INTERNATIONAL STANDARD

ISO 17340

First edition
2014-05-01

Metallic materials — Ductility testing — High speed compression test for porous and cellular metals

Matériaux métalliques — Essais de ductilité — Essai de compression à haute vitesse des métaux poreux et cellulaires

Reference number
ISO 17340:2014(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 2, *Ductility testing*.

Introduction

Porous and cellular metals have attractive properties due to their unique cell morphology. When they are used as impact energy absorbing components in automotive structures, knowledge of their high-speed compressive properties is necessary for industrial design. The high-speed compressive deformation behaviour of porous and cellular metals is quite different from their static compressive properties. Testing methods for static compressive deformation are, therefore, insufficient for characterization of high-speed compressive deformation. Standardization of a testing method for the high-speed compressive behaviour of porous and cellular metals is required.

Metallic materials — Ductility testing — High speed compression test for porous and cellular metals

1 Scope

This International Standard specifies methods for high speed compression testing, at room temperature, of porous and cellular metals having a porosity of 50 % or more. The speed range applicable to this test method is 0,1 m/s to 100 m/s (or 1 s^{-1} to 10^3 s^{-1} in terms of the initial strain rate when the specimen height is 100 mm).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 376, *Metallic materials — Calibration of force-proving instruments used for the verification of uniaxial testing machines*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 13314, *Mechanical testing of metals — Ductility testing — Compression test for porous and cellular metals*

ISO 80000-1, *Quantities and units — Part 1: General*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13314 and the following apply.

3.1
test speed
movement speed of the pressing jig, which applies the compressive force to the test piece, when the pressing jig contacts the test piece

3.2
initial strain rate
value derived by dividing the test speed by the initial height of the test piece

3.3
sampling frequency
frequency used to sample the measurement data per unit time

3.4
drop height
initial distance between the pressure application plane of the pressing jig and the top surface of the test piece in the drop weight impact testing machine

3.5
approach length
initial distance between the pressure application plane of the pressing jig and the top surface of the test piece in the servo-type high-speed compression testing machine

4 Principle

This test consists of applying an impact force at test speeds between 0,1 m/s and 100 m/s to porous and cellular metals and measuring the compressive force and displacement for evaluation of their high-speed compressive deformation characteristics, such as plateau stress and energy absorption. Test methods that apply high-speed compressive forces to porous and cellular metals are the drop weight impact test and the servo-type high-speed compression test.

The drop weight impact test applies the compressive force by dropping a weight from a specified height. The test speed is controlled by the drop height. Due attention should be paid to the fact that the weight will be decelerated during the period of compressive deformation. When the drop height necessary to reach the specified test speed cannot be obtained, application of an initial velocity to the weight is possible.

The servo-type high-speed compression test applies the compressive force using a hydraulic or electric high-speed servo mechanism. The test speed is changed by the servo control. The drive unit shall be capable of following the test speed.

5 Testing machine

5.1 Type of testing machine

The testing machines to be used for high-speed compression testing of porous and cellular metals are the drop weight impact testing machine and the servo-type high speed compression testing machine.

5.2 Drop weight impact testing machine

5.2.1 General

An example of the basic composition of the drop weight impact testing machine is shown in Figure 1.

The drop weight impact testing machine consists of a weight, guide frame, pressing jig, load cell, displacement sensor, and absorber, as described below.

5.2.2 Weight

The weight shall drop vertically along the guide frame and shall be capable of applying the compressive force to the test piece.

The weight shall not be deformed by the impact when dropped and it should be possible to change the mass freely.

5.2.3 Pressing jig

The pressing jigs are located above and below the test piece and are used to apply the compressive force to the test piece. The pressing jig shall be of a construction such that it does not deform due to the compressive force, allowing correct transmission of the compressive force in the axial direction and preventing the action of forces, such as bending stress, etc., other than the compressive force on the test piece.

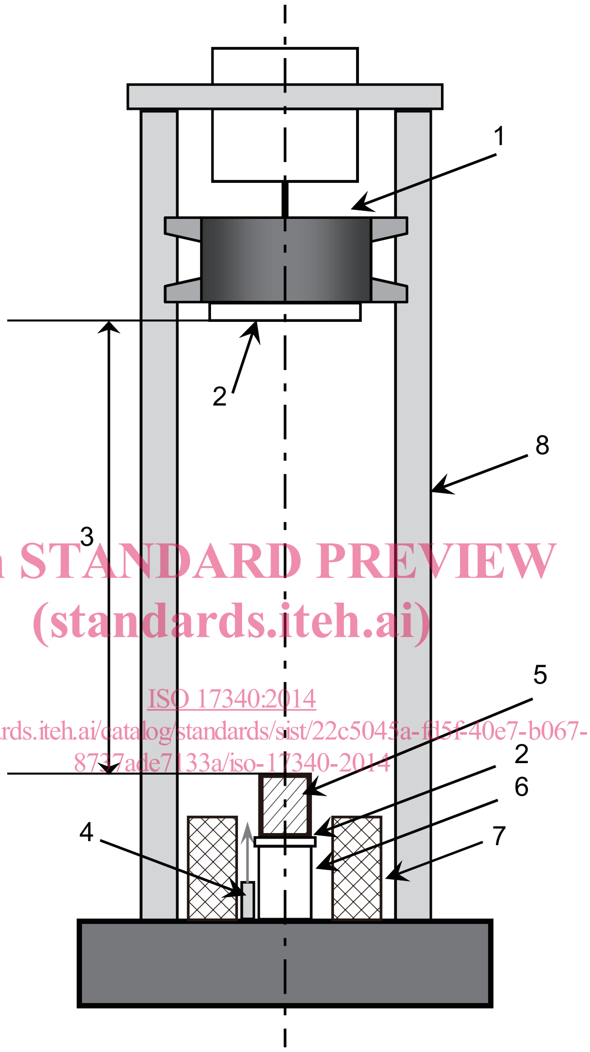
The area of the pressing surfaces shall be sufficiently large to ensure an even application of the compressive force over the entire end surface of the test piece until compressive deformation is complete.

The pressing surfaces shall be polished flat and installed in such a manner that the centre of the planes is aligned with the centre line of the testing machine and the planes are parallel to each other.

5.2.4 Load cell

The load cell shall be capable of measuring the compressive force acting on the test piece. For calibration of the load cell, ISO 376 shall be taken into consideration.

The resonant frequency and stiffness of the load cell shall be sufficiently high and the compressive force shall be measured to an accuracy of ±1 %.



Key

1 weight
2 pressing jig
3 drop height
4 displacement sensor
5 test piece
6 load cell
7 absorber
8 guide frame

Figure 1 — Schematic of a drop weight impact testing machine

5.2.5 Displacement sensor

The displacement sensor shall be capable of measuring the travel of a drop weight during tests and shall be of a non-contact type to avoid inertia effects.

The response speed of the displacement sensor shall be higher than the test speed. Measurement with laser-type displacement sensors, optical displacement sensors, etc. with high accuracy is recommended.

5.2.6 Absorber

The absorber shall be capable of stopping the weight and preventing it from damaging the load cell after compressing the test piece to the specified height.

5.3 Servo-type high-speed compression testing machine

5.3.1 General

Among servo-type high-speed compression testing machines, the basic composition of the servo-hydraulic-type high-speed compression testing machine is shown in Figure 2.

The servo-type high-speed compression testing machine consists of a pressing jig, load cell, displacement sensor, rupture pin, and stopper, as described below.

5.3.2 Pressing jig

The pressing jig shall be the same as described in 5.2.3.

5.3.3 Load cell

The load cell shall be the same as described in 5.2.4.

5.3.4 Displacement sensor

The displacement sensor shall be the same as described in 5.2.5.

5.3.5 Rupture pin

The rupture pin is a test force transmission part provided to protect the load cell and the pressing jig from damage resulting from excessively large compressive forces.

The material and the size of the rupture pin shall be capable of resisting the required test force adequately and of breaking, without large plastic deformation, below the load capacity of the load cell and the pressing jig.

5.3.6 Stopper

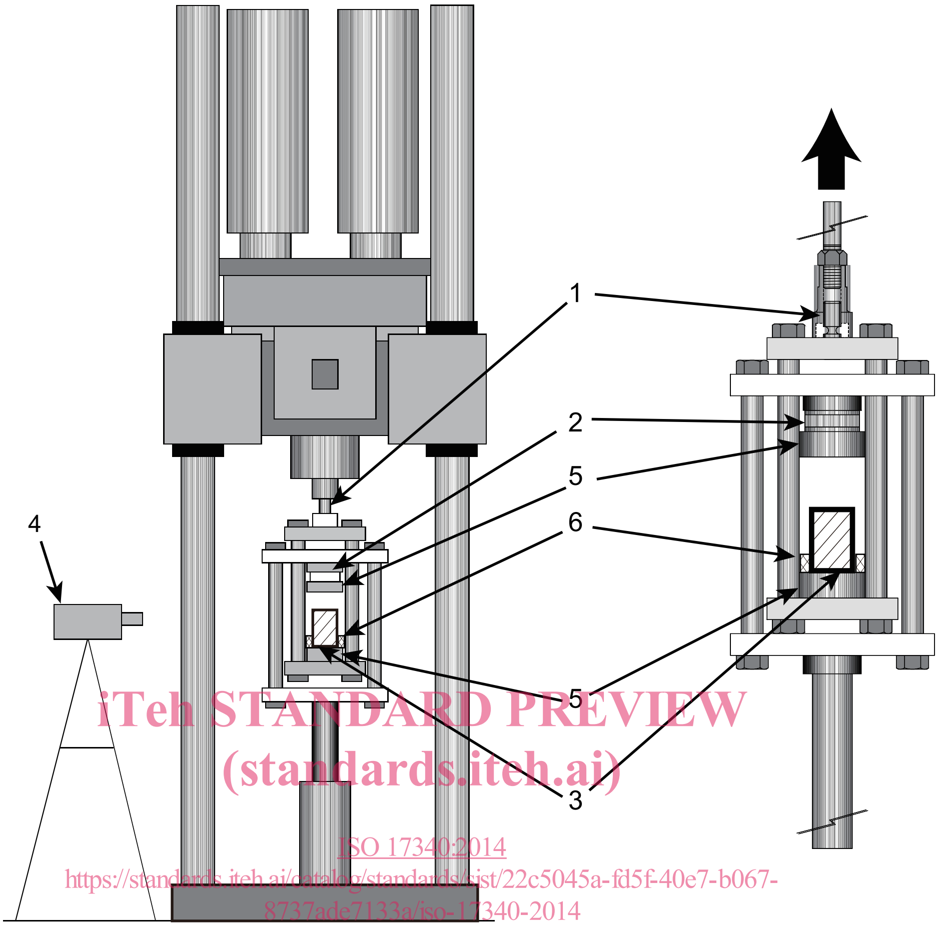
The stopper shall be provided between pressing jigs and shall be capable of stopping the movement of the pressing jigs after having deformed the test piece to the specified height.

6 Test piece

6.1 Preparation of test piece

The test piece shall be prepared by machining, electro-discharge machining, etc., as specified in ISO 13314.

Cutting into test pieces shall be executed with the utmost care so as not to alter the cellular structure or pore shape of the porous and cellular metals.



Key

1 rupture pin
2 load cell
3 test piece
4 displacement sensor
5 pressing jig
6 stopper

Figure 2 — Schematic of a servo-hydraulic type high-speed compression testing machine

6.2 Shape and dimensions of the test piece

The shape and dimensions of the test piece shall be as described below.

a) The shape of the test piece shall be a square prism, a rectangular prism, or a column.

b) The length of the shorter side or diameter of the test piece shall be no less than 10 times the average pore size.

c) The average pore size shall be measured in the cut section.

d) The initial height of the test piece, H_0, shall be between one and two times the diameter or length of the shorter side of the test piece. In the case of the drop weight impact test, however, the initial