

**FEDERAL HIGHWAY ADMINISTRATION (FHWA) POOLED FUND PROJECT  
QUARTERLY PROGRESS REPORT**

**Lead Agency: Kansas Department of Transportation**

<b>FHWA Pooled Fund Project</b>	<b>FHWA Pooled Fund Project - Report Period</b>	
	<b>Quarter 1 (July 1 – September 30, 2023)</b>	
	Quarter 2 (October 1, 2023 – December 31, 2024)	
	Quarter 3 (January 1 – March 31, 2024)	
	Quarter 4 (June 1 – August 31, 2024)	
<b>Project Title:</b>		
Standardization of Rigid Inclusions for Transportation Projects - Phase I		
<b>Lead Agency Contact Point:</b> David Behzadpour	<b>Phone Number:</b>	<b>Email:</b> David.Behzadpour@ks.gov
<b>Lead Agency Project ID:</b>	<b>Project Start Date:</b> July 1, 2023	<b>Project End Date:</b> June 30, 2025

Overall Project Statistics:

Total project budget	Total cost to date for the project	Percentage of work completed to date
240,000	26,935.16	12%

Quarterly Project Statistics:

Total project expenses and percentage up to this Quarter	Funds expended this Quarter	Total percentage of work completed to date
26,935.16 and 11%	26,935.16	12%

**Project Description:**

Rigid inclusions are grouted or cemented columns used to improve loose or soft soils. They have been increasingly used in practice in the United States, mostly for embankment, retaining walls, and box culvert support in transportation applications. Several types of equipment and methods are available in the practice to install rigid inclusions with different trade names. Installation of rigid inclusions may cause full or partial displacement of their surrounding soils that disturb soils, neighboring rigid inclusions, and/or existing structures, depending on the type of equipment and method used, installation procedure, and type of soil. Rigid inclusions are often installed under a load transfer platform to support embankment or structure loads. The methodology and equipment-driven installation has been closely guarded and much is proprietary (commercial competitive advantage), which has left the DOTs dependent on and obligated to the contractor. No well-accepted design methods and construction specifications are available to assess and consider installation effects on their surrounding soils, neighboring rigid inclusions, and nearby existing structures, down drag forces in rigid inclusions under embankment or structure loads, and stability of embankments with side slopes supported by rigid inclusions. Research, including the state of the practice (Phase I) and full-scale field tests (Phase II), is needed to quantify rigid inclusion installation effects, develop design methods considering their effects on load transfer analysis, axial load capacity, and displacement calculations for vertical loads and evaluating the stability of rigid inclusion-supported embankments, and develop construction specifications for minimizing installation effects and improving long-term performance.

**Objectives:**

The main objectives of the Phase I study are to assess the state of the practice of rigid inclusions used for embankment and structure support, analyze existing data and design methods available in the literature or agencies, identify knowledge gaps and missing data and procedures, and develop a plan for full-scale field tests to be carried out in the Phase II study.

Tasks for this study include:

- 1) Literature Review and Assessment of Current Practices
- 2) Evaluating design methodologies
- 3) Developing a Full-scale Field Test Program

**Dr. Jie Han** of the University of Kansas (KU) is the principal investigator for this research project.

**Progress this Quarter (includes literature review, plan for online survey):**

The research team has collected a large number of references including several case studies on the current practice of rigid inclusions, performed literature review, and compiled some information and data. The research team has also prepared a draft questionnaire for an online survey to solicit direct input from state DOTs, designers, and contractors on the current practices for the standardization process.

**Anticipated work next quarter:**

The research team will work with consultants to review what the research team has gathered in terms of the literature review and review/improve the online survey questionnaire. The research team and consultants will organize a meeting with the executive committee to report the findings from the literature review and seek inputs about the online survey questionnaire. After this meeting, the research team will distribute the survey questionnaire among state DOTs, designers, and contractors and collect the survey responses by the end of next quarter.

**Significant Result:**

The literature review so far shows that much research has been done on load transfer mechanisms (soil arching and tensioned membrane) and critical heights above rigid inclusions to prevent differential settlement. A large number of methods including analytical and numerical methods are available to design load transfer platforms above rigid inclusions but these methods often yield significantly different results. Several studies examined the accuracy and differences of these design methods. However, limited research has been done on installation effects and slope stability of embankments supported by rigid inclusions.

**Circumstances affecting the project or budget:**

No challenges have been encountered so far that might affect the completion of the project within the time, scope, and fiscal constraints set forth in the agreement.