Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 12, December -2017

An Overview Study of Fly Ash

Anirudh Singh Sindhal[1], Jaswant Gehlot[1], Puneet Hiranandani[2], Dr. D.G.M. Purohit[3]

[1]*M.E. Scholar, Department of Civil Engineering, M.B.M. Engineering College, J.N.V. University, Jodhpur, Rajasthan, India*
[2]*Lecturer, Department of Civil Engineering, Govt. Polytechnic College, Jodhpur, Rajasthan, India*
[3]*Professor, Department of Civil Engineering, M.B.M. Engineering College, J.N.V. University, Jodhpur, Rajasthan, India*

Abstract —*India is a vast country with huge population. The demand is not only on industrialization and housing but also equally on infrastructure where interconnecting the whole nation through road network is one of the important ongoing activities. If the interlinking of rivers also comes true this is another dimension of development. All these projects bring in lot of pressure on the construction material, with major thrust on bricks and concrete, because of their voluminous consumption. India is bestowed to generate more than 150 million tons of industrial by products annually which can best be utilized in bricks cement and concrete. Fly ash is the major by product and is available in almost all parts of the nation. Hence solving the fly ash problem is tantamount to solving the major share of the issue. In this background authors discuss the use of fly ash in bricks and concrete with special emphasis on FaL- G technology. The indicators for sustainable development are also discussed thereupon. In view of its voluminous availability bituminous coal is used in about 95% of coal- based thermal power generation, thus generating major lot of fly ash as ASTM Class F. This review paper present the classification of fly ash uses in various parts of construction and how to help in environment protection by using fly ash.*

Keywords- *Characteristic of Fly Ash, Classification of Fly Ash, Fly Ash in Roads, Black Cotton Soil, Fly Ash in Marine*

I. INTRODUCTION

1.1 General

Fly ash is generally finely divided residue ash particle resulting from the combustion of coal in the furnace which blows along with flue gas in the furnace. These ash are collected with the help of electric precipators and termed as fly ash. Fly ash is the most widely used pozzolanic material all over the world.

Table 1: According to the IS: 3812- Part-1 2003 the standard chemical requirement of FLY ASH

S.NO.	CHARACTERSTIC	REQUIREMENTS
1	Silicon dioxide (Si02) plus ahsminium oxide (A1203) plus km oxide (Fe2O3) in percent by mass, Min	70
2	Silicon dioxide (SiO2) in percent by mass, Min	35
3	Reactive silica in percent by mass,Min	20
4	Magnesium oxide (MgO) in percent by mass, Max	5
5	Total sulphur as sulphur trioxide (S03) in percent by mass, Max	3
6	Available alkalis as sodium oxide (Na2O) in percent by mass, Max	1.5
7	Total chloride in present by mass, Max	0.05
8	Loss on ignition in percent by mass, Max	5

Table 2: According to the IS: 3812- Part-1 2003 the standard physical requirement of FLY ASH

S.NO.	CHARACTERSTIC	REQUIREMENTS
1	Fineness-specific surface in m2/kg by Blaine's permeability method, Min	320
2	Particles retained on 45 micron IS sieve (wet sieving) in percent, Max	34
3	Lime reactivity — Average compressive strength in N/mm3, Min	4.5
4	Lime reactivity — Average compressive strength in N/mm3, Min	Not less than 80 percent of the strength of corresponding plain cement mortar cubes
5	Soundness by autoclave test – Expansion of specimen in percent, Max	0.8

1.2 Various type of definitions given in IS 4305

Pulverized Fuel Ash — Ash generated by burning of ground or pulverized or crushed coal or lignite fired boilers. It can be fly ash, bottom ash, pond ash or mound ash.

Siliceous Pulverized Fuel Ash — Pulverized fuel ash with reactive calcium oxide less than 10 per cent, by mass. Such fly ash is normally produced from burning anthracite or bituminous coal and has pozzolanic properties.

Calcareous Pulverized Fuel Ash — Pulverized fuel ash with reactive calcium oxide not less than 10 per cent by mass. Such fly ash are normally produced from lignite or sub-bituminous coal and have both pozzolanic and hydraulic properties.

Reactive Calcium Oxide (CaO) — That fraction of the calcium oxide which under normal hardening condition can form calcium silicate hydrates or calcium aluminate hydrates.

Fly Ash — Pulverized fielash extracted from flue gases by any suitable process such as by cyclone separator or electro-static precipitator.

Bottom Ash — Pulverized fuel ash collected from the bottom of boilers by any suitable process.

Pond Ash — Fly ash or bottom ash or both mixed in any proportion and conveyed in the form of water slurry and deposited in pond or lagoon.

Mound Ash — Fly ash or bottom ash or both mixed in any proportion and conveyed or carried in dry form and deposited dry.

1.3 Extraction of Fly Ash
Fly ash may be extracted from flue gases of ground or pulverized or crushed coal or lignite fired boilers by any suitable process; such as, by cyclone separation or electrostatic precipitation; bottom ash from the boilers shall not be added to the fly ash. Fly ash collected at later stages of electrostatic precipitator is finer than the fly ash collected at initial stages of electrostatic precipitator.

1.4 Classification of fly ash
Class F Fly Ash: The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 10% lime (CaO). 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.
Class C Fly Ash: Fly ash produced from the burning of younger lignite or subbituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO_4) contents are generally higher in Class C fly ashes.

Figure 1: fly ash dumped

II. FLY ASH IN ROAD

2.1 General
Coal fly ash, or Pulverised Fuel Ash (PFA) as it has been traditionally known, has been used for many years in road construction. The applications range from the use as a simple general fill material, because it is lightweight and cost effective, through to its use in concrete as an addition to improve the chloride resistance, prevent alkali silica reaction, etc thereby enhancing durability. In more recent times it has been fully accepted both as a binder and aggregate in hydraulically bound mixtures for Highway Works. While fly ash is often specified because of technical and commercial advantages, there are significant environmental and sustainability benefits associated with its use. In many of the applications fly ash is a direct replacement for virgin aggregate so there are issues of resource depletion, reduction in overall CO_2 emissions, diverting material from landfill and reducing vehicle movements that require consideration. In some applications it partially replaces Portland cement or lime, both of which, during their manufacture, are high CO_2

emitters. Here the use of fly ash can result in significant overall reductions in green house gas emissions, as well as sustainability benefits associated with its durability and resulting extended life expectancy. This paper will review the various applications for coal fly ash associated with road construction, summarise the technical benefits and discuss in detail the environmental and sustainability considerations of its use.

2.2 Pozzolanic fly ash as fill up

Pozzolanic fly ash as a fill material has been used for many years as an alternative to in road construction projects. It is used for fill applications because-

1. It is lightweight when compared to most materials, having a particle density of 2.10 to 2.3 and a dry bulk density ranging from 1100kg/m3 to 1450kg/m3 . This leads to savings in material, transport costs and reduces settlement in underlying soils.
2. When properly compacted, PFA settles less than 1% during the construction period with no long-term settlement. It is an easy material to compact with readily available equipment when used at the optimum moisture content. The self-hardening properties of some pozzolanic fly ash's offer considerable strength advantages over natural clay and granular materials. As PFA is pozzolanic, the small quantity of free lime normally present will enhance the strength of the resulting embankment. This reaction can be increased by mixing lime with the PFA when being placed. It is the pozzolanic reaction that is principally used in soil stabilisation and hydraulically bound sub-bases as the binder.
3. Pozzolanic fly ash can exceed the design strength immediately after compaction. The design figures normally quoted are fresh saturated data which are conservative.
4. The immediate strength of PFA means simple shallow trenches have a reduced need for shoring.
5. With proper profiling PFA fill can be trafficked in all weathers.

Pozzolanic fly ash embankments should be constructed on a free draining layer that acts as a capillary break. Materials like concrete that may be attacked by sulfates should also isolated from pozzolanic fly ash a with a capillary break and metallic items should not be placed closer than 500mm from pozzolanic fly ash.

The pozzolanic fly ash is normally placed in 150mm layers, compacted to 100mm, using standard vibrating rollers. As with all fine grained materials, the surface of the pozzolanic fly ash embankment should be capped either with the construction, a capping layer, top soil, etc. It should be profiled to ensure adequate drainage, especially during the construction period. Pozzolanic fly ash, if properly profiled, will shed rain water easily, allowing construction to continue in poor weather conditions. If it should become saturated with water, it can be dug out, spread out and allowed to dry before being reused without any detriment.

It can be used as both a General Fill, or as a Structural Fill ,the Specification for Highway works. For general fill, 95% of maximum bulk density and moisture content are the critical control parameters, whereas for structural applications the effective angle of internal friction φ' and effective cohesion c' are required.

2.3 Pozzolanic fly ash in concrete construction

There are a number of benefits in using PFA based concrete as follows:

- Improves long term strength performance and durability.
- Reduces permeability, which reduces shrinkage, creep and gives greater resistance to chloride ingress and sulfate attack.
- Minimises the risk of alkali silica reaction.
- Reduces the temperature rise in thick sections.
- Makes more cohesive concrete that has a reduced rate of bleeding, is easier to compact, gives better pumping properties and improves the surface finish of the finished structure.

The benefits of using PFA stem from the pozzolanic reaction. This is when Portland cement hydrates it produces quantities of alkali calcium hydroxide (lime). Pozzolanas, like fly ash, react with this lime to form stable calcium silicate and aluminate hydrates. These hydrates fill the voids within the concrete, removing some of the lime and thus reducing the permeability. This process improves the strength, durability, chloride and sulfate resistance of the concrete. The pozzolanic reaction occurs relatively slowly at normal temperatures enhancing strength in the longer term relative to normal Portland Cement concrete. It is the pozzolanic reaction that imparts most of the benefits in many applications. The finer fraction of fly ash, i.e. those particles that pass the 45μm sieve, act as a solid particulate plasticiser. These particles are spherical and act like ball bearings within the concrete reducing the water requirement for a given workability. A reduction in the water content further lowers the permeability and increases strength and durability. In addition the concrete is more cohesive, has a lower rate of bleeding and is less prone to segregation.

2.4 Fly Ash Bound Mixtures (FABM) for highways and other pavements

Fly ash bound mixtures (FABM) are mixtures of PFA/fly ash and other constituents that are compatible with compaction by rolling and a performance that relies on the pozzolanic properties of the fly ash. The first use of FABM in the UK was on the A52 at Froghall some 10 years ago (UKQAA c, 2007), which has performed very well, however, it must be remembered the French have been using HBMs for many years for their roads and motorway network very successfully.

FABM can be specified and formulated to meet capping, sub-base and base requirements of all classes of road, airfield, port, residential and commercial pavements. In FABM, fly ash is the main constituent of the binder with lime, quick or hydrated, usually the other constituent. Cement can substitute for lime but is not as effective in mobilising the full pozzolanic and thus cementing potential of the fly ash.

Table 3: Compressive strength in MPa of treated fly ash

Age of 1:1 sealed cylindrical specimens cured @ 20C	Fly ash with 2.5% CaO	Fly ash with 5% CaO	Fly ash with 7% CEM 1	Fly ash with 9% CEM 1
7 days	1.5	2	3	5
28 days	4	4	4	8
91 days	5	7.5	6	9

Compared to mixtures based on cement, FABM based on lime are slow-setting, slow hardening, self-healing mixtures. This more protracted rate of hardening has distinct advantages in pavement construction. In the short term, FABM have extended handling times and thus the versatility of unbound granular pavement materials. In the medium term, FABM are autogenous, in that they possess a pozzolanic reserve which allows them to re-heal should say cracking occur under differential settlement. In the long term, FABM develop significant stiffness and strength with the performance and durability of bituminous and cement bound mixtures. Where quicker hardening is required, say in cold weather, the addition of gypsum or the partial or complete replacement of lime with cement can be employed. FABM based on cement however, behave like cement bound mixtures (CBM) and do not have the advantages of laying flexibility and autogenous healing described above.

Figure 2: Fly Ash in Road

III. ROAD IN BLACK COTTON SOIL

3.1 General

Construction of road in a black cotton soil is a challenging task in the civil engineering field. Excessive heaves associated with swelling of expansive soil can cause considerable distress to lightweight civil engineering structures. When the B.C. soil comes in contact with the moisture, it shows considerable volumetric changes. Due to this type of phenomenon, many problems associated regarding maintenance and economic life of the highway and roadway. An attempt is made here to find out solution by using fly ash, which is a by-product of thermal power station. Fly ash becomes a main concern of worry because of its disposal problems and hazardous nature. Use of fly ash in an expansive soil gives economical and ecological solution for stabilization of sub grade of road embankment. So it is a case of “Churning waste into wealth and turning ash into cash”. Experimental works have been carried out in a laboratory, which shows that fly ash improves various engineering properties of the expansive soil like liquid limit, plastic limit, plasticity index, swelling pressure, swelling index, shear strength etc. Investigation says that fly ash is a good stabilizing agent for the construction of road in the black cotton soil.

The B.C. soil is expansive in nature and posses high swelling and shrinkage properties. The B.C. soil is hard so long as it is dry but loses its stability almost completely when it becomes wet. When again it becomes dry it shows lots of cracks on its surface. Expansive soil undergoes extensive volumetric change when subjected to fluctuating moisture. Considerable damage has taken place over the years to canals, roads, buildings and other existing structure, constructed on or with the use of black cotton soil. The present thrust is on the construction of road on the expansive soil. The typical behavior of this soil under different climatic condition has made construction of road over them, due to considerable volumetric change of this soil. Due to shrinkage properties of this soil, top surface settled excessively and shows failure.

The pavements constructed in black cotton soil areas are found to suffer from early failure. In flexible pavements with heavy traffic excessive unevenness, ruts, waves and corrugations are formed almost after every monsoon season, resulting in heavy cost of maintenance demand every year. An attempt is here made to eliminate such problems by adopting proper soil stabilization technique. The term soil stabilization is used to indicate any treatment or process on soil to improve its strength or bearing power by reducing its susceptibility to the adverse influences of water and traffic. Soil stabilization of black cotton soil is to be done with fly ash in this case. Fly ash is a hazardous by-product of thermal power station. Disposal of fly ash becomes the main concern for many countries because of its bulk production. However wastes are not completely worthless. Fly ash is having good cementing and pozzolanic properties. Use of fly ash in road construction on the black cotton soil is an excellent technique of killing two birds with one stone meaningful utilization of industrial waste and stabilizing this high expansive black cotton soil.

3.2 Construction Methodology
3.2.1 Blending Method
In this method sub grade is strengthen by blending of expansive soil and fly ash. At the time of addition of fly ash, the soil should be reasonably in pulverized state. Whereas light texture soils are generally friable, and therefore easy to pulverize, this is not so in the case of the black cotton soil, which is soft and sticky when wet but very hard when dry. Degree of pulverization should be aimed like given in a following table in the field.
The best method of pulverization is by using power roller rather than using manual labour. After pulverization of soil, blending of soil and fly ash is to be done. This can be done by In-place mixing method. The soil sub grade may be treated with a small portion of fly ash up to the desire depth of 0.8 to 1.00 meter. A layer of compacted soil fly ash (30 % fly ash) is to be used to construct the sub grade. Some factors are to be kept in our mind to while adding fly ash in the soil. Three factors, delay time, moisture content and fly ash addition ratio are governing factors for the compressive strength and durability of the sub grade in a black cotton soil. When there will not availability of good earth material for sub base and base then we must go for same black cotton soil and it should be also stabilized in a same manner by using this fly ash.

3.2.2 Strip Method
The procedure to be adopted for construction of road in this method is similar to construction of embankments using normal soil. The original ground should be leveled, scarified and sprinkled with water and then compacted by rolling so as to achieve 97% of the modified proctor density. Fly ash and cover soil should be spread in layers of uniform thickness over the entire width of the embankment, by mechanical means. The cover soil and fly ash should be laid simultaneously to ensure confinement of fly ash. The most efficient lift thicknesses are a function of roller weight and vibratory energy. Medium weight rollers with dead weight in range of 6 to 10 tons, provide satisfactory compaction for loose lift thickness of about 25 centimeter. For better compaction heavier vibratory rollers are required. Two passes without vibration followed by 6 to 10 passes with vibration would be generally sufficient to compact individual layer. Moisture content of the fill material should be checked at the site of placement prior to commencement of compaction. Moisture content of fly ash laid for compaction should vary from OMC to OMC +2%. Moisture content of cover soil should be maintained at its OMC. Where water is required to be added to the fill material, it should be sprinkled uniformly without flooding. At moisture contents higher than the appropriate range, fly ash will liquefy and would be difficult to confine and compact. At lower moisture content ash may require an excessive amount of energy to compact.

3.2.3 Sand Drain Method
This method is also known as Sand blanket method. When ground water is encountered in close proximity to the propose embankment, a blanket drainage material should be provided. In this method, a drain of some diameter (d) is to be provided and depth of sand drain is 2.5 times diameter is to be provided below the pavement thickness. This will also provide a working platform for the construction of fly ash fill.

3.3 Compatibility of Fly Ash as a Stabilizing Agent
3.3.1 Advantages of Fly Ash
1. Fly ash reduces swelling properties of the soil, which gives stability to the embankment during the wet season. Hence the road in such type of expansive soil gets more service life. There will not be any problems like settlement and failure of pavement.
2. Fly ash is used as a fill material, which eliminates needs for expensive borrow materials
3. It expedites the construction process by improving excessive wet or unstable sub grade.
4. It improves the sub grade condition, which ultimately results in the reduction of thickness of pavement. Thus, the economical benefits can be directly achieved by such type of depth reduction.
5. Low specific gravity of fly ash results in a low base pressure.
6. Fly ash is a good drying agent, which is effectively utilized to reduce the soil moisture content in the field.
7. Fly ash can be spread and compacted by using conventional construction equipment.
8. The pozzolanic hardening of fly ash imparts additional strength and very less settlement.
9. On one hand fly ash proves to be an effective admixture for improving the soil quality, on other hand in this type of utilization affords means of disposing of industrial by product without adversely affecting environment.

3.3.2 Limitation of Fly Ash Usages

1. Fly ashes are not available in bags in certified quality packs, which is the main limitation in their ready utilization.
2. Erosion of fly ash is the main concern when using as a fill material. Due to its fine-grained non-cohesive nature, fly ash is easily suspected to erosion.
3. Transportation of fly ash should be careful enough hence pollution can be avoided due to spreading of fine particles in air on route of transportation.
4. The sulphate content of fly ash some time causes concern about possibilities of sulphate attack on adjacent concrete structure.

Figure 3: Fly ash mixing with a disc harrow and Road on Black Cotton Soil

IV. BEHAVIOR OF FLY ASH WITH MARINE WATER

4.1 General

Potable water is the most important ingredient in the making of conventional concrete and concrete is the most widely used material in the world next to water. Only 2.5% of the world's water bodies are said to be of fresh water and the remaining constitute of sea water. According to the report of the World Meteorological Organization, more than half of the world's population would not have enough drinking water by 2025. The construction officials in coastal areas have long been facing the challenge of building and maintaining durable concrete structures in a salt water environment. Gradual penetration of sea salts and the subsequent formation of expansive and leachable compounds lead to disintegration of structural concrete. Cement is the most costly and energy intensive component of concrete. The unit cost of concrete can be reduced as much as possible by partially replacing cement with fly ash. Fly ash is available in abundance as a by-product from thermal projects in India. Waste products like fly ash, (which otherwise is hazardous to the atmosphere, may be used as part partial replacement of cement with fly ash and the fly ash) when used in concretes have been known to have higher resistance to chloride ion penetration than concrete made with ordinary Portland cement. In the present study two grades of reference fly ash concrete M20, M25 were prepared using potable water for mixing and curing. The same grades of fly ash concrete were once again prepared using potable water for mixing and cured in sea water. Once again the same grades of fly ash concrete were prepared using sea water for mixing as well as curing. Investigation was carried out for fresh concrete properties and hardened concrete properties on specimens cured for 7, 28 & 90 days.

4.2 Effect of fly ash with cement in marine environment

Canon has stated that by adding fly ash to the extent of 15% by weight of cement in lean concrete (W/C=0.8) strength equal to the corresponding plane concrete within 90days was achieved. C. Marthong, T.P. Agrawal in v comparative study on effects of concrete properties when OPC of varying grades 33, 43, 53 were partially replaced by fly ash. The main variable investigated in this study is variation of fly ash dosage of 10%, 20%, 30% and 40%. The compressive strength, durability and shrinkage of concrete were mainly studied. Test results shows that, inclusion of fly ash generally improves the concrete properties upto certain percent or replacement in all grades of OPC.

Deepa A. Sinha and Elizabeth George have designed M25 and M30 concrete mixtures with different percentages ofash substitution without any addition of chemical admixtures. It was found that not only the 28 and 90 days compressive strength but also the flexural strength and durability of fly ash concrete was satisfactory up to 50% fly ash substitution for cement. Dhuraria has recorded that earlier strengths could be achieved in fly ash concrete by adjusting the various ingredients in such a way that the quantity of cement and fly ash in the final mix is more than the quantity of cement replaced. Fly ash concrete mix appeared drier than normal concrete mix but gets satisfactorily compacted with adequate vibrations. Falah M. Wegian in 2010 examined the technical paper on effect of seawater for mixing and curing on structural concrete. In this article, the effects of mixing and curing concrete with seawater on the compressive, tensile, flexural and bond strengths of concrete were investigated. Concrete mixes were prepared by varying coarse aggregates, cement proportions and types. Six groups of concrete mixes were mixed and cured in fresh water, six groups were mixed and cured in seawater, while four groups were mixed with fresh water and cured in seawater. The compressive strength and subsequently the other related strengths of concrete were shown to increase for specimens mixed and cured in seawater at early ages up to 14 days, while a definite decrease in the respective strengths was observed for ages more than 28 days and up to 90 days. The reduction in strength increases with an increase in exposure time, which may be due to salt crystallization formation affecting the strength gain.Fly ash concrete in marine environment from csiro research report bre no (fly ash reference data sheet no.6.2 that fly ash blended cements are more suitable as binders for marine concrete structures than Portland cements. The use of fly ash blended cement in marine concrete will lead to higher resistance to chloride attack and good resistance to seawater damage. The overall results are longer service life in marine exposure. Hanh H. Pham1, Kien T. Tong1, Thanh T. Le1,2 examined the result of high strength concrete using fly ash for the structures in Vietnamese marine environment for sustainability reported that the research results of a high strength concrete (compressive strength of above 80 MPa) which has up to 35% cement content replaced by fly ash to be used for the structures in Vietnamese marine environment. The use of this concrete probably helps extend the service life of the infrastructures and also helps reduce a large amount of an industrial waste (fly ash) discharged from Vietnamese thermal power plants. This will be able to improve all three aspects of a sustainable construction which comprises economy, natural resource and environment.

Lovewell, Washa has stated that flyash concrete may develop some compressive strength as the corresponding plain concrete at earlier ages by over dosing the fly ash suitability. Md. Moinul Islam, Md. Saiful Islam, Md. Al-Amin and Md. Mydul Islam in 2012 examined that Suitability of sea water on curing and compressive strength of structural concrete as a part of durability study, this paper describes the effect of sea water on compressive strength of concrete when used as mixing and curing water. Concrete specimens were cast from four different grades and plain water as well as sea water was used as mixing water in making the test specimens. Test specimens were cured under sea water as well as plain water upto 180 days. Test results indicate that sea water is not suitable for mixing as well as curing of concrete. Concrete specimen made and cured with sea water exhibits compressive strength loss of about 10% compared to plain water mixed and cured concrete. MYUNG SUG CHO and JAE MYOUNG NOH in 2011examined the assessment of properties and durability of fly ash concrete used in korean nuclear power plants presented that the quality suitability of fly ash manufactured in Korea is assessed and the basic physical properties of fly ash mixed concrete and its durability against primary causes of aging are verified through experimental methods. Because of the internal structure filling effect from the pozzolanic reaction of fly ash and the resulting improvements in mechanical performance in such areas as strength and salt damage resistance, the durability of fly ash mixed concrete is shown to be superior. It is judged that this result can be applied in measures not only for improving the safety of NPP structures in operation in Korea but also for implementing effective structure life management should extending the life of structures be needed in the future. M. Collepardi examined the result of Concrete durability in a Marine Environment reported that this model is adopted to examine the durability of reinforced concrete structures exposed to a marine environment. At least three aggressive agents in sea water can cause deterioration of the reinforced concrete structures chloride, sulphate and alkali ions. The specific aggressive action of each aggressive agent is examined corrosion of the metallic bars caused by chloride ions, damage of the cement paste carried out by sulphate attack, and swelling disruption of concrete if alkali-reactive aggregates are present in the concrete. In order to prevent the damage of concrete structures exposed to a marine environment the following measures should be adopted: to reduce the water cement ratio by using super plasticizers; to employ cementations binders based on the combination of Portland cement with mineral addition such as fly ash and/or blast furnace slag.

O.O. Akinkurolere, cangrujiang and O.M. Shobola school of civil Engineering and Architecture, Wuhan University of Technology, Nigeria, West Africa in 2007 examined that the influence of salt water on the compressive strength of concrete reported that this study is aimed at investigation the effect of sea water as mixing or curing water on concrete compressive strength. This paper therefore presents the result and findings of an experimental research on the influence of salt water from Lagos lagoon, in Nigeria on concrete compressive strength. In the research, concrete cubes were cast with fresh and salt water using a 150×150×150 mm mould and a mix ratio of 1:2:4 by weight of concrete 0.6 watercement ratio were used. A total of 132 concrete cubes were made. Half of the cubes were made using fresh water and remaining half were made using salt water. They were cured in fresh and seawater respectively. The concrete cubes were tested for compressive strength at 7, 14, 21 and 28 days. The compressive strength of concrete is shown to be increased by the presence of salt or ocean salt in the mixing and curing water. The rate of strength gain is also affected when the concrete is cast with fresh water and cured with salt water and vice- versa. Mixing concrete with salt water and curing with salt- water increases the compressive strength rapidly and the strength was still increasing at 28 days. P. Kumar Mehta University of California, Berkeley, USA examined the high-performance, high-volume fly ash concrete for sustainable development reported that 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, sulphate 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. RaimaLateefige has investigated the effect of seawater concentration, on mixing and curing, and compressive strength of concrete. The compressive strength of the cubes determined through crushing at 7, 14, 21 and 28 days respectively. The compressive strength of concrete cast with sea water showed an increase in strength at 7, 14, 21 and 28 days .A remarkable rapid increase was noted in concrete cubes cast with seawater and cured seawater at 7, 14, 21 and 28 days as well. At 7 days of curing, concrete cast with seawater and cured with seawater has attained strength of about 79% of the 28 days compressive strength of the control test. He found that 28 days, SS (cubes cast with seawater and cured with seawater) has attained strength of about 114% of 28 days compressive strength of control.

V. PROTECTION OF ENVIRONMENT BY USING FLY ASH IN ROAD

5.1 General

It has been found that stabilization with fly ash, improves the natural and mechanical characteristics of soils (plasticity, compressive strength and particle size distribution). As a result, the improvement of the forest road networks from one side and the economy in natural inert materials and the exploitation of fly ash from the other, the importance of such an intervention in the protection of the forest ecosystem and the natural environment in general are obvious.

5.2 Problem to Environment due to Fly Ash

One of the most interesting by-products of the production processes, is fly ash (F. A.), a fine grained residue of coal combustion in Thermal Production Stations of Electrical Energy, the usage of which has gained greater importance the moment the preservation of natural resources, the economizing of energy and the increase of environmental sensitivity and viable growth, has become an international issue. Internationally, fly ash has been used in many applications (ASCE, 1993; Linn and Symons, 1988) for several years, always aiming at the most beneficial end use and the protection of the environment (EC, 2000; European Committee for Standardization, 2000). Through the stabilization of soils of high plasticity with fly ash, it has been found that not only mechanical properties were improved, compressive and shear strengths were increased and the volume expansion of soil was controlled, but also a financially viable and durable pavement was created (Querol et al., 1996). In Greece, the annual production reaches 12 million tones, a percentage of which was used in road and soil construction, in the stabilization-improvement of soils, in the construction of embankments and mostly in the creation of new construction materials, as an addition to cement/concrete (Ftikos and Tsimas, 1985). As a result of soil stabilization with fly ash, compression strength and plasticity were improved, while it was proven that ash can be used successfully as an additive for the base and sub-base layer construction of pavement, as well as for the construction of embankments in compressed soils (Christoulas et al., 1983; Mouratidis, 2004; Kolias and Karahalios, 2005).

Other researchers have proven that the mixtures of ash with inert materials reach 50%-70% of the strength of the corresponding mixtures of cement-inactive materials (Mouratidis, 2004), while the addition of ash reduces the necessary pavement thickness and, at the same time, the construction cost (Kolias and Karahalios, 2005). In the laboratories of the Confederacy Polytechnic School of Zurich (ETH), after research on the enforcement of subordinate sand-gravel paving with ash and cement, it appeared that its strength was improved about 40%, while its average deflection under the influence of circulating masses decreases about 35% in relation to the natural soil (Eskioglou et al., 1996). Finally, soil stabilization with the mixture of 30% ash and 8% lime decreased the deflection rate of the stabilized layer about 1,7 times in comparison to the deflection of natural soil (Eskioglou and Efthymiou, 1996). Considering all of the above, it is attempted, in the present assignment, to investigate the possibility of clay soil stabilization and the crushed, natural, sand-gravel stabilization with various quantities of ash, so that any alteration of their mechanical properties can be recorded, to the benefit of economy and environmental protection.

5.3 Methods and Research material

The research took place in the Laboratories of Public Works of Central Macedonia , and the materials used were Ptolemaida ash from the steam electrical station in Kardia, clay soils and natural sand-gravel from the University forest of Pertouli, and finally, crushed sand-gravel from the quarry of Trikala. The geological ground of the research area is mostly flysch and the soils that were studied are instable clay with low bearing capacity. Through the method of random specimen collection, the excavation positions were selected, and 20, in total, soil specimens were collected. For every soil specimen there was a particle size distribution analysis, calculation of the Atterberg limits, compaction with the modified AASHTO T-180 method, definition of optimum moisture content w% and the corresponding dry density γd- (AASHO, 1986; 1987). Then the stabilization of the soil and sand-gravel specimens with ash in various percentages followed. Change of soil plasticity under the effect of ash in various percentages was measured, while change in the Proctor rates was calculated and the unhindered compressive strength was computed after a sample curing for 7, 28 and 90 days. The cylindrical soil samples, of dimensions 50x100 mm, were prepared with optimum moisture content and were statically compacted, according to the B.S.-1924/1975 method, testing 10 (British Standards, 1975).

VI. CONCLUSIONS

Utilization of bulk quantity of Industrial waste produced globally is a serious concern in today's era. Nearly 75% of India's total installed power generation is from thermal power station which is 90% coal based, producing tremendous quantity of fly ash as well as pond ash, which requires a large area to dispose off. The bulk utilization of fly ash is only possible by the way of geotechnical application such as embankment construction, backfill material and sub base material.

Various results obtained from this review research paper have been shown as under:

1. PFA/fly ash has considerable benefits when used in road construction, whether it is for embankment construction, for concrete in roads and bridges or for sub-base materials as in Fly Ash Bound Mixtures. Where PFA replaces virgin aggregates, or acts as a cementitious binder, significant reductions in overall CO2 emissions are possible to the benefit of the environment. In addition the existing stocks of material represent a large mineral reserve for future generations ensuring the sustainable construction of our road infrastructure. However, we are all responsible for the future of this planet and by maximising the use of by-products materials, such as PFA, this will reduce virgin aggregate depletion and leave resources for the future.
2. Addition of fly ash reduces liquid limit, plastic limmit, plasticity index and swelling characteristics of the soil. Hence fly ash improves most of the engineering properties of the black cotton soil as expansive soil tends to become non expansive in nature.
3. Fly ash improves the CBR value of the black cotton soil. This improved value of CBR gives reduction in thickness of pavement which ultimately results in a cost saving.
4. Fly ash is a hazardous industrial waste, which can be effectively utilized in road construction.
5. Moving from the laboratory to field construction site, there would be some variation introduced as results of relatively uncontrolled construction practices as compare to carefully controlled laboratory condition

REFERENCES

[1]. Alam Singh "Basic Soil Mechanics and Foundation", CBS Publishers and Distributors, India.
[2]. Punmia B.C., "Soil Mechanics and Foundation", Laxmi Publications Pvt. Ltd., India.
[3]. K.R. Arora "Soil Mechanics and Foundation Engineering", Standard Publishers and Distributors, New Delhi.
[4]. IS 3812-1: Specification for Pulverized Fuel Ash, Part 1: For Use as Pozzolana in Cement, Cement Mortar and Concrete.
[5]. IS 3812-2: Specification for Pulverized Fuel Ash, Part 2: For Use as Admixture in Cement Mortar and Concrete.
[6]. Using Coal Fly Ash In Road Construction Ljmu 2008 Annual International Conference 20th -21st February 2008, Liverpool, Uk
http://www.ukqaa.org.uk/wp-content/uploads/2014/02/LJMU-Pavement-Feb-2008.pdf
[7]. Construction of a Road in the Black Cotton Soil using Fly Ash M. D. ZafarEqyaabal and A. Ambica
http://www.indjst.org/index.php/indjst/article/download/87490/66872
[8]. Stabilization Of Expansive Soils Using Flyash S. BhuvaneshwarR. G. Robinson S. R. Gandhi
http://www.civil.iitm.ac.in/people/faculty/srgandhi/International
[9]. A Study On Fly Ash Concrete In Marine Environment S. BhanuPravallika, V. Lakshmi
http://convertonlinefree.com/PDFToWORDEN.aspx
[10]. Protection Of Environment By The Use Of Fly Ash In Road Construction
http://users.auth.gr/pxeskio/papers/442_ESKIOGLOU_proof.pdf

