Experimental Study on Ground Improvement on Volcanic Ash Soils in Japan Using Cement and Chemical Additives

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1. Introduction

Volcanic regions present opportunities and challenges to the population around and within them depending on the type of volcanic activity or the objective of what one intends to do. Volcanic ash soil, a weathering product of volcanic may present good opportunities for agricultural activities due to its good fertility and water-retention properties. Volcanic regions also present opportunities for exploitation of geothermal energy resources. With these opportunities comes infrastructure development like roads, railways, geothermal power plants etc. Volcanic ash soils also present challenges for construction due to their unique geotechnical properties that are considered problematic. These soils are known to be highly compressible with low shear strength making them unsuitable for construction purposes. Ground improvement, the technique of improving the physical and mechanical characteristics of soil is essential in civil engineering and construction to establish a solid foundation for buildings, bridges, and other infrastructure. This procedure is used to stabilize problematic soil conditions, such as brittle soil or areas prone to settling and subsidence, in order to support the weight of structures and avert a potential failure.

2. Materials and Methods

This study examines the properties of two types of volcanic ash soil, Kuroboku (black soil) and Akaboku (red soil) from Mount Aso, Kumamoto Prefecture in Japan, and explores the effect of enhancing their mechanical properties through the use of blast furnace slag cement and chemical additives which include Glenium, Master ease, Rheobuild and Mighty 150. These additives are high-performance water-reducing agents and air-entraining agents which help in improving the pumpability of cement mixtures by reducing its viscosity among other uses. The geotechnical and chemical properties of these soils were examined and analyzed through laboratory experiments. The materials were mixed at different designated proportions of cement and at different water-to-cement ratios. The improved soils were then tested for their workability using the 15-stroke table flow test method and placed in cylindrical molds for curing. The compressive strength of the cured specimens were then tested by the UCS test method after curing for 7, 14, and 28 days.

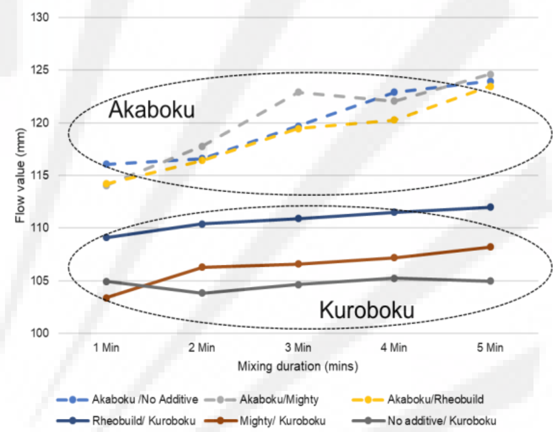

Figure 2 Workability of Kuroboku and Akaboku at 450 kg/m^3, w/c =80%.

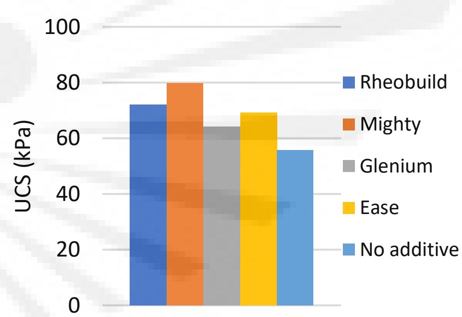

Figure 2 Kuroboku UCS after 28 days of curing.

3. Results and discussions

From the soil properties tests, it was determined that the soils are fine-grained, contain organic matter and have a high natural water content. It was also observed that kuroboku has a higher allophanic content of 53.8% than Akaboku which has 5% allophane content. From the workability and compressive strength tests, the results show that the soils treated with just the cement and no chemical additive showed poor or low workability while the ones with chemical additives showed improved workability as shown in エラー! 参照元が見つかりません。. The experiment also revealed that high allophane content soils (Kuroboku) have poor workability and this can be tackled by the use of chemical additives. It was also observed that the compressive strengths and workability improved with increasing solidification material amount. The compressive strengths of the specimens showed increasing strength with increasing curing days. Rheobuild and mighty 150 at mixing proportions of 450kg/m^3 of cement and 80% water-to-cement ratio were the additives that showed the best improvement in workability and compressive strength as shown in **エラー! 参照元が見つかりません。**.