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Experimental Study on Strength Properties of Polypropylene Fibre Reinforced Geopolymer Concrete

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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 quantities. Presently the percentage of replacement has been increasing. 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 dioxide emission

Alkaline liquid Sodium hydroxide and Sodium silicate solution are used in this project as binders. It is used in Geo polymerization process. Reactions occur at high rate when the alkaline liquid contains soluble silicate, either sodium or potassium silicate compared to the use of only alkaline hydroxides. The tensile strength and compressive strength of Geo polymer concrete have been studied and compared with OPC. Polypropylene is one of the cheapest & abundantly available polymers. Polypropylene fibres are resistant to most of the chemicals & it would be cementations matrix which would deteriorate first under aggressive chemical attack. Its melting point is high (about 165 degree centigrade). So that a working temp (about 100 degree centigrade).

KEYWORDS: Sodium Hydroxide, Sodium Silicate, Polypropylene fibre

I. INTRODUCTION

Concrete usage around the world is second only to water. Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The environmental issues associated with the production of OPC are well known. The amount of the carbon dioxide released during the manufacture of OPC due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced. In addition, the extent of energy required to produce OPC is only next to steel and aluminium. On the other hand, the abundant availability of fly ash worldwide creates opportunity to utilize this by-product of burning coal, as a substitute for OPC to manufacture concrete. When used as a partial replacement of OPC, in the presence of water and in ambient temperature, fly ash reacts with the calcium hydroxide during the hydration process of OPC to form the calcium silicate hydrate (C-S-H) gel. The development and application of high volume fly ash concrete, which enabled the replacement of OPC up to 60% by mass (Malhotra 2002; Malhotra and Mehta 2002), is a significant development.

In 1978, Davidovits (1999) proposed that binders could be produced by a polymeric reaction of alkaline liquids with the silicon and the aluminum in source materials of geological origin or by-product materials such as fly ash and rice husk ash. He termed these binders as geopolymers.

Palomo et al (1999) suggested that pozzolans such as blast furnace slag might be activated using alkaline liquids to form a binder and hence totally replace the use of OPC in concrete. In this scheme, the main contents to be activated are silicon and calcium in the blast furnace slag. The main binder produced is a C-S-H gel, as the result of the hydration process.

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II. LITERATURE STUDY

G.V.T Gopalakrishna et al.(2013) The purpose of this paper is to bring out the advantageous results of geopolymer concrete with polypropylene fibre. The geopolymer concrete mixes with polypropylene fibres were prepared and the cylinders were heat cured in laboratory oven. Slump tests and compressive tests were done. Better workability and increase in compressive strength were noticed. Durability tests were conducted for sulphate and sulphuric acid resistance and the cylinders were durable to chemical environment. The work has been extended to the structural members like slab beam column and its behaviour were studied.

R.Venkatasubramani et al.(2013) The ordinary Portland cement (OPC), which is widely used material not only consumes significant amount of natural resources and energy but also pollutes the atmosphere by the emission of CO₂. So as to reduce this ill effect, the search for alternative result is geo polymer concrete. The strength study has to be carried out for different binder composition of fly ash and GGBS was used as the materials. This paper presents the results of an experimental investigation to determine the performance characteristics of geo polymer reinforced concrete. The mechanical properties of the specimen were studied for both Ambient and Heat curing. The strength properties test was carried out after 28 days for Ambient curing and 24 hours for Heat curing showed that the increase of mechanical properties (Compressive, Split tensile and Flexural strength) resulting from added of polypropylene fibre was relatively high. The test results were studied and it is found that 100% GGBS binder composition with 0.25% polypropylene fibres has shown better performance.

P.Eswaramoorthi et al.(2014) 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. Presently the percentage of replacement has been increasing. 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 Its is used in Geo polymerization process. Reaction occur at high rate when the alkaline liquid contains soluble silicate, either sodium or potassium silicate compared to the use of only alkaline hydroxides. A mix proportion for Geo polymer concrete was designed and carried out tests for different grade of concrete. The tensile strength and compressive strength of Geo polymer concrete have been studied and compared with OPC. Polypropylene is one of the cheapest & abundantly available polymers. polypropylenefibres are resistant to most of the chemicals & it would be cementations matrix which deteriorate first under aggressive chemical attack. Its melting point is high (about 165 degrees centigrade). So that a working temp (about 100 degree centigrade).

P.Chandrasekaran et al.(2014) Now a day's high performance concrete are being widely used all over world. Most applications of high strength concrete have been in high rise buildings, long span bridges and in some special applications in structures. In developed countries, using high strength concrete in structure today would result in both technical and economic advantage. In high strength concrete, it is necessary to reduce the water/cement ratio and which in general increase the cement content. To overcome low workability prolem, different kinds of mineral admixtures (flyash, rice husk ash, silica fume etc.) and chemical admixtures are used to achieve the required workability. In the present experimental investigation, the mechanical properties of high-strength concrete of grades M60, at 28 days characteristic strength with different replacement levels of cement with silica fume are considered. Standard cubes (150mm x 150mm x 150mm), standard cylinders (150mm dia x 300mm height) and standard prisms (100mm x 100mm x500mm) were considered in the investigation. all specimens were cast with and without polypropylene fibre. The mechanical properties viz., compressive strength, flexural strength and split tensile strength, of high strength concrete with various replacement of polypropylene fibre 0.5%, 1%,1.5% and 2% and silica fume viz., 10%, 20%, and 30% , has been considered.

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III. MATERIALS

3.1 Fly Ash

The fly ash is should be used having high fineness, low carbon content and good reactivity. The characteristics of fly ash such as specific gravity, grain size, compaction characteristics permeability coefficient, shear strength parameters and consolidation parameters are the same as those for natural soils. The procedure for determination of this parameter is also similar to those soils the quality of fly ash was found to satisfy the requirement of fly ash.

3.2 Water

Portable water was used for casting of all specimens of this investigation

3.3 Fine aggregate

Sand is either round or angular grain and is often found mixed in various grading of fineness at different zones. Fine aggregate properties are evaluated as per the IS2386 methods. The four zones of river sand are used for the preparation of mortar cubes. Though it contains impurities it has to cleaned and well sieved so that the mortar will not affect the structure.

3.4 Coarse aggregate

The coarse aggregate used was broken crushed stone and it was free from clay lambs weeds and other organic matters are non-porous .the water absorption capacity is less than 1%.the size of which passes through 26 mm sieve and retained on 19mm sieve the properties of the coarse aggregate.(From IS: 383-1970 this is Zone)

3.5 Sodium Hydroxide

Generally the Sodium Hydroxides are available in solid state by means of pellets and flakes. The cost of the Sodium Hydroxide is mainly varied according to the purity of the substance. Since our Polypropylene Fibre Reinforced Geo polymer Concrete is homogeneous material and its main process to activate the Sodium Silicate so it is recommended to use the lowest cost i.e. up to 94% to 96% purity. In this investigation the Sodium Hydroxide pellets were used.

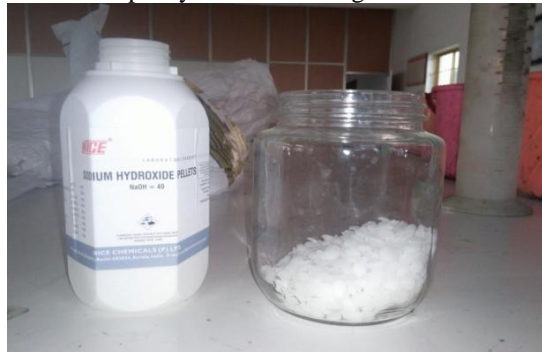


Figure: 1 Sodium Hydroxide pellets

3.6 Sodium Silicate

Sodium Silicate also known as water glass or liquid glass,available in liquid (gel) form. In this Sodium Silicate is used for the making of Polypropylene Fibre Reinforced Geo polymer Concrete.



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Figure: 2 Sodium Silicate gel

3.7 Polypropylene fibre

In this investigation, polypropylene fibres are used an average diameter of 10 μm , a length of 20mm.



Figure:3 Polypropylene Fibres

IV. EXPERIMENTAL INVESTIGATION

4.1 Compressive Strength

Compressive strength is one of the important properties of concrete. Concrete cubes of size 150mmx150mmx150mm were cast with and without of fly ash .After 24 hours, the specimens were demoulded and subjected to water curing. After 7,14and 28days of curing specimens were taken and allowed to dry and tested in compressive strength testing machine.

4.2 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 and without of fly ash .After 24 hours, the specimens were demoulded and subjected to water curing. After 7,14 and 28days of curing specimens were taken and allowed to dry and tested in universal testing machine by placing the specimen horizontal.

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

4.3 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 100mm width with 100mm depth and length of 500mm concrete beam.The specimen is subjected to bending, using four point loading until it fails. The distance of the loading point (l) is 100mm and the supporting point (L) is 300mm.

The flexural strength of concrete = $P \times L \times 1000 / B \times D^2$

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V. TEST RESULTS

5.1 Compressive strength:

Table :1 Compressive strength Test Results

Curing Period	Compressive strength (N/mm ²)		
	Conventional concrete	GPC	GP with PPF concrete
7 days	9.5	12.83	14.8
14 days	15.93	18.87	23.7
28 days	23.47	25.03	26.43

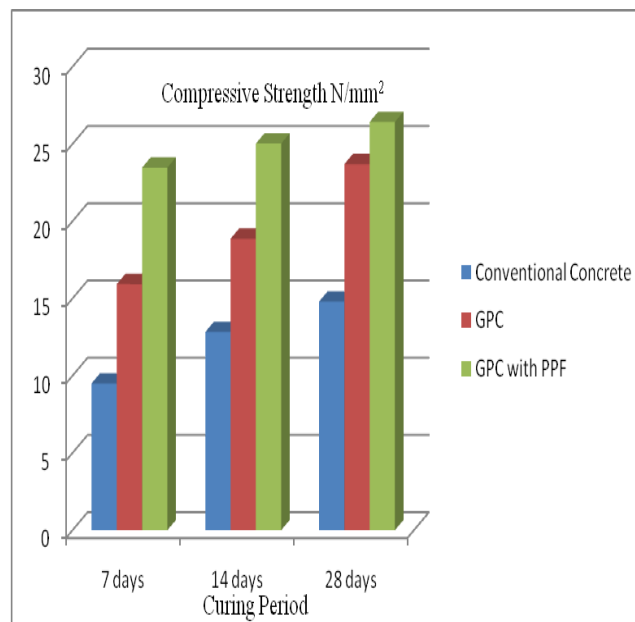


Figure:4 Compressive Strength Test Results

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5.2 Split Tensile Strength

Table:2 Split Tensile Strength Test Results

Curing Period	Split Tensile Strength (N/mm ²)		
	Conventional concrete	GPC	GP with PPF concrete
7 days	1.27	1.6	2.27
14 days	2.17	2.63	2.83
28 days	3.57	3.93	4.37

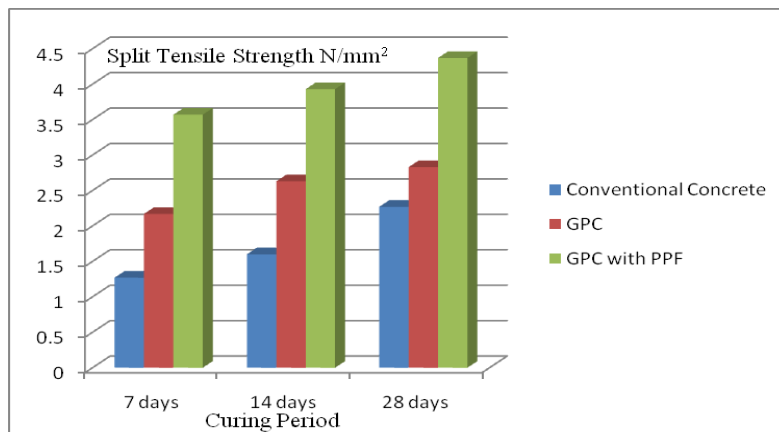


Figure:5 Split Tensile Strength Test Results

5.3 Flexural Strength

Table:3 Flextural Strength Test Results

Curing Period	Flexural Strength (N/mm ²)		
	Conventional concrete	GPC	GP with PPF concrete
7 days	1.23	1.68	1.97
14 days	1.85	2.41	2.7
28 days	3.39	3.52	4.06

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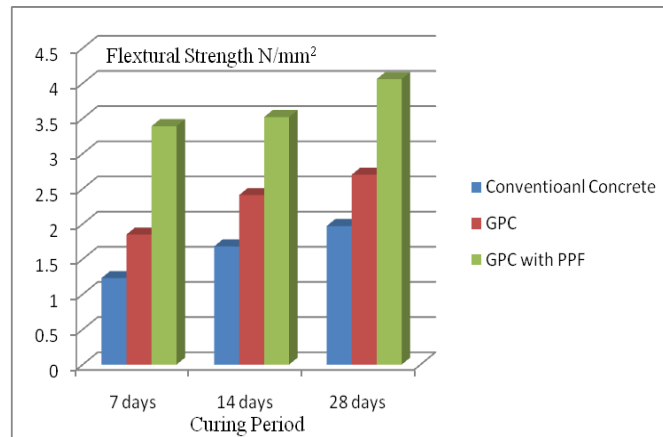


Figure:6 Flexural Strength Test Results

VI. CONCLUSION

Compressive strength of the Geo polymer concrete without fibres has increased by 10.63%, then Conventional concrete. Split tensile strength of the Geo polymer concrete without fibres have increased by 11.58%, then Conventional concrete. Flexural strength of the Geopolymer concrete without fibres has increased by 11.70%, then Conventional concrete. Compressive strength of the Geo polymer concrete with fibres has increased by 10.70%, then Conventional concrete. Split tensile strength of Geo polymer concrete with fibres has increased by 13.62%, then Conventional concrete. Flexural strength of the Geo polymer concrete with fibres has increased by 13.80%, then Conventional concrete. Geo polymer concrete produces a substance that is comparable to or better than traditional cements with their properties. Due to geo polymer concrete the consumption of cement, emission of carbon dioxide and greenhouse effect are reduced.

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