Review on Study of X-Ray Diffraction on a Mixture of Black Cotton Soil & Pond Ash

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Abstract— The black cotton soil is a troublesome expansive soil that causes numerous issues in the construction of structures built on it. It has a swollen and impervious appearance, as well as weak geotechnical subgrade properties. The aim of this study is to find a way to improve the various geotechnical properties of black cotton soil and pond ash. This study looks at how to enhance the engineering properties of black cotton soil with varying amounts of pond ash. In this study, pond ash is mixed in black cotton soil in proportions ranging from 0% to 50%. Testing is often used to assess engineering parameters. The Atterberg limits were used to investigate the engineering properties of black cotton soil with various percentages of pond ash. (Liquid Limit, Plastic Limit, and Plasticity Index), standard proctor test, differential free swelling index, swelling pressure and wet sieve analysis tests are conducted.

Keywords: Pond Ash, Plasticity Index, Degree of Expansiveness, Maximum Dry Density, Shear Strength, Swelling Pressure

I. INTRODUCTION

A. General

Industrial operations produce a significant amount of waste materials as a result of rapid industrialization. Such wastes are harmful to both human health and the environment. Proper management is expected to reduce the effect of such waste materials. Waste materials may be used for a variety of uses, which is a good way to handle them. Waste materials such as fly ash (FA), pond ash (PA), scrap tyre, and rice husk ash (RHA) are produced in large quantities, making their use for general purposes difficult. Significant amounts of such wastes may be used in civil engineering construction. One of the most important ground improvement strategies is the use of such waste materials as admixtures to enhance soil characteristics. This approach can be used to strengthen problematic soils, such as soft clay or swelling soil that are unable to support the structure's load. On a global scale, power plants produce a large amount of FA and PA as waste products. Around 200 million m2 of land in India has been occupied by millions of tonnes of PA deposits. Because of the presence of radioactive elements and heavy metallic substances in the leachate compounds generated by the ash ponds, groundwater and surface water sources, as well as soil, are contaminated.

The engineering properties of PA can be improved using various techniques among which the incorporation of lime/cement in the PA by mechanical mixing has been found to be the most reliable approach. The results of laboratory investigation carried on silty sand and PA reinforced with randomly distributed polyester fibers. They showed that incorporation of fibers results in the improvement of various characteristics of soil (e.g. peak compressive strength, California bearing ratio (CBR), ductility, and peak friction angle). The CBR of PA improves with addition of cement. The increase in compaction leads to an increase in maximum dry density (MDD) and a decrease in optimum moisture content (OMC).

Pond ash is the by-product of thermal power plants, which is considered as a waste material and its disposal is a major problem from an environmental point of view and also it requires a lot of disposal areas. Actually, there are three types of ash produced by thermal power plants, viz. 1 fly ash, 2 bottom ash, and 3 pond ash. Fly ash is collected by mechanical or electrostatic precipitators from the flue gases of power plant; whereas, bottom ash is collected from the bottom of the boilers. When these two types of ash, mixed together, are transported in the form of slurry and stored in the lagoons, the deposit is called pond ash. The volume of pond ash produced by thermal power plants is very large compared to that of the other two ashes, viz. fly ash and bottom ash. The task to utilize the pond ash to the maximum possible extent is still a major problem throughout the world. To solve the problem, pond ash has potential applications in different areas like structural fills and highway embankment. Pond ash is a lightweight and self-draining material compared to natural soil. For successful application of pond ash as fill material in civil engineering construction, knowledge of compaction characteristics of the fill material is essential to achieve effective compaction in the field.

B. X-RAY Diffraction

X-ray diffraction (XRD) has been a popular technique to search out the phases for different types of samples. In the current approach, principal component analysis has been used to have an idea of the minerals present, in qualitative manner, in the soil under study. X-ray diffraction (XRD) is widely applied for the qualitative and quantitative analysis of soil mineralogy. The efforts required for conventional approaches of soil XRD data analysis are currently restrictive for such large data sets, resulting in a need for computational methods that can aid in defining soil property – soil mineralogy relationships (Black cotton soil and pond ash).

C. Problem Statement

Black cotton soil covers the 51.8 million hectares land in India. The black cotton soil is very hard when dry but lose it strength completely when in wet condition. Expansive soils are a worldwide problem that poses several challenges for civil engineers As result of this variation in soil, significant distress occurs in soil, which is subsequently followed by damage to the overlying structure. The recent past huge amount of pond ash are generated by the thermal power plants. This research project deals with how to improve engineering properties of black cotton soil with different percentage of pond ash

Fig 1.1: Black cotton soil

D. Objective

The objectives of the current study can be recognized as follows:

- To Analyze Stability of Black cotton soil by mixing pond
- To find all mineral content (108 types) in the soil
- To Check effect on black cotton soil with shrinkage losses
- To increase Fertility of black cotton soil for agricultural use
- Utilization of Pond ash (waste product from Stem Power Plant)

E. Scope of the Study

A correct approach to sampling procedure is always a critical issue in scientific investigation. Aim of this work is to assess the potentialities of the X-ray diffraction technique, i.e. as a preliminary tool to assess soil samples variability, in terms of geochemical features, in the context of geographical traceability. The differentiation pattern observed in soil samples, as obtained by this fast and non-destructive analytical approach

F. Methodology

Various such as Atterberg's limit (liquid limit and plastic limit), Differential free swelling, Swelling pressure, OMC and MDD, UCS, etc. tests have been performed to find out the engineering properties of black cotton soil as well as soil mixed with pond ash. The percentage of pond ash may have varied from 0% to 50% at 10% interval.

1) Material Used

- Black Cotton Soil – About 100 kg of soil sample for the present work was collected from the Kusumba, Dhule.
- Each sentinel site covers (10×10 km)
- Pond Ash – The pond ash sample is collected form Thermal Power Station, (From Online order).
- X-ray diffractometer – North Maharashtra University, Jalgaon.

2) Experimental Methods

a) Experimental materials

The different materials (i.e. soil, PA, RHA and cement) used in the study have same properties as reported in previous research

b) Soil The soil used in this investigation is kaolin clay. According to unified soil classification system (USCS), the soil is classified as clay with low plasticity

c) Pond ash Light grey colour Class F PA was used in the study. The PA is of nonplastic type possessing a specific gravity of 2.1. The ash may be categorized as Class F type as per ASTM C618-12 (2012). The compositions and properties of PA

3) Data Analysis:

Descriptive Statistics (mean, graphs) and inferential statistics (Univar ate analysis) were used through SPSS Version 16 or MS excel application.

II. LITERATURE REVIEW

A. Lucia Bertcchini et.al. (2012)

the possibility to establish objective criteria to trace the origin of food and to follow its production process is critical to guarantee not only the consumers, but also the producers, in order to promote high levels of safety, hygiene and to protect their products The X-Ray diffraction spectra, collected on the powder of each soil sample, were treated as fingerprint profiles to be deciphered by multivariate and multi-way data analysis, namely PCA and PARAFAC. The differentiation pattern observed in soil samples, as obtained by this fast and non-destructive analytical approach, well matches with the results obtained by characterization with other costly analytical techniques, such as ICP/MS, GFAAS, FAAS, etc.

B. Virendra Singh and H.M. Agrawal (2012)

To observe the main soil forming compounds, complex formation mechanism between different elements and to find toxic compounds in the soil. However, performing X-ray diffraction (XRD) with soil samples is not so simple because of many complexities like variable chemical and structural compositions of soil minerals, including interstratification with swelling interlayers and various defects that may cause large differences in the XRD reflection intensities between different species of the same mineral In the current approach, principal component analysis (PCA) has been used to have an idea of the minerals present, in qualitative manner, in the soil under study. PCA was used on the elemental concentrations data of 17 elements, determined by the energy dispersive X-ray fluorescence (EDXRF) technique. XRD analysis of soil samples has been done also to identify the minerals of major elements. Some prior treatments like removal of silica by polytetrafluoroethylene (PTFE) slurry and grinding with alcohol, were given to samples to overcome the peak overlapping problems and to attain fine particle size which is important to minimize micro-absorption corrections, to give reproducible peak intensities and to minimize preferred orientation

C. Mehdi Parian and Pertti Lamberg (2015)

Geometallurgy has gained attention in recent years and different approaches are used for implementation. It is natural to use mineralogy to some extent as a link between geology and mineral For a geometallurgical program, the number of samples to be analysed is large, therefore a method for obtaining mineral grades needs to be cost-efficient, relatively fast, and reliable. Automated mineralogy based on scanning electron microscopy is generally regarded as the most reliable

method for analysing mineral grades. However, the method is time demanding and expensive. Quantitative X-ray diffraction has a relatively high detection limit, 0.5%, while the method is not suitable for some base and precious metal ore

D. Aarohi V. Langalia and Mayuriwala (2015)

Black cotton soil is the most expansive soil having less bearing capacity and high swell index. Its stabilization is required to mainly improve the stated properties. It is found that Black cotton soil mainly stabilized using Fly ash, Lime and Cement. Agricultural wastes are also used to stabilize Black cotton soil, but they cannot be used as a single stabilizing component. Combination of Bagasse ash with other additives proves to be very effective and cheaper method of stabilization. Stabilization of soils is an effective method for improvement of soil properties and the pavement system performance. Plasticity Index is one of the important properties of soil to determine the behaviour of soil in presence of water

E. Sangamesh Konnur and Sahana Antaratani (2017)

The present study is to investigate the properties such as maximum dry density, optimum moisture content and unconfined compressive strength of black cotton soil stabilized with admixture, chemical and combination of both with varying percentages. So, the present study is conducted to check the performance by individual (i.e. parent soil) and combinations of both chemical and Pond Ash with soil. It was expected that, the combination of soil with Pond Ash and Sodium Lignosulphonate may improves Engineering Properties (by means of strength) with respect to parent soil. Black cotton soil is stabilized with the Pond Ash and Sodium Lignosulphonate.

F. Vidya Pathak et.al. (2017)

Soil modification has emerged as a new area for research in the geotechnical engineering and the main purpose of most of researches is to determine optimum amount of additive with considering economy and effectiveness. In present study, sea salt has been used as an additive. The effect of addition of sea salt on properties of fine grained black cotton soil is determined in laboratory. This soil exhibits volume change behaviour with variation in the water content. Volume changes have caused reduction in sustainability of structure supported on black cotton soil.

G. P. Imran Khan and M.Kalpana (2018)

A test examination is apportioned to check the effect of stone dust on designing and quality properties of the Black Cotton Soils. The properties of stable soil like compaction qualities, triaxial compressive quality and California bearing proportion were assessed and their varieties with substance of stone dust zone unit assessed. Expansion of either Optimum extent of stone dust or Optimum extent of its mix to the Black Cotton Soil has enhanced the quality attributes of sub review..

H. Kinjal C. Chaudhari et.al. (2018)

From the study it has been concluded that Surat is covered with black cotton soil. Soil stabilization has proved to be very economical as it provides cheap materials for the construction of low cost roads. Local materials can be used effectively. There are many techniques of soil stabilization. Cement stabilization is an important method of stabilization. It has proved very much effective in case of sandy soil due to ease of pulverization and mixing and the smaller quantity of cement required. Many researchers attempt to stabilize the black cotton soil with use of cementious materials and agricultural waste as a combination; here we discuss some of works based on use of rice husk ash, burnt brick dust and bagasse ash which used in combination with cement or any other material.

I. Suresh Kommu and SS.Asadi (2018)

Soil grows gradually after some time and comprises of the different inside and out very surprising materials. Inorganic materials, or those materials that unit of estimation non-living, grasp worn rocks and minerals, The paper focuses on fly ash generated from the coal pink-slipped thermal power plants is generally sluiced into ash ponds by wet disposal methodology. This ash contains variety of soluble major and trace parts comparable to As, Fe, Cd, Hg, Zn, Pb. The activity of metals primarily depends on 2 issues comparable to pH scale and hydraulic physical phenomenon.

J. M. Butlera, Andrew M. Sila (2019)

Conventional approaches to the assessment of soil mineralogy by XRPD typically involve a first stage of identification of the minerals present and a subsequent stage that seeks to quantify the relative abundance of the different minerals identified in the soil. Cluster analysis of soil XRPD data represents a rapid method for grouping data into discrete classes based on mineralogical similarities, and thus allows for sets of mineralogical distinct soils to be defined and investigated in greater detail. Effective cluster analysis requires minimisation of sample-independent variation and maximisation of sample-dependent variation, which entails pre-treatment of XRPD data in order to correct for common aberrations associated with data collection

K. Research Gap

After carrying out thorough literature survey it can be concluded that the past researches consist of X ray Diffraction on various soils in powder forms and various test they did on cluster analysis and try to form a group of similar type of soil and to find their physical properties in various cluster forms. Chemometrics is also done on soil by using X Ray Diffraction, chemical discipline that uses mathematical calculation and statics too for design optimum measurement and to collect maximum chemical information. Due to urbanization in rural area where large area is covered with black cotton soil, so I am trying to find out results obtain by X Ray Diffractometer by analyzing mixture of black cotton soil and pond ash.

III. CONCLUSIONS

At present, Black Cotton soil is expansive soil which expands when it contacts with water. This is the major reason of failure of black cotton soil strata. A different area having different types of black cotton soil and it is engineering properties. These properties may be improved by adding or mixing the different types of admixture or fibre or stabilizing materials. Most of the times, the black cotton soil is stabilized by

synthetic fibres and natural fibres. The polypropylene, polyester are synthetic and jute is natural fibre. This research project deals with how to improve engineering properties of black cotton soil with different percentage of pond ash.

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