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Low Volume and High Volume Fly Ash Cement Concrete With and Without Curing

T. Raghunathan*, A. Ramasubramanian**
(Lecturer, Civil Engineering, P.A.C. Ramasamy Raja Polytechnic College, Rajapalayam, Tamil nadu -626108, India
**(Junior Drafing Officer,, Civil Engineering, P.A.C. Ramasamy Raja Polytechnic College, Rajapalayam, Tamil nadu -626108, India*

ABSTRACT
In this paper a basic research on using fly ash in low volume Fly ash Concrete (LVFAC) viz. 5,10, 15, 20 percentages and high volume Fly ash Concrete (HVFAC) mixes of high strength and low strength with M20and M30 grade cement concrete was studied. Both these mixes were cured in water. Similar set of cubes were left uncured in ambient condition. All the mixes were studied for compressive strength and weight.

Keywords: - *Fly Ash, curing, cement concrete, compressive strength*

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I. INTRODUCTION

Cement concrete is a one of the widely used material in the world. Due to this 5% of air pollution is contributed by Civil Construction industry. There has been a emphasis on reducing the air pollution by reducing the cement content in concrete by replacing cement with pozzolanic materials such as fly ash. Fly ash is a waste product obtained from Electrostatic precipitators. Fly ash is dumped in open lands and contributes to air pollution by increasing the suspended particulate matter in ambient air. Fly ash utilization is now followed like religion with stringent rules of adding them in cement itself.

Lot of research is going on in utilization of fly ash in concrete both as high volume and low volume replacements. Vallarasu Manoharan Southararajan et al.,[1] observed that high volume fly ash (50%) addition in concrete showed a reduction in strength. Cengiz Duran Atiş,[2] studied shrinkage and strength and observed that 50% replacement HVFA concrete developed higher strength than OPC concrete at 28 days. Mark Reiner et al.,[3] studied high-volume percentage replacements from 40 to 70%. study revealed that 50 and 60% cement replacement percentages were the best candidates for full-scale testing. They also created alley panel and curb, and gutter sections using the high volume fly ash mixes. Chong Hao Huang et al.,[4] studied the effect of replacing ratio of fly ash (FA), ambient relative humidity, temperature, curing age and w/c on carbonation of concrete made with low-volume fly ash. Baert et al., [5] investigated 40 or 60% of the cement content by low-calcium fly ash on the compressive strength and durability of the concrete. They observed that Concrete with fly ash performed better in lactic/acetic and sulphuric acid during accelerated experiments. The chloride diffusion coefficients resulting from accelerated chloride migration tests were significantly lower for concrete with fly ash than for the control concrete. Yu J et al., [6] concluded that Green structural concrete with 80% cement replaced by local Chinese fly ash has been recently developed to achieve a target characteristic compressive strength of 45 MPa. P. Kumar Mehta,[7] specifies that, Minimum of 50% of fly ash by mass of the cementations materials must be maintained for high performance HVFAC and Cement content, generally not more than 200kg/m^3 is desirable. Shree Laxmi Prashant [8] concludes that fly ash improves the quality of concrete in its fresh state by improving the workability. HVFA concrete is highly durable compared to normal concrete because of reduced calcium hydroxide content. Crouch et al.,[9] state that use of HVFA mixtures are ideal for warm weather concrete placing. Madhavi et al.,[10] suggest that HVFAC has lower strength at early ages but at later age HVFAC shows continuous increase in strength properties. Significantly both the crack width and drying shrinkage reduce and thus contribute to the long term durability of concrete. Mini Soman et al.,[11] study discloses that high volume of Fly Ash in concrete reduces the water demand and improves the workability. Study also reveals that the OPCC and HVFAC exhibits similar hardened properties.

Dale [12] summarizes that HVFA concretes can offer substantial performance benefits, in addition to their sustainability advantages in terms of reductions in cost, embodied energy, and CO2 emissions. Roohul Khan et al.,[13] study concludes that the addition of fly ash in LVFA, stone dust and recycled aggregate together will enhance its compressive strength and will render it more green and sustainable. T.P.singh, [14] research results show that HVFAC is indeed an excellent material with later age properties superior to conventional concrete, namely - compressive strength, flexural strength, elastic modulus, abrasion resistance and permeability. Pandurangan ET AL.,[15] revealed that the high volume fly ash shows better performance when compared with conventional concrete. Ronit ET AL.,[16] that high volume fly ash concrete achieves the required strengths at higher ages and improved performance characteristics were observed from strength and durability studies. Tapeshwar Kalra ET AL., [17] flexural strength of fly ash concrete at 50% replacement level increased in strength with referral concrete is 30.16% 30.65% at 7 & 28 days.

Ordinary Portland cement of RAMCO was used for this research. Fly ash was procured from Tuticorin. Natural Sand and Natural Coarse aggregate of 20mm size available locally was used.

II. TEST PROCEDURE

M20 and M30 concrete were deigned based on ACI method. For low volume fly ash mixes, fly ash was added as percentage by weight of cement viz. 5%, 10%, 15% and 20%. High volume fly ash mixes of high strength and low strength were obtained from data in Concrete Technology book[18]. Cubes of 15cm cubes were cast and compressive strength and weight were compared.

TABLE-1 Mix Design For M20 Concrete As Per ACI Method

Mix	Cement KG/M3	Fine aggregate KG/M3	Coarse aggregate KG/M3	Water KG/M3
M20	284.62	686.82	1198.56	185
	1	2.41	4.21	0.65
M30	365	608.94	1198.56	182.5
	1	1.66	3.28	0.50

TABLE-2 Mix Design As Per Concrete Technology Book

Mix	Cement KG/M3	Fine aggregate KG/M3	Coarse aggregate KG/M3	Water KG/M3
HVF-LS	125+165 (FA)	800	1170	145
	1+1.32 (57%)	2.76	4.03	0.50
HVF-HS	180+220 (FA)	760	1110	200
	1+1.22 (55%)	1.9	2.78	0.50

III. TEST RESULTS

Cement has fineness of 1%, specific gravity of 2.96, consistency of 30% and initial setting time of 26 minutes. The sand used has specific gravity of 2.56, fineness modulus of 2.33. Coarse aggregate or jally has specific gravity of 2.6, water absorption of 4% and fineness modulus of 7.12. Specific gravity of fly ash is 1.89. water has total dissolved solids of 1240ppm and chloride content of 372.33ppm

TABLE-3 Compressive Strength In N/mm^2

Mix	Cured	Uncured
M20	15.8	12.4
M-30	23.5	21.2
HVF-LS	9.4	6.2
HVF-HS	11.6	12.3
LVF2-5	19.8	18.5
LVF2-10	19.4	18.7
LVF2-15	16.2	15.3
LVF2-20	18.5	15.4
LVF3-5	29.3	21.8
LVF3-10	28.1	26.6
LVF3-15	20.1	17.4
LVF3-20	24.6	15.9

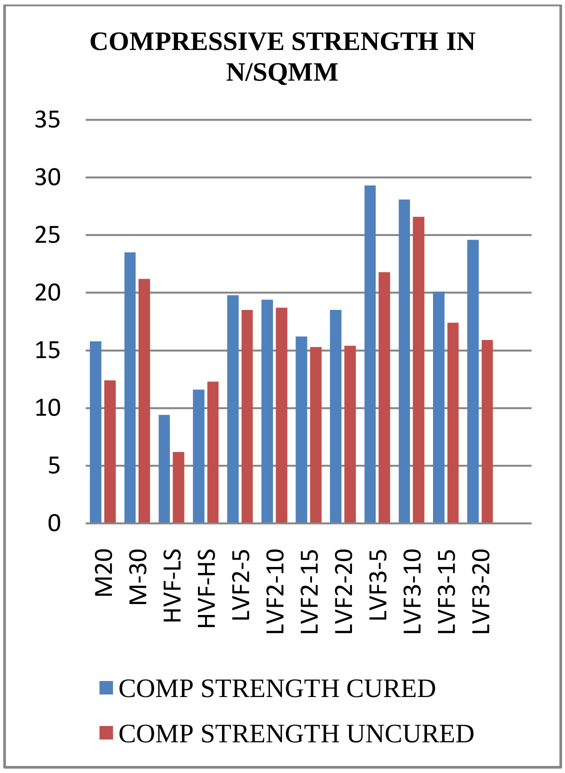

Fig-1 Compressive strength of mixes in N/sqmm

TABLE-4 Comparison Of Weight

Mix	Cured	Uncured
M-20	8.1	8.2
M-30	8.9	9
HVF-LS	8.5	8.7
HVF-HS	8.5	8.7
LVF2-5	8.7	8.8
LVF2-10	8.7	8.8
LVF2-15	8.4	8.6
LVF2-20	8.3	8.4
LVF3-5	8.7	8.8
LVF3-10	8.5	8.6
LVF3-15	8.4	8.5
LVF3-20	8.4	8.4

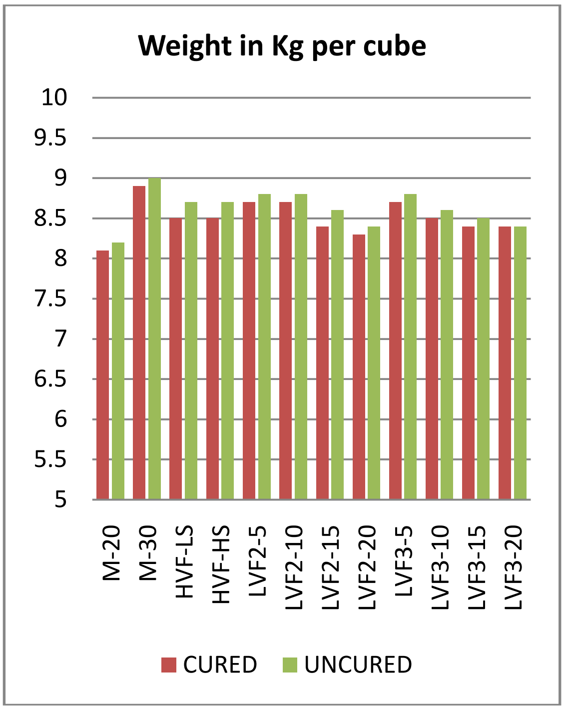

Fig-Weight 15cm cubes in N/sqmm

NOTE: -

M20 and M30 are standard control mix concretes of 20 N/sqmm and 30 N/sqmm respectively. HVF-LS is High volume fly ash Low strength mix, HVF-HS is High volume fly ash High strength mix, LVF2-5 is Low volume fly ash concrete of M20 mix with 5% fly ash by weight of cement, LVF3-5 is low volume fly ash concrete of M30 mix with 5% fly ash by weight of cement

IV. RESULT DISCUSSION AND CONCLUSION

- The cured cubes showed higher compressive strength when compared to uncured ones.
- HVF- High strength mix shows compressive strength similar to M20 mix.
- All the mixes of M20 and M30 show lesser strength than intended target strength. This may be due to high water cement ratio of 0.5 and above and also due to hand compaction during casting.
- Cured cubes of LVFAC of M30 mix (LCF3) with 5% , 10% and 20% fly ash shows higher strength than Control M30 mix.
- This shows that 5% , 10% and 20% of fly ash in concrete mix can contribute to additional strength in 28 days if water curing is adopted.
- The weight of cubes varies from 8 to 9 kg per cube which is not a big difference.

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