INTERNATIONAL STANDARD

ISO 717-2

Fourth edition
2020-12

Acoustics — Rating of sound insulation in buildings and of building elements —

Part 2: Impact sound insulation

Acoustique — Évaluation de l'isolement acoustique des immeubles et des éléments de construction —

Partie 2: Protection contre le bruit de choc

Reference number
ISO 717-2:2020(E)

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Published in Switzerland

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Foreword

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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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 126, *Acoustic properties of building elements and of buildings,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 717-2:2013), which has been technically revised.

The main changes compared to the previous edition are as follows:

— A new Annex D with a method for rating heavy/soft impact sound insulation using an A-weighted maximum impact sound pressure level.

A list of all parts in the ISO 717 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Methods of measurement of impact sound insulation in buildings and of building elements have been standardized in ISO 10140-3 and ISO 16283-2. These methods give values for the impact sound insulation which are frequency dependent. The purpose of this document is to standardize a method whereby the frequency-dependent values of impact sound insulation can be converted into a single number characterizing the acoustical performance.

Acoustics — Rating of sound insulation in buildings and of building elements —

Part 2:
Impact sound insulation

1 Scope

This document

a) defines single-number quantities for impact sound insulation in buildings and of floors,

b) gives rules for determining these quantities from the results of measurements carried out in one-third-octave bands in accordance with ISO 10140-3 and ISO 16283-2, and in octave bands in accordance with that option in ISO 16283-2 for field measurements only,

c) defines single-number quantities for the impact sound reduction of floor coverings and floating floors calculated from the results of measurements carried out in accordance with ISO 10140-3, and

d) specifies a procedure for evaluating the weighted reduction in impact sound pressure level by floor coverings on lightweight floors.

The single-number quantities in accordance with this document are intended for rating impact sound insulation and for simplifying the formulation of acoustical requirements in building codes. An additional single-number evaluation in steps of 0,1 dB is indicated where it is needed for the expression of uncertainty (except for spectrum adaptation terms). Numerical values of the single-number quantities are specified where required for calculations.

The rating of measurements over an enlarged frequency range is given in Annex A.

A method for obtaining single-number quantities for bare heavy floors according to their performance in combination with floor coverings is given in Annex B.

Example calculations of single-number quantities are given in Annex C.

The rating of measurements with a heavy and soft impact source (rubber ball) is given in Annex D.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 10140-1, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 1: Application rules for specific products*

ISO 10140-3:2010, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 3: Measurement of impact sound insulation*

ISO 10140-5, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 5: Requirements for test facilities and equipment*

ISO 12999-1, *Acoustics — Determination and application of measurement uncertainties in building acoustics — Part 1: Sound insulation*

ISO 16283-2:2018, *Acoustics — Field measurement of sound insulation in buildings and of building elements — Part 2: Impact sound insulation*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
single-number quantity for impact sound insulation rating
value of the relevant reference curve at 500 Hz after shifting it in accordance with the method specified in 4.3.1 or the value of the relevant reference curve at 500 Hz after shifting it in accordance with the method specified in 4.3.2, reduced by 5 dB

Note 1 to entry: Terms and symbols for the single-number quantity used depend on the type of measurement. Examples are listed in Table 1 for impact sound insulation properties of building elements and in Table 2 for impact sound insulation in buildings. In general, new single-number quantities are derived in a similar way.

Note 2 to entry: This quantity is expressed in decibels.

3.2
spectrum adaptation term
C_I
value to be added to the single-number quantity (e.g. L_n) to take account of the unweighted impact sound level, thereby representing the characteristics of typical walking noise spectra

Note 1 to entry: This quantity is expressed in decibels.

3.3
weighted reduction in impact sound pressure level
difference between the weighted normalized impact sound pressure levels derived with a bare heavy reference floor or a lightweight reference floor, without and with a floor covering

Note 1 to entry: The quantity derived with a bare heavy reference floor is denoted by ΔL_w and is expressed in decibels.

Note 2 to entry: The quantity derived with a lightweight reference floor is denoted by $\Delta L_{t,w}$ and is expressed in decibels. According to the type of reference floor it is denoted as $\Delta L_{t1,w}$, $\Delta L_{t2,w}$, $\Delta L_{t3,w}$.

3.4
equivalent weighted normalized impact sound pressure level of a bare heavy floor
$L_{n,eq,0,w}$
sum of the weighted normalized impact sound pressure level of the bare floor under test with the reference floor covering and the weighted reduction in impact sound pressure level of the reference floor covering

Note 1 to entry: This quantity is calculated in accordance with the method specified in this document.

Note 2 to entry: This quantity is expressed in decibels.

3.5
A-weighted maximum impact sound pressure level
$L'_{iA,Fmax}$
A-weighted maximum impact sound pressure level determined with Fast time-weighting when measured with a heavy and soft impact source, the rubber ball

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: For field measurements it is denoted as $L'_{i,Fmax}$.

Note 3 to entry: It is determined as described in ISO 10140-3, ISO 10140-5 or ISO 16283-2. The reported values are averaged over all receiving points and all source positions.

3.6
Standardized A-weighted maximum impact sound pressure level
$L'_{iA,Fmax,V,T}$
A-weighted maximum impact sound pressure level determined with Fast time-weighting when measured with a heavy and soft impact source, the rubber ball, and increased by a correction term for room volume and reduced by a correction term for reverberation time and Fast time weighting

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: For field measurements it is denoted as $L'_{i,Fmax,V,T}$.

Note 3 to entry: It is determined as described in ISO 10140-3, ISO 10140-5 or ISO 16283-2. The reported values are averaged over all receiving points and all source positions.

4 Procedure for evaluating single-number quantities for impact sound insulation rating

4.1 General

The values obtained in accordance with ISO 10140-3 and ISO 16283-2 are compared with reference values (see 4.2) at the frequencies of measurement within the range 100 Hz to 3 150 Hz for measurements in one-third-octave bands or 125 Hz to 2 000 Hz for measurements in octave bands.

The comparison shall be carried out in accordance with 4.3.

Table 1 — Single-number quantity for impact sound insulation of floors

Derived from one-third-octave band values		Defined in	
Single-number quantity	Term and symbol		
Weighted normalized impact sound pressure level, $L_{n,w}$	Normalized impact sound pressure level, L_n	ISO 10140-3:2010	Formula (1)

Table 2 — Single-number quantities for impact sound insulation in buildings

Derived from one-third-octave band or octave band values		Defined in	
Single-number quantity	Term and symbol		
Weighted normalized impact sound pressure level, $L'_{n,w}$	Normalized impact sound pressure level, L'_n	ISO 16283-2:2018	Formula (3)
Weighted standardized impact sound pressure level, $L'_{nT,w}$	Standardized impact sound pressure level, L'_{nT}	ISO 16283-2:2018	Formula (1)

4.2 Reference values

The set of reference values used for comparison with measurement results shall be as given in Table 3. The reference curves are shown in Figures 1 and 2.

NOTE The reference values for the octave bands 125 Hz to 1 000 Hz are equivalent to the energetic sum (rounded to integers) of these for the relevant one-third-octave band. The energetic sum from one-third-octave bands 800 Hz, 1 000 Hz and 1250 Hz is 61,41 dB which is rounded to 61 dB. Despite this, the reference value for the octave band 1 000 Hz is 62 dB to keep it consistent with older versions of this standard. The reference value for the octave band 2 000 Hz has been reduced to take care of the one-third-octave band 3 150 Hz, which (for bare heavy floors) can contribute considerably to the unfavourable deviations.

4.3 Method of comparison

4.3.1 Measurements in one-third-octave bands

To evaluate the results of a measurement of L_n, L'_n or L'_{nT} in one-third-octave bands, the measurement data shall be given to one decimal place.[1)] Shift the reference curve in increments of 1 dB (0,1 dB for the purpose of expression of uncertainty) towards the measured curve until the sum of unfavourable deviations is as large as possible but not more than 32,0 dB.

An unfavourable deviation at a particular frequency occurs when the results of measurements exceed the reference value. Only the unfavourable deviations shall be taken into account.

The value, in decibels, of the reference curve at 500 Hz, after shifting it in accordance with this procedure, is $L_{n,w}$, $L'_{n,w}$ or $L'_{nT,w}$ respectively.

Table 3 — Reference values for impact sound

Frequency Hz	**Reference values** dB One-third-octave bands	Octave bands
100	62	
125	62	67
160	62	
200	62	
250	62	67
315	62	
400	61	
500	60	65
630	59	
800	58	
1 000	57	62
1 250	54	

1) The different parts of ISO 10140 and ISO 16283 state that the results shall be reported "to one decimal place". However, if the octave or one-third-octave values have been reported with more than one decimal digit, the values shall be reduced to one decimal place before use in the calculation of the single number rating. This is done by taking the value in tenths of a decibel closest to the reported values: XX,XYZ ZZ ... is rounded to XX,X if Y is less than 5 and to XX,X + 0,1 if Y is equal to or greater than 5. Software developers should ensure that this reduction applies to the true input values and not only to the displayed precision (as shown on the screen or printed on paper). Generally this can be implemented by the following sequence of instructions: multiply the (positive) number XX,XYZ ZZ ... by 10 and add 0,5, take the integer part and then divide the result by 10. For further details see ISO 80000-1[1].

Table 3 *(continued)*

Frequency Hz	Reference values dB	
	One-third-octave bands	Octave bands
1 600	51	
2 000	48	49
2 500	45	
3 150	42	

4.3.2 Measurements in octave bands

To evaluate the results of a measurement of L'_{n} or L'_{nT} in octave bands, the measurement data shall be given to one decimal place.[1)] Shift the reference curve in increments of 1 dB (0,1 dB for the purpose of expression of uncertainty) towards the measured curve until the sum of unfavourable deviations is as large as possible but not more than 10,0 dB.

The value, in decibels, of the reference curve at 500 Hz, after shifting it in accordance with this procedure and then reducing it by 5 dB is $L'_{n,w}$ or $L'_{nT,w}$, respectively.

An unfavourable deviation at a particular frequency occurs when the results of measurements exceed the reference value. Take into account only the unfavourable deviations.

4.4 Statement of results

The appropriate single-number quantity shall be given with reference to this document. The results of measurements shall also be given in the form of a diagram as specified in ISO 10140-3 and ISO 16283-2.

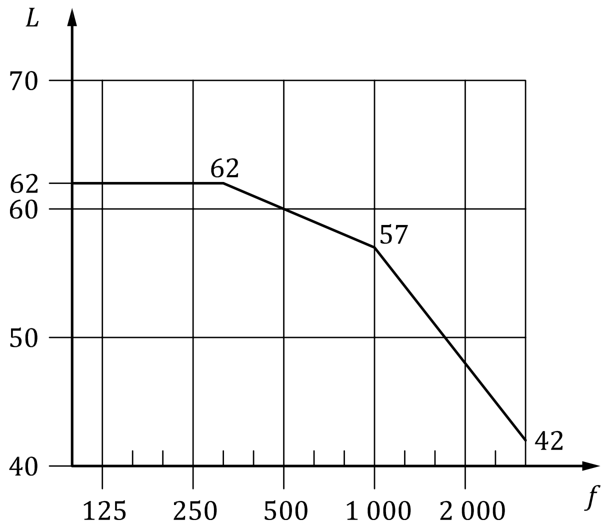
The uncertainty of the weighted single-number quantities may also be stated, in accordance with ISO 12999-1. In this case the numbers shall be given to one decimal place.

EXAMPLE

$L_{n,w} = 53,2 \pm 1,0$

Spectrum adaptation terms do not have uncertainty values of their own.

For field measurements in accordance with ISO 16283-2, it shall be stated whether the single-number quantity is calculated from results in one-third-octave bands or octave bands. In general, there can be differences between single-number quantities calculated from one-third octave or octave band measurements of about ±1 dB. Ratings based on one-third octave band measurements are preferred.

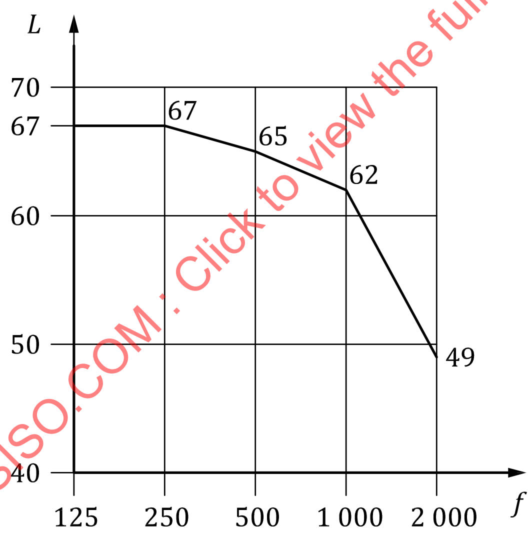


Key

f frequency, in Hz

L reference value, in dB

Figure 1 — Curve of reference values for impact sound, one-third octave bands



Key

f frequency, in Hz

L reference value, in dB

Figure 2 — Curve of reference values for impact sound, octave bands

4.5 Impact sound insulation measured with heavy and soft impact sources

When impact measurements are carried out using the rubber ball as an impact source as described in ISO 10140-3 or ISO 16283-2, the rating method to determine the single-number quantity, which is an A-weighted maximum impact sound pressure level, shall be calculated according to Annex D.

5 Procedure for evaluating the weighted reduction in impact sound pressure level by floor coverings on bare heavy floors

5.1 General

The reduction of impact sound pressure level (improvement of impact sound insulation), ΔL, of floor coverings when tested on a homogeneous concrete slab floor as described in ISO 10140-1 is independent of the normalized impact sound pressure level of the bare floor, $L_{n,0}$. However, the weighted normalized impact sound pressure levels of the floor with and without a floor covering depend to some extent on $L_{n,0}$. In order to obtain comparable values for ΔL_w between laboratories, it is therefore necessary to relate the measured values of ΔL to a reference floor.

5.2 Reference floor

The reference floor is defined by the values for the normalized impact sound pressure level $L_{n,r,0}$ given in Table 4 and Figure 3.

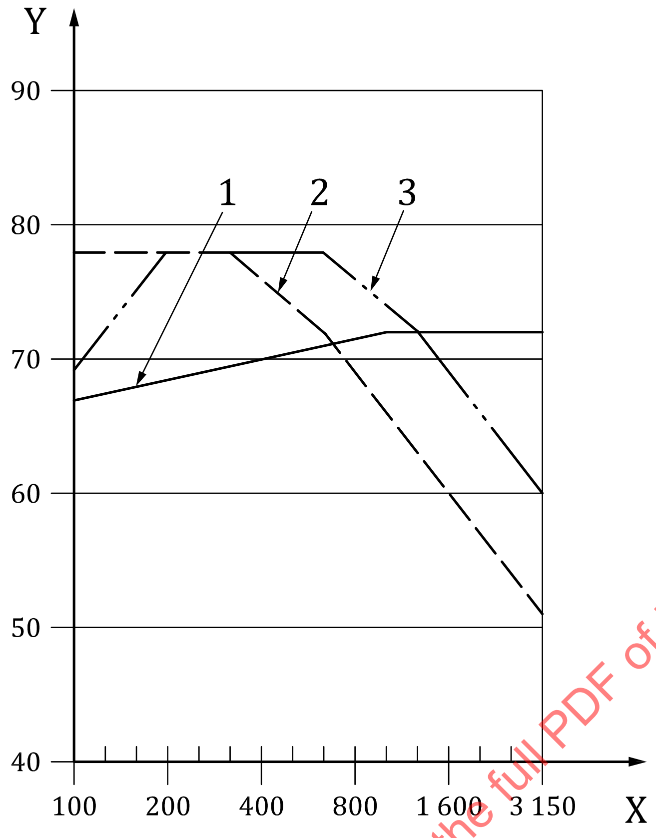
Table 4 — Normalized impact sound pressure level of the reference floor

Frequency Hz	$L_{n,r,0}$ **for heavyweight floors** dB	$L_{n,t,r,0}$ [a] **for lightweight floors C1 and C2** dB	$L_{n,t,r,0}$ [a] **for lightweight floors C3** dB
100	67	78	69
125	67,5	78	72
160	68	78	75
200	68,5	78	78
250	69	78	78
315	69,5	78	78
400	70	76	78
500	70,5	74	78
630	71	72	78
800	71,5	69	76
1 000	72	66	74
1 250	72	63	72
1 600	72	60	69
2 000	72	57	66
2 500	72	54	63
3 150	72	51	60
$L_{n,r,0w}$ or $L_{n,t,r,0w}$ dB	78 (77,6 dB)	72 (71,8 dB)	75 (75,0 dB)
$C_{I,r,0}$ or $C_{I,t,r,0}$ dB	−11 (-10,3 dB)	0 (0,0 dB)	−3 (-2,8 dB)

[a] The index, t, is used to distinguish results for lightweight floors from those for heavyweight floors; it originates from the word "timber".

The weighted normalized impact sound pressure level of the heavy reference floor, $L_{n,r,0,w}$, evaluated in accordance with 4.3.1, is 78 dB (77,6 dB).

NOTE The values given in Table 4 represent a straight-line idealization of the normalized impact sound pressure level of a 120 mm homogeneous concrete floor slab, levelling off, as in the practical case, at frequencies above 1 000 Hz.



Key

X frequency (Hz)

Y $L_{n,(t,)r,0}$ (dB re 20 µPa)

1 heavyweight floor

2 lightweight floors C1 and C2

3 lightweight floor C3

Figure 3 — Reference curves for standard reference floor elements

5.3 Calculation

Calculate the weighted reduction of impact sound pressure level ΔL_w according to Formulas (1) and (2):

$$L_{n,r} = L_{n,r,0} - \Delta L \quad (1)$$

$$\Delta L_w = L_{n,r,0,w} - L_{n,r,w} = 78 - L_{n,r,w} \quad (2)$$

where

$L_{n,r}$ is the calculated normalized impact sound pressure level of the reference floor with the floor covering under test;

$L_{n,r,0}$ is the defined normalized impact sound pressure level of the reference floor (see Table 4);

ΔL is the reduction in impact sound pressure level measured in accordance with ISO 10140-1;

$L_{n,r,w}$ is the calculated weighted normalized impact sound pressure level of the reference floor with the floor covering under test;

$L_{n,r,0,w}$ is obtained from $L_{n,r,0}$ in accordance with 4.3.1.

5.4 Statement of results

The single-number quantity ΔL_w shall be given with reference to this document in accordance with ISO 12999-1. The results of measurements shall also be given in the form of a diagram as specified in ISO 10140-1.

The uncertainty of ΔL_w may also be stated. In this case the numbers shall be given to one decimal place.

EXAMPLE

$\Delta L_w = 18{,}9 \pm 1{,}1$

Spectrum adaptation terms do not have uncertainty values of their own.

The reduction in impact sound pressure level measured on a concrete floor slab as defined in ISO 10140-1 and the single-number quantity ΔL_w may only be used in connection with similar types of massive floors (concrete, hollow concrete, hollow bricks, etc.); it is not appropriate for use on other types of construction.

6 Procedure for evaluating the weighted reduction in impact sound pressure level by floor coverings on lightweight floors

6.1 General

The reduction of impact sound pressure level (improvement of impact sound insulation), $\Delta L_{t,1}$, $\Delta L_{t,2}$, $\Delta L_{t,3}$, of floor coverings when tested on one of the three lightweight reference floors as described in ISO 10140-5 is independent of the normalized impact sound pressure level of the bare reference floor $L_{n,t1,0}$, $L_{n,t2,0}$ and $L_{n,t3,0}$, respectively.

However, the weighted, normalized impact sound pressure levels of a lightweight floor with and without a floor covering depend on the $L_{n,t,0}$ value for the bare floor on which the floor covering is used. In order to obtain values for $\Delta L_{t,w}$, which are comparable between laboratories and especially which can be used to calculate the normalized impact sound pressure level of lightweight floors with the floor covering, the measured values of $\Delta L_{t,1}$, $\Delta L_{t,2}$ and $\Delta L_{t,3}$ shall be related to the respective reference curves for the lightweight floors given in ISO 10140-5.

6.2 Reference curves for the reference lightweight floors used to calculate $\Delta L_{t,w}$

In ISO 10140-5, there are three different reference lightweight floors and, therefore, it is necessary to define different types of reference curves for the calculation of $\Delta L_{t,w}$. The reference curves are defined by the relevant values for $L_{n,t,r,0}$. Table 4 contains the reference values for $L_{n,t,r,0}$ along with the weighted, normalized impact sound pressure levels for the different reference floors.

Values of $\Delta L_{t,w}$ calculated with the reference floor for type C1 or C2 shall be designated as $\Delta L_{t,1,w}$ or $\Delta L_{t,2,w}$ respectively; values of $\Delta L_{t,w}$ calculated with the reference floor for type C3 shall be designated as $\Delta L_{t,3,w}$.

6.3 Calculation

The calculation shall be carried out as specified in 5.3, substituting the heavy reference floor by a lightweight reference floor.

6.4 Statement of results

The single-number quantity $\Delta L_{t,1,w}$, $\Delta L_{t,2,w}$ or $\Delta L_{t,3,w}$ shall be given with reference to Clause 6. The results of measurements shall be given in the form of a diagram as specified in ISO 10140-1.

Annex A
(informative)

Additional weighting procedure

A.1 General

This annex introduces an additional rating method by describing an adaptation term based on the unweighted linear impact sound level.

The rating by $L_{n,w}$ has been shown to be quite adequate in characterizing impact noise like walking for wooden floors and concrete floors with effective coverings such as carpets or floating floors. However, it insufficiently takes into account level peaks at single (low) frequencies, for instance with timber joist floors, or the behaviour of bare concrete floors in this respect. There is clear evidence (see References [3] to [6]) that the unweighted impact level of the tapping machine is more representative of the A-weighted impact levels as caused by walking for all types of floor, while this rating is also more restrictive to single noise peaks (replacing thereby the 8 dB rule which was used in ISO 717-2:1982).

Therefore an adaptation term C_I is introduced to take this effect into account, given as a separate number which cannot be confused with the value for $L_{n,w}$. This term is so defined that for massive floors with effective coverings its value is about zero, while for timber joist floors with dominating low frequency peaks it will be slightly positive. For concrete floors without cover or with less effective covering, it will range from −15 dB to 0 dB.

If these effects are to be taken into account in requirements, these could be written as the sum of $L'_{n,w}$ and C_I.

A.2 Calculation of spectrum adaptation term

A.2.1 Spectrum adaptation term for impact sound level

Measured values of L_n, L'_n or L'_{nT} in one-third-octave bands in the frequency range 100 Hz to 2 500 Hz or in octave bands in the frequency range 125 Hz to 2 000 Hz shall be given to one decimal place, then added up on an energetic basis $L_{n,sum}$, $L'_{n,sum}$ or $L'_{nT,sum}$ and rounded to an integer.[2)]

NOTE The summation on an energetic basis is calculated for k frequency bands by

$$L_{sum} = 10 \lg \sum_{i=1}^{k} 10^{L_i/10}$$

The resulting spectrum adaptation term C_I is then calculated as an integer from one of Formulas (A.1) to (A.3):

$$C_I = \left(L_{n,sum} - 15 - L_{n,w}\right) \tag{A.1}$$

$$C_I = \left(L'_{n,sum} - 15 - L'_{n,w}\right) \tag{A.2}$$

2) XX,YZZ Z ... is rounded to XX if Y is less than 5 and to XX + 1 if Y is greater than or equal to 5. For further details see ISO 80000-1[1]. Software implementers should be aware that calculation of the spectrum adaptation terms involves floating-point calculations that are never exact and may incur rounding errors. In some rare cases, this may lead to a difference of +1 dB or −1 dB in the final result. In order to avoid rounding errors, it is strongly recommended that the highest possible machine accuracy available be used for floating-point representation and mathematical operations.

$$C_{\mathrm{I}} = \left(L'_{\mathrm{n}T,\mathrm{sum}} - 15 - L'_{\mathrm{n}T,\mathrm{w}}\right) \quad \text{(A.3)}$$

NOTE Calculations of the spectrum adaptation term can additionally be carried out for an enlarged frequency range (including 50 Hz + 63 Hz + 80 Hz). The term is then denoted as $C_{\mathrm{I},50–2\,500}$ or $C_{\mathrm{I},63–2\,000}$.

An example of the calculation of the single-number quantity and the adaptation term is given in Annex C.

A.2.2 Spectrum adaptation term for the impact sound reduction of floor coverings

To gather experience in the field of the unweighted impact sound level in addition to the calculation of the weighted reduction in impact sound pressure level ΔL_{w} based on the reference curve (Figure 1), a spectrum adaptation term for flat response for the impact sound reduction may be determined and stated. This spectrum adaptation term $C_{\mathrm{I}\Delta}$ is calculated from

$$C_{\mathrm{I}\Delta} = C_{\mathrm{I,r,0}} - C_{\mathrm{I,r}} \quad \text{(A.4)}$$

where

$C_{\mathrm{I,r}}$ is the spectrum adaptation term for the reference floor with the floor covering under test;

$C_{\mathrm{I,r,0}}$ is the spectrum adaptation term for the reference floor with $L_{\mathrm{n,r,0}}$ in accordance with A.2.1 where $C_{\mathrm{I,r,0}} = -11$ dB.

For calculations of uncertainty where one decimal place is required, $C_{\mathrm{I,r,0}} = -10{,}3$ dB.

A single-number reduction based on the unweighted linear impact sound pressure level ΔL_{lin} may be calculated from

$$\Delta L_{\mathrm{lin}} = L_{\mathrm{n,r,0,w}} + C_{\mathrm{I,r,0}} - (L_{\mathrm{n,r,w}} + C_{\mathrm{I,r}}) = \Delta L_{\mathrm{w}} + C_{\mathrm{I}\Delta} \quad \text{(A.5)}$$

where

$L_{\mathrm{n,r,w}}$ is the calculated normalized impact sound pressure level of the reference floor with the floor covering under test;

$L_{\mathrm{n,r,0,w}}$ is obtained from $L_{\mathrm{n,r,0}}$ in accordance with 4.3.1 where $L_{\mathrm{n,r,0,w}} = 78$ dB.

For calculations of uncertainty where one decimal place is required, $L_{\mathrm{n,r,0,w}} = 77{,}6$ dB.

A.2.3 Spectrum adaptation term for the impact sound reduction of floor coverings on lightweight floors

To gather experience with the unweighted impact sound level for lightweight floors, a spectrum adaptation term for flat response for the impact sound reduction may also be calculated for the floor coverings on lightweight floors. The spectrum adaptation term, $C_{\mathrm{I}\Delta,\mathrm{t}}$, is calculated from Formula (A.6):

$$C_{\mathrm{I}\Delta,\mathrm{t}} = C_{\mathrm{I,t,r,0}} - C_{\mathrm{I,t,r}} \quad \text{(A.6)}$$

where

$C_{\mathrm{I,t,r}}$ is the spectrum adaptation term for the lightweight reference floor with the floor covering under test;

$C_{\mathrm{I,t,r,0}}$ is the spectrum adaptation term for the lightweight reference floor with $L_{\mathrm{n,t,r,0}}$ — it takes the value 0 dB for the reference curve for floors of type C1 and C2 and −3 dB for the reference curve for floors of type C3.

For calculations of uncertainty where one decimal place is required, $C_{I,t,r,0}$ is 0,0 dB for the reference curve for floors of type C1 and C2 and−2,8 dB for the reference curve for floors of type C3.

Values of $C_{I\Delta,t}$ calculated with the lightweight reference floor of type C1, C2 or C3 shall be respectively designated as $C_{I\Delta,t1}$, $C_{I\Delta,t2}$ and $C_{I\Delta,t3}$.

A single-number reduction based on the unweighted linear impact sound pressure level $\Delta L_{lin,t}$ may be calculated from

$$\Delta L_{t,lin} = L_{n,t,r,0,w} + C_{I,t,r,0} - (L_{n,t,r,w} + C_{I,t,r}) = \Delta L_{t,w} + C_{I\Delta,t} \quad (A.7)$$

where

$L_{n,t,r,w}$ is the calculated normalized impact sound pressure level of the lightweight reference floor with the floor covering under test;

$L_{n,t,r,0,w}$ is obtained from $L_{n,t,r,0}$ in accordance with 4.3.1. Values for $L_{n,t,r,0,w}$ are listed in Table 4 for the three lightweight reference floor types.

Values of $\Delta L_{t,lin}$ calculated with the lightweight reference floor of type C1, C2 or C3 shall be respectively designated as $\Delta L_{t1,lin}$, $\Delta L_{t2,lin}$ and $\Delta L_{t3,lin}$.

Annex B
(informative)

Procedure for evaluating the equivalent weighted normalized impact sound pressure level of bare heavy floors

B.1 General

For the rating of impact sound properties of floors in general, the weighted normalized impact sound pressure level, $L_{n,w}$, is used. However, a bare concrete floor is seldom used without a floor covering.

Therefore in this annex a method to calculate an equivalent weighted normalized impact sound pressure level for bare concrete floors is given to describe the impact sound insulation of a bare floor with respect to the effect of a floor covering on this floor.

The equivalent weighted normalized impact sound pressure level of a bare heavy floor, $L_{n,eq,0,w}$ (see 3.4), can be used to calculate the weighted normalized impact sound pressure level $L_{n,w}$, of this bare floor with a floor covering with known ΔL_w, as follows:

$$L_{n,w} = L_{n,eq,0,w} - \Delta L_w \quad \text{(B.1)}$$

where

$L_{n,eq,0,W}$ is the equivalent weighted normalized impact sound pressure level of a bare heavy floor;

ΔL_w is the weighted reduction in impact sound pressure level.

NOTE It is possible to show that $L_{n,eq,0,w}$ in Formula (B.1) may be substituted by ($L_{n,0,w}$ + $C_{I,0}$ + 11) to give Formula (B.2) and that $L_{n,w}$ for a bare floor characterized by $L_{n,0,w}$ with a covering characterized by ΔL_w and ΔL_{lin} is given by Formula (B.3)

$$L_{n,w} = L_{n,0,w} + C_{I,0} + 11 - \Delta L_w \quad \text{(B.2)}$$

or

$$L_{n,w} + C_I = L_{n,0,w} + C_{I,0} - \Delta L_{lin} = L_{n,0,w} + C_{I,0} - (\Delta L_w + C_{I\Delta}) \quad \text{(B.3)}$$

where

$L_{n,0,W}$ is the weighted normalized impact sound pressure level of a bare heavy floor;

$C_{I,0}$ is the spectrum adaptation term for the bare floor.

B.2 Reference floor covering

The reference floor covering is defined by the values for the reduction of impact sound pressure level (improvement of impact sound insulation), ΔL_r, given in Table B.1.

The weighted reduction in impact sound pressure level of the reference floor covering, $\Delta L_{r,w}$, evaluated in accordance with Clause 5, is 19 dB.

NOTE The values given in Table B.1 represent a straight-line idealization of the general shape of the reduction in impact sound pressure level by a floor covering, with a slope of 12 dB per octave.

Table B.1 — Reduction in impact sound pressure level of the reference floor covering

Frequency Hz	ΔL_r dB
100	0
125	0
160	0
200	2
250	6
315	10
400	14
500	18
630	22
800	26
1 000	30
1 250	30
1 600	30
2 000	30
2 500	30
3 150	30

B.3 Calculation

The equivalent weighted normalized impact sound pressure level of bare massive floors, $L_{n,eq,0,w}$, is calculated using Formulas (B.4) and (B.5):

$$L_{n,1} = L_{n,0} - \Delta L_r \tag{B.4}$$

$$L_{n,eq,0,w} = L_{n,1,w} + \Delta L_{r,w} = L_{n,1,w} + 19 \tag{B.5}$$

where

$L_{n,1}$ is the calculated normalized impact sound pressure level of the floor under test with the reference floor covering;

$L_{n,0}$ is the normalized impact sound pressure level of the bare floor under test, measured in accordance with ISO 10140-3;

ΔL_r is the defined reduction in impact sound pressure level of the reference floor covering (see Table B.1);

$L_{n,1,w}$ is the calculated weighted normalized impact sound pressure level of the floor under test with the reference floor covering and is obtained from $L_{n,1}$ in accordance with 4.3.

Annex C
(informative)

Examples of the evaluation of a single-number quantity

Examples are given of the evaluation of a single-number quantity based on the result of:

a) measurements in a laboratory with:

— determination of the impact sound level of a bare heavy floor, and of that floor with a floor covering (Table C.1),

— determination of the reduction in impact sound pressure level of the floor covering (Table C.2);

b) measurements in situ with determination of the impact sound level of the floor (Table C.3).

Table C.1 — Example: Calculation of $L_{n,W}$ and C_I for laboratory measurements in one-third octave bands on a bare heavy floor with and without a floor covering

Frequency	Bare heavy floor			With floor covering		
	L_n	Reference values shifted by +19 dB	Unfavourable deviation	L_n	Reference values shifted by +4 dB	Unfavourable deviation
Hz	dB	dB	dB	dB	dB	dB
100	62,1	81	—	59,1	66	—
125	63,2	81	—	59,5	66	—
160	63,5	81	—	61,6	66	—
200	66,2	81	—	63,2	66	—
250	68,5	81	—	65,3	66	—
315	70,0	81	—	66,5	66	0,5
400	71,7	80	—	67,7	65	2,7
500	73,1	79	—	67,0	64	3,0
630	73,8	78	—	67,1	63	4,1
800	73,5	77	—	66,5	62	4,5
1 000	73,8	76	—	66,1	61	5,1
1 250	73,3	73	0,3	62,5	58	4,5
1 600	73,1	70	3,1	57,9	55	2,9
2 000	73,0	67	6,0	52,7	52	0,7
2 500	72,4	64	8,4	47,0	49	
3 150	71,2	61	10,2	48,0	46	2,0
	$L_{n,sum}$ = 83,523 8... = 84 dB C_I = 84 − 15 − 79 = −10 dB		Sum 28,0 < 32,0 $L_{n,w}$ = 79 dB	$L_{n,sum}$ = 76,059 3... = 76 dB C_I = 76 − 15 − 64 = −3 dB		Sum 30,0 < 32,0 $L_{n,w}$ = 64 dB

Table C.2 — Example: Calculation of ΔL_w and ΔL_{lin} for laboratory measurements in one-third octave bands with a floor covering on a standard floor

Frequency Hz	Bare floor $L_{n,0}$ dB	With covering L_n dB	Reduction $\Delta L = L_{n,0} - L_n$ dB	Reference floor $L_{n,r,0}$ dB	Reduction $L_{n,r,0} - \Delta L$ dB	Reference value + 3 dB dB	Unfavourable deviation dB
100	65,2	62,2	3,0	67,0	64,0	65	—
125	66,3	62,6	3,7	67,5	63,8	65	—
160	68,0	66,1	1,9	68,0	66,1	65	1,1
200	68,5	65,5	3,0	68,5	65,5	65	0,5
250	68,0	64,8	3,2	69,0	65,8	65	0,8
315	69,0	65,5	3,5	69,5	66,0	65	1,0
400	69,3	65,3	4,0	70,0	66,0	64	2,0
500	70,2	64,1	6,1	70,5	64,4	63	1,4
630	70,7	64,0	6,7	71,0	64,3	62	2,3
800	71,2	64,2	7,0	71,0	64,0	61	3,0
1 000	71,5	63,8	7,7	72,0	64,3	60	4,3
1 250	72,1	61,3	10,8	72,0	61,2	57	4,2
1 600	73,0	57,8	15,2	72,0	56,8	54	2,8
2 000	74,0	53,7	20,3	72,0	51,7	51	0,7
2 500	73,5	48,1	25,4	72,0	46,6	48	—
3 150	73,1	49,9	23,2	72,0	48,8	45	3,8
			$L_{n,sum}$ = 75,252 7... = 75 dB C_I = 75 − 15 − 63 = −3 dB ΔL_{lin} = 78 − 11 − (63 − 3) = 7 dB			Sum 27,9 < 32,0 $L_{n,w,r}$ = 63 dB ΔL_w = 78 − 63 = 15 dB	