



SURFACE VEHICLE RECOMMENDED PRACTICE

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Deflection Measurement for Friction Materials Using Segment Applicator

RATIONALE

Legacy test methods to measure the deflection under a load of friction materials use destructive sampling to control the measurement using a known stress load. This SAE Recommend Practice addresses the brake pad deflection characteristics similar to SAE J2468, with the following refinements:

- Use of a 25 mm diameter flat plunger to apply stress on the brake pad material applied stress between 0.5 MPa and 8.0 MPa.
- Use of graphical and tabular formats to summarize and present the test results.
- Inclusion of guidelines to improve the accuracy and repeatability of the test method.
- Use of the complete brake pad assembly without the need to cut segment for testing.

The deflection characteristics of friction materials 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 Recommend Practice specifies a method for measuring the deflection of friction materials and disc brake pad assemblies in a manner more consistent with classical material compressive strain testing.

This SAE test method differs from SAE J2468 in the preload and maximum load applied to the test sample when deflection is measured. It adopts the material applied stress levels found in ISO 6310 (0.5 to 8.0 MPa) using a 25 mm diameter flat plunger.

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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 J2468 High-Preload Deflection and Compressibility Test Procedures for Friction Materials

SAE J2986 Brake Pads, Lining, Disc, and Drum Wear Measurements

SAE J3079/1 Validation of Compressibility Test Systems for Friction Materials

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

3. DEFINITIONS

Table 1 - Symbols and definitions

Symbol	Definition	Units
c _o	Outer chamfer of plunger	mm
d _c	Corrected deflection	µm
d _e	Machine deflection	µm
d _m	Measured deflection	µm
d _o	Deflection offset	µm
d _z	Zeroed deflection	µm
F	Total force applied to the sample during testing	N
t _a	Total assembly thickness	mm
t _b	Backing plate (or shoe table) thickness	mm
t _f	Friction material thickness	mm
r _o	Outer radii of piston adaptor	mm

3.1 COMPRESSIBILITY

Transient deflection or reduction in thickness of the test sampled 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).

3.1.1 UNIT COMPRESSIVE MEASUREMENT (UCM)

This is another term for segment or specific compressibility.

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 DEFLECTION OFFSET (d_o)

Deflection offset is the corrected deflection value 0.5 second prior to the loading cycle.

3.4 LOAD CYCLE

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.

3.5 MEASURED DEFLECTION (d_m)

Deflection measured during the test.

3.6 MACHINE DEFLECTION (d_e)

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

3.7 PLUNGER

Device used to apply the load to the test sample.

3.8 PRELOAD

Steady-state load applied to the test sample prior to the load cycle.

3.9 ZEROED DEFLECTION (d_z)

Corrected deflection adjusted to 0.0 μm during the pre-load condition 0.5 second prior to the loading cycle. Use Equation 2.

$$d_z = d_c - d_o \quad (\text{Eq. 2})$$

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
Operating load range	200 to 4000 N
Analog-to-digital converter for force measurement	16 bit minimum
Rate to apply the load	1841 N/s $\pm$ 10 N/s
Control of load at pre-load	± 5 N
Control of load at target load	± 10 N
Rated accuracy for instrumentation controlling load	± 1 N
Signal noise for instrumentation controlling load	≤ 1 N
Resolution of the deflection measuring device	$\pm 0.15 \mu\text{m}$
Force exerted on the plunger by the deflection measuring device	≤ 1 N
Flatness and parallelism of steel plate	$\leq 2 \mu\text{m}$
Sampling rate for force and deflection measurement	1 to 1000 Hz

4.1 Facilities

Test facility capable of maintaining test equipment and test hardware at 23 °C $\pm$ 5 °C and 50% $\pm$ 10% RH.

4.2 Test Stand

A compressibility test stand with a uniaxial load frame and loading device that provides loading of the test specimen such that the plunger applies stress to the friction material surface while the backplate is supported by a base designed to allow for positioning without nibs/pips interference.

4.3 Alignment System

The test stand must have a 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.

4.4 Deflection Measurement Device

Use a device for measuring piston simulator deflection with a resolution of $\leq \pm 0.15 \mu\text{m}$. Deflection measurement device shall exert less than 1.0 N of force during measurement.

4.5 Test Stand Verification

Verify the control and measurement capability of the test stand: perform a gage repeatability and reproducibility study with at least ten preselected test samples and at least three operators, with three repeats each.

NOTE: Refer to SAE J3079/1 for a recommended practice on test system validation.

4.6 Plunger

The 25 mm dia plunger is a device that applies the load from the test stand to the test sample (onto the friction surface). Plungers shall be mounted onto some form of flexible mounting to allow for alignment compensating for parallelism issues between friction surface and steel back of a disc pad assembly and mount directly into the loading device. Deflection shall be measured between the 25 mm dia plunger surface and sample support base.

NOTE 1: The plunger is a precision device. It must be protected during storage to avoid contact with other parts and it must be stored in an environmentally controlled location. Conduct a visual inspection before and after testing. Verify the surface topography at least annually using optical or laser holography methods. Verify flatness and parallelism to be within specification. If any part of the plunger shows surface damage (nicks, corrosion, or excessive material deposits), it should be reworked, re-qualified, or replaced. See Figures 3 and 4 for illustrations.

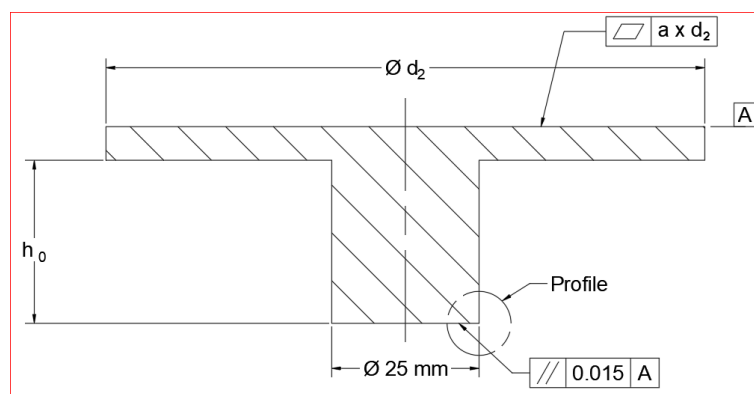


Figure 3 - Basic geometry for plunger
(a = 0.0000635 mm/mm; d₂ = adapter diameter to fit adapter fixture; h₀ should be minimized)

NOTE 2: Unless otherwise specified by the test requestor, the default piston simulator uses a radius (r₀) of 0.1 mm. See Figure 4.