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# Effect of Lime on Strength Characteristic of Fly Ash Concrete

**Vinay Singh**
*M. Tech. Research Scholar*
*Jabalpur Engineering College*
*Jabalpur (M.P.), [INDIA]*
*Email: vinaysing9303@gmail.com*

**R. K. Yadav**
*Associate Professor*
*Department. of Civil Engineering*
*Jabalpur Engineering College*
*Jabalpur (M.P.), [INDIA]*
*Email: rkyadav07@gmail.com*

**Dr. Rajeev Chandak**
*Professor, Head of the Department*
*Department. of Civil Engineering*
*Jabalpur Engineering College*
*Jabalpur (M.P.), [INDIA]*
*Email: rchandak@jec-jabalpur.org*

***Abstract*—*This paper presents the results of an experimental investigation on the effect of lime on strength characteristics of fly ash concrete In this experimental study a design mix of M30 grade concrete is taken containing 30% fly ash by weight of Ordinary Portland Cement. The mix is further added by hydrated lime in the proportion of 5%,10%,15% & 20% by weight of cementitous material (cement + Fly ash) replacing fine aggregate by an equal amount of lime. Test results revealed that the addition of lime up to a certain limit improved the early age compressive strength of fly ash concrete. It has been found that addition of 5% lime improves the 7days compressive strength by 20%. The 28 days compressive was also increased by 9.9%.*

## 1. INTRODUCTION

Fly ash is a residual material of energy production using coal, which has been found to have numerous advantages for use in the concrete industry. Some of the advantages include improved workability, reduced permeability, increased ultimate strength, reduced bleeding, better surface finish and reduced heat of hydration. For several years it has been used in varying proportions and compositions in concrete. Research indicates that there are still additional benefits to be gained if the concrete industry can further optimize its use in concrete. Several types of fly ash are produced depending on the type of coal and the coal combustion process. It is a pozzolanic material and has been classified into two classes, F and C, based on the chemical composition of the Fly ash. All fly ashes have a particle size ranging less than 0.075 mm.

The fineness and lime content properties of fly ash are of great concern since they will affect the air content and water demand of the concrete. The above parameters that greatly affect the durability and strength of concrete respectively. This study seeks to optimize the use of fly ash by taking advantage of the properties of Lime with fly ash, to produce concrete with improved results and added benefits. A series of tests will be carried out, analyzed and compared to concrete manufactured with Portland cement and Fly ash as cementitious material and adding 5%, 10%15% & 20% of lime by the weight of cementitous material. The tests to be done will focus on the compressive strength, at different age. The results presented in this paper are the preliminary results of the study, discussing the

compressive strength at different age. The main reason for the low early strength development of fly ash concrete is the unavailability of sufficient quantities of Ca $(OH)_2$ to react with the fly ash particles. Hence, there is a possibility of improving the pozzolanic reaction of fly ash by adding lime.

## 2. RESEARCH SIGNIFICANCE

This study proves that fly ash can be successfully used in the cement concrete up to 30% by mass of OPC without adversely affecting the strength & durability of concrete. Considering the intangible cost of disposal problem of fly ash and hidden cost of environmental protection, the methodology appears to be indeed successful. Fly ash is actually a solid waste. So, it is priceless. If it can be used for any purpose then it will be good for both environment and economy. Use of this fly ash as a raw material in Portland cement is an effective means for its management and leads to saving of cement and economy consequently. Hence it is a safe and environmentally consistent method of disposal of fly ash. However the rate of strength development is less, Due to lesser rate of strength deash finds specific application in mass concreting e. g. dam construction. It can be concluded that power plant waste is extensively used in concrete as a partial replacement for cement and an admixture. This paper envisages the effect of lime on strength of fly ash concrete at different ages.

## 3. OBJECTIVES

The objectives of the study are summarized below:

To study the compressive strength of concrete by placing 30% of cement weight by fly ash and then adding lime in ratio of 0%, 5%, 10%,15%, & 20% by weight of cementitious material.

(a) To study the variation of strength by adding lime different proportions and to find the optimum quantity of lime.

## 4. MATERIALS & METHODOLOGY USED

***Cement:*** Ordinary Portland Cement (OPC) conforming to IS 8112-1989 was used for this study, The OPC"BIRLA" of 43 grade has been used.

***Fine Aggregate:*** River Sand conforming to zone-II of IS 383-1970 has been used.

***Coarse Aggregate:*** Two fractions of coarse aggregate having nominal maximum as 20mm & 10mm were used in this study.

The following laboratory tests were performed on aggregates as per relevant IS code and mix design of M 30 grade of concrete containing fly Ash will be carried out. The laboratory test programme was proposed as under.

***(A) Physical properties of coarse aggregates (20 mm and 10mm size)***

- Sieve Analysis And Fineness Modulus
- Specific Gravity
- Water Absorption

***(B) Physical properties of fine aggregates***

- Sieve analysis
- Specific gravity
- Water absorption

***(C) Mix design (M 30 grade) as per IS 10262:2009 Containing OPC and Fly ash.***

***(D) Addition of 5%, 10%, 15%, & 20% of Lime of the weight of Cementitious materials in the Fly ash Concrete.***

***(E) Study of Compressive Strength at 7 & 28 days***

**Table 1 :Chemical Properties of Lime**

| S.No. | Test Parameter | Test Value |
|---|---|---|
| 1 | Loss of ignition (%) | 36.5 |
| 2 | Silica as $SiO_2$ %) | 6.5 |
| 3 | Calcium oxide as CaO (%) | 49.8 |
| 4 | Magnesia as MgO (%) | 1.2 |

**Table 2:Chemical Properties of Fly Ash**

| S.No | PARAMETER (Chemical properties) | Test Value | Requirement. As per IS:3812 (P:1):2003 |
|---|---|---|---|
| 1 | Silicon Dioxide (Sio2) +Aluminium Oxide (Al2O3)+Iron Oxide (Fe2o3)in % by mass | 71.47 | 70 |
| 2 | Silicon Dioxide (Sio2)I% by mass,Min | 64.27 | 35 |
| 3 | Magnesium Oxide (Mgo) in % by mass,Max | 1.41 | 5.0 |
| 4 | Total Sulphur as Sulphur trioxide(So3) in % by mass, Max | 1.21 | 3.0 |
| 5 | Total Chloride in % mass | 0.012 | 0.05 |
| 6 | Loss Of Ignition In % By mass(Max.) | 1.27 | 5 |

## 5. EXPERIMENTAL PROCEDURE

In this study M-30 GRADE of concrete was designed as per IS Code. In this study firstly we have replaced 30% of OPC with Fly ash and then later on keeping cementitious same. We are replacing 5%, 10%, 15% & 20% of sand with lime.

For each replacement 5 sets of cubes were casted in each set 6 cubes were casted and later on the compressive strengths of cubes was to be checked at 7 & 28 days.

## 4. RESULTS

The Test result obtained are summarized in Table 3 shown below and the variation is shown in the figure 1.

**Table 3:Results**

| Lime Quan-tity | 7 Days Strength | 28 Days Strength |
|---|---|---|
| 0% | 27.56 | 39.11 |
| 5% | 33.07 | 43.00 |
| 10% | 32.24 | 41.07 |
| 15% | 28.11 | 40.68 |
| 20% | 27.73 | 40.44 |

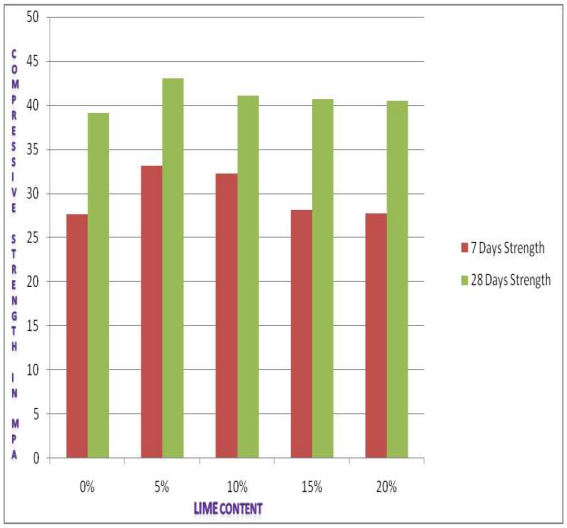


*Figure 1: Strength Analysis*

## VI. Conclusion

On the basis of the results obtained in this study, the following conclusions have been drawn:

(a) The addition of lime improved the early age compressive strength of Fly ash concrete but up to a certain limit.

The optimum quantity of lime is found as 5%, At this replacement the 7 days compressive strength was increased by 20% and 28 days strength by 9.9%. The main reason for the increase in strength is due to availability

of sufficient quantity of $Ca(OH)_2$ to react with Fly ash particle and improving the pozzolonic reaction of Fly ash with the addition of lime.

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