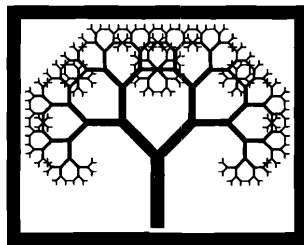


**ADVANCES
IN
BOUNDARY ELEMENT
METHODS**

**ADVANCES
IN
BOUNDARY ELEMENT
METHODS**

*Edited by
B.H.V. Topping*



CIVIL-COMP PRESS

CIVIL-COMP PRESS
10 Saxe-Coburg Place
Edinburgh, EH3 5BR, UK

CIVIL-COMP PRESS is an imprint of Civil-Comp Limited

© 1996, *Civil-Comp Limited*

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN 0-948749-46-6

Printed in the Scottish Borders
by
MEIGLE PRINTERS LIMITED
Galashiels, Scotland

❖CONTENTS❖

1. ANALYSIS USING BOUNDARY METHODS

- 1.1 BEM FORMULATION FOR (3D) ELASTIC INCOMPRESSIBLE SOLIDS, S.V. Tsinopoulos*, D. Polyzos* and D.E. Beskos#, *Department of Mechanical Engineering and #Department of Civil Engineering, University of Patras, Patras, Greece..... 1
- 1.2 AN EFFICIENT TECHNIQUE FOR BOUNDARY ELEMENTS WITH SUBREGIONS, J.A.F. Santiago, V.A. Valentim and J.C.F. Telles, COPPE/Federal University of Rio de Janeiro, Rio de Janeiro, Brazil..... 9
- 1.3 APPROXIMATION OF BOUNDARY DENSITIES IN REGULARIZED BEM FORMULATIONS, V. Sladek and J. Sladek, Institute of Construction and Architecture, Slovak Academy of Sciences, Bratislava, Slovakia..... 17
- 1.4 ON NON-LINEAR TRANSFORMATIONS FOR THE INTEGRATION OF THE SINGULAR KERNELS IN THE BOUNDARY ELEMENT METHOD, M. Doblare and L. Gracia, Mechanical Engineering Department, University of Zaragoza, Zaragoza, Spain29
- 1.5 BOUNDARY ELEMENT ANALYSIS OF WAVE SCATTERING IN TRANSVERSELY ISOTROPIC SOLIDS, A. Saez and J. Dominguez, School of Engineering, University of Seville, Seville, Spain43
- 1.6 ANALYSIS OF THE ELASTIC-PLASTIC PROBLEM INVOLVING FINITE PLASTIC STRAIN USING THE BOUNDARY ELEMENT METHOD, A. Lorenzana, J. Pereda and J.A. Garrido, Department of Strength of Materials and Structures, University of Valladolid, Valladolid, Spain53

2. ANALYSIS OF PLATES AND SHELLS

- 2.1 A BOUNDARY ELEMENT ANALYSIS OF NON-SMOOTH PLATE PROBLEMS, M. Aristodemo and D. Archina, Department of the Art, Science and Technology of Construction, University of Reggio Calabria, Reggio Calabria, Italy.....65

3. SOIL-STRUCTURE INTERACTION PROBLEMS

- 3.1 3-D DYNAMIC FOUNDATION-SOIL-FOUNDATION INTERACTION ON A LAYERED SOIL MEDIUM, D.L. Karabalis* and M. Mohammadi#, *Department of Civil Engineering, University of Patras, Patras, Greece, #The LPA Group, Norcross, United States of America 73
- 3.2 A BOUNDARY ELEMENT FORMULATION FOR THE COMPUTER DESIGN OF SUBSTATION GROUNDING, I. Colominas, F. Navarrina and M. Casteleiro, Department of Applied Mathematics, University of La Coruna, La Coruna, Spain..... 81

4. CONTACT PROBLEMS

- 4.1 EFFECT OF INTERELEMENTAL CORNERS WHEN MODELING SMOOTH CONTACT SURFACES, J.C. del Cano* and F. Paris#, *Department of Strength of Materials and Structures, University of Valladolid, Valladolid, Spain, #Department of Continuum Mechanics, University of Seville, Seville, Spain89

5. DYNAMIC PROBLEMS

- 5.1 FORCED VIBRATIONS OF 3-D SOLIDS BY THE DUAL RECIPROCITY BEM, J. Agnantiaris*, D. Polyzos* and D.E. Beskos#, *Department of Mechanical Engineering and #Department of Civil Engineering, University of Patras, Patras, Greece99
- 5.2 COMPUTATION OF T-STRESSES IN ELASTODYNAMICS BY THE BOUNDARY ELEMENT METHOD, J. Sladek and V. Sladek, Institute of Construction and Architecture, Slovak Academy of Sciences, Bratislava, Slovakia..... 105

5.3 SIMULATION OF THE DUFFING OSCILLATOR WITH TIME-VARYING MASS BY A BEM IN TIME, H.J. Holl, A.K. Belyaev and H. Irschik, Division of Technical Mechanics, Johannes Kepler University of Linz, Linz, Austria.....	113
5.4 A SOLUTION TECHNIQUE FOR CATHODIC PROTECTION WITH DYNAMIC BOUNDARY CONDITIONS BY THE BOUNDARY ELEMENT METHOD, J.A.F. Santiago and J.C.F. Telles, COPPE/Federal University of Rio de Janeiro, Rio de Janeiro, Brazil	121
5.6 TRANSIENT ELASTODYNAMIC ANALYSIS BY THE BOUNDARY ELEMENT METHOD WITH TIME DEPENDENT FUNDAMENTAL SOLUTIONS, J.A.M. Carrer and W.J. Mansur, COPPE/Federal University of Rio de Janeiro, Rio de Janeiro, Brazil	129
5.7 DYNAMIC SOIL-STRUCTURE INTERACTION IN BRIDGE ABUTMENTS, A. Martinez*, J. Mateo# and E. Alarcon*, *Department of Structural Mechanics and Industrial Constructions, Technical University of Madrid, Madrid, Spain, #Universidad Pontificia Comillas, Madrid, Spain	135
6. BOUNDARY ELEMENT METHODS IN DESIGN	
6.1 A SIMPLIFIED BEM ANALYSIS OF PILE GROUPS, J.Batista de Paiva and R.R. Trondi, Structures Department, Sao Carlos Civil Engineering School, Brazil.....	145

❖ PREFACE ❖

This volume contains a selection of papers presented at *The Third International Conference in Computational Structures Technology*, held in Budapest from 21st August-23rd August 1996. The papers in this volume include the following topics: Boundary Element Methods; Soil-Structure Interaction Problems; Contact Problems; Dynamic Problems; and Boundary Element Methods in Design. Other papers from the conference are published in:

- Advances in Computational Structures Technology
Civil-Comp Press, 1996, ISBN 0-948749-40-7
- Advances in Finite Element Technology
Civil-Comp Press, 1996, ISBN 0-948749-41-5
- Advances in Optimization for Structural Engineering
Civil-Comp Press, 1996, ISBN 0-948749-42-3
- Advances in Analysis and Design of Composites
Civil-Comp Press, 1996, ISBN 0-948749-43-1
- Advances in Computational Methods for Simulation
Civil-Comp Press, 1996, ISBN 0-948749-44-X
- Advances in Computational Techniques for Structural Engineering
Civil-Comp Press, 1996, ISBN 0-948749-45-8

I am grateful to: Professor D. Beskos (University of Patras, Greece); Professor E. Alarcon (TU Madrid, Spain); Professor M. Doblare (University of Zaragoza, Spain); Professor D.L. Karabalis (University of Patras, Greece), and Professor J. Dominguez (University of Seville, Spain) for their help in the preparation of this volume. I should like to thank all the authors for their contributions and in particular those who presented their papers in Budapest. I must also thank the members of the Conference Editorial Board who helped in many ways before and during the conference. The members of the Editorial Board for Computational Structures Technology Conference 1996, were: Professor H. Adeli, USA, Professor N. Akkas, Turkey, Professor E. Alarcon, Spain, Professor J. Argyris, Germany, Professor O. Axelsson, The Netherlands, Professor K.J. Bathe, USA, Dr L. Berke, USA, Professor H.J.C. Barbosa, Brazil, Professor J.W. Baugh, USA, Professor T. Belytschko, USA, Professor P.G. Bergan, Norway, Professor D. Beskos, Greece, Professor P. Bettles, UK, Professor N. Bicanic, UK, Professor R.I. Borja, USA, Professor F. Brezzi, Italy, Dr John W. Bull, UK, Professor C. Cingini, Italy, Dr. A.H.C. Chan, UK, Professor I. St Doltsinis, Germany, Professor I.S. Duff, UK and France, Dr L. Dunai, Hungary, Professor A. Eriksson, Sweden, Professor D. Frangopol, USA, Professor J.A. Teixeira de Freitas, Portugal, Professor F. Frey, Switzerland, Professor R. Fruchter, USA, Professor M.B. Fuchs, Israel, Professor G. Gambolati, Italy, Professor M. Geradin, Belgium, Professor D.E. Grierson, Canada, Professor D. Hartmann, Germany, Professor P. Hajela, USA, Professor E. Hinton, UK, Professor M.A. Hogge, Belgium, Professor T.J.R. Hughes, USA, Professor M. Ivanyi, Hungary, Professor W.M. Jenkins, UK, Dr P.K. Jimack, UK, Professor S. Kaliszky, Hungary, Professor D.I. Karabalis, USA, Professor A. Kaveh, Iran, T. Kenny, UK, Dr A.I. Khan, Australia, Professor N. Kikuchi, USA, Professor U. Kirsch, Israel, Professor Dr M. Kleiber, Poland, Professor V.K. Koumousis, Greece, Professor W.B. Kratzig, Germany, Professor P. Ladeveze, France, Professor K.L. Lawrence, USA, Dr. S.H. Lee, USA, Professor P. Leger, Canada, Professor A.Y.T. Leung, Hong Kong, Dr. R. Levy, Israel, Professor A. Liolios, Greece, Professor W.K. Liu, USA, J. Mackerle, Sweden, Professor G. Maier, Italy, Professor J. Mandel, USA, Professor H.A. Mang, Austria, Professor I.M. May, UK, Dr J.J. McKeown, UK, Professor J.L. Meek, Australia, Dr H.P. Mlejnek, Germany, Professor G. Molnarka, Hungary, Professor C.A. Mota Soares, Portugal, Dr D.T. Nguyen, USA, Professor A. K. Noor, USA, Professor R. Ohayon, France, Professor E. Onate, Spain, Dr K. Orsborn, Sweden, Professor D.R.J. Owen, UK, Professor M. Papadrakakis, Greece, Professor P.Y. Papalambros, USA, Professor K.C. Park, USA, Professor D. Parsons, USA, Dr. M.N. Pavlovic, UK, Professor M.S. Pereira, Portugal, Dr V.K. Peshkam, UK, Professor E. Ramm, Germany, Professor F. Rammerstorfer, Austria, Professor G. De Roeck, Belgium, Professor A. Samartin, Spain, Professor B. Schrefler, Italy, Professor K. Sweitzerhof, Germany, Dr. G.M. Seed, UK, Professor N. Schirraishi, Japan, Dr. H.D. Simon, USA, Professor G.S. Springer, USA, Dr. I. Sobieski, USA, Professor K.S. Surana, USA, Professor C.A. Syrmakizis, Greece, Professor B.A. Szabo, USA, Professor R. Szilard, USA, Professor G Thierauf, Germany, Dr G. Turvey, UK, Professor Y. Ueda, Japan, Dr G. Vanderplaats, USA, Dr V.B. Venkayya, USA, Professor K.S. Virdi, UK, Professor Z. Waszczyszyn, Poland, Professor N.P. Weatherill, UK, Professor N-E Wiberg, Sweden, Professor J.P. Wolf, Switzerland, Professor W. Wunderlich, Germany, Professor Yong Bin Yang, Taiwan, and Dr. Th. Zimmermann, Switzerland.

The idea of holding the Third International Conference on Computational Structures Technology in Budapest came from János Sziveri, Heriot-Watt University, Edinburgh. I should like to thank him for his help, advice and support over the two year period before this conference. My thanks are also due to all at Civil-Comp Press for their help and perserverance in the realisation of this conference, particularly Szandra Köves and Maisie Sales. The assistance of members of the Structural Engineering Computational Technology Research Group at Heriot-Watt University,

Edinburgh is gratefully acknowledged particularly from Péter Iványi, Biao Cheng, Ardeshir Bahreininejad, Joao P.B. Leite and Janet Wilson.

Barry Topping
Department of Mechanical and Chemical Engineering
Heriot-Watt University, Edinburgh
August 1996