International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online)
Vol. 3, Issue 1, pp: (349-354), Month: April 2015 - September 2015, Available at: www.researchpublish.com

Study on Strength Parameters for Composite Concrete by Using Fly Ash Aggregate and Glass Powder

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Abstract: **Selection of the project is to use glass powder and fly ash, effectively and environment friendly nature in concrete construction. Glass powder as well as Fly ash is a waste material from glass industry and thermal power plant respectively. According to Indian Standards method mix design was done for M_{20} Grade of concrete. Ordinary Portland cement of 53 grade was selected. In this project, the cement is partially replaced by glass powder for 25%, 30% and coarse aggregate were partially replaced by fly ash aggregate from 25% to 50% by step in steps of 5%. In recent times, the addition of artificial aggregates has shown a reasonable cut down in the construction costs and had gained good attention due to quality on par with conventional aggregates. This provides an environmental friendly method of fly ash and glass powder disposal.**

Keywords: **Fly ash aggregates (FAA), Glass powder (GP), Glass powder concrete (GPC), Fly ash Aggregate Concrete (FAAC), Compressive Strength, Split tensile strength, Flexural strength, Control concrete (CC).**

1. INTRODUCTION

Fly ash aggregates were prepared by mixing fly ash with cement and water. The properties of glass powder and fly ash coarse aggregates were studied. The aggregate crushing value and aggregate impact value of fly ash coarse aggregates were also studied. The cement and fly ash proportions of 20:80, 30:70, 40:60 respectively were tried with a suitable water cement ratio of 0.3 to get the fly ash aggregates. The aggregates prepared are known as fly ash aggregates. These aggregates can be used in making light weight concrete. The fly ash aggregate was light in nature and its use in concrete reduced the self weight of the structure.

Even glass powder also partially replaced of 25% and 30% for cement in concrete. The concrete cubes, cylinders and beams were casted with the fly ash aggregates obtained from the above optimum value from fly ash aggregate and cement. Then from the obtained optimum value the compressive strength, split tensile strength and flexural strength were tested and compared with control concrete. This paper briefly presents the compressive strength; split tensile strength and flexural strength of all the concrete mixes were investigated at different days of curing.

2. MATERIALS USED

Cement: In this project ordinary Portland cement (OPC) of 53 grade confirming to Indian standard IS 12269-1987 was used. Its physical properties are given below.

Fly ash: In this work fly ash is collected from the industrial waste of 2x250 MW Thermal Power Plant at Torangallu, Bellary of Jindal Thermal Power Company Ltd confirming to IS:3812-1981. Its physical properties are given below.

Glass powder: It was taken from the waste disposed by the Impact Safety Glass Works Private Ltd, old madras road, avalahalli, Bangalore. Its physical properties are given below.

Sand: Locally available river sand of grading zone II confirming to IS 383-1970 was used in this experimental work. Its physical properties are given below.

Natural Coarse Aggregate: Locally available crushed stone conforming to graded aggregate of nominal size 20 mm as per IS 383-1970 was used in this experimental work. Its physical properties are given below.

Formation of Fly Ash Aggregates:

The constituents like cement, fly ash and water produce the fly ash aggregates. Water is the binding material that paves the way for the function of the aggregate with good bond property.

- ***Proportions for Fly Ash Aggregates:***

Cement and fly ash are constituents for preparation of the aggregates. Also water is the binder when it is added to increase the workability. Three different proportions of cement and fly ash such as 20:80, 30:70 and 40:60 were tried.

- ***Preparation of Fly Ash Aggregates:***

Cement and fly ash were mixed in above three proportions in a concrete mixer. Water was added to the mix by adopting the water cement ratio of 0.3. The contents were thoroughly mixed in the drum until the complete formation of fly ash aggregates.

This method of formation of fly ash aggregates is called pelletisation.

- ***Drying and Curing of Fly Ash Aggregates:***

The fly ash aggregates were taken out from the mixer and allowed to dry for a day. Then the aggregates were cured in a water tank for 30 days.

Sl no		Cement	Glass powder	Fly ash	Fine aggre
1	Fineness	94.76	91.73	91.93	
2	Specific gravity	3.155	2.61	2.13	2.71

Sl no		Natural coarse aggregate	Fly ash coarse aggregate (80:20)	Fly ash coarse aggregate (70:30)	Fly ash coarse aggregate (60:40)
1	Impact value (%)	20.91	26.22	23.55	20.37
2	Crushing value	31.5	37.62	30.65	28.70
3	Specific gravity	2.72		1.649	

3. MIX PROPORTIONS

Ingredient properties of ingredients like specific gravities of cement, glass powder, fly ash, fine aggregate and coarse aggregate were determined in Concrete Lab. Moisture contents and water absorptions of fine aggregate and coarse aggregate of both natural aggregate and manufactured fly ash aggregate were also determined in the concrete Lab. The results are given below,

The concrete mix design has been carried out for M20 grade concrete as per IS: 10262-2009. Details are given below.

- Mix proportion of **Controlled** concrete

Cement	Fine Aggregate	Coarse Aggregate
1	1.772	2.902

- Mix proportion of **Glass powder** concrete

Replacement	Cement	Glass Powder	Fine Aggregate	Coarse Aggregate
25%				
	1	0.333	2.335	30824
30%				
	1	0.429	2.505	4.103

- Mix proportion of **Fly ash coarse aggregate** concrete.

Replacement	Cement	Fine Aggregate	Coarse Aggregate	
			Granite Aggregate	Flyash Aggregate
25%	1	1.772	2.176	0.440
30%	1	1.772	2.031	0.528
35%	1	1.772	1.886	0.616
40%	1	1.772	1.741	0.704
45%	1	1.772	1.596	0.792
50%	1	1.772	1.451	0.880

- Mix proportion of **Glass powder** and **Fly ash coarse aggregate** concrete.

Replacement	Cement	Glass powder	Fine Aggregate	Coarse Aggregate	
				Granite Aggregate	Fly ash Aggregate
25%	1	0.333	1.772	2.176	0.440
30%	1	0.333	1.772	2.031	0.528
35%	1	0.333	1.772	1.886	0.616
40%	1	0.333	1.772	1.741	0.704
45%	1	0.333	1.772	1.596	0.792
50%	1	0.333	1.772	1.451	0.880

4. TEST PROCEDURE

- Three cubes of standard dimensions (150 mm x 150 mm x 150 mm),
- Three cylinders of standard dimensions (150 mm diameter and 300 mm height),
- Three concrete prisms of standard dimensions (100mm x 100mm x 500mm), were cast for above mentioned mix for M_{20}. Along with controlled concrete (M20) using normal ingredients: cement, coarse aggregate and fine aggregate and water, and cured for 7, 14, 28 days. The grade of concrete used was M20.

The cubes were tested in compression testing machine and the compressive strengths of the cubes for 28 days.

The cylinders were tested in tensile testing machine and the tensile strengths of the cylinders are compared with that of cylinders.

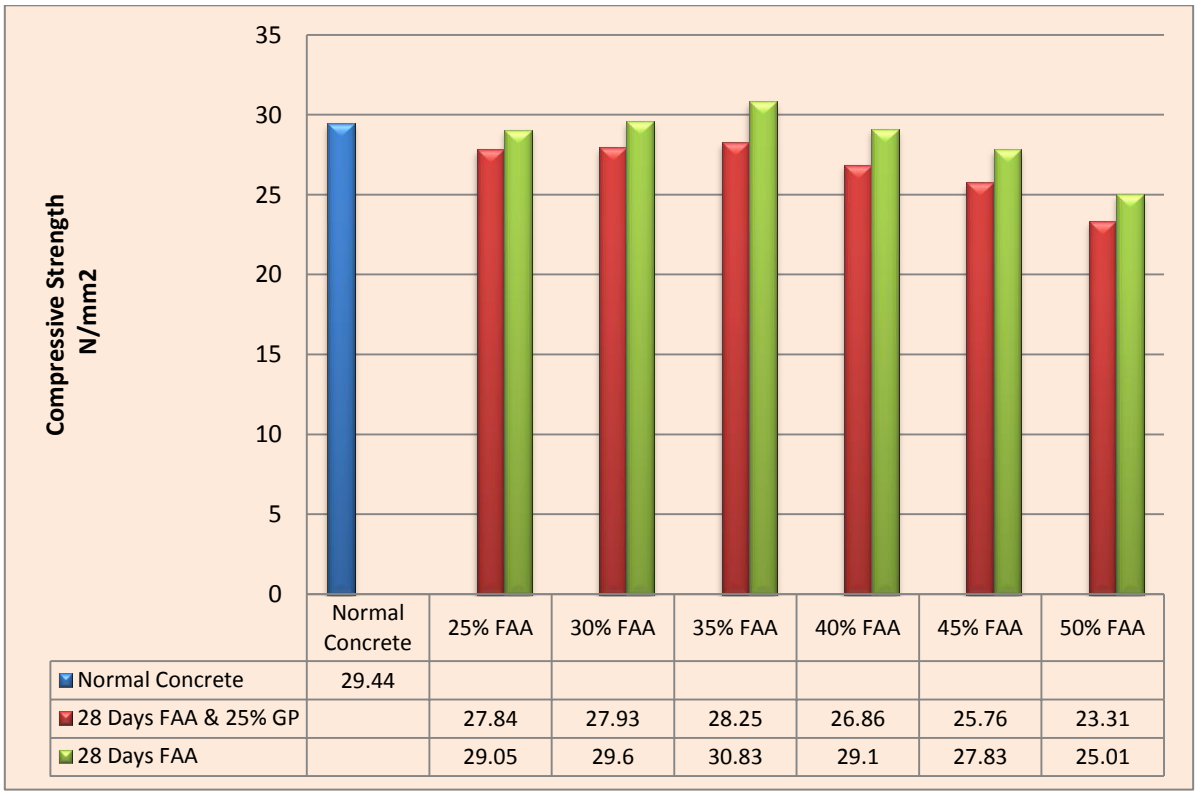
The concrete prisms were tested for flexural strengths and the flexural strengths of the concrete prisms are compared with that of concrete prisms.

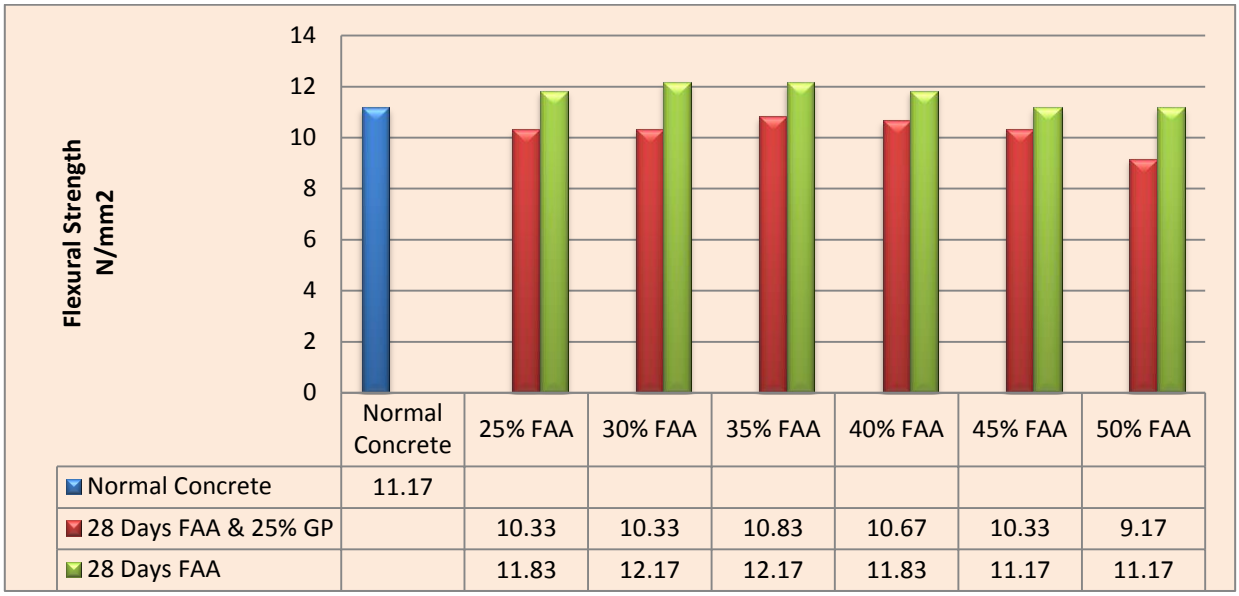
5. TEST RESULTS

Experimental test results and discussions are presented in this chapter Concrete cubes, cylinders and prisms were cast and tested for their respective compressive, flexural and split tensile strengths of concrete in Concrete and Highway Engineering Lab as per the methodology specified in the previous chapter. The results are given in Tables and they have been shown. Comparisons are made between the conventional or controlled concrete and composite concrete with respect to their strengths as well as its weight.

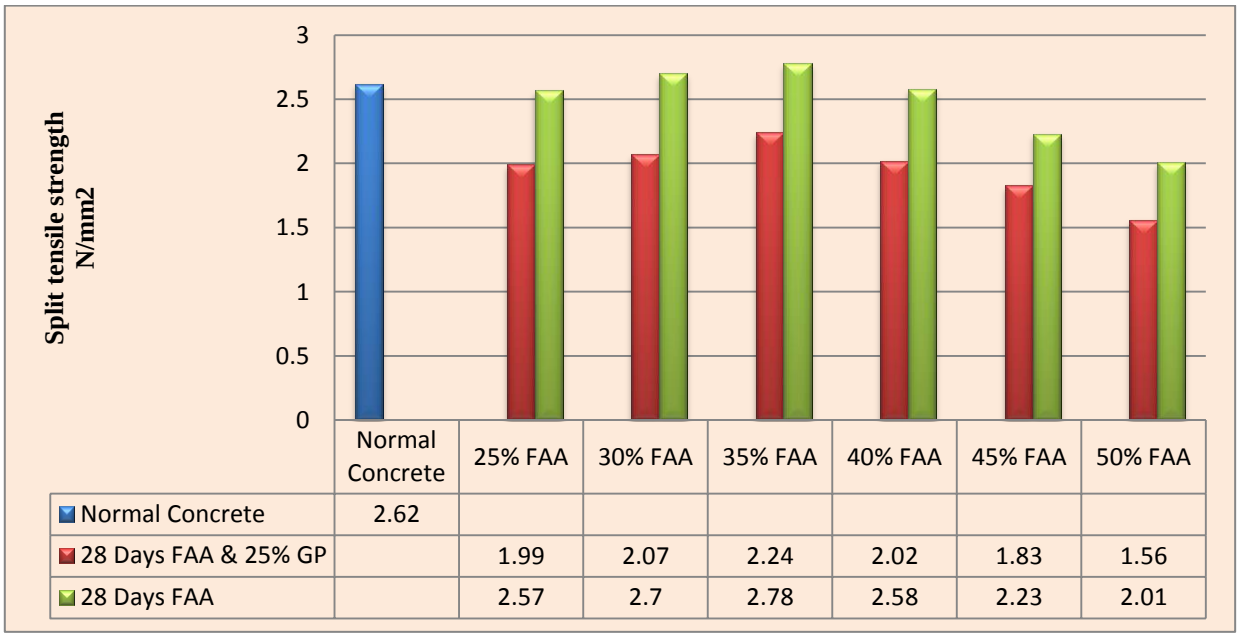
Mix Designation Of M_{20} concrete	Compressive Strength (N/mm^2)	Flexural Strength (N/mm^2)	Split tensile Strength (N/mm^2)	Weight
	28 days	28 days	28 days	28 days
Controlled concrete	29.44	11.17	2.62	8.39
GPC				
(25%)	29.38	11.33	2.42	8.33
(30%)	18.27	7.67	1.38	8.17
FACA				
(25%)	29.05	11.83	2.57	8.14
(30%)	29.60	12.17	2.70	8.02
(35%)	30.83	12.17	2.78	7.80
(40%)	29.10	11.83	2.58	7.61
(45%)	27.83	11.17	2.23	7.39
(50%)	25.01	11.17	2.01	7.12
25%GP & FACA				
(25%)	27.84	10.33	1.99	8.10
(30%)	27.93	10.33	2.07	7.94
(35%)	28.25	10.83	2.24	7.79
(40%)	26.86	10.67	2.02	7.51
(45%)	25.76	10.33	1.83	7.33
(50%)	23.31	9.17	1.56	7.06

GRAPHS

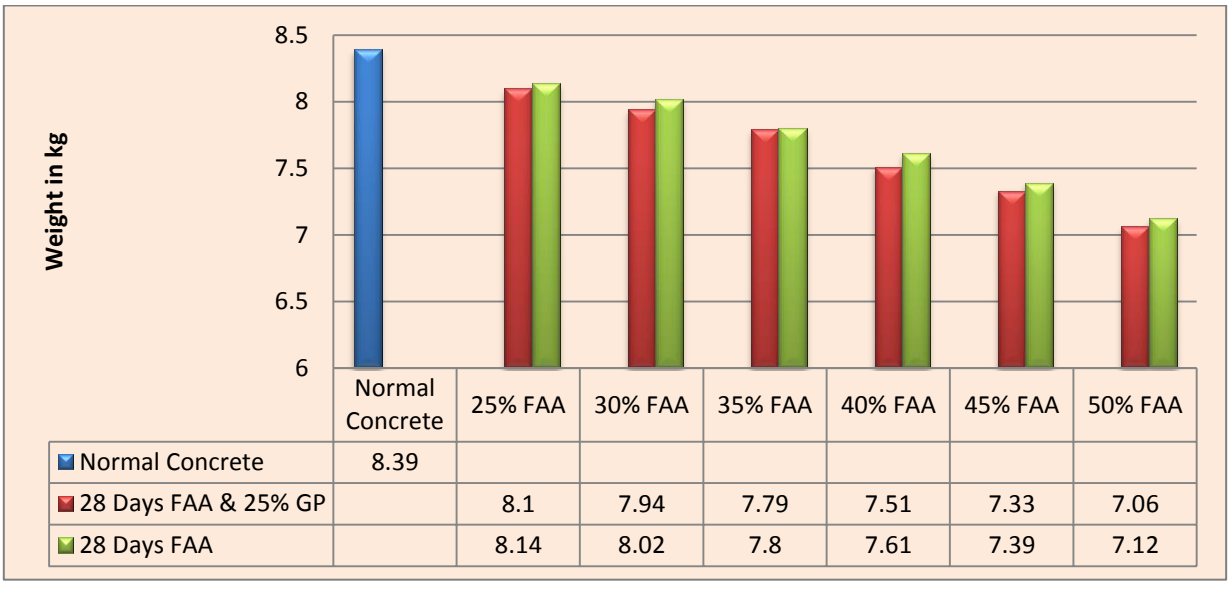




	Normal Concrete	25% FAA	30% FAA	35% FAA	40% FAA	45% FAA	50% FAA
Normal Concrete	11.17						
28 Days FAA & 25% GP		10.33	10.33	10.83	10.67	10.33	9.17
28 Days FAA		11.83	12.17	12.17	11.83	11.17	11.17



	Normal Concrete	25% FAA	30% FAA	35% FAA	40% FAA	45% FAA	50% FAA
Normal Concrete	2.62						
28 Days FAA & 25% GP		1.99	2.07	2.24	2.02	1.83	1.56
28 Days FAA		2.57	2.7	2.78	2.58	2.23	2.01



	Normal Concrete	25% FAA	30% FAA	35% FAA	40% FAA	45% FAA	50% FAA
Normal Concrete	8.39						
28 Days FAA & 25% GP		8.1	7.94	7.79	7.51	7.33	7.06
28 Days FAA		8.14	8.02	7.8	7.61	7.39	7.12

6. RESULTS AND DISCUSSION

- Concrete cubes of mix 25% to 50% fly ash aggregate compressive strength decreases having an optimum value for 35% mix compared to control concrete.

Concrete prisms of mix 25% to 50% fly ash aggregate flexural strength randomly varies but lesser compared to the control concrete.

- Concrete cubes of mix 25% to 50% fly ash aggregate weight decreases gradually with increase in the manufactured FAA

- Concrete cylinders of mix 25% to 50% fly ash aggregate split tensile strength is lesser compared to the control concrete having an optimum at 35% mix.

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