GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW14198

Front Frame Vertical Static Stiffness Evaluation Procedure

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 determine the front frame vertical static stiffness of the frame from a full-frame vehicle.

1.2 Applicability. Frames from GM and competitive full-frame vehicles.

1.3 Remarks. The vertical stiffness of the front frame is an important factor in the level of on-road shake and steering wheel dither experienced by the occupants of a full-frame vehicle. High vertical stiffness in this area also provides a solid foundation for the powertrain, front suspension and steering system, which simplifies the tuning of the mounts for those components. Frame static stiffness metrics are intended as an improvement over the previous practice of specifying free-free frame mode frequencies, which have not been shown to relate to full vehicle performance.

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

2.3 Additional References.

- Subsystem Technical Specification (SSTS)

3 Resources

3.1 Facilities. A large bedplate.

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 Spherical bearings.

3.2.2 Elephant's feet.

3.2.3 Force ring transducers.

3.2.4 Dial indicators.

3.2.5 Wedge blocks.

3.2.6 Threaded rod/nuts.

3.3 Test Vehicle/Test Piece. A Frame including bolt-on hardware (e.g., bumpers and cross members).

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3.4 Test Time.

Calendar time:	1 day
Test time:	3 hours
Coordination time:	5 hours

3.5 Test Required Information. May require fabrication for load application interface.

3.6 Personnel/Skills. One (1) engineer and one (1) technician skilled in calibration and data acquisition using force transducers and dial indicators.

4 Procedure

4.1 Preparation.

4.1.1 Calibrate force ring transducers.

4.1.2 Boundary Conditions. Constrain the frame at the No. 1 and No. 2 body mount brackets on both sides. See Appendix A, Figure A1.

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.

4.3.1 Force Input Locations. Applied vertically through the front suspension damper (shock absorber) brackets, simultaneously.

4.3.2 Displacement Measurements. On the damper brackets as close as practical to the force input on both sides. Also, on the center bolt of the No. 1 body mount constraint on both sides. See Appendix A, Figure A1.

5 Data

5.1 Calculations.

5.1.1 Geometry.

Where:

$X_{Cantilever}$	Measured Fore/Aft Distance Between No. 1 Body Mount Constraint and Applied Load (mm)
$X_{Constraint}$	Measured Fore/Aft Distance Between No. 1 and No. 2 Body Mount Constraints (mm)
$X_{Normalize}$	GMT370 (see 5.2)
$X_{Cantilever}$	Distance (620 mm)

5.1.2 Measurements (for each load case).

Where:

F	Applied Force (N)
Z_L	Measured Vertical Displacement on Shock Tower, Near Applied Load, Left (mm)
Z_R	Measured Vertical Displacement on Shock Tower, Near Applied Load, Right (mm)
Z_{RefL}	Measured Vertical Displacement on No. 1 Body Mount Constraint, Left (mm)
Z_{RefR}	Measured Vertical Displacement on No. 1 Body Mount Constraint, Right (mm)

See Appendix A, Figure A2.

5.1.3 Equations.

5.1.3.1 Effective Load (N).

$$\text{Load}_{\text{Effective}} = 2 * F$$

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5.1.3.2 Effective Deflection (mm).

$$\text{Deflection}_{\text{Effective}} = \frac{(Z_L - Z_{\text{Re}\,fL}) + (Z_R - Z_{\text{Re}\,fR})}{2}$$

5.1.3.3 Front Frame Vertical Static Stiffness (N/mm).

$$\text{K}_{\text{Front Frame Vertical}} = \frac{Load_{Effective}}{Deflection_{Effective}}$$

5.1.3.4 Normalized Front Frame Vertical Static Stiffness (N/mm).

$$\text{K}_{\text{Normalized Front Frame Vertical}} = \frac{X_{Cantalever}}{X_{Normalize}} \times K_{FrontFrameBending}$$

Note: Use the generated data to plot the Effective Load vs. the Effective Displacement for all load cases.

5.2 Interpretation of Results. Observe the quality of data in graphs (see Appendix B, Figure B1). A least-squares fit of the data points (see Appendix B, Table B1), should produce a straight line with a correlation coefficient of at least 0.95. The slope of the line generated is the front frame vertical static stiffness Newtons/millimeters (N/mm). In order to compare frames of different cantilever lengths, all data is normalized to the GMT370 cantilever length (see 5.1.1).

5.3 Test Documentation. The single number for normalized front frame vertical static stiffness (N/mm) should be presented with existing values for other frames, and compared to the Subsystem Technical Specifications (SSTS).

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.

Applied Forces: Static loads that are induced onto the frame at specific locations (e.g., front shock attachments).

Boundary Condition: Constraining forces applied to the frame that prevent frame gross motion during applied forces.

Static Stiffness: The slope of the force versus deflection curve for the frame when it is subjected to a given static load case while constrained by specified boundary conditions.

7.2 Acronyms, Abbreviations, and Symbols.

FST	Full Size Truck
IDSR	Integration Driven Subsystem Requirements
MST	Mid-Size Truck
N&V	Noise and Vibration
VPO	Vehicle Performance Owner

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