



45 Degree Curb Impact Test for Wheels and Tires

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 test assesses the performance of road wheels and tires (not compact temporary use/spares) in association with a vehicle suspension, structure, and mass impacting a 100 mm high curb fixture at a 45 degree angle to the direction of vehicle travel.

1.2 Applicability. This test applies to cars, wagons, sport utility vehicles, passenger vans, pickup trucks, and cargo vans. The test is an on-vehicle system validation of the tire/wheel assembly components. It applies to wheels and tires used in developing road regions. The Global Wheel Validation Guidelines define the situations where wheels should be tested and the Global Tire Validation Guidelines define the situations where tires should be tested.

1.3 Remarks. Two (2) tire and wheel assemblies are assessed in this test per run, and must be installed on the same side of the vehicle.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15445 GMW16590 GMW17574

2.3 Additional References.

GM Drawing 9590710: Wheel Spec - Wheel Uniformity and Low Point Marking

3 Resources

3.1 Facilities. This test requires a straight, smooth, paved, level test roadway of sufficient length to allow vehicles to accelerate to an impact velocity of at least 64 km/hr and slow to a stop afterwards. The test roadway should be wide enough to allow the driver to keep the test vehicle on it if the impact changes the direction of vehicle travel. An anchoring system is necessary to secure the curb fixture to the test roadway.

3.2 Equipment.

3.2.1 Wheel uniformity machinery capable of measuring wheel uniformity coefficients, as described in GMW17574.

3.2.2 Position measurement machinery capable of determining wheel bead seats radial and lateral coordinates, as described in GMW17574.

3.2.3 Tire pressure gauge.

3.2.4 Ballast which conforms to appropriate proving ground ballasting procedures.

3.2.5 Device capable of correctly indicating vehicle speed, such as the vehicle speedometer, radar unit, Global Positioning System (GPS) device, etc.

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June 2017

Page 1 of 17

Documents

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3.2.6 Curb fixture, as specified in Appendix A. The cross-section dimensions are shown in Appendix A, Figure A1.

3.3 Test Vehicle/Test Piece.

3.3.1 Test vehicle for which the wheels and tires are intended, or a test vehicle that is as close as possible to design intent. The test vehicle must be capable of the requested test loads and must meet trim height specifications. Otherwise, it may not clear the curb fixture. Also, confirmation that the vehicle meets trim height specifications provides additional confidence that its suspension components are design intent.

Note: The test vehicle must have all airbags disabled and verified as disabled by properly trained personnel prior to this severe impact test.

3.3.2 Test Wheels. Two (2) wheels should be provided. (If the test is focused on wheel performance, the wheels should be minimum stock condition unless otherwise specified by the test requestor. If the test is focused on tire performance, the wheels may be either minimum stock or nominal stock, and if there are multiple wheel sizes, tests should be performed for all sizes. The wheels should be as close to production intent as possible.)

3.3.3 Test Tires. Two (2) tires should be provided for the wheel-focused test. Four (4) tires should be provided for each tire-focused test. This is because it is recommended that both of the 30 km/hr series of impacts and the 35 km/hr series of impacts should each start with unused sets of tires. In addition, if one of the impacts in the 35 km/hr series results in a tire getting cut all the way through (total sudden loss of air pressure), tire replacement would be necessary to complete the testing.

Note: For testing focused on wheel performance, the tires should be new and unused and as close to production intent construction as possible. For testing focused on tire performance, the tires should be new, unused, and the latest construction available for the vehicle. If there are multiple tire sizes, tests should be performed for all sizes.

3.3.4 Non-Test Assemblies. Appropriately sized non-test assemblies for use on the other side of the vehicle from the test assemblies should be of the same nominal sizes as the test wheels and tires to ensure that there is no significant vehicle static roll angle due to differences in size.

3.4 Test Time.

Calendar time: 5 days
Test time: 14 hours
Coordination time: 4 days

3.5 Test Required Information.

- Tire size(s).
- Tire pressure(s).
- Test assembly locations on the test vehicle, for example, left front and left rear corner locations.
- Test speed, if the test is focused on wheel performance.
- Maximum test speed, if the test is focused on tire performance.

3.6 Personnel/Skills. Personnel should have the following training or credentials:

- Vehicle lift/hoist operation.
- Trained in use of wheel uniformity measurement equipment.
- Trained in use of mounting tire.
- Trained in vehicle alignment.
- Must meet appropriate Proving Grounds Driving Regulations to operate a vehicle on the test roadway.

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June 2017

Page 2 of 17



Documents

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4 Procedure

4.1 Preparation.

Note: Follow Vehicle Security Process Requirements. Since this test requires a test vehicle, follow the security measures required for all preproduction vehicle properties.

4.1.1 Disable Airbags. If the test vehicle was not provided with all airbags disabled, they must all be disabled and verified as disabled by properly trained personnel prior to this severe impact test.

4.1.2 Perform a pretest assessment of the test wheels. If a wheel has a dent, it should not be used for the wheel-focused or tire-focused test. If a wheel does not meet the applicable uniformity requirements in GM Drawing 9590710, it should not be used for the tire-focused test, but may be used for the wheel-focused test.

Note: The wheel drawing uniformity requirements are an acceptable alternative to assess whether or not a wheel should be used for the tire-focused test.

4.1.2.1 Measure and record pretest uniformity coefficients, as described in GMW17574.

4.1.2.2 Measure and record pretest bead seats radial and lateral coordinates as described in GMW17574.

4.1.3 Perform a pretest assessment of the test tires by inspecting them for visible damage. If a tire has visible damage, it should not be used for the wheel-focused test or the tire-focused test.

4.1.4 Mount each test tire on its respective test wheel.

4.1.5 Check to Make Sure Test Vehicle Meets Specifications.

4.1.5.1 Check Vehicle Trim Height. This should be done at curb mass as specified in GMW15445. If the vehicle is an Integration Vehicle and does not meet its trim height specifications, it should not be used for testing. If it is an earlier prototype vehicle (i.e., a Mule vehicle), it must meet its suspension point trim height specifications, but does not have to meet its body point trim height specifications. This is because the bodies on earlier prototypes are not necessarily constructed to provide this level of dimensional accuracy. If the vehicle does not meet specifications, it may be that one (1) or more suspension components are not correct.

4.1.5.2 Check Vehicle Alignment. This should be done at curb mass as specified in GMW15445. If the vehicle does not meet its alignment specifications, it should not be used for the test.

4.1.6 Install each test assembly on the test vehicle in the position requested and inflate every tire on the test vehicle to the pressure(s) requested. If position is not specified, typical placement is left front and left rear corner locations. Record the positions of the specific test assemblies.

Note: For some vehicles, the front and rear design intent assemblies may differ in their dimensions and pressures, and this intent should be reflected in set up. If the pressures are not specified, use pressure specifications (placard pressure) for the vehicle for which the test assemblies are intended. As noted in 3.3, the non-test wheels and tires should be of the same nominal sizes as the test wheels and tires to ensure that there is no significant vehicle static roll angle due to differences in sizes.

4.1.7 Ballast the test vehicle per appropriate proving ground ballasting procedures and driving regulations. Start this part of the procedure with the vehicle at curb mass.

Note: An example of a ballasting procedure is GMW15445.

4.1.7.1 Weigh the test vehicle prior to ballasting. Check to ensure that the test vehicle will clear the curb fixture before ballasting. Contact the test requestor for guidance if the vehicle will not clear the curb fixture.

4.1.7.2 The front test axle weight should be equal to the maximum front axle design load for all vehicle models for which the test assemblies are intended. The rear test axle weight should be equal to 85% of the maximum rear axle design load for all vehicle models for which the test assemblies are intended. The maximum front and rear design loads are sometimes referred to as architectural limits (sometimes as front and rear Gross Axle Weight Rating (GAWR)), and are the same for all vehicle models in a program.

Note: The axle loading specified may exceed the design intent placard values for the actual test vehicle used. If the difference is significant, the vehicle manager should be informed. If the test vehicle will not clear the curb fixture after ballasting to the test axle weights, alternative test axle weights calculated using the Gross Vehicle Weight Rating (GVWR) for the model of the test vehicle may be used, but must be communicated to the test requestor and documented in the test request and the test results. The alternative test axle weights are calculated as follows.

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June 2017

Page 3 of 17



Documents

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4.1.7.2.1 Vehicle before/after weight distribution is calculated using the sum of the maximum front axle status load and the maximum rear axle status load. The percentage of weight in the front is the ratio of the maximum front axle status load divided by this sum, and the rear percentage is the ratio of the maximum rear axle status load divided by this sum.

4.1.7.2.2 The alternative front test load is the vehicle model GVWR multiplied by the front weight distribution percentage. The rear test load is 85% of the vehicle model GVWR multiplied by the rear weight distribution percentage.

4.1.7.2.3 If the alternative test loads, as described in section 4.1.7.2.2, are still too high to allow the test vehicle to clear the curb fixture, a waiver of the GMW instructions from the program team or Global Subsystem Leadership Team (GSSLT) lead is required in order to use lower test loads. The recommended next set of test loads to try is the maximum front axle status load on the front and 85% of the maximum rear axle status load in the rear.

4.1.7.3 Add ballast to the vehicle to match the calculated test axle weights. It is recommended to have the left side of the vehicle weigh close to the same as the right side of the vehicle. It is difficult in practice to achieve equal weight side to side, so this is not a requirement.

4.1.7.4 Weigh the test vehicle after ballasting. This should include values for total, axles, and corners.

4.1.7.5 Check to ensure that the test vehicle after ballasting will clear the curb fixture. Contact the test requestor for guidance if the vehicle will not clear the curb fixture.

4.1.8 If necessary, calibrate the device selected to indicate vehicle speed to read correctly at the requested impact velocity (i.e., if a radar unit is used for this purpose, calibrate it according to its manufacturer's instructions).

Note: Whenever instrumentation is placed in a test vehicle, its installation and use must be governed by the appropriate proving ground driving regulations.

4.1.9 Configure the curb fixture depending on whether the test is focused on wheel or tire.

4.1.9.1 If the test is to determine wheel performance, the curb fixture must be set up at the appropriate 45 degree angle to the direction of vehicle travel so that the inboard part of the tire and wheel assembly contacts the curb fixture first. This results in the most damage to the wheel, since the inboard rim of the wheel deflects the most under impact (i.e., if it is intended to impact the left side assemblies, the curb fixture must be at the 45 degree angle where the left end is farther forward than its right end). See Figure 1.

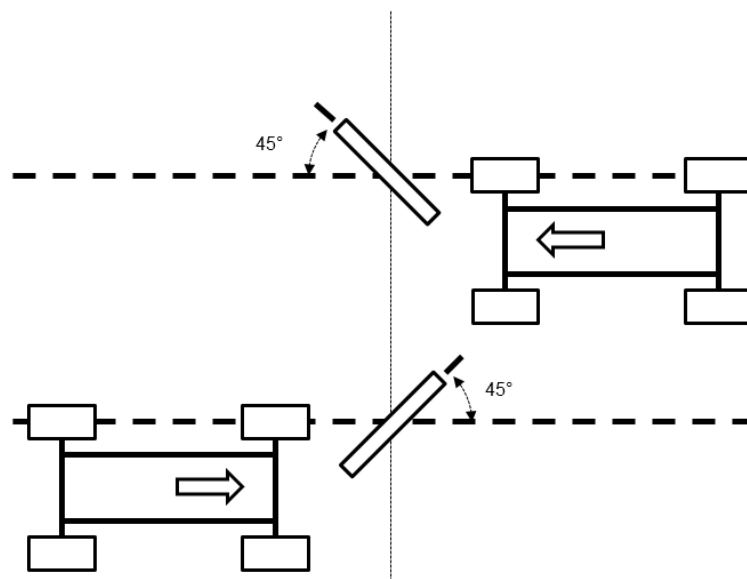


Figure 1: Curb Fixture Orientation for Wheel-Focused Test

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June 2017

Page 4 of 17



Documents

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4.1.9.2 If the test is to determine tire performance, the curb fixture must be set up at the other 45 degree angle to the direction of vehicle travel (as compared to the wheel test configuration) so that the outboard part of the tire and wheel assembly contacts the curb fixture first. This results in the most damage to the tire, since the outboard rim of the wheel deflects the least under impact, resulting in the greatest impact loading on the tire (i.e., if it is intended to impact the left side assemblies, the curb fixture must be at the 45 degree angle where the right end is farther forward than its left end). See Figure 2.

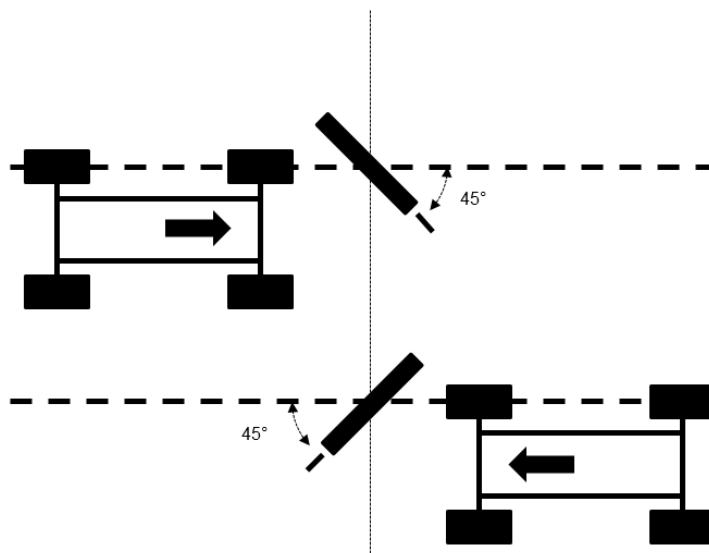


Figure 2: Curb Fixture Orientation for Tire-Focused Test

4.2 Conditions.

4.2.1 Environmental Conditions. The test roadway must be free of snow and ice and any significant loose material, such as gravel or sand. For the wheel-focused test, the pavement of the test roadway may be wet, but should not have any standing water. For the tire-focused test, the pavement should be dry.

Note: For the tire-focused test, any testing run on summer-only tires should be conducted at 4 °C (40 °F) or higher.

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 Wheel Test. Perform the following steps if the test is focused on wheel performance:

4.3.1.1 Drive to the Test Roadway. Coat the impact zone of the curb fixture with a solid paint marker or other suitable material in order to indicate the impact location on the tire. Check tire inflation pressures at the closest location allowed immediately before driving over the curb fixture. Adjust to requested pressure(s), and record. This is done because tire pressure may change while driving to the test facility.

4.3.1.2 Drive over the curb fixture at 30 km/hr or the impact target velocity specified by the test requestor. Take care to ensure that the velocity of the test vehicle is maintained for the rear impact, as well as the front impact, since the front impact may reduce the test vehicle velocity.

4.3.1.3 Immediately after driving over the curb fixture, check tire pressures at the closest location allowed and record. Record the actual vehicle velocity. Check tire pressures 30 minutes after impacts and record. However, if the ambient temperature is expected to change significantly during the 30 minutes (for example, if tire pressures immediately after the impact are measured in cold weather and then the vehicle is brought back to a heated garage, or, if the weather is hot outside, and the garage is cool) a different method should be used. Allow the vehicle temperature to stabilize, measure initial tire pressures, record, wait 30 minutes, measure the tire pressures again, and record.

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June 2017

Page 5 of 17

AVA Documents
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4.3.1.4 Remove each test assembly from the test vehicle for post-test evaluation. Inspect each test assembly for damage and record observations. Examine wheels for dents or cracks. Examine tires for any damage, such as bulges or broken plies on the sidewalls or cracks on the tread crown or tire shoulder areas. Photograph as appropriate. Mark the position of each tire on the wheel before dismounting. Once dismounted, check each wheel for visible deformation on inboard and outboard flanges and record observations. Photograph as appropriate.

4.3.1.5 Perform posttest assessment of test wheels:

4.3.1.5.1 Inspect each wheel for cracks using dye penetrant or equivalent.

4.3.1.5.2 Measure and record posttest uniformity coefficients, as described in GMW17574.

4.3.1.5.3 Measure and record posttest bead seats radial and lateral coordinates, as described in GMW17574.

4.3.1.6 Perform posttest assessment of dismounted test tires:

4.3.1.6.1 Inspect for visible damage and record observations.

4.3.1.7 Perform posttest vehicle alignment check and correct to specification as necessary. This should be done at curb mass, as specified in GMW15445.

Note: The vehicle is allowed to be out of alignment specifications after the one impact of the wheel test. This does not invalidate the test.

4.3.2 Tire Test. Perform the following steps, if the test is focused on tire performance:

4.3.2.1 Drive to the Test Roadway. Coat the impact zone of the curb fixture with a solid paint marker or other suitable material in order to indicate the impact location on the tire. Immediately before driving over the curb fixture, check tire inflation pressures at the closest location allowed, adjust to requested pressure(s), and record. This is done, because in driving to the test facility, tire pressure may change.

4.3.2.2 Drive over the curb fixture at 30 km/hr. (Take care to ensure that the velocity of the test vehicle is maintained for the rear impact as well as the front impact, since the front impact may reduce the test vehicle velocity.)

4.3.2.3 Immediately after driving over the curb fixture, check tire pressures at the closest location allowed. Record and restore tire pressure to the requested pressure(s) if necessary. Record the actual vehicle velocity. Examine the impact location for tire damage, such as bulges or broken plies on the sidewalls or cracks on the tread crown or tire shoulder areas, and record. Photograph as appropriate.

Note: If there is any loss of tire pressure greater than 14 kPa (2 psi) or if there is any structural damage to a tire, the test may be stopped.

Repeat the impact described in 4.3.2.2 and the inspection described here in 4.3.2.3, but only for a maximum of four (4) total valid impacts. If the current impact is at the same location as a previous impact that had damage, this invalidates the current impact, and it should be repeated. Check tire pressures 30 minutes after all impacts are complete and record. However, if the ambient temperature is expected to change significantly during the 30 minutes (i.e., if tire pressures immediately after the impact are measured in cold weather and then the vehicle is brought back to a heated garage, or, if the weather is hot outside, and the garage is cool), a different method should be used. Allow the vehicle temperature to stabilize, measure initial tire pressures, record, wait 30 minutes, measure the tire pressures again, and record.

Note: The tires used for the 30 km/hr impacts may be reused for the 35 km/hr impacts, if there is no structural damage to the tires. Any 35 km/hr impact that occurs at a 30 km/hr impact location is valid. However, it is recommended that a new set of tires be used for the 35 km/hr impacts.

4.3.2.4 Drive over the curb fixture at 35 km/hr or the impact target velocity specified by the test requestor. (Take care to ensure that the velocity of the test vehicle is maintained for the rear impact as well as the front impact, since the front impact may reduce the test vehicle velocity.)

4.3.2.5 Immediately after driving over the curb fixture, check tire pressures at the closest location allowed, record, and restore to the requested pressure(s) if necessary. Record the actual vehicle velocity. Examine tires for damage such as bulges, broken plies on the sidewalls, or cracks on the tread crown or tire shoulder areas, and record. Photograph as appropriate.

Note: If a tire gets cut all the way through in an impact (total sudden loss of air pressure), replace the tire and continue testing. However, if this happens more than once at the same vehicle corner, then the test may be stopped.

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June 2017

Page 6 of 17



Documents
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