BS ISO 7626-2:2015

BSI Standards Publication

Mechanical vibration and shock — Experimental determination of mechanical mobility

Part 2: Measurements using single-point translation excitation with an attached vibration exciter

bsi.

...making excellence a habit.™

Document Sharing Hub

National foreword

This British Standard is the UK implementation of ISO 7626-2:2015. It supersedes BS 6897-2:1990 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GME/21/3, Mechanical vibration, shock and condition monitoring - Measurement and evaluation of mechanical vibration and shock in stationary structures.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2015.
Published by BSI Standards Limited 2015

ISBN 978 0 580 83256 7
ICS 17.160

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 May 2015.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS ISO 7626-2:2015

INTERNATIONAL STANDARD

ISO 7626-2

Second edition
2015-04-01

Mechanical vibration and shock — Experimental determination of mechanical mobility —

Part 2: Measurements using single-point translation excitation with an attached vibration exciter

Vibrations et chocs — Détermination expérimentale de la mobilité mécanique —

Partie 2: Mesurages avec utilisation d'une excitation de translation en un seul point, au moyen d'un générateur de vibrations solidaire de ce point

Reference number
ISO 7626-2:2015(E)

Documents
Document Sharing Hub

© ISO 2015

Full document details: BS ISO 7626-2:2015

COPYRIGHT PROTECTED DOCUMENT

© ISO 2015

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

© ISO 2015 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 7626-2:2015

Contents

Page

Foreword ... **v**
Introduction ... **vi**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms and definitions ... **1**
4 Overall configuration of the measurement system ... **2**
5 Support of the structure under test ... **3**
5.1 General ... 3
5.2 Grounded measurements ... 3
5.3 Ungrounded measurements ... 3
6 Excitation ... **4**
6.1 General ... 4
6.2 Excitation waveforms ... 4
6.2.1 General ... 4
6.2.2 Discretely dwelled sinusoidal excitation ... 4
6.2.3 Slowly swept sinusoidal excitation ... 5
6.2.4 Stationary random excitation ... 5
6.2.5 Other excitation waveforms ... 5
6.3 Vibration exciters ... 5
6.4 Avoidance of spurious forces and moments ... 8
6.4.1 General ... 8
6.4.2 Transducer mass loading ... 8
6.4.3 Transducer rotational inertia loading ... 8
6.4.4 Exciter attachment restraints ... 8
7 Measurement of the exciting force and resulting motion response ... **9**
7.1 General ... 9
7.2 Attachment of transducers ... 9
7.3 Mass loading and mass cancellation ... 10
7.4 Signal amplifiers ... 10
7.5 Calibrations ... 11
7.5.1 General ... 11
7.5.2 Operational calibration ... 11
8 Processing of the transducer signals ... **14**
8.1 Determination of the frequency-response function ... 14
8.1.1 General ... 14
8.1.2 Sinusoidal excitation ... 14
8.1.3 Random excitation ... 14
8.2 Filtering ... 14
8.2.1 Sinusoidal excitation ... 14
8.2.2 Random excitation ... 14
8.3 Avoidance of saturation ... 15
8.4 Frequency resolution ... 15
8.4.1 General ... 15
8.4.2 Sinusoidal excitation ... 15
8.4.3 Random excitation ... 15
8.4.4 Periodic excitation ... 15
9 Control of the excitation ... **16**
9.1 General ... 16
9.2 Time required for sinusoidal excitation ... 16
9.2.1 General ... 16
9.2.2 Discretely dwelled sinusoidal excitation ... 16

AVA Documents
Document Sharing Hub

© ISO 2015 – All rights reserved

Full document details: BS ISO 7626-2:2015

9.2.3 Slowly swept sinusoidal excitation ... 17
9.3 Time required for random excitation ... 17
9.4 Dynamic range ... 18
9.4.1 General ... 18
9.4.2 Sinusoidal excitation ... 18
9.4.3 Random excitation ... 18
10 Tests for valid data ... 18
11 Modal parameter identification ... 19
Annex A (normative) **Tests for validity of measurement results ... 20**
Annex B (normative) **Requirements for excitation frequency increments and duration ... 23**
Annex C (informative) **Modal parameter identification ... 25**
Bibliography ... 26

© ISO 2015 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 7626-2:2015

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 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 108, *Mechanical vibration, shock and condition monitoring*.

This second edition cancels and replaces the first edition (ISO 7626-2:1990), which has been technically revised.

ISO 7626 consists of the following parts, under the general title *Mechanical vibration and shock — Experimental determination of mechanical mobility*:

— *Part 1: Basic terms and definitions, and transducer specifications*

— *Part 2: Measurements using single-point translational excitation with an attached vibration exciter*

— *Part 5: Measurements using impact excitation with an exciter which is not attached to the structure*

© ISO 2015 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 7626-2:2015

Introduction

General introduction to the ISO 7626- series **on mobility measurement**

Dynamic characteristics of structures can be determined as a function of frequency from mobility measurements or measurements of the related frequency-response functions, known as accelerance and dynamic compliance. Each of these frequency-response functions is the phasor of the motion response at a point on a structure due to a unit force (or moment) excitation. The magnitude and the phase of these functions are frequency-dependent.

Accelerance and dynamic compliance differ from mobility only in that the motion response is expressed in terms of acceleration and displacement, respectively, instead of in terms of velocity. In order to simplify the various parts of ISO 7626, only the term "mobility" is used. It is understood that all test procedures and requirements described are also applicable to the determination of accelerance and dynamic compliance.

Typical applications for mobility measurements are for:

a) predicting the dynamic response of structures to known or assumed input excitation;

b) determining the modal properties of a structure (natural frequencies, damping ratios and mode shapes);

c) predicting the dynamic interaction of interconnected structures;

d) checking the validity and improving the accuracy of mathematical models of structures;

e) determining dynamic properties (i.e. the complex modulus of elasticity) of materials in pure or composite forms.

For some applications, a complete description of the dynamic characteristics can be required using measurements of translational forces and motions along three mutually perpendicular axes as well as measurements of moments and rotational motions about these three axes. This set of measurements results in a 6 × 6 mobility matrix for each location of interest. For N locations on a structure, the system thus has an overall mobility matrix of size $6N \times 6N$.

For most practical applications, it is not necessary to know the entire $6N \times 6N$ matrix. Often it is sufficient to measure the driving-point mobility and a few transfer mobilities by exciting with a force at a single point in a single direction and measuring the translational response motions at key points on the structure. In other applications, only rotational mobilities might be of interest.

Mechanical mobility is defined as the frequency-response function formed by the ratio of the phasor of the translational or rotational response velocity to the phasor of the applied force or moment excitation. If the response is measured with an accelerometer, conversion to velocity is required to obtain the mobility. Alternatively, the ratio of acceleration to force, known as accelerance, can be used to characterize a structure. In other cases, dynamic compliance, the ratio of displacement to force, can be used.

NOTE Historically, frequency-response functions of structures have often been expressed in terms of the reciprocal of one of the above-named dynamic characteristics. The arithmetic reciprocal of mechanical mobility has often been called mechanical impedance. It should be noted, however, that this is misleading because the arithmetic reciprocal of mobility does not, in general, represent any of the elements of the impedance matrix of a structure. Rather, conversion of mobility to impedance requires an inversion of the full mobility matrix. This point is elaborated upon in ISO 7626-1.

Mobility test data cannot be used directly as part of an impedance model of the structure. In order to achieve compatibility of the data and the model, the impedance matrix of the model is converted to mobility or vice versa (see ISO 7626-1 for limitations).

© ISO 2015 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 7626-2:2015

Introduction to this part of ISO 7626

For many applications of mechanical mobility data, it is sufficient to determine the driving-point mobility and a few transfer mobilities by exciting the structure at a single location in a single direction and measuring the translational response motions at key points on the structure. The translational excitation force can be applied either by vibration exciters attached to the structure under test or by devices that are not attached.

Categorization of excitation devices as “attached” or “unattached” has significance in terms of the ease of moving the excitation point to a new position. It is much easier, for example, to change the location of an impulse applied by an instrumented hammer than it is to relocate an attached vibration exciter to a new point on the structure. Both methods of excitation have applications to which they are best suited. This part of ISO 7626 deals with measurements using a single attached exciter; measurements made by impact excitation without the use of attached exciters are covered by ISO 7626-5.

© ISO 2015 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 7626-2:2015

Documents
Document Sharing Hub

INTERNATIONAL STANDARD ISO 7626-2:2015(E)

Mechanical vibration and shock — Experimental determination of mechanical mobility —

Part 2: Measurements using single-point translation excitation with an attached vibration exciter

1 Scope

This part of ISO 7626 specifies procedures for measuring linear mechanical mobility and other frequency-response functions of structures, such as buildings, machines and vehicles, using a single-point translational vibration exciter attached to the structure under test for the duration of the measurement.

It is applicable to measurements of mobility, accelerance, or dynamic compliance, either as a driving-point measurement or as a transfer measurement. It also applies to the determination of the arithmetic reciprocals of those ratios, such as free effective mass. Although excitation is applied at a single point, there is no limit on the number of points at which simultaneous measurements of the motion response may be made. Multiple-response measurements are required, for example, for modal analyses.

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 7626-1, *Mechanical vibration and shock — Experimental determination of mechanical mobility — Part 1: Basic terms and definitions, and transducer specifications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7626-1 and ISO 2041 and the following apply.

Note As this part of ISO 7626 deals with mechanical mobility, the notes to the definitions below provide more detail than is given in ISO 2041.

3.1
frequency-response function
frequency dependent ratio of complex motion response to complex excitation force for a linear system

Note 1 to entry: Excitation may be harmonic, random or transient functions of time. The frequency-response function does not depend on the type of excitation function if the tested structure can be considered a linear system in a certain range of the excitation or response. In such a case, the test results obtained with one type of excitation may be used for estimating the response of the system to any other type of excitation. Phasors and their equivalents for random and transient excitation are discussed in Annex B.

Note 2 to entry: Linearity of the system is a condition which, in practice, is met only approximately, depending on the type of system and on the magnitude of the input. Care has to be taken to avoid nonlinear effects, particularly when applying impulse excitation. Structures which are known to be nonlinear (e.g. structures with fluid elements) should not be tested with impulse excitation and great care is required when using random excitation for testing of such structures.

© ISO 2015 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 7626-2:2015

Note 3 to entry: Motion may be expressed in terms of velocity, acceleration or displacement; the corresponding frequency response function designations are mobility, accelerance and dynamic compliance, respectively. In some publications, these quantities are alternately referred to (in whole or in part) as mechanical admittance, inertance and receptance, respectively. These alternate terms are avoided herein, and are provided only for reference.

[SOURCE: ISO 2041:2009, 1.53, modified]

3.2
mobility
mechanical mobility
complex ratio of the velocity, taken at a point in a mechanical system, to the excitation force, taken at the same or other point in the system

Note 1 to entry: Mobility is the ratio of the complex velocity-response at point *i* to the complex excitation force at point *j* with all other measurement points on the structure allowed to respond freely without any constraints other than those constraints which represent the normal support of the structure in its intended application.

Note 2 to entry: The term "point", as used here, designates both a location and a direction. The terms "coordinate" and "degree-of-freedom" have also been used with the same meaning as "point".

Note 3 to entry: The velocity response can be either translational or rotational, and the excitation force can be either a rectilinear force or a moment.

Note 4 to entry: If the velocity response measured is a translational one and if the excitation force applied is a rectilinear one, the units of the mobility term are m/(N · s) in the SI system.

Note 5 to entry: Mechanical mobility is an element of the inverse of mechanical impedance matrix.

[SOURCE: ISO 2041:2009, 1.54, modified]

3.3
driving-point mobility
Y_{jj}
frequency-response function formed by the complex velocity-response at point *j* to the complex excitation force applied at the same point with all other measurement points on the structure allowed to respond freely without any constraint other than those constraints which represent the normal support of the structure in its intended application

[SOURCE: ISO 2041:2009, Note to 1.55, modified]

3.4
transfer mobility
Y_{ij}
frequency-response function formed by the complex velocity-response at point *i* to the complex excitation force applied at point *j* with all points on the structure, other than *j*, allowed to respond freely without any constraint other than those constraints which represent the normal support of the structure in its intended application

[SOURCE: ISO 2041:2009, 1.56, modified]

3.5
frequency range of interest
span between the lowest frequency to the highest frequency at which mobility data are to be obtained in a given test series

[SOURCE: ISO 7626-1:2011, 3.1.5, modified]

4 Overall configuration of the measurement system

Individual components of the system used for mobility measurements carried out in accordance with this part of ISO 7626 shall be selected to suit each particular application.

© ISO 2015 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 7626-2:2015