



Mechanical Properties of Geopolymer Concrete Using Foundry Sand

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ABSTRACT: Geopolymer concrete is the which concrete of inorganic composite materials consisting of eco-friendly materials such as industrial by products. GGBS is used as a fully replacement for fly ash which is used as conventional main binder material for Geopolymer concrete. Bagasse ash is used as partial replacement for GGBS. Foundry sand is used as fine aggregates. Alkaline solution is readily prepared and bought from a chemical company. This paper, deals about the compressive strength, Split-tensile strength of various mix proportions of 0,5,10,15 &20 of Bagasse ash for GGBS under ambient curing. Finally, the increase in proportion of Bagasse ash is decreasing the strength of the Geopolymer concrete under ambient curing.

KEYWORDS: GGBS, Bagasse Ash, Foundry sand, Geopolymer concrete

I. INTRODUCTION

Geopolymers also gain more engineering properties compared to cement. Use of cement globally adopted due to ease in operation, mechanical properties and low cost of production as compared to other construction materials. Production of Portland cement is increasing due to the increasing demand of construction industries. Therefore, the rate of production of carbon-di-oxide released to the atmosphere during the cement production of Portland cement is also increasing. Generally, for each ton Portland cement production, releases a ton of carbon di oxide in the atmosphere. Geopolymer is an inorganic alumina silicate polymer synthesized from alkaline activation of various alumina -silicate materials of geological origin or by product materials like Fly ash, GGBS, metakaolin, etc., The polymerisation process involves a fast chemical reaction of alumina silicate minerals under alkaline condition chain. Therefore, to reduce the pollution, it is necessary to reduce or replace the cement from concrete by other cementitious materials like Fly Ash, Ground Granulated Blast Furnace Slag, Metakaolin, silica fume etc., Geopolymers are gaining increased interest as binders with low carbon-di-oxide emission in comparison to Portland cement.

II. OBJECTIVES

- To find the optimum solution to binder ratio by trial mixes from the mix attaining the achieved compressive strength.
- To study the strength properties of the geopolymer concrete at various proportions.

III. MATERIALS

GGBS	3.00
Bagasse ash	2.67
Foundry sand	2.5
Coarse Aggregate	2.7

Table-III.1 Specific gravity



IV. MIX DESIGN

The following procedure is design mix for M25 grade of Geo polymer concrete.

The following data are considered for mix design

- Characteristic compressive strength of GPC (f_{ck}) = 25 N/mm²
- Type of curing = Ambient Curing
- Specific surface of GGBS = 385 m²/kg
- Solution to binder ratio = 0.50
- Type of fine aggregate (IS 383-1970) = Foundry sand confirming to ZONE IV

The quantity of materials for 1m³ are as follows

MATERIAL	QUANTITY (kg/m ³)
Binder content	440
Fine aggregate	589.22
Coarse Aggregate	1223.7
Alkaline Solution	240
Solution to binder ratio	0.50

Table-IV.1 Quantity of materials

V. TRIAL MIXES

Initially the trial mixes are done to find out the optimum value for the solution to binder ratio. The solution binder ratio is taken as 0.30,0.40 & 0.50. The solution binder ratio 0.50 is taken as optimized value at which the compressive strength is taken and the mix are further carried out.

VI. RESULT AND DISCUSSIONS

MIX -1 (CONTROL MIX)

In this mix proportion only GGBS is included. This mix is also called as control mix. The quantity derived for 1m³

	GGBS	BAGASSE ASH	FOUNDRY SAND	COARSE AGGREGATE	ALKALINE SOLUTION
QUANTITY	440	-	589.22	1223.7	240

Table -VI -1Mix proportion for Mix-1

RESULTS OBTAINED

LOAD (kN)	SIZE (mm)	COMPRESSIVE STRENGTH (N/mm ²)
706	150x150	31.42
682	150x150	30.33
804	150x150	35.73
AVERAGE		32.49

Table VI-2Compressive Strength for 100% GGBS at 7 days

RESULTS OBTAINED

LOAD (kN)	SIZE (mm)	COMPRESSIVE STRENGTH (N/mm ²)
889	150x150	39.53
879	150x150	38.94
8470	150x150	37.65
AVERAGE		38.70

Table VI -3Compressive Strength of 100% GGBS at 28 days**MIX -2**

This mix is inclusive of 5% of bagasse ash with GGBS. The quantity derived for 1m³

	GGBS	BAGASSE ASH	FOUNDRY SAND	COARSE AGGREGATE	ALKALINE SOLUTION
QUANTITY	418	22	589.22	1223.7	240

Table VI -4 Mix proportion for 5% Bagasse ash**RESULTS OBTAINED**

The following results are obtained at 7 days of ambient curing

SIZE (mm)	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
150x150	622	27.63
150x150	687	30.52
150x150	594	26.45
AVERAGE		28.20

Table VI -5Compressive Strength of 5% Bagasse Ash at 7 days**RESULTS OBTAINED**

The following results are obtained at 28 days of ambient curing

SIZE (mm)	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
150x150	845	37.58
150x150	877	38.98
150x150	867	38.52
AVERAGE		38.36

Table VI - 6Compressive Strength of 5% Bagasse Ash at 28 days

Mix-3

This mix is inclusive of 10% of bagasse ash with GGBS. The quantity derived for 1m³

	GGBS (kg)	BAGASSE ASH (kg)	FOUNDRY SAND (kg)	COARSE AGGREGATE (kg)	ALKALINE SOLUTION (kg)
QUANTITY	396	44	589.22	1223.7	240

Table VI -7 Mix proportion for 10% Bagasse ash

RESULTS OBTAINED

The following results are obtained at **7 days** of ambient curing

SIZE (mm)	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm²)
150x150	598	26.59
150x150	627	27.89
150x150	472	20.99
AVERAGE		25.15

Table VI -8 Compressive Strength of 10% Bagasse Ash at 7 days

RESULTS OBTAINED

The following results are obtained at **28 days** of ambient curing

SIZE (mm)	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm²)
150x150	748	33.28
150x150	698	31.00
150x150	652	28.96
AVERAGE		31.08

Table VI -9 Compressive Strength of 10% Bagasse Ash at 28 days

Mix-4

This mix is inclusive of 15% of bagasse ash with GGBS. The quantity derived for 1m³

	GGBS (kg)	BAGASSE ASH (kg)	FOUNDRY SAND (kg)	COARSE AGGREGATE (kg)	ALKALINE SOLUTION (kg)
QUANTITY	374	66	589.22	1223.7	240

Table- VI -10 Mix proportion for 15% Bagasse ash



RESULTS OBTAINED

The following results are obtained at 7 days of ambient curing

SIZE (mm)	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
150x150	496	22.04
150x150	560	24.89
150x150	624	27.75
AVERAGE		24.89

Table VI -11Compressive Strength of 15% Bagasse Ash at 7 days

RESULTS OBTAINED

The following results are obtained at 28 days of ambient curing

SIZE (mm)	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
150x150	570	25.35
150x150	677	30.10
150x150	757	33.65
AVERAGE		29.7

Table VI -12Compressive Strength of 15% Bagasse Ash at 28 days

Mix-4

This mix is inclusive of 15% of bagasse ash with GGBS.The quantity derived for 1m³

	GGBS (kg)	BAGASSE ASH (kg)	FOUNDRY SAND (kg)	COARSE AGGREGATE (kg)	ALKALINE SOLUTION (kg)
QUANTITY	352	88	589.22	1223.7	240

Table- VI -13 Mix proportion for 15% Bagasse ash

RESULTS OBTAINED

SIZE (mm)	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
150x150	470	20.89
150x150	491	21.83
150x150	575	25.56
AVERAGE		22.76

Table- VI -14Compressive Strength of 20% Bagasse Ash at 7 days

The following results are obtained at 28 days of ambient curing

SIZE (mm)	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
150x150	622	27.68
150x150	553	24.59
150x150	642	28.56
	AVERAGE	26.94

Table- VI -15Compressive Strength of 20% Bagasse Ash at 28 days

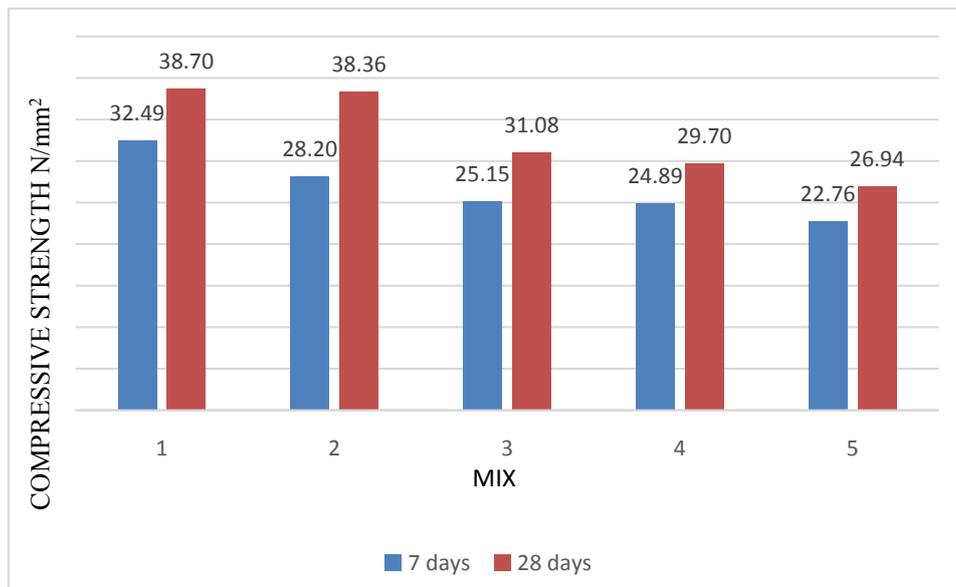


Fig. VI-1 Compressive Strength

SPLIT- TENSILE STRNGTH

The following results are obtained at 7 days of ambient curing

MIX	SPLIT TENSILE STRENGTH (N/mm ²)
Mix-1	2.65
Mix-2	2.45
Mix-3	2.29
Mix-4	1.98
Mix-5	1.88

Table-VI – 16Split Tensile Strength at 7days

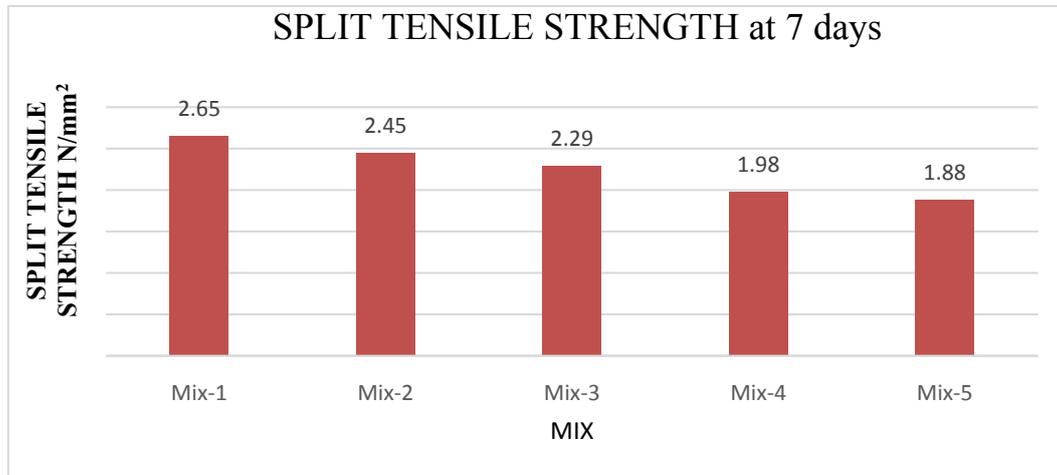


Fig. VI-2 Split Tensile Strength

VII. CONCLUSION

- Based on the results it is concluded that the increase in the proportion of the bagasse ash in the replacement of GGBS the strength of the Geopolymer concrete decreases.
- It is found that MIX-1,2 & 3 attains the characteristic compressive strength of 25 N/mm² at 7 days of ambient curing.
- It is found that the bagasse ash is can be used only as a partial replacement where it cannot be used as a fully replaced binder material.
- It is also found that the tensile strength of the concrete decreases with increase in the proportion of the bagasse ash.

REFERENCES

1. Nath, P. and Sarker, P. K. (2014) 'Effect of GGBFS on setting, workability and early strength properties of fly ash geopolymer concrete cured in ambient condition', *Construction and Building Materials*. Elsevier Ltd, 66, pp. 163–171. doi: 10.1016/j.conbuildmat.2014.05.080.
2. Yamini J. Patel, Niraj Shah, (2018) 'Development of self-compacting geopolymer concrete as a sustainable construction material' *Sustainable Environment Research* 28 (2018) 412e421
3. M.I. Abdul Aleem and P.D. Arumairaj (2012) "Optimum mix for the geopolymer concrete"
4. Benny Joseph, George Mathew, (2012) "Influence of aggregate content on the behavior of fly ash based geopolymer concrete". *Scientia Iranica A* (2012) 19 (5), 1188–1194
5. Hadi, M. N. S., Farhan, N. A. & Sheikh, M. Neaz. (2017). "Design of geopolymer concrete with GGBFS at ambient curing condition using Taguchi method". *Construction and Building Materials*, 140 424-431.
6. Pradip Nath, Prabir Kumar Sarker, (2014), "Effect of GGBFS on setting, workability and early strength properties of fly ash geopolymer concrete cured in ambient condition" *Construction and Building Materials* 66 (2014) 163–171.
7. Prakash R. Vora, Urmil V. Daveb,(2013), "Parametric Studies on Compressive Strength of Geopolymer Concrete" *Procedia Engineering* 51 (2013) 210 – 219.
8. Kewal, (2015) "FOUNDRY SAND BASED GEOPOLYMER CONCRETE" – Review, *International Research Journal of Engineering and Technology (IRJET)*, Volume: 02 Issue: 05 | Aug-2015.
9. Asha Philip, Ashok Mathew, (2015), "Experimental Study on Mechanical Properties of Geopolymer Concrete Using GGBS" *International Journal of Science and Research (IJSR)* ISSN (Online): 2319-7064
10. IS 456:2000 "PLAIN AND REINFORCED CONCRETE" - CODE OF PRACTICE.
11. Subhash V. Patankar, Yuwaraj M. Ghugal and Sanjay S. Jamkar, (2015), "Mix Design of Fly Ash Based Geopolymer Concrete," Springer India 2015, V. Matsagar (ed.), *Advances in Structural Engineering*, DOI 10.1007/978-81-322-2187-6_123.
12. D.B. Raijiwala, H.S. Patil, (2012), "Geopolymer concrete – A concrete of the next decade" *Concrete solutions – Grantham, Mechtcherine&Schneck* (eds), ISBN 978-0-415-61622.
13. IS 383 (1970): Specification for Coarse and Fine Aggregates.