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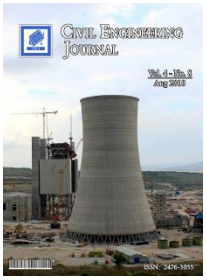

Effect of Cyclic Stress Level and Overconsolidation Ratio on Permanent Deformation Behaviour of Clayey Subsoil

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Abstract

This paper presents the results of a series of one-way cyclic triaxial tests carried out to investigate the role of cyclic stress level and overconsolidation ratio (OCR) on the permanent deformation behaviour of saturated clayey subsoil during long-term cyclic loading. Based on the test results and shakedown concept, two cyclic threshold deviator stress ratios can be defined: the plastic shakedown limit cyclic deviator stress ratio CSRpt (0.46) and the plastic creep shakedown limit cyclic deviator stress ratio CSRpc (0.75). It was found that, below CSRpt, the soil experiences slight deformation and gradually achieves a long-term steady state response. Within the range of CSRpt<CSR<CSRpc, the plastic strain will accumulates substantially and becomes unstable. Once the CSRpc is exceeded significant deformation and failure may occur. In the practical engineering, CSRpt can be used for preliminary design of pavement foundation. In addition, based on the test results, a simplified permanent axial strain model that explicitly considers the effects of CSR and OCR is developed.

Keywords: Saturated Clayey Subsoil; Cyclic Stress Ratio; Overconsolidation Ratio; Permanent Axial Strain; Explicit Model.

1. Introduction

The development of modern transport infrastructures (motorways, railways, ports, and airports) across the deep soft clay outcrops encountered in southeast China, has led to the construction of embankments on soft ground with poor geotechnical characteristics, namely with low shear strength and high compressibility. When the organic content of these soils is high, notable creep settlement can also be observed, which contributes to an increase in the maintenance costs over exploitation time and can even compromise the functionality of the structure [1]. Some improvement techniques, such as the preloading by mechanical surcharging, by using vacuum are usually used applied to attenuate the creep effects of the soft ground. However, vast engineering practice indicates that although the creep settlement is less due to the foundation reinforcement, during their operational life they are subject to a large number of repeated loads, which under unfavorable conditions can result in the accumulation of unacceptably large plastic strains [2]. For example, the Shanghai Metro Line-1 showed modest (2-6 mm) settlements at multiple locations over the 2 years between its construction end and operational opening. However, an unfavorable excessive settlement of 60 mm was developed over the first 8 months of service and an additional 180 mm over 18 years of operation [3]. Despite the incomplete consolidation and creep settlement, the permanent deformation induced by long-term traffic loading is an important component of the total subgrade settlement. Therefore, it is of scientific value and practical significance to investigate the deformation behaviour of soft clays under traffic loading. The dynamic response (cyclic degradation and cyclic pore water pressure) of soft clay under cyclic loading have been studied in considerable depth in the past, many threshold stress level [4] and empirical formulas for deformation predictions have been proposed [5].

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