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MANAGEMENT OF FLY ASH IN CONSTRUCTION OF NATIONAL HIGHWAY PROJECTS

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ABSTRACT

In India, large quantities of fly ash being generated, as most of our energy demand is met through coal based thermal power station. The fly ash generation is expected to grow further as coal would continue to remain major source of energy at least for next 25 years. The fly ash which is a resource material, if not manage well, may pose environmental challenges. On the other hand, development of transport infrastructure is imperative for rapid economic growth of the country. During the recent past, road transport has come to occupy a dominant role in the transportation system. The use of fly ash in National Highway Roads and embankment construction not only facilitate mass disposal of fly ash but also provide significant benefits in terms of engineering and economic considerations. This Project report emphasis on the proper Management of fly ash in the Construction of National Highway Projects.

KEYWORDS: *Fly ash, Construction, Highway, Embankment*

I. INTRODUCTION

The increasing demand for electricity has led to setting up of a number of thermal power stations. This in turn has led to increasing production of power plant wastes like fly ash. There are 125 thermal power plants in the country, which currently produce about 170 million tons of fly ash every year. The current worldwide production of the fly ash is more than 700 miliion tons. With the increase in demand of power energy and coal being the major source of energy, more and more thermal power plants are expected to be commissioned in near future. As per estimates, fly ash generation is expected to increase to about 225 million tons by 2017.

On the other hand, development of transport infrastructure is imperative for rapid economic growth of the country. During the recent past, road transport has come to occupy a dominant role in the transportation system .Growth of road transport has been around 8 to 10 percent in respect of both freight and passenger traffic. Share of the freight traffic by road, has risen phenomenally from 11 percent in 1951 to about 60 percent at present. The total number of automobiles on our roads has increased from 0.30 million in 1951 to about 27 million at present. The development of road network has not kept pace with it. Neglect of road network has led to a host of problems like congestion, delay, and higher vehicle operating cost, accidents and environmental degradation. Resources provided, so the quality of our road network needs large scale improvement.

Fly ash is produced as a result of coal combustion in thermal power plants. Fly ash is defined as a heterogeneous mixture of amorphous and crystalline phases and is generally fine powdered ferroaluminosilicate material with Al, Ca, Fe, Na and Si as the predominant elements. Certain elements like B, Mo, S and Se are characteristically enriched in flyash particles. The emission of fly ash from the stack into the atmosphere is controlled by particulate devices such as scrubbers, mechanical and electrostatic precipitators (ESP)

The increasing demand for electricity has led to setting up of a number of thermal power stations. This in turn has led to increasing production of power plant wastes like fly ash. There are 120 thermal power plants in the country, which currently produce about 112million tons of fly ash every year. The current

worldwide production of the fly ash is more than 700 million tons. With the increase in demand of power energy and coal being the major source of energy, more and more thermal power plants are expected to be commissioned in near future. As per estimates, fly ash generation is expected to increase to about 225 million tons by 2017.

In recent decades, the industrialization and urbanization are the two phenomena that are going unabated all over the world. Apart from the need for these phenomena, one has to look into their negative impacts on the global environment and social life. Most important ill effect of these global processes has been the generation of large quantities of industrial wastes. 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.

.The use of fly ash in National Highway Roads and embankment construction not only facilitate mass disposal of fly ash but also provide significant benefits in terms of engineering and economic considerations. This Project report emphasis on the proper Management of fly ash in the Construction of National Highway Projects.

II. SCOPE OF THE STUDY

Although the scope for use of fly ash in concrete, brick making, soil-stabilization treatment and other applications has been well recognized, only a small quantity of the total ash produced in India is currently utilized in such applications. Most of the ash generated from the power plants is disposed off in the vicinity of the plant as a waste material covering several hectares of valuable land. The bulk utilization of ash is possible in two areas, namely, ash dyke construction and filling of low-lying areas. Coal ash has been successfully used as structural fills in many developed countries. However, this particular bulk utilization of ash is yet to be implemented in India. Since most of the thermal power plants in India are located in areas where natural materials are either scarce or expensive, the availability of fly ash is bound to provide an economic alternative to natural soils in the Embankment construction and other application in National Highway Projects.

III. OBJECTIVE OF THE STUDY

1. To Study of fly ash for National Highway projects and field aspect of fly ash.
2. To Study design criteria, management and working methodology for National Highway project.
3. Analysis of study data regarding fly ash utilization.
4. Discussion &Suggestions for effective Utilization of fly ash for Highway Projects.

IV. LITERATURE REVIEW

Second Nizammudin bridge approach road Embankment

The Nizammuddin bridge constructed over river Yamuna at New Delhi was to be connected to the main roads on eastern and western side by construction of about 2 km approach road . The peculiarity of the site was a challenge to the engineers especially when they propose to use a non-conventional material for construction of embankment. The eastern embankment of about 1.7 km length is in flood zone and is of about 7 to 8 meter height. The systematic and gainful utilization of fly ash a geotechnical material in earlier cited projects, gave confidence to the engineers of PWD, Delhi supported by CRRI Delhi and fly ash mission, PWD Delhi took up the use of fly ash for construction of this embankment.

OKHLA fly over bridge and Hanuman setu embankments

Carrying the conviction based on the analysis and the past experiences, efforts were launched with project agencies designing/implementing roads and embankments projects for use of fly ash. As it happens in the initial stages it was very difficult to convince the project authorities that fly ash if not better is at least as good as soil for such application on technical aspects and is definitely better on economical aspects. The discussion with Public Works Department (PWD), Delhi engineers for Okhla

fly over bridge embankments during 1995 was a break through. PWD, Delhi engineers were quite supportive and had good understanding of the subject. PWD Delhi agreed to use fly ash for this project embankment. To start with,fly ash was used for half the width of the embankment and the balance half was made by use of soil , primarily because the project engineers wanted to have a real life comparison between workability and suitability of the two materials.

The experience was so satisfying that within next few months PWD, Delhi took a decision to use fly ash for Hanuman Setu, near old Delhi railway station. It was experienced by the project team that working on fly ash, especially in rains is much better and project work can be started within two hours of rain on fly ash as compared to about 6-8 hours on soils. This is primarily because of higher permeability of fly ash.

V. USES OF FLY ASH IN EMBANKMENT CONSTRUCTION

Fly ash properties are unique as an engineering material. Some of the engineering properties of fly ash that are of particular interest when fly ash is used as a highway embankment or fill material are its moisture-density relationship, particle size distribution, shear strength and permeability. Fly ash in this application must be stockpiled and conditioned to its optimum moisture content to ensure that the material is not too dry and dusty or too wet. When fly ash is at or near its optimum moisture content, it can be compacted to its maximum density and will perform in an equivalent manner to well-compacted soil. Fly ash has proved to be versatile materials with many possible applications in the highway embankment.

Coal fly ash has been successfully used as a structural fill or embankment material for highway construction projects. Compared with conventional soils used to build embankments, fly ash is somewhat of a unique engineering material. When dry, fly ash is cohesion less and considered by many as a dusty nuisance. When saturated, fly ash becomes an unmanageable mess. But, as with most fine-grained soils, fly ash can be easily handled and compacted at more intermediate moisture contents, and does exhibit some cohesion.

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.

Fly ash being generally a cohesion less material, Fly ash gets consolidated at a faster rate and primary consolidation is completed very quickly. So it has low compressibility and shows negligible post construction settlements.

Fly ash is a fine –grained material with practically no cohesion. However, when the fly ash in wet state is left undisturbed for a long period, development of some apparent cohesion has been observed. In view of its compatibility and development of apparent cohesion leading to strength development over a period of time, it is possible to use fly ash as a fill material in low lying areas and also in the construction of embankments.

Fig. No.1 Fly Ash Embankment Construction

VI. LABORATORY TEST RESULTS

Table No. 1 Laboratory test results of fly ash material collected from Nasik Thermal Power Station for used in khed-sinnar national highway embankment construction.

Parameter	Observed test results	Limits as per IRC SP:58-2001
Specific Gravity	2.1	1.90 – 2.55
Plasticity	Non Plastic	Non Plastic
Maximum Dry Density (g/cc)	1.2	0.9 – 1.60
Optimum Moisture Content (per cent)	30.0	38.0 – 18.0
Cohesion (kN/m^2)	Negligible	Negligible
Angle of Internal Friction	32^o	$30^o – 40^o$
Coefficient of Consolidation (Cv (cm^2/s)	$2.8x\ 10^3$	$1.7 \times 10^5 – 2.0 \times 10^3$
Compression Index Cc	0.30	0.05 – 0.40
Permeability (cm/s)	5×10^4	$8 \times 10^6 – 7 \times 10^4$
Practical Size – Distribution (per cent of materials)	–	–
Clay size fraction (Less than 0.002mm)	1 .0	1 – 10
Silt size fraction (0.075 to 0.002mm)	29.0	8 – 85
Sand size fraction (4.75 to 0.075mm)	70	7 – 90
Gravel size fraction (80 to 4.75mm)	0	0 – 10
Coefficient of Uniformity	9.3	3.1 – 10.7

Geotechnical Properties of fly ash

VII. MANAGEMENT FOR EMBANKMENT CONSTRUCTION WITH FLY ASH

The material for fly ash embankment shall be obtained from Nasik Thermal Power Station. Fly ash shall be delivered to the site in covered dump truck to minimize loss of moisture and dusting. Haulage of fly ash material shall proceed only when sufficient spreading and re-compaction plant is operating at the place of deposition.

The stockpiling of fly ash if required shall be done by taking proper precautions to avoid dusting. Traffic movements shall be restricted to those areas which are kept moist to prevent dispersing ash into air by tyres of passing vehicles. The approved ash ponds will be cleared of vegetation by dozing into heaps. The fill material will be dug out by hydraulic excavator/JCB, loaded into tippers trolleys and transported for construction of embankment in layers.

The tippers will be directed to systematically unload embankment fly ash material to facilitate spreading by dozer / hydraulic motor grader / tractor dozer. The fill material will be watered to optimum moisture content to achieve the desired density and compacted by using vibratory rollers. The fill material will be laid in suitable layers and compacted to the required level of compaction mentioned in the specifications.

VIII. EARTH COVER

Embankment shall be constructed with fly ash should be covered on top and side by soil to prevent erosion of ash and selected sub grade on top adopting a side slope of 2:1(H:V). For embankment up to 3m height, the side earthen covers of 2.0meter width shall be provided with the soil of minimum density 1.52gm/cc. For height more than 3m intermediate soil layers of minimum 200mm thickness at 1.5meter height and the side earthen cover of 2.0mtr width shall be provided. One or more intermediate layers shall be provided as per design requirements. The compacted soil thickness shall not exceed 400mm and shall not be less than 200mm. The vertical distance between such layers shall be 1.5 to 3.0 meter. The top 500mm of embankment shall be constructed using selected earth to form the sub grade ofthe road pavement.

The areas where work is to be executed in single carriageway i.e. in case of widening of existing road additional blanket for fly ash filling may be required to support the partial embankment on other side.

While making the first carriageway two earthen side covers shall be made at both ends of the embankment to confine the fly ash layers while making the second carriageway one more earthen side cover shall be made at the outer side edge to confine the fly ash layers. For the purpose of measurement the three earthen side covers shall be measured as soil and the volume in between, excluding the sandwiched layer if any, as fly ash.

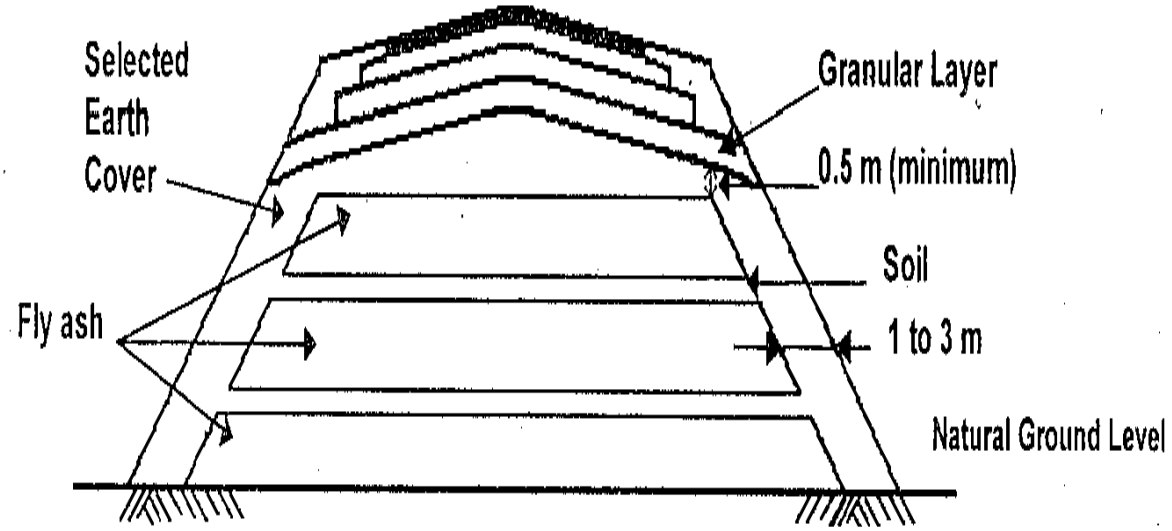


Fig. No.2 Typical Cross–Section of Embankment with Alternate Layer of Fly Ash and Soil

IX. SPREADING AND COMPACTION

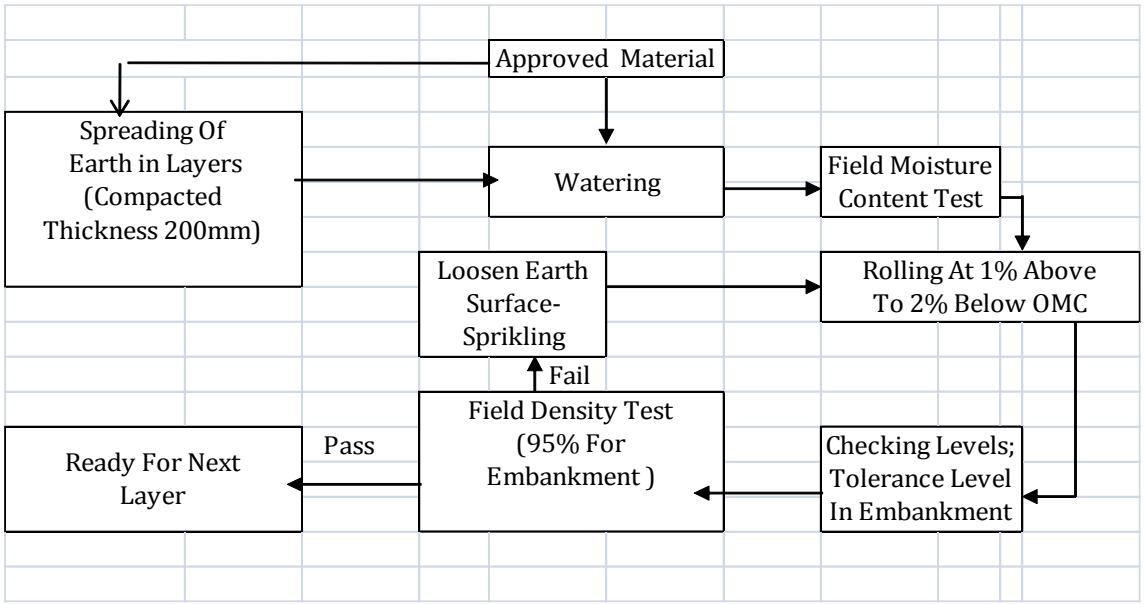
First one layer of cover soil in 2.0meter width as defined earlier shall be laid and compacted to 200mm thickness. Then another layer of cover soil shall be laid to form the cover layer of 2.0mtr width and loose layer thickness up to 400mm thick, to ensure confinement of fly ash. Subsequently fly ash shall be laid inside the confining layers of cover soil. Clods in cover soil shall be broken to have a maximum size up to 50mm or as permitted for earthen embankments. The cover soil and fly ash should be laid simultaneously before compaction to ensure proper confinement of fly ash. The fill material shall preferably be spread by mechanical means. Manual spreading may be permitted by the Engineer-in-charge if the quantum of work is less. Vibratory roller of dead weight 80-100 KN. shall be used. In fly ash loose layer thickness maximum up to 400 mm shall be adopted if site trials show satisfactory compaction.

Moisture content of the fill material shall be checked at the site of placement prior to commencement of compaction. Moisture content of fly ash laid for compaction shall normally vary from OMC to OMC ± 2%. The moisture content limits can be varied as desired by the Engineer. Depending on the weather conditions, specified compaction shall be achieved as revealed through actual site trials. Moisture content of cover soil shall be maintained at its OMC. Where water is required to be added to the fill material, it shall be sprinkled from a water tanker fitted with a sprinkler capable of applying water uniformly without any flooding. The water shall be mixed thoroughly by disking or harrowing or by manual means until uniform moisture content shall be obtained throughout the depth of the layer. If the material delivered to the construction site is too wet, it shall be dried by aeration and exposure to sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required value, the entire work of compaction shall be suspended.

Each layer of fly ash shall be thoroughly compacted to the specified density. Two passes without vibration followed by 5 to 8 passes with vibration would be sufficient to compact each layer.

Fig No. 3 Grading &Compaction of Fly Ash for Embankment Construction

X. FLOW CHART FOR THE CONSTRUCTION OF EMBANKMENT



XI. CONCLUSION

India is a growing country and systematic transportation system is essential for its development. It is true that we are investing a major part of our budget for developing an efficient transportation system but to increase the rate of growth with the available resources, construction costs are required to be minimized. For this some alternative material like fly ash is needed to be utilized as a highway material.
1.The use of fly ash in highway projects will solve the disposal problem and automatically reduce the construction cost. Hence this project is aimed to describe the use of fly ash in National Highway construction. If the fly ash is utilized on large scale in Embankment construction in National Highway Projects, the infrastructure development can be completed at lesser cost and will also help for environmental protection of our country.
2. The availability of fly ash is bound to provide an economic alternative to natural soils in the embankment construction.
3. Fly ash being generally a cohesion less Material, Fly ash gets consolidated at a faster rate and primary consolidation is completed very quickly, so it has low compressibility and shows negligible post construction settlements.
4. Based upon the study uses of fly ash in National Highway embankment construction results in reduction in construction cost by about 50 to 75 percent depend upon the lead. Typically cost of borrow soils varies from about 200 to 400 rs per cubic meter. Fly ash is available free of cost at the power plant and hence only transportation cost , laying and rolling cost are there in case of fly ash. Hence the economy is directly related to the transportation of fly ash.

5. Fly ash has been successfully used in many highway embankments construction projects across the country. Fly ash has several advantages for the construction of embankments. The main advantages are its low unit weight and high shear strength. The Pozzolanic hardening of fly ash imparts additional strength and very little settlements, making it more suitable for use in embankments.

6. The use of fly ash is not only safe but provides economical, durable, eco-friendly and sustainable constructions. The use of fly ash and its materials also conserve mineral resources, natural resources and the environment by reduction in CO2 emissions as well as reduced mining activity.

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BIOGRAPHY

Fareed Ahmad Malik student of Final year in ME Civil, from Shri Sant Gadge Baba College of Engineering & Technology. I am doing research / Project under Guidance of Prof. R.U. Borole. I am doing project on Management of fly ash in construction of National Highway Project.I had been pass out BE Civil Engineering from North Maharastra University from SSGBCOET 2010-11, I have dream that I will get Master degree, its delay but time come my dream will be true.

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