Notes on Numerical Fluid Mechanics
and Multidisciplinary Design 126

Jens C.O. Nielsen · David Anderson
Pierre-Etienne Gautier · Masanobu Iida
James T. Nelson · David Thompson
Thorsten Tielkes · David A. Towers
Paul de Vos *Editors*

Noise and Vibration Mitigation for Rail Transportation Systems

Proceedings of the 11th International Workshop on Railway Noise, Uddevalla, Sweden, 9–13 September 2013

BOMBARDIER
the evolution of mobility

Springer

Jens C.O. Nielsen · David Anderson
Pierre-Etienne Gautier · Masanobu Iida
James T. Nelson · David Thompson
Thorsten Tielkes · David A. Towers
Paul de Vos
Editors

Noise and Vibration Mitigation for Rail Transportation Systems

Proceedings of the 11th International Workshop on Railway Noise, Uddevalla, Sweden, 9–13 September 2013

Springer

Editors
Jens C.O. Nielsen
Department of Applied Mechanics/CHARMEC
Chalmers University of Technology
Göteborg, Sweden

David Anderson
Acoustic Studio Pty Ltd.
Stanmore New South Wales
Australia

Pierre-Etienne Gautier
SYSTRA
Paris, France

Masanobu Iida
Railway Technical Research Institute
Environmental Engineering Division
Tokyo, Japan

James T. Nelson
Wilson, Ihrig and Associates
Emeryville, USA

David Thompson
University of Southampton Inst. Sound and Vibration
Southampton
United Kingdom

Thorsten Tielkes
Deutsche Bahn AG
Munich
Germany

David A. Towers
Harris Miller Miller and Hanson Inc.
Burlington
USA

Paul de Vos
DHV BV, Amersfoort
The Netherlands

ISSN 1612-2909
ISBN 978-3-662-44831-1
DOI 10.1007/978-3-662-44832-8

ISSN 1860-0824 (electronic)
ISBN 978-3-662-44832-8 (eBook)

Library of Congress Control Number: 2014949173

Springer Heidelberg New York Dordrecht London
© Springer-Verlag Berlin Heidelberg 2015
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

[Springer-Verlag GmbH Berlin Heidelberg] is part of Springer Science+Business Media (www.springer.com)

Preface

This volume contains the peer reviewed contributions to the 11th International Workshop on Railway Noise (IWRN11), which took place in Uddevalla, Sweden, on September 9–13, 2013. The workshop was organised by the Competence Centre in Railway Mechanics (CHARMEC) and the Departments of Applied Mechanics and Applied Acoustics at Chalmers University of Technology in Gothenburg, Sweden. It was supported by Bombardier Transportation, voestalpine Schienen, Lucchini and Chalmers / CHARMEC.

The workshop was attended by 160 delegates from 19 countries around the world: Sweden (33 delegates), Germany (18), United Kingdom (17), France (12), The Netherlands (11), China (8), Australia (7), Austria (7), Belgium (7), Czech Republic (7), Denmark (7), Switzerland (6), Japan (5), United States (4), Norway (3), South Korea (3), Spain (3), Finland (1) and Hong Kong (1).

Railway traffic is, in comparison with other modes of transportation, safe and environmentally friendly and is generally described as the most sustainable mode for regional and international transports. According to the White Paper on Transport, issued by the European Commission in 2011, one of the key goals by 2050 is a 50 % shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport. This will contribute to a 60 % reduction in carbon emissions by the middle of the century. To promote the shift from road to rail, the environmental impact induced by the railway in terms of noise and vibration needs to be further reduced.

Since the first IWRN in 1976, held in Derby (UK) with some 35 delegates, the workshop series has been established as a regular event that every three years brings together the leading researchers and engineers in all fields related to railway noise and vibration. The workshops have to a great extent contributed to the understanding and solution of many problems in railway noise and vibration, building a scientific foundation for reducing the environmental impact by air-borne, ground-borne and structure-borne noise and vibration.

Following the tradition from previous workshops, the scientific programme of IWRN11 was held as a single-session event (no parallel sessions) over three and a half days. The programme contained 55 oral presentations and 36 poster presentations, the latter including a three-minute oral presentation to introduce each poster. The present

volume contains the peer reviewed papers from 84 of these presentations, including 2 state-of-the papers on ground-borne vibration due to railway traffic and on railway noise generated by high-speed trains. IWRN11 covered 9 different topics of railway noise and vibration: 1. Prospects, legal regulation and perception, 2. Wheel and rail noise, 3. Prediction, measurements and monitoring, 4. Ground-borne vibration, 5. Squeal noise and structure-borne noise, 6. Aerodynamic noise generated by high-speed trains, 7. Resilient track forms, 8. Grinding, corrugation and roughness, and 9. Interior noise and sound barriers.

There is no formal organisation behind the IWRN but rather an informal, committed International Committee. It supports the chairman during the preparation process with the experience and expertise of its members. Assistance is given to formulate the scientific programme by reviewing the submitted abstracts, to act as session chairmen, and to act as peer review group and editors of the IWRN proceedings published in this volume.

The International Committee is grateful to Anders Frid, Wolfgang Kropp, Roger Lundén, Astrid Pieringer and Peter Torstensson of the local committee for their great commitment and care in organising the workshop. Special thanks to Pernilla Appelgren Johansson, Christian Johansson and Sara Nielsen for their work related to the administration, communication and graphic design of material for the Workshop, and to the staff of Bohusgården Hotel & Conference Centre.

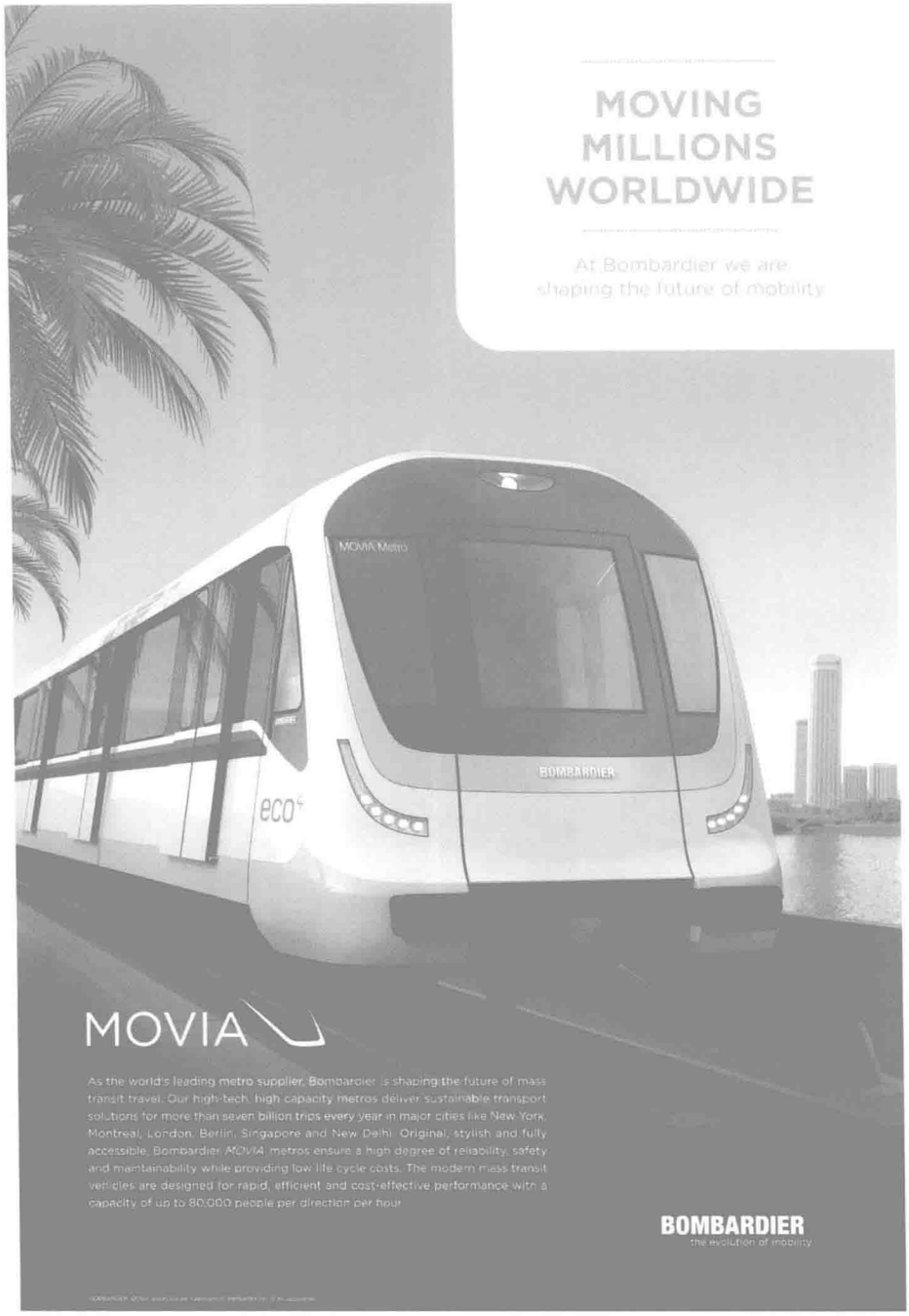
The editors of this volume are grateful to Professor Wolfgang Schröder as the general editor of the "Notes on Numerical Fluid Mechanics and Multidisciplinary Design" and also to the staff of the Springer Verlag (in particular Dr Leontina Di Cecco) for the opportunity to publish the proceedings of the IWRN11 workshop in this series. Note that previous workshop proceedings have also been published in this series (IWRN9 in volume 99 and IWRN10 in volume 118).

We hope that this volume will be used as a "state-of-the-art" reference by scientists and engineers involved in solving noise and vibration problems related to railway traffic.

June 2014

Jens C.O. Nielsen
David Anderson
Pierre-Etienne Gautier
Masanobu Iida
James T. Nelson
David Thompson
Thorsten Tielkes
David A. Towers
Paul de Vos

此为试读,需要完整PDF请访问: www.ertongbook.com



MOVING MILLIONS WORLDWIDE

At Bombardier we are shaping the future of mobility

MOVIA

As the world's leading metro supplier, Bombardier is shaping the future of mass transit travel. Our high-tech, high capacity metros deliver sustainable transport solutions for more than seven billion trips every year in major cities like New York, Montreal, London, Berlin, Singapore and New Delhi. Original, stylish and fully accessible, Bombardier *MOVIA* metros ensure a high degree of reliability, safety and maintainability while providing low life cycle costs. The modern mass transit vehicles are designed for rapid, efficient and cost-effective performance with a capacity of up to 80,000 people per direction per hour.

BOMBARDIER
the evolution of mobility

Contents

Poster Session 1: Prospects, Legal Regulation, Perception/Wheel and Rail Noise/Prediction, Measurements, Monitoring

Session 5: Ground-Borne Vibration – Part 1

Session 6: Ground-Borne Vibration – Part 2

Poster Session 2: Interior Noise, Sound Barrier/Grinding, Corrugation, Roughness/Resilient Track Forms

此为试读,需要完整PDF请访问: www.ertongbook.com

Session 8: High-Speed Trains, Aerodynamic Noise – Part 1

Session 9: High-Speed Trains, Aerodynamic Noise – Part 2

Session 9: Ground-Borne Vibration – Part 3

Poster Session 3: Ground-Borne Vibration/High-Speed Trains, Aerodynamic Noise/Squeal Noise, Structure-Borne Noise

Session 10: Resilient Track Forms

Session 11: Grinding, Corrugation, Roughness

Session 11: Interior Noise, Sound Barrier – Part 1

Session 12: Interior Noise, Sound Barrier – Part 2

Railway Noise Control in Europe: Current Status

J. Oertli

Swiss Federal Railways, Infrastructure
Mittelstrasse 43, 3000 Bern, Switzerland
jakob.oertli@sbb.ch

Summary. Railways are a sustainable means of transport. Nonetheless, railways do have an influence on the environment. The most important effect is noise, especially the noise emitted from freight trains.

European Union policy supports noise reduction and has addressed the issue in interoperability directives and corresponding technical specifications. The Environmental Noise Directive (END) requires member states to submit noise maps and action plans. The EU is mostly responsible for noise creation aspects, while member states may additionally enact specific legislation for noise reception. Numerous studies have considered the economics of railway noise control, comparing the costs and benefits of different noise control possibilities. Based on these studies, the railways have adopted the following noise control strategy: 1) Reduce the noise of all new freight vehicles by introducing TSI limit values. 2) Promote the retrofitting of existing freight vehicles with composite brake blocks. 3) Build noise barriers and install insulated windows. 4) Pursue further solutions in special cases.

Noise differentiated track access charges (NDTAC) have been proposed as the main incentive for retrofitting the rolling stock by the EU and several European countries such as Switzerland.

Although the railways have made considerable progress in railway noise reduction, several problematic trends may be observed: 1) There is a tendency towards protecting capital instead of people, for example by introducing compensation for home owners based on property values. 2) Whole system optimizations are rare and infrastructure measures may counteract noise reduction efforts. 3) There are exaggerated expectations from certain new technologies. 4) Often the overall picture is not considered, such as the trade off between noise control and the modal split between road and rail. 5) Simplifications may lead to wrong conclusions, for example the noise reduction potential of a given measure often depends on local conditions and generalizations are not possible.

1 Introduction

Railways are a sustainable and climate friendly means of transport. Nonetheless, railways have an influence on the environment, the main effect being noise, especially

© Springer-Verlag Berlin Heidelberg 2015

J.C.O. Nielsen et al. (eds.), *Noise and Vibration Mitigation for Rail Transportation Systems*, Notes on Numerical Fluid Mechanics and Multidisciplinary Design 126, DOI: 10.1007/978-3-662-44832-8_1

the noise emitted from freight trains. This paper summarizes the main railway noise activities in Europe in terms of policy, economics, technical possibilities as well as the strategy of the railways to deal with noise issues. It concludes with some problematic trends.

The author is chairman of the UIC (International Union of Railways) Network Noise and Vibration. This article is based on the information gained through the work and contacts of this network.

2 European Policy and Incentives

European sustainability policies include promoting the railways. A recent activity in this field is the Greening Transport Package (COM/2007/0551). To enable this, railway noise concerns must be addressed. European noise legislation includes the Environmental Noise Directive (END, 2002/49/EC) which requires noise maps and actions plans, the recast of the first railway package (Directive 2012/34/EU), adopted in November 2012, which foresees an optional introduction of noise-differentiated track access charges, and the Technical Specifications for Interoperability (TSI) which define noise creation values for certain types of rolling stock. The TSI set maximum levels of noise produced by new (conventional) railway vehicles. In addition reducing the existing noise limits for new wagons and locomotives is on the agenda and a revised TSI Noise is planned for the end of 2013 or the beginning of 2014.

European research framework programs include numerous railway noise projects. A financing for silent freight rolling stock may be possible through the Connecting Europe Facility (COM/2011/665/3) with a substantial budget earmarked for transport projects. It allows the EU to co-fund retrofitting of existing freight wagons with silent brake blocks with a maximum of 20 % of the eligible costs. As of this writing (May 2013), the proposal was in discussion between the Parliament and the Council.

In a recent (April 2013) road map [1], the EU Commission describes different options for promoting the retrofitting of freight wagons with silent composite brake blocks. These include a baseline scenario where no action is planned, increased financial support for retrofitting, NDTAC, mandatory application of TSI Noise limits to existing railway wagons (which would lead to a de facto ban of cast iron brake blocks), introduction of noise limits along the Trans European railway network. An assessment of the impact of these scenarios is planned until the mid 2014.

3 National Legislation and Incentives

National legislation differs throughout Europe. Many countries have reception limits for new and significantly altered lines, however only Switzerland, Italy and Norway have limits for existing lines. Usually limit values apply to the façade of buildings but in some cases (e.g. Norway) they apply to indoor areas. In The Netherlands, Germany and Switzerland noise differentiated track access charges are in effect. Germany, France and Austria spend considerable amounts on existing lines, even though noise

abatement is not stipulated by the legislation. Finally, there is a Swiss plan to ban cast iron brake blocks by 2020.

Most European countries have national incentives and policies promoting the implementation of retrofitting the rolling stock with silent brake blocks. The most prominent examples are Switzerland, where all Swiss rolling stock is in the process of being retrofitted with composite brake blocks. This programme is financed by the government, which in turn receives the funds mostly from the road sector. Switzerland has also introduced noise differentiated track access charges (see chapter 6). The Netherlands are also very active in promoting retrofitting. Some of the activities include the launching of numerous studies and pilot projects to test composite brake blocks and the introduction of noise differentiated track access charging. Also, in Germany, noise differentiated track access charges have come into effect. Additionally Germany has strongly supported the development of LL-brake blocks (see chapter 5). A summary of national initiatives and legislation is given in the 2010 UIC state of the art report on railway noise [2].

4 Economics of Railway Noise Control

Numerous studies (e.g. the STAIRRS project [3]) have considered the economics of railway noise control, comparing the costs and benefits of different noise control possibilities and combinations thereof. In general, noise barriers, especially high ones have a poor cost-benefit ratio, while retrofitting the freight fleet has a beneficial cost-benefit ratio. To date network wide cost benefit studies for other measures (e.g. rail dampers, rail grinding) however are lacking.

5 Noise Control Strategy of the Railways

The railways have adopted the following noise control strategy: 1) Reduce the noise of all new freight vehicles by introducing and adopting TSI limit values. 2) Promote the retrofitting of existing freight vehicles with composite brake blocks. 3) Build noise barriers and install insulated windows. 4) Pursue further solutions in special cases. Such further solutions include rail dampers, acoustic rail grinding, solutions for trains parked in depots and stations, solutions against curve squeal, measures on steel bridges, and to improve the noise situation in railway freight yards. The current situation in terms of retrofitting and noise barriers is as follows:

Retrofitting: Railway rolling noise is caused by rough wheels on rough rails, significant noise reduction can be achieved by replacing cast-iron brake blocks with composite brake blocks. Two types of composite brake blocks are available: 1) The K-blocks are homologated however require adapting the wheel set due to the different braking characteristics. This makes retrofitting a fairly expensive option. 2) The LL brake block has similar braking characteristics to the cast iron brake block. This makes retrofitting less expensive than with K-blocks. The EuropeTrain project tested the LL brake block on 200'000 km throughout Europe. Homologation of this brake block was approved

此为试读,需要完整PDF请访问: www.ertongbook.com