



SURFACE VEHICLE STANDARD

J3175™

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Superseding J3175 NOV2019

Road Vehicles - Friction Materials - Finished Brake Pad
Normalized Elastic Constant of Friction Material

RATIONALE

Measurement of variations in elastic properties because of raw materials, internal cracks, or other factors can be useful for quality control. Elastic properties are also important for lining characterization. The purpose of this test procedure is to evaluate the normalized elastic constant of friction material on a finished brake pad.

SAE J3175 has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

This SAE standard specifies a method for testing and measuring a normalized elastic constant of brake pad assemblies using ultrasound. This document applies to disc brake pad assemblies and its coupons or segments used in road vehicles.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J380 Specific Gravity of Friction Material

SAE J2725 Road Vehicles - Friction Materials - Elastic Properties Measurements

3. DEFINITIONS

3.1 NORMALIZED ELASTIC CONSTANT OF FRICTION MATERIAL (NECFM)

A measure of the elastic constant (C_{44}) independent of friction material density.

C_{44} can be referred to from SAE J2725.

3.2 ULTRASONIC MODES

Shear wave/ultrasonic wave mode where the direction of wave propagation is perpendicular to the friction surface of a brake pad.

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3.3 COORDINATE SYSTEM DEFINITION

See Figure 1.

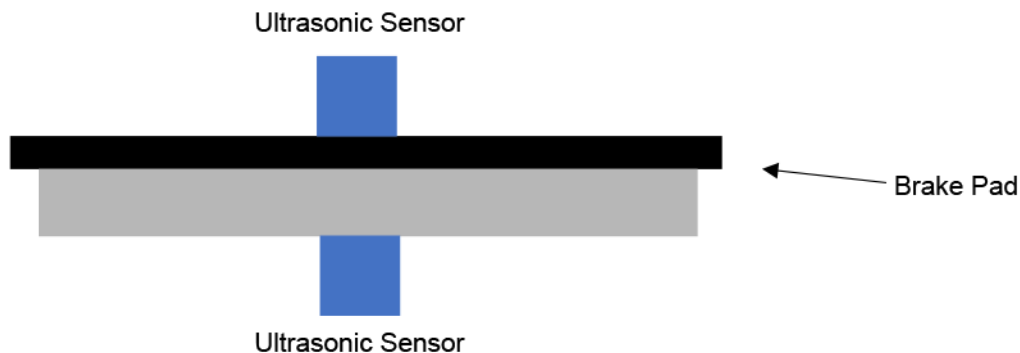


Figure 1 - Coordinate system

4. SYMBOLS

D_{friction}	Friction thickness ($D_{\text{total}} - D_{\text{plate}}$), in meters (m)
D_{plate}	Constant, nominal pressure plate design thickness, in meters (m)
D_{total}	Overall thickness of pad at given measurement point, in meters (m)
NECFM	Normalized Elastic Constant of Friction Material, in pascals (Pa)
$T^{\text{s}}_{\text{measured}}$	Transit time when measuring calibration steel block, in seconds (s)
$T^{\text{s}}_{\text{offset}}$	System delay ($T^{\text{s}}_{\text{measured}} - T^{\text{s}}_{\text{standard}}$), in seconds (s)
$T^{\text{s}}_{\text{plate}}$	transit time through pressure plate ($D_{\text{plate}} / V^{\text{s}}_{\text{plate}}$), in seconds (s)
$T^{\text{s}}_{\text{total}}$	Transit time through brake pad, in seconds (s)
$T^{\text{s}}_{\text{standard}}$	Constant (known transit time through certified calibration block), in seconds (s)
$T^{\text{s}}_{\text{friction}}$	Measured transit time through friction material ($T^{\text{s}}_{\text{total}} - T^{\text{s}}_{\text{offset}} - T^{\text{s}}_{\text{plate}}$), in seconds (s)
$V^{\text{s}}_{\text{friction}}$	Velocity of shear wave in friction, in milliseconds (ms)
$V^{\text{s}}_{\text{plate}}$	Constant (3228), velocity through standard pressure plate, in milliseconds (ms)
$\rho_{\text{normalized}}$	1, in kilograms per cubic meter (kg/m^3)

5. EQUIPMENT

The test equipment needs to be capable of meeting the specifications indicated on Table 1.

Table 1 - Minimum test system capabilities and specifications

Parameter	Minimum requirement or capability
Micrometer (or other means of measuring pad thickness)	± 0.03 mm.
Ultrasonic pulse signal generator	Repeated pulses equal to or less than $0.2 \mu\text{s}$ in width and of sufficient amplitude to generate an averaged waveform with defined peaks and valleys at the receiver output.
Waveform digitizer and display	Acquisition sampling rate at least 50 MHz, ability to display waveforms in real-time, have automatic or manual peak detection, signal averaging (50 times minimum), and automatic time-of-flight measurement capability. Timing precision of ± 10 nanoseconds.
Coupling load fixture	The coupling load test fixture must be capable of supplying and monitoring up to 1000 N (220 pounds) of compressive load to the samples and of maintaining the polarization of the ultrasonic sensors to better than ± 5 degrees. The precision of the load fixture should be ± 20 N (5 pounds). For shear wave transducers, the direction of polarization as is indicated on the sensors. The fixture must allow for rotation of each sensor (about the propagation direction) to ensure that the polarization of the sensors are co-linear.
Ultrasonic shear sensors (N=2)	The shear wave transducers must be linearly polarized with polarization clearly marked. They must operate with a center frequency in the range from 1 to 5 MHz and have a 10 dB bandwidth greater than 80%, and have an active piezoelectric element.
Optional: Software for waveform analysis and obtaining friction time-of-flight ($T_{\text{friction}}^{\text{S}}$)	
Propagation timing standard (calibration block)	With known shear wave transit time of ± 5 nanoseconds.
Sensor concentricity relative to each other	Less than 0.5 mm.

5.1 Facilities

Test facility capable of maintaining test equipment.

5.2 Test stand verification

Verify the measurement capability of the test stand using with the following items:

- Appropriate checklists to verify features, functionality, and specifications (full scales, accuracies, sampling rates, etc.).
- Gage repeatability and reproducibility study with at least ten preselected brake pads and at least three operators, with three repeats each.

5.3 Test Stand Condition

All test equipment, fixtures, and samples shall be inspected prior to use. Nicks, burs, corrosion, or contamination on any contacting surfaces can cause variation in the test equipment that can exceed the intended measurement capability of the test procedure.

5.4 Calibration

- Because of triggering delays in the instrumentation and propagation delays in the piezoelectric sensors, it is necessary to calibrate the system using a test sample where the propagation time is known or measured independently. A propagation timing standard with known shear waves must be accurate to $\pm 0.2 \mu\text{s}$. Stainless steel is recommended for calibration due to its uniform physiochemical properties. The calibration block whose transit time for shear waves has been measured independently should be used and should be 15 to 26 mm in thickness.