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Laboratory Analysis of Fly Ash Mix Cement Concrete for Rigid Pavement.

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ABSTRACT
This experiment was conducted to investigate the engineering properties of fly ash cement concrete for rigid pavement construction. Results have shown that 30% of fly ash and 70% of cement has a superior performance. In addition, the use of fly ash would result in reduction of the cost of cement which is usually expensive in all construction materials. High strength of concrete can be made by this and the further integration of admixture or alternate adds to improve the properties of concrete. Test result of specimens indicates that the workability and strength chacteristcs are changed due to incorporation with fly ash. Slump test having an appropriate workable mix of a concrete, gave sufficient compressive strength and flexural strength. Test results of 28 days specimens have graphically interpolated for the different results and so that to calculate the optimum content of fly ash.
Keywords: Fly ash, concrete mix, construction material, rigid pavement.

I. INTRODUCTION

The use of concrete has recently gained popularity as a resource-efficient, durable and cost effective. A concrete mix with fly ash can provide environmental and economical benefits. Fly Ash concrete enhances the workability, compressive strength, flexural strength and also increases its pumpability, durability and concrete finishing. It also reduces corrosion, alkali silica reaction, sulphate reaction shrinkage as it decreases its permeability and bleeding in concrete.The disposal of fly ash is a serious environmental problem. In India, 110 million of fly ash is produced and 2-30 percent is used and rest occupies vast tracks of valuable land as a pond.

The fly ash used in concrete industry by partly replacement it with cement and also in embankment for filling the material.Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. These industrial wastes are dumped in the nearby land and the natural fertility of the soil is spoiled.

Cement with fly ash reduces the permeability of concrete and dense calcium silicate hydrate (C–S–H). Past Research shows that adding fly ash to concrete, as a partial replacement of cement (less than 35 percent), will benefit both the fresh and hardened states. While in the fresh state, the fly ash improves workability. This is due to the smooth, spherical shape of the fly ash particle. The tiny spheres act as a form of ball bearing that aids the flow of the concrete. This improved workability allows for lower water-to-cement ratios, which later leads to higher compressive strengths. In the hardened state, fly ash contributes in a number of ways, including strength and durability. While fly ash tends to increase the setting time of the concrete. The pozzolanic reaction removing the excess calcium hydroxide, produced by the cement reaction, and forming a harder CSH.

This paper presents the effect of fly ash replacement on compressive strength and flexural strength of concrete along with the slump and other fresh and hardened properties. A comparative cost investigation with different replacement of fly ash has presented.

II. METHODOLOGY & EXPERIMENTAL PROGRAM

I.Fly Ash

Fly ash is composed of the non-combustible mineral portion of coal. Particles are smooth, round ‘ball bearings’ finer than cement particles. Sizes of particle are 0.1Gm-150 Gm. It is a pozzolanic material which reacts with free lime in the presence of water, converted into calcium silicate hydrate (C-S-H) which is the strongest and tough portion of the paste in concrete. The fly ash for testing purpose is collected from industrial area Mandideep near Bhopal, Madhya Pradesh.

Fig.1: Sample of Fly Ash.

II. Cement

The cement used for experimental purpose is Ordinary Portland Cement (OPC). The Ordinary Portland Cement of 43 grade (Ultra Tech OPC) conforming to IS:8112-1989 is used.The cement is in dry powdery form with the good quality chemical compositions and physical characteristics. Many tests were conducted on cement; some of them are specific gravity, consistency tests, setting time tests, compressive strengths, etc.

S.No.	Physical Properties of Cement	Result	Requirement as per I.S Code (IS:8112-1989)
1	Specific Gravity	3.15	3.10-3.15
2	Standard Consistency (%)	28%	30-35
3	Initial Setting Time (Min)	35 Min	30 Minimum
4	Final Setting Time (Min)	178 Min	600 Maximum
5	Compressive Strength-7Days	28.38 N/mm^2	33 N/mm^2
6	Compressive Strength-28Days	42.31N/mm^2	43N/mm^2

Table.1: Properties of Ultra Tech Cement (OPC 43 grade).

III. Aggregates

Aggregates are the chief constituents in concrete. They give body to the concrete, decrease shrinkage and achieve economy. One of the most significant factors for producing feasible concrete is good gradation of aggregates. Good grading implies that a samplefractions of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste means less quantity of cement and less water, which are further mean increased economy, inferior shrinkage and superior durability.

Coarse Aggregate

Crushed stone were used as coarse aggregates; the fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 are used. The Flakiness Index and Elongation Index were maintained well below 15%.

Fine aggregate

Locally available Narmada River sand was used as fine aggregates. Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. The river sand and crushed sand is used in mixture as fine aggregate conforming to the requirements of IS: 383. The river sand is washed and screened, to abolishdeadly materials and over size particles.

S.No	Test	Fine Aggregate	Coarse Aggregate	
			20 mm	**10 mm**
1	Fineness Modulus	3.36	7.54	3.19
2	Specific Gravity	2.60	2.70	2.70
3	Water Absorption (%)	1.50	0.50	0.50
4	Bulk Density (gm/cc)	1753	1741	1711

Table.2: Properties of Aggregates.

IV. Water

Water is an important constituent of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Water which is pure and safe for drinking purpose is used and water cement ratio was 0.42 for design mix M30.

III. Mix Design

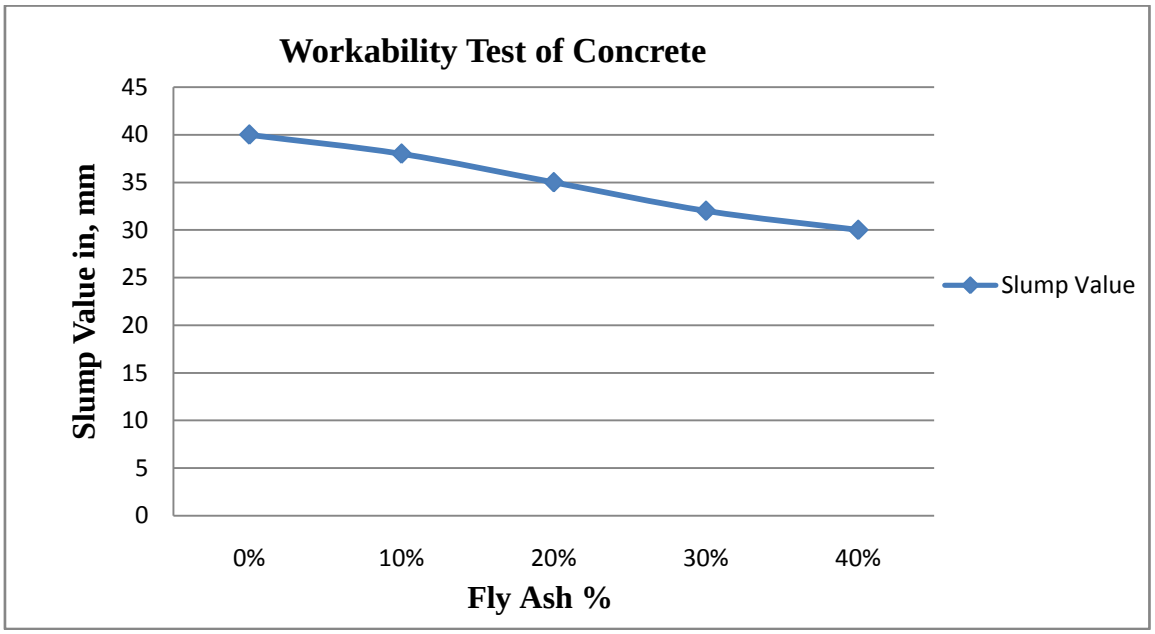
The preferred characteristic strength of 30 N/mm^2 at 28 days was used in this study. IS 456 method was applied in designing the mix. A total of 45 cubes and 30 beams were prepared for this study in 5 sets. All set were prepared in control mix of water cement ratio 0.42. Three samples from each set of the mix were tested at the age of 7, 14, and 28 days for compressive strength and 7 and 28 days for flexural strength.

Preparation of Specimen:

All concrete mixes were prepared using a motorized mixer of mix design proportion, 1:1.27:2.83 with constant water cement ratio of 0.42. Cube specimens are prepared of size 150mm×150mm×150mm and Beam specimen of 100mm×100mm×500mm. The specimens were cured in a curing room at 30ºC temperature and 90% relative humidity. Fly Ash mix concretes were tested at 7, 14 and 28 days of age to get compressive strength and 7 and 14 days for flexural strength values.

Details of Cube Specimen				Details of Beam Specimen			Slump Value (%)
S.No	**Name of Cube Sample**	**Fly Ash (%)**	**Weight of Fly Ash in Mix (gm)**	**Name of Beam Sample**	**Fly Ash (%)**	**Weight of Fly Ash in Mix (gm)**	
1	C 0	0	00	B 0	0	00	40
2	C 10	10	156	B 10	10	235	38
3	C 20	20	312	B 20	20	470	35
4	C 30	30	468	B 30	30	705	32
5	C 40	40	624	B 40	40	940	30

Table.3: Details of specimens prepared for test.



Graph.1: Workability test of concrete mix with different percentage of Fly Ash.


Figure.2: Curing of Specimens.

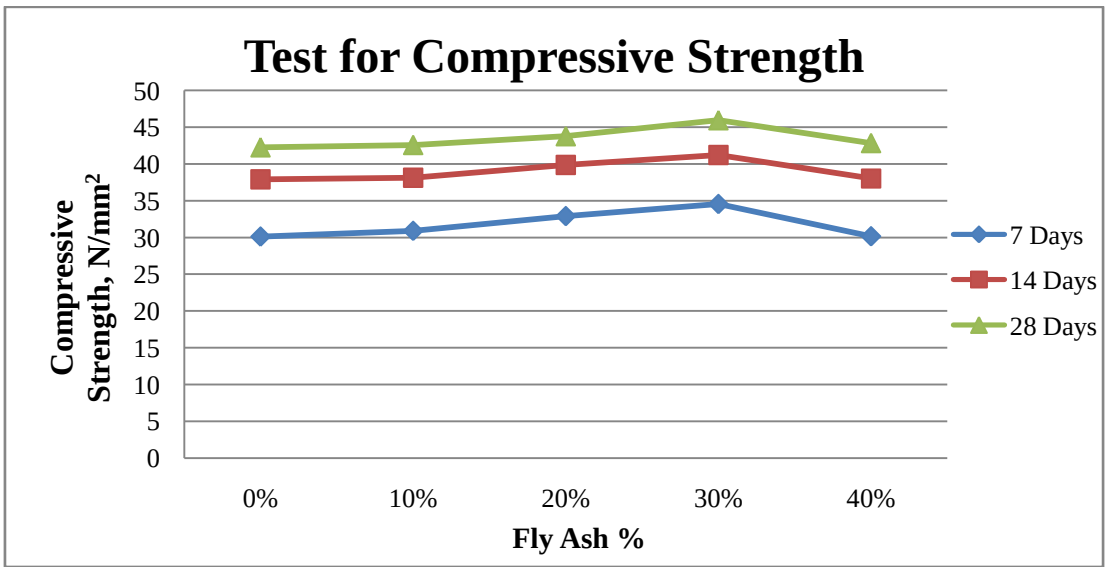

Figure.3: Specimen Prepared for test.

Testing of Specimen:

The compressive strength and flexural strength of all concrete specimens was determined following Indian standard testing procedure [IS 516:1959]. The specimens were removed from the moulds after 24 hours and subsequently immersed in water for different age of testing. For each test three specimens were tested for the determination of average compressive and flexural strength. Test was performed on compression testing machine having capacity of 200 MT. The compressive strength tests was conducted on a Compression testing machine and flexural strength was carried on third point loading machine.Average value of samples has been reported below.

S.No	Cube Sample Name	Fly Ash %	7 Days Strength N/mm^2	14 Days Strength N/mm^2	28 Days Strength N/mm^2
			Average of Three Samples		
1	C 0	0	30.11	37.89	42.27
2	C 10	10	30.89	38.12	42.59
3	C 20	20	32.90	39.88	43.78
4	**C 30**	**30**	**34.55**	**41.22**	**45.95**
5	C 40	40	30.15	38.00	42.85

Table.4: Test Results of Compressive strength.

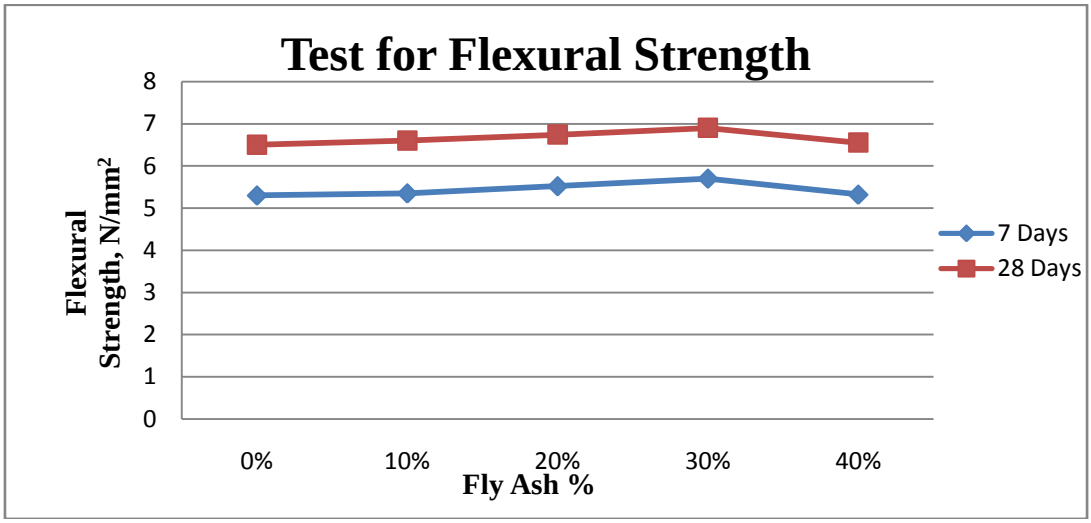


Graph.2: Compressive strength test of concrete mix with different percentage of Fly Ash.

Figure.4: Testing of concrete cube in compression testing machine.

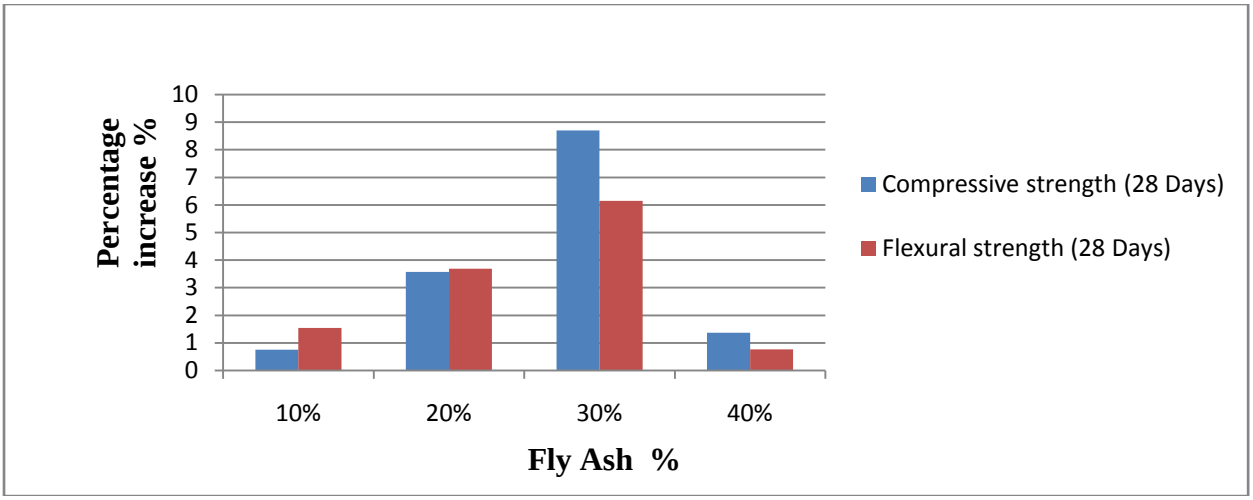
S.No	Beam Sample Name	Fly Ash %	7 Days Strength N/mm^2	28 Days Strength N/mm^2
			Average of Three Samples	
1	B 0	0	5.30	6.50
2	B 10	10	5.35	6.60
3	B 20	20	5.52	6.74
4	**B 30**	**30**	**5.70**	**6.90**
5	B 40	40	5.32	6.55

Table.5: Test Results of Flexural strength.



Graph.3: Flexural strength test of concrete mix with different percentage of Fly Ash.

The compressive strength of the concrete cubes had been tested at the interval of 7, 14 and 28 days. It seems that the strength goes on increasing with the increase in fly ash but after the replacement of 40% Fly Ash with Cement the strength decrease. The flexural strength of concrete is tested at the interval of 7 and 28 days and it is seemed that flexural strength goes on increase up to 30% replacement. The strength variation is more on compressive as compared to flexural strength .



Graph.4: 28 Days percentage increase of strength with different percentage of Fly Ash.

IV. Conclusions

- The workability of concrete decreases with the increase in fly ash, the particles of Fly ash reduces the amount of water required to produce a given slump. The circular shape of the fly ash particles and its dispersive ability provide water reducing characteristics.
- The compressive strength and flexural strength increases with the increase of fly ash in concrete up to 30% replacement with cement in conventional mix, however the compressive strength increases more as compared to flexural strength, the values are acceptable as per IRC.
- Mixing of fly ash in concrete conventional mix has resulted in considerable variation in the properties of fresh concrete. Integration of fly ash in concrete increased the cohesiveness of the mix, prohibited segregation and resulted in reduced bleeding. Higher percentages of fly ash can cause a change in color of the mix.
- Incorporation of fly ash in concrete can save the coal & thermal industry disposal costs and produce a 'greener' concrete for construction.
- The research can be conducted further on higher grades of concrete or integration of such waste material by which more impact can be created improvement of strength.

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