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Geopolymer Concrete with Glass Fiber Reinforcment & Its Properties

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Abstract

Concrete is the world's most versatile, durable and very reliable material. Geopolymer concrete is an innovative construction material which is produced by the chemical action of inorganic molecules. Fly ash is a by-product of coal obtained from the thermal power plant and it is available in plenty worldwide. Fly ash is rich in silica and alumina reacted with alkaline solution produced aluminosilicate gel and it is acted as the binding material for the concrete. Glass fiber reinforced Geopolymer concrete (GFRGC) is the combination of fly ash, alkaline liquid, fine aggregate, coarse aggregate and glass fibers. The present work is only an accumulation of information about GFRGC and the research work which is already carried out by other researchers.

Keywords: Glass fibers, geopolymer concrete, fly ash, fiber reinforcement

Introduction

Geopolymer is a type of concrete with amorphous, alumino-silicate product that exhibits the ideal properties of rock forming properties i.e. hardness, chemical stability and longevity. The properties of geopolymer concrete include high early strength, low shrinkage, freeze-thaw resistance, sulphate resistance and corrosion resistance. However, geopolymer concrete does not utilize any Portland cement in it and the binder is produced by the reaction of an alkaline liquid with a source of material which is rich in silica and alumina.

Fiber reinforced concrete [1] is a relatively a new composite material in which fibers are introduced in the matrix as micro reinforcement, so as to improve the strength like tensile strength, cracking strength and other properties of concrete. Glass fiber reinforced concrete is a type of another fiber reinforced concrete which is mainly used in exterior building and as architecture pint of view.

Types and properties of glass fibers

Glass fibers are available in continuous or chopped lengths. Glass fibers have large tensile strength and elastic modulus but have brittle stress-strain characteristics and low creep at room temperature. Glass fibers are usually are usually round and straight with diameters from 0.005 mm to 0.015 mm. They can be also bonded together to produce the bundle of glass fibers with diameter up to 1.3 mm.

Materials

The materials used in the glass fiber reinforced geopolymer concrete are low calcium dry fly ash as the source material, fine aggregates, coarse aggregates, glass fibers, alkaline liquid, water and super plasticizers.

Review of Literature

The study [7] was made to determine the mechanical properties of Geopolymer concrete composites (GPCC), which contains fly ash, alkaline liquids and glass fibers. The ratio for alkaline liquids to fly ash was fixed as 0.4 and in the experiment they replaced 100% ordinary Portland cement with fly ash. The addition of glass fibers made to the mix with 0.01%, 0.02% and 0.03%. From the experiments performed it was observed that the geopolymer concrete composite had relatively higher strength in one day short curing time than the geopolymer concrete and ordinary Portland cement.

The experimental investigation [6] was made to analyze the impact of glass fibers on the mechanical properties of hardened GPC both in ambient curing and in heat curing at 60°C for 24 in hot air oven. In the 100% replacement of OPC with fly ash mixture, the ratio of alkaline liquid to fly ash was 0.4. Glass fibers were added in the volume fractions of 0.01%, 0.02% and 0.03% volume of concrete. It was observed that the compressive strength split tensile strength and flexural strength of

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heat cured GPC found more than that of ambient cured GPC.

The experimental study [5] was made to study the mechanical properties of GPCC containing 90% fly ash, 10% OPC, alkaline liquids and glass fibers (0.01%, 0.02% and 0.03% by volume of concrete) and alkaline liquid to fly ash ratio was 0.4. Replacement of 10% of fly ash by OPC in the mix resulted in an enhanced 73% compressive strength, 128% split tensile strength and 17% flexural strength as compared to GPC mix. Replacement of 10% fly ash by OPC in the GPC mix eliminates delay in setting time and necessity of heat curing to gain strength which resulted in GPCC mix.

The study [4] on the experimental program to determine the mechanical properties of GPC which contained fly ash, alkaline liquids, fine and coarse aggregates & glass fibers was made. The ratio of alkaline liquids to fly ash was maintained as 0.35 and 100% replacement of OPC mix was made. Also glass fibers were added to the mix in the proportion of 0.01%, 0.02%, 0.03% and 0.04% by volume of concrete. With the experimental program it was observed that the glass fibers reinforced GPC had relatively higher strength in short period of curing time i.e. 3 days than GPC and OPC concrete. With the addition of volume fraction of glass fibers showed maximum increase in compressive strength of 20.2% and flexural strength of 57 % with the respect to GPC mix without fibers.

Result and Comparision

The comparison is done for adding varying amount of glass fibers and plain cement concrete with zero percent fiber with the same material. The results of the compressive strength, flexural strength and split tensile strength are as presented in the following table.

Table 1: Comparison of Compressive strength

Author	Type of GPC	Curing	No of days	Compressive strength			
				with GF (MPa)			wihtout GF (MPa)
				0.01%	0.02%	0.03%	
Satish Kumar, et al (2012)	100% replacement of OPC	Heat curing (24 hours)	28	26.94	28.74	27.58	24.26
K. Vijay, et al (2012)	100% replacement of OPC	Heat curing (24 hours)- 60°C	28	15.77	24.4	25.87	28.49
Dr. Mrs. S. A. Bhalchanra, et al (2010)	100% replacement of OPC	Heat curing (8 hours)- 90°C	28	38.33	40	43.67	36.33
K. Vijay, et al (2012)	90% replacement of OPC	Heat curing (24 hours)	28	35.97	32.08	40.73	38.28

Table 2: Comparison of Flexural strength

Author	Type of GPC	Curing	No of days	Flexural strength			
				with GF (MPa)			wihtout GF (MPa)
				0.01%	0.02%	0.03%	
K. Vijay, et al (2012)	100% replacement of OPC	Heat curing (24 hours)- 60°C	28	4.2	5.25	5.31	5.4
Dr. Mrs. S. A. Bhalchanra, et al (2010)	100% replacement of OPC	Heat curing (8 hours)- 90°C	28	5.41	5.96	6.28	4.00
K. Vijay, et al (2012)	90% replacement of OPC	Heat curing (24 hours)	28	5.78	5.12	6.8	5.84

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Table 3: Comparison of Split Tensile strength

Author	Type of GPC	Curing	No of days	Compressive strength with GF (MPa)			wihtout GF (MPa)
				0.01%	0.02%	0.03%	
Satish Kumar, et al (2012)	100% replacement of OPC	Heat curing (24 hours)	28	2.3	2.5	2.33	1.93
K. Vijay, et al (2012)	100% replacement of OPC	Heat curing (24 hours)- 60°C	28	1.35	1.78	1.83	3.02
K. Vijay, et al (2012)	90% replacement of OPC	Heat curing (24 hours)	28	1.96	1.86	2.71	2.67

Conclusion

From the above results and comparison following point are observed:

- Compressive strength, flexural strength and split tensile strength was found to be more for addition of 0.03% glass fibers by volume of concrete.
- Compressive strength, flexural strength and split tensile strength found to be increased with the respect of increase in percentage volume fraction of glass fibers from 0.01%, 0.02% and 0.03%
- Only 90% replacement of OPC in the mix of GPC shown better values of compressive strength, flexural strength and split tensile strength as compared to the 100% replacement of OPC.

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