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Mechanical vibration and shock — Hand-arm vibration — Measurement and evaluation of the vibration transmissibility of gloves at the palm of the hand

Vibrations et chocs mécaniques — Vibrations main-bras — Mesurage et évaluation du facteur de transmission des vibrations par les gants à la paume de la main

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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.

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 documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2, www.iso.org/directives.

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 4, *Human exposure to mechanical vibration and shock*.

This second edition cancels and replaces the first edition (ISO 10819:1996), of which it constitutes a technical revision. The main changes are stronger criteria for antivibration gloves and the addition of a method for measuring the material thickness.

Introduction

Because of the growing demand to reduce health risks associated with exposure to hand-transmitted vibration, gloves with vibration-reducing materials are often used to attenuate vibration transmitted to the hands. These gloves normally provide little reduction in hand-transmitted vibration at frequencies below 150 Hz. Some gloves can increase the vibration transmitted to the hands at these low frequencies. Gloves with vibration-reducing materials that meet the requirements of this International Standard to be classified as an antivibration glove can be expected to reduce hand-transmitted vibration at frequencies above 150 Hz. These gloves can reduce but not eliminate health risks associated with hand-transmitted vibration exposure.

Field observations indicate that gloves with vibration-reducing materials can result in positive and negative health effects. Positive health effects can occur with gloves that reduce finger tingling and numbness and that keep the hands warm and dry. Negative health effects can occur with gloves that increase the vibration transmitted to the hands at low frequencies and that increase hand and arm fatigue because they increase the hand grip effort required to control a vibrating machine.

Gloves tested in accordance with the requirements of this International Standard are evaluated in a controlled laboratory environment. The actual vibration attenuation of a glove in a work environment can differ from that measured in a controlled laboratory environment.

Vibration transmissibility measurements made in accordance with the requirements of this International Standard are performed only at the palm of the hand. The transmission of vibration to the fingers is not measured. When evaluating the effectiveness of a glove with a vibration-reducing material used to reduce vibration transmitted to the hand, vibration transmission to the fingers should also be assessed. However, research subsequent to the publication of this International Standard is needed to develop a measurement procedure that can be used to measure the vibration transmissibility of gloves at the fingers.

The measurement procedure specified in this International Standard only addresses glove properties that can reduce health risks associated with hand-transmitted vibration in work environments. It does not address glove properties necessary to reduce other hand-related health and safety risks in work environments.

The measurement procedure specified in this International Standard can also be used to measure the vibration transmissibility of a material that is being evaluated for use to cover a handle of a machine or for potential use in a glove.

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WARNING — This International Standard defines a screening test procedure for measuring the vibration transmission through gloves with an embedded vibration-reducing material. Many factors not addressed in this International Standard can influence the transmission of vibration through these gloves. Therefore, use the vibration transmissibility values obtained in accordance with this International Standard with caution in the assessment of the vibration-reducing effects of gloves.

1 Scope

This International Standard specifies a method for the laboratory measurement, data analysis, and reporting of the vibration transmissibility of a glove with a vibration-reducing material that covers the palm, fingers, and thumb of the hand. This International Standard specifies vibration transmissibility in terms of vibration transmitted from a handle through a glove to the palm of the hand in one-third-octave frequency bands with centre frequencies of 25 Hz to 1 250 Hz.

The measurement procedure specified in this International Standard can also be used to measure the vibration transmissibility of a material that is being evaluated for use to cover a handle of a machine or for potential use in a glove. However, results from this test cannot be used to certify that a material used to cover a handle meets the requirements of this International Standard to be classified as an antivibration covering. A material tested in this manner could later be placed in a glove. When this is the case, the glove needs to be tested in accordance with the measurement procedure of this International Standard and needs to meet the vibration attenuation performance requirements of this International Standard in order to be classified as an antivibration glove.

NOTE ISO 13753[1] defines a method for screening materials used for vibration attenuation on the handles of machines and for gloves.

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.

ISO 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

ISO 5349-1, *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 1: General requirements*

ISO 5805, *Mechanical vibration and shock — Human exposure — Vocabulary*

ISO 8041, *Human response to vibration — Measuring instrumentation*

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

EN 388, *Protective gloves against mechanical risks*

EN 420, *Protective gloves — General requirements and test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041, ISO 5805 and the following apply.

3.1
glove vibration transmissibility
ratio of the acceleration measured on the palm adaptor of the gloved hand to the acceleration measured on the instrumented handle

Note 1 to entry: Glove vibration transmissibility values greater than 1 indicate that the glove amplifies the vibration, and values lower than 1 indicate that the glove attenuates the vibration.

4 Symbols and abbreviations

The following symbols and abbreviations are used.

$a_{h(Pb)}(f_i)$	unweighted r.m.s. acceleration measured on the bare adaptor in the ith one-third-octave band
$a_{h(Pbx,y,z)}(f_i)$	value of $a_{h(Pb)}(f_i)$ on three mutually orthogonal axes, respectively
$a_{h(Pg)}(f_i)$	unweighted r.m.s. acceleration measured on the palm adaptor of the gloved hand in the ith one-third-octave band
$a_{h(Pgx,y,z)}(f_i)$	value of $a_{h(Pg)}(f_i)$ on three mutually orthogonal axes, respectively
$a_{h(S)}(f_i)$	unweighted r.m.s. acceleration for spectrum S in the ith one-third-octave band
$a_{hw(S)}(f_i)$	frequency-weighted r.m.s. acceleration for spectrum S in the ith one-third-octave band
$a_R(f_i)$	unweighted r.m.s. acceleration measured at the reference position on the handle in the ith one-third-octave band
$C_{V,T}(f_i)$	coefficient of variation for the corrected handle-gloved hand transmissibility in the ith one-third-octave band
$C_{V,T(S)}$	coefficient of variation for the handle-gloved ISO-weighted hand transmissibility for spectrum S
f_i	centre frequency of the ith one-third-octave band
H	subscript representing one-third-octave frequency bands from 200 Hz to 1 250 Hz
i_L	frequency band number of the lowest one-third-octave band associated with each spectrum S according to Table 2
i_U	frequency band number of the uppermost one-third-octave band associated with each spectrum S according to Table 2
M	subscript representing one-third-octave frequency bands from 25 Hz to 200 Hz
S	spectrum, $S = S_M$ or S_H
$s_T(f_i)$	standard deviation for the corrected handle-gloved hand transmissibility in the ith one-third-octave band
$s_{T(S)}$	standard deviation for the handle-gloved ISO-weighted hand transmissibility for spectrum S
$T_b(f_i)$	handle-adaptor bare adaptor transmissibility in the ith one-third-octave band
$T_g(f_i)$	handle-gloved hand transmissibility in the ith one-third-octave band

$T_{b(S)}$	handle-adaptor bare adaptor ISO weighted transmissibility for spectrum S
$T_{g(S)}$	uncorrected handle-gloved hand ISO weighted transmissibility for spectrum S
$T(f_i)$	corrected handle-gloved hand transmissibility in the ith one-third-octave band
$T_{(S)}$	corrected handle-gloved ISO weighted hand transmissibility for spectrum S
$\overline{T}(f_i)$	mean value for the corrected handle-gloved hand transmissibility in the ith one-third-octave band
$\overline{T}_{(S)}$	mean value for the handle-gloved ISO-weighted hand transmissibility for spectrum S
W_{hi}	ISO frequency-weighting factor specified in ISO 5349-1 for the ith one third-octave frequency band associated with each spectrum S

5 Measuring principle and equipment

5.1 General principle and setup

The method specified in this International Standard is used to measure the vibration input to a gloved hand that is transmitted through the glove at the palm of the hand, which grips and pushes on an instrumented handle. The glove vibration transmissibility (3.1) measured at the palm is used as an index to judge the vibration-reducing effectiveness of the glove. A vibration excitation system (normally an electromechanical shaker) shall be used to generate the required vibration input. The vibration in the direction of the excitation shall be simultaneously measured at the middle point of the top of the instrumented handle (see Annex A) and between the palm of the hand and glove by means of a palm adaptor. The adaptor shall contain an accelerometer and shall be placed inside the glove between the hand and handle. To compensate for the frequency response of the palm adaptor, the glove vibration transmissibility is calculated as the ratio of the vibration transmissibility values at the palm of the hand with a glove, as measured with the palm adaptor, divided by the corresponding transmissibility values associated with the bare palm adaptor attached to the handle.

A schematic drawing of a recommended vibration measurement setup is shown in Figure 1. The acceleration at the reference point in the instrumented handle, $a_R(f_i)$, and the vibration at the palm of the hand, $a_{h(Pb)}(f_i)$ or $a_{h(Pg)}(f_i)$, shall be measured simultaneously. Annex A shows examples of instrumented handles. The diameter of that part of the instrumented handle that is clasped by the hand shall be (40 ± 0,5) mm.

The values of the grip and feed forces shall be displayed continuously so the test subject can continually monitor them and consistently apply the required grip and feed forces throughout a test.

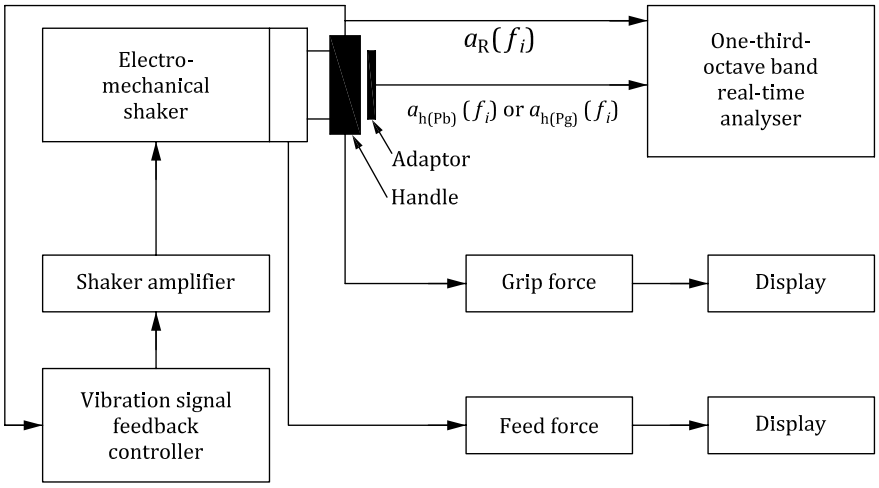


Figure 1 — Schematic diagram for measurement of glove vibration transmissibility

5.2 Measuring equipment

5.2.1 General requirements

A minimum of a two-channel, one-third-octave band real-time frequency analyser and two accelerometers are required.

The elements of the measuring chain shall fulfill the requirements of ISO 8041.

5.2.2 Transducer mounting

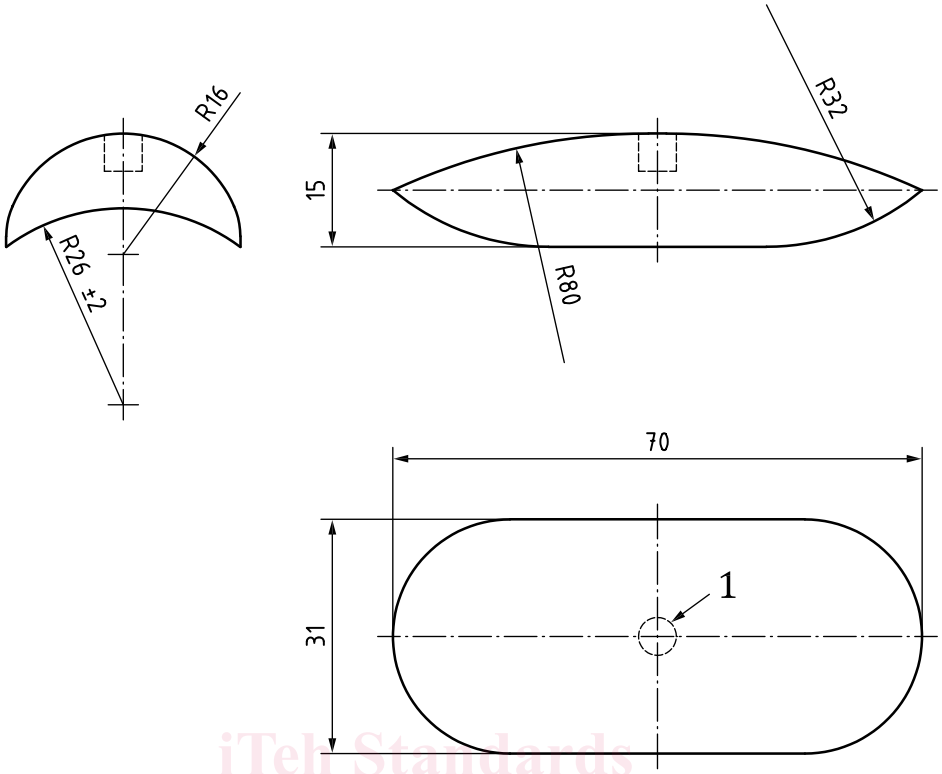
5.2.2.1 Mounting at the reference point in the handle

A single-axis accelerometer shall be embedded within the top surface of the test handle that will be in contact with the palm adaptor. The accelerometer shall be placed near the centre of the length of the handle, and its measurement axis shall be parallel to the vibration excitation axis. The exact location of the accelerometer shall be marked on the surface of the handle.

5.2.2.2 Mounting for measurement at the palm of the hand

To measure vibration at the palm of the hand, a palm adaptor shall be used that contains an accelerometer (may be a single axis or triaxial accelerometer) with the dimensions and shape shown in Figure 2. Its mass, which includes the mass of the accelerometer, shall not exceed 15 g. The palm adaptor shall be made of a rigid material, such as wood or hard plastic.

Dimensions in millimetres



Key

1 accelerometer location

NOTE Unless otherwise specified, all tolerances are ±0,5 mm.

Figure 2 — Adaptor for holding the accelerometer in the palm of the hand

To ensure measurement accuracy, the calibration consistency of the two accelerometers installed in the handle and the palm adaptor, respectively, shall be checked by affixing the adaptor to the test handle with a contact force of (80 ± 10) N. The adaptor shall be positioned on the surface of the handle as close as possible to the accelerometer installed on the handle (see Annex A), and the adaptor shall be aligned with the vibration axis of the handle. The palm adaptor shall be held in place by means of a lightweight elastic element (e.g. rubber bands). The measured bare palm adaptor vibration transmissibility shall be within the amplitude range of 0,95 to 1,05 over the one-third-octave frequency range of 25 Hz to 1 250 Hz.

Care should be taken to ensure that the palm adaptor has solid contact with the test handle along a single straight line that runs the length of the adaptor. Deviations from unity transmissibility in excess of ±5 % can occur when the palm adaptor, which has a radius greater than the test handle radius, does not have good contact with the test handle.

5.2.3 Frequency analyses

Frequency analyses in one-third-octave frequency bands shall be conducted. The one-third-octave band filters shall fulfill the requirements for one-third-octave filters specified in IEC 61260, class 1.

5.2.4 Grip force measuring system

Grip force is the force used to grip the handle along the axis of vibration (see ISO 15230[2]). It is measured according to the scheme shown in Figure 3.