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Characterization of pavement texture by use of surface profiles —

Part 5: Determination of megatexture

Caractérisation de la texture d'un revêtement de chaussée à partir de relevés de profils de la surface —

Partie 5: Détermination de la mégatexture

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13473-5 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

ISO 13473 consists of the following parts, under the general title *Characterization of pavement texture by use of surface profiles*:

— *Part 1: Determination of Mean Profile Depth*

— *Part 2: Terminology and basic requirements related to pavement texture profile analysis*

— *Part 3: Specification and classification of profilometers*

— *Part 4: Spectral analysis of surface profiles* [Technical Specification]

— *Part 5: Determination of megatexture*

Introduction

Pavement surface texture largely influences factors such as noise emission caused by tyre/road interaction (Reference [7]), tyre/pavement friction (Reference [8]), and comfort, as well as rolling resistance and wear of tyres. Reliable methods of texture measurement are therefore essential.

Texture is subdivided into micro-, macro- and megatexture according to ISO 13473-2. A method for measurement and calculation of a macrotexture indicator based on a profile measurement is specified in ISO 13473-1. A procedure for measuring macrotexture by the volumetric patch method is described in ISO 10844:1994[2], Annex A. Currently, no reliable and practical method of measuring pavement microtexture *in situ* is available. This part of ISO 13473 aims to provide means of measuring and calculating megatexture indicators useful for pavement surface characterization.

Megatexture is an important texture range lying between macrotexture and unevenness. This type of texture has wavelengths of the same order of magnitude as a tyre/road interface and is often a result of potholes or 'washboarding'. Some common types of singularities, such as a single depressed or protruding spot on the pavement, will also show up in a texture profile spectrum as megatexture. Although some pavements, such as paving stones, possess an intrinsic megatexture, it is usually an unwanted characteristic resulting from defects in the surface.

The scope of ISO 13473 (all parts) does not include profile analysis of road unevenness, which is dealt with in ISO 8608[1].

Characterization of pavement texture by use of surface profiles —

Part 5: Determination of megatexture

1 Scope

This part of ISO 13473 specifies procedures for determining the average depth or level of pavement surface megatexture by measuring the profile curve of a surface and calculating megatexture descriptors from this profile. The technique is designed to give meaningful and accurate measurements and descriptions of pavement megatexture characteristics for various purposes.

Since there is an overlap between megatexture and the surrounding ranges, the megatexture descriptors unavoidably have a certain correlation with corresponding measures in those ranges. This part of ISO 13473 specifies measurements and procedures which are in relevant parts compatible with those in ISO 13473-1, ISO 8608[1] and EN 13036-5[6].

2 Normative references

The following referenced documents are indispensable for the application 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 13473-2:2002, *Characterization of pavement texture by use of surface profiles — Part 2: Terminology and basic requirements related to pavement texture profile analysis*

ISO 13473-3:2002, *Characterization of pavement texture by use of surface profiles — Part 3: Specification and classification of profilometers*

ISO/TS 13473-4:2008, *Characterization of pavement texture by use of surface profiles — Part 4: Spectral analysis of surface profiles*

ISO/IEC NP Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

3 Terms and definitions

For the purposes of this part of ISO 13473, the terms and definitions in ISO 13473-2, especially the following, apply.

3.1 General terms

3.1.1
pavement texture
texture
deviation of a pavement surface from a true planar surface, with a texture wavelength less than 0,5 m

NOTE It is divided into micro-, macro- and megatexture according to 3.2.

[ISO 13473-2:2002]

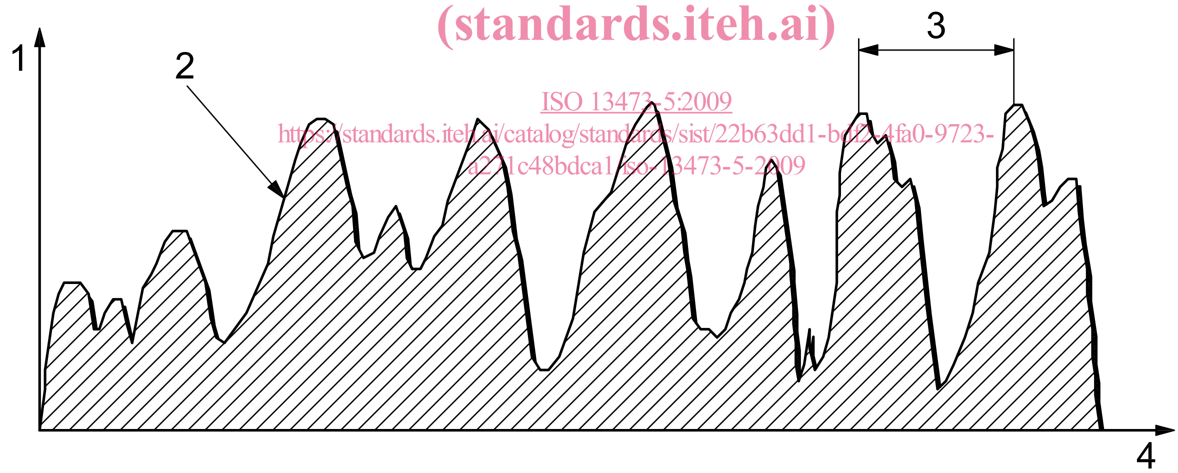
3.1.2
surface profile
texture profile
two-dimensional sample of the pavement surface generated if a sensor, such as the tip of a needle or a laser spot, continuously touches or shines on the pavement surface while it is moved along a line on the surface

NOTE 1 The profile of the surface is described by two coordinates: one in the surface plane, called “distance” (the abscissa), and the other in a direction normal to the surface plane, called “vertical displacement” (the ordinate). An example is illustrated in Figure 1. The distance may be in the longitudinal or lateral (transverse) directions in relation to the travel direction on a pavement, or any direction between these.

NOTE 2 Adapted from ISO 13473-2:2002.

NOTE 3 Texture profile is similar to surface profile but limited to the texture range.

NOTE 4 “Texture wavelength” is a descriptor of the wavelength components of the profile and is related to the concept of the Fourier transform of a time series. However, mathematically the correspondence is not exact. Note that vertical displacement (height) has an arbitrary reference.



Key

1 vertical displacement
2 profile
3 texture wavelength
4 distance

Figure 1 — Illustration of some basic terms describing pavement surface texture

3.1.3
profilometer
device used for measuring the profile of pavement surface

NOTE 1 Current designs of profilometers used in pavement engineering include, but are not limited to, sensors based on laser, light sectioning, needle tracer and ultrasonics technologies.

[ISO 13473-2:2002]

NOTE 2 Specifications for profilometers are dealt with in ISO 13473-3.

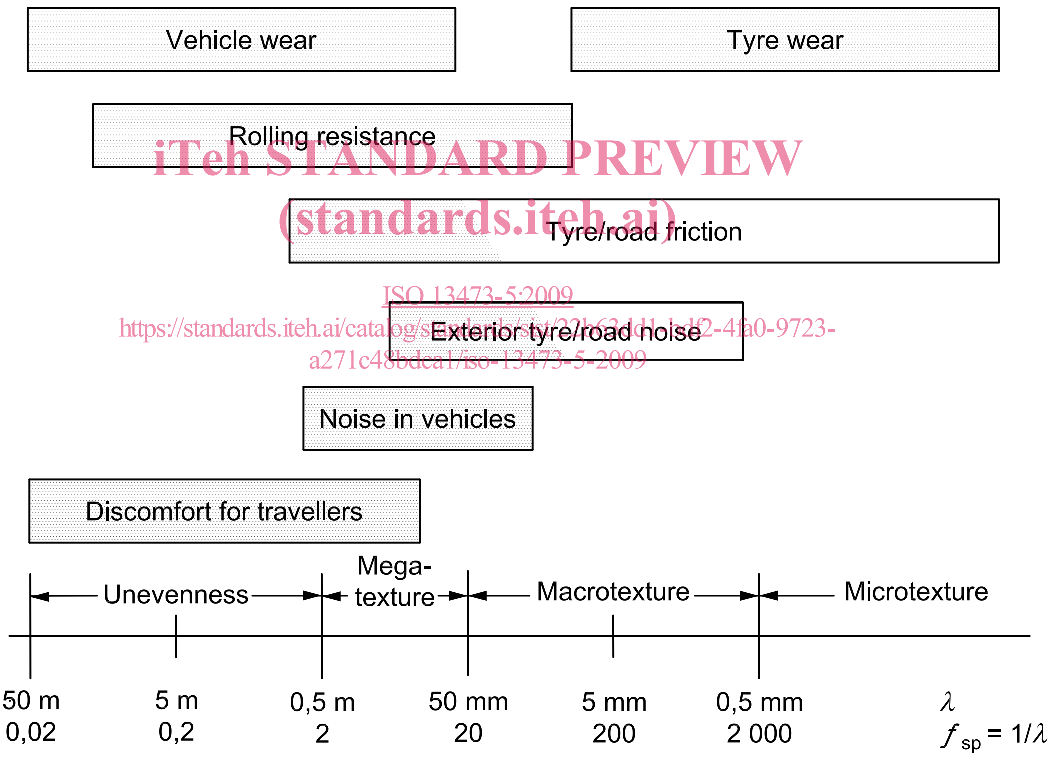
3.2 Ranges of texture

3.2.1
microtexture
pavement microtexture
deviation of a pavement surface from a true planar surface with the characteristic dimensions along the surface of less than 0,5 mm, corresponding to texture wavelengths up to 0,5 mm expressed as one-third-octave centre wavelengths

NOTE 1 Peak-to-peak amplitudes normally vary in the range 0,001 mm to 0,5 mm. This type of texture is the texture which makes the surface feel more or less harsh but which is usually too small to be observed by the eye. It is produced by the surface properties (sharpness and harshness) of the individual chippings or other particles of the surface which come in direct contact with the tyres.

NOTE 2 Figure 2 illustrates the different texture ranges, with approximate limits regarding their effects on vehicle-pavement interactions.

[ISO 13473-2:2002]



Key

λ texture wavelength

f_{sp} spatial frequency, cycles/m

NOTE A lighter shade indicates a favourable effect of texture over this range, and a darker shade indicates an unfavourable effect.

Figure 2 — Ranges in terms of texture wavelength and spatial frequency of texture and unevenness and their most significant, anticipated effects

3.2.2
macrotexture
pavement macrotexture
deviation of a pavement surface from a true planar surface with the characteristic dimensions along the surface of 0,5 mm to 50 mm, corresponding to texture wavelengths with one-third-octave bands including the range 0,63 mm to 50 mm of centre wavelengths

NOTE 1 Peak-to-peak amplitudes may normally vary in the range 0,1 mm to 20 mm. This type of texture is the texture which has wavelengths of the same order of size as tyre tread elements in the tyre/road interface. Surfaces are normally designed with a sufficient macrotexture to obtain a suitable water drainage in the tyre/road interface. The macrotexture is obtained by suitable proportioning of the aggregate and mortar of the mix or by surface finishing techniques.

NOTE 2 Based on physical relations between texture and friction/noise, etc., the World Road Association (PIARC), originally defined the ranges of micro-, macro- and megatexture (Reference [9]). Figure 2, which is a modified version of the original PIARC figure, illustrates how these definitions cover certain ranges of surface texture wavelength and spatial frequency. Note that ride discomfort includes effects experienced in and on motorized road vehicles and bicycles, as well as wheelchairs and other vehicles used by disabled people.

NOTE 3 Adapted from ISO 13473-2:2002.

3.2.3
megatexture
pavement megatexture
deviation of a pavement surface from a true planar surface with the characteristic dimensions along the surface of 50 mm to 500 mm, corresponding to texture wavelengths with one-third-octave bands including the range 63 mm to 500 mm of centre wavelengths

[ISO 13473-2:2002]

NOTE Peak-to-peak amplitudes normally vary in the range 0,1 mm to 50 mm. This type of texture is composed of wavelengths with the same order of size as a typical tyre/road interface and is often created by potholes or ripples in the surface. It is usually an unwanted characteristic resulting from defects in the surface. Surface roughness with longer wavelengths than megatexture is referred to as unevenness and typically takes the form of undulations in the surface.

3.2.4
unevenness
pavement unevenness
deviation of a pavement surface from a true planar surface with the characteristic dimensions along the surface of 0,5 m to 50 m, corresponding to wavelengths with one-third-octave bands including the range 0,63 m to 50 m of centre wavelengths

NOTE 1 Pavement characteristics at wavelengths longer than 0,5 m are considered to be above that of texture and are referred to here as “unevenness”. For airfield applications, even wavelengths longer than 50 m would be considered.

[ISO 13473-2:2002]

NOTE 2 Longitudinal unevenness is a type of surface roughness which, through vibrations, affects ride comfort in, and road holding of, vehicles. Transverse unevenness, e.g. due to the presence of ruts, affects safety through lateral instability and water accumulation. It is not the intention of this part of ISO 13473 to include terms which are specifically related to unevenness. Such terms are defined in ISO 8608[1], ISO 16063-1[3], ASTM E 950-98[4], and EN 13036-5[6].

3.3 Megatexture measurement method

3.3.1
profilometer method
method in which the profile of a pavement surface is measured and the data used for calculation of certain mathematically defined measures

NOTE In most cases, the profile is recorded for subsequent analysis, in some cases it may be used only in real-time calculations.

[ISO 13473-2:2002]

3.4 Terms and parameters related to spectrum analysis of texture profiles

NOTE These terms and their applications are further described in ISO/TS 13473-4.

3.4.1
texture spectrum
spectrum obtained when a profile curve has been analysed by either digital or analog filtering techniques in order to determine the magnitude of its spectral components at different **texture wavelengths** (see 3.4.2) or **spatial frequencies** (see 3.4.3)

NOTE 1 A texture spectrum presents the magnitude of each spectral component as a function of either texture wavelength or spatial frequency.

NOTE 2 Adapted from ISO 13473-2:2002.

3.4.2
texture wavelength
λ
quantity describing the horizontal dimension of the irregularities of a texture profile

[ISO 13473-2:2002]

NOTE 1 Texture wavelength is normally expressed in metres or millimetres.

NOTE 2 Wavelength is a concept commonly used and accepted in electrotechnical and signal-processing vocabularies. Since many users of this part of ISO 13473 may not be accustomed to using the term wavelength in pavement applications, and because electrical signals are often used in the analyses of road surface profiles, there is the possibility of confusion. Hence the expression 'texture wavelength' is preferred here to make a clear distinction in relation to other applications.

NOTE 3 The profile may be considered as a stationary, random function of the distance along the surface. By means of a Fourier analysis, such a function may be mathematically represented as an infinite series of sinusoidal components of various frequencies (and wavelengths), each having a given amplitude and initial phase. For typical and continuous surface profiles, a profile analysed by its Fourier components contains a continuous distribution of wavelengths. The texture wavelength in ISO 13473 (all parts) is the reciprocal of the spatial frequency, the unit of which is reciprocal metre, equivalent to cycles per metre. See also 3.4.3.

NOTE 4 The wavelengths may be represented physically as the various lengths of periodically repeated parts of the profile; see Figure 1.

3.4.3
spatial frequency
f_{sp}
inverse of **texture wavelength** (3.4.2)

NOTE 1 Spatial frequency is normally expressed in reciprocal metres, see also 3.4.2, Note 3.

NOTE 2 The term “frequency” used in the time domain (more precisely “temporal frequency”), corresponds to “spatial frequency” in the space domain.

NOTE 3 Adapted from ISO 13473-2:2002.

3.5 Terms and parameters related to texture profile level

3.5.1
texture profile level
$L_{tx,\lambda}$
$L_{TX,\lambda}$
logarithmic transformation of an amplitude representation of a profile curve, $Z(x)$, the latter expressed as a root mean square value

NOTE 1 To distinguish between octave and one-third-octave bands, the subscript for L is written in capital letters when it relates to octave bands, $L_{TX,\lambda}$, and in lower case letters when it refers to one-third-octave bands, $L_{tx,\lambda}$.

NOTE 2 The texture profile level, in decibels, relative to a reference value of 10^{-6} m in one-third-octave bands having centre texture wavelength, λ, $L_{tx,\lambda}$, or the texture profile level, in decibels, relative to a reference value of 10^{-6} m in octave bands having centre texture wavelength, λ, $L_{TX,\lambda}$, can be expressed by Equation (1):

$$\left.\begin{aligned} L_{TX,\lambda} &= 10 \lg \frac{a_\lambda^2}{a_{ref}^2} \text{ dB} = 20 \lg \frac{a_\lambda}{a_{ref}} \text{ dB} \\ L_{tx,\lambda} &= 10 \lg \frac{a_\lambda^2}{a_{ref}^2} \text{ dB} = 20 \lg \frac{a_\lambda}{a_{ref}} \text{ dB} \end{aligned}\right\} \quad (1)$$

where

a_λ is the root mean square (r.m.s) value of the vertical displacement, in metres, of the surface profile;

a_{ref} is the reference value, i.e. 10^{-6} m.

NOTE 3 Octave-band and one-third-octave band filters are specified in ISO 13473-2:2002, 4.4.

EXAMPLE L_{tx80} denotes the texture profile level for the one-third-octave band having a centre texture wavelength of 80 mm, see ISO 13473-2:2002, Table 1.

NOTE 4 Texture amplitudes expressed as r.m.s. values, whether filtered or not, can have a range of several magnitudes; typically 10^{-5} m to 10^{-2} m. Spectral characterization of signals is used frequently in studies of acoustics, vibrations, and electrotechnical engineering. In all those fields it is most common to use logarithmic amplitude scales. The same approach is preferred in this part of ISO 13473.

NOTE 5 Texture profile levels in practical pavement engineering typically range from 20 dB to 80 dB with these definitions.

NOTE 6 Adapted from ISO 13473-2:2002.

3.5.2
megatexture level
L_{Me}
special case of texture profile level with the profile passing through a bandpass filter encompassing all one-third-octave bands within the megatexture range according to 3.2.3

[ISO 13473-2:2002]

3.6 Terms related to profilometer performance

3.6.1
evaluation length
l
length of a sample from a profile which has been or is to be analysed

NOTE Evaluation length is normally expressed in metres or millimetres.

[ISO 13473-2:2002]

4 Significance and use of the megatexture indicators

4.1 General

The indicator L_{Me} shall always be calculated and reported to ensure comparability between measurements. Depending on the aim of the study in question and information already obtained (e.g. unevenness or macrotexture measures), any or all of the three other indicators mentioned below may also be reported.

