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Experiment on Properties of Concrete Prepared with Partial Replacement of Fly Ash with Cement

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Abstract – **There has been lot of researches took place over using fly ash as additive in cement, admixture in concrete and cement replacement material in concrete. In this paper we discuss about the potential for using fly ash as a supplementary cementitious material. Fly ash has been used as a replacement of cement in concrete at levels ranging from 5% to 20% of mass of the cement. Different grades of concrete mixes with varying percentage of fly ash content prepared and the mechanical properties of the concrete have been investigated. Theexperimental results show that compressive strength of concrete was measured for 7, 28days and compaction factor is taken as a measure of workability. A different comparative study is done consisting of rate and strength as parameters. Compressive strength of concrete at different proportions of cement being replaced by fly ash has been checked and results have been found effective and applicable. Hence, a comparative study is done and use of fly ash as a cement replacement in concrete can be analysed and compared. This experiment aims to study the effects of Fly ash as partial replacement of cement in concrete and ascertain the optimum proportion of fly ash for different grades of concrete which is acceptable, applicable and economical. This paper studies the variation in compressive strength of different grades of concrete at different percentages of fly ash.**

Keywords – **fly ash, compressive strength, flexural strength, split tensile strength, workability, waste material.**

I. INTRODUCTION

The present day, the world is facing the construction of very challenging and difficult civil engineering structures. There has been a lot of research over using fly ash as additive in cement, admixture in concrete and cement replacement material in concrete. The vast majority of waste fly ash material generated each year is held in ash dams or similar dumps. This unproductive use of land and the associated long-term financial burden of maintenance has led to realization that alternative uses for fly ash as a value-added product. Utilisation of fly ash in the construction industry is one of the most suitable methods of fly ash disposal in large quantity. The aim of looking at new areas that will expand the positive reuse of fly ash, thereby helping to reduce the environmental and economic impacts of disposal.

II. MATERIALS AND ITS PROPERTIES

Material needed for the concrete are cement, fine aggregate (sand), course aggregate (broken stone), fly ash, water. The materials used for the project is collected and made sun dried before usage.

a) Cement

Cement is a fine, grey powder. It is mixed with water and materials such as sand, gravel, and crushed stone to make concrete. Cement and water form a paste that binds the other materials together as the concrete hardens Portland Pozzolanic Cement (PPC) contains two basic ingredients namely argillaceous and calcareous. In argillaceous materials clay predominates and in calcareous materials calcium carbonate predominates.

b) Fine Aggregate

The particles that are passing through 4.75mm sieve is called as fine aggregate. It may be the natural sand deposited by rivers, crushed stone sand or crushed stone sand or crushed gravel sand. The river sand issued as fine aggregate conforming to requirements ofIS:383-1970 comes under zone II.

c) Coarse Aggregate

The particles that are retained on 4.75mm sieve are called as coarse aggregate. It may be gravel, crushed stone and broken stone bricks. It sieves is greater than 4.75mm. The fraction of aggregates used in the experimental work passed in 20mm sieve and retained on 10mm IS sieve comes under Zone II aggregates conforming to IS: 383-1970.

d) Fly Ash

Fly ash is a pulverized product from thermal power plants generated by the burning of coal. Class F are generally low-calcium fly ashes with carbon contents less than 5% but sometimes as high as 10% Class C fly ash has a higher percentage of calcium oxide and is more commonly used for structural concrete. Class C fly ash normally is composed of high-calcium fly ashes with carbon content less than 2%.

e) Water

Water conforming to the requirements of IS: 456-2000 is found to be satisfactory for making concrete. It is generally stated that water fit for drinking is suitable for making concrete.

TABLE I PHYSICAL PROPERTIES OF CEMENT

Sl.no.	Property	Cement
1	Specific Gravity	3.31
2	Initial Setting Time	42mins
3	Final Setting Time	487mins
4	Fineness Modulus	3%
5	Standard consistency	31%

TABLE II CHEMICAL COMPOSITION OF FLY ASH

Chemical composition (%)	Fly ash
Silicon dioxide	56.2
Aluminium oxide	32.4
Calcium oxide	2.5
Magnesium oxide	1.7
Iron oxide	3.4
Sodium oxide	0.4
Potassium oxide	1.5

III. EXPERIMENTAL CONDITIONS

a) Concrete Mixes

Mix proportion for M30 grade concrete used in this study was 1: 1.5: 2.5 conforming to IS 10262-2009 with water-cement ratio of 0.45. Cement is partially replaced by fly ash at 0%,10%,15% and 20%.After the analysis of the best proportion of the concrete the steel scrap is added to concrete for the preferred proportion by the total volume of the concrete.

b) Preparation of Test Specimen

Weight batching of materials and hand mixing of concrete were adopted. After thorough mixing, the concrete was placed into the moulds which were properly oiled. After mixing of concrete in moulds, proper compaction by hand was given. Cubes of size 150*150*150mm, cylinders of size 150mm diameter and 300mm length, prism of size 500mm*100mm*100mmwere casted. Demoulding of specimen was done after 24 hours of casting and specimens were cured in water tank for 7 and 28 days.

IV. TESTS AND RESULTS

a) Compressive Strength Test

Compressive strength test was conducted to calculate compressive strength developed in concrete specimens containing fly ash individually at 7 and 28 days respectively. Cube mould casted was used for this test. It was done on compressive testing machine (CTM) having loading capacity 2000kN.

TABLE III COMPRESSIVE STRENGTH

S.No	Specimen	7 Days (N/Mm²)	28 Days (N/Mm²)
1	FA0	19.36	32.27
2	FA5	20.60	33.72
3	FA10	22.56	35.81
4	FA15	23.90	36.78
5	FA20	20.71	34.52

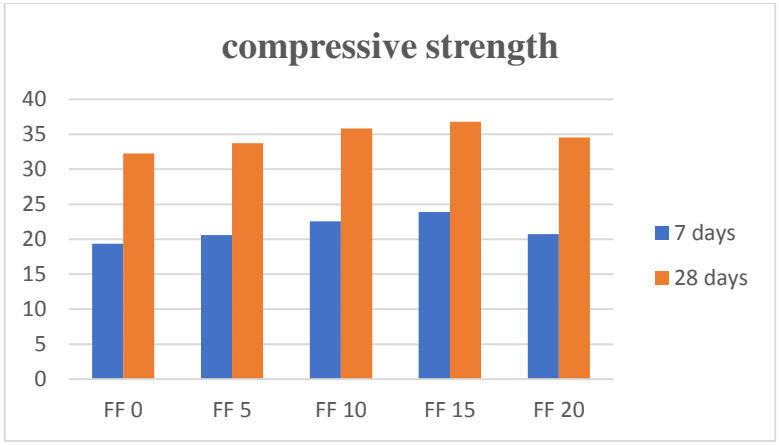

Fig. 1. Compressive Strength Test

b) Split Tensile Strength

The split tensile strength of concrete is one of the basic and important properties. This test on concrete cylinder is a method to determine the tensile strength of concrete.

TABLE IV SPLIT TENSILE STRENGTH

S.no	Specimen	7 days (n/mm²)	28 days (n/mm²)
1	FA0	1.01	1.68
2	FA5	1.08	1.78
3	FA10	1.14	1.91
4	FA15	1.34	2.13
5	FA20	1.11	1.77

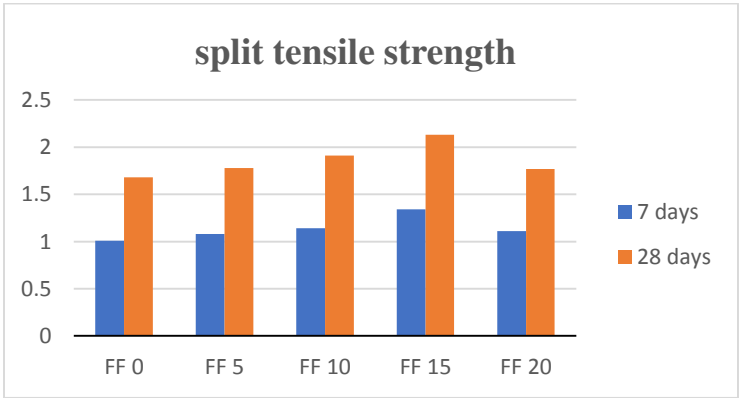

Fig. 2. Split Tensile Strength

c) Flexural Strength

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 6 x 6-inch (150 x 150 mm) concrete beams with a span length of at least three times the depth

TABLE V FLEXURAL STRENGTH

S.no	Specimen	28 days (n/mm²)
1	FA0	2.89
2	FA5	3.23
3	FA10	4.33
4	FA15	5.78
5	FA20	4.91

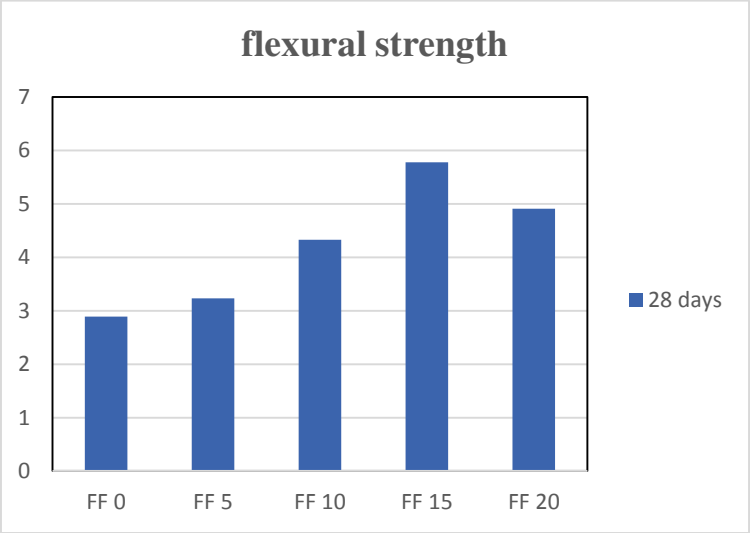

Fig. 3. Flexural Strength

V. CONCLUSION

Based on the experimental work carried out, the following conclusions have been made;

1. Fly ash can be used as a replacement of cement because of its tendency to form C-S-H gel on reaction with Calcium hydroxide.
2. Bleeding in fly ash concrete is significantly reduced and other properties like cohesiveness, pumping characteristics and surface finish are improved.
3. Compressive strength test, split tensile test and flexural strength test are carried out.
4. FA15 shows 15% increase of compressive strength compare to FA0. This may be due to pozzolanic reaction between concrete.
5. The split tensile and flexural strength for FA15 also exhibits an increase of 21% & 27% compare to FA0.

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