ENERGY-SECTOR BRIEF

Maintenance Division, Roadway Asset Management

16-10 PERFORMANCE OF PAVEMENT IN THE ENERGY SECTOR

From 10,000 to 24,000 wells were permitted in the state of Texas over each of the last 15 years. Most of these wells have been developed and are producing. The development of each well typically requires from 1,000 to 2,000 heavy truck movements. Most of these trucks are at or near legally loaded limits. Truck traffic is also generated over the production life of the well and vehicles are required to service the well, re-complete the well and haul salt water and crude oil and other liquid mixtures from the well.

This increased truck traffic has significantly impacted the Texas Department of Transportations (TxDOT) Farm to Market (FM) road network and some of its trunk State Highway (SH) and United States (US) designated highways. Many of these roadways have experienced considerable damage and have required maintenance and rehabilitation. Significant state financial resources (several billions of dollars) has and will continue to be devoted to repair the road network that serves the energy sector of the state's economy. In anticipation of these large expenditures, TxDOT formed a special design and operating group within the Maintenance Division to assist Districts, manage the repair program and provide information to the administration. As part of this effort the TxDOT Maintenance Division initiated an Interagency Agreement Contract (IAC) with the Texas A&M Transportation Institute. One of the tasks of the effort was to define current TxDOT maintenance and rehabilitation operations associated with the repair of roadways impacted by energy development and production. In addition, one of the phases of the effort was associated with defining the performance of the repaired roadway to provide information that would assist the TxDOT Districts in planning and performing future maintenance and rehabilitation activities.

Performance information is available in this Energy Sector Brief as well as Implementation Reports IR-14-01 and IR-16-05 and Research Report RR-16-02. These documents as well as other information developed in the effort are available on the TxDOT Maintenance Division (MNT) SharePoint site at https://txdot.sharepoint.com/sites/division-mnt/SitePages/Home.aspx

BACKGROUND

Current TxDOT pavement repair practices associated with roadways subjected to energy development and production traffic were defined in four workshops involving 12 Districts and interviews conducted in 11 Districts. These Districts were located in the oil and gas development efforts in the Eagle Ford Shale of South Texas, the Permian Basin of West Texas and the Barnett Shale of North Central Texas. Information from these meetings has been summarized in Implementation Report IR-14-01. This document not only contains TxDOT current practices for repair of the roadways but also contains information on the performance of certain maintenance techniques and materials. Information was also collected on specific roadway sections as part of this study. Forensic type analyses were conducted on four Farm to Market roadways that experienced premature distress. This information is contained in Technical Memorandum TM-14-02, TM-14-03, TM-14-06 and TM-15-01. A more structured performance study was conducted on thirteen pavement sections built in 2014 and 2015 associated with the design-build energy sector program in South Texas and the pavement rehabilitation program in South Texas contracted through a bid/build contracts. This information is documented in Implementation Report IR-16-05 and Research Report RR-16-02.

PREMATURE DISTRESS

Premature distress has occurred on a small portion of the pavements rehabilitated and maintained in the energy development and production area of the state. This premature distress and it causes provides valuable information that will help guide the selection of future repair methods for heavily traffic roadways. Lessons learned from meetings discussing premature distress with TxDOT personnel and more formal investigations of premature distress are provided below for routine maintenance, preventive maintenance and rehabilitation operations.

It is important to note that the performance of pavement repair techniques in the energy sector is greatly affected by the amount of truck traffic on the roadways. Pavements in the energy development areas of the state experienced very large growth in truck traffic.

Routine Maintenance

Information on shoulder edge repair, shallow patching, deep patching and level-up patching were the main routine maintenance operations discussed with Districts. Energy Sector Briefs ESB-14-03, ESB-15-01, ESB-15-02, ESB-15-03 and ESB-15-04 and Implementation Report IR-14-01 summarize District experiences with these routine maintenance operations.

Patching of roadways impacted by energy development is common. A wide variety of patching materials have been used. Most cold patching materials have not performed for extended periods of time. The solvents used in these patching materials that allow for stockpiling, placement and compaction typically do not fully escape the mixture and shoving and rutting in warm and hot weather is likely. The use of hot mix asphalt provides an improved patch provided the patched area is treated properly. Districts have reported performance problems with hot mixed-cold laid materials, proprietary materials and limestone rock asphalt products. Some of these patching materials have also been used reasonably successful as temporary patching materials.

Pavement edge repairs include patching (non-continuous), strip seals and widening operations. **Spot or non-continuous patching** (ESB-15-02 and ESB-15-03) should be considered as only a temporary fix for most pavements in the energy development impacted area. Narrow roadways (18 to 24 ft.) and heavy truck traffic results in early performance problems with nearly any materials used for patching the shoulders. This type of repair may be necessary to temporarily improve safety and "hold the road together" until more extensive repairs can be scheduled and performed.

PREMATURE DISTRESS (continued)

Widening operations (ESB-14-03) involving the removal of existing subgrade and/or base materials and placing flexible base or stabilized materials to extend pavement widths to 28–32 ft. have better success than patching. Depth of removal and replacement is on the order on 8 to 12 inches. Energy Sector Briefs ESB-16-04 and ESB-16-05 provides guidance on appropriate depths of repairs. The use of reclaimed asphalt pavement (RAP) without the use of additional asphalt binder has not performed well in some Districts. Widening to a minimum pavement width of 28 ft. to 32 ft. is recommended.

Strip seals are commonly placed as a surfacing on the pavement widening operations identified above. Surface treatments (chip seals) are placed to cover the area of the pavement widened and about 6 to 12 inches onto the pavement. Strip seals and fog seals are also utilized without removal and replacement of the gravel or subgrade materials in some west Texas Districts to help "hold" the shoulder or reduce the amount of future shoulder edge deterioration or raveling. Fog seals are sprayed about 24 inches in width with half on the gravel shoulder and half on the pavement. Strip seals or fog seals placed without widening the pavement are usually temporary.

Preventive Maintenance

Double and some triple surface treatments are commonly used as part of the repair strategies on roadways impacted by energy development. Energy Sector Briefs ESB-15-05 and ESB 16-01 provide information on the materials used for these surface treatments and seal coats. The use of surface treatments or seal coats in heavy truck traffic areas and where traffic is decelerating and accelerating (intersections) and turning (driveways and intersections) typically results in dislodgement of the aggregate and/or bleeding of the asphalt binder. The use of seal coats over flexible bas in high-traffic areas can cause the cover stone to become embedded into the base, contributing to bleeding problems.

Aggregate or chip loss is also a problem with surface treatments or seal coats. Improper embedment of the chip in the asphalt binder will cause stone loss particularly in cold weather. Heavy truck traffic will contribute to the performance problem. Good construction practices and correctly designed material quantities are critical to performance under heavy truck traffic conditions. Performance of surface treatments and chip seals under heavy traffic should not be the same as performance expected on lower traffic volume roadways without accelerating/decelerating/turning traffic. As truck traffic volumes increase, improved performance will be obtained with the use of hot mix asphalt surfaces provided thickness design procedures are utilized to establish layer depths.

Rehabilitation

Many of the roadways in the energy development and impacted areas of Texas are narrow Farm to Market roadways. The first priority for most Districts was to widen these roadways to 28 to 32 ft. in width by adding shoulders or by performing rehabilitation operations.

Quarter Point rehabilitation was performed by maintenance crews as well as under contract. Many roadways in the energy sector deteriorated from the shoulder to the center of the pavement. To extend the life of the roadways, several Districts repaired the outside quarter of the travel lanes and added shoulders on each side of the pavement. This activity is no longer utilized by most Districts as ride quality after construction was not at a desirable level and the interior portion of the roadway (not repaired) often experienced deterioration in a short period of time. The quarter point repair techniques were performed "under traffic" which contributed to the inability to provide a smooth riding surface.

Typical rehabilitation activities included pulverization of existing materials in the roadway (full depth recycling (FDR)), spreading the pulverized materials with or without additional flexible base material to 28 to 32 ft. and modifying with 2 to 3 percent portland cement. Typically, additional flex base materials are placed on the FDR subbase material and either a surface treatment or hot mix asphalt surface course. This has been referred to as a **four layer system** (subgrade, FDR layer, flexible base layer and surface layer).

A similar repair technique utilizing emulsified asphalt or foamed asphalt has been used on roadways as well. The process involves the pulverization of the existing asphalt bound surface and base course, adding additional flexible base and widening the pavement, stabilizing the pulverized and blended materials with emulsified asphalt or foamed asphalt and placing a double surface treatment or hot mix asphalt surface. This has been referred to as a **three layer system** (subgrade, FDR layer and surface layer).

Most of the experience to date has been with the four layer systems. **Ride quality** has been an issue on several rehabilitation projects placed with flexible bases below double surface treatments. Construction techniques and specifications need to be developed to improve the ride quality of these pavements that are constructed under traffic.

Bleeding of two course surface treatments is common when these types of rehabilitation process are utilized. Some of the causes of this bleeding are discussed above.

The use of relatively **thin hot mix asphalt** as a surfacing material on top of the four layer systems described above has caused problems. Localized **alligator cracking** followed by potholes is evident on several roadways when the hot mix asphalt is less than about 3 to 4 inches. This premature distress can occur within a few months after construction is completed. Energy Sector Briefs ESB-16-04 and ESB-16-05 as well as Implementation Report IR-15-01 and Research Report RR-14-03 provide guidance on thickness designs for the hot mix asphalt.

Early Reopening to Traffic

Some energy sector roadways that serve as corridors for the energy development related traffic have also experienced premature distress within a few months of construction. Since these roadways are constructed "under traffic", truck traffic often is allowed on a partially completed hot mix asphalt section. Several roadways have experienced alligator cracking and pothole formation when traffic is allowed on the pavement after about 3 to 4 inches of a designed 6 to 7 inch hot mix asphalt section is placed. This has been particularly evident when Type B hot mix asphalt has been placed as the first 3 to 4 inches and traffic operates on this material.

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