



Use of fly ash in highway construction in India: A clean approach to environmental management

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Introduction:

Rapid growth of industrialization and large scale infrastructural development in India has resulted in scarcity of construction material and unchecked increase in the environmental pollution. Highway construction requires an enormous amount of earth material which is not available in abundance near urban areas, so in order to counteract this problem and to meet the increasing demand use of waste material arising from any sector such as domestic, industrial and mining etc. in constructing highway is promoted. One such material is fly ash which is generally categorized as an industrial waste and is collected from the various thermal power plants situated across the country. The solid waste possesses potential to be incorporated as a filling material in national highway embankments. The term fly ash is used commonly as generate term to denote any type of coal ash.

When pulverised coal is burnt in the furnace of power stations, about 80% of the ash produced is very fine in nature. This part gets carried along with flue gases and is collected by using either electro-static precipitator or cyclone precipitator. This is called flight ash. The remaining ash sinters and falls down at the bottom of furnace. This is known as bottom ash. Fly ash may be disposed in dry form (in ash mounds) or through water (slurry) in a pond. When fly ash and bottom ash are mixed and disposed in the form of water slurry to ash ponds, it is called pond ash. For the purpose of embankment construction either pond ash, bottom ash or mound ash can be used. Fly ash being the very fine material is not recommended for embankment construction.

Environmental and health hazards caused by the fly ash:

- The ash released from coal fired power plants is one of the primary reasons for the air pollution in India.
- If the untreated fly ash is directly disposed of underground then, it can make soil infertile and soil pollution.
- When fly ash is disposed of in lakes, ponds, or rivers it can cause serious illness to the people living in the nearby villages and can even turn fatal for some of the aquatic creatures.
- Toxic compounds and heavy metals present in the fly ash can cause serious health issues like lung cancer, neurological damage, and can even lead to premature mortality.
- Higher disposal of fly ash on the grounds retards the recharging of groundwater.

Environmental benefits of fly ash utilisation in civil engineering:

- Increasing the life of concrete roads and structures by improving concrete durability.

- Reduction in amount of coal combustion products that must be disposed in landfills
- Conversion of other natural resources and materials.
- Net reduction in energy use and greenhouse gas and other adverse air emissions when fly ash is used to replace or displace manufactured cement.

Fly ash is causing environmental pollution, creating health hazards and requires large areas of precious land for disposal due to increasing concern for environmental protection and growing awareness of the ill effects of pollution, disposal of ash generated at thermal power plants has become an urgent and challenging task. Fly ash can be utilised in many ways as shown through extensive research and development efforts as well as field demonstration. But bulk utilization is possible in the field of civil engineering application specially construction of road embankments. Typically in developed urban and industrial areas, natural borrow sources are scarce, expensive or inaccessible. The environmental degradation caused due to the use of topsoil for embankment construction is very high. Moreover, many power plants are situated in urban areas, and therefore, fly ash can provide an environmentally preferable alternative to natural borrow soil.

Properties of fly ash

The properties of fly ash vary depending upon type of coal, its pulverisation and combustion techniques, their collection and disposal system etc. ash collected from the same ash pond may exhibit different physical and engineering properties depending on point of collection depth etc. Obviously ash from two different thermal power plants can be expected to have different properties. These factors can be easily taken care during characterization, design and quality control operations during construction. Fly ash possesses several desirable characteristics, such as light weight, ease of compaction, faster rate of consolidation etc. spreading and compaction of fly ash can be started much earlier in comparison to soil after a rainfall. Fly ash would be a preferred material for construction of embankments over weak subsoil.

Favourable characteristics of fly ash for use in roads and embankments-

- Light weight as compared to commonly used fill material (local soil), therefore, causes lesser settlements.
- Higher value of California Bearing Ratio as compared to soil provides for a more efficient design of road pavement.
- Pozzolan hardening property imparts additional strength to the road pavements / embankments and decreases the post construction horizontal pressure on retaining walls.
- Amenable to stabilization with lime and cement.
- Can be compacted over a wide range of moisture content, results in lesser variation in density with changes in moisture content.
- Easy to handle and compact because the material is light.
- Can be compacted using either vibratory or static rollers.
- Offers greater stability of slopes due to higher angle of friction.
- High permeability and ensures free and efficient drainage.
- Faster rate of consolidation makes it an ideal material for road fills.
- Low compressibility results in ease of compaction.
- Conserves good earth, thereby protecting the environment.
- Low sulphur content of fly ash can add long term strength and durability to sub-grade.
- Fly ash effectively dries wet soil and provides an initial rapid strength gain which is very useful during construction in wet, unstable ground conditions.

- Fly ash decreases swelling potential of expansive soil.

Before Commencement of road works following information on the fly ash to be used should be made available:

- Particle size analysis of the material(1)
- The maximum dry density (MDD) and optimum moisture conduct (OMC) as per IS heavy compaction test and the graphs of density plotted against moisture conduct, for this test (2).

Environmental issues during construction:

- The primary environmental concern regarding use of fly ash for embankments would be contamination of ground and surface water due to heavy metal leaching. But most of the fly ashes are relatively inert. Moreover, coal used in Indian thermal power plants have high as content. As a result, enrichment of heavy metals is lower compared to fly ash produced by thermal power plants abroad.
- The leaching problem can be minimised by controlling the amount of water, which infiltrates into fly ash embankment. Normally, percolation of water into the fly ash core will be minimum when sides and top are protected using good earth. Further, by providing impervious wearing course to the pavement constructed over the embankment seepage can be minimised. Properly benched and protected (with soil cover with vegetation or soil cover with stone pitching) side slope can minimised leaching problem. The alkaline nature of the fly ash- water solution also restricts heavy metal leaching.
- The fly ash embankments should be covered on the sides and top by soil to prevent erosion of soil.
- In cases where stockpiling of fly ash at site is inevitable, adequate precautions should be taken to prevent dusting by spraying water on stockpiles at regular intervals or cover the surface of stockpiles with tarpaulins or thin layer of soil or other granular material not subject to dusting. Traffic movements may be restricted to those areas which are kept moist, to prevent tyres of passing vehicles dispersing ash into the air.

Government initiatives

Ministry of environment forest and Climate Change (MoEF&CC) has issued various notifications for fly ash utilization. The principal notification was issued on 14.09.1999, which was subsequently amended vide notification dated 27.08.03, 03.11.2009 and 25.01.2016. As per notification of MoEF&CC, it is mandatory to use fly ash in the construction of road or flyover embankments within a radius of 300 km of a thermal power plant. The cost of transportation of ash for road construction projects or for manufacturing of ash based products or use as soil conditioner in agriculture activity within a radius of 100 KMs from a coal or lignite based thermal power plant shall be borne by such coal or lignite based thermal power plant and cost of transportation beyond the radius of hundred kilometres and up to three hundred kilometres shall be shared equally between the user and the coal or lignite based thermal power plant. The coal or lignite based thermal power plant shall within a radius of three hundred kilometres bear the entire cost of transportation of ash to the site of road construction projects under Pradhan Mantri Gramin Sadak Yojana and asset creation programmes of the Government involving construction of building, road, dams and embankments. The use of fly-ash in road construction is permitted as per the standards & specifications evolved by the Indian Road Congress /Ministry. The physical and chemical

properties of fly ash and the design methodology to be adopted for an embankment construction has been specified in IRC: SP: 58:2001. "Guidelines for use of fly ash in road construction". Section 305 i.e. "Embankment constructions" of MoRT&H Specifications for Road and Bridge works lays down the specifications for use of fly ash in embankment construction.

In view of the above ministry has issued various guidelines for use of fly ash in Road/flyover embankment construction on NH word vide

And again requested to use fly-ash in the read construction, in line with the guidelines of MoEFCC, MoRTH, IRC, MoP, TTPs, BIS.

Challenges:

Ministry of environment, forests and Climate Change (MoEFCC) directed the National Highway Authority of India (NHAI) to use fly ash for its projects to restrict the use of top soil, the instructions are being followed in a restricted member. The ministry instructions come on but even now, soil is being used in projects.

- The issue of lesser off-take of fly ash in road construction activities of the Ministry of Road Transport and Highways and its executing agencies (NHAI, State PWDs, NHIDCL) has been reviewed at the level of ministry. It was pointed out that the Thermal Power Plants have been found to be reluctant to bear transportation cost in accordance with the latest notification issued by the MoEF&CC on the subject.
- A lot of issues regarding the transportation of fly ash from thermal power plants are yet to be resolved. Vehicles in which fly ash will be transported need to be fully covered so that it does not cause problem for areas from which the trucks are passing.
- It is the responsibility of the generators of fly ash to make proper arrangements of disposal of fly ash. The tyres of the trucks also need to be fully cleaned before it moves out of the thermal plant.
- The Construction projects are to be completed in time bound manner but the supply schedule /cycle of fly ash do not match.
- There is lack of training of contractors and consultants for using fly ash.

Conclusion:

The use of coal for power generation results in an increased quantum of fly ash production. All out efforts are to utilize this fly ash not only from environmental Consideration, but also to avoid land usage for fly ash dumping. Though there has been a steady progress in fly ash utilization, we have a long way to go to reach the target of 100 percent fly ash utilization. Fly ash can become a wealth generator by making use of it for producing "green building" materials, roads, agriculture etc. National Highway Authority of India (NHAI) is currently using of fly ash and proposed to use another in future projects. We all will work together to make 100 percent usage of fly ash. Despite numerous notification and advisories from the government, no action has been taken to curb the menace of top soil excavation that has been specifically banned. Deviation from the notification is seriously hampering the ecology. The fertile agricultural land is being constructed into desolate barren lands.

Support at government level may increase the use of fly ash in NH projects viz:

- Use of fly ash should be established due to intrerent cost and performance benefits and not by mandatory mechanism.
- Making use of fly ash mandatory in NH projects some time delays project completion in case fly ash are not available. This increases cost and claims from contractors.

- Share fly ash availability status for NH use exclusively.

Reference:

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3. IS: 2720 (Part-8)-1983, Methods of Test for soils- Determination of water content-Dry Density Relation Using Heavy Compaction, Bureau of Indian Standards, New Delhi.
4. Fly Ash Mission, Department of Science and Technology, Government of India Technical Reports on characterization of Indian Fly Ashes. (Prepared by IISc, Bangalore), 2000.
5. IRC: SP:58. Guidelines for use of fly ash in Road Embankments, New Delhi 2001