A COMPREHENSIVE STUDY AND APPORACH IN ENHANCING THE PROPERTIES OF GLASS FIBER REINFORCED GEO POLYMER CONCRETE

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ABSTRACT: *A study is done in enhancing the properties of the glass fiber which is to be functioned based on the glass fire reinforced geo-polymer concrete which is based on the fly ash, alkaline liquids with fine amp. This geo polymer constituent's area being affected with the inclusion of glass fibers based on their density strengths like compressive and flexural which is obtained from hardened geo-polymer concrete composite. The alkaline liquids which are mixed with fly ash with some aspect ratio which has been fixed by using 0.35 replacement in 100% of mixture. For alkaline liquid combination ratio of Sodium hydroxide solution to Sodium silicate solution was fixed as 1.00. Glass fibers were added to the mix in 0.01%, 0.02%, 0.03% & 0.04% by volume of concrete. By enhancing these test results we are easily obtained the glass fiber reinforced geo-polymer which has higher strength in short span of time like 3-5 days where the ordinary Portland cement concrete cannot.*

Keywords: *coarse aggregates, cement constituents, fly ash.*

1.0 Introduction:

Ordinary Portland cement (OPC) is a cover utilized as a part of cement and concrete based materials. While OPC has served an essential part in development, its creation is related with natural results including noteworthy ozone depleting substance discharge. Carbon dioxide outflow exchanging is probably going to be a basic factor for the development business, specifically, the bond and solid industry. Fly ash is a coal burning item made out of fine particles that are driven out of the evaporator with the pipe gases. Advantages of fly ash are based on the reactions of silica from ash with portlandite from cement reactions. All the properties like shape properties and fineness of cement can influence the above reaction. For boost of fly powder reactivity there were various methods like Mechanical activation, thermal activation etc.

Cement Production and Consumption:

Cement is normally produced using limestone and earth or shale. These crude materials are removed from the quarry pulverized to a fine powder and after that mixed in the right extents. This mixed crude material is known as the 'crude encourage' or 'furnace nourish' and is warmed in a rotating oven where it achieves a temperature of around 1400 oC to 1500 oC. In its most straightforward shape, the revolving oven is a tube up to 200 meters in length and maybe 6 meters in width, with a long fire toward one side The crude encourage enters the furnace at the chill end and step by step goes off to the hot end, at that point drops out of the oven and chills off.

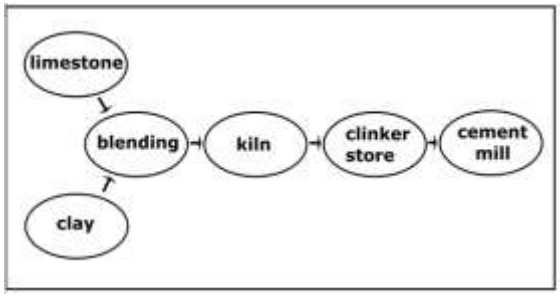


Fig. 1.2 Process of manufacturing of cement

The disadvantage of the cement is the pollution. From an environmental point of view cement has a negative impact. Manufacturing of cement emits ton of ozone harming substance (CO2) into the air

Objective of The Study:

The objectives of this project are

- To study the development and mechanism of Glass fibre reinforced Geo polymer Concrete.
- To determine the strength and durability properties of Glass fibre reinforced Geo polymer Concrete.

2.0 Literature Review:

[1] Anjan Chatterjee (2011) has investigated into newer avenues of bulk use of fly ash produced in India, where generation of electricity has been overwhelmingly dependent on the combustion of high-ash coal. The present availability of fly ash had already exceeded 130 million tons, and its generation would likely to reach 170 million tons by the coming years. Although the gainful use of fly ash was close to 50% of the quantity generated, a countrywide directive has been established to effectively use the entire quantity generated in the years to come.

[2] Chandramouli et al (2010) had directed exploratory examination to contemplate the impact of utilizing the salt protection glass strands on compressive, split malleable and flexural quality on M20, M30, M40 and M50 evaluations of cement. The mechanical properties of glass fiber fortified polyester polymer concrete were assessed. The creator watched that the modulus of break of polymer concrete containing 20 for each penny polyester sap and around 79 for each penny fine silica total is around 20 MPa.

[3] Fernandez-Jimenez et al (2005) made a microscopic study of a set of alkali-activated and thermally cured fly ash samples to establish a descriptive model for the micro structural development of fly ash-based cementations Geo polymers. Class F fly ash which was mixed with 8Msolution of NaOH with 0.35 as the ratio of solution/ash and cured in an oven at 850 C for 5 h, 24 h and 60 days. Based on the findings from the microscopic study, it was emphasized that the presence of soluble silica in the activating dissolution played an important role in the micro structural development of the cementations' systems

3.0 Geo polymer technology:

To recommend that a basic fluid could be utilized to respond with the silicon (Si) and the aluminum (Al) in a source material of land starting point or in side-effect materials, for example, fly cinder and rice husk powder to deliver fasteners. Since the synthetic response that happens for this situation is a polymerization procedure, and in this way he begat the term 'Geo polymer' to speak to these folios Geo polymer is an individual from the group of inorganic polymers. The substance arrangement of the Geo polymer material is like regular zeolitic materials, yet the microstructure is nebulous.

Material of Geo polymerization:

The source materials may be natural minerals such as kaolinite, Calcined kaolinite (metakaolin) and clays. Alternatively, industry waste products such as fly ash, slag, red mud, rice-husk

ash and silica fume may be used as raw materials for the synthesis of Geo polymers. It has been proved that calcined materials such as slag, fly ash and metakaolin which are mostly amorphous, under-go high reaction during Geo polymerization than non-calcined materials.

Alkaline Liquid

Locally available silicates and hydroxides of sodium are used to prepare alkaline liquid. Though silicates and hydroxides of potassium could be used to prepare alkaline liquid, sodium based silicates and hydroxides are used in this research considering the high cost of potassium based chemicals. Sodium silicate is the common name for a compound sodium meta silicate, Na_2SiO_3, also known as water glass or liquid glass.

Na_2 CO_3 + SiO_2 results to produce Na_2SiO_3 + CO_2

Sodium hydroxide (NaOH), also known as caustic soda, is a caustic metallic base. It is used in many industries, mostly as a strong chemical base, in the manufacture of pulp and paper, textiles, drinking water, soaps and detergents and as a drain cleaner. Worldwide production of NaOH was approximately 60 million tonnes in 2004, while the demand was 51 million tones. Pure sodium hydroxide is a white solid available in the form of pellets, flakes and granules.

4.0 Materials And Methodology

The methodology is the essential stage to determine the successful of achieving the aim and objectives. In methodology the major process involved are the collection and study of literature reviews, collection of materials and testing the mechanical, Durability properties of the concrete samples and discussing the results achieved

Fly ash:

Fly ash is used as a cementations material drawn from burning of coal in high temperature. There are two types of Fly ash such as ASTM class F and 2. ASTM class C Fly ash used in this study was low-calcium (ASTM Class F) dry fly ash. Since the ASTM class F contains calcium of about 5% by mass, whereas class C contains more than 5% of calcium which tends to change in micro structure of concrete and properties of concrete. Class C fly ash normally comes out of coal power plants with higher lime content generally more than 15 % often as high as 30 % may give class C unique self-hardening characteristics.

Table :the synthetic piece of the fly fiery debris utilized as a part of the blend.

S.No.	Chemical composition	Specifications as per IS: 3812-2003	Properties of fly ash used
1	SiO_2+Al_2O_3+Fe_2O_3	70% (min.)	90.50%
2	SiO2	35% (min.)	58.00%
3	CaO	5% (max.)	3.60%
4	SO_3	2.75% (max.)	1.80%
5	Na_2O	1.50% (min.)	2.00%
6	MgO	5.00% (max.)	1.91%
7	LOI	12.00% (max.)	2.00%

Class F fly ash with low calcium content from Rayalaseema Thermal Power Plant, Kadapa, India, having fineness of 290 m^2/kg confirming to the requirements as per IS 3812-2003 code is used.

Table: The physical properties of Glass fibers used are presented

Physical properties	Value as given by the manufacturer
Specific Gravity	2.68
Elastic Modulus(GPa)	72
Tensile Strength(MPa)	1700
Length(mm)	12

Specific Gravity of Fine Aggregate and Coarse Aggregate

The definition of specific gravity is the ratio of the weight in air of a given volume of a Material at a stated temperature to the weight in air of an equal volume of distilled water at a stated temperature. The purpose of the test is to determine the specific gravity of soil passing 4.75 mm sieve by density bottle method. 50 g of sample of fly ash is taken in each 3 bottles and added with water; weight of water + bottle is taken. Then all the 3 bottles are subjected to sand bath, heating is done up to air bubbles are seen in the bottle. This is done to remove the entrapped air in the mixture; the bottle is kept for around 1 hour so that the temperature comes to 27° C

Design for M30 Grade of Geopolymer Concrete Using Proposed Method

Based on the mix design steps discussed in preceding section, a sample mix proportioning for M30 grade of geo polymer concrete is carried out using proposed method. Following preliminary data is considered for the mix design:

1. Characteristic compressive strength of Geo polymer Concrete (f_{ck}) = 30 MPa.
2. Type of curing: Ambient curing
3. Workability in terms of flow: 25–50 % (Degree of workability—Medium)
4. Fly ash: Fineness in terms of specific surface: 290 m^2/kg
5. Alkaline activators (Na_2SiO_3 and NaOH)
   - Concentration of Sodium hydroxide in terms of molarity: 12 M
   - Concentration of Sodium silicate solution: 50.32 % solid content
   - Solution-to-fly ash ratio by mass: 0.35
   - Sodium silicate-to-sodium hydroxide ratio by mass: 2.7
   - Fine aggregate

Type: Natural river sand confirming to grading zone-II as per IS 383,

- Fineness Modulus = 2.91
- Water absorption: 3.67 %
- Water content: Nil

Table: Materials required for M30 grade geo polymer concrete

Ingredients of geopolymer Concrete	Fly Ash	NaOH	Na2sio3	Sand	Coarse aggregate	Total water (W/GPB)	Extra Water
Quantity (kg/m3)	365	34.53	93.22	676.28	1255.97	90	0
Proportions	1	0.35		1.85	3.44	0.25	0

Fine-to-total aggregate content is 33.2% for fineness modulus of sand of 2.91

Calculation of fine and coarse aggregate content

Total aggregate content = [Wet density of GPC] – [Quantity of fly ash + Quantity of both solutions + extra water, if any]
= 2425 – [365 + 127.75 + 0]
= 1932.25 kg/m^3
Sand content = Fine-to-total aggregate content in %] x [Total quantity of all- in-aggregate]
= (35/100) x 1932.25
= 676.28 kg/m^3
Coarse aggregate content= [Total quantity of all-in-aggregate] – [Sand content]
= 1932.25 – 676.28
= 1255.97 kg/m^3

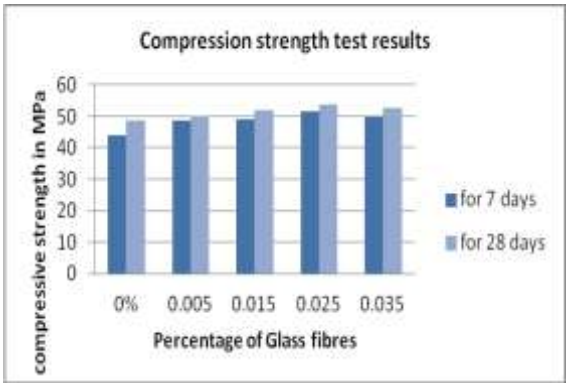
Compression strength test:

The following table gives the values of compressions test of the specimens with various mix proportions for 7 and 28 days.

Table.8.2.1 - Compression test values for 7 and 28 days

Description	Compressive strength in MPa	
	for 7 days	for 28 days
GPC	43.81	48.61
$GFGPC_{0.005\%}$	48.76	50.32
$GFGPC_{0.015\%}$	48.93	51.89
$GFGPC_{0.025\%}$	51.64	53.76
$GFGPC_{0.035\%}$	49.89	52.63

It can be observed that with the increase in glass fiber content, both 7 & 28 days compressive strength increased up to 0.025% and then it started decreasing. The maximum increase in compressive strength is 10.5%. This increase is mainly due to filling up of internal pores by the glass fibres dandifying the transition zone.



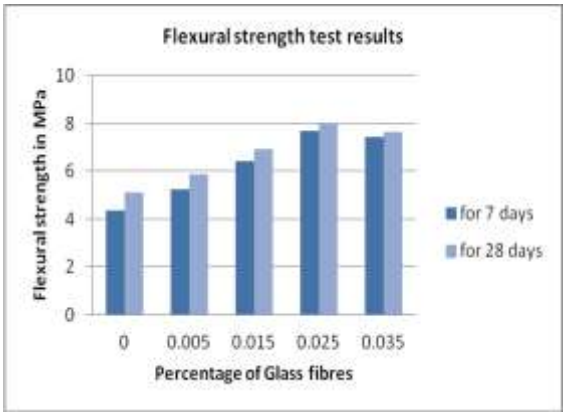
Graph: Variation of compressive strength with Glass fibre percentage

Flexural strength test:

Flexural strength is the ability of a material under load to resist deformation. Flexural strength as a value should indicate the maximum stress experienced within a material at point of rupture. It is known that glass fibres commonly increase the flexural strength, but on the other hand, they may have a detrimental effect on the flexural strength with rising fibre content beyond the optimal fibre weight content. The decrease in the flexural strength above the optimal concentration can be attributed to a weak inter-facial bond between the fibre and the matrix, probably due to the agglomeration of the fibres. Flexural strength test values for 7 and 28 days

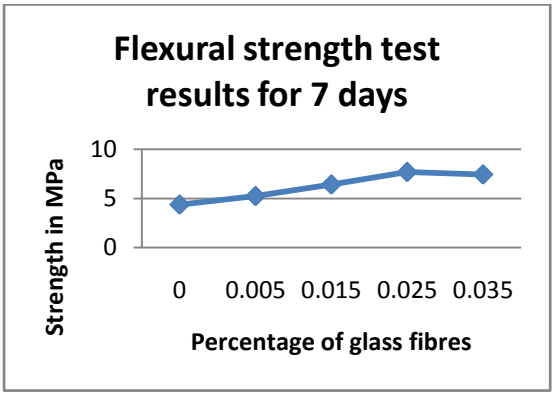
Description	**Flexural strength in MPa**	
	for 7 days	**for 28 days**
GPC	4.36	5.1
$GFGPC_{0.005\%}$	5.23	5.89
$GFGPC_{0.015\%}$	6.41	6.93
$GFGPC_{0.025\%}$	7.68	8.01
$GFGPC_{0.035\%}$	7.43	7.64

The variation of 7 & 28 day flexural strength of Glass fibre reinforced Geopolymer concrete with fibre content is depicted



Variation flexural strength with Glass fibre percentage

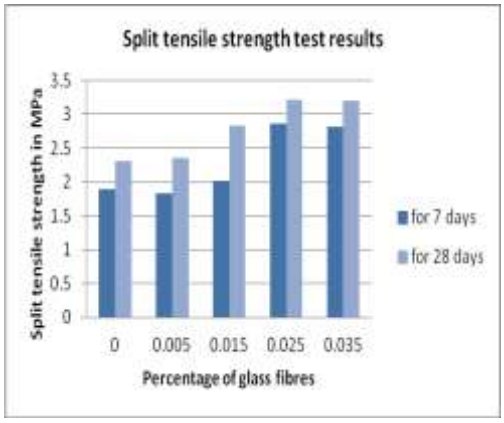
It can be observed that the flexural strength increased considerably with increase of glass fibre up to 0.025% and then decreased. The maximum increase in 28 day flexural strength is 57% at 0.025% of glass fibres the following figures represent the graphs showing the variation of flexural strength for 7 and 28 days.



Similar to compressive strength, here also there is no much difference between the 7 and 28 days strength and the optimum values are obtained at the inclusion of 0.025% of glass fibres.

Split tensile strength test:

The following table gives the values of split tensile strength test of the specimens with various mix proportions for 7 and 28 days.Similar trend is observed for split tensile strength (see The maximum split tensile strength is achieved at a percentage of 0.025. The maximum increase in split tensile strength is about 39.3%



Graph: Variation of split tensile strength with Glass fibre percentage

CONCLUSIONS:

The following conclusions are drawn based on the experimental work conducted in this investigation:

- Glass Fibre reinforced geopolymer concrete can completely eliminate the use of conventional cement in concrete, thus making it a sustainable concrete.
- Inclusion of glass fibres by 0.025% by volume helps in considerable increase in flexural and split tensile strengths.
- Within brief period, low calcium fly fiery remains based Geo polymer concrete has grown great compressive quality and is appropriate for auxiliary applications.
- Addition of 0.025% volume division of glass fiber gives most extreme increment in compressive, flexural and elastic qualities by 10.5%, 57%, and 39.3% separately when contrasted with Geo polymer concrete without glass filaments From this study it is recommended that 0.025% of glass fibres may be used in Geo polymer concrete for optimum results.

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