



Designation: E 707 – 90 (Reapproved 2002)

Standard Test Method for Skid Resistance Measurements Using the North Carolina State University Variable-Speed Friction Tester¹

This standard is issued under the fixed designation E 707; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the measurement of skid resistance of paved surfaces or laboratory-prepared specimens using the North Carolina State University Variable-Speed Friction Tester.²

1.2 The Variable-Speed Friction Tester (VST) is a pendulum-type tester with a locked-wheel smooth rubber tire at its lower end. A stream of water at a selected water test velocity is directed by a nozzle along the specimen surface in the path of contact between the locked-pendulum tire and the specimen. The friction between the tire and the specimen is measured from the energy lost in the pendulum. The tester is suitable for field tests on pavement surfaces as well as laboratory use (see Note 1).

1.3 The values measured, VSN (variable-speed (tester) number), represent the frictional properties obtained with the apparatus and procedures stated herein and do not necessarily agree or correlate directly with those obtained by other skid-resistance measuring methods.

NOTE 1—Uneven pavement surfaces in the field may provide inaccurate VSN measurements. Extreme care should be taken when using the VST in the field.

1.4 *This standard does not purport to address all of the safety concerns, if any, 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.*

2. Referenced Documents

2.1 ASTM Standards:

¹ This test method is under the jurisdiction of ASTM Committee E17 on Vehicle-Pavement Systems and is the direct responsibility of Subcommittee E17.23 on Surface Characteristics Related to Tire Pavement Slip Resistance.

Current edition approved May 25, 1990. Published July 1990. Originally published as E 707 – 79. Last previous edition E 707 – 79 (1984).

² Mullen, W. G., Whitfield, J. K., Gibson, David, and Matlock, T. L., Highway Research Program Project ERSD 110-76-2, "Implementation for Use of Variable Speed Friction Tester and Small Wheel Circular Track Wear and Polishing Machine," Final Report. Highway Research Program, North Carolina State University, P.O. Box 5993, Raleigh, NC 27650.

E 274 Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire³

E 524 Specification for Standard Smooth Tire for Pavement Skid Resistance Tests³

E 867 Terminology Relating to Traveled Surface Characteristics³

3. Summary of Test Method

3.1 The test apparatus consists of a frame that supports a pendulum arm with a small rim (go-cart) wheel and a smooth, no tread-pattern tire mounted at the lower end of the arm. An adjustable nozzle, mounted on the frame, directs a thin sheet of water at the desired water test velocity that impinges at a low angle ($3.5 \pm 0.5^\circ$) on the specimen surface. This wets the contact area between the pendulum tire and the specimen.

3.2 The tester is positioned and leveled on a roadway pavement or on a laboratory floor stand that holds specimens such that the pendulum arm, when released from a horizontal position, will swing downward and prior to contact will exchange potential energy for kinetic energy. The vertical pendulum position is adjusted before each test to provide a specified maximum normal load between the tire and the specimen. The specified load is checked before each test by a strain gage, load cell, or other appropriate instrument. The nozzle pressure regulator is adjusted to give the desired water test velocity at the nozzle exit. With the pendulum arm and pointer in the horizontal starting position, the nozzle valve is opened, and the water stream is directed along the test surface. The pendulum arm is activated by releasing the pendulum trigger. This allows the pendulum arm and tire to swing downward to contact the test surface and swing upward to a stop and start the return swing. On the return swing the operator catches the pendulum and returns the pendulum upward until it latches in the starting position.

3.3 The skid resistance of the specimen is determined from the average of three consistent pointer readings indicated by the upward pendulum swing limit after contacting the specimen. The number indicated by the pointer is equal to 100 sin

³ Annual Book of ASTM Standards, Vol 04.03.

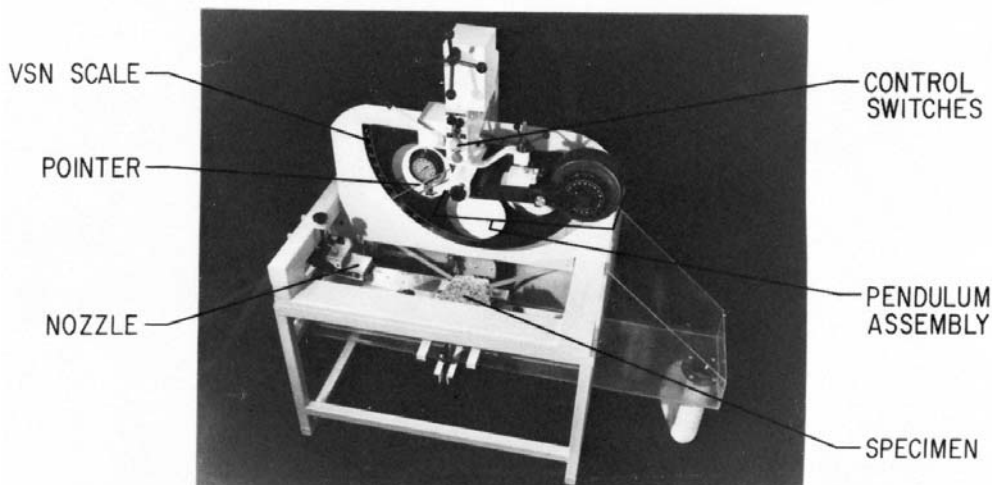


FIG. 1 Variable Speed Friction Tester (VST) Laboratory Setup

θ , where θ is the angle between the upward limit pointer position after the pendulum contacts the specimen in a test and the pointer position when the pendulum is allowed to swing without contacting the specimen.

4. Significance and Use

4.1 The Variable Speed Friction Tester provides a means to measure laboratory or field pavement surface friction properties for simulated vehicle operating speeds.

4.2 Simulated vehicle operating speeds are varied by varying the water speed or velocity as it passes over the specimen or pavement. A variable water-flow rate or velocity corresponds to a variable tire-over-pavement speed in a vehicle-operation sense.

4.3 Measurement of friction at various simulated vehicle operating speeds allows the establishment of friction-speed gradients on laboratory specimens or on field pavements.

5. Apparatus²

5.1 *Pendulum* (Fig. 1)—The pendulum, including wheel and tire, shall weigh 9.3 ± 0.2 kg (20.5 ± 0.9 lb). The distance from the pivot axis of the pendulum to the wheel axis shall be 457.0 ± 3.0 mm (18 ± 0.1 in.). Both axes shall be parallel in space. The period of oscillation of the pendulum shall be 1.4 ± 0.2 s.

5.2 *Wheel and Tire*—The tire shall be a smooth, no-pattern tread tire,⁴ conforming to the rubber requirement of Specification E 524, having an approximate 4.10/3.50-5, 90-mm (3.5-in.) tread width. The tire shall be mounted on a suitable 25 by 75-mm (5 by 3-in.) rim.

5.2.1 The tire, inflated to 138 kPa (20 psi), shall be prepared for testing by turning it on a lathe. The tread shall be trued with an appropriate grinding tool to produce a “flat tread surface” or an infinite tread radius. The shoulder shall be beveled to provide a tread width of 75.0 ± 3.0 mm (3 ± 0.1 in.). The tread surface shall be ground to provide a tread surface that feels smooth to the touch and has a dull sheen.

5.2.2 The tire shall be conditioned for test measurements at each new tire position by operating the pendulum against a standard laboratory surface (Note 2) repeatedly until successive friction readings (VSN) do not vary by more than ± 0.5 VSN (Note 3).

NOTE 2—A standard surface can be made using a porous grinding stone. Such a surface should yield VSN readings in the 55 to 65 range.

NOTE 3—Readings on a standard surface will increase initially until the tire position is conditioned at which time the readings will stabilize. As many as 150 tests may be required to condition a tire position.

5.2.3 A change in tire position due to excessive wear shall be made if check measurements against the standard laboratory surface vary consistently by more than ± 1 VSN. Each new tire position shall be conditioned for test measurements following the procedure in 5.2.2.

5.3 *Nozzle*—The nozzle shall have an exit opening of 0.50 ± 0.01 by 75.0 ± 5.0 mm (0.0200 ± 0.0004 by 3.0 ± 0.2 in.) and shall be made of stainless steel or other corrosion-resistant material. The configuration of the nozzle cavity shall be such that the transition from supply hose cross section to nozzle exit cross section shall be as smooth as possible, particularly in the vicinity of the nozzle exit in order to minimize the likelihood of vortex generation and resultant poor exit flow pattern. The surface finish of the nozzle interior in the exit region shall be that obtainable with 600-grit metallurgical polishing paper with soap. The final polishing shall be in the direction of flow.

⁴ A tire suitable for this purpose is available from McCreary Tire & Rubber Co., Indiana, PA.