Texas Department of Transportation

Research Digest

Research and Technology Implementation Division

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Recent TxDOT Research Publications

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Item 1. Seal Coat and Rumble Strip Guidelines Predicting Rumble Strip Noise Performance

TEXAS A & M TRANSPORTATION INSTITUTE
TTI 7029-P1 | 2026

The application of seal coat, or chip seal, on pavements will partially fill existing rumble strips (Figure 1) and can reduce the performance of rumble strips to alert drivers of possible lane departure. If the reduction is severe enough, the seal coat treatment can undermine the ability of the rumble strip to serve its intended function (1). In TxDOT research project 0-7029, the research team at the Texas A&M Transportation Institute investigated the impact of sequential seal coats, seal coat grade type, and other factors on rumble strip performance. The key recommendations from of the study, presented in this document, can guide TxDOT engineers about whether seal coat should be placed over an existing rumble strip.

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This report is available for free download (11 pages, 1.6 MB):
https://library.ctr.utexas.edu/hostedpdfs/tti/0-7029-P1.pdf

More information available in the TxDOT Research Library Catalog.

Item 2. Strut and Tie Method for Reinforced Concrete Members with Cold Joints

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH
CTR 7117-1 | 2026

Cold joints are a frequent and often unavoidable occurrence in reinforced concrete construction; however, current design provisions offer limited guidance for assessing their effect on load transfer and failure mechanisms, particularly when cold joints intersect critical load paths in disturbed regions. This research proposes a mechanically-based analytical approach that integrates shear-friction behavior into the strut-and-tie method (STM) framework. The analytical model was informed by a comprehensive literature review, a survey of US transportation agencies, and an extensive experimental program consisting of slant shear, deep beam, and a drilled-shaft footing cap test. The study investigated both two- and three-dimensional structural behavior and evaluated the effects of joint orientation, surface roughness, and reinforcement configuration on cold joint performance. Experimental results revealed distinct shear transfer mechanisms in cold joints intersected by compression struts. These findings guided the development of an analytical framework that captures interface behavior and supports a rational design procedure. The proposed analytical approach is compatible with existing design

specifications, addressing both interface shear resistance and strut effectiveness within the STM framework. This research delivers validated practical design guidelines for reinforced concrete structures with cold joints, advancing the reliability, safety, and consistency of structural design.

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This report is available for free download (278 pages, 32.8 MB):
https://library.ctr.utexas.edu/ctr-publications/0-7117-1.pdf

More information available in the TxDOT Research Library Catalog.

Item 3. Operational and Capital Cost Management at Rural and Small Urban Transit System

TEXAS A & M TRANSPORTATION INSTITUTE
TTI 7133-1 | 2026

One of the goals of the public transit system is to provide a high-quality and affordable service while ensuring the system remains cost-efficient. Since the COVID-19 pandemic, public transit systems have experienced substantial changes in passenger ridership, revenue streams, operational costs, and capital costs. In Texas and other regions, rural and small urban transit systems can be significantly challenged by these changes in addition to those caused by high turnover and a lack of comprehensive resources focused on cost management. To address these challenges, this study aimed to develop resources and training materials to assist Texas's rural and small urban transit systems in managing operational and capital costs. To create useful materials for rural and small urban transit systems, the research team identified the cost

management needs of transit agencies in Texas, conducted a national review of resources and best practices for operational and capital cost management, and synthesized the findings into cost management guidance and training products, including a guidebook, an instructor-led workshop, and an online course. These products were developed, reviewed, and then pilot tested to ensure they were useful to Texas rural and small urban transit systems.

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This report is available for free download (134 pages, 1.5 MB):
https://library.ctr.utexas.edu/hostedpdfs/tti/0-7133-r1.pdf

More information available in the TxDOT Research Library Catalog.

Item 4. Managing Operational and Capital Costs at Rural and Small Urban Transit Systems: A Guidebook 2023

TEXAS A & M TRANSPORTATION INSTITUTE
TTI 7133-P1 | 2026

Rural and small urban transit systems across the United States face fiscal challenges caused by the growing gap between the cost of providing transit service and available federal, state, and local funding. Impacts of the COVID-19 pandemic continue to be felt by many transit systems, evidenced by ridership and fare revenue levels that remain significantly lower than pre-pandemic levels. In Texas, the fiscal challenges facing rural and small urban transit systems are compounded by an increasing population that is growing increasingly older (1)—often increasing the need for public transit. Rural and small urban transit agencies often experience regular turnover among key staff, which, when combined with a lack of knowledge management and documentation practices, creates critical gaps in knowledge and procedures. All of these

factors create a context in which understanding and managing costs at rural and small urban transit systems are paramount but also very difficult to do and do well. Rural and small urban transit systems need a reliable go-to resource for cost management, which is the core scope and objective of this Guidebook.

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This report is available for free download (301 pages, 4.7 MB):
https://library.ctr.utexas.edu/hostedpdfs/tti/0-7133-P1.pdf

More information available in the TxDOT Research Library Catalog.

Item 5. Managing System Costs: Operational and Capital Cost Management at Rural and Small Urban Public Transit Systems

TEXAS A & M TRANSPORTATION INSTITUTE
TTI 7133- P2 | 2026

This workshop aims to equip transit systems in Texas and beyond to understand and manage operational and capital costs and to provide a go-to resource for cost management best practices.

This report is available for free download (436 pages; 11.4 MB):
https://library.ctr.utexas.edu/hostedpdfs/tti/0-7133-P2.pdf

More information available in the TxDOT Research Library Catalog.

Item 6. Managing Operational and Capital Cost at Rural and Small Urban Transit Systems

TEXAS A & M TRANSPORTATION INSTITUETE
TTI 7133-P3 | 2026

Online Course for Managing System Costs: Operational and Capital Cost Management at Rural and Small Urban Public Transit Systems.

This course is available for free download (Running time 9 hrs.):
https://www.youtube.com/7133playlist

More information available in the TxDOT Research Library Catalog.

Item 7. Artificial Intelligence for Pavement Condition Assessment from 2D/3D Surface Images

TEXAS STATE UNIVERSITY
TXST 7150-1 | 2026

The development of a national standard data format for two-dimensional/three-dimensional (2D/3D) pavement surface images and Artificial Intelligence (AI) Machine Learning (ML) in Computer Vision adopted by AASHTO and embraced by state DOTs has provided TxDOT the opportunity to develop new methods for automated pavement condition assessment. This research implements automated pavement condition evaluation using 2D/3D surface imagery and Artificial Intelligence. A comprehensive image library was established in the AASHTO standard data format, capturing diverse pavement conditions and surface types in Texas. The dataset includes 5,892 2D/3D image pairs and associated labels for Asphalt Concrete (ACP), 7,750 for

Jointed Concrete (JCP), and 5,776 for Continuously Reinforced Concrete Pavement (CRCP). These correspond to 10,885, 16,943, and 13,779 individual distress instances, respectively, as defined by the TxDOT Pavement Management Information System (PMIS) for a total of 19,418 images. Neural network models such as YOLO (You Only Look Once) series were trained on the established library datasets for generalization and robustness of pavement distress measurements. Leveraging vision-based AI and ML models, the system automatically detects and measures surface distresses, achieving a mAP50 of over 0.80 for ACP, 0.70 for JCP, and 0.75 for CRCP on the validation datasets. These models were integrated into practical tools for calculating PMIS distress scores and delivered via a dedicated software application for TxDOT. A pilot study was implemented using both the library and vendor-collected field data in 2024 to validate the efficacy of the proposed methods. The research concludes with actionable recommendations and a strategic roadmap designed to transition these findings into full-scale operational implementation within TxDOT's pavement management system.

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This report is available for free download (225 pages 16.1 MB):
https://library.ctr.utexas.edu/hostedpdfs/tsusm/0-7150-1.pdf

More information available in the TxDOT Research Library Catalog.

Item 8. Using Vehicle Probe Data to Evaluate Speed Limits, Year 3

TEXAS A & M TRANSPORTATION INSTITUTE
TTI 7156-01-1 | 2026

Speed limits are among the most visible and routinely enforced traffic control devices motorists encounter in their everyday driving. Speed limits are set using speed zone studies. This research project investigated how to make speed zone studies and speed zone decisions more effective and efficient. Researchers explored the thresholds for speed zone factors, applying the previously developed suggested speed limit based on a probe data (SSL Probe) protocol for corridors to determine if improvements are needed. Researchers also used the findings from these efforts to refine the guidelines on how to use probe data within a speed zone study. The SSL Probe protocol was used to estimate the 85th percentile speed needed for a speed zone study for 32

freeway corridors and 246 non-freeway corridors. The suggested speed limits based on the estimated85th percentile speeds were similar to the suggested speed limits identified using on-site speed data or were generally within 5 mph. While the Texas Department of Transportation (TxDOT) Procedures for Establishing Speed Zones manual would need to be revised prior to being able to use probe data in a speed zone study, the use of these predicted 85th percentile speeds can provide a quick check on the need for a speed zone study. Based on discussions with TxDOT staff, reviews of other recent research studies, and the research team's engineering judgment, researchers suggest new factors for use in a speed zone study.

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This report is available for free download (60 pages, 1.4 MB):
https://library.ctr.utexas.edu/hostedpdfs/tti/0-7156-01-R1.pdf

More information available in the TxDOT Research Library Catalog.

Item 9. Guide on Using Alternative Data Source for a Texas Speed Zone Study, Updated

TEXAS A & M TRANSPORTATION INSTITUTE
TTI 7156- 01-P1 | 2026

Within Texas, the Texas Department of Transportation Procedures for Establishing Speed Zones (TxSZ) and the Texas Manual on Uniform Traffic Control Devices (TxMUTCD) are used for setting speed limits other than statutory speed limits. The TxSZ details how to conduct an engineering study that is needed when investigating the appropriate speed limit for a speed zone. The objective of this guide is to provide methods and examples on how to use alternative sources of data when evaluating speed limits. It does not replace the material in the TxSZ or the TxMUTCD. Rather, it provides suggestions on how INRIX speed data can be used in an engineering study required in a speed zone study and demonstrates other supplemental methods and guidance when conducting a speed zone study. It provides step-by-step instructions on how to obtain the INRIX speed data, convert into representative free-flow speed measures, and use them in both the TxSZ method and the Speed Limit Setting Tool. The 2026 version of the guide includes additional case studies along with updated instructions on obtaining INRIX speed data.

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• Chapter 3. State 1—Identify Study Area(s) for the Speed Zone Study
• Chapter 4. Stage 2—Gather Data Needed for Conducting the Speed Zone Study
• Chapter 5. Stage 3—Calculate Speed Measures (Vehicle Speed Distribution)
• Chapter 6. Stage 4—Investigate/Identify Suggested Speed Limit
• Chapter 7. Speed Limit Case Studies
• References

This report is available for free download (106 pages, 4.6 MB):
https://library.ctr.utexas.edu/hostedpdfs/tti/0-7156-01-P1.pdf

More information available in the TxDOT Research Library Catalog.

Item 10. Improving Traffic Signal System Planning, Design, and Management with Big Data Enhanced ATSPM System

UNIVERSITY OF TEXAS AT ARLINGTON
UTA 7160-1 | 2026

In this project, an ATSPM-in-the-loop simulation framework is developed to introduce the data-driven ATSPM framework into traffic signal planning and design. Literature review on ATSPM and Best practice survey are conducted first. Then the research team explores and documents how to set up two real-world open-source ATSPM systems: Utah-DOT ATSPM system and big-data-empowered UTA-In-Motion, an add-on module for ATSPM systems. Multiple integrating software tools are developed to parse simulation outputs into real-world ATSPM signal logs and WGS84 trajectories as the data feeds of ATSPM systems. Two case studies are conducted to demonstrate how this new framework can be used for traffic signal design projects. Last but not least, the research team presents their research outcome during state and national conference and webinars as technology transfer activities.

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• Chapter 1. Introduction
• Chapter 2. Literature Review
• Chapter 3. Stakeholder Survey on ATSPM
• Chapter 4. VISSIM Model Calibration
• Chapter 5. Software Development
• Chapter 6. A Case Study of Using ATSPM-in-the-Loop Simulation to Optimize Traffic Signal Timings
• Chapter 7. A Case Study of Using ATSPM-in-the-Loop Simulation for Complex Traffic Signal Timing Design
• Appendix A. The Questionnaire of the Survey
• Appendix B. Value of Research

This report is available for free download (162 pages, 13.5 MB):

https://library.ctr.utexas.edu/hostedpdfs/uta/0-7160-r1.pdf

More information available in the TxDOT Research Library Catalog.

Item 11. Barrier Striping for the Reduction of Accidents

TEXAS A & M TRANSPORTATION INSTITUTE
TTI 7171-1 | 2026

Barrier striping is a roadway safety countermeasure designed to enhance driver awareness of concrete barriers, particularly under adverse weather and low-visibility conditions. This study evaluated the short- and long-term safety effectiveness of retroreflective barrier striping across multiple sites in Texas. The research involved a comprehensive literature review of barrier delineation practices, a detailed examination of existing installations, and the implementation and evaluation of new treatments at selected high-crash locations. Data collection included crash records, roadway geometry, traffic volume, meteorological conditions, and probe vehicle speed data. Analytical methods encompassed descriptive statistics, crash rate comparisons, logistic and linear regressions, Negative Binomial, and survival analysis to assess the impact of striping on crash frequency, severity, and operating speeds. The findings revealed notable reductions in barrier-related crashes at treated sites, with relatively stronger improvements observed at nighttime, underscoring the benefits of increased retro-reflectivity. Speed analysis suggested limited but measurable effects on vehicle operating behavior. Based on these results, the project team refined the Texas Department of Transportation's draft special specification for barrier striping, offering updated guidance on materials, spacing, and installation procedures. Overall, barrier striping demonstrates promising potential as an effective countermeasure to improve roadway safety, though continued evaluation and site-specific considerations are recommended. Future research should further explore surrogate safety measures, maintenance requirements, and the effectiveness of alternative striping materials.

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This report is available for free download (108 pages, 5.2 MB):
https://library.ctr.utexas.edu/hostedpdfs/tti/0-7171-r1.pdf

More information on the report available in the TxDOT Research Library Catalog.

Item 12. Analysis and Recommendations for Calculating Reimbursement Eligibility Levels for Utility Relocations

TEXAS A & M TRANSPORTATION INSTITUTE
TTI 7176-1 | 2026

The Texas Department of Transportation (TxDOT) spends hundreds of millions of dollars on utility relocations every year. Of the various situations in which a utility relocation is eligible for reimbursement, one of the most complex situations is when parts of the existing utility facility involve a property interest because the utility owner either has an easement or owns the property in fee simple. A wide range of practices exist for what constitutes eligibility for reimbursement. The purpose of this research was to review and provide recommendations on the methodologies TxDOT uses to determine reimbursement eligibility and calculate utility reimbursement amounts. The research team conducted a review of national practices that included an analysis of relevant laws, regulations, and manuals, as well as interviews with state department of transportation officials. The research team conducted an analysis of a sample of utility agreements at TxDOT, including a review of reimbursement costs and reimbursement eligibility calculation methodologies, and prepared recommendations for implementation. The recommendations include strategies to consider for the calculation of eligibility ratios as well as strategies to improve the quality of utility agreements to make the review and approval process more consistent, accurate, and reliable.

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This report is available for free download (238 pages, 12.2 MB):
https://library.ctr.utexas.edu/hostedpdfs/tti/0-7176-R1.pdf

More information available in the TxDOT Research Library Catalog.

Item 13. Incorporation of Network level Texture Data Pavement Performance Management

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH
CTR 7178-1 | 2026

Pavement surface texture plays a critical role in vehicle–pavement interactions, influencing skid resistance, safety, and overall driving performance. Recognizing its importance, the Texas Department of Transportation (TxDOT) has invested in applying advanced equipment and

methodologies to collect high-resolution macrotexture data at highway speeds at the network-level. However, despite the well-established link between texture and surface performance, the effective integration of texture data into pavement management systems remains a challenge. This research presents a comprehensive analysis of pavement texture and Skid Number (SN) data, examining their impact on wet-weather crashes and their potential for incorporation into TxDOT's pavement management framework. Key findings confirm the consistency of texture measurements across different spatial sampling intervals, reveal a negative correlation between adequate friction/texture levels and wet-weather crash risk, and demonstrate the relationship between pavement friction and texture. The study also explores the use of texture data for roadway segmentation, supplementing missing surface material information, identifying and quantifying distress such as flushing, and informing pavement management decision trees. Recommendations include improving data collection practices, enhancing preprocessing of raw texture data and expanding texture metrics beyond MPD, and integrating texture-based investigatory and intervention thresholds into TxDOT's decision-making processes to optimize maintenance strategies and roadway safety.

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This report is available for free download (214 pages, 11.1 MB):
https://library.ctr.utexas.edu/ctr-publications/0-7178-r1.pdf

More information available in the TxDOT Research Library Catalog.

Item 14. Construction Management Plan (CMP) Best Practices & Recommendations

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH
CTR 7182-P2 | 2026

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CMP Definition and Components -- CMP Development Best Practices -- Key Findings From 0-7182 Determine Effectiveness of CMPS -- Recommendations on CMP Format and Content Aligned with the CMP SOP and CMP Development Best Practices

This report is available for free download (52 pages, 1.2 MB):
https://library.ctr.utexas.edu/ctr-publications/0-7182-p2.pdf

More information available in the TxDOT Research Library Catalog.

Item 15. Hydrologic Approaches to Playa Lakes, Areas of Significant Karst Geology, and Arid Regions (Synthesis of Current State of Knowledge and Practice)

UNIVERSITY OF TEXAS AT ARLINGTON
UTA 7201-01 | 2026

Playa lakes, arid regions, and karst terrains constitute important geographic and hydrological features across Texas, each presenting unique challenges due to their complex and varied hydrology. Currently, there are no uniform guidelines or standards for the hydrological and hydraulic design of transportation infrastructure in these landscapes, leading designers to rely heavily on project-specific judgment to determine suitable hydrological parameters. This report provides a comprehensive synthesis of current knowledge and best practices related to hydrological studies within three distinct landscapes: playa lakes, arid regions, and karst terrains. The research findings were obtained through an extensive literature review, surveys, and follow-up interviews. Based on existing knowledge, the following conclusions were reached regarding the current hydrology approaches in playa lakes, arid regions, and karst terrains: Playa Lakes: There is no method specific to the hydrology of playa lakes. Traditional hydrological methods, including the Rational Method and the NRCS Curve Number method, often prove inadequate because they fail to fully account for the complexities of playa lake systems, specifically the influence of infiltration, evaporation, sediment mobilization, and the dynamic interplay between surface and subsurface water flows. Karst Regions: The FHWA recommends various standard and empirical hydrologic methods for estimating runoff in karst regions. However, these methods are site-specific and often fail to capture the full complexity of subterranean interactions, leading to inaccurate predictions of peak flows and flood extents. Arid Zones:

Traditional hydrological methods, such as NRCS Curve Number method, which often rely on data and parameters from more humid climates, frequently underperform in arid environments, resulting in inaccurate flood predictions and potentially inadequate infrastructure design. The research reveals significant challenges in accurately predicting rainfall-runoff and effectively managing flood risks in these diverse environments, underscoring the need for region-specific approaches and further investigation. The inherent complexities of the hydrological processes within each region demand a refined understanding that extends beyond traditional methodologies.

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This report is available for free download (68 pages, 960 KB):
https://library.ctr.utexas.edu/hostedpdfs/uta/0-7201-r1.pdf

More information available in the TxDOT Research Library Catalog.

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