Strength Behaviour of Geopolymer Concrete by Using Different Mineral Admixtures

P.Kavya[1], Dr. K.Chandramouli[2], J. Sree Naga Chaitanya[3], Dr.N.Pannirselvam[4],G. Hari Chandra Prasad[5]
[1&3]Assistant professor of civil Engineering, NRI Institute of Technology, Perecherla, Guntur, AP, India.
[2]Professor and HOD of civil Engineering, NRI Institute of Technology, Perecherla, Guntur, AP, India.
[4]Associate Professor, Department of Civil Engineering, SRM Institute of Science and Technology, Kattankulathur, Chennai, Tamilnadu, India
[5]B. Tech student Department of civil Engineering, NRI Institute of Technology, Perecherla, Guntur, AP, India

Abstract: The world is developing rapidly and the construction of buildings takes vital role. If we go through in detail the usage of concrete gets raised up so it leads to the shortage of the natural resources. In order to save our natural resources, by replacing some of the proportions in the concrete with the following measures. By using fly ash and metakaolin, fly ash and GGBS as admixture in geopolymer concrete in equal percentages (50-50%). The results obtained from compressive strength, split tensile strength test for the age of 7 and 28days strength. The combined use of two admixtures and super plasticizer allowed increasing the strength parameters.

IndexTerms **- fly ash, GGBS, metakaolin, sodium hydroxide and sodium silicate.**

I. INTRODUCTION

Concrete is the broadly utilized development material that makes best establishments, compositional designs, spans, streets, block dividers, fences and posts. The creation of one ton of Portland concrete transmits roughly one ton of CO_2 into the air.Geopolymer concrete can be considered as alternative material to Portland cement concrete attributable to its advantages as far as energy preservation and ecological assurance. Geopolymer is an inorganic aluminosilicate material synthetized at room temperature or somewhat above through soluble base reactive aluminosilicate. These silicon and aluminum are dissolved in an alkaline activating solution and subsequently polymerizes into molecular chain which works as calcium silicon hydrate to bind the aggregate materials. The response of the materials having aluminosilicate with others having soluble alkalis produce a manufactured antacid silicate material called geopolymer. The geo-polymerization process involves dissolution of the geopolymer reactants in a strong alkali solution yielding polymeric Si–O–Al–O bonds in amorphous form.
Geopolymer was first introduced by Davidovits in 1978 to describe a family of mineral binders that could cure in alkaline solution as an alternative to conventional Portland cement concrete. Mineral admixtures like fly ash, GGBS, metakaolin and other admixtures like baggas ash etc. are used as binders by reacting with alkali solutions. Alkali solutions like sodium hydroxide, sodium silicate and potassium hydroxide, potassium silicate are used for reacting with admixtures.Geopolymers possess high early strength, low shrinkage, freeze resistance, sulphate resistance, corrosion resistance, acid resistance, fire resistance and no dangerous alkali-aggregate reaction.

II. OBJECTIVES

- The aim of the project is to study the strength difference between the two geopolymer concrete using three different mineral admixtures for 7 and 28 days.
- Fly ash,ground granulated blast furnace slag and metakaolin are used to find the strength behavior of concrete.

III. MATERIALS

a. Fine aggregate

The locally available river sand, passing through 4.75 mm was used in this experimental work. The following properties of fine aggregates were determined as per IS: 2386-1963 and sieve analysis were presented in below Table 1.

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

b. Coarse aggregate

In present study, coarse aggregate of size 20 mm conforming to IS: 383-1970. The material passed through 20 mm sieve and retained on 4.75 mm sieve is used for the work and presented in table 2.

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 mm

c. Fly ash:

The fly ash utilized in this examination was gotten from different nuclear energy station. The residue assortment framework removes fly debris from the ignition gases, either physically or by utilizing electrostatic precipitators, until it is delivered into the air as Fly ash particles are normally circular, better than Portland concrete and chalk, differing from less than 1 μm to close to 150 μm in measurement. The structures and relative convergences of non-ignitable matter in the coal choose the fly debris substance synthesis. The substance synthesis comprises primarily of silicon (SiO_2), aluminum (Al_2O_3), iron (Fe_2O_3) and calcium (CaO)

oxides, while magnesium, potassium, sodium, titanium and sulfur are additionally present in lower sums. Fly ash substance synthesis is displayed in Table 3.

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

d. Ground granulated blast furnace slag:

Granular blast furnace slag (GGBS) is a by-product of the steel plant, produced by rapid cooling of molten steel with water or moisture. The properties that is beneficial to the concrete industry because it is very economical to produce. Has a high degree of chemical resistance and retains excellent thermal properties. SiO_2, CaO, MgO and Al_2O_3 are the main components of the slag composition. The chemical composition of GGBSis presented in table 4.

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 the chemical shrinkage and porosity of GGBS slurry are much higher than those in cement slurry, and it is a concern during solidification. The drying shrinkage is directly caused by the heat of hydration and increases with the increase of the modulus of the glass activator and the amount of water.

e. Metakaolin:

Metakaolin is natural hydroxylated clay, called mineral kaolin. It is a pozzolani material by nature and a picture of metakaolin is presented. Metakaolin is a suitable type of hard and dissolved rock in an Alkali-silica activator solution. It has Temperature of resistance range between 600℃ and eight hundred centigrade for high concrete. Metakaolin is used to lift the raw material for kaolin.

Reported optimum activation temperatures vary between 550 and 850°C for varying durations; however the range 650-750℃ is most commonly quoted. In comparison with other clay minerals kaolinite shows a broad temperature interval between dehydroxylation and recrystallization, much favoring the formation of metakaolin and the use of thermally activated kaolin clays as pozzolans. Also, because the octahedral layer is directly exposed to the interlayer, structural disorder is attained more easily upon heating. The chemical composition of the metakaolin presented 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

f. Sodium silicate:

Sodium Silicate is obtained from a locally available store in a liquid form. This is a common name of compound sodium Meta silicate which is commonly known as liquid glass or water glass. It is slightly grey in color containing at least 55-57% of water.

g. Sodium hydroxide:

Sodium hydroxide is obtained from a local store which in form of pellets and having 99% purity. The pellet are spherical in shape, small in size and contains compressed mass of sodium hydroxide. The details of pellets are presented in table 6.

Table 6: Details of mass of pellets dissolved in water

Molarity	Mass of sodium hydroxide
16M	640 g

IV. RESULTS

a. Compressive strength:

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 7.

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	7days	43.51	46.20
2	28days	62.91	66.42

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	
		fly ash and GGBS	fly ash and metakaolin
1	7days	4.21	4.55
2	28days	6.07	6.48

V. CONCLUSION

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 alkali proportion of 1:2 ($NaOH/Na_2SiO_3$) gives a compressive strength of 43.51and 62.91N/mm^2 for 7 and 28days.
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 alkali proportion of 1:2 ($NaOH/Na_2SiO_3$) gives a compressive strength of 46.20 and 66.42N/mm^{2}for 7 and 28days.
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 alkali proportion of 1:2 ($NaOH/Na_2SiO_3$) gives a split tensile strength of 4.21 and 6.07N/mm^2 for 7 and 28days.
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 alkali proportion of 1:2 ($NaOH/Na_2SiO_3$) gives a split tensile strength of 4.55 and 6.48N/mm^2 for 7 and 28days.

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AUTHORS PROFILE

A. kavya Assistant Professor at NRI Institute of Technology, Andhra Pradesh, India, she completed her M. Tech in structural engineering from KL University. Her research interests include concrete Technology and structural engineering.

J. SREE NAGA CHAITANYA Assistant Professor in Civil Engineering working at NRI Institute of Technology, Andhra Pradesh, India, she completed M. Tech in structural engineering from JNTUH. Her research interests include concrete Technology and structural engineering. She is the author of over 10 papers in referred journals and International Conference including 1 paper. She is a member of M.I.S.T.E, IAENG.

Dr. K. CHANDRAMOULI Working as Professor & HOD Civil Engineering at NRI Institute of Technology, Andhra Pradesh, INDIA. He completed Ph.D. from JNTU Hyderabad. His research interests include Concrete Technology and Structural Engineering. He published over 115 papers in various international journals and International Conferences, which includes 14 SCOPOUS INDEXED research papers. He received 5 International awards for his research in concrete technology. He is the member of WORLD RESEARCH COUNCIL, M.I.S.T.E., M.I.C.I., IAENG.

Dr. N. PANNIRSELVAM working as Associate Professor in SRMIST, Kattankulathur, Tamilnadu, He completed Ph.D. from Annamalai University, Tamilnadu as full-time research scholar and has 15 years of teaching experience and 4 years in VIT University, Vellore. At presently guiding 7 PhD Scholars. His research interests include concrete composites, concrete materials and structural engineering. He published over 60 papers in various international journals. He has been serving as reviewer and editorial board member in reputed international journals.

G. Hari Chandra prasad Pursuing B. Tech in department of civil engineering in NRI Institute of technology.