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

GEOPOLYMER CONCRETE

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***Abstract*— Geopolymer concrete can be used as one of the best alternatives to the regular OPC concrete.**

While making Geopolymer the Cement is replaced by Fly Ash which is an industrial waste.

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

This study also compares the split tensile 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*— molarity, green concrete, split tensile strength, oven curing, alkaline activator.**

I. INTRODUCTION

The term 'geopolymer' was first introduced by Davidovits in 1978 to describe a family of mineral binders with a chemical composition similar to zeolites but with an amorphous microstructure. Two main constituents of geopolymers are source materials and alkaline liquids. The source materials on alumino-silicate should be rich in silicon (Si) and aluminum (Al). They could be by-product materials such as fly ash, silica fume, slag, rice-husk ash, red mud, etc. Geopolymers are also unique in comparison to other aluminosilicate materials (e.g. aluminosilicate gels, glasses, and zeolites). The concentration of solids in geopolymerisation is higher than in aluminosilicate gel or zeolite synthesis. Geopolymer which is naturally cured at ambient outdoor temperature can be considered as a curing free concrete.

II. METHODS

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.

In this present work, our main goal is to compare the split tensile strength of Geopolymer concrete and the OPC concrete, with Geopolymer concrete cured at a different curing temperature in the oven and OPC concrete in water and then tested at an interval of 3days, 7days and 28 days.

III. CONSTITUENTS

Following materials are generally used to produce GPCC:

Fly ash,
Alkaline activator,
Fine aggregates, and
Coarse aggregates
Water

Fly Ash:- Fly ash, also known as "pulverized fuel ash" in the United Kingdom, is finely divided residue resulting from the combustion of ground or powdered coal. The hardened fly ash concrete shows increased strength together with a lower permeability, where the latter leads to a higher resistance towards aggressive admixtures, in addition, partial replacement of cement with fly ash reduces the production cost of concrete due to the lower price of fly ash compared to cement.

Alkaline activator:- For alkaline activator, the sodium hydroxide in pallets form have been taken and sodium silicate in liquid form has been taken, mixed in the ratio of 1:1.
The sodium hydroxide was kept constant at 16M. It is recommended that the NaOH solution should be made 24 hours before casting and should be used with 36 hours of mixing the pellets with water as after that it is converted to a semi-solid state.

Fine aggregates:- Clean and surface dry sand available locally was used which is free from clay, silt, and organic particles. Sand passing through IS 4.75 mm sieve was used for casting all the specimens. Specific gravity and fineness modulus is 2.7 and 2.85 respectively.

Coarse Aggregates:- Locally available coarse aggregate is used .coarse aggregate passing through IS 20mm sieve and retained on 10mm sieve are used and its specific gravity is 2.65. The coarse aggregate was used in saturated surface dry (SSD) condition.

Water:- Generally potable water should be used. This is to ensure that the water is reasonable free from such impurities as suspended solids, organic matter, and dissolved salts, which may adversely affect the properties of the concrete, especially the setting, hardening, strength, durability, pit value, etc.

IV. METHODS

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

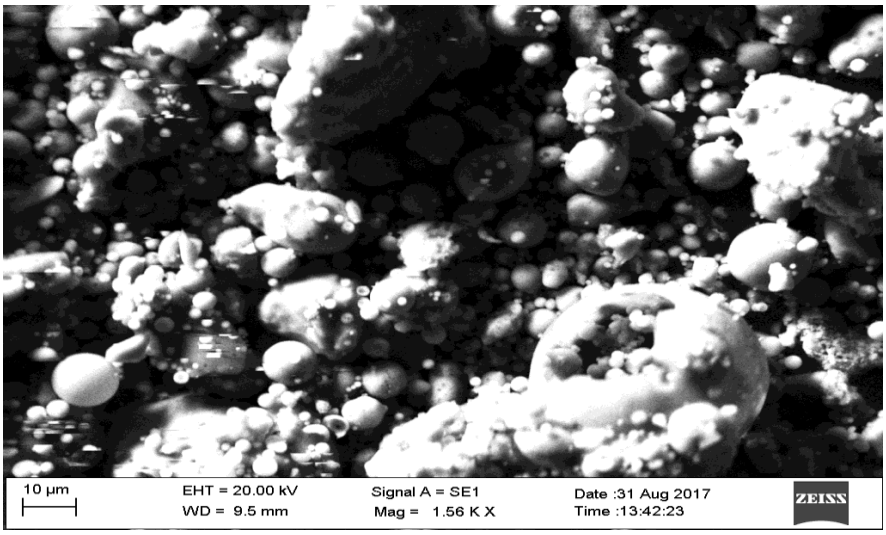

Fig 1 SEM image of Fly Ash sample

Table I Chemical constituents of Fly Ash

Elements	Weight %
C K	15.73
O K	63.47
Al K	7.07
Si K	12.61
K K	0.26
Ca K	0.08
Ti K	0.27
Fe K	0.51

During the casting of G20 specimens as there are no any code provisions available for the casting of the geopolymer concrete so that the Indian Standard code is adopted 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 II Material required for 1 m^3 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

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.

Table III Material required for 1 m^3 of OPC concrete

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

V. RESULTS

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

Table IV Av split tensile strength of GPC specimens

DAYS	60˚C			120˚C		
	24H	48H	72H	24H	48H	72H
3DAYS	1.5	1.52	1.53	1.62	1.66	1.41
7DAYS	2.2	2.26	2.26	2.2	2.3	2.1
28DAYS	2.6	2.8	2.82	2.62	2.84	2.59

Table V Av split tensile strength of GPC specimens

DAYS	OPC
3DAYS	1.8
7DAYS	2.13
28DAYS	2.8

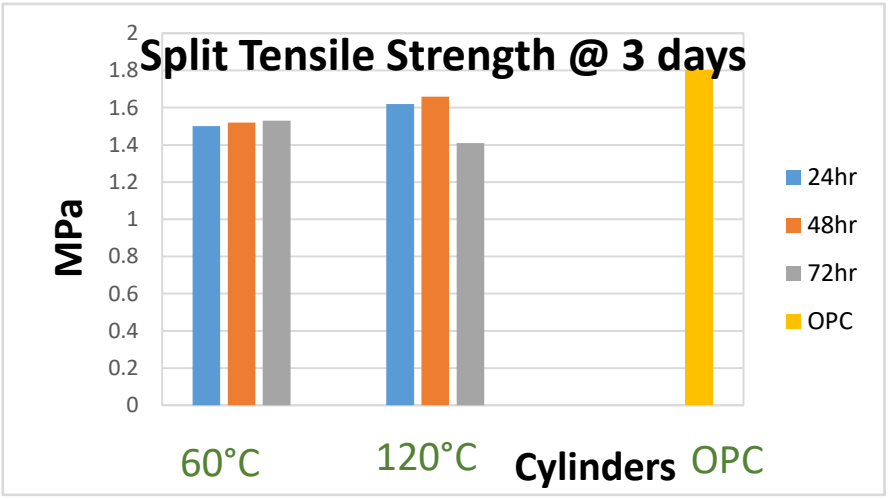

Fig 5.10 Split Tensile Strength of cylinders at different temperature and comparison with OPC concrete at 3days

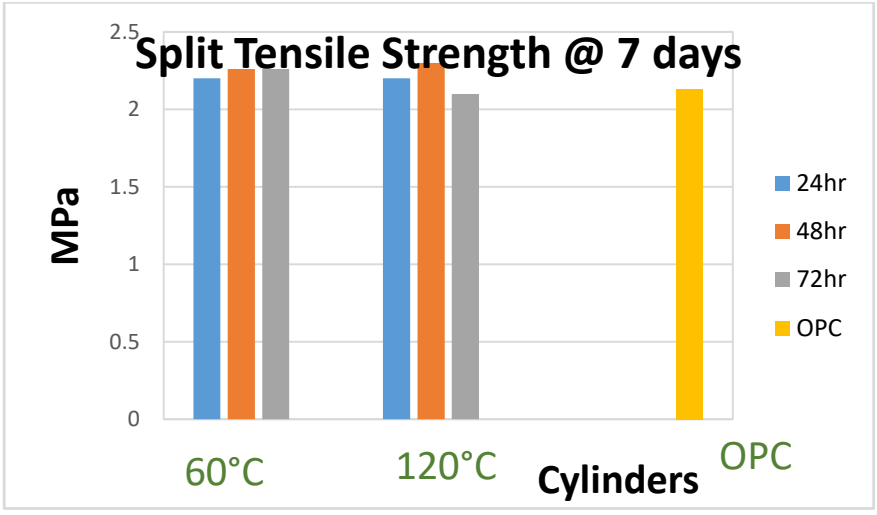

Fig 5.11 Split Tensile Strength of cylinders at different temperature and comparison with OPC concrete at 7days

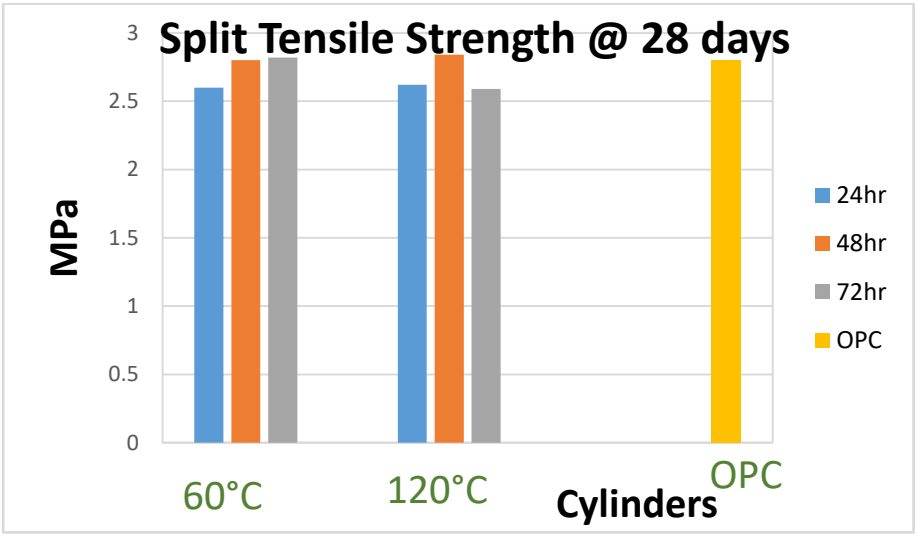

Fig 5.12 Split Tensile Strength of cylinders at different temperature and comparison with OPC concrete at 28days

VI. CONCLUSIONS

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

ii. Sodium hydroxide is also very corrosive to areas such as the eyes, skin, and nose.

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

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

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

vi. 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.

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