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A Literature Review on Flexural and Shear Behavior of Geopolymer Concrete Beam with Carbon Fiber

Pruthviraj B. S.[1], Dr. S.B. Anadinni[2]
[1]*Ph. D Scholar*
[2]*Associate Dean, School of Engineering, Presidency University, Bangalore - 560064*

Abstract: ***In 1979 Davidovits introduced the Geopolymer concrete to reduce the use of ordinary Portland Cement. The depletion of the ozone layer and global warming issue has increased more awareness of the construction industries to use eco-friendlier materials. The use of Geopolymer technology could reduce the CO_2 emission in to the atmosphere, caused by cement industries by about 80%. The use of Geopolymer concrete has started to gain attention in the field of research and construction practices, due to its numerous advantages in using the by-product waste to replace cement and also to reduce the greenhouse gas emission at the time of its production. Fly ash and GGBS which is one of the source materials for Geopolymer binders and also available abundantly in India, but the utilization till date is limited. The recent research about Geopolymer concrete states, that it has the potential to replace the conventional cement based concrete by locally available resources. This paper focuses on presenting a brief historyand also a review of Geopolymer Concrete technology with the aim of introducing the technology and the vast categories of materials that may besynthesizedby alkali activation of alumino silicates.***

Keywords: FlyAsh, GGBS, Carbondioxide, Fibres in concrete, Geopolymer Concrete, NaoH, Strength, Durability and Applications.

I. INTRODUCTION

Ordinary Portland Cement is considered is one of the most important material for construction but the production of 1 ton of OPC directly generates 0.55 tons of CO_2, howeverdavidovits study states that for production of 1 ton of Geopolymer concrete generates only 0.184 tons of co_2. In India more than 100 million tons of flyash is produced annually and out of this, only 17-20% is being utilized either in concrete or in stabilization of soil. Flyash based Geopolymer concrete becomes more environment friendly as it does not use Portland cement at all. Geopolymer concrete is produced by alkali activation of flyash or GGBS combined with aggregates. The advance in the field of Geopolymer concrete has been till date the result of an empirical approach rather than scientific. The results obtained by the empirical approach the for different studies cannot be related to one another. The Geopolymers are a group of inorganic polymer produced by the result of reaction between an alkaline solution and aluminosilicate as source. The low calcium fly ash based Geopolymer concrete uses fly-ash and alkaline solution as binding agent. In India the flyash available is mostly low calcium based, when it is used in Geopolymer concrete results good in terms of compressive strength, fire resistance and also chemical attack as per the available data from previous research. So far researchers have shown a significantly good results when a molarity of sodium hydroxide solution in the range of 10M to 16M. The main factor which defines the properties of Geopolymer concrete is Aluminum silicate, molarities of NaOH, super plasticizer and the curing conditions.

II. OBJECTIVE AND SCOPE

The main objective is to study the flexural and shear behavior of Geo-polymer concrete beam with and without carbon fiber using Fly ash, and GGBS.

III. MATERIALS

The materials used are

A. Flyash

Flyash is a fine powder that is a byproduct of burning pulverized coal in electric generation power plants. Fly ash is a pozzolan, a substance containing aluminous and siliceous material that forms cement in the presence of water

B. GGBS

It has the same chemical properties as OPC, but the proportions are different. The addition of GGBS in GPC increases the strength of concrete.

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C. Alkaline Activator Solution

In Geopolymer concrete alkaline activator solution is one of the very important material. Sodium hydroxide is one of the most common alkaline activator solution used in geopolymerization.

IV. LITERATURE REVIEW

Ganapati Naidu & Prasad (2012) carried out a study on strength properties of geopolymer concrete using low calcium flyash replacing with slag in 5 different percentages. From the test results, it was concluded that, with maximum (28.57%) replacement of flyash with slag (Mix No:5), achieved a maximum compressive strength of 57MPa for 28 days, also Higher concentrations of GGBS (Slag) result in higher compressive strength of geopolymer concrete. 90% of compressive strength was achieved in 14 days and the average density of geopolymer concrete was equal to that of OPC concrete.

Prakash R. Vora&Urmil V. Dave (2013)carried outa study on casting 20 Geo-polymer concretemixes to evaluate the effect of various parameters affecting its compressive strength in order to enhance its overall performance. From the test results, it was concluded that, the ratio of alkaline liquid to fly ash, by mass does not affect the compressive strength of the geo-polymer concrete. And, compressive strength of the geo-polymer concrete increases with increase of concentration in terms of molarities of sodium hydroxide. Also, Workability of the geo-polymer concrete mix increases with the addition of super plasticizer up to 4% of fly ash by mass.

A Maria Rajesh, and M. Adams Joe (2014)studied Use of geo-polymer concrete as an alternative material over Portland cement concrete to reduce the adverse effects on the environment. Also conducted tests on compressive strength, split tensile strength and flexural tests for specimens with combination of different molarity. From the test results, it was concluded that The compressive strength of GPC specimens with 12M is 1.25 times more than that of GPC with other molarities after 28 days of hot curing. And the split tensile strength of GPC specimens with 12M is 1.18 times more than that of GPC with other molarities after 28 days of hot curing, also the Flexural strength of GPC specimens with 12M is 1.058 times more than that of GPC with other molarities after 28 days of hot curing.

Prof. Y. D. Deore&Jayesh B (2016) studied the effect of the Geo-polymer binder on fracture characteristics of concrete has been investigated by one point bending on beam specimens, using M-25 grade of concrete. From the test results, it was concluded that, with the addition of Glass fibers and Carbon fibers in Geo-polymer concrete reduced the workability of concrete mix, also the requirement of water content ratio is less as compared to other concrete, and the addition of fibers reduces the crack propagation in concrete and reaches higher peak value, and glass fibers give more strength in cracking propagation as compare to the Carbon fibers.

Abdullah ZawawiAwing, Wahid Omar (2018)intended to study the properties of flyashbased Geopolymerconcrete. To increase the performance of Geo-polymer concrete beam, the effects of additional steel fiber. Two tests scales were used: small and full scale test. Majority focused on small scale approach. From the test results, it was concluded that the shear capacity of beam was delayed due to additional fiber, finer crack was also observed. Also Setting time of the Geo-polymer concrete could be improved up to 3 hrs with the addition of naphthalene based admixtures.

Mohammad Amin and Sandeep(2018)carried out a study on M20 grade Geo-polymer concrete that can be used in low traffic pavements to combat against the flood risks and recharge ground water. From the test results, it was concluded that, No-fines geo-polymer technology will result good for global warming reduction and minimizing flood risks because of no cement present in Geo-polymer concrete and the ability of absorbing large amount of water and enough strength and infiltration rate is achieved which can be used for low traffic roads and pavements.

Mark Reed (2018) carried out a study on the effect of heat curing by comparing the mechanical properties such as compressive strength and ductility of ambient cured and heat cured Geo-polymer concrete samples. From the test results, it was concluded that, adding polypropylene fibers actually causes a small decline in the fracture energy and fracture toughness of concrete (4 to ± 8 %) in the case of concretes with 0.15 % fibers.

Faiz Shaikh and Sharany (2018) carried out study on Fly ash based Geo-polymer were cast where carbon and basalt fiber were added as 0.5, 1 and 1.5% by weight of fly ash and each series of samples were tested at ambient temperature and also heated at 200, 400, 600 and 800 C. From the test results, it was concluded that, Geo-polymer containing 1 wt% basalt and 1 wt% carbon fiber exhibited better compressive strength. And among two fibers composites, the carbon fiber Geo-polymer exhibited better performance than its basalt fiber, also at 800 C the cracking in 1 wt% carbon fiber reinforced Geo-polymer is less than its basalt fiber counterpart and pure geo-polymer.

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Shabarish V. Patil&Sachin(2019) conducted Study on the comparison of the compressive strength with both destructive and non-destructive method is checked for M30, M40, and M50 grade of Geo-polymer concrete cured in an oven and in ambient temperature condition, by using rebound hammer test. From the test results, it was concluded that, the compressive strength of oven cured Geopolymer concrete is more as compared to ambient cured irrespective of the age of concrete. And, from the regression analysis, it is clear that he NDT method for GPC will be more accurate for oven cured specimen as compared to ambient cured specimen.

V. LIMITATIONS

Based on experimental results and observations, the following conclusions were made by the researchers

A. In comparison with conventional concrete, Geo-polymer concrete did not harden immediately at room temperature.
B. A minimum of 3 days was taken forcomplete setting was taken for Geo-polymer concrete without leaving a nail impression on hardened surface.

These above 2 limitations of Geopolymer concrete mix were eliminated by replacing 10% of flyash by OPC.

VI. ADVANTAGES

A. The replacement OPC by Flyash results in reduction of cast.
B. Enhancement in compressive strength
C. Fire proof (higher resistance to heat)
D. Eco friendly
E. Low permeability

VII. CONCLUSION

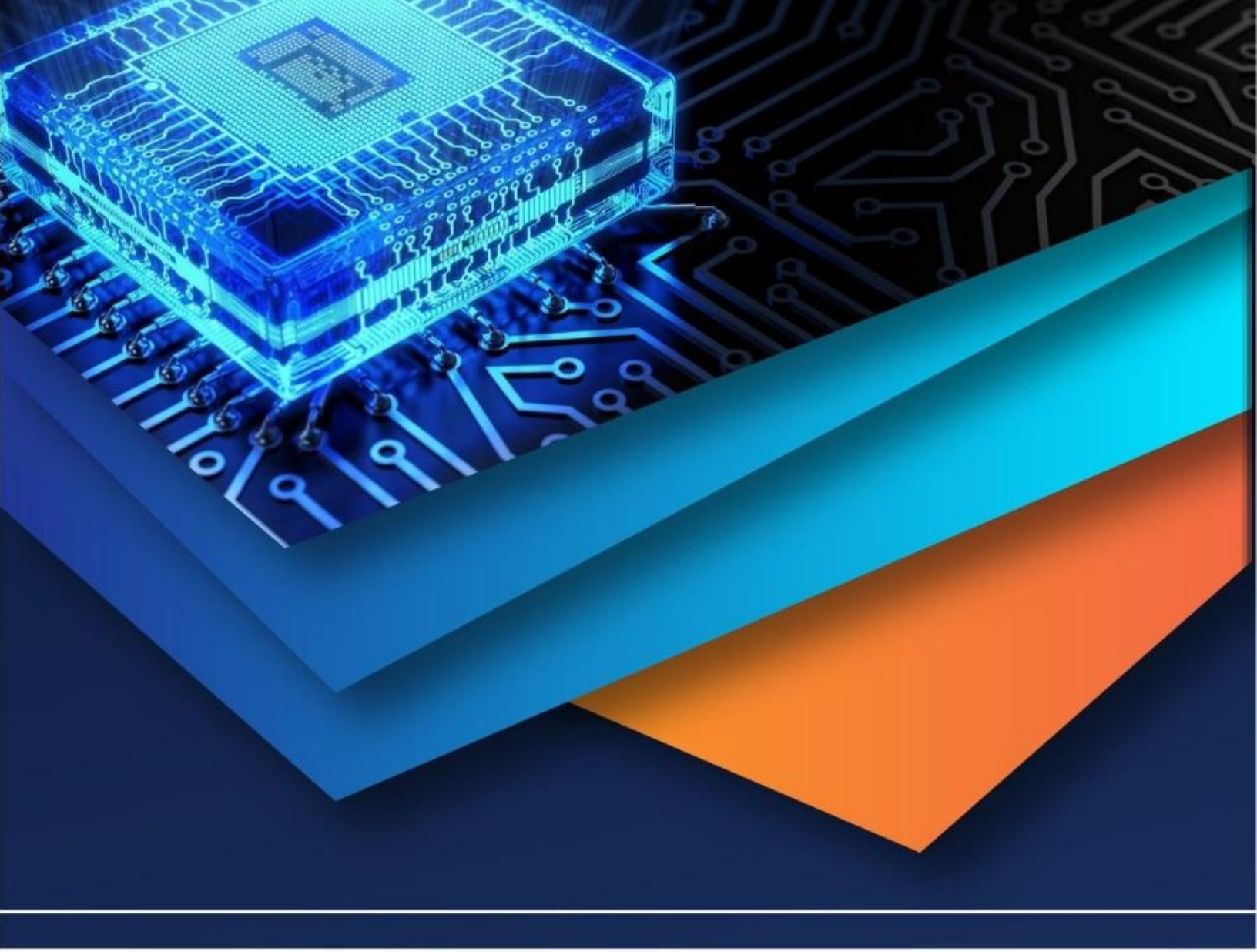
From the past research it can be summarized that:

A. Geopolymer has excellent properties within both acid and salt environments.
B. Addition of glass and carbon fibres in geopolymer concrete reducedthe workability of concrete mix. The workability og the Geopolymer concrete can be enhanced by addition of suitable chemical admixture.
C. The addition of fibres reduced the crack propagation in concrete and also reaches higher peak value.
D. Glass fibres provide more strength in cracking propagation as compare to the carbon fibre.
E. Inclusion of GGBS in flyash based geoploymer concrete gives a huge impact on the compressive and tensile strength.

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