Replacement of Cement by Fly Ash in Concrete

Jayanta Chakraborty[1], Sulagno Banerjee[2]
[1]PG Student, RKDF Institute of Science& Technology, SarvepalliRadhakrishnan University
[2]Assistant Professor, Seacom Engineering College, Howrah Dhulagarh

Abstract

From the very beginning of the nineteenth century,it has been come to light that Fly Ash may substitute cement in concrete industry. It may be mentioned here that Fly Ash amounting to 15% to 25 % by mass has been used as cementitious material in concrete. The compressive strength of concrete was examined by replacing different proportions of cement with Fly Ash. However, the actual amount to be used mainly depends on the properties of Fly Ash, methods of applications as well as the Geographic location and climatic condition of the area concerned. A various numbers of research works in regards to use Fly Ash as additive in cement, admixture, n concrete and cement replacement material were done. But most of the research works were related to few percentages of cement replacement for the concrete of lower grades.In this context, an experiment is carried out to examine the effects of Fly Ash on compressive strength of different high grade concrete for different quantity of Fly Ash, taking into account different curing periods. An investigation has also been conducted to examine the effects of Fly Ash on mechanical properties of fresh and hardened concrete by mixing different grades of concrete with varying percentage of Fly Ash. The compressive strength of concrete was measured by 7, 28 and 60 days and the compaction factor was taken from the measurement of workability. Considering the different rate and strength as parameters a comparative study has been conducted .By replacing different proportions of cement with Fly Ash ,the compressive strength of cement has been checked and the results have been found effective and applicable. This paper analyses vividly the effects of Fly Ash as partial replacement of cement in concrete and to ascertain the use of optimum quantity of Fly Ash for different qualities of concrete which will be acceptable , applicable and economical. Here it is also explained the variation in compressive strength of different qualities of concrete at different percentage of Fly Ash at various curing periods.

Keywords: - *Fly-ash, Additive, Admixture, Compaction factor*

I. INTRODUCTION

A various numbers of research have been conducted to examine the effects of use of Fly Ash as additive in cement, admixture in concrete and as replacement of cement in concrete. The compressive strength of concrete was checked by replacing different proportions of cement with suitable quantities of Fly Ash and the results have been found most effective and applicable. Incidentally most of the research works have been conducted only for a limited percentage of cement replacement that too for a lower grade of concrete. It is therefore necessary to conduct an extensive research on compressive strength of different qualities of concrete as well as different proportions of Fly Ash at different curing periods. Herein below the various methods of using the Fly Ash as a cement replacement in concrete is discussed vividly.

II. METHODOLOGY

Materials used in the time to time experiments are as under:

Cement: Ordinary Portland cement (Ambuja Cements of 53 grades) was used having specific gravity: 3.10, 31.5% Consistency and compressive strength 53 MPa

Fly ash: From the combustion of pulverized coal and transported by the flue gases of boilers by pulverized coal, Fly Ash is produced. It was obtained fromKolaghat thermal power station, dried and subsequently used.

Fine Aggregate: Natural sand with maximum size of 4.75 mm was used with specific gravity 2.55 and fineness modulus 2.61.

Coarse Aggregate: Natural aggregates with maximum size of 40 mm were used with specific gravity of 2.68 and fine modulus 7.5.

Water: Drinking water from Seacom Engineering College, Howrah Dhulagarh was used for the preparation of concrete. The quality was uniform and the water samples were potable.

The concrete mix was designed for M25, M35 and M50 grade and the mix design was done as per IS 10262-1982 and IS 456-2000. The properties of constituents of concrete was taken into account for mix design of concrete. Different concrete mixes with varying fly ash content percentage were produced, replacing 0% (reference concrete), 15%, 25%, 35%, 45%, 55% and 65% cement in terms of weight. For compressive strength tests cube specimens of 150mm size were casted. The cubes were casted in stainless steel moulds and wet cured at standard temperature until the time of test. The cubes were cured for a time period of 7, 28 and 60 days.

III. RESULTS AND TABLES

The variations in compressive strength of different mixes in respect of curing time for a particular percentage of Fly Ash is explained in Figures 1 to 7.The behavior of strength of concrete with passage of time is shown in the aforesaid figures. It is found that for all mixes ,increase in compressive strength is not the same with passage of time. Some mixes have low early strength but gain high strength in course of time whereas some mixes have high early strength but achieve low strength at the end.

% of fly ash	grade M25 compressive strength in N/mm²			grade M35 compressive strength in N/mm²			Grade M50 compressive strength in N/mm²		
	7	28	60	7	28	60	7	28	60
0	25	46	50	33	50	56	38	57	61
15	24	43	47	37	50	56	37	56	60
25	18	39	41	28	47	52	24	54	59
35	19	37	40	29	44	46	25	51	55
45	15	29	32	23	37	38	28	48	50
55	10	21	30	17	28	33	24	41	45
65	6	14	20	12	23	28	9	32	37

Table 1: Variation in Compressive Strength of Different Concrete Mixes for 7, 28 and 60 Days Curing and Differe Percentages of Fly Ash.

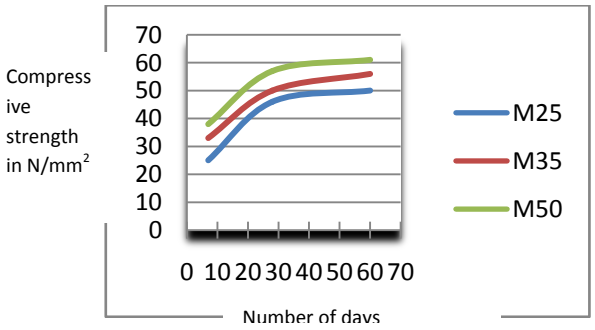

Figure 1 :0% Fly Ash Replaced

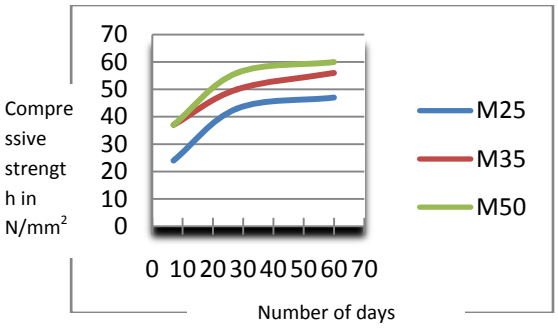

Figure 2 : 15% Fly Ash Replaced

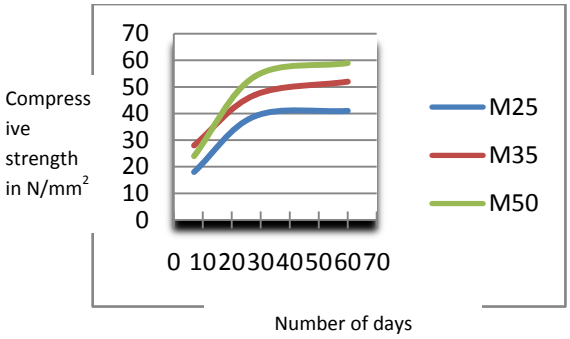

Figure 3 : 25% Fly Ash Replaced

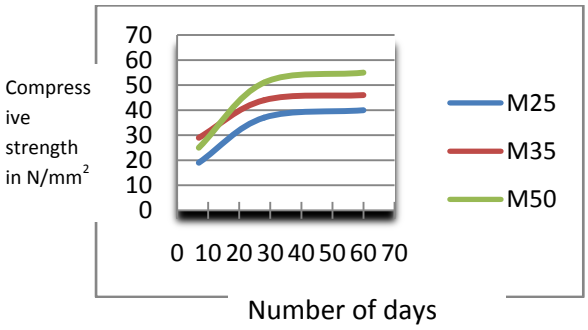

Figure 4: 35% Fly Ash Replaced

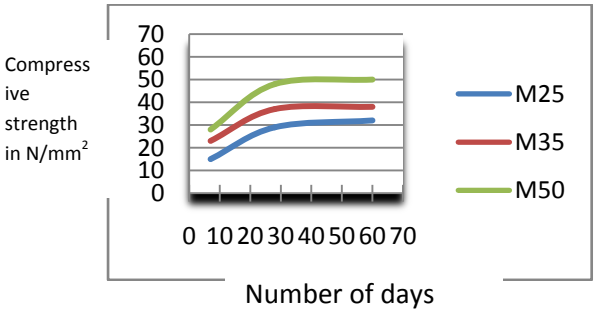

Figure 5 : 45% Fly Ash Replaced

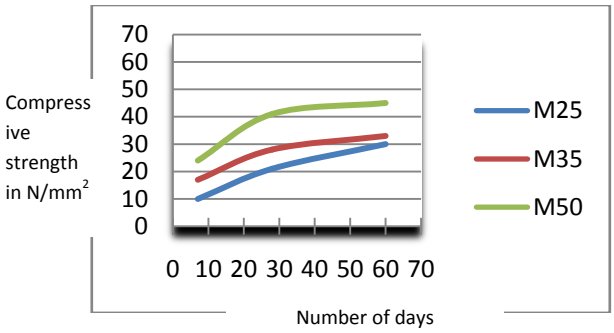

Figure 6 : 55% Fly Ash Replaced

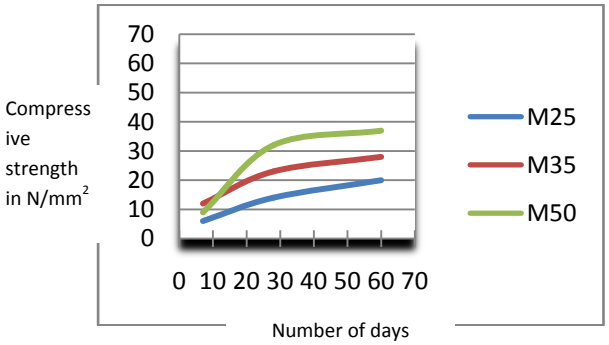

Figure 7 :65% Fly Ash Replaced

IV. CONCLUSION

1. Experiments on different times suggest that the compressive strength of concrete mixes decrease with increase presence of Fly Ash. It should be kept in mind that the optimum limit of mixing of Fly Ash is 45 % and more than that may not be safe for different concrete mixes.
2. Generally with the increase of fly ash there is steep increase in strength from 7 to 28 days which is indicative that early strength of concrete is reduced with increase in proportion of fly ash. Above all the variation in early strength is more than that of in later strength. Hence the fact remains that Fly Ash has an adverse effect on early strength of concrete.
3. Depending upon the percentage of Fly Ash as well as time of curing sometimes mixes of higher strength can be economical than that of mix of lower strength.

REFERENCE

1) Prabhakar J. (April 1999). "Use of Fly Ash in Development of New Building Material," CE & CR journal.
2) Renganswamy A. (April 1999). "Fly Ash Production in India," CE & CR journal.
3) Vimal Kumar, (June 2003). "Fly Ash in Construction" CE & CR journal.