INTERNATIONAL STANDARD

ISO 9052-1

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Acoustics — Determination of dynamic stiffness —

Part 1 : Materials used under floating floors in dwellings

Acoustique — Détermination de la raideur dynamique —

Partie 1 : Matériaux utilisés sous les dalles flottantes dans les bâtiments d'habitation

Reference number
ISO 9052-1 : 1989 (E)

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.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9052-1 was prepared by Technical Committee ISO/TC 43, *Acoustics*.

ISO 9052 will consist of the following parts, under the general title *Acoustics — Determination of dynamic stiffness*:

— *Part 1: Materials used under floating floors in dwellings*

— *Part 2: Materials used for vibration and sound insulation of equipment in buildings*

Acoustics — Determination of dynamic stiffness —

Part 1:
Materials used under floating floors in dwellings

1 Scope

This part of ISO 9052 specifies the test method for determining the dynamic stiffness of resilient materials used under floating floors. Dynamic stiffness is one of the parameters that determine the sound insulation of such floors in dwellings.

This part of ISO 9052 applies to the determination of dynamic stiffness per unit area of resilient materials with smooth surfaces (see clause 6) used in a continuous layer under floating floors in dwellings. It does not apply to loadings lower than 0,4 kPa[1)], for example materials in wall linings, or greater than 4 kPa[1)], for example materials under machinery foundations (see note 2).

This part of ISO 9052 is mainly intended to be used for comparing production samples of similar materials of known specified quality.

For restrictions concerning the airflow resistivity of the resilient material to be tested, see 8.2.

NOTES

1 The dependence of dynamic stiffness on prestatic load is of minor importance in the case of materials usually applied in wall linings, for example polystyrene or mineral fibre. The differences between dynamic stiffness values measured with a static load of 2 kPa in accordance with this part of ISO 9052 and those measured with a very low preload are of the order of 10 % to 20 %.

2 A further part of ISO 9052 will deal with the determination of dynamic stiffness of materials used in technical floating floors (high static load).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9052. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9052 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7626-2 : —[2)], *Vibration and shock — Experimental determination of mechanical mobility — Part 2: Measurements using single-point translation excitation with an attached vibration exciter.*

ISO 9053 : —[2)], *Acoustics — Materials for acoustical applications — Determination of airflow resistance.*

3 Definitions

3.1 dynamic stiffness: The ratio of dynamic force to dynamic displacement.

For the purposes of this part of ISO 9052, dynamic stiffness per unit area, s', is used and is given by the following equation:

$$s' = \frac{F/S}{\Delta d} \qquad \ldots (1)$$

where

S is the area of the test specimen;

F is the dynamic force acting perpendicularly on the test specimen;

Δd is the resulting dynamic change in thickness of the resilient material.

In this part of ISO 9052, the following quantities are used:

— dynamic stiffness per unit area of the material's structure, s'_s;

— dynamic stiffness per unit area of enclosed gas (e.g. air), s'_a;

— apparent dynamic stiffness per unit area of the test specimen, s'_t;

— the dynamic stiffness per unit area of the installed resilient material, s'.

1) 1 Pa = 1 N/m^2

2) To be published.

3.2 natural frequency, f_0: Frequency of free oscillation of a system.

The natural frequency of a resiliently supported floor is given by the following equation:

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{s'}{m'}} \qquad \ldots (2)$$

where

s' is the dynamic stiffness per unit area of the installed resilient material;

m' is the mass per unit area of the supported floor.

3.3 resonant frequency, f_r: Frequency at which resonance occurs in the test arrangement.

The resonant frequency is given by the following equation:

$$f_r = \frac{1}{2\pi}\sqrt{\frac{s'_t}{m'_t}} \qquad \ldots (3)$$

where

s'_t is the apparent dynamic stiffness per unit area of the test specimen;

m'_t is the total mass per unit area used during the test.

4 Principle

Determination of the apparent dynamic stiffness per unit area of the test specimen, s'_t, by a resonance method in which the resonant frequency, f_r, of the fundamental vertical vibration of a spring-and-mass system is measured, the spring being the test specimen of the resilient material under test and the mass being a load plate.

5 Test arrangement

The specimen shall be placed between two horizontal surfaces, i.e. the base (or baseplate) and the load plate. The load plate shall be square, with dimensions (200 ± 3) mm × (200 ± 3) mm, and made of steel. The base (or baseplate) and the load plate shall have profile irregularities of less than 0,5 mm and be sufficiently rigid to avoid bending waves in the frequency range of interest.

The excitation is applied by one of the methods shown in figures 1, 2 or 3.

The total load on the test specimen including all measuring and/or excitation equipment shall be 8 kg ± 0,5 kg.

Excitation and measuring devices shall be applied in such a way that only vertical oscillations (i.e. without rotational components) occur.

For the test set-up shown in figure 1, the inertia of the base shall be such that in vibration its velocity is negligible compared with that of the load plate.

For the test arrangements shown in figures 2 and 3, the mass of the baseplate shall be at least 100 kg.

6 Test specimen

At least three square specimens of dimensions 200 mm × 200 mm shall be taken. The surfaces of the test specimens shall be considered to be smooth if the surface irregularities are less than 3 mm.

The test specimen shall be covered with a waterproof plastic foil, approximately 0,02 mm thick, on which a thin paste of plaster of Paris and water is applied to a depth of at least 5 mm so that any unevenness is covered. Before the plaster begins to set, the load plate shall be bedded onto it as shown in figures 1a), 2a) and 3a).

In the case of closed cell materials, the joint between the specimen and the base (or baseplate) shall be sealed around the perimeter with a fillet of petroleum jelly. See figures 1b), 2b) and 3b).

7 Procedure

7.1 General

The resonant frequency, f_r, of the fundamental vertical vibration of the test specimen and the load plate can be determined by using either sinusoidal, white noise or pulse signals.

All these methods are equivalent. In case of dispute, the method using sinusoidal signals (7.2) shall be the reference method.

7.2 Sinusoidal signals

Obtain the resonant frequency by varying the frequency of excitation, while keeping the excitation force constant.

If the resonant frequency depends on the amplitude of the excitation force, this dependence shall be determined down to as low a value as possible and the resonant frequency shall be found by extrapolation to zero force amplitude.

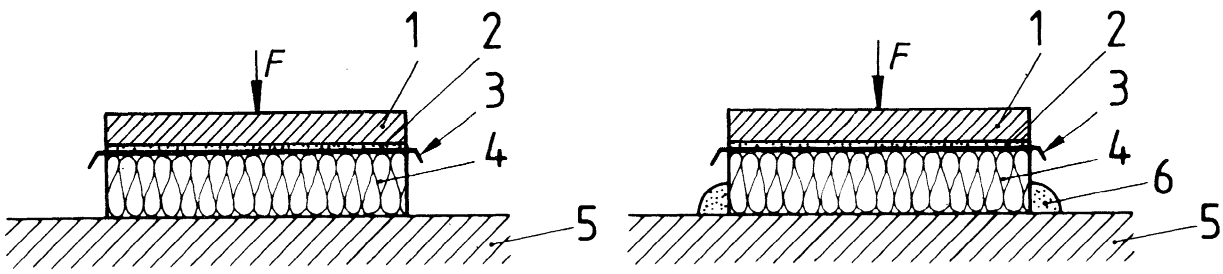
Depending on the expected stiffness value, the measurement interval used as the basis for extrapolation shall be as follows:

$0{,}2\ \mathrm{N} \leqslant F \leqslant 0{,}8\ \mathrm{N}$ where $s' > 50\ \mathrm{MN/m^3}$

$0{,}1\ \mathrm{N} \leqslant F \leqslant 0{,}4\ \mathrm{N}$ where $s' \leqslant 50\ \mathrm{MN/m^3}$

Within these intervals, measurements shall be taken at least at three points.

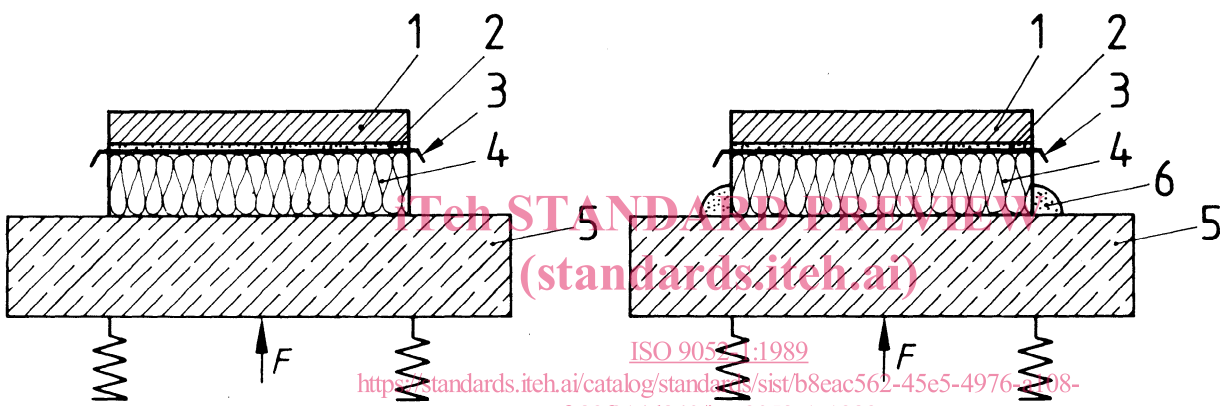
NOTE — When testing material with high internal damping, the vertical vibration maximum is not pronounced. In this case, resonance can be detected by observing the phase shift between the excitation and vibration signal.



1 Load plate
2 Plaster of Paris
3 Foil
4 Test specimen
5 Base
6 Petroleum jelly

a) **Open cell materials** b) **Closed cell materials**

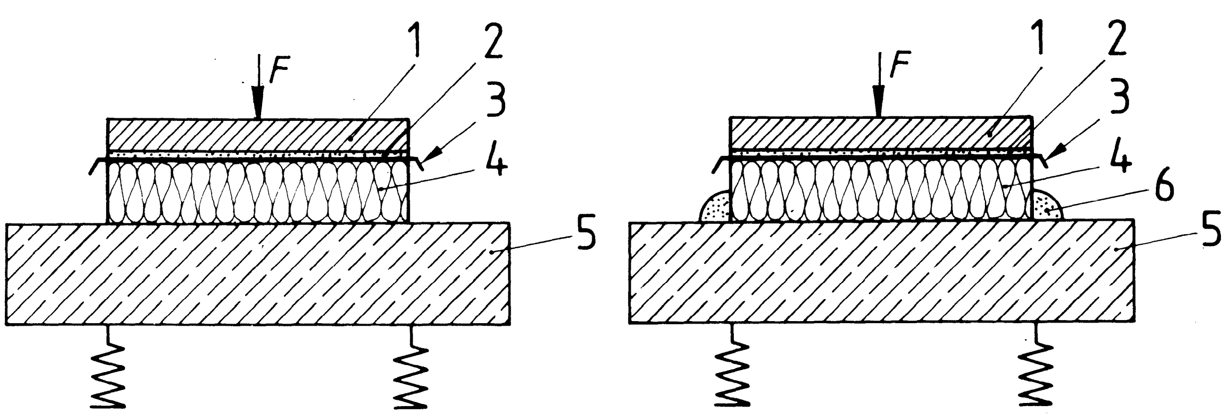
Figure 1 — Excitation of the load plate — Vibration measurement of the load plate only



1 Load plate
2 Plaster of Paris
3 Foil
4 Test specimen
5 Base
6 Petroleum jelly

a) **Open cell materials** b) **Closed cell materials**

Figure 2 — Excitation of the load plate — Vibration measurements of both the load plate and the baseplate



1 Load plate
2 Plaster of Paris
3 Foil
4 Test specimen
5 Base
6 Petroleum jelly

a) **Open cell materials** b) **Closed cell materials**

Figure 3 — Excitation of the baseplate — Vibration measurements of both the load plate and the baseplate

7.3 White noise or pulse signals

Obtain the resonant frequency by analysing the frequency response of the system in accordance with ISO 7626-2 or by using impact excitation.[1]

8 Expression of results

8.1 Apparent dynamic stiffness per unit area of the test specimen, s'_t

The apparent dynamic stiffness per unit area of the test specimen, s'_t, in newtons per cubic metre, is given by the following equation:

$$s'_t = 4\,\pi^2\, m'_t f_r^2 \qquad \ldots (4)$$

where

m'_t is the total mass per unit area used during the test, in kilograms per square metre;

f_r is the extrapolated resonant frequency, in hertz.

8.2 Dynamic stiffness per unit area, s', of the resilient material

Depending on the airflow resistivity, r, in the lateral direction, the dynamic stiffness per unit area, s', of the resilient material is given as shown in a), b) and c) below. The airflow resistivity, r, shall be determined in accordance with ISO 9053.

a) For high airflow resistivity, where $r \geqslant 100$ kPa·s/m²

$$s' = s'_t \qquad \ldots (5)$$

b) For intermediate airflow resistivity, where 100 kPa·s/m² $> r \geqslant$ 10 kPa·s/m²

$$s' = s'_t + s'_a \qquad \ldots (6)$$

The dynamic stiffness per unit area of the enclosed gas, s'_a, is calculated in accordance with equation (7) which is based on the assumption that sound propagation in resilient material is isothermal:

$$s'_a = \frac{p_0}{d\varepsilon} \qquad \ldots (7)$$

where

p_0 is the atmospheric pressure;

d is the thickness of the test specimen under the applied static load;

ε is the porosity of the test specimen.

NOTE — For p_0 = 0,1 MPa and ε = 0,9, the dynamic stiffness per unit area of the enclosed gas, s'_a, in meganewtons per cubic metre, is given by:

$$s'_a = \frac{111}{d}$$

when d is expressed in millimetres.

c) For low airflow resistivity, where $r <$ 10 kPa·s/m² and if the dynamic stiffness per unit area of the enclosed gas, s'_a, calculated in accordance with equation (7) is small compared with the apparent dynamic stiffness per unit area of the test specimen, s'_t:

$$s' = s'_t \qquad \ldots (5)$$

The error caused by disregarding s'_a shall be stated in the test report.

NOTE — The value of s' cannot be determined by this method, if $r <$ 10 kPa·s/m² and s'_a is not negligible compared with s'_t.

9 Test report

The following information shall be included in the test report:

a) the reference to this part of ISO 9052;

b) a description of the material, including date of production, test specimen, number, dimensions, thickness under the applied load, mass per unit area;

c) the excitation test arrangement (figures 1, 2 or 3), excitation signals (sinusoidal, white noise, pulse), vibration measurement (acceleration, velocity, displacement);

d) the date of the test, environmental conditions (for example temperature, relative humidity);

e) the extrapolated frequency, f_r, in hertz, the apparent dynamic stiffness per unit area of the test specimen, s'_t, the dynamic stiffness per unit area of the enclosed air, s'_a, and, if possible, dynamic stiffness per unit area, s', of the resilient material.

All values for the dynamic stiffness per unit area shall be stated in meganewtons per cubic metre to the nearest meganewton per cubic metre.

If, in the case of materials with airflow resistivity less than 10 kPa·s/m², the dynamic stiffness of the enclosed gas, s'_a, is not considered separately, the reason and the estimated error should be given (see 8.2).

1) Impact excitation will be dealt with in ISO 7626-5 (in preparation).

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