International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 6, June-2018

FLY ASH BASED GEOPOLYMER CONCRETE

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***Abstract*— Geopolymer concrete is one of the best alternatives to the regular concrete.**

In the process of making the geopolymer, concrete cement is replaced by the fly ash and the alkaline activator is added to it.

This study examines the effect of the elevated temperature curing on the compressive strength of Geopolymer concrete for the curing period of 24Hr, 48Hr, 72Hr.

This study also compares the compressive strength of the Geopolymer concrete with the ordinary Portland Cement concrete at a time interval of 3 days, 7 days and 28 days.

The Alkaline to fly ash ratio was kept same as the water/cement ratio in the case of ordinary Portland cement concrete.

Keywords— Geopolymer concrete, Fly ash, Alkaline activator, curing, molarity.

I. INTRODUCTION

Geopolymer concrete is a greener alternative to the regular concrete.

In the production of cement, there is an emission of CO_2 gas in a huge amount which is dangerous for the human beings. So by using the fly ash instead of cement geopolymer concrete reduces the greenhouse gas emission.

Our power sectors mainly depend on the coal for the generation of electricity. After the generation of the electricity, the main problem is to dispose of the fly ash that is getting produced after the coal has been burnt.

The geopolymer concrete utilizes the fly ash as its constituents. So the problem of disposal of fly ash is solved.

II. METHODS

2.1 Constituents of Geopolymer concrete:-

The constituents of the geopolymer concrete are fly ash, sodium silicate, sodium hydroxide, coarse aggregate, fine aggregate.

The fly ash has been collected from National thermal power corporation (NTPC) Sipat, Bilaspur, C.G.

Sodium silicate in liquid form (in alkaline grade) and sodium hydroxide in flakes form was purchased from a local supplier in bulk.

Locally available Coarse aggregate and fine aggregate has been used.

2.1.1 Fly ash

The XRD analysis of the fly ash has been done and following constituents have been found.

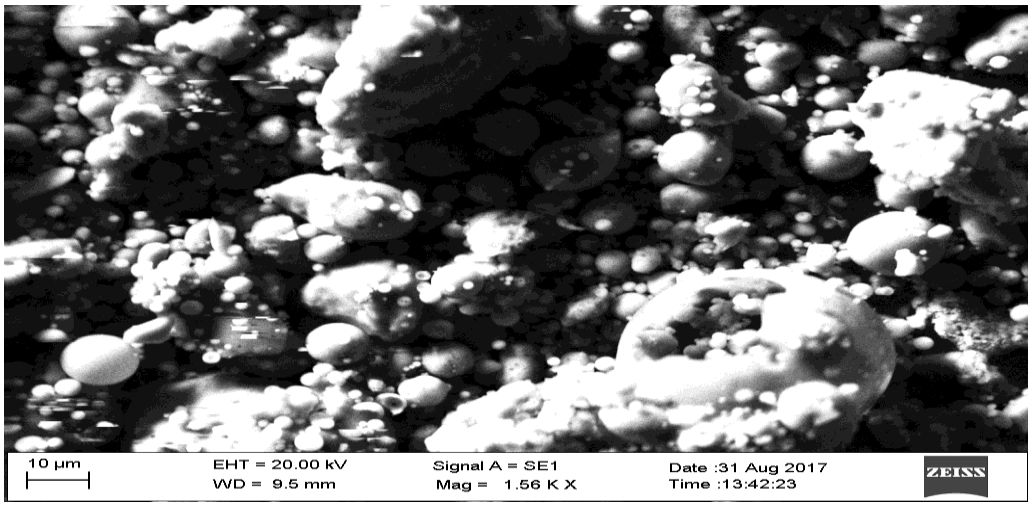


Fig .1 SEM of fly ash sample

Table I Chemical Composition of fly ash

Elements	Weight %
C K	2.01
O K	57.88
Al K	12.59
Si K	23.38
K K	0.64
Ca K	0.27
Ti K	0.99
Fe K	2.23

Table II Physical properties of fly ash

Property	Fly ash
Fineness	19
Initial setting time	12
Final setting time	220

2.1.2 Alkaline activator

Commercially available alkaline grade sodium silicate in solution form and sodium hydroxide in flakes form has been used as an alkaline activator.

The molarity of sodium hydroxide used in this experiment is 16M. To achieve this molarity 640 gms of sodium hydroxide flakes are dissolved in one litre of water.

The sodium silicate to sodium hydroxide ratio was kept constant at 1:1 in this experiment.

The alkaline activator solution was prepared 24 hrs before the casting of the specimens.

2.2 Mix proportions

We are casting G20 specimens and there is no any code provisions available for the casting of the geopolymer concrete so that all we are adopting the Indian Standard code that is used for the regular concrete.

The alkaline activator to the fly ash ratio was kept constant at 0.5 throughout the experiment.

Table III Material required for 1 m³ of geopolymer concrete

S.no.	Description	Mass in kg
1	Fly ash	480
2	Mass of water	240
3	Mass of fine aggregate	884
4	Mass of coarse aggregate	1702
5	A/F ratio	0.5
6	Na_2SiO_3/NaOH ratio	1

Table IV Material required for 1 m³ of OPC concrete

S.no.	Description	Mass in kg
1	Cement	480
2	Fine aggregate	884
3	Coarse aggregate	1702
4	Water	240

2.3 Casting and curing

The alkaline activator solution has been prepared 24 hrs before the casting of the specimen.

The fly ash and fine aggregate have been mixed together after that coarse aggregate has been added to it and mixed together.

Then the alkaline activator has been added to the mix and then all the constituents are mixed uniformly.

Then the mix has been placed into the moulds in three equal layers with 25 number of blows at each layer.

After that, it has been left for a period of 24 hrs. After that moulds are opened and the specimens are placed into the oven at a temperature of 60°C and 120° C for a period of 24Hrs, 48 Hrs and 72 Hrs.

After that, the specimens were cured at ambient temperature for a period of 3 days, 7 days and 28 days.

The OPC specimens were cast and the samples are placed in the water for curing and tested at an interval of 3 days, 7 days and 28 days.

III. **RESULTS**

The test is done on Geopolymer concrete cubes in the compressive testing machine to determine its compressive strength after the age of 3 days,7 days and 28 days. Oven curing method was adopted for the curing of concrete specimens. The compressive strength obtained at age of 3 days, 7 days and 28 days are given below

Table V Avg. compressive strength test results of geopolymer concrete cubes at 60°C

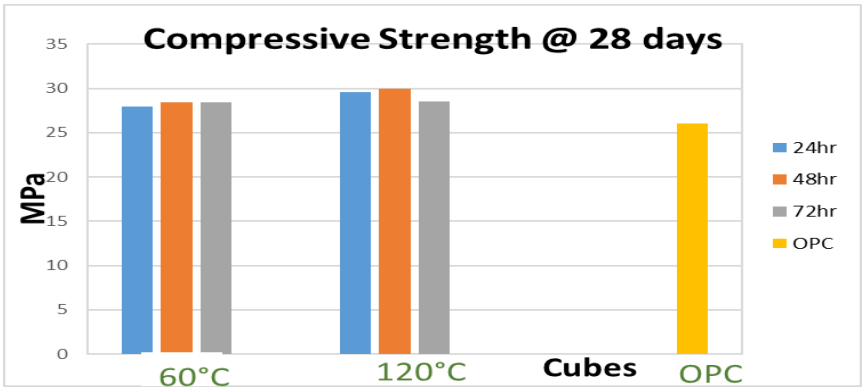
Days	Compressive strength in N/mm^2 at 60°C		
	24 Hr	48 Hr	72 Hr
3 Days	9.6	9.8	9.8
7 Days	22.6	22.6	23
28 Days	28	28.4	28.4

Table VI Avg. compressive strength test results of geopolymer concrete cubes at 120°C

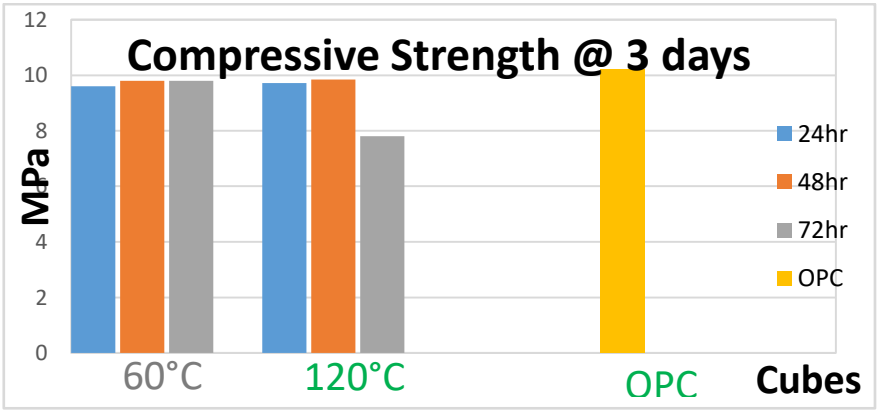
Days	Compressive strength in N/mm^2 at 120°C		
	24 Hr	48 Hr	72 Hr
3 Days	9.72	9.84	7.8
7 Days	22.8	23.6	22.2
28 Days	29.6	30	28.5

Table VII Avg. compressive strength test results of OPC concrete cubes

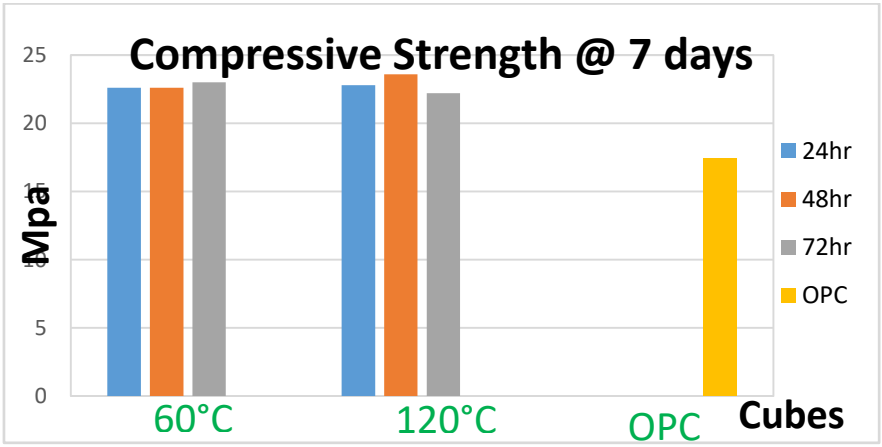
Days	Compressive strength in N/mm^2
3 Days	10.2
7 Days	17.4
28 Days	26



Graph 1 Compressive strength @3 days



Graph 2 Compressive strength @7 days



Graph 3 Compressive strength @28 days

IV. CONCLUSIONS

Based on the experimental study conducted on M20 grade Geopolymer concrete the following conclusions have been drawn-

i. It is observed that the rate of gain of Compressive strength of Geopolymer concrete is more than the conventional concrete made up of OPC.

ii. It is also observed that Compressive strength of Geopolymer concrete is more than that of conventional concrete made up of OPC.

iii. It is also observed that rate of gain of compressive strength increases with increasing the time for oven curing.

iv. Sodium hydroxide is also very corrosive to areas such as the eyes, skin, and nose. If not handled properly, Sodium hydroxide can be very harmful to health if mishandled.

v. Due to rapid strength gain property permits Geopolymer concrete to be applied in areas where a fast and reliable fix is required such as on highways.

vi. Geopolymer concrete is economical as compared to normal concrete.

vii. Solutions should be mixed 24h prior to casting of specimen because it takes time for the polymerization process to begin.

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