

Earthworks in Europe

The Geological Society of London
Books Editorial Committee

Chief Editor

RICK LAW (USA)

Society Books Editors

JOHN GREGORY (UK)

JIM GRIFFITHS (UK)

JOHN HOWE (UK)

HOWARD JOHNSON (UK)

PHIL LEAT (UK)

NICK ROBINS (UK)

RANDELL STEPHENSON (UK)

Society Books Advisors

ERIC BUFFETAUT (FRANCE)

JONATHAN CRAIG (ITALY)

TOM MCCANN (GERMANY)

MARIO PARISE (ITALY)

SATISH-KUMAR (JAPAN)

GONZALO VEIGA (ARGENTINA)

MAARTEN DE WIT (SOUTH AFRICA)

Geological Society books refereeing procedures

The Society makes every effort to ensure that the scientific and production quality of its books matches that of its journals. Since 1997, all book proposals have been refereed by specialist reviewers as well as by the Society's Books Editorial Committee. If the referees identify weaknesses in the proposal, these must be addressed before the proposal is accepted.

Once the book is accepted, the Society Book Editors ensure that the volume editors follow strict guidelines on refereeing and quality control. We insist that individual papers can only be accepted after satisfactory review by two independent referees. The questions on the review forms are similar to those for *Journal of the Geological Society*. The referees' forms and comments must be available to the Society's Book Editors on request.

Although many of the books result from meetings, the editors are expected to commission papers that were not presented at the meeting to ensure that the book provides a balanced coverage of the subject. Being accepted for presentation at the meeting does not guarantee inclusion in the book.

More information about submitting a proposal and producing a book for the Society can be found on its web site: www.geolsoc.org.uk.

It is recommended that reference to all or part of this book should be made in one of the following ways:

RADFORD, T. A. (ed.) 2012. *Earthworks in Europe*. Geological Society, London, Engineering Geology Special Publications, **26**.

HODGSON, I. F., BEALES, S. P & CURD, M. J. 2012. Use of tyre bales as lightweight fill for the A421 improvements scheme near Bedford, UK. In: RADFORD, T. A. (ed.) *Earthworks in Europe*. Geological Society, London, Engineering Geology Special Publications, **26**, 101–108. <http://dx.doi.org/10.1144/EGSP26.12>

GEOLOGICAL SOCIETY ENGINEERING GEOLOGY SPECIAL PUBLICATION NO. 26

Earthworks in Europe

EDITED BY

T. A. RADFORD
Atkins Ltd, Epsom, UK

2012
Published by
The Geological Society
London

THE GEOLOGICAL SOCIETY

The Geological Society of London (GSL) was founded in 1807. It is the oldest national geological society in the world and the largest in Europe. It was incorporated under Royal Charter in 1825 and is Registered Charity 210161.

The Society is the UK national learned and professional society for geology with a worldwide Fellowship (FGS) of over 10 000. The Society has the power to confer Chartered status on suitably qualified Fellows, and about 2000 of the Fellowship carry the title (CGeol). Chartered Geologists may also obtain the equivalent European title, European Geologist (EurGeol). One fifth of the Society's fellowship resides outside the UK. To find out more about the Society, log on to www.geolsoc.org.uk.

The Geological Society Publishing House (Bath, UK) produces the Society's international journals and books, and acts as European distributor for selected publications of the American Association of Petroleum Geologists (AAPG), the Indonesian Petroleum Association (IPA), the Geological Society of America (GSA), the Society for Sedimentary Geology (SEPM) and the Geologists' Association (GA). Joint marketing agreements ensure that GSL Fellows may purchase these societies' publications at a discount. The Society's online bookshop (accessible from www.geolsoc.org.uk) offers secure book purchasing with your credit or debit card.

To find out about joining the Society and benefiting from substantial discounts on publications of GSL and other societies worldwide, consult www.geolsoc.org.uk, or contact the Fellowship Department at: The Geological Society, Burlington House, Piccadilly, London W1J 0BG: Tel. + 44 (0)20 7434 9944; Fax + 44 (0)20 7439 8975; E-mail: enquiries@geolsoc.org.uk.

For information about the Society's meetings, consult *Events* on www.geolsoc.org.uk. To find out more about the Society's Corporate Affiliates Scheme, write to enquiries@geolsoc.org.uk.

Published by The Geological Society from:

The Geological Society Publishing House, Unit 7, Brassmill Enterprise Centre, Brassmill Lane, Bath BA1 3JN, UK

The Lyell Collection: www.lyellcollection.org

Online bookshop: www.geolsoc.org.uk/bookshop

Orders: Tel. + 44 (0)1225 445046, Fax + 44 (0)1225 442836

The publishers make no representation, express or implied, with regard to the accuracy of the information contained in this book and cannot accept any legal responsibility for any errors or omissions that may be made.

© The Geological Society of London 2012. No reproduction, copy or transmission of all or part of this publication may be made without the prior written permission of the publisher. In the UK, users may clear copying permissions and make payment to The Copyright Licensing Agency Ltd, Saffron House, 6–10 Kirby Street, London EC1N 8TS UK, and in the USA to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, USA. Other countries may have a local reproduction rights agency for such payments. Full information on the Society's permissions policy can be found at: www.geolsoc.org.uk/permissions.

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library.

ISBN 978-1-86239-352-3

ISSN 0267-9914

Distributors

For details of international agents and distributors see:

www.geolsoc.org.uk/agentsdistributors

Typeset by Techset Composition Ltd, Salisbury, UK

Printed by Cambrian Printers Ltd, Aberystwyth, UK

Preface

The design and construction of earthworks has a significant impact on a project both in terms of cost as well as environmental consequences, including setting and achievement of sustainability targets. This volume focuses on recent developments in: the suitability of materials, including the reuse of arising, for engineering or landscape purposes; soil improvement techniques; geotechnical risk and performance, including the design response to natural and man-made hazards; measurement and mitigation of any adverse environmental impact; and asset management in the face of climate change.

The introduction of European Standards and the national annexes has brought about a review of the design codes used for earthworks and highlighted the variations in practice between countries. The specifications for the execution of earthworks vary considerably from one country to another; in particular because they were primarily derived from US specifications established in the 1950s, or are based on national experience, which is often difficult to export. However the enhancement and enlargement of the European Union has increased the need to consider professional activities beyond national boundaries.

The 2nd International Seminar on Earthworks in Europe (2009) followed on from the inaugural event held in France in 2005. The first seminar was organized primarily to promote discussions across the European countries. Consequently it was a natural progression to ensure that the 2nd seminar built upon these discussions to facilitate the promotion of technical progress and to aid understanding of recent developments/issues in the design and construction of earthworks in member states of the European Union (including new and candidate countries). It is hoped that the 2nd seminar and future events will promote the professions of engineering geology and geotechnical engineering in the design of earthworks for transport infrastructure. Hopefully it will also encourage dialogue between earthworks professionals throughout Europe and enhance pan-European linkages and collaboration, facilitate discourse on national practices and the establishment of European standards and encourage an increase in coordinated earthworks research in Europe.

The editor wishes to thank all those involved in the organization of the 2nd International Seminar on Earthworks in Europe. This includes all members of the organizational and technical committees for giving their time; the thanks are also extended to the employers of those professionals who without their backing and commitment to the profession such events would not be possible.

Particular thanks are due to the Sessions Chairs; Alex Kidd (PIARC), Ursula Lawrence (seminar Publicity), Peter Gilbert (BGA), Ivan Hodgson (EGGS) and Anna Morley (seminar Secretary) who aided the smooth running of the seminar, as well as to the treasurer, Ian Duncan. To the presenters who, without them there would not have been a seminar. The authors are thanked for showing patience during the editorial process. Recognition is due to Georgina Worrall and her staff in the Geological Society Conference Office for their assistance running the event. The editor would also like to thank Angharad Hills at the Geological Society Publishing House and Jim Griffiths for their help in getting this Special Publication into print.

TRACEY RADFORD

Chair, 2nd International Seminar on Earthworks in Europe