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Investigation on Membrane Cured Geopolymer Concrete- Review

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Abstract- Cement concrete is widely used material in civil engineering construction. However emission of carbon dioxide during the production of cement is hampering the image of concrete as a sustainable material. Therefore efforts are being made to reduce the consumptions of cement by using cementitious material such as fly ash as a partial replacement. Large amount of fly ash produced in thermal power station is creating environmental pollution, if not disposed properly. Geopolymer concrete is a new development in concrete technology in which cementitious material, rich in silica and alumina, is activated using alkaline solution.

In this report the investigation is carried to check the various parameters of geopolymer concrete. For this research work M30 grade of geopolymer concrete is designed. Sodium silicate and sodium hydroxide was used as alkaline liquid with the ratio of 2.5. Fly ash to solution ratio is 0.35. For each test three cubes, cylinders or beams were casted as per requirement of test procedure. All these specimens are wraped with plastic bag for curing in an oven for different temperature for analyzing effect of membrane. These cubes were examine by the membrane cured for the polymerisation. Due to membrane cured the moisture losses were entrapped.

Keywords- Geopolymer Concrete, Fly Ash, Membrane Cured, Alkaline solution.

INTRODUCTION

Cement industries releases CO2 in the atmosphere, which is one of cause of global warming. Also, in Most of the fly ash is disposed of as a waste material that coves several hectors of valuable land. So, efforts are needed to make concrete more environmental friendly by using fly ash which helps in reduce global warming as well as fly ash disposal problem. (Satpute Manesh B,2012). Thermal Power Plant are the two major issues concern with the environmental pollution and human health. Both these issue can be solve partially by utilizing fly ash in concrete by partial or full replacement of cement. Geopolymer concrete is a new cementitious material which is produced by chemically activation of fly ash with highly alkaline solutions like sodium hydroxide and sodium silicate. Subhash V. Patankar,et al. (2012).

We conducted study on the effects of sodium hydroxide concentration on the compressive strength of fly ash-based geo-polymer mortar. The authors have reported that alkaline concentration was proportionate to the compressive strength of geo-polymer mortar. They have claimed that higher concentration of sodium hydroxide solution result in a higher compressive strength of geo-polymer mortar. Hong ling Wang in their study on synthesis and mechanical properties of meta kaolinite-based geo-polymer have reported that higher concentration of sodium hydroxide solution provides better dissolving ability to meta kaolinite and produces more reactive bond for the monomer, consequently increase inter-molecular bonding strength of the geo-polymer. They have revealed that mechanical properties of the meta kaolinite-based geo-polymer activating meta kaolinite with sodium hydroxide and sodium silicate solution were greatly dependent on the concentration of sodium hydroxide solution. With the increase of sodium hydroxide concentration, the compressive strength, flexural strength and apparent density of the resulting geo-polymer were increased.

LITERATURE REVIEW

S. S. Jamkar et al [1] have highlighted on the effect of fly ash fineness on the compressive strength of geopolymer concrete. The specimens were cured in an oven for 4, 8, 12, 16, 20 and 24 hours at 90°C. The compressive strength results show that the fly ash fineness plays a vital role in the activation of geopolymer concrete. An increase in the fineness increased both workability and compressive strength. It was also observed that finer particles resulted in increasing the rate of reaction needing less heating time to achieve a given strength..

Subhash Patankar et.al [2] recommended that effect of concentration of sodium hydroxide, temperature, duration of heating, and test period on the development of geopolymer mortar. It is observed that the workability as well as compressive strength of geopolymer mortar increases with increase in concentration of sodium hydroxide solution in terms of molarity. It is also observed that the compressive strength of geopolymer concrete increases with increase in test period up to three days. The suitable preparation of geopolymer mortar, 13-molar solution of sodium hydroxide is recommended on the basis of workability and compressive strength.

Prakash R. Vora et.al [3], have described the experimental work conducted by casting 20 geopolymer concrete mixes to evaluate the effect of various parameters affecting its the compressive strength in order to enhance its overall performance. Various parameters i.e. ratio of alkaline liquid to fly ash, concentration of sodium hydroxide, ratio of sodium silicate to sodium hydroxide, curing time, curing temperature, dosage of super plasticiser, rest period and additional water content in the mix have been investigated. The test results show that compressive strength increases with increase in the curing time, curing temperature, rest period, concentration of sodium hydroxide solution and decreases with increase in the ratio of water to geopolymer solids by mass & admixture dosage, respectively. The addition of naphthalene based superplasticiser improves the workability of fresh geopolymer concrete. It was further observed that the water content in the geopolymer concrete mix plays significant role in achieving the desired compressive strength.

Satpute Manesh B et.al[4] have studied of effect of duration and temperature curing on compressive strength of geopolymer concrete. Geopolymer concrete is manufactured by cement fully replacing with processed fly ash which is activated by alkaline solutions like Na2Sio3 and NaoH. Cubes of size 150mm X 150mm X 150mm were made at solution to fly ash ratio of 0.35 with 16 Mole concentrated sodium hydroxide solution. The specimens were cured in oven at 60°C, 90°C and 120°C for 6, 12, 16, 20 and 24 hour's duration. Test results show that the compressive strength increases with increase in duration and temperature of oven curing up to 24 hrs.

Subhash Patankar et.al [5] studied that the flow of geopolymer concrete increases with increase in water-to-geopolymer binder ratio after changing the quantity of water. Geopolymer concrete becomes more viscous with decrease in water-to-geopolymer binder ratios because of the less quantity of water in the mixture. The compressive strength of geopolymer concrete is inversely proportional to the water-to-geopolymer binder ratio. Suitable range of this binder ratio is in the range of 0.25 to 0.35.

Sandeep Hake, et al [6], the oven heat curing of geopolymer concrete has been attempted by various researchers, but for curing of geopolymer concrete is quite difficult on site by using oven, so there is scope on types of curing which makes geopolymer concrete cure easily. The oven heat curing for geopolymer concrete is mostly used. The researchers studied only for different curing temperature in oven curing, but only few of them work on steam, membrane curing and no one work on accelerated curing, as well as comparison on steam, accelerated, membrane, natural and oven curing. So there is scope on method of curing of geopolymer concrete. Also researchers studied for different curing time like 6,12,18,24 and the optimum strength obtained at 18 Hrs of Curing. The different curing temperatures like 60°C, 90°C, 120°C and 150°C. The different type of curing like Oven, Accelerated, Membrane and Steam curing are need to be Study. The effect on compressive strength of Geopolymer concrete by using these parameter need to be study.

Davidovits introduced the term geopolymer in 1978 to represent the mineral polymers resulting from geochemistry [7]. Geopolymer are a class of inorganic polymer formed by the reaction between the alkaline solution, silica and alumina present in source material. The hardened material has an amorphous 3-dimensional structure similar to that of an alumino silicate glass. However unlike a glass these materials are formed at low temperature and as a result can incorporate an aggregate skeleton and a reinforcing system if required, during the forming process. The most common activator is a mixture of water, sodium hydroxide and sodium silicate but other alkali metal systems or mixtures of different alkalis can be used.

Djwantoro Hardjito and etal. [8] studied the influence of curing temperature, curing time and alkaline solution-to-fly ash ratio on the compressive strength. It was reported that both the curing temperature and the curing time influenced the compressive strength. The authors confirmed that the temperature and curing time significantly improves the compressive strength, although the increase in strength may not be significant for curing at more than 60°C. In addition, the compressive strength decreases when the water-to-geopolymer solids ratio by mass increased. The drying shrinkage strains of fly ash based geopolymer concretes were found to be significant.

Subhash V. Patankar et al. [9] studied the effect of quantity of water, temperature duration of heating on compressive strength of fly ash based geopolymer concrete. Na2Sio3 solution containing Na2O of 16.45%, SiO2 of 34.35% and H2O of 49.20% and sodium hydroxide solution with concentration of 13 Molar were used in geopolymer concrete as alkaline activators. Geopolymer concrete mixes were prepared with 0.35 solutions to processed fly ash ratio. Workability was measure by flow table apparatus. Geopolymer concrete cubes of 150 mm X 150 mm X 150 mm were cast. The temperature of curing was varied as 40°C, 60°C, 90°C, and 120°C for each period of 8, 12 and 24 hours of oven heating and tested after a rest period of 1,2,3,7and 28 days after demoulding the concrete cube. Test results show that the quantity of water plays important role in balancing workability but not effect on strength. While higher temperature requires less duration of heating to achieve desired strength and vice versa. Author says that the rest period of 3 days is sufficient after heating at and above 90°C temperature.

V.M. Malhotra [10] uses the fly ash in 1930 as a workability-improving admixture. Later on its application increases as people are aware about pozzolanic reactivity of fly ash. It is used in the manufacture of Portland Pozzolana Cement (P.P.C.), partial replacement of cement and workability-improving admixture in concrete. But its utilization is limited to 20% throughout the world.

An important achievement in this regard is the development of high volume fly ash (HVFA) concrete that utilizes up to 60 percent of fly ash, and yet possesses excellent mechanical properties with enhanced durability performance.

Prabir K. Sarker et al (2013) geopolymer as an alternative binder can help reduce CO2 emission of concrete. The binder of geopolymer concrete (GPC) is different from that of ordinary Portland cement (OPC) concrete. Thus, it is necessary to study the effects of the geopolymer binder on the behavior of concrete. In this study, the effect of the geopolymer binder on fracture characteristics of concrete has been investigated by three point bending test of RILEM TC 50 – FMC type notched beam specimens. The peak load was generally higher in the GPC specimens than the OPC concrete specimens of similar compressive strength. The failure modes of the GPC specimens were found to be more brittle with relatively smooth fracture planes as compared to the OPC concrete specimens. The post-peak parts of the load–detection curves of GPC specimens were steeper than that of OPC concrete specimens. Fracture energy calculated by the work of fracture method was found to be similar in both types of concrete.

Vaibhav A. Kalmegh, et al. [12] shows Cement is the important material for the constructions. But, ordinary Portland cement concrete structure emits large amounts of carbon dioxide, which results the global warming. Global warming is a big challenge for earth. Portland cement industry is one of the largest producers of carbon dioxide. The production of one ton of Portland clinker produces approximately one ton of carbon dioxide. A need of present status is to find alternative binder system to make concrete. On the other scenario huge quantity of fly ash generated around the globe from thermal power plants and generally used as a filler material in low level areas. The main constituent of geo-polymer concrete is fly ash and alkaline solutions. Fly ash is the main by product created from thecombustion of coal in coal-fired power plants. Geo-polymer is an inorganic alumina-Hydroxide polymer synthesized from predominantly silicon (Si) and aluminum (Al) materials of geological origin or byproduct materials such as fly ash. Geo-polymer is a type of alumino-hydroxide product having ideal properties of rock-forming elements. The main advantage of geo-polymer concrete is that it is eco-friendly.

CONCLUSION

In this research review paper, membrane curing of geopolymer concrete is discussed in brief. Oven heat curing of geopolymer concrete has been attempted by various researchers. But for curing of geopolymer concrete is quite difficult on site by using oven, so there is scope to work on types of curing which makes geopolymer concrete cure easily. Most of researcher used only oven heat curing for geopolymer concrete. For the polymerization the heat is required to the geopolymer concrete .They studied only for different curing temperature in oven curing, but only few researcher work on membrane, so there is scope on method of curing of geopolymer concrete. So there is scope to study the mechanical properties like short term as well as long term property of geopolymer concrete. Also researchers studied for different curing time like 6,12,18,24 hours and also for different curing temperature but few researchers worked on different rest period, so there is scope for work.

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