

## PROJECT SUMMARY REPORT

# 0-7161: Develop Settlement Criteria and Design Approach for Embankments and Retaining Walls Built on Compressible Soils

### Background

Construction of bridges and roadways often encounters highly compressive clay or very loose sand. If not addressed appropriately, these soils can settle significantly after construction. Therefore, suitable settlement mitigation measures need to be taken to ensure the long-term performance of bridges and roadways. However, settlement mitigation often has a large time and cost footprint on projects that involve placement of embankment on very thick layers of compressible, low-permeability soil, adding months and/or millions of dollars to a project. Therefore, selection of settlement mitigation should consider not only the effectiveness of the method but also the associated cost and time. Given the scale and urgency of current projects, setting reasonable settlement criteria and achieving a balance between the cost of ground improvement measures and time of preloading is becoming increasingly important. This research aims at identifying settlement criteria and development of a design guidance that settlement, cost, and construction time can be accounted for when different mitigation methods are assessed, based on site condition, to achieve balanced time and cost.

### What the Researchers Did

The overarching objective of the study is to establish settlement criteria and a design procedure with which settlement mitigation measures can be appropriately selected and designed. To fulfill the objective, the following tasks were performed:

- Conduct a comprehensive literature review on settlement criteria and zoning methods used to link settlement criteria with the relative distance to a bridge,
- Construction cost information related to different mitigation methods has been collected through various resources, including databases, manuals,

and literature,

- Develop a survey questionnaire and solicit input from other state DOTs on their practice on settlement criteria. The survey questionnaire was sent to 49 state DOTs and 23 state DOTs returned the survey. A few selected state DOTs were telephone interviewed,
- Compile and analyze survey results and suggest settlement criteria for mitigations,
- Develop a series of cost-time charts that can be used by preliminary design for mitigation method selection,
- Develop guidance to select and design settlement mitigation method in detail, which can account for cost and construction time based on site-specific information, and
- Develop and calibrate a design tool to assist in determining design parameters and estimate associated cost and time.

#### Research Performed by:

University of Texas at San Antonio (UTSA) and Tarleton State University (TTU)

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What They Found

Based on the results from this study, it was found out:

- Among the 23 state DOTs that responded to the survey, only a few indicated that they do not have settlement criteria. The remaining 19 states have some criteria even though the criteria may not appear in any written document,
- The criteria used by the 19 states vary from each other. Three out of 19 states do not have a fixed value for allowable settlement, but require the embankment settlement to be compatible with the bridge settlement, so that the differential settlement between bridge and approach is negligible,
- Nine of 19 states use a single settlement criterion, but the remaining ten states divide embankment into zones based on its distance from the bridge and specify settlement criteria for each zone. Many states use the approach slab as Zone 1,
- Construction costs vary significantly. Therefore, the cost estimate should be based on local data,
- Based on the validation, the existing design methods for various settlement mitigation methods can reasonably provide good estimate on post-construction settlement when detailed site information is available.

What This Means

- It is ideal to choose settlement mitigation methods based on project cost, construction time and this distance from bridge abutment.
- Settlement criteria need to account for the relative distance from a bridge and project needs.

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