



Synthetic Braking

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 define a common process for simulating proving ground braking events in the test laboratory on an inertially-reacted multi-axis road simulator.

1.2 Applicability. This standard can be applied to any inertially-reacted multi-axis road simulator, but is currently intended for implementation on the MTS 329LT and MTS 329PC Road Simulators. This standard documents the overall processing steps, but does not provide the detailed steps for performing the processing. The output files are desired data files suitable for test development on an inertially-reacted multi-axis road simulator. It is assumed that the end user is familiar with the correct utilization of these types of files.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15227

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment. Inertially reacted, and multi-axis, road simulator.

3.3 Test Vehicle/Test Piece. Not applicable.

3.4 Test Time. 1 h to 4 h, depending on volume of data.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Test technician familiar with test facilities and equipment.

4 Procedure

4.1 Preparation. Not applicable.

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. Real-time braking events require stopping distances that would exceed the displacement capability of an inertially-reacted road simulator. In order to facilitate these road events in the test laboratory, the

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real time braking events are replaced with synthetic braking events in which the peak longitudinal forces and peak wheel brake torques are achieved within the displacement constraints of an inertially-reacted multi-axis road simulator.

4.3.1 Brake Events. The braking events that need to be conducted in the test laboratory are: Forward (Moderate, Hard, and Full Rates) and Reverse (Hard and Full Rates). These brake events need to be performed at the ballast conditions that were recorded during the Road Load Data Acquisition (RLDA) at the proving ground. Since the light rate braking events do not contribute significantly to the fatigue damage, they are not run in the laboratory test. It is also appropriate to combine two different rate stops if they produced similar loads. Note that if Panic Brake and/or Chatter Bump Stops have much higher loads than any other stops, they/it should be included as a separate event(s).

4.3.2 Brake Event Identification. A representative brake event needs to be identified at each different rate stop at each ballast condition. This event is normally chosen based on the sum of the front wheel brake torques, and should fall between the mean and maximum value for a given rate stop. The number of brake stop repeats should also be weighed when deciding on a representative event. See Appendix A, Table A1 for an example of a typical brake event summary.

4.3.3 Channel Extraction. Extract the required channels from the original data set. These should include the four (4) longitudinal wheel or ball joint forces (one (1) per wheel corner), the four (4) brake torques (one (1) per wheel corner), the vehicle speed and the brake activation switch. All files do not need to be processed since the significant brake events typically exist within a subset of the road surfaces.

4.3.4 Determine Peak Values. Using the time histories with the channels extracted, identify the stop to be simulated and determine the peak values to be used in the synthetic braking file. Normally the peak value used is the maximum value (on a per channel basis) seen during a particular stop. See Appendix B, Figures B1 and B2 for an example of a typical forward braking event from the road. The Panic Brake and Chatter Bump Stop schedules are highly dynamic events where the peak values are difficult to obtain. During past tests when the peak dynamic values of Panic Brake and Chatter Bump Stop schedules were used during testing, non-representative damage has occurred to the test specimens. It is recommended that the mean value of the dynamic portion of the Panic Brake and Chatter Bump Stop brake events be used as the peak value for the synthetic brake files.

4.3.5 Synthetic Brake File Scaling. Starting with the original synthetic brake file, scale each channel using the peak values identified in 4.3.4 (make sure the polarity is the same as used for the road data). See Appendix C, Table C1 for a summary sheet used to calculate the required scalars. Also note that the original synthetic brake file has ten repeats in the file to increase test execution efficiency. See Appendix D, Figures D1 and D2 to view the unscaled synthetic brake file. Note that adequate time has been provided in the beginning of the file to allow for the brake system to reach full pressure typically 15.17 MPa (2200 psi).

4.3.6 Control Bandwidth. The scaled synthetic brake file should be filtered to create a desired data file for test development. The control bandwidth is 0.2 Hz to 40 Hz. The synthetic brake file is designed so that: (1) there are equal areas above and below the x-axis, and (2) the frequency content is between 0.2 Hz and 40 Hz. This insures that when the filter is applied there is essentially no mean shift or loss of peak amplitude.

4.3.7 Test Development. The files are now ready for test development. The standard is the same as for test development for any other real-time file, except that a new transfer function is required and the brakes must be activated at the beginning of the file using an external brake pressurization system. Rubber faced brake pads should be used in lieu of standard brake pads to reduce the chance of slippage. Reference GMW15227 (Brake system activation) for more information on using rubber faced brake pads.

4.3.8 Test Execution. When playing out the synthetic brake drive files out during test execution, an automatic means of triggering the external brake pressurization system must be provided. This can be accomplished by either: (1) Providing a digital to analog (D/A) control channel in the drive file, or (2) using a digital output line with file edge triggers.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. It is assumed that the end user is familiar with the correct utilization of these types of files.

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 **Documents**
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5.3 Test Documentation. Output files.**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.**

MTS 329LT: Model 329 Light Truck Road Simulator (manufactured by MTS Systems Corporation).

MTS 329PC: Model 329 Passenger Car Road Simulator (manufactured by MTS Systems Corporation).

7.2 Acronyms, Abbreviations, and Symbols.

D/A Digital to Analog

RLDA Road Load Data Acquisition

WOT Wide Open Throttle

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Test to GMW15225

9 Release and Revisions

This standard was originated in March 2006. It was first approved by the Global Structural Development Lab Expert Team in November 2007. It was first published in March 2008.

Issue	Publication Date	Description (Organization)
1	MAR 2008	Initial publication.
2	DEC 2013	Procedure updated. (Global Structural Durability Laboratory Expert Team)
3	FEB 2018	Updated template and technical content. (Global Structural Durability Laboratory Expert Team)

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