Research Project

**03-4GT**

C a p s u l e

# LTRC

Technology Transfer Program

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# Determination of Interaction between Bridge Concrete Approach Slabs and Embankment Settlement

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**LTRC**


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*Sponsored jointly by the Louisiana Department of Transportation and Development and Louisiana State University*



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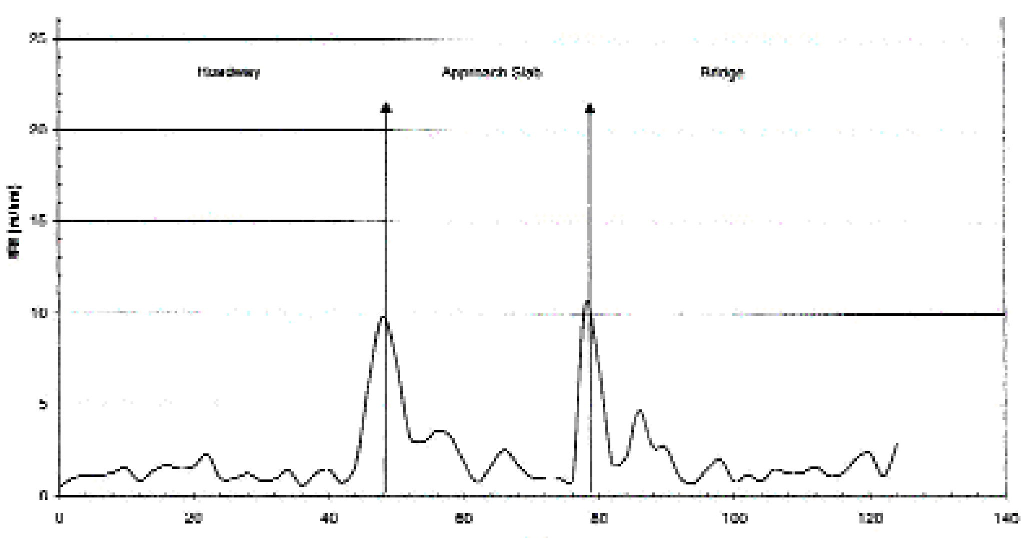
## Problem

Bridge approaches in Louisiana are normally reinforced concrete slabs that connect the deck of a bridge with the adjacent paved roadway. Their function is to provide a smooth transition between bridge decks and roadway pavement. However, complaints about the ride quality of bridge approach slabs still arise and need to be resolved. The complaints usually describe a "bump" that motorists feel when they approach or leave bridges. Field observations indicate that either faulting or a sudden change in slope grades of approach slabs causes this "bump."

Concrete approach slabs can lose their contact supports due to various reasons, including the settlement of embankments on which the slabs are built. When settlement occurs, the slabs will bend in a concave manner and cause a sudden change in slope grades of approach slabs. Slab load/weight will also be redistributed to the ends of the slabs, i.e., to bridge abutments and the subgrade near the paved roadway. Due to the redistribution of loading, faulting can occur at either the joint between the roadway pavement and the approach slab (R/S joint) or the joint between the approach slab and the bridge deck (S/D joint), thus affecting bridge approach slab rideability.

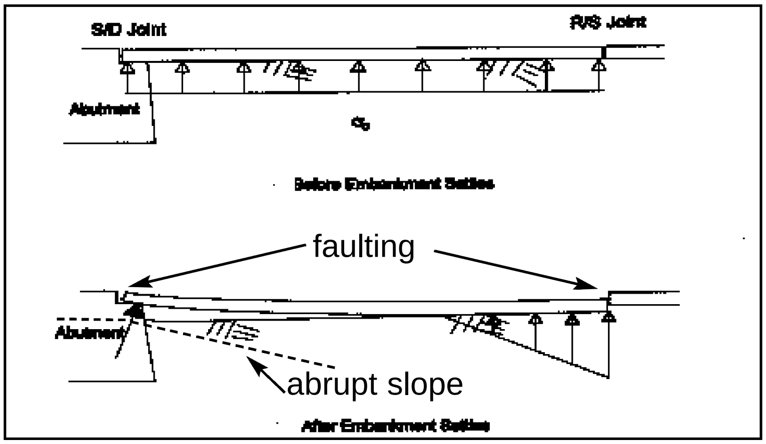
## Objective

LaDOTD has launched a major Louisiana Quality Initiative (LQI) effort to explore different methods for a potential solution of the approach slab settlement problem. The LQI is a joint effort of research, design, construction, and maintenance personnel.

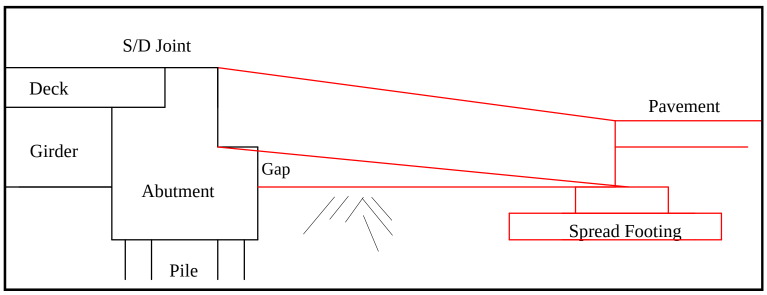



*IRI Profile at Bridge Approach Slab*

One LQI objective includes investigation of the feasibility for designing approach slabs strong enough to lose a portion of their contact supports without detrimental deflection. In this solution, the flexural rigidity of approach slabs will be increased, allowing some embankment settlement without a decrease in ride quality. This solution requires a thorough understanding on the interaction among bridge approach slabs, bridge abutments, and embankment settlement. To help LaDOTD design engineers develop such a solution, correlations of the approach slab's faulting and deflection with approach embankment settlement are required. The objective of this research is to establish these correlations for use in the design of bridge approach slabs and foundations.




*Development of "Bump" Problem*




*Concept for Potential Solution of "Bump" Problem*

## Description

It is anticipated that the research will accomplish the following tasks:

**Task 1.** Examine and review the current practice for analyzing the interaction among bridge approach slabs, bridge abutments, and embankment settlements. This will include a literature search of previous or on-going research and case studies on this issue.

**Task 2.** Analyze the interaction between approach slabs and the abutments they connect. Determine the mechanism and magnitude of faulting at S/D joints. This interaction will affect the stability of the bridge and the ride comfort of its approach slabs. Such interaction varies with the maximum differential settlement between an abutment and its approach embankment, slab length, slab flexural rigidity, the geometry of the designed roadway, etc.

**Task 3.** Analyze the interaction between slabs and their supporting embankments. Determine the mechanism and magnitude of the slab's deflection. The suggested analysis should establish a correlation among the length, the flexural rigidity, the geometry and deflection of approach slabs, and the maximum differential settlement between abutments and their approach embankment.

**Task 4.** Analyze the distribution and change of contact stress between slabs and their supporting embankments. Determine the mechanism and magnitude of faulting at R/S joints. The analysis should determine the maximum contact stress between approach slabs and their supporting embankments. Predict the resulting maximum faulting at R/S joints at different slab lengths, flexural rigidity, maximum differential settlements between abutments and their approach embankment, geometries of designed roadways, etc.

**Task 5.** Apply the results from tasks 1, 2, 3, and 4. Using information obtained from LaDOTD, the structural design of approach slabs and their foundations will be evaluated. Optimization of LaDOTD design plans may be possible.

**Task 6.** Recommend a field-monitoring program to collect field data. This monitoring program will be incorporated into the evaluation of LaDOTD test sections of concrete approach slabs. The collected field-test data will be used to verify, validate, or modify the correlations developed in this study. LTRC engineers will be responsible for this field-monitoring program.

**Task 7.** Prepare a final report documenting the entire research effort, recommending a guideline that LaDOTD design staff can utilize to improve approach slab designs and preserve approach slab rideability.

## Implementation Potential

Rational design of approach slabs is necessary for serviceability of the bridge/roadway transition, as well as the life expectancy of the highway system. Through this research, design aids (curves and tables) will be developed. New approach slab designs can be further evaluated using numerical modeling. Resultant design methodologies will eventually lead to a solution of the "bump" problem.