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Acoustics — Specification of test tracks for the purpose of measuring noise emitted by road vehicles

Acoustique — Spécification des surfaces d'essai pour le mesurage du bruit émis par les véhicules routiers

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Contents

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Annexes

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10844 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

Annex A forms an integral part of this International Standard. Annexes B, C, D, E and F are for information only.

Introduction

Measurements of vehicle noise emission taken in accordance with the procedures described in ISO 362 and ISO 7188 can be influenced significantly by the type of road or test track surface on which the vehicles are run. In general, the road surface parameters affecting the noise emission of vehicles are the texture characteristics, sound absorption and possibly also mechanical impedance or stiffness properties of the surface layer.

In order to minimize the variation in vehicle noise measurements made at different testing locations it is, therefore, necessary to specify carefully the materials, design, construction and properties of the test surface.

The principal objective of the test method described in ISO 362 is to provide a method of testing the noise emitted from the power unit related sources on the vehicle and, therefore, implicitly, with no significant contribution from the tyre/road interaction noise. Similarly, the test method described in ISO 7188 refers explicitly to the contribution of tyre/road noise and states that the surface should provide for minimum tyre/road noise during the test. Consequently, it can be assumed that any test track specification used for vehicle noise testing according to these International Standards should attempt to minimize the contribution of noise from the tyre/road interaction.

In addition, it is important that if the test is to provide a high degree of reproducibility between different test sites, the surface design should not only minimize the variation in vehicle noise induced by the intersite variation of tyre/road noise, but should also ensure that the noise generated by the power unit related sources on the vehicle is unaffected by the surface used. This latter consideration precludes the use of road surfaces which have open textures and which have the property of absorbing noise from the power unit and other related sources.

Annex A specifies a method for test surface macrotexture measurement. Annex B gives guidelines regarding how an appropriate test surface can be constructed, without giving any guarantee that the implementation will be entirely successful. Annex C discusses some general considerations and annex D gives guidance on the expected reproducibility. Annex E gives information on the harmonization of this International Standard with other standards (in-service or proposed). Annex F is a bibliography.

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Acoustics — Specification of test tracks for the purpose of measuring noise emitted by road vehicles

1 Scope

This International Standard specifies the materials, design, construction and properties of a test surface in order to minimize intersite variation in vehicle noise measurements.

In particular, the surface design given in this International Standard will

— produce relatively low levels of tyre/road noise under a wide range of operating conditions including those appropriate to vehicle noise testing;

— provide negligible absorption of noise from the vehicle's power unit and related sources;

— be consistent with general road-building practice (see annex B).

Although this International Standard has been developed particularly for use with the ISO 362 and ISO 7188 test procedures, it can be used for vehicle noise testing generally where it is desirable to achieve a low level of tyre/road noise during the test.

This International Standard does not take into account the influence on tyre/road noise of purely tyre-related parameters such as tyre construction, tread pattern, inflation pressure and tyre loading. It follows that since the surface is not intended to produce significant tyre/road noise levels, it is not particularly designed for the testing and comparison of tyre/road noise.

2 Normative references

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

ISO 362:1981, *Acoustics — Measurement of noise emitted by accelerating road vehicles — Engineering method.*

ISO 565:1990, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings.*

ISO 7188:1985, *Acoustics — Measurement of noise emitted by passenger cars under conditions representative of urban driving.*

ISO 10534-1:—[1], *Acoustics — Determination of sound absorption coefficient and impedance or admittance — Part 1: Impedance tube method.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 residual voids content: The residual voids in road surface concrete consist of pockets of air between the aggregate particles. These air pockets are either interconnected with each other and with the surrounding atmosphere (accessible or communicating voids) or sealed off (non-communicating voids).

The residual voids content of the test surface, expressed as a percentage, is determined from core specimens by

1) To be published.

$$(1 - \rho_A/\rho_R) \times 100$$

where

ρ_A is the apparent or bulk density of the specimen;

ρ_R is the maximum theoretical density of specimen.

The apparent or bulk density ρ_A is determined by the equation

$$\rho_A = m/V$$

where

m is the mass of a test specimen (core) taken from the road surface;

V is the volume of the same specimen, *not* including the air volume within the surface macrotexture.

The density ρ_R is determined by direct measurement of the mass and volume of the bitumen and the mass and volume of the aggregate contained in each test specimen, as follows:

$$\rho_R = \frac{m_B + m_A}{V_B + V_A}$$

where

m_B is the mass of binder;

m_A is the mass of aggregate;

V_B is the volume of binder;

V_A is the volume of aggregate.

NOTE 1 The absorption coefficient, which is the most relevant parameter in this context, increases with the residual voids content of the road surface concrete, but it is only the accessible or communicating voids content that determines the sound absorption. Since the accessible voids content is usually highly correlated to the total residual voids content, it is sufficient for the purposes of this International Standard to refer to the latter quantity which is well known amongst road builders. Annex C contains additional information.

3.2 sound absorption coefficient: Sound waves impinging on the road surface will be partly reflected and partly absorbed. The sound absorption coefficient α denotes that fraction of the impinging sound intensity which is absorbed in the road surface material:

$$\alpha = \frac{\text{not reflected sound intensity}}{\text{total impinging sound intensity}}$$

The sound absorption coefficient is, in general, dependent on frequency and on angle of incidence. For the purposes of this International Standard, a frequency range of 400 Hz to 1 600 Hz and normal incidence is assumed (see also annex C).

3.3 macrotexture: Deviation from perfect smoothness that occurs within the horizontal wavelength range 0,5 mm to 50 mm.

NOTES

2 Macrotexture can be achieved in many different ways; e.g. by adding chippings, machining patterns, exposing the coarse mix aggregate, and designing mixes with sufficient voids content to permit surface water drainage.

3 Depending on the mix design and the compaction method used, either positive or negative macrotexture can be created; prominent aggregates or cavities may contribute to the macrotexture level (see ref. [1] in annex F).

3.4 texture depth: Average thickness of a layer of very fine and specified glass spheres spread out over the surface so that they fill the macrotexture of the surface. The upper surface of the filling material is the same as the plane touching the peaks of the surface. For further definitions of this, including the materials and method used, refer to annex A.

NOTE 4 The method is derived from that specified in ref. [2] in annex F and very similar to the well-known sand-patch method as described in ref. [3].

4 Required characteristics of the surface

A surface is considered to conform to this International Standard provided that *either* the voids content *or* the sound absorption coefficient meets the requirements given in 4.1 or 4.2 (respectively). In addition, the performance requirements given in 4.3 and 4.4 as well as the design requirements given in 5.2 shall be met.

4.1 Residual voids content

The residual voids content of the test track paving mixture shall not exceed 8 % as measured by the procedure given in 6.1. See note 5 in 4.2 below.

In addition, no single core shall have a voids value which is higher than 10 %.

4.2 Sound absorption coefficient

The sound absorption coefficient, α, shall not exceed 0,10 as measured by the procedure given in 6.2.

NOTE 5 The most relevant parameter is the sound absorption, although residual voids content is more familiar among road constructors and may therefore be preferred by many. Since residual voids content is a less appropriate parameter and its measurement is subject to larger uncertainties, some surfaces may fail to meet this criterion but may still comply with the sound absorption requirement. Some surfaces may therefore erroneously be rejected when based only on voids measurement. Annex C provides further background information.

4.3 Texture depth

The mean texture depth (MTD) measured according to the volumetric patch method (see 6.3 below) shall be

$$MTD \geqslant 0{,}4 \text{ mm}$$

4.4 Homogeneity of the surface

The surface shall be made as homogeneous as possible within the test area.

NOTE 6 This includes the texture and voids content, but it should also be observed that if the rolling process results in more effective rolling at some places than at others, the texture may be different and unevenness causing bumps may also occur.

4.5 Period of testing

In order to confirm that the surface continues to conform to the texture and voids content or sound absorption requirements stipulated in this International Standard, periodic testing of the surface shall be carried out at the following intervals.

a) For residual voids content or sound absorption:

- when the surface is new;
- if the surface meets the requirement when new, no further periodic testing is required; if it does not meet the requirement when it is new, it may do so later because surfaces tend to become clogged and compacted with time.

b) For texture depth, MTD:

- when the surface is new;
- when the noise testing starts (NB: not before 4 weeks after laying); and
- then every 12 months.

5 Test surface design

5.1 Area

When designing the test track layout, it is important to ensure that, as a minimum requirement, the area traversed by the vehicles running through the test strip is covered with the specified test material with suitable margins for safe and practical driving. Therefore the width of the track shall be at least 3 m and the length of the track shall extend beyond lines AA and BB (see figure 1) by at least 10 m at either end. Figure 1 shows a plan of a suitable test site and indicates the minimum area which shall be machine laid and machine compacted with the specified test surface material.

ISO 362 and ISO 7188 require measurement to be carried out on both sides of the vehicle. This can be done either by measuring with two microphone locations (one on each side of the track) and driving in one direction, or measuring with a microphone only on one side of the track but driving the vehicle in two directions. If the former method is used, the requirements of figure 1 shall be observed. If the latter method is used, then there are no surface requirements on that side of the track where there is no microphone.

5.2 Design requirements for the surface

The test surface shall meet four design requirements:

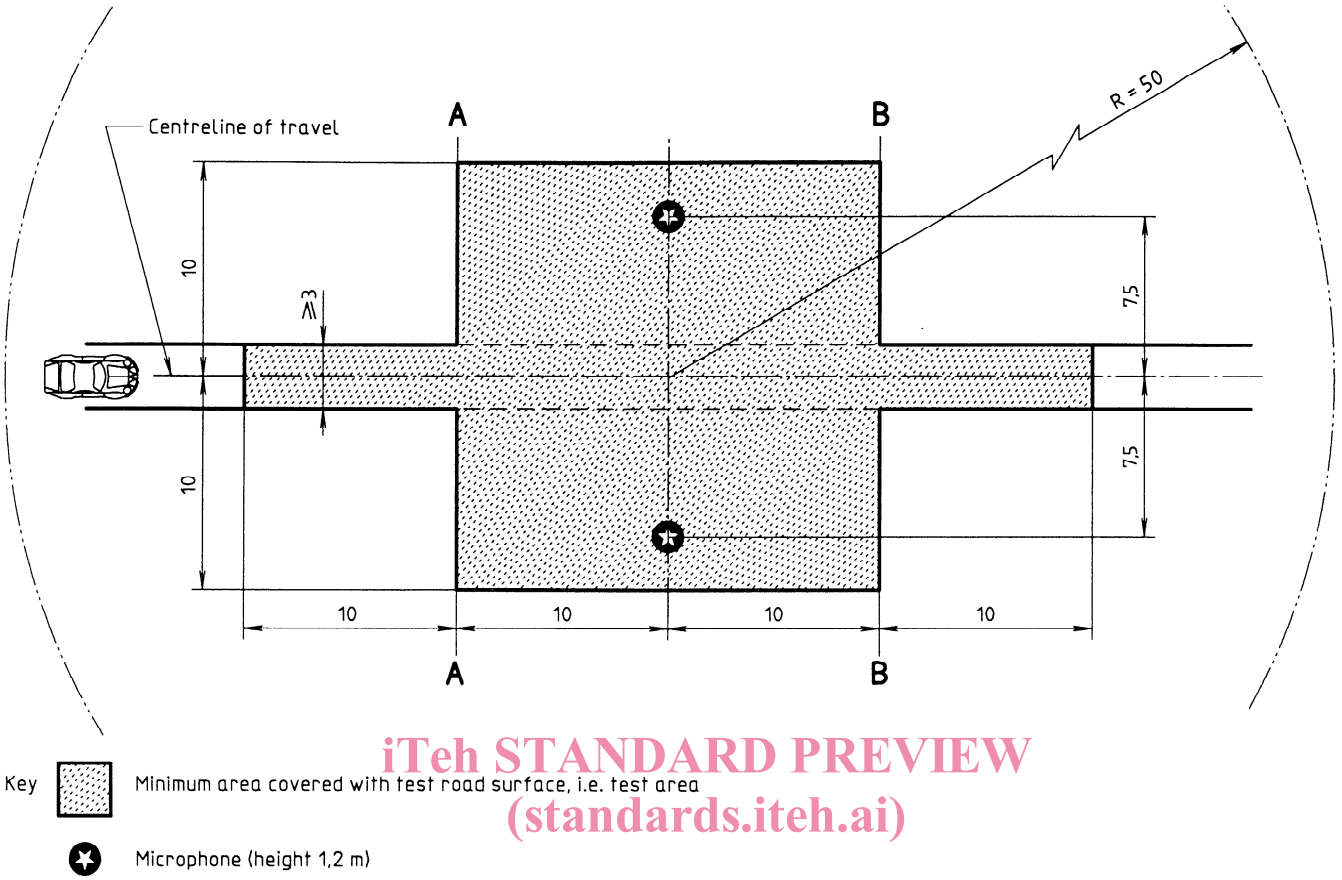
a) it shall be a dense asphaltic concrete;

b) the maximum chipping size shall be 8 mm nominal (tolerances allow from 6,3 mm to 10 mm);

c) the thickness of the wearing course shall be $\geqslant$ 30 mm;

d) the binder shall be a straight penetration grade bitumen without modification.

Dimensions in metres



NOTE — There shall be no large acoustically reflective objects within this radius.

Figure 1 — Minimum requirements for test surface area

6 Test methods

6.1 Measurement of the residual voids content

For the purpose of this measurement, take cores from the track at least at four different positions which are equally distributed in the test area between lines AA and BB (see figure 1). In order to avoid inhomogeneity and unevenness in the wheel tracks, do not take cores in the wheel tracks themselves, but close to them. Take two cores (minimum) close to the wheel tracks and one core (minimum) approximately midway between the wheel tracks and each microphone location.

If there is a suspicion that the condition of homogeneity is not met (see 4.4), take cores from more locations within the test area.

Determine the residual voids content for each core. Then calculate the average value from all cores and compare it with the requirement of 4.1.

NOTE 7 The test surface constructor is reminded of the problem which may arise when the test area is heated by pipes or electrical wires and cores must be taken from this area. Such installations have to be carefully planned with respect to future core drilling locations. It is recommended to leave a few locations of size approx. 200 mm × 300 mm where there are no wires/pipes or where the latter are located deep enough in order not to be damaged by cores taken from the surface layer.

6.2 Sound absorption coefficient

The sound absorption coefficient (normal incidence) shall be measured by the impedance tube method using the procedure specified in ISO 10534-1.

Regarding test specimens, the same requirements shall be followed as regarding the residual voids content (see 6.1).

Measure the sound absorption in the range between 400 Hz and 800 Hz and in the range between 800 Hz and 1 600 Hz (at least at the centre frequencies of the third-octave bands) and identify the maximum values for both of these frequency ranges. Then average these values, for all test cores, to constitute the final result.

If the highest value is obtained at 800 Hz, this value shall be retained for one of the frequency bands only.

6.3 Volumetric macrotexture measurement

For the purposes of this International Standard, make texture depth measurements on at least 10 positions evenly spaced along the wheel tracks of the test strip and compare the average value with the specified minimum texture depth. See annex A for a description of the procedure.

7 Stability with time and maintenance

7.1 Influence of age

In common with many other surfaces, it is expected that the tyre/road noise levels measured on the test surface may increase slightly during the first 6 to 12 months after construction.

The surface will achieve its required characteristics not earlier than 4 weeks after construction. The influence of age on the noise from trucks is generally less than that from cars.

The stability over time occurs mainly from polishing and compaction by vehicles driving on the surface. It shall be periodically checked as specified in 4.5.

7.2 Maintenance of the surface

It is essential that loose debris or dust which could significantly reduce the effective texture depth be removed from the surface. In countries with winter climates, salt is sometimes used for de-icing. Salt may alter the surface temporarily or even permanently in such a way as to increase noise and is therefore not recommended.

7.3 Repaving the test area

If it is necessary to repave the test track, it is usually unnecessary to repave more than the test strip (of 3 m width, see figure 1) where vehicles are driving, provided the test area outside the strip met the requirement for residual voids content or sound absorption when it was measured.

8 Documentation of the surface and of tests performed on it

8.1 Documentation of the test surface

The following data shall be given in a document describing the test surface.

a) The location of the test track.

b) Type of binder, binder hardness, type of aggregate, maximum theoretical density of the concrete (ρ_R), thickness of the wearing course and grading curve determined from cores from the test track.

c) Method of compaction (e.g. type of roller, roller mass, number of passes).

d) Temperature of the mix, temperature of the ambient air and wind speed during laying of the surface.

e) Date when the surface was laid and name of contractor.

f) All or at least the latest test result, including

1) the residual voids content of each core;

2) the locations in the test area where the cores for voids measurement have been taken;

3) the sound absorption coefficient of each core (if measured); specify the results both for each core and each frequency range as well as the overall average;

4) the locations in the test area where the cores for absorption measurement have been taken;