Fly ASH Aggregates on Strength and Workability Characters of Geo-Polymer Concrete

T.P.Meikandaan, M.Hemapriya, K.Anitha

***Abstract:** The Present study deals with preparation of FA aggregates. Artificial aggregates with FA (class C) and combination of fly ash and GGBFS were preparedTwo sorts of restoring techniques were embraced for aggregates. Restoring strategies incorporate water relieving and Chemical restoring (NaoH). The tests results the fly ash water cured and chemically cured aggregates were performed well, so these two types of aggregates were adopted for preparation of GPC mixes. The GGBFS replacement content in finalized as 30% from phase I results. The GPC mixes with 8 M, 10 M, 12 M NaoH Solution concentrations were cast using fly ash aggregates. Workability and strength test were done on the GPC samples. It was observed that GPC mix W6 attained a maximum compressive strength of 42.89 MPa among GPC specimens with water cured aggregates. It is observed that the specimens with chemically cured aggregates. It is observed that the GPC mix with chemical cured aggregate have better workability and bonding with the matrix.*

Keywords – GPC; GGBFS; NaoH; Fly ash (class C)

I. INTRODUCTION

Assembling of one tone of OPC, one tone of carbon dioxide into the environment, which thusly influences the remarkable component of a worldwide temperature alteration. In reducing this global warming effect and to study the appropriateness of geo-polymer concrete as an option in contrast to the OPC to acquire a basic evaluation solid this examination has been done[1]-[4].

A. Objectives

• To artificially prepare fly ash aggregate and to study its properties.

• To pick the best aggregates dependent on the properties and to utilize these fly fiery remains totals as complete swap of coarse total for the GPC blends.

• To determine compressive strength and workability variation of GPC at 0 % and 10 % GGBFS percentage replacements.

B. Need for the study

The setting of the GPC is the main problem. At low temperatures the GPC does not set quickly. So geopolymer concrete is mainly used for precast members where elevated temperature curing is done. GPC we are partially replacing fly ash with GGBFS to improve setting properties[5]-[6].

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II. METHODOLOGY

The methodology adopted for Study is

- Performing tests on Fly ash Aggregates
- Selection of best aggregates from the test results
- Determination of material properties
- Performing trial GPC mixes
- Casting of GPC
- Testing of GPC specimens
- Discussions
- Conclusion

A. Fly Ash Aggregates

Preparation process of FA aggregates. The various properties on the aggregates are discussed.

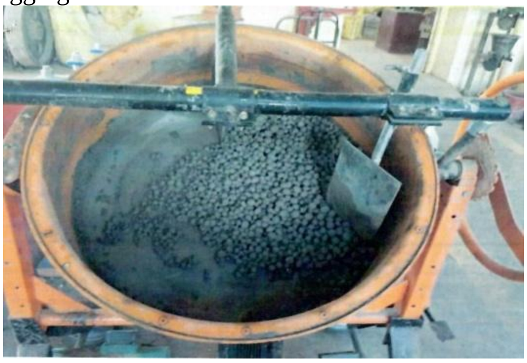

Figure - 1 Drum Pelletizer

B. Manufacturing Procedure Of Fly Ash Aggregate

First the speed and angle are adjusted according to the size of aggregate needed. Then the batched fly ash is added in to the drum and drum is allowed to rotate. The water is sprinkle at regular intervals of time until the formation of pellets start[7]-[9]. Then the drum is left to rotate for 10 – 15 minutes to complete the pelletization. Fig 1 shows the drum the preparation of fly ash aggregates using drum pelletizer.

After the pelletization these aggregates are to be cured. The following curing methods are adopted.

1. Water curing: The aggregates are cured in water for 14 days.

2. Chemical curing: The aggregates are cured in NaOH solution for 7 days.

After the pelletization these aggregates are ready to use for their intended purposes[32]-[34].

The following are the types of aggregate combinations to be performed for the present study:

i. FA aggregate (water cured)
ii. FA aggregate (chemical cured)
iii. GGBFS replaced FA aggregate (1:5)

iv. GGBFS replaced FA aggregate (1:3)
v. GGBFS replaced FA aggregate (1:2)

III. EXPERIMENTAL INVESTIGATION

A. Compressive Strength Test

The individual Compressive strength of a pellet is found out by testing it under CBR testing machine as shown in fig. 4.2. The compressive strength for different aggregates are shown in the table 1.

Table – 1 Compressive Strength of FA

Aggregate Type	Compressive Strength in MPa		
	10mm	12mm	16mm
Pure Fly Ash (Water Cured)	4.85	4.55	4.15
Fly Ash with NaOH (8M) Curing	6.30	5.51	4.09
Fly Ash + GGBFS (5:1)	2.95	2.33	2.15
Fly Ash + GGBFS (3:1)	3.50	3.20	2.55
Fly Ash + GGBFS (2:1)	4.10	3.85	3.40

B. Specific Gravity Test

The test for specific gravity is carried out on all type of aggregate and the results are tabulated below in table 2

Aggregate Type	Specific Gravity
Pure Fly Ash	1.87
Fly Ash with NaOH (8M) Curing	1.88
Fly Ash + GGBFS (5:1)	1.88
Fly Ash + GGBFS (3:1)	1.90
Fly Ash + GGBFS (2:1)	1.91

Table 2 - Specific gravity of fly ash aggregate

Description	Quantity (kg)					
	C_1	C_2	C_3	C_4	C_5	C_6
Fly ash	440.36	440.36	440.36	308.46	308.46	308.46
GGBFS	-	-	-	131.90	131.90	131.90
Sodium hydroxide	44.00	44.00	44.00	44.00	44.00	44.00
Sodium silicate	110.00	110.00	110.00	110.00	110.00	110.00
Coarse aggregate	856.50	856.50	856.50	856.50	856.50	856.50
Quarry Dust	568.00	568.00	568.00	568.00	568.00	568.00
Extra water (10% wt of fly ash)	44.04	44.04	44.04	44.04	44.04	44.04
Super plasticizer (1.5% wt of fly ash)	6.61	6.61	6.61	6.61	6.61	6.61

Table - 6 Details for the GPC mixes with chemical cured aggregates

IV. RESULTS AND DISCUSSION

After mixing the concrete is cast in to the moulds in 3 layers in traditional method by tamping each layer in 25 blows. Then these moulds are kept on table vibrator for 1 minute for compaction. The excess amount of concrete is scraped off by using a trowel[10]-[12]. These moulds are left for 24 hours as appeared in fig 5.3 at room temperature, After one day the blocks are de shaped and 3D squares are presented to climate till the day of the test.

A. Compressive Strength

The test is carried out to determine the compressive strength of all the GPC specimens. The slump values, dry density and compressive strength results are shown in table 1

Mix No.	Mean Slump (mm)	Mean Density (kg/m^3)	Average Crushing Strength (MPa)	
			7 days	28 days
W_1	80	2130	12.60	19.33
W_2	75	2130	13.83	22.67
W_3	75	2141	15.67	26.50
W_4	60	2135	29.57	35.13
W_5	55	2140	32.10	38.86
W_6	50	2153	33.73	42.13

Table - 1Compressive Strength and Slump values of GPC mixes with water cured aggregates (PHASE – I)

Mix No.	Mean Slump (mm)	Mean Density (kg/m^3)	Average Crushing Strength (MPa)	
			7 days	28 days
C_1	90	2190	24.87	34.30
C_2	80	2205	27.33	36.7
C_3	80	2210	30.50	39.40
C_4	65	2200	51.73	55.53
C_5	55	2204	53.30	59.43
C_6	55	2220	57.37	64.14

Table -2 Compressive Strength & Slump values of GPC mixes with chemical cured aggregates (PHASE – I)

Mix No.	Mean Slump (mm)	Mean Density (kg/m^3)	Average Crushing Strength (MPa)	
			7 days	28 days
W_1	80	2130	12.60	19.33
W_2	75	2130	13.83	22.67
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C_1	90	2190	24.87	34.30
C_2	80	2205	27.33	36.7
C_3	80	2210	30.50	39.40
C_4	65	2200	51.73	55.53
C_5	55	2204	53.30	59.43
C_6	55	2220	57.37	64.14

Table 3 - Compressive Strength and Slump values of GPC mixes (Water and chemical cured) aggregates (PHASE – I)

Mix No.	Mean Slump (mm)	Mean Density (kg/m^3)	Average Crushing Strength (MPa)	
			7 days	28 days
W_1	85	2124	16.47	20.59
W_2	70	2121	16.11	20.44
W_3	80	2133	15.93	23.41
W_4	65	2142	34.44	36.15
W_5	60	2145	34.42	37.93
W_6	60	2151	34.46	42.89

Table 4 - Compressive Strength and Slump values of GPC mixes with water cured aggregates (PHASE – II)

Mix No.	Mean Slump (mm)	Mean Density (kg/m^3)	Average Crushing Strength (MPa)	
			7 days	28 days
C_1	95	2178	29.48	35.26
C_2	85	2207	29.05	37.48
C_3	90	2296	29.53	39.88
C_4	60	2213	57.11	56.28
C_5	65	2207	56.13	60.10
C_6	55	2234	56.00	64.56

Table 5 - Compressive Strength and Slump values of GPC mixes with chemical cured aggregates (PHASE – II)

Mix No.	Mean Slump (mm)	Mean Density (kg/m^3)	Average Crushing Strength (MPa)	
			7 days	28 days
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C_1	95	2178	29.48	35.26
C_2	85	2207	29.05	37.48
C_3	90	2296	29.53	39.88
C_4	60	2213	57.11	56.28
C_5	65	2207	56.13	60.10
C_6	55	2234	56.00	64.56

Table 6 - Compressive Strength and Slump values of GPC mixes with (Water and chemical cured) aggregates (PHASE – II)

Mix No.	Average Crushing Strength (MPa) Phase - I		Average Crushing Strength (MPa) Phase - II	
	7 days	28 days	7 days	28 days
W_1	12.60	19.33	16.47	20.59
W_2	13.83	22.67	16.11	20.44
W_3	15.67	26.50	15.93	23.41
W_4	29.57	35.13	34.44	36.15
W_5	32.10	38.86	34.42	37.93
W_6	33.73	42.13	34.46	42.89
C_1	24.87	34.30	29.48	35.26
C_2	27.33	36.7	29.05	37.48
C_3	30.50	39.40	29.53	39.88
C_4	51.73	55.53	57.11	56.28
C_5	53.30	59.43	56.13	60.10
C_6	57.37	64.14	56.00	64.56

Table 7 - Work done in (Phase I & Phase – II) Comparison of Average Crushing Strengthin Water cured and Chemical cured Fly ash aggregates

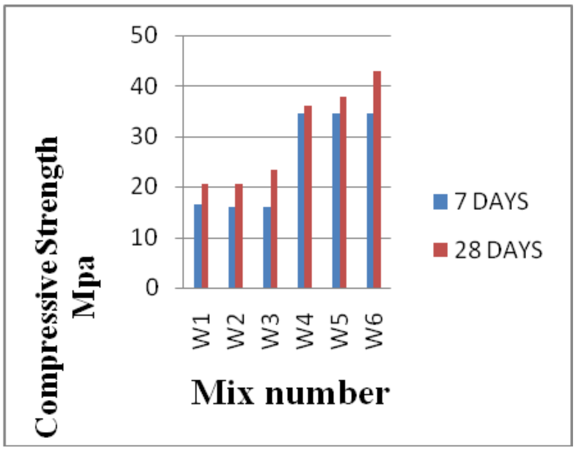

Figure - 1 Results of Compressive Strength of GPC mixes (Phase - I)

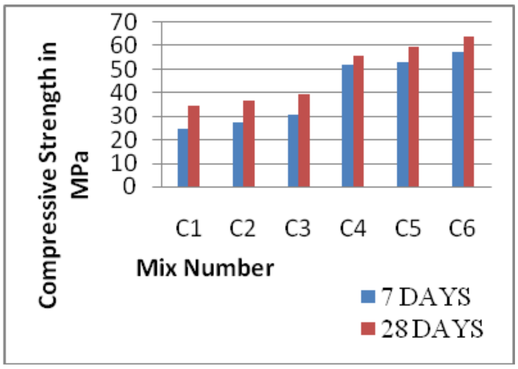

Figure - 2 Results of Compressive Strength of GPC mixes (Phase - I)

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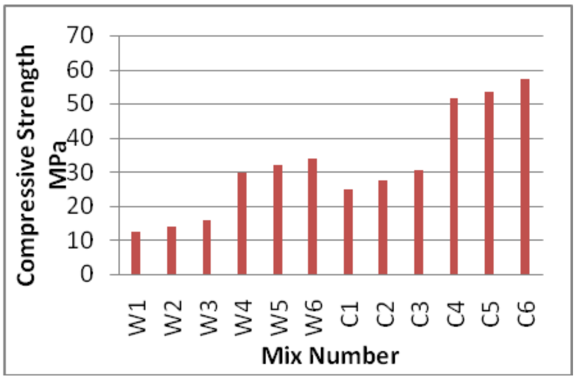

Figure – 3 Results of 7 days Compressive Strength of GPC (mixes water and chemical cured) aggregates (Phase - I)

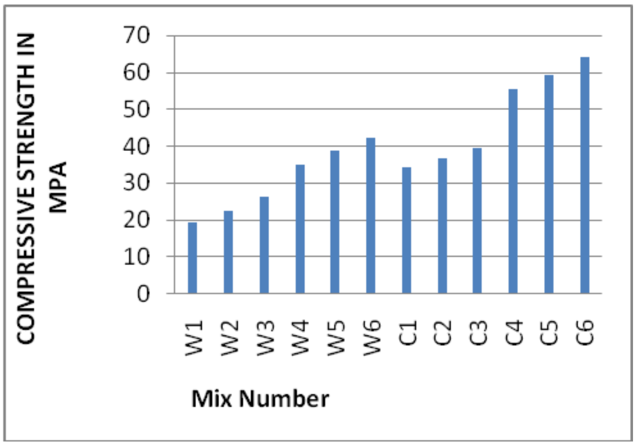

Figure – 4 Results of 28 days Compressive Strength of GPC mixes (water and chemical cured) aggregates (Phase - I)

From the fig1, 2 , 3 , 4 it is shown that with the increase of GGBFS replacement from 0 % to 30% the compressive strength of all the GPC mixes increases nearly by 40%. This demonstrates the incomplete supplanting of fly powder with GGBFS gives better setting properties and quality addition of GPC blends[13]-[17]. Maximum compressive strength of 64.14 MPa is obtained form GPC mix C_6. The compressive strength of GPC mixes increased by 45% to 50 % for GPC mixes with chemical cured aggregates compared to GPC mixes with water cured aggregates.

The maximum compressive strength for GPC mix with water cured aggregates is obtained as 42.89 MPa and for GPC mixes with chemical cured aggregates is obtained as 64.56 MPa. From the above results we can infer that these GPC mixes can be used for structural elements.

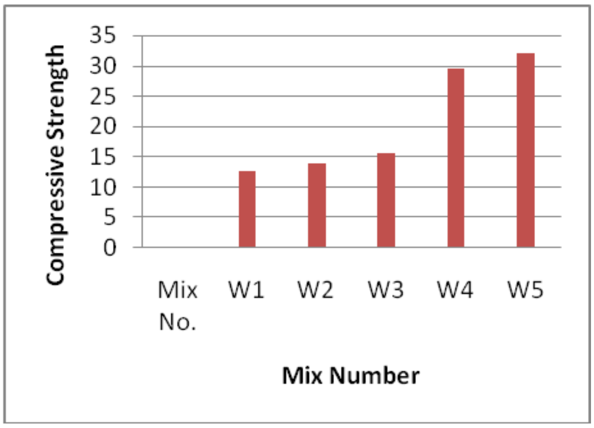

Figure – 5 Results of slump for GPC mixes with water cured aggregates (Phase - I)

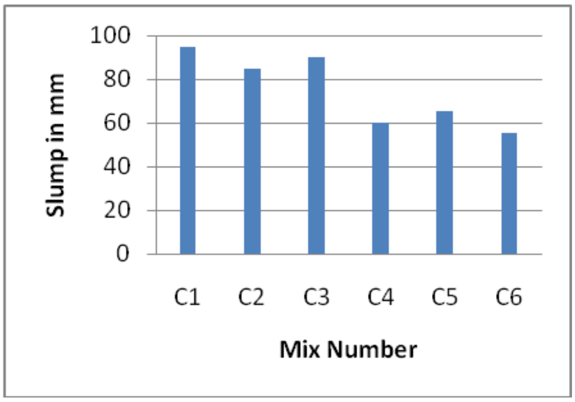

Figure - 6 Results of slump for GPC mixes with chemical cured aggregates (Phase - I)

It is seen from Fig. 6.5 and Fig. 6.6 that the slump esteems for the GPC blends with water relieved and synthetic restored totals are almost comparative[18]-[22]. Greatest droop of 90 mm is acquired for GPC blend C1.With the increase of GGBFS content from 0% to 30% there is reduction of slump value up to 25% and the slump is minimum of 50 mm is obtained for the GPC mix W_6.

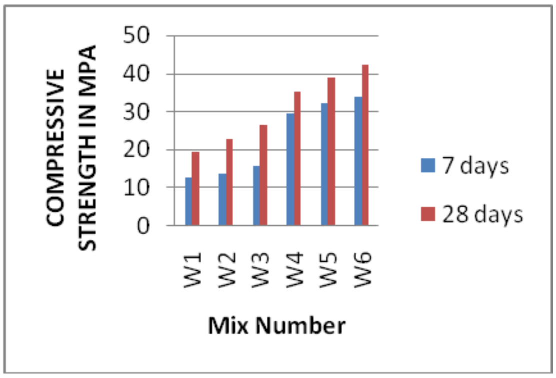

Figure – 7 Results of Compressive Strength of GPC mixes with Chemical cured aggregates (Phase - I)

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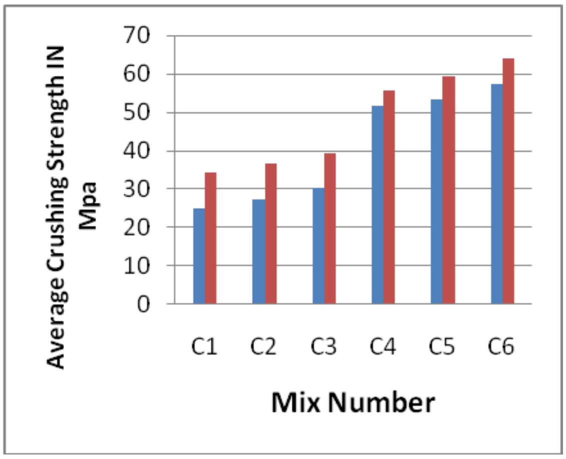

Figure – 8 Results of Average Crushing Strength of GPC mixes (Phase - II)

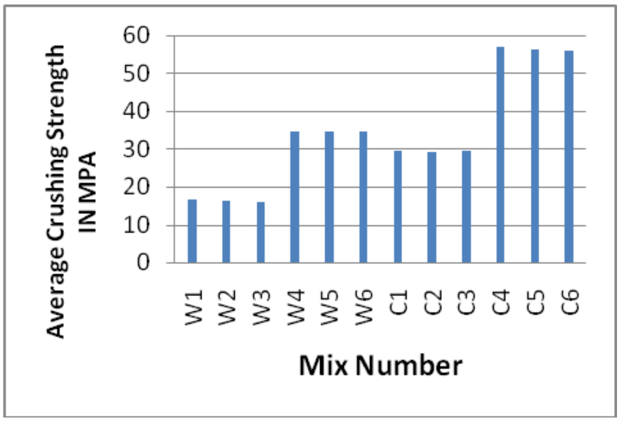

Figure – 9 Results of 7 days Average Crushing Strength of GPC mixes (water and Chemical cured) aggregates (Phase - II)

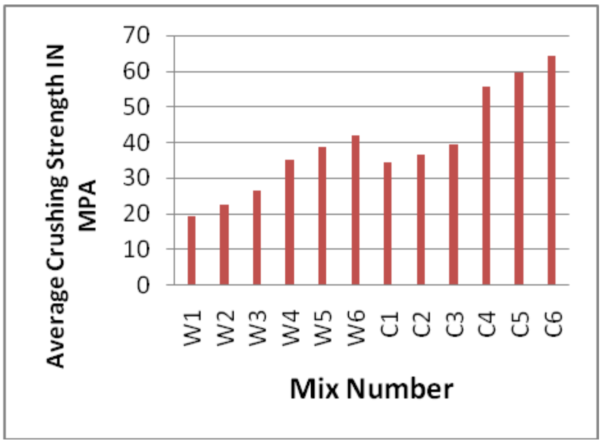

Figure - 10 Results of 28 days Average Crushing Strength of GPC mixes (Phase - II)

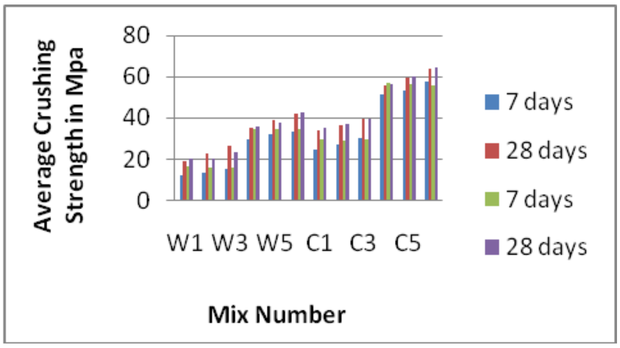

Figure – 11 Work done in (Phase I & Phase – II) Comparison of Average Crushing Strength in (Water and Chemical cured) Fly ash aggregates

V.CONCLUSION

- The fly ash with water relieving and compound restoring acquired higher compressive quality qualities. The most extreme compressive quality of pellets acquired is 6.30 MPa for substance fix totals and 4.85 MPa for water restored totals.
- The Fly ash with compound relieving have less water ingestion because of the development of shell on the outskirts of the totals. The least water absorption is obtained as 14.20%. So in order to accommodate the loss of water due to water absorption[23]-[26].
- The specific gravity of water cured fly ash aggregates is obtained as 1.87 and 1.88 for chemical cured aggregates, which is around 65% of ordinary coarse.
- As the % GGBFS replacement increases the compressive strength of GPC also increases by 40%. GPC mixes with partial replacement of Fly ash with GGBFS the compressive strength increases. So, the maximum compressive strength achieved is 64.56. MPa for GPC mix C_6 with chemical cured aggregates.
- The compressive strength for GPC mix increased nearly by 40% for 0% to 30% GGBFS replacement irrespective of type of aggregate.
- GGBFS makes the setting and solidifying properties of GPC better. The functionality of GPC blend lessens with increment in % GGBFS substitution. The slump is of 90 mm is acquired for GPC blend C1 with 0% GGBFS substitution and synthetic restored fly slag totals.
- It is observed from the tested GPC specimens that the bonding of aggregates with the matrix is better for the GPC specimens with chemical cured fly ash aggregates.
- The usage of GGBFS in GPC can overcome the curing problems of GPC to adopt it for normal construction work and from the test results obtained and it is stated that these GPC mixes C_4, C_5 and C_6 can be used for structural purposes[27]-[31].
- Finally using GPC with fly ash aggregates as an alternative of ordinary cement concrete will reduce the CO_2 emission in to the atmosphere and make environment eco-friendly.

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