

# **12th International Conference on Civil, Structural and Environmental Engineering Computing 2009**

## **(CC 2009)**

**Civil-Comp Proceedings 91**

**Funchal, Madeira, Portugal  
1-4 September 2009**

**Volume 1 of 7**

**Editors:**

**B. H. V. Topping  
R. C. Barros**

**L. F. Costa Neves**

**ISBN: 978-1-61567-727-6**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2010) by Civil-Comp Press  
All rights reserved.

Printed by Curran Associates, Inc. (2010)

For permission requests, please contact Civil-Comp Press  
at the address below.

Civil-Comp Press  
Dun Eaglais  
Station Brae, Kippen  
Stirling FK8 3DY  
United Kingdom

Phone: +44 (0) 1786 870 166  
Fax: +44 (0) 1786 870 167

[www.civil-comp.com](http://www.civil-comp.com)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# Contents

## Preface

### Steel and Steel-Concrete Composite Structures

Session organised by L.F. Costa Neves and L. Lima

1	Evaluation of the Resistance of RHS "T" Joints under Axial Loading: A Parametric Study R.M.M.P. de Matos, L.F. Costa-Neves, L.R.O. de Lima, J.G. Santos da Silva and P.C.G. da S. Vellasco	1
2	The Influence of the Chord Axial Load on the Resistance of RHS "T" Joints with Axially Loaded Braces: A Parametric Study R.M.M.P. de Matos, L.F. Costa-Neves, L.R.O. de Lima, J.G. Santos da Silva and P.C.G. da S. Vellasco	17
3	Resistance and Stiffness of Welded Rolled Hollow Section Beam-Column Joints with Concrete Filled Chords J.K. Szlendak	33
4	A Parametric Analysis of Composite Beams with T-Perfobond Shear Connectors J.C. da C. Vianna, L.F. Costa Neves, P.C.G. da S. Vellasco and S.A.L. de Andrade	44
5	Numerical Modelling of Non-Linear Behaviour of Timber-Concrete Composite Structures S.M.R. Lopes, L.F.C. Jorge and H.M.P. Cruz	57
6	Numerical Evaluation of Stainless Steel Joints subject to Tension A.T. da Silva, J. de J. dos Santos, L.R.O. de Lima, P.C.G. da S. Vellasco, S.A.L. de Andrade and J.G.S. da Silva	69
7	Numerical Behaviour of Steel Columns subject to Localized Fire Loading A. Santiago, C. Haremza, L. Simões da Silva and J.P. Rodrigues	82
8	Design of a Steel Apparatus for Experimental Torsion Tests of Concrete Hollow Beams L.F.A. Bernardo, A.M. Jorge and S.M.R. Lopes	102
9	The Influence of the Semi-rigid Behaviour of Column Base Plates and Beam-to-Column Joints on the Non-linear Dynamical Response of Steel Portal Frames F. da R. de C. Lopes, J.G.S. da Silva, P.C.G. da S. Vellasco, L.R.O. de Lima and L.F. da C. Neves	117
10	Vibration Analysis of Composite Floors Induced by Human Rhythmic Activities N.A. dos S. Langer, J.G.S. da Silva, L.R.O. de Lima, P.C.G. da S. Vellasco and L.F. da C. Neves	133

### Stability and Non-Linear Behaviour of Thin-Walled Members and Structures

Session organised by D. Camotim and L. Dunai

11	Dynamic Analysis Based Seismic Performance Quantification of a Steel Corrugated Shear Wall System L.G. Vigh, G.G. Deierlein, E. Miranda, A. Liel and S. Tipping	147
12	Generalised Beam Theory based Local and Global Dynamic Analysis of High-Speed Railway Bridge Decks R. Bebiano, N. Silvestre and D. Camotim	162
13	Dynamic Buckling Estimation for Beam-Columns with Open Cross-Sections T. Kubiak	182
14	Dynamic Stability of Bowstring Arches J.M. Martínez, O.R. Ramos and M.A. Serna	198
15	Finite Element Simulation of Slender Thin-Walled Box Columns by Implementing Real Initial Conditions L. Pavlovčič, U. Kuhlmann, B. Froschmeier and D. Beg	212
16	Determination of the Patch Loading Resistance of Girders with Corrugated Webs using Nonlinear Finite Element Analysis B. Kövesdi and L. Dunai	232
17	Analysis of Scaffolds with Semi-Rigid Connections exhibiting Looseness U. Prabhakaran, R.G. Beale and M.H.R. Godley	250
18	The Effect of Local Geometric Imperfections on the Non-Linear Analysis of Stub Columns M.M. Pastor, M. Casafont, F. Roure and M. Ferrer	268
19	Numerical Investigation of Adjustable Telescopic Steel Props J. André, A.M. Baptista and D. Camotim	282
20	Numerical Analysis of Compressed Cold Formed Steel Members considering Initial Geometric Imperfections S.J. de Castro Almeida, J. Munaiar Neto and M. Malite	310
21	Non-Linear Generalised Beam Theory Formulation for Open-Section Thin-Walled Members with Arbitrary Support Conditions C. Basaglia, D. Camotim and N. Silvestre	324
22	On the Relevance of Local-Distortional Interaction in the Post-Buckling Behaviour and Strength of Cold-Formed Steel Lipped Channel Columns P.B. Dinis, N. Silvestre and D. Camotim	345
23	Local-Global Buckling Interaction of Steel Cold-Formed Members: An Integrated Approach of Effective Width and Direct Strength Methods E.M. Batista	371
24	Local and Global Buckling and Post-Buckling Analysis of Thin-Walled Members using Enhanced Beam Finite Elements R.M. Gonçalves, D. Camotim and M. Ritto-Corrêa	391
25	Updated Lagrangian Formulation for Nonlinear Stability Analysis of Flexibly Connected Thin-Walled Frames G. Turkalj, J. Brnic and D. Lanc	408

26	Large-Deflection-Theory Analysis of the Effect of Web Initial Curvature on the Ultimate Strength of Steel Plate Girder J. Kala, Z. Kala, J. Melcher and M. Škaloud	428
27	Dynamic Response of Conical Shell Structures subjected to Pulse Pressure R.J. Mania and K. Kowal-Michalska	438
28	Dynamic Crushing of Thin-Walled Beam-Columns: Theoretical and Experimental Analysis M. Kotelko, R.J. Mania and Z. Kołakowski	450
29	Buckling Sensitivity Analysis of Thin-Walled Structures using Shell Finite Elements and Nonlinear Computational Methods Z. Kala and J. Kala	464
30	On the Calculation of the Critical Moment for Lateral-Torsional Buckling of Beams S. Ádány, A.L. Joó and D. Visy	475
31	First-Order, Buckling and Post-Buckling Behaviour of GFRP Pultruded Beams: Part 1 Experimental Study J.R. Correia, F.A. Branco, N. Silva, D. Camotim and N. Silvestre	495
32	First-Order, Buckling and Post-Buckling Behaviour of GFRP Pultruded Beams: Part 2 Numerical Simulation N.M.F. Silva, D. Camotim, N. Silvestre, J.R. Correia and F.A. Branco	515
33	Buckling Analysis of Thin Sections using the Finite Strip Method with a Coupled Stiffness Matrix D.D. Milašinović and I. Milaković	541
34	Linear Buckling Analysis of Compressed Members combining the Generalised Beam Theory and the Finite Element Method M. Casafont, M.M. Pastor, E. Caamaño and F. Marimon	560
35	Buckling Analysis of Plates Stiffened by Parallel Beams E.J. Sapountzakis and V.G. Mokos	578
36	The Effect of Rounded Corners of Cold-Formed Steel Members in the Buckling Analysis via the Direct Strength Method Z. Beregszászi and S. Ádány	598

#### **High Speed Trains: Vehicle Track Dynamic Analysis and Related Environmental Problems**

Session organised by J. Pombo and Z. Dimitrovová

37	The Dynamic Design of High Speed Railway Tracks using a Combined Multibody and Finite Element Approach S. Bruni and S. Alfi	612
38	Influence of Track Conditions and Wheel Wear State on the Loads Imposed on the Infrastructure by Railway Vehicles J. Pombo, J. Ambrósio, M. Pereira, R. Verardi, C. Ariaudo and N. Kuka	630
39	Development of the Next Generation High-Speed Trains for Scandinavia S. Stichel, R. Persson, G. Himmelstein, E. Andersson and A. Orvnäs	652
40	Interaction of High Speed Train and Railway Structure during an Earthquake M. Tanabe, H. Wakui, N. Matsumoto, M. Sogabe and Y. Tanabe	672

41	Vibration Reduction for Railway Bridges Travelled by High-Speed Trains M.D. Martínez-Rodrigo, J. Lavado, J. Nasarre and A. Doménech	689
42	Vibrations of Beams on a Random Foundation due to a Moving Load: Wavelet Approach P. Koziol and Z. Hryniwicz	709
43	Assessment of the Significance of the Bridge-Train Interaction in Dynamic Analysis of Bridges subjected to Moving Loads M. Majka and M. Hartnett	725
44	Transverse Vibrations in Beams Supported by a Piece-Wise Homogeneous Visco-Elastic Foundation Z. Dimitrovová and L. Frýba	736
45	Behaviour of a Ballasted Track under Cyclic Loading: Numerical and Laboratory Investigations O. Jirousek, L. Hor nicek, J. Jira, J. Kunecky, D. Kytyr and J. Vycichl	756
46	Longitudinal Vibration Analysis of the Deck of a Floating Type Cable-Stayed Railway Bridge subjected to Train Braking W. Qu, J. Liu and Y.L. Pi	767
47	Prediction of Structure-Borne Vibrations induced in a Large Structure by Train Passage F. Braghin, S. Bruni and A. Collina	783
48	The Cancellation Phenomenon for Simply Supported Beams and Plates subjected to Moving Loads P. Museros and M.D. Martínez-Rodrigo	796
49	Wavelet Analysis of Multilayered Ground Vibrations as a Result of High Speed Trains P. Koziol	811

### **Climate Change as an Engineering Challenge**

Session organised by Ž. Turk

50	Modelling the Impact of Climate Change on Runoff to and Diffuse Phosphorus Loads in Lake Balaton A. Clement and Á. Kovács	827
51	Using the Deep Oceans for Energy Retrieval and for the Burial of Carbon Dioxide C.T.F. Ross	840

### **Robust Optimal Design by Stochastic Optimization Procedures**

Session organised by K. Marti, G.I. Schuëller and T. Vietor

52	Reliability Based Optimal Design of Frames with Limited Residual Strain Energy Capacity J. Lógó, M. Movahedi Rad, T. Tamássy, J. Knabel and P. Tauzowski	859
53	Reliability based Limit Design of Skeletal Structures J. Knabel, P. Tauzowski and R. Stocki	876
54	Methodological Support for the Early Stages of Vehicle Body Development: A Stochastic Design Approach for Passenger Vehicles K. Kirchner and T. Vietor	890
55	Maintenance Strategies for Uncertain Mechanical Systems considering the Effects of Fatigue M.A. Valdebenito and G.I. Schuëller	902

56	Comparison of Several Approaches to the Linear Approximation of the Yield Condition and Application to the Robust Design of Frames for the case of Uncertainty S. Zier	922
57	Uncertainty and Robustness in Structural Design M. Beer and M. Liebscher	940
58	Stochastic Optimal Structural Control: Active Control Actions K. Marti	954

### **Topology and Shape Optimization Problems**

Session organised by V. Pomezanski

59	Computational Techniques for Effective Structural Performance Design of D-Regions S. Yindeesuk and D.A. Kuchma	969
60	A Shape Optimization Method of a Body Located in Viscous Flow using Acoustic Velocity K. Terachi and M. Kawahara	989
61	Shape Optimization of a Body located in Incompressible Flow using the Adjoint Equation Method M. Sakamoto and M. Kawahara	1003
62	Heuristic Features of the Extended SIMP Algorithm in Topology Optimization V. Pomezanski	1021
63	Application and Validation of Topology Optimization for the Design of D-Regions in Reinforced Concrete Structures S. Yindeesuk and D.A. Kuchma	1038
64	Optimization of Lightweight Aggregate Concrete Units using a Genetic Algorithm L.C. Sousa, C.F. Castro, C.C. António and H. Sousa	1049

### **Optimum Design of Skeletal Structures**

Session organised by M.P. Saka

65	An Improved Harmony-Search Algorithm for Truss Structure Optimization L. Lamberti and C. Pappalettere	1061
66	Optimum Design of High-Rise Steel Buildings using an Evolution Strategy Integrated Parallel Algorithm O. Hasançebi, T. Bahçecioğlu, Ö. Kurç and M.P. Saka	1080
67	Topology Optimization of Tall Skeletal Building Frameworks using a Hybrid Genetic Algorithm C.M. Chan, K.M. Wong and C.F. Yiu	1111
68	Optimum Structural Patterns for Vertical Buildings E.K. Julistiono and D.J. Gunaratnam	1129
69	Ant Colony Optimization of Irregular Steel Space Frames including the Effect of Warping I. Aydoğdu and M.P. Saka	1150

### **Robust Optimisation for Structural Dynamics**

Session organised by A. El Hami and N. Bouhaddi

70	Optimization Safety Factors for the Design of an Ultrasonic Motor B. Radi, A. Makhloifi and A. El Hami	1178
----	---	------

- 71 Analytical Approximation to the Reliability of Linear Systems for Robust Design 1189  
A.A. Taflanidis

### **Probabilistic Approaches to Structural Mechanics**

Session organised by A. El Hami and M. Karama

- 72 Structural Reliability Assessment using a Direct Determined Probabilistic Calculation 1209  
P. Janas, M. Krejsa and V. Krejsa
- 73 A Probabilistic Approach to the Fatigue Life Estimate of a Temporary Steel Bridge 1229  
M. Rieger and P. Marek
- 74 Coupling Global and Reliability Based Optimisation 1245  
R.H. Lopez, E.S. Cursi and A. El-Hami

### **Assesment of Structures using Numerical Models**

Session organised by F.J. Pallares and J.M. Adam Martinez

- 75 Structural Damage Assesment aided by Modal Testing 1261  
S. Ivorra, C.M. Gisbert, P.A. Calderón and F.J. Pallares
- 76 Gothic Belltower Assesment using Dynamic Analysis 1271  
S. Ivorra, F. Pallarés and J.M. Adam
- 77 Dynamic Analysis of a Steel Column under a Vehicle Impact Load 1279  
B. Ferrer, S. Ivorra, E. Segovia and R. Irles
- 78 Concrete Porosity Measured using Image Processing Techniques 1287  
J.T. Assis, J.R.C. Pessôa, R.A. Einsfeld, G. Carvalho, Á.S. Bourguignon and R.L.B. Breder
- 79 Poundings of Seismically Isolated Buildings with Adjacent Structures 1297  
P. Polycarpou and P. Komodromos
- 80 Parameters Influencing the Seismic Response of Ancient Columns and Colonnades 1311  
L. Papaloizou and P. Komodromos
- 81 Dynamic Identification of Reduced Scale Masonry Bridges 1328  
A. Bencich, S. Lagomarsino and G. Riotti
- 82 Influence of Track Irregularities on the Dynamic Behaviour of Medium Span Viaducts 1338  
C. Rigueiro, C. Rebelo and L. Simões da Silva
- 83 The Impact of a Bump on the Response of a Bridge to Traffic 1347  
A. González, D. Cantero and E.J. O'Brien
- 84 Numerical Modelling of the Dynamic Behaviour of Masonry Arches 1362  
M. Girardi, C. Padovani, A. Pagni and G. Pasquinelli
- 85 Assessment of the Static Behaviour of Heritage Masonry Buildings using Numerical Modelling 1375  
M. Betti, M. Orlando and A. Vignoli
- 86 Non-linear Analysis of the Soil-Structure Interaction of Baldornon's Church, Spain using the Finite Element Method 1393  
J.J. Del Coz Diaz, P.J. García Nieto, A. Lozano Martínez-Luengas and F.P. Álvarez Rabanal
- 87 Use of Mixed Time Integration for Efficient Welding Simulation of Steel Plate Girders 1413  
J. Néz̄, L. Dunai and B.H.V. Topping

## **Computational Experimental Mechanics**

Session organised by D. Borza

- |    |  |      |
|----|--|------|
| 88 | Assessment, Measurement and Monitoring of the New Bridge crossing the Danube in Bratislava<br>J. Benčat, Z. Bergerová and D. Papán | 1433 |
| 89 | Experimental and Computational Full Data Fields of Thermally Stressed Composite Structures<br>I. Nistea, N. Benmezian and D. Borza | 1445 |

## **Building Information Modelling**

Session organised by Y. Arayici

- |    |   |      |
|----|---|------|
| 90 | Radio Frequency Identification and Building Information Modeling: Integrating the Lean Construction Process<br>J.M. Taylor, S.A. Coady and J. Chesser   | 1455 |
| 91 | A Building Information Modeling Platform for Analysis Software in the Architecture, Engineering and Construction Industry<br>Z.L. Ma, Y. Feng and Y.L. Zhao   | 1479 |
| 92 | Building Information Modeling Integrated to Multi-Performance based Generation Design<br>M.L.V.X. Andrade and R.C. Ruschel  | 1490 |
| 93 | Integrating Building Information Modelling and Geographic Information Systems for Large-Scale Facilities Asset Management: A Critical Review<br>X. Zhang, Y. Arayici, S. Wu, C. Abbott and G. Aouad | 1502 |
| 94 | Using Building Information Model Data for Generating and Updating Diagnostic Models<br>G. Provan, J. Ploennigs, M. Boubekeur, A. Mady and A. Ahmed  | 1520 |

## **Meshless, Mesh-free and Mesh Reduction Methods**

Session organised by S.M. Hashemi

- |     |  |      |
|-----|--|------|
| 95  | In-Plane Analysis of Arches by using the Element-Free Galerkin Method<br>R.E. Erkmen and M.A. Bradford   | 1535 |
| 96  | Application of Smooth Particle Hydrodynamics to solving Problems with Exacting Conditions<br>P.P. Prochazka and S. Peskova                       | 1554 |
| 97  | A Dynamic Stiffness Element for Vibration of Cracked Composite Timoshenko Beams<br>S. Borneman, S.M. Hashemi and H. Alighanbari                  | 1568 |
| 98  | A Super-Convergent Formulation for Dynamic Analysis of Soft-Core Sandwich Beams<br>E. Adique and S.M. Hashemi                                    | 1582 |
| 99  | On the Boundary Integral Element Method for a Solution of Shallow Tunnels using Neumann Series<br>Y.S. Karinski, M.Y. Antes and D.Z. Yankelevsky | 1594 |
| 100 | Radial Basis Function Solution of the Lid-Driven Cavity Problem using the Stream Function Formulation<br>M. Kindelan and F. Bernal               | 1607 |
| 101 | The Natural Neighbour Radial Point Interpolation Method: A Non-Linear Analysis Review<br>L.M.J.S. Dinis, R.M. Natal Jorge and J. Belinha         | 1625 |

- 102 Meshfree Structural Analysis using the Modified Radial Point Interpolation Method 1642  
 S. Nakata, K. Hasegawa and S. Tanaka

### **Coupled Multi-field Problems**

Session organised by R. Schmidt

- 103 On Nonlinear Thermo-Electro-Elasticity Theory and Finite Element Analysis of Piezolaminated Thin-Walled Structures 1656  
 R. Schmidt and S. Lentzen
- 104 Stress Dependent Magnetic Hysteresis implemented in an Electromagnetic Field Computation 1665  
 A. Sipeky, I. Jancskar, Z. Sari and A. Ivanyi
- 105 Coupled Salt and Moisture Transport in Cement Mortar: Modelling Desorption Isotherm using a Neural Network 1677  
 M. Koniorczyk, M. Wojciechowski and D. Gawin

### **Green Structures: Modeling, Design and Simulation**

Session organised by N.S. Al-Kaabi

- 106 Design and Analysis of Insulation Blocks for Masonry Structures 1695  
 J. Pencik and L. Matejka
- 107 Thermal Improvement of Lightweight Façades containing Slotted Steel Girders 1708  
 J. Varadi and E. Toth
- 108 An Application Model for Green Building Implementation: The Civil Engineer's Role 1720  
 N.S. Al-Kaabi, H.D. Imran, A.A. Al-Harmoudi, A.S. Al-Maamari, I.N. Al-Amirah and B.N. Rajab
- 109 Global Warming and the Thermal Performance of Light Steel Residential Buildings: Parametric Study 1737  
 P. Santos, H. Gervásio, L. Simões da Silva and A. Gameiro Lopes
- 110 Design and Analysis of Window Sub-Frames from Recycled Polymers 1754  
 L. Matejka and J. Pencik

### **Algorithms Based on Domain Decomposition Methods**

Session organised by J. Kruis and V. Vondrak

- 111 The Schwarz Domain Decomposition Method for Analysis of Geocomposites 1764  
 R. Blaheta, O. Jakl, J. Starý and K. Krečmer
- 112 A Simple FETI-Based Approach to Homogenization of Debonding Composites 1776  
 P. Gruber and J. Zeman
- 113 Improving Convergence of Scalable FETI-DP for Contact Problems 1792  
 D. Horák and Z. Dostál
- 114 Parallel Adaptive Finite Element Computations with Dynamic Load Balancing 1807  
 B. Patzák and D. Rypal
- 115 Effective Algorithms for Implementation of FETI-Based Domain Decomposition Methods 1826  
 P. Kabelíková, T. Kozubek, A. Markopoulos and T. Brzobohatý
- 116 MatSol: Parallel Algorithms based on Domain Decomposition Methods 1837  
 V. Vondrák, T. Kozubek, A. Markopoulos, T. Brzobohatý and R. Kučera

- 117 A Non-linear Dynamic Parallel Domain Decomposition based Algorithm 1846  
 J. Dobiáš, S. Pták, Z. Dostál, V. Vondrák and T. Kozubek

### **Reinforced Concrete Structures**

- 118 Developing a Life-Cycle Management System for Reinforced Concrete Buildings based on Fully-Probabilistic Deterioration Models 1860  
 K. Lukas, A. Borrmann, M. Zintel, T. Mayer and E. Rank
- 119 Comparison of Alternatives for Remodelling of Laboratory Tests of Concrete 1874  
 J. Brozovsky, P. Konecny, M. Mynarz and O. Sucharda
- 120 Time-Dependent Analysis of Concrete Bridges with Creep, Shrinkage and Cable Relaxation 1886  
 X.T. Si, F.T.K. Au, R.K.L. Su and N.C.M. Tsang
- 121 Approach to the Assessment of Concrete Structures based on Non-Linear Elasto-Plastic Analysis 1903  
 O. Sucharda and J. Brozovsky
- 122 Nonlinear Analysis of Slender Reinforced Concrete Columns 1917  
 S.L. Pires and M.C.A.T. Silva
- 123 Softening of Joints in Reinforced Concrete Structures: A Non-Linear Dynamic Approach 1937  
 Y. Timsah, H. Basha and A. El Sourri

### **Reinforced Concrete: Design**

- 124 Minimum Cost Design of Reinforced Concrete Beams using a Nonlinear Programming Approach 1957  
 I. Merta and S. Kravanja
- 125 Concrete Stability Achieved by Confinement in a Reinforced Concrete Column 1968  
 P.G. Papadopoulos, H. Xenidis, D. Plasatis, P.D. Kiousis, C. Karayannis and A. Diamantopoulos

### **Fibre Reinforced Concrete**

- 126 Modelling of Fibre Reinforced Concrete Based Materials under Static and Dynamic Loading 1982  
 A. Materna and J. Brožovský
- 127 Elastoplastic Modelling of Fibre Reinforced Concrete Samples 1994  
 A. Materna, J. Ciganek and J. Brozovsky
- 128 Optimization of Fibre-Reinforced Concrete Mixture Design 2008  
 B. Mičulka, J. Cigánek, A. Materna and J. Brožovský

### **Nuclear Containment**

- 129 Finite Element Computation of Early Age Thermal Cracking in Concrete Supercontainers for Radioactive Waste Disposal 2019  
 B. Craeye, G. De Schutter, H. Van Humbeeck, W. Wacquier and A. Van Cotthem
- 130 Finite Element Simulations of the Thermal Conditions in a High-Level Waste Repository 2038  
 J. Novak and M. Hokr
- 131 Computer Simulation of Concrete Structures subject to Cyclic Temperature Loading 2048  
 T. Krejčí, T. Koudelka, J. Šejnoha and J. Zeman

- 132 Analysis of a Nuclear Power Plant Containment 2063  
 T. Koudelka, T. Krejčí and J. Šejnoha

### **Steel Structures**

- 133 Buckling of Geometrically Imperfect Thin-Walled Circular Cylinders under External Hydrostatic Pressure 2078  
 C.T.F. Ross, A.P.F. Little and T. Bowler
- 134 A New Rigid Saddle-like Connection suitable for Retrofitting of Existing Buildings 2094  
 M. Foroughi, M.A. Barkhordari and M. Shojaeeefard
- 135 Normalization of Moment-Rotation Axis for Comparison of Connection Rigidities 2104  
 M.A. Barkhordari and M. Foroughi
- 136 Computational Frame Analysis of Partially Restrained Connections with Strain Softening Effects 2110  
 S. Taufik, S. Baharom and R.Y. Xiao
- 137 A Single Equation Yield Surface of an I-Section for Bimoment and Biaxial Bending Moments 2121  
 A. Shoaib and R.P. West
- 138 Reliability Assessment of Steel Frames Allowing for Corrosion Effects 2139  
 V. Křivý
- 139 Buckling Behaviour of Slender Pin-Ended Circular Steel Arches under Pressure using the Dynamic Relaxation Method 2154  
 T. Van Roosbroeck and S. Adriaenssens

### **Materials Modelling**

- 140 Identification of Material Parameters from Nanoindentation of Heterogeneous Structural Materials 2166  
 J. Němeček, K. Forstová and J. Němečková
- 141 Combining Nanoindentation and Real-Time Tomography for Micro Finite Element Models of Materials with Complex Inner Structure 2176  
 O. Jirousek, J. Nemecek and P. Zlamal
- 142 Modeling of the E-Beam Periodic Poling Process 2187  
 A. Nagyváradi and G. Almási

### **Discrete Media Mechanics**

- 143 A Variational Approach to Non-Local Energy Minimization of Random Elastic Lattices 2197  
 J. Zeman, R.H.J. Peerlings and M.G.D. Geers

### **Masonry Structures**

- 144 Development of Design Software for Plain Masonry Buildings 2209  
 R. Marques, J.P. Gouveia, P.B. Lourenço and C. Leão
- 145 Buckling Analysis of Uniform Nonlinear Masonry Members under Combined Load and Different End Conditions using the Collocation Method 2221  
 I. Mura
- 146 An Interface Model for Multi-Scale Nonlinear Analysis of Masonry Structures 2235  
 L. Macorini and B.A. Izzuddin

## **Aluminium Structures**

- 147 Stress Reduction in Redesigned Aluminium Lifting Brackets 2251  
J.W. Bull and C.H. Woodford

## **Timber Structures**

- 148 Simulation-Based Reliability Assessment of Timber Structures 2262  
A. Lokaj and P. Marek
- 149 Non-Linear Finite Element Analysis of Two-Layer Timber Beams considering Interlayer Slip and Uplift 2280  
A. Kroflič, I. Planinc, M. Saje, G. Turk and B. Čas
- 150 Shape and Discrete Sizing Optimization of Timber Truss Girders 2298  
S. Šilih, E. Kozem Šilih, S. Kravanja and M. Premrov
- 151 Robustness Evaluation of Timber Structures with Ductile Behaviour 2309  
P.H. Kirkegaard, J.D. Sørensen and D. Cizmar
- 152 Experimental and Finite Element Vibration Analysis of Floor Systems with Rotated I-Joists 2322  
J.M. Wolfe, K. Shrestha and A. Ebrahimpour

## **Structural Monitoring and Damage Detection Methods**

- 153 The Influence of Temperature on the Deformations of St. Vitus Cathedral and St. George's Basilica in Prague Castle 2339  
P. Beran and J. Máca
- 154 Improvement of a Dynamic Model for the Study of a Damaged Flexible Pavement 2351  
B. Picoux, G. Lefeuvre-Mesgouez, A. El Ayadi, A. Mesgouez and C. Petit
- 155 Non-Destructive Testing of Stone Masonry using Acoustic Attenuation Tomography Imaging 2367  
G. Concu, B. De Nicolo, C. Piga and V. Popescu
- 156 Structural Health Monitoring with Ambient Vibration and Photonic Sensors 2383  
V. Albert Pérez, J.V. Fuente Ramírez, R. Fernández Díaz, R. Martínez Barea, N. González Roura and J. Yuste Navarro
- 157 Health Monitoring of Partially Instrumented Structures 2404  
M.P. Limongelli
- 158 Novel Methods in Condition Monitoring of Large Scale Structures 2420  
P. Archbold and S. Liu

## **Control of Structures**

- 159 Parameter Identification of Large-Scale Magnetorheological Dampers in a Benchmark Building 2434  
A. Bahar, F. Pozo, L. Acho, J. Rodellar and A. Barbat
- 160 Semi-Active Control of Base-Isolated Structures using a new Inverse Model of Magnetorheological Dampers 2453  
A. Bahar, F. Pozo, L. Acho, J. Rodellar and A. Barbat
- 161 A Finite Element Model for the Analysis of Viscoelastic Sandwich Structures 2482  
J. Moita, A. Araújo, P. Martins, C.M. Mota Soares and C.A. Mota Soares

162	The Use of Tuned Mass Dampers for Structural Vibration Control: Numerical Studies of Shear Buildings under Earthquakes and of a Pedestrian Bridge M.M. Paredes and R.C. Barros	2502
163	Reliable Multiple Model Adaptive Controller for Vibration Handling X. Zhong, F. Gillot, A. Saidi and M. Ichchou	2522
164	Static and Dynamic Analysis of Functionally Graded Material Panels with Piezoelectric Layers under Mechanical and Electrical Loadings B. Behjat, M. Salehi, M. Sadighi, M.R. Khoshravan and A. Armin	2537
165	Adaptive Active Damping Control Strategy for Residual Vibration Free Positioning of Linearly Actuated Robots M. Bachmayer and H. Ulbrich	2555
166	Design of New Materials for Passive Vibration Control Z. Dimitrovová and H.C. Rodrigues	2570
167	Passive and Semi-Active Seismic Protection of the ASCE Cable-Stayed Bridge M. Domaneschi and L. Martinelli	2592

#### **Earthquake and Seismic Engineering**

168	Loss of Structural Capacity of Frame Type Buildings affected by Tunnel Induced Settlements S.U. Dikmen and A.M. Turk	2608
169	Seismic Response of Buildings with Uncertain-but-Bounded Mass Distribution P. Cacciola, G. Muscolino and C. Versaci	2619
170	An Innovative Computing Environment for Seismic Risk Assessment M. Dolenc and R. Klinc	2635
171	The Effect of Ground Water Depth on the Seismic Response of Reinforced Concrete Frame Buildings S.U. Dikmen and A.M. Turk	2642
172	Shortcomings of the Winkler model in the Assessment of Sectioned Tunnels under Seismic Loading L. Andersen and J.H. Lyngs	2655
173	A Distributional Approach to the Dynamics of Rigid Blocks A. Baratta and O. Corbi	2674
174	Seismic Protection of Sliding-Rocking Non-Symmetric Rigid Blocks through Base Isolation A. Di Egidio and A. Contento	2690
175	Rocking Motion of Rigid Blocks and their Coupling with Tuned Sloshing Dampers A. Baratta, I. Corbi and O. Corbi	2709
176	Computational Methods for Identification of Vibrating Structures F.J. Cara, J. Carpio, J. Juan and E. Alarcon	2723
177	On Fling and Baseline Correction using Quadrature Mirror Filters A.A. Chanerley, N.A. Alexander and B. Halldorsson	2741

#### **Seismic Design**

178 Time-History Dynamic Behaviour of Reinforced Concrete Buildings Strengthened using Steel Shear Walls A.C. Masri	2764
179 Seismic Buckling Analysis of Steel Anchored Tanks M.A. Al-Kashif, H.M. Ramadan, A. Rashed and M. Haroun	2775
180 On the Influence of Openings in the Seismic Response of Structural Walls Y. Timsah	2788
181 Base-Isolated Structure Response using Friction Dampers with a Coupling Mechanism A. Mateo Alay, N. Hori and N. Inoue	2803
182 Assessing the Suitability of Equivalent Linear Elastic Analysis of Seismically Isolated Multi-Storey Buildings E. Mavronicola and P. Komodromos	2817
183 Inelastic Dynamic Response of Reinforced Concrete Buildings under Seismic Forces H.S. Basha	2837

### **Plate and Shell Problems**

184 Collapse of Thick-Walled Stainless Steel Circular Cylinders under Uniform External Pressure C.T.F. Ross, A. Spahiu, G.X. Brown and A.P.F. Little	2857
185 An Unsymmetric Eigenproblem governing Vibrations of a Plate with attached Loads M. Stammberger and H. Voss	2880
186 Elastic-Plastic Buckling of Cylinders and Tubes under Torsion J. Blachut	2890
187 Prediction of Sheeting Failure by the Theory of Fictitious Elastic Strain at Failure M. Rosmanit	2905
188 Vibration Analysis of Rectangular Mindlin Plates with Mixed Edge Supports Y. Xiang, S.K. Lai, L. Zhou and C.W. Lim	2918

### **Structural Mechanics**

189 Symmetry in Structural Systems and its Recognition A. Zingoni	2929
--	------

### **Impact and Impulse Loading**

190 Rigid-Plastic Beams under Impulsive Loading A. Khan, D. Lloyd Smith and B.A. Izzuddin	2944
191 Three-Dimensional Discrete Element Modeling of the Damage Behaviour of Cross-Ply Laminate under Low-Velocity Impact D.M. Yang, Y.Q. Tan, J.Q. Ye and Y. Sheng	2960

### **Fracture Mechanics**

192 Two-Parameter Fracture Analysis of Wedge Splitting Test Specimens S. Seitl, P. Dymáček, J. Klusák, L. Řoutil and V. Veselý	2970
---	------

193 Numerical Approach for the Crack Growth Process in Bituminous Concrete F. Dubois, R. Moutou-Pitti, B. Picoux and C. Petit	2980
194 Cracked Volume Specified Work of Fracture V. Veselý, P. Frantík and Z. Keršner	2996

### **Modelling Composites**

195 Nonlinear Variational Bounds for Composites P.P. Prochazka and S. Peskova	3014
196 Nonlinear Transient Analysis of Viscously Damped Laminated Sandwich Composite Plates ubjected to a Blast Load Z. Kazancı	3025

### **Composite Structures**

197 Collapse of Carbon-Glass Composite Circular Cylinders under Uniform External Pressure P.T. Smith, C.T.F. Ross and A.P.F. Little	3043
198 Dynamic Analysis of Composite Structures made from Viscoelastic Frequency and Temperature Dependent Materials E. Barkanov	3058
199 Finite Element Modelling of Axially Loaded Concrete-Filled Steel Tubes H.S. Basha	3071
200 Dynamic Relaxation Creep Buckling Analysis of Annular Sector Composite Plates S.R. Falahatgar and M. Salehi	3088
201 Fire Analysis of Steel-Concrete Composite Slabs with Interlayer Slip T. Hozjan, M. Markovič, I. Planinc, M. Saje and S. Srpčič	3104
202 A Three-Dimensional Beam Element for Nonlinear Elasto-Plastic Analysis of Composite Steel-Concrete Members M.A. Bradford and Y.L. Pi	3118
203 Finite Element Stability Analysis of Damaged Composite Shell Structures W. Wagner	3135
204 Cyclic Behaviour of Axially Loaded Laminated Composite Beams B.G. Tugay and H.S. Türkmen	3150
205 Numerical Modelling of the Effect of Openings in the Composite Beam Flange of Composite Connections S. Baharom, S. Taufik and R.Y. Xiao	3161
206 Numerical Evaluation of Mixed Steel-Concrete Structures including Joint Behaviour J. Henriques, L. Simões da Silva and I. Valente	3173
207 A Simplified Analysis of the Brazier Effect in Composite Beams L. Damkilde and B. Lund	3193
208 A Displacement Solution for Transverse Shear Loading of Composite Beams using the Boundary Element Method E.J. Sapountzakis and V.G. Mokos	3204

## **Dynamic Analysis of Structures**

- 209 Dynamics of an Inclined Cableway with Moving Cars: Modelling and Computation Method 3225  
M. Knawa and D. Bryja

## **Wide Span Structures**

- 210 Aerodynamic Analysis of Textile Roofs Combining the use of Computational Fluid Dynamics and Textile Architecture Software 3243  
J. Tejera Parra
- 211 Integrated Digital Design Tool for Form Finding 3259  
P.H. Kirkegaard
- 212 Aerodynamic Behaviour of Hyperbolic Paraboloid Shaped Roofs: Wind Tunnel Tests, Proper Orthogonal Decomposition and Computational Fluid Dynamics Analysis 3271  
F. Rizzo, P. D'Asdia, M. Lazzari, G. Olivato and L. Procino
- 213 Numerical Simulation for the Wind Pressure Distribution of the Large-Span Roof of a Velodrome 3289  
Z.H. Liu, J. Li, L.L. Chen and L.M. Tian
- 214 Analysis of Large-Span Steel Suspended Members subjected to Tension and Bending 3300  
S. Kmet and M. Tomko

## **Bridge Engineering**

- 215 Dynamic Interaction of Pedestrians and Footbridges 3320  
J. Máca and M. Valášek
- 216 The Estimation of Traffic Characteristics for Bridge Loading with the introduction of Long Combination Vehicles 3331  
C. Carey, B. Enright and C. Caprani
- 217 Vertical Crowd Load Models for Vibration Serviceability Assessment of Footbridges 3348  
P. Archbold
- 218 Discrete Analysis for Classical and Single-Pylon Suspension Bridges 3361  
J. Idnurm, M. Kiisa and S. Idnurm

## **Analysis and Design of Framed Structures**

- 219 Solutions for Progressive Collapse Mitigations in New Designs 3372  
O.A. Mohamed
- 220 Stiffness Reduction Factors for Geometric and Material Nonlinearity of Reinforced Concrete Beams and Columns subject to Short Term Loading 3381  
A.C. Sousa, M. Pereira and R.C. Barros
- 221 A Simplified Procedure for the Assessment of Second-Order Effects in Three-Dimensional Framed Structures 3404  
A.C. Sousa, M. Pereira and R.C. Barros

## **Tall Buildings**

- 222 A New Pre-Stressed Bracing System for Tall Buildings 3424  
R. Fojtík and M. Rosmanit

- 223 Space-Time Finite Element Dynamic Analysis of Transfer Plate Structures in Tall Buildings 3439  
H. Zhang and J.S. Kuang

### **Dam, Arch and Embankment Engineering**

- 224 Using an Artificial Intelligence Method to Model the Behaviour of Embankment Dams 3450  
C. Curt, M. Le Goc and R. Tourment
- 225 Hydrodynamic Distress of Liquid Containment Systems 3463  
G. Papazafeiropoulos, Y. Tsompanakis and P.N. Psarropoulos
- 226 Buckling Strength of Concrete Arch Dams of Single Curvature 3487  
A. Zingoni, K. Mudenda and V. French

### **Rock Engineering**

- 227 Numerical Simulation of the Fracture Process in Layered Rock 3502  
B. Debecker and A. Vervoort
- 228 A Straightforward Algorithm for Acoustic Emission Localization in Anisotropic Media 3516  
B. Debecker and A. Vervoort
- 229 Evaluation of the Joint Roughness Coefficient using the Digital Image Correlation Method 3527  
S.H. Tung, M.H. Shih and J.C. Kuo
- 230 The Microscopic Mechanism associated with Mechanical Behaviour of Sandstone: Using a Bonded Particle Model 3539  
M.C. Weng and H.H. Li

### **Pavement Engineering**

- 231 A Comparative Study of Roughness Indices for Monitoring the Performance of Thin Seal Flexible Pavements subjected to Low Traffic Volumes in Australia 3553  
R. Hesami, K.J. McManus, R.P. Evans and R. Hassan
- 232 Network Level Pavement Condition Preparation with Minimum Message Length 3570  
M. Byrne and A.R. Parry

### **Geotechnical Engineering**

- 233 Geosynthetic Reinforcement for Seismic Mitigation of Geostructures 3586  
Y. Tsompanakis, I. Tzavara, V. Zania and P.N. Psarropoulos
- 234 Convergence Acceleration Techniques in Computer Aided Design Systems for Grounding Analysis in Layered Soils 3600  
I. Colominas, J. París, F. Navarrina and M. Casteleiro
- 235 Bearing Capacity Evaluation of Shallow Foundations using the Distinct Element Method 3620  
M.C. Weng, S.H. Tung, C.C. Yu and C.I. Ho
- 236 Technology Support for Improved Construction Plant and Worker Safety 3631  
Z. Riaz and D.J. Edwards
- 237 GroundXML: An Addition of Alignment and Subsoil Specific Cross-Sectional Data to the LandXML Scheme 3651  
M. Obergrießer, Y. Ji, T. Baumgärtel, T. Euringer, A. Borrman and E. Rank

238 Monitoring and Engineering in the Design of Large Offshore Driven Piles in Hard Soils E. Nicolini	3662
239 Numerical Modelling of Large-Diameter Steel Piles at Horns Rev A.H. Augustesen, K.T. Brødbæk, M. Møller, S.P.H. Sørensen, L.B. Ibsen, T.S. Pedersen and L. Andersen	3677
240 Face Deformation of Masonry Retaining Walls Reinforced with Geotextiles M.I.M. Pinto, A.S.C. Correia and M.L.C. Lopes	3691
241 OpenSlope: An Open-Source Object-Oriented Approach to Slope Stability Analysis A. Keshavarz and M. Tabarroki	3701
242 Characterising Soil Moisture as an Indicator of Transport Corridor Slope Instability using Remotely Sensed Data A.J. Hardy, P. Miller, J. Mills and S. Barr	3713
243 Site Response Analysis using the Preisach Formalism P. Cacciola, G. Biondi and E. Cascone	3728
244 Evaluation of the Load-Displacement Relationships for Large-Diameter Piles in Sand S.P.H. Sorensen, K.T. Brodbeck, M. Moller, A.H. Augustesen and L.B. Ibsen	3745
245 Numerical Analysis of the Deformation of an Embankment Reinforced using a Geogrid J. Jíra, J. Jírová and M. Micka	3764

### **Traffic Engineering**

246 Simulation Based Design of Optimal Phasing Plans for an Intersection with Semi-Actuated Signals M.L. Simões, A. Pires-Costa and P. Milheiro-Oliveira	3776
---	------

### **Water Engineering**

247 The Use of Error Dynamics for Calibration of Water Distribution Systems T. Koppel and A. Vassiljev	3788
---	------

### **Bathymetric Studies**

248 Numerical Depth Inversion of the Entrance of Leixões Harbour A. Mesquita and P. Avilez-Valente	3802
---	------

### **Hydrology Modelling**

249 Investigations into Flushing of Pollutants in the Irish Sea T. Dabrowski and M. Hartnett	3818
250 Modelling Heavy Metals in the Mersey Estuary M. Hartnett and A. Berry	3833
251 An Optimal Control of Dissolved Oxygen in Shallow Water Flow T. Sekine and M. Kawahara	3848
252 An Adaptive Mesh Solute Transport Model S. Nash and M. Hartnett	3870

- 253 A Nested Hydrodynamic Model Incorporating Flooding and Drying 3882  
S. Nash and M. Hartnett

- 254 A Bi-dimensional Shallow Water Model with Polynomial Dependence on Depth 3902  
J.M. Rodríguez and R. Taboada-Vázquez

### **Soil-Structure Interaction**

- 255 Fourier Amplitudes of the Foundation Motion connected with Soil-Structure Interaction 3922  
A. Hayir and V. Gicev

- 256 Nonlinear Soil-Linear Structure Interaction: Energy and Strain Distribution 3932  
V. Gicev and A. Hayir

### **Fluid-Structure Interaction**

- 257 Hybrid Elements in Fluid-Structure Interaction Analysis of Plates and Shells 3951  
Y. Kerboua, A.A. Lakis, M. Thomas, L. Marcouiller and M.H. Toorani

- 258 A Fluid-Structure Interaction Analysis of a Hydraulically Damped Rubber Mount 3967  
L.R. Wang, Q. Zhang, Z.H. Lu and I. Hagiwara

### **Computational Fluid Dynamics**

- 259 Holistic Simulation of the Suppression of Sand Transfer in Deserts 3978  
S. Ishikura, T. Yuasa, Y. Kawaguchi and M. Yamamoto

- 260 Computational Fluid Dynamics Modelling of the Mixing of Sewage Sludge in an Anaerobic Digester 3988  
J. Bridgeman

- 261 Experimental and Numerical Evaluation by Computational Fluid Dynamics of Wind Loads on Sheeted Scaffolds 4004  
H. Irtaza, R.G. Beale and M.H.R. Godley

- 262 Interactive Design of Hydraulic Turbomachinery 4023  
H. Hérenger, S. Roller and E. Göde

### **Modelling Acoustics Problems**

- 263 A Visualization Method for Acoustic Wave Propagation 4040  
S. Weyna

- 264 A Note on the Prediction of Airborne and Impact Sound Insulation between Contiguous Acoustic Spaces using the Boundary Element Method: T vs. Cross Junction 4050  
P. Santos and A. Pereira

### **Optimization Problems**

- 265 A New Design Method for Machine Tools Frames using the Finite Element Method and Genetic Algorithms 4065  
J. Kosmol, K. Lehrich, P. Wilk and M. Niedbała

- 266 Local and Global Strategies Applied to Waterflooding Optimization 4099  
B. Horowitz, S.M.B. Afonso, R.B. Willmersdorf and L.J.N. Guimarães

## **Computer Aided Design**

- |  |      |
|--|------|
| 267 Design Intent Oriented Surface Reconstruction<br>V. Berkahn and K. Kaapke                            | 4118 |
| 268 An IFC-Based Framework for Optimizing Prefabrication Configurations<br>A. Khalili and D.K.H. Chua    | 4128 |
| 269 Three-dimensional Models applied to Building Rehabilitation<br>A.Z. Sampaio, J. Neves and B. Martins | 4140 |

## **Virtual Environments**

- |  |      |
|--|------|
| 270 Virtual Testing Environments for Composite Materials and Components in Civil Engineering<br>E. Dado, E. Koenders and S. Özsariyildiz | 4150 |
|--|------|

## **Parallel Computing**

- |  |      |
|--|------|
| 271 High Performance Parallel Computing in Structural Topology Optimization<br>I. Colominas, J. París, F. Navarrina and M. Casteleiro  | 4163 |
| 272 Designing Inherently Parallel Software for Finite Element Analysis<br>R.I. Mackie  | 4180 |
| 273 Numerical Analysis of Coupled Problems with Discontinuities<br>J. Kruis and J. Maděra  | 4193 |
| 274 Distributed Parallel Computation of Three-Dimensional Incompressible Flows using an Implicit Monolithic Finite Element Formulation<br>A.R.E. Antunes, R.S. Da Silva, P.R.M. Lyra and R.B. Willmersdorf | 4203 |

## **Object Oriented Programming**

- |  |      |
|--|------|
| 275 An Object-Oriented Programming Approach for the Analysis of Spatial Reinforced Concrete Frames<br>J. Schenk, T. Löhning and U. Starossek | 4216 |
| 276 On XFEM Integration within an Object-Oriented Finite Element Code<br>R. Chamrová and B. Patzák   | 4227 |
| 277 An Object Oriented Framework for Isogeometric Analysis<br>D. Rypl and B. Patzák  | 4236 |
| 278 An Architecture for an Environmental Process Controller based on Geoprocessing<br>L.A.O.L. Roque   | 4249 |

## **Modelling and Simulation: Computational Environments**

- |  |      |
|--|------|
| 279 Modelling and Simulation of a Two-phase Flow Network with the MATLAB - COMSOL Numerical Packages in the .NET Environment<br>Z. Sari, I. Jancskar and A. Sipeky | 4262 |
|--|------|

## **Mesh Generation**

- |  |      |
|--|------|
| 280 Analysis of the Flow around a Windmill using the Finite Element Method<br>R. Hoshiko and M. Kawahara | 4269 |
|--|------|

281 Generation of Delaunay Meshes D. Krybus and B. Patzák	4282
--	------

282 An Investigation of the Convergence of Mesh Smoothing J. Radó, F. Hartung and P. Iványi	4292
--	------

### **Finite Element Technology**

283 Finite Element Technology in Modelling of Constant-Variable Boundary-Interface Conditions D. Kovačević and I. Matijević	4303
--	------

284 Profile Reduction for Sparse Matrices using an Ant System A. Kaveh and P. Sharafi	4315
--	------

285 Mixed Finite Element Formulations with Volume Bubble Functions for Triangular Elements I. Caylak and R. Mahnken	4330
--	------

286 Closed-Form Matrices for Higher Order Tetrahedral Finite Elements S.E. McCaslin, P. Shiakolas, B. Dennis and K.L. Lawrence	4350
---	------

287 Control of Expression Growth in Symbolic Processing of Finite Element Stiffness Matrices S.E. McCaslin, B. Dennis, P. Shiakolas and K.L. Lawrence	4364
--	------

288 Three-dimensional Implementation of the Ahmad Shell Element: Derivation and Performance Assessment L. Jendele and J. Cervenka	4376
--	------

### **Finite Volume Method**

289 Numerical Simulation of the Pressure Load on Step Spillway Surfaces S.R. Sabbagh-Yazdi and M. Abbasifard	4395
---	------

### **Building Design**

290 A Systematic Analysis of the Vulnerability of Buildings to Localised Collapse V. Janssens and D.W. O'Dwyer	4412
---	------

### **Construction Engineering**

291 Programming for Field Engineering Quantity Collection: A Case Study F. Peterson and M. Fischer	4423
---	------

292 An Automated System for Mobile Crane Selection, Swing Control and Ground Pressure Calculation S. Hasan, M. Al-Hussein, U.H. Hermann and H. Safouhi	4440
---	------

### **Project Management**

293 An Information System for Project and Risk Management of Public Projects A.P. Chassiakos	4454
---	------

### **Author Index**

### **Keyword Index**