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# Investigation on Geopolymer Concrete by Using Different Mineral Admixtures

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***Abstract:** The world is rapidly changing, and building construction is becoming increasingly important. If we look at it closely, the use of concrete increases, resulting in a scarcity of natural resources. To save our natural resources, replace some of the concrete proportions with the following methods. Using equal quantities of fly ash and metakaolin, fly ash and GGBS as admixtures in geopolymer concrete (50-50%). The results of the compressive strength split tensile strength, for 28, 56 and day strength tests. The combination of two admixtures and a super plasticizer allowed the strength parameters to be increased.*
***Keywords:** Metakaolin , Ggbs. flyash, sodium hydroxide , sodium silicate, Compressive strength and Split tensile strength.*

## I. INTRODUCTION

The material that works well for foundations, compositional designs, spans, streets, block dividers, fences, and posts is concrete, which is a widely used construction material. One tone of CO2 is released into the atmosphere during the production of one tone of Portland concrete. Due to its benefits in terms of energy conservation and environmental assurance, geopolymer concrete might be viewed as a Portland cement concrete alternative. An inorganic aluminosilicate substance known as geopolymer is created by reacting soluble base reactive aluminosilicate at room temperature or slightly above. The silicon and aluminium are dissolved in an alkaline activating solution, where they then polymerize to form molecular chains that function as calcium silicon hydrate to bind the aggregate components. The reaction between materials containing aluminosilicate and those containing soluble alkalis results in a synthetic antacid silicate substance known as geopolymer. Amorphous polymeric Si-O-Al-O linkages are produced via the geo-polymerization method, which requires dissolving the geopolymer reactants in a strong alkali solution.

Davidovits first used the term "geopolymer" in 1978 to refer to a group of mineral binders that may replace traditional Portland cement concrete by curing in an alkaline solution. By reacting with alkali solutions, mineral admixtures such as fly ash, GGBS, metakaolin, and other admixtures such baggas ash etc. are utilised as binders. To react with admixtures, alkali solutions such as sodium hydroxide, sodium silicate, and potassium hydroxide, potassium silicate are utilised. High early strength, low shrinkage, resistance to freezing, sulphate, corrosion, acid, and fire, as well as the absence of a risky alkali-aggregate reaction, are all characteristics of geopolymers.

## II. OBJECTIVES

1) The project's objective is to compare the strengths of two geopolymer concrete utilising three different mineral admixtures throughout the course of seven and twenty-four days.
2) To determine how concrete behaves in terms of strength, three materials are used: fly ash, ground-up blast furnace slag, and metakaolin.

## III. MATERIALS

1) *Fine Aggregate:* In this experimental work, river sand that passes through 4.75 mm that is locally accessible was utilised. According to IS: 2386-1963, the following characteristics of fine aggregates were identified, and sieve analysis is shown in Table 1 below.

Table 1 Physical Properties of river sand

| S.No. | Physical properties | Manufactured sand |
|---|---|---|
| 1. | Specific gravity | 2.7 |
| 2. | Water absorption | 3.28% |
| 3. | Maximum size | 4.75mm |

2) *Coarse Aggregate:* In the current study, 20 mm coarse aggregate that complies with IS: 383-1970 was used. The material utilised for the study is shown in table 2 after being passed through a 20 mm filter and remaining on a 4.75 mm screen.

Table 2 Physical properties of coarse aggregate

| S.no | Physical properties | Coarse aggregate |
|---|---|---|
| 1. | Specific Gravity | 2.8 |
| 2. | Water Absorption | 0.71% |
| 3. | Maximum size | 20 m |

3) *Fly Ash:* The several nuclear energy stations from which the fly ash used in this study was obtained. Using electrostatic precipitators or physically, the residue collection system removes fly debris from the ignition gases so that it can be released into the atmosphere as More consistently rounded than Portland concrete or chalk, fly ash particles range in size from less than 1 mm to about 150 mm. The coal's non-ignitable matter structures and relative convergences favour the synthesis of fly debris. Silicon (SiO2), aluminium (Al2O3), iron (Fe2O3), and calcium (CaO) oxides make up the majority of the substance's production, with smaller amounts of magnesium, potassium, sodium, titanium, and sulphur also present. Table 3 shows the synthesis of fly ash material.

Table 3 Chemical composition of fly ash

| Constituents | Percentage / (%) |
|---|---|
| $SiO_2$ | 52.03 |
| $Al_2O_3$ | 32.31 |
| $Fe_2O_3$ | 7.04 |
| Cao | 5.55 |
| MgO | 1.30 |
| $SO_3$ | 0.07 |
| $K_2O$ | 0.68 |
| CI | 1.00 |

4) *Ground Granulated Blast Furnace Slag:* Granular blast furnace slag (GGBS) is a by-product of the steel industry that is created when water or other moisture is used to rapidly cool molten steel. Due to its low production costs, concrete has qualities that are advantageous to the sector. possesses good thermal properties and a high level of chemical resistance. The primary elements of the slag composition are SiO2, CaO, MgO, and Al2O3. Table 4 provides the GGBS's chemical make-up.

Table 4: Chemical composition of GGBS

| Constituents | Percentage / (%) |
|---|---|
| CaO | 30-50% |
| $SiO_2$ | 28-38% |
| $Al_2O_3$ | 8-24% |
| MgO | 1-18% |
| MnO | 0.68% |
| $TiO_2$ | 0.58% |
| $K_2O$ | 0.37% |
| $N_2O$ | 0.27% |

Saturated GGBS slurry has a substantially higher chemical shrinkage and porosity than cement slurry, which is problematic during solidification. The heat of hydration directly contributes to drying shrinkage, which also rises as the glass activator's modulus and water content rise.

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5) *Metakaolin:* Natural hydroxylated clay known as mineral kaolin is known as metakaolin. By nature, it is a pozzolani substance, and metakaolin is shown. A appropriate kind of hard, dissolved rock for an alkali-silica activator solution is metakaolin. For high concrete, the temperature range for resistance is between 600°C and 800°C. The raw material for kaolin is raised using metakaolin. Although reported ideal activation temperatures range from 550 to 850°C for varied times, the temperature range of 650–750°C is most frequently mentioned. With a wider temperature range between dehydroxylation and recrystallization than other clay minerals, kaolinite favours the synthesis of metakaolin and the use of thermally activated kaolin clays as pozzolans. Additionally, structural disorder is more easily acquired during heating because the octahedral layer is directly exposed to the interlayer. The metakaolin's chemical make-up is shown in table 5.

Table 5: Chemical composition of the metakaolin

| S.No | Oxide composition | Value |
|---|---|---|
| 1 | $SiO_2$ | 54 |
| 2 | $Al_2O_3$ | 31.7 |
| 3 | $TiO_2$ | 1.41 |
| 4 | $Fe_2O_2$ | 4.89 |
| 5 | $ZrO_2$ | 0.1 |
| 6 | $K_2O$ | 4.05 |
| 7 | $Na_2O$ | 2.32 |
| 8 | Mno | 0.11 |
| 9 | $SiO_2$ | 1.71 |

6) *Sodium Silicate:* Liquid sodium silicate can be purchased from a nearby retailer. This is a frequent term for the substance sodium meta silicate, also referred to as water glass or liquid glass. It has a light grey tint and at least 55–57% water content.
7) *Sodium Hydroxide:* The 99% pure sodium hydroxide is purchased from a nearby store in the form of pellets. The compressed mass of sodium hydroxide is contained within the small, spherical pellets. Table 6 lists the specifics of pellets.

Table 6: Details of mass of pellets dissolved in water

| Molarity | Mass of sodium hydroxide pellets in litre water |
|---|---|
| 16M | 640 g |

## IV. EXPERIMENTAL INVESTIGATIONS

### A. *Compressive Strength Results*

Compressive strength is the capacity of material or structure to resist or withstand under compression and the cast specimens are tested in compression testing machine and tabulated in table

Table 7: Compressive strength of fly ash and GGBS

| S.No. | Age | Compressive strength ($N/mm^2$) | |
|---|---|---|---|
| | | fly ash and GGBS | fly ash and metakaolin |
| 1 | 28days | 62.91 | 66.42 |
| 2 | 56days | 68.26 | 77.38 |
| 3 | 90days | 73.21 | 77.64 |

### *B. Split tensile Strength*

A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. It is an indirect method of testing tensile strength of concrete and tested values presented in table 8.

Table 8: Split tensile strength of fly ash and GGBS

| S.No. | Age | Split tensile strength ($N/mm^2$) | |
|---|---|---|---|
| | | fly ash and GGBS | fly ash and metakaolin |
| 1 | 28days | 6.07 | 6.48 |
| 2 | 56days | 6.61 | 7.06 |
| 3 | 90days | 7.08 | 7.58 |

## V. CONCLUSIONS

1) In the setting of this investigation, it is seen that geopolymer concrete made of fly ash and GGBS at 16 M of NaOH with antacid proportion of 1:2 ($NaOH/Na_2SiO_3$) gives a compressive strength of 62.91, 68.26 and 73.21 $N/mm^2$ for 28, 56 and 90 days.
2) In the setting of this investigation, it is seen that geopolymer concrete made of fly ash and metakaolin at 16 M of NaOH with antacid proportion of 1:2 ($NaOH/Na_2SiO_3$) gives a compressive strength of 66.42, 77.38 and 77.64 $N/mm^2$ for 28, 56 and 90 days.
3) In the setting of this investigation, it is seen that geopolymer concrete made of fly ash and GGBS at 16 M of NaOH with antacid proportion of 1:2 ($NaOH/Na_2SiO_3$) gives a split tensile strength of 6.07, 6.61 and 7.08 $N/mm^2$ for 28, 56 and 90 days.
4) In the setting of this investigation, it is seen that geopolymer concrete made of fly ash and metakaolin at 16 M of NaOH with antacid proportion of 1:2 ($NaOH/Na_2SiO_3$) gives a split tensile strength of 6.48, 7.06 and 7.58 $N/mm^2$ for 28, 56 and 90 days.

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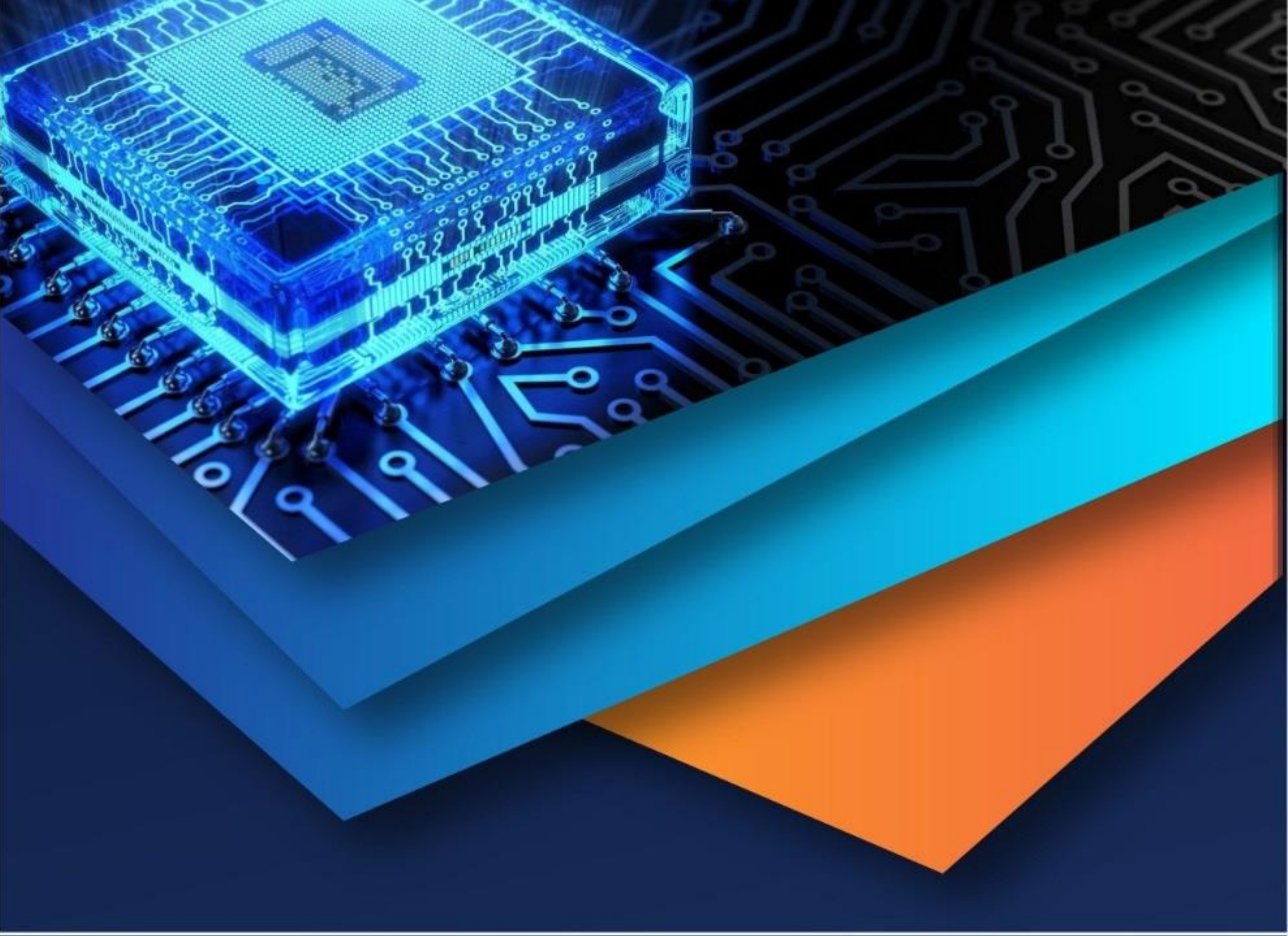


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