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16. Abstract

In the early 1990s several Texas Department of Transportation (TxDOT) districts started using full depth recycling (FDR) techniques to rehabilitate their roadways. A variety of stabilizers were used including cement, lime, fly ash, and asphalt emulsions.   Project 0-4182 was initiated to survey the performance of the initial FDR projects, to document what successes and problems have been identified, and to develop recommendations for those districts wishing to embark on FDR programs. In this project nondestructive testing (NDT) was conducted in six districts with both the falling weight deflectometer (FWD) and ground penetrating radar (GPR); visual condition surveys were completed and discussions were held with district and area office personnel.

Although the majority of the pavements surveyed in this study were found to be performing well, several problems were documented. These problems include longitudinal cracking in sections built in East Texas on clay subgrades, bonding problems with primarily fly ash treated bases, and excessive cracking with some cement treated bases. To address each of these problems the TxDOT districts have developed new construction specifications and improved design criteria, which are documented in this report. Environmental factors also appear to play a big role in constructability and performance of emulsions and fly ash treated bases. Their performance has been good in west Texas and the panhandle, but they have not performed well in the high humidity/high rainfall areas of east Texas.

The NDT in the project design phase to assist in the pavement design process and the heavy involvement of the district laboratory in selecting and controlling the stabilization process on a project-specific basis appear to be key factors in establishing a successful FDR program.   Based on the results presented, consideration should be given to modifying current construction specifications.

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FIELD PERFORMANCE AND DESIGN RECOMMENDATIONS FOR FULL DEPTH RECYCLING IN TEXAS

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DISCLAIMER

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 the Federal Highway Administration (FHWA) or the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation. The engineer in charge was Tom Scullion, P.E., (Texas, #62683).

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Special thanks go to the falling weight operators—Roger Wells from Amarillo, Carlton Womack from Dallas, and Tracy House from Austin, who collected data on many miles of Texas highways. Ronald Hatcher, the laboratory supervisor from Childress, is acknowledged for his help in locating project design information and for providing an insight into how the Childress District does project-level testing. Lee Gustavus from Texas Transportation Institute (TTI) helped with all of the ground penetrating radar (GPR) data collection.

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CHAPTER 1
INTRODUCTION

Rehabilitating an old pavement by pulverizing and stabilizing the existing pavement is a process referred to as full depth recycling (FDR). The stabilized layer becomes either the base or subbase of the new pavement structure. This process is relatively new to Texas. In the early 1990s the Bryan and Lubbock Districts constructed their first few projects on low-volume roadways. Initial experiences in those districts were positive, and both districts have now recycled several hundred miles of low-volume roadways.

The first step in the construction sequence is to pulverize the existing pavement as shown in Figure 1. A second pass is often made to add the required stabilizer. In Texas a range of traditional stabilizers have been used including cement, lime fly ash, and asphalt emulsions. Curing and priming practices are known to vary substantially around the state and are subject to external factors such as the need to open the highway to traffic as soon as possible. In many areas in East Texas the highways are normally subjected to traffic at the end of a day's construction.

Figure 1. FDR on US 290 in the Bryan District.

The reported success in the Bryan and Lubbock Districts has caused many districts to initiate FDR programs. There is also interest to move the process to higher volume roadways. In a state the size of Texas there are numerous concerns about the best engineering practices to use with this process. For example, several questions were raised which included:

- What testing should be done prior to pavement recycling?
- How should stabilizer types and amounts be designed in the laboratory?
- How are the current projects performing in the various regions of Texas?
- What lessons can be transferred to districts wishing to initiate FDR programs?
- What revisions are needed to meet current specifications?
- From existing sections what layer moduli values are appropriate for future pavement designs?

Project 0-4182 entitled “Full Depth Recycling: Field Performance and Design Guidelines” was initiated in the fall of 2000 to address these issues. The first task of this project was to survey current district practice with regard to their use of FDR techniques. Of the 25 districts surveyed, 16 indicated that they had built one or more sections. Chapter 2 presents the results from the questionnaire survey.

The main focus of this project was to visit districts that are active in FDR and to survey the performance of field sections. The researchers visited the following six districts in this project:

1) The Bryan District has primarily used either cement or lime to upgrade its farm-to-market (FM) network. The subgrades in this district are very variable, but it has large areas of highly plastic clays. The existing FM road network is very thin (typically 6 inches of flexible base) and has multiple surface treatments. The district has high rainfall, high humidity, and relatively warm/wet winters.
2) The Lubbock District has made widespread use of fly ash to treat its low-volume FM roadways. This district has relatively good subgrades, low humidity, and low rainfall.
3) The Amarillo District has used a variety of stabilizers with mixed success. Although it found problems with calcium-based stabilizers, the district has several sections constructed with asphalt emulsions that are reported to be performing well. The

district has relatively good subgrades and low humidity, but it does experience cold winter weather with several freeze/thaw cycles each year.

4) The Childress District largely uses fly ash to treat its roadways. This district uses FDR techniques for both high-volume and low-volume roadways. The subgrades in this district are good with low humidity.
5) The Yoakum District largely uses lime to rehabilitate its FM network. The researchers selected this district because it constructed an experimental section in which the traditional lime treatment was compared with an asphalt emulsion section. The district has typically fair subgrades with high humidity.
6) The Waco District has not made widespread use of FDR techniques, but it did construct an experiment on a FM roadway in which four different treatments were compared.

In each case the research team collected falling weight deflectometer (FWD) and GPR to document both in-situ strengths and subsurface moisture conditions. The performance of the sections was monitored and, where possible, existing laboratory design data were assembled. Interviews were also conducted with several district pavement engineers and area engineers to discuss the do's and don'ts of the FDR process. The results from the district visits are presented in Chapter 3 of this report.

In Chapter 4 the researchers summarize all of the information generated and develop laboratory design and pavement design guidelines for TxDOT.

CHAPTER 2
SURVEY OF DISTRICT EXPERIENCE

SURVEY RESPONSES

Researchers conducted a survey of current pavement reclamation practices in Texas as part of this project. Mark Thomlinson, the Amarillo District engineer, sent the survey to each district pavement engineer by e-mail in January 2001. Survey responses were received from the following 16 districts: Abilene, Amarillo, Atlanta, Beaumont, Brownwood, Bryan, Childress, Corpus Christi, Fort Worth, Houston, Laredo, Lubbock, Pharr, Tyler, Wichita Falls, and Yoakum. All of these districts reported using pavement reclamation techniques, although the Houston District employs a plant-mixing method rather than the practice of mixing in place. The responses of each district to the survey questions are summarized in this chapter. Each of the 12 questions presented in the text below is followed in most cases by a figure and a detailed discussion of the answers provided.

Approximately How Many Projects Has Your District Completed in the Last Five Years?

As shown in Figure 2, about 50 percent of the districts responding to the survey completed, on average, one pavement reclamation project per year during the last five years. The Abilene and Bryan Districts most frequently employ FDR, reporting completion of more than 30 projects during the last five years in each district. Other districts more frequently using pavement reclamation techniques include the Lubbock, Yoakum, Corpus Christi, Atlanta, Childress, and Laredo Districts, in descending order.

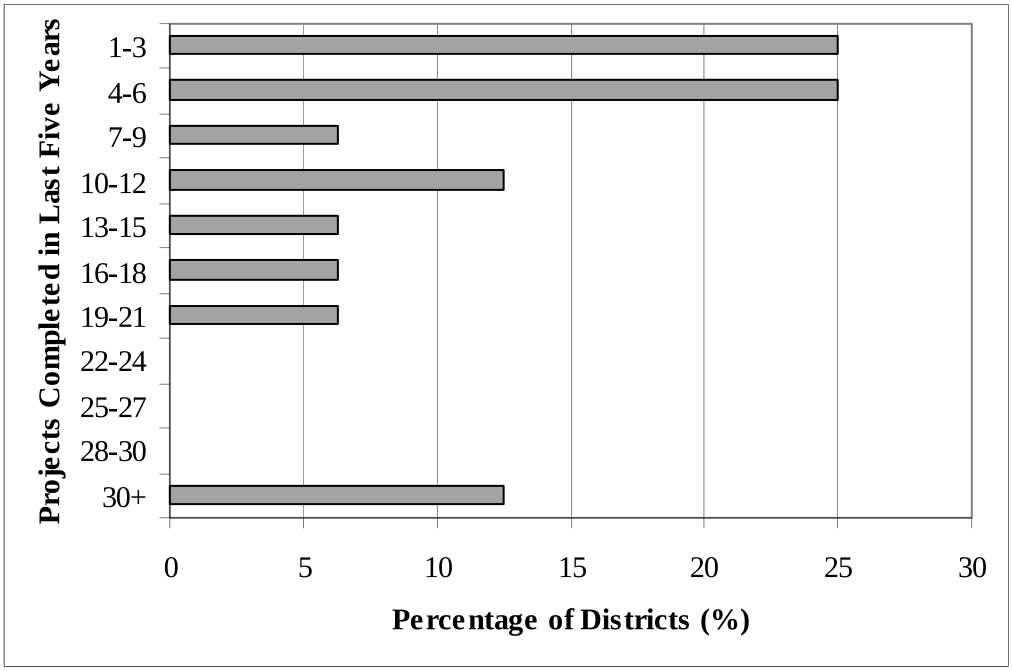


Figure 2. Projects Completed in Last Five Years.

What Types of Performance Problems Have You Encountered?

Figure 3 indicates that longitudinal and transverse cracking are the problems most often encountered with reclaimed pavements. Some districts indicated that combinations of these problems ultimately led to unacceptable pavement roughness. Water sensitivity was reported in the Atlanta, Beaumont, Bryan, and Pharr Districts. The Childress District reported finishing and priming problems on pavements reclaimed using fly ash. The Bryan District also noted problems with finishing, but attributed them to traffic control procedures. The Abilene and Corpus Christi Districts did not report any routine deficiencies with the performance of reclaimed pavements in those jurisdictions.

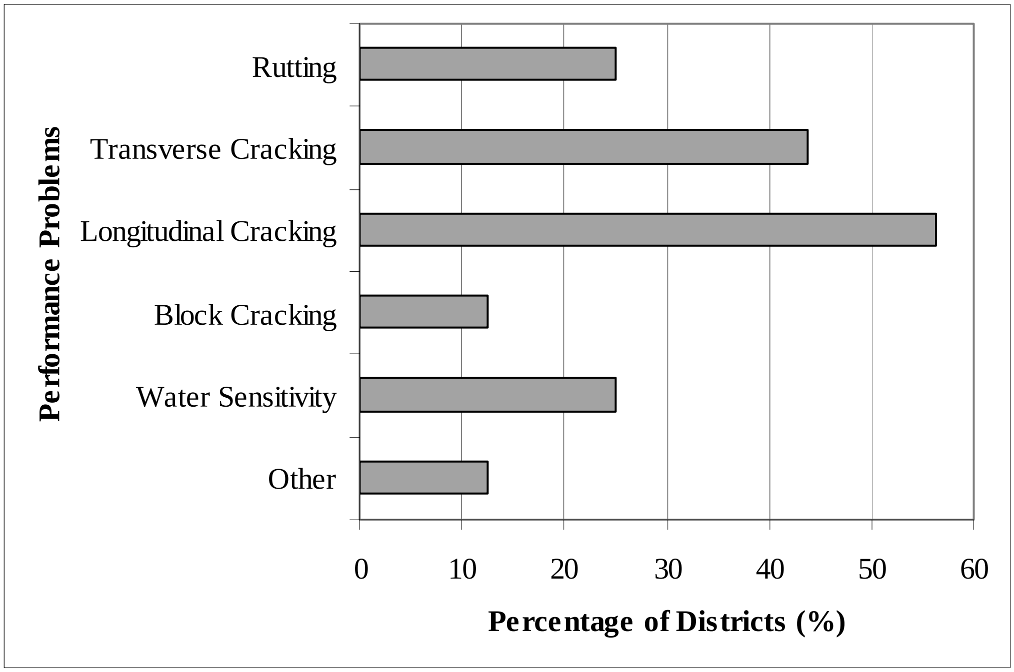


Figure 3. Performance Problems.

What Characteristics Are Used to Select Candidate Sections?

Figure 4 shows that distress and traffic levels are the most important factors in selecting a candidate pavement section. Several of the districts check Pavement Management Information System (PMIS) scores for comparison with maintenance costs and input from area engineers and maintenance supervisors to assist in selection of candidate sections. Most of the projects are completed on distressed low-volume roads, although the Abilene, Bryan, and Lubbock Districts reported using the technique on higher volume corridors as well. Lower traffic volumes can be more easily handled on newly reclaimed roadways where the surface layer has not yet been placed. The Brownwood District reported that the method is especially effective on roads requiring repeated maintenance efforts involving deep cold mix patches just to obtain acceptable ride quality. Several districts apply the technique given evidence of base failures, although the Houston District prohibits reclamation when the aggregate, such as river gravel, has proven to be a poor performer. The pavement thickness specification applied by the Childress District requires that the roadway be 8 inch or less in order to consider pavement reclamation techniques. Some districts noted that the ability of adjacent developments to tolerate the dusting that results from pavement reclamation activities was also an important factor.

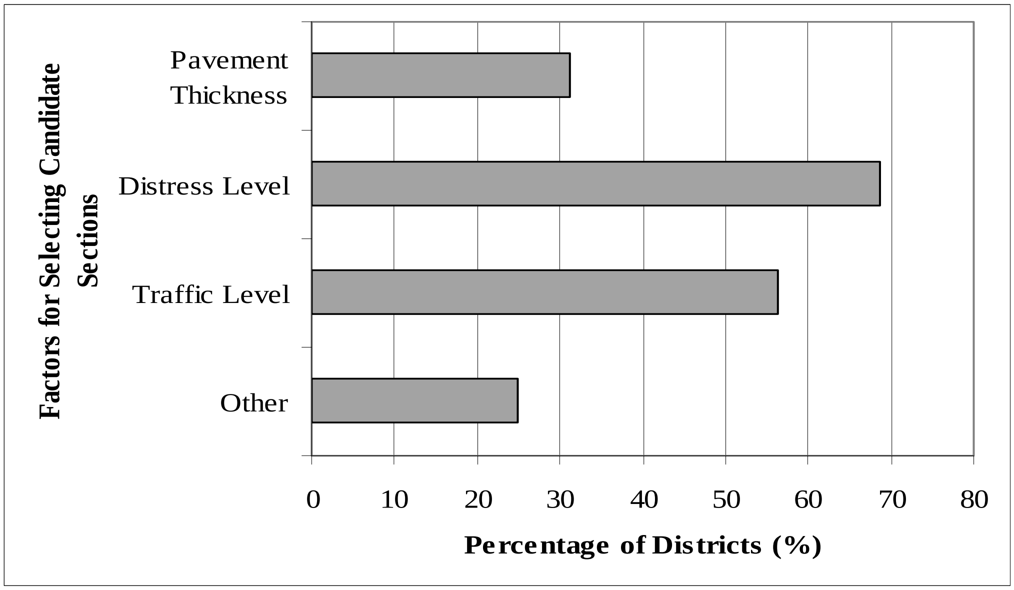


Figure 4. Factors for Selecting Candidate Sections.

What Types of Pavement Evaluations Are Completed on Candidate Sections?

Survey responses given in Figure 5 indicate that evaluations of candidate sections are most often completed with falling weight deflectometers, visual distress ratings, and coring. Many districts also use driving inspections to informally determine the condition of each candidate section. The use of ground penetrating radar seems limited to the evaluation of high-volume roadways.

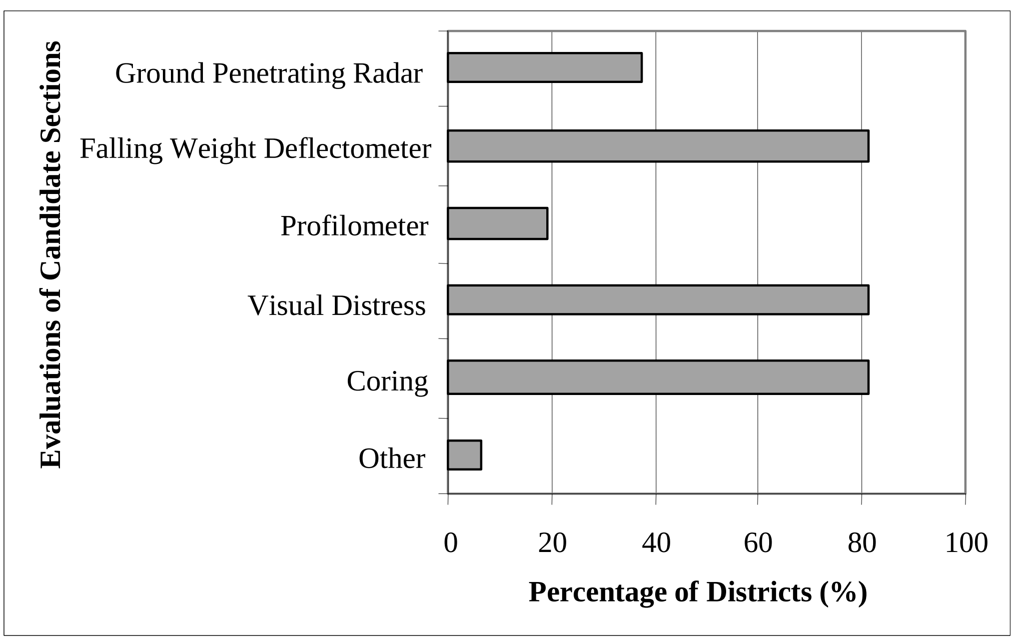


Figure 5. Evaluations of Candidate Sections.

What Types of Stabilizers Are Used?

Figure 6 shows that cement and lime are the most common stabilizers used in pavement reclamation projects. Other stabilizers include mixtures of 3 percent lime and 6 percent fly ash and combinations of 1 percent cement with foamed asphalt. Products such as Roadbond™ or EN1™ also have been utilized. The Childress District reclaims some sections without using any stabilizer at all. Four of the districts applying cement use as much as 6 percent, but most use between 1 and 4 percent. The use of lime varies from 1 to 10 percent, with most districts using less than 6 percent. Fly ash usage also varies between 1 and 10 percent. Emulsions are used by the Amarillo, Beaumont, and Yoakum Districts in amounts ranging from 1 to 7 percent.

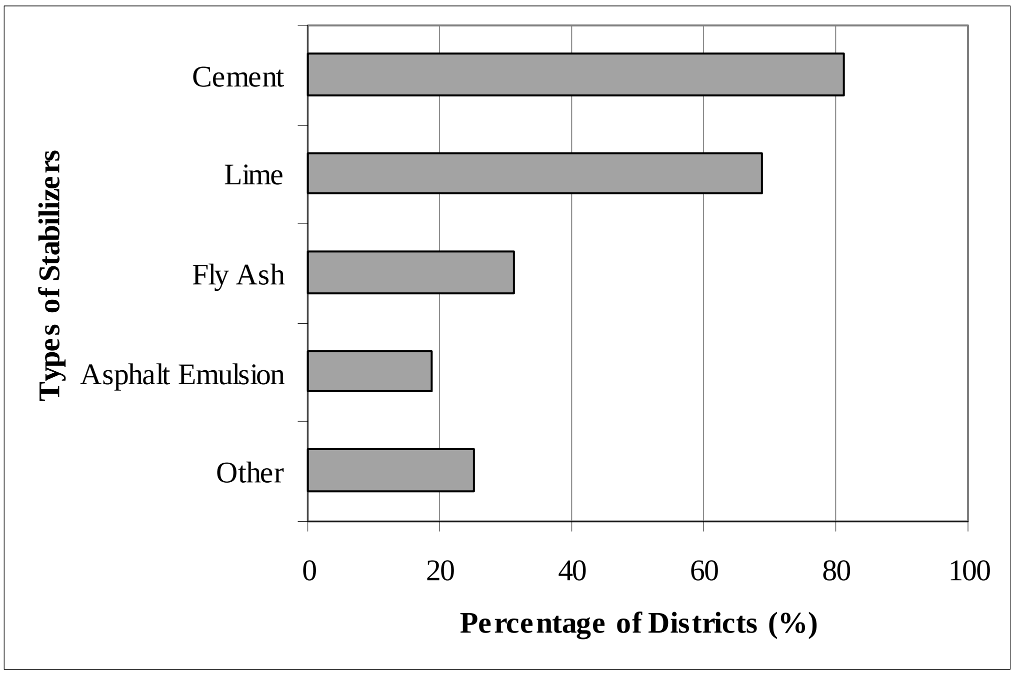


Figure 6. Types of Stabilizers.

What Factors Are Used to Determine the Type of Stabilizer?

According to Figure 7, district experience is the most important factor in determining the type of stabilizer used in pavement reclamation projects. Some laboratory testing is conducted, however, the Fort Worth District utilizes laboratory and field testing to investigate the suitability of the in situ aggregate for cement stabilization before proceeding with pavement reclamation. When lime is proposed as a stabilizer, the Atlanta District determines the mineralogy, gradation, plasticity index, and depth of the base material. For a low plasticity index, cement is often recommended, while lime is utilized for stabilizing materials with a high plasticity index. The

Bryan District sometimes uses the tube suction test (TST) to determine the type of stabilizer. Other districts also use triaxial strength testing and densities to compare improvements resulting from different stabilizers. Some districts also consider the ability of the unsurfaced road to withstand traffic, where cement is thought to perform better than lime or fly ash. Surveys cited an interest in new products and methods as a factor in selecting the type of stabilizer.

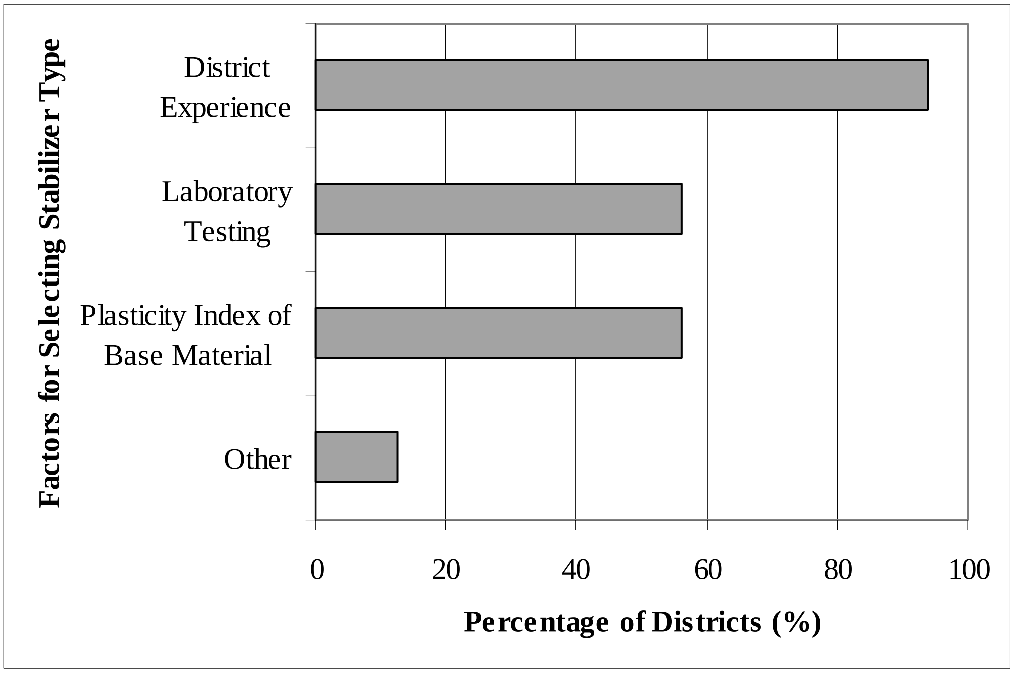


Figure 7. Factors for Selecting Stabilizer Type.

What Factors Are Used to Determine the Amount of Stabilizer?

As in the selection of the type of stabilizer, district experience is the paramount factor in determining the amount of stabilizer as shown in Figure 8. Compressive strength is the second most important factor, with target strengths most commonly between 150 and 350 psi. The Abilene District reported the lowest target strength, which was just 35 psi. Only the Bryan District reported using results of the tube suction test for determining the amount of stabilizer to use in pavement reclamation projects. Specific to lime stabilization, pH testing is used by some districts.

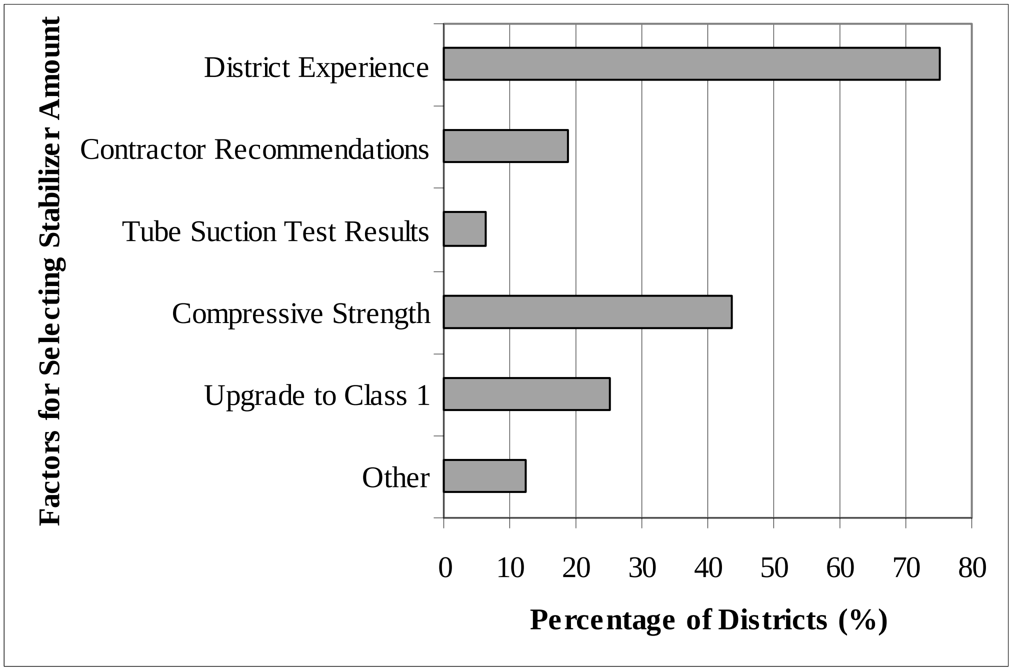


Figure 8. Factors for Selecting Stabilizer Amount.

What Construction Specifications Do You Use?

Figure 9 shows that most districts use a compaction specification to control the construction quality of reclaimed pavements. For gradation, compaction, and curing, many districts cited adherence to Items 260, 262, 275, and 276 in the Texas Standard Specifications. The Abilene District prohibits trafficking and the placement of the surface layer until the curing process reduces the in situ water content to below 80 percent of the optimum moisture content, while the Houston District does not allow trafficking until the curing process is complete, presumably after 72 hours as stated in Item 276. The latter practice is also followed by the Lubbock District. The Bryan District usually opens reclaimed roads, though unsurfaced, to traffic at the end of the day, a method also utilized by the Corpus Christi District given the absence of adequate detour routes. The Yoakum District uses a prime coat of an asphalt emulsion to simultaneously facilitate curing and provide a more durable surface under trafficking. The Houston District specifies that all finishing operations must be completed within a period of five hours after cement is added to the reclaimed material when cement stabilization is desired. The Childress and Laredo Districts require a minimum compaction of 98 percent of the maximum density achieved with Tex-113-E, while the Amarillo, Beaumont, Wichita Falls, and Yoakum Districts require a minimum of 95 percent compaction. The Wichita Falls District

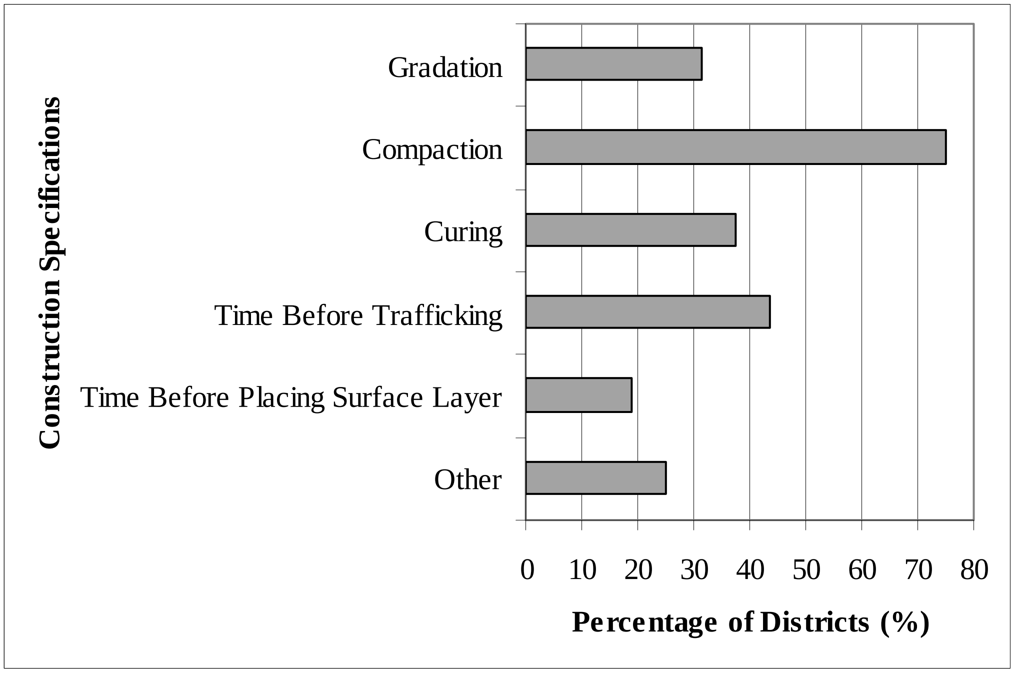


Figure 9. Construction Specifications.

prohibits placement of the surface layer until at least 24 hours after the base is finished, and the Corpus Christi District specifies that surface treatments should be placed on all finished sections at the end of each work week. Some districts further require that the reclamation process not introduce any deleterious material such as clay or organics into the base material.

Have You Constructed Any Experimental Sections Side by Side to Compare Different Stabilizers?

The Brownwood, Bryan, Corpus Christi, Wichita Falls, and Yoakum Districts reported the construction of experimental sections to compare different stabilizers. These stabilizers included cement, lime, and asphalt emulsion. The Bryan District investigated different percentages of cement, and the Yoakum District compared combinations of asphalt and cement, asphalt and lime, and asphalt alone. The Corpus Christi District built experimental sections to evaluate different types of subgrade stabilization and various flexible base materials, but those sections were not constructed using pavement reclamation techniques. The Atlanta District had one project planned for the summer of 2001.

What Aspects of Pavement Reclamation Especially Warrant Additional Investigation for Future Projects?

Figure 10 indicates that most of the districts feel that further research on the selection of stabilizer type and content is needed. The Childress and Lubbock Districts also suggested additional work addressing problems observed with bonding of prime coats to surfaces of stabilized base courses, especially those constructed using fly ash. Determination of modulus values for reclaimed pavements and assessments of ride quality were also recommended for future research.

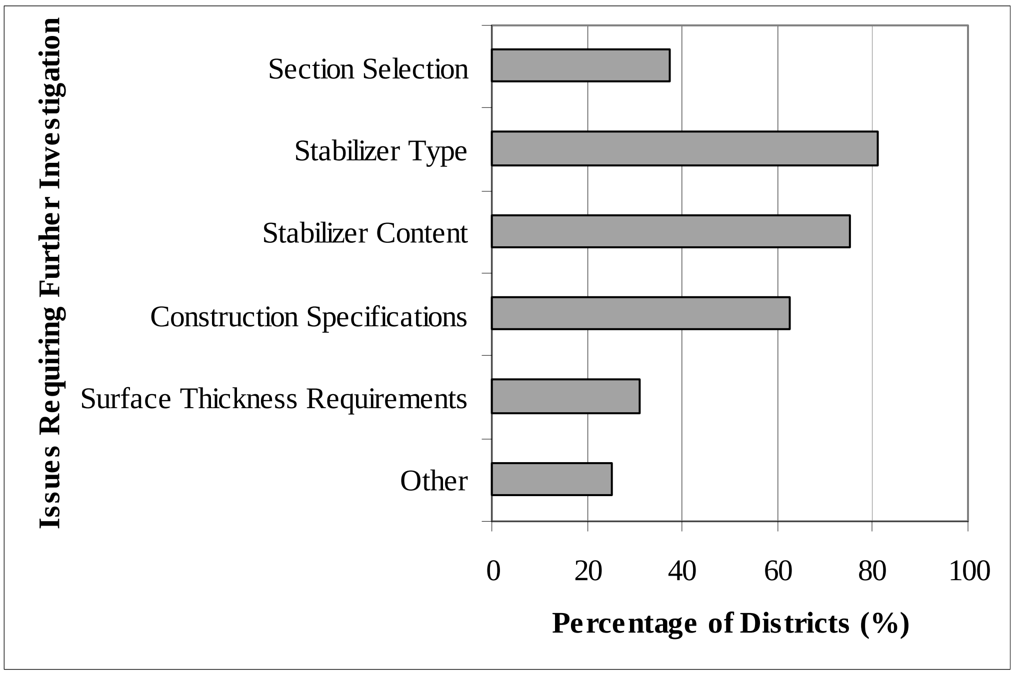


Figure 10. Issues Requiring Further Investigation.

Overall, How Would You Rate the Performance of Recycled Sections in Your District?

Figure 11 summarizes the performance of reclaimed pavements. Most of the districts feel that these pavements provide good performance by restoring the original structural capacity of the roadway. Pavement reclamation methods also reduce material costs and haul costs, as well as reduce waste material. The Abilene and Fort Worth Districts reported excellent performance, with only low severity longitudinal cracking on some sections. The Tyler District suggested that if the problem requiring rehabilitation was associated with the base layer, and if the contractor performed the reclamation properly, the resulting pavement would have a life expectancy of approximately 10 years. The Atlanta District emphasized the importance of effective crack seal

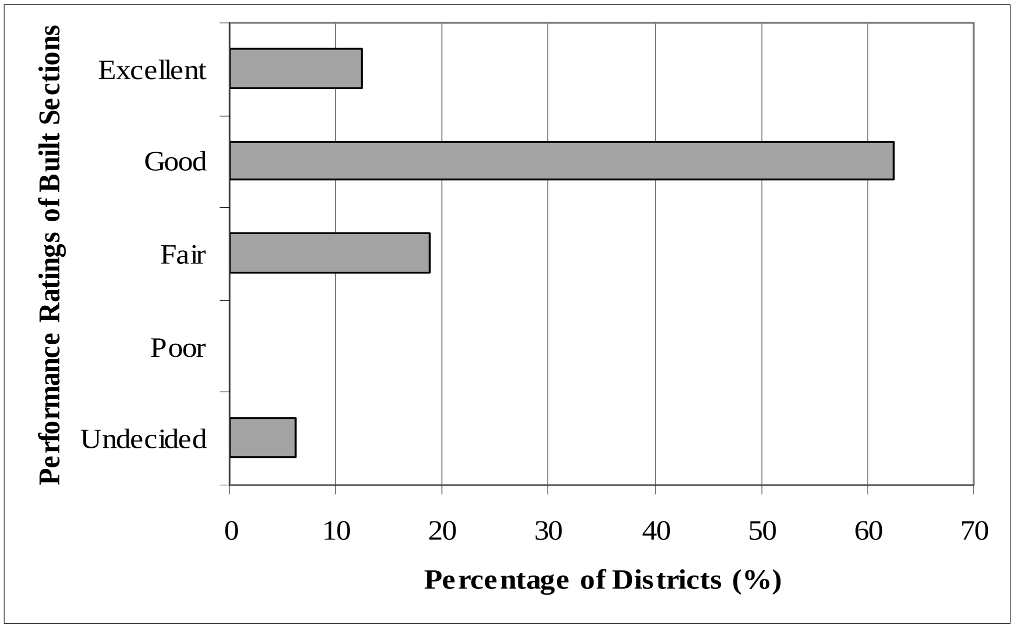


Figure 11. Performance Ratings of Built Sections.

and seal coat programs to ensure pavement longevity. Many districts also overlay the reclaimed layer with new base material in order to increase the structural capacity of the pavement, with the Yoakum District citing a minimum thickness of 12 inch. The Brownwood District determined that increasing the base layer thickness is more cost efficient than subgrade stabilization in many cases. Some districts noted problems with longitudinal cracking and rutting in pavement reclamation projects, but they felt in many cases the reclaimed layer was not the cause of the poor performance. However, the Amarillo District reported frequent problems with cement stabilization resulting from excessive cement amounts that led to unacceptable shrinkage cracking and slab behavior.

Do You Have Any Upcoming Projects Where Pavement Reclamation Is Being Considered?

The encouraging performance of reclaimed pavements has led many districts to continue using pavement reclamation techniques as shown in Figure 12.

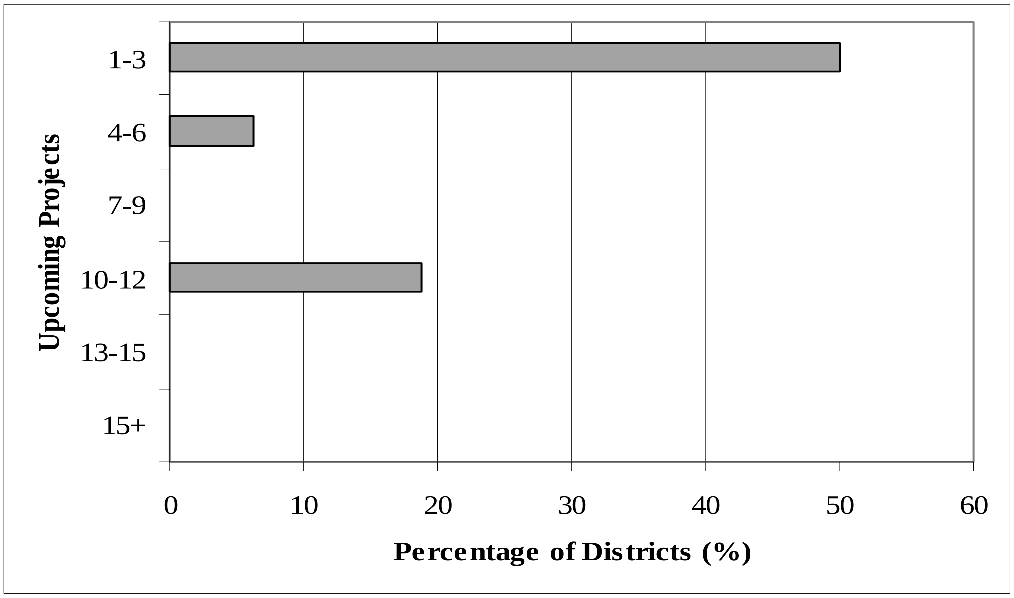


Figure 12. Upcoming Projects.

SUMMARY OF FINDINGS FROM SURVEY RESPONSES

Sixteen districts responded to the survey distributed as part of this project. Overall, these districts have obtained good pavement performance using pavement reclamation techniques. The most common types of distress encountered in reclaimed pavements are longitudinal and transverse cracking. Distress and traffic levels are the most important factors used in selecting a candidate pavement section, where most projects are completed on low-volume roads experiencing base failures. Typical pavement evaluations include the use of falling weight deflectometers, visual distress ratings, and coring. Cement and lime are the most commonly used stabilizers, and their application amounts vary from 1 to 6 percent and 1 to 10 percent, respectively. District experience is the most important factor in determining the type and amount of stabilizer to use on particular projects, although some laboratory testing is completed in several districts. Laboratory tests usually include particle size analyses, measurements of plasticity index, and triaxial strength testing. Target strengths for stabilized materials range from 35 to 350 psi.

In the field, the districts require a minimum compaction of 95 or 98 percent of the maximum density achieved with Tex-113-E. Some districts allow trafficking within 24 hours, while others require completion of a 72-hour period of curing before they allow trafficking. Most districts specify at least 24 hours before placement of a surface layer, with some allowing as much as one week. A limited number of experimental sections have been constructed to compare different stabilizers, but some were not built using pavement reclamation techniques. Districts indicated that further research on the selection of stabilizer type and content is needed, as well as additional work investigating the bonding of prime coats to surfaces of stabilized base courses. The reduction in material and haul costs, as well as the reduction in waste material, have led to continued application of pavement reclamation techniques, which are often associated with flexible base overlays to increase structural capacity.

CHAPTER 3
DISTRICT FIELD PERFORMANCE STUDIES

BRYAN DISTRICT

The Bryan District has used full depth recycling since the early 1990s. The prime focus of this work has been to upgrade the farm-to-market system, which typically consists of 6 to 8 inches of unstabilized aggregate base and a two-course surface treatment directly over a raw or lime-treated subgrade. In the late 1980s it was clear that a large percentage of these roadways was structurally inadequate to carry the increasing agricultural and oilfield development traffic.

Around 1993 the district adopted an aggressive approach to upgrading this network. Two basic pavement designs were implemented:

1. For low-volume roadways the existing roadways were recycled with either lime or cement stabilizer to a depth of 10 inches, then a two-course surface treatment was placed.
2. For higher volume roadways an additional flexible base layer was placed on top of the recycled and stabilized layer.

Design Procedures

In the early 1990s the approach to designing the reclaimed pavements in the Bryan District was as follows. The goal was to chemically stabilize the top 10 inches of the existing pavement structure to use it as either a base or subbase layer. In the case of a subbase a granular overlay would be placed over the treated layer followed by a two-course surface treatment. The procedure includes the following steps:

1. At approximately 1 mile intervals take samples from each project to a depth of 7 ft, log pavement structure, and return samples to the laboratory for testing.
2. For each location complete TxDOT Form 476A noting the basic soil properties including plasticity index (PI) and soil gradation. Of particular interest are the values for the existing base and top of subgrade.
3. Use the PI and soil binder (percent passing #40 sieve) as inputs to TxDOT method Tex-121-E to determine the amount of lime stabilization required. The goal is to

stabilize the top 10 inches. If the 10 inches includes 6 inches of low PI base and 4 inches of clay subgrade, then do an analysis for both materials and calculate a weighted average to arrive at the final stabilizer content. If the top 10 inches contains substantial clay, then select lime as the stabilizer; for low PI materials (PI < 10) use cement stabilization.

4. If a granular base is to be used, then its thickness is designed using one of the department's approved design procedures, either Texas triaxial, district modified potential vertical rise (PVR) (Tex-124-E) test or the flexible pavement system (FPS) programs.

Several issues arise that make the design process complex. The major issue is the variability of the pavement structures. These sections are low-volume roadways that have received substantial maintenance over their lives. It is not uncommon to find only 3 to 4 inches of base at one location and 10 to 12 inches at the next. The Bryan District also has a large variability in soils. In several counties the soil type can change from sand to expansive clay in the same section.

Monitoring of Recycled Pavements in the Bryan District

In 1998 twenty-five of the full depth recycled sections were selected for structural monitoring. These sections were all between 2 and 5 years of age at the time of testing. The testing included a visual assessment of condition, falling weight deflectometer testing to identify in-place stiffness values, a ground penetrating radar survey to identify areas of trapped moisture, as well as dynamic cone penetrometer and field coring. The results of this investigation were documented in TTI Report 3903-S, "In-place Engineering Properties of Recycled and Stabilized Pavement Layers" (Syed and Scullion, 2000). The in-place moduli found on these pavements is summarized below along with a discussion of the longitudinal cracking problems found. As part of Project 0-3903, recommendations were made to add a grid fabric to the design section in areas thought prone to longitudinal cracking. In this current project the researchers performed visual inspections on the most recent pavements constructed in Bryan that incorporated the grid system.

Performance Studies on Bryan's Recycled Pavements

The key factor influencing the performance of the FDR projects in the Bryan District was the type of subgrade material. This is clearly shown in Table 1, which relates the observed performance to the plasticity index of the subgrade soil. The Class A group was for projects with no visual distress and excellent ride. Class C projects had developed substantial distress, normally longitudinal cracking. The higher the PI the worse the sections are performing.

Table 1. Number of Projects in Each Performance Group (1998 Data).

Soil Plasticity Index (PI)	A Good	B Fair	C Poor
> 35	1	5	8
15-35	6	7	1
<15	9	2	0

The main performance problem was related to the formation of longitudinal cracks in the pavement structure. In the late 1990s Texas experienced a series of hot dry summers, and these cracks were found from field trenching to be caused by edge drying of the subgrade soils. Based on Table 1 it is concluded that the current pavement reclamation process is working well for sections built on low to moderate PI soils, but the process is not performing well on sections constructed on high PI material (PI > 35). In the Bryan District the majority of the high PI soils are also expansive in nature. The use of a stiff base layer on top of a high shrink/swell soil did not appear to be working. Other contributing factors to the severity of the cracking are the steepness of side slopes, the presence of trees near the pavement edge, long dry summers, and the stiffness of the stabilized layer.

From the FWD analysis the in-place moduli values were reasonable. The moduli values backcalculated for the stabilized layers are summarized in Tables 2 and 3.

Table 2. Backcalculated Moduli Values for All Sections.

% Stabilizer	# sections	Moduli (ksi)			
		High	Low	Avg.	Standard Deviation
3	12	1075	20	270	198
4	12	1610	70	508	244
5	6	950	400	680	178
6	3	1240	143	-	-
7	1	1279	-	-	-

Table 3. Backcalculated Moduli Values for Stabilized Base Sections Only (No Subbases).

% Stabilizer	Number of Sections	Moduli (ksi)		
		High	Low	Avg.
3	7	300	20	180
4	4	1610	125	450
5	2	715	400	557

For those sections with granular bases over stabilized subbases, the range of backcalculated moduli for the granular bases is 85 to 196 ksi with an average value of approximately 150 ksi.

As described above, most of the recycled pavements in the Bryan District studies were found to be performing well. Apart from the section on high PI soils, few cracks were found in any of the other sections, even though they had backcalculated moduli values in excess of 500 ksi and only a two-course surface treatment. The lack of cracking was attributed to the district policy of opening the recycled pavement to traffic at the end of the construction day. This practice did not impact long-term strengths and probably helped substantially in reducing shrinkage cracking.

In some cases concerns were raised about the variability of the existing pavements and the fact that in many instances a recycling depth of 10 inches would result in several inches of subgrade soils being mixed in with the base layer, which would cause the stabilizer content to be increased. It was agreed that a better approach on the thin pavement would be to place a layer of new flexible base over the structure prior to treatment. This revision was adopted in the late 1990s.

As described above, the major concern in the initial studies was the performance of the sections built over highly plastic clay material. Severe longitudinal cracking problems were encountered on several projects, and these cracks were documented to be occurring in the subgrade soils as a result of subgrade drying during summer drought periods. Examples of this type of distress are shown in Figure 13.

Figure 13. Severe Longitudinal Cracking Problems in Some of the Initial Recycled Pavements in the Bryan District.

Use of Geogrids for Sections Built on Highly Plastic Clays

It was clear to Bryan personnel that the design methodology would need to be modified to minimize the impact of edge drying. Based on the recommendations of TTI Project 0-3903 (Syed and Scullion, 2000) the district experimented with the use of geogrids. It was proposed that the grid would be placed on top of the stabilized layer and beneath the granular base layer as shown in Figures 14 and 15. The idea was that the fabric layer would not reinforce the base

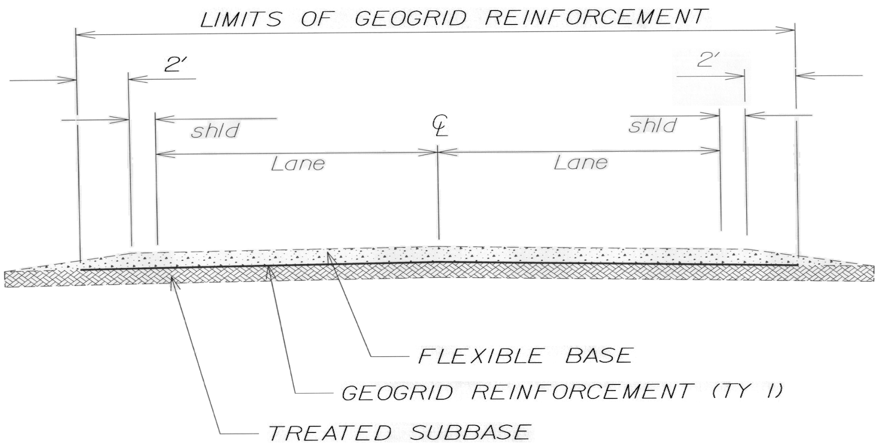


Figure 14. Typical Section from a Bryan Section over High PI Soils.
Schematic courtesy of Darlene Goehl, P.E.

Figure 15. Geogrid Reinforcement on Expansive Soils.
Schematic courtesy of Darlene Goehl, P.E.

layer but would provide a slippage plane so that any movements from lower layers would not reflect through the upper layers.

To evaluate the effectiveness of the grid approach on an experimental basis, in 1996 the district constructed two grid experimental sections on FM 1915. A control section with no grid was constructed between the two sections utilizing the geogrid. Details of the sections, as well as subgrade and pavement condition information, are shown in Table 4.

Table 4. Details of the Experimental Grid Section Constructed in the Bryan District.

Section 1	Control Section	Section 2
Geogrid and 8-inch Flexible Base	No Geogrid 8 inch Flexible Base	Geogrid and 5 inch Flexible Base
0.65 m West of Little River Relief Bridge	1.6 miles west of Little River Relief Bridge	2.5 miles west of Little River Relief Bridge
Subgrade 6 inches to 6 ft PI = 37 Black Clay Subgrade 6 to 8 ft PI = 36 Gray Clay	Subgrade 0 to 1 ft PI = 26 Brown Clay Subgrade 1 to 2 ft PI = 19 Tan Silty Clay Subgrade 2 to 6 ft PI = 37 Black Clay Subgrade 6 to 8 ft PI = 31 Gray Clay	Subgrade 0 to 8 ft PI = 49 Black Clay
No cracking after 3 years	Longitudinal cracking	No cracking after 3 years

The sections were just over 3 years old at the time of inspection. The first geogrid section starts at the Little River relief bridge and is 0.8 mile long. The section had one blade-on patch and one longitudinal crack approximately 4 ft long. Numerous longitudinal cracks were found in the control section, which is also 0.8 mile long. Figure 16 shows these distresses. The second section with the grid reinforcement, which is 0.6 mile long, had no visible defects. Figure 17 shows this geogrid section on FM 1915. From the soil information given in Table 4 the performance of the second geogrid section is interesting, as this section has the worst soil conditions with a deep high PI subgrade (PI > 49). From previous experience it is known that this section would have been a good candidate for severe longitudinal cracking.

Overall the second grid section had no signs of distress and is performing better than the first grid section. Both grid sections are performing much better than the section without any grid reinforcement. The control section without the grid has numerous longitudinal cracks. In this section the grid reinforcement has shown to be quite effective at reducing longitudinal cracking.

Figure 16. Longitudinal Cracking in Control Section (no grid) of FM 1915 after 3 Years in Service.

Figure 17. Condition of Second Geogrid Section on FM 1915 (No Distress after 3 Years in Service).

Current District Approach to Minimize Longitudinal Cracking

The success of the FM 1915 test has caused the Bryan District to incorporate a geogrid option in all current and future full depth recycling projects. To identify possible grid locations the Bryan District routinely performs the following site investigation on all upcoming FDR projects:

1. Review the U.S. Department of Agriculture (USDA) county soils maps to identify potentially problematic areas in the section. Each county map contains tables with typical plasticity index ranges for each soil and lists the limiting factors, if any (such as shrink swell), for use of the soils in roadways.
2. Perform field boring every 1.0 miles to a depth of 10 ft, and determine the Atterberg limits with depth (typically at each change in soil type).
   i. Additional coring may be performed to verify the geographic limits of potentially problematic soils. In sections of sandy materials, coring is only performed every mile.
   ii. Locations with plasticity indices greater than 35 at depths above 7 ft are tentatively considered candidates for geogrid reinforcement.
3. With the above information the district pavement engineer drives the section to make the final determination of the geogrid limits.
   i. The road is examined for visual signs of distress (cracking, quantity of maintenance treatments, etc.).
   ii. In the summer months the soil in the shoulders can be examined for cracking.
   iii. The proximity of vegetation to the roadway and the steepness of side slopes are considered.

In the current projects constructed within the Bryan District, geogrid is placed anywhere from 0 to 50 percent of the project limits. In 2001 dollars the cost of the treatment is $1.65 per square yard. In all instances a minimum of 5-inches untreated granular base and surface seal are placed over the grid.

New Laboratory Test Procedures

In recent years the trend in the Bryan District has been to use FDR techniques on higher volume roadways. For these roadways the district primarily uses cement stabilization. However, because of the concern of excessive strength and high potential for shrinkage cracking the district has adopted a new approach to selecting the optimal stabilizer content. On a trial basis the district has adopted a two-criteria approach using both strength and moisture susceptibility. They require a 7-day unconfined compressive strength of 300 psi and a final dielectric value in the tube suction test of less than 10, using the procedure described in Guthrie and Scullion, 2002. Details of this approach are given in Chapter 4 of this report.

Conclusions

The performance of the FDR sections in the Bryan District has been good except for those sections constructed on high PI soils. The district is convinced that the best approach to minimizing this problem is to incorporate a grid layer on top of the treated layer.

LUBBOCK DISTRICT

The Lubbock District initiated an aggressive recycling program in the early 1990s. The focus was to upgrade its low-volume farm-to-market system, which typically carries less than 500 vehicles per day. The district now has well in excess of 200 miles of recycled pavement. This district has relatively good subgrade support and low rainfall. The district does have several freeze/thaw cycles in a typical winter. There are few readily available sources of traditional stabilizers (cement or lime), but the district does have a local source for Class C fly ash. The tolk station fly ash has 25.6 percent calcium oxide. In the early 1990s the Lubbock District initiated a series of in-house studies to determine the best levels of fly ash stabilization that could be used to treat the locally available base materials. As with other surrounding districts, the Lubbock District base materials are either sand and gravel or lower quality limestone (caliche).

Current Design Approach

In the early 1990s the district lab did a series of Texas triaxial tests with local materials with different levels of stabilizer and stabilizer types. A typical series of strength test results are shown in Figure 18. In all cases the treated materials were tested in accordance with Tex-121-E.

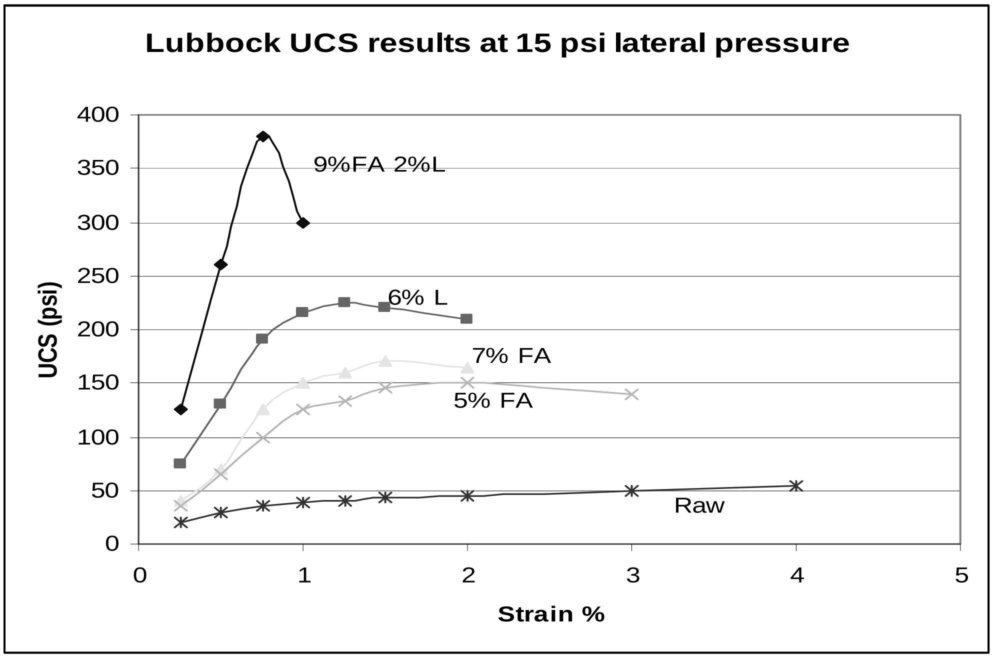


Figure 18. Lubbock Stress Strain Curves for Various Stabilizers (Baker, 1995).

They were dry cured and then subjected to a 10-day capillary rise. The district based is decision on optimum stabilizer content on the 15 psi confined strength data. The district noted that it is possible to get high initial compressive strengths for any material by simply increasing the stabilizer content. However, they noted that in the laboratory the failure mode for the high-strength samples changed to sudden brittle failure. The district engineers concluded that this failure mode was undesirable and that the lack of flexibility would cause problems in the field. They opted for lower compressive strengths in a hope to achieve a balance between strength and flexibility. The current criterion they specify is strength of 175 psi at 15 psi confining at the end of the 10-day capillary rise. In the initial projects the stabilizer of choice was fly ash because of its availability and low cost (40 to 50 percent cost of lime or cement, based on 1997 data).

Current Construction Specification

The Lubbock District has developed its own construction specification for constructing fly ash treated bases; this is special specification 2041. A comparison of their specification with the traditional TxDOT specification is shown in Table 5.

Table 5. Comparison of Lubbock Construction Spec with Traditional TxDOT Methods (Young, 2001).

	LBB District SS 2041	Statewide SS 2028	Item 266
Pulverization	1-1/4″ Sieve 100% Pass	1-3/4″ Sieve 100% Pass	2-1/2″ Sieve 100% Pass
Temperature	35 °F and Rising No less than 32 °F	None	35 °F and Rising
Density	Per SP 132-007 98%	95%	95%
Curing	3 days no equipment	3 days no equipment	Primed Cured for 7 days
Finishing	Prior to Prime Dry min. 48 hours	Prime Immediately	See Above

The main differences are the degree of pulverization, degree of compaction, and finishing. The Lubbock District keeps traffic off the reworked section for a minimum of 5 days after the addition of the fly ash. This requirement is because of the relatively slow strength gain. The district recommends 2 days drying prior to priming. The 2-day dry back is to ensure that the treated base is not holding excessive moisture that will cause problems after sealing. Fly ash bases have a high affinity for moisture and, as will be discussed later, one universal concern with these materials is bonding of the surface material. The district did also comment that one of their major concerns with the use of fly ash was the top 0.25 inch of base turns to powder after the 2 days. In some instances after dry back the surface needs to be "tight-bladed" prior to the application of the prime.

The 5 days construction is feasible in the Lubbock District because the sections are all on lightly trafficked roadways with adequate shoulders. This delay may cause problems in other areas of the state where construction under traffic is mandatory and traffic is placed on the completed section at night.

Monitoring Performance of Recycled Pavements in the Lubbock District

For inclusion in this study the district nominated 10 projects that they have been monitoring with falling weight deflectometer. These 10 sections ranged in length from 3 to 16 miles, with a total length of 99 miles. They were some of the first projects constructed in the district, and all were constructed in 1995. In an attempt to establish the optimal stabilizer content five of the sections were treated with 5 percent fly ash, one section had 7 percent, three had 10 percent, and one experimental site was constructed of 100 percent fly ash base. The 100 percent fly ash base is made by keeping the fly ash material under water for a period of up to 2 years. The material cements itself, the water is then drained off the site, and the material is mined and crushed similar to any other aggregate.

All of the sections are on relatively lightly trafficked highways with typically between 100 and 600 vehicles per day, with 20-year estimates of equivalent single axles (ESALs) of less than 200,000. The one exception was FM 301 in Cochran County, which had sections with average daily traffic around 2500 with an 18 kip ESALs of 500,000. On all of the projects the wearing surface was a two-course surface treatment. To monitor these sections GPR data were collected to identify if any of these bases have any moisture problems. At the time of testing none of the sections showed any unusual moisture patterns. It was concluded that the GPR was of limited use in evaluating the sections, so the focus of this study will be on the FWD data. The FWD data were first collected in 1996, and FWD data have been collected on an annual basis. In this study all of the FWD data were processed using the MODULUS 6 (Liu and Scullion, 2001) software to determine an in-place base modulus. A typical set of FWD data from this study is shown in Figure 19, this being the year 2000 data from FM 301 in Cochran County. To evaluate the sections the following information was used: a) the average maximum deflection for the section, which for this site was 21.2 mil; b) the average base modulus for the section at the drop height closest to 9000 lb, which was 116 ksi; and c) the percentage of the section where the base modulus fell below the district's target modulus for a Class 1 flexible base of 50 ksi, which in this case was 5 out of 35 drop locations or 14 percent. The summary results for the FWD data for all years for all projects are shown in Table 6.

The performance of these projects will be discussed later in this section. In terms of the measured structural strength properties, the summary results presented in Table 6 produce the following conclusions:

- The 5 percent fly ash stabilizer level was not effective in upgrading this material. Long term in situ strengths are similar to those expected from a typical flexible base in this area and well below those anticipated for a Class 1 material.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 6.0)

District:5 (Lubbock)
County :40 (COCHRAN)
Highway/Road: FM 301

	Thickness(in)	MODULI RANGE(psi) Minimum	MODULI RANGE(psi) Maximum	Poisson Ratio Values
Pavement:	0.50	663,400	663,400	H1: v = 0.35
Base:	7.50	20,000	300,000	H2: v = 0.35
Subbase:	0.00			H3: v = 0.00
Subgrade:	130.60(User Input)	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mil): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	10,475	25.70	9.06	4.85	3.38	2.54	2.09	1.63	663.4	59.4	0.0	19.8	19.70	300.0
0.102	10,630	26.69	7.11	3.22	2.20	1.69	1.33	1.07	663.4	41.4	0.0	28.8	16.20	181.6
0.200	10,574	14.26	5.48	2.57	1.95	1.18	1.11	0.81	663.4	111.5	0.0	36.2	15.68	263.2
0.310	9,986	33.70	13.32	5.87	3.22	2.19	1.71	1.31	663.4	41.2	0.0	14.8	6.43	111.6
0.405	10,185	23.19	9.09	4.69	3.05	2.05	1.41	1.10	663.4	70.8	0.0	20.1	12.50	178.2
0.503	10,248	17.68	8.84	4.55	2.51	1.38	1.04	0.91	663.4	126.4	0.0	22.1	2.58	92.3
0.604	9,791	17.37	9.26	5.26	2.99	1.89	1.31	0.97	663.4	162.6	0.0	18.0	4.73	134.0
0.716	10,030	28.54	11.74	5.49	3.40	2.42	1.72	1.20	663.4	55.7	0.0	16.0	10.66	279.3
0.792	9,390	24.20	11.00	5.40	3.04	2.18	1.67	1.29	663.4	73.0	0.0	15.9	9.15	127.4
0.905	10,300	18.58	9.50	4.51	2.46	1.60	1.17	0.93	663.4	117.6	0.0	21.3	4.90	106.5
1.009	10,407	19.44	10.00	5.30	3.09	2.05	1.55	1.20	663.4	138.5	0.0	18.3	7.72	158.1
1.108	10,296	21.32	9.83	5.04	2.95	1.93	1.46	1.13	663.4	99.0	0.0	19.1	8.36	162.2
1.206	10,288	16.02	8.54	4.57	2.74	1.84	1.39	1.07	663.4	187.8	0.0	20.7	8.54	196.2
1.310	10,216	16.00	7.12	3.59	1.94	1.22	0.98	0.74	663.4	116.9	0.0	27.6	4.38	101.1
1.412	10,077	27.80	12.11	5.73	3.20	2.08	1.57	1.22	663.4	60.2	0.0	16.0	5.38	121.7
1.503	10,276	22.43	11.14	5.33	3.00	2.02	1.56	1.28	663.4	95.5	0.0	17.6	7.05	126.1
1.602	10,522	24.41	12.19	6.02	3.52	2.35	1.77	1.46	663.4	95.4	0.0	15.9	7.45	163.6
1.707	10,177	21.68	12.19	6.63	3.67	2.28	1.65	1.31	663.4	131.8	0.0	14.6	3.48	117.7
1.803	10,506	18.76	9.07	4.31	2.51	1.67	1.30	1.09	663.4	114.1	0.0	22.3	7.31	154.0
1.903	10,193	25.44	12.78	5.79	3.17	2.18	1.65	1.31	663.4	78.1	0.0	15.8	7.78	110.3
2.003	10,061	38.38	17.18	7.66	4.64	3.29	2.54	1.95	663.4	44.7	0.0	11.1	9.78	170.8
2.108	10,272	36.90	18.47	8.60	4.90	3.31	2.42	1.81	663.4	55.2	0.0	10.5	7.32	143.1
2.206	10,812	18.92	8.31	4.04	2.65	1.93	1.50	1.14	663.4	109.5	0.0	23.9	14.78	300.0
2.305	10,542	16.88	7.35	3.17	1.85	1.37	1.07	0.78	663.4	99.3	0.0	29.1	8.80	118.9
2.400	10,558	15.22	8.87	4.69	2.80	1.93	1.48	1.17	663.4	233.9	0.0	20.3	8.19	189.0
2.504	10,486	19.44	8.55	4.15	2.37	1.57	1.22	0.98	663.4	95.0	0.0	23.6	6.97	134.7
2.611	10,268	15.16	8.72	4.55	2.56	1.66	1.23	0.97	663.4	200.9	0.0	21.2	4.81	124.4
2.702	10,411	19.08	10.48	5.50	3.16	2.01	1.45	1.15	663.4	149.6	0.0	17.7	4.78	143.2
2.815	10,467	24.47	9.22	3.47	1.71	1.13	0.84	0.72	663.4	49.9	0.0	26.7	8.45	64.7
2.903	10,649	10.02	5.56	3.09	1.72	1.11	0.81	0.61	663.4	300.0	0.0	34.7	5.04	114.8 *
3.001	10,761	28.15	9.84	4.04	2.13	1.37	1.03	0.81	663.4	44.4	0.0	24.0	4.67	89.1
3.101	10,471	13.08	7.60	3.36	2.03	1.32	1.00	0.83	663.4	206.4	0.0	27.5	7.09	145.7
3.200	10,292	14.25	7.51	3.77	2.13	1.22	0.78	0.55	663.4	169.1	0.0	26.6	2.24	100.2
3.302	10,312	16.38	8.28	3.96	1.96	1.06	0.73	0.56	663.4	121.0	0.0	26.0	8.39	77.4
3.400	10,161	12.29	7.05	3.61	1.96	1.20	0.87	0.70	663.4	228.6	0.0	27.3	2.00	103.2
Mean:		21.20	9.78	4.75	2.76	1.83	1.38	1.08	663.4	116.7	0.0	21.5	7.81	138.1
Std. Dev:		6.73	2.78	1.29	0.75	0.56	0.43	0.33	0.0	62.9	0.0	6.0	4.01	47.2
Var Coeff(%):		31.74	28.42	27.03	27.20	30.33	30.74	30.13	0.0	53.9	0.0	28.1	51.39	34.1

Figure 19. Typical Set of FWD from Lubbock District (FM 301 in Year 2000).

Table 6. Summary Results from the Lubbock District.

County	Roadway	% Fly Ash	Thick (in)	1) Average Max Deflection (mil), 2) Base Modulus (ksi), 3) % below Target Modulus*						
				1996	1997	1998	1999	2000	2001	2002
Floyd	FM 97	5	6	33.7 (59) 70%	34.0 (47) 77%	-	-	54.8 (34) 86%	54.8 (30) 91%	-
Lynn	FM 211	5	6	26.8 (80) 19%	-	34.0 (52) 54%	39.0 (42) 67%	42.0 (41) 82%	-	42.0 (41) 79%
Garza	FM 399	5	6	34.7 (40) 88%	-	48.0 (28) 97%	48.3 (29) 97%	48.8 (27) 97%	62.0 (23) 97%	51.0 (26) 100%
Crosby	FM 2794	5	6	-	37.6 (46) 74%	42.4 (41)	45.9 (39) 82%	46.0 (39) 86%	37.0 (33) 86%	49.0 (33) 89%
Hockley	FM 301	5	6	-	32.0 (45) 64%	-	34.1 (59) 55%	33.5 (61) 48%	-	39.0 (45) 77%
Gaines	FM 1429	7	6	-	20.8 (118) 16%	-	25.4 (106) 27%	26.5 (86) 20%	22.0 (128) 18%	21.8 (105) 20%
Cochran	FM 301	10	7.5	-	14.9 (151) 3%	-	17.4 (189) 0%	21.2 (116) 14%	20.7 (104) 14%	19.5 (135) 13%
Cochran	FM 1894	10	7.5	-	17.1 (111) 6%	-	19.2 (138) 3%	20.1 (125) 12%	19.4 (139) 12%	20.0 (120) 6%
Cochran	FM 1779	10	7.5	16.1 (158) 0%	14.7 (136) 0%	-	16.5 (198) 0%	21.9 (132) 10%	21.9 (133) 23%	21.7 (117) 16%
Lamb	FM 37	100	10	-	12.1 (195) 0%	-	-	12.4 (241) 0%	-	12.7 (199) 0%

* The target modulus for a flexible base in Lubbock is 50 ksi.

- The 10 percent fly ash level was effective at upgrading this material. These sections are stronger than that anticipated for a Class 1 material. After 7 years in service, based on these three sections an average of 12 percent of the section has strength of less than 50 ksi. Based on this environment and traffic levels the performance of the 10 percent fly ash sections is judged to be very good.
- With only one section (FM 1429) at the intermediate fly ash level of 7 percent, it is difficult to draw strong conclusions. However, in terms of the FWD data 7 percent is clearly better than the 5 percent level.
- The 100 percent fly ash section is substantially stiffer than the 10 percent level. After 7 years in service the average base modulus was close to 200 ksi, with no locations showing moduli values less than the target value of 50 ksi. However the performance of this section has been inferior to the 10 percent fly ash level. In FY 2001 substantial cracking was noted in this section, with one 0.5 mile section being noted to have 25 percent alligator cracking.
- Based on the results shown in Table 6 the following FPS 19 design moduli values are recommended for fly ash bases in the Lubbock District:

    - 5 percent fly ash – treat as flexible base
    - 7 percent fly ash – design modulus 100 ksi
    - 10 percent fly ash – design modulus 125 ksi

To further demonstrate the concerns with the 5 percent stabilizer level, the FWD data from FM 211 in Lynn County are shown in Figures 20 and 21. In both cases it is clear that the structure is getting weaker with time. The deflections shown in Figure 20 are increasing with time, and the base modulus shown in Figure 21 is decreasing. For this site the average deflection increased from 26.8 mil in 1996 shortly after construction to over 42 mil in 2002. The average base modulus dropped from over 80 ksi in 1996 to less than 42 ksi in 2002.

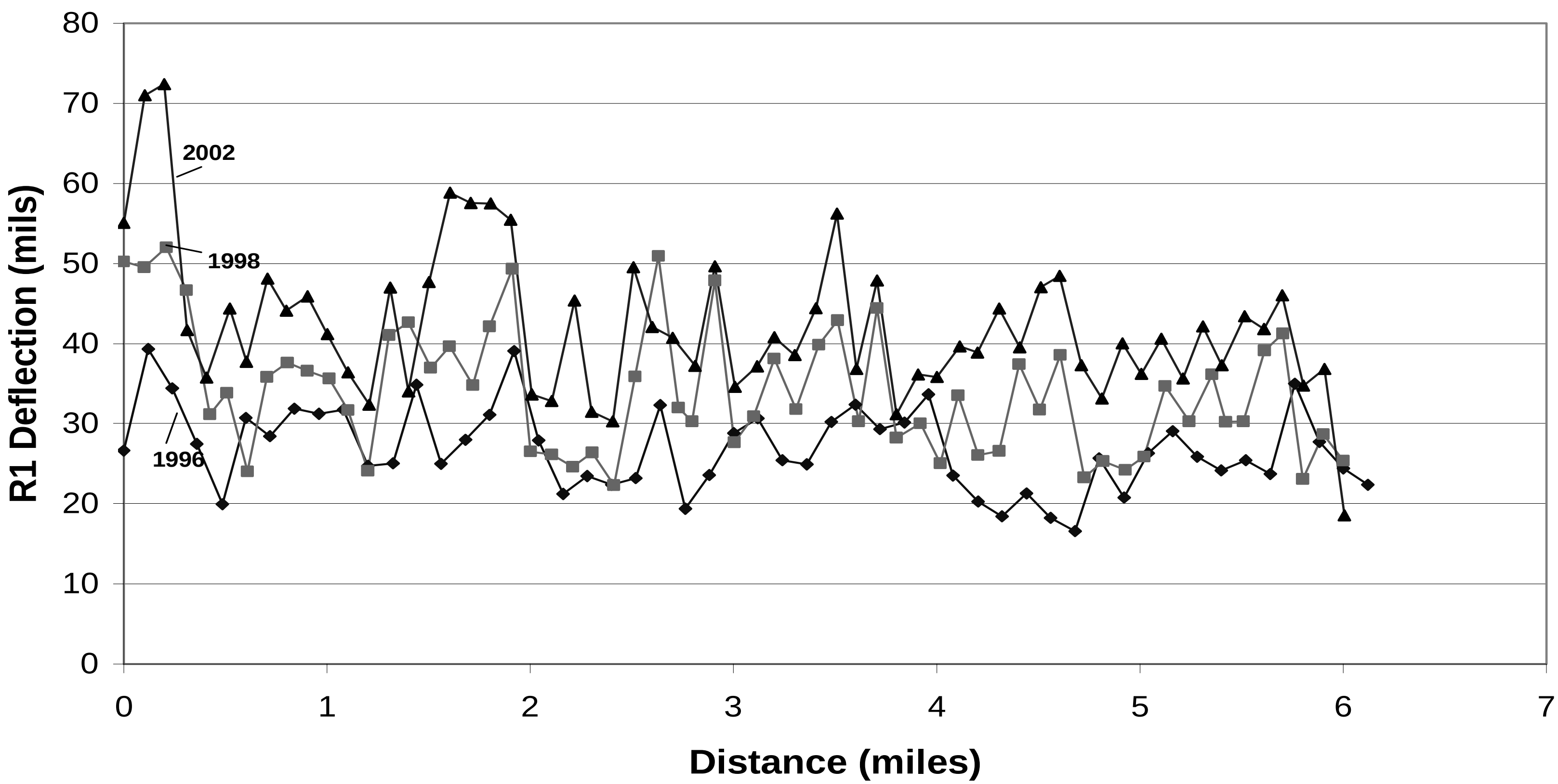


Figure 20. Maximum Deflections Measured at 9000 lb Design Load from 1996 to 2002 for FM 211 in Lynn County.

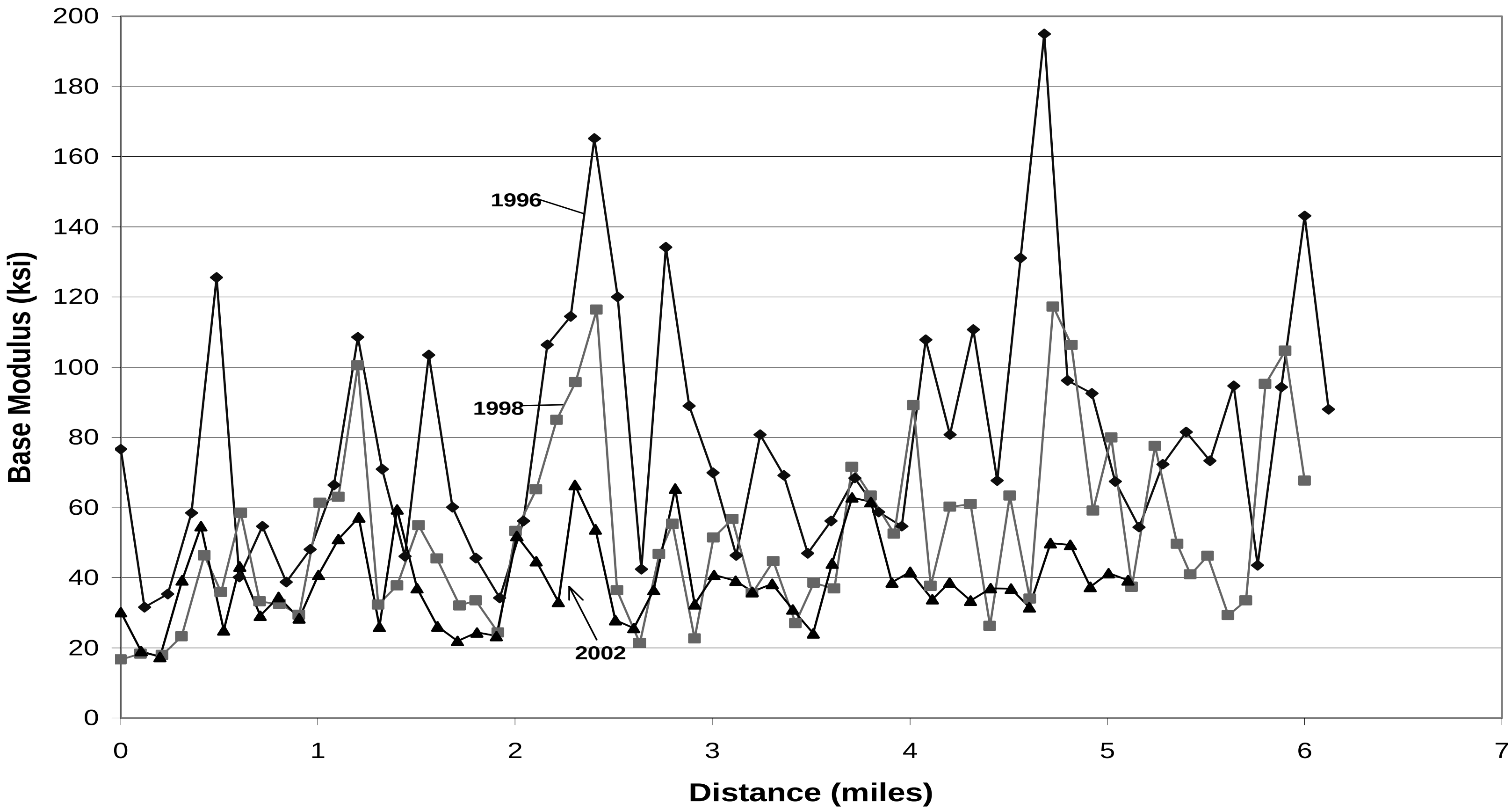


Figure 21. Backcaculated Base Moduli Value from 1996 to 2002 for FM 211 in Lynn County.

Condition Data

After 7 years in service the Lubbock District is happy with the performance of these fly ash treated sections; none of the sections have received any additional rehabilitation and only minor maintenance. From a review of the 2001 PMIS data and from visual inspections, little or no distress was apparent on any of the sections. The majority of the sections were in excellent condition as shown in Figure 22. At the 5 percent level the only distress found was minor rutting. FM 97 in Floyd County in a few locations was measured to have 10 percent minor rutting (0.5 to 1 inch) and 5 percent major rutting. An example of the minor rutting from FM 399 in Garza County is shown in Figure 23. This section is approximately 4 miles long, and the only distress found was the 300- to 400-ft section of shallow rutting.

Figure 22. FM 301 10% Fly Ash Excellent Condition.

Figure 23. Minor Rutting on FM 399 Garza County.

From a review of the PMIS data, the only section that has shown any substantial distress is the 100 percent fly ash section on FM 37. This section was by far the stiffest in the study. In 2001 both longitudinal cracking and alligator cracking were found in several of the 0.5-mile PMIS evaluation sections. One section was reported to have 25 percent alligator cracking. The ride values in most of the section were above 4.0, but in the badly cracked section this value had fallen to below 3.5.

Conclusions from Lubbock District

- The performance of the low-volume sections stabilized with 10 percent fly ash has been exceptionally good both structurally and visually. After 7 years in service the ride value on the sections is above 4.0 with little or no distress. For future pavement designs a base modulus of 125 ksi can be used in FPS.
- The 5 percent fly ash level did not produce a structurally sound base, and the stiffer 100 percent fly ash section did not work well, primarily due to excessive cracking.
- The district should continue monitoring the sections with both 7 and 10 percent fly ash for at least two more years. The indication from the 10 percent sections is that after 7 years in service they are just starting to show increases in deflections and reductions in moduli values. FM 1779 initially had no locations below the 50 ksi target, but by 2002 16 percent of the section was below the target.
- In the conditions that exist in the Lubbock District the concept of designing the bases to meet Class 1 requirements (175 psi at 15 psi confining after 10 days capillary) appears to work well for these low-volume roadways.
- Based on the Lubbock stress strain curves it could be possible to expand the strength criteria with a minimum strain criteria. A minimum value should be 0.75 percent vertical strain at failure, which would ensure that the base behaves as a high quality flexible base rather than a "semi-rigid" layer.
- Based on statewide average cost data for lime and cement of around $90/ton, the use of fly ash at $32/ton (year 2000) appears to be cost effective. This may or may not be the case. As discussed above, the optimum fly ash content for Lubbock conditions appears to be around 10 percent. In other areas of the state several bases are now routinely treated with cement in the 2 to 3 percent range. The Lubbock District should initiate a laboratory study on future projects to determine if low levels of cement or blended stabilizers can more economically meet the strength and strain criteria discussed above. The laboratory studies should include possible lime/fly ash and cement/fly ash blends.
- The issue of whether these results from the Lubbock District are transferable to other areas of Texas needs careful consideration. The subgrade strengths in this district are generally good to very good (12 to 18 ksi), the material is generally silty/sandy with

good drainage, and the district gets low rainfall compared with many areas of the state. The traffic on the monitor sections was very low, typically less than 400 vehicles per day. The district also keeps traffic off the treated section for 5 days after treatment, which would severely restrict this treatment in many areas.

- The district recommends that studies be conducted to identify field construction techniques and materials that improve the bond between the fly ash base and surfacing material.

CHILDRESS DISTRICT

The Childress District has been actively recycling pavements since the early 1990s. The district generally has very good subgrade support conditions. The main stabilizer used in the Childress District is fly ash from the Tolk power station near Amarillo. The same fly ash is used in the Lubbock and Amarillo Districts. Unlike several other districts, the Childress District's experience with fly ash stabilization has been extremely positive. As will be described below, the district does not restrict its use to the low-volume roadways, and many sections of US 287 have fly ash treated bases and relatively thin surfacing. Several of these sections with 20-year design traffic in excess of 7 million 18 kips ESALs are more than 5 years old and have performed well with little or no distress, as shown in Figure 24.

Figure 24. US 287 near TRM 216 (10 inch Fly Ash Base (6% FA), 2 inch HMA Constructed Summer 1998, Heavy Traffic, Excellent Condition).

Pavement Design Approach

The Childress District's approach to pavement design is described below:

- For every FDR project the district laboratory decides the type and amount of stabilizer from testing of materials extracted from each project. This process involves use of the full Texas triaxial procedure (Tex-117-E) with a full 10-day soak. In most cases samples will be constructed at 4, 6, and 8 percent fly ash as well as a combination of lime and fly ash. The district modified the test procedure slightly for fly ash treated materials. The samples are moist cured for 7 days as specified in Tex-117-E but then are left on a bench top at room temperature for 7 days prior to capillary rise. As with the Lubbock District, the Childress District's goal is to design a "super" flexible base rather than a stiff base with little flexibility. After capillary the minimum acceptable values are unconfined strength of 45 psi and confined strength of 175 psi at 15 psi confinement.
- The laboratory personnel are also active during construction. Texas triaxial tests are run on a regular basis throughout the project to ensure that the base is being constructed as designed.
- The district has experimented with a variety of different priming and finishing techniques. For the sand gravel fly ash treated bases, the district has shot straight AC-5 or CRS-1P with very good results. For limestone bases the district has used the "muddy water" finish where the top 0.5 to 1 inch of the base is scarified and treated with a dilute MS-2 emulsion (10 percent dilution). Although these approaches are reported to have worked well, they acknowledge that this is a critical area and better priming materials and finishing techniques are needed.
- On every project a minimum of a one-course surface treatment is placed prior to any surfacing.
- For thickness design the district uses the FPS 19 design program, and for the fly ash base a moduli value of between 250 and 350 ksi is typically assumed.

Monitoring the Performance of the Childress FDR Sections

In the study both GPR and FWD data were collected on several of the district's FDR projects. Mr. Ronald Hatcher, the head of the district laboratory, also supplied the design test results for each of the projects. The GPR data were useful in confirming layer thicknesses. At the time of testing, none of the projects exhibited any unusual GPR signals in terms of base moisture contents. The FWD deflection data were processed using the MODULUS 6.0 software. The FWD analysis, together with the typical pavement cross-section, laboratory test results, and pavement performance, as recorded in TxDOT's PMIS system, are included in Appendix A. A summary of this information is shown in Table 7.

In Table 7 data from 17 recycled sections in Childress are reported. Each section presents the following information:

- section number and highway number;
- design traffic in terms of 18 kips ESALs (available from the plan sheets for some of the sections);
- construction year;
- the stabilizer type (FA-Fly Ash, L-Lime);
- base thickness (in some of the sections a subbase layer is present beneath the stabilized layer. 12″FA 6″Flex indicates that the fly ash treated layer is 12 inches thick and is on top of a 6 inch untreated flexible base layer);
- laboratory data from the district laboratory;
- surface type and thickness;
- modulus value in ksi used by district staff with FPS to compute layer thicknesses;
- average modulus value in ksi found in the field from backcalculation of FWD data (Details are shown in Appendix A. Also given is the percentage of the locations where the backcalculated value was less than 50 ksi. The 50 ksi limit is the modulus value often used for a good flexible base. Therefore, this percentage indicates the length of the project where the fly ash stabilization was not effective); and
- performance data, which include pavement score (100 is perfect) and section ride value (5% is perfectly smooth).

Table 7. Summary Results from Childress District (See Appendix A for Details).

Section	Design 18 kips millions	Const. Year	Stabilizer Type	Thickness Base	Lab Design Data (*)	Surface Type + Thick.	Modulus (ksi) Assumed in Design	Modulus (ksi) Field FWD (% Below 50 ksi)	2002 PMIS Performance (**)
SH 70 (1)	.34	97	7% FA	12″ FA 6″ Flex	60 (183) +1.3	2 CST	300	113 14%	100 (3.6)
US 287 (2)	7.3	98	6% FA	10″ FA 8″ Flex	95 (185) -.3	1 CST 2 HMA	370	203 0%	100 (4.1)
US 287 (3)	NA	93	6% FA	9″ FA 8.5″ Flex	NA	1 CST 2.5 HMA	NA	459 0%	100 (4.5)
US 287 (4)	NA	96	6% FA	10″ FA 13″ Flex	116 (287) +1.4	1 CST 2.5 HMA	NA	590 0%	97 (3.8)
US 83 (5)	1.17	97	8% FA	6″ FA 12″ Flex	122 (297) +1.9	2 CST	300	168 2%	100 (3.9)
US 83 (6)	2.6	97	8% FA	10″ FA 10.5″ Flex	130 (241) +.9	2 CST	300	134 5%	100 (4.3)
US 70 (7)	0.54	98	2% L + 2% FA	12″ LFA	120 (216) +1.5	1 CST 2 HMA	300	280 3%	100 (4.1)
FM 97 (8)	NA	99	4% FA	12″ FA	53 (170) +.5	2 CST	NA	181 1%	100 (3.6)
US 82 (9)	NA	95	6% FA	6″ FA 10″ Flex	73 (213) +.9	2 CST	NA	184 1%	100 (4.6)
US 82 (10)	1.68	97	6% FA	6″ FA 5″ Flex	58 (180) +0.6	2 CST	300	230 0%	100 (4.6)
US 70 (11)	0.54	00	2% L + 2% FA	8″ LFA 4″ Flex	87 (218) +1.0	1 CST 2.5 HMA	300	128 19%	100 (3.9)
US 83 (12)	1.84	97	8% FA	12″ FA 10″ Flex	123 (232) +0.5	2 CST 2 HMA	250	268 0%	99 (3.9)

Table 7. Summary Results from Childress District (See Appendix A for Details) (Continued).

FM 261 (13)	NA	99	7% FA	9″ FA	92 (195) +2.6	2 CST	NA	103 7%	100 (3.6)
SH 203 (14)	NA	99	6% FA	7″ FA	85 (196) +1.5	2 CST	NA	85 7%	57 (2.7)
US 287 (15)	6.9	99	6% FA	10″ FA 7″ FB	43 (189) +0.4	1 CST 3.5 HMA	275	503 0%	100 (4.4)
US 287 (16)	NA	92	15% FA	8″ FA 15″ FB	NA	1 CST 3.5 HMA	NA	213 0%	61 (3.5)
US 287 (17)	NA	97	4% FA	16″ FA 8″ FB	138 (289) 0.5	1 CST 3 HMA	NA	626 0%	100 (3.6)

* Laboratory data from district Texas triaxial tests run prior to design include compressive strengths at 0 psi and 15 psi confined and moisture content above optimum at end of 10 day capillary rise. For section 1, 60 and 183 psi are unconfined and confined strengths during Texas triaxial test; the sample reached 1.3 percent above optimum moisture content (OMC) at the end of the 10 day capillary.

** Performance data from the worst 0.5-mile section in the project, from the 2002 PMIS survey. For section 1,100 is the pavement score and 3.6 the ride value. Scores range from 100 (perfect) to 0. Scores less than 70 are a concern. The ride value typically ranges from 5 (perfectly smooth) to 1.5 (very rough).

Conclusions from Childress Sections

Drawing solid conclusions from the data presented in Table 7 is difficult because the pavements are all different ages. Furthermore, it is the authors' belief that the ultimate performance is also strongly based on construction-related issues, such as the quality of the surface seal, etc. The construction issue is not included in the field performance data. However, the following general conclusions are offered:

1) The overall conclusion from this analysis is that the fly ash sections in the Childress District are performing exceptionally well. The district has such confidence with this treatment that the approach is used on high-volume roadways such as US 287. For section 2, the 20-year design traffic is 7.3 million ESALs. The section was constructed in 1998, and after 4 years it has no distress and an excellent ride. There are several factors that contribute to the overall success, namely:
    a) the heavy involvement of the district laboratory in the design and construction process;
    b) the very good subgrade in this district (For section 2 the subbase layer was computed to have a moduli of 80 ksi and a subgrade of 28 ksi, both of which are excellent. The stiff layers provide excellent support to the fly ash layer); and
    c) the recognition that the fly ash base must be sealed to obtain satisfactory performance (They vary the prime material based on the type of material treated, and for each section they apply a one-course surface treatment); and
    d) traffic restriction on the section for a minimum of three days, which is possible in this district but would not be feasible in many other districts.
2) There is a large variation in moduli value at each stabilizer content. The average values are shown in Table 8. These results appear unreasonable because the higher the percent fly ash the lower the average moduli value. However the percent fly ash was assigned based on Texas Triaxial Class (TTC) criteria so that the better materials received lower levels of stabilizer. Also two sections at 4 percent fly ash both had materials that did not gain excessive moisture during capillary rise. The average gain in moisture was only 0.5 percent, so it is reasonable to assume that these materials will continue to gain strength with time.

Table 8. Average Moduli Values for Fly Ash Bases in the Childress District.

Stabilizer Content	Average Moduli Value	Range (ksi)	# Projects
4%	403 ksi	181-626	2
6%	307 ksi	85-590	7
8%	190 ksi	134-268	3

One other important conclusion is that these values are high. A typical Class 1 base will have values of less than 70 ksi. The worst performing section (section 14) has an average moduli value (85 ksi) that is higher than those associated with Class 1 base material.

3) All of the sections are performing very well except two projects. The two poorly performing sections are sections 14 and 16. Section 14 on SH 203 is the worst performing section in the study. The cause of the below-average performance is not fully known at this time, but it is assumed to be related to a poorly performing surface seal. Section 16 is badly cracked, but this is the oldest section, which was constructed in 1992 with 15 percent fly ash. The section was also placed on a cracked and seated old jointed concrete pavement, which may be the cause of much of the cracking.

4) The relationship between eventual field modulus and laboratory design strengths is shown in Figure 25. There is a general increase in field modulus with increase in laboratory strength. The one outlier in the data is section 5, where the confined design strength was 297 psi but the field modulus was only 168 ksi. The other two sections with similar laboratory strengths resulted in field moduli values close to 600 ksi. One possible explanation is that the aggregates used in section 5 had a high affinity for moisture.

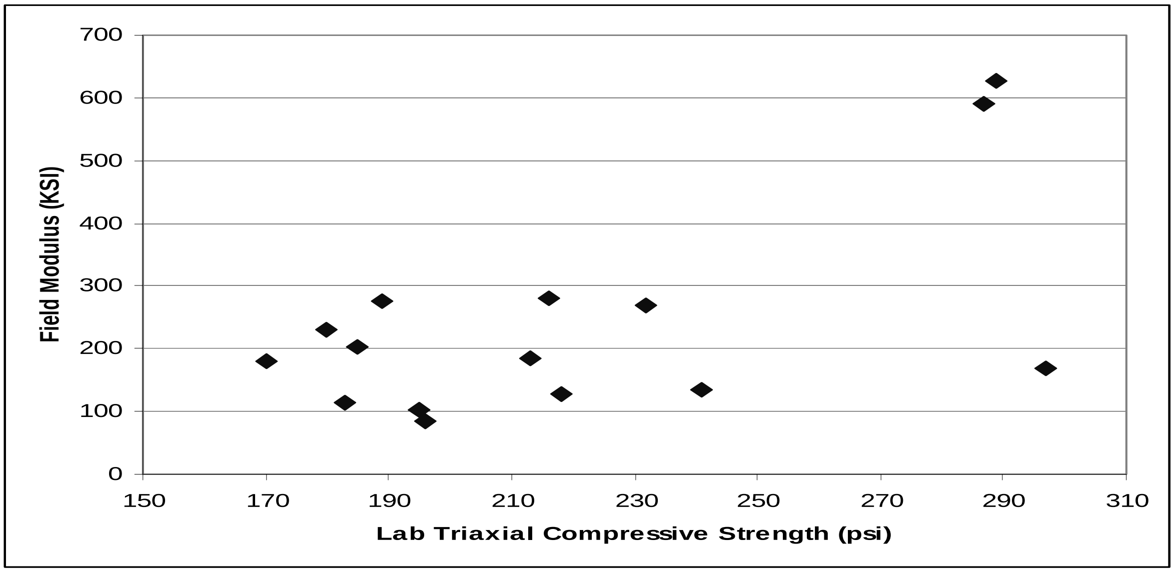


Figure 25. Average Base Modulus (ksi) Backcalculated from FWD Data Against Laboratory Design Compressive Strength Data (psi) (Texas Triaxial Test at 15 psi Confining).

5) It is difficult to draw positive conclusions between the laboratory and field results primarily because the field sections are all different ages. It appears that there is a relationship between the amount of moisture increase in the laboratory sample and the variability of deflections measured in the field. Figure 26 shows a comparison between the laboratory moisture data and the percentage of the section that is below a target value of 50 ksi. This value (50 ksi) was chosen to represent the modulus of an untreated flexible base. The y axis shows the increase in moisture content above optimum at the end of the 10-day capillary rise in the TTC test.

From Figure 26 all of the bases with gains in moisture content of 0.8 percent or less had less than 1 percent of the section with moduli values less than 50 ksi. This is further evidence of the importance of keeping the bases well sealed. The fly ash treatment increases base modulus and strength, but it also appears to increase the affinity of the base to draw in moisture. From Table 7 all but one of the bases ended up at a moisture content higher than optimum.

It is also noted that all of the bases on high-volume roadways (sections 2, 6, 12, 15, and 17) had moisture increase on average of 0.4 percent. It seems that this would be a reasonable value to set as design criteria on future high-volume projects.

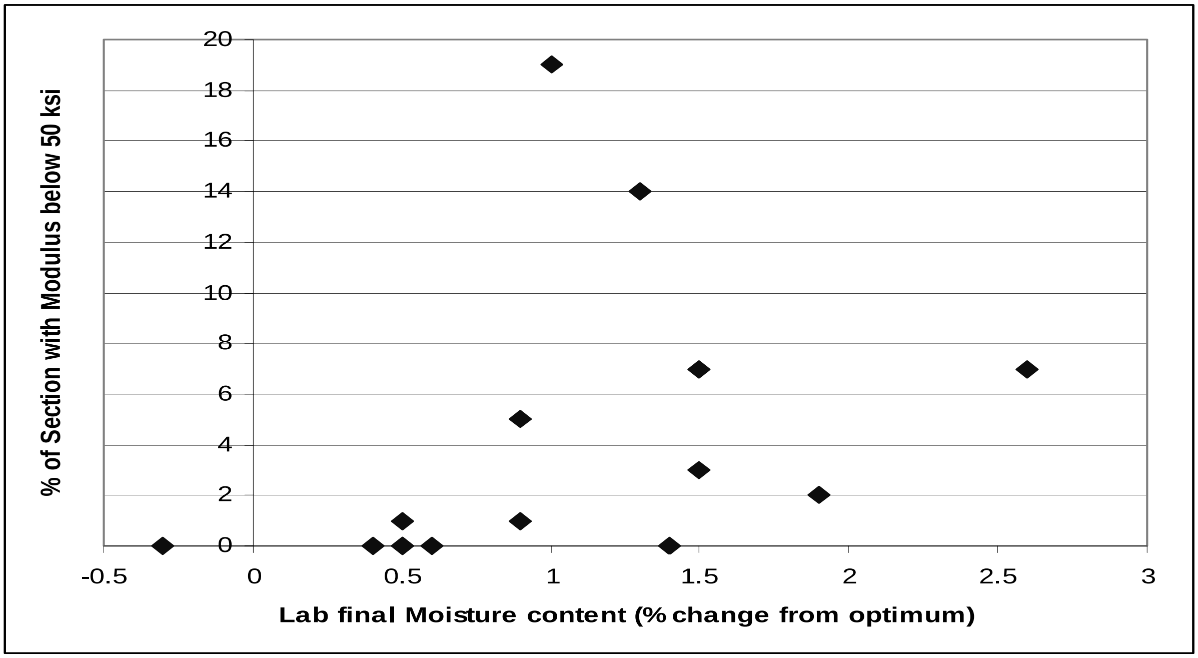


Figure 26. Percentage of Section with Backcalculated Modulus less than 50 ksi against Moisture Susceptibility of Base (Increase in Moisture Content in % above Optimum after 10 Day Capillary Rise).

6) The one concern about the use of fly ash in recycled bases is its moisture susceptibility. This moisture susceptibility means that performance seen in Childress would not necessarily match performance in other areas of the state, particularly in the high rainfall areas of east Texas. Indeed, as will be shown later in this report, a fly ash base in the Waco District did not perform well. A secondary concern expressed by several districts currently using fly ash was that the price continues to rise and it may be more economical to revert back to a more traditional stabilizer such as lime or cement.

As part of this project a limited laboratory investigation was conducted on the two common bases from the Childress District, namely gravel and limestone. The district provided optimum moisture content information for the bases and samples of the fly ash, lime, and cement available within the district. Duplicate equivalent samples were made with the following stabilizers: 7 percent fly ash, 2.5 percent cement, and 4 percent lime. The samples were compacted based on the district-supplied moisture contents and densities and then cured for 7 days in a sealed bag in a high humidity room. After curing, the seismic modulus was measured on the samples. The unconfined compressive strength was recorded, as well as the compressive strength after a 4-hour soak. Another set of samples was subjected to the tube suction test described in the next section of this report. The purpose of this limited study was to determine if equivalent engineering properties could be obtained with the traditional stabilizers (lime and cement) as compared to the fly ash, which has proven to be effective in the Childress District. The results of this limited study are shown in Tables 9 and 10.

Table 9. Comparison of Properties on Gravel Base Materials from the Childress District.

	7% Fly Ash	2.5% Cement	4% Lime
7-day Unconfined Compressive Strength (UCS) (psi)	89	273	97
7-day UCS (after 4 hr soak)	29	222	51
Final Dielectric (after TST)	16.3	15.3	NA
Seismic Modulus (ksi)	215	997	NA

Table 10. Comparison of Properties on Limestone Base Materials from the Childress District.

	7% Fly Ash	2.5% Cement	4% Lime
7-day UCS (psi)	221	332	171
7-day UCS (after 4 hr soak)	166	460	46
Final Dielectric (after TST)	18.8	5.5	NA
Seismic Modulus (ksi)	2270	1432	NA

From the results shown in Tables 9 and 10 it appears that the gravel material treated with fly ash is highly moisture susceptible. The results show that the unconfined strength dropped from 89 to 29 psi after a 4-hour soak. The final dielectric value of this sample at the end of the TST was 16.3, which is above the recommended maximum value of 10 (see Chapter 4 for details of the TST). These results clearly demonstrate the importance of getting a good surface seal on stabilized bases. As discussed earlier in the text and in the results from the Amarillo District, the performance of these bases is largely dictated by the quality of the surface seal. The lime results were similar to those from the fly ash, but the lime also did poorly in the 4-hour soak on the limestone material. The 2.5 percent cement results were somewhat better, however, the gravel material sample still failed the tube suction test requirement, although it had higher strengths and better retained strength on wetting. The concern with the cement is that the stiffnesses are too high, which could cause other problems. With the limestone material it looks as if cement contents less than 2.5 percent could provide properties similar to those obtained with fly ash. This could potentially make cement or cement/fly ash blends an economic option in the Childress District.

AMARILLO DISTRICT

The Amarillo District has been constructing full depth recycling projects since the early 1990s. The performance of the majority of these sections has been less than satisfactory. The early efforts focused on the use of cement, lime, and fly ash stabilizers. In several instances blends of these stabilizers, for example cement/fly ash, were used. The cement sections were initially designed to have high early compressive strength (TxDOT specifications typically require 7-day strengths of 500 psi). These stiff bases were covered by thin HMA surfacing typically around 2 to 3 inches. All of the cement treated bases (CTB) initially developed a shrinkage crack pattern of transverse cracks at typically 10- to 15-ft intervals. These cracks are not typically a problem if they are sealed and provide good load transfer. However, in Amarillo the preliminary cracks let moisture into the pavement and on high-volume roadways this clearly led to severe structural problems. Examples of these problems are shown in Figures 27 and 28. The secondary distresses were the results of moisture ingress and heavy truck loads leading to structural failure in the wheel paths. The cement treated base on IH 40 was eventually completely replaced with full depth concrete after less than 5 years in service.

Figure 27. Loop 335 NB CTB Structural Damage.

Figure 28. IH 40 EB CTB Structural Failure.

The district reported problems with stabilizers other than cement. The performance of the fly ash sections was not satisfactory primarily due to bonding problems between the base and the surfacing layer.

In recent years the Amarillo District has discontinued using calcium-based stabilizers for its full depth reclamation projects in favor of asphalt materials. Several of these projects have been constructed recently and were included in the monitoring effort described below.

Monitoring Performance of Recycled Pavements in the Amarillo District

Seven full depth recycled projects were selected for inclusion in this project. In each case the existing structure was mixed together and treated with a stabilizer. An eighth section involving a new full depth fly ash treated base was also included for comparison purposes. For each section both ground penetrating radar and falling weight deflectometer data were collected. A summary of the information collected for each section is shown in Appendix B. The data collected are summarized in Table 11 and photographs of the distresses found on several sections are shown in Figures 29 to 31.

Table 11. Summary of Performance of Full Depth Reclaimed Sections in Amarillo District.

Section No. (Highway)	ADT	Const. Date	Stabilizer Type	Thickness (in)	HMA Thickness (in)	Base Modulus ksi (% of section below 50 ksi)	Condition (2002)	Performance Problems
1 (SH 207)	5000	7/98	2% C + 1% FA	8 CTB over 7 Flex	2.5	213 (4%)	3.9 (Fair)	Slippage problems shortly after opening to traffic Some longitudinal and transverse cracking throughout project
2 (LP 335)	3400	6/99	2.5% L	10 LTB	5.5	257 (14%)	*	Longitudinal cracking Received a chip seal in 2002
3 (LP 335)	6700	6/01	2.5% L	12 LTB	5.5	229 (0%)	1.1 (Very good)	New section, minor longitudinal cracking
4 (US 54)	1400	3/96	3% C	8 CTB 10 Flex	1.5	685 (0%)	5 (Very poor)	Lots of cracking, rough ride
5 (US 87)	3800	10/94 Ovl. 10/99	2% A	5 ATB 12 Flex	4	44 (76%)	*	Overlay in 1999. In 2002 wheel path cracking throughout project
6 (US 87)	3800	11/99	8% FA	14	1.5	169 (6%)	2.3 (Very good)	Cracking on surface and evidence of base pumping in several locations
7 (US 287)	4000	11/99	4% A	8 ATB 10 Flex	6.5	366 (0%)	1.2 (Excellent)	Minor longitudinal cracking, good ride
8 (US 287)	4100	9/02	6% A	10 ATB 12 Flex	6.5	275 (0%)	1 (Excellent)	New section

Key: Stabilizers: C (Cement), L (Lime), Fa (Class C Fly Ash), A (Asphalt Emulsion)
Condition: Based on Amarillo District Inspections and Annual Condition Report (Nagel, 2002)
1 – 1.5 Excellent, 1.6–2.5 Very Good, 2.6–3.5 Good, 3.6 - 4.5 Fair, 4.6 - 5 Poor, * No Rating after Treatment

Figure 29. Section 1 SH 207 Hutchinson County – Cement/Fly Ash Base.
Patched area, initial problems relating to slippage between the base and surface.

Figure 30. Section 5 US 87 SB Dalhart to Hartley (Last overlay 2 years old).
Emulsion stabilization (2%). FWD indicated that the stabilized layer is weak. Structural damage apparent after 7 years.

Figure 31. Section 6 US 287 NB Hartley to Dalhart (2 years old).
Eight-inch fly ash treated flexible base with underseal and thin surfacing. Evidence of base pumping several places throughout project. FWD indicated that the base strength was reasonable. Problems assumed to be caused by a lack of bonding of base to surface.

The key points to note from Table 11 are:

- The highest modulus section (SH 54) is the worst performing section.
- The lime sections are performing well, but they are still relatively new. The variability in base modulus is high with 14 percent of the section having a modulus of less than 50 ksi, which is a value found on untreated bases.
- The 2 percent high float emulsion did not effectively stabilize the recycled asphalt pavement (RAP) material, the base modulus is low, and the section is showing structural problems. The residual asphalt from the emulsion is targeted at 60 percent of the application rate, therefore a 2 percent application rate would have 1.2 percent residual asphalt. On this section this was not enough.
- The asphalt emulsion sections on US 287 applied at the 4 and 6 percent rate are new, but the initial performance and FWD data are very good. Monitoring should continue on the sections.
- The cracking and pumping problems on the fly ash section on US 87 appear to be related to bonding problems rather than base strength. The average base modulus for the section is 169 ksi, which is very good.

Conclusions and Recommendations

1) The performance of the cement-stabilized bases in Amarillo has been poor due to excessive shrinkage cracking. Even low levels of cement (3 percent on SH 54) resulted in excessive transverse and longitudinal cracking. The SH 54 base is also very stiff. It was calculated to have stiffness in excess of 500 ksi. Recommendations on improved criteria for selecting stabilizer contents and new construction techniques are given later in this report.
2) The performance of the fly ash sections has not been satisfactory. The major problem appears to be the lack of bonding between the base and surfacing layer. Statewide more research is needed to develop improved bonding techniques for these stabilizers. All districts surveyed indicated that lack of bonding is a problem, and they have attempted a variety of methods in the field.
3) The relatively new lime-treated sections on Loop 335 are performing well at this time. The oldest section was opened to traffic in November 1998. Longitudinal cracks were noted in 2001, and the section was given a seal coat in 2002. On this section the deflections are very variable; although the average moduli is high at over 250 ksi, 15 percent of the section has moduli values of less than 50 ksi.
4) The initial asphalt-stabilized base section did not perform well on US 87. The FWD indicates that the stabilized base on this section is weak. Even though a relatively thick HMA layer was placed (5 to 6 inches), cracking is now evident throughout its length. However, the problem is probably associated with the low levels of asphalt used (2 percent).
5) The new asphalt-treated sections on US 287 look very good. The use of the CSS-1 emulsion has resulted in bases with high moduli values (366 and 275 ksi) and very uniform deflections. At the time of monitoring these sections were only 2 years old. This age is too young to draw definite conclusions, and these sections should continue to be monitored. At this time TxDOT does not have laboratory test procedures for designing emulsion treated bases; this is a topic in which future research is needed.

YOAKUM DISTRICT

The Yoakum District routinely uses its in-house maintenance forces to recycle its thin farm-to-market highways to upgrade their load-carrying capabilities. Most of the existing structures consist of multiple seal coats and 4 to 8 inches of gravel base. The stabilizer traditionally used in this process is lime. No formalized design procedures exist to select the optimal stabilizer content, and as the lime is added by maintenance forces it may vary from job to job. The target lime content was stated to be in the 1.5 to 2 percent range. The Yoakum District does have areas of highly plastic soils, but in general the soils are better than those found in the Bryan District described earlier. The Yoakum District has experienced some of the same longitudinal cracking problems as those reported in Bryan, but these were not as extensive or severe and, in general, the district was fairly happy with the performance of the lime-treated sections.

In the 1990s the district had success with the use of emulsion-treated recycled pavements for various maintenance applications, so the district decided to construct a test section to identify if emulsions could be used to replace lime. In 1998 the district included a 4-mile-long emulsion-treated section in a recycling project on FM 237 in Dewitt County. Based on recommendations from the emulsion suppliers, one section was treated with an emulsified asphalt (residual asphalt between 2.3 and 3 percent) and the other was treated with 1.5 percent lime. The typical section for this highway is shown in Figure 32.

From discussions with the Yoakum District engineers, the emulsified-treated base was difficult to construct. In the Yoakum District it is usual to put the traffic on the section as soon as possible. As the vast majority of these sections are two-lane highways with low-strength shoulders, it is usually mandatory to let the traffic drive on the section that night. This practice was not possible with the emulsified base section, as the section was not strong enough to carry traffic for at least the first 2 days after treatment. The district experimented with the use of cement to improve early strength, but while this did improve the break time and early strength, they did not achieve the goal of being able to let traffic on the section the same day as treatment.

Monitoring of Sections

The sections were 3 years old at the time of testing and the traffic loads have been relatively light. The evaluation consisted of a visual inspection, ground penetrating radar survey (to assess layer thickness and base moisture condition), falling weight deflectometer survey (in

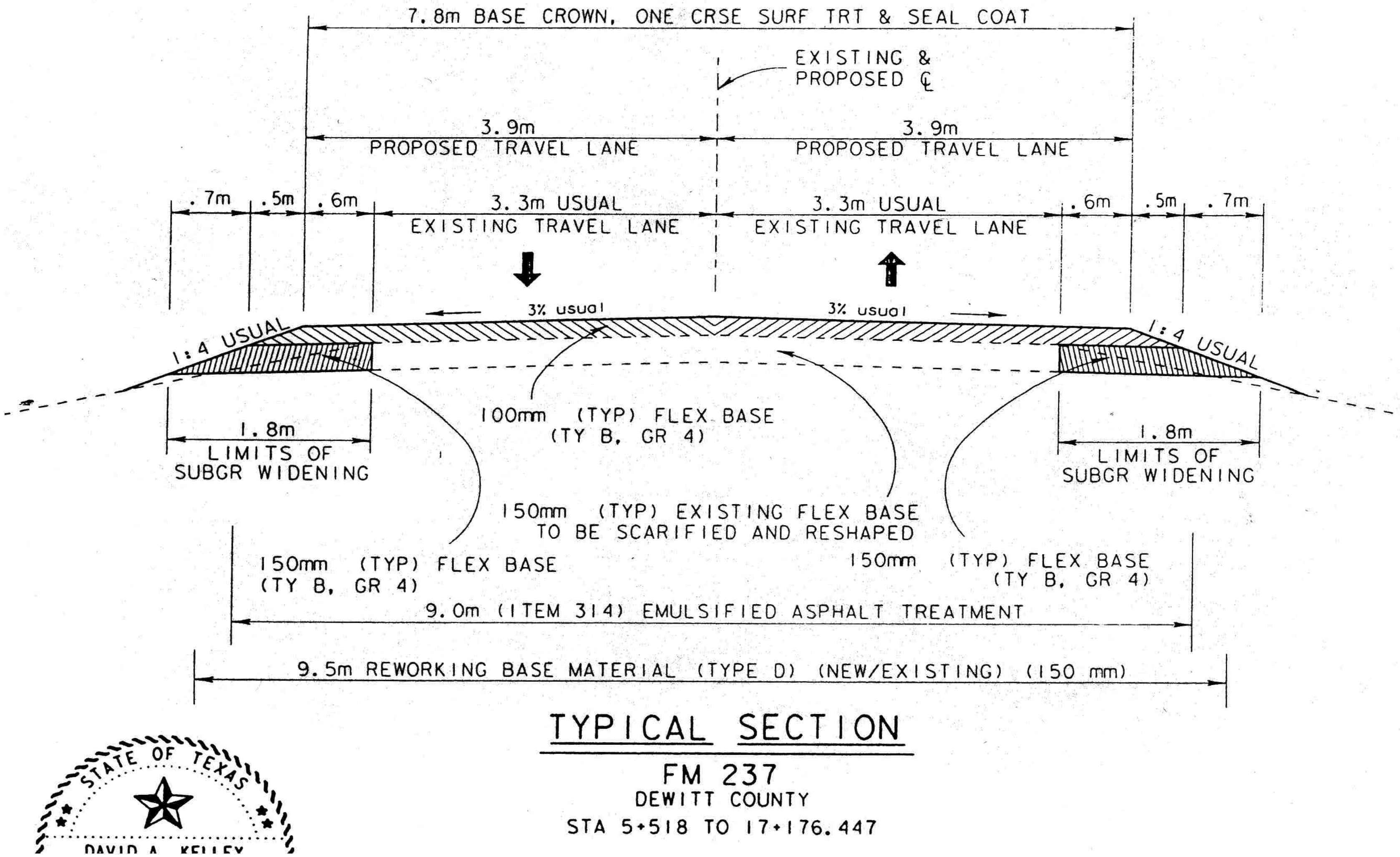


Figure 32. TxDOT's Typical Section for the Emulsified Asphalt Project.
Note the layers shown in the plans (4-inch over 6-inch) can all be seen in the GPR data.

situ modulus of base), dynamic cone penetrometer survey (in situ shear strength), and field coring of the asphalt-treated base (ATB) section.

Results of Analysis

Collected data indicate the following conclusions:

The ATB is showing wheel path cracking, but no distresses were found in the lime-treated section. Examples of the crack patterns found in the west end of the ATB project are shown in Figure 33. The cracking was most apparent in the wheel paths, although it was not restricted to the wheel paths. In some areas more of a block crack pattern was observed. The source of the cracking was not established in this testing. Although the deflections are higher in this section, they are not excessively high so this may not be the typical load associated damage. If this cracking appeared shortly after construction it may be related to construction issues, such as sealing the base too early.

The FWD was processed with the MODULUS 6.0 backcalculation system, and the results are shown in Figure 34. This is the MODULUS 6 output for the first 4 miles of the ATB section. The pavement was modeled as 1 inch of surface over 10 inches of ATB over a 6 inch foundation course. The modulus of the top layer was fixed, and this thin layer will have little impact on the results. The subgrade was classified as good with a modulus of 16.4 ksi. The average base modulus at 71 ksi is good, but it is noted that at several locations (1.77, 2.2, and 2.8 miles) the deflections were higher and the base modulus substantially lower. Values of 40 ksi and below are cause for concern, especially as the surface of this highway now has substantial cracking. It will be interesting to repeat measurements a year from now.

Researchers obtained similar FWD results for the first 3 miles of the lime-treated base section as shown in Figure 35. In comparison the average max deflection is lower (12.8 versus 20.7 mil) and the base modulus is higher (227 ksi versus 71 ksi). These values are typical for well-stabilized bases (however, usually with more than 1.5 percent lime). Only one drop location (9.81 miles) has high deflection and relatively low modulus. But at this location all the layers including the subgrade are lower than the average values.

Figure 33. Wheel Path Cracking in the ATB Section.

It was found that the average modulus of the lime-treated base section was three times higher than that of the ATB, (227 ksi versus 71 ksi). The average maximum deflection in the lime section was 40 percent less than the ATB section. The ATB section had several locations where the base modulus was calculated to be low. Using the 50 ksi target modulus, 25 percent of the ATB section was below this target, whereas none of the lime section was below 50 ksi. In summary, for the ATB section the base modulus was classified as good for 67 percent of the section, fair for 19 percent and poor for 14 percent. For the lime section 95 percent of the section was classified as good with 5 percent fair. This rating is based on the base/subgrade modulus ratio concept; if the ratio is greater than 3 then the base is classified as good, if it is less than 2 then it is classified as poor. The average ATB base modulus overall is similar to that of a good flexible base. However, from the field coring little evidence of stabilization was found. The base is 3 years old at the time of testing; it will be interesting to repeat measurements to determine if the modulus is decreasing with time. Even with only 1.5 percent lime the average base modulus is high at over 200 ksi, which is a stiff base well above that found for typical flexible base material.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District: Yoakum
County : Dewitt
Highway/Road: FM 237

	Thickness (in)	MODULI RANGE (psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	1.00	403,300	403,300	H1: v = 0.35
Base:	10.00	20,000	300,000	H2: v = 0.35
Subbase:	6.00	10,000	150,000	H3: v = 0.35
Subgrade:	150.19	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock	
0.000	8,985	23.04	8.50	3.43	2.08	1.38	1.02	0.79	403.3	43.3	16.4	25.0	5.03	81.5	
0.200	8,866	22.22	11.08	4.48	2.31	1.51	1.19	0.93	403.3	53.2	10.0	20.2	8.19	84.1	*
0.601	8,814	24.04	13.09	6.15	3.33	2.16	1.70	1.38	403.3	56.0	10.0	14.2	7.80	106.9	*
0.805	9,092	16.94	10.20	5.18	2.83	1.76	1.29	0.98	403.3	103.0	10.0	18.9	6.36	109.2	*
1.001	8,981	16.32	7.22	3.52	2.09	1.45	1.07	0.84	403.3	72.4	22.9	24.0	4.35	178.3	
1.088	8,929	18.40	10.59	6.54	4.33	3.03	2.21	1.69	403.3	89.0	36.4	11.5	2.39	274.3	
1.207	9,064	16.32	8.69	5.47	3.43	2.30	1.72	1.37	403.3	93.3	42.0	15.1	1.38	212.3	
1.401	8,937	16.67	11.78	7.49	4.26	2.57	1.72	1.28	403.3	136.2	10.0	12.2	6.69	125.4	*
1.575	9,025	13.39	6.95	3.43	2.05	1.44	1.13	0.89	403.3	107.1	24.5	25.0	6.54	188.1	
1.773	8,977	30.74	12.34	6.70	4.15	2.85	2.06	1.59	403.3	32.6	26.5	11.7	2.49	262.4	
2.013	9,021	18.19	9.48	5.48	3.60	2.50	1.77	1.34	403.3	77.5	37.9	14.4	2.72	215.4	
2.200	8,905	34.05	11.33	5.66	3.42	2.39	1.74	1.30	403.3	25.1	29.3	14.2	3.40	220.9	
2.401	9,112	13.65	6.30	3.54	2.21	1.50	1.07	0.82	403.3	92.9	45.1	24.2	1.93	217.5	
2.519	8,957	24.39	10.13	5.28	3.31	2.33	1.74	1.39	403.3	42.5	30.0	14.6	4.36	300.0	
2.801	9,044	39.50	10.80	5.07	2.78	1.74	1.26	0.99	403.3	20.0	18.2	17.4	2.16	110.9	*
2.996	9,191	14.46	7.40	4.36	2.81	2.04	1.57	1.29	403.3	94.8	67.3	18.3	4.28	300.0	
3.406	8,965	16.22	9.63	5.13	3.30	2.32	1.72	1.36	403.3	104.1	23.2	15.4	5.69	300.0	
3.605	9,001	16.63	9.49	5.31	3.39	2.11	1.69	1.31	403.3	100.3	21.8	15.6	4.42	135.0	
3.800	9,048	20.86	12.09	6.15	3.43	2.08	1.50	1.14	403.3	76.3	10.0	15.3	5.42	122.9	*
3.945	8,933	23.00	11.57	5.82	3.57	2.37	1.75	1.35	403.3	58.3	14.7	14.2	4.61	199.6	
Mean:		20.95	9.93	5.21	3.13	2.09	1.55	1.20	403.3	73.9	25.3	17.1	4.51	167.2	
Std. Dev:		6.99	1.93	1.15	0.72	0.48	0.34	0.26	0.0	31.4	14.9	4.4	1.98	76.2	
Var Coeff(%):		33.36	19.47	22.00	22.90	23.12	21.95	21.78	0.0	42.6	58.7	26.0	43.84	43.6	

Figure 34. FWD Results from Modulus 6 for the Asphalt Emulsion-Treated Section on FM 237.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District: Yoakum
County : Dewitt
Highway/Road: FM 237

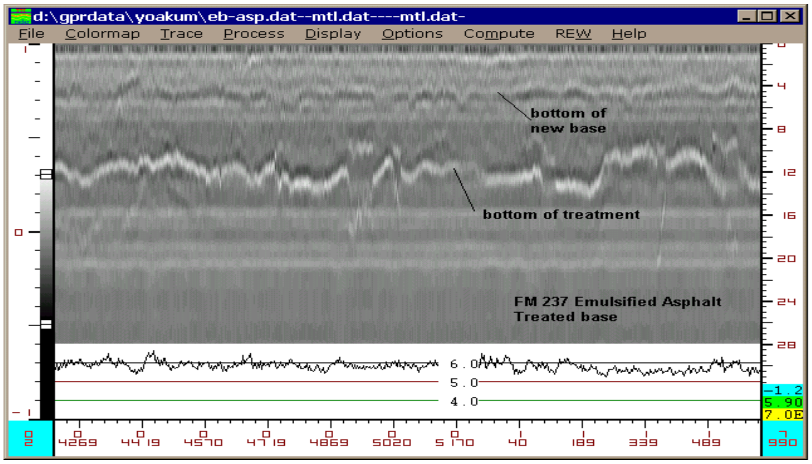
	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	1.00	403,300	403,300	H1: v = 0.35
Base:	10.00	20,000	500,000	H2: v = 0.35
Subbase:	6.00	10,000	150,000	H3: v = 0.35
Subgrade:	214.35	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
7.364	8,965	12.71	7.13	4.73	3.11	2.10	1.57	1.03	403.3	139.0	39.7	19.4	1.07	218.4
7.601	8,802	19.22	11.56	6.50	4.31	2.98	2.20	1.64	403.3	91.1	14.9	13.5	3.17	283.5
7.820	8,890	13.38	9.49	6.41	4.41	3.13	2.29	1.75	403.3	228.5	16.7	13.6	1.21	276.3
7.993	9,001	10.76	7.80	5.07	3.53	2.48	1.78	1.32	403.3	306.7	16.2	17.6	1.91	230.3
8.202	8,802	12.65	8.37	5.82	3.93	2.94	2.15	1.55	403.3	191.0	37.9	14.4	1.07	210.4
8.399	8,886	15.29	8.18	5.26	3.56	2.56	1.87	1.28	403.3	97.7	48.8	16.6	0.92	169.9
8.601	8,842	14.37	9.39	6.44	4.59	3.33	2.53	1.83	403.3	154.6	44.1	12.6	0.68	213.0
8.805	9,044	9.75	7.14	4.92	3.50	2.37	1.72	1.27	403.3	390.3	16.3	18.3	1.18	220.2
9.110	9,088	7.17	4.72	3.42	2.55	1.93	1.47	1.17	403.3	367.1	150.0	23.2	2.22	300.0 *
9.206	8,997	15.26	8.97	5.43	3.64	2.59	1.91	1.44	403.3	117.7	27.6	16.3	1.87	267.2
9.393	9,056	10.95	6.39	4.35	3.00	2.03	1.39	1.04	403.3	185.3	42.7	20.9	2.67	173.4
9.615	8,909	13.65	9.41	5.91	3.93	2.73	2.02	1.57	403.3	188.8	15.3	15.2	2.71	290.5
9.811	8,786	28.20	15.65	9.83	6.17	3.78	2.31	1.59	403.3	55.5	10.0	10.0	6.18	130.9 *
10.001	9,064	6.16	5.11	4.15	3.19	2.45	1.83	1.44	403.3	500.0	150.0	18.6	6.03	297.0 *
10.062	9,251	9.15	5.43	3.64	2.54	1.84	1.37	1.06	403.3	206.2	98.8	23.8	0.67	292.6
10.207	8,890	19.74	14.79	9.49	6.09	3.94	2.65	1.91	403.3	123.3	10.0	9.9	6.14	179.0 *
10.429	9,211	17.56	10.30	6.25	4.20	2.80	2.08	1.63	403.3	106.6	19.9	14.9	1.42	202.6
10.604	9,064	7.93	4.57	3.08	1.95	1.33	0.96	0.68	403.3	252.4	56.3	30.8	1.33	228.9
Mean:		13.55	8.58	5.59	3.79	2.63	1.89	1.40	403.3	205.7	45.3	17.2	2.36	231.4
Std. Dev:		5.34	3.12	1.82	1.10	0.67	0.44	0.32	0.0	118.7	43.9	5.2	1.87	56.3
Var Coeff(%):		39.40	36.37	32.45	29.06	25.46	23.08	22.98	0.0	57.7	96.9	30.2	79.25	24.5

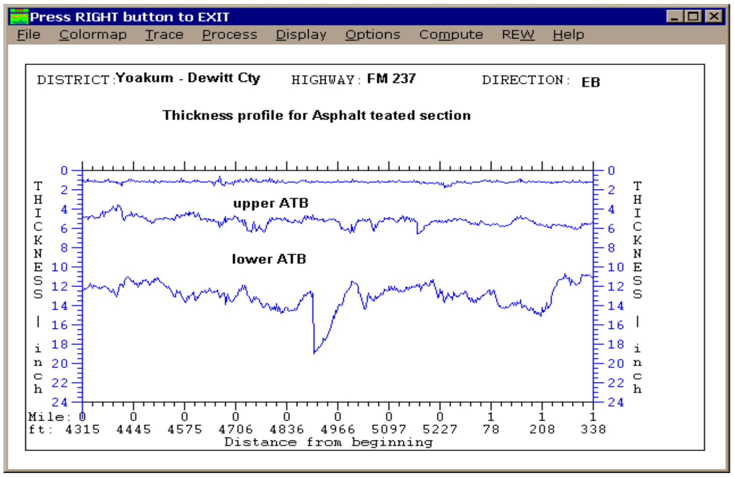
Figure 35. FWD Results from Modulus 6 for the Lime-Treated Section on FM 237.

The ground penetrating radar was able to detect each of the layers in the pavement structure, and no moisture problems were found in either the ATB or lime treated bases. Both bases are dry and not holding moisture. The results for the asphalt stabilized base are shown in Figure 36. The top figure shows the COLORMAP display for about 1500 ft of pavement. The surface is at the top of the figure, and the distance from the start of the section is shown at the bottom in miles and feet, and the depth scale is on the right. The bottom of the base layer is clear in the data. The estimated depths of each of the layers are shown in the second figure. The bottom graph is the base dielectric; desirable (dry) values are values less than 10. As can be seen the base results are around 6 to 7. These results are very good, indicating that this base is dry and not pulling in any significant moisture. You would only start to worry if these values were 14+. With the good sandy subgrade and low rainfall, these numbers are perhaps to be expected.

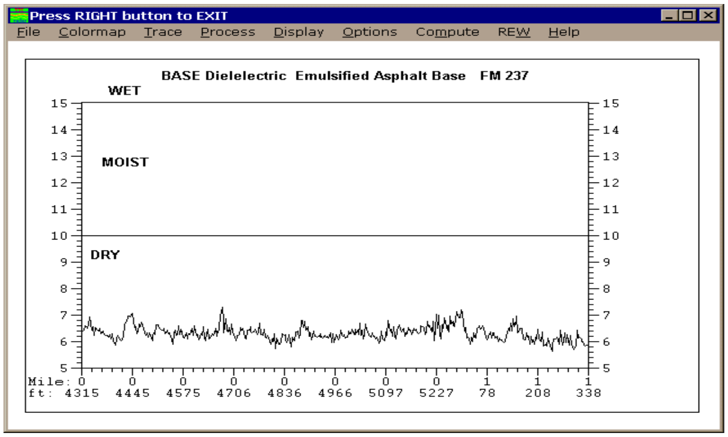
The dynamic cone penetrometer confirmed that the ATB has similar properties to that of a good flexible base. One set of data is shown in Figure 37. It was relatively easy to penetrate with penetration rates of 2.3 and 3.1 mm/blow. This translates to a California Bearing Ratio (CBR) value of 114 and 82, both typical of Texas Triaxial Class 1 material. Dynamic cone penetrometer data were obtained for one test location in the eastbound direction. The graph shows the rate of penetration through each layer in the pavement structure. Significant changes in slope indicate a transition into another layer. The faster the penetration, the weaker the layer. Changes in slope were detected at approximately 11 and 15 inches beneath the surface. Using standard equations the penetration rate can be converted into CBR and resilient modulus values. For the ATB at this location the average slope was 2.3 mm/blow, which computes to a CBR value of 114 and a resilient modulus of 52 ksi. (This 52 ksi is in the ballpark of the values computed later from the FWD data.)



a) COLORMAP Display (All Interfaces Clear).



b) Calculated Layer Thicknesses.



c) Base Dielectric (Indicates Base Is Very Dry, No Moisture Retention Problems).

Figure 36. GPR Data from Emulsified Asphalt Base Section on FM 237.

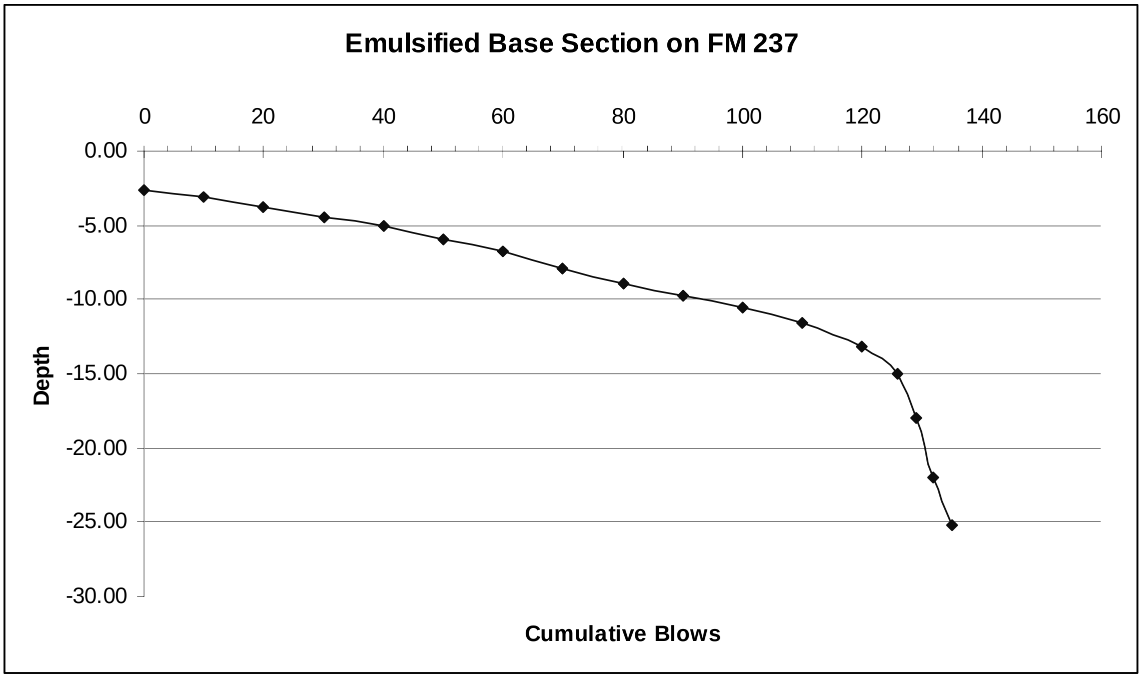


Figure 37. Dynamic Cone Penetration Data from FM 237.

Figure 38 shows photographs obtained during the coring operation. The ATB totally disintegrated and from down-hole observations it did not appear that the asphalt had coated many of the aggregates. It was very difficult to see any evidence of asphalt treatment. More asphalt is probably needed to coat this material.

Figure 38. Coring Emulsified Base (No Evidence of Base Stabilization).

Conclusions and Recommendations

From discussions with the Yoakum District engineers the emulsified-treated base was difficult to construct, and the curing time was a problem when there was a need to get traffic on the section as soon as possible. From the monitoring results the long-term performance of the ATB section is also a concern. It is already showing surface distress, and its stiffness is substantially less than the traditional lime section. These observations result in the following recommendations:

1) For this type of base, material lime appears to be a better stabilizer.
2) If emulsified asphalt is to be tried again, a laboratory test protocol should be developed to determine the optimum asphalt content. Field coring found little evidence of effective stabilization, and the 2.3 percent asphalt was probably too little to effectively treat this material. Some new laboratory test procedures are available to design these mixes.

WACO DISTRICT

The Waco District has constructed only a few sections using full depth recycling. However in February of 2000 the district constructed four experimental test sections on a short section of FM 3371 to compare the merits of different stabilizers. The sections of roadway are on a header bank section that extends across Lake Limestone in Limestone County. The average daily traffic for the section was 700 with some heavy agricultural truck traffic.

For each experimental section the process was essentially the same. The top 4 inches of the existing roadway was scarified and mixed with 4 inches of new base material. The blended materials were then treated, compacted, and surfaced with a two-course surface treatment. The four experimental sections are as follows.

- Test Section 1 (1000 ft) Blend 4 inches of new crushed limestone with the existing base and treat with a liquid stabilizer (Roadbond) supplied by Wright Asphalt products.
- Test Section 2 (500 ft) Same as section 1 but no additives were used, this was the control section.
- Test Section 3 (500 ft) Same as section 1; this time 2.5 percent Type 1 cement was used.

- Test Section 4 (1320 ft) The new base was 4 inches of 100 percent fly ash base, provided by a local power plant near Bremond.

One the district's main objectives was to determine if the fly ash by-product could be used successfully to replace the traditional crushed limestone. The construction sequence and preliminary observations were provided in a TxDOT technical report "Demonstration Project Report on the Use of Fly Ash Base" (Kennedy, 2000). A view of the completed section is shown in Figure 39.

Figure 39.   View of Sections 1, 2, and 3 in June 2002.

Monitoring

Monitoring was conducted in June of 2002 when the pavement was just over 2 years old. Monitoring consisted of both falling weight deflectometer and ground penetrating radar testing, together with a visual evaluation of each section.

Results

From the visual inspections two of the four sections appear to be experiencing structural base failures. Photographs of typical distress patterns are shown in Figure 40. The Roadbond section is experiencing localized rutting in the inside wheel path at several locations. The most severe structural problems are in the fly ash base section; these would be classified as base failures using TxDOT standard distress classifications. Both the control section and the cement stabilized section show no major distresses. However, in the cement stabilized section a few localized areas of block cracking were observed. There were no distresses in the control section.

Ground Penetrating Radar Results

GPR data were collected in both directions and processed using the COLORMAP analysis system (Scullion and Chen, 1999). Typical results are shown in Figure 41. The surface of the section was a two-course surface treatment with 8 inches of treated base. The major observation from these data is the variability of the dielectric of the base layer. The dielectric is an indicator of the amount of moisture present in the base layer. Values from sections 1, 2, and 3 were in the range of 10 to 14, which is reasonable for Texas based materials; the fly ash section was in the range of 16 to 20, which is high.

Two factors influence the GPR results. Firstly, these sections are alongside lake limestone so moisture is readily available to "wick up" into the base. Secondly, the fly ash base is an unusual material. As reported by Kennedy (2000) the optimum moisture content for this material is 32 percent, whereas the typical base is between 6 to 8 percent.

Falling Wight Deflectometer Results

The FWD data were processed using the MODULUS 6.0 backcalculation program. Results from all four sections are shown in Figures 42 through 45, and are summarized in Table 12.

Table 12. Summary of FWD Results from Experimental Sections in Waco.

Section	Treatment	Max Average Deflection (mil)	Average Base Modulus (ksi)	Design Base Modulus *(ksi)	% of Base Modulus below 50 ksi
1	Roadbond	37.1	45	20	58
2	Control	19.1	110	83	0
3	Cement	10.5	659	470	0
4	Fly Ash	36.5	39	21	71

* (weakest subsection found with MODULUS 6.0's segmentation routine)

a) Section 1 Roadbond Treated

b) Section 4 Fly Ash Base

c) Section 3 Cement Stabilized Section

Figure 40. Typical Distresses on FM 3371.

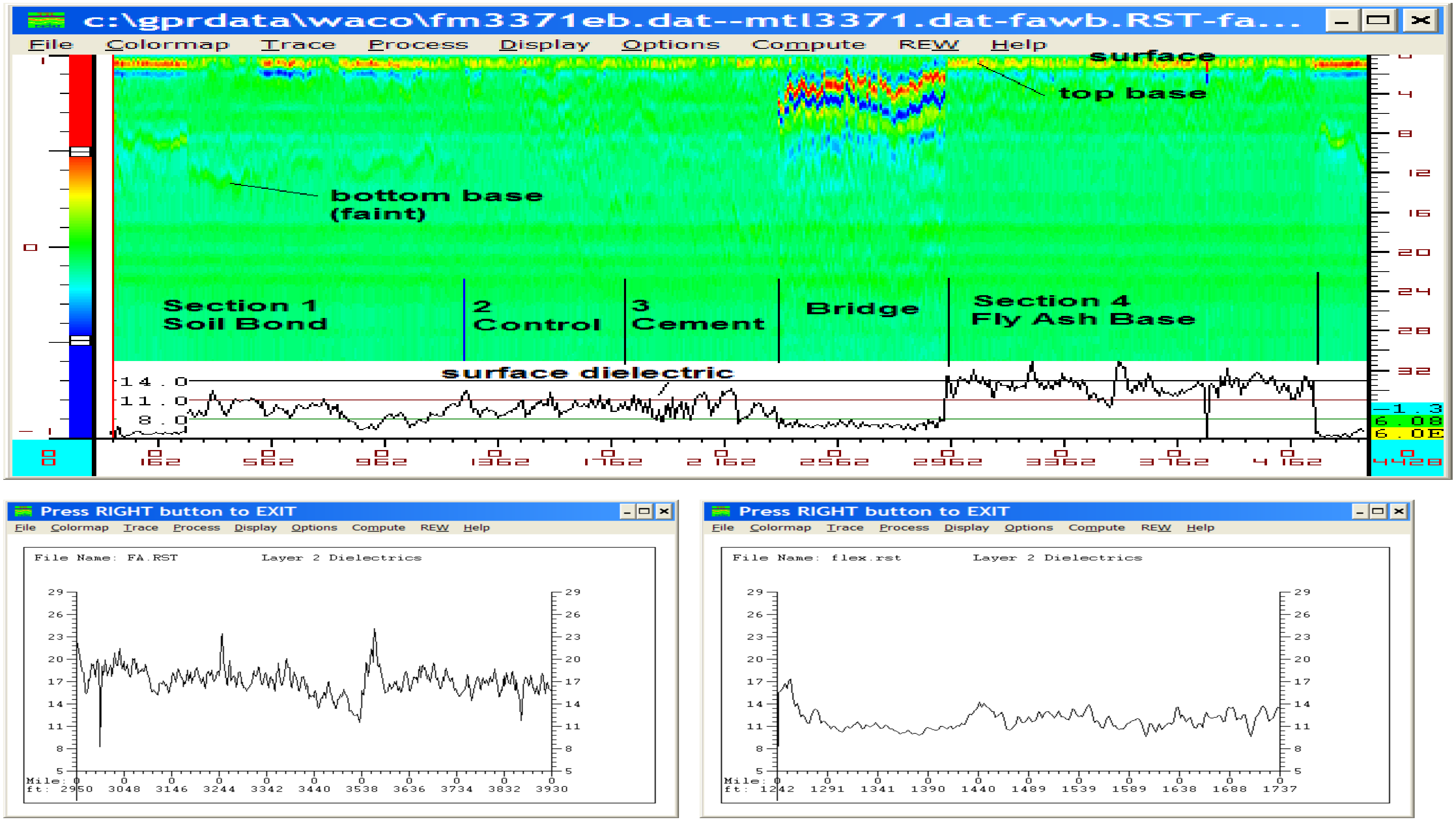


Figure 41. GPR Data from FM 3371.

The top figure is the COLORMAP display from the entire project. The lower plots show the dielectric plots for the fly ash base and control section. The key issue is that the higher dielectric indicates that the fly ash is holding more moisture than the other sections.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District: Waco
County : Limestone
Highway/Road: FM 3371

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	222,600	222,600	H1: v = 0.35
Base:	8.00	10,000	150,000	H2: v = 0.35
Subbase:	12.00	10,000	150,000	H3: v = 0.35
Subgrade:	240.00	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	9,700	22.02	9.30	4.73	3.52	2.70	2.09	1.72	222.6	58.9	37.2	15.5	8.28	300.0
0.020	10,129	19.13	7.43	3.55	2.50	1.90	1.50	1.26	222.6	75.8	33.8	22.7	11.97	300.0
0.031	10,026	19.36	8.57	3.99	2.41	1.65	1.21	1.01	222.6	77.4	28.7	22.3	5.02	207.8
0.041	9,712	19.45	8.72	4.06	2.56	1.89	1.38	1.21	222.6	76.4	27.6	20.6	7.05	259.1
0.051	10,252	15.13	6.21	3.31	2.30	1.69	1.34	1.13	222.6	112.8	39.7	24.4	11.50	300.0
0.061	9,930	19.27	7.84	3.42	2.27	1.75	1.42	1.18	222.6	73.8	30.8	23.3	11.88	129.4
0.070	10,681	16.10	6.21	3.00	2.04	1.56	1.11	0.95	222.6	100.7	41.0	27.4	13.70	300.0
0.080	9,998	23.90	8.74	3.96	2.52	1.78	1.33	1.11	222.6	51.4	29.4	22.3	7.04	187.2
0.090	9,092	29.01	8.30	3.58	2.41	1.78	1.39	1.14	222.6	30.6	29.1	21.7	9.63	119.1
0.100	9,088	40.68	13.41	4.42	2.83	2.06	1.61	1.34	222.6	24.4	12.8	18.9	9.86	53.8
0.110	8,202	92.56	24.73	2.44	2.02	2.13	1.86	1.59	222.6	10.0	10.0	18.5	40.61	57.2 *
0.120	8,131	69.47	19.75	5.19	3.07	2.37	1.94	1.62	222.6	10.1	10.0	14.1	12.00	60.6 *
0.131	8,731	50.33	15.91	5.23	3.08	2.06	1.70	1.34	222.6	18.2	10.0	16.3	6.16	54.4 *
0.140	8,544	53.19	14.23	4.95	2.99	2.15	1.74	1.45	222.6	15.3	10.8	16.5	6.73	56.8
0.150	8,774	47.54	15.40	5.00	2.81	2.02	1.54	1.35	222.6	19.8	10.0	17.5	7.22	54.1 *
0.160	9,199	42.91	15.41	5.22	2.81	1.93	1.49	1.35	222.6	25.8	10.0	18.8	8.05	55.6 *
0.171	8,560	40.04	15.21	5.17	2.91	2.05	1.65	1.51	222.6	26.7	10.0	17.0	8.76	55.8 *
0.180	8,806	40.83	15.15	5.02	2.81	1.98	1.54	1.28	222.6	26.4	10.0	18.1	9.00	54.6 *
0.190	9,108	45.59	15.10	5.26	3.15	2.30	1.66	1.40	222.6	22.4	10.7	17.3	7.16	56.9
Mean:		37.18	12.40	4.29	2.68	1.99	1.55	1.31	222.6	45.1	21.1	19.6	10.61	260.5
Std. Dev:		20.37	5.02	0.88	0.40	0.28	0.25	0.21	0.0	32.2	12.1	3.5	7.64	48.6
Var Coeff(%):		54.77	40.48	20.61	14.79	13.84	15.95	15.72	0.0	71.3	57.3	17.6	71.98	56.9

Figure 42. FM 3371 Soil Bond Section.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District: Waco
County : Limestone
Highway/Road: FM 3371

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	222,600	222,600	H1: v = 0.35
Base:	8.00	10,000	150,000	H2: v = 0.35
Subbase:	12.00	10,000	150,000	H3: v = 0.35
Subgrade:	169.64	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.195	9,728	26.61	11.84	5.35	3.21	2.15	1.56	1.27	222.6	52.9	19.8	16.9	5.50	189.2
0.200	9,879	16.80	8.57	4.69	3.19	1.98	1.50	1.23	222.6	117.4	28.1	18.4	3.30	130.3
0.205	10,069	20.02	9.19	4.57	2.83	1.89	1.43	1.19	222.6	81.6	25.8	19.8	3.59	199.6
0.210	9,970	16.84	9.00	4.48	2.78	1.89	1.45	1.22	222.6	123.5	24.4	19.7	4.18	229.6
0.215	10,137	16.47	8.62	4.44	2.76	1.85	1.42	1.07	222.6	127.3	26.2	20.3	3.41	204.3
0.221	10,252	16.22	8.74	4.59	2.82	2.11	1.56	1.31	222.6	136.4	28.3	19.3	5.44	249.2
0.225	9,160	29.45	13.83	5.00	2.77	2.00	1.61	1.44	222.6	54.4	10.0	18.9	10.95	60.2 *
0.230	10,590	16.04	10.30	5.41	3.26	2.06	1.56	1.27	222.6	150.0	25.7	18.4	3.53	144.4 *
0.235	10,530	13.31	8.82	4.61	2.89	1.99	1.55	1.33	222.6	150.0	63.4	17.2	9.75	255.4 *
Mean:		19.08	9.88	4.79	2.95	1.99	1.52	1.26	222.6	110.4	28.0	18.8	5.52	190.1
Std. Dev:		5.40	1.82	0.37	0.21	0.10	0.07	0.10	0.0	38.1	14.5	1.2	2.88	109.8
Var Coeff(%):		28.27	18.46	7.71	7.14	5.17	4.49	8.11	0.0	34.5	51.7	6.2	52.16	57.7

Figure 43. FM 3371 Control Section (4 Inch New Base Blended with Existing Material).

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District: Waco
County : Limestone
Highway/Road: FM 3371

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	222,600	222,600	H1: v = 0.35
Base:	8.00	100,000	2,000,000	H2: v = 0.25
Subbase:	12.00	10,000	150,000	H3: v = 0.35
Subgrade:	233.66	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.290	10,657	16.50	10.52	5.87	3.76	2.71	2.00	1.50	222.6	208.4	27.1	17.1	3.79	300.0
0.295	10,451	12.52	8.90	5.35	3.37	2.39	1.74	1.42	222.6	448.5	20.9	20.9	2.29	300.0
0.300	10,260	11.12	7.93	4.76	3.19	2.21	1.67	1.33	222.6	537.6	22.4	22.4	2.64	268.0
0.305	10,308	9.88	7.34	4.52	2.93	2.00	1.54	1.14	222.6	657.8	23.1	24.7	2.72	235.0
0.310	10,816	8.91	6.63	4.18	2.92	2.00	1.63	1.24	222.6	918.0	26.5	26.5	3.38	236.0
0.320	10,494	9.18	6.44	3.94	2.68	1.90	1.45	1.15	222.6	713.3	27.6	27.6	3.14	300.0
0.325	10,665	9.43	6.44	4.07	2.78	1.98	1.48	1.21	222.6	472.2	61.5	23.1	3.05	300.0
0.330	10,534	10.88	7.17	4.14	2.75	1.89	1.42	1.13	222.6	394.5	35.8	24.4	3.05	245.6
0.335	10,189	13.06	7.74	3.98	2.66	1.88	1.44	1.14	222.6	217.5	36.0	22.1	5.16	300.0
0.340	9,990	12.69	8.05	4.39	2.82	1.93	1.46	1.21	222.6	274.0	28.6	21.9	3.40	240.9
0.345	10,208	8.63	6.59	4.26	2.89	1.98	1.46	1.18	222.6	917.2	22.9	26.0	1.42	239.4
0.350	10,363	6.97	5.52	3.70	2.65	1.91	1.41	1.17	222.6	1409.6	30.5	28.0	1.80	269.6
0.355	9,545	6.93	5.19	3.48	2.57	1.89	1.45	1.18	222.6	731.6	90.4	22.6	2.48	300.0
0.360	9,839	7.53	5.93	3.94	2.87	2.02	1.43	1.21	222.6	1122.4	31.5	24.5	1.39	202.9
0.365	9,712	9.31	7.25	4.76	3.28	2.24	1.60	1.27	222.6	892.9	17.3	22.5	1.16	220.3
0.370	8,806	10.12	7.85	5.02	3.36	2.18	1.62	1.27	222.6	696.5	13.1	20.5	2.11	165.7
0.375	9,966	14.79	10.04	5.34	3.19	2.13	1.57	1.26	222.6	280.3	16.2	20.6	3.21	193.8
0.380	9,875	10.57	7.89	4.92	3.34	2.31	1.68	1.28	222.6	625.8	21.0	21.0	1.82	251.2
0.385	10,776	9.35	6.86	4.37	2.98	2.09	1.58	1.25	222.6	824.8	25.7	25.7	2.04	294.9
0.390	10,542	9.99	7.27	4.48	3.03	2.11	1.60	1.28	222.6	680.1	24.6	24.6	2.51	277.8
0.395	10,681	9.21	7.22	4.47	3.20	2.12	1.57	1.29	222.6	914.7	21.7	25.3	2.68	183.0
0.400	10,248	14.25	11.67	7.48	4.82	3.25	2.23	1.82	222.6	580.8	10.0	16.5	1.96	185.3 *
Mean:		10.54	7.57	4.61	3.09	2.14	1.59	1.27	222.6	659.9	28.8	23.1	2.60	254.2
Std. Dev:		2.51	1.57	0.86	0.49	0.32	0.20	0.15	0.0	303.2	17.2	3.0	0.91	47.7
Var Coeff(%):		23.84	20.79	18.69	15.75	14.84	12.37	12.01	0.0	45.9	59.5	13.0	35.17	19.3

Figure 44. FM 3371 Cement-Treated Base (2.5% Cement).

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District: Waco
County : Limestone
Highway/Road: FM 3371

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	222,600	222,600	H1: v = 0.35
Base:	8.00	10,000	150,000	H2: v = 0.35
Subbase:	12.00	10,000	150,000	H3: v = 0.35
Subgrade:	84.12	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.520	8,063	48.22	21.76	8.24	4.43	2.95	2.30	1.83	222.6	21.2	10.0	6.8	10.30	69.7 *
0.530	8,520	51.20	15.80	5.33	3.13	2.57	1.87	1.59	222.6	16.9	12.3	11.2	15.42	55.4
0.540	8,921	38.69	13.64	5.67	3.61	2.62	1.95	1.59	222.6	25.4	19.4	11.0	10.22	96.5
0.550	8,310	43.07	14.07	5.12	3.18	2.33	1.77	1.52	222.6	20.5	14.5	11.6	12.51	60.8
0.560	8,008	59.99	16.60	4.87	3.07	2.27	1.78	1.54	222.6	12.4	10.0	10.8	16.03	54.4 *
0.570	9,064	35.61	14.46	6.20	3.67	2.47	1.85	1.59	222.6	33.1	15.6	10.7	7.84	119.9
0.580	9,561	17.54	9.18	5.55	3.83	2.60	2.02	1.44	222.6	94.2	49.4	11.0	3.87	228.1
0.590	9,255	21.67	10.24	6.08	4.01	2.74	1.99	1.56	222.6	59.9	38.8	9.7	2.46	248.7
0.600	8,365	32.57	13.98	6.57	4.20	2.87	2.11	1.72	222.6	32.8	19.1	8.3	6.44	300.0
0.610	9,446	30.00	12.67	6.14	3.80	2.63	1.94	1.55	222.6	41.0	22.8	10.6	5.99	286.0
0.620	8,897	51.09	18.96	7.34	4.11	2.89	2.11	1.70	222.6	20.7	10.9	8.9	10.49	72.9
0.630	9,918	23.62	10.32	5.47	3.59	2.43	1.83	1.48	222.6	56.3	34.1	12.0	5.47	224.0
0.640	9,207	35.76	13.01	5.90	3.52	2.39	1.74	1.44	222.6	30.2	19.3	11.7	6.46	196.1
0.650	8,683	44.80	17.90	6.16	3.48	2.37	2.11	1.66	222.6	24.8	10.1	10.3	14.02	56.8
0.660	8,425	65.39	25.72	8.04	3.93	2.66	2.22	1.88	222.6	13.2	10.0	7.4	14.30	55.8 *
0.670	9,247	41.46	15.61	6.43	3.78	2.46	1.80	1.56	222.6	27.4	14.0	10.8	7.27	93.2
0.680	9,040	32.99	12.87	5.49	3.20	2.18	1.69	1.32	222.6	35.1	16.7	12.6	8.24	114.5
0.690	10,355	15.70	8.38	4.99	3.82	2.90	1.96	1.55	222.6	102.9	85.2	11.8	6.26	160.7
0.700	9,756	25.11	13.33	6.77	4.24	2.82	2.02	1.53	222.6	72.3	20.4	9.9	3.95	203.3
0.710	10,069	18.07	6.58	4.08	3.07	2.23	1.67	1.40	222.6	53.5	137.7	13.8	8.52	300.0 *
0.720	10,081	34.84	9.70	4.27	2.92	2.18	1.76	1.38	222.6	27.9	29.3	17.9	12.02	140.6
Mean:		36.54	14.04	5.94	3.65	2.55	1.93	1.56	222.6	39.1	28.5	10.9	8.96	104.6
Std. Dev:		13.81	4.53	1.08	0.43	0.25	0.18	0.14	0.0	25.4	30.6	2.3	3.95	59.9
Var Coeff(%):		37.80	32.29	18.12	11.84	9.71	9.09	8.90	0.0	64.8	107.2	21.1	44.13	57.3

Figure 45. FM 3371 Fly Ash Base Section.

Conclusions

The main conclusions from the Waco experiment are as follows:

1) The best performing section was the control section where no stabilizer was added. Four inches of new base were blended with the existing material. The in-place modulus was high at 110 ksi, and after 4 years the section shows no distress. One item for consideration here is that in general the subgrade support in this section is very good, averaging around 20 ksi for sections 1, 2, and 3. In this instance it appears that no stabilizers are required to obtain good performance.
2) The 2.5 percent cement stabilization is performing well except for some localized areas of cracking. The average stiffness of the cement-treated base is very high at over 650 ksi. On future projects consideration should be given to lower layers of cement.
3) The fly ash and Roadbond material performed poorly. As these sections are close to a lake, there are large amounts of available subsurface moisture. The fly ash section appears to have a moisture susceptibility problem. The reason for the failure of the Roadbond section is not known; however, this section has exceptionally high deflections, some in excess of 90 mil.

CHAPTER 4

RECOMMENDATIONS ON SELECTING STABILIZER TYPES

OVERALL APPROACH

Various methods are used by TxDOT districts to select the type and amount of stabilizer to use in FDR projects. These are placed into three general groupings:

1) District Experience	Several districts run no job-specific laboratory tests. They base their decisions on historical experiences with local materials.
2) District-wide Studies	Many districts often have only two or three base types. In these instances a design sequence is run once for each material type. The selected stabilizer type is then used on all future projects with that material.
3) Project-specific Studies	Materials are taken from each specific project and a design sequence is run on each project at different stabilizer contents. In some instances different stabilizers will also be run. This is done in the Childress District where the initial sequence uses fly ash and an alternate set is run with a lime/fly ash blend.

From the performance results shown in Chapter 3, as a minimum districts should be encouraged to at least use the level 2 testing described above. The sections in the Lubbock District are performing well at the 10 percent fly ash level. However the benefit of going to project-specific testing is shown in the performance of the Childress projects.

SELECTION CRITERIA

The criteria on which stabilizer type and level to use are selected depends on many issues related to: a) the goal of the stabilization, b) the traffic loads on the section, c) the quality of the subgrade support, d) the rainfall in the area, and e) the environment. One set of criteria may be used for one class of FM roadways and another for high-volume interstate pavements. It is also important to combine the laboratory design criteria with the pavement structural design system.

For example, if a roadway meets a Texas triaxial criteria then a certain moduli value should be used within the flexible pavement design system FPS 19. The results discussed in Chapter 3 present some very useful data on establishing selection criteria and design moduli values.

In all new design projects the use of nondestructive testing (NDT) technology is strongly recommended. Both the FWD and GPR can be used to check the variability of the existing structure. In selecting stabilizer types it is critical to know both the in-place strengths and thicknesses. Problems have been encountered in several districts when localized areas of thin bases caused the recycling operation to cut into the clay subgrade. The goal of FDR should be to avoid cutting into the subgrade layer; if thin structure is suspected then additional base material should be placed on the surface prior to recycling the structure.

It is also necessary to take samples from the highway at regular intervals. A recommended minimum sampling interval is 0.5 mile. In areas without shallow bedrock, boring should be made to a minimum of 7 ft to map the base type and layering at the top of the subgrade. Once the uniformity of the existing highway has been defined, it will be necessary to obtain auger samples of the existing surface and base materials. One area where future research is needed is to establish gradation limits for the milled surface and base layers that have had a minimum of two passes with a pulverizer. The milling operation does tend to break down some of the softer aggregate types. Work is continuing in this area. Currently, the researchers propose the following to simulate the breakdown in the field:

- Auger a sample to the depth of the recycling operation and return it to the laboratory.
- Run a gradation on this material, using at least four sieve sizes (¾ inch and below).
- Measure the amount of material retained on a ¾-inch sieve; the large stones will be scalped from the laboratory molded sample.
- To each sieve size ¾ inch and below add back a proportional amount of material to account for the scalped larger stones.

In selecting a stabilizer type and content the first question should be “Do I need to add any stabilizer at all?”. The Waco project demonstrated that in some instances it is simply necessary to blend in several inches of new base material. If the existing pavement has performed well (not excessive maintenance and few structural failures), if the existing base is uniform, if the existing subgrade is good (Modulus > 15 ksi), and if moisture ingress is not a problem, then the Waco experience of adding 4 to 6 inches of new Class 1 base material would be recommended.

However, based on failure investigations conducted by TxDOT into base overlays around the state it is strongly recommended that the new base be tested to ensure it is higher quality than the existing. Several forensic studies have indicated that putting more moisture susceptible material on top of existing good quality material will lead to rapid structural failure. If limited testing is performed then the old and new bases should be blended together. If this option is chosen it is recommended that a simple laboratory sequence (Tex-117-E) be run to ensure that the blended material is indeed a high quality base. If the blended base is Texas triaxial Class 2 or less then the level 1 design discussed below should be considered.

In the section below criteria will be presented on how to select the appropriate stabilizer content. The decision on which stabilizer type to use will be influenced by several other factors, such as when the section will be opened to traffic and the environmental condition.

If the decision is that a stabilizer should be added to the existing materials then based on the performance data shown in Chapter 3, three levels of design criteria are recommended for implementation in TxDOT. These criteria levels are described below.

Level 1 Design Criteria (Top Quality Flexbase Criteria)

To Be Used for:

a) low-volume roadways where moisture is not a concern,
b) roadways with good subgrade support (backcalculated E subgrade > 15 ksi),
c) original section that has performed well, and
d) sections with reasonable thickness and quality of existing base.

Recommended Criteria

The objective is to create a pavement that will still exhibit the characteristics of a traditional flexible base pavement, which will not exhibit any brittle failure characteristic.

Run a full Texas Triaxial test (Tex-117-E) with a full 10-day capillary rise test (no accelerated tests). Add enough stabilizer to pass the Class 1 criteria:

Min strength at 0 psi confining 45 psi
Min strength at 15 psi confining 175 psi

Recommended Design Modulus

Use a base modulus of 100 ksi within FPS 19. This base is higher than the modulus normally allowed for Class 1 materials, but it is assumed that the materials will get stiffer with time.

Level 2 Design Criteria (Super Flexible Base)

To Be Used for:

a) high volume roadways,

b) roadways with good subgrade support, and

c) sections where moisture susceptibility is a concern.

Recommended Criteria

The objective is to create a base that has superior load-carrying capibilities than an existing flexible base, which is not moisture suceptible.

Run a full Texas triaxial test (Tex-117-E) with a full 10-day capillary rise test (no accelerated tests). Pass the following:

Min strength at 0 psi confining	60 psi
Min strength at 15 psi confining	225 psi
Moisture at end of capillary rise	No more than 0.5% higher than molding moisture content

Recommended Design Modulus

Use a base modulus of 150 ksi within FPS 19. This base is higher than the modulus normally allowed for Class 1 materials, but it is assumed that the materials will get stiffer with time and that the material will not be severely impacted by moisture.

Level 3 Design Criteria

To Be Used for:

a) roadways where base has to bridge over poor subgrade,

b) wet areas where moisture susceptibility is a problem,

c) roadways with high traffic loads,

d) existing pavement that has structural problems, and

e) sections where the existing base materials are variable.

Recommended Criteria

To design a stabilized layer with good load-bearing capabilities, you need good moisture resistance to avoid shrinkage cracking problems associated with over-stabilization. If the existing base is very variable, it may be necessary to place new flexible base material over the existing base prior to pulverization.

Recommendations are based on unconfined compressive strength results and tube suction results on small samples (4-inch diameter by 4.5-inch height). The tube suction test is decribed in the next section of this chapter.

Criteria after 7 day moist cure:

Unconfined compressive strength	300 psi
Final dielectric after 10 days	< 10
Final strength after TST	> 85% of 7 day strength

This dual criteria approach of satisfying both a strength and moisture susceptibility requirement has been shown to work well with several Texas base materials. The only problem has been that with very poor materials it may take substantial levels of stabilizer to meet the dielectric criteria. At these stabilizer levels the unconfined strengths could be very high. In these instances other problems such as shrinkage cracks could be a problem. Research is underway in TxDOT to evaluate methods of minimizing shrinkage cracks with either precracking or the use of fabrics over the stabilized base. Recommendations will be developed in this area in the next year.

The use of the TST as a durability test has been demonstated by comparison to existing durability tests. Work is also underway to accelerate this testing. One option under consideration is the use of a 4-hour soak prior to compressive strength testing and then to compare a wet to dry strength. This work is not complete, but recommendations will be presented in this area.

Recommended Design Modulus

Meeting the criteria above, it should be possible to use a design base modulus of 200 ksi. However, with high-volume roadways consideration should be given to secondary problems associated with shrinkage cracks (see Figure 28). On high-volume roadways a minimum base and surface thickness should be specified.

NEW LABORATORY DESIGN APPROACH FOR LEVEL 3 DESIGNS

The basic concept of the TTI approach is that the selection of the stabilizer content should be based on strength and moisture susceptibility criteria, rather than strength alone. The current design procedures, in use by most DOTs, are solely strength based and specify high 7-day strengths. The assumption is that bases with high strengths will also have high resistance to both freeze/thaw and wet/dry cycling. This strength criterion leads to high stabilizer contents that may perform poorly in the field. However, by satisfying both strength and durability criteria it is possible to use lower strength criteria. TTI has two methodologies under development to satisfy this dual criteria approach. The more complete procedure involves two laboratory tests: unconfined compressive strength test and tube suction test. Research studies at TTI have shown that the TST is highly correlated to the American Society for Testing Materials (ASTM's) wet/dry durability test. The associated criteria with these tests are: 1) UCS after 7 days > 300 psi, 2) TST < 10 after 10-day capillary rise, and 3) UCS after capillary rise > 85 percent of 7-day strength.

One advantage of the TST approach is that it is much faster than the ASTM procedure, taking 10 days as opposed to 45 days for the 10-cycle brush test. However, for many applications 10 days may still be too long. In order to develop a more rapid test, a simple wet/dry strength test is under development. In this test two batches of samples are made at each stabilizer content. Both are cured for 7 days. One set is then soaked for 4 hours prior to the compressive strength test, and the second batch is subjected to the UCS test without soaking. The selection criteria are that the soaked strength should be at least 85 percent of the dry strength. This accelerated test in under evaluation at this time.

Tube Suction Test

The tube suction test was developed at the Texas Transportation Institute for identifying granular base materials potentially susceptible to moisture damage under traffic and environmental loading (Scullion and Saarenketo, 1997). This test has recently been adapted as an indicator of stabilized base durability. When running the test the stabilized samples stand in a water bath as shown in Figure 46. The moisture susceptibility ranking is based on the final surface dielectric values of compacted specimens after a 10-day capillary soak.

Figure 46. TST Setup for Stabilized Base Idaho Samples.

The Adek Percometer™, a 50 MHz dielectric probe shown in Figure 47, is used in the test to measure the dielectric values of specimens. The dielectric value of a material is the ratio of its electric permittivity to the dielectric permittivity of free space and is indicative of its storage capacity in an electrical field. For electrical fields alternating at frequencies between 10^6 and 10^9 Hz, the extent to which charges can be stored in a material depends primarily upon the ability of its molecules to be polarized, or physically reoriented.

The Adek Percometer operates with the electrical field generated between a central node and an outer ring arranged in coaxial fashion. The electrical field extends beyond the face of the probe so that dielectric measurements are sensitive to a depth of approximately 25 mm while being completely non-destructive. The dielectric value is determined from the change in capacitance measured by the probe when in contact with the test material.

Figure 47. Dielectric Constant Value Measurement Using the Adek Probe.

For materials with high suction and sufficient permeability, a substantial amount of unbound water rises within the aggregate matrix during soaking and leads to higher dielectric values in the TST. Conversely, non-moisture-susceptible materials maintain a strong moisture gradient throughout the test, with little moisture reaching the surface, and they have lower dielectric values at the end of the TST. The high dielectric values are a direct measurement of the amount of unbound water reaching the surface of the sample. It is this unbound moisture that governs many of the significant engineering properties including freeze/thaw resistance and shear strength. Clearly for stabilized materials a high surface dielectric indicates that moisture can flow within the stabilized material. In the field this moisture may be present in the subgrade soils, from the pavement edges, or through surface cracks. The flow within a stabilized material is potentially very problematic leading to poor freeze/thaw resistance and possibly a reversal of the stabilization (via leaching or other secondary chemical reactions).

Typical Test Results After Tube Suction Test

Six samples were subjected to the TST; in addition, the two field cores were also tested. The results are listed in Table 13. In addition to the dielectric results, tests also measured the seismic modulus (before and after capillary rise) and the UCS (after capillary rise).

Table 13. TST Results.

Material Type	No.	Cement Content (%)	Seismic Modulus (ksi)		UCS (psi)	Dielectric Value
			7 day	18 day		
Dark Material	A1	6	388.7	401.6	609.2	4.13
	A4	5	308.6	416.4	668.7	3.69
	A7	4	299.5	317.9	419.8	3.93
	A10	3	329.9	270.6	250.8	3.83
	A13	2	248.3	256.9	142.2	3.80
	A15	1	198.7	263.2	56.0	5.66
Cores	C1	6	/	566.8	817.2	4.00
	C2	6	/	258.6	610.8	4.80

The strength results from Table 13 are shown schematically in Figure 48. For the test material (dark) there is a linear relationship between stabilizer content and moisture conditioned strength.

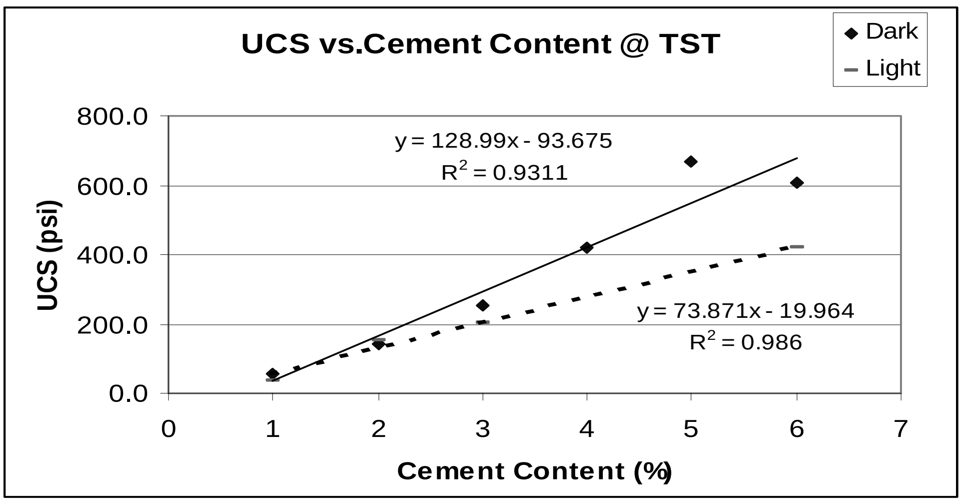


Figure 48. Effect of TST on UCS.

CORED SPECIMENS VS. LAB SPECIMENS

Two 4- by 4.5-inch specimens were prepared from field cores, and the design cement content was 6 percent. The comparison of cored (C) and lab molded specimens (A and B) is listed in Table 14. As shown in this table, the UCS, seismic of core specimen C1, is greater than those of laboratory samples. The UCS of C2 is almost the same as A1. The dielectric values are very close. The comparison seems reasonable, as the cored samples are over 1 year old as compared to the 7-day old laboratory samples.

Table 14. Comparison of Cored and Lab Specimens.

Specimen	UCS (psi)	Seismic Modulus (ksi)	Dielectric Value	Material Sources
A-6%	609.2	401.6	4.13	Dark
C-6%-1	812.7	566.8	4.00	Cored
C-6%-2	610.8	258.6	4.80	Cored

CONCLUSIONS

TxDOT should consider adopting the dual strength moisture susceptibility concept in its construction specification Items 275 and 260 for field mixed cement and lime stabilization.

The current criteria focus solely on 7-day unconfined compressive strength criteria. More research is needed to evaluate if it is possible to accelerate the moisture susceptibility criteria by the use of a wet/dry strength ratio based on a 4-hour soak prior to strength testing.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

In the questionnaire survey conducted in 2001, it was found that 16 of the 25 TxDOT districts have constructed at least one full depth recycling project. Several districts including Bryan, Lubbock, and Childress have several hundred miles of highways built and several of the older sections are now (2003) approaching 10 years old. Within each of these districts the initial focus was on upgrading the low-volume roadways, but based on the preliminary success the districts are now actively recycling higher volume roadways.

The results of this study are summarized below in two sections covering 1) general conclusions and recommendations, and 2) areas where future studies should focus.

CONCLUSIONS

The performance of numerous FDR projects around the state have been included in this report. This includes condition assesment of pavement performance and stuctural evaluations primarily with the falling weight deflectometer. The majority of the districts surveyed were extremely happy with the performance of their sections, and statewide many more pavements will be recycled in the next five years.

1. <u>Use of NDT and Field Coring</u>
   - As a minimum each potential project should be cored to a depth of 3 ft to identify the type of base material and subgrade material. In heavy clay areas the subgrade should be drilled to a minimum of 6 ft. Maximum spacing of cores should be 1 mile.
   - On projects with HMA surfacings a GPR survey should be conducted to identify the thickness of the HMA and to locate areas of full depth patching.

   Conducting project-specific testing is highly recommended. Both the Childress and Bryan Districts' laboratories are heavily involved in all steps of design and construction control. For laboratory studies, samples of the layer to be treated should be taken, if possible, with an auger drill. This process will break up the HMA material. If an auger is not used the HMA and base should be pulverized in the laboratory to a similar gradation to that anticiated in the field. In normal practice it is necessary to remove all the materals retained on a 1.25 inch sieve and replace this with proportational amounts on each of the finer sieve sizes.

2. Recommendations on Selecting Stabilizer Type

Combine the observed pavement performence with the recommendations from Kearney, 1999. The following should be considered when selecting stabilizer types:

- Fly Ash
  1) Complete stabilization at least one month before first freeze.
  2) Do not use if early opening to traffic required.
  3) Two weeks warm/hot weather desirable after stabilization.
  4) May not be suitable in East Texas in areas with shallow water tables or high rainfall areas (based on Waco experience).
  5) RAP/old base with silty-clay from subgrade (PI > 10).

- Lime
  1) Complete stabilization at least one month before first freeze.
  2) Two weeks warm/hot weather desirable after stabilization.
  3) RAP/old base with silty-clay from subgrade (PI > 10).

- Cement
  1) Complete stabilization at least one month before first freeze.
  2) RAP/old base with low plasticity soils.

- Emulsion
  1) RAP/base with non plastic fines.
  2) Less than 25 percent passing No 200 sieve and PI < 6.
  3) Perform when air temperature is 60 degrees F and rising--two weeks warm/hot weather desirable after stabilization.
  4) Not suitable in areas with humidity > 80 percent based on Yoakum. experience. May not be suitable in East Texas in areas with shallow water tables or high rainfall areas.
  5) In projects with early opening to traffic add small amounts of cement to enhance early strength.

In the laboratory testing it is critical that the amount of stabilizer be selected both on strength and moisture susceptibility requirements. For stabilized bases to be used on high-volume roadways, especially in east Texas, the combination of unconfined compressive strength, tube suction test, and retained strength after capillary rise should be used. Recommendations on laboratory criteria are given in Table 15.

3. Design Guidelines

Large amounts of FWD data are presented in this report, and from discussions with district staff there is not one design procedure that works well in all areas of the state. The quality of the subgrade, the existing pavement condition, the anticipated traffic loads, the thickness and quality of the existing materials, and the environment have large impacts on pavement performance. Indeed one of the major findings from the Waco project was that the best performing section did not have any stabilizing agent added.

The design recommendations were presented in Chapter 4, and they are summarized in Table 15. It is assumed that future pavement design will be performed with mechanistic/empirical design procedures such as FPS 19 or the new American Association of State Highway Transportation Officials (AASHTO) design guide. For each design option our recommended base modulus value is provided. These values are conservative and somewhat lower than those reported in the district summary tables. It is proposed that these values be used on future designs until the district has experience with FDR and can demonstrate long-term moduli values different from those recommended.

Designers should be careful when performing structural evaluations on FDR projects treated with cement. High moduli values substantially greater than 200 ksi can be obtained. However, these projects frequently exhibit shrinkage cracks, and problems are often found with secondary deterioration around these cracks. Until further studies are completed on precracking and long-term performance, high moduli values are not recommended for cement-stabilized bases.

As shown in Table 15 the use of grids to minimize edge cracking in areas of plastic subgrade soils is encouraged. As done in the Bryan District these grids should be placed on top of the stabilized layer and covered with a thin layer of granular base. It should also be a matter of policy to avoid cutting into the subgrade layer if at all possible. If there are locations where the existing structure is less than the recommended milling depth, then flexible base or RAP should be added prior to pulverization.

Table 15. Summary of Design Recommendations for Future FDR Projects.

Objective	Base Thickening	Upgrade to Class 1	Super Flexible Base	Stabilized Base
Used When	• Existing base is uniform • No widespread structural damage • Existing subgrade is good (>15 ksi) • Low traffic	• Low-volume roadway • Good subgrade • Moisture not a concern	• High-volume roadways • Moisture a concern • Reasonable subgrade > 10 ksi • Early opening to traffic	• Bridging over poor subgrade • Strengthening required • Low-quality variable base • High rainfall • Early opening to traffic
Selection of Stabilizer	No stabilizer Add new flex base only	Full Texas triaxial evaluation 117-E 1) 45 psi at 0 psi confining, 2) 175 psi at 15 psi confining	Full Texas triaxial evaluation 117-E 1) 60 psi at 0 psi confining, 2) 225 psi at 15 psi confining, 3) < 0.5% gain in moisture over molding moisture after 10 days capillary	7 day moist cure, then 1) UCS > 300 psi, 2) Dielectric < 10 after 10 days capillary rise 3) 85% retained strength
* FPS 19 Design Recommendations	Lowest of 70 ksi or 4 times subgrade modulus	100 ksi	150 ksi	200 ksi
Comments	1) New base should be of higher or equal quality than existing, 2) Use Bomag to blend existing and new			1) Avoid cutting into subgrade, add new base where needed 2) Consider grids and flex base overlay where high PI soils exist (PI > 35) 3) If lab strength > 350 psi then use microcracking

* Conservative value: District may wish to change this value based on long-term performance studies.

4. Pulverization

The specifications on the level of pulverization and target gradation should be reviewed. Item 275 (Road Mixed Cement Treated) calls for 100 percent passing the 2-inch sieve; for lime treatment Item 260 calls for 100 percent passing the 2.5-inch sieve. The Lubbock District has much tighter levels. They specify in Item 2041 (special specification) that 100 percent must pass the 1.25 inch sieve. As FDR is dealing with primarily old HMA surfaces and flexible base materials, consideration should be given to tightening the requirement on Items 260 and 275.

The level of pulverization and target gradation are important because a) the district should do laboratory testing to determine the best stabilizer and optimim amount, and b) in general the traditional stabilizers will work better if sufficient fines are generated so that the matrix can be bonded together.

More work is needed to determine the gradation of typical Texas materials after one, two and three passes of the pulverizer. Problems have been reported with softer limestone bases that "powder" with repeat passes of the pulverizer. This is a problem because excessive fines may cause insufficient stabilizer to be added.

5. Priming Base

Each one of the districts that use fly ash commented that this is one area where additional reseach should be undertaken. Getting the surface to "stick" to the base was a critical issue in the Amarillo, Lubbock, and Childress Districts. As discussed earlier, the fly ash bases will continue to gain strength with time, but this base can have serious loss of strength if it is not adequately sealed. The problems observed in the Amarillo District on SH 207 and US 87 (NB) are thought to be caused by a lack of bonding between layers.

There are several issues that should be resolved when working with fly ash treated bases. Firstly, the fly ash will increase the moisture requirements of the base, so large amounts of moisture will be required to obtain adequate compaction. Secondly, during the curing process the top of the base is reported to turn to powder. This powder is a chemical composition known as tenardite (sodium sulfate), which is observed as a white powder that forms on the surface. This material is highly water susceptible and should be bladed or broomed off the surface prior to applying the prime of surfacing. Therefore, two issues must be addressed: 1) how to ensure that the fly ash base has cured, and 2) how to ensure that sealing it will not trap large amounts of moisture under the seal. This end result is accomplished in the Lubbock District by specifying that after the 3-day wet cure the base should be left drying for an additional 2 days. As far as which is the best method of sealing these bases, it is acknowleged that the standard emulsion treatment with MS-2 is not effective. The district with the most success is Childress, and it recommends the following:

a) For fly ash treated sand/gravel base do not apply traditional prime material, but use either a straight AC-5 or a polymer modified material such as CRS-1P.
b) For limestone treated materials use the "muddy" water approach, recommended by Mantilla and Button (1994) where the top 1 inch of the finished base is scarified and treated with a dilute emulsion (MS-2 at 10 percent dilution).

It is recommended that a laboratory study be initiated to further study these bonding issues. TTI Report 1334-1F by Mantilla and Button developed techniques for measuring the bond strength of prime coat materials. Their work focused on untreated granular base materials. Their test procedures should be used to study the impact of curing time, base moisture content, and prime material type on the ultimate bond strength. Attempts should be made to duplicate the slippage failures that have been observed in the field. Methods of measuring and handling the tenadite problem should also be addressed.

6. Benefits of Underseals

Underseals are placed on a routine basis in the Childress and Lubbock Districts, and the performance of the fly ash treated bases has been very good. However, underseals were placed on projects in the Amarillo District that very early developed pumping problems. Also, some forensic investigations have found that underseals placed too early can trap moisture under the seal causing localized tears when traffic is placed on the seal.

For an underseal to be effective, it is critical to ensure that the base is not holding large amounts of moisture. If this is a concern then special notes can be placed in the construction plans to indicate that the base must be at least 2 percent below optimum moisture content before placing the underseal. Checking for excessive moisture is also important if the section receives substantial rainfall prior to placing the seal.

FUTURE WORK

As more and more districts adopt FDR techniques for their highways and with the transition to FDR on higher volume roadways, it is important to continue to monitor and evaluate the existing sections and new approaches. In this study several areas were identified where future research and implementation studies should be conducted. These include the following.

1. Priming Studies

   As described above this is one of the top priorities of many districts. For each environment and base type, recommendations should be given on:

   a) how to test the existing structure to ensure that it is ready for a prime,
   b) how to prepare the surface, and
   c) which material and technique works best.

2. Pulverization Studies

   Consideration should be given to tightening the current pulverization specifications in Items 260 and 275. Also, studies should be conducted on how pulverization effects the gradation of the existing material and how TxDOT laboratories can obtain samples and mold materials to match the anticipated field gradations.

3. Accelerated Durability Tests

   The use of the tube suction test to measure the moisture susceptibility of stabilized bases is a definite improvement over traditional strength-based design criteria. However, for some projects the additional 10 days of testing may be problematic. Efforts should be made to determine if an accelerated strength test can be developed. It is proposed to run a series of these tests to determine if the wet/dry strength after a 4-hour soak gives similar results to that obtained with a 10-day capillary rise.

4. Design Guidelines for Asphalt Emulsion Mixes

   The emulsion sections constructed in the Amarillo District in 1999 look very good after 2 years. These sections should continue to be monitored with time. However, currently TxDOT does not have any design criteria for selecting the optimal emulsion levels for base materials. From a literature search, some agencies are using wet/dry indirect tensile test results to select stabilizer levels (Wirtgen, 1998). Studies should be conducted to compare the different design approaches for emulsion-treated materials. Consideration should be given to the following procedures:

- Texas triaxial (at room and elevated temperatures),
- UCS and tube suction approach,
- an indirect tension test, and
- resilient modulus approaches.

5. Percentage RAP Studies

Currently TxDOT districts limit the amount of RAP in their FDR sections to 50 percent. However, several other agencies have reported success with stabilizing 100 percent RAP sections with cement or asphalt emulsions (Kearney and Huffman, 1999). Studies should be conducted to determine if there is an upper limit on the amount of RAP to include in FDR projects, and if high levels of RAP should be restricted.

6. Cost Benefits of Fly Ash When Compared to Cement and Lime Stabilization

The Lubbock and Childress Districts have been big proponents for the use of fly ash in the FDR programs. However, as in Lubbock it was determined that relatively high levels of fly ash treatment (7 to 10 percent) are required to get good long-term performance. Initially the price of fly ash was 30 to 40 percent that of traditional stabilizers. However, in recent years the price of fly ash has begun to rise and it is anticipated that more increases will be forthcoming. Consideration should be given to conducting either in-house or, through interagency agreements, comparative studies to identify which levels of traditional stabilizers (cement, lime, and asphalt emulsion) can be used to obtain engineering properties similar to those obtained with the fly ash levels that have been shown to perform well in the Panhandle districts. A limited study was conducted as part of this research program, and it was determined that with the limestone aggregates from Childress that less than 2.5 percent cement could give similar properties to 7 percent fly ash.

7. <u>Upgrading Specifications 260 and 275</u>

As a long-term objective, consideration should be given to developing a new specification for FDR projects. Most of the work around the state is conducted under Items 260 and 275, and these are currently being revised and updated. The problems with these items is that they cover both soils and FDR stabilization. Rather than try to expand these items to accommodate FDR requirements, it may be easier to develop a new item for FDR. It will be important to address many unique features of FDR such as pulverization, traffic handling, curing, and priming requirements.

8. <u>Documentation of Good Practices</u>

As this is a rapidly developing area, consideration should be given to developing a good practices training school or training video. In the next 5 years TxDOT will be losing to retirement many of the district laboratory engineers and designers who have developed new approaches. It is critical to document these techniques in a manner in which they can be readily shared with other districts. Candidates for inclusion of a training video would be:

* how to get the district laboratory involved in selection stabilizer types and controlling construction (as done in the Childress District),
* how to minimize problems with longitudinal cracking (as done in the Bryan District),
* new laboratory testing procedure (TST details), and
* how to apply effective surface seals.

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APPENDIX A

CHILDRESS DISTRICT FULL DEPTH RECYCLED SECTIONS

Key:

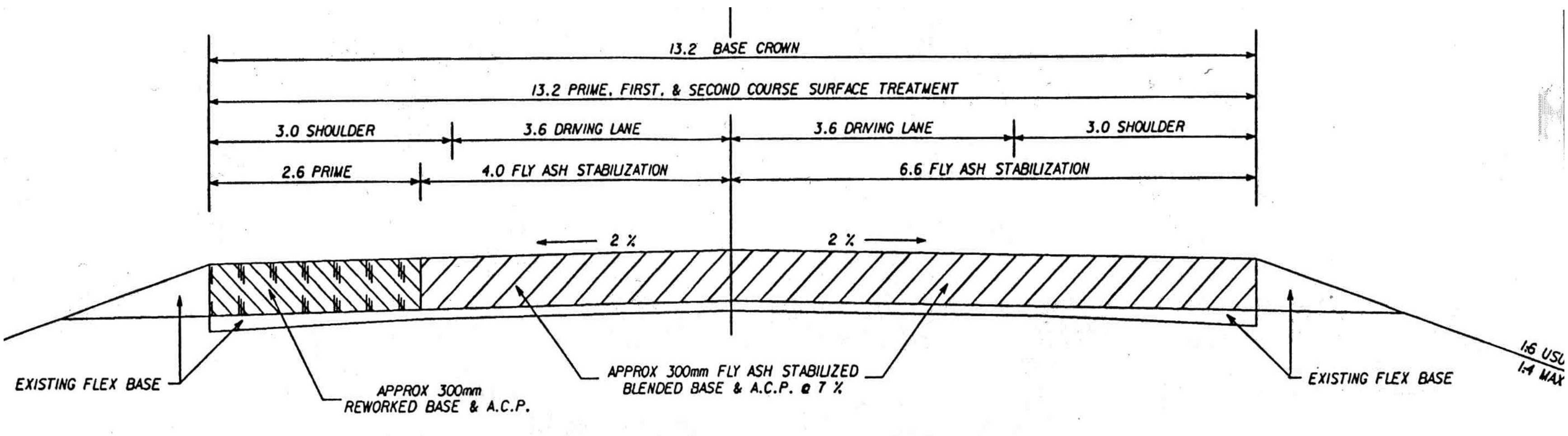
Raw TTC	- Texas triaxial class of base untreated
Compr. Strengths	- Failure stress at 0 psi and 15 psi lateral pressure
% Moisture	- Change in sample moisture content during 10-day capillary rise
Rutting	- % wheel paths
Long	- Longitudinal cracking 1 in ft/100 ft
Alligator	- % wheel paths
Transverse	- Number per 100 ft
Block Cir.	- % Area
Failures	- Number
Patching	- % Area
Ride	- 5.0 smooth – 2.5 rough

Section	County	Highway	Begin	End
1	Dickens	SH 70	226+0.700	236+0.829

Lab Design Data

Base Type	Sand/Gravel + RAP
Raw TTC	3.1
Stabilizer	7% FA
Compr. Strengths Lat. 0 and (15 psi)	60 and (183 psi)
% change in moisture from OMC	+1.3%

Construction Date 6/1997



PMIS Condition Data (Nov 2002) **Overall Average Score = 100**

Rutting _0_ Long. _0_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _0_ Patch _0_ Ride _3.6_

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Dickens
Highway/Road: SH 70

	Thickness(in)	MODULI RANGE(psi) Minimum	MODULI RANGE(psi) Maximum	Poisson Ratio Values
Pavement:	0.50	663,400	663,400	H1: v = 0.35
Base:	12.00	10,000	250,000	H2: v = 0.35
Subbase:	0.00			H3: v = 0.00
Subgrade:	207.89	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock	
0.000	8,929	28.33	12.69	5.34	3.13	2.17	1.67	1.40	663.4	35.8	0.0	16.3	8.11	104.4	
0.100	9,744	15.30	6.64	3.58	2.67	1.83	1.50	1.15	663.4	90.7	0.0	25.5	8.24	300.0	
0.200	9,211	25.15	15.19	8.59	5.66	3.72	2.64	2.08	663.4	64.4	0.0	10.6	4.04	192.6	
0.301	9,771	23.79	14.24	7.38	4.46	2.89	2.13	1.87	663.4	63.9	0.0	13.6	7.47	173.4	
0.404	9,116	27.39	13.69	7.68	5.52	3.70	2.81	2.07	663.4	52.5	0.0	11.3	4.28	213.1	
0.500	8,715	19.57	12.96	7.55	5.08	3.30	2.45	2.05	663.4	88.9	0.0	11.2	4.21	174.8	
0.600	10,165	22.18	11.04	6.40	4.55	3.31	2.67	2.04	663.4	77.2	0.0	15.2	6.80	300.0	
0.700	10,542	27.47	12.47	5.90	3.86	2.78	2.01	1.70	663.4	47.9	0.0	16.7	4.28	300.0	
0.800	9,275	12.40	7.41	4.67	3.22	2.36	1.89	1.54	663.4	166.4	0.0	18.9	3.80	300.0	
0.901	9,116	27.31	11.38	5.65	3.82	2.56	2.31	1.69	663.4	41.2	0.0	15.1	4.94	300.0	
1.000	10,065	19.66	11.97	6.89	5.17	3.19	2.40	2.00	663.4	100.4	0.0	13.8	4.74	128.0	
1.104	9,672	19.80	13.35	7.79	5.02	3.62	2.66	2.36	663.4	101.1	0.0	11.9	4.66	300.0	
1.201	9,700	14.55	10.50	7.26	5.04	3.54	2.79	2.16	663.4	195.8	0.0	12.0	2.76	300.0	
1.300	9,231	25.06	13.62	7.78	5.56	3.77	2.78	2.34	663.4	63.9	0.0	11.3	3.52	235.0	
1.400	9,795	33.59	13.98	7.83	5.67	4.36	3.31	2.66	663.4	40.0	0.0	11.6	9.82	300.0	
1.500	10,014	13.57	7.79	4.64	3.36	2.52	2.05	1.74	663.4	155.8	0.0	19.9	5.99	300.0	
1.600	9,454	20.09	11.87	6.25	4.36	2.49	2.35	1.72	663.4	78.6	0.0	14.8	8.64	100.6	
1.701	9,525	26.29	8.89	4.04	2.65	1.85	1.53	1.10	663.4	38.4	0.0	23.0	4.86	193.6	
1.800	8,929	14.71	6.76	2.67	1.73	1.48	1.19	0.94	663.4	73.7	0.0	28.8	13.52	74.0	
1.901	9,744	17.01	9.42	5.39	3.59	2.39	1.88	1.56	663.4	98.9	0.0	18.1	3.32	196.3	
2.000	9,513	11.33	8.23	6.41	4.67	3.36	2.43	2.01	663.4	250.0	0.0	13.9	5.40	245.0	*
2.101	9,541	24.49	12.36	6.70	4.34	3.16	2.36	1.81	663.4	58.6	0.0	13.9	4.24	300.0	
2.200	8,993	13.06	7.95	4.61	3.30	2.19	1.66	1.28	663.4	138.1	0.0	18.7	3.66	187.9	
2.300	8,743	12.14	6.61	3.81	2.31	1.65	1.16	0.90	663.4	119.3	0.0	24.1	2.58	217.4	
2.400	9,926	8.61	5.93	3.19	1.95	1.33	0.97	0.83	663.4	224.6	0.0	31.3	6.58	229.0	
2.502	10,332	11.68	6.67	3.70	2.42	1.63	1.27	0.95	663.4	156.4	0.0	27.8	3.65	206.9	
2.600	8,858	12.53	7.09	3.72	2.18	1.43	1.04	0.76	663.4	107.4	0.0	25.2	7.17	161.6	
2.708	10,181	24.91	11.86	6.65	4.25	2.76	2.22	1.72	663.4	58.2	0.0	15.5	2.88	170.5	
2.803	8,615	20.37	12.94	7.58	5.12	3.70	2.93	2.28	663.4	87.0	0.0	10.5	5.33	300.0	
2.901	10,336	16.97	9.95	5.62	3.93	2.90	2.31	1.82	663.4	118.2	0.0	17.2	5.46	300.0	
3.002	10,141	25.02	12.58	7.38	5.12	3.59	2.85	2.16	663.4	67.4	0.0	13.3	4.86	300.0	
3.100	10,347	16.34	10.84	6.51	4.52	3.08	2.39	1.86	663.4	140.8	0.0	14.9	3.98	237.5	
3.203	9,835	27.92	14.81	8.19	5.24	3.40	2.69	2.34	663.4	54.1	0.0	12.1	4.38	175.0	

Figure A1. Modulus 6 Results of Section 1, Childress.

3.300	10,788	14.15	9.17	5.99	5.46	3.17	2.66	2.14	663.4	226.6	0.0	14.8	7.84	300.0	
3.402	9,140	33.70	16.39	7.64	4.25	2.81	2.04	1.82	663.4	32.4	0.0	12.1	9.64	124.2	
3.500	8,858	16.05	8.62	4.67	2.89	2.04	1.57	1.22	663.4	86.0	0.0	19.3	4.11	275.3	
3.600	8,441	23.38	9.09	4.14	2.57	1.87	1.42	1.11	663.4	40.6	0.0	20.0	4.70	203.0	
3.700	9,259	17.20	7.13	3.57	2.72	1.84	1.30	1.04	663.4	69.2	0.0	23.7	5.75	300.0	
3.805	9,100	24.00	8.80	4.00	2.45	1.87	1.46	1.07	663.4	41.6	0.0	22.3	6.17	196.7	
3.901	8,310	29.38	10.59	5.02	3.30	2.28	1.49	1.27	663.4	31.1	0.0	16.4	4.11	300.0	
4.000	9,231	25.48	10.35	5.22	3.37	2.27	1.75	1.46	663.4	43.6	0.0	17.4	2.14	216.8	
4.101	8,627	33.25	14.45	7.02	4.87	3.49	2.62	2.16	663.4	32.5	0.0	11.1	5.10	300.0	
4.201	9,489	35.15	13.19	7.03	4.57	3.43	2.72	2.24	663.4	32.6	0.0	13.1	6.29	300.0	
4.301	9,029	30.09	14.98	7.67	5.39	3.59	2.77	2.32	663.4	43.0	0.0	11.0	4.52	300.0	
4.400	9,851	21.23	11.54	6.00	3.89	2.58	2.06	1.54	663.4	70.8	0.0	16.2	5.24	194.1	
4.500	9,609	12.20	7.54	3.99	2.35	1.52	1.15	0.87	663.4	129.9	0.0	25.5	7.70	161.4	
4.700	10,236	23.48	9.21	4.80	3.23	2.43	1.89	1.38	663.4	54.2	0.0	20.4	6.12	215.6	
4.800	9,875	12.23	5.82	3.32	2.42	1.63	1.36	1.12	663.4	133.0	0.0	28.5	7.17	203.0	
4.901	10,351	27.38	9.07	4.78	3.26	2.35	1.82	1.57	663.4	42.8	0.0	21.8	7.60	300.0	
5.000	9,390	12.83	8.54	5.09	3.48	2.59	1.71	1.40	663.4	163.0	0.0	17.5	3.42	150.2	
5.101	8,945	15.34	9.31	5.79	3.62	2.39	2.25	1.67	663.4	115.9	0.0	15.7	6.63	190.8	
5.201	9,545	14.65	7.42	4.37	2.80	1.78	1.34	1.06	663.4	102.6	0.0	23.1	2.11	146.4	
5.300	9,545	22.78	11.62	6.57	4.89	2.89	2.32	1.89	663.4	67.3	0.0	14.2	5.17	300.0	
5.400	8,862	20.82	8.82	4.99	3.61	2.20	1.71	1.46	663.4	57.4	0.0	17.5	3.82	121.2	
5.505	9,402	13.03	8.20	4.84	3.21	2.37	1.76	1.38	663.4	150.2	0.0	18.8	3.47	299.8	
5.602	9,700	20.04	9.89	5.82	3.44	2.25	1.53	1.32	663.4	70.6	0.0	18.1	5.15	179.3	
5.701	9,899	12.71	9.10	5.13	3.67	2.48	1.91	1.57	663.4	179.1	0.0	17.7	4.94	215.3	
5.801	9,970	12.06	8.51	4.99	3.60	2.39	1.74	0.80	663.4	193.6	0.0	18.6	4.35	187.7	
5.901	10,220	14.59	9.11	5.52	3.65	2.30	1.88	1.46	663.4	140.4	0.0	18.8	3.99	141.2	
6.000	10,951	18.49	8.36	5.00	3.44	2.49	1.97	1.44	663.4	92.0	0.0	21.9	6.71	300.0	
6.102	10,649	14.64	8.62	5.17	3.78	2.53	1.78	1.48	663.4	147.9	0.0	19.9	2.15	198.1	
6.200	10,705	22.51	10.00	4.42	3.08	2.09	1.57	1.18	663.4	57.8	0.0	22.4	4.30	145.2	
6.300	9,589	21.95	9.17	4.55	3.08	2.09	1.51	1.24	663.4	53.7	0.0	20.4	2.78	300.0	
6.401	9,823	10.87	6.77	4.38	3.04	1.98	1.49	1.13	663.4	204.2	0.0	22.3	1.97	165.5	
6.502	10,570	13.54	7.39	4.63	3.19	2.16	1.54	1.20	663.4	149.8	0.0	23.2	1.56	215.5	
6.600	10,026	19.42	10.43	6.28	3.56	2.52	1.77	1.44	663.4	82.7	0.0	17.4	4.70	133.7	
6.703	11,503	13.92	8.43	4.78	3.38	2.39	1.74	1.36	663.4	165.2	0.0	23.0	2.99	246.4	
6.900	9,231	13.07	7.13	4.06	2.65	1.80	1.43	1.08	663.4	120.7	0.0	23.0	3.23	225.3	
7.000	10,351	14.47	7.80	4.02	2.40	1.72	1.24	0.97	663.4	107.2	0.0	26.2	4.72	186.7	
7.101	10,757	8.82	5.17	3.10	2.05	1.60	1.21	0.98	663.4	250.0	0.0	32.8	5.61	300.0	*
7.200	9,807	14.43	10.10	6.26	3.84	2.60	1.78	1.36	663.4	144.5	0.0	16.2	7.15	182.0	
7.412	9,815	18.26	8.37	4.23	2.93	2.23	1.80	1.41	663.4	74.4	0.0	21.6	7.12	300.0	
7.502	10,769	20.89	9.03	4.26	2.51	1.56	1.07	0.89	663.4	59.7	0.0	26.6	7.84	131.6	
7.602	10,665	10.79	6.00	3.46	2.18	1.53	1.16	0.86	663.4	177.3	0.0	31.1	2.78	294.6	
7.700	11,313	14.96	9.42	5.29	3.35	2.29	1.74	1.40	663.4	141.5	0.0	21.7	4.30	240.8	
7.801	11,142	8.37	4.50	3.11	2.12	1.55	1.15	0.94	663.4	250.0	0.0	35.6	8.26	277.7	*
7.901	10,586	9.76	5.56	3.53	2.51	1.83	1.35	0.99	663.4	243.5	0.0	28.3	4.52	212.8	
7.999	10,034	14.26	7.27	4.18	2.75	1.91	1.41	1.05	663.4	114.7	0.0	24.4	1.66	272.2	
8.103	9,843	8.99	5.64	3.69	2.50	1.76	1.29	0.95	663.4	250.0	0.0	26.1	1.16	220.8	*
8.200	10,359	8.89	4.92	3.22	2.28	1.65	1.22	1.02	663.4	250.0	0.0	31.0	5.54	270.8	*
8.300	10,947	10.52	5.86	3.49	2.36	1.43	1.23	1.02	663.4	194.5	0.0	31.5	4.48	116.6	
8.401	9,609	12.79	7.71	4.43	2.88	1.91	1.39	1.20	663.4	138.0	0.0	22.3	3.61	188.5	
8.500	11,055	13.83	7.61	4.28	2.96	1.96	1.57	1.15	663.4	141.6	0.0	25.4	3.73	182.5	

Figure A1. Modulus 6 Results of Section 1, Childress (Continued).

8.600	10,717	13.70	5.90	2.90	1.87	1.31	1.02	0.82	663.4	100.3	0.0	34.5	5.36	284.0
8.702	9,803	10.02	4.48	2.60	1.87	1.54	1.17	1.02	663.4	166.8	0.0	34.6	12.14	300.0
8.800	9,410	11.99	8.80	5.97	4.00	3.02	2.29	1.84	663.4	230.9	0.0	14.2	2.99	300.0
8.900	10,340	10.95	6.84	4.28	2.98	2.14	1.60	1.26	663.4	218.1	0.0	23.0	1.98	300.0
9.000	10,316	17.70	8.76	4.40	2.68	1.89	1.46	1.10	663.4	79.7	0.0	23.3	4.26	226.9
9.100	10,006	13.23	8.10	4.75	3.17	2.13	1.55	1.23	663.4	147.1	0.0	21.2	2.78	207.2
9.200	10,681	22.72	8.91	4.22	2.82	1.79	1.33	1.05	663.4	54.3	0.0	25.0	2.84	300.0
9.301	9,934	10.45	7.52	4.62	3.04	2.20	1.78	1.23	663.4	238.6	0.0	20.2	5.23	300.0
9.400	10,105	14.87	8.53	4.39	2.87	1.87	1.43	1.16	663.4	108.8	0.0	23.1	4.80	167.0
9.500	10,312	14.43	10.00	5.63	3.93	2.43	1.76	1.36	663.4	147.3	0.0	17.9	6.65	128.8
9.600	11,150	12.94	7.78	4.72	3.35	2.33	1.70	1.37	663.4	183.4	0.0	22.8	2.10	250.6
9.700	10,502	27.59	16.87	8.77	5.32	3.42	2.22	1.71	663.4	59.3	0.0	12.4	9.28	151.1
9.805	11,043	22.64	11.96	5.00	2.81	1.93	1.39	1.22	663.4	58.8	0.0	22.0	12.16	98.9
9.900	11,126	21.51	14.09	8.37	5.11	3.36	2.31	1.75	663.4	97.6	0.0	13.9	7.16	190.6
9.999	8,536	16.04	9.10	4.42	2.69	1.81	1.31	1.03	663.4	77.3	0.0	19.4	7.81	215.2
10.101	9,529	17.57	7.70	4.24	3.05	2.28	1.63	1.36	663.4	77.6	0.0	21.5	7.11	217.8
Mean:		18.11	9.46	5.24	3.50	2.40	1.83	1.45	663.4	113.8	0.0	19.9	5.18	220.4
Std. Dev:		6.57	2.79	1.49	1.03	0.69	0.54	0.45	0.0	63.3	0.0	6.1	2.34	79.7
Var Coeff(%):		36.28	29.47	28.49	29.51	28.69	29.39	30.79	0.0	55.6	0.0	30.6	45.19	37.3

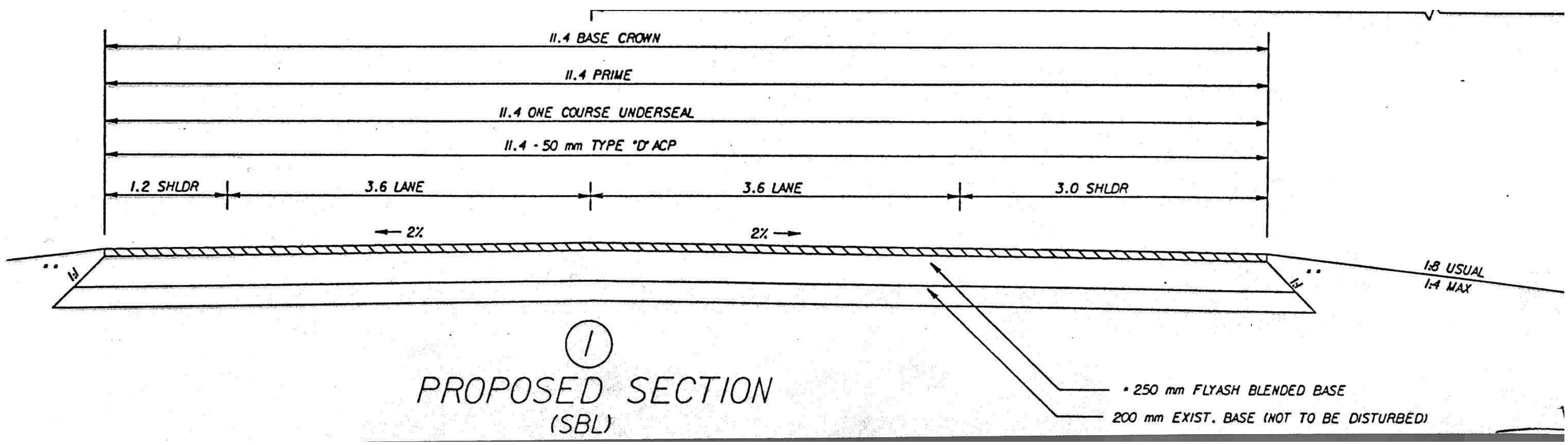
Figure A1. Modulus 6 Results of Section 1, Childress (Continued).

Section	County	Highway	Begin	End
2	Hall	US 287 (NBL)	214+0.690	216+1.294

Construction Date 5/1998

Lab Design Data

Base Type	Salvage Base
Raw TTC	NA
Stabilizer	6% FA
Compr. Strengths Lat. 0 and (15 psi)	95 and (185 psi)
% change in moisture from OMC	-0.3%



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting 0 Long. 0 Alligator 0 Trans. 0 Block Cr. 0 Failures 0 Patch 0 Ride 4.1

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Hall
Highway/Road: US 287

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	2.00	891,800	891,800	H1: v = 0.35
Base:	10.00	30,000	500,000	H2: v = 0.35
Subbase:	8.00	10,000	200,000	H3: v = 0.35
Subgrade:	280.00	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	10,510	4.42	2.49	1.78	1.51	1.28	1.11	0.98	891.8	500.0	70.9	53.8	18.30	300.0 *
0.103	10,002	12.83	7.74	4.66	3.14	2.21	1.67	1.30	891.8	127.2	22.0	21.5	2.12	300.0
0.207	9,744	22.84	13.83	7.51	4.53	3.00	2.13	1.63	891.8	52.0	10.0	14.5	3.92	202.2 *
0.301	9,839	18.95	11.13	6.50	4.51	3.28	2.52	2.06	891.8	67.9	22.1	14.1	2.33	300.0
0.400	10,038	12.69	7.78	5.15	3.90	3.06	2.41	1.98	891.8	115.6	80.5	15.6	2.26	300.0
0.507	9,998	14.50	8.26	5.01	3.61	2.72	2.15	1.74	891.8	86.0	52.4	17.3	2.66	300.0
0.608	9,914	6.90	5.15	3.92	2.98	2.25	1.85	1.41	891.8	494.1	78.9	20.6	1.56	300.0
0.716	9,986	7.70	5.05	3.47	2.70	2.09	1.71	1.46	891.8	243.0	135.2	22.5	2.84	300.0
0.806	9,962	7.25	4.66	3.17	2.42	1.83	1.55	1.18	891.8	246.5	136.7	25.2	3.64	300.0
0.900	10,034	5.84	4.14	3.15	2.44	1.85	1.52	1.16	891.8	500.0	52.1	29.4	7.21	300.0 *
1.000	10,193	7.14	3.67	2.49	1.96	1.52	1.16	1.07	891.8	186.8	200.0	34.5	3.43	300.0 *
1.100	10,351	6.63	4.38	3.17	2.47	1.98	1.63	1.35	891.8	323.5	200.0	25.0	2.50	300.0 *
1.201	10,256	16.99	9.00	4.75	3.22	2.27	1.79	1.48	891.8	66.7	25.7	20.6	3.00	300.0
1.302	9,787	15.07	9.09	5.85	4.11	3.00	2.30	1.80	891.8	100.2	30.2	15.3	1.22	300.0
1.401	9,732	16.92	10.39	5.73	3.73	2.54	1.87	1.43	891.8	89.2	10.1	18.8	2.76	238.3
1.500	9,203	16.26	9.56	4.93	2.79	1.89	1.50	1.22	891.8	74.6	10.0	22.3	5.05	130.5 *
1.600	9,017	11.31	5.56	2.73	1.67	1.18	0.92	0.79	891.8	87.6	25.5	35.3	3.40	229.5
1.700	9,577	12.30	7.32	3.84	2.43	1.68	1.24	1.08	891.8	116.8	14.8	27.9	4.07	261.8
1.801	9,466	7.83	3.98	2.35	1.64	1.41	1.01	0.84	891.8	134.9	135.3	35.2	5.06	300.0
1.901	9,315	5.81	3.78	2.86	2.14	1.70	1.37	1.20	891.8	330.3	200.0	26.1	1.47	300.0 *
2.000	9,505	5.62	3.82	2.92	2.11	1.68	1.26	1.15	891.8	428.9	131.7	27.9	1.18	300.0
2.102	8,878	13.47	6.05	3.13	2.11	1.50	1.25	0.90	891.8	56.6	51.2	26.7	3.02	300.0
2.201	9,541	7.84	2.97	1.54	1.05	0.80	0.69	0.59	891.8	100.6	153.1	57.5	5.17	300.0
2.303	9,557	5.07	2.64	1.63	1.22	0.73	0.68	0.54	891.8	270.1	121.5	57.0	5.89	109.6
2.402	9,434	4.41	3.06	1.85	1.41	1.07	0.88	0.78	891.8	494.3	112.1	43.2	5.20	300.0
2.500	9,434	8.95	4.60	2.73	2.03	1.52	1.32	1.06	891.8	112.8	139.6	29.2	4.75	300.0
2.601	9,823	13.67	7.99	4.68	3.26	2.38	1.85	1.50	891.8	99.9	32.2	19.5	2.85	300.0
Mean:		10.71	6.23	3.76	2.63	1.94	1.53	1.25	891.8	203.9	83.5	28.0	3.96	300.0
Std. Dev:		5.02	2.95	1.56	0.98	0.69	0.51	0.39	0.0	156.7	63.6	12.3	3.24	100.6
Var Coeff(%):		46.83	47.36	41.46	37.35	35.48	33.04	31.31	0.0	76.9	76.2	44.0	81.79	35.1

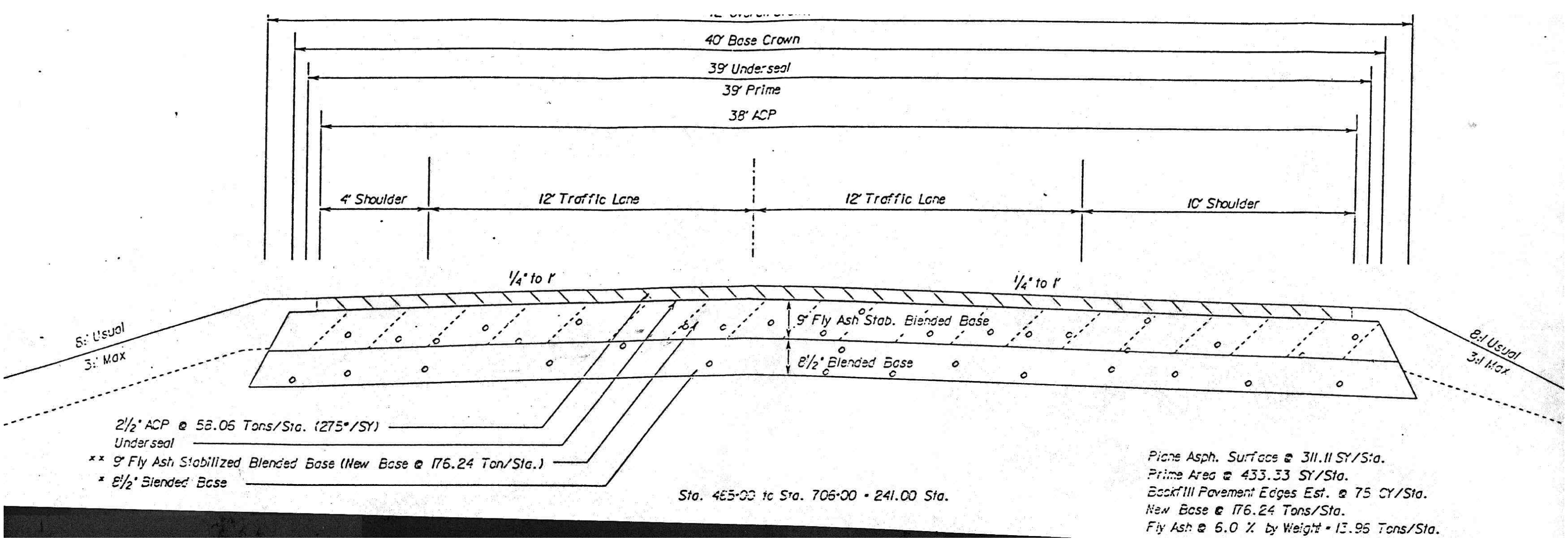
Figure A2. Modulus 6 Results for Section 2, Childress.

Section	**County**	**Highway**	**Begin**	**End**
3	Hall	US 287 (SBL)	208+0.822	214+0.510

Construction Date 7/1993

Lab Design Data

Base Type	Salvage
Raw TTC	NA
Stabilizer	6% FA
Compr. Strengths Lat. 0 and (15 psi)	NA
% change in moisture from OMC	NA



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting _0_ Long. _0_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _0_ Patch _0_ Ride _4.5_

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)				MODULI RANGE(psi)	
County :Hall		Thickness(in)	Minimum	Maximum	Poisson Ratio Values
Highway/Road: US 287	Pavement:	2.50	891,800	891,800	H1: v = 0.35
	Base:	9.00	30,000	1,200,000	H2: v = 0.35
	Subbase:	8.00	10,000	300,000	H3: v = 0.35
	Subgrade:	280.50	15,000		H4: v = 0.40

	Load	Measured Deflection (mils):							Calculated Moduli values (ksi):				Absolute	Depth to
Station	(lbs)	R1	R2	R3	R4	R5	R6	R7	SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	ERR/Sens	Bedrock
0.209	10,169	6.37	3.41	1.94	1.48	1.00	0.93	0.76	891.8	179.9	165.5	45.4	5.58	300.0
0.403	10,109	3.91	2.42	1.77	1.41	1.12	0.94	0.81	891.8	587.3	300.0	45.6	4.66	300.0 *
0.605	10,129	4.07	2.26	1.54	1.22	0.89	0.79	0.66	891.8	400.3	300.0	55.9	4.00	300.0 *
0.799	10,125	3.43	2.14	1.64	1.35	1.16	1.04	0.87	891.8	1163.1	300.0	45.4	9.82	300.0 *
1.000	10,395	4.12	2.47	1.85	1.54	1.31	1.09	0.98	891.8	656.9	300.0	42.4	8.23	300.0 *
1.202	9,966	5.20	3.16	2.16	1.71	1.39	1.15	1.00	891.8	309.1	300.0	35.5	3.73	300.0 *
1.400	10,137	4.88	3.05	2.16	1.67	1.36	1.14	0.98	891.8	370.7	300.0	36.5	3.41	300.0 *
1.601	10,065	3.63	2.43	1.88	1.65	1.35	1.21	1.04	891.8	1200.0	86.8	43.1	14.47	300.0 *
1.800	10,002	3.76	2.47	2.05	1.56	1.09	1.09	1.02	891.8	1200.0	32.8	50.2	11.37	300.0 *
2.000	10,661	3.58	2.43	1.89	1.59	1.30	1.30	0.94	891.8	1200.0	300.0	41.0	8.43	300.0 *
2.200	9,628	4.97	2.95	2.04	1.60	1.35	1.13	0.99	891.8	314.7	300.0	36.3	5.16	300.0 *
2.404	9,815	2.70	1.36	1.03	0.86	0.58	0.44	0.36	891.8	755.7	300.0	88.4	6.84	256.5 *
2.600	9,839	3.23	1.65	1.13	0.89	0.76	0.69	0.59	891.8	557.0	300.0	73.2	10.71	300.0 *
2.800	9,863	7.79	5.10	3.39	2.36	1.65	1.19	0.87	891.8	292.7	30.5	29.0	0.50	259.8
3.000	9,068	8.13	4.87	2.64	1.76	1.31	1.10	0.89	891.8	152.0	45.2	32.8	5.28	300.0
3.202	9,068	8.06	4.14	2.42	1.72	1.34	1.12	0.96	891.8	104.5	151.2	31.7	4.08	300.0
3.400	9,044	7.22	4.23	2.58	1.91	1.44	1.15	1.02	891.8	161.9	113.2	30.2	2.80	300.0
3.600	9,231	6.74	4.34	2.77	1.99	1.56	1.33	1.03	891.8	222.8	112.1	28.1	4.16	300.0
3.801	9,160	7.22	4.39	2.69	2.04	1.38	1.26	1.00	891.8	182.8	95.6	29.5	4.67	260.9
4.001	9,374	7.24	4.07	2.43	1.59	1.21	1.04	0.87	891.8	165.0	83.2	36.3	4.35	300.0
4.202	9,338	5.35	3.70	2.74	2.07	1.56	1.32	1.10	891.8	403.7	192.4	27.5	2.09	300.0
4.402	9,227	4.73	3.20	2.57	1.98	1.50	1.32	1.09	891.8	485.5	300.0	27.9	2.62	300.0 *
4.601	9,203	7.26	4.22	2.44	1.73	1.22	1.06	0.92	891.8	168.7	76.4	34.5	4.36	300.0
4.800	9,481	6.74	4.65	3.23	2.36	1.77	1.35	1.20	891.8	338.3	74.6	25.7	1.14	300.0
5.000	8,945	7.26	5.02	3.34	2.22	1.56	1.33	1.06	891.8	292.1	32.1	26.4	3.87	300.0
5.201	9,112	4.22	2.96	2.32	1.71	1.40	0.94	0.89	891.8	696.6	171.1	33.3	2.95	186.0
5.400	9,056	7.56	5.17	3.19	2.04	1.24	0.99	0.88	891.8	294.0	11.3	36.2	3.56	137.9
5.602	10,133	4.86	3.74	2.91	2.26	1.74	1.26	1.06	891.8	1200.0	47.1	30.1	2.24	298.5 *
6.112	9,259	6.65	3.98	2.82	1.99	1.42	1.08	0.83	891.8	237.6	92.4	30.5	1.41	300.0
6.306	9,779	7.30	4.00	2.50	1.75	1.28	0.97	0.78	891.8	169.1	100.6	36.5	0.74	300.0
6.500	9,477	9.79	5.26	3.22	2.31	1.71	1.29	1.12	891.8	100.8	92.8	26.1	0.91	300.0
6.700	9,454	7.43	4.04	2.75	2.10	1.59	1.21	0.98	891.8	138.9	237.2	28.5	0.81	300.0
Mean:		5.79	3.54	2.38	1.76	1.33	1.10	0.92	891.8	459.4	167.0	38.1	4.65	300.0
Std. Dev:		1.82	1.08	0.61	0.38	0.27	0.20	0.17	0.0	364.1	108.6	13.6	3.36	63.1
Var Coeff(%):		31.50	30.46	25.61	21.50	20.29	18.24	18.06	0.0	79.3	65.0	35.8	72.28	21.4

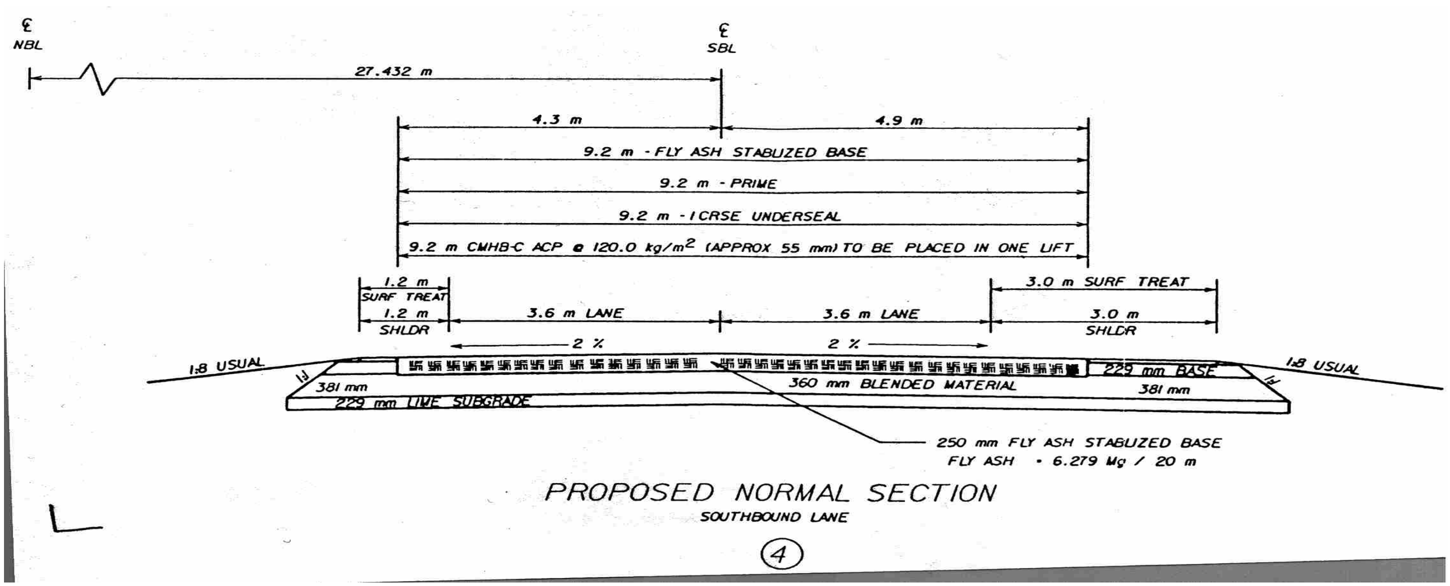
Figure A3. Modulus 6 Results for Section 3, Childress.

Section	County	Highway	Begin	End
4	Hardeman	US 287 (SBL)	250+0.486	232+0.274

Lab Design Data

Base Type	Salvage
Raw TTC	3.1
Stabilizer	6% FA
Compr. Strengths Lat. 0 and (15 psi)	116 and (287 psi)
% change in moisture from OMC	+1.4%

Construction Date 3/1996



PMIS Condition Data (Nov 2002) Overall Average Score = 97

Rutting 3 Long. 10 Alligator 0 Trans. 4 Block Cr. 0 Failures 0 Patch 0 Ride 3.8

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Hardeman
Highway/Road: US 287

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	2.50	663,400	663,400	H1: v = 0.35
Base:	10.00	30,000	1,200,000	H2: v = 0.35
Subbase:	13.00	10,000	300,000	H3: v = 0.35
Subgrade:	274.50	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	9,628	3.54	3.01	2.52	2.05	1.65	1.32	1.06	663.4	1200.0	105.6	28.7	6.89	300.0 *
0.402	11,269	5.39	4.04	3.17	2.58	1.96	1.65	1.50	663.4	817.8	121.3	24.9	1.44	300.0
0.600	11,154	5.33	4.41	3.60	2.87	2.27	1.83	1.52	663.4	1200.0	67.2	22.6	1.96	300.0 *
0.800	11,480	5.61	4.09	3.14	2.48	2.00	1.61	1.35	663.4	662.6	134.4	25.8	1.01	300.0
1.000	11,396	3.85	2.16	1.47	1.12	0.94	0.81	0.69	663.4	471.4	300.0	60.5	4.11	300.0 *
1.202	11,221	5.87	3.93	2.98	2.31	1.84	1.52	1.21	663.4	438.6	155.0	27.4	1.18	300.0
1.406	11,047	6.12	3.27	2.49	1.83	1.37	1.11	0.85	663.4	258.3	169.1	37.1	1.91	300.0
1.604	11,646	3.37	2.13	1.45	1.07	0.83	0.69	0.52	663.4	760.2	222.6	66.3	3.11	300.0
1.800	10,129	3.24	2.17	1.63	1.26	1.00	0.87	0.75	663.4	1200.0	82.5	52.8	7.98	300.0 *
2.000	11,567	3.34	2.23	1.83	1.32	0.98	0.83	0.73	663.4	1177.2	205.4	51.8	2.93	300.0
2.200	10,892	5.09	2.82	2.12	1.69	1.39	1.24	0.93	663.4	320.6	300.0	35.7	2.84	300.0 *
2.403	11,511	4.54	3.04	2.24	1.77	1.32	1.16	0.92	663.4	627.1	193.3	38.3	2.46	300.0
2.603	10,510	3.50	2.19	1.53	1.24	1.02	0.70	0.59	663.4	651.7	231.4	52.4	3.44	206.7
2.806	10,427	4.51	3.12	2.35	1.95	1.35	1.15	0.98	663.4	695.3	135.6	33.5	2.64	300.0
3.002	10,439	5.30	3.37	2.61	2.09	1.68	1.44	1.19	663.4	368.8	255.8	26.9	1.32	300.0
3.200	9,903	3.49	2.30	1.67	1.35	1.06	0.88	0.70	663.4	665.6	259.4	42.5	1.81	300.0
3.402	10,395	5.73	3.78	2.83	2.07	1.59	1.28	1.00	663.4	436.5	95.8	30.1	1.16	300.0
3.603	9,887	5.50	3.70	2.88	2.29	1.87	1.52	1.28	663.4	401.5	183.0	23.4	0.50	300.0
3.801	11,186	6.06	4.51	3.39	2.48	1.76	1.25	0.95	663.4	891.9	18.4	35.7	0.42	255.0
4.000	10,133	4.81	2.77	1.79	1.21	0.92	0.61	0.43	663.4	397.6	69.4	58.7	2.08	176.2
4.206	10,522	9.15	5.59	4.05	2.81	2.07	1.53	1.19	663.4	221.8	40.3	24.2	1.54	300.0
4.400	10,343	8.73	5.55	3.65	2.46	1.72	1.34	1.01	663.4	238.0	28.6	28.9	1.52	300.0
4.601	10,026	14.89	8.29	4.76	3.37	2.47	2.00	1.54	663.4	72.7	34.1	18.4	2.62	300.0
4.800	9,724	8.52	5.17	3.36	2.67	1.80	1.48	1.05	663.4	184.9	54.9	24.2	2.67	252.8
5.000	9,120	8.12	6.23	4.43	3.35	2.42	1.83	1.59	663.4	409.0	17.2	19.0	1.45	300.0
Mean:		5.74	3.75	2.72	2.07	1.57	1.27	1.02	663.4	590.8	139.2	35.6	2.44	300.0
Std. Dev:		2.57	1.51	0.94	0.68	0.49	0.39	0.33	0.0	338.4	89.4	13.9	1.76	45.6
Var Coeff(%):		44.79	40.24	34.59	32.90	30.99	30.42	31.94	0.0	57.3	64.2	39.0	72.12	15.5

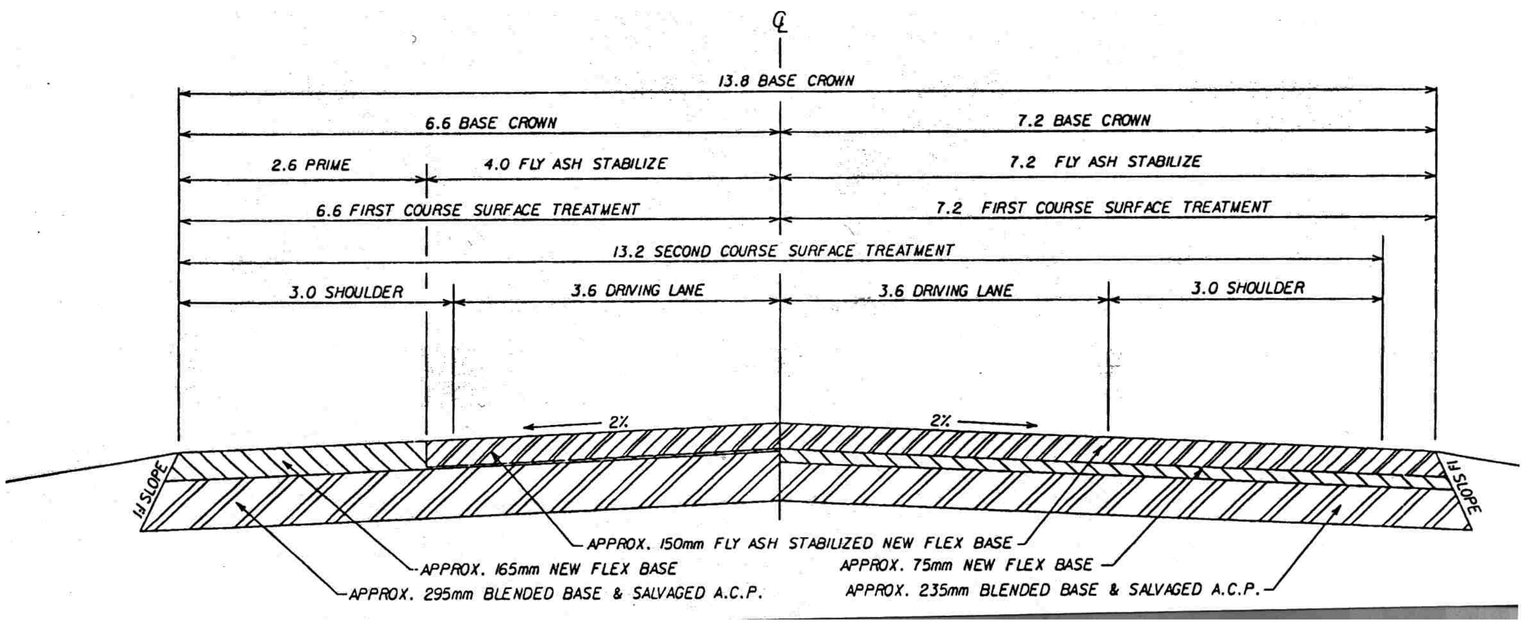
Figure A4. Modulus 6 Results for Section 4, Childress.

Section	County	Highway	Begin	End
5	King	US 83	238+0.702	248+0.066

Construction Date 7/1997

Lab Design Data

Base Type	Crushed Limestone
Raw TTC	2.9
Stabilizer	6% FA
Compr. Strengths Lat. 0 and (15 psi)	122 and (297 psi)
% change in moisture from OMC	+1.9%



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting _0_ Long. _2_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _0_ Patch _0_ Ride _3.9

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :King
Highway/Road: US 83

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	663,400	663,400	H1: v = 0.35
Base:	6.00	30,000	500,000	H2: v = 0.35
Subbase:	12.00	10,000	150,000	H3: v = 0.35
Subgrade:	177.04	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.101	9,760	16.37	10.67	6.24	3.66	2.49	1.78	1.39	663.4	319.9	21.1	16.5	1.25	169.8
0.202	10,196	8.94	5.91	3.68	2.65	1.81	1.42	1.12	663.4	486.0	86.3	24.1	2.39	228.1
0.301	10,137	11.20	7.39	5.35	4.37	3.09	2.46	1.78	663.4	284.7	140.5	14.0	3.16	300.0 *
0.400	10,129	10.13	6.81	4.65	3.56	2.71	2.23	1.82	663.4	321.6	142.2	16.3	3.62	300.0
0.501	10,177	8.78	5.74	4.09	2.83	1.89	1.43	1.06	663.4	500.0	100.2	22.5	2.72	194.2 *
0.600	10,236	8.43	4.76	3.21	2.27	1.46	1.07	0.83	663.4	269.7	130.7	28.5	3.46	151.0
0.702	10,093	10.22	6.46	3.74	2.46	1.67	1.48	1.04	663.4	368.3	60.5	25.1	4.23	220.6
0.811	10,169	14.16	9.41	6.14	4.11	2.60	2.06	1.54	663.4	391.9	38.8	15.7	2.80	145.0
0.901	10,244	11.01	6.48	4.21	2.99	2.20	1.61	1.31	663.4	227.0	97.6	20.8	0.62	255.6
1.000	9,851	11.03	8.07	5.76	3.83	2.54	1.84	1.47	663.4	500.0	61.1	15.8	4.16	192.1 *
1.102	10,042	10.56	6.74	4.46	3.07	2.15	1.40	1.25	663.4	421.6	65.4	20.9	2.99	141.1
1.201	10,304	9.31	5.99	4.18	3.19	2.31	1.78	1.36	663.4	330.2	150.0	19.4	1.76	269.6 *
1.300	9,974	9.67	7.24	5.13	3.70	2.26	1.63	1.35	663.4	500.0	76.2	18.1	6.60	121.8 *
1.401	9,986	13.61	8.36	5.07	3.37	2.31	1.64	1.26	663.4	276.2	43.4	18.7	0.81	214.2
1.500	9,311	11.43	7.55	5.02	3.54	2.41	1.85	1.49	663.4	350.6	64.1	16.2	1.50	230.5
1.600	9,684	11.19	7.81	5.74	4.03	2.87	2.30	1.73	663.4	448.5	83.8	14.0	2.47	300.0
1.700	9,088	9.26	5.97	4.23	2.98	2.10	1.51	1.13	663.4	356.2	98.2	18.7	1.76	228.1
1.800	9,104	15.75	10.41	6.55	4.26	3.12	2.25	1.52	663.4	255.6	35.6	12.6	1.57	300.0
1.901	9,541	10.13	6.32	4.11	2.95	2.03	1.53	1.28	663.4	305.1	84.8	20.2	1.18	246.5
2.000	9,307	12.28	5.69	3.01	2.12	1.61	1.39	1.07	663.4	112.5	76.1	26.3	5.94	300.0
2.100	9,561	13.04	5.90	2.45	1.40	0.96	0.82	0.63	663.4	150.2	33.4	38.5	5.03	92.9
2.200	9,327	16.03	8.41	4.67	2.87	1.63	1.31	0.94	663.4	169.5	26.2	21.5	3.78	99.1
2.300	9,577	14.09	7.70	4.54	2.95	1.97	1.41	1.10	663.4	185.2	41.0	20.9	2.15	198.7
2.400	9,160	17.01	9.03	4.80	2.69	1.59	1.43	1.10	663.4	159.8	22.1	20.9	3.94	111.9
2.502	9,048	16.97	10.19	5.96	4.09	2.81	2.17	1.63	663.4	158.2	35.9	13.5	2.33	258.3
2.602	9,259	15.33	8.20	4.61	3.17	2.07	1.60	1.32	663.4	140.9	40.7	18.9	1.92	169.7
2.704	9,593	21.31	11.70	6.09	3.85	2.62	1.96	1.46	663.4	120.4	22.5	15.3	1.91	241.5
2.801	9,330	15.05	8.44	4.93	3.45	2.37	1.82	1.50	663.4	148.6	47.3	16.9	1.93	249.2
2.902	9,303	13.43	7.25	4.41	3.10	2.07	1.79	1.30	663.4	141.9	64.0	18.8	3.29	195.8
3.002	8,945	14.47	7.11	3.66	2.39	1.73	1.39	1.09	663.4	118.0	42.8	22.9	3.11	300.0
3.101	9,243	15.98	7.98	4.52	3.09	2.10	1.58	1.36	663.4	109.9	45.2	19.1	1.22	226.6
3.200	9,247	16.52	7.29	2.96	1.91	1.30	1.09	0.78	663.4	99.4	28.7	28.9	5.76	83.1
3.306	9,235	14.30	6.67	2.81	1.83	1.12	0.87	0.69	663.4	133.6	30.4	31.7	3.52	100.9
3.402	8,739	20.45	10.68	5.30	3.16	2.34	1.51	1.39	663.4	106.7	20.0	16.5	3.08	193.5
3.500	8,854	14.30	6.73	3.61	2.33	1.61	1.24	0.96	663.4	111.9	43.8	23.8	0.93	260.1
3.600	9,358	12.06	6.29	4.23	3.10	2.45	1.91	1.56	663.4	111.4	143.6	17.8	4.08	300.0
3.700	8,822	19.23	9.12	4.97	3.46	2.34	1.72	1.64	663.4	78.1	36.2	16.3	1.60	219.9
3.801	8,782	20.01	8.11	3.26	2.01	1.45	1.18	0.96	663.4	68.6	23.1	25.6	6.42	80.0
3.900	8,735	17.52	7.78	3.76	2.56	2.01	1.65	1.33	663.4	73.5	40.2	20.3	7.06	300.0

Figure A5. Modulus 6 Results for Section 5, Childress.

4.001	8,882	16.08	7.26	3.57	2.27	1.64	1.40	1.18	663.4	91.4	38.2	23.3	4.34	300.0	
4.101	9,330	8.74	4.22	2.76	2.27	1.76	1.33	1.20	663.4	182.2	150.0	26.3	8.76	300.0	*
4.200	8,504	21.76	11.80	5.32	3.00	1.94	1.26	1.01	663.4	119.0	12.5	17.6	2.53	129.6	
4.293	9,354	11.85	5.60	3.91	2.86	2.29	1.43	1.42	663.4	100.5	150.0	20.2	3.52	123.7	*
4.501	8,794	17.01	7.73	3.81	2.43	1.55	1.32	1.02	663.4	92.9	31.2	22.7	3.06	148.5	
4.601	9,148	15.87	6.62	3.47	2.54	1.69	1.36	1.08	663.4	73.9	55.3	23.3	3.21	300.0	
4.700	9,025	16.82	8.24	4.40	3.04	2.26	1.76	1.34	663.4	92.2	45.0	18.2	3.90	274.8	
4.800	9,100	17.44	7.89	3.93	2.76	1.98	1.62	1.85	663.4	79.5	42.3	20.5	4.50	300.0	
4.900	8,882	16.99	7.99	3.74	2.56	1.72	1.52	1.21	663.4	92.4	33.9	21.8	4.76	272.3	
5.000	9,219	15.35	7.57	3.94	2.69	1.96	1.45	1.28	663.4	112.9	43.7	21.6	2.77	281.7	
5.100	9,048	13.62	7.19	4.59	3.06	2.25	1.75	1.46	663.4	126.0	68.0	17.7	1.30	300.0	
5.201	9,021	19.52	10.93	6.09	4.27	2.87	2.09	1.70	663.4	115.5	30.0	13.3	2.01	213.2	
5.301	9,040	20.90	9.95	4.91	2.96	2.01	1.55	1.21	663.4	87.5	23.1	18.4	1.76	211.2	
5.400	8,977	15.30	8.57	5.06	3.37	2.37	1.73	1.29	663.4	149.9	40.4	16.4	0.55	247.5	
5.500	8,921	16.35	8.41	4.82	3.45	2.31	1.68	1.44	663.4	106.6	44.7	16.7	1.93	201.2	
5.600	8,862	21.73	10.52	4.93	3.21	2.07	1.91	1.43	663.4	78.6	23.2	16.9	5.52	290.1	
5.700	9,187	15.12	7.64	4.42	3.13	2.24	1.38	1.41	663.4	117.8	49.7	19.2	4.84	250.2	
5.800	9,084	18.02	8.28	4.65	3.31	2.23	1.87	1.24	663.4	73.8	49.6	17.3	3.24	210.2	
5.900	9,160	13.02	6.50	4.45	3.48	2.32	1.99	1.56	663.4	89.9	146.4	16.7	3.88	189.9	
6.000	8,989	17.24	8.16	4.49	3.06	1.90	1.56	1.14	663.4	92.5	38.4	19.2	2.67	130.9	
6.105	9,239	10.88	5.48	3.31	2.33	1.77	1.43	1.21	663.4	136.4	102.5	23.8	3.47	300.0	
6.200	8,862	12.43	7.05	3.90	2.63	2.21	1.68	1.29	663.4	161.8	58.6	19.5	6.36	300.0	
6.400	9,136	19.17	8.00	4.30	2.97	1.86	1.71	1.42	663.4	63.0	42.7	19.5	4.30	135.2	
6.501	9,231	21.96	8.43	4.17	2.98	2.06	1.85	1.41	663.4	48.4	41.4	19.3	5.24	300.0	
6.600	9,084	19.27	8.97	4.81	3.23	2.02	1.68	1.36	663.4	81.9	33.4	18.1	2.98	135.8	
6.700	9,100	22.98	9.84	4.24	3.15	2.30	1.89	1.76	663.4	55.8	28.9	17.9	8.19	117.9	
6.800	9,180	21.36	9.03	4.57	3.15	2.07	1.69	1.31	663.4	60.9	33.5	18.4	3.01	300.0	
6.900	9,156	21.69	8.71	4.42	3.20	2.23	1.97	1.41	663.4	49.9	42.7	17.6	5.21	300.0	
7.000	8,770	20.91	9.56	4.56	2.99	2.09	1.53	1.35	663.4	73.4	25.6	18.1	3.01	300.0	
7.100	8,782	23.23	10.47	4.05	2.54	1.87	1.57	1.15	663.4	66.7	18.3	19.9	8.76	69.9	
7.202	8,540	17.62	8.43	4.49	3.00	2.15	1.64	1.32	663.4	84.5	36.7	17.5	2.45	300.0	
7.300	8,925	18.30	8.46	4.07	2.70	1.84	1.44	1.02	663.4	86.5	30.6	20.7	3.08	300.0	
7.401	8,743	20.31	11.42	6.52	4.05	3.16	2.35	1.78	663.4	106.3	28.3	12.3	4.34	300.0	
7.500	9,044	18.07	8.25	4.31	2.82	2.12	1.54	1.34	663.4	81.1	38.1	19.5	2.85	300.0	
7.600	8,969	16.15	8.13	4.31	2.94	2.09	1.63	1.25	663.4	106.6	40.9	19.0	2.80	300.0	
7.700	8,989	13.54	6.79	3.65	2.43	1.72	1.39	1.06	663.4	129.3	48.9	23.0	2.13	300.0	
7.801	8,635	25.39	11.69	4.35	2.48	1.74	1.45	1.11	663.4	67.0	13.1	20.1	7.81	63.5	
7.902	8,981	13.42	6.47	3.32	2.26	1.66	1.20	1.16	663.4	121.0	49.2	24.9	2.83	233.7	
8.001	8,822	11.38	6.20	3.14	1.96	1.37	1.17	0.87	663.4	204.1	42.0	27.1	3.44	286.9	
8.104	8,949	13.67	5.22	2.98	2.32	1.48	1.07	0.98	663.4	68.2	88.3	26.3	3.32	300.0	
Mean:		15.46	7.92	4.39	2.98	2.07	1.61	1.29	663.4	168.9	55.7	20.0	3.45	195.5	
Std. Dev:		4.08	1.69	0.89	0.61	0.44	0.32	0.26	0.0	122.5	36.3	4.4	1.85	108.8	
Var Coeff(%):		26.41	21.33	20.38	20.36	21.06	20.18	20.02	0.0	72.5	65.2	22.0	53.45	51.3	

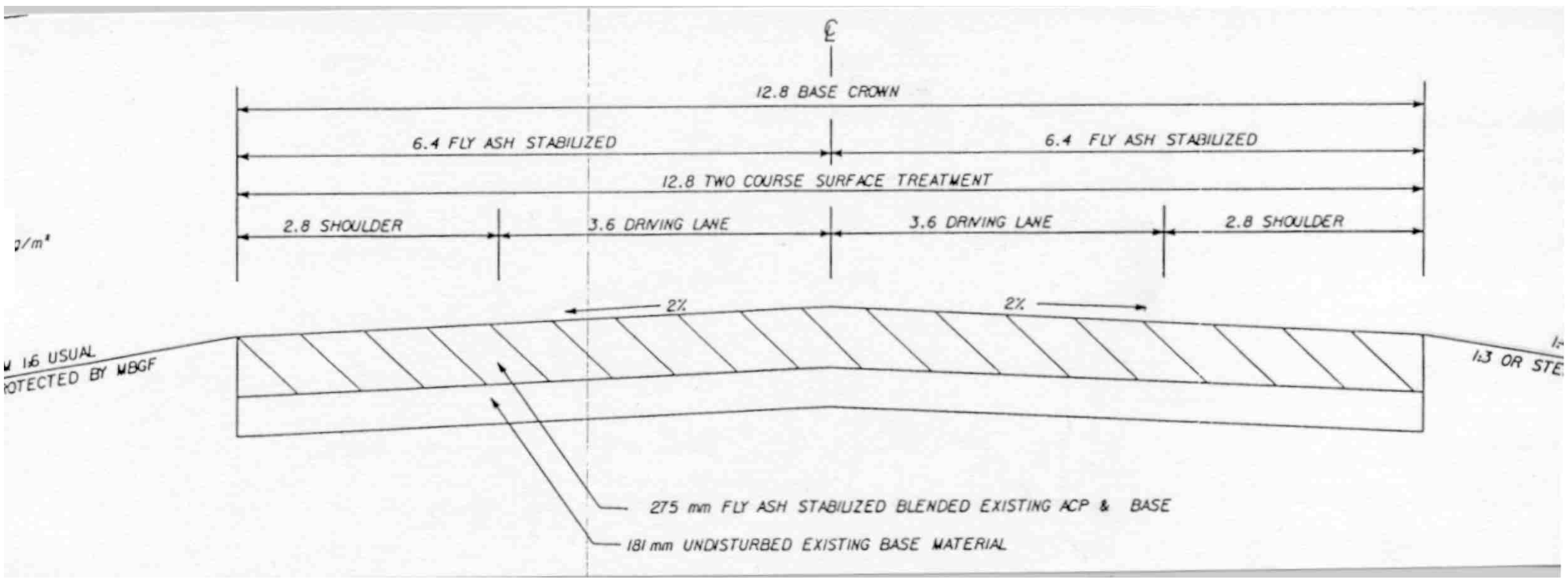
Figure A5. Modulus 6 Results for Section 5, Childress (Continued.

Section	County	Highway	Begin	End
6	King	US 83	224+0.650	232+0.274

Construction Date 12/1997

Lab Design Data

Base Type	Sand/Gravel + RAP
Raw TTC	3.0
Stabilizer	8% FA
Compr. Strengths Lat. 0 and (15 psi)	130 and (241 psi)
% change in moisture from OMC	+0.9%



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting __0__ Long. __4__ Alligator __0__ Trans. __0__ Block Cr. __0__ Failures__0__ Patch _0 Ride __4.3

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

		Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
District:25 (Childress)					
County :King					
Highway/Road: US 83	Pavement:	0.50	663,400	663,400	H1: v = 0.35
	Base:	10.00	30,000	500,000	H2: v = 0.35
	Subbase:	10.50	10,000	150,000	H3: v = 0.35
	Subgrade:	179.44	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	9,315	17.66	10.52	6.04	3.76	2.44	1.84	1.39	663.4	118.5	13.1	16.7	3.56	170.4
0.100	9,529	11.48	6.59	4.09	2.63	1.70	1.22	0.94	663.4	184.0	27.7	24.4	1.46	159.5
0.200	9,613	8.37	4.40	2.85	1.81	1.08	0.78	0.59	663.4	234.9	44.0	36.0	3.90	110.9
0.301	9,561	9.07	5.06	3.23	2.15	1.51	1.11	0.91	663.4	208.7	57.7	27.8	0.22	263.3
0.400	9,541	8.31	4.34	2.69	1.80	1.30	1.03	0.87	663.4	195.3	86.1	31.3	2.60	300.0
0.501	9,466	12.01	7.36	4.46	2.74	1.86	1.41	1.15	663.4	181.7	24.7	22.2	3.61	228.3
0.600	9,620	8.07	4.82	3.31	2.31	1.76	1.32	1.09	663.4	248.5	97.2	24.1	1.17	300.0
0.703	9,505	12.55	7.02	4.63	3.28	2.31	1.70	1.46	663.4	143.8	51.4	18.3	0.91	271.5
0.800	9,338	10.24	4.55	2.88	2.00	1.45	1.12	0.96	663.4	117.9	110.8	27.9	1.90	300.0
0.900	9,033	12.74	6.98	4.34	3.03	2.19	1.61	1.43	663.4	129.1	44.2	18.8	0.99	269.9
1.001	9,231	10.72	5.83	3.61	2.43	1.58	1.37	1.06	663.4	158.3	48.4	24.3	3.07	163.2
1.103	9,295	12.14	6.60	4.09	2.80	2.03	1.56	1.32	663.4	137.1	48.9	20.7	1.27	300.0
1.200	8,886	10.49	5.76	3.66	2.48	1.72	1.32	1.07	663.4	160.4	48.4	22.9	0.72	266.6
1.302	8,735	16.74	8.66	5.06	3.38	2.23	1.67	1.25	663.4	90.0	24.0	17.0	1.52	184.9
1.400	8,766	12.50	6.77	3.92	2.59	1.65	1.26	1.06	663.4	131.9	28.0	22.8	2.40	147.3
1.501	8,874	10.10	6.20	3.99	2.65	1.70	1.35	1.02	663.4	214.8	30.6	22.1	2.57	152.7
1.600	8,802	10.33	6.07	3.82	2.58	1.63	1.26	1.01	663.4	192.6	31.6	23.0	2.18	140.6
1.700	10,987	23.26	10.00	5.53	3.67	2.74	2.11	1.60	663.4	59.4	36.0	17.8	3.42	300.0
1.903	10,717	21.08	12.27	6.88	4.19	2.69	1.99	1.54	663.4	110.2	12.0	17.5	3.45	160.4
2.002	11,154	13.59	8.79	5.11	3.08	1.98	1.48	1.09	663.4	237.7	12.7	26.3	3.64	156.6
2.102	10,848	10.59	5.86	3.60	2.30	1.70	1.17	1.02	663.4	202.5	48.5	29.3	1.25	300.0
2.200	10,053	18.02	9.65	5.07	3.15	2.17	1.69	1.26	663.4	95.4	21.6	20.1	4.66	261.8
2.300	10,403	19.56	9.94	5.16	3.35	2.15	1.56	1.23	663.4	88.9	19.1	20.9	2.80	154.6
2.401	10,133	21.94	10.64	5.91	3.97	2.79	2.08	1.61	663.4	69.5	25.6	16.1	2.13	300.0
2.500	10,538	14.75	7.87	4.21	2.60	1.80	1.31	1.02	663.4	127.1	26.6	25.8	3.11	259.6
2.606	11,281	9.21	6.00	3.66	2.43	1.70	1.28	0.99	663.4	322.3	41.8	29.4	2.69	283.4
2.700	11,547	12.31	7.10	3.37	1.80	1.04	0.72	0.59	663.4	202.3	15.2	46.4	3.81	95.9
2.804	9,970	15.43	7.76	4.19	2.61	1.65	1.17	0.81	663.4	112.1	21.7	25.9	1.43	142.1
2.901	10,089	15.46	9.12	5.00	2.99	1.64	1.24	0.96	663.4	158.9	10.3	26.6	3.50	91.9
3.000	10,606	14.95	7.02	3.66	2.16	1.55	1.21	1.02	663.4	105.7	31.3	29.4	4.19	168.2
3.105	11,019	11.26	6.52	3.61	2.35	1.63	1.32	0.93	663.4	194.2	40.8	29.2	4.54	263.2
3.201	11,547	12.79	6.87	3.76	2.48	1.82	1.32	1.03	663.4	159.8	43.7	29.0	3.50	238.0
3.300	11,551	12.79	6.52	4.24	3.13	2.40	1.87	1.61	663.4	136.7	113.1	22.2	2.62	300.0
3.402	8,659	21.85	9.57	4.10	2.20	1.44	1.15	0.90	663.4	54.0	13.0	24.2	6.15	99.9
3.501	8,762	19.81	10.50	4.87	2.61	1.65	1.19	0.94	663.4	75.3	10.0	22.0	5.60	100.5 *
3.600	9,048	25.99	11.99	4.76	2.60	1.77	1.42	1.09	663.4	47.7	10.9	21.0	8.90	77.7
3.700	10,471	16.53	9.36	4.30	2.35	1.57	1.16	0.98	663.4	120.2	13.4	29.3	7.34	107.0
3.800	10,161	13.66	9.39	5.76	3.67	2.39	2.02	1.46	663.4	209.4	19.3	17.8	5.64	170.9
3.904	9,569	21.17	13.04	6.89	4.07	2.63	1.80	1.44	663.4	95.5	10.0	15.9	3.53	170.1 *

Figure A6. Modulus 6 Results for Section 6, Childress.

4.000	10,149	19.61	11.00	5.76	3.25	2.18	1.61	1.30	663.4	102.2	12.2	20.7	4.78	128.9	
4.100	9,601	31.30	15.26	6.69	3.47	2.17	1.69	1.51	663.4	42.1	10.0	16.3	6.46	91.1	*
4.202	9,549	27.26	11.06	4.53	2.63	1.96	1.60	1.33	663.4	42.4	16.1	21.2	8.52	88.5	
4.303	10,518	22.88	13.21	7.16	4.74	3.11	2.22	1.79	663.4	93.3	13.3	15.0	2.78	181.6	
4.400	10,030	22.47	12.89	7.00	4.15	2.50	1.83	1.38	663.4	91.3	10.0	16.9	3.34	121.4	*
4.500	10,292	19.60	9.61	5.59	3.56	2.56	2.20	1.53	663.4	79.0	33.0	17.4	4.01	300.0	
4.602	10,626	14.27	7.56	4.74	3.13	2.17	1.60	1.23	663.4	135.6	39.2	22.0	0.51	269.5	
4.711	10,951	21.80	9.61	5.61	4.02	2.87	2.10	1.78	663.4	64.5	45.4	17.1	1.69	260.3	
4.800	10,510	19.71	5.66	2.51	1.71	0.96	0.74	0.70	663.4	51.3	43.1	40.4	3.28	146.6	
4.901	10,328	20.90	8.18	4.15	2.87	1.98	1.53	1.39	663.4	57.8	36.5	22.9	2.93	300.0	
5.001	10,129	27.71	14.99	7.61	4.82	3.26	2.72	2.02	663.4	61.6	13.4	13.0	6.29	235.4	
5.206	9,787	28.65	12.48	5.94	3.91	2.50	1.74	1.51	663.4	46.4	13.8	16.3	2.65	300.0	
5.303	10,506	14.34	7.46	4.16	2.68	1.75	1.35	1.18	663.4	127.5	30.9	25.6	2.45	168.5	
5.400	10,963	11.52	6.62	3.91	2.54	2.13	1.40	1.15	663.4	187.3	49.8	25.6	4.06	300.0	
5.500	10,685	13.93	8.04	5.11	3.55	2.14	1.82	1.48	663.4	162.9	33.2	20.4	3.68	116.2	
5.600	10,534	13.15	7.63	4.49	3.04	2.24	1.69	1.33	663.4	159.8	39.0	21.7	2.72	300.0	
5.700	10,415	9.89	5.29	3.33	2.31	1.77	1.39	1.01	663.4	178.4	93.8	26.4	3.08	203.8	
5.801	10,618	13.22	8.10	5.14	3.56	2.57	1.90	1.59	663.4	184.2	37.0	18.6	1.06	283.1	
5.901	10,733	17.37	10.06	5.67	3.60	2.49	1.90	1.67	663.4	123.1	22.2	19.0	3.71	272.2	
6.000	10,614	12.97	8.21	5.12	3.63	2.40	1.97	1.46	663.4	197.4	33.9	18.8	3.39	182.6	
6.102	11,714	12.42	6.67	4.68	3.78	2.51	2.49	2.48	663.4	166.7	114.4	19.2	7.70	181.9	
6.200	10,614	15.05	8.57	5.40	3.99	2.73	2.15	1.49	663.4	135.0	46.2	16.9	2.54	236.4	
6.311	11,015	11.63	7.95	5.66	3.72	2.63	1.91	1.59	663.4	333.8	27.6	19.1	1.49	251.5	
6.500	10,594	18.07	10.46	5.98	4.25	2.68	2.05	1.84	663.4	120.0	21.8	17.0	3.50	140.6	
6.600	10,955	17.07	10.43	6.35	4.44	3.20	2.41	0.74	663.4	140.9	28.8	15.3	2.19	88.8	
6.700	10,034	22.41	11.40	5.02	2.89	1.94	1.50	1.23	663.4	69.4	12.6	21.8	6.97	144.4	
6.800	9,271	19.89	9.44	4.98	3.19	2.31	1.80	1.43	663.4	67.2	24.5	17.7	4.07	300.0	
6.901	9,434	20.68	7.85	3.78	2.42	1.63	1.16	1.07	663.4	54.6	25.7	25.0	2.48	209.4	
7.003	10,780	20.99	7.70	4.01	2.64	1.81	1.39	1.07	663.4	57.8	40.3	25.8	1.69	239.7	
7.101	10,665	14.50	7.39	3.44	2.20	1.55	1.28	1.01	663.4	114.5	29.7	29.7	7.10	251.4	
7.200	11,285	10.63	7.09	4.61	3.11	2.16	1.63	1.22	663.4	313.5	35.6	23.5	1.88	270.2	
7.300	10,467	13.31	7.58	4.50	2.93	1.97	1.50	1.13	663.4	159.9	31.1	23.3	2.05	207.3	
7.500	10,268	20.30	9.33	4.28	2.52	1.72	1.36	1.16	663.4	71.5	18.4	24.9	5.31	167.5	
7.600	10,741	17.12	9.91	6.22	4.20	3.02	2.21	1.59	663.4	129.1	29.7	16.0	0.93	205.2	
7.700	10,979	16.69	7.93	3.54	2.29	1.61	1.34	1.17	663.4	92.2	28.5	29.0	7.16	158.5	
7.800	10,304	23.72	12.38	6.97	4.28	2.98	2.19	1.70	663.4	75.2	16.7	15.1	2.39	264.2	
7.900	11,039	20.46	11.39	6.20	3.91	2.57	2.04	1.47	663.4	102.6	17.7	18.4	4.71	181.7	
8.000	10,653	18.01	11.65	7.34	4.89	3.30	2.34	1.87	663.4	161.3	15.3	14.4	1.35	220.5	
8.101	11,631	12.24	6.65	4.11	2.90	2.25	1.71	1.49	663.4	162.7	80.7	23.9	3.04	300.0	
8.205	10,637	21.11	12.51	7.52	5.26	3.50	2.68	1.91	663.4	107.1	19.6	13.1	2.54	198.6	
Mean:		16.31	8.61	4.80	3.10	2.11	1.61	1.27	663.4	134.9	34.2	22.4	3.35	200.4	
Std. Dev:		5.29	2.49	1.22	0.81	0.55	0.43	0.34	0.0	64.7	24.2	5.9	1.92	83.3	
Var Coeff(%):		32.44	28.88	25.40	25.95	26.02	26.61	26.76	0.0	48.0	70.6	26.6	57.43	42.5	

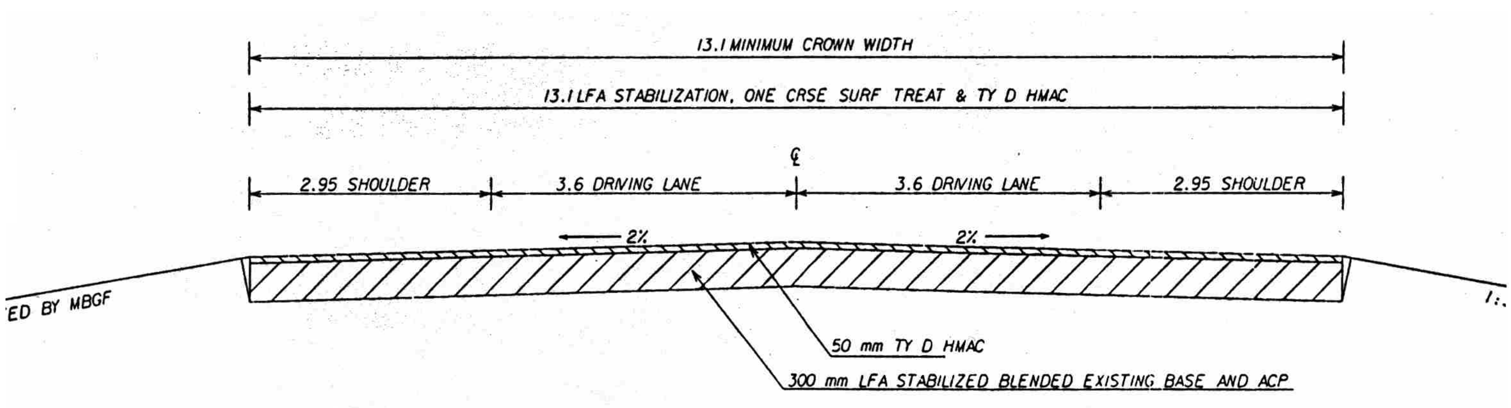
Figure A6. Modulus 6 Results for Section 6, Childress (Continued).

Section	County	Highway	Begin	End
7	Foard	US 70	418+0.000	428+0.265

Construction Date 8/1998

Lab Design Data

Base Type	Crushed Limestone
Raw TTC	NA
Stabilizer	2% L 2% FA
Compr. Strengths Lat. 0 and (15 psi)	120 and (216 psi)
% change in moisture from OMC	+1.5%



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting _0_ Long. _0_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _0_ Patch _0_ Ride _4.1_

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County : Foard
Highway/Road: US 70

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	2.00	663,400	663,400	H1: v = 0.35
Base:	12.00	30,000	600,000	H2: v = 0.35
Subbase:	0.00			H3: v = 0.00
Subgrade:	199.80	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	8,878	12.15	7.26	4.58	2.91	1.99	1.60	1.28	663.4	112.4	0.0	18.1	4.37	244.4
0.100	8,786	14.04	9.84	6.58	5.07	3.69	2.74	2.22	663.4	143.2	0.0	10.5	2.10	299.2
0.201	9,120	9.15	6.73	4.67	3.16	2.24	1.52	1.20	663.4	226.8	0.0	17.4	4.30	167.6
0.301	8,433	23.46	12.71	6.06	3.91	2.30	1.96	1.54	663.4	32.6	0.0	12.8	5.72	300.0
0.401	8,528	20.00	9.65	3.67	2.19	1.47	1.18	0.97	663.4	31.8	0.0	20.9	7.46	66.5
0.500	8,615	11.65	7.00	3.67	2.21	1.21	0.88	0.72	663.4	84.6	0.0	23.6	11.12	90.9
0.602	8,635	12.95	7.96	5.07	3.33	2.35	1.55	1.33	663.4	104.2	0.0	15.8	2.20	151.6
0.701	10,959	13.80	7.12	4.89	3.66	2.53	1.94	1.41	663.4	137.9	0.0	19.6	7.13	254.9
0.802	9,060	5.68	4.76	3.98	2.90	2.09	1.65	1.20	663.4	600.0	0.0	18.6	4.18	300.0 *
0.902	8,886	7.14	6.00	4.20	3.47	2.52	1.70	1.32	663.4	458.5	0.0	15.6	4.72	157.2
1.001	8,790	9.85	7.01	4.99	3.57	2.57	1.92	1.29	663.4	222.9	0.0	14.8	1.54	158.5
1.100	8,985	12.27	8.94	6.53	4.86	3.62	2.70	2.10	663.4	201.8	0.0	10.9	0.94	300.0
1.204	8,699	18.53	11.44	7.57	5.39	3.47	2.91	1.99	663.4	77.8	0.0	10.0	3.17	162.9
1.300	9,231	7.49	5.70	4.23	3.19	2.22	1.65	1.32	663.4	394.9	0.0	17.7	2.09	270.9
1.403	9,084	11.17	7.67	5.18	3.56	2.34	1.66	1.50	663.4	156.4	0.0	15.7	3.93	179.0
1.500	9,100	14.52	8.65	4.49	2.92	1.87	1.31	1.00	663.4	74.8	0.0	18.8	5.26	152.7
1.603	8,528	11.42	8.18	5.05	3.43	2.15	1.61	1.26	663.4	129.1	0.0	15.3	5.53	138.1
1.700	9,124	7.14	4.94	3.50	2.49	1.74	1.23	1.02	663.4	317.8	0.0	22.8	1.04	201.4
1.800	8,802	15.15	9.28	5.58	3.82	2.54	2.04	1.55	663.4	87.0	0.0	14.0	4.06	196.2
1.906	8,866	9.15	6.88	5.14	3.47	2.32	1.73	1.33	663.4	243.5	0.0	15.5	4.98	203.0
2.000	9,116	8.03	5.52	3.64	2.54	1.72	1.37	0.98	663.4	246.3	0.0	21.7	4.06	215.4
2.101	9,156	7.14	5.89	4.63	3.35	2.45	1.84	1.43	663.4	492.4	0.0	15.6	3.48	300.0
2.200	9,060	6.97	5.14	3.34	2.16	1.00	0.85	0.73	663.4	226.2	0.0	28.4	14.68	72.2
2.301	9,064	12.29	8.49	5.75	4.20	2.93	2.13	1.68	663.4	158.1	0.0	13.2	1.52	252.4
2.401	9,195	12.48	8.94	6.39	4.84	3.48	2.63	2.11	663.4	192.6	0.0	11.5	1.34	300.0
2.500	9,064	9.80	6.08	3.94	2.80	1.95	1.44	1.10	663.4	172.9	0.0	19.9	2.17	275.5
2.601	9,072	7.81	5.00	3.73	2.82	1.99	1.58	1.26	663.4	322.3	0.0	20.1	3.74	300.0
2.701	8,762	6.59	4.15	3.07	2.01	1.46	1.00	0.77	663.4	295.7	0.0	26.4	1.55	171.2
2.802	8,568	17.20	9.40	5.30	3.51	2.00	1.48	1.31	663.4	56.1	0.0	15.5	5.30	100.3
2.901	8,715	9.39	6.04	4.14	2.85	1.95	1.42	1.12	663.4	183.1	0.0	18.6	1.48	238.9
3.001	8,580	14.58	9.19	5.48	3.49	1.83	1.24	1.07	663.4	73.8	0.0	16.1	12.60	85.5
3.100	8,814	8.55	6.43	4.68	3.63	2.64	1.92	1.58	663.4	325.7	0.0	14.7	1.35	244.1
3.201	8,905	9.25	7.03	5.75	4.56	3.49	2.70	1.68	663.4	427.6	0.0	10.8	1.02	132.4
3.301	8,957	13.04	9.64	6.92	5.06	3.31	2.54	2.00	663.4	162.4	0.0	11.0	3.98	176.0
3.400	8,886	12.53	8.31	6.08	4.75	3.50	2.73	2.13	663.4	190.1	0.0	11.4	3.41	300.0
3.500	9,485	7.67	5.17	4.30	3.38	2.57	2.16	1.70	663.4	545.0	0.0	16.0	4.61	300.0
3.600	9,525	15.10	10.05	6.07	3.96	2.55	1.88	1.56	663.4	95.5	0.0	14.6	4.96	161.0

Figure A7. Modulus 6 Results for Section 7, Childress.

3.700	8,838	9.41	6.62	4.66	3.37	2.32	1.67	1.17	663.4	222.3	0.0	16.3	1.87	179.8	
3.800	8,639	21.07	11.68	6.11	3.89	2.58	2.25	1.40	663.4	43.9	0.0	12.8	6.21	198.8	
3.902	9,001	8.39	5.49	4.07	2.93	2.13	1.54	1.22	663.4	273.5	0.0	18.9	1.41	235.3	
4.001	8,981	9.31	6.59	4.95	3.63	2.60	2.03	1.63	663.4	277.8	0.0	14.9	1.40	300.0	
4.100	9,104	8.43	5.37	3.84	2.71	1.81	1.30	0.94	663.4	231.3	0.0	21.2	1.34	194.3	
4.200	8,627	12.65	8.84	5.15	3.29	2.06	1.56	1.21	663.4	102.4	0.0	15.8	6.93	138.8	
4.300	8,985	8.10	5.56	4.17	3.07	2.14	1.67	1.24	663.4	313.3	0.0	18.0	1.82	277.1	
4.400	9,148	9.95	6.94	5.32	4.09	3.00	2.27	1.82	663.4	287.8	0.0	13.5	1.67	300.0	
4.500	8,675	10.45	6.28	4.35	3.36	2.42	2.12	1.62	663.4	190.5	0.0	15.8	6.39	300.0	
4.601	8,925	10.78	6.93	4.94	3.95	2.93	2.24	1.71	663.4	219.7	0.0	14.0	4.90	271.2	
4.700	8,993	8.42	5.57	3.50	2.45	1.65	1.13	0.83	663.4	198.5	0.0	22.8	2.52	170.8	
4.800	8,846	10.83	9.11	7.00	4.85	3.73	2.76	2.12	663.4	269.3	0.0	10.0	4.63	300.0	
4.900	9,191	9.87	6.33	4.86	3.54	2.54	1.93	1.52	663.4	243.0	0.0	16.0	2.20	300.0	
5.003	8,719	11.61	7.97	5.34	3.99	2.73	2.04	1.56	663.4	161.7	0.0	13.5	2.16	240.0	
5.101	8,917	9.10	5.92	4.44	3.16	2.28	1.60	1.35	663.4	239.2	0.0	17.4	0.99	196.6	
5.200	9,370	6.53	4.70	3.54	2.60	1.82	1.32	0.91	663.4	443.0	0.0	22.4	1.14	166.4	
5.302	9,624	6.51	4.37	3.26	2.54	1.76	1.29	1.07	663.4	454.1	0.0	24.3	2.34	250.5	
5.400	9,346	9.87	7.55	5.45	4.16	3.07	2.36	1.88	663.4	300.2	0.0	13.2	1.92	300.0	
5.503	9,231	7.66	5.56	3.80	2.96	1.95	1.56	1.23	663.4	330.9	0.0	19.8	3.78	173.9	
5.600	9,541	10.19	6.28	4.02	2.93	2.12	1.59	1.33	663.4	181.2	0.0	19.9	3.61	300.0	
5.701	9,632	7.24	4.59	3.08	2.18	1.54	1.11	0.80	663.4	283.1	0.0	27.3	1.63	195.9	
5.812	8,639	11.91	6.87	4.09	2.76	1.98	1.41	1.08	663.4	106.6	0.0	19.1	3.09	216.2	
5.902	9,740	9.71	6.07	3.90	2.82	2.01	1.63	1.23	663.4	201.2	0.0	20.8	4.38	300.0	
6.005	9,517	8.46	5.59	3.24	2.69	1.89	1.30	1.04	663.4	230.7	0.0	22.9	5.46	300.0	
6.101	9,327	13.11	8.59	5.01	3.07	2.01	1.50	1.06	663.4	101.5	0.0	17.9	6.05	177.1	
6.202	9,303	13.28	8.69	5.58	3.71	2.54	1.85	1.40	663.4	119.4	0.0	15.1	2.68	249.2	
6.300	9,450	11.02	8.26	5.89	4.41	3.28	2.31	1.63	663.4	239.1	0.0	12.8	1.72	185.8	
6.400	9,529	10.62	7.59	5.43	3.97	2.87	2.17	1.71	663.4	235.6	0.0	14.4	1.55	300.0	
6.500	9,446	10.56	6.64	4.11	2.82	1.95	1.46	1.14	663.4	154.3	0.0	20.4	3.43	260.2	
6.601	9,124	14.04	8.81	5.29	3.37	2.36	1.78	1.42	663.4	96.6	0.0	15.9	4.03	300.0	
6.701	8,294	17.28	8.63	3.28	1.52	0.93	0.70	0.59	663.4	33.3	0.0	26.3	17.25	66.9	
6.800	8,655	11.85	8.21	5.62	3.70	2.44	1.63	0.90	663.4	132.8	0.0	14.3	5.84	116.5	
6.902	8,953	7.97	5.49	3.60	2.38	1.68	1.21	0.96	663.4	227.0	0.0	22.2	3.21	230.5	
7.006	8,822	6.24	4.17	2.50	2.15	1.36	1.20	0.94	663.4	338.8	0.0	27.4	7.83	300.0	
7.103	8,731	5.84	4.41	3.26	2.48	1.83	1.39	1.07	663.4	543.7	0.0	20.9	1.43	281.9	
7.201	8,770	4.73	3.18	2.14	1.37	0.84	0.59	0.45	663.4	366.4	0.0	41.0	6.64	121.2	
7.300	8,524	6.49	5.33	3.73	2.94	1.98	1.46	1.22	663.4	432.3	0.0	18.1	4.30	203.0	
7.401	8,635	10.21	7.35	5.46	4.01	2.82	2.06	1.54	663.4	225.8	0.0	13.2	1.72	247.7	
7.501	8,639	7.27	5.66	4.38	3.32	2.52	1.93	1.51	663.4	468.9	0.0	14.8	0.96	300.0	
7.600	8,909	5.42	4.38	3.22	2.30	1.62	1.21	0.93	663.4	559.1	0.0	23.1	3.59	282.1	
7.703	9,136	5.59	4.50	3.52	2.52	1.81	1.40	1.14	663.4	600.0	0.0	21.4	2.97	300.0	*
7.800	9,231	6.13	5.28	3.99	3.12	2.29	1.76	1.38	663.4	600.0	0.0	17.3	2.79	300.0	*
7.902	8,933	4.93	3.72	2.84	1.87	1.24	0.93	0.69	663.4	527.5	0.0	29.3	5.19	183.2	
8.000	8,810	5.05	4.27	3.17	2.32	1.61	1.20	0.91	663.4	600.0	0.0	23.2	4.20	260.9	*
8.100	8,790	4.94	4.17	2.63	1.89	1.29	0.88	0.63	663.4	485.3	0.0	28.8	5.94	165.1	
8.201	9,029	6.09	5.26	3.79	2.70	1.91	1.39	1.06	663.4	501.3	0.0	19.7	5.36	245.6	
8.303	9,048	7.09	5.62	4.31	3.13	2.10	1.32	1.19	663.4	378.1	0.0	18.6	7.35	126.7	
8.403	9,529	9.37	6.74	4.64	3.05	1.93	1.34	1.09	663.4	203.0	0.0	19.3	6.73	143.2	
8.503	9,537	8.15	6.81	5.22	4.04	2.92	2.20	1.81	663.4	470.2	0.0	13.6	3.00	300.0	
8.601	9,426	7.43	5.63	3.94	2.80	1.85	1.23	0.94	663.4	314.9	0.0	21.4	5.63	150.9	

Figure A7. Modulus 6 Results for Section 7, Childress (Continued).

8.709	9,541	4.90	3.67	2.70	1.96	1.27	0.98	0.78	663.4	600.0	0.0	31.0	3.38	156.3	*
8.801	9,315	6.81	5.09	3.56	2.70	1.88	1.44	1.14	663.4	412.9	0.0	21.3	2.47	268.0	
8.900	8,905	7.65	5.81	4.10	3.09	2.17	1.54	1.10	663.4	335.2	0.0	17.8	2.50	190.7	
9.001	8,850	7.43	5.97	4.22	3.12	2.28	1.50	1.29	663.4	356.1	0.0	17.3	3.79	145.4	
9.106	8,695	5.83	4.29	3.03	2.12	1.50	1.10	0.78	663.4	410.4	0.0	24.9	2.24	184.3	
9.201	8,766	5.48	5.06	3.64	2.76	2.08	1.43	1.17	663.4	600.0	0.0	18.6	4.86	172.6	*
9.303	8,909	9.76	7.49	5.80	4.36	3.20	2.33	1.77	663.4	303.8	0.0	12.0	1.75	253.8	
9.402	8,901	7.94	6.49	4.96	3.54	2.46	1.90	1.49	663.4	370.8	0.0	14.8	4.28	277.2	
9.502	8,917	7.76	5.44	4.09	3.15	2.30	1.73	1.32	663.4	369.3	0.0	17.2	1.77	269.1	
9.604	8,679	11.87	7.45	4.67	3.06	1.81	1.27	0.94	663.4	107.9	0.0	18.2	6.63	110.5	
9.705	8,663	9.19	6.71	4.89	3.48	2.55	1.91	1.40	663.4	256.5	0.0	14.8	1.76	221.2	
9.801	8,969	10.82	6.86	4.35	2.90	1.95	1.45	1.06	663.4	139.8	0.0	18.8	2.89	208.8	
9.912	8,945	7.54	6.81	5.35	4.40	3.18	2.52	2.17	663.4	600.0	0.0	11.2	3.62	300.0	*
10.000	8,874	9.38	6.57	4.46	3.37	2.37	1.70	1.37	663.4	227.3	0.0	16.4	1.53	222.3	
10.115	8,782	9.62	6.73	4.89	3.16	2.14	1.38	1.12	663.4	186.1	0.0	17.0	5.97	139.9	
10.202	8,794	6.70	5.01	3.48	2.54	1.84	1.13	0.94	663.4	345.5	0.0	21.8	4.12	118.7	
10.300	8,862	6.69	5.31	4.11	3.05	2.20	1.56	1.30	663.4	476.6	0.0	17.3	3.09	206.2	
10.404	8,961	8.84	5.76	3.87	2.80	2.03	1.59	1.19	663.4	226.7	0.0	19.3	3.23	300.0	
10.500	9,172	11.28	8.05	5.59	3.79	2.62	1.96	1.46	663.4	175.2	0.0	14.4	3.34	271.5	
10.600	9,676	6.68	5.04	4.12	3.27	2.22	1.74	1.38	663.4	600.0	0.0	18.1	2.50	215.4	*
10.700	9,362	5.10	3.61	2.43	1.72	1.22	0.91	0.78	663.4	481.8	0.0	33.5	2.71	286.5	
10.800	9,136	6.13	4.26	3.08	2.24	1.47	0.98	0.65	663.4	377.1	0.0	26.7	3.72	148.7	
10.901	8,786	11.77	4.70	3.55	2.63	1.93	1.44	1.13	663.4	110.7	0.0	23.3	14.08	294.1	
Mean:		9.70	6.59	4.47	3.20	2.22	1.65	1.28	663.4	280.3	0.0	18.4	3.99	213.8	
Std. Dev:		3.56	1.84	1.07	0.80	0.61	0.49	0.38	0.0	158.8	0.0	5.3	2.83	94.9	
Var Coeff(%):		36.66	27.97	24.03	25.15	27.62	29.55	29.34	0.0	56.7	0.0	28.8	70.98	45.2	

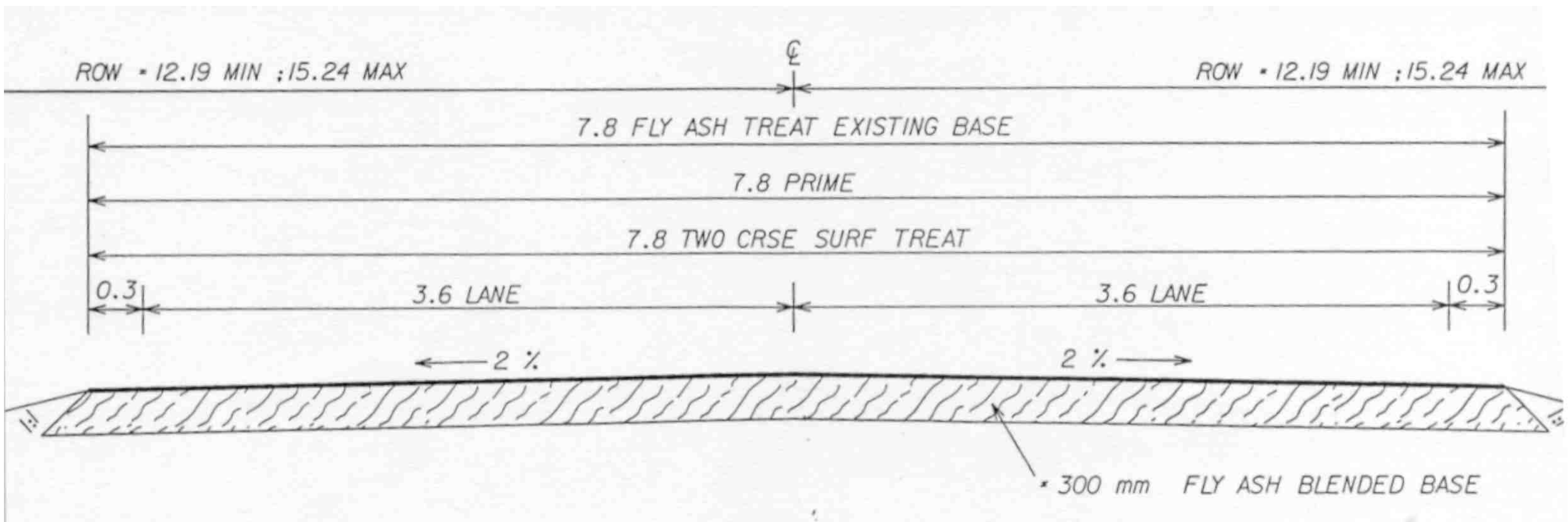
Figure A7. Modulus 6 Results for Section 7, Childress (Continued).

Section	County	Highway	Begin	End
8	Motley	FM 70	348+0.00	356+0.643

Lab Design Data

Base Type	Salvage
Raw TTC	3.2
Stabilizer	4% FA
Compr. Strengths Lat. 0 and (15 psi)	53 and (179 psi)
% change in moisture from OMC	+0.5%

Construction Date 2/1999



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting _0__ Long. _0__ Alligator _0__ Trans. _0__ Block Cr. _0__ Failures _0_ Patch _0__ Ride _3.6

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District: 25 (Childress)
County : Motley
Highway/Road: FM 70

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	283,700	283,700	H1: v = 0.35
Base:	12.00	30,000	600,000	H2: v = 0.35
Subbase:	0.00			H3: v = 0.00
Subgrade:	174.49	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	11,245	21.30	13.20	7.05	4.35	2.97	2.16	1.73	283.7	96.8	0.0	15.6	4.50	249.9
0.206	11,952	18.32	12.45	7.74	5.04	3.17	2.41	1.87	283.7	151.9	0.0	15.1	4.07	142.4
0.402	11,845	16.29	11.45	6.99	4.54	3.23	2.33	1.85	283.7	182.1	0.0	16.1	3.12	244.5
0.601	11,789	17.86	10.91	7.21	4.90	3.28	2.37	1.94	283.7	159.3	0.0	15.7	1.23	205.8
0.814	11,639	11.01	7.21	4.92	3.61	2.50	1.97	1.44	283.7	344.1	0.0	21.2	3.49	259.1
1.015	11,301	11.17	8.77	5.86	4.48	3.09	2.13	1.60	283.7	381.0	0.0	17.0	3.33	176.7
1.200	11,893	11.91	9.10	6.16	4.10	2.62	2.03	1.49	283.7	310.0	0.0	18.9	4.48	151.0
1.400	11,567	14.61	9.30	5.89	3.99	2.82	2.12	1.64	283.7	200.3	0.0	18.2	2.42	300.0
1.601	11,436	13.30	7.89	4.88	3.29	2.31	1.63	1.27	283.7	199.2	0.0	21.4	2.46	202.5
1.801	11,921	14.94	10.86	7.48	5.06	3.38	2.41	1.82	283.7	242.5	0.0	15.5	3.29	203.4
2.201	10,208	19.89	12.30	6.88	4.43	2.91	2.07	1.44	283.7	98.1	0.0	14.6	3.81	184.0
2.400	10,649	15.29	9.97	6.08	4.07	2.83	2.03	1.67	283.7	164.1	0.0	16.4	2.04	232.0
2.600	11,198	28.74	15.26	7.37	4.85	2.95	2.43	1.77	283.7	57.7	0.0	14.4	5.61	300.0
2.802	10,713	23.73	13.91	7.90	4.96	3.04	2.56	1.98	283.7	81.4	0.0	13.7	4.83	129.3
3.002	9,303	30.02	19.40	10.93	6.04	3.65	2.63	2.04	283.7	52.2	0.0	9.5	12.18	126.5
3.200	9,799	35.06	17.96	8.63	5.39	3.53	2.54	1.95	283.7	38.4	0.0	11.0	5.88	189.1
3.400	10,137	13.97	10.11	6.56	4.20	2.73	2.04	1.54	283.7	189.9	0.0	15.4	4.93	171.2
3.600	11,801	16.00	10.96	6.67	4.45	2.73	1.82	1.10	283.7	167.0	0.0	17.4	6.49	125.8
3.805	10,530	17.67	12.05	6.78	4.72	2.72	2.22	1.67	283.7	127.5	0.0	14.8	6.07	102.9
4.001	10,494	22.30	9.34	5.02	3.24	2.31	1.72	1.41	283.7	65.7	0.0	19.4	7.25	300.0
4.200	10,292	23.91	13.19	6.86	4.12	2.71	1.97	1.43	283.7	67.6	0.0	15.0	4.68	188.3
4.400	10,280	18.72	12.65	7.69	4.91	3.49	2.46	1.92	283.7	125.6	0.0	12.9	3.17	217.5
4.600	11,118	12.92	8.79	5.74	3.99	2.57	1.94	1.48	283.7	236.4	0.0	18.4	2.50	156.6
4.800	10,510	11.50	7.98	5.04	3.24	2.61	1.61	1.21	283.7	247.1	0.0	19.6	4.57	300.0
5.001	10,820	11.14	9.13	5.93	3.90	2.93	2.00	1.45	283.7	323.6	0.0	17.2	4.57	300.0
5.400	10,359	20.17	12.57	6.63	3.98	2.61	1.80	1.31	283.7	89.8	0.0	15.7	6.46	183.4
5.600	10,117	16.13	11.09	6.31	4.07	2.61	1.92	1.40	283.7	133.9	0.0	15.6	5.00	157.2
5.800	10,200	17.43	9.72	5.61	3.54	2.34	1.78	1.35	283.7	108.2	0.0	17.8	2.75	188.4
6.003	10,518	18.95	8.92	3.89	2.16	1.64	1.25	0.88	283.7	72.5	0.0	23.7	11.28	114.7
6.208	10,208	15.15	10.81	6.24	3.94	2.47	1.75	1.35	283.7	145.8	0.0	16.2	6.89	140.2
6.400	10,618	11.39	8.45	6.19	4.08	2.69	1.77	1.67	283.7	297.1	0.0	17.4	5.80	150.1
6.600	10,610	14.50	10.64	7.93	5.09	3.20	2.11	1.54	283.7	217.2	0.0	14.2	7.96	144.5
6.800	11,833	10.80	8.76	5.83	3.89	2.68	2.02	1.52	283.7	372.4	0.0	19.2	4.48	256.8
7.000	11,178	12.89	9.71	6.09	4.07	2.63	1.91	1.61	283.7	237.1	0.0	17.8	4.77	161.2
7.200	10,697	20.48	12.74	7.31	4.67	3.06	2.17	1.67	283.7	102.1	0.0	14.5	3.68	181.6
7.401	11,134	10.50	8.08	5.71	4.20	2.72	1.89	1.53	283.7	385.5	0.0	18.2	4.38	160.0
7.601	11,003	10.04	7.70	4.91	3.11	1.99	1.28	1.00	283.7	289.9	0.0	22.5	7.72	137.0

Figure A8. Modulus 6 Results for Section 8, Childress.

7.801	10,892	11.81	6.93	4.54	3.22	2.28	1.71	1.35	283.7	241.9	0.0	21.6	5.03	300.0
8.000	11,090	14.72	8.56	4.42	2.74	1.72	1.20	0.88	283.7	131.0	0.0	23.8	4.13	137.0
8.203	10,582	10.01	6.29	3.26	2.00	1.34	0.98	0.75	283.7	208.9	0.0	29.3	5.92	198.3
8.400	10,816	24.07	16.94	8.19	6.35	3.93	2.76	2.25	283.7	90.5	0.0	11.7	8.19	300.0
Mean:		16.84	10.78	6.37	4.17	2.76	2.00	1.53	283.7	181.3	0.0	17.2	5.01	187.0
Std. Dev:		5.80	2.93	1.40	0.89	0.52	0.39	0.33	0.0	98.0	0.0	3.7	2.25	54.0
Var Coeff(%):		34.43	27.16	22.02	21.33	19.04	19.70	21.37	0.0	54.0	0.0	21.8	44.95	29.4

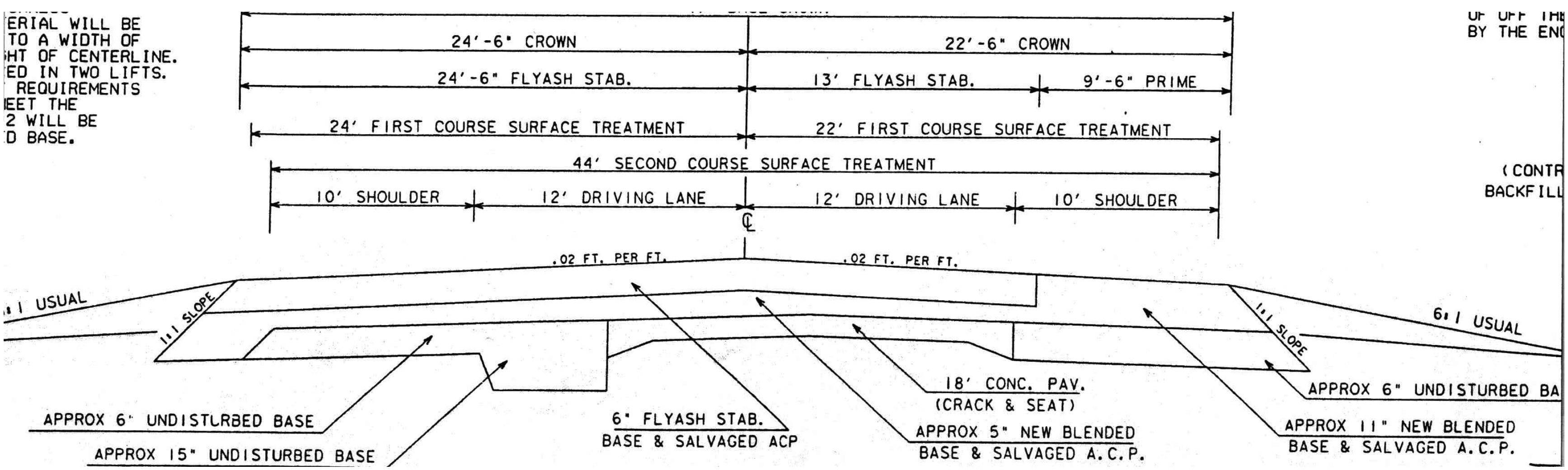
Figure A8. Modulus 6 Results for Section 8, Childress (Continued).

Section	County	Highway	Begin	End
9	Knox	US 82	426+0.00	432+0.00

Lab Design Data

Base Type	60% New Limestone 40% RAP
Raw TTC	3.0
Stabilizer	6% FA
Compr. Strengths Lat. 0 and (15 psi)	73 and (213 psi)
% change in moisture from OMC	+0.9%

Construction Date 5/1995



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting _0_ Long. _0_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _0_ Patch _0_ Ride _4.6_

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Knox
Highway/Road: US 82

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	663,400	663,400	H1: v = 0.35
Base:	6.00	30,000	600,000	H2: v = 0.35
Subbase:	10.00	40,000	500,000	H3: v = 0.25
Subgrade:	283.50	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock	
0.000	8,897	8.13	3.18	2.15	1.76	1.37	1.05	0.85	663.4	95.6	500.0	32.5	8.12	300.0	*
0.101	9,239	9.67	6.40	4.74	3.56	2.68	2.15	1.73	663.4	248.2	201.1	16.4	1.86	300.0	
0.200	9,243	7.96	5.45	3.89	2.96	2.16	1.72	1.38	663.4	359.4	209.9	19.6	1.84	300.0	
0.300	8,739	13.26	7.12	4.31	3.33	2.54	1.93	1.43	663.4	103.2	103.5	17.8	3.77	226.8	
0.400	8,862	7.85	5.47	4.11	3.26	2.46	2.05	1.57	663.4	343.7	289.3	16.8	2.64	300.0	
0.500	8,882	10.12	6.03	4.10	3.15	2.44	1.88	1.42	663.4	159.1	181.7	18.2	2.65	252.6	
0.601	9,183	9.48	5.31	3.64	2.81	2.04	1.66	1.31	663.4	155.3	215.2	21.5	2.68	300.0	
0.700	9,108	10.61	6.33	4.03	2.96	2.11	1.59	1.34	663.4	206.3	94.3	20.6	1.32	300.0	
0.806	9,275	12.50	6.73	4.06	3.03	2.22	1.72	1.44	663.4	128.3	96.0	20.7	2.86	300.0	
0.914	9,477	12.13	6.30	4.02	2.95	2.29	1.88	1.41	663.4	109.2	154.3	20.8	4.03	243.1	
1.010	9,573	13.04	5.89	3.69	2.87	2.20	1.72	1.37	663.4	73.6	216.4	21.8	4.38	300.0	
1.100	9,140	15.30	7.33	4.42	3.35	2.35	1.81	1.44	663.4	80.5	86.6	19.1	2.47	292.6	
1.200	9,477	15.45	7.52	4.35	2.99	2.19	1.70	1.35	663.4	98.4	61.2	21.0	1.78	300.0	
1.301	9,195	13.19	6.78	4.24	3.13	2.39	1.93	1.49	663.4	98.5	123.1	19.4	3.48	295.0	
1.400	9,112	13.09	6.61	4.26	3.24	2.45	1.92	1.52	663.4	88.7	155.4	18.8	2.99	300.0	
1.500	8,897	13.79	7.14	4.52	2.87	2.50	1.79	1.50	663.4	110.2	76.3	19.1	3.82	300.0	
1.601	8,925	15.16	7.82	4.56	3.16	2.39	1.79	1.42	663.4	105.6	57.0	18.7	2.23	300.0	
1.700	8,786	14.83	7.62	4.59	3.28	2.37	1.82	1.34	663.4	99.4	66.4	18.2	1.70	224.5	
1.801	8,600	16.93	8.80	5.13	3.58	2.65	2.02	1.55	663.4	91.2	48.4	16.1	2.03	297.1	
1.900	9,040	7.93	5.12	3.59	2.84	2.15	1.69	1.38	663.4	257.7	263.9	20.2	2.71	300.0	
2.004	8,886	10.61	5.91	3.82	2.77	2.06	1.56	1.22	663.4	151.4	121.6	21.2	1.52	300.0	
2.100	8,754	13.89	7.80	4.98	3.68	2.66	2.17	1.63	663.4	113.6	88.1	16.1	2.23	300.0	
2.202	8,798	16.14	8.53	5.07	3.61	2.74	2.17	1.70	663.4	93.0	62.6	16.2	3.10	300.0	
2.301	9,076	7.96	5.53	4.03	3.21	2.26	1.86	1.39	663.4	363.6	229.5	18.2	2.73	295.8	
2.400	9,287	8.77	5.47	4.00	3.01	2.30	1.78	1.41	663.4	218.6	244.5	19.5	1.86	300.0	
2.502	9,180	8.61	6.17	4.67	3.67	2.76	2.12	1.67	663.4	366.7	232.8	15.8	0.76	300.0	
2.600	9,001	11.52	7.15	4.91	3.34	2.27	1.76	1.37	663.4	250.0	72.3	18.0	1.85	229.6	
2.700	8,957	8.21	5.64	3.97	2.99	2.24	1.74	1.39	663.4	335.9	189.7	18.7	1.66	300.0	
2.804	9,040	12.35	6.73	4.71	3.56	2.69	2.07	1.64	663.4	106.1	177.2	16.9	1.68	300.0	
2.901	8,981	14.98	8.55	5.24	3.92	2.72	2.12	1.68	663.4	126.6	62.8	16.0	2.39	270.7	
3.001	8,663	15.85	8.59	4.89	3.42	2.41	1.72	1.30	663.4	121.7	40.0	17.5	1.74	221.5	*
3.102	9,211	8.24	5.65	4.27	3.37	2.51	2.04	1.66	663.4	319.0	283.4	17.1	2.22	300.0	
3.202	9,072	14.79	9.30	5.76	4.00	2.70	2.21	1.59	663.4	202.4	45.9	15.2	2.87	219.6	
3.301	9,191	7.49	5.01	3.69	2.95	2.30	1.77	1.40	663.4	292.2	367.6	19.2	2.49	300.0	
3.402	9,044	10.13	6.24	4.25	3.02	2.16	1.68	1.28	663.4	222.5	113.6	19.5	0.82	300.0	
3.500	9,227	9.10	6.58	4.90	3.91	3.01	2.31	1.75	663.4	341.7	234.1	14.9	1.10	257.4	

Figure A9. Modulus 6 Results for Section 9, Childress.

3.601	9,128	11.43	6.80	4.62	3.28	2.46	1.84	1.45	663.4	171.9	109.1	18.2	0.59	300.0
3.700	9,128	9.32	5.59	3.90	3.13	2.27	1.76	1.40	663.4	175.0	231.7	19.4	2.57	300.0
3.800	8,949	15.42	7.28	4.73	3.43	2.59	2.03	1.61	663.4	68.7	119.5	17.4	2.24	300.0
3.901	9,033	10.56	5.17	3.54	2.83	1.99	1.56	1.28	663.4	93.3	301.8	22.1	2.65	289.7
4.000	9,080	9.77	6.29	4.61	3.60	2.50	1.93	1.59	663.4	226.4	181.5	16.8	1.68	265.4
4.101	9,489	9.79	6.00	4.04	3.04	2.39	1.89	1.56	663.4	188.1	192.2	19.5	3.38	300.0
4.204	9,116	8.76	5.27	3.72	2.93	2.14	1.68	1.31	663.4	193.5	237.9	20.4	2.52	300.0
4.300	9,132	10.28	6.16	4.06	3.13	2.44	1.89	1.53	663.4	160.7	178.7	18.7	3.26	300.0
4.403	9,005	11.44	7.24	4.57	3.29	2.21	1.73	1.29	663.4	259.6	67.2	18.5	2.24	204.9
4.503	8,937	11.72	6.28	3.85	2.84	2.19	1.62	1.37	663.4	128.4	106.4	20.9	2.86	276.5
4.601	9,148	14.41	8.07	4.96	3.57	2.24	2.04	1.38	663.4	129.2	63.9	17.8	4.73	136.7
4.702	9,060	10.65	6.48	4.24	3.05	2.21	1.77	1.27	663.4	194.4	106.8	19.4	1.68	300.0
4.801	8,925	12.94	8.33	5.57	4.00	2.86	2.09	1.56	663.4	228.2	67.6	15.0	0.71	246.8
4.913	9,088	8.66	5.63	3.63	2.70	2.06	1.57	1.26	663.4	276.5	148.0	21.2	2.86	300.0
5.000	8,981	11.18	7.12	4.61	3.33	2.42	1.89	1.44	663.4	223.8	90.1	17.7	1.64	300.0
5.103	8,778	15.11	8.98	6.11	4.68	3.52	2.67	1.96	663.4	107.7	102.4	12.6	1.53	222.9
5.201	8,949	9.64	6.76	5.18	3.88	2.91	2.35	1.84	663.4	311.1	186.4	14.5	1.53	300.0
5.301	8,886	15.90	8.33	5.15	3.72	2.78	2.15	1.69	663.4	91.1	72.3	16.2	2.05	300.0
5.401	9,025	11.94	7.28	4.39	2.99	2.11	1.56	1.24	663.4	241.1	53.2	20.0	1.05	284.7
5.501	8,834	9.53	5.95	3.96	2.97	2.10	1.61	1.13	663.4	232.2	124.7	19.7	1.50	300.0
5.601	8,846	6.98	4.93	3.68	2.90	2.18	1.75	1.35	663.4	408.6	301.3	18.8	1.79	300.0
5.700	8,778	18.97	8.37	5.00	4.15	2.82	2.37	1.82	663.4	47.6	101.9	15.1	4.59	300.0
5.802	8,917	12.86	6.53	4.41	3.57	2.64	2.22	1.80	663.4	86.7	194.8	17.2	4.55	300.0
5.900	9,092	11.11	6.75	4.41	3.35	2.49	1.92	1.53	663.4	170.3	125.0	17.9	2.16	300.0
6.018	9,116	9.86	5.44	3.66	2.46	1.73	1.35	1.07	663.4	179.6	115.3	24.2	1.00	300.0
Mean:		11.59	6.64	4.36	3.25	2.39	1.87	1.46	663.4	184.1	153.2	18.6	2.42	300.0
Std. Dev:		2.83	1.20	0.64	0.45	0.32	0.26	0.20	0.0	91.9	90.4	2.8	1.23	49.1
Var Coeff(%):		24.43	18.07	14.57	13.90	13.51	14.10	13.46	0.0	49.9	59.0	15.1	50.59	17.3

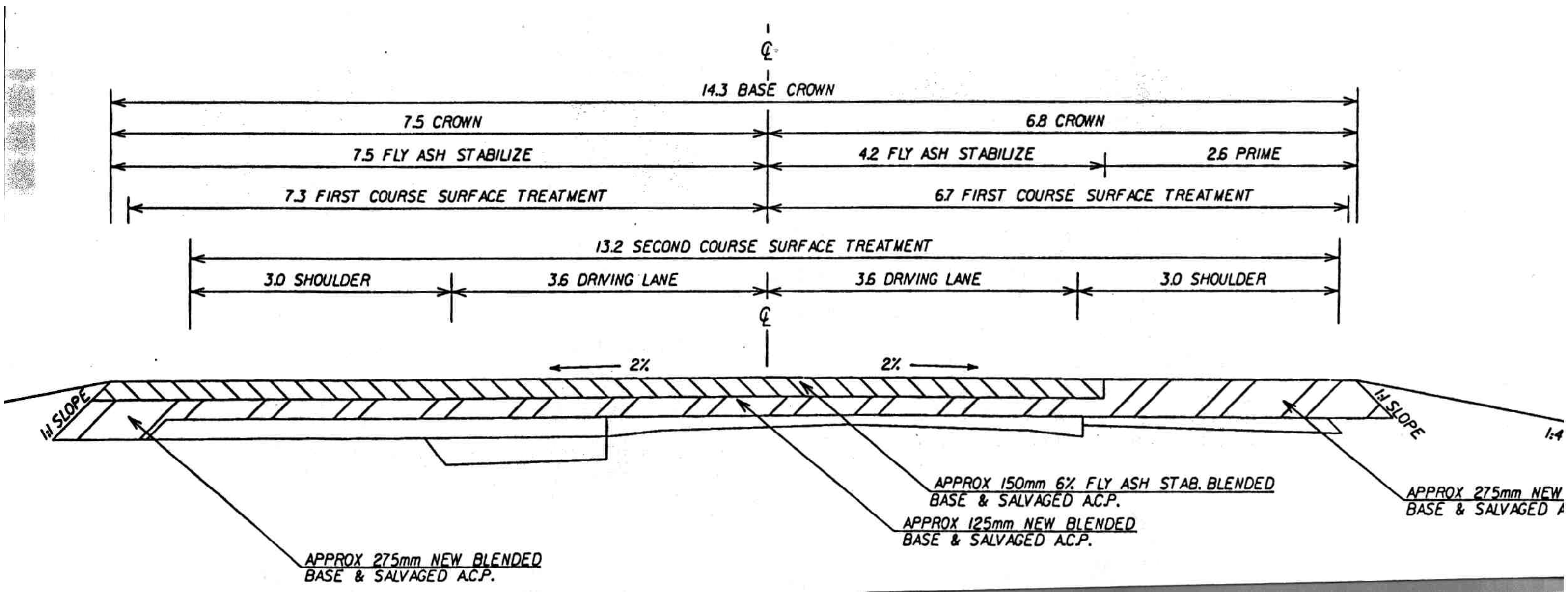
Figure A9. Modulus 6 Results for Section 9, Childress (Continued).

Section	County	Highway	Begin	End
10	Dickens	SH 70	432+0.00	436+1.567

Lab Design Data

Base Type	Salvage
Raw TTC	4.1
Stabilizer	6% FA
Compr. Strengths Lat. 0 and (15 psi)	58 and (180 psi)
% change in moisture from OMC	+0.6%

Construction Date 10/1996



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting 0 Long. 0 Alligator 0 Trans. 0 Block Cr. 0 Failures 0 Patch 0 Ride 4.6

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Dickens
Highway/Road: SH 70

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	505,600	505,600	H1: v = 0.35
Base:	6.00	30,000	600,000	H2: v = 0.35
Subbase:	10.00	40,000	500,000	H3: v = 0.25
Subgrade:	283.50	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	9,831	14.95	7.46	4.76	3.35	2.43	1.78	1.40	505.6	97.8	96.1	19.5	1.42	262.1
0.100	10,073	7.09	5.25	4.35	3.48	2.67	2.20	1.72	505.6	600.0	441.4	16.3	1.94	300.0 *
0.200	10,026	7.75	4.79	3.73	3.07	2.34	1.86	1.46	505.6	287.3	500.0	19.4	5.08	300.0 *
0.300	9,986	7.20	4.12	3.15	2.65	2.22	1.70	1.52	505.6	324.6	500.0	22.1	9.41	300.0 *
0.400	9,887	9.53	5.31	3.96	3.20	2.54	2.10	1.78	505.6	149.9	500.0	18.6	6.82	300.0 *
0.500	9,907	7.27	4.93	3.73	3.09	2.33	2.01	1.57	505.6	459.6	393.3	18.9	4.44	300.0
0.600	9,458	9.65	5.73	4.17	3.29	2.61	2.08	1.60	505.6	138.3	500.0	17.2	4.60	281.3 *
0.700	9,446	9.23	5.48	4.11	3.35	2.54	2.04	1.62	505.6	154.9	500.0	17.2	4.19	300.0 *
0.800	9,438	10.72	6.51	4.81	3.77	2.91	2.24	1.79	505.6	147.4	300.5	15.7	2.80	300.0
0.900	9,605	10.88	6.49	4.26	3.20	2.40	1.91	1.51	505.6	168.1	163.0	18.8	2.89	300.0
1.000	8,953	14.57	8.20	4.96	3.57	2.73	2.13	1.62	505.6	119.8	73.7	16.3	3.05	273.8
1.100	9,346	10.31	6.16	4.35	3.43	2.57	2.07	1.59	505.6	166.7	226.9	17.4	3.55	300.0
1.201	9,370	9.39	5.95	4.13	3.22	2.53	2.06	1.76	505.6	220.5	239.4	17.7	4.53	300.0
1.300	9,124	10.11	6.21	4.10	3.07	2.24	1.78	1.46	505.6	187.3	153.2	18.7	2.18	300.0
1.400	9,374	7.43	4.80	3.64	2.63	1.78	1.60	1.31	505.6	342.5	254.7	21.8	4.21	212.8
1.500	9,342	9.28	5.66	3.80	3.17	2.33	1.94	1.46	505.6	202.9	241.0	18.8	5.23	300.0
1.600	9,231	7.82	4.91	3.67	2.88	2.11	1.79	1.44	505.6	280.9	322.0	19.6	4.32	300.0
1.700	9,370	8.84	5.58	4.18	3.19	2.27	1.93	1.41	505.6	249.4	253.6	18.3	3.62	300.0
1.802	9,275	9.54	6.11	4.43	3.46	2.46	2.17	1.61	505.6	234.4	222.8	16.9	4.26	300.0
1.900	9,231	9.92	5.68	3.54	2.61	1.96	1.55	1.33	505.6	178.2	141.1	22.2	3.67	300.0
2.001	9,227	7.90	4.91	3.44	2.52	1.92	1.58	1.31	505.6	266.8	236.8	21.8	3.89	300.0
2.100	9,319	7.82	5.01	3.63	2.85	2.21	1.92	1.41	505.6	310.6	313.2	19.4	5.50	300.0
2.201	9,271	10.03	5.34	3.69	2.63	1.84	1.48	1.22	505.6	136.6	200.2	22.3	1.89	284.8
2.301	9,219	8.15	5.05	3.53	2.74	1.98	1.69	1.24	505.6	257.5	242.7	20.8	4.15	300.0
2.401	9,406	8.05	5.18	4.07	3.07	2.34	1.93	1.59	505.6	282.8	358.3	18.1	3.61	300.0
2.500	9,279	7.42	5.13	3.71	2.76	2.13	1.77	1.41	505.6	407.9	259.6	19.8	3.37	300.0
2.600	9,319	7.51	4.72	3.42	2.47	1.88	1.45	1.26	505.6	292.1	262.2	22.5	2.63	300.0
2.700	9,354	6.40	4.04	3.15	2.41	1.81	1.61	1.20	505.6	418.1	407.9	22.7	5.50	300.0
2.800	9,271	7.28	4.32	2.80	2.15	1.65	1.23	1.05	505.6	256.8	245.8	25.8	4.63	283.9
2.900	9,235	7.87	5.39	3.46	2.69	1.96	1.57	1.32	505.6	404.4	165.5	21.4	3.39	300.0
3.000	9,267	9.56	5.49	3.69	2.59	1.78	1.50	1.17	505.6	190.1	147.3	22.5	2.40	243.3
3.100	9,183	8.75	5.28	3.55	2.73	2.03	1.58	1.24	505.6	208.3	209.6	20.8	3.10	300.0
3.200	9,132	7.94	4.92	3.63	2.58	1.90	1.50	1.28	505.6	259.9	233.8	21.4	2.06	300.0
3.300	9,323	8.89	5.38	3.68	2.87	2.15	1.77	1.39	505.6	213.5	225.6	20.1	4.18	300.0
3.401	9,144	10.27	6.39	3.92	2.83	2.02	1.56	1.20	505.6	244.6	92.3	20.8	2.20	300.0
3.500	8,981	8.62	4.73	3.03	2.33	1.86	1.45	1.21	505.6	166.6	234.1	23.4	6.39	300.0
3.600	9,092	9.64	5.11	3.22	2.42	1.81	1.49	1.19	505.6	140.8	193.3	23.4	4.84	300.0

Figure A10. Modulus 6 Results for Section 10, Childress.

3.700	9,040	9.00	4.47	2.70	2.12	1.52	1.19	0.94	505.6	131.7	214.4	27.3	5.52	300.0
3.800	9,128	11.36	6.43	4.04	2.85	2.10	1.67	1.35	505.6	158.4	104.5	20.4	2.20	300.0
3.901	9,068	10.00	5.00	3.19	2.30	1.74	1.35	1.13	505.6	119.7	193.6	24.4	4.07	300.0
4.001	9,164	8.31	4.67	2.86	2.09	1.57	1.27	0.97	505.6	216.7	158.9	26.7	4.87	300.0
4.101	9,283	7.71	4.69	3.33	2.55	1.70	1.54	1.01	505.6	272.1	237.8	22.8	5.20	187.7
4.201	9,251	7.90	5.02	3.38	2.35	1.76	1.37	1.09	505.6	310.9	168.0	23.7	2.42	300.0
4.300	9,279	8.50	5.15	3.52	2.53	1.85	1.44	1.17	505.6	223.2	194.8	22.3	1.69	300.0
4.400	9,132	10.94	5.23	2.90	1.86	1.23	1.03	0.80	505.6	161.5	63.6	30.6	3.54	180.3
4.501	9,311	8.44	5.08	3.40	2.57	1.87	1.41	1.11	505.6	219.7	208.1	22.5	2.33	300.0
4.602	9,017	10.08	5.19	3.21	2.38	1.73	1.37	1.10	505.6	131.2	160.1	24.2	3.65	300.0
4.700	8,965	9.89	5.28	3.08	2.18	1.44	1.39	0.77	505.6	171.0	102.8	25.9	5.90	177.8
4.800	9,044	12.33	6.04	3.52	2.99	2.05	1.69	1.39	505.6	87.5	168.0	20.8	6.18	300.0
4.907	9,231	8.66	4.75	3.14	2.31	1.67	1.35	0.95	505.6	175.7	212.9	24.7	3.32	300.0
5.001	9,164	10.81	6.05	3.78	2.60	1.87	1.38	1.06	505.6	182.6	90.5	22.6	0.76	274.7
5.100	9,223	6.71	4.16	3.17	2.43	1.77	1.46	1.15	505.6	333.2	370.4	22.9	3.98	300.0
5.201	9,009	9.00	4.89	3.04	2.34	1.64	1.11	1.04	505.6	164.5	165.8	25.5	3.39	159.1
Mean:		9.12	5.36	3.65	2.77	2.05	1.66	1.31	505.6	230.7	242.7	21.2	3.87	300.0
Std. Dev:		1.72	0.79	0.52	0.43	0.36	0.30	0.25	0.0	99.9	117.4	3.1	1.55	53.3
Var Coeff(%):		18.83	14.66	14.16	15.68	17.69	18.15	18.75	0.0	43.3	48.4	14.6	40.19	18.2

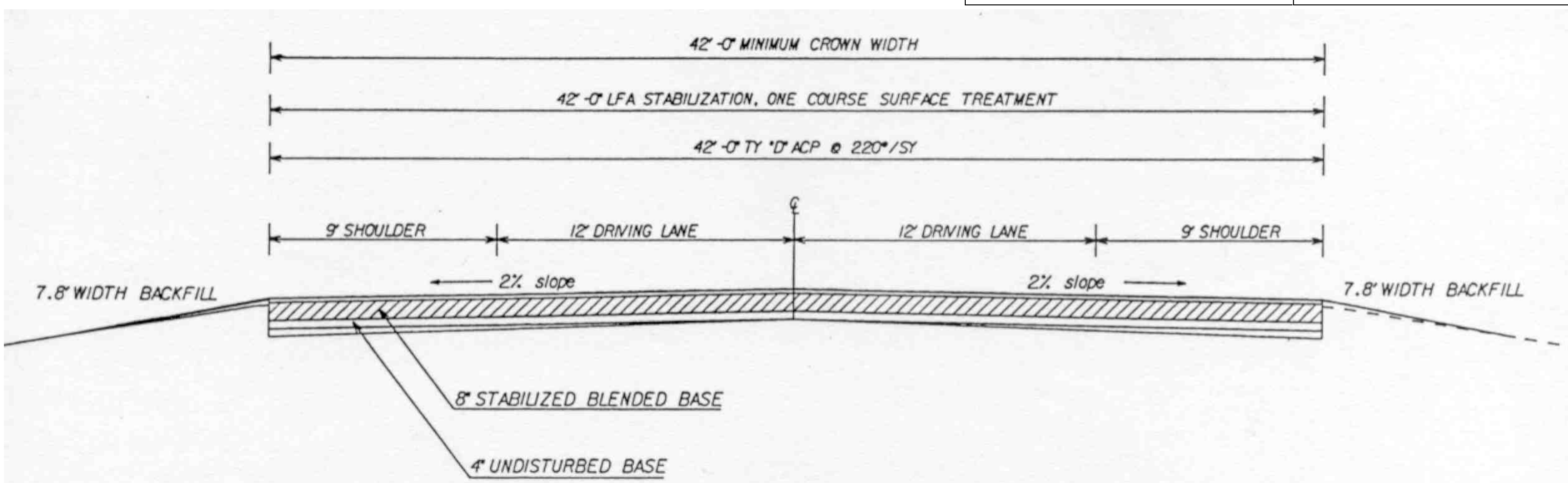
Figure A10. Modulus 6 Results for Section 10, Childress (Continued).

Section	County	Highway	Begin	End
11	Foard	US 70	428+0.265	432+1.474

Lab Design Data

Base Type	Salvage
Raw TTC	NA
Stabilizer	2% L 2% FA
Compr. Strengths Lat. 0 and (15 psi)	87 and (218 psi)
% change in moisture from OMC	+1.0%

Construction Date 11/1999



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting _0_ Long. _0_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _0_ Patch _0_ Ride _4.1_

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Foard
Highway/Road: US 70

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	2.50	663,400	663,400	H1: v = 0.35
Base:	8.00	30,000	600,000	H2: v = 0.35
Subbase:	4.00	10,000	150,000	H3: v = 0.35
Subgrade:	157.82	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	11,209	10.53	5.11	4.27	3.37	2.54	2.07	1.60	663.4	301.7	150.0	20.0	14.91	300.0 *
0.100	12,048	7.16	5.94	5.04	3.99	3.08	2.37	1.76	663.4	600.0	52.6	21.3	20.84	289.2 *
0.200	10,212	16.91	11.60	7.43	4.73	3.14	2.24	1.66	663.4	143.2	16.2	12.4	1.91	219.2
0.300	9,315	14.96	9.17	5.09	3.05	2.07	1.48	1.28	663.4	94.1	23.3	16.9	3.36	223.2
0.400	9,243	20.29	12.37	6.78	4.04	2.57	1.88	1.53	663.4	62.2	13.6	12.9	3.12	165.9
0.500	9,426	11.14	7.82	5.56	3.42	2.32	1.73	1.36	663.4	263.2	26.6	15.3	3.10	266.8
0.600	9,672	13.29	8.80	5.81	3.89	2.67	1.99	1.47	663.4	148.7	67.0	13.9	1.65	299.1
0.700	9,414	17.44	10.78	6.35	4.10	2.70	1.91	1.35	663.4	81.6	29.9	13.1	1.39	205.9
0.800	8,778	20.90	11.92	5.42	2.80	1.60	1.19	1.06	663.4	38.9	10.0	16.7	5.16	96.5 *
0.901	9,076	15.45	9.30	5.13	2.85	1.74	1.12	0.80	663.4	90.5	10.0	18.7	2.64	130.4 *
1.003	9,191	12.24	8.32	5.07	3.22	2.09	1.43	1.01	663.4	182.5	14.1	16.8	1.88	188.3
1.100	10,097	8.50	5.03	2.57	1.50	0.88	0.66	0.50	663.4	223.1	17.3	40.9	3.99	122.3
1.204	9,664	14.57	8.93	5.11	3.02	1.79	1.11	0.73	663.4	118.8	10.0	19.9	2.21	125.5 *
1.301	9,354	20.73	8.89	1.93	0.30	0.18	0.22	0.17	663.4	44.3	13.3	44.3	116.41	46.4 *
1.401	9,450	15.29	7.86	3.84	2.26	1.51	1.13	0.98	663.4	64.3	26.7	22.4	3.83	190.1
1.502	9,783	11.20	6.28	3.44	2.09	1.31	0.88	0.66	663.4	133.8	27.1	27.3	0.79	156.4
1.601	9,390	15.83	6.74	2.11	0.91	0.57	0.44	0.33	663.4	42.8	12.8	42.8	10.13	51.4 *
1.700	9,473	14.17	9.27	5.66	3.81	2.48	1.71	1.41	663.4	133.8	29.4	14.6	1.10	191.4
1.804	9,775	9.80	6.83	4.60	3.33	2.50	1.93	1.48	663.4	264.4	150.0	15.8	4.28	300.0 *
1.903	9,330	14.90	9.11	5.04	3.29	2.24	1.64	1.49	663.4	86.8	45.2	15.9	3.46	272.3
2.001	9,533	17.14	10.52	6.45	4.30	3.03	2.17	1.70	663.4	74.8	75.4	12.3	2.03	264.9
2.101	9,668	10.53	6.31	3.77	2.44	1.65	1.20	0.84	663.4	145.8	81.3	22.4	2.03	258.5
2.303	9,553	8.89	4.68	2.23	1.16	0.72	0.52	0.40	663.4	158.4	15.5	46.5	3.15	100.1
2.401	9,493	10.04	6.69	4.37	3.04	2.19	1.78	1.42	663.4	194.7	150.0	16.9	3.92	300.0 *
2.500	8,901	25.46	12.95	5.59	3.14	2.18	1.69	1.36	663.4	30.0	10.0	14.7	6.71	135.6 *
2.603	9,064	32.43	19.63	9.95	5.52	3.31	2.38	1.84	663.4	30.0	10.0	8.6	6.38	126.6 *
2.700	9,493	17.56	9.44	4.52	2.68	1.84	1.01	0.82	663.4	62.5	13.0	20.2	4.17	201.4
2.804	9,160	27.22	14.60	6.16	3.43	1.87	1.57	1.24	663.4	30.0	10.0	14.0	7.79	115.5 *
2.910	9,025	25.70	15.03	7.41	4.18	3.12	1.76	1.37	663.4	36.4	10.0	11.5	4.72	139.5 *
3.000	9,553	12.32	6.32	3.18	1.85	1.36	0.76	0.75	663.4	90.8	29.6	28.1	4.24	174.4
3.101	9,652	11.59	6.11	3.74	2.70	1.86	1.54	1.27	663.4	108.3	150.0	20.8	6.31	300.0 *
3.201	9,489	16.64	10.01	5.88	3.81	2.95	2.40	2.00	663.4	64.5	128.5	12.9	6.39	300.0 *
3.301	9,760	7.15	5.10	3.65	2.71	1.92	1.43	1.05	663.4	555.1	150.0	20.5	2.96	267.1 *
3.403	9,366	14.22	8.88	5.09	3.19	1.93	1.43	1.09	663.4	115.8	17.5	17.3	2.83	134.5
3.500	9,207	22.33	13.13	6.60	3.71	2.26	1.56	1.19	663.4	46.5	10.0	13.8	2.47	136.4 *
3.600	8,870	16.82	9.63	4.92	2.85	1.74	1.25	1.02	663.4	70.4	10.2	18.1	2.71	138.5
3.701	8,846	16.53	9.61	5.14	3.02	1.79	1.35	1.24	663.4	77.0	10.4	17.3	3.12	125.1

Figure A11. Modulus 6 Results for Section 11, Childress.

3.801	9,180	14.32	10.02	6.83	4.60	3.14	2.31	1.80	663.4	161.8	39.9	11.2	1.49	281.4
3.900	8,854	9.52	5.34	2.95	1.85	1.17	0.86	0.65	663.4	133.5	50.3	27.5	2.35	163.5
4.001	9,271	15.83	7.41	3.12	1.93	1.44	1.20	1.02	663.4	39.9	73.8	24.5	9.18	115.8
4.104	9,466	7.26	4.05	2.26	1.26	0.65	0.79	0.60	663.4	225.1	31.4	43.4	10.45	300.0
4.200	8,937	12.67	7.06	3.36	2.11	1.17	0.97	0.69	663.4	92.5	16.7	25.2	5.93	105.5
4.300	9,172	17.18	9.82	4.38	2.63	1.80	1.43	1.24	663.4	57.1	18.0	18.5	7.30	182.0
4.400	9,315	20.70	12.95	6.58	3.66	2.01	1.45	1.25	663.4	54.6	10.0	14.5	5.71	102.6 *
4.501	8,564	17.49	9.96	5.02	2.84	1.94	1.44	0.98	663.4	56.3	15.6	16.0	4.60	143.4
4.601	8,659	13.57	8.33	4.56	3.19	2.28	1.59	1.28	663.4	82.4	78.8	15.3	4.22	221.1
4.700	8,894	12.41	7.37	4.56	3.11	1.85	1.35	1.30	663.4	112.7	53.3	17.3	1.84	127.4
Mean:		15.29	8.96	4.86	3.00	1.98	1.45	1.15	663.4	128.2	42.9	20.2	7.05	172.3
Std. Dev:		5.43	3.08	1.60	1.03	0.73	0.53	0.42	0.0	116.9	45.0	9.3	16.71	93.6
Var Coeff(%):		35.49	34.36	32.99	34.53	36.93	36.44	36.43	0.0	91.1	105.0	45.7	237.13	55.3

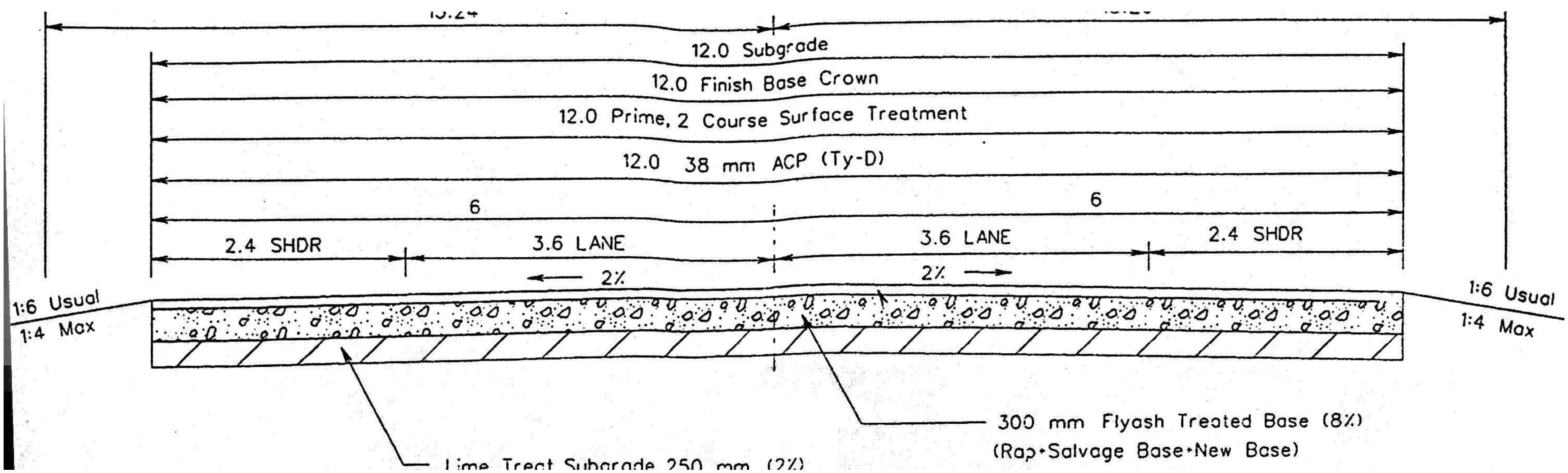
Figure A11. Modulus 6 Results for Section 11, Childress (Continued).

Section	County	Highway	Begin	End
12	Wheeler	US 83	116+0.370	118+0.060

Construction Date 2/1997

Lab Design Data

Base Type	Salvage
Raw TTC	NA
Stabilizer	8% FA
Compr. Strengths Lat. 0 and (15 psi)	123 and (232 psi)
% change in moisture from OMC	+0.5%



PMIS Condition Data (Nov 2002) Overall Average Score = 99

Rutting _6_ Long. _6_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _0_ Patch _0_ Ride _3.9_

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Wheeler
Highway/Road: US 83

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	2.00	663,400	663,400	H1: v = 0.35
Base:	12.00	30,000	700,000	H2: v = 0.35
Subbase:	10.00	5,000	2,000,000	H3: v = 0.35
Subgrade:	241.84	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	10,506	12.85	8.32	5.58	4.11	2.84	2.20	1.71	663.4	158.6	17.8	16.8	2.09	259.2
0.100	9,048	4.55	3.17	2.35	1.60	1.10	0.92	0.60	663.4	593.6	26.0	39.9	3.67	238.1
0.200	8,850	7.25	4.01	2.23	1.49	1.03	0.73	0.56	663.4	178.1	27.6	42.9	2.66	201.4
0.300	9,378	4.88	3.26	2.04	1.29	0.83	0.69	0.61	663.4	435.8	19.2	59.2	5.46	150.5
0.400	8,810	7.81	4.85	3.04	1.97	1.35	0.95	0.72	663.4	216.4	13.7	35.1	2.01	197.3
0.600	9,195	5.96	4.29	3.08	2.30	1.72	1.34	1.06	663.4	438.1	36.4	25.3	1.88	300.0
0.700	8,997	6.95	4.76	3.54	2.67	2.06	1.71	1.44	663.4	301.0	67.6	19.3	2.09	300.0
0.800	9,418	6.77	4.89	3.87	3.06	2.42	1.92	1.54	663.4	406.0	81.5	17.0	0.25	300.0
0.900	9,112	6.19	3.69	2.70	2.16	1.70	1.37	1.09	663.4	229.7	203.4	22.8	1.38	300.0
1.000	9,259	7.35	3.72	2.40	1.77	1.38	1.06	0.88	663.4	153.9	118.4	31.9	2.06	300.0
1.100	9,267	5.97	3.71	3.15	2.55	1.96	1.78	1.48	663.4	276.8	377.1	18.1	2.61	300.0
1.201	9,434	8.48	5.81	4.10	2.91	2.13	1.62	1.24	663.4	265.4	20.7	21.1	1.80	279.3
1.301	9,029	16.70	8.29	4.78	3.13	2.21	1.63	1.29	663.4	58.5	20.3	18.2	0.86	285.4
1.400	8,842	5.85	3.91	2.76	2.04	1.60	1.22	0.99	663.4	334.3	62.2	26.1	1.87	300.0
1.500	9,092	8.49	4.67	3.26	2.61	2.05	1.66	1.38	663.4	136.6	174.7	19.2	1.68	300.0
1.600	9,235	4.97	3.32	2.58	2.02	1.61	1.26	1.03	663.4	427.7	167.0	25.6	0.36	300.0
1.700	9,620	12.95	8.24	5.02	3.33	2.18	1.68	1.21	663.4	135.9	7.8	23.2	3.54	174.1
1.791	9,489	15.93	9.15	5.11	3.48	2.04	1.41	1.05	663.4	87.4	7.2	23.6	2.66	107.1
Mean:		8.33	5.11	3.42	2.47	1.79	1.40	1.10	663.4	268.5	80.5	27.0	2.16	265.8
Std. Dev:		3.72	1.99	1.09	0.76	0.52	0.42	0.34	0.0	145.8	96.7	11.1	1.23	91.8
Var Coeff(%):		44.72	38.84	31.81	30.80	29.05	29.85	30.80	0.0	54.3	120.2	41.3	56.72	36.5

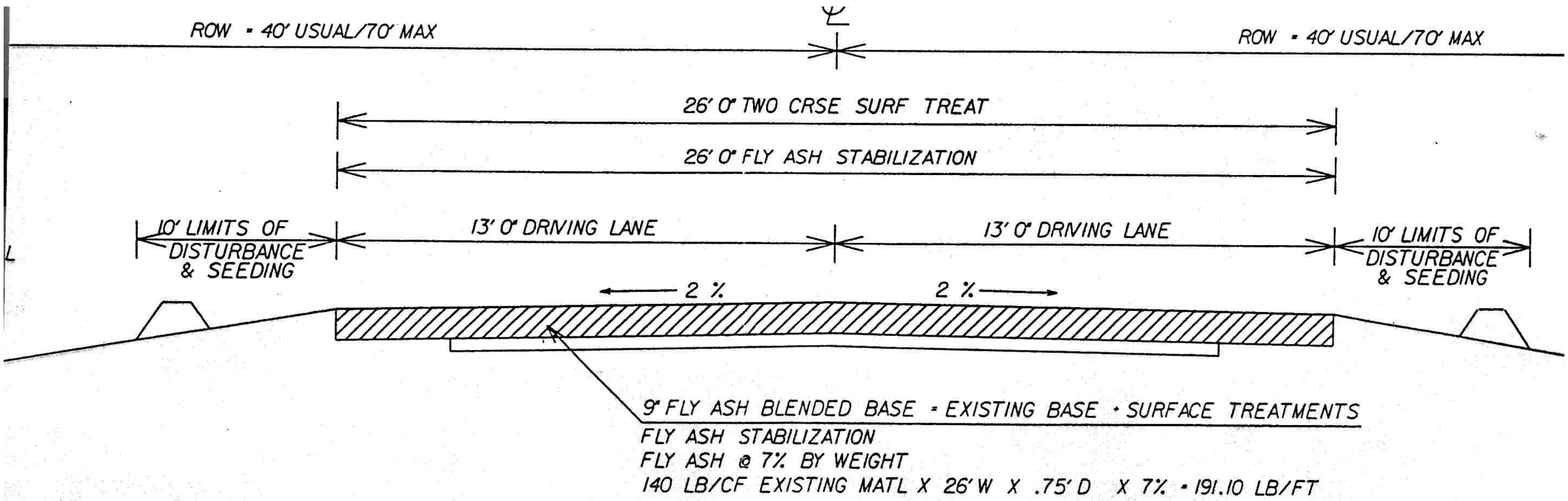
Figure A12. Modulus 6 Results for Section 12, Childress.

Section	County	Highway	Begin	End
13	Dickens	FM 261	340+0.00	354+0.400

Lab Design Data

Base Type	NA
Raw TTC	NA
Stabilizer	7% FA
Compr. Strengths Lat. 0 and (15 psi)	92 and (195 psi)
% change in moisture from OMC	+2.2%

Construction Date 11/1999



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting _2_ Long. _0_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _0_ Patch _0_ Ride _3.6_

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Dickens
Highway/Road: FM 261

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	663,400	663,400	H1: v = 0.35
Base:	9.00	30,000	600,000	H2: v = 0.35
Subbase:	6.00	10,000	150,000	H3: v = 0.35
Subgrade:	149.26	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock	
0.000	11,015	36.42	12.31	4.70	3.06	2.04	1.56	1.22	663.4	32.9	17.0	20.9	6.47	67.0	
0.100	12,103	14.73	7.40	4.18	2.59	1.69	1.18	0.86	663.4	146.2	46.1	29.0	0.43	167.0	
0.200	12,802	21.42	10.19	5.42	2.98	2.04	1.24	0.98	663.4	104.7	20.1	25.3	2.66	110.2	
0.300	12,572	18.45	6.82	3.53	2.29	1.56	1.16	0.91	663.4	76.3	80.4	32.9	3.23	222.9	
0.400	12,163	15.85	5.94	3.02	1.81	1.15	0.89	0.63	663.4	93.5	55.5	39.4	1.84	142.2	
0.499	11,031	33.50	13.57	5.00	3.47	2.07	1.64	1.25	663.4	42.1	13.0	19.6	8.03	61.3	
0.602	11,027	42.09	17.74	8.94	5.51	3.87	2.88	2.16	663.4	33.0	19.4	10.8	4.76	286.8	
0.700	11,511	32.84	13.11	7.01	4.92	3.29	2.44	1.77	663.4	39.2	53.9	13.7	3.30	202.5	
0.800	12,111	20.58	6.67	3.02	1.90	1.32	1.01	0.83	663.4	61.8	52.0	37.1	5.16	180.9	
0.901	12,719	14.66	6.08	3.59	2.35	1.64	1.14	0.92	663.4	102.7	149.5	32.4	0.99	182.1	
1.001	11,337	30.48	15.15	8.85	5.57	3.91	2.54	2.31	663.4	58.9	32.4	11.7	1.37	148.9	
1.100	11,396	23.52	11.08	5.24	3.24	2.07	1.46	1.08	663.4	76.6	18.3	21.1	2.91	151.0	
1.200	11,905	27.46	13.56	7.33	4.73	3.43	2.81	1.99	663.4	62.6	48.1	14.1	5.92	300.0	
1.300	11,662	22.39	9.64	5.01	3.24	2.16	1.27	2.29	663.4	74.1	29.3	22.4	4.29	54.9	
1.400	12,016	21.81	7.00	4.45	2.75	2.12	1.37	0.96	663.4	53.5	150.0	26.7	3.67	259.2	*
1.500	11,837	19.72	12.19	7.41	4.38	2.72	1.79	1.26	663.4	182.2	10.4	17.4	1.23	135.8	
1.600	11,611	25.72	9.69	4.88	2.77	2.08	1.50	1.28	663.4	53.8	32.9	23.2	3.80	130.4	
1.700	12,095	19.46	8.51	4.24	3.23	1.97	1.10	0.86	663.4	87.2	40.8	25.9	7.87	300.0	
1.801	11,499	19.68	9.59	4.93	3.11	2.20	1.85	1.03	663.4	86.8	45.4	21.4	5.42	300.0	
1.900	12,266	11.11	4.49	2.39	1.70	1.28	1.11	0.86	663.4	141.4	150.0	42.1	10.49	300.0	*
2.002	12,159	18.70	6.81	3.65	2.40	1.87	1.37	1.10	663.4	66.4	150.0	29.4	5.78	300.0	*
2.100	11,762	14.31	6.55	4.04	2.74	2.19	1.46	1.17	663.4	113.4	150.0	26.2	3.57	300.0	*
2.200	11,905	20.85	6.17	3.88	2.89	2.04	1.56	1.26	663.4	56.0	150.0	28.2	9.52	300.0	*
2.307	11,877	18.97	5.82	3.66	2.59	1.79	1.48	1.11	663.4	62.8	150.0	30.2	8.26	250.4	*
2.400	11,217	28.68	11.87	6.52	4.44	2.92	2.10	1.66	663.4	46.4	49.8	15.0	1.87	180.3	
2.501	11,460	30.93	14.63	8.42	6.27	4.30	3.48	2.67	663.4	45.3	107.7	10.8	4.68	250.6	*
2.600	11,396	22.42	11.31	5.54	3.45	2.48	1.74	1.39	663.4	83.0	25.8	19.2	5.20	291.2	
2.701	11,170	28.86	16.80	8.11	4.82	3.47	2.35	1.83	663.4	80.8	10.3	13.3	7.00	193.2	
2.800	11,917	20.66	11.53	7.99	4.47	2.98	2.49	1.85	663.4	118.6	44.9	14.9	6.09	124.8	
2.900	11,051	21.76	11.56	6.80	4.56	3.15	2.42	1.88	663.4	83.1	61.7	14.2	3.24	271.0	
3.002	10,105	28.15	15.15	7.99	5.24	3.57	2.57	2.07	663.4	64.5	20.3	11.2	4.48	250.7	
3.102	11,265	26.85	13.64	7.97	4.94	3.55	2.38	2.10	663.4	68.6	35.8	13.0	2.14	296.3	
3.200	10,725	20.46	12.67	7.80	4.87	3.34	2.49	1.90	663.4	126.9	29.1	12.5	3.20	267.0	
3.300	11,213	28.08	13.17	7.27	4.77	3.28	2.45	1.88	663.4	55.3	43.5	13.6	3.12	263.5	
3.401	11,436	23.03	11.13	5.59	3.39	2.15	1.73	1.41	663.4	79.0	22.9	19.9	4.45	146.4	
3.500	10,602	27.04	16.37	8.66	5.00	3.19	2.27	1.81	663.4	88.1	10.0	12.4	3.80	156.0	*
3.601	11,349	21.15	13.33	8.08	6.43	3.88	3.12	2.56	663.4	116.1	71.2	10.9	6.15	300.0	

Figure A13. Modulus 6 Results for Section 13, Childress.

3.701	11,480	20.91	11.04	5.74	4.02	2.59	1.98	1.52	663.4	93.9	37.9	17.9	4.52	300.0	
3.801	11,416	27.05	13.33	6.25	3.65	2.31	1.71	1.34	663.4	71.6	12.5	18.4	4.03	147.0	
3.902	10,645	30.52	19.16	10.44	6.33	3.68	2.26	1.87	663.4	77.2	10.0	10.3	5.96	111.7	*
4.000	10,598	23.02	11.53	6.69	3.96	2.69	1.85	1.54	663.4	79.2	26.8	15.6	1.11	182.7	
4.101	9,799	21.23	12.17	6.85	4.26	2.73	1.84	1.35	663.4	105.7	14.1	14.1	1.32	159.7	
4.200	10,848	22.36	11.83	5.83	3.48	2.19	1.81	0.02	663.4	88.6	16.9	18.3	6.14	142.3	
4.300	10,296	21.09	12.39	7.41	5.17	3.21	2.65	2.02	663.4	99.3	42.8	11.9	5.31	133.8	
4.400	10,244	23.54	13.29	7.47	4.53	3.05	2.19	1.78	663.4	91.9	17.3	13.1	2.95	228.1	
4.501	11,460	26.05	12.23	5.83	3.43	2.40	1.44	1.48	663.4	70.6	15.1	19.5	3.40	169.5	
4.600	10,637	19.80	11.01	5.79	3.48	2.39	1.76	1.51	663.4	105.8	22.1	17.8	4.24	205.3	
4.700	10,475	20.94	10.23	4.95	2.52	1.67	1.26	0.94	663.4	88.2	11.9	23.5	4.64	83.9	
4.827	10,725	23.11	12.65	6.84	4.27	2.85	2.06	1.54	663.4	90.3	20.9	14.9	3.12	206.5	
4.901	10,399	18.37	12.51	8.03	5.41	3.59	2.64	1.99	663.4	181.7	31.6	11.3	2.67	199.0	
5.000	10,216	18.61	9.97	5.33	3.33	2.31	1.94	1.25	663.4	95.1	37.4	17.6	5.78	280.6	
5.100	10,665	18.81	10.85	6.87	4.41	2.95	2.05	1.53	663.4	121.6	41.0	14.3	0.80	195.2	
5.201	11,047	16.34	10.13	6.28	4.43	3.19	2.46	2.02	663.4	139.5	94.7	14.3	3.56	300.0	
5.303	10,363	24.13	13.76	7.14	4.05	2.45	1.62	1.43	663.4	91.1	10.0	15.6	2.41	123.9	*
5.400	10,375	32.94	19.58	10.38	6.04	3.17	3.19	1.65	663.4	63.4	10.0	10.0	9.13	117.1	*
5.501	10,979	25.96	15.22	8.64	5.06	3.11	2.19	1.65	663.4	101.1	10.0	13.2	2.12	133.4	*
5.600	10,196	21.09	10.88	5.55	3.47	2.20	1.69	1.41	663.4	85.2	20.9	17.6	3.99	146.8	
5.700	10,208	19.55	12.14	6.30	3.56	2.19	1.54	1.26	663.4	127.8	10.0	17.5	4.31	131.0	*
5.801	9,946	29.18	13.88	6.62	3.94	2.65	2.04	1.69	663.4	52.6	14.1	14.1	5.25	193.0	
5.901	10,562	26.78	11.68	4.62	2.37	1.49	1.13	1.03	663.4	56.8	10.0	24.4	4.62	76.2	*
6.000	9,783	25.54	12.22	5.06	2.44	1.36	1.01	0.84	663.4	55.7	10.0	21.7	7.94	74.3	*
6.100	10,260	14.25	9.24	5.72	3.78	2.44	1.96	1.47	663.4	198.1	40.8	16.4	3.75	160.8	
6.200	10,403	31.00	15.02	7.74	4.54	2.85	2.26	1.69	663.4	55.4	13.2	13.2	3.93	145.9	
6.307	10,463	18.77	11.68	5.95	3.08	1.67	1.28	1.06	663.4	127.3	10.0	20.8	7.27	89.1	*
6.506	10,244	22.46	9.29	4.56	2.74	1.77	1.32	1.11	663.4	61.3	22.9	21.8	1.42	160.7	
6.601	10,510	31.53	15.23	6.93	3.85	2.28	1.98	1.34	663.4	52.4	10.0	15.3	6.80	114.8	*
6.700	10,582	16.93	8.13	4.25	2.67	1.81	1.37	1.15	663.4	96.2	40.3	23.7	2.85	221.1	
6.806	10,042	25.40	12.04	5.47	2.80	1.90	1.44	1.23	663.4	63.6	10.0	19.5	5.71	85.9	*
6.902	10,784	17.14	7.08	3.74	2.02	1.26	0.97	0.62	663.4	89.3	27.4	30.3	1.81	100.9	
7.001	10,121	33.36	13.79	6.34	4.09	2.56	1.82	1.32	663.4	40.1	14.8	14.5	3.25	232.2	
7.103	10,534	25.28	11.09	4.67	2.98	2.00	1.59	1.49	663.4	57.0	18.0	20.2	6.38	102.2	
7.200	9,247	48.85	20.92	11.09	6.99	4.63	3.25	2.88	663.4	30.0	10.0	7.5	4.54	219.9	*
7.400	11,035	16.50	7.00	4.39	2.75	1.88	1.38	1.06	663.4	83.3	102.8	24.2	1.21	237.2	
7.500	10,681	28.93	13.54	5.69	2.73	1.72	1.24	0.89	663.4	53.6	10.0	20.5	5.14	73.7	*
7.601	11,082	26.18	9.65	4.81	2.72	1.78	1.30	1.11	663.4	51.5	24.5	23.4	0.62	127.8	
7.701	12,219	14.20	6.78	4.20	2.95	2.13	1.74	1.40	663.4	128.1	150.0	25.8	4.17	300.0	*
7.806	11,301	17.31	8.22	3.46	1.90	1.04	0.82	0.72	663.4	111.9	13.0	35.7	2.78	101.3	
7.900	10,769	21.38	10.08	4.99	2.96	2.02	1.50	1.18	663.4	77.5	23.4	20.9	3.86	179.6	
8.000	10,971	25.36	11.08	4.76	2.40	1.70	1.22	1.01	663.4	64.6	11.4	24.5	5.81	81.4	
8.100	9,990	35.28	17.80	8.66	4.68	3.42	2.54	1.94	663.4	46.7	10.0	11.2	6.89	108.6	*
8.200	9,235	22.15	13.95	8.54	5.57	3.77	2.93	2.35	663.4	99.3	28.6	9.2	4.52	244.5	
8.301	9,354	30.45	16.00	8.81	5.67	4.07	3.11	2.58	663.4	49.4	28.5	9.0	5.77	300.0	
8.400	10,196	20.45	12.16	6.97	4.37	3.46	2.43	1.79	663.4	100.0	40.8	12.6	6.02	300.0	
8.500	10,312	27.94	16.36	8.50	5.13	3.79	2.60	2.10	663.4	79.1	12.2	11.3	6.42	229.0	
8.600	10,721	24.79	16.59	9.71	5.52	3.27	2.26	1.78	663.4	113.5	10.0	11.5	5.73	118.8	*
8.700	11,261	20.56	10.62	5.32	2.90	2.09	1.28	0.98	663.4	104.1	15.0	22.5	4.09	106.7	
8.801	11,003	19.82	12.05	6.39	4.11	2.82	1.95	1.43	663.4	130.0	19.4	16.0	4.25	187.7	

Figure A13. Modulus 6 Results for Section 13, Childress (Continued).

8.900	10,185	18.62	10.87	6.57	4.45	2.36	2.21	1.79	663.4	132.1	22.3	14.7	7.16	86.6	
9.000	9,696	30.58	16.35	8.64	5.15	3.70	2.76	2.22	663.4	58.4	13.8	10.4	6.09	206.0	
9.101	10,427	25.04	13.85	6.29	3.79	2.26	1.72	1.34	663.4	80.2	10.0	16.7	5.74	202.6	*
9.201	9,994	34.42	19.59	10.04	5.47	2.87	2.70	1.92	663.4	51.8	10.0	10.2	9.53	90.6	*
9.306	10,427	17.28	9.41	4.98	3.75	1.70	1.32	0.97	663.4	132.3	17.6	20.9	7.17	300.0	
9.400	9,362	26.87	17.04	7.90	4.41	2.69	2.03	1.42	663.4	68.0	10.0	11.8	7.24	126.8	*
9.502	10,669	14.12	8.97	5.31	3.17	2.10	1.47	1.06	663.4	222.4	18.6	20.6	2.66	191.1	
9.601	10,459	23.30	9.83	3.01	1.28	0.88	0.68	0.66	663.4	57.6	11.1	37.0	9.42	53.2	*
9.701	10,534	19.12	11.12	5.25	2.81	1.78	1.12	1.00	663.4	118.4	10.0	22.7	3.07	99.2	*
9.802	9,779	21.18	12.62	7.47	4.69	3.33	2.33	1.84	663.4	101.5	27.0	11.7	3.16	300.0	
9.901	10,951	19.18	10.66	5.66	3.35	2.15	1.60	1.39	663.4	116.8	19.6	19.5	4.08	157.2	
10.000	10,093	19.52	10.62	6.30	4.21	2.99	2.19	1.88	663.4	88.2	61.4	14.0	2.79	275.0	
10.100	10,010	16.77	9.44	4.95	3.18	1.87	1.35	1.17	663.4	130.8	17.6	20.3	3.62	108.3	
10.201	10,216	14.04	9.61	5.41	3.50	2.50	2.04	1.52	663.4	197.3	38.3	16.7	6.46	300.0	
10.300	10,912	17.80	8.57	4.39	2.69	1.66	1.23	0.98	663.4	101.9	26.0	24.8	2.28	127.4	
10.400	10,252	21.12	12.20	6.65	4.16	2.27	2.35	1.48	663.4	108.3	15.1	15.1	8.30	141.2	
10.500	9,958	29.03	16.06	8.31	4.30	2.62	0.90	1.52	663.4	58.8	10.0	14.1	19.52	92.0	*
10.600	9,756	20.69	12.86	7.70	4.80	2.87	2.15	1.70	663.4	130.2	11.4	12.6	2.40	118.8	
10.700	11,082	17.25	9.44	4.87	3.04	2.27	1.53	1.04	663.4	119.3	33.6	21.4	4.71	294.5	
10.802	10,502	18.17	13.25	8.72	5.81	2.70	1.79	2.05	663.4	212.4	10.0	13.2	10.87	74.7	*
10.900	10,308	18.73	11.06	6.82	4.69	3.37	2.55	2.04	663.4	103.9	77.4	12.5	3.47	300.0	
11.000	10,709	17.23	10.98	7.30	4.42	3.06	2.22	1.81	663.4	173.6	34.2	13.9	2.75	228.1	
11.100	10,812	12.39	8.50	4.60	2.83	1.93	1.70	1.11	663.4	234.6	34.4	22.1	8.16	234.7	
11.204	11,793	18.63	10.96	6.06	3.70	2.30	1.63	1.28	663.4	153.7	17.0	19.9	2.80	133.6	
11.300	9,783	20.55	10.59	4.83	2.64	1.55	1.01	0.90	663.4	86.9	10.0	22.5	2.88	108.3	*
11.400	9,799	19.52	8.20	3.35	1.72	1.16	0.83	0.78	663.4	72.8	13.4	31.1	5.05	84.6	
11.500	10,479	24.22	11.60	6.21	3.28	1.45	1.33	1.06	663.4	76.4	10.0	20.4	8.20	71.7	*
11.600	9,422	26.87	15.01	9.15	6.18	4.66	3.76	2.89	663.4	54.5	74.8	8.1	5.92	300.0	
11.700	10,633	24.19	11.93	5.80	3.48	2.18	1.91	1.14	663.4	71.5	17.9	17.6	6.48	139.3	
11.900	11,245	20.75	10.57	5.18	2.89	1.70	1.56	1.41	663.4	99.8	14.2	23.3	6.76	109.3	
12.001	10,737	25.76	14.23	6.98	3.76	2.32	1.56	1.31	663.4	80.4	10.0	16.7	3.24	103.9	*
12.101	10,963	19.52	12.89	7.63	4.77	3.05	2.27	1.65	663.4	171.7	14.0	14.0	3.57	157.4	
12.201	11,611	15.33	9.97	6.19	3.99	2.74	2.12	1.52	663.4	204.6	46.4	17.1	3.43	254.0	
12.300	10,296	19.38	11.28	6.65	4.17	2.94	1.94	1.21	663.4	115.2	28.9	14.4	1.82	300.0	
12.402	10,618	20.50	12.11	7.18	4.52	3.09	2.39	1.74	663.4	111.5	32.3	13.4	3.93	254.7	
12.500	10,518	14.19	8.79	5.33	3.53	2.31	1.54	1.08	663.4	202.4	29.4	18.8	0.78	155.9	
12.600	10,824	17.29	10.81	6.44	4.40	3.13	2.29	1.75	663.4	141.8	53.1	14.2	3.26	268.6	
12.706	11,245	14.67	10.43	6.98	4.68	3.09	2.04	1.65	663.4	345.0	18.7	15.3	0.31	152.3	
12.801	10,415	13.23	8.66	5.32	3.37	2.36	1.58	1.23	663.4	237.6	30.3	18.8	1.72	159.7	
12.900	10,423	15.59	10.46	6.31	4.10	2.40	1.69	1.31	663.4	240.8	10.7	17.3	2.60	108.0	
13.001	10,443	23.81	14.40	7.27	4.14	2.71	1.82	1.56	663.4	98.0	10.0	14.9	3.79	139.2	*
13.101	10,375	29.19	17.43	8.48	4.69	2.64	1.79	1.31	663.4	67.1	10.0	12.9	7.71	101.8	*
13.204	10,018	19.89	13.36	8.42	5.58	3.86	2.81	2.38	663.4	145.5	32.9	10.2	3.22	277.7	
13.300	10,280	37.61	26.54	15.01	9.33	6.18	4.39	3.41	663.4	72.7	10.0	6.0	5.17	236.0	*
13.400	10,530	22.15	16.36	8.83	5.00	3.19	2.38	1.91	663.4	136.6	10.0	12.0	6.58	137.6	*
13.503	10,955	12.54	9.43	6.04	3.98	2.72	2.03	1.58	663.4	404.2	23.6	16.7	3.47	243.0	
13.601	10,773	17.27	11.40	7.51	4.99	3.32	2.56	2.12	663.4	178.4	47.7	12.6	2.92	200.9	
13.700	10,276	18.86	13.28	9.30	6.13	4.19	3.03	2.31	663.4	205.3	33.0	9.6	1.93	265.4	

Figure A13. Modulus 6 Results for Section 13, Childress (Continued).

13.801	10,836	16.59	11.10	6.41	4.06	2.73	1.90	1.36	663.4	199.2	17.9	16.2	3.14	195.4
Mean:		22.55	11.86	6.38	3.94	2.58	1.91	1.49	663.4	103.9	34.0	18.1	4.57	164.8
Std. Dev:		6.23	3.36	1.91	1.24	0.84	0.65	0.52	0.0	57.8	35.0	6.9	2.58	80.8
Var Coeff(%):		27.63	28.31	29.97	31.50	32.57	33.83	34.84	0.0	55.6	102.7	37.9	56.47	49.5

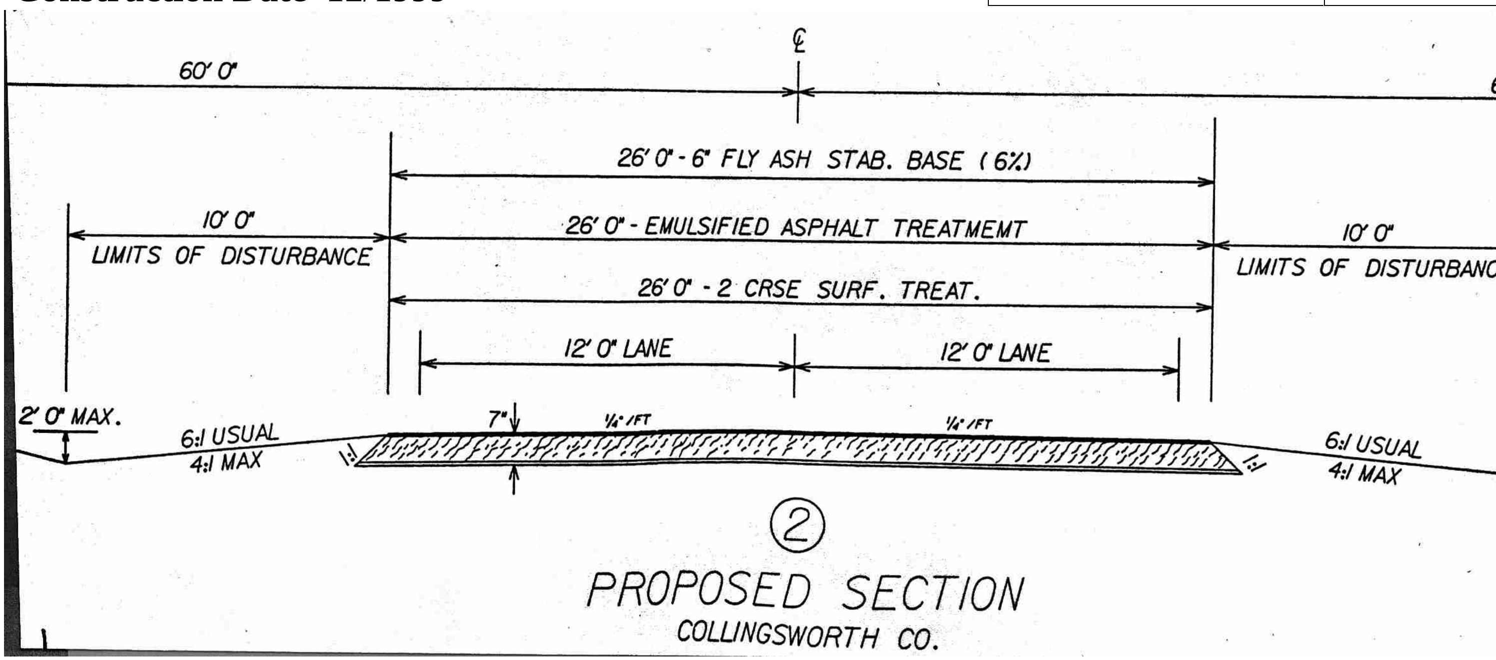
Figure A13. Modulus 6 Results for Section 13, Childress (Continued).

Section	County	Highway	Begin	End
14	Donley	SH 203	364+0.518	392+0.467

Lab Design Data

Base Type	Crushed Limestone
Raw TTC	NA
Stabilizer	6% FA
Compr. Strengths Lat. 0 and (15 psi)	85 and (196 psi)
% change in moisture from OMC	+1.5%

Construction Date 12/1999



PMIS Condition Data (Nov 2002) Overall Average Score = 57

Rutting _2_ Long. _0_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _2_ Patch 50 Ride _2.7_

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Donley
Highway/Road: SH 203

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	0.50	663,400	663,400	H1: v = 0.35
Base:	7.00	20,000	500,000	H2: v = 0.35
Subbase:	6.00	5,000	150,000	H3: v = 0.35
Subgrade:	121.92	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	10,618	26.18	11.14	5.29	3.05	1.96	1.73	1.48	663.4	55.1	33.5	17.3	6.40	145.8
0.201	11,221	27.98	13.88	6.72	3.68	2.42	2.04	1.27	663.4	75.8	22.4	15.0	6.59	110.9
0.400	11,182	28.71	13.43	5.92	3.42	2.16	1.61	1.24	663.4	68.1	19.2	16.5	5.35	147.6
0.600	11,194	27.31	14.13	6.58	3.70	2.88	1.80	1.36	663.4	79.4	23.8	14.7	8.05	126.8
0.800	9,620	29.80	13.32	6.67	4.17	3.46	2.49	2.00	663.4	38.8	60.8	11.0	11.19	300.0
1.000	11,027	26.58	13.21	6.17	3.50	2.10	1.38	1.30	663.4	85.7	17.2	16.4	1.91	118.0
1.200	11,221	25.80	12.92	6.51	4.13	2.83	2.27	1.77	663.4	69.5	49.2	14.2	7.13	253.1
1.401	11,098	33.66	16.29	7.29	4.01	2.77	2.19	1.59	663.4	59.2	16.6	13.2	8.45	114.2
1.600	11,281	35.30	16.31	6.67	3.72	2.63	1.88	1.43	663.4	54.1	14.0	14.4	8.89	89.2
1.800	11,476	27.05	14.76	7.09	4.19	2.83	2.13	1.62	663.4	92.1	23.8	14.0	6.90	179.7
2.000	11,074	26.36	15.74	8.19	5.02	3.21	2.35	1.92	663.4	112.2	23.0	11.5	4.77	159.3
2.200	9,990	33.46	17.06	7.49	4.29	2.60	2.04	1.68	663.4	60.9	11.7	11.7	6.17	125.8
2.405	10,284	24.20	10.45	3.99	2.37	1.66	1.27	1.00	663.4	64.3	19.8	21.2	9.49	67.1
2.603	10,840	25.20	12.31	5.38	2.96	1.97	1.47	1.22	663.4	82.2	18.8	17.9	6.80	111.7
2.800	10,900	15.12	8.26	4.76	2.96	1.89	1.26	0.99	663.4	155.7	67.7	20.9	1.08	149.9
3.000	10,121	33.22	12.98	4.73	2.56	1.86	1.52	1.16	663.4	43.2	12.6	18.3	10.75	60.8
3.202	11,543	23.53	12.44	5.80	3.24	2.20	1.54	1.32	663.4	107.6	22.3	17.9	5.95	120.7
3.401	10,622	40.91	20.82	7.11	4.30	2.39	1.91	1.60	663.4	51.9	6.3	13.1	9.84	56.0
3.600	10,594	21.56	12.01	5.81	3.48	2.21	1.69	1.24	663.4	115.4	25.1	16.0	5.38	149.1
3.802	11,162	38.13	20.89	9.66	5.15	3.21	2.38	1.78	663.4	71.3	8.9	10.7	5.97	102.6
4.000	11,074	36.40	17.15	6.50	3.78	2.75	1.89	1.67	663.4	51.8	12.3	14.0	10.66	66.8
4.201	10,236	35.30	20.22	9.95	5.61	3.60	2.52	1.80	663.4	74.8	10.6	9.2	5.34	137.1
4.400	10,784	23.65	11.22	5.23	3.40	2.44	1.81	1.41	663.4	67.5	47.2	16.6	8.24	265.9
4.601	11,007	27.89	13.05	4.87	2.62	1.78	1.37	1.11	663.4	71.9	12.5	20.0	9.56	63.8
4.802	10,888	27.81	13.72	6.59	4.22	2.64	2.06	1.65	663.4	66.5	31.1	13.8	5.28	300.0
5.000	9,473	25.15	11.80	5.60	3.72	2.51	1.92	1.53	663.4	54.3	41.5	13.5	7.34	300.0
5.201	11,110	16.21	10.98	5.16	2.76	1.84	1.41	1.18	663.4	264.7	16.5	20.5	8.33	98.6
5.402	10,133	27.74	15.29	6.86	3.96	2.52	1.91	1.56	663.4	85.5	13.9	12.9	7.01	151.8
5.600	10,494	32.41	16.60	7.04	3.78	2.46	1.83	1.52	663.4	68.0	10.8	13.5	7.62	102.8
5.804	10,351	30.11	14.53	7.65	4.46	2.92	2.11	1.50	663.4	57.3	29.3	11.9	3.77	165.2
6.001	9,609	27.39	14.03	5.70	3.12	2.00	1.50	1.21	663.4	73.6	11.1	15.1	7.97	86.5
6.201	9,581	17.17	9.79	5.00	3.02	2.00	1.47	1.20	663.4	134.3	34.3	16.8	4.99	191.3
6.401	11,368	24.81	13.41	6.18	3.48	2.19	1.80	1.07	663.4	107.1	18.3	16.5	6.66	126.9
6.600	9,895	22.76	13.57	6.26	3.59	2.36	1.75	1.35	663.4	120.7	14.9	13.9	7.50	144.1
6.800	11,051	27.42	14.67	6.41	3.55	2.35	1.91	1.42	663.4	89.8	15.4	15.2	8.69	116.8
7.001	10,498	29.78	14.52	6.88	4.09	2.44	2.04	1.56	663.4	63.8	20.4	13.3	5.73	116.6
7.200	10,705	30.40	16.44	7.24	4.41	2.96	2.05	1.66	663.4	74.8	16.5	12.4	7.50	148.9

Figure A14. Modulus 6 Results for Section 14, Childress.

7.400	10,709	31.17	16.73	7.60	4.60	2.71	1.89	1.50	663.4	78.3	13.2	12.4	4.24	208.1
7.606	10,657	29.18	13.60	5.67	3.43	1.51	1.78	1.44	663.4	69.2	13.0	16.9	12.05	97.6
7.800	10,117	29.23	13.81	6.06	3.61	2.52	1.92	1.51	663.4	56.5	21.6	13.9	8.70	142.8
8.000	11,337	31.56	15.11	7.33	4.26	2.94	2.22	1.52	663.4	59.2	27.0	13.3	6.73	158.5
8.201	10,351	27.11	14.00	6.19	3.56	2.19	2.27	2.24	663.4	77.9	17.3	14.4	9.68	300.0
8.402	11,380	24.30	13.01	6.52	3.89	2.30	1.73	1.53	663.4	107.1	23.4	15.8	3.59	112.0
8.602	11,595	24.77	11.94	5.57	3.25	2.23	1.58	1.28	663.4	81.5	29.7	18.2	5.84	158.2
8.805	9,907	30.56	15.21	6.92	3.64	2.50	1.81	1.48	663.4	64.1	13.5	12.9	7.13	95.5
9.000	9,716	24.52	14.78	7.43	4.42	2.87	2.02	1.66	663.4	110.9	17.2	11.3	5.36	176.6
9.205	10,701	22.63	12.87	5.85	3.32	2.28	1.74	1.36	663.4	116.1	19.4	16.0	8.44	132.9
9.400	10,153	23.29	14.15	6.55	3.81	2.42	1.91	1.38	663.4	126.8	14.3	13.6	7.60	152.5
9.601	9,998	26.35	13.53	6.37	3.70	2.13	1.55	1.25	663.4	82.5	15.4	14.3	2.97	104.8
9.802	10,975	25.09	9.93	6.42	3.49	2.20	1.86	1.31	663.4	45.0	124.7	15.8	5.29	107.1
10.000	10,455	19.63	9.85	4.40	2.57	1.97	1.37	1.13	663.4	95.8	34.1	20.2	9.05	157.7
10.201	11,015	23.77	12.44	5.60	3.46	2.41	1.86	1.36	663.4	88.2	29.9	16.4	8.65	179.2
10.407	9,716	53.14	27.24	10.48	5.48	4.65	2.39	1.89	663.4	35.9	5.2	8.2	11.64	73.7
10.600	11,329	20.48	13.91	7.19	3.88	2.43	1.79	1.44	663.4	232.9	13.1	15.2	5.57	104.5
10.802	10,852	24.24	12.11	6.34	4.08	2.91	2.11	1.71	663.4	68.9	62.2	14.0	6.50	254.3
11.000	10,034	27.03	13.93	7.04	4.08	2.32	1.96	1.53	663.4	79.0	18.6	13.0	5.08	102.3
11.206	10,788	26.59	15.37	6.65	3.79	2.54	1.89	1.48	663.4	101.7	14.0	14.1	8.80	127.9
11.401	9,795	25.54	14.24	7.39	4.52	2.73	1.83	1.48	663.4	93.1	19.7	11.7	2.21	123.0
Mean:		27.63	14.16	6.49	3.76	2.48	1.86	1.46	663.4	85.2	24.1	14.8	6.97	135.4
Std. Dev:		6.04	3.03	1.21	0.67	0.52	0.30	0.25	0.0	39.9	18.9	2.8	2.36	53.9
Var Coeff(%):		21.87	21.38	18.71	17.93	20.83	16.33	16.93	0.0	46.8	78.3	18.9	33.91	40.0

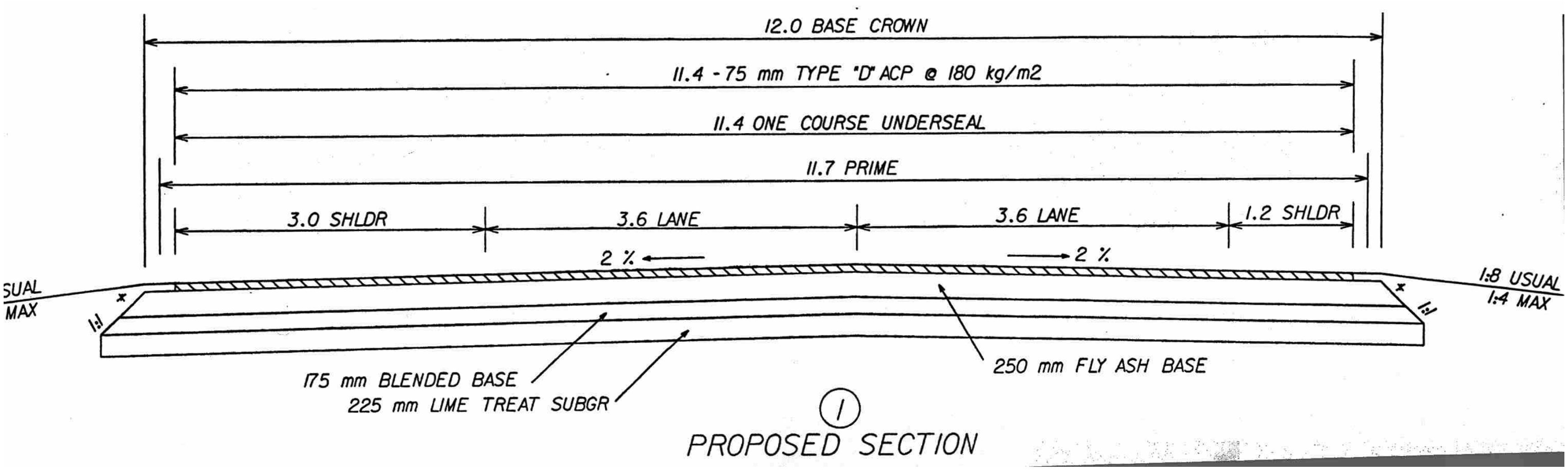
Figure A14. Modulus 6 Results for Section 14, Childress (Continued).

Section	County	Highway	Begin	End
15	Childress	US 287 (NBL)	216+1.365	224+0.923

Construction Date 2/1999

Lab Design Data

Base Type	Sand/Gravel + RAP
Raw TTC	2.5
Stabilizer	6% FA
Compr. Strengths Lat. 0 and (15 psi)	43 and (189 psi)
% change in moisture from OMC	+0.4%



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting __0__ Long. __0__ Alligator __0__ Trans. __0__ Block Cr. __0__Failures__0__ Patch _0__ Ride __4.4

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County : Childress
Highway/Road: US 287

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	3.50	20,000	470,000	H1: v = 0.35
Base:	10.00	30,000	900,000	H2: v = 0.35
Subbase:	7.00	10,000	150,000	H3: v = 0.35
Subgrade:	279.50	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	9,191	6.14	3.50	2.22	1.87	1.49	1.23	1.01	451.7	236.7	150.0	32.2	6.64	300.0 *
0.202	9,199	4.46	2.23	1.40	1.21	0.98	0.82	0.65	153.1	900.0	150.0	51.6	9.24	300.0 *
0.405	9,017	5.50	2.65	1.50	1.15	0.89	0.72	0.61	470.0	171.8	150.0	52.3	5.08	300.0 *
0.601	9,295	6.94	3.19	1.79	1.51	1.21	0.99	0.81	332.3	145.7	150.0	42.6	8.99	300.0 *
0.805	9,330	5.80	3.00	2.11	1.83	1.52	1.29	1.05	118.3	900.0	150.0	33.6	8.59	300.0 *
1.000	9,267	5.23	2.51	1.59	1.27	1.00	0.76	0.61	304.3	287.1	150.0	51.9	7.27	300.0 *
1.201	9,060	9.05	4.56	2.24	1.32	0.85	0.61	0.46	470.0	71.4	47.4	45.0	6.19	180.4 *
1.400	9,239	5.44	2.78	1.77	1.56	1.29	1.07	0.88	236.0	406.8	150.0	40.7	10.79	300.0 *
1.603	9,128	9.96	3.94	2.11	1.74	1.40	1.17	0.92	178.6	88.2	150.0	35.5	8.23	300.0 *
1.800	9,291	5.70	3.23	2.15	1.82	1.51	1.26	1.05	130.3	900.0	150.0	32.4	7.15	300.0 *
2.001	9,072	7.15	3.02	1.74	1.42	1.13	0.91	0.76	280.7	132.5	150.0	43.8	8.43	300.0 *
2.200	9,223	4.41	2.24	1.59	1.40	1.17	0.93	0.76	191.4	900.0	150.0	46.7	11.43	300.0 *
2.401	9,211	5.84	3.28	2.31	1.96	1.63	1.34	1.11	470.0	302.7	150.0	30.3	8.72	300.0 *
2.600	9,287	5.79	3.35	2.26	1.83	1.47	1.17	0.94	348.2	321.2	150.0	33.0	5.24	300.0 *
2.800	9,414	4.83	2.72	1.95	1.69	1.42	1.19	0.99	424.3	561.1	150.0	36.6	10.56	300.0 *
3.006	9,009	7.33	4.30	2.47	1.79	1.31	1.02	0.81	470.0	156.0	62.1	33.4	3.25	300.0 *
3.203	9,315	5.43	2.66	1.61	1.38	1.17	0.98	0.83	112.6	900.0	117.4	45.2	10.43	300.0 *
3.406	9,291	5.20	2.97	2.16	1.93	1.60	1.34	1.12	470.0	900.0	25.7	34.1	13.44	300.0 *
3.600	9,426	5.13	3.07	2.42	2.11	1.79	1.50	1.26	275.4	900.0	150.0	28.4	9.49	300.0 *
3.800	9,195	4.62	3.01	2.21	1.94	1.60	1.32	1.09	470.0	900.0	97.3	30.1	8.04	300.0 *
3.983	9,374	4.67	2.71	2.01	1.84	1.58	1.37	1.16	470.0	900.0	24.8	38.4	16.35	300.0 *
4.201	9,422	4.43	2.52	1.75	1.51	1.24	1.03	0.86	251.0	900.0	150.0	41.7	8.87	300.0 *
4.400	9,120	5.41	3.11	1.65	1.44	1.18	0.99	0.86	470.0	227.0	150.0	42.7	9.79	300.0 *
4.600	9,327	6.66	4.30	3.01	2.52	2.04	1.68	1.38	470.0	304.0	150.0	22.7	4.75	300.0 *
4.843	9,223	8.69	3.49	2.51	2.13	1.74	1.45	1.20	50.1	900.0	150.0	28.9	6.31	300.0 *
5.000	9,287	5.78	2.85	1.74	1.44	1.16	0.95	0.80	357.1	228.4	150.0	44.9	8.78	300.0 *
5.200	9,156	8.07	4.02	2.19	1.77	1.44	1.18	0.96	428.3	103.5	150.0	33.0	6.71	300.0 *
5.401	9,342	6.49	3.20	2.17	1.79	1.50	1.28	1.09	100.5	900.0	61.4	34.8	10.19	300.0 *
5.601	9,330	5.69	2.77	1.69	1.43	1.18	1.01	0.88	99.9	900.0	150.0	42.9	9.40	300.0 *
5.800	9,227	9.00	4.04	2.07	1.65	1.32	1.09	0.94	351.4	82.3	150.0	36.6	6.59	300.0 *
5.965	9,183	9.89	3.40	1.46	1.27	1.09	0.94	0.80	224.0	67.9	150.0	49.7	13.06	133.5 *
Mean:		6.28	3.18	2.00	1.66	1.35	1.12	0.92	310.6	503.0	130.2	38.6	8.64	300.0
Std. Dev:		1.62	0.60	0.37	0.31	0.27	0.24	0.20	143.9	357.0	40.4	7.7	2.73	69.5
Var Coeff(%):		25.81	19.00	18.39	18.73	20.21	21.54	22.04	46.3	71.0	31.0	20.0	31.55	23.2

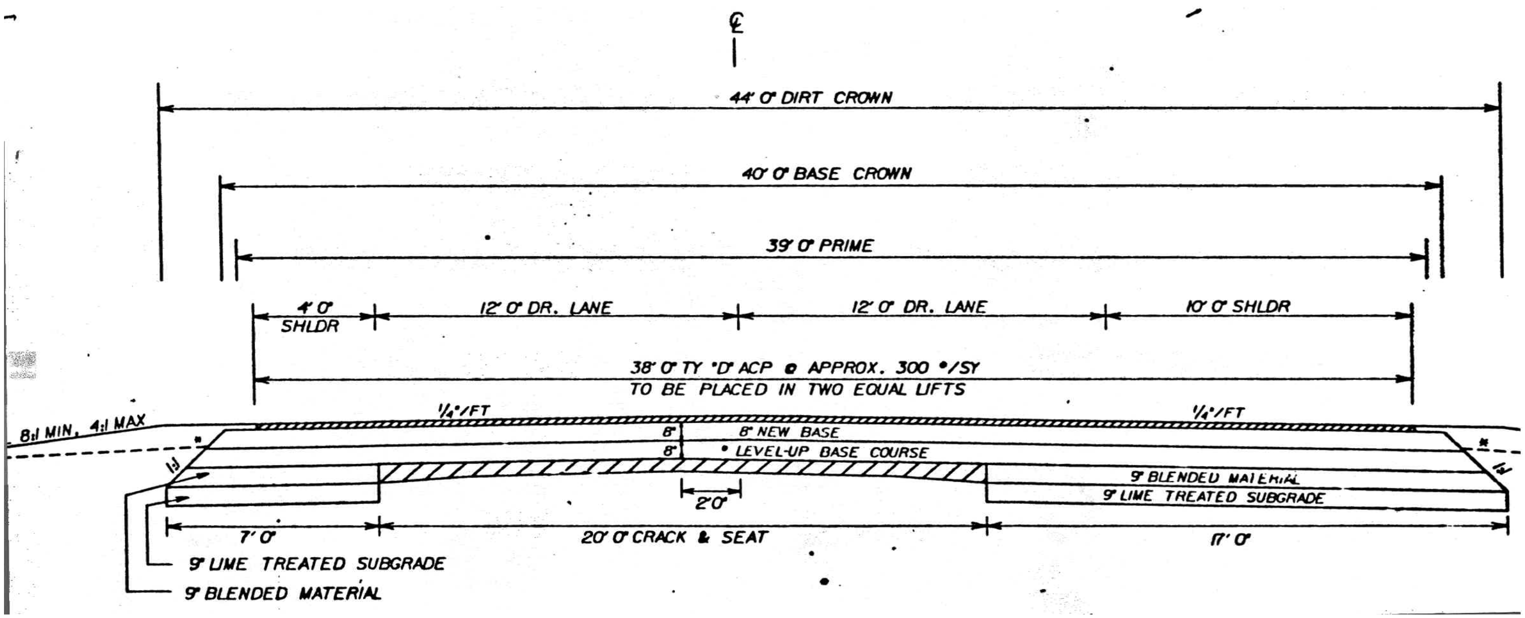
Figure A15. Modulus 6 Results for Section 15, Childress.

Section	**County**	**Highway**	**Begin**	**End**
16	Childress	US 287 (SBL)	242+0.729	250+0.486

Lab Design Data

Base Type	NA
Raw TTC	NA
Stabilizer	15% FA
Compr. Strengths Lat. 0 and (15 psi)	NA
% change in moisture from OMC	NA

Construction Date 12/1992



PMIS Condition Data (Nov 2002) Overall Average Score = 61

Rutting 3 Long. 118 Alligator 0 Trans. 4 Block Cr. 0 Failures 0 Patch 0 Ride 3.5

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District:25 (Childress)
County :Childress
Highway/Road: US 287

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	3.50	600,000	1,480,000	H1: v = 0.35
Base:	8.00	20,000	1,500,000	H2: v = 0.35
Subbase:	15.00	5,000	500,000	H3: v = 0.35
Subgrade:	273.50	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	10,717	7.54	4.28	2.63	2.00	1.60	1.29	1.10	1480.0	72.4	212.2	28.1	0.80	300.0 *
0.200	10,975	4.49	2.52	1.72	1.26	1.01	0.90	0.71	1480.0	202.3	297.0	45.7	3.00	300.0 *
0.403	10,483	4.78	2.35	1.59	1.31	0.96	0.74	0.67	611.8	220.7	280.4	50.8	1.85	300.0
0.602	10,439	5.55	2.91	1.88	1.49	1.22	1.02	0.86	1480.0	94.1	500.0	34.9	1.06	300.0 *
0.802	10,788	5.36	3.03	2.11	1.75	1.53	1.28	1.04	1381.3	140.1	500.0	29.1	2.28	300.0 *
1.000	10,526	4.29	2.55	1.87	1.33	0.88	0.86	0.66	642.0	489.2	143.9	48.9	4.97	218.4
1.200	10,653	9.20	5.38	2.65	1.54	1.01	0.84	0.57	1480.0	71.8	39.8	44.1	3.09	173.7 *
1.400	10,264	5.06	2.83	1.99	1.61	1.33	1.12	0.97	1480.0	129.0	500.0	30.9	0.84	300.0 *
1.600	10,848	5.68	2.73	1.90	1.64	1.42	1.26	1.07	600.0	163.4	500.0	34.9	4.64	300.0 *
1.800	10,216	5.24	3.15	2.29	1.90	1.59	1.26	1.10	1414.4	160.5	365.0	26.3	0.66	300.0
2.000	10,308	6.52	3.26	1.88	1.45	1.18	0.98	0.80	1468.6	59.3	500.0	36.7	1.13	300.0 *
2.202	10,173	3.89	2.19	1.59	1.32	1.15	0.93	0.78	1128.6	254.9	500.0	38.8	2.24	300.0 *
2.402	10,256	5.61	3.27	2.24	1.79	1.48	1.22	0.98	1480.0	123.2	332.7	28.4	0.82	300.0 *
2.600	10,379	5.18	3.33	2.30	1.88	1.52	1.32	1.10	1480.0	200.2	245.7	27.8	2.36	300.0 *
2.800	10,312	4.41	2.72	1.86	1.68	1.39	1.15	0.99	1480.0	211.2	447.3	30.1	2.46	300.0 *
3.000	10,439	5.31	3.41	2.54	1.95	1.34	1.23	0.86	654.9	427.2	126.5	32.1	3.49	300.0
3.200	10,371	5.15	2.65	1.75	1.39	1.15	0.99	0.86	1339.2	114.4	500.0	37.0	1.84	300.0 *
3.403	10,355	5.50	3.37	2.46	2.05	1.69	1.43	1.20	1480.0	148.7	390.8	23.8	0.73	300.0 *
3.605	10,264	4.94	3.27	2.61	2.20	1.87	1.56	1.33	1121.5	282.8	390.3	21.2	0.20	300.0
3.800	10,208	4.38	2.82	2.29	1.92	1.64	1.38	1.15	879.3	344.1	494.0	24.4	0.40	300.0
4.003	10,363	4.11	2.76	2.19	1.82	1.50	1.28	1.06	1112.9	425.0	374.9	27.3	0.72	300.0
4.200	10,161	4.38	2.85	1.97	1.62	1.03	1.01	0.92	1415.8	360.1	140.6	38.3	5.32	169.5
4.400	10,105	4.58	2.70	1.95	1.92	1.23	0.71	0.61	600.0	522.4	133.1	40.2	10.51	300.0 *
4.600	10,129	5.85	4.47	3.14	2.45	1.97	1.67	1.33	1480.0	365.0	95.4	22.0	3.01	300.0 *
4.800	10,097	5.42	3.46	2.46	1.88	1.50	1.19	0.97	1397.6	225.7	149.1	29.1	0.33	300.0
5.003	10,057	5.83	3.05	1.95	1.42	1.13	0.91	0.73	1168.5	115.3	203.8	38.5	1.14	300.0
5.201	10,141	5.04	3.13	2.22	1.79	1.49	1.22	1.01	1480.0	187.3	277.2	28.2	1.08	300.0 *
5.400	9,771	5.72	3.27	2.37	1.93	1.62	1.31	1.09	1085.1	130.1	370.4	24.8	0.40	300.0
5.604	9,855	6.14	2.96	1.78	1.47	1.38	1.21	1.00	900.1	87.6	500.0	32.0	6.75	300.0 *
5.804	10,097	5.92	3.30	2.10	1.49	1.26	1.00	0.86	1480.0	88.7	294.1	33.7	2.26	300.0 *
Mean:		5.37	3.13	2.14	1.71	1.37	1.14	0.95	1222.7	213.9	326.8	32.9	2.35	300.0
Std. Dev:		1.06	0.64	0.36	0.29	0.27	0.23	0.20	326.0	130.9	149.8	7.8	2.26	54.4
Var Coeff(%):		19.70	20.54	16.81	16.92	19.61	20.21	20.91	26.7	61.2	45.8	23.5	96.26	18.4

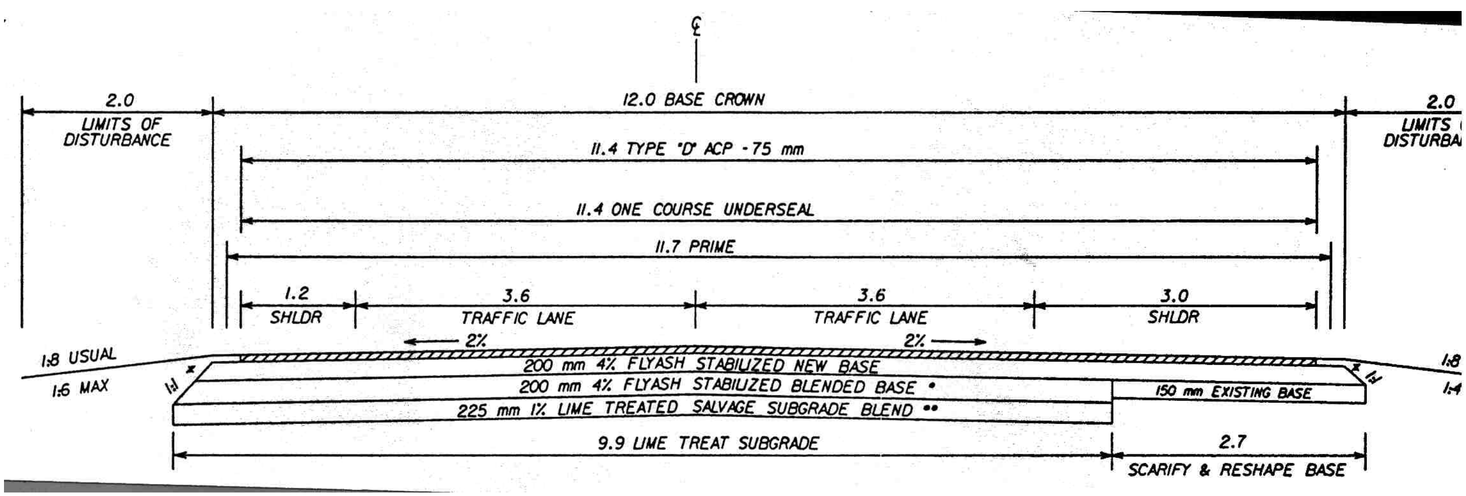
Figure A16. Modulus 6 Results for Section 16, Childress.

Section	County	Highway	Begin	End
17	Childress	US 87 (SBL)	226+1.230	228+1.617

Lab Design Data

Base Type	Sand/Gravel
Raw TTC	NA
Stabilizer	4% FA
Compr. Strengths Lat. 0 and (15 psi)	138 and (289 psi)
% change in moisture from OMC	+0.5%

Construction Date 9/1997



PMIS Condition Data (Nov 2002) Overall Average Score = 100

Rutting _0_ Long. _0_ Alligator _0_ Trans. _0_ Block Cr. _0_ Failures _0_ Patch _0_ Ride _3.6_

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 5.1)

District: 25 (Childress)
County :Childress
Highway/Road: US 87

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	3.00	600,000	1,480,000	H1: v = 0.35
Base:	16.00	20,000	1,500,000	H2: v = 0.35
Subbase:	8.00	10,000	150,000	H3: v = 0.35
Subgrade:	273.00	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	10,741	3.32	2.58	2.25	1.90	1.55	1.34	1.08	1286.6	1237.2	37.4	27.9	1.11	300.0
0.100	10,427	6.91	5.76	4.57	3.36	2.36	1.76	1.30	1480.0	255.1	10.0	20.2	8.42	278.1 *
0.201	11,078	1.78	1.21	1.06	1.04	0.82	0.78	0.63	1480.0	1500.0	43.2	82.0	15.71	300.0 *
0.301	10,467	2.87	2.41	2.07	1.74	1.38	1.16	0.96	1480.0	1451.4	12.4	33.5	2.33	300.0 *
0.386	10,931	3.34	2.67	2.38	1.79	1.41	1.31	0.95	1480.0	1109.8	13.0	34.2	4.43	300.0 *
0.500	10,451	3.22	2.62	2.27	1.96	1.56	1.31	1.13	1354.4	1265.0	30.1	26.7	1.79	300.0
0.600	10,546	3.42	2.68	2.30	1.81	1.57	1.22	1.03	1480.0	1020.2	12.7	32.9	1.81	300.0 *
0.701	10,367	3.53	2.77	2.35	1.96	1.59	1.33	1.13	1432.2	993.8	16.3	28.9	0.63	300.0
0.800	10,912	4.52	3.49	2.80	2.31	1.74	1.46	1.24	1480.0	607.8	13.9	29.1	1.92	300.0 *
0.901	12,644	2.74	2.22	1.85	1.59	1.39	1.18	1.03	1480.0	1500.0	97.3	39.2	3.54	300.0 *
1.001	10,749	4.53	3.49	2.87	1.96	1.50	1.29	0.96	1480.0	497.7	10.6	35.4	5.39	300.0 *
1.100	10,844	5.76	3.15	2.45	1.93	1.53	1.26	1.06	600.0	279.1	150.0	31.9	1.85	300.0 *
1.201	10,645	4.41	3.31	2.67	2.16	1.80	1.47	1.24	1480.0	590.3	37.6	26.0	0.78	300.0 *
1.301	10,677	6.72	4.94	3.44	2.46	1.74	1.28	1.04	1480.0	214.9	10.0	31.8	4.24	300.0 *
1.400	10,796	6.76	5.20	3.43	2.56	1.80	1.41	1.04	1480.0	207.2	19.1	27.0	4.92	300.0 *
1.500	11,066	7.62	4.61	2.85	1.87	1.52	1.21	0.99	1480.0	126.1	64.8	32.7	3.57	300.0 *
1.602	10,451	6.91	4.80	3.55	2.50	1.87	1.31	1.25	1480.0	212.2	10.0	29.6	2.94	232.0 *
1.700	10,892	8.39	5.02	2.98	2.11	1.32	1.14	0.84	1480.0	127.0	12.8	40.0	4.20	155.7 *
1.802	10,923	6.36	4.19	3.01	1.95	1.51	1.18	0.96	1480.0	228.2	13.6	37.9	3.55	300.0 *
1.901	10,483	4.08	3.22	2.47	1.89	1.44	1.14	0.95	1480.0	562.5	11.2	37.5	3.02	300.0 *
2.000	10,173	4.59	3.78	2.95	2.33	1.70	1.48	1.14	1480.0	514.6	10.0	28.0	4.06	300.0 *
2.100	10,586	6.19	4.06	3.30	2.57	1.66	1.37	1.16	600.0	358.1	10.0	32.0	3.86	185.5 *
2.202	10,673	4.40	3.37	2.52	1.94	1.35	1.07	0.91	1480.0	458.7	11.8	39.5	4.56	300.0 *
2.300	10,391	5.83	4.33	2.89	1.93	1.43	1.15	0.91	1480.0	241.5	11.4	37.5	5.30	300.0 *
2.400	9,620	9.26	6.46	4.17	3.01	2.17	1.87	1.31	1480.0	105.2	19.9	19.4	3.69	300.0 *
Mean:		5.10	3.69	2.78	2.11	1.59	1.30	1.05	1394.9	626.5	27.6	33.6	3.90	300.0
Std. Dev:		1.93	1.23	0.73	0.47	0.29	0.21	0.16	243.5	478.7	32.8	11.5	3.00	59.7
Var Coeff(%):		37.93	33.40	26.22	22.18	18.50	16.52	14.87	17.5	76.4	118.9	34.1	76.80	20.2

Figure A17. Modulus 6 Results for Section 17, Childress.

APPENDIX B

AMARILLO DISTRICT'S FULL DEPTH RECYCLED PROJECTS

Section 1

County	Hutchinson
Highway	SH 207
From	Junction with SH 152
To	TRM 72 (approximately 9 miles south)
Construction	7/98
Stabilizer Used	2% cement + 1% fly ash (8 inch treated base over 7 inch flex base). An underseal was placed on top of the base.
Performance Data base.	Shortly after construction several long sections, particularly on curves, had the surface delaminate from the base. These areas were patched. After 3 years in service the section was inspected and substantial areas of longitudinal cracking were found; some transverse and block cracking was also apparent.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 6.0)

District:4 (Amarillo)
County :118 (HUTCHINSON)
Highway/Road: SH 207

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	3.20	340,000	1,040,000	H1: v = 0.35
Base:	8.00	50,000	1,000,000	H2: v = 0.25
Subbase:	7.00	10,000	150,000	H3: v = 0.35
Subgrade:	226.01(by DB)	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.209	9,096	8.62	5.87	3.54	2.35	1.56	1.07	0.81	1040.0	179.4	19.6	26.4	1.00	203.8 *
0.401	9,152	9.36	6.96	4.71	3.11	2.16	1.48	1.16	1040.0	260.9	10.0	20.8	0.93	202.8 *
0.621	9,227	7.02	4.85	3.14	2.31	1.71	1.29	1.05	1040.0	212.8	91.8	24.1	2.30	300.0 *
0.802	9,211	7.16	5.05	3.18	2.26	1.63	1.21	0.96	1040.0	236.0	53.3	25.2	2.35	300.0 *
1.003	9,084	14.54	7.20	3.89	2.59	1.76	1.24	0.99	361.7	52.2	45.8	22.4	1.04	236.8
1.218	9,327	5.67	3.24	1.61	1.14	0.80	0.50	0.46	1040.0	176.5	65.2	54.0	4.86	300.0 *
1.280	9,271	6.05	4.21	2.81	2.15	1.65	1.30	1.06	1040.0	279.3	150.0	25.2	3.15	300.0 *
1.401	9,156	8.81	5.50	3.22	2.29	1.68	1.24	1.00	1040.0	98.8	84.8	24.2	2.39	300.0 *
1.601	9,279	6.20	4.50	2.94	2.18	1.58	1.20	0.98	1040.0	323.6	80.5	26.2	2.32	300.0 *
1.801	9,207	6.94	4.60	2.72	1.96	1.43	1.09	0.89	1040.0	170.2	90.9	28.7	3.28	300.0 *
2.002	9,227	7.53	4.65	2.74	2.11	1.60	1.24	1.02	1040.0	120.4	150.0	26.5	4.15	300.0 *
2.201	9,195	8.38	5.26	3.05	2.25	1.61	1.26	1.03	1040.0	110.3	90.4	25.2	3.10	300.0 *
2.400	9,108	8.82	6.10	3.80	2.68	1.82	1.29	0.96	1040.0	184.5	26.3	22.4	1.37	248.6 *
2.612	9,001	10.87	6.18	2.91	1.62	1.04	0.72	0.58	1040.0	65.8	17.5	36.0	1.32	132.3 *
2.800	9,029	6.10	3.89	2.08	1.35	0.89	0.67	0.54	1040.0	201.9	38.7	43.6	3.43	210.9 *
3.000	9,092	10.14	9.34	4.70	3.54	2.50	1.81	1.39	1040.0	209.9	10.0	17.6	7.44	300.0 *
3.197	9,219	8.93	6.78	4.67	3.44	2.46	1.79	1.38	1040.0	265.9	32.9	17.0	0.99	300.0 *
3.400	9,052	13.59	8.71	5.46	3.78	2.44	1.58	1.02	350.0	146.7	13.4	17.0	2.19	159.7
3.606	9,223	6.09	4.35	2.66	1.70	1.00	0.64	0.46	436.3	554.0	13.1	43.6	3.09	123.6 *
3.800	8,905	16.10	10.91	6.08	3.62	2.20	1.44	1.04	1040.0	50.0	10.0	17.1	3.91	136.1 *
4.004	9,084	11.17	8.43	5.30	3.76	2.57	1.84	1.40	1040.0	167.0	15.0	16.0	1.84	265.9 *
4.202	9,156	8.75	6.87	4.64	3.39	2.48	1.80	1.37	1040.0	309.8	23.2	17.2	1.90	300.0 *
4.412	9,128	4.58	3.07	1.89	1.15	0.66	0.39	0.25	456.3	697.0	19.2	64.0	4.37	115.5 *
4.600	8,921	10.98	6.94	3.54	2.06	1.16	0.74	0.56	1040.0	52.6	25.7	29.1	9.47	109.3 *
Mean:		8.85	5.98	3.55	2.45	1.68	1.20	0.93	933.5	213.6	49.0	27.9	3.01	244.2
Std. Dev:		2.90	1.96	1.16	0.81	0.57	0.42	0.32	244.0	151.2	42.4	12.2	2.04	93.2
Var Coeff(%):		32.78	32.87	32.78	33.06	33.93	34.79	33.91	26.1	70.8	86.5	43.8	67.92	40.6

Figure B1. Modulus 6 Results from Section 1, Amarillo.
Moderately stiff base with high variability, 3 drop locations with moduli values around 50 ksi.

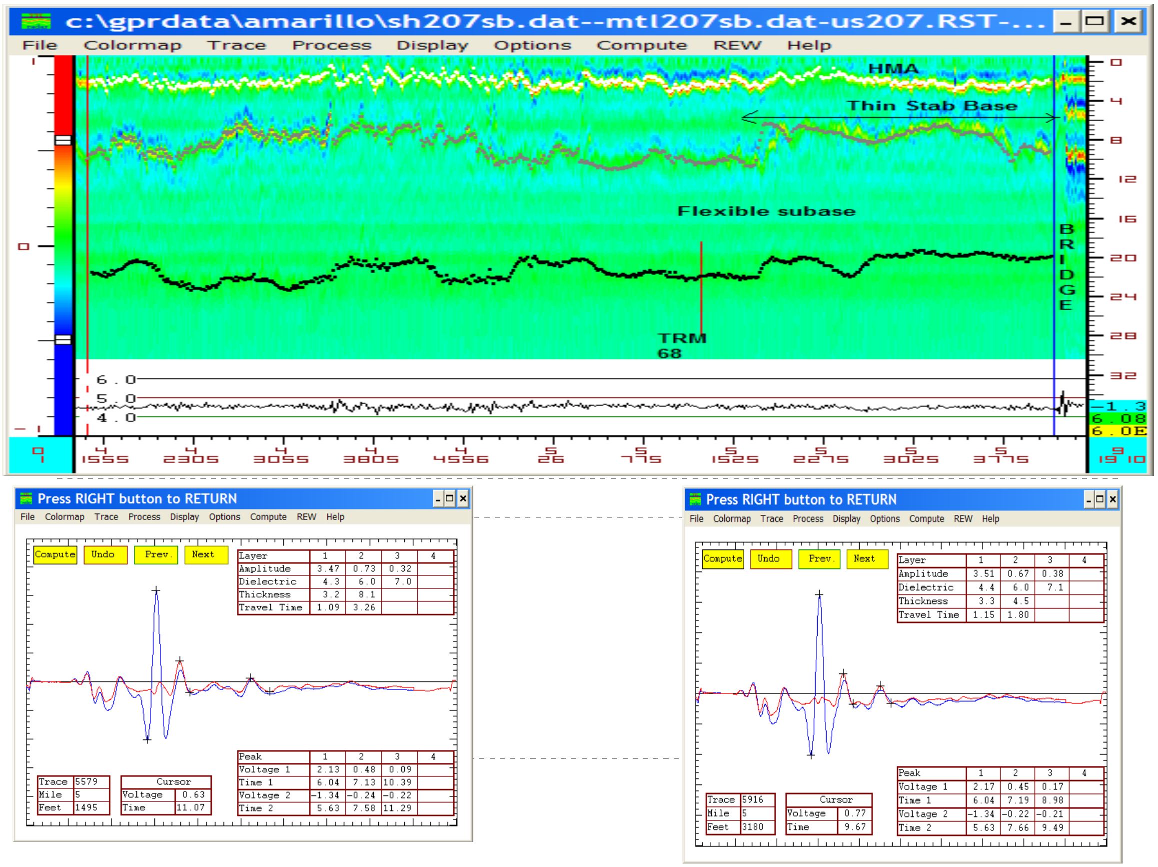


Figure B2. GPR Data from Section 1, Amarillo.
The layer interfaces are all clear in the data. The most noticeable feature in this section is the variability in treated base thickness. The thin locations were excluded from the FWD analysis shown in Figure B1.

Section 2

County	Randall
Highway	Loop 335
From	IH 40
To	Whitaker Road (approx. 5 miles)
Construction	Type B in Nov 1998, final surface in March 99. No underseal. Stabilized base thickness was 10 inches and a total of 5.5 inches of HMA was placed (4 inches of Type B and 1.5 inches of Type D).
Stabilizer Used	2.5% lime
Performance Data	In 2001 the condition was inspected and found to be excellent, the only distress present were small lengths of longitudinal cracking. In 2002 a seal coat was placed on the section.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 6.0)

District:4 (Amarillo)
County :191 (RANDALL)
Highway/Road: Loop 335

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	5.50	100,000	620,000	H1: v = 0.35
Base:	10.00	40,000	600,000	H2: v = 0.25
Subbase:	0.00			H3: v = 0.00
Subgrade:	240.00(User Input)	10,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock	
0.000	8,897	11.49	8.68	6.24	5.06	3.86	2.93	2.28	365.8	188.4	0.0	10.9	2.04	124.0	
0.104	8,997	15.78	12.11	8.45	6.37	4.65	3.45	2.67	526.2	66.4	0.0	8.8	0.96	132.1	
0.200	9,108	10.82	7.78	5.08	4.03	3.01	2.33	1.85	394.5	142.9	0.0	14.2	3.43	131.8	
0.300	9,072	8.01	5.40	3.75	3.01	2.32	1.81	1.43	220.2	479.9	0.0	19.0	3.88	120.2	
0.420	8,846	13.43	8.76	4.90	3.31	2.34	1.73	1.39	364.1	45.2	0.0	17.0	2.88	118.0	
0.475	8,997	9.90	7.77	5.41	4.18	3.00	2.35	1.77	620.0	142.0	0.0	13.4	2.21	142.2	*
0.599	8,675	21.52	13.22	6.40	3.68	2.47	1.99	1.68	100.0	40.0	0.0	13.2	9.65	81.5	*
0.701	8,993	6.27	4.58	3.18	2.50	1.88	1.43	1.13	620.0	297.2	0.0	22.6	2.14	117.8	*
0.801	8,941	7.83	5.87	4.01	3.04	2.17	1.63	1.26	620.0	172.2	0.0	18.7	1.66	115.1	*
0.901	8,854	9.00	6.54	4.54	3.36	2.43	1.79	1.36	620.0	128.1	0.0	16.7	0.68	113.6	*
1.000	8,890	9.81	7.21	4.89	3.76	2.66	2.00	1.46	593.4	117.8	0.0	15.2	1.63	96.5	
1.100	8,937	9.59	7.09	5.36	4.48	3.37	2.54	1.94	275.3	389.1	0.0	12.5	1.55	107.4	
1.201	8,774	12.06	8.76	5.73	4.18	2.91	2.13	1.64	582.4	64.5	0.0	13.7	1.14	115.4	
1.302	8,794	9.59	6.66	4.30	3.17	2.31	1.76	1.41	449.7	116.9	0.0	17.7	2.42	137.0	
1.402	8,846	6.59	5.10	3.77	3.09	2.39	1.83	1.41	620.0	392.6	0.0	17.2	1.78	104.5	*
1.501	8,814	9.33	6.60	4.40	3.36	2.50	1.91	1.48	420.9	155.4	0.0	16.5	2.62	118.2	
1.600	8,723	15.21	11.26	7.25	5.13	3.53	2.50	1.83	550.9	40.0	0.0	11.1	1.35	105.4	*
1.764	8,969	9.25	6.40	4.47	3.43	2.49	1.85	1.38	356.2	189.6	0.0	16.9	1.39	102.7	
1.906	8,933	6.50	4.85	3.62	2.95	2.30	1.80	1.40	445.5	534.7	0.0	18.3	2.14	109.1	
2.017	8,862	8.25	6.43	4.70	3.67	2.72	2.04	1.55	620.0	213.8	0.0	14.9	1.20	109.7	*
2.100	9,025	6.33	4.76	3.56	2.89	2.24	1.73	1.37	499.8	508.4	0.0	18.9	1.71	119.9	
2.201	8,909	8.53	6.18	4.41	3.48	2.64	1.98	1.60	414.1	246.1	0.0	16.1	1.85	118.3	
2.302	8,794	13.80	9.59	5.77	4.00	2.75	2.02	1.62	478.4	42.8	0.0	14.3	1.52	112.5	
2.400	8,953	6.56	4.74	3.41	2.65	1.98	1.50	1.18	560.3	302.9	0.0	21.3	1.39	120.0	
2.502	8,540	19.28	12.06	6.57	4.19	2.76	2.01	1.58	139.4	40.0	0.0	12.6	4.68	95.4	*
2.604	8,997	6.89	5.27	3.86	3.10	2.36	1.80	1.44	620.0	328.7	0.0	17.8	1.50	124.4	*
2.702	8,977	7.25	5.19	3.81	3.17	2.50	1.95	1.57	303.9	600.0	0.0	17.3	3.10	131.5	*
2.804	9,056	6.77	4.63	3.29	2.70	2.03	1.56	1.21	269.7	595.4	0.0	21.4	2.81	103.3	
2.904	9,040	6.70	4.62	3.29	2.63	1.97	1.45	1.07	351.1	419.0	0.0	22.2	2.07	89.8	
3.013	8,901	8.25	5.81	4.06	3.12	2.29	1.69	1.28	434.4	204.8	0.0	18.3	1.40	105.9	
3.108	8,762	13.37	9.73	7.07	5.61	4.06	2.97	2.22	283.5	140.7	0.0	10.1	1.36	111.4	
3.201	8,945	11.49	8.30	5.59	4.30	3.18	2.31	1.68	416.2	115.8	0.0	13.2	1.86	97.6	
3.309	8,679	20.92	14.54	8.27	5.30	3.45	2.42	1.92	152.9	40.0	0.0	10.3	6.27	92.4	*
3.405	8,822	15.76	10.07	5.58	3.52	2.38	1.83	1.40	252.5	40.0	0.0	15.5	3.03	105.9	*
3.503	8,953	8.11	5.16	3.75	2.92	2.19	1.68	1.35	168.0	573.3	0.0	19.7	2.26	136.7	
3.615	8,921	9.37	5.98	4.12	3.22	2.41	1.82	1.43	165.0	355.8	0.0	18.0	3.08	122.9	
3.724	8,973	9.60	6.54	4.56	3.37	2.39	1.81	1.41	365.9	155.2	0.0	17.2	1.12	132.6	

Figure B3. Modulus 6 Results from Section 2, Amarillo.

3.804	9,060	7.96	4.99	3.52	2.79	2.04	1.50	1.16	180.4	486.0	0.0	21.6	2.26	101.3	
3.830	8,897	9.19	5.89	3.86	2.93	2.13	1.64	1.26	256.8	188.7	0.0	19.6	2.94	111.2	
3.907	8,909	9.55	6.00	4.11	2.92	2.03	1.50	1.09	269.3	150.2	0.0	20.0	0.66	117.4	
4.003	8,854	10.69	7.02	4.64	3.41	2.41	1.76	1.36	301.3	119.5	0.0	17.0	1.25	110.5	
4.103	8,850	10.13	5.87	3.91	3.04	2.31	1.77	1.42	109.8	420.8	0.0	19.2	4.59	135.5	
4.205	9,005	7.67	4.94	3.48	2.73	2.03	1.57	1.19	197.9	499.1	0.0	21.3	2.77	101.1	
4.304	8,878	10.28	6.48	4.44	3.33	2.39	1.78	1.35	205.4	188.0	0.0	17.4	1.75	112.0	
4.403	9,021	7.87	5.73	4.12	3.26	2.46	1.91	1.49	445.0	289.5	0.0	17.3	1.94	117.6	
4.502	9,040	8.55	5.99	4.17	3.29	2.39	1.72	1.30	390.3	215.5	0.0	18.0	1.76	95.9	
4.600	9,112	5.46	4.18	3.06	2.58	1.94	1.52	1.15	620.0	566.0	0.0	21.8	2.33	89.2	*
4.702	9,037	9.09	6.89	5.13	4.19	3.13	2.31	1.70	473.7	252.9	0.0	13.5	1.59	95.9	
4.801	9,152	5.51	3.89	2.89	2.42	1.86	1.43	1.12	514.9	600.0	0.0	23.8	3.19	102.1	*
Mean:		10.02	6.98	4.67	3.53	2.57	1.93	1.49	391.9	257.2	0.0	16.8	2.34	111.6	
Std. Dev:		3.72	2.44	1.29	0.85	0.58	0.42	0.32	162.4	179.9	0.0	3.6	1.51	14.1	
Var Coeff(%):		37.08	35.01	27.69	24.10	22.73	21.63	21.34	41.4	69.9	0.0	21.2	64.57	12.6	

Figure B3. Modulus 6 Results from Section 2, Amarillo (Continued).
The average base modulus is high at over 250 ksi, however the section has substantial variability. At seven drop locations the base modulus was computed to be less than 50 ksi, which is traditionally used for an untreated Class 1 flexible base.

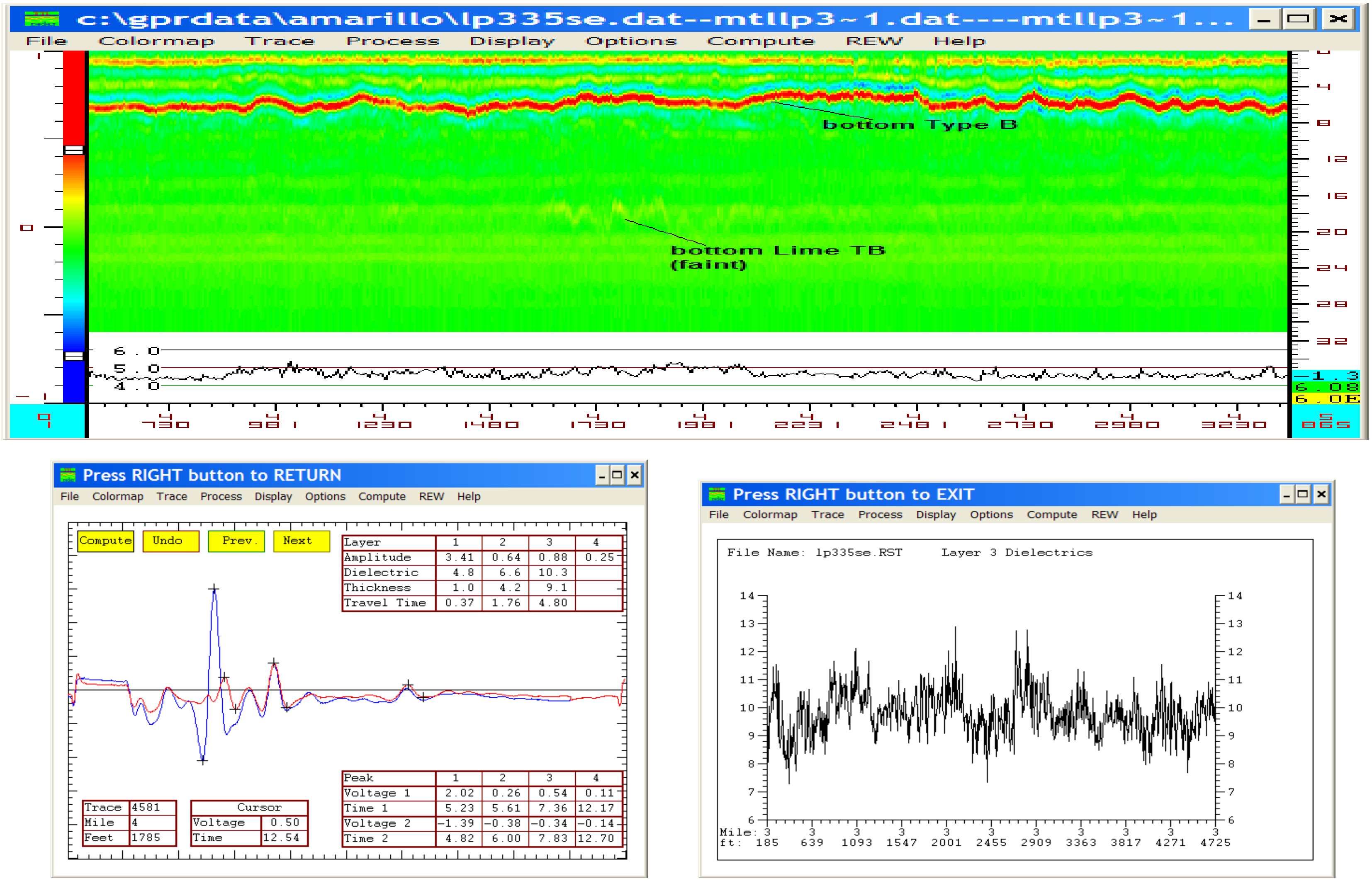


Figure B4. GPR Data from Section 2, Amarillo.

The top of the lime treated base is clear, no defects in hot mix. Some high values of base dielectric indicating higher moisture contents.

Section 3

County	Randall
Highway	Loop 335
From	IH 27
To	45th Street (approximately 4.5 miles)
Construction	6/01. Total HMA thickness 5.5 inches (4 inches of Type B, 1.5 inches of Type D). No underseal. Treated base is 12 inches over a 6-inch treated subgrade.
Stabilizer Used	2.5% lime
Performance Data	This section is relatively new. After 1 year the section was rated as excellent, with only minor amounts of longitudinal cracking.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 6.0)

District:4 (Amarillo)
County :191 (RANDALL)
Highway/Road: Loop 335

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	5.50	340,000	1,040,000	H1: v = 0.35
Base:	12.00	50,000	500,000	H2: v = 0.35
Subbase:	6.00	25,000	75,000	H3: v = 0.35
Subgrade:	240.00(User Input)	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.115	9,048	9.09	6.96	4.94	3.89	2.78	1.96	1.47	1040.0	86.5	25.0	14.5	2.46	92.5 *
0.201	9,172	7.87	6.02	4.26	3.44	2.55	1.86	1.49	1040.0	131.3	25.4	16.2	2.13	98.3 *
0.311	9,255	6.52	5.21	4.01	3.30	2.54	1.94	1.50	1040.0	251.6	29.0	15.9	1.60	106.9 *
0.403	9,215	6.53	5.07	3.57	2.96	2.22	1.73	1.39	1040.0	186.3	44.3	18.0	1.84	124.4 *
0.515	9,148	7.28	5.67	4.20	3.20	2.35	1.71	1.29	1040.0	127.0	43.3	16.9	2.84	104.4 *
0.603	9,287	5.21	4.08	3.28	2.88	2.32	1.84	1.46	952.6	500.0	68.6	16.5	1.44	104.1 *
0.707	9,315	5.64	4.41	3.42	2.95	2.34	1.85	1.46	1040.0	338.3	74.2	16.6	1.41	105.1 *
0.808	9,203	5.72	4.61	3.57	3.04	2.37	1.83	1.44	1040.0	290.0	75.0	16.3	2.22	107.3 *
0.900	9,283	6.60	5.24	3.98	3.30	2.54	1.94	1.47	1040.0	247.2	28.5	16.0	1.65	97.2 *
1.001	9,271	6.10	4.97	3.89	3.40	2.67	2.08	1.66	1040.0	334.3	53.0	14.3	2.18	112.8 *
1.100	9,180	6.60	5.30	4.07	3.49	2.76	2.21	1.73	1040.0	292.6	32.0	14.1	1.28	106.6 *
1.248	9,251	5.16	4.02	3.08	2.62	2.06	1.59	1.25	1040.0	371.1	57.8	19.3	1.72	102.8 *
1.400	9,076	7.15	5.77	4.35	3.81	3.06	2.41	1.93	1040.0	219.2	66.0	12.3	2.02	117.6 *
1.501	9,108	5.70	4.63	3.64	3.20	2.57	2.03	1.61	1040.0	417.2	42.7	14.7	1.81	106.2 *
1.608	9,124	5.37	4.25	3.30	2.89	2.30	1.82	1.44	1040.0	378.9	75.0	16.4	1.71	103.0 *
1.707	9,183	5.37	4.30	3.44	2.98	2.41	1.91	1.54	1038.1	471.6	44.1	15.8	1.31	120.0 *
1.835	9,195	6.51	5.32	4.18	3.64	2.94	2.33	1.86	1040.0	342.3	37.3	12.9	1.60	116.5 *
1.911	9,235	5.52	4.57	3.60	3.13	2.50	2.01	1.63	1040.0	449.1	42.5	15.2	1.64	124.9 *
2.004	9,295	5.10	3.79	2.73	2.13	1.57	1.13	0.87	1040.0	254.5	27.7	27.2	1.97	88.5 *
2.110	9,251	5.82	4.44	3.29	2.59	1.93	1.41	1.07	1040.0	212.2	44.3	21.0	2.13	97.0 *
2.161	9,219	6.07	4.57	3.32	2.69	2.05	1.54	1.19	1040.0	208.6	45.1	19.9	1.56	102.9 *
2.302	9,072	8.50	6.70	4.89	4.02	3.04	2.35	1.85	1040.0	129.4	34.7	12.8	1.49	121.9 *
2.401	9,199	8.27	6.45	4.74	3.89	2.96	2.27	1.75	1040.0	134.3	42.2	13.3	1.46	109.1 *
2.506	9,116	8.14	5.78	3.70	2.94	2.19	1.67	1.27	747.4	88.0	75.0	18.2	2.12	98.8 *
2.600	9,227	7.42	5.87	4.41	3.78	2.96	2.30	1.78	1040.0	179.0	72.2	12.9	1.91	102.5 *
2.710	8,977	8.26	6.62	4.98	4.19	3.26	2.51	1.92	1040.0	155.5	39.3	11.7	1.76	104.1 *
2.802	9,068	6.37	4.56	3.25	2.53	1.90	1.43	1.10	771.0	195.2	30.9	21.6	0.82	105.4
2.904	9,168	6.32	4.91	3.58	3.00	2.30	1.82	1.44	1040.0	229.7	40.2	17.3	1.57	112.2 *
3.007	9,152	6.93	5.59	4.20	3.42	2.57	1.93	1.47	1040.0	176.5	44.0	15.3	2.43	102.6 *
3.103	9,275	7.07	5.56	4.09	3.35	2.49	1.85	1.42	1040.0	160.3	41.8	16.3	2.42	103.6 *
3.200	9,203	7.91	6.15	4.53	3.67	2.74	2.06	1.55	1040.0	148.4	26.4	14.8	1.58	100.1 *
3.306	9,247	6.88	5.65	4.27	3.66	2.82	2.15	1.63	1040.0	211.4	68.5	13.5	2.76	94.0 *
3.415	9,243	7.45	5.72	4.17	3.41	2.62	2.01	1.52	1023.5	160.3	42.9	15.3	1.33	98.6
3.514	9,132	7.06	5.44	4.00	3.21	2.42	1.81	1.40	1040.0	160.9	41.8	16.4	1.65	109.9 *
3.601	9,215	6.11	4.78	3.66	2.95	2.25	1.71	1.32	1040.0	256.4	28.2	18.1	1.36	106.7 *
3.713	9,219	9.28	6.76	4.59	3.62	2.67	2.00	1.54	800.1	78.8	60.7	14.9	1.62	111.0
3.815	9,112	9.72	7.25	4.81	3.71	2.72	2.06	1.56	940.5	58.2	62.7	14.4	1.38	106.3

Figure B5. Modulus 6 Results from Section 3, Amarillo.

3.901	9,100	7.52	5.70	4.05	3.38	2.55	1.94	1.47	941.7	144.8	51.7	15.4	1.93	95.8
4.000	9,136	7.03	5.29	3.86	3.16	2.44	1.86	1.45	870.2	185.4	45.1	16.4	1.40	110.0
4.106	9,112	6.55	5.06	3.79	3.13	2.40	1.83	1.42	1039.3	225.7	28.4	16.8	1.39	106.5 *
4.202	9,132	6.95	5.25	3.70	2.96	2.22	1.70	1.33	1040.0	147.8	42.9	18.0	1.24	113.2 *
4.298	9,291	5.31	3.87	2.88	2.33	1.81	1.42	1.15	876.4	282.8	75.0	22.3	0.83	131.2 *
Mean:		6.81	5.29	3.91	3.23	2.48	1.90	1.48	1005.7	229.0	47.0	16.3	1.74	106.0
Std. Dev:		1.17	0.87	0.56	0.46	0.36	0.29	0.23	78.0	109.2	16.0	3.0	0.45	8.6
Var Coeff(%):		17.20	16.38	14.30	14.18	14.32	15.08	15.33	7.8	47.7	34.1	18.1	25.90	8.2

Figure B5. Modulus 6 Results from Section 3, Amarillo (Continued).
Low variations in maximum deflections, relatively stiff base. Relatively uniform but section only 1 year old.

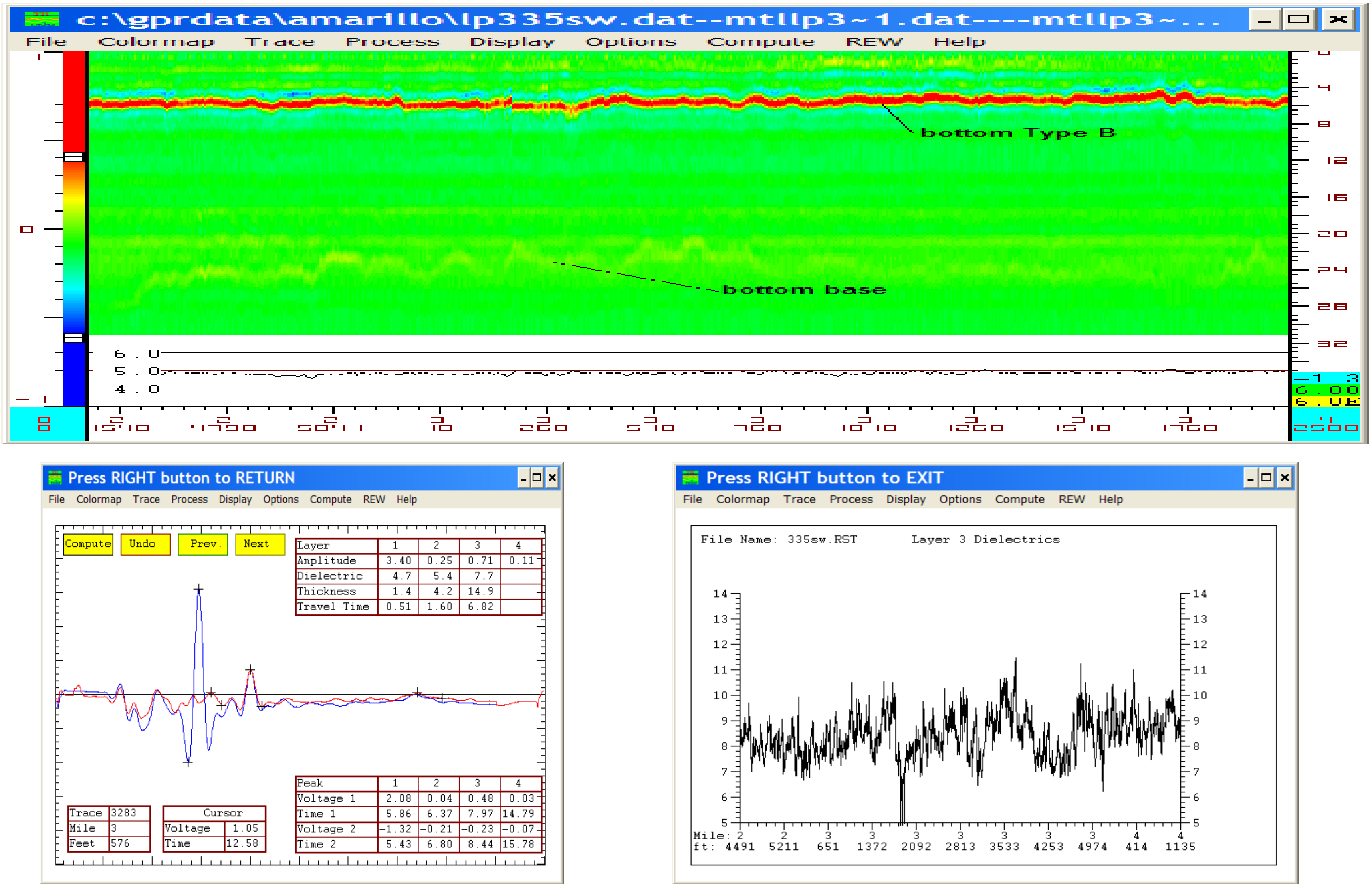


Figure B6. GPR Data from Section 3, Amarillo.
Layer interfaces clear, no problems detected in GPR data.

Section 4

County	Hartley
Highway	US 54
From	TRM 242
To	TRM 252 (10 miles approx.)
Construction	3/96
Stabilizer Used	3% cement. 8 inches of cement treated material over 10 inches of untreated base. 1.5 inch HMA surface.
Performance Data	The district rated the performance of this section as very poor. Substantial cracking initiated easily in the life. Crack seals were placed. The ride quality was impacted by the cracking. The Amarillo District has reported little success with cement stabilization; even at low levels like 3 percent the performance has been poor.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 6.0)

District:4 (Amarillo)
County :104 (HARTLEY)
Highway/Road: US 54

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	2.00	200,000	200,000	H1: v = 0.35
Base:	8.00	100,000	2,000,000	H2: v = 0.25
Subbase:	10.00	10,000	150,000	H3: v = 0.35
Subgrade:	214.36(User Input)	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	ERR/Sens	Absolute Depth to Bedrock
0.211	11,166	10.26	5.42	3.30	2.48	1.83	1.37	1.17	200.0	175.2	133.0	29.8	2.79	294.3
0.401	11,170	7.75	4.46	3.36	2.66	1.90	1.48	0.99	200.0	491.6	150.0	27.6	4.34	300.0 *
0.607	10,912	8.10	5.70	4.01	3.03	2.21	1.71	1.31	200.0	636.2	111.2	21.8	1.10	273.0
0.803	10,900	9.84	6.93	4.51	3.37	2.47	1.89	1.50	200.0	435.4	78.3	19.9	2.20	300.0
1.003	11,233	7.25	5.41	3.51	2.70	1.99	1.58	1.20	200.0	749.9	124.8	25.0	3.00	300.0
1.200	11,484	7.39	4.78	3.30	2.63	2.09	1.62	1.14	200.0	699.8	150.0	26.4	4.35	174.9 *
1.408	10,943	10.74	5.12	3.39	2.50	1.79	1.54	0.91	200.0	144.8	150.0	29.1	3.66	300.0 *
1.608	10,661	11.49	6.69	4.01	3.00	2.19	1.66	1.32	200.0	179.8	82.0	23.3	2.98	300.0
1.801	10,761	9.47	4.99	3.04	2.28	1.62	1.22	0.95	200.0	188.8	128.0	31.8	2.39	300.0
1.957	11,063	7.38	4.89	3.48	2.76	2.08	1.60	1.04	200.0	672.8	150.0	24.5	2.58	140.3 *
2.201	9,895	13.54	7.06	4.18	2.95	2.14	1.59	1.27	200.0	112.7	60.3	22.3	1.80	289.0
2.411	10,618	9.72	6.69	5.02	3.76	2.67	1.83	1.24	200.0	624.5	64.3	18.0	2.46	159.2
2.602	10,574	11.77	5.45	3.93	2.90	2.09	1.56	1.19	200.0	122.1	150.0	24.8	2.50	267.1 *
2.800	10,880	7.61	5.01	3.23	2.48	1.87	1.45	1.13	200.0	465.7	142.4	27.1	2.62	300.0
3.001	10,030	13.69	8.29	4.27	2.57	1.61	1.12	0.92	200.0	194.5	14.7	28.7	2.02	136.7
3.205	9,477	6.40	4.32	3.43	2.61	1.81	1.44	1.10	200.0	791.5	150.0	22.1	2.36	257.4 *
3.408	11,059	8.71	4.88	3.26	2.48	1.70	1.39	0.89	200.0	259.5	150.0	29.6	2.86	230.4 *
3.605	10,475	11.83	7.70	4.10	2.57	1.61	1.26	1.01	200.0	276.2	19.2	28.9	3.71	135.4
3.799	9,811	7.53	5.88	3.81	2.72	1.93	1.71	1.03	200.0	642.5	80.8	21.3	5.68	300.0
3.953	10,177	13.43	7.90	4.21	2.75	1.89	1.35	1.01	200.0	173.6	25.1	25.3	2.39	219.1
4.207	8,985	7.61	4.76	3.17	2.28	1.57	1.08	0.82	200.0	390.0	68.6	26.5	1.83	172.9
4.412	10,602	8.00	5.34	3.24	2.26	1.59	1.14	0.85	200.0	522.1	56.2	30.8	2.12	217.5
4.606	10,268	14.06	6.78	3.38	2.19	1.47	1.05	0.78	200.0	113.1	29.9	32.2	2.96	200.7
4.800	9,875	9.78	5.91	3.61	2.59	1.85	1.39	1.07	200.0	235.8	68.5	24.9	2.07	285.1
5.001	10,685	7.59	5.49	3.64	2.60	1.77	1.29	0.91	200.0	862.8	50.4	26.9	1.85	221.5
5.200	10,630	12.02	7.56	4.45	2.73	1.61	1.04	0.78	200.0	339.2	13.9	30.5	1.35	108.7
5.403	10,935	11.20	6.88	4.22	3.02	2.22	1.69	1.32	200.0	228.5	69.9	23.1	2.86	300.0
5.602	10,776	8.04	5.79	3.46	2.26	1.46	1.19	0.76	200.0	630.7	38.2	31.4	5.52	156.0
5.803	11,055	5.62	3.56	2.83	1.95	1.51	1.21	0.81	200.0	1196.1	150.0	33.7	3.95	151.4 *
5.902	10,614	5.00	3.94	2.99	2.36	1.59	1.23	0.84	200.0	2000.0	27.8	36.9	12.04	199.8 *
6.091	10,455	6.45	4.65	3.00	2.19	1.56	1.11	0.80	200.0	951.9	70.0	30.7	1.89	194.2
6.204	11,063	5.26	3.73	2.55	2.04	1.50	1.10	0.86	200.0	2000.0	32.9	41.0	11.14	246.4 *
6.408	11,122	7.89	4.21	2.82	2.07	1.55	1.13	0.96	200.0	296.5	150.0	35.4	2.82	239.7 *
6.602	9,021	8.87	6.51	4.10	2.78	1.94	1.44	1.04	200.0	505.6	32.2	20.8	3.01	285.4
6.811	9,001	8.72	5.06	3.31	2.32	1.63	1.23	0.93	200.0	227.5	80.7	25.4	0.79	295.1
7.000	8,941	10.39	5.01	3.22	2.31	1.59	1.17	0.89	200.0	117.4	103.5	26.3	1.17	243.7
7.203	9,358	9.63	3.82	2.60	1.97	1.49	1.11	0.91	200.0	115.6	150.0	32.5	6.36	281.8 *

Figure B7. Modulus 6 Results from Section 4, Amarillo.

7.606	9,187	6.52	3.01	2.13	1.72	1.37	1.09	0.87	200.0	307.8	150.0	36.7	11.48	300.0	*
7.801	9,191	5.59	2.56	2.20	1.78	1.46	1.14	0.90	200.0	787.2	150.0	34.0	13.64	300.0	*
7.857	9,434	7.81	3.79	2.56	2.08	1.62	1.25	1.00	200.0	223.2	150.0	31.2	8.54	300.0	*
Mean:		9.00	5.40	3.47	2.52	1.80	1.36	1.01	200.0	502.2	93.9	28.0	3.88	229.1	
Std. Dev:		2.42	1.36	0.64	0.41	0.30	0.24	0.18	0.0	441.0	50.1	5.1	3.16	74.6	
Var Coeff(%):		26.90	25.21	18.56	16.47	16.62	17.45	17.78	0.0	87.8	53.3	18.4	81.38	32.6	

Figure B7. Modulus 6 Results from Section 4, Amarillo (Continued).
Very stiff base with average modulus close to 500 ksi.

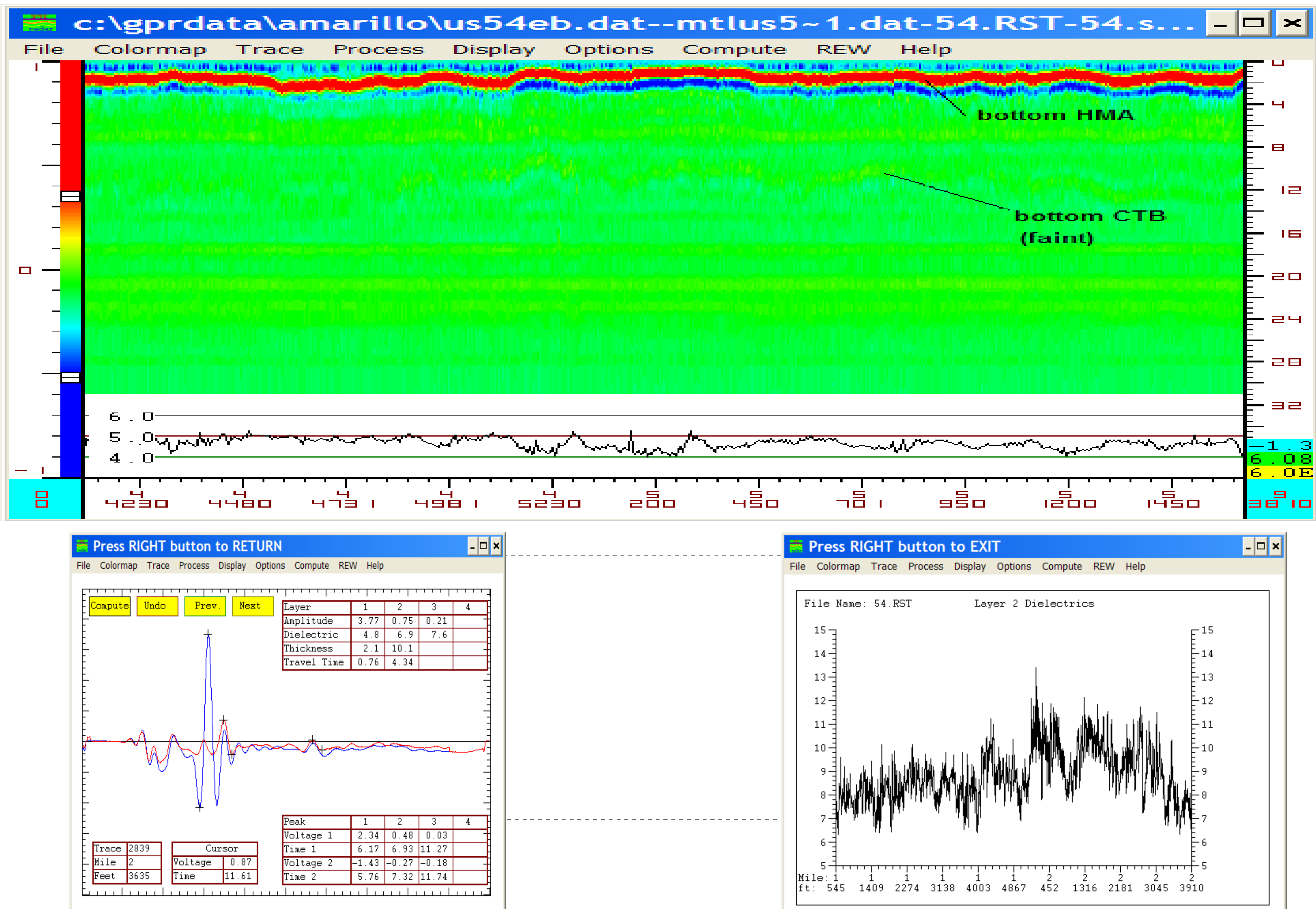


Figure B8. GPR Data from Section 4, Amarillo. No defects apparent in data.

Section 5

County	Hartley
Highway	US 87 (SB only)
From	Dalhart
To	Hartley (approx 12 miles)
Construction	10/94
Stabilizer Used	5 inches cold inplace hi-float emulsion, was used to treat 5 inches of recycled base and RAP. The plans call for 2 percent residual asphalt. Initial surface was 1.5 inches, but an overlay was placed in 1999. The total HMA thickness at the time of FWD testing was 4 inches.
Performance Data	A visual inspection was conducted in Dec 2002. The section was cracked throughout its length. The cracking was mostly longitudinal but located primarily in the wheel paths. Thought to be potentially structural cracking.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 6.0)

District:4 (Amarillo)			MODULI RANGE(psi)		
County :104 (HARTLEY)		Thickness(in)	Minimum	Maximum	Poisson Ratio Values
Highway/Road: US 0087	Pavement:	4.00	160,000	720,000	H1: v = 0.35
	Base:	5.00	20,000	1,000,000	H2: v = 0.35
	Subbase:	12.00	10,000	150,000	H3: v = 0.35
	Subgrade:	261.12(User Input)	15,000		H4: v = 0.40

	Load	Measured Deflection (mils):							Calculated Moduli values (ksi):				Absolute	Depth to	
Station	(lbs)	R1	R2	R3	R4	R5	R6	R7	SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	ERR/Sens	Bedrock	
0.603	9,120	13.66	5.92	3.10	2.18	1.54	1.15	0.93	286.0	28.7	84.9	26.7	0.50	300.0	
0.800	9,080	12.48	7.31	4.15	2.78	1.93	1.50	1.18	681.8	39.7	50.0	20.3	0.95	300.0	
1.001	9,124	12.96	7.69	4.61	3.06	2.10	1.49	1.15	190.0	190.9	30.7	20.1	0.78	248.9	
1.208	8,949	19.06	9.26	4.89	3.19	2.15	1.54	1.19	160.0	48.8	25.4	18.7	1.09	246.9	*
1.402	9,076	10.85	5.00	2.83	2.05	1.53	1.20	0.96	376.3	35.1	150.0	27.0	1.44	300.0	*
1.603	9,176	7.36	3.32	2.13	1.63	1.22	0.93	0.73	160.0	218.3	150.0	38.1	3.74	300.0	*
1.802	8,965	16.91	7.88	3.89	2.50	1.76	1.32	1.04	303.3	21.8	48.5	21.8	1.31	300.0	*
2.013	8,949	16.74	8.69	4.55	3.03	2.03	1.48	1.15	275.6	43.1	30.1	19.4	1.20	235.0	
2.202	8,913	16.42	9.52	5.30	3.63	2.55	1.85	1.44	462.7	32.6	35.8	15.5	0.79	293.7	
2.400	8,842	25.86	13.04	5.73	3.48	2.39	1.81	1.48	216.4	20.0	16.0	15.8	1.51	156.5	*
2.601	8,866	19.19	10.93	5.95	3.92	2.67	1.97	1.57	380.9	29.8	26.0	14.5	0.65	270.7	
2.800	8,981	20.54	12.95	6.93	4.11	2.54	1.79	1.42	500.4	49.6	10.6	15.4	0.74	144.6	
3.001	8,842	17.62	9.48	4.74	3.07	2.14	1.56	1.26	431.1	20.0	35.2	18.0	0.56	300.0	*
3.254	8,985	25.43	15.71	7.53	4.09	2.38	1.62	1.29	443.5	20.0	10.0	14.9	4.53	115.5	*
3.400	8,965	15.18	7.81	3.79	2.18	1.43	1.05	0.86	266.2	68.5	20.3	27.1	0.18	160.0	
3.600	8,826	19.74	10.94	4.45	2.37	1.56	1.25	1.06	415.3	22.9	14.7	22.9	3.18	95.0	*
3.800	8,937	16.13	7.31	3.07	1.72	1.19	0.93	0.81	287.8	29.7	28.9	29.7	3.74	113.9	*
4.201	8,985	12.15	6.34	3.56	2.40	1.67	1.23	0.98	353.6	60.8	49.9	24.0	0.43	300.0	
4.401	8,901	19.38	9.76	5.46	3.98	2.99	2.31	1.89	249.8	20.0	70.2	13.5	1.69	300.0	*
4.606	8,814	23.13	11.83	6.63	4.67	3.33	2.48	1.93	212.1	20.0	39.3	11.8	0.50	300.0	*
4.800	8,985	13.96	6.13	3.23	2.30	1.65	1.27	1.04	297.2	24.2	102.4	24.2	0.83	300.0	*
5.000	8,850	17.85	6.31	3.24	2.39	1.77	1.35	1.10	160.0	24.0	67.3	24.0	4.66	300.0	*
5.200	8,901	16.72	9.62	5.88	4.07	2.80	2.02	1.52	181.0	92.7	30.4	14.5	0.85	281.1	
5.602	9,255	10.84	6.24	3.69	2.76	2.04	1.57	1.24	720.0	32.6	139.1	20.0	0.92	300.0	*
5.814	8,894	16.93	8.16	4.13	2.74	1.90	1.45	1.13	304.8	23.4	45.9	20.4	0.72	300.0	
6.000	9,080	12.32	6.39	3.63	2.44	1.67	1.18	0.91	256.6	87.1	42.7	24.8	1.05	242.4	
6.201	9,168	10.87	6.21	3.57	2.57	1.87	1.43	1.05	720.0	33.1	107.4	21.5	0.80	264.3	*
6.401	9,076	13.65	8.30	4.82	3.19	2.19	1.59	1.25	442.2	85.0	29.5	18.5	0.41	297.9	
6.801	9,060	17.13	9.59	5.33	3.84	2.69	1.96	1.53	422.0	25.0	48.8	14.9	1.28	300.0	
7.000	8,961	15.84	7.56	4.04	2.91	2.18	1.70	1.33	311.2	20.0	102.2	18.5	1.77	300.0	*
7.181	9,116	13.02	8.04	4.22	3.09	2.25	1.72	1.35	720.0	33.3	51.9	18.5	3.58	300.0	*
7.400	8,913	15.90	9.69	5.13	3.29	2.15	1.53	1.14	591.1	44.2	20.8	18.0	1.29	195.0	
7.600	9,096	11.63	6.52	3.75	2.70	1.95	1.48	1.19	700.7	25.8	119.2	20.3	0.43	300.0	
7.801	8,862	21.74	11.91	6.39	4.06	2.75	1.99	1.56	203.0	46.7	17.9	14.3	0.51	255.7	
8.000	8,750	23.04	14.09	6.65	3.93	2.61	1.88	1.47	471.5	20.0	12.8	14.4	1.37	192.2	*
8.202	8,973	19.11	11.52	6.19	3.87	2.51	1.76	1.29	367.0	58.3	14.9	15.6	1.06	185.1	
8.401	8,679	30.06	17.46	8.39	5.30	3.65	2.75	2.22	245.5	20.0	12.1	10.4	2.08	291.4	*

Figure B9. Modulus 6 Results from Section 5, Amarillo.

8.600	8,560	30.76	18.20	8.89	5.52	3.52	2.46	1.90	266.4	20.0	10.0	10.2	2.30	164.2	*
8.800	8,778	22.52	12.83	6.26	3.73	2.47	1.77	1.43	389.5	22.3	15.1	15.0	0.68	207.7	
9.001	9,100	13.38	8.18	4.71	3.19	2.17	1.61	1.27	720.0	43.1	38.5	18.3	0.84	271.1	*
9.208	8,667	26.23	14.38	7.03	4.52	3.18	2.45	2.00	240.1	20.0	18.0	12.0	1.95	300.0	*
9.402	8,850	17.66	9.57	4.95	3.43	2.32	1.72	1.31	414.6	20.3	41.6	16.5	1.44	300.0	
9.600	9,108	13.65	7.76	4.59	3.18	2.25	1.67	1.33	422.2	53.2	47.8	18.0	0.39	300.0	
9.806	9,001	16.07	10.48	5.77	3.62	2.29	1.58	1.24	640.2	70.8	14.3	17.4	1.22	161.8	
10.007	9,156	13.08	8.54	5.21	3.78	2.69	1.94	1.46	720.0	63.4	42.2	15.4	1.46	281.6	*
10.200	9,152	10.93	6.06	3.76	2.80	2.08	1.57	1.23	553.4	40.5	129.3	19.6	0.35	300.0	
10.403	9,156	11.85	6.88	4.11	3.09	2.29	1.72	1.33	719.1	25.8	146.2	17.7	0.84	300.0	*
10.612	9,251	8.93	5.15	3.15	2.36	1.77	1.35	1.09	720.0	54.5	140.3	23.3	0.98	300.0	*
10.808	9,013	13.65	6.41	3.36	2.47	1.88	1.58	1.26	356.6	21.5	150.0	21.5	3.46	300.0	*
11.007	9,152	10.54	5.85	3.43	2.36	1.65	1.17	0.92	396.4	96.0	54.0	25.2	0.97	249.1	
11.244	9,080	11.78	6.86	4.05	3.02	2.25	1.73	1.38	720.0	24.8	149.9	17.8	0.90	300.0	*
11.402	9,116	9.40	5.27	3.12	2.31	1.71	1.31	1.05	720.0	40.8	145.1	23.6	0.85	300.0	*
11.600	9,180	10.92	6.19	3.61	2.68	1.95	1.47	1.14	720.0	30.0	134.1	20.7	0.75	300.0	*
11.801	9,080	17.86	10.97	5.48	3.30	2.16	1.56	1.31	703.5	23.4	18.5	17.9	0.76	196.0	
Mean:		16.31	8.96	4.76	3.16	2.19	1.62	1.28	429.4	44.2	59.0	19.2	1.36	254.6	
Std. Dev:		5.24	3.19	1.45	0.83	0.54	0.38	0.30	192.6	37.8	47.9	5.1	1.08	94.6	
Var Coeff(%):		32.11	35.55	30.45	26.38	24.41	23.61	23.48	44.9	85.5	81.1	26.7	79.63	37.1	

Figure B9. Modulus 6 Results from Section 5, Amarillo (Continued).

Extremely low moduli value from the emulsion base. This is lower than would have been anticipated from a Class 1 flexible base. It is possible that the 2 percent emulsion was not sufficient to effectively treat this material.

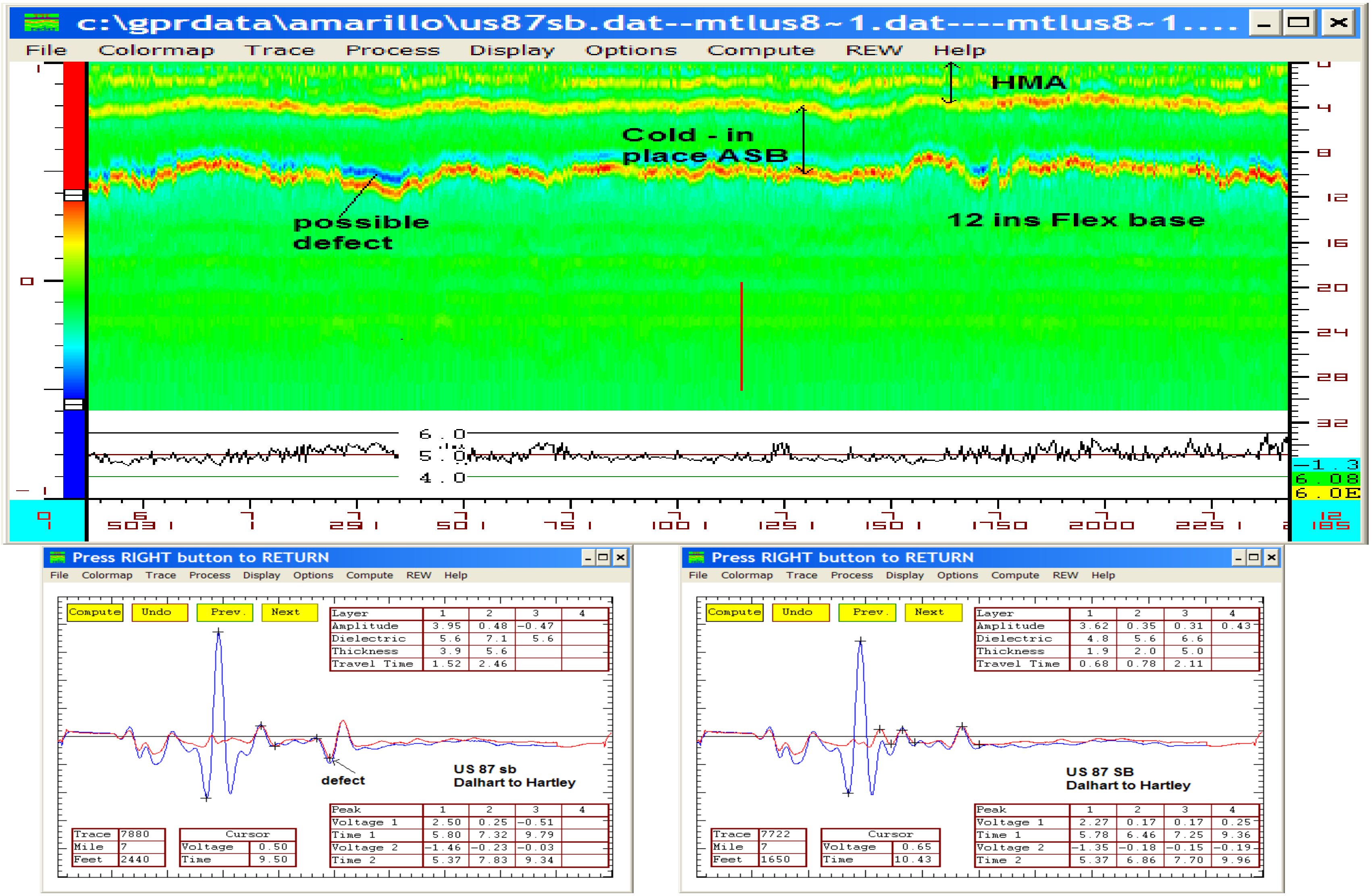


Figure B10. GPR Data from Section 5, Amarillo.

All interfaces clear in GPR data. Possible problems at the bottom of the treated layer. Looks like a low density problem at bottom.

Section 6

County	Hartley
Highway	US 87 (NB only)
From	Hartley CL
To	Dalhart
Construction	11/99
Stabilizer Used	This was not an in-place recycling job, it was new construction where the subgrade was treated with 10 percent fly ash and the 14 inch thick base was treated with 8 percent fly ash. The top of the base had a one-course ST and 1.5 inches of Type D Hot Mix.
Performance Data	Even though this is a new section performance has not been good. Longitudinal cracking is evident in the surface, and areas of alligator cracking with base pumping are evident. No GPR data were collected on this project.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 6.0)

District:4 (Amarillo)
County :104 (HARTLEY)
Highway/Road: US 0087

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	2.00	283,700	283,700	H1: v = 0.35
Base:	14.00	30,000	400,000	H2: v = 0.35
Subbase:	0.00			H3: v = 0.00
Subgrade:	248.10(User Input)	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock	
0.000	9,275	7.19	4.17	2.02	1.36	0.95	0.72	0.62	283.7	169.3	0.0	44.7	7.50	300.0	
0.201	9,156	10.31	5.18	2.73	2.00	1.51	1.18	0.94	283.7	112.7	0.0	31.1	5.34	300.0	
0.404	9,223	7.36	4.24	2.35	1.65	1.20	0.93	0.76	283.7	189.6	0.0	38.1	4.43	300.0	
0.602	9,291	9.61	6.17	3.44	2.36	1.75	1.34	1.06	283.7	152.0	0.0	25.8	5.30	300.0	
0.803	9,164	7.90	4.90	2.76	1.98	1.46	1.22	1.05	283.7	192.5	0.0	31.0	6.20	300.0	
1.000	9,287	9.66	5.62	3.06	1.94	1.37	1.04	0.79	283.7	127.8	0.0	31.1	6.47	300.0	
1.210	9,517	4.19	3.05	2.33	1.91	1.49	1.14	0.89	283.7	400.0	0.0	40.6	15.50	298.7	*
1.404	9,386	6.52	4.09	2.50	1.83	1.39	1.09	0.89	283.7	280.4	0.0	34.3	4.43	300.0	
1.601	9,084	11.75	6.49	3.28	2.28	1.68	1.29	1.06	283.7	96.3	0.0	26.1	4.76	300.0	
1.800	9,239	7.90	4.06	2.18	1.60	1.20	0.91	0.74	283.7	160.7	0.0	39.9	4.91	300.0	
2.000	9,394	5.36	3.71	2.59	2.00	1.42	1.02	0.76	283.7	400.0	0.0	33.1	3.22	216.2	*
2.202	9,334	6.30	4.21	2.43	1.71	1.17	0.86	0.62	283.7	261.9	0.0	37.7	6.19	227.9	
2.400	9,239	10.24	6.09	3.11	2.23	1.61	1.50	0.95	283.7	126.3	0.0	27.4	8.67	300.0	
2.602	9,191	10.35	4.49	2.21	1.66	1.17	0.85	0.64	283.7	97.7	0.0	38.8	5.03	300.0	
2.796	9,084	10.89	5.40	2.54	1.78	1.32	1.02	0.82	283.7	93.2	0.0	32.9	5.22	277.7	
2.895	9,219	7.19	3.93	2.02	1.42	1.00	0.73	0.57	283.7	172.7	0.0	44.2	5.09	300.0	
3.003	9,247	11.02	5.30	2.70	1.81	1.25	0.86	0.63	283.7	92.5	0.0	34.1	5.32	172.8	
3.203	9,187	11.94	6.54	3.18	2.16	1.45	1.03	0.79	283.7	88.8	0.0	27.9	8.40	300.0	
3.400	9,227	9.12	6.03	3.59	2.69	2.02	1.55	1.26	283.7	190.3	0.0	22.6	4.56	300.0	
3.601	9,295	9.69	5.57	3.33	2.64	2.07	1.65	1.31	283.7	170.1	0.0	24.2	6.58	300.0	
3.800	9,132	13.46	8.55	4.53	3.04	2.09	1.53	1.21	283.7	91.8	0.0	19.6	7.30	251.8	
4.000	9,295	6.30	3.77	2.11	1.47	1.06	0.78	0.63	283.7	235.7	0.0	43.3	4.59	256.8	
4.200	9,263	10.41	6.39	3.73	2.62	1.75	1.20	0.93	283.7	133.4	0.0	24.8	5.79	172.1	
4.392	9,037	13.30	7.50	4.07	2.72	1.97	1.56	1.29	283.7	87.7	0.0	21.4	5.02	300.0	
4.506	9,271	6.19	3.57	1.98	1.31	0.85	0.60	0.46	283.7	214.4	0.0	49.1	7.40	157.2	
4.616	9,247	7.69	4.85	2.78	1.88	1.25	0.88	0.67	283.7	185.6	0.0	34.2	7.12	185.5	
4.802	9,454	6.87	4.32	2.72	1.98	1.55	1.24	0.99	283.7	279.8	0.0	31.2	4.99	300.0	
5.000	9,191	11.37	8.29	4.62	2.80	1.84	1.41	1.13	283.7	119.3	0.0	20.8	11.95	180.5	
5.201	9,021	16.85	10.24	5.30	3.56	2.46	1.80	1.44	283.7	66.7	0.0	16.3	6.77	269.8	
5.413	9,342	9.01	4.65	2.76	2.15	1.65	1.31	1.07	283.7	161.6	0.0	31.1	6.29	300.0	
5.600	9,263	10.83	6.97	3.88	2.70	1.89	1.44	1.17	283.7	130.4	0.0	22.9	5.43	289.3	
5.801	9,287	8.26	5.51	3.43	2.60	1.98	1.56	1.28	283.7	234.5	0.0	23.1	4.59	300.0	
6.002	9,323	9.08	5.94	3.65	2.67	1.91	1.43	1.11	283.7	188.1	0.0	23.5	3.20	300.0	
6.201	9,108	11.46	6.29	3.35	2.33	1.75	1.31	1.07	283.7	103.7	0.0	25.9	4.46	300.0	
6.424	8,798	21.85	12.27	5.67	3.63	2.55	2.01	1.62	283.7	41.1	0.0	14.4	7.05	249.2	
6.600	9,231	10.96	5.14	2.24	1.53	1.15	0.94	0.80	283.7	88.5	0.0	38.0	6.92	126.6	
6.841	9,319	7.16	4.62	2.85	1.96	1.33	0.96	0.73	283.7	226.7	0.0	33.0	5.44	215.6	

Figure B11. Modulus 6 Results from Section 6, Amarillo.

7.000	9,152	10.22	6.52	3.75	2.27	1.42	0.94	0.66	283.7	121.3	0.0	27.1	13.89	135.4	
7.201	9,330	10.60	6.33	3.28	2.18	1.50	1.14	0.93	283.7	115.2	0.0	28.3	7.19	245.7	
7.401	9,180	11.98	6.87	3.59	2.35	1.63	1.21	0.97	283.7	95.7	0.0	25.4	6.83	267.3	
7.600	9,303	5.88	3.94	2.41	1.69	1.21	0.90	0.72	283.7	307.8	0.0	37.0	4.66	280.6	
7.803	9,323	5.30	3.41	2.37	1.81	1.36	1.03	0.84	283.7	400.0	0.0	35.3	3.23	300.0	*
8.001	9,291	7.02	3.96	2.00	1.25	0.90	0.65	0.51	283.7	170.7	0.0	47.0	7.84	278.6	
8.201	9,271	6.89	3.51	1.74	1.22	0.85	0.62	0.50	283.7	168.8	0.0	50.7	4.96	300.0	
8.400	9,247	9.95	6.37	3.94	2.75	1.88	1.39	1.09	283.7	155.8	0.0	22.9	4.26	234.1	
8.604	9,430	5.43	3.38	2.23	1.76	1.35	1.06	0.86	283.7	400.0	0.0	36.1	4.01	300.0	*
8.802	9,064	10.94	6.51	3.78	2.63	1.80	1.27	0.91	283.7	120.5	0.0	23.8	4.82	194.6	
9.003	9,191	9.54	5.06	2.58	1.97	1.50	1.17	0.96	283.7	129.0	0.0	32.2	6.68	300.0	
9.204	8,770	21.59	8.83	3.29	2.52	1.82	1.36	1.11	283.7	34.0	0.0	23.3	7.60	62.2	
9.401	9,044	11.98	7.43	4.41	3.30	2.42	1.79	1.39	283.7	125.3	0.0	18.4	3.52	278.4	
9.600	9,370	5.20	3.73	2.76	2.21	1.67	1.26	0.98	283.7	400.0	0.0	29.8	6.78	294.8	*
9.800	9,164	12.30	6.48	3.51	2.41	1.72	1.31	1.07	283.7	92.9	0.0	25.3	3.25	300.0	
10.000	9,013	12.60	7.85	4.44	2.97	2.05	1.56	1.27	283.7	102.0	0.0	19.9	5.55	261.0	
10.200	9,128	11.13	6.70	3.61	2.33	1.57	1.22	0.98	283.7	108.2	0.0	25.6	7.13	209.6	
10.408	9,040	13.98	8.36	4.15	2.67	1.91	1.54	1.24	283.7	78.6	0.0	20.9	7.12	300.0	
10.600	8,870	16.61	8.17	2.96	2.09	1.71	1.32	1.10	283.7	49.7	0.0	26.0	10.86	59.0	
10.801	9,291	5.72	3.48	2.17	1.58	1.17	0.87	0.69	283.7	313.6	0.0	40.5	2.66	276.9	
10.877	9,327	7.29	4.88	3.07	2.23	1.59	1.21	0.99	283.7	252.8	0.0	28.1	3.32	300.0	
11.000	9,140	8.99	4.94	2.61	1.73	1.14	0.76	0.56	283.7	127.5	0.0	35.9	8.23	150.9	
11.206	9,315	5.22	2.65	1.80	1.40	1.06	0.81	0.64	283.7	353.6	0.0	48.5	6.33	300.0	
11.401	9,187	8.63	6.69	4.04	2.78	1.93	1.38	1.06	283.7	204.4	0.0	21.3	7.97	219.7	
11.600	9,037	9.02	5.58	3.25	2.24	1.67	1.35	1.09	283.7	162.3	0.0	26.6	5.36	300.0	
11.801	8,735	20.94	10.63	5.06	3.64	2.65	1.94	1.55	283.7	43.8	0.0	15.3	4.66	300.0	
12.050	8,993	15.99	7.69	4.29	2.88	1.94	1.40	1.02	283.7	63.1	0.0	20.5	3.36	211.2	
Mean:		9.94	5.75	3.14	2.20	1.58	1.19	0.94	283.7	169.7	0.0	30.2	6.09	251.4	
Std. Dev:		3.82	1.93	0.89	0.58	0.41	0.32	0.26	0.0	96.7	0.0	8.7	2.37	139.1	
Var Coeff(%):		38.44	33.55	28.35	26.31	25.92	26.93	27.84	0.0	57.0	0.0	28.9	38.92	55.4	

Figure B11. Modulus 6 Results from Section 6, Amarillo (Continued).
Large variation in maximum deflection and base modulus. At four locations the base modulus is computed to be less than 50 ksi.

Section 7

County	Sherman
Highway	US 287
From	Sherman County Line
To	3.5 miles North
Construction	11/99
Stabilizer Used	Subgrade was treated with 10 percent fly ash. The total base thickness is 18 inches. The top 8 inches of the base was treated with a 4 percent CSS-1 emulsion with a RR-650 reclaimer. Compaction with a padded foot, then pnuematic then steel wheel rollers. No underseal was used; then approximately 4 inches of type B and 2.5 inches of type D surface were placed.
Performance Data	Very good, some minor longitudinal cracking.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 6.0)

District:4 (Amarillo)
County :211 (SHERMAN)
Highway/Road: US 287

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	6.50	20,000	470,000	H1: v = 0.35
Base:	18.00	50,000	1,000,000	H2: v = 0.35
Subbase:	0.00			H3: v = 0.00
Subgrade:	266.19(by DB)	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
0.000	9,148	7.06	3.80	2.59	2.17	1.71	1.34	1.08	207.6	201.4	0.0	25.2	2.52	116.7
0.100	10,455	4.89	2.44	1.61	1.38	1.12	0.88	0.74	282.5	394.1	0.0	45.6	3.89	300.0
0.200	9,120	7.08	3.44	2.51	2.18	1.76	1.45	1.19	144.0	369.7	0.0	24.4	2.57	126.8
0.306	9,140	6.91	2.94	1.96	1.75	1.46	1.20	0.98	121.4	429.7	0.0	30.6	5.27	300.0
0.402	9,203	6.65	3.17	2.08	1.86	1.57	1.28	1.05	148.8	375.5	0.0	28.9	5.61	300.0
0.503	9,223	8.36	4.07	3.07	2.77	2.30	1.89	1.50	113.8	441.1	0.0	18.5	2.74	300.0
0.605	9,100	9.23	3.85	2.80	2.47	2.05	1.67	1.35	87.2	392.7	0.0	21.2	3.33	300.0
0.701	9,120	7.73	4.02	2.94	2.78	2.35	1.96	1.67	125.0	525.9	0.0	17.3	3.88	300.0
0.810	9,084	9.37	4.69	3.31	2.77	2.15	1.76	1.39	128.2	187.0	0.0	19.6	2.24	112.6
0.900	9,235	5.78	2.40	1.83	1.70	1.42	1.17	1.00	132.8	951.0	0.0	29.6	3.06	300.0
1.000	9,176	6.20	2.62	1.82	1.63	1.36	1.11	0.91	132.8	547.0	0.0	32.7	4.39	300.0
1.103	9,128	7.05	2.87	1.94	1.69	1.37	1.09	0.87	118.4	370.1	0.0	32.4	4.02	300.0
1.208	9,108	7.56	3.13	2.20	1.91	1.54	1.26	1.02	110.3	382.0	0.0	28.3	3.40	300.0
1.300	9,299	5.45	2.44	1.80	1.59	1.31	1.06	0.86	164.8	625.6	0.0	33.9	2.78	300.0
1.411	9,136	8.37	3.97	2.57	2.22	1.79	1.46	1.19	131.1	216.0	0.0	25.0	4.70	300.0
1.521	9,211	6.44	2.78	1.95	1.76	1.43	1.17	0.95	132.6	506.6	0.0	30.9	3.80	300.0
1.600	9,088	7.72	3.39	2.24	1.99	1.67	1.36	1.13	113.4	352.3	0.0	26.8	5.43	300.0
1.700	9,033	8.38	3.85	2.46	2.12	1.70	1.43	1.17	123.5	217.4	0.0	25.9	5.23	300.0
1.801	9,207	7.54	3.58	2.51	2.24	1.84	1.50	1.20	129.3	370.7	0.0	24.1	3.68	300.0
1.900	9,191	7.50	3.47	2.24	1.92	1.57	1.29	1.06	140.6	252.8	0.0	28.8	5.22	300.0
1.960	9,160	6.61	2.74	1.83	1.62	1.36	1.13	0.94	123.0	469.0	0.0	32.8	5.52	300.0
2.100	9,160	6.71	2.84	1.89	1.63	1.31	1.08	0.90	131.9	356.0	0.0	33.6	4.44	300.0
2.200	8,985	9.20	4.09	2.24	1.95	1.63	1.37	1.11	118.7	145.5	0.0	28.9	8.81	300.0
2.300	9,076	9.36	3.63	2.27	1.96	1.59	1.28	1.05	89.4	219.0	0.0	28.3	5.73	300.0
2.400	9,176	5.88	2.54	1.77	1.61	1.38	1.17	0.98	137.0	700.2	0.0	31.7	5.34	300.0
2.500	9,100	7.26	3.13	2.03	1.80	1.50	1.24	1.04	118.8	363.3	0.0	29.8	5.83	300.0
2.600	9,160	6.94	3.16	2.01	1.73	1.42	1.15	0.94	149.3	267.7	0.0	32.1	5.44	300.0
2.705	9,172	6.65	3.23	2.20	1.96	1.61	1.33	1.10	153.0	376.9	0.0	27.4	4.36	300.0
2.807	9,104	7.70	3.51	2.19	1.97	1.65	1.36	1.13	121.3	302.7	0.0	27.3	6.62	300.0
2.900	9,160	7.63	3.35	1.90	1.63	1.34	1.08	0.89	144.3	181.0	0.0	35.5	7.21	300.0
3.000	9,195	7.65	3.73	2.44	2.18	1.84	1.54	1.28	132.3	325.2	0.0	24.4	5.92	300.0
3.102	9,160	7.34	3.96	2.74	2.44	2.02	1.65	1.34	164.7	299.8	0.0	21.4	3.91	300.0
3.201	9,207	7.98	4.47	3.30	2.89	2.38	1.91	1.58	163.2	280.7	0.0	17.6	2.38	145.9
3.304	9,219	8.46	4.36	2.97	2.72	2.26	1.88	1.55	126.9	314.5	0.0	19.4	4.67	300.0
3.406	9,172	6.34	3.19	2.11	1.86	1.56	1.31	1.07	170.4	359.0	0.0	28.4	5.52	300.0
3.503	9,001	9.48	5.05	3.13	2.53	1.95	1.56	1.28	174.5	107.6	0.0	22.0	3.26	300.0
Mean:		7.40	3.44	2.32	2.04	1.67	1.37	1.12	139.1	366.0	0.0	27.5	4.52	290.7
Std. Dev:		1.13	0.66	0.46	0.40	0.33	0.27	0.22	34.0	163.8	0.0	5.8	1.47	113.3
Var Coeff(%):		15.31	19.19	20.03	19.80	19.48	19.70	19.53	24.4	44.8	0.0	21.2	32.43	39.0

Figure B12. Modulus 6 Results from Section 7, Amarillo.
The base was treated as one layer. Overall stiffness very high with low variability.

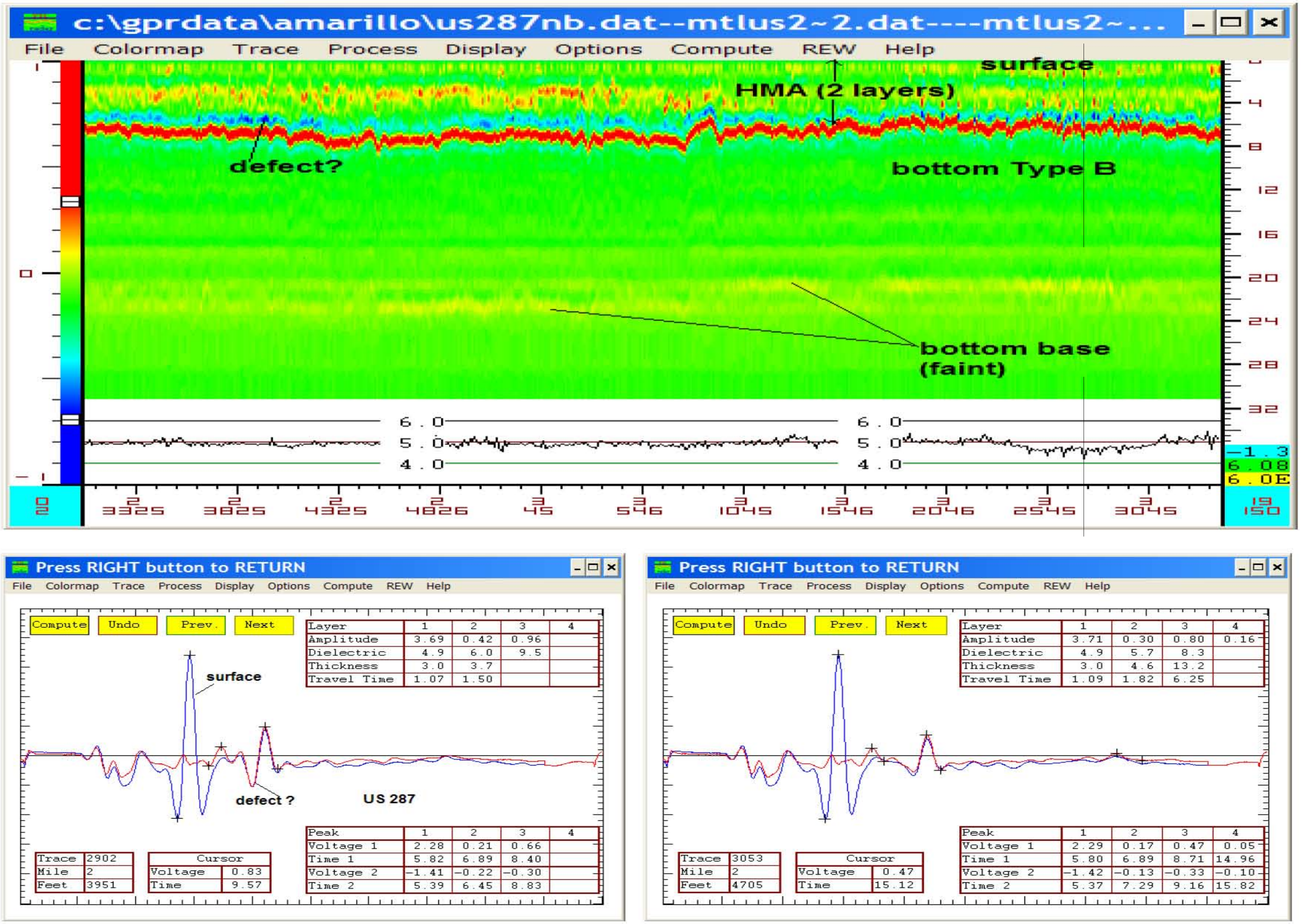


Figure B13. GPR Data from Section 7, Amarillo.
No problems in GPR data, both top and bottom of base can be located.

Section 8

County	Sherman
Highway	US 287
From	3.9 miles north of Moore County line
To	Sherman City Limits
Construction	9/02
Stabilizer Used	Subgrade was treated with 10 percent fly ash. The total base thickness is 22 inches. The top 10 inches of the base was treated with a 6 percent CSS-1 emulsion with a RR-650 reclaimer. Compaction with a padded foot, then pnuematic then steel wheel rollers. No underseal was used; then approximately 4 inches of type B and 2.5 inches of type D surface were placed.
Performance Data	New section, no problems to date.

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 6.0)

District:4 (Amarillo)
County :211 (SHERMAN)
Highway/Road: US 0287

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	6.50	50,000	300,000	H1: v = 0.35
Base:	22.00	50,000	1,000,000	H2: v = 0.35
Subbase:	0.00			H3: v = 0.00
Subgrade:	271.50(by DB)	15,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): R1	R2	R3	R4	R5	R6	R7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Depth to Bedrock
3.800	9,080	7.44	2.98	1.85	1.62	1.31	1.05	0.89	125.2	188.5	0.0	32.3	4.54	300.0
4.100	9,191	6.50	3.03	2.02	1.85	1.54	1.25	1.05	148.5	257.4	0.0	24.5	4.15	300.0
4.400	9,112	6.74	2.86	1.70	1.51	1.24	1.02	0.82	148.1	191.4	0.0	34.1	5.69	300.0
4.706	9,195	7.90	3.45	2.22	2.00	1.65	1.43	1.17	116.7	208.0	0.0	23.4	5.24	300.0
5.001	9,199	6.43	2.73	1.83	1.62	1.38	1.13	0.93	134.3	289.6	0.0	28.1	4.54	300.0
5.300	9,120	7.30	3.09	2.04	1.83	1.53	1.27	1.04	116.9	251.5	0.0	25.0	4.58	300.0
5.605	9,160	7.44	3.30	2.21	1.98	1.69	1.39	1.17	119.8	244.7	0.0	22.5	4.59	300.0
5.907	9,140	8.30	3.64	2.44	2.19	1.91	1.62	1.34	102.3	244.2	0.0	19.7	5.45	300.0
6.205	9,168	6.43	2.89	1.98	1.82	1.57	1.37	1.16	130.8	349.7	0.0	23.0	5.10	300.0
6.501	9,084	7.89	3.18	2.01	1.89	1.64	1.40	1.21	97.3	294.9	0.0	23.9	6.76	300.0
6.800	9,195	7.35	3.36	2.30	2.05	1.74	1.46	1.20	125.5	248.2	0.0	21.4	4.21	300.0
7.101	9,187	7.46	3.07	1.95	1.71	1.43	1.15	0.94	123.6	205.6	0.0	29.3	4.81	300.0
7.400	9,187	6.30	2.83	2.03	1.81	1.56	1.27	1.06	139.8	326.8	0.0	23.8	3.36	300.0
7.706	9,033	9.33	4.07	2.24	1.91	1.56	1.24	1.00	124.5	101.9	0.0	27.9	5.84	300.0
8.000	9,144	7.68	3.06	1.97	1.76	1.45	1.19	0.96	112.3	223.0	0.0	28.3	4.65	300.0
8.300	9,092	8.73	3.84	2.48	2.17	1.79	1.48	1.21	112.2	162.9	0.0	22.0	4.41	300.0
8.600	9,100	8.08	3.07	1.86	1.67	1.42	1.20	1.00	102.2	220.0	0.0	30.3	6.94	300.0
8.907	9,152	6.94	3.11	2.20	2.03	1.74	1.46	1.23	121.2	329.2	0.0	20.7	3.91	300.0
9.208	9,108	7.77	3.14	2.01	1.81	1.56	1.30	1.10	106.0	245.0	0.0	25.8	6.09	300.0
9.501	9,068	11.68	3.98	2.35	2.08	1.76	1.47	1.22	67.6	152.8	0.0	26.2	7.12	300.0
9.822	9,076	9.23	3.63	2.14	1.91	1.61	1.35	1.13	96.6	162.7	0.0	27.0	6.93	300.0
10.104	9,100	7.06	2.84	1.78	1.62	1.38	1.17	0.99	117.2	263.0	0.0	29.4	6.44	300.0
10.410	9,128	7.50	2.81	1.82	1.65	1.41	1.17	0.98	100.5	309.9	0.0	28.9	5.66	300.0
10.701	9,136	7.76	2.77	1.78	1.59	1.36	1.14	0.94	97.4	285.5	0.0	31.3	6.10	300.0
11.007	9,243	6.77	2.63	1.77	1.60	1.35	1.12	0.91	115.8	336.9	0.0	29.5	4.56	300.0
11.301	9,152	6.20	2.76	2.00	1.86	1.61	1.37	1.17	129.4	426.8	0.0	21.7	3.85	300.0
11.602	9,068	8.96	3.56	2.29	1.98	1.61	1.28	1.01	101.3	165.1	0.0	26.0	3.85	300.0
11.901	9,112	8.62	2.83	1.83	1.68	1.41	1.14	0.92	82.0	295.7	0.0	30.9	5.33	300.0
12.201	9,076	9.70	3.33	1.86	1.74	1.51	1.28	1.08	79.6	196.0	0.0	31.1	9.25	300.0
12.500	9,152	8.37	2.24	1.21	1.19	1.07	0.93	0.82	75.7	356.8	0.0	46.4	11.78	300.0
12.801	9,215	6.98	2.21	1.46	1.42	1.23	1.07	0.91	91.9	613.6	0.0	33.2	6.37	300.0
13.101	9,144	7.38	2.53	1.60	1.55	1.37	1.18	1.00	90.9	469.7	0.0	30.1	7.53	300.0
13.403	9,203	7.53	2.57	1.64	1.61	1.42	1.26	1.07	87.2	529.0	0.0	28.2	7.59	300.0
13.717	9,116	8.44	2.50	1.35	1.27	1.07	0.87	0.70	86.7	225.0	0.0	46.8	8.90	300.0
14.001	9,092	7.98	1.89	1.11	1.04	0.91	0.78	0.65	74.5	417.7	0.0	52.4	9.40	300.0
14.300	9,084	7.56	3.05	2.14	1.83	1.46	1.18	0.94	115.6	221.2	0.0	26.6	2.24	102.3
14.615	9,124	7.94	3.18	2.25	1.99	1.63	1.32	1.07	102.5	255.2	0.0	23.5	2.80	300.0
14.909	8,993	10.87	3.51	2.26	1.99	1.63	1.28	1.01	67.8	189.4	0.0	27.4	4.36	300.0
15.201	9,080	6.73	3.24	2.30	1.98	1.58	1.24	0.98	168.0	199.2	0.0	23.8	1.77	97.9

Figure B14. Modulus 6 Results from Section 8, Amarillo.

15.506	9,124	8.64	3.15	2.06	1.80	1.44	1.14	0.91	96.0	201.5	0.0	29.8	3.64	300.0
15.802	9,080	8.00	2.86	1.85	1.68	1.43	1.20	1.01	90.6	310.8	0.0	28.8	5.80	300.0
16.102	9,088	8.47	3.19	1.80	1.65	1.41	1.21	1.02	100.0	191.2	0.0	32.0	8.53	300.0
16.401	9,116	7.81	2.87	1.91	1.70	1.41	1.14	0.94	100.0	263.1	0.0	29.4	4.19	300.0
16.700	9,084	8.23	2.94	1.88	1.72	1.44	1.21	0.99	88.8	290.6	0.0	28.6	5.70	300.0
17.000	9,144	7.51	2.75	1.93	1.70	1.43	1.18	0.97	99.3	327.7	0.0	27.9	3.66	300.0
17.330	9,187	7.84	2.09	1.20	1.04	0.84	0.67	0.55	90.8	237.6	0.0	58.5	5.93	300.0
17.605	9,295	7.19	1.52	0.86	0.80	0.68	0.59	0.52	82.0	424.3	0.0	71.3	9.45	300.0
17.742	9,037	8.64	2.15	1.01	0.96	0.82	0.70	0.59	77.5	198.0	0.0	62.3	11.97	60.4
17.900	9,072	7.90	1.70	0.89	0.87	0.75	0.63	0.53	73.6	348.6	0.0	65.4	10.94	300.0
18.201	9,052	8.94	2.79	1.88	1.81	1.59	1.34	1.16	70.2	478.5	0.0	25.6	5.96	300.0
18.504	9,136	5.72	1.17	0.63	0.48	0.35	0.25	0.20	111.7	309.9	0.0	111.7	9.84	300.0 *
18.800	8,933	7.52	4.19	2.79	1.91	1.25	0.86	0.63	300.0	77.6	0.0	30.1	7.31	84.7 *
Mean:		7.84	2.93	1.86	1.67	1.40	1.16	0.96	108.4	275.3	0.0	32.8	5.95	300.0
Std. Dev:		1.10	0.60	0.44	0.36	0.30	0.26	0.22	35.0	104.7	0.0	16.0	2.31	183.4
Var Coeff(%):		14.00	20.63	23.51	21.60	21.63	22.18	22.56	32.3	38.0	0.0	48.7	38.84	61.1

Figure B14. Modulus 6 Results from Section 8, Amarillo (Continued). Base treated as one layer in analysis, overall looks good.

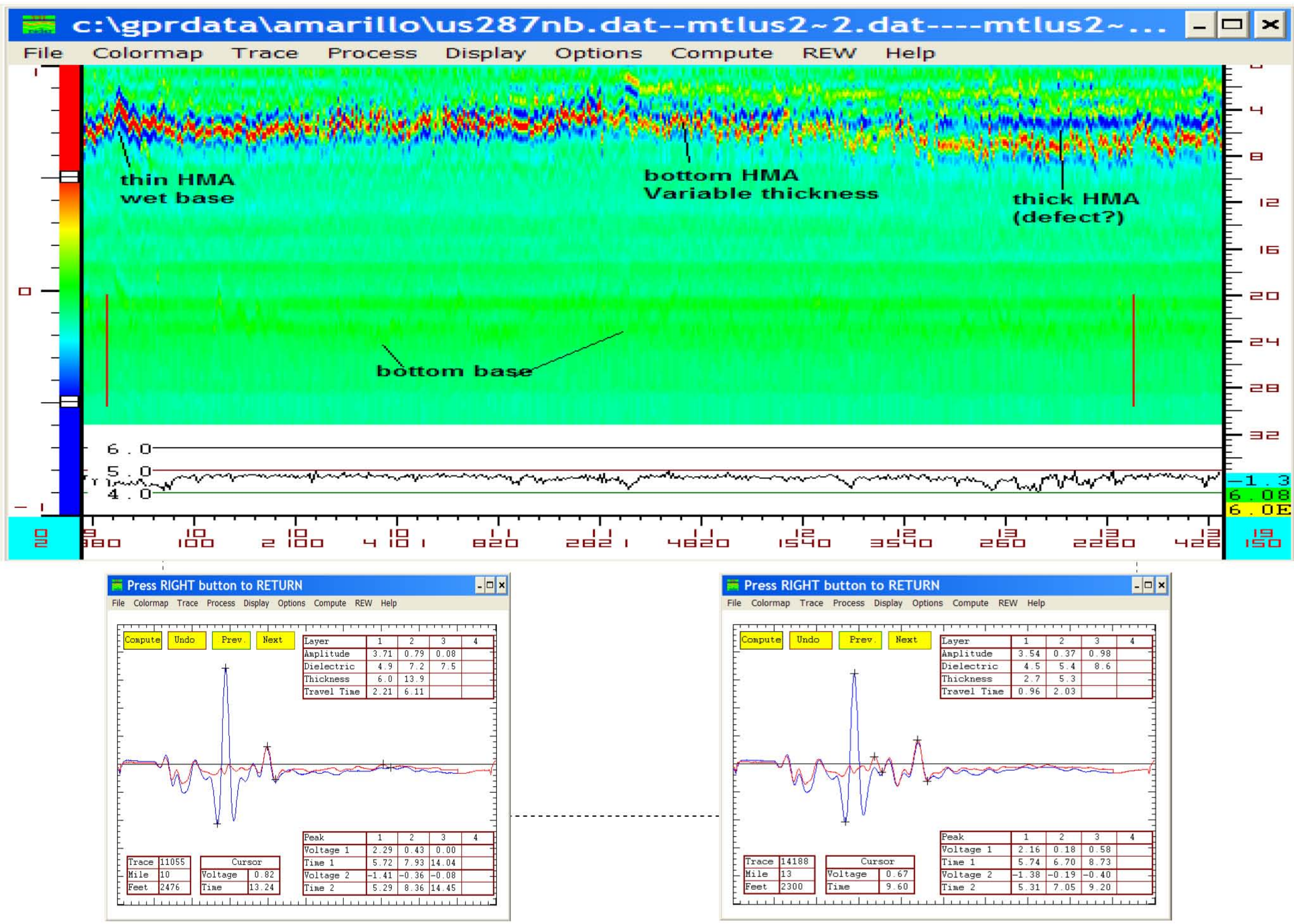


Figure B15. GPR Data from Section 8, Amarillo. Base looks good. In this area there is a concern about the lower Type B layer. The blue interface could be areas of low density or segregated mix.