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Geological Engineering in Fly Ash

Raghupathi,
Assistant Professor,
Department of Civil Engineering ,
Christu Jyothi Institute of Technology and Science.

Abstract:

Industrial and development activities due to constant pressure, and the ecological balance of nature is difficult to get a look in, and the geographical and environmental pollution is a rapid increase. Environmental geotechnics conceptual understand ing of this multi-disciplinary problems and emerged as a response to the need to describe. This paper highlights the scope of geotechnical environment, has been described, in particular, contact with fly ash problem. Fly ash thermal power plants and the disposal of a serious problem that comes from an industrial waste. It contains traces of heavy metals, fly ash until very fine particles and 4000-8000 cm2 / g clarity about and have a lot of time, as the problem was very serious. This paper from human settlements with fly ash on the environment describes the various problems posed. In order to plan for the safe disposal is very important, from the perspective of the geological engineering is associated with the description of fly ash. It also fly ash and geographically exposed to the environmental problems posed by the disposal is being practiced all over the world, that various corrective measures is described.

I. INTRODUCTION

Sustainable development of resource exploitation, the direction of investment, technical development and in line with future structural changes, as well as the direction of current required, which is a process. Closely associated with the environmental capacity. In recent years he made a series of interrelated problems that affected more carefully to decode without a face has proved almost impossible. The expansion of industrial capacity large (for example, minerals and oil, and the location of the sub-surface soil analysis and the basics of building and equipment design and identify land to work) is to take place, when he 1940 During the 1960s around a geological engineer, played a crucial role in the process of development. However, during this period, our environment related issues were given virtually no attention. By 1970, geological engineer's role was to be a relatively minor environmental decision. In 1980, especially in developing countries, has emerged in the area of waste management technology major expansion and has been taking the concept of environmental geotechnology. Almost all human activities with environmental geotechnology connect. And identify environmental geotechnology and a more efficient approach to problem solving classification has the advantage of a multi-utility.

II. FLY ASH

Fly ash comes from thermal power stations and disposal of industrial waste is a serious one that is growing and constantly. Therefore, to reduce this problem in an easy, low-cost technique is forced to watch. The concept of sustainable development should be taken into account, where it is so. This paper fly global environment and safe disposal of ash, which is essential for effective planning in fly ash, engineering description of the problem posed by fly ash to provide a variety of objectives. Paper fly ash disposal and the environment posed by the geographical problem on practice in many parts of the world to talk about the various corrective measures described. The speed and pace of industrialization thermal power plants, not only resulted in a large number of India, but also in other countries, to meet the needs of domestic and industrial energy. Fly ash from power plants, a waste product in India, as a by-product of fly ash produced every year around 100 million tones is expected to be.

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Breakdown of values cover a large area of land near the plant as the electricity generated by the plants get rid of all of ash. In India, the problem of management and disposal of coal ash, because of the high ash in coal (ie 30% to 50%) are more complicated. The World Bank in 2015, the disposal of coal ash in the energy sector in its report on environmental issues, 1,000 square kilometers or one square meter of land per person that is required warned India. Coal ash stored and the land in this area, water and wind impact on the environment. Fly ash allergic bronchitis, silicosis, and asthma as to cause the disease have been reported. In addition, fly ash contaminate surface water and may also have an impact on the ground, and affect aquatic life, it is not harmful to plants, and near metal structures exposed to looting. In the area of West Bengal Santhaldih, Borelia health officials in the studies, and a large number of people in this area, due to the contamination of air, skin disease and lung infections, are victims of fly ash and water that . The problem it contains traces of heavy metals, in the form of fly ash until a very serious matter, very fine particles 4000-8000 cm2 / g clarity about and have a lot of time.

Table 1: Chemical composition of fly ash (Narasimha Rao, 1999)

CONSTITUENTS	PERCENTAGE
Silica (SiO_2)	49-67
Alumina (Al_2O_3)	16-29
Iron oxide (Fe_2O_3)	4-10
Calcium oxide (CaO)	1-4
Magnesium oxide (MgO)	0.2-2
Sulphur (SO_3)	0.1-2
Loss on Ignition	0.4-0.6
Surface area (m^2/N)	2300-5700

The knowledge of chemical composition is essential as the constituent of the ash are likely to affect the index and engineering properties of ash.

2.1 Specific Gravity

Specific gravity of fly ash is needed while using the fly ash for geotechnical applications. Table 2 indicates the range of specific gravity of different coal ashes.

Table 2: Values of specific gravity of coal ashes (Sridharan, 2000).

MATERIAL	SPECIFIC GRAVITY
Bottom ash	2.28-2.78
Fly ash	
USA	2.03-2.49
India	1.84-2.67
Pond ash	
India	1.58-2.39
UK	2.10-2.24
Poland	1.90-2.31
Soils	2.60-2.80

As it is evident from this table, most of the coal ashes have very low values of specific gravities. Due to this ashes have tremendous advantages in geotechnical engineering practice such as construction of embankments, retaining walls and abutments.

2.2 Grain Size Distribution

Fly ash is typically a uniform silt-sized material. Table 3 shows the range of typical values of particle sizes of Indian coal ashes.

2.3 Atterberg Limits

The Liquid limit of fly ash (obtained from cone penetration method.) is found to range between 43% to 49% and it is non-plastic in nature. As per the Unified Classification system, fly ash will fit into ML group, (Sridharan, 2000).

III. ENGINEERING PROPERTIES

The density of ash is an important parameter since it controls its strength, compressibility and permeability characteristics. The degree of compaction of soil/ash is

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measured conventionally in terms of dry density. The compacted unit weight depends upon the amount and method of energy application, and material properties such as grain size, gradation, particle shape, plasticity and moisture content at compaction. The choice of the method of compaction depends on the type of material to be densified. Coal ash is non-plastic and uniformly graded indicating a need for vibratory densification; but the fineness of the particles also suggests that high pressure may be necessary. Fly ash compaction might thus be expected to be a hybrid experience with fine and coarse-grained soils.

3.1 Permeability characteristics

The properties of soil or ash which permits percolation or seepage of water under a gradient is known as permeability and coefficient of permeability is defined as the velocity of flow which will occur through the soil or ash under a unit hydraulic gradient. This parameter is important in designing the liner to contain leachate migration, dyke to prevent the loss of water as well as for the stability of slopes. The range of coefficient of permeability values for pond ash and fly ash are given in Fig 1.

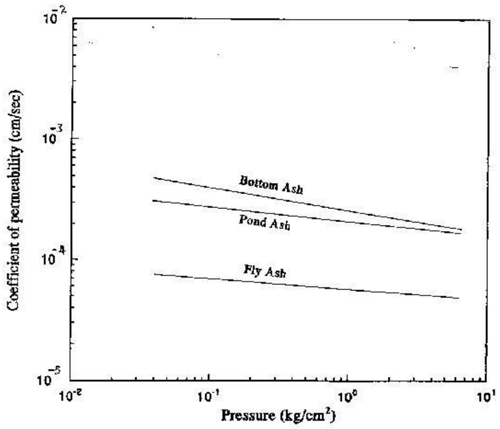

Fig. 1 Variation of co-efficient of permeability with pressure

The in-situ horizontal permeability of pond ash is normally10 to 15 times greater than in-situ vertical permeability. This is because lagoon deposits are highly stratified. Like in case of soils, permeability of fly ash also decreases with increase in degree ofcompaction as can be observed from Fig 1.

Some of fly ashes do have permeability values as low as those for clayey soils. This aspect is very useful in utilization of ash as a low permeable barrier to reduce the migration of solutes and possible ground water pollution.

3.2 Consolidation and compressibility characteristics

To estimate the settlement of the structure placed on fly ash embankments or fills, one-dimensional consolidation tests on undisturbed sample from the reclamation fills gave values of co efficient of consolidation, cV of the order of 0.57-1.14cm2/min (□d in the range of 0.75 to 1.3 g/cm3). But the actual in-situ values are much higher (around 3-10 times the laboratory values). Since primary consolidation for fly ash will be completed by about one minute, it is difficult to take the time compression readings manually for cV calculations using classical deformations Vs time plots. These high rates of consolidation suggest that in most cases primary consolidation will be practically complete when the fill construction is over. This high rate of consolidation of fly ash is favorable particularly for its use as embankment and reclamation fills. Equally important is the secondary consolidation, which accounts for 20-30% of the total compression, which depends on the nature of the fly ash and the duration of curing. The coefficient of secondary consolidation values decrease with curing time due to age hardening of fly ash. They are also highly dependent on the pozzolanic activity of fly ash that depends on the free lime content, carbon content and chemical composition of the glass phases. Another important factor, which influences the compressibility of ash, is its initial density or void ratio. Typical range of values for cc is presented in Table 4 (Sridharan et al 1996).

Table 3. Values of compression index for ashes (Sridharan et al, 1996).

3.3 Strength characteristics

For any engineering application of fly ash, its strength characteristics are essential. In a general sense,

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strength means shear strength only. In some special uses, as in highway engineering where the pavement section and sub grade resist repetitive point loads with very low deformation tolerances, the composite strength-stiffness for the sub grade needs be determined. For this, one of the most common test is the California bearing ratio (CBR) test.

3.4 Shear strength parameters

Both total strength parameters and effective strength parameters are required in designs. For example, in the case of dyke design, total strength parameters are required for stability analysis during construction period or for sudden draw-down Conditions

PLACEMENT VOID RATIO.	CONDITION OF PLACEMENT.	C_C	COMMENTS.
0.3-1.0	Conditioned	0.19-	Very dense to
1.0-2.0	compacted	0.24	mediam dense.
	Hydraulically	0.24-	Medium dense
2.0-3.0	placed in	0.61	to loose.
	Lagoons.		
	Lagoon ashes to	0.61-	Loose to very
	loose	0.88	loose.
	Dumps.		

whereas the effective strength parameters are required for designing the slope for steady seepage case and for the long term stability. Strength properties of the fly ashes get affected by variations in density, moisture content, particle size distribution and chemical compositions. Since the fly ash is freely draining material, effective stress parameters are easily realized. Typical results of shear strength parameters are shown in figures 2 and 3 (Sridharan et al 1998). The friction angle of 270 to 350 is obtained for these fly ashes under saturated conditions. Thus a minimum value of friction angle of 250 can be expected for fly ashes.

3.5. California Bearing Ratio

In highway engineering, where the pavement section and sub grade have to resist repetitive loads with very low deformation tolerance, composites stiffness parameters are employed for the sub grade. California Bearing Ratio is more commonly used to describe the composites strength-stiffness parameters. CBR value for fly ash varies from 6.8 to 13.5% for soaked condition and from 10.8-15.4 % for unsoaked condition as reported in literature (Sridharan et al 1996). The low CBR value can be attributed to the decreased effective weight and loss of surface tension. Bottom ash show substantially higher CBR values, the CBR value of pond ash is almost in the range for bottom ash. The addition of materials like mooram improves the CBR value. The CBR value of pond ash has been observed to increase from 22% to 45.3% upon addition of 33% of mooram.

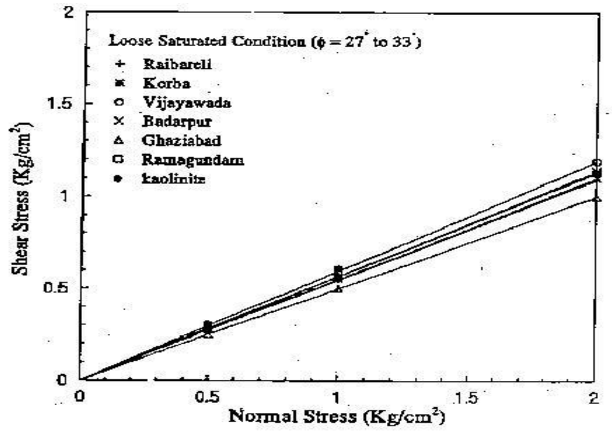

Fig. 2 Failure envelops for fly ash

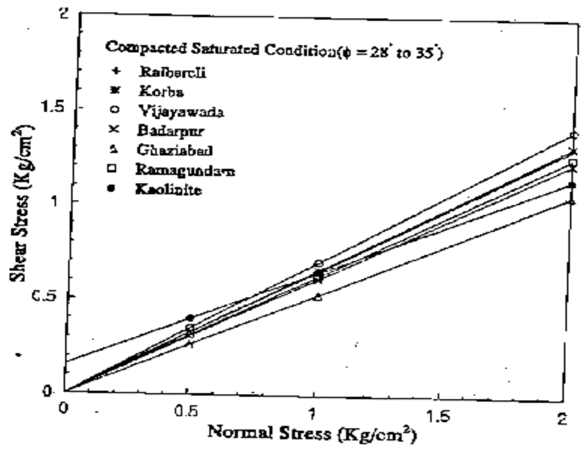

Fig. 2 Failure envelops for fly ash

IV. APPLICATIONS OF FLY ASH

From the above discussion of the characteristics and properties of fly ash, it is clear that fly ash can be used in various geo-technical applications. Some of the typical geo-technical and other applications are indicated in subsequent paragraphs (Singh et al 1999; Shroff, 1999; Tike et al,1999; Vimal Kumar et al, 1999).

4.1 Geo-technical applications

Some of the geo-technical application of fly ash is in the field of embankment construction, fills, sub-base, pavement and stabilization.

4.1.1. Embankment

Use of fly ash in embankment construction not only utilizes fly ash for gainful application but also provides the following advantages: -

- Saves topsoil 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 of embankment and filling up of low-lying areas thus created.
- Does not deprive the nation of the agricultural produce that would be grown on the top soil which otherwise would have been used for embankment construction.
- Reduces the demand of land for disposal/deposition of flyash that otherwise would not have been used for construction of embankment.
- Uses flyash which otherwise could have been a source of pollution.

Some typical examples of embankments constructed using fly ash are listed below:

- Embankments of flyover bridges in Delhi, Okhla fly over bridge and Hanuman Setu.
- Saranath culvert approach embankment, Varanasi.
- New Varuna bridge approach embankment.
- Delhi metro is using fly ash for landfill and embankment construction.
- Road embankment at Bhuj and Ramagundum.
- Approach embankment for second Nizamuddin Bridge, New Delhi. (1.8 Km long, 6 to 9 m high approach road embankment constructed using fly ash. 1.5 lakh m3 of fly ash is estimated to have been consumed.)

V. CONCLUSIONS

Fly ash is a by-product obtained from thermal power stations. It affects the ecosystem of the area drastically. It pollutes air as well as water and requires a vast land area for its disposal, the value of which cannot be compensated by money specially in a country like India, where land population ratio is much less as compared to other countries. Hence any project, which aims at achieving sustainable development of the country, should consider handling this problem effectively and efficiently. This calls for a thorough understanding of physical, chemical and engineering characteristics of fly ash. Even though many geotechnical and other applications using fly ash are quoted in literature, before venturing into any such applications, the engineering characterization of the fly ash to be used is necessarily to be carried out. The result of various research programs undertaken by premier institutions in India and abroad with regard to the characterisation of fly ash are favourable for its mass usage in the field.

VI. ACKNOWLEDGEMENTS

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