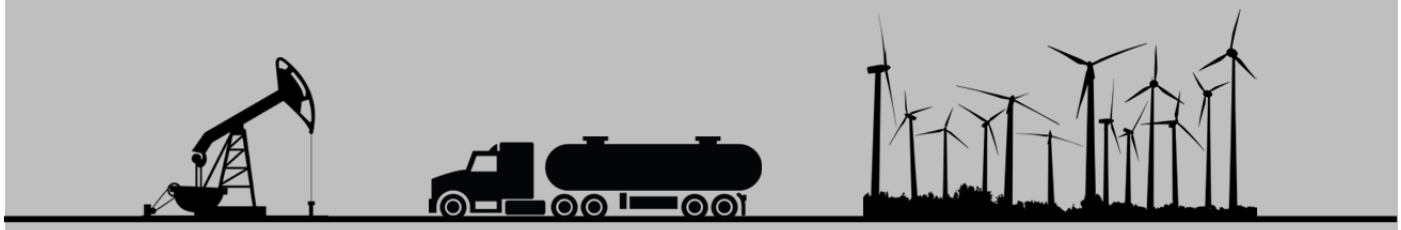
Rehabilitation Recommendations for FM 468 in La Salle County

Technical Memorandum TM-14-03



Prepared for Texas Department of Transportation
Maintenance Division

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December 2014

TxDOT Contract No. 47-4PV1A007

TTI Contract No. 409186

Texas A&M Transportation Institute

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INTRODUCTION

Premature distress occurred on FM 468 in La Salle County soon after construction. The Laredo District asked the Texas A&M Transportation Institute to perform an investigation to determine the cause of the premature distress. The pavement under investigation was repaired by removing the existing surface treatments and placing a 3-inch hot mix asphalt (HMA) layer. This technical memorandum provides a summary of the investigation conducted and the findings of the investigation.

EXECUTIVE SUMMARY

The mode of failure of FM 468 was primarily fatigue cracking of a stiff HMA overlay placed on a weak thin pavement with very high deflections. The multiple chip seals on the existing pavement were removed and a relatively thin (3 inches), stiff HMA layer was placed. The HMA layer prematurely cracked under the heavy loads letting water into the base. The unusually heavy rainfall in the early months of 2014 was also a contributing factor. The addition of full depth shoulders potentially attributed to trapping moisture in the base. The failure sequence is shown below.

Initially fine hairline cracks were observed in the wheel paths; these rapidly deteriorate into the classical fatigue pattern with evidence of base pumping. Rapid failure then occurred under the extremely heavy traffic.

Figure 1. Progression of Observed Pavement Failure on FM 468.

The pre-existing pavement was badly distressed but did not experience the level of rapid and severe failure found in the new pavement. As a best guess, this is possibly attributed to the multiple seals and strip seals applied to the existing section, which were waterproofing the base and were relatively tolerant of high strains associated with heavy truck traffic. These seals were removed and replaced with a single thin brittle HMA layer.

Field testing at one of the most severely distressed locations found the following:

- The pavement did not have an adequate base. As shown below, the base was less than 2 inches in thickness.
- FWD deflections in the lanes were measured to be extremely high. Deflections in the 70 and 80 mil range at the 9000 lb load on a pavement with 3 inches of HMA are indicative of a weak or inadequate foundation layer.

Figure 2. Inadequate Foundation Layer.

Six pavement rehabilitation options were proposed. All options included the construction of some type of stabilized base or subbase layer. The materials taken from the existing pavement are shown below. The new base was taken from a stockpile at a TxDOT yard in Cotulla.

Figure 3. Materials from Existing Pavement.

Two combinations of materials were formulated, laboratory tests performed and results provided to the District staff in early May 2014.

- The use of 6 percent Portland cement in the sandy subgrade created a stiff layer that was not moisture susceptible. The 7 day Unconfined compressive strength (UCS) was 220 psi, and the indirect tension strength was 53 psi, with no loss of strength after submerging the sample in water for 4 hours.
- A combination of 50 percent new base, 38 percent reclaimed asphalt pavement (RAP), and 12 percent old base was effectively stabilized with either 3 percent Portland cement or a combination of 2.4 percent foamed asphalt and 1 percent Portland cement. Both these options will produce an acceptable stabilized base.

A total of six pavement re-design alternatives were proposed to the Laredo District staff with various combination of treated base and treated subgrade. Several issues drove the discussion with the District. These being a) the desire not to raise the roadway because of the existing driveways and b) the need to establish a foundation layer in the pavement structure. A decision was made to focus efforts on the following two designs:

- **Option 1b** remove existing HMA; cement stabilize the existing sandy subgrade with 6 percent cement and place full depth HMA.
- **Option 6** Undercut section, cement stabilize subgrade and add both flexible base and a two course surface treatment (CST).

FPS 21 was used to generate designs; the following were important considerations:

- Traffic level – The District recommended 20 year Equivalent Single Axle Load (ESALs) of 7 million (the initial design used only 0.3 million ESALs).
- Subgrade Support – based on FWD testing, a design modulus of 7.5 ksi was used; this is close to the value of 8 ksi used in the initial design.
- The use of a 10 year design life – this was thought appropriate at it is uncertain how long the current intense traffic loadings will be in utilizing the roadway.
- The modulus value to assign to the cement stabilized sand – Laboratory tests indicated that the stabilized subgrade with 6 percent Portland cement was not moisture susceptible and had a UCS at the low end of the cement treated base range. The values in the TxDOT pavement design guide for CTB are recommended to be from 80 to 150 ksi; therefore for the FPS analysis, a design modulus of 80 ksi was assigned to the sand layer treated with 6 percent cement.
- Treatment width – consideration was given to avoiding the potential from trapping water against the full depth HMA shoulders.

The following pavement designs were developed using FPS 21 using the above criteria.

Table 1. Pavement Designs Developed.

Option	Type	Layer Thickness	Comments
1 b)	Cement treat + thick HMA	Remove 6.5 inches Treat 8 inches 6% Cement 6.5 inches HMA	Only treat main lanes, existing full depth shoulders can remain
6	Cement treat subbase + Flex base + 2 CST	Undercut 11 inches Treat 8 inches 6% Cement 10 inches Flexible base 2 CST	Must treat BOTH main lanes and shoulder to match section and avoid trapping water

Options require construction in a trench with possible weak zones with a vertical construction joint; efforts should be made to stagger the joint if possible.

It is acknowledged that limited funding is available to implement these recommendations and that the District may need to prioritize this work. The table below shows the average FWD deflections for various sections in the eastbound direction along this highway.

Table 2. Average FWD Deflections for Various Sections Eastbound Sections of FM 486.

TRM Section Limits			Average Max deflection (mils)	Section #
440	to	440 +1.1	44.5	1
440 +1.1	to	442	33.8	2
442	to	442 + 0.5	51.8	3
442 + 0.5	to	444 + 0.1	44.9	4
444 + 0.1	to	446 + 1.6	51.8	5
446 + 1.6	to	450	37.9	6
450	to	IH 35	24.7	7

Based on average moduli values and layer thicknesses, the following table shows target values for FWD deflections at a load level of 9000 lb for FM 486.

Table 3. Target Values for FWD Deflections at Load Level of 9000 lbs for FM 486.

Target Deflections	Comments
< 32 mils	Good structure; adequate base thickness and base strength
32–48 mils	Marginal pavement showing deterioration
>48 mils	Very poor structure - no discernable base layer

Based on these results, the District should focus funding on sections 3 and 5 above. Most of the severe failures are also currently in section 5.

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