EXPERIMENTAL INVESTIGATION OF STRENGTH PARAMETERS OF ALKALI ACTIVATED FLY-ASH CONCRETE

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ABSTRACT — The process of alkali activation of waste pozzolan material to produce alkali activated binders has become important area of research because pozzolan such as fly-ash can be alkali activated and can be used totally in place of cement in concrete as an environment friendly binding material called as Alkali Activated Fly-Ash Concrete. In the present paper alkali activated fly-ash is used instead of cement to make Alkali Activated Fly-Ash Concrete (AAFC). Paper presents a summary of an experimental work that was conducted to determine the compressive strength of Alkali Activated Fly-Ash Concrete. There are two different methods of curing. Comparison of Compressive strength for room temperature curing and for elevated temperature curing i.e. oven curing is done.

KEYWORDS — **Alkali Activated Binders, Pozzolan, Fly-Ash, Alkali Activated Fly-Ash Concrete (AAFC), Oven curing.**

I. INTRODUCTION

The Portland cement is very important and major construction material used in construction industry the production process of Portland cement releases large amount of CO_2 gas in to the atmosphere hence the production of Portland cement contribute to the greenhouse gases and global warming of planet as CO_2 gas released from manufacturing process of Portland cement also lot of energy required for production.

It is important to search an alternative, environment friendly binding material instead of Portland cement for concrete to reduce the production of the hazardous gases. It is expected that in coming few years the civil engineering community have to produce structure with concept of sustainable development, material which are able to give high performance with low environmental impact along with place construction cost and energy.

The alkali activated fly ash concrete provides one way towards this objective. In design of concrete, civil engineers use or assume number of properties of harden concrete, but there is very less knowledge about behavior of alkali activated pozzolans concrete therefore it is worth to study the properties of alkali activated pozzolans concrete. In 1999 palomo suggested that pozzolans such as fly ash might be activated using highly alkaline liquids to form a binder and hence totally replace the use of OPC in concrete. In present paper efforts made to study the properties of fly ash based alkali activated concrete.

There are two main constituents of alkali activated fly ash concrete, namely the source material i.e. fly ash and alkali liquids. The source materials for the alkali activated concrete should be reach in silicon (Si) and aluminum (Al) materials such as fly ash, silica fume, rice husk ash choice of source materials depends upon factors such as availability of materials, applications, cost etc.

The most common alkaline liquids used for alkali activation are combination of sodium hydroxide (NaoH) or potassium hydroxide (KOH) and sodium silicate or potassium silicate. The nature of AAFC is that of stiff paste with high viscosity and low workability.

II. EXPERIMENTAL WORK

In this research source material which is used for the experiment is class – F Fly-Ash according to ASTM, 80 % passing through 45 micron sieve. The chemical composition is according to table No. 1 given below.

Table No. 1 classification of Class- F Fly Ash

CHEMICAL COMPONENTS	CLASS- F FLY ASH
SiO	54.90 %
Al_2O_3	25.80 %
Fe_2O_3	6.90 %
CaO	8.70 %
MgO	1.80 %
SO_3	0.60 %
Na_2O & K_2O	0.60 %

Sodium hydroxide pellets where dissolved in water to get the alkaline solutions for the alkali activated fly ash concrete. Dissolved sodium hydroxide solution mixed with sodium silicate solution which has chemical composition of sodium oxide (Na_2O) =14.7%, silicon oxide (SiO_2) =29.4% and water =55.9% the pH is highly alkaline i.e. 11.4.

Alkali liquid ratio i.e. sodium silicate to sodium hydroxide ratio is of 2.5, the alkali liquid to source material i.e. fly ash ratio is of 0.35 and water to binding solid ratio is of 0.21. The table no. 2 shows the concrete mix proportion for 1 m^3 of alkali activated fly ash concrete.

Table No. 2 Concrete Mix Proportions

MATERIALS	PROPORTIONS
Pozzolan [Fly ash]	408 Kg/m^3
Fine aggregates	554 Kg/m^3
Course aggregates	1294 Kg/m^3
Sodium Hydroxide solution	41 Kg/m^3
Sodium silicate solution	103 Kg/m^3

Fly-ash and aggregates were dry mixed in mixer for minimum 3 minutes. This was followed by adding alkali activators i.e. alkali liquids and final mix were for another 3 minutes To determine the compressive strength of alkali activated fly ash concrete samples were prepared in sizes as required by standard test into pre oiled moulds of dimensions 150mm x 150mm x 150mm.

Fig No. 1 Concrete mix

Fig No. 2 Cube Specimens

Sample were cast in moulds in three layers and vibrated by means of vibrating table to remove any entrapped air. It was observed that alkali activated fly ash concrete strongly adheres the mould hence oiling of the moulds is very important factor to ensure clean release of samples, specimens were de-moulded 24 hours after casting and cured in 2 curing regimes and at 3 different temperatures.

1. Room Temperature Curing –
   The selected samples are kept at room temperature and at dry conditions up to day of testing.
2. Oven Curing at 60º Temperature –
   Specimens were cured in oven chamber at 60 degree and removed after 8 hours and kept at room temperature till day of testing.
3. Oven Curing at 80º Temperature –
   Specimens were kept at 80 degrees and removed after 8 hours and kept at room temperature till day of testing.

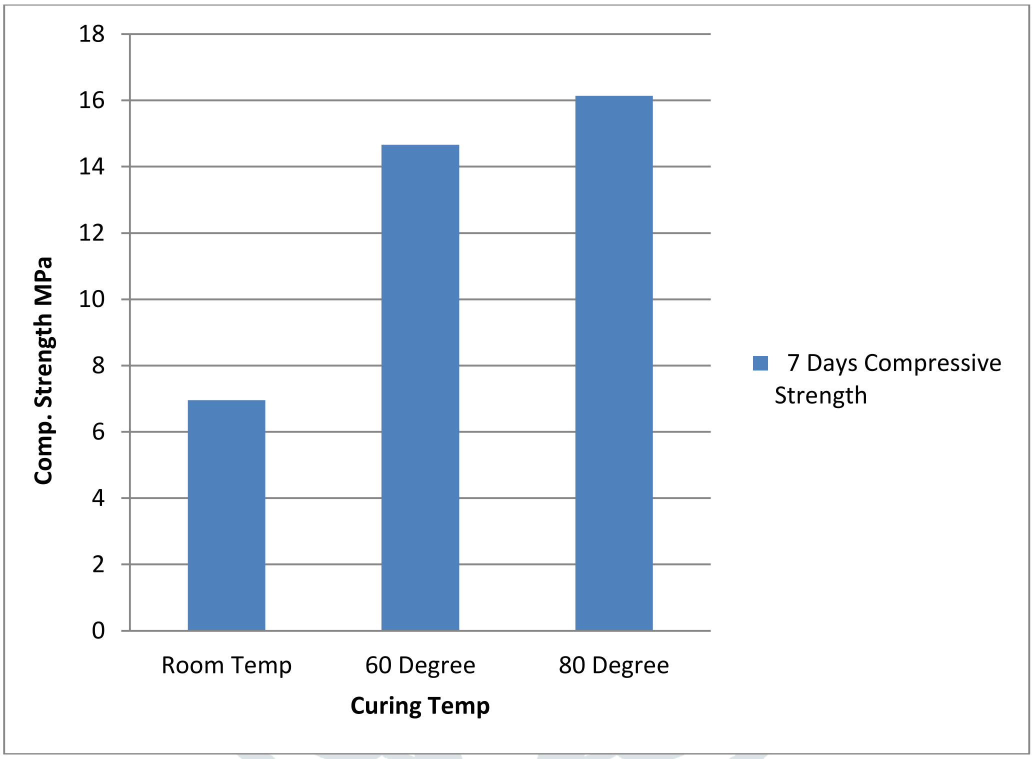
The uniaxial compessive strength test on the concrete cube specimen was done at 7 days and 28 days.

Fig No. 3 Cube Specimens

Fig No. 4 Compressive Testing on CTM

Table No. 3 compressive test result for 7 days

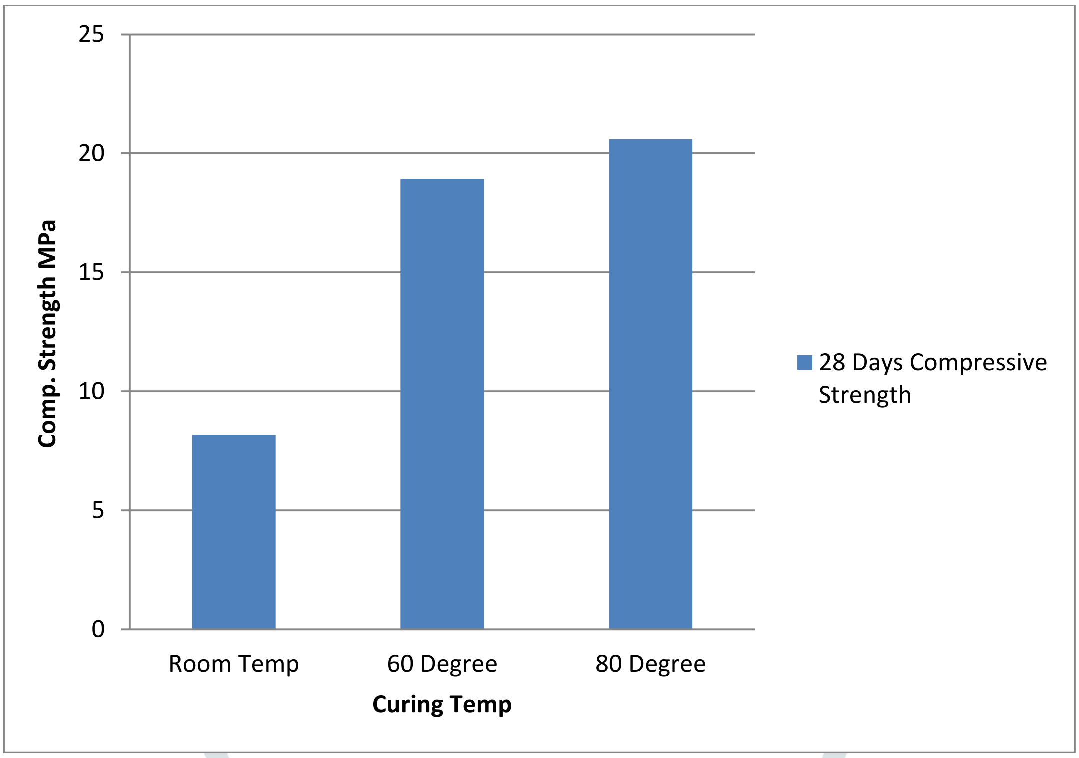
Curing Temp.	Sample No.	Weight Kg	Compressive strength MPa	Avg. Compressive strength MPa
Room Temp.	Sample1	8.42	6.22	6.96
	Sample 2	8.37	7.11	
	Sample 3	8.41	7.55	
60^0	Sample1	8.38	15.55	14.66
	Sample 2	8.39	14.66	
	Sample 3	8.41	13.77	
80^0	Sample1	8.39	16.88	16.14
	Sample 2	8.37	15.55	
	Sample 3	8.44	16	



Graph No. 1. 7 Days Compressive Strength

Table No. 4 compressive test result for 28 days

Curing Temp.	Sample No.	Weight Kg	Compressive strength MPa	Avg. Compressive strength MPa
Room Temp.	Sample1	8.90	8.89	8.18
	Sample 2	8.43	7.66	
	Sample 3	8.42	7.99	
60^0	Sample1	8.36	19.55	18.93
	Sample 2	8.37	18.46	
	Sample 3	8.47	18.78	
80^0	Sample1	8.44	20.86	20.60
	Sample 2	8.39	21.33	
	Sample 3	8.42	19.63	



Graph No. 2. 28 Days Compressive Strength

III.RESULT AND DISCUSSION

The obtained results for investigation of compressive strength of Alkali Activated Fly-Ash Concrete for 7 days are shown in table no. 3 and graph no. 1 and results for 28 days are shown in table no. 4 and graph no. 2, samples were cured at 3 different temperatures. Samples were kept for room temperature curing till day of testing has low compressive strength. Samples which are cured at elevated temperature comparatively give high compressive strength. In all 3 cases of curing the strength of concrete increases with the age of concrete.

IV.CONCLUSION

1) Samples cured at room temperature exhibited very low compressive strength and it is not suitable to use
2) Samples cured at 60^0 and 80^0 in oven for 8 hours shows good moderate compressive strength t 7 days and 28 days
3) From the results obtained from experiments Alkali Activated Fly-Ash has potential to replace the OPC in concrete

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