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Experimental Investigation on Geopolymer Concrete

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Abstract:- **Environmental pollution is the biggest menace to the human race on this planet today. It means adding impurity to environment. It has a severe effect on the ecosystem. There are many reasons which cause pollution. In our construction industry, cement is the main ingredient material for the concrete production. But the production ofcement means the production of pollution because of the emission of CO2 during its production. To produce environmental friendly concrete, we have to replace the cement with the industrial by products such as fly-ash, GGBS (Ground granulated blast furnace slag) etc. The project aims to study the compressive strength characteristics of geopolymer concrete using fly ash and GGBS which are producing at ambient temperature conditions without water curing. Even oven dry curing method was adopted to see the variation in the compressive strength of geopolymer concrete.**

Keywords:-- **Chemistry, Physical and Chemical properties, Sieve Analysis, Mix Design, Compressive strength, Slump Test, Mix Proportion.**

I. INTRODUCTION

There are two different sources of CO_2 emission during cement production. Combustion of fossil fuels to operate the rotary kiln is the largest source and other one is the chemical process of calcining limestone into lime in the cement kiln also produces CO_2.In India about 2,069,738 thousands of metric tons of CO_2 is emitted in the year of 2010. The cement industry contributes about 5% of total global carbon dioxide emissions. On the other side the demand of concrete is increasing day by day for its ease of preparing and fabricating in all sorts of convenient shapes. So to overcome this problem, the concrete to be used should be environmental friendly. One possible alternative is the use of alkali activated binder using industrial by-products containing silicate materials. The most common industrial by-products used as binder materials are Fly Ash (FA) and Ground Granulated Blast Furnace Slag (GGBS). It has been widely used as a cement replacement material.

II. THE OBJECTIVES OF PRESENT STUDY

The aim primarily is on achieving a proper mix design and mixing method that will provide a 28 days compressive strength of at least 30 MPA which is 1.5 times the ordinary Portland concrete(OPC

- The main objective of the project is to prepare concrete without using cement.
- To study the compressive strength of fly ash and GGBS based geopolymer concrete.
- To study the effect of concentration of alkaline activator solution in geopolymer concrete the molar ratios considered are 8M, 10M and 12M Sodium Hydroxide solutions are used.
- To find out the difference in compressive strength by using different curing methods (Ambient and oven dry curing methods).

III. MATERIALS AND METHOD

Fly Ash: For our present project we have used Low calcium Fly-Ash (Grade I) from Ratnagiri thermal plant, Maharashtra.This Conforms to Grade 1 as per IS: 3812-2003.

Ground Granulated Blast Furnace Slag (GGBS): For our project study we have brought GGBS from Alcon cement company(ACC) Pvt. Ltd, San José de Areal, Margao, Goa.

***Fine Aggregates*:** Natural river sand was used as fine aggregate. The bulk specific gravity in oven dry condition and water absorption of the sand as per IS 2386 (Part III, 1963) were 2.685 and 1.5% respectively. The gradation of the sand was determined by sieve analysis as per IS 383 (1970). The fineness modulus of sand was found to be 3.36.

Coarse Aggregates: Crushed granite stones of size 20 mm and 10 mm were used as coarse aggregate. The bulk specific gravity in oven dry condition and water absorption of the coarse aggregate 20 mm and 10mm as per IS 2386 (Part III, 1963) were 2.73 and 0.5% respectively. The gradation of the coarse aggregate of size 20mm and 10mm was determined by sieve analysis as per IS 383 (1970).

Water : The water content in Geopolymer concrete is the combined water present in the alkali solution. Distilled

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water is used for the preparation of the Sodium Hydroxide solution.

Sodium Hydroxide: **(**Specific Gravity = 1.004) Generally NaOH is available in market in pellets or flakes form with 96% to 98% purity where the cost of the product depends on the purity of the material. The solution of NaOH was formed by dissolving it in water with different molarity.In our project NaOH solution of 8M, 10M & 12M solution were prepared prior to day of mixing. It is recommended that the NaOH solution should be made 24 hours before casting and should be used within 36 hours of mixing the pellets with water as after that it is converted to semi-solid state.

Sodium Silicate: It is also known as water glass which is available in the market in gel form. The ratio of SiO2 and Na2O in sodium silicate gel highly affects the strength of geopolymer concrete. Mainly it is seen that a ratio ranging from 2 to 2.5 gives a satisfactory result. The sodium silicate solution is of commercial grade from Phayade marketing's Karwaruttar Kannada dist. Karnataka.

3.1 Sieve Analysis:

Fine aggregate confirms to Zone II according to IS: 383-1970 (RA 2007) obtained from sieve analysis table.

Coarse Aggregates: Crushed granite stones of size 20 mm and 10 mm were used as coarse aggregate. The bulk specific gravity in oven dry condition and water absorption of the coarse aggregate 20 mm and 10mm as per IS 2386 (Part III, 1963) were 2.73 and 0.5% respectively. The gradation of the coarse aggregate of size 20mm and 10mm was determined by sieve analysis as per IS 383 (1970).

3.2 Physical Test:

Table 3.2

Tests	Coarse Aggregate	Fine Aggregate
Fineness modulus	5.8	3.36
Specific Gravity	2.73	2.68

3.3 Simplified method of mix proportioning using absolute volume method:

Total water content = Total water present in combined solution

= Water present in NaOH Solution + Water in Na2SiO3 Solution

IV FIGURES AND TABLES:

4.1 Mix Design table for 8M, 10M and 12M Molarity

Table 4.1

Sl. No.	Description	8M	10M	12M
1.	Molar solution	320	400	480
2.	Water in 'a' molar solution	75.75%	71.43%	67.57%
3.	Water content (N)	140 litre	140 litre	140 litre
4.	Quantity of NaOH (A)	77.45 kg/m3	79.35 kg/m3	81.12 kg/m3
5.	Quantity of Na2SiO3 (B)	193.62 kg/m3	198.37 kg/m3	202.8 kg/m3
6.	Total solute (A+B)	271.07 kg/m3	277.72 kg/m3	283.92 kg/m3
7.	Volume of NaOH (a)	0.07714 m3	0.07903 m3	0.08079 m3
8.	Volume of Na2SiO3 (b)	0.1434 m3	0.1469m3	0.1502m3
9.	Volume of particular concrete	0.7794 m3	0.7740m3	0.7690m3
10.	Quantity of base material @ 18.5%	321.22 kg	329.09 kg	336.44 kg
11.	In the base material (60% fly ash and 40% GGBS)			
	60% Fly ash	192.73 kg	197.45 kg	201.86 kg
	40% GGBS	128.48 kg	131.63 kg	134.57 kg
12.	Absolute volume of fly ash	0.0758 m3	0.0777m3	0.07947m3
13.	Absolute volume of GGBS	0.0462 m3	0.0473m3	0.0484m3
14.	Total absolute volume of fly ash and GGBS (f)	0.122 m3	0.125 m3	0.128 m3
15.	Absolute volume of combined aggregate= 1-a-b-f	0.6574 m3	0.6490m3	0.641 m3
16.	Weight of coarse aggregate=absolute vol. of combined agg. x2.73x1000x0.62	1112.71kg	1098.49kg	1084.95kg
17.	Weight of fine aggregate=absolute vol. of combined agg.x2.68x1000x0.38	669.49 kg	660.94kg	652.79kg

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4.2 Comparison of Compressive Strength obtained for different molarities using Ambient and Oven Dry Curing Method.

Table 4.2 .1for ambient curing

Sl. No.	Different molarities(M)	7 days. Compressive strength, (N/mm^2)	14 days. Compressive strength, (N/mm^2)	28 days. Compressive strength, (N/mm^2)
1	8	17.75	22.86	30.4
2	10	19.81	24.47	32.32
3	12	20.7	25.55	33.95

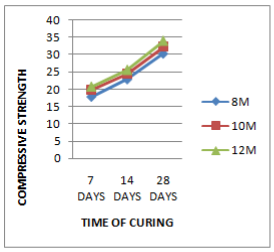

Fig. 4.2.1

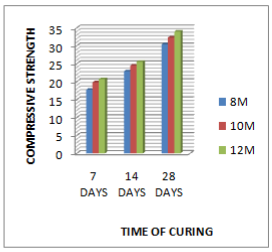

Fig. 4.2.1

Table 4.2.2 oven dry

Sl. No.	Different molarities(M)	7 days. Compressive strength, (N/mm^2)	14 days. Compressive strength, (N/mm^2)	28 days. Compressive strength, (N/mm^2)
1	8	23.37	30.35	33.67
2	10	25.67	32	35.08
3	12	28.2	32.6	37.3

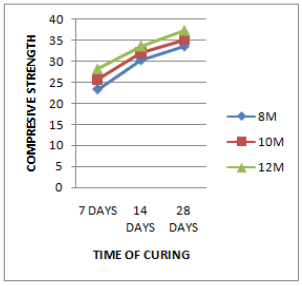

Fig. 4.2.2

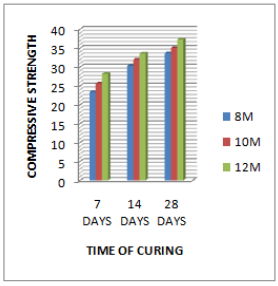

Fig. 4.2.2

V CONCLUSION

- Among all the curing type namely ambient and oven dry, Oven dry shows much higher strength as compared to ambient curing.
- The setting time of GPC increase with increase in molarities.
- The investigation have shown that using GGBS along with Fly ash as base materials, it is possible to produce Geopolymer concrete of compressive strength of about 37.3N/mm2 when adopted dry curing method and for ambient curing method compressive strength of about 33.95N/mm2 for a curing period of 28 days and 12 molarities.
- Fly ash which is by product from thermal plants can be efficiently used in geo polymer concrete thus no landfills are required to dumb the fly ash. Hence adoption of geopolymer concrete proves to be pollution free and environmental friendly.

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