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STUDY ON EFFECT OF FLY ASH USED IN CEMENT AT JRP, REWA

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ABSTRACT

Fly ash consumption in concrete as fractional replacement of cement is gaining importance little by little. Technological enhancements in thermal power plant operations over and above collection technique of fly ash enhanced the quality of fly ash. Add-on cementitious materials such as fly ash is currently used as clinker replacement to diminish costs and environmental pollution related with the production of cement. To study the usage of fly ash in concrete, cement is substituted partially by fly ash in concrete. In this experimental work concrete mix equipped with replacement of fly ash and without fly ash. Effect of fly ash on workability, setting time, compressive strength and water content are studied. To identify the influence of fractional replacement of cement by fly ash on the properties of concrete, experiments were conducted on different concrete mixes.

KEYWORD : ***Fly Ash, Pozzolana, Concrete, Workability, strength.***

INTRODUCTION

Concrete is the highest used construction material in the world. Cement is the core binding material in concrete. Concluded the past 3 decades, the production of cement has grown speedily all over the world.Universal demand for electric power is gotten from thermal power plants. Coal is being scorched for the production of electricity in turn produces waste such as fly ash, bottom ash and boiler slag.Pozzolanas are constituents which have slight or no essential cementitious properties, but which grow cementitious properties in the presence of calcium hydroxide (lime) and water. Such materials frequently derived from natural deposits. Many modern pozzolanas still originate from natural deposits, but the bulk of pozzolana originate from the burning of powdered coal during electric power generation. This product is typically called fly ash. There are presently three classes of pozzolana defined by the ASTM: Class N, Class C, and Class F. Class N are natural pozzolanascalcined shale, calcined volcanic ash, etc. Class F is fly ash nominally produced from anthracite, bituminous, and some sub- bituminous coals. Class C is nominally produced from fly ash derived from combustion of lignite and some sub- bituminous coals[1]. Fly ash is a much cheaper material than Portland cement, so that large replacements can result in significant economic savings[2].Setting is defined as the onset of rigidity in fresh concrete. Although specific trials are defined, i.e. initial and final setting. Portland cement is the primary dynamic ingredient in concrete that causes setting. Fly ash frequently has a propensity to retard the time of setting of cement comparative to comparable concrete made without fly ash. Significant work has already been done to assess the impact on the setting time, Bleeding workability and Water Requirement, due to quantitative use of fly ash as a component[3-8].

Physical Requirements of fly ash as per BIS is shown in Table-1 and as per ASTM is shown in Table- 2.

Table -1: Physical Requirements of fly ash as per (BIS)

S.N.	Characteristics	Requirements (Siliceous and Calcareous Fly ash)
1	Fineness- Specific surface in m2/kg, (Min.)	320
2	Particle retained- on 45-micron IS sieve in % (Max.)	34
3	Lime reactivity- in N/mm2, (Min.)	3.5
4	Compressive strength-at 28 days in N/mm2, (Min.)	Not less than 80% of the strength of plain cement mortar cubes
5	Soundness by auto clave test- Expansion in % (Max.)	0.8

Table -2: Physical Requirements of fly ash as per (ASTM)

S.N.	Characteristics	Requirements (Siliceous and Calcareous Fly ash)
1	Particle retained- on 45- micron IS sieve in % (Max.)	34
2	Water requirement- in % on control, (Max.)	105
3	Strength Activity index –with Portland cement at 7 and 28 days, in %, (Min	75
4	Soundness by auto clave test- Expansion in % (Max.)	0.8

Fly ash is a fine particulate substantial with the main chemical constituents being SiO_2, Al_2O_3, $Fe_2O_3$and CaO. These chemicals are accountable for its pozzolanic activity. The general dissimilarity in three major constituents will be as follows: SiO_2 (25-60%), Al_2O_3 (1030%) and Fe_2O_3 (5-25%)[1].

Table -3: Chemical Requirements of Fly Ash (As per BIS)

S.N.	Characteristics	Requirements	
		Siliceous Fly ash	Calcareous Fly ash
1	SiO_2+Al_2O_3+Fe_2O_3 (% by mass, Min.)	70	50
2	SiO_2 (% by mass, Min.)	35	25
3	Reactive silica (% by mass, Min.)	20	20
4	MgO (% by mass, Max.)	5	5
5	SO_3 (% by mass, Max.)	3	3
6	Na_2O (% by mass, Max.)	1.5	1.5
7	Total Chlorides (% by mass, Max.)	0.05	0.05
8	Loss on Ignition (% by mass, Max.)	5	5

Table -4: Chemical Requirements of Fly Ash (As per ASTM)

S.N.	Characteristics	Requirements	
		Siliceous fly ash	Calcareous Fly ash
1	$SiO_2+Al_2O_3+Fe_2O_3$ (% by mass, Min.)	70	50
2	Moisture Content (% by mass, Max.)	3	3
3	SO_3 (% by mass, Max.)	5	5
4	Loss on Ignition (% by mass, Max.)	4	4

EXPERIMENTAL

Thermogravimetric Analysis (TGA) and differential thermogravimetric (DTG) methods are used to measure the modification in mass of powders as a result of the decomposition of segments at different temperatures. In cements, these performances are particularly useful to measure the consumption of calcium hydroxide by SCMs such as fly ash[9]. DTG can be used to measure the chemically bound water and carbonation due to the acquaintance of material to air. The weight loss versus temperature curve of a hydrated cement observed between 105° C to 1000°C can be separated.The continuous weight loss between 105° and 500°C is because of decomposition of calcium silicate hydrate, calcium sulphates, ettringite and other minor hydrates.The sudden change in mass between 400 and 500°C is generally due to the dehydration of calcium hydroxide.Thermogravimetric analysis (TGA) using the Mettler Toledo TGA/SDTA851e equipmentwas carried out in dry nitrogen atmosphere. The samples after curing at required ageswere put in isopropanol to stop the hydration. The samples were taken out after 7 days and stored in a desiccator under vacuum for 2 days. Silica gel was placed under samples to keep the samples free from moisture. The dry crushed sample to powder form were put in a crucible covered with an aluminium lid to evade carbonation and adulteration of the sample. The temperature range of the experimental instrument was from 20°C to 1000°C. The differential thermogravimetric analysis (DTG) graphs of neat cement paste (OPC) and cement fly ash blend paste (PPC) at 3 days, 7 days and 28 days.

RESULT & DISCUSSION

The Following table explores that the fly ash useddecreases the quantity of lime stone raising from mines. 28.3% fly ash is used in PPC in JRP which reduces the consumption of fossil fuel and ultimately reduces the generation quantity of different pollutant like suspended matter, emission of $SO_x$and $NO_{x.}$IS:4032-1985,W1-1010,IS:4031-1988 are the set of methods of analysis of cement, are used in present research work at QC lab.

It found that the particle size distribution and amorphous content is sufficient to evaluate the strength potential of a fly ash in concrete.When water is mixed with fly ash, it primarily lowers pH as the sulphate deposited on the surface.The pH is characteristically 9-11 for fly ash, even though the pH for those ashes with higher free calcium oxide contents can increase to 12.The chemical and physical properties of fly ash particles are a purpose of the mineral matter in the coal, the ignition conditions, and post-ignition cooling. During the ignition process, the heat causes the inorganic mineral to become unsolidified or instable or to react with oxygen.

Table:5: Analysis of Ordinary Portland Cement (OPC)

Characteristics	Requirement	Methods of Test	Sample Size	Sampling Method	Frequency
Composition					
Clinker(%w/w)	95-98				
Gypsum(%w/w)					
Mineral	03-05				
Chemical	02-04				
Chemical					
LSF	0.66-1.02	IS:4032-1985	5 kg	W1-1010	Day/Weekly Average
AM	Min. 0.66	do	do	Do	do
IR(%w/w)	Max 3.0	do	do	Do	do
MgO (%w/w)	Max 6.0	do	do	Do	do
SO_3 (%w/w)	Max 3.0	do	do	Do	do
LoI (%w/w)	Max 5	do	do	Do	do
Chloride (%)	Max 0.1	do	do	Do	Weekly Average
Physical					
Fineness (M2/Kg)	Min 225	IS:4031-1988	1 Kg	Do	Day Average
Initial Setting Time (Min.)	Min. 30	do	do	Do	do
Final SettingTime (Min.)	Max. 600	do	do	Do	do
Le-Chatelier Expansion (mm)	Max. 10	do	5 Kg	Do	do
autoclave Expansion (%)	Max. 0.8	do	do	Do	do
Comp. Strength (Mpa)					
3 Days	25.0 min	do	do	Do	do
7 Days	35.0 min	do	do	Do	do
28 Days	45.0 min	do	do	Do	do

Table:6: Analysis of Pozolana Portland Cement (PPC)

Characteristics	Requirement	Methods of Test	Sample Size	Sampling Method	Frequency
Composition					
Clinker(%w/w)	60.83				
Gypsum(%w/w)					
Mineral	03-05				
Chemical	02-04				
Pozzolana	15-35				
Chemical					
IR(%w/w)	13.5-38.0	IS:4032-1985	5 Kg	W1-1010	Day/Weekly Average
MgO (%w/w)	Max 6.0	do	do	Do	do
SO_3 (%w/w)	Max 3.0	do	do	Do	do
LoI (%w/w)	Max 5	do	do	Do	do
Chloride (%)	Max 0.1	do	do	Do	Weekly Average
Physical					
Fineness (M2/Kg)	Min 225	IS:4031-1988	5 kg	Do	Day Average
Initial Setting Time (Min.)	Min. 30	do	do	Do	do
Final SettingTime (Min.)	Max. 600	do	do	Do	do
Le-Chatelier Expansion (mm)	Max. 10	do	do	Do	do
autoclave Expansion (%)	Max. 0.8	do	do	Do	do
Comp. Strength (Mpa)					
3 Days	20.0 min	do	do	Do	do
7 Days	28.0 min	do	do	Do	do
28 Days	38.0 min	do	do	Do	do

CONCLUSION

The main conclusions from this study are fly ashes mostly prolong the induction period, finer fly ashes can increase the rate of hydration during the acceleration period.In spite of the relatively low reactivity of the fly ashes, many of the mortars with fly ashes gave strengths comparable to the strength of the mortars containing ordinary Portland cement.

It has been recognized that concrete containing fly ash will carbonate at a similar rate compared with Portland cement concrete of the same 28-day strength[10-15]. This means that fly ash rises the carbonation rate on condition that the basis for comparison is an equal w/cm. It has also been shown that the upsurge due to fly ash is more distinct at higher levels of replacement and in poorly-cured concrete of low strength[16-17].

Mortars with finer fly ashes commonly showed higher strengths. Amalgamation of fly ash in concrete can save the coal and thermal industry removal cost and produce a "greener" concrete for construction. With the use of mineral admixture, the cost is significantly reduced due to no use of mechanical vibrators plus viscosity modifying admixtures also evaded.

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