PUBLICLY AVAILABLE SPECIFICATION

ISO/PAS 16940

First edition
2004-02-01

Glass in building — Glazing and airborne sound insulation — Measurement of the mechanical impedance of laminated glass

Verre dans la construction — Vitrages et isolation aux bruits aériens — Mesurage de l'impédance mécanique du verre feuilleté

Reference number
ISO/PAS 16940:2004(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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.

ISO/PAS 16940 was prepared by Technical Committee ISO/TC 160, *Glass in building*, Subcommittee SC 2, *Use considerations*.

Glass in building — Glazing and airborne sound insulation — Measurement of the mechanical impedance of laminated glass

1 Scope

This Publicly Available Specification describes a method for the measurement of the loss factor and the equivalent bending rigidity modulus of laminated glass test pieces. The aim is to compare the properties of interlayers. These two parameters (and others such as density and thicknesses of glass components) can be related to the sound transmission loss (STL) of the glazing itself.

NOTE The Cremer equation as shown in Annex C can be used to determine the STL.

2 Normative references

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

ISO 12543-1:1998, *Glass in building — Laminated glass and laminated safety glass — Part 1: Definitions and description of component parts*

ISO 140-1, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 1: Requirements for laboratory test facilities with suppressed flanking transmission*

ISO 140-3, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 3: Laboratory measurements of airborne sound insulation of building elements*

ISO 717-1, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 12543-1 and the following apply.

3.1
laminated glass
assembly consisting of two sheets of glass joined together with the interlayer that will be characterized by the method of this Publicly Available Specification

NOTE 1 Adapted from ISO 12543-1:1998.

NOTE 2 The interlayer type and makeup should be specified.

4 Test method

4.1 Measurement of mechanical impedance (MIM) of laminated glass

4.1.1 Principle

The loss factor and the equivalent bending rigidity modulus are determined from the measurement of the input impedance of a glass beam sample. The input impedance is the transfer function between the injected force in one point and the velocity. This transfer function has resonances corresponding to a maximum of the response of the system (resonance frequency).

4.1.2 Measurement

The input impedance is measured with an impedance head giving both parameters (force and velocity) at the fixation point of the tested structure. Tested samples are beams of dimensions (25 ± 2) mm × (300 ± 1) mm; this limits the number of resonances in a given frequency band compared with a plate sample. The glass panes shall be nominally 4 mm thick for comparison purposes. The input impedance is measured at the centre of the sample, i.e. at half-length. For the fixation, good balance between left and right sides is needed, and the centre part shall be precisely determined. The vibration mode of the sample shall be as shown in Figure 1, i.e. a bending vibration of two "free clamped" half beams.

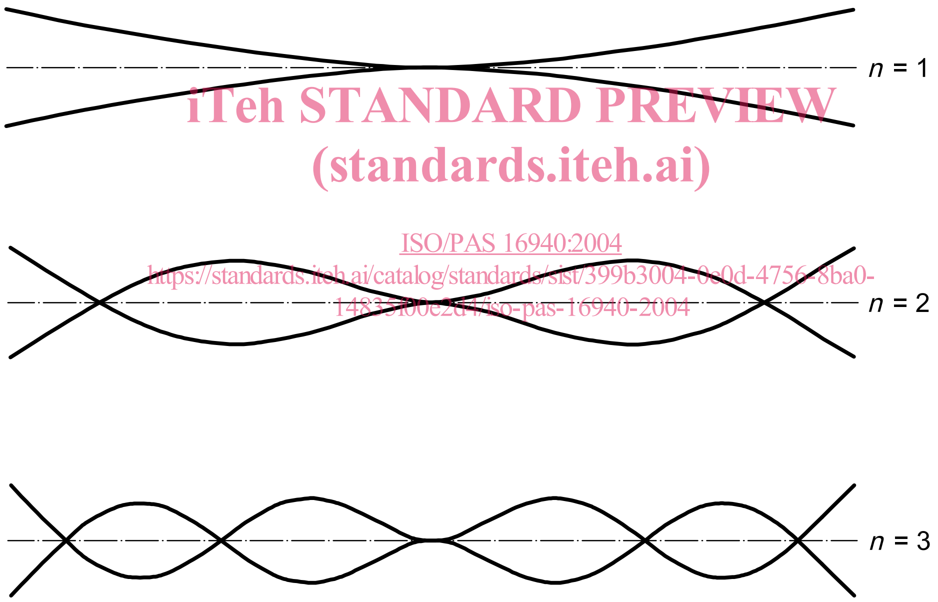


Figure 1 — Examples of vibration modes

The sample is glued (with a cyanoacrylic glue) onto an impact button of 15 mm diameter. The impact button shall be flat (see Annex A).

NOTE Fixation balance is easier to achieve with inverted V buttons, but flat buttons have been chosen because they are more readily available.

A white noise type force between 0 Hz and 5 000 Hz is used.

4.1.3 Determination of resonance frequencies and loss factors

When the transfer function corresponding to the input impedance is measured, resonance frequencies $f_{\text{res},i}$ are noted as well as the resonance curves for each resonance frequency (i index corresponding to i^{th} resonance). Bandwidths used are sufficient to get good accuracy. By defect, 1,25 Hz bandwidths are used. The loss factor is then calculated using the relationship

$$\eta_i = \Delta f_i / f_{\text{res,i}}$$

as shown in Figure 2, and is a function of the frequency.

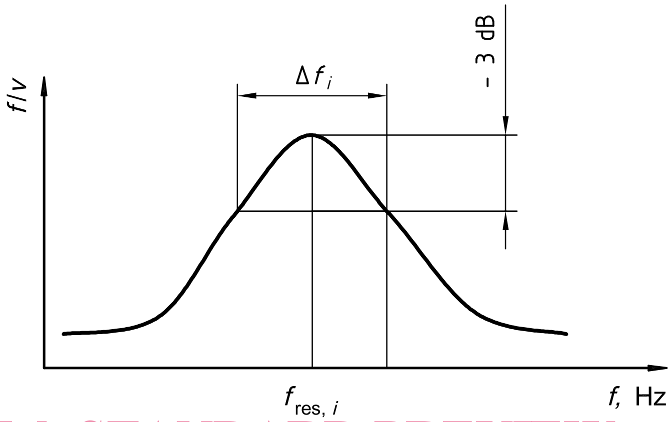


Figure 2 — Determination of the loss factor

If the outcome (see Annex D) does not allow readable data to be obtained at –3 dB on both sides of the peak, data at –2 dB shall be used by using the formula

$$\Delta f / f = \Delta f / f_{-2\text{dB}} \times 1{,}31$$

4.1.4 Test equipment

The measuring set-up shall be as described in Annex A and made of the following:

— an environmental chamber or air conditioned room;

— a white noise generator;

— a power amplifier;

— a shaker;

— an impedance head;

— two measuring amplifiers;

— an FFT dual channel analyser plus calculation system.

This apparatus set-up shall be coherent with the dimensions and masses of the samples.

The impedance head is an integrated system with a force transducer and an accelerometer. The force transducer is a transducer that generates an output voltage proportional at the input force. It is a piezoelectric sensor.

The accelerometer is a transducer generating an output voltage proportional to the input acceleration. It may be piezoelectric, strain gauge, etc.

The test equipment is shown in Annex A. A typical result is shown in Annex D.

Calculations may be done directly from the analyser, or automatically with a specific software.

4.2 Test procedure

Measurements shall be carried out at 20 °C ± 1 °C. This parameter is very sensitive. The samples shall be kept for at least 1 h at the measurement temperature before performing the test.

The values of the resonance frequency and of the loss factor for the first three modes shall be noted.

The equivalent bending rigidity moduli for the first three modes should be calculated in accordance with Annex B.

The corresponding sound transmission loss curves should be calculated for the third mode in accordance with Annex C.

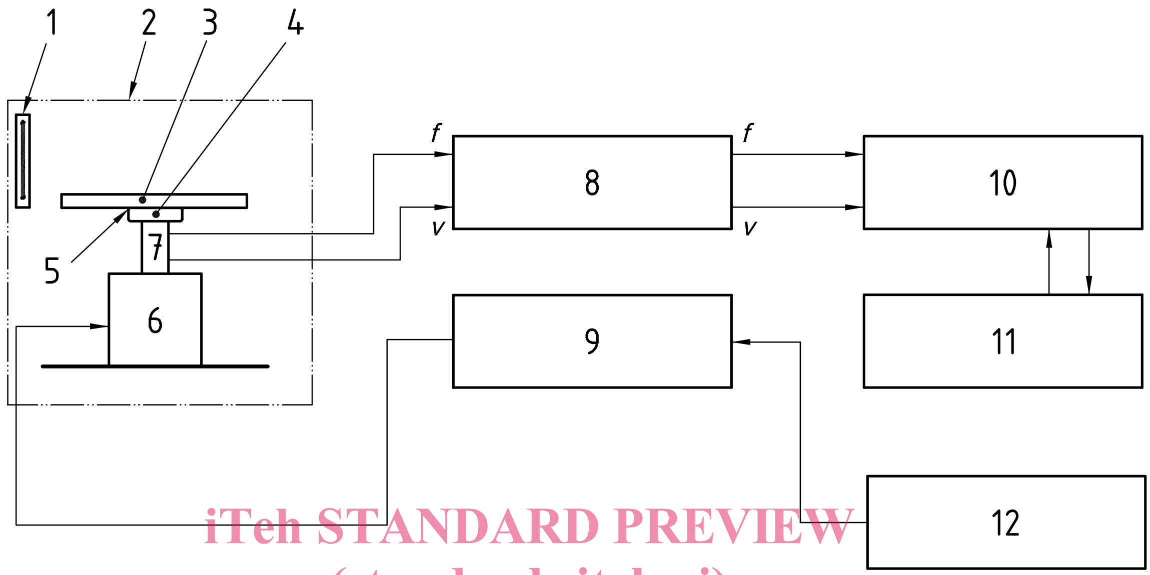
The R_w value, in accordance with ISO 717-1, should be calculated and quoted to one decimal place.

4.3 Test report

The test report shall list the values of the resonance frequencies and loss factors for the first three modes.

Annex A
(normative)

Measurement set-up



Key

1 thermometer
2 environmental chamber
3 specimen
4 impact button
5 instantaneous adhesive
6 shaker
7 impedance head
8 measuring amplifiers of mechanical impedance
9 power amplifier
10 FFT analyser
11 computer
12 noise generator

Figure A.1 — Apparatus set-up