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EXPERIMENTAL INVESTIGATION FOR FLEXURAL STRENGTH OF FLY ASH CONCRETE WITH ADDITION OF ALKALINE ACTIVATER

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ABSTRACT

Cement is the most energy intensive construction material which production increases 3% annually. The production of one ton of cement liberates about one ton of carbon dioxide to the atmosphere. So, one of the way to produce eco-friendly concrete to reduce the use of Cement by replacing fly-ash with alkaline liquids. In this project comparison of Flexural strength of Geopolymer concrete with Control concrete. At first mix proportion for M40 Grade is found using IS method. In proportion the cement is fully replaced by fly-ash with alkaline liquids. Sodium silicate (Na2Sio3) and Sodium hydroxide (NaOH) solution are used as alkaline liquids in different Molarities proportions. Concentration of NaOH was kept 8M and 10M in order to make 1Kg of solution; 400g of pellets were dissolved in the 1 liter of water. Both the liquids were mixed together and alkaline solution was prepared. In this project casting of beam of size 1000 X 150 X 150 mm are cast for finding flexural strength. The beams are tested at 7, 14 and 28 days. And then the strength Geopolymer concrete compared with Nominal concrete.

Keywords: geopolymer concrete, molarity, flyash, alkaline activators.

INTRODUCTION

The geopolymer technology proposed by Davidovits shows considerable promise for application in concrete industry as an alternative binder to the Portland cement. In terms of reducing the global warming, the geopolymer technology could reduce the carbon-di-oxide emission to the atmosphere caused by cement and aggregates industries by about 80%.Inspired by the geo-polymer technology and the fact that mixture proportions, the manufacture of low calcium fly ash-based geopolymer concrete the short term properties of the geo-polymer concrete in the fresh and hardened states.The scope of the present project work is the investigation on flexural strength of fly ash concrete obtained from alkaline activator involved development of an alkali activated concrete.

LITERATURE REVIEW

S. E. Wallah and B. V. Rangan.There is no substantial gain in the compressive strength of heat-cured fly ash based geopolymer concrete with age. Fly ash-based geopolymer concrete cured in the laboratory ambient conditions gains compressive strength with age. The 7th day compressive strength of ambient-cured specimens depends on the average ambient temperature during the first week after casting; higher the average ambient temperature higher is the compressive strength.

Shankar H. Sanni, Khadiranaikar. Fly ash based GPC specimens prepared with different alkali content showed varying degree of deterioration when exposed to sulphuric acid.Specimens received white deposits on the surfaces during exposure to magnesium sulphate solution which gradually transformed from soft and flaky shape to hard and rounded shape. Higher ratio of sodium silicate-to-sodium hydroxide liquid ratio by mass, gives the higher compressive strength of geopolymer concrete.The addition of high-range water-reducing admixture, up to approximately 2% of fly aby mass, improved the workability of fresh geopolymer concrete with very little effect on the compressive strength of hardened concrete.

METHODOLOGY

Ordinary Portland Cement concrete (OPC) was designed for a characteristic strength of M40 grade as per IS 10262-2009 and the mix proportion thus obtained are presented in Table-1 Standard mix design approaches are not available for GPCs, as they are a new class of construction materials. In the present experimental work, GPC mix proportion for M 40 grade was obtained by trial and error method.

Table - 1. Mix proportions.

Materials	**Quantity** (kg/m^3)
Coarse aggregates	1293.6
Sand	554.4
Alkaline liquid	157.72
Water	59.926
Fly ash	398.28

MIXING

It was found that the fresh fly ash-based geopolymer concrete was dark in colour (due to the dark colour of the fly ash), and was cohesive. The amount of water in the mixture played an important role on the behaviour of fresh concrete. When the mixing time was long, mixtures with high water content bled and segregation of aggregates and the paste occurred. This

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phenomenon was usually followed by low flexural strength of hardened concrete.Davidovits suggested that it is preferable to mix the sodium silicate solution and the sodium hydroxide solution together at least one day before adding the liquid to the solid constituents. He also suggested that the sodium silicate solution obtained from the market usually is in the form of a dimer or a trimer, instead of a monomer, and mixing it together with the sodium hydroxide solution assists the polymerisation process. When this suggestion was followed, it was found that the occurrence of bleeding and segregation ceased.

The effects of water content in the mixture and the mixing time were identified as test parameters in the detailed studied. From the preliminary work, it was decided to observe the following standard process of mixing in all further studies.

- Mix sodium hydroxide solution and sodium silicate solution together at least one day prior to adding the liquid to the dry materials.

- Mix all dry materials in the pan mixer for about three minutes. Add the liquid component of the mixture at the end of dry mixing, and continue the wet mixing for another four minutes.

Therefore it can be seen that these mixes have a high alkaline liquid amount, a medium amount of water and the NaOH is of a high concentration.This is an important observation, as if this were to occur within a practical application it could have significant.

PROCEDURE FOR MAKING GEO POLYMER CONCRETE SPECIMEN

In the laboratory, first fly ash and the aggregates were mixed together. The aggregates were prepared in saturated-surface-dry condition. The alkaline liquid was mixed with the extra water, if any. The liquid components of the mixture were added to the dry materials and the mixing continued usually for another four minutes. The fresh concrete could be handled up to 120 minutes without any sign of setting and without any degradation in the compressive strength.

The mixture was cast in 150 x 150 x 1000 mm beam steel mould. Immediately after casting, the samples were covered by a film to avoid the loss of water due to evaporation. Then the beam were removed from the mould and then placed in curing in room temperature. The flexural strength test studied on a beam at 7, 14, 28 days and results are tabulated.

The beam specimens were 150mm wide and 150mm deep in cross section. They were 1000mm in length. The clear cover of the beam was 25mm.High yield strength deformed steel bars of diameter 16mm; 12mm and 8mm were used as the longitudinal reinforcement in the specimens.

Three different percentages of tensile reinforcement of 1.82 to 3.33% tension reinforcement (8 to11% of corresponding balanced section reinforcement) were used. Two legged vertical stirrups of 8 mm diameter at a spacing of 100 mm centre to centre were provided as shear reinforcement.

Preliminary tests also revealed that fly ash-based geopolymer concrete did not harden immediately at room temperature. When the room temperature was less than 30ºC, the hardening did not occur at least for 24 hours. Also, the handling time is a more appropriate parameter (rather than setting time used in the case of OPC concrete) for fly ash-based geopolymer concrete.

RESULTS AND DISCUSSIONS

Cube compression test

The test specimen was mounted in a UTM of 1000 kN capacity. The supports of the beam rested on a stiffened steel box girder of length 1000mm. The effective span of the beam was 750 mm. The load was applied on two points each 250mm away from centre of the beam towards the support.The load was applied to the 2.5KN interval. The specimen is tested on 28th day to study flexural strength property of the high calcium fly ash based geopolymer concrete on ageing

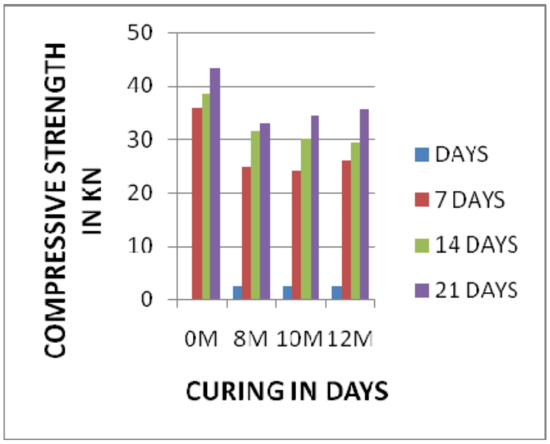

Figure-1. Comparison of compressive strength of geopolymer concrete with varying molarities.

Split tensile test

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist, the direct tension because of its low tensile and brittle in nature. However the determination of tensile strength of concrete is necessary to determine the load at which the concrete members crack. The cracking is a form a tensile failure.

A total of 12 cylinders for M-40 grade controlled concrete with of with alkaline were tested.The test consists of applying a compressive line load along the opposite generator of a concrete cylinder placed with its axis horizontal between the compressive plates of CTM.

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The load was increased until the specimen fails, and the maximum load applied to the specimen during the test was recorded. The mean value of the three specimen of each type is taken as final split tensile strength value.

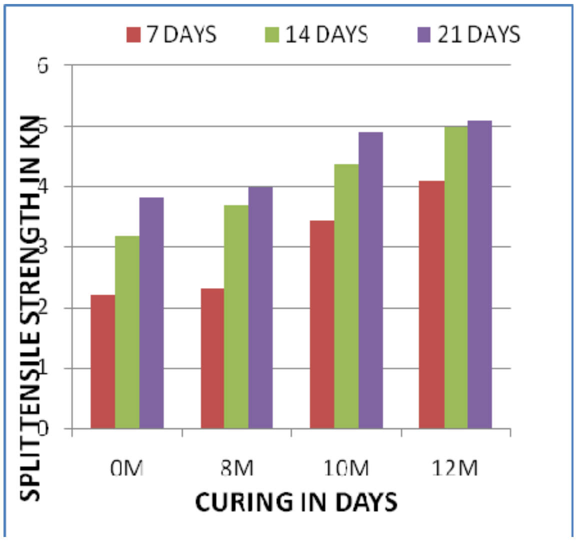

Figure-2. Split tensile strength of geopolymer concrete with varying molarities.

Flexural strength

Flexural test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to flexural strength.

Figure-3. First crack formed in specimen.

Table-2. Flexural strength of geopolymer concrete (Concentration of NAOH is 8M) 100% of fly ash in concrete.

Specimen No.	7 days (KN)	14 days (KN)	28 days (KN)
1	40	50	56
2	42.2	48.2	56.2
3	42.4	49.1	58

Table-3. Flexural strength of geopolymer concrete (Concentration of NAOH is 10M) 100% of fly ash in concrete.

Specimen No.	7 days (KN)	14 days (KN)	28 days (KN)
1	46.25	52.3	60.21
2	45.20	52.36	62.35
3	46.02	53.6	60.21

Table-4. Flexural strength of conventional concrete.

Specimen No.	7 days (KN)	14 days (KN)	28 days (KN)
1	52.5	58	66
2	50	58.5	65.6
3	50.1	59	67

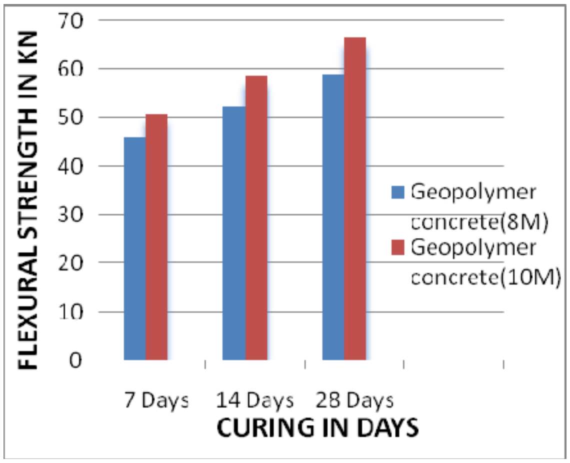

Figure-4. Comparison of flexural strength of gpc with varying molarities.

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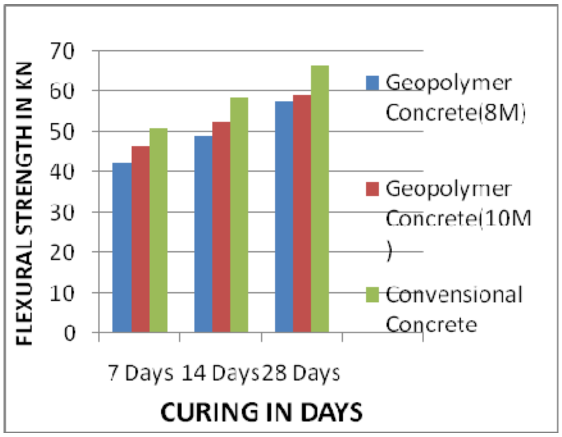

Figure-5. Comparison of flexural strength of gpc with conventional concrete.

5. CONCLUSIONS

The ratio of alkaline liquid to fly ash, by mass does not affect the compressive strength of the geopolymerconcrete.The flexural strength is determined from 28 days with addition of 8 molarities and 10 molarities of NaOH were 57.73KN and 59.35KN.The flexural strength of the geopolymer concrete increases with increase of concentration in terms of molarities. For 28 days curing period with addition 10M of NaOH attain the higher flexural strength at 59.35KN.The compressive strength of the geopolymer concrete increases with increase in the curing time. But flexural strength of geopolymer concrete is lower than the conventional concrete

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