Study Of Various Fineness Of Fly Ash As A Partial Replacement Of Cement In Concrete

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Abstract— The purpose of this experimental investigation is to study the behavior of Concrete using Various fineness Fly ash. In this investigation was manufactured by usual ingredients such as cement, fine aggregate, coarse aggregate, water and mineral admixtures such as Fly ash at various replacement levels. The water binder ratio (w/b) adopted is 0.45. The concrete used in this investigation was proportioned to various target a mean strength of 20MPa, 25MPa, 30MPa. Specimens such as cubes, were cast and tested for various mixes are cast with 0%, 12.5%, 25%, and 37.5% replacement of various fineness Fly ash to study the mechanical properties such as compressive strength at different ages of concrete such as 7, 28, and 90 days. The mix Design as per IS 10262-1982.
Keywords: Fly ash, partial replacement, cement ,fine and coarse aggregate, water ,compressive strength.

Introduction

Concrete as is well known is a heterogeneous mix of cement, water and aggregates. The admixtures may be added in concrete in order to enhance some of the properties desired specially. It is widely recognized that proportioning and mixing of the constituents of concrete such as cement, sand and coarse aggregates and compaction are important steps in concrete making process. Quality control measures are expected to keep a check on the quality of concrete being produced. These include tests on wet concrete such as workability tests and tests on hardened concrete.

In its simplest form, concrete is a mixture of paste and aggregates. Various materials are added such as fly ash, admixture to obtain concrete of desired property. The character of the concrete is determined by quality of the paste. The key to achieving a strong, durable concrete rests in the careful proportioning, mixing and compacting of the ingredients. The detailed experimental investigation done to study the effect of partial replacement of cement with FA on cement. In this project I started proportion form 0% FA and mix together in concrete by replacement of cement, last proportion taken 37.5%FA.Numerous tests are performed on wet concrete such as workability tests such as compaction factor test and slump test. The tests on hardened concrete FA mix together in concrete to improve the workability of concrete. The work presented in this project reports an investigation on the behavior of concrete produced from blending cement with FA. The physical and chemical properties of FA and OPC were first investigated. Mixture proportioning was performed to produce high workability concrete (200- 240 mm slump) with strength of M20, M25, M30for the control mixture. The effect of FA on concrete properties was studied by means of the fresh properties of concrete

are destructive test while the destructive test includes compressive test on concrete cube for size (150 x 150 x 150) mm, as per IS: 516 – 1959, IS: 5816 – 1999 and IS: 516 – 1959 respectively. In actual practice, test on workability of wet concrete are carried out to ensure uniform quality concrete only. Strength is not a measurable at that stage with the available technology. Therefore the concrete samples are to be cured for 28 days in normal method to arrive at the compressive strength and for necessary follow up action. It is not only difficult to dismantle the suspected portion of concrete at such a stage but also expensive in terms of time and money. Predicting the strength at the manufacturing stage, however, is yet to receive due attention of engineers. Hence, any new approach that is capable of predicting reliably the compressive strength of hardened concrete based on the properties of the ingredients and the wet concrete will be helpful to practicing engineers. Besides, such tests could be performed with the same ease as the workability tests.

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and the mechanical properties. i.e. Compressive strength.

Materials and Methods.

The utilization of fly ash as cement replacement material in concrete or as additive in cement introduces many benefits from economical, technical and environmental points of view. Four set of mixture proportions were made. First was control mix (without fly ash).

Fly Ash: Class F type Fly ash with various fineness obtained from Khaparkheda thermal power plant , conforming to IS 3812-Part 1-2003 the physical and chemical properties are given in table.

Cement: Ordinary Portland cement 53 grade with physical and Chemical properties as given in table has been used in this experimental study.

Fine Aggregate: Locally available river sand (coarse sand) confirming to grading Zone III of IS:383-1970 was used in this experimental work. Its physical properties are dealt with in table.

Table 1 Chemical Properties of Fly Ash and Cement :

Test Conducted	Cement	Hopper No.1	Hopper No.2	Hopper No.3	Requirements as per IS3812 (part 1)-2003
Loss of ignition-%	0.61%	1.43	2.52	4.11	Max. 5.0
Silicon Dioxide(SiO2)in percentage by mass	20.78%	56.02	56.05	53.11	Min. 35
Silicon Dioxide(SiO2)+Aluminium oxide(Al2O3)+Iron oxide(Fe2O3) in percentage by mass	20.785 +4.44% +2.88%	88.89	88.76	85.20	SiO2+Fe2O3+Al2O3 Min. 70%
Magnesium Oxide (MgO) --- %	3.66%	0.55	0.19	0.54	5.0 Max.
Total Sulpher as SO3 in percentage by mass	2.75%	Below 0.1	0.32	0.24	Max. 3.0
Calcium oxide (CaO)-%	63.78%	1.53	0.995	0.29	----------

Table 2 Physical Properties of Fly Ash and Cement :

Test Conducted	Cement	Hopper No.1	Hopper No.2	Hopper No.3	Requirements as per IS3812 (part 1)-2003
Consistancy (%)	22	27.5	27.5	25.00	---------
Specific gravity (gm/cc)	3.15	2.040	2.061	2.173	---------
Setting Time Initial (min) Final (min)	 120 240	 250 330	 245 325	 240 325	---------
Soundness Test (mm) By Autoclave expansion method (%)	0.8	-0.0516	-0.0502	-0.0312	Max. 0.8
Fineness % by weight		45.55	24.45	2.70	Not more than

by sieving (% Retention on 45 micron sieve-wet sieving	------				34
Fineness (Specific Surface) (Sq.m./kg) By Blains Air Permeability	-------	229	320	536	Min 320
Flow %	------	15.0%	14.0%	12.0%	…….
Compressive strength (Mpa) 1) 7 Days 2) 28 Days 3) 90 Days	 34 44	 19.00 31.00 46.00	 20.0 34.0 58.0	 31.50 47.00 67.00	Not less than 80% of cement at 28 days. (Min.33)

Table 3Basic properties of Aggregates

Property	Fine Aggregate	Coarse Aggregate
Fineness Modulus	**2.406**	**5.04**
Specific Gravity	**2.61**	**2.67**
Water Absortion	**----------**	**7.2%**

Coarse Aggregate:Locally available stones confirming to grded aggregate of norminal size 10 mm as per IS 383-1970 Was used in this experimental work. Its physical properties are dealt with in table 3.

Water: Potable water with pH value of 7.0 and confirming to IS 456-2000 was used for making concrete and curing the specimen as well.

Testing Methodology:-

The evaluation of fly ash for use as a supplementary cementations material (SCM),ie as a pozzalona ,begins with the concrete or mortar testing .The ordinary Portland cement (Respective specimens were tested after 28 days for compressive strength. The mixture proportions are summarized in table 4A, 4B,4C

OPC) confirming IS 269 is replaced with the fly ash. The data from the fly ash concrete is compared with data from a “Control” concrete without fly ash. The water to cement ratio of each mixture therefore varies considerably as 0.35 to 0.50 in concrete. The cube samples were cast on the mould of size (150 x 150 x 150)mm for each M20,M25 and M30 grade concrete with partial replacement of cement with fly ash as 00.00%. 12.5% ,25.00% and 37.50% with water cement ratio were also casted. After about 24 h the specimens were de-moulded and moist curing was continued till the

in which the mixtures were designated according to the type and the amount of cementations materials included.

Table 4 A: Quantities for M20 grade of concrete

SR.NO.	CEMENT (Kg/m3)	HOPPER NO.	F.A. (%)	FA (Kg/m3)	CEMENT (Kg/m3)	SAND (Kg/m3)	AGG. (Kg/m3)	WATER (litre)
1	383	1	00.00	00.00	383.00	559.00	1213.00	186.71
2	383		12.50	47.87	335.13	559.00	1213.00	186.71
3	383		25.00	95.75	287.25	559.00	1213.00	186.71
4	383		37.50	124.47	258.53	559.00	1213.00	186.71
5	383	2	00.00	00.00	383.00	559.00	1213.00	186.71
6	383		12.50	47.87	335.13	559.00	1213.00	186.71
7	383		25.00	95.75	287.25	559.00	1213.00	186.71
8	383		37.50	124.47	258.53	559.00	1213.00	186.71
9	383	3	00.00	00.00	383.00	559.00	1213.00	186.71
10	383		12.50	47.87	335.13	559.00	1213.00	186.71
11	383		25.00	95.75	287.25	559.00	1213.00	186.71
12	383		37.50	124.47	258.53	559.00	1213.00	186.71

Table 4 B: Quantities for M25 grade of concrete

SR.NO.	CEMENT (Kg/m3)	HOPPER NO.	F.A. (%)	FA (Kg/m3)	CEMENT (Kg/m3)	SAND (Kg/m3)	AGG. (Kg/m3)	WATER (litre)
13	456	1	00.00	00.00	456.00	540.00	1171.00	186.877
14	456		12.50	57.00	399.00	540.00	1171.00	186.877
15	456		25.00	114.00	342.00	540.00	1171.00	186.877
16	456		37.50	171.00	285.00	540.00	1171.00	186.877
17	456	2	00.00	00.00	456.00	540.00	1171.00	186.877
18	456		12.50	57.00	399.00	540.00	1171.00	186.877
19	456		25.00	114.00	342.00	540.00	1171.00	186.877
20	456		37.50	171.00	285.00	540.00	1171.00	186.877
21	456	3	00.00	00.00	456.00	540.00	1171.00	186.877
22	456		12.50	57.00	399.00	540.00	1171.00	186.877
23	456		25.00	114.00	342.00	540.00	1171.00	186.877
24	456		37.50	171.00	285.00	540.00	1171.00	186.877

Table 4 C: Quantities for M30 grade of concrete

SR.NO.	CEMENT (Kg/m3)	HOPPER NO.	F.A. (%)	FA (Kg/m3)	CEMENT (Kg/m3)	SAND (Kg/m3)	AGG. (Kg/m3)	WATER (litre)
25	479	1	00.00	00.00	479.00	534.00	1132.00	186.80
26	479		12.50	59.875	419.125	534.00	1132.00	186.80
27	479		25.00	119.75	359.25	534.00	1132.00	186.80
28	479		37.50	179.625	299.375	534.00	1132.00	186.80
29	479	2	00.00	00.00	479.00	534.00	1132.00	186.80
30	479		12.50	59.875	419.125	534.00	1132.00	186.80
31	479		25.00	119.75	359.25	534.00	1132.00	186.80
32	479		37.50	179.625	299.375	534.00	1132.00	186.80
33	479	3	00.00	00.00	479.00	534.00	1132.00	186.80
34	479		12.50	59.875	419.125	534.00	1132.00	186.80
35	479		25.00	119.75	359.25	534.00	1132.00	186.80
36	479		37.50	179.625	299.375	534.00	1132.00	186.80

Compressive Strength:Compressive strength tests were performed on compression testing machine using cube samples as per IS 3812. Three samples per batch were tested with the

average strength values reported in this paper. The loading rate on the cube is 0.1 mm/min. The comparative studies were made on their characteristics for different concrete ratio of M20, M 25 and M30 with partial replacement of cement with fly ash as00.00%, 12.50%, 25.00% and 37.5%.

Table: Compressive Strength test on M20, M 25 and M30 Grade of concrete

HOPPER NO.	SR. NO.	M20			SR. NO.	M25			SR. NO.	M30		
		7 DAY	28 DAY	90 DAY		7 DAY	28 DAY	90 DAY		7 DAY	28 DAY	90 DAY
1	1	20.15	27.71	28.30	13	21.63	35.85	36.89	25	31.11	41.78	43.26
	2	18.22	23.50	26.23	14	17.63	30.82	29.71	26	29.03	32.15	35.70
	3	17.92	24.67	28.89	15	17.92	31.41	33.63	27	27.70	34.97	40.59
	4	17.92	22.97	25.34	16	18.82	26.52	32.00	28	20.74	28.75	40.00
2	5	20.15	27.71	28.30	17	21.63	35.85	36.89	29	31.11	41.78	43.26
	6	18.50	24.60	27.56	18	21.56	32.60	35.71	30	29.50	35.70	37.49
	7	18.37	27.27	29.78	19	20.74	32.23	37.04	31	28.50	32.89	41.03
	8	17.77	25.34	26.52	20	18.87	29.04	31.41	32	21.70	29.19	41.04
3	9	20.15	27.71	28.30	21	21.63	35.85	36.89	33	31.11	41.78	43.26
	10	19.00	24.60	28.15	22	23.64	36.60	39.26	34	29.78	33.64	43.26
	11	19.11	28.30	31.56	23	21.48	33.56	38.07	35	29.78	36.89	42.97
	12	18.07	26.60	26.97	24	18.96	31.26	32.45	36	22.52	32.45	41.18

Workability of concrete: This tests were performed by slump test, compacting factor test, flow test, Vee-Bee test etc but only used to slump test . As per IS 1199-1959. Each sample was tested with various per potion. Values reported in this paper.

Table: **Slump for M20,M25 and M30 grade of concrete**.

HOPPER NO.	SR NO.	M20 SLUMP (mm)	SR NO.	M25 SLUMP (mm)	SR NO.	M30 SLUMP (mm)
1	1	70	13	68	25	55
	2	67	14	60	26	53
	3	64	15	61	27	45
	4	55	16	56	28	43
2	5	70	17	68	29	55
	6	50	18	66	30	49
	7	30	19	62	31	50
	8	30	20	60	32	45
3	9	70	21	70	33	55
	10	80	22	68	34	50
	11	70	23	65	35	49
	12	39	24	56	36	47

RESULTS AND DISCUSSION:

All the 36 mixtures were tested for their corresponding properties and their results were shown in tables. Adequate strength developments were found in concrete made of the mixed cement and various fineness of fly ash as cement replacement for 00.00%, 12.50% ,25.00% and 37.50% in concrete.

CONCLUSIONS:

Extensive experimentation has been carried out to determine the effect of addition of different percentages and different fineness of

fly ash as cement replacements on workability characteristics of concrete. Based on the above experimental and analytical analysis the following conclusions can be drawn.

1. The incorporation of fly ash as cement replacement material up to 37.50% resulted in a reduction of density of concrete.
2. The replacement of cement with fly ash then the increasing the percentage of fly ash then degree of workability is decrease.
3. Based on the resulted obtained , it can be concluded that the replacement of fly ash is affected by main factors also fineness of fly ash
4. The very fine material then its compressive strength is high.
5. In this investigation hopper no 3 is very fine as compared to hopper no.1 and hopper 2.
6. Also the compressive strength is also high hopper no.3 as compared to hopper no.1 and hopper no.2.
7. Generally fly ash cost is zero then replacement concrete is economical concrete.
8. When fly ash is added in concrete , it not only improves long age strength of concrete but also makes the concrete very cohesive and there is overall saving of Portland cement.
9. The utilization of fly ash then to provide safeguard of environment.

SUMMARY: The paper has provided the comprehensive review of the various analyses of the paper on fly ash and fly ash concrete to investigate the concrete works and various methology of concrete and various testing also done by IS codes

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