High Strength Concrete With Pond-Ash as Partially Replaced by Fine Aggregate and Fine Fly-Ash , Alccofine as Cement

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Abstract

Due to increase in the growth of industrial sectors the power requirement of the country is rapidly increasing. India depends on Thermal Power as its main source, thus increase in power requirement every year. Present scenario of our country shows 75 % of country's total installed power generation is thermal of which coal-based generation is 90%. The coal reserves of the country are predominately of lower grades (average of 35% ash content), non-cooking and as a result more than 110 million MT coal ash is being generated every year. Ash generation may likely reach to 170 million MT by 2012. Use of coal brings huge amount of ash every year. Lots of research has been carried out for effective utilization of fly ash in construction industries due to its fine particles and Pozzolonic properties. But little literature is available on pond ash utilization. Pond ash being coarser and less Pozzolonic than fly ash can be used as fine aggregates in concrete by partial replacement of sand. As per M60 Mix Design in this project we will replace the alccofine and fine fly ash partially with cement and pond fly ash as a replacement of fine aggregate. In mix G1, G2, G3 we will replace cement with alccofine 4% and fine fly ash 26% and pond fly ash varies 10%, 20%, and 30% as replacement of F.A. Similarly in mix G4,G5,G6 alccofine 6% and fine fly ash 24% and pond fly ash same as 10%,20%,30%. The Concrete specimens will tested at different age level for Mechanical Properties of concrete, namely, Cube Compressive Strength, Split Tensile Strength, Flexural Strength with other properties such as Compacting Factor, with respect to 7,28,56,90 Days strength. The main aim of our study as project is to get the economical and eco-friendly High strength Concrete (HSC).

Keyword- Alccofin, Cement, Fine aggregate and fine fly-ash, Pond Ash

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I. INTRODUCTION

Pozzolanic concretes are used extensively throughout the world where oil, gas, nuclear and power industries are among the major users. The applications of such concretes are increasing day by day due to their superior structural performance, environmental friendliness, and energy conserving implications. Research has been conducted on the use of fly ash, volcanic ash, volcanic pumice, pulverized-fuel ash; blast slag and silica fume as cement replacement material. Fly ash and others are pozzolanic materials because of their reaction with lime liberated during the hydration of cement. These materials can also improve the durability of concrete and the rate of gain in strength and can also reduce the rate of liberation of heat, which is beneficial for mass concrete. Concretes containing mineral admixtures are used extensively throughout the world for their good performance and for ecological and economic reason.

In the past few years, many research and modification has been done to produce concrete with higher strength and durability.

A. High Strength Concrete

- It is important to note the high-strength and high performance concrete are not synonymous.
- Concrete is defined as "high-strength concrete" solely on the basis of its compressive strength measured at a given age.
- In the 1970's, any concrete mixtures that showed 40 Mpa or more compressive strength at 28-days were designed as high-strength concrete.
- Later, 60-100 MPa concrete mixtures were commercially developed and used in the construction of high-rise buildings and long-span bridges in many parts of the world
- In normal strength concrete, the micro cracks form when the compressive stress reaches ~ 40% of the strength. The cracks interconnect when the stress reaches 80-90% of the strength.
- For HSC, Iravani and Macgregor reported linearity of the stress-strain diagram at 65 to 70, 75 to 80 and above 85% of the peak load for concrete with compressive strengths of 65, 95, and 105 MPa.
- The fracture surface in HSC is smooth. The cracks move without discontinuities between the matrix and aggregates.

Normal Strength	20-50 MPa
High Strength	50-100 MPa
Ultra High Strength	100-150 MPa
Especial	> 150 MPa

Table 1: Typical Classification of Concrete

II. MATERIALS USED

A. Cement

Sr no.	characters	result	As per IS: 8112-1939
1	Specific Gravity	3.14	3.15
2	Initial Setting Time	35 Min	>30 Min
3	Final Setting Time	225 Min	<600 Min
4	Fineness of cement	10%	10%
5	Compressive Strength 3 days 7 days 28 days	23.5 35.8 60	>23 >33 >53

Table 2: PC 53 grade properties to IS: 8112-1939

Sr.no	Type of test	Test Method	Result
1	CaO%	IS-1727	0.25
2	SiO2%	IS-1727	73.6
3	Al2O3%	IS-1727	9.1
4	MgO%	IS-1727	0.05
5	SO3%	IS-1727	0.01
6	NaO2%	IS-4032	0.004
7	K2O%	IS-4032	0.002
8	Total Chloride%	IS-12423	0.002
9	L.O.I	IS-1727	3.7
10	Fe2O3%	IS-4031	1.35
11	TiO2%	IS-4031	Nil
12	P2O3%	IS-4031	0.0001

Table 3: Pond fly ash chemical properties

Sr. no	Characteristic	Results
1	Lime reactivity ,N/mm2	8 min
2	Retention On 25 Micron Sieve	>0.5
3	Drying Shrinkage, percentage	0.06
4	Soundness by Autoclave expansion, percent	0.05
5	Specific gravity	2.2
6	Compressive Strength, as percent of strength of corresponding plain cement mortar cubes	80

Table 4: Fine Fly Ash Physical Properties

Sr. No	Type of test	Test Method	Result obtained
1	CaO%	IS-1727	0.50
2	SiO_2%	IS-1727	67.60
3	Al_2O_3%	IS-1727	11.30
4	MgO%	IS-1727	0.10
5	SO_3%	IS-1727	0.06
6	NaO_2%	IS-4032	0.035
7	K_2O%	IS-4032	0.005
8	Total Chloride%	IS-12423	0.008

9	Loss on Ignition%	IS-1727	2.60
10	Fe_2O_3%	IS-4031	1.15
11	TiO_2%	IS-4031	Nil
12	P_2O_3%	IS-4031	0.0002

Table 5: Chemical Composition of Fly Ash

B. Alccofine

Fineness (cm2/gm)	Specific Gravity	Bulk Density (Kg/m3)	Particle Size Distribution		
			d 10	d 50	d 90
12000	3.1	700-900	1.5µ	5.0µ	9µ

Table 6: Physical Properties of Alccofine

Cao	So3	Sio2	Al2O3	Fe2O3	MgO	Cl
61-64%	2-2.4%	21-23%	5-5.6%	3.8-4.4%	0.8-1.4%	0.03-0.05%

Table 7: Chemical Composition of Alccofine

Property	Fine Aggregate	Coarse Aggregate
Specific gravity	2.63	2.61
Fineness modulus	2.25	6.61
SSD absorption (%)	0.86	1.12
Void (%)	36.2	39.6
Unit weight	1690	1615

Table 8: Physical properties of aggregates

C. Fine Aggregate

Natural sand with a 4.75-mm maximum size was used as a fine aggregate. It was tested as per Indian Standard Specifications IS: 383-1970. Its properties are shown in Table.

D. Coarse Aggregate

Coarse aggregate used in this study were 20-mm nominal size, and were tested as per Indian Standard Specifications IS 383-1970.

III. MIX PROPORTIONS

Six mixture proportions were made. So in this project we will replace the alccofine and fine fly ash partially with cement and pond fly ash as a replacement of fine aggregate. In mix G1, G2, G3 we will replace cement with alccofine 4% and fine fly ash 26% and pond fly ash varies 10%, 20%, 30% as replacement of fine aggregate. Similarly in mix G4,G5,G6 alccofine 6% and fine fly ash 24% and pond fly ash same as 10%,20%,30%. In mix GA we will replace cement with alccofine 4% and fine fly ash 26%. Similarly in mix GB alccofine 6% and fine fly ash 24% Show in table X (A) and (B).

M 60	G1	G2	G3	G4	G5	G6	GA	GB
Cement(kg)	420	420	420	420	420	420	420	420
Fly ash(kg)	156	156	156	144	144	144	156	144
Aalcofine(kg)	24	24	24	36	36	36	24	36
Water(kg)	198	210	221	198	210	221	179	179
F.a(kg)	676.8	601.6	526.4	676.8	601.6	526.4	752	752
P.a(kg)	75.2	150.4	225.6	75.2	150.4	225.6	-	-
C.a(20) (kg)	672	672	672	672	672	672	672	672
C.a(10) (kg)	448	448	448	448	448	448	448	448
Admixer(kg)	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
W/b	0.33	0.35	0.37	0.33	0.35	0.37	0.263	0.263

Table 9 (A): Mix Proportion

M60	*ALCCOFINE*	*FINE FLY ASH*	*POND FLY ASH*
G1	*4%*	*26%*	*10%*
G2	*4%*	*26%*	*20%*
G3	*4%*	*26%*	*30%*
G4	*6%*	*24%*	*10%*
G5	*6%*	*24%*	*20%*
G6	*6%*	*24%*	*30%*
GA	*4%*	*26%*	*0%*
GB	*6%*	*24%*	*0%*

Table 9 (B): Mix Proportion

IV. TEST & RESULTS

A. Marsh Cone Test

Cement = 70% Fly-Ash = 22% Alccofine = 8%

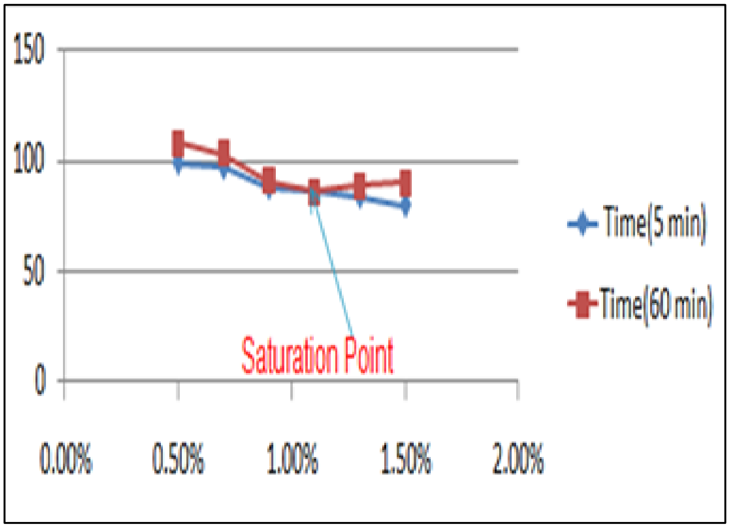

Fig. 1: Graph of mash cone test

B. Rebound Hammer

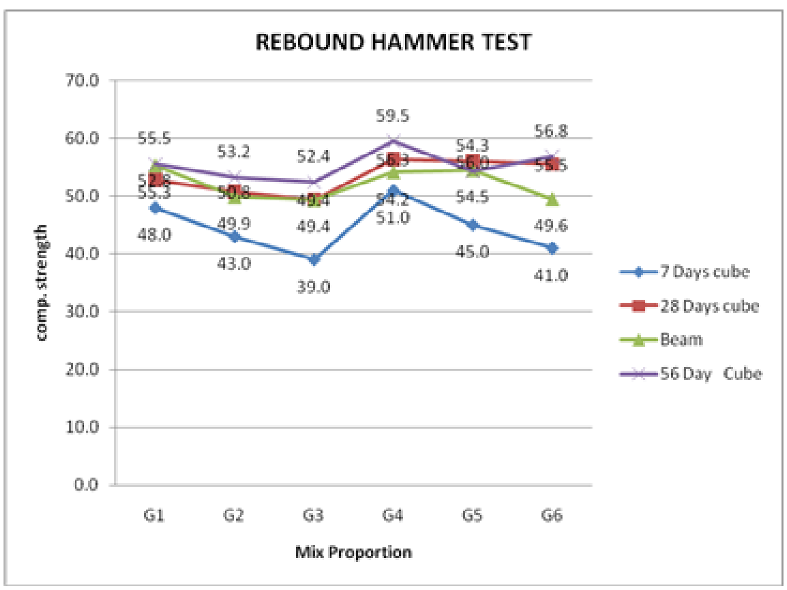

Fig. 2: Graph of comp. Strength of 7, 28 &56 days cube & 28days beam

Mix Pro.	7 Day	28 Day	56 Day	Beam
G1	48.0	52.8	55.5	55.3
G2	43.0	50.8	53.2	49.9
G3	39.0	49.4	52.4	49.4
G5	45.0	56.0	54.3	54.5
G6	41.0	55.5	56.8	49.6

Table 10: Compressive Strength of 7, 28 & 56 days cube & 28days beam

C. Ultrasonic Pulse Velocity Test

Mix Proportion	Cube 7 day	Cube 28 day	Beam
G1	4.26	4.17	4.03
G2	4.24	4.41	4.17
G3	4.17	4.55	4.07
G4	4.52	4.23	3.99
G5	4.39	4.42	4.05
G6	4.26	4.19	3.95

Table 11: U.P.V results of 7, 28 days cube & 28days beam

Sr. No	Pulse velocity by Cross Probing (Km/sec)	Concrete Quality Grading
1	Above 4.5	Excellent
2	3.5 to 4.5	Good
3	3.0 to 3.5	Medium
4	Below 3.0	Doubtful

Table 12: Velocity criteria as per IS-13311 (part1)1992

D. Compressive Strength of Cube

MIX	7-DAY MPa	28-DAY Mpa	56-DAY MPa
G1	39.5	38.80	60.77
G2	36.5	42.00	61.17
G3	32	40.20	51.05
G4	50.40	62.00	70.76
G5	46.3	55.90	65.43
G6	42.1	59.40	68.58
GA	47.36	58.82	72.9
GB	54.67	63.45	66.12

Table 13: Compressive strength results of 7, 28 & 56 days cube

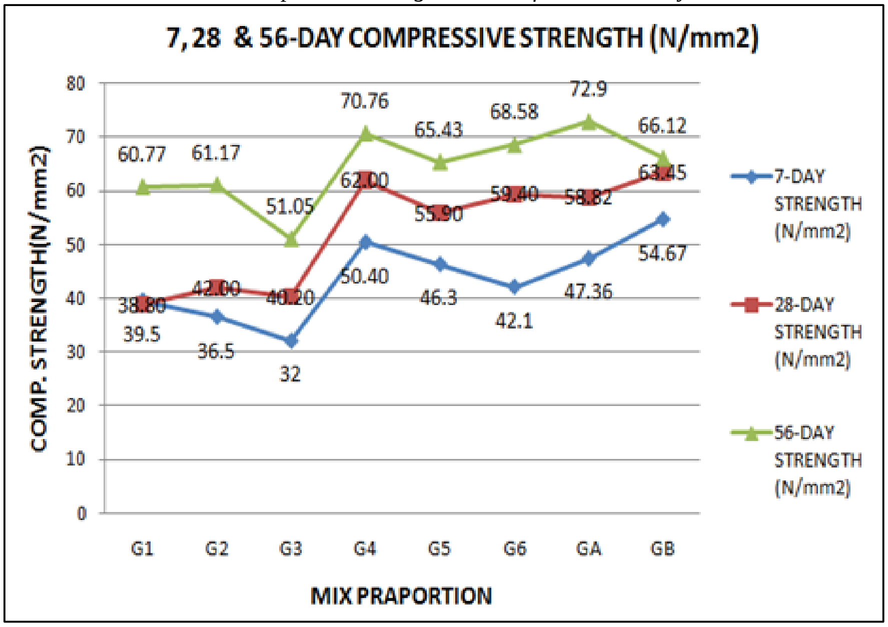

Fig. 3: Graph of comp. Strength of 7, 28 & 56 days cubes

E. Split Tensile Strength of Cylinder

MIX	*28-DAY*	*56-DAY*	*LIMIT*
G1	*3.57*	*4.79*	*5.42*
G2	*3.76*	*4.13*	*5.42*
G3	*2.89*	*4.71*	*5.42*
G4	*3.98*	*4.70*	*5.42*
G5	*3.46*	*4.24*	*5.42*
G6	*4.49*	*5.13*	*5.42*
GA	*4.32*	*5.34*	*5.42*
GB	*3.95*	*5.33*	*5.42*

Table 14: Tensile strength results of 28 & 56 days cylinder

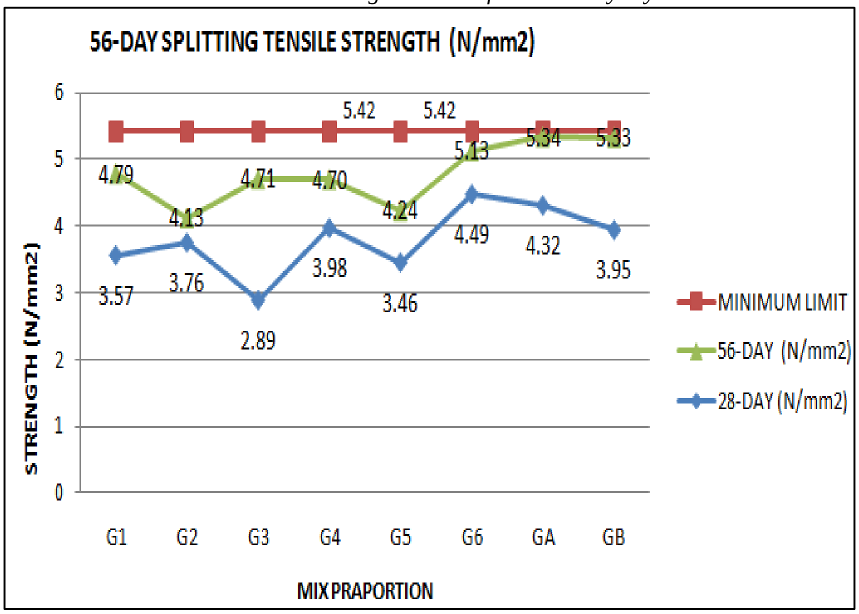

Fig. 4: Graph of tensile Strength of 28 &56 days cylinder with permissible limit

F. Flexural Bending Strength of Beam

Mix	G1	G2	G3	G4	G5	G6	GA	GB
Flexural strength	5.5	4.8	5.07	4.8	4.6	4.8	5.5	6.0

Table 15: Flexural bending strength results of 28 days beam

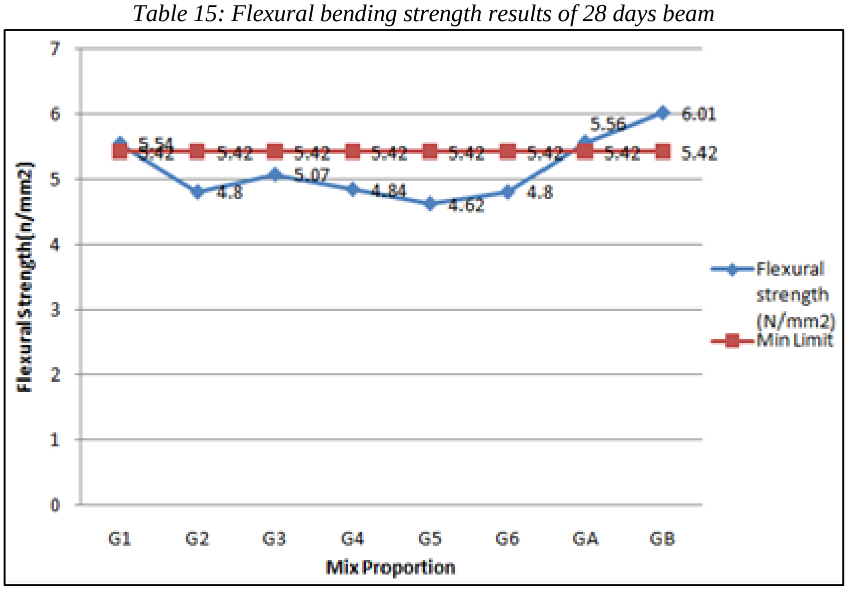

Fig. 5: Graph of flexure Strength of 28 days beam with permissible limit

V. CONCLUSIONS

A. *Workability*

- The workability of concrete decreased with the increase in Pond fly ash content due to the increase in water demand, which is incorporated by increasing the dosage of Super plasticizer.

B. *Compressive Strength*

- We are getting highest strength for using 6% alccofine as a cement replacement and 10% pond ash as a replacement in fine aggregate.
- We get 50.4 Mpa compressive strength at 7 days and 62.0 Mpa compressive strength at 28 days for water curing samples and 67.7 Mpa compressive strength at 28 days for self-curing samples for above mentioned usage.

C. *Flexural Strength*

- We are getting 4.84Mpa flexural strength for 6% alccofine and 10%pond ash usage at 28 days
- The Flexural strength of cylinder we concluded that we are not getting tensile strength up to desired limits of 5.42 Mpa

D. *Splitting Tensile Strength*

- We are getting 3.98 Mpa splitting tensile strength for 6% alccofine and 10 % pond ash usage at 28 days.
- The split tensile strength of cylinder we concluded that we are not getting tensile strength up to desired limits of 5.42 Mpa
- In area like Mumbai , Kerala ,Goa where the pond ash is easily available with low cost than the fine aggregate, the use of pond ash as replacement of sand highly beneficial as well as reducing environmental problems.

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