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# INTERNATIONAL STANDARD 140 / VIII

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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## Acoustics — Measurement of sound insulation in buildings and of building elements — Part VIII : Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a standard floor

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*Acoustique — Mesurage de l'isolation acoustique des immeubles et des éléments de construction —  
Partie VIII : Mesurage en laboratoire de la réduction de la transmission des bruits de chocs par  
les revêtements de sol sur plancher normalisé*

ISO 140-8:1978

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# Acoustics — Measurement of sound insulation in buildings and of building elements —

## Part VIII : Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a standard floor

### 0 INTRODUCTION

The purpose of this International Standard is to establish a method for determining the noise reducing value of a floor covering under standard test conditions. The test is limited to the specification of procedures for the physical measurement of sound originating from an artificial source (standard tapping machine) and is not concerned with the subjective significance of the results.

### 1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method for measuring the acoustical properties of floor coverings from the view point of reducing impact noise transmission.

This International Standard is applicable to all floor coverings, whether single or multi-layered, as installed on a standard floor. In the case of multi-layered coverings, they may be factory-assembled or assembled at the test site. The test method applies only to laboratory measurements. It does not contain any provision that permits an assessment of the effectiveness of a floor covering *in situ*.

### 2 REFERENCES

ISO 140/I, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part I : Requirements for laboratories.*

ISO 140/II, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part II : Statement of precision requirements.*

ISO 140/VI, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part VI : Laboratory measurements of impact sound insulation of floors.*

ISO/R 354, *Measurement of absorption coefficients in a reverberation room.*

IEC Publication 179, *Precision sound level meters.*

IEC Publication 225, *Octave, half-octave and third-octave band filters intended for the analysis of sound and vibrations.*

### 3 DEFINITIONS

**3.1 average sound pressure level in a room :** Ten times the common logarithm of the ratio of the space and time average of the sound pressure squared to the square of the reference sound pressure, the space average being taken over the entire room with the exception of those parts where the direct radiation of a sound source of the near field or the boundaries (wall, etc.) is of significant influence. This quantity is denoted by  $L$  :

$$L = 10 \lg \frac{p_1^2 + p_2^2 + \dots + p_n^2}{n p_0^2} \text{ dB} \quad \dots (1)$$

where

$p_1, p_2, \dots, p_n$  are the r.m.s. sound pressures at  $n$  different positions in the room;

$p_0 = 20 \mu\text{Pa}$  is the reference sound pressure.

**3.2 impact sound pressure level :** The average sound pressure level in a specific frequency band in the receiving room when the floor or the covering under test on a standard floor is excited by the standardized impact sound source. This quantity is denoted by  $L_i$ .

**3.3 normalized impact sound pressure level :** The impact sound pressure level  $L_i$  increased by a correction term which is given in decibels, being ten times the common logarithm of the ratio between the measured equivalent absorption area  $A$  of the receiving room and the reference equivalent absorption area  $A_0$ . This quantity is denoted by  $L_n$  :

$$L_n = L_i + 10 \lg \frac{A}{A_0} \text{ dB} \quad \dots (2)$$

where  $A_0 = 10 \text{ m}^2$ .

In all cases where it is uncertain whether results are obtained without flanking transmission, the normalized impact sound pressure level should be denoted by  $L'_n$ .

**3.4 reduction of impact sound pressure level (improvement of impact sound insulation) :** For a given frequency band (octave or third-octave), the reduction in normalized impact sound pressure level resulting from installation of the test floor covering. This quantity is denoted by  $\Delta L$  :

$$\Delta L = L_{n0} - L_n \quad \dots (3)$$

where

$L_{n0}$  is the normalized impact sound pressure level in the receiving room in the absence of floor covering;

$L_n$  is the normalized impact sound pressure level when the floor covering is in place.

NOTE — If the receiving room absorption is unchanged during the test, it is assumed that the reduction in impact sound pressure level is equivalent to the reduction in normalized impact sound pressure level. This applies especially in the case of a test on a small specimen when only one microphone position in the receiving room could be used.

## 4 EQUIPMENT

The standardized impact sound source, i.e. the tapping machine, should conform to ISO 140/VI. Only metal-tipped hammers should be used.

The further equipment shall be suitable for meeting the requirements of clause 6.

## 5 TEST ARRANGEMENT

### 5.1 General arrangement

Two vertically adjacent rooms are used, the upper one being designated the "source room" and the lower one the "receiving room". They are separated by a standard floor on which the floor covering under test is installed. The airborne sound insulation between source room and receiving room must be such that the level of airborne sound transmission from source room to receiving room will be at least 10 dB below the level of transmitted impact sound in each frequency band, see ISO 140/I.

### 5.2 Details of test arrangement

#### 5.2.1 Source room

The size and shape of the source room are not important.

#### 5.2.2 Receiving room

The receiving room should meet the requirements of ISO 140/I.

#### 5.2.3 Test floor

The floor on which the test coverings are to be installed should consist of a reinforced concrete slab of thickness  $120 \pm 20$  mm. It should be homogeneous and of uniform thickness. The surface area, viewed from the receiving room, should be at least  $10 \text{ m}^2$ . On the source room side,

the permissible test area for installation of floor coverings of category I (see 5.3.3) will be the region at least  $0,5 \text{ m}$  from the edges of the floor slab.

### 5.2.4 Condition of floor surface

The surface of the test floor should be perfectly flat (to  $\pm 1 \text{ mm}$  in a horizontal distance of  $200 \text{ mm}$ ), and sufficiently hard to endure the impacts of the tapping machine. If a screed is applied to the surface of the test floor, it should adhere perfectly at all points, and should not chip, crack or become pulverized.

## 5.3 Preparation and installation of test specimen

### 5.3.1 Classification

Depending upon the type of floor covering, the test specimens should be samples which are either slightly larger than the tapping machine or of room size.

#### 5.3.1.1 CATEGORY I (SMALL SPECIMENS)

This category includes flexible coverings (plastics, rubber, cork, matting, or combinations thereof), which may be installed loosely or adherently to the floor surface. The method of installation should be described clearly in the report.

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#### 5.3.1.2 CATEGORY II (LARGE SPECIMENS)

This category includes rigid homogeneous surface materials or complex floor coverings of which at least one constituent is rigid. The assembled floor covering may be tested under load. In this case, the average load should be  $100 \text{ kg/m}^2$  (see, for example, figure 1).

#### 5.3.1.3 CATEGORY III (STRETCHED MATERIALS)

This category includes flexible coverings which cover the floor from wall to wall. Large specimens should be tested, but loading is not required.

#### 5.3.1.4 MATERIALS OF UNCERTAIN CLASSIFICATION

In the case of uncertainty as to the appropriate category for a material, the testing laboratory will decide whether small or large specimens will be tested.

### 5.3.2 Installation

#### 5.3.2.1 ADHESIVE MOUNTING

Coverings to be mounted with adhesive should be installed with great care, normally with adhesive covering the entire surface. If the adhesive is applied in isolated patches, the exact procedure should be described. The manufacturer's

instructions for use of the adhesive should be followed, especially with regard to the amount and the open-time. The type of adhesive and the open-time should be reported.

**5.3.2.2 CURING PERIOD PRIOR TO TEST**

Coverings such as concrete floating slabs cast in place should not be tested until after the customary curing period, for example three weeks for ordinary concrete.

**5.3.3 Size and number of specimens**

**5.3.3.1 CATEGORY I**

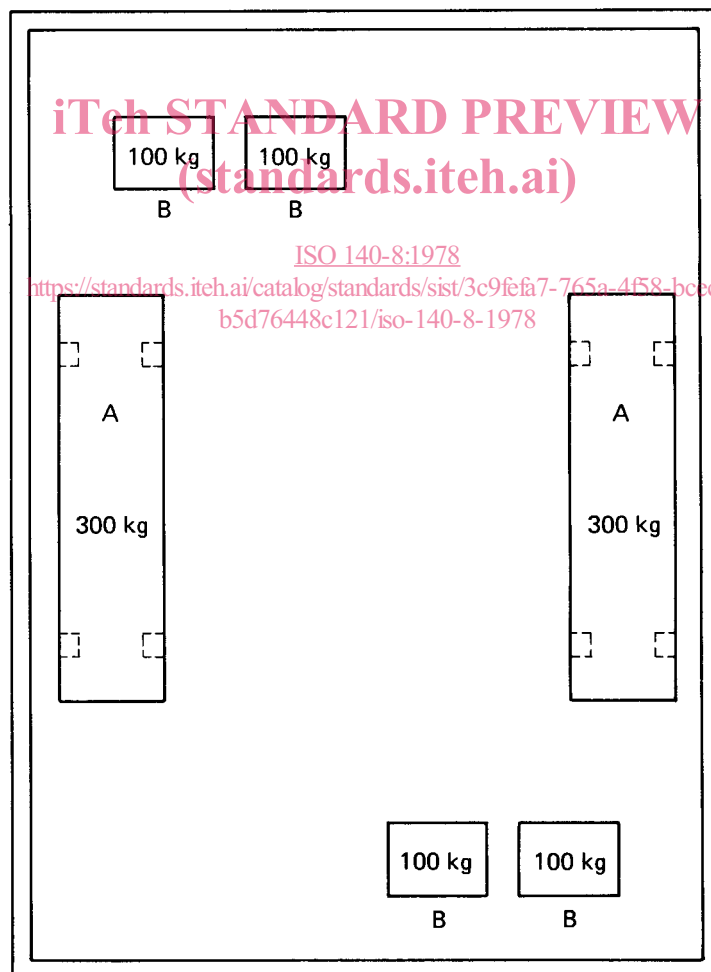
Three samples (see 5.2.3), preferably of different production runs but from the same source, should be installed. Each sample must be large enough to support the whole tapping machine.

**5.3.3.2 CATEGORIES II AND III**

The specimen should cover the whole surface from wall to wall, or in any case at least 10 m<sup>2</sup> with a smaller dimension of at least 2,3 m.

**5.4 Influence of temperature and humidity**

Usually, and always in the case of surfaces whose acoustical properties are likely to depend on either temperature or humidity, the temperature at the centre of the upper floor surface and the humidity of the air in the source room should be measured and reported. The floor temperature thus observed should preferably be in the range 18 to 25 °C.



The weights might be concrete blocks of approximately 50 kg each and of dimensions 290 mm × 290 mm × 280 mm. Rectangles labelled A are panels supported on four legs of dimensions 50 mm × 50 mm and supporting six weights; rectangles B represent two superposed weights.

**FIGURE 1 – Typical loading arrangement for category II floor coverings (see 5.3.1.2)**

**6 TEST PROCEDURE AND EVALUATION**

**6.1 Generation of sound field**

The impact sound shall be generated by the tapping machine (see clause 4). Concerning the position of the tapping machine, see 6.5.

On the bare floor slab or on a floating floor, the duration of measurements should be sufficiently brief to ensure that the surface is not damaged.

On a resilient surface, the measurements should not begin until after the noise level has become steady.

**6.2 Measurement of impact sound pressure level**

The impact sound pressure level in the receiving room should be an average over space and time. This average may be obtained by using a number of fixed microphone positions or a continuously moving microphone with an integration of  $p^2$ .

The indicating device should be designed to determine r.m.s. values of the sound pressure or corresponding pressure levels. If a sound level meter is used, it should conform to IEC Publication 179 for precision sound level meters. It is recommended to use the meter response "slow". The complete measuring system including the microphone shall be adjusted before each series of measurements to enable absolute values of sound pressure level to be obtained.

When in any frequency band the sound pressure level in the receiving room is less than 10 dB above the background level, then the background level should be measured just before and after the determination of sound pressure level due to the sound source and a correction as given in the table shall be applied.

TABLE – Correction to sound pressure level readings

Difference between sound pressure level measured with tapping machine operating and background level alone	Correction to be subtracted from sound pressure level measured with tapping machine operating to obtain sound pressure level due to tapping machine alone
dB	dB
3	3
4 to 5	2
6 to 9	1

The above corrections, if any, are to be made to the individual readings.

If the difference is less than 3 dB, i.e. the impact sound pressure level is less than the background level, a precise value of the impact sound pressure level cannot be determined.

**6.3 Frequency range of measurements**

The sound pressure level should be measured by using third-octave or octave band filters. The discrimination characteristics of the filters should be in accordance with IEC Publication 225.

Third-octave band filters having at least the following centre frequencies in hertz should be used :

100	125	160	200	250	315
400	500	630	800	1 000	1 250
1 600	2 000	2 500	3 150		

If octave band filters are used, as a minimum the series beginning with centre frequency 125 Hz and ending at 2 000 Hz should be used.

**6.4 Measurement and evaluation of the equivalent absorption area**

The correction term of equation (2) containing the equivalent absorption area should be evaluated from the reverberation time measured according to ISO/R 354 and evaluated using Sabine's formula :

$$A = \frac{0,163 V}{T} \dots (4)$$

where

$A$  is the equivalent absorption area, in square metres;

$V$  is the receiving room volume, in cubic metres;

$T$  is the reverberation time, in seconds.

See, however, the note in 3.4.

**6.5 Position of the tapping machine**

**6.5.1 Adjustment of the tapping machine**

For each machine position, on bare floor or on the floor covering, the machine should be adjusted to have a free fall of 40 mm; when situated on a floor covering specimen, the hammers should touch the specimen at least 100 mm from the edges.

If the tapping machine is placed on a very resilient layer, hard pads may be necessary under the supports of the tapping machine to guarantee a fall of 40 mm for the hammers.

**6.5.2 Materials of category I**

The tapping machine should be placed successively on each specimen of floor covering, being wholly on the specimen in each case, and on the bare floor slab on either side of the specimen and as close to it as possible, the axis of the hammers being always parallel to the long dimension of the specimen (see figure 2).

For each specimen of floor covering, the impact noise level corresponding to the bare floor is the arithmetic mean of

the levels determined for the two machine positions on either side of the specimen.

NOTE – When the impact levels are measured at a single point only in the receiving room, the measurements should be made within a sufficiently short time so that there will be no variation in equivalent absorption area of the receiving room during measurements.

**6.5.3 Materials of categories II and III**

The tapping machine should be placed successively on the bare floor and on the floor when entirely covered by the floor covering. Machine locations should not be too close to the edges (minimum 0,5 m) nor in a corner of the room.

Each set of measurements (bare floor and covered floor) should be made with as many machine positions as are necessary to yield a reliable mean value; in any case the number of positions should be not less than three.

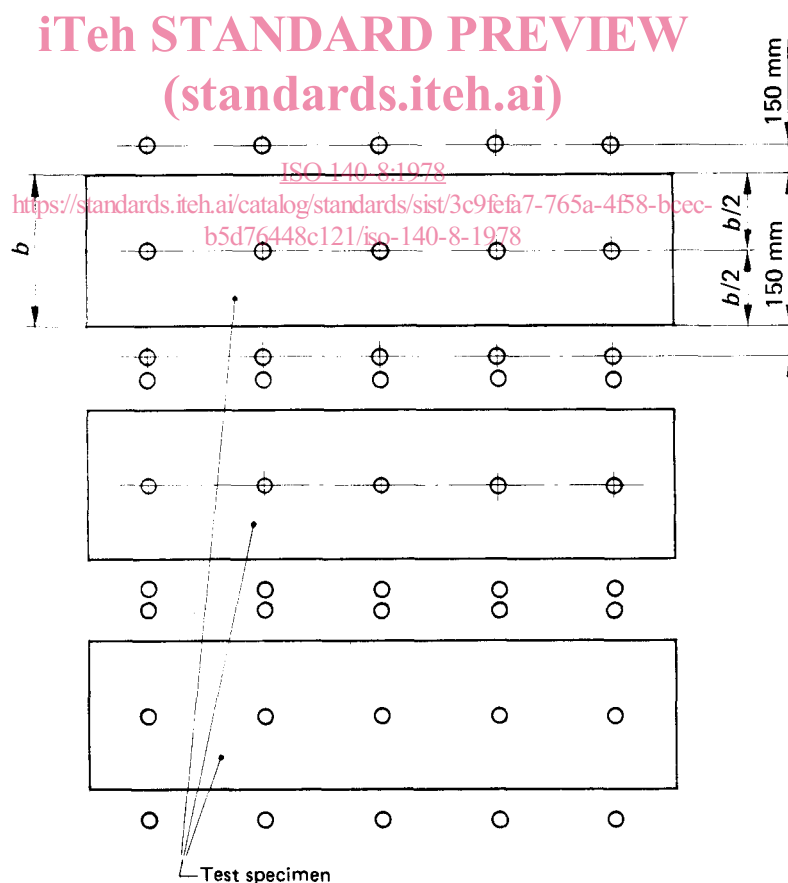
**6.6 Measurement procedure**

Each organization should determine a normal test procedure which complies with this International Standard.

The necessary criteria which affect the repeatability of the measurements are shown below :

- number and sizes of diffusing elements, where used;
- minimum distances between microphone and room boundaries with regard to near fields;
- number of microphone positions or, in the case of a moving microphone, the microphone path;
- averaging time of the levels;
- method of determining the equivalent absorption area, which involves a number of repeated readings in each position.

An example of typical test conditions is given in the annex.



The small circles mark the positions where the hammers of the tapping machine should strike the bare floor or the test specimens respectively.

**FIGURE 2 – Typical test arrangement for specimens of category I floor coverings**

**7 PRECISION**

It is required that the measurement procedure should give satisfactory repeatability. This can be determined in accordance with the method shown in ISO 140/II and should be checked from time to time, particularly when a change is made in procedure or instrumentation.

NOTE — Numerical requirements for repeatability are under consideration pending further experience with this test procedure.

**8 EXPRESSION OF RESULTS**

For the statement of the test results, the reduction in impact sound pressure level due to the floor covering under test should be calculated according to 3.4 and given for all frequencies of measurement, in tabular form and/or in the form of a curve. Also the normalized impact sound pressure level of the bare floor used in the test should be stated in the same manner.

The band width used for the measurement and for the presentation shall be stated in every graph or table.

For graphs with the level in decibels plotted against frequency on a logarithmic scale, the length for a 10:1 frequency ratio should be equal to the length for 10 dB, 25 dB or 50 dB on the ordinate scale.

**9 TEST REPORT**

With reference to this International Standard the test report shall state :

- a) name or organization that has performed the measurements;
- b) date of test;
- c) size and shape of receiving room, construction and thickness of the walls;
- d) dimensions of the test floor;
- e) for the floor covering, the layers of multi-layered

coverings and the adhesives, the names and addresses of the manufacturers, the commercial designation, and the source of supply of the specimen used in the test;

f) detailed description, including the type, the mass, surface dimensions and thickness (under load where specified, see 5.3.2.1) of the test specimens, with appropriate drawings where necessary;

g) method of mounting, with particular reference to the adhesive, its mass per unit area and open-time, and in the case of floating slab floors the curing time for the concrete;

h) temperature and humidity of the source room;

**j**) number and location of microphones;

**k**) number, location and installation time of the loads, where used;

**m**) type of filters used;

**n**) mass and number of supports of the tapping machine;

**p**) a statement as to whether the test specimen suffered visible damage during the test (for example compaction);

NOTE — It is desirable that the tested specimen be retained in the laboratory for subsequent inspection.

**q**) reduction in impact sound pressure level due to the floor covering under test, as a function of frequency;

**r**) normalized impact sound pressure level of the bare floor used in the test, as a function of frequency;

**s**) brief description of details of procedure and equipment (see 6.6);

**t**) the following statement : "These results are based on tests made with an artificial source under laboratory conditions".

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## ANNEX

## EXAMPLE OF A TEST PROCEDURE

An example of a test procedure which will normally be expected to give satisfactory repeatability is given below :

When the receiving room is substantially rectangular with a volume of about 50 m<sup>3</sup> it will contain at least three randomly orientated diffusing elements or an equivalent area of rotating vane, the former having a typical edge length of 1,2 m each. The diffusers should not be suspended from the ceiling under test.

The conditions of placement of the tapping machine and specimen are clearly stated in 6.5.1, 6.5.2, 6.5.3. It is required that two different random microphone positions are used for each of the three tapping positions, each

reading from each position having an averaging time of 5 s in each frequency band. No microphone position should be nearer than 0,7 m to the room boundaries or diffusers.

As an alternative, the sound field sampling procedure can be carried out using a rotating microphone device having a sweep radius between 1 m and 1,5 m. In this case, the plane of the traverse is inclined in relation to the room boundaries and the device should have a traverse time equal to the averaging time, which should be a minimum of 30 s.

The equivalent absorption area should be determined from readings taken using three microphone positions with two reverberation time analyses at each position.

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