TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 4352 - 4357

Experimental Study of Geopolymer Concrete by Addition of Nano-Silica and Steel Fiber

A S Kumar[1], M Eswar Kumar Yadav[2], P R Kishore[3], Nitesh Kumar Yadav[4]

[1,2,3]Assistant Professor, Department of Civil Engineering, Aditya Engineering College (A), Surampalem,

[4] PG Scholar, Department of Civil Engineering, Aditya Engineering College (A), Surampalem.

Article Info
Volume 82
Page Number: 4352 - 4357
Publication Issue:
January-February 2020

Abstract

Geopolymer concrete is an alternative material to concrete which is characterized by long chains or networks of inorganic molecules for use in transportation infrastructure construction. It is processed from natural materials or industrial by products which significantly reduce carbon footprint and also better durability.

However, material development is still in its infancy, In this paper we discuss the mechanical properties of geopolymer concrete.

In this paper effect of nano-silica and fibers M35 grade has been studied by varying the percentage of 0.5%, 1%, and 1.5% by volume of concrete. In the present study, a geopolymer concrete of M35 grade is considered and addition of nano-silica at 1%, 2% and 3% respectively and steel fiber at 0.5%, 1% and 1.5% respectively to percentage of cement for testing the compression and split tensile strength at 7th and 28th days and the durability of the fiber added concrete is checked by Electro-Chemical Corrosion Test.

Article History
Article Received: *18 May 2019*
Revised: *14 July 2019*
Accepted: *22 December 2019*
Publication: *21 January 2020*

Keywords: *Geopolymer concrete , sodium hydroxide(NaoH) , sodium silicate(Na2sio3) , Hooked end steel fiber reinforced concrete, accelerated corrosion*

I. INTRODUCTION

Geopolymers are a group of materials that are manufactured from an alumino silicate mixture and an alkaline solution. They have a wide variety of uses and advantages over OPC. Alternative binders to OPC including geopolymers belong to the Alkali Activated Materials (AAM) group. A major advantage of using geopolymers and AAM over OPC is an increase in durability. Cements analyzed from Egyptian and Roman structures are shown to have crystalline zeolitic phases in addition to the OPC like hydrates. These crystalline phases are one of the reasons why researchers believe that ancient cement was so much more durable to modern cement. This durability comes from the three dimensional ring structure and polymeric chain of the alumino silicates. Unlike cement, water is not used in the reaction of the alumino silicates; instead water is evaporated out during the curing process. Applications for geopolymer cements stem from their high heat tolerance, affordability and reduced environmental impact.

1.1 Research significance

The aim of our project is to use the Geopolymer concrete with Nano-silica and Hooked end Steel Fiber.

Our objective is to add the Nano- silica with Geoploymer concrete and Steel Fiber to the concrete and to study the strength properties of concrete with the variation in Nano-silica content. i.e., to study the strength properties of concrete (M35 Grade) of 0%, 1%, 2% and 3% at 7 and 28 days. Later on getting strength , addition of steel fiber of 0%, 0.5%, 1%, 1.5% at 7 and 28 days . The strength properties being studied are as follows:

1. Compressive strength.
2. Split Tensile Strength.
3. Corrosion resistance.

1.2 Scope of work

This study is limited to investigate the compressive strength ,Split Tensile Strength and corrosion resistance of the Nano-silica and steel fiber concrete cubes. variation in Nano-silica content. i.e., to study the strength properties of concrete (M35 Grade) of 0%, 1%, 2% and 3% at 7 and 28 days. Later on getting strength , addition of steel fiber of 0%, 0.5%, 1%, 1.5% at 7 and 28 days are used.

II. TEST MATERIALS

2.1 Materials

The materials used in this present work are steel fiber, Ordinary Portland cement (53 grade), coarse aggregates and fine aggregates.

2.2 Cement

Cement is a binder which hardens and binds other materials together.

2.3 Aggregates

Crushed granite is coarse aggregate (CA) passing through 20 mm having Specific gravity (SG) of 2.62 and water absorption is 0.45. The fine aggregate (FA) has SG 2.44 and water absorption (WA) 1.

2.4 Steel fiber

Steel wire fibers are dispersed randomly in the cement concrete can lessen or even supplant traditional rebar and welded reinforcement which expands the rigidity or tensile strength. It can be connected in modern industrial floors, street roads, strip foundation, street surfacing, bridge spans and different developments with standard basic requests. Steel fibers of 4mm width and 50mm length are utilized.

Figure 1: Hooked end steel fiber

Mix proportions

Cement = 454.56 kg/m^3

FA = 721.4 kg/m^3

CA = 1082.2 kg/m^3

Water = 181.82 kg/m^3

Water-cement ratio = 0.43

Mix design for alkaline solution

For one cube

Alkaline solution to binder ratio = 2.5[with 12 M NaOH and 50% Na_2SiO_3]

Mass of sodium hydroxide solution

= 42.4615*0.003375

= 0.143 kg [1 Cube]

Mass of sodium silicate solution

= 84.92*0.003375

= 0.286 kg

For one cylinder

Mass of NaOH solution = 42.4615 * 0.00531

= 0.23 kg

January - February 2020
ISSN: 0193 - 4120 Page No. 4352 - 4357

Mass of Na2SiO3 solution = 84.92*0.00531

= 0.45 kg

III. EXPERIMENTAL TESTING PROCEDURE

3.1 Accelerated corrosion process

The electro chemical procedure of Corrosion test for steel is finished with various responses happening at the cathodic and anodic destinations. Oxygen and water is supplied to keep the response. In fresh cement concrete the pH of pores solution is around 12.5 In present condition a steady oxide "passive" layer is formed over the surface of steel which gives good resistance against corrosion.

All specimens were place in the salt solution tank and is connected to positive end of power supply at titanium poles utilizing copper core cable. The negative connection of the circuit was given utilizing a bit of exposed steel electrode partly submerged in the arranged solution. Figures demonstrate the accelerated corrosion test setup. A consistent 16A current was gone through the NaCl solution and samples for 45 days. In this arrangement plan steel fibers went about as an expending anode to keep up the present course through the concrete samples.

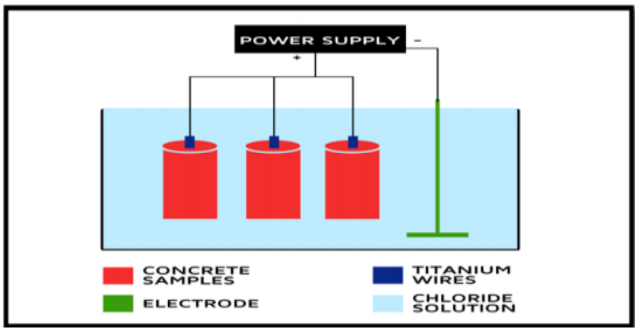

Figure 2: Schematic diagram of the accelerated corrosion test used

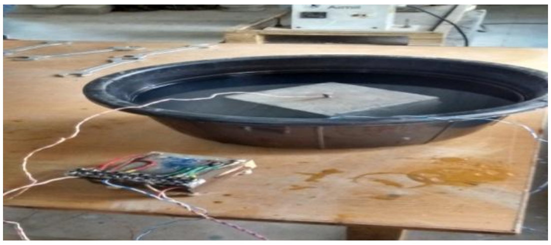

Figure 3: Accelerated Corrosion apparatus

3.2 Compressive strength

The most important mechanical property is compressive strength as concrete is very strong in compression and this test is done on compression testing machine.

Figure 4: Compression testing machine

3.3 Split Tensile Strength

For Split Tensile strength test, a cylindrical sample of measurement 300 mm length and 150 mm diaacross were casted. The casted samples were demoulded (after 24 hours) and were cured and tested for 7 and 28 days spilt tensile strength.

Split Tensile quality (MPa) = 2P/π DL, Where, P = , D = distance across of chamber, L = length of chamber

IV. RESULTS AND DISCUSSIONS

The present experimental study is carried out to find out the workability, mechanical properties and corrosion resistance of 150mm*150mm*150mm cubes with varying ratio of steel fiber to the cement. The cubes are tested for compressive strength and Split Tensile Strength at 7 days, 28 days. The results mechanical properties of specimens are presented in the tabular forms..The cubes are immersed in NaCl solution and current is passed 5 hour duration and the mechanical properties are reported in tabular form and the graphical representations for various ratios are presented.

4.1 Compressive strength of percentage of Nano-silica

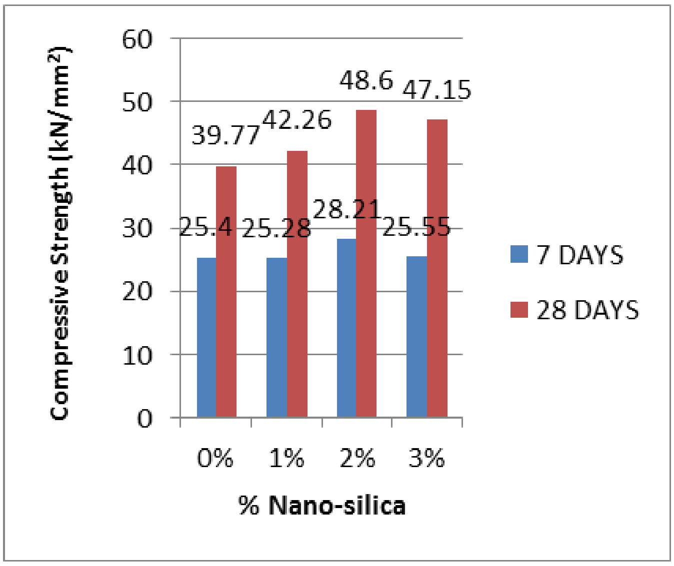

Chart 1: : Variation of Compressive Strength gives the higher strength for percentage of Nano-silica for 7 , 28 days

4.2 Compressive Strength gives the higher strength for percentage of Nano-silica and steel fiber for 7 , 28 days

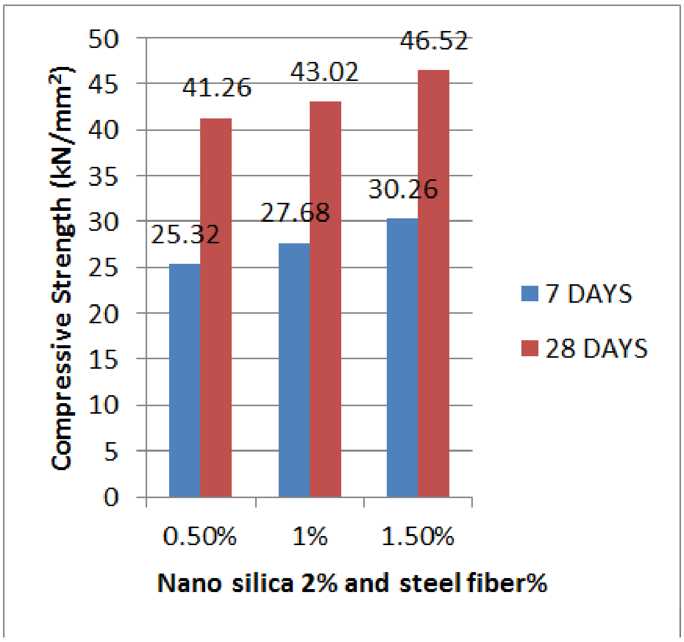

Chart 2 Variation of Compressive Strength gives the higher strength for percentage of Nano-silica and steel fiber for 7 , 28 days

4.3 SPLIT TENSILE STRENGTH RESULT FOR 7,28 DAYS

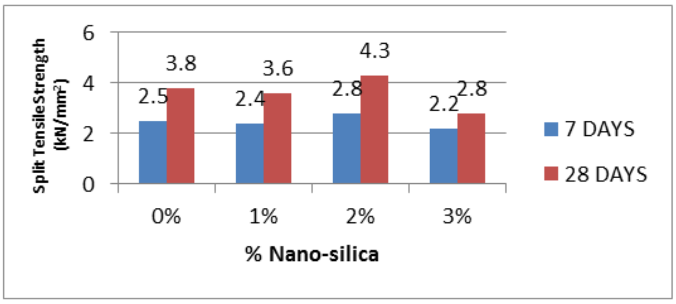

Chart 3: Variation of Split tensile Strength gives the higher strength for the different percentage of Nano-silica for 7 , 28 days of the specimens.

4.4 Split tensile strength result for 7,28 days

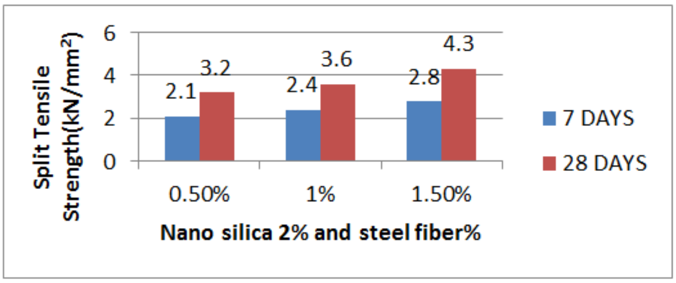

Chart 4: Variation of Split tensile Strength gives the higher strength for the different percentage of Nano-silica for 7 , 28 days

4.5 Compressivestrengthfor steelfiber and accelerated corrosion

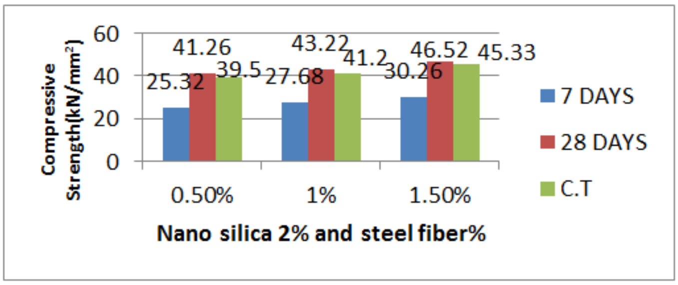

Chart 5: Variation of compressive Strength gives the higher strength for the different percentage of Nano-silica and accelerated corrosion for 7 , 28 days

5. CONCLUSIONS

1. The current experimental procedure utilized for accelerated corrosion in steel fiber reinforced concrete is a good technique to implement corrosion in concrete specimens (less time) .

2. Steel fibers performs better than normal concrete in corrosion tests.

3.The workability of Steel fiber reinforced concrete decreases with increase of ratio of steel fibers in concrete.

4. In steel fiber concrete the performance of specimens were not much influenced to corrosion attack. The compressive and split tensile strength is very less influenced after corrosion attack.

5. Steel fiber reinforced concrete has very slight decrease in compressive strength and Split tensile Strength after conducting accelerated corrosion test at 1.5% dosage of steel fiber due to discontinuity of fibers. Hence it is preferable to use 1.5% dosage of steel fibers to decrease corrosion effect

7. Geopolymer concrete exhibited higher compressive strength when compared to ordinary Portland concrete.

8. In medium grade Geopolymer concrete NaOH plays a vital role in attaining strength, in view of trials and cost parameter 12M is recommended as optimum molarity for NaOH.

9. The reaction of Nano Silica is extremely slow during ambient temperatures, subsequently heat curing is recommended for Nano Silica based Geopolymer concrete in order to achieve higher strength at early age.

10. Geopolymer concrete has gained strength in contradiction to loss of weight in case of ordinary Portland concrete, post exposure to aggressive environment.

11. Geopolymer concrete exhibited superior performance in terms of mechanical properties and durability in aggressive environment when compared to ordinary Portland concrete.

12. Compressive strength of Geopolymer concrete is comparatively higher than ordinary concrete for the same grade of concrete. It is also observed that the 7 days compressive strength is almost equals to two third of 28 days strength which supports the application of this concrete.

13. When compared with flexural strength for M35 grade normal concrete estimated as per IS456 : 2000, the flexural strength of GPC is 3.31 N/mm2 which is marginally less than the estimated value.

14. The temperature resistance of Geopolymer concrete is very much higher and behaves good enough under 3 hours of oven curing at 200oc.

SCOPE FOR FURTHER STUDY

1. The mix done for grade M35 in this study can be extended for other grades.

2. Different alternatives to sand and coarse aggregates can be used like the materials discussed above.

3. The percentage of Sodium Hydrooxide and Sodim Silicate can be varied and can be used with different alternatives of ingredients of concrete.

4. Finally it can be said that there is alot of scope for the study of sustainable concrete.

REFERENCE

[1] Prakash R.Vora, Urmil V.Dave, “Parametric studies on compressive strength of geopolymer concrete”, science direct,2013,procedia engineering 51,pp.210-219.

[2] Kolli Ramujee,M.Potharaju, development of low calcium fly ash based geopolymer concrete,IJET,2014,Vol.6, pp.1-4.

[3] L. Krishnan, S.Karthikeyan, S.Nathiya, geopolymer concrete an eco- friendly construction material, IJRET, 2014, Vol.3, special issue.11, pp.164-167.

[4] P.Vignesh, K.Vivek, an experimental investigation on strength parameters of fly ash based geopolymer concrete with GGBS, IRJET, 2015, Vol.2, issue.2, pp.135-142.

[5] Neetu Singh, Sameer Vyas, R.P.Pathak, effect of aggressive chemical environment on durability of green geopolymer concrete, IJEIT, 2013, Vol.3, issue.4, pp.277-284.

January - February 2020
ISSN: 0193 - 4120 Page No. 4352 - 4357

[6] Bapugouda patil, Veerendra kumar. M, Dr.H .Narendra, durability studies on sustainable geopolymer concrete, IRJET, 2015, Vol.2,
[7] Milind V.Mohod8"Performance of steel fiber reinforced concrete",International Journal of Engineering and ScienceISSN: 2278-4721, Vol. 1, Issue 12 (December 2012), PP 01-04.
[8] Nikhil A.Gadge9"Mix design of fiber reinforced concrete (frc) usingslag& steel fiber", ISSN: 2249-6645 International Journal of Modern Engineering Research (IJMER) Vol. 3, Issue. 6, Nov - Dec. 2013 pp-3863-3871.
[9] Ranjitsinh K. Patil10 "Comparative study of effect of basalt, glass and steelfiber on compressive and flexural strength ofconcrete",eISSN: 2319-1163 International Journal of Research in Engineering and Technology.
[10] Vikrant S. Vairagade11"Introduction to steel fiber reinforced concrete on engineering performance of concrete", ISSN 2277-8616 International Journal of Scientific & Technology Research Volume 1, Issue 4, May 2012.
[11] Concrete technology by M.S. Shetty , S.Chand publishing company
[12] IS 10262:2009 Guidelines for mix design of concrete.