Journal of Materials Research and Technology 33 (2024) 7123–7135

Contents lists available at ScienceDirect

Journal of Materials Research and Technology

journal homepage: www.elsevier.com/locate/jmrt

Effect of the loss on ignition on the unconfined compressive strength of residual clays from Bogotá-Colombia stabilized with cement

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ARTICLE INFO

Keywords:
Clayey waste
Soil cement
Pavements
Clays
Marginal waste
Soil stabilization
Unconfined compression strength
Plasticity index

ABSTRACT

Organic matter in rock aggregates, such as subgrade, sand, and gravel, originates from the decomposition of organic remains, including plants and domestic waste. The method used to measure the organic matter content in aggregates for infrastructure projects is known as Loss on Ignition (LOI) in which the difference in weight before and after calcination is considered the percentage of loss due to oxides, carbon, nitrogen, phosphorus, and sulfur derived from the organic material. This study compares the compressive strength of three clayey wastes sourced from Bogotá, Colombia, each with different organic matter contents measured by loss on ignition (LOI), mixed with varying cement contents. A total of 153 cylindrical samples were manufactured using a monotonic compression compaction technique with different cement and water dosages. Monotonic compression is a type of test in which a load is applied continuously from zero until failure occurs, without any unloading. The physical characterization was reviewed with plasticity limits, specific gravity (Gs), methylene blue index (M.B.I.), chemical composition with X-ray Fluorescence (XRF) X-ray diffraction (XRD) and SEM micrographs. Through multivariate statistical techniques, compressive strength was correlated with the Water/Cement ratio and the Cement/Residue ratio, resulting in a function that facilitates calculation of cement dosage and water content. The study identified that the response surfaces of clayey residue types exhibit tighter concavity as organic matter content increases, indicating a narrower range for determining optimum moisture content with higher LOI. This experimental investigation aims to explore the feasibility of incorporating clayey waste enhanced with hydraulic cement into materials for infrastructure construction, thereby reducing reliance on natural resources. However, the results indicate that these materials can be utilized in constructing sustainable pavements by applying more rigorous moisture measurement and control techniques to the mixtures. This approach compensates for the use of waste materials by reducing the need for landfills, saving production energy, preventing pollution from material extraction and exploitation, and decreasing gas emissions that contribute to global climate change.

1. Introduction

The excessive exploitation of natural resources is the main cause of the global crisis, and the biggest challenge facing the current generation is the reduction of emissions and carbon footprint on the planet [1]. The 'Bend the Trend 2024' report compares the increase in material consumption over the last 50 years, rising from 8.4 to 13.2 tons per year per inhabitant worldwide. This represents an average growth of 2.3% per year. The construction sector is one of the main sources of environmental degradation, with natural resource consumption estimated at 106.6 billion tons per year and less than 5% of waste being reused [2] such as fly ash, rubber fiber, the reclaimed asphalt pavement (RAP), silica fume, acai ash [3] (see Table 1). There is also abundant research regarding the use of waste materials in soils and construction materials [4–6]. although the composition are very much dependent of the location of the research. Despite efforts to utilize local raw materials in the region [7,8], technical specifications often limit their use in most infrastructure projects [9], although there are large scale successful cases particularly when the use of waste materials is included in the regulation [10,11].

Materials such as compressible clays, organic clays, and peat are strata that typically need to be removed and discarded at construction sites due to their high organic matter content, tendency to swell, absorption capacity, deformability, and low strength [12]. These cohesive

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https://doi.org/10.1016/j.jmrt.2024.11.081
Received 9 October 2024; Received in revised form 7 November 2024; Accepted 9 November 2024
Available online 10 November 2024