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State of Art-Lime Added Geopolymer Concrete

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Abstract -*In modern India, demand for more infrastructure development is rising day by day in both urban as well as rural areas which require cement as per today's technology. The production of cement in India the 2017 is expected to reach 407 tons according to IBEF (India Brand Equity Foundation). But this ordinary Portland cement is causing more environmental problems, pollution and greater emission of CO2. Fly ash creates environmental problems as most of the fly ash is stored in open landfills and heavy metals from it reach into groundwater and pose threat to health of surrounding population. To tackle this issue, we can use industrial waste material like fly ash which proves to be more eco friendly when used in geopolymer concrete along with lime. The main objective of this project to study the various property of geopolymer concrete and compare it with OPC Concrete. Other objective of this project is to define various parameters such as molarities, temperature variation and Optimum percentage of lime addition. Sodium silicate and Sodium hydroxide ratio, course aggregate ratio, replacement of lime percentage and binder ratio.*

Key Words: Geopolymer concrete, Fly Ash, Slaked Lime, Alkaline solution.

1. INTRODUCTION

Geopolymer concrete is an innovative and eco friendly construction material and an alternative to Portland cement concrete. Use of geopolymer reduces the demand of Portland cement which is responsible for high CO_2 emission and pollution. Geopolymer cement concrete is made from utilization of waste materials such as fly ash. Fly ash is the waste product generated from thermal power plant and ground granulate blast furnace slag is generated as waste material in steel plant.

Fly ash is the byproduct of coal combustion collected by the mechanical or electrostatic precipitator (ESP) before the flue gases reach the chimneys of thermal power stations in very large volumes. The texture, physical, chemical, geological properties of fly ash generated from coal including heavy metal content and radioactivity are similar to those of common soils. Due to these properties of fly ash, it can be safely used in agriculture, mines, road, building material, infrastructure development etc. The pozzolanic property of fly ash/lime reactivity enables it to be used in manufacture of cement and in concrete to replace cement. The use of fly ash for various applications is beneficial from health and environment point of view also.

Slake lime was created when calcium oxide reacts with water to form calcium hydroxide. A lot of heat is produced in the reaction, which may even cause the water to boil.

Sodium hydroxide and Sodium silicate are commercially available in market in Flake and pellet form. In all forms, sodium hydroxide is highly corrosive and reactive.

Sodium silicate is stable in neutral and alkaline solutions. In acidic solutions, the silicate ion reacts with hydrogen ions to form silica acid, which when heated and roasted forms silica gel, a hard, glassy substance. The sodium hydroxide and sodium silicate solution is prepared one day before the casting.

2. LITERATURE REVIEW

Subhash Patankar et.al[1] 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.

Prakash R. Vora et.al[2] investigated that the ratio of alkaline liquid to fly ash, by mass does not affect the compressive strength of the geopolymer concrete. The

sodium silicate to sodium hydroxide ratio by mass equal to 2 has resulted into the higher compressive strength as compared to the ratio of 2.5 for the geopolymer concrete. The compressive strength of the geopolymer concrete increases with increase of concentration in terms of molarities of sodium hydroxide. 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. Compressive strength of the geopolymer concrete decreases with increase in the ratio of water to geopolymer solids by mass.

Subhash Patankar et.al[3] 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. The rate of gain of strength is slow when heat cured at 40°C as compared to strength at 120°C. But there is no appreciable change in compressive strength beyond curing temperature of 90°C. The duration of heating in the range of 6 to 24 hours produces higher compressive strength. However, the increase in strength beyond 12 hours is not very significant. 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.

B. Siva Konda Reddy et.al[4] highlighted that the concrete sample cured at 60°C the samples without cement is giving more strength at early ages and showing less strength at late ages when compared with geopolymer concrete sample with cement. When fly ash is replaced by cement for making of geopolymer concrete, normal curing is giving more strength compared to temperature curing at 60°C.Higher concentrations of sodium hydroxide (in the range of 10 M to16 M) solution results in a higher compressive strength of geopolymer concrete for all mixes.

Kolli Ramuji et.al[5] investigated that for Water/binder ratio & alkaline liquid/Fly ash ratio are the governing factors in designing the Geopolymer mix design for various grades. The Water/binder ratio 0.21 and Alkaline liquid to fly ash ratio of 0.40 are suggested for G40 which indicates improvement in compressive strength of geopolymer concrete can be achieved by decreasing water binder ratio. The compressive strength attained at 28 days for Geopolymer concrete under ambient curing is almost equal to compressive strength achieved by Geopolymer concrete at 7 days.

B.H.Shinde et.al[6] investigated that the activator solution prepared before 1day produce the same strength as solution prepared at the time of mixing. The mortar curing after 4 days rest period produce ultimate compressive strength at 7 days. The mortar cubes cured at 80°C temperature for 1 day gives the maximum compressive strength. The solution to fly ash ratio 0.5 gives the ultimate strength to mortar for all ratios of sodium silicates to sodium hydroxide. The mix with Sodium silicates to sodium hydroxide ratio 1.5 and 2.0 provide the maximum strength as compared to other ratio.

Subhash Patankar et.al[7] studied that the fineness of fly ash plays a role in the strength development of geopolymer concrete. The mass density of geopolymer concrete increased with the increasing fly ash fineness. A higher fineness resulted in a higher workability as measured by the flow test. The alkalinity of geopolymer concrete was slightly affected by the fly ash fineness but it was similar to that of cement concrete.

B.Siva Konda Reddy et.al[8] recommended that the workability of geopolymer concrete is reduced with higher concentrations of sodium hydroxide (in the range of 10 M to16 M) solution which results in a higher compressive strength. There is a slight increase in the compressive strength with age of the concrete for a defined concentration of NaOH solution. The addition of high-range water reducing admixture with 1.5% of fly-ash resulted no much impact on the compressive strength of the hardened concrete, but improved workability of fresh geopolymer concrete.

Debabrata Dutta et.al[9] studied that Pore sizes get reduced after addition of Lime stone dust into geopolymer paste sample. This phenomena influences water absorption and compressive strength. Incorporation of Lime stone dust up to 12% increases the compressive strength of paste specimens about 40%.This could be due to the notable variations of porosity between the specimens prepared with or without Lime stone dust. Water absorption values were found directly related to total porosity of specimens. For paste specimens, water absorption showed a decreasing trend in water absorption with increasing Lime stone dust content.

Nisha Jain et.al[10] investigated that, the compressive strength goes on increasing with the increase in the rest period of geopolymer concrete with addition of 10% of Lime and it's cured at normal room temperature. The maximum compressive strength was achieved at the completion of 28 days of rest period thereby giving it a wide scope. The compressive strength achieved by grade M30 of geopolymer concrete cured at normal room temperature at a rest period of 7 days is higher than the

compressive strength achieved by ordinary concrete for similar rest period.

Nisha Jain et.al[11] studied that Compressive strength can be achieved for both the grade of GPC by replacing Fly ash with Cement for various percentages i.e. 5% & 10% by opting wet curing. The compressive strength goes on increasing with the increase in replacement percentage with cement in M30 grade of GPC by opting wet curing where maximum can be achieved by replacing 10% with cement.

Mohammad Areeb Qidwai et.al[12] investigated that the geopolymer concrete also shows excellent resistance to sulfate attack, good acid resistance, undergoes low creep, and suffers very little drying shrinkage. If steam curing of geopolymer concrete is done then its increases the strength of concrete. It is impermeable and shows higher resistance to heat. The increase in the content of bases increases both compressive as well as tensile strength. The setting time is very short so it is necessary to add super plasticizer to delay the setting time.

CONCLUSION

This research review paper discusses addition of lime to geopolymer concrete in order to increase solution to binder ratio significantly. The curing of GPC with heating is necessary. To remove the heat curing by adding lime in it so that internal heat curing occurred which is helpful for the polymerization. The compressive strength of GPC increases with addition of Slaked lime as it provides extra heat to the solution. Many researchers worked on different type of curing such as oven, steam, membrane and accelerated curing with this type of method on site is difficult. Therefore we concluded that addition of lime and natural sunlight make curing of geopolymer.

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