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American National Standard

Template Method for Ground Impedance

Secretariat
Acoustical Society of America

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American National Standards Institute, Inc.

Abstract

This American National Standard describes procedures for obtaining the real and imaginary parts of the specific acoustic impedance of natural ground surfaces outdoors. The Standard uses templates to compare measured sound pressure level differences with a specific set of calculated level differences. The impedance values are obtained from a model based on best fit of measured and calculated level differences. The Standard may also be used to obtain the impedance of porous sound absorbing material.

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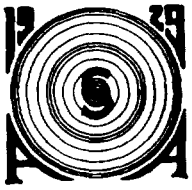

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Foreword

[This Foreword is for information only and is not a part of *American National Standard Template Method for Ground Impedance*, ANSI S1.18-1999.]

This Standard was developed under the jurisdiction of Accredited Standards Committee S1, Acoustics, using the American National Standards Institute (ANSI) Accredited Standards Committee Procedure. The Acoustical Society of America provides the Secretariat for Accredited Standards Committee S1, Acoustics.

Accredited Standards Committee S1, Acoustics, under whose jurisdiction this Standard was developed, had the following scope:

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

At the time this Standard was submitted to Accredited Standards Committee S1, Acoustics, for approval, the membership was as follows:

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Working Group S1/WG20, Ground Impedance, which assisted Accredited Standards Committee S1, Acoustics, in the development of this Standard, had the following membership:

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Suggestions for improvements of this Standard will be welcomed. Send suggestions for improvement to Accredited Standards Committee S1, Acoustics, in care of the ASA Standards Secretariat, 120 Wall Street, 32nd Floor, New York, NY 10005-3993, USA.

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American National Standard

Template Method for Ground Impedance

0 Introduction

This Standard is concerned with obtaining ground impedance from simple *in situ* measurements. It is possible to perform the measurements with simple instrumentation such as a hand-held sound level meter. The Standard adopts the use of templates to compare sound pressure level differences measured above ground surfaces with calculated level differences. The real and imaginary parts of the ground impedance are obtained by best fit.

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

The impedance tube is in common use to measure the 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, second, it is invasive. This Standard does not recommend the use of an impedance tube for the measurement of ground impedance.

Free-field techniques include a multitude of variations based on the type of excitation, angle of incidence, number of microphones, and parameter evaluation. All enjoy the advantage that the measurement is performed on the ground in its natural condition. However, due to the spherical wavefronts, the theoretical framework is mathematically intricate, making the direct extraction of both the real and imaginary parts of the impedance difficult. Research on this point is ongoing. The use of an impedance model overcomes some of the difficulties. This Standard uses three well-established ground impedance models to calculate a set of templates for free field level differences. The use of a user-defined model is not precluded. The real and imaginary parts of the impedance are obtained by best fit to measured level differences.

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

1 Scope

This Standard describes recommended procedures to characterize, and the instrumentation to measure, the acoustic properties of a variety of ground surfaces. Although this Standard is intended primarily for outdoor measurements, indoor measurement of intact portions of a ground surface, such as sod, is also allowed.

The use of the Standard to characterize the properties of porous materials in general from a free field measurement is allowed.

The Standard yields values of the real and imaginary parts of the specific acoustic impedance of ground surfaces in the frequency range between 250 and 4000 Hz for outdoor sound propagation predictions. The Standard uses the variation of the ground attenuation with ground properties to obtain the impedance. Outside the frequency range of interest, the method is not expected to yield accurate results.

2 Purpose

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

3 Application

This Standard may be used to obtain the impedance of commonly occurring ground surfaces. The Standard offers a choice between a simple one-parameter model and a more precise two-parameter model to calculate templates suitable for routine environmental purposes. In cases where more precision is required, guidance is given to use a four-parameter model and its simplification to calculate alternative templates.

The template method is not applicable to complex ground structures such as multiple-layered material. The template method is expected to yield less accuracy with snow-covered ground.