Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 5, No. 2, February, 2019

Analytical and Numerical Modelling of One-Dimensional Consolidation of Stabilized Peat

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Received 10 November 2018; Accepted 10 February 2019

Abstract

The objective of the paper is to compare and evaluate analytical and numerical solutions of one-dimensional consolidation of stabilized peat. The type of analytical method used to solve the problem is exact method by separation of variables and utilization of Fourier series. Plaxis 2D 8.2 Professional version software was used to find numerical solution to the problem by employing the finite element method. One-dimensional consolidation problem of stabilized peat was solved numerically and validated with the one solved analytically based on laboratory experimental results. From the results, it was discovered that the consolidation characteristics of stabilized peat evaluated numerically were found to have close approximation to those evaluated analytically. There is a novel value in developing an accurate numerical prediction for the vertical consolidation of stabilized peat considering the complexity of the soil treatment method. It must be noted that peat is highly problematic because it is produced from plant decomposition with extremely high organic matter.

Keywords: One-Dimensional Consolidation; Stabilized Peat; Analytical Method; Numerical Solution.

1. Introduction

Recent advancement of mathematical modelling in geomechanics has seen the development of numerous published research works of one-dimensional consolidation of soils by analytical and numerical methods [1-13]. Despite of that, not many analytical and numerical solutions that solved one-dimensional consolidation problem of stabilized peat were found in the literature of geomechanics. This is because not much research was done on one-dimensional consolidation problem of the stabilized soil due to the difficulty at finding suitable chemical additives that can be used to stabilize highly problematic peat. In fact, the complexity of peat stabilization is fueled by the presence of highly acidic organic substance in the soil and the soil rapid consolidation settlement. Unlike the behavior of saturated clay which is dependent on the types of mineral [14], the consolidation of peat is largely dependent on the amount of organic matter which dictates the soil long term deformation under a loading application. Consolidation is a time-dependent process involving the dissipation of porous fluid pressure and the deformation of the soil skeleton [15]. Soil consolidation is mainly caused by change in effective stress, which results from increase in total stress or decrease in pore pressure [16]. The process of consolidation must be carefully studied when evaluating the compression properties of stabilized peat. Following the success of stabilizing peat with calcium chloride and polycarboxylate induced rapid setting cement in laboratory with reference to the work of Wong [17]; standard oedometer consolidation tests were performed on the stabilized soil in order to study its consolidation characteristics. The optimal mix design for the stabilized peat specimen in the oedometer consolidation tests is comprised of 300 kg m^{-3} dosage of binder by mass of wet peat at natural moisture content of 677% (The binder is composed of 90% Portland Composite Cement and 10% fly ash in composition), 4% calcium chloride by mass of the binder, and 596 kg.m^{-3} silica sand by mass of the wet peat. The test specimen was allowed to cure in water

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http://dx.doi.org/10.28991/cej-2019-03091254