ISSN: 2278-0181
NCNTCE-2015 Conference Proceedings

A Study of Autoclave Aerated Brick using Geo-Polymer

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Abstract- **This study is compared the behaviour of geopolymer brick and geopolymer Autoclave Aerated brick. The geopolymer contains sodium hydroxide and sodium silicate, which is reacted with water and produced heat in the process of heat of hydration.The geopolymer brick is laid by the ratio of 1:3 (it means 1 kg of fly ash and 3 kg of M sand) and 200 gram of geopolymer mixed with 500 ml of water. The geopolymer Autoclave Aerated brick is laid by the ratio of 1:3 (it means 1 kg of fly ash and 3 kg of M sand) and 200 gram geopolymer mixed with 500 ml of water. Additionally the 20 gram of aluminium powder mixed with 25 ml of water. The test done on bricks are compression test (7, 14, 28 days), water absorption test. The result obtain from the compression test for geopolymer brick (7, 14, 28 days) 8.7Mpa, 19.53Mpa, 24.56Mpa. and test for geopolymer Autoclave Aerated brick (7, 14, 28 days) 8.4Mpa, 18.92Mpa, 23.53Mpa. water absorption test for geopolymer brick 2.45. and test for geopolymer Autoclave Aerated brick 1.98**

Key words: Fly ash,Sodium Silicate, Sodium Hydroxide and aluminium powder.

I) INTRODUCTION

Demand for concrete as construction material is on the increase and so is the production of cement. The production of cement is increasing about 3% annually The production of one ton of cement liberates about one ton of CO_2 to atmosphere . Among the green house gases, CO_2 contributes about 65% of global warming. Furthermore, it has been reported that the durability of ordinary Portland cement concrete is under examination, as many concrete structures especially those built in corrosive environments start to deteriorate after 20 to 30 years, even though they have been designed for more than 50 years of service life. Although the use of Portland cement is unavoidable in the foreseeable future, many efforts are being made to reduce the use of Portland cement in concrete. On the other hand, the abundant availability of fly ash worldwide creates opportunity to utilize this by-product of burning coal, as a substitute for OPC to manufacture concrete. When used as a partial replacement of OPC, in the presence of water and in ambient temperature, fly ash reacts with the calcium hydroxide during the hydration process of OPC to form the calcium silicate hydrate (C-S-H) gel. The development and application of high volume fly ash concrete, which enabled the replacement of OPC up to 60% by mass, is a significant development. Davidovits proposed that binders could be produced by a polymeric reaction of alkaline liquids with the silicon and the aluminium in source materials of geological origin or by-product materials such as fly ash and rice husk ash. He termed these binders as geopolymers.

II MATERIALS

A.Fly ash

Fly Ash, an industrial by-product from Thermal Power Plants (TPPs), with current annual generation of approximately 108 million tones and its proven suitability for variety of applications as admixture in cement/concrete/mortar, lime pozzolana mixture (bricks/blocks) etc. is such an ideal material which attracts the attention of everybody. Cement and Concrete Industry accounts for 50% Fly Ash utilization, the total utilization of which at present stands at 30MT (28%). The other areas of application are Low lying area fill (17%), Roads &Embankments (15%), Dyke Raising (4%), Brick manufacturing (2%) etc. The life cycle cost of Fly Ash based building materials/constructions is much lower taking into account the environmental benefits and durability aspects.

III) MATERIALS PROPERTIES

a. CHEMICAL ANALYSIS OF FLY ASH

Table 1 Elements present in the materials

CHEMICAL COMPONENT	PERCENT%
Sio_2	59.32
Al_2o_3	19.72
Sio_2/Al2o3	3.01
Sio2+Al2o3	79.04
Cao	6.90
Fe2o3	7.22
Mgo	2.23
S03	0.36
Na2o	1.11
K2O	1.27
Tio2	1.00
Mno2	0.18
P2o5	0.1
Sro	0.23

Elements present in the materials

B. SODIUM HYDROXIDE

Sodium hydroxide also known as **lye** or **caustic soda**, has the molecular formula **NaOH** and is a highly caustic metallic base. It is a white solid available in pellets, lakes, granules, and as a 50% saturated solution. Sodium hydroxide is soluble in water, ethanol and methanol. This alkali is deliquescent and readily absorbs moisture and carbon dioxide in air. Sodium hydroxide is used in many industries, mostly as a strong chemical base inthemanufactureof pulp and paper, te xtiles, drinking water, soap sand detergents and as a drain cleaner. Worldwide production in 2004 was approximately 60 million tones, while demand was 51 million tones. Although molten sodium hydroxide possesses properties similar to those of the other forms, its high temperature comparatively limits its applications.

b. NaOH molecular weight

Molar mass of NaOH = **39.99711 g/mol**This compound is also known as Sodium Hydroxide. Convert grams NaOH to moles or moles NaOHtograms

Molecular weight calculation: 22.98977 + 15.9994 + 1.00794

Fig.2 Sodium hydroxide

1.4 SODIUM SILICATE

Sodium silicate is the common name for a compound sodium metasilicate, Na_2SiO_3, also known as water glass or liquid glass. It is available in aqueous solution and in solid form and is used in cements, passive fire protection, refractory's, textile and lumber processing, and automobiles. Sodium carbonate and silicon dioxide react when molten to form sodium silicate and carbon dioxide:[1]

$$Na_2CO_3 + SiO_2 \rightarrow Na_2SiO_3 + CO_2$$

Anhydrous sodium silicate contains a chain polymeric anion composed of corner shared $\{SiO_4\}$ tetrahedral, and not a discrete SiO_3^{2-} ion.[1] In addition to the anhydrous form, there are hydrates with the formula $Na_2SiO_3 \cdot nH_2O$ (where n = 5, 6, 8, 9) which contain the discrete, approximately tetrahedral anion $SiO_2(OH)_2^{2-}$ with water of hydration. For example, the commercially available sodium silicate pentahydrate $Na_2SiO_3 \cdot 5H_2O$ is formulated as $Na_2SiO_2(OH)_2 \cdot 4H_2O$ and the nonahydrate $Na_2SiO_3 \cdot 9H_2O$ is formulated as $Na_2SiO_2(OH)_2 \cdot 8H_2O$.[2]

c. PROPERTIES

Sodium silicate is a white powder that is readily soluble in water, producing an alkaline solution. It is one of a number of related compounds which include sodium orthosilicate, Na_4SiO_4, sodium pyrosilicate, $Na_6Si_2O_7$, and others. All are glassy, colourless and soluble in water.

d.COMPRESSIVE STRENGTH

The compression test is used to determine the hardness of brick specimen. The strength of a brick specimen depends upon Fly ash, cement, Fine aggregate, Glass fibreand , w/c ratio, curing temperature, and age and size of specimen. The specimen should be given sufficient time for hardening and then it should be cured for 21 days. After 21 days, it should be loaded in the testing machine and tested for maximum load.

Specimen Type	Average Compressive Strength, N/mm^2		
	7 Days	**14Days**	**28 Days**
0% Geopolymer	9.1	17.7	24
0.02% Geopolymer AABrick	9.2	17.9	24.2
0.04% Geopolymer AABrick	9.2	18	24.4
0.06% Geopolymer AABrick	9.3	18.2	24.7
0.08% Geopolymer AABrick	8	16.7	22

The test was conducted as per IS 3495 (part 1 to 4): 1992. The bricks of standard size 230mm x 100mm x 70mm were used to find the compressive strength of brick. Specimens were placed on the bearing surface of UTM, of capacity 2000 kN without eccentricity and a uniform rate of

loading of 140 kg/cm per minute was applied till the failure of the brick. The maximum load was noted and the compressive strength was calculated.

Fig 6. Compression testing of brick

Table 2.compressive strength of brick

The compressive strength (f_{ck}) of the brick is

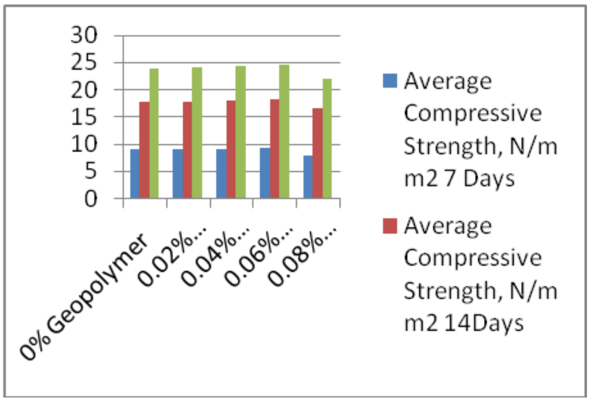
$$f_{ck} = P/A (N/mm^2)$$

Where,

P - Compressive load in N

A - Area of the brick specimen in mm^2

Table 1.3 Compressive Strength

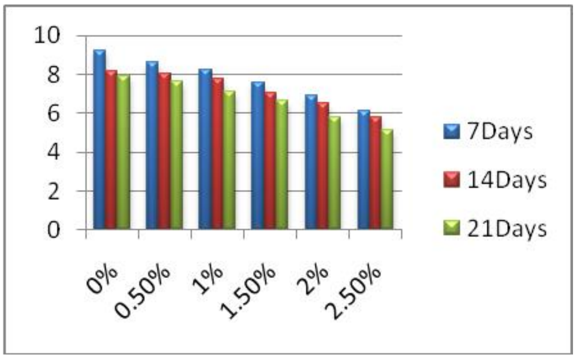


Compressive Strength of brick

WATER ABSORPTION TEST

This test was conducted as per IS 3495 (part 1 to 4): 1992 .The dry weight of the bricks are taken by using weighing Balance. The number of specimens for the test shall be selected according to IS 5454 : 1976. Immerse completely dried specimen in clean water at a temperature of 27 f 2°C for 24 hours. Remove the specimen and wipe out any traces of water with a damp cloth and weigh the specimen. Complete the weighing 3 minutes after the specimen has been removed from water (M_2).Water absorption, percent by mass, after 24-hour immersion in cold water is given by the following formula:

Table 1.4 Water absorption test



4.2.1 Water Absorption Test

CONCLUSIONS

By using the isothermal calorimetric technique it was possible to identify the geopolymerization process of an alkali-metakaolin system at different curing temperatures. It was observed the existence of an optimum curing temperature, 60 °C to obtain the best geopolymerization process. This fact was reinforced by leaching analysis carried out on these inorganic geopolymers. As a result of this, the geopolymer obtained at this temperature exhibited the best physical and mechanical properties. The information gained contributes to a better understanding of the geopolymerization process and opens the possibility to design the synthesis of this kind of geopolymers for specific applications.

Specimen Type	Water absorption in %		
	Days	14Days	21 Days
0% Geopolymer AABrick	.24	8.15	7.93
0.02% Geopolymer AABrick	8.6	8.05	7.65
0.04% Geopolymer AABrick	8.2	7.75	7.11
0.06% Geopolymer AABrick	7.57	7.03	6.65
0.08% Geopolymer AABrick	6.89	6.52	5.79

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