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Strength and Cost Comparison of Normal and Fly Ash based Concrete

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Abstract: ***A concrete is composite material made from a mixture of broken stone or gravel, sand , cement, and water which can be spread or poured into moulds and forms mass resembling stone on hardening. Most concrete is poured with reinforcing materials embedded to provide tensile strength, yielding reinforced concrete. Fly ash is the finely divided residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. Over 61 million metric tons of fly ash were produced in 2011. Currently, over 20 million metric tons of fly ash are used in annually in variety of engineering applications. Typical engineering application includes, Portland cement concrete, soil and road base stabilization, grouts, structural fill and asphalt fillers. Fly ash utilization, especially in concrete has significant environmental benefits including increasing the life of concrete structure by improving concrete durability. Conservation of others natural resources and materials. Fly ash reduced cracking due to its strength and water content.***

I. INTRODUCTION

In India coal fly ash is coal combustion product that has various application in highway construction. Since the first edition of fly ash facts for highway engineers ie use of fly ash in highway construction has increased and new application have been developed This document provides basic technical information about the various uses of fly in highway construction. Fly ash has been used in roadways and interstate highways since the early 1950s. In 1974, the Federal Highway Administration encourage the use of fly ash in concrete pavement with Notice N 5080.4, which urged states to allow partial substitution of fly ash for cement whenever feasible.

In addition, in January 1983, the environmental protections agency published federal comprehensive procurement guidelines for cement and concrete containing fly ash to encourage the utilization of fly ash and established compliance deadlines. This document is sponcerd by the U.S. Department of transportation through the Federal Highway Administration, in cooperation with the American Coal Ash Association and the United States Environmental Protection Agency. The United States Government assumes no liability for its contents or use. The Federal Highway Administration endorses no products or manufacturers.

This publication does not constitute a standard specification or regulation. The united states environmental protection agency suppose the beneficial use of coal combustion products as an important priority and endorses efforts by the Federal Highway Administration as described in this document.

Fly ash is commonly used as a pozzolan in PCC applications. Pozzolans are siliceous or siliceous and aluminous materials, which in a finely divided form and in the presence of water, react with calcium hydroxide at ordinary temperatures to produce cementitious compounds.

The unique spherical shape and particle size distribution of fly ash make it a good mineral filler in hot mix asphalt (HMA) applications and improves the fluidity of flowable fill and grout.

The consistency and abundance of fly ash in many areas present unique opportunities for use in structural fills and other highway applications. Fly ash utilization, especially in concrete, has significant environmental benefits including:

1) Increasing the life of concrete roads and structures by improving concrete durability,
2) Net reduction in energy use and greenhouse gas and other adverse air emissions when fly ash is used to replace or displace manufactured cement,
3) Reduction in amount of coal combustion product. Fly ash is produced from the combustion of coal in electric utility.

II. OBJECTIVES

The main objective of the present study is to compare the strength characteristics of M45 concrete by using sample of different percentages of fly ash by mass of cementitious material, and also comparison is made between there cost. To achieve this objective following steps are to be followed:

A. Design of M45 concrete mix to obtain the ratio of different components of concrete.
B. By using the above calculated ratio samples for compressive and flexural strength test for 21.62% replacement of cement by fly ash is to be made
C. Compressive strength of 7 and 28 days is to be calculated by casting cubes for M45 mix at 21.62% fly ash replacement by cement.
D. Flexural strength of 7 days is to be calculated by casting beam shaped samples of M45 mix at 21.62% fly ash replacement by cement
E. Comparison of the compressive and the flexural strength obtained at different.
F. Cost comparison of 21.62% fly ash concrete is to be made.

III. SCOPE OF STUDY

The scope of present study aims at providing the M45 concrete with that optimum quantity of fly ash content which could be used in structure or road construction with acceptable strength values so, that the cost of construction can be reduced to a great extent and also by achieving this the harmful impact of fly ash on environment could be reduced.

IV. EXPERIMENTAL PROGRAMME

The following test programmed was planned to investigate the results:

To obtain the physical properties of the concrete constituents i.e. Ordinary Portland cement , fine aggregates, coarse aggregate and fly ash.
Development of various mix combinations for concrete. Casting and curing.
Testing of specimens for Compressive Strength and flexural strength.

V. RESULTS AND DISCUSSIONS

Table 5.1 (a): Compressive strength of M45 concrete for 21.62% Fly Ash content.

Sr.No.	% Of Fly Ash Concrete	Curing Period	Compressive Strength N/mm2	Average Compressive Strength N/mm2
1	21.62%	7	43.77 45.32 44.15	44.41
2	21.62%	28	54.28 53.45 52.32	53.35

Table 5.1(b): Combined Table of Compressive strength of M45 concrete for 21.62% fly ash content.

% Fly Ash Concrete	7Day's Curing (MPA)	28Day' Curing (MPA)
21.62%	44.41	53.35

Table 5.1 (c): Flexural strength of M45 concrete for 21.62% fly Ash content.

Sr. No	% Of Fly Ash Concrete	Curing Period In Day's	Flexural Strength N/mm2	Average Flexural Strength N/mm2
1	21.62%	7	7 6.5 5.5	6.33

VI. COST COMPARISION

Table 6.1: Market Rates of Various Materials of Concrete.

Composition Of Concrete	Current Market Rates
Cement	7 Rs/Kg
River Sand	1.2Rs/Kg
Crush Sand	0.5 Rs/Kg
CA-10mm	0.95 Rs/Kg
CA-20 mm	0.9 Rs/Kg
Fly Ash	2.5 Rs/Kg
Admixture	100.00 Rs/Lit
FACF(Fine aggregate coarse fly ash)	1.0Rs/Kg

Table 6.1 (a): Per Cubic Meter Cost Normal M45 Grade Concrete.

Composition of concrete	Qty cum in Kg	Rate	Cost
Cement	430	7 Rs/Kg	3010/-
River Sand	548	1.2Rs/Kg	657.6
Crush Sand	189	0.5 Rs/Kg	94.5
CA-10mm	416	0.95 Rs/Kg	395.2
CA-20mm	737	0.9 Rs/Kg	663.3
Admixture	4.3	100.00 Rs/L	430
FACF	74	1.0Rs/Kg	74
Total			5323/-

TABLE 6.1 (B): PER CUBIC METER COST OF 21.62% FLY ASH CONTENT M45 CONCRETE

Composition of Concrete	Qty Per Cum in Kg	Rates	Cost
Cement	370	7 Rs/Kg	2590
River Sand	524	1.2Rs/Kg	628.8
Crush Sand	252	0.5 Rs/Kg	126
CA-10mm	447	0.95 Rs/Kg	424.65
CA-20mm	719	0.9 Rs/Kg	647.1
Fly Ash	80	2.5 Rs/Kg	200
Admixture	4.5	100 Rs/Lit	450
Total			5065/-

A. Mix Design Report & Result As Per Basic Available Material

` Concrete mix design report	
Grade of concrete	M45
Maximum size of aggregates, mm	20
Slump of concrete, mm	125 (+/-25mm)
Target mean design strength, n/mm2	53.25
Brand of cement	Ultratech
Type of cement	Opc /53 grade
Specific gravity of cement	3.11
Source of fine aggregates (bhandara sand)	Bhandara, nagpur
Type of fine aggregates	Natural
Specific gravity river sand	2.630
Specific gravity of crushed sand	2.870
Absorption of sand in %	1.2
Absorption of crushed sand % (panchgaon)	2.40
Sand in total aggregate	27%
Crushed sand in total aggregates	13%
Source of coarse aggregates , nagpur	Panchgaon, nagpur
Types of coarse aggregates	Crushed nagpur
Specific gravity of coarse aggregates ,20mm	2.94
Specific gravity of coarse aggregates ,10mm	2.92
Absorption of coarse aggregates 20mm %	0.86
Absorption of coarse aggregates 10mm %	0.97
Coarse aggregate 20 mm in total aggregates	37%
Coarse aggregate 10 mm in total aggregates	23%
Weight average specific gravity for aggregates	2.836
Specific gravity of fly ash	2.2
Fly ash in total cementitious material %	17.7
Specific gravity of admixture	1.09
Specific gravity of bipolar	1.01
Dosage of admixture- basf master polyhead8318in, w/w cement	1.00%

B. Seive Analysis Results

IS Seive Size	Cum% Of Passing			Cum % Of Passing			Total	IS 383 Limit	
	20mm	10mm	R/Sand	20mm	10mm	R/Sand	100	Min	Max
40	100	100	100	37	23	27	100	100	100
25	100	100	100	37	23	27	100	100	100
20	93	100	100	35	23	27	98	95	100
10	5	95	100	2	22	27	64	50	65
4.75	1	4	97	0	1	26	40	30	50
0.6	0	1	43	0	0	11	15	10	35
0.15	0	0	1	0	0	0	1	0	6

C. Test Method & Results As Per Is 4031 (Opc Ultratech 53 Grade)

Sr. No.	Test Conducted	Result	Requirement As Per IS : 269:2015
1	CONSISTANCY	29.5%	Not specified
2	INITIAL SETTING TIME	165 minutes	Shall not be less than 30 minutes
3	FINAL SETTING TIME	225 minutes	Shall not be more than 600 minutes
4	COMPRESSIVE STRENGTH 72+ /-1h 168+/-2h 672+/- 4h	 30.4 Mpa 40.3 Mpa TYC	 Shall not be less than 27 Mpa Shall not be less than 37 Mpa Shall not be less than 53 Mpa
5	FINENESS By Blaines Permeability Method	301m2/Kg	Shall not be less than 225 m2/Kg
6	SOUNDNESS By Lechateliers Method	1.5mm	Shall not be more than 10mm
7	DENSITY	3.15gm/cc	Not Specified

D. Test Method & Results (River Sand)

Deleterious material is 2386 part 1&2-1963 ra2011.

Sr.No.	Test Conducted	Result	Limit As Per IS 383-2016
		River Sand	Natural Sand
1	Coal &Lignite	0.29	Max 1% by Weight
2	Clay lumps	0.33	Max 1% by Weight
3	Material Finer Than 75 micron	1.01	Max 3% by Weight
4	Shale#	<0.002	Max 1% by Weight
5	Total Deleterious material	1.63	Max 5% by Weight

VII. CONCLUDING REMARKS

Base on the present study following conclusions can be drawn:

A. The compressive and flexural strength of M45 concrete at 21.62% fly ash replacement by the mass of cement are acceptable, and therefore can be used in construction practice

B. If we compare normal M45 grade of concrete with the compressive and flexural strength of M45 concrete at 21.62% fly ash replacement by the mass of cement the result are acceptable and at a cost lower than M45 grade concrete.BAs in this present study I have Reused the waste product i.e. fly ash, by Reducing the quantity of cement in concrete, in this way the waste product i.e fly ash, is Recycled into a much useful and cost effective concrete

C. If more serious work is done in this field surely concrete and construction industry would be in gainful side and concrete upto some extent would be eco-friendly.

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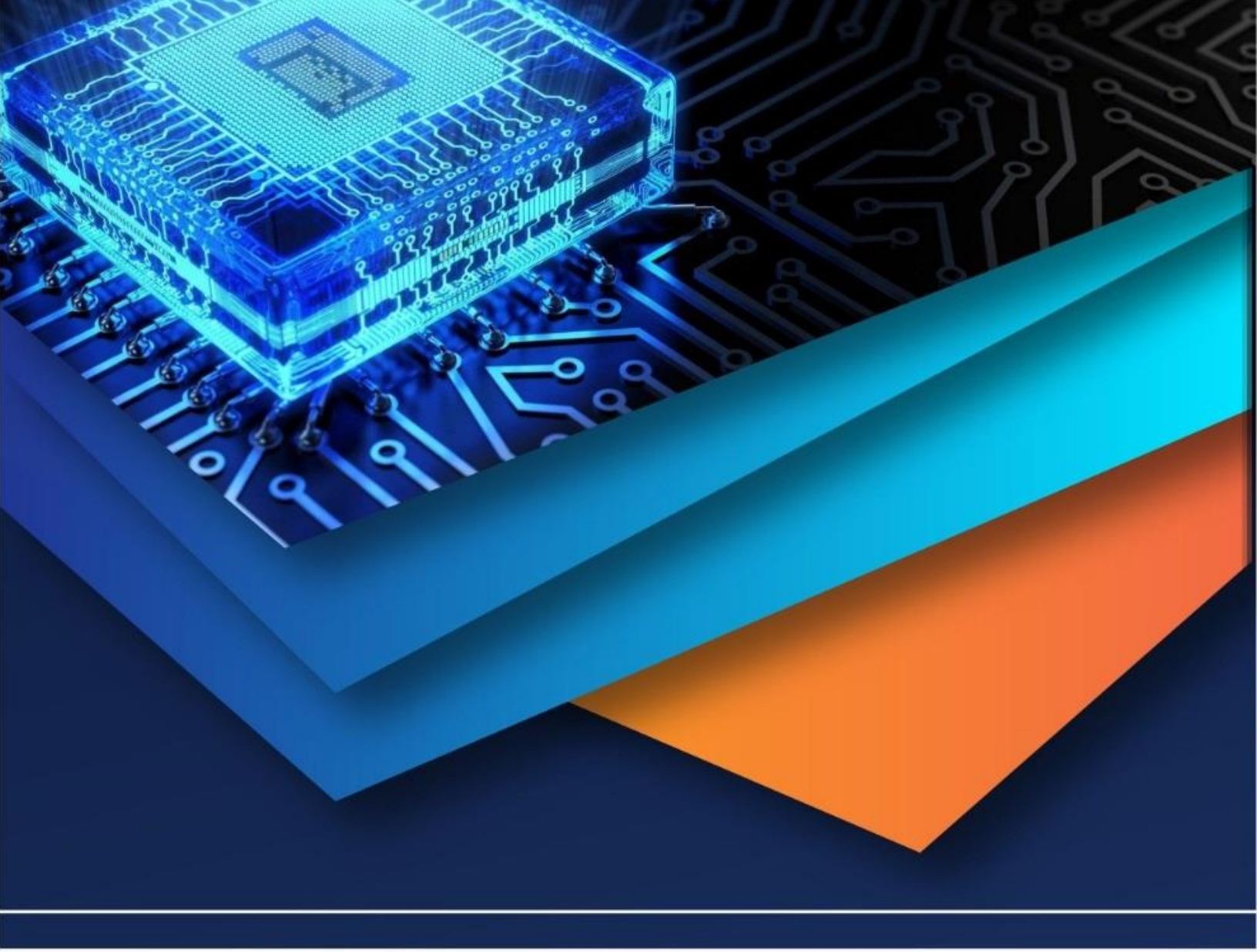

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