TECHBRIEF

Performance Trends of Rehabilitated AC Pavements

Publication No. FHWA-RD-00-165
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Background

A primary objective of the Long Term Pavement Performance (LTPP) program is to develop improved design methodologies and strategies for the rehabilitation of existing pavements. One of the experiments designed to address this objective is General Pavement Study (GPS) 6.

The GPS-6 experiment, "AC Overlay of AC Pavements," involves pavement test sections where an asphalt concrete (AC) overlay was placed on an existing AC pavement. The GPS-6 experiment is further divided into two parts—GPS-6A and GPS-6B test sections. The GPS-6A part of the experiment includes those test sections for which a detailed condition survey of the existing surface was not performed prior to overlay placement. Conversely, the GPS-6B part includes those sections for which detailed distress surveys were performed prior to overlay. There are 60 GPS-6A test sections and 65 GPS-6B test sections in the LTPP program.

This TechBrief summarizes the results of a study of the GPS-6 experiment, entitled "Performance of Rehabilitated Asphalt Concrete Pavements in the LTPP Experiments—Data Collected Through February 1997." The study documents performance trends of the 125 GPS-6 test sections using distress data collected through February 1997. The test sections represent a diverse range of conditions. The age of the overlays range from 0.1 to 26.4 years (with an overall mean age of 7.3 years), while the traffic levels range from 10 to 1,900 thousand equivalent single-axle loads (KESALs) per year (with an overall mean of 300 KESALs per year).

Distresses Considered in the Study

Six distress types or performance indicators were used to evaluate the performance trends or characteristics of the LTPP GPS-6 test sections. They include fatigue cracking, longitudinal cracking in the wheelpath, longitudinal cracking not in the wheelpath, transverse cracking, rutting, and roughness (as measured by the International Roughness Index [IRI]). The extent of these distresses was divided into different categories for relative comparisons. The different levels of distress used in the study are defined in table 1 on the following page. Table 2, also on the following page, shows the percentages of the GPS-6 test sections having nominal and greater than nominal levels of distress, respectively. As table 2 shows, more than half of the GPS-6 test sections have no fatigue cracking, longitudinal cracking in the wheelpath, or longitudinal cracking not in the wheelpath.

LTPP

The Long Term Pavement Performance (LTPP) program is a 20-year study of in-service pavements across North America. Its goal is to extend the life of highway pavements through various designs of new and rehabilitated pavement structures, using different materials and under different loads, environments, subgrade soil, and maintenance practices. LTPP was established under the Strategic Highway Research Program, and is now managed by the Federal Highway Administration.

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Fatigue and Longitudinal Cracking in Wheelpaths

Only 15 percent of the GPS test sections have more than a nominal level of fatigue cracking and only 10 percent have longitudinal cracking in the wheelpath greater than the nominal level. Most of the GPS test sections have performed well past 10 years of age with little fatigue cracking. The following is a summary of observations regarding the occurrence of fatigue cracking and longitudinal cracking in the wheelpath:

- The GPS-6A data show that overlay designs that provide pavement structure consistent with traffic expectations can be expected to perform well for more than 10 years.

- The study concludes that fatigue cracking and longitudinal cracking in the wheelpath are related. Specifically, the longitudinal cracking in the wheelpath will eventually propagate or evolve into fatigue cracking with continued traffic loading.

Transverse Cracking

Thirty-five percent of the GPS-6 test sections have more than a nominal amount of transverse cracking. Although transverse cracking was found to increase with age, some overlays have survived with limited or no transverse cracking for long periods of time. The following is a list of general observations regarding the occurrence of transverse cracking:

- As the thickness of the overlay increases, the incidence of transverse cracking decreases.

- Where transverse cracking has occurred, the data show that the amount of cracking is dependent on the condition of the original pavement prior to overlay placement. The overlays placed on pavements that were classified as being in good condition exhibit about a 50-percent increase in time to the same level of transverse cracking as those overlays placed over pavements that were classified as being in poor condition.

- The age of the AC overlay was found to have an effect on the occurrence of transverse cracks for thin overlays (less than 60 mm), but no measurable effect for the thicker overlays. As the thickness of the AC layer increases, the binder and mixture properties become much more important and the age of the mix becomes less important. Although the LTPP data do not conclusively support those findings, they do not contradict them.

- While it is a widely accepted belief that transverse cracking is, to some degree, a result of low temperatures, only a moderate amount of transverse cracking occurs in the Canadian test sections, where low temperatures are common.

Table 1. Magnitude of distress for each category.

Distress Type	Nominal	Moderate	Excessive
Fatigue cracking, m^2	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, no.	1 - 10	11 - 50	> 50
Rutting, mm	< 7	7 - 20	> 20
Roughness (IRI), m/km	< 1.6	1.6 - 2.4	> 2.4

- The data show that traffic levels are not particularly important to the occurrence of transverse cracks in AC overlays.

Longitudinal Cracking Not in Wheelpath

Twenty-one percent of the GPS-6 test sections have exhibited greater than nominal longitudinal cracking not in the wheelpath. The following is a list of general observations regarding the occurrence of longitudinal cracking not in the wheelpath:

- Thicker overlays consistently have less longitudinal cracking not in the wheelpath, as well as a lower incidence of cracking.

- Overlay age and condition of the pavement prior to the overlay appear to have little or no impact on the performance of the overlay in resisting longitudinal cracking not in the wheelpath. However, 45 percent of the overlays over pavements known to have longitudinal cracking not in the wheelpath prior to the overlay have successfully resisted reflection of these cracks through to the surface during their early years.

Rutting

Thirty-three percent of the GPS-6 test sections have rut depths that are greater than the nominal level of rutting selected for this study. The following is a list of general observations regarding the occurrence of rutting:

- Thick overlays are not superior to thin overlays in resisting rutting.

- Traffic levels are important in predicting rutting, but other factors (such as material properties and construction techniques/quality control) are probably more important.

- Although rutting is a problem nationwide, it is not a significant problem in the LTPP test sections. Indeed, as far as rutting as a pavement distress is concerned, the LTPP test sections represent pavements that tend not to rut. Hence, LTPP can provide information on how to design pavements that do not rut versus data explaining why pavements are rutting.

- For the majority of AC overlays in the LTPP program, rutting becomes sufficient to require rehabilitation only after 15 years or more (with traffic levels ranging from 10 to 1,877 KESALs per year). In fact, excessive rut depths

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

Distress Type	Levels of Distress			
	None, %	Nominal, %	Greater Than Nominal, %	
			Moderate	Excessive
Fatigue cracking	76	9	8	7
Longitudinal cracking in wheelpaths	61	30	10	0
Transverse cracking	40	25	27	8
Longitudinal cracking not in wheelpaths	52	27	17	4
Rutting	n/a*	67	33	0
Roughness	n/a	79	17	4

**n/a = not applicable*

have been measured on only a limited number of the LTPP test sections through 1997.

Roughness

Twenty-one percent of the GPS-6 test sections have IRI values that are greater than the nominal level of roughness selected for use in this study. The following is a list of general observations regarding roughness:

- Substantial reductions in pavement roughness can be obtained by the placement of an AC overlay, even for pavements that were not especially rough when constructed.

- The long-term control of roughness can be attained with thin and thick overlays. In other words, the increase in roughness for both thin and thick overlays is quite nominal for many years after an overlay is placed, even when placed on pavements that have moderate to excessive levels of roughness.

- The condition of the original pavement for the LTPP test sections appears to have little to do with the initial roughness of the overlay or in the long-term growth of roughness in the overlay.

- The amount of traffic (or ESALs) on an overlay clearly affects the growth of roughness or increasing IRI values, but it is quite possible to construct AC overlays for heavy traffic that will remain smooth for 15 or more years.

General Summary and Conclusions

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. Additional monitoring on these sites will be extremely valuable as the materials, traffic, and climate data become available.

From this and other studies, it appears that rutting and roughness distress are somewhat easier to deal with than cracking. The data show that the long-term control of rutting and roughness is gained or lost during construction. If the AC mix will resist rutting adequately and is placed at a reasonable density, the early permanent deformation will be limited and the future rutting rate will be nominal. Similarly, if the overlay material is not subjected to excessive permanent deformation and is placed relatively smooth (approximate IRI of 0.8 m/km), it probably will not become very rough over its service life.

Researcher—This study was performed by Fugro-BRE, 8240 MoPac Expressway, Suite 220, Austin, TX 78759, telephone: (512) 346-0870, fax: (512) 346-8750. Contract No. DTFH61-96-C-00003.

Distribution—This TechBrief is being distributed according to a standard distribution. Direct distribution is being made to the Resource Centers and Divisions.

Availability—This TechBrief is based on *Performance of Rehabilitated Asphalt Concrete Pavements in the LTPP Experiments – Data Collected Through February 1997* (Report No. FHWA-RD-00-029). Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. A limited number of copies will be available from the R&T Report Center, HRD-11, FHWA, 9701 Philadelphia Court, Unit Q, Lanham, MD 20706, telephone: (301) 577-0818, fax: (301) 577-1421.

Key Words—Asphalt concrete pavements, rehabilitation, and asphalt concrete overlays.