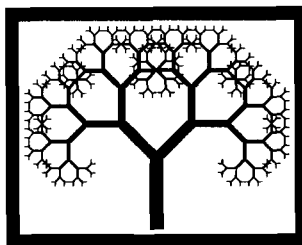


**COMPUTATIONAL
STEEL STRUCTURES
TECHNOLOGY**

COMPUTATIONAL STEEL STRUCTURES TECHNOLOGY

Edited by
M. Iványi, J.P. Muzeau and 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

© 2000, *Civil-Comp Limited*

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

ISBN 0-948749-72-5

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

❖CONTENTS❖

1.	COMPUTER AIDED DESIGN OF STEEL STRUCTURES	
1.1	CONSTEEL AS THE PROTOTYPE OF A CAD/CAM ORIENTED PROGRAM FOR CONCURRENT DESIGN OF BEAM-COLUMN STRUCTURES, F. Papp and M. Ivanyi, Department of Steel Structures, Technical University, Budapest, Hungary	1
1.2	OBJECT-ORIENTED DEFINITION OF COMPRESSED BATTENED MEMBER FOR AN AUTOMATIC CAD PROCEDURE, J. Szalai and F. Papp, Department of Steel Structures, Technical University, Budapest, Hungary.....	13
1.3	A COMPUTER PROGRAMME FOR THE ANALYSIS AND DESIGN OF STEEL STRUCTURES, A.V. Avdelas and P. Stavridis, Department of Civil Engineering, Institute of Steel Structures, Aristotle University of Thessaloniki, Thessaloniki, Greece.....	19
2.	ANALYSIS OF STEEL STRUCTURES	
2.1	FINITE ELEMENT ANALYSIS OF LOCAL STRAINS IN PLATE GIRDERS, I. Okura†, K. Nézó‡, L. Dunai‡ and M. Iványi‡, †Department of Civil Engineering, Osaka University, Osaka, Japan, ‡Department of Steel Structures, Technical University, Budapest, Hungary	27
2.2	NONLINEAR FINITE ELEMENT ANALYSIS OF PLATE GIRDERS WITH STIFFENER-END-GAPS, J. Nézó, L. Dunai and M. Iványi, Department of Steel Structures, Technical University, Budapest, Hungary.....	35
2.3	LANCZOS EIGENVALUE ANALYSIS APPLIED TO BUCKLING OF STEEL PILLARS, Y. Nagata and M. Kawahara, Department of Civil Engineering, Chuo University, Tokyo, Japan	43
2.4	UNIFORM AND PATCH LOADED STEEL PLATES: COMPARISONS BETWEEN ANALYSIS AND EXPERIMENT, G.J. Turvey† and M.Y. Osman‡, †Department of Engineering, University of Lancaster, Lancaster, U.K., ‡Faculty of Engineering and Technology, Nile Valley University, Atbara, Sudan	49
2.5	NUMERICAL AND EXPERIMENTAL ANALYSIS FOR DETERMINATION OF THE MECHANICAL PROPERTIES OF HEAT TREATED STEELS, A. Nayebi, G. Mauvoisin, O. Bartier and R. El Abdi, Laboratoire de Recherche en Mécanique Appliquée, Université de Rennes, Rennes, France	61
3.	MODELLING OF STEEL STRUCTURES	
3.1	FRACTURE MECHANICS BASED FATIGUE ANALYSIS OF BRIDGES USING PLANE STRAIN CRACKED WELD MODELS, K. Kiss and L. Dunai, Department of Steel Structures, Technical University, Budapest, Hungary.....	71
3.2	COMPUTER MODELLING AND EXPERIMENTS FOR BASE PLATE COLUMN CONNECTION USED IN PIPING INDUSTRY, D. Laplume, D. Lamblin and G. Guerlement, Institut Mécanique et Architecture, Faculté Polytechnique de Mons, Mons, Belgium.....	79
4.	ANALYSIS, MODELLING AND DESIGN OF STEEL CONNECTIONS	
4.1	SWAGED BOLTS: MODELLING OF THE INSTALLATION PROCESS AND NUMERICAL ANALYSIS OF THE MECHANICAL BEHAVIOUR, M. Dréan†, A.-M. Habraken‡, A. Bouchaïr† and J.P. Muzeau†, †Laboratoire d'Etudes et Recherches en Mécanique des Structures, Blaise Pascal University, Clermont-Ferrand, France, ‡M.S.M., University of Liège, Liège, Belgium.....	87
4.2	COMPUTATIONAL ANALYSIS AND DESIGN OF SEMI-CONTINUOUS STEEL FRAME STRUCTURES, C.D. Fisher and R.Y. Xiao, Department of Civil and Environmental Engineering, University of Southampton, Southampton, United Kingdom.....	99
4.3	DYNAMIC BEHAVIOUR OF SEMI-RIGID STEEL FRAMING CONNECTION USING FRICTION DAMPING AND ADAS DEVICES, M. Tehranizadeh, Department of Civil Engineering, Amirkabir University of Technology, Tehran, Iran.....	107

5. DESIGN OF STEEL STRUCTURES

- 5.1 OPTIMUM DESIGN OF COMPRESSION COLUMNS OF WELDED I-SECTION AND COMPARISON WITH ROLLED PROFILES, K. Jármai and J. Farkas, Department of Materials Handling and Logistics, University of Miskolc, Miskolc, Hungary..... 119
- 5.2 PRACTICAL ADVANCED ANALYSIS IN SEISMIC DESIGN OF STEEL BUILDING FRAMES AND 1997 LRFD EVALUATIONS, I.H. Chen† and W.F. Chen‡, †Skidmore Owings & Merrill LLP, San Francisco, CA, United States of America, ‡College of Engineering, University of Hawaii, Manoa, United States of America..... 131
- 5.3 REALISTIC MINIMUM WEIGHT DESIGN OF STEEL FRAMEWORKS, W. Gutkowski†, J. Zawidzka†, J. Zawidzki†, D. Laplume‡, G. Guerlement‡* and S. Boulanger*, †Institute of Fundamental Technological Research, Warsaw, Poland, ‡Institut Mécanique et Architecture, Faculté Polytechnique de Mons, Mons, Belgium, *Bureau d'études Adem SPRL, Mons, Belgium..... 147
- 5.4 HEURISTIC APPROACH TO STEEL FRAME STRUCTURAL OPTIMISATION, A. Krajnc and D. Beg, Faculty of Civil and Geodetic Engineering, University of Ljubljana, Ljubljana, Slovenia..... 155
- 5.5 OPTIMUM DESIGN OF STEEL I-SECTION TAPERED GIRDERS BY USING THE LAGRANGE PENALTY FUNCTION APPROACH, M. Hosseini† and A. Heydari‡, †Lifeline Engineering Department, International Institute of Earthquake Engineering and Seismology, Tehran, Iran, ‡Structural Engineering Group, Tehran South Branch of the Islamic Azad University, Tehran, Iran..... 165

❖ PREFACE ❖

This volume contains a selection of contributed papers presented at *The Fifth International Conference on Computational Structures Technology* and *The Second International Conference on Engineering Computational Technology*, held in Leuven, Belgium from 6-8 September 2000. The papers in this volume include the following topics: Computer Aided Design of Steel Structures; Analysis of Steel Structures; Modelling of Steel Structures; Analysis, Modelling and Design of Steel Connections; and Design of Steel Structures. The complete list of conference proceedings volumes are as follows:

- Identification, Control and Optimisation of Engineering Structures
G. De Roeck and B.H.V. Topping (Editors)
Civil-Comp Press, 2000, ISBN 0-948749-74-1
- Computational Civil and Structural Engineering
G. De Roeck and B.H.V. Topping (Editors)
Civil-Comp Press, 2000, ISBN 0-948749-73-3
- Computational Steel Structures Technology
M. Iványi, J.P. Muzeau and B.H.V. Topping (Editors)
Civil-Comp Press, 2000, ISBN 0-948749-72-5
- Computational Concrete Structures Technology
Z. Bittnar and B.H.V. Topping (Editors)
Civil-Comp Press, 2000, ISBN 0-948749-71-7
- Developments in Engineering Computational Technology
B.H.V. Topping (Editor)
Civil-Comp Press, 2000, ISBN 0-948749-70-9
- Computational Techniques for Materials, Composites and Composite Structures
B.H.V. Topping (Editor)
Civil-Comp Press, 2000, ISBN 0-948749-69-5
- Computational Mechanics: Techniques and Developments
B.H.V. Topping (Editor)
Civil-Comp Press, 2000, ISBN 0-948749-68-7
- Finite Elements: Techniques and Developments
B.H.V. Topping (Editor)
Civil-Comp Press, 2000, ISBN 0-948749-67-9
- Computational Engineering using Metaphors from Nature
B.H.V. Topping (Editor)
Civil-Comp Press, 2000, ISBN 0-948749-66-0
- Computational Mechanics for the Twenty-First Century
B.H.V. Topping (Editor)
Saxe-Coburg Publications, 2000, ISBN 1-874672-13-X

I should like to thank all the authors for their contributions and in particular those who presented their papers in Leuven. I must also thank the members of the Conference Editorial Boards who helped in many ways before and during the conference.

The members of the Editorial Board for Computational Structures Technology Conference 2000, were: Prof. H. Adeli, USA; Prof. S. Ahmad, Bangladesh; Prof. Dr. N. Akkas, Turkey; Prof. J.E. Akin, USA; Prof. E. Alarcon, Spain; Prof. G. Alduncin, Mexico; Prof. E. Anderheggen, Switzerland; Prof. F. Armero, USA; Dr. H. Askes, The Netherlands; Prof. M.H. Baluch, Saudi Arabia; Prof. N. Banichuk, Russia; Prof. C.C. Baniotopoulos, Greece; Prof. H.J.C. Barbosa, Brazil; Prof. K.J. Bathe, USA; Prof. J.L. Batoz, France; Prof. J. Baugh, USA; Dr. A.A. Becker, England; Prof. T. Belytschko, USA; Prof. M. Bernadou, France; Prof. N. Bicanic, Scotland; Prof. Z. Bittnar, Poland; Prof. K-U. Bletzinger, Germany; Prof. P. Boisse, France; Prof. R.I. Borja, USA; Prof. M. Bradford, Australia; Prof. F. Brezzi, Italy; Prof. D. Briassoulis, Greece; Prof. M.L. Bucalem, Brazil; Prof. T. Bulenda, Germany; Dr. J.W. Bull, England; Prof. O.S. Bursi, Italy; Prof. G.F. Carey, USA; Prof. H.C. Chan, Hong Kong; Dr. D. Chapelle, France; Prof. W.F. Chen, USA; Prof. G. Cheng, China; Prof. J. Chenot, France; Dr. G. Chiandussi, Italy; Prof. C-K. Choi, Korea; Prof. K. K. Choi, USA; Dr. C. Cini, Italy; Prof. J.Y. Cognard, France; Prof. R. de Borst, The Netherlands; Prof. G. de Roeck, Belgium; Dr. M.A. de Rosa, Italy; Prof. G. Degrande, Belgium; Dr. R. Delpak, Wales; Prof. C.S. Desai, USA; Dr. M. Dhanasekar, Australia; Prof. M. Doblare, Spain; Prof. I. Doltsinis, Germany; Prof. L. Dunai, Hungary; Dr. E.N. Dvorkin, Argentina; Dr. N.F.F. Ebecken, Brazil; Prof. I. Elishakoff, USA; Prof. F. Erbatar, Turkey; Prof. A. Eriksson, Sweden; Prof. H.A. Eschenauer, Germany; Prof. M. Farshad, Switzerland; Prof. C.A. Felippa, USA; Prof. T.E. Fenske, USA; Dr. A.J. Ferrante, Italy; Prof. D. Frangopol, USA; Prof. M.B. Fuchs, Israel; Prof. R.E. Fulton, USA; Prof. P. Gaudenzi, Italy; Prof. N. Gebbeken, Germany; Prof. U.A. Girhammar, Sweden; Prof. J-C. Gelin, France; Prof.

P.L. Gould, USA; Prof. R.V. Grandhi, USA; Prof. D. Grierson, Canada; Prof. R. Haftka, USA; Prof. P. Hajela, USA; Prof. P. Hamelin, France; Prof. D. Hartmann, Germany; Prof. G.R. Heppler, Canada; Prof. J. Herskovits, Brazil; Prof. M. Hoit, USA; Prof. T.J.R. Hughes, USA; Prof. M. Ibrahimbegovic, France; Prof. H. Irschik, Austria; Prof. M. Iványi, Hungary; Prof. K. Jarmai, Hungary; Prof. M. Kamiya, Japan; Prof. T. Kant, India; Prof. B. Karihaloo, Wales; Prof. S. Kato, Japan; Prof. J.T. Katsikadelis, Greece; Prof. A. Kaveh, Iran; Prof. M. Kawaguchi, Japan; Dr A. Khan, Australia; Prof. U. Kirsch, Israel; Dr. M. Kleiber, Poland; Prof. M.D. Kotsovos, Greece; Prof. V. Koumoussis, Greece; Prof. A. Kounadis, Greece; Prof. W.B. Kräzig, Germany; Prof. B.H. Kroplin, Germany; Prof. P. Ladèveze, France; Prof. K.L. Lawrence, USA; Prof. S.H. Lee, USA; Prof. Le Tallec, France; Prof. A.Y.T. Leung, England; Prof. R. Levy, Israel; Prof. A. Liolios, Greece; Prof. P.B. Lourenço, Portugal; Prof. I. MacLeod, Scotland; Dr J. Mackerle, Sweden; Prof. G. Manfredi, Italy; Prof. H.A. Mang, Austria; Prof. D. Manolis, Greece; Prof. J.B. Martin, South Africa; Prof. H.G. Matthies, Germany; Dr E.A.W. Maunder, England; Prof. I.M. May, Scotland; Prof. F. Mazzolani, Italy; Prof. J.L. Meek, Australia; Prof. U.F. Meissner, Germany; Prof. C. Meyer, Germany; Prof. M. Mikkola, Finland; Dr. S. Modak, USA; Dr. K. Morgan, Wales; Prof. C.A. Mota Soares, Portugal; Prof. Z. Mroz, Poland; Dr. A. Muc, Poland; Prof. J.-P. Muzeau, France; Prof. A. Needleman, USA; Prof. G.P. Nikishkov, Japan; Prof. A.K. Noor, USA; Prof. H. Nooshin, England; Prof. R. Ohayon, France; Prof. N. Olhoff, Denmark; Prof. J. Oliver, Spain; Prof. E. Onate, Spain; Prof. E. Papa, Italy; Prof. M. Papadarakakis, Greece; Prof. P. Papalambros, USA; Prof. D. Parsons, USA; Prof. P. Pedersen, Denmark; Dr D. Peric, Wales; Prof. J. Petrolito, Australia; Prof. C.P. Providakis, Greece; Dr. E. Providas, Greece; Prof. J. Rakowski, Poland; Prof. C.V. Ramakrishnan, India; Prof. E. Ramm, Germany; Prof. F.G. Rammerstorfer, Austria; Prof. B.D. Reddy, South Africa; Prof. E. Riks, The Netherlands; Prof. H. Rothert, Germany; Dr. E. Salajegheh, Iran; Prof. A. Samartin, Spain; Prof. A. Samuelsson, Sweden; Prof. J.L.T. Santos, Portugal; Prof. E. Schnack, Germany; Dr B.A. Schrefler, Italy; Prof. G.I. Schueller, Austria; Prof. K. Schweizerhof, Germany; Dr A. Selby, England; Prof. G.J. Simitses, USA; Prof. S. Sloan, Australia; Prof. P. Spanos, USA; Dr E. Spreeuw, The Netherlands; Prof. G. Steven, Australia; Prof. H. Sugimoto, Japan; Prof. K.S. Surana, USA; Prof. C.C. Swan, USA; Prof. C.A. Symakezis, Greece; Prof. B.A. Szabo, USA; Dr K.Y. Sze, Hong Kong; Prof. I. Takewaki, Japan; Prof. T. Tarnai, Hungary; Prof. J.W. Tedesco, USA; Prof. A.B. Templeman, England; Prof. G. Thierauf, Germany; Prof. R. Tinawi, Canada; Dr. V.V. Toropov, England; Prof. M. Touratier, France; Prof. P. Trompette, France; Prof. G. Tsamasphyros, Greece; Dr G. Turvey, England; Prof. F. van Keulen, The Netherlands; Prof. J. Vantomme, Belgium; Prof. I. Vardoulakis, Greece; Prof. F. Venancio-Filho, Brazil; Dr. P. Venini, Italy; Prof. K.S. Viridi, England; Prof. W. Wagner, Germany; Prof. X. Wang, USA; Prof. Z. Waszczyszyn, Poland; Prof. N.P. Weatherill, Wales; Prof. R. Weixin, Singapore; Prof. D.W. White, USA; Prof. N.E. Wiberg, Sweden; Prof. E.L. Wilson, USA; Prof. M. Witkowski, Poland; Prof. U. Wittek, Germany; Dr J.P. Wolf, Switzerland; Dr J. Wood, Scotland; Dr R.D. Wood, Wales; Prof. P. Wriggers, Germany; Dr. G. Yagawa, Japan; Prof. Y-B. Yang, Taiwan and Dr T. Zimmermann, Switzerland.

The members of the Editorial Board for Engineering Computational Technology Conference 2000, were: Prof. R. Abascal, Spain; Dr R. Adey, England; Prof. M.H. Aliabadi, England; Dr. C.J. Anumba, England; Prof. C.G. Armstrong, Northern Ireland; Prof. Z.P. Bazant, USA; Prof. A.I. Beltzer, Israel; Prof. G.F. Carey, USA; Dr. B. Codenotti, Italy; Prof. L. Damkilde, Denmark; Prof. F. Darve, France; Dr M. Dayde, France; Dr C. Di Napoli, Italy; Prof. E. Dick, Belgium; Prof. I.S. Duff, England; Dr A. Duller, Wales; Prof. D.J. Evans, England; Prof. A. Faghri, USA; Dr J. Fingberg, Germany; Prof. U. Gabbert, Germany; Prof. R.R. Gajewski, Poland; Prof. L. Gaul, Germany; Dr P.L. George, France; Prof. D. Givoli, Israel; Prof. B. Gustafsson, Sweden; Dr S. Hernandez, Spain; Dr. S. Idelsohn, Argentina; Prof. M.H. Imam, Saudi Arabia; Prof. A.R. Ingraffea, USA; Prof. K. Ishii, Japan; Dr M. Isreb, Australia; Prof. Y. Jaluria, USA; Prof. J. Jeronimidis, England; Dr P.K. Jimack, England; Dr M. Kara, England; Prof. T.G. Keith Jr., USA; Prof. V.M. Kovenya, Russia; Dr B. Kumar, Scotland; Prof. Y.S. Kim, USA; Dr D. Kiritisis, Switzerland; Dr. L. Lämmer, Germany; Prof. P. Leger, Canada; Dr G. Lonsdale, Germany; Prof. T. Lookman, Canada; Prof. J.J. McGuirk, England; Dr J.J. McKeown, Northern Ireland; Dr. R.I. Mackie, Scotland; Prof. M. Malafaya-Baptista, Portugal; Prof. N.C. Markatos, Greece; Prof. K. Matsuno, Japan; Prof. G. Meier, Italy; Prof. A. Meyer, Germany; Dr. J. Miles, Wales; Prof. G. Molnarka, Hungary; Prof. C.M. Mota Soares, Portugal; Prof. Z. Mroz, Poland; Dr M. Napolitano, Italy; Prof. D.T. Nguyen, USA; Prof. A.K. Noor, USA; Prof. P.H. Oosthuizen, Canada; Prof. K. Orsborn, USA; Prof. M.P. Païdoussis, Canada; Dr P.C. Pandey, India; Dr I.C. Parmee, England; Dr R. Pozo, USA; Dr A. Preumont, Belgium; Prof. H-W. Reinhardt, Germany; Prof. Z. Ren, Slovenia; Dr L.M. da S. Ribeiro, Portugal; Prof. J. R. Rice, USA; Dr D. Robinson, Northern Ireland; Prof. D. Roose, Belgium; Prof. F-X Roux, France; Dr M.G. Sainsbury, Hong Kong; Prof. H. Schaeffer, USA; Prof. K.N. Seetharamu, Malaysia; Prof. R.P. Shaw, USA; Prof. M.S. Shephard, USA; Dr J. Sienz, Wales; Dr H.D. Simon, USA; Prof. K. Sobczyk, Poland; Dr J. Sobieski, USA; Prof. B. Spalding, England; Prof. G.E. Stavroulakis, Germany; Prof. B. Sunden, Sweden; Prof. K.K. Tamma, USA; Dr T.D. Taylor, USA; Dr A.S. Usmani, Scotland; Prof. W.S. Venturini, Brazil; Prof. V.R. Voller, USA; Dr C. Walshaw, England; Dr M. Wolfshtein, Israel; Dr P K Woodward, Scotland and Prof. L.C. Wrobel, England.

These Conferences could not have been organised without the contribution of many people who helped in their planning, organisation and execution. Professor G. De Roeck was a valuable source of help locally in Leuven and in many aspects of the organisation of the conferences. Professor K.J. Bathe and Professor A.K. Noor were a constant source of encouragement and their continued support of this series is gratefully acknowledged. Professor Z. Bittnar,

Professor M. Iványi, Professor J.P. Muzeau and Professor G. De Roeck contributed to the success of the meeting by helping with the organisation and editorial of the volumes as listed above.

My thanks are also due to all at Civil-Comp Press for their help and perseverance in the realisation of this conference, particularly Mrs Rosemary Brodie. The assistance of members of the Structural Engineering Computational Technology Research Group at Heriot-Watt University, Edinburgh is gratefully acknowledged particularly from Roman Putanowicz, Janos Nező and Péter Iványi. The delights of Leuven were first drawn to my attention by Jelle Muylle, a former student of Professor G. De Roeck. Jelle's tireless and enthusiastic assistance in bringing these Conferences to fruition is gratefully acknowledged.

Barry H.V. Topping
Department of Mechanical and Chemical Engineering
Heriot-Watt University, Edinburgh
August 2000