

Computational Science, Engineering and Technology Series: 28

**Civil and Structural
Engineering Computational Technology**

Saxe-Coburg Publications on Computational Engineering

Trends in Parallel, Distributed and Grid Computing for Engineering

Edited by: P. Iványi and B.H.V. Topping

Developments and Applications in Engineering Computational Technology

Edited by: B.H.V. Topping, J.M. Adam, F.J. Pallarés, R. Bru and M.L. Romero

Developments and Applications in Computational Structures Technology

Edited by: B.H.V. Topping, J.M. Adam, F.J. Pallarés, R. Bru and M.L. Romero

Substructuring Techniques and Domain Decomposition Methods

Edited by: F. Magoulès

Soft Computing in Civil and Structural Engineering

Edited by: B.H.V. Topping and Y. Tsompanakis

Trends in Civil and Structural Engineering Computing

Edited by: B.H.V. Topping, L.F. Costa Neves and R.C. Barros

Parallel, Distributed and Grid Computing for Engineering

Edited by: B.H.V. Topping and P. Iványi

Trends in Computational Structures Technology

Edited by: B.H.V. Topping and M. Papadrakakis

Trends in Engineering Computational Technology

Edited by: M. Papadrakakis and B.H.V. Topping

Computational Methods for Acoustics Problems

Edited by: F. Magoulès

Mesh Partitioning Techniques and Domain Decomposition Methods

Edited by: F. Magoulès

Object Oriented Methods and Finite Element Analysis

R.I. Mackie

Programming Distributed Finite Element Analysis

R.I. Mackie

Computer Aided Design of Cable-Membrane Structures

B.H.V. Topping and P. Iványi

Domain Decomposition Methods for Distributed Computing

J. Kruis

Civil and Structural Engineering Computational Technology

Edited by

B.H.V. Topping and Y. Tsompanakis



© Saxe-Coburg Publications, Stirlingshire, Scotland

published 2011 by
Saxe-Coburg Publications
Dun Eaglais
Station Brae, Kippen
Stirlingshire, FK8 3DY, UK

Saxe-Coburg Publications is an imprint of Civil-Comp Ltd

Computational Science, Engineering and Technology Series: 28
ISSN 1759-3158
ISBN 978-1-874672-55-5

British Library Cataloguing in Publication Data

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

Cover image: Design created, with permission, using Yuri Vishnevsky's "Silk".
<http://weavesilk.com>

Printed in Great Britain by Bell & Bain Ltd, Glasgow

Contents

Preface	iii
1 Role and Perspective of Computational Structural Analysis for Sustainable Reconstruction and Seismic Risk Mitigation after an Earthquake V. Gattulli	1
2 Concrete as the Multiphase Material in Biological Shields against Nuclear Radiation C.E. Majorana, B. Pomaro, V.A. Salomoni, F. Gramegna and G. Prete	35
3 Development of Realistic Three-Dimensional Track Models for Railway Vehicle Dynamic Analyses J. Pombo and J. Ambrósio	65
4 Dynamic Analysis of Beam Structures under Moving Loads: A Review of the Modal Expansion Method Z. Dimitrovová	99
5 Virtual Experiments and a Statistically Equivalent Representative Volume Element for Macroscopic Constitutive Laws M. Šejnoha, J. Vorel, R. Valenta and J. Zeman	131
6 Applications of Graph Products and Canonical Forms in Structural Mechanics: A Review A. Kaveh and H. Rahami	157
7 Numerical and Experimental Assessment of Stainless and Carbon Bolted Tensioned Members P.C.G. da S. Vellasco, L.R.O. de Lima, J. de J. dos Santos, A.T. da Silva, S.A.L. de Andrade and J.G.S. da Silva	187
8 Numerical Evaluation of the Ultimate Bearing Capacity of Steel Structures C.J. Gantes	219
9 Recent Developments in the Analysis of Stiffened Plates E.J. Sapountzakis	243

10	Numerical Modelling and Analysis of Composite Structures subject to Extreme Loading R.Y. Xiao, Z.W. Gong, C.S. Chin and C.G. Bailey	279
	Author Index	301
	Keyword Index	303

Preface

This volume comprises the Invited Lectures presented at “The Thirteenth International Conference on Civil, Structural and Environmental Engineering Computing” (CC 2011) held in Chania, Crete, Greece from 6-9 September 2011. The CC conference series began in London in 1983. The CC 2011 conference was held concurrently with “The Second International Conference on Soft Computing Technology in Civil, Structural and Environmental Engineering” (CSC 2011). We are grateful to the authors and co-authors of the Invited Lectures included in this volume. Their contribution both to these conferences and to this book is greatly appreciated.

Other papers presented at this conference are published as follows:

- *The Invited Review Lectures from CC 2011 and CSC 2011 are published in:* Computational Technology Reviews, Volume 4, Saxe-Coburg Publications, Stirlingshire, Scotland, 2011.
- *The Invited Lectures from CSC 2011 are published in:* Soft Computing Methods for Civil and Structural Engineering, Y. Tsompanakis and B.H.V. Topping, (Editors), Saxe-Coburg Publications, Stirlingshire, Scotland, 2011.
- *The Contributed Papers from CC 2011 are published in:* Proceedings of the Thirteenth International Conference on Civil, Structural and Environmental Engineering Computing, B.H.V. Topping and Y. Tsompanakis, (Editors), (Book of Summaries with a CD-ROM of full-text papers), Civil-Comp Press, Stirlingshire, Scotland, 2011.
- *The Contributed Papers from CSC 2011 are published in:* Proceedings of the Second International Conference on Soft Computing Technology in Civil, Structural and Environmental Engineering, Y. Tsompanakis and B.H.V. Topping, (Editors), (Book of Summaries with a CD-ROM of full-text papers), Civil-Comp Press, Stirlingshire, Scotland, 2011.

We would like to thank the members of the CC 2011 Conference Editorial Board for their help before and during the conference: Dr J.M. Adam, Spain; Prof. H. Adeli, USA; Prof. Dr S.M.L. Adriaenssens, Belgium; Dr N.A. Alexander, UK; Prof. A.H. Al-Gadhib, Saudi Arabia; Dr S.A. Alghamdi, Saudi Arabia; Prof. H.M. Al-Humaidi, Kuwait; Dr N.S. Al-Kaabi, United Arab Emirates; Mr J.M. Alonso, Spain; Prof. D. Ambrosini, Argentina; Assoc Prof. R. Amor, New Zealand; Dr L. Andersen, Denmark; Prof. C.J. Anumba, USA; Dr Y. Arayici, England; Prof. A.J. Aref, USA; Dr

A.F. Ashour, UK; Dr I.M. Asi, Jordan; Dr C.E. Augarde, UK; Prof. Y. Ayvaz, Turkey; Prof. J.R. Banerjee, UK; Prof. C.C. Baniotopoulos, Greece; Prof. A. Baratta, Italy; Dr M.A. Barkhordari, Iran; Dr B. Basu, Ireland; Prof. J.W. Baugh, USA; Dr R.G. Beale, UK; Prof. I. Becchi, Italy; Prof. A.A. Becker, UK; Prof. J. Bencat, Slovakia; Prof. A. Benjeddou, France; PD Dr V. Berkhahn, Germany; Dr A. Bjelanovic, Croatia; Prof. J. Blachut, UK; Prof. F. Bontempi, Italy; Dr D. Borza, France; Prof. M.A. Bradford, Australia; Prof. F.A. Branco, Portugal; Dr J. Bridgeman, UK; Dr J. Brozovsky, Czech Republic; Prof. J.W. Bull, UK; Prof. F. Buyle-Bodin, France; Dr P. Cacciola, UK; Prof. R. Cajka, Czech Republic; Prof. D. Camotim, Portugal; Prof. F. Casciati, Italy; Dr L.M.Santos Castro, Portugal; Dr S. Chandra, India; Dr A.P. Chassiakos, Greece; Dr H.-P. Cheng, USA; Prof. Y.K. Chow, Singapore; Prof. I. Colominas, Spain; Prof. A. Combescure, France; Assoc. Prof. L. Contrafatto, Italy; Prof. J.G.S. da Silva, Brazil; Prof. L. Damkilde, Denmark; Assoc. Prof. J. de Brito, Portugal; Prof. G. De Matteis, Italy; Prof. G. De Roeck, Belgium; Prof. P.R.B. Devloo, Brazil; Prof. J. Dias, Germany; Prof. Z. Dimitrovová, Portugal; Prof. L.M.J.S. Dinis, Portugal; Dr M. Dolenc, Slovenia; Dr M. Domaneschi, Italy; Prof. L. Dunai, Hungary; Dr A. Dusi, Italy; Prof. A. Ebrahimpour, USA; Dr D.J. Edwards, UK; Dr-Ing. A. Elenas, Greece; Prof. A. Elhami, France; Prof. J. Ermopoulos, Greece; Dr D. Eyheramendy, France; Dr I. Faraj, UK; Prof. F. Farinha, Portugal; Prof. I. Flood, USA; Prof. L. Fryba, Czech Republic; Prof. M.B. Fuchs, Israel; Dr E. Gal, Israel; Prof. Ch. Gantes, Greece; Dr P. Gardner, UK; Prof. V. Gattulli, Italy; Prof. R.I. Gilbert, Australia; Prof. F. Gonzalez Vidosa, Spain; Prof. D.E. Grierson, Canada; Prof. N. Grujovic, Serbia; Dr Z.W. Guan, UK; Prof. M.N.S. Hadi, Australia; Prof. F. Hadipriono, USA; Dr M. Hartnett, Ireland; Assoc. Prof. O. Hededal, Denmark; Dr M. Hirokane, Japan; Prof. G. Hofstetter, Austria; Prof. C.A. Issa, Lebanon; Dr P. Ivanyi, Hungary; Prof. B.A. Izzuddin, UK; Prof. P. Jayachandran, USA; Dr L. Jendele, Czech Republic; Prof. D.S. Jeng, UK; Dr T. Ji, UK; Prof. X. Jia, USA; Dr X. Jiang, USA; Dr O. Jirousek, Czech Republic; Dr E.S. Kameshki, Kingdom of Bahrain; Prof. M. Kaminski, Poland; Prof. A. Kaveh, Iran; Prof. T. Kerh, Taiwan; Dr A.I. Khan, Australia; Prof. J.T. Kim, Korea; Prof. N. Kirac, Turkey; Prof. S. Kmet, Slovakia; Dr P. Komodromos, Cyprus; Prof. J. Kosmol, Poland; Dr T. Koudelka, Czech Republic; Prof. V.K. Koumoussis, Greece; Dr D. Kovacevic, Serbia; Dr K. Krabbenhoft, Australia; Dr T. Krejci, Czech Republic; Dr J. Kruis, Czech Republic; Prof. J.S. Kuang, Hong Kong; Prof. H.G. Kwak, Korea; Dr J.E. Laier, Brazil; Prof. R. Landolfo, Italy; Prof. F. Lebon, France; Dr C.K. Lee, Singapore; Prof. P. Leger, Canada; Dr V.M A. Leitão, Portugal; Dr C.J. Leo, Australia; Prof. A.Y.T. Leung, Hong Kong; Prof. R. Levy, Israel; Prof. L. Lima, Brazil; Prof. S.Y.Liong, Singapore; Prof. J. Logo, Hungary; Prof. P.B. Lourenco, Portugal; Prof. P.E.D. Love, Australia; Dr J. Wei-Zhen Lu, Hong Kong; Dr R.I. Mackie, UK; Prof. C.E. Majorana, Italy; Prof. M. Malafaya-Baptista, Portugal; Prof. Dr K. Marti, Germany; Dr M.D. Martinez-Rodrigo, Spain; Prof. I. May, UK; Prof. F.M. Mazzolani, Italy; Prof. T.J. McCarthy, Australia; Dr G. Milani, Italy; Prof. S.A. Mirza, Canada; Assoc. Prof. E.S. Mistakidis, Greece; Prof. A. Miyamoto, Japan; Prof. R. Montenegro Armas, Spain; Prof. G. Montero, Spain; Prof. C.A. Mota Soares, Portugal; Dr I. Mura, Italy; Prof. G. Muscolino, Italy; Prof. T. Nakai, Japan; Dr J. Naprstek, Czech

Republic; Prof. L.F. Costa Neves, Portugal; Dr S.T. Ng, Hong Kong; Dr J. Novak, Czech Republic; Prof. E. O'Brien, Ireland; Prof. H.R. Ovesy, Iran; Dr F.J. Pallares, Spain; Dr A. Palmeri, UK; Assist. Prof. P.G. Papadopoulos, Greece; Prof. M. Papadarakakis, Greece; Dr B. Patzak, Czech Republic; Prof. O. A. Pekau, Canada; Dr C. Pellegrino, Italy; Dr M. Phiri, UK; Dr Y.-L. Pi, Australia; Dr B. Picoux, France; Dr J. Pombo, Portugal; Ms V. Pomezanski, Hungary; Prof. C.P. Providakis, Greece; Dr P.N. Psarropoulos, Greece; Dr M.Y. Rafiq, UK; Prof. A.A. Ramezani pour, Iran; Prof. M. Raoof, UK; Dr Y. Ribakov, Israel; Dr A. Riccio, Italy; Prof. N. Rizzi, Italy; Dr C. Romanel, Brazil; Prof. M.L. Romero, Spain; Dr M. Rouainia, UK; Dr D. Rypl, Czech Republic; Prof. R.L. Sack, USA; Assoc. Prof. F. Saje, Slovenia; Prof. M.P. Saka, Turkey; Dr M. Salehi, Iran; Prof. L.M. Santos Castro, Portugal; Assoc. Prof. E.J. Sapountzakis, Greece; Prof. T. Schanz, Germany; Prof. K. Schilling, Germany; Prof. G.I. Schuëller, Austria; Dr W. Sebastian, UK; Dr M. Sejnoha, Czech Republic; Dr A.G. Sextos, Greece; Prof. K.-J. Shou, Taiwan; Dr R.C. Silva, Brazil; Prof. L. Simoni, Italy; Prof. S. Singh, USA; Prof. M.J. Skibniewski, USA; Prof. R.M. Skitmore, Australia; Prof. J. Sladek, Slovakia; Prof. I.F.C. Smith, Switzerland; Prof. J.E. Souza de Cursi, France; Dr R. Spallino, Denmark; Dr M.C. Suarez Arriaga, Mexico; Prof. I. Takahashi, Japan; Dr T.T. Tanyimboh, UK; Prof. P.F. Teixeira, Portugal; Prof. R.A. Tenenbaum, Brazil; Prof. A. Tesar, Slovakia; Prof. D. Thambiratnam, Australia; Dr D. Theodossopoulos, UK; Prof. G. Thierauf, Germany; Prof. H.R. Thomas, UK; Dr W. Tizani, UK; Prof. B.H.V. Topping, UK; Prof. V.V. Toropov, UK; Prof. C.P. Tsai, Taiwan; Prof. T.-K. Tsay, Taiwan; Prof. G. Turk, Slovenia; Prof. Z. Turk, Slovenia; Dr H.S. Turkmen, Turkey; Prof. J. Turmo, Spain; Dr G.J. Turvey, UK; Prof. Y. Uematsu, Japan; Dr C. Vale, Portugal; Dr L.S. Vamvakeridou-Lyroudia, UK; Prof. M.M.B.R. Vellasco, Brazil; Prof. P.C.G. da S. Vellasco, Brazil; Prof. Dr-Ing. T. Victor, Germany; Prof. W. Wagner, Germany; Prof. C.M. Wang, Singapore; Dr A.S. Watson, UK; Dr M.C. Weng, Taiwan; Prof. T.P. Williams, USA; Prof. R.Y. Xiao, UK; Prof. Y.-B. Yang, Taiwan; Dr J.Q. Ye, UK; Dr J. Zeman, Czech Republic; Prof. C. Zeris, Greece; Prof. Q.L. Zhang, China; Prof. A. Zingoni, South Africa; and Prof. P.P. Zouein, Lebanon.

Finally, we are grateful to Jelle Muylle (Saxe-Coburg Publications) for his help in coordinating the publication of this book and for all his administrative and organisational skills in organising these conferences. We also wish to thank Dawn Sewell (Civil-Comp Press) for her administrative support.



**HERIOT
WATT**
UNIVERSITY

Professor B.H.V. Topping
University of Pécs, Hungary
& Heriot-Watt University, Edinburgh, UK



**TECHNICAL
UNIVERSITY
OF CRETE**

Professor Y. Tsompanakis
Technical University of Crete
Chania, Greece

