Impactful Resilient Infrastructure Science and Engineering (IRISE)

-Project Scope of Work-

(FY 2024-25 (IRISE Year 7) Annual Work Program)

SUMMARY PAGE

Project Title: Common Sense Compaction for Soils/Embankment

Person Submitting Proposal: Dr. Lucio Salles de Salles

Proposed Funding Period: 01/03/25 - 09/31/2025

Project Duration: 9 months

Project Cost: $31,998

Project Title: Common Sense Compaction for Soils/Embankment

Problem Statement: Adequate compaction of roadway materials is crucial for ensuring the performance and longevity of roadway infrastructure. Current PennDOT specifications mandate proctor analysis of soils followed by compaction testing using a nuclear gauge. The proctor test determines the optimal moisture content at which a specific soil type achieves its maximum density, assumed to be a "non-movement" condition. However, the challenge arises as the material can vary significantly from one excavator bucket to the next, depending on its source. For a precise assessment of compaction, conducting a proctor analysis for every bucket of material is nearly impractical. Presently, the general approach involves obtaining a proctor from the general area and aligning the nuclear density results as closely as possible. Although nuclear density gauges provide direct measurements of density and moisture content, their accuracy is affected by sample heterogeneity, spatial bias, surface roughness, and the presence of oversize aggregate particles in the detector path. Furthermore, the use of radioactive source material in nuclear density gauges poses safety hazards, requiring State and Federal permits for use and transport, along with extensive operator training. The current PennDOT procedure, therefore, proves unnecessarily expensive and may potentially lead to under-compaction due to variations in materials and reliance solely on the nuclear gauge. Recognizing these challenges, there is a compelling need to develop an alternative specification that emphasizes achieving uniform support and "non-movement" conditions. This necessitates test procedures utilizing devices that are accurate, user-friendly, cost-effective, and nonradioactive. Some state transportation agencies, such as the Minnesota (MnDOT), Missouri (MoDOT), and Indiana (InDOT) Departments of Transportation, have explored the use of the Dynamic Cone Penetrometer (DCP) and Lightweight Deflectometer (LWD) as alternative means of embankment and subgrade compaction control. However, these technologies have yet to be evaluated for suitability under Pennsylvania conditions.

Project Objectives: Assess the suitability of DCP and LWD technologies for compaction quality control in Pennsylvania conditions. If deemed effective, develop recommendations for a specification that establishes acceptance criteria based on these technologies. Ultimately, the project will deliver actionable insights and recommendations, aiming to enhance the efficiency, accuracy, and safety of soil and embankment compaction practices in Pennsylvania.

Project Scope:

The scope of this project encompasses the evaluation and recommendation of alternative compaction testing technologies for soil and embankment materials in Pennsylvania. The primary goal is to address the limitations of current PennDOT procedures, which rely heavily on Proctor analysis and nuclear density gauges. The project will focus on assessing alternative technologies such as DCP and LWD for their potential to provide accurate, cost-effective, and safe compaction quality control. To achieve this, we will conduct a thorough review of specifications and practices from other state DOTs, focusing on MnDOT, MoDOT, and InDOT. We will compare these practices with PennDOT's current requirements to identify key differences and potential advantages of DCP and LWD technologies.

We will carry out a comparative field test to evaluate the performance of selected technologies and specifications under Pennsylvania conditions, documenting the efforts associated with collecting

alternative data. The results will be compared to those obtained using the current PennDOT approaches. Based on the findings, we will develop recommendations for the implementation of these alternative technologies in Pennsylvania. The outcomes of the project will be summarized in a series of short reports, culminating in a final letter-report that incorporates feedback and provides comprehensive recommendations.

Task Statements

The objectives of this project will be realized through the completion of the following tasks:

Task A: Review of out-of-state specifications

The first task involves conducting a comprehensive review of specifications and practices from other state Departments of Transportation (DOTs) that have adopted DCP and LWD technologies. This will include an in-depth analysis of MnDOT, MoDOT, and InDOT specifications to understand their methodologies and outcomes.

Task B: Comparative field testing

In this task, we will conduct a field test to compare the performance of selected technologies against PennDOT's current QA/QC requirements. This involves selecting a testing site with the help from the IRISE community. We will document the data collection process, including the time and effort associated with each method. The test results will be analyzed and compared to identify any discrepancies.

Task C: Recommendations for implementation

Formulate recommendations for implementing alternative technologies for QA/QC in the compaction of subgrade and pavement unbound layers.

Task D: Draft letter-report

Compile a letter-report summarizing the research findings.

Task E: Final letter-report

A final letter-report, taking into consideration comments that were received on the draft final report, will be prepared.

Deliverables:

1. Task A: A short review of specifications for effective soil compaction from other US Departments of Transportation, and a video conference with relevant DOT personnel on the reviewed specifications within 4 months from the notice to proceed date.
2. Task B: A short report documenting the field testing and comparative analysis within 6 months from the notice to proceed date.
3. Task C: A memo summarizing the main recommendations for implementations of technologies and proposed modifications to specifications within 7 months from the notice to proceed date.
4. Task D: Draft letter-report summarizing the research findings 8 months from the notice to proceed date.
5. Task E: Final letter-report to be submitted to the Research Project Manager within 9 months from the notice to proceed date.

Key Personnel:

Principal Investigator:

Dr. Lucio Salles de Salles (RIT)

Other Personnel:

Undergrad Students:

To Be Named Undergraduate Student Researcher (RIT)

Proposed Person-Hours by Task:

Team Member	**Task A**	**Task B**	**Task C**	**Task D**	**Task E**	**Total**
Key Project Team Members, Estimated Hours Per Task						
Lucio Salles de Salles	85	115	23	18.4	20	261.4
Undergraduate Student	70	75	20	9	0	174
Total	**155**	**190**	**43**	**27.4**	**20**	**435.4**

Schedule:

Calendar Year	2025								
Months	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Task A									
Task B									
Task C									
Task D									
Task E									

Budget: The total project cost is $31,9998

Acknowledged By:

9-13-2024

Lucio Salles de Salles
Principal Investigator