



SURFACE VEHICLE RECOMMENDED PRACTICE

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Tests to Define Tire Size (Geometry), Mass, Inertias

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 trio of test methods which determine basic tire size (geometry), mass, and moments of inertia. The methods apply to any tire so long as the equipment is properly scaled to conduct the measurements for the intended test tire. The data are suitable for 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 unpaved. Within the context of this Recommended Practice, forces applied to the surface on which the tire is operating are not considered.

1.1 Procedures

Three procedures are specified. The first procedure determines the tire's undeflected radius, section width, and section height. The second determines the mass of the tire and of the wheel on which the tire is mounted. The third procedure determines moments of inertia about the three Cartesian axes defined in Recommended Practice SAE J2710.

1.2 Test Machines

No specific purpose-built test machines are required to use the procedures in this Recommended Practice although individual test laboratories may have specific purpose built test machines for making certain measurements, for example, inertias. Each procedure can be applied using an ensemble of jigs and tools specific to itself. Example tools and jigs adequate for each procedure are specified within the Required Measurement Tools section of the description of each specific procedure.

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 770870 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>.

SAE 810066 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 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

ASTM F1502-05(2010) Standard Test Method for Static Measurements on Tires for Passenger Cars, Light Trucks, and Medium Duty Vehicles

2.1.3 OSHA Publications

Available from U.S. Department of Labor/OSHA, 200 Constitution Avenue, Washington, DC 20210, Tel: 800-321-6742, www.osha.gov/pls/publications/pubindex.list.

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

2.1.4 ISO Publications

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

ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories

2.1.5 FMVSS Publications

Available from U.S. Department of Transportation, National Highway Traffic Safety Administration, Office of Communications and Consumer Information (NPO-502), 400 Seventh St., SW, Washington, DC 20590.

FMVSS 139 New Pneumatic Radial Tires for Light Vehicles

3. DEFINITIONS

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

3.1 WHEEL

A wheel is a rim together with the disc or spider that allows attachment of a rim to the vehicle's hubs. A wheel cross-section schematic is shown in Figure 1.

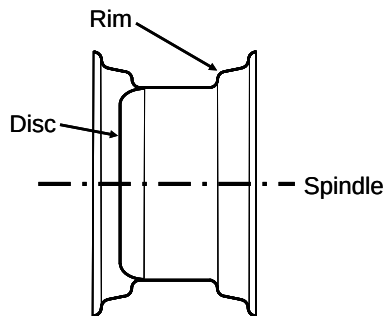


Figure 1 - Wheel cross-section

3.2 MOMENTS OF INERTIA

The moments of inertia are defined in the double primed axis system introduced in SAE J2710. Figure 2 shows the SAE J2710 axis system for the special case of no camber or inclination. That case applies in this Recommended Practice. The wheel is sketched in rear elevation. The view is forward along the X'' - axis looking at the Y'' - Z'' plane. The system's origin is at the point that the spin axis intersects the wheel plane, which is the plane halfway between the rim flanges (SAE J2047). The system is a right-handed, orthogonal, Cartesian system. The X'' and Z'' axes lie in the wheel plane. The Y'' - axis is to the right. If the tire is mounted with the tire face to the right, as if it were on the right side of a vehicle, Y'' is outward.

3.2.1 Wheel Moments of Inertia

3.2.1.1 Wheel Moment of Inertia about the Y'' - Axis

This is the moment of inertia of the wheel alone about the Y'' - Axis.

3.2.1.2 Wheel Moment of Inertia about the Z'' - Axis

This is the moment of inertia of the wheel alone about the Z'' - Axis. The moment of inertia of the wheel about the X'' - Axis is the same due to wheel symmetry.

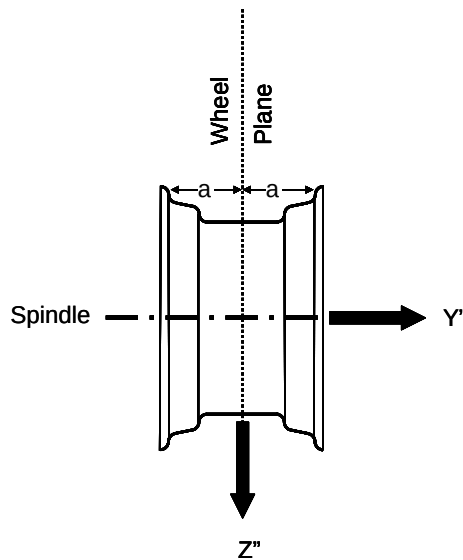


Figure 2 - Rear elevation view of the double primed axis system

3.2.2 Tire Moments of Inertia

3.2.2.1 Tire Moment of Inertia about the Y'' - Axis

This is the moment of inertia of the tire alone about the Y'' - Axis.

3.2.2.2 Tire Moment of Inertia about the Z'' - Axis

This is the moment of inertia of the tire alone about the Z'' - Axis. The moment of inertia of the tire about the X'' - Axis is the same due to tire symmetry.

NOTE: The moments of inertia about the X'' and Z'' axes are not necessarily identical to those about axes through the center of gravity of the tire-wheel assembly. This is due to a possible offset of the c.g. from the origin of the X'', Y'', Z'' Axis System along the Y'' - Axis. This offset, when present, arises from an offset wheel disc and tire asymmetries and requires application of the parallel-axis theorem, which is applied in 13.5, and is discussed in all engineering dynamics books, as noted in Footnote 7.

3.2.3 Masses

3.2.3.1 Wheel Mass

This is the mass of the wheel alone in the absence of a tire.

3.2.3.2 Tire Mass

This is the mass of the tire alone in the absence of a wheel.

3.3 Tire Undeformed Radius

This is one-half of the Tire Overall Diameter as defined in SAE J2047.

3.4 Test

A test is execution of the procedures described in this Recommended Practice one time on one tire at a single set of test conditions.

3.5 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_T	Y" offset of the tire c.g. from the X"/Z" - plane
d_W	Y" offset of the wheel c.g. from the X"/Z" - plane
d_{WT}	Y" offset of the wheel/tire c.g. from the X"/Z" - plane
d	Unspecified Y" offset of the c.g. from the X"/Z" - plane
k	Stiffness of Torsional Pendulum
I_C	A Calibration Inertia for the Torsional Pendulum
I_0	Residual Inertia of Torsional Pendulum
I_{Y_T}	Tire Inertia about the Y" - Axis
I_{Z_T}	Tire Inertia about the Z" - Axis
I_{Y_W}	Wheel Inertia about the Y" - Axis
I_{Z_W}	Wheel Inertia about the Z" - Axis
M_T	Tire Mass
M_W	Wheel Mass
M_{IT}	Inner Tube Mass
p	Inflation Pressure
R_0	Tire Undeformed Radius
σ	Standard Deviation (Note Subscripts)
SH	Section Height
SW	Section Width
T	Period of Oscillation

NOTE 1: If mass, Y" offset of the c.g., or inertia appears with the subscript, WT; this signifies that the entire tire/wheel assembly is being considered.

NOTE 2: The period of oscillation may appear with a subscript indicating the state of the torsional pendulum when the data are taken. For example, T_0 would be the period if the only inertia present were the residual inertia.

5. LABORATORY QUALITY SYSTEM REQUIREMENT

The laboratory performing the procedures specified in this Recommended Practice shall have a quality system either conforming to ISO/IEC 17025 or which can be shown to be functionally equivalent to ISO/IEC 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.