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Development of Geopolymer Brick Using Fly Ash

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***Abstract:** This research looked on the use of geopolymer brick in the construction industry. The need for bricks is rising rapidly. For example, all brick kilns rely on good quality clay from agricultural fields. Another issue facing the brick industry is the creation of high-temperature bricks, which necessitates fossil fuels. This method produces a lot of CO_2 and uses a lot of fossil fuels. Due to the high energy consumption and lack of natural resources, geopolymer brick is a more sustainable and greener material. Geopolymer brick is made from waste materials such as fly ash, rice husk, and other similar materials that are high in alumina and silica content. A variety of activators, including sodium hydroxide and sodium silicate, are used to activate these materials. 10 N/mm2 is the compressive strength of the brick that we were able to attain through this research.*
***Keywords:** Ordinary Portland cement (OPC); Fly Ash (FA); compressive strength test*

I. INTRODUCTION

Building materials are in high demand as the country reaches the height of its growth. The demand for these resources is expanding at a startling rate. The demand for brick is highly unpredictable, despite the fact that it is one of the most commonly used building materials. But because all brick kilns in India rely on high-quality clay that is gathered from agricultural fields, the unrestricted use of clay is harmful to society as a whole.

It is also a time-consuming and energy-intensive technique to manufacture bricks at high temperatures, which is a problem that the brick industry is coping with. Massive quantities of fossil fuels are consumed during the manufacturing process of burned bricks, resulting in enormous carbon dioxide emissions into the environment.

Because of the significant energy consumption and depletion of natural resources associated with the production of burnt bricks from clay resources, the manufacture of burnt bricks from clay resources is not currently regarded to be environmentally advantageous. Making bricks out of industrial waste products such as fly ash and rice husk ash, among other things, is both environmentally and economically beneficial because, in addition to saving valuable top agricultural soil, it also achieves the social goal of removing waste from the environment, which is a win-win situation. As previously stated, the biggest disadvantage of using burned bricks is the substantial amount of energy required during the firing process to get the desired result. During the recent past, humans have been experimenting with several different techniques of producing bricks. Geopolymerization is one of the most effective methods that could be considered in this case. It is also quite inexpensive. When raw materials such as silicas and alumina dissolve in the presence of extremely concentrated alkaline solutions, the result is the formation of aluminosilicate gel. This gel is then condensed with silica and alumina polymerization to generate three-dimensional polymeric structures, which is referred to as geopolymeric structure formation in the scientific community. This research will look into the application of geopolymerization to the production of bricks manufactured from fly ash.

GEOPOLYMER BRICK INVOLVES A CHEMICAL REACTION

Silica-Alumina Material + Activator(Sodium Hydroxide + Sodium Silicate) + Water = Binder

II. EXPERIMENTAL WORK

A. *Constitutive Materials of Geopolymer Mortar*

1) *Fly ash:* We used fly ash from the ultratech power plant in Mohali, which contains the right proportion of alumina and silica, both of which are essential components of the geopolymerization reaction. It also met the criterion for class F fly ash that complied with IS 3812 (Part I), which is required for the production of geopolymer brick.
2) *Fine aggregates:* Fine aggregates were made from natural river sand from Zone III , which had a specific gravity of 2.62 and a silt content of 4.5 percent, making it an appropriate choice for this application.
3) *Alkaline Solution:* To achieve a binding effect, different ratios of sodium hydroxide and sodium silicate were utilised as activators in different experiments at different molarities of sodium hydroxide.

B. Preparation of Alkaline solution

Sodium hydroxide was used to make alkaline solutions of 8M, and 10M concentrations. (8M means that 8x40=320gram sodium hydroxide was used in 1 litre of distilled water). Sodium hydroxide was used to activate the alumina silicate component of the geopolymer brick and to create a strong bond between the elements of the geopolymer brick. When sodium hydroxide combines with water, a tremendous amount of heat is produced as a result. It should take at least 24 hours to prepare the alkaline solution that will be used in the geopolymer mix. A critical factor in the bonding process is the concentration of sodium hydroxide. Following that, sodium silicate and sodium hydroxide should be mixed and let to sit for 24 hours at varying ratios of 1.5, 2, and 2.5 respectively.

Figure 1 Preparation of alkaline solution

C. Experimental Work

Geopolymer brick is made in the same way as clay brick. The bricks were made with different ratios of sodium hydroxide and sodium silicate at 8M, and 10M. After casting, the bricks were stored at 60°C for 24 hours before being returned to ambient temperature.

III. RESULTS

The specimen was tested in accordance with Indian standard codes. Because geopolymer brick is a standard brick with no standards, developing a brick of such standards that meets the requirements of the Indian Standard code is a challenge. Compressive strength test was performed on geopolymer brick at 7 days, 14 days, and 28 days

TABLE I
Compressive strength at 8M

Samples	Ratio of SS/SH	Testing at days	Fly Ash (Grams)	Sand (grams)	Sodium Silicate (ml)	Sodium Hydroxide (ml)	Compressive Strength (N/mm^2)	Temperature
1	1.5	3	539.43	1618.35	129.468	86.312	3.8	60^0c
2	1.5	7	539.43	1618.35	129.468	86.312	5.9	60^0c
3	1.5	28	539.43	1618.35	129.468	86.312	8.8	60^0c
4	2	3	539.43	1618.35	143.85	71.92	4.6	60^0c
5	2	7	539.43	1618.35	143.85	71.92	6.5	60^0c
6	2	28	539.43	1618.35	143.85	71.92	9.6	60^0c
7	2.5	3	539.43	1618.35	154.128	61.65	4.1	60^0c
8	2.5	7	539.43	1618.35	154.128	61.65	5.5	60^0c
9	2.5	28	539.43	1618.35	154.128	61.65	8.2	60^0c

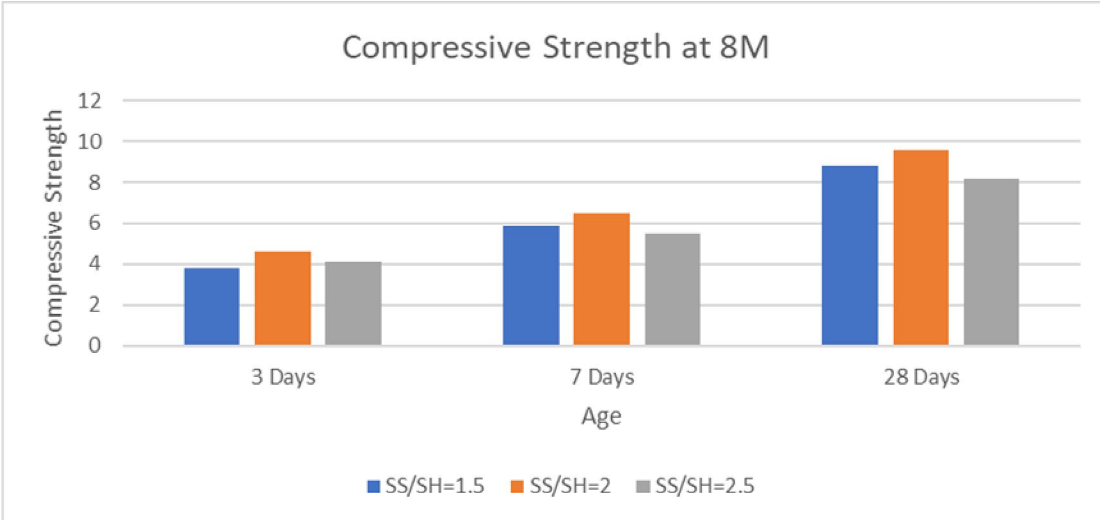

Figure 2 Compressive strength of fly ash Geopolymer Brick at 8M

TABLE 2. Compressive strength at 10M

Samples	Ratio of SS/SH	Testing at days	Fly Ash (Grams)	Sand (grams)	Sodium Silicate (ml)	Sodium Hydroxide (ml)	Compressive Strength (N/mm^2)	Temperature
1	1.5	3	539.43	1618.35	129.468	86.312	4.5	60^0c
2	1.5	7	539.43	1618.35	129.468	86.312	6.6	60^0c
3	1.5	28	539.43	1618.35	129.468	86.312	9.7	60^0c
4	2	3	539.43	1618.35	143.85	71.92	5.2	60^0c
5	2	7	539.43	1618.35	143.85	71.92	7.8	60^0c
6	2	28	539.43	1618.35	143.85	71.92	10.2	60^0c
7	2.5	3	539.43	1618.35	154.128	61.65	5.5	60^0c
8	2.5	7	539.43	1618.35	154.128	61.65	6.3	60^0c
9	2.5	28	539.43	1618.35	154.128	61.65	9	60^0c

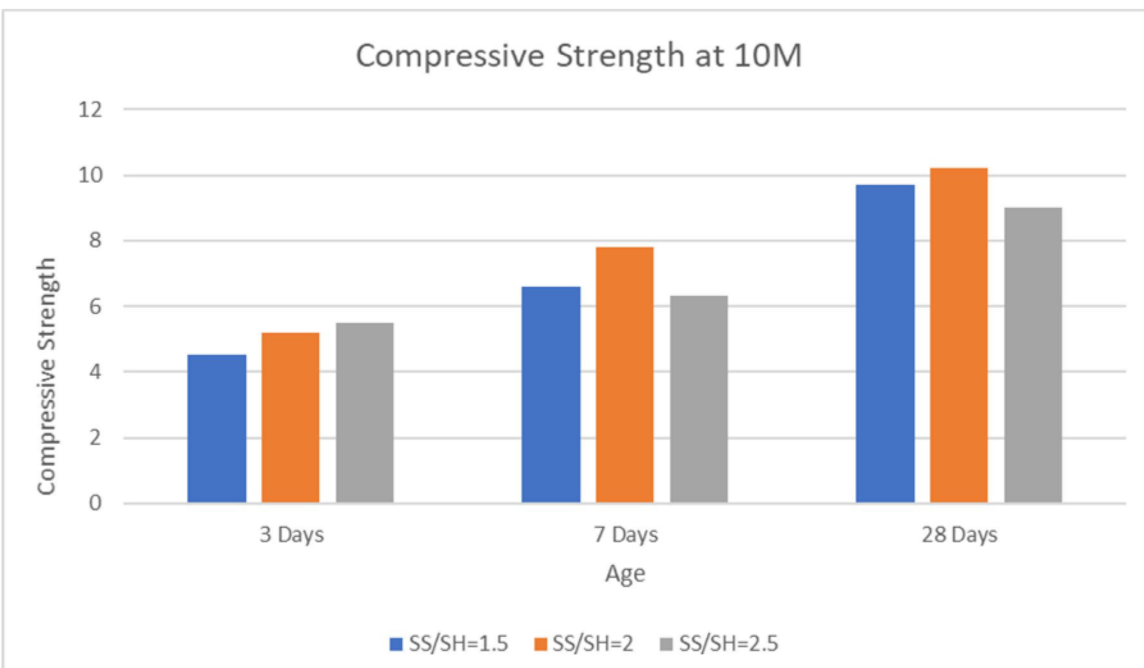

Figure 3 Compressive strength of fly ash Geopolymer Brick at 10M.

IV. CONCLUSIONS

It was determined that the 10N/mm^2 brick strength we were aiming for could be achieved at 10M with a sodium silicate to sodium hydroxide ratio of 2 when using sodium silicate. The maximum compressive strength was achieved after 28 days of curing, although further increases in compressive strength are possible as the age of the mortar is increased due to the fact that the rate of polymerisation reaction in geopolymer brick is slower than that of conventional brick. This is due to the fact that the rate of polymerisation reaction in geopolymer brick is slower than that of conventional brick. The researchers discovered in this investigation that increasing the molarity of sodium hydroxide has the additional effect of enhancing the compressive strength. The samples were only kept in the oven for the first 24 hours, after which they were left to cure at room temperature for the remainder of the time. If you want to acquire strength as rapidly as possible, you can leave them in the oven for a longer period of time. This cutting-edge building material is recommended since it has the potential to save both our agricultural areas and our fossil fuel reserves.

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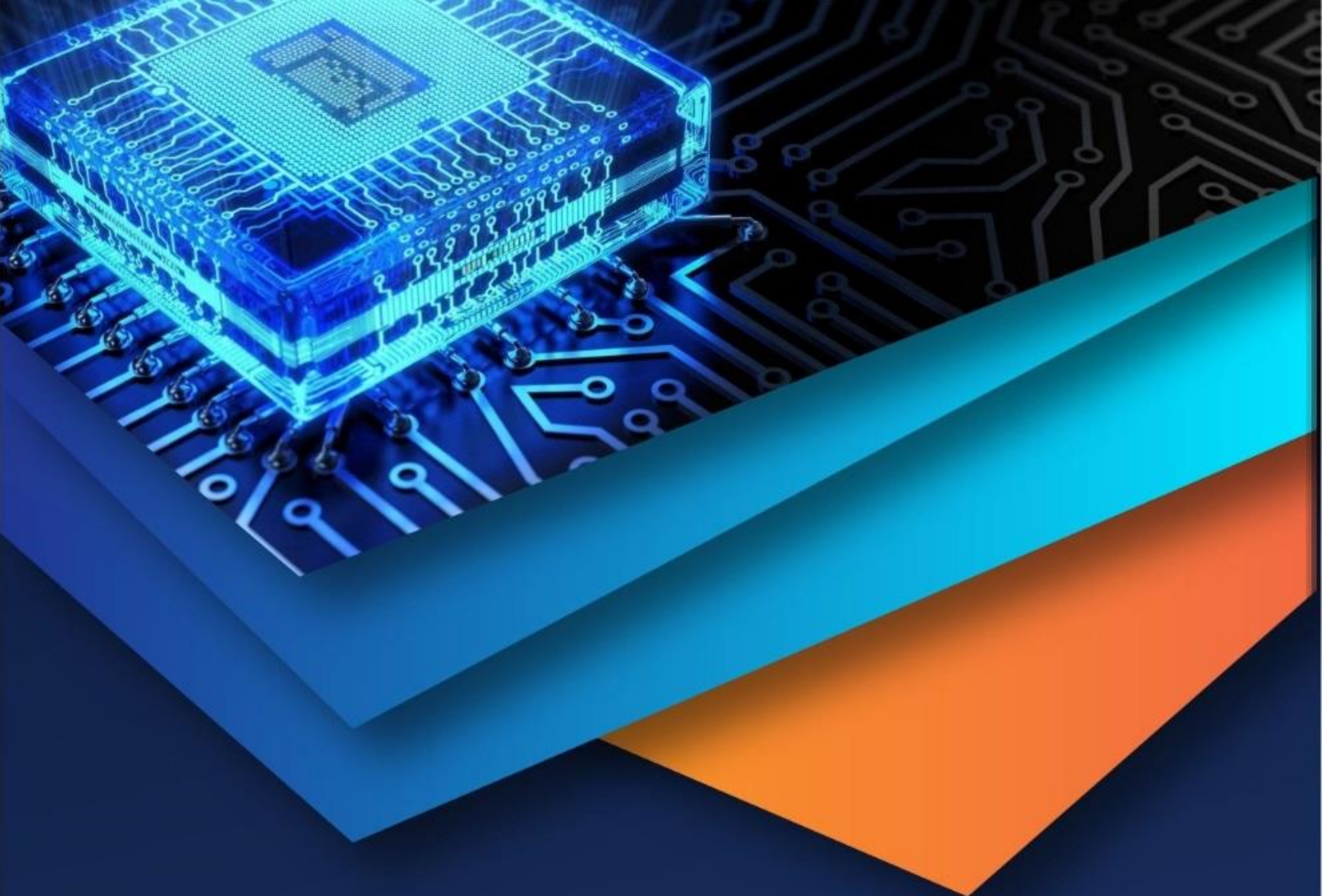

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