March-April 2020
ISSN: 0193-4120 Page No. 8394 - 8400

Geopolymer Concrete using Industrial Waste

R.Subalakshmi[1], C V Gokul[2]

[1,2] Department of Civil Engineering, Sri Sai Ram Engineering College, Chennai-600044, Tamil Nadu, India
[1]subalaskshmi.civil@sairam.edu.in

Article Info
Volume 83
Page Number: 8394 - 8400
Publication Issue:
March - April 2020

Article History
Article Received*: 24 July 2019*
Revised*: 12 September 2019*
Accepted*: 15 February 2020*
Publication*: 09 April 2020*

Abstract

The element of this research is to decrease the utilization of concrete inside the development place. At the hour of concrete introduction, discharge of CO2 is unavoidable and situation moreover gets infected. Utilizing waste cloth like fly debris and GGBFS as a substitution of concrete in concrete diminishes the want of concrete. The compressive pleasant parameter have become carried out on arranged chamber and blocks with particular combination extents using half of fly debris and 1/2 of GGBFS as opposed to concrete. The sand is reasonably supplanted with M-sand with Na2SiO3 and NaOH (8M and 12M) is carried out due to the fact the coupling operator. Filaments are remembered for it with the purpose that compressive pleasant of the robust increment. Usage of contemporary-day waste declines the fee of advent of concrete and discharge of CO2 is faded to the extra noteworthy diploma while contrasted with traditional concrete.

Keywords; *Fly debris, GGBFS, Fibers*

I. INTRODUCTION

As Concrete is the maximum frequently utilized improvement cloth. Generally, concrete is created thru using the Ordinary Portland Cement because the folio. Be that as it may, the assembling of the Portland concrete is a strength centered way and discharges loads of ozone harming substance to air. Creation of 1 ton of Portland concrete calls for about 2.Eight large portions of crude materials, together with gas and one among a type materials and henceforth it is remarkable that concrete creation drains big degree of commonplace belongings. Because of de-carbonation of lime, assembling of 1 ton of concrete produces round one ton of carbon dioxide. These days, there is a main fear approximately the improvement of non-compulsory materials to Portland concrete. In this manner, there are endeavors to accumulate the opposite type of cementatious materials for turning in concrete.

Utilization of Fly debris and GGBFS in the substitution of concrete diminishes the want of concrete and along those traces decreases the discharge of CO2. Right now, of cement every in new and solidified cement are dissected via supplanting the concrete honestly through distinctive path blends utilising Fly particles and GGBFS. For improving the nice and durability of robust, admixtures and Polypropylene Fibers are delivered.8M NaOH, 12M NaOH and Na2SiO3 are utilized due to the fact the admixtures.

II. GEOPOLYMER TECHNOLOGY

Geopolymer is an inorganic polymer like normal zeolitic substances, however the microstructure is undefined in place of crystalline. The polymerization technique consists of generously a short substance response below antacid condition on Si-Al minerals that result in a 3 dimensional polymeric chain and ring structure comprising of Si-O-Al-O bonds. The geopolymerisation reaction is exothermic and occurs beneath environmental tension at temperatures under a hundred°C.

Polypropylene filaments have been protected for the duration of blending of the components to beautify the exquisite of framework preserving.

Published by: The Mattingley Publishing Co., Inc.

March-April 2020
ISSN: 0193-4120 Page No. 8394 - 8400

Polypropylene is one of the least expensive and richly reachable polymers.

Formation of Geopolymer Concrete

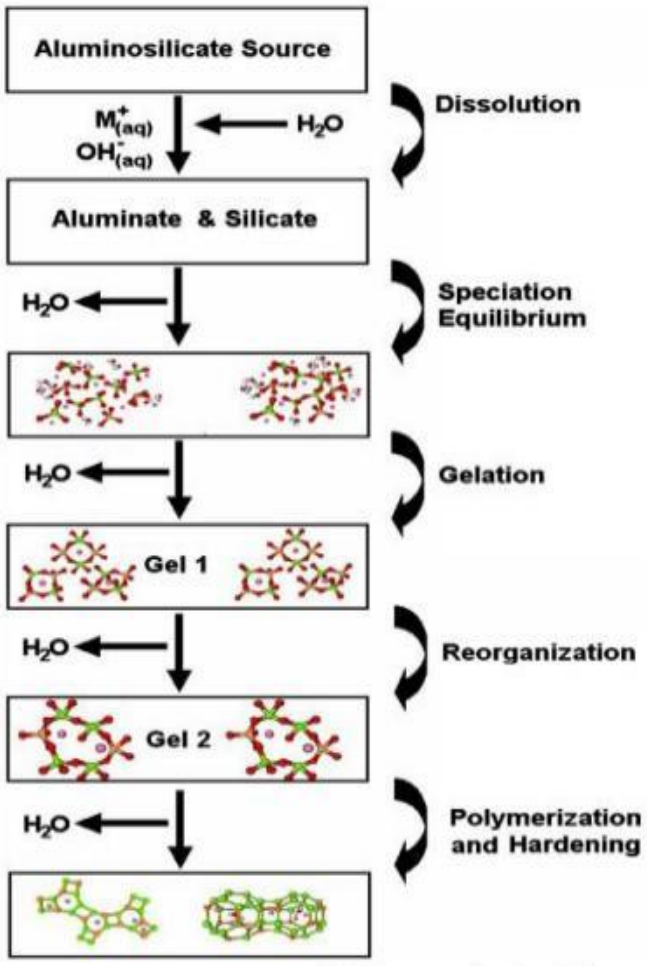

Fig.1 Formation of Geopolymer Concrete

III. EXPERIMENTAL

Materials Used

The materials utilized proper now Fly particles, GGBFS, Sodium Hydroxide (NaOH), Sodiun Silicate (Na2SiO3). Lab checks were led in line with Seems to be 2386-1963,IS 383-1970, IS 516-1959, IS 5816-1999, IS 456-2000, IS 3812-1981 for sorting out the substances belongings and the approach for test for best of concrete and each compressive and tractable.

Blend Design And Material Proportions

The essential concept of a combination configuration is to select and amount appropriate substances so that you can provide a critical high-quality and capability. Since Geopolymer concrete is the developing kind of cement, the guidelines from the Bureau of Indian Standards are yet to be figured. Subsequently, the combination shape for geopolymer concrete relies upon on Trial and Error manner.

Five blends of the extent of GGBFS 1/2 of was based. The method of Mix configuration is as consistent with the subsequent:

- In the structure of geopolymer solid blend, coarse and first rate totals collectively were taken as seventy five% of entire mixture thru mass. This properly worth is like that applied in OPC concrete wherein it will be in the scope of seventy five% to 80% of the whole combo by using mass.
- Fine standard become taken as 40% via mass of the all out totals.
- From the past literary works evidently the ordinary thickness of fly particles based totally geopolymer concrete is like that of OPC concrete (2400 kg/m3).
- Knowing the thickness of cement, the joined mass of essential fluid and fly debris can be determined.
- By searching forward to the share of primary fluid to fly debris as zero.Four, mass of fly debris and mass of soluble fluid changed into determined.
- From the mass of fly debris, in view of the quantity of GGBFS to be protected the mass of GGBFS became determined.
- Sodium hydroxide of molarity 8M became taken into consideration for shape. To get mass of sodium hydroxide and sodium silicate arrangements, the percentage of sodium silicate answer for sodium hydroxide association became saved as 2.Five.

Published by: The Mattingley Publishing Co., Inc.

March-April 2020
ISSN: 0193-4120 Page No. 8394 - 8400

 The water to geopolymer solids percentage by using mass became saved up at zero.Three for all blends. Additional water and first-rate plasticizer BASF poly have a look at 8994 were added to the combination to carry out beneficial cement.

 The stage of polypropylene strands changed into 0.04% and have become stored consistent for all blends.

Table.1 Mix Proportions

No	Fly ash	GGBFS	Coarse aggregate		Fine aggregate		Activators		Extra water in lit	BASF poly heed 8994	Fibers (Kg)
			20 mm	12.5 mm	R. Sand	M. Sand	Na_2SiO_3	NaOH			
	(Kg)										
M1	16.36	16.36	20.61	20.61	13.74	13.74	-	-	9.16	-	-
M2	16.36	16.36	20.61	20.61	13.74	13.74	4.67	1.86	2.63	10.1	-
M3	16.36	16.36	20.61	20.61	13.74	13.74	4.67	1.86	2.63	10.1	0.032
M4	16.36	16.36	20.61	20.61	13.74	13.74	4.67	1.86	2.63	10.1	-
M5	16.36	16.36	20.61	20.61	13.74	13.74	4.67	1.86	2.64	10.1	0.032

Following proportions are proposed for testing,

M1 - Mix OF 50% Fly ash + 50% GGBFS + Water

M2 - Mix OF 50% Fly ash + 50% GGBFS + 8M NaOH + Na2SiO3

M3 -Mix OF 50% Fly ash + 50% GGBFS + 8M NaOH + Na2SiO3 + Polypropylene Fiber M4 - Mix OF 50% Fly ash + 50% GGBFS + 12M NaOH + Na2SiO3

M5 - Mix OF 50% Fly ash + 50% GGBFS + 12M NaOH + Na2SiO3 + Polypropylene Fiber

Molarity Calculation

Quantity of NaoH solution in concrete depends upon the concentration of the solution expressed in terms of molarity, M. NaOH of 8 molar concentration consist of 8x40 = 320grams per litre of water. Were 40 is the molecular weight of NaOH. Though 320 grams is large in volume, it has been reduced to 262 grams for one litre of water for 8M NaoH. 8M NaOH consists of 26.23% of solids and 73.77% of water.

NaOH of 12 molar concentration consist of 12x40 = 480grams per litre of water. Though 480 grams is large in volume, it has been reduced to 360 grams for one litre of water for 12M NaOH. 12M NaOH consists of 36.09% of solids and 63.91% of water. This shows that water was the major component in the sodium hydroxide solution and NaOH solids was only a fraction of the mass of NaOH solution.

IV. PREPARATION OF ALKALINE LIQUIDS

A blend of sodium hydroxide arrangement and sodium silicate arrangement was utilized as basic activators for geopolymerisation. At the room temperature basic fluids are set up by blending of sodium hydroxide arrangement and sodium silicate. At the point when the arrangements combined polymerization process occur for example both the arrangements begin to respond with one another. It discharges high measure of warmth with the goal

Published by: The Mattingley Publishing Co., Inc.

March-April 2020
ISSN: 0193-4120 Page No. 8394 - 8400

that it is left for about least 60 minutes, consequently the basic fluid as a coupling operator is prepared.

Testing techniques

Absolutely 72 solid shapes (150 mm x 150 mm x 150 mm) for compressive quality and 72 chambers (150 mm distance across and 300 mm tallness) for split rigidity were thrown. Standard cast iron molds were utilized for throwing the test examples.

V. RESULTS AND DISCUSSION

Physical properties – Slump Test

All the blends were commonly strong and sparkling in appearance because of the nearness of sodium silicate. All the blends were tried for droop and the test outcomes are appeared in table beneath.

Table.2 Slump test Result

Mix	Slump value in "mm"
M_1	60
M_2	143
M_3	118
M_4	139
M_5	121

Even though the measured slump values are more than 100mm, all the mixtures were generally stiff and the workability was poor. Inclusion of polypropylene fibers reduces the slump values.

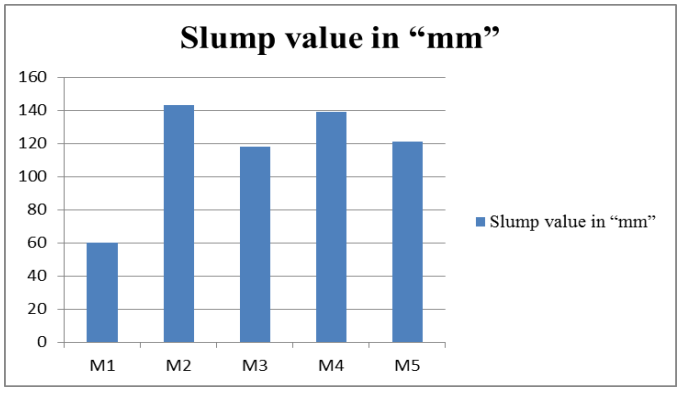

Fig.2 Variation of Slump with NaOH

Compressive Strength of Paver Block with and without Admixtures

The specimens were tested for compressive strength at the age of 28 days and the results are tabulated below:

Table.3 Compressive Strength

Mix	Compressive Strength (N/mm^2)			
	3 day	7 day	14 day	28 day
M_1	3.095	4.339	7.935	12.86
M_2	7.761	12.513	21.756	28.209
M_3	11.597	18.530	32.264	41.682
M_4	9.984	15.958	27.991	36.013
M_5	14.650	23.413	40.940	52.625

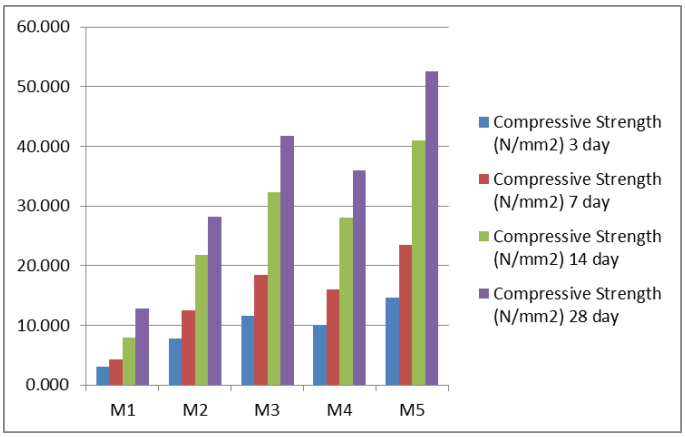

Fig.3 Variation of Compressive Strength with NaOH

The results indicate that the compressive strength increases with the increase in the percentage of GGBFS.

Split Tensile Strength

The specimens were tested for compressive strength at the age of 28 days and the results are tabulated below:

Published by: The Mattingley Publishing Co., Inc.

March-April 2020
ISSN: 0193-4120 Page No. 8394 - 8400

Table.4 Split Tensile Strength

Mix	Split Tensile Strength (N/mm^2)			
	3 day	7 day	14 day	28 day
M_1	0.986	1.342	1.653	2.021
M_2	3.236	4.854	6.040	7.766
M_3	4.407	6.963	9.113	11.489
M_4	3.545	5.247	6.705	8.403
M_5	4.947	7.915	10.980	13.060

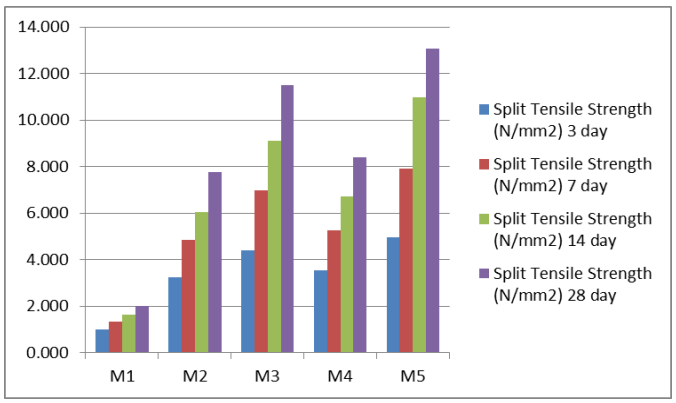

Fig.4 Variation of Split Tensile Strength with NaOH

The test results indicate that the split tensile strength of the fibre reinforced geopolymer concrete increases with an increase in the percentage of GGBFS.

Cost Analysis

The cost of Fiber Reinforced Geopolymer Concrete is found to be greatly less than conventional concrete, at the same time without compromising on the strength aspect – both compressive and tensile strength are comparatively more in GFRC.

One of the core reasons for the reduction in cost is the partial replacement of river sand by manufactured sand bringing the cost of fine aggregate from Rs.9360 to Rs.5076 [combined price of river sand (Rs.4680) and M.sand (Rs.396)]

The second major cause for this cost discrepancy is the total replacement of cement by fly ash and GGBFS, bringing the cost of binder material from Rs.3255 to Rs.430. but additionally we have to add super plasticizers and Polypropylene Fibers to increase long term strength of final structure. Sodium hydroxide and Sodium silicate are to be added to initiate the polymerization.

Cost estimate shows that the cost of conventional concrete per cubic meter is Rs.13233 whereas cost of GFRC is only Rs.8040, expressing the cost of GFRC in terms of conventional concrete:

$$\% \text{ cost of GFRC} = \left(\frac{Cost\ of\ GFRC/\text{m3}}{Cost\ of\ conventional\ concrete/\text{m3}}\right) x\ 100\%$$

$$= \left(\frac{8040}{13233}\right) x\ 100\%$$

$$= 60.75\%$$

Therefore it cost only about 60% of the actual cost of concreting in case of GFRC with additional benefits of strength and durability.

Table.5 Comparative Cost Estimate of Conventional concrete and GFRC

MATERIAL	RATE (per Ton)	Conventional conc		GFRC	
		Qty.	Cost (Rs.)	Qty.	Cost (Rs.)
20 mm Aggregate	600	1080	648	540	324
12.5 mm Aggregate	480	Nil	-	540	260
M Sand	1100	Nil	-	360	396
River Sand	13000	720	9360	360	4680
Cement	7500	430	3225	Nil	-
Fly Ash	500	Nil	-	215	107.50
GGBFS	1500	Nil	-	215	322.50
NaOH (12M)	30000	Nil	-	19.275	578.50
Na_2SiO_3	16000	Nil	-	44.700	715.50
Polypropylene Fibers	145000	Nil	-	0.900	130.50
Super plasticizers	52000	Nil	-	10.100	525.50
TOTAL		Rs.13233		Rs.8040	

VI. CONCLUSION

So as to create eco-accommodating cement from enterprise squanders i.E., fly particles and GGBFS, the aggregate systems were installation by means of the use of supplanting OPC by using manner of FA(50%) and GGBFS(50%) with Geopolymer fiber

Published by: The Mattingley Publishing Co., Inc.

through which include admixtures and affiliation of 3-d shapes, chambers have been readied

The threw examples at that aspect uncovered to compressive and detail stress attempted at three,7,14 and 28 days one at a time. From the test effects, the accompanying cease may be drawn:

- When contrast with normal cement with association of route blends, M5 combination (half Fly debris + half of GGBFS + 12M NaOH + Na2SiO3 + Polypropylene Fiber) offers increment in compressive and cut up stress of 42% and 20% one after the other.

- Reduction in fee is each different preferred characteristic of utilising mechanical waste as a substitution of OPC. About forty% of the arrival cost is diminished with the resource of substitution.

- By using mechanical waste in concrete as opposed to concrete, CO2 outflow in the introduction of concrete is maintained a strategic distance from thru the way wherein average an unnatural weather alternate is likewise controlled.

REFERENCES

[1]. Prakash R. Vora, Urmil V. Dave (2013) "Parametric Studies on Compressive Strength of Geopolymer Concrete", Procedia Engineering 51, pp:210-219.

[2]. S.Subbiah ilamvazhuthi and Dr.G.V.T.Gopalakrishna (2013), "Execution of Geopolymer Concrete with Polypropylene Fibers", International Journal of Innovations in Engineering and Technology (IJIET), Vol. 3, Issue 2, pp 148-156.

[3]. M.I. Abdul Aleem and P.D. Arumairaj, "Ideal combo for the geopolymer stable", Indian Journal of Science and Technology, Vol. 5, No. Three (Mar 2012), pp:2299-2301

[4]. Anuar K.A et al,(2011) "Quality Characteristics of Geopolymer Concrete Containing Recycled Concrete Aggregate", International Journal of Civil and Environmental Engineering IJCEE-IJENS, Vol:eleven, No: 01,pp:fifty nine-sixty

[5]. Subhash V. Patankar, et al, "Impact of Concentration of Sodium Hydroxide and Degree of Heat Curing on Fly Ash-Based Geopolymer Mortar", Indian Journal of Materials Science, Volume 2014

[6]. R.Anuradha, et al, "Adjusted policies for Geopolymer robust combination configuration utilizing Indian Standard", ASIAN Journal of Civil Engineering (Building and Housing) Vol.13, No.Three, 2012, pp 353-364.

[7]. Sathish Kumar.V, et al, "An Experimental Study on Properties of Glass Fiber Reinforced Geopolymer Concrete", International Journal of Engineering Research and Applications (IJERA)Vol.2, Issue 6, November-December 2012, pp.722-726

[8]. P.Eswaramoorthi, G.E.Arunkumar, "Strands Study On Properties Of Geopolymer concrete With Polypropylene, International Refereed Journal of Engineering and Science (IRJES), Volume 3, Issue 2 (February 2014), pp:60-seventy five.

[9]. Anurag Mishra et al, "Impact Of Concentration Of Alkaline Liquid And Curing Time On Strength And Water Absorption Of Geopolymer Concrete", ARPN Journal of Engineering and Applied Sciences, Vol. Three, No. 1, February 2008, pp: 14-18.

[10]. H. Gokulram, R. Anuradha, "Quality Studies on Polypropylene Fiber Reinforced Geopolymer Concrete utilising M-Sand", International Journal of Emerging Trends in Engineering and Development, Issue 3, Vol.2 (March 2013), pp 242-250.

[11]. Kolli.Ramujee, Dr.M.Potharaju, Development Of Mix Design For Low Calcium Based Geopolymer Concrete In Low, Medium And Higher Grades - Indian Scenario, Journal Of Civil Engineering And Technology, Volume 1, Issue 1, July-December (2013), pp. 15-25.

March-April 2020
ISSN: 0193-4120 Page No. 8394 - 8400

[12]. IS-2386-1963 (Part I&III), "Strategy for take a look at for Aggregate robust, Bureau of Indian Standards, New Delhi.
[13]. IS: 383-1970, "Detail for coarse and quality totals from the normal hotspots for solid", Bureau of Indian Standards, New Delhi.
[14]. IS: 516-1959, "Strategy for take a look at for pleasant of Concrete", Bureau of Indian Standards, New Delhi.
[15]. IS: 5816-1999, Methods of test for parting strain of sturdy chambers, Bureau of Indian measures, New Delhi.
[16]. IS: 456-2000, Code of education for easy and strengthened solid, Bureau of Indian measures, New Delhi.
[17]. IS: 3812-1981, Indian Standard Specification for Fly Ash for Use as Pozzolona and Admixture, Bureau of Indian benchmarks, New Delhi.
[18]. Shetty, M. S., (2002), Concrete Technology, 5th changed launch, S.Chand and Company.

Published by: The Mattingley Publishing Co., Inc.