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Geopolymer Concrete Using Lime, With Ambient Curing

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ABSTRACT

Geo-polymer materials represent an innovative technology that is generating huge amount of interest in the construction industry considering sustainable material. Although geo-polymer concrete is a new technology but the use of this technology has started from the time of pyramids though that time it did not come in the front of the researchers like now to grasp their interest in it. The name "Geo-polymer" was coined by Prof. J. Davidovits in 1978 and he found that the polymerization process involves a substantially fast chemical reaction under alkaline condition on Si-Al minerals that result in 3D polymeric chain and ring structure consisting of Si-O-Al-O bonds. The strength of geopolymer depends on the nature of source material, chemical composition, types of activator solution, solution to fly ash ratio, rest period, types of curing and curing temperature. But in practice it is not possible to produce the temperature curing to structure. Without temperature cutting the geopolymer concrete cannot set early and gain strength. But it is possible by using lime in some percentage with fly ash. Hydraulic lime is a general term for varieties of lime (calcium oxide), or slaked lime (calcium hydroxide), used to make lime mortar which set through hydration. It gains strength over time hence providing flexibility and avoiding the need for expansion joints. This paper presents information on fly ash based geopolymer mortar with ambient curing. In this experimental works the paper covers the materials and chemical proportions, curing temperature and type and the effect of addition of lime in geopolymer concrete. In addition to that the hydrated lime will be used as curing agent.

In this project we will study the processing of geopolymer using lime with alkaline activators. The factors that influence early age compression strength such as sodium hydroxide (NaOH) molarity and sodium silicate (Na_2SiO_3) with theirratios will be studied, sodium hydroxide and sodium silicate withtheir ratios as (Na_2SiO_3/NaOH) 2 and NaOH molarity 13 with addition of 5% - 20% of lime will be added as per results based on trial taken into account.

Keywords : Geo-Polymer, Calcium Oxide, Sodium Hydroxide, Theirratios

I. INTRODUCTION

Concrete is one of the most widely used construction materials which are usually associated with Portland cement as the main ingredient for making concrete. The demand for concrete as a construction material is increasing day by day. In India the production of the fly ash will be about 1373 million tons annually (ICC 201 2). On the other hand, the climate change due to global warming which is one of the greatest environmental issues has become a major concern during the last decade. The global warming is caused by the emission of greenhouse gases such as CO_2 into the atmosphere by human activities. Among the greenhouse gases, CO_2 contributes about 65% of global warming. The cement industry is responsible for about 6% of all CO_2 emissions because the production of one ton of

Portland cement emits approximately one ton of CO_2 into the atmosphere.

II. OBJECTIVES

1) To study the effect of varying lime, workability on geopolymer concrete.
2) To study the effect of initial setting time of Geopolymer mortar with replacement of Lime in various percentage
3) To study the effect of strength for various replacement of lime percentage.

III.SCOPE OF PROJECT WORK

1) For low cost construction work.
2) Effect of fineness of fly ash on properties of geopolymer concrete.
3) Effect of different curing methods on properties of geopolymer concrete.
4) Study of durability of geopolymer concrete
5) Effect of various types of fibers on geopolymer concrete.
6) Using locally available materials.
7) Effective utilization of waste material.
8) To reduce the cost of construction.

IV.METHODOLOGY

Prepare mix design of M40 Grade concrete by using is method

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Normal concrete

Marble Powderwaste concrete

Using Lime (5% replacement to Fly Ash)

Using Lime (10% replacement to Fly Ash))

Using Lime (15% replacement to Fly Ash))

Using Lime (25% replacement to Fly Ash))

↓

Casting of cubes (with varying of % of Lime)

↓

Ambient Curing of these cubes for 7 & 28 days

Testing of these cubes

Comparing normal and Geopolymer concrete result

V. RESULT

Following are the result of compressive test carried on % of varying of Lime

1) Normal concrete (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Load (KN)	Comp. Strength(N/mm²)	Avg. Comp.strength (N/mm²)
1	7	22500	801	37.33	
2	7	22500	790	36.22	36.96
3	7	22500	802	37.35	

2) 5% replacement to Lime(N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp.strength(N/mm²)
1	7	22500	39.11	
2	7	22500	32.44	35.25
3	7	22500	34.22	

3) 10% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp.strength(N/mm²)
1	7	22500	36.00	
2	7	22500	26.28	31.92
3	7	22500	32.88	

4) 15% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp.strength(N/mm²)
1	7	22500	36.88	
2	7	22500	29.77	32.73
3	7	22500	31.55	

5) 20% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp.strength (N/mm²)
1	7	22500	33.77	
2	7	22500	26.22	29.47
3	7	22500	28.44	

7) Normal concrete (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Load (KN)	Comp. Strength (N/mm²)	Avg. Comp.strength (N/mm²)
1	28	22500	1110	49.95	
2	28	22500	1130	50.75	50.57
3	28	22500	1050	51.01	

8) 5% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp.strength(N/mm²)
1	28	22500	54.22	
2	28	22500	48.00	51.11

3	28	22500	51.11	

9) 10% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp.strength(N/mm²)
1	28	22500	48.44	
2	28	22500	40.88	44.44
3	28	22500	44.00	

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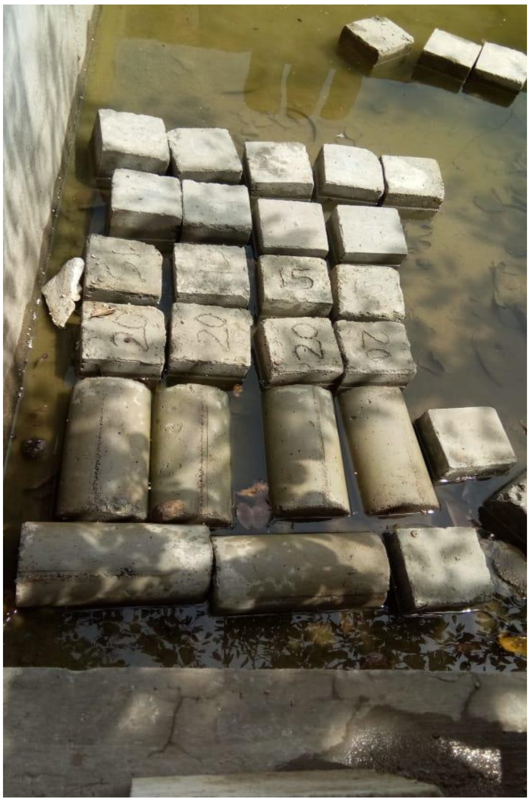

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Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp.strength(N/mm²)
1	7	22500	36.88	
2	7	22500	29.77	32.73
3	7	22500	31.55	

5)20% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(	Avg. Comp.st

			N/mm²)	rength(N/mm²)
1	7	22500	33.77	
2	7	22500	26.22	29.47
3	7	22500	28.44	

6) Normal concrete (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Load (KN)	Comp. Strength(N/mm²)	Avg. Comp. strength(N/mm²)
1	28	22500	1110	49.95	
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1	28	22500	54.22	
2	28	22500	48.00	51.11
3	28	22500	51.11	

8) 10% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp.strength(N/mm²)
1	28	22500	48.44	
2	28	22500	40.88	44.44
3	28	22500	44.00	

9) 15% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp. strength(N/mm²)
1	28	22500	50.22	
2	28	22500	43.11	46.07
3	28	22500	44.88	

10) 20% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp. strength(N/mm²)
1	28	22500	42.66	
2	28	22500	38.66	43.55
3	28	22500	40.00	

11) 15% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp. strength(N/mm²)
1	28	22500	50.22	
2	28	22500	43.11	46.07
3	28	22500	44.88	

12) 20% replacement to Lime (N/mm²)

Sr. No.	Days	C/S Area(mm²)	Comp. Strength(N/mm²)	Avg. Comp. strength(N/mm²)
1	28	22500	42.66	
2	28	22500	38.66	43.55
3	28	22500	40.00	

X. CONCLUSION

1) Workability of Geopolymer concrete was found to be very stiff before addition of extra for every percentage of lime replacement. When extra water was added to the Geopolymer concrete mix, it was workable only for 5% and 10% but for 15% and 20% it required more than extra water calculated as per design. When extra water was added to the solution, it ultimately reduces the concentration of sodium silicate and sodium hydroxide solutions and increases the workability of concrete mix. As alkaline

solutions are viscous (i.e. offers resistance to flow) in behavior, addition of extra water to it reduces viscosity of Geopolymer concrete mix. As the time increases workability of Geopolymer concrete mix also increases after wet mixing of ingredients.

2) As conventional concrete requires external curing due to heat of hydration reaction but there is expulsion of water in the polymerization process of Geopolymer concrete so no extra curing is required.
3) The Pore sizes get reduction after addition of Lime into geopolymer concrete. This phenomena influences water absorption and compressive strength. Incorporation of Lime up to 10% increases the compressive strength of paste specimens about 44%. The reduction in compressive strength due to lower curing temperature may be compensated by incorporation of calcium compound which can accelerate the rate of geopolymerisation even at low temperature.
4) The compressive strength goes on increase with the increase in the rest period of geopolymer concrete (M30) with addition of 10% of Lime when cured at normal room temperature. The maximum compressive strength was achieved at the completion of 28 days of rest period thereby giving it a wide scope. The compressive strength achieved by 5% and 10% of geopolymer concrete cured at normal room temperature at a rest period of 7days is higher than the compressive strength achieved by 15% and 20% for similar rest period

XI. REFERENCES

[1]. Anuradha R., Sreevidya V., Venkatasubramani R., and Rangan B.V. (2012), guidelines for geopolymer concrete mix design using Indian standards," Asian journal of Civil Engineering, vol. 13, pp. 353–364.

[2]. ASTM. (2001). "Standard test method for compressive strength of cylindrical concretespecimens." C39, West Conshohocken, PA.

[3]. ASTM. (2008a). "Standard specification for coal fly ash and raw or calcined natural pozzolan for use in cement." C618, West Conshohocken, PA.

[4]. ASTM. (2008b). "Standard test methods for time of setting of hydraulic cement mortar by modified vicat needle." C807, West Conshohocken, PA.

[5]. Bernal Susan, Ruby, Gutierrez De, Delvasto Silvio; Rodriguez (November 15-18, 2006), "Performance of geopolymer concrete reinforced with steel fibers," IIBCC 10th Int. Inorganic bonded fibre composite conference, Sao Paulo-Brazil.

[6]. Bhosale M.A., and Shinde N.N. (July-August 2012), "Geopolymer concrete by using fly ash in construction," ISOR Journal of mechanical and civil engineering, vol.1, PP. 25-30.

[7]. Chaterjee Anjan K. (28-30 JUN 2010 Italy), "Indian fly ashes, their characteristics, and potential for mechano-chemical activation for enhanced usability".

[8]. Chindaprasirt P., Chareera T., Hatanaka S. & Cao T. (2011"High strength geopolymer using fine high calcium fly ash" American Society of Civil Engineers.

[9]. Davidovits J. (2008), "Geopolymer Chemistry and Applications." 2nd Ed., Institute Geopolymer, St. Quentin, France.

[10]. Davidovits, J. (1999). "Chemistry of geopolymer systems, terminology." Proc., 2nd Int. Conf., Geopolymere. Davidovits, R. Davidovits, and C. James, eds., Geopolymer Institute, Saint-Quentin, France, 9–40.