



Durability of Plastic and Elastomer Parts in Combination with Metal Parts

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. Durability of plastic and elastomer parts when combined with metal parts and when subjected to $+23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

Determination of the fatigue life of test parts in a single step durability test to a defined number of cycles or until failure (for hydro mounts and hydro bushings additional test of fluid loss).

1.2 Foreword. Not applicable.

1.3 Applicability. For plastic and elastomer parts of the engine mount.

2 References

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

2.1 External Standards/Specifications.

DIN 53513

DIN 53535

2.2 GM Standards/Specifications.

None

3 Resources

3.1 Facilities. Not applicable.

3.2 Equipment. Schenck-type test equipment or equivalent may be used for the test. A hydraulic actuator with a closed servo-hydraulic control circuit (uniaxial test in the major load direction). For multiaxial tests, hydraulic actuators are placed at angles of 90° to form right-angled Cartesian coordinates. Additional angular movements are simulated using additional actuators (refer to test scheme in component drawing).

3.2.1 Durability Test.

3.2.1.1 Control of Test Force. Perform a force-controlled durability test. Mount the load cell on the transverse beam (stationary side) free from side forces. Measure the test amplitudes at the respective test frequency with the distance sensor in the hydraulic actuator.

3.2.1.1.1 Cascade Control. The test force is applied to the test part exactly sinusoidally (command signal). For the non-linear characteristics of elastomer components, a cascade control unit corrects this signal to the smallest deviation of non-linearity (feedback signal). The aperiodic borderline case of a square signal introduced is applicable for optimization.

3.2.1.1.2 Control of Peak Values. During the entire durability test, minimum. and maximum. values are kept on a constant level to assure a reliable evaluation of displacement changes.

3.2.1.2 Recording of Hysteresis Data. (Applicable to recording of minimum. and maximum. forces and for evaluation of set in paragraph 7.1.1 only).

The load cell (load range: $\pm 10\text{ kN}$ statically, in certain cases $\pm 25\text{ kN}$ statically) supplies the force values, the displacement sensor (displacement: $\pm 50\text{ mm}$) installed in the hydraulic actuator supplies the displacement values. The force-displacement couples forming the hysteresis shall be recorded simultaneously.

For the specification to drawing, the hysteresis of the starting cycle (100 cycles) and the cycle subsequent to the specified number of cycles shall be recorded during the durability test and be put into relation. (This system may be used to record several hystereses during the durability test until the limit of cycles is reached. One of these hysteresis will be the hysteresis of the specified number of cycles, see paragraph 7.1.1.2).

3.3 Test Vehicle/Test Piece. On samples, type samples, and in cases of arbitration, the durability test shall be made no earlier than 7 days and for quality control no earlier than 72 h after manufacture of the part. Before the durability test, allow the parts to soak at $+23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ for at least 8 hours.

3.4 Test Time. See 3.3.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Not applicable.

4 Procedure

4.1 Preparation. Not applicable.

4.2 Conditions.

4.2.1 Environmental Conditions. Unless otherwise specified the test shall be performed at $+23 \pm 5\text{ }^{\circ}\text{C}$.

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 Durability Test. Install part to be tested in the test fixture in a way that it corresponds with vehicle installed position. For direction and level of the test forces refer to component drawing specifications. The test force is composed of the dynamic preload F_m (share of engine mass under dynamic ride conditions), about which the vibrational force $\pm F_a$ vibrates symmetrically. The preload F_m simultaneously is the operating point and the basis of computation for the dynamic characteristics for the evaluation to drawing specification.

The applied test force shall be observed by means of control units (see paragraph 3.2.1.1.1 and paragraph 3.2.1.1.2). The durability test shall be performed at least until first cracks of the test part can be documented, but until a cycle limit of $N = 2\,000\,000$ cycles.

For a statistical evaluation at least 5 test parts shall be tested per test force level. The responsible test engineer makes the final decision about the number of test parts. The durability test shall be performed at $+23 \pm 5\text{ }^{\circ}\text{C}$. The surface temperature of the test parts is measured during the durability test.

4.3.2 Determination of Dynamic Characteristics. During the running single-step durability test the hysteresis are recorded and evaluated at the beginning of the test (e.g., 100 cycles) and after the specified number of cycles (e.g., as specified in the drawing).

The dynamic characteristics:

- Displacement in operating point (in millimeter (mm))
- Set (in percent (%))
- Dynamic rate (in Newton millimeter (N/mm))
- Maximum displacement (in millimeter (mm))
- Minimum displacement (in millimeter (mm))
- Average displacement (in millimeter (mm))

These are parameters for the elastic characteristics in the operating point (mostly preload F_m) or within the limits of the test force.

The dynamic characteristics:

- Damping rate (in Newton second per millimeter (N s/mm))
- Damping force (in Newton (N))
- Lost deformation work (in Newton millimeter (N/mm))
- Loss angle (in degrees) are parameters for the damping characteristics of the test parts in the operating point (mostly preload F_m) or within the limits of the test force.

The stiffness factor k^* describes the change of the dynamic characteristics (dynamic rate) by the durability test in a wide area around the operating point.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results.

5.2.1 Evaluation of the Hysteresis Measured – Dynamic Characteristics. The hystereses measured are evaluated according to the dynamic characteristics listed in paragraph 4.3.2. This may be done with an evaluation computer. A number of graphs showing the dynamic characteristics versus the number of cycles recorded, result from this evaluation. For representative fatigue results which correspond with a constant curve of the dynamic rate within specified limits, the V 50% curve (Gaussian normal distribution) shall be determined for a representative number of at least 5 test parts per batch and per test force level.

5.3 Test Documentation.

5.3.1 Drawing Specification.

5.3.1.1 Durability Test. The drawing specification for the durability test to paragraph 4.3.1 includes the following:

Test forces, test frequencies, minimum specified cycles until first crack (statistically), maximum allowed set under the effect of preload F_m at specified cycles (computation see paragraph 7.1.1.2).

Installation position and load directions of test forces are specified by the relevant drawing.

5.3.1.2 Dynamic Characteristics. The values specified in the drawing for the fatigue test to paragraph 4.3.1 include the following details in addition to paragraph 5.3.1:

The initial statistical values of special dynamic characteristics and their maximum allowed deviation until the specified number of cycles.

5.3.2 Test Report.

5.3.2.1 Durability Test. When testing to paragraph 5.3.1 the test report shall include the following details:

- a. Title
- b. Name and number of test part, drawing number.
- c. Manufacturer.
- d. Date of manufacture, supply, or receipt.
- e. Serial of manufacturer's number.
- f. Name of plastic or elastomer quality.
- g. Title of test specification.
- h. Test forces specified to drawing.
- i. Number of cycles until first crack of each part or N 90% value for cycles until first cracks plus number of test parts, including graphic representation and dispersion ratio (N 90%/N 10%) compared to the values specified to drawing (statistics for cycles until first crack: Gaussian Normal Distribution Statistics).
- j. Maximum surface temperature during fatigue test.
- k. Observation notes during the single tests.

5.3.2.2 Dynamic Characteristics. When testing according to paragraph 4.3.1 the test report shall include the following details:

5.3.2.2.1 A through J, see paragraph 5.3.2.1.

5.3.2.2.2 K Single values or V 50% value including dispersion of the special dynamic characteristics (statistics for initial values: Gaussian normal distribution) in comparison with the values specified in the drawing.

5.3.2.2.3 L Maximum deviation of the V 50% curve (statistics of the curve of the dynamic characteristics during the durability test: Gaussian normal distribution) until the specified cycles and until failure in comparison with the maximum allowed dispersion to drawing. Graphs may be added.

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.