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Slope Stability of Embankments on Soft Soil Improved with Vertical Drains

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Abstract

The overloads of structures or embankments built on clayey soft ground are generally applied gradually, respecting a specific phasing. This phasing on construction allows the undrained shear strength of clay increasing over consolidation in order to avoid the risk of collapse during loading. In this work, the undrained shear strength of clay over the consolidation was estimated following SHANSEP method of which parameters proposed by eight researchers have been employed, as well as the slope stability analysis of embankments on soft soils during staged construction. Assessment of factor of safety for slope stability was conducted basing on the Bishop method. Additionally, the variations of undrained shear strength and factor of safety were presented. In order to validate the methods discussed in this study, slope stability analysis of five embankments constructed on clayey soft soils improved by the vertical drain technique in a high-speed railway construction project in Morocco was performed. For these embankments, field measurements about lateral displacement are presented. It was found that some of the adopted methods is in a good agreement with field measurements. Hence, generalization of these methods to many soft ground cases can be proposed.

Keywords: Shear Strength; Slope Stability; Soft Soil; Consolidation; Vertical Drains.

1. Introduction

The vertical drain system is an effective method for accelerating soil consolidation. It has several fields of application such as roads and railway embankments. These embankments are generally constructed following many phases to ensure the stability of the ground soil during construction. The undrained shear strength of foundation soils usually increases over consolidation, and it is very important to determine appropriately the gain in shear strength in the geotechnical engineering practice. Several researches have been conducted to determine undrained shear strength (Su) using field or laboratory tests. A series of research studies [1–3] have proposed correlations for the undrained shear strength of normally consolidated soils (Cu = Su) as a function of plasticity index (PI) or liquidity index (LI), or even liquid limit (LL), which implicitly shows the reduction of water content over consolidation. Janbu [4] has correlated (Su) with vertical effective stress σ'_v. Many researchers have predicted the increase in the undrained shear strength (Su) by the SHANSEP technique basing on correlation formula with (OCR) [5–8]. Other studies investigated instrumented test embankments or case histories to predict and determine undrained shear strength (Su) [9–13]. However, samples disturbance phenomenon has long been a problem and difficulties in obtaining undisturbed samples was discussed [14, 15]. Karlsson and Viberg (1967) found no unique relationship and concluded that there are several factors influencing

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