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Influence of Stress Path on Cross-Anisotropic Behavior of Geomaterials

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Abstract

Roadway response under traffic loading is highly dependent on the mechanical properties of the roadway sublayers such as base, subbase, and, subgrade. As an indicator of the stress-strain characteristics of roadway foundation layers, resilient modulus (M_R) becomes an important stiffness parameter when evaluating the performance of these layers. Thus, determining the M_R of geomaterials under different stress states that are experienced in the field plays an important role in fulfilling the designed pavement life. However, conventional testing methods are insufficient for exerting the complicated stress states experienced in the field on geomaterials. In addition, directional dependency of the stiffness characteristics of geomaterials, which affects the roadway response as a result of principal stress rotation, cannot be captured by these conventional testing devices due to the lack of applying true triaxial stress states. Thus, a need for an advanced testing equipment arises to determine stress path and directional dependent stiffness characteristics of geomatrials. SPAX-3000, a cyclic true triaxial testing device, was used in this study to determine the influence of the various stress path slopes on the cross anisotropy ratios (ratio of horizontal M_R to vertical M_R) of geomaterials. A series of stress path slope tests (m=3, 1.7, 1.5, -1.7, -3), compression tests ($m < 0$), and extension tests ($m > 0$), were carried out on two base and two subgrade materials and cross anisotropy ratios were determined for each material. Results showed that the base materials had lower cross-anisotropy ratios (0.04 to 0.16) compared to the subgrade materials (0.03 to 0.52). For all the geomaterials, higher directional dependency was observed when geomaterials were subjected to only compression and extension stress states. The results of this study are expected to contribute to the understanding of the effect of various stress path slopes on the cross-anisotropic behavior of geomaterials to account for the stiffness characteristics of these materials during the principal stress rotation under traffic loading. The results also claimed that different foundation layers have distinctive responses for the same stress path slopes. Therefore, it is believed that implementing these results in mechanistic pavement/roadway design for different foundation layers will be enhancing the reliability of the design outputs.