LTPP Study Provides Insight on Expected Overlay Performance

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Just how long on average does an asphalt overlay last? This question is key to engineers involved in pavement life cycle cost analysis (LCCA) of pavements. As alternative strategies are developed and then compared through LCCA, the expected performance life parameters are critical in determining which alternative provides the lowest overall life cycle cost.

For asphalt pavement alternatives, state agencies must decide what is the design life of the initially constructed or reconstructed section, and then what is the design life of any rehabilitation method such as asphalt overlays. Typically, agencies will assign a longer life to the initially constructed asphalt pavement and a shorter life to any subsequent overlays.

A study sponsored by the Federal Highway Administration (FHWA), and conducted by the consulting firm Fugro-BRE, provides some interesting insight as to how long asphalt pavements, and particularly hot mix asphalt overlays, can be expected to perform.

Background of Study

The Long Term Pavement Performance (LTPP) program is funded by FHWA to develop improved design methods and strategies for the rehabilitation of existing pavements. General Pavement Study (GPS) 6, entitled "AC Overlay of AC Pavements," is one of the experiments within the LTPP program and contains 125 test sections where an existing asphalt concrete (AC) pavement was overlaid with AC.

GPS-6 is divided into two sections: GPS-6A and GPS-6B. GPS-6A test sections generally had AC overlays placed prior to 1990 when the LTPP program started. They did not have a detailed pavement condition survey conducted prior to the overlay. Conversely, GPS-6B sections generally had AC overlays placed after 1990 and had detailed pavement condition surveys performed prior to placement of the overlay. There are 60 GPS-6A sections and 65 GPS-6B sections included in the LTPP program.

Distress data was collected when the overlay had been in-place for only 6 months, and then approximately every two years thereafter, using the LTPP Distress Identification Manual protocol. Roughness measurements as measured by the International Roughness Index (IRI) were taken on a regular basis.

This article summarizes the results and performance trends of the GPS-6 sections through February 1997. The test sections cover a diverse range of conditions. The age of the AC overlays range from 0.1 to 26.4 years with an average of 7.3 years. Traffic levels range from 10,000 to 1,900,000 ESALs per year and average 300,000.

Distress Types Considered

The six distress types used to evaluate the performance trends of the GPS-6 test sections were fatigue cracking, longitudinal cracking in the wheelpath, longitudinal cracking not in the wheelpath, transverse cracking, rutting and roughness. Levels (nominal, moderate and excessive) were defined for each distress type for relative comparisons in the study and are depicted in Table 1. Table 2 shows the percentages of the test sections with each of the different levels for each distress through 1997.

Fatigue and Longitudinal Cracking in Wheelpaths

Seventy-six percent of the test sections had no fatigue cracking and 61 percent had no longitudinal cracking in the wheelpath. The following observations were made regarding fatigue and longitudinal cracking in the wheelpaths:

- Longitudinal cracking in the wheelpath will eventually propagate into fatigue cracking with repeated traffic loadings.
- The majority of the GPS-6 test sections have performed well past 10 years of service with little sign of fatigue cracking.

Transverse Cracking

Forty percent of the test sections had no transverse cracking. The following observations about transverse cracking were made:

Table 1. Magnitude of distress for each category

Distress Type	*Nominal*	*Moderate*	*Excessive*
Fatigue cracking, m2	1-10	11-60	>60
Longitudinal cracking in the wheelpath, m	1-50	51-160	>160
Longitudinal cracking not in the wheelpath, m	1-50	51-160	>160
Transverse Cracks, number	1-10	11-50	>50
Rutting, mm	<7	7-20	>20
Roughness (IRI), m/km	<1.6	1.6-2.4	>2.4

Table 2. Percentages of GPS-6 test sections with respective levels of distress.

Distress Type	*Levels of Distress*			
	None	*Nominal*	*Moderate*	*Excessive*
Fatigue cracking	76	9	8	7
Longitudinal cracking in wheelpath	61	30	10	0
Transverse Cracking	40	25	27	8
Longitudinal cracking not in wheelpath	52	27	17	4
Rutting		67	33	0
Roughness		79	17	4

- The incidence of transverse cracking decreases with increased overlay thickness.
- The occurrence of transverse cracks on thin overlays (less than 60mm) was affected by the age of the AC overlay; however, there was no measurable effect by age for the thicker overlays.
- Traffic levels do not greatly affect the occurrence of transverse cracks in AC overlays.

Longitudinal Cracking Not in Wheelpath

Fifty-two percent of the test sections had no longitudinal cracking outside of the wheelpath. The following observations about longitudinal cracking not in the wheelpath were made:

- Thicker overlays consistently exhibit less incidence of cracking.
- The overlay age and condition of the existing pavement prior to overlay appears to have little effect on the performance of the overlay to resists longitudinal cracking not in the wheelpath.

Rutting

Sixty-seven percent of the test sections selected for this GPS-6 study have rut depths of 7 mm or less. The following observations about rutting were made:

- Thick overlays were not better at resisting rutting.
- Predicting traffic levels is important in deterring rutting. However, proper material selection, construction techniques and quality control are probably more important.
- The LTPP test sections do not tend to rut. For the majority of overlays in this study, rutting only became sufficient to require rehabilitation after more than 15 years.

Roughness

Seventy-nine percent of the GPS-6 test sections have no greater than a nominal level of roughness (IRI values of 1.6 m/km or less). The following observations about roughness are provided:

- Placement of an AC overlay can substantially reduce roughness.
- A smooth overlay (both thin and thick) tends to stay smooth, even when placed over existing pavements that have moderate to excessive levels of roughness.

Summary and Conclusions

Publication No. FHWA–RD-00-165, which summarizes this entire GPS-6 experiment through February 1997, concludes with these words:

"Clearly, the majority of the AC overlays included in the LTPP database have served for 15 years or more before the load and non-load related distresses became sufficient to require rehabilitation. More importantly, there are a number of test sections where the overlays have less than only nominal levels of distress for more than 20 years of service."

Other conclusions state that properly designed and constructed AC overlays will control rutting and roughness. An AC mixture designed to resist rutting and placed with adequate density will resist early and long-term deformation. Also, if the above is obtained and the overlay is placed relatively smooth (approx. IRI of 0.8 m/km), it should remain smooth over its service life. Long-term monitoring of these 125 sections will continue to provide valuable data with regards to performance trends and their relation to traffic, climate and materials.

Certainly there are many factors that go into the actual performance of hot-mix overlays, such as condition and strength of the existing pavement structure, overlay thickness, traffic and climate conditions, quality of the mixture and proper construction.

Although we know there is no single answer or formula to determine how long an overlay will last, engineers involved in LCCA must typically make educated assumptions with regards to the design life. This applies not only to overlays, but to the construction and rehabilitation methods being considered in the analysis. Engineers should use the best actual in-place performance data. Ideally, each state DOT should track this with their pavement management system—subdividing the various rehabilitation methods into different categories, such as overlay thickness (thick, medium or thin) and mix type (Superpave, SMA, Marshall).

Performance studies such as the LTPP GPS-6 experiment provide this critical LCCA information, allowing engineers to make the best educated choices when assigning design life to the various construction and rehabilitation methods.

This article is based upon FHWA's Publication No. RD-00-165, *Performance Trends of Rehabilitated AC Pavements*