International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 12 | Dec -2016 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDIES OF GEOPOLYMER MORTAR WITH FINE AGGREGATE PARTIALLY REPLACED BY CRUSHED LATERITE

K.Siddharth[1], P.T.Ayswariya Lakshmi[2], R.Abhinaya Vishnu[3]

[1,2,3]*Assistant Professor, Department of Civil Engineering, Hindusthan College of Engineering And Technology, Tamilnadu, India*

Abstract -*Cement which is used in preparing cement mortar, on production produces high amount of CO_2 which is very harmful to environment. In an attempt to eliminate the use of cement, studies were made on geopolymer mortar. Use of geopolymer mortar has no adverse effect on the environment as cement. Geopolymer mortar was prepared by blending fly-ash, sand and alkaline solution. River sand which is used as fine aggregate in conventional concrete is also depleting on a higher rate. So laterite rocks were used as a partial replacement for fine aggregates. Laterite rocks were crushed to the required size and used in this mortar. Crushed laterite rocks were tested for suitability to replace fine aggregates. So in this project both the cement and fine aggregates were replaced in concrete which is effective. Laterite rocks are replaced in order of 0 %, 25%, 50%, 75% for fine aggregate and test are carried out for obtaining behavior. Compression test and split tensile test were carried out on the test specimen. The results reflect that the 25% replacement gives a increase in strength and 50% gives a good increase in strength. Whereas 75% replacement gives an sudden decrease in strength. So it is advisable to replace the crushed laterite rocks around 50% in geopolymer.*

***Key Words*:Geopolymer, laterite, fly-ash, crushed aggregate, alkaline**

1.INTRODUCTION

The production of each ton of cement release approximately an equal amount of carbon dioxide into the atmosphere. The emission of carbon dioxide is one of the major problems that causes global warming. Cement industry is partially responsible for this problem. The increased use of cement can be reduced by employing alternative materials like fly ash, Laterite soil etc. can be used

Thus the disposal problems of fly ash which is an industrial waste can also be reduced. As the need for power increases, the volume of fly ash would increase. Laterite is locally available, cost effective, energy efficient and environment friendly building material in Kerala. The term geopolymer was coined by Joseph Davidovits in 1978. Geopolymers are a class of inorganic polymer formed by the reaction between an alkaline solution and an alumina silicate source and are synthesized by the activation of source materials which are rich in silica and alumina by alkaline media. Synthesis of geopolymer consists of three basic steps.

The first is the dissolution of alumino silicate in a strong alkali solution. This is followed by reorientation of free ion clusters. The last step is polycondensation. When in contact with a high pH alkaline solution, aluminosilicate reactive materials are rapidly dissolved into solution resulting in the release of aluminate and silicate ions, most likely in the monometric form, which afterwards condensate to form a rigid network. Amorphous geopolymers are obtained by carrying out the polycondensation reaction at temperatures from 20 to 90o C, while crystalline materials are formed in the autoclave at higher temperatures, up to 200 o C, geopolymer possess three-dimensional silicoaluminate structures consisting of linked sio4 and alo4 tetrahedral by sharing all the oxygen atom

Laterite is one such marginal material abundantly in many parts of the world, particularly in tropics and sub tropics. In India, there are large deposits of laterite in the peninsular region, which have not been fully utilized so far.

In this work, fly ash based geopolymer is used as the binder to produce concrete. Sodium silicate and sodium hydroxide is used as alkaline liquid and super plasticizer is added to improve workability. Effectiveness of laterite sand as partial replacement of fine aggregate in geopolymer concrete is analyzed in this study. Specimens were casted at varying total aggregate content, molarities and partial replacement i.e 0%, 25%, 50%, 75% of fine aggregate with laterite aggregate. Regarding this scenario, this project aims at replacing fine aggregate sand with crushed laterite in the geopolymer technology, so that the consumption of sand is reduced and hence reducing the extinction of river sand.

2. OBJECTIVE

The objectives of the present research is to evaluate the comparative performance of geopolymer mortar manufactured using locally available low calcium Fly ash. The current research utilizes low calcium fly ash obtained from Mettur Thermal Power Plant (MTPP). The mortar is prepared by using 1:2 ratio and replacing sand with crushed laterite. A comprehensive experimental program has been undertaken to appreciate some of the hardened properties of this low calcium fly ash based blended Geopolymer mortar at ambient temperatures beside the evaluation of some of the synthesizing parameters of the blended fly ash geopolymer mortar. The broad areas include:

- To produce geopolymer (GP) mortar with flyash and crushed laterite.
- Study on the effect of synthesizing parameters on the hardened properties of geopolymer mortar.

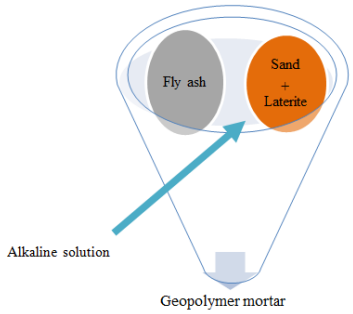


Fig. 1 Schematic Representation of Objective of Research

3. METHODOLOGY

Following preparation process was observed for preparing geopolymer mortar specimens.

- The required materials are procured and tested for basic properties.
- Mix proportioning is achieved and mixes are designated.
- Mix sodium silicate solution, sodium hydroxide pellets and water according to mix proportion, to make alkaline activator, at least one day prior to its use in manufacturing geopolymer.
- For preparing geopolymer mix hand mixings, were used throughout the work. Fly ash in dry sate vigorously wherever required.
- Alkaline activator is mixed with the dry blend for about ten to fifteen minutes to make homogeneous paste.
- Next sand in saturated surface dry condition is slowly added to geopolymer paste while wet mixing in progress and continue wet mixing for another 10-15 minutes after adding the sand for preparing the Geopolymer mortar specimens.
- Transfer geopolymer mix to the molds which are greased properly.
- Vibrate fresh geopolymer mix in the molds on vibration table for 2-3minutes to remove entrapped air in the mix.
- Rest period of 60 minutes is given to fresh specimens prior to placing them in the oven for thermal curing for 24 hours at 85*°C*. The rate of heating oven is 0.5°C to 1°C per minute starting from room temperature and Jar controlled depending on temperature level.
- Removed specimen from molds at room temperature air drying at room temperature until tested or exposed to elevated temperature.
- The specimens are evaluated for their strength properties at 7, 14 28 days.
- The results are analyzed and discussed.

3.1 Mix Proportion

A mixture of flyash, sand and alkaline solution is called Geopolymer mortar. Flyash, river sand and crushed laterite in its original form acts just as a filler material and hence cannot function as binder. Hence, to activate both flyash, river sand and crushed laterite a strong alkali solution of sodium hydroxide and sodium silicate is used. The activated flyash blend is rich in silica and aluminum which function as a binder.

Table – 1: Mix Ratio

Mix	Mix Constituents			Binder-Blend Ratio	Na_2SiO_3/NaOH
	FA	LATERITE	Sand		
Con Mix(CM)	1	0	2	0.34	2.5
Mix 1(M_1)	1	0.25	1.75	0.34	2.5
Mix 2(M_2)	1	0.50	1.50	0.34	2.5
Mix 3(M_3)	1	0.75	1.25	0.34	2.5

Binder - Alkaline solution (Sodium Hydroxide & Sodium Silicate)
Blend - Laterite & Fine sand
NaOH = 9.6% of binder
Na2SiO3 = 2.5 times of NaOH = 24% of binder
Ref Mix(RM) = 100% Flyash + 0% Laterite
Mix 1(M1) = 75% Sand + 25% Laterite
Mix 2(M2) = 50% Sand + 50% Laterite

Mix 3(M3) =75% Sand +25 % Laterite

Table – 2: Mix Proportion

MIX ID	FLYASH Kg/m³	SAND Kg/m³	LATERITE Kg/m³	ALKALINE SOLUTION lit/m³
CM (0%)	700	1400	0	245
M1 (25%)	700	1050	350	245
M2 (50%)	700	1400	700	245
M3 (75%)	700	350	1050	245

3.2 Preparation Of Alkaline Liquid

- Sodium hydroxide(40M) pellets are generally used to prepare alkaline liquid.
- In this research NaOH solution of 16 Molar concentration were used which consists of 16x40=640 grams of NaOH pellets per liter of solution, where 40 is the molecular weight of NaOH.
- To make the solution, a mass of 444 grams of NaOH solids are measured and dissolved in 556 ml of water.
- Once the pellets gets dissolved sodium silicate solution of 2.5times of NaOH solution is mixed to prepare the alkaline liquid.
- It is to be noted that the solution is prepared at least one day prior to casting.

Fig. 2 Preparation of alkaline solution

3.3 Preparation of Specimens

- For the study of compressive strength, split tensile strength and for which cube and cylinder specimens were casted.
- Cube size of 70 x70 x70 mm
- Cylinder size of 50mm dia x 100mm

Fig. 3 Specimens casted for testing

4. EXPERIMENTAL INVESTIGATION

Specimens were casted and heat cured and prepared for experimental test. All the tests were carried out based on IS codalprovisons.

4.1 Compressive Strength Test

- Compression loading tests on mortar cubes were carried out on a compression testing machine of capacity 2000KN.
- Loading rate is 2.5KN/s as per IS:516:1959 is applied.
- Test is performed on 14 & 28 days.
- Compressive strength = Maximum load/c/s area of the cube Expressed in N/mm2

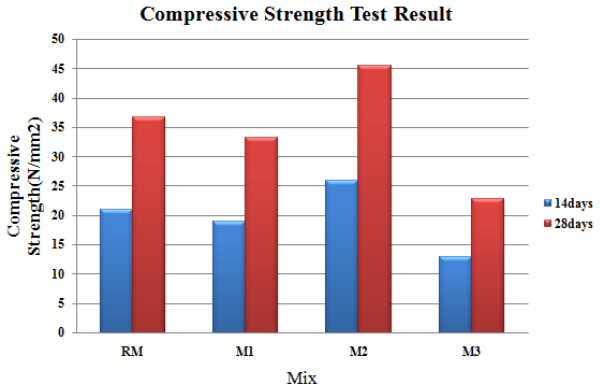
Fig. 4 Compressive strength test

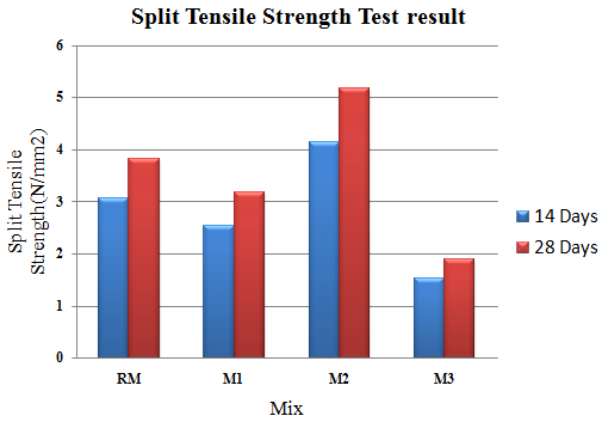
4.2 Split Tensile Strength Test

- Expressed as the minimum tensile stress needed to split the material apart.
- Splitting strength gives about 5-12% higher value than the direct tensile strength.
- Test is performed on 14 & 28 days.

Fig. 5 Split tensile strength test

5. RESULTS AND CONCLUSION





Based on the experimental work reported in this study, the following conclusions are made

- The optimum % of Crushed laterite was found between 25% to 50% which increases the strength of the mortar.
- On increasing the addition of Crushed Laterite beyond 75% it reduces the overall strength of the mortar.
- Better results are obtained for compressive strength and split tensile strength of cubes and cylinders on heat curing at 60ºC.

REFERENCES

[1] Asiedu Emmanue , Agbenyega Allan (2014),‘ Suitability of laterite Fines as a partial replacement for sand in the production of sandcrete bricks ’, Mordern Applied Science, Vol.4, Issue 10, Pp 9-15

[2] Ann Maria Jose, Binu M Issac, Dhanya Krishnan(2015) Department of Civil Engineering Amal Jyothi engg. College, Kanjirapally , kottayam , India “Investigation about the effect of laterite as fine aggregate on the Strength of Geopolymer concrete.”

[3] M.Komljenovic,Z.Bascarevic, V. Bradic (2010), ‘Mechanical And Microstructural Properties of Alkali-Activated Fly Ash Geopolymers’, Journal of Hazardous Material, Vol.181, Issue 1-3, Pp 35-42

[4] Michaela Steinerova, (2011) “Mechanical Properties of Geopolymer Mortars In Relation To Their Porous Structure” institute of Rock Structure And Mechanics, Academy of Sciences of The Czech Republic.

[5] S. Songpiriyakij (2007), ‘Effect of Temperature On Compressive Strength of Fly Ash-Based Geopolymer Mortar’, Silikaty 48(4), Pp.183-197.

[6] Suresh Thokchom, Dr.Partha Ghosh And Dr. Somnathghosh, (2009) “Acid Resistance of Flyash Based Geopolymer Mortars”, International Journal of Recent Trends In Engineering Vol. 1 No. 6, May, Pp.36-40.

[7] V. Sreevidya, R. Anuradha, D. Dinakar, Dr. R. Venkatasubramani (2012) “Acid Resistance of Flyash Based Geopolymer Mortar Under Ambient Curing And Heat Curing” International Journal of Engineering Science And Technology, Vol. 4, No.02 Pp 681-684

[8] Vanchaisata, Apha Sathonsaowaphak, Prinya Chindaprasirt, (2012) ‘Resistance of Lignite Bottom Ash Geopolymer Mortar To Sulfate And Sulfuric Acid Attack’, Cement & Concrete Composites, Vol-34, Pp 700-708.