



AMERICAN NATIONAL STANDARD

Method for Determining the Acoustic Impedance of Ground Surfaces

Secretariat:

Acoustical Society of America

Approved on October 31, 2018:

American National Standards Institute, Inc.

Abstract

This Standard describes procedures for obtaining the real and imaginary parts of the normalized acoustic impedance ratio of ground surfaces from in-situ measurements of the sound pressure levels at two vertically separated microphones using specified geometries and the averaged values of the difference between the simultaneous, instantaneous sound-pressure signals at the two microphones. It enables the user to either deduce parameters for a ground impedance model by fitting spectral data to templates or obtain values of the normalized specific acoustic impedance ratio of the ground entirely from measurements and independently of any model for the acoustic impedance of the ground surface except as a check on the validity of the resulting values.

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Method for Determining the Acoustic Impedance of Ground Surfaces

ANSI/ASA S1.18-2018

Accredited Standards Committee S1, Acoustics

Standards Secretariat
Acoustical Society of America
1305 Walt Whitman Road, Suite 300
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ANSI/ASA S1.18-2018
(Revision of ANSI S1.18-2010)

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Contents

| | | |
|-----|---|----|
| 1 | Scope | 1 |
| 2 | Normative references | 1 |
| 3 | Terms and definitions | 2 |
| 4 | Measurement method | 2 |
| 4.1 | Recommended geometries | 2 |
| 4.2 | Time convention | 3 |
| 4.3 | Measurement procedure | 4 |
| 4.4 | Ground and environmental conditions | 4 |
| 4.5 | Determination of the normalized specific acoustic impedance ratio | 5 |
| 4.6 | Procedure to determine best fit in Step 1 | 7 |
| 4.7 | Minimization procedure for Step 2 | 8 |
| 5 | Required instruments for measuring ground impedance outdoors | 9 |
| 5.1 | Sound source | 9 |
| 5.2 | Microphones | 9 |
| 5.3 | Calibration | 9 |
| 5.4 | Sound level meter/analyzer | 10 |
| 5.5 | Miscellaneous | 10 |
| 5.6 | Configuration of measuring system | 10 |
| 5.7 | Wind speed | 10 |
| 6 | Measurement | 10 |
| 6.1 | Area of ground | 10 |
| 6.2 | Data collection | 10 |
| 7 | Data reduction | 11 |
| 7.1 | Corrections | 11 |
| 7.2 | Experimental error | 11 |
| 8 | Reporting | 12 |
| 8.1 | Introductory information | 12 |
| 8.2 | Documentation of the instrumentation | 12 |
| 8.3 | Meteorological data | 12 |
| 8.4 | Impedance values | 12 |
| 8.5 | Other observations | 12 |
| 9 | Templates for obtaining normalized surface impedance model parameters | 13 |
| 9.1 | Templates for the one-parameter impedance model | 13 |
| 9.2 | Templates for the two-parameter normalized surface impedance model | 14 |
| | Annex A (informative) Worked examples of procedure | 21 |
| A.1 | Example 1: Cricket field at the Open University, UK | 21 |

| | | |
|--|---|----|
| A.2 | Example 2: Institutional grass at the National Research Council, Canada..... | 26 |
| A.3 | Example 3: University lawn at Oldenburgh in Germany..... | 30 |
| A.4 | Example 4: Granite gravel road on U.S. Army Research Laboratory testing facility..... | 34 |
| Annex B (informative) Example impedance parameters | | 37 |
| B.1 | One-parameter model | 37 |
| B.2 | Two-parameter model | 37 |
| Annex C (informative) Formulae for the complex sound pressure ratio | | 38 |
| Annex D (informative) Mathematical functions | | 40 |
| Annex E (informative) Software for deduction of surface impedance according to ANSI/ASA S1.18-2018 | | 42 |
| Bibliography | | 43 |

Tables

| | |
|---|----|
| Table 1 – Template 1A—Pre-calculated level differences (dB) for Geometry A using the one-parameter model | 13 |
| Table 2 – Template 1B—Pre-calculated level differences (dB) for Geometry B using the one-parameter model | 14 |
| Table 3 – Template 2A—Pre-calculated level differences (dB) for Geometry A using the two-parameter model | 15 |
| Table 4 – Template 2B—Pre-calculated level differences (dB) for Geometry B using the two-parameter model | 18 |
| Table A.1 – Cumulative error, E, for one-parameter templates, computed using Equation (8) in 4.6 | 22 |
| Table A.2 – Cumulative error, E, for the two-parameter templates, computed using Equation (8) in 4.6 | 24 |
| Table A.3 – Cumulative error, E, for the one-parameter templates, computed using Equation (8) in Clause 4.6 | 27 |
| Table A.4 – Cumulative error, E, for the two-parameter templates, computed using Equation (8) in Clause 4.6 | 27 |
| Table A.5 – Cumulative Error, E, for Example 2 | 31 |
| Table B.1 – Parameter values obtained using one-parameter model | 37 |
| Table B.2 – Parameter values obtained using two-parameter model [11]..... | 37 |

Figures

| | |
|---|----|
| Figure 1 – Geometrical definitions: h_s = source height, h_t = top microphone height, h_b = bottom microphone height, d = source/receiver horizontal separation | 3 |
| Figure 2 – Point source and vertically separated microphones at the Open University, UK | 9 |
| Figure 3a – Template curves for Geometry A and eight values of effective flow resistivity, σ_{eff} , between 10 and 3200 kPa s m ⁻² | 13 |
| Figure 3b – Template curves for Geometry B and eight values of effective flow resistivity, σ_{eff} between 10 and 3200 kPa s m ⁻² | 14 |
| Figure 4a – Template curves for Geometry A with $\alpha_e = 3 \text{ m}^{-1}$ and three values of effective flow resistivity, σ_e (10, 100, and 1000 kPa s m ⁻²) | 16 |
| Figure 4b – Template curves for Geometry A with $\alpha_e = 50 \text{ m}^{-1}$ | 16 |
| Figure 4c – Template curves for Geometry A with $\alpha_e = 100 \text{ m}^{-1}$ and three values of effective flow resistivity, σ_e (10, 100, and 1000 kPa s m ⁻²) | 17 |
| Figure 4d – Template curves for Geometry A with $\alpha_e = 250 \text{ m}^{-1}$ and three values of effective flow resistivity, σ_e (10, 100, and 1000 kPa s m ⁻²) | 17 |
| Figure 5a – Template curves for Geometry B with $\alpha_e = 3 \text{ m}^{-1}$ and three values of effective flow resistivity, σ_e (10, 100, and 1000 kPa s m ⁻²) | 19 |
| Figure 5b – Template curves for Geometry B with $\alpha_e = 50 \text{ m}^{-1}$ | 19 |
| Figure 5c – Template curves for Geometry B with $\alpha_e = 100 \text{ m}^{-1}$ and three values of effective flow resistivity, σ_e (10, 100, and 1000 kPa s m ⁻²) | 20 |
| Figure 5d – Template curves for Geometry B with $\alpha_e = 250 \text{ m}^{-1}$ and three values of effective flow resistivity, σ_e (10, 100, and 1000 kPa s m ⁻²) | 20 |
| Figure A.1 – Template plots for 1 parameter impedance model | 21 |
| Figure A.2 – Comparisons of measured LD spectra with two-parameter model templates | 22 |
| Figure A.3 – Normalized specific acoustic impedance ratio deduced from six sets of averaged complex sound pressure ratios. Those deduced from Geometry B are plotted as broken lines. The mean values are plotted as dotted lines. | 24 |
| Figure A.4 – A comparison of normalized specific acoustic impedance ratio spectra deduced from Steps 1 and 2 (broken line) | 25 |
| Figure A.5 – Template method (Step 1) using data obtained with a single microphone | 25 |
| Figure A.6 – Template for Geometry A and the one-parameter model with superimposed NRC data | 26 |
| Figure A.7 – Template for Geometry B and the one-parameter model with superimposed NRC data | 26 |

| | |
|---|----|
| Figure A.8(a) – Templates for Geometry A and the two-parameter model with superimposed NRC data | 27 |
| Figure A.8(b) – Template for Geometry A and the two-parameter model with superimposed NRC data | 28 |
| Figure A.9(a) – Template for Geometry B and the two-parameter model with superimposed NRC data | 28 |
| Figure A.9(b) – Template for Geometry B and the two-parameter model with superimposed NRC data | 28 |
| Figure A.10 – Normalized specific acoustic impedance ratio deduced from the measured complex sound pressure ratios using Geometry A..... | 29 |
| Figure A.11 – Normalized surface impedance spectra deduced from Step 1 (one-parameter model = solid line; two-parameter model = dashed line and dotted line) and Step 2 (thicker continuous line) | 29 |
| Figure A.12 – Normalized surface impedance spectra deduced from Step 1 (one-parameter model = solid line; two-parameter model = dashed line and dotted line) and Step 2 (thicker continuous line) | 30 |
| Figure A.13 – Data and one-parameter model templates for Geometries A and B..... | 30 |
| Figure A.14 – Data and two-parameter model templates for Geometries A and B | 31 |
| Figure A.15 – Deduced normalized surface impedance ratio spectra using all ten measurements..... | 32 |
| Figure A.16 – Smoothed normalized specific acoustic impedance ratio deduced using Geometry B | 32 |
| Figure A.17 – Normalized specific acoustic impedance ratio spectra deduced from both Geometries A and B and best-fit impedance model predictions | 33 |
| Figure A.18 – ARL data superimposed on one-parameter templates (a) Geometry A and (b) Geometry B | 34 |
| Figure A.19 (a) to (h) – ARL Gravel road data superimposed on two-parameter templates..... | 35 |

Foreword

[This Foreword is for information only and is not a part of the American National Standard ANSI/ASA S1.18-2018 American National Standard Method for Determining the Acoustic Impedance of Ground Surfaces. As such, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard.]

This Standard comprises a part of a group of definitions, standards, and specifications for use in acoustics. It was developed and approved by Accredited Standards Committee S1 - Acoustics under its approved operating procedures. Those procedures have been accredited by the American National Standards Institute (ANSI). The Scope of Accredited Standards Committee S1 is as follows:

Standards, specifications, methods of measurement and test, and terminology in the field of physical acoustics, including architectural acoustics, electroacoustics, sonics and ultrasonics, and underwater sound, but excluding those aspects which pertain to biological safety, tolerances, and comfort.

This Standard is a revision of ANSI/ASA S1.18-2010, which has been modified and corrected. A template method is augmented by a procedure to utilize measurements of the magnitude and relative phase of the averaged ratio of the difference between instantaneous sound-pressure signals at two specific locations relative to the location of a sound source and thereby deduce the real and imaginary parts of the complex normalized specific acoustic impedance ratio.

This Standard is not comparable to any existing ISO Standard.

This Standard includes five Annexes, all of which are informative and are not considered part of this Standard.

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Working Group S1/WG 20, Measurement of Ground Impedance and Attenuation of Sound due to the Ground, which assisted Accredited Standards Committee S1, Acoustics, in the development of this Standard, had the following membership.

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Suggestions for improvements to this Standard will be welcomed. They should be sent to Accredited Standards Committee S1 - Acoustics in care of the Standards Secretariat of the Acoustical Society of America, 1305 Walt Whitman Road, Suite 300, Melville, New York 11747. Telephone: 631-390-0215; FAX: 631-923-2875; E-mail: asastds@acousticalsociety.org.

Introduction

Experimental techniques to measure impedance include the use of an impedance tube, techniques that measure the sound pressure levels above a surface, and direct measurements of sound pressure and volume velocity.

This Standard does not consider the direct measurement of sound pressure and volume velocity.

The impedance tube is in common use to measure the acoustic impedance of porous materials. It has the advantage of a straightforward theoretical framework that allows direct determination of both the real and imaginary parts of the impedance. However, its application in the field to obtain ground impedance suffers from two major disadvantages. First, it requires an accurate measurement of the distance from the first interference minimum to an ill-defined test surface, and, secondly, it is invasive. This Standard does not recommend the use of an impedance tube for the measurement of the acoustic impedance of a ground surface.

Techniques that use measurements of sound pressure levels above a surface include several variations based on the type of excitation, angle of incidence, number of microphones, and fitting methods. All enjoy the advantage that the measurement is performed on the ground in its natural condition. However, because of the spherical wavefront, the theoretical framework is mathematically intricate. Annexes C and D detail the expressions and special functions used in the calculations in Clause 4.

American National Standard

Method for Determining the Acoustic Impedance of Ground Surfaces

1 Scope

Outdoor sound close to the ground is influenced by the acoustical properties of the ground. This Standard describes recommended procedures to characterize, and the instruments to measure quantities that may be used to deduce, the acoustical properties of ground surfaces. Although this Standard is intended primarily for outdoor measurements, indoor measurement of undisturbed portions of a ground surface, such as sod, is within its scope also.

The Standard yields the real and imaginary parts of the normalized specific acoustic impedance ratio of ground surfaces in the frequency range between 250 and 4000 Hz for outdoor sound propagation predictions. The Standard uses measurements of the interference between direct and ground-reflected sound to deduce both normalized specific acoustic impedance ratio and impedance model parameters. The impedance-ratio model parameters of effective flow resistivity and a porosity factor, determined from best fits to the templates of calculated level differences, may be used to estimate the normalized specific acoustic impedance ratio at frequencies outside the specified range.

The basic purpose of this Standard is to establish uniform procedures for obtaining the real and imaginary parts of the normalized specific acoustic impedance ratio of ground surfaces outdoors.

The method is applicable to all nominally flat, commonly occurring surfaces including grassland or snow-covered ground.

The method is not applicable to rough grounds where the variation in height is greater than half of the shortest wavelength of interest. For the specified upper frequency of 4 kHz this limits the variation in height to about 5 cm. See also Clause 4.4.

2 Normative references

The following referenced documents are indispensable for the application of this Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI/ASA S1.1, American National Standard Acoustical Terminology

ANSI/ASA S1.4/Part 1/IEC 61672-1, American National Standard Electroacoustics – Sound level meters – Part 1: Specifications (a nationally adopted international standard)

ANSI/ASA S1.11/Part 1/IEC 61260-1, American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters (a nationally adopted international standard)

ANSI/ASA S1.40, American National Standard Specifications and Verification Procedures for Sound Calibrators,

IEC 61094-4 Ed.1.0 1995 Measurement microphones - Part 4: Specifications for working standard microphones