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# Analysis of Development of Porous fly ash-based Geopolymer with Low Thermal Conductivity

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**Abstract:** In this paper development of porous ash primarily based geopolymer with low thermal conductivity. Porous ash-based geopolymer material was created exploitation ash and metal water glass as original material and H2O2 as foaming agent. The development of sustainable construction and construction materials with reduced environmental footprint in each producing and operational phases of the fabric lifecycle is attracting increased interest within the housing and industry worldwide. Within the future the area of development of fiber reinforced cement free fly ash primarily based geopolymer concrete will be using by treated natural fibre and synthetic fiber.

**Keywords:** Geopolymer, Fiber Reinforced Concrete.

## I. INTRODUCTION

Industrialization leads to the generation and unharnessed of undesirable pollutants into the surroundings. In recent years, there's an increasing awareness on the amount and variety of hazardous solid waste generation and its impact on human health. The demand for the concrete as a fabric of construction can increase because the demand for infrastructure development will increase, particularly in countries like China and India. so as to satisfy this demand, the production of Portland cement should increase. However, the contribution of greenhouse emission emission from Portland cement production is regarding one.35 billion tons annually or about seven-member of the entire green House Gas (GHG) emissions to the earth's atmosphere. moreover, Portland cement is among the most energy-intensive construction materials, when aluminum and steel. Geopolymer concrete is proved to own excellent engineering properties with a reduced carbon footprint. It not solely reduces the greenhouse gas emissions (compared to Portland cement primarily based concrete) however additionally utilizes a large quantity of industrial waste materials like ash and slag. Because of these positive attributes, it's becoming an increasingly well-liked construction material.

Geopolymers exhibit a large type of properties and characteristics, as well as high compressive strength, low shrinkage, heat resistance [8] and acid and hearth resistance [9], and seem to be a fascinating various to standard Portland cement and environmentally property characteristics [10]. Besides, the carbon dioxide emission because of production of fly ash-based geopolymer is a minimum of 80th less compared to manufacture of standard Portland cement.

Geo polymer may be a novel binding material created from the reaction of fly ash with an alkaline resolution. In geopolymer Portland cement isn't used at all. It's the potential to exchange OPC in concrete manufacturing and manufacture ash primarily based geo polymer concrete, low Ca with excellent physical and mechanical properties. so as to provide geo polymer low Ca ash must be activated by an alcalescent solution to provide polymeric Si-O-Al bonds. Geopolymer concrete reinforced with randomly distributed separate fibers resembles the fiber reinforcement concrete in several of its properties. Typically the separate fibers are simply added and mixed with the ash, a lot of a similar as cement, lime or the other additives. Fiber reinforced geopolymer concrete was found to outperform the management mix with relation to flexural strength, sturdiness and shrinkage while reducing carbon emissions by approximately seventieth.70%.

## II. THEORY

Use of concrete in construction contributes over seven-member of worldwide carbon di-oxide emissions. If emission targets are to be met some radical changes ought to be created to reduce this value. the utilization of geopolymer binder and artificial fibers in place of Portland cement and steel reinforcement to provide fiber reinforced geopolymer concrete (FRGC) provides a lower carbon different to standard concrete by combining fiber reinforcement and geopolymer technology.

A. Natural Fiber as Geopolymer Concrete Reinforcing Material

Natural fibers, as reinforcement, have recently attracted the attention of researchers due to their benefits over different established materials. They environmentally friendly, totally biodegradable, abundantly available, renewable, and low cost and have density. Plant fibers are light compared to glass, carbon and aramid fibers. The biodegradability of plant fibers will contribute to a healthy system whereas their low price and high performance fulfills the economic interest of trade. Once natural fiber-reinforced plastics are subjected, at the top of their life


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cycle, to combustion method or landfill, the free quantity of carbon dioxide of the fibers is neutral with relation to the assimilated amount throughout their growth.

Natural fibers are prospective reinforcing materials and their use thus far has been additional traditional than technical. They need long served several helpful functions however the applying of materials technology for the use of natural fibers because the reinforcement in concrete has only taken place in relatively recent years. The distinctive properties of fiber reinforced concretes are improved tensile and bending strength, larger ductility, and larger resistance to cracking and therefore improved impact strength and toughness.

Natural fibers type an interesting different for the most wide applied fiber within the construction technology, the fibers like flax, hemp, jute or sisal have the benefits of density, high toughness, comparable specific strength, reduction in tool wear, simple separation, and low energy of fabrication. They need high specific properties like stiffness, impact resistance and flexibility. Additionally, they're available in large amounts, renewable and biodegradable. Different fascinating properties include low price and density, knowing that natural fibers are low cost and have a higher stiffness per weight than glass, which results in lighter parts, the big interest in natural fibers is evident.

B. Natural Fiber Sisal as Reinforcement Materia

Sisal Fiber is one in all the widest used natural fibre and is extremely simply cultivated. It’s obtained from sisal plant. (The plant known formally as agave Sisalana) These plants manufacture rosettes of sword-shaped leaves that begin out toothed, and gradually lose their teeth with maturity. Every leaf contains variety of long, straight fibers which might be removed during a method called decortications.

Fig.1 Natural Sisal Fiber

Fig. 2 Making of Sisal Fiber Reinforced Concrete

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Throughout decortications, the leaves are beaten to remove the pulp and material, leaving the robust fibers behind. The fibers will be spun into thread for twine and textile production, or pulped to create paper product.

Sisal fiber is totally biodegradable, green composites were made-up with soy protein resin changed with gelatin. Sisal fiber, changed soy protein resins, and composites were characterized for his or her mechanical and thermal properties. it's extremely renewable resource of energy. Sisal fiber is exceptionally durable and a low maintenance with minimal wear and tear. Its fiber is simply too robust for textiles and materials. it's not appropriate for a smooth wall end and additionally not recommended for wet areas.

Sisal fiber is creamy white in color and lustrous. It will do to 1 meter long with a diameter of 200 to 400 microns. The sisal fiber may be a coarse hard fiber that is robust, durable, and stretchable and doesn't absorb wet simply, doesn't deteriorate in salt water and has affinity for dye. Agricultural twine and ropes is still one in all the biggest markets for sisal fiber, whereas the best fiber grades are used for manufacturing of rugs and home furnishing.

## III. PROPOSED METHODOLOGY

To study the compressive and flexural strength behavior of geopolymer concrete mixed with sisal fiber in random manner, thus a series of experiments were conducted within the laboratory on geopolymer reinforced with sisal fibers and additionally on unreinforced geopolymer concrete. The main points of procedure are as follows:

- Identification of raw materials like ash, sisal fiber, alkaline substance, fine mixture & coarse aggregate for concrete preparation.
- Characterization properties of ash, fine aggregate & coarse mixture and sisal fiber.
- Process for preparation of normal size cube specimens of optimized combine for compressive strength and flexural strength.
- Filling & compaction of concrete combine into moulds for creating the planned concrete elements.
- Heat treatment of concrete elements by optimized curing procedures.

Fig.3 Specimen Sample for Compressive and Flexural Strength.

## IV. RESULT & DISCUSSION

TABLE I COMPRESSIVE STRENGTH OF REFERENCE GEOPOLYMER CONCRETE, AMBIENT CURED AND TESTED AFTER 3, 7AND 14 DAYS

| Compressive Strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.59 | 145.13 | 6.45 | 6.63 |
| | 2 | 8.87 | 120.15 | 5.34 | |
| | 3 | 8.72 | 182.03 | 8.09 | |

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|---|---|---|---|---|---|
| 7 days | 1 | 8.80 | 434.03 | 19.29 | 20.10 |
| | 2 | 8.76 | 549.90 | 24.44 | |
| | 3 | 8.90 | 372.83 | 16.57 | |
| 14 days | 1 | 8.82 | 715.50 | 31.80 | 27.22 |
| | 2 | 8.9 | 539.33 | 23.97 | |
| | 3 | 8.96 | 582.53 | 25.89 | |

TABLE II COMPRESSIVE STRENGTH OF FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL-0.5%) AMBIENT CURED AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive Strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.64 | 172.04 | 7.65 | 8.65 |
| | 2 | 8.92 | 209.09 | 9.29 | |
| | 3 | 8.7 | 202.70 | 9.01 | |
| 7 days | 1 | 8.69 | 521.33 | 23.17 | 26.25 |
| | 2 | 8.6 | 633.60 | 28.16 | |
| | 3 | 8.52 | 617.18 | 27.43 | |
| 14 days | 1 | 8.72 | 654.53 | 29.09 | 32.15 |
| | 2 | 8.75 | 768.83 | 34.17 | |
| | 3 | 8.68 | 746.78 | 33.19 | |

TABLE III COMPRESSIVE STRENGTH OF FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL-1%) AMBIENT CURED AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.9 | 172.33 | 7.66 | 9.44 |
| | 2 | 8.64 | 224.83 | 9.99 | |
| | 3 | 8.57 | 240.05 | 10.67 | |
| 7 days | 1 | 8.74 | 522.23 | 23.21 | 28.61 |
| | 2 | 8.5 | 681.30 | 30.28 | |
| | 3 | 8.9 | 727.43 | 32.33 | |
| 14 days | 1 | 8.82 | 767.70 | 34.12 | 35.73 |
| | 2 | 8.96 | 910.13 | 40.45 | |
| | 3 | 8.9 | 733.73 | 32.61 | |

TABLE IV COMPRESSIVE STRENGTH FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL-1.5%) AMBIENT CURED AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive Strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.88 | 261.58 | 11.63 | 10.40 |
| | 2 | 8.51 | 208.57 | 9.27 | |
| | 3 | 8.6 | 231.66 | 10.30 | |
| 7 days | 1 | 8.85 | 792.68 | 35.23 | 31.65 |
| | 2 | 8.81 | 632.03 | 28.09 | |
| | 3 | 8.59 | 711.45 | 31.62 | |
| 14 days | 1 | 8.71 | 911.03 | 40.49 | 40.47 |
| | 2 | 8.59 | 909.90 | 40.44 | |
| | 3 | 8.61 | 911.03 | 40.49 | |

TABLE V COMPRESSIVE STRENGTH OF FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL-2%) AMBIENT CURED AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 | 1 | 8.72 | 281.18 | 12.50 | 12.21 |

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|---|---|---|---|---|---|
| days | 2 | 8.75 | 245.77 | 10.92 | |
| | 3 | 8.68 | 297.25 | 13.21 | |
| 7 days | 1 | 8.87 | 852.08 | 37.87 | 37.10 |
| | 2 | 8.87 | 751.73 | 33.41 | |
| | 3 | 8.85 | 900.68 | 40.03 | |
| 14 days | 1 | 9 | 896.40 | 38.64 | 40.96 |
| | 2 | 8.86 | 974.03 | 43.29 | |
| | 3 | 8.9 | 921.60 | 40.96 | |

TABLE VI COMPRESSIVE STRENGTH OF FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL-2.5%) AMBIENT CURED AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.93 | 211.54 | 9.40 | 9.62 |
| | 2 | 8.72 | 192.53 | 8.56 | |
| | 3 | 8.51 | 245.32 | 10.90 | |
| 7 days | 1 | 8.39 | 8.39 | 28.49 | 29.15 |
| | 2 | 8.57 | 17.14 | 25.93 | |
| | 3 | 8.81 | 26.43 | 33.04 | |
| 14 days | 1 | 8.67 | 678.38 | 30.15 | 31.12 |
| | 2 | 8.81 | 743.63 | 33.05 | |
| | 3 | 8.59 | 678.38 | 30.15 | |

TABLE VII COMPRESSIVE STRENGTH OF REFERENCE GEOPOLYMER CONCRETE, THERMAL CURED AT 600C FOR 48 HRS AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.67 | 331.43 | 14.73 | 13.82 |
| | 2 | 8.91 | 322.88 | 14.35 | |
| | 3 | 8.76 | 278.55 | 12.38 | |
| 7 days | 1 | 8.93 | 790.88 | 35.15 | 32.14 |
| | 2 | 8.72 | 722.03 | 32.09 | |
| | 3 | 8.51 | 656.33 | 29.17 | |
| 14 days | 1 | 8.80 | 788.40 | 35.04 | 37.15 |
| | 2 | 8.76 | 882.45 | 39.22 | |
| | 3 | 8.90 | 836.78 | 37.19 | |

TABLE VIII COMPRESSIVE STRENGTH OF FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL-0.5%), THERMAL CURED AT 600C FOR 48 HRS AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.79 | 347.59 | 15.45 | 14.63 |
| | 2 | 8.71 | 310.37 | 13.79 | |
| | 3 | 8.58 | 329.57 | 14.65 | |
| 7 days | 1 | 8.72 | 789.98 | 35.11 | 33.25 |
| | 2 | 8.75 | 705.38 | 31.35 | |
| | 3 | 8.68 | 749.03 | 33.29 | |
| 14 days | 1 | 8.81 | 944.33 | 41.97 | 40.31 |
| | 2 | 8.59 | 882.00 | 39.20 | |
| | 3 | 8.69 | 894.60 | 39.76 | |

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TABLE IX COMPRESSIVE STRENGTH OF FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL- 1%), THERMAL CURED AT 600C FOR 48 HRS AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.76 | 362.04 | 16.09 | 15.36 |
| | 2 | 8.81 | 389.07 | 17.29 | |
| | 3 | 8.9 | 285.91 | 12.71 | |
| 7 days | 1 | 8.93 | 822.83 | 36.57 | 34.92 |
| | 2 | 8.72 | 884.25 | 39.30 | |
| | 3 | 8.51 | 649.80 | 28.88 | |
| 14 days | 1 | 8.72 | 911.70 | 40.52 | 42.11 |
| | 2 | 8.68 | 983.03 | 43.69 | |
| | 3 | 8.52 | 947.48 | 42.11 | |

TABLE X COMPRESSIVE STRENGTH OF FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL-1.5%), THERMAL CURED AT 600C FOR 48 HRS AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.67 | 409.07 | 18.18 | 17.38 |
| | 2 | 8.89 | 379.57 | 16.87 | |
| | 3 | 8.6 | 384.22 | 17.08 | |
| 7 days | 1 | 8.85 | 929.70 | 41.32 | 39.49 |
| | 2 | 8.77 | 862.65 | 38.34 | |
| | 3 | 8.69 | 873.23 | 38.81 | |
| 14 days | 1 | 8.72 | 954.00 | 42.40 | 42.96 |
| | 2 | 8.75 | 989.55 | 43.98 | |
| | 3 | 8.68 | 956.25 | 42.50 | |

TABLE XI COMPRESSIVE STRENGTH OF FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL-2%), THERMAL CURED AT 600C FOR 48 HRS AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive Strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.75 | 394.52 | 17.53 | 17.46 |
| | 2 | 8.83 | 362.74 | 16.12 | |
| | 3 | 8.7 | 421.25 | 18.72 | |
| 7 days | 1 | 8.53 | 896.63 | 39.85 | 39.68 |
| | 2 | 8.8 | 824.40 | 36.64 | |
| | 3 | 8.74 | 957.38 | 42.55 | |
| 14 days | 1 | 8.84 | 1072.00 | 47.64 | 46.37 |
| | 2 | 8.73 | 1016.00 | 45.18 | |
| | 3 | 8.95 | 1041.75 | 46.30 | |

TABLE XII COMPRESSIVE STRENGTH OF FIBER REINFORCED GEOPOLYMER CONCRETE (SISAL-2.5%), THERMAL CURED AT 600C FOR 48 HRS AND TESTED AFTER 3, 7 AND 14 DAYS

| Compressive strength | | | | | |
|---|---|---|---|---|---|
| **Days** | **S. No.** | **Weight of Sample cube** | **Load (kN)** | **Strength (MPa)** | **Average Strength (MPa)** |
| 3 days | 1 | 8.81 | 329.08 | 14.63 | 14.72 |
| | 2 | 8.59 | 348.18 | 15.47 | |
| | 3 | 8.69 | 316.50 | 14.07 | |
| 7 | 1 | 8.87 | 747.90 | 33.24 | 33.46 |

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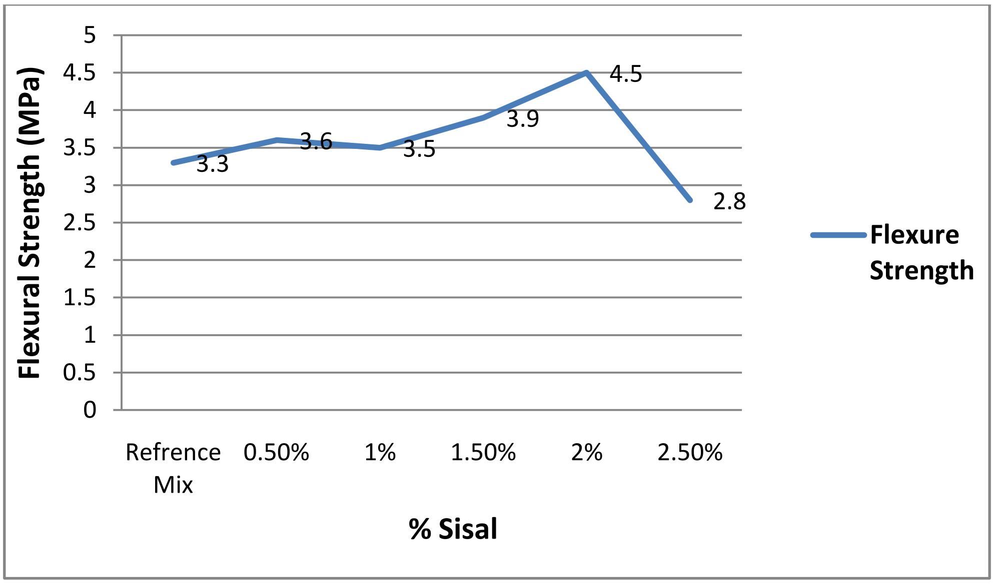
|---|---|---|---|---|---|
| days | 2 | 8.7 | 791.33 | 35.17 | |
| | 3 | 8.59 | 719.33 | 31.97 | |
| 14 days | 1 | 8.77 | 828.00 | 36.80 | 35.71 |
| | 2 | 8.5 | 817.20 | 36.32 | |
| | 3 | 8.81 | 765.22 | 34.01 | |

TABLE XIII COMPARISON OF COMPRESSIVE STRENGTH OF GEOPOLYMER CONCRETE THERMAL CURED AT 600C FOR 48 HRS. AND AMBIENT CURED.

| | **Ambient temp** | | | **Oven dried (60$^0$C for 48 hrs)** | | |
|---|---|---|---|---|---|---|
| | **Strength(MPa)** | | | **Strength(MPa)** | | |
| **Sisal Fiber %** | **3 days** | **7 days** | **14 days** | **3 days** | **7 days** | **14 days** |
| Reference | 6.63 | 20.1 | 27.22 | 13.82 | 32.14 | 37.15 |
| 0.5 | 8.65 | 26.25 | 32.15 | 14.63 | 33.25 | 40.31 |
| 1 | 9.44 | 28.61 | 35.73 | 15.36 | 34.92 | 42.1 |
| 1.5 | 10.40 | 31.65 | 40.47 | 17.38 | 39.49 | 42.96 |
| 2 | 12.21 | 37.1 | 40.96 | 17.46 | 39.68 | 46.37 |
| 2.5 | 9.62 | 29.15 | 31.12 | 14.72 | 33.46 | 35.71 |

TABLE XIV FLEXURAL STRENGTH AT DIFFERENT PERCENTAGE OF SISAL FIBER, THERMAL CURED AT 600C FOR 48 HRS AND TESTED AFTER 28 DAYS.

| **S. No.** | **Percentage (Sisal Fiber)** | **Weight (kg) of 15 X 15 X 70 cm Beam** | **Flexural Strength (MPa)** |
|---|---|---|---|
| 1 | Reference | 43.27 | 3.3 |
| 2 | 0.50% | 41.29 | 3.6 |
| 3 | 1% | 40.81 | 3.5 |
| 4 | 1.50% | 40.75 | 3.9 |
| 5 | 2% | 40.86 | 4.5 |
| 6 | 2.50% | 40.08 | 2.8 |




CSIR-AMPRI has developed numerous grades of green geopolymer concrete combine by activation of class F ash that gains desired strength at 60 ºC. The optimized style mix & curing temperature were adopted for conducting trials with R3 ash for development of desired strength geopolymer concrete. (Fly ash obtained from Satpura Thermal power station Sarni, District-Betul was named R3), that was to be used for this study.

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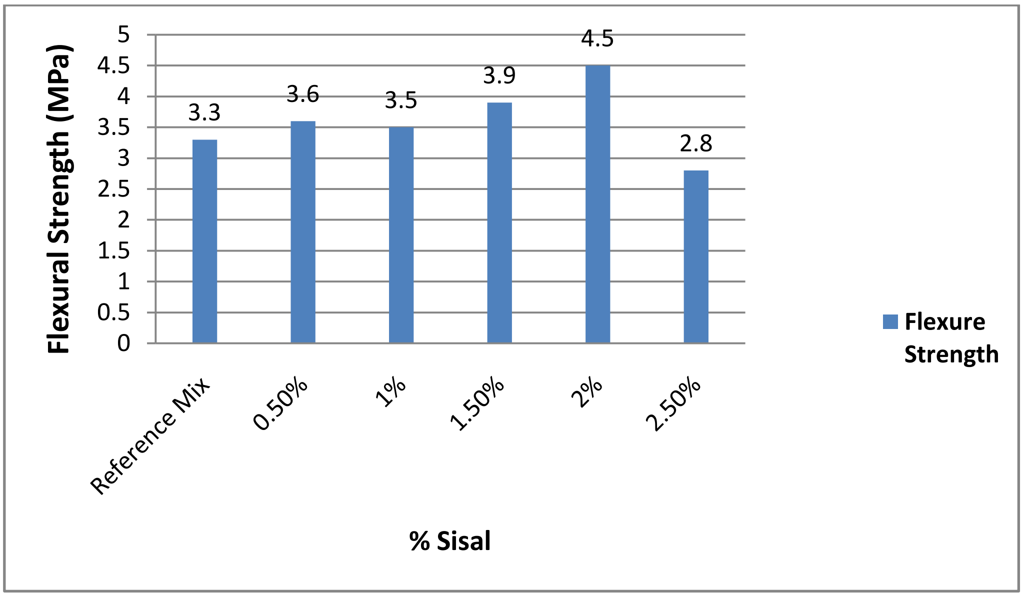


Fig.3 Comparison of Flexural strength of fiber reinforced geopolymer concrete at different percentage of sisal thermal cured at 600C for 48 hrs.

## V. CONCLUSION

This result analysis of the paper provides fresh Geo polymer Concrete is formed using the planning mix developed by CSIR-AMPRI as a reference mix for the experimental program. For experimental program the percentage of sisal fiber of length 1 cm is taken within the vary of 0.5%, 1%, 1.5%, 2%, 2.5% w/w of fly ash. The compressive strength of the Reference mix, just in case of ambient curing at temperature of 35-40ºC was 27.22 MPa at 14 days and just in case of curing at controlled temperature during a hot air oven for 48 hrs. at the temperature of 60ºC was 37.15 MPa at 14 days. The optimized percentage of the sisal fiber is 2, that shows the optimum compressive and flexural strength compared to the reference mix.When the optimized ratio of sisal 2 the compressive and flexural strength each decreases.

## REFERENCES

[1.] Junjie Feng, Ruifang Zhang, Lunlun Gong, Ye Li, Wei Cao, Xudong Cheng “Development of porous fly ash-based geopolymer with low thermal conductivity”, 2014 Elsevier Ltd.
[2.] Zuhua Zhang , John L. Provis , Andrew Reid , Hao Wanga “Geopolymer foam concrete: An emerging material for sustainable construction”, 2014 Elsevier Ltd.
[3.] Michael Yong Jing Liu, U. Johnson Alengaram∗, Mohd Zamin Jumaat, Kim Hung Mo, “Evaluation of thermal conductivity, mechanical and transport properties of lightweight aggregate foamed geopolymer concrete”, Energy and Buildings 72 (2014).
[4.] Partha Sarathi Deb , Pradip Nath, Prabir Kumar Sarker, “The effects of ground granulated blast-furnace slag blending with fly ash and activator content on the workability and strength properties of geopolymer concrete cured at ambient temperature”, 2014 Elsevier Ltd.
[5.] Ramin Hosseini Kupaei , U. Johnson Alengaram a,Mohd Zamin Bin Jumaat , Hamid Nikraz, “Mix design for fly ash based oil palm shell geopolymer lightweight concrete”, 2013 Elsevier Ltd
[6.] Davidovits J. Geopolymers_inorganic polymeric new materials. J Therm Anal Calorim 2008;37(8):1633–56.
[7.] Davidovits J. High-Alkali Cements for 21st Century Concretes. ACI Special Publication; 1994. 144.
[8.] Wongpa J, Kiattikomol K, Jaturapitakkul C, Chindaprasirt P. Compressive strength, modulus of elasticity, and water permeability of inorganic polymer concrete. Mater Des 2010;31(10):4748–54.
[9.] O’Connor SJ, MacKenzie KJD. A new hydroxide-based synthesis method for inorganic polymers. J Mater Sci 2010;45(12):3284–8.
[10.] Kani EN, Allahverdi A. Effects of curing time and temperature on strength development of inorganic polymeric binder based on natural pozzolan. J Mater Sci 2009;44(12):3088–97.
[11.] Hardjito D, Wallah SE, Sumajouw DMJ, Rangan BV. On the development of fly ash-based geopolymer concrete. ACI Mater J 2004;10(6):467–72.
[12.] Bakharev T, Sanjayan JG, Cheng Yi-Bing. Alkali activation of Australian slag cements. Cem Concr Res 1999;29(1):113–20.
[13.] Barbosa VFF, Mackenzie KJD. Thermal behaviour of inorganic geopolymers and composites derived from sodium polysalate. Mater Res Bull 2003;38(2):319–31.
[14.] Wu H-C, Sun P. New building materials from fly ash-based lightweight inorganic polymer. Constr Build Mater 2007;21(1):211–7.
[15.] Duxson PF-JA, Provis J, Lukey G, Palomo A, Van Deventer J. Geopolymer technology: the current state of the art. J Mater Sci 2007;42(9):2917–33.