Kansas Department of Transportation

TECHNICAL SUMMARY

Pullout Resistance of Reinforcement of Lightweight Cellular Concrete Fill

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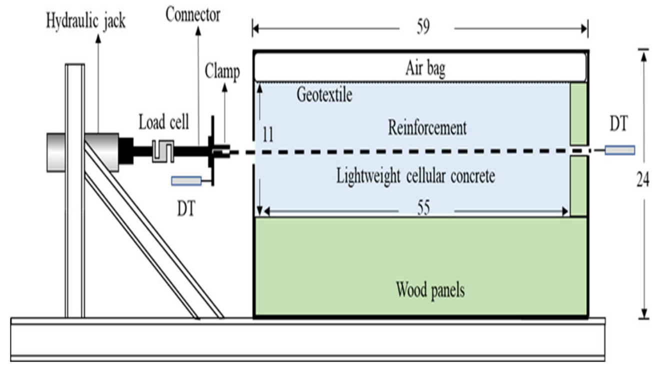

Cross-Sectional View of Pullout Test Setup

Introduction

Lightweight Cellular Concrete (LCC) (also called foam or gas concrete) has been increasingly used as a backfill in geotechnical applications including mechanically stabilized earth (MSE) walls. However, there have been limited studies on the pullout resistance of geosynthetic or steel reinforcement embedded in LCC. Ramezani, Vilches, and Neitzert (2013) conducted small-scale model tests and numerical simulations to investigate the pullout resistance of steel strips embedded in LCC with different reinforcement geometries and patterns. Their pullout tests consisted of a galvanized steel strip (2 inches wide × 3 inches long) cast in the middle of a foam concrete cube (4 inches × 4 inches × 4 inches). Their test results revealed that the interface (bonding) strength between the steel strip and the LCC was mainly provided by chemical adhesion, which depended on the age. Their investigation was mainly for structural applications and the density of the LCC was 75 pcf, which is almost double that used for geotechnical applications. To the best knowledge of the authors, so far, no publication is available in the literature about pullout resistance of geosynthetics in LCC. Therefore, research is needed to evaluate the pullout behavior of reinforcement in LCC, especially geosynthetic reinforcement in LCC.

Project Description

LCC is a special construction material, which is typically composed of portland cement, water, and air voids created by a foaming agent. This material has been increasingly used as a backfill material for geotechnical applications. This report presents a series of laboratory tests conducted to evaluate the material properties of LCC including density, permeability, compressive strength, shear strength, compressibility, elastic modulus, and Poisson's ratio with different cement to fly ash ratios and at different ages. LCC specimens used in this research project were cast in the field, and the cement to fly ash ratios used for the production of the specimens ranged from 50:50 to 100:0. Large direct shear box tests were conducted on prismatic specimens with a size of 12 inches long, 12 inches wide, and 8 inches high, while small direct shear box tests were conducted on cylindrical specimens with a size of 2.5 inches in diameter and 1 inch high. This report also presents a series of pullout tests conducted in the laboratory to investigate pullout resistance of extensible reinforcement (geogrid) and inextensible reinforcement (steel strip) embedded in LCC. Pullout displacements and pullout forces were monitored using linear variable displacement transducers (LVDT) and a load cell during the pullout process. This research project investigated the effects of age, normal stress, LCC type, cold joint, and re-pullout on pullout resistance and calculated the pullout resistance factors F^* for geogrid and steel strip embedded in LCC.

Project Results

This report presents a series of laboratory tests to evaluate the material properties of LCC and the pullout resistances of geogrid and steel strip in LCC specimens cast in the field. Based on the test results, the following conclusions can be drawn:

The average wet densities of LCC ranged from 30 to 36 pcf at the age of 28 days and the average dry densities ranged from 21 to 24 pcf at the same age. The dry density was approximately 67% of the wet density. The density increased as the cement to fly ash ratio increased. All LCC specimens used in this study are considered ultra-low density cellular concrete.

The permeability values for LCC measured using the falling head method ranged from 2.1×10-5 to 3.0×10-4 in./s, respectively. In general, the permeability decreased as the hydraulic gradient and the confining stress increased.

For the small shear box tests, the cohesion values of the LCC specimens ranged from 19 to 37 psi, while their frictional angles ranged from 19 to 63 degrees. For the large shear box tests, the cohesion values of the LCC specimens ranged from 33 to 50 psi, while their frictional angles ranged from 23 to 79 degrees. The large shear box tests measured higher shear strengths than the small shear box tests.

Project Information

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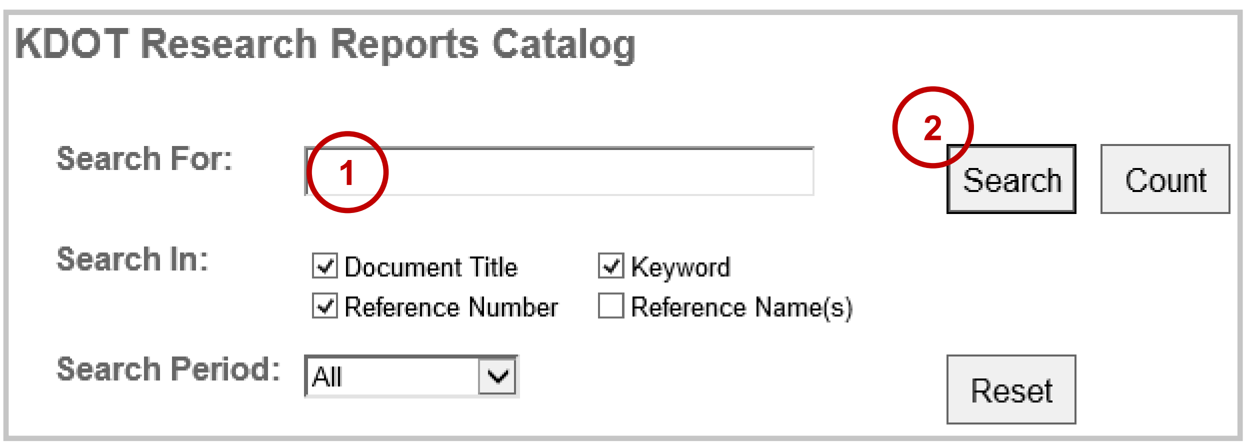

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