International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 02 - Issue 08 || August 2016 || PP. 47-50

Enhancement of compressive strength of geopolymer concrete by varying ratio of Na_2Si0_3/ NaoH and by varying molarity of NaoH

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Abstract: Global warming is one of the major problem in the world today. Global warming is caused by the environmental pollution. Construction Industries are responsible for environmental pollution as 1 ton production of cements approximately emits one ton of CO_2 into the atmosphere. So, there is need to search for alternative to cement. Geopolymer technology is new innovative technology in the world of concrete technology. In Geopolymer Concrete 100 % replacement of cement is possible with another source material which is rich in silica and alumina . Source material is activated with alkaline activators which act as binders . In present investigation molarity of NaOH is varied from 8M, 10M . Na_2SiO_3 consisiting of Na_2O = 15.02%, SiO_2 =,34.01% H_2O = 50.93% is used. Natural rivner sad having fineness modulus = 3.15 is used as fine aggregate. Combination of Na2Sio3 and NaOH solution is used as alkaline activators. Na_2SiO_3/NaOH ratio is kept as 1, 1.5,2. Compressive strength of geopolymer concrete is checked .

Keywords: Alkaine Activators , Fly ash, Geopolymer concrete, Na_2SiO_3 , NaOH

I. INTRODUCTION

Utilization of concrete as a major construction material is a worldwide phenomenon and the concrete industry is the largest user of natural resources in the world. This use of concrete is driving the massive global production of cement, estimated at over 2.8 billion tones according to recent industry data. Associated with this is the inevitable carbon dioxide emissions estimated to be responsible for 5to 7% of the total global production of carbon dioxide[1]. Significant increases in cement production have been observed and were anticipated to increase due to the massive increase in infrastructure and industrialization in India, China and South America. Demand for concrete as construction material is on the increase and so is the production of cement. In order to address environmental effects associated with. Control of global warming is major concern in today's life**.** Geopolymer technology is new innovative technology in the world of concrete technology in which 100 % replacement of cement is possible with another source material which is rich in silica and alumina . Source material is activated with alkaline activators which act as binders. In present investigation molarity of NaOH is varied from 8M, 10M . Na_2SiO_3 consisting of Na_2O =15.06% , SiO_2 =34.01% , H_2O = 50.93% is used. Natural river sand having fineness modulus = 3.15 is used as fine aggregate. Combination of Na2Sio3 and NaOH solution is used as alkaline activators. Na_2SiO_3/NaOH ratio is kept as 1, 1.5,2. Compressive strength of geopolymer concrete is checked**.**

II. LITERATURE REVIEW

Subhash Patankar et.al.(December 2014) [5] suggested Mix Design of Fly Ash Based Geopolymer Concrete. They carried experimental investigation for the gradation of geopolymer concrete and a mix design procedure is proposed on the basis of quantity and fineness of fly ash, quantity of water, grading of fine aggregate, fine to total aggregate ratio. Water-to-geopolymer binder ratio of 0.35, alkaline solution-to-fly ash ratio of 0.35 and sodium silicate-to-sodium hydroxide ratio of1.0 by mass were fixed on the basis of workability and cube compressive strength.Workability of geopolymer concrete was measured by flow table apparatus and cubes of 150mm side were cast and tested for compressive strength after specified period ofoven heating. The temperature of oven heating was maintained at 60 °C for 24 h duration. According to them the results of workability and compressive strength are well match with the required degree of workability and compressive strength.

B. Vijaya Rangan (April 2014) conducted study on fly ash based geopolymer concrete. Salient factors that influence the properties of the geopolymer concrete in the fresh and hardened states are identified. Test data of various short-term and long-term properties of the geopolymer concrete are then presented. The paper describes the results of the tests conducted on large-scale reinforced geopolymer concrete members and

illustrates the application of the geopolymer concrete in the construction industry. Some recent applications of geopolymer concrete in the precast construction and Geopolymer concrete has excellent compressive strength and is suitable for structural applications.[2]

III. INDENTATIONS AND EQUATIONS

1.1. Material Required for geopolymer concrete

- P 63 fly ash
- Fine Aggregate
- Coarse Aggregate
- Alkaline Activators
- Extra Water

Fly Ash

In present investigation P63 fly ash obtained from Dirk India Ltd. Nashik was used having following features

TABLE 1 GENERAL FEATURES

Presentation	Finely divided dry powder
Colour	Light grey
Bulk Weight	Aprox. 0.90 metric ton per cubic meter
Specific density	Aprox. 2.30 metric ton per cubic meter
Size	90% < 45 micron
Particle shape	Spherical
Package	30 kg paper bags, 1 metric ton big-bags and bulk tankers

POZZOCRETE 63 TEST CERTIFICATE (SPECIMEN) AS PER DIRK INDIA PVT.LTD.

Test No.	Test	Unit	IS-3812 Specification	Typical Test Results	
1	Fineness Specific Surface by Blaines Permeability Method (Min.)	m^2/kg	320	435	
2	ROS (Residue Over Sieve) # 350 (45 Microns) Max.	%	34	9.88	
3	Lime Reactivity (Min.)	N/mm^2	4.5	7.40	
4	Moisture Content (Max.)	%	2	0.28	
5	Autoclave Expansion (Max.)	%	0.8	0.023	
6	Compressive Strength at 28 days-	N/mm^2	80% of strength of plain cement concrete		
	Pozzocrete + Cement Mortar			52.10	95.94%

	Plain Cement Concrete			54.3
7	Chemical Analysis			
	Test	%	IS Specification	
	Loss On Ignition (Max.)	%	5	1.00
	$SiO_2+Al_2O_3+ Fe_2O_3$	%	70 min. by mass	93.15
	SiO_2	%	35 min. by mass	60.42
	MgO	%	5 max. by mass	1.82
	SO_3	%	3 max. by mass	0.83
	Na_2O	%	1.5 max. by mass	0.47
	Total Chlorides	%	0.05 max. by mass	0.031

COARSE AGGREGATE: Crushed angular aggregate of 20mm size (65% of total coarse aggregate) & 12.5 mm size (35% of total coarse aggregate) was used as coarse aggregate

Sr. No	**Characteristics**	**Value**
1	Type	Crushed
2	Coarse aggregate -I	20 mm
3	Coarse aggregate-II	12 .5 mm
4	Specific Gravity	2.76
5	Water Absorption	0.995%

Alkaline Activators: In the present investigation, sodium based alkaline activators are used.

- Sodium Silicate : Sodium silicate solution having Na2O =15.06% , SiO2 = 34.01% ,H2O = 50.93% procured from Shanti Chemicals , Belgum was used.
- Sodium Hydroxide : Sodium hydroxide flakes procured from Abhay Chemicals Nashik was used to prepare sodium hydroxide solution.[3],[4],[5].

SODIUM SILICATE

SODIUM HYDROXIDE

1.2. MIX DESIGN PROCEDURE OF GEOPOLYMER CONCRETE:

Quantity of Fly Ash : Quantity of fly ash depends upon fineness of fly ash and workability of concrete .
Pozzocrete 63 is having $435m^2/kg$ fineness of fly ash

Table 2 shows material required for P 63 fly ash for varying ratio of Na_2SiO_3/NaOH. Mix design procedure suggested by Dr. S.V.Patankar(2) is used to obtain the quantities of materials.[5]

TABLE 1. MATERIAL REQUIRED FOR DIFFERENT NA_2SIO_3/NAOH RATIO AND P 63

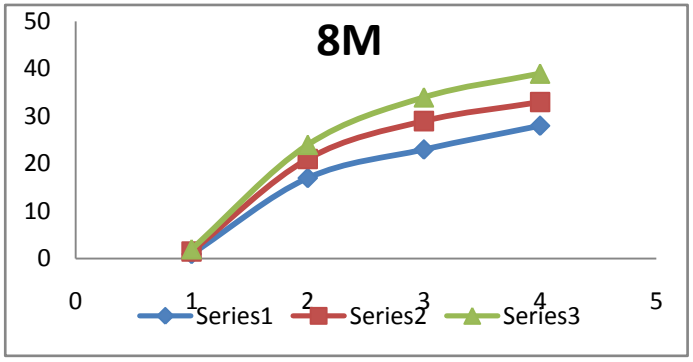
Sr. No.	**Molarity**	**Na_2SiO_3/NaOH**	**Fly Ash (kg/m^3)**	**Fine Aggregate (kg/m^3)**	**Coarse Aggregate (kg/m^3)**	**Extra Water (kg/m^3)**
01	8	1.0	410	676.98	1285.28	19.237

02		1.5		675.88	1283.21	22.41
03		2.0		675.03	1281.89	24.57
04		1.0		675.86	1283.16	22.42
05	10	1.5	410	674.97	1281.48	25.04
06		2.0		674.39	1280.36	26.74

IV. RESULT

COMPRESSIVE STRENGTH OF GEOPOLYMER CONCRETE FOR VARYING RATIO OF Na_2SiO_3/ NaOH

Sr. No.	Molarity	Na2Sio3/ NaOH	Compressive Strength (N/mm2)		
			3 Days	7 Days	28 Days
01	8	1.0	17	23	28
02		1.5	21	29	33
03		2.0	24	34	39
04	10	1.0	18	27	32
05		1.5	24	33	37
06		2.0	29	38	43



Na_2SiO_3/NaOH : 1.0 - Series
1Na_2SiO_3/NaOH : 1.5 - Series
2Na_2SiO_3/NaOH : 2.0 Series 3

V. CONCLUSION

Fineness of fly ash is very important to decide quantity of fly ash. As fineness of fly ash goes on increasing, less quantity of fly ash is required. It is observed that fine aggregate quantity is slightly decreased as we increase the ratio of Na_2SiO_3/NaOH.Also, quantity of coarse aggregate goes on decreasing as there is increase in ratio of Na_2SiO_3/NaOH. But extra water required increases as there is increase ratio of Na_2SiO_3/NaOH. Fly ash quantity depends on fineness of fly ash. Na_2SiO_3 is sticky gel and it requires more time for setting in winter and rainy season as we increase ratio of Na_2SiO_3/NaOH. While Preparing NaOH solution, care should be taken to avoid irritation to skin and eyes . Also. NaOH should prepare one day before use of it in concrete.

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