INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

IJARIIT

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 3)
Available online at: www.ijariit.com

Partial replacement of cement by fly-ash in concrete

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ABSTRACT

The paper deals with the strength of cement concrete by using flyash with cement in concrete. Partial replacement of cement by the use of flyash is being famous and gaining importance today, mainly on account of the improvement in the long term durability of concrete and ecological benefits. Technological improvements in thermal power plant operations and flyash collection systems have resulted in improving the consistency of flyash. To study the effect of partial replacement of cement by fly-ash, studies have been conducted on concrete mixes with 10%, 20%, 30% replacement of total cement 53grade percentage. In this paper, the effect of fly-ash on compressive strength is studied.

Keywords— *Flyash, Grade of concrete, Compressive strength*

1. INTRODUCTION

Huge amount of flyash is collected from various hydrothermal power plants and industries which uses boilers, in our India there is a huge industrial web where tons of flyash is generated daily as waste product of the industries and contributing the emission of carbon dioxide to the nature and becoming the reason for global warming, so to re-use these waste product in cement concrete and to observe the changes in the strength of concrete, compressive strength test is conducted for various grades M10 M20 and M30 be 10% 20% and 30% of replacement of cement by flyash in concrete.

2. FLY-ASH

Fly ash is one of the residues generated in combustion and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal. Fly ash is generally captured by precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace is in this case jointly known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of Silicon Dioxide (SiO_2) (both amorphous and crystalline) and Calcium Oxide (CaO), both being endemic ingredients in many coal-bearing rock strata. Toxic constituents depend upon the specific coal bed makeup, but may include one or more of the following elements or substances in quantities from trace amounts to several per cent: arsenic, beryllium, boron, cadmium, chromium, chromium, cobalt, lead, manganese, mercury, molybdenum, selenium, strontium, thallium, and vanadium, along with dioxins and PAH compounds. In some cases, such as the burning of solid waste to create electricity ("resource recovery" facilities a.k.a. waste-to-energy facilities), the fly ash may contain higher levels of contaminants than the bottom ash and mixing the fly and bottom ash together brings the proportional levels of contaminants within the range to qualify as nonhazardous waste in a given state, whereas, unmixed, the fly ash would be within the range to qualify as hazardous waste.

(Effects on Compressive Strength When Cement Is Partially Replaced By Fly-Ash by Aman Jatale, Kartikey Tiwari, Sahil Khandelwal)

2.1 Chemical Composition of Fly-ash

Table 1: Chemical Composition of Fly-ash

Component	Bituminous	Subbituminous	Lignite
SiO_2 (%)	20-60	40-60	15-45
Al_2O_3 (%)	5-35	20-30	20-25
Fe_2O_3 (%)	10-40	4-10	4-15
CaO (%)	1-12	5-30	15-40
LOI (%)	0-15	0-3	0-5

3. EXPERIMENT

There are total 27 standard cubes are prepared, for grade M-10 M-20 & M-30 with 10% 20% & 30% replacement of cement by fly ash in concrete to obtain their compressive strength in 7 days, 28days and 56 days.

Earlier studies have found that the flash ash concrete kept gaining the strength even after 28 days and in some cases, it is found that it kept gaining strength after years of casting.

3.1 Procedure

First of all the mould preferably of cast iron, thick enough to prevent distortion, is used to prepare the specimen of size 150*150*150mm.

Fig. 1: Cube Mould

During the placing of concrete in the moulds, it is compacted with the tamping bar 16mm diameter, 0.6mm long and bullet-pointed at the lower end, with not less than 25 strokes per layer. Then these moulds are placed on the vibrating table and are compacted until the specified condition is attained.

Fig. 2: Vibrating table

The test specimens are stored in a place free from vibration, in the moist air of at least 90% relative humidity and at a temperature of 27degree +_2degree C for 24 hrs from the addition of water to the dry ingredients.

After this period, the specimen is marked and submerged water and kept there until taken out just prior to the test. The water in which the specimens are submerged are renewed every 7 days. The specimens are not to be allowed to become dry at any time until they have been tested.

Fig. 3: UTM machine during testing

The cube is then taken out of the curing tank and placed in the UTM machine so to find the maximum load at which the concrete fails by compression.

3.2 Contents used in the preparation of various samples

Table 2: Cube results

07Days Results	7.12	9.24	10.54	12.62	15.68	19.56	25.84	30.58	32.57
28 Days Results	11.45	13.89	16.12	21.89	23.45	26.47	32.54	39.21	40.89
56 Days Results	12.68	15.58	18.58	24.12	26.84	30.12	38.76	43.45	45.46

4. RESULTS

Table 3: Results

S. No.	Type of Mix	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
	Trial Mix No	TM 01 (30% FA)	TM 02 (20% FA)	TM 03 (10% FA)	TM 04 (30% FA)	TM 05 (20% FA)	TM 06 (10% FA)	TM 07 (30% FA)	TM 08 (20% FA)	TM 09 (10% FA)
1	Grade	M 10	M 10	M 10	M 20	M 20	M 20	M 30	M 30	M 30
2	Ingredients	kg/m3	kg/m3	kg/m3	kg/m3	kg/m3	kg/m3	kg/m3	kg/m3	kg/m3
3	Total Cementatious Content	230	230	230	330	330	330	425	425	425
4	Cement 53 Grade (Ambuja / Ultra Tech / ACC)	161	184	207	231	264	297	297	340	382
5	Flyash	69	46	23	99	66	33	128	85	43
6	Fly ash percentage (%)	30.00%	20.00%	10.00%	30.00%	20.00%	10.00%	30.12%	20.00%	10.12%
7	20MM	612	612	612	557	557	557	571	571	571
8	10MM	531	531	531	477	477	477	476	476	476
9	R. SAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	C. SAND	906	906	906	915	915	915	824	824	824
11	FREE WATER	180	180	180	175	175	175	174	174	174
12	ADMIXTURE	2.3	2.5	2.6	4.29	4.4	4.65	5.525	5.845	5.948
13	W / C RATIO	0.78	0.78	0.78	0.53	0.53	0.53	0.41	0.41	0.41
14	ADMIXTURE TYPE	SNF Base	SNF Base	SNF Base	SNF Base	SNF Base	SNF Base	SNF Base	SNF Base	SNF Base

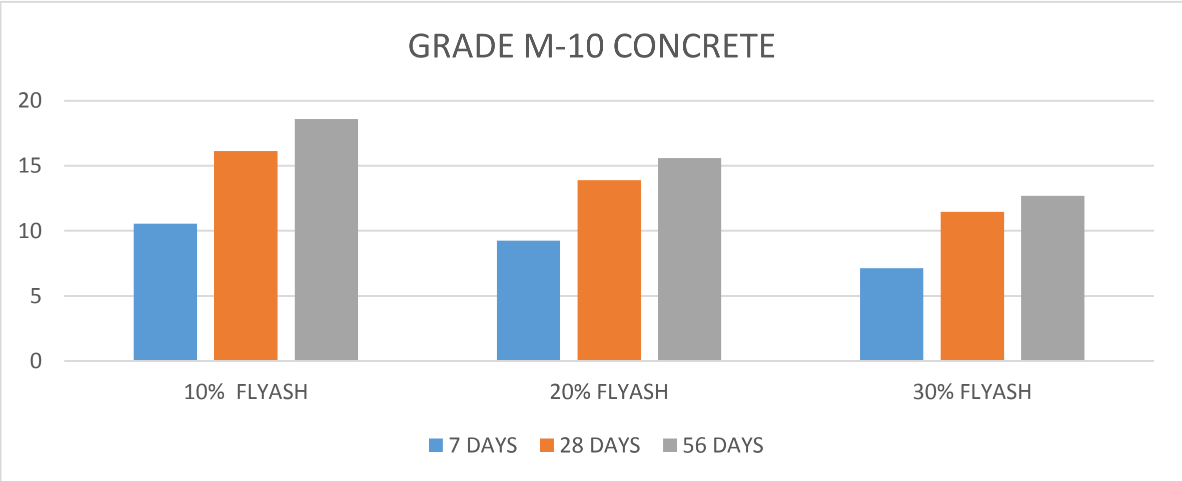

Fig. 4: Grade M-10 concrete

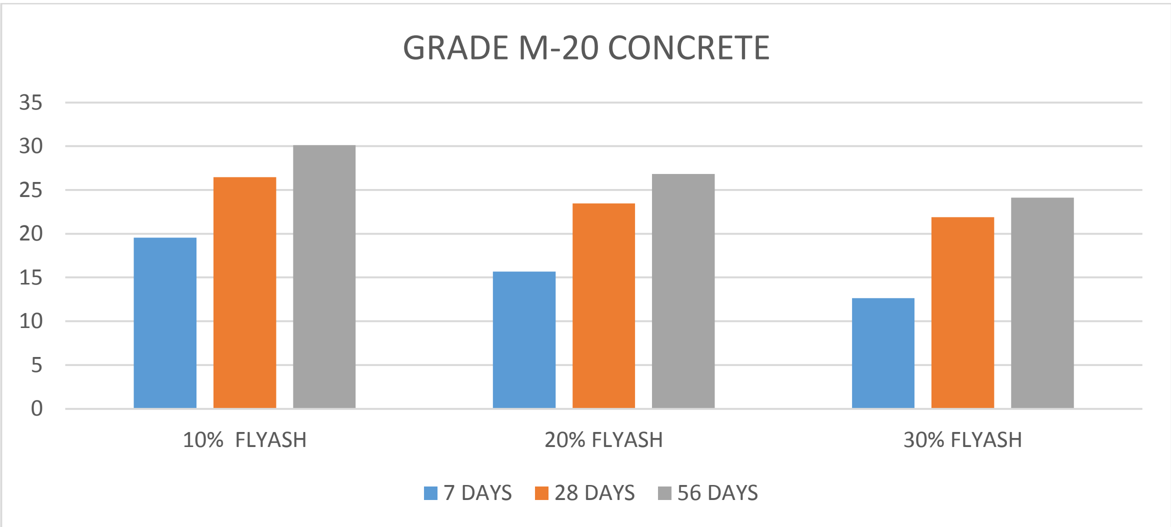

Fig. 5: Grade M-20 concrete

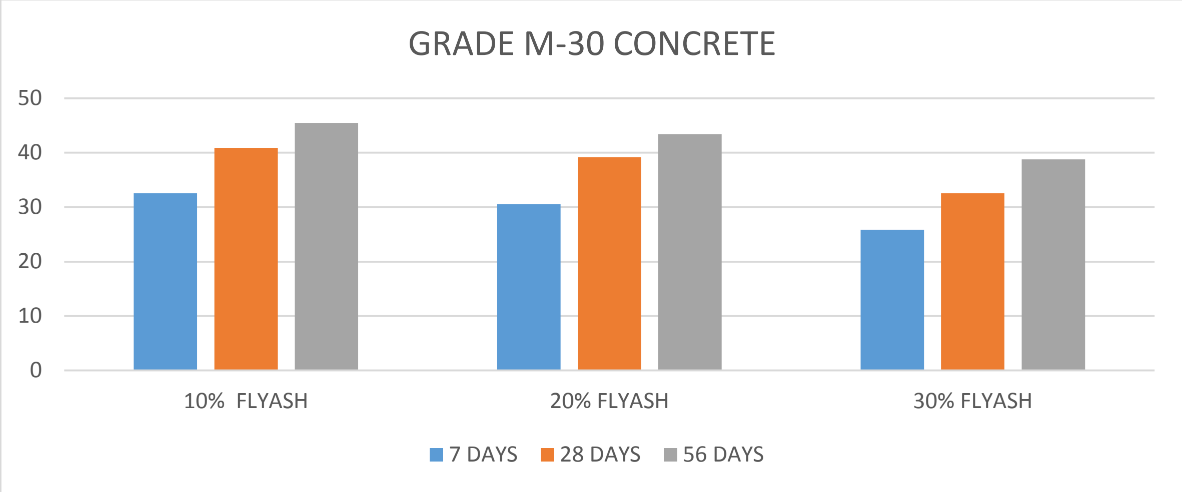

Fig. 6: Grade M-30 concrete

5. CONCLUSION

(a) Lesser the % of Flyash more was the admixture consumption due to Constant W/C Ratio maintained.
(b) Approximately 3 To 4 % of strength variation was observed by varying 10% of flyash content in each trial.
(c) Compressive Strength gained from 28 To 56 Days was approximately 10 to 15 %.

Use of fly ash improves the workability of concrete. This phenomenon can be used either the unit water content of mix or to reduce the admixture dosage.

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