

KEYNOTE ADDRESS

FLY ASH: A PARADIGM SHIFT “PROVING ITS WORTH” TO “IMPLEMENTATION ERA” Vimal Kumar*

ABSTRACT

The worthiness of fly ash and its products has been proved beyond doubt. Consumption of about 80 million tonne fly ash per annum by this prime sector of economy is the testimony along with the standards, specifications and guidelines issued by Bureau of Indian Standard, Indian Road Congress, Central Water Commission and incorporation of the same in the lists of approved materials and rates by CPWD, PWDs and other major agencies.

The extraordinary notification of Ministry of Environment and Forests, Government of India, S.O. 2804(E) dated 3rd November 2009, the second amendment to the Principal notification S.O. 763(E) dated 14th September 1999, on fly ash utilization, ushers an era of sale of fly ash (as it has proved its worth) and puts responsibility on major user agencies, statutory (approving and regulating) agencies and facilitating (including financing) agencies to ensure large scale utilization of fly ash with the objective to conserve environment.

The paper delineates the application of fly ash, the proven technical advantages along with economic and ecological impact aspects and thereafter proceeds to bring to the fore the responsibilities and duties assigned by the above referred notification of 3rd November 2009, that need to be noted and acted upon by all to harness the benefits and usher “an era of implementation of fly ash”.

* Dr. Vimal Kumar, Scientist G and Head Fly Ash Unit, Department of Science and Technology, Ministry of Science and Technology, Government of India, New Delhi
The views expressed are that of the author and not necessarily of the organization of his affiliation

PREAMBLE

Fly ash, a residue of burning of pulverized coal / lignite in thermal power stations is a ferro-alumina silicate mineral with major matrix elements like silica, aluminium, iron together with other non organic matters having majority of particles ranging from a few microns to 100 microns; small percentage of particles range upto about 300/350 microns (the term fly ash includes dry fly ash from ESP, bottom ash, pre heater ash, economizer ash and a combination of these when stored either in pond or mound). The fly ashes of Indian coals are generally alkaline, pozzolanic in nature and low in heavy metal / toxic elements as well as radionuclides. By virtue of these properties Indian fly ashes are quite safe for various utilizations including for construction and also in agriculture sector. The chemical, mineralogical and geotechnical properties of fly ashes have made fly ash a very useful raw material. It has wide applications ranging from manufacture of fly ash bricks, clay-fly ash bricks, blocks, pavers interlocking blocks, light weight blocks, concretes of various grades and types including self compacting concrete and high strength / high performance concrete and roller compacted concrete, manufacture of cement, manufacture of pre-fabs, light weight aggregates, manufacture of wood substitutes, door panels / ply wood substitute, partitioning material, roofing sheets and gypsum board substitutes etc. In addition, fly ash is a good substitute of soil for geo technical applications such as reclamation of low lying

areas, construction of road / fly over embankments and construction of earthen dams. Fly ash has also been successfully used for stabilization of problematic soils such as swelling black cotton soils, marshy / wet lands etc.

Till early 1990's, fly ash was considered as a hazardous industrial waste and by the end of 1990's, as a result of concerted efforts under Fly Ash Mission, Department of Science and Technology, Government of India, along with many other agencies the fly ash was proved to be a useful material without any harmful effects and was thus moved from hazardous list to industrial waste list and now it's the time to shift the fly ash to raw material category.

The recent developments on technology front are opening up the avenues for manufacture of fly ash bricks with more than 80 per cent ash content and in some cases around 95 per cent ash content is being attempted. Fly ash based cementing material with more than 90 per cent fly ash content (without lime or cement clinker content) is also being perfected.

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.

Policy and statutory measure has also been taken by the Government from time to time to facilitate and promote use of fly ash, including directing responsibilities on related stakeholder agencies / bodies.

The worthiness of fly ash for use is primarily governed by:

- (i) Scientific and technical aspects of various applications of fly ash
- (ii) Technical advantages of use of fly ash in
- (iii) Economics of use
- (iv) Ecological impact including conservation of resources.

Fly ash has passed these litmus tests with flying colours and has become a sought after material. Now, it's time to implement the use of fly ash on a large scale, especially when the notification issued by Ministry of Environment Forest, Government of India on 3rd November 2009 makes it a tradable commodity.

This paper makes an attempt to highlight and bring to the fore the salient features of fly ash regarding technical advantages, economics and ecological impact for use and there after moves on to the some salient features of 3rd November 2009 notification dealing with assigning of responsibilities to various agencies for facilitating the large scale utilization of fly ash.

“Scientific and technical aspects of various applications of fly ash in construction industry” are not being dealt in this paper as these have been addressed earlier at a number of occasions in sufficient depth and are also being addressed to by a number of scientists and technologists in this volume.

TECHNICAL ADVANTAGES

Fly ash, clay-fly ash bricks, blocks, tiles, pavers, interlocking blocks etc. are generally stronger and durable as compared to corresponding clay products. They also have low water absorption, practically no efflorescence and being factory made, are of uniform size.

Fly ash based cements provides high long term strength and better concretes in terms of workability, impermeability, resistance to attack of sulphates / chlorides / carbon dioxide and other hazardous environments. Fly ash reacts with available free lime and forms stable and strength imparting compounds. Fly ash is an essential component of self compacting and roller compacted concretes etc.

Light weight / cellular blocks can be manufactured with fly ash substituting cement up to about 40% and sand substitution up to about 20%. The densities range from 650 kg / m³ onwards. The compressive strength of these blocks is commensurate to the end application, have low water absorption by virtue of unconnected pores and provide good thermal insulation. The cellular / light weight blocks are also fire retardant. The construction is faster and consumes less amount of mortar because of less no of joints and uniform size of blocks.

Light weight sintered fly ash aggregates make the concrete lighter, eco-friendly and less heat conducting. Similarly, the fly ash bricks, blocks manufactured by use of light weight aggregates are also less in weight with good thermal insulation properties.

Fly ash based wood substitutes for door panels, ply wood, partitioning material and roofing sheets, gypsum board substitutes etc. are manufactured with 60-70% ash content and the balance being the polymer based adhesive and non forest reinforcements. These products are weather proof, water proof, termite proof, UV radiation proof, fire retardant and can be cut, nailed, processed like wood items with similar carpentry tools. By virtue of the above said properties these materials are of good strength and are durable as well as eco friendly.

Fly ash has good geotechnical properties such as higher angle of internal friction, wide range of working OMC, good compaction properties, no subsequent settlements and good load bearing capacity when compacted and confined. By virtue of these properties fly ash has been proved to be a excellent material for geo-technical applications such as reclamation of low lying areas, construction of road / fly over embankments including reinforced walls and construction of earthen dams.

Fly ash being a light weight material as compared to soil, has been successfully used over weak soils and also marshy / wet lands. Fly ash also has the ability to stabilize problematic soil such as swelling black cotton soils, red lateratic soils, desert soils etc. because of its chemical constituents.

ECONOMICS

Fly ash bricks, blocks, pavers, interlocking blocks etc. are generally air water cured though can also be steam cured to accelerate the curing process, but are not burnt. Further, these products being factory made can be manufactured round the year and are economical as compared to corresponding conventional construction materials.

The construction becomes more economical because of faster rate of construction, less consumption of mortar and plaster etc.

Use of fly ash in cement and concrete makes it economical. In concrete, fly ash substitutes cement which is high cost product. In cement manufacturing fly ash substitutes clinker which is also a relatively high cost material. For cement substitution by fly ash, fly ash remains economical even if transported for more than 1000km.

Use of light weight, cellular blocks / aggregates provides the economics by virtue of reduction of load of the structure and saving in air conditioning power consumption by about 15 per cent.

Fly ash based wood substitute materials and other similar materials being durable for long life provide economics over corresponding conventional materials and they are also maintenance free.

Use of fly ash in geotechnical applications including reinforced walls provides economics by virtue of ease of construction, faster compaction and generally less lead distance.

ECOLOGICAL IMPACT

All applications of fly ash in construction lead to conservation of top soil (used for manufacture of brick, reclamation of low lying, construction of embankments etc.), conservation of coal and CO₂ emissions (used for burning of clay bricks and for manufacture of clinker / power consumption in cement manufacturing), lime and gypsum used in cement manufacturing, low level of mining activity due to conservation of above said mineral resources (coal, lime, gypsum, soil etc.) and also conservation of forest because use of fly ash based wood substitute materials.

Thus, use of fly ash in construction is eco-friendly. The estimates indicate that the current level of use of fly ash of 80 million tonnes / year conserves annually 300 lakh tonne coal, 650 lakh tonne lime, 400 lakh tonne top soil (3000 acres of land) and 300 lakh tonne CO₂ generation etc.

NOTIFICATION: RESPONSIBILITIES AND DUTIES ASSIGNED

The Government, Central as well as State Governments take a number of fiscal as well as statutory and policy measures from time to time to promote and facilitate use of fly ash for various applications including for construction industry. Exemption / concessions have been given at different points of time by different Governments for excise duty, octroi, sales tax, vat etc. Incentives / facilitation for availability of land and other infrastructure facility have already been extended. Guidelines and statutory notifications have been issued by Ministry of Power, CEA, MoEF and Ministry of Road Transport and Highways, CPWD as well as many State Governments.

Ministry of Environment and Forest (MoEF) Govt. of India has brought notification no. S.O. 763(E) on 14th September 1999 and amendment no. S.O. 979(E) dated 27th August 2003 under Environment (Protection) Act, 1986 regarding fly ash utilization. These have been further amended on 3rd November 2009 vide notification no. S.O. 2804(E). Following are the important features of 3rd November 2009 notification that may be noted by the concerns in the construction industry for providing the required support, facilitation and discharging their respective responsibilities and duties in implementation of these notifications. (for details please refer to the full text of notifications available at the website of MoEF and also at www.c-farm.org)

Building Construction Agencies

(1A) Every construction agency engaged in the construction of buildings within a radius of hundred kilometers from a coal or lignite based thermal power plant shall use only fly ash based products for construction, such as cement/concrete, fly ash bricks or blocks or tiles or clay fly ash bricks, blocks or tiles or cement fly ash bricks or bricks or blocks or similar products or a combination or aggregate of them, in every construction project.

(1B) The provisions of sub-paragraph (1A) shall be applicable to all construction agencies of Central or State or Local Government and private or public sector.

Building Specification Agency

(a) in sub-paragraph (2), for the words “schedules of specifications and construction applications, including appropriate standards and codes of practice, within a period of four months from the publication of this notification”, the words “tender documents, schedules of specifications and construction applications including appropriate standards and codes of practice within a period of four months from the publication of this notification” shall be substituted;

(b) for sub-paragraph (2A), the following sub-paragraph shall be substituted, namely:—

“(2A) Building construction agencies both in public and private shall prescribe the use of fly ash and fly ash-based products in their respective tender documents, schedules of specifications and construction applications, including appropriate standards and codes of practice and make provisions for the use of fly ash and fly ash based bricks, blocks or tiles or aggregates of them in the schedule of approved materials and rates within a period of four months from the publication of this notification.”;

Building Approving Agency

It shall be the responsibility of the agencies either undertaking construction or approving the design or both to ensure compliance of the provisions of sub-paragraph (1A) and to submit annual returns to the concerned State Pollution Control Board or Pollution Control Committee, as applicable”;

Minimum fly ash content for building materials or products to qualify as “fly ash based products” has been specified.

Road Construction Agency

(5) No agency, person or organization shall, within a radius of hundred kilometers of a thermal power plant undertake construction or approve design for construction of roads or flyover embankments with top soil. The guidelines or specifications issued by the Indian Road Congress (IRC) as contained in IRC specification No. SP: 58 of 2001 as amended from time to time, regarding use of fly ash shall be followed. 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 organisation or on production of a certificate of “fly ash not available” from the thermal power plant(s) (TPPs) located within hundred kilometers of the site of construction. This certificate shall be provided by the TPP within two working days from the date of receipt of a request for fly ash, if fly ash is not available”;

(i) in sub-paragraph (6), for the words “Voids created due to soil borrow area shall be filled up with ash with proper compaction and covered with topsoil kept separately as above. This would be done as an integral part of embankment project within the time schedule of the project”, the words “Voids created at soil borrow area shall be filled up with fly ash with proper compaction and covered with topsoil kept separately as above. This would be done as an integral part of embankment project” shall be substituted;

Road Specification Agency

“(2B) All agencies undertaking construction of roads or fly over bridges and reclamation and compaction of low lying areas, including Department of Road Transport and Highways (DORTH), National Highways Authority of India (NHAI), Central Public Works Department (CPWD), State Public Works Departments and other State Government Agencies, shall within a period of four months from the publication of this notification:-

a. make provisions in their tender documents, schedules of approved materials and rates as well as technical documents for implementation of this notification, including those relating to soil borrow area or pit as per sub-paragraph (6) of paragraph 1; and

b. make necessary specifications or guidelines for road or fly over embankments that are not covered by the specifications laid down by the Indian Road Congress (IRC).

Reclamation of Low Lying Area

“(7) No agency, person or organisation shall within a radius of hundred kilometers of a coal or lignite based thermal power plant undertake or approve or allow reclamation and compaction of low-lying areas with soil. Only fly ash shall be used for compaction and reclamation. They shall also ensure that such reclamation and compaction is done in accordance with the specifications and guidelines laid down by the authorities mentioned in sub-paragraph (1) of paragraph 3.

Building by law agency

(3) All local authorities shall specify in their respective tender documents, building bye-laws and regulations, the use of fly ash and fly ash-based products and construction techniques in building materials, roads embankments or for any usage with immediate effect.

Financial Institutions

(5) All Financial institutions and agencies, which fund construction activities, shall include a clause in their loan or grant document for compliance of the provisions of this notification.

CONCLUSIONS

Fly ash that was treated as a hazardous industrial waste till early 1990's, shifted to industrial waste category during late 1990's on proving it's worth, is now ready to be shifted to "Raw Material" category since it has become a tradable commodity with effect from notification no. S.O. 2804(E) dated 3rd November 2009 of MoEF, Government of India. The notification has put the responsibilities and duties for major user agencies, statutory agencies as well as facilitating agencies to ensure large scale utilization of fly ash that we all need to note and act upon with all sincerity for a successful "Implementation Era" for large scale use of fly ash.