



Strut Tower Strength and Durability

1 Scope

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 determine the stiffness (load versus displacement) and fatigue characteristics of the strut tower or the subassembly of the tower and surrounding structure for Computer Aided Engineering (CAE) model development and correlation. To evaluate and validate Design Validation (DV) or Product Validation (PV), the strut tower and surrounding structure directly in support of the tower at the component or subassembly level for deformation and fatigue.

Note: This test may be used for component or subsystem evaluation of the front or rear strut tower and surrounding structure.

1.2 Foreword. This procedure provides a general approach to develop the fixtures and perform the test. This procedure is recommended for new materials such as aluminum, new technology of fastening, adhesives or rivets, and new manufacturing, such as cast, extrusion, stamping and for front and rear strut towers. This test procedure is comprised of the following parts.

- Fixture and constraints design/construction.
- Load application and CAE model correlation.
- Fatigue durability test under pothole and Belgian Block loads.

1.3 Applicability.

1.3.1 This procedure is applicable to all Body Frame Integral (BFI) structure designs with strut towers that take suspension loads through the struts.

1.3.2 New materials, new technology of manufacturing, or new fastening methods, may require this type of test to increase confidence in the CAE results.

1.3.3 The test can be used to validate at component or subsystem level by the supplier or GM.

1.3.4 For fatigue durability, only the potholes and Belgian Block schedule loads (virtual or based on road loads) are used

1.3.5 For the purpose of simplicity, only single axis (vertical) loads are considered.

1.3.6 The methods of material specification checks are not included in this procedure. They are the responsibility of Materials Engineering.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

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2.3 Additional References.

- CG583 – Development/Validation Test and Vehicle Review
- Subsystem Technical Specifications (SSTS)

3 Resources

3.1 Facilities. Physical test laboratory, virtual or measured loads engineering, Structure Integration and Body System CAE.

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.

3.2.1 A rigid bedplate of sufficient mass, size, strength and stiffness to be able to anchor the fixture and sustain the dynamic loads without impacting the test.

3.2.2 Servo hydraulic load application system comprised of high pressure hydraulic oil supply, high speed (fast reacting) servo valves with signal controllers/programmers with feedback loop to both apply the input signals and collect the feedback.

Note: For static stiffness, the single axis (push/pull type) static load may be applied using a universal test machine (Ingstrom type) if a servo hydraulic system is not available. See Appendix A, Figure A1.

- Fixture to fix the test samples to the bed plate.
- Load cell of adequate capacity with valid calibration.
- String pots to measure displacement and set

3.3 Test Vehicle/Test Piece.

Note: The decision to test the tower as a component or subsystem must be made first. It is based on the purpose of the test (Tower as a component, Tower as a subsystem with suspension components, Tower and Rail with suspension components as a subsystem). Choose only one (1) side (right or left) and get matching side components of suspension and rails as necessary.

3.3.1 Tower as a component. See photographs in Appendix A, Figure A1.

3.3.2 Tower as a subsystem with suspension components. See photographs in Appendix B, Figure B1 and Figure B2.

3.3.3 Tower and Rail with suspension components as a subsystem. See photographs in Appendix C, Figure C1 and Figure C2.

Note: Make sure that any adhesive used in the test specimen is cured to its specific requirement.

3.4 Test Time. Excluding Fixture Preparation Time.

- Tower as a component – one (1) week.
- Tower as a subsystem with suspension components – two (2) weeks.
- Tower and Rail with suspension components as a subsystem – three (3) weeks.

3.5 Test Required Information. Test request documentation shall outline specific information and test parameters. Refer to Body Structures paragraphs from Subsystem Technical Specifications (SSTS) (if applicable).

3.5.1 Compliance to material specifications are coordinated by Materials Engineering.

3.6 Personnel/Skills. Experience in setting up fixture build and running tests using the servo hydraulic controllers, programmers, and equipment is required for a successful evaluation.

4 Procedure

4.1 Preparation.

4.1.1 Prepare Fixtures.

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4.1.1.1 The fixture must be rigid.

4.1.1.2 The fixture surface contour must match the contour of the test sample such that there is no change in stress to the test sample.

4.1.1.3 The fixture must be reusable for multiple samples of the same design parts.

4.1.1.4 The fixtures must allow space for suspension components and their movement.

4.1.2 Decide locations and methods of constraints. Constraints must be compatible with purpose of the test and should not change the stress level in the test sample. Use test setup photographs as a guide.

4.1.3 Choose correct equipment that will be able to apply loads. The actuators and servo controllers including valves and programmers must match.

4.1.4 Decide if measured road loads or predicted virtual loads will be used. The Belgian Block schedule loads need to be converted to a block cycle equal to one (1) life, see Appendix A, Table A1. Assistance from the test engineer, Body CAE, and Virtual Loads Group will be required. Pothole loads are applied as received.

4.1.5 Procure necessary body and suspension components.

4.1.5.1 Body Components:

- Tower - Required for both component and subsystem test.
- Rails - Required for subsystem test.

4.1.5.2 Suspension Components. Strut assembly, upper strut mount, lower control arm, upper control arm, tie rod, rotor, hub, steering knuckle, and fasteners.

4.1.5.3 Prepare the strut. Get the full jounce design position of the strut from the suspension engineer. Empty out the strut and weld the rod to the strut body in the full jounce position.

Note: This is to be clarified to the body and suspension engineers prior to the test for their agreement. They may decide on another position depending on the test purpose and tower sensitivity.

4.1.6 Test Setup.

4.1.6.1 Prepare Test Sample. Assemble components necessary to test as a component or subsystem. The load must be applied through the correct interface.

4.1.6.2 Set up the fixture and test sample leaving enough room to attach the load arm to the hub. Allow space for suspension movement.

4.1.6.3 Set up the servo hydraulic actuator, load cell, controllers, plumbing lines, control sensors, etc., such that the start of the load is in correct position of the suspension and at correct angle into the tower. Use test setup photographs as a guide. See Appendix A, Figure A2.

4.1.6.4 Avoid unintended moments (binds) around the coupling points. Use correct torques, mark the fasteners, set up displacement sensors at points of interest, and check rigidity of fixtures and the bed plate in order to avoid a resonance problem.

4.2 Conditions.

4.2.1 Environmental Conditions. Test is to be conducted at ambient condition. Testing in hot, cold, or humid environments, may need to be done based on the type of materials used in the design. This must be decided on prior to start of the test.

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 Test Sign Off. Conduct test sign off on the CG583 form. The sign off must include validation, design release and analysis engineers. All performance requirements must be specified for a validation test.

4.3.2 Load Application. Program the load inputs and feedback loops. Verify signal generation.

4.3.2.1 Apply the loads in agreed upon sequence and collect the data at chosen points for deflection.

4.3.2.2 Pause at appropriate cycle or time marks to check for any damage or deformation exceeding the requirement. Document all observations thoroughly (photograph, video). If visibly damaged (crack or permanent set), inform the validation engineer before resuming the test.

4.3.2.3 Plan a tear down Design Review Based on Test Results (DRBTR) at the end of the test.

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5 Data

5.1 Calculations. As necessary for fatigue life

5.2 Interpretation of Results. Main items to look for are cracks on the tower, doming of the tower, permanent set of the upper strut mount, breakage or bending of the suspension links. See photographs of doming and permanent set included in Appendix A, Figure A3, and Figure A4.

5.2.1 Verify if requirements (reliability, deformation/set, functional) were met. If not, initial root cause investigation will be necessary to decide if an issue Problem Report and Tracking System (PRTS+) is required.

5.3 Test Documentation. Written and photographic documentation is to be generated and maintained on all factors involved in the test. The documentation is to be included in the test report as appropriate. The report must be filed in the Global Document Management (GDM) Database.

6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

7 Notes

7.1 Glossary. Not applicable.

7.2 Acronyms, Abbreviations, and Symbols.

AWD	All-Wheel Drive
BFI	Body Frame Integral
CAE	Computer Aided Engineering
DRBTR	Design Review Based on Test Results
DV	Design Validation
GDM	Global Documentation Management
PRTS+	Problem Report and Tracking System
PV	Product Validation
SSTS	Subsystem Technical Specification

8 Coding System

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

Test to GMW17058

9 Release and Revisions

This standard was originated in September 2013. It was first approved by the Underbody Structures Global Subsystem Leadership Team in November 2013. It was first published in November 2013.

Issue	Publication Date	Description (Organization)
1	NOV 2013	Initial publication.

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