STUDY OF FLY ASH MORTAR: COMPRESSIVE STRENGTH

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ABSTRACT

The use of fly ash as a cement replacement makes the mortar less permeable to harmful ions due to its finer particle size distribution and pozzolanic reactions. This results in an enhanced high performance and more durable mortar. Number of studies of the effects of the fly ashes on the behavior of cement pastes, mortars, and concretes were also carried out. Paper has examined the effect of fly ash used as replacement addition to the Ordinary Portland cement (OPC) on the compressive strength development of cement mortars of five hopper fly ashes at Khaperkheda Thermal Power Plant. The mix proportion 1:3 of cement mortar in which cement is partially replace with fly ash as 0%, 10%, 20%, 30%,and 40% by the weight of cement. Compressive strengths of the mortar specimens were determined at 7 and 28 days. Test results show that strength increases with the increase of fly ash up to an optimum value, beyond which, strength values start decreasing with further addition of fly ash.

Keywords - *Fly ash mortar[1] & Compressive strength[2]*

1. INTRODUCTION:

Mortar is a worldwide accepted building construction material in all types of civil engineering structures. Stone and Brick masonry construction is very much preferred one for load bearing structures and high rise buildings. Most of the walls of buildings and residential houses are masonry walls, made of stones, bricks or concrete blocks, with rendering on both sides. Even though mortar makes up as little as 7% of the total volume of a masonry wall, it plays a crucial role in the performance of the structure. Due to the environment concern and the need to conserve energy, various research efforts have been directed toward the utilization of waste materials. The cost of cement is also steadily increasing. With ever-increasing environmental problems because of industrial waste products comes a great need to use these products in an appropriate manner to reduce health and environmental problems. For this purpose, experimental investigation is carried out to develop the data on the compressive strength development of mortar with time and with different percent replacement of Fly Ash.

In the present study various parameters were studied are:

- Calculation of fineness of five units Khaperkheda Thermal Power Station fly ash.
- To select the Fly Ash mix proportion for cement mortar.
- To investigate change in compressive strength of cement mortar with Fly Ash replacement. The strengths were measured at the age of 7 & 28 days.

2. MATERIAL USED:

2.1 Cement (OPC- 43 grades):

The cement used was Ordinary Portland cement (43 Grade) with a specific gravity of 3.15. Initial and final setting time of the cement was 23 min and 365 min, respectively, conforming to I.S-8112- 1989.

Table 1: Chemical properties of cement (OPC)

Materials	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	LOI	SO_3	K_2O	Na_2O_3
Cement	19.71	5.20	3.73	62.91	2.54	0.96	2.72	0.90	0.25

Ordinary Portland Cement OPC 43 grade cement is used for this whole experimental study. Ordinary Portland cement of 43 grades was tested for different tests and physical test results on OPC were as follows:

1) Normal consistency = 23%

2) Initial Setting time = 20 min.

3) Final Setting Time = 362 min.

4) Specific Gravity = 3.15

2.2 Fly Ash:

Fly ash used was obtained Khaperkheda Thermal Power Station Nagpur, Maharashtra, India. Fly ash is defined as the fine residue resulting from the burning of ground or powdered coal in thermal power plants. In India, nearly 90 mt. of fly ash is produced per year and is mainly responsible for environmental pollution. Fly ash contains variety of substances of which trace metals are of special interest due to their cumulative build up, long life, and high toxicity to man, plants, and animals through air, water, and soil. Fly ash generated from Khaperkheda thermal power plant in 2013-14 is 1428000 ton and total fly ash is utilized for Bricks, stowing, agricultural, cement, landfills and other purpose. Fly ash is commonly used to supplement Portland cement in concrete production, where it can bring both technological and economic benefits, and is increasingly finding use in synthesis of geopolymers.

Table 2: Chemical Composition of Fly Ash

Name	Formula	Percentage
Silica	SiO_2	62
Iron oxide	Fe_2O_3	63
Aluminum	Al_2O_3	26
Titanium oxide	TiO_2	1.8
Potassium oxide	K_2O	1.28
Calcium oxide	CaO	1.13
Magnesium oxide	MgO	0.49
Phosphorus pent oxide	P_2O_5	0.40
Sulfate	SO_4	0.36
Disodium oxide	Na_2O	0.28

2.3 Aggregate

Good quality river sand was used as a fine aggregate. As hydraulic cement is commonly mixed with certain proportions of sand, when used in construction, the nature and quality of sand used, and the method of manipulating the materials in forming the mortar have quite as important, an effect upon the final strength of the work as the quality of the cement itself. The fineness modulus, specific gravity and dry density are 2.32, 2.68 and 1690 kg/m^3

3. EXPERIMENTAL PROGRAMS

The evaluation of fly ash for the use of supplementary cementitious material i.e. as a pozzolona, begins with the mortar testing. Mortar is similar to concrete in that it contains cement, water and aggregate, except that in fine aggregate is the only aggregate present. With the control mortar i.e. without fly ash, 10%, 20%, 30% and 40% of the ordinary Portland cement (OPC) conforming IS 296 is placed with the fly ash.

3.1 Specific Gravity and Fineness of Fly Ash

Table 3: Specific Gravity and Fineness fly ashes

Physical Test	Specific Gravity(gm/cc)	Fineness
Unit 1	2.08	612
Unit 2	2.11	630
Unit 3	2.12	655

3.2 Flow Test:

The mortar flow test utilizes a specially designed table that repeatedly rises and drops a known quantity of mortar 25 times. During the test, the mortar will spread or flow to form a circular mass and the diameter of the mass is measured and compared to the initial size. The increase in the size is expressed as a percentage of the initial size; for most mortar the required flow is 110%. The flow test is repeated, using a fresh batch of mortar each time, until the desired flow is achieved.

3.3 Compressive Strength

The proportion of control plane cement mortar mixture is 1:3 cement and sand respectively. The specimen used for compressive strength is 70.6 mm X 70.6 mm X 70.6 mm. For the purpose of evaluating the influence of the fly ash on the strength 10%, 20%, 30% and 40% FA as the cement replacement by mass were prepared. Graph shows the composition of the mortars prepared and tested.

The compressive strength was calculated as follows:

Compressive strength (MPa) = Failure load / cross sectional area.

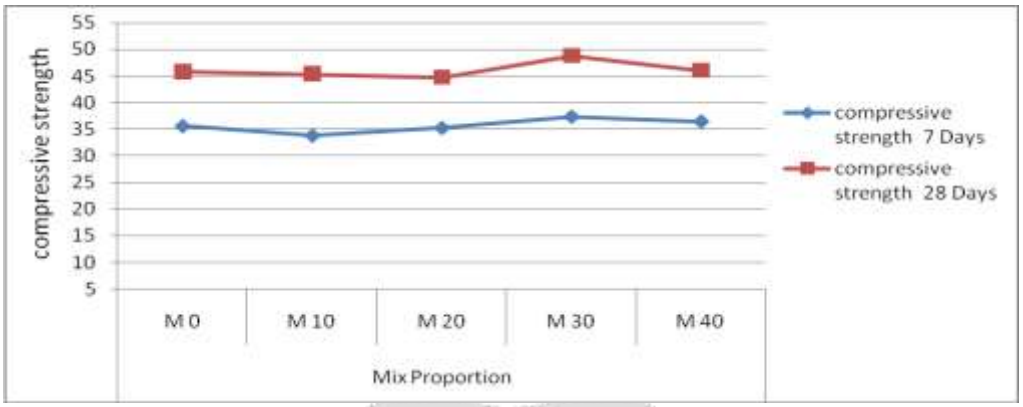

Chart -1: Compressive strength of fly ash mortar for Unit-I of Khaperkheda power plant

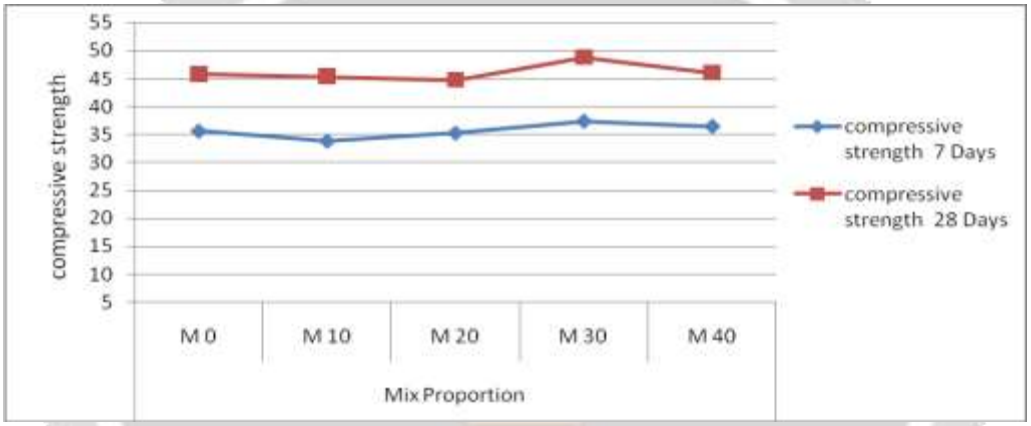

Chart -2: Compressive strength of fly ash mortar for Unit-II of Khaperkheda power plant

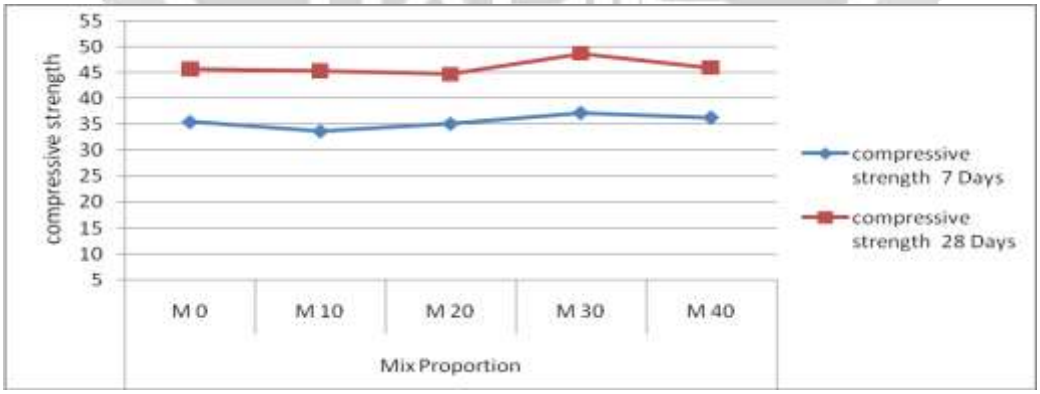

Chart -3: Compressive strength of fly ash mortar for Unit-II of Khaperkheda power plant

4. RESULTS:

Above graph shows that the compressive strength of the fly ash mortar gives less strength than plane cement mortar cube. But the strength deference is slightly varying.

From the above first and second result it is clear that the M20 mix i.e. replacement of cement by an amount of 20% shows better result than other replacement of mixture. And when the fineness of the fly ash increases i.e. in third unit of thermal power plant strength increases in high replacement. Hence it is consider up-to 20% to 30% replacement of cement with fly ash gives the better result.

5. CONCLUSIONS:

Fly ash is found to be superior to other supplementary materials like slag, and silica fume. Due to low specific gravity of fly ash which leads to reduction in mass per unit volume, thus adding it reduces the dead load on the structure. Used of Fly ash helps in reducing the environment pollution during the disposal of excess Fly ash. Cement is costly material, so the partial replacements of these materials by fly ash ash reduce the cost of concrete.

Based on the results presented above, Compressive strength increases with the increase in the percentage of Fly ash up to replacement (20% FA) of Cement in mortar for different mix proportions.

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