
Standard Method of Test for

Measurement of Vehicular Response to Traveled Surface Roughness

AASHTO Designation: T 286-96 (2000)

ASTM Designation: E 1082-90 (1995)



1. SCOPE

- 1.1. This test method covers the determination of vehicular response to traveled surface roughness.
- 1.2. This test method utilizes an apparatus that measures the relative motion of a sprung mass system in response to traveled surface roughness where the mass is supported by automotive type suspension and tires.
- 1.3. The values stated in SI units are to be regarded as the standard.
- 1.4. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Specific precautionary statements are given in Section 6.

2. REFERENCED DOCUMENTS

- 2.1. *ASTM Standards:*
 - E 177, Practice for Use of the Terms Precision and Bias in ASTM Test Methods¹
 - E 178, Practice for Dealing with Outlying Observations²
 - E 867, Terminology Relating to Vehicle-Pavement Systems
 - E 1136, Specification for a Radial Standard Reference Test Tire

3. SUMMARY OF TEST METHOD

- 3.1. Vehicular response to traveled surface roughness is calculated from an accumulated vertical position, velocity, or accelerometer measurements divided by the test section length. A vehicle is brought to the desired test speed and lateral position in the lane to be tested. The test apparatus is placed in operation and a constant speed is maintained throughout the test. Pertinent information affecting test results must be noted.

4. SIGNIFICANCE AND USE

- 4.1. This test method provides a means of evaluating traveled response to surface roughness. The measured values represent vehicular response to traveled surface roughness obtained with the

equipment and procedures stated herein and do not necessarily agree or correlate directly with those obtained by other methods.³

5. APPARATUS

- 5.1. *Test Apparatus*—consists of an axle-to-frame displacement measuring sensor, a displacement accumulator, a distance measuring system and a recording system mounted in a vehicle that is either a suitable vehicle or a suitable single axle, two-wheel trailer towed by a vehicle.
- 5.2. *Test Automobile*—The vehicle used to house the displacement measurement sensor. It shall be equipped as follows:
 - 5.2.1. Engine in front,
 - 5.2.2. Rigid rear axle,
 - 5.2.3. Rear springs (coil, single leaf, gas),
 - 5.2.4. Rear sway bar,
 - 5.2.5. Heavy-duty shock absorbers,
 - 5.2.6. Tires dynamically balanced (GM-TPC),⁴ or ASTM Standard E 1136,
 - 5.2.7. Cruise control,⁵ and
 - 5.2.8. Air conditioning.⁵
- 5.3. *Test Trailer*—A two-wheel trailer, when required, shall be specifically designed and equipped to house the displacement measurement sensor, meeting the following requirements:
 - 5.3.1. 3048 ± 25 mm (120 ± 1 in.) from the center of the hitch to the center of the axle,
 - 5.3.2. 1651 ± 127 (65 ± 5 in.) from the center of the tire to the center of the tire,
 - 5.3.3. Coil spring shock absorber suspension system,
 - 5.3.4. Sway bar,
 - 5.3.5. Tires dynamically balanced (GM-TPC)⁴,
 - 5.3.6. Mass and suspension system balanced to provide a response to the range of traveled surface roughness to be measured, and
 - 5.3.7. Rigid axle.
- 5.4. *Instrumentation:*

- 5.4.1. *General Requirements*—The instrumentation shall function accurately at ambient temperatures between 4.4°C and 37.8°C (40°F and 100°F). All electronic and mechanical components of the system will be adequately designed to withstand adverse conditions such as dust, moisture, vibrations, and shocks that may be encountered in traversing the traveled surfaces to be measured.
- 5.4.2. *Displacement Measuring Sensor*—Capable of measuring relative vertical axle-to-frame displacement in increments of 3.175 mm (0.125 in.) or less in response to traveled surface roughness.
- 5.4.3. *Displacement Accumulator*—Capable of accumulating the output of the displacement, velocity, or acceleration measurement sensors in one or both directions and transmitting an output, which is a function of the measured displacement, to the recording system.
- 5.4.4. *Distance Measuring System*—Must indicate distance by producing an output directly proportional to traveled distance that will actuate a high-speed counter capable of accepting count rates equivalent to the highest possible test speed. The system shall accommodate measurements in either meters or kilometers (feet or miles) and have calibration adjustment capability.
- 5.4.5. *Recording System*—Must provide an accumulative graphic, printed, or digital display of the outputs of the displacement accumulator and distance measurement system.

6. SAFETY PRECAUTIONS

- 6.1. The test vehicle, as well as attachments to it, shall comply with applicable state and federal laws. Precautions imposed by law shall be taken to ensure the safety of operating personnel and the public.

7. CALIBRATION

- 7.1. *Speed*—Calibrate the vehicle speedometer that is used to indicate the test speed by determining the time required to traverse an accurately measured (± 0.1 percent), level and straight section of pavement at a constant indicated speed. Calibration speeds should encompass the normal speed (or speeds) required for testing. A minimum of three test runs at each speed should be made for calibration. The precision of measured distance/time for the three test runs should be within ± 3.2 km/h (± 2 mph) of the average. The tangent section of pavement used for this calibration should be at least 0.8 km (0.5 mile) in length.
- 7.2. *Distance*—Calibrate the distance output by determining the distance recorded after traversing an accurately measured (± 0.1 percent) level, tangent pavement section at a constant indicated speed. Distance calibrations should incorporate all calibration speeds. A minimum of three test runs should be made at each speed. The precision of the distance output for the three test runs should be within ± 1 percent of the average. The tangent section of pavement used for this calibration should be at least 1.6 km (1.0 mile) in length.
- 7.3. *Vehicular Response to Traveled Surface Roughness*—Prior to calibration, exercise caution to ensure proper operation of all electronic and mechanical equipment. Operation should comply with the manufacturer's recommended procedures and the requirements of this test method. Calibration shall consist of adjusting the output of the displacement accumulator of a particular test apparatus through mathematical or mechanical means to correspond to a measure of response to roughness determined by one of the following reference methods, selected by the individual agency.