentration , ranging between 20.5 N/mm² to 21 N/mm². It has been observed that for ambiently cured samples there is an increase in compressive strength of geopolymer mortar with molarity.

SAMPLES	COMPRESSIVE STRENGTH (N/mm^2)
8M	11.83
	11.74
	12.24
10M	16.75
	17.65
	17.05
12M	19.26
	19.66
	20.16
14M	20.76
	20.46
	20.86

C. VARIATION OF COMPRESSIVE STRENGTH WITH MOLARITY

The results of the compressive strength test indicates the influence of molarity on the compressive strength of geopolymer mortar. For both oven dried and ambiently cured samples the compressive strength is found to be increasing with increase in molarity of NaOH[2]. A graphical representation of the variation of compressive strength with NaOH molarity is shown in Fig 6.3. The graph also shows the variation of compressive strength for oven dried and ambiently cured samples. Oven dried samples possessed greater compressive strength as compared to ambiently cured samples.



VIII. CONCLUSION

- The ideal ratio of baggase ash to fly ash was determined to be 70:30.
- It has been noted that compressive strength increases with increase in NaOH molarity, because with the increase in hydroxide molarity dilution of initial solid materials takes place at a faster rate.
- The oven dried samples possess higher compressive strength as compared to ambiently cured samples because heat curing enhances polymerization process.

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