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Experimental Study on Partial Replacement of Cement with Coal Fly Ash

Anurag Singh[1], Shikha Pal[2]

[1]M.Tech Student, Department of Civil Engineering, Lucknow Institute of Technology, Lucknow, U.P., (India),
[2]Assistant Professor, Dept. of Civil Engineering, Allenhouse Institute of Technology, Kanpur, U.P., (India),

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Abstract - *Presently about 105 million tons fly ash is generated every year in India as a by-product of coal consumed in the thermal power plants. The thermal power plant is only the source to produce 65% of the total electricity produced in our country. Due to the presence of toxic metals in fly ash, it causes water pollution through percolation. It also causes silting and other problems for human and aquatic life, therefore, it cannot be disposed in sea or river[1]. Fly ash is being consumed (tones/day) by several organizations in production of cement, bricks, cellular blocks, asbestos sheets, filling low lying areas and construction of roads This paper deals with the effect of coal fly ash mortar and the resulting increase in flexural bond strength. However, it is still desirable to have the mortar be the weaker link to avoid stress induced failure in units thus requiring replacement of masonry rather than repainting of mixture. Coal fly ash modification has resulted in both improved flexural and compressive strengths. Ordinary Portland cement and Portland pozzolana cement were recovered by ground coal ash. Normal consistency and setting time of the pastes containing ordinary Portland cement and coal ash for 0%, 5%, 10%, 15%, 20% and 25% of the ordinary Portland cement replacement were tested. The compressive strength of mortars containing ordinary Portland cement with coal ash from 5% to 25% replacements was also investigated. Six different concrete mixes with the coal ash replacing 0%, 5%, 10%, 15%, 20% and 25% of the ordinary Portland cement were prepared for 30MPa concrete with water to cement ratio of 0.46 - 0.55, where maximum strength is obtained at w/c of 0.55. It can therefore be concluded that 15% replacement of cement by coal ash results in a similar concrete properties.*

***Key Words*: Compressive Strength, Workability, Fly Ash, Replacement.**

1.INTRODUCTION

There are various reasons behind choosing fly ash as a replacement material can be further explained as Fly ash is also called “pulverized fuel ash” and is a coal combustion product . Green concrete is formed by mixing fly ash with concrete. It is so called as fly ash is environmental friendly. Fly ash if not used properly produces a lot of environmental problems as ground water contamination, fugitive dust, health issues etc. Fly ash has the required strength to replace cement in concrete and is highly durable. Fly ash is commonly replacing 0 to 30% of the cementitious material by mass. Fly ash is cost efficient and thus helps us in maintaining economical balance. It is also said to reduce internal temperature and improve workability. Because of this, it results in ball bearing action of spherical particles of fly ash. It also improves the grading of the mixture because the fine particle distribution system is smoothened out. It also reduces the amount of water required. Fly ash increases compressive strength, pumping ability, concrete finishing, flexural strength, corrosion, shrinkage and alkali silica reaction. The most attractive property is durability of fly ash concrete as compared to traditional PCC.

2. MATERIALS

A. Cement: Ordinary Portland cement is used in the project work, as it is readily available in local market. The cement used in the project has specific gravity of 3.15.

B. Coarse Aggregate: Crushed angular coarse aggregate were used. The specific gravity is 2.65. The coarse aggregate used in the project work are 20 mm down grade.

C. Fine Aggregate: River sand was used as fine aggregate. The specific gravity is 2.40. The fine aggregate used in the project work is 4.75 mm down grade.

D. Fly ash: Fly ash is powder recovered from the gases of coal fired electricity production Inexpensive.

2.1 Cement

Ordinary Portland cement mortar, most commonly known as OPC mortar or just cement mortar, is produced by mixing powdered OPC, aggregate and water. It was invented in 1794 by Joseph Aspdin and later on patented on 18 December 1824. It was popular during the late nineteenth century, and had by 1930 it became more popular than lime mortar as construction material because of its advantage over lime mix mortar. The advantages of Portland cement are that it sets hard and quickly speeding up the construction works. In addition, skilled workers are needed to build a building out of Portland cement mortar. To talk about strength of mortar, it changes basically on the ratio of cement, lime and sand used in mortar. The ingredients and the mix ratio for each type of mortars are specified under the IS CODES. be used. Other font types may be used when required for special purposes. It is a predetermined and homogeneous mixture of materials principally containing lime (CaO) and silica (SiO_2) with low concentrations of Alumina (Al_2O_3) and iron oxide (Fe_2O_2). Ordinary Portland cement (OPC) is the most important type of cement. The OPC is classified into three grades depending upon the strength of the cement at 28 days

when tested as per IS 4031-1988, namely 33 grade, 43 grade and 53 grade.

2.2 Fly Ash

Coal fly ash is a byproduct of coal which is one of materials with potential pozzolanic property that can be blended with Portland cement. Made mainly of silica, this product can be used as a composite of minerals in mortar mix and concrete. Depending on the incinerating conditions, the resulting coal fly ash may contain satisfactory amount of SiO2 and Al2O3, making its use as a supplementary cementitious material (SCM) to reduce the quantity of cement to be used in blended cement. The coal fly ash consists of almost 50% of cellulose, 25% of hemicelluloses and 25% of lignin. Each ton of coal fly ash approximately 26% of coal (at a moisture content of 50%)and 0.62% of residual ash. The residue after the fire reveals a chemical composition of silicon dioxide (SiO2).

Table -1: CSA Specification of Coal Fly Ash

Type F	<7% CaO
Type CI	8-19% CaO
Type CH	>20% CaO

Fig -1: Coal Fly Ash

2.3 Aggregates

Natural sand with a size of 4.75 mm (zone II) was used with a Sp. gravity of 2.6 and a fineness modulus 2.63. The environmental collection with a maximum size of 40 mm was used with a Sp. gravity of 2.7 and a fine modulus 7.51.

2.4 Water

The quality of water is important because foreign material present in water can adversely affect the strength of concrete. Water used for the production and treatment of concrete must be sufficiently clean and free from toxic substances such as oil, acid, sugar, mud, alkali, salt, organic matter and other hazardous substances in concrete. When water is drunk, it is considered appropriate to make concrete. Hence, potable tap water available at Geotech Engineering Lab was used in this study for mixing and curing.

2.5 Admixture

Admixture is defined as essential, with the exception of cement, water and compounds used As a concrete ingredient it is also added to the bench immediately before or during mixing. Super plasticizers are usually distinctive in their nature, and they make possible the production of concrete/mortar which in its new and hardened state, it is very different from concrete made using a water-based mixer. In this research work, Ligno-sulphates as super-plasticizer is used. Study shows that the super plasticizers inhibit the hydration reaction causing the reduced formation of Ca(OH)2 as well as a lower degree of polymerization of the silicate anions.

3. METHODOLOGY

3.1 OMC and MDD Test

In this test total sample of 3 kegs for each sample are taken and water should be added 8% of the weight of the sample and mixed thoroughly. The sample should be compacted in three layer being given 25 blows from the 2.6 k. g hammer drop from a height of 310 mm above the sample. The operation of dropping the hammer is such that, the operator should ensure that the tube of rammer is kept clear of soil so that rammer always falls freely. Now, take some amount of sample into crucible and weight it. Then after put this sample into oven for 24 hour and again weight the dry sample. And finally check the weight of empty crucible. This process is continued by increasing the amount of water by 4% till the weight of sample decreases with increase in water..

3.2 Workability

A well-balanced fly ash concrete mix will work better compared to Portland cement of the same concrete slump value. This means that, at a given slump, fly ash concrete flows and consolidates better than a conventional Portland cement concrete when vibrated. The use of fly ash also improves bonding and reduces concrete separation. The circular particle structure softens the mix making it easy to pump and reduce wear on the equipment.

3.3 Compressive Strength Test

The compressive strength is one of the most important design parameters required for mortar. This series of tests determines the strength attained by the mortar whose cement quantity is replaced with CFA varying from 0 to 25% and compressive strength at various percentage replacement of CFA is found . The results plotted on the graphs below are the average value of the three cubes tested at each age and CFA percentage. Compressive strength is defined as resistance of mortar to axial loading. Cubes are put in the machine and after tighten its wheel start button is pressed as

pressure is begin to apply. The reading is note down where the cracks are developed in the cubes.

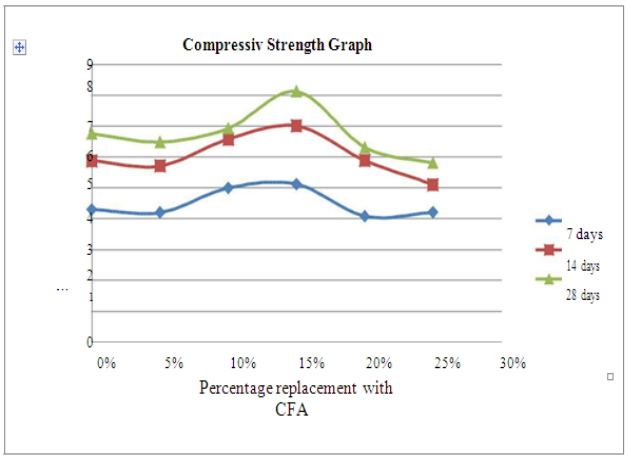

Chart-1 Compressive Strength Variation

4. CONCLUSIONS

The use of coal as a cement replacing material in concrete production was studied and after the research work is done, the following conclusions were made:

1. Higher replacements of cement by coal ash resulted in higher normal consistency (implying higher water demand for certain workability) and longer setting time.
2. The workability of mortar and concrete containing coal ash decreases slightly as the coal ash content increases which is due to the higher water demand of coal ash.
3. The investigation of this thesis has revealed that replacement of ordinary Portland cement and Portland pozzolana cement by coal ash from 10% to 15% leads to better compressive strength than that of the control mortar with 100% ordinary Portland cement. And the compressive strength decreases as the coal ash replacement increases over 15%.
4. After all the strength obtained by using CFA in OPC and PPC both with partial replacement of cement ,the strength obtain with 15% replacement of cement by CFA in maximum is all cases.

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