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Effect of Metakaoline on Fly ash based Geopolymer concrete

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ABSTRACT:This research paper is about the effect of metakaoline on types of fibre reinforced alkali activated class F fly ash based geopolymer concrete. The addition of metakaoline shows the increase in the strength of geopolymer concrete as compared to plane GPC. For this the various parameters are checked like different percentage addition of metakaolin, temperature variation effect, steel fibre addition also the compressive, tensile, pull out etc test are carried out by different types of curing.

KEYWORDS: Geopolymer, Metakaolin, Flyash.

I. INTRODUCTION

The geopolymer technology was first introduced by Davidovits in 1978. His work considerably shows that the adoption of the geopolymer technology could reduce the CO_2 emission caused due to cement industries. Materials rich in Si (like fly ash, slag and rice husk) and materials rich in Al (clays like kaolin) are the primary requirement to undergo geopolymerization. Metakaolin (MK) is accessible in dry powder structure and is obtained from Zigma International, Khalapur Dist. Raigad. It is accessible in 40Kg sacks, shade of which is white under the item name "Pozzofilz". According to ASTM 618 the base measure of SiO2, Al2O3 and Fe2O3 that needs to be present in a class N pozzolan is 70%. Along these lines a sullied wellspring of kaolin may be used to bring about a pozzolanic material that meets the ASTM C618 necessities.

II. LITERATURE REVIEW

Davidovits (1999)In 1978, Davidovits proposed that an alkaline liquid could be used to react with the silicon (Si) and the aluminum (Al) in a source material of geological origin or in by product materials such as fly ash and rice husk ash to produce binders. Because the chemical reaction that takes place in this case is a polymerization process, Davidovits(1994, 1999)) coined the term ‘Geo-polymer’ to represent these binders. Geo-polymers are members of the family of inorganic polymers. The chemical composition of the geo-polymer material is similar to natural zeoliticmaterials,butthe microstructure is amorphous instead of crystalline (Palomo et al. 1999; Xuandvan Deventer 2000).

A. R. Krishnaraja et.al, (2009)studied on utilization of fly ash and Ground Granulated Blast Slag as an alternative material in concrete reduces the use of OPC in concrete. Evolution of geopolymer concrete cured at ambient temperature broadens its suitability and applicability to concrete based structures. This paper presents the mix proportions and outcome of an experimental study on the density and compressive strength of geopolymer concrete. Fly ash was used as a base material which was made to react with sodium hydroxide and sodium silicate solution to act as a binder for fine and coarse aggregate. Ground Granulated Blast Slag was replaced in different proportions to fly ash to enhance various properties of concrete. The concrete was subjected to curing at ambient temperature. Based on the study carried out, replacement of GGBS in fly ash up.

S. Mandal, et.al, (2012)studied on the compressive strength of geopolymer concrete by changing the various parameters such as water to binder ratio, curing temperature and curing duration. For their experimental work they took the fly ash from National Thermal Power Corporation, Farakka, sodium hydroxide and sodium silicate was used as alkaline activator. The concentration of alkali activator was varied as 4M, 8M and 10M also water
to binder ratio varied from 0.45, 0.50 and 0.60. The casted specimens were cured at 60 to 902c and tested at different ages such as 3,7,28 & 48 hours. After the test results it was concluded that higher molarity concentration gives the better result also the compressive strength was increased with curing

temperature and curing duration. But after 48 days it doesn't gives the better result.

PuputRisdanareni, et.al, (2014)studied on the influence of alkali activator on mechanical properties of geopolymer concrete. For their investigation they used trass (combination of fly ash & volcanic material), sodium hydroxide and sodium silicate was used as alkaline activator. Concentration of NaOH was 8M & 10M and the ratio of alkaline activator by mass was 0.5, 1, 1.5, 2 & 2.5. The test results show that higher of NaOH concentration, higher the mechanical strength of geopolymer concrete also the compressive strength increases with increase in the ratio of alkaline activator

Jee-Sang Kim, et.al, (2011)studied on geopolymer concretes are new class of construction materials that have emerged as an alternative to Ordinary Portland cement concrete. Considerable researches have been carried out on material development of geopolymer concrete; however, a few studies have been reported on the structural use of them. This paper presents the bond behaviors of reinforcement embedded in fly ash based geopolymer concrete. The development lengths of reinforcement for various compressive strengths of concrete, 20, 30 and 40 MPa, and reinforcement diameters, 10, 16 and 25 mm, are investigated. Total 27 specimens were manufactured and pull-out test according to EN 10080was applied to measure bond strength and slips between concrete and reinforcements. The average bond strengths decreased from 23.06MPa to 17.26 MPa, as the diameters of reinforcements increased from 10mm to 25mm. The compressive strength levels of geopolymer concrete showed no significant influence on bond strengths in this study. Also, the bond-slip relations between geopolymer concrete and reinforcement are derived using non-linear regression analysis for various experimental conditions.

III. METHODOLOGY

This paper presents the result from studies on mix design development to enhance workability & strength of geopolymer concrete. The influence of factors such as curing temperature& regime, aggregate shape, strength, moisture content, preparation & grading on workability & strength are present. Very little knowledge and know-how of making of fly ash-based geo-polymer concrete were available in the published literature. Due to this lack of information, the study began based on limited available literature on geo-polymer pastes and mortars.

Chemical	Composition
SiO	50% - 55%
Al2O3	38% - 42%
CaO	1%-3%
TiO2	0.8-1.2
Na2O	<1%
Fe2O3	0.2-0.5
K2O	<1%
MnO	<0.5%
MgO	<0.1%

Various parameters are checked to find out the effect of metakaolin in geopolymer concrete. To see the percentage addition effect matakaolin added fly ash based geopolymer concrete is prepared with percentage variation in Metakaolin with 18 hours of curing time, 7 days of rest period. For each percentage three specimens are prepared and its average strength is taken. The effect of temperature variation is observed for 5% metakaolin with varying temperature 40^0 to 150^0 by keeping 18 hrs curing time constant. To increase the strength of this particular concrete various literatures are studied and steel fibres are used for the same. It is added in the concrete with increasing gap of 0.5% and studied the various factors. For the tensile strength three types of curing were used, to check the effect of curing type on strength of concrete.Likewise, the tensile strength its flexural behaviour and bond strength is also checked with varying types of curing.

IV. OBESERVATIONS AND RESULTS

The investigation based on the various parameter involved fly ash based fibres reinforces lime and metakaolin added geopolymeric concrete. In the preliminary study the different types of Fibres were added into the concrete. The details study on the metakaolin added concrete shows better result but when the lime percentage and fly ash were used into the concrete.

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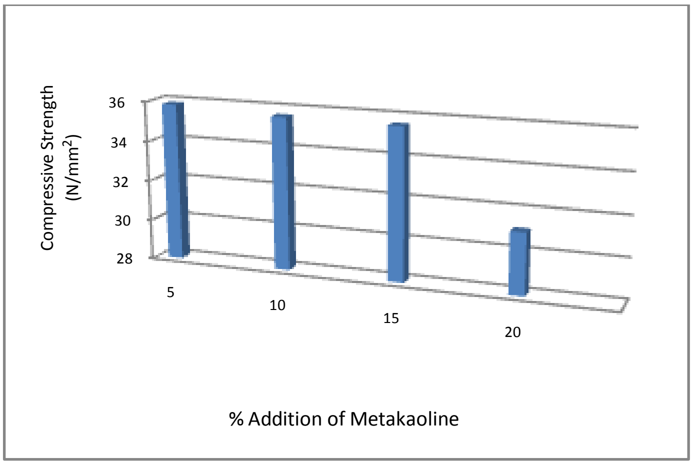

Fig. 1 Effect of Percentage Addition of Metakaolin based GPC

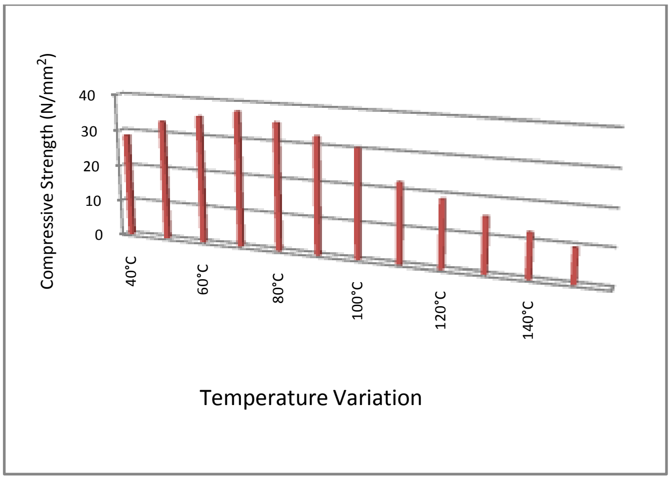

Fig 2.Effect of Temp. Variation of Metakaolin based GPC

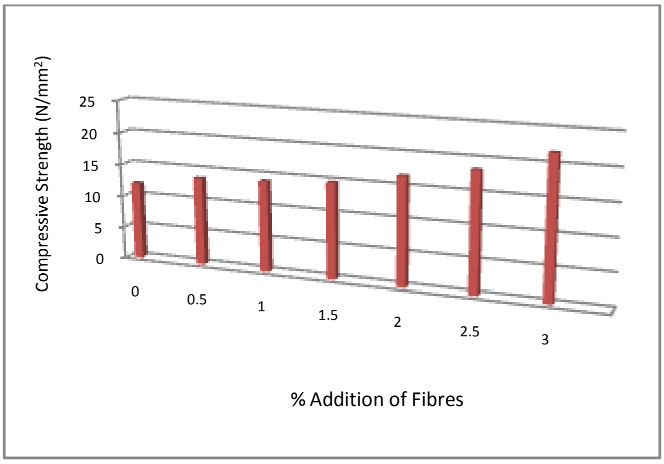

Fig 3.Effect of % addition of Steel Fibres of Metakaolin based GPC

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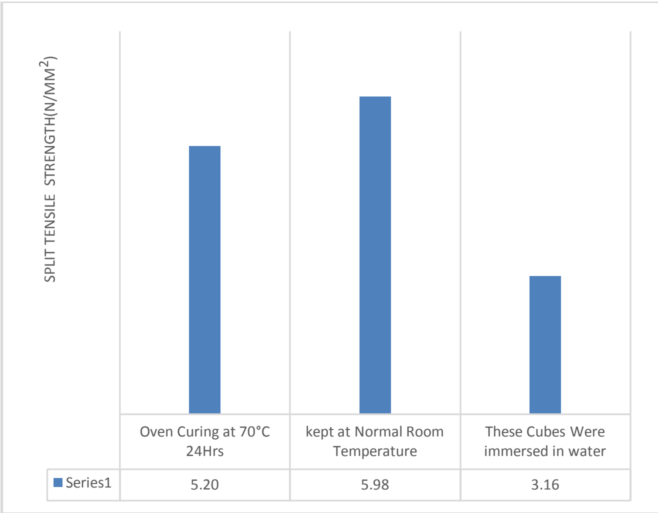

Fig 4.Effect of Split Tensile Strength of Types of Curing on Lime and Metakaolin added GPC

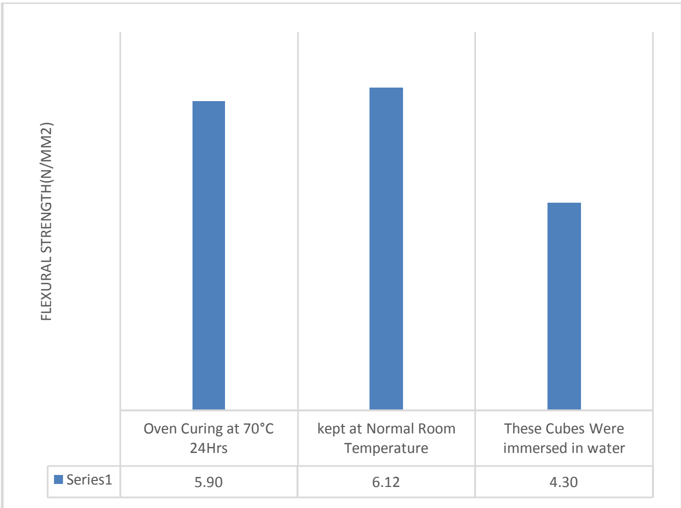

Fig 5.Effect of Flexural strength of Types of Curing on Lime and Metakaolin added GPC

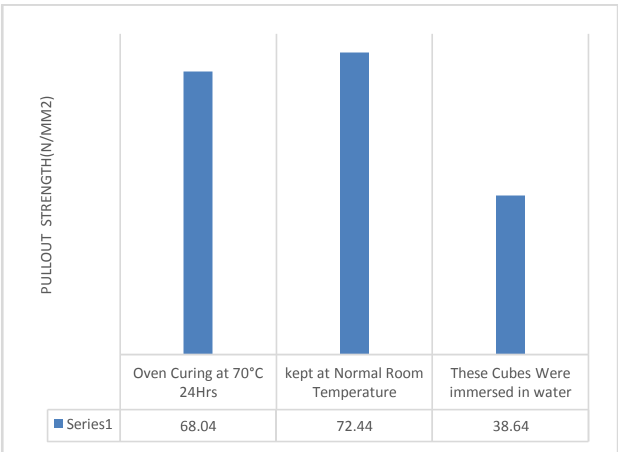

Fig 6.Effect of Pull-out Strength of Types of Curing on Lime and Metakaolin added GPC

V. CONCLUSION

1. Metakaolin concrete consisting of 88% OPC + 12% MK (binary blending) with 1.0% super plasticizer gives improved durability and mechanical properties.
2. The mechanical properties are further improved with the incorporation of crimped steel fibers in proportion to the fiber content used.
3. Mechanical properties like split tensile strength, modulus of rupture, are considerably improved even with the addition of 0.50% of steel fibers. At higher fiber content, the mechanical properties are further improved.
4. Up to 400^0C, the behaviour of Metakaolin concrete is better than OPC concrete of both the grades.
5. Corrosion results obtained after 90 days of immersion of the specimens in artificial sea water gives a result of 95% of corrosion activity for Geopolymer concrete.
6. It has been observed that, as the percentage fibres increases the compressive as well as tensile properties were increases but after three percentage the strength reduces.
7. The percentage lime addition increases the strength upto 15 percentage only after that the workability of concrete reduces.
8. The addition of all ingredients gives the good compressive strength of concrete, as well as gives better result in all other mechanical properties of concrete.

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