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Study and Analysis of Rigid Pavements Using Fly Ash

Vallabuni Vinay Kalyan¹, P.Sandeep Chandra² Mohammed Ibrahim³,

B.Tech Student, Department of Civil Engineering, MRITS College, Maisammaguda, Dulapally, Secunderabad, DIST. Medchal, India¹

Assistant Professor, Department of Civil Engineering, MRITS College, Maisammaguda, Dulapally, Secunderabad, DIST. Medchal, India^{2,3}

ABSTRACT: This paper attempts the investigation on the use of fly ash in cement concrete industries. In developed countries use of mineral admixtures such as fly ash and silica fume and rice husk ash etc has already adopted in making concrete. This includes commercial application on large scale either for addition or for replacement of cement. In India too much replacement has already been programmed and adopted with the introduction of ready mixed concrete and the process has been accelerated in recent times, in order to effect the economy in construction. An investigation was undertaken to study the effects of fly ash in concrete. In this paper Mechanical properties at different levels of replacements were found. Fly ash from Vijayawada thermal power station, Vijayawada, A.P is proposed for the study. Cement replacement levels by fly ash were 0, 20, 30, 40, 50 and 60 percents are proposed for analysis in this project work. As quality criteria, Compressive strengths of cubes at the ages of 3, 7, and 28, days were determined as per the normal Code practices. The results are presented in the relevant tables and graphs. The performance of the designed mixes using fly ash content is good enough and the results are presented for kind recommendation to the various cement concrete industries.

KEYWORDS: Ordinary Portland Cement, Fly Ash, Concrete.

I. INTRODUCTION

Concrete is a composite construction material composed primarily of aggregate, cement and water. There are many formulations that have varied properties. The aggregate is generally coarse gravel or crushed rocks such as limestone, or granite, along with a fine aggregate such as sand. The cement, commonly Portland cement, and other cementitious materials such as fly ash, serve as a binder for the aggregate.

Various chemical admixtures are also added to achieve varied properties. Water is then mixed with this dry composite which enables it to be shaped (typically poured) and then solidified and hardened into rock-hard strength through a chemical process known as hydration. The water reacts with the cement which bonds the other components together, eventually creating a robust stone-like material. Concrete has relatively high compressive strength, but much lower tensile strength. For this reason is usually reinforced with materials that are strong in tension (often steel). Concrete can be moulded by many processes, such as the freezing of trap Concrete is widely used for making architectural structures, foundations, brick/block walls, pavements, bridges/overpasses, motorways/roads, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences and poles and even boats. Famous concrete structures include the BurjKhalifa (world's tallest building), the Hoover Dam, the Panama Canal and the Roman Pantheon ped water. Fly ash is the ash produced in small dark flecks by the burning of powdered coal or other materials and carried into the air.

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II. LITERATURE REVIEW ON FLY ASH

S.K. Kaushik discussed quality of Indian fly ashes in general and parameters involved in production of ternary blend concretes with high fly ash contents. Experimental test results of the authors for a high slump 80-90 Mpa strength concrete with low calcium fly ash contents almost equal to those of cement are discussed. Flow ability addition, pore refinement and strengthening effects due to fly ash. Developments of poly carboxylate based super plasticizers have helped in achieving Flow ability with low water-binder ratio concretes containing high volume of fly ash.

N.P. Rajamane, J. Annie Peter and S. Gopala Krishna (2) investigated concrete with 28 day compressive strengths of about 85 Mpa and 105 Mpa were taken and a cement replacement level (CRL) of about 25 % was considered; these concretes were blended with both GGBS and silica fume keeping the total CRL at 25 %. The 90 day compressive strength of 94 to 116 Mpa was achieved. The use of Pozzolanas such as Ground Granulated Blast Furnace Slag (GGBS) and silica fume (SF) in cement concrete, individually as mineral admixture (MA).

M.M. Prasad (3) investigated the effect of 17%, 22%, 27% and 32% cement replacement by fly ash and silica fume on conventional M20 grade of concrete. M20 grade Of concrete has been considered as reference mix. Specimens are cast and cured normally for 28 days and then tested for flexural strength and split tensile strength to failure as per IS specifications and the results have been compared. The test results shows that the flexural and split tensile strength of fly ash-silica fume concrete containing up to 27% fly ash plus silica fume are comparable to that of conventional concrete.

ACI committee 226 reports, in this report briefly describe the physical, chemical and pozzolanic properties of silica fume. Methods of using silica fume in concrete are mentioned and the properties of fresh and hardened concrete incorporating it are described. The durability of silica fume concrete is discussed and the limitations of its use in concrete are outlined. The report is concluded by testing research needs.

S. Gopala Krishna (5) carried out experimental investigations at SERC, Chennai, to study the role of Supplementary Cementitious

Materials (SCMs) in concrete mixtures. Details of typical concrete of M40 grade mixtures, which were studied incorporating SCMs at different cement replacement levels, their strength and durability properties are given in this paper. Based on results of the study, it is demonstrated that it is possible to produce concrete mixtures having desired strength development and durability properties using SCMs available in India.

In this paper an attempt has been made to study the strength parameters of concrete using fly ash as a partial replacement of cement.

III. EXPERIMENTAL PROCEDURE

A. Materials Used:

(i). **Cement:** Ordinary Portland cement of conforming to ISI standards IS:8112-1989 has been used. In order to avoid the possible variation in the properties of cement from various batches all the specimens are prepared from the same batch of cement.

The results of tests concluded on cement are given in table 1 below

Table 1: Physical properties of cement

S. No.	PROPERTY	VALUE	REQUIREMENTS AS PER IS CODES2386
1	Cement	PPC	-
2	Grade	53	-
3	Fineness	2%	Not >10% as per IS:2386 part 1
4	Specific gravity	3.0	IS:2386 part 3 (2-3.15)
5	Standard	31%	Should be <35% as per

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	consistency		IS:2386 part 3
6	Initial Setting Time	41 Minutes	Not < 30 minutes as per IS:2386 part 3
7	Final Setting Time	240 Minutes	Not >600minutes as per IS:2386 part 3

(ii). Fly ash:

Fly Ash used in the present experimental study was obtained from Vijayawada thermal power station, Vijayawada.

(iii). Aggregates

1. Fine Aggregate:

Locally available sand has been used as fine aggregate. The sand is free from clayey matter, silt and organic impurities and that sand confirms to zone-I. (or The fine aggregate was standard river sand procured locally and was conforming to zone II .The fine Aggregate was selected as per code IS 2386 part II .100% of particles taken has passed from 4.75 mm and retained on 100 microns is used. The physical properties of Fine Aggregate are given in table 2 below.

Table 2 :- Physical properties of Fine Aggregate

S. No.	PROPERTY	VALUE	REQUIREMENTS AS PER IS CODES2386-1963
1	Fine Aggregate	Sand	1963
2	Specific Gravity	2.58	2.6-2.8
3	Water Absorption	0.25%	Should not be more than 1% for construction
4	Density	1500 kg/m ³	Not>1550kg/m ³
5	Fineness Modulus	2.74	2.6-2.9

2. Coarse Aggregate:

Coarse aggregate of 20 mm nominal size machine crushed angular granite metal from local source has been used in the experimental work. The Physical properties of the coarse aggregate are shown in table 3 below.

Table 3:- Physical properties of coarse aggregate

S.no	Property	Value	Requirements as Per IS 2386-1963 part- III
1	Specific Gravity	2.71	2.6 to 2.8
2	Water Absorption	0.33%	Should not be > 1%
3	Fineness Modulus	7.78	6.5-8.5

(iv) Water:

Locally available potable water which is free from concentration of acids and organic substances has been used in this work.

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B. Mix Design For M40 Grade Concrete: (as per ISI 10262-2009)

Characteristic compressive strength required in the field at 28 days

(f_{ck})= 40 Mpa

$$\begin{aligned} \text{Target mean strength of concrete}(f_m) &= f_{\min} + k_s \\ &= 40 + 1.65 \times 5 \\ &= 48.25 \text{ N/mm}^2 \end{aligned}$$

Water/cement ratio = 0.4

Selection Of Water And Sand Content:

For 20mm maximum size aggregate sand conforming for grading zone 2,

water content per cubic meter of concrete = 186 kg.

sand content as percentage of total aggregates by absolute volume = 35%.

Required sand content as percentage of total aggregates by absolute volume

$$= 35 - 3.5 = 31.5 \%$$

Required water content = $186 + 186 \times 3 / 100 = 191.58 \text{ kg/m}^3$

Determination Of Cement Content:

Water-cement ratio = 0.4

Water = 191.58 lts

Cement = $191.58 / 0.4 = 478.94 \text{ kg/m}^3$

Determination Of Coarse And Fine Aggregate Contents:

$$V = [w + C/S_c + 1/P * F_a/S_{fa}] * 1/1000$$

$$C_a = [(1-P)/P * F_a * S_{ca}/S_{fa}]$$

Where:

V = Absolute volume of fresh concrete, which is equal to gross volume (m³).

w = Mass of water (kg) per m³ of concrete

C = Mass of cement (kg) per m³ of concrete

S_c = Specific gravity of cement

P = Ratio of Fine aggregate to total aggregate by absolute volume

F_a, C_a = Total masses of F.A & C.A (kg) per m³ of concrete

S_{fa}, S_{ca} = specific gravity of saturated, surface dry fine & coarse aggregate

$$0.98 = (W + c/S_c + 1/P * F_a/S_{fa}) * 1/1000$$

$$980 = (191.58 + 478.94/3.08 + 1/0.308 * F_a/2.58)$$

$$F_a = 516.67 \text{ kg/m}^3$$

$$C_a = \{(1 - 0.308)/0.308\} \times 516.67 \times 2.8/2.58 = 1259.81 \text{ kg/m}^3$$

MIX PROPORTIONS:

The mix proportion considered as follows

Water content = 0.4

Sand = 1.53 kg

Cement = 1 kg

Coarse aggregate (10 mm) = 2 kgs

Coarse aggregate (20 mm) = 1.33 kgs

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IV. TESTS CONDUCTED

i) Compressive strength:

Compressive strength of concrete is the most important parameter and representative of overall quality of concrete. It mainly depends upon the water/cement ratio of the mix and curing and age after it is cast. Compressive strength of concrete is determined by testing the cylindrical or cubical specimens of concrete using a compression testing machine, at various age such as: 3,7 and 28 days.

Procedure for finding Compressive Strength of Concrete:

- Compression test is done as per IS:516-1959
- All the concrete specimens were tested in a 2000KN capacity compression-testing machine.
- Concrete cube of size 150mm X 150mm X 150mm is placed on Compressive Testing Machine and grip it firmly between top and bottom plates.
- Apply the load at the rate of 140 kg/sq.cm/minute till the specimens failed.
- Note down the ultimate load at the failure of specimen, when the load is applied.
- Divide the ultimate load by the area of specimen ,
- Then the compressive strength has been calculated.

Compressive Strength has been calculated by using formula:

$$\sigma_b = \text{Load/Area in N/mm}^2$$

ii) Split Tensile Strength:

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete member may crack. The cracking is a form of tension failure.

Apart from the flexure test the other methods to determine the tensile strength of concrete can be broadly classified as:

- Direct methods and
- Indirect methods

The direct methods suffers from a number of difficulties related to holding the specimen properly in the testing machine without - introducing stress concentration, and to the application of uni-axial tensile load which is free from eccentricity to the specimen. Because the concrete is weak in tension even a small eccentricity of load will induce combined bending and axial force condition and concrete fails at the apparent tensile stress other than the tensile strength.

Because of the difficulties associated with direct tension test. A number of indirect methods have been developed to determine the tensile strength. In these tests in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses developed in the specimen. The tensile stress at which the failure occurs is termed the tensile strength of concrete. The splitting tests are well known indirect tests used for determining the tensile strength of concrete sometimes referred to as split tensile strength of concrete

Testing of cylinders for split tensile strength:

This test is conducted in a 2000KN capacity compression -testing machine by placing the cylindrical specimen horizontally, so that its axis is horizontal between the plate's of the testing machine. The load is applied uniformly at a constant rate until failure by splitting along the vertical diameter takes place.

Load at which the specimen failed is recorded and the splitting tensile stress is obtained using the formula based on IS:5816-1970.

The following relation is used to find out the split tensile strength of the concrete.

$$F = \frac{2p}{\pi DL} \text{ in N/mm}^2$$

where p = compressive load on the cylinder

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D= diameter of the cylinder
L= length of the cylinder.

V. RESULTS AND DISCUSSIONS

This Compressive and split tensile strength development of Control concrete and Rice husk ash concrete at different curing periods are listed below. The present investigation is based on the IS method for Control concrete.

A. Compressive Strength:

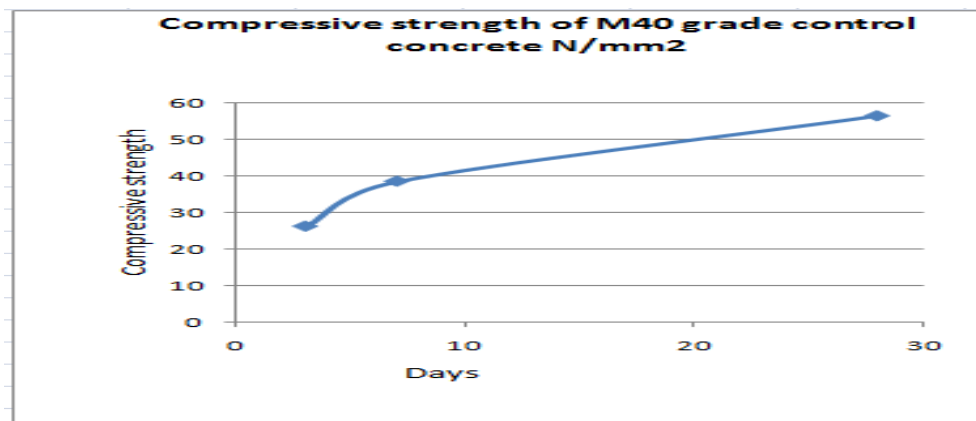
To study the strength development of Fly ash concrete in comparison to Control concrete, compressive strength tests were conducted at the ages of 3, 7, 28 days. The tests results are reported in the table 4 for control concrete and in the table 5 for Fly ash concrete respectively.

i) Compressive Strength of M40 grade Control Concrete:

The strength achieved at different ages namely 3, 7, 28 days for Control concrete are given in the table 4.

Grade of Concrete	3 days	7 days	28 days
M40	26.30	38.64	56.55

From the Graph 1, it is clear that as the age advances, the strength of Control concrete increases. The rate of increase of strength is higher at curing period at 28 days.



Graph 1. Compressive strength of M40 grade control concrete

ii) Compressive Strength of Fly Ash Concrete:

Table 5 represents the variation of compressive strength with age for M40 grade Fly Ash concrete, in this table, variation of compressive strength with age is depicted for each replacement level of Fly Ash considered namely 20%, 30%, 40%, 50% and 60%. Along with the variations shown for each replacement, variations is also shown for control concrete i.e., for 0% replacement.

In each of these variations, it can be clearly seen that, as the age advances, the compressive strength also increases. Graphical representation is also shown below graph 2.

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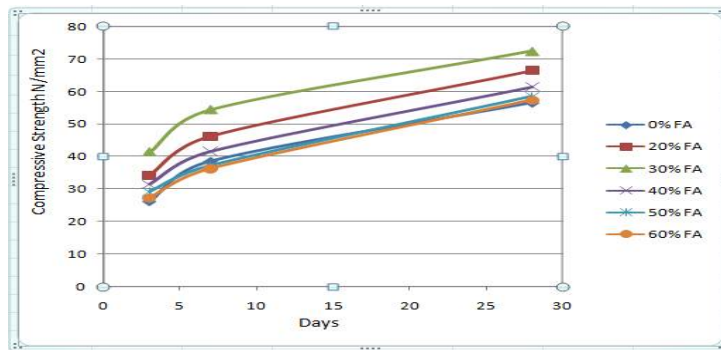
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Table 5. Compressive Strength obtained at different ages with different replacement levels						
Age in days	0% FA	20% FA	30% FA	40% FA	50% FA	60% FA
3	26.30	34.29	41.43	31.52	29.36	27.38
7	38.64	46.29	54.47	41.58	37.36	36.40
28	56.55	66.46	72.40	61.33	58.50	57.40

Graph 2: Compressive strength of M40 grade concrete with different % replacement at different ages



B. Split Tensile Strength:

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete member may crack.

i) Split Tensile Strength of Control Concrete:

The strength achieved at different ages namely 3, 7, 28 and 56 days for Control concrete are given in the table

Table 6. Split tensile strength of M40 grade control concrete N/mm²			
Grade of Concrete	3 days	7 days	28 days
M40	1.17	2.16	3.10

From the Graph 3, it is clear that as the age advances, the strength of Control concrete increases.

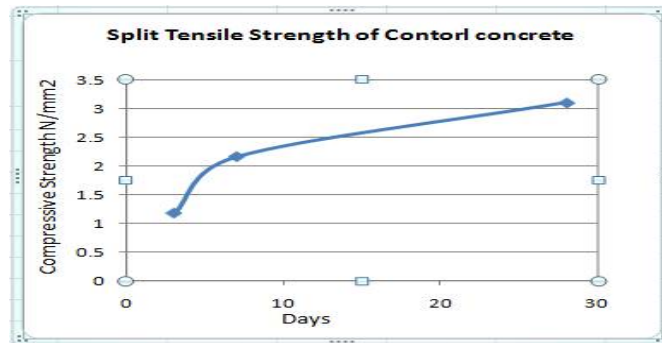
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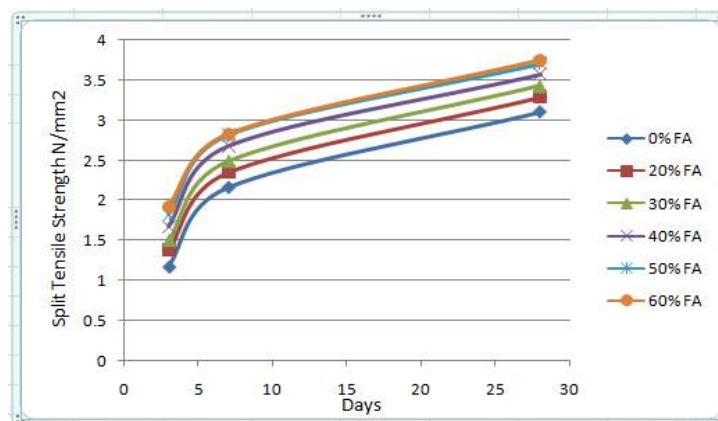
Graph 3. Split Tensile Strength of M40 grade Control Concrete



ii) Split Tensile Strength of Fly Ash (FA) Concrete:

Variation of Split tensile strength with respect to age and percentage of FA and effect of FA percentage on Split Tensile strength of M40 grade concrete is depicted in the table 7.

Table 7. Split Tensile Strength of Concrete with different % replacements of FA at Different ages			
% FA	3 days	7 days	28 days
0%	1.17	2.16	3.10
20%	1.38	2.35	3.29
30%	1.50	2.49	3.43
40%	1.68	2.68	3.57
50%	1.83	2.82	3.71
60%	1.93	2.83	3.75



Graph 4. Split Tensile Strength of Concrete with different % of FA at different ages.

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VI. CONCLUSION

- ❖ The Fly Ash can be suitable substituent's for cement.
- ❖ The required compressive strength of any mix can be obtained with Fly Ash resolving the conventional cement to that extent.
- ❖ Very high strength above the normal required strength of concrete with Fly Ash replacement is noticed.
- ❖ The strengths of the concrete mix cubes are increasing up to 30% fly Ash and then the strengths are decreasing when compared with normal concrete.
- ❖ By this studies/ analysis, M40 grade concrete with the maximum replacement of 30% Fly Ash may be recommended.

VII. FUTURE SCOPE

- ❖ The design can be extended for various other Concrete grades using the Fly Ash replacement to get the required strength values and suitable proportions can be derived and practiced.

REFERENCES

1. ACI Committee 226 (1988) Use of Fly Ash in Concrete.
2. S.K. Kaushik " Quality of Concrete using Fly ash contents " International Conference on Engineering Materials, 1998.
3. N.P. Rajamane, J. Annie Peter and S. Gopala Krishna " Performance of admixtures produced using a new technology as a Mineral Admixture in Concrete," Cement and Concrete Research (2000).
4. M.M. Prasad " Strength Development of Concrete with Fly ash and silica fumes," Cement & Concrete Composites (2002).
5. S. Gopala Krishna " The role of Supplementary Cementitious Materials (SCMs) in concrete mixtures" Cement and Concrete Research 2004.
6. Concrete Technology by M.S.SETTI
7. Concrete Technology by A.R SANTHA KUMAR.
8. Mix design by N. KRISHNA RAJU. CODE BOOKS
9. IS 456-2000
10. IS 10262 - 2009