



Tire Impact Response

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. This standard is written to describe, in general terms, the tire testing method required to evaluate a tire component against specified ride performance criteria for impact response. The specific criteria is in terms of Vertical Band Limited Energy (7 Hz to 17 Hz) (Newtons Root Mean Square (N-rms)), Fore-Aft Band Limited Energy (10 Hz to 50 Hz) N-rms, Vertical and Fore-Aft Peak (Newtons), Vertical and Fore-Aft Damping (percent critical), and Vertical and Fore-Aft Modal Participation/Amplitude (Newtons), as a tire encounters simulated irregular road surfaces.

1.2 Applicability. This standard is restricted to controlled laboratory tests on passenger and light truck tires.

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

2.3 Additional References.

Statement of Requirements (SOR)

3 Resources

3.1 Facilities. Any test facility (General Motors or outside) that is providing data to GM for the Tire Envelopment Test. Any outside testing facilities must have demonstrated an acceptable correlation with GM, prior to submitting data into the test system.

3.2 Equipment.

3.2.1 Equipment required for tire envelopment testing consists of a 1.7 m (67 in) or larger diameter laboratory test dynamometer, as well as the associated controllers and instrumentation as required for the test method in use. The roadwheel is surfaced with 80 grit 3M-ite to provide a surface more representative of highway surfaces.

3.2.2 A roadwheel cleat, built to the cross section dimensions shown in Figure 1, and built to assemble crosswise onto the dynamometer roadwheel, is also required for this test procedure. Assure that the cleat has 100% contact across the drum (a pre-bent cleat producing higher contact pressures at the center of the drum is sometimes used to ensure full contact).

3.2.3 Equipment shall have optical encoders with a minimum of 1024 counts/revolution installed on both tire spindle and roadwheel.

3.2.4 Equipment shall have a force measurement upper limit $\geq F_z$: 20 000 N, F_x : 10 000 N.

3.2.5 Equipment structure should have a minimum first resonance frequency for all channels of 125 Hz, given an inertia mass (metal object) of 25 kg applied to the spindle.

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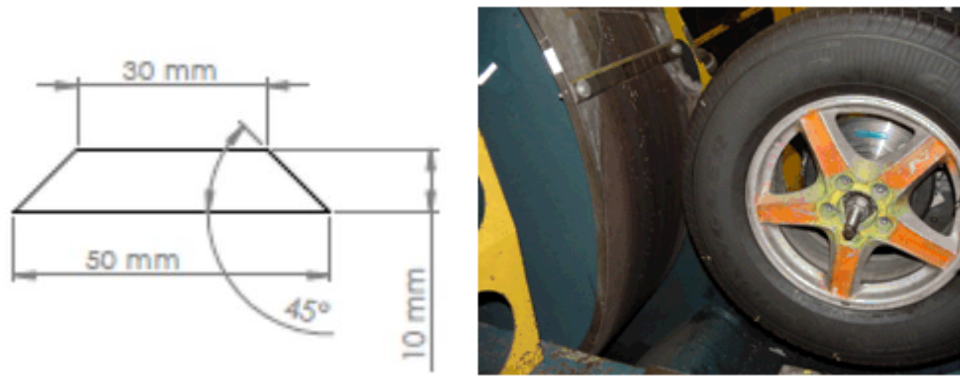


Figure 1: Roadwheel Cleat Dimensions and Illustration

3.3 Test Vehicle/Test Piece. A tire-wheel assembly is required to run a tire envelopment test. The test requester will either specify the exact part number of a wheel they are providing, or specify the width and diameter of the test wheel that they want to be used.

3.4 Test Time.

Calendar time: 1 day
 Test hours: 2 hours
 Coordination hours: 1 hour

3.5 Test Required Information. Required information includes tire size, construction number, load rating, service description, wheel width, test load and test pressure. If a specific wheel is provided, the wheel part number should also be provided. Additional information required may vary by test site.

3.6 Personnel/Skills. Test operator should have adequate training and be familiar with the local operator's procedure.

4 Procedure

4.1 Preparation.

4.1.1 Tires must be mounted on the appropriate wheels (see 3.3).

4.1.2 All tires must be mounted in the proper orientation with respect to the front face of the test wheels. Whitewall tires must be mounted whitewall out with respect to the front face of the wheels. Blackwall tires must be mounted with the cosmetic or intended outboard sidewall mounted out with respect to the front face of the test wheels.

4.1.3 All tires must be balanced and bead seated prior to testing.

4.1.4 Assemblies or individual tires and wheels should be at ambient room temperature ($24.0\text{ }^{\circ}\text{C} \pm 3.0\text{ }^{\circ}\text{C}$) for a minimum of 2 h prior to testing.

4.2 Conditions.

4.2.1 Environmental Conditions. Ambient temperature must be kept at $24.0\text{ }^{\circ}\text{C} \pm 3.0\text{ }^{\circ}\text{C}$. A method for monitoring ambient temperature must be in place.

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.

4.2.2.1 Load and Pressure. Tires must be tested to the load and pressure specified on the test request. The load is most often a two (2) passenger vehicle load. The pressure is most often the cold placard pressure, increased by 20 kPa to reflect the warm pressure requested for the test.

4.2.2.2 Speed. The test speeds used to test tire envelopment are dependent on the roadwheel size. For a roadwheel diameter of 1.7 m, a range of speeds from 10 km/h to 80 km/h in 2.5 km/h increments is used. For a roadwheel diameter ≥ 2.0 m, a range of twenty (20) speeds from 5 km/h to 100 km/h is used. The tire assembly is rotating in the clockwise (CW) direction.

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4.3 Instructions.

4.3.1 Starting the Test.

4.3.1.1 The assembly should always be mounted on the Highway Speed Uniformity (HSU) machine in the standard position, in which the valve stem is aligned with the zero (0) mark on the spindle. If this is not possible because the spindle studs do not line up with the boltholes, the assembly is rotated CW until the studs and boltholes do line up. The angle through which the assembly was rotated is recorded and then used to correct the phase angles of the Fast Fourier Transform (FFT).

4.3.1.2 Minimizing the radial runout is very important to minimize mounting contribution to uniformity. Follow local mounting instructions using expandable collets and other mounting hardware, in order to optimize the centering of the tire/wheel mounting to the machine.

4.3.1.3 The tire is manually set to the specified tire pressure and capped, prior to starting the test.

4.3.1.4 Warm Up. The first step is to warm up the tire. The tire warm up is performed at the test load and pressure and 120 km/h in the CW direction, with no cleat, for 20 minutes.

4.3.1.5 At the end of the warm up, test pressure is adjusted to requested warm pressure. Then data is collected for 8 s or six (6) revolutions at each test speed, without a cleat on the roadwheel.

4.3.1.6 After the warm up and no cleat data collection is completed, the test is stopped just long enough to mount the 10 mm roadwheel cleat to the roadwheel and manually adjust the tire pressure to the specified pressure. The tire must not be removed at this time, between the no cleat data collection and the cleat data collection.

4.3.2 Data Collection.

4.3.2.1 The tire load is stabilized at the specified radial load.

4.3.2.2 The first of the standard speeds is acquired and stabilized.

4.3.2.3 The composite data is then acquired once the tire has reached a steady state condition. Data will be collected for a minimum of 8 s or six (6) revolutions of the roadwheel, whichever is larger. More data may be needed, if required for the correlation of the machine.

4.3.2.4 The speed is then adjusted to the next speed of the set of standard speeds running from 10 km/h to 80 km/h. The speed and load are both adjusted, stabilized, and the load carriage is locked. Repeat 4.3.2.3 and 4.3.2.4 until all speeds have been tested.

4.3.2.5 The specific data signals that need to be collected, are listed in Table 1. The data should be collected for either 8 s or six (6) revolutions of the roadwheel, whichever is larger, at a collection rate of 1024 Hz.

Table 1: Data Signals

Required Signals	Units
Fx (Fore-aft Force)	Newtons
Fy (Lateral Force)	Newtons
Fz (Radial Force)	Newtons
Mx (Moment around X-axis)	Newton·meters
Mz (Moment around Y-axis)	Newton·meters
Roadwheel once per revolution, that gives cleat location	Counts
Roadwheel Position, Roadwheel Encoder Count (0 to 1024)	Counts
Tire/Spindle Position, Tire/Spindle Encoder Count (0 to 1024)	Counts

Note: Cannot feed the multiple encoder pulse trains into an analog input, frequency is in excess of Altered Auditory Feedback (AAF). The multiple encoder pulses go into a counter/timer module.

Note: This test should not include any balance compensating method.

Note: Counter must reset to zero once per revolution (at the z index pulse or equivalent), which allows the counter to indicate position rather than just counts.

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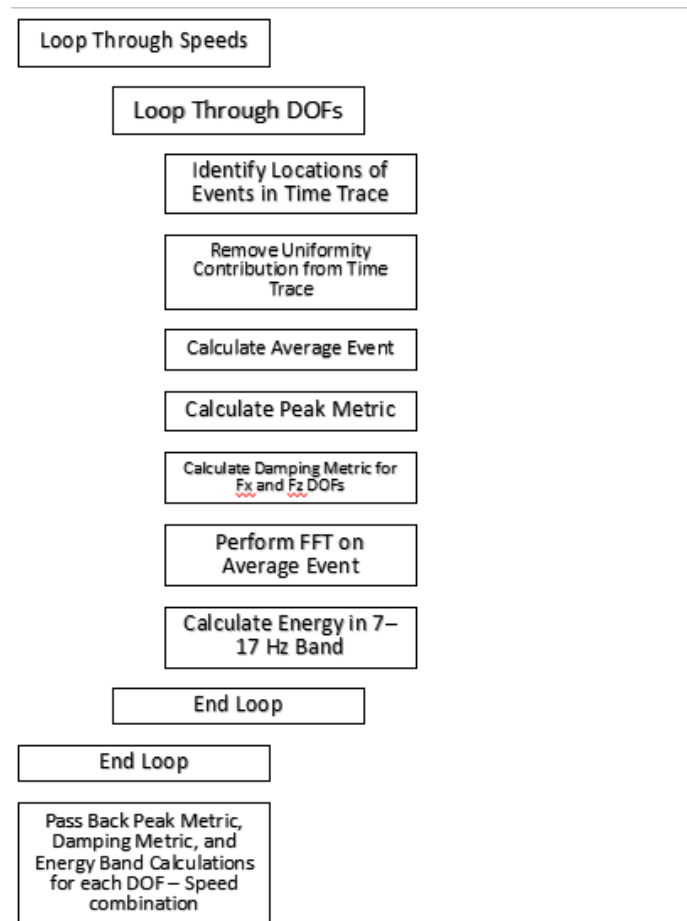
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5 Data

5.1 Calculations. Approved testers will receive a copy of the executable to post process the data. The required format of the raw data, in a Remote Procedure Call (RPC) III file format, is provided in Appendix C. The RPC naming convention is shown in Appendix E. A summary flow chart of the data analysis is provided in Figure 2.



Note: DOF = Degrees of Freedom

Figure 2: Flow Chart of Data Analysis Process

5.2 Interpretation of Results. The measurement results for Vertical Band Limited Energy (7 Hz to 17 Hz) (N-rms), Fore-Aft Band Limited Energy (10 Hz to 50 Hz) N-rms, Vertical and Fore-Aft Peak (Newtons), Vertical and Fore-Aft Damping (percent critical), and Vertical and Fore-Aft Modal Participation/Amplitude (Newtons) shall be compared to the Statement of Requirements (SOR) for the released tire. A Tyre Data Exchange (TYDEX) file format of the results will be required, and will be generated by the supplied executable. The TYDEX files will have the time history, spectra, and the key value pairs. Format is provided in Appendix D.

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

- Test results report (generated by the Global Tire-Wheel Test System (GTWTS) if submitting Extensible Markup Language (XML) files)
- Test result data files (XML format)
- TYDEX file
- Raw data (RPC III format), to be stored at test site

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