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Cyclic simple shear behavior of a tropical alluvial soil

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ABSTRACT

Tropical alluvial soil has distinctive physical characteristics when compared to common sedimentary soils. Ignoring such distinctive characteristics might lead to geotechnical problems that require a thorough re-investigation. Foundation failures have been identified along some river banks of tropical alluvial soil deposits in Sarawak, Malaysia, which were speculated to be due to cyclic loading effects. This paper presents preliminary results on tropical alluvial soil engineering behaviors from simple shear cyclic loading tests. Specimens measuring 50 mm in diameter and 16 mm in height were obtained from three undisturbed samples. They were sheared using an Electro-Mechanical Dynamic Cyclic Simple Shear (EMDCSS) for thirty cycles at three different target displacements. The results showed hysteresis loops, where the shear stress decreases as the cycle increases. Excess pore water pressures develop during shearing, which correspond to the target displacement levels. The damping ratio increases as the shear strain increases but decreases as the cycle increases. The normalized shear modulus decreases as both the shear strain and loading cycle increase. A comparison with previous literature on cohesive soils shows that the tropical alluvial soil has a lower damping ratio and normalized shear modulus, which range from 3.3% to 9% and 0.0004 to 0.01, respectively. The findings indicate that the tropical alluvial soil has a potential reduction in strength when subjected to continuous cyclic loading. The paper provides a better understanding for academics and engineering professionals before conducting design or remedial work in the tropical alluvial soil environment.

1. Introduction

Alluvial soil, or alluvium, refers to soil deposits that are generated from the sedimentation of transported particles by running water. Its composition may consist of sand, silt, clay, gravel, and organic materials (e.g., peat). All sedimentary soils are generally considered to have similar behaviors due to their depositional processes. However, alluvial soil in the tropics has unusual characteristics when compared to common sedimentary soils (Francis et al., 2019). The tropical alluvial soil has a low preferred orientation of particles, which contradicts the general belief that all sedimentary soils are highly anisotropic (Hasan et al., 2022). Such distinctive characteristics are related to the high cycle of weathering in the tropical environment, which does not occur in temperate regions.

As a tropical region, Sarawak has a large alluvial soil deposit that can be found along the coastal areas and areas connected to the Rajang River through the division of Kuching, Sri Aman, Sarikei, and Sibu (JMG, 2022). The Rajang river is the longest river system in Malaysia and the main contributor to the sedimentation located on the separation between the delta alluvium plain and the coastal alluvium plain at the midpoint between the Oya River and the Igan distributary of the Rajang River (Ashraf et al., 2021). The tropical alluvial soil in Sarawak and in some other places is sometimes mistakenly identified as marine clay due to its proximity and similar physical appearance.

The abovementioned areas are the current focal points in Sarawak due to an on-going mega project that involves constructing 10 new bridges connecting coastal towns (Uemedgenta, 2022). However, records in the past showed numerous wharf, jetty, and bridge failures had occurred in this area. Lack of appropriate design was found to be the cause, especially with regards to pile lateral movement from tidal fluctuations and dredging activities (Lee et al., 2018). Such loadings are cyclic in nature, which could worsen the problems.

There has been a lack of research carried out to study the behavior of tropical alluvial soils. The soil strength behavior under monotonic

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