

A Review on Effect of Different Aspect Ratio Steel Fiber in Slag based Geopolymer Concrete

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Abstract — Global warming is one of the most pronounced terms in this present century. Five to eight percent of the world's manmade Greenhouse gas emissions are from the Cement industry itself. Geopolymers are showing great potential and several researchers have critically examined the various aspects of their ability as binder system. Thus Geopolymer based Concrete is highly environment friendly and the same time it can be made as high performance concrete. The mixes of binder is combined alkaline solution of sodium hydroxide and sodium silicate with ground granulated blast furnace slag. So in this study an attempt is made to know the strength of geopolymer concrete by adding hooked end steel fiber in the mix. The studies showed the load carrying capacity of most of the GPC mix beams. The acid attack of sulfuric acid is studied to check the durability properties of geopolymer concrete and change in mass of concrete. It has been concluded that the steel fiber used in geopolymer concrete upto 1.5% is improved compressive strength and flexural strength. This paper presents a review of the literature, outlining the various research approaches undertaken in an effort. It is expected that this review will provide a key step in advancing the understanding of this innovative construction material.

Keywords—Ground granulated blast furnace slag, alkaline liquid, steel fiber, compressive strength, acid attack, flexural Strength

I. INTRODUCTION

Ordinary Portland cement has been a binder for Civil Engineering tasks for a long time. But at present, there are many new issues branching from its ever increasing use. Cement production consumes huge quantities of virgin materials, is energy intensive, and leads to high emission of the greenhouse gas CO₂, which is the main reason behind Global warming. Installation of new cement plants is becoming increasingly capital-intensive. Finally, many cement concrete structures have exhibited early distress and problems, which has an adverse effect on the resource productivity of the industry. To overcome all such limitations, a new cementitious composite called “Geopolymer” is evolved. The name geopolymer was coined by a French Professor Davidovits in 1978 to represent a broad range of materials characterized by networks of inorganic molecules. It is a type of inorganic polymer composite, which has recently emerged as a prospective binding material based on novel utilization of engineering materials. It is an established fact that the greenhouse gas emissions are reduced by 80% in Geopolymer concrete.

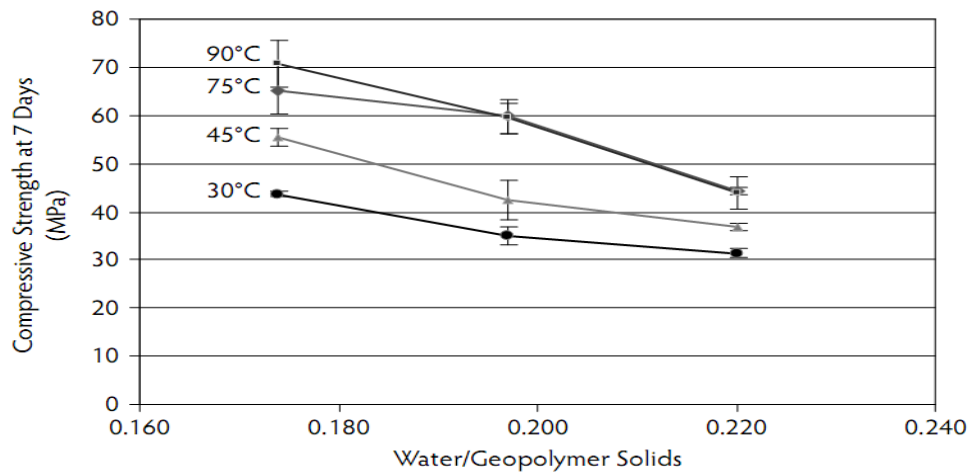
The geo-polymeric concretes are commonly formed by alkali activation of industrial aluminosilicate waste materials such as fly ash (FA), Ground Granulated Blast furnace Slag (GGBS), etc and have very small footprints of greenhouse gases when compared to traditional concretes. They can be designed as high strength concrete too. Main advantages of geopolymers are their chemical stability, resistance to the sulphate corrosion and long lasting strength. Because of possible realization of even superior chemical and mechanical properties compared to Ordinary Portland cement (OPC) based concrete mixes, and higher cost effectiveness, GPC mixes based on FA and GGBS are being discussed for their potential application in concrete industry including structural concreting, precast panels and ready-mixes. The uses of steel fiber with different aspect ratio showed the load carrying capacity of the geopolymer concrete and enhanced the mechanical properties of geopolymer concrete.

II. LITERATURE REVIEW

1. Development and properties of low-calcium fly-ash-based geopolymer concrete

Hardjito D., Rangan B.V.

They explained that primary difference between geopolymer concrete and portland cement concrete is the binder. As in the case of portland cement concrete, the coarse and fine aggregates occupy about 75 to 80% of the mass of geopolymer concrete. This component of geopolymer concrete mixes can be designed using the tools currently available for portland cement concrete. They performed tests to establish the effect of the water/geopolymer solids ratio by mass on the compressive strength and workability of geopolymer concrete. The test specimens were 100 x 200 mm cylinders, heat cured in an oven at various temperatures for 24 hours.



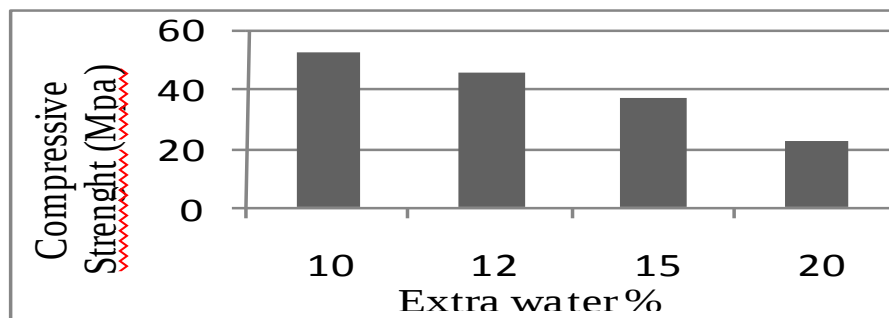
The results of these tests, plotted in figure. Show that the compressive strength of geopolymer concrete decreases as the water/geopolymer solids ratio by mass increases. This trend is analogous to the well-known effect of the water/cement ratio on the compressive strength of Portland cement concrete. Obviously, as the water/geopolymer solids ratio increases, workability increases because the mixes contain more water. ^[3]

2. Compressive strength characteristics of Low calcium Fly ash based geopolymer concrete

Ahmed M.F. and Nuruddin M.F.

They explained that the addition of water improved the workability characteristics of freshly prepared concrete mixtures; however, the addition of water beyond certain limit resulted in bleeding and segregation of fresh concrete and decreased the compressive strength of the concrete significantly.

The results obtained are graphically represented in Figure and concluded that the compressive strength of Geopolymer concrete significantly decreased as the amount of extra water increased. ^[1]



3. Study on Mechanical Properties of Geopolymer Concrete Using M-Sand and Steel Fibers

Parashivamurthy R, Laxmi.G.G

They studied to know the strength of geopolymer concrete by adding hooked steel bars in the mix. By making 3 mixes with varying proportion of fly ash and ggbs like 1st mix with 70% fly and 30% ggbs, 2nd mix with 50% fly ash and 50% ggbs and finally 60% fly ash and 40% ggbs. For all the 3 mixes hooked steel fiber were added and from this 24 cubes, 24 cylinders, 24 beams casted. And all the test specimens were tested for compression test, flexural test and split tensile test. And finally strength of geopolymer concrete with steel fibers was determined.

They concluded that the workability of the gpc mix diminished with addition of steel fibres. The optimum dosage of steel fibres for an aspect ratio of 50 is 1.5% by volume of concrete and observed that addition of super plasticizer will improve the workability as long as total water to gpc solid ratio is within 0.35. Also concluded that there is no necessity of exposing geopolymer concrete to high temperature for achieving of high strength. ^[5]

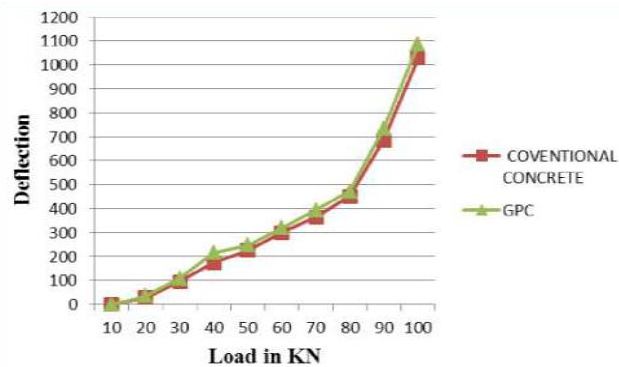
4. Fibers Study On Properties Of Geopolymerconcrete With Polypropylene

P.Eswaramoorthi, G.E.Arunkumar

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 geopolymerization 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. A mix proportion for geopolymer concrete was

designed and carried out tests for different grade of concrete. The tensile strength and compressive strength of geopolymer concrete have been studied and compared with opc. Polypropylene is one of the cheapest & abundantly available polymers. Polypropylene fibers 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).

They concluded that geopolymer concrete produces a substance that is comparable to or better than traditional cements with their properties. Low-calcium fly ash-based geopolymer concrete has excellent compressive strength and is suitable for structural applications. As per load deflection test, strain energy absorbed, ductility factor and, toughness index, are considerably increases in gpc with addition of polypropylene fibers. Due to geopolymer concrete the consumption of cement, emission of carbon dioxide and greenhouse effect are reduced.^[4]

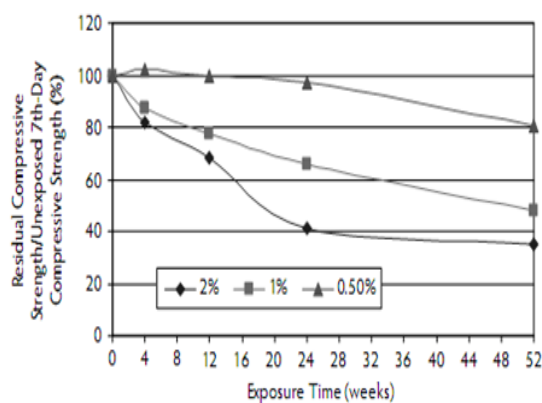


5. Low-calcium fly ash-based geopolymer concrete: Long term properties

Wallah S.E., Rangan B.V.

They studied the sulfuric acid resistance of heat-cured, low calcium, geopolymer concrete. The concentrations of the sulfuric acid solution were 2%, 1%, and 0.5%. The sulfuric acid resistance of geopolymer concrete was evaluated based on the mass loss and the residual compressive strength of the test specimens after acid exposure up to one year. The test specimens, 100 x 200 mm cylinders, were made using Mix 1 and were heat cured at 60°C for 24 hours after casting. The visual appearance of specimens after exposure to sulfuric acid solution showed that acid attack slightly damaged the surface of the specimens.

So they concluded that the maximum mass loss of test specimens of about 3% after 1 year of exposure is relatively small compared to that for Portland cement concrete as reported in other studies. As shown in Figure exposure to sulfuric acid caused degradation in the compressive strength; the extent of degradation depended on the concentration of the acid solution and the period of exposure.^[6]



III. CONCLUSION

All the above reviews conclude that water has no hardening or weakening effect on GPC, the addition of water improved the workability characteristics of freshly prepared concrete mixtures. GPC mix will become less fluid with increasing mixing time. When fibre is added to concrete, the mix becomes stiff. So the workability is decreased with more addition of fibre. The workability can be improved by adding super plasticizer to some extent.. As per load deflection test, strain energy absorbed, ductility factor and, toughness index, are considerably increases in GPC with

addition of polypropylene fibers. Compressive strength of 1.5% steel fiber geopolymer concrete has found to be increase in strength, when compared to that of conventional concrete. The acid attack of sulfuric acid caused degradation in the compressive strength. The addition of water improved the workability characteristics of freshly prepared concrete mixtures. So, the addition of water beyond certain limit resulted in bleeding and segregation of fresh concrete and decreased the compressive strength of the concrete significantly.

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