International Journal of Advance Research in Science and Engineering
Vol. No. 5, Special Issue No. 01 , May 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

EFFECT OF MOLARITY ON GEOPOLYMER CONCRETE

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ABSTRACT

This paper presents the details of the studies carried out on development of strength for various grades of geo-polymer concrete with varying molarity. The alkaline liquids used in this study for the geo-polymerization are sodium hydroxide (NaoH) and sodium silicate (Na_2SiO_3). Different molarities of sodium hydroxide solution (1M to 16M) are taken to prepare different mixtures. The test specimens were 150 x 150 x 150 mm cubes. The geo-polymer concrete specimens are tested for their compressive strength at the age of 7 and 28 days. GPC mix formulations with compressive strength ranging from 15 to 52MPa have been developed. Experimental investigations have been carried out on workability, the various mechanical properties of GPCs. The test results indicate that the combination of fly ash and alkaline solution can be used for development of geo-polymer concrete.

I INTRODUCTION

The Cement production generated carbon dioxide, which pollutes the atmosphere. The Thermal Industry produces a waste called fly ash which is simply dumped on the earth, occupies larges areas. The waste water from the Chemical Industries is discharged into the ground which contaminates ground water. By producing Geo-polymer Concrete all the above mentioned issues shall be solved by rearranging them. Waste Fly Ash from Thermal Industry + Waste water from Chemical Refineries = Geo polymer concrete. Since Geo-polymer concrete doesn't use any cement, the production of cement shall be reduced and hence the pollution of atmosphere by the emission of carbon dioxide shall also be minimized as per B. Vijaya Rangan [6].

Every year the production of Portland cement is increasing with the increasing demand of construction. Therefore the rate of production of carbon dioxide released to the atmosphere is also increasing. Each ton of Portland cement releases a ton of carbon dioxide into the atmosphere. The greenhouse gas emission from the production of Portland cement is about 1.35 billion tons annually, which is about 7% of the total greenhouse gas emission. On the other side, fly ash is the waste material of coal based thermal power plant, available abundantly but pose disposal problem. Several hectors of valuable land is acquired by thermal power plant for the disposal of fly ash. As it is light in weight and easily flies, creates severe health problems like asthma, bronchitis, etc as per M. Neville, "Properties of Concrete [14]

Geo-polymer is a new Material in the world of concrete in which cement is totally replaced by pozzolanic material (Fly ash) that is rich in silica and alumina and activated by alkaline liquids to act as a binder in the concrete. The demand of concrete is increasing day by day to complete the need of development of infrastructure facilities. It is well known fact

that the production of OPC not only consumes significant amount of natural resources and energy but also releases huge quantity of carbon dioxide to the atmosphere. Therefore, it is necessary to find alternatives to make the concrete environment friendly with consideration of natural resources and atmospheric pollution. The type of strength are given as per Nguyen Van Chah [12]

II RESEARCH REVIEW

Research conducted by Fernandez-Jimenez, et al. [1] on the effects of alkaline solution on the final product of geopolymer has shown that a combination of sodium hydroxide and sodium silicate produced a solid material almost without pores and has a strong bond between aggregate and geopolymer matrix.

In a research study conducted by Hardjito et al. [2] on geopolymer concrete manufactured from low-calcium fly ash activated with sodium silicate and sodium hydroxide solution, the authors have reported higher compressive strength and better durability of geopolymer concrete compared to Portland cement concrete. They have demonstrated that a combination of sodium hydroxide and sodium silicate solutions can be a good application for activator in fly ash-based geopolymer concrete.

Concentration of sodium hydroxide is the most important factor for geopolymer synthesis [3]. The solubility of aluminosilicate increases with increase in hydroxide concentration [4]. The use of higher concentration of sodium hydroxide yield higher compressive strength of geopolymer concrete [5].

B. Vijaya Rangan(6) conducted study on the effects of sodium hydroxide concentration on the compressive strength of fly ash-based geopolymer mortar. The authors have reported that alkaline concentration was proportionate to the compressive strength of geopolymer mortar. They have claimed that higher concentration of sodium hydroxide solution result in a higher compressive strength of geopolymer mortar.

In their study on synthesis and mechanical properties of metakaolinite-based geo-polymer have reported that higher concentration of sodium hydroxide solution provides better dissolving ability to metakaolinite and produces more reactive bond for the monomer, consequently increase inter-molecular bonding strength of the geo-polymer [7].

As per Davidovits. J., (1991) Dissolution occurs immediately upon contact between the alkaline solution and the pozzolanic material and allows for ionic interface between species and the breaking of covalent bonds between silicon, aluminum and oxygen atoms. Similarly to PCC, this process generates rapid and intense heat and is directly proportional to the pH level of the activating solution. The rate of dissolution is relevant to the amount and composition of the ashes and the pH of the activating solution [8].

III FINALIZATION OF PARAMETER

In our research we get the Percentage replacement of cement by fly ash: 100%. ,we decided to add the solution for binding and polymerisation purpose. According to studying of previous papers which was published by the journal other on geopolymer concrete they use sodium silicate for polymerisation purpose so, we use that solution. After solve the polymerisation issue the strength is important factor because all the appearance of concrete is mainly depends on that so, we get the ideas from various papers which is mainly based on geopolymer concrete strength.

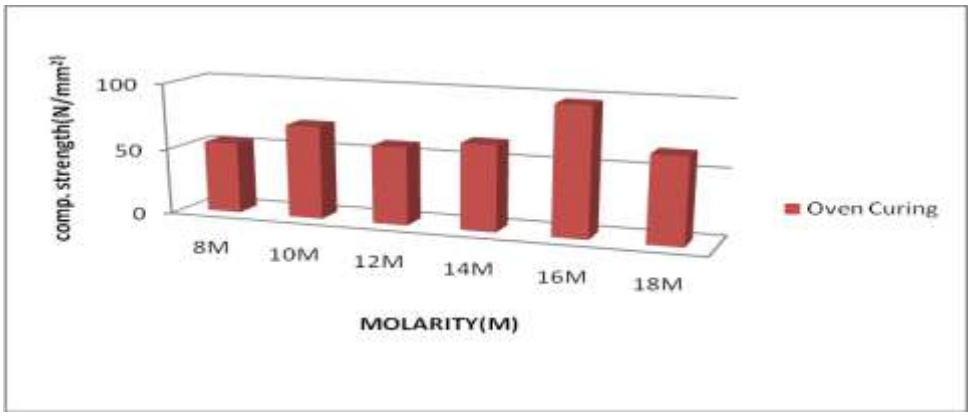
According to that we used sodium hydroxide for strength purpose of concrete. The solution ratio is used for concrete is 2.5. The strength of concrete is mainly depends on water cement ratio of concrete so, w/c ratio is inversely proportional to strength of concrete. If W/C ratio is minimum then compressive strength of concrete is more. If W/C ratio is maximum then comp. strength is low.

We take the W/C ratio is 0.35 according to IS provision. After casting the cube then it is put in oven for oven curing about 24hrs. at the temperature of 80 c. Molarity is taken for testing the concrete is varies between 8M,10M,12M,14M,16M and 18M. and each molarity 3 cubes are casting for test accrding to that 16M results is better than other molar so, we decided the work is carried out on 16M.

IV SYSTEM DEVELOPMENT

In this study, The geopolymer concrete is made up of using fly ash, fine aggregate, Coarse aggregate and alkaline liquid. The alkaline liquids are Sodium hydroxide (NAOH) and Sodium Silicate (Na_2Sio_3). The sodium silicate to sodium hydroxide ratio used is 2.5 and the solution to fly ash ratio is 0.35. For preparing 8,10,12,14,16 Mole solution of Sodium Hydroxide in one liter solution the following steps to be adopted. For preparation of 1M solution there is requirement of 40 gms sodium hydroxide pellets in solid form. While we mix 40 gms pellets in one liter solution then we get 1M sodium hydroxide solution. The heat evaluation rate is so high at the time of mixing pellets into water. Due to Sodium hydroxide solution was prepared one day prior to the casting of concrete cubes to avoid any contamination during the mixing of ingredients of geopolymer concrete. Similarly, we prepare 8,10,12,14,16,18 M solution for geopolymer concrete by adding 8 x 40=320, 10 x 40=400, 12 x 40=480, 14 x 40=560, 16 x 40 = 640, 18 x 40 = 720 gms sodium pellets then we get 8,10,12,14,16,18 M one liter sodium hydroxide solution. Then all ingredients of concrete were thoroughly mixed in concrete mixer. Then, required quantity of Sodium Hydroxide solution and sodium silicate solution with proper proportion was added and mixed until homogeneous mix was formed. After making the homogeneous mix, workability test by slump cone and compaction factor is determined. Then, cubes of size 150 mm X 150 mm X 150 mm were cast in three layers as per standard process. Then after demoulding of cube these cube placed for curing of geopolymer concrete. The various methods are adopted for Oven Curing at temperatures like 80^0C. These cubes were placed at room temperature after curing up to the testing age. The testing age for cube will be assumed as 7 day which was fixed from past literature review. The effect of temperature and types of curing on geopolymer concrete are as follows.

Fig. 1 Compression testing of sample in digital compression testing maching



Graph 1 molarity Vs Comp. strength

V RESULT AND DISCUSSION

Graph shows the effect of molarity on geopolymer concrete and curing on geopolymer concrete. In oven heat curing the temperature for curing is 80 ^{0} C. The effect of molarity on geopolymer concrete varies from 8M to 18M. it will show the optimum result at 16M. Also in effect of molarity on geopolymer concrete varies from 8M to 16M the minimum result we get at 8M.

VI CONCLUSION

- Geopolymer concrete which is manufactured by the polymeric reaction of fly ash and alkali activated solution is used for this experiment. The study of influence of molarity on compressive strength of geopolymer mortar have revealed as listed below-
- It has been observed that as the molarity increases, compressive strength increases.
- Molarity also affects the velocity. The velocity increases with increase in molar concentration.
- The compressive strength and velocity are dependent, i.e. as the compressive strength increases the velocity also increases or as the velocity increases the compressive strength increases. The Geopolymer binder may be treated as future environment friendly alternative to Portland cement in certain industrial applications.
- It has been observed that the fly ash to solution ratio decreases, compressive strength increases.

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