Fly ash as an embankment material

1Dr. R.R. Singh, 2Er.NitinGoyal, 3Er.NavpreetKaur
1Associate professor (CED), PEC University of Technology, Chandigarh, INDIA
2,3Research scholar (CED), PEC University of technology, Chandigarh, INDIA

Abstract

Fly ash (FA)- is a waste by- product extracted by mechanical /electrostatic precipitator, obtained from coal fired power plants. India has some of the largest reserves of coal in the world. At present scenario, around 160 million-tons of fly-ash is produced which is nearly twice over the last decade. In India most of the thermal power plants are utilizing bituminous and sub-bituminous coal and produce large quantities of fly ash. High ash content (30% - 50%) coal contributes to these large volumes of fly ash. Fly-ash is used in various sectors like brick making, roads & embankments construction, cement manufacturing, agricultural uses, reclamation of low lying areas, mine filling, Ash Dyke Raisingetc .The unutilized huge quantity of fly ash has drawn the attention of researchers to explore new strategies for bulk utilization. Fly ash embankment is one of the thrust areas to consume fly ash in bulk .As in India current scenario of utilization of fly ash in roads and embankment is only 6%.The present paper represents the potential applications for fly ash as an embankment material.Fly ash possesses most of the important and favorable geotechnical characteristic for its usage as embankment fill.

Keywords: *Embankment material, Fly ash, Laboratory tests, Strength, Compaction*

1. Introduction

"Waste transformations"is the powerful term used in effective solid waste management technique. The thermal power plants in India consume more than 300 million-tons of coal and generate nearly 100,000 MW power. This produces fly-ash around 163.56 million-tons out of which only 61.37% is being utilized. Though fly ash has wide variety of applications in civil engineering industries but bulk utilization of fly ash is possible only if it is used as an embankment material. Direct use of fly ash in highway embankment projects consumes large volumes of fly ash and provides a promising solution to the disposal problem, but also an economic alternative to the use of traditional materials. Since the intended use of these materials is as embankment construction materials, emphasis is given to the determinationof their mechanical characteristics, including compaction, permeability, strength, stiffness, and compressibility.

2. Literature review

Several studies have been carried out in which the engineering properties and the physical and chemical characteristics of fly ash were determined in the laboratory. Fly ash has been used as embankment fill since long ago in England and United States. Some of the case histories (Fiber and Digioia, 1976) reveal that fly ash embankment will provide light weight stable fill which will be stronger than most natural soils, due to age hardening characteristics, of the material. The expressway connecting between Grand and Greenwood avenues in Waukegan, Illinois, USA was constructed over a fill embankment with 2.4m of earth fill on the outsides of fly ash slopes. In India during early 70's fly ash embankment was constructed in Raichur district of Karnataka for a length of 1km. presently the approach embankment for second NizamuddinBridge along NH 24 in New Delhi was constructed using pond ash. The embankment design incorporate use of ash and soil in layers, along with stone pitching over suitable soil cover on the sides.

3. Fly ash and its properties

3.1 Chemical composition of fly ash

Fly ash is a fine grained cohesion lessmaterial, normally grey in color. The color of fly ash depends on the presence of oxide of iron and carbon content. The chemical composition of fly ash depends on the characteristics and composition of minerals present in coal during burning, degree of pulverization of coal and boiler temperature. The major constituent are silica, alumina and iron constituting about 95% by weight of its total composition. The other constituents are oxides of calcium, magnesium, sodium, potassium and sulphur. Oxides of sodium and potassium react with water and get converted into respective hydroxides. Presence of crystalline phases of silica possesses very low reactivity with lime at ordinary temperature than amorphous silica. In the present study, fly ash collected from a single electrostatic precipitator of**Guru Gobind Singh** super thermal power plant Ropar was used. Based on origin, composition and nature, fly ash can be classified as lignitic fly ash –class C or anthracitic fly ash – Class F . Fly ash utilized for present study of

class F. The chemical composition of Ropar fly ash presented in table in 1

Table 1chemical composition of Ropar fly-ash

Sio2	63,93 %
Al2O3	23,72 %
Fe2O3	7,93 %
TiO2	1,42 %
CaO	0,68 %
K20	1,08 %
MgO	0,44 %

3.2 Physical properties of fly ash

3.2.1 Specific gravity

The specific gravity depends upon chemical constituent in the fly ash. The value of specific gravity varies from 1.9 to 2.5. Ashes which contain high iron oxide content have high specific gravity. Presence of carbon content in fly ash decreases the value of specific gravity. The specific gravity of Ropar fly ash is 2.2.

3.2.2 Grain Size Analysis

Fly ash is a fine grained material. The specific surface area of fly ash which varies from 4000-7000 cm2/gm is more than the specific surface area of cement (3000cm2/gm). The average grain size (D50) of fly ash ranges from .02-.06 mm. In Ropar fly ash more than 75% of the particles are finer than .075 mm.

3.2.3 Atterbergs Limits

Fly ash is a non-plastic material. In dry state it is completely cohesion less. In partially saturated state, some apparent cohesion is developed in fly ash .The liquid limit of fly ash varies from 30% to 60%. The liquid limit of ROPAR fly ash is in the range of 45% to 47%.

3.3 Geotechnical properties of fly ash

3.3.1Compaction characteristics

The density of compacted fly ash is lower than that of conventional earth fill compacted at same effort. This property of fly ash is due to uniform gradation of the particles but presence of carbon content decreases maximum dry density (MDD) and increases optimum moisture content (OMC). The maximum dry density and optimum moisture content of fly ash generally range from 10 KN/m3 to 16 KN/m3 and 15% to 40% respectively. The MDD and OMC of ROPAR fly ash in light compaction test are 12.24 KN/m3 and 36%, respectively.

3.3.2 Strength parameters

The important factors in utilization of fly ash as engineering material are its physical property, chemical reactivity and curing conditions. The factors that affect the gain in strength of fly ash are: compaction, compression, consolidation.

3.3.3 Permeability characteristics

The coefficient of permeability of class F fly ash range from 6x10-7 to 2x10-9 m/s. There is decrease in permeability with respect to time due to self-cementation properties of fly ash and helps in drainage.

4 Factors governs fly ash as an embankment material

4.1 It is light weight material as compared to natural soils hencesuitable as embankment fill over soft compressible ground. A well compacted fly ash embankment would exert 60% of the pressure on foundation compared to natural soils.

4.2 The compaction curve of fly ash is relatively flat, showing that the degree of compaction is less sensitive to water content and fly ash can be used even in wet condition as an embankment material.

4.3 Fly ash possess high angle of shearing resistance, greater stability of slopes could be achieved as compared to natural soils.

4.4 Compaction of fly ash can be done with rapid increases in density within five to six passes of using either static or vibratory roller, thus making the construction cost effective.

4.5 Above all its factors its availability in abundant could be utilized effectively avoiding depletion of natural geo material and offsetting problems like disposal and environmental pollution.

5 Conclusion

As the fly ash is available in abundant and there are lots of problems associated with fly ash in disposing and toxity with heavy metal leached to ground water table. On the other side fly ash has considerable geotechnical, a chemical and physical property which substitutes the fly ash on soil and avoiding depletion of natural geo material and problems like disposal and environmental pollution fly ash can be used as an embankment material, this paper has been attempted to promote the use of fly ash as an embankment material in Highway Engineering.

6. References

[1]. MdAquil Ahmad, Mohammad Shahnawaz, Mohd. FaizSiddiqui andZainulHasan Khan , A Statistical Review on the Current Scenario of Generation and Utilization of Fly-Ash in India, *International Journal of Current Engineering and Technology, Vol.4, No.4 (Aug 2014),2434-2438.*

[2] Central Electricity Authority India 2012-13, Annual Report on Fly-ash utilization.

[3]. S. Bhuvaneshwari, R. G. Robinson , S. R. Gandhi, Stabilization of expansive soils using flyash, *Fly Ash Utilization Programme (FAUP), TIFAC, DST, New Delhi – 110016, Fly Ash India 2005, New Delhi,VIII 5.1-VIII 5.10.*

[4]. Bumjoo Kim; Monica Prezzi; and Rodrigo Salgado,Geotechnical Properties of Fly and Bottom Ash Mixtures for Use in Highway Embankments,Journal of Geotechnical and GeoenvironmentalEngineering, Vol. 131, No. 7, July 1, 2005, 914–924/

[5] Neeraj ,*strength studies of cement and crumbedrubber mixed fly ash* , PEC University of Technology,Chd