Investigation Study on Geo-Polymer Concrete

Vimalraj[1], Shaib Shabir[2], Vishal Singh[3]
[1,2,3] *MTech, Construction Technology and Management, Vellore Institute of Technology, Vellore*

Abstract **- Now a day in a fast-moving world, we don't want to do the work for a long time, and we are not using the materials with one benefit, so we are looking into the material which has more than one benefits. A new material is created to make more efficient and looking for less limitations in it. Many research is going on new material innovation. geo-polymer concrete is one of the new materials. It is widely used in many construction fields. Normally the geo-polymer concrete has many advantages in it. The permeability in the geo-polymer concrete is less because the air voids present in the concrete is very less as compared to the conventional concrete. Now we can see the properties, merits & demerits, manufacturing process and areas where the geo-polymer concrete are used.**

INTRODUCTION

Geo-polymer concrete is one of the new construction materials. It becomes more famous in recent years because of its advantages. The geo-polymer concrete is highly environmentally friendly as compared to the normal conventional concrete. The geo-polymer concrete is made by reacting aluminate and silicate bearing materials with a caustic activator. Fly ash and slag from iron and metal production are used in geo-polymer. It will increase the properties of the geo-polymer concrete and in other hand it will clean the environment. Geo-polymer concrete does not require heat to make it and it will not produce any harmful gases like carbon dioxide. But in normal conventional concrete requires heat to make it and it will also emit harmful gases like carbon dioxides. We have to add element, or the substance require for the geo-polymer concrete, fly ash from thermal power plant, GGBS from steel plant, Fine aggregate and coarse aggregate and alkaline activator solution. This substance should be mixed in the proper mix ratio.

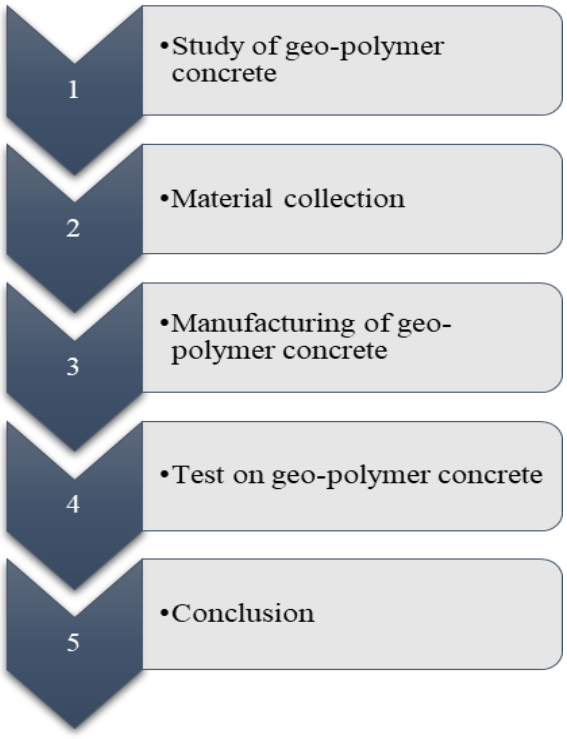
OBJECTIVES

The geo-polymer concrete is compared to the conventional concrete and we can find many advantages in geo-polymer concrete.

- The geo-polymer concrete does not require heat to make it, but the conventional concrete requires heat.
- The geo-polymer concrete will not emit any harmful gases, but the conventional concrete will emit harmful gases.
- The geo-polymer is very small in size it can fill the air voids present in the concrete so, the permeability of the concrete will get reduced.
- The cost of the geo-polymer concrete is economic.

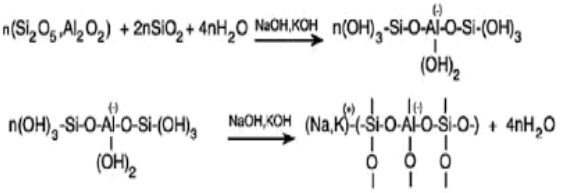
When we use geo-polymer concrete there is no change in the strength and properties. We have only advantage in using geo-polymer concrete as compared to the normal conventional concrete. It is also more environmentally friendly as compared to the normal conventional concrete.

METHODOLOGY



Study of geo-polymer concrete:

The general knowledge about the geo-polymer concrete is very much important and the chemical substance present in the geo-polymer and what are the reaction may occur in the geo-polymer should be studied and properties of the geo-polymer and manufacture of the geo-polymer should be known. Everything about the geo-polymer like the reaction of the geo-polymer at different temperature should be well. Every information will help us to apply the geo-polymer at different problems and application.



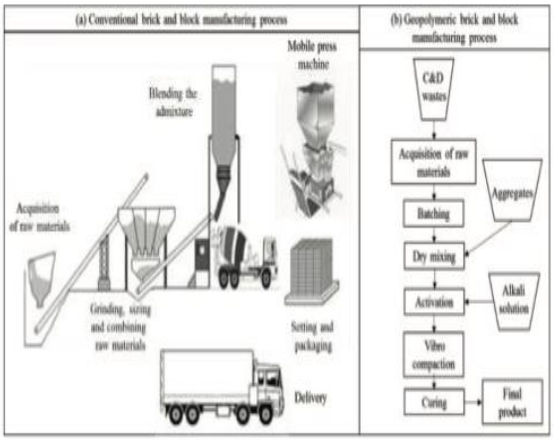
Material collection

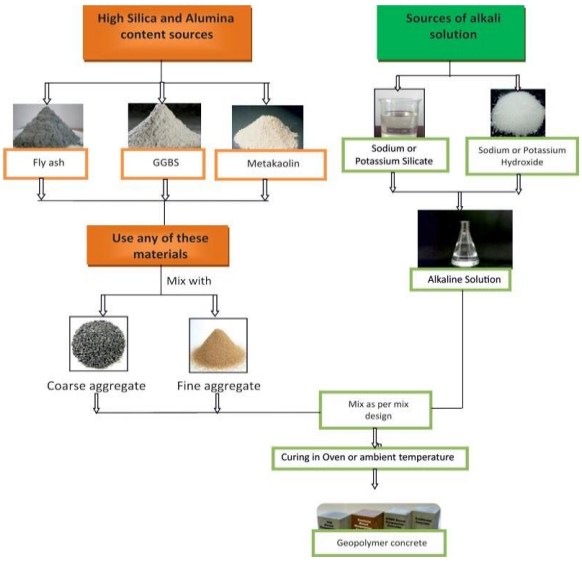
The following materials are required to produce geo-polymer concrete:

- Fly ash from thermal power plant.
- GGBS from steel plant.
- Fine aggregate and coarse aggregate.
- Alkaline activator solution.

Manufacturing of geo-polymer

The manufacturing of geo-polymer concrete is made by, in one hand mix fly ash, GGBS & metakaolin. In other hand prepare the alkaline solution by mixing sodium or potassium silicate and sodium or potassium hydroxide. Then mix both the substance with coarse aggregate and fine aggregate. Then curing is done by use of oven or at ambient temperature. Finally, we get the geo-polymer concrete.





Test on geo-polymer concrete

Compressive strength

Geo-polymer Concrete

Alkaline/Fly Ash Ratio		0.55
Sieve Designation particle size range (mm)		½"- 1" (12.5 – 25)
% by Mass	Fly Ash	16.67 %
	Fine Aggregate	24.50 %
	Coarse Aggregates	45.50 %
	Sodium Hydroxide	2.62 %
	Sodium Silicate	6.54 %
	Added Water	4.17 %
Total Percentage (%)		100 %

The compressive strength of geo-polymer concrete is compared with the normal conventional concrete and at the end of 28 days there is not much difference in the strength of concrete for both geo-polymer concrete and conventional concrete. The geo-polymer concrete is made at the mix ratio that has given above. The conventional concrete is made with the use of M45 grade cement.

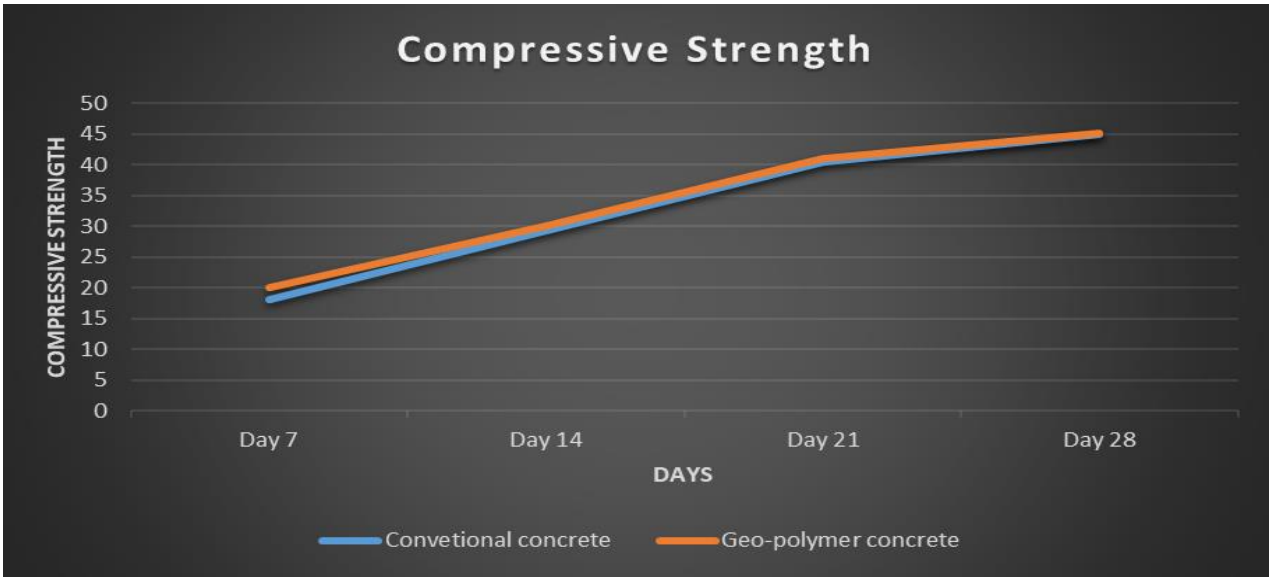
Formula:

$$\text{Compressive Strength of Concrete} = \frac{\text{Max Load Carried by Specimen}}{\text{Top Surface Area of Specimen}}$$

Compressive Strength Values

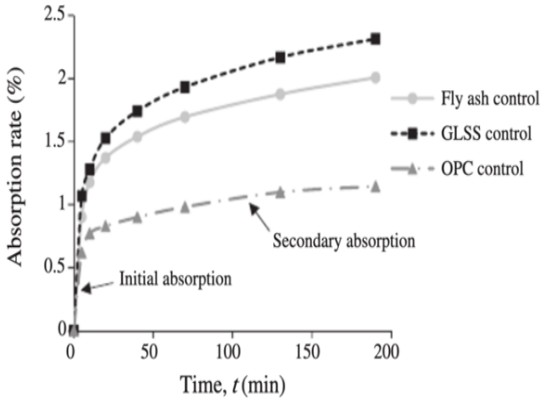
S.No	7 Days	14 Days	21 Days	28 Days
Conventional concrete	18	29.25	40.5	45
Geo-polymer concrete	20	30	41	45.13

Chart



Sorptivity, Porosity and Water absorption

Concrete type	f_cC (MPa)	E_c(MPa)	∂	Density (kg/m^3)	Water absorption (%)	AVPV (%)
Fly ash control	49.51	30093.02	0.00217	2463.87	3.51	8.64
Fly ash sodium chloride	47.37	29542.34	0.00241	2268.38	2.28	5.98
Fly ash sodium sulphate	42.88	27119.94	0.00203	2250.04	3.72	9.14
Fly ash sodium sulphate + magnesium sulphate	46.95	30278.87	0.00184	2183.67	3.37	8.63
Fly ash sulphuric acid	44.12	34572.66	0.00170	2169.28	3.42	8.77
GLSS control	34.20	28880.28	0.00171	2412.11	3.17	9.95
GLSS sodium chloride	32.78	29707.30	0.00173	2435.80	2.69	9.35
GLSS sodium sulphate	30.01	28028.48	0.00197	2413.90	3.38	9.71
GLSS sodium sulphate + magnesium sulphate	32.91	28146.79	0.00158	2452.80	3.00	9.14
GLSS sulphuric acid	31.72	29977.94	0.00170	2311.48	3.22	10.08
OPC control	71.06	42900.28	0.00192	2344.40	2.44	5.85
OPC sodium chloride	67.25	39962.53	0.00246	2340.11	0.94	2.61
OPC sodium sulphate	60.12	41319.13	0.00204	2342.23	2.16	6.92
OPC sulphuric acid	52.17	39698.47	0.00193	2326.58	2.93	9.31



CONCLUSION

- The colour of the geo-polymer concrete is light in colour and the surface is more smooth than normal conventional concrete.
- The compressive strength of the specimens are depends upon the curing temperature and method of curing influences.
- The compressive strength of the geo-polymer concrete can be increased by the addition of 40% of GGBS.
- There is no mix-design for the Geo-polymer concrete, so we have to look into many outcomes

of the test make by different cement at different ratio.

REFERENCE

[1] L.D. Wakely, T.S. Poole, J.J. Ernzen, B.D. Neeley, Salt saturated mass concrete under chemical attack, in: P. Zia (Ed.), High Performance Concrete in Severe Environments, Am. Concr. Inst., vol. SP-140, 1993, pp. 239–267.

[2] ASTM C 642–06, Standard test method for density, absorption, and voids in hardened concrete, ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428–2959, United States, 2008.

[3] ASTM C 1585–04, Standard test method for measurement of rate of absorbtion of water by hydraulic-cement concretes, ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428–2959, United States, 2007.

[4] AS 1012.9, Method of testing concrete - Determination of properties related to the consistency of concrete, Australian Standard: Methods of Testing Concrete,1999.

[5] AS 1012.10, Method of testing concrete - Determination of indirect tensile strength of concrete cylinders (Brazil or Splitting Test), Australian Standards, 2000.

[6] AS 1012.11, Method of testing concrete - Determination of the modulus of rupture, Australian Standards, 2000.

[7] Cheng, T. W. and J. P. Chiu (2003). "Fire-resistant Geo Polymer Produced by Granulated Blast Furnace Slag." Minerals Engineering 16(3): 205-210.

[8] Bakharev, T. (2005b). Geopolymeric materials prepared using Class F fly ash and elevated temperature curing. Cement and Concrete Research.

[9] ACI Committee 232 (2004). Use of Fly Ash in Concrete. Farmington Hills, Michigan, USA, American Concrete Institute: 41.

[10] American Society for Testing and Materials (2001). Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete. Philadelphia, USA: 4.

[11] In Concrete. Farmington Hills, Michigan, ACI Committee 232 (2004). Use of Fly Ash USA, American Concrete Institute: 41.

[12] Rangan, B.V., Hardiito, D., Wallah, S.E., & Sumajouw, D.M.J. (2005b). Studies of fly ash-based geopolymer concrete. Paper presented at the World Congress Geopolymer 2005, Saint-Quentin, France.