Texas Department of Transportation

TEXAS TECH UNIVERSITY
Multidisciplinary Research in Transportation

PROJECT SUMMARY REPORT

0-7148: Develop Design Details for CRCP Whitetopping and Unbonded Overlays

Background

A significant and growing maintenance backlog challenges America's roads despite billions in funding. The Texas Department of Transportation (TxDOT) directs approximately 45 cents of every dollar to maintenance and replacement. While common, asphalt overlays are often a short-term solution that fails to address underlying structural problems. Concrete overlays offer a more durable alternative, but their success hinges on a reliable design methodology.

This research identified a critical void in current practice. Existing TxDOT design methods for concrete overlays rely on outdated national guides, such as the AASHTO 1993 guide, which uses an empirical approach from the 1950s that is ill-suited for modern pavement systems. Furthermore, there is no standardized TxDOT procedure for designing Continuously Reinforced Concrete Pavement (CRCP) whitetopping or unbonded overlays, leaving engineers without a validated framework. This project addresses the need for a data-driven and accessible design method to build more durable and cost-effective CRCP overlays, ensuring that repaired roads stay fixed for longer.

What the Researchers Did

The primary objective was to develop and validate a practical, deflection-based design methodology for CRCP whitetopping and unbonded concrete overlays. The research was founded on the principle that pavement deflection is a primary and reliable indicator of structural capacity and future performance, a key lesson from the historic AASHO Road Test. The project employed a holistic approach combining a nationwide survey, extensive field testing, and mechanistic modeling.

•Nationwide Survey: Researchers surveyed state transportation agencies to understand current practices, challenges, and design needs related to CRCP overlays.

•Field Testing: A field program was conducted on new CRCP construction projects to quantify the direct correlation between the deflection of the base layer before paving and the final deflection of the completed CRCP system. This involved using a Falling Weight Deflectometer (FWD) to measure deflections and a Dynamic Cone Penetrometer (DCP) to assess subgrade conditions on projects with slab thicknesses ranging from 7 to 15 inches.

•Mechanistic Modeling: To expand upon the field data, a calibrated Finite Element Method (FEM) model was developed using ANSYS software. A dynamic analysis was essential to accurately simulate FWD loading. The model was used to generate a comprehensive set of correlation curves that relate base deflection to CRCP deflection for slab thicknesses from 4 to 15 inches across a wide range of subgrade conditions.

•Reinforcement Analysis: The team reviewed existing reinforcement design models and analyzed field performance data to develop recommendations for CRCP used at intersections.

What They Found

•A "Statewide Deflection Curve" was established, which demonstrates that any new, structurally sound

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CRCP has a predictable “signature” deflection based on its thickness. This curve serves as a diagnostic tool to assess an existing pavement’s condition by determining its “structurally equivalent” new thickness.

•The calibrated FEM computer model successfully generated a complete set of correlation curves that form the basis of the new design method.

•Two practical engineering tools were created: a graphical Design Nomograph and a user-friendly, Python-based software program. Both tools seamlessly integrate design traffic, existing pavement deflection, and the new correlation data to provide a straightforward process for determining the required overlay thickness.

•For CRCP at intersections, reducing steel reinforcement below the typical 0.6%–0.7% range provides only marginal cost savings while creating significant risks to long-term performance and pavement reliability.

•Implementing shallow saw-cuts at CRCP intersection is a cost-effective strategy to control random cracking, improve aesthetics, and reduce future maintenance needs.

What This Means

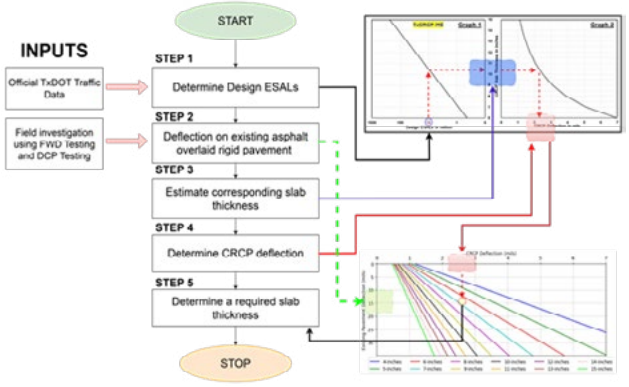
This research fills a critical void by providing engineers with a validated, data-driven, and accessible framework for designing durable and cost-effective CRCP overlays. The deflection-based method offers a rational alternative to outdated empirical approaches, with case studies demonstrating its potential to reduce overlay thickness compared to current methods, leading to significant cost savings. Designers now have a standardized procedure to evaluate existing pavements and confidently design a CRCP overlay.

Recommendations:

•Adopt the proposed deflection-based design methodology for all future CRCP Whitetopping and Unbonded overlay projects.

•Consider using low COTE reinforcement for CRCP construction at intersections to enhance constructability.

•Implement saw-cutting at CRCP intersections as a standard practice to control cracking patterns and improve aesthetics.



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