Overview of Utilization of fly ash as cementitious material

R.A.Khan[1],M.U.Siddiiqui [2],M.W.Baig[3]
[1,2]*Lecturer, Department of Civil Engineering , Integral University,Campus Shahjahanpur, U.P.(India)*
[3]*In-charge, Integral University Campus ,Shahjahanpur.U.P.(India)*
rehankhan200158@yahoo.com, Mobile No:- +91-9936603061

Abstract : **As per Indian standard grade M20, by partial replacement of cement using fly ash can increase strength of cement. If we add 10%, 20%, 30%, 40%, fly ash ,hypo sludge(Industrial waste) then it can be replacement of cement which can be a alternate sources of low cost concreate which is approximately 850/- per cubic concreate .In this paper we will study the utilization of fly ash as a supplementary cementitious (SCM) and will compare with ordinary concrete and this technology can be a best sources for the temporary shelter especially for those who are affected by Natural calamities or natural disaster**

Key words: **SCM,CaO,SiO_2,Al_2O_3.Mg0.IS,W/C**

1. INTRODUCTION

We all know ,fly ash is a byproducts of coal and annual output of fly ash is more than 110 million tones .But unfortunately utilization of Fly ash is below 25%.If we want to change the perception of fly ash as a waste material to a quality resource material then thorough study on the material with proper awareness is necessary. Then definitely it will be positive effects in this field of construction.

Fly ash effects the plastic properties of concrete by improving it workability and fly ash also play a important roles in terms of performance of concrete it also increase strength and reduces permeability, reducing corrosion of reinforcement shell, increase sulphate resistance and also it reduce the alkali aggregate reaction. In this paper we will discuss & compare strength and efficiency with the conventional method. In this paper we will also study the effects of this technology in terms of our environment.

2. DESIGN MIX MATERIALS

A) Cement

The Ordinary Portland Cement of 53 grade conforming to IS : 8112-1989 has been used.

It is the most commonly used cement and many tests were conducted on cement ; some of them are Specific gravity , consistency tests , setting tests , etc .

Table –I PROPERTIES OF CEMENT

Sr.no.	Physical Properties of Cement	Result
1	Specific gravity	3.14
2	Standard consistency(%)	31.2%
3	Initial setting time (hours , mins)	89
4	Final setting time (hours , mins)	208

B) Coarse Aggregate

The coarse aggregates are the fractions from 80mm to 4.75mm. Crushed coarse aggregates from crushed basalt rock, confirming to IS:383 is used . The Flakiness and Elongation Index were maintained well below 15%.

C) Fine Aggregates

Fine aggregates are the fractions from 4.75 to 150 micron. The Haldwani river sand and crushed sand is used in combination as fine aggregate confirming to the requirements of IS:383 . Washed and screened river sand is used to eliminate deleterious materials and over sized particles.

TABLE – II PROPERTIES OF CEMENT

Property	Fine Aggregate	Coarse Aggregate	Grit
Fineness modulus	3.2	7.08	6.8
Specific Gravity	2.687	2.624	2.876
Water Absorption	1.2	1.88	1.455
Bulk Density	1.81	1.339	1.345

D) Water

Water is an important ingredient of concrete as it participates in the chemical reaction (Hydration of cement). Since it helps to form the strength giving cement gel , the quantity and quality of water is required to be looked into very carefully.

E) Hypo sludge

This hypo sludge contains minimum amount of silica, low calcium and maximum calcium chloride . Due to silica and magnesium properties sludge behaves like cement. Tendency of silica and magnesium is to improve the setting of the concrete. Fig. below shows raw hypo sludge, Table – 3 shows the hypo sludge chemical properties and comparison between cement and hypo sludge

TABLE-3 COMPARISON OF CEMENT AND HYPO SLUDGE

Sr.no.	Constituents	Cement (in %)	Hypo sludge (in %)
1.	Lime (CaO)	61	38.98
2.	Silica (SiO2)	23	10.98
3.	Alumina(Al2O3)	5	0.68
4.	Magnesium(MgO)	1	1.857
5.	Calcium Sulphate	4	0.565

F) Fly ash

The quality of fly ash is assessed on the basis of some of the key parameters like pozzolanic activity, material retained on 45 micron sieve, loss on ignition and other chemical parameters. It is advisable to qualify a source of fly ash all the test as specified in IS shall be conducted initially and only key parameters can be tested for each batch to ensure a consistent quality of fly ash .

3 DESIGN MIX METHODOLOGY

A mix M20 grade was designed as per IS 10262:2009 method and the same was used to prepare the test samples. The design mix proportions are done in Table 4 and 5.

TABLE-4 MIX DESIGN PROPORTIONS

	Water	Cement	Fine Aggregate	Coarse Aggregate
By weight {kg}	185	382	731.6	1202.84
By volume{ m3}	0.48	1	1.98	3.08

Table -5 CONCRETE DESIGNS MIX PROPORTIONS (M20)

Sr.no.	W/C ratio	Cement	Fine Aggregate	Coarse Aggregate	Fly ash	Hypo sludge
1.	0.45	1.00	1.88	3.14	0.00	-
2.	0.45	0.90	1.88	3.14	0.10	-
3.	0.45	0.80	1.88	3.14	0.20	-
4.	0.45	0.70	1.88	3.14	0.30	-
5.	0.45	0.60	1.88	3.14	0.40	-
6.	0.45	1.00	1.88	3.14	-	0.00
7.	0.45	0.90	1.88	3.14	-	0.10
8.	0.45	0.80	1.88	3.14	-	0.20

9.	0.45	0.70	1.88	3.14	-	0.30
10.	0.45	0.60	1.88	3.14	-	0.40

4. EXPERIMENTAL METHODOLOGY

A) Workability of fresh concrete by slump test

Slump test is used to determine the workability of fresh concrete. Slump test as per IS:1199-1959 is followed. T are Slump cone and tamping rod.

The apparatus used for doing slump test.

B) Compressive strength test

Concrete cubes of size 150mmX150mmX150mm are casted for concrete M20 grade. Cubes with replacement of Ordinary Portland Cement with hypo sludge and fly ash at 10% , 20%, 30% and 40% levels are cast. During casting the cubes are mechanically vibrated using 20mm diameter nozzle. After 24 hours the specimen is remove from the mould and subjected to water curing for 7 and 28 days. After proper curing, the specimens tested for compressive strength using calibrated compression testing machine of 2000KN capacity.

5. RESULT

A) Workability of Fresh Concrete

Slump test is used to determine the workability of fresh concrete. In experiment , workability reduces at higher replacement of Fly ash with cement and vice versa it increases with higher replacement of hypo sludge as shown in table 6.

TABLE-6 : SLUMP TEST FOR M20 PARTIAL REPLACEMENT % FLYASH & HYPO SLUDGE

% Replacement	Slump in mm (Fly ash)	Slump in mm (Hypo Sludge)
0	26	25
10	20	24
20	19	25
30	18	34
40	11	38

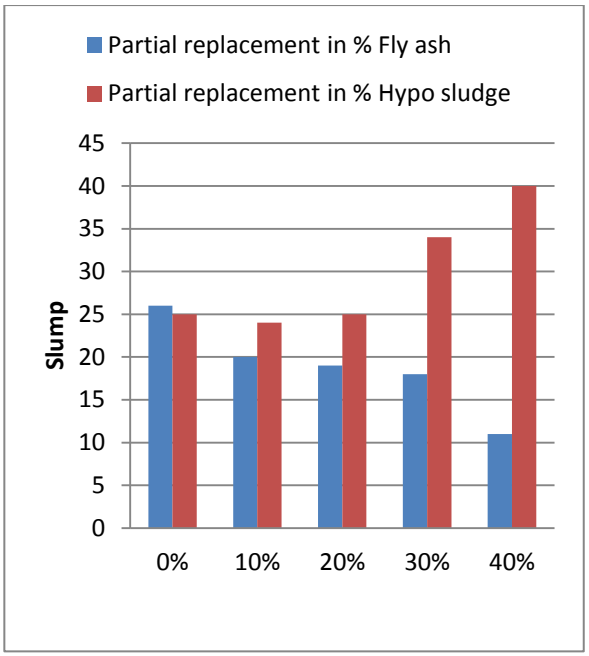

Figure.1 Slump test for M20 Partial Replacement in % Fly ash and Hypo sludge

TABLE -7 COMPRESSIVE STRENGTH OF CUBES FOR M20 AT 7 & 28 DAYS

Partial Replacement in %		7 days	28 days
Fly ash	0%	30.45	34.00
	10%	27.54	30.49
	20%	27.89	42.09
	30%	26.87	38.80
	40%	27.44	31.31
	0%	30.45	30.45
	10%	33.12	35.28
	20%	27.81	31.99
	30%	25.13	27.59
	40%	20.91	25.89

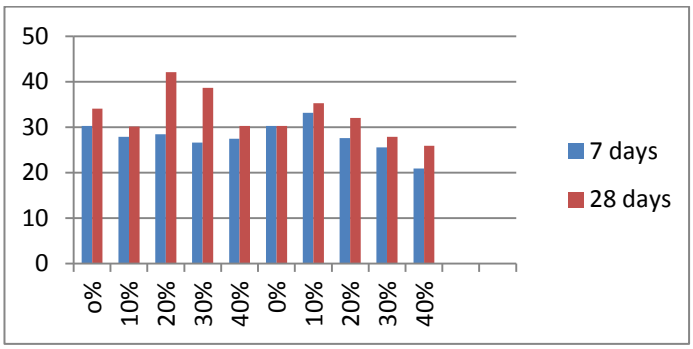

Figure.2 Compressive strength of cubes at 7 days and 28 days

6. ECONOMIC FEASIBILITY

TABLE-8 COSTS OF MATERIALS

Sr.no.	Materials	Rate (Rs/Kg)
1.	Cement (OPC 53 grade)	5.800
2.	Fly ash	0.52
3.	Hypo sludge	0.50
4.	Fine Aggregate	0.68
5.	Coarse Aggregate (20mm Down)	0.70.
6.	Grit	0.72

TABLE – 9 MATERIALS FOR DESIGN MIX M20 GRADE CONCRETE

Materials	% reduction in cement	Cement [kg/m3]	Fine aggregate [kg/m3]	Coarse aggregate & Grit [kg/m3]	Fly ash [kg/m3]	Hypo sludge [kg/m3]	Total cost [m3]	% change in cost
Fly ash	0	382.00	731.6	1202.84	0	-	3555.076	
	10	344.40	731.6	1202.84	37.60	-	3356.548	
	20	304.00	731.6	1202.84	78	-	3143.236	
	30	266.45	731.6	1202.84	115.55	-	2944.972	
	40	225.50	731.6	1202.84	156.50	-	2728.756	
	0	382.00	731.6	1202.84	-	0	3555.076	
	10	344.40	731.6	1202.84	-	37.60	3355.796	
	20	304.00	731.6	1202.84	-	78	3141.67	
	30	266.45	731.6	1202.84	-	115.55	2942.661	
	40	225.50	731.6	1202.84	-	156.50	2725.626	

7. CONCLUSION

The following observations are made regarding the resistance of partially replaced hypo sludge and fly ash.

i) Compressive strength of concrete measured after 7 days decreases when the percentage of replacement of fly ash increases , and at replacement of 10% hypo sludge compressive strength increases after 7 days.

ii) Compressive strength of the concrete measured 28 days increases when the percentage of replacement of fly ash increases up to 30% and if replacement of 20% hypo sludge compressive strength increases after 28 days.

iii) This material can be used for economic feasibility specially government temporary shelters.

iv) Environmental effects from wastes and residual amount of cement can be reduced.

v) A better measure by a New Construction Material's formed.

vi) Workability reduces at higher replacement of fly ash and vice versa it

increases with higher replacement of hypo sludge.

REFERENCES

1. " CPCB Annual Report 2004-2005 ".
2. Website : http:/www.moef nic in
3. Website : http:/www.crridom.gov.in
4. Singh Yashpal, '*Fly Ash Utilization in India*" http:/www.wealthywaste.com/fly-ash-utilization-in-india
5. "*High Volume Fly Ash Concrete Technology: Fly Ash summary status report in India*"prepared by CII. India and CANMET Natural Resources, Canada. www.hvfacprojectindia.com/summary Report.pdf
6. Dan Ravina and Mehta .P. K (1986), "*Properties of fresh concrete containing large amount of fly ash*", Cement and Concrete Research, Vol 16,pp:227-238.
7. Dan Ravina and Mehta. P. K (1988),"*Compressive Strength of low cement /high fly ash concrete*."Cement and concrete Research, Vol.18,pp:571-583
8. IS : 10262-1982, "*Indian Standard Recommended Guidelines for concrete mix design*",BIS,New Delhi.
9. Desai J P, *First HVFA concrete road in India at Ropar, Punjab*" The Indian Concrete Journal, April 2003, Vol 777,No.4,pp:1022-1025
10. Langley W.S., Carette G.G.,Malhotra V.M,"*Structural Concrete incorpating high volumes of ASTM class F fly ash*" , ACI mater J 86 (1989),pp,:507-514.
11. Gambhir M.L. "*Concrete Technology*" Tata McGraw Hill Company, New Delhi
12. *Indian Standard Specification for coarse and fine aggregates from natural source for concrete* IS 383:1970 Bureau of Indian Standards New Delhi.
13. *Indian Standard Code of practice for plain and reinforced concrete* , IS456:2000, bureau of Indian Standard , New Delhi
14. *Indian standard recommended guidelines for concrete mix design* , IS10262-2009 bureau of Indian Standards, New Delhi.