Geopolymer Concrete: Eco friendly

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Abstract- With the boom in infrastructure, construction activities are taking place at a faster pace. Lot of new construction materials and latest technological equipments are being used. Geopolymer concrete is an ecofriendly material, which was invented by Prof Davidotis. It is an aluminisilicate material formed by the alkali activation of waste material such as fly ash, metakoline , granulated glass furnace slag etc. Lot of research have been carried out but the best curing time and curing temperature at which maximum compressive strength is achieved is yet to be calculated .In this research paper, the compressive strength of geopoymer concrete has been studied at different curing time of 120 and 72 hours and curing temperature of 25 ^{0} C, 40^0 C,80^0 C. Fly ash obtained from Ropar Thermal Power plant along with 20 mm coarse aggregates , fine aggregates in the ratio of 1 :2 :1 was mixed . The ratio of alkaline liquid to fly ash was kept 0.4. Ratio of sodium hydroxide to sodium silicate was kept 1.5.

Keywords – alkaline liquid, construction, curing time, curing temperature , compressive strength ,geopolymer concrete.

I. INTRODUCTION

The usage of concrete is increasing day by day. It is made up of cement, coarse aggregates, fine aggregates , water. Cement is the main binder to produce concrete. CO_2 is released due to the calcination of limestone.CO_2 is the main constituent of global warming due to green house gas emissions in the atmosphere. Prof Davidotis proposed an aluminisilicate polymer "geopolymer". There are two main constituents :source material and alkaline liquids. The source material should be rich in silica and aluminium ,flyash, metakaoline etc. The alkaline liquids are generally combination of sodium hydroxide and sodium silicate or potassium hydroxide and potassium silicate. In geopolymer concrete, the silica and aluminium present in the source material are induced by alkaline activators to form gel. This geopolymer gel binds aggregates and other materials to form the geopolymer concrete.

Low-calcium fly ash-based geopolymer concrete has excellent compressive strength, very little drying shrinkage and low creep, excellent resistance to sulfate attack and good acid resistance. It can be used in many infrastructure applications. One ton of low-calcium fly ash can be utilized to produce about 2.5 cubic meter of high quality geopolymer concrete and the bulk cost of chemicals needed to manufacture this concrete is cheaper than the bulk cost of one ton of Portland cement. Given the fact that fly ash is considered as a waste material, the low calcium fly ash-based geopolymer concrete is, therefore, cheaper than the Portland cement concrete. Moreover, reduction of one ton of carbon dioxide yields one carbon credit and this carbon credit significantly adds to the economy offered by the geopolymer concrete. In terms of reducing global warming, geopolymer technology could reduce approximately 80% of CO_2emission to the atmosphere caused by cement and aggregate industry.

II. EXPERIMENT

The manufacturing of geopolymer concrete is similar to cement concrete. The process involves the preparation of alkaline solution, dry mixing, wet mixing, curing & testing of samples. To prepare sodium hydroxide solution of 12 molarity, 480 g (12 x 40) i.e. (molarity x molecular weight) of sodium hydroxide pellets were dissolved in one liter of distilled water. The mass of sodium hydroxide solids in the solution varies depending on the concentration of the solution expressed in terms of molar M. Fly ash obtained from Ropar Thermal Power Plant along with 20 mm coarse aggregates, fine aggregates in the ratio of 1 :2 :1 was mixed . Coarse aggregate of size 20mm having the specific gravity of 2.78 and fineness modulus of 7.21 (IS:2386) was used. The fineness modulus of fine sand used was 2.41 with a specific gravity of 2.6The ratio of alkaline liquid to fly ash was kept 0.4 and ratio of sodium hydroxide to sodium silicate was kept 1.5. The prepared NaOH solution was added to sodium silicate solution proportionately according to the mix, 24 hours before casting. The coarse aggregate, fine aggregate, flyash were taken in required amount in a mixing tray and dry mixed manually for about two minutes.The alkaline liquid was gradually added to the mix in the mixer. The mixing of total mass continued until the mixture became

homogeneous and uniform in color. The fresh geopolymer concrete was casted in cubes of size 100 X 100 X 100 mm to three layers and was compacted by using the standard compaction rod so that each layer receives 25 strokes followed by further compaction on the vibrating table.

The casted specimens were kept in oven for 25ºC for the curing period 120 hours and another specimens were kept in an oven for 40 ^{0} C, 80 ^{0} C hours for 72 hours and after the required curing period the specimens were removed from the oven and were kept open at room temperature until testing.

Fig 1:Samples being mixed in the mixer

Compressive Strength Of Geopolymer Concrete

The specimens were removed from the oven; after the cooling of the samples, the specimens for the required period (3rd day, 7th day,14 days and 28 days) were tested as per IS 516 : 1979 in the Compressive Testing Machine of capacity 2000 kN for obtaining ultimate load of the specimens

The compressive strength is one of the most noteworthy properties of hardened concrete and is considered as the characteristic material value for the classification of concrete.

A set of three cubes for each mix were tested on the specified curing period. The average compressive strength of the three cubes for all mix composition was done.

The results of tests at 7 days, 14 days and 28 days were recorded for further analysis.

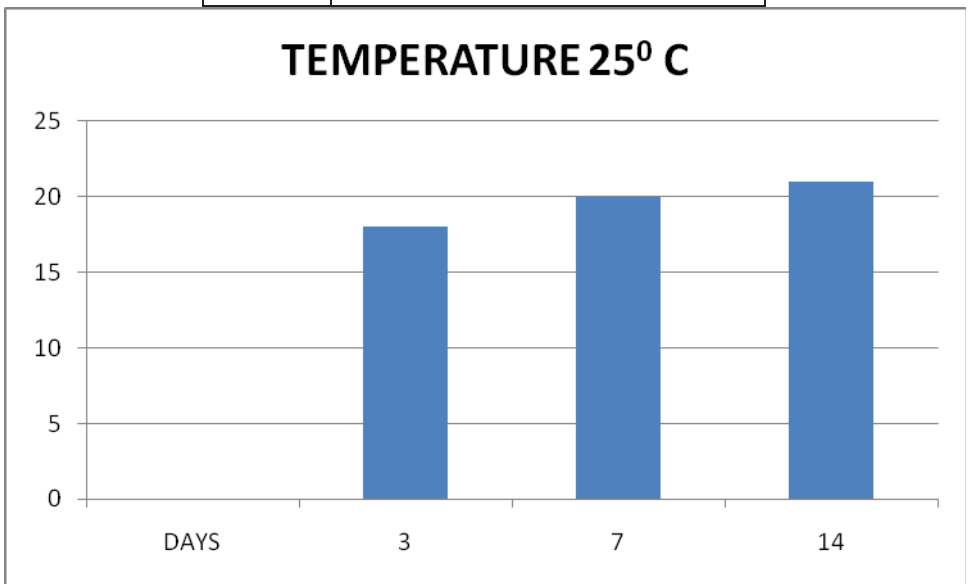
Fig 2: samples being tested in compression testing machine

III. RESULT

The coarse aggregate (20 mm), fine aggregate and fly ash, all the three mixed in the ratio {2:1:1}. Ratio of alkaline liquid to fly ash is 0.4. The ratio of sodium hydroxide to sodium silicate is 1.5.The samples were casted in 100X100X100mm moulds, after that it was cured at curing temperature of 25 ^{0} C for 120 hours. The samples were tested at 7th day, 14th day and 28 days to determine the compressive strength of geopolymer concrete. The following results were observed.

TEMPERATURE 25^0 C

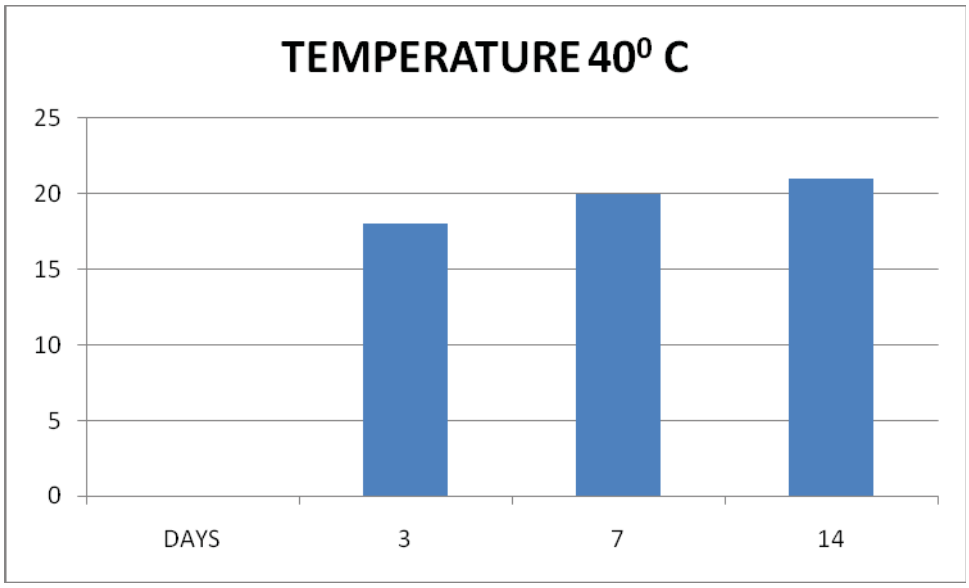
DAYS	COMPRESSIVE STRENGTH(N/MM^2)
7	2
14	3
28	4.5



The coarse aggregate (20 mm), fine aggregate and fly ash, all the three mixed in the ratio {2:1:1}. Ratio of alkaline liquid to fly ash is 0.4. The ratio of sodium hydroxide to sodium silicate is 1.5.The samples were casted in 100X100X100mm moulds, after that it was cured at temperature 40 ^{0} C for 72 hours. The samples were tested at 7th day, 14th day and 28 days to determine the compressive strength of geopolymer concrete. The following results were observed.

TEMPERATURE 40^0 C

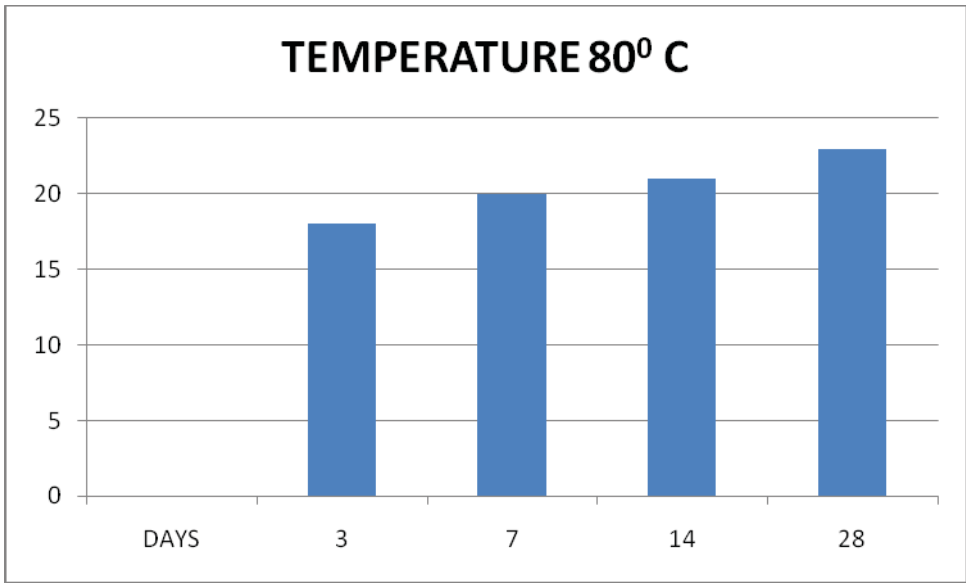
DAYS	COMPRESSIVE STRENGTH(N/MM^2)
7	2.5
14	3.5
28	5



The coarse aggregate (20 mm), fine aggregate and fly ash, all the three mixed in the ratio {2:1:1}. Ratio of alkaline liquid to fly ash is 0.4. The ratio of sodium h The coarse aggregate (20 mm), fine aggregate and fly ash, all the three mixed in the ratio {2:1:1}. Ratio of alkaline liquid to fly ash is 0.4. The ratio of sodium hydroxide to sodium silicate is 2.The samples were casted in 100X100X100mm moulds, after that it was cured at temperature 80 ^{0} C for 72 hours. The samples were tested at 3rd day, 7$^{th\ h}$ day, 14th day and 28 days to determine the compressive strength of geopolymer concrete. The following results were observed.

TEMPERATURE 80^{0} C

DAYS	COMPRESSIVE STRENGTH(N/MM^{2})
3	18
7	20
14	21
28	23



IV.CONCLUSION

The compressive strength increases with the increase in curing temperature. If the curing temperature is 25^0 C and curing time is 120 hours , the compressive strength is less as compared to the sample casted at curing temperature of 80^0 C for 72 hours. The increase in the ratio of sodium hydroxide to sodium silicate increases the compressive strength of geopolymer concrete.

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