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Study on Mechanical properties of Geo Polymer Concrete Using M-Sand and Glass Fibers

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ABSTRACT- Fly Ash is one of the major waste materials available from thermal power plants. Its treatment and disposal was a problem in the early stages. Researchers found out a useful method of replacing fly ash for cement in calculated qualities.Here an experiment has been conducted to study the performance of concrete using fly ash as the major binding material without of cement. Low calcium fly ash is preferred as a source material than High calcium fly ash because of to reducing more carbon di-oxide emission. Alkaline liquid Sodium hydroxide and Sodium silicate solution are used in this project as binders. It is used in Geo polymerization process.A mix proportion for Geopolymer concrete was designed and tests were carried out. The compressive, tensile & flexural strength of Geopolymer concrete have been studied and compared with OPC.Glass is one of the cheapest & abundantly available fibers. Glass fiber has been extensively used in reinforced cement. Glass fibers were added to the mix in fractions of 0.5%, 1%,1.5% and 2% to the weight of cement. Based on the test results, optimum % were formulated with respect to compressive,tensile & flexural strength.

KEYWORDS: Fly ash.Geo polymer concrete, alkaline liquids, glass fibers, density.

1. INTRODUCTION

Concrete is one of the most widely used construction material in the world, it is usually associated with Ordinary Portland Cement (OPC) as the main component for making concrete. Production of one tone of cement requires about 2 tons of raw materials of shale and limestone, and also releases large amount of carbon dioxide (CO_2) to the atmosphere that significantly contributes to Greenhouse gas Emissions. The amount of Carbon dioxide released during the manufacturing process of OPC is in the order of 1 ton for every ton of OPC produced. Globally, the OPC production contributes about 7% of the world's Carbon dioxide. This is adding about 1.6 billion tons of Carbon dioxide to the atmosphere. Therefore there is a need to find an alternative type of binders to produce more environmental friendly concrete. A promising alternative is to target reduction in CO_2 emissions from Cement manufacture through the substitution with Fly ash. The use of Fly ash may reduce the total energy demand for producing mortar and concrete, lower the emissions of greenhouse gasses into the atmosphere from the construction industry, and recycle the fly ash that otherwise only disposed in landfill. In this view, the use of fly ash can make valuable contribution to the reduction of environmental impact from construction industry.Geopolymer is an inorganic alumina-silicate compound, synthesized from materials of geological origin or from by-product materials such as fly ash, rice husk ash, etc., that are rich in silicon and aluminium.The geopolymer technology could reduce the CO_2 emission to the atmosphere caused by cement and aggregates industries by about 80%.Direct alkaline activation of industrial wastes, such as fly ash can be employed to produce Geopolymer which can be gainfully utilized to manufacture novel concretes for constructions.This can be considered as a sustainable approach to construction since the internal energy content of these new concretes are much less than that of Ordinary Portland Cement based Concretes (OPCCs) and by this process Portland cement, one of the largest contributors to greenhouse gas is completely eliminated. Since for GPC, it does not have any standards codes for mix design. The strength has to be carried out for different binder composition of Fly ash and M-Sand incorporated with 0.25 percent of Glass Fibers.

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2.METHODOLOGY

2.1 FLOW CHART

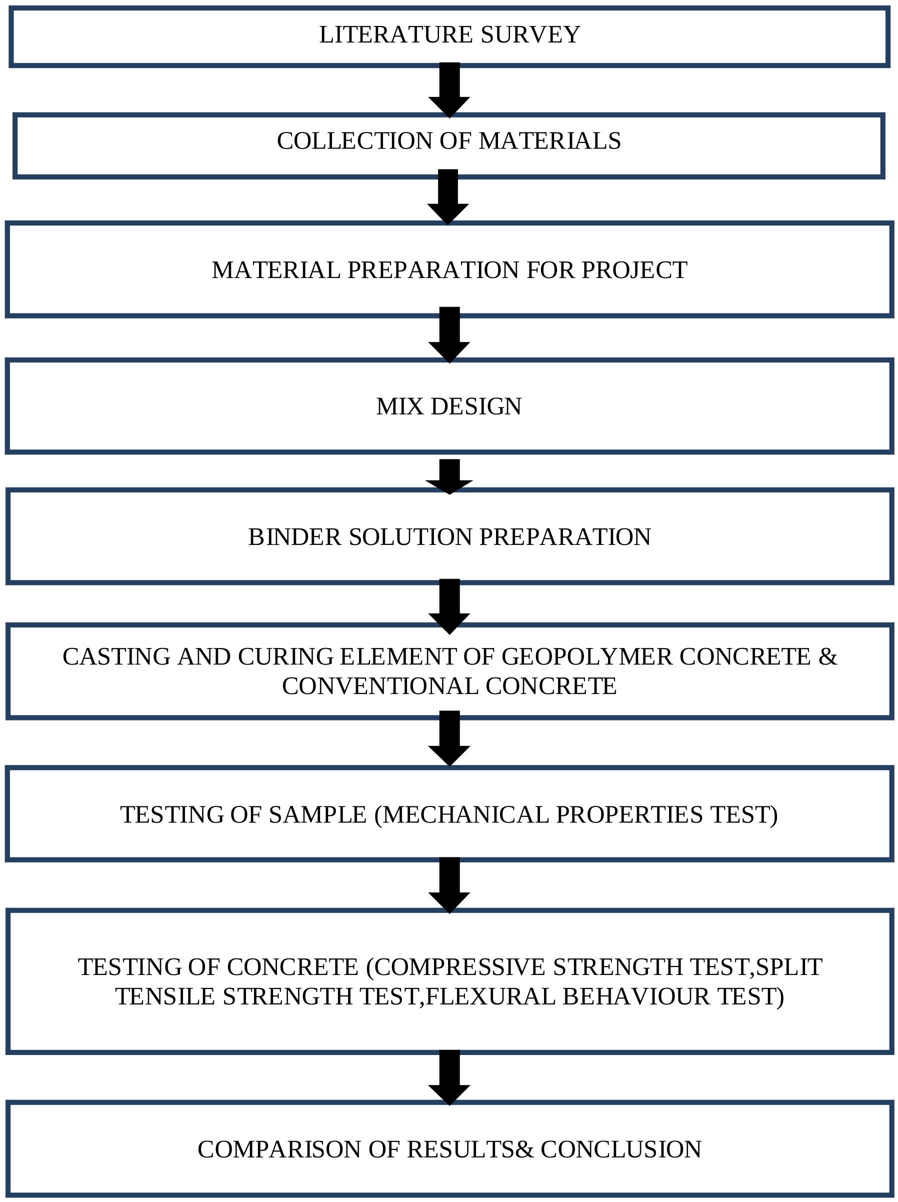

Figure 2.1 Flow chart

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3. EXPERIMENTAL INVESTIGATIONS

3.1 INTRODUCTION

In order to develop the fly ash based geo polymers concrete technology, therefore, a rigorous trail-and-error process was used. The focus of the study was to identify the salient parameters that influence the mixture proportions and the properties of low calcium fly ash- based geo polymers concrete. Also as in the case of OPC the aggregates occupied 75-80 % of the total mass of concrete. In order to minimize the effect of the properties of the aggregates on the properties of fly ash based geo polymers.

3.2 PREPARATION OF GEOPOLYMER CONCRETE

3.2.1 Sodium Hydroxide Solution

Sodium Hydroxide pellets are taken and dissolved in water at the rate of 16 molar concentrations. It is strongly recommended that the sodium hydroxide solution must be prepared 24 hours prior to use and also if it exceeds 36 hours it terminate to semi solid liquid state. So the prepared solution should be used within this time.

3.2.2 Molarity Calculation

The solids must be dissolved in water to make a solution with the required concentration. The Concentration of sodium hydroxide solution can vary in different molar. The mass of NaOH solids in a solution varies depending on the concentration of the solution.

For instance, NaOH solution with a concentration of 16 molar consists of 16 x 40 = 640grams of NaOH solids per liter of water, were 40 is the molecular weight of NaOH. Note that the mass of water is the major component on both the alkaline – solutions. The mass of NaOH solids was measured as 444 grams per Kg of NaOH solution with Concentration of 16 molar.

3.2.3Fibre Proportion

Glass fibre of 0.5%, 1% , 1.5% and 2% is used in this project in order to find out the optimum dosage of glass fibre based on its compressive , tensile and flexural test results.

4.RESULT AND DISCUSSION

4.1 GENERAL

For M 25 grade conventional concrete and geopolymer concrete the compressive strength, tensile strength and load deflection test results are conducted. GPC values are higher than conventional concrete higher concentration (in terms of molar) of sodium hydroxide solution results in higher compressive strength of fly ash-based geopolymer concrete.

4.2 COMPRESSIVE STRENGTH - Compressive strength is one of the important properties of concrete. Concrete cubes of size 150mmx150mmx150mm were cast with Glass fibers. After 24 hours, the specimens were demoulded and subjected to water curing. After 28 days of curing specimens were taken and allowed to dry and tested in compressive strength testing machine.

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TIME PERIOD	CONVENTIONAL (N/mm^2)	0.50%	1%	1.50%	2%
7 days	19.9	21.44	24.92	24.93	18.21
14 days	23.25	25.22	27.51	27.45	22.56
21 days	27.5	31.85	30.02	28.5	26.88
28 days	34.02	33.06	38.58	31.08	29.48

TABLE 4.1 COMPRESSIVE STRENGTH:(% of fiber added)

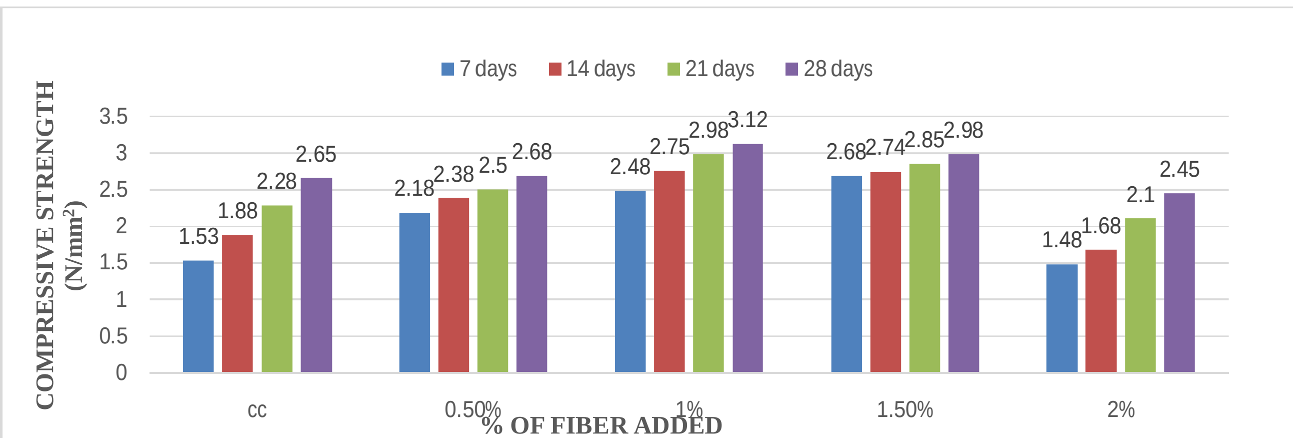

Figure 4.2 Compressive strength chart

4.3 SPLIT TENSILE STRENGTH

Split tensile strength is indirect way of finding the tensile strength of concrete by subjecting the cylinder to a lateral compressive force. Cylinders of size 150mm diameter and 300mm long were cast with Glass fibers. After 24 hours the specimen were demoulded and subjected to water curing. After 28 days of curing of specimens were taken and allowed to dry and tested in universal testing machine by placing the specimen horizontal.

Split tensile strength, $f_{sp} = 2P/\pi\, bd$

Where, P = Load applied to the specimen in N
b = Breadth of the specimen in mm
d = Depth of the specimen in mm

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TABLE 4.2 SPLIT TENSILE STRENGTH: (% of fiber added)

TIME PERIOD	CONVENTIONAL (N/mm^2)	0.50%	1%	1.50%	2%
7 days	1.43	2.08	2.43	2.52	1.4
14 days	1.84	2.25	2.64	2.6	1.95
21 days	2.14	2.48	2.88	2.75	2.05
28 days	2.5	2.55	3	2.84	2.35

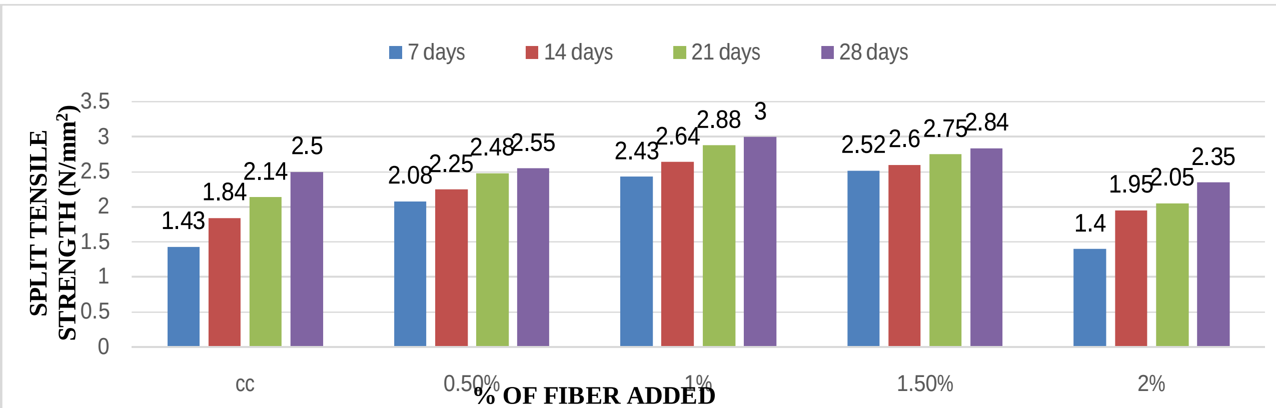

Figure 4.2 Split tensile strength chart

4.4 FLEXURAL STRENGTH

- Flexural strength of a concrete is a measure of its ability to resist bending. Flexural strength can be expressed in terms of 'modulus of rupture'.
- Concrete specimens for flexural strength were cross sectional area of 150mm width with 150mm depth and length of 700mm concrete beam.
- The specimen is subjected to bending, using four point loading until it fails. The distance of the loading point (l) is 150mm and the supporting point (L) is 450mm. The flexural strength of concrete = P x L x 1000 / B x D Where,

P - Maximum load applied to the specimen in kN.
L - Length of the specimen in mm.
B - Width of the specimen in mm
D - Diameter of the specimen in mm.

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TABLE 4.3 FLEXURAL STRENGTH (% of fiber added)

TIME PERIOD	CONVENTIONAL (N/mm^2)	0.50%	1%	1.50%	2%
7 days	1.06	2.01	2.54	2.26	1.02
14 days	1.75	3.65	3.78	3.95	1.95
21 days	2.25	4.98	4.88	5.02	2.2
28 days	3.25	5.28	7.05	5.75	3.24

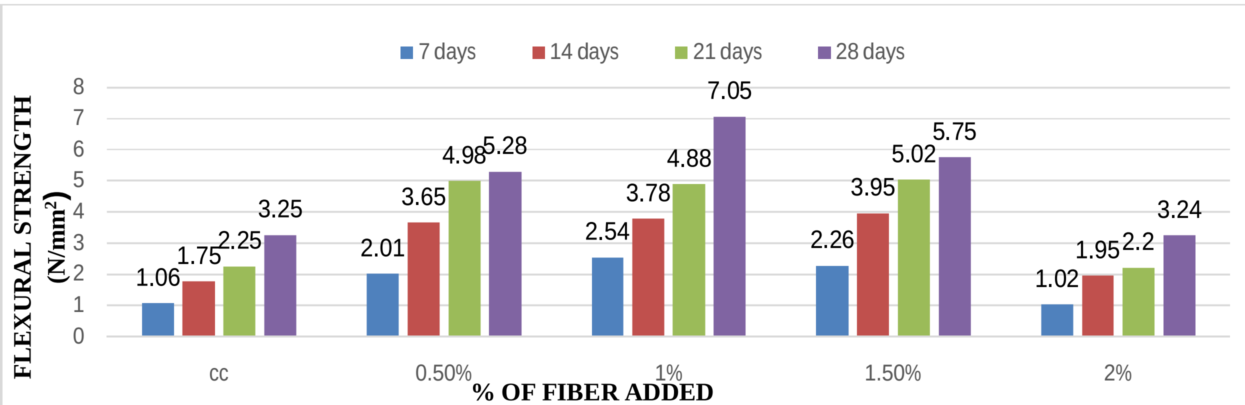

Figure 4.3 Flexural strength chart

5. CONCULSION

- Compressive strength of 1% glass fiber reinforced concrete has found to be 10% increase in strength, when compared to that of Conventional concrete.
- Split tensile strength of 1% glass fiber reinforced concrete has found to be 10% increase in strength, when compared to that of Conventional concrete.
- Flexural strength of 1% glass fiber reinforced concrete has found to be 20% increase in strength, when compared to that of Conventional concrete.
- Hence 1% concentration of glass fibers is found to be the optimum dosage for his project work.
- For the future work, the continuation of project research with the various replacement that are fly ash for the cement and m-sand for the fine aggregate to find the better optimum dosage and the effectiveness of concrete with these replacements.

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