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EFFECT OF NA_2SIO_3/NAOH RATIO FOR FLY ASH BASED SELF-COMPACTING GEOPOLYMER CONCRETE

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Abstract - *This paper presents the details of the studies carried out on development of strength for various grades of geo-polymer concrete with varying molarity. The alkaline liquids used in this study for the geo-polymerization are sodium hydroxide (NaOH) and sodium silicate (Na2SiO3). Different molarities of sodium hydroxide solution (1M to 18M) are taken to prepare different mixtures. The waste water from the Chemical Industries is discharged into the ground which contaminates ground water. By producing Geo-polymer Concrete all the above-mentioned issues shall be solved by rearranging them. Waste Fly Ash from Thermal Industry + Waste water from Chemical Refineries = Geo polymer concrete*

Key Words: NaOH1, Na2SiO32, fly ash3, Self-compacting concrete4, Geo polymer concrete5.

1. INTRODUCTION

The SCGC is a distinctive concrete, which does not require any extra compaction, it will flow and compact by way of its self-weight, mainly at congested reinforcement. The SCGC is manufactured through utilizing industrial by means of-products like Fly ash, GGBS, waste glass powder, silica fume and rice husk ash, materials containing extra alumina and silica can be used. These materials can be activated by adding an alkaline solution (Sodium Hydroxide and sodium silicate). By utilizing of superplasticizers like Viscosity modifying Agent (VMA), concrete can flow. The Self Compacting Concrete is a special concrete, which does not require compaction. It will flow and compacted by its self-weight. Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement.

II. LITERATURE REVIEW

Brief information of the research work done by researchers about topic which will help us to decide about the subject is as given below.

MadheswaranC.K et.al [2013 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, and 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

Subhash V. Patankar, et.al (2013) investigated that, the desired compressive strength was achieved by fixing the solution-to-fly ash ratio of 0.35for 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. It also investigated that, 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. Similarly, 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 upto three days. It is 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.

Sourav K r. Das et.al (2014) investigated that, with a higher Na2SiO3 gives a higher strength, and generally with a ratio of 2.5. Heat cures geopolymer concrete gives higher strength. 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. Geopolymer concrete has excellent properties as discussed earlier so it can be very useful for rehabilitation and retrofitting works

Hake et al (2015) reported that the cement production generated carbon dioxide, which pollutes the atmosphere. The thermal industry produces a waste called fly ash which is simply dumped on the earth, which occupies larger areas. The waste water from the chemical industries is discharged into the ground which contaminates ground water. By producing geopolymer concrete, all the above-mentioned issues shall be solved by rearranging them. Waste fly ash from thermal industry + waste water from chemical refineries geopolymer concrete. Further, the use of fly ash as a value-added material as in the case of geopolymer concrete reduces the consumption of cement. Reduction of cement usage will reduce the production of cement which in turn cut the CO 2 emissions. Many researchers have worked on the development of geopolymer cement and concrete for the past ten years. The present work deals with the result of the experimental investigation carried out on geopolymer concrete using processed and unprocessed fly ash with sodium silicate and sodium hydroxide. The study analyses the effect of processed and unprocessed fly ash on compressive strength and split tensile strength for different temperatures. To study the effect of different types of processed and unprocessed fly ash, we use processed fly ash such as P60, P80, and P100 fromDirk India Pvt. Ltd. And unprocessed fly ash from different cities such as Bhusawal, Nashik, and Beed. In this paper, the effect of the alkaline solution on different fly ash is investigated.

Nisha Jain et.al [2016] she is 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. It also 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. Grade M30 having alkaline solution ratio as 2.5 and were cured at 90°C in an oven for 24 hrs with the addition of optimized lime percentages (10%). The lime percentages were calculated in accordance with the weight of fly ash. After the completion of the defined curing time, these specimens were kept at normal room temperature with a rest period or testing age of 07, 14, 21, 28, and 56 days. The specimens were tested after testing age to know the effect of the rest period on the strength of GPC with lime addition into geopolymer concrete.

3. Experimental Program

3.1 Material

- Fly ash
- Aggregates (coarse agg. & fine agg.)
- NaOH
- Na2SiO3
- Lime

The mix design under the Guidelines of "The European Guidelines for Self-Compacting Concrete"

4. RESULTS AND DISCUSSION

4.1 The effect of molarity on geopolymer concrete.

[1]

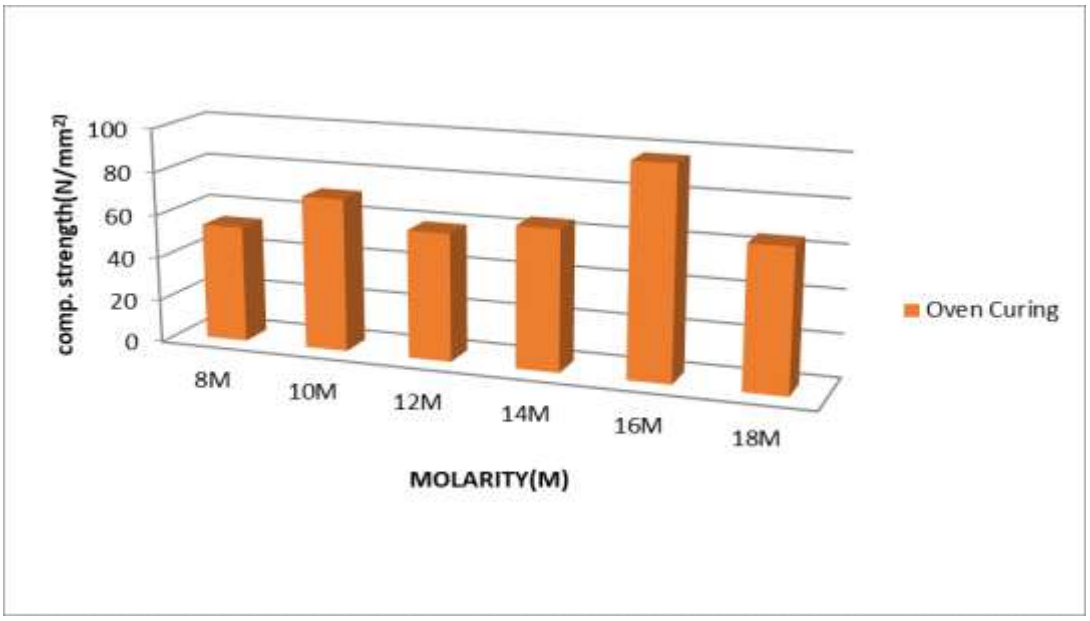

Fig 4.1 molarity and comp. strength

The above fig shows that for 16 molar gives higher value of compressive strength.

[2]

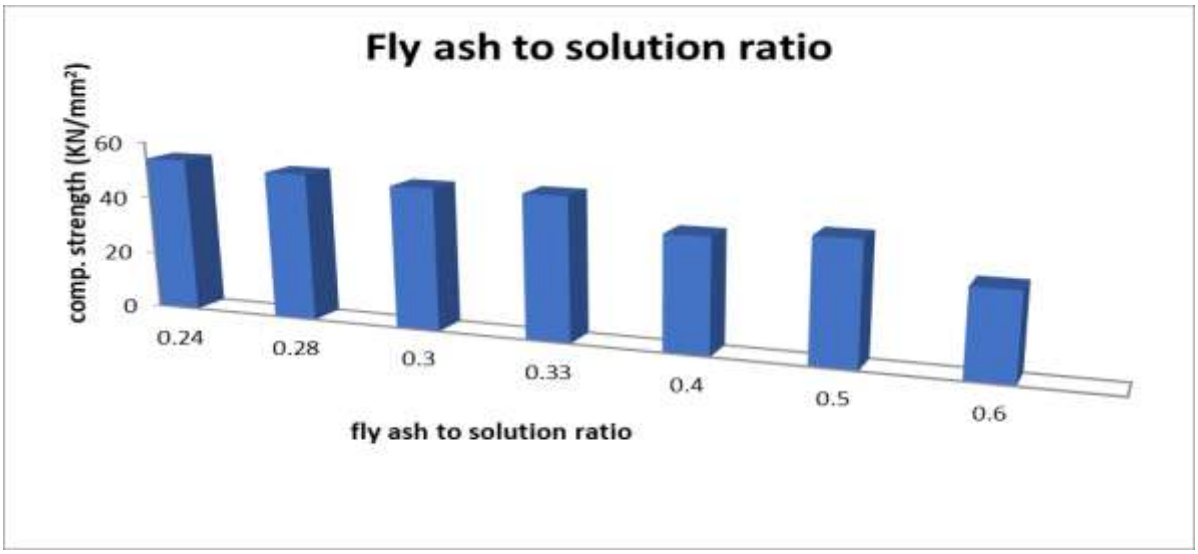

Fig 4.2 fly ash to solution ratio and comp. strength

the above fig shows that 0.24 fly ash to solution ratio gives the higher compressive strength.

[3]. Natural sunlight effect on geopolymer concrete

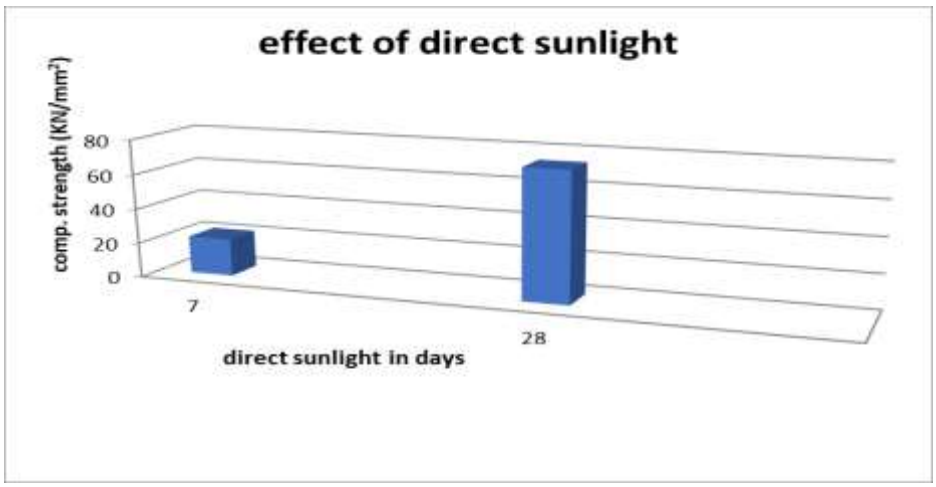

Fig 4.3 effects of direct sunlight and comp. strength

The above fig shows that 28 days of direct sunlight gives maximum compressive strength as compared to 7 days ratio.

4.2 Flowability tests

The mix design under the Guidelines of "The European Guidelines for Self-Compacting Concrete" i.e. EURO CODE

All Material below

1. Fly Ash = 6 kg
2. Coarse Aggregate = 12.50 kg
3. Fine Aggregate = 7 kg
4. Na2SiO3 = 2.00 lit
5. NaOH = 2.00 lit
6. VMA = 110 Gram / ML
7. EXRTA WATER = 450 ML

4.3 Graph of flowability tests

Slump cone test: -

Fig 4.4 Slump cone test

We take 7 trials through europian guidelines code criteria out of that the trial no.6 gives maximum slump value.

Inverted Slump cone test: -

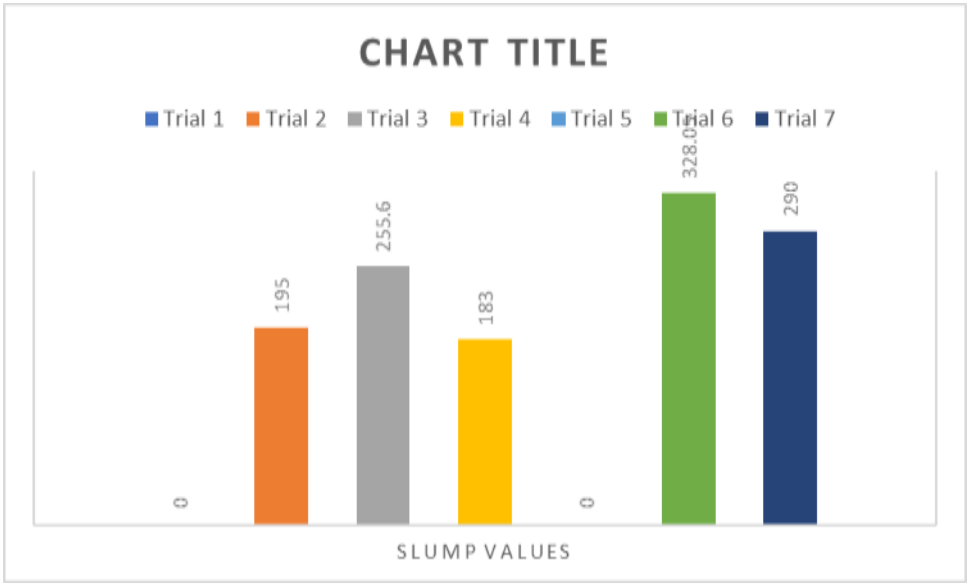

Fig 4.5 Inverted Slump cone test

We take 7 trials through europian guidelines code criteria out of that the trial no.6 gives maximum slump value.

CONCLUSIONS

Based on the experimental work reported in this study, the following conclusions are drawn:

[1] The compressive strength is increased with decrease in Fly-ash to solution ratio from 0.6 to 0.45 but the compressive strength decreased with further decrease in Fly-ash to solution ratio from 0.35. Hence 0.35 can be taken as optimum value for high strengths.

[2] The decrease in water content favours the formation of geopolymerization process, which demands for increase of concentration of Sodium hydroxide and sodium silicate silicates. Hence increase in concentration of NaOH results in increase of compressive strength. Hence it is recommended 16M concentrations for medium grade.

[3] These constituents of Geopolymer Concrete shall be capable of being mixed with a relatively low-alkali activating solution and must be curable in a reasonable time under ambient conditions.

[4] Fly ash-based geopolymer with 16M NaOH concentration shows excellent result with high compressive strength (97 MPa) for 7th days of testing.

[5] If the alkaline solution ratio of geopolymer concrete is increases then strength and properties of concrete are also increases.

[6] After the curing of cubes with the help of oven at 80 C temperature for 24 hours then it placed for rest period in the presence of natural sunlight if rest periods are increases then strength of geopolymer also increases.

[7] The government can make necessary steps to extract sodium hydroxide and sodium silicate solution from the waste materials of chemical industries, so that the cost of alkaline solutions required for the geopolymer concrete shall be reduced.

[8] The fresh geopolymer concrete is easily handled up to 120 min without any sign of setting and without any degradation in the compressive strength.

[9] If the fly ash to solution ratio increases then slump value of geopolymer concrete also decreases.

[10] The fly ash, once considered as waste material, has found usefulness through Geopolymer concrete in construction industries and become a valuable material.

[11] Development of high strength Geopolymer concrete manufactured with silicates and hydroxides of potassium and the effects of higher strength.

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BIOGRAPHIES

I PG Student. I have Completed this project under the guidance of Dr.S.L. Hake. Special thanks to him.

Guide – Dr.S.L. Hake.