

**EXPERIMENTAL ANALYSIS ON GEOPOLYMER CONCRETE
USING DIFFERENT FORMS OF FINE AGGREGATE**

Submitted in partial fulfillment of the requirements for the award of Bachelor
of Technology degree in Civil Engineering

By

S.SHABARISH (Reg.No.37200908)

E. KARTHICK VISHWA (Reg.No.37200904)



**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

Accredited with Grade "A" by NAAC

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Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119

www.sathyabama.ac.in



DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of
E.KARTHICK VISHWA(37200904) AND S.SHABARISH(37200908)
Carried out the project entitled **EXPERIMENTAL ANALYSIS
ON GEOPOLYMER CONCRETE USING DIFFERENT FORMS OF
FINE AGGREGATE** under my supervision from SEPTEMBER 2020
TO APRIL 2021

Internal Guide

Mrs.B. PRIYADHARSHINI

Head of the Department

Submitted for Viva voice Examination held on

Internal Examiner

External Examiner

DECLARATION

We E.KARTHICK VISHWA (37200904) and S.SHABARISH(37200908) hereby declare that the Project Report entitled EXPERIMENTAL ANALYSIS ON GEOPOLYMER CONCRETE USING DIFFERENT FORMS OF FINE AGGREGATE done by us under the guidance of Ms. ASS.PROF.B.PRIYADHARSHINI is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering / Technology degree in civil engineering

1.

2.

SIGNATURE OF THE CANDIDATE

DATE:

PLACE:

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ABSTRACT

Concrete is the world's most generous man-made content. Portland cement is a key component in most concrete mixtures. However, cement manufacturing accounts for nearly 5% of global carbon dioxide emissions. Engineers and scientists must develop and implement green building materials in order to construct a more sustainable environment. Because of its corrosion resistant, geopolymer concrete is much more durable than ordinary concrete. It's therefore much more durable than regular concrete. Geopolymer concrete is a revolutionary recycled building material that can pave the way for green building. Geopolymer concrete is concrete that is manufactured without the use of any cement. Instead, As a binding medium, fly ash, a byproduct of thermal power plants, is used. This ash includes fly ash reacts with alkaline solutions such as to form a gel that binds fine and coarse aggregates, sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3) are combined.

In addition to river sand, another artificial substance known as M-Sand (manufactured sand) is used as a fine aggregate. Preparation and curing of concrete cubes 150 x 150 x 150 mm, cylinder specimens 150 mm diameter and 300 mm height, and prism specimens 1200 x 100 x 100 mm in ambient conditions. The Cube compressive strength, Split Tensile Strength, and Flexure strength were measured at 7 and 28 days. Hopefully, geopolymer concrete would soon overtake ordinary Portland cement as the most abundant man-made commodity on the planet.

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LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviations	Description
AAS	Alkaline Activator Solution
CA	Coarse Aggregate
FA	Fine Aggregate
GPC	Geopolymer Concrete
NaOH	Sodium Hydroxide
Na ₂ SiO ₃	Sodium Silicate
N/mm ²	Newton per millimeter square

CHAPTER1

INTRODUCTION

1.1 GENERAL

Concrete is the world's second most used building material. OPC has traditionally been used as a binding agent in the preparation of concrete. Concurrently, Onetonne of Portland cement emits one tonne of CO₂ into the atmosphere. So we have to find an alternative binding material for concrete.

Davidovits suggested in 1978 that a polymer could be developed by a polymeric reaction of alkaline liquids with silicon and aluminium in geological source materials such as fly ash and rice husk ash are examples of byproduct materials. These polymers were dubbed geopolymers by him.

Geopolymer concrete is manufactured using conventional concrete technology methods.

1.2 GEOPOLYMER MATERIAL

Geopolymers are polymeric polymer materials that are inorganic. In 1978, Joseph Davidovits The term geopolymer was coined to describe a recently discovered geosynthesis that creates inorganic polymeric materials. The geopolymer material's chemical composition is similar to that of natural factors extracted, but its microstructure is shapeless. Geopolymer that has been treated with sodium hydroxide and regenerated at high temperatures yields a more stable crossaluminosilicate polymer structure. Geopolymer properties and applications are being researched by a broad variety of scientific and industrial disciplines.

1.3 ADVANTAGES OF GEOPOLYMERCONCRETE

The primary benefits of geopolymer concrete are

1. Reducing the discharge of carbon content.
2. Fly ash is in expensive.
3. Better compressive strength.
4. Fire-resistant.
5. Permeability is poor.
6. Environmentally safe.
7. Excellent in both acidic and alkaline conditions.
8. High tenacity.
9. Extremely low creep and shrinkage.
10. Chemical resistance.

1.4 PROPERTIES OF GEOPOLYMERCONCRETE

1. Before stiffening, the product has a long workinglife.
2. Impenetrable.
3. Greater heat resistance and resistance to all inorganic solvents.
4. Higher compressivestrength.
5. Goodworkability.
6. Very high early strength.

1.5 APPLICATION

In the short term, Precast structural components and decks made of geopolymer concrete, as well as structural furnishing made of geopolymer fibre composites, are examples of geopolymer concrete applications for bridges. have a high potential. Because of the relative ease of treating critical materials, geopolymer processing is more advanced in precast applications as well as the need for many current geopolymers to cure in a regulated high-temperature setting. Precast paving pavers and slabs, bricks, and precast pipes are available. Other potential near-term applications.

1.6 LIMITATIONS

- 1 The alkaline solution is expensive.
- 2 The triggering solution's high alkalinity poses a safety danger.
- 3 Practical difficulties of using the steam curing / high temperature curing method.
- 4 Significant research is being conducted to develop geopolymer systems that solve these technological challenges.

1.7 CURING

The most significant step in the geopolymerisation process is the curing of freshly prepared geopolymer concrete features. Concrete curing improves the final properties of geopolymer concrete. Curing of geo-polymer concrete is mainly carried out at raised temperatures.

The specimens are kept at room temperature for one day after casting to allow them to rest. The time taken from the completion of casting of test specimen to the start of curing at an elevated temperature is referred to as the "Rest Period" in reacting polymerization. Specimens are natural place of snow and sunlight for ambient condition at 30°C to 40°

1.8 LITERATURE REVIEW

A comprehensive analysis of the literature is an integral component of any scholarly research initiative. The review is a thorough examination of a body of literature that contributes to the solution to the study issue. Science journals, scholarly texts, authoritative libraries, and primary sources are among the common sources of information studied. On occasion, newspapers, magazines, books, photographs, audio and video recordings, and other secondary references are included.

Primary sources are foundational records related to a particular topic or concept that are the source of knowledge under review. They are frequently eyewitness accounts relayed by a participant or investigator during a competition or discovery.

Secondary sources are publications or recordings that refer to or address previously presented information. There may be physical journals, electronic databases, or the Internet. A review of the relevant literature serves as the foundation for all good research and writing.

This literature review will serve as the framework by which investigation will be regarded as a continuous operation. As a result, it is a necessary component of the scientific method. Abstracts of related publications are given below.

Davidovits et al It was proposed that an alkaline solution be used to create binders by reacting with silicon (Si) and aluminium (Al) in a geological source or byproduct material like fly ash and GGBS. Since the chemical reaction He coined the term geo polymer to describe these binders in this case, which is a polymerization process. There are some two drawbacks to geopolymer concrete: it takes a long time to set and needs Heat curing is used to increase strength. OPC fixed these two defects in the geopolymer concrete mix by replacing 10% of the fly ash with alkaline liquids on a mass basis, resulting in the Geopolymer Concrete Composite.

Cement, fine and coarse aggregate, and prefabricated water make up concrete. The water in this GGBS is naturally occurring, as is the coarse aggregate, which is both naturally occurring and factory-crushed.

Shyam Prakash et al. (2007) According to the manufacturer, manufactured sand meets fine aggregate specifications. Power, gradation, and shape angularity are examples of such characteristics. It's even possible to manufacture the desired grade of manufactured sand. The mechanical properties of manufactured sand, according to them, are determined by the raw material's sources, i.e. the parent rock. As a consequence, quarry selection is important in the production of high-quality fine aggregate.

Saeed Ahmad et al. (2008) have discovered that as the proportion of treated sand increased, the compressive power of different blend ratios increased from 7% to 33%, while workability declined from 11% to 67%.

Anurag Mishra et al. (2008) This paper describes the conclusions of an experimental study on the strength and absorption properties of geopolymer concrete. The NaOH concentration and healing time were varied in experiments. Geopolymer concrete is dependent on fly ash. According to the findings, compressive pressure rises from 8M to 16M as NaOH concentration rises. Increases in compressive strength were also observed as curing time was increased. Except for the 72-hour curing time, tensile strength increased as NaOH concentration increased. Water absorption declined as concentration and curing time increased. In two cases, however, only a minor rise was detected.

S.E. Wallah and B. V. Rangan (2009) verified that the compressive strength of heat-cured fly ash-based geopolymer concrete does not increase dramatically with age. When cured at room temperature, the strength of the geopolymer concrete dependent on fly ash grows when one gets older. The compressive power of ambient temperature cured on the seventh day. The average temperature within the first week following casting has an impact on geopolymer concrete.

K. Vijai et al. (2011) This paper presents the findings of an The mechanical properties of Geopolymer Concrete Composites (GPCC) containing 90% fly ash, 10% Ordinary Portland Cement (OPC), alkaline liquids, and various fine aggregates were investigated experimentally. The alkaline liquid to fly ash ratio in the mixtures was 0.4. On a mass basis, OPC replaces 10% of the fly ash. Steel fibre reinforced geopolymer concrete's Compressive strength, split tensile strength, and flexural strength are all measurements. Compressive strength, split tensile strength, and flexural strength are all measurements are all measured. are increased by 13%, 18%, and 34%, respectively, with a 0.5 percent volume fraction of different fine aggregates added. when compared to the GPCC combination Similarly, adding 0.75 percent volume fraction of different fine aggregates improved As compared to the GPCC combination, compressive strength, split tensile strength, and flexural strength increased by 24%, 24%, and 44%, respectively.

Shanmugapriya et al. (2012) The experimental researchers concluded that replacing natural fine aggregates with silica fume and processed sand would boost concrete's compressive and flexural strength. They suggested that the ideal replacement rate for natural sand with processed sand is 50%.

Mahendra R and Chit Lange (2010) Steel fibre adds a consistent improvement in flexural and break tensile strength but just The compressive strength of natural sand concrete and engineered sand concrete is also significantly higher.

Gnanasundar et al.(2013) The results of studies on the strength development of different grades of geopolymer concrete with varying molarity are presented in this paper. There are three different molarities of sodium hydroxide solution (3M, 5M, and 7M). used to produce various mixtures. The test results indicate that geopolymer concrete can be made from a travel ash and granulated furnace slag mixture that has been crushed (GGBS). As the concentration of geopolymer concrete grows, so does its compressive power. Noah increases, according to the results of the experiments. It has been discovered that as the amount of GGBS and Compressive increases, so does the intensity of the geopolymer. A geopolymer mix's compressive strength is estimated to be between 45 and 60 MPa, with a limit of 60 MPa for 100 percent GGBS.

N. Ganesan et al. (2013) This paper studied the engineering Compressive strength and fracturing tensile strength are two properties of geopolymer concrete. The formalised paraphrase concrete norm used was M 30. The fine aggregate percentages taken into account are 0.25 %, 0.5 %, 0.75 %, and 1 %. The addition of different fine aggregates in varying volume fractions slightly increasesthecompressivestrengthofGPC. The pressure rises from 3.22 percent for a 0.25 percent volume fraction of fibre to 8.51 percent for a 1% volume fraction. As the proportion of fibre volume fractions increased from 0.25 percent to 1 percent, the splitting tensile strength increased from 23.26 percent to 61.63 percent. The SFRGPC strength models correctly predict compressive and splitting tensile strength.

P. Naveen John et al. (2014) In this analysis, two types of systems were considered: one that replaced 100% of the cement with fly ash and another that replaced 100% of the river sand with processed sand. A sodium hydroxide concentration of 12M, according to the article, offers good workability and compressive power. Different molarities of sodium hydroxide solutions are considered, namely 3M, 5M, 7M, and 9M. Sodium hydroxide's molarity rises as its concentration rises, so does the power of geopolymer. The results of an experimental study were discussed, as well as the mechanical properties of Geopolymer Concrete Composites with similar binder compositions. The cement replacement rates (17% to 20% by Ground Granulated Blast Furnace Slag) (GGBS) were compared (GPCC). The results of the tests indicate that GGBS concrete is durable has a 13.82 percent improvement in compressive strength as the ambient temperature rises as compared to standard concrete.

P.K. Jamdade and U. R. Kawade (2014) Geopolymer concrete's compressive strength can be increased by using the oven curing method was calculated. The geopolymer concrete is cured in the oven at Temperatures range from 60°C to 90°C to 120°C. The results show the compressive strength increases with increasing the curing temperature and time have a significant impact on the compressive strength of geopolymer concrete. As the polymerization process progresses, the longer the curing time, the greater the compressive force.

Yasir Sofi and Iftekar Gull (2014) investigated the various properties of geopolymer concrete based on fly ash. The M20 grade geopolymer was generated by rising the nominal mix ratio from 1:1.5:3 to 1:1.5:3 the alkaline liquid-to-fly ash ratio was increased from 0.3 to 0.45 (fly ash, fine and coarse aggregates). Compressive, tensile, and flexural strength tests were carried out on the geopolymer concrete based on fly ash.

The parameters affecting compressive strength, flexural strength, and tensile strength were investigated and experimentally demonstrated. It was found that raising the alkaline liquid to fly ash ratio decreases the strength of geopolymer concrete based on fly ash. Geopolymer-based concrete based on it was also discovered that fly ash has a high compressive strength and a long lifespan.

Rounak Hussain et al.(2015) In this analysis, bottom The source materials for Ash and GGBS were used in the geopolymer concrete for paver bricks-based geopolymer. In geopolymerisation, an alkaline solvent A sodium hydroxide (NaOH) and sodium silicate mixture was used (Na_2SiO_3). The $\text{Na}_2\text{SiO}_3/\text{NaOH}$ ratio is set to 2.5. The findings of the experiments indicate thatthe compressive resistance of M30 and M35grade was achieved at young ages under ambient curing. The required compressive intensity for 6M NaOH concentration was achieved after 3 days for M30 grade and 1 day for 8M grade. The required compressive strength for 6M NaOH was achieved in the case of M35grade.

G. Ramkumar et al.(2015) Describes the evolution of fine aggregates reinforced geopolymer concrete. Geopolymer concretes (GPCs) are a revolutionary form of construction material that has arisen as a feasible alternative to ordinary Portland cement concrete (OPCC) and have the ability torevolutionise the construction industry.Significant research has been conductedperformed to develop Geopolymer concretes (GPCs), such as ambient temperature curing and the use of stainless and mild various fine aggregates. The aim of this paper is to look at different fine aggregates reinforced geopolymer concretes. In the binder levelThree GPC mixes of fly ash (50%) and GGBS (50%) were considered, as well as a regulation GPC mix and a GPC mix of additional stainless various fine aggregates, and a GPC mix with mild various fine aggregates.

According to the studies, the majority of the GPC mix's load carrying capacity was, in most cases, greater than that of the conventional OPCC mix. GPC beams had greater deflections at different times, including duty load and peak load.

K.Vivek et al. (2015) The use of fibre reinforcement Geopolymer composites have the ability to enhance flexural strength and fracture toughness. Because natural sand is scarce, quarry dust is being used to substitute fine aggregates. The optimal amount of GGBS replacement of fly ash in GPC will be determined. The concrete's water absorption property is less than the nominal value. Different molarities of sodium hydroxide solutions, namely 3M, 5M, 7M, and 9M, are considered. If the equivalence point of sodium hydroxide increases, so does the pressure of the geopolymer. The results of the tests show that GGBS concrete has at 13.82 percent water content improvement in compressive strength over traditional concrete. The geopolymer concrete achieves 60-70 % compressive strength in 7 days.

Rajiwala et al. (2015) Using a constant The compressive strength of geopolymer concrete based on an alkaline solution to fly ash (by mass) ratio of 0.35 on the use of low-calcium fly ash is being researched. The following parameters are being taken into account: potassium hydroxide (KOH) solution molar concentration The sodium Hydroxide solution to potassium Hydroxide solution mass ratio. Wet-Mixing Time's Influence on Curing Temperature Compressive strength is affected by handling time. What effect does a superplasticizer have an effect on compressive power, solids mass ratio, compressive force, and stress. The effect of a superplasticizer on concrete slump, the effect of the water-to-geopolymer -strain relationship of Geopolymer concrete in compression is being researched. The compressive strength of concrete cubes was measured at 7 and 28 days of age was measured using a compressive measuring system and cubes cured at 600° C.

Following research all four exposed faces cracked in the same way, with little or no harm to the faces that came into contact with the platens (top and bottom). The cracking resembled a vertical zigzag pattern.

Bhorwani et al. (2015) Two curing methods were used on the casted specimen: oven curing and ambient curing. The water-cured control concrete was cast and cured according to IS 10262: 2009. At 3 days, the strength of geopolymer concrete synthesised with only slag as the sole binder grows and is equal to the strength of standard control concrete at 7 days. However, at later points, strength gains are a little slower. The rate of strength gain at ambient temperature is sluggish. However, the mixture of fly ash and slag geopolymer concrete is similar to the target pressure after 28 days. Although slag cures faster in the beginning, the increase in strength over time is slow after 7 days of ambient curing. When compared to ambient curing, oven curing provides more power.

1.9 OBJECTIVE

1. Geopolymer concrete's compressive strength will be investigated.
2. The object of this research is to investigate the split tensile strength of geopolymer concrete.
3. Investigate the flexural power of geopolymer concrete.

CHAPTER 2

AIM OF THE STUDY AND SCOPE OF THE STUDY

2.1 AIM OF THE STUDY

The project's objective

1. To examine the use of fly ash in concrete by removing all cement.
2. To investigate the use of different fine aggregates as reinforcement material in Geopolymer Concrete.
3. To study the use of Manufactured sand rather of River sand as Fine aggregate for Geopolymerconcrete.

2.2 SCOPE OF THE STUDY

1. The use of geopolymer concrete in the building industry has culminated in the complete discharge of cement from concrete, giving rise to the term "Green Concrete."
2. Instead of cementFly ash, a byproduct of thermal power plants, can be used as an unbreakable material. Because of its higher calcium content, cement produces a large amount of carbon dioxide when reacted with water, which is extremely harmful to the atmosphere.
3. This will be cost effective and also a better way for managing the disposal. Thus the abstraction of replacing cement fully by fly ash seems to been couraging.
4. To increase construction efficiency while maintaining the highest levels of product quality in the face of natural sand scarcity.
5. The normal sand is fully returned by manufacturing sand, having a high Silica content, which activated the manufacture of good bonding among the materials in the Geopolymer concrete year due to expansion in the ConstructionIndustry.

CHAPTER 3

METHODOLOGY AND MATERIAL

3.1 METHODOLOGY OF THE STUDY

To investigate the behaviour of the concrete filled hollow component, tests were performed on cubes and beams with two-point loading applied normally to the entire beams. The outcomes of studies investigation were used for improving the durability of the structure in normal and seismic zones .Fig 3.1 shows the methodology flowchart.

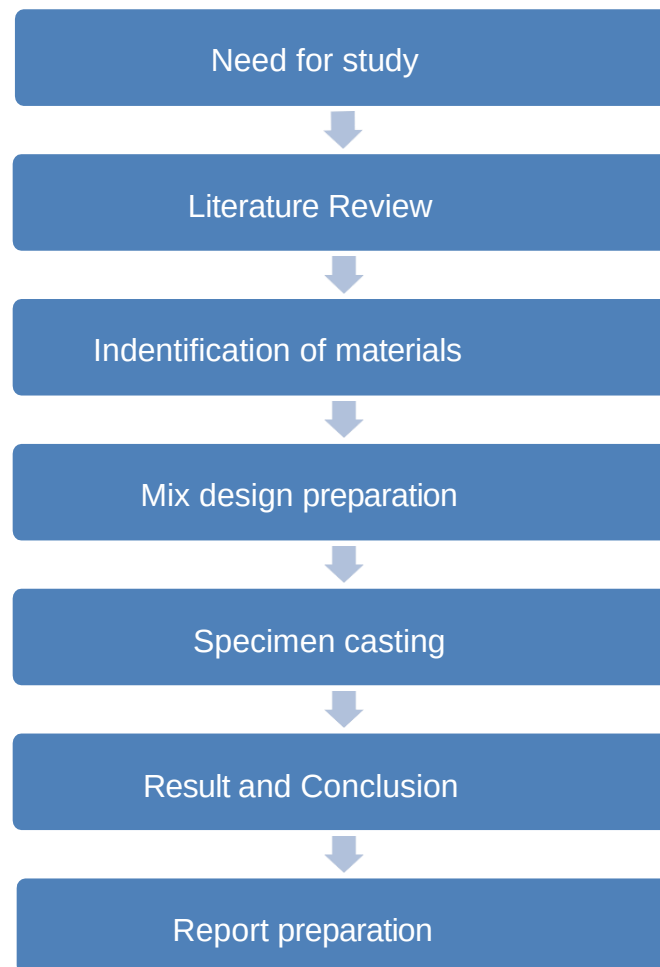


Fig 3.1 Methodology Flow chart

3.2 MATERIALS PROPERTIES

3.2.1 *General*

Geopolymer concrete can be made from a number of materials, including class F fly ash in this sample. OPC and other aggregates consume 75-80 percent of total concrete mass. The following parts go over the constituent materials used in the production of GPC. This section describes the chemical and physical properties of the constituent materials.

GPCs are usually made from the following materials:

- A. Fly ash
- B. Fine aggregate
- C. Coarse aggregate
- D. Alkaline liquid
- E. various fine aggregates

A. Fly Ash

Fly ash is a byproduct of pulverised coal combustion. that is obtained from the flue gases of thermal power plants by mechanical or electrostatic partition. The spherical shape of the particle increases flow capacity and decreases water demand. The fly ash used in this study was collected from a thermal power station and has a low calcium F content. Fly ash makes a major contribution to the workability, chemical resistance, and depletion in thermal cracking. The fly ash is depicted in Fig 3.2, and its chemical composition is shown in Table 3.1.



Fig 3.2 Fly ash

Table 3.1 Fly Ash's chemical composition

compound	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO
Fly ash	49.45	29.61	10.72	3.47	1.3
compound	Na ₂ O	K ₂ O	TiO ₂	Mn ₂ O ₃	SO ₃
Fly ash	0.31	0.54	1.76	0.17	0.27

B. FineAggregate

Because of natural resource depletion and a decline in fine aggregate due to environmental issues, concrete manufacturers are looking for suitable alternative fine aggregate. Manufactured sand is one such option. M sand is crushed aggregate formed from hard granite stone that has been cubically moulded, polished, and graded to be used in place of river sand. By forming a stronger bond than river sand, it increases both Compressive and flexural strength are two types of strength. It has a fixed gravity of 2.61 and a fineness modulus of 4.66. Fine aggregate properties can be seen in Table 3.2, and the M Sand can be seen in Fig 3.2.

Table 3.2 Properties of Fine Aggregate

Sl.No	Property	Value
1	Loose sand bulk density	1898kg/m ³
2	Sand's bulk density when compacted	1645Kg/m ³
3	Specific gravity	2.61
4	Water absorption	3.6%



Fig3.3 M Sand

C. CoarseAggregate

Coarse aggregate is composed of naturally occurring rock particles that can be collected by crushing. The aggregate we are using has a thickness of 20mm. The specific gravity of the fine aggregate used is 2.67. The coarse aggregate properties are depicted in Table 3.3, and the coarse aggregate is shown in Fig3.4.

Table 3.3 Coarse Aggregate Properties

Sl.No	Property	Value
1	Particle Shape	Angular
2	Spectral Gravity	2.67
3	Fineness modulus	7.15
4	Water Absorption	0.33%



Fig 3.4 Coarse Aggregate

D. Alkaline Liquid

At room temperature, Alkaline liquids are typically created by combining sodium hydroxide solution and sodium silicate. When the solutions are mixed together, the two solutions begin to react, i.e. (polymerisation occurs), and a significant amount of heat is released, so it is suggested that the alkaline liquid be left for around 24 hours before it is ready to be used as a binding agent.

a) Sodium hydroxide

Pure sodium hydroxide is a whitish solid available in pellets, flakes, granules, and solutions. Water, ethanol, and methanol dissolve it, but ether and other non-polar solvents do not.

The hydration of sulphuric acid, like the dissolution of solid sodium hydroxide in water, is an extremely exothermic reaction that produces a significant amount of heat, posing a safety risk due to the likelihood of splashing. The resulting solution is typically colourless and odourless. As it comes into contact with skin, it feels sticky, similar to other alkaline solutions. The sodium hydroxide solids were obtained from local suppliers and were laboratory grade in pellet form with an 80 percent purity. Dissolving the pellets in water yielded the Sodium Hydroxide (NaOH) solution.

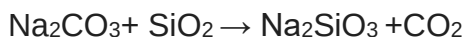
The mass of sodium hydroxide solids in a solution was affected by the concentration of sodium hydroxide solids in the solution, which was calculated in molar, M. For example, There was an 8M sodium hydroxide solution present $8 \times 40 = 320$ grammes of per litre of solution sodium hydroxide solids (in pellet form), The molecular weight of sodium hydroxide is 40. The Sodium Hydroxide Flakes are depicted in Fig.3.5.



Fig.3.5 Sodium Hydroxide Flakes

b) Sodium Silicate

Sodium silicate is the common name for compounds with the formula $\text{Na}_2(\text{SiO}_2)_n\text{O}$. Na_2SiO_3 is a well-known member of this series (sodium meta silicate). These items, also known as water glass or liquid glass, can be used in both aqueous and solid states. Commercial samples can be greenish or blue due to the presence of iron-containing impurities, despite the fact that pure compounds are colourless or translucent. These products, also known as water glasses or liquid glasses, are suitable for use in both aqueous and solid states. Though pure compositions are colourless or translucent, industrial samples can be greenish or blue due to iron-containing impurities.



Local suppliers supplied the sodium silicate solution (water glass). The chemical composition of sodium silicate solution was determined. $\text{Na}_2\text{O}=8\%$, $\text{SiO}_2=28\%$, and water= 64% by mass. Alkaline liquid is created by combining Sodium hydroxide solution and sodium silicate solution. The sodium silicate solution is made up of depicted in Fig.3.6.



Fig 3.6 Sodium Silicate Solution

c) Distilled Water

Distilled water is water that has been distilled to eliminate all impurities. The method of boiling water and condensing the steam into a clean container is known as distillation. Deionized water is preferred over tap water. Distilled water is used in chemical and biological laboratories, as well as in industry. If these alternatives are not clean enough, filtered water is used. When ultrapure water is needed, double distilled water is used.

Tap water contains minerals and ions that can be corrosive to the structure of concrete, causing anti-corrosion additives to deplete more easily. Distilled water increased the exothermic chemical reactions bonding pure without any impurities, and since the pH value is lower, any chemical reaction will occur without reaction with its own compositions.

E. Fine aggregates of various types

The various types of fine aggregates used here are as follows:

1. MSAND
2. RIVERSAND
3. SILICASAND

MSAND: Manufactured sand (M-Sand) is a form of artificial sand that is created by grinding Strong stones are crushed into small angular particles the size of sand, which are then washed and finely graded for use as building aggregate. It outperforms river sand as a building material.

RIVER SAND: River sand is the product of millions of years of natural weathering of rocks. The Kaveri (also spelled Cauvery) river runs through Karnataka and Tamil Nadu in India. After the Godavari and the Krishna, it is the third largest river in south India, and the largest in Tamil Nadu.

SILICA SAND: Silica sand is quartz that has been broken down into tiny granules by the action of water and wind over time. Oil and gas recovery companies use commercial silica sand as a proppant in both traditional and unconventional resource plays. The various fine aggregates are depicted in Fig. 3.7.



Fig 3.7 M SAND, RIVER SAND, SILICA SAND

3.3 CONCRETE PREPARATION

Fine and coarse aggregates are collected and combined with the pan mixture for around 5 minutes. The coarse aggregate is prepared with a saturated, dry surface. After that, the mixture was treated with an alkaline solvent and blended for 5 minutes. Fresh concrete can be treated for up to 120 minutes without corroding or setting. To assess the workability of fresh concrete, the traditional slump test is used. Since geopolymer concrete adheres strongly to the mould, oiling the moulds is important for release when casting in three layers by hand compacting each cube specimen. With a regular concrete compaction rod, each layer was compacted for 25 strokes.

The water/cement ratio specifies how much water is in the concrete mix; adding more or less water to the mix reduces the strength of the concrete. The Slump Test was used to evaluate the workability and slump value of the concrete after it had been thoroughly mixed.

3.4 MIX PROPORTION:

Table 3.4 Mix Proportions

Ingredients	M sand	River sand	Silica sand
Fly ash (kg/m ³)	405	405	405
Fine aggregate (kg/m ³)	683.13	683.13	683.13
Coarse aggregate (kg/m ³)	1268.66	1268.66	1268.66
Sodium hydroxide (kg/m ³)	70.88	70.88	70.88
Sodium silicate (kg/m ³)	70.88	70.88	70.88
Super plasticizer (kg/m ³)	7.5	7.5	7.5
Various fine aggregates (%)	0%	0.25%	0.50%

3.5 FRESH CONCRETE TESTS

In this inquiry, the workability checks were performed on fresh concrete. Workability influences both the rate of placement and the degree of compaction of concrete. On fresh concrete, slump tests were performed.

3.6 PREPARATION OF SAMPLES

To achieve optimum strength, fresh concrete was placed into moulds with care, using a damping rod to extract entrapped air. After every third filling of the mould with material, vibrators were used, and the top surface was properly levelled at the end.

3.7 DEMOULDING

The fresh concrete in the mould was levelled and set for 24 hours after it was levelled. Concrete specimens were identified using permanent markers before being removed from the mould. In preparation for the next batch of concrete mix, the moulds were cleaned and processed. The demoulding is depicted in Fig.3.8.





Fig 3.8 After demoulding specimen

3.8 CURING

Curing is a critical process that prevents concrete specimens from losing moisture while acquiring the necessary strength. Inadequate curing is often to blame for the emergence of unexplained cracks on a concrete specimen's surface. Until the day of specimen testing, ambient curing at room temperature is maintained. The curing is represented in Fig.3.9.



FIG 3.9 CURING

3.9 TESTS ON HARDENED CONCRETE

3.9.1 Compressive Strength

A concrete cube's compressive strength is known as its maximum resistance to axial loading. For each batch of mix, Compression testing was performed on three specimens measuring 150 mm x 150 mm x 150 mm. After curing, specimen testing was performed as soon as possible. Prior to testing, the dimensions of the specimen were measured. Specimens were loaded into the testing machine after they had been washed and dried on the floor. The platen was lowered until it made contact with the specimen's top surface. In compliance with IS 516– 1959, the specimen was tested for compressive strength using a calibrated compressive enhance digital indicator – ACTM. These samples' compressive strength was measured. The compressive strength is depicted in Fig.3.10.



Fig 3.10 Compressive testing

3.9.2 Split Tensile Strength Test

On cylinders 150mm in diameter and 300mm in height, a split tensile test was performed. Specimen processing should begin as soon as possible after curing. The measurements of the specimens were determined prior to processing. Specimens that have been cleaned and cured are loaded into the testing machine. The platen was lowered and allowed to make contact with the top surface of the specimen. The force was introduced, and it was gradually increased. The split tensile strength was determined after evaluating the maximum load at which the specimen failed. The split tensile test is depicted in Fig. 3.11.



Fig 3.11 Split Tensile Testing

3.9.3 Flexural Strength Test

A prism with dimensions of Flexural strength was measured at 150 mm width, 150 mm depth, and 700 mm length. The specimen should be tested as soon as possible after curing. When the specimen is about to come into contact with the rollers, The supporting and loading rollers' bearing surfaces are washed, and any loose sand or other materials on the specimen's surface are removed. The specimen is then fed into the unit, which moves the load to the uppermost surface of the caste in the mould along two lines 20cm apart. The specimen's orientation is carefully aligned with the axis of the loading unit. There is no packing between the bearing surfaces of the specimen and the rollers. The load is applied without producing any form of shock. The flexural strength was measured. The flexural strength test is depicted in Fig3.12.



Fig 3.12 Flexure strength Test

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTERPRETATION OF TEST RESULTS

The test results are recorded and compared to the values obtained from different codes. The following section discusses the effects of compressive strength and split tensile strength tests for different fine aggregate proportions.

4.2 COMPRESSIVE STRENGTH

The compressive strength of concrete is the primary parameter that determines its other properties. The effect of different fine aggregates with different volume fractions and concrete age at the time of testing on the flexural strength of geopolymer concrete composite was investigated and described. The results of the flexural strength test are shown. The average compression test result for 7th strength was seen in Table 4.1. The compression strength test result for the 7th day was seen in Fig 4.1.

Table 4.1: Average Compression Test Outcomes (7 Days Strength)

Sl.No	Mix	Compressive Strength (N/mm ²)
1	M sand	22.01
2	River sand	22.81
3	Silica sand	23.84

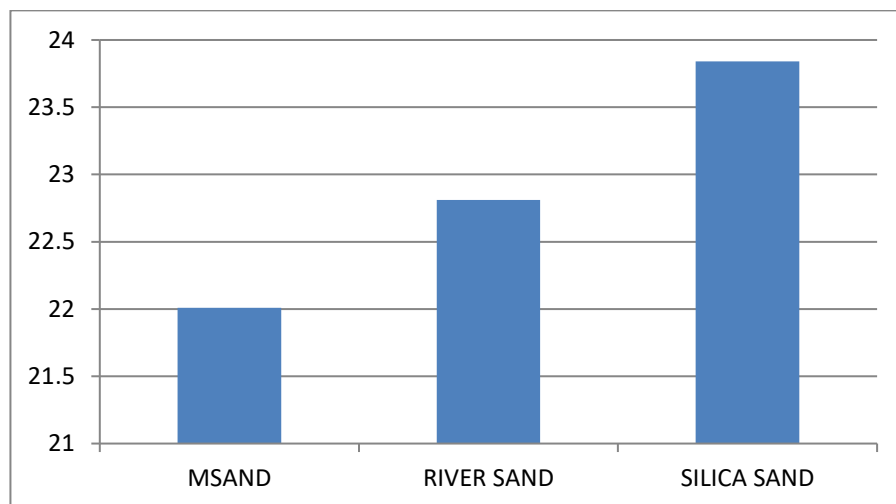


Fig4.1 Compressive Strength on the 7thDay

The average compression test result for 28th day strength is seen in Table 4.2. The compression test results for the 28th day are seen in Fig.4.2.

**Table 4.2 Average Compression Test Outcomes
(28 Days Strength)**

Specimen Name	Mix	Compressive Strength (N/mm²)
1	Msand	35.85
2	Riversand	37.02
3	Silicasand	38.77

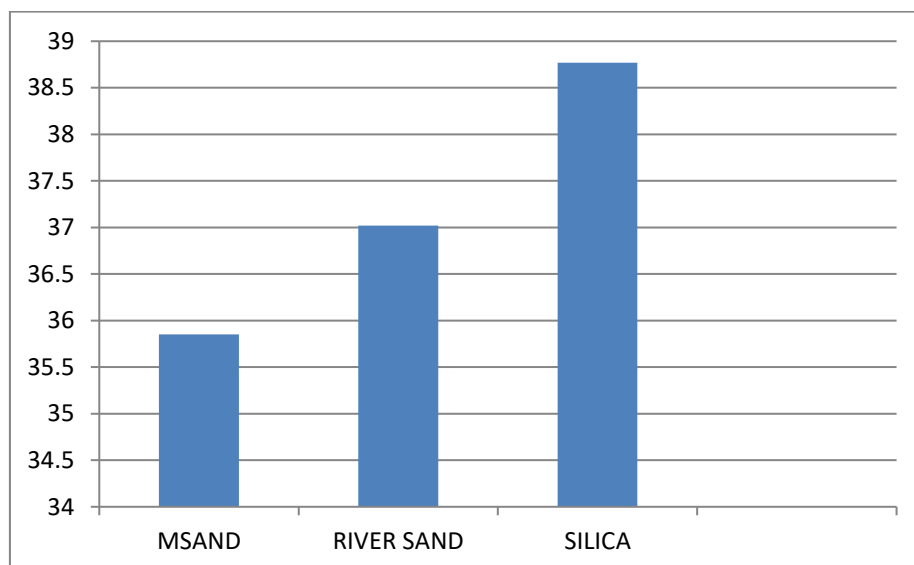


Fig 4.2 On the 28th day, compressive strength

4.3 SPLIT TENSILE STRENGTH

The impact of various factors on the split tensile strength of a geopolymer concrete composite, such as the addition of various fine aggregates in different volume fractions and the concrete's age at the time of testing, has been investigated and presented. The results of the tensile strength test on split tensile are shown.

**Table 4.3 Split Tensile Test Results on Average
(7 Days Strength)**

Sl.No.	Mix	Split Tensile (N/mm ²)
1	M sand	2.09
2	River sand	2.09
3	Silica sand	2.12

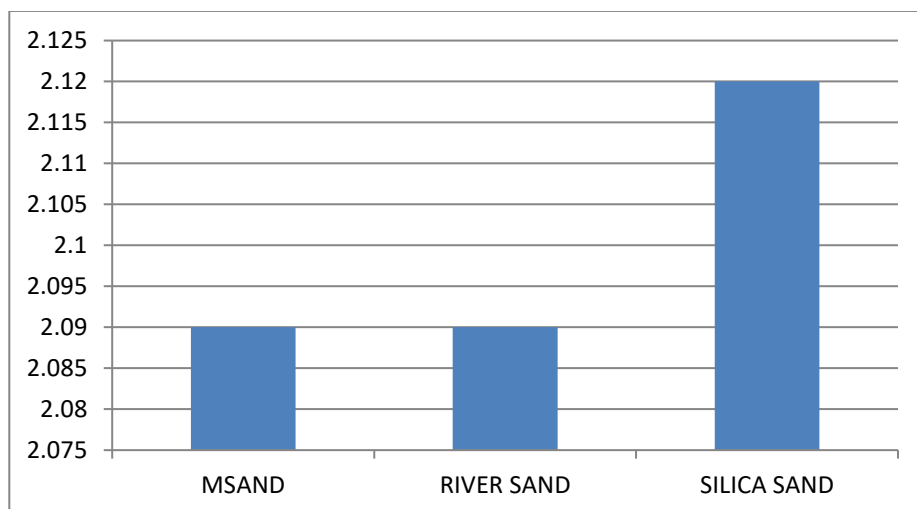


Fig4.3 Tensile Strength on the 7th Days

**Table 4.4 Split Tensile Test Results on Average
(28 Days Strength)**

Sl.No.	Mix	Split Tensile (N/mm ²)
1	M sand	2.65
2	River sand	2.80
3	Silica sand	2.84

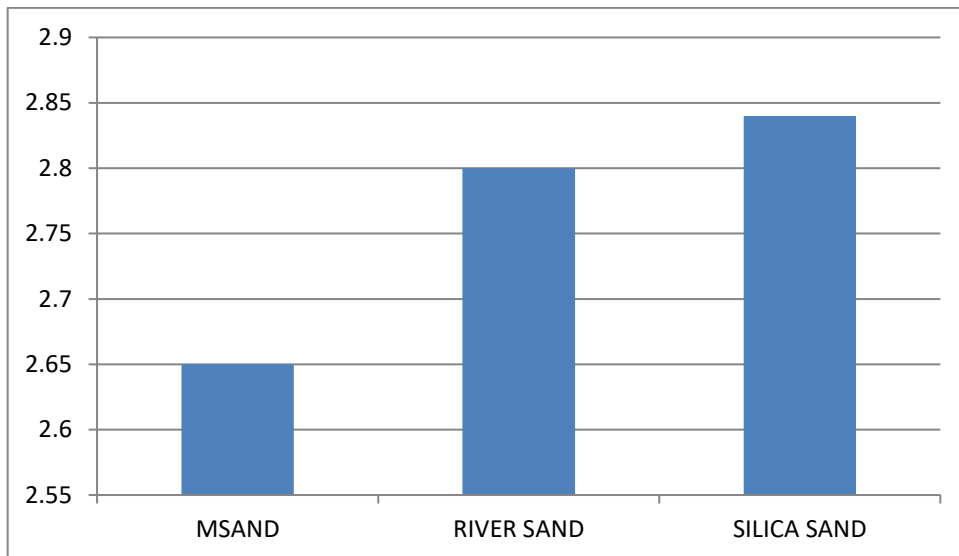


Fig 4.4 Tensile Strength on the 28th Days

4.4 FLEXURALSTRENGTH

The effect of different fine aggregates with different volume fractions and concrete age at the time of testing on the flexural strength of geopolymer concrete composite was investigated and described. The flexural strength test results are shown.

Table 4.5 Flexure Test Results on Average
(7 Days Strength)

Sl.No.	Mix	Flexure Strength (N/mm ²)
1	M sand	2.55
2	River sand	2.63
3	Silica sand	2.75

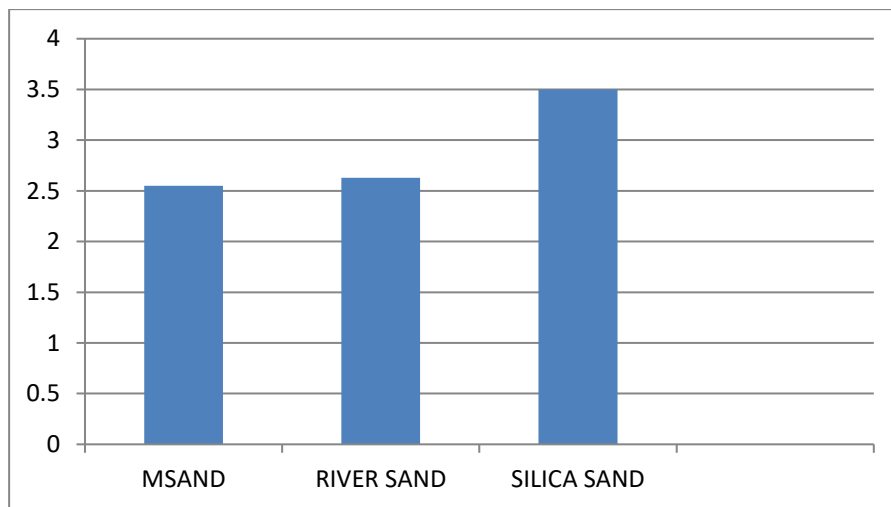


Fig4.5 Flexural Tensile Strength in 7 Days

Table 4.6 Flexure Test Results on Average
(28 Days Strength)

Sl.No.	Mix	Flexure Strength (N/mm ²)
1	M sand	5.68
2	River sand	5.86
3	Silica sand	6.12

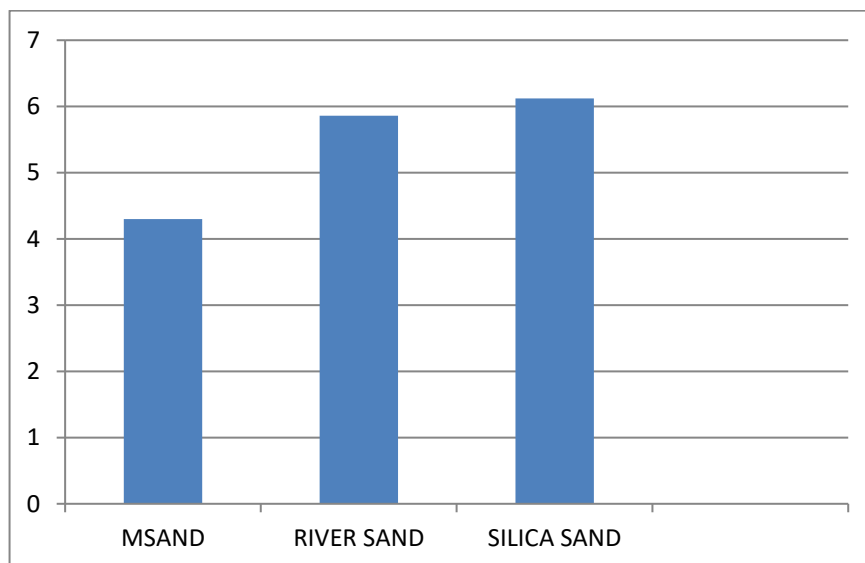


Fig 4.6 Flexural Tensile Strength in 28 Days

4.5 DISCUSSION

1. For Compression TestResult:

On the seventh day, silica sand cube has a higher compressive strength (23.84) than river sand cube (22.81) and M-sand cube (22.01).

On the 28th day, silica sand cube has a higher compressive strength (38.77) than river sand cube (37.02) and M-sand cube (35.85)

2. For Split TensileStrength:

On the seventh day, silica sand cube has a higher split tensile strength (2.12) than river sand cube (2.09) and M-sand cube(2.09).

On the 28th day, silica sand cube has a higher split tensile strength (2.84) than river sand cube (2.80) and M-sand cube(2.65)

3. For Flexural Strength:

On the seventh day, silica sand cube has a higher flexural strength (2.75) than river sand cube (2.63) and M-sand cube (2.55)

On the 28th day, silica sand cube has a higher flexural strength (6.12) than river sand cube (5.86) and M-sand cube(5.68)

CHAPTER 5

SUMMARY AND CONCLUSION

5.1 SUMMARY

The results of experimental research on the physical and microstructural. This chapter addresses the properties of manufactured sand. Unlike natural sand (spherical particles), processed sand (angular particles) allows for stronger particle interlocking, resulting in increased strength and durability.

1. Geopolymer concrete reduces cement consumption, carbon dioxide emissions, and greenhouse gas emissions.
2. At the end of the 7th and 28th days, geopolymer concrete has a high compression strength. As a result, it was discovered that geopolymer concrete has a higher strength than conventional concrete made of various types of fine aggregates.
3. The inclusion of fibres in concrete reduces crack propagation while increasing peak value.
4. The compressive, break tensile, and flexure tests demonstrate that geopolymer concrete can be used in place of conventional Portland cement concrete
5. A high percentage of different fine aggregates is needed to increase the power of geopolymer fine aggregates based on fly ash
6. Geopolymer concrete's tensile power, it gradually rises until it reaches 0.75.
7. Geopolymer concrete's tensile power, it gradually rises until it reaches 0.75.
8. As 1% fine aggregates are applied to the volume of concrete, the amount of fine aggregates in the concrete decreases.

5.2 CONCLUSION

1. During the project, We investigated the usage of fly ash as a cement substitute and performed compressive power, flexural, and split tensile tests.

2. As a result of the results obtained, we can conclude that using fly ash instead of cement results in better concrete quality, and geopolymer concrete is superior to conventional concrete.

5.3 FUTURE SCOPE OF WORK

1. In our project, we focused on 12 molarity; in the future, different molarities of alkaline liquids should be investigated.

2. In our project, we used 60 °C as the curing temperature; in the future, different curing temperatures for different fine aggregate geopolymer concrete should be tested. In our project we have done for 60 °C in future different temperature of curing should be checked for the various fine aggregate geopolymer concrete.

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