International Standard

ISO 13473-5

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

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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 document 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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This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 13473-5:2009), which has been technically revised.

The main changes are as follows:

— default measure RMS_{Me} in mm instead of L_{Me} in dB;

— use the same pre-processing procedures as in ISO 13473-1 (drop-out and spikes);

— use digital filters to calculate megatexture, earlier done by spectral analysis;

— improvements of the uncertainty description of megatexture calculations;

— informative annex with reference program and reference calculations, available at the www.erpug.org homepage.

A list of all parts in the ISO 13473 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

Pavement surface texture largely influences factors such as noise emission caused by tyre/road interaction (see Reference [1]), tyre/pavement friction (see Reference [2]), and comfort, as well as rolling resistance (see Reference [3]) and wear of tyres. Reliable methods of measuring and characterizing texture 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[4]. A procedure for measuring macrotexture by the volumetric patch method is described in EN 13036-1[5]. Currently, no reliable and practical method of measuring pavement microtexture in situ is available. This document aims to provide means of measuring and calculating a megatexture indicator 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 (e.g. a pothole) or protruding (e.g. caused by tree roots) 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. Megatexture is an undesirable feature, the higher the value, the worse the road is perceived: megatexture is known to increase tyre/road noise by inducing tyre vibrations. At the same time, these tyre vibrations cause energy dissipation in the tyre. The rolling resistance increases and this leads to highly unwanted fuel consumption and CO_2 emission (see also 3.2).

Characterization of pavement texture by use of surface profiles —

Part 5: Determination of megatexture

1 Scope

This document specifies a procedure for determining the magnitude of pavement surface megatexture by measuring the surface profile and calculating a megatexture descriptor from this profile. The technique is designed to give meaningful and accurate measurements and descriptions of pavement megatexture for various purposes, such as for the prediction of the acoustic quality of the pavement or the assessment of the rolling resistance.

Since there is an overlap between megatexture and the surrounding ranges, megatexture descriptors unavoidably have a certain correlation with corresponding measures in those ranges. This document specifies measurements and procedures which are in relevant parts compatible with those in ISO 13473-1[4], ISO 8608[6] and EN 13036-5[7].

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 13473-2, *Characterization of pavement texture by use of surface profiles — Part 2: Terminology and basic requirements related to pavement texture profile analysis*

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

ISO/PAS 13473-6, *Characterization of pavement texture by use of surface profiles — Part 6: Verification of the performance of laser profilometers used for pavement texture measurements*

3 Terms and definitions

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

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

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

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

3.1 General terms

3.1.1
texture wavelength
λ
quantity describing the horizontal dimension of the irregularities of a *texture profile* (3.1.3)

Note 1 to entry: Texture wavelength is normally expressed in metres (m) or millimetres (mm).

Note 2 to entry: Texture wavelength is a descriptor of the wavelength components of the profile and is related to the concept of the Fourier Transform of a series regularly sampled measurement points along a spatial axis. Vertical displacement (height) has an arbitrary reference.

3.1.2
pavement texture
texture
deviation of a pavement surface from a true planar surface, with a *texture wavelength* (3.1.1) less than 0,5 m

Note 1 to entry: It is divided into micro-, macro- and megatexture according to 3.2.

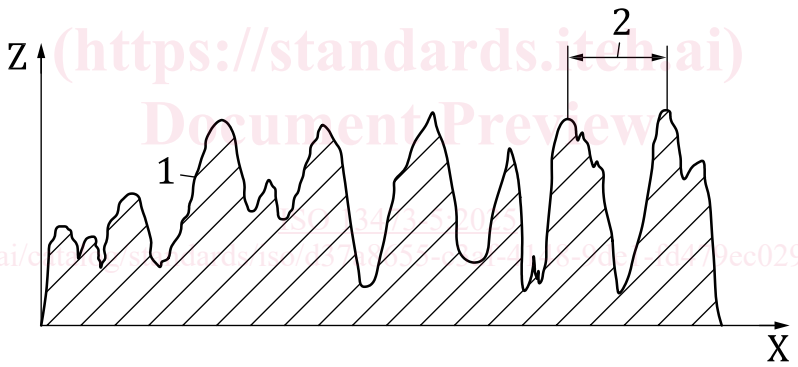
3.1.3
surface profile
texture profile
upper contour of a vertical cross-section through a pavement

Note 1 to entry: The surface profile (texture profile) is further indicated with its mathematical descriptor $Z(X)$.

Note 2 to entry: A typical profile recording of a pavement surface is illustrated in Figure 1 (vertical scale exaggerated), including the terms profile, distance, vertical displacement and wavelength. "Wavelength" in the figure is an illustration of a component of the profile related to the wavelength concept but it is not correct from a strictly mathematical point of view. Furthermore, the reference (bottom) line is arbitrary.

Note 3 to entry: 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 given in Figure 1. The distance may be in the longitudinal or lateral (transverse) directions in relation to the travel direction on a pavement, or in a circle or any other direction between these extremes.

Note 4 to entry: Texture profile is similar to surface profile but limited to the texture range.



Key
X distance
Z vertical displacement
1 surface profile
2 texture wavelength

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

3.1.4
drop-out
data in the measured texture profile indicated by the sensor as invalid

3.1.5
spike
unusually high and sharply defined peak in the measured texture profile, which is not part of the true texture profile and is not indicated as invalid by the sensor

Note 1 to entry: See Annex A for a quantitative definition of a spike.

3.1.6
profilometer
device used for measuring the profile of a pavement surface Z(X) to be used for calculation of certain mathematically defined measures

Note 1 to entry: 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. The most common sensor type used in profilometers is laser based. In most cases, the profile is recorded for subsequent analysis, in some cases it may be used only in real-time calculations.

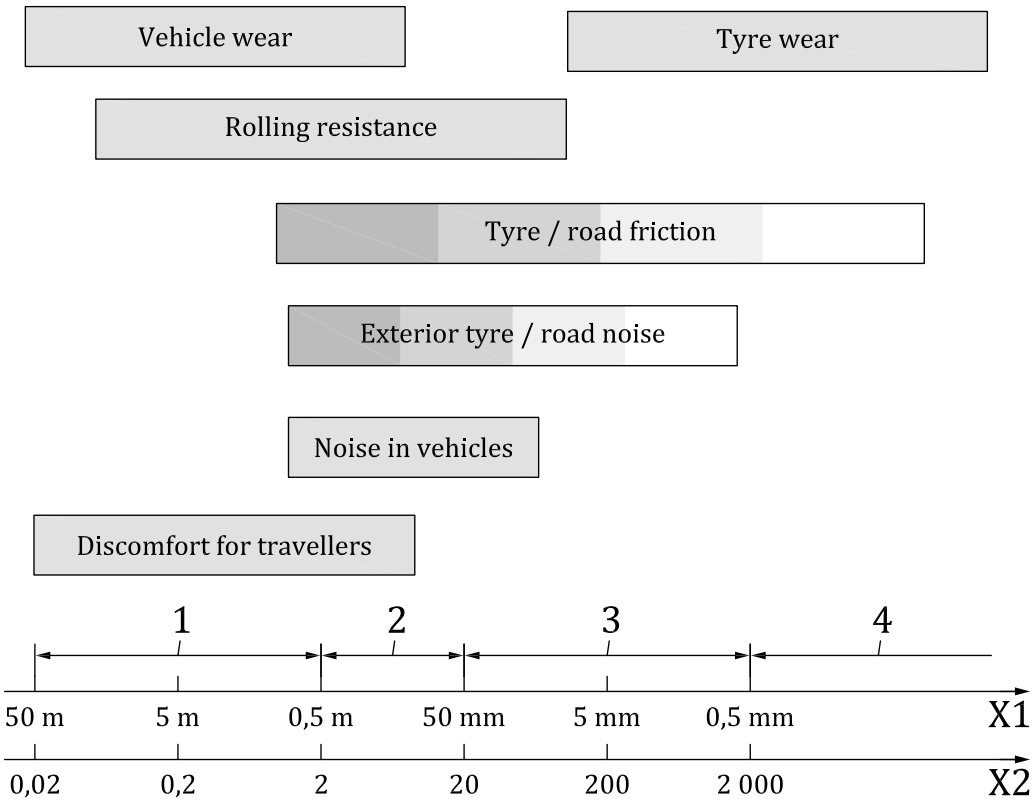
Note 2 to entry: Specifications for profilometers are dealt with in ISO 13473-3.

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 to entry: 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 aggregate or other particles of the surface which come in direct contact with the tyres.

Note 2 to entry: Based on physical relations between texture and friction, noise, etc., the World Road Association (PIARC) has defined the ranges of micro-, macro- and megatexture earlier; see Reference [8]. Figure 2 illustrates how these definitions cover certain ranges of surface texture wavelength and spatial frequency, and how various characteristics are influenced within these ranges.



Key

X1 wavelength
X2 spatial frequency [1/m]
1 unevenness
2 megatexture
3 macrotexture
4 microtexture

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

Figure 2 — Ranges in terms of wavelength and spatial frequency of texture and unevenness and their most significant, anticipated effects[8]

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 to entry: 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. The size of the macrotexture has a positive correlation with the stone size of the pavement.

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

Note 1 to entry: 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, but it can as well be intrinsic to the pavement (e.g. cobble stones). 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 to entry: 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.

Note 2 to entry: 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 document to include terms which are specifically related to unevenness. Such terms are defined in ISO 8608[6], ISO 16063-1[9], ASTM E950/E950M-09[10] and EN 13036-5[7].

3.3 Megatexture measurement method

3.3.1
measurement length
l_m
length of an uninterrupted texture profile which has been or is to be measured

Note 1 to entry: Measurement length is normally expressed in metres.

3.3.2
evaluation length
l_e
length of a portion of one or more profiles for which megatexture RMS_{Me} (3.3.5) is to be evaluated

Note 1 to entry: Evaluation length is normally expressed in metres.

Note 2 to entry: The evaluation length is always smaller or equal to the measurement length.

3.3.3
calculation length
l_c
length of a portion of one or more profiles for which megatexture RMS_{Me} (3.3.5) is to be calculated

Note 1 to entry: Calculation length is normally expressed in metres or millimetres.

Note 2 to entry: The calculation length is always smaller or equal to the evaluation length. One RMS_{Me} value is presented per calculation length.

3.3.4
megatexture profile $Z'(X)$
texture profile after application of the megatexture digital filters (see Annex D) to the *texture profile Z(X)* (3.1.3)

3.3.5
megatexture root mean square deviation of the profile
RMS_{Me}
root mean square (RMS) value of the ordinate values of megatexture profile $Z'(X)$ within a calculation length l_c

$$RMS_{Me} = \sqrt{\frac{1}{l_c}\int_0^{l_c} Z'^2(X)\,dX}$$

where

l_c is the calculation length;

$Z'(X)$ is the megatexture profile.

Note 1 to entry: RMS_{Me} is normally expressed in millimetres (mm) in this application.

Note 2 to entry: RMS_{Me} is denoted R_q (from "rugosité quadratique" in French) in ISO 4287. However, when dealing with pavements, RMS_{Me} is preferred, since it is already one of the most used terms in pavement analysis. Furthermore, there is a risk of confusing of the terms R_q and R_{ku} which are pronounced similarly.

Note 3 to entry: In case the texture level L_{Me} (expressed in dB re. 1 µm) is given, the RMS_{Me}, expressed in mm, is easily calculated with the equation $RMS_{Me} = 0{,}001 \cdot \log(L_{Me}/20)$. Inversely, if the RMS_{Me} is given (expressed in mm), the L_{Me} is found with the expression $L_{Me} = 20 \cdot \log(RMS_{Me} \cdot 1\,000)$ (dB re. 1 µm). L_{Me} was used as a standard indicator in the previous version of this standard.

4 Measurement instruments

4.1 Instruments in general

4.1.1 General

The technology for measuring the profile can be chosen freely by the user as long as the requirements of this document are met. An instrument which produces a signal that is proportional to the distance between a sensor's reference plane and a given surface sample point, can be used. Typically, the sensor would normally be an electro-optical device or a video camera, but other devices that comply with the requirements of ISO 13473-3 may be used. The final output shall be linearly related to the texture profile and linearity may be obtained either in hardware or software.

The profilometer system shall also provide means of moving the sensor along or across the surface at an elevation (vertically) which is essentially constant over at least one full wavelength. However, this is not applicable when the profile is produced by a technique such as light sectioning where the profile and its reference line or plane are recorded instantaneously.

The profilometer system shall meet the following specifications in accordance with ISO 13473-3:

— mobility class: mobile, fast or slow;

— texture wavelength: class EF (63 mm to 500 mm) or wider;

— minimum vertical measuring range: 60 mm;

— vertical resolution: 0,04 mm or better;

— horizontal resolution: less than or equal to the sampling interval;

— maximum sampling interval: 5 mm;

— texture wavelength range of sensor and recording system: the frequency response of the entire measuring and data collection system shall be within ±1 dB over the entire megatexture range;

— background noise: maximum RMS value: 0,05 mm (see further in ISO 13473-3);