SLOVENSKI STANDARD

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Kmetijski kolesni traktorji - Sedež voznika - Laboratorijske meritve prenosa vibracij

Agricultural wheeled tractors -- Operator's seat -- Laboratory measurement of transmitted vibration

Tracteurs agricoles à roues -- Siège du conducteur -- Mesurage en laboratoire des vibrations transmises

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Tracteurs agricoles à roues — Siège du conducteur — Mesurage en laboratoire des vibrations transmises

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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 approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 5007 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry.*

This first edition cancels and replaces the first edition of the Technical Report, ISO/TR 5007 : 1980, of which it constitutes a technical revision.

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Agricultural wheeled tractors — Operator's seat — Laboratory measurement of transmitted vibration

1 Scope

This International Standard specifies a method for measuring and evaluating the effectiveness of the seat in reducing the vertical whole-body vibration transmitted to the operator of an agricultural tractor.

Vibration which reaches the operator other than through his seat, for example that sensed by his feet on the platform or control pedals or by his hands on the steering-wheel, is not covered.

This International Standard applies to seats fitted to agricultural wheeled tractors within specified tractor classes, each class being defined as a group of tractors having similar vibration characteristics (see table 2). Input vibrations for tractors not in a defined class may be measured at the seat attachment point during field operations and used for input to the vibration test table.

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 868 : 1985, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness).*

ISO 2041 : 1975, *Vibration and shock — Vocabulary.*

ISO 2631-1 : 1985, *Evaluation of human exposure to whole-body vibration — Part 1: General requirements.*

ISO 4253 : 1977, *Agricultural tractors — Operator's seating accommodation — Dimensions.*

ISO 4865 : —[1], *Vibration and shock — Methods for analysis and presentation of data.*

ISO 5353 : 1978, *Earth-moving machinery and tractors and machinery for agriculture and forestry — Seat index point.*

IEC 225 : 1966, *Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations.*

3 General

3.1 A simulated tractor vibration is specified as the test input to the operator seat on a laboratory test stand. This test input is based on measured data from tractors driven on a standardized test track and on data obtained from field tests under various conditions of use. The test input for a particular tractor class is a representative value for the tractors within that class.

3.2 The specification of the procedures, instruments and evaluation methods allows the measurements to be made and reported with acceptable precision.

3.3 The vibration is evaluated in accordance with ISO 2631-1. The procedure includes a means of weighting the vibration level at different frequencies to take account of the frequency sensitivity of the human operator.

4 Definitions

The terminology used in this International Standard is generally in accordance with ISO 2041. For the purposes of this International Standard, the following additional definitions also apply.

1) To be published.

4.1 whole-body vibration : Vibration transmitted to the body as a whole through the buttocks of a seated operator.

4.2 tractor class : Tractors having similar ride vibration characteristics at the seat attachment point, grouped by virtue of various mechanical characteristics.

4.3 unballasted mass : Mass of tractor in working order with full tanks and radiators, but less the mass of the operator and without removable ballast weights, special equipment or other loads. Where relevant the mass of protective structure shall be included.

4.4 operator seat : That portion of the tractor provided for the purpose of supporting the buttocks of the seated operator, including any suspension system and other mechanisms provided, for example for adjusting the seat position.

4.5 frequency analysis : Process of arriving at a quantitative description of a vibration amplitude as a function of frequency.

4.6 measuring period : Time duration in which vibration data for analysis is obtained.

5 Symbols and abbreviations

For the purposes of this International Standard, the following symbols and abbreviations apply :

a = instantaneous acceleration

a_f = r.m.s. value of 1/3 octave acceleration having centre frequency f

a_w = frequency-weighted acceleration signal

a_{wf} = weighted r.m.s. acceleration calculated as described in 6.4.1, 6.4.2 or 6.4.3

a_{wfB} = a_{wf} at base of seat (see 6.2.1)

a_{wfS} = a_{wf} at the operator vibration-sensing disc (see 6.2.2)

a^*_{wfS} = corrected value of a_{wfS} (see 10.2.4)

B_e = resolution bandwidth of a frequency analysis, in hertz

f = frequency, in hertz

T = analysis time duration, in seconds

W_f = frequency-dependent dimensionless weighting factor

g = acceleration due to gravity, by international agreement equal to 9,806 65 m/s^2 at sea level

r.m.s. = root mean square

PSD = power spectral density expressed as mean square acceleration per unit bandwidth (m/s^2)^2/Hz

PDF = probability density function of acceleration amplitudes

SIP = seat index point (see ISO 5353)

6 Instrumentation and frequency analysis

6.1 Acceleration transducers

Vibration at the seat base and vibration transmitted to the operator shall be sensed by acceleration transducers (accelerometers), located as described in 6.2.1 and 6.2.2 respectively.

The accelerometers, together with their amplifiers, shall be capable of measuring r.m.s. acceleration levels ranging from 0,05 m/s^2 to 10 m/s^2 with a crest factor of up to 6. The accelerometers and amplifiers shall be capable of an accuracy of ± 2,5 % of the actual r.m.s. vibration level in the frequency range 0,8 Hz to 80 Hz. The resonant frequency of the accelerometers shall be greater than 300 Hz, and they shall be capable of sustaining instantaneous acceleration levels up to 100 m/s^2 without damage.

6.2 Transducer mounting

6.2.1 Vibration at seat base

This vibration shall be sensed by an accelerometer attached to a rigid portion of the test stand or the seat mounting base. The accelerometer shall be located within the vertical projection of the seat cushion not more than 100 mm from the vertical longitudinal plane through the centreline of the seat, and shall be aligned parallel to the measurement Z-axis (see figure 1).

If the vibration test stand is of the pivoting type illustrated in figure 2, the accelerometers at the seat base and on the disc described in 6.2.2 shall be at the same distance from the pivot ± 20 mm.

6.2.2 Vibration transmitted to operator

This vibration shall be sensed by an accelerometer attached at the centre of a disc 250 mm ± 50 mm in diameter placed between the seated operator and the seat cushion. The disc shall be made of semi-rigid material of A/80 to A/90 (Shore hardness durometer type A) when measured in accordance with ISO 868 with a rigid centre part 75 mm ± 5 mm in diameter to which the accelerometer is attached. A disc design is shown in figure 3.

When the disc is placed on the seat, the accelerometer shall be approximately midway between the ischial tuberosities of the seated operator and aligned parallel to the measurement Z-axis (see figure 1).

6.3 Electronic recorders

The electrical signals generated by the transducers may be recorded on magnetic tape for later analysis. The magnetic tape recorder shall be capable of a replay accuracy of at least ± 3 % of the r.m.s. value of the total signal within the frequency range 1 Hz to 80 Hz.

6.4 Frequency weighting

Frequency weighting may be achieved in any of three ways: by analysis of the acceleration into one-third octave band levels, weighting the levels in individual bands and recombination, by direct use of electrical filters in a broadband method, or by digital analysis of the acceleration into constant bandwidth levels, weighting the levels in individual bands and recombination. The three methods are described in 6.4.1 to 6.4.3.

Small differences in absolute values of weighted vibration may result from the three different weighting methods pending the gathering of further experience, but, providing the same method is used for weighting both input and seat vibration as is required in 10.2.3, these differences are considered unlikely to affect the final result significantly.

6.4.1 One-third octave bandwidth method

Each vibration tape recording, or vibration signal where a tape recorder is not used, shall be analysed into one-third octave component accelerations for the centre frequencies of table 1. (The centre frequencies of table 1 are an extrapolation of IEC 225.) The r.m.s. value of each component, a_f, shall be averaged over the duration specified for the measurement. The one-third octave values shall each be multiplied by the weighting factors, W_f, listed in table 1, and a weighted acceleration value, a_{wf}, calculated for each recording as follows:

$$a_{wf} = \left[\sum_{f=1}^{20} W_f^2 \times a_f^2 \right]^{\frac{1}{2}}$$

Table 1 — Frequency weighting factors (in accordance with ISO 2631-1)

One-third octave centre frequency f	Weighting factor W_f
1	0,5 = − 6 dB
1,25	0,56 = − 5 dB
1,6	0,63 = − 4 dB
2	0,71 = − 3 dB
2,5	0,8 = − 2 dB
3,15	0,89 = − 1 dB
4	1 = 0 dB
5	1 = 0 dB
6,3	1 = 0 dB
8	1 = 0 dB
10	0,8 = − 2 dB
12,5	0,63 = − 4 dB
16	0,5 = − 6 dB
20	0,4 = − 8 dB
25	0,315 = − 10 dB
31,5	0,25 = − 12 dB
40	0,2 = − 14 dB
50	0,16 = − 16 dB
63	0,125 = − 18 dB
80	0,1 = − 20 dB

To satisfy the following,

$$2B_e T \geqslant 140$$

the minimum sampling time, T, is 300 s.

6.4.2 Broadband method

This method, if employed for direct indication of the weighted vibration, shall consist of an electronic weighting network incorporated between the transducer and a time integration stage. The weighting network shall have an insertion loss conforming to the curve in figure 4 for Z-axis (vertical) vibration. The loss shall not deviate from the curve by more than ± 0,5 dB for frequencies between 2 Hz and 4 Hz, and ± 2 dB at any other frequency. The integration stage shall be capable of indicating the integral of the square of weighted acceleration, a_{wf}, for the time period of the test run T. That is,

$$(a_{wf})^2 = \frac{1}{T} \int_{t=0}^{T} a_w^2 \, dt$$

The minimum sampling time, T, is 120 s.

6.4.3 Constant bandwidth method

Each vibration tape recording, or vibration signal where a tape recorder is not used, shall be analysed into constant bandwidth acceleration levels over the frequency range from 1 Hz to 20 Hz by appropriate digital methods (see ISO 4865). The sampling time, T, in seconds, shall satisfy the following :

$$2 B_e T \geqslant 140$$

and resolution bandwidth, B_e, in hertz,

$$B_e \leqslant 0,3$$

The constant bandwidth r.m.s. levels shall be each multiplied by a weighting factor calculated for each centre frequency from figure 4 for Z-axis (vertical) vibration. A weighted acceleration value, a_{wf}, shall be calculated as the square root of the sum of the squares of the weighted constant bandwidth levels over the range 1 Hz to 20 Hz.

6.5 Calibration

6.5.1 General

Acceleration transducers should be calibrated in accordance with a suitable recognized calibration method. In particular, the calibration procedures should ensure that the acceleration sensitivity varies less than ± 2,5 % of a mean value over the frequency range 0 to 40 Hz and less than ± 6,0 % of mean value over the frequency range of 0 to 80 Hz.

The effects of ambient temperature on the performance of all instruments shall be known. Instruments shall be operated