

Acoustics and vibration — Laboratory measurement of vibro-acoustic transfer properties of resilient elements —

Part 4: Dynamic stiffness of elements other than resilient supports for translatory motion

The European Standard EN ISO 10846-4:2003 has the status of a
British Standard

ICS 17.140.01

National foreword

This British Standard is the official English language version of EN ISO 10846-4:2003. It is identical with ISO 10846-4:2003.

The UK participation in its preparation was entrusted by Technical Committee EH/1, Acoustics, to Subcommittee EH/1/4, Machinery noise, which has the responsibility to:

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- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN ISO title page, the EN ISO foreword page, the ISO title page, pages ii to v, a blank page, pages 1 to 33, the Annex ZA, an inside back cover and a back cover.

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Acoustics and vibration - Laboratory measurement of vibro-acoustic transfer properties of resilient elements - Part 4:
Dynamic stiffness of elements other than resilient supports for
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Acoustique et vibrations - Mesurage en laboratoire des propriétés de transfert vibro-acoustique des éléments élastiques - Partie 4: Raideur dynamique en translation des éléments autres que les supports élastiques (ISO 10846-4:2003)

Akustik und Schwingungstechnik - Laborverfahren zur Messung der vibro-akustischen Transfereigenschaften elastischer Elemente - Teil 4: Bestimmung der dynamischen Transfersteifigkeit von elastischen Elementen mit Ausnahme elastischer Stützelemente für translatorische Schwingungen (ISO 10846-4:2003)

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Foreword

This document (EN ISO 10846-4:2003) has been prepared by Technical Committee ISO/TC 43 "Acoustics" in collaboration with Technical Committee CEN/TC 211 "Acoustics", the secretariat of which is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2004, and conflicting national standards shall be withdrawn at the latest by March 2004.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of ISO 10846-4:2003 has been approved by CEN as EN ISO 10846-4:2003 without any modifications.

NOTE Normative references to International Standards are listed in Annex ZA (normative).

INTERNATIONAL STANDARD

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Acoustics and vibration — Laboratory measurement of vibro-acoustic transfer properties of resilient elements —

Part 4:

Dynamic stiffness of elements other than resilient supports for translatory motion

*Acoustique et vibrations — Mesurage en laboratoire des propriétés de
transfert vibro-acoustique des éléments élastiques —*

*Partie 4: Raideur dynamique en translation des éléments autres que les
supports élastiques*



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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.

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 10846-4 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*, in collaboration with ISO/TC 108, *Mechanical vibration and shock*.

ISO 10846 consists of the following parts, under the general title *Acoustics and vibration — Laboratory measurement of vibro-acoustic transfer properties of resilient elements*:

- *Part 1: Principles and guidelines*
- *Part 2: Dynamic stiffness of elastic supports for translatory motion — Direct method*
- *Part 3: Indirect method for determination of the dynamic stiffness of resilient supports for translatory motion*
- *Part 4: Dynamic stiffness of elements other than resilient supports for translatory motion*
- *Part 5: Driving point method for the determination of the low frequency dynamic stiffness of elastic supports for translatory motion*

Introduction

Passive vibration isolators of various kinds are used to reduce the transmission of vibrations. Examples are automobile engine mounts, resilient supports for buildings, resilient mounts and flexible shaft couplings for shipboard machinery, and small isolators in household appliances.

This part of ISO 10846 specifies a direct and an indirect method for measuring the dynamic transfer stiffness function of linear resilient elements (other than resilient supports) such as resilient bellows, hoses, shaft couplings, power supply cables and pipe hangers. This part of ISO 10846 belongs to a series of International Standards on methods for the laboratory measurement of the vibro-acoustic properties of resilient elements, which also includes documents on measurement principles and on a direct, an indirect and a driving point method for resilient supports. ISO 10846-1 provides global guidance for the selection of the appropriate International Standard.

The laboratory conditions described in this part of ISO 10846 include the application of static preload, where appropriate.

The results of the method described in this part of ISO 10846 are useful for resilient elements that are used to reduce the transmission of structure-borne sound (primarily frequencies above 20 Hz). The method does not characterize completely elements that are used to attenuate low-frequency vibration or shock excursions.

Acoustics and vibration — Laboratory measurement of vibro-acoustic transfer properties of resilient elements —

Part 4: Dynamic stiffness of elements other than resilient supports for translatory motion

1 Scope

This part of ISO 10846 specifies two methods for determining the dynamic transfer stiffness for translations of resilient elements other than resilient supports. Examples are resilient bellows, shaft couplings, power supply cables, hoses and pipe hangers (see Figure 1). Elements filled with liquids, such as oil or water, are excluded.

NOTE 1 Pipe hangers are extensionally deflected, as opposed to elastic supports which are compressed. Therefore, the test conditions are different from those described in ISO 10846-2 and ISO 10846-3.

The methods are applicable to resilient elements with flat flanges or flat clamp interfaces. It is not necessary that the flanges be parallel.

Resilient elements which are the subject of this part of ISO 10846 are those that are used to reduce

- a) the transmission of audiofrequency vibrations (structure-borne sound, 20 Hz to 20 kHz) to a structure which may, for example, radiate unwanted sound (airborne, waterborne or other), and
- b) the transmission of low-frequency vibrations (typically 1 Hz to 80 Hz), which may, for example, act upon human subjects or cause damage to structures of any size when the vibration is too severe.

In practice, the size of the available test rig(s) determines restrictions for very small and for very large resilient elements.

Measurements for translations normal and transverse to the flanges or clamp interfaces are covered in this part of ISO 10846. Annex A provides guidance for the measurement of transfer stiffnesses that include rotatory components.

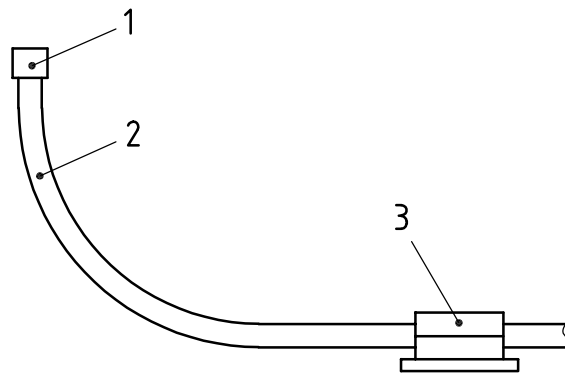
The direct method can be applied in the frequency range from 1 Hz up to a frequency that is usually determined by the lowest resonance frequency of the test arrangement frame (typically 300 Hz for test rigs with dimensions of the order of 1 m).

NOTE 2 In practice, the lower frequency limit depends on the dynamic excitation system.

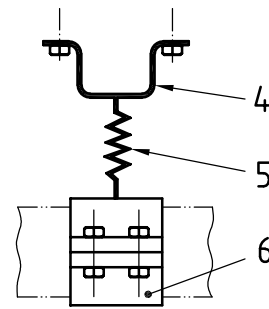
The indirect method covers a frequency range that is determined by the test set-up and the isolator under test. The range is typically from a lower frequency between 20 Hz and 50 Hz, to an upper frequency between 2 kHz and 5 kHz.

The data obtained according to the methods specified in this part of ISO 10846 can be used for

- product information provided by manufacturers and suppliers,
- information during product development,
- quality control, and
- calculation of the transfer of vibration through resilient elements.



a) Power cable including connector and clamping device



b) Pipe hanger

Key

- 1 connector
- 2 cable
- 3 clamp
- 4 fixture
- 5 flexible element
- 6 pipe clamp

Figure 1 — Examples of resilient elements with flat flanges or clamps

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 266, *Acoustics — Preferred frequencies*

ISO 2041, *Vibration and shock — Vocabulary*

ISO 5348, *Mechanical vibration and shock — Mechanical mounting of accelerometers*

ISO 7626-1, *Vibration and shock — Experimental determination of mechanical mobility — Part 1: Basic definitions and transducers*

ISO 7626-2, *Vibration and shock — Experimental determination of mechanical mobility — Part 2: Measurements using single-point translation excitation with an attached vibration exciter*

ISO 10846-1, *Acoustics and vibration — Laboratory measurement of vibro-acoustic transfer properties of resilient elements — Part 1: Principles and guidelines*

ISO 16063-21, *Methods for the calibration of vibration and shock transducers — Part 21: Vibration calibration by comparison with a reference transducer*

GUM:1993, *Guide to the expression of uncertainty in measurement*. BIPM/IEC/IFCC/ISO/IUPAC/IUPAP/OIML

3 Terms and definitions

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

3.1

resilient element

element of which one of the functions is the reduction of the vibration transmission in a certain frequency range

3.2

resilient support

resilient element suitable for supporting part of the mass of a machine, a building or another type of structure

3.3

test element

resilient element under test, including flanges and auxiliary fixtures, if any

3.4

blocking force

F_b

dynamic force on the output side of a resilient element which results in zero displacement output

3.5

dynamic transfer stiffness

$k_{2,1}$

frequency-dependent ratio of the complex blocking force $\underline{F}_{2,b}$ on the output side of a resilient element to the complex displacement $\underline{u}_1$ on the input side during simple harmonic motion, defined by the following formula

$$k_{2,1} = \underline{F}_{2,b} / \underline{u}_1$$

NOTE The value of $k_{2,1}$ can be dependent upon the static preload, temperature and other conditions.

3.6

loss factor of resilient element

η

ratio of the imaginary part of $k_{2,1}$ and the real part of $k_{2,1}$ (i.e. tangent of the phase angle of $k_{2,1}$) in the low-frequency range where inertial forces in the element are negligible

3.7

frequency-averaged dynamic transfer stiffness

k_{av}

function of the frequency of the average value of the modulus of the dynamic transfer stiffness over a frequency band Δf

NOTE See 8.3.

3.8

point contact

contact area which vibrates as the surface of a rigid body

3.9

normal translation

translational vibration normal to the flange of a resilient element

3.10

transverse translation

translational vibration in a direction perpendicular to that of the normal translation

3.11

linearity

property of the dynamic behaviour of a resilient element, if it satisfies the principle of superposition

NOTE 1 The principle of superposition can be stated as follows. If an input $x_1(t)$ produces an output $y_1(t)$ and in a separate test an input $x_2(t)$ produces an output $y_2(t)$, superposition holds if the input $a \cdot x_1(t) + b \cdot x_2(t)$ produces the output $a \cdot y_1(t) + b \cdot y_2(t)$. This must hold for all values of a , b and $x_1(t)$ and $x_2(t)$; a and b are arbitrary constants.

NOTE 2 In practice, the above test for linearity is impractical and a limited check of linearity is done by measuring the dynamic transfer stiffness for a range of input levels. In effect this procedure checks for a proportional relationship between the response and the excitation (see 7.7).

3.12

direct method

method in which the input displacement, velocity or acceleration and the blocking output force are measured

3.13

indirect method

method in which the vibration transmissibility (for displacement, velocity or acceleration) of a resilient element is measured, with the output loaded by a compact body of known mass

3.14

transmissibility

T

ratio of the complex displacements on the output side $\underline{u}_2$ to those on the input side $\underline{u}_1$ of the test element during simple harmonic motion, defined by the following formula

$$T = \underline{u}_2 / \underline{u}_1$$

NOTE For velocities v and accelerations a , transmissibilities are defined in a similar way and have the same value.

3.15

force level

L_F

level calculated by the following formula

$$L_F = 10 \lg \frac{F^2}{F_0^2} \text{ dB}$$

where F^2 denotes the mean square value of the force in a specific frequency band and $F_0 = 10^{-6}$ N is the reference force

3.16

acceleration level

L_a

level calculated by the following formula

$$L_a = 10 \lg \frac{a^2}{a_0^2} \text{ dB}$$

where a^2 denotes the mean square value of the acceleration in a specific frequency band and $a_0 = 10^{-6}$ m/s² is the reference acceleration

3.17