



Force-Deflection Characteristics of Elastomeric Components under Bi-axial Stress

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. Determination of spring characteristic of elastomeric components. The test, according to this test procedure, provides information on the visco-elastic behavior of the elastomers used.

1.2 Applicability. All elastomeric components.

2 References

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

2.1 External Standards/Specifications.

DIN 862

DIN 876

DIN 878

DIN 6370

2.2 GM Standards/Specifications.

GMW14734

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.

3.2 Equipment.

3.2.1 Universal Testing Machine. For stressing of elastomeric components up to 50 kN maximum with constant velocity (maximum deviation $\pm 10\%$), short form in text universal testing machine.

- **Force measurement:** $\pm 1.5\%$ of the relevant value.
- **Deflection measurement:** ± 0.05 mm.

3.2.1.1 Total deformation of universal testing machine frame, testing and clamping devices etc. $\leq 1\%$ of deformation of the elastomeric components subjected to force $F_{\max}$ ($+F_v$). In this case, correction of the measurement results by the deformation of the testing machine is not necessary.

3.2.1.2 If the deformation of universal testing machine frame, testing and clamping devices etc., is within the range $> 1\%$ to $\leq 10\%$ of deformation of the elastomeric components, then correction of the measurement results shall be performed.

3.2.1.3 Measurements with testing equipment, in which deformation $> 10\%$ of the deformation of the elastomeric components are not permissible.

Note: The measurement of deformation of the testing equipment shall be performed using a **rigid substitute body** under the same testing and configuration parameters as the component measurement.

3.2.1.4 The velocity v_i shall be selected according to the application. The correction measurement shall cover the entire evaluation area.

3.2.1.5 The **rigid substitute body** is defined as the outer contour of the elastomeric component pressed into the corresponding component mount, according to the relevant component drawing, with an inserted pin.

3.2.1.6 The pin shall be tightened to the specified torque according to the elastomeric component drawing.

3.2.1.7 A test device for applying an additional constant force F_j to the elastomeric component hereafter referred to as the "test device".

3.2.1.8 A test device which enables a stress to be gradually applied to the elastomeric component, up to a force $F_j = F_{vj} + F_{j \max}$ at a constant velocity of $1.25 \pm 0.10 \times 10^{-3} \text{ m s}^{-1}$, and subsequently maintains this force at a constant value. The moment at which the force reaches its maximum value shall be indicated by the test device. The test device shall span a range of force from 50 N to 4000 N with an accuracy of $\leq 10 \text{ N}$.

3.2.1.9 Test devices which apply the force by means of suitable masses, such as lever systems, are preferred.

3.2.1.10 Workbench with machine vice 160 DIN 6370.

3.2.1.11 Measuring plate according to DIN 876 made of cast iron, $400 \times 400 \text{ mm}$.

3.2.1.12 Testing and clamping devices for installing and fastening the elastomeric components on the universal testing machine. Roller tables and roller or ball straight-line mechanisms for forces up to 10 kN.

3.2.1.13 Stop watch or clock with a display range of 600 s and a reading accuracy of 0.1 s.

3.2.1.14 Dimensional Measuring Equipment.

3.2.1.14.1 Dimensional change measuring instrument, e.g., dial gauge according to DIN 878 with a display range of 25 mm, a measuring accuracy of $\pm 0.01 \text{ mm}$ and constant measuring force over the measuring path of $< 2 \text{ N}$.

3.2.1.14.2 Dimensional measuring instrument, e.g., caliper gauge according to DIN 862.

3.2.1.14.3 Dimensional measuring instrument, e.g., high-accuracy marking gauge with fine adjustment of the slider, vernier 0.1 mm, marking height 500 mm maximum.

3.3 Test Vehicle/Test Piece.

3.3.1 Test Material.

3.3.1.1 Test Sample Form. Test samples are elastomeric components (elastomeric components or elastomeric/metal components), which are used as components in vehicles.

3.3.1.2 Number of Test Samples. At least three (3) test samples shall be tested.

3.4 Test Time. Per Section 4.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Conform to company and/or laboratory requirements. Technician training records must be available upon request.

4 Procedure

4.1 Preparation.

4.1.1 Test Sample Preparation. For initial sampling and in cases of arbitration, the test shall be performed no earlier than 7 days, and for continuous quality control no earlier than 72 h, after vulcanization. Before testing, the test samples shall be stored in an unstressed condition for at least 8 h at $+23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$.

4.1.1.1 Summary of Test Method. Testing of the deformation of elastomeric components for vehicles (elastomeric components or elastomeric/metal components) with constant velocity at $+23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$.

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 Test Procedure.

4.3.1.1 General. The test sample shall be tested according to the data shown in the test specifications and the design drawings of the elastomeric component with regard to installation instructions, stressing devices etc., as well as in accordance with the relevant test procedure. Between two tests on the same test sample, a period of at least 24 h shall elapse.

Before testing, the weight of the test sample, the testing and clamping devices etc. shall be compensated on the universal testing machine and test device, if this has an influence on the force display or the forces F_i and F_j .

4.3.1.2 Determination of Height h_{0i} . The height h_{0i} shall be measured according to GMW14734 at $+23\text{ °C} \pm 5\text{ °C}$, if this value is required for the elastomeric component.

4.3.1.3 Test Procedure. The test sample shall be stressed with $F_j = F_{vj}$ at a velocity of $1.25 \pm 0.10 \times 10^3\text{ m/s}$, the dimensional change measuring equipment shall be set to zero ($s_j = 0$), and the stress shall be reduced with an equal speed to zero $F_j = 0$. This cycle shall be repeated until the deflection change under stress F_{vj} is $\leq 0.01\text{ mm}$ (normally three (3) cycles will be sufficient).

The zero point of the dimensional change measuring equipment is then fixed.

4.3.1.4 Increase the force, applied to the elastomeric component under test, at a velocity of $1.25 \pm 0.10 \times 10^3\text{ m/s}$ until the total force of $F_j = F_{vj} + F_{j\text{ max}}$ is applied. This time is $t = t_0$, and shall be indicated by the test device. The measuring period shall commence at this time. The force F_j , applied to the elastomeric component, is maintained at a constant value during the remainder of the test.

4.3.1.5 The test sample shall be stressed $600\text{ s} \pm 10\text{ s}$ from time t_0 , with $F_i = F_{vi}$ and v_i shall be measured if required. Set force indicating equipment to $F_i = 0$, and displacement indicating equipment to $s_i = 0$, then proceed according to diagram in Appendix A, Figure A1.

4.3.1.6 Stress the test sample with the additional force $F_i = F_{i\text{ max}}$ at the velocity v_i , and subsequently reduce the force at the same speed by the value $F_{i\text{ max}}$. In addition, at specified values of F_i the relevant values of s_j shall be determined.

4.3.1.7 Repeat the stress cycle according to 4.3.1.5, three (3) times.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results.

5.3 Test Documentation.

5.3.1 Evaluation and Rating.

5.3.1.1 Record the initial curve $F_i = f(s_i, F_{vj} + F_{j\text{ max}})$ on the force-deflection characteristic.

5.3.1.2 Record the spring characteristic $F_i = f(s_i, F_{vj} + F_{j\text{ max}})$ on the same force-deflection characteristic of $F_i = F_{vi}$ to $F_i = F_{vi} + F_{i\text{ max}}$ during the fourth stress cycle and also determine the deflection s_{fi} .

5.3.1.3 Determination of the spring rate c_i at the point P of the spring characteristic (5.3.1.2).

Note: For tolerance specifications, the spring characteristic $F_i = f(s_i, F_{vj} + F_{j\text{ max}})$ and the deflection s_{fi} according to 5.3.1.2, as well as the spring rate c_i according to 5.3.1.3 and the height h_{0i} shall be used.

The tolerance range zero point for the spring characteristic $F_i = f(s_i, F_{vj} + F_{j\text{ max}})$ can be moved along the abscissa of the force-deflection characteristic via the deflection $s_{fi\text{ max}}$.

5.3.2 Report.

5.3.2.1 With reference to this standard, the test report shall also include the following:

- Part name.
 - Part number or drawing number.
 - Test specification number.
 - Additional identification.
 - Grade of elastomer.
 - Manufacturer, date of manufacture.
 - Date of test.
 - Test sample serial number.
- 5.3.2.2** Furthermore, the following shall be specified.
- Initial forces F_{vi} and F_{vj} in N.
 - Forces $F_{i\text{ max}}$ and $F_{j\text{ max}}$ in N.