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Volume change in compacted claystone–bentonite mixture as affected by the swamp acidic water

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Abstract

Water containing sulfuric acid with a pH up to 3 is prevalent in swampy areas. This article focuses on the effects of the solution on volume change of compacted claystone–bentonite mixture. Claystone was obtained from Banjarbakula landfill and it was mixed with bentonite on a 5, 10, 15, and 20% dry mass basis. Samples possessed the dry density of 16 kN/m^3 and moisture content of 10, 15, and 20%. The odometer examined the samples' swelling and compression in both pure and acidic water. Characterization tests i.e., XRF, XRD, and FTIR were also performed. The results showed that swelling and compression were affected by initial moisture and bentonite content. Samples with a moisture content of 20% showed compression in acidic water. Acidic water changed the water absorbed on the clay surface without altering the mineral. A mixture containing 20% bentonite compacted to optimum moisture content was found at best in reducing the acidic water effects.

Keywords: claystone; bentonite; swelling; compression; clay liner

1. Introduction

Numerous materials have been proposed as waste barriers, one of which is a mixture of claystone and bentonite. Along with the clay minerals it contains, claystone is used to recycle waste material from excavation [1]. Previously, claystone from excavation was considered as an undesirable construction material, particularly when it came into contact with water [2,3]. During the development of the Banjarbakula landfill in Banjarbaru, South Kalimantan, Indonesia, an approximately 8000 m^3 of claystone was dumped for being seen undesirable. In fact, the economic and environmental concerns should be addressed from the use of this material [1] considering some economic benefits from of the utilization of this material.

Hydraulic conductivity, shear strength, compressibility and swelling characteristics are some of the properties commonly evaluated in relation to the use of bentonite–based materials as a landfill barrier. These properties are strongly influenced by the bentonite content in the mixture. Khalid et al. [4] found that the influence of bentonite on the geotechnical properties was more evident at a bentonite percentage of more than 10% for clay–bentonite mixture. Meanwhile, adding more than 20% bentonite to silty sand had no effect on the hydraulic conductivity of the clay liner [5].

Clay liners, as a barrier, are extremely prone to interact with substances other than water. In the nuclear waste repository, the sealing material will interact with the saline solution of the surrounding host rock. This will bring an effect on the canister's corrosion, the swelling and self-sealing capability of the bentonite back fill, and a sophisticated geochemical calculation [6]. Wang et al. [1] found that, due to the high sample density and low salinity of the water utilized, water chemistry had no effect on the swelling behavior of compacted claystone–bentonite mixs. The swelling pressure of compacted claystone–bentonite mixture is affected by the final dry density of bentonite in the mixture, while the claystone used is considered to behave as sand [1].

Claystone, on the other hand, is highly impacted by the minerals it contains. Its combination with bentonite will bring effect on the mixture's behavior overall. The swelling capacity of bentonite is also determined by the chemistry of saturating fluids; the higher the salinity, the lower the sample's swelling capacity in which has a negligible effect on samples with a high density (i.e. 17−19 kN/m^3) [1].

Besides density, water salinity has an effect on hydromechanical materials containing a large amount of smectite (i.e. 50% bentonite) [6]. Apart from swelling characteristics, Siddiqua et al. [6] examined the influence of salt on compression and swelling indices (i.e., c_c and c_s) obtained by consolidation tests. c_c was found to decrease in the presence of saline solution, indicating its influence on the sample's compressibility behavior. On natural stiff clay, the similar results were reported by Ngunyen et al. [7]. Clays with a high smectite content experienced more alterations than

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