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Exploring Fly Ash Utilization in Construction of Highways in India

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Abstract: *Fly Ash is a major issue because electricity generation in the country would remain predominantly coal-based for a couple of coming decades. Current annual production of Fly Ash is about 131MT/year and is expected to increase to 300-400 MT/year up to 2016. Some of the problems associated with Fly ash are large area of land required for disposal and toxicity. Fly ash, being treated as waste and a source of air and water pollution till recent past, is in fact a resource material and has also proven its worth over a period of time. Fly ash is having potential for gainful utilization till is put to right use. It has now emerged not only as a resource material but also as an environment savior. Though the fly ash utilization is old practices in roads & building construction, there is still hesitation to adopt fly ash as a pavement & Building material for various reasons. This paper presents different ways of using Fly ash in various Components of Road crust Construction and its subsequent environmental effects. It also discusses the Government Policy in maximizing utilization of fly ash.*

Keywords: *Fly ash, TPP, HVFAC, Stabilizations, CBR, Sustainability*

I. Introduction

Fly ash is a naturally-cementitious coal combustion by-product. It is extracted by the precipitators in the smokestacks of coal-burning power plants to reduce pollution. About 120 coals based thermal power stations in India are generating 70% of power and producing about 131 million tone fly ash per year. With the increasing demand of power and coal being the major source of energy, more and more thermal power stations are expected to be commissioned/ augment their capacities in near future. Continuous studies have been carried out in India towards management of fly ash (FA), disposal and utilization. The quality of fly ash which depends on coal, coal particle fineness, percentage of ash in coal, combustion technique used, air/fuel ratio, burners used, and type of boiler. Fly ash is available in large quantities in our country as waste product from a number of thermal power stations and industrials plant using pulverized coal as a fuel for the boilers. The increased industrialization, the present level of production of fly ash is expected to double in the next 10 years.[1]

1.1.1 Background

World at present produces around approximately 1528 Million Tons of coal fly ash when India at present produces around 131 Million Tons of Ash per annum. Out of this fly ash 30 percent fly ash were used as Portland cement replacement in concrete and other application were as low-value road base material and fills. Even though the beneficial use of fly ash in concrete has been known for many decades, it is still not yet fully utilized. [2]

Table 1.1: Fly Ash Generation and Utilization in different Countries

Sr. No	Country	Annual Ash Production, MT	Ash Utilization %
1	India	131	38
2	China	100	45
3	USA	75	65
4	Germany	40	85
5	UK	15	50
6	Australia	10	85
7	Canada	6	75
8	France	3	85
9	Denmark	3	2
10	Italy	2	100
11	Netherland	2	100

II. Fly Ash

2.1 Definition of fly ash

Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity. These micron-sized earth elements consist primarily of silica, alumina and iron. When mixed with lime and water the fly ash forms a cementitious compound with properties very similar to that of Portland cement.

According to IS:10153-1982[6] fly ash is a finely divided residue resulting from the combustion of ground or powdered coal and transported by the fuel gases of boiler fired by pulverized coal.

The use of fly ash as a pozzolanna and fine aggregates and also other allied purposes is well established in a number of countries abroad, but it has come in vogue in India only recently. Some recent investigations of Indian fly ashes have proved their suitability for various uses.

Disposal of fly ash is a problem being faced by most of the thermal power plants where it is being produced. This material, however, may be utilized in a number of ways, some of which have been mentioned in this paper. If proper means and methods are not adopted for utilization and disposal of fly ash the problem will increase in magnitude, due to its increased production, over the few years.

2.2 Classes of Fly Ash

According to ASTM C-618 Fly ash is broadly classified into two major categories: Class F and Class C fly ash. The chief difference between these two classes is the amount of calcium, silica, alumina, and iron content. The chemical properties of the fly ash are largely influenced by the chemical content of the coal burned (i.e., anthracite, bituminous, and lignite).

2.2.1 Class 'F' fly ash

The burning of old anthracite and bituminous coal typically produces Class F fly ash which contains less than 10% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class 'F' Fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementitious compounds. Alternatively the addition of a chemical activator such as sodium silicate (water glass) to a Class 'F' ash can lead to the formation of a geo-polymer.

2.2.2 Class 'C' Fly ash

Class 'C' Fly ash produced from the burning of younger lignite or sub bituminous coal generally contains more than 20% lime (C_aO). This type of ash does not require an activator & the contents of Alkali and sulfate (SO_4) are generally higher as compare to the Class 'F' Fly ash.

Fig. 1 Typical ash colour (Class "F" & "C" Fly ash)

III. Methods of fly ash collection

3.1 Dry fly ash (fly ash)

Dry ash is collected from different rows of electrostatic precipitators. It is available in two different grades of fineness in silos for use as resource material by different users in dry ash disposal; the fly ash is transported by truck, chute or conveyor at the site and disposed of by constructing a dry embankment (dyke).

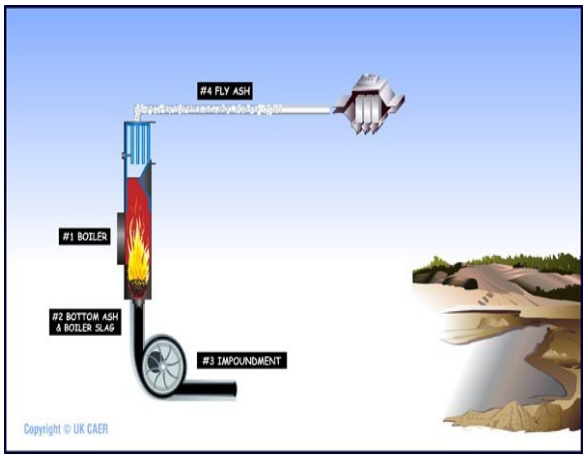

Fig.2.1 fly ash captured by air pollution control equipment.

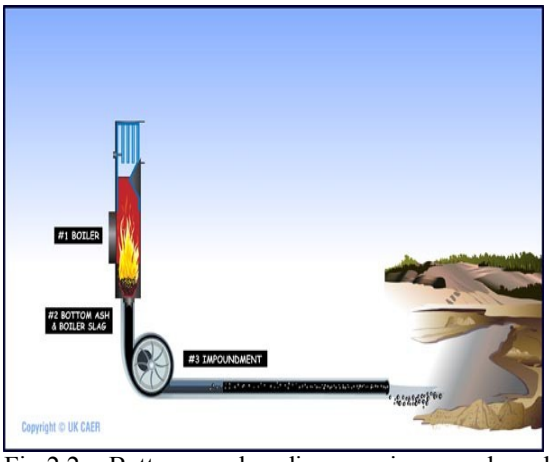

Fig.2.2 Bottom ash dispose in pond ash

3.2 Wet bottom ash

Bottom ash is collected from the bottom of the boiler and transported to hydro bins and then ash mound. In wet disposal, the fly ash is transported as slurry through pipe and disposed off in impoundment called "Ash Pond". Most of the power plants in India use wet disposal system. [3]

IV. Use of Fly Ash for Road Construction

Fly ash can be used for construction of road and embankment. This utilization has many advantages over conventional methods. Saves top soil which otherwise is conventionally used, avoids creation of low lying areas (by excavation of soil to be used for construction of embankments). Avoids recurring expenditure on excavation of soil from one place for construction and filling up of low lying areas thus created. Fly Ash may be used in road construction for:

1) Filling purposes. Addition of Fly Ash has not shown any adverse effects on the ground water quality in the vicinity of experimental plots.
2) Soil mixed with Fly Ash and lime increases California Bearing Ratio (CBR), increased (84.6%) on addition of only Fly Ash to soil.
3) Stabilizing and constructing sub-base or base.
4) Upper layers of pavements. Concrete with Fly Ash (10-20% by wt) is cost effective and improves performance of rigid pavement.[2]

4.1 Use of Fly Ash in Road Embankment Construction

The favorable Properties of Fly ash/Pond Ash for use in embankment is listed as below and its engineering properties is mentioned in Table 2

- Pozzolanic nature
- Light weight, Non plastic
- High shear strength
- Ease of compaction
- Self hardening
- Amenable to stabilization
- High permeability
- Faster rate of consolidation

The Salient Details regarding design and construction of road embankment using fly ash for backfill, Stabilizations and sub base construction of Semi/Rigid pavements are provide in IRC:SP-58 2001 "Guidelines for Use of Fly-ash In Road Embankment Indian Roads Congress Special Publication".[8]

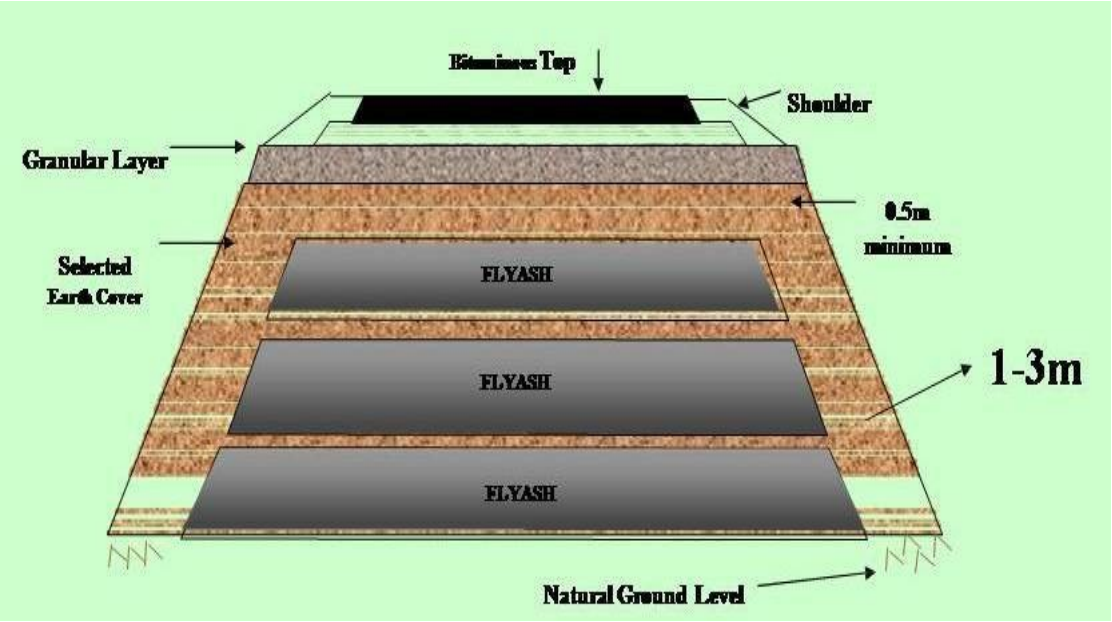

Table 2 Engineering Properties of Fly Ash		
Sr. No	**Parameter**	**Range**
1	Specific Gravity	1.90 - 2.55
2	Plasticity	Non-Plastic
3	Maximum Dry Density (gm/cc)	0.9 - 1.60
4	Optimum Moisture Content (%)	18-38
5	Cohesion (KN/m^2)	Negligible
6	Angle of Internal Friction (Φ)	30^o to 40^o
7	Coefficient of Consolidation C_v (cm^2/sec)	1.75×10^{-5} - 2.01×10^{-3}
8	Compression index C_c	0.05 - 0.4
9	Permeability (cm/sec)	8×10^{-6} - 7×10^{-4}
10	Particle Size Distribution(% of materials)	
	Clay size fraction	1 - 10
	Silt size fraction	8 - 85
	Sand size fraction	7 - 90
	Gravel size fraction	0 - 10
11	Coefficient of Uniformity	3.1 - 10.7

Typical cross section of fly ash road embankment

4.2 Some case History of Use of Pond Ash in Road/Railway Embankment.[4]

A) Approach Embankment for Second Nizamuddin Bridge at Delhi
- Length of embankment - 1.8 km
- Height varies from 6 to 9 m
- Ash utilized - 1,50,000 cubic meter
- Embankment opened to traffic in 1998
- Approximate savings due to usage of fly ash is about Rs.1.00 Crore

B) Fly ash Embankment from G.T Road to Kajouri chowk, Delhi

C) Four-laning work on NH-6, Dankuni to Kolaghat, Km 17 to 72, West Bengal
- Height of embankment - 2 to 4 m
- Water logged & Soft sub-soil conditions

Fly Ash was used as Alternative Material as 2.0 million cum Earth proposed in contract document. Haul distance more than 100 km so High transportation cost, which would result delays in expected completion of the project

D) Signature Bridge, New Delhi
Embankment done with fly ash in water logged area

E) Okhla Flyover Approach Embankment
- First geo-grid reinforced fly ash approach embankment constructed in the country
- Length of embankment - 59 m
- Height varied from 5.9 to 7.8 m
- Ash utilized - 2,700 cubic metre
- Opened to traffic in 1996

F) Hanuman Setu Flyover Approach Embankment
- Geo-grid reinforced fly ash approach embankment
- Length of embankment - 138.4 m
- Height varied from 3.42 to 1.0 m
- Opened to traffic in 1997

G) Sarita Vihar Flyover Approach Embankment
- Length of embankment - 90m
- Max height - 5.25 m
- Embankment opened to traffic in Feb 2001
- Polymeric friction ties used for reinforcement

H) Noida-Greater Noida Expressway
- Height of embankment varies from 3m to8m
- Approximately 23 km stretch
- Six Lane Carriageway with Median
- Side shoulders – 1.5m Paved & 1m Unpaved
- Fly-ash covered with Good Earth. [5]

4.3 Lime + Fly Ash treated Soil for improved Sub-Grade/Sub-base

Lime fly-ash treatment increases California Bearing Ratio (CBR), only on addition of fly ash @ 85 % C.B.R value is increased. Lime fly-ash treatment is generally effective for soils which contain a relatively high percentage of clay and silty clay.

This work shall consist of laying and compacting an improved sub-grade/lower sub-base of soil treated with lime & fly-ash on prepared sub-grade in accordance with the requirements of this specifications and in conformity with the lines, grades and cross sections shown on the drawings or as directed by the engineer.

Soil: The soil used for stabilization shall be the local clayey soil breaking the soil into pieces less than 20mm etc by means of Disc Harrowing.

Lime: Lime for lime- stabilization work shall be commercial dry lime slaked at site or pre-slaked lime delivered to the site in suitable packing. The lime shall have purity of not less than 70 percent by weight of quick lime (C_aO)

Fly Ash: Fly Ash used shall be locally available probably Pond ash available

Water: 60 to 70 liters/m^2 water to be used for lime stabilization shall be clean and free from injurious substances. Potable water shall be preferred.

Quantity of lime & Fly ash in stabilized mix : 10 kg/m^2 lime + 50 kg/m^2 fly ash + dry soil shall be mixed. The laboratory CBR/UCS value shall be at least 1.5 times of the minimum field value of CBR/UCS. Lime at the rate of 10kg/m^2& Fly ash at the rate of 50kg/m^2 to be mixed with the soil in dry state. Dry lime & Fly ash shall be prevented from blowing by adding water to the lime. No traffic other than the mixing equipment shall be allowed to pass over the spread soil +Lime + fly ash until after completion of mixing. Mixing or remixing operations, regardless of equipment used, shall continue until the material is free of any white streaks or pockets or lime and the mixture is uniform.

Immediately after spreading, grading and leveling of the mixed compaction shall be carried out with approved equipment preceded by a few passes of lighter rollers if necessary.

The sub-base course shall be suitably cured for a minimum period of 24 hours after which subsequent pavement courses shall be laid to prevent the surface from drying out and becoming friable. [6]

4.3.1 Some Case Histories of use of Pond Ash + Lime treated Soil for improved Sub-Grade/Sub-base

A) In Surat region the soil generally is Black cotton soil which CBR Value is 2%, the Fly-Ash + Lime treatment is done to improve the CBR of the Sub-base/sub-grade. This treatment is used in all Arterial Road, Collector Roads & Residential Roads within city limits of Surat Mahan agar Palika.

B) In NTPC internal Plant roads in Bharuch Fly-Ash + Lime treatment has been done before laying of Sub-base layer.

4.4 Use of Fly Ash in Bituminous Mix Layer

Bituminous concrete/ Dense Bituminous Macadam are a composite material consisting of bitumen as a binder and mineral aggregate. The composition of Fine and course aggregates should be in line with respective Gradation as given in Section 500 of MORTH. The fine aggregates shall consist of material passing 2.36mm sieve and retained on the 75 micron sieve. Particle smaller than 75 micron is made available by addition of filler as per MORTH Clause 507.2.4.

Both Class F and Class C fly ash can typically be used as a mineral filler to fill the voids and provide contact points between larger aggregate particles in Bitumen mixes. This application is used in conjunction or as a replacement for, other binders (such as Portland cement or hydrated lime). For use in bituminous pavement, the fly ash must meet mineral filler specifications outlined in Table-9 of MORTH. The hydrophobic nature of fly ash gives pavements better resistance to stripping. Fly ash has also been shown to increase the stiffness of the asphalt matrix, improving rutting resistance and increasing mix durability. [2]

4.5 HVFAC in Concrete Pavement.

Major Chemical constituents of fly ash are Oxides of silica, aluminum, iron, calcium & magnesium. Many concrete roads projects are under construction and many more are in pipeline.

Design Requirement:

- Flexural Strength-4.5 MPa for M40 Plain cement concrete pavement
- Flexural Strength-3.8 MPa for M30 Rural concrete pavement
- Flexural Strength-5.0 MPa for M45 Good Performance concrete pavement
- Flexural Strength-5.0 MPa for M50 High Performance concrete pavement for white topping

Slip-Forming is used for Construction.

Fly Ash is ideal for the interstate Highway System and secondary Roads. Concrete Prepared with High volume fly ash (HVFA) is more durable than asphaltic concrete and needs almost no maintenance. Being low permeability of high performance concrete leads a long-lasting concrete pavement and does not require rehabilitation and reconstruction. Studies have also proved that in concrete pavement, due to its higher reflectance, allows big savings in energy consumption.

The pavement could be designed for longer life up to 50 years. The design of a highway pavement is based on flexural strength and HVFA concrete keeps gaining strength with age which is an in-built safety factor.

There is no reinforcing steel in pavement concrete and roller compacted concrete. Thus the corrosion of steel is a non issue. Pavement Quality Roads increases fuel efficiency of transport trucks by 11%, resulting in cost savings and lower exhaust emissions.

HVFA concrete is competitive with asphaltic concrete even on first-cost basis. [2]

In paper by P Kumar Mehta a brief review is presented of the theory and construction practice with concrete mixtures containing more than 50% fly ash by mass of the cementitious material. Mechanisms are discussed by which the incorporation of high volume of fly ash in concrete reduces the water demand, improves the workability, minimizes cracking due to thermal and drying shrinkage, and enhances durability to reinforcement corrosion, sulfate attack, and alkali-silica expansion. For countries like China and India, this technology can play an important role in meeting the huge demand for infrastructure in a sustainable manner. [8]

4.6 Advantages of HVFAC

Among the Sustainability issues, the three major ones that are widely discussed may be summarized as below

4.6.1 Climate change - In many parts of the world, extreme weather patterns are occurring with greater frequency. Most scientists believe that this phenomenon is associated with the high emission rates of green-house gases, primarily carbon dioxide, the environmental concentrations of which has increased from 280 to 370 parts per million volumes mainly during the industrial age. The transportation industry and the Portland cement industry happen to be the two largest producers of carbon dioxide. The latter is responsible for approximately 7% of the world's carbon dioxide emissions. [8]

4.6.2 Resource productivity - The concrete industry is the largest consumer of virgin materials such as sand, gravel, crushed rock, and fresh water. It is consuming Portland and modified Portland cements at an annual rate of about 1.6 billion metric tons. The cement production consumes vast amounts of limestone and clay besides being energy-intensive.

With the advent of high performance concrete mixtures, some structures are now being designed and built for a service life of 100 years. In this context, it should be noted that the Factor Ten Club, a group of scientists, economists and business people have made a declaration that, within one generation, nations can achieve a tenfold increase in their resource productivity through a 90% reduction in the use of energy and materials.[8]

4.6.3 Industrial ecology - Achieving a dramatic improvement in resource productivity through durability enhancement of products is, of course, a long-term solution for sustainable development.

The construction industry already uses concrete mixtures containing cement replacement materials, such as 15% to 20% fly ash or 30% to 40% slag by mass. it is now possible to produce high-performance concrete mixtures containing 50% to 60% fly ash by mass of the blended cementitious material. Fly ash is readily available in most parts of the world. China and India, the two countries that consume large amounts of cement, together produce over 300 million tons of fly ash per year. [8]

3.7. Salient Features of high-performance concrete

The characteristics defining a HVFA concrete mixture are as follows:

• Minimum of 50% of fly ash by mass of the cementitious materials must be maintained.

• Low water content, generally less than 130 kg/m^3 is mandatory.

• Cement content, generally no more than 200kg/m^3 is desirable.

4.8 Usage of Fly Ash in Concrete Road Construction.

A) Fly Ash was permitted for use on NH-4 four lanning projects from Satara to Kolhapur. The project was executed by MSRDC. Out of 5 Packages of this project in two Packages Cement was replaced with fly ash to the Proportion of 50%.

B) MCD Demonstration Road Projects Location- Fatehpur Beri, New Delhi

- Length 100 rmt, Width 7 metres
- Thickness 270mm
- Concrete road was constructed using 3 grades of concrete to compare performance and suitability for pavement construction
    - M30 Plain (Without Fly ash)
    - M 30 HVFAC (with 50% Fly ash)
    - M40 HVFAC (with 50% Fly ash)

Very good encouraging results were obtained.

4.9 Usage of Fly ash in Kerb Casting

Kerb casting can be done with 50% age replacement of cement with fly ash using Slip Forming.
M25 Grade slip forming Kerb was casted by Gujarat State Highway projects

4.10 Other Disposal and Market Sources

4.10.1 Cellular Light Weight Concrete (CLC) Blocks: These are substitute to bricks and conventional concrete blocks in building with density varying from 800 kg/m^3 to 1800 kg/m^3.

4.10.2 Development of Fly Ash Based Polymer Composites as Wood Substitute: Fly ash based composites have been developed using fly ash as filler and jute cloth as reinforcement. This technology has been developed by Regional Research Laboratory, Bhopal in collaboration with Building Materials & Technology Promotion Council (BMTPC) and TIFAC. One commercial plant has also been set up based on this technology near Chennai [8].

4.10.3 Portland Pozzolanna Cement: Up to 35% of suitable fly ash can directly be substituted for cement as blending material. Addition of fly ash significantly improves the quality & durability characteristics of resulting concrete. In India, present cement production per annum is comparable to the production of Fly Ash. Hence even without enhancing the production capacity of cement; availability of the cement (fly ash based PPC) can be significantly increased.

4.10.4 Fly Ash- Sand-Lime-(Gypsum /Cement) Bricks /Blocks**:** Fly Ash can be used in the range of 40-70%. The other ingredients are lime, gypsum /cement, sand, stone dust/chips etc. Minimum compressive strength (28 days) of 70 kg/cm^2 can easily be achieved and this can go up to 250 Kg/cm^2 (in autoclaved type).

4.10.5 Roller compacted concrete: Another application of using fly ash is in roller compacted concrete dams. Many dams in the US have been constructed with high fly ash contents. Fly ash lowers the heat of hydration allowing thicker placements to occur. This has also been demonstrated in the Ghatghar Dam Project in India [2].

4.10.6 Use of Fly Ash in Agriculture: The field demonstration experiments carried out under varied agro-climatic conditions and soil types across the country by various R & D Institutes / Universities on the cultivation of different field crops (cereals, pulses, oil seeds, sugar cane, vegetables, etc.) and forestry species with different doses of fly ash and pond ash as soil modifier / source of economical plant nutrients with and without organic manure bio-fertilizer and chemical fertilizers in respect to crop yield, soil health, quality of crop produce, uptake of nutrients and toxic heavy metals, ground water quality [2]

V. Initiatives taken by Government of India in the direction Conversion of fly ash into wealth generator

Initiatives taken in the direction of creating Fly Ash grading facility at Thermal Power Plants

As circular by CPWD, IS 456:2000 etc. specifies certain grade of fly ash (conforming to IS 3812) for cement/concrete applications which is not easily available at Thermal Power Plants. Therefore, it was felt necessary to create some fly ash processing facility at TPP so that graded fly ash can be made available to end user. In this regard, letters have been issued to many Thermal Power Stations detailed presentation has been made to Central Electricity Authority and discussions are in progress with some of the TPPs [9].

Government Of India Ministry of Road Transport & Highway in continuation to the Ministry's letter No.RW/NH-33044/30/2001-S&R(R) Dated 4th December, 2003 forwarded thereby the amendments to the Clause 305 "Embankment Construction" of MORTH fourth revision along with list of Thermal Power Plant generating Fly/Pond Ash in different states, it is stated that that Ministry of Environment & Forests, Government of India vide notification No. S.O. 979(E) dated 27th August, 2003 published in the Gazette of India, Part-II- Section 3-Sub-section (ii) has made use of Fly/Pond ash compulsory in road embankment construction. [10]

Sub paragraph (g) of paragraph 2 of the notification at page 10 makes the following amendments:

'No agency, person or organization shall, within a radius of 100 kilometers of a thermal power plant undertake construction or approve design for construction of roads or flyover embankments in contravention of the guidelines/specifications issued by the India Road Congress(IRC) as contained in IRC specification No. SP: 58 of 2001. Any deviation from this direction can only be agreed to on technical reasons if the same is approved by Chief Engineer (Design) or Engineer-in-Chief of the concerned agency or organization or on production of a certificate of "Pond ash not available" from the thermal power plant(s) (TPPs) located within 100 kilometers of the site of construction. This certificate shall be provided by the TPP within two working days from the date of making a request for ash'.

2. Further vide Sub paragraph (2B) of paragraph 5 at page 13 of the notification, all agencies undertaking construction of roads or fly over bridges including Ministry of Road Transport & Highways (MORT&H), National Highways Authority of India (NHAI), Central Public Works Department (CPWD), State Public Works Departments and other State Government Agencies, shall within three months from the 1st day of September, 2003-

a. make provisions in their tender documents, schedules of approved materials and rates as well as technical documents, including those relating to soil borrow area or pit as per sub-paragraph(7) of paragraph 1; and
b. Make necessary specifications /guidelines for road or fly over embankments that are not covered by the specifications laid down by the Indian Road Congress (IRC).

3. In compliance to above, in second part of Para 2 of the Ministry's letter of even number dated 30th July, 2003 referred above, the words 'economically viable lead' stand substituted as 'a radius of one hundred kilometers of a thermal power plant'.

4. It is, therefore, requested that the requisite amendments may please be carried out at the appropriate places and complied strictly.

5. It is requested that quarterly 'Action Taken Report' on use of fly/pond ash in road/flyover embankment construction on NH/other centrally sponsored works in your State/Organization may please be forwarded to the

Ministry addressed to Shri S.S.Nahar, SE(R) S&R, Room No. 340, Transport Bhavan, 1, Parliament Street, New Delhi- 110 001. [10]

As per provisions in MORT&H Revision-5 clauses 601.2.2 & 602.2.2

Cement: Any of the following types of cement may be used with prior approval of the Engineer:

Sr. No	Type	Conforming to
1	Ordinary Portland Cement 43 Grade	IS:8112
2	Portland Blast Furnace Slag Cement	IS:455
3	Portland Pozzolanna Cement	IS:1489-Part I
4	Ordinary Portland Cement 53 Grade	iv) IS:12269

Note:
1) Fly ash up to 20 percent by weight of Cement may be used in 53 Grade Cement. No fly ash shall be used in any other grade of Cement other than 53 Grade. The fly ash shall conform to IS: 3812 (Part-I).
2) Site mixing of fly ash shall be permitted only after ensuring availability at site, uniform blending through a specific mechanical facility with automated process control like batch mix plant conforming to IS:4925 and IS:4926.
3) Mix design will be done as per IRC: SP: 49. The OPC content shall not be less than 135 kg/cum in case of blending at site. The curing period may be suitably enhanced (by at least about 2 days).
4) Ground Granulated Blast Furnace Slag (GGBFS) obtained by grinding granulated slag conforming to IS: 12089. GGBFS shall not be used in any other grade of cement except 53grade. The content of GGBFS shall be up to 50 percent by weight of Ordinary Portland Cement 53 grade
5) Mix design will be done as per IRC: 44. The OPC content shall not be less than 310 kg/cum in case of blending at site. The curing period may be suitably enhanced by at least about 2 days.
6) The Portland Pozzolana Cement produced in factory shall not have fly ash content more than 25 percent. The Portland Pozzolana Cement produced in factory with fly ash content more than 25 percent shall not be used. Certificate from the manufacturer to this effect shall be procured before use. [11]

VI. Conclusion

The use of coal for power generation results in an increased quantum of fly ash production, which has reached about 131 million tons per year. All out efforts are to utilize this fly ash not only from environmental considerations, but also to avoid land usage for fly ash dumping. Though there has been a steady progress in fly ash utilization from 1990, we have a long way to go to reach the target of 100 per cent fly ash utilization.

Fly ash can become a wealth generator by making use of it for producing "green building"materials, roads, agriculture etc. Full utilization of the generating stock will provide employment potential for three hundred thousand people and result in a business volume of over Rs.4,000 crore."

Cement and Concrete Industry accounts for 50% Fly Ash utilization, the total utilization of which at present stands at 30MT (38%). The other areas of application are Low lying area fill (17%), Roads & Embankments (15%), Dyke Raising (4%), and Brick manufacturing (2%)
Government has also framed policy so that fly ash is used.
National Highway Authority of India (NHAI) is currently using 60 lakh m^3 of Fly Ash and proposed to use another 67 lakh m^3 in future projects. We all will work together to make 38% usage to 100% usage of fly ash.

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