International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.04, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

INVESTIGATION OF MIXTURE OF FIBERS WITH FLY ASH BASED GEO-POLYMER CONCRETE

SANJEEV KUMAR[1], NAVEEN HOODA[2]

[1]M.Tech. Student (Civil), M.R.I.E.M. Rohtak, Haryana

[2]Asst. Professor, Dept. of Civil Engineering, M.R.I.E.M., Rohtak, Haryana

ABSTRACT

The usage of concrete is increasing very rapidly day by day for construction purpose. Ordinary Portland Concrete (OPC) is harmful for environment as it emits CO_2 and other harmful gases during its manufacturing. Alternative of OPC is needed to make environment friendly concrete which has better construction properties than OPC. So, this paper discussed about such alternatives like fly ash based geo polymer concrete. The main objective of the study is to obtain a better understanding of the mechanical properties of geo-polymer concrete, cured at room temperature. A significant number of mix variations were carried out to investigate the influence that the various parameters, present in the matrix, have on the compressive strength of the geo-polymer concrete based on fly ash / slag. Promising results were found, since concentrations as high as 72 MPa were obtained. The sodium hydroxide solution had the most significant influence on the elastic modulus of the geo-polymer concrete. The proportionality limit depended mainly on the compressive strength of the geo-polymer concrete, while the amount of fibers increased the energy absorption of the concrete. . From the knowledge obtained during this study, it can be concluded that the use of geo-polymer concrete based on fly ash / slag, as an alternative binder material, is still a long time away, as there are many complications that must be addressed, especially the low modulus of elasticity.

Keywords: Geo-polymer Concrete; Fly Ash; OPC; Binders.

1. INTRODUCTION

Across the globe, **usual Portland cement** was about 4 Gt in 2013 (Statista 2014). With the current average growth rate of the global community, OPC production levels will only increase, provide sufficient stocks to build infrastructure that will ensure that life is not enough. Just about 7% of the atmospheric heat products due to the production of OPC (Hardjito et al., 2004). The OPC carbon footprint is, on average, about 820 kg of CO2 per tonne manufactured (Motorwala et al., 2008).

French professor Joseph Davidovits coined the term Geo-polymer in 1978 [2].They are chains or arrangement of inorganic molecules connected using covalent bonds. Geo polymer is a new concept which replaces the Ordinary Portland Cement (OPC).Geo polymer is mainly dependent on the industrial products like fly ash or slag, silica, rice-husk, red mud etc. and natural products like meta kaolinite, clays in order to produce silicon (Si) and aluminium (Al)

[3][4]. Fly ash is a fine powder which is by product from burning of coal. Fly ash based geo polymer concrete is best substitute to the ordinary concrete as it is rich in silica and alumina, both these alumina and silica reacted with the alkaline solution in order to produce a gel type binder called "alumino-silicate gel". Fly ash based geo polymer concrete not only beneficial in reducing the green house gases effect but also reduce the excess requirement of water and that increases the life period and strength of the geo polymer concrete.

Geo-polymer concrete is well-known for auto-resistant, acoustic resistance and fire resistance, and therefore it is designed to build some of the features such as OPC. Geo-polymers generate about 80% of CO2 under OPC during production, making it a better environment for production (Saturday 2011, Alzeer and MacKenzie 2013).

As OPC information, there is a painful failure in the geo-polymer concrete which causes less conversion. There are two types of self-control for the purposes of standard metal validation. The metal iron enters the cabin to the trash and adds the evolution of the evolution. If not, the files can be added to improve worship gaps. The study of extracting mosquito and poly-propylene was being investigated in order to clear the concern of ash / geo-polymer slag. One way of research is used to combine body compilation. Geo-polymer Concrete Features are available to test on cubes, cylinder-and model models.

The material used, properties, application and limitations about fly ash based geo-polymer were discussed in the earlier sections of this paper. Comparison between fly ash based geo polymer concrete and ordinary concrete is also shown in this paper. In the last section of this paper future and the conclusion is also discussed.

2. BACKGROUND OF GEO-POLYMERS

In 1978, Prof. D. D. Jewel State Dwotot gave the introduction of another mining family that contains an unremarkably certifiable building known as Jupiter. It's an excellent shake vigorous that is made by alloys-siciate powder and dissolvable liquid. Inside the donning centers, the key target of investigation was to discover fireworks in Europe for a couple of sparklers. This examination incited the work of safe barges of voyage vessels and wood watercrafts, et cetera. Works with high efficiency and strong execution of fake intensifies, suppose, possibly alcoholized (process and L-2009) once the guideline focus is utilized as a locale of the work of potential solid, suppose, and bond.

3. TERMINOLOGY

"Geo-polymer", generally, is defined as solid and solid that combines aluminum sulfur and alkaline silicate alkalinelic sizes (Provis et al., 2009). Chemical selection of these polymers is based on silico-aluminates. Poly (sialate) is selected for use, with "sialate" as summary of silicon-oxo-aluminate (Davidovits 1989, Davidovits 1991). The poly (sialate) network contains Si4 + & Al3 + ions without competing, ion sharing ions and lines from hurricanes to crystals (Davidovits 1989, Sakulich 2011).

The poly (salate) formula is provided as follows:

Mn (-(SiO2) z–AlO2) n, wH2O

When "z" is important among 1 and 3 depending on the reaction chemistry, "M" is an alkali object used; "N" is a degree of polymerization and a "w" hydration degree (Sakulich 2011, Davidovits 1989).

Geo-polymer terminology Vs ordinary Portland cement terminology

Figure 1 shows OPC medicines (**Left) and geo-polymers (Right). The OPC is** difficult to use through the hydration process while geo-polymers make it difficult for the poly-condensation process. Figure 2.2 shows OPC medicines (Left) and geo-polymers (Right). The OPC is difficult to use through the hydration process while geo-polymers make it difficult for the poly-condensation process.

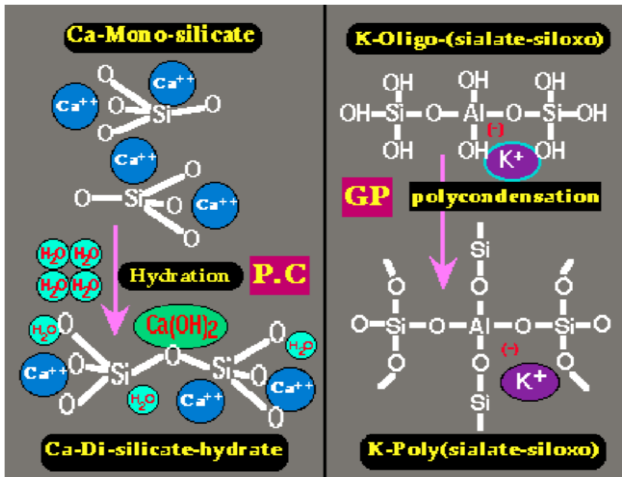

Fig.1 Portland cement and geo-polymer cement (2013)

High heat is encountered once the hydride is usually blasted (Dudeotot 2013). It ought to be noted that in Ca hemorrhoids, product solely permit tiny quantities of Ca. Hydraulic gel is inclined to work with bio-polymeric, wherever there's formally high levels of Ca.

4. WATER CONTENT IN THE MIXTURE

Water does not participate in the crystallization method, but instead the hidden measure of water in the mix impacts the execution of the land concrete. Lloyd et al. (2010) thought about the water substance of polymer-based solids in different mixes. For suddenness content, add sogginess to the hydroxide game plan, incorporate clamminess in the citrate course of action, and add additional water to the mix. The geo-polymer solids content is acknowledged to be the fly red hot flotsam and jetsam mass, the sodium hydroxide tablet mass and the sodium citrate quality. The weight nature of polymer strong decays as the degree of hard solids in the polymer (Lloyd and Rangan 2010) increases. Clamminess content moreover impacts the getting ready point of confinement of new land concrete

5. TYPES OF FIBERS

As specified over, the strands can be separated into microfibers and microfibers. These classes can be separated into various fiber materials. The kinds of filaments that can be utilized are as per the following (ACI 544, 1973).

- Glass
- Steel
- Synthetic
- Natural strands

The strands are delivered in various shapes and sizes (Figure 2), which impacts the holding qualities between the fiber and the solid network. The greatest bond length of a fiber is half of the full length of the fiber.

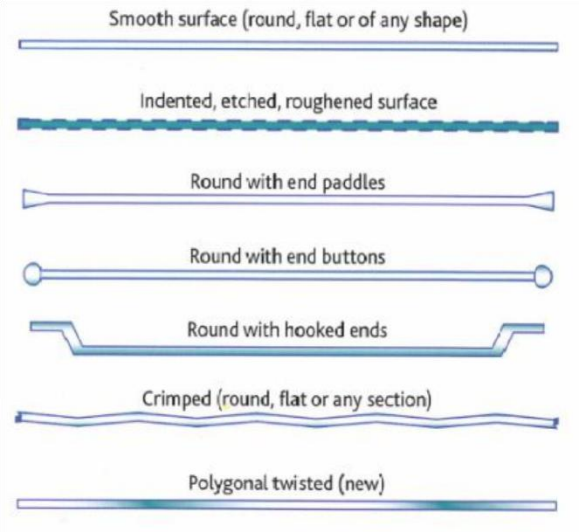

Fig 2 Type of fibers (Cement & Concrete Association of New Zealand 2009)

6. GEO-POLYMER CONCRETE MIXING PROCEDURES

Different solid blenders have been utilized, contingent upon the size and motivation behind the blend. All the blends, with the exception of those containing filaments, were completed in a 25 l skillet blender. The fiber strengthened geo-polymer concrete blends required a bigger volume blender and it was chosen to lease a 400 l drum blender from a neighborhood apparatus procuring organization. The blending time and system of all the blends were steady, beyond what many would consider possible, all through the blending time frame to guarantee consistency. All the dry materials were first combined before any fluid was included. The sand was included first took after by the folio (fly fiery remains and additionally slag) and after that the stone. The soluble arrangements and extra water were

added independently to the blend. A blending system of Hardjito et al. (2005) was utilized as a kind of perspective in this investigation. The correct blending systems are given in the accompanying areas.

WORKABILITY

The accessibility of geochemical concrete isn't an essential piece of this exploration. Be that as it may, to acquire data on the stream ability of unpredictable polymer concrete from fly fiery remains/slag cinder, an aggravation test with a breadth was done. As said over, all homogeneous solid blends have self-pressure properties.

7. GEO-POLYMER SOLID DROOP TEST

In light of the self-pressure nature, no weight is required on the penis if the cone is loaded with polymer concrete. Subsequent to refilling, lift the cone from the plate so the land cement can stream without blocking. After the stream of atomic cement ceased, the test was finished.

Measure one opposite to the greatest distance across and most extreme breadth to broaden the stream. The normal measurement of the breadth was.

8. PRESSURE TESTS

The compressive tests were done as per the SANS 5863:2006. Altogether, six 100x100x100 mm solid shapes were tried 7 days (three blocks) and 28 days (three 3D shapes) in the wake of throwing. The blocks were tried on the 200t Contest pressure testing machine (Figure 4.1) which was utilized to decide the most extreme heap of each solid shape. A steady load rate of 180 kN/m in was connected to the non-throwing sides of the solid shape until disappointment.

The greatest powers were utilized to compute the compressive quality of each 3D shape. The compressive quality is computed utilizing:

$$\boldsymbol{\sigma = \frac{F}{A}} \textbf{(4.1)}$$

Where σ- Compressive strength (MPa) F- Maximum force obtained from contest N

A - Surface area on which force is applied (mm^2)

The average compressive strength of the three cubes was taken as the compressive strength of a certain mix.

- % slag of the cover mass
- Sodium silicate to sodium hydroxide proportion: 2.5
- Sodium hydroxide fixation: 6 M

The reference blend configuration is appeared in Table 1

Table 1: Reference mix design for Phase (kg/2400kg)

Materials	(kg/2400kg)
Coarse aggregates	1177
Fine aggregates	505
Slag	187
Fly ash	278
Sodium silicate solution	183
Sodium hydroxide solution (6 Molar)	74

- Mix designs for modulus of elasticity tests

Keeping in mind the end goal to guarantee practically identical outcomes, just stage B blends were tried for versatile elastic tests. Different components were concentrated to examine the impact of unpredictable polymer concrete from fly fiery debris slag on hardness. Note that the physical structure of the blend is clarified, so we will just depict the parameters. A sum of 12 half and half outlines was utilized to decide the modulus of flexibility of polymer solid blends of slop and fly fiery remains. Three examples were tried and the normal versatile modulus of a few blended plans was taken.

9. RELATED WORK

Saravanan et al. proposed a scheme on the "Fly-ash Based Geo-polymer Concrete". In their work they show that binders could be formed by polymeric reaction of alkaline liquids with the silicon and the aluminum in the main materials like fly ash and rice husk ash and these binders are named as Geo- Polymer. Huge quantity of fly ash is generated by thermal power stations and a fraction of that fly ash can be used in concrete manufacturing. After several failure in the starting, the trial and error process doing well in outcome to look upon in manufacturing of geo-polymer concrete using fly ash. After this, different tests were carried out on hardened geo-polymer concrete to measure the effect of leading parameters that affect its properties.

Vora and Dave proposed on the "Compressive Strength of Geo-polymer Concrete" by casting different geo-polymer concrete mixes to calculate the effect of different factors disturbing the compressive strength of geo-polymer concrete in order to improve its in general performance. Different factor i.e. curing time, curing temperature, quantity of fly ash & alkaline liquid, proportion of sodium silicate to sodium hydroxide, rest period and water content in the mix have been examined. The ratio of alkaline fluid to fly ash, by mass does not influence the compressive strength of the geo-polymer concrete. Test results obtained by them shows that the compressive strength of the geo-polymer concrete increases by increasing the curative time. Though, beyond 24 hours the strength does not increases much. Compressive strength of the geo-polymer concrete reduced as the ratio of water increases to geo-polymer solids by mass. As curing temperature gone high in between 60^0C to 90^0C, the compressive strength of the geo-polymer concrete also increases. With the addition of super plasticizer to the

concrete mix up to 4% of fly ash by mass, the workability of the geo-polymer concrete mix increases. Research work observed by the author's shows that, a wide range of factors are there that can affect the compressive strength of the geo-polymer concrete.

Lloyd and Rangan give short information of fly ash-based geo-polymer concrete. It shows that concrete of geo-polymer mix is compatible to produce precast concrete products used for rehabilitation of structures after a disaster. The author's research is targeting in the workability of geo-polymer in violent soil conditions and marine surroundings.

Chokkalingam et al. carried out research on strength development of geo-polymer concrete with fly ash. In their study, low calcium fly ash was used to made geo-polymer concrete. The geo-polymer mix combined with sodium silicate and sodium hydroxide solutions. In it concentration of sodium hydroxide mixture is 12 Molarity (12M).

10. RESULTS

In this part, the consequences of the considerable number of tests depicted are accounted for. This incorporates mach inability, compressive quality, modulus of flexibility, three point twisting test, round board test, single fiber extraction test, set time test, and temperature test. All tests were done at the predetermined age except if generally expressed.

11. CONCLUSION & FUTURE WORK

Geo-polymer concrete can be used in user-friendly environment same as workable for normal port land concrete. Fly ash-based geo polymer has better characteristics as compared to Ordinary Portland Concrete (OPC) like compressive strength, exposure to destructive atmosphere, workability and exposure to elevated heat. As having the better early strength, Geo-polymer Concrete can be efficiently used for precast manufacturing, by that massive production can be obtained in small period and its breakdown can also be reduced during transportation.

In India there have been different sources of fly ash which have different chemical and physical properties which increases strength and other properties of geo-polymer concrete. Source of fly-ash will also help in achieving a better mixture design procedure for geo-polymer concrete. Thermal properties of geo polymer concrete, mortar, paste and other fields to be explored for future work. For measuring fire endurance capacity of geo polymer concrete fire test can be conducted on fly ash based geo-polymer concrete beams.

REFERENCES

[1]. Al Bakri, Mohd Mustafa, H. Mohammed, H. Kamarudin, I. Khairul Niza, and Y. Zarina, "Review on fly ash-based geopolymer concrete without Portland Cement," *Journalof engineering and technology research* 3,vol. 1, pp. 1-4, 2011.

[2]. Davidovits, Joseph., "Geopolymers: inorganic polymeric newmaterials," *Journal of Thermal Analysis andcalorimetry* 37, vol. 8, pp.1633-1656, 1991.

[3]. Saravanan, G., C. A. Jeyasehar, and S. Kandasamy, "Flyash Based Geopolymer Concrete-A State of the Art Review." *Journal of Engineering Science &Technology Review* 6, vol.1, 2013.

[4]. NS Tung, V Kamboj, A Bhardwaj, "Unit commitment dynamics-an introduction", International Journal of Computer Science & Information Technology Research Excellence, Volume 2, Issue 1, Pages 70-74, 2012.

[5]. Aleem, MI Abdul and P. D. Arumairaj, "Geopolymer concrete-A review," International *journal of engineering sciences& emerging technologies* 1, vol. 2, pp.118-22, 2012.

[6]. Ryno, Barnard. "Mechanical properties of fly ash/slag based geopolymer concrete with the addition of macro fibres," PhD diss., Stellenbosch: Stellenbosch University, 2014.

[7]. Preet Khandelwal, Surya Prakash Ahirwar, Amit Bhardwaj, Image Processing Based Quality Analyzer and Controller, International Journal of Enhanced Research in Science Technology & Engineering, Volume 2, Issue 7, 2013.

[8]. Wallah, Steenie, and B. Vijaya Rangan, "Low-calcium fly ash-based geopolymer concrete: Long-term properties," 2006.

[9]. Hardjito, Djwantoro, and B. Vijaya Rangan, "Development and properties of low-calcium fly ash-based geopolymer concrete." , 2005.

[10]. Hardjito, D., S. E. Wallah, D. M. J. Sumajouw, and B. V. Ranga. "Introducing fly ash-based geopolymer concrete: manufacture and engineering properties," In *30th Conference on our World inConcrete and Structures*, pp. 23-4, 2005.

[11]. VK Kamboj, A Bhardwaj, HS Bhullar, K Arora, K Kaur, Mathematical model of reliability assessment for generation system, Power Engineering and Optimization Conference (PEDCO) Melaka, Malaysia, 2012 IEEE.

[12]. Joseph, Benny, and George Mathew, "Influence of aggregate content on the behavior of fly ash based geopolymer concrete," *Scientia Iranica* 19, vol. 5, pp. 1188-1194, 2012.

[13]. Bernal, S., De Gutierrez, R., Delvasto, S. & Rodriguez, E. 2010. Performance of an Alkali-Activated Slag Concrete Reinforced with Steel Fibers. *Construction and Building Materials,* 24(2).

[14]. Bernard, E.S. &Pircher, M. 2000. *Influence of geometry on performance of round determinate panels made with fiber reinforced concrete*. University of Western Sydney, Nepean, School of Civic Engineering and Environment.