STUDY ON CONVENTIONAL AND GEOPOLYMER BRICKS

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ABSTRACT

Bricks are widely used for construction and building material around the world. Burnt clay brick is one of the ancient building materials. The use of waste materials in bricks can lessen the consumption of clay material and reduce the environmental burden due to accumulation of waste materials. Furthermore, addition of recycled materials can decrease the high carbon footprint. The various bricks are purchased and also were manufactured using fly ash, ground granulated blast furnace slag and alkaline solution, there is no need of clay and it is called geo-polymer bricks. These geo-polymer bricks are becoming popular in the world now a day. The main constituent of conventional clay bricks contains rich silica and alumina and it replaced with various geo-polymer trial mixes. In this study, the compressive strength of various bricks purchased and the manufactured geo-polymer bricks have been tested. The test results are to be compared with different types of bricks.

KEY WORDS: Various Bricks, Alkaline Solution, Geo-polymer bricks, Compressive Strength.

INTRODUCTION

Brick plays a very important role in the field of civil engineering construction. Bricks are used as an alternative of stones in construction purpose. Bricks are being used for the construction of walls of any size, construction of floors, construction of arches and cornices, construction of brick retaining wall, making broken bricks of required size as aggregates in concrete. Bricks are traditionally manufactured by mixing clay with enough water to form a mud that is then poured into a mould of the desired shape and size, and hardened through fire or sun. Cement is widely used in concrete industry since many decades it releases green house gas i.e. carbon dioxide (CO_2), into the atmosphere while manufacturing it. Geopolymer technology is one of the recent technologies applied to reduce the use of Portland cement. Fly ash and ground granulated blast furnace slag reacts with alkaline solutions to form a cementations material. Fly ash based geopolymer does not emit carbon dioxide.

OBJECTIVES

1. To study the properties of various types of bricks available in market.
2. To develop a method to manufacture of Geopolymer bricks.
3. To carry out the tests on various types of bricks including Geopolymer bricks.

4. Analyzes the various approaches on production of Geopolymer bricks.

LITERATURE STUDY

K. Mahendran [1] compared Chamber Clay bricks, Fly ash bricks, AAC blocks, CLC blocks and Porotherm blocks based on their engineering properties and economic aspects. Various tests were carried out to determine the engineering properties. Cost benefit analysis made for each building blocks from the obtained results.

P.P. Gadling [2] presented the Fly Ash brick properties, manufacturing process material required for preparing the clay bricks and fly ash bricks as per Indian standard code provisions, inspection and quality control. Use of this additive could have practical implications as a means of recycling and for achieving cost savings in brick production.

C. Antony Jeyasehar [3] conducted research work on "Strength and Durability Studies on Fly ash based Geopolymer Bricks" to improve the quality of geopolymer mortar through special treatments and study the property, particularly the acid resistance. The durability tests such as water absorption test and acid resistance test (HCl and H2SO4) are also conducted.

Safeer Abbas *et al.* [4] investigated brick production using Fly Ash (FA). Mechanical and durability properties of bricks were studied. Utilization of Fly Ash in brick production can lead towards economical and sustainable construction.

Danielle *et al.* [5] compared the environmental impacts of three wall types commonly built in Brazil. Differences in impacts mainly result from the use of distinct natural resources and processes. It has run different sensitivity analyses to test the final results. The concrete manufacturing process has a great impact on Climate Change and Resource Depletion.

EXPERIMENTAL INVESTIGATION

(1) COMPRESSIVE STRENGTH TEST ON PURCHASED BRICKS

The compressive strength of bricks is carried out as per **IS: 1077:1992**, and the result is given in Table 1. In this work, three classes conventional bricks and fly ash bricks are tested (Figures 1 to 4). Compression strength, $\sigma = P/A$.

Table 1 Compressive strength of Bricks

Sl. No.	Specimens	Size of the Bricks (mm)	Average Compressive Strength of Purchased Bricks (N/mm^2)
1	1st Class Clay Bricks	225 × 100 × 75	15.25
2	2nd Class Clay Bricks	210 × 100 × 75	3.59
3	3rd Class Clay Bricks	210 × 95 × 75	2.12
4	Fly Ash Bricks	230 × 105 × 70	9.02

Fig.1 First Class Brick

Fig.2 Second Class Brick

Fig.3 Third Class Brick

Fig.4 Fly Ash Brick

(2) GEOPOLYMER BRICK MORTAR PREPARATION

1. **Fly Ash (Class - F)**

   The fly ash used to manufacture geo-polymer brick in this study low calcium fly ash (Class F) obtained from Mettur Thermal Power Station. Fly ash contain rich amount of silica and alumina. Specific gravity of Fly ash was 2.15.

2. **Ground Granulated Blast Furnace Slag (GGBS)**

   GGBS is partially added with fly ash for making geopolymer bricks. It increases the engineering properties of the material. By-product from the blast-furnaces used to make iron. It contain rich amount of silica and alumina. Specific gravity of GGBS was 2.62.

3. **Fine Aggregate**

   The sand is sieve using 1.18 mm sieve and mix with appropriate proportion. Sand required for the manufacture shall be clean and free from impurities like clay. The grading of fine aggregates, as per **IS: 383-1970** within the limits and described as fine aggregates, Grading Zones II. Specific gravity of sand was 2.67

4. **Sodium Hydroxide (NaOH)**

   Sodium hydroxide is also known as caustic soda, is a caustic metallic base. It is used in many industries, mostly as a strong chemical base in the manufacture of textiles, drinking water, soaps and detergents. It is very soluble in water with liberation of heat.

5. **Sodium Silicate (Na_2SiO_3)**

   Sodium silicate is also known as water glass or liquid glass, available in liquid (gel) form. Silicates were supplied to the detergent company and textile industry as bonding agent.

6. **Activator Solution**

   Generally an alkaline solution is prepared by mixing sodium silicate and sodium hydroxide pellets with water. The strength of concrete depends upon the concentration of sodium hydroxide in terms of molarity.

(3) GEOPOLYMER BRICKS DESIGN

The concentration of NaOH used in the experiment is based on the research of previous researches. All the mortars are designed similar to the normal mortar. Accordingly the performances of geopolymer bricks specimens made with 3M and 4M of NaOH are evaluated.

(4) CASTING OF GEOPOLYMER BRICKS

The alkaline activator is prepared in the laboratory by mixing with the sodium hydroxide solution with the sodium silicate solution about 24 hours before actual mortar mixings to enhance reactivity of the solution. Fine Aggregates, prepared in saturated surface dry condition, and the binders (Fly ash and GGBS) were dry mixed thoroughly in the mixture. Premixed alkaline activated solution is then added gradually in the mixture. Mixing is continued for further 4 to 6 minutes depending on the consistency of the mixture (Figure 5). Curing temperature is an important factor till now for the strength of geopolymer bricks. Generally the curing which is done for geopolymer is after demoulding the specimens are cured under the ambient (atmosphere 25 to 35 degree) curing (Figures 6 and 7).

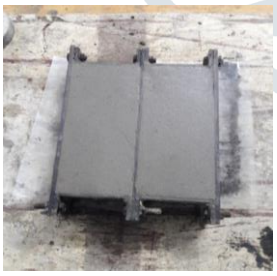

Fig.5 Bricks in Mould Fig.6 Geopolymer Bricks Fig.7 Ambient Curing

(5) TESTING OF GEOPOLYMER BRICKS

All three brick specimens are tested one by one and average result is taken as brick's compressive/crushing strength. The tests on bricks carried out as per **IS 3495: 1992** (Part 1) determination of compressive strength (Figure 8).

Fig.8 Compressive testing of Geopolymer Brick

RESULTS AND DISCUSSION

The compressive strength of different mixes geopolymer bricks is given in Table 2. The concentration of 3 molarity geopolymer bricks with 70 % fly ash and 30% GGBS showed 3.93 MPa and it is suitable for construction purpose.

Table : 2 Trial Mixes of Geopolymer Bricks

Sl. No.	NaOH	FA : GGBS	Average Compressive Strength (N/mm^2)
1	4M	50 : 50	22.28
2	4M	75 : 25	16.78
3	4M	90 : 10	14.84
4	3M	70 : 30	3.93
5	3M	75 : 25	2.77
6	3M	80 : 20	1.90
7	3M	90 : 10	1.31

CONCLUSION

Based on the experimental study carried on conventional burnt clay bricks, Fly ash and Geopolymer bricks the conclusions are derived. The conventional burnt clay bricks of three classes and Fly Ash bricks purchased in the local market tested for compressive strength. As per IS code, minimum strength of compressive strength of bricks is 3.5 N/mm^2.Based on the performances of geopolymer bricks specimens made with 3M and 4M of NaOH, various trial mixes are evaluated. Hence, that ambient cured Geopolymer bricks it is recommended for construction purposes based on this compressive strength, Eco-Friendly and also reduce global warming. since it is satisfying Engineers strength requirements.

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