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Effect of Steel Fiber on Alkali activated Fly Ash Concrete

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ABSTRACT
Concrete is the world's most important Construction material so the demand of cement is increases. The production of cement is highly energy intensive & the production on one ton of cement liberates about one ton of CO_2 to atmosphere. The contribution of cement industry to the greenhouse gas emission is estimated to be about 70% of the total green gas emission. Also it consumes large amount of natural resources. Hence it is essential to find alternative to cement. Geopolymer concrete is an innovative material in which the binder is produced but the reaction of an alkaline liquid with a source material that is rich in silica alumina.
The present work deals with the result of the experimental investigation carried out on geopolymer concrete using steel fiber. The study analyses the effect of steel on compressive strength. Geopolymer concrete mixes were prepared using low calcium fly ash & activated by alkaline solution. (NaOH & Na2SiO3) with alkaline liquid to fly ash ratio of 0.35 Alkaline solution. Used for present study combination of sodium hydroxide & sodium silicate with ratio 2.5. The mix was designed for molarity of 16M & grade chosen for investigation was M30. Hooked end steel fiber . All tests were conducted according to IS-code procedure. The result for each variation are tabulated & discussed in details & some important conclusions are made.

I. INTRODUCTION

Now a days, Concrete is one of the most widely used construction materials. It is usually associated with Portland cement as the component for making concrete. Ordinary Portland Cement (OPC) is conventionally used as the primary binder to produce concrete. Production of Portland cement is currently exceeding 2.6 billion tons per year worldwide & growing at 5% annually. 5-8% of all humans generated atm. Carbon-di-oxide worldwide comes from the concrete industry. Among the greenhouse, carbon-di-oxide contributes about 65% of global warming.

Although the use Portland cement is still in avoidable until the foreseeable future, many efforts are being made in order to reduce the use of P.C.C. On the other hand, a huge volume of fly ash is generated around the world. Most of the fly ash is not effectively used, & a large part of it disposed in landfills which affects aquifers & surface bodies of fresh water.

Fiber reinforced Cement or Concrete (Polypropylene fiber) is a relatively new composite material in which fibers are introduced in the matrix as micro reinforcement, so as to improve the tensile, cracking & other properties of concrete. Glass Fiber Reinforced Concrete (GFRC) is a type of Fiber reinforced Concrete which is mainly used in exterior building façade panels & as architectural precast concrete steel.

The term "Geopolymer" was 1st introduced by Davidovits 1978 to describe a family of minerals binders with chemical composition similar to zeolites but with an amorphous microstructure. Wallahet ET. al. (2006) explained that, Heat-cured ash based geopolymer concrete undergoes low creep & very little drying shrinkage in the order of about 100 micron strains after one year and it has an excellent resistance to Sulphate attack. Akeen et. al. (2012) mentioned that, Geopolymer Concrete can be used in the precast industries, so that huge production is possible in short duration & the breakage during transportation shall also be minimized. It shall be effectively used for the beam column junction reinforced concrete stricture & infrastructure works.

In addition to that the fly ash shall be effectively used & hence no landfills are required to dump the fly ash. Annear et. al. (2011) explained that the higher concentration of sodium solution & also sodium silicate are placed inside the geopolymer concrete will produce higher compressive strength of geopolymer concrete because NaOH & Na_2SiO_3 will make the good bonding between aggregate & paste of the concrete.

In this represent, the geopolymer technology proposed by Davidovits shows considerable promise for application in concrete industry as an alternative binder to the Portland cement.

II. SCOPE & SIGNIFICANCE OF STUDY

Basically, on overall, this study experimental in nature whereby the investigation is focused on the development of a few concrete materials called Geopolymer Concrete. This research is actually done to observe the durability aspect of proposed mix of geopolymer concrete through the carbonation process. Not just focusing on that matter, the research is done to investigate the strength of geopolymer concrete after exposed to several conditions such as natural weather, indoor, immersed in the water & put inside the chamber. For both curing regimes either ambient condition or oven the specimens will be test for initial strength after 7 days & 28 days.

At preliminary stage, a mix of proportion of geopolymer concrete was developed as well as producing as OPC that was as control subject. A set of mix proportion which consist 6 cubes (150mm x 150mm x 150mm) each set of geopolymer concrete for 3 cubes each for 7 day & 28 day test period respectively & OPC each prepared to test the initial strength of the concrete. This is to make sure that the proportion are achieved the target strength which is 30 MPa. As a control purpose both type of concrete must achieve the target strength.

At the 2nd stage, all the casted cubes are removed by 24 hrs. Time interval and put in oven for dry curing at 80ºC for 18 hrs. The different exposure regimes were looked into prior to studying the variation in depth of the carbonated area of the specimen. The exposure period are also influenced the increasing of carbonated area. The strength performance of this concrete has been investigated through the compressive test conducted on the panel prepared. Then, the pH profiles of the specimens were tested using specific chemical liquid.

Finally, all tested are done based on the prepared schedule & observed by supervisor. The result of the effect of carbonation to the concrete & pH profile will be discussed in the form of graphs & picture. Other than that, the factor that influenced the carbonation process such as carbon dioxide concentrated & climate & exposure also has been discussed in this study. On overall, the test are conducted in this research is according to the existing standard.

The outcome of the study would provide information on the performance of geopolymer concrete in term of durability when subjected exposure condition. Further more, the finding from the research would be useful knowledge on the geopolymer industry for producing possessing enhanced strength & durability for comparison to OPC.

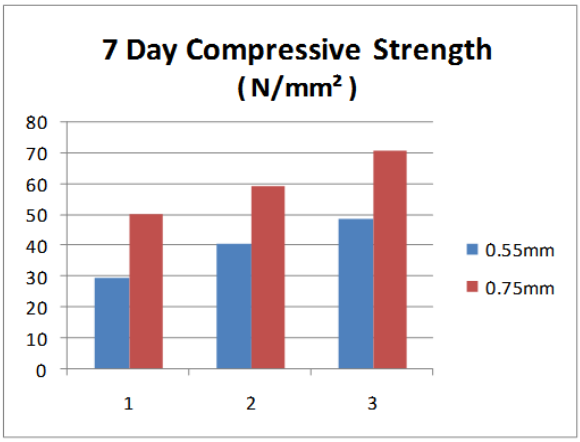
III. AGGREGATES

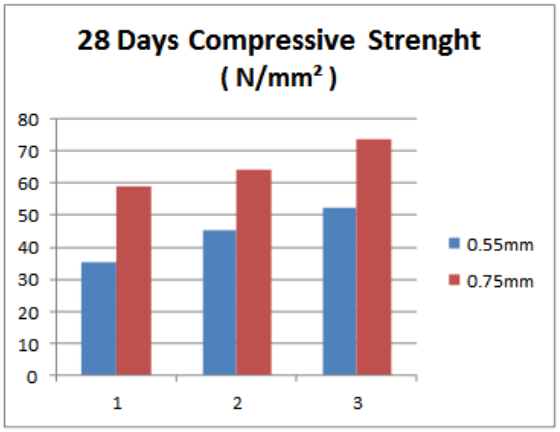
A. Fine Aggregate (Natural Sand)
B. Coarse Aggregate (12 mm , 16 mm)
C. Fly Ash (Pozzocrete 63)
D. Alkaline Solution (NaOH , Na_2SiO_3)
E. 3D Dramix Steel Fiber (Hooked End)

Here we used the two types of Hooked End 3D Dramix Steel Fibers Aspect ratio of 0.55 mm & 0.75 mm which is manufactured by Bekaert Industries.

The coarse aggregate of 16 mm which sieved passing through 16 mm & retaining in 14 mm sieve. The alkaline solutions in which Flakes a form of sodium hydroxides is taken & readies it for 16M. The extra water is added about 200 ml proper finishing on vibrating table.

Fly Ash	4.8 kg
Na_2SiO_3	1250 ml
NaOH	500 ml
Sand	7.8 kg
Fine Aggregate 12 mm	4.5 kg
Coarse Aggregate 16 mm	7.6 kg





IV. CONCLUSION

Replacement of cement by Fly Ash in GPC mix resulted in an enhanced Compressive Strength. Addition of Steel Fiber in Geopolymer concrete composition enhanced its Mechanical Strength. The Compressive Strength of Steel Fiber reinforced Geopolymer concrete composition increase with respect to increase in the percentages volume fraction from 0.30 to 0.80.

Addition of percentage of Steel Fibers by Fly Ash resulted in an enhanced Compressive Strength. Addition of 3% of Steel Fiber of 0.55 mm and 0.75 mm gives enhanced compressive strength in 7 day test period and after 28 days it increased by 8 %.

REFERENCES

[1] S. Aravindan, Jagadish. N and Peter Guspher. A, "Experimental Investigation of Alkali Activated Slag and Fly Ash based Geopolymer Concrete", ARPN Journal of Engineering and Applied Sciences, ISSN: 1819-6608, Volume 10, No. 10, pp. 4701-4705.

[2] 2. Sandeep L.Hake, Dr. R. M. Damgir and Dr S.V. Patankar, "State of Art- Investigation of Method of Curing on Geopolymer Concrete", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN : 2278-1684, p-ISSN : 2320-334X, Volume 12, Issue 3 Ver. II, May-Jun 2015, pp. 40-44.

[3] A. Sivakumar and K. Srinivasan, "High Performance Fiber Reinforced Alkali Activated Slag Concrete", International Science Index International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, Volume 8, No. 2, 2014, pp. 1248-1251.

[4] Davidovits J. (2002), "Personal Communication on the Process of Making of Geopolymer Concrete".

[5] Cheng T. W. & J. P. Chiu (2003), "Fiber-Resistance Geopolymer produced by Granulated Blast Furnace Slag", Minerals Engineering 16(3) : 205-210

[6] Fernandez – Jimenez A. & A. Palomo (2003), "Characterization of Fly ash ; Potential Reactivity as Alkaline Cement", Fuel 82(18) : 2259-2265.

[7] Gourley J. T. (2003), "Geopolymers; Opportunities for Environmentally Friendly Construction Materials", Materials 2003 Conference: Adaptive Materials for a Modern Society, Sydney, Institute of Material Engineering, Australia.

[8] Jaarsveld J. G. S., J. S. J. Van Deventer & G. C. Lukey (2002), "The Effect of Composition & Temp. on the Properties of Fly ash & Kaolinite based Geopolymers", Chemical Engineering Journal 89(1-3) : 63-73.

[9] Jaarsveld J.G.S., J. S. J. Van Deventer & G. C. Lukey (2003), "The Characterization of Source Materials in Fly ash based Geopolymer", Materials Letters 57(7) : 1272-1280.

[10] Sourav Kr. Das, Amarendra Kr. Mohapatra and A. K. Rath, "Geopolymer Concrete - Green Concrete for the Future - A Review", International Journal of Civil Engineering Research, ISSN: 2278-3652, Volume 5, No. 1, 2014, pp. 21-28.

[11] Sathish Kumar. V, Blessen Skariah Thomas and Alex Christopher, "An Experimental Study on the Properties of Glass Fibre Reinforced Geopolymer Concrete", International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622, Volume 2, Issue 6, November- December 2012, pp. 722-726.

[12] Harijito D., Rangan B.V., (2005), "Development & Research report GC1, Curtin University of Technology, Perth, Australia.

[13] M S Shetty, Concrete technology- Theory & practice, New Delhi India SChand & Company Ltd 2006

[14] Srinivasan et al., (2014), "An investigation of flexural behavior of glass fiber reinforced GPC beams", IJESRT ISSN: 2277-9655

[15] Hui. L1 & Delong. XU. 2009. The future resources for eco-building materials:2. Fly ash & Coal waste, Journal Of Wuhan University of Technology. 24(4):667-672.

[16] Manjunath. S, Radhakrishna G.S, C. Giridhar & Mahesh Jadhav. 2011. Compressive Strength development Journal of Earth Sciences & Engineering.4(6): 830-834.

[17] Mazaheripour H, Ghanbarpour S, Mirmorandi SH & Hosseinpor 1. 2011. The effect of polypropylene fibers on the properties of fresh & hardened light wt. self-compacting concrete. Construction & building materials. 25:351-358.

[18] Okan Karahan & Cengiz Duran Atis. 2011. The durability properties of polypropylene fiber reinforced fly ash concrete. Material & Design. 32:1044-49.

[19] R.Anuradha, V. Sreevidya, R. Venkatasubramani & B.V. Rangan. 2011. Modified guidelines for geopolymer concrete mix design using Indian std. Asian Journal of Civil Engineering (Building & Housing). 13(3): 353-364.

[20] Thokchom. S, P. Ghosh. P & Ghosh. S. 2010. Performance of Fly Ash & Based Geopolymer Mortars in Sulphate Solution. Journal Of Engineering Science & Technology Review. 3(1): 36-40

[21] Bakharev T. 2005. Resistance of Geopolymer materials to acid attack. Cement & Concrete Research. 35:658-670

[22] Venkateswararao J., Srinivasa Rao K., Rambabu K. and Brahma Reddy T., "Comparative Study on Mechanical Properties of Geopolymers and their Composites", ARPN Journal of Engineering and Applied Sciences, ISSN: 1819-6608, Volume 8, No. 10, October-13, pp. 800-805.

[23] P. Jyotsna Devi and Dr. K. Srinivasa Rao, "A Study on the Flexural and Split Tensile Strengths of Steel Fibre Reinforced Concrete at High Temperatures", International Journal of Education and Applied Research, ISSN : 2348-0033 (Online) ISSN : 2249-4944 (Print), Volume 4, Issue 2, Jan - June 2014, pp. 49-53.

[24] S. Srinivasan, A. Karthik and Dr. S. Nagan, "An Investigation on Flexural Behavior of Glass Fibre Reinforced Geopolymer Concrete Beams", International Journal of Engineering Sciences & Research Technology, ISSN: 2277-9655, Volume 3, No. 4, April-14, pp. 1963-1968.

[25] Jimmy Susetyo, Paul Gauvreau and Frank J. Vecchio, "Steel Fiber-Reinforced Concrete Panels in Shear : Analysis and Modeling", ACI Materials Journal Title No. 110-S25, Volume 110, No. 2, March-April 2013, pp. 285-296.

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