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16. Abstract

The overall objective of this study is to develop a rehabilitation plan for US 59 in the Lufkin District. The rehabilitation plan covers a relatively long time period and includes numerous performance periods. There is the possibility that any one (or a combination) of several pavement rehabilitation strategies can be used on a specific section of the highway, depending on the expected life and cost of the treatment. Since some of these pavement design strategies have not previously been constructed in the Lufkin District, it is important to not only document construction and costs, but also to monitor the sections closely to determine the effectiveness of each rehabilitation strategy.

This report describes the construction and cost of the test sections built as part of this project. Seven of the test sections were constructed on rigid jointed concrete pavement (constructed in the 1940s) that had previously been overlaid with asphalt concrete pavement (ACP). The remaining seven test sections were constructed on a flexible pavement structure (constructed in the mid-1960s) that had been overlaid several times since initial construction.

Rehabilitation design strategies included removal of old ACP, the application of new base material, joint and crack repair, crack and seating, and the use of differently sized aggregates in the ACP materials. Because the cost of these strategies ranges from approximately $4.78/m2 ($4.00/yd2) to $39.47/m2 ($33.00/yd2), this initial cost and construction information will be essential in evaluating long-term performance.

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CONSTRUCTION OF REHABILITATION TEST SECTIONS ON US 59

IN THE LUFKIN DISTRICT

by

Brent T. Allison
B. Frank McCullough

Research Report 987-3

Research Project 3-110-89/94-987

A Long-Range Plan for the Rehabilitation of US 59 in District 11

conducted for the

Texas Department of Transportation

by the

CENTER FOR TRANSPORTATION RESEARCH
Bureau of Engineering Research
THE UNIVERSITY OF TEXAS AT AUSTIN

August 1994

IMPLEMENTATION STATEMENT

This report describes the construction of project test sections only. The implementation of project findings will be described in the final project report.

Prepared in cooperation with the Texas Department of Transportation.

DISCLAIMERS

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 views or policies of the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

NOT INTENDED FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES

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TABLE OF CONTENTS

SUMMARY

The overall objective of this study is to develop a rehabilitation plan for US 59 in the Lufkin District. The rehabilitation plan covers a relatively long time period and includes numerous performance periods. There is the possibility that any one (or a combination) of several pavement rehabilitation strategies can be used on a specific section of the highway, depending on the expected life and cost of the treatment. Since some of these pavement design strategies have not previously been constructed in the Lufkin District, it is important to not only document construction and costs, but also to monitor the sections closely to determine the effectiveness of each rehabilitation strategy.

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CHAPTER 1. INTRODUCTION

1.1 BACKGROUND

US 59 is one of the oldest and longest highways in Texas. Beginning in Laredo, US 59 moves north through Victoria, Houston, Lufkin, and Nacogdoches, before it finally ends across the state in Texarkana (Fig 1.1). Originally constructed in the Lufkin District during the 1940s as a two-lane facility, the highway today consists of a 9-7-9 jointed concrete pavement. Its expansion joints are spaced every 35.58 m (120 feet) and its contraction joints every 4.57 m (15 feet); shoulders were expanded in the 1960s and 1970s.

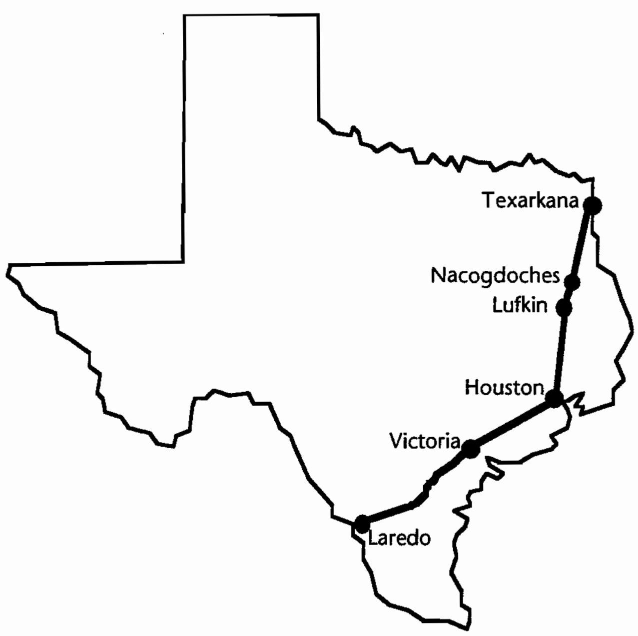


Figure 1.1. Map of US 59

Within the Lufkin District, US 59 passes through San Jacinto, Polk, Angelina, Nacogdoches, and Shelby Counties, for a total distance of 209.3 km (130 miles), as shown in Figure 1.2. An increase in traffic during the 1960s and 1970s required that most of US 59 in the Lufkin District be improved to a four-lane divided facility. This improved area includes a 143.29-km (89-mile) stretch from the northeastern boundary of the Houston metropolitan area to the southern limits of Nacogdoches; various urban sections in the northern end of the district were also improved.

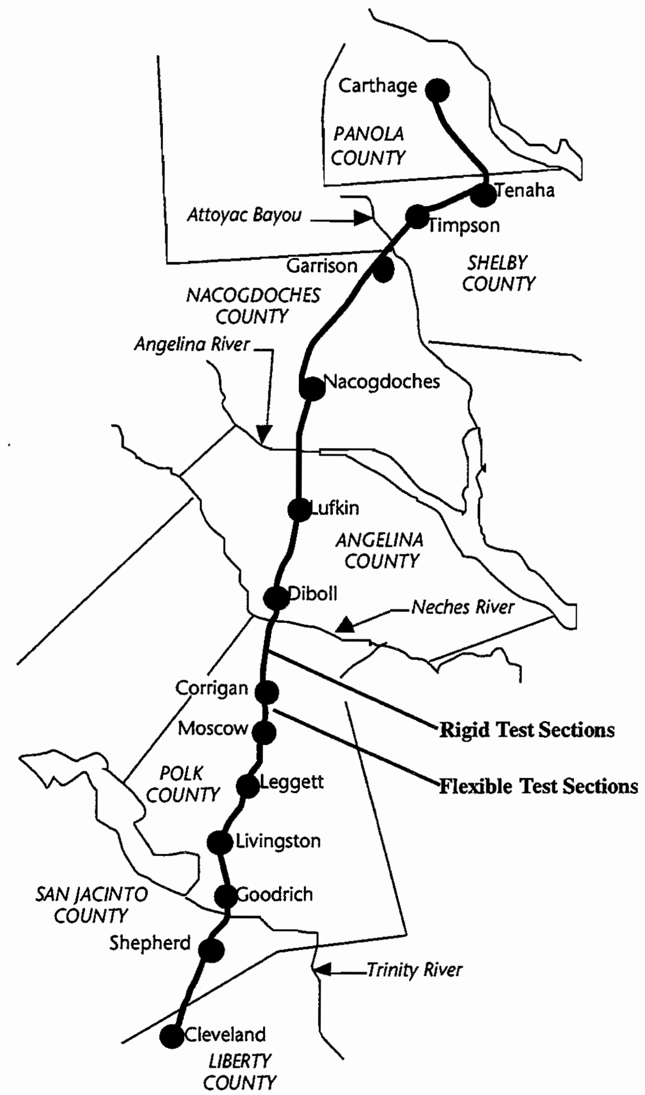


Figure 1.2. Map of US 59 in the Lufkin District, including county boundaries

The distress evident on both the new asphalt concrete pavement and the original jointed concrete pavement — a result of heavy loads and harsh environment — has prompted a need for a cost effective, long-term rehabilitation strategy. To identify the best rehabilitation alternative, we constructed a series of test sections, each utilizing candidate methods for future rehabilitation of US 59 in the Lufkin District. This report documents the construction of the various rehabilitation strategies used on the test sections.

1.2 OBJECTIVE

The objective of this project is to develop a long-range rehabilitation plan for US 59 within the Lufkin District over a 10- to 15-year period. The plan will estimate the annual cost of rehabilitating and maintaining all of US 59 in the Lufkin District, using findings obtained from the construction of the test sections.

The first step in the process of developing a long-range plan was to collect historical data on US 59 and select possible sites for construction of the test sections. This step was completed and documented in CTR Report 987-1 (Ref 1). The second step was to construct a series of test sections to implement the various rehabilitation strategies selected. This report documents the construction and costs of these test sections. The final step will involve long-term monitoring of the test sections, with consideration given to maintenance costs, pavement performance, environmental and traffic conditions, and overall cost of each rehabilitation strategy.

1.3 SCOPE

The long-range plan developed as part of this project will be directed toward the needs of US 59 within the Lufkin District. A task force comprised of Center for Transportation Research staff, Lufkin District engineers, and Texas Department of Transportation Division 8 personnel has directed the development of the long-term rehabilitation plan for the Lufkin District. Although this long-range plan is being developed for the Lufkin District, the framework of this plan may be utilized for the cost-effective rehabilitation of pavements throughout Texas.

CHAPTER 2. PRE-EXISTING CONDITION OF TEST SECTIONS

2.1 SELECTION OF TEST SECTION SITES

The first step in developing a long-range rehabilitation plan was to select two sites on which to construct the test sections necessary for assessing the various types of rehabilitation strategies. The first site was to be constructed over the rigid pavement that was placed back in the 1940s; the second site was to be placed within the flexible lanes placed in the 1960s. To ensure that the selected test section sites were appropriate, we collected data and reported our findings to the project task force, which then selected the actual rehabilitation sites. Both Lufkin District personnel and CTR obtained data from the following:

1) Falling Weight Deflectometer (FWD)
2) Automated Road Analyzer (ARAN)
3) Ground Penetrating Radar (GPR)
4) Coring (1 per mile)
5) State historical records
6) General condition survey

This information was gathered over the entire length of US 59 within the Lufkin District. The general condition survey involved locating an area having minimal longitudinal grades and curves. State historical records were used to ensure that the pavement at the selected sites was representative of existing pavement along US 59 in the Lufkin District (especially in terms of structure and traffic conditions). To minimize traffic disruption, we avoided sites having intersections and drives.

After evaluating all the information collected, the project task force selected appropriate test section sites: The rigid test section site is located just north of Corrigan near the intersection of Farm Road 357. The rigid sections run from station number 1490+00 to 1420+00, totaling 2,133.6 m (7,000 feet). The flexible sections are located just south of Corrigan at station numbers 1060+00 through 990+00, also totaling 2,133.6 m (7,000 feet).

2.2 THE PRE-EXISTING CONDITION OF THE TEST SECTIONS

Several types of information were gathered at the selected sites in order to precisely determine and document the condition of the pavement prior to rehabilitation. The type of information gathered is discussed below.

ARAN

The automated road analyzer (ARAN) was used to document the surface condition of the test sections. The video that resulted from this effort will enable CTR to correlate distresses that occur after construction with pre-overlay distresses.

Profile

The profilometer was used to document the profile of the road at the test sections prior to construction. Profile measurements have been taken again at regular intervals during the long-term monitoring period following construction in order to make a before-and-after comparison.

FWD

Falling weight deflectometer (FWD) measurements were taken prior to construction every 50 feet on both the rigid and flexible sections. The FWD documents the condition of the pavement below the surface layer by measuring deflections that may be used to estimate the load transfer characteristics. Figure 2.1 shows the FWD recording the condition of the pavement at the future rigid test section site.

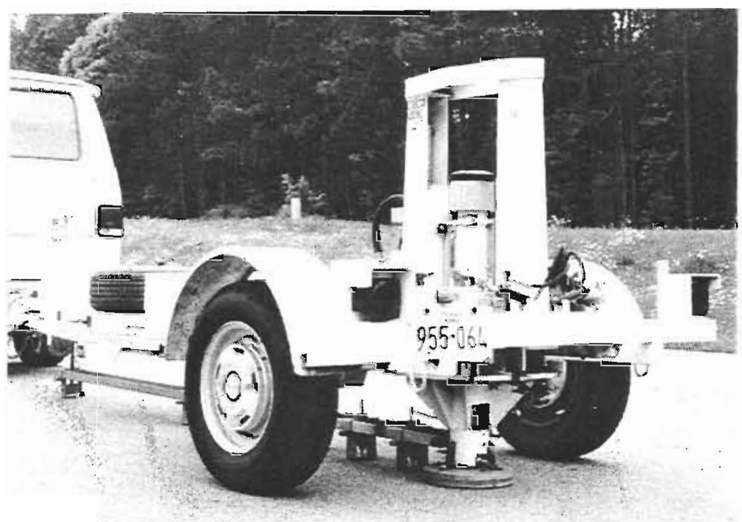


Figure 2.1. The FWD operating within the flexible sections

FWD measurements were also taken during construction on the rigid sections R1 and R2 after the milling off of the asphalt layer (which exposed the jointed concrete pavement, or JCP). For the Project 987 post-construction report, we will compare FWD measurements taken prior to construction, during construction, and at various times after construction.

GPR

Pulse Radar, Inc., provided and operated a ground-penetrating radar (GPR) at the test section sites. The ground-penetrating radar is used not only to determine the amount and depth of stripping that has taken place in the pavement, but also to estimate layer thicknesses. The results of the GPR measurements taken prior to rehabilitation can be found in Report 987-1 (Ref 1).

Historical Records

Past records provided the project with several types of information regarding US 59 within the Lufkin District. For example, the construction history of the test sections, shown in Tables 2.1

and 2.2, proved useful as a design base. Two cores were taken within the rigid sections and two within the flexible sections to verify the depths indicated in the construction records. These cores confirmed the information collected from the tables.

Table 2.1. Construction history at US 59 flexible sections

Date	Construction
1966	15.24-cm (6.0-in.) lime-treated subgrade 15.24-cm (6.0-in.) cement-treated base 11.43-cm (4.5-in.) black base 3.81cm (1.5-in.) ACP
1974	2.54-cm (1.0-in.) AC overlay
1978	3.81-cm (1.5-in.) AC overlay
1985	8.12-cm (3.2-in.) AC overlay

Table 2.2. Construction history at rigid sections

Date	Construction
1943	9-7-9 PCC
1953	3.81-cm (1.5-in.) AC overlay
1964	3.81-cm (1.5-in.) AC overlay
1971	3.04-cm (1.2-in.) ACP
1979	3.3-cm (1.3-in.) AC overlay
1982	3.81-cm (1.5-in.) AC overlay

Traffic data were collected by Lufkin District personnel from D-10. This traffic data included both the history of traffic and a future projection of what traffic numbers will likely be in the years to come. The future traffic predictions were derived from past trends and the expected growth of industry and population. US 59 within the Lufkin District includes a high percentage of truck traffic. US 59 offers a direct north route from the Port of Houston and is also used by the large logging industry within the district. Figure 2.2 shows a typical logging truck, a common site, traveling on US 59. The heavy truck traffic, which comprises over 20 percent of the overall traffic in the Lufkin District, is a major contributor to the number of failures that have occurred on US 59 in the Lufkin District in the past. These failures were documented in the set of detailed condition surveys conducted by CTR personnel.

Figure 2.2. Truck traffic in the flexible sections

Condition Survey

A detailed condition survey was undertaken just prior to construction to document the surface condition of the asphalt pavement. The condition survey involved marking down all surface distresses, including cracking, patches, and failures. The survey forms also indicated where FWD measurements and cores were taken. The condition survey was placed in a data base by CTR personnel and will be maintained throughout the project. With this condition survey, we will be able to determine if any post-construction distresses are past failures reflecting through, or if they were caused by a combination of design characteristics and field conditions. A sample of the condition survey conducted in March 1991 is contained in Appendix A.

Photographs and Video

Photographs and video were taken in conjunction with the condition survey to document the surface condition of the pavement. Figure 2.3 shows the general condition of the rigid pavement site prior to the start of rehabilitation, as documented in photographs and video.

Section Identification

The final step in our preparations for rehabilitation was the installation of permanent markers to identify the location of the start and end of each section. Lufkin District personnel placed section identification markers approximately 18.29 m (20 yards) from the pavement edge. These markers are attached to a standard 1.22-m (4-foot) high delineator post to avoid being lost or destroyed by mowers. With the section identification markers in place, the construction phase of the project was ready to begin.

Figure 2.3. Rigid sections prior to rehabilitation

Figure 2.4. Permanent identification markers

CHAPTER 3. RIGID TEST SECTIONS

3.1 CONSTRUCTION PREPARATION

There have been several attempts to rehabilitate the jointed concrete pavement along US 59 since its construction in 1943. Owing to inadequate funding and to a lack of knowledge regarding the life-cycle costs of various repair alternatives that could be utilized when rehabilitating jointed concrete pavement, the typical rehabilitation technique has involved placing a Type D 3.81- or 5.08-cm (1.5 or 2-inch) asphalt overlay over the existing surface as needed. The purpose of constructing the rigid set of test sections was to examine six alternative design strategies that may prove to be more cost effective and efficient than the typical rehabilitation alternative now being used. The rigid test sections sites selected for construction of the various design alternatives are located just south of FM 357 on US 59, beginning at station 1490+00 and proceeding south to station number 1420+00.

Time and Weather

Construction of the rigid test sections was originally scheduled to begin in March 1991. However, the actual preparation to divert traffic on the rigid sections did not begin until June 11, 1991. Yet even with the traffic diversion arrangement in place, there continued to be delays: No work was possible before late July, owing to the unusually high levels of rainfall in the district. During the rehabilitation period (March 1991 – July 1992), record amounts of rainfall were recorded in the Lufkin District. Several areas along the test sections had standing water prior to and during construction. This type of heavy moisture not only caused a delay in the preparation, materials production, and construction phases, but also saturated the soil surrounding the rehabilitation sections. (High levels of water surrounding the roadway and saturating the base materials can contribute to pavement failure.) Once again, such conditions point to a need to identify pavement design alternatives that may best deal with these unique situations found in the Lufkin District.

Materials Production and Detour Construction

On the rigid test sections, two detours were designed to move the traffic from the southbound lanes across to one of the northbound lanes. During the construction of the detours, north and southbound traffic was reduced to one lane using cones to separate traffic from construction equipment. On July 18, the construction crews from Moore Brothers Construction began to roll back the top soil on the planned detours. Detour #4, which moved traffic to the northbound side, began at station 1501+00 and ran though station 1487+00. Detour #3, which returned traffic to the southbound lanes, ran from station 1424+00 to 1414+00. Once again, heavy rainfall delayed materials production and construction of the detours. When the weather conditions permitted, fill material was brought in to bring the detours up to grade level (Fig 3.1). The fill dirt came from a borrow pit off F.M. 942, 6.44 km (4 miles) southeast of Corrigan. Figure 3.2 shows the blading of the fill material in preparation for the placement of the foundation base.

Figure 3.1. Hauling of fill material to Detour #4

Placement then included 20.32 cm (8 inches) of cement-treated foundation and a one-course surface treatment, followed by 25.4 cm (10 inches) of Type A flexible base material with a prime coat and one-course surface treatment. Finally, a 5.08-cm (2-inch) Type C asphalt base was placed on the detour surfaces. All asphalt was supplied by East Texas Asphalt located in Lufkin, Texas, approximately 32.19 km (20 miles) from the rigid section sites. Concrete barriers were placed in the northbound lanes to separate the bidirectional traffic. The detours were finished and ready for traffic by August 28; traffic was diverted that afternoon (Fig 3.3). Figure 3.4 illustrates the traffic handling plan and shows the layout of the test sections.

Figure 3.2. Blading of fill material for preparation of base

Figure 3.3. Finished view of Detour #4

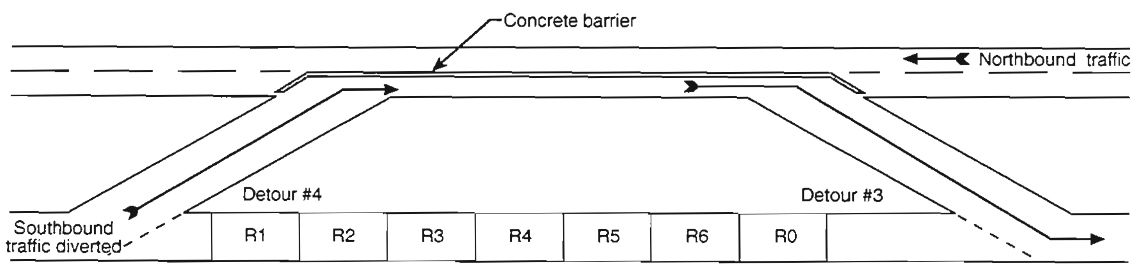


Figure 3.4. Traffic diverting plan on rigid sections

3.2 CONSTRUCTION OF THE RIGID TEST SECTIONS

The typical cross section of rigid pavement consists of the 17.78 cm (7 inches) of jointed concrete pavement placed in 1943, followed by approximately 17.78 cm (7 inches) of asphalt that has been placed in several layers over time. Figure 3.5 shows the existing cross section within the selected rigid pavement test site, including the driving lanes and shoulder areas.

Section R1

In August 1989, a rehabilitation pilot study was conducted on what was later to become the first 121.92 m (400 feet) of section R1. In the pilot study, the existing asphalt concrete was milled off and the underlying jointed concrete pavement repaired. The repair included removing and replacing failed joints with both a precast slab and a dowel basket joint; all cracks in the shattered slabs were then repaired with high-molecular-weight monomer (HMWM). Deflection testing performed prior to and after repair confirmed that load transfer was restored across the joints and cracks in the slabs. The repairs and construction of the pilot study are documented in Report 987-1 (Ref 1).

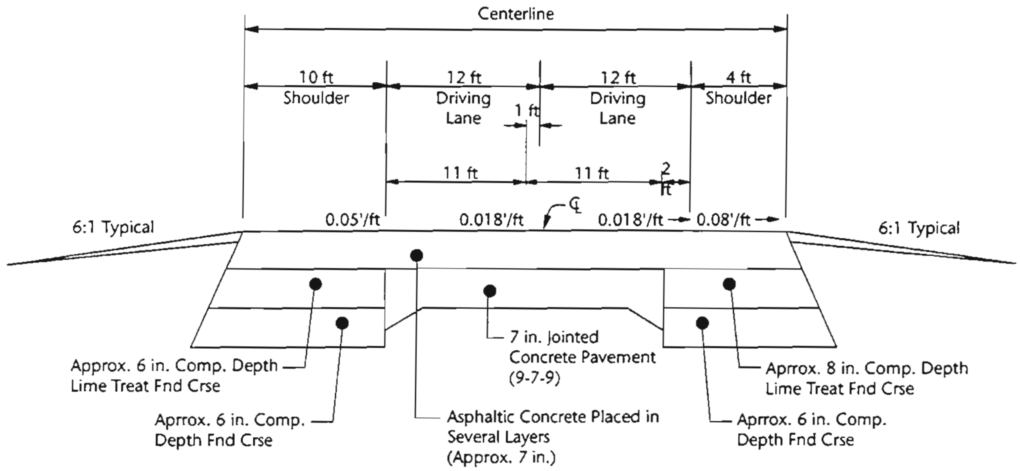


Figure 3.5. Existing typical cross section in rigid pavement test sites

On August 30, 1991, the surface material was once again milled off, exposing the JCP. All cracks and joints were water blasted and then air blasted. After the cracks and joints were cleaned, a thin layer of black tar was applied in the joints to act as a sealer. Sand followed by HMWM was once again applied to the cracks. In this process 189.27 L (50 gallons) of HMWM were used, along with over 453.59 kg (1,000 pounds) of sand. All the exposed joints were sealed and the exposed cracks were treated with the HMWM. A detailed condition survey of Section R1 was conducted in order to monitor the success of the joint and crack repairs (Appendix B). Cores were taken over the treated cracks and joints to confirm the strength of the bond. Figure 3.6 shows the placement of the HMWM and sand, while Figure 3.7 shows the subsequent cores.

Figure 3.6. Placement of HMWM and sand

Figure 3.7. Cores taken from Monomer repair

FWD deflection measurements were also taken again to estimate the load transfer. Both the cores and FWD data confirmed that the integrity of the slabs and joints had been restored. The inside shoulder was then removed and excavated in preparation for shoulder extension (Fig 3.8).

Figure 3.8. Excavation and preparation for shoulder extension

Figure 3.9 shows the design plan for the shoulder extension. The inside shoulder of the jointed concrete pavement was extended 1.98 m (78 inches) using 22.86 cm (9 inches) of portland cement concrete (Fig 3.10).

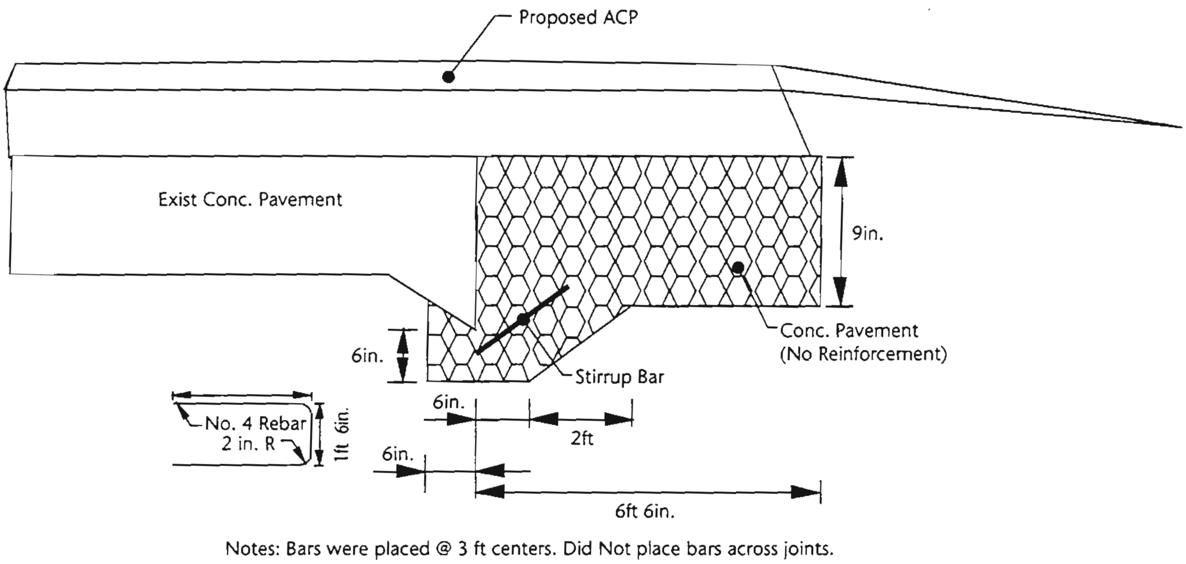


Figure 3.9. Design of extended shoulder in R1

Figure 3.10. Placement of extended shoulder

After all repairs were made and after the shoulder was extended, a one-coarse surface treatment was applied over the 304.8-m (1,000-foot) section, followed by 6.35 cm (2.5 inches) of Type C base. The base was then followed by a 3.81-cm (1.5-inch) Type C surface material. After the placement of all the roadway material, a pavement saw was used to make 34 saw cuts over the joints in an attempt to control cracking. The saw cut was set at a 1.91 cm (3/4 inch) depth (approximately). The cuts started at 79.25 m (260 feet) into the section and were placed every 4.57 m (15 feet) to match the joint spacing. The cuts ended 234.70 m (770 feet) into the section. This completed the construction of Test Section R1. Figure 3.12 shows the post-construction cross section now in place in Section R1.

Figure 3.11. Saw cut over joint in R1

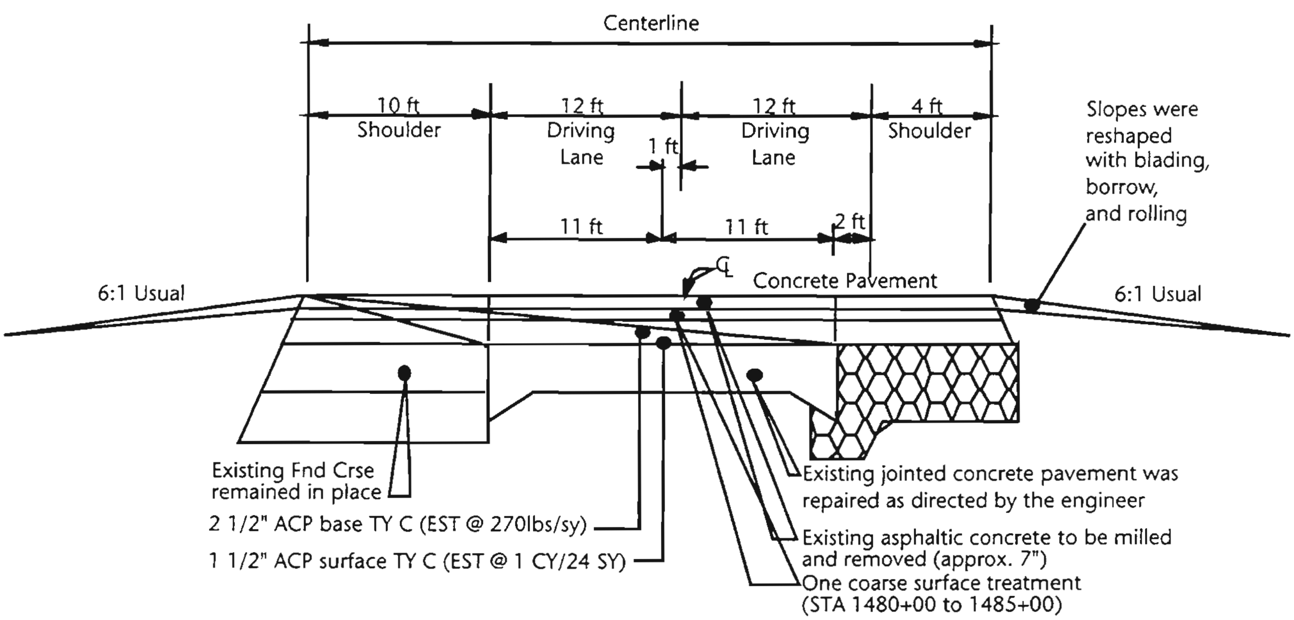


Figure 3.12. Post-construction cross section of R1

Section R2

In Section R2, the existing asphalt was milled and removed on September 4. After the exposed surface was cleaned (on the morning of September 10), the crack and seat operation began on Research Test Section R-2A and R-2B. The roto-milling operation went very smoothly, and the exposed jointed-concrete pavement was very clean, which would suggest that a tack coat was never used on the pavement prior to the first overlay (Fig 3.13). There was some evidence along the jointed-concrete pavement of extensive joint repair that had affected the surface of the concrete. The crack and seat was performed by a Houston subcontractor. The equipment used for the crack and seat operation was a Woergten hammer and a 45,359-kg (50-ton), rubber-tired roller pulled by a front-end loader.

Figure 3.13. Roto-milling of Section R2

The Woergten drop hammer, capable of dropping a 5896.7-kg (13,000-pound) load at a height of 1.83 m (6 feet), can crack pavements that are 33.02 to 38.1 cm (13 to 15 inches) thick. However, because of the relative thinness of the pavement on US 59 in Lufkin (a 9-7-9 jointed-concrete pavement), the hammer was operated at a drop height of only 30.48 cm (12 inches) to 45.72 cm (18 inches). The target nominal crack spacing was 60.96 cm (24 inches). To achieve this 60.96-cm (24-inch) nominal crack-spacing, the hammer was initially set to drop every 60.96 cm (24 inches). Since the jointed-concrete pavement was 3.35 m (11 feet) wide, it was initially envisioned that one pass of the hammer would achieve a random 60.96-cm (24-inch) crack-spacing across the entire pavement width. However, once the cracking operation had begun, it became obvious that more than one pass would be necessary. Therefore, the hammer was shifted to within 20.32 cm (8 inches) of the pavement edge of the left-hand shoulder. The first pass produced the desired crack spacing. After the first pass along this section, the hammer was placed on the right-hand side of the pavement 8 inches from the edge. To complete the cracking operation, a third pass was made down the center of the jointed-concrete pavement spanning the longitudinal joint. This method appeared to give the desired uniform 60.96-cm (24-inch) nominal crack-spacing using the Woergten drop hammer (Figs 3.14 and 3.15).

Figure 3.14. Woergten drop hammer

Figure 3.15. Uniform cracking resulting from Woergten drop hammer

To seat the newly-cracked concrete pavement, a 31,751-kg (35-ton) proof roller, towed by a medium-sized, front-end loader, was used. The ballast used in the roller was 1.37 m^3 (18 cubic yards) of bank sand. The roller made five passes across each section of the pavement, with the entire operation taking approximately 1.5 hours. As the 31,751-kg (35-ton) roller was moving across the pavement section, very little movement in the cracked pieces of concrete was evident. It seemed that the structural integrity of the pavement was very high despite the extensive cracks in the pavement. However, some slight movements were noticed around some of the more deteriorated joints.

Figure 3.16. Seating roller

Following the crack-and-seat operation, a one-course surface treatment was applied to the entire test section. Then 6.35 cm (2 .5 inches) of Type C base was placed, followed by 3.81 cm (1.5 inches) of Type C surface material on the first 152.4 m (500 feet) of the section. Following that, 10.16 cm (4 inches) of Type C base were placed on the second 152.4 m (500 feet) in two lifts, followed by a lift of 3.81 cm (1.5 inches) of Type C surface material. This completed the construction of Test Section R2 (Figs 3.17 and 3.18).

Section R3

In Test Section R3, 5 of the existing 17.78 cm (7 inches) of asphalt concrete were milled and removed. Next, 20.3 cm (8 inches) of flexible base were placed over the remaining 5.08 cm (2 inches) of asphalt concrete. The flexible base was brought in from the maintenance yard in Corrigan (rather than from East Texas Asphalt in Lufkin). A prime coat and one-course surface treatment was then applied over the flexible base. Then, 3.81 cm (1.5 inches) of Type C base and 3.81 cm (1.5 inches) of Type C surface were placed over the entire test section in two lifts, completing construction of Test Section R3 (Fig 3.19).

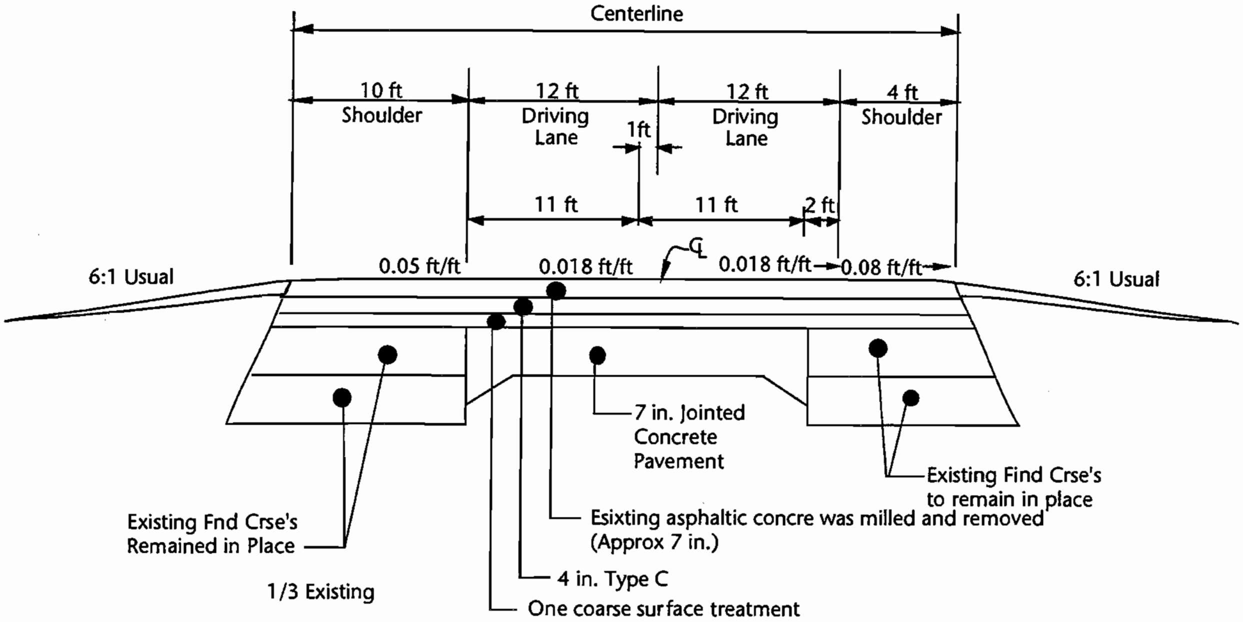


Figure 3.17. Post-construction cross section of R2A

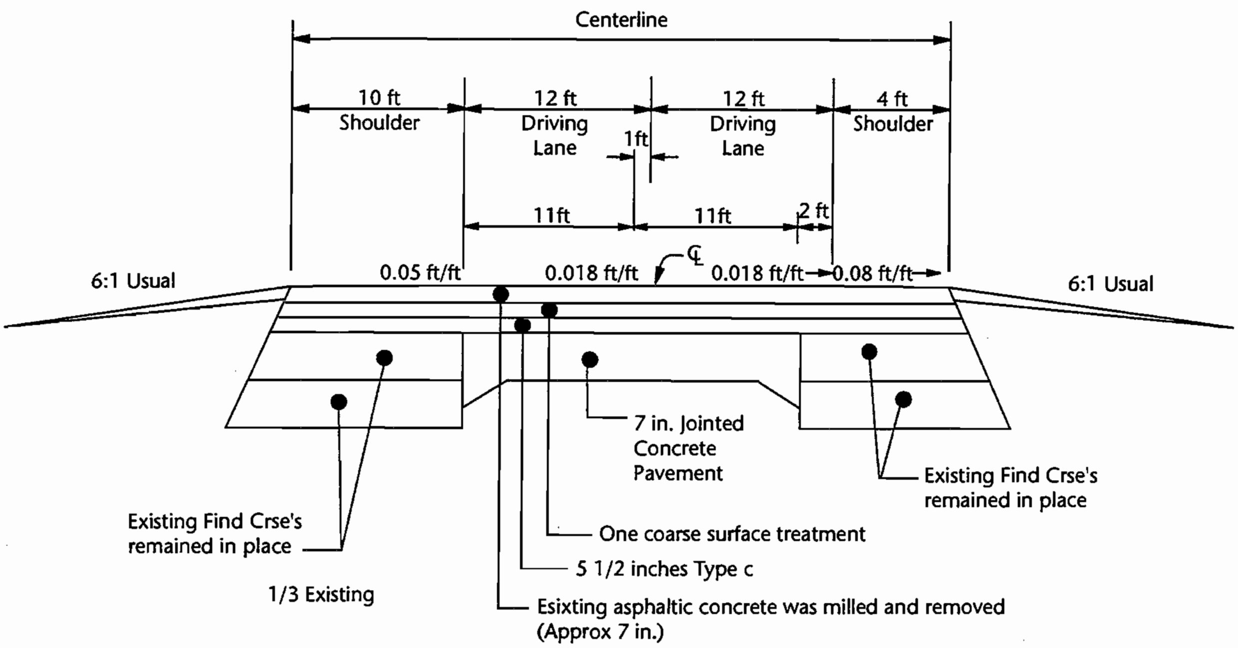


Figure 3.18. Post-construction cross section of R2B

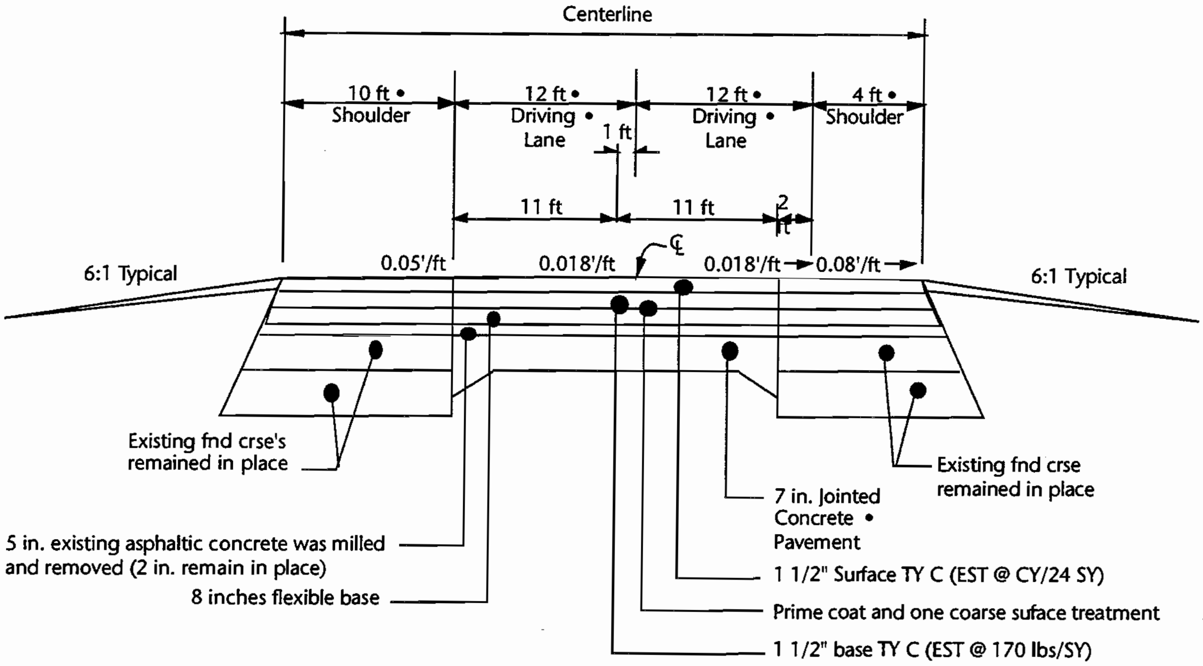


Figure 3.19. Post-construction cross section of R3

Section R4

In Test Section R4, the existing pavement was not disturbed. A 8.89-cm (3.5-inch) open graded Type G asphalt base with an unusually large coarse aggregate was placed over the existing surface. During placement of the Type G aggregate, some segregation became apparent: The large aggregate was separating from the small aggregate in the auger. The auger appeared to leave the smaller aggregate in the center of the lane and push only the larger aggregate to the outside of the lane. Although adjustments were made to the auger, the segregation was not much affected. The Type G material was followed by 7.62 cm (3 inches) of Type B base and 3.81 cm (1.5 inches) of Type C surface material. Figure 3.20 shows the placement of the Type G material. Figure 3.21 shows the final cross section of R4. Before the overlay process began, an under-drain was installed to collect the water and drain it into the outfalls. The Type G material that was placed between the surface material and the existing overlay — less dense than the other layers — allowed water to move through the material. The under-drain was constructed of a 2.54-cm (1-inch) thick piece of rigid corrugated plastic surrounded by a fine mesh filter. This filter was attached at the bottom to a PVC pipe with small holes to collect the water. The special material surrounding the rigid plastic and the PVC pipe would allow water into the pipe, but filter out any other elements. The under-drain seemed to be functioning properly after the R4 test section was completed.

Figure 3.20. Placement of Type G material in R4

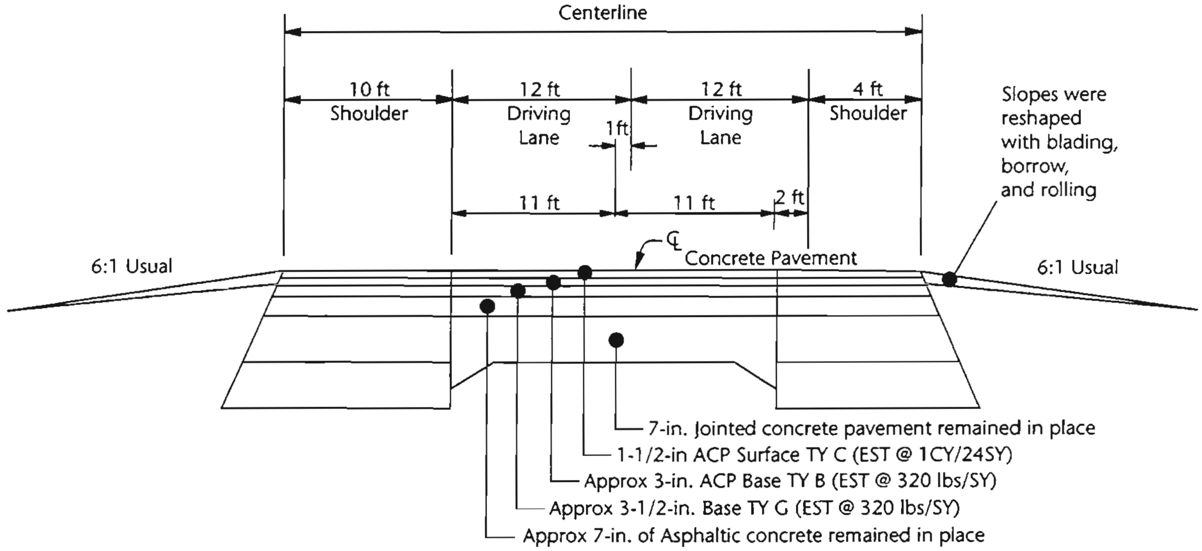


Figure 3.21. Post-construction cross section of R4

Section R5

In the first half of Test Section R5, a 2.54-cm (1-inch) plant mix seal was placed over the existing asphalt pavement. An SBS-modified 2.54-cm (1-inch) plant mix seal was then placed over the second 152.4 m (500 feet) of section R5. Then 3.81 cm (1.5 inches) of Type C base was applied to all of section R5, followed by 3.81 cm (1.5 inches) of Type C surface material. Figure 3.22 shows the post-construction cross section of R5.

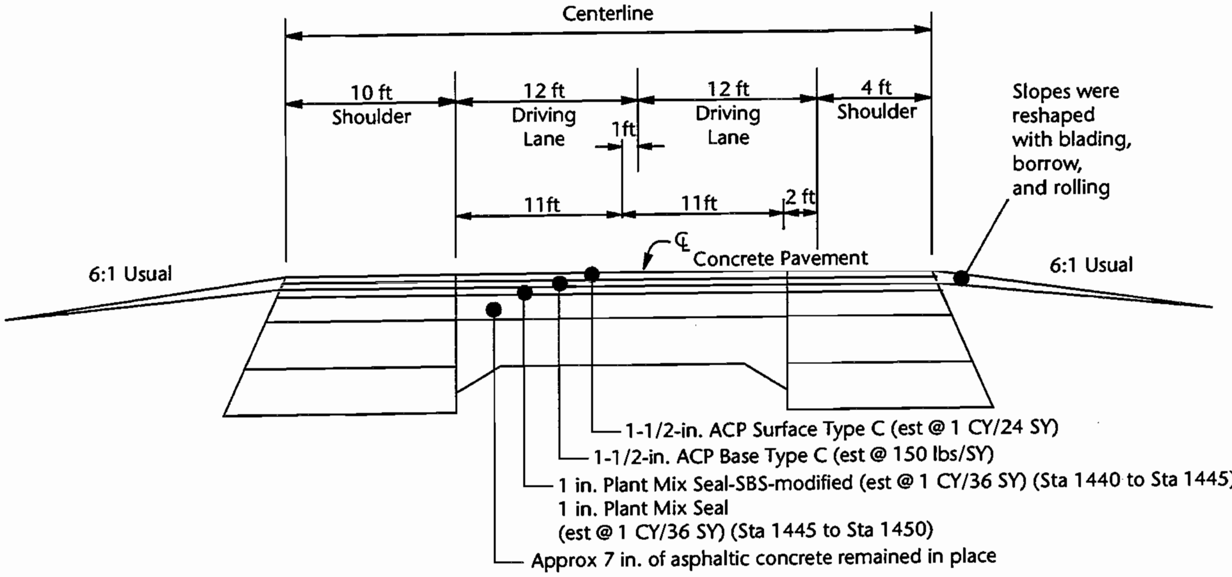


Figure 3.22. Post-construction cross section of R5

Section R6

On Test Section R6, the existing layers remained in place. Next, 3.81 cm (1.5 inches) of Type C base were applied, followed by 3.81 cm (1.5 inches) of Type C surface material. Figure 3.23 shows the cross section of R6.

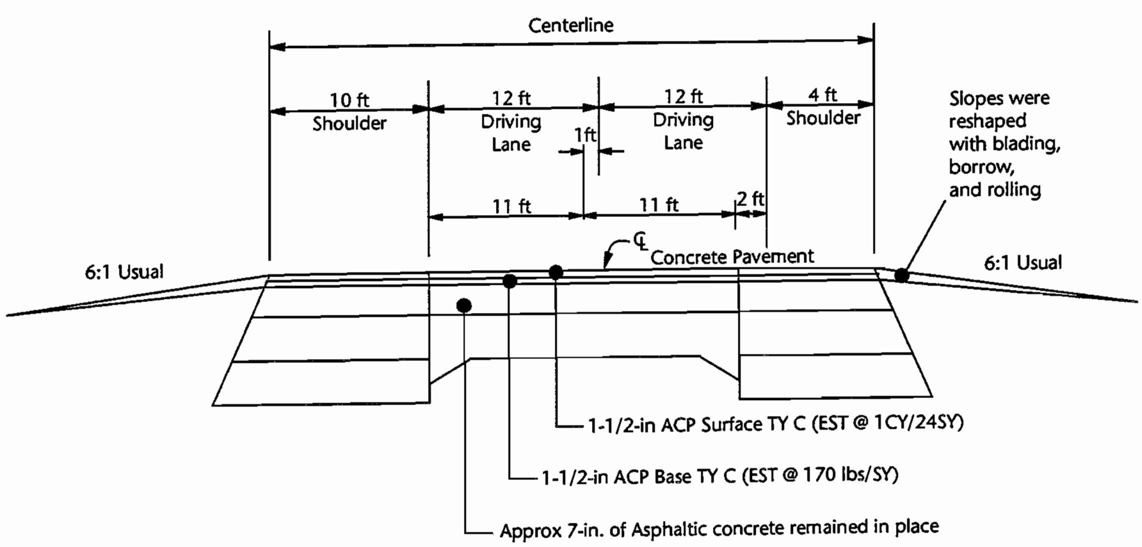


Figure 3.23. Post-construction cross section of R6

Section R0

Test Section RO is the control section and had received the typical treatment used by the district in the past. A standard Type-D surface material was placed over the existing asphalt. This allows for comparison between the performance of the six alternate design test sections and the conventional rehabilitation technique used on this highway. The weight-in-motion traffic system (WIM) was installed in Section R0 prior to the sections being opened to traffic. Figure 3.24 is the post-construction cross section of R0.

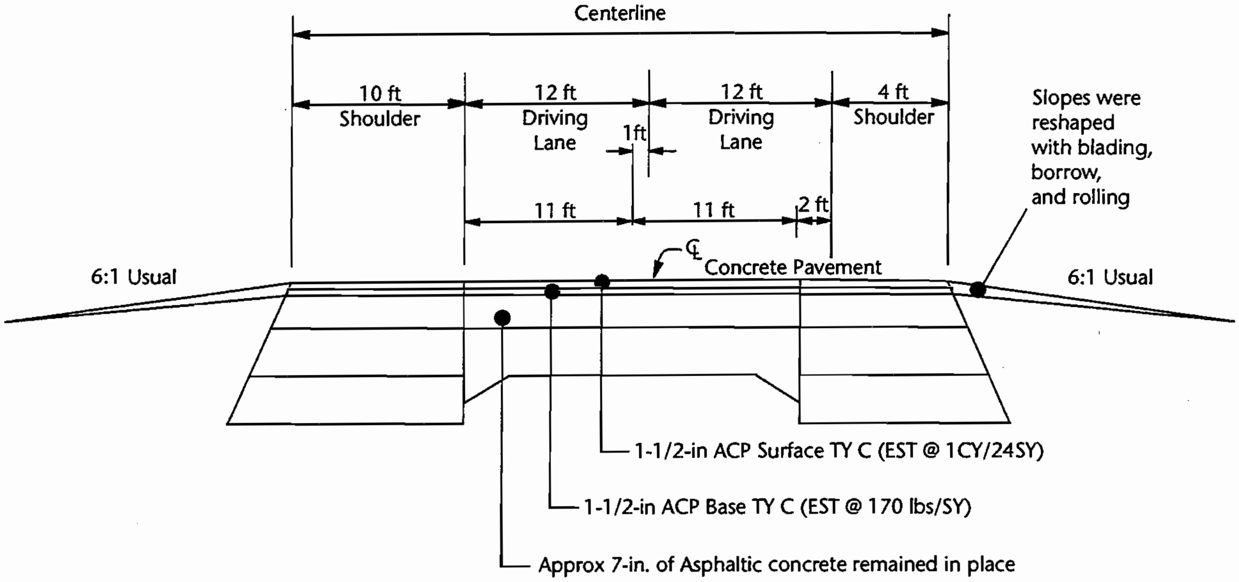


Figure 3.24. Post-construction cross section of R0

3.3 OTHER INFLUENCING FACTORS

After completion of Section R0, the rigid test sections were opened to traffic on April 19, 1992 — 9 months after construction on the detours had begun. Traffic was blocked off the inside lanes in both the northbound and southbound directions. This enabled the contractor to begin removing the material that was used to construct the detours. The material was removed and the median was restored to its original condition.

The delay was due to heavy rain that disrupted the construction phase of the project. Just prior to the opening of the sections to traffic, several types of testing were completed, including FWD measurements, profile or ride measurements, photograph and video documentation, rut depth measurements, and core samples used to verify thickness and to obtain splitting tension, modulus of elasticity, density, and maximum density measurements. These measurements, along with a comparison of before-construction and after-traffic performance, will be documented in Research Report 987-4.

After traffic was opened to the rigid sections, we realized that the striping placement was off by approximately 45.72 cm (18 inches). This dramatically affected the accuracy of the WIM system. In April 1993, we determined that the striping should be moved 45.72 cm (18 inches) over towards the outside shoulder, as shown in Figure 3.26.. Figure 3.25 shows the striping being removed by a sandblaster. The effect of moving the striping on performance and testing will be documented in Report 987-4.

Figure 3.25. Sandblaster removing striping

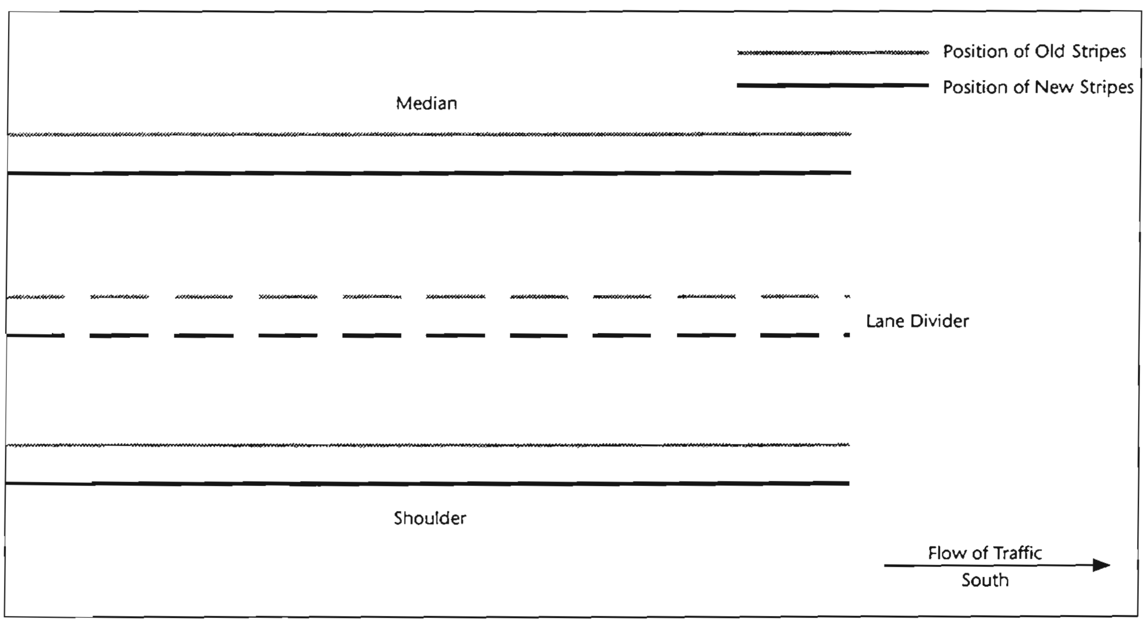


Figure 3.26. Replacement of new striping

CHAPTER 4. FLEXIBLE TEST SECTIONS

4.1 CONSTRUCTION PREPARATION

The flexible sections of US Highway 59, originally placed in 1966, have been subjected to various rehabilitation efforts over the years. The typical rehabilitation technique has been to use a Type D asphalt concrete overlay ranging from a 2.54 cm (1 inch) thickness (1974) to the 8.13 cm (3.2 inch) thickness used in 1985. The purpose of selecting a flexible test section site is to determine possible rehabilitation techniques that may prove to be cost effective over the life of the pavement. Just as with the rigid sections, we selected six design alternatives and one control section. The flexible test section site is located just south of Corrigan, beginning at station 1060+00 and ending at station 990+00.

Section Preparation

As mentioned in Chapter 3, inclement weather hampered the construction of the flexible sections. In preparation for the construction of the detours, cores were taken from the northbound shoulder (where traffic would be rerouted) to assess the quality of the material present. After examining the cores, we determined that the quality of the shoulder material was below the standard needed to support traffic. On August 12, 1991, the undesirable material was bladed out of the 3.05-m (10-foot) outside shoulder, and 171,458 kg (189 tons) of layered Hot Mix Type D were then placed on the shoulders at stations 982+00 to 984+00, 991+00 to 996+20, 1000+50 to 1005+70, 1015+20 to 1016+50, and 1028+10 to 1033+00. The barricades were placed on the flexible sections' northbound lanes on August 26, 1991. To insure the northbound lanes could support the upcoming additional traffic, 1,262,801 kg (1,392 tons) of HMAC were placed along the inside lane, and 1,123,094 kg (1,238 tons) of HMAC were placed in the outside lane. Additional HMAC was then used to bring the 3.05-m (10-foot) outside shoulder even with the grade. Construction of the detours began once the lane preparations were completed.

Detour Construction

On October 11, district personnel began removing the top soil on the north detour of the flexible sections. Within a month, all embankment material had been hauled, placed, and bladed on Detours #1 and #2. On November 11, placement of the flexible base material began for both detours. Throughout the next month, a prime coat was shot and 5.08 cm (2 inches) of Type C base were placed on both detours. Figure 4.1 shows the proposed detour plan.

Because the detour plan, as proposed, threatened to block several subdivision entrances, we moved Detour #2 farther south. Under the direction of the district, it was determined that the first few flexible design sections could be constructed under traffic. The detour was removed and construction began on a new detour 914.4 m (3,000 feet) to the south.

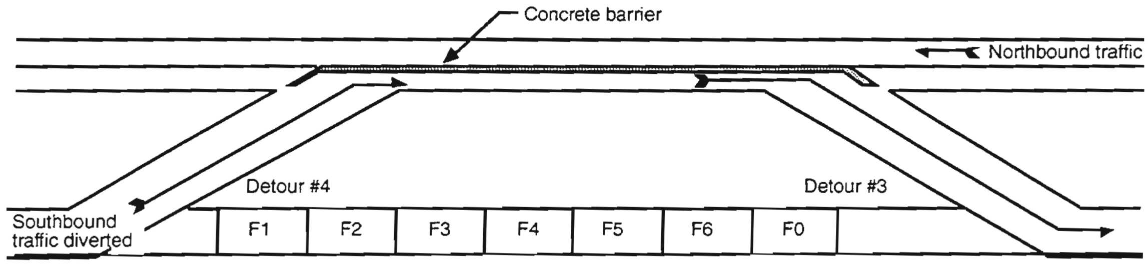


Figure 4.1. Proposed detour plan

The new detour was being constructed on an incline. To avoid problems created by water build up behind the detour, a pipe was placed to allow rainwater to flow through the detour (Fig 4.2). The new detour was not in place until late May 1992. Traffic was moved from the southbound lanes onto the detour on May 26. Within 4 hours of the traffic move, the detour experienced dramatic failure. During the months of construction, the base and underlying soil of the detour had become extremely saturated. By moving the heavy traffic (mostly trucks), the base of the detour began to slide out, causing the surface to collapse. Figure 4.3 shows Detour #2 experiencing failure caused by traffic. Repair attempts were considered, but it was determined that total reconstruction would be necessary to restore detour functioning. Because of time and cost constraints, we decided to complete the construction of the flexible sections by rehabilitating one lane at a time, while leaving the second lane open to traffic. The outside lane was to be constructed first from end to end, followed by the inside lane. Detour #1 and the failed detour were both removed during the first two weeks in June.

Figure 4.2. Pipe placement in Detour #2

Figure 4.3. Failing detour under traffic

4.2 FLEXIBLE TEST SECTION CONSTRUCTION

Each of the six test sections and the control section are approximately 304.8 m (1,000 feet) long. The current typical cross section of the flexible pavement consists of 15.24 cm (6 inches) of lime-treated subgrade, followed by 15.24 cm (6 inches) of roadbed-treated base (Fig 4.4). Next there is 15.24 cm (6 inches) of cement-treated base, followed by 11.43 cm (4.5 inches) of black base. In total, 27.94 cm (11 inches) of asphalt have been placed in various layers over time.

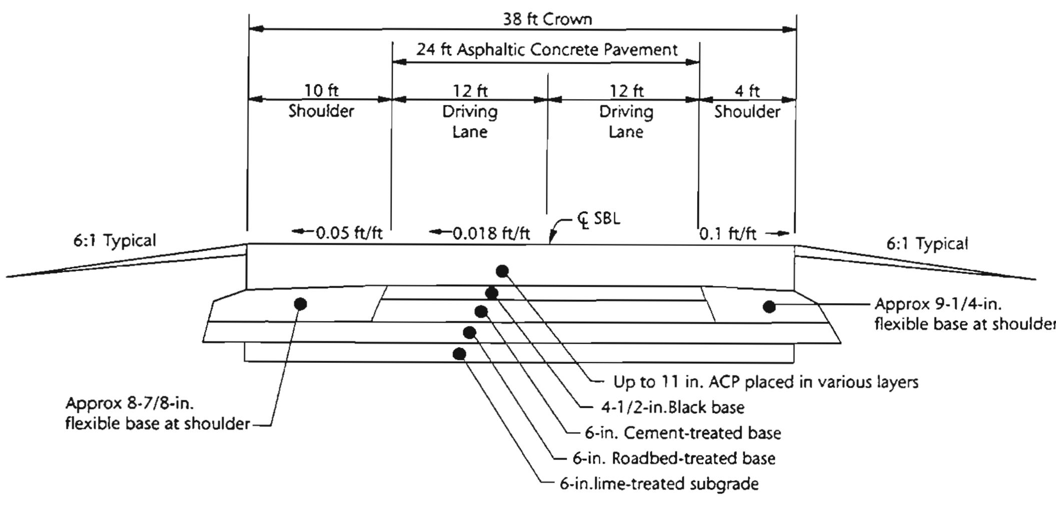


Figure 4.4. Existing typical cross section in flexible test sites (1 ft=0.304 m, 1 in.=2.54 cm)

Section F1

Test section rehabilitation began on the outside lane of Section F1. In Section F1, all existing material remained in place. About 7.62 cm (3 inches) of SBS-modified Type D asphalt was placed in two lifts over the existing material. Figure 4.5 shows the post-construction cross section of Test Section F1.

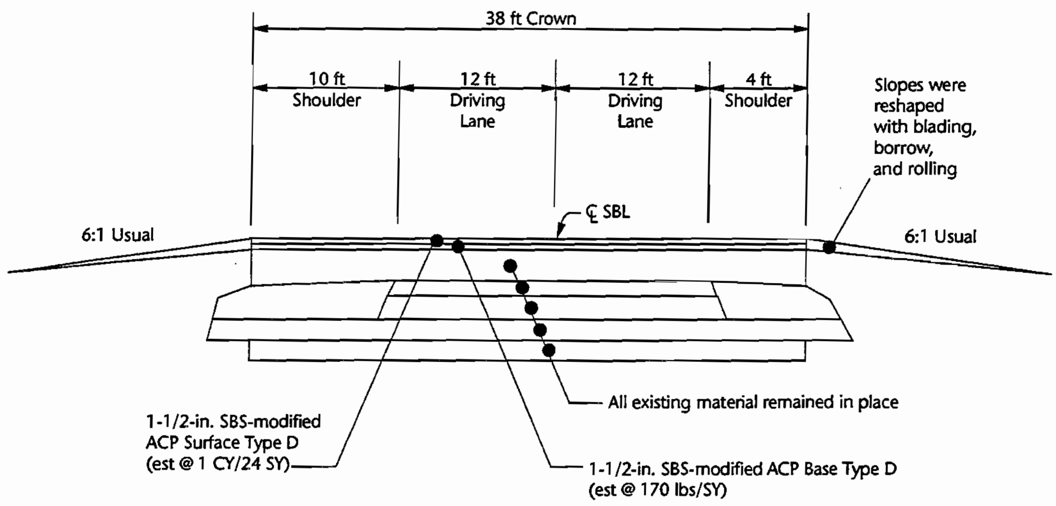


Figure 4.5. Post-construction cross section of F1 (1 ft=0.304 m, 1 in.=2.54 cm)

Section F2

In Test Section F2, a 7.62-cm (3-inch) layer of SBS-modified Type C asphalt was placed in two lifts over the existing materials. Figure 4.6 shows the post-construction cross section of F2.

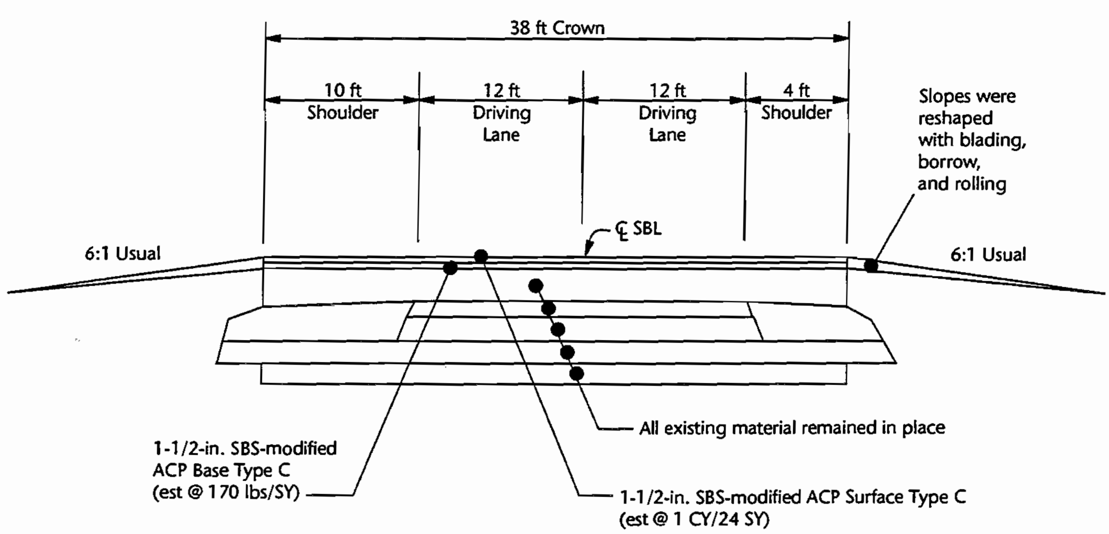


Figure 4.6. Post-construction cross section of F2 (1 ft=0.304 m, 1 in.=2.54 cm)

Section F3

In Test Section F3, 7.62 cm (3 inches) of Type B asphalt concrete were placed over the existing asphalt, followed by 3.81 cm (1.5 inches) of Type C asphalt. Figure 4.7 shows the post-construction cross section of F3.

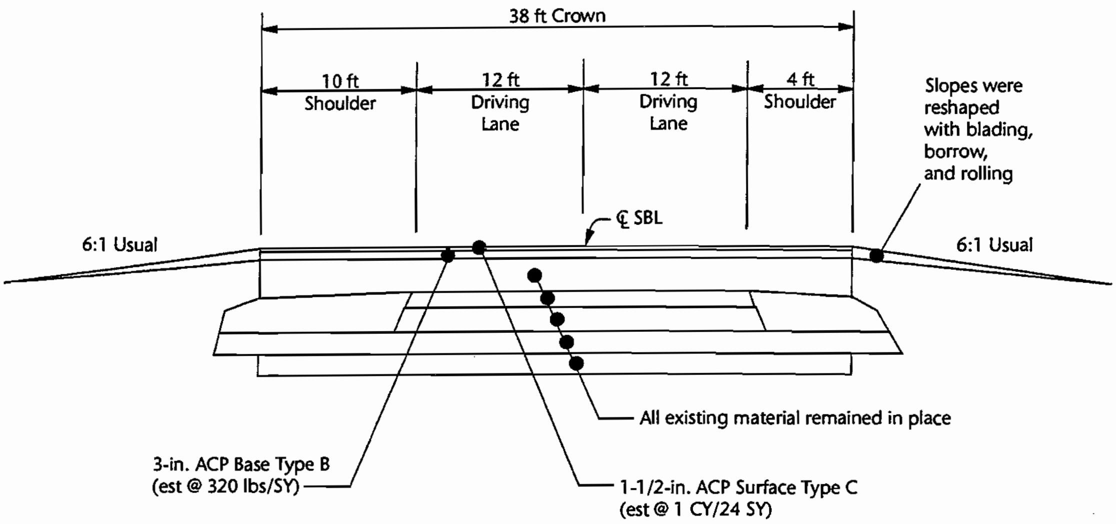


Figure 4.7. Post-construction cross section of F3 (1 ft=0.304 m, 1 in.=2.54 cm)

Section F4

In Test Section F4, 7.62 cm (3 inches) of Type C asphalt were placed over the existing materials in two lifts (Fig 4.8).

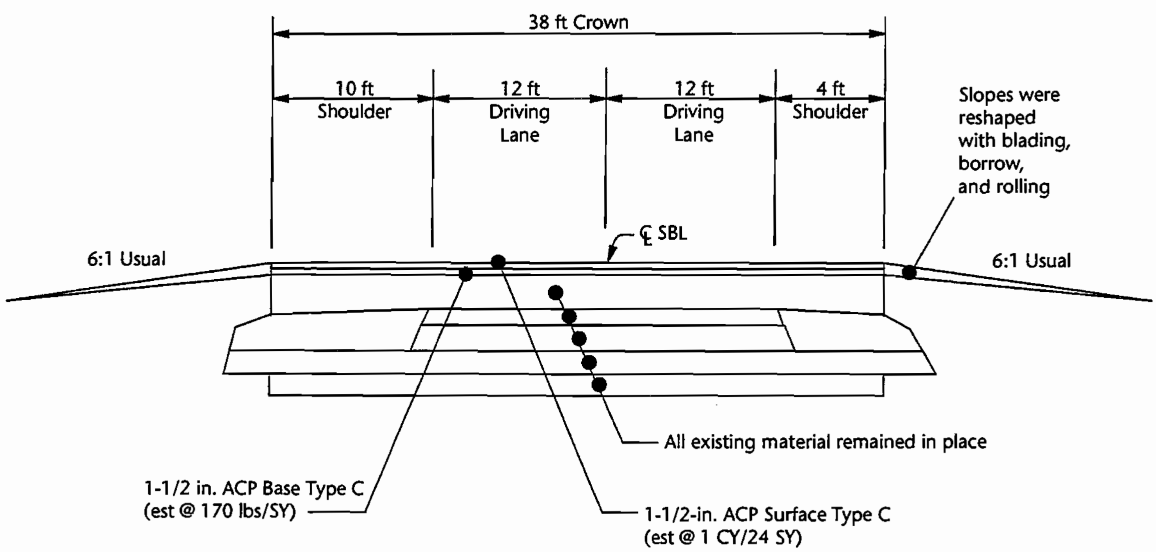


Figure 4.8. Post-construction cross section of F4 (1 ft=0.304 m, 1 in.=2.54 cm)

Section F5

In Test Section F5, the existing 27.94 cm (11 inches) of asphalt were milled and removed. About 25.4 cm(10 inches) of flexible base were then placed over the exposed black base. A prime coat and a one-course surface treatment were then applied to the flexible base, followed by 7.62 cm (3 inches) of Type C asphalt placed in two lifts. Figure 4.9 shows the post-construction cross section of F5.

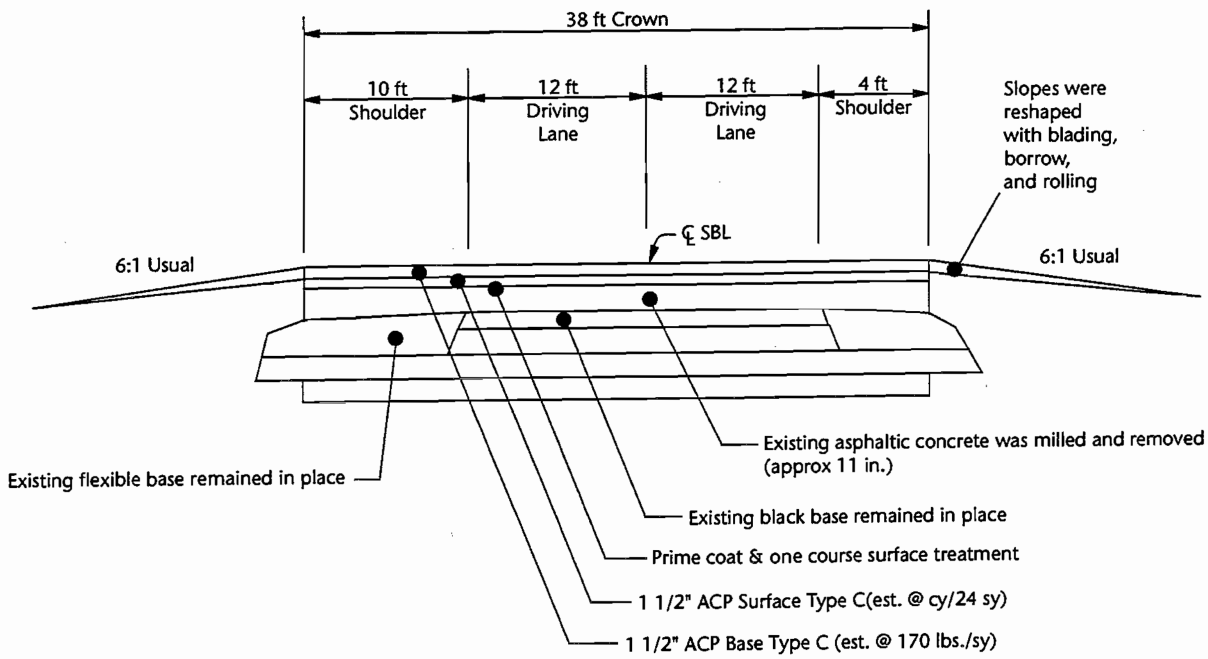


Figure 4.9. Post-construction cross section of F5 (1 ft=0.304 m, 1 in.=2.54 cm)

Section F6

For Test Section F6, all 27.94 cm (11 inches) of existing asphalt were milled and removed, exposing the black base; 7.62 cm (3 inches) of Type B asphalt were then placed over the black base. This was followed by 15.24 cm (6 inches) of Type C asphalt, which was placed in three 5.08-cm (2-inch) lifts (Fig 4.10).

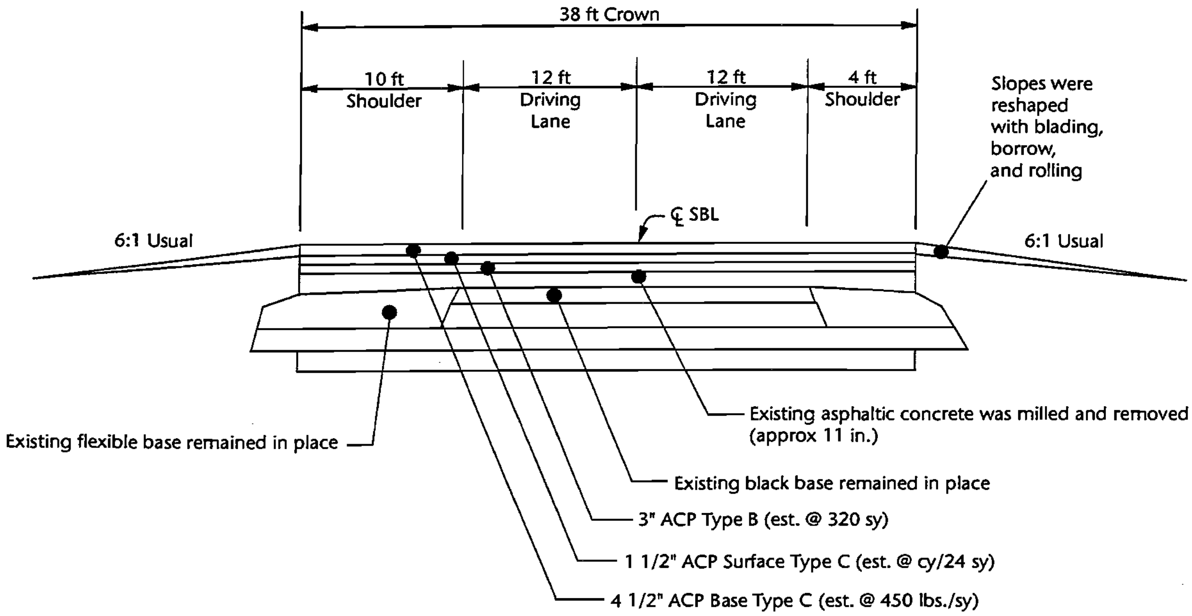


Figure 4.10. Post-construction cross section of F6 (1 ft=0.304 m, 1 in.=2.54 cm)

Section F0

Test Section F0 is the control section within the flexible sections. In section F0, 3.08 cm (1.5 inches) of Type D asphalt were placed over the existing asphalt in the first 152.4 m (500 feet) (F0A) and 7.62 cm (3 inches) of Type D asphalt were placed over the remaining 152.4 m (500 feet) in two lifts (F0B). Figures 4.11 and 4.12 show the existing cross sections.

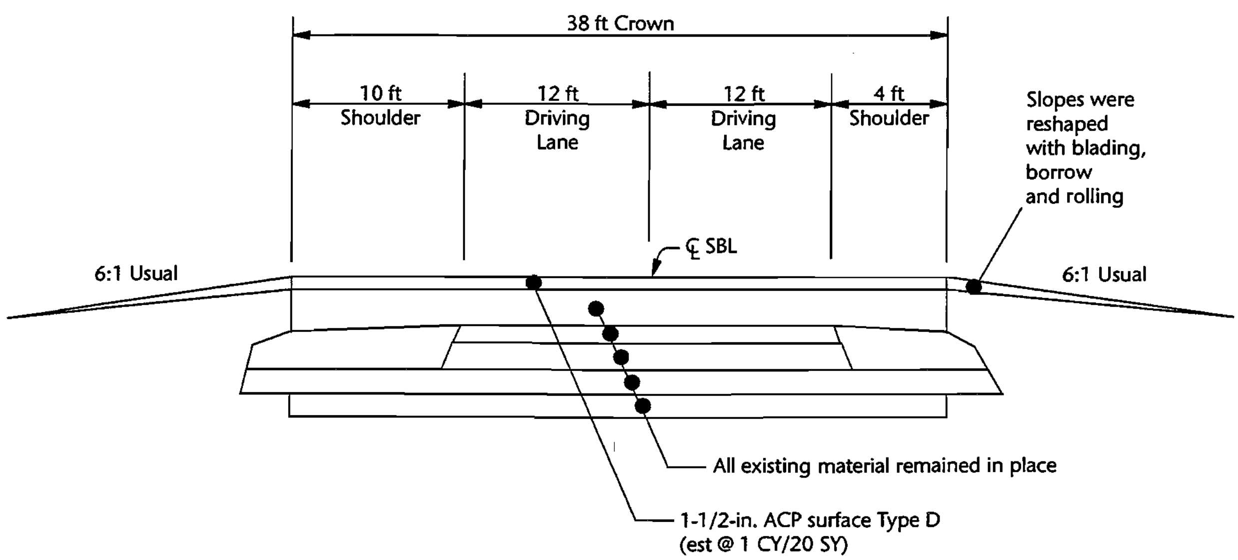


Figure 4.11. Post-construction cross section of F0A (1 ft=0.304 m, 1 in.=2.54 cm)

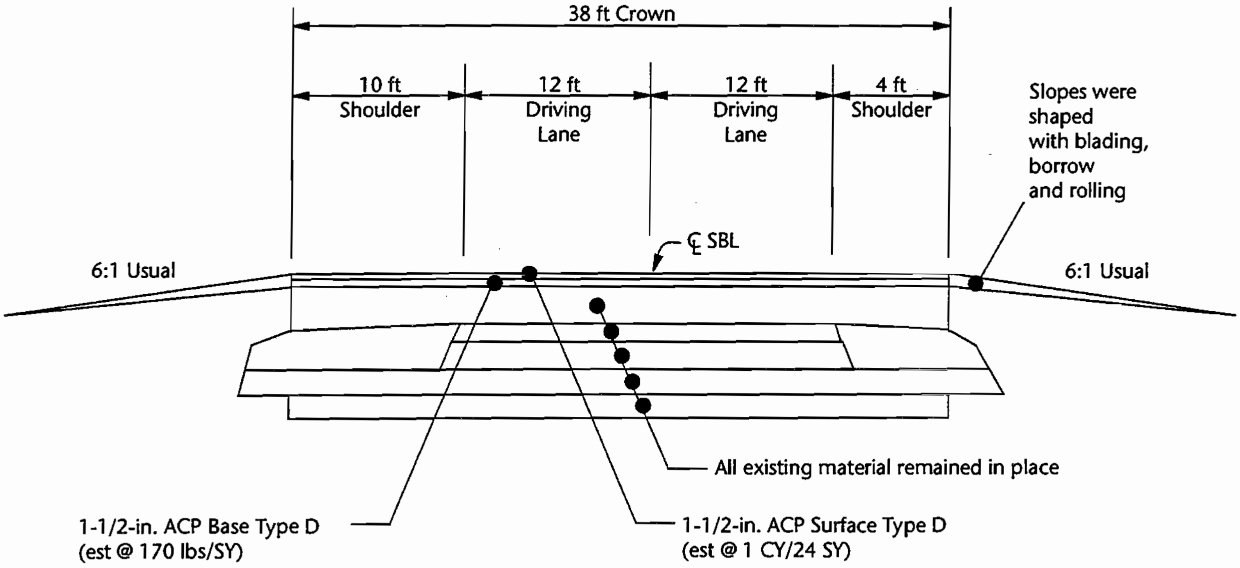


Figure 4.12. Post-construction cross section of F0B (1 ft=0.304 m, 1 in.=2.54 cm)

With construction on the main lanes completed, work began on the deceleration areas and on the transition areas where the local driveways enter into the subdivisions. Before opening the section to traffic, the weighing-in-motion equipment was installed within the sections. All work was completed by July 7, 1992. The following day the job was approved and officially accepted by the State of Texas.

CHAPTER 5. WEIGHING-IN-MOTION INSTALLATION

5.1 BACKGROUND

An important part of the monitoring plan was the installation of state-of-the-art weighing-in-motion equipment (WIM). The WIM equipment was installed within the limits of both the rigid and the flexible sections. This equipment allows an engineer to correlate test section performance with the number of 80-kN (18-kip) equivalent axle loads (ESALs) applied to the pavement.

The WIM equipment provides accurate and important information around the clock. This information includes vehicle classification, traffic counts, axle configuration, axle position within the lane, vehicle speed, axle and wheel weights, and pavement temperature. This information can be correlated with test section performance by taking into account such data as percentage of trucks and their average weight, or total number of vehicles passing over the sections and the seasonal variations to these totals. The WIM-assisted traffic monitoring effort within the test sections will yield one of the most extensive and accurate collections of traffic data related to pavement performance in Texas.

5.2 INSTALLATION

The WIM equipment was placed in the control section (R0 and F0) of both the rigid and flexible design sections. Before rehabilitation construction began, it was necessary to place conduit in the control section where the WIM equipment would be located. A concrete saw was used to cut a groove in the pavement for insertion of the conduit. District personnel made several passes with the saw, cutting a 5.08-cm (2-inch) wide and 7.62-cm (3-inch) deep gap. Conduit containing the wiring necessary to connect the WIM pads to the data recorders was placed in the sawed gap. Cold mix was then placed on top of the conduit.

After the contractor completed overlaying the control sections, the WIM equipment was ready to be installed, beginning with the loop detectors. A concrete saw was used to cut a 3.56-cm (1.4-inch) wide by 2.54-cm (1-inch) deep groove in the pavement. Four grooves were cut forming a rectangle (Fig 5.1). A set of wires placed in the loop would detect vehicles; that is, as a vehicle passes over the inductance loop detector, the WIM system is activated and the measurements recorded.

The next task was to install the WIM transducers, or weight pads. These pads are used to weigh the vehicle while it is in motion. By staggering the pads as shown in Figure 5.1, the speed of the vehicle can also be obtained. To install the weighing pads, a saw was used to make cuts where the new overlay could be removed for the pad (Fig 5.2). The area cut out by the pavement saw was sandblasted and measured to obtain the right depth for weight pad installation (Fig 5.3). The weighing pads were then put in place and the wire used to transmit the desired information (Fig 5.4) was inserted.

The next task was to install lateral wheel position sensors. These sensors are designed to receive an inferred beam from a transmitter. If a car passes through the inferred beam, the beam is broken. When the beam is broken, the sensor measures the axle configuration and axle placement of the vehicle. The sensor itself is installed off the shoulder of the road. The transmitter is placed on the edge of the weigh pad. Figure 5.5 shows the inferred transmitter on the edge of the weight pad. The sensor can also be seen in the background on the inside lane.

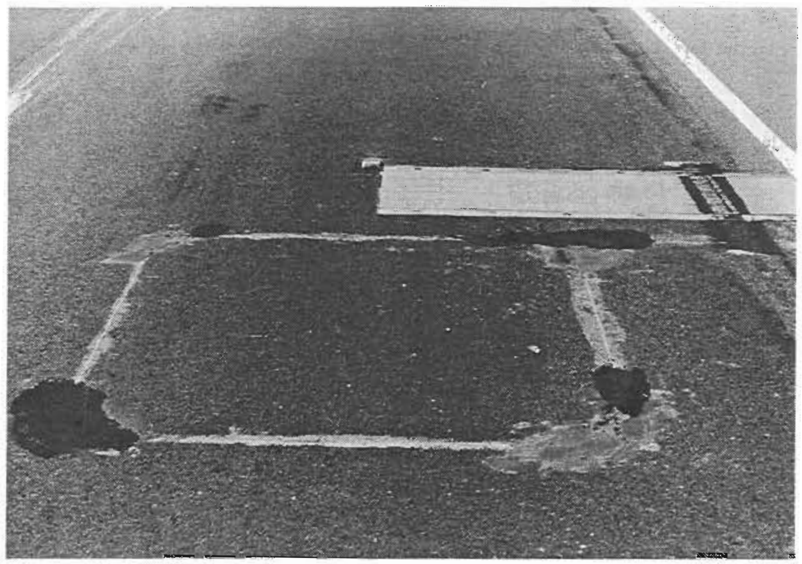


Figure 5.1. Loop detector in front of weight pad

Figure 5.2. Concrete saw used to remove overlay at WIM site

Figure 5.3. Sandblaster preparing WIM pad site

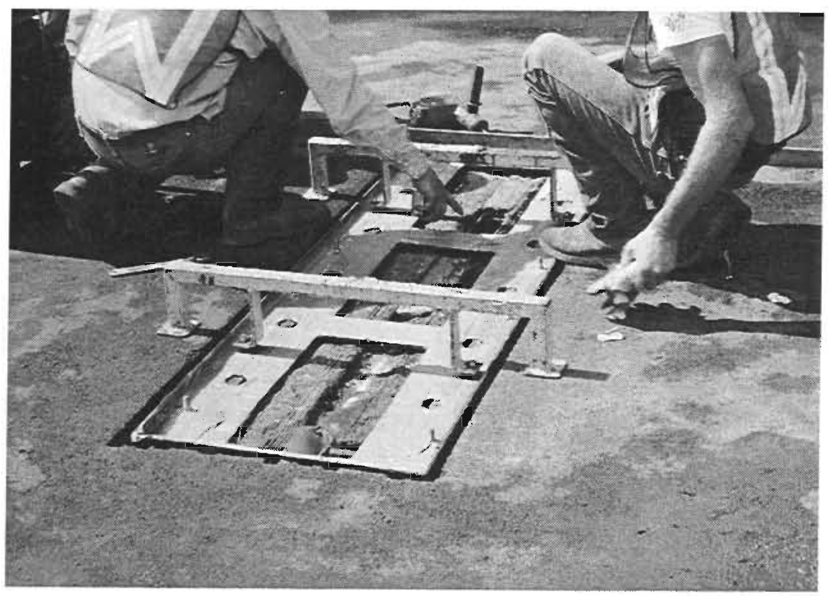


Figure 5.4. Installing the WIM pad

The transducers and loop detectors were then sealed to keep moisture out of the electronic equipment. On the side of the road, a computer was placed in a steel box to read the measurements. This computer hooked into a nearby telephone wire so that the data it collected and stored could be downloaded from distant locations. The equipment was calibrated and ready to run as traffic was opened to the test sections. Figure 5.6 shows the layout of the WIM equipment.

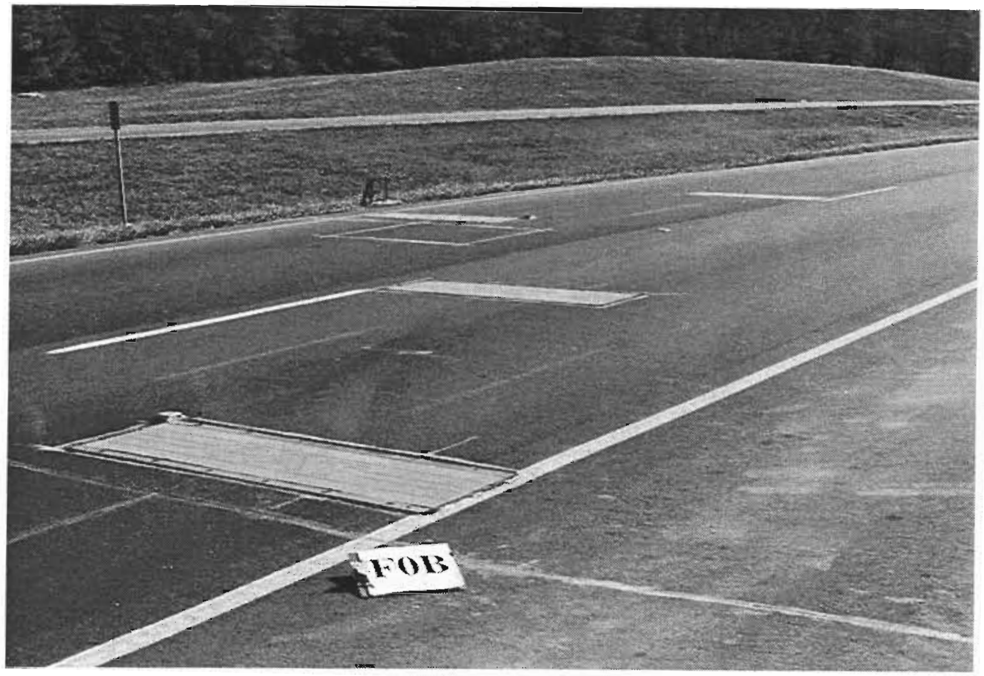


Figure 5.5. Infrared lateral wheel position sensors

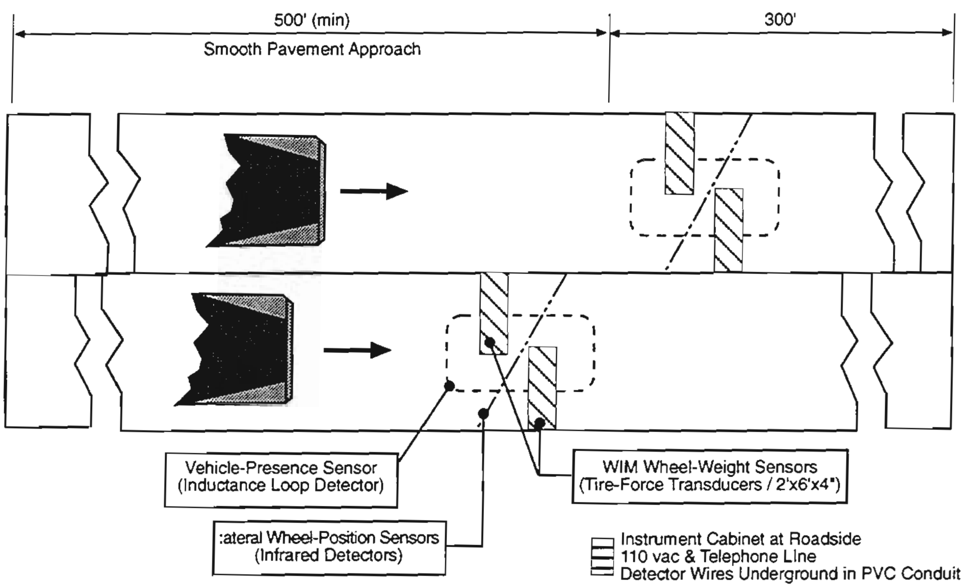


Figure 5.6. Layout of WIM equipment (1 ft=0.304 m, 1 in.=2.54 cm)

5.3 OTHER FACTORS

As mentioned in Chapter 3, the striping in the rigid section was placed 45.72 cm (18 inches) from the planned striping location. Having the traffic moved over by 45.72 cm (18 inches) dramatically affected the results obtained by the WIM equipment. In April 1993, the striping of the rigid section was removed and placed 45.72 cm (18 inches) over, as was originally planed. For further details concerning the weight-in-motion equipment and the corresponding results found in the test section study, see Reports 987-2 and 987-4.

CHAPTER 6. CONSTRUCTION COSTS

This chapter discusses the construction costs for the test sections previously described. First, a general background pertaining to the cost is provided. Next, the contract bidding process, along with associated costs, is reviewed.

6.1 BACKGROUND

In preparing the plans, specifications, and estimate (PS+E) for the project, considerable effort went into developing a detailed set of plans and bid documents so that maximum information could be gleaned from the bidding process. It was felt that, in order to make a life-cycle costs analysis of the entire section of US 59, reliable data must be available. On February 16, 1989, a pre-bid conference was held in the Lufkin District office to acquaint the prospective contractors with the scope and intent of the operation. At the conference, Center for Transportation Research staff and Lufkin District personnel answered contractors' questions and made presentations on various facets of the project.

On March 5, 1991, at the bid letting in Austin, Texas, three contractors officially submitted bids on the project. The Moore Brothers Construction Company of Lufkin, Texas, was the low bidder, and they were awarded the project 30 days later. The next section discusses the bid process.

6.2 OVERVIEW OF CONTRACT BIDDING

Table 6.1 summarizes the bidding relating to Test Section R0. In looking at the table, moving from left to right, the first few columns pertain to the description of the work item, the units of measure, and the estimate of quantities. Next is the bidding information for each of the contractors. First, the unit cost bid is presented; this is extended with quantities to provide the total cost. The next column pertains to the average bid of the three contractors — presented in terms of the unit costs and total costs. The last column is the engineer's estimate of the cost developed during the planning process for the project.

Table 6.1. Summary of construction bidding on R0

Test Section R0 (Station 1420+00 - 1430+00)					BIDDER									
WORK DESCRIPTION					*Moore Brothers*		*Porter*		*C.C.E.*		*Average Bid*		*Engineer Estimate*	
Action	**Subaction**	**Itm #**	**Unt**	**Qnt**	**Unt Cst**	**Ttl Cst**	**Unt Cst**	**Ttl Cst**	**Unt Cst**	**Ttl Cst**	**Unt Cst**	**Ttl Cst**	**Unt Cst**	**Ttl Cst**
Slope Reshaping														$0
														$0
(20 CY/Sta.)	Borrow	131	CY	233.3	$12.45	$2,905	$7.00	$1,633	$10.00	$2,333	$9.82	$2,290	$5.50	$1,283
														$0
(0.5 HR/Sta.)	Blading	150	HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$83.33	$417	$30.00	$150
														$0
1 & 1/2" ACP		3691-7	CY		$75.65		$80.00		$83.00		$79.55		$73.00	$0
														$0
Surface Type D			(SY)	4222	$3.78	$15,959	$4.00	$16,888	$4.15	$17,521	$3.98	$16,789	$3.65	$15,410
TOTALS						$19,364		$18,796		$20,329		$19,496		$16,843

Table 6.1 shows that the bid for any one item may range from 2 to 78 percent of the average, whereas the maximum variation of the average from the contractors' bid is approximately 9 percent. Looking at the engineer's cost estimate and comparing it with the average bid cost, the average cost is approximately 16 percent more than the engineer's estimate.

Appendices C and D detail the prices bid by the competing contractors for the rigid test sections and the flexible test sections, respectively. As these appendices show, individual items reveal the complexity of the bid plans. For example, in Test Section R1 (Appendix C), where considerable repair and restoration of the existing pavement were required, a large number of action and sub-action items are presented in terms of bid items. In general, the overall costs are higher than the engineer's estimate, though the variability between contractors is relatively small.

6.3 ANALYSIS OF COSTS

This section examines pavement costs for both the rigid and flexible pavement test sections. The costs are examined in both a cost for yd^2 and a cost per two-lane mile.

Rigid Pavement Test Sections

Table 6.2 summarizes bid prices for the rigid pavement test sections for each of the contractors (and which may be compared with the engineer's estimate). The bids are based on a two-lane mile cost. All comparisons have been converted to a square-yard basis to provide relative comparison with figures in Table 6.3.

Looking at Table 6.2 from the contractor's perspective, only 3 bids of the 24 combinations were less than the engineer's estimate, and of these, the Moore Brothers had two of the units. The largest variation comes with Test Section R1, where the approximate variation is \$6.00. This is to be expected since the complex repairs, restorations, etc., could be quite expensive and was anticipated in the engineer's estimate.

A relative look at the costs between tests sections, reveals the Test Section R0, or the standard method of operation, has the lowest costs. The relative difference between the highest and the lowest costs is approximately a ratio of 7 to 1.

Table 6.2. Contractor bids for rigid section by mile

BIDDER	Cost Per Mile for Rigid Test Sections								
	R0	R1	R2-A	R2-B	R3	R4	R5	R6	Ave Cost (\$/Mi/Section)
Engineer Estimate	\$88,931	\$578,436	\$348,371	\$396,295	\$376,532	\$440,016	\$185,173	\$151,338	\$320,636
Moore Brothers	\$102,237	\$658,569	\$328,327	\$362,872	\$413,935	\$445,799	\$216,326	\$163,073	\$336,392
Porter	\$99,240	\$741,436	\$352,888	\$380,303	\$464,008	\$465,595	\$210,029	\$153,843	\$358,418
C.C.E., Inc.	\$107,335	\$799,121	\$391,486	\$436,064	\$580,920	\$562,772	\$233,143	\$174,417	\$410,657
Average Bid	\$102,938	\$733,042	\$357,567	\$393,080	\$486,288	\$491,388	\$219,833	\$163,778	\$368,489

Figure 6.1 provides a relative comparison of those costs per two-lane mile for each of the tests sections in terms of contractor and the engineer's estimate. Looking at the figure, it is apparent that the relative magnitude of the costs for each test section is the same for each

contractor, i.e., R0 is the smallest and R1 is the highest. There is an exception of some position shifting on R3 and R4, since the costs for both test sections are relatively equal for a given contractor.

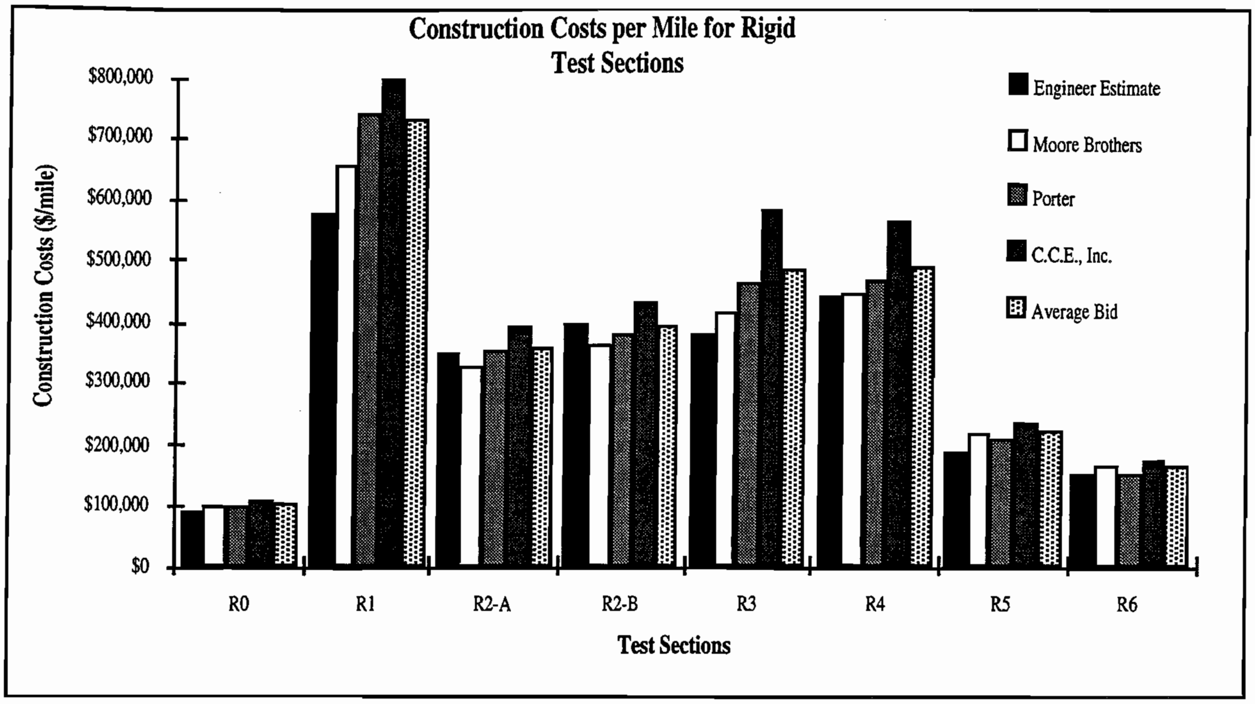


Figure 6.1. Contractor bids for rigid section by mile

Table 6.3. Contractor bids for rigid section by square yard

BIDDER	Cost ($/SY) for Rigid Test Sections								
	R0	R1	R2-A	R2-B	R3	R4	R5	R6	Ave Cost ($/SY/Section)
Engineer Estimate	$3.99	$25.95	$15.63	$17.78	$16.90	$19.74	$8.31	$6.79	$14.39
Moore Brothers	$4.59	$29.55	$14.73	$16.28	$18.57	$20.00	$9.71	$7.32	$15.09
Porter	$4.45	$33.27	$15.83	$17.06	$20.82	$20.89	$9.42	$6.90	$16.08
C.C.E., Inc.	$4.82	$35.86	$17.57	$19.57	$26.07	$25.25	$10.46	$7.83	$18.43
Average Bid	$4.62	$32.89	$16.04	$17.64	$21.82	$22.05	$9.86	$7.35	$16.53

Figure 6.2 presents the total costs for each of the test section alternatives. In this case, there is a grouping on a test section by contractor to present the relative distribution. In terms of total costs, R1 has the largest variation bid between the prices between the contractors, though, percentage-wise, the others are also large.

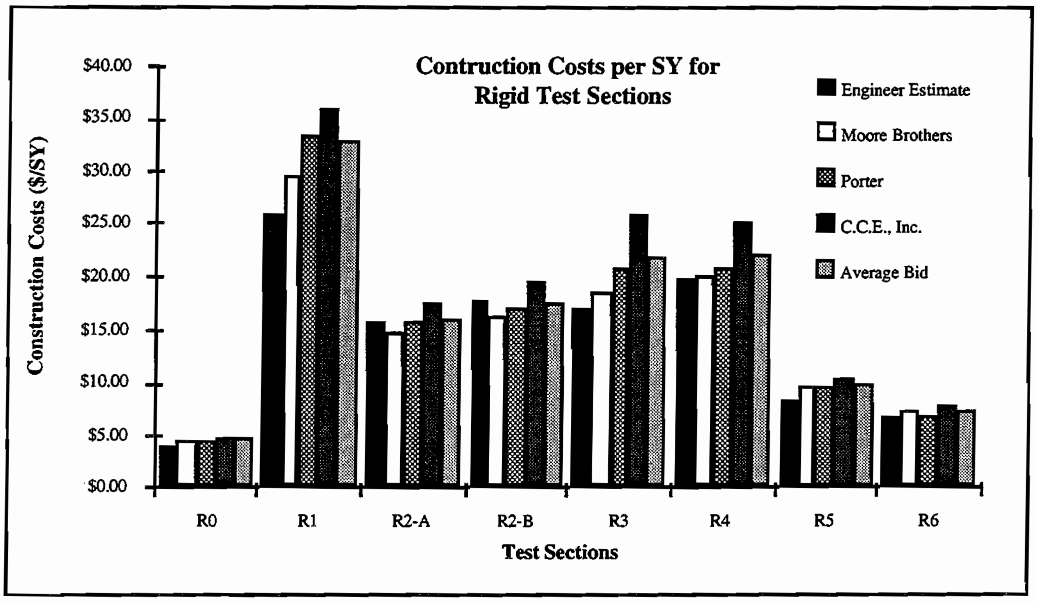


Figure 6.2. Contractor bids for rigid section by square yard

Table 6.2 and Figure 6.1 provide the costs per two-lane mile for each of the test sections. The actual costs were in terms of a shorter section (i.e., 1/10 of a mile), but have been extended to per-mile basis. Although the relative shapes of the curves are similar as would be expected, the cost per mile is a familiar practice and may be used for cost estimates. Once again, Table 6.3 and Figure 6.2 are presented on a square-yard-cost basis.

Flexible Pavement Test Sections

Tables 6.4 and 6.5 present the cost of construction on a two-lane mile and square-yard basis for each test section. Test Sections F5 and F6, the largest on a unit-cost basis, represent a 5-to-1 ratio. In this case, the engineer's estimate is much closer to the average bid price. This is to be expected, since there were more known facts about each item based on previous experience. Again, the spread between contractors is small. Figures 6.4 and 6.5 summarize or plot the data found in Tables 6.4 and 6.5.

Table 6.4. Cost of construction on a two-lane-mile basis

BIDDER	Cost Per Mile for Flexible Test Sections								
	F1	F2	F3	F4	F5	F6	FOA	FOB	Ave Cost ($/Mi/Section)
Engineer Estimate	$170,402	$173,225	$217,474	$148,705	$399,128	$479,956	$86,512	$144,952	$227,544
Moore Brothers	$186,399	$185,897	$189,529	$157,543	$453,301	$448,589	$96,817	$159,465	$234,692
Porter	$191,309	$165,516	$211,059	$150,683	$489,766	$443,726	$96,162	$152,355	$237,572
C.C.E., Inc.	$197,029	$198,084	$232,822	$169,960	$639,388	$520,382	$102,937	$170,889	$278,936
Average Bid	$191,579	$183,166	$211,137	$159,395	$527,485	$470,899	$98,639	$160,903	$250,400

Table 6.5. Cost of construction on square-yard basis

BIDDER	Cost ($/SY) for Flexible Test Sections								
	F1	F2	F3	F4	F5	F6	F0A	F0B	Ave Cost ($/SY/Section)
Engineer Estimate	$7.65	$7.77	$9.76	$6.67	$17.91	$21.54	$3.88	$6.50	$10.21
Moore Brothers	$8.36	$8.34	$8.50	$7.07	$20.34	$20.13	$4.34	$7.16	$10.53
Porter	$8.58	$7.43	$9.47	$6.76	$21.98	$19.91	$4.31	$6.84	$10.66
C.C.E., Inc.	$8.84	$8.89	$10.45	$7.63	$28.69	$23.35	$4.62	$7.67	$12.52
Average Bid	$8.60	$8.22	$9.47	$7.15	$23.67	$21.13	$4.43	$7.22	$11.24

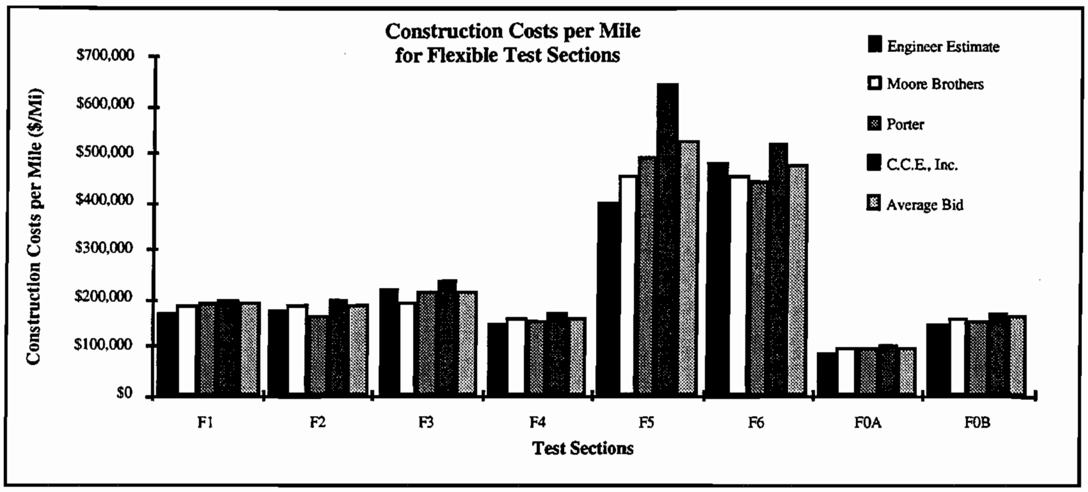


Figure 6.4. Cost of construction on a two-lane-mile basis

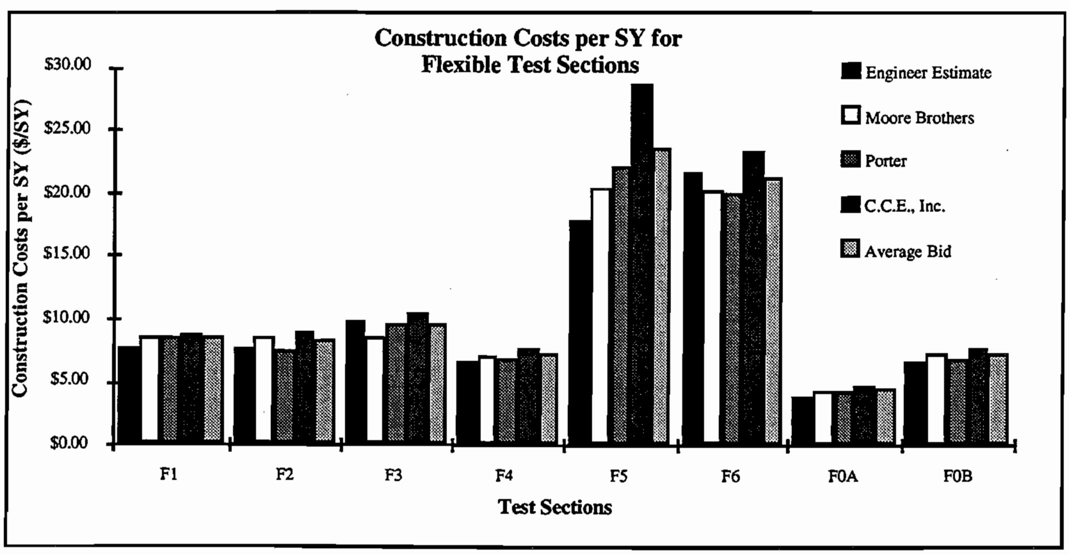


Figure 6.5. Cost of construction on square-yard basis

6.4 SUMMARY

The performance data for each of these tests sections will continue to be compiled over the life of the facility. Thus, any evaluation of the sections must take into account the years of service and the costs associated with maintenance.

In general, the rigid pavement tests sections are more expensive to construct — with the exception of the typical operations used in the past. Again, at this point, a decision as to the most appropriate rehabilitation type cannot be made until the performance information is integrated with the cost data for their initial cost plus future maintenance operations. At that time the costs can be reviewed in terms of cost per ESAL application for a given performance history.

CHAPTER 7. POST-CONSTRUCTION MONITORING PLAN

7.1 MONITORING PLAN

With both the construction and the cost analysis completed, the next phase of the project is the post-construction performance monitoring. This monitoring is essential to providing accurate and detailed information that correlates the test section performance with the rehabilitation design and rehabilitation costs. A monitoring plan was outlined by CTR personnel and approved by the Lufkin District and the project engineer. Figure 7.1 shows the monitoring schedule.

	Before Construction	DURING CONSTRUCTION	NOT OPEN TO TRAFFIC	JUNE '92	September '92	December '92	March '93	June '93	September '93	December '93	March '94	
				Months After Construction								
Rigid Test Site												
Rut Depth	X			X	X	X	X	X	X		X	
FWD	X	X	X				X			X	X	
Condition Survey	X			X						X	X	
Profile	X		X	X			X			X	X	
Cores (No.)	X		X								X	
Flexible Test Site												
Rut Depth	X			X	X	X	X	X	X		X	
FWD	X							X		X	X	
Condition Survey	X			X						X	X	
Profile	X			X				X		X	X	
Cores (No.)	X		X								X	

Figure 7.1. Long-term monitoring plan

7.2 TYPES AND METHODS OF DATA COLLECTION

Several types of data will be collected during the post-construction monitoring phase of the project. Each type of data and the method used to collect the data are discussed below.

Rut Depth Measurements

Rut depth measurements are used to measure the amount of rutting that will occur over time in the wheelpaths of the test section lanes. Rut depth measurements will be taken in both wheelpaths and both lanes in each test section, as shown in Figure 7.2. As can be seen in the diagram, measurements will start 15.24 m (50 feet) into the test section and will be taken every 15.24 m (50 feet) from that point forward. A total of 80 rut depth measurements will be taken in each 304.8-m (1,000-foot) test section.

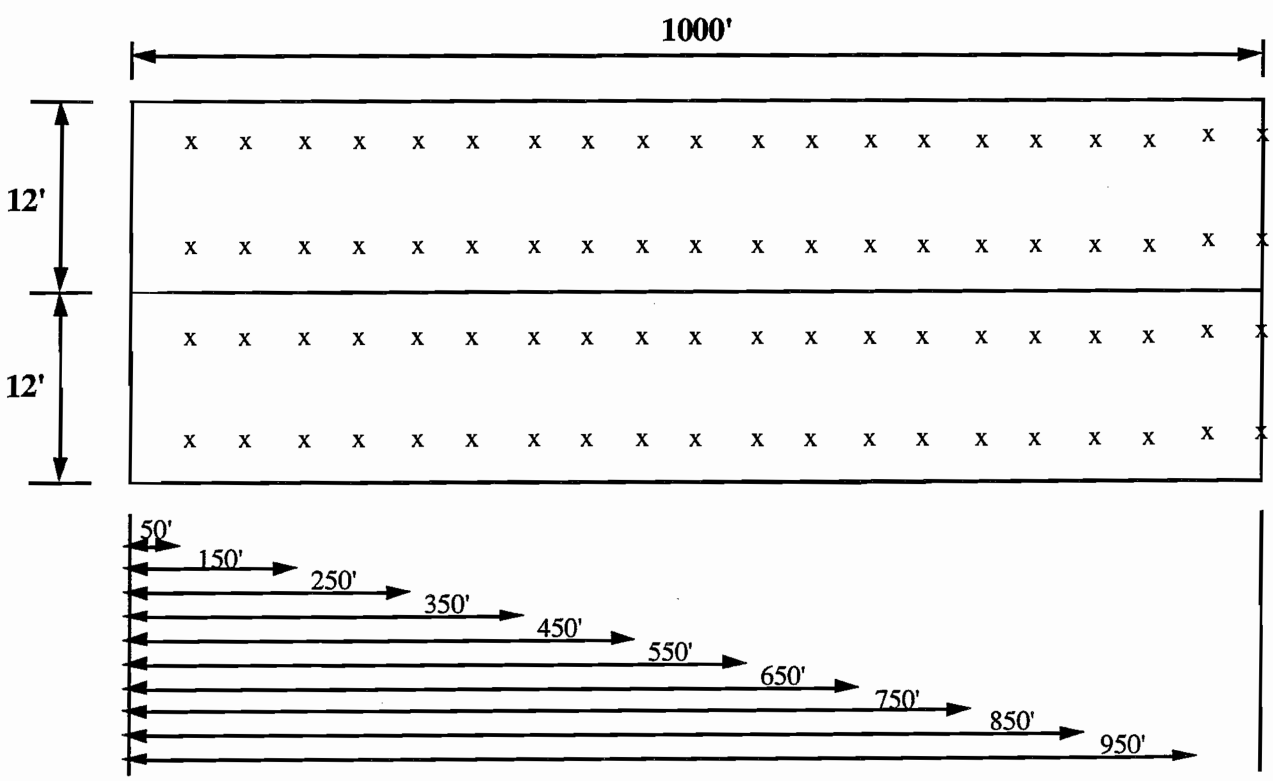


Figure 7.2. Rut depth measurement locations (1 foot=0.304 m)

The rut depth measurements are to be taken at the same locations within each test section at each monitoring period. To insure the rut depth measurements are taken in the same place, two types of markers will be put in place in each test section. The first marker will be a painted outline of the rut bar occurring every 15.24 m (50 feet) in each wheel path. The second marker will be placed by hammering a nail with a tin marker into the shoulder at each 15.24-m (50-foot) location. CTR personnel will be responsible for taking the rut depth measurements.

FWD

The falling weight deflectometer will be used at various times during future monitoring to test for load transfer and to indicate the general condition of the underlying layers of the pavement. The FWD is used as a performance indicator and will be an important measurement tool used extensively in the performance report. The FWD measurements are to be taken every 15.24 m (50 feet) in the outside wheelpaths. The 15.24-m (50-foot) locations are marked by the rut depth paint marking, so the FWD measurements will be taken along with the rut measurements. The FWD will run only in the outside wheelpath, owing to safety factors in traffic handling when the sections are opened. The FWD measurements will be recorded by the Lufkin District, with the assistance of CTR.

Condition Surveys

A detailed condition survey will be conducted at every testing stage. The condition survey will contain testing locations for coring, FWD, and rut measurements. This condition survey will also include all distresses, such as transverse, alligator, block, and longitudinal cracking, shoving, and any unusual conditions that may occur. The condition survey enables researchers to monitor the development of distresses over time. A sample of a condition survey form is included in Appendix B. The condition surveys are to be conducted by CTR.

Profile

Profiles should be measured at the same time FWD measurements are recorded. The profile evaluates the ride (or roughness) of the road surface. Profile measurements, the recording of which does not require traffic handling, will prove important for the performance report. Profile measurements will be taken by D-8 maintenance profile crew out of Austin, under the direction of either CTR or the Lufkin District.

Cores

Twenty-eight cores, taken immediately after construction, will be tested for resilient modulus, tensile strength, creep, density, and mix characteristics. The cores will also be used to verify layer thicknesses. More cores may be added to the monitoring plan as needed. The cores are to be taken by the district.

Weight-In-Motion

As discussed in Chapter 5, the weight-in-motion machine will be used to provide long-term traffic counts. The traffic information will be collected daily and correlated to the performance of the test sections over time. The data collected for the WIM will be downloaded by modem from CTR in Austin. The district may need to assist with WIM equipment maintenance.

Data Collection

The data collection will fulfill the third stage of the project. The information will be used to measure performance and, eventually, improve the design of pavements throughout the Lufkin District and the rest of US 59.

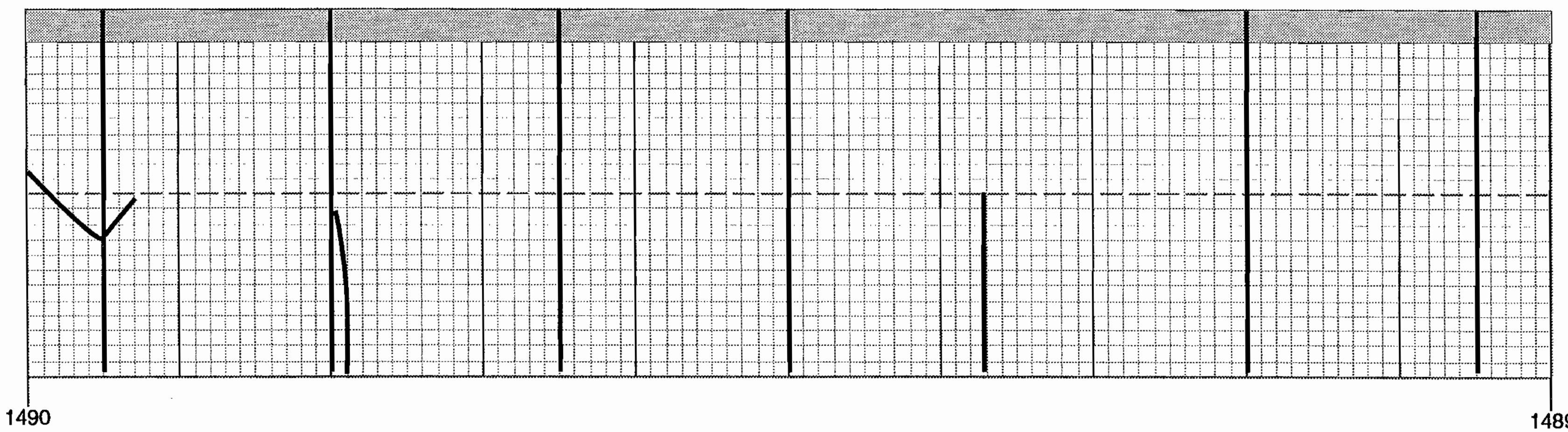
REFERENCES

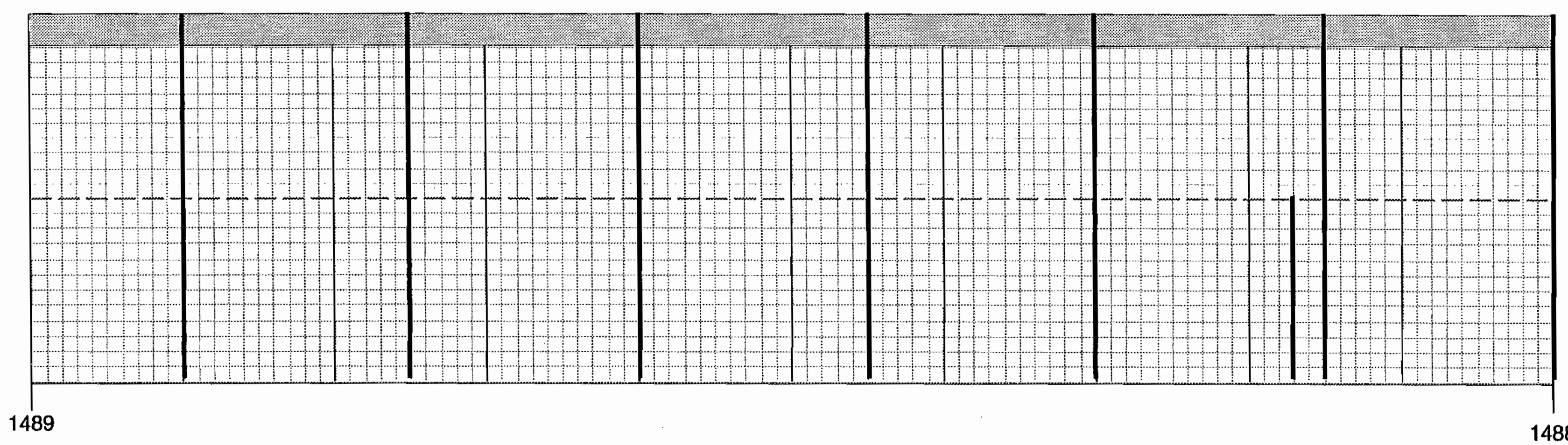
1. Hoskins, B., B. F. McCullough, and D. Fowler, "The Development of a Long-Range Plan for U.S. 59 in District 11." Research Report 987-1, Center for Transportation Research, The University of Texas at Austin, 1991.
2. Lee, C. E., and S. K. Ahmad, "Effects of Work Zone Detours on Rural Highway Traffic Operations." Research Report 987-2, Center for Transportation Research, The University of Texas at Austin, 1993.

APPENDIX A:
SAMPLE OF PRECONSTRUCTION CONDITION SURVEY

PROJECT 987, US HIGHWAY 59 SOUTH OF LUFKIN
TESTSECTION
DIRECTION: SB
LANES: 1 & 2
CONCRETE PAVEMENT CRACK DATA
SURVEY DATES: 3/15/91

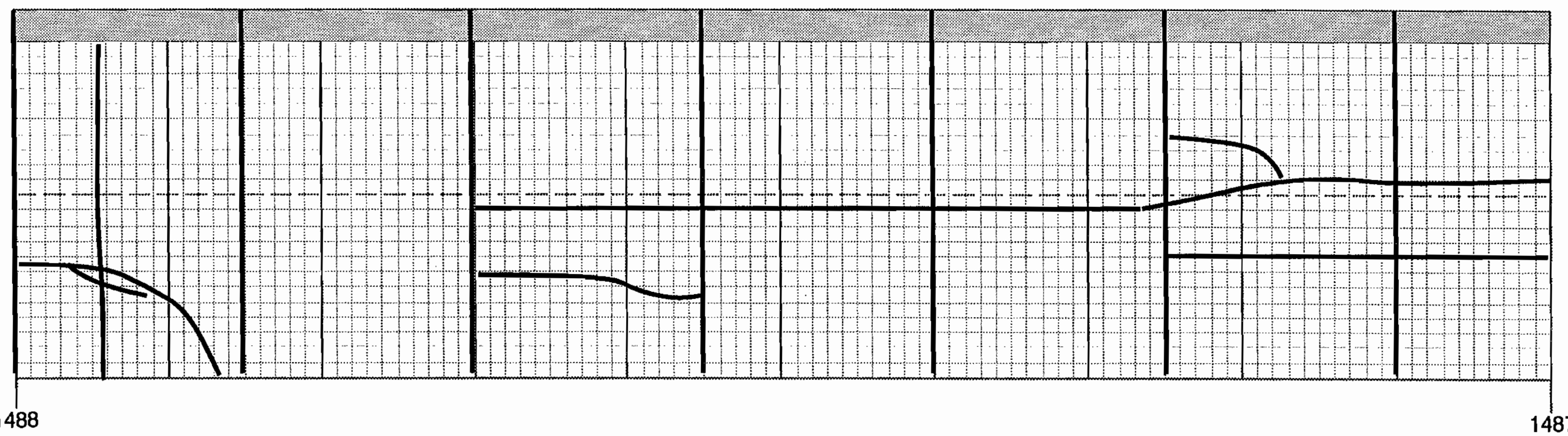
KEY:
- Joint Cracks
- Random Cracks
- Centerline
- Concrete Cores
- Falling Weight Deflectometer Readings

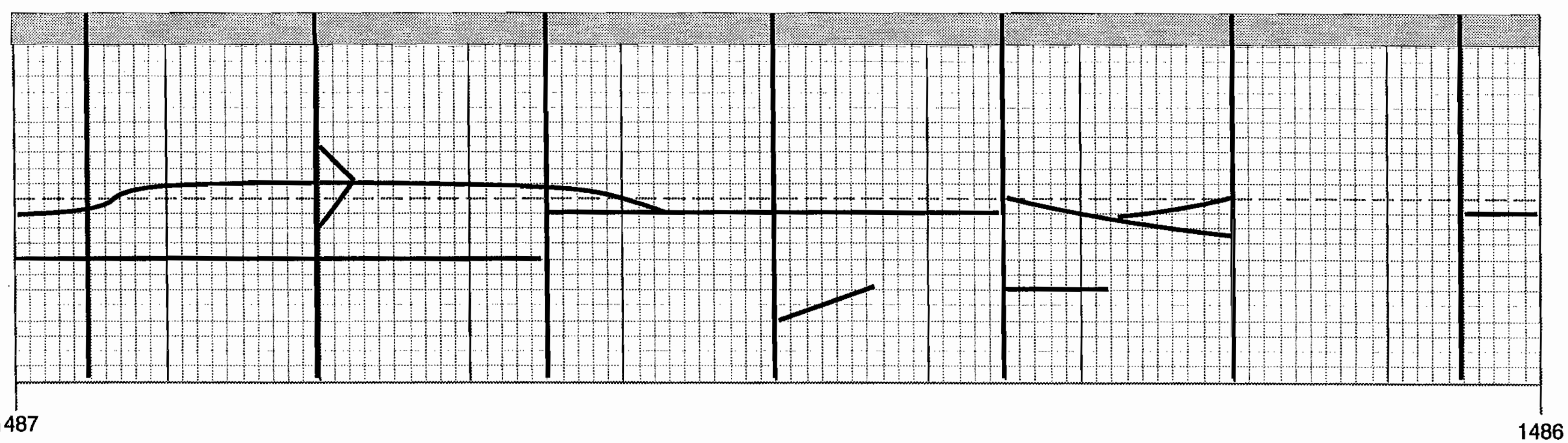




PROJECT 987, US HIGHWAY 59 SOUTH OF LUFKIN
TESTSECTION
DIRECTION: SB
LANES: 1 & 2
CONCRETE PAVEMENT CRACK DATA
SURVEY DATES: 3/15/91

KEY:
- Joint Cracks
- Random Cracks
- Centerline
- Concrete Cores
- Falling Weight Deflectometer Readings





PROJECT 987, US HIGHWAY 59 SOUTH OF LUFKIN
TESTSECTION
DIRECTION: SB
LANES: 1 & 2
CONCRETE PAVEMENT CRACK DATA
SURVEY DATES: 3/15/91

KEY:
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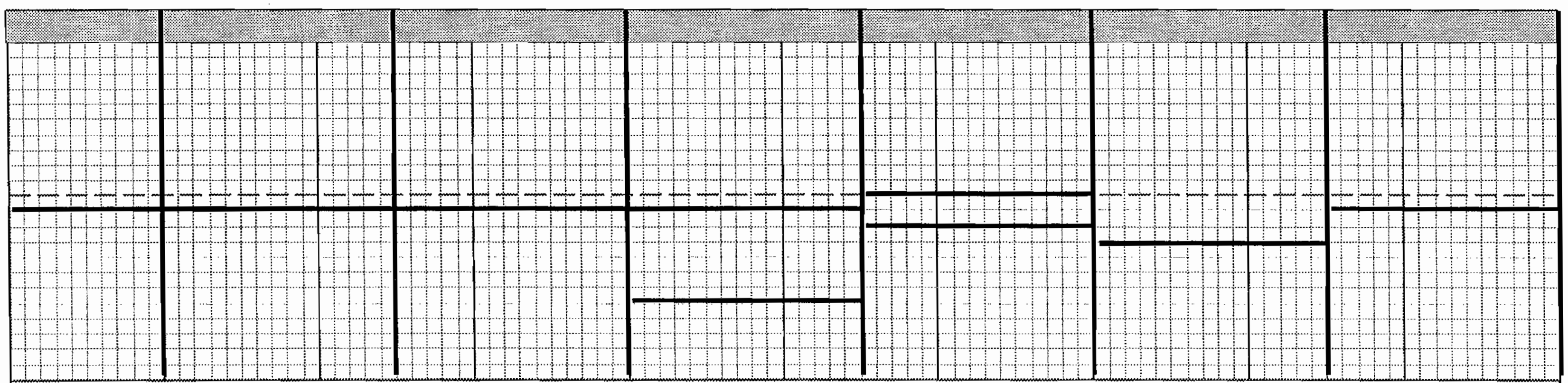
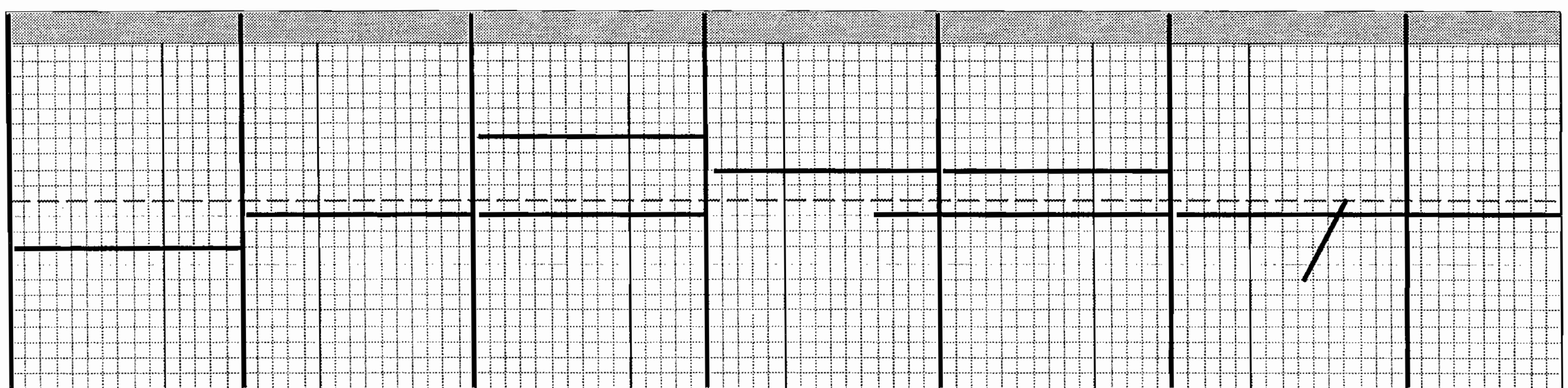
- Random Cracks
- Centerline
- Concrete Cores
- Falling Weight Deflectometer Readings

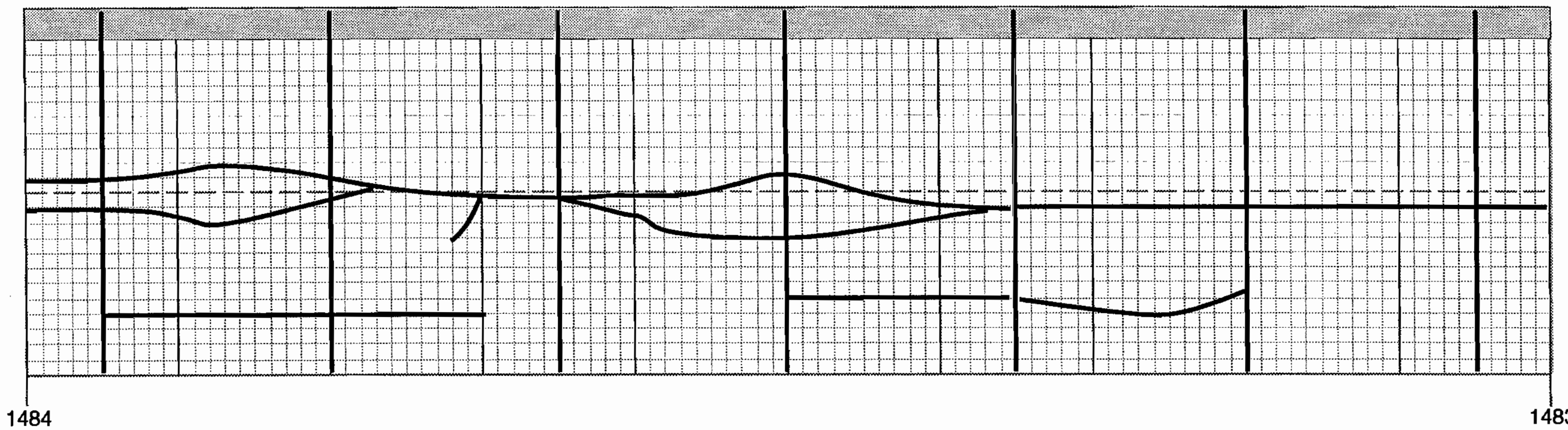


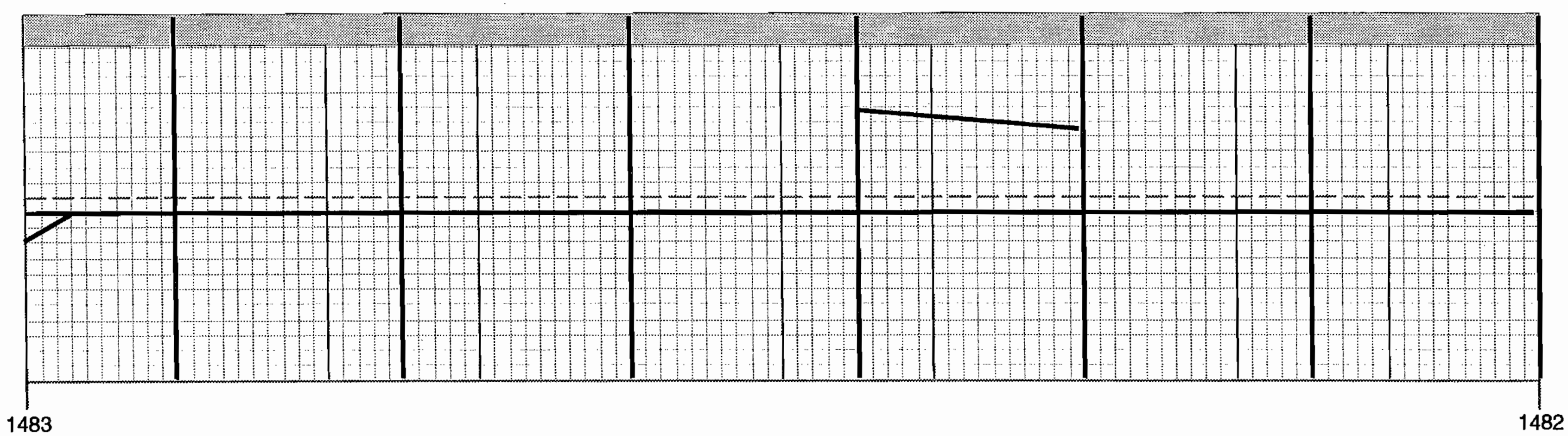
1486 — 1485



1485 — 1484

PROJECT 987, US HIGHWAY 59 SOUTH OF LUFKIN TESTSECTION DIRECTION: SB LANES: 1 & 2 CONCRETE PAVEMENT CRACK DATA SURVEY DATES: 3/15/91	KEY: Joint Cracks Random Cracks Centerline Concrete Cores Falling Weight Deflectometer Readings





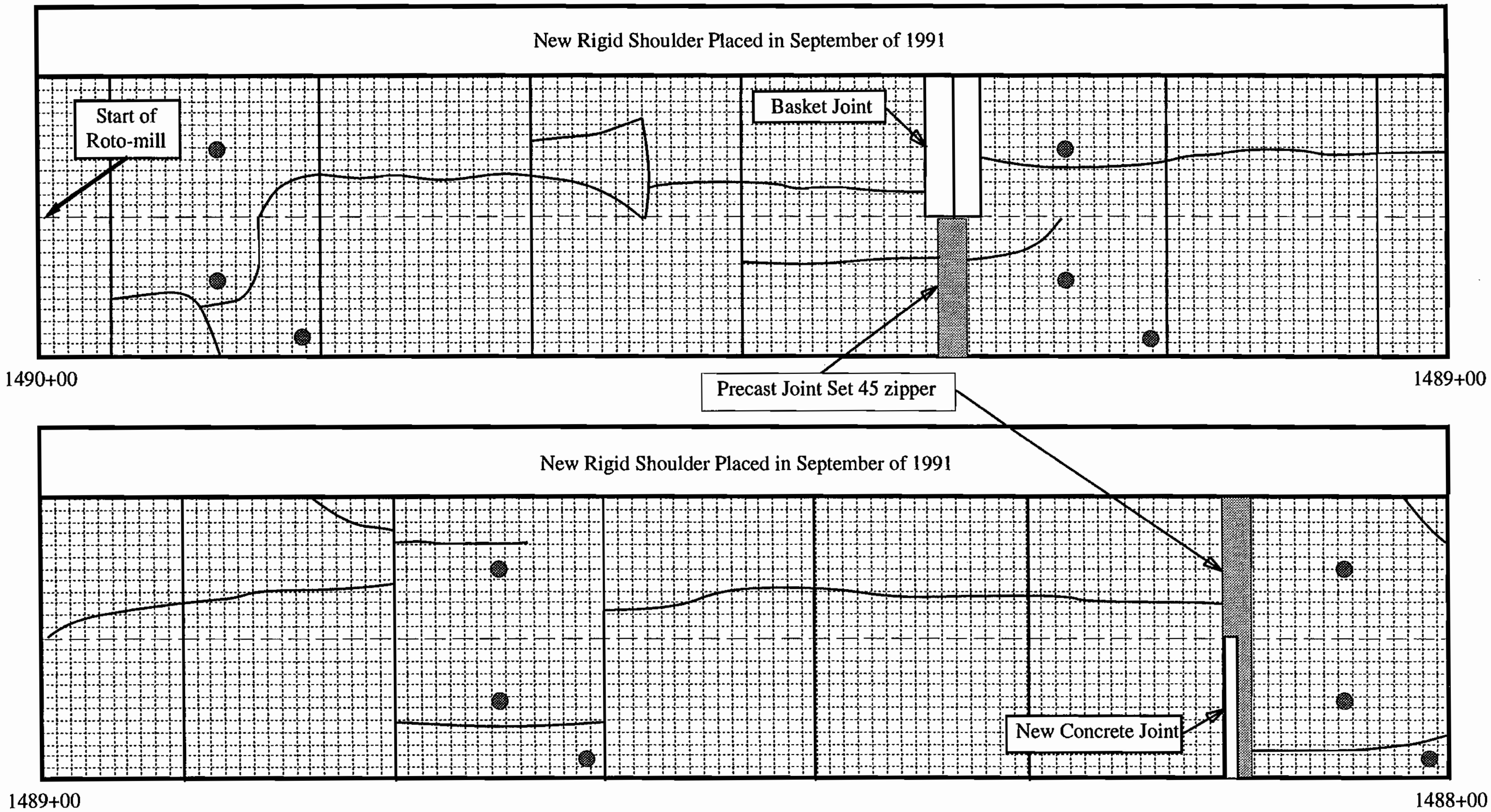
APPENDIX B:

CONDITION SURVEY OF AFTER ROTOMILLING AND REPAIRS OF RIGID TEST SECTION #1

Project 987 * U.S. 59 * Lufkin Texas
Test Section: R1
Direction: South Bound
Crack and Testing Data
September 25, 1991

Key:
- Joinys
- FWD
- Cracks
- Spalls (repaired with monymer)
- Cores

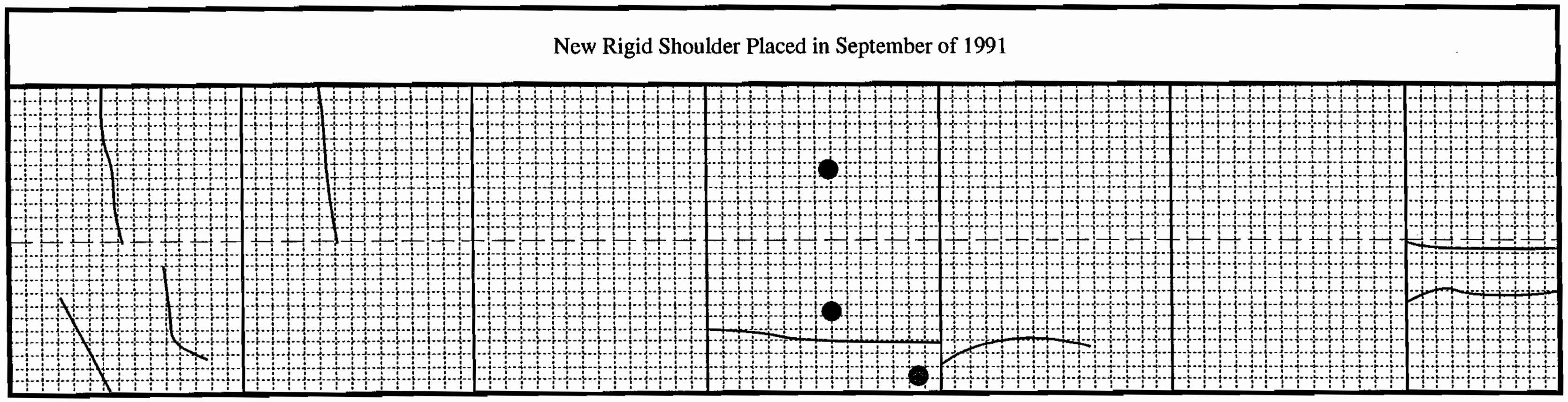
Condition Survey Performed by Eric Moody



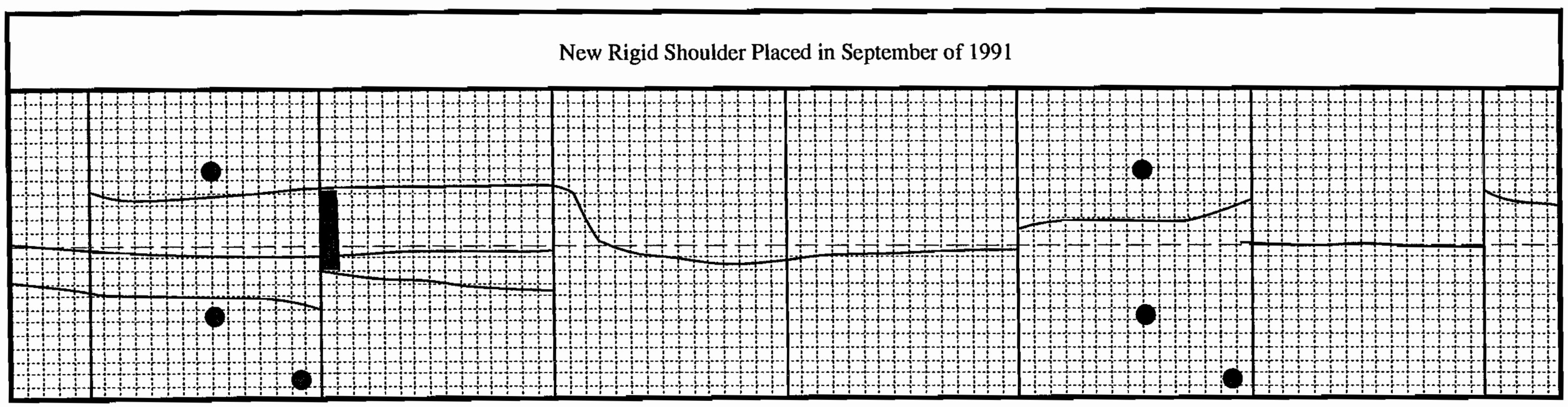
Project 987 * U.S. 59 * Lufkin Texas
Test Section: R1
Direction: South Bound
Crack and Testing Data
September 25, 1991

Key:
- Joinys
- FWD
- Cracks
- Spalls (repaired with monymer)
- Cores

Condition Survey Performed by Eric Moody



1488+00 1487+00



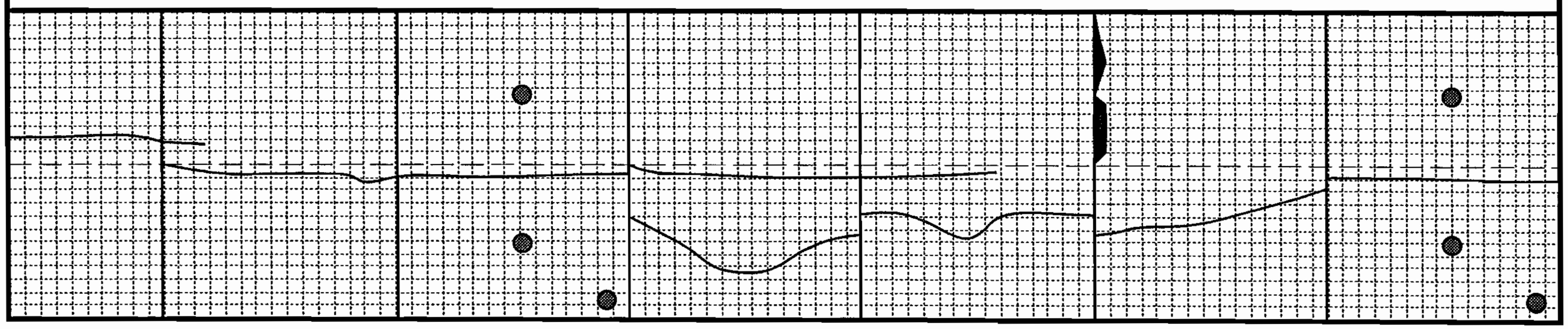
1487+00 1486+00

Project 987 * U.S. 59 * Lufkin Texas
Test Section: R1
Direction: South Bound
Crack and Testing Data
September 25, 1991

Key:
Joinys
FWD
Cracks
Spalls (repaired with monymer)
Cores

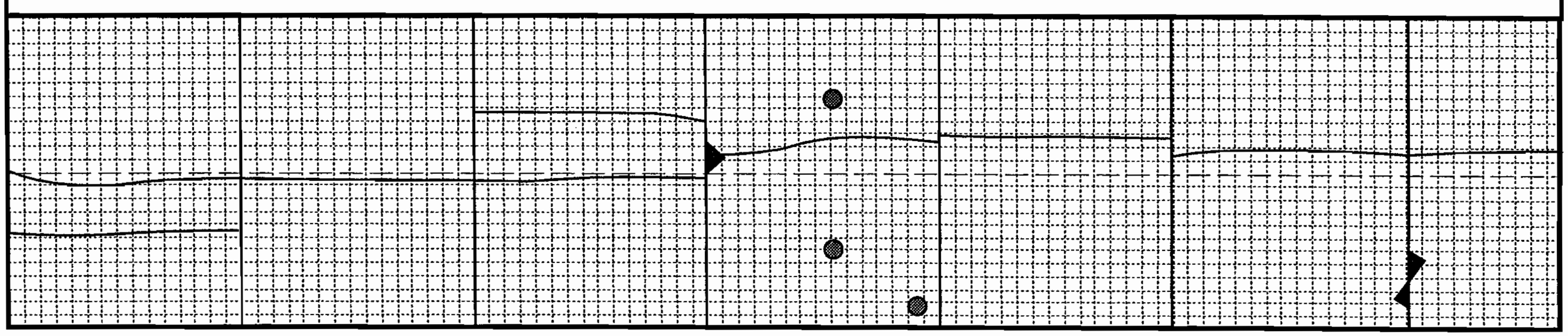
Condition Survey Performed by Eric Moody

New Rigid Shoulder Placed in September of 1991



1486+00 1485+00

New Rigid Shoulder Placed in September of 1991

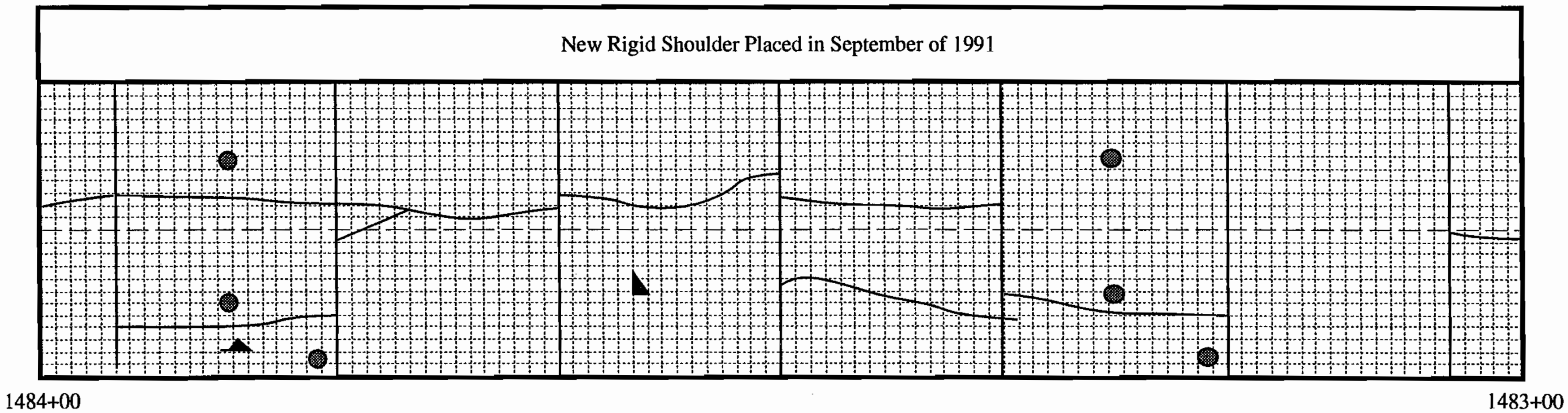


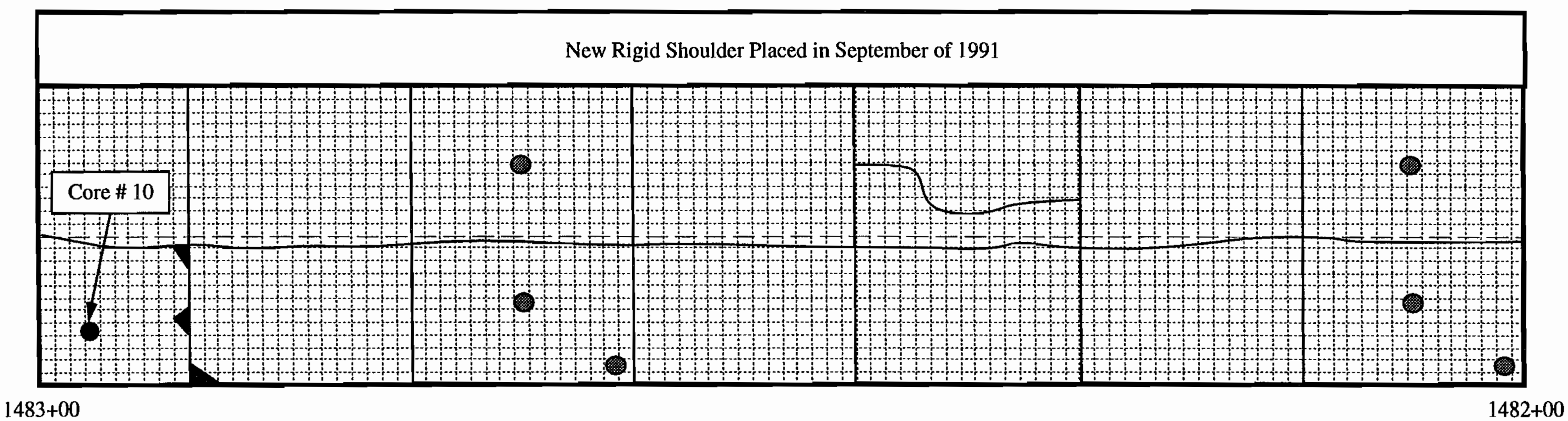
1485+00 1484+00

Project 987 * U.S. 59 * Lufkin Texas
Test Section: R1
Direction: South Bound
Crack and Testing Data
September 25, 1991

Key: Joinys, FWD, Cracks, Spalls (repaired with monymer), Cores

Condition Survey Performed by Eric Moody

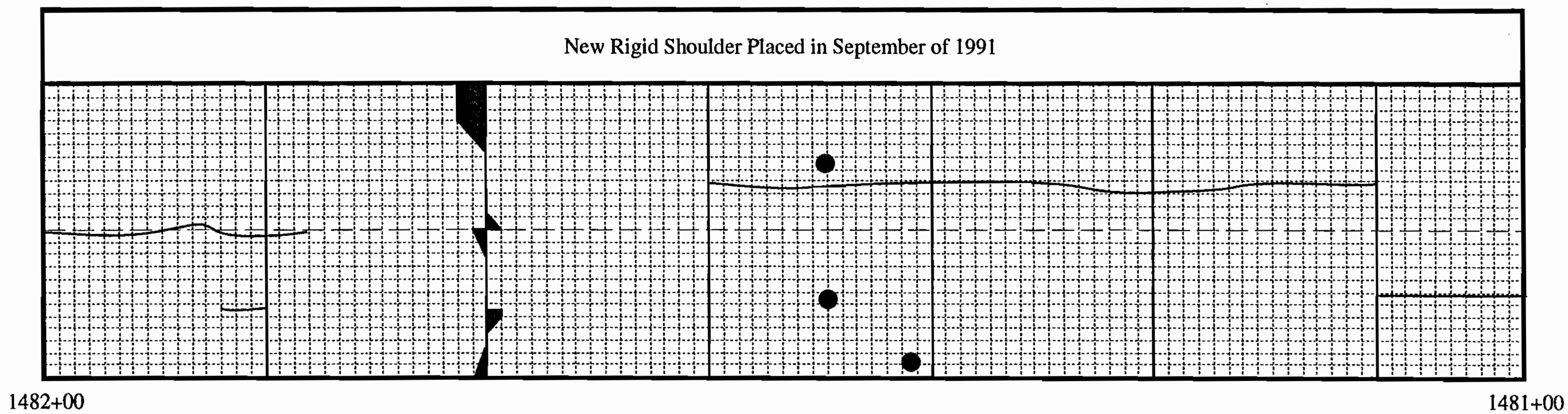


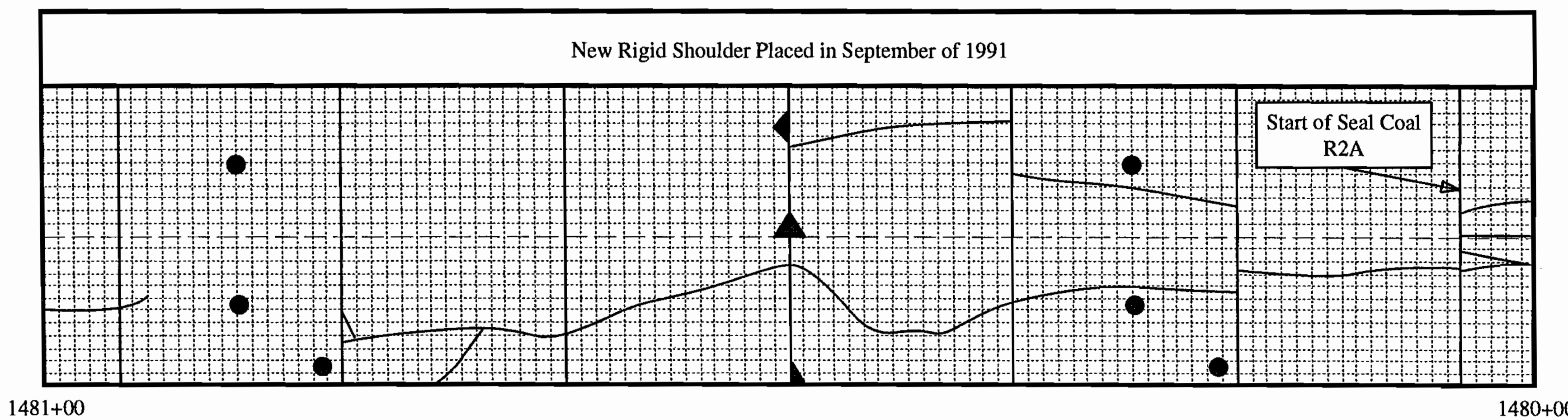


Project 987 * U.S. 59 * Lufkin Texas
Test Section: R1
Direction: South Bound
Crack and Testing Data
September 25, 1991

Key:
- Joinys
- FWD
- Cracks
- Spalls (repaired with monymer)
- Cores

Condition Survey Performed by Eric Moody





APPENDIX C:

UNIT BID PRICES BY COMPETING CONTRACTORS FOR RIGID TEST SECTION TXDOT LETTING ON MARCH 5, 1991

TEST SECTION: R0	WORK DESCRIPTION					BIDDER									
LOCATION: South Bound						Moore Brothers		Porter		C.C.E.		Average Bid		Engineer Estimate	
STATION: 1420+00-1430+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	Slope Reshaping														$0
NOTES															$0
Slopes to be replaced with	(20 CY/Sta.)	Borrow (20 CY/Sta.)	131	CY	233.3	$12.45	$2,905	$7.00	$1,633	$10.00	$2,333	$9.82	$2,290	$5.50	$1,283
blading, borrow, and rolling.															$0
Existing FND CRSE remain in	(0.5 HR/Sta.)	Blading (0.5 HR/Sta.)	150	HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$83.33	$417	$30.00	$150
place. Existing 7" JCP to remain															$0
in place. Approximately 7" of	1 & 1/2" ACP		3691-7	CY		$75.65		$80.00		$83.00		$79.55		$73.00	$0
AC to remain in place.															$0
	Surface Type D			(SY)	4222	$3.78	$15,959	$4.00	$16,888	$4.15	$17,521	$3.98	$16,789	$3.65	$15,410
	TOTALS						$19,364		$18,796		$20,329		$19,496		$16,843

TEST SECTION: R1	WORK DESCRIPTION					BIDDER									
LOCATION: South Bound						Moore Brothers		Porter		C.C.E.		Average Bid		Engineer Estimate	
STATION: 1475+00-1480+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	Slope Reshaping	Blading	150	HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$83.33	$417	$30.00	$150
NOTES															
See Notes for R1 Test Section	Mill & Remove 7" AC		3525_35	SY	4222	$1.40	$5,911	$2.00	$8,444	$3.00	$12,666	$2.13	$9,007	$3.00	$12,666
	Sawing $ Sealing Joint		3658	LF	1054	$1.90	$2,003	$8.00	$8,432	$3.20	$3,373	$4.37	$4,602	$3.00	$3,162
	1482+50 & 1487+50														
	Repair JCP	HMWM	3656	Gal	110	$215.00	$23,650	$60.00	$6,600	$400.00	$44,000	$225.00	$24,750	$200.00	$22,000
		Slab replaced	3617	SY	75	$150.00	$11,250	$300.00	$22,500	$165.00	$12,375	$205.00	$15,375	$80.00	$6,000
		Clean & seal Joints	3383	LF	2475	$2.60	$6,435	$8.50	$21,038	$1.50	$3,713	$4.20	$10,395	$1.30	$3,218
	Shoulder	Concrete Pavement		SY	722	$50.00	$36,100	$48.00	$34,656	$45.00	$32,490	$47.67	$34,415	$35.00	$25,270
		& Stirrup Bar													
	Course Surface Treatment	Asphalt	320_1001	Gal		$1.75		$3.00		$2.50		$2.42		$1.10	
				SY	2111	$0.61	$1,288	$1.05	$2,217	$0.88	$1,858	$0.85	$1,787	$0.39	$823
	(1480-1485)	Aggeregate	320_9001	CY		$100.00		$65.00		$50.00		$71.67		$45.00	
				SY	2111	$0.83	$1,752	$0.54	$1,140	$0.42	$887	$0.60	$1,260	$0.38	$802
	2 & 1/2"ACP Base TY C		3691	TON		$39.74		$37.50		$44.00		$40.41		$39.00	
	(270 lbs/SY)		_02	SY	4222	$5.36	$22,630	$5.06	$21,363	$5.94	$25,079	$5.45	$23,024	$5.27	$22,250
	1 & 1/2" ACP Sur. TY C		3691	CY		$75.09		$78.20		$82.00		$78.43		$75.00	
	(1 CY/24 SY)		_08	SY	4222	$3.13	$13,215	$3.26	$13,764	$3.42	$14,439	$3.27	$13,806	$3.13	$13,215
	TOTALS						$124,733		$140,428		$151,354		$138,838		$109,556

TEST SECTION: R2-A	WORK DESCRIPTION					BIDDER									
LOCATION: South Bound						Moore Brothers		Porter		C.C.E.		Average Bid		Engineer Estimate	
STATION: 1475+00-1480+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	Slope Reshaping	Borrow	131	CY	116.7	$12.45	$1,453	$7.00	$817	$10.00	$1,167	$9.82	$1,146	$5.50	$642
NOTES		Blading	150	HR	2.5	$100.00	$250	$55.00	$138	$95.00	$238	$83.33	$208	$30.00	$75
See R2-A Description															
	Remove Old Concrte Pave.		104	SY	50	$25.00	$1,250	$100.00	$5,000	$10.00	$500	$45.00	$2,250	$5.00	$250
	Mill & Remove		3525	SY	2111	$1.40	$2,955	$2.00	$4,222	$3.00	$6,333	$2.13	$4,503	$3.00	$6,333
	7"Asphalt Surface														
	Crack & Seat existing JCP		3655	SY	2111	$2.00	$4,222	$1.10	$2,322	$3.00	$6,333	$2.03	$4,292	$3.00	$6,333
	One Course Surface	Asphalt	320_1001	GAL		$1.75		$3.00		$2.50		$2.42		$1.10	
	Treatment			SY	2111	$0.61	$1,288	$1.05	$2,217	$0.88	$1,858	$0.85	$1,787	$0.39	$823
		Aggregate	320_1001	CY		$100.00		$65.00		$50.00		$71.67		$45.00	
				SY	2111	$0.83	$1,752	$0.54	$1,140	$0.42	$887	$0.60	$1,260	$0.38	$802
	2 & 1/2" ACP Base TY C		3691	TON		$39.74		$37.50		$44.00		$40.41		$39.00	
	(270 lb/SY)		_02	SY	2111	$5.36	$11,315	$5.06	$10,682	$5.94	$12,539	$5.45	$11,512	$5.27	$11,125
	1 & 1/2" ACP Sur. TY C		3691	CY		$75.09		$78.20		$82.00		$78.43		$75.00	
	(1 CY/24 SY)		_08	SY	2111	$3.13	$6,607	$3.26	$6,882	$3.42	$7,220	$3.27	$6,903	$3.13	$6,607
	TOTALS						$31,093		$33,419		$37,074		$33,862		$32,991

TEST SECTION: R2-B	WORK DESCRIPTION					BIDDER									
LOCATION: South Bound						Moore Brothers		Porter		C.C.E.		Average Bid		Engineer Estimate	
STATION: 1475+00-1480+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	Slope Reshaping	Borrow	131	CY	116.65	$12.45	$1,452	$7.00	$817	$10.00	$1,167	$9.82	$1,145	$5.50	$642
NOTES		Blading	150	HR	2.5	$100.00	$250	$55.00	$138	$95.00	$238	$83.33	$208	$30.00	$75
See R2-A Description															
	Remove Old Concrte Pave.		104	SY	50	$25.00	$1,250	$100.00	$5,000	$10.00	$500	$45.00	$2,250	$5.00	$250
	Mill & Remove		3525	SY	2111	$1.40	$2,955	$2.00	$4,222	$3.00	$6,333	$2.13	$4,503	$3.00	$6,333
	7"Asphalt Surface														
	Crack & Seat existing JCP		3655	SY	2111	$2.00	$4,222	$1.10	$2,322	$3.00	$6,333	$2.03	$4,292	$3.00	$6,333
	4" ACP Base TY C		3691	TON		$39.74		$37.50		$44.00		$40.41		$39.00	
	(420 lb/SY)		_02	SY	2111	$8.35	$17,627	$7.88	$16,635	$9.24	$19,506	$8.49	$17,922	$8.19	$17,289
	1 & 1/2" ACP Surface		3691	CY		$75.09		$78.20		$82.00		$78.43		$75.00	
	TYC (270 lb/SY)		_08	SY	2111	$3.13	$6,607	$3.26	$6,882	$3.42	$7,220	$3.27	$6,903	$3.13	$6,607
	TOTALS						$34,364		$36,015		$41,295		$37,225		$37,529

TEST SECTION: R3	WORK DESCRIPTION					BIDDER									
LOCATION: South Bound						Moore Brothers		Porter		C.C.E.		Average Bid		Engineer Estimate	
STATION: 1460+00-1470+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	Slope Reshaping	Borrow	131	CY	233	$12.45	$2,901	$7.00	$1,631	$10.00	$2,330	$8.74	$2,036	$5.50	$1,282
NOTES		Blading	150	HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$70.00	$350	$30.00	$150
See R3 Description															
	Mill & Remove		3535	SY	4222	$1.40	$5,911	$2.00	$8,444	$3.00	$12,666	$2.35	$9,922	$3.00	$12,666
	7" Asphalt Surface														
	Prim Coat		310	Gal		$1.97		$3.00		$3.00				$1.10	
				SY	4222	$0.39	$1,647	$0.60	$2,533	$0.60	$2,533	$0.45	$1,900	$0.22	$929
	One Course Surface	Asphalt	320_1001	Gal		$1.75		$3.00		$2.50				$1.10	
	Treatment			SY	4222	$0.61	$2,575	$1.05	$4,433	$0.88	$3,715	$0.73	$3,082	0.39	$1,647
		Aggregate	-9001	CY		$100.00		$65.00		$50.00				$45.00	
				SY	4222	$0.83	$3,504	$0.54	$2,280	$0.42	$1,773	$0.54	$2,280	$0.38	$1,604
	8"Flex Base TYA		249	CY	1173	$28.88	$33,876	$35.00	$41,055	$48.00	$56,304	$33.47	$39,260	$22.00	$25,806
	1 & 1/2" ACP Base TY C		3691	TON		$39.74		$37.50		$44.00				$39.00	
	(170 lb/SY)		_02	SY	4222	$3.38	$14,270	$3.19	$13,468	$3.74	$15,790	$3.41	$14,397	$3.32	$14,017
	1 & 1/2" ACP Sur, TY C		3691	CY		$75.09		$78.20		$82.00				$75.00	
	(1 CY/24 SY)		_08	SY	4222	$3.13	$13,215	$3.26	$13,764	$3.42	$14,439	$3.23	$13,637	$3.13	$13,215
	TOTALS						$78,399		$87,883		$110,026		$86,864		$71,315

TEST SECTION: R4	WORK DESCRIPTION					BIDDER									
LOCATION: South Bound						Moore Brothers		Porter		C.C.E.		Average Bid		Engineer Estimate	
STATION: 1450+00-1460+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	Slope Reshaping	Borrow	131	CY	233	$12.45	$2,901	$7.00	$1,631	$10.00	$2,330	$8.74	$2,036	$5.50	$1,282
NOTES		Blading	150	HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$70.00	$350	$30.00	$150
See R4 Description															
	3 & 1/2" ACP Base TY G		3691	TON		$41.51		$41.00		$45.00				$42.00	
	(320 lbs/SY)		_04		4222	$6.64	$28,034	$6.56	$27,696	$7.20	$30,398	$6.78	$28,625	$6.72	$28,372
	3" ACP Base TY B		3691	TON		$38.08		$36.85		$41.00				$40.00	
	(320 lbs/SY)		_03		4222	$6.09	$25,712	$5.90	$24,910	$6.56	$27,696	$6.24	$26,345	$6.40	$27,021
	1 & 1/2" ACP Sur, TY C		3691	CY		$75.09		$78.02		$82.00				$75.00	
	(1 CY/24 SY)		_08		4222	$3.13	$13,215	$3.25	$13,722	$3.42	$14,439	$3.23	$13,637	$3.13	$13,215
	Prefaabricated Underdrains		5607												
			_01	LF	2000	$6.50	$13,000	$9.00	$18,000	$14.00	$28,000	$8.88	$17,760	$6.00	$12,000
			_02	LF	130	$8.25	$1,073	$15.00	$1,950	$25.00	$3,250	$14.56	$1,893	$10.00	$1,300
	TOTALS						$84,434		$88,184		$106,589		$90,647		$83,339

TEST SECTION: R5
LOCATION: South Bound
STATION: 1440+00-1450+00

NOTES
See Notes for R5 Descrpition

Action	Subaction	Item No.	Unit	Quant.	Moore Brothers Unit Cost	Moore Brothers Total Cost	Porter Unit Cost	Porter Total Cost	C.C.E. Unit Cost	C.C.E. Total Cost	Average Bid Unit Cost	Average Bid Total Cost	Engineer Estimate Unit Cost	Engineer Estimate Total Cost
Slope Reshaping	Borrow	131	CY	233	$12.45	$2,901	$7.00	$1,631	$10.00	$2,330	$8.74	$2,036	$5.50	$1,282
	Blading	150	HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$70.00	$350	$30.00	$150
1" Plant Mix Seal-SBS		3375												
1440 to 1445	ASphalt	_010	TON	5.85	$207.00	$1,211	$260.00	$1,521	$210.00	$1,229	$189.25	$1,107	$80.00	$468
(200 lbs/CY)	#NAME?													
	Aggregate	_002	CY		$84.10		$75.00		$89.00				$60.00	
(1 CY/36 SY)			SY	2111	$2.34	$4,940	$2.08	$4,391	$2.47	$5,214	$2.14	$4,518	$1.67	$3,525
	Tack Coat	_003	Gal		$0.01		$2.00		$3.00				$0.50	
(0.05 GAL/SY)			SY	2111			$0.10	$211	$0.15	$317	$0.07	$148	$0.03	$63
1" Plant Mix Seal		3375												
1445 to 1450	Asphalt	_001	TON	5.85	$117.00	$684	$260.00	$1,521	$118.00	$690	$141.25	$826	$70.00	$410
(200lbs/CY)														
	Aggeregate	_002	CY		$84.10		$75.00		$89.00				$60.00	
(1 CY/36 SY)			SY	2111	$2.34	$4,940	$2.08	$4,391	$2.47	$5,214	$2.14	$4,518	$1.67	$3,525
	Tack Coat	_003	Gal		$0.01		$2.00		$3.00				$0.50	
(0.05 GAL/SY)			SY	2111	$0.00		$0.10	$211	$0.15	$317	$0.07	$148	$0.03	$63
1 & 1/2" ACP Base TY C		3691	TON		$39.74		$37.50		$44.00				$39.00	
(150 lbs/SY)		_02	SY	4222	$2.98	$12,582	$2.81	$11,864	$3.30	$13,933	$3.00	$12,666	$2.93	$12,370
1 & 1/2" ACP Sur, TY C		3691												
(1 CY/24 SY)		_08	CY		$75.09		$78.20		$82.00				$75.00	
			SY	4222	$3.13	$13,215	$3.26	$13,764	$3.42	$14,439	$3.23	$13,637	$3.13	$13,215
TOTALS						$40,972		$39,780		$44,157		$39,954		$35,072

TEST SECTION: R6
LOCATION: South Bound
STATION: 1430+00-1440+00

NOTES
See R6 Description

Action	Subaction	Item No.	Unit	Quant.	Moore Brothers Unit Cost	Moore Brothers Total Cost	Porter Unit Cost	Porter Total Cost	C.C.E. Unit Cost	C.C.E. Total Cost	Average Unit Cost	Average Total Cost	Engineer Estimate Unit Cost	Engineer Estimate Total Cost
Slope Reshaping	Borrow	131	CY	233	$12.45	$2,901	$7.00	$1,631	$10.00	$2,330	$8.74	$2,036	$5.50	$1,282
	Blading	150	HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$70.00	$350	$30.00	$150
1 & 1/2" ACP Base TY C		3691	TON		$39.74		$37.50		$44.00				$39.00	
(170 lbs/SY)		_02	SY	4222	$3.38	$14,270	$3.19	$13,468	$3.74	$15,790	$3.41	$14,397	$3.32	$14,017
1 & 1/2" ACP Sur. TY C		3691												
(1 CY/24 SY)		_08	CY		$75.09		$78.20		$82.00				$75.00	
			SY	4222	$3.13	$13,215	$3.26	$13,764	$3.42	$14,439	$3.23	$13,637	$3.13	$13,215
TOTALS						$30,886		$29,138		$33,035		$30,421		$28,663

APPENDIX D:

UNIT BID PRICES BY COMPETING CONTRACTORS FOR FLEXIBLE TEST SECTION TXDOT LETTING ON MARCH 5, 1991

TEST SECTION: F1						BIDDER									
LOCATION: South Bound	WORK DESCRIPTION					Moore Brothers		Porter		C.C.E.		Average		Engineer Estimate	
STATION: 1090+00-1080+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	1) Slopes	Borrow		CY	150	$12.45	$1,868	$7.00	$1,050	$10.00	$1,500	$9.82	$1,473	5.5	$825
NOTES		Blading		HR	5	$100.00	$500	$55.00	$275	$55.00	$275	$70.00	$350	30	$150
	2) 1 1/2" SBS Modified ACP Surface			CY		$90.87		$99.50		$98.00		$96.12		$80.00	
	Type D (1 CY/24 SY)			SY	4222	$3.79	$16,001	$4.15	$17,504	$4.08	$17,240	$4.01	$16,915	$3.33	$14,073
	3) 1 1/2" SBS Modified ACP base			TON		$47.19		$48.50		$51.00		$48.90		$48.00	
	Type D (170 lb/SY)			SY	4222	$4.01	$16,935	$4.12	$17,405	$4.34	$18,302	$4.16	$17,548	$4.08	$17,226
	170 lb/SY=> 0.085*47.19=>$4.0115/SY														
	TOTALS						$35,304		$36,234		$37,317		$36,285		$32,274

TEST SECTION: F2						BIDDER									
LOCATION: South Bound	WORK DESCRIPTION					Moore Brothers		Porter		C.C.E.		Average		Engineer Estimate	
STATION: 1080+00-1070+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	1) Slopes	Borrow		CY	150	$12.45	$1,868	$7.00	$1,050	$10.00	$1,500	$9.82	$1,473	$5.50	$825
NOTES		Blading		HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$83.33	$417	$30.00	$150
	2) 1 1/2" SBS Modified ACP Surface			CY		$90.42		$85.50		$98.00		$91.31		$81.00	
	Type C (1 cy/24 SY)			SY	4222	$3.77	$15,906	$3.56	$15,041	$4.08	$17,240	$3.80	$16,062	$3.38	$14,249
				TON		$47.19		$41.75		$51.00		$46.65		$49.00	
	3) 1 1/2" SBS Modified ACP base			SY	4222	$4.01	$16,935	$3.55	$14,983	$4.34	$18,302	$3.96	$16,740	$4.17	$17,585
	Type C (170 lb/SY)														
	TOTALS						$35,209		$31,349		$37,517		$34,692		$32,809

TEST SECTION: F3						BIDDER									
LOCATION: South Bound	WORK DESCRIPTION					Moore Brothers		Porter		C.C.E.		Average		Engineer Estimate	
STATION: 1070+00-1060+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	1) Slopes	Borrow		CY	150	$12.45	$1,868	$7.00	$1,050	$10.00	$1,500	$9.82	$1,473	$5.50	$825
NOTES		Blading		HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$83.33	$417	$30.00	$150
	2) 1 1/2" ACP Surface			CY		$75.09		$78.20		$82.00		$78.43		$75.00	
	Type C (1 CY/24 SY)			SY	4222	$3.13	$13,210	$3.26	$13,757	$3.42	$14,425	$3.27	$13,797	$3.13	$13,194
				TON		$30.08		$36.85		$41.00		$35.98		$40.00	
	3) 1 1/2" ACP base			SY	4222	$4.81	$20,320	$5.90	$24,893	$6.56	$27,696	$5.76	$24,303	$6.40	$27,021
	Type B (320 lb/SY)														
	TOTALS						$35,897		$39,975		$44,096		$39,989		$41,190

TEST SECTION: F4
LOCATION: South Bound
STATION: 1060+00-1050+00
NOTES

WORK DESCRIPTION: Action	Subaction	Item No.	Unit	Quant.	Moore Brothers Unit Cost	Moore Brothers Total Cost	Porter Unit Cost	Porter Total Cost	C.C.E. Unit Cost	C.C.E. Total Cost	Average Unit Cost	Average Total Cost	Engineer Estimate Unit Cost	Engineer Estimate Total Cost
1) Slopes	Borrow		CY	150	$12.45	$1,868	$7.00	$1,050	$10.00	$1,500	$9.82	$1,473	$5.50	$825
	Blading		HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$83.33	$417	$30.00	$150
2) 1 1/2" ACP Surface			CY		$75.09		$78.20		$82.00		$78.43	$0	$75.00	
Type C (1 CY/24 SY)			SY	4222	$3.13	$13,210	$3.26	$13,757	$3.42	$14,425	$3.27	$13,797	$3.13	$13,194
			TON		$39.74		$37.50		$44.00		$40.41	$0	$39.00	
3) 1 1/2" ACP base			SY	4222	$3.38	$14,261	$3.19	$13,458	$3.74	$15,790	$3.44	$14,503	$3.32	$13,996
Type C (170 lb/SY)														
TOTALS						$29,839		$28,539		$32,190		$30,189		$28,165

TEST SECTION: F5
LOCATION: South Bound
STATION: 1050+00-1040+00
NOTES

WORK DESCRIPTION: Action	Subaction	Item No.	Unit	Quant.	Moore Brothers Unit Cost	Moore Brothers Total Cost	Porter Unit Cost	Porter Total Cost	C.C.E. Unit Cost	C.C.E. Total Cost	Average Unit Cost	Average Total Cost	Engineer Estimate Unit Cost	Engineer Estimate Total Cost
1) Slopes	Borrow		CY	150	$12.45	$1,868	$7.00	$1,050	$10.00	$1,500	$9.82	$1,473	$5.50	$825
	Blading		HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$83.33	$417	$30.00	$150
2) Existing AC to be milled and removed			SY	4222	$1.40	$5,911	$2.00	$8,444	$3.00	$12,666	$2.13	$9,007	$3.00	$12,666
3) 10" Type A flexilbe Base			CY	1466	$28.88	$42,338	$35.00	$51,310	$48.00	$70,368	$37.29	$54,672	$22.00	$32,252
(CY * thickness (10"/36(1YD=36") = SY)			SY		$8.02		$9.72		$13.33		$10.36		$6.11	
4) Prime Coat			Gal		$1.97		$3.00		$3.00		$2.66		$1.10	
Asphalt = 0.35 Gal/SY			SY	4222	$0.39	$1,663	$0.60	$2,533	$0.60	$2,533	$0.53	$2,243	$0.22	$929
													$1.10	
5) Course surface Treatment	Asphalt		Gal		$1.75		$3.00		$2.50		$2.42			
Asphalt = 0.35 Gal/SY			SY	4222	$0.61	$2,586					$0.20	$862		
	Aggregate		CY		$100.00		$55.00		$95.00		$83.33		$45.00	
Aggregate=1CY/120SY			SY	4222	$0.83	$3,518	$0.46	$1,935	$0.79	$3,342	$0.69	$2,932	$0.38	$1,583
6) 1 1/2" ACP Surface Type C (1CY/24 SY)			CY		$75.09		$78.20		$82.00		$78.43		$75.00	
			SY	4222	$3.13	$13,210	$3.26	$13,757	$3.42	$14,425	$3.27	$13,797	$3.13	$13,194
7) 1 1/2" ACP base Type C (170 lb/SY)			TON		$39.74		$37.50		$44.00		$40.41		$39.00	
			SY	4222	$3.38	$14,261	$3.19	$13,458	$3.74	$15,790	$3.44	$14,503	$3.32	$13,996
TOTALS						$85,855		$92,762		$121,100		$99,906		$75,595

TEST SECTION: F6						BIDDER									
LOCATION: South Bound	WORK DESCRIPTION					*Moore Brothers*		*Porter*		*C.C.E.*		*Average*		*Engineer Estimate*	
STATION: 1040+00-1030+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	1) Slopes	Borrow		CY	150	$12.45	$1,868	$7.00	$1,050	$10.00	$1,500	$9.82	$1,473	$5.50	$825
NOTES		Blading		HR	5	$100.00	$500	$55.00	$275	$95.00	$475	$83.33	$417	$30.00	$150
	2) Existing AC to be milled and removed			SY	4222	$1.40	$5,911	$2.00	$8,444	$3.00	$12,666	$2.13	$9,007	$3.00	$12,666
	3) 3" ACP Type B (320 lbs/SY)			TON		$38.08		$36.85		$41.00		$38.64		$40.00	
				SY	4222	$6.09	$25,724	$5.90	$24,893	$6.56	$27,696	$6.18	$26,104	$6.40	$27,021
	6) 1 1/2" ACP Surface Type C (1 CY/24 Y)			CY		$75.09		$78.20		$82.00		$78.43		$75.00	
				SY	4222	$3.13	$13,210	$3.26	$13,757	$3.42	$14,425	$3.27	$13,797	$3.13	$13,194
	7) 4 1/2" ACP base Type C (450 lb/SY)			TON		$39.74		$37.50		$44.00		$40.41		$39.00	
				SY	4222	$8.94	$37,751	$8.44	$35,623	$9.90	$41,798	$9.09	$38,391	$8.78	$37,048
	TOTALS						$84,963		$84,042		$98,560		$89,188		$90,904

TEST SECTION: F0A						BIDDER									
LOCATION: South Bound	WORK DESCRIPTION					*Moore Brothers*		*Porter*		*C.C.E.*		*Average*		*Engineer Estimate*	
STATION: 1030+00-1025+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	1) Slopes	Borrow		CY	75	$12.45	$934	$7.00	$525	$10.00	$750	$9.82	$736	$5.50	$413
NOTES		Blading		HR	2.5	$100.00	$250	$55.00	$138	$95.00	$238	$83.33	$208	$30.00	$75
	2) 1 1/2" ACP Surface			CY		$75.65		$80.00		$83.00		$79.55		$73.00	
	Type D (1 CY/20 SY)			SY	2111	$3.78	$7,985	$4.00	$8,444	$4.15	$8,761	$3.98	$8,397	$3.65	$7,705
	TOTALS						$9,169		$9,107		$9,748		$9,341		$8,193

TEST SECTION: F0B						BIDDER									
LOCATION: South Bound	WORK DESCRIPTION					*Moore Brothers*		*Porter*		*C.C.E.*		*Average*		*Engineer Estimate*	
STATION: 1025+00-1020+00	Action	Subaction	Item No.	Unit	Quant.	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost
	1) Slopes	Borrow		CY	75	$12.45	$934	$7.00	$525	$10.00	$750	$9.82	$736	$5.50	$413
NOTES		Blading		HR	2.5	$100.00	$250	$55.00	$138	$95.00	$238	$83.33	$208	$30.00	$75
	2) 1 1/2" ACP Surface			CY		$75.65		$80.00		$83.00		$79.55		$73.00	
	Type D (1 CY/24 SY)			SY	2111	$3.15	$6,654	$3.33	$7,037	$3.46	$7,301	$3.31	$6,997	$3.04	$6,421
				TON		$40.48		$37.50		$44.00		$40.66		$38.00	
	3) 1 1/2" ACP base			SY	2111	$3.44	$7,264	$3.19	$6,729	$3.74	$7,895	$3.46	$7,296	$3.23	$6,819
	Type D (170 lb/SY)														
	TOTALS						$15,101		$14,428		$16,183		$15,237		$13,727