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Experimental Investigation of properties of Geopolymer Concrete for Oven Curing

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***Abstract*—In today's world new technologies are developing for comfort ability of human beings. As per the need of human beings new inventions are done. Due to this, most of them are responsible for pollution. As we know, construction industry is developing very fast day to day. 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 properties for oven curing method of Geopolymer concrete .**

Keywords- Alkali Activators, Fly ash, Geopolymer concrete

I. 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.

II. LITERATURE REVIEW

Subhash V. Patankar et.al [1]says, desired compressive strength was achieved by fixing the solution-to-fly ash ratio of 0.35 for the Mix Design of Fly Ash Based Geopolymer Concrete on the basis of various parameters such as quantity and fineness of fly ash, quantity of water and grading of fine aggregate.

Sourav Kr. Das et.al [2]says, with a higher Na2SiO3 gives a higher strength, and generally with a ratio of 2.5. The rate of increase of strength is rapid in the initial 24 hours of curing beyond that the gain of strength was moderate so the specimens should be cured for 24 hours only which will be sufficient enough.

Subhash V. Patankar et.al [3]says, for viscous mix, the concrete subside slowly for long time after lifting the slump cone which prose difficulties in measuring actual slump value. For less viscous but flowable mix, the slurry part flows from bottom of slump cone during placing of geopolymer concrete which affect the slump value. It is also observed that the compressive strength of geopolymer concrete decreases with increase in water-to-geopolymer binder ratio by changing the quantity of water.

B. Vijaya Rangan [4] says Test data show that the compressive strength increased with age in the order of 10 to 20 percent when compared to the 7th day compressive strength. Geopolymer concrete offers several economic benefits over Portland cement concrete. Heat-cured low-calcium fly ash-based geopolymer concrete also shows excellent resistance to sulfate attack and fire, good acid resistance, undergoes low creep, and suffers very little drying shrinkage.

III. MATERIALS AND SPECIFICATIONS

1. **Fly ash**: Low calcium class F processed fly ash from Dirk India private limited under the name of the product POZZOCRETE 60. The specific gravity of the Fly Ash used is 2.26. The fineness of the Fly Ash by Blaine's method is 360m^2/kg.

2**. Activators**: The alkaline liquid used was a combination of sodium hydroxide and sodium silicate solution. Sodium hydroxide (NaOH) in flakes form with 98% purity and Sodium silicate solution purchased from local chemical supplier used as alkaline liquid. Molarity of the NaOH solution was 16M.

3. **Aggregates**: Locally available 12.5 mm and 20 mm crushed aggregates to be used as coarse aggregates having specific gravity 2.7. Locally available river sand is to be used as fine aggregate in the concrete mixes having specific gravity 2.4.

4. **Super plasticizer**: The use of a commercially available super-plasticizer has helped to improve the workability of concrete for High grade of concrete.BB2 super plasticizer was used in this mix and its dosage was 3% of the mass of binder material comprising of Fly ash.

IV. 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 Na2SiO3 i.e. alkaline solution ratio, amount of NaOH and Na2SiO3 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

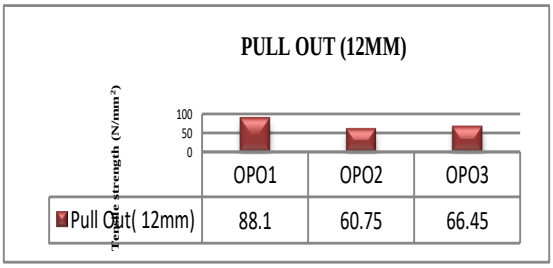
In this paper, different type of curing is done on geopolymer concrete. Firstly, Heat curing of specimens is done in oven at different temperature for obtaining Optimum curing temperature. In this method, specimen is kept in oven for 24hrs to have complete polymerization of geopolymer concrete. Secondly, 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. As per, the test on geopolymer concrete at different types 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. Therefore, at optimum temperature for oven curing different types of test are conducted on the geopolymer concrete.

V. RESULTS

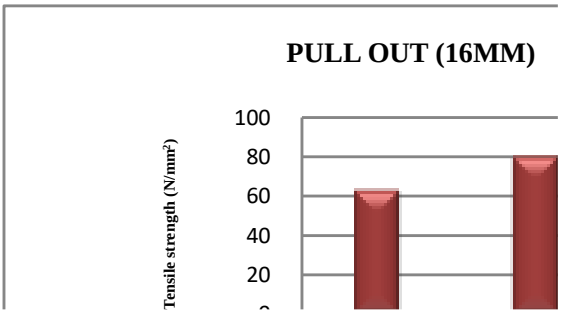
The following test had been conducted at optimum oven curing temperature for different properties of M30 and M60 grade.

1. Pull Out

This test is used for the comparison of the bond resistance of different types of reinforcing bars with concrete and also for comparing different concrete mixes for their bond characteristics with steel reinforcing bars.



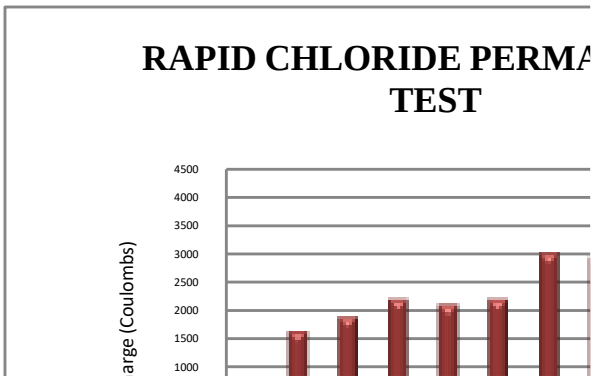
Graph 1.Pull out strength for 12mm bar at 7 days



Graph 2.Pull out strength for 16mm bar at 7 days

2. Rapid Chloride Permeability Test

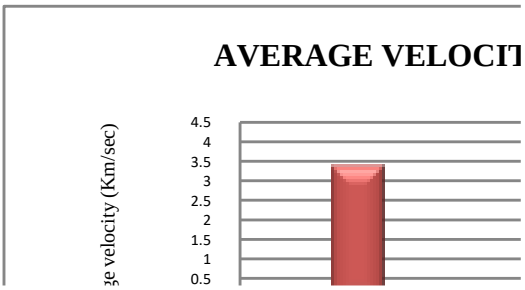
The chloride permeability for the geopolymer concrete is moderate. The graph represents fluctuating type for rapid chloride test. In this for every hour charge in coulomb is determined.



Graph 3. RCPT Test at 07 days rest period

3. Ultrasonic Pulse Velocity Test

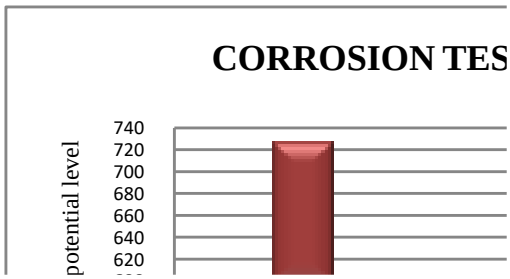
According to IS13311 (part 1):1992, quality of concrete is find as per velocity criterion for grade M30 is medium and M60 is good.



Graph 4.Ultrasonic Pulse velocity for M30 and M60

4. Corrosion Test

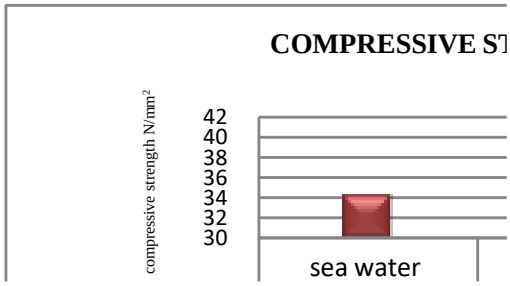
The cubes are tested by corrosion test measurement apparatus.



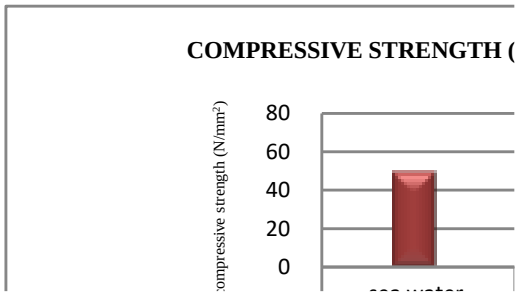
Graph 5.Ultrasonic Pulse velocity for M30 and M60

5. Sea Water

Oceans make up 80 percent of the surface of the earth; therefore, a large number of structures are exposed to seawater either directly or indirectly (e.g. winds can carry seawater spray up to a few miles inland from the coast).



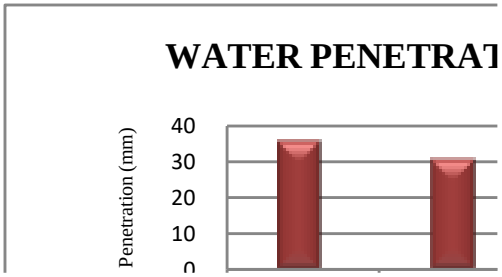
Graph 6. Comparison between strength of sea water and GPC (M30)



Graph 7. Comparison between strength of sea water and GPC (M60)

6. Water Permeability Test

Permeability of concrete is important when dealing with durability of concrete particularly in concrete used for water retaining structures or watertight sub-structures. Structures exposed to harsh environmental conditions also require low porosity as well as permeability.



Graph 8. Water Penetration

VI. CONCLUSION

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 pull out strength can be achieved by oven curing for both the grade of geopolymer concrete.
3. Rapid chloride penetration test gives medium results (as per Table No. 3.5.9.1) for the chloride permeability for the geopolymer concrete for both the grades and opting oven curing.
4. Corrosion results obtained after 90days of immersion of the specimens in artificial sea water gives a result of 95% of corrosion activity for both the grades of geopolymer concrete
5. Artificial Sea water degrades the geopolymer concrete for both the grades also by decreasing its compressive strength in a month.
6.After performing the ultrasonic pulse velocity test for both the grade of concrete, the test results in medium quality of concrete for M30and for M60 the tests results for good quality of concrete.

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