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Use of Fly Ash and GGBS wıth Alkalıne Solution based Geopolymer

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Abstract

Utilization of cement is worldwide acknowledged because of simplicity in activity, mechanical properties and minimal expense of creation when contrasted with other development materials. Generally for each ton of Portland cement production, releases a ton of carbon dioxide in the atmosphere. Nearly 7% greenhouse emission from cement industry. This venture report is examining the properties of fly ash and GGBS based geopolymer concrete to discover their solidarity properties. Examples were projected and relieved for various restoring curing periods at surrounding room temperature to decide the GPC properties viz. parting pliable, flexural strength and compressive. Test results reveal that augmentation in GGBS replacement redesigned the mechanical properties of GPC at all ages at encompassing room temperature.

KEYWORD: Geo polymer, Alkaline solution, Compressive strength, Flexure strength.Durability

Introduction

The requirement for genuinely practical alternatives for 21st century is perhaps the main difficulties confronting the worldwide local area. Support is characterized as to keep up with and to proceed with an interaction going on, and supportability implies that life on our planet can be supported for a long time to come. Since the climate is surely the most basic concern, and a structural specialist keeps manageability rules to don't affect any adverse consequence on the climate. The totals and water needed for concrete are among the most bountiful materials on the Earth and numerous nations are independent in these materials. The basic raw material for adding concrete is limestone, the most abundant mineral on earth. The results of various industries, such as evaporative crushed stone and blast furnace granular slag (GGBS), can be used to seriously replace binders or reuse quality, which would reduce the natural effects of free aggregation(Sumalatha et al., 2020; Dharek et al.,2021). The strength of Geopolymer concrete was studied by Jamkar et al., 2013, Vora and Dave, 2013, Shaikh and Vimonsatit, 2015, Reddy et al., 2016,Dao et al., 2019, Dharek et al., 2018). The durability studies on Geopolymer concrete were also conducted by many researchers (Law et al., 2015; Ganesan et al., 2015; Luhar et al., 2019; Cheema et al., 2009; Kabir et al., 2019, Dharek et al., 2020).

The properties of geopolymer concrete were studied by several researchers (Xie et al., 2019; Li et al., 2019; Jena and Panjgrahi, 2029; Amran et al., 2020; Noushini et al., 2020; Shahmansouri et al, 2020; Amran et al., 2021; Moghaddam et al., 2021; Shahmansouri et al., 2021). The source materials and alkaline liquid are fundamental parts of geopolymers. A complete survey about these constituents and whatever other admixtures that may have constructive outcome on the conduct of Geopolymers will be introduced by writings, use of sodium silicate to sodium hydroxide as the alkaline liquid upgraded the reaction between the source material and the alkaline liquid. Hence, starting blend plans for the creation of geopolymer substantial utilizing sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3) to frame the basic arrangement were ready. Cost of Potassium based arrangement was another factor that impacts the dynamic of utilizing alkaline liquid. A path and blunder measure utilized for calibrating the strength of the blends, including diverse base debris substance. Creation of geopolymer concrete were continued with Testing techniques and standards for manufacturing of OPC concrete. It could assist with an applicable correlation between the two items. source proportion as a significant factor in mechanical properties of concrete was fixed at 70% by weight inside the blend and its size, dampness content, shape and fineness modulus were noticed cautiously to explore the impact of replace of fly ash and aggregates were utilized distinctly from one source.

Materials and Methods

Fly Ash

Dry low calcium fly ash was given from Tamil Nadu. Ten packs of fly ash with normal load of 20 kg were gotten from Tamil Nadu and put away in a dry and cool storage. For synthetic examination, fly debris was sieved to molecule size under 75µ.

Alkalıne Lıquıd

A mixture of sodium hydroxide and sodium silicate was used as the base solution in this experiment. The test used 10 m of sodium hydroxide (NaOH) (molecular mass 400 g / mol) in liquid form at pH 14, 50 g / l at 20 ° C. The relative concentration of sodium silicate was 2.13 g / cm^3.

Aggregates

aggregates are given from nearby asset, put away uncovered outside of the lab. In this assessment coarse aggregates with ostensible sizes of 10mm and fine aggregates are used. Totals were prepared in SSD condition and a while later are fixed in plastic sacks around month before the blending. Thus, coarse totals and sand were doused autonomously in water, thereafter appropriated on a plastic sheet until their superficial turn out to be dry. SSD condition of geopolymer cement ought to be arranged to evade the maintenance of the alkaline solution arrangement course of action by the totals which lessen the polymerization of the fly ash. This cycle was astoundingly dreary and aggregates are ready in over 10 days. During status ambient temperature, thickness of totals layers and capacity of totals were unique, in this manner close to the completion of the way toward arranging SSD condition, all packs were united together to make them uniform.

Proportions, Mixing, and Casting

Since there is no standard procedure/descriptive composite design report for UFFA/GBBS geopolymer composites, the comprehensive design used in this study is based on literature review and results. The improved field test results obtained in this study are based on a total mixture of 77 fine-grained and resistant aggregate samples. The mass of the mixture is 1296 kg/m3 kg/m3. The GPC concentration is calculated to be 2400 kg/m 3 and the alkaline liquid (NaOH, 10 M)/binder ratio is maintained in a 1:2:5 (mass) Cm mixture. The design aims to achieve a drop of 150 ± 10 mm using plasticizer given in the table 1

Table 1 : material mix proportions

Mix ingredient	**Concrete making material for 1 cubic meter concrete**				
Ratio of addition of UFFA:GGBFS	**100:0**	**75:25**	**50:50**	**25:75**	**0:100**

UFFA:GGBS, in kg	281+0.0	210.7+70.25	140.5+140.5	70.25+210.7	0.0+281.0
Mass of Na_2Sio_3	201.2	201.2	201.2	201.2	201.2
Mass of NaOH, in kg	80.4	80.4	80.4	80.4	80.4
Mass of C-agg, kg	1320.6	1320.6	1320.6	1320.6	1320.6
Mass of F-agg, kg	566	566	566	566	566
Mass of PC adm,in kg	1.686	2.248	2.81	2.81	4.215

Figure 1: Mixing of concrete in pan mixer

Results

Compressıve Strength

For the replacement of cement in geopolymer fly ash and GGBS are used. Utilization of source material in Geopolymer increment the strength more than the ordinary concrete. It very well may be seen the utilization of 100% GGBS in geopolymer concrete is extremely high contrasted with 100% fly ash based Geopolymer concrete. The GGBS based concrete will be a lot stiffer than Fly Ash based concrete, thus GGBS based concrete requires more admixture contrasted with Fly Ash based concrete. Figure 3 and Table 2 shows the compressive strength of GPC blends in with various extents of fly ash and GGBS at various curing periods.

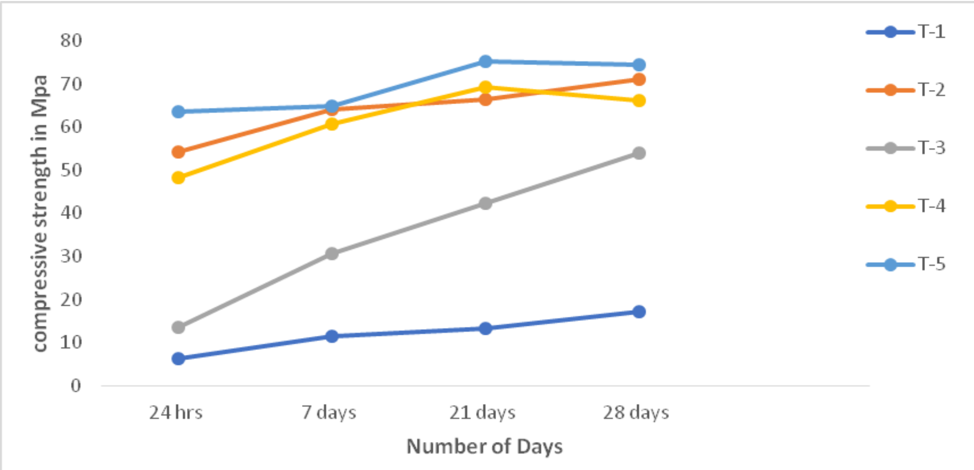
Table 2: Average strength of all mix proportion

S N	Concrete mixes	24 hrs (Mpa)	7 days (Mpa)	21 days (Mpa)	28 days (Mpa)
Trial 1	100%FA+0%GGBS	6.32	11.55	13.37	17.15
Trial 2	50%FA+50%GGBS	54.11	63.99	66.53	71.04
Trial 3	75%FA+25%GGBS	13.48	30.65	42.20	53.89
Trial 4	25%FA+75%GGBS	48.20	60.58	69.15	66.08
Trial 5	0%FA+100%GGBS	63.53	64.84	75.15	74.31

Figure 2 : Cube testing in CTM

Figure 3: Graph showing all mix proportion

Figure 3 : Compressive strength of GPC



Flexural strength

For this test 100mm x 100mm x 500mm prisms are cast and tested at 28 days using UTM in two-point loading arrangements. Mechanical dial gauge reading gives the central deflection at an interval of 100kg loading shown in the figure 4 with their flexural strength values shown in the table 3.

Figure 4 : Testing of flexural load

Table 3: Flexural strength of GPC

Specimen	Concrete mix	Loads (KN)	Flexural strength (Mpa)

1	100%FA	8.54	3.42
2	100%GGBS	7.14	2.85

GGBS and Fly ash be adequately utilized in GPC for complete substitution of cement. use of source material in GPC expands the strength than the typical concrete. It tends to be seen that utilization of 100% Fly ash in GPC gives high flexural strength than 100% replacement of GGBS in GPC.

Alkalı Aggregate Test

Ascertain contrast between the zero readings of the example and the readings of the specimen periodically, with somewhere around three middle readings, for 14 days after the zero perusing, at roughly a same time every day. In the procedure that readings are proceeded past the 14day period, take no less than one perusing each week. The aggregates utilized for this test is as M sand and river sand shown in the figure 5 with their expansion of mortar bar at different period given in the table 4.

Figure 5: Storing and testing of mortar bar

Table 4: expansion of mortar bar at different period

Zero reading	3 days	7 days	14 days
	100 %GGBS (river sand)		
8.736	8.631	8.497	8.352
10.283	10.212	10.012	9.889
	100%GGBS (M sand)		
6.061	6.011	5.865	5.779
7.250	7.105	7.009	6.925
	100%FA (River sand)		
11.090	10.925	10.896	10.65
10.342	10.198	10.025	9.931
	100%FA (M sand)		
6.804	6.712	6.572	6.320
6.995	6.725	6.659	6.525
	75%GGBS and 25%FA (M sand)		
9.322	9.210	9.089	8.931
7.479	7.356	7.259	7.108

75%FA and 75%GGBS (M sand)			
9.645	9.428	9.352	9.219
8.472	8.402	8.253	8.019
50%GGBS and 50%FA (M sand)			
8.746	8.639	8.596	8.451
7.821	7.732	7.682	7.508

Above table shows the various reading taking in length gauge at different ages.

Table 5: Average expansion of different mix sample expressed in terms of %

Specimen	Expansion (%)
100% GGBS (river sand)	0.156
100%GGBS (M sand)	0.122
100%FA (river sand)	0.170
100%FA (M sand)	0.191
75%GGBS and 25%FA (M sand)	0.152
75 %FA and 25%GGBS (M sand)	0.175

As per ASTM C-1260, Development of GPC is under 0.1% at 16 days in the wake of projecting are characteristic harmless conduct much of the time, the extension over 0.2% at 16 days subsequent to projecting are demonstrative of possibly malicious extension, and development somewhere in the range of 0.1 and 0.2% at 16 days in the wake of projecting incorporate the two totals that are known to be harmless and injurious in field execution. In our analysis, the normal developments of different blend extents that incorporate river sand and M-sand gives in the middle 0.1 and 0.2%. when contrasted with GGBS based Geopolymer concrete the normal extension is not exactly Fly ash based Geopolymer concrete. Also, Geopolymer concrete made with M-sand show more development than river sand.

Chloride Ion Penetration Test (RCPT) (ASTM: C 1202 -97)

This test method (ASTM C 1202) involves the determination of the conductivity of concrete to give a quick indication of resistance to chloride ion penetration. The correlation between this test method and this test procedure and the long-term chloride-water collection process (procedure described in AASHTO T 259) can be applied to concrete types. The entire samples are connected properly and the charge recorded in automatic data processing equipment at every 30 min interval for entire 6 hrs given in the table 6.

Sample 1--100% FA and 0 % GGBS   Sample 2—75% FA and 25% GGBS

Sample3—50% FA and 50% GGBS   Sample 4—25% FA and 75% GGBS

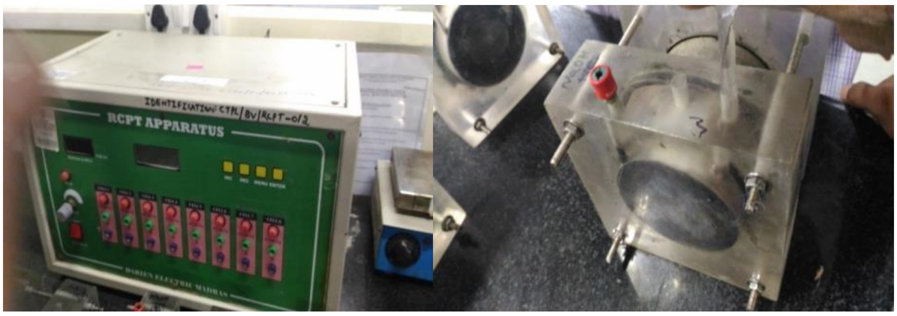
Sample 5—0% FA and 100% GGBS

Table 6 : charges passed through the specimen in mA

Time (min)	**Current (mA)**				
Trial Mixes	**1**	**2**	**3**	**4**	**5**
00	1010	863	722	578	249
30	1019	871	729	587	255
60	1022	879	735	585	271
90	1028	882	739	589	278
120	1039	891	742	591	287

150	1042	899	745	594	293
180	1049	902	748	597	299
210	1061	913	752	601	308
240	1065	921	755	603	317
270	1072	924	757	605	329
300	1079	932	759	607	341
330	1083	944	762	612	349
360	1091	952	768	616	352

Figure 6: RCPT Test



Rcpt apparatus mould along with test cell

NaOH and NaCl desiccators along with specimen

Water Permeabılıty Test (DIN 1048 part 5)

Permeability of cement is significant when managing strength of cement. Particularly in water retaining structures, water tight, sub structure. Design exposed to horse natural conditions likewise required low permeability. Such unfriendly component can bring about degradation of reinforced concrete.

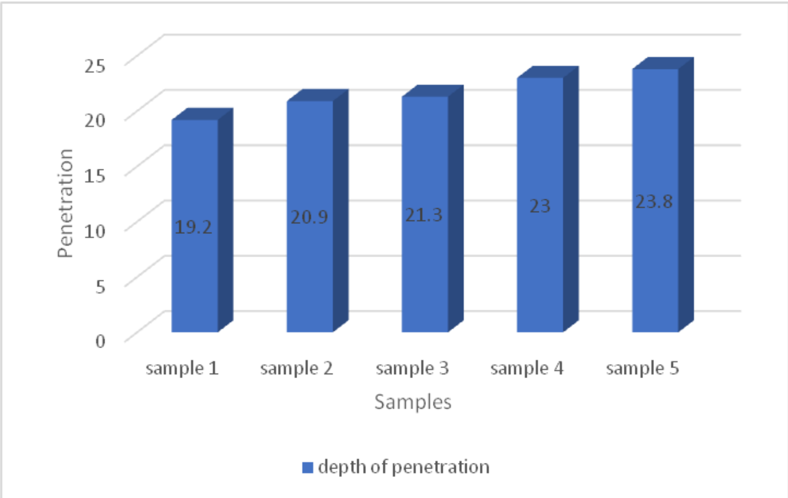
Figure 7: Permeability test

The mean of the maximum depth of penetration obtained from the test specimen is taken as the test result shown in the table 7.

Table 7 : depth of penetration in mm

Mix	Depth of penetration (mm)
Sample 1	19.2
Sample 2	20.9
Sample 3	21.3
Sample 4	23.0
Sample 5	23.8

Figure 8 : depth of penetration for different samples in mm



Permeability on concrete is significant when managing the strength of GPC. Normally, the depth of penetration should not exceed more than 25mm for great cement. It very well may be found in the outcomes. So that it is inferred that GPC have great opposition against the water infiltration. Particularly in Fly Ash based GPC shows preferable water permeability obstruction over GGBS based GPC.

Conclusıons

From this research study, it was obseved that the use of GGBS and Fly ash in geo polymer substantial expands the strength 1.5 times more than nominal concrete. The higher the concentration of GGBS brings about the higher compressive strength, increment the GGBS behind 25% the quick setting was noticed. The flexural strength of Fly Ash and GGBS based geopolymer shows more than that of nominal concrete. Geopolymer concrete is fails in RCPT test since it shows more than 4000 as indicated by ASTM C-1202 code. Fly Ash based geo polymer substantial shows preferable water permeability over that of GGBS geopolymer concrete.

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