



SURFACE VEHICLE STANDARD

J3079™-2

JUL2016

Issued

2016-07

Low-preload Deflection Measurement for Brake Pads, Noise Shims, and Brake Pad Assemblies

RATIONALE

This standard addresses brake pad deflection characteristics similar to SAE J2468 with the following refinements:

- The brake system pressure range is from 30 kPa to 13000 kPa
- Test results are summarized both graphically and in tabular format
- Includes guidelines to improve the accuracy and repeatability
- Includes a description of a test procedure for noise insulators

The deflection characteristics of friction materials, noise insulators, and disc brake pad assemblies are commonly used in caliper and brake system design as well as for quality control during manufacturing. Pad deflection influences many design characteristics including brake fluid consumption, caliper stiffness and mass, caliper piston retraction, and park brake adjustment. The deflection also influences performance characteristics including brake pedal travel, brake drag, park brake performance, and the propensity of the brake system to generate noise and roughness.

1. SCOPE

This SAE Standard specifies a method for measuring the deflection of friction materials, noise insulators, and disc brake pad assemblies to be used in road vehicles with a Gross Vehicle Weight Rating below 4336 kg.

This part of the SAE J3079 includes the test for deflection and creep at various pressures under ambient temperature conditions.

This SAE test method differs from SAE J2468 and ISO 6310 in the preload and maximum load applied to the test sample when deflection is measured. It also introduces additional measurements such as for deflection offset, hysteresis, and creep.

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Documents

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2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J160 Swell, Growth, and Dimensional Stability of Friction Materials and Noise Insulators when Exposed to Elevated Temperatures

SAE J2468 Road Vehicles – Brake Linings – Compressibility Test Procedure

2.1.2 ISO Publications

Copies of these documents are available online at <http://webstore.ansi.org/>

ISO 6310 Road Vehicles – Brake Linings – Compressive Strain Test Methods

2.1.3 EKB/VDA publications

Available from German Association of the Automotive Industry (VDA), Behrenstraße 35, 10117 Berlin, Tel: +49 30 897842-0, www.vda.de/en

EKB 1108 Compressibility Test for Anti-Noise Shims

3. DEFINITIONS

Table 1 – Symbols and definitions

Symbol	Definition	Units
A_o	Brake pad contact area with the rotor	mm ²
A_p	Piston(s) hydraulic area	mm ²
A_s	Sample or coupon contact area with heating platen	mm ²
C_i	Inner chamfer of piston adaptor	mm
C_{load}	Creep	µm
C_o	Outer chamfer of piston adaptor	mm
d_c	Corrected deflection	µm
d_e	Machine deflection	µm
d_m	Measured deflection	µm

Table 1 – Symbols and definitions (continued)

d_o	Deflection offset	μm
d_z	Zeroed deflection	μm
h_{cycle}	Hysteresis for the entire cycle	%
h_{load}	Hysteresis as a specific steps (equivalent hydraulic pressure or force) within the cycle	μm
h_o	External height of the piston simulator without the interface feature with the upper platen	mm
h_i	Internal depth of the piston simulator	mm
F	Total force applied to the sample during testing	N
P_{eq}	Equivalent Hydraulic Pressure	kPa
t_a	Total assembly thickness	mm
t_b	Backing plate (or shoe table) thickness	mm
t_f	Friction material thickness	mm
r_i	Inner radii of piston adaptor	mm
r_o	Outer radii of piston adaptor	mm

3.1 Compressibility

Compressibility is the transient deflection or reduction in thickness of the test sample due to compressive load. Deflection is measured in the direction of the applied load, perpendicular to the friction surface. Deflection or reduction in thickness is measured in micrometers (μm).

3.2 Corrected Deflection - d_c

Measured deflection minus the machine deflection using Equation 1:

$$d_c = d_m - d_e \quad \text{Eq. 1}$$

3.3 Creep - C_{load}

Creep is the tendency of the test sample to deform gradually while under clamp load. Creep is calculated using deflection data that is zeroed prior to the 3rd loading cycle. Creep is calculated at discrete pressure levels by subtracting the zeroed deflection at the discrete pressure during the third loading cycle from the zeroed deflection 0.5 seconds prior to the end of the creep load condition. Use Equation 2.

$$C_{\text{load}} = d_z @ \text{load } 0.5 \text{ s prior to the end of the creep loading condition} - d_z @ \text{load during 3rd cycle apply} \quad \text{Eq. 2}$$

3.6 Hysteresis per Cycle - h_{cycle}

The graph shows deflection in μm on the y-axis and force in N on the x-axis. Two blue curves represent the loading and unloading paths. The loading curve starts at point 'a' and ends at point 'd'. The unloading curve starts at point 'd' and ends at point 'c'. A hysteresis loop is formed by the loading curve (a to d) and the unloading curve (d to c). A vertical dashed line at force F_{z_i} intersects the loading curve at point 'e' and the unloading curve at point 'a'. A vertical dashed line at force F_{z_i+1} intersects the loading curve at point 'b' and the unloading curve at point 'c'. A horizontal dashed line at deflection d_{z_i} intersects the loading curve at point 'a' and the unloading curve at point 'c'. A horizontal dashed line at deflection d_{z_i+1} intersects the loading curve at point 'b' and the unloading curve at point 'd'. A shaded rectangular area is bounded by the loading curve (a to b), the unloading curve (c to d), and the vertical dashed lines at F_{z_i} and F_{z_i+1} . An arrow points to this shaded area with the text: "area corresponding to the energy stored from F_{z_i} to F_{z_i+1} ".

Area a-c-d-e: total energy stored within the hysteresis loop

Figure 1 – Deflections and forces to calculate cycle hysteresis

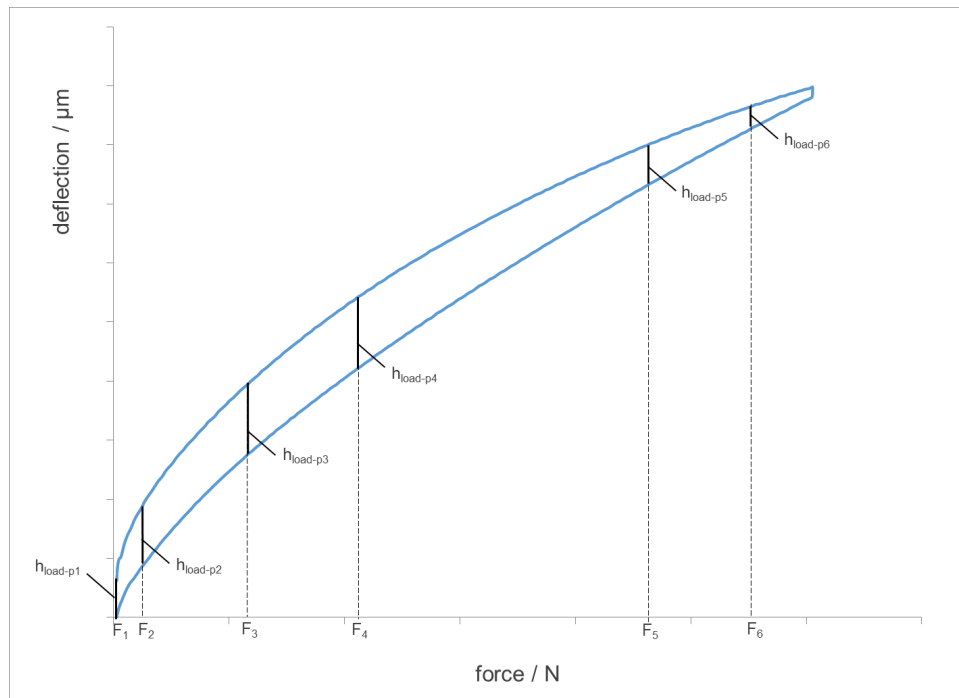
$$h_{load} = \frac{E_{release} - E_{apply}}{E_{apply}} \quad \text{Eq. 3}$$

$$E_{\text{applied}} = \sum_{z=1}^n (F_{z+1} - F_z)(d_{z+1, \text{applied}} + d_{z, \text{applied}})/2 \quad \text{Eq. 4}$$

$$E_{release} = \sum_{z=1}^n (F_{zi+1} - F_{zi})(d_{zi+1 release} + d_{zi release})/2 \quad \text{Eq. 5}$$

3.7 Hysteresis at Load - h_{load}

Hysteresis for a given load is defined as the difference between the deflection during the release step minus the deflection during the apply step. Use the zeroed deflection d_z for this calculation. Use Equation 6; see Figure 2.



$F_1, F_2, \dots, F_6$: specific load steps or loads equivalent to specific hydraulic pressure levels

$h_{load-p1}, h_{load-p2}, \dots, h_{load-p6}$: hysteresis for load steps 1-to-6

Figure 2 – Deflections and forces to calculate hysteresis

$$h_{load-i} = d_{zi\ release} - d_{zi\ apply}$$

Eq. 6

3.8 Load Cycle

Load cycle is the loading of the test sample that occurs after the preload. For this test procedure, the load cycle uses a constant rate to apply load during the apply and release conditions, with a constant load dwell time at the maximum and at the minimum loads.

3.9 Measured Deflection - d_m

Deflection measured during the test.

3.10 Machine Deflection - d_e

Deflection measured during the third cycle of the machine deflection test.

3.11 Piston Hydraulic Area - A_p

Area of the caliper bore used to convert the test system's actuator load to equivalent hydraulic pressure. This area is generally larger than the area calculated using the outside diameter of the piston simulator.

3.12 Piston Simulator

Piston simulator is a device used to apply the load to the test sample replicating the interface of the caliper piston(s) from the caliper assembly.

3.13 Preload

Preload is the steady state load applied to the test sample prior to the load cycle. For this procedure, the preload was reduced compared to other industry standard tests to more closely match how the test sample is preloaded in a brake caliper.

3.14 Zeroed Deflection - d_z

Corrected deflection adjusted to 0.0 μm during the pre-load condition 0.5 seconds prior to the loading cycle. Use Equation 7.

$$d_z = d_c - d_o$$

Eq. 7

4. EQUIPMENT

Table 2 – Minimum test system capabilities and specifications

Parameter	Minimum Requirement or Capability
The test facilities and equipment shall be in good working order and shall have a valid calibration label	Calibration records
Load capacity for hydraulic brake applications – allows for 13,000 kPa equivalent hydraulic pressure for a twin 51 mm piston simulator. Larger applications will need a larger actuator.	53 kN minimum
Analog-to-digital converter for force measurement	16-bit minimum
Rate to apply the equivalent system pressure	(1000 to 10 000) kPa/s
Control of equivalent pressure at pre-load	± 5 kPa
Control of equivalent pressure at target load	± 10 kPa
Rated accuracy for instrumentation controlling equivalent system pressure	± 5 kPa
Signal noise for instrumentation controlling equivalent system pressure	≤ 5 kPa
Resolution of deflection measuring device	± 0.1 μm
Force exerted on piston simulator by the deflection measuring device	≤ 1 N
Flatness and parallelism of steel plate	≤ 2 μm
Temperature control accuracy of heating platen	± 2 $^{\circ}\text{C}$
Sampling rate for force and deflection measurement	1 to 1000 Hz
Sampling rate for temperature measurement	1 to 50 Hz minimum

4.1 Facilities

Test facility capable of maintaining test equipment and test hardware at (23 ± 5) $^{\circ}\text{C}$ and $(50 \pm 10)\%$ RH.

4.2 Test Stand

A compressibility test stand with uniaxial load frame and loading device that provides loading of the test specimen similar to how it is loaded by the piston and rotor in a brake caliper assembly.

4.3 Alignment System

The test stand must have self-alignment capability to allow the piston simulator to align its contact surface to the specimen under test. The alignment system cannot cause extra compliance in the deflection measurement of the test specimen.