TTI: 0-7188

Best Practices for Pavement Widening

Technical Report 0-7188-R1

Cooperative Research Program

TEXAS A&M TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS

sponsored by the
Federal Highway Administration and the
Texas Department of Transportation
https://tti.tamu.edu/documents/0-7188-R1.pdf

Technical Report Documentation Page

1. Report No. FHWA/TX-24/0-7188-R1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle BEST PRACTICES FOR PAVEMENT WIDENING		5. Report Date Published: February 2026
		6. Performing Organization Code
7. Author(s) Bryan Wilson, Darlene Goehl, Tom Scullion, Madeline Sellards		8. Performing Organization Report No. Report 0-7188-R1
9. Performing Organization Name and Address Texas A&M Transportation Institute The Texas A&M University System College Station, Texas 77843-3135		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. Project 0-7188
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office 125 E. 11th Street Austin, Texas 78701-2483		13. Type of Report and Period Covered Technical Report: September 2023–August 2024
		14. Sponsoring Agency Code
15. Supplementary Notes Project sponsored by the Texas Department of Transportation and the Federal Highway Administration. Project Title: Synthesis: Pavement Widening Best Practices URL: https://tti.tamu.edu/documents/0-7188-R1.pdf		

16. Abstract

Premature pavement failures have occurred on several widening projects, including shoulder widenings, conversion of two-lane roadways to Super 2 sections, and other safety enhancements. Repairing these early failures is time-consuming, expensive, disrupts traffic, and poses safety hazards. Key contributing factors include poor-quality materials, poor joint construction, and inadequate drainage. These issues could have been avoided through proper pavement condition assessment, design, and construction practices, but detailed guidance on which methods to employ and which can be project specific is not readily available to district personnel. Therefore, there is a need to document and implement better widening practices across TxDOT.

17. Key Words Pavement, Widening, Pavement Evaluation, Pavement Design, Construction		18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service Alexandria, Virginia https://www.ntis.gov	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 92	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

BEST PRACTICES FOR PAVEMENT WIDENING

by

Bryan Wilson, Ph.D., P.E.
Assoc. Research Scientist
TTI

Darlene Goehl, P.E.
Research Engineer
TTI

Tom Scullion, P.E.
Senior Research Engineer
TTI

and

Madeline Sellards
Student Assistant
TTI

Report 0-7188-R1
Project 0-7188
Project Title: Synthesis: Pavement Widening Best Practices

Sponsored by the
Texas Department of Transportation
and the
Federal Highway Administration

Published: February 2026

TEXAS A&M TRANSPORTATION INSTITUTE
College Station, Texas 77843-3135

DISCLAIMER

This research was sponsored by the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The engineer(researcher) in charge of the project was Bryan Wilson, P.E. #126948.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

ACKNOWLEDGMENTS

This project was sponsored by TxDOT and FHWA. The authors thank Katelyn Kasberg, Ruben Carrasco, Oscar Flores, Peyman Barghabany, Sangick Lee, Gisel Carrasco, Miles Pearson, Bryce Turentine, Charlie Reed, Vanessa Rosales-Herrera, Hui Wu, Dina Dewane, and Sergio Cantu.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

CHAPTER 1. BACKGROUND AND LITERATURE REVIEW

BACKGROUND

Pavement widening (Figure 1) is done to increase the capacity of the roadway and to improve roadway safety (e.g. adding shoulders, adding a travel or auxiliary lane, or expanding the existing lane or shoulder width) (*1*, *2*). While the approach to building a widened pavement is similar to new construction, widening presents additional challenges for pavement design, constructability, and pavement management. These challenges include:

- Building a uniform pavement structure, across the existing and new pavement, that has adequate pavement drainage and consistent material properties.
- Ensuring that both the new and existing pavement have adequate structural capacity to perform for the design life of the widening.
- Managing the practical constraints of construction and minimizing disruptions to traffic.
- Optimizing the long-term maintenance operations of the pavement as a whole.

Figure 1. Pavement Widening in Beaumont District.

When the improper or insufficient widening approach is taken, the consequences are often reflected throughout the entire project, and often directly in the traveling lane. The newly completed project can quickly turn into an expensive maintenance or rehabilitation issue.

In addition to technical challenges, implementing widening best practices is further complicated by the uncertain funding mechanisms for projects and the varied experience of the personnel designing and implementing the widening. Projects may be built by contractors through statewide letting, routine maintenance contracts, or in-house maintenance forces.
Both contractors and state forces may lack property training and equipment to perform the work.

Also, there is confusion whether Category 8 Highway Safety Improvement Program (CAT 8 HSIP) funding may be used for widening projects or not (*3*). As a result, some districts are driven toward short-term, low-cost solutions rather than widening designs that optimize life cycle costs of the entire pavement.

LITERATURE REVIEW

The team synthesized information from the existing literature on the following topics:

- Types of widening failures.
- Pre-design pavement evaluation.
- Long-term cost-effective pavement.
- Cross-section design.
- Pavement layer design, materials, and construction.
- Construction equipment.

This review focused on research reports, journal articles, agency specifications, and other repositories of industry expertise. While several publications are cited, a few were particularly relevant and influential to this literature review.

Burton et al., Flexible Pavement Narrow Widening Best Practices and Lessons Learned, 2013

In the mid-2010s, a research team at the Center for Transportation Research at the University of Texas at Austin, Burton et al., sought to identify best practices for pavement widening (*3*, *4*). Citing another study, the team notes that about 20 to 39 percent of highway mileage, with lanes less than 12 ft wide, have little to no shoulder (*5*). Several challenges to pavement widening included construction equipment constraints, material selection options, and construction methods. The team conducted a literature review, interviews with industry experts, and a webinar workshop to identify challenges and possible solutions. They developed a decision support tool to help in the design and management of widening projects.

Varin and Saarenketo, Road Widening Guidelines, 2012 and Tikkanen, Road Widening: Literature Review and Questionnaire Responses, 2010

In 2010, Tikkanen synthesized road widening practices in European countries (*6*, *7*). In a review of the literature, he documented several cross-sectional diagrams of how widenings are done in different countries. He also distributed a questionnaire asking pavement engineers how they would approach widenings in difficult scenarios. In a follow-up study, Varin and Saarenketo produced road widening guidelines. These addressed the types and causes of road widening failures, pre-design evaluation methods, and widening and repairing designs.

Hilbrich and Scullion, Design Considerations for Flexible Pavement Widening, 2007

In the mid-2000s, a study was conducted by Hilbrich and Scullion at the Texas A&M Transportation Institute (TTI) (*8*), which was spurred into existence by several Safety Bond Projects being let for the construction of widenings of roads less than 24 ft wide. The study scope was a literature review and a survey of the Texas Department of Transportation (TxDOT) districts. The focus of the survey was a series of hypothetical widening scenarios where the respondent would describe what types of testing and designs they would recommend given the condition of the pavement, drainage geometry, etc. The project result was widening guidance, including which field and laboratory tests to perform, soil stabilization criteria, embankment widening, joint construction, and more.

California Department of Transportation Highway Design Manual, Ch. 680: Pavement Design for Widening Projects

The 2020 *Highway Design Manual* includes a concise discussion of pavement widening best practices, with a focus on a holistic approach to optimizing life cycles costs of the entire pavement, not just the widened section (*2*).

WIDENING FAILURES AND MECHANISMS

Poor pavement widening practices may result in premature pavement failure, such as longitudinal cracking, fatigue cracking, rutting and depressions, and shoulder erosion. The mechanisms, or causes, of these failures are described in this section.

Dissimilar Pavement Layers

A common problem is the integration of dissimilar pavement layers between the existing and widened pavement structure. Variations in layer thickness, materials, and compaction quality contribute to issues like longitudinal cracking—a common distress in widened pavements (Figure 2). The distinct mechanical properties of adjacent layers result in differential movement under traffic and thermal loads, inducing tensile stresses that lead to the development of cracks over time.

Figure 2. Longitudinal Crack in a Widened Pavement.

Moreover, dissimilar pavement layers can exacerbate moisture-related problems by restricting lateral subsurface drainage. In the TxDOT Pavement Manual, this is known as the "bathtub" effect (Figure 3) (*1*). Differences in porosity between adjacent layers, whether due to the material type or level of compaction, increase the risks of moisture being trapped within the pavement structure. Trapped moisture in the base and subgrade can compromise the load-bearing capacity, and moisture in asphalt layers can cause stripping. Pavements in cold regions with trapped moisture are further susceptible to freeze-thaw, frost-heave, and spring-thaw damage.

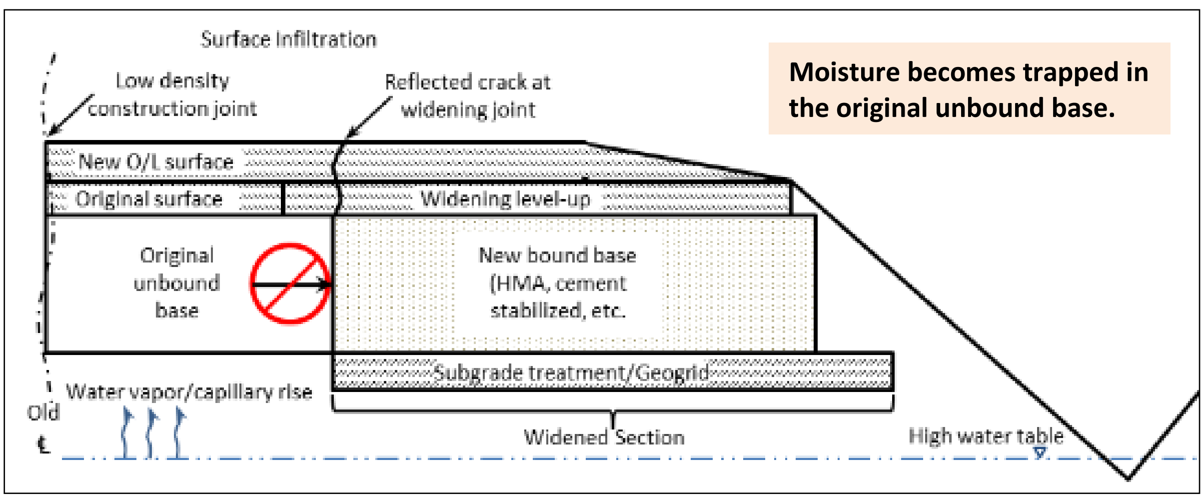

Figure 3. Trapped Moisture Resulting in the "Bathtub" Effect (1).

Longitudinal Joint Quality and Location

Even with appropriate selection of pavement layer materials and thicknesses, the quality and location of the longitudinal joints (the interface between the existing and new pavement) will influence the pavement performance. On the surface, poorly constructed joints have high porosity that traps moisture and tends to crack and deteriorate prematurely. But even joints between the existing and new subsurface layers can reflect up through the surface, as shown in Figure 4. An example of a poor joint placement of a thick-layer asphalt widening is shown in Figure 5.

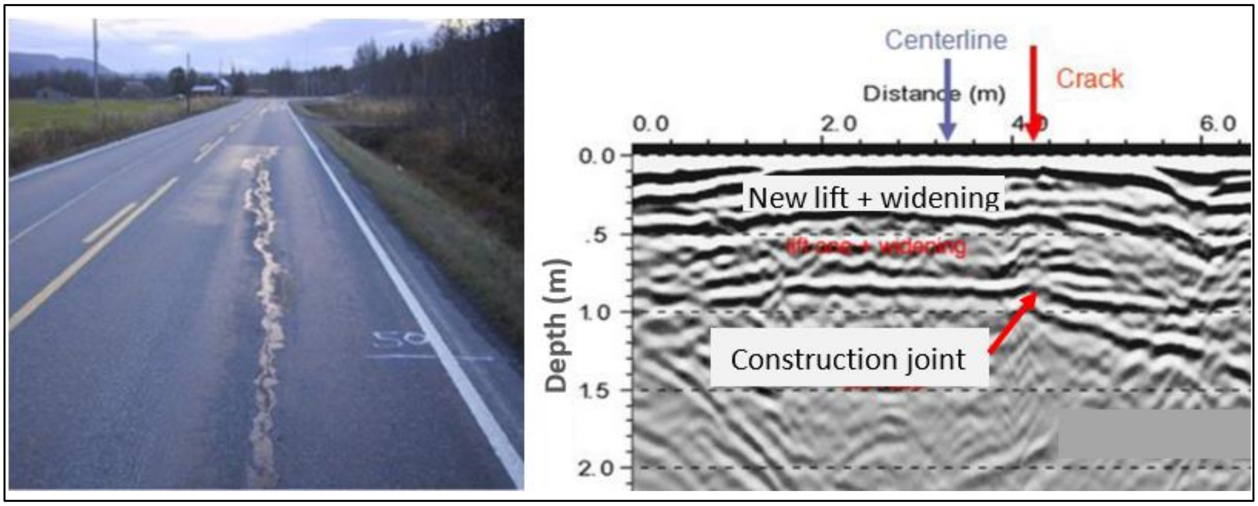

Figure 4. Reflection Cracking from a Subsurface Longitudinal Joint (*6*).

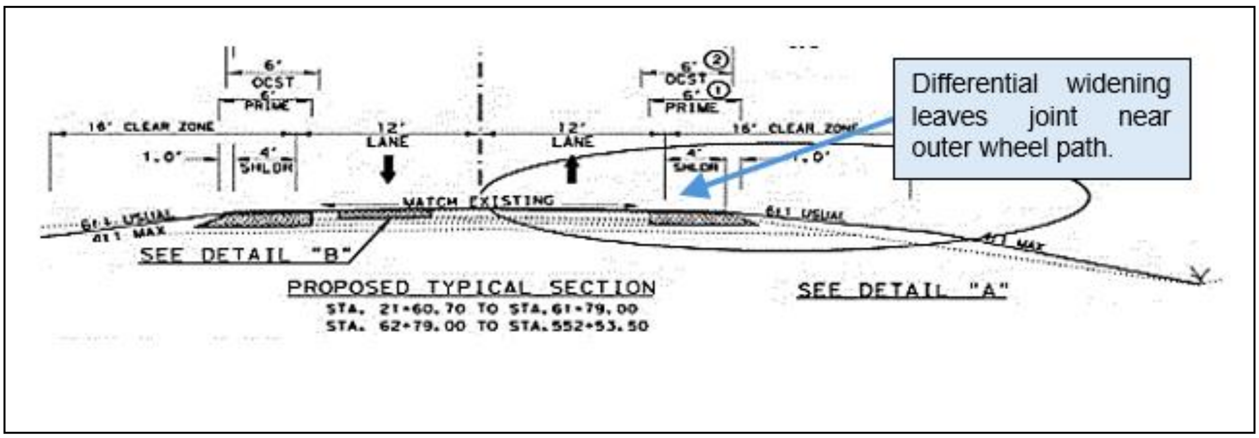

Figure 5. Typical Section with Problematic Joint Location.

Traffic stresses can dramatically accelerate pavement deterioration if the construction joint is in the wheel path. A 2015 report for Florida Department of Transportation focused on the importance of proper joint construction for widening projects, among other topics (*9*). The researchers did a survey of state departments of transportation (DOTs) and national pavement organizations to determine the state of the practice. Longitudinal crack formation and reflective cracking were the two most common widening distresses.

Inadequate Structural Support

The quality of the materials used in widening must be adequate to support traffic loads. However, widening projects are sometimes given less attention and resources, and the quality of the layers, especially before the surface, may be neglected.

Permanent deformation in the base or subgrade layer will cause wheel path rutting and possibly fatigue cracking. The following project in Texas is an example of failure in the outside wheel path due to poor subgrade support. The wheel path was cracking and potholing shortly after construction, and the DOT has had to place an emergency patch multiple times (Figure 6). Falling weight data were taken in the shoulder and in the old lane, in alternating fashion throughout the project. The data clearly show just how much weaker the outside wheel path and shoulder were (Figure 7). The issue could have been avoided by stabilizing the subgrade, but the engineer failed to sample and test the subgrade beforehand.

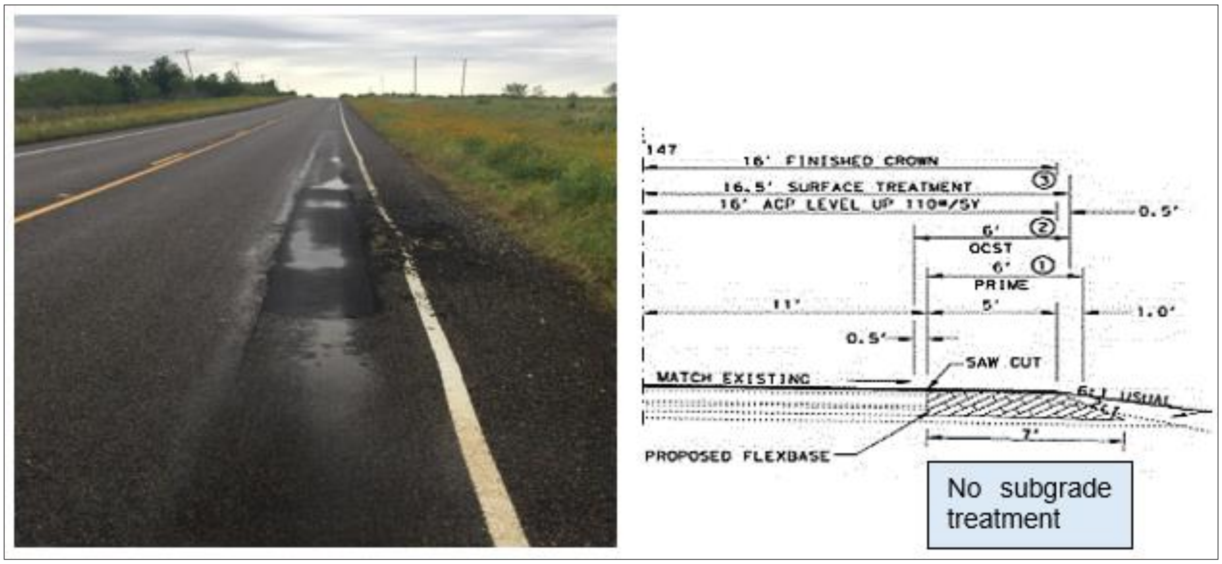

Figure 6. Widening Failure and Typical Section.

Figure 7. Deflection Data in Lane versus Shoulder and Outside Wheel Path.

If the thickness of the surface layer is inadequate, the layer may fatigue. Also, stress concentrations in the base and subgrade will be higher than anticipated and may cause permanent deformation. Inadequate layer thickness may occur if the design layer is tapered or if thickness is not carefully monitored during construction. One example of a failure due to inadequate pavement support was a Super 2 project in Texas (US 83 in the San Angelo District). The project had several instances of fatigue cracking and permanent deformation along the inside wheel path (Figure 8). The designers planned on reusing the existing shoulder as part of the new lane. They had assumed the shoulder had the same pavement structure as the main lanes, but it was actually much weaker and not capable of carrying live traffic (Figure 9). The issue may have been avoided by testing the pavement condition of the existing shoulder during the design stage.

Figure 8. Failure of US 83 on Inside Lane.

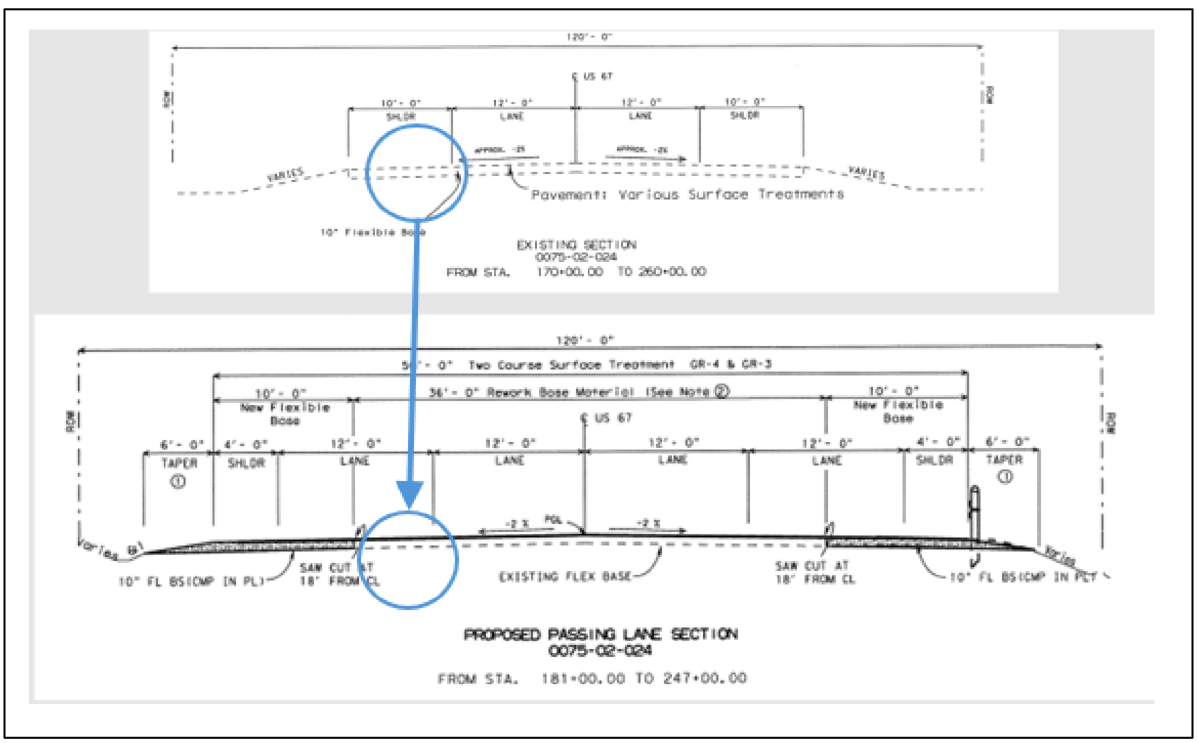

Figure 9. Existing and Proposed Typicals of US 83, Reusing Shoulder for Live Traffic.

Differential Settlement

Some amount of pavement settlement after construction occurs naturally and often uniformly. But in a widening project, the new pavement may settle next to the existing pavement. This can cause permanent deformation and roughness issues. Varin and Saarenketo cite this as a particular problem over peat soils in Norway (see Figure 10) (*6*). Peat soils in the United States are most common in the northern mid-west. Texas, on the other hand, has substantial clayey soils, which can shrink and swell with wetting and drying cycles.

Figure 10. Settlement of a Widened Road Shoulder over Peat Soil in Norway (*6*).

Stability and Drainage

Widening can result in steeper side slopes, which can be less stable if not designed correctly. Backfill material can erode and collect at the bottom of the ditch. The piling material then causes poor drainage, which can create problems for the pavement itself. Figure 11 shows a widening in Norway that has excessive edge deformation and standing water. The backfill was inadequately compacted, which is how the erosion started.

Figure 11. Edge and Drainage Failure (*6*).

PRE-DESIGN PAVEMENT EVALUATION

Before determining a widening strategy, the pavement engineer should perform a pre-design evaluation of the pavement structure, pavement condition, and subgrade. The evaluation will inform key aspects of the widening strategy, such as:

- Decide if the existing lanes and shoulders are structurally sufficient.
- Verify the layer materials and thicknesses to match.
- Decide where to cut existing edges to form the construction joint.
- Determine the bearing capacity of the subgrade and whether stabilization is required.
- Identify existing and potential drainage issues.

The TxDOT *Pavement Manual* states that a falling weight deflectometer (FWD) survey is essential if the existing shoulder will carry traffic after the widening. The manual also emphasizes the benefit of a ground penetrating radar (GPR) survey to compare lane and shoulder pavement structures (*1*).

Hilbrich and Scullion recommended specific evaluations based on the pavement type and condition, as shown in Table 1 (*8*). Construction records should always be reviewed. In the field, they recommend taking soil borings, performing an FWD survey, and measuring subgrade strength with a dynamic cone penetrometer. When the pavement condition is poor, pavement cores and a GPR survey are recommended. In the lab, they recommend measuring several base and subgrade material properties and, as needed, performing stabilization designs.

On every widening project, the California Department of Transportation (Caltrans) recommends reviewing as-built records of the existing pavement structure, including materials, mix designs, and layer thicknesses, in addition to reviewing the current pavement condition survey data (*2*). At times, especially if the pavement is not in good condition, an FWD survey is recommended. The layer deflections and moduli from the FWD analysis can be helpful for pavement design and to identify locations to sample the subgrade for further laboratory testing.

Varin and Saarenketo promote the use of modern non-destructive pavement evaluation equipment in the pre-design phase (*6*). The goal of the evaluations is to determine the cause of existing pavement failures so the issue can be corrected in the new widened pavement. At a minimum, they recommend a GPR survey, material sampling, video recording and distress analysis, laser scan, and drainage analysis. The GPR survey should include both longitudinal and cross-section scans, both within the existing pavement and near the widening edge. The GPR survey can identify locations to sample materials for further lab testing. Material characterization of the existing road materials and subgrade is essential. A mobile laser scanner (LiDAR) can measure pavement and roadside geometry (e.g., pavement width, cross slope, ditch dimensions). They also discuss FWD surveys and a roughness and rut depth survey with a profilometer.

Table 1. Pre-Design Evaluation Recommendations (*8*).

Evaluation Description	Information Needed	Minimum Testing Recommendations (MTR): Flexible Pavement Good Condition	MTR: Flexible Pavement Poor Condition	MTR: Jointed Concrete Pavement
Preliminary review of construction records	Existing material properties, mix designs, and layer thicknesses	X	X	X
Field: **Soil borings**	Soil properties and subgrade moduli. Also provides samples for laboratory testing.	X	X	X
Pavement cores	Verify material properties and thicknesses.	X	X	
FWD survey	Layer moduli (for flexible pavement design)	X	X	X
GPR survey	Detection of moisture in base and layer thicknesses		X	
Dynamic cone penetrometer	Determination of subgrade strength	X	X	X
Laboratory: **Base Materials**				
Engineering properties	Optimum moisture and density	X	X	X
Sieve analysis	Gradation		X	X
Modified triaxial	Triaxial classification		X	
Capillary rise/tube suction	Indication of moisture susceptibility		X	
Stabilization design (if any)	Optimum stabilizer content		X	X
Laboratory: **Subgrade Materials**				
Engineering properties	Optimum moisture, density, and Atterberg limits	X	X	X
Sulfate testing	Sulfate content	X	X	X
Organics testing	Organic content	X	X	X
Stabilization design (if any)	Optimum stabilizer content	X	X	X

LONG TERM COST-EFFECTIVE PAVEMENT

The Caltrans *Highway Design Manual* provides a few items to consider before starting the widening design (*2*). The final widened pavement should be an overall cost-effective structure for the rest of the design life. This means that the engineer should evaluate the life-cycle cost of both the existing and new pavement and consider how and when each part of the pavement will need maintenance.

It is strongly encouraged to perform rehabilitative or preventative work on the existing pavement in conjunction with the new widening construction. Examples of activities are improving the ride quality with mill and overlay, performing structural full-depth repairs, concrete surface grinding, or simply applying crack seal. This will extend the service life of the existing pavement while reducing future design work, workforce mobilization, and traffic delays. Also, doing rehabilitation or prevention up front can bring the entire pavement to the same maintenance schedule, which helps minimize maintenance costs and associated traffic delays throughout the service life of the pavement.

Along a similar vein, the TxDOT *Pavement Manual* states "reworking/widening of the pavement section full-width, yielding an upgraded, uniform, full-width section can often be obtained for a nominal additional cost…Consideration of this technique may be most appropriate for narrower or shoulder widening jobs" (*1*). During a pavement widening workshop, TxDOT districts reported that full-depth reclamation was only 15 to 22 percent more expensive than a two-sided narrow widening, but resulted in a superior pavement with better long-term performance (*3*).

CROSS-SECTION DESIGN

In most cases, the ideal design for a widened pavement is to maintain the cross section and materials of the existing pavement (*1*, *2*, *4*, *6*, *8*). As stated in the TxDOT *Pavement Design Manual*, "this serves two purposes:

- It maintains uniformity in the section which facilitates future evaluation and rehabilitation options for the section as a whole; and
- It maintains subsurface drainage patterns which are essential to preventing trapped moisture (*1*).

Exceptions to this philosophy are generally related to poor performance in the existing section or the desire to expedite construction of the widened section."

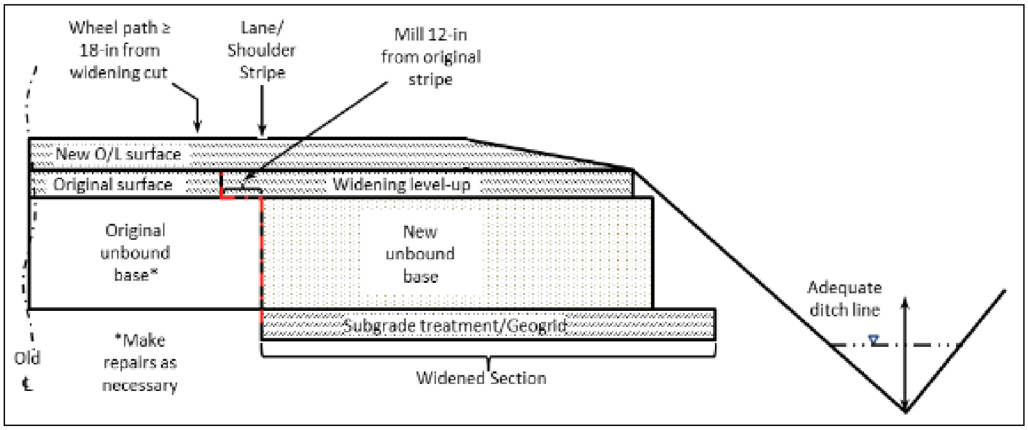

Figure 12. Maintain Existing Cross Section throughout Widening (*1*).

The rest of this section discusses cross-section design principals for narrow widenings, curve widenings, joint placement, and ditches. Specific considerations for the design, materials, and construction of each pavement layer type are presented in a later section.

Narrow Widening

The pavement engineer must decide whether to widen one or both sides of the roadway. If the proposed widening is very narrow, it may be more practical and less expensive to widen on one side. This better accommodates construction equipment and improves the ability to adequately stabilize and compact the pavement layers. However, this approach often moves traffic to drive over a sub-optimal pavement structure like an existing shoulder. In contrast, widening both sides, if only increasing shoulder widths, will keep traffic in the center of the existing pavement and any widening-related cracks will form in the new shoulder (Figure 13) (*6*).

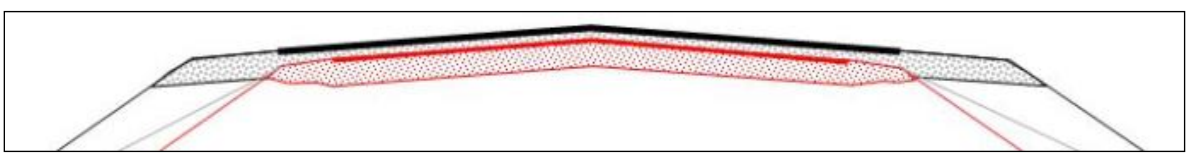

Figure 13. Shoulder Widening on Both Sides Minimizes Premature Cracking in the Travel Lane (*6*).

Joint Placement

Agencies employ a variety of strategies to minimize widening joint distresses. Figure 14 illustrates three joint shapes, which are benched (or stepped), vertical, and angled. Benching, or stepped joints, is the progressive offset of every layer. In the United Kingdom, each layer is offset by at least 150 mm (6 inches). Montana also notches the hot mix asphalt (HMA), base, and subgrade layers. Texas, and several other state agencies, will offset the HMA layers from the deeper layers, but the base and subgrade will be in the same vertical cut joint. Many Nordic countries recommend a tapered cut instead, with angle recommendations between 45 to 80 degrees.

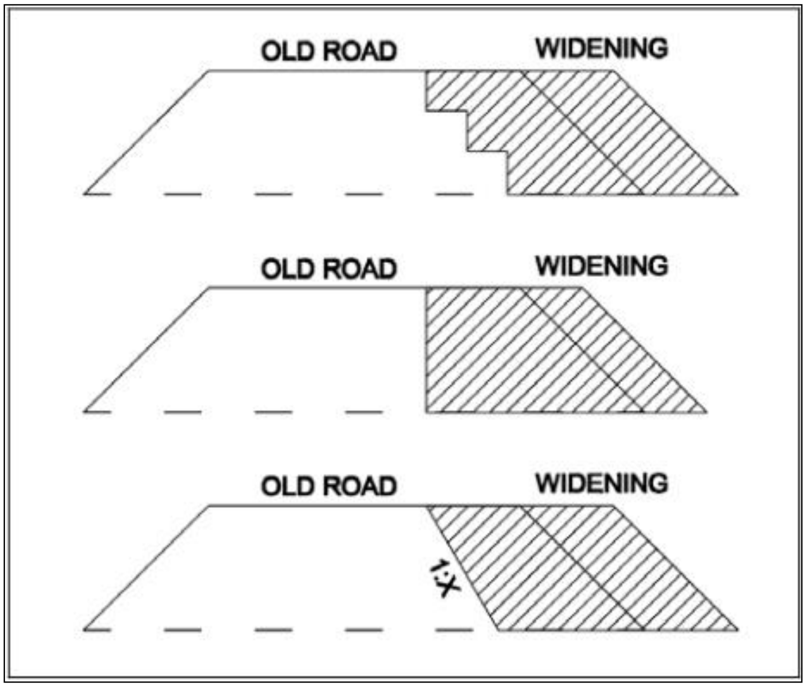

Figure 14. Types of Construction Joints: Benching (Stepped), Vertical, and Angled (*6*).

DITCHES

Road widening will necessitate cutting a new drainage ditch. Ensure that new ditches are adequately designed and cut to keep surface water below the pavement structure. Varin and Saarenketo (*6*) state that the bottom of the drainage system should be at least 25 to 30 cm (approximately 10 to 12 inches) below the road structure (Figure 15). By comparison, TxDOT requires a ditch depth of at least 6 inches from the top of the subgrade (*10*, *11*). A proper ditch slope will ensure safety and minimize erosion. When widening in a confined right-of-way, the ditch slope may need to be steeper because the ditch cannot be moved. In this case, the slope should be reinforced and roadside safety devices, like guardrails, may need to be installed.

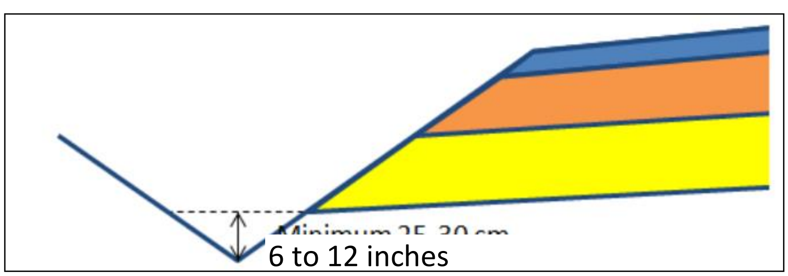

Figure 15. Adequate Drainage below Pavement Structure (*6*, *10*).

Other constraints with ditch placement or poorly draining subgrade might warrant more technical drainage solutions (Figure 16). Edge drains, consisting of perforated pipe, geotextile, and drainable fill material, were the focus of several studies (Birgisson and Roberson (*12*), Hilbrich and Scullion (*8*), and Fleckenstein and Allen (*13*)). One study reported that subgrade moisture in the shoulder was lower in pavements with installed edge drains, and that these pavements had better long-term ride quality (*13*).

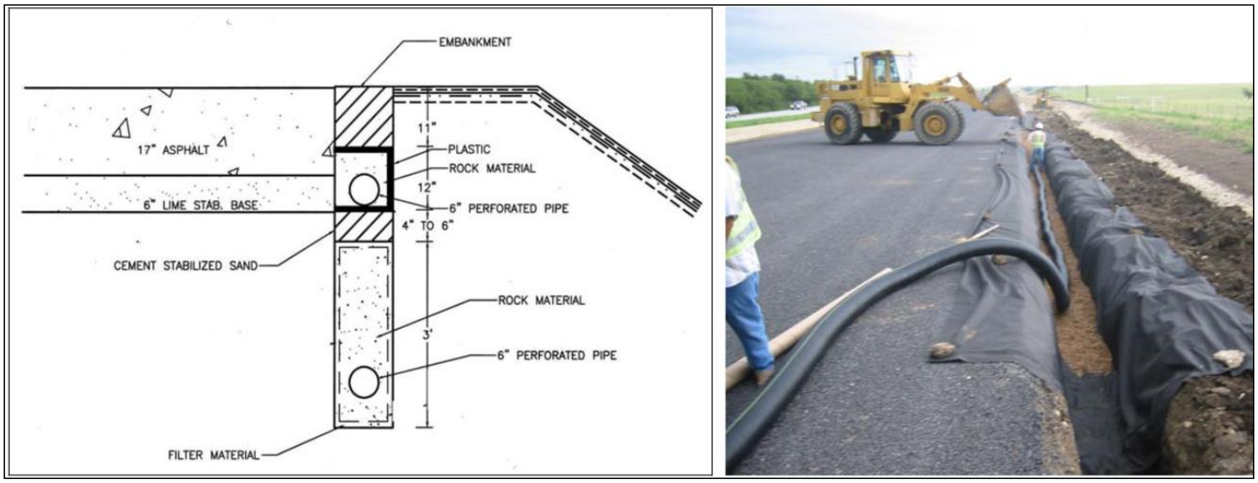

Figure 16. Edge Drain Configuration.

PAVEMENT LAYER DESIGN, MATERIALS, AND CONSTRUCTION

General best practices for pavements (including layer design, material selection, and construction methods) also apply to pavement widening structures. Valuable resources on these topics are available from TxDOT, the Federal Highway Administration, and trade associations. This section, however, focuses on unique considerations for pavement widening projects. The discussion is organized by pavement layer: subgrade, base, HMA, and concrete.

Subgrade

As needed, stabilize the subgrade under the widening, below the level of the existing base layer. Stabilization will reduce the effect of shrinking and swelling and reduce longitudinal edge cracking. Alternatively, use a geogrid between the subgrade and the base.

The details of designing and constructing stabilized subgrade is outside the scope of this study but is provided in the TxDOT *Pavement Manual* and in "Treatment Guidelines for Soils and Base in Pavement Structures" (*1*, *14*).

Widening the pavement over a compressive soil can lead to differential settlement between the new and existing pavement. One cost-effective method to manage this issue is preloading the subgrade. The process is described by Varin and Saarenketo, who have experience evaluating pavements placed over peat soils, common in northern Europe (*6*). First, the new drainage ditch is installed, and the old ditch filled with the borrow. Over 6 inches of the existing soil is removed, and a geotextile is placed on the exposed surface. The preload material is added in stages until the designed height and left for about 90 days. Settlement plates are used to monitor the progress of settlement. Excess preload is then removed, and the widened pavement constructed. If it can be accommodated, delay placement of the final riding surface while structure continues to settle under traffic driving on an intermediate or temporary layer.

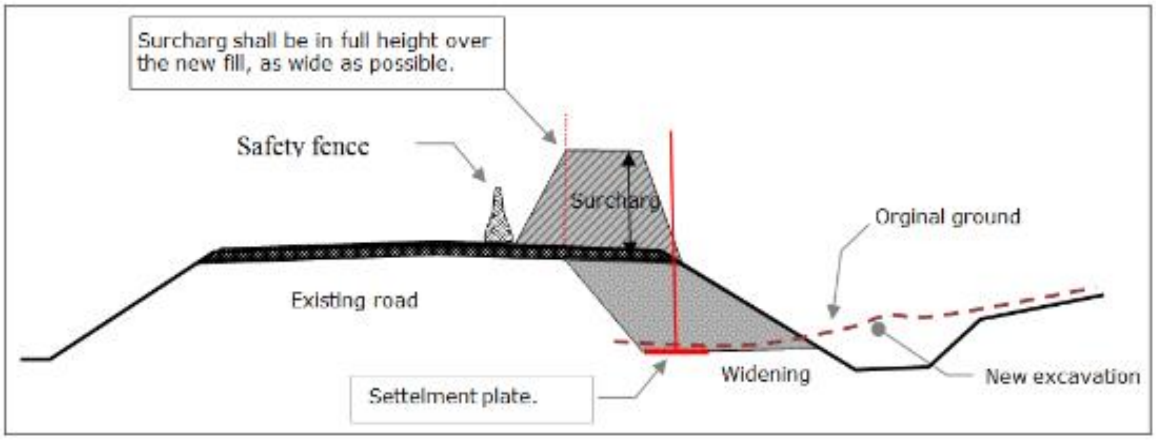

Figure 17. Pre-Loading in Pavement Widening in Norway, Iceland, and Finland (*7*).

Base Layer

For pavements with unbound granular base, TxDOT recommends:

- As reasonably as possible, match the moisture susceptibility of the new base material with the existing. If the new material is less susceptible, moisture can migrate into the old base. If it is more susceptible, moisture can accumulate in the new base (*1*).

For pavements with stabilized base:

- It is still recommended to try and match the existing stabilized layer materials and thickness (*1*).
- In some circumstances, the widening construction may be expedited by using full-depth HMA in lieu of a stabilized base. This should only be done if the existing stabilized base is not moisture susceptible, as confirmed by laboratory testing.

The moisture susceptibility of unbound base is determined by fines content and the plastic indices. There is no standardized TxDOT moisture susceptibility test for stabilized materials, but several methods have been proposed (e.g., tube suction test, compressive strength after 24-hr soak or vacuum saturation, and freeze-thaw test (*15–17*)).

When rehabilitation of the existing roadway coincides with a pavement widening, there is an added opportunity to homogenize the base across the pavement structure. With in-place reclamation, after the existing asphalt and/or base are milled and pulverized, the material should be spread uniformly across the existing section and the widening. Then, new granular base or stabilizer can be applied to both sections at the same time. Poor quality subgrade should never be incorporated into the new base.

Details for best practices for base layers is also provided in the TxDOT *Pavement Manual* and in "Treatment Guidelines for Soils and Base in Pavement Structures" (*1*, *14*).

As reported in a Florida study (*9*), Arkansas and Maryland DOT recommend using concrete base for narrow widenings, 4 ft or less. Arkansas DOT further qualifies this application for curb and gutter sections. Research conducted by Deschamps et al. at Purdue University in 1999 found that a widening failure was a result of sub-standard compaction of fill and inadequate benching (*18*). They concluded that the failures would not have occurred if proper attention were given to the existing specifications.

Asphalt Pavement

Every source in the literature review recommends offsetting the construction joint of the asphalt surface from the base widening joint. The amount of offset varies by agency but should be no less than 6 inches. TxDOT recommends an offset of 12 inches (*1*). Achieving the offset requires additional milling of the HMA beyond the widening interface.

In the widening, apply an intermediate level-up HMA layer to match the existing HMA layer. Then apply an overlay across the full section. Final longitudinal mat joints should be placed at the lane stripes.

According to Caltrans (*2*), if the existing pavement is in good condition, has at least 90 percent of the traffic load capacity in equivalent single axle load (ESALs), and the widening is 9 ft or less, the existing pavement can be reincorporated into the widened pavement. Otherwise, it is preferable to remove existing pavement and construct new lanes to new construction standards. Figure 18 shows the widening cross section that Caltrans recommends when the existing HMA is in good condition. It does not recommend widening HMA pavements with concrete unless the concrete will be placed across all truck permitted lanes or funding is in place to replace existing lanes with concrete within 10 years. Also, the pavement material type must be consistent within a given travel lane. For example, lanes should not be half asphalt and half concrete because they will wear at different rates.

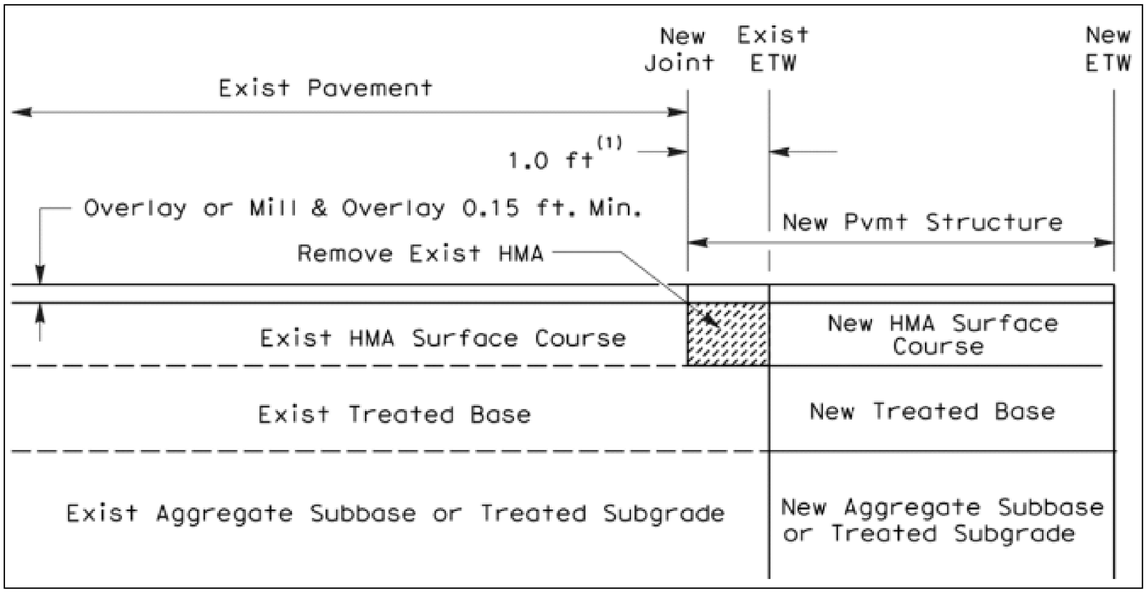

Figure 18. Widening Asphalt Pavement (*2*).

Table 2. Treatment of Existing HMA in Widening by Caltrans.

Existing HMA Condition	Action
Good	Overlay existing HMA for final surface coarse.
Marginal **(oxidation, raveling, minor cracking)**	Mill 0.15 ft of existing HMA and overlay.
Poor	Rehabilitate existing HMA at least adjacent to widening.

Based on a review of other state practices (*9*), Maryland DOT requires that tack coat be applied to vertical saw cuts when placing the new HMA layers. The practice in Virginia is to mill the adjacent travel lane to a minimum depth of 1.5 inches and replace to match the widening.

Concrete Pavement

Hilbrich and Scullion state that, when widening jointed concrete pavement (JCP), it is not necessary to match the full cross section (*8*). Attention should still be given to the moisture susceptibility of the base material, however. JCP widenings are often performed with full depth HMA or cement-treated base (Figure 19). Proper methods for tying adjacent slabs should be implemented.

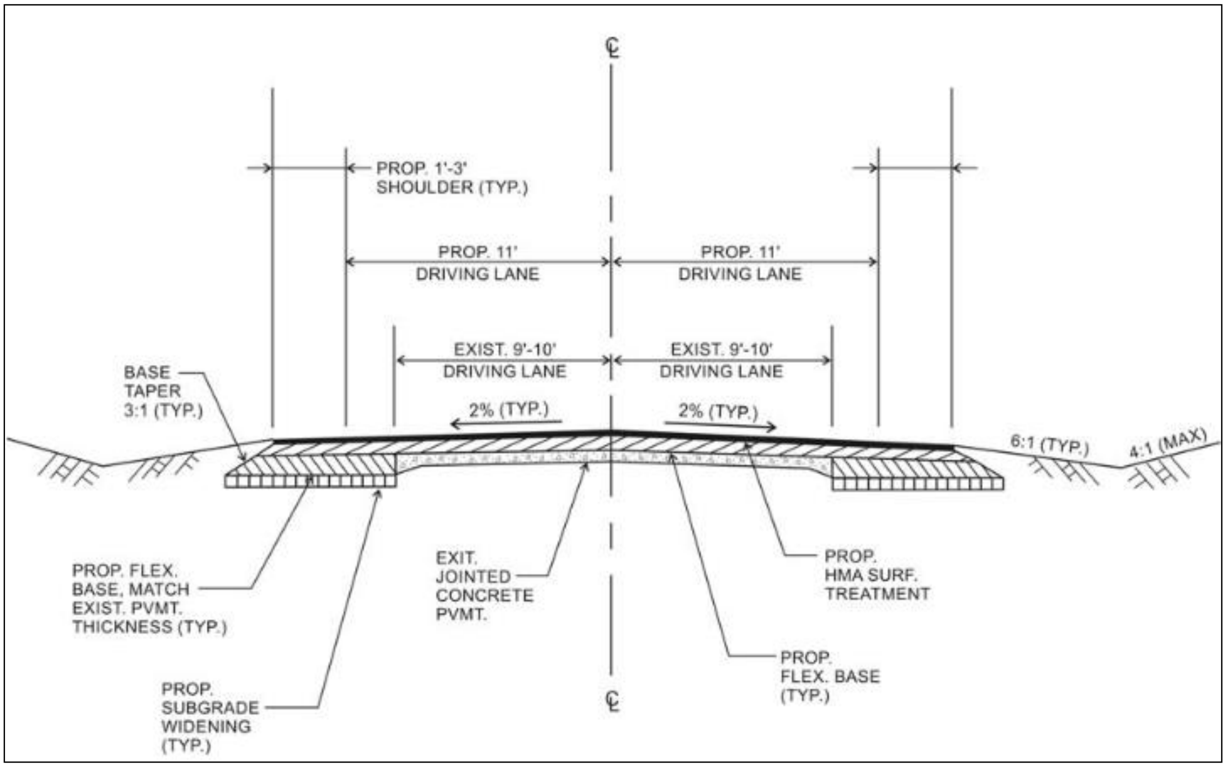

Figure 19. Typical Section for Widening Jointed Concrete Pavements.

Caltrans requires placing the longitudinal widening joint for concrete pavement at the lane lines in most cases (*2*). In certain cases, with truck lanes adjacent to auxiliary lanes, the joint should be located 0.5 ft outside the lane. Slabs should not be less than 8 ft wide in truck permitted lanes or joints within 2 ft of the wheel paths.

CONSTRUCTION EQUIPMENT

Standard paving equipment can be used for widening projects with added lanes or wide shoulders; however, narrow widening projects present a particular challenge. The information in this section is provided only to show that narrow equipment is available and is not meant as an endorsement of these manufacturers. Some contractors, however, are unlikely to invest in specialized equipment when there is no guarantee that they can recoup the cost long-term (*3*). At the beginning of a widening project, the contractor should demonstrate to TxDOT that their methods and equipment are adequate to complete the project, and to establish the paving speed (generally limited to 1 mile).

As reported by Hilbrich and Scullion (*8*), narrow widening projects often include a general note indicating that the joint line is saw cut. However, in practice, based on interviews, this can mean use of a milling machine, use of a motor grader with a coulter blade (an agricultural implement), or a grader with a widening attachment. In a workshop by Virginia Transportation Research Center, one discussion point mentioned that milling machines do a good job providing a uniform trench and can maneuver around drives and intersections (*3*). Some full-scale milling machines offer variable cutter widths as narrow as 2 ft. Alternatively, the Wirtgen W 100 Fi (Figure 20) is an example of a compact milling machine, which is designed similar to a full-scale machine. Alternatively, the Asphalt Zipper and Road Hog are milling and reclaiming attachments for skid steers, loaders, or backhoes. These devices do not include a material transfer conveyor.

Wirtgen W 100 Fi	Asphalt Zipper 960 Xi	RoadHog Cold Planer for Wheel Loader
44,000 lbs.	14,000 lbs.	10,600 – 14,000 lbs.
39-inch cut	96-inch cut	48 – 96-inch cut

Figure 20. Compact Cold Planer Machines.

Adding granular backfill or HMA to the pavement edge can be a challenge, especially if the pavement edge is steep. A roadway widener (Figure 21) operates on the existing pavement and delivers material from its hopper, laterally, onto the roadway edge. A strike-off gate is positioned to catch and shape the material to the desired width, thickness, and cross slope. One device shown here is a self-propelled unit, and the other is an attachment for a skid steer or loader. Wideners can have a dual discharge feature to widen both sides of the road simultaneously. The models shown here are sized with narrow widening in mind, but larger models can theoretically also apply 1–14 ft of material width. It is important to choose the appropriately sized equipment for the job. A contractor in San Antonio tried laying asphalt with a smaller Weiler machine, but the strike-off tool broke and the job was unsuccessful (*4*).

CAT Weiler W330B	Road Widener FH
14,800 lbs.	2,900 lbs.
1 to 6 ft application width	1 to 4 ft application width

Figure 21. Roadway Wideners (https://www.weilerproducts.com/, https://www.roadwidenerllc.com/).

From a survey by Hilbrich and Scullion, there was a common complaint among TxDOT districts about obtaining the required density in narrow shoulder widening (*8*). A typical roller is oversized for some applications. Examples of appropriately sized compactors are shown in Figure 22. The fourth device is an attachment for a skid steer and compliments the road widener device. For comparison, typical full-size roller compactors have drums that are 65 to 85 inches wide and weigh around 25,000 to 50,000 lb. for soil and 20,000 to 30,000 lb. for asphalt. Even when rollers are appropriately sized, density requirements can still be difficult to meet because of the lighter weight of the equipment. Based on discussions with maintenance supervisors and pavement contractors, this can be overcome by placing multiple thinner lifts. Another work-around is to cut deeper into the existing pavement to accommodate standard equipment.

HAMM HC 50i P (Soil)	CAT CS34 (Soil)	Volvo DD25B (Asphalt)	Road Widener Offset Vibe Roller Attachment
12,000 lbs.	9,800 lbs.	5,500 lbs.	570 to 800 lbs.
54 in. drum	50 in. drum	39 in. drum	24 to 48 in. drum

Figure 22. Example of Compactors for Narrow Widenings (https://www.wirtgen-group.com/, https://www.cat.com/, https://www.volvoce.com/).

Also, in speaking with maintenance supervisors from several districts, it was found that in some cases when the widening addition is around 2 ft, the rear tandem of a fully loaded 6-ton dump truck will be used to achieve required densities and will follow behind the motor grader (*4*).

PAVEMENT WIDENING DECISION SUPPORT TOOL

A deliverable of the 2013 TxDOT pavement widening project (*4*) was a decision support tool. The tool was intended to assist district personnel to review design constraints, materials compatibility, constructability, and long-term performance of widening projects. The tool inputs addressed the following topics:

- Reason/goals of the project.
- Right-of-way needs.
- Project priority (stake holders).
- Performance problems.
- Construction problems.
- Equipment.

The output from the tool is a list of treatment options that might result in constructability or future maintenance problems, and those treatments that are expected to provide good long-term performance. After demonstrating the tool to the project panel, the participants suggested the tool was too detail-intense for some people to use and agreed that connecting the tool with other databases could be helpful. The research team does not expect that this tool was ever implemented.

LITERATURE REVIEW SUMMARY

Pavement widening serves as a crucial strategy for enhancing roadway capacity and safety. Successful pavement widening projects should achieve a uniform pavement structure across existing and new sections with proper drainage and consistent material properties, ensure adequate structural capacity, manage construction constraints, minimize traffic disruptions, and optimize long-term maintenance operations. The ramifications of an improper or insufficient widening approach can affect the entire project, often manifesting directly in the traveling lane and leading to costly maintenance or rehabilitation issues.

The literature review has provided insights into the technical challenges and considerations associated with pavement widening. This report covered key aspects such as widening failures, pre-design pavement evaluation, cross-section design, pavement layer materials and construction methods, equipment, and other critical elements. This synthesized information serves as a valuable resource for understanding and addressing successful pavement widening projects.

CHAPTER 2. SURVEY OF BEST PRACTICES

SURVEY METHODOLOGY

The research team developed a survey on various pavement widening topics, building off their findings from the literature review and feedback from the TxDOT research panel. The survey addressed the following topics:

- Project types and funding,
- Pre-design,
- Pavement layer design,
- Widening cut and longitudinal joints,
- Narrow widenings,
- Roadside drainage and utilities,
- Treatment of existing pavement,
- Widening distresses, and
- Overall rating of widening challenges.

The questionnaire was implemented in the online survey platform Qualtrics. An exported version of the questionnaire is in Appendix A.

During February 2024, the survey was distributed to all 25 TxDOT districts. The invitation was sent to the directors of construction and directors transportation planning and development, with the instruction to coordinate together and with other sections (e.g. maintenance and materials) to complete one survey response per district. At the state level, the survey was sent to the construction (CST), maintenance, and design (DES) divisions.

As illustrated in Figure 23, 22 TxDOT districts and two state-level divisions responded to the survey.

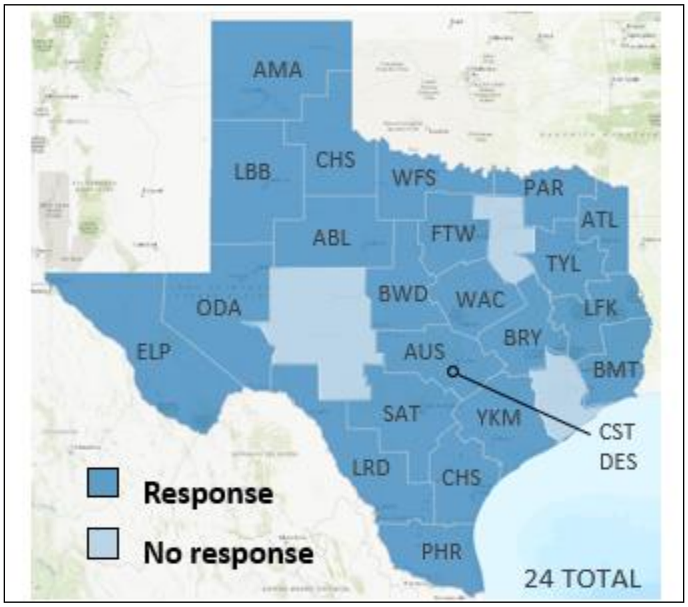

Figure 23. Surveyed Districts and Divisions.

PROJECT TYPES AND FUNDING

As shown in Figure 24, over 70 percent of districts reported that narrow widening (≤ 6 ft), adding shoulders, and adding lane projects were common or somewhat common projects, with one to more than three projects a year. Curve realignments were rarest, with almost 80 percent stating these projects occurred once every two years or longer.

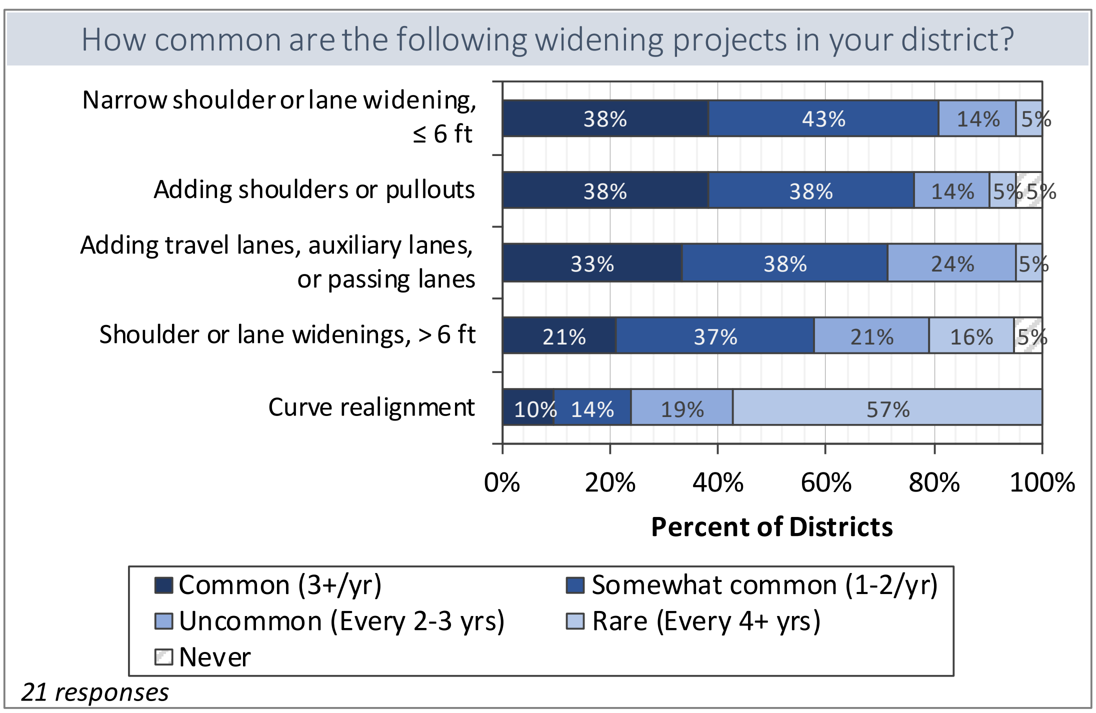

Figure 24. Types of Widening Projects.

A variety of funding sources for widening projects are used by all the districts. No district uses just one source. Most funding is provided through Category (CAT) 1—Preventative Maintenance and Rehabilitation and CAT 8—Safety funds, used by at least 90 percent of districts (see Figure 25). About 70 percent of districts perform widenings with in-house maintenance forces, which can present challenges with access to the appropriate equipment and a trained workforce. Thirty percent of districts use routine maintenance contracts and other CAT funds.

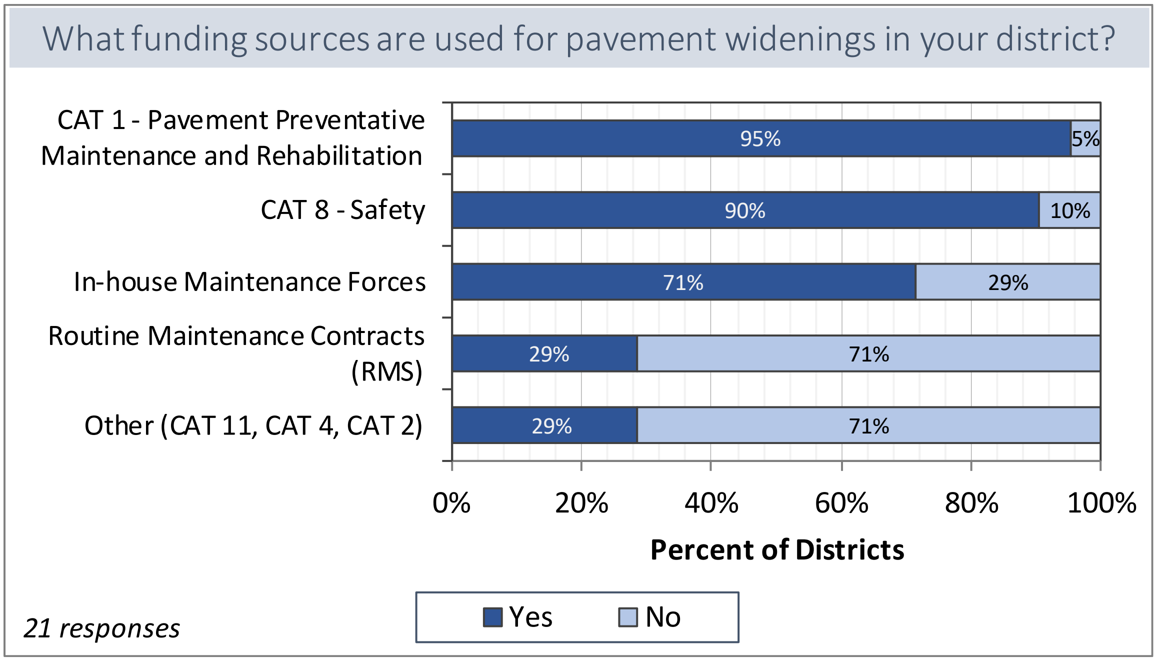

Figure 25. Widening Funding Sources.

The districts mentioned several issues that funding and funding categories present:

- Limited funding, in general:
  - Maintenance funds are insufficient to accommodate the whole roadway. Projects are broken out into multiple years.
  - Cannot pay to rehabilitate the roadway, which leads to joint issues.
  - Pavement repair is a significant cost on systematic widening projects and may get neglected.
  - Widenings may require specialized equipment and materials.
- CAT 1 funding:
  - Not used to add capacity or passing lanes.
- CAT 8 funding:
  - Many narrow FM roads have insufficient traffic to qualify.
  - Cannot be used to buy right-of-way, making it difficult to meet design criteria.
  - Fixed funds did not adjust for inflation.
  - Slower speed of letting.

The Childress, Odessa, Paris, and Tyler districts each expressed that funding has not been a problem lately. The Yokum district said that the recent addition of a district safety funding category (CAT 11SF) has helped get widenings funded in a timely manner.

PRE-DESIGN

The districts were asked about which pre-design pavement evaluations are employed when widening pavements in either good condition or marginal condition. From Figure 26, nearly every district will review as-built plans and perform a visual inspection. Most will review pavement management data and drill/sample existing materials. About half will run soil characterization tests, soil sulphate tests, and a roughness/rutting analysis. About a third will even do a GPR survey on the good pavement.

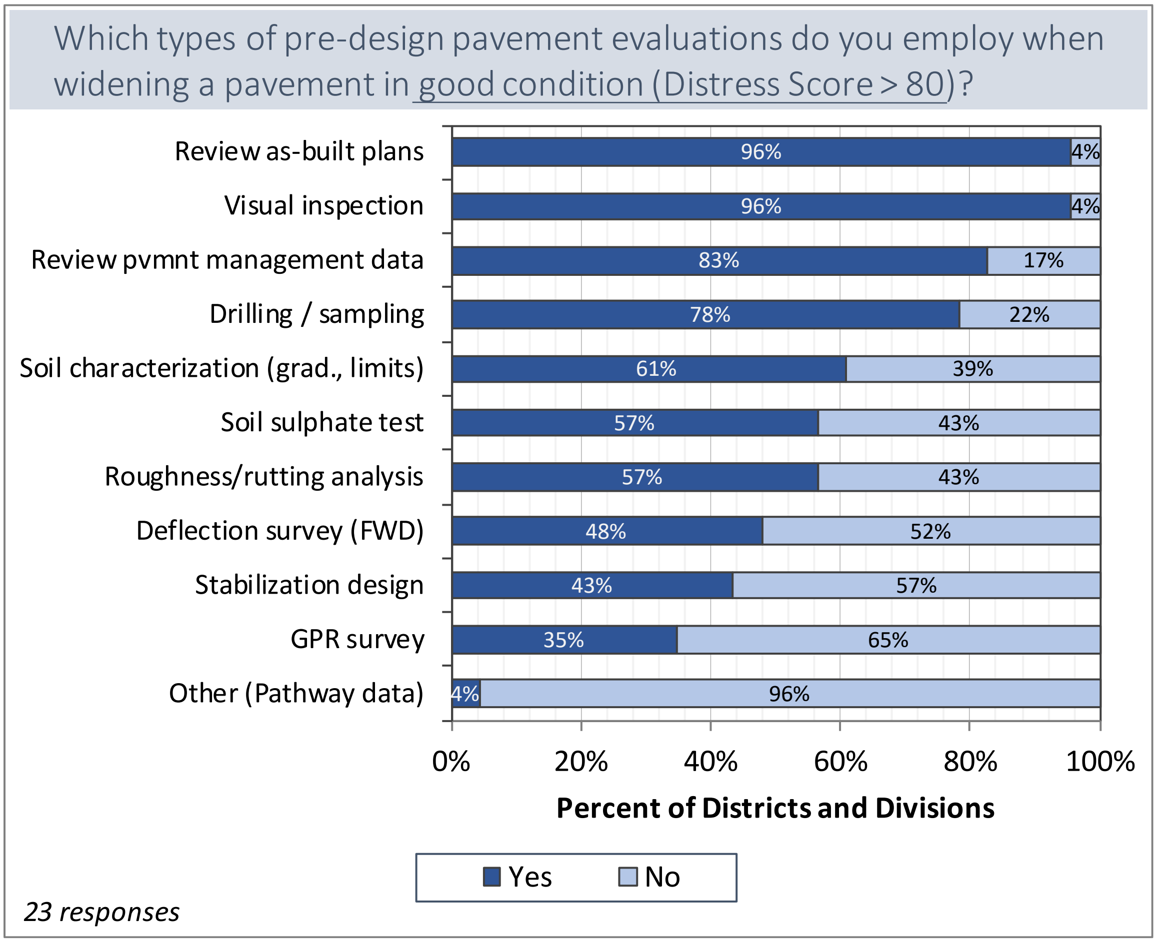

Figure 26. Pre-Design Evaluation (Good Condition).

When the pavement is in marginal condition (Figure 27), districts opt to use more intensive evaluation methods (e.g., drill/sampling, deflection survey, soil characterization, GPR survey) when planning the new design. A widening project can be ruined if the condition of the existing pavement and quality of the subgrade are not taken into consideration.

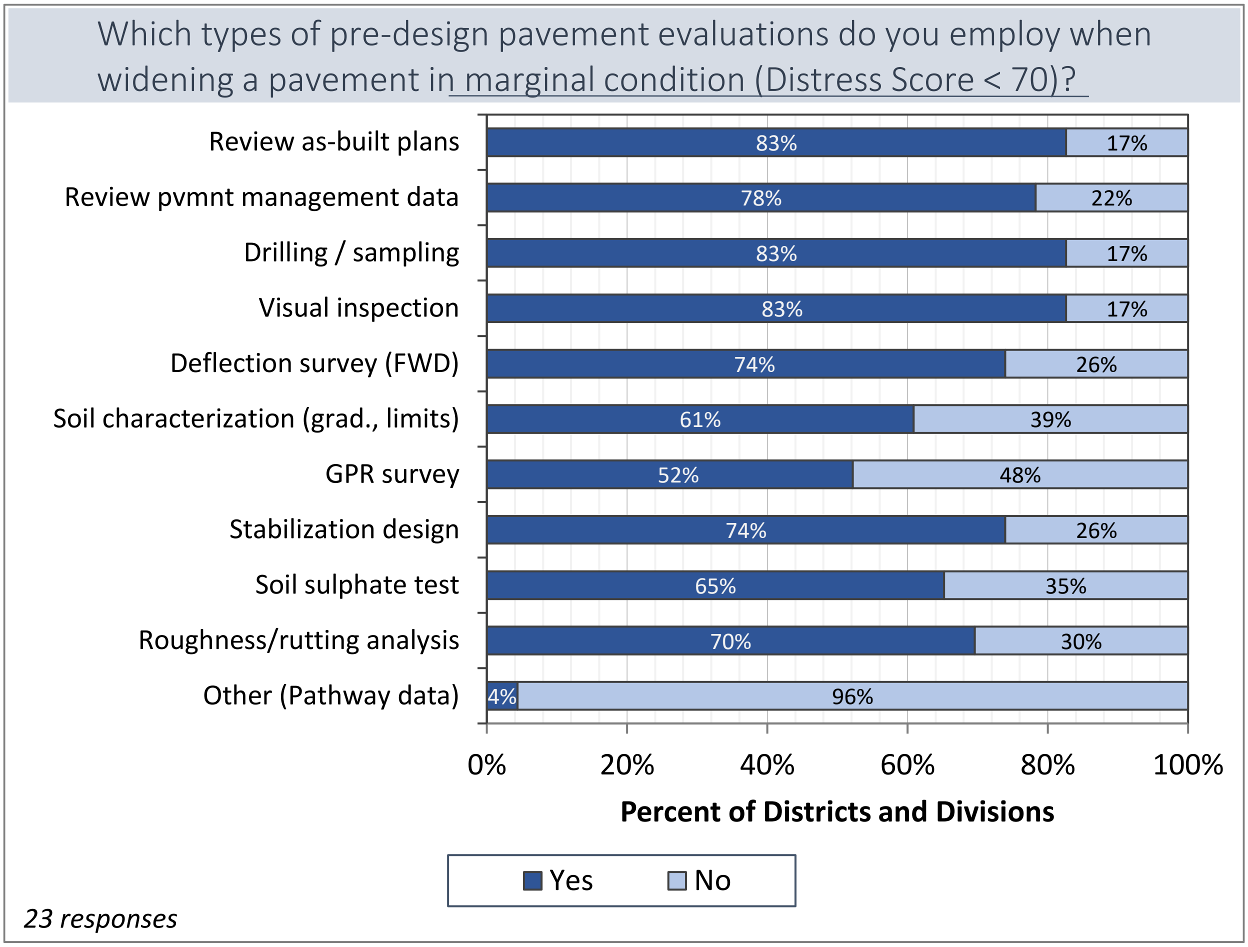

Figure 27. Pre-Design Evaluation (Marginal Condition).

Specific guidance to pre-design evaluation was provided by several districts:

- Not every tool is required on every project, but a combination of different methods is often used together.
- Pre-design is helpful to determine the economical solution (i.e., whether a full rehabilitation is warranted or if the existing pavement can be reused).
- Locating any previous widening of other types of material (i.e., concrete) is important.
- Also evaluate the drainage performance.
- Issues with high plastic index soils and sulphates will vary in different regions of Texas.

PAVEMENT LAYER DESIGN

The standard guidance for pavement widening is to match the existing layer materials and thicknesses to reduce distress from dissimilar materials and ensure good drainage. Still, just over 50 percent of districts will always or often strive to do this. In cases where they do not match, the districts cite the following:

- Many of the smaller roads are multiple layer seal coats, which require more nuance when matching.
- Avoid placing permeable and non-permeable layers next to each other.
- Match materials and thicknesses based primarily on traffic needs, not existing pavement.
- Matching does not apply when rehabilitating everything.
- Often do widening with hot mix or blackbase, which are easier to place and compact than some flex base.
- Stabilized subgrade to improve strength and performance, even if existing is not stabilized.

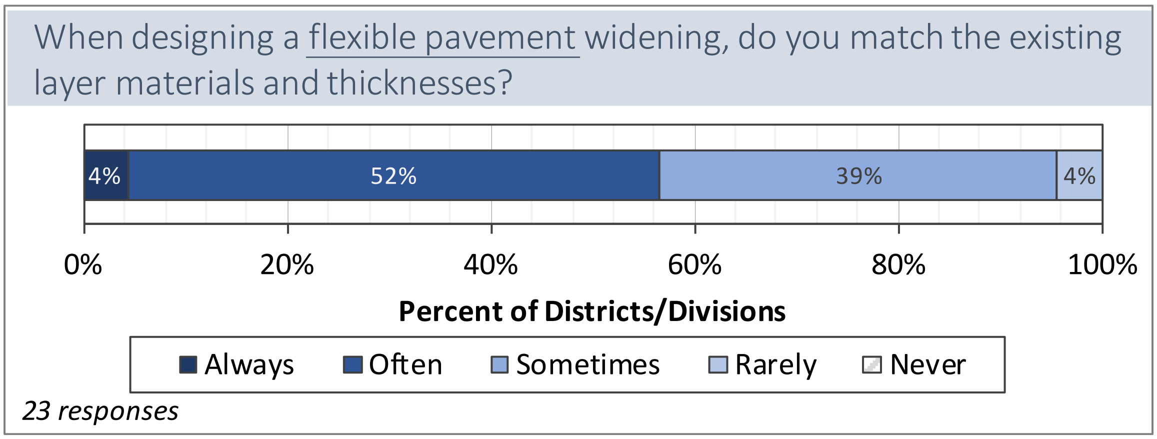

Figure 28. Matching Flexible Pavement Layers.

Widening of rigid or composite pavements is rare, but it is more common to match the existing pavement layers (Figure 29). In some cases, a district will construct flexible shoulders next to rigid lanes. In Lufkin, they widen the base and bond breaker more than the surface to accommodate the paving equipment. The Beaumont district said that the exact widening design will depend on the existing roadway condition, widening width, cost, etc.

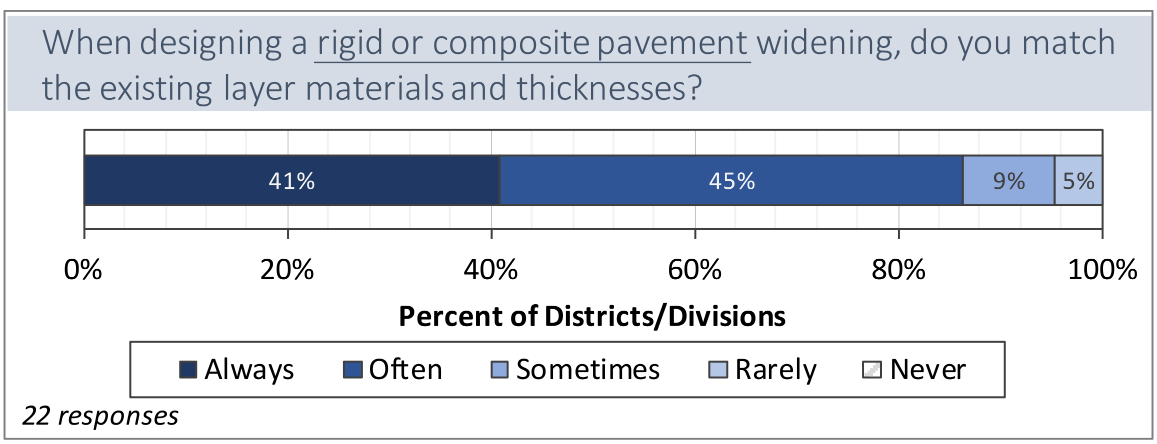

Figure 29. Matching Rigid Pavement Layers.

Over 85 percent of districts will verify the structural adequacy of their designs, whether for new construction or when incorporating the existing shoulder (Figure 30). Methods to verify the structure include:

- FWD,
- Core sampling and testing,
- FPS-21/23,
- GPR, and
- Pavement quality data in Pavement Analyst or from Hawkeye.

YKM mentioned they conservatively use the mainline ESALs when designing frontage roads.

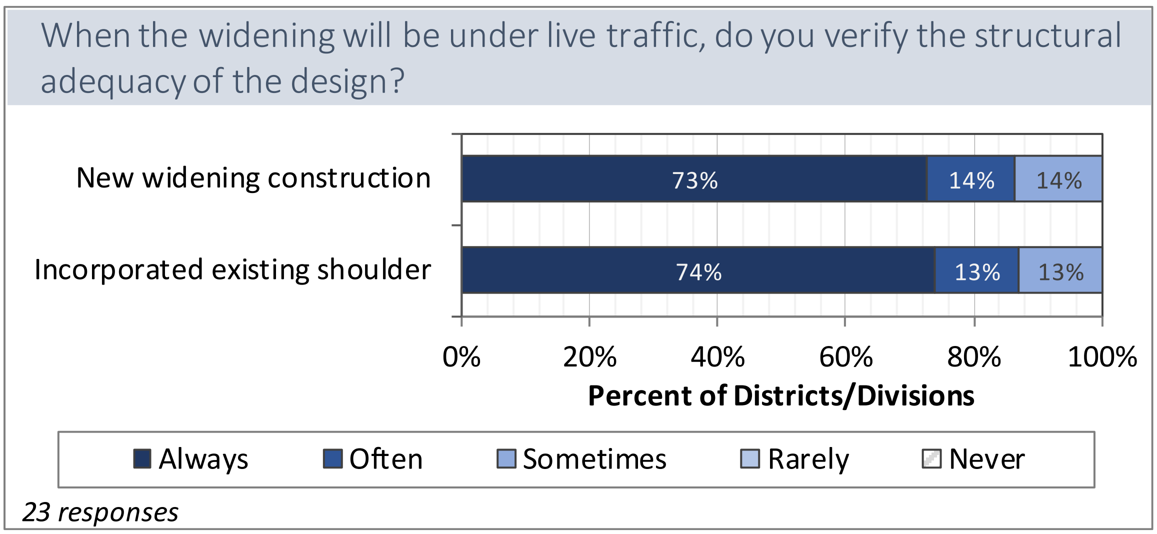

Figure 30. Verification of Structural Adequacy.

WIDENING CUT AND LONGITUDINAL JOINTS

The districts use milling, sawing, and/or blading to cut into the pavement, with milling and sawing preferred over blading. Tips for cutting into the pavement are:

- A clean, straight cut will improve joint density and reduce failures.
- Milling and sawing generally have better outcomes and are recommended for cutting HMA.
- Achieving a quality joint from blade cutting is highly dependent on operator and the pavement layer condition. Not recommended by many districts. More feasible for unbound materials.
- Must cut far enough into the existing pavement to remove deteriorated edge material.
- Strip sealing over the joint can reduce later issues.

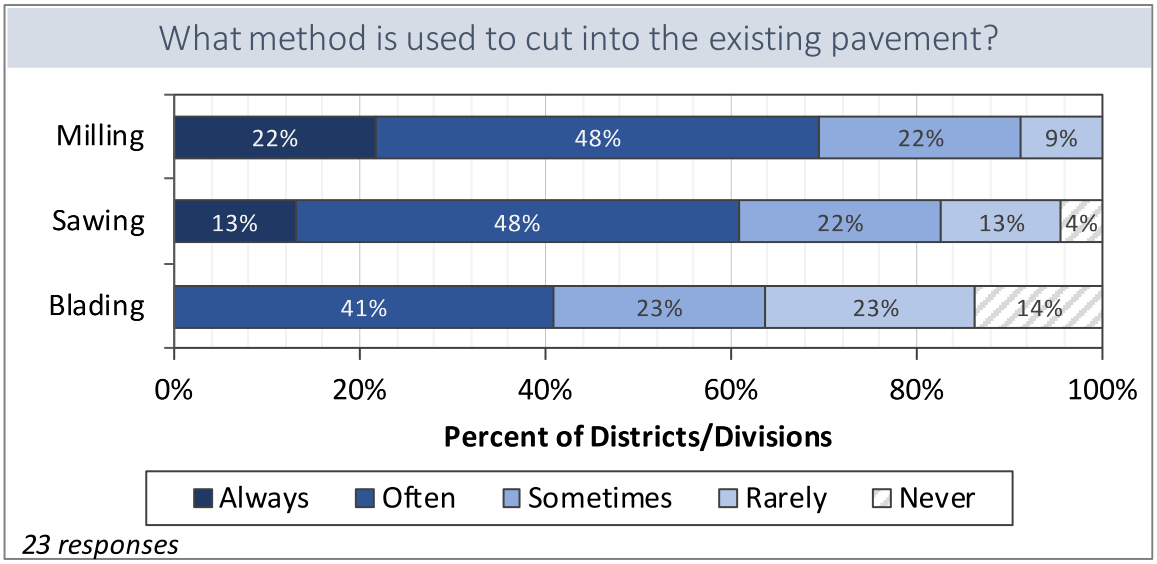

Figure 31. Cut-in Method.

Districts generally do a good job aligning the final HMA layer joint away from the wheel path (Figure 32). One third of districts always ensure the subsurface widening cut joint is also away from the wheel path, and about two thirds often locate it away from traffic.

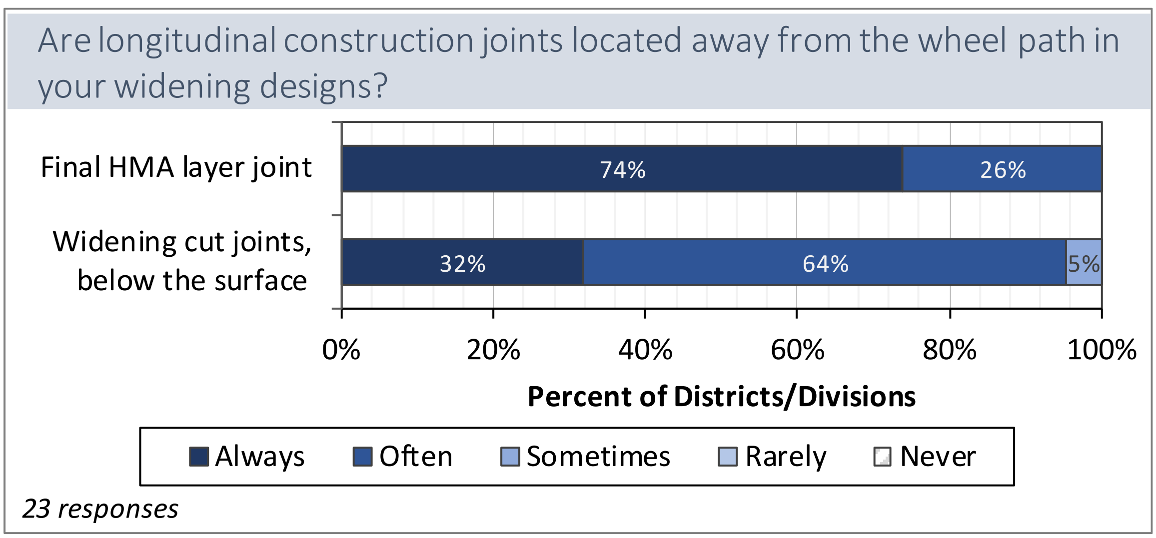

Figure 32. Longitudinal Joint Location versus Wheel Path.

Offsetting the construction joints, known as notching, is done between layers of HMA by 73 percent of the districts (Figure 33). Double notching, which is putting an additional joint between the HMA and the base, is done by 64 percent of districts. Notching between the base and subgrade is done by a little less than half the districts. Notching rigid and composite pavement is not typically done.

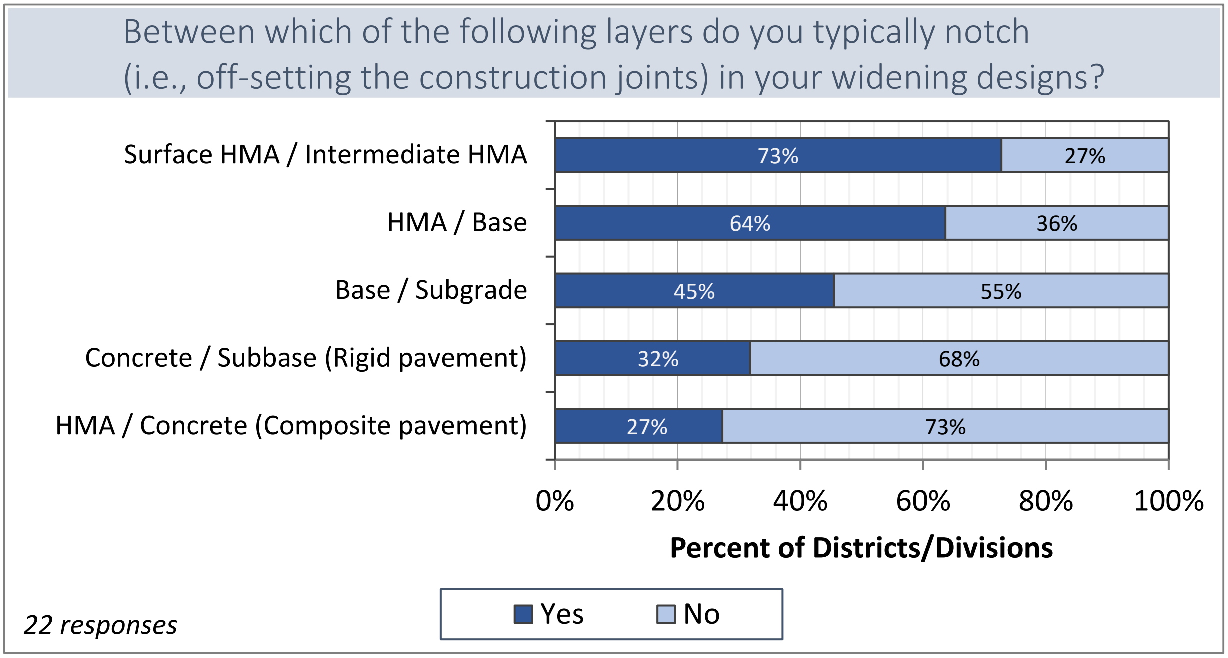

Figure 33. Layer Notching at the Joint.

Some additional advice for the quality of widening joints is:

- BMT has found it difficult to properly mix and compact cement-treated base in-place.
- CHS recommends applying tack coat on the vertical face of the cut joint and being consistent with the offsets.
- Lubbock (LBB) prefers not to notch pavement layers.
- LFK has a good local contractor that can do upwards of 2 miles in a day. Use milling machine to cut into pavement, widen 3 ft with a road widener machine with plant-mixed cement-treated flexible base (pug base).
- ODA recommends missing the old and new flex base at the joint, stair stepping the hot mix joint layers, and using subtrade widening for shorter jobs.
- San Antonio (SAT) says to seal the joint and pay attention to the sequence of work.
- Wichita Falls (WFS) and YKM say to cut where the pavement is in sound condition. YKM says even on narrow roadways, cut 1 ft into the travel lane if there is enough travel room.

NARROW WIDENINGS

As previously reported, most of the widening projects are narrow widenings of the shoulder or lane and are less than 6 ft wide. The districts were asked what the minimum feasible width would be (Figure 34). The median was 4 ft, and the average was 4.5 ft. Some districts were comfortable going as low at 2 ft, and others would prefer to not construct a widening less than 8 ft.

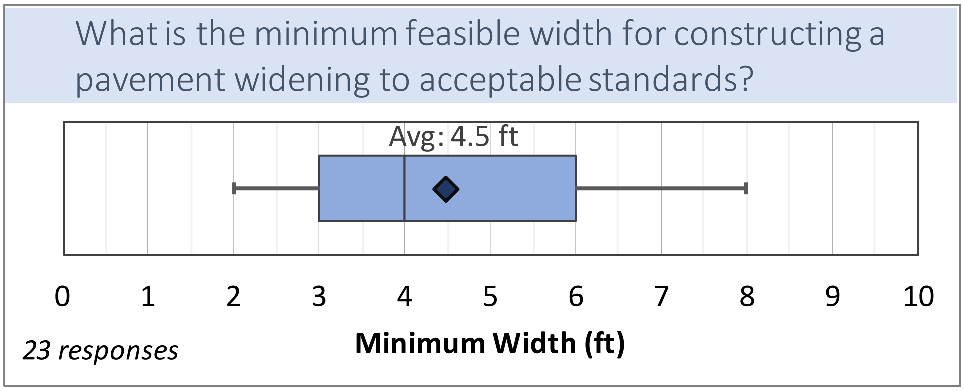

Figure 34. Minimum Width for Acceptable Construction.

Districts provided several tips for narrow widenings. The discussion is summarized below, and the detailed comments are in Appendix A.

- AMA - I placed my special jobs supervisor over these projects. He ensures we have all needed equipment, materials, and employees. We ensure the base is placed in lifts with an adequate amount of water, compacted, and sealed.
- AUS - Narrow widenings are usually for safety and not designed for travel. Design is usually deficient for permanent travel. Need to make good record of this to not use for travel in future.
- BMT - Notes are added for several items such as subgrade widening, proof rolling, vertical edges, tack coat requirements, and lift thicknesses.
- BWD - We try for 6 ft width where possible for compaction in the field. During construction, the contractor may have to overbuild and cut off excess or buy a smaller roller and hope they can achieve density requirements.
- CHS - I went down to 2 ft because we manage to lay high quality narrow widenings with a blade-in method that we have employed with our in-house forces on lower volume roads. We would not go that narrow on a construction project. For construction projects, we have gone as narrow as 4 ft with widenings utilizing hot mix for the base layer and had great success. Contractors have adapted with road widening equipment that can go down this narrower as opposed to paver width. If we are utilizing flex base, 4–6 ft width is going to be on the lower end to be able to place it and compact it properly. On higher volume roadways or major widenings, we anticipate regular roadbuilding equipment (ability to treat subgrade normally, paver width paving operation, etc.)
- CRP - We try to stick to 6 ft where possible. If over-building is necessary, it is incorporated into the plans and the quantities are accounted for as well. This also helps with phasing for construction.
- ELP - Similar process as with any other project.
- FTW - construction phasing should be considered during design one lane traffic control, if detours are not feasible.

- LRD - We design a minimum of 4 ft for constructability.
- LFK - We ensure there are not pavement drop offs overnight and they prime the pug base weekly.
- ODA - We avoid narrow widenings. Our widenings are usually 8–10 ft.
- PAR - We usually widen with full depth TY-B hot mix. We do this a 3076 Exempt and core once a day full depth (Min 8 inches).
- PHR - We do not allow anything less than 2 ft.
- SAT - use concrete.
- TYL - Design
  1) Predesign meeting.
  2) Pre-ride with Area Engineer, 30, 60, 90 percent reviews.
- WFS - Typically we are converting 20 ft roadways to 28 ft. We try to build a wider subbase than the surface. Flex base is not used much due to time constraints and working it in tight or smaller spaces.
- YKM - During our pre-design meetings, we discuss constructability issues and condition of our existing pavement.
- LBB, WAC, ODA - Avoid narrow widenings.

ROADSIDE DRAINAGE AND UTILITIES

Ditch geometry and drainage is considered always by 65 percent of districts and often by 35 percent (Figure 35.)

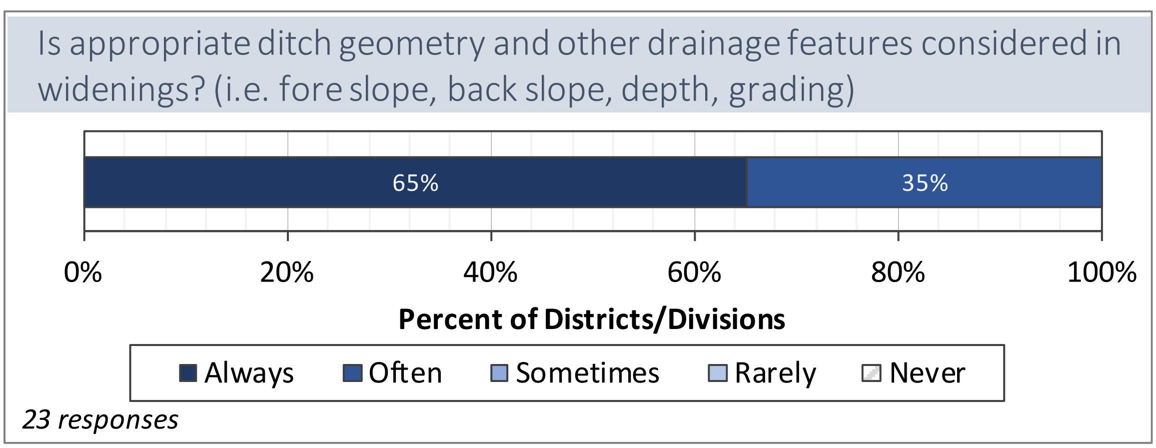

Figure 35. Ditch Geometry.

The districts' approaches to drainage design are shown in Table 3, approaches to limited right-of-way are shown in Table 4, and approaches to utility management are shown in Table 5. These are the full responses.

Table 3. District Comments: Drainage Design.

District	Comments
ABL	Adjusting backslopes to maintain ditch geometry.
ATL	Try to maintain ditch line 2 ft below the base.
AUS	Drainage will always be assessed during subject-matter expert review. May not always take place during in-house maintenance work but is recommended to always have net positive flow.
BMT	Adequate roadway crown must be provided. Also, the depth of the ditch is a concern. We try to ensure the ditch depth is a minimum of 6 inches below the subgrade of the widening. We must also look at cross-structures and parallel structures to ensure they are properly safety treated and do not conflict with the proposed materials. At times, Item 760 Cleaning and Reshaping Ditches is needed to ensure proper drainage for a dry subgrade.
BWD	We try to maintain 1.5-ft to 2-ft ditch flowline below the subgrade.
CHS	I didn't answer always because often on narrower widenings (think 4-ft-wide HMA), we don't change the ditch grades because there is room to fit the widening adequately within the existing front slopes. When we are doing a full-lane width widening, most of the time the ditches need to be realigned (moved outwards) to maintain adequate front slopes and ditch capacity. We design these on a case-by-case basis.
CRP	We are extremely flat in this district, so terrain grade changes are rarely an issue.
ELP	Follow Roadway Design criteria.
FTW	Keep positive drainage. Maintain the flowline below the subgrade.
LRD	Luis—For CAT 1 funding we do address culvert extensions and address grading, CAT 8 funding is limited to address any upgrades to culverts but address some grading. TPD—Upon evaluating existing conditions and any right of way (ROW) constraints, we check for impacts to ditch capacity when performing these widenings.
LBB	Re-establish ditch flow lines and extend needed structures.
LFK	We set up blade work to adjust the ditches and replace most if not all the driveway pipes because we have to set them back closer to the row line. We extend and safety treat our cross-drainage structures.
ODA	Regrade front slope and reestablish ditch flow with item 700 or excavation and embankment beyond subgrade widening limits.
PAR	We try to relocate the drainage early into the project, especially ditches, to allow enough time to thoroughly dry out. We have sometimes undercut the existing ditch area to remove any potential unacceptable material. We do this so we do not trap water of saturated material under our widening. We also try to provide flatter front slope to keep the water away from the new pavement structure.
PHR	It is one of the most important things in the design process.
SAT	Identify problematic areas; analyze existing ditch capacity and review frequency; maintain flow and slopes in clear zone.
TYL	Review existing plans, field verify, and field measure or get a survey of project. During the field visit, look for erosion problems and ask the Maintenance Department for information, like over topping at any structures. Verify each structure ditch and creek of what's upstream and downstream that m be a concern. Run a hydraulic report.
WAC	Evaluate the existing drainage and how widening will impact it. Analyze the design year as well as the 100 year flood and confirm that the design will not adversely impact the existing flood conditions.
WFS	Perform analysis on all existing and proposed cross drainage structures to ensure minimum performance guidelines are met. Verify if any drainage easements are needed and if there are any existing concerns (flooding or performance issues) from the Area Engineer and/or maintenance supervisor. Verify adequate parallel ditches to convey water and no standing water exist.
YKM	Front slope usually controls the amount we can widen.
CST	Drain during construction, drain after construction.
DES	Verifying ditch capacity.

Table 4. District Comments: Right-of-Way.

District	Comments
ABL	Narrow ROW is difficult. May require slop protection in some instances. Urban sections usually require storm sewer to accommodate widening.
ATL	We have done spot widenings with maintenance forces. Clean ditches, widen structures as much as possible.
BMT	Typically, with the use of storm drains.
BWD	Most of ours are rural, but we cut cross-sections to see if ROW is required and buy it if we need to unless it is just 1 or 2 areas, we may steepen the backslope or provide riprap or retaining wall.
CHS	It's difficult when there is limited ROW. Many times, we have changed our Super 2 designs to the alternating design (as opposed to the separated design) so that we don't have to widen so much on one side at a time and to keep adequate ditches. We try to plan ahead enough that we can purchase ROW if necessary. Urban environment widenings do not come into play very much being in a rural district such as Childress.
ELP	We try to maintain the same drainage patterns. If ponding is an issue, we visit strategies within the drainage manual that can be implemented within budget. Coordinate with maintenance to get a history of the area.
FTW	Close drainage system, inlet designs.
LRD	Luis—It is difficult to address drainage issues in limited ROW. TPD—We do an assessment of existing hydrology and hydraulics and consider any need for storm sewer parallel to the flowline of the ditch with drop or curb inlets as needed.
LBB	Analyze curb and gutter (C&G) if it will not convey the flow then storm sewer is placed.
LFK	We do not have this very often since we are a rural district, but we have had to install storm sewers in some instances to accommodate drainage with limited ROW.
ODA	Use steeper front slopes. Try to avoid metal beam guard fence (MBGF) but add where needed. Utilize rip ap on 3:1 or stepper front slopes, usually in urban areas. ROW not usually an issue in rural areas.
PAR	Many times, we must abandon the process described in the previous question and have to consider storm drainage systems in conjunction with C&G.
PHR	Add trunk line and inlets if possible. If not possible then move ditch line alignment.
SAT	Concrete line ditches; curb; convert to storm drain.
TYL	Review existing plans, field verify, and field measure or get a survey of project. During the field visit, look for erosion problems and ask the Maintenance Department for information, like over topping at any structures. Verify each structure ditch and creek of what's upstream and downstream that might be a concern. May need to add storm drain to the scope and run a hydraulic report.
WAC	Sometimes we need to convert to a closed system. Other times if already closed but trunk lines need to be upsized, then we can put them under the pavement instead of the usual offset.
WFS	With difficulty. Contractors are responsible for maintaining positive drainage throughout the project life, design phases of work in plans, specifications and estimate (PSE). Perform adequate cross-sectional analysis to ensure proper drainage is maintained.
YKM	Consider curb and gutter/storm sewer.
CST	Storm sewer.

Table 5. District Comments: Utilities.

District	Comments
ABL	Utility locates during design and coordination of utility adjustment prior to construction.
AMA	Our widening jobs generally do not affect utilities. If we do have an issue, we will look at other options to work around the utility.
ATL	Coordinate like any other project.
BMT	Early coordination is the key. Beaumont has two employees that stay on top of any need utility adjustments.
BWD	Same as any other project, just identify potential conflicts, try to avoid them if possible, and move the utility if needed.
CHS	Planning and coordination with utilities to get their lines out of the way before construction. For maintenance widenings (narrower and smaller scale), turn in locates and verify we aren't going to be close to any utilities.
CRP	Avoiding utilities for widenings is always a top priority.
ELP	Coordinate with utility companies and verify location and depth of utilities.
FTW	Subsurface utility exploration (SUE) investigations. Early coordination. Conflict matrix. Relocations.
LRD	Luis—We have to plan ahead to know if we would have any conflicts; close coordination with Utility Section, area office, and maintenance office when in the design stage. TPD—Our district follows standard procedure for utility investigation via 811 calls and contact the utility owners to resolve any conflicts to relocate any utilities closer to the ROW line as needed.
LBB	Perform SUE and relocate as needed.
LFK	We identify potential hazards during the preliminary design phase. Then relocate or work around those that cannot relocate. Also mitigate issues.
ODA	Try to avoid cutting too deep into subgrade. Coordinate early.
PAR	The same as any other project. If the utility is within our ROW, we will require them to make the necessary adjustments to accommodate our design. That being said, if the city or utility does not have the means or time frame to get the job done, we have in some cases added the work to the project if big enough or reconfigured our design to avoid the conflicts.
PHR	They are managed during the design phase.
SAT	Utility conflict matrix analysis; SUE levels D, C, B for projects; Level A, as needed; avoid, mitigate, relocate.
TYL	In the design phase, at 30% complete, schedule the first utility coordination meeting. Then host a utility meeting for 60% and 90% completion. We may host multiple meetings with each utility to help move the project along. Communicate, Communicate, Communicate.
WAC	Identify conflicts in the 30% phase of the project. Bring in utilities in this stage. Attempts will be made to design around the conflicts but coordinate with the utilities for those conflicts that can't be missed for relocation.
WFS	Identify conflicts during design process and coordinate relocation prior to letting.
YKM	Relocate or design around.
CST	Coordination as early as possible.
DES	Relocate or cap.

TREATMENT OF EXISTING PAVEMENT

Most districts always or often do maintenance or rehabilitative work on the existing pavement at the same time they do a widening (Figure 36). In some cases, maintenance is not warranted (pavement in good condition) or there may not be enough funding. The most common actions are to do a full-width overlay, seal, or mill and overlay (Figure 37). Most districts also perform partial or full-depth recycling of the existing pavement in a more extensive rehabilitation effort. Few districts crack seal the old pavement, which would not be necessary if it were being overlaid already.

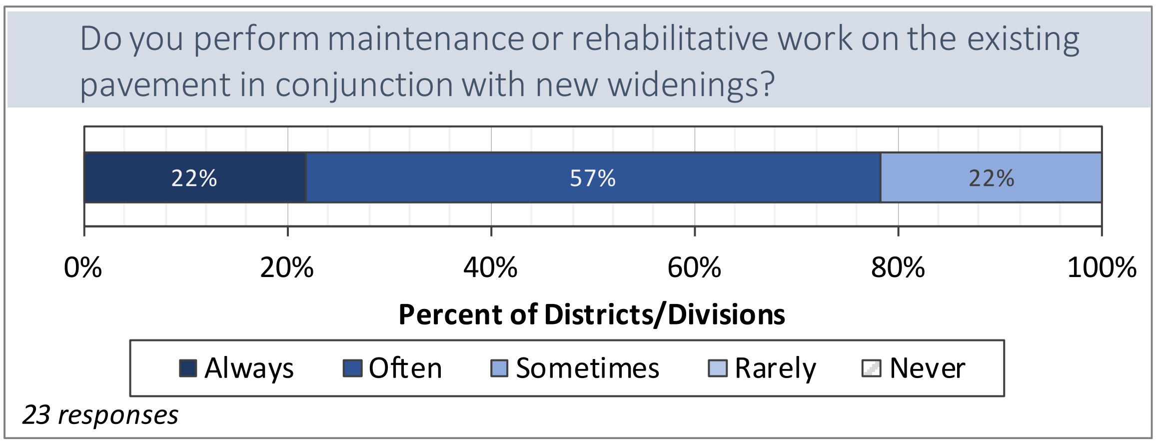

Figure 36. Maintenance and Rehabilitation on Existing Pavement.

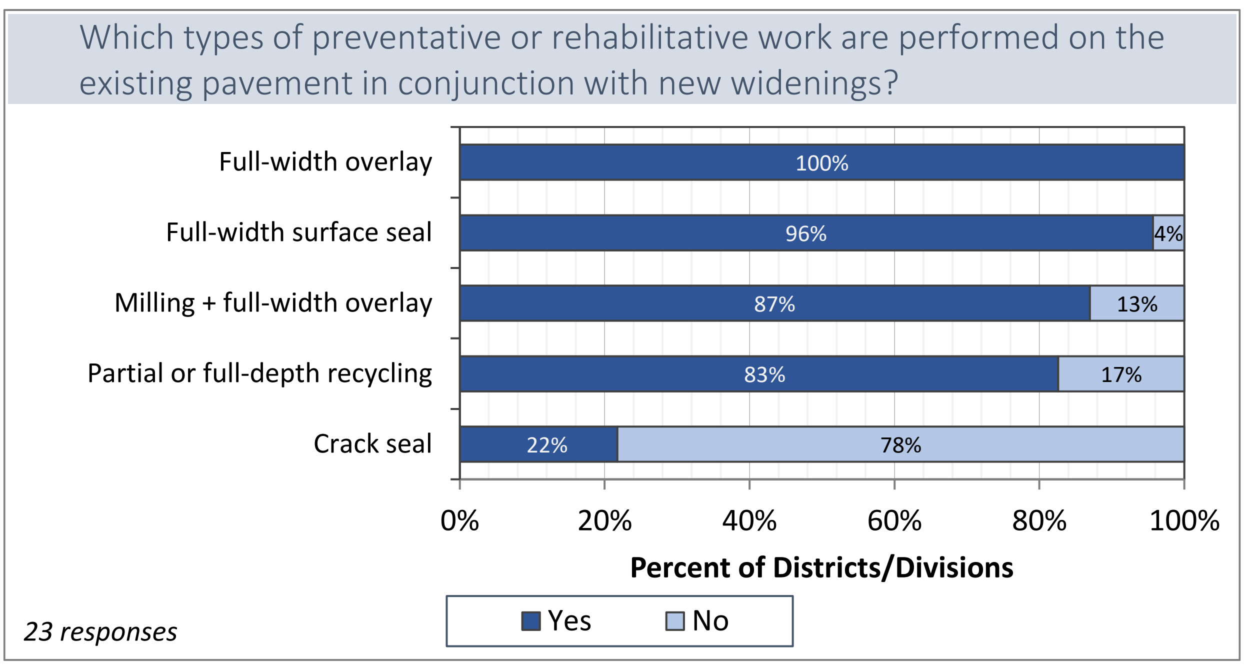

Figure 37. Types of Preventative and Rehabilitation Work.

WIDENING DISTRESSES

Many types of distresses can occur on widening projects. The most common is cracking at the joint, occurring often and very often in a third of districts. This is followed closely by reflection cracking of the subsurface joint and then by settlement and rutting. Other distresses in the widened section are fatigue cracking, edge cracking, and edge drop-off. In the existing pavement, rutting and fatigue cracking can also occur, which might indicate that the existing pavement may be further in its life cycle and wearing faster than the new widening. Drainage is often a concern for 14 percent of districts. But just because these distresses are present does not necessarily indicate that they are a concern.

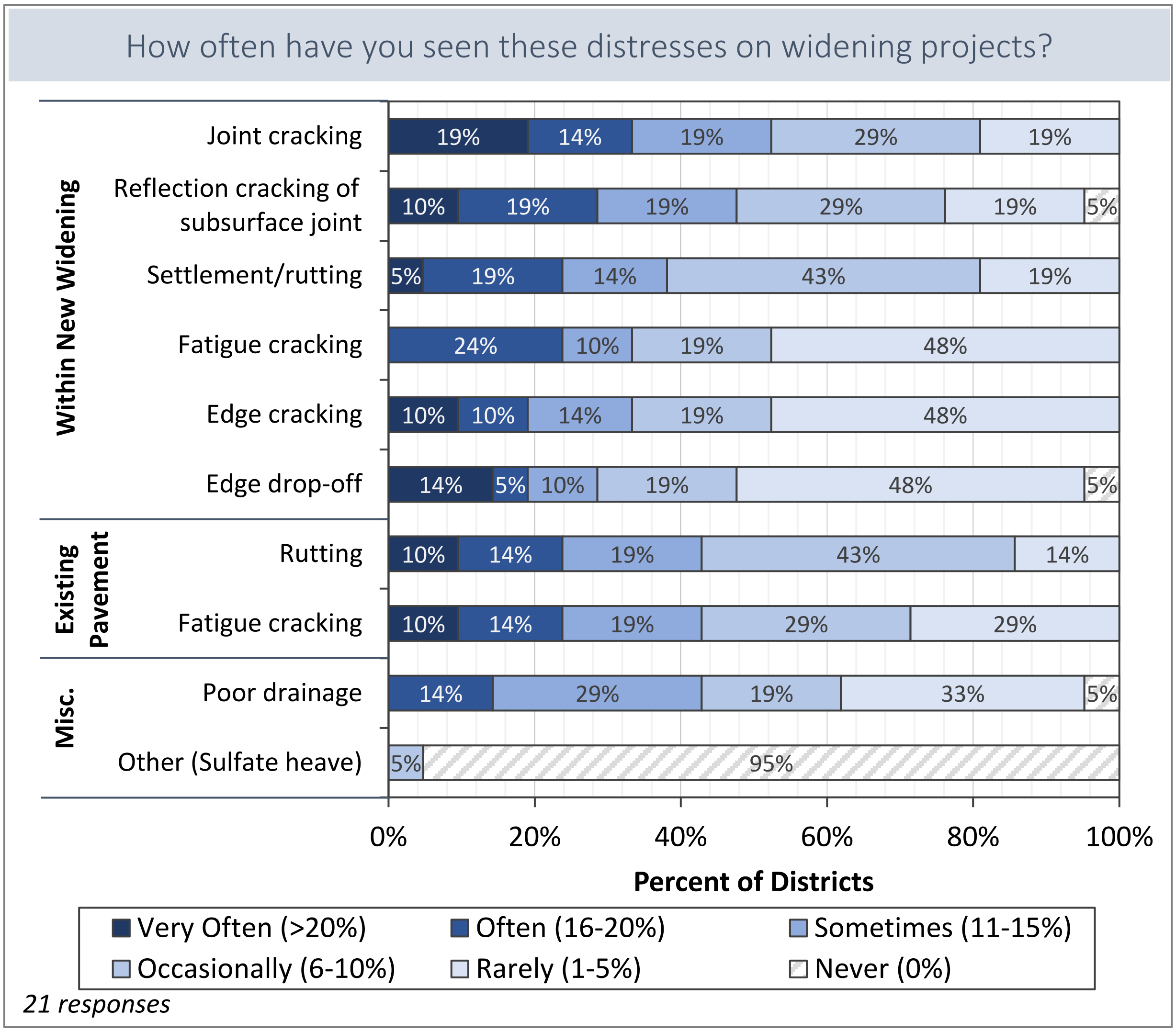

Figure 38. Widening Distresses.

The districts were asked which distresses required expedited repairs on widening projects (Figure 39). The most problematic distress was settlement/rutting in the new widening, followed by rutting in the existing pavement, and then fatigue cracking. Edge drop-off was also a concern that needed to be addressed by about half of districts because widenings often create steep fore slopes, especially in limited right-of-way.

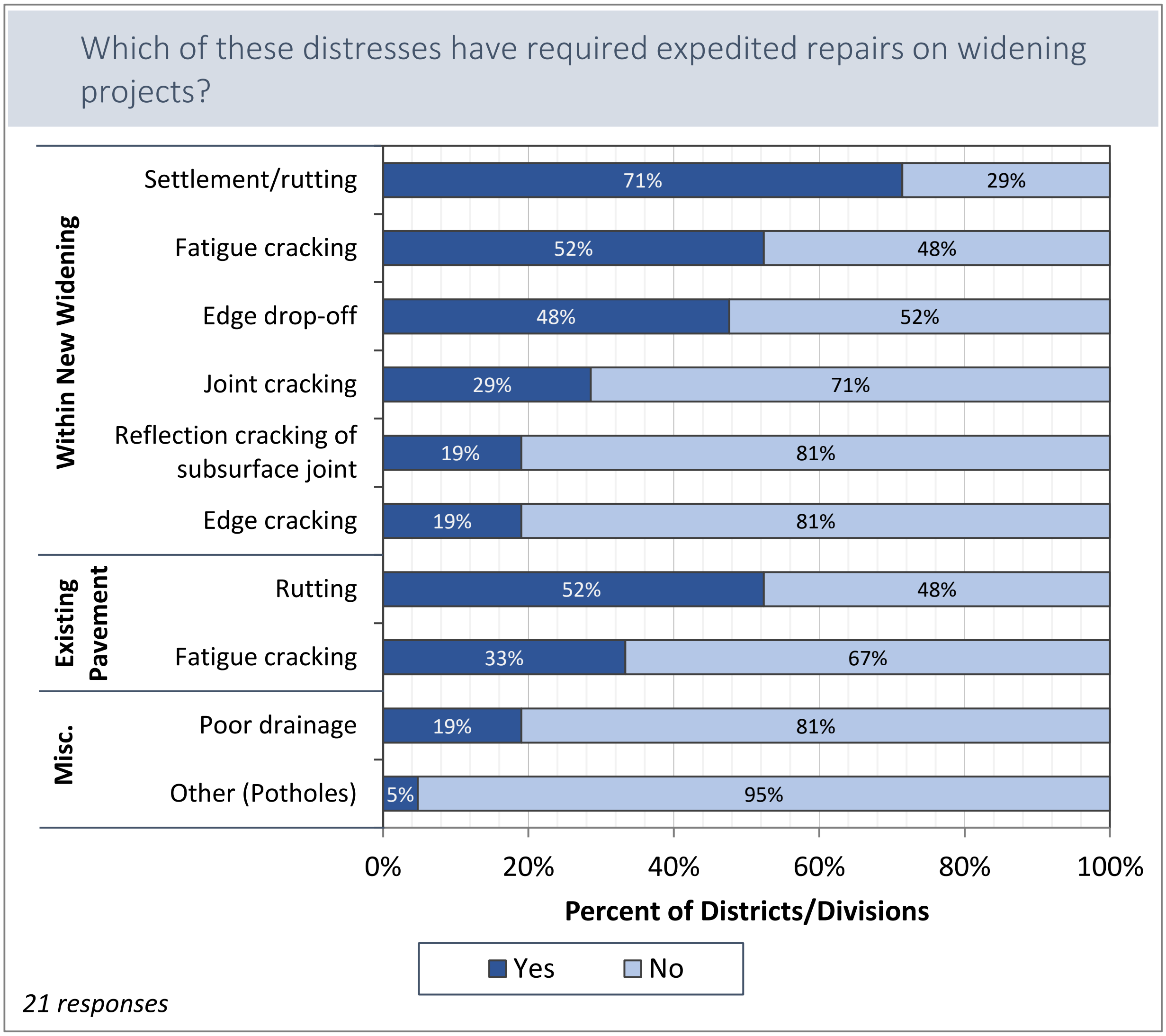

Figure 39. Widening Distresses Requiring Repairs.

OVERALL RATING OF WIDENING CHALLENGES

There are several practical and engineering challenges that pavement widenings present. The districts rated the challenges on a scale of 1 to 5 (Figure 40). The biggest challenge is designing a suitable widening with limited right-of-way. The biggest issue this presents is to driver safety and drainage (which is listed separately as #4). Next is funding, as discussed earlier in the survey, then work force experience. There is expertise in knowing the proper way to design and construct widenings, but that knowledge is not always with the ones who are in charge. A key outcome of this project is to provide user-friendly and practice-ready guidelines that can be used by TxDOT and industry.

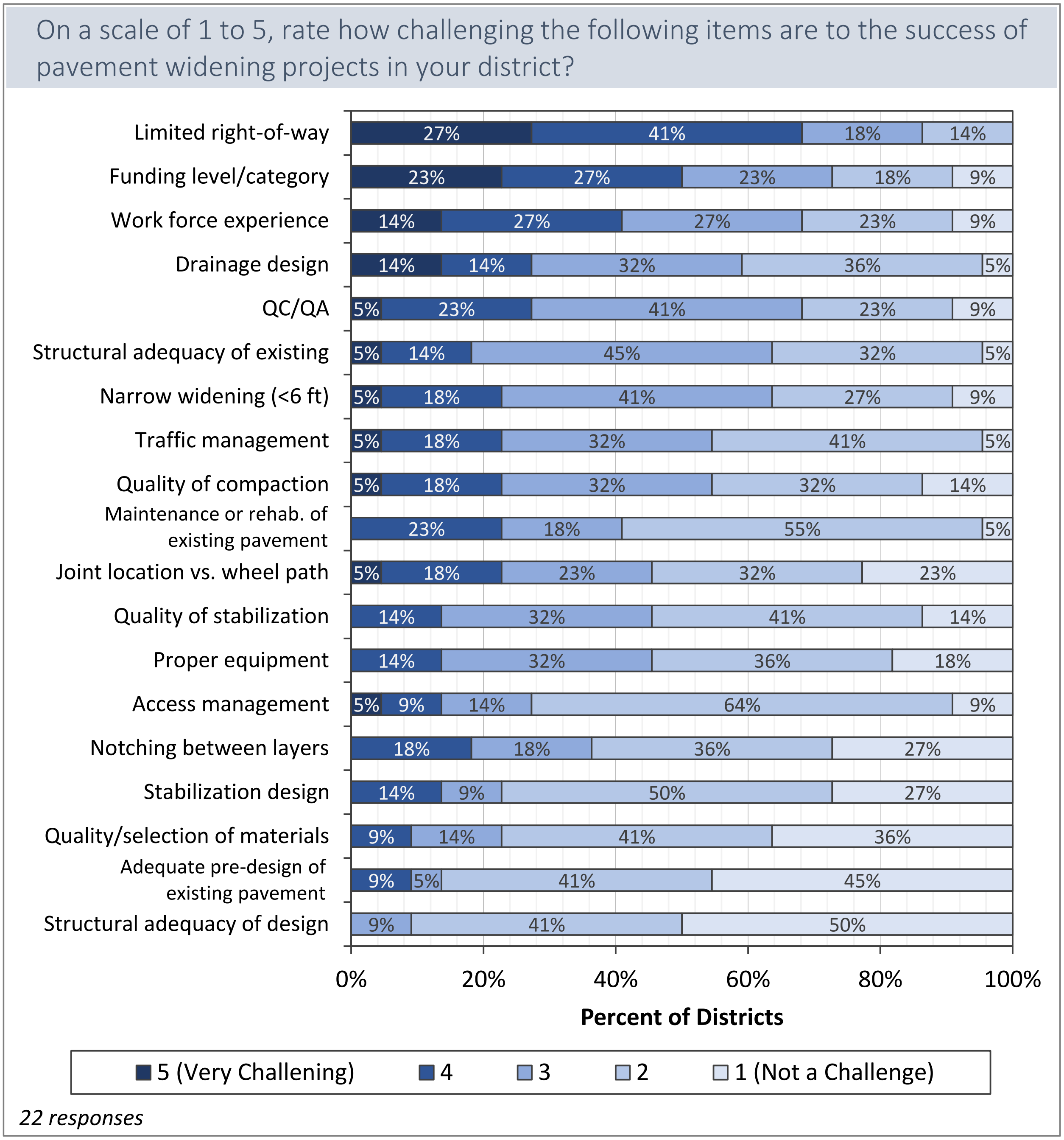

Figure 40. Widening Challenges.

The list of issues continues with quality control/assurance, structural adequacy of the existing pavement, feasibility of narrow widenings, traffic management, and compaction quality. For nearly every challenge, there is always one or a few districts that find a particular issue to be challenging or very challenging. So even if it is not a big issue statewide, there is still a need to address the issue and help communicate best practices with these districts.

SURVEY CONCLUSION

Pavement widening serves as a crucial strategy for enhancing roadway capacity and safety. Successful pavement widening projects should achieve a uniform pavement structure across existing and new sections with proper drainage and consistent material properties, ensure adequate structural capacity, manage construction constraints, minimize traffic disruptions, and optimize long-term maintenance operations. The ramifications of an improper or insufficient widening approach can affect the entire project, often manifesting directly in the traveling lane and leading to costly maintenance or rehabilitation issues.

The survey of TxDOT districts has provided insights into the technical challenges and considerations associated with pavement widening. This report covered several aspects from project funding to design, drainage, and other critical elements. The input from the districts will be carefully considered as the researchers develop guidelines for widening best practices.

CHAPTER 3. CASE STUDIES

This chapter contains the methods and results from case studies of four pavement widenings in Texas that represent narrow widenings and lane additions (e.g., two-lane to Super 2 conversions), and that have demonstrated good and poor performance.

CASE STUDY METHODS

The research team requested information about good and poor performing widening projects from several TxDOT districts. Projects in good condition should be at least 10 years old, while projects in poor condition should have demonstrated performance issues within 5 years of construction. They requested narrow widening projects (< 7 ft) and lane addition projects like two-lane to Super 2 highway conversions.

For each project, the team obtained the construction plans and pavement distress and roughness data from pavement management information system. On poor performing projects, forensic testing was performed to determine what the underlying issues might have been. Test methods employed include FWD, coring, and GPR profiling to map asphalt air voids content. The team reviewed the data to identify which factors may have been critical to the success or responsible for the early distress of each project. The team prepared case study reports for each project. In consideration of the agency and contractor, the location details of the poor performing projects were anonymized.

PROJECT 1—SUPER 2 WIDENING IN GOOD CONDITION

<u>Highway:</u> SH 105
<u>District:</u> Beaumont
<u>County:</u> Liberty
<u>Limits:</u> STA 215+50.00 to STA 881+90.00
REF MRK NO 734+1.293 to REF MRK 724-1.327
<u>Total Length:</u> 12.61 miles
<u>Control-Section-Job (CSJ):</u> 0951-01-061
<u>Completion Year:</u> 2009

This Super 2 widening consisted of adding passing lanes and widening the shoulder along various sections of SH 105. Aside from an overlay, the existing pavement structure was largely unaltered. This pavement project was considered a success, and no major repairs have been made to the road since its completion 15 years ago. There were various overlays and chip seals done as routine maintenance.

Project 1 Pavement Structure

The existing pavement had a 7-inch compacted select material on the bottom layer, a 9-inch flex base layer over this, and a 4-inch surface of asphalt. The widened sections had a bottom layer of 7-inch treated subbase, a layer over this of 13-inch flex base with prime, and a 4-inch surface of hot mixed asphalt (HMA) type (TY) C. The difference between these two pavement structures is shown in Figure 41. For superelevated sections, the HMA TY D was placed as a level-up to reach desired plan widths and cross slopes. Figure 42 is a common preconstruction typical section.

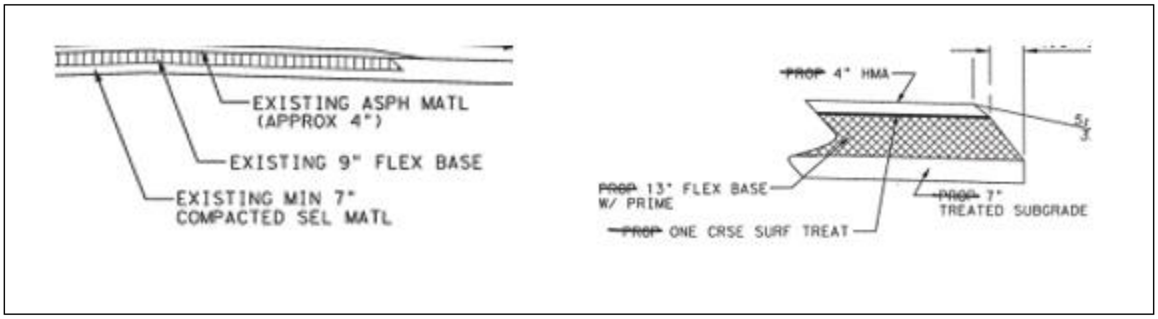

Figure 41. Existing Structure (Left) versus Widened Structure (Right), Project 1.

Project 1 Typical Sections

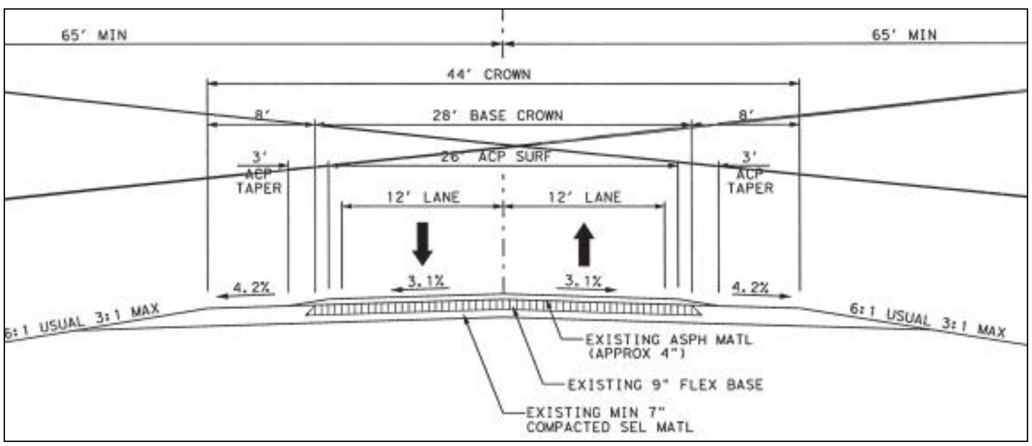

Figure 42. Pre-Construction Existing Typical Section, Project 1.

<u>Typical Section Example 1:</u> One of the more common typical sections post-construction is shown in Figure 43. The pavement was widened by 11.5 ft on each side for adding a 10-ft shoulder on both sides of the road. The widening occurred on the edge of previously existing exterior lanes. The widening joint was aligned with the lane stripe and away from the wheel path. A surface treatment was placed over the new shoulder and over the joint.

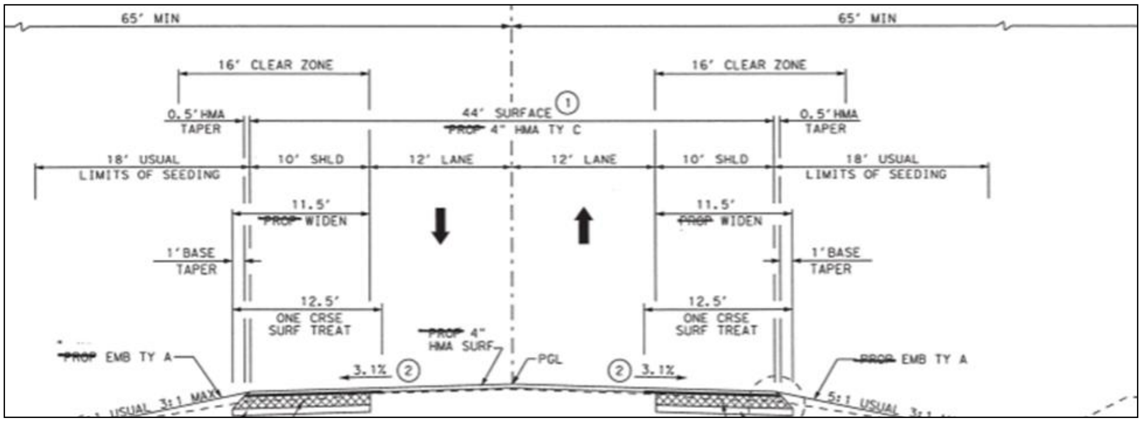

Figure 43. Post-Construction Typical Section Example 1, Project 1.

Typical Section Example 2: Another common post-construction typical section is shown in Figure 44. The pavement was widened by 17.5 ft on both sides to accommodate for one additional traffic lane and a 10-ft shoulder on both sides of the road. The widening joint was placed in the middle of the outside lanes and was not in the wheel path.

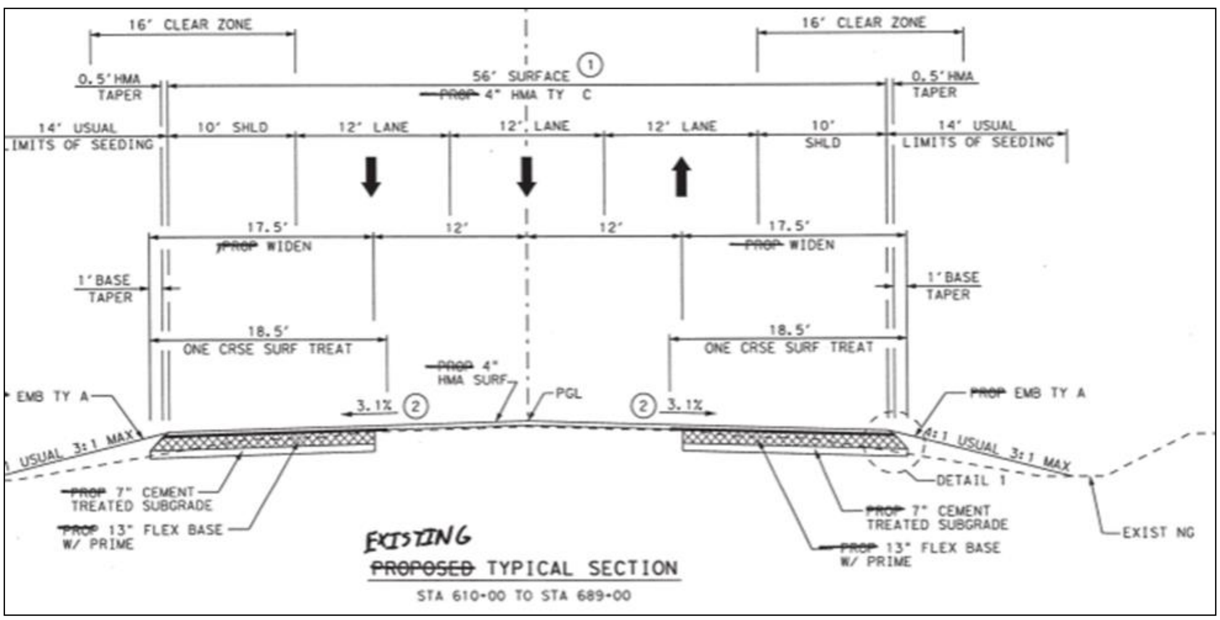

Figure 44. Post-Construction Typical Section Example 2, Project 1.

The construction work and the widened pavement several years later are shown in Figure 45.

Figure 45. Construction (2008) and Current Pavement (2021), Project 1.

Project 1 Performance

The widening project was completed in 2009, and the ride and distress scores 10 to 15 years later, from 2019 to present, are shown in Figure 46 and Figure 47, respectively. New construction did not occur over that time, but various overlays and chip seals were done as upkeep. The averages for the ride score 10 years after construction are about 4.25 on a scale of 0–5. The averages for the distress score stayed consistent at about 95 on a scale of 0–100. Some locations along the project had significantly lower distress and ride scores.

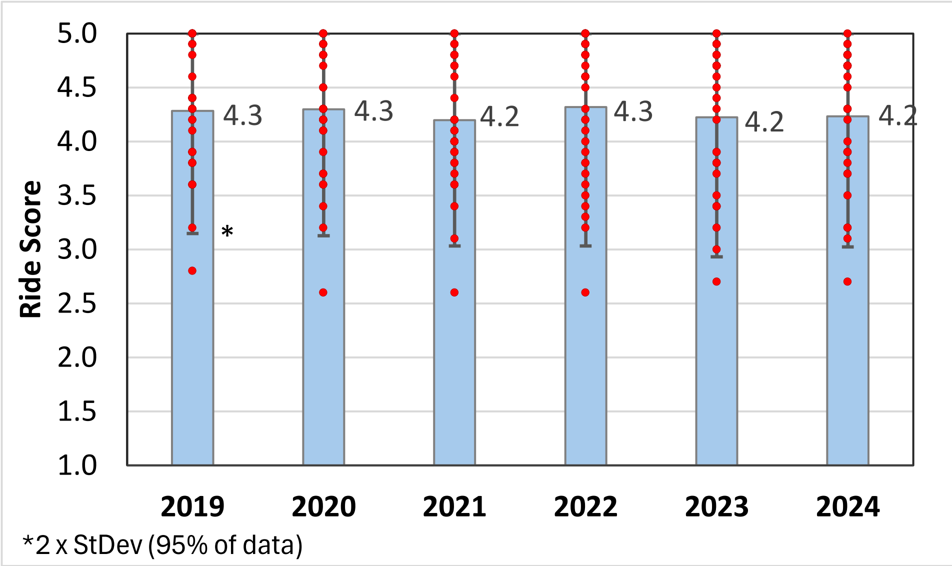

Figure 46. Ride Score Data versus Year, Project 1.

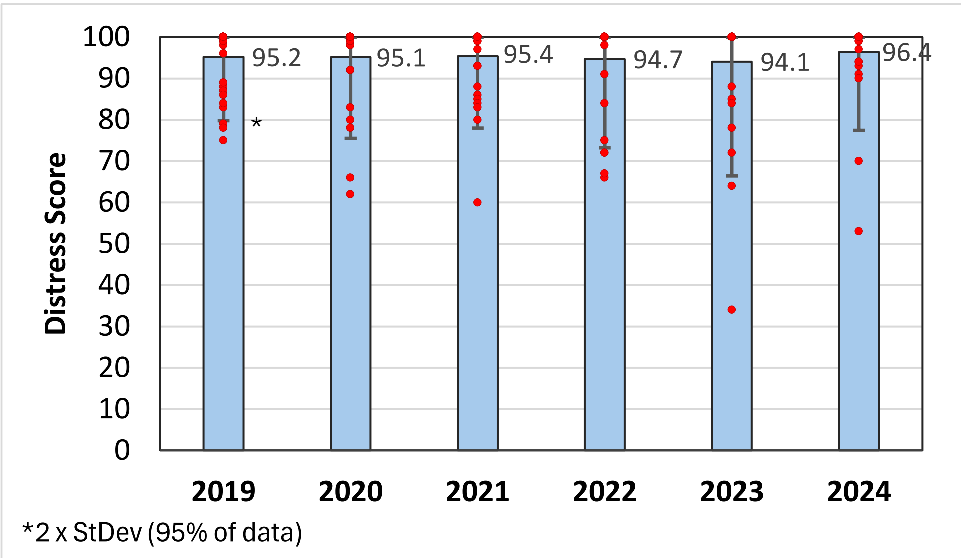

Figure 47. Distress Score Data versus Year, Project 1.

Project 1 Conclusion

Overall, this project was considered a success, and the data show that even 10 years after without any major repairs, the ride and distress were in good standings. Major contributing factors to the success were that widening did not occur in/near the wheel path of the lanes and that the subgrade was treated.

PROJECT 2—NARROW WIDENING IN GOOD CONDITION

Highway: FM 1001
District: Titus
County: Atlanta
Limits: STA 0+17.60 to STA 146+95.60
REF MRK NO 234+0.996 to REF MRK 226+0.000
Total Length: 9.04 miles
CSJ: 0734-02-016
Completion Year: 2010

This project is a collection of narrow widenings on different roads throughout Atlanta, as shown in Figure 48. One of the CSJs inside the project, a section of FM 1001 that underwent the narrow widening (varies from 1 to 3 ft), is also shown. This project was considered a success.

Project 2 Pavement Structure

Before construction, the pavement structure was 6 to 8 inches of flex base with multiple bituminous surfaces (e.g., chip seals). The widenings extended upon this 10 inches of flex base, shown in Figure 48. The surface of both the existing and new pavement were overlayed with a surface treatment.

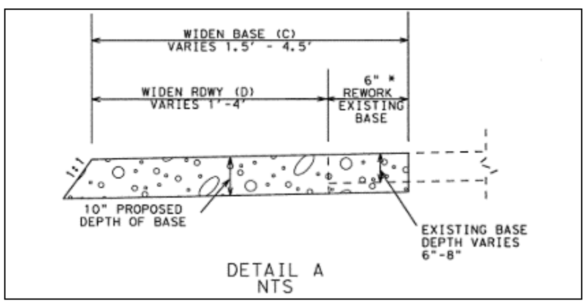

Figure 48. Widened Section Pavement Structure, Project 2.

Project 2 Typical Sections

The existing typical section had 9 or 10-ft paved lanes and a few feet of unpaved shoulders. The widenings varied between 1 to 3 ft of added paved shoulders in each direction of travel, shown in Figure 50. The widening cut into the existing pavement by 6 inches and included reworking the material. The widening joint was away from the wheel path. The edges had 10 ft of backfill added to maintain a safe and effective ditch slope.

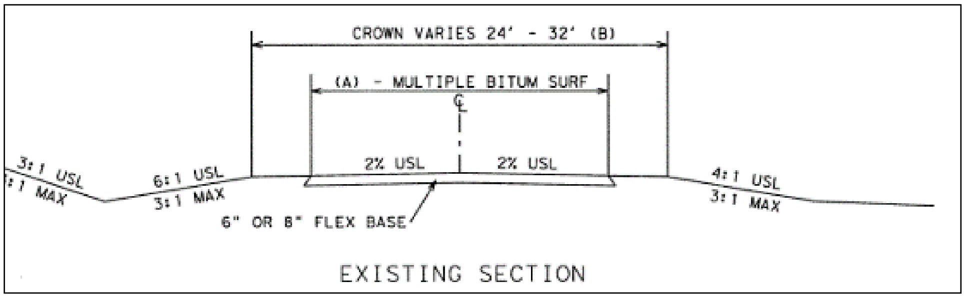

Figure 49. Pre-Construction Typical Section, Project 2.

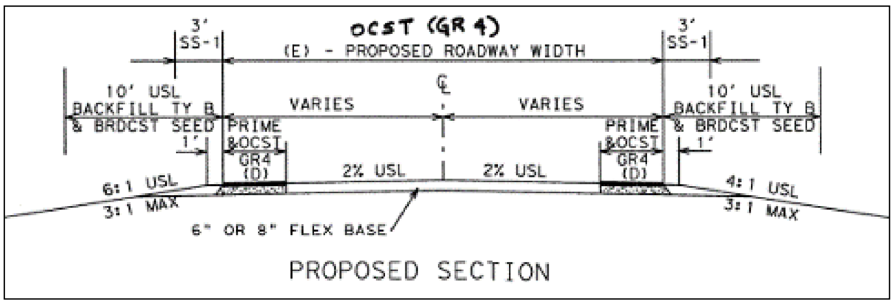

Figure 50. Post-Construction Typical Section, Project 2.

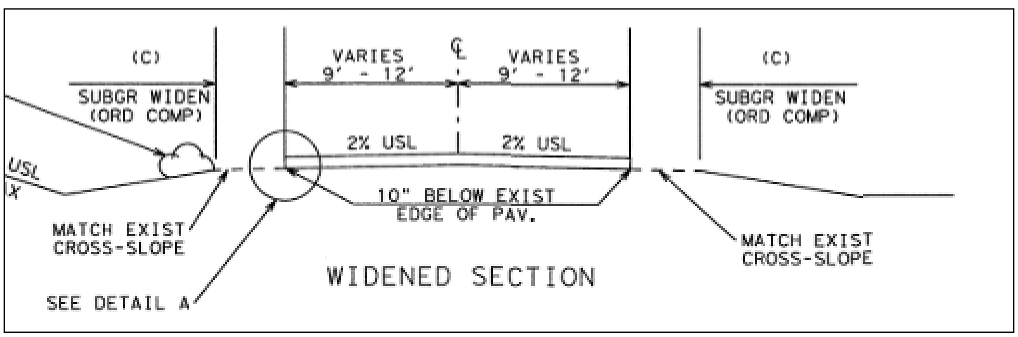

Figure 51. Post-Construction Widened Section, Project 2.

An example of Project 2 before and after the widening is shown in Figure 52.

Figure 52. Existing (2008) and Widened Pavement (2013), Project 2.

Project 2 Performance

The project was completed in 2010, and these data began 5 years later in 2015. The ride scores, shown in Figure 53, are consistent with averages all close to 3.5. The average distress scores, shown in Figure 54, all stay above 90.

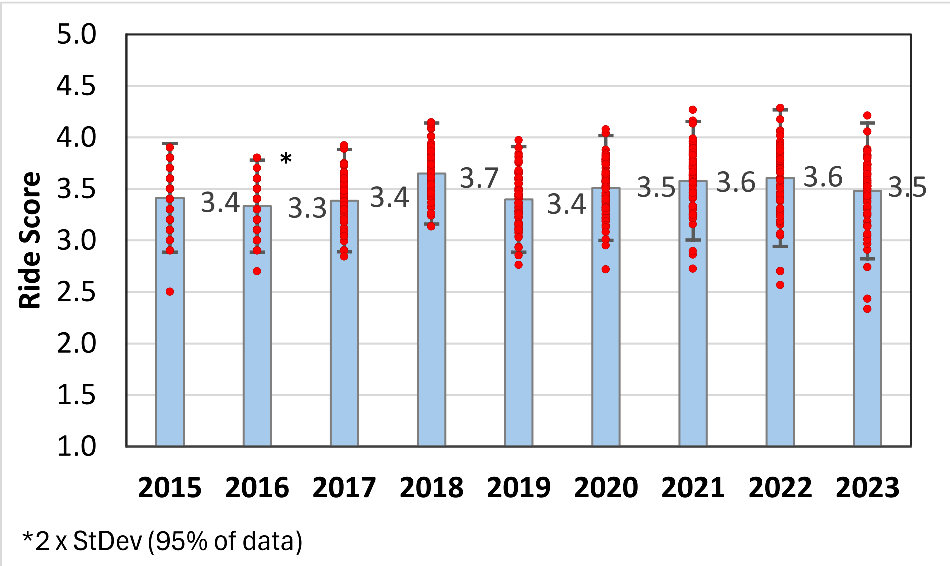

Figure 53. Ride Score versus Year, Project 2.

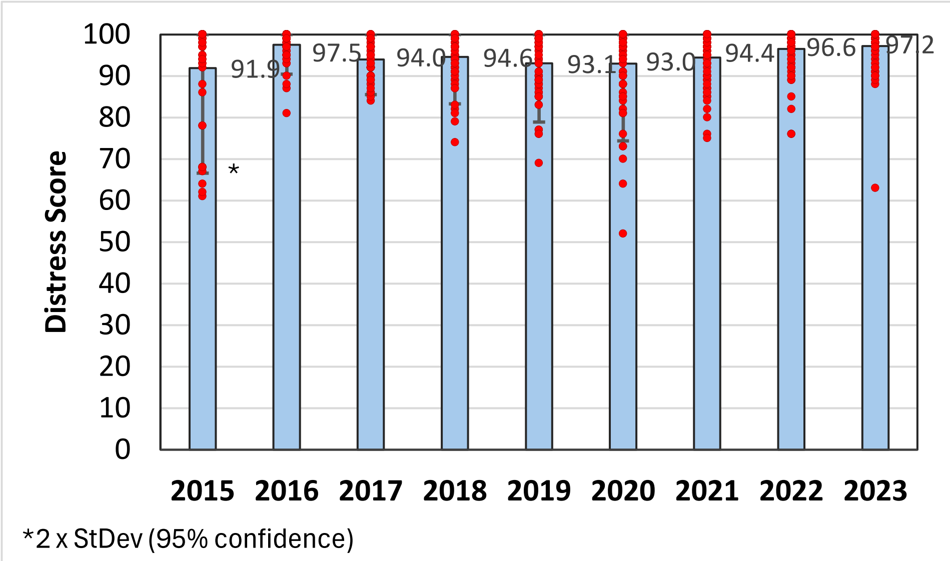

Figure 54. Distress Score versus Year, Project 2.

Project 2 Conclusion

Overall, this project was considered a success, and the data show that five years after construction, without any major repairs, the ride scores were average but consistent and the distress scores were good.

PROJECT 3—MULTI-LANE WIDENING WITH LOCALIZED FAILURE

In consideration of the agency and contractor, the location details of this project are anonymized.

Route: NA
District: NA
County: NA
Limits: NA
Total Length: 2.177 miles
CSJ: NA
Completion Year: 2020 (2018 pavement)

This project was a multi-lane widening on an urban minor arterial with 8000 average annual daily traffic (AADT) and 5 percent trucks. There were many additional factors at play such as curbs, gutters, and pavement markers. Paving was competed in 2018, and the project began seeing failures 6 months after in one lane. The outside lane was eventually milled and repaved as a result.

Project 3 Pavement Structure

The original pavement structure was 6 inches of asphalt concrete pavement over 6 inches of iron ore base. The pavement structure of the widened sections was 8 inches of cement/lime treated subgrade, 10 inches of flex base with a prime coat and blotter and surface treatment over it, and 2 inches of dense-grade Type C asphalt concrete surface. The widening was saw cut 6 inches into the existing pavement. This structure is illustrated in Figure 55. The intersection between the existing pavement and the widened section is shown in Figure 56. The existing road surface was milled, and the entire surface was inlayed with 2 inches of asphalt surface material.

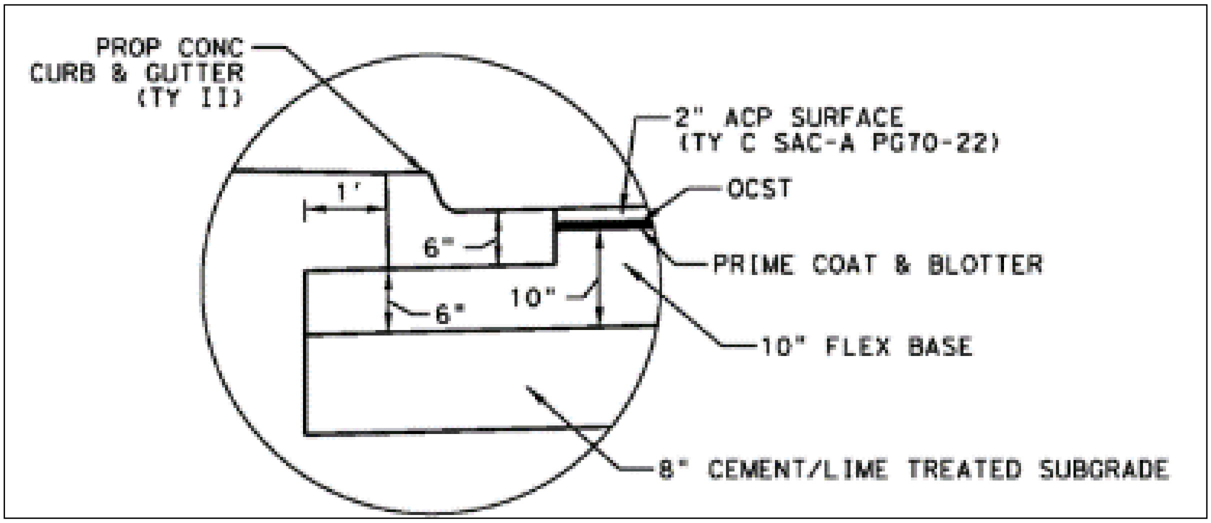

Figure 55. Post-Construction Widened Pavement Structure, Project 3.

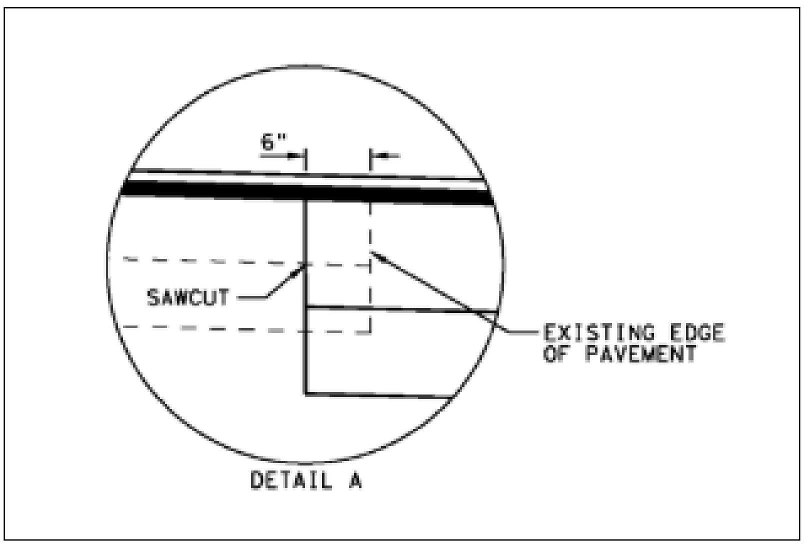

Figure 56. Intersection of Previous Pavement and New Pavement Structure, Project 3.

Project 3 Typical Sections

The previously existing typical section for much of the project was a two-lane road with 12-ft travel lanes and 8-ft shoulders on each side, as shown in Figure 57. The pavement structure in the travel lanes and shoulders was the same. Some sections varied to account for medians and turning lanes when necessary.

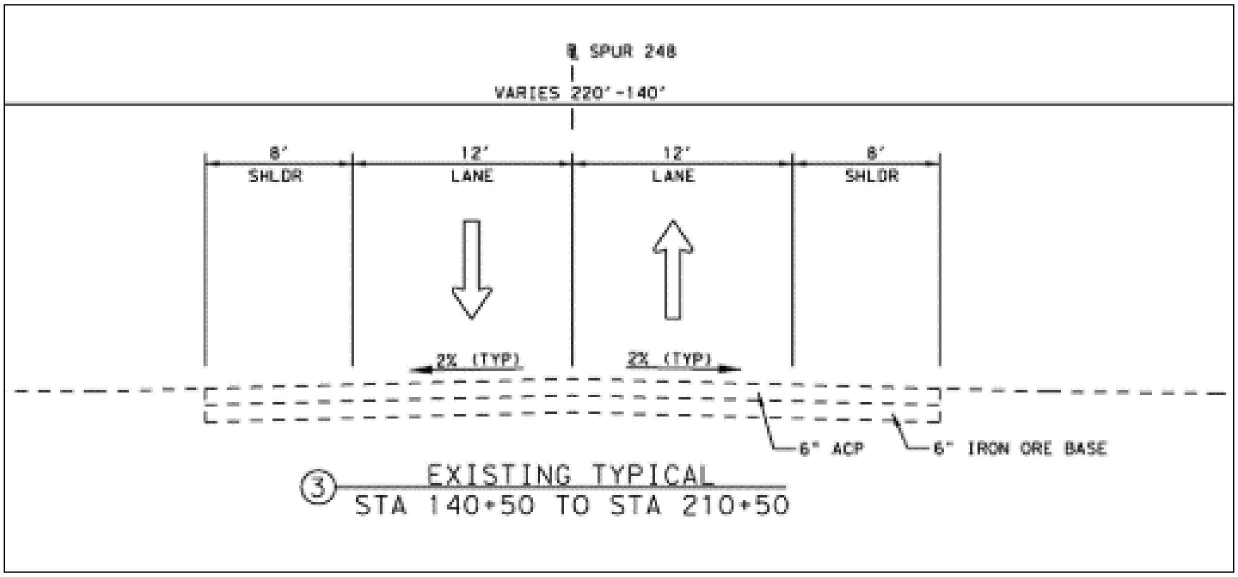

Figure 57. Pre-Construction Typical Section, Project 3.

The new typical section, shown in Figure 58, shows a widening of 19 ft on both sides to account for two lanes of travel in each direction, a center turning lane, and a bike lane in each direction of travel. The existing structure constituted the inside lanes and a two-way turn-lane, and the widening created 12-ft outside travel lanes, a bike lane, and curb and gutter. Another shorter section of the road had a 19-ft widening on one side and 31-ft widening on the other to account for an extra turning lane. The location of the widening joint was nearest the lane line but might encroach on the driver's side wheel path in the outside lane.

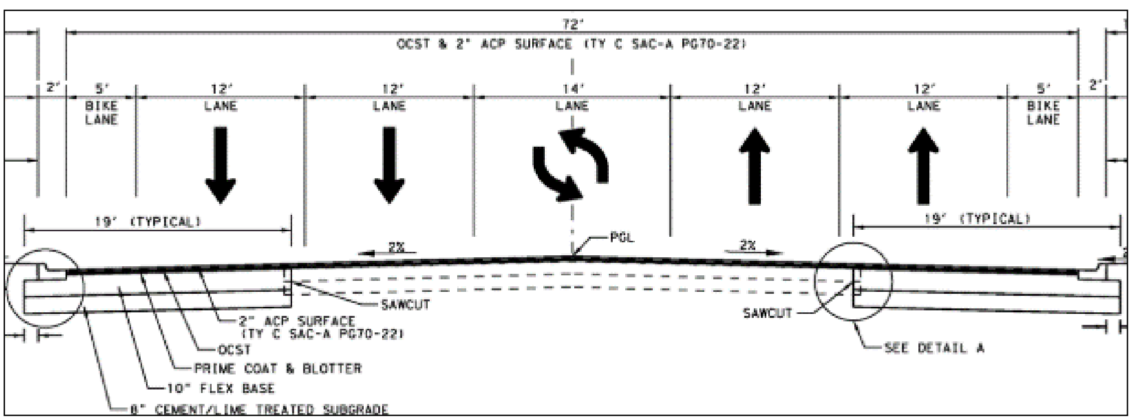

Figure 58. Post-Construction Typical Section, Project 3.

Figure 59. Existing Roadway and during Construction, Project 3.

Project 3 Performance

Six months after construction, significant fatigue cracking had developed in the outside wheel paths of the outside lanes (Figure 60). Cracking was worst in the westbound lane. TxDOT and TTI performed several forensic tests to determine what the issue might be.

Figure 60. Premature Fatigue Cracking, Project 3.

The forensic tests included coring, air void determination of cores, air void profiling with GPR, modulus testing of the stabilized base, and material characterization of the HMA. The cores verified that the widened HMA was 2 inches thick, compared to about 8 inches in the other lanes (Figure 61). The base appears to have been stabilized, but the plans show it as normal flex base. In some areas, the base layer was cracked near the top surface, like the cores in Figure 61.

Figure 61. Cores from Distressed Widening (left) and from Inside Lane (right).

The GPR air voids analysis is shown in Figure 62. These are heat-maps of the air voids content over the westbound outside and inside lanes. The color gradient matches the pay scale for the asphalt item, with green being full bonus. Red hatched areas were heavily distressed, and the data were omitted from the analysis. Figure 62 shows that the surface voids were highest in the outside lanes in the wheel path area. The inside lane had lower air voids overall. However, these results do not establish cause and effect. Most likely, the high air voids content is an indication that the surface is cracking, rather than the cause of the cracking.

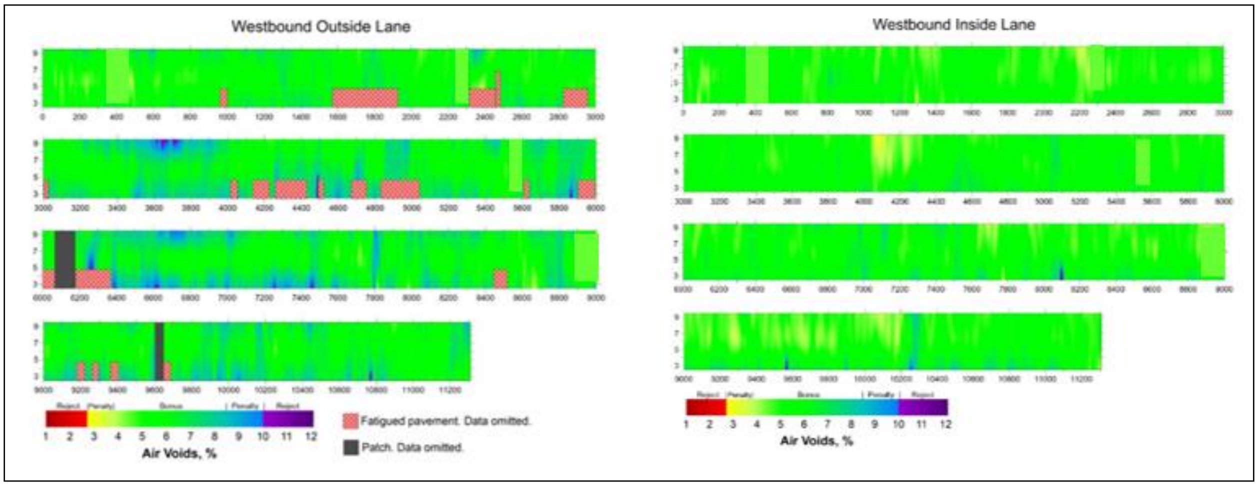

Figure 62. Air Voids Percent in Outside Lane (Left) and Inside Lane (Right), Project 3.

The most likely cause of the widening failure was an under-designed pavement structure. The base layer was not strong enough to support the 2 inches of HMA to prevent it from fatiguing. Then, when the base itself cracked in-situ, the HMA deterioration accelerated. Using a stiffer stabilized base could improve the design, as could using a thicker HMA.

Shortly thereafter, a complete mill-inlay of the outside lanes was performed. The completed repair is shown in Figure 63. Additional spot repairs have been performed in subsequent years.

Figure 63. Repaired Outside Widened Lanes, Project 3.

Project construction began during 2016 and finished in early 2020. The ride and distress score data shown in Figure 64 and Figure 65, respectively, cover one year before the project began to three years after construction finished. The average ride scores, shown in Figure 64, have a clear improvement in 2019 after paving, moving from about 3.5 to 4.25. The ride immediately drops the next year but then stabilizes at 4. The distress scores, shown in Figure 65, also improved in 2019 but degrade in 2020. But after another repair, the scores are maintaining a score of 100.

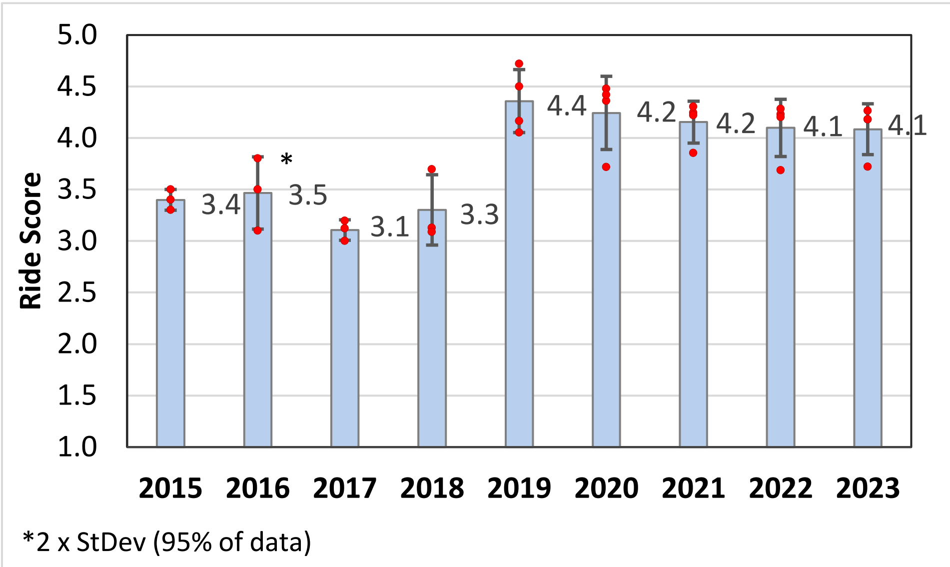

Figure 64. Ride Score versus Year, Project 3.

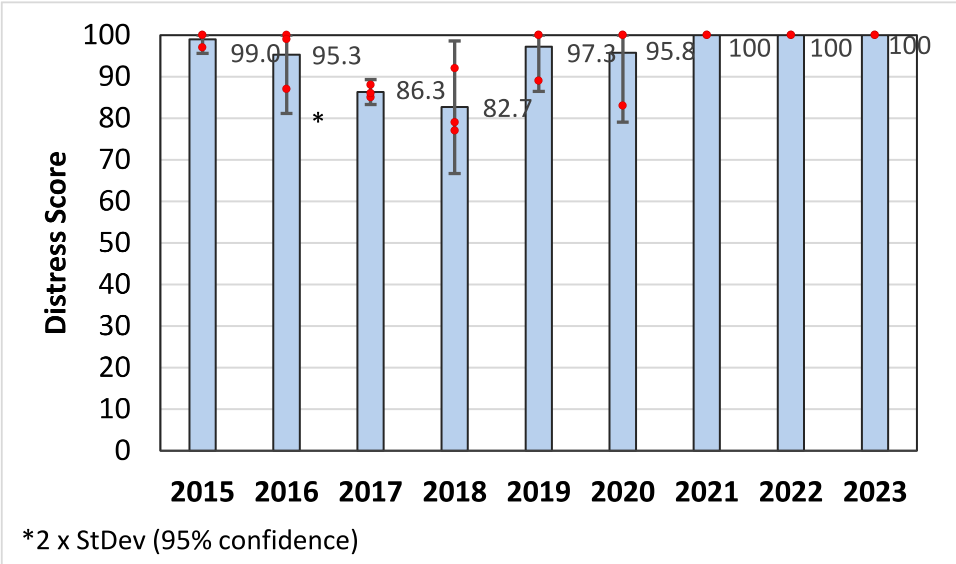

Figure 65. Distress Score versus Year, Project 3.

Project 3 Conclusion

Overall, this project was not considered a success since only six months later, much widened pavement fatigued was seen. After completion of the project, the ride and distress scores are both seen to improve and become more consistent, but this may be caused by other factors such as which lane the data were collected in. Only the exterior lanes of the project were seeing high levels of failure, possibly due to an under-designed pavement layer thinness.

PROJECT 4—NARROW WIDENING IN POOR CONDITION

In consideration of the agency and contractor, the location details of this project are anonymized.

Route: NA
District: NA
County: NA
Limits: NA
Total Length: 2.177 miles
CSJ: NA
Completion Year: 2018

This project was a narrow widening to add safety shoulders and increase the lane width. The road was a rural major collector with around 600 AADT and 18 percent truck traffic. This project is an example of failure in the outside wheel path due to poor subgrade support.

Project 4 Pavement Structure

The previously existing pavement structure was composed of four layers over an untreated subgrade. There were 2.5 inches of flex base on the bottom with 2 inches of HMA over this, then 6 inches of flex base, and finally a surface of 3 inches of HMAC. This can be seen in Figure 66. The structure for the widened section is 12 inches of flex base with approximately 1.5 inches of asphaltic concrete pavement level-up and surface treatment as the surface, which can be seen in Figure 67.

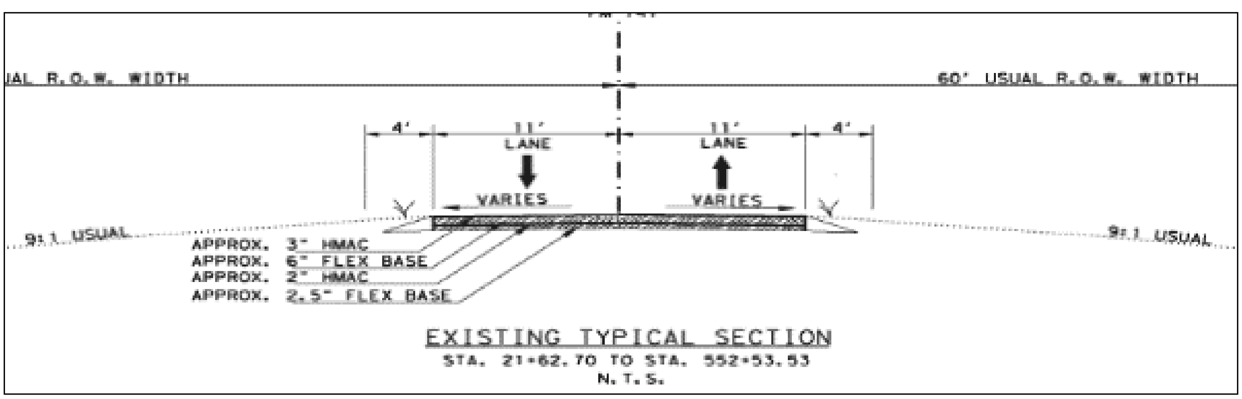

Figure 66. Pre-Construction Existing Typical Section, Project 4.

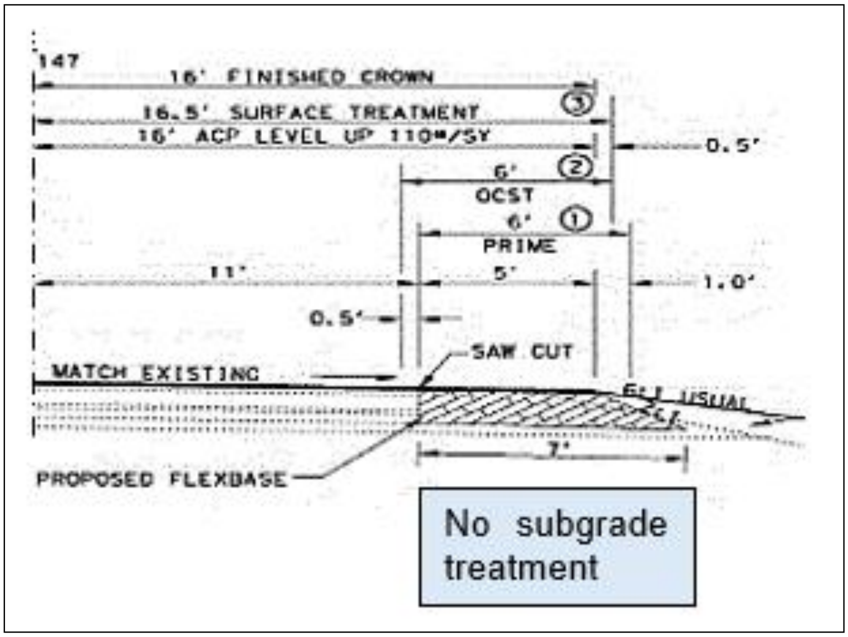

Figure 67. Post-Widening Pavement Structure, Project 4.

Figure 68 shows a visual for the difference in thickness between the existing pavement and the widening. Based on this data, it is apparent that the thinner widening structure is actually partially in the lane immediately next to the wheel path.

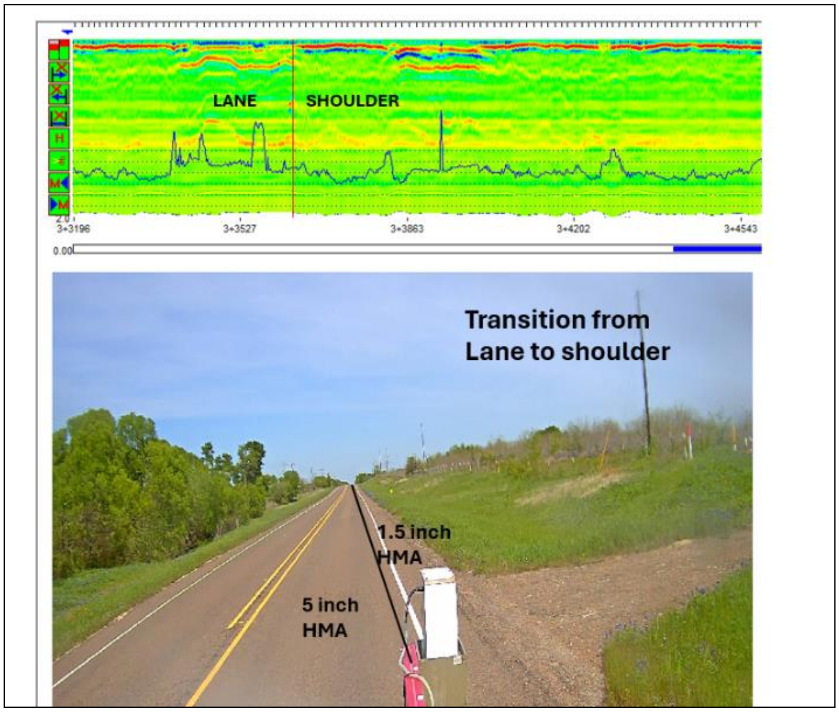

Figure 68. Surface Thickness Lane versus Widening, Project 4.

Project 4 Typical Sections

The previously existing typical section, shown in Figure 66, has one lane in each direction of travel.

The new typical section, shown in Figure 69, shows the widening of about 6 ft on each side of the road to accommodate for larger lanes and safety shoulders. As-needed patch work can also be seen in one of the lanes. The widening was inside of the lanes near the exterior edge and the wheel path. The differential widening leaves a joint near the outer wheel path.

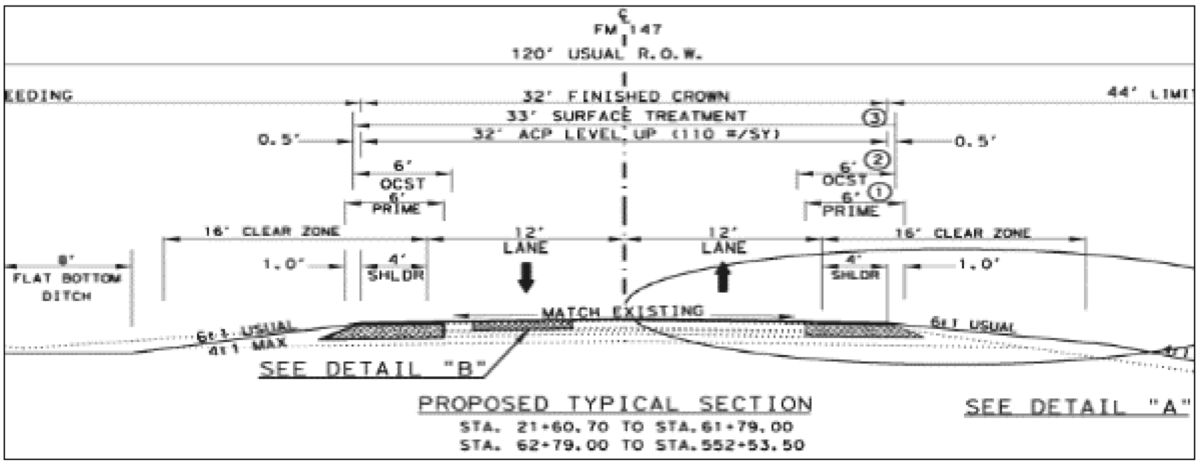

Figure 69. Post-Construction Typical Section, Project 4.

Project 4 Performance

The wheel path was cracking and potholing shortly after construction, as shown in Figure 70. The DOT has had to place emergency blade-on patches multiple times.

Figure 70. Deflection in Lane versus Shoulder in 2019, Project 4.

To analyze the issue, falling weight data were taken in the shoulder and in the old lane in alternating fashion throughout the project. During the visit, the researchers noted that drivers feel more comfortable driving away from the centerline on the two-lane road, especially heavy trucks (Figure 71). This puts the tires at the joint widening and over the widening itself. The falling-weight data clearly show just how much weaker the widened shoulder was (Figure 72). The issue could have been avoided by stabilizing the subgrade or designing a thicker surface layer, but the subgrade quality was not tested beforehand.

Figure 71. Traffic Tends to Drive near the Lane Edge and into the Widening, Project 4.

Figure 72. Deflection Data in Lane versus Shoulder, Project 4.

One rehabilitation option to get uniform section and move the joint out of the wheel path included:

- 8-ft-wide mill, remove top 3.5 inches starting in the middle of the lane and extending into shoulder.
- Rework base—ensure that uniform density is obtained.
- Prime and seal the base (seal is critical—perhaps inverted Prime RC 250 with Grade 5 rock).
- Place 3.5 inches of HMA (preferably 2 inches of Type B and 1.5 inches of Type D).

Construction began in 2015, and this project was completed in 2018. The ride score data, shown in Figure 73, start in 2015, with averages from 2015–2017 of around 3.75 until they are improved in 2018 to averages around 4.23 from 2018–2023. The average distress scores, shown in Figure 74, stayed generally the same throughout 2016–2022 at over 95. This was a slight increase from 2015, which was at an average of 90.

A change order occurred during the project to add subgrade stabilization. While this may have helped, the overall thinness of the widening surface (about 1.5 inches) combined with the sections that did not receive the subgrade stabilization caused the widening to have much pavement fatigue very quickly after construction (about six months.)

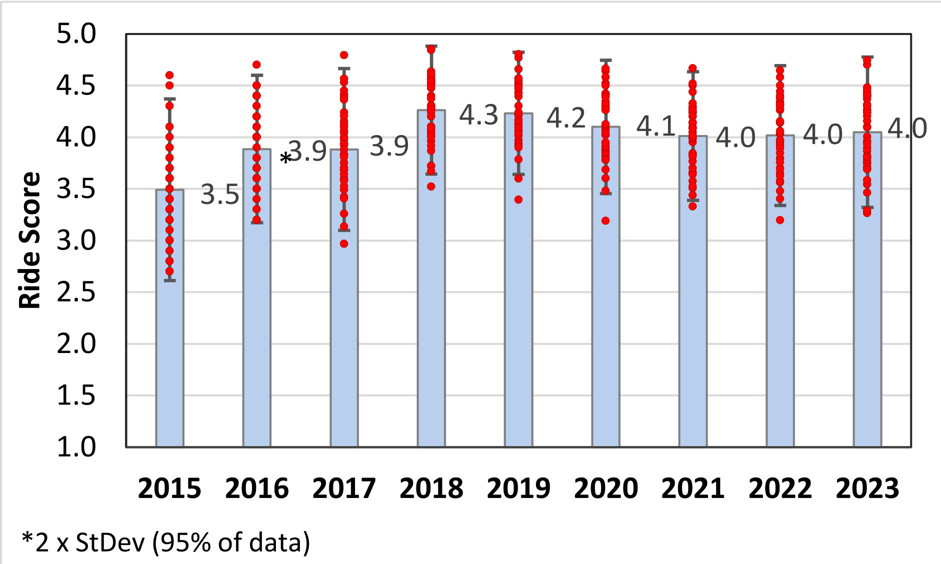

Figure 73. Ride Score versus Year, Project 4.

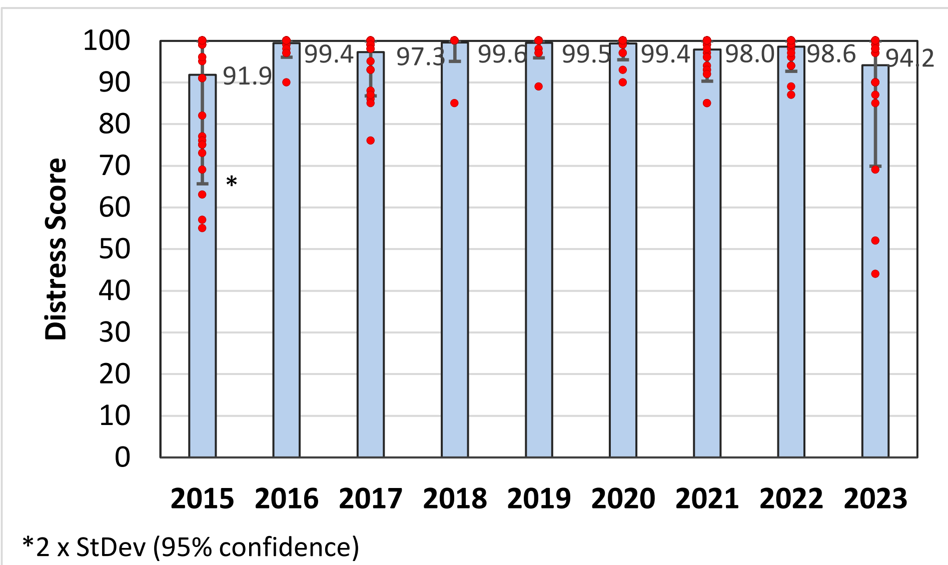

Figure 74. Distress Score versus Year, Project 4.

Project 4 Conclusion

This project was not considered a success due to rapid wheel path cracking and potholing in the widened sections within six months of construction. Forensic investigations revealed significantly weaker support in the widened shoulders compared to the existing lanes. The widening joint near the outer wheel path, inadequate surface thickness, inadequate subgrade stabilization, and lack of pre-construction subgrade testing likely contributed to the premature distress. Future widening projects should ensure adequate pavement thickness, competent subgrade support, and strategic joint placement away from wheel paths to avoid similar issues.

CASE STUDY OVERALL CONCLUSION

This chapter summarized case studies of four pavement widening projects in Texas, including two successful projects (Super 2 widening and narrow widening) and two poorly performing projects (multi-lane widening and narrow widening). The studies aimed to identify the factors contributing to the success or premature distress of each project.

Key lessons learned for successful pavement widening include:

- Placing widening joints away from wheel paths to minimize traffic loading on the joint.
- Ensuring adequate thickness and structural capacity of the widened pavement section to handle anticipated traffic.
- Stabilizing or improving subgrade and base layers to provide competent and uniform support, especially when the existing pavement layers are thin.
- Conducting pre-design testing of the existing pavement structure and subgrade to inform the widening design.
- Providing a robust and impermeable surface layer to protect the underlying widening layers from moisture intrusion.

By incorporating these best practices into future widening projects, TxDOT can improve the long-term performance and life cycle costs of widened pavements. The specific design and construction approaches should be tailored to the site conditions, traffic levels, and materials availability of each project.

CHAPTER 4. RECOMMENDATIONS

The research team developed a pavement widening best practices booklet, which can be found in product P1 from this research.

The research team reviewed existing TxDOT construction specifications, found in the Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges. The specifications relevant to pavement widening are shown in Table 6. Each item was reviewed by the research team. TxDOT just completed an extensive review and update to its specifications and has adopted them beginning September 1, 2024. The research team does not recommend changes and additions to current and proposed standard specifications or special specifications.

Table 6. 2024 TxDOT Specifications.

Item	Description
110	Excavation
112	Subgrade Widening
132	Embankment
134	Backfilling Pavement Edges
152	Road Grader Work
210	Rolling
216	Proof Rolling
247	Flexible Base
250	Geogrid Base Reinforcement
251	Reworking Base Courses
260	Lime Treatment (Road-Mixed)
275	Cement Treatment (Road-Mixed)
276	Cement Treatment (Plant-Mixed)
290	Emulsified Asphalt Treatment (Road-Mixed)
291	Foamed Asphalt Treatment (Road-Mixed)
292	Asphalt Treatment (Plant-Mixed)
320	Equipment for Asphalt Concrete Pavement
341	Dense-Graded Hot-Mix Asphalt
342	Permeable Friction Course
344	Superpave Mixtures
346	Stone-Matrix Asphalt
347	Thin Overlay Mixtures
348	Thin Bonded Friction Course
351	Flexible Pavement Structure Repair
356	Fabric Underseal
360	Concrete Pavement
361	Full-Depth Repair of Concrete Pavement

REFERENCES

1. TxDOT. Flexible Pavement Design: Pavement Detours and Pavement Widening. In *Pavement Manual*, Texas Department of Transportation.
2. California Transit Authority. *Chapter 680 - Pavement Design for Widening Projects*. 2020.
3. Burton, M., A. Smit, M. Trevino, J. Prozzi, and M. Murphy. *Best Practices for Flexible Pavement Structure Widening: Workshops*. Publication 0-6748-P2. Center for Transportation Research, The University of Texas at Austin, Austin, TX, 2013.
4. Burton, M., M. Y. Kim, A. Smit, M. Trevino, H. Wu, M. Murphy, and J. Prozzi. *Flexible Pavement Narrow Widening Best Practices and Lessons Learned*. Publication FHWA/TX-14/0-6748-2. Center for Transportation Research, The University of Texas at Austin, Austin, TX, 2013, p. 194.
5. Tsyganov, A. R., R. B. Machemehl, N. M. Warrenchuk, and Y. Wang. *Before-After Comparison of Edgeline Effects on Rural Two-Lane Highways*. Publication 0-5090–2. Center for Transportation Research, The University of Texas at Austing, Austin, TX, 2006.
6. Varin, P., and T. Saarenketo. *Road Widening Guidelines*. 2012.
7. Tikkanen, S. *Road Widening: Literature Review and Questionnaire Responses*. 2010.
8. Hilbrich, S., and T. Scullion. *Design Considerations for Flexible Pavement Widening*. Publication FHWA/TX-07/0-5429-1. Texas Transportation Institute, College Station, TX, 2007.
9. Applied Research Associates (ARA). *Improvement of Widening Joint Design and Construction Practices for Flexible Pavements*. Publication ARA TR-1-B04384. Tallahassee, FL, 2015.
10. TxDOT. Flexible Pavement Design: Pavement Detours and Pavement Widening. In *Pavement Manual*, Texas Department of Transportation.
11. TxDOT. Roadway Design Manual. http://onlinemanuals.txdot.gov/txdotmanuals/rdw/index.htm. Accessed Mar. 3, 2023.
12. Birgisson, B., and R. Roberson. Drainage of Pavement Base Material: Design and Construction Issues. *Transportation Research Record, Journal of the Transportation Research Board*, Vol. No. 1709, 2000, pp. 11–18.
13. Fleckenstein, L. J., and D. Allen. Evaluation of Pavement Edge Drains and Their Effect on Pavement Performance. *Transportation Research Record, Journal of the Transportation Research Board*, Vol. No. 1519, 1996, pp. 28–35.
14. TxDOT. *Treatment Guidelines for Soils and Base in Pavement Structures*. Materials & Tests Division, Soils, & Aggregates Section, Austin, TX, 2019.
15. Roper, M. B. *Evaluation of Laboratory Durability Tests for Stabilized Aggregate Base Materials*. Thesis - Master of Science. Brigham Young University, Provo, UT, 2007.
16. Scullion, T., S. Sebesta, J. P. Harris, and I. Syed. *Evaluating the Performance of Soil-Cement and Cement-Modified Soil: A Laboratory Investigation*. Portland Cement Association, Skokie, Illinois, 2004.
17. Wilson, B. T., W. S. Guthrie, and D. L. Eggett. Analysis of Fly Ash as a Partial Substitute for Portland Cement to Minimize Freeze-Thaw Damage in Cement-Treated Base. Presented at the 90th Annual Meeting of the Transportation Research Board, 2011.
18. Deschamps, R. J., C. S. Hynes, and P. Bourdeau. *Embankment Widening Design Guidelines and Construction Procedures*. Publication FHWA/IN/JTRP-99/04, 2039. Purdue University, West Lafayette, IN, 1999, p. FHWA/IN/JTRP-99/04, 2039.

APPENDIX A. SURVEY QUESTIONNAIRE

TxDOT 0-7188 Survey on Pavement Widening

Introduction

Pavement widening is commonly done to increase the capacity of the roadway and/or improve roadway safety. While the approach to building a widened pavement is similar to new construction, widening presents additional challenges for pavement design, constructability, and pavement management. The Texas Department of Transportation has funded a synthesis study on best practices for

pavement widening, including a survey of TxDOT district experience.

Survey Scope

This survey contains 33 questions about pavement widening practices. Specific topics addressed are:

- Project types and funding
- Pre-design evaluation
- Pavement layer design
- Longitudinal joints
- Narrow widenings
- Roadside drainage and utilities
- Existing pavement treatment
- Distress
- Rate widening challenges

The survey should take approximately 45 minutes.

Survey Completion Date

Please complete this survey by February 29.
If you have any questions or comments, please don't hesitate to contact me, Bryan Wilson, by email or phone.
Thank you!

Contact Information

Bryan Wilson, PhD, PE
Associate Research Engineer Texas A&M
Transportation Institute b-wilson@tti.tamu.edu
(979) 317-2331

Respondent Information

Name	
District/Division	
Position	
Phone number	
Email	

Project Types and Funding

Q1. How common are the following widening projects in your district?

Widening Project Frequency

	Never	Rare (1 every 4+ years)	Uncommon (1 every 2 to 3 years)	Somewhat common (1 or 2 each year)	Common (3 or more each year)
Adding travel lanes, auxiliary lanes, or passing lanes	○	○	○	○	○
Adding shoulders or pullouts	○	○	○	○	○
Shoulder or lane widenings, >6 ft	○	○	○	○	○
Narrow shoulder or lane widening, ≤6 ft	○	○	○	○	○
Curve realignment	○	○	○	○	○
Other (describe)	○	○	○	○	○

Q2. What funding sources are used for pavement widenings in your district? (Select all that apply.)

- ☐ CAT 1 - Pavement Preventative Maint. and rehab.
- ☐ CAT 8 - Safety.
- ☐ RMS - Routine Maintenance Contracts.
- ☐ In-house Maintenance Forces.
- ☐ Other (describe).

Q3. Describe any issues that funding or the funding categories themselves have presented to pavement widening projects.

Pre-Design

Q4. Which types of pre-design pavement evaluations do you employ when widening a pavement in good vs. marginal condition?
(Select all that apply.)

	Good condition (Distress Score > 80)	Marginal condition (Distress Score < 70)
Review as-built plans	☐	☐
Review pavement management data	☐	☐
Visual inspection	☐	☐
GPR survey	☐	☐
Deflection survey (FWD)	☐	☐
Roughness/rutting analysis	☐	☐
Drilling / sampling	☐	☐
Soil characterization (gradation, Atterberg limits)	☐	☐
Soil sulphate test	☐	☐
Stabilization design	☐	☐
Other	☐	☐

Q5. Describe any specific aspects of these pre-design evaluation tasks that are important to the success of pavement widening projects.

Pavement Layer Design

Q6. When designing a flexible pavement widening, do you do you match the existing layer materials and thicknesses?
(i.e., flexible or stabilized base, and hot mix asphalt.)

Never ○ Rarely ○ Sometimes ○ Often ○ Always ○

Q7. When not matching, how do the widening layer materials and thicknesses typically differ?

Q8. When designing a rigid or composite pavement widening, do you do you match the existing layer materials and thicknesses?
(i.e., subbase, concrete, and hot mix asphalt if any.)

Never ○ Rarely ○ Sometimes ○ Often ○ Always ○

Q9. When not matching, how do the widening layer materials and thicknesses typically differ?

Q10. Do you stabilize base and/or subgrade materials for pavement widening projects?

	Frequency				
	Never	Rarely	Sometimes	Often	Always
Base stabilization					
Subgrade stabilization					
Geogrid reinforcement					
Other (describe)					

Q11. Describe your approach to base stabilization.

Q12. Describe your approach to subgrade stabilization.

Q13. Describe your approach to geogrid reinforcement.

Q14. When the widening will be under live traffic, do you verify the structural adequacy of the design? Consider both new construction and incorporating an existing shoulder into the new travel lane.

Frequency to Verify Structural Adequacy

	Never	Rarely	Sometimes	Often	Always
New widening construction	○	○	○	○	○
Incorporated existing shoulder	○	○	○	○	○

Q15. How do you verify the structural adequacy?

Widening Cut and Longitudinal Joints

Q16. What method is used to cut into the existing pavement?

Never		Rarely	Sometimes	Often	Always
Blading Milling	○	○	○	○	○
Sawing	○	○	○	○	○
	○	○	○	○	○

Q17. Does the cut-in method affect the performance of the widening? Please explain how.

Q18. Are longitudinal construction joints located away from the wheel path in your widening designs?
Consider both the final layer joint and widening cut joints below the surface.

Frequency Located Away from Wheel Path

	Never	Often	Sometimes	Often	Always
Final HMA layer joint	○	○	○	○	○
Widening cut joints, below the surface	○	○	○	○	○

Q19. Between which of the following layers do you typically notch (i.e. off- setting the construction joints) in your widening designs?
(Select all that apply.)

- ☐ Surface HMA / Intermediate HM
- ☐ HMA / Base
- ☐ Base / Subgrade
- ☐ Concrete / Subbase (Rigid pavement)
- ☐ HMA / Concrete (Composite pavement)

Q20. What other design or construction practices are important for successful widening joints?

Narrow Widenings

Q21. What is the minimum feasible width for constructing a pavement widening to acceptable standards?

	Feet								
	0	1	2	3	4	5	6	7	8
Minimum width									

Q22. How are narrow widenings managed during the design process and/or during construction?

Roadside Drainage and Utilities

Q23. Is appropriate ditch geometry and other drainage features considered in your pavement widening designs?
(i.e. fore slope, back slope, depth, grading)

Never	Rarely	Sometimes	Often	Always
○	○	○	○	○

Q24. Describe your approach to drainage design in widenings.

Q25. How do you manage drainage design when widening with limited right-of-way and in a built urban environment?

Q26. How do you manage utility conflicts in widenings?

Existing Pavement Treatment

Q27. Do you perform maintenance or rehabilitative work on the existing pavement in conjunction with new widenings?

Never	Rarely	Sometimes	Often	Always
○	○	○	○	○

Q28. Which types of preventative or rehabilitative work have been performed on the existing pavement in conjunction with new widenings? (Select all that apply.)

- ☐ Crack seal
- ☐ Full-width surface seal
- ☐ Full-width overlay
- ☐ Milling + full-width overlay
- ☐ Partial or full-depth recycling
- ☐ Other (describe)

Widening Distresses

Q29. How often have you seen these distresses on widening projects?

Approximate frequency with respect to all widening projects. "Very Often" is defined as occurring on more than 20% of widening projects.

Approximate Frequency

	Never (0%)	Rarely (1-5%)	Occasionally (6-10%)	Sometimes (11-15%)	Often (16-20%)	Very Often (>20%)
New pavement						
Joint cracking	◯	◯	◯	◯	◯	◯
Reflection cracking of subsurface joint	◯	◯	◯	◯	◯	◯
Settlement / rutting	◯	◯	◯	◯	◯	◯
Fatigue cracking	◯	◯	◯	◯	◯	◯
Edge cracking	◯	◯	◯	◯	◯	◯
Edge drop-off	◯	◯	◯	◯	◯	◯
Existing pavement						
Rutting (existing pavement)	◯	◯	◯	◯	◯	◯
Fatigue cracking (existing pavement)	◯	◯	◯	◯	◯	◯
Misc						
Poor drainage	◯	◯	◯	◯	◯	◯

Other (describe)

Q30. Which of these distresses have required expedited repairs on widening projects? (Select all that apply.)

- ☐ » Joint cracking
- ☐ » Reflection cracking of subsurface joint
- ☐ » Settlement / rutting
- ☐ » Fatigue cracking
- ☐ » Edge cracking
- ☐ » Edge drop-off
- ☐ » Rutting (existing pavement)
- ☐ » Fatigue cracking (existing pavement)
- ☐ » Poor drainage
- ☐ » Other (describe)

Overall Rating of Widening Challenges

Q31. On a scale of 1 to 5, rate how challenging the following items are to the success of pavement widening projects in your district?
1 = Not a Challenge and 5 = Very Challenging.

	Not a challenge 1	2	3	4	Very challenging 5
Funding level / category	○	○	○	○	○
Adequate pre-design pavement evaluation	○	○	○	○	○
Structural adequacy of design	○	○	○	○	○
Structural adequacy of existing	○	○	○	○	○
Quality/selection of materials	○	○	○	○	○
Stabilization design	○	○	○	○	○
Joint location vs. wheel path	○	○	○	○	○
Notching between layers (joint offsets)	○	○	○	○	○
Maintenance or rehab. of existing pavement	○	○	○	○	○
Limited right-of-way	○	○	○	○	○
Drainage design	○	○	○	○	○
Narrow widening (<6 ft)	○	○	○	○	○
Quality of compaction	○	○	○	○	○

	Not a challenge 1	2	3	4	Very challenging 5
Quality of compaction	○	○	○	○	○
Quality of stabilization	○	○	○	○	○
Proper equipment	○	○	○	○	○
Work force experience	○	○	○	○	○
QC/QA	○	○	○	○	○
Traffic management	○	○	○	○	○
Access management	○	○	○	○	○
Other (describe)	○	○	○	○	○
	○	○	○	○	○

Q32. What other pavement widening practices or experiences would be helpful for the research team to know?

Conclusion

Q33. Would you be willing to participate in the next research task, in which the research team evaluates existing widening projects in good and poor condition?

(Effort includes identifying projects, and providing historic design, construction, and performance documentation.)

○ Yes
○ No

This is the end of the survey.

You may review your answers with the "Survey Sections" button. Please do this if you are still collaborating on questions with others in your district or division.

When you are satisfied with your answers, press the "Submit" button to finish the survey.