Kansas
Department of Transportation

TECHNICAL SUMMARY

Standardizing Rigid Inclusions for Transportation Projects—Phase I

Report Number: FHWA-KS-25-02 ▪ Publication Date: December 2025

Jie Han, Ph.D., P.E.
Sameep Lamsal
Haohua Chen
Robert L. Parsons, Ph.D., P.E.
Yuqiu Ye, Ph.D.

The University of Kansas

Introduction

A variety of equipment and installation methods, often marketed under different trade names, are currently used for RI installation. Depending on the chosen equipment, installation technique, and soil conditions, the installation process can result in partial or full displacement of the surrounding soil, potentially disturbing adjacent soils, neighboring inclusions, and nearby structures. Typically, these inclusions are installed beneath a load transfer platform (LTP) to help support embankments or structures. However, many of these installation methods are proprietary and closely guarded for commercial advantage, leaving Departments of Transportation (DOTs) highly dependent on contractors for design and implementation. At present, no universally accepted design methodologies or construction specifications exist to evaluate the load transfer mechanism and installation-induced effects on surrounding soils, adjacent inclusions, or existing structures.

The failures of RI-supported (RIS) earth structures recently have highlighted the lack of stability analysis of such systems. A two-phase approach, starting with a comprehensive review of current practices (Phase I) followed by full-scale field testing (Phase II), is needed to evaluate installation effects and improve or develop design methodologies that account for installation effects and slope stability. These methodologies should include the analysis of load transfer behavior and vertical and lateral deformations under loading. The research should also verify or improve the guidelines for the load transfer technology with RI systems as one of the ground modification methods for highway structures developed through the NCHRP 10-121 project.

Project Description

Evaluation of the design methods involved a comparison of results calculated from the popular design methods BS 8006-1, EBGEO, CUR226, and the Federal Highway Administration (FHWA) for three key design parameters (load efficacy, differential settlement and reinforcement strain). The measured data were available in the literature, including 24 full-scale experiments and four model tests. The comparison results revealed variations and inconsistencies of the calculated results among the design methods. Numerical analyses were also performed for two case studies, and their results were compared with the results from the design methods. Methods CUR226 and FHWA comparatively more accurately predicted all three design parameters, while BS 8006-1 overestimated all these parameters.

This study also utilized the Column-Wall Method (CWM), Equivalent Strength Method (ESM), Stress Reduction Method (SRM), and Pile Support Method (PSM) to evaluate the stability of RI-supported (RIS) embankments. The results showed that the ESM led to a high strength of the equivalent area that prevented deep-seated failure. The SRM overestimated the factors of safety (FS) by more than 10% compared to those from the CWM while the PSM significantly overestimated the FS as compared to the CWM. This study reviewed the effects of RI installation on existing adjacent structures based on a limited number of documented case studies. This study also summarized the special provisions for RI projects of four state departments of transportation, identified the knowledge gaps in the current practice, and developed a plan for second-phase field evaluation of RIs for embankment/wall supports.

Project Results

The EBGEO, CUR226, and FHWA methods were shown to more accurately estimate load efficacy and differential settlement than the BS 8006-1 method, and the CUR226 and FHWA methods more accurately estimated geosynthetic tension than the other methods. Numerical methods provided reasonable predictions of the field performance of RIS embankments over soft soils for estimated load efficacy and differential settlement.

Based on knowledge gaps identified in Chapter 6, a comprehensive full-scale field test with instrumentation should examine possible differences in RI behavior under embankments with walls and slopes and evaluate RI behavior in load tests compared to RI behavior under embankments. Future studies should also improve existing design methods by considering installation effects, compressibility of layered soils, and allowable deformation and then develop an accurate analysis method for the stability of RIS embankments under undrained and drained conditions. Finally, future research should develop special provisions for RI projects and procedures for proper instrumentation and monitoring of RI installation and performance of RIS embankments.

Project Information

For information on this report, please contact Jie Han, Ph.D., P.E., University of Kansas, 1530 W 15th St, Lawrence, KS 66045; 785-864-3714; jiehan@ku.edu.

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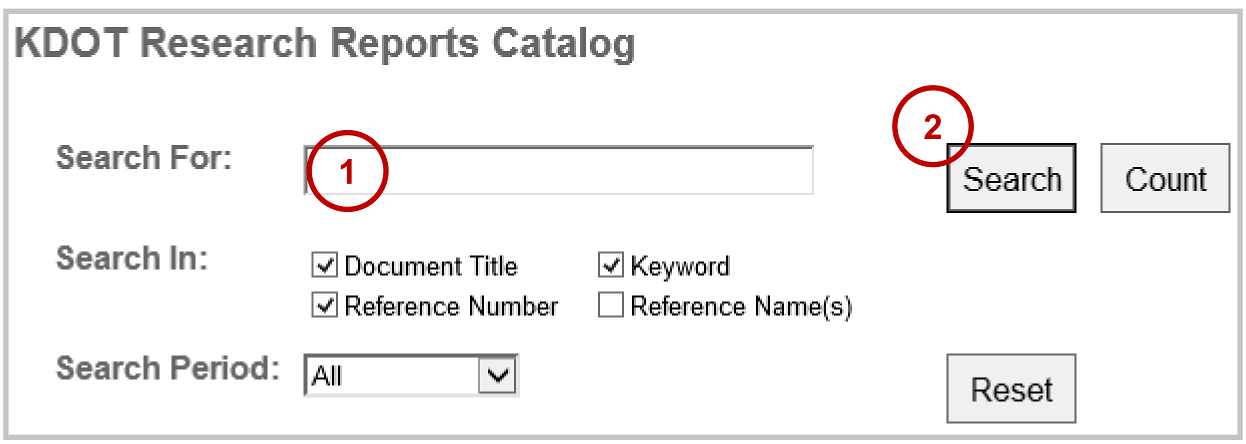

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