BEST: International Journal of Management, Information Technology and Engineering (BEST: IJMITE)
Vol. 2, Issue 1, Jan 2014, 1-6

DURABILITY STUDY OF STRUCTURAL ELEMENTS USING FLY ASH AGGREGATES

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ABSTRACT

Now a days one of the major problem in construction industries is insufficient and unavailability of construction materials. On the other side the main environmental problem is the disposal of the fly ash. In the experimental study, an attempt has been made to use the fly ash in concrete and experiments have been conducted for fly ash aggregate concrete with respect to acid resistance test.

The main theme of this investigation is fully replaced by coarse aggregates by fly ash aggregates (FAA). The Fly ash aggregates were prepared by the adding of cement with fly ash in six proportions such as 10:90 15:85, 20:80, 25:75, 30:70. The specimen cubes were cast and put in acid for 45 days at the end of 28 days & 56 days curing water. Durability of specimens were assessed by immersing them in 3% of NACL &1% of sulphuric acid solution, periodically monitoring surface deteriorations and loss in weight.

KEYWORDS: Fly Ash, Cement, NACL, Sulphuric Acid, Fly Ash Aggregate

INTRODUCTION

Besides good strength durability is an important property of construction materials. Though ordinary Portland cement possesses good strength, its performance is doubtful in condition of extreme exposure. So, different theoretical studies are made and found that the durability of ordinary Portland cement which invariably reports about its performance with regard to acid resistance.

This investigation was made to improve the performance of ordinary Portland cement by incorporating different proportions of fly ash have been reported to be advantageous. At present, fly ash has been used in proportions of ordinary Portland cement and as a partial cement replacement material. Now it has been concentrated in preparation of fly ash aggregates to utilize more amount of fly ash. The fly ash aggregates obtained from different proportions cement and fly ash has its own influence in the concrete strength. Conventional fine and coarse aggregates in concrete were completely replaced by fly ash aggregates. This report will monitor the importance and influence of fly ash aggregates in the durability of concrete with respect to acid resistance.

PROPORTIONS OF FLY ASH AGGREGATES

Cement and fly ash are constitutions for preparation of the Fly ash aggregates. Also water is the binder where it is added to increase the workability. Five different cement fly ash proportions are taken and subjected to palletisation process.

Table 1: Five Different Cement Fly Ash Proportions are Taken and Tabulated

Trial		Cement	Fly Ash (%)
1	R1	10	90
2	R2	15	85
3	R3	20	80
4	R4	30	70
5	R5	40	60

PROPERTIES OF FLY ASH

Physical Properties

Fly ash consists of fine, powdery particles that are predominantly spherical in shape, either solid or hollow, and mostly glassy (amorphous) in nature. The carbonaceous material in fly ash is composed of angular particles. The particle size distribution of most bituminous coal fly ashes is generally similar to that of silt (less than a 0.075 mm or No 200 sieve). Although sub- bituminous coal fly ashes are also silt- sized, they are generally slightly coarser then bituminous coal fly ashes.

The specific gravity of fly ash usually ranges from 2.1 to 3.0, while its specific surface area (measured by the Blaine air permeability method) may range from 170 to 1000 m^2 /kg

The color of fly ash can vary gray to block, depending on the amount of unburned carbon in the ash. The lighter the color, the lower the carbon content. Lignite or sub-bituminous fly ashes are usually light tan to buff in color, indicating relatively low amounts of carbon as well as the presence of some lime or calcium. Bituminous fly ashes are usually some shade of gray, with the lighter shades of gray generally indicating a higher quality of ash.

Chemical Properties

Fly ash material solidifies while suspended in the exhaust gases and is collected by electrostatic precipitators or filter bags. Since the particles solidify while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5µm to 100 µm. they consist mostly of silicon dioxide(Sio_2) which is present in two forms :amorphous, which is rounded and smooth, and crystalline, which is sharp, pointed and hazardous; aluminium oxide (Al_2o_3) and iron oxide (Fe_2o_3). Fly ashes are generally highly heterogeneous, consisting of a mixture of glassy particles with various identifiable crystalline phases such as quartz, mullite, and various iron oxide.

Table 2: Normal Range of Chemical Composition for Fly Ash Produced from Different Coal Types (Expressed as Percent by Weight)

Component	Bituminous	Sub Bituminous	Lignite
SiO_2	20-60	40-60	15-45
Al_2O_3	5-35	20-30	10-25
Fe_2O_3	10-40	4-10	4-15
CaO	1-12	5-30	15-40
MgO	0-5	1-6	3-10
SO_3	0-4	0-2	0-10
Na_2O	0-4	0-2	0-6
K_2O	0-3	0-4	0-4
LOI	0-15	0-3	0-5

Cement

43 grade ordinary Portland cement (OPC) will be used for the study programme and the specific gravity of cement was found to be 2.85. Volume stability is an important character of the cement that affects the durability. The volume stability of the cement is mainly influenced by two parameters viz. Free Lime and Magnesia.

These ingredients, when present in cement, exhibit a strange phenomenon as explained below. While other components undergo normal hydration, they remain dormant in the beginning and goes for a late reaction which involves expansion after a period of 5-7 years, when the whole structure has totally hardened.

The stress exerted by such expansion reaction leads to cracks and damage of the construction. BIS has rightly added a clause in the specification that such expansion determined through Le-chatelier tests should not exceed 10mm.

The physical, chemical and strength properties of 43 grade cement are given.

Table 3: Physical, Chemical and Strength Properties of 43 Grade Cement

S.No	Characteristics	Value
1	Standard consistency	28%
2	Fineness by sieving through IS 90 Micro Sieve	5%
3	Setting time	
	• Initial setting time	30 min
	• Final setting time	480 min
4	Specific gravity	2.85

Fine Aggregate

For ordinary Concrete River sand was used in preparing the concrete as it is locally available in sand quarry.

Coarse Aggregate

For ordinary concrete 20mm normal size grades aggregate were used. The size of the coarse aggregate & fine aggregate as tabulated below. And these experimental study fly ash aggregates were used.

Table 4: Size of Aggregates

Aggregates	Coarse Aggregates	Fine Aggregates
Size	<4.75 mm	4.75 mm to 20 mm

Water

Ordinary tap water of MPNMJ Engineering College will be used in the preparation of concrete.

EXPERIMENTAL INVESTIGATION

The following test were conducted and compared,

- Acid resistance test.
- Sulphate resistance test.

TEST RESULTS FOR 28 DAYS CURING

Table 5: The Weight and Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete for Specimen I

Specimen I	R1	R2	R3	R4	R5	C.C
W1(kg)	5.360	5.809	5.890	6.074	6.287	8.820
W2(kg)	5.195	5.619	5.778	5.860	6.057	8.400
W.L(%)	3.07	3.27	3.39	3.46	3.65	4.16

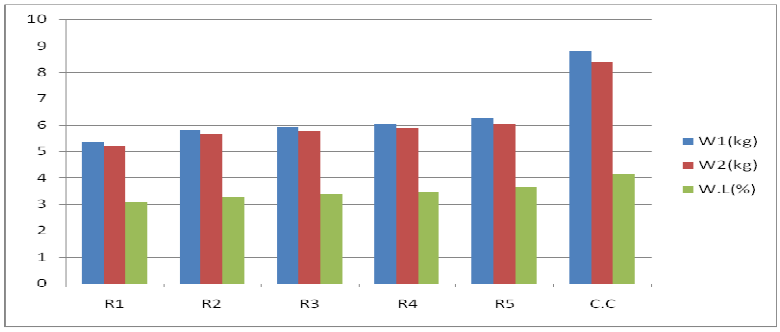

Figure 1: Comparison of Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete

Table 6: The Weight and Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete for Specimen II

Specimen II	R1	R2	R3	R4	R5	C.C
W1(kg)	5.340	5.915	5.915	6.100	6.257	9.000
W2(kg)	5.169	5.746	5.701	5.887	6.003	8.624
W.L(%)	3.20	3.25	3.48	3.49	3.58	4.18

Figure 2: Comparison of Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete

Table 7: The Weight and Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete for Specimen III

Specimen	R1	R2	R3	R4	R5	C.C
W1(kg)	5.350	5.905	5.90	6.05	6.250	8.900
W2(kg)	5.180	5.713	5.709	5.862	6.021	8.531
W.L(%)	3.28	3.251	3.323	3.107	3.66	4.15

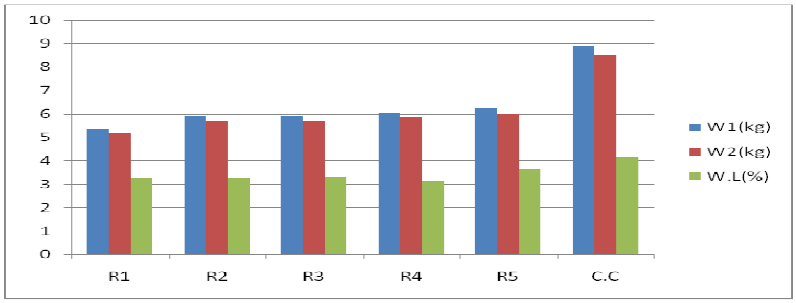

Figure 3: Comparison of Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete

TEST RESULTS FOR 56 DAYS CURING

Table 8: The Weight and Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete for Specimen I

Specimen I	R1	R2	R3	R4	R5	C.C
W1(kg)	5.431	5.598	5.833	5.988	6.280	8.955
W2(kg)	5.268	5.426	5.644	5.793	6.056	8.575
W.L(%)	3.00	3.07	3.24	3.42	3.56	4.24

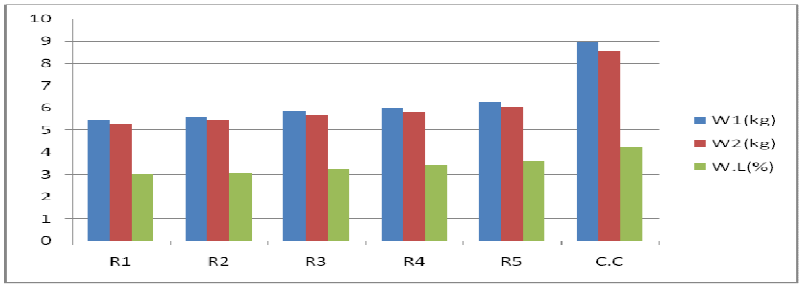

Figure 4: Comparison of Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete

Table 9: The Weight and Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete for Specimen II

Specimen II	R1	R2	R3	R4	R5	C.C
W1(kg)	5.510	5.676	5.852	6.080	6.120	8.452
W2(kg)	5.340	5.491	5.664	5.870	5.904	8.058
W.L(%)	3.08	3.19	3.21	3.45	3.52	4.66

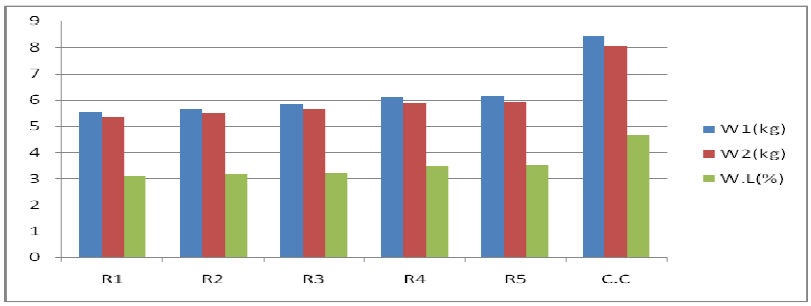

Figure 5: Comparison of Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete

Table 10: The Weight and Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete for Specimen III

Specimen	R1	R2	R3	R4	R5	C.C
W1(kg)	5.485	5.678	5.825	6.025	6.322	9.05
W2(kg)	5.320	5.505	5.638	5.830	6.110	8.658
W.L(%)	3.01	3.05	3.21	3.24	3.35	4.33

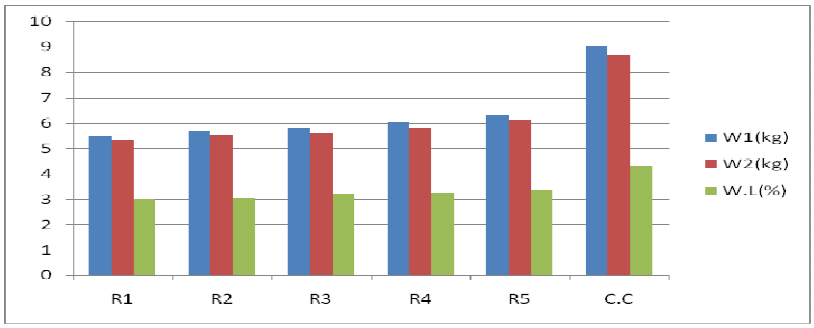

Figure 6: Comparison of Weight Losses for Fly Ash Aggregate Concrete and Conventional Concrete

CONCLUSIONS

Fly ash aggregate concrete specimens cast with different proportions showed varying degree of deterioration when exposed to sulphuric acid.

Loss in weight was observed in all fly ash aggregate concrete specimens and compared with conventional concrete specimens.

The weight losses for six ratios of fly ash aggregate concrete specimens and conventional concrete specimens were determined.

The result shows that the higher quantity of fly ash in making fly ash aggregate specimens recorded lower weight losses during the acid resistance test.

Considering the above durability aspects, the fly ash aggregate concrete may be adopted.

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