Physical Properties of Geopolymer Concrete Incorporating Silica Fume and Ground Granulated Blast-Furnace Slag

Ahmed Mohmed Ahmed

Acharya nagarjuna university, Guntur, Civil Engineering Department

Abstract: ***This research presents new matrixes geo-polymer concrete, cementing mainly on engineering properties discusses the physical properties. In addition, the study of polymer concrete on two productions. GEO-polymer concrete GGBS and SF was created. Alkaline solution were used in this study. They are sodium hydroxide, sodium silicate solution and superplasticizer. 150 mm x 150 mm x 150 mm sample cube with a size of compressive strength were put to the test. GGBS concrete compressive strength of geo-polymer age 7, 14 and 28 days were 54.17, 66 and 69 on the MPa. And compressive strength of polymer concrete SF ground tests at the age of 7, 14 and 28 days were 1.45 1.42 1.45, and the MPa. GGBS concrete geo-polymer curing time at all compressive strength showed improved results. But geopolymer concrete compressive strength of SF given. In addition, 7 and 28 days old, low permeability and GGBS was made of geopolymer concrete were tested when absorption shown.***

Keywords: Geopolymer Concrete, Silica Fume, Ground Granulated Blast, Furnace Slag.

1. Introduction

1.1 Background

Global warming due to climate change has become a major concern. Global warming is carbon dioxide (CO2) in the atmosphere by human activities such as is caused by emissions of greenhouse gases. Between greenhouses gases CO2 global warming (McCaughey, 2002) contributes about 65%. A ton of Portland cement in the production environment (Davidovits, 1994; almost a ton of CO2 emissions because some cement industry CO2 emissions is attributed to McCaughey, 2002).

Several attempts to use in Portland cement concrete progress in global address are issues to reduce warming. Such as fly ash (FA), Silica fume (SF), ground granulated blast furnace slag (GGBS), rice-husk ash and optional for Portland cement binders and kaolin as these are supplementary cementing materials include the use of.

On the other hand, inorganic waste materials such as sand, dust and glass and many are available coal ash inosilicate synthetically alum, iron-containing waste and phosphor gypsum as in some countries. Some applications of inorganic waste disposal materials are a major environmental problem. Inorganic waste materials to make use of these applications will be beneficial to the environment.

The world and the rapid increase in the population in economic growth in energy demand has led to an increase. Worldwide, coal reserves the most stable and available source of fossil energy. The use of coal as an energy source, however, coal ash (an alum inosilicate content) as the production of large amounts of waste material is included. It is estimated that more than 300 billion tons coal fly-ash are produced annually (Coccus et al, 1999). The lower rate of recurrence of ashes (Kikuchi, 1999).

Environmentally friendly to produce concrete, Mehta (2002) natural resources, low energy, suggested use and minimize carbon dioxide emissions. He attempts to these short-term "industrial ecology" as classified. To reduce the impact of unintended by-industry's long-term goal to reduce the rate of consumption of goods can be achieved by. Similarly, McCaffrey (2002) suggested that the cement industries the amount of carbon dioxide (CO2) emissions by reducing the amount of concrete, cement and cement to reduce the number of buildings by using cement, claimed in cargo volume can be minimized.

In this regard, the proposed application of geopolymer Davidovits (1988) to promise concrete industry in Portland cement (Dixson et al, 2007) as an alternative to binder shows. In terms of global warming, the detailed analysis of geopolymer quite Gartner (2004) as shown by cement industries due to atmospheric CO2 emissions can be reduced.

There are many detrimental effects on the environment by products that have and they have the same properties as OPC. FA and coal waste which are commonly referred to by the energy industry, waste coal series products. FA about 200 million tones and an annual 200 million tons of coal waste are produced in China. Chinese thermal power industry and coal mining, with rapid growth in the volume of industrial wastes will go continuously. GGBS is a byproduct as it is produced during extraction of iron from ore. SF, Containing silica, silicone or silicone-or micro-alloys produced by the production of a product by itself. SF is an amorphous solid high silica content (Voigt and others, 2004) with.

1.2 Statement of Problem

Currently, the world's annual output about 1.6 billion tones or OPC (Mehta, p, 2001-Malhotra, V. M, 2002) carbon dioxide in the atmosphere is about 7% of global loading. By

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the year 2010, the global cement consumption 2 billion tones, meaning that around 2 billion tons of CO2 will be released in the atmosphere is expected to reach.

Considering how geopolymer concrete to FA, SF and to add contents such as by-products GGBS is important research on geopolymer concrete mix SF and GGBS intend to study. This compressive strength and workability, permeability geopolymer concrete initial surface absorption test (ISAT) is aimed at by the use of the test. Finally, the study holds a codification and to draw conclusions from the test results.

1.3 Objectives

1. To determine the workability of fresh geopolymer concrete by using local materials.
2. To determine the effect of SF and GGBS to compression strength in the geopolymer concrete.
3. To test concrete mix for compressive strength and determine the permeability by ISAT.

1.4 Scope of Study

This study focuses on the strength and permeability of concrete geopolymer made SF and GGBS. Since the first idea-action in structural design structural elements should be able to carry the load imposed is the most important property of concrete strength. Strength attribute is also important because it is more difficult to directly measure the many other important properties which relate to.

Regarding this matter, geopolymer concrete was SF and GGBS. Geopolymer concrete tests are performed on samples of the concrete specific age. All the power test at the age of 7, 14 and 28 days are limited.

2. Literature Review

In 1978, the term "polycondense" to convert, and "Geopolymer polymer" (Davidovits, 1991) at low temperatures like fast with the ability to adapt to any shape new content features, Davidovits was created. The fact that geopolymeric based concrete has a very long service life, those metals waste encapsulation and OPC low CO2 emissions, 0.18 ton cement (Davidovits, 2002) of CO2 based geopolymeric Davidovits cementations systems due to many advantages related to the environment, primarily Reported. High alkaline conditions under silicate with different alumina-silicate oxides, including a chemical reaction to produce polymer Geopolymerisation Si-Al-O-Si-O bond indicating that only Al can become the source of Geopolymerisation goods. He is a pioneer in which silicon and aluminum from the ashes of an amorphous phase power stations or mining and quarrying waste held in an important quantity is required.

Soil chemical analysis shows that it is in the concrete an alumina and silicate binder can be used as if it is blended by the catalyst solution, such as are material. Geopolymer concrete is solid without known as OPC. The solid is usually FA uses as a base material. Research has shown that performs high compressive strength geopolymer concrete and ordinary concrete to produce even greater durability. The geopolymer excellent mechanical properties, as well as fire and acid resistance (Cheng et al., 2003 and Yodmunee, 2006) is also well known.

In this regard, for the application of geopolymer concrete industry as a promising alternative Binder OPC (Dixson et al, 2007) to shows. In terms of global warming, the detailed analysis of geopolymer quite Gartner (2004) as shown by cement industries due to atmospheric CO2 emissions can be reduced.

According to Davidovits (1994), automobile and aerospace geopolymeric materials, non-ferrous foundries and metallurgical, civil engineering and plastics industries such as a wide range of applications in various industries. Type of application of Geopolymeric materials in terms of nuclear proportions SI chemical composition is determined by: Al polysialate in.

Geopolymer binders a promising alternative to acid-resistant concrete may develop. Geopolymer are a novel binder that Alumina-silicate depends on structural integrity rather than calcium silicate hydrate since to bonds, they have been acid-resistant (Davidovits, 1994) as being reported.

This in essence chemistry and molecular structure according to Davidovits (1999) discusses the geopolymer is worth. Geopolymer alum inosilicates words poly (isolate) are nominated by based on. The term isolate abbreviations as Silicon-Oxo-aluminate is used for. Different network which means a still hypothetical monomer as a result of condensation of Orthosialate can be considered; (OH) 3-Si-Al-O-(OH) 3 or tetrahedral SiO4 and AlO4 ion connected alternatively to share by oxygen. Positive Ions (Na +, K +, Ca ++, mg ++, NH4 +, H3O +, + Ba) Al-negative charge 4 or 6-fold coordination framework for balance must exist in the cavities. Poly (sialate-siloxo) in the formation of a number of polysialate, including Orthosialate Si (OH) 4 condensation of silicic acid with results, i.e. a geopolymer three basic forms (Davidovits, 1999) can take one:
- Poly (isolate), which is [-Si-Al-O-o-] repeating unit.
- Poly (sialate-siloxo), which is [-Si-O-Si-Al-O-O-] repeating unit.

Poly (sialate-siloxo), which is [-Si-O-Si-O-Si-Al-O-O-] repeating unit.

3. Mix Proportions of Geopolmer Concrete

- Primary difference between concrete and OPC Geopolymer binder. Silicon and aluminum oxides in low-calcium FA that loose coarse aggregate, fine aggregate, and with a geopolymer concrete as other United Nations reacted breakwater to create alkaline liquid paste geopolymer materials react with it.
- In the case of the OPC, coarse and fine aggregates geopolymer concrete to capture approximately 75-80% of the mass. Geopolymer concrete mix for this component of OPC equipment currently available can be made using the. Compressive strength geopolymer concrete proportion and workability components and materials that are influenced by the properties of geopolymer paste. Experimental results (Hardhat and Ranjan, 2005) is shown below:

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- Sodium hydroxide solution at high concentration (molar) compressive strength geopolymer concrete in terms of this results in higher.
- High sodium hydroxide solution sodium silicate solution to higher compressive strength geopolymer concrete collective led by ratio.
- Naphthalene sulphonate-based superplasticizer by approximately 4% of the mass in addition to the FA by fresh increases the workability of geopolymer concrete; However, a slight decline of compressive strength concrete hardened when more than 2% superplasticizer dose.
- When the water content increases mixing • fresh geopolymer concrete slump price rises.
- Na2O H2O molar ratio increases to as e.g. concrete compressive strength geopolymer-• the decreases.

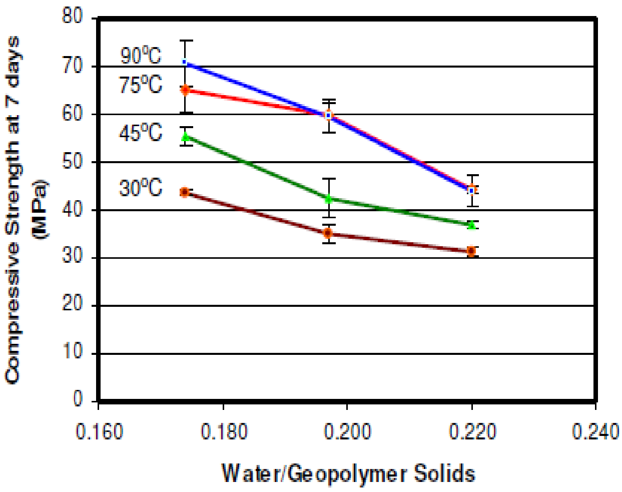

Figure 3.1: Effect of Water-to-Geopolymer Solids Ratio by Mass on Compressive Strength of Geopolymer Concrete (Hardhat and Ranjan, 2005)

Figure 3.1 effect of compressive strength geopolymer solids to water proportion and workability of geopolymer concrete by mass on the shows. Test samples at various temperatures in the oven were recovering heat for 24 hours. The results of these tests plotted in Figure 3.1 show geopolymer concrete compressive strength geopolymer solids ratio by mass increases as water (Hardhat and Ranjan, 2005) is reduced. This tendency of Portland cement concrete compressive strength test on the water to cement ratio is analogous to the well-known effect. Of course, the increased proportion of solids geopolymer as more water mixture contained increased workability.

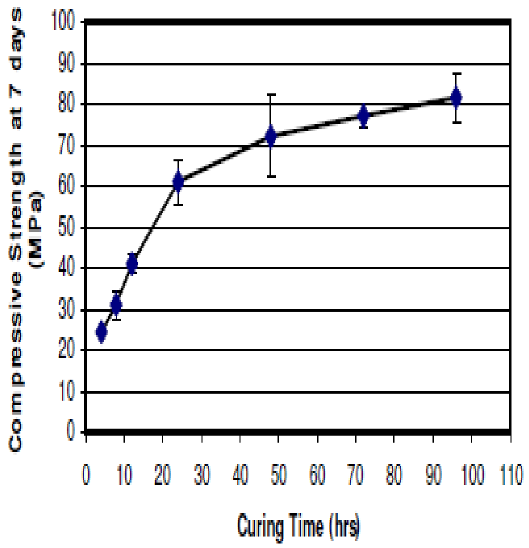

Figure 3.2: Effect of Curing Time on Compressive Strength of Geopolymer Concrete (Hardhat and Ranjan, 2005)

Figure 3.2 effects of compressive strength geopolymer of curing time on solid shows. Test samples heat in an oven at 60oC were recovering. Curing time 4 hours from 96 hours (4 days) different. Now the power of curing time, resulting in higher compressive Polym-origination process has improved. Rate of increase in treatment time was up for 24 hours of rapid; Beyond 24 hours, only medium (Hardhat and Ranjan, 2005) is in power. Therefore, time heat treated practical applications must not exceed 24 hours.

4. Results and Discussion

In this chapter, containing different materials of different geopolymer concrete mixes will be discussed with all of the power. According to the methods described in Chapter 3 all tests were carried out. Discussion according to the objectives stated in the first part three will be subdivided into sections. Then, the results will be discussed accordingly found.

Result of the Study

The following tables show the result of the tests which have carried in the laboratory.

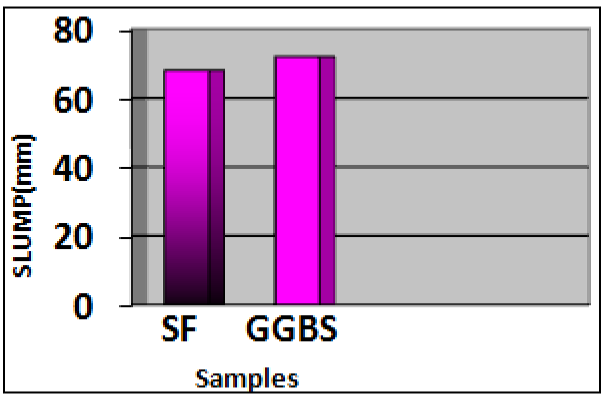

Figure 3.1: Comparisons between SF and GGBS

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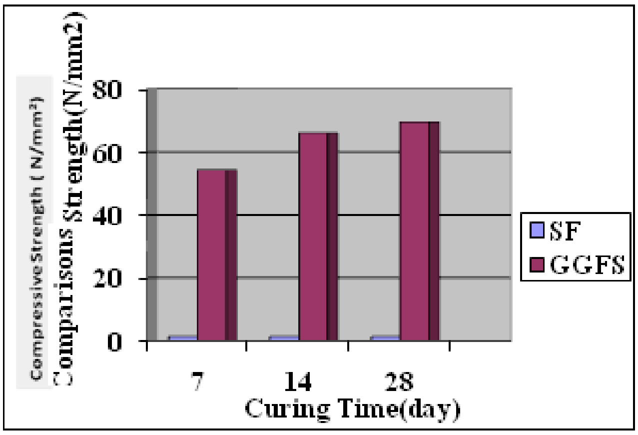

Figure 3.2: Comparisons between the Cubes Strength at ages 7, 14 and 28 Days

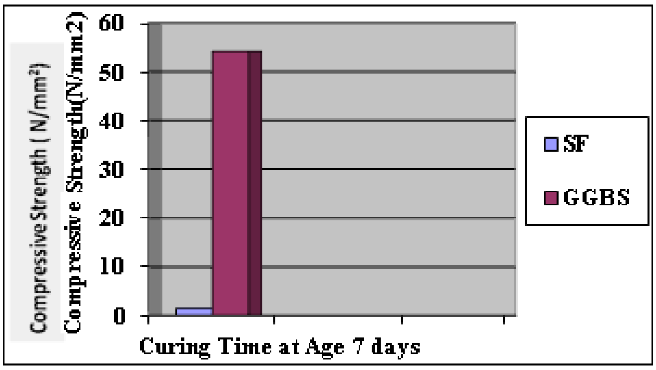

Figure 3.3: Relationship between the Cubes Strength at Age 7 Days

5. Conclusion and Future Work

Present study this chapter, key findings and became the geopolymer concrete GGBS and SF presents a summary of economic benefits.

In this study, an inquiry geopolymer concrete, By Joe product materials (GGBS and SF) and by a reaction between alkaline liquid set was produced with the presence of physical properties of was to determine. GGBS and SF as source material were used to create geopolymer concrete. Sodium silicate solution and sodium hydroxide solution were mixed together as alkaline liquid. Silicon and aluminum in alkaline liquid GGBS and SF loose aggregates and concrete arrived to produce other materials bound geopolymer paste form Reacted with. Aggregates sand and 7 mm, 10 mm and 14 mm granite-type as coarse aggregate. In addition, to improve the workability of the concrete fresh geopolymer superplasticizer was used.

The SF and contained two of geopolymer concrete measurable GGBS cubes 7, 14 and 28 days old, were tested. The behavior of the geopolymer concrete results was aimed to figure out. In addition, geopolymer concrete strength and durability were also tested. Tests results are shown in Chapter 4 that increases strength geopolymer GGBS concrete with age, but SF 7 to 28 days of age were found in the results. The result, the compressive strength geopolymer concrete made of GGBS in 7-14 days and 14-28 days of age at 3 to increase about 12 MPa.

SF incorporation of geopolymer concrete mixes the finer pore structure in low permeability produced concrete as follows as a result. GGBS cement a supplementary material as characteristics of pore structure using improved when appropriate water was treated. Longer treatment durations result in finer pore structure and permeability. This and this has been confirmed and is discussed in Chapter 4 where geopolymer concrete GGBS used SF more than is sustainable. It has also been seen in term of high strength high performance concrete that can be used for important marine structures and stability such as structured. The most important requirements of concrete permeability good one. The study of geopolymer concrete also GGFS SF and permeability test to study is conducted. It was found that low permeability.

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