



Suspension Vertical Stroking Durability Test

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. To evaluate the durability of suspension components when subjected to vertical loads/displacements applied at the wheel center location(s). If a body or frame is used to mount the suspension components (instead of a rigid fixture) the test may also provide useful information about the durability of the body/frame at the suspension connections.

1.2 Applicability. This procedure is applicable to Body On Frame (BOF) and Body Frame Integral (BFI) vehicles.

1.3 Remarks. This test is usually used when road load data is not available. It can be used to stroke one (1) side of the suspension or two (2) sides simultaneously.

Real time testing can be run, if road load data is available. Vertical load and Lower Control Arm (LCA) angular displacement are typically required.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3425 GMW14872

2.3 Additional References.

CG190 Evaluation Report Writing Template
Subsystem Technical Specification (SSTS)

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.

3.1.3 Major Facility. Laboratory, physical test department.

3.1.4 Minor Facility.

3.1.4.1 One (1) bedplate area 1.8 m² (6 ft²) with hydraulic power supply.

3.1.4.2 An overhead crane.

3.2 Equipment.

3.2.1 Load Application. Two (2) servo hydraulic actuators with linear variable differential transformers. Actuators must have sufficient stroke to cycle the suspension through its full range of motion.

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3.2.2 Fixturing.

3.2.2.1 One (1) rigid test fixture that simulates the body and provides mounting provisions for the suspension components (in true vehicle position). A full or half body buck, or vehicle frame section, may be substituted for the rigid test fixture.

3.2.2.2 Four (4) angle stands tall enough to support the rigid test fixture, high enough to allow hydraulic actuators to be positioned vertically under the wheel spindles, or suspended above the wheel spindle.

3.2.2.3 Two (2) spindle adapters for connecting the wheel bearing to the hydraulic actuator and load cell (refer to Figure A2, Appendix A). Substitute a Multi-Use Load Arm (MULA), with the correct offset, if using the complete knuckle/hub assembly.

3.2.2.4 One (1) steering gear lock out fixture (if testing a front suspension) to prevent rotation of the steering knuckles.

3.2.2.5 A strut machine or a spring compressor may be needed to assemble test specimens.

Caution: Follow manufacturer's instructions for safe use of this equipment.

3.2.3 Instrumentation.

3.2.3.1 One (1) calibrated load cell for each hydraulic actuator. Load cell capacity is that required to measure maximum vehicle mass carried on both front wheels (refer to 4.1.1). Using a load cell that has a range well above two (2) times the weight of the vehicle measured on one (1) wheel (2G), load will reduce resolution and test accuracy. Substitute a Rotary Variable Differential Transformer (RVDT) if using real time data.

3.2.3.2 One (1) or two (2) hydraulic controller(s) (depending on the number of actuators).

3.2.3.3 Fastener Monitoring. All fasteners secured by the test lab should be torqued to minimum specification and recorded. Apply paint pen, torque-seal, or equivalent for indexing all fasteners. During test, and at end of test, report observations where fastener is off scribe and/or torque-seal is compromised (e.g., broken) noting the specific attachment location. End of test breakaway torques in the on direction should be measured and recorded for all joints.

3.2.3.4 One (1) or two (2) electric fan(s) or air amplifier(s) to blow cooling air over the struts or shocks. One (1) fan needed if cycling one (1) side, two (2) needed for two (2) sided cycling.

3.2.3.5 One (1) aerosol can of white stencil ink to paint parts and allow easier crack detection.

3.3 Test Vehicle/Test Piece.

3.3.1 All test material should be dimensionally certified prior to receipt to confirm that it is representative of design intent. The test, validation, and release engineers should consider testing worst case scenarios such as minimum gauge thickness materials, minimum/maximum stack up of parts, minimum/maximum fastener torques, parts designed to the maximum stress level, etc.

3.3.2 The test, validation, and release engineers should determine how many samples and how many lives need to be tested to meet platform reliability requirements.

3.3.3 The release engineer is responsible for providing the parts and information in 3.3.3.1 thru 3.3.3.5, and 3.5.

3.3.3.1 Drawings showing body mounting coordinates of interface suspension components. Detail drawings are also needed for each suspension component that mounts to the body (only needed if conducting test on a rigid test fixture).

3.3.3.2 Suspension D or Z height data (that corresponds to the vehicle weight determined in 3.5.2.) and documentation showing how to record these measurements.

3.3.3.3 Wheel offset: The lateral distance between the outboard face of the wheel bearing (the surface that the wheel contacts) and the center of the tire tread.

3.3.3.4 Assembly information showing assembly position, sequence, static torque specification, etc.

3.3.3.5 One (1) full suspension system for each sample to be tested. The test material should be received in ready to test condition. Parts required include:

- a. Lower control arms.
- b. Upper control arms.
- c. Springs (springs that have the maximum stress level for the model being tested are usually used).
- d. Stabilizer bar links.

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Documents

Document Sharing Hub

- e. All suspension fasteners.
- f. Knuckles.
- g. Wheel bearings.
- h. Lug nuts.
- i. Struts or shocks.
- j. Front axle for Four Wheel Drive (4WD)/All Wheel Drive (AWD) trucks.
- k. Knuckle/hub assembly (for trucks).
- l. Mounts.
- m. Steering gear, gear linkage, and tie rod ends (usually only need one (1) set per test).

Brake parts are not necessary unless the brake anchor bracket is integral to the strength of the knuckle. If the brake drum/rotor is eliminated, a spacer should be placed between the wheel spindle adapter and the wheel bearing, or else the wheel offset feature of the spindle adapter will have to be changed accordingly.

Include the brake parts when using the full knuckle/hub assembly for trucks. The brake parts are required to keep the rotor from spinning by either applying external brake pressure or mechanically pinning the rotor to the brake caliper. This is accomplished by drilling a hole through the caliper, piston, and rotor. A bolt is then installed through the three (3) pieces.

Do not reuse material from other tests unless it can be determined that the previous testing will not affect the results of this test. If used parts are used, document the previous history of those parts in the test report.

3.4 Test Time.

Calendar time: 40 days to 60 days

Test time: 864 h to 1000 h

Coordination time: 70 h to 80 h

3.5 Test Required Information.

3.5.1 Performance objectives for development and/or validation testing including test loads or displacements, the number of cycles that must be performed and specific acceptance criteria.

3.5.2 The platform mass analyst is responsible for providing the maximum weight on one front or rear wheel (highest mass option content at gross vehicle weight) ballast condition.

3.6 Personnel/Skills.

3.6.1 One (1) laboratory test technician skilled in the set up, tuning, and use of hydraulic test equipment and controllers.

3.6.2 One (1) test engineer for test planning, direction, and incident analysis.

3.6.3 One (1) validation engineer to help acquire material from the release engineer, plan test timing, and determine test sample size requirements and the number of lives for each sample.

4 Procedure

4.1 Preparation.

4.1.1 Load Determination – calculate the constant amplitude 2G (see 7.1) vertical test load using the formula:

$$2G \text{ vertical test load} = 2W_{\text{Max}}$$

Where:

W_{Max} = Maximum weight on one (1) wheel (refer to 3.5.2).

For each cycle of the constant amplitude test, the wheel spindle is stroked from a load near zero (approximately 10 N), to the 2G load, and back to the near zero load at 0.5 to 1.5 Hz. The test is not cycled to zero load because any load controller overshoot will result in the suspension being pulled down past its full rebound stops.

4.1.2 Real Time Test.

4.1.2.1 Data Acquisition. Data should be recorded at the Proving Ground over the durability schedule for the specific vehicle. LCA angle and vertical wheel load are the preferred data channels.

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