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# Effect of Addition of Fly Ash on Workability of Concrete

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**Abstract:** ***Fly ash varies significantly in composition. It is residue left from burning coal, which is collected on an electrostatic precipitator or in a bag house. It mixes with flue gases that result when powdered coal is used to produce electric power. Fly ash is a pozzolanic material which produces calcium-silicate-hydrate (C-S-H) when reacts with free lime present in cement during the hydration. Use of fly ash in concrete imparts several environmental benefits and thus it is eco-friendly. It saves the cement requirement for the same strength thus saving of raw materials such as limestone, coal etc required for manufacture of cement. Fly ash is pozzolanic material & it improves the properties of concrete like compressive strength & Durability. This paper present the experimental result carried out to determine workability and compressive strength of concrete at different replacement of PPC. Under this project percentage replacement are 5 percent, 10 percent and 15 percent in the concrete. The addition of fly ash improves the strength of concrete. When 5% fly ash is added to the concrete then the strength and workability both increases but when we add 10% and 15% at both percentages the strength as well as the workability of the concrete decreases. So this clears that the best replacement of cement is with the addition of 5% of fly ash to obtain better results.***

**Keywords:** Fly Ash, Concrete

## 1. Introduction

Fly ash is defined as a finely divided residue resulting from the combustion of ground or powdered coal and transported by flue gases from the combustion zone to the particle removal system. Fly ash particles are typically spherical, finer than Ordinary Portland cement, ranging in diameter from less than 1μm. In order to decrease the environmental waste, the development of sustainable products for the composite materials by means of recycled materials such as polymer, fly ash and glass reinforced plastics has been used. The use of fly ash in Portland cement concrete (PCC) has many benefits and improve concrete performance in both the fresh and hardened state. Fly ash use in concrete improves the workability of plastic concrete, and the strength and durability of hardened concrete. Generally, fly ash benefits fresh concrete by reducing the mixing water requirement and improving the paste flow behaviour. In the recent past based on studies carried out by few researchers it is revealed that even while using blended cement content in concrete, the proportion of cement can be reduced by adding pozzolanic material like fly ash as partial replacement of PPC. It is reported that it is possible to produce low cost High Performance Concrete (HPC), with 90 day strength in the range of 70 N/mm2, using low quality fly ash.

## 2. Related Work

a) **K.P Ramaswamy and M. Nazeer (2007)** presents a study on the use of fly ash in masonry mortar. Ordinary Portland cement (OPC) is partially replaced with fly ash at the dosage of 0 to 50% by weight of cement that incorporation of fly ash in cement mortar improves the workability significantly.

b) **L. Lam, Y.L. Wong (2005)** presents the results of a laboratory study on high strength concrete prepared with large volumes of low calcium fly ash. The parameter included compressive strength, heat of hydration, chloride diffusivity, degree of hydration, and pore structures of fly ash/ cement concrete and corresponding pastes.

c) **D. Hardjito and B. V. Rangan (2001)** "Development and properties of fly ash based geopolymer concrete" based on these test results, it is suggested that naphthalene sulphonate–based super plasticiser may be used to improve the workability of fresh low-calcium fly ash-based geopolymer concrete. However, the content of the super plasticiser not be more than 2% of the mass of fly ash.

## 3. Materials and Methodology

The materials used for this research are aggregates, fly ash and cement. All these materials are mixed in a proper mix design and then the tests are done. The mix design is given below in the table and the tests results are given in the result section.

1) After these studies, make a mix design of M-25 grade of concrete (I.S.: 10262:2009) and addition fly ash with the replacement of cement in the concrete mix design.
2) Fly ash will be replace as percentages of 5%, 10%,15% in the design mix and check the compressive strength and tensile strength after 7, 14 and 28 days.
3) Fly ash gives the long terms effective results. The summary of the works are given in the table in result section and take the average value of three specimens.
4) The table for mix design given below is for casting of 3 cubes.

| % replacement | Fly ash in (gm) | Cement in (kg) | Coarse sand in (kg) | Aggregates in (kg) | |
|---|---|---|---|---|---|
| | | | | 10 mm | 20 mm |
| 5 | 250 | 4.75 | 6 | 6.70 | 4.50 |
| 10 | 500 | 4.50 | 6 | 6.70 | 4.50 |
| 15 | 750 | 4.25 | 6 | 6.70 | 4.50 |

## 4. Result

### 1) Sieve analysis of aggregates

The sieve analysis of aggregates is done as per IS: 2386 (Part I) – 1963. And the results are shown below in table.

| Sieve size | Mass retained In gm | % retained | Cumulative % retained | Cumulative % passing |
|---|---|---|---|---|
| 20mm | 0 | 0 | 0 | 100 |
| 16mm | 52 | 5.2 | 5.2 | 94.8 |
| 12.5mm | 536 | 53.6 | 58.8 | 41.2 |
| 10mm | 320 | 32 | 90.8 | 9.2 |
| 4.75mm | 92 | 9.2 | 100 | 0 |
| Total | 1000gm | | | |

**2) Impact value test**

This test is used to determine the toughness of aggregates. This test is done as per IS: 2386 (Part IV) – 1963. The result of this test is given below.

Weight of sample (W1) =350 gm
Weight of aggregate after sieving through 2.36mm sieve (W2) =60 gm
Impact value= W2÷W1×100 %
= 60÷350×100
= 17.14 %

**3) Workability tests**

Workability of concrete is the property of freshly mixed concrete which determines the ease and homogeneity with which it can be mixed, placed, consolidated and finished. The following tests are done for workability.

**a) Slump cone test and flow test**

| Test | Percentage replace | Result |
|---|---|---|
| Slump cone value in (mm) | 0 | 72 |
| | 5 | 61 |
| | 10 | 48 |
| | 15 | 28 |
| Flow test value in (%) | 0 | 105 |
| | 5 | 115 |
| | 10 | 113 |
| | 15 | 11 |

**b) Vee-Bee test and compaction factor value test**

| Test | Workability description | Percentage of fly ash | | | |
|---|---|---|---|---|---|
| | | 0 | 5 | 10 | 15 |
| Vee-Bee test value in (sec.) | Extremely dry | 28 | 32 | 30 | 29 |
| | Very stiff | 15 | 18 | 17 | 16 |
| | Stiff | 6 | 10 | 8 | 7 |
| | Stiff plastic | 2 | 5 | 4 | 3 |
| | Plastic | 1 | 3 | 2 | 2 |
| Compaction factor value | Very low | 0.78 | 0.75 | 0.72 | 0.71 |
| | Low | 0.85 | 0.82 | 0.80 | 0.78 |
| | Medium | 0.92 | 0.89 | 0.88 | 0.86 |
| | High | 0.95 | 0.94 | 0.91 | 0.90 |

**4) Compressive strength test**

Under this test the cube which are casted at the site are placed in machine to measure the strength of the cubes at different days. The test results at different days for different cubes are given below for different percentages of fly ash.

| Percentage replacement | Compressive strength (N/mm²) | | |
|---|---|---|---|
| | 7 days | 14 days | 28 days |
| 0 | 20 | 26 | 35 |
| 5 | 21.2 | 28.35 | 38.40 |
| 10 | 20.84 | 27.28 | 37.36 |
| 15 | 20.35 | 26.17 | 36.84 |

## 5. Conclusion

1) Use of fly ash improves the workability as well as the strength of concrete.
2) The workability of concrete increased with the addition of fly ash but at 5% it is maximum as compared to the 10% and 15%. But no addition of fly ash in concrete in place of cement has less workability than 5%, 10% and 15%.
3) Compressive strength of concrete also increases with the addition of fly ash in concrete in place of cement. As the above tests results shows that the addition of 5% of fly ash has maximum with respect to the 10% and 15% addition of fly ash in place of the cement. Beyond 5% the strength of the concrete decreases at 10% and 15% but the strength at these percentages is greater than the 0% addition of fly ash.

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