Proceedings of the
Tenth International Conference on
Computational Structures Technology
Civil-Comp Proceedings

Proceedings of the First International Conference on Parallel, Distributed and Grid Computing for Engineering
Edited by: B.H.V. Topping and P. Iványi

Proceedings of the Ninth International Conference on Computational Structures Technology
Edited by: B.H.V. Topping, M. Papadrakakis

Proceedings of the Sixth International Conference on Engineering Computational Technology
Edited by: M. Papadrakakis, B.H.V. Topping

Proceedings of the Eleventh International Conference on Civil, Structural and Environmental Engineering Computing
Edited by: B.H.V. Topping

Proceedings of the Ninth International Conference on the Application of Artificial Intelligence to Civil, Structural and Environmental Engineering
Edited by: B.H.V. Topping

Proceedings of the Fifteenth UK Conference of the Association of Computational Mechanics in Engineering
Edited by: B.H.V. Topping

Proceedings of the Eighth International Conference on Computational Structures Technology
Edited by: B.H.V. Topping, G. Montero, R. Montenegro

Proceedings of the Fifth International Conference on Engineering Computational Technology
Edited by: B.H.V. Topping, G. Montero, R. Montenegro

Proceedings of the Tenth International Conference on Civil, Structural and Environmental Engineering Computing
Edited by: B.H.V. Topping

Proceedings of the Eighth International Conference on the Application of Artificial Intelligence to Civil, Structural and Environmental Engineering
Edited by: B.H.V. Topping

Proceedings of the Seventh International Conference on Computational Structures Technology
Edited by: B.H.V. Topping, C.A. Mota Soares

Proceedings of the Fourth International Conference on Engineering Computational Technology
Edited by: B.H.V. Topping, C.A. Mota Soares
Proceedings of the
Tenth International Conference on
Computational Structures Technology

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

CIVIL-COMP PRESS
## Contents

### Preface

### Editorial Board

**Railway Research: Vehicle Dynamics, Infrastructure Response and their Interaction**  
Special session organised by J. Pombo, L. Baeza and Z. Dimitrovová

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Influence of Pantograph Components on the Contact Quality of the Overhead System for High Speed Trains</td>
<td>J. Pombo, J. Ambrósio and M. Pereira</td>
</tr>
<tr>
<td>3</td>
<td>An Efficient Method for the Mechanical Study of Pantograph-Catenary Interaction</td>
<td>J. Benet</td>
</tr>
<tr>
<td>4</td>
<td>Passive Safety of Railway Interiors using a Multibody Approach</td>
<td>M. Carvalho and J. Ambrosio</td>
</tr>
<tr>
<td>5</td>
<td>Nonlinear Dynamics of a Vehicle with a Semi-Active Suspension</td>
<td>A. Mitura and J. Warminski</td>
</tr>
<tr>
<td>6</td>
<td>Formation of Railway Transition Curves based on Advanced Dynamic Vehicle Models</td>
<td>K. Zboinski and P. Woznica</td>
</tr>
<tr>
<td>7</td>
<td>Simulation of Degraded Wheel-Rail Adhesion Conditions on a Scaled Roller Rig for Railway Bogies: The Effect of Wheel-Roller Contact on Control Performance</td>
<td>M. Malvezzi, E. Meli and L. Pugi</td>
</tr>
<tr>
<td>8</td>
<td>Application of the Moving Shape Functions Method to Curved Railroad Tracks</td>
<td>R. Chamorro and J.L. Escalona</td>
</tr>
<tr>
<td>9</td>
<td>Finite Element Analysis of Contact Problems with Complicated Properties</td>
<td>M.I. Chebakov, V.I. Kolesnikov, E.M. Kolosova and A.V. Nasedkin</td>
</tr>
<tr>
<td>10</td>
<td>Vertical Dynamic Studies of an Indian Railway Vehicle Moving on a Straight Track</td>
<td>H. Kumar and C. Sujatha</td>
</tr>
<tr>
<td>11</td>
<td>Dynamic Response of a Coupled Vehicle-Track System to Real Longitudinal Rail Profiles</td>
<td>C. Vale and R. Calçada</td>
</tr>
<tr>
<td>12</td>
<td>The Influence of Track Modelling Options on the Simulation of Train-Track Interaction</td>
<td>S. Alfi, S. Bruni and E. Di Gialleonardo</td>
</tr>
</tbody>
</table>
13 The Impact of Structural Deformations of Wheelset and Rail on Wheel-Rail Contact
I. Kaiser

14 Development and Implementation of a Finite Element based Wheel-Rail Contact Model for Multibody Applications
S. Magheri, M. Malvezzi, E. Meli and S. Papini

15 A Quasistatic Approach for the Thermoelastic Rolling Contact Problem with Graded Materials
A. Chudzikiewicz and A. Myśliński

16 Tribological Transformations of Surface: A Thermo-Mechanical Modelling
G. Antoni, T. Désoyer and F. Lebon

17 Improving the Speed and Accuracy of the Frictional Rolling Contact Model “CONTACT”
E.A.H. Vollebregt

18 Dynamic Analysis of High Speed Railway Traffic Loads on Ballast and Slab Tracks
J.M. Goicolea, K. Nguyen, F. Galbadón and M. Bermejo

19 A Settlement Model for Ballast at Transition Zones
J.N. Varandas, P. Hölscher and M.A.G. Silva

20 Modeling and Analysis of Vehicle-Track Dynamic Behavior at the Connection between Floating Slab and Non-Floating Slab Track
L. Wu, Z.F. Wen, X.B. Xiao, W. Li and X.S. Jin

21 Reduced Models for Vibration Analysis of Sleepers in High Speed Rail Long Tracks
E. Leon, D.C. Rizos and J.M. Caicedo

22 High Speed Train-Track-Bridge Dynamic Interaction in Transition Zones
A. Roda, J. Martínez, P. Vila and J. Carballeira

23 Modeling the Dynamic Response of a Railway Bridge and Vehicle System
F.L.M. Beghetto and J.E. Abdalla Filho

24 Train Bridge Interaction: Problems and Models
G. Diana, S. Bruni, A. Collina, R. Corradi and S. Alfi

25 The Validity of Simplified Dynamic Analysis of the New Årsta Bridge Response to Moving Trains
I. González

26 Lateral Dynamic Response of Railway Vehicles on Bridges: Numerical Model and Applications
P. Antolín, J.M. Goicolea, M.A. Astiz and A. Alonso

27 The Effect of Track Defects on the Dynamics of Wagons under Brake-Traction Torque
Z. Zhang and M. Dhanasekar

28 Analysis of the Dynamic Forces in the Crossing of Railway Turnouts
V.L. Marke, M.J.M.M. Steenbergen and I. Shevtso

29 Detection of Fatigue Crack Initiation at Welded Joints of Railway Steel Truss Bridges under the Dynamic Action of Moving Trains
W. Qu, Z. He, J. Liu and Y.-L. Pi

30 A Dynamic Finite Element Model for a Wheel Passing a Crossing Nose
M. Pletz, W. Daves and H. Ossberger
31 Modeling Vehicle and Rail Vibrations caused by High Speed Trains using a Coupled Finite Element Methodology
L.A. Matthews, J.C. Caicedo and D.C. Rizos

32 An Explicit Domain Coupling Procedure for Vibration Analysis of High Speed Rail Systems
J. Mulliken, D.C. Rizos and J.M. Caicedo

33 Implementation of a Three-Dimensional Time Domain Formulation for the Prediction of Vehicle Induced Vibrations
N. Correia dos Santos, J. Barbosa, R. Calçada, A. Azevedo and R. Delgado

34 Induced Vibrations because of High-Speed Train Passage on Ballast and Non-Ballast Tracks
P. Galvín, A. Romero and J. Domínguez

35 Potential of Inter-vehicle Lateral Damper for Improving Riding Comfort of High-speed Train
K. Tanifuji and T. Toshimitsu

36 Critical Velocity obtained using Simplified Models of the Railway Track: Viability and Applicability
Z. Dimitrovová and A.F.S. Rodrigues

37 Generalized Beam Theory Dynamic Analysis of a Two-Track High-Speed Railway Bridge Deck
R. Bebiano, N. Silvestre and D. Camotim

38 Interaction of a Beam and Supporting Continuum under a Moving Periodic Load
J. Náprstek and C. Fischer

39 The Free Vibration Response of Elastically Supported Beams traversed by Moving Loads and its Application to Railway Bridges
M.D. Martínez-Rodrigo, E. Moliner and J. Nasarre

40 Effects of the Variability on the Dynamic Certification Criteria: Application to Contact Variability
C. Funfschilling, G. Perrin, T.M. Nguyen and P.E. Gautier

41 A Novel Approach to Extract Reference Trajectories from Measured Data Sets of Urban Light-Rail Systems
M. Tiefenbacher and M. Kozek

42 Prediction of Forced Self-Sustained Oscillations using Anticipating Synchronization
T. Pyragienë

43 Evaluation of the Dynamic Behaviour of Very High-Speed Railway Tracks and their Vibration
P.A. Ferreira and A. López-Pita

**Damage Identification Methods**

Special session organised by J.V. Araujo dos Santos and H.M.R. Lopes

44 An Advanced Genetic Algorithm for Structural Damage Detection
J.D. Villalba and J.E. Laier

45 Multiple Crack Identification in a Beam using a Genetic Algorithm
K. Kumar, A. Dutta and S.K. Deb

46 Parameter Identification using Discrete Wavelet Transform
T. Okhami and S. Koyama

47 Vibration-based Damage Identification in Sandwich Beams using Artificial Neural Networks
M. Sahin
48 Damage Localization based on Modal Parameters using the Finite Element Method and Neural Networks
A. Garcia-Gonzalez, A. Gonzalez-Herrera and A. Garcia-Cerezo

49 A Comparison of Neural Networks and Model Updating Methods for Damage Localization
A. Garcia-Gonzalez, A. Gonzalez-Herrera, J.F. Velasco, A. Garcia-Cerezo and J.M. Diaz Santiago

50 Damage Evaluation using Reflection Intensity from Damage in Metallic and Carbon Fibre Reinforced Polymer Laminated Structures
N. Hu, H. Fukunaga, Y. Liu and Y. Li

51 Application of the Cross-Entropy Method to Estimate Stiffness Distribution in Plate-Type Structures
B.J. Walsh, A. Gonzalez and D. Cantero

52 A Numerical-Experimental Method for the Damage Location in Composite Plates
D. Montalvão, A.M.R. Ribeiro and J. Duarte-Silva

53 An Improved Modal Strain Energy Method for Damage Assessment
B.L. Wahalathantri, D.P. Thambiratnam, T.H.T. Chan and S. Fawzia

54 Damage Localisation in Beams using the Ritz Method and Speckle Shear Interferometry
J.V. Araújo dos Santos, H.M.R. Lopes, J. Ribeiro, N.M.M. Maia and M.A. Pires Vaz

55 The Fourier Coefficient Method for Damage Detection in Beams
A. Morassi

56 The Complex Plane Representation Method for Structural Damage Detection
C. Valente, D. Spina, S. Gabriele and A. De Leonardi

57 On the Robustness of the Average Power Ratios in Damping Estimation: Application in the Structural Health Monitoring of Composites Beams
J. Morlier and H.P. Yin

58 Damage Analysis of Concrete Structures using Polynomial Wavelets
C.M. Silva and L.M.S.S. Castro

59 A Novel Plate Element with Kinematic Assumptions for Modelling Delamination
C. Fernández Casanova, J.L. Pérez-Aparicio and A. Gallego

60 A Neural Approach to Crack Identification in Shafts using Wave Propagation Signals
L. Rubio and B. Muñoz-Abella

61 Computational Simulation of a Non-Destructive Testing Technique for Steel Bar Sizing in Concrete Structures using Eddy Current Testing and Neural Networks

62 Evaluation of Structural Damage in Beam Structures using the Strain Energy Method
I. Štimac Granić and D. Granić

63 On the Effect of a Combination of Passive and Active Electric Potential Computer Tomography Methods using Piezoelectric Film for Crack Identification
S. Kubo, T. Sakagami, S. Ioka and K. Tsuboi

64 A Parallel Implementation of the Sigma-Point Kalman Filter
S. Eftekhar Azam, A. Ghisi and S. Mariani

65 Using the Digital Image Correlation Technique to Measure the Mode Shape of a Cantilever Beam
M.H. Shih, W.P. Sung and S.H. Tung
Maximum Likelihood Estimation of Modal Parameters in Structures Using the Expectation Maximization Algorithm
F.J. Cara, J. Carpio, J. Juan and E. Alarcon

Composite and Adaptive Structures: Modeling, Simulation and Testing
Special session organised by C.M. Mota Soares

A Simple $C^0$ Continuous Higher Order Hellinger-Reissner Type Element for the Analysis of Magneto-Electro-Elastic Plates featuring Continuous Interlaminar Stresses
S.J. Hossain and S. Subhamoy

Finite Element based Simulation, Design and Control of Adaptive Lightweight Structures
M. Fischer, F. Dieringer, G. Iosiflis, K.-U. Bletzinger and R. Wüchner

Modelling and Characterization of Shear Actuated Piezoelectric Fibre Composites
M.A. Trindade and A. Benjeddou

A Constitutive Model for Unidirectional Plies: Implementation and Application in Finite Element Analyses
Th. Flatscher and H.E. Pettermann

Mechanical Modelling of Hybrid Sandwich Composites
C. Chambon and S. Diebels

A Finite Deformation Exact Geometry Four-Node Solid-Shell Element for Piezoelectric Composite Structures
G.M. Kulikov and S.V. Plotnikova

Analytical Solution for the Transient Response of Symmetric Magnetoelectric Laminated Beams
C. Orlando, A. Milazzo and A. Alaimo

A Smart Triangular Finite Element with Drilling Degrees of Freedom
M.A. Neto, R.P. Leal and W. Yu

Nonlinear Dynamic Behaviour of Laminated Plates subjected to Localised Blast Loading
Z. Kazanci and H.S. Turkmen

Analytical Approaches to Model the Stiffness Reduction in Multi-Layered Carbon Fiber Composites with Process-Induced Defects
D. Chrupalla, D. Hartung and I. Khattab

Issues in Finite Element Modelling for Laminated Composites
W.S. Chan, K.L. Lawrence and F. Alamgir

Optimization of Passive Vibration Damping of Rotor Blade Structures using Shunted Piezoelectric Elements
J.-F. Deü, A. Sénéchal and O. Thomas

A Physically Motivated and Layer-based Fatigue Concept for Fiber-Reinforced Plastics
H. Krüger and R. Roljes

A Predictive Model for In-Plane Shear Behaviour of Fiber-Reinforced Cementitious Composites

Modelling and Testing of the Properties of Recovered Composite Material
On the Enhanced Impact Resistance of Damped Composites
C. Toscano and F. Lenzi

Assessment of a Layerwise Mixed Least-Squares Model for Analysis of Multilayered Piezoelectric Composite Plates
F. Moleiro, C.M. Mota Soares, C.A. Mota Soares and J.N. Reddy

Determination of Stochastic Properties of Carbon Nanotube-Epoxy Composites
M.M. Shokrieh and R. Rafiee

Reliability Assessment of Composite Structures with Multiple Failure Modes
C.A. Conceição António and L.N. Hoffbauer

Using the Finite Element Method to Analyze Asymmetric Double Cantilever Beam Specimens
V. Mollón, J. Bonhomme, A. Argüelles and J. Viña

Damage Assessment in Carbon Fibre Reinforced Polymer Plates based on Dynamic Measurements with Fibre Bragg Grating Sensors
J. Frieden, J. Cugnoni, J. Botsis and Th. Gmüer

A Preliminary Study on Flutter Suppression Concepts for Aeronautical Components
L.D. Paulo, A.P. Pereira, P.V. Gamboa, J.M.A. Silva

Multiphysics Analysis of a Functionally Graded Material Conductor with Spatial Variation of Material Properties
J. Murín, V. Kutiš and J. Paulech

Modelling and Analysis of Concrete Structures
Special session organised by I. Paya-Zaforteza and J. Turmo-Coderque

Trends and Perspectives in Non-Linear Analysis of Concrete Structures under Complex Three-Dimensional Load Combinations
J.M. Bairán, S. Mohr and A.R. Marí

A General Analytical Integration of Reinforced Concrete Sections subject to Axial Force and Biaxial Bending
Z.G. Guan and J.Z. Li

Equilibrium Models for Lower Bound Limit Analyses of Reinforced Concrete Slabs
E.A.W. Maunder and A.C.A. Ramsay

Shear-Transfer Capacity of Reinforced Concrete
K.N. Rahal

Bending Moment-Shear Force Interaction for Elements without Stirrups: Improvement of the Eurocode 2 Shear Procedure
A. Cladera, J.L. Pérez and F. Martínez-Abella

A Study of the Shear Behaviour of Reinforced Concrete Sections with Fibre Reinforcement
C.S. Chin, R.Y. Xiao and Z.W. Gong

Calibration of Finite Element Models for Soil-Pile Interaction
J.M. Mayoral, J.Z. Ramírez and S.F. Zaldivar

Modelling the Response of Reinforced Concrete Columns under Biaxial Bending, Shear and Axial Forces
J.M. Bairán, E. Osorio and A.R. Marí
Modelling Columns Supporting Flat Slabs using Stiffened Shell Elements
A.M. Nafie

On the Behavior of Slab-Column Connections under Lateral Loads
E. El-Awady, M. Husian and M. Zaghlal

Numerical Study on the Influence of the Plate to Beam Eccentricity in Usual Building Slabs
H.B.S. Silva, J.B. Paiva and J.S. Giongo

Imperfection Sensitivity Factor in the Buckling of Single and Double Curvature Concrete Shells
A. Tomás, P. Martí and J.P. Tovar

On the Influence of Masonry Infills in Concrete Buildings
J. Leite and P.B. Lourenço

Numerical Modeling and Calibration of Impact Testing of Reinforced Concrete Panels
M. Abdel-Mooty and S. Shaabaan

An Iterative Form-Finding Method for Antifunicular Shapes in Spatial Arch Bridges
J.J. Jorquera Lucerga

A Unified Model Connecting Structural Analysis and Reinforcement Design
D. Xu, Y. Zhao and F.Y. Xu

A New Bridge over the River Palancia for the Motorway A-23 Sagunto-Somport
F. Gonzalez-Vidosa, J. Alcalá, F.J. Martínez and C. Perea

Analysis and Design of Steel and Composite Structures
Special session organised by L.F. Costa Neves

Computational Modelling of Beams Curved In-Plan
R.E. Erkmen and M.A. Bradford

Analytical Evaluation for Local and Overall Buckling Behaviour of Square Steel Tube Truss Members
T. Ohtsuka and S. Motoyui

Material Composition of Bucket Foundation Transition Pieces for Offshore Wind Turbines
A. Nezhentseva, L. Andersen, L.B. Ibsen and E.V. Sørensen

Tests and Ratings of Short-Span Railway Composite Bridges
J. Benčat and D. Papán

Towards an Optimized Layout of Steel and Concrete Composite Building Structures
C. Costa, L.F. Costa-Neves, L.R.O. de Lima and J.G.S. da Silva

Dynamic Analysis of Building Composite Floors Subjected to Human Walking

Vibration Analysis of a Production Platform induced by Mechanical Equipment

Distortional Buckling of Stiffened Cold-Formed Steel Channel Sections
H.R. Naderian, M. Azhari and H.R. Ronagh

Computational Simulation of a Composite Flooring System under Fire Loading
R.Y. Xiao, Z.W. Gong and C.S. Chin
A Finite Element Formulation to Account for Shear-Lag Effects in Composite Bridges with Complex Structural Arrangements
M. Mursi, F. Gara, G. Ranzi and G. Leoni

Connections in Steel and Composite Structures
Special session organised by L.F. Costa Neves

Structural Behavior of Composite Beams Considering the Bond-Slip Effect
H.G. Kwak and J.W. Hwang

Application of Model Updating to Determine the Stiffness of a Bolted Joint and its Validation using Dynamic Testing

Introducing a Method to Enhance a Poor Rigid Connection
M.A. Barkhordari, M. Foroughi, S.M. Aqaee and H. Varaee

Determination of Bending Stiffness in Bolted Joints by the Finite Element Method and Experimental Validation

Advanced Steel Moment Connection Calculation using MS Excel and the Eurocode 3 Component Method
L. Borges, M. Thomann and S. Bouron

An Approximate Method for the Ultimate Strength of Horizontally Curved Composite Plate Girders
M. Bashe, N.E. Shanmugam and A.R. Khalim

Non-Gradient Methods in Optimization
Special session organised by J.F. Aguilar Madeira and H. Pina

Pseudo-Adaptive Penalization to Handle Constraints in Particle Swarm Optimizers
M.S. Innocente and J. Sienz

Global Optimization using Particle Swarm Optimization and a Comparison with Evolutionary Algorithms and an Artificial Immune System
M. Szczepanik, A. Poteralski, W. Kuś and T. Burczyński

Optimum Stacking Sequence Design of a Blended Laminated Wing Structure using Permutation Genetic Algorithms (permGA)
D. Liu, D.C. Barton, V.V. Toropov and O.M. Querin

A Cellular Genetic Algorithm for Structural Optimisation
S. Gholizadeh and E. Salajegheh

Discrete Sizing and Continuous Shaping Optimisation of Space Trusses using a Hybrid Metaheuristic Method
A. Csébfalvi

Multi-Objective Self-Adaptive Genetic Search for Structural Robust Design
C.A. Conceição António

Multi-Objective Optimisation of Hot Forging Processes using a Genetic Algorithm
C.F. Castro, C.C. António and L.C. Sousa

Optimum Design of Concrete Cantilever Retaining Walls using the Harmony Search Algorithm
A. Akin and M.P. Saka
Assessment of Structures using Numerical Models

Special session organised by J.M. Adam and F.J. Pallarés

137 Seismic Reliability of Reinforced Concrete Structures including Soil-Structure Interaction
J. Salajegheh, E. Salajegheh, M.J. Fadaee and M. Khatibinia

138 The “Rognosa” Tower in San Gimignano: Digital Acquisition and Structural Analysis

139 Numerical Modelling of Panel Joints
J. Brozovsky and A. Materna

140 Analysis of the Traffic Induced Vibrations on a 19th Century Heritage Chapel using Finite Element Modelling
P. Tamvakou, M.M. Paredes and R.C. Barros

141 Modelling Progressive Collapse of Structures
D. O’Dwyer and V. Janssens

142 Strong Ground Motion Variability Effects in the Seismic Response of an Urban Bridge Design
J.Z. Ramírez, J.M. Mayoral and F.A. Flores

143 Evaluation of Residual Strength of Pipelines Containing Corrosion Defects
J.E. Abdalla Filho, R.D. Machado, R.J. Bertin and M.D. Valentini

144 On the Numerical Simulation of Impacts for the Investigation of Earthquake-Induced Pounding of Buildings
P. Polycarpou and P. Komodromos

145 Damage Assessment of a Self-Weight Metallic Roof with Skylights using the Finite Element Method
J.J. Del Coz Diaz, F.P. Álvez Rabanal, P.J. García Nieto and A. Lozano Martínez-Luengas

146 Assessment of the Resistance of Steel K-joints between Rectangular Hollow Sections with Galvanizing Holes using the Finite Element Method
J.J. Del Coz Diaz, C. López-Colina Pérez, M.A. Serrano López and F.P. Álvarez Rabanal

147 Investigation of the Gyroscopic Effect on a Wind Turbine Model with ANSYS
X. Liu, K.R. Leimbach and D. Hartmann

148 Assessment of Masonry Arch Behaviour through Photogrammetric Models and the Finite Element Method
J.C. Caamaño, A. Álvarez, J. Armesto and B. Riveiro
149 A New Damage Detection Method for Bridge Condition Assessment
A. Miyamoto and Z.H. Yan

**Computational Structural Stability**
Special session organised by H.A. Mang

150 First Order Solutions of Cracked Timoshenko Columns
G. Vadillo, J.A. Loya and J. Fernández-Sáez

151 Numerical Wrinkling Prediction of Thin Hyperelastic Structures by Direct Energy Minimization
Y. Lecieux and R. Bouzidi

152 Implementation of a Direct Procedure for Critical Point Computations
J. Mäkinen, R. Khouia, A. Fedoroff and H. Marjamäki

153 Computational Probabilistic Design of Time-Dependent Stability of Steel Beams
A. Kudzys, O. Lukoševičienė and A.K. Kvedaras

154 Optimisation of Stability-Constrained Geometrically Nonlinear Shallow Trusses using a Higher Order Path-Following Method
A. Csébfalvi

155 Elastic-Plastic Buckling of Cones under Combined Loading
J. Blachut

156 Compressional Stability Analysis of Composite Plates with Multiple Through-the-Width Delaminations by using Higher Order Shear Deformation Theory
M. Kharazi, M. Taghizadeh and H.R. Ovesy

157 Criterion for Elastic Buckling Analysis
R. Adman and M. Saidani

158 Post-Buckling Analysis of Composite Plates Containing Embedded Delaminations by using Higher Order Shear Deformation Theory
H.R. Ovesy, M. Kharazi and M. Taghizadeh

159 A Semi Energy Finite Strip Method for Post-Buckling Analysis of Relatively Thick Laminates
H.R. Ovesy, M. Hajikazemi and H. Assaei

160 Dynamic Stability of Functionally Graded Material Cylindrical Shells based on Higher-Order Theory using the Finite Strip Method
H.R. Ovesy and J. Fazilati

161 A Dual Energy Criterion for the Stability Analysis of Geometrically Exact Three-Dimensional Frames
H.A.F.A. Santos

**Control of Vibration in Civil Engineering**
Special session organised by R.C. Barros and A. Baratta

162 Analysis of Displacement Vibration Isolation of Nonlinearly Damped Multi-Storey Building Structures using an Output Frequency Response Function
P.F. Guo, Z.Q. Lang and Z.K. Peng

163 Development of a Displacement-Dependent Damper for Base Isolated Structures
M. Ikenaga, K. Ikago and N. Inoue
164 Optimum Seismic Response Control of Multiple Degree of Freedom Structures using Tuned Viscous Mass Dampers
K. Ikago, Y. Sugimura, K. Saito and N. Inoue

165 Suppression of Plate Vibrations by using Attachments
K.A. Alsaif and M.A. Foda

166 Semi-Active Control of Structures using a Combined Genetic Algorithm - Neural Network - Fuzzy Controller
H. Ghafrarzadeh and V. Hamedi

167 Optimum Design of Active and Passive Cable Stayed Footbridges
F.L.S. Ferreira and L.M.C. Simoes

168 Numerical Investigation of Potential Usage of Rubber-Soil Mixtures as a Distributed Seismic Isolation Approach
E. Mavronicola, P. Komodromos and D.C. Charmpis

169 Semi-Active Vibration Control of a Three Degree-of-Freedom Scaled Frame with a Magneto-Rheological Damper
M.B. Cesar and R.C. Barros

170 Optimization of Viscoelastic Dampers as described by the Fractional Rheological Model
Z. Pawlak and R. Lewandowski

171 Seismic-Damper Robust-Design for Protection of Isolated Bridges against Near-Fault Excitations
A.A. Taflanidis

**Probabilistic Approaches to Structural Mechanics**

Special session organised by A. Elhami

172 Numerical Modelling of Structures involving Random Spatial Variability
D.L. Allaix and V.I. Carbone

173 Statistics of Uncertain Dynamical Systems
R. Croquet and E. Souza de Cursi

174 Propagation of Uncertainties using the Method of Moments
M. Beckers and U. Naumann

175 Reliability-Based Design Optimization under Eigen-Frequency Constraints using a System Reliability Approach
Y. Aoues and A. El-Hami

176 Reliability-based Design Optimization of Soil Tillage Machines while considering Fatigue Life Performance
A. Abo Al-Kheer, Y. Aoues, A. El-Hami and M. Eid

177 Integration of Economical Requirements into the Probabilistic Approach for the Design of Soil Tillage Machines
A. Abo Al-kheer, Y. Aoues and A. El-Hami

178 Optimization of the Tube Hydroforming Process using Probabilistic Constraints on Failure Modes
A. Ben Abdessalem, A. El Hami and A. Cherouat

179 A Vector-Space Approach for Stochastic Finite Element Analysis
S. Adhikari
180  Reliability Based Geometry and Topology Optimization of Truss Structures
A.J. Torii, R.H. Lopez, F. Biondini and A. El-Hami

181  A Bilevel Approach to treat the Decomposed Topology Optimization Problem
A. Makrizi, B. Radi and A. El Hami

**Eigenvalues of Continuous Systems**
Special session organised by S. Ilanko

182  Eigenvalues of Continuous Systems
S. Ilanko

183  Free Vibration of Beams Carrying Spring-Mass Systems: A Dynamic Stiffness Approach
J.R. Banerjee

184  Karhunen-Loéve Decomposition and Model Order Reduction applied to the Non-Linear Dynamics of an Extensible Cable
M.R. Escalante, C.P. Filipich and M.B. Rosales

185  Buckling in Corrugated Paperboard Structures by Analytical and Numerical Methods
C. Kueh, N. Navaranjan and M. Duke

186  Theory and Compact Program for the Sturm-Liouville Problem on Homogeneous Trees
W.P. Howson and A. Watson

187  On the Material Coupled Motion of a Composite Bar
W.P. Howson, A. Watson and B. Rafezy

188  The Boundedness of Gorman’s Superposition Method for Free Vibration Analysis
Y. Mochida

189  Natural Frequencies of Tapered Cylindrical Shells by Wittrick-Williams Algorithm
N. El-Kaabazi and D. Kennedy

190  The Rayleigh-Ritz Method to solve Vibration Problems of Complex Structures
L.E. Monterrubio

191  The Superposition Method for Computing Free Vibration Eigenvalues of Elastic Structures
D.J. Gorman and S.D. Yu

**Slender Structures: Analysis and Design**
Special session organised by I. Doltsinis and V. Dias da Silva

192  Numerical Modelling of Normal and High Strength Concrete Slender Columns
A.C. Barrera, J.L. Bonnet, M.L. Romero and M.A. Fernández

193  Numerical Simulation of Transient Vibrational Power Flows in Slender Heterogeneous Structures
É. Savin

194  LTB-UC: A Finite Element Tool for Lateral-Torsional Buckling Analysis of Tapered I-Beams
A. Andrade, P. Providência, D. Camotim and A.H. Duarte

195  Three-Dimensional Frames subject to Large Rotations
V. Dias da Silva
Local, Distortional and Global Post-Buckling Analysis of Frames using Generalised Beam Theory
C. Basaglia, D. Camotim and N. Silvestre

About the Numerical Non-Linear Modelling of Steel Fiber Reinforced Concrete Structures

Nonlinear Three-Dimensional Elasto-Plastic Analysis of Slender Steel Arches
Y.-L. Pi, M.A. Bradford and W. Qu

High Accuracy Post-buckling Analysis of Box Section Struts using Three Different Versions of Finite Strip Method
S.A.M. Ghannadpour, H.R. Ovesy and M. Nassirnia

Refined Beam Models for Static and Dynamic Analysis of Wings and Rotor Blades
E. Carrera, E. Giorcelli, G. Mattiazzo and M. Petrolo

Structural Optimization and Optimal Structural Control under Uncertainty
Special session organised by K. Marti, G.I. Schuëller and T. Vietor

Stochastic Analysis in Parametric Finite Element Modelling
J.G. Sanchez, K. Kirchner and T. Vietor

Sensitivity Analysis and Optimization of Sandwich Plates with Metallic Foam Cores in the presence of Uncertain Parameters
M. Corradi, N. Daina, M. Di Sciuva, M. Gherlone and M. Mattone

Plastic Behaviour and Stability Constraints in the Reliability based Shakedown Analysis and Optimal Design of Skeletal Structures
J. Lógó, M. Movahedi Rad and M. Hjiaj

Ship Structure Design with Optimization under Uncertainty
J.M. Vasconcellos and G. Cury

Stochastic Mechanics for the Assessment of Ancient Masonry Constructions
A. Baratta and O. Corbi

Optimal Structural Control under Stochastic Uncertainty: Stochastic Optimal Open-Loop Feedback Control
K. Marti

Robust Performance Optimization of Linear Controlled Stochastic Systems
A.A. Taflanidis, J.T. Scruggs and J.L. Beck

Robust Control in Smart Structures using the $H_{\infty}$ Criterion and $m$-Analysis
A. Moutsopoulos, G.E. Stavroulakis and A. Pouliezos

Convergence of Successive Regression Approximations for Solving Noisy Equations
I. Deák

Smart Structure Theories motivated by Continuum Physics Formulations
Special session organised by H. Irschik

Control of Plate Vibrations with Piezo Patches using an Infinite Dimensional Port Controlled Hamiltonian System with Dissipation Formulation
T. Rittenschober and K. Schlacher
211 Finite Element Modeling for Coupled Electromechanical Behavior of Nonlinear Piezoelectric Shells as Material Surfaces
Yu. Vetyukov and A. Belyaev

212 The Multiplicative Decomposition in Continuum Mechanics applied to Smart Structures
A. Humer

213 Piezoelectric Vibrations of Elastic Structures with Spatial Local Nonlinearities
R. Heuer

214 Piezoelectric Actuator and Sensor Networks for Active Control of Continuous Structures
M. Krommer, D. Huber, M. Zellhofer and Y. Vetyukov

215 A Continuum Mechanics Approach for Smart Beams: Applications
C. Zehetner and J. Gerstmayr

216 A Continuum Mechanics Approach for Geometrically Nonlinear Shear-Deformable and Smart Beams
H. Irschik and J. Gerstmayr

217 A Three-Dimensional Continuous Material Model for a Pile of Thin Sheets and Frictional Contact
J. Gerstmayr, A. Pechstein and L.G. Aigner

New Trends in the Simulation of Multi-Body Systems with Contact
Special session organised by S. Dumont and F. Lebon

218 The Influence of Contact Model, Friction and Lubrication on the Dynamics of Cylindrical Clearance Joints
C. Pereira, P. Flores, A. Ramalho and J. Ambrósio

219 Efficient Simulation of Structural Failure of Large Scale Complex Structures by using Multibody Dynamics
T. Sikiwat, M. Breidt and D. Hartmann

220 Simulation of Energy Absorption Effects during Helmet Collision with a Hard Obstacle
Č. Mitrović, N. Trišović, T. Lazović and A. Marinković

221 Numerical Modelling of Thermomechanic Couplings in Frictional Contact: Application to Tire Rolling
A. Kongo Kondé, I. Rosu, F. Lebon, N. Cocheteau and L. Seguin

222 Non Smooth Contact Dynamics Approach for Cohesive Multi-Contact Systems
H. Haddad, M. Guessasma and J. Fortin

223 Multiscale Approach for Modelling the Behaviour of Contact Interfaces
H. Hamza, S. Dumont, M. Guessasma and J. Fortin

224 Numerical Simulations of Controlled Collapse Considering Uncertainty
A. Piotrow and W. Graf

Numerical Modelling of Steel and Steel-Concrete Composite Structures
Special session organised by M.L. Romero

225 Non-Linear Analysis of High Performance Steel Plate Girders subjected to Weak Axis Bending
A.N. Gergess and R. Sen

226 Numerical Modelling of the Mechanical Behaviour of Steel Pipes subject to Combined Loads
H.A. Sánchez Sánchez, M.J. Pérez de la Cruz and V. Flores Cobos
227 Residual Stress Measurement and its Numerical Calibration in Welded Steel Plate Girders
J. Néző, L. Dunai and B.H.V. Topping

228 Stability of Stiffened Cold-Formed Steel I-Sections using the Bubble Finite Strip Method
H.R. Naderian, M. Azhari and H.R. Ronagh

229 Finite Element Modelling and Parametric Study of Three-Dimensional Semi-Rigid Composite Joints
B. Gil, R. Goñi and E. Bayo

230 Prediction of the Fire Resistance of Slender Concrete Filled Tubular Columns using a Three-Dimensional Numerical Model
A. Espinos, M.L. Romero, C. Ibañez and A. Hospitaler

231 Shear Test based Identification of the Hardening Behaviour of Stainless Sheets after the Onset of Necking using Cubic Spline Interpolation
M. Vrh, M. Halilović and B. Štok

Built Heritage Strengthened with Composite Materials
Special session organised by D. Oliveira and C. Pellegrino

232 Nonlinear Finite Element Analysis of Strengthened Masonry Buildings subject to Seismic Action

233 In-Plane Behavior of Tuff Masonry Panels Strengthened with Fibre-Reinforced Plastic Cross Layout
G. Marcari, D.V. Oliveira, G. Fabbrocino and P.B. Lourenço

234 Seismic Upgrading Works carried out with Composite Materials on Historic Constructions
A. Borri, G. Castori, M. Corradi and A. Giannantoni

235 Twenty Years of Fiber Reinforced Polymer Applications in Italy for Restoration, Strengthening and Seismic Upgrade of Historical Structures: Materials and Case Studies
P. Casadei and E. Agneloni

236 Comparisons between Numerical and Experimental Results for Fibre-Reinforced Polymer Strengthened Concrete Elements
G. Mazzucco, V. Salomoni, C. Pellegrino and C. Majorana

237 A Thermo-Hygro-Chemo-Mechanical Numerical Approach to Prevent Problems of Repair of Concrete Structures
G. Sciumè and B.A. Schrefler

Simulations of Human and Robotic Movements
Special session organised by A. Eriksson

238 Finite Element Formulations for Fast Computation of Large and Moderately Large Deformations
D. Marinković and M. Zehn

239 Dynamic Interaction between Human Gait and Footbridges
J. Máca, M. Valášek, J. Machač and T. Vampola

240 Non-Linear Finite Element Modelling of a Test System for a Maintenance Robot
H. Marjamäki, J. Mäkinen and P. Pertola

241 Free-Time Optimization of Targeted Movements based on Temporal Finite Element Approximation
R. Pettersson, A. Nordmark and A. Eriksson
Differential Quadrature, Generalized Methods and Related Discrete Element Analysis Methods
Special session organised by C.N. Chen

242 An Element-by-Element Iteration Procedure for the Solution of Discrete Algebraic Systems of DQ-Related Discrete Element Analysis Methods
C.N. Chen

243 A Vectorial Approach for the Formulation of Finite Element Beams in Finite Rotations
S. Lopez and G. La Sala

244 Nonuniform Shear Deformable Axisymmetric Orthotropic Circular Plates Resting on a Two-Parameter Elastic Foundation Solved using the DQEM with a DQ Model
C.N. Chen

Timber Structures
Special session organised by P.H. Kirkegaard

245 Robustness Analysis of a Wide-Span Timber Structure with Ductile Behaviour
P.H. Kirkegaard, J.D. Sørensen, D. Cizmar and V. Rajčić

246 Finite Element Modelling of Shear Walls using Connector Shear Elements based on Continuum Plasticity
U.A. Girhammar, P.J. Gustafsson and B. Källsner

247 A Numerical Study on the Influence of Natural Varying Humidity on the Moisture State of Structural Timber Members
T. Hozjan, G. Turk and S. Svensson

Vibrations of Continuous Systems
Special session organised by A.V. Singh

248 Bi-Linear Reduced Order Models
A. Saito and B.I. Epureanu

249 Identification of Fixed-Free Double-Walled Carbon Nanotube-Based Mass Sensor
C. Versaci, G. Muscolino and I. Elishakoff

250 An Analytical Approach to the Computation of the Frequency Response Function
M. Lázaro, J.L. Pérez-Aparicio and J.J. Gómez-Hernández

Meshless Methods

251 A Local Radial Basis Function Interpolation Model to Simulate Time-Domain Acoustic Wave Propagation
L. Godinho, C. Dors, D. Soares Jr. and P. Amado-Mendes

Finite Element Modelling

252 Comparison of Different Finite Element Models for the Simulation of the Ring-Ball on Ring Test
J. Barredo, L. Hermanns, I. del Rey, A. Fraile and E. Alarcón

253 Comparison of Different Finite Element Models for the Transient Dynamic Analysis of Laminated Glass for Structural Applications
J. Barredo, M. Soriano, L. Hermanns, A. Fraile, M. López and M.S. Gómez
Finite Element Technology
254 Special Finite Element Formulations based on Asymptotic Thin Layer Models
   C. Sussmann and D. Givoli
255 A Co-Rotation Shell Element with Material Nonlinearities
   J. Xu, K.H. Tan, Z.X. Li and C.K. Lee

Extended Finite Element Method
256 Accurate Stress Recovery for the Two-Dimensional Fixed Grid Finite Element Method

Discrete Element Methods
257 Discrete Elements in the Evaluation of the Cracking Process in Concrete Beams
   M.A.M. Shzu and G. Doz
258 The Distinct Element Method Simulation of Trap Performance of Check Dams used for Wood Contained
   Debris Flow
   S. Katsuki and H. Shibuya

Graph Techniques
259 Canonical Forms and Graph Theory for Calculating the Eigenfrequencies of Symmetric Space Frames
   A. Kaveh and L. Shahryari
260 Regular Graphs Factorization for Partitioning
   M. Mahdavinia and Y. Navabzadeh Esmæeley
261 Eigensolution of Locally Modified Regular Structures using the Shifted Inverse Iteration Method
   A. Kaveh and H. Fazli

Augmented Lagrangian Method
262 An Augmented Lagrange Method to Solve Large Deformation Three-Dimensional Contact Problems
   M. Tur, J. Albelda, E. Giner and J.E. Tarancón

Microstructures
263 Hybrid Computing Model for Decomposed Partial Differential Equation Systems arising from
   Microstructural Three-Dimensional Problems
   K. Schrader and C. Könke

Nanotechnology
264 Numerical Analysis of Complex Systems Evolution with Phase Transformations at Different Spatial Scales
265 Electrospun Nanofiber Structures for Advanced Nanocomposites
   L.Yu. Kossovich and Y. Salkovskiy
Modelling Discontinuities

266 Two Fields Formulations for the Implementation of an Extrinsic Cohesive Law
F. Cazes, M. Coret and A. Combescure

267 Progress in the Formulation of Finite Elements with Embedded Discontinuities to Model Failure in Solids
F. Armero and J. Kim

Concrete Modelling

268 Mesh Size Dependency and Related Aspects of Lattice Models
M. Vořechovský and J. Eliáš

269 Crack Prediction in Local and Non-Local Finite Element Models for Reinforced Concrete
S. Chan, A.D. Jefferson and R.J. Lark

270 Multi-Scale Modelling of Concrete Degradation such as Efflorescence and Laitance
L. Jendele, I. Smid and J. Cervenka

Composites: Damage

271 Discrete Element Method Simulation of the Damage Evolution in Cross-Ply Laminate under Tensile Loading
D.M. Yang, J.Q. Ye, Y.Q. Tan and Y. Sheng

272 Simulating the Effect of Porosities on Stiffness and Strength of Composite Materials
R. Rolfes, S. Czichon, M. Vogler and E. Jansen

Composite Materials

273 On Selected Cost Functionals for Laminated Composites
P. Procházka and Š. Pešková

274 The Development of a Program to Aid the Design of Composite Structures
A. Ramsaroop and K. Kanny

275 Numerical Analysis and Optimisation of Tubular Adhesive Joints under Tensile Loading
J.Y. Cognard, H. Devaux and L. Sohier

Modelling of Foam Composites

276 Evaluation of the Stress State in Aluminium Foam Sandwiches
F. Palano, V. Dattoma, R. Nobile and F.W. Panella

Composite Plates

277 Dynamic Response of a Laminated Composite Plate with Viscoelastic Stiffeners subject to Blast Load
O. Acar Ezer, D. Kececi Balkan, H.S. Türkmen and Z. Mecitoğlu

278 Dynamic Behaviour of the Laminated Sandwich Plate with a Stepwise Graded Viscoelastic Core
E. Tengiz, D.K. Balkan, H.S. Türkmen and Z. Mecitoğlu

279 An Analysis of Buckling Delamination of Composite Rectangular Thick Plates with an Inner Rectangular Crack
S.D. Akbarov, N. Yahnioglu and E.E. Karatas
Non-Linear Materials
280 Explicit Nonlinear Formulation of Bridge Bearings with the Mullins Effect  
M.H.B.M. Shariff

Layered, Functionally Graded and Piezoelectric Composite Laminates
281 A Reduced Order Model for Structural-Acoustic Internal Problems with Piezoelectric Shunt Damping  
W. Larbi, J.-F. Deu and R. Ohayon
282 Some Finite Element Approaches with Symmetric Matrices for Modelling of Porous Piezocomposite Devices  
subject to Acoustic and Electric Loads  
G. Iovane and A. Nasedkin
283 The Effects of Aspect Ratio on Postbuckling Behavior of Rectangular Plates of Functionally Graded Materials  
H. Assaee, H.R. Ovesy, M. Hajikazemi and M.H. Sadr Lahidjani
284 Dynamic Equations for an Orthotropic Piezoelectric Plate  
K. Mauritsson and P.D. Folkow
285 A Theoretical Investigation on the Free Vibration of Functionally Graded Beams  
N. Wattanasakulpong, B.G. Prusty, D.W. Kelly and M. Hoffman
286 Thermal Buckling Analysis of Functionally Graded Plates using the Finite Strip Method  
S.A.M. Ghannadpour, H.R. Ovesy and M. Nassirnia
287 A Higher-Order Exact Geometry Solid-Shell Element undergoing Finite Rotations  
S.V. Plotnikova and G.M. Kulikov

Plate and Shell Structures
288 A New Accurate yet Simple Shear Flexible Triangular Plate Element with Linear Bending Strains  
L. Damkilde and R.R. Pedersen
289 Cross-Stiffened Circular Plates: An Elasto-Plastic Large Deflection Analysis  
G.J. Turvey and M. Salehi
290 Dynamic Behaviour of Tapered Plates subjected to Blast Loading  
S. Susler, Z. Kazanci and H.S. Turkmen
291 Geometrical and Material Non-Linear Analyses of Model Submarine Pressure Hulls  
C.T.F. Ross, C. Bull, M. Al-Enezi and A.P.F. Little

Metal Forming
292 The Stress in Thickness Direction in Simulations with Shell Elements  
St. Kugler, P.A. Fotiu and J. Murin
293 An Experimental and Numerical Study of Ductile Damage for Cold Metal Forming Applications  
P.O. Bouchard, S. Fanini and U. Ziarsolo

Boundary Element Method
294 Inelastic Nonuniform Torsion of Bars using the Boundary Element Method  
E.J. Sapountzakis and V.J. Tsipiras
295 Sound Emission from a Three-Dimensional Enclosure with an Opening using a Boundary Element Method

296 Boundary Element Formulation for Contact Analysis using a Tangent Operator
E.D. Leonel and W.S. Venturini

297 Nonlinear Analysis of Timoshenko Beams on a Tensionless Three-Parameter Foundation
E.J. Sapountzakis and A.E. Kampitsis

Boundary Integral Methods

M.Y. Antes, Y.S. Karinski and D.Z. Yankelevsky

Hybrid Element Methods

299 Hybrid-Trefftz Displacement Elements for Incompressible Biphasic Media
J.A. Teixeira de Freitas and M. Toma

300 Hybrid-Mixed Stress Finite Element Models for the Dynamic Analysis of Reinforced Concrete Frame Structures
M.R.T. Arruda and L.M.S.S. Castro

301 Hybrid Computational Modelling of Heterogeneous Materials
J. Novák, L. Kaczmarczyk, P. Grassl and C.J. Pearce

302 A Hybrid Finite Element-Scaled Boundary Finite Element Method for Multiple Cohesive Crack Propagation
E.T. Ooi and Z.J. Yang

303 Time Integration Procedures with Hybrid-Mixed Stress Finite Elements
M.R.T. Arruda and L.M.S.S. Castro

304 A Hybrid Finite Element-Scaled Boundary Finite Element Method for Reinforced Concrete Modelling
E.T. Ooi and Z.J. Yang

305 Hybrid Displacement Finite Element Models for the Physically Nonlinear Analysis of Three-Dimensional Concrete Structures
J.M.A. Martins and L.M.S.S. Castro

306 Hybrid-Mixed Stress Finite Element Models for the Physically Non-Linear Analysis of Concrete Three-Dimensional Structures
C.S.R. Garrido and L.M.S.S. Castro

Elasto-Plasticity Problems

307 Consistently Linearized Implicit Algorithm for Orthotropic Elasto-Plasticity with Mixed Hardening
M.A. Caminero and F.J. Montáns

308 Mixed Finite Elements with Enhanced Plastic Behavior
A. Bilotta, G. Garcea and L. Leonetti

309 Strategies for the Analysis of the Non-Linear Behaviour of an Adhesive in Bonded Assemblies
R. Créac’hcadec and J.Y. Cognard
310 The Finite Cell Method for Elasto-Plastic Problems
   A. Abedian, J. Parvizian, A. Düster, H. Khademyzadeh and E. Rank

Structural Design
311 Design of Submarine Pressure Hulls under External Hydrostatic Pressure
   C.T.F. Ross, T. Whittaker and A.P.F. Little

Re-Analysis of Structures
312 Reanalysis of Nonlinear Structures using a Reduction Method of Combined Approximations
   M. Guedri, T. Weisser and N. Bouhaddi

Structural Optimization
313 A Bi-level Method for Shape and Member Sizing Optimization of Frame Structures
   F. Flager, A. Adya and M. Fischer
314 Efficient Global Optimization of a Structural Frame
   B. Horowitz, L.J.N. Guimarães and S.M.B. Afonso
315 Cost Optimum Design of Reinforced Concrete Simply Supported One-way Slabs
   I. Merta and S. Kravanja

Topology Optimization
316 Topology Optimization for Chiral Elastic Bodies
   D. Veber and A. Taliercio
317 Conceptual Layouts and Angles of DiaGrid for Building Frames using Topological Optimization
318 A Consistent and Efficient Unconstrained Multicriterion Approach for Topology Optimization
   Y.-H. Chou and C.-Y. Lin
319 Reliability-Based Topology Optimisation of Space Structures using Ant Colony Optimisation
   M.J. Fadaee, E. Salajegheh, J. Salajegheh and M. Mashayekhi
320 Heuristic Features of the Co-SIMP Algorithm in Topology Optimization: Numerical Examples
   V. Pomezanski

Crashworthiness
321 The Dynamic Simulation of Crashworthy Landing Gear
   T.U. Kim, S.C. Kim and I.H. Hwang

Vehicle Safety
322 Safety Requirements and Crashworthiness for an Unbelted Occupant
   B. Alzahabi
323 Optimum Design of a Rack and Pinion Gear Pair using the Taguchi Method
   W.S. Chung, D.H. Jung, H.S. Song and Y.K. Seo
Uncertainties in Stochastic Systems

324 Frequency Response of Stochastic Dynamic Systems: A Modal Approach
   S. Adhikari and B. Pascual

325 Stochastic System Identification using Kalman Filtering
   S. Eftekhar Azam and S. Mariani

Seismic Engineering

326 Corrected Ground Motion Functions in the Case of a Near-Fault Earthquake
   J. Györgyi

327 Impact of Seismic Design Criteria on Progressive Collapse Investigation
   O.A. Mohamed, A.N. Najmal and O.F. Abbas

328 Inelastic Time History Analysis of Steel Moment Frames subjected to Pulse-like Ground Motions
   S. Yaghmaei-Sabegh

329 Evaluation of the Seismic Behaviour of Steel Transmission Towers with Different Boundary Conditions
   T. Mazda, M. Matsumoto, N. Oka and N. Ishida

330 Probabilistic Study of the Seismic Behaviour of Structures
   A. Yazdani

331 Numerical Analysis of Panel Buildings subject to Seismic Loading
   J. Brozovsky and A. Materna

332 Implementing Modal Analysis Software on Multi-Core Computers: With Application to Seismic Analysis of
   Space Trusses
   R.I. Mackie

Dynamics: General

333 Using a Rotational Periodicity Method for the Calculation of the Natural Vibration of a Turbine Blade of
   Progressive Design
   P. Polach

334 The Finite Strip as a Spectral Element for Moving Load Analysis
   I. Kožar, N. Torić and Ž. Jeričević

Non-Linear Dynamics

335 Positional Finite Elements for Geometrical Non-Linear Dynamics of Shells
   H.B. Coda

336 Nonlinear Dynamics of a Support Excited Portal Frame Structure
   R.M. Brasil and L.M. Orbolato

Dynamics: Human Motion

337 A Topology Design of a Composite Dance Hall Roof
   P. Rosko
338 A Spectral Method for Predicting Floor Vibration Produced by Rhythmic Crowd Loads
T. Ji and T. Zheng

Penalty Methods
339 The Bipenalty Method for Explicit Time Integration
H. Askes, M. Caramés-Saddler and A. Rodríguez-Ferran
340 Introducing Negative Penalty Functions in Least Square Optimisation
S. Ilanko and G.K. Bharathy

Damping
341 Bending Vibrations of Euler-Bernoulli Beams Treated with Non-Local Damping Patches
S. Gonzalez-Lopez and J. Fernandez-Saez
342 On Damping Experimental Estimation
C. Rainieri, G. Fabbrocino and E. Cosenza

Engineering Simulation
343 Spatial Motion Analysis of a Floating Crane and a Cargo with Elastic Boom based on a Three-Dimensional Beam
K.P. Park, J.H. Cha and K.Y. Lee

Engineering Analysis and Design
344 Static Modal Formulation of Aeroelastic Effects in Overall Aircraft Loads Models
I. Ruiz Juretschke, M. Calvo Blanco, J.M. Román García and J. López-Díez
345 Design and Analysis for a Drum Type Washing Machine with a Fixed Tub Structure

Masonry Structures
346 Numerical Modelling of Unreinforced Masonry Walls using Contact Elements
A.H. Akhaveissy
347 Analysis of Masonry Panels using the No-Tension Approach
A. Baratta and I. Corbi
348 Seismic Design of Masonry Walls subject to Out-of-Plane Bending
L. Reindl, J. Park, H. Nords and C. Butenweg
349 Evaluation of Nonlinear Behaviour of Historical Masonry Structures subject to Wind Load using Finite Element Analysis
A. Mutoh
Investigation of the Seismic Behaviour of Masonry Infilled Frames
M. Foroughi, M.A. Barkhordari and S.M. Aqaee

A Nonlinear Multimodal Procedure for Masonry Buildings
H. Norda, L. Reindl and K. Meskouris

Structural Assessment of Cantilevered Stone Stairs
D. O’Dwyer and O. Bashoren

Assessment of Masonry Arch Bridge Behaviour subject to Service and Flood Loads
M. Afraz Habibi and M.T. Ahmadi

A Numerical Study of Non Structural Masonry Walls with Bed Joint Reinforcement subject to Flexure
E.A. Oliveira, R.M. Silva and P.B. Lourenço

Structural Mechanics

An Improved Third-Order Mass Matrix for Timoshenko’s Flexural Wave Propagation
J.-E. Laier

Estimation of the Critical Flutter Load of a Non-uniform Double-beam subjected to a Follower Force
I. Takahashi

An Innovative Timoshenko Beam Element
M. Memari and R. Attarnejad

Cable, Truss and Space Structures

Dynamic Analysis of Cable Roofs under Turbulent Wind using a Frequency Domain Approach
S.A. Ghafari Oskoei, G. McClure and I. Mahmoudzadeh Kani

Seismic Reliability of Double-Layer Grid Space Structures
E. Salajegheh and I. Mansouri

Influence of Joint-Rigidity on the Behaviour of Single-Layer Square Plan Structures
A.M. Altuna, A.L. Arancibia and I. Puente

Complex Nonlinear Analysis of a Cable Roof Structure based on Diagnostics and Tests
S. Kmet and M. Tomko

The Behaviour of Cable Structures subject to Supporting System Deformation
V. Kulbach and J. Idrum

A Modular Truss System for Pedestrian Traffic and a Computer Implementation of an Algorithm for Creating the Truss Structure
M. Zawidzki

Tall Buildings

Dynamic Analysis of Non-Planar Coupled Shear Walls with Stiffeners using a Continuous Connection Method
C.D. Turkozer, O. Aksogan, E. Emsen and R. Resatoglu
Symbolic Computing

365  Software Supported Implementation of Efficient Solid-Shell Finite Elements
    S. Mattern and K. Schweizerhof

Author Index

Keyword Index
The Tenth International Conference on
Computational Structures Technology
is organised in association with:
Preface

This volume comprises the summaries of contributed papers presented at The Tenth International Conference on Computational Structures Technology (CST 2010) held in Valencia, Spain from 14 to 17 September 2010. The full papers from the conference are available on the accompanying CD-ROM. The ECT conference series began in Edinburgh during 1991. The 2010 conference was held concurrently with The Seventh International Conference on Engineering Computational Technology (ECT 2010).

The special sessions included in this volume of proceedings are:

- Railway Research: Vehicle Dynamics, Infrastructure Response and their Interaction
  organised by J. Pombo, L. Baeza and Z. Dimitrovová
- Damage Identification Methods
  organised by J.V. Araujo dos Santos and H.M.R. Lopes
- Composite and Adaptive Structures: Modeling, Simulation and Testing
  organised by C.M. Mota Soares
- Modelling and Analysis of Concrete Structures
  organised by I. Paya-Zaforteza and J. Turmo-Coderque
- Analysis and Design of Steel and Composite Structures
  organised by L.F. Costa Neves
- Connections in Steel and Composite Structures
  organised by L.F. Costa Neves
- Non-Gradient Methods in Optimization
  organised by J.F. Aguilar Madeira and H. Pina
- Assessment of Structures using Numerical Models
  organised by J.M. Adam and F.J. Pullarés
- Computational Structural Stability
  organised by H.A. Mang
- Control of Vibration in Civil Engineering
  organised by R.C. Barros and A. Baratta
- Probabilistic Approaches to Structural Mechanics
  organised by A. Elhami
- Eigenvalues of Continuous Systems
  organised by S. Ilanko
- Slender Structures: Analysis and Design
  organised by I. Doltsinis and V. Dias da Silva
- Structural Optimization and Optimal Structural Control under Uncertainty
  organised by K. Marti, G.I. Schuëller and T. Vietor
- Smart Structure Theories motivated by Continuum Physics Formulations
  organised by H. Irschik
- New Trends in the Simulation of Multi-Body Systems with Contact
  organised by S. Dumont and F. Lebon
• Numerical Modelling of Steel and Steel-Concrete Composite Structures
  organised by M.L. Romero
• Built Heritage Strengthened with Composite Materials
  organised by D. Oliveira and C. Pellegrino
• Simulations of Human and Robotic Movements
  organised by A. Eriksson
• Differential Quadrature, Generalized Methods and Related Discrete Element Analysis Methods
  organised by C.N. Chen
• Timber Structures
  organised by P.H. Kirkegaard
• Vibrations of Continuous Systems
  organised by A.V. Singh

We are particularly grateful to the organisers of these special sessions.

The following sessions are also included in this volume:

• Meshless Methods
• Finite Element Modelling
• Finite Element Technology
• Extended Finite Element Method
• Discrete Element Methods
• Graph Techniques
• Augmented Lagrangian Method
• Microstructures
• Nanotechnology
• Modelling Discontinuities
• Concrete Modelling
• Composites: Damage
• Composite Materials
• Modelling of Foam Composites
• Composite Plates
• Non-Linear Materials
• Layered, Functionally Graded and Piezoelectric Composite Laminates
• Plate and Shell Structures
• Metal Forming
• Boundary Element Method
• Boundary Integral Methods
• Hybrid Element Methods
• Elasto-Plasticity Problems
• Structural Design
• Re-Analysis of Structures
• Structural Optimization
• Topology Optimization
• Crashworthiness
• Vehicle Safety
• Uncertainties in Stochastic Systems
• Seismic Engineering
• Dynamics: General
• Non-Linear Dynamics
• Dynamics: Human Motion
• Penalty Methods
• Damping
• Engineering Simulation
• Engineering Analysis and Design
• Masonry Structures
• Structural Mechanics
• Cable, Truss and Space Structures
• Tall Buildings
• Symbolic Computing

Other papers presented at the conferences in 2010 are published as follows:

• The Review Lectures from CST 2010 and ECT 2010 are published in:
• The Invited Lectures from CST 2010 are published in:
• *The Invited Lectures from ECT 2010 are published in:*  

• *The Contributed Papers from ECT 2010 are published in:*  

We would like to thank the “Universidad Politécnica de Valencia”, particularly the “Escuela Técnica Superior de Ingeniería del Diseño” and the “Centro de Formación Permanente”, for their help in the organisation of these conferences.

We are grateful to Jelle Muylle for designing these conference proceedings 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 before and during the conference.

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

Dr J.M. Adam  
Dr F.J. Pallarés  
Professor R. Bru  
Professor M.L. Romero  
Universidad Politécnica de Valencia, Spain
Editorial Board

The members of the Conference Editorial Board for the Tenth International Conference on Computational Structures Technology are:

Dr J.M. Adam, Spain
Prof. H. Adeli, USA
Prof. S. Adhikari, UK
Prof. Dr S.M.L. Adriaenssens, Belgium
Prof. C. Agelet de Saracibar, Spain
Prof. J.F. Aguilar Madeira, Portugal
Prof. E. Alarcon, Spain
Prof. M. Amabili, Canada
Dr L. Andersen, Denmark
Prof. C.A.C. Antonio, Portugal
Prof. T. Aoki, Japan
Prof. H.R. Arabnia, USA
Prof. J.V. Araujo dos Santos, Portugal
Dr R. Ardito, Italy
Prof. F. Armero, USA
Dr A.F. Ashour, UK
Prof. H. Askes, UK
Prof. N.O. Attoh-Okine, USA
Dr C.E. Augarde, UK
Prof. J. Awrejcowicz, Poland
Dr L. Baeza, Spain
Dr A. Bahreininejad, Iran
Prof. B. Balachandran, USA
Prof. J.R. Banerjee, UK
Prof. C.C. Baniotopoulos, Greece
Dr T.N. Baranger, France
Prof. A. Baratta, Italy
Prof. H.J.C. Barbosa, Brazil
Prof. E. Barkanov, Latvia
Dr M.A. Barkhordari, Iran
Prof. R.C. Barros, Portugal
Prof. K.J. Bathe, USA
Prof. J.-M. Battini, Sweden

Prof. F. Bay, France
Dr R.G. Beale, UK
Prof. A.A. Becker, UK
Prof. G. Beer, Austria
Prof. T. Belytschko, USA
Prof. A.C. Benim, Germany
Prof. A. Benjedou, France
Dr M. Betti, Italy
Prof. N. Bicanic, UK
Prof. M.L. Bittencourt, Brazil
Prof. Z. Bittnar, Czech Republic
Prof. J. Blachut, UK
Prof. P. Boisse, France
Prof. M. Bonnet, France
Prof. F. Bontempi, Italy
Assoc. Prof. B. Boroomand, Iran
Dr P.O. Bouchard, France
Prof. Ph. Bouillard, Belgium
Prof. M.A. Bradford, Australia
Prof. F.A. Branco, Portugal
Prof. A. Brenčič, Italy
Prof. D. Briassoulis, Greece
Dr J. Brozovsky, Czech Republic
Prof. R. Bru, Spain
Dr M. Brunig, Germany
Dr J.W. Bull, UK
Prof. T. Burczynski, Poland
Prof. F. Buyle-Bodin, France
Prof. P.A. Calderon, Spain
Prof. D. Camotim, Portugal
Prof. E. Carrera, Italy
Prof. F. Casciati, Italy
Dr G. Cederbaum, Israel
Prof. A.H.C. Chan, UK
Dr S. Chandra, India
Prof. C.-N. Chen, Taiwan
Prof. W.F. Chen, USA
Prof. G.D. Cheng, China
Dr J.-R.C. Cheng, USA
Prof. J.L. Chenot, France
Prof. F. Chinesta, France
Prof. C. Cinquini, Italy
Prof. H.B. Coda, Brazil
Dr J.P. Coyette, Belgium
Prof. J.J. Coz Diaz, Spain
Prof. A. Csebfalvi, Hungary
Prof. M. Cuomo, Italy
Prof. V.D. da Silva, Portugal
Prof. L. Damkilde, Denmark
Dr K. Davey, UK
Prof. S. De, USA
Prof. R. de Borst, Netherlands
Prof. J.A.T. de Freitas, Portugal
Dr M. De Giorgi, Italy
Prof. G. De Roeck, Belgium
Prof. G. de Saxcé, France
Prof. M. Di Paola, Italy
Prof. Z. Dimitrovová, Portugal
Prof. M. Doblaré, Spain
Dr M. Dolenc, Slovenia
Dr I. Doltsinis, Germany
Prof. M. Domaszewski, France
Dr S. Dumont, France
Prof. L. Dunai, Hungary
Prof. J. Eberhardsteiner, Austria
Prof. A. Elhami, France
Prof. A. Eriksson, Sweden
Prof. R.E. Erkmen, Australia
Dr J.M. Escobar Sánchez, Spain
Prof. C.A. Felippa, USA
Prof. G. Ferro, Italy
Prof. F.C. Ferreira, Portugal
Prof. D.O. Ferro, USA
Prof. A. Frangi, Italy
Prof. D.M. Frangopol, USA
Prof. M.I. Friswell, UK
Prof. M.B. Fuchs, Israel
Prof. G. Gambolati, Italy
Prof. V. Gattulli, Italy
Prof. P. Gaudenzi, Italy
Prof. L. Gaul, Germany
Prof. Dr-Ing. N. Gebbeken, Germany
Prof. J.-C. Gelin, France
Prof. R.I. Gilbert, Australia
Prof. D. Givoli, Israel
Prof. L. Godinho, Portugal
Prof. F. Gonzalez Vidosa, Spain
Prof. R.V. Grandhi, USA
Prof. D.E. Grierson, Canada
Prof. M. Grigoriu, USA
Prof. A.A. Groenwold, South Africa
Dr Z.W. Guan, UK
Prof. R.M. Guedes, Portugal
Prof. Dr K. Hackl, Germany
Prof. I. Hagiwara, Japan
Prof. Dr-Ing habil D. Hartmann, Germany
Dr E. Haug, France
Prof. G.R. Heppler, Canada
Prof. S. Hernández Ibáñez, Spain
Prof. G. Hofstetter, Austria
Prof. M. Hoit, USA
Prof. J. Holnicki-Szulc, Poland
Prof. O.S. Hopperstad, Norway
Prof. N. Hu, Japan
Prof. T.J.R. Hughes, USA
Dr L. Iannucci, UK
Prof. A. Ibrahimbegovic, France
Assoc. Prof. S. Ilanko, New Zealand
Prof. G. Iovane, Italy
Prof. H. Irschik, Austria
Prof. I. Iskhakov, Israel
Prof. C.A. Issa, Lebanon
Prof. A. Ivankovic, Ireland
Dr P. Ivanyi, Hungary
Dr S. Ivorra, Spain
Prof. B.A. Izzuddin, UK
Dr A.D. Jefferson, UK
Prof. M. Kaliske, Germany
Dr E.S. Kameshki, Kingdom of Bahrain
Prof. M. Kaminski, Poland
Prof. T. Kant, India
Prof. J.D. Kaplunov, UK
Prof. D.L. Karabalis, Greece
Prof. A. Kaveh, Iran
Professor D. Kennedy, UK
Dr A.I. Khan, Australia
Prof. P.H. Kirkegaard, Denmark
Prof. U. Kirsch, Israel
Prof. M. Kojic, Serbia
Dr P. Komodromos, Cyprus
Prof. L.Yu. Kossovich, Russia
Dr A.S.K. Kwan, UK
Prof. Y.W. Kwon, USA
Prof. P. Ladeveze, France
Dr N.D. Lagaros, Greece
Dr Z.Q. Lang, UK
Prof. K.L. Lawrence, USA
Prof. E. Lebon, France
Dr C.K. Lee, Singapore
Prof. U. Lee, Korea
Prof. W.-I. Lee, Korea
Dr C.J. Leo, Australia
Prof. A.Y.T. Leung, Hong Kong
Prof. R. Levy, Israel
Prof. R. Lewandowski, Poland
Prof. R.W. Lewis, UK
Prof. K.M. Liew, Hong Kong
Prof. A. Liolios, Greece
Prof. G.-R. Liu, Singapore
Prof. S.H. Lo, Hong Kong
Prof. J. Logo, Hungary
Prof. H.M.R. Lopes, Portugal
Prof. P.B. Lourenco, Portugal
Prof. J. Maca, Czech Republic
Dr R.I. Mackie, UK
Prof. K. Maekawa, Japan
Prof. C.E. Majorana, Italy
Prof. H.A. Mang, Austria
Prof. S. Mariani, Italy
Prof. Dr K. Marti, Germany
Prof. D.M. Martinez-Rodrigo, Spain
Dr E.A.W. Maunder, UK
Prof. I. May, UK
Prof. F.M. Mazzolani, Italy
Dr C.T. McCarthy, Ireland
Prof. T.J. McCarthy, Australia
Prof. G. McClure, Canada
Dr G. Mejak, Slovenia
Prof. R.V.N. Melnik, Canada
Prof. P. Miguel, Spain
Prof. A. Mikkola, Finland
Dr G. Milani, Italy
Assoc. Prof. E.S. Mistakidis, Greece

Prof. A. Miyamoto, Japan
Prof. F.J. Montans, Spain
Prof. R. Montenegro Armas, Spain
Prof. G. Montero, Spain
Prof. C.A. Mota Soares, Portugal
Prof. C.M. Mota Soares, Portugal
Prof. J. Murin, Slovakia
Prof. G. Muscolino, Italy
Prof. C. Navarro, Spain
Dr L.A.C. Neves, Portugal
Prof. L.F. Costa Neves, Portugal
Prof. G.P. Nikishkov, Japan
Prof. A.K. Noor, USA
Dr D. O'Dwyer, Ireland
Prof. R. Ohayon, France
Dr D.V. Oliveira, Portugal
Prof. E. Onate, Spain
Dr H.R. Ovesy, Iran
Dr L. Palleares, Spain
Dr F.J. Palleares, Spain
Prof. E. Papa, Italy
Dr V. Papadopoulos, Greece
Dr B. Patzak, Czech Republic
Dr I. Paya-Zaforteza, Spain
Dr C.J. Pearce, UK
Dr C. Pellegrino, Italy
Prof. M.S. Pereira, Portugal
Prof. J. Petrolito, Australia
Prof. Y Petryna, Germany
Dr Y.-L. Pi, Australia
Dr B. Picoux, France
Prof. H. Pina, Portugal
Prof. Peter M. Finsky, USA
Dr J. Plesek, Czech Republic
Dr J. Pombo, Portugal
Prof. C.P. Providakis, Greece
Prof. J. Rakowski, Poland
Prof. F.G. Rammerstorfer, Austria
Prof. E. Rank, Germany
Prof. B.N. Rao, India
Prof. M. Raoof, UK
Dr Y. Ribakov, Israel
Dr P. Ribeiro, Portugal
Dr A. Riccio, Italy
Prof. H. Rodrigues, Portugal
Dr K. Rohwer, Germany
Prof. Dr-Ing. habil R. Rolfes, Germany