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Evaluate Compressive Strength of Geopolymer by Using Different Fibers and Curing Conditions

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Abstract*: Day by day conservatory emissions is increases on earth. In manufacture of Portland cement(PC), obliquely we are escalating the carbon dioxide in atmosphere by the invention of PC.. Industrial by-products such as fly ash(FA), ground granulated blast furnace slag(GGBS), rice husk, bagasse, etc. are mainly used in manufacturing industry because these resources contain good bonding assets, amplified stability and decreased the porosity. evaluate to PC these assets are inexpensively good. Auxiliary by means of these manufacturing by products we are eventually lessening the carbon dioxide. PC with the manufacturing by products such as FA, bagasse , GGBS, Rice Husk Ash, Metakaolin etc., In these materials GGBS, FA, bagasse are commonly used for bursting substitution of PC. match up to PC GGBS, FA, rice husk be as well offer privileged compressive strength results when activate by alkali with similar curing's. This concrete is known as Geo polymer concrete(GPC). To prepare the GPC we require alkali solutions(AS) like NaOH and Na_2SiO_3. arrange the AS, by considering singular molarities of NaOH like 9M and 14M and singular concentrations of Na2SiO3 like 40%. get ready the AS of NaOH and Na2SiO3 discretely one hour before the mixing of GPC. dispose the cubes to find the mechanical properties such as compressive strength, and density of GPC. The specimens were tested after 28 days of special curing's. To improve the properties of GPC, we are accumulation different fibers and go on it for 28 days of different curing conditions of GPC. finally we know the compressive strengths of different fibers and curing conditions of GPC

***Keywords* : GGBS, Silica fume, Na2SiO3, NaOH. Gypsum, Glass fiber, Steel fiber.**

I. INTRODUCTION

Geo polymer concrete is a free cement concrete which is made up of manufacturing by products made up of FA, GGBS, SF, bottom ash, bagasse. As the infrastructure development growing worldwide the demand for concrete increases and also the demand for cement greenhouse gases co_2 emission is more. Due to the emissions of co_2 global warming occurs. Due to that global warming heat increases on the earth. Co_2 emissions leads to the occurrence of pollution in the environment and also human are being effected to several health hazards & problems

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By replacing of OPC with industrial byproducts it leads to reducing the co_2 emissions in the atmosphere. By using Geo polymer concrete it prevents the hazardous problems in the environment. It also enhances the more compressive strength compared to ordinary Portland cement. The properties of GPC is it reduces the heat of hydration, reduces the efflorescence formations on concrete structures, & it prevents the sulphate attack, chloride attack, acid attack on concrete. By incorporation of steel and glass fibers into Geo polymer concrete it prevents the cracks during plastic shrinkage and drying shrinkage. Increases the tensile strength of concrete and also increase freeze thaw resistance. By using the glass fibers it increases the heat resistance of concrete. It reduces the soundness and thermal resistance.

II. DESIGN OF MIX PROPORTION

We have to take two grades of concrete are M15 & M20. We go through various studies on the geopolymer materials we select the materials as binder are GGBS & silica fume with various percentages. These have similar binding properties like cement and these are economical and ecofriendly, so in the place of cement we use GGBS & silica fume as a binder. Selection of molarities of NaOH. From trial mixes of geopolymer concrete of different molarities (6M, 8M, 9M, 12M, 14M) tested on comparison testing machine for 7 days cured in different curing conditions ambient & water. Then according to compressive strength of cubes in7 days, 8M gives maximum strength than other molarities. So, we adopt molarities for NaOH as 8M for entire study. Selection of concentration of Na2SiO3 were 15%, 45%, 65% tested on compression testing machine for 7 days cured in different curing conditions (ambient & water). 15% & 45% of Na_2SiO_3 gives very high strengths among all other concentrations so we adopt Na_2SiO_3 concentrations are 15% & 45%. Selection of A/B. This solution is prepared by mixing of sodium hydroxide(SH) solution & sodium silicate(SS) solution. Trial mixtures of different alkaline to binder ratios 0.6, 0.7, 0.9 were tested on compression testing machine for 7 days in different curing conditions. A/B ratio of 0.6 mixture is very difficult to prepare the mixture with low workability & unable to use 0.9 due to the mixture is turned into slurry & 0.7 gives maximum results. So, we adopt A/B ratio as 0.7 for entire study. Selection of ratio of NaOH to Na_2SiO_3 from the literature study NaOH to Na_2SiO_3 was maintained in the ratio of 1:2.5. ¬ So, we adopt SS to SH value is 2.5 for entire study.

A. Mix Proportions Calculations

For conventional concrete mix design proper code of practice and defined procedure are available. But GPC there is no proper system of follow no defined procedure are available.

So based on the conventional concrete mix design we have to design the GPC mix design also. The alkali activators are NaOH and Na2SiO3 in geopolymer concrete mix.

B. Calculation for Solution Preparation

By the reference of Perry's hand book for chemical engineers is the standard reference book used all over the world since it was published in 1915 by Prof. Perry (Green, 1999). In this book various proportions of sodium hydroxide solution at various concentrations data are available.

III. Concrete Specimens

A. Preparation of Solution

First take the required weights of NaOH flakes and Na_2SiO solution, for preparing concentrated solution. Na_2SiO_3 solution is dissolved in water very easily, but sodium hydroxide flakes are not easily dissolved in water so, stirred until the sodium hydroxide flakes are completely dissolved in water. The ratio of sodium silicate and sodium hydroxide by mass was maintained 2.5 Both solutions are prepared separately, before 24 hour to the concrete mix. ¬ During the preparation of sodium hydroxide solution some amount of heat can be generated. Due to that heat the solution is evaporated easily. So that particularly for controlling evaporation losses sealed the solution.

B. Mixing of Ingredients

Based on the trail mixes, and considering the strength parameter, Ground granulated blast furnace slag is used as 70% and silica fume is used as 30% ; and gypsum is used as 5% of binder to get desired setting time in the finished products. River sand used as fine aggregates and coarse aggregates are 20mm and 10mm are used. The used alkali activators are NaOH and Na_2SiO_3. After testing the physical and chemical properties of ingredients, the mix was prepared by using all materials to prepare geo polymer concrete cubes (150mm X 150mm X 150mm). Take the weights of GGBS, fly ash, and silica fumes respectively with gypsum, river sand, coarse aggregates separately. First properly mix the GGBS, fly ash, silica fume and gypsum. Once mixing is completed pour fine aggregate and coarse aggregates. These all materials were mixed together by electrical mixture for 2-3 minutes. After that add alkali activated solution like sodium hydroxide and sodium silicate concentrated solution. After adding these solutions, the mixing is continuously for another 2-5 minutes.

C. Preparation of Cubes

After mixing geopolymer concrete is placed into moulds in 3 layers. Each layer was compacted by 25 blows by using tamping rod. The diameter of tamping rod is 20mm. after tamping the specimens; the specimens are placed in vibration table for 1 minute. After mixing, casting, curing and testing the geo polymer concrete cubes.

Fig. 1.Preparation of cubes.

IV. Method of Curing

Curing is the process during which special care is taken to maintain conditions favorable to continued hydration of cement and cementations material in concrete. Once curing is completed the specimens are placed in a room at room temperature. After 24hrs of time the specimens are separated from moulds. Curing plays a vital role on strength maturity and toughness of concrete.

A. Ambient Curing

Ambient curing means the cubes are exposed to air and natural sunlight for 28 days. Fly ash based or ggbs geopolymer concrete reveals that hardening makes fast in ambient curing rather than the water curing. If curing is not done, there is water deficiency which causes insufficient hydration, as a result there will be causing cracks and shrinkage, poor strength development and lower durability. These are the issues occur when OPC used in concrete, then no need water curing for GPC because it does not produce carbon dioxide.

Fig. 2.Ambient curing of cubes.

B. Water Curing

Water curing means the cubes are placed in water for 28 days. Water is the important ingredient of concrete it causes the chemical reaction with cement is called as "hydration of cement". The hydration reaction causes the concrete to set and develop strength & it takes 28 days to complete development of strength. Water curing is very important to prevent evaporation losses and to keep control on the temperature of concrete.

Fig. 3.Water curing of cubes.

V. Mechanical Tests on GPC

The main aim is to finding the mechanical properties of the geopolymer concrete and the details of the test procedure are explained below.

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A. Compressive strength of GPC cubes

The compressive strength tests on GPC cubes were perform on a 2000kN aptitude hydraulic testing machine in conflict to the pertinent Indian standard IS: 516-1959. 6 cubes are prepared for each mix. Each 3 cubes were cured at ambient, and water curing for 28 days.

Fig. 4.Compressive strength testing machine.

B. Density of Geopolymer Concrete Cubes

After 28 days of ambient curing to find out the variations of density of geopolymer concrete cubes. Age of concrete increases there is a chance of little bit change in density.

Fig. 5.weighing machine to find density of cube.

VI. RESULTS AND DISCUSSION

Geopolymer concrete for various cubes are prepared by using different concentrations of NaOH and Na2SiO3 by adopting a alkali binder ratio of 0.7 based on different trails.

A. Mechanical Properties of Geopolymer Concrete

To find mechanical properties of GPC we have to done tests like compressive strength and density tests.

B. Compressive Strength of Geopolymer Concrete cubes

Combinations of NaOH and Na2SiO3 were used for the preparation of geopolymer cubes. The size of the specimens is 150mmm X 150mm X 150mm were used for the conducting compressive test. These specimens are tested in compression testing machine after 28 days of ambient curing.

C. Compressive strengths of Geopolymer concrete of M15 grade at 8Molarity

Table- II: Calculation of compressive strengths of GPC for M15 grade

% of Na_2SiO_3	Type of Material	Curing conditions	Compressive strength (28 days)
15%	Glass	Water curing	31.66
		Ambient curing	32.96
	Steel	Water curing	31.34
		Ambient curing	35.38
45%	Glass	Water curing	36.17
		Ambient curing	39.44
	Steel	Water curing	37.75
		Ambient curing	40.63

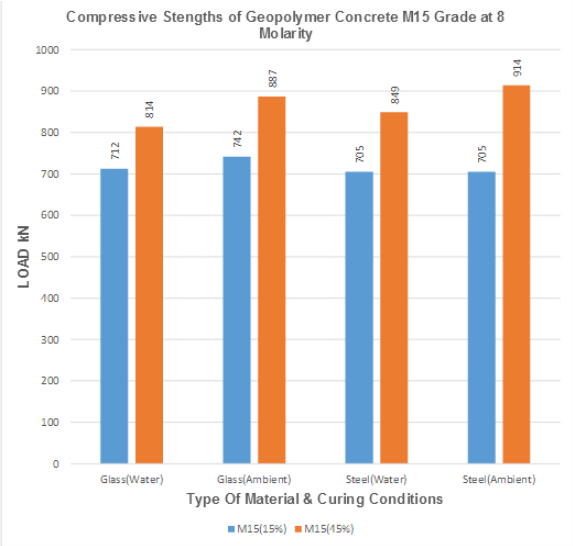
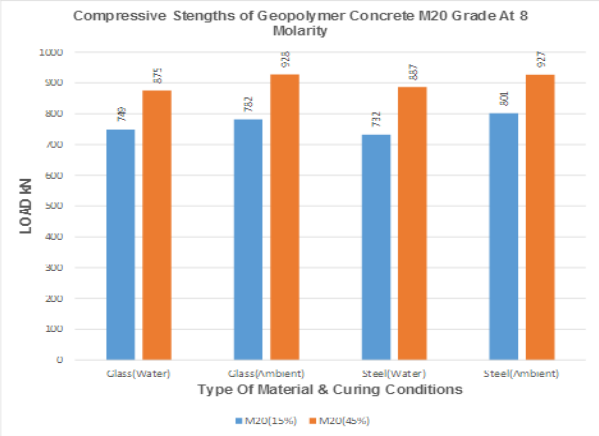


Table- II: Calculation of compressive strengths of GPC for M20 grade

% of Na_2SiO_3	Type of Material	Curing conditions	Compressive strength (28 days)
15%	Glass	Water curing	33.28
		Ambient curing	34.75
	Steel	Water curing	32.54
		Ambient curing	35.62
45%	Glass	Water curing	38.87
		Ambient curing	41.26
	Steel	Water curing	39.41
		Ambient curing	41.19



VII. CONCLUSION

1. Compressive strength of GPC is increases with the increasing of sodium silicate deliberation. Compared to 15% and 45%, the compressive strength is more at 45% concentration.
2. Compared to ambient curing and water curing more compressive strength is observed at ambient curing conditions.
3. Compared to steel and glass fibers more strength is observed for glass fibers.
4. Based on visual observation workability of geopolymer concrete increase with the increase of sodium silicate concentration.
5. Based on visual observation temperature will also affect the mix. The setting time decreases with the increase of temperature

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