International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-5, January 2020

Mechanical Strength Properties of Geopolycrete with GGBS for Composite Construction

P.T.Ayswariya Lakshmi, S.Maragatham

Abstract:Concrete which is at high necessity is both economically and environmentally facing contradictions. Invoking this issue as the need of time, Geopolymer has made its existance into construction. But in further stage cement and river sand are both causing depletion to natural resource. The hybrid geopolycreteis eco-friendly, non-corrosive and good durability. Substantial research papers has reported the studies on GGBS &Geopolymer. Composite construction involves the technique in which material efficiency of two different materials go hand in hand. This paper explains the mechanical behavior of GGBS blended Geopolymer Concrete and the results are discussed for its application in composite slab. The hybrid geopolycrete of M25 grade is tested for strength and durability properties by casting test specimens. The design for the slab is performed manually.

Keywords : Composite slab, Decking sheet,Geopolymer concrete, GGBS, Fly ash .

I. INTRODUCTION

An alternative eco-friendly concrete binder called "GEOPOLYMER" is developed, an aluminosilicate material. Fly ash (also known as flue-ash) is a residue generated by combustion of coal which is rich in alumina and silica. Geopolymer reduces about 80% of emission CO2. Geopolymer was synthesized with fly ash, GGBS, alkaline solution, M-sand. Geopolymer concrete is ambient cured and requires no water curing[1].

Geopolymer is an inorganic alumino-silicate compound, synthesized from materials of geological origin or from by-product materials such as fly ash, rice husk ash, etc., which are rich in silicon and aluminum[2]. Fly ash is one of the residues generated from the combustion of coal, generally captured from the chimneys of coal-fired power plants.The important strategy in making materials more environmental friendly is consumption of fly ash in manufacture of Geopolymer. Based on this reason, in order to utilize this industrial waste in a better way fly ash is used as the base material in this project.

Accordingly, the present project aims in replacing the cement with fly ash using Geopolymer concrete. Hence CO2 and consumption of OPC is reduced. The obtained result is being applied on the emerging construction technology.[5]

GGBS comprises of CaO, aluminum oxide, magnesium oxide, silicon di-oxide. Its possible when the GGBS is added in Geopolymer concrete will boost the strength of the concrete and curing is done at normal room temperature. The chemical content of ground granulated blast furnace slag remains the same as in normal PPC cement but different in proportion.[6]

II. OBJECTIVE

1. To study the material properties of raw material and incorporate in the mix design.
2. To compare the mechanical strength properties of the test specimens for various percentage of GGBS from 0% - 30%.[3]
3. Achieve ambient curing of the specimens.
4. To design the specification of composite slabs.

III. METHODOLOGY

Fly ash:

Fly ash of class F from Mettur Thermal Plant (MTPP) was used. Fly ash used are conforming to IS 3812-1981.

Fine aggregate:

Clean and dry M-sand was used. Sand passing through IS 4.75mm Sieve was used for casting all the specimens. Fine aggregate used are conforming to IS 383-1970.

Coarse aggregate:

Coarse aggregate is a board category of coarse particulate material used in the construction, including gravel, crushed stone, slag, recycled concrete and geosynthetic aggregate.

Water:

Castings of specimens were done with the portable water.

Alkaline solution:

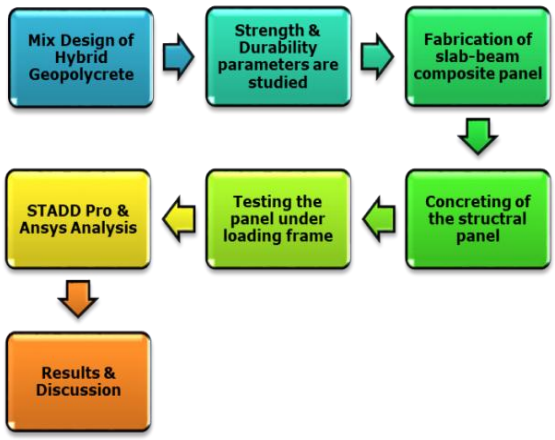
Sodium Hydroxide and Sodium Silicate are used to prepare the Geopolymer mortar.

Manuscript published on January 30, 2020.
* Correspondence Author

P.T.Ayswariya Lakshmi*, Ph.D Scholar, Department of Civil Engineering, School of Engineering, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, India.

Email: ayswariyasrikanth@gmail.com

Dr.S.Maragatham, Professor & Dean, Department of Civil Engineering, School of Engineering, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, India. Email: prof.maragatham@gmail.com



Mix design[7]

a.) Design stipulation for proportioning:
Grade designation = M25
Size of coarse aggregate = 20 mm
Specific gravity of fly ash = 2.02
Specific gravity of Coarse aggregate =2.78
Specific gravity of FA (M- Sand) = 2.72
Sand confirming = Zone II
Specific gravity of NaOH = 1.47
Specific gravity of Na2Sio3 = 1.6

b.) Mix Design

i) Selection of fly ash to comp. Ratio = 540 Kg/m3

ii) Selection of alkaline ratio = 0.61

Alkaline liquid = 255 Kg/m3

Na2Sio3 = 2.5 NaOH

NaOH = 75 Kg/m3

Na2Sio3 = 150 Kg/m3

iii.) Volume of Concrete = 1 m3

iv) Determine of aggregate content

$$V = \left[\frac{S_o}{S_{so}} + \frac{S}{S_s} + \frac{f}{S_f} + \frac{1}{p} \frac{f_a}{S_{fa}} \right] \times \frac{1}{1000}$$

$$V = \left[\frac{S}{S_{so}} + \frac{S}{S_s} + \frac{f}{S_f} + \frac{1}{(1-p)} \frac{C_a}{S_{ca}} \right] \times \frac{1}{1000}$$

V = [100-2] % = 0.98

S_o = NaOH in Kg/m^3

S_{SO} = Specific gravity of NaOH

S = Na_2Sio_3 in Kg/m^3

S_s= Specific gravity of Na_2Sio_3

F = Fly ash in Kg /m^3

S_{fa} = Specific gravity of FA

C_a = CA in Kg/ m^3

S_{ca}= Specific gravity of CA

P = ratio of FA to total aggregate by absolute volume of 20mm aggregate (35%)

Fa = 583.29 kg\ m3 Ca = 1107.5 Kg/ m^3

Decreases in sand content = 0% for zone II

Total aggregate by absolute volume = 35

Na_2Sio_3	NaOH	Extra H_2O	Fly ash	FA	CA
150	75	13.5	450	583.29	1107.5
450	450	450	450	450	450
0.333	0.1667	0.03	1	1.3	2.46

Mix Proportions

Fly ash = 590 Kg / m3

Na2Sio3 = 257.15 Kg / m3

NaOH = 102.85 Kg/ m3

Alkaline liquid ratio = 0.61

FA = 420 Kg / m3

CA = 846.8 Kg / m3

Na_2Sio_3	NaOH	Fly ash	Fine aggregate	Coarse aggregate
257.15	102.85	590	420	846.8
0.61	**:**	**1**	**:** **0.71**	**:** **1.4**

Preparation of Alkaline Liquid

Sodium hydroxide pellets are generally used to prepare alkaline liquid.

In this research NaOH solution of 16 Molar concentrations were used per litre.[4]

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. 1 Preparation of alkaline solution

Preparation of Specimens

- For the study of compressive strength, split tensile strength, flexural test and for which cube, cylinder and prism specimens were casted.
- Cube size of 150 mm x150 mm x 150 mm
- Cylinder size of 100mm dia x 200mm
- Prism size of 700 mm x 150 mm x 150 mm.

Fig. 2 Specimens casted for testing

Tests Performed:

a. Compressive Strength Test

Fig.3 Compressive Strength Test

b. Split Tensile Strength Test

Fig.4 Split Tensile Strength Test

c. Flexural Strength Test

Fig.5 Flexural Strength Test

Design:

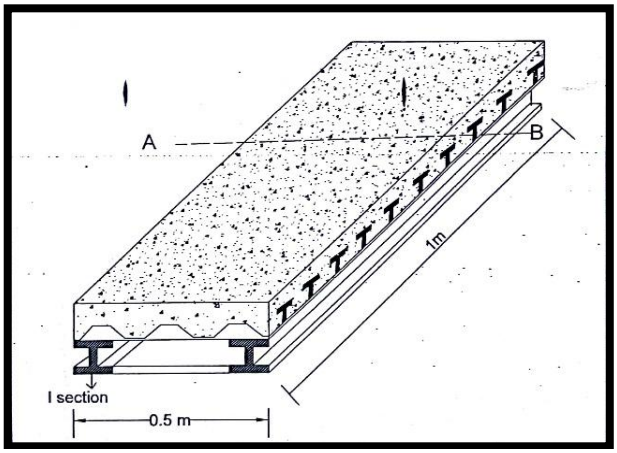


Fig.6 Slab-Beam Panel

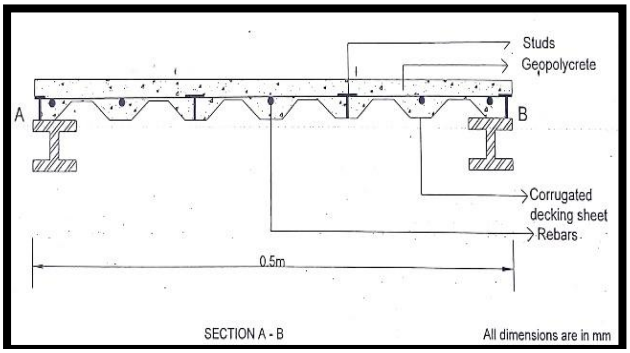


Fig.7 Design Section View

Beam	Steel I section as per IS 800
Decking Sheet	Corrugated Decking Sheet Length & Breadth – As Required Thickness – 0.8 to 2mm
Shear Connectors	Studs – d_1 10mm to 25mm d_2 19mm to 41mm
Testing	Loading frame test for slab, Behaviour of steel beams on loading
Indian Standard Codes	IS 456 – 2000 (2016) IS 800 – 2007 IS 11384 – 1985 (2003) EN 1994 – 1 – 1 (2004)
Application	Mezzanine Floors Industrial Buildings Residential Buildings

Fig.8 Design Data

***Note : Only the slab specimens are considered for the study.**

IV. RESULT AND DISCUSSION

a. Compressive Strength Test

Table.1 Compressive Strength Result

Mix no.	% of Fly ash	% of GGBS	Compressive strength (N/mm^2)
M1	90	10	24.4
M2	80	20	25.5
M3	70	30	27.5
M4	60	40	26.7

b. Split Tensile Strength Test

Table.2Split Tensile Strength Result

Mix no.	% of Fly ash	% of GGBS	Split-tensile strength (N/mm^2)
M1	90	10	2.54
M2	80	20	2.65
M3	70	30	2.86
M4	60	40	2.77

c. Flexural Strength Test

Table.3Flexural Strength Result

Mix no.	% of Fly ash	% of GGBS	Flexural strength (N/mm^2)
M1	90	10	3.45
M2	80	20	3.53
M3	70	30	3.67
M4	60	40	3.61

1) The working ease of the geopolymer concrete prepared by blending GGBS with fly ash was found to be good.

2) Geopolymer concrete blended GGBS gave better performance in split tensile strength and flexural strength.

3) With reference to IS 5816:1997, the value must range between 1/8-1/10th of the fck of geopolymer concrete for split tensile strength.

4) Addition of GGBS accelerated the earlier setting time and ambient curing helps in practical applications

V. CONCLUSION

1) The working ease of the geopolymer concrete prepared by blending GGBS with fly ash was found to be good.

2) Geopolymer concrete blended 30% of GGBS gives better performance in split tensile strength and flexural strength.

3) With reference to IS 5816:1997, the value must range between 1/8-1/10th of the fck of geopolymer concrete for split tensile strength.

4) Addition of GGBS accelerated the earlier setting time and ambient curing helps in practical applications

5) This technique is an excellent alternative solution to the CO2 producing Portland cement concrete.

ACKNOWLEDGMENT

We acknowledge all the authors in the reference for framing a guideline for the base of this research work.

REFERENCES

1. Shweta Mane et.al 2012, "Investigation of Geopolymer Mortar and Concrete Under High Temperature ", ISSN 2250-2459, ISO 9001:2008,vol 2
2. V. Sreevidya et.al 2012, "Acid Resistance of Fly Ash Based Geopolymer Mortar Under Ambient Curing and Heat Curing", ISSN:0975-5462, vol.4.
3. M. VijayaSekar Reddy et.al 2013, "Durability Aspects of Standard Concrete", ISSN 2319-6009, vol.2.
4. J. Guru Jawahar et.al 2016, "Performance of Fly ash and GGBS Based Geopolymer Concrete in Acid Environment", ISSN 2321-2705, vol.3
5. Priyanka.A. et.al 2013, "Effect of replacement of natural sand by manufactured sand on the properties of cement mortar", ISSN: 0976-4399, vol3, No 3.
6. AkinsolaOlufemi Emmanuel et.al 2012, "Investigation of salinity effect on compressive strength of reinforced concrete", ISSN:1913-9063, vol 5, No 6
7. Anuradha.R et.al 2012, "Modified Guidelines for Geopolymer concrete mix design using Indian Standard", Asian journal of Civil Engineering(building & housing), vol 13, NO 3.
8. Adams Joe.M et.al 2013, "Experimental investigation on the effect of M-sand in high performance concrete", e-ISSN:2320-0847, vol 2.

AUTHORS PROFILE

Ms.P.T.Ayswariya Lakshmi, B.E., M.E., has published a Book titled Ferro Geopolymer Technique for the Cnstruction of Chaise Lounge – A Real Time Product Designing Aid in Lambert Academic Publishing as Co-Author. Published 5 Journals and 9 papers in Conferences, Received a best research project award from International Journal of Trendy Research in Engineering and Technology.Membership in International Association of Engineers, International Association of Hydrological Science and ISRD.

Dr.S.Maragatham, Professor and Dean, School of Engineering, Avinashilingam Institute for Home Science andHigher Education for Women, Coimbatore, completed her Ph.D. from PSG College of Technology, Coimbatore. She hasmore than 35 years of experience in teachingand research. Her area of specialization is in Structural Enginering.