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Assessment Of Rutting And Resilient Behaviour In Unbound Material Depending On Initial State

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Extended Abstract

Unbound pavements are significant in Australia's extensive road network, providing crucial support and resilience under varying climatic and traffic conditions. These pavements are constructed using aggregate layers compacted to form a stable foundation. However, seasonal variations cause compacted soils used as formation layers for unbound pavements to vary in water content and suction constantly. The performance of the unbound pavements can be impacted by these fluctuations and the effects of cyclic traffic-induced loads, which can change the soil's hydro-mechanical behaviour [1]. For this reason, accurately measuring the soil's water retention properties under cyclic loading is crucial for evaluating its behavior under repeated loads.

Understanding compacted soils used in unbound pavements requires precisely describing the soil's water retention behaviour. This is significant because water retention characteristics significantly impact the accumulated deformation and resilience modulus of such soils under cyclic loading. To fully understand the cyclic response of unsaturated soils, any interpretive framework must include a water retention component that considers the changes in soil suction and water content during cyclic loading. From an experimental perspective, this can be accomplished by cyclic testing unsaturated soil samples while continuously monitoring suction, water content, and volume changes [2]. Psychrometer or axis translation techniques have often been used to assess soil suction during cyclic triaxial testing. Several researchers have employed the axistranslation method, which involves applying air pressure and measuring the water pressure at the sample's top or bottom. However, this process may not realistically simulate the situ situation, where air pressure is atmospheric, and water pressure is negative [3]. Additionally, many previous studies have investigated repeated load triaxial (RLT) tests under constant confining pressure, which are frequently used to estimate the rut resistance of geomaterials. However, these tests may not accurately simulate the behavior of unbound pavement materials [4]. Therefore, it is crucial to implement an alternative test method that applies a more realistic stress path to geomaterials, effectively simulating actual traffic loading on pavements.

To overcome the gap in previous research, this study conducted a series of constant radial stiffness triaxial (CRST) tests on silty sand, which is commonly used in unbound pavements. The goal was to evaluate the resilient and permanent responses of this sand under cyclic loading. We employed a tensiometer technique that improves suction measurement by testing soil samples at negative water pressure and atmospheric air pressure. This tensiometer is capable of measuring pore water pressure within the range of -2,000 to 2,000 kPa, with a resolution of ±0.5 kPa, to directly measure suction. The device is a small suction probe that utilizes a ceramic porous stone with an air entry value of 1,500 kPa and features a water reservoir with a capacity of 5.02 mm^3 [5]. In addition, we replaced the RLT test with the CRST test. The CRST test uses a boundary condition of continuous lateral stiffness, providing dynamically changing lateral stress conditions that reflect the lateral stiffness of the surrounding pavement at the loading location. This approach allows for a more accurate simulation of pavement stress compared to the constant lateral stress in traditional RLT tests.

Based on the test results, we developed empirical formulations to characterise the plastic strain and resilient modulus under various initial densities and water contents. The calculated plastic strain and resilient modulus were plotted as isograms on the compaction plane to help with pavement design and field compaction control. In addition, by continuously measuring the suction during cyclic loading, A water retention model was developed to predict the water retention behaviour and suction variations of the tested soil under cyclic loading in the actual situation. This model aims - to reduce the risks associated with climate change for the construction of the pavement, resulting in the building of transportation infrastructure in a more sustainable manner.

References

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