

Experimental Work on Total Replacement of Cement by Fly Ash and Alkaline Solution

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ABSTRACT: This paper represents the experimental study on total replacement of cement by Fly ash and Alkaline solution. The effects of use of Fly ash and Alkaline solution on the properties of Fly ash based concrete particularly Compressive Strength. The molarities of Fly ash based concrete are 8 Molar and 12 Molar which compared with the grades of conventional concrete M30 and M60 respectively. For this experimental work two mix design methods were adopted. The alkaline solution used is the combination of Sodium silicate and Sodium hydroxide. The curing method adopted is oven dry method.

KEYWORDS: Fly Ash, Sodium Silicate, Sodium Hydroxide, Sodium silicate to Sodium hydroxide ratio, Solution to Fly ash ratio.

I. INTRODUCTION

For the few decades construction sector is increasing rapidly in India. Hence demand and production of cement is increasing. The production of cement is 455 million tonnes per year which results in large amount of CO₂ emission. It causes adverse effect on the environment. On the other hand disposal problem of fly ash is increasing which needs excess of land. Production of Fly ash is 185 Million tonnes per year. Hence to minimise the effect of CO₂ on environment we have fully replaced cement by fly ash and alkaline solution..

II. OBJECTIVE

1. Alternative to OPC concrete.
2. Decrease production of carbon dioxide.
3. To study effect of change in molarities of NaOH on strength of geopolymer concrete.
4. To study effect of curing temperature and curing period of geopolymer concrete.
5. To check the strength of fly ash based concrete for different molarities (i.e. 8M & 12M).

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6. Cost comparison for different fly ash to solution ratio.

III. METHODOLOGY

The tests taken on aggregates are Impact value test, Crushing value test and Abrasion test as well as the test taken on Fly ash and solution is Initial setting time and Final setting time.

IV. EXPERIMENTAL WORK

A. Mixing of Alkaline Solution

There were two methods used for mixing of alkaline solution.

- Method 1-

In 1st Method calculated amount of Sodium Silicate (Na_2SiO_3) and Sodium Hydroxide (NaOH) were dissolved for 24 hours before casting.

- Method 2-

In 2nd Method calculated amount of Sodium Hydroxide (NaOH) were dissolved in calculated amount of water for 24 hours before casting.



Fig1: Mixing of solutions(Na_2SiO_3 & NaOH)

Figure 1 shows that Sodium Silicate(Na_2SiO_3) and Sodium Hydroxide(NaOH) are mixed for 24 hours before casting.



Fig 2: Mixing of solutions (NaOH &Water)

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Figure 2 shows that Sodium Hydroxide(NaOH) and water are mixed for 24 hours before casting.

B. Mould Preparation

The aggregates, Crush Sand, Fly Ash and Alkaline Solution required for the study was provided by **CSK concrete** plant, Sinhgad Road, Pune.

The aggregates, Sand, Fly Ash, Alkaline Solution and Water were mixed and placed in the mould. For 8 MOLAR ratio of Alkaline Solution to fly ash was taken as 0.40 and for 12 MOLAR it was taken as 0.30. Sodium Silicate to Sodium Hydroxide ratio was taken as 1.50 for both 8M and 12M.

Mix Design of fly ash based concrete 12 MOLAR		
Material	Material quantity	Material Quantity in Percentage
Fly Ash	1.17Kg	14.1
Crush sand	2.53 Kg	30.48
20 mm aggregate	2.98 Kg	35.90
10 mm aggregate	0.73 Kg	8.79
Sodium Hydroxide	0.1404Kg	4.23
Sodium Silicate	0.2106Kg	
Super plastizer (Conplast SP-430)	4.85 ml	0.06
Water	533.25 ml	6.43

Table1.Mix design of fly ash based concrete (12 molar)

Mix Design of fly ash based concrete 8 MOLAR		
Material	Material Quantity	Material Quantity in Percentage
Fly ash	0.95 Kg	11.56
Crush Sand	2.65 Kg	32.24
20 mm aggregate	2.96 Kg	36.01
10 mm aggregate	0.74 Kg	9.00
Sodium Hydroxide	0.152 Kg	4.63
Sodium Silicate	0.228 Kg	
Super plastizer(Conplast SP-430)	5.33 ml	0.065
Water	533.25 ml	6.53

Table2.Mix design of fly ash based concrete (8molar)

C. Mould Preparation

The moulds were kept in Oven for curing at 60⁰C and cured for 24 hours, 48 hours and 4 days. The moulds were taken out from Oven and unmoulded. The unmoulded cubes were rested at room temperature to cool down and then tested in Compression Testing Machine.

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Fig.3. Testing of cube in compression testing machine

12Molar Cube	Compressive Strength(N/mm ²)		
	24 Hours	48Hours	4 Days
Cube 1	34.8	41.51	56.22
Cube 2	33.68	43.02	58.40
Average	34.24	42.26	57.31

Table3: Compressive Strength result of 12MOLAR

12Molar Cube	Compressive Strength(N/mm ²)		
	24 Hours	48Hours	4 Days
Cube 1	18.57	27.11	36.13
Cube 2	20.67	25.15	35.28
Average	19.22	26.13	35.70

Table4: Compressive Strength result of 8MOLAR

Cost Comparison Of Conventional concrete And Fly Ash Based Concrete		
Grade Of Conventional Concrete	M60	M30
Cost of Material of One Cube	28.41 Rs	26.93 Rs
Grade of Fly Ash Based Concrete	12 MOLAR	8 MOLAR
Cost of Material Of One Cube	28.47 Rs	29.4 Rs

Table5: Cost comparison

V. CONCLUSION

We here by conclude after completing the project that,

1. Fly ash based concrete is a good and effective alternative to ordinary Portland cement concrete.
2. Fly ash based concrete is an ecofriendly concrete as there is no use of cement.
3. The 8 Molar fly ash based gives less strength as compared to 12 Molar fly ash based concrete.
4. At temperature upto 60°C fly ash based concrete gives significant strength cured for 2 days as compared to conventional concrete.

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5. Strength of 8 Molar fly ash based concrete is greater than M30 conventional concrete & strength of 12 molar fly ash based concrete is slightly less than M60 conventional concrete.
6. Cost of 8 Molar fly ash based concrete is 9% greater than conventional concrete M30 & cost of 12 Molar fly ash based concrete is same as conventional concrete M60.

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