**1.1 Introduction**

Soil stabilization is an essential aspect of civil engineering and construction projects, aiming to improve the engineering properties of weak or problematic soils. Weak soils pose significant challenges due to their inadequate load-bearing capacity, excessive settlement, and low shear strength, which can compromise the stability and performance of structures (Dash *et al*., 2019). Conventional soil stabilization techniques often involve the use of cement, lime, or other chemical additives, which can be expensive and environmentally detrimental (Tiwari *et al.,* 2020).

Finding further use for biomass wastes will have a salutary effect on the environment, particularly in a developing country like Nigeria, where waste collection tends to be low and these wastes often constitute a menace to the environment. Furthermore, cohesive soils which fall within the band of soils that could be modified abound in Nigeria and are routinely used as sub-base and base course materials in pavement construction, which in some cases do have to be improved or modified with the addition of cement in order to raise the strength parameter to the expected standard (Yinusa & Ahmed, 2014).

These soils typically exhibit low shear strength, high compressibility, and poor load-bearing capacity, which can pose significant challenges for infrastructure development (Choudhary *et al*., 2018; Kavak *et al*., 2019). Traditional methods of soil stabilization involve the use of cement, lime, or chemical additives, which can be costly and may have detrimental environmental impacts (Alawad *et al.*, 2019).

Agricultural waste materials have attracted considerable attention as potential resources for soil stabilization due to their abundance and potential beneficial properties (Nguyen *et al.*, 2019). These waste materials, such as crop residues and byproducts, are generated in large quantities during agricultural processes. The disposal of agricultural waste presents significant environmental challenges and can contribute to pollution and resource depletion. However, many of these waste materials possess inherent characteristics that make them suitable for soil improvement, including high silica and pozzolanic content (Narayanasamy and Santhanam, 2017).

Pozzolanic materials, such as MHA, react with calcium hydroxide in the presence of water to form cementitious compounds, contributing to improved soil strength and stability (Jha et al., 2019). The pozzolanic activity of MHA can enhance the properties of weak soils, including increased shear strength, reduced compressibility, and improved durability (Narayanasamy and Santhanam, 2017).

In recent years, there has been a growing interest in exploring sustainable and eco-friendly alternatives for soil stabilization. One such alternative is the utilization of agricultural waste materials, which not only helps address the waste management issue associated with these materials but also provides a cost-effective and environmentally friendly solution for soil improvement (Azeez *et al.*, 2020; Demirel and Dalkılıç, 2021). Agricultural waste materials are abundantly available, and their utilization in soil stabilization can contribute to a circular economy and reduce the reliance on traditional stabilizing materials.

Maize husk ash (MHA) is an agricultural waste material generated during the processing of maize (*Zea mays*) for food production. It is typically discarded or underutilized, leading to environmental concerns and waste management challenges (Choudhary *et al*., 2020). Maize husk ash is rich in silica and possesses pozzolanic properties, which make it a potential candidate for soil stabilization applications (Nasir *et al*., 2021). Pozzolanic materials, when mixed with calcium hydroxide (lime) and water, react chemically to form cementitious compounds that contribute to the improvement of soil strength and stability (Akinmusuru *et al.,* 2021; Kumar *et al.*, 2022).

Maize husk ash (MHA) is one such agricultural waste material that holds promise for weak soil stabilization. Maize (Zea mays) is one of the most widely cultivated cereal crops globally, and the processing of maize for food production generates substantial amounts of husk waste (Ayinde et al., 2019). Maize husk ash is typically discarded or underutilized, leading to environmental concerns and waste management issues. However, recent studies have revealed the potential of MHA as a soil stabilizer due to its pozzolanic properties and high silica content (Adeoye *et al*., 2018).

Several studies have investigated the use of various agricultural waste materials, such as rice husk ash, sugarcane bagasse ash, and wheat straw ash, for soil stabilization (Choudhary *et al*., 2020; Reddy *et al.*, 2021; Singh *et al*., 2022). However, the potential utilization of maize husk ash as a soil stabilizer has received relatively less attention. Therefore, further research is necessary to evaluate the geotechnical properties, pozzolanic activity, and long-term performance of stabilized soils using maize husk ash.

**1.2 Statement of Problem**

Weak soils present a significant challenge in the construction industry, requiring effective stabilization methods. Conventional stabilization techniques often involve the use of expensive materials and complex procedures. Moreover, these methods may have adverse environmental impacts, such as increased carbon emissions and depletion of natural resources. Therefore, there is a growing need for sustainable and cost-effective alternatives that can improve soil strength and stability while minimizing the environmental footprint.

The disposal of agricultural waste materials, including crop residues and byproducts, presents environmental challenges due to their large-scale production and limited disposal options. These waste materials, if not managed properly, can contribute to pollution, land degradation, and resource depletion. However, many agricultural waste materials possess inherent properties that make them potential for use as soil stabilization agent.

Among these agricultural waste materials, maize husk ash (MHA) is generated in substantial quantities during the processing of maize for food production. Maize husk ash is typically discarded or underutilized, leading to waste management concerns and environmental issues. However, recent studies have shown that MHA exhibits promising properties for soil stabilization due to its high silica content and pozzolanic activity.

Maize husk ash is a waste material generated in large quantities during the processing of maize (*Zea mays*) for food production. It is typically discarded or underutilized, leading to environmental concerns and waste management issues. However, recent studies have shown that MHA possesses promising properties for soil stabilization due to its high silica and pozzolanic content. By harnessing the potential of MHA, it is possible to transform this waste material into a valuable resource for strengthening weak soils.

The problem addressed in this research project is the need for sustainable and cost-effective techniques to stabilize weak soils. By investigating the utilization of maize husk ash for soil stabilization, the study aims to address the following specific issues:

Limited availability of affordable soil stabilization materials: Conventional soil stabilization methods often involve the use of expensive materials, such as cement or lime, which may not be economically viable for all projects. There is a need to explore alternative materials that are readily available, cost-effective, and possess the desired stabilizing properties.

Environmental concerns associated with agricultural waste: Improper disposal of agricultural waste materials, including maize husk, can contribute to environmental pollution and resource depletion. Finding sustainable and beneficial applications for these waste materials, such as soil stabilization, can help alleviate environmental concerns while providing economic benefits.

Inadequate knowledge and guidelines for utilizing maize husk ash for soil stabilization: While there have been studies on the potential of agricultural waste materials for soil stabilization, including MHA, there is a lack of comprehensive guidelines and recommendations for their effective utilization. This research project aims to bridge this knowledge gap by investigating the geotechnical properties and long-term performance of stabilized soils using maize husk ash.

By addressing these issues, this research project seeks to provide a sustainable solution for weak soil stabilization while minimizing the environmental impact associated with the disposal of agricultural waste materials.

**1.4 Justification of the Study**

Weak or unstable soil poses significant challenges in construction and engineering projects. Weak soils often lack the required strength and stability to support structures, leading to settlement, subsidence, and structural failures. Traditional methods of soil stabilization, such as cement or lime treatment, can be costly and environmentally unfriendly. Therefore, there is a need for sustainable and cost-effective soil stabilization techniques.

Maize (corn) is a widely cultivated crop globally, and its husks are considered agricultural waste after harvesting. The disposal of maize husks can lead to environmental issues and waste management challenges. Utilizing maize husk ash as a soil stabilizer offers an eco-friendly solution by repurposing agricultural waste, reducing landfill burdens, and contributing to a circular economy. Maize husk ash contains silica, which exhibits pozzolanic properties when combined with calcium hydroxide in the presence of water. This reaction results in the formation of cementitious compounds, like calcium silicate hydrate (C-S-H), which contributes to soil stabilization. Pozzolanic reactions enhance soil strength and reduce its susceptibility to volume changes due to moisture variations.

Compared to traditional stabilizers like cement or lime, maize husk ash is a cost-effective alternative. The material is locally available in regions with significant maize production, reducing transportation costs. By utilizing agricultural waste instead of manufactured stabilizers, the overall project cost can be significantly reduced, making it an attractive option, especially for rural or low-budget projects. Improved Soil Engineering Properties: Maize husk ash incorporation improves various soil engineering properties, including increased California Bearing Ratio (CBR), reduced compressibility, and improved shear strength. These enhancements make the stabilized soil suitable for construction purposes, providing a reliable foundation for buildings, roads, and other infrastructure projects.

Using maize husk ash for soil stabilization aligns with sustainable development goals and environmental conservation efforts. By promoting the use of agricultural waste instead of non-renewable resources, this technique reduces the carbon footprint associated with soil stabilization processes, contributing to a greener and more sustainable construction industry. The utilization of maize husk ash for soil stabilization has been subject to extensive research and testing. Several studies have demonstrated its effectiveness in improving soil properties and providing stable foundations. Case studies and successful applications of maize husk ash in weak soil stabilization provide concrete evidence of its viability as a practical and reliable soil stabilization technique.

**1.4 Aim and Objectives of the Study**

**1.4.1 Aim**

The aim of this research is to investigate the effect of maize husk ash in stabilized weak soil in order to improve its physical and engineering properties.

**1.4.2 Objectives**

The specific objectives of this work are as follows;

1. To obtain adequate maize husk ash under controlled burning of maize husk fiber.
2. To determine physical and engineering properties of the untreated soil samples.
3. To investigate the effect of the maize husk ash on soil density and strength characteristics.

**1.5 Scope and Limitation of the Study**

The scope of this research project on the utilization of maize husk ash (MHA) for weak soil stabilization encompasses several key aspects. The study involves conducting laboratory tests to assess the geotechnical properties of weak soil samples and determine their baseline characteristics. This includes tests such as grain size analysis, Atterberg limits, compaction tests, and shear strength tests. This analysis will provide insights into the potential of MHA as a soil stabilizer. The study focuses on the investigation of different techniques for incorporating maize husk ash into weak soils. It explores methods such as direct mixing, pre-soaking, and lime activation to optimize the stabilization process. The research project includes mechanical testing of the stabilized soil samples to evaluate their strength, compressibility, and durability. Tests such as unconfined compression tests, California Bearing Ratio (CBR) tests, and cyclic loading tests may be conducted. Also, the study aims to analyze the long-term performance of the stabilized soils using maize husk ash. This includes evaluating factors such as strength gain over time, resistance to environmental conditions, and durability under different loading conditions.

**1.6 Significance of the Study**

The utilization of maize husk ash for weak soil stabilization offers several potential benefits. Firstly, it provides a sustainable solution to the growing environmental concern of agricultural waste disposal. By converting maize husk ash into a soil stabilizer, it reduces the reliance on traditional stabilizing materials and promotes a circular economy approach.

Secondly, the use of maize husk ash as a soil stabilizer can significantly improve the engineering properties of weak soils. It enhances their shear strength, compressibility, and load-bearing capacity, thereby enabling the construction of more stable and reliable structures. This has implications for a wide range of applications, including road construction, embankments, and foundation engineering.

Lastly, the research project aims to contribute to the existing body of knowledge regarding the utilization of agricultural waste materials for soil stabilization. By investigating the geotechnical properties, pozzolanic activity, and long-term performance of stabilized soils, this study will provide valuable insights and practical recommendations for engineers, researchers, and policymakers involved in sustainable construction practices.

**1.7 Methodology**

The geotechnical properties of the natural soil and the soil with maize husk at a varying percentage of coir were determined in accordance with BS 1377 (1990) to ascertain the degree of alteration involved.

The following laboratory tests will be conducted:

1. Natural moisture content test
2. Specific gravity test
3. Particle size distribution (Sieve analysis)
4. Atterberg’s limits test
5. Compaction test
6. CBR

**References**

Adeoye, O. A., Oladele, A. S., & Onyelowe, K. C. (2018). Comparative study of maize cob and maize husk ash as supplementary cementitious materials. *Journal of Materials and Environmental Science*, 9(8), 2279-2289.

Akinmusuru, J. O., Awodoyin, R. O., & Babalola, O. A. (2021). Stabilization of lateritic soil with maize cob ash. *International Journal of Innovative Science and Research Technology,* 6(1), 663-669.

Alawad, F. A., Attom, M. F., & Othman, A. M. (2019). Comparative study of soil stabilization using cement and lime. *International Journal of Engineering Research and Technology*, 12(5), 668-675.

Ayinde, A. A., Ajibade, O. M., & Oni, O. I. (2019). Utilization of maize husk ash as partial replacement of cement in concrete production. *Journal of Physics: Conference Series*, 1286, 12-67.

Azeez, A. R., Adeyanju, A. A., Salami, R. A., & Aliyu, M. M. (2020). Application of agricultural waste in soil stabilization: A review. *International Journal of Civil Engineering and Technology*, 11(2), 259-273.

Choudhary, R., Kumar, R., & Chauhan, R. S. (2018). Stabilization of soil using lime and cement. *International Journal of Innovative Research in Science, Engineering and Technology,* 7(12), 17619-17624.

Choudhary, R., Kumar, R., & Chauhan, R. S. (2020). A review on stabilization of soil using agricultural waste materials. *Materials Today: Proceedings*, 33(5), 2202-2207.

Dash, S. K., Sahoo, P. K., & Patra, C. R. (2019). Stabilization of weak soil using cementitious materials. International Journal of Geotechnical Engineering, 13(1), 33-40.

Demirel, B., & Dalkılıç, N. (2021). Utilization of agricultural waste materials for soil stabilization. *International Journal of Innovative Research in Science, Engineering and Technology*, 10(6), 8051-8061.

Kavak, A., Özgan, K., & Çınar, H. E. (2019). Investigation of soil stabilization with lime-cement and lime fly ash mixtures. *Journal of Materials in Civil Engineering*, 31(9), 04019190.

Kumar, S., Sahu, K. K., & Singh, A. (2022). Stabilization of soil using maize husk ash. *Journal of Physics: Conference Series*, 1988, 012023.

Narayanasamy, R., & Santhanam, M. (2017). Stabilization of expansive soils using agricultural waste. *Indian Geotechnical Journal,* 47(1), 69-75.

Nasir, S. S., Ahmed, A., Murali Krishna, I. V., & Kumar, S. A. (2021). Utilization of agricultural waste in soil stabilization. *Journal of Physics: Conference Series*, 2003, 012102.

Nguyen, N. H., Nguyen, L. T., Nguyen, L. H., & Nguyen, D. H. (2019). Utilization of agricultural waste for soil stabilization. *IOP Conference Series: Materials Science and Engineering,* 697, 032059.

Reddy, P. S., Kumar, P. S., & Rao, K. V. (2021). An experimental study on stabilization of soil using maize husk ash. *Materials Today: Proceedings,* 45(1), 2035-2041.

Singh, P. K., Gautam, S. P., & Prasad, S. (2022). A review on utilization of maize husk ash in soil stabilization. *Materials Today: Proceedings,* 55(1), 70-75.

Tiwari, V. M., Singh, V., & Awasthi, J. P. (2020). Stabilization of soil using waste materials - A review. *IOP Conference Series: Materials Science and Engineering,* 739, 012055.

Yinusa A. J. & Ahmed, O. A. (2014). An Evaluation of the Influence of Corn Cob Ash on the Strength Parameters of Lateritic Soils. *Civil and Environmental Research*, 6(5), 1-11.