INTERNATIONAL STANDARD

ISO 20270

First edition
2019-11

Acoustics — Characterization of sources of structure-borne sound and vibration — Indirect measurement of blocked forces

Acoustique — Caractérisation des sources de bruit solidien et de vibrations — Mesurage indirect des forces bloquées

Reference number
ISO 20270:2019(E)

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Published in Switzerland

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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 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).

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

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Introduction

This document has been developed in response to demand from mechanical industries for an agreed method of specifying the "source strength" of sources of structure-borne sound and vibration. Quantities which independently characterize a source are the free velocity and blocked force: ISO 9611[2] specifies a measurement procedure for the former in which the machine, a vibration source, is mounted on soft mounts to approximate free suspension. The blocked forces are the forces the operating machine would exert when constrained by a perfectly rigid foundation. They can potentially be measured directly by inserting force transducers in between the operating machine and a rigid foundation. However, this document describes an indirect method for measurement of blocked forces using an inverse method. Whereas the measurement of free velocity requires the source to be resiliently mounted and direct measurement of blocked forces requires the machine mounts to be blocked, the indirect measurement, as defined in this document, can theoretically be carried out with the source attached to any receiver structure. Essentially the same measurement techniques are used in the diagnosis of structure-borne sound using "transfer path analysis" (TPA), also called "source path contribution" analysis (SPC).

A method of characterizing sources of structure-borne sound and vibration by the indirect measurement of blocked forces at the points of connection to supporting, or receiver, structures is described in this document. The measurement method is applied in situ, which means that the source is connected to a receiver structure while the measurements are performed. In theory, the use of any receiver structure is valid provided the vibration source mechanisms of the specimen remain representative of those in a real installation. Therefore, the receiver structure can be part of a real installation, such as a machine foundation or a building, but can also be a specially designed test stand if it provides representative dynamic loading for the source.

The method specifies a two-stage measurement procedure comprising, first, a passive test in which frequency response functions (FRF) of the assembled source-receiver structure are measured, and secondly, measurement of vibration in an operational test. The blocked forces are obtained by solving the inverse problem. It is well known that inverse solutions of this type can result in very large errors, particularly if there is inconsistency in the input data. Such errors vary significantly depending on the case and the skill of the operator. Therefore, a means of estimating the uncertainties in the blocked force, through a process called on-board validation, forms an essential part of this measurement procedure.

The blocked forces are obtained in narrow frequency bands that can subsequently be converted to approximate octave or third octave frequency bands.

The in situ blocked force method is intended to complement the reception plate method of EN 15657[3]. The reception plate method offers a simplified approach in which forces and velocities are effectively averaged over the feet of an operating machine by mounting on a standard plate. The approximations allow measurements to be simplified but information about distribution and phase of the forces and velocities is lost. This document aims to provide an alternative for structure borne sound sources not compatible with the reception plate approach or where more detail is needed about the distribution of the forces.

The blocked forces obtained from this document can be used for the following purposes:

a) obtaining data for preparing technical specifications for vibrationally active components (sources);

b) obtaining input data for prediction of vibration in, or sound radiated sound from, structures connected to the source;

c) obtaining diagnostic information about the contribution of particular blocked forces to a target vibration or sound pressure (in situ transfer path analysis).

Prediction of sound and vibration in a new assembly [as in b) above] does not form a normative part of this document, although guidelines for prediction are provided in Annex E. For prediction purposes, extra data are needed in addition to the measured blocked forces. Specifically, the frequency response functions (FRFs) of the new assembly (which consists of the source connected to the new receiver

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structure) need to be known. These FRFs can in principle be measured (if the assembly is available for measurement), calculated (for example using numerical methods) or calculated by combining the FRFs of the separate source and the receiver structures (dynamic substructuring) whether measured or calculated.

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Acoustics — Characterization of sources of structure-borne sound and vibration — Indirect measurement of blocked forces

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1 Scope

This document specifies a method where a vibrating component (a source of structure-borne sound or vibration) is attached to a passive structure (or receiver) and is the cause of vibration in, or structure-borne sound radiation from, the assembly. Examples are pumps installed in ships, servo motors in vehicles or machines and plant in buildings. Almost any vibrating component can be considered as a source in this context.

Due to the need to measure vibration at all contact degrees of freedom (DOFs) (connections between the source and receiver), this document can only be applied to assemblies for which such measurement is possible.

This document is applicable only to assemblies whose frequency response functions (FRFs) are linear and time invariant.

The source can be installed into a real assembly or attached to a specially designed test stand (as described in 5.2).

The standard method has been validated for stationary signals such that the results can be presented in the frequency domain. However, the method is not restricted to stationary signals: with appropriate data processing, it is also applicable to time-varying signals such as transients and shocks (provided linearity and time invariance of the FRFs are preserved).

This document provides a method for measurement and presentation of blocked forces, together with guidelines for minimizing uncertainty. It provides a method evaluating the quality of the results through an on-board validation procedure but does not comment on the acceptability or otherwise of the results.

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

ISO7626-2, *Mechanical vibration and shock — Experimental determination of mechanical mobility — Part 2: Measurements using single-point translation excitation with an attached vibration exciter*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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