



SURFACE VEHICLE RECOMMENDED PRACTICE

J1988™

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Residual Aligning Moment Test

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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Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board format.

1. **Scope**—This SAE Recommended Practice describes the determination of tire pull force properties for an uninclined tire (SAE J670e) on a laboratory flat surface tire force and moment machine. It is suitable for accurately determining pull forces and residual aligning moments for passenger and light-truck tires. These properties are important determinants of vehicle trim (See section 2.1.2). They describe steady-state, free-rolling pull effects ascribable to tires.

The test method described in this document is suitable for comparative evaluation of tires for research and development purposes. The method is also suitable for modeling when followed carefully.

2. References

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

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

SAE J670e—Vehicle Dynamics Terminology

- 2.1.2 TIRE SCIENCE AND TECHNOLOGY—Available from The Tire Society, P.O. Box 1502, Akron, OH 44309-1502

Tire/Vehicle Pull: An Introduction Emphasizing Plysteer Effects, M.G. Pottinger, TSTCA, Vol 18, No 3, July-September, 1990

3. **Definitions**—The definitions which follow are of special meaning in this document and may be worded somewhat differently from those in SAE J670e for instructional reasons. Other definitions which are used, including the tire axis system, are found in SAE J670e.

The symbology used in this document was chosen for convenient use in computer programming.

3.1 Aligning Moment Characteristics

- 3.1.1 AL0—*Aligning Moment at Zero Slip Angle* for the Straight Free Rolling Tire Operating in Left Rotation.

- 3.1.2 AP—*Plysteer Aligning Moment* is an Aligning Moment for the Straight Free Rolling Tire. It is the average of the Aligning Moments at Zero Slip Angle in Left and Right Rotations. It does not change direction with respect to the Tire Axis System when the Tire Direction of Rotation is reversed.
- 3.1.3 AR0—*Aligning Moment at Zero Slip Angle* for the Straight Free Rolling Tire Operating in Right Rotation.
- 3.1.4 AS—*Aligning Stiffness* is the average of the Aligning Stiffnesses of the Free Rolling Tire in Left and Right Rotations.
- 3.1.5 ASL—*Aligning Stiffness in Left Rotation* is the first derivative of the Aligning Moment of the Free Rolling Tire with respect to Slip Angle determined at Zero Slip Angle, Zero Inclination Angle, and Zero Path Curvature with the Tire rotating in Left Rotation.
- 3.1.6 ASR—*Aligning Stiffness in Right Rotation* is the first derivative of the Aligning Moment of the Free Rolling Tire with respect to Slip Angle determined at Zero Slip Angle, Zero Inclination Angle, and Zero Path Curvature with the Tire rotating in Right Rotation.
- 3.1.7 CRAT—*Conicity Residual Aligning Moment (Torque)* is the Residual Aligning Moment Component in Right Rotation which separates the tire's Residual Aligning Moment from that due to Plysteer alone. CRAT changes sign with respect to the Tire Axis System when the direction of Tire Rotation is reversed.
- 3.1.8 PRAT—*Plysteer Residual Aligning Moment (Torque)* is the Aligning Moment of a tire without Conicity existing when the Lateral Force of a tire without Conicity is zero. PRAT does not change sign with respect to the Tire Axis System when the direction of Tire Rotation is reversed.

The Aligning Moment curve of a tire without Conicity is obtained by averaging the Left and Right Rotation curves for Aligning Moment.

- 3.1.9 RATL—*Residual Aligning Moment (Torque) in Left Rotation* is the Aligning Moment of the tire operating in Left Rotation which exists when the tire's Left Rotation Lateral Force is zero.
- 3.1.10 RATR—*Residual Aligning Moment (Torque) in Right Rotation* is the Aligning Moment of the tire operating in Right Rotation which exists when the tire's Right Rotation Lateral Force is zero.

3.2 Lateral Force Characteristics

- 3.2.1 CLF—*Conicity Lateral Force* is the Lateral Force at Zero Slip Angle in Right Rotation minus the Plysteer Lateral Force. Conicity Lateral Force changes direction with respect to the Tire Axis System, but not the Tire Face, due to a change in Tire Direction of Rotation.
- 3.2.2 CS—*Cornering Stiffness* is the average of the Cornering Stiffnesses of the tire in Left and Right Rotations.
- 3.2.3 CSL—*Cornering Stiffness in Left Rotation* is the absolute value of the first derivative of the Lateral Force with respect to Slip Angle determined at Zero Slip Angle, Zero Inclination Angle, and Zero Path Curvature with the Tire rotating in Left Rotation.
- 3.2.4 CSR—*Cornering Stiffness in Right Rotation* is the absolute value of the first derivative of the Lateral Force with respect to Slip Angle determined at zero Slip Angle, Zero Inclination Angle, and Zero Path Curvature with the Tire in Right Rotation.
- 3.2.5 LL0—*Lateral Force at Zero Slip Angle* for the Straight Free Rolling Tire Operation in Left Rotation.
- 3.2.6 LR0—*Lateral Force at Zero Slip Angle* for the Straight Free Rolling Tire Operating in Right Rotation.

- 3.2.7 PLF—*Plysteer Lateral Force* is the Lateral Force for the Straight Free Rolling Tire which is the average of the Lateral Forces at Zero Slip Angle, Zero Inclination Angle, and Zero Path Curvature in Left and Right Rotations. It changes direction with respect to the Tire Face, but not the Tire Axis System, when the direction of Tire Rotation is reversed.

The Lateral Force curve of the tire without Conicity is obtained by averaging the Left and Right Rotation curves for Lateral Force.

- 3.2.8 PRLF—*Plysteer Residual Lateral Force* is the Lateral Force of a tire without Conicity existing when the Aligning Moment of a tire without Conicity is zero.

3.3 Rotation Sense

- 3.3.1 LR—*Left Rotation* is operation of the Tire in counterclockwise rotation when the Tire Face is being viewed. A normally mounted tire on the left side of a vehicle moving forward operates in Left Rotation.
- 3.3.2 PR—*Right Rotation* is operation of the Tire in clockwise rotation when the Tire Face is being viewed. A normally mounted tire on the right side of a vehicle moving forward operates in Right Rotation.
- 3.3.3 TF—*Tire Face* is the outwardly directed side of a tire mounted on a vehicle in accordance with the vehicle or tire manufacturer's specification or general practice.

In the case of directional tires, the side facing outward on the right side of the vehicle with the tire operating in the proper sense of rotation is taken as the Tire Face.

3.4 Table 1—Symbols

TABLE 1—SYMBOLS

SAE J1988	Defined Term
AL0	Aligning Moment at zero Slip Angle in Left Rotation
AP	Plysteer Aligning Moment
AR0	Aligning Moment at zero Slip Angle in Right Rotation
AS	Aligning Stiffness
ASL	Aligning Stiffness in Left Rotation
ASR	Aligning Stiffness in Right Rotation
CLF	Conicity Lateral Force
CRAT	Conicity Residual Aligning Moment
CS	Cornering Stiffness
CSL	Cornering Stiffness in Left Rotation
CSR	Cornering Stiffness in Right Rotation
F _x	Longitudinal Force
F _y	Lateral Force
F _z	Normal Force
IA (γ)	Inclination Angle
LL0	Lateral Force at zero Slip Angle in Left Rotation
LR	Left Rotation
LR0	Lateral Force at zero Slip Angle in Right Rotation
M _x	Overturning Moment
M _z	Aligning Moment
PLF	Plysteer Lateral Force
PRAT	Plysteer Residual Aligning Moment