IS : 9901 (Part VIII) - 1981
(Reaffirmed 1995)

Indian Standard

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

UDC 699·84 : 692·53 : 534·833·522·4·08

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Price Rs 7.00

September 1982

Indian Standard

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

Acoustics Sectional Committee, LTDC 5

Chairman

DR M. PANCHOLY
Emeritus Scientist
National Physical Laboratory
New Delhi

Members	*Representing*
DR K. ACHYUTHAN	Ministry of Defence (R & D)
SHRI R. S. VOHRA (*Alternate*)	
SHRI SANDEEP AHUJA	Ahuja Radios, New Delhi
SHRI S. P. JERATH (*Alternate*)	
COL T. R. BHALOTRA	Ministry of Defence (DGI)
LT COL KISHAN LAL (*Alternate*)	
DR A. F. CHHAPGAR	National Physical Laboratory (CSIR), New Delhi
DR P. N. GUPTA	Department of Electronics, New Delhi
SHRI TEK CHANDANI (*Alternate*)	
SHRI R. K. JAIN	Electronic Component Industries Association (ELCINA), New Delhi
SHRI L. K. VISHWANATH (*Alternate*)	
SHRI K. S. KALIDAS	Railway Board (Ministry of Railways)
SHRI V. JAYARAMAN (*Alternate*)	
SHRI J. S. MONGA	Botton Industrial Corporation, New Delhi
SHRI M. S. MONGA (*Alternate*)	
SHRI B. C. MUKHERJEE	National Test House, Calcutta
SHRI J. K. BHATTACHARYA (*Alternate*)	
DR (KUMARI) SHAILAJA NIKAM	All India Institute of Speech & Hearing, Mysore
SHRI K. D. PAVATE	Central Electronics Engineering Research Institute (CSIR), Pilani
SHRI M. R. KAPOOR (*Alternate*)	
SHRI A. V. RAMANAN	Films Division, Bombay
RESEARCH ENGINEER	Directorate General of All India Radio, New Delhi

(*Continued on page* 2)

(*Continued from page* 1)

Members	*Representing*
SHRI SARWAN KUMAR SHRI K. CHANRACHUDAN (*Alternate*)	Directorate General of Civil Aviation, New Delhi
SHRI M. SHANKARALINGAM SHRI R. S. ARORA (*Alternate*)	Directorate General of Supplies & Disposals, New Delhi
SHRI M. N. SHUKLA SHRI S. K. TANDON (*Alternate*)	Posts and Telegraphs Board, New Delhi
SUPERINTENDENT SURVEYOR OF WORKS (FOOD)	Central Public Works Department, New Delhi
SHRI L. K. VISHWANATH SHRI K. D'SA (*Alternate*)	Peico Electronics & Electricals Ltd, Bombay; *and* The Radio Electronics and Television Manufacturers' Association, Bombay
SHRI R. C. JAIN, Head (Electronics)	Director General, ISI (*Ex-officio Member*)

Secretary
SHRI PAVAN KUMAR
Assistant Director (Electronics), ISI

Indian Standard

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. FOREWORD

0.1 This Indian Standard (Part VIII) was adopted by the Indian Standards Institution on 3 December 1981, after the draft finalized by the Acoustics Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The purpose of this 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 measurements by means of an artificial source (standard tapping machine) under laboratory conditions and is not concerned with the subjective significance of the results.

0.3 This standard, which covers laboratory measurements of the reduction of transmitted impact noise by floor covering on a standard floor is one of the series of Indian Standards on measurement of sound insulation in buildings and of building elements. Other standards in this series are:

Part I	Requirements for laboratories
Part II	Statement of precision requirements
Part III	Laboratory measurements of airborne sound insulation of building elements
Part IV	Field measurements of airborne sound insulation between rooms
Part V	Field measurements of airborne sound insulation of facade elements and facades
Part VI	Laboratory measurements of impact sound insulation of floors
Part VII	Field measurements of impact sound insulation of floors.

0.4 While preparing this standard, assistance has been derived from ISO/DIS 140/VIII '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', issued by the International Organization for Standardization.

0.5 In reporting the result of a test made in accordance with this standard, if the final value observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960* .

1. SCOPE

1.1 This standard Part (VIII) specifies a method for measuring the acoustical properties of floor coverings from the viewpoint of reducing impact noise transmission.

1.2 This standard is applicable to all floor coverings, whether single or multi-layered, as installed on a standardized floor structure. 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 measurement. It does not contain any provision that permits an assessment of the effectiveness of a floor covering *in situ*.

2. TERMINOLOGY

2.0 For the purpose of this standard, the terms and definitions given in IS : 1885 (Part III/Sec 8)-1974† and IS : 9901 (Part VI)-1981‡ shall apply in addition to the following terms.

2.1 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 ΔL:

$$\Delta L = (L_n)_o - L_n$$

where

$(L_n)_o$ = normalized impact sound pressure level in the receiving room in the absence of floor covering; and

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

*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary: Part III Acoustics, Sec 8 Architectural acoustics.

‡Measurement of sound insulation in buildings and of building elements: Part VI Laboratory measurements of impact sound insulation of floors.

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.

3. EQUIPMENT

3.1 The standardized impact sound source, that is, the tapping machine, should conform to IS : 9901 (Part VI)-1981*. Only metal-tipped hammers should be used.

3.2 Further the equipment shall be suitable for meeting the requirements of **5**.

4. TEST ARRANGEMENT

4.1 General Arrangement

4.1.1 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* IS : 9901 (Part I) - 1981†].

4.2 Details of Test Arrangement

4.2.1 *Source Room*

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

4.2.2 *Receiving Room*

4.2.2.1 The receiving room should meet the requirements of IS : 9901 (Part I) - 1981†.

4.2.3 *Test Floor*

4.2.3.1 The floor on which the test coverings are to be installed should consist of a reinforced concrete slab of thickness 120±20 mm. It should be homogeneous and of uniform thickness. The surface area, viewed from the receiving room, should be at least 10 m². On the source room side, the permissible test area for installation of floor coverings of category 1 (*see* **4.3.3**) will be the region at least 0·5 m from the edges of the floor slab.

*Measurement of sound insulation in buildings and of building elements: Part VI laboratory measurements of impact sound insulation of floors.

†Measurement of sound insulation in buildings and of building elements: Part I Requirements for laboratory

4.2.4 *Condition of Floor Surface*

4.2.4.1 The surface of the test floor should be perfectly flat (to ± 1 mm in a horizontal distance of 200 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.

4.3 Preparation and Installation of Test Specimens

4.3.1 *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.

4.3.1.1 *Category* 1 (*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.

4.3.1.2 *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 kg/m^2 (*see* for example, Fig. 1).

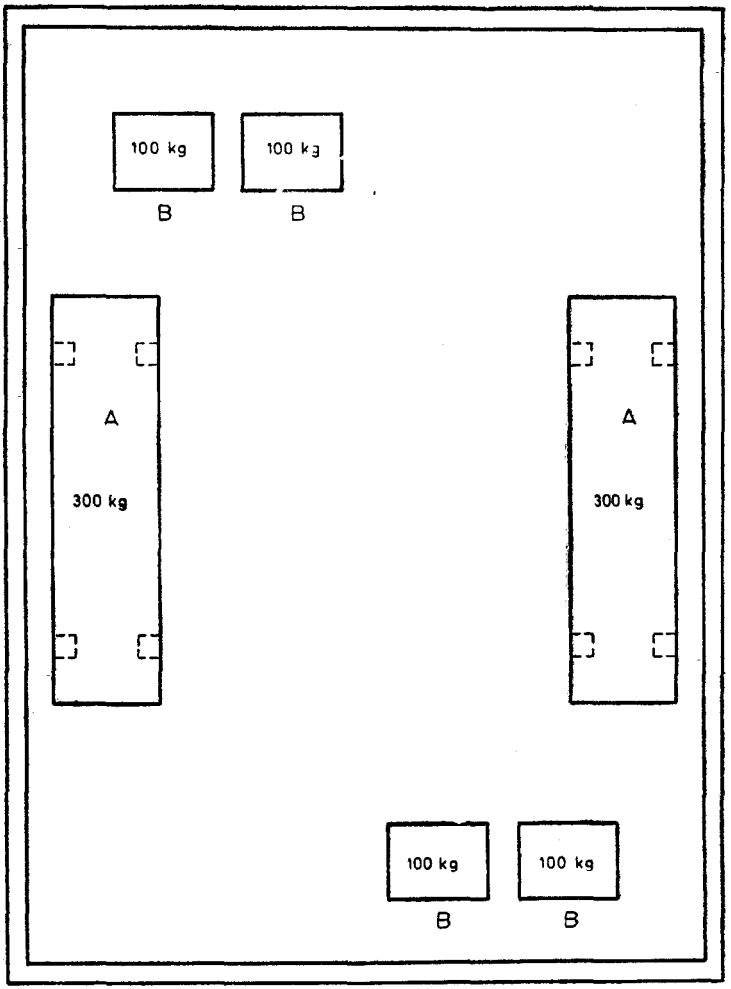
4.3.1.3 *Category III* (*Stretched Materials*) — This category includes flexible coverings which cover the floor from wall to wall. Large specimens should be tested, but loading is not required.

4.3.1.4 *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.

4.3.2 *Installation*

4.3.2.1 *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.

4.3.2.2 *Curing period prior to test* — Coverings such a concrete floating slabs cast in place should not be tested until after the customary curing period, for example, three weeks for ordinary concrete.



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; rectangler *B* represent two superposed loads.

FIG. 1 TYPICAL LOADING ARRANGEMENT FOR CATEGORY II FLOOR COVERINGS (*see* **4.3.1.2**)

4.3.3 *Size and Number of Specimens*

4.3.3.1 *Category I* — Three samples (*see* **4.2.3**), preferably of different production runs but from the same source, should be installed. Each sample must be large enough to support the whole impact machine.

4.3.3.2 *Categories II and III* — The specimen should cover the whole surface from wall to wall, or in any case at least 10 m^2 with a minimum dimension of 2·3 m.

4.4 Influence of Temperature and Humidity — Generally, and certainly 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 $27 \pm 2°C$.

5. TEST PROCEDURE AND EVALUATION

5.1 Generation of Sound Field

5.1.1 The impact sound shall be generated by the tapping machine (*see* **3**). The position of the tapping machine shall be in accordance with **5.5**.

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

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

5.2 Measurement of Impact Sound Pressure Level

5.2.1 The impact sound pressure level in the receiving room should be an average obtained by using a number of fixed microphone positions or a continuously moving microphone with an integration of p^2.

5.2.2 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 Table 1 shall be applied.

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

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

TABLE 1 CORRECTION TO SOUND PRESSURE LEVEL READINGS

(*Clause* 5.2.2)

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

5.2.5 The indicating device should be designed to determine rms values of the sound pressure or corresponding pressure levels. If a sound level meter is used, it should conform to IS : 9779-1981* for precision sound level meters. It is recommended to use the meter response "slow". The complete measuring system including the microphone shall be calibrated before each series of measurements to absolute values for measurements in diffuse sound fields.

5.3 Frequency Range of Measurements

5.3.1 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 IS : 6964-1973†.

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

100 125 160 200 250 315 400 500 630 800
1000 1250 1600 2000 2500 3150 Hz

5.3.3 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.

NOTE 1 — Use of lower frequency is dependent on the distribution of natural frequency.

NOTE 2 — The minimum reverberation times for the empty room are adjusted to a volume of 180 m^3. For other volumes, these times should be multiplied by the factor ($V/180$) 1/3 (V being the volume of the room expressed in cubic meters) except at high frequencies, where the air absorption is the predominant factor influencing the decay rate.

*Specification for sound level meters.

†Specification for octave, half-octave and third-octave band filters for analysis of sound and vibrations.

5.4 Measurement and Evaluation of the Equivalent Absorption Area

5.4.1 The correction term of equation (2) containing the equivalent absorption area should be evaluated from the reverberation time measured according to IS : 8225-1976* and using Sabine's formula:

$$A = \frac{0{\cdot}163\ V}{T}$$

where

A = equivalent absorption area in square metres,

V = receiving room volume in cubic metres,

T = the reverberation time in seconds.

(*See* Note in **2.1**)

5.5 Position of the Tapping Machine

5.5.1 *Adjustment of the Tapping Machine*

5.5.1.1 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.

NOTE — 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 40 mm for the fall of the hammers.

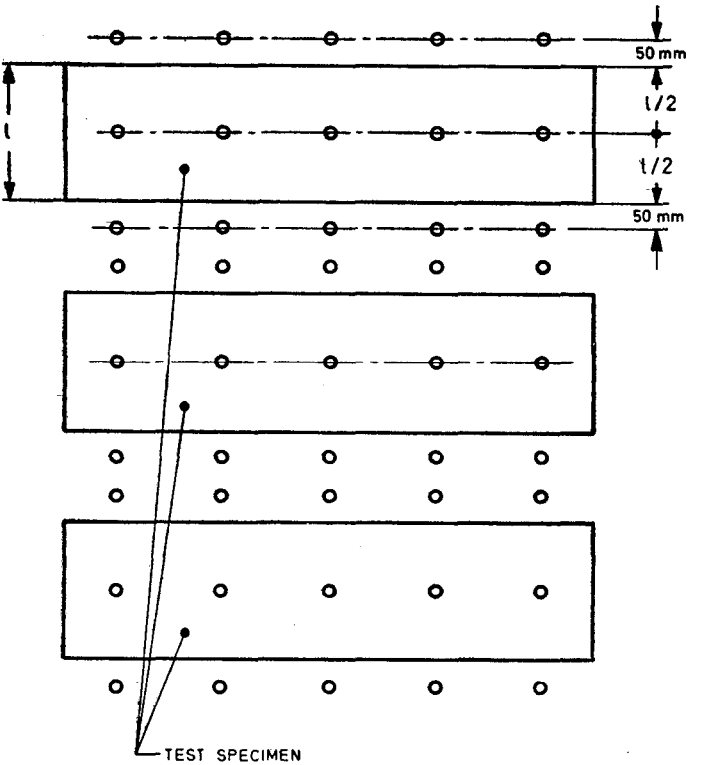
5.5.2 *Materials of Category I*

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

5.5.2.2 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.

*Method of measurement of absorption coefficients in a reverberation room.



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

FIG. 2 TYPICAL TEST ARRANGEMENT FOR SAMPLES OF CATEGORY I FLOOR COVERINGS

5.5.3 *Materials of Categories II and III*

5.5.3.1 The impact 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.

5.5.3.2 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.

5.6 Measurement Procedure

5.6.0 A test procedure which complies with this standard should be determined.

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

a) Number and sizes of diffusing elements, where used;
b) Minimum distances between microphone and room boundaries;
c) Number of microphone positions or in the case of a moving microphone, the traversing path;
d) Averaging time of the levels; and
e) Method of determining the equivalent absorption area, which involves a number of repeated readings in each position.

5.6.1.1 An example of typical test conditions is given in Appendix A.

6. PRECISION

6.1 It is required that the measurement procedure should give satisfactory repeatability. This can be determined in accordance with IS : 9901 (Part II)-1981* 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.

7. EXPRESSION OF RESULTS

7.1 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 2.1 and given for all frequencies of measurement 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.

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

7.3 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 or 50 dB on the ordinate scale.

*Measurement of sound insulation in buildings and of building elements: Part II Statement of precision requirements.

8. TEST REPORT

8.1 The test report should 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 sample used in the test;

f) Detailed description, including the type, the mass, surface dimensions and thickness (under load where specified, *see* **4.3.2.1**) 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) Band width (octave or third-octave) of filters used in the test;

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* **3** and **5.6**);

t) Certification of the testing agency; and

u) The following statement: "The results are based on tests made with an artificial source under laboratory conditions".

APPENDIX A

(*Clause* 5.6.1.1)

TEST PROCEDURE

A-1. EXAMPLE OF A TEST PROCEDURE

A-1.1 Where the receiving room is substantially rectangular with a volume of about 50m³ 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.

A-1.2 The conditions of placement of the tapping machine and specimen are clearly stated in **5.5.1, 5.5.2** and **5.5.3**. 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.

A-1.3 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 an averaging time equal to the traverse time, which should be a minimum of 30 s.

A-1.4 The equivalent absorption area should be determined from readings taken using three microphone positions with two reverberation time analyses at each position.