



SURFACE VEHICLE RECOMMENDED PRACTICE

J1987™

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Force and Moment Test Method

RATIONALE

Committee recommends to stabilize the document. Auto and tire manufacturers are running their own force and moment methods so there seem to be no users of the document. However, if the Committee determines in the future that by revising the method more users could be attracted to use it then the document can be brought out of stabilization for revision.

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Documents

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1. **Scope**

- 1.1 This SAE Recommended Practice describes the determination of passenger car and light truck tire force and moment properties on a belt-type flat surface test machine. It is suitable for accurately determining five tire forces and moments in steady-state under free-rolling conditions as a function of slip angle and normal force which are incrementally changed in a given sequence.
- 1.2 Heavy-duty tires are not considered in this document, because the measuring system would have force and moment ranges too large to meet sensitivity requirements for passenger and light truck tire force and moment measurements. A standard for heavy-duty truck tires would have many of the same features as this document, but the measuring system, would have to be extensively altered.
- 1.3 Inclination angle combined with slip angle, pull forces, and any combination with spindle torque are not considered in this document. Standards needed for these topics will be considered separately.
- 1.4 The test method described in this document is suitable for comparative evaluations of tires for research and development purposes. The method is also suitable for use in manufacturing quality control and vehicle dynamics modeling.
- 1.5 The values of tire forces and moments obtained on the test machine defined in the procedure outlined can be correlated with similar test machines using the procedure defined in this document.

2. **References**

- 2.1 **Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

- 2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001

SAE J670—Vehicle Dynamic Terminology

SAE 760029—"Effects of Test Speed and Curvature on Cornering Properties of Tires", M.G. Pottinger, K.D. Marshall, E.A. Arnold

SAE 770870—"The Effect of Tire Break-In on Force and Moment Properties", K.D. Marshall, R.L. Phelps, M.G. Pottinger, W. Pelz

SAE 810006—"The Effect of Tire Aging on the Force and Moment Properties of Radial Tires", M.G. Pottinger, K.D. Marshall

2.1.2 TIRE AND RIM ASSOCIATION PUBLICATIONS—Available from Tire and Rim Association, Coply, OH 44321-2793.

Tire and Rim Association Yearbook

2.1.3 Other Publications

M.G. Pottinger, Tire/Vehicle Pull; "Ply Steer Effects", Clemson University Tire meeting, October 1988.

3. **Definitions**—These terms follow the definitions given in [SAE J670] and in the [TRA Yearbook].

3.1 **Aligning Stiffness**—First derivative of aligning moment of a free-rolling tire with respect to slip angle, evaluated at zero slip angle. For practical purposes, aligning stiffness may be approximated by subtracting the -1 degree slip angle value of the aligning moment from the $+1$ degree slip angle of aligning moment and dividing by 2.

3.2 **Aligning Stiffness Coefficient**—Ratio of aligning stiffness to the absolute value of normal force.

3.3 **Aligning Moment**—Moment about the Z' axis acting on the tire by the road. The aligning moment is shown in Figure 1. The aligning moment shown in Figure 1 is positive.

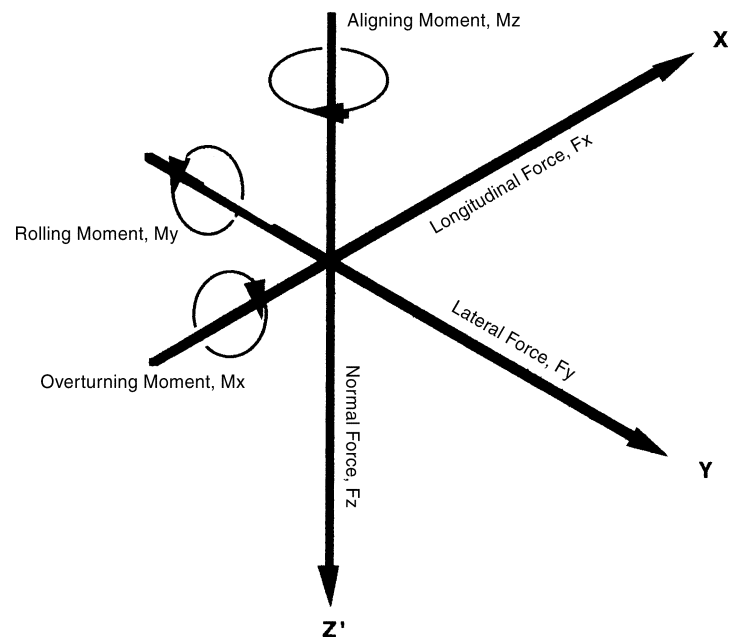


FIGURE 1—TIRE AXIS SYSTEM

3.4 **Aligning Moment Offset**—Average aligning moment of a free straight-rolling tire. The aligning moment offset is dependent on the direction of tire rotation. It is different, generally speaking, in left and right tire rotation. [see 2.1.3.]

3.5 **Center-of-Tire-Contact**—Intersection of the wheel plane and the normal projection of the spin axis onto the road plane. The center-of-tire contact is the origin of the tire axis system shown in Figure 1.

- 3.6 Cornering Stiffness**—Absolute value for the first derivative of the lateral force of the free-rolling tire with respect to slip angle, evaluated at zero slip angle. For practical purposes, cornering stiffness may be approximated by taking the absolute value of the quantity yielded by subtracting the +1 degree slip angle value of the lateral force from the -1 degree slip angle value of the lateral force and dividing by 2.
- 3.7 Cornering Stiffness Coefficient**—Ratio of cornering stiffness to the absolute value of normal force.
- 3.8 Free-Rolling Tire**—Loaded rolling tire operating without application of driving or braking torque.
- 3.9 Inclination Angle**—Angle between the X'—Z' plane and the wheel plane. Figure 2 shows a positive inclination angle. The X' axis is into the paper.

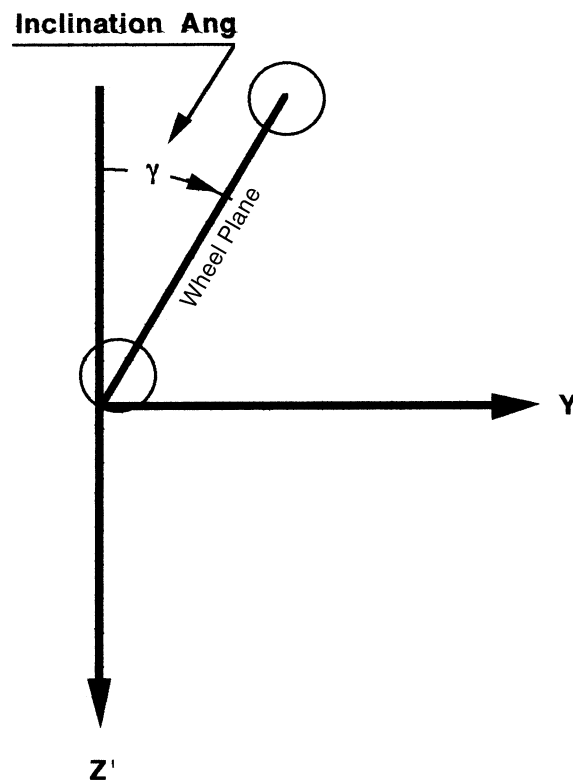


FIGURE 2—INCLINATION ANGLE

- 3.10 Lateral Force**—Component of the tire force vector in the Y' direction acting on the tire by the road. Lateral force is shown in Figure 1. The lateral force shown in Figure 1 is positive.
- 3.11 Lateral Force Offset**—Average lateral force of a free straight-rolling tire. The lateral force offset is dependent on the direction of tire rotation. The direction of tire rotation may be taken as either left or right. [2.1.3]
- 3.12 Left Rotation**—Operation of the tire on the left side of the vehicle moving forward, with the tire face to the left.
- 3.13 Loaded Radius**—Distance from the wheel center to the center-of-tire contact measured in the wheel plane.
- 3.14 Longitudinal Force**—Component of the force vector in the X' direction acting on the tire by the road. Positive longitudinal force is shown in Figure 1.