Geopolymer Effects on Brick using Different Molarity

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Abstract— Geopolymer requires an alkaline to induce it pozzolanic property and to accelerate the Geopolymerization process. The Geopolymerization process occurs due to the mixing of fly ash, sodium silicate and sodium hydroxide as the alkaline activator is used. The purpose of the present study is to investigate the behaviour of fly ash based Geopolymers bricks and to study its durability. In this work main focus is on use of cement by replacing fly ash for making geopolymer bricks. The bricks were cast with proportion of fly ash to sand 1:3. The ratio of fly ash to alkali solution is used 2 and sodium silicate to sodium hydroxide is 2.5.The bricks were casted size of 230mmX110mmX90mm. The alkaline solution was prepared using sodium hydroxide and sodium silicate mix together for 24 hours with different type of molarities such as 6M, 8M, 10M, 12M, 14M, 16M.The specimens were cured at constant oven temperature at 80oC for 48 hours. It is observed that the geopolymer bricks give maximum compressive strength as compared to country bricks and fly ash bricks. In geopolymer bricks the maximum compressive strength is gain for brick casted with 10 Molarity.

Key words: Fly Ash, Alkaline Solution, Crushes Sand

I. INTRODUCTION

Geopolymeric, one of viable technology, is currently receiving increased attention in academic and industrial communities for its ability to produce fly ash-based, kaolin base or raise husk ash base geoplymers material in several applications. Geopolymer was first developed by Davidovits in 1979, are said to possess excellent mechanical performance with respect to high compressive strength, chemical resistant and fire resistant. The synthesis of geoplymers has been carried out by chemical reaction of aluminosilicate materials with alkaline silicate solutions at ambient or slightly elevated temperatures, yielding amorphous to semi-crystalline polymeric structures.

Building bricks are usually made from clay and sand, which are mixed and moulded in various ways and need to be dried and burned. Nevertheless, geopolymers bricks are made with less energy and low cost than that needed in production of conventional bricks. The development of geoplymers brick is an important step towards to produce bricks with better performance and environmental friendly material. Fly ash based geoplymers required heat to increase the geopolymerization process in order to obtain higher compressive strength. The Geopolymer requires an alkaline activator to induce it pozzolanic property and to accelerate the geopolymerization process. The ratio of fly ash to alkaline activator and sodium silicate to sodium hydroxide play an important role in obtaining desirable compressive strength. The concentration of NaOH solution in this study was 12M (1).The main focus of the investigation is on optimum utility of the available fly ash and minimizing the water absorption and attaining high compressive strength. Increase in curing temperature increases the compressive strength of the geopolymer mortar. The steam curing increases strength and the strength of stream cured bricks is more when compared to air curing (2). However when the geopolymers sample cured at temperature more than 60° C, The compressive strength is decreased. It can be concluded that the optimum curing temperature for fly ash based geopolymers is 60° C. (5). The test results revealed that a 12M NaOH solution produced the highest compressive strength for the geoplymers. A study conducted D. Hardjito (7) shown that the use of a Na2SiO3 / NaOH Ratio of 2.5 gave the higest compressive strength; where as a ratio of 0.4 resulted in lower compressive strength. Fly ash based geopolymers have been studied by several decades due to their excellent mechanical properties. The optimum ratio of fly ash to sand 1:3 shows good performance in workability and structure which is suitable for use in production of geoplymers bricks (6).

A. Geoplymers

Geopolymers are inorganic, typical ceramic materials forms long chain covalent bond amorphous network. The composition of the geo-polymer material is comparable to zeolitic material, materials however microstructure is of amorphous state rather than crystalline. In geopolymerization practice quick reaction of alkaline activated solution with silica-Alumina minerals takes place and formation of a three dimensional polymeric chain and ring structure made of Si-O-Al-O bonds takes place.

II. MATERIALS AND EXPERIMENTAL DETAILS

A. Materials

1) Fly Ash

The fly ash was obtained from the Manhunt power plant, Lumut, Perak, Malaysia, andnit was equivalent to ASTM Class F fly ash. When used in Portland cement, class F fly ash can be used as a Portland cement replacement ranging from 100% cementious material. F fly ash is required as cementing agent such as Portland cement. So that reactive and hard compound is formed. Alternatively, adding a chemical explosive to the cascade factories like sodium silicate (water glass) can create a geographical power to form class F. The fly ash derived from the bituminous and hard shiny black coal is referred as (class F) fly ash or low-calcium fly ash.

2) Alkaline Solution

Alkaline solution is a composite mixture with sodium hydroxide (NaOH) or potassium hydroxide (KOH) and sodium silicate are also known as water glass (Na_2SiO_3). The sodium hydroxide was used in pellet form with 98 % purity. Sodium can be Hydroxide solution prepared by dissolving NaOH Solid form in a different type of molar different in water Mass. Both measures should be done in 24 hours before use.

B. Mortar mixes

To achieve the desired molarity sodium Hydroxide pellets were taken and dissolved in distilled water. The mass of

NaOH solids in solution varies depending on the concentration of the solution. The fly ash based bricks mortar was cast of size 230mmX110mmX90mm. In this work fly ash to crush sand ratio is taken as 1:3 as per IS 2250-1981.The mass of geopolymer solids is the sum of the mass of fly ash, sodium hydroxide and the mass of Na_2SiO_3 ($Na_2SiO_3.5H_2O$) The mortar mix proportions are taken as shown in table 1.

III. EXPERIMENTAL WORK

In experimental work the materials fly ash, crush sand, alkaline solution was mixed with different molarity. The crush sand and fly ash were weighted firstly and mixed together properly about 2 minutes based on the mix design and then alkaline solution is added into crush sand and fly ash to become a geoplymers paste and mixed together properly for 2 min and NaOH solution of various molarity Like a 6M, 8M, 10M, 12M, 14M, 16M.as shown in table 1. Weight of 1 morality is 40 for NAOH solution. Water was added into this dry mixture and mixed together about 4-5 min. Then this homogeneous mixture is placed into a mould.

Sr. no.	Molarity for NaOH	Fly ash kg	Sand kg	NaOH (kg)	Na_2SiO_3 (kg)	Alkaline solution
1.	M6 (6X40)	124	372	54	132	186
2.	M8 (8X40)	124	372	54	132	186
3.	M10 (10X40)	124	372	54	132	186
4.	M12 (12X40)	124	372	54	132	186
5.	M14 (14X40)	124	372	54	132	186
6.	M16 (16X40)	124	372	54	132	186

Table 1: Detailed Mix Design

IV. MOULDING AND CURING PROCESS

The mixture was mixed until it becomes homogeneous, a mould of size 230mmX110mmX90mm were used for casting bricks. A Minimum of three samples was produced for each mix design to determine the average value of the compressive strength and to determine the water absorption. The samples were cured at a temperature of 80° C for 48 hrs. After that, the samples were kept at room temperature for seven days. Then the bricks were tested for compressive strength and water absorption.

V. RESULT AND DISCUSSION

A. Compressive Strength Test Result

The bricks of size 230mmX110mmX90mm were tested for compressive strength after seven days. The results are presented in table No.2 and Fig No.1.The compressive strength increased upto 10M and then decreases.

Sr. No.	Type of bricks	Compressive strength (Mpa)
1.	Country bricks	8.29
2.	Fly ash bricks	9.81
3.	Geopolymer bricks 6M	14.28
	8M	20.40
	10M	24.48
	12M	14.28
	14M	12.24
	16M	10.20

Table 2: Compressive Strength of Various Specimens

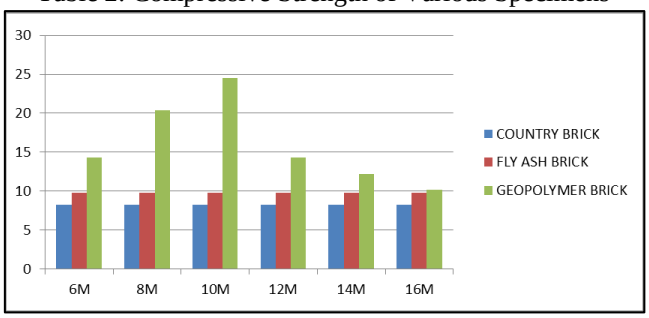

Fig. 1: Compressive strength of various specimens

From Fig No.1 is observed that the highest compressive strength is observed for brick casted with 10M of NaOH solution. The compressive strength of geoplymers bricks is higher as compared to other bricks. The compressive strength of country bricks is 8.29MPa, fly ash bricks are 9.81MPa and geopolymer bricks are 24.48 respectively.

B. Water Absorption Test

To study the water absorption of geopolymer bricks, the bricks were tested for water Absorption test. The bricks were placed in an oven 80°C temp. When the curing period is completed, the brick were immersed in the water tank and kept for 24 hours in water and weight is taken $W_1$and W_2.

The water absorbed by the entire specimen was calculated as follows.

% of water absorption = $W_2 – W_1 / W_1 * 100$

W1 = Weight of the dry brick.

W2 = Weight of the wet brick.

Sr. No.	Type of bricks	Water absorption (%)
1.	Country bricks	10.75
2.	Fly ash bricks	6.43
3.	Geopolymer bricks 6M	2.1
	8M	1.8
	10M	1.44
	12M	1.72
	14M	2.01
	16M	2.3

Table 3: Water Absorption of Various Specimens

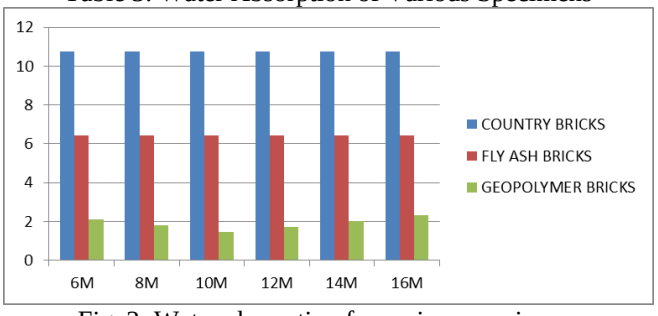

Fig. 2: Water absorption for various specimens

The results from above Table No.3 and Fig No.2 are observed that the water absorption is decreases upto 10M and then increases. The water absorption of geopolymer bricks is very low as compared to other bricks. The water absorption of country bricks is 10.75%, fly ash bricks are 6.43% and geopolymers bricks are 1.44%.

VI. CONCLUSIONS

From the detailed experimental investigations following conclusions are drawn

1) The compressive strength of country brick is 8.29 MPa, fly ash brick is 9.81 MPa and the highest compressive strength of geoplymers brick casted with 10M NaOH solution is 24.48 MPa.
2) The water absorption of country brick is 10.1% the, fly ash brick is 6.4% and the water absorption of geoplymers brick is 1.44 %.
3) The unit weight of geoplymers brick is very high than of the other type of brick.

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