SLOVENSKI STANDARD
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Protihrupne ovire za cestni promet - Preskusna metoda za ugotavljanje akustičnih lastnosti - 6. del: Bistvene karakteristike - Terenske vrednosti izolirnosti pred zvokom v zraku pri usmerjenem zvočnem polju

Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 6: Intrinsic characteristics - In situ values of airborne sound insulation under direct sound field conditions

Lärmschutzvorrichtungen an Straßen - Prüfverfahren zur Bestimmung der akustischen Eigenschaften - Teil 6: Produktspezifische Merkmale - In-situ-Werte der Luftschalldämmung in gerichteten Schallfeldern

Dispositifs de réduction du bruit du trafic routier - Méthode d'essai pour la détermination de la performance acoustique - Partie 6: Caractéristiques intrinsèques - Valeurs in situ d'isolation aux bruits aériens dans des conditions de champ acoustique direct

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ICS:

17.140.30	Emisija hrupa transportnih sredstev	Noise emitted by means of transport
93.080.30	Cestna oprema in pomožne naprave	Road equipment and installations

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

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ICS 17.140.30; 93.080.30

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English Version

Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 6: Intrinsic characteristics - In situ values of airborne sound insulation under direct sound field conditions

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 226.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (prEN 1793-6:2016) has been prepared by Technical Committee CEN/TC 226 “Road equipment”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This European Standard has been prepared, under the direction of Technical Committee CEN/TC 226 “Road equipment”, by Working Group 6 “Anti noise devices”.

This document will supersede EN 1793 6:2012.

With respect to the superseded document, the following changes have been made:

— An improved definition of the test signal and considerations about the Signal to Noise (S/N) ratio;

— Clarification on the calculation of single number ratings for qualification purposes and other purposes;

— The declaration of measurement uncertainty and the related confidence level is now mandatory. The reported uncertainties have an impact on the determination of informative categories of single number rating performance; depending on the performance of the product this could potentially result in products being 'downgraded' to a lower category. As a result, the informative annex in the previous version of this European Standard that addressed categories of single number rating has been removed. The performance of the noise reducing device is, from now on, only to be reported in terms of the numeric values of the single number rating.

— Revised information on the determination of measurement uncertainty.

EN 1793-6 is part of a series of documents and should be read in conjunction with the following:

— EN 1793-1, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 1: Intrinsic characteristics of sound absorption under diffuse sound field conditions*;

— EN 1793-2, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 2: Intrinsic characteristics of airborne sound insulation under diffuse sound field conditions*;

— EN 1793-3, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 3: Normalized traffic noise spectrum*;

— EN 1793-4, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 4: Intrinsic characteristics — In situ values of sound diffraction*;

— EN 1793-5, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 5: Intrinsic characteristics — In situ values of sound reflection under direct sound field conditions.*

Introduction

Noise reducing devices alongside roads need to provide adequate sound insulation so that sound transmitted through the device is not significant compared with the sound diffracted over the top. This European Standard specifies a test method for assessing the intrinsic airborne sound insulation performance for noise reducing devices designed for roads in non-reverberant conditions. It can be applied in situ, i.e. where the noise reducing devices are installed. The method can be applied without damaging the surface.

The method can be used to qualify products to be installed along roads as well as to verify the compliance of installed noise reducing devices to design specifications. Regular application of the method can be used to verify the long term performance of noise reducing devices.

The method requires the averaging of results of measurements taken at different points behind the device under test. The method is able to investigate flat and non-flat products.

The method uses the same principles and equipment for measuring sound reflection (see EN 1793-5) and airborne sound insulation (the present document).

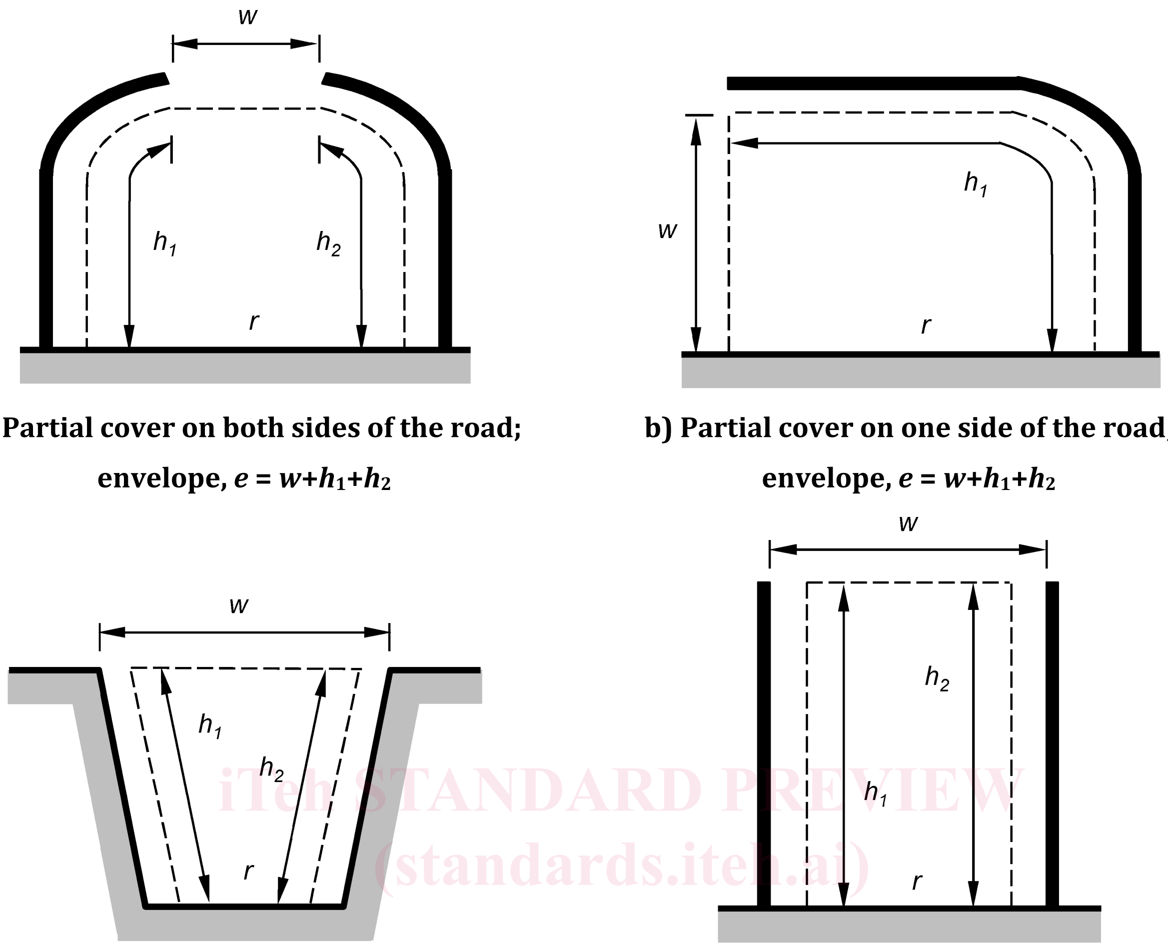
The measurement results of this method for airborne sound insulation are comparable but not identical with the results of the EN 1793-2 method, mainly because the present method uses a directional sound field, while the EN 1793-2 method assumes a diffuse sound field (where all angles of incidence are equally probable). Research studies suggest that good correlation exists between laboratory data, measured according to EN 1793-2 and field data, measured according to the method described in the present document [4], [5], [6], [7], [15].

The test method described in this European Standard should not be used to determine the intrinsic characteristics of airborne sound insulation for noise reducing devices to be installed in reverberant conditions, e.g. inside tunnels or deep trenches or under covers.

For the purpose of this European Standard, reverberant conditions are defined based on the geometric envelope, *e*, across the road formed by the barriers, trench sides or buildings (the envelope does not include the road surface) as shown by the dashed lines in Figure 1. Conditions are defined as being reverberant when the percentage of open space in the envelope is less than or equal to 25 %, i.e. reverberant conditions occur when $w/e \leq 0,25$, where $e = (w+h_1+h_2)$.

This European Standard introduces a specific quantity, called sound insulation index, to define the airborne sound insulation of a noise reducing device. This quantity should not be confused with the sound reduction index used in building acoustics, sometimes also called transmission loss. Research studies suggest that a very good correlation exists between data measured according to EN 1793-2 and data measured according to the method described in this document.

NOTE This method may be used to qualify noise reducing devices for other applications, e.g. to be installed nearby industrial sites. In this case, the single-number ratings will preferably be calculated using an appropriate spectrum.



a) Partial cover on both sides of the road; envelope, $e = w+h_1+h_2$

b) Partial cover on one side of the road; envelope, $e = w+h_1+h_2$

c) Deep trench; envelope, $e = w+h_1+h_2$

d) Tall barriers or buildings; envelope, $e = w+h_1+h_2$

Key

r road surface

w width of open space

NOTE Figure 1 is not to scale.

Figure 1 — Sketch of the reverberant condition check in four cases

1 Scope

This European Standard describes a test method for measuring a quantity representative of the intrinsic characteristics of airborne sound insulation for traffic noise reducing devices: the sound insulation index.

The test method is intended for the following applications:

— determination of the intrinsic characteristics of airborne sound insulation of noise reducing devices to be installed along roads, to be measured either in situ or in laboratory conditions;

— determination of the in situ intrinsic characteristics of airborne sound insulation of noise reducing devices in actual use;

— comparison of design specifications with actual performance data after the completion of the construction work;

— verification of the long term performance of noise reducing devices (with a repeated application of the method);

— interactive design process of new products, including the formulation of installation manuals.

The test method is not intended for the determination of the intrinsic characteristics of airborne sound insulation of noise reducing devices to be installed in reverberant conditions, e.g. inside tunnels or deep trenches or under covers.

Results are expressed as a function of frequency in one-third octave bands, where possible, between 100 Hz and 5 kHz. If it is not possible to get valid measurement results over the whole frequency range indicated, the results need to be given in a restricted frequency range and the reasons for the restriction(s) need to be clearly reported.

2 Normative references

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

EN 1793-3, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 3: Normalized traffic noise spectrum*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

3 Terms and definitions

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

3.1
noise reducing device
device that is designed to reduce the propagation of traffic noise away from the road environment

Note 1 to entry: This may be a noise barrier, cladding, a road cover or an added device. These devices may include both acoustic and structural elements.

3.2
acoustical elements
elements whose primary function is to provide the acoustic performance of the device

3.3
structural elements
elements whose primary function is to support or hold in place acoustic elements

3.4
sound insulation index
result of airborne sound insulation test described by Formula (1)

3.5
reference height
height h_S equal to half the height, h_B, of the noise reducing device under test: $h_S = h_B/2$ (see Figures 2 and 3)

Note 1 to entry: When the height of the device under test is greater than 4 m and, for practical reasons, it is not advisable to have a height of the source $h_S = h_B/2$, it is possible to have h_S = 2 m, accepting the corresponding low frequency limitation (see 4.5.8).

3.6
source reference plane for sound insulation index measurements
plane facing the sound source side of the noise reducing device and touching the most protruding parts of the device under test within the tested area (see Figures 2, 4 and 9)

Note 1 to entry: The device under test includes both structural and acoustic elements.

3.7
microphone reference plane
plane facing the receiver side of the noise reducing device and touching the most protruding parts of the device under test within the tested area (see Figures 4 and 9)

Note 1 to entry: The device under test includes both structural and acoustic elements.

3.8
source reference position
position facing the side to be exposed to noise when the device is in place, located at the reference height h_S and placed so that its horizontal distance to the source reference plane is d_s = 1 m (see Figures 2, 5, 8 and 9)

Note 1 to entry: The actual dimensions of the loudspeaker used for the background research on which this European Standard is based are: 0,40 m x 0,285 m x 0,285 m (length x width x height).

3.9
measurement grid for sound insulation index measurements
vertical measurement grid constituted of nine equally spaced points

Note 1 to entry: A microphone is placed at each point (see Figures 3, 5, 6, 8, 9 and 4.5).

3.10
barrier thickness for sound insulation index measurements
distance t_B between the source reference plane and the microphone reference plane at a height equal to the reference height h_S (see Figures 4, 8 and 9)

3.11
free-field measurement for sound insulation index measurements
measurement taken with the loudspeaker and the microphone in an acoustic free field in order to avoid reflections from any nearby object, including the ground (see Figure 6)

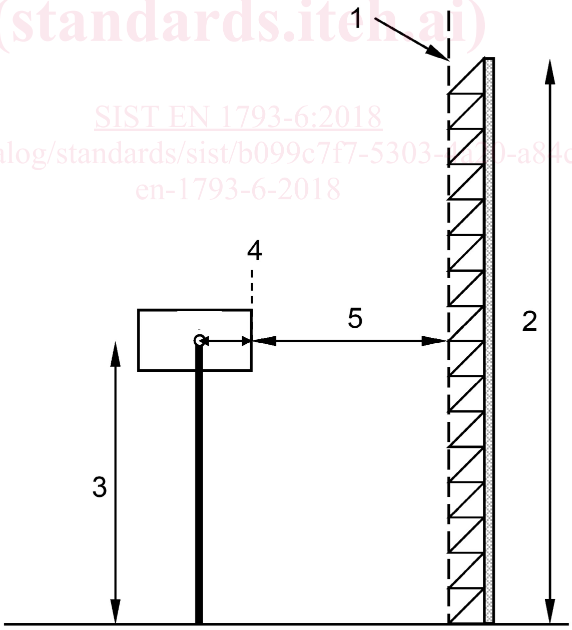
3.12
Adrienne temporal window
composite temporal window described in 4.5.6

3.13
background noise
noise coming from sources other than the source emitting the test signal

3.14
signal-to-noise ratio, S/N
difference in decibels between the level of the test signal and the level of the background noise at the moment of detection of the useful event (within the Adrienne temporal window)

3.15
impulse response
time signal at the output of a system when a Dirac function is applied to the input

Note 1 to entry: The Dirac function, also called δ function, is the mathematical idealisation of a signal that is infinitely short in time which carries a unit amount of energy.



Key

1 source reference plane

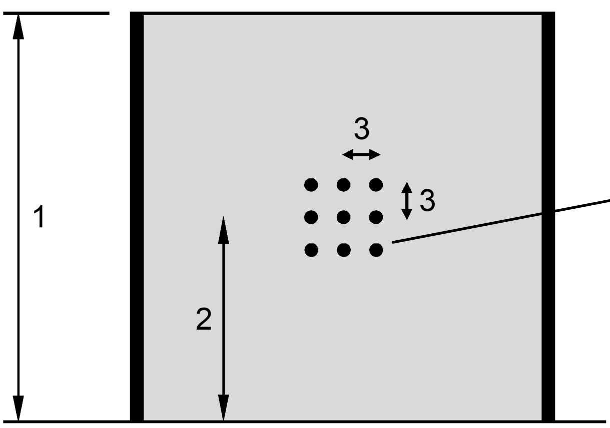
2 noise reducing device height, h_B [m]

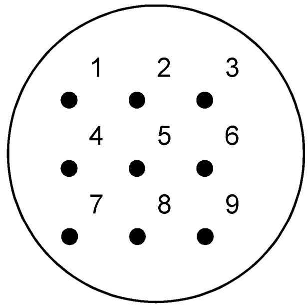
3 loudspeaker height, h_s [m]

4 loudspeaker front panel

5 distance between the loudspeaker front panel and source reference plane, d_{SB} [m]

Figure 2 — Sketch of the loudspeaker-microphone assembly in front of the noise reducing device under test for sound insulation index measurements (not to scale)





Key

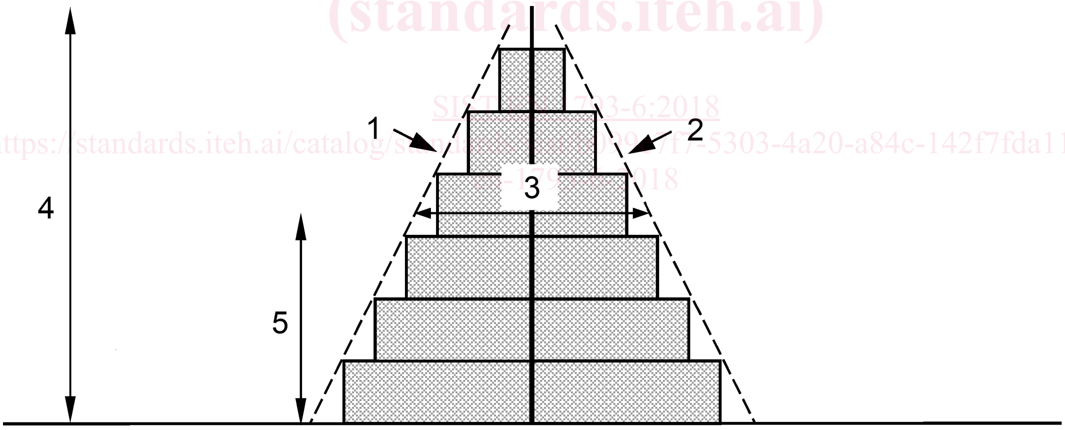
1 Noise reducing device height, h_B (m)

2 reference height, h_S (m)

3 Orthogonal spacing between two adjacent microphones, s (m)

Figure 3(a) — Measurement grid for sound insulation index measurements as seen from the receiver (not to scale)

Figure 3(b) — Numbering of the measurement points as seen from the receiver (not to scale)



Key

1 sound source reference plane

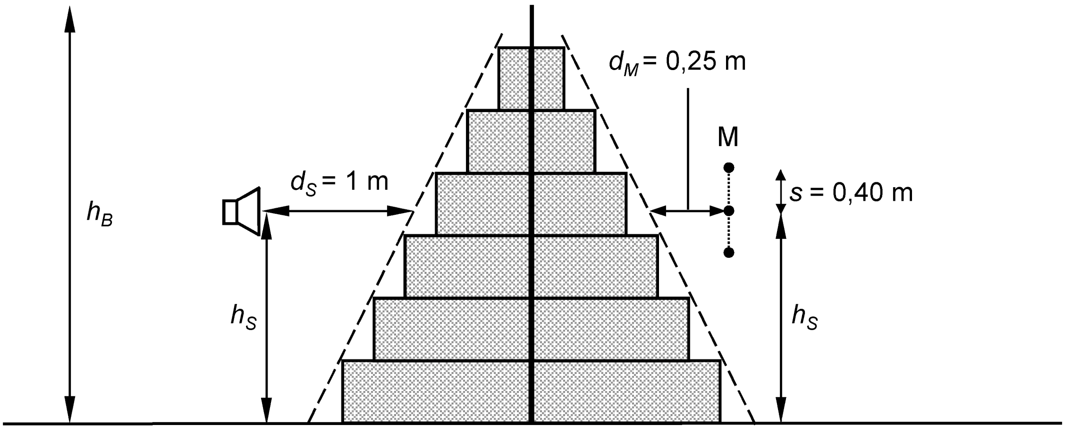
2 microphone reference plane

3 noise reducing device thickness, t_B, at height h_S [m]

4 noise reducing device height, h_B [m]

5 reference height, h_S [m]

Figure 4— Sound source and microphone reference planes (side view, not to scale)



Key

M measurement grid

s distance between two vertical or horizontal microphones in the grid

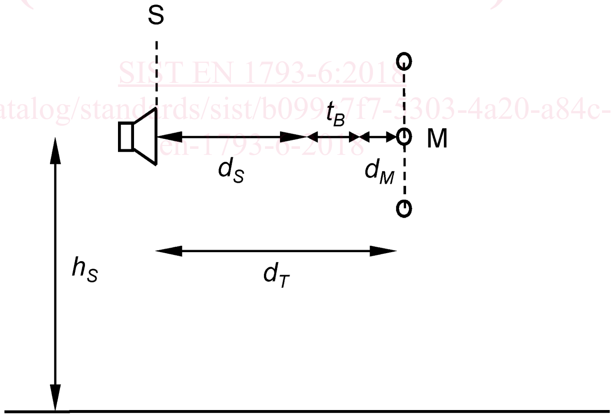
h_S reference height

h_B noise reducing device height (m)

d_S horizontal distance [loudspeaker - source reference plane] at height h_S

d_M horizontal distance [microphone 5 - source reference plane] at height h_S

Figure 5 — Placement of the sound source and measurement grid for sound insulation index measurement (side view, not to scale)



Key

S loudspeaker front panel

M measurement grid

h_S reference height

d_S horizontal distance [loudspeaker - source reference plane] at height h_S

t_B Noise reducing device thickness at height h_S

d_M horizontal distance [microphone 5 - source reference plane] at height h_S

d_T horizontal distance [loudspeaker - microphone 5] at height h_S

NOTE $d_T = d_S + t_B + d_M$; see Formula (3).

Figure 6 — Sketch of the set-up for the reference "free-field" sound measurement for the determination of the sound insulation index (not to scale)

4 Sound insulation index measurements

4.1 General principle

The sound source emits a transient sound wave that travels toward the device under test and is partly reflected, partly transmitted and partly diffracted by it. The microphone placed on the other side of the device under test receives both the transmitted sound pressure wave travelling from the sound source through the device under test, and the sound pressure wave diffracted by the top edge of the device under test (for the test to be meaningful the diffraction from the lateral edges should be sufficiently delayed). If the measurement is repeated without the device under test between the loudspeaker and the microphone, the direct free-field wave can be acquired. The power spectra of the direct wave and the transmitted wave give the basis for calculating the sound insulation index.

The sound insulation index shall be the logarithmic average of the values measured at nine points placed on the measurement grid (scanning points). See Figure 3 and Formula (1).

The measurement shall take place in a sound field free from reflections within the Adrienne temporal window. For this reason, the acquisition of an impulse response having peaks as sharp as possible is recommended: in this way, the reflections coming from other surfaces can be identified from their delay time and rejected.

4.2 Measured quantity

The expression used to compute the sound insulation index SI as a function of frequency, in one-third octave bands, is:

$$SI_j = -10 \cdot \lg \left\{ \frac{1}{n} \sum_{k=1}^{n} \frac{\int_{\Delta f_j} \left| F\left[h_{tk}(t) w_{tk}(t) \right] \right|^2 df}{\int_{\Delta f_j} \left| F\left[h_{ik}(t) w_{ik}(t) \right] \right|^2 df} \right\} \quad (1)$$

where

$h_{ik}(t)$	is the incident reference component of the free-field impulse response at the k_{th} scanning point;
$h_{tk}(t)$	is the transmitted component of the impulse response at the k^{th} scanning point;
$w_{ik}(t)$	is the time window (Adrienne temporal window) for the incident reference component of the free-field impulse response at the k^{th} scanning point;
$w_{tk}(t)$	is the time window (Adrienne temporal window) for the transmitted component at the k^{th} scanning point;
F	is the symbol of the Fourier transform;
j	is the index of the j^{th} one-third octave frequency band (between 100 Hz and 5 kHz);
Δf_i	is the width of the jth one-third octave frequency band;
$n = 9$	is the number of scanning points.

4.3 Test arrangement

The test method can be applied both in situ and on barriers purposely built to be tested using the method described here. In the second case, the specimen shall be built as follows (see Figure 7):

— a part, composed of acoustic elements;

— a post (if applicable for the specific noise reducing device under test);

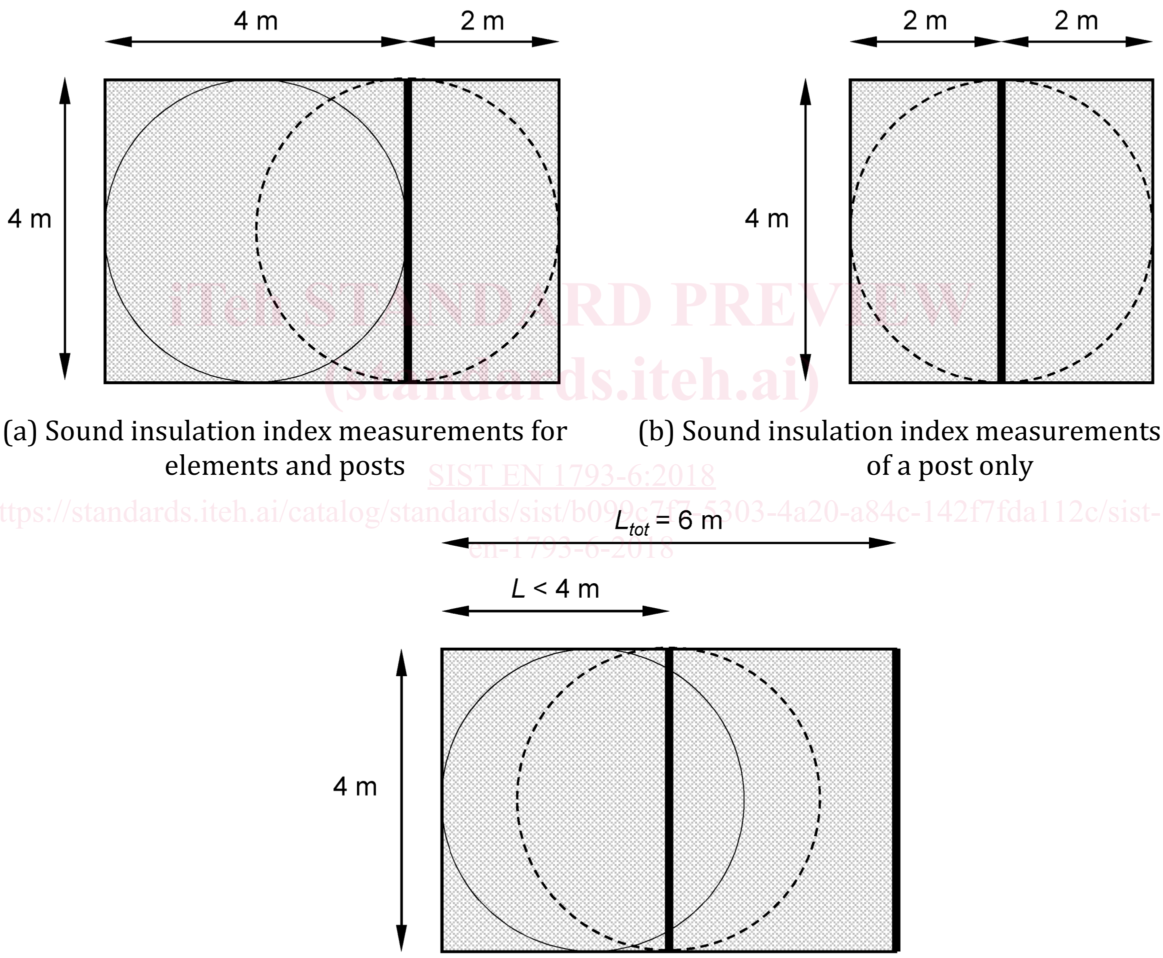
— a part, composed of acoustic elements.

The test specimen shall be mounted and assembled in the same manner as the manufactured device is used in practice with the same connections and seals.

The tested area is a circle having a radius of 2 m centred on the middle of the measurement grid. The sample shall be built large enough to completely include this circle for each measurement.

For qualifying the sound insulation index of posts only, it is only necessary to have acoustic elements that extend 2 m or more on either side of the post (see Figure 7).

If the device under test has a post to post distance less than 4 m, the distance between posts should be reduced accordingly but the overall minimum width of the construction should be the same as shown in Figure 7.



(a) Sound insulation index measurements for elements and posts

(b) Sound insulation index measurements in front of a post only

(c) Sound insulation index measurements in front of a sample having a post to post distance smaller than 4 m

Key

Thin circles: tested area for elements

Dotted circles: tested area for posts

L actual horizontal length of the acoustic elements having a post to post distance smaller than 4 m

L_{TOT} minimal horizontal length of the sample if the post to post distance is smaller than 4 m

Figure 7 — Sketch of the minimum sample required for measurements in laboratory conditions