Soft Computing Methods
for
Civil and Structural Engineering

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

Soft Computing Methods
for
Civil and Structural Engineering

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

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

Contents

ii

Preface

This volume comprises the Invited Lectures presented at "The Second International Conference on Soft Computing Technology in Civil, Structural and Environmental Engineering" (CSC 2011) held in Chania, Crete, Greece from 6-9 September 2011. The CSC conference series began in Madeira, Portugal in 2009. The CSC 2011 conference was held concurrently with "The Thirteenth International Conference on Civil, Structural and Environmental Engineering Computing" (CC 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 these conferences 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 CC 2011 are published in:*
  Civil and Structural Engineering Computational Technology, B.H.V. Topping and Y. Tsompanakis, (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 CSC 2011 Conference Editorial Board for their help before and during the conference: Prof. W.D. Annicchiarico, Venezuela; Prof. T. Arciszewski, USA; Dr A. Bahreininejad, Malaysia; Dr J. Bai, Wales; Prof.

TECHNICAL UNIVERSITY OF CRETE

Professor Y. Tsompanakis
Technical University of Crete
Chania, Greece

UNIVERSITY OF PÉCS   **HERIOT WATT UNIVERSITY**

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

iv