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UTILIZATION OF FLY ASH IN CONSTRUCTION INDUSTRIES FOR ENVIRONMENT MANAGEMENT

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ABSTRACT

Fly ash is naturally cementations coal combustion by-product. A fine glass powder recovered from the gases of burning coal during the production of electricity is fly ash. The combustion of powdered coal in thermal power plants produces fly ash. Disposal of high amount of fly ash from thermal power plants absorb huge amount of water, energy and land area by ash ponds. Generation of large quantities of industrial waste is one of the most important ill effects of these global processes. Therefore, the problems related with their safe management and disposal has become a major challenge to environmentalists and scientists. Second related problem is the pressure on land, materials and resources to support the developmental activities, including infrastructure.

This fly ash has several uses in construction industry like fill material in concrete, additives in road construction, brick making mosaic tile production etc. The paper focuses on the current utilization fly ash in construction industry.

Key words: *Fly ash; Construction, Emissions, Particulate Matter (PM)*

INTRODUCTION

Flyash is a by-product of coal-fired electric generating plants. Fly ash is one of three general types of coal combustion byproducts (CCBP's). The use of these byproducts offers environmental advantages by diverting the material from the waste stream, reducing the energy investment in processing virgin materials, conserving virgin materials, and allaying pollution. Coal-based thermal power stations have been operated for more than 50 years in India, but the concept of developing environment-friendly solutions for fly ash utilization is major concern now a days. Overall fly ash utilization in India stands at a fairly low level of about 15% of the quantity generated. Several factors to be considered for fly ash utilization in India, among numerous factors that account for the low level of utilization, are listed as follows:, a. Poor understanding of the chemistry of fly ash and its derivatives for proper end applications. b. Absence of standards and specifications for fly ash products. c. Lack of reliable quality assurance for fly ash products Poor public awareness about the products and their performance. d. Non-availability of dry fly ash collection facilities Easy availability of land with top soil at cheap rates for manufacturing conventional bricks. e. Lack of proper coordination between thermal plants and ash users. Fly ash utilization in the country is gaining momentum owing to the stringent regulations that the Ministry of Environment and Forests, Government of India has stipulated, as also to increased awareness about the benefits of using fly ash for various products (MoEF, 1999, 2001 & 2011).

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Fly ash from coal-fired thermal power stations is an excellent potential raw material in construction industry.

FLY ASH IN CONSTRUCTION MATERIALS

Coal fly ash is a naturally-occurring product of the coal combustion process. It is nearly identical in composition to volcanic ash. When mixed with calcium hydroxide, it has many of the same properties as cement. Replacing a portion of the cement with fly ash creates a cementitious material that, when used as an input with aggregates, water and other compounds, produces a concrete mix that is well-suited to road, airport runway and bridge construction (Motz and Geiseler, 2001). Fly ash concrete has a number of very significant, well-documented benefits that make it a mixture of choice for many state and local transportation departments and transportation engineers. It is more durable, yet less expensive than other traditional Portland cement blends. Fly ash concrete has also been praised for its environmental benefits as a “green” building material—putting to use an energy production byproduct that reduces the demand for carbon-intensive portland cement and requires less water in the hydration process.

FLY ASH IN CEMENTS

As concrete technology evolves and environment deteriorates, it is now clear that the unlimited use of construction materials, with initial cost being the prevalent selection criterion is a practice of the past. Environmental concerns expressed by new legislation and commercial trends have pushed the concrete industry towards minimizing its environmental impact, mainly by reducing CO2 and PM emissions as well as natural resource consumption (Mrouch et al., 2001; Zhao et al., 2010). Since there is great demand for raw materials, and natural resources are scarce, it should be expected that the use of high volumes of alternative materials in concrete would be economically advantageous. Research, however, shows that there is a low profit margin for natural aggregate replacement, either due to lack of financial incentives or inadequate legislation (Marinkovic et al., 2010). Also, the environmental gain from using alternative aggregates is limited, depending on transport distances (Rao et al., 2007). In order for the construction industry to aim at producing such concretes, the environmental and financial gains must be clear and the technological innovations must be available. Knowledge dissemination seems to be an important factor regarding waste recycling and by-product utilization, since countries that provide government support on new technology implementation and have also introduced relevant standards for the utilization of waste materials in concrete show considerably higher utilization rates (Neville, 2000). Depending on available resources, supplementary cementing materials (SCM) like fly ash can be used as partial replacement for Portland cement (Poon et al., 2002), while alternative materials can be used to substitute natural aggregates, producing a greener concrete in terms of resource and energy consumption (Zakaria and Cabrera, 1996; Malhotra and Mehta, 1996). The fact that the use of fly ash can, in many cases, increase the durability of concrete without compromising strength (Papadakis and Tsimas, 2005) has attracted a lot of attention regarding their incorporation in concrete.

On the other hand, the extensive use of alternative materials as aggregates in concrete was delayed, mainly because cheap, good quality natural aggregates were readily available in most parts of the world, but also because extensive research regarding the properties of concrete with alternative aggregates is required (anonymous, 2012). Legislation against quarrying and restriction in landfilling and deposition of waste, however, has increased interest in this area (Anonymous, 1999). Thus, it is of great importance that research aims at providing solutions for maximizing the utilization of alternative materials, both binders and aggregates, in construction. Construction and demolition waste (CDW), high calcium fly ash (HCFA) and Electric Arc Furnace (EAF) slag are materials in abundance which will continue to be produced in large volumes in the future. All these alternative materials show considerable potential for utilization in a high added value application such as concrete, but currently find little use.

FLY ASH IN BRICKS

Two Indians have invented a climate-friendly technology that produces bricks without using any coal whatsoever. The new fly ash brick technology has the potential to completely eliminate carbon emissions from India's large brick-making industry which burns huge amounts of coal and emits millions of tons of carbon dioxide each year.

Another significant benefit of the new technology is that unlike clay bricks, which use valuable topsoil as raw material, the new method uses fly ash, an unwanted residue from coal-fired power plants. This fly ash is presently dumped on acres of land, damaging both the environment and the health of populations around power plants. The use of fly ash is particularly important as, with India's plans to use coal to expand power production, the generation of fly ash is set to increase while the availability of topsoil is bound to decrease.

A further advantage is that fly ash bricks can be produced in a variety of strengths and sizes. This means that apart from their conventional use in building walls etc. fly ash bricks can also be used for the construction of a variety of infrastructure projects such as roads and pavements, dams and bridges.

Given the numerous benefits of the new fly ash brick technology, the inventors are providing the technology without invoking the patent. The government of India has also issued a number of notifications encouraging its use. In addition, a World Bank project is helping to promote the new method by enabling entrepreneurs to earn carbon credit revenues to offset some of their initial costs.

More than 16,000 FaL-G brick plants are now in operation throughout the country, up from just 100 in 2000. Fly ash bricks account for about one-sixth of India's annual brick production, putting over 20 million tons of fly ash to productive use each year (Swain, 1979).

FLY IN ROAD CONSTRUCTION

Fly ash can be utilized in many ways in the field of civil engineering applications, roads, railways and dam embankments. Fly ash has been used in low lying areas as structural fill for developing residential sites for mine filling. Embankments for roads and highway bridges were constructed using the fly ash to generate from coal fired power plants. Fly ash has also been used as backfill materials behind the retaining walls (Gray, 1972). Literature suggests that fly ash has been also used as Geotechnical properties for supporting structural loads (Leonards and Bailey, 1982). They have stated that load tests carried out on compacted fly ash beds show that fills materials can support large loads with small settlements. A few major projects of fly ash are such as construction of Okhla fly over bridge in Delhi using about 4,800 tonnes of fly ash; Construction of reinforced fly ash approaches embankment at the Hanuman statue; Development for LPG plant by Indian Oil Corporation using about 300,000 tones of pond ash from National Thermal Power Corporation (NTPC), Badarpur; and Construction of approach embankment of the Nizamuddin bridge in Delhi uses about 150,000 tones of fly ash.

Embankment fill is typically an earthen material to use to create a strong stable base. Embankment fills are usually constructed by compacting earthen materials. Therefore, compaction and permeability properties are very important to good performance of the embankment. The shear strength and compressibility is also important measures of the compacted material. Local soil at a backfilled site may be too weak to support. For this purpose, local soil is replaced by compacted fly ash material as fill to provide the needed bearing capacity and strength. The use of fly ash in highway embankments and fills is the second highest use of this material. It behaves like a fine sand material but has a lower density (Murthy et al, 2000; Mckerall et al., 1982). Embankments and fills are also the highest use application of bottom ash. Bituminous (Pozzolanic) fly ash is more frequently used to construct embankments and structural backfills than sub bituminous or lignite (self cementing) fly ash (ADAA, 2009). This is due in part to the self-cementing characteristics of the latter type, which hardens almost immediately after the addition of water (CCAA, 2011).

The graphical representation of PM emission data from construction site are as follows:-

The above PM sampling data shows that the PM emission at construction area are in higher side during the working hours of the construction work and it will decrease on the later part of the day as construction work stop and can create an health problem in the nearest locality.

ENVIRONMENTAL BENEFITS OF UTILIZATION FLY ASH IN CONSTRUCTION MATERIALS

Use of Fly ash as a green building material both reduces the demand for carbon-intensive Portland cement and requires less water in the setting process.

In the published technical literature some of the effective strategies to produce more sustainable concrete is to replace a portion of the cement conponent with one or more SCMs such as fly ash (Wilson and Tagaza, 2006). The benefits of the use of fly ash towards more sustainable construction materials include:-

- Reduction in CO2, PM emissions and embodied energy;
- Reduction in resource use;
- Reuse of industrial by-products as alternative raw materials; and
- Sustainability achieved through efficient design and enhanced durability.
- The feasibility of using fly ash as an alternative to activated carbon was examined for colour removal from synthetic dye solutions.

CONCLUSION

The literature review revealed that fly ash finds a numerous application in the cement industries, construction industry, polymer industries and in pollution control. Due to limited water resources and increasing pollution levels, many methods are used for removing pollutants from wastewater, and among them, the adsorption method is widely used because it is versatile as it removes diverse pollutants. The fly ash produced as waste materials can be a good construction material for highway or expressway embankments. Fly ash has been successfully used in more than ten highway embankments construction projects across the country. The use of fly ash in the construction materials also proved to reduced the PM emission at the construction site.

While there is already awareness as to the benefits that fly ash can provide in the quest for sustainable construction material, given the volumes of fly ash being produced and technological advances in the construction industry, much potential remains to further exploit its advantages. The challenge to achieve a sustainable concrete future will however require a paradigm shift by designers and builders from an accelerated construction schedule approach to a focus on increasing durability, service life, embodied energy, through the conservation of our natural resources using by-products where appropriate.

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