Texas A&M Transportation Institute

PROJECT SUMMARY

Texas Department of Transportation

0-6856: Sustainable Perpetual Asphalt Pavements and Comparative Analysis of Lifecycle Cost to Traditional 20-Year Pavement Design

Background

Perpetual pavement (PP), especially appropriate for heavily trafficked highways, is defined as a long-lasting thick hot-mix asphalt (HMA) pavement structure with a service life in excess of 50 years without major structural rehabilitation and/or reconstruction activities. Since 2001, Texas has designed and constructed 10 PP sections on the heavily truck-trafficked IH 35 corridor and SH 114 in Fort Worth. With the oldest section having a service life of over 14 years, there is an opportunity to review the existing PP design and construction practices with a view to improving and enhancing the design procedures and, subsequently, recommending the best construction practices for cost-effectiveness. The concern about PP was cost because it was suggested that PP was excessively thick and that its multiple layer lifts of different HMA mixes made PP difficult and expensive to construct. Thus, a critical review of current PP practices and field performance was warranted with recommendations on how to make these PP structures cost-competitive with both conventional flexible pavements and rigid concrete pavements.

What the Researchers Did

Researchers conducted extensive reviews of existing PP design and construction practices, case studies on in-service PPs with field performance, and life-cycle cost comparisons with conventional flexible and rigid pavements. Also, to enhance the mechanistic-empirical (M-E) design for Texas PP, researchers identified an endurance limit (EL) determination approach and test protocol to determine default EL criteria for Texas typical mixes used for PPs. Based on the findings, researchers recommended new/enhanced Texas PP design and construction practices to meet cost- and performance-effectiveness.

What They Found

After assessing the existing PP design and construction practices with a view to enhancing the design procedures and recommending the best construction practices for Texas PPs, researchers concluded that:

- Global PP data collected from other states and countries showed that Texas PP design requires the thickest HMA layers (22 in.), while those PP sections in other states/countries using thinner layers showed comparably good field performance.

Research Performed by:
Texas A&M Transportation Institute

Research Supervisor:
Lubinda Walubita, TTI

Researchers:
Sang Ick Lee, TTI
Sheng Hu, TTI
Tom Scullion, TTI

Project Completed:
11-30-2017

- Based on the field performance evaluation, in-service Texas PPs are still in good condition without major structural rehabilitation activities while they are more than 14-year old.
- The life-cycle cost analysis shows the beneficial cost-effectiveness of PPs compared to the conventional flexible and rigid pavements during their life cycle (50 years) as:
  - Initial construction cost: rigid > PP > flexible.
  - User cost: flexible > PP > rigid.
  - Total agency cost: rigid > flexible ≥ PP.
- With a thinner thickness of HMA layers, three PP structural design alternatives were proposed/recommended based on three traffic levels, namely:
  - Equivalent single axle loads (ESALs) ≤ 30 million.
  - 30 million < ESALs ≤ 50 million.
  - ESALs > 50 million.
- The M-E design procedure for Texas PPs was enhanced by developing default EL criteria for typical Texas HMA mixes and incorporating them into the enhanced Texas mechanistic-empirical flexible pavement design system (TxME).
- PP constructability should be improved by using more workable materials such as dense-graded or Superpave mixes, proper material transfer devices, and optimized compaction lift thickness of the HMA layers (i.e., ≤ 4 in.). Also, the infrared thermal imaging system, ground-penetrating radar, and compaction-monitoring system should be considered as effective tools for quality control/quality assurance (QC/QA).

What This Means

PP is a cost- and performance-effective alternative compared to conventional 20-year flexible and rigid pavements for heavily trafficked highways. However, Texas PP needs significant improvement in material quality and thickness reduction. Texas PP design and construction will be cost-effectively optimized without compromising the structural performance if the following recommendations are implemented:

- Use Superpave or dense-graded HMA mixes for asphalt concrete layers instead of stone-filled HMA mixes for better compactability and constructability.
- Reduce the total HMA thickness from the current average of 22 in. to an optimum of about 14 to 16 in. for cost-effectiveness.
- Incorporate an improved construction procedures and QC/QA protocol for Texas PP best practice.
- Use the software package including FPS and the enhanced TxME incorporating the new EL approach to enhance the M-E design of Texas PP structures.

For More Information

Project Manager:
Wade Odell, TxDOT, (512) 416-4737

Research Supervisor:
Lubinda Walubita, TTI, (979) 862-3356

Technical reports when published are available at **http://library.ctr.utexas.edu.**

Research and Technology Implementation Office
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
Keyword: Research