International Standard ISO 4385

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Plain bearings — Compression testing of metallic bearing materials

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4385 was developed by Technical Committee ISO/TC 123, *Plain bearings*, and was circulated to the member bodies in January 1979.

It has been approved by the member bodies of the following countries :

Australia	India	Romania
Bulgaria	Italy	South Africa, Rep. of
Chile	Korea, Rep. of	Spain
Czechoslovakia	Libyan Arab Jamahiriya	Sweden
Egypt, Arab Rep. of	Netherlands	United Kingdom
France	New Zealand	USA
Germany, F.R.	Poland	USSR

No member body expressed disapproval of the document.

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Plain bearings — Compression testing of metallic bearing materials

1 Scope and field of application

This International Standard specifies a method for the compression testing of metallic bearing materials.

Compression testing within the meaning of this International Standard serves for the determination of the behaviour of metallic materials under uniaxial compression loading which is uniformly distributed over the cross-section. For this purpose, a cylindrical specimen with an original cross-section S_0 is subjected to compression which is slowly and continuously increased, and the compressive force used is measured.

2 Definitions

2.1 compressive stress (nominal compressive stress) σ_d : At any moment of the compression test, the quotient of the compressive force F and the original cross-section S_0 :

$$\sigma_d = \frac{F}{S_0} \qquad \ldots (1)$$

2.2 compressive strength σ_{dB} : Quotient of the compressive force F_B (which is measured when the first crack or fracture occurs) and the original cross-section S_0 :

$$\sigma_{dB} = \frac{F_B}{S_0} \qquad \ldots (2)$$

If no crack occurs, the test is continued until a given total compression ϵ_{dt}. Then the compressive strength $\sigma_{d...}$ is the quotient of the compressive force F corresponding to this total compression and the original cross-section S_0; for example, at a given total compression of 50 % :

$$\sigma_{d50} = \frac{F_{50}}{S_0} \qquad \ldots (3)$$

NOTE — The given total compression shall not be exceeded : 50 %.

2.3 compressive limits : Quotients of the compressive forces F corresponding to a small ($\leqslant$ 2 %) non-proportional compression ϵ_{db} or to a permanent compression ϵ_{dr}, and the original cross-section S_0.

Specially stipulated compression limits are :

2.3.1 compression limit 0,2 %, $\sigma_{d0,2}$: Limit corresponding to a non-proportional or permanent compression of 0,2 % :

$$\sigma_{d0,2} = \frac{F_{0,2}}{S_0} \qquad \ldots (4)$$

In the case of metallic materials with a continuous compressive stress-compressive curve, the 0,2 % compression limit is determined instead of the compressive yield point (see 2.4).

2.3.2 compression limit 2 %, σ_{d2} : Limit corresponding to a non-proportional or permanent compression of 2 %.

$$\sigma_{d2} = \frac{F_2}{S_0} \qquad \ldots (5)$$

2.4 natural compressive yield point σ_{dF} : Quotient of the compressive force F_F (at which the compressive stress-compression curve begins to increase unsteadily simultaneously with the appearance of a noticeable permanent compression) and the original cross-section S_0.

$$\sigma_{dF} = \frac{F_F}{S_0} \qquad \ldots (6)$$

2.5 differential length ΔL_d : At any moment of the test, the difference between the original gauge length L_0 and the actual gauge length L.

$$\Delta L_d = L_0 - L \qquad \ldots (7)$$

If ΔL_d is divided by the original gauge length L_0, the result is the compression ϵ_d which is expressed as a percentage.

$$\epsilon_d = \frac{\Delta L_d}{L_0} \times 100 \qquad \ldots (8)$$

Depending on whether it is a question of elastic, non-proportional, permanent or total compression, the symbols ϵ_{de}, ϵ_{dp}, ϵ_{dr} or ϵ_{dt} respectively are used.

2.6 fracture compression (or compression at the first crack) ϵ_{dB} : Ratio between the permanent differential length ΔL_{dB}, after fracture or occurrence of the first crack in the specimen, and the original gauge length L_0, expressed as a percentage.

$$\epsilon_{dB} = \frac{\Delta L_{dB}}{L_0} \times 100 \qquad \ldots (9)$$

2.7 change in area ΔS_d : At any moment of the test, the difference between the largest resultant cross-section S and the original cross-section S_0 of the specimen.

$$\Delta S_d = S - S_0 \qquad \ldots (10)$$

If ΔS_d is divided by the original cross-section S_0, the result is the relative enlargement of the cross-section (bulging) q_d, expressed as a percentage.

$$q_d = \frac{\Delta S_d}{S_0} \times 100 \qquad \ldots (11)$$

2.8 relative enlargement of the fracture cross-section (fracture bulging) ψ_{dB} : Ratio between the permanent largest cross-sectional area ΔS_{dB} after the first crack of the specimen occurs and the original cross-section S_0, expressed as a percentage.

$$\psi_{dB} = \frac{\Delta S_{dB}}{S_0} \times 100 \qquad \ldots (12)$$

If the specimen fractures after the first crack, then the relative enlargement of the fracture cross-section cannot be determined.

3 Test equipment

The test is to be carried out on compression testing machines.

Pressure plates shall have planed and ground surfaces with a minimum Rockwell hardness of 60 HRC.

The differential length can be obtained by measuring the specimen itself or the distance between the two pressure plates. The method of obtaining the differential length shall be indicated in the test report.

4 Specimen shape and preparation

Cylindrical specimens are used. The ratio between the height h_0 and the diameter d_0 of a specimen is

$$\frac{h_0}{d_0} = 1 \qquad \ldots (13)$$

Specimens are preferred with a diameter of 20 mm. They are to be completely machined.

The end faces of the specimens are to be finely polished or ground. They are to be parallel and perpendicular to the axis of the specimen. The generated surface is to be finely polished or ground.

5 Test procedure

Before starting the compression test, the diameter d_0 and the height h_0 of the specimen shall be measured to an accuracy of 0,1 mm.

The specimen is centered in the compression testing machine or in the pressure application apparatus used in such a way that, if possible, the distance between the axis of the specimen and the line of effective applied force does not exceed 0,5 mm.

Before each compression test, both pressure plates should be slightly greased, for example with petroleum jelly.

5.1 Determination of the compressive strength

With an increase in stress of a maximum of 30 N/(mm^2·s), compress the specimen until fracture, the first crack occurs or the given total compression ϵ_{dt} is reached. Measure the required force and, in accordance with equation (2) or (3), determine the compressive strength. It is recommended that the compression stress-compression curve be drawn. Measure the compression to an accuracy of 0,1 mm.

5.2 Determination of compressive limits using a fixed measuring device to measure differential length

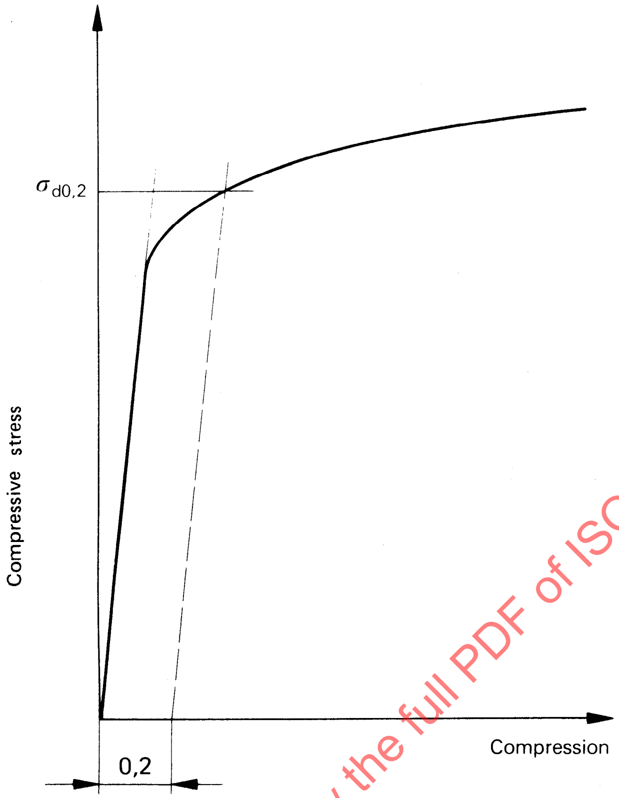
During this compression test requiring continuous measurement of the differential length by a measuring device fixed to the specimen (for example for the determination of the 0,2 % compression limit), continuously increase the load applied to the specimen with an increase in stress of a maximum of 30 N/(mm^2·s) until the non-proportional differential length corresponding to the compressive limit to be determined, has been reached. Then remove the measuring device from the specimen. Continue the compression test according to 5.1.

The measuring device shall permit determination of the non-proportional differential length corresponding to the compression at the required compressive limit, to an accuracy of 0,01 mm or 10 %, whichever is the larger.

Determine the stress corresponding to the non-proportional compression for the required compressive limit on the basis of the compressive stress-compression. For this purpose, for example, in the case of the 0,2 % compressive limit, draw a line in the compressive stress-compression diagram at a distance of 0,2 % compression, parallel to Hooke's straight line (see figure 1). The ordinate of the point of intersection with the compressive stress-compression curve is the required 0,2 % compressive limit.

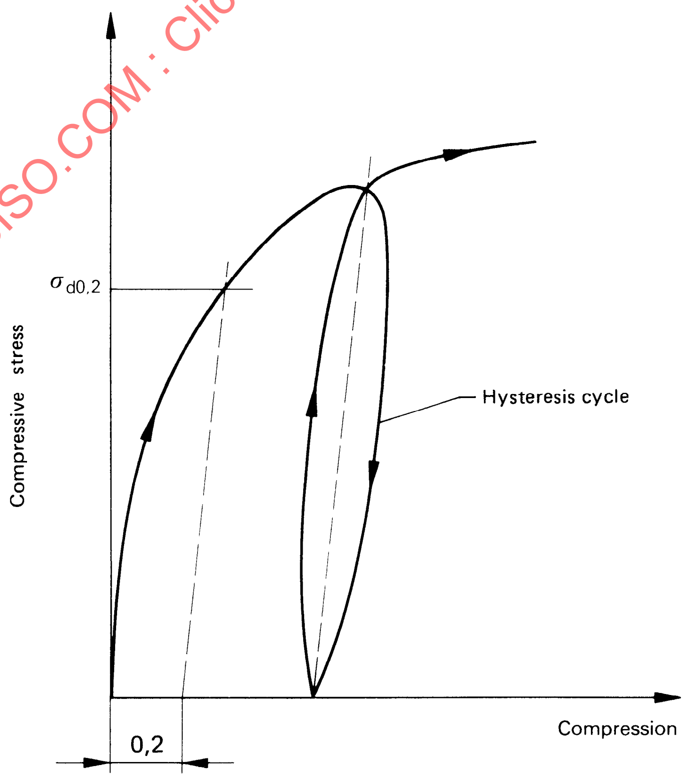
NOTE — If the compressive stress-compression curve is plotted using individual measuring points, use at least ten points approximately evenly distributed over the stress range.

If Hooke's straight line in the compressive stress-compression diagram is so short that the parallel line can not be drawn with sufficient accuracy, then it is recommended that the loading is removed from the specimen after the compressive limit has been reached and then reapplied. Draw the line parallel to the centre line of the hysteresis cycle (see figure 2). In the test report, it shall be indicated that this method has been used to determine the compressive limit.



NOTE — Graph not according to scale.

Figure 1 — Determination of the 0,2 % compressive limit $\sigma_{d0,2}$ with the help of a line parallel to Hooke's straight line at a distance of 0,2 % compression



NOTE — Graph not according to scale.

Figure 2 — Determination of the 0,2 % compressive limit $\sigma_{d0,2}$ with the help of a line parallel to the centre line of the hysteresis cycle at a distance of 0,2 % compression

5.3 Determination of the compressive limit by gradually increased force

Load the specimen with a gradually increased force for 30 s. After removal of the force or after reduction of the force to a preforce, measure the permanent differential length. Draw the compressive stress-compression curve on the basis of these measured values. The respective compressive limits are taken from this curve.

The permanent differential length can be measured :

a) as the change in height of the specimen after removal of the force and removal of the specimen from the compression testing machine;

b) by a differential length measuring device fixed to the specimen after reduction of the force to preforce.

The differential length measuring device shall be accurate to within 0,01 mm.

NOTE — As concerns 5.3 a) above, the specimen must be centered according to clause 5 when it is reinstalled in the compression testing machine.

6 Test report

The test report shall include the following information :

a) reference to this International Standard;

b) method of sampling and manufacturing of the specimen (for example chill casting : chill and casting temperature);

c) dimensions of the specimen;

d) method of measuring the differential length and, if necessary, the method of determination of the compressive limit in accordance with the note to 5.2;

e) lubricant used for greasing the pressure plates;

f) test temperature to an accuracy of 1 °C;

g) strength values σ_{dB}, σ_{d50}, $\sigma_{d0,2}$, σ_{d2}, σ_{dF}, in newtons per square millimetre, rounded off to the nearest whole;

h) deformation characteristic values ϵ_{dB}, ψ_{dB} expressed as a percentage, rounded off to the nearest whole number.