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AMERICAN NATIONAL STANDARD

Methods for the Experimental Determination of Mechanical Mobility, Part II: Measurements Using Single-Point Translational Excitation

Secretariat:

Acoustical Society of America

Approved 9 February 1982:

American National Standards Institute, Inc.

Abstract

This standard is the second part of a set of five standards covering the experimental determination of mechanical mobility on structures by a variety of methods appropriate for different test situations. Part I of the set (ANSI 2.31-1979) covers basic concepts and definitions as well as instruments used in mobility measurements. The material in Part I is common to most mobility measurement tasks. The present Part II of the set describes measurements in situations where single point

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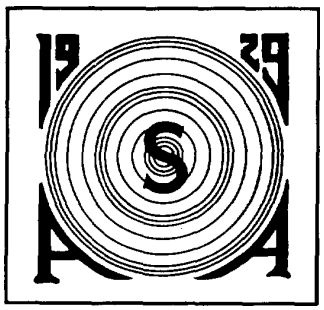

FOREWORD

[This Foreword is not a part of American National Standard Method for the Experimental Determination of Mechanical Mobility. Part II: Measurement Using Single-Point Translational Excitation, S2.32-1982 (ASA Catalog No. 32-1982).]

This standard has been developed under the jurisdiction of American National Standards Committee S2 using the American National Standards Institute (ANSI) Standards Committee Procedure. The Acoustical Society of America holds the Secretariat for Committee S2. This standard has been approved for publication by ANSI and by the Acoustical Society of America Committee on Standards (ASACOS).

This scope of Standards Committee S2 on Mechanical Shock and Vibration under whose jurisdiction this standard was prepared is as follows:

> Standards, specifications, methods of measurement and test, and terminology in the fields of mechanical shock and vibration, but excluding those aspects which pertain to safety, tolerance, and comfort.

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S. Feldman
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Suggestions for improvement of this standard will be welcomed. They should be sent to the Standards Secretariat, Acoustical Society of America, 335 East 45th Street, New York, NY 10017.

CONTENTS

APPENDICES

FIGURES

TABLE

American National Standard Methods for the Experimental Determination of Mechanical Mobility. Part II: Measurements Using Single-Point Translational Excitation

0 INTRODUCTION

0.1 Introduction to the Set of Mobility Measurement Standards

Dynamic characteristics of structures can be determined as a function of frequency from measurements of mobility or of the related frequency response functions called accelerance and dynamic compliance. Each of these frequency response functions are ratios of the motion response of a structure to the exciting force. The magnitude and the phase of these ratios are functions of frequency.

In this set of standards the phrase "mobility measurement" is used in a general sense which includes the determination of mobility, accelerance, and dynamic compliance from the measurements of the exciting force and the motion response of the structure.

Mobility measurements are typically used for:

(1) Predicting the dynamic response of structures to known or assumed input forces

(2) Determining structural resonance modes (natural frequencies, mode shapes, and damping ratios)

(3) Predicting the dynamic interaction of interconnected structures

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

(5) Checking the validity and improving the accuracy of mathematical models of structures.

For some applications, a *complete* description of the dynamic characteristics may 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 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 may be of interest.

In order to simplify the use of standards for the varied mobility measurement tasks encountered in practice, the complete mobility measurement standard will be published as a set of five separate parts:

Part I (ANSI S2.31-1979) covers basic definitions and transducers. The information in Part I is common to most mobility measurement tasks.

Part II (the present document) covers mobility measurements using single-point translational excitation with an attached exciter.

Part III will cover mobility measurements using single-point rotational excitation with an attached exciter. This information is primarily intended for rotor system torsional resonance predictions.

Part IV will cover measurements of the entire mobility matrix using attached exciters. This will include the translational, rotational, and combination terms required for the 6×6 matrix for each location on the structure.

Part V will cover mobility measurements using impact excitation.

NOTE: At the time when Part II was published, Parts III, IV, and V were in preparation.

Mechanical mobility is defined as the frequency response function formed by the ratio of the phasor of the response velocity to the phasor of the applied force. If the response is measured with an accelerometer, conversion to velocity is required to obtain the mobility. Alternatively, the ratio of acceleration to force, called accelerance, may be used to characterize a structure. In still other cases, dynamic compliance, the ratio of displacement to force, may 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. This point is elaborated upon in Appendix B of ANSI S2.31-1979.