



Tires/Wheels Mass Moment of Inertia

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The purpose of this standard is to describe the method for determining the mass moment of inertia of tires, wheels, and assemblies about the spin and steer axis using the torsional pendulum table.

1.2 Applicability. The discussion in this procedure is restricted to controlled laboratory tests on passenger car, light truck, and compact spare tires.

1.3 Remarks.

1.3.1 Mass moment of inertia data is used in such applications as vehicle coast down analysis, brake system design, chassis design, and vehicle dynamic/performance simulations.

1.3.2 The mass moment of inertia values of interest includes spin axis and steer axis mass moment of inertia for tires, wheels, and assemblies.

1.3.3 The basic methods of mass moment of inertia testing involves placing an object on the torsional pendulum table platen and displacing the platen in either the Clockwise (CW) or Counterclockwise (CCW) direction, 5 degrees from the center (at rest) position, and then releasing the platen. The period of oscillation is measured to calculate the mass moment of inertia.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW16590

3 Resources

3.1 Facilities. A test lab with appropriate space for equipment as per 3.2.

3.2 Equipment.

3.2.1 Instrumentation for measuring periods of oscillation (Appendix A Figure A1).

3.2.2 A torsional pendulum table (Appendix A, Figure A2).

3.2.3 A fixture to support the test object for steer axes measurements (Appendix A, Figure A3).

3.2.4 Equivalent types of equipment can be used.

3.3 Test Vehicle/Test Piece. The test piece can be a compact spare, passenger car, or a light truck tire assembly, or a wheel.

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3.4 Test Time.

Calendar time: 1 day
 Test time: 25 hours
 Coordination time: 1 hour

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Test technician shall be qualified on the basis of appropriate education, training, experience, and/or demonstrated skills.

4 Procedure

4.1 Preparation. Mount tires on usage width wheels and inflate to standard pressures as indicated in Appendix B, Table B1.

4.1.1 Tires and assemblies need to be mounted, inflated, and conditioned to the test temperature for at least 24 hr.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.

4.3.1 Run a control object to monitor the torsional pendulum table performance. The control object results should be plotted against time. Corrective action should be taken after any control object tests that exceed out of control, control object limits.

4.3.2 Install tire/wheel assembly or other parts to be measured onto the torsional pendulum table platen.

Note: Care should always be taken when working with this equipment, because of the fragile components.

4.3.2.1 The mass moment of inertia for the steer axis of tires, wheels, and assemblies is measured about the geometric center of those objects.

4.3.3 Stop all motion of the platen.

4.3.4 Displace the platen in either CW or CCW direction, approximately 5 degrees and then release. Data will be averaged over several periods of oscillations. The difference between the CW and CCW measurement should not be more than 0.001 s, if they are, the measurements should be repeated.

4.3.5 Record the mass moment of inertia data on the Appendix C, Data Sheet C1.

5 Data**5.1 Calculations.**

5.1.1 Determine the period of oscillation of the mass moment of inertia test object and table.

5.1.2 Compute the inertia of a test object by using the following equation:

$$I_{\text{object}} = m \times T^2 + b \quad (\text{Equation 1})$$

Where:

T = Period of oscillation.
m = Calibrated coefficient.
b = Calibrated coefficient.

5.1.3 The basis for the equation is from a single degree of freedom sprung inertia model. The period of oscillation for such a system is given by:

$$T = 2\pi \times \sqrt{\left(\frac{I_{\text{total}}}{K}\right)} \quad (\text{Equation 2})$$

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Where:

k = Stiffness of the rotational spring.

Since the inertia in this equation includes both the test object and the test table, these inertias must be separated in the equation:

$$I_{\text{total}} = I_{\text{object}} + I_{\text{table}} \quad (\text{Equation 3})$$

Solving Equation 2 and Equation 3 for I_{object} gives an equation in the same form as Equation 1.

5.1.4 The coefficients (m and b) of Equation 1 can be found by measuring a series of known inertias.

5.2 Interpretation of Results.

5.2.1 A wheel or tire/wheel assembly spin axis mass moment of inertia is determined directly by placing the test piece on the platen and then taking an inertia measurement.

5.2.2 Tire spin axis mass moment of inertia is determined indirectly by subtracting wheel spin inertia from assembly spin inertia.

5.2.3 A wheel or tire/wheel assembly steer axis mass moment of inertia is determined indirectly by placing the test piece on the platen with a fixture and then taking inertia measurements of the wheel or assembly plus fixture and of the fixture only. The steer inertia is then the wheel and fixture inertia minus the fixture inertia.

5.2.4 The tire steer axis mass moment of inertia is determined indirectly by subtracting the wheel steer inertia from the assembly steer inertia.

5.3 Test Documentation. The test results documentation should include the following:

- Test results report.
- Completed data sheets.

Sample data sheets are given in Appendix C, Data Sheet C1 and Appendix D, Data Sheet D1.

Note: For data being loaded into the Global Tire-Wheel Test System (GTWTS), submit electronically the test results data Extensible Markup Language (XML) files format and other supporting files listed above. GMW16590 defines the electronic file details (e.g., file types, file naming convention, and detailed file formats) for the GTWTS.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes**7.1 Glossary.**

Light Truck and Commercial Tire: Refers to the tire type, not the vehicle application. Light truck and commercial tires are intended primarily for use on load bearing or multi-purpose vehicles.

Mass Moment of Inertia: The mass moment of inertia is the integral of $r^2 dm$, where r is the perpendicular distance of the mass element, dm , from an axis of interest and the integration is over the entire body.

Passenger Car Tire: Refers to the tire type, not the vehicle application. Passenger car tires are intended primarily for use on passenger vehicles. However, these tires may also be used on light truck and multi-purpose vehicles.

Period: The time (in seconds) for a single oscillation of the torsional pendulum table platen.

Platen: The surface area of the torsional pendulum table where the part to be tested is mounted and centered.

Spin Axis Mass Moment of Inertia: The mass moment of inertia about the rotational axis of a tire, wheel or assembly.

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