Fly Ash an Environmental Issue and construction material

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Abstract : Fly ash, a waste generated by thermal power plants and from a municipal waste incineration plant is as such a big environmental concern. In this paper is carried out to study the utilization of fly ash as a construction material, so as to provide an environmentally consistent way of its disposal and reuse. Due to these cementitious properties know a day's Fly ash can be used as prime material in many cement-based products, such as poured concrete, concrete block, and brick.

Index Terms **– Fly ash, Waste, thermal power, Environmental concern, use of fly ash**

1. INTRODUCTION

Fly ash is a fine powder that is a byproduct of burning pulverized coal in electric generation power plants. Fly ash is a pozzolan, a substance containing aluminous and siliceous material that forms cement in the presence of water. When mixed with lime and water, fly ash forms a compound similar to Portland cement. This makes fly ash suitable as a prime material in blended cement, mosaic tiles, and hollow blocks, among other construction materials. When used in concrete mixes, fly ash improves the strength and segregation of the concrete and makes it easier to pump.

2. Fly Ash Generation and Environmental Issue

Fly Ash is one of the coal combustion products, composed of the fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom of the boiler is called bottom ash. The recycling of fly ash has become an increasing concern in recent years due to increasing landfill costs and current interest in sustainable development. Fly ashes having high content of toxic/ heavy metals may be used deposited under expert advice.

The environment ministry's expert panel opined that the interface between the water and fly ash at the bottom of fly ash filled void results in leaching of heavy metals into groundwater system as evident by high levels of trace elements particularly heavy metals in ground water samples collected from sites located close to the ash filled voids.

It also found out that there is Reduction in recharging of groundwater due to fly ash filled mine voids.

Ash-filled voids cannot support tree species because of poor root system development which in turn results in uprooting of trees even by low velocity winds.

Further according to a recent study by the Centre for Science and Environment (CSE), an NGO working on environmental issues, fly ash disposal remains a major problem with only about 50-60% of the total fly ash generated by the power sector being utilized. Around 173 million tones of fly ash was produced across India in 2013-14.

The remaining is dumped into poorly designed and maintained ash ponds. As per estimates, about a billion tones of this toxic ash lie dumped in these ponds, polluting land, air and water. By 2021-22, the thermal power sector is estimated to produce 300 million tones of fly ash a year and with that, utilization of all the fly ash being generated is going to become even tougher.[5]

Fly ash can be defined as a waste residue that is released from coal combustion process in electric power stations. Fly ash is the unburned residue that is carried away from the burning zone in the boiler by the flue gases and then collected by either mechanical or electrostatic separators. Malaysia started the development of coal-fired electric power station in year 1987 and currently there are six coals fired electric power station in Malaysia. Those electric power stations produce about 6.8 million tones of fly ash. According to statistics, fly ash rate of production is clearly far outweighs consumption due to increased amounts of energy being generated by coal-fired power plants and widely available across the globe as shown in Table 1

Table 1. Fly ash production in different countries [1]

Country	Amount of Production (million tons/year)	Country	Amount of Production (million tons/year)
India	112	France	3
Malaysia	6.8	Germany	40
China	100	Denmark	2
Canada	6	Australia	10
USA	75	Netherland	2
UK	15	Italy	2

Netherland 2 Fly ash contains silica, alumina, ferric oxide and other oxides material that might turn fly ash into hazardous material. This hazardous material is contributing factor in air, water and soil pollution that lead to human health problems and various geo-environmental issue. These bad situations will interrupt the entire ecological cycles if not properly disposed therefore good waste management practice needed to sustain a healthy environment. Fly ash emissions from coal combustion units show a wide range of composition with present of elements below atomic number 92 and considered as major source of air pollution. The ultrafine particle of fly ash will behave like cumulative poisons after remain for long periods of time when reaches the respiratory region. As a result, several physiological disorders and other related health problems such as respiratory problem, cancer, anaemia, hepatic disorder, gastroenteritis and dermatitis will arise. Several studies on the present ground showed that wet disposal of this waste causes migration of metal into the soil. The populations located near the fly ash dumping area facing surface water pollution and underground water pollution. However, the surface water pollution is more critical than the underground water pollution. The surface water pollution decreases the fish population and other aquatic organisms due to heavy metal material and organic matter content contained in the water. The surface water contamination also causes skin diseases, diarrhea and death due to bathing and drinking of water from the contamination river.[4]

3. ENVIRONMENTAL AND SOCIAL BENEFITS OF USING FLY ASH BRICKS

The environmental and social benefits of using Fly ash bricks and its positive environmental effects are:

Eliminate carbon emissions

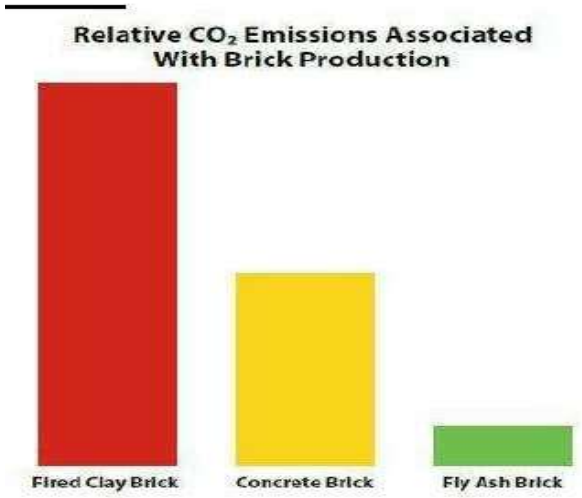
-The climate-friendly fly ash brick technology produces bricks without using coal. It has the potential to eliminate carbon emissions from India's large brick-making industry, which burns huge amounts of coal and emits millions of tons of carbon dioxide each year.(Reference 2.0)

Earning carbon credits

-Production of Fal-G bricks could lead to the purchase of carbon credits from Indian companies: manufacturing Fal-g bricks instead of clay bricks could earn Indian industry carbon credits.(Reference 6.0)

Variety of uses-

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.(Reference 2.0).Use of fly ash in the construction of roads and embankments has been successfully demonstrated in the country and it is gaining acceptance.(Reference 1.0)

Saves top soil-

FaL-Gor Fly ash-Lime-Gypsum, also saves huge quantities of valuable topsoil that is traditionally used in clay brick production. It replaces soil with fly ash, an unwanted residue from coal-fired power plants that currently occupies over 125,000 acres of land. Putting fly ash to productive use thus not only reduces water, air, and soil pollution, but also improves the health of populations living near these plants, who often complain of respiratory problems. 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.

Speed up construction process-

Large fly ash bricks and blocks also help save mortar and speedup the construction process.

Source of all the year round employment-

Traditional coal-fired brick kilns do not provide a stable source of income for workers. The kilns close down during the monsoon, forcing the workers to move away to look for other work. This leaves their children unable to attend school; in fact, many children end up working alongside their parents in these kilns in contravention of laws prohibiting child labor. By contrast, FaL-G brick plants operate throughout the year, providing year-round employment.(Reference 2.0)

Prevention of dumping of fly ash in ponds-

Fly ash brick plants use more than 20 million tons of fly ash, which would otherwise have been dumped into hazardous ash mounds and ponds.(Reference 2.0)

4. Properties of fly ash: [3]

As a building material, fly ash has impressive workability and durability properties to concrete. It reduces its water demand by 10%. It also has spherical particles which act as lubricants which improves paste flow. These are just some of the important features of fly ash which are useful in the production of blended cement.

Chemical Composition of Fly Ash

The chemical composition of fly ash depends upon the type of coal used and the methods used for combustion of coal.

Table No 2: Chemical composition of fly ash of different coals.[3]

Component	Bituminous Coal	Sub bituminous Coal	Component
SiO2 (%)	20-60	40-60	**SiO2 (%)**
Al2O3 (%)	5-35	20-30	**Al2O3 (%)**
Fe2O3 (%)	10-40	4-10	**Fe2O3 (%)**
CaO (%)	1-12	5-30	**CaO (%)**
LOI (%)	0-15	0-3	**LOI (%)**

Physical Properties of Fly Ash [3]

The physical properties of fly ash are,

1. Fineness of Fly Ash

As per ASTM, the fineness of the fly ash is to be checked in both dry n wet sieving. The fly ash sample is sieved in 45 micron sieve and the percentage of retained on the 45 micron sieve is calculated. Further fineness is also measured by Lech atelier method and Blaine Specific Surface method.

2. Specific Gravity of Fly Ash

The specific gravity of fly ash ranges from a low value of 1.90 for a sub-bituminous ash to a high value of 2.96 for an iron-rich bituminous ash.

3. Size and Shape of Fly Ash

As the fly ash is a very fine material, the particle size ranges in between 10 to 100 micron. The shape of the fly ash is usually spherical glassy shaped.

4. Colour

The colour of the fly ash depends upon the chemical and mineral constituents. Lime content in the fly ash gives tan and light colours where as brownish colour is imparted by the presence of iron content. A dark grey to black colour is typically attributed to an elevated un-burned content.

Classification of Fly Ash [3]

The classification of fly ash is done differently as per codes used. They are

1. Type of Fly Ash as per IS Codes (IS 3812-1981)

A. Grade I

This grade of Fly ash is derived from bituminous coal having fractions SiO2+Al2O3+Fe2O3 greater than 70 %.

B. Grade II

This grade of Fly ash derived from lignite coal having fractions SiO2+Al2O3+Fe2O3 greater than 50 %.

2. Type of Fly Ash as per American Society for Testing and Materials (ASTM C618) [3]

Depending on the type of coal and the resultant chemical analysis, ASTM has classified flyash into ,

A. Type C

Type C fly ash is produced from the combustion of lignite or sub bituminous coals, contains CaO higher than 10 percent and possesses cementitious properties in addition to pozzolanic properties.

B. Type F

Type F fly ash is produced from the combustion of bituminous or an anthracite coal contains CaO below 10 percent and possesses pozzolanic properties.[3]

Utilization

- In developed countries more than 80% Fly Ash is used for the manufacturing following:-

- In agriculture
- Building material
- Bricks construction
- Mine fills
- Metallurgy
- Use of new material
- Environmental control
- Embankment

CONCLUSIONS:

Fly ash is the residue from the combustion of bituminous coal, generally as a result of the generation of electricity at thermal power generation plant. It is important to protect environment, conserve the top soil, and prevent dumping of fly ash from Thermal Power Stations on land and to promote utilization of ash in the manufacture of building materials and construction activity. The industry is facing problem to develop efficient and economical technique recycle these materials. Recycling of fly ash will conserve the natural raw materials and abridge the disposal cost. It will also create new revenues and business opportunities while protecting the environment. The Constructive and Environment friendly use of Fly Ash For building materials like, manufacture of Portland cement, embankment construction, soil stabilization material, component in the production of flow able fill, filler mineral in asphalt road laying to fill the voids, as component in geoploymers. Roller compacted concrete dams, manufacture of fly ash bricks& Concrete Blocks and fly ash is treated with silicon hydroxide, it acts as a catalyst.

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