



SURFACE VEHICLE RECOMMENDED PRACTICE

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Low Speed Enveloping Test with Perpendicular and Inclined Cleats

RATIONALE

This technical report is being Stabilized because it covers technology which is mature and not likely to change in the foreseeable future.

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1. SCOPE

This SAE Recommended Practice describes a test method for measuring the forces and moments generated at a spindle when a tire rolls over a rectangular obstacle, cleat, at very low speed. The cleat used in a particular test condition is configured with its crest either perpendicular, 90 degrees, to the path of the tire or optionally with its crest inclined at an angle to the path of the tire. The carriage to which the spindle is attached is rigidly constrained in position during each test condition so as to provide a good approximation to fixed loaded radius operation. The method discussed in this document provides cleat envelopment force and moment and tire angular position histories as functions of distance traveled. These histories are essentially free from variations due to tire non-uniformities. The method applies to any size tire so long as the equipment is properly scaled to conduct the measurements for the intended test tire. The data are suitable for use in determining parameters for road load models and for comparative evaluations of the measured properties in research and development.

NOTE: Herein, road load models are models for predicting forces applied to the vehicle spindles during operation over irregular surfaces, paved or otherwise. Within the context of this document, forces applied to the road or terrain surface are not considered.

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 J2047 Tire Performance Technology

SAE J2429 Free-Rolling Cornering Test for Truck and Bus Tires

SAE J2710 Modal Testing and Identification of Lower Order Tire Natural Frequencies of Radial Tires

SAE J2730 Dynamic Cleat Test with Perpendicular and Inclined Cleats

Marshall, K., Phelps, R., Pottinger, M., and Pelz, W., "The Effect of Tire Break-In on Force and Moment Properties," SAE Technical Paper 770870, 1977, <https://doi.org/10.4271/770870>.

Pottinger, M. and Marshall, K., "The Effect of Tire Aging on Force and Moment Properties of Radial Tires," SAE Technical Paper 810066, 1981, <https://doi.org/10.4271/810066>.

2.1.2 Rubber Manufacturers Association Publications

Available from Rubber Manufacturers Association, 1400 K Street, NW, Suite 900, Washington, DC 20005, Tel: 202-682-4800, www.rma.org.

OSHA Standard 1910.177 Servicing Multi-piece and Single Piece Rim Wheels (Available in wall chart form as #TTMP-7/95)

2.1.3 ISO Publications

Copies of these documents are available online at <http://webstore.ansi.org/>.

ISO Standard 17025 General Requirements for the Competence of Testing and Calibration Laboratories

3. DEFINITIONS

The definitions that follow are of special meaning in this document and are either not contained in other Recommended Practices or are worded somewhat differently in this practice.

3.1 THE PARALLEL AXIS TIRE COORDINATE SYSTEM

This system is defined in SAE J2710 and extended in SAE J2730 to allow tire rotation. For axes definitions and associated geometry, please see SAE J2730.

3.2 THE TIRE FORCES AND MOMENTS

This set of spindle centered forces and moments is fully defined in SAE J2730.

3.3 TEST

A Test is execution of the procedure described in this document one time on one tire at a single set of conditions.

3.4 TEST PROGRAM

A Test Program is a designed experiment involving a set of the tests described in this practice.¹

4. NOMENCLATURE

Table 1 lists the symbols used in this document. For further information on items not in Section 4 of this practice, please see SAE J2047.

Table 1 - Symbols defined

Symbol	Defined Term
D	Distance Traveled
$F_{X''}$	Parallel System Longitudinal Force
$F_{Y''}$	Parallel System Lateral Force
$F_{Z''}$	Parallel System Normal Force
Φ	Angular Displacement of Tire
$M_{X''}$	Parallel System Overturning Moment
$M_{Z''}$	Parallel System Aligning Moment
R_l	Tire Loaded Radius
R_{lmax}	Maximum R_l Expected During Test Machine Use
V	Test Velocity

5. LABORATORY QUALITY SYSTEM REQUIREMENT

The laboratory performing the procedures specified in this document shall have a quality system either conforming to ISO 17025 or which can be shown to be functionally equivalent to ISO 17025. The elements of such a system are assumed below and are not, therefore, specifically called out within this practice.

¹ There are many experimental possibilities: repeated tests of the same tire, tests of the same tire under multiple test conditions, tests of tires with different specifications (design details), application of this test as part of a series of different tests, etc.

6. APPARATUS

The required apparatus consists of a test machine with a test surface (round or flatbed) capable of rolling test tires over at least a quarter revolution prior to cleat envelopment, as defined in the test conditions, 10.4. It is preferable that the apparatus allow at least a full tire revolution before cleat envelopment starts. This would allow the relaxation phenomena to become complete.

The test surface shall allow mounting of rectangular cleats, one at a time, as specified in this practice. The machine shall have an instrumented spindle capable of measuring three forces (F_x , F_y , and F_z) and two moments (M_x and M_z) developed during tire envelopment of the cleat. Additionally, the relative displacement of the spindle with respect to the test surface in the X"-Axis direction, D , and the tire angular displacement, Φ , about the spindle shall be measured during envelopment using absolute encoders. The speed of travel during envelopment does not have to be constant due to the angular displacement measurements that are taken. Figure 1 is a schematic of both common machine types: a round test surface (drum) and a plank. Appropriate data acquisition equipment is considered to be part of the apparatus. The space housing the loading machine is also considered to be part of the apparatus.

6.1 Environmental Vibration and Isolation

Cleat envelopment generates significant forces. The instrumented spindle will respond to force signals regardless of whether they reach it directly from the tire/wheel system, as is desired, or, as environmental noise, from a source in the laboratory environment through the floor and then the machine frame.

The machine's planned environment should be tested for significant structure borne vibration arising from the laboratory environment prior to installation.² If the vibration found is insignificant from the standpoint of this document, the machine can be mounted on a normal foundation. If significant environmentally associated vibrations are discovered, which will affect results, either follow the mitigation practices described in SAE J2730 or filter the data suitably so as to suppress spurious results due to environmental vibration.

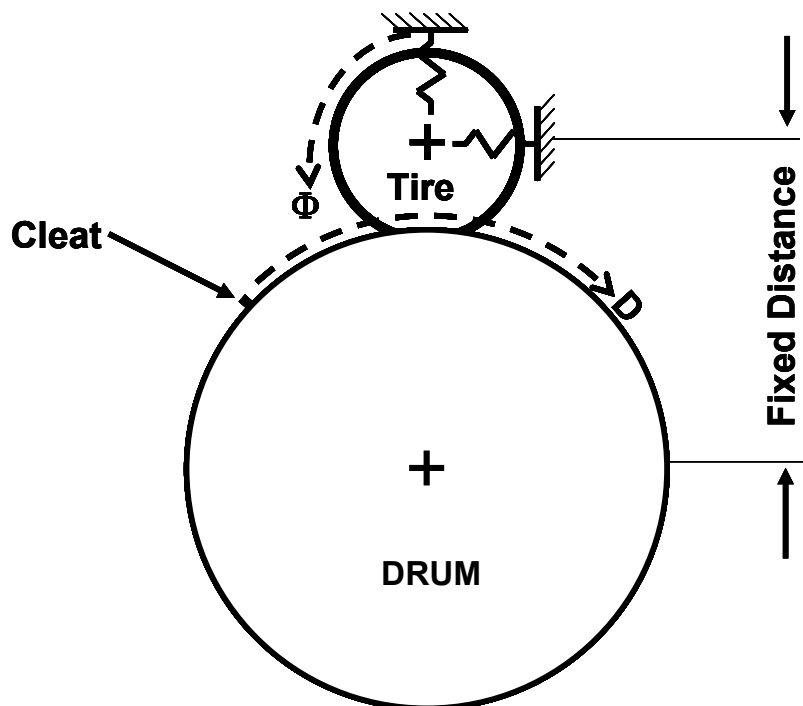


Figure 1A - Round test surface or drum machine

² Significance is a judgment that should be made by a competent expert in machine isolation.