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Road vehicles — Brake linings — Compressive strain test method

Véhicules routiers — Garnitures de freins — Méthode d'essai de la compressibilité

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6310 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Braking systems and equipment*.

This second edition cancels and replaces the first edition (ISO 6310:1981), which has been technically revised.

Annex A forms a normative part of this International Standard. Annex B is for information only.

Introduction

The compressive strain of a brake lining is an important design parameter in the evaluation of brake-fluid volume displacement, brake-pedal travel and the propensity for judder or noise.

Road vehicles — Brake linings — Compressive strain test method

1 Scope

This International Standard specifies a method for test and measurement of the compressive strain of brake linings which is applicable to road-vehicle disc-brake pad assemblies, drum-brake shoe assemblies and friction materials without a backing plate.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 611, *Road vehicles — Braking of automotive vehicles and their trailers — Vocabulary*.

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 611 and the following apply.

3.1
compressive strain
ε
ratio of the reduction in thickness of the brake lining, due to compressive forces and temperatures, to its initial thickness (measured in the direction of the application force, perpendicular to the friction surface)

4 Symbols and units

Table 1 gives the symbols and corresponding units used in this International Standard.

Table 1 — Symbols and units

Symbol	Description	Unit
i	Test sample	—
x	Test load [a]	—
$\overline{d_i}$	Average thickness of i	mm
$\Delta d_{i,x,\mathrm{tot}}$	Total deflection measured by the test equipment at x for i	µm
$\Delta d_{e,x}$	Deflection of the test equipment itself at x	µm
$\Delta d_{i,x}$	Net deflection of i at x (allowing for test-equipment deflection)	µm
n	Number of test samples	—
$\varepsilon_{i,x}$	Individual compressive strain of i at x	—
$\overline{\varepsilon_x}$	Mean compressive strain of n samples at x	—
t_1	Test temperature for hot test	°C
t_2	Highest temperature of hot test	°C
$\varepsilon_{i,x} = \frac{\Delta d_{i,x}}{\overline{d_i}}$ $\overline{\varepsilon_x} = \frac{\sum_{i=1}^{i=n} \varepsilon_{i,x}}{n}$		
[a] Test load x is a constant value of 1 MPa, 2 MPa, 4 MPa and 8 MPa for pads, and 1,5 MPa and 3 MPa for linings.		

5 Principle

Either of two procedures may be used for applying the test load:

a) a force to give a unit area pressure (procedure A, the default test method), expressed in megapascals;

b) pressure equivalent to hydraulic line pressures acting on the vehicle braking system (procedure B), expressed in bar[1)].

Procedure B is normally used when the braking system is hydraulically activated.

Test results from procedure A and procedure B should not be directly compared.

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2

6 Test equipment

The test equipment shall consist of the following:

a) ram (or dummy-piston) with a mechanism to facilitate uniform loading;

b) plate designed to give protection from corrosion and avoid deformation and material adherence;

c) loading device able to compress the lining between the ram and the plate;

d) device for measuring, to a guideline accuracy of 100 N, the compressive force between the plate and the ram;

e) gauge for measuring, to an accuracy of 0,001 mm, the reduction in thickness of the sample on the plate and in contact with the ram near its centreline;

f) heating device for raising the temperature of the plate to that specified (see 7.2);

g) micrometer.

In addition, an optional device can be used for measuring the temperature of the test sample.

7 Test-rig specifications

7.1 Loading

The maximum force shall be that which gives a lining pressure against counterface at the friction surface of 8 MPa for a disc-brake pad, and 5 MPa for a drum-brake lining (procedure A). Alternatively (procedure B), a force corresponding to a vehicle line pressure of up to 160 bar into the brake may be applied.

The load shall be increased at a rate of approximately $(4 \pm 0,5)$ MPa·s^{-1} for procedure A or (80 ± 10) bar·s^{-1} for procedure B.

7.2 Hot plate

For the hot test, t_1 on the surface shall be 400 °C (but may be lower or higher in special cases).

7.3 Loading ram

7.3.1 General

For disc-brake pads, the sample should be a pad assembly or section of an assembly in the case, for example, of a commercial-vehicle pad. The lining sample shall be agreed between the respective parties, but sample type I or III could be used (see 7.3.2 and 7.3.4).

The following subclauses give the loading-ram specifications for the different test sample types.

7.3.2 Sample type I (friction material without backing plate)

The face of the ram shall be flat and the periphery shall at least circumscribe the periphery of the sample (see Figure 1).

7.3.3 Sample type II (disc-brake pad assembly)

Under normal circumstances, the surface of the ram shall have the same form (e.g. solid or annular piston) and location as the actual contact surface of the piston or pistons of the brake to which the pad is fitted.

However, as many basic brake configurations exist (finger callipers, double pistons etc.), a single piston may be used for the test.

If calculating in unit area pressure, the actual friction material area in contact with the mating face shall be used.

See Figure 2.

7.3.4 Sample type III (drum-brake shoe assembly)

The ram shall have the same curvature as the inside curvature of the shoe. Ideally, for a curved sample, the arc should be about 40 mm, or of a size that gives an equal ratio of length to width. See Figure 3.

Sample type I is to be preferred for cases where curvature could influence the results.

8 Sampling

Five samples should be measured for the room temperature test.

The flatness of the sample and its surface roughness should be the same as that of normal production; otherwise, the test results could be influenced.

Depending on the specific need, disk-brake pad assemblies (sample type II) may be tested either with or without anti-noise shims or rubber coatings. This shall be recorded in the test report.

Heat-transfer measurements may be taken where needed (see Figure 4 for the location of the measuring device).

9 Procedure

9.1 General

9.1.1 Using a micrometer, measure the thickness of the sample at five points, as shown in Figure 5 a). Calculate the average value of the thickness, $\overline{d_i}$. If the pad sample contains a slot, take the measurements as shown in Figure 5 b).

9.1.2 Place the sample on the heating plate at room (ambient) temperature [(23 ± 5) °C], with its friction surface against the surface of the plate and with the ram correctly located to simulate real conditions.

9.2 Test cycle

9.2.1 Room temperature test

9.2.1.1 Perform three loading and unloading cycles, starting from a preload of 0,5 MPa (procedure A) or 5 bar (procedure B), holding this for 1 s and then increasing to the maximum required pressure at the maximum load rate (see 7.1.)

9.2.1.2 Carry out deflection measurements by zeroing the gauge while holding the sample at preload and taking displacement readings, $\Delta d_{i,x,\mathrm{tot}}$, at the maximum load x on the first and third cycles.

On the third cycle, thickness reduction readings, $\Delta d_{i,x,\mathrm{tot}}$, can be taken on the increasing pressure phase at 1 MPa, 2 MPa and 4 MPa for pads, and 1,5 MPa for linings.

If more than three cycles are performed this shall be stated in the test report.

9.2.2 Hot test

9.2.2.1 Remove the sample from the heating plate.

9.2.2.2 Heat the plate to the stabilized surface temperature of $t_1 \pm 10$ °C.

9.2.2.3 Place the sample on the heating plate and apply a preload of 0,5 MPa (procedure A) or 5 bar (procedure B) to ensure good thermal contact. Maintain the load for 10 min ± 30 s.

9.2.2.4 For heat transfer, record temperatures at the backing plate, t_2.

9.2.2.5 Perform two cycles, as for the first and third cycles of 9.2.1.

9.2.2.6 On completing the test, cool the equipment to ambient temperature.

The test cycle is illustrated in Figure 6.

10 Test-device deflection compensation

It is accepted that during compressive testing of friction material the test device itself will also deflect. This deflection, $\Delta d_{e,x}$, shall be compensated, either manually or automatically, in order to determine the net displacement of the friction-material sample, i, given by the equation:

$$\Delta d_{i,x} = \Delta d_{i,x,\mathrm{tot}} - \Delta d_{e,x}$$

Measure $\Delta d_{e,x}$ by loading the ram with the piston in place on the base plate without a sample, but with a hardened steel plate to prevent damage to the heating plate, then reading the displacement gauge at the different pressures given in clause 9.

11 Report

A specimen test report is presented in annex B. Other formats are acceptable provided they include at least the following information:

— manufacture and reference of brake lining including batch reference;

— type of sample (type I, II or III), reference to any additional coatings, shims etc;

— size of the sample (pad area);

— number of samples n;

— assembly thickness $\overline{d_i}$ in millimetres to an accuracy of 0,1 mm;

— thickness of friction material;

— piston size (in the case of a disc pad).

— procedure adopted (A or B);

— the mean value for cold compressive strain for the n samples ($\overline{\varepsilon_x}$);

— the mean value for hot compressive strain for the n samples ($\overline{\varepsilon_x}$).