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Development of Geopolymer Mortar Using Fly Ash

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Abstract: ***The purpose of this study was to investigate the potential applications of geopolymer mortar in the building industry. With rising pollution and climate change, it is vital to select a greener and more environmentally friendly material for your project. Because cement contributes significantly to environmental damage, we must limit our reliance on it. Geopolymer mortar, which is made from alumina and silica-rich by-products such as fly ash and rice husk ash and is utilised in the construction of roads and buildings, is another sustainable material. An alkaline solution is used for the activation of these compounds. The compressive strength of geopolymer mortar was investigated in this study utilising a variety of modified alkaline solution ratios. As a result, the creation of a geopolymer mortar may help to reduce dependency on cement.***
Keywords: Ordinary Portland cement (OPC); Fly Ash (FA); compressive strength test

I. INTRODUCTION

Currently, when development work is at its pinnacle, the need for building materials is expanding on a daily basis in the modern world. The use of mortar is expanding in tandem with the increase in construction operations. Mortar is composed of three basic components: cement, fine aggregate, and water, all of which are present in specified amounts. The cement serves as the primary structural component of the mortar. Cement manufacture entails the crushing, heating, and grinding of limestone, which results in a significant amount of carbon dioxide being released into the atmosphere. India is the world's second-largest producer of cement, with 340 million metric tonnes of cement expected to be produced by 2020. With such a large amount of carbon dioxide being emitted, it is our only responsibility to seek out alternatives that are more sustainable and environmentally friendly. One such substance is geopolymer mortar, which is composed of industrial waste products such as fly ash, rice husk, and other similar materials that have high levels of alumina and silica. The waste materials are activated by soaking them in an alkaline solution including sand for many days. This study will examine compressive strength at various sodium silicate and sodium hydroxide ratios, among other things.

II. EXPERIMENTAL WORK

A. Constitutive Materials of Geopolymer Mortar

1) *Alumina silica waste material like fly ash:* It is the raw material used to make geopolymeric glue. In this study, low-calcium fly ash (ASTM Class F) is used. It was taken from the Ultratech cement factory in Mohali and meets the requirements of IS: 3812-1987[33]. Table 3.1 shows the chemical composition of fly ash based on an X-Ray Fluorescence (XRF) study. This table shows the chemical make-up of fly ash. More than 90% of the fly ash made by burning coal is made up of silicon and aluminium oxides. The Si to Al molar ratio is 2.14, which meets the basic requirements for making cement and concrete proposed by Davidovits . More than 60% of fly ash particles are less than 45 microns in size, with a specific gravity of 2.06 and a specific surface area of 440,000 sq/m/kg, or 440 sq/m/kg (Blaine).
2) *Fine aggregates:* Natural river sand from zone 3 was used as fine aggregates, and its specific gravity was 2.62 and silt content was 4.6 percent, making it an excellent choice.
3) *Alkaline Solution:* To achieve a binding effect, different ratios of sodium hydroxide and sodium silicate were utilised as activators in different experiments.

B. Preparation of Alkaline solution

12M alkaline solution was prepared with sodium hydroxide (12M means 12x40=480gram sodium hydroxide was used in 1 litre distilled water). To activate the alumina silicate component and generate a strong link between the geopolymer brick elements, sodium hydroxide was utilized. A huge amount of heat is generated when sodium hydroxide reacts with water. Preparing the alkaline solution for use in the geopolymer mix should take at least 24 hours. The sodium hydroxide concentration is vital in the bonding process. Following that, sodium silicate should be mixed with sodium hydroxide and kept for 24 hours in different ratios of 1.5, 2, and 2.5.

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C. Experimental Work

Geopolymer mortar is made in the same way as cement mortar. The cubes were made with different ratios of sodium hydroxide and sodium silicate at 12M. After casting, the cubes were stored at 60°F for 24 hours before being returned to ambient temperature.

III. RESULTS

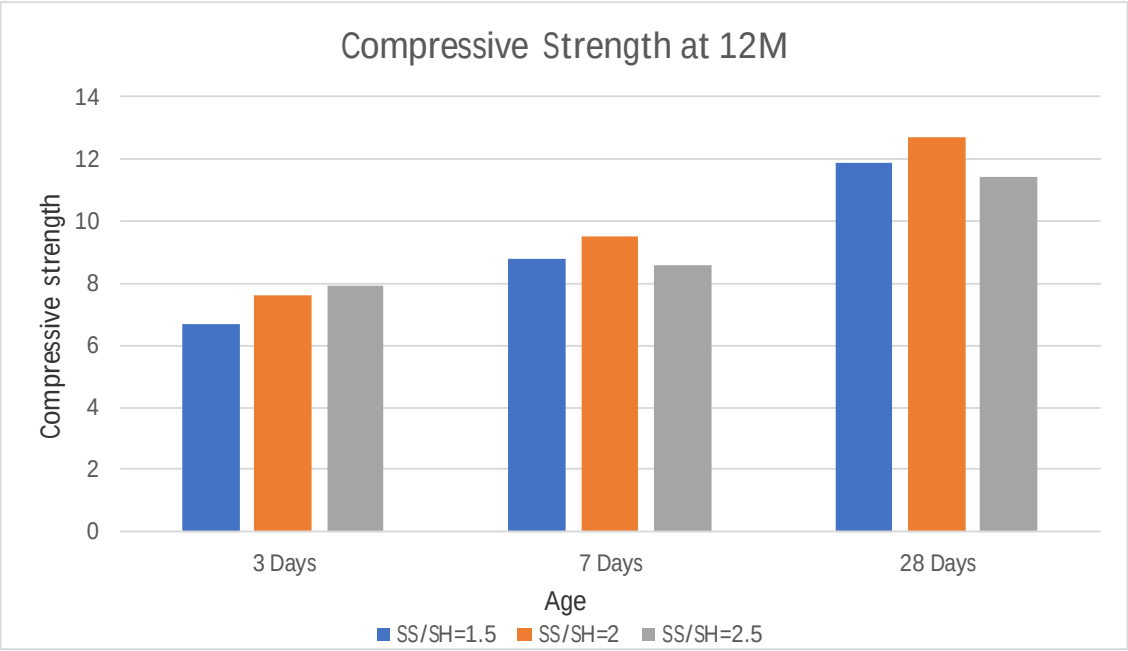
A. Compressive Strength of Geopolymer Mortar

In accordance with IS code 4031(part 6): 1988 for cement mortar, the compressive strength of geopolymer mortar samples was measured after curing. The outcomes of 7day, 14day, and 28day tests were analysed.

Table I
Compressive Strength AT 3, 7, AND 28 DAYS

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	6.7	60^0c
2	1.5	7	539.43	1618.35	129.468	86.312	8.8	60^0c
3	1.5	28	539.43	1618.35	129.468	86.312	11.9	60^0c
4	2	3	539.43	1618.35	143.85	71.92	7.6	60^0c
5	2	7	539.43	1618.35	143.85	71.92	9.5	60^0c
6	2	28	539.43	1618.35	143.85	71.92	12.7	60^0c
7	2.5	3	539.43	1618.35	154.128	61.65	7.9	60^0c
8	2.5	7	539.43	1618.35	154.128	61.65	8.6	60^0c
9	2.5	28	539.43	1618.35	154.128	61.65	11.4	60^0c

Figure 1
Compressive Strength of fly ash Geopolymer with Standard sand(1:3) at 12m.



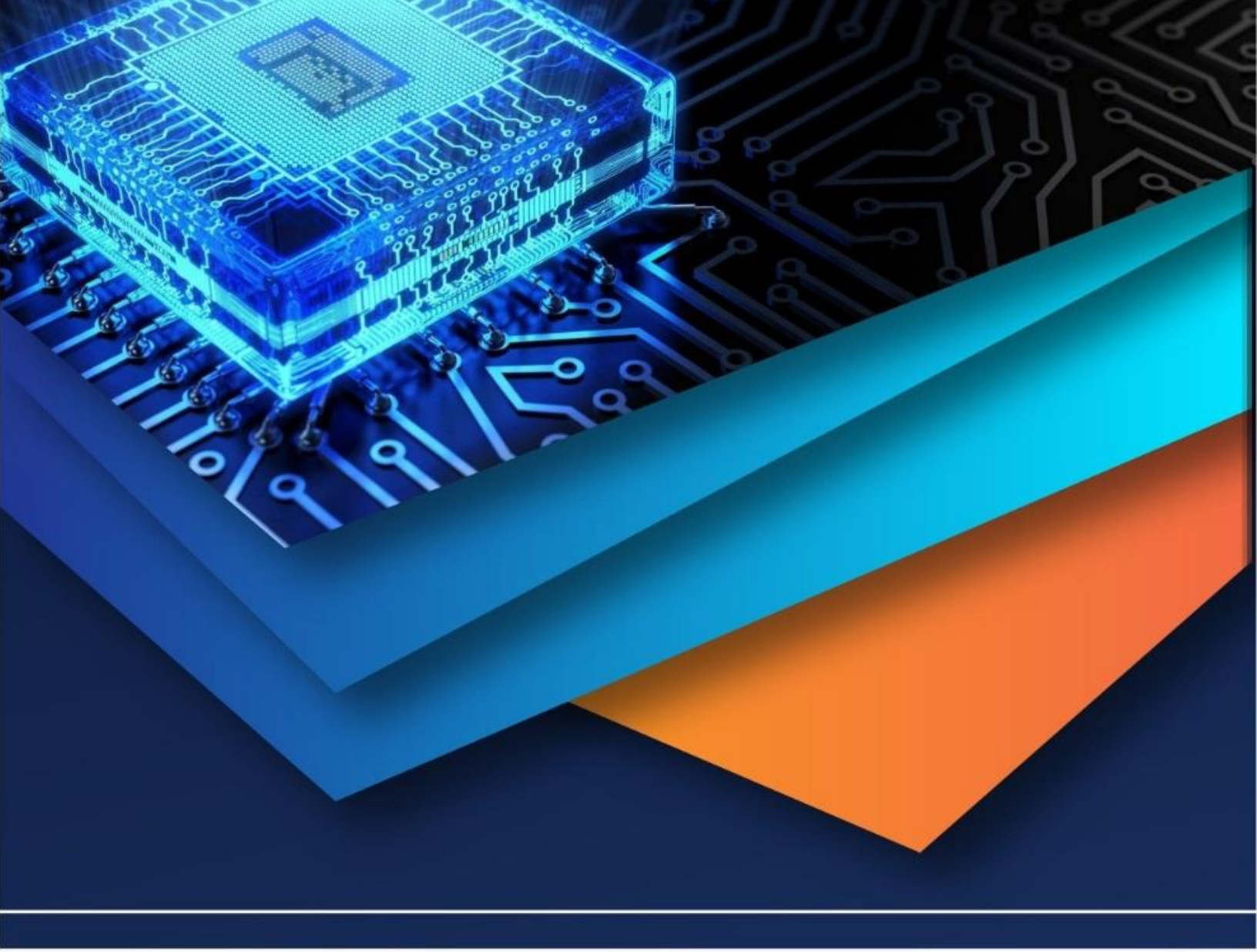
IV. CONCLUSIONS

It was discovered that raising the sodium silicate to sodium hydroxide solution ratio from 1.5 to 2 results in an increase in compressive strength, but that increasing the ratio further from 2 to 2.5 results in a decrease in compressive strength. Maximum compressive strength was achieved after 28 days of curing, although further increases in compressive strength are possible when the age of the mortar is increased due to the fact that the rate of polymerisation reaction in geopolymer mortar is slower than that of conventional mortar. The samples were only maintained in the oven for the first 24 hours, following which they were allowed to cure at room temperature. They can be kept in the oven for a longer period of time if you want to gain strength quickly. Geopolymer mortar is recommended as a cutting-edge building material that can be used to replace cement as a binding material in cement mortars in the future.

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