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"A Characteristic Study of Light Weight Geopolymer Concrete"

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Abstract -

The main objective of this work is to make light weight Geopolymer cementious material. The Alkaline liquids such as sodium hydroxide (NaoH) and sodium silicate (Na2Sio3) are used for polymerization process. Cubes were cast for different mix proportions/molarities and the cube specimens are tested for their compressive strength, density. The result shows that light weight Geopolymer concrete cubes gains strength within 24 hours without water curing at ambient temperature. Also the strength of Geopolymer concrete was increased with decrease in molarity of the solution in a mix.

Key Words: Geopolymer concrete, fly ash, aluminum powder, activated solution etc.

1. INTRODUCTION

The term Geopolymer was defined by Davidovits in 1978 to represent a broad range of materials characterized by chains of inorganic molecules (Geopolymer Institute 2010). [4,15,16,17] The fly ash or slag is used to provide a source of silicon (Si) and aluminum (Al), which is dissolved in an alkaline activating solution which polymerizes into molecular chains and networks to create the hardened binder.

The major problem that the world is facing today is the environmental pollution. In the construction industry mainly the production of ordinary Portland cement (OPC) will cause the emission of pollutants which results in environmental pollution. The emission of carbon dioxide during the production of ordinary Portland cement is tremendous because the production of one ton of Portland cement emits approximately one ton of CO2 into the atmosphere. [1,18] The Geopolymer technology is an alternative to application in concrete industry.[2,19] The Geopolymer concrete has two limitations such as the delay in setting time and the necessity of heat curing to gain strength. The work aims to study the compressive strength characteristics quality of Geopolymer concrete using fly ash and Aluminum powder which can produce at ambient temperature conditions without water curing.

2. MATERIAL USED

2.1Fly ash:

Fly ash is one of the most abundant materials on the Earth. It is also a crucial ingredient in the creation of Geopolymer concrete due to its role in the Geopolymerization process. A pozzolana is a material that exhibits cementations properties when combined with calcium hydroxide. Fly ash is the main by product created from the combustion of coal in coal-fired power plants. There are two "classes" of fly ash, Class F and Class C. Each class of fly ash has its own unique properties. The chemical composition of fly ash are shown in the table no.1 [1, 3]

Table 1: Chemical Composition of Fly Ash

OXIDES	Sio_2	Al_2O_3	Fe_2O_3	CaO	K_2O	Na_2O	MgO	SO_3	LOI	SiO_2/Al_2O_3
%	52.0	33.9	4.0	1.2	0.83	0.27	0.81	0.28	6.2	1.5

2.2 Chemicals:

2.2.1. Sodium Hydroxide- The sodium hydroxide solids of a laboratory grade in pellets form with 99% purity, obtained from local suppliers. The sodium hydroxide (NaOH) solution was prepared by dissolving the pellets (a small, rounded, compressed mass of a substance of sodium hydroxide) in water. The mass of sodium hydroxide solids in a solution varied depending on the concentration of the solution expressed in terms of molar, M.

2.2.2 Sodium Silicate- Sodium silicate solution (water glass) obtained from local suppliers was used. The chemical composition of the sodium silicate solution was Na2O=8%, SiO2=28%, and water 64% by mass. The mixture of sodium silicate solution and sodium hydroxide solution forms the alkali liquid.

2.3 Preparation of alkaline solution: As there are no code provisions for the mix design of Geopolymer concrete, in order to produce a desirable strength in lightweight Geopolymer concrete, a trial and error process is commonly used. We adopt various mix proportions for with different proportion of the solutions for different molarities. [2M,3M,4M,5M,8M etc.]

Depending on the concentration of sodium hydroxide solution required, flakes of sodium hydroxide were added in a litter of distilled water instead of preparing one- litter solution. Then molarity was found from the laboratory measurements.

For example, 3 M sodium hydroxide solution consists of 3 × 40 = 120 grams of NaOH solids per liter of solution. But instead of that, 120 gm sodium hydroxide flakes were added in a litter of distilled water. So the total volume of solution was 1.030 litters. The solid contained in a litter of sodium hydroxide solution was estimated as (120/1030) × 1000 = 116.40 gm. Therefore the molarity of solution is (116.40/40) = 2.91 M instead of 3 M. [2]

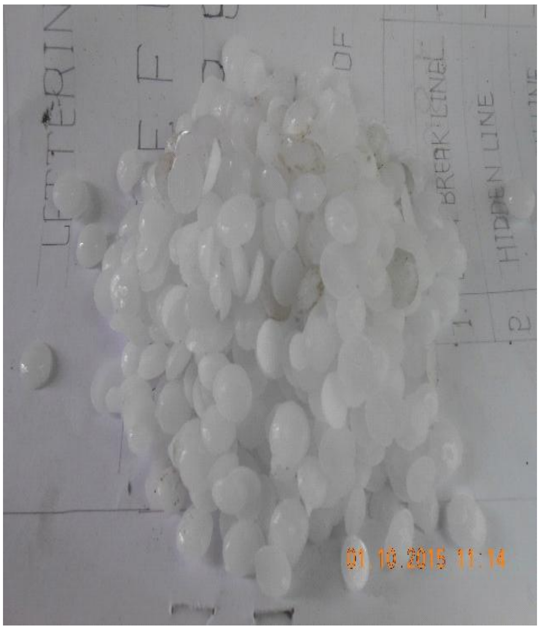


Fig.1: Sodium silicate palates.

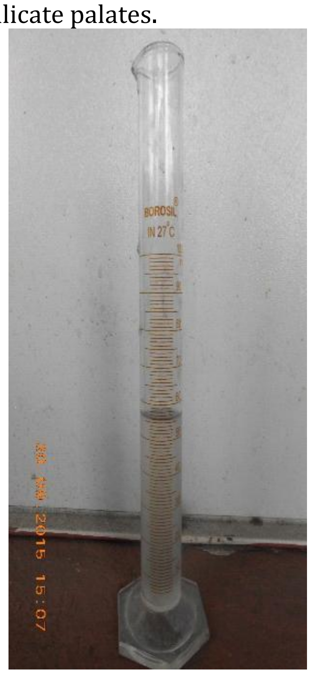


Fig.2: Alkaline solution in measuring cylinder.

2.4 Casting and Curing

For casting a cube we adopt following mix designs.

Table 2: Mix designs.

Mix	Fly ash gm	Cement gm	Lime/ Silica Flume gm	Aluminium Powder gm	Solution + Water ml	No.Of Molarity Of Solution ml
M-2.1	165	17.5 [10%]	3 [silica flume]	0.21	140	2
M-2.2	87.5 [50%]	43.75 [25%]	43.75 [25%]	0.28 [0.16%]	110	2
M-2.3	131.25 [75%]	26.25 [15%]	17.5 [10%]	0.10 [0.06%]	200	2
M-1.1	87.5 [50%]	43.75 [25%]	43.75 [25%]	0.28 [0.16%]	130	1

In addition to this we use hardener and alkaline solution in appropriate quantities. For ambient curing of light weight Geopolymer concrete it is placed at room temperature for some time and then it is placed for head curing.

Fig.3: Casting and placing of light weight geopolymer concrete

Fig4: Light weight geopolymer concrete slurry in mould at initial stage

Fig.6: light weight geopolymer concrete slurry in mould at final stage

3. RESULTS

The results of the experimental investigation are presented in this work. Provided the results of the various proportion of the light weight Geopolymer concrete with various molarities.

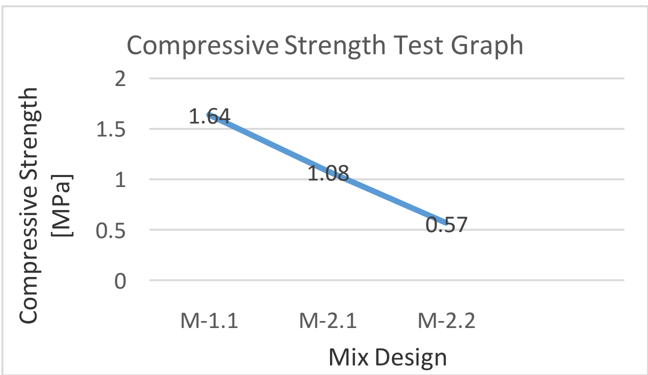
3.1 Compressive Test.

The compressive strengths of the each specimen are calculated by taking the average value of specimens. The specimens were tested as per mix proportion of the light weight concrete.

Mix	Compressive Strength [KN/m³]
M-1.1	1.64
M-2.1	1.08
M-2.2	0.57

Table 3.1- compressive strength test results of light weight concrete.

In table no.3.1, the light weight Geopolymer concrete shows results of compressive strength test. In this test mix design M-1.1, M-2.1, M-2.2 shows compressive strength of 1.64MPa, 1.08MPa, 0.57MPa respectively.



Graph 1: Development of compressive strength as per mix design.

Above graph shows relationship between the compressive strength v/s mix designs. In the graph mix design 1st shows higher compressive strength i.e. 1.64MPa.

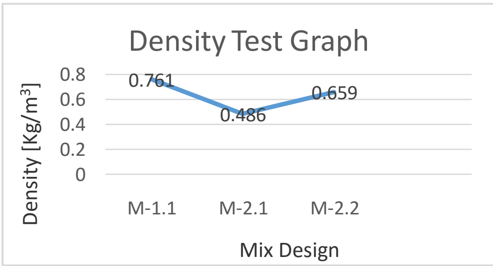
3.2 Density test.

The density of the each specimen is calculated by taking the average of the specimens. The specimens were tested as per mix proportion of the light weight concrete.

Mix	Density [Kg/m³]
M-1.1	0.761
M-2.1	0.486
M-2.2	0.659

Table 3.2- Density test results of light weight concrete.

In table no.3.2, the light weight Geopolymer concrete shows results of density test. In this test mix design M-1.1, M-2.1, M-2.2 shows density of 0.761 g/cm³, 0.486 g/cm³ and 0.659 g/cm³ respectively



Graph 2: Development of density as per mix design.

Above graph shows relationship between the density v/s mix designs. In the graph mix design 1st shows higher density i.e. 0.761 Kg/m³

4. CONCLUSION

- The light weight Geopolymer concrete gain the strength within 24 hours without water curing.
- The strength of light weight Geopolymer concrete was increased with decreased in molarity of alkaline solution.
- It was observed that, with a 1M solution the sample gives good compressive strength with achievable density to make it light weight.
- It is observed that 1M solution gives compressive strength in between 1.64 Mpa to 2 Mpa with density of 0.750 Kg/m³ to 0.850Kg/m³

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