

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE 721.10.01

GUIDE FOR USING THE LOCKED-WHEEL FRICTION TESTER TO MEASURE FRICTIONAL
PROPERTIES OF PAVEMENT

1. SCOPE

- 1.1 This procedure establishes a process for collecting friction data of roadways using a Locked-Wheel Friction Tester. Friction measurements are obtained by locking a test tire on a device-wetted surface while traveling at a specific speed (typically 40 mph).
- 1.2 Tests are conducted using rib-tread and smooth-tread test tires. Ribbed tires are used as an indicator of the micro-texture properties of pavement. Smooth tires are used as an indicator of the macro-texture properties of pavement.
- 1.3 The resulting Friction Number (FN) is non-dimensional value and represents the average coefficient of friction measured across a test interval.

2. PURPOSE

- 2.1 To establish a procedure for safe operation of a Locked-Wheel Friction Tester and the of quality pavement friction data for WVDOH.

3. REFERENCED DOCUMENTS

- a. AASHTO T 242: Frictional Properties of Paved Surfaces Using a Full-Scale Tire
- b. AASHTO M 261: Rib-Tread Standard Tire for Special-Purpose Pavement Frictional-Property Test.
- c. AASHTO M 286: Smooth-Tread Standard Tire for Special-Purpose Pavement Frictional-Property Test.
- d. WVDOT Skid Measurement System Evaluation, Report Number TRC-625 which is available upon request from DOHMCSnTRoadway@wv.gov.
- e. WVDOH Construction Manual

4. DEFINITIONS

- 4.1 Locked-Wheel Friction Tester: The entire apparatus, including Tow Vehicle, attached Locked-Wheel Skid Trailer, and all supporting components such as the on-board computer, force transducers, instrumentation, air, water and braking systems, etc.
- 4.2 Tow Vehicle: The automotive vehicle, capable of towing the Locked-Wheel Skid Trailer and maintaining constant speed within ± 1 mph while the Test Tire is completely locked.

- 4.3 Locked-Wheel Skid Trailer: The two-wheel trailer, pulled behind the Tow Vehicle, and equipped with a Test Tire mounted on the left (driver's) side.
- 4.4 Friction Number (FN): This represents the average coefficient of friction measured across a test interval. FN(40) represents the Friction Number calculated by the computer at a test speed of 40 ± 1 mph and is determined by the following formula:

$$\text{FN}(40) = 100 \times \mu = 100 \times (F / W)$$

Where:

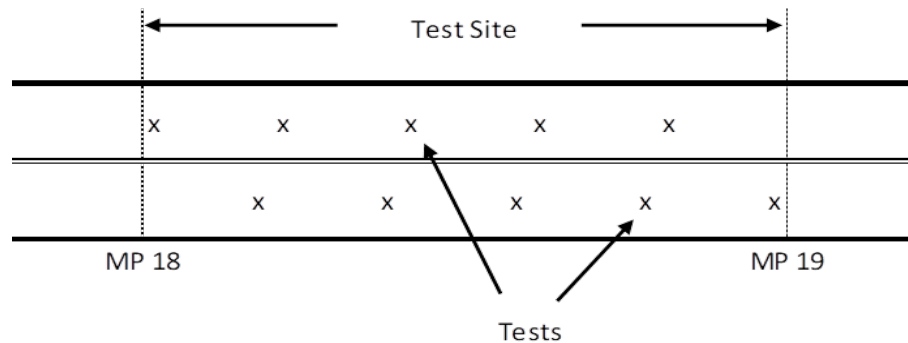
μ = Coefficient of friction

F = Tractive horizontal force applied to the tire, lbs.

W = Vertical load applied to the tire, lbs.

- 4.5 Test Site: The location of the pavement to be tested, including all traffic lanes, defined by beginning and ending mileposts. Note: a test site may be specific to a project, or may be any stretch of existing roadway.

Example Tests within a Test Site



5. EQUIPMENT REQUIREMENTS

- 5.1 All electronic and mechanical components of the Locked-Wheel Friction Tester shall be adequately designed and built to meet or exceed the requirements set forth in AASHTO T 242 Section 4.

6. SAFETY PRECAUTIONS

- 6.1 The Locked-Wheel Friction Tester shall comply with all applicable State and Federal Laws. Additional precautions shall be taken beyond those imposed by law to ensure the

safety of all personnel and the general public. At minimum the following conditions must be followed when testing with a Locked-Wheel Friction Tester:

- a. Test lanes must be free of debris and obstructions.
 - b. Heavy acceleration and deceleration should be avoided while testing.
 - c. Test lanes may remain open to traffic unless deemed unsafe.
 - d. Testing shall only be conducted at speeds recommended by the manufacturer.
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7. CALIBRATION AND CORRELATION

- 7.1 The Locked-Wheel Friction Tester shall be calibrated and correlated annually for compliance to the ASTM E274/E274M Standard.
 - 7.2 During calibration, the Locked-Wheel Friction Tester shall undergo, at minimum, the following tests to verify the systems are working properly:
 - a. Water delivery system
 - b. Speed measuring system
 - c. Distance measuring system
 - d. Force and load transducer measuring system
 - e. Ability of the brake to completely lock the test wheel
 - 7.3 The Evaluation and Field Test Center maintains a Locked-Wheel Friction Test System which is considered a Skid Measurement Standard and is validated annually. During correlation, the Locked-Wheel Friction Tester is operated on three separate test surfaces along with the Standard System. Statistical analysis is then performed on the test data to produce correlation equations. These equations are used to adjust future test results, allowing old and new data, as well as data from different systems to be compared.
 - 7.4 An example of the calibration and correlation procedure of the Locked-Wheel Friction Test System is described in the referenced "WVDOT Skid Measurement System Evaluation, Report Number TRC-625".
 - 7.5 Modifications and/or changes to the electrical or mechanical components will require the system to be re-calibrated and re-correlated.
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8. DATA COLLECTION

- 8.1 Data is collected at the time of testing by the system computer. The data collected by the computer includes the location, speed and the calculated Friction Number (FN).
- 8.2 Do not test pavement if ambient and/or surface temperature is less than 45° F.
- 8.3 Do not test pavement if debris or standing water is present.

- 8.4 Pavement test sites shall be tested with both the Rib-Tread and Smooth-Tread tire. High Friction Surface Treatment locations shall be tested with the Rib-Tread tire only.

9. PRE-TEST INSPECTION

- 9.1 Prior to testing, inspect all cable and hose connections from test vehicle to trailer. Ensure all fittings are secure, not leaking, worn, or dragging the ground.
- 9.2 Check safety lighting and ensure it is working properly. Inspect the test tires according to the referenced *AASHTO M 261* and *AASHTO M 286*.
- 9.3 Inspect the pavement surface for changes in texture, segregation, polishing, pushing or other issues which may affect friction. Areas of inconsistency shall be noted and explained in the Materials Inspection Report.

10. TEST SPEED

- 10.1 All reasonable efforts shall be made to perform tests at 40 ± 1 mph. Tests conducted at less than 39 mph or greater than 41 mph will typically be considered invalid and will not be included when calculating the average friction values of the project. If speed cannot be maintained at 40 ± 1 mph due to safety or traffic conditions, the Engineer may approve testing at a different speed. In this case, the following formula is to be used to adjust the resulting Friction Number results:

$$FN(40) = FN(\text{speed}) - 0.5 * (40 - \text{speed})$$

Where: $FN(\text{speed})$ = Friction Number from test at (speed) mph

$FN(40)$ = Friction Number adjusted to 40 mph

11. POSITION AND FREQUENCY OF TESTS

- 11.1 Testing shall be conducted in the left wheel path of the roadway.
- 11.2 A minimum of five (5) tests shall be conducted with each tire in each lane-mile of each test site. Except for High Friction Surface Treatment locations which shall be tested with only the Rib-Tread tire as stated in 8.4.
- 11.3 Tests shall be spaced evenly throughout the test site, as safety and traffic conditions permit.

12. REPORTING OF TEST RESULTS

- 12.1 A Materials Inspection Report shall be submitted to the requesting Division/District.
- 12.2 The Report shall include the location, speed and calculated Friction Numbers from each test, as well as the average Friction Number for each lane at each test site.
- 12.3 The report shall also include weather conditions, areas of inconsistency in the pavement and general observations of the test site.

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