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EFFECT ON GEOPOLYMER CONCRETE FOR DIFFERENT TYPES OF CURING METHOD

VARSHA V. YEWALE
PG Student, Department of Civil Engineering,
G.H. Raisoni College of Engineering & management Chas, Ahmednagar, Maharashtra,

SANDEEP L. HAKE
Assistant Professor, Department of Civil Engineering,
G.H.Raisoni College of Engineering & management Chas, Ahmednagar, Maharashtra ,India(e-mail:

MOHAN.N.SHIRSATH
Assistant Professor & Head, Department of Civil Engineering,
G.H.Raisoni College of Engineering & management Chas, Ahmednagar, Maharashtra ,India

ABSTRACT:

In today's world the problems we are facing day to day life is pollution and disposal of waste material of industries. In the manufacturing process of cement, emission of CO_2 is more and also consumes significant amount of natural resource. In thermal power station, Main problem is disposal of waste material as well as industrial by- product like fly ash from thermal power plant. In this paper, we had studied different types of curing method for Geopolymer concrete and evaluate the best method of curing. In this four types of curing had been done to study the effect on the geopolymer concrete and which one is the more efficient. Oven curing and steam curing had been done for different elevated temperature to evaluate optimum temperature. Water curing had been done similar to that of conventional concrete.

KEYWORDS: Alkali Activators, Fly ash, Geopolymer concrete, oven curing , steam curing, water curing and room temperature curing

INTRODUCTION:

Geopolymer concrete is a concrete which is use as one of the concrete to reduce the pollution by reducing production of cement. Due to production of cement many greenhouse gases like carbon dioxide which is harmful to earth atmosphere are emitted from cement industry in billion tons. To preserve the earth's atmosphere introduction to Geopolymer concrete is done by Davidovits in 1978.By this new technology reduction in production of cement which led to reduction in emission of carbon –di-oxide. In this new technology, Geopolymer concrete is a new material in which cement is fully replaced by pozzolanic materials that is rich in silicon (Si) and Aluminum (Al) like Fly ash. Pozzolanic activity of fly ash is due to the presence of finely divided glassy silica and lime that produce calcium silicate hydrates. The calcium hydroxide Ca $(OH)_2$ provides the right environment for pozzolanic action. It is activated by highly alkaline solution to produce the binder which binds the aggregate in concrete when subjected to elevated temperature.

In this new technology, Geopolymer concrete is a new material in which cement is fully replaced by pozzolanic materials that is rich in silicon (Si) and Aluminum (Al) like Fly ash. Fly ash is a material which is obtained from thermal power plant as a waste material . Pozzolanic activity of fly ash is due to the presence of finely divided glassy silica and lime that produce calcium silicate hydrates. The calcium hydroxide Ca $(OH)_2$ or Sodium Hydroxide NaOH or Potassium Hydroxide KOH with calcium silicate or sodium silicate or potassium silicate provides the right environment for pozzolanic action. It is activated by highly alkaline solution to produce the binder which binds the aggregate in concrete. In Geopolymer concrete, concrete is to be kept at elevated temperature for curing so that polymerization can be complete for targeted compressive strength.

LITERATURE REVIEW:

Kamlesh.C.Shah et.al [1] says the test results demonstrate that oven cured fly ash based geopolymer concrete have an excellent resistance to sulphate attack, Salt attack and acid attack. The geopolymer concrete is good alternative of construction material of from both strength and durability considerations. experimental work different parameters were used such as ratio of alkaline liquid to fly ash 0.40 ,0.45 and 0.50, ratio of NaOH to sodium silicate (Na_2SiO_3) 2.0 and 2.5, molarities of sodium hydroxide(NaOH) 10M ,12M, 14M and 16M, Curing temperature 60^0C, 90^0C and 120^0C, addition of super plasticiser. A mix Proportion based on the result of preliminary investigation is to be developed for geopolymer concrete.

Mohamed Aquib Javeed et.al [2] says sustainable Geo-polymer concrete has been achieved in a sequential procedure starting with the trial mixes designed by the Rangan method of mix design which is regarded as a simple mix design. Rangan method gives the calculation of quantity of materials used in the mix design but the dosage of super plasticizer are finalized using trial and error. Compressive strength of concrete increases with increasing the concentration of sodium hydroxide.

Prakash R. Vora et.al [3] says with increase in the curing temperature in the range of 60^0C to 90^0C, the compressive strength of the geopolymer concrete also increases. The compressive strength of the geopolymer concrete increases with increase in the curing time. However, the increase in strength beyond 24 hours is not much significant. 1 day rest period increases the

compressive strength of the geopolymer concrete as compared to that for the concrete without the rest period.

Kolli.Ramujee et.al [4] says to develop the mix design for Geo-polymer concrete in different grades of concrete that is low, medium and higher grades. They have considered the design parameters as alkaline liquid to fly ash ratio and water to geo polymer solids ratio. Seven different mixes for each grade is casted, tested and optimized. Based on results they have suggested water to binder ratio of 0.27, 0.21 & 0.158 and alkaline to binder ratios of 0.5, 0.40, and 0.35 are suggested for M20, M40, & M60 respectively.

Madheswaran C.K et.al [5] says studied the variation of strength for different grades of geo polymer concrete by varying the molarities of sodium hydroxide. Different molarities of NaOH (3M, 5M, 7M) are taken to prepare different mixes and cured in the ambient temperature. GPC mix formulations with compressive strength ranging from 15 to 52 M pa have been developed. The specimens are tested for their compressive strength at the age of 7 and 28 days. The compressive strength of GPC increased with increasing concentration of NaOH.

R. Anuradha et.al [6] with the generic information available on geopolymer, a rigorous trial-and-error method was adopted to develop a process of manufacturing fly ash-based geopolymer concrete following the technology currently used to manufacture Ordinary Portland Cement concrete. After some failures in the beginning, the trail-and-error method yielded successful results with regard to manufacture of low-calcium (ASTM Class F) fly ash based geopolymer concrete. Geopolymer concrete is an excellent alternative solution to the CO_2 producing port land cement concrete. Low-calcium fly ash-based geopolymer concrete has excellent compressive strength within a day and is suitable for structural applications.

Shankar H. Sanni et.al [7] says for any grade of GPC, as ratio of alkaline solution increases, the workability of mix goes on increasing. The study showed that the strength of geopolymer concrete can be improved by decreasing the water/binding and aggregate/binding ratios. It was observed that water influences the geopolymerization process and the hardening of concrete. Inclusion of increased binder content enhances the geoplymerization and affects the final strength. The optimum dosage for alkaline solution, which is used a geopolymer binder can be considered as 2.5, because for this ratio, the GPC specimens of any grade produced maximum strength results with compression and tension. The fly ash can be used to produce geopolymeric binder phase which can bind the aggregate systems consisting of sand and coarse aggregate to form geopolymer concrete (GPC). Therefore these concretes can be considered as eco-friendly materials.

S. Kumaravel [8] says the results establish that slag as a part of fly ash binder is effective to accelerate setting time of geopolymer concrete in ambient condition. The geopolymer concrete possesses good compressive strength and well suited to manufacture precast concrete products. Low calcium fly ash-based geopolymer concrete has excellent compressive strength and is suitable for structural applications.

EXPERIMENTAL WORK:

MIXING AND CASTING:

In Geopolymer concrete, mixing of the all ingredients is done in concrete mixer as per conventional method. For casting Geopolymer concrete, a day before sodium hydroxide is to be prepared as per the requirement of the molarity. The need to prepare the NaOH a day before is that it liberates heat as we mix the NaOH with water and hence, this liberated heat will not allow the other ingredients to bind together. This led to decrease in compressive strength of concrete. Since compressive strength of concrete is inversely proportional to the water – to- Geopolymer binder ratio. As per the ratio of NaOH to Na_2SiO_3 i.e. alkaline solution ratio, amount of NaOH and Na_2SiO_3 is calculated and mixed together an hour before the casting with extra water or super plasticizer if any. As per the conventional method of mixing firstly dry mixing of Fly Ash, coarse aggregate and fine aggregate is done in concrete mixer for 2-3min. After thorough dry mix of Fly Ash and aggregate, alkaline solution is poured in three layers on dry mix in the concrete mixer for 2-3 minutes. After proper mixing of all ingredients, fresh concrete appeared to be dark in color, cohesive and viscous. From this concrete, specimen are casted and then vibrated on table vibrators for compaction. While vibrating concrete mould, top surface of each mould is leveled with trowel. After 24 hours of casting, all specimens are demoulded.

CURING:

In this paper, different type of curing is done on geopolymer concrete. Firstly, Heat curing of specimens is done in oven at different temperature for obtaining Optimum curing temperature. In this method, specimen is kept in oven for 24hrs to have complete polymerization of geopolymer concrete.

Secondly, Steam curing of specimen is done in accelerated curing tank at different temperature for obtaining optimum curing temperature at 18hrs to have complete polymerization of geopolymer concrete. In this type of curing it was observed that as the temperature goes on increasing, the compressive strength goes on increasing. Thirdly, water curing of specimen is done as per conventional method. Lastly, room temperature curing of specimen is done.

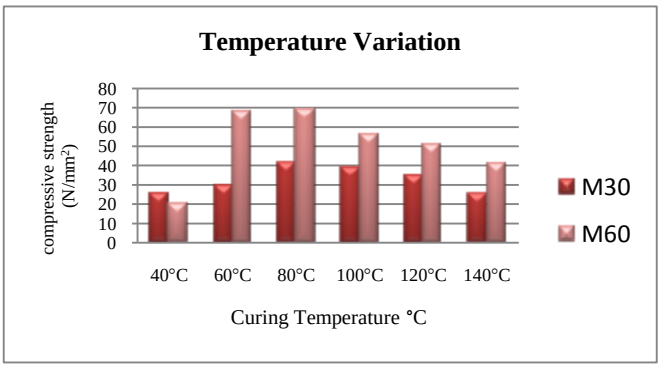
RESULTS:

The following test had been conducted at optimum curing temperature and time for efficient curing type for both grade of concrete.

COMPRESSION TESTING:

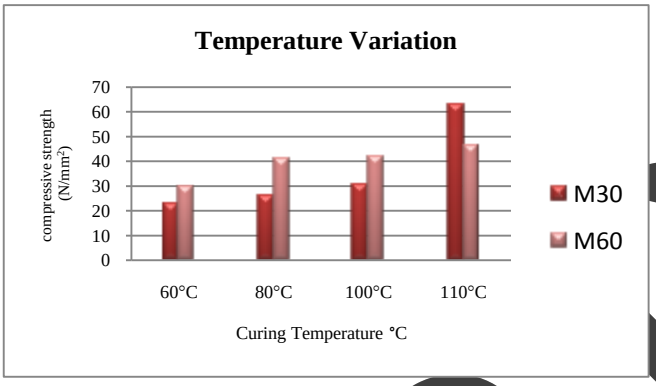
Compressive strength of concrete had been done to get the optimum curing temperature and efficient curing type from different type of curing.

a.) OVEN CURING:



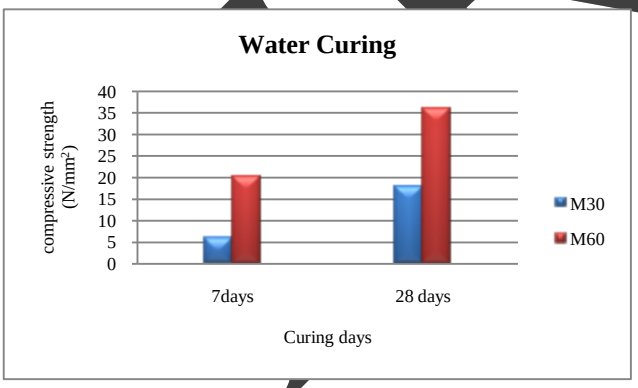
Graph No.1. 7 Days Oven Curing Compressive Strength for M30 & M60

b.) STEAM CURING:



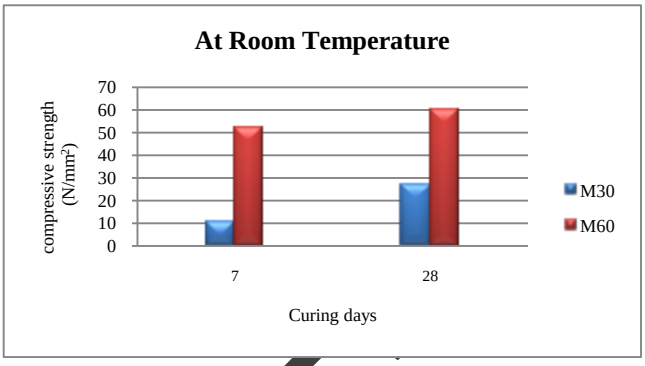
Graph No.2. 7 Days Steam Curing Compressive Strength for M30 & M60

c.)WATER CURING:



Graph No.3. 7 & 28 Days Water Curing Compressive Strength for M30 & M60

d.) ROOM TEMPERATURE CURING:



Graph No.6. 7 & 28 Days Water Curing Compressive Strength for M30 & M60

CONCLUSION:

From this experimental investigation it can be concluded:

1. In the oven curing, as we increase the temperature of curing for optimum time the compressive strength goes on increasing up to optimum temperature after that its decreases. In this type of curing, we get 28 days strength of concrete in 7 days of rest period at 80°C temperature.
2. In the steam curing, as we increase the temperature of curing for optimum time the compressive strength goes on increasing. In this type of curing, we get 28 days strength of concrete in 7 days of rest period at 100°C temperature.
3. In the water curing, as we increase the rest period of curing the compressive strength goes on increasing. In this type of curing, compressive strength of geopolymer concrete is increase but the strength is not up to the characteristic strength at 28 days.
4. In the room temperature curing, as we increase the rest period of curing the compressive strength goes on increasing. In this type of curing, we get the characteristic strength at 28 days of rest period instead at 7 days rest period.
5. From all above type of curing we can conclude that oven curing is efficient type of curing for geopolymer concrete because for steam curing the temperature required to get characteristic strength is more as compared to oven curing. In water curing, characteristic strength of geopolymer concrete is not achieved at 28 days of rest period. In room temperature curing, as the rest period goes on increasing the compressive strength increases but the time required for this is more as compared with oven curing.

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