Texas A&M Transportation Institute

PROJECT SUMMARY

Texas Department of Transportation

# 0-6744: New HMA Shear Resistance and Rutting Test for Texas Mixes

## Background

Traditionally run at one test temperature (122°F), the Hamburg wheel tracking test (HWTT) (Figure 1) has a proven history of successfully identifying and screening hot-mix asphalt (HMA) mixes that are prone to rutting and/or susceptible to moisture damage (stripping). However, with the record summer temperatures of recent years, several premature shear and rutting failures have occurred in the field with HMA mixes that had passed the HWTT in the laboratory. Most of these field failures occurred in high-shear-stress environments, particularly in areas having:

- Slow-moving (accelerating/decelerating) traffic at controlled intersections.
- Stop-go traffic.
- Elevated temperatures.
- Heavy/high traffic loading.
- Lower-performance asphalt-binder grades.

As a step toward mitigating the aforementioned issues, supplementary HMA shear resistance and permanent deformation (PD) tests in parallel with the HWTT need to be developed that can be applicable for both laboratory-molded and field-cored specimens. At a minimum, such a test protocol must have the following characteristic features:

- Applicability for routine HMA mix design and screening of mixes to be placed in high-shear-stress and elevated-temperature areas.
- Practical, cost-effective, reasonable test duration and easy implementation by the Texas Department of Transportation.
- Easy test sample preparation.
- An acceptable level of test variability and reliability.
- Potential to simulate and/or correlate with field rutting performance.

## What the Researchers Did

To enhance the performance of the existing HMA shear resistance and PD/rutting tests and to develop new supplementary and/or surrogate rutting tests, the researchers:

**Figure 1. Hamburg Wheel Tracking Tester.**

- Comprehensively evaluated the HWTT protocol and the Tex-242-F test procedures in terms of the data analysis methods to enhance the HWTT's rutting predictive capabilities under high-shear environments.
- Recommended updates and modifications to the Tex-242-F (HWTT) test procedures.
- Developed a new HMA shear test, namely the simple punching shear test (SPST) (Figure 2), and the associated draft specifications.
- Comparatively evaluated and correlated the HWTT and the SPST to other HMA PD/rutting tests, namely:
  - The uniaxial repeated load permanent deformation test.
  - The dynamic modulus test.
  - The flow number test.


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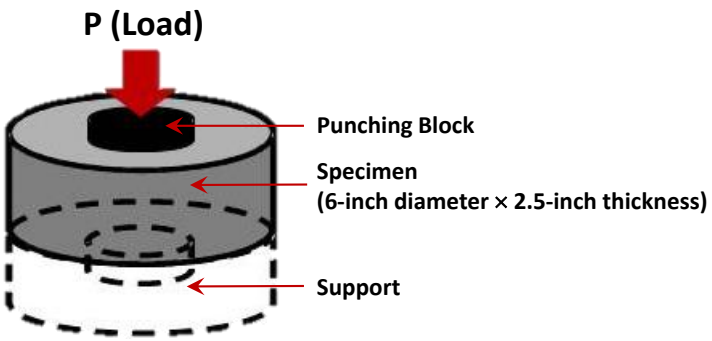


**Figure 2. Simple Punching Shear Test Loading Configuration.**

- Correlated and preliminarily validated the laboratory test results with HMA field rutting performances.
- Conducted finite element simulations with three-dimensional dynamic loading for shear stress-strain modeling of HMA pavement (PVMNT) structures.

## What They Found

After evaluating seven commonly used Texas HMA mixes with markedly different resistances to rutting/shear failures, along with some selected in-service highway pavement sections, the researchers concluded that:

- The proposed modifications of the Tex-242-F (HWTT) test procedures, including testing at multiple/higher test temperatures and multiple/lower wheel speeds, and following stricter maximum sample sitting time requirements are critical for improving the HWTT performance in predicting HMA field rutting under high-shear-stress environments.
- The modification of the current HWTT data interpretation to incorporate the rutting-path history can result in better understanding of the HMA field rutting performances, especially in terms of predicting early-life rutting at high-shear-stress locations such as controlled intersections or urban stop-go environments.
- The SPST has promising potential in evaluating the HMA shear properties and can be practically used as a surrogate test method to supplement the existing HMA rutting-shear tests such as the HWTT.
- Critical highway areas such as intersections or urban stop-go sections with slow-speed, decelerating, and turning vehicles, as well as zones of sustained elevated temperatures, experience high-shear stresses from traffic loading. HMA mixes used in these locations are more prone to shear failure and must be designed to have sufficient shear strength using the SPST and/or modified HWTT test methods.

## What This Means

The work conducted in this study shows promise in optimizing protocols of the HMA shear resistance and PD/rutting tests to better simulate field rutting conditions. HMA mix screening and material selection will be cost-effectively optimized and premature rutting failures minimized if the following steps are properly followed:

- The recommended updates and proposed modifications for the HWTT procedures (Tex-242-F) should be properly implemented.
- The SPST concept should be investigated further and implemented as a supplementary test to the HWTT.
- HMA mixes to be placed in high-shear-stress areas (e.g., highway intersections, stop-go sections, and slow-vehicle-speed zones) and high-PVMNT-temperature environments should be evaluated by the SPST and HWTT at appropriate test conditions (i.e., high temperatures and/or low speeds) for sufficient HMA shear strength characterization and resistance to PD/rutting during the laboratory mix design and screening stages.

## For More Information

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