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Enhancing the Characteristics of Fly Ash Based Composite Material

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Abstract*—Coal is one of the primary sources of energy all over the world. About 70% of the total energy consumption in the country is fulfilled by coal. India has one of the largest reserves of coal in the world. Indian coal has high ash content and low calorific value. The energy derived from coal in India is about twice that of energy derived from oil, as against the world, where energy derived from coal is about 30% lower than energy derived from oil. Thermal power stations produce large quantities of fly ash. High ash content coal contributes to large volumes of fly ash. The current production of fly ash is about 120 Million tonnes per year and is expected to reach around 170 Million tonnes by 2012 A.D. This has posed a serious disposal and ecological problem in addition to occupying a large tract of scarce cultivable land. The country's dependence on coal for power generation is increasing and so the production of fly ash will be more. Fly ash causes air, water and soil pollution when it is exposed to environment. This project is an attempt to find a suitable utilization for a particular fly ash sample. The area required for disposing fly ash will be minimised and so damage to the environment will be minimum. In this project various experiments were carried out on fly ash samples. Based on the results obtained from these experiments, a suitable use for the fly ash is ascertained. The main constituents of the composite are:

1. Fly ash 2. Lime 3. Gypsum 4. Cement

Different samples were taken with different lime proportions (0, 2, 4 and 6) % of fly ash (by weight), percentages of gypsum were (0, 1, 2, 3, and 4 and 5) % of fly ash (by weight) and that of cement were (0, 2, 4, 6, 8 and 10) % of fly ash (by weight) and their properties were studied. The results from these above experiments helped in determining the potential of the fly ash for use, in making composite materials. Composite material made of fly ash is subject to a variety of different loading conditions, and so different types of stresses develop. Based on the different strength of composites it can be used in various geotechnical applications like construction of roads, Embankment, dams and reservoirs and mine filling.

***Keywords*— Coal, Fly Ash, Lime, Gypsum, Composite Materials**

I. INTRODUCTION

Composite materials also called composites are materials made from two or more constituent materials with significantly different properties, that when combined, produce a material with characteristics different from the individual components. They can be used in buildings, bridges, pavements, or any other of areas of service. The composite used in any case must have the strength and ability to resist the external force from applied loads, from the weight of the concrete itself or from a combination of these.

Therefore the composition of the composites is of utmost importance.

- Fly ash

Fly ash is the residue left from burning coal, which is collected on an electrostatic precipitator. It mixes with flue gases that result when powdered coal is used to produce electric power. Since the oil crisis of the 1970s, the use of coal has increased. In 1992, 460 million metric tons of coal-ash was produced worldwide. About 10 percent of this was produced as fly ash in the United States. In 1996, more than 7 million metric tons were used in concrete in the U.S.

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Economically, it makes sense to use as much of this low-cost ash as possible, especially if it can be used in concrete as a substitute for cement. Earlier in around 1914 it was recognized as pozzolanic ingredient for use in concrete which means it's a siliceous or siliceous-and-aluminous material that reacts with calcium hydroxide to form cement. When portland cement reacts with water, it produces a hydrated calcium silicate (CSH) and lime. The hydrated silicate develops strength and the lime fills the voids. Properly selected fly ash reacts with the lime to form CSH–the same cementing product as in portland cement. This reaction of fly ash with lime in concrete improves strength. Typically, fly ash is added to structural concrete at 15-35 percent by weight of the cement, but up to 70 percent is added for mass concrete used in dams, roller-compacted concrete pavements, and parking areas. Special care must be taken in selecting fly ash to ensure improved properties in concrete.

The current production of fly ash is about 120 Million tonnes per year and is expected to reach around 170 Million tonnes by 2012 A.D (Kumar and Singh, 2006). This has posed a serious disposal and ecological problem in addition to occupying a large tract of scarce cultivable land. Although the beneficial use of fly ash in concrete, brick making, soil stabilization treatment and other applications have been recognized, only a small quantity of the total fly ash is being utilized in our country currently in such applications.

There are two classes of fly ash: "F" is made from burning anthracite and/or bituminous coal, and "C" is produced from lignite or sub-bituminous coal.

Till now most of the research works have been on the use of fly ash in cement and concrete.

- PREPARATION OF FLY ASH COMPOSITE MATERIAL

The fly ash is chosen for its low lime content as well as its availability in abundance. On the basis of the literature reviewing, different lime proportions (0, 2, 4 and 6) % of fly ash (by weight) were selected. Similarly, percentages of gypsum were (0, 1, 2, 3, and 4 and 5) % of fly ash (by weight). And that of cement are (0, 2, 4, 6, 8 and 10) % of fly ash (by weight).

Additives required:

1. Fly Ash
2. Lime
3. Gypsum
4. Cement

II. EXPERIMENTAL WORK

Following tests were done on the fly ash samples:-

i. Moisture content
ii. Specific gravity
iii. pH
iv. Compressive strength.

i. MOISTURE CONTENT

- Percentage of moisture = (loss in weight / wt of coal taken) * 100
- Moisture content of the fly ash sample collected from PTPS is found to be 0.15 % Moisture content of the fly ash sample collected from ETPS is found to be 0.2 %

ii. SPECIFIC GRAVITY

- Specific Gravity of the fly ash sample collected from PTPS is found to be 2.35.
- Specific Gravity of the fly ash sample collected from ETPS is found to be 2.20

iii. pH DETERMINATION

At the time of addition of water to fly ash the sulphate deposited on the surface of the particles is brought into solution as sulphuric acid and therefore the pH is low. The pH rises significantly as calcium is leached into solution with variable amount of lime, gypsum and cement by percentage of weight of fly ash. Generally the pH is around 9 to 11 for fly ash. Addition of only a very small quantity of free calcium is enough to increase the pH. The pH is on the lower side i.e. around 9 as most of the water soluble materials that can influence the pH were washed out.

iv. COMPRESSIVE STRENGTH

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Compressive strength data for the core specimen containing fly ash obtained from Panipat Thermal Power Plant fly ash and Yamuna Nagar thermal power plant fly ash is given in Table.

PARTICULARS	*CURING DAYS*	*Compressive strength (MPa)*	
		Fly Ash from PTPS	*Fly ash from YMTPS*
SAMPLE NO.1	*7*	*0.5*	*0.4*
SAMPLE NO.2	*14*	*0.95*	*0.80*

The results compressive strength decreases when fly ash quantity was increased from certain proportions of the cement used by weight. The sample mix, containing fly ash with other mixing proportions showed compressive strengths of 0.6 MPa at the 7-day age and 1 MPa at the 14-day age of curing.

Thus, these results indicate that concrete containing low-calcium fly ash can be proportioned to meet the requirements of strength and workability for structural grade concretes. The desired strength can be achieved by adjusting the amount of fly ash, lime, gypsum and cement for the same water to cementitious ratio to achieve the desired strength and workability.

From the investigation of experiment it showed that at high fly ash replacement levels, the proportion of fly ash concrete strength to reference concrete strength increased substantially from 7 day to 14 days of curing.

CONCLUSIONS

After conducting all the experiment related to Enhancing the Characteristics of Fly Ash Based Composite Material the following are the factors affecting Strength Gain of Lime-Cement-Gypsum-Fly ash composite material:

FLY ASH CHARACTERISTICS

Fly ash type (classification, particle size distribution, etc.)

Fly ash chemistry (pH, cation exchange capacity, etc.)

Fly ash mineralogy (silica content, presence of gypsum, etc.)

Moisture content

Organics (type, amount, degree of decomposition, origin)

MIXING

MixingDevice

Mixing time

Types of stabilization agent/agents

Proportions of stabilizer

Time restraints during mixing and compacting

COMPACTING

Packing pressure

Packing tool /method

Sample size (mould size)

CURING

Curing time

Curing temperature

Curing humidity

Applied load

Strength test

Sample extraction

Type of test

Loading rate

cyclic loading

general findings

for a given proportion, increase in the dose rate increases the strength of the sample

the strength of the fly ash composite appears to be very sensitive to the addition of lime.

the strength of the fly ash composite increases with increase in setting time.

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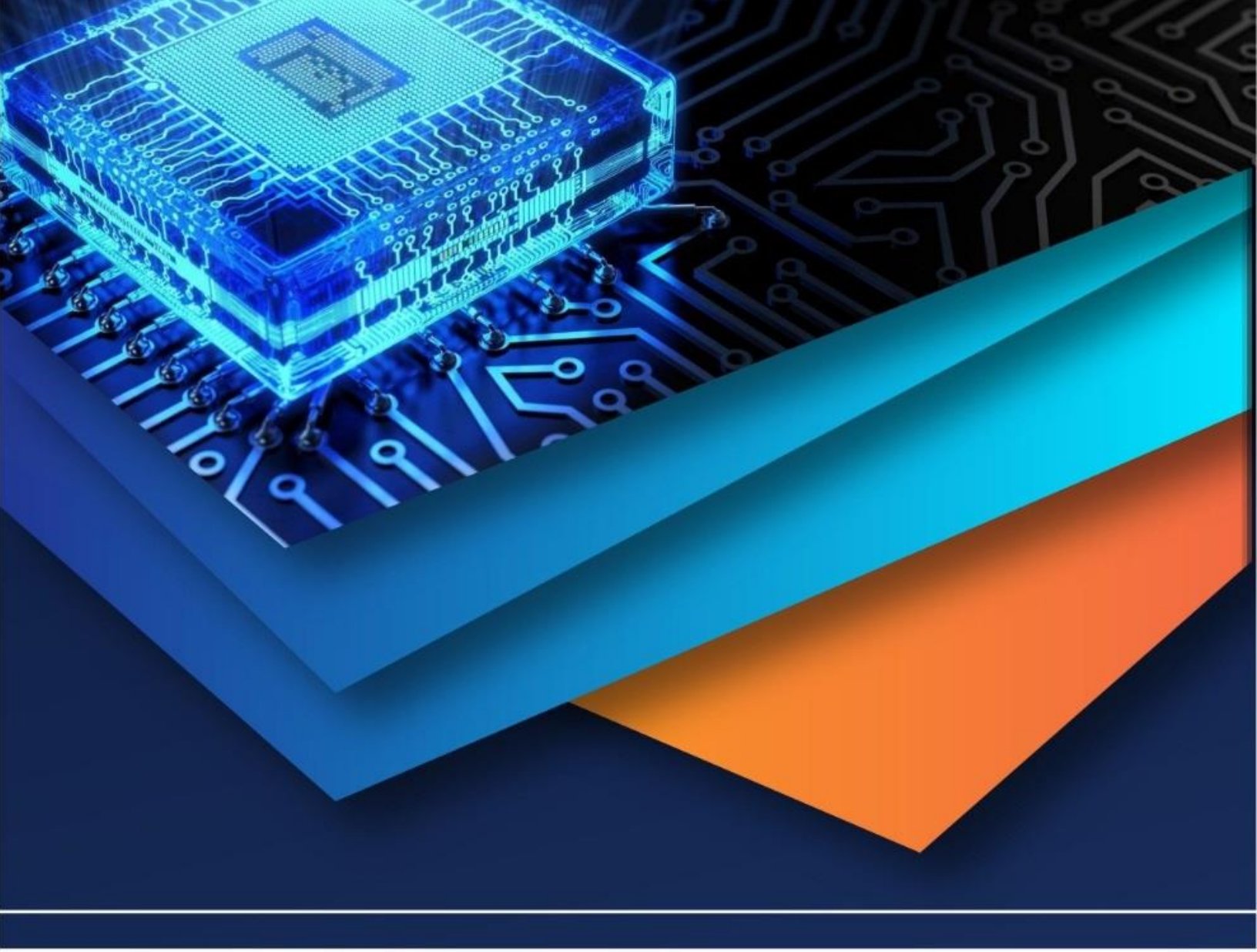

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