Texas Department of Transportation

TEXAS TECH UNIVERSITY
Multidisciplinary Research in Transportation

PROJECT SUMMARY REPORT

0-7173: Develop Guidelines for Evaluation of Embankment Conditions in Bridge Approach Slabs and Pavement Structures

Background

Bridge approach slabs (BAS) and the pavement sections built over roadway embankments are among the most frequently maintained assets on the Texas highway network. Because bridges rest on deep foundations while the approach embankment and its founding soils continue to deform under traffic, selfweight, lateral movement, and moisture changes, differential movement develops over time, resulting in the familiar bump at the end of the bridge, often along with faulting, cracking, lane separation, and voids beneath the slab. The visible symptom, however, does not by itself identify the cause.

Similar visible distress can result from compression of embankment fill or foundation soils, loss of materials through water infiltration and washout, lateral stress buildup behind retaining walls, or nonuniform slab support. Although these problems are widespread, current TxDOT documentation has not offered a unified procedure for assessing the condition of an in-service embankment or for linking visible distress to the mechanism that produced it. Repairs are often chosen from surface appearance alone, and when the driving distress mechanism is still active, the same distress tends to return within a few years. Project 0-7173 was undertaken to develop practical guidance for evaluating in-service BAS, adjacent pavement, and embankment conditions and for selecting maintenance and repair strategies that address both the underlying cause and the remaining surface distresses.

What the Researchers Did

The research team combined a synthesis of existing practice with an extensive field program to build evaluation guidelines and a repair-selection framework based on observed distress mechanisms. The work consisted of the following tasks:

• Review of Literature and Practice: Published research and the maintenance practices of TxDOT and other state DOTs were synthesized, covering evaluation techniques and post-construction repair methods for approach slabs, pavements, and embankments.

• Statewide District Survey: A questionnaire distributed to all TxDOT districts documented what types of distress are commonly encountered, how underperforming sections are identified and evaluated, which repairs are used, and how often they are repeated.

• Test Section Selection: From 30 candidate sections, 11 final test sections were selected to represent different distress types, pavement structures (CRCP and asphalt), and embankment configurations, including both slope and retaining wall sections with heights of 11 to 35 ft.

• Field and Laboratory Evaluation: Field investigations were conducted for 11 sections, employing falling weight deflectometer (FWD) testing, ground penetrating radar (GPR), coring, deep dynamic cone penetrometer (DCP) testing, cone penetration testing (CPT), and laboratory testing of soil samples.

• Mechanism Classification and Repair Guidance: The combined evidence was used to classify four primary distress mechanisms and develop a mechanism-based maintenance and repair framework with draft interpretation guidelines for the evaluation data.

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What They Found

The principal findings of the project are summarized as follows:

• Every responding district reported settlement, heave, or faulting at bridge approaches, and half of the response indicated that distress appeared within five years of construction. Identification relies almost entirely on visual observation, the embankment itself is seldom tested, and 80 percent of respondents had repaired the same section again within 10 years.

• The evaluation methods complement one another: FWD testing rapidly screens long lengths for weak structural response, GPR maps voids and thickness variation, coring confirms slab condition and repair history, DCP/CPT testing characterizes embankment fill materials, and laboratory testing provides information on soil composition.

• Central FWD deflections on CRCP exceeding 1.5 times the statewide average for well-performing sections corresponded to possible voids or prior foam injection, and deflections exceeding 2.0 times the average were a strong indicator. These thresholds are draft screening values derived from this dataset and should be verified before broader application.

• A draft three-tier classification of in-service embankment materials was developed from the DCP data: acceptable at a minimum soil modulus of 18 ksi or more, fair between 8 and 18 ksi, and poor below 8 ksi. Considering DCP variability, higher threshold values can be used for conservative purposes: below 10 ksi (poor), 10 – 20 ksi (fair), and above 20 ksi (acceptable).

• Four primary distress mechanisms were identified: compression of embankment or foundation materials, loss of materials through washout, lateral stress buildup behind retaining walls, and non-uniform slab support. Compression was the most common, and more than one mechanism was active at most sections.

• A three-level repair framework was developed: identify the active mechanism from evaluation data (Level 0), apply primary repairs that address the root cause, such as joint sealing, densification, or wall stabilization (Level 1), and then correct the remaining surface distress (Level 2).

What This Means

Project 0-7173 provides TxDOT with a consistent, evidence-based procedure for diagnosing embankment-related distress before committing to a repair. By pairing a staged field evaluation with the mechanism-based repair framework, districts can determine whether a distress mechanism is still active, direct the first repair effort at its root cause, and reserve surface treatments for stabilized conditions, potentially reducing the cycle of repeated repairs documented in the district survey.

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