

PD ISO/TS 14837-32:2015



BSI Standards Publication

Mechanical vibration — Ground-borne noise and vibration arising from rail systems

Part 32: Measurement of dynamic
properties of the ground

bsi.

...making excellence a habit.™

National foreword

This Published Document is the UK implementation of ISO/TS 14837-32:2015.

The UK participation in its preparation was entrusted by Technical Committee GME/21, Mechanical vibration, shock and condition monitoring, to Subcommittee 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 2016.
Published by BSI Standards Limited 2016

ISBN 978 0 580 83932 0
ICS 17.160; 45.080

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

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 January 2016.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

TECHNICAL
SPECIFICATION

ISO/TS
14837-32

First edition
2015-12-15

Mechanical vibration — Ground-borne noise and vibration arising from rail systems —

**Part 32:
Measurement of dynamic properties of the ground**

Vibrations mécanique — Vibrations et bruits initiés au sol dus à des lignes ferroviaires —

Partie 32: Mesurage des propriétés dynamiques du sol



Reference number
ISO/TS 14837-32:2015(E)

© ISO 2015



COPYRIGHT PROTECTED DOCUMENT

© ISO 2015. Published in Switzerland

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
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Symbols	1
4 Transmission of ground-borne noise and vibration	3
4.1 General.....	3
4.2 Ground-borne noise versus vibration — Effect of frequency.....	4
5 Parameters for wave propagation in the ground	4
5.1 General.....	4
5.2 Fundamental wave propagation parameters.....	4
5.3 Material loss and non-linearity.....	9
5.4 Geometry effects, stratification and lateral variability of the ground.....	13
5.5 Nearfield effects.....	15
5.6 Anisotropy.....	15
5.7 Ground water effects — Ground materials as a two-phase medium.....	16
6 Methods for parameter estimation and measurement	16
6.1 Stratification and classification of the ground: Boring logs and seismic investigations.....	16
6.2 Soils versus rock.....	17
6.3 Empirical estimation methods based on index parameters.....	17
6.3.1 General.....	17
6.3.2 Effective (bulk) mass density.....	18
6.3.3 Wave speeds and elastic shear modulus.....	18
6.3.4 Non-linearity and material loss factor.....	21
6.4 Indirect determination from geotechnical in-situ penetration tests.....	25
6.4.1 General.....	25
6.4.2 Cone penetration test.....	26
6.4.3 Standard penetration test.....	26
6.5 Direct in-situ measurement of dynamic ground parameters.....	27
6.5.1 General.....	27
6.5.2 Surface wave measurements.....	30
6.5.3 Down-hole (and up-hole) measurements — Seismic CPT (S-CPT).....	33
6.5.4 Cross-hole measurements.....	36
6.5.5 Other measurements — Refraction and multi-channel p- and s-wave reflection, resistivity.....	39
6.5.6 Other in-situ methods.....	40
6.6 Laboratory measurement of dynamic ground parameters.....	40
6.6.1 General.....	40
6.6.2 Piezo measurements.....	41
6.6.3 Resonant column testing.....	43
6.6.4 Cyclic triaxial, DSS and torsional shear testing.....	44
7 Strategy for ground parameter determination	44
7.1 General.....	44
7.2 Expected severity of ground-borne vibration and noise.....	44
7.3 Parameter estimation from available information.....	44
7.4 Summary of in-situ measurements versus laboratory measurements.....	45
7.5 Direct measurement of vibration and noise propagation as an alternative to measuring dynamic properties and use of calculation models.....	45
Annex A (informative) Abbreviations used in this part of ISO 14837	47
Bibliography	48

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*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

ISO 14837 consists of the following parts, under the general title *Mechanical vibration — Ground-borne noise and vibration arising from rail systems*:

- *Part 1: General guidance*
- *Part 32: Measurement of dynamic properties of the ground*

The following parts are under preparation:

- *Part 31: Measurement for the evaluation of complaints at residential buildings*

Introduction

In order to resolve received vibration and noise from rail systems where there is soil or rock in part of the transmission path between the source at the track and the receiver location in the building, it is necessary to know the noise and vibration transmission function of the ground. To know this necessitates knowledge of the properties of the materials in the ground and their stratification which influence the transmission. In general there is a need to measure or in other ways to estimate these properties. To this aim, this part of ISO 14837 defines methods for measurement and estimation of the relevant dynamic ground parameters.

After a brief survey about ground-borne noise and vibration in [Clause 4](#), the key content of this part of ISO 14837 is outlined in two clauses. [Clause 5](#) defines the relevant dynamic ground parameters, describes how they are interrelated and how they are related to basic physics of wave propagation. [Clause 6](#) deals with methods to determine these parameters: [6.3](#) presents simple estimation methods based on empirical correlations with conventional geotechnical and engineering geological index parameters; [6.4](#) presents methods for indirect determination from geotechnical in-situ penetration test data, while [6.5](#) and [6.6](#) present more precise methods for direct measurement of the parameters in-situ and in the laboratory.

Mechanical vibration — Ground-borne noise and vibration arising from rail systems —

Part 32: Measurement of dynamic properties of the ground

1 Scope

This part of ISO 14837 provides guidance and defines methods for the measurement of dynamic properties of the ground through which ground-borne noise and vibration is transmitted, from the operation of rail systems and into foundations of neighbouring buildings. The purpose is to determine the parameters of the ground system which are necessary to reliably predict the noise and vibration transmission, to design railroads and foundations to meet noise and vibration requirements, to design countermeasures and to validate design methods.

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 14837-1:2005, *Mechanical vibration — Ground-borne noise and vibration arising from rail systems — Part 1: General guidance*

3 Symbols

The following symbols are used in this part of ISO 14837.

NOTE	Abbreviations are summarized in Annex A .
B	dimensionless constant in equation for G_{\max}
D	loss-related distance attenuation factor
d	distance travelled by wave
E_{\max}	Young's modulus, low-strain dynamic value
e	void ratio, $e = \varphi / (1 - \varphi)$
f	frequency
G	complex shear modulus
G_{\max}	shear modulus, low-strain dynamic value
G_{sec}	secant shear modulus, dynamic value
I_p	plasticity index
K_{\max}	bulk modulus, low-strain dynamic value
k^*	complex wave number