GM	WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW14180

Frame Global Bending 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 global 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 frame is an important factor in the level of on-road shake experienced by the occupants of a full-frame vehicle. Frame rigidity also affects the perceived structural feel of the vehicle. 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 Front End Sheet Metal (FESM) and No. 5 body mount brackets on both sides. See Appendix A, Figure A2.

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 center of the No. 2 body mount brackets, simultaneously to both sides.

4.3.2 Displacement Measurements. On the No. 2 body mount brackets on both sides, as close as practical to the force input. Also, on the center bolts of the FESM and No. 5 body mount constraints on both sides. See Appendix A, Figure A1.

5 Data

5.1 Calculations.

5.1.1 Geometry.

Where:

X_{Front}	Measured Fore/Aft Distance Between FESM Body Mount Constraint and Applied Load (mm)
X_{Rear}	Measured Fore/Aft Distance Between No. 5 Body Mount Constraint and Applied Load (mm)
L	Measured Fore/Aft Distance Between FESM and No. 5 Body Mount Constraints (mm)

5.1.2 Measurements (for each load case).

F	Applied Force (N)
Z_L	Measured Vertical Displacement on No. 2 Body Mount, Near Applied Load, Left (mm)
Z_R	Measured Vertical Displacement on No. 2 Body Mount, Near Applied Load, Right (mm)
$Z_{RefFESML}$	Measured Vertical Displacement on FESM Body Mount Constraint, Left (mm)
$Z_{RefFESMR}$	Measured Vertical Displacement on FESM Body Mount Constraint, Right (mm)
Z_{Ref5L}	Measured Vertical Displacement on No. 5 Body Mount Constraint, Left (mm)
Z_{Ref5R}	Measured Vertical Displacement on No. 5 Body Mount Constraint, Right (mm)

See Appendix A, Figure A2.

5.1.3 Equations.

5.1.3.1 Effective Load (N).

$$F_{Effective} = 2 * F$$

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5.1.3.2 Effective Deflection (mm).

$$Z_{Effective} = \frac{Z_{LoadL} + Z_{LoadR}}{2} - Z_{Rigid}$$

5.1.3.3 Rigid Displacement Due to Imperfect Constraints (mm).

$$Z_{Rigid} = \frac{X_{Forward}}{X_{Forward} + X_{Rearward}} * \left(\frac{Z_{Ref5L} + Z_{Ref5R}}{2} - \frac{Z_{RefFESML} + Z_{RefFESMR}}{2} \right) + \frac{Z_{RefFESML} + Z_{RefFESMR}}{2}$$

5.1.3.4 Unscaled Frame Global Vertical Static Stiffness (N/mm).

$$K_{UnscaledGlobalFrameVertical} = \frac{F_{Effective}}{Z_{Effective}}$$

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

In order to compare frames with different geometries, a normalization technique was developed. This assumes that the frame behaves as a simply supported beam subjected to a concentrated load.

5.1.3.5 Frame Vertical Bending Efficiency *(Solve Equation for EI)* (kNm^2).

$$\frac{F_{Effective}}{Z_{Effective}} = \frac{6LEI}{X_{Front} * X_{Rear}(L^2 - X_{Front}^{\ 2} - X_{Rear}^{\ 2})}$$

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 unscaled frame global static stiffness (N/mm).

5.3 Test Documentation. The single number for frame vertical bending efficiency (kNm^2) 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.

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