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A REVIEW OF STRUCTURAL PERFORMANCE OF GEOPOLYMER CONCRETE

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ABSTRACT

OPC manufacture is the second biggest source of CO2, which pollutes the atmosphere. In addition, a lot of energy was spent for adhesive production. Therefore, it is unavoidable to find another material to the most luxurious and resource-intensive Portland cement.

The geopolymeric concrete is an groundbreaking building material that consequences from the biochemical action of mineral particles. Fly ash, a by-product of current control plants, is sold in large quantities throughout the world. The fly ash is rich in silica, and the alumina reacts with alkaline solutions and forms an aluminosilicate gel, which acts as a binder for the concrete. This is an outstanding other building material for existing cement concrete. Geopolitic concrete should be made without the use of common portland cement This article briefly describes the specific geopolitical components, their strengths and their possible uses. In addition to its advantages, the practical use of geopolymer concrete is very incomplete. The main reason for this is the lack of research on physical elements, design and applied research. This article studied the physical and structural characteristics of geopolymer concrete to identify gaps in research in this area for the development of future research. The analysis showed that geopolymer concrete can change the desired structural characteristics with better mechanical properties of the concrete, greater strength and greater than that of ordinary concrete. The practical design standards require more work and, finally, an exhaustive study of the structural elements to guarantee practicality.

INTRODUCTION

Concrete is the mixture of cement, fine aggregates and leveling aggregates. Some additives are added for some time to obtain the desired properties of the concrete.

The normal concretes we use contain ordinary Portland cement, which is the most carbon dioxide generating element. For example, the manufacture of one ton of cement produces one ton of carbon dioxide. [7]

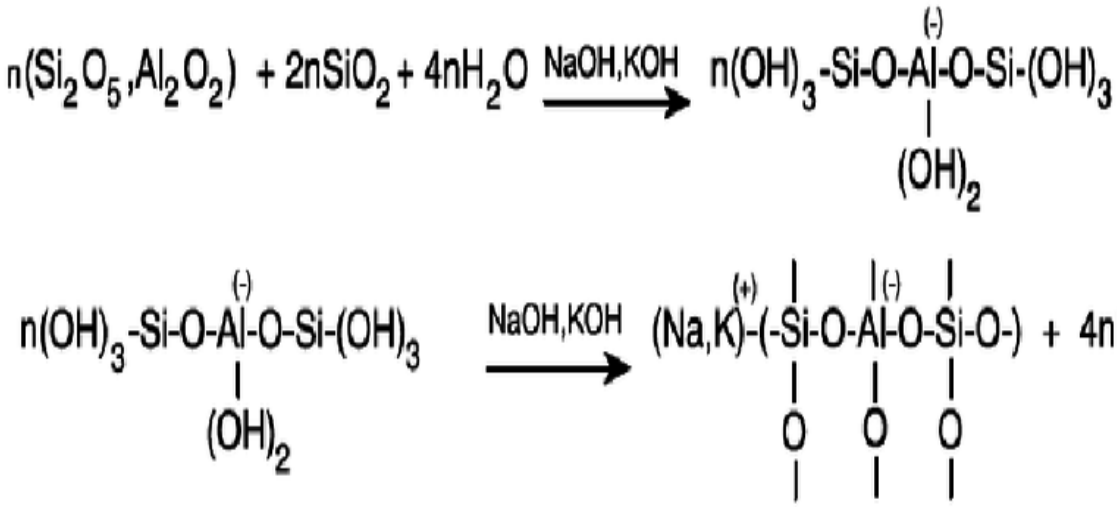
Since we are currently faced with the problems of depletion of the ozone layer and global warming, we need some alternative source for construction, so the researchers presented a new type of concrete that is known as geopolymer concrete, which has better mechanical properties and is durable compared to conventional concrete. .

Geopolymer concrete can replace ordinary concrete, as it has greater strength and structural characteristics compared to ordinary concrete. [5]

Geopolymer concretes can be made from anything that contains Si and Al. These materials will be natural or mineral, or industry byproducts, fly ash and industrial waste are commonly used.

The geopolymer concrete is produced by the reaction of inorganic molecules. Fly ash, which is used in geopolymer concrete, is a by-product of coal and is produced in large quantities in

thermal power plants. Fly ash contains alumina and silica, which react with alkaline solutions to form aluminosilicate gels, which act as binders for the aggregate. [12]
For geopolymer concrete reactions, water must also not remove water, if present in the material during mixing, the fly ash reacts with an aqueous solution containing sodium hydroxide and sodium silicate. This reaction produces materials with three-dimensional polymer chains and ring structures consisting of Si-O-Al-O bonds. The formation of geopolymer concretes can be described by following reactions.



Geopolymer concretes are more advantageous as compared to conventional concretes but the production cost of geopolymer concrete is more than conventional concrete. Before 2001 the work done on geopolymer concretes was limited but after 2016 it increased dramatically which shows that research scholars gave attention to this particular field. [1]

LITERATURE REVIEW

Necessity of Geopolymer Concretes

Since the construction industry is rapidly growing in the world, which is increasing every day, and the main component used in construction is a binder, known as ordinary Portland cement. According to the survey, 260.00 thousand tons of cement are held annually. used in the world, and this requirement of cement is increasing every year. But on the other hand, the production of this huge amount of cement produces a huge amount of carbon dioxide, which pollutes the environment, and the production requires a large amount of energy. [2]
Due to the shortcomings of conventional Portland cements, it is necessary to find an alternative source of binding materials for which geopolymers are innovative building materials.
Geopolymer made from the chemical reaction of inorganic molecules. Fly ash from power plants of thermal power plants and alkaline water from chemical refineries. Fly ash is rich in silicon and aluminum, which react with an alkaline solution and form an aluminosilicate gel, which serves as a binder for concrete. [7]

Geopolymer Concretes in Materials

Many studies have been conducted to determine the performance of geopolymer concrete, which includes the effect of the CSH phase, mixing and healing of geopolymer concrete. Various experiments have shown that the strength of concrete depends on the alkalinity of the activator and this temperature also plays an important role in the activation of silica-alumina. [4]
The study showed that in the FA / SG mixture during activation at lower temperatures (about 27 ° C), activation of SG prevails, whereas at higher temperature levels (about 60 ° C) both FA and SG are activated. However, SG contributes to the strength of pasta due to the compactness of the microstructure. The structure of amorphous geopolymer is more interesting from the point of view of mechanical properties of geopolymer concrete and paste and depends on the ratio Sio2, Al2O3, the ratio R2O / Al2O3 and the ratio Sio2 / R2o and the ratio of liquid solids. The compressive strength of geopolymer concretes increases with alkali content, and the strength decreases with silica. [10]
The following figure shows the effects of activator dosage which tells us those higher pore volumes with decrease strength of paste the setting time of paste increases with Sio2/Al2O3 ratios.

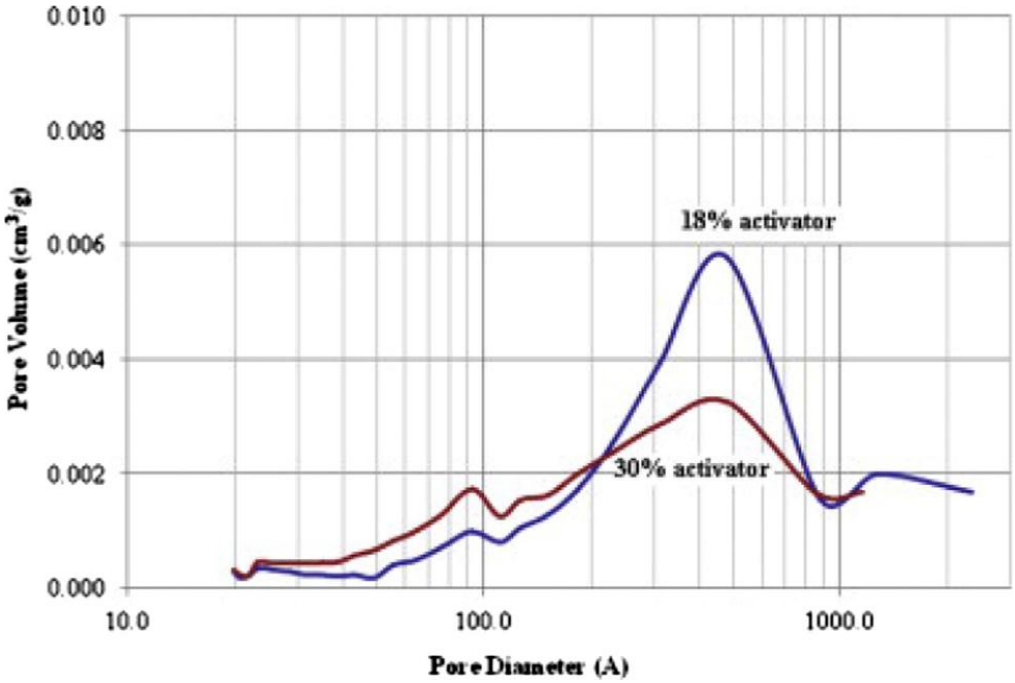


Figure: 1 Pore volume distribution at different activator dosages

Sucrose forms an insoluble metal complex in the paste, which reduces the hydration properties of geopolymer concretes and pastes, on the other hand, citric acid reduces the strength and accelerates the processes of hydration. [1]
The workability of geopolymer concretes and pastes can be enhanced with the help of plasticizers based on naphthalene and polycarboxylates, but with the help of these superplasticizers based on polycarboxylates, the process of hydration and 1/3 of the compressive strength of geopolymeric concretes is reduced. [9]

Geopolymer Concretes performance in Beams, Slabs and Columns

By studying the effects of geopolymers in structural elements like beams, slabs and columns it is found that geopolymer concretes beams are same as conventional concretes beams, [3] investigated that shear capacity of beam is delayed due to additional steel fibers and minor cracks also appears in concrete surface.
In columns brittle fractures occurred which is little difference between geopolymer concretes columns and conventional concrete columns for increasing the ductility of geopolymer concrete columns steel fibers and confinement can be used while in geopolymer concrete slabs the ductility and energy observed is better than ferocement slabs. [2]
The following table shows that the past research and studies on structural elements like columns, beams and slabs.

Table 1. Summary on structural performance of geopolymer concrete. [6]

Structural elements	Researchers	concrete type	testing variables	Remarks
Beam	Sumajouw et al.	Fly ash-based	Reinforcement ratio	Flexural strength increases with increasing gain, similar to with the behavior of ordinary RC rays
	Sumajouw et al.	Fly ash-based		
	Dattatreya et al.	Fly ash- based	Reinforcement ratio, concrete compressive strength	The effect of reinforcement ratio on geopolymer concrete beams is practically similar to conventional beams due to bending and plasticity
	Ng et al.	Fly ash- based		
	Mourougane et al.	Fly ash-based		
	Yost et al.	Fly ash- based	Fly ash ratio Steel fiber content	A decrease in post-peak plasticity was observed. The shear capacity was delayed due to fibers, a smaller crack was also observed
	Andalib et al.	POFA + Fly ash-based		
	Srinivasan et al.	Fly ash-based	Miscellaneous reinforcement configuration	Higher shear strength is observed for geopolymer concrete
	Devika and Deepthi	Fly ash-based	Coefficient of elasticity tensile	
	Kathirvel and Kaliyaperumal	Fly ash-based		No significant different in the shear behaviour between geopolymer concrete beam and ordinary RC beam
	Visintin et al.	Fly ash-based	Coefficient of POFA-fly ash Fiberglass content	

Column	Sujatha et al.		The proportion of steel fiber and hybrid polypropylene	Similar to the cracking pattern, as in the RC beam
	Rahman and Sarker	Fly-ash based And cementbased		Flexural capacity increased by about 35% with fiberglass. Overuse Fiber reduced performance
	Sumajouw et al.	Fly ash-based	Recycled share Aggregate	Flexural capacity increased by 30% due to the use of hybrid steel polypropylene fiber
	Ganesan et al. [89]	Fly ash-based	Shear span ratio	More cracks, greater crack width, but better deflection and ductility
	Nagan and Karthiyaini	Fly ash-based	Concrete compressive strength	Direct shear test results show that shear friction properties for Geopolymer concrete used in experimental studies falls under range of shear-friction properties of installed OPC concrete
	Rajendran and Soundarapandian	Fly ash-based	Gain and biaxial load eccentricities	Geopolymer concrete columns is better to RC columns up to 34% in ultimate strength
			Longitudinal reinforcement concrete compression coefficient and strength	The failure was due to the destruction of concrete on the compression side, similar to ordinary RC speakers
Slab	Nagan and Mohana	Fly ash-based	Steel fiber volume and aspect ratio	Similar failure, crushing with fragile way
		Fly ash-based	Effect of the conclusion	The inclusion of stele fibers increased the load capacity to 56%.
				The tensile strength of the concrete

				column of geopolymer is improved by about 30%. Confinement further increased load capacity and ductility

METHODOLOGY

The following are the ingredients of Geopolymer concrete
1.Fly-Ash- rich- Silica and Aluminum 2. Sodium-Hydroxide or Potassium-Hydroxide 3.Sodium-Silicate or Potassium-Silicate. [8]
The main essential of geopolymer concrete is fly-ash which is gotten from coal or thermal plants, the fly ash contain silicon and aluminum which due to which they have potential to be used like cement and for this first fly ash should be activated .the flyash can be activated by using alkaline solution. The flyash containing silicon and aluminum when react with alkaline solution then the chemical process obtained is called Polymerization. The chemical analysis and physical analysis report on flyash are shown in following tables.

Table 2. Chemical analysis report of fly ash [10]

Material	Chemical composition (in percentage)								
Fly Ash	SiO_2	Al_2O_3	Fe_2O_3	Ca O	Mg O	Na_2O	K_2O	SO_4	LOI
	063.97	027.62	05.69	000.37	000.84	000.5	000.25	000.35	0.45

Table 2. Physical analysis report of fly ash [10]

Material	Particle Size Distribution						
FlyAsh	>500l	300_500-µ	150_300-µ	150_90-µ	90_45-µ	<45-µ	Specific Gravity
NIL	00.00	01.43	11.68	48.1	31.92	06.77	02.01

Preparation and Formation

The rudimentary and simple code of formation of geopolymer fly ash is the decay of aluminum sulphate by alkali in fly ash and the following polycondensation. Responses can happen at reasonable temperatures, so production is careful vigor efficient and a foundation that is much cleaner. Though, the real replies that took place are very complex and problematic to understand. Seemingly, there is a feedback between the fly ash and the alkali and the concentration between the resulting Si4 + and Al3 +, escorted by other complex nucleation, oligomerization and polymerization procedures, which finally lead to the arrival of new aluminosilicate polymers

with new three-dimensional structures of formless tissue. [11] When tested or used, the already prepared fly ash geopolymer paste is poured into a mold and located in an oven at the wanted fever or left at room temperature to cure for a specific time to form the structure.

Figure: 2 The schematic drawings showing the process from fly ash to fly ash-based geopolymer cement/concrete

An important role in the formation of the polymerization is played by the alkaline activation of fly ash: in alkaline solutions (Na2SiO3, NaOH, KOH or K2SiO3), silica, alumina or aluminosilicate in the hydrolysis of fly ash - Si-O - Si or - Si-O-Al bond of disintegrated aluminosilicate and releases the active species Al3 + and Si4 +. The particles of Al3 + and Si4 +, which react actively, form nuclei, and the oligomers of aluminosilicates consist of tetrahedra of SiO4 and AlO4. The chains in the aluminosilicate oligomers may be in the form of poly-chains of Al-O-Si, polysialate-siloxane-Al-O-Si-Si and polyisary-disiloxane chains-Al-O-Si-Si-Si, depending on the relationship. Si/Al. In the aluminosilicate monomers, Si4 + is partially replaced by Al 3+, and the negative charge formed in the aluminosilicate chains is balanced with alkaline cations, such as Na + or K +. [12]

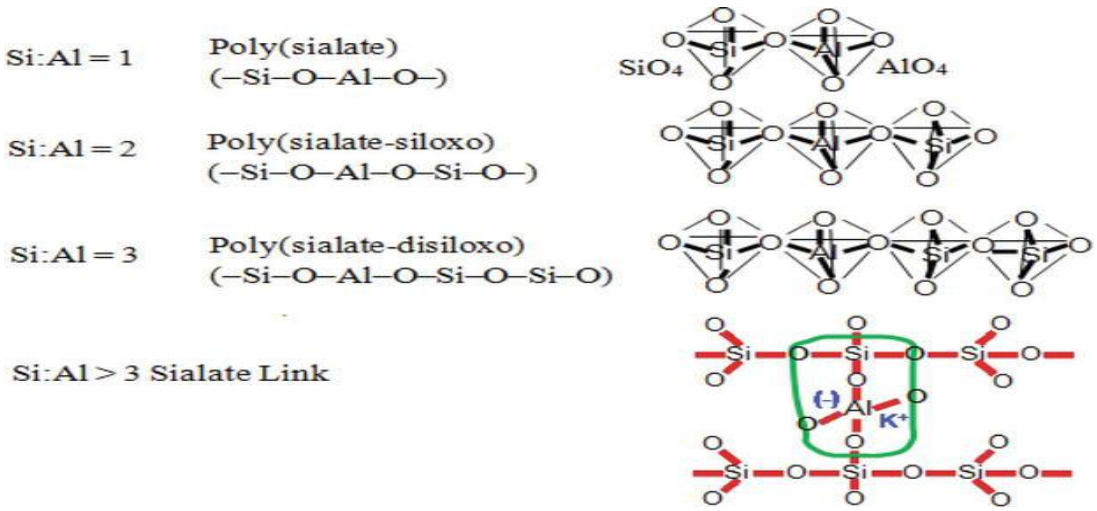


Figure: 3 Reliant upon the unlike Si/Al molar ratio, dissimilar alumino silicate hawsers is shaped in the alumino silicate oligomers which then further to form geopolymer

CONCLUSIONS

Due to the high initial capacity, geopolymeric concrete can be used, at least in industry, so that a large production is possible in a short time and should be minimized during transport. The geopolymer moisture concrete must be effectively used for the prefabricated beam concrete structure. Moisture of geopolymer concrete should also be used in infrastructure construction. In addition, the flash must be used effectively, and therefore it is not necessary for any ground level to scatter the flash.

The government can take measures to reduce the content of sodium hydroxide and sodium silicate solution in the unused of the biological industry, so that prices of basic prices of biopolar concrete are reduced. As a general rule, these characteristics were evaluated by power or load with the traditional OPC concrete during the test of a cylinder, beam, column and slab of biological concrete. The cylinder compression test and BM exam are the most and most evaluative. The previous study includes a series of changes, which include an additional proportion of cement, mixing ratio, Nano freight ratio, silicone effect, glass fiber effect, CA ratio of 2 and slag, PVA fiber add effect, recycle total, extra proportion, liquid ratio ratio, treatment time and Condition, pro ratio of SP for content performance, active car type, high temperature, overall types and effect. According to the terms of structural performance, competitiveness on competitiveness, concrete composition strength, FA/SG ratio, different qualification configuration, glass fiber content, recycled overall ratio, embroidery ratio ratio, absorbent, aspect ratio, lock The effect of the effect, ratio of proportion, qualification and volume of competitiveness. Investigation of the impact of different aluminosilicates was also undermined by the lack of test. Usually, two test scales were used: small and full scale. The test efforts on a slight scale mass. It is create that geopolymer is appropriate as important elements. It was also found that the full-scale test is not yet for non-FAF based geopolymer concrete.

RECOMMENDATIONS

Untried investigations on stability, especially Crack-propagation Complete-scale experimental investigations on physical rudiments Non Fly Ash based geopolymer concrete. Experienced examinations on applying HWAAC in changing alkali deeds for geopolymer concrete.

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