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The Behavior of Clayey Soil Reinforced With Waste Aluminium Pieces

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Abstract

There are huge amounts of waste metal pieces produced from the processes of the metal industry, the disposal of these waste materials face financial and environmental difficulties. The present study aims to investigate the effect of industrial waste aluminium pieces on the stress-strain behaviour and compaction characteristics of clayey soil. A series of unconfined compression and modified compaction tests were conducted during the experimental work. Four different amounts of waste aluminium pieces were used during the experimental work, namely 0%, 5%, 10%, 15%, and 20% by the dry weight of the specimens. From the analyses of the test results, we observed am increases in maximum dry unit weight and decreases in optimal soil water content. In addition, the unconfined compression strength increases significantly as the amount of the waste aluminium pieces increase until 10% and then decrease.

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Keywords: Clay; waste aluminium pieces; compaction; unconfined compression strength.

1. Introduction

Soil improvement is the modification of one or more engineering soil properties by mechanical or chemical methods. Increasing strength and enhancing load-bearing capacity are some aims of the soil improving methods. Aluminium waste is certainly not a problem for the world.

Researchers are investigating the use of these wastes for soil stabilization. This will help to reduce the risk of natural destruction and reducing the waste amount. Highly debatable if that is eco-friendly or even economical. It certainly

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is not in the case of aluminium. Soil stabilizing by adding chemical materials is one of the most common methods for treating soils. Lime, cement and other binder materials have been used to improve some mechanical and plastic properties of soils since many years ago. Stabilization with fibers has been developed as another soil improving method in recent years. Some studies have been carried out on the effects of fibre inclusion on mechanical behaviour of stabilized soils. Some researches mixed scrap tire rubber with sand. Others mixed waste rubber with clayey soil, and some researchers reinforced lightweight soil with waste fishing nets. These researchers reported that fibre reinforcement causes an increase in unconfined compressive strength, ductility and toughness of soil samples [1, 4, 7]. They used triaxial testing apparatus to study the shear strength properties of waste tire particles in various size and shapes. Many researchers have reported that waste tire shreds have been used as lightweight fill material in many embankments and retaining structures [2, 3, 5, 6, 8, and 9]. According to the author's knowledge, the use of waste aluminium pieces has not been previously studied as a soil improvement method, because recycling aluminium is the way to go. However, improving soil properties with scrap metallic fibres is still a relatively new method in civil engineering works. Soil improvement with waste aluminium pieces has not been previously studied in the literature. This study aims to evaluate the mechanical properties of the clay-waste aluminium stabilization. A series of experiments have been conducted on the mixtures of clay with various ratios of waste aluminium pieces (0%, 5%, 10%, 15%, and 20% by dry weight) in modified proctor and unconfined compression strength testing set ups.

2. Materials and Method

Soil: The clayey soil used in this experimental work was collected from the campus of Gaziantep University. Tests were conducted using clayey soil passing the 4.75 mm sieve. The soil was filtered to a viscosity limit, plastic limit, plasticity index values of 49, 23, and 26, respectively. The specific density of the clayey soil was found to be 2.72 g/cm^3. The particle size distribution curve for the sample is presented in Figure 1. The soil was classified as CL according to the Unified Soil Classification System.

Solid waste material: The waste materials used during the experimental work were waste aluminium pieces. The aluminium pieces were the results of the mechanical processing of the metal using CNC (computer numerical control machine) in the industrial area of Gaziantep, Turkey. The aluminium pieces had a specific density of 2.80 g/cm^3. The grain size distribution of the waste material is presented in Figure 1. The aluminium pieces have a spiral shape as shown in the Figure 2.

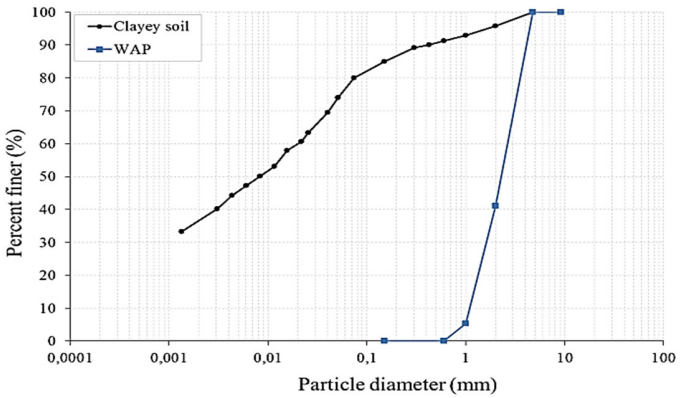

Figure 1. Grain size distribution of the clayey soil and waste aluminium pieces.