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**Metallic materials - Compression test method at elevated
temperature**

金属材料 高温压缩试验方法

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Table of Contents

1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols and descriptions	1
5 Principle	3
6 Test pieces	3
7 Test equipment	5
8 Test conditions	6
9 Determination of properties	7
10 Rounding of test results	10
11 Treatment of test results	10
12 Test report	10

1 Scope

The document specifies the principle, test pieces, test equipment, test conditions, determination of properties, rounding of test results, treatment of test results and test report for the compression testing of metallic materials at elevated temperature.

It applies to the determination, under uniaxial compression at a temperature above room temperature, of the proof strength for a non-proportional compressive extension, the proof strength for a total compressive extension, the upper compressive yield strength, the lower compressive yield strength, the compressive modulus of elasticity and the compressive strength.

2 Normative references

GB/T 7314 Metallic materials - Compression test method at room temperature; GB/T 8170 Rules of rounding off for numerical values and expression and judgement of limiting values; GB/T 10623 Metallic materials - Mechanical testing - Vocabulary; GB/T 12160 Metallic materials - Calibration of extensometer systems used in uniaxial testing; GB/T 16825.1 Metallic materials - Verification of static uniaxial testing machines - Part 1: Tension and/or compression testing machines - Verification and calibration of the force measuring system.

Dated references apply in the edition cited; undated references apply in their latest edition, including any amendments.

3 Terms and definitions

The terms and definitions of GB/T 7314 and GB/T 10623 apply, together with the following.

3.1 soaking time: the time for which the test temperature is held steady before the compressive force is applied.

4 Symbols and descriptions

Table 1 lists the symbols used in the document with their units and descriptions, grouped under test piece, deformation, force, proof and yield and compressive strength and modulus of elasticity, and temperature.

Test piece group, all in millimetres unless stated: original thickness of the test piece; original width of the test piece; original diameter of the test piece; height of the constraining device; length of the unconstrained part of a sheet test piece; length of the test piece; original gauge length of the test piece; and the original cross-sectional area of the test piece, in square millimetres.

Deformation group: the specified non-proportional compressive strain and the specified total compressive strain, both as percentages; the actual deformation of the original gauge length section under force and the deformation of the original gauge length section under force, both in millimetres; and the deformation magnification, dimensionless.

Force group, all in newtons: the actual compressive force, which for a test without lateral constraint equals the force at the upper end of the test piece; the force at the upper end of the test piece; the actual upper yield compressive force and the actual lower yield compressive force at yield; the friction force; the maximum actual compressive force during compression to failure for a brittle material, or the compressive force at the specified strain for a ductile material; and the actual compressive force at the specified non-proportional compressive deformation.

Strength and modulus group, all in newtons per square millimetre, with a note stating that one newton per square millimetre equals one megapascal: the compressive modulus of elasticity; the upper compressive yield strength; the lower compressive yield strength; the compressive strength of a brittle material or the compressive stress at the specified strain for a ductile material; the proof strength for a specified non-proportional compressive extension; and the proof strength for a specified total compressive extension.

Temperature group: the set or specified temperature at which the test is carried out, in degrees Celsius; the measured temperature at the surface of the test piece, in degrees Celsius; and the soaking time, in minutes.

5 Principle

An increasing uniaxial compressive force is applied along the axis of the test piece in an elevated temperature environment and the relevant compressive mechanical properties are determined.

6 Test pieces

6.1.1 The shape and dimensions of the test piece are to be designed so that: the compression within the gauge length is uniform and uniaxial throughout the test; the deformation measured by the extensometer equals the deformation of the gauge length section along the axis of the test piece; and the ends do not fail before the end of the test.

Cylindrical test pieces (Figure 1), square prism test pieces (Figure 2), sheet test pieces (Figure 3) and sheet test pieces with lugs (Figure 4) are recommended, and any other type of test piece meeting the requirements above may also be used. The key to Figure 1 gives the length of the test piece as 2.5 to 3.5 times, or 5 to 8 times, the original diameter, and the original diameter as 10 mm to 20 mm with a tolerance of plus or minus 0.05 mm. The key to Figure 4 gives the original gauge length as 50 mm with a tolerance of plus or minus 0.05 mm. All the figures are dimensioned in millimetres.

6.1.2 Figures 1 and 2 are test pieces without lateral constraint. Test pieces whose length is 2.5 to 3.5 times the original diameter, or 2.5 to 3.5 times the original width, are suitable for determining the proof strength for a non-proportional compressive extension, the proof strength for a total compressive extension, the upper and lower compressive yield strengths and the compressive strength. Test pieces whose length is 5 to 8 times the original diameter or the original width are suitable for determining the proof strength at a non-proportional compressive strain of 0.01 percent and the compressive modulus of elasticity. Test pieces whose length is 1 to 2 times the original diameter or the original width are suitable only for determining the compressive strength.

6.1.3 Figures 3 and 4 are sheet test pieces and are to be tested held in a constraining device.

6.1.4 The distance from either end of the original gauge length to the end face of the test piece is to be not less than half the diameter, or half the width, of the test piece.

6.1.5 The length of a sheet test piece is calculated by Formula (1) as the height of the constraining device plus the length of the unconstrained part.

6.1.6 The length of the unconstrained part of a sheet test piece is to be calculated from the relevant mechanical properties of the material under test and the height of the constraining device, and the platen is not to touch the constraining device during compression.

6.2.1 The number, position and orientation of the blanks taken are to comply with the relevant product standard or with the agreement between the parties concerned.

6.2.2 Cutting the blanks and machining the test pieces are to be done in a way that

prevents the properties of the material being altered by cold working or by heat effects.

6.2.3 Where the thickness of a sheet test piece is the thickness of the product, the original surface is to be kept and is to be free of scratches and other damage; where the thickness is a machined thickness, the surface roughness is to be no worse than that of the original surface. The permitted deviation of the thickness, or of the diameter, within the gauge length is 1 percent or 0.05 mm, whichever is the smaller.

6.2.4 Cylindrical test pieces are machined according to Figure 1 and rectangular section test pieces according to Table 2, the edges being free of burrs.

6.2.5 Test pieces are to be straight; test pieces cut from coil or strip may carry a slight curvature that does not affect the determination of the properties.

Table 2 gives the dimensions and permitted deviations of rectangular section test pieces, in millimetres, in five columns: thickness, width, length, permitted deviation and figure number. Its three rows read: thickness from 0.2 up to but not including 2, width 12.5, length equal to the height of the constraining device plus the length of the unconstrained part, permitted deviation plus or minus 0.05, Figure 4; thickness from 2 up to but not including 10, width 12.5, the same length rule, permitted deviation plus or minus 0.05, Figure 3; thickness 10 and above, width 10 to 20, length 2.5 to 3.5 times, or 5 to 8 times, or 1 to 2 times the width, permitted deviation plus or minus 0.05, Figure 2. The note to Table 2 states that the head of a test piece less than 0.3 mm thick is generally bent, the printed shape of the bend being lost from the source text.

7 Test equipment

7.1.1 The accuracy of the testing machine is to be class 1 or better and is to comply with GB/T 16825.1.

7.1.2 The working surfaces of the upper and lower platens of the testing machine are to be parallel, the parallelism being not worse than 0.0002 to 1 mm/mm within the 100 mm of the mounting area. The platen material is to be hard enough and resistant enough to oxidation at the test temperature to prevent plastic indentation or eccentricity under the maximum load, and the hardness of the platens should be not less than 55 HRC.

7.1.3 Where the test piece is of high hardness, backing plates of a suitable hard material are to be placed at its two ends, and after the test the plate faces are to be free of permanent deformation. The parallelism of the two end faces of the backing plates is to be not worse than 0.0002 to 1 mm/mm, and the surface roughness Ra is to be not greater than 0.8 micrometres.

7.2.1 The additional devices are the force guiding device, the levelling block, the protective shield and the constraining device.

7.2.2 Testing machines that do not meet the platen parallelism requirement are to be fitted