

Table of Contents

Preface and Committees

Keynote Lectures

Theory and Practice in Reducing the Vulnerability of Residential Buildings Subjected to Extreme Loads - a Multi Hazard Perspective D.Z. Yankelevsky, S. Schwarz and Y. Karinski	3
Urban Habitat Constructions under Catastrophic Events: The COST C26 Action F.M. Mazzolani	15
Mitigating Impact Frailty of Concrete with Fiber Reinforcement N. Banthia	26

Chapter 1: Performance of Materials

Dynamic Fracture of Concrete–3D Numerical Study of Compact Tension Specimen J. Özbolt, A. Sharma and H.W. Reinhardt	39
Free Water Influence on the Dynamic Tensile Behaviour of Concrete B. Erzar and P. Forquin	45
How to Determine the Dynamic Fracture Energy of Concrete. Theoretical Considerations and Experimental Evidence J. Weerheijm and I. Vejt	51
Compressive Behavior of Plain and Fiber-Reinforced High-Strength Concrete Subjected to High Strain Rate Loading S.S. Wang, M.H. Zhang and S.T. Quek	57
Experimental Investigation of High Strain-Rate Behaviour of Glass M. Peroni, G. Solomos, V. Pizzinato and M. Larcher	63
Simulation of Laminated Glass Loaded by Air Blast Waves M. Larcher, M. Teich, N. Gebbeken, G. Solomos, F. Casadei, G.A. Falcon and S.L. Sarmiento	69
Meso-Scale Simulation of Concrete: Blast and Penetration Effects and AAR Degradation G. Cusatis, G. Di Luzio and L. Cedolin	75
Numerical Modelling of Honeycomb Energy Dissipating Materials J. Reay, T. Bennett and A. Tyas	81
Dynamic Behaviour of Reinforcing Steel Bars in Tension E. Cadoni, M. Dotta, D. Forni and N. Tesio	86
Analysis of Impact Response of Sand Cushion for Rockfall by Distinct Element Method T. Watanabe, H. Masuya, A. Satoh and S. Nakamura	92
Static-Dynamic Properties of Reactive Powder Concrete with Blast Furnace Slag H.H. Pan, J.P. Peng, Y.S. Tai and C.S. Chang	100
Threshold Characteristics of Short Pulse Loads Causing Fracture in Concrete and Rocks I.V. Smirnov, Y.V. Petrov, Y.V. Sudenkov and E. Cadoni	106
Influence of Fibre Shapes on Dynamic Compressive Behaviour of Fibre Reinforced Concrete Z. Xu, H. Hao and H.N. Li	112
Electrical Properties of Carbon Nanotubes Cement Composites for Monitoring Stress Conditions in Concrete Structures L. Coppola, A. Buoso and F. Corazza	118
Strain-Rate Effect on the Tensile Behaviour of High Strength Alloys E. Cadoni, M. Dotta, D. Forni and S. Bianchi	124
Experimental Study of the High Strain Rate Shear Behaviour of Ti6Al4V J. Peirs, P. Verleysen and J. Degrieck	130
Experimental and Numerical Analysis of Pure Aluminium for Dynamic Applications G. De Matteis, G. Brando and F.M. Mazzolani	136

Characterisation of Aluminium Matrix Syntactic Foams under Static and Dynamic Loading M. Altenaiji, G.K. Schleyer and Y. Zhao	142
Influence of Free Water and Strain-Rate on the Shear Behaviour of Concrete P. Forquin	148
Tension and Compression Behavior of Pre-Stressed Steel Strands at High Strain Rate A.M. Bragov, E. Cadoni, A.Y. Konstantinov and A.K. Lomunov	154
Multiscale Fracture Model for Quasi-Brittle Materials Y.V. Petrov and V. Bratov	160
Mechanical Properties of A359/SiCp Metal Matrix Composites at Wide Range of Strain Rates W. Moćko and Z.L. Kowalewski	166
Experimental Analysis of Mechanical Characteristics of Composite Materials Influenced by their Components at Indoor and Elevated Temperature A. Trombeva-Gavriloska, M. Cvetkovska, V. Gavriloski and T. Samardzioska	172
Mechanical Behavior of Advanced High Strength Steel at High Strain Rates N.K. Singh, E. Cadoni, M.K. Singha and N.K. Gupta	178
Studies on Effect of Refractory Chemicals on Cement Mortar N. Suresh, R. Jeyalakshmi and U. Suresh	184
Mechanical Characterization of Cement Composites Reinforced with Fiberglass, Carbon Nanotubes or Glass Reinforced Plastic (GRP) at High Strain Rates L. Coppola, E. Cadoni, D. Forni and A. Buoso	190
Analysis of the Strain-Rate Behavior of a Basalt Fiber Reinforced Mortar D. Asprone, F. Iucolano, E. Cadoni and A. Prota	196
Textile Reinforced Mortar at High Temperatures I. Colombo, M. Colombo, A. Magri, G. Zani and M. di Prisco	202
Existence of Optimal Energy Saving Parameters for Different Industrial Processes V. Bratov, Y.V. Petrov and G. Volkov	208
Analytical and Numerical Study of Early-Time Response in Pulse-Loaded Visco-Elastic Composites K. Micallef, A. Soleiman-Fallah, P.T. Curtis, D.J. Pope and L.A. Louca	214
Dynamic Tensile Behaviour of Self Compacting Steel Fibre Reinforced Concrete A. Caverzan, E. Cadoni and M. di Prisco	220

Chapter 2: Performance of Structures

Influence of Loading Rate on Shear Failure Resistance of RC Beams T. Fukuda, S. Sanuki, M. Miyakawa and K. Fujikake	229
Evaluation of the Load Carrying Capacity of a Rockfall Protection Gallery S. Ghadimi Khasraghy, C. Röthlin and T. Vogel	235
Effects of Short Fiber Reinforcement on the Local Damage of Concrete Plates under High Velocity Impact Loading M. Beppu, C. Abadie, J. Takahashi and A. Ogawa	241
Dynamic Response Analysis for Rigid Steel Portal Frames under Impact Loading M. Komuro, N. Kishi, Y. Kurihashi and W.F. Chen	247
Experimental Study on Contact Force between a Train Wheel and a Prestressed Concrete Sleeper K. Goto, M. Sogabe and K. Asanuma	253
Rigid-Body-Spring Network with Visco-Plastic Damage Model for Simulating Rate Dependent Fracture of RC Structures K. Kim, J.E. Bolander and Y.M. Lim	259
Numerical Simulation of Impact Response Behavior of Rectangular Reinforced Concrete Slabs under Falling-Weight Impact Loading N. Kishi, Y. Kurihashi, S. Ghadimi Khasraghy and H. Mikami	266
Load Redistribution Using Compressive Membrane Action in Reinforced Concrete Buildings B.M. Punton, M.P. Byfield and P.P. Smith	272

SMA in Mitigation of Extreme Loads in Civil Engineering: Study of their Application in a Realistic Steel Portico	
V. Torra, A. Isalgue, C. Auguet, G. Carreras, F. Casciati, F.C. Lovey and P. Terriault	278
Coupled Discrete Element/Finite Element Method for the Analysis of Large Reinforced Concrete Structures Submitted to an Impact	
L. Daudeville, J. Haelewyn, P. Marin and S. Potapov	284
Numerical Crash Analysis of Composite Racing Car Front Impact Attenuator by Use of Explicit FEM Codes	
G. Belingardi and J. Obradovic	290
Lateral Collapse of Woven-Fabric Composite Tubes under Quasi-Static and Impact Loads	
S.S. Tokekar, M.K. Singha and N.K. Gupta	296
Characterization of Blast Effects on Surrounding Soil: Internal Detonations in Underground Pipes	
P. Bonalumi, M. Colombo, C. Comina, M. di Prisco, S. Foti and A. Galli	302
Numerical Simulation of a Terrorist Attack	
R. Andreotti, G. Riganti and M. Boniardi	308
Numerical Simulation of Steel Bolted Beam-Column Connections Subjected to Dynamic Loading	
L. Chang, T.K. Hai, F.T. Ching and A. Tyas	314
Numerical Studies on Cumulative Damage of RC Members under Repeated Impact Loading	
H. Tamai and Y. Sonoda	320
Experimental and Analytical Evaluation of Progressive Collapse Resistance of a Full-Scale Structure Following Severe Loss of Load Bearing Elements	
M. Sasani and A. Kazemi-Moghaddam	326
A Study on the Estimation of Failure Mode in Impact Analysis Using SPH Method	
Y. Sonoda, S. Tokumaru and J. Fukazawa	332
Shock Loads Induced on Metal Structures by LHC Proton Beams: Modelling of Thermo-Mechanical Effects	
M. Scapin, L. Peroni, A. Dallochio and A. Bertarelli	338
Effects of Outrigger Truss Systems on Collapse Initiation Times of High-Rise Towers Exposed to Fire	
D. Isobe and T.T.T. Le	344
Importance of Time-Dependent Material Behavior in Predicting Strength of Steel Columns Exposed to Fire	
M.A. Morovat, M.D. Engelhardt, E.M. Taleff and T. Helwig	350
An Experimental Research on the Fire Behavior of Composite Truss Structure Used at World Trade Center	
Y.J. Lee and H.Y. Kim	356
Use of Plate Thermometers for Better Estimate of Fire Development	
A. Byström, U. Wickström and M. Veljkovic	362
The Influence of Fire Scenarios on the Structural Behaviour of Composite Steel-Concrete Buildings	
E. Nigro, A. Ferraro and G. Cefarelli	368
Seismic Analysis of Concrete Gravity Dams: Nonlinear Fracture Mechanics Models and Size-Scale Effects	
M. Paggi, G. Ferro and F. Braga	374
Experimental Study on Performance Evaluation of an Indonesian R/C Building Damaged by the 2009 Sumatra Earthquake	
Y. Sanada, Y. Nitta, T. Tomonaga and Y. Sashima	380
Simulation of Seismic Load Resistance of Core-Walls for Tall Buildings	
S. Kono, K. Sakamoto and M. Sakashita	386
Pressure of Snow Avalanches against Buildings	
E. Bovet, B. Chiaia, V. De Biagi and B. Frigo	392
Investigation of Concrete Slabs under Impact Load	
A. Hummeltenberg, B. Beckmann, T. Weber and M. Curbach	398
Evaluation of Dynamic Collapse Behavior of Steel Moment Frames Damaged by Blast	
K.K. Lee, L. Chung, S.H. Lee, T.W. Park and J. Rho	404

Example Validation of Numerical Modeling of Blast Loading	
J. Wojciechowski, M. Balcerzak, C. Bojanowski, L. Kwasniewski and M. Gizejowski	410
Performance of Sacrificial Cladding Structure Made of Empty Recyclable Metal Beverage Cans under Large-Scale Air Blast Load	
S. Palanivelu, W. van Paepegem, J. Degrieck, B. Reymen, E. Segers, J.M. Ndambi, J. Vantomme, J. Van Ackeren, J. Wastiels, D. Kakogiannis and D. Van Hemelrijck	416
Performance of Protective Doors and Windows under Impact and Explosive Loads	
L. Kruszka and R. Rekucki	422
Recent Efforts on Blast Damage Mitigation for Dams	
M.K. Sharp, Y. Seda-Sanabria and E.E. Matheu	428
Structural Response and Reliability Analysis of RC Beam Subjected to Explosive Loading	
M. Acito, F. Stochino and S. Tattoni	434
SDOF Models for RC and FRC Circular Plates under Blast Loads	
M. Colombo and P. Martinelli	440
Impact Response Analysis of Wire Ring Net System Using the Concept of Particle Method	
Y. Sonoda, Y. Hata and K. Fukunaga	446
Internal Explosions in Embedded Concrete Pipes	
P. Bonalumi, M. Colombo and M. di Prisco	452

Chapter 3: Strengthening of Structures under Extreme Loading

Numerical Simulation of Blast Mitigation Cladding with Gradient Metallic Foam Core	
J.D. Li, H.Y. Zhou and G.W. Ma	461
Using Perforated Plates as a Blast Wave Shielding Technique for Application to Tunnels	
G. Langdon, G. Nurick, N. Du Plessis and I. Rossiter	467
BlastWall: An Integrated Wall and Window Retrofit System	
D. Hadden, R. Cleave and K. Fischer	473
Composite Steel Stud Blast Panel Design and Experimental Testing	
T.J. Mander and Z.I. Smith	479
Performance of Different Seismic Retrofitting Techniques in Case of Blast-Induced Progressive Collapse	
D. Asprone, F. Jalayer, A. Prota and G. Manfredi	485
Aerodynamic Damping and Fluid-Structure Interaction of Blast Loaded Flexible Structures	
M. Teich, N. Gebbeken and M. Larcher	491
The Effect of Anchorages on FRP Strengthening of RC Walls to Resist Blast Loads	
A.A. Mutalib and H. Hao	497
Soft Projectile Impacts on Thin Reinforced Concrete Slabs: Tests, Modelling and Simulations	
C. Pontiroli and A. Rouquand	503
Openings' Shape and Location Effects on the Pressure Field in a Partially Confined Explosion	
Y. Karinski, V. Feldgun, D. Tzemakh and D. Yankelevsky	509
Simplified Methods for Improving the Blast Resistance of Cold-Formed Steel Walls	
B. Bewick, C. O'Laughlin and E. Williamson	515
Experimental Study on the Influence of Boundary Condition on the Behavioral Characteristics of CFT Square Columns under Constant Axial Load upon a Fire	
H.Y. Kim, K.H. Park and K.H. Kwon	521
An Experimental Study on the Fire Behavior of Concrete Segments in Tunnel Linings	
K.H. Park, H.Y. Kim and B.Y. Min	527
Bond Models for FRP Bars Anchorage in Concrete Slabs under Fire	
E. Nigro, A. Bilotta, G. Cefarelli, G. Manfredi and E. Cosenza	533
SMA in Mitigation of Extreme Loads in Civil Engineering: Damping Actions in Stayed Cables	
V. Torra, A. Isalgue, C. Auguet, G. Carreras, F.C. Lovey, P. Terriault and L. Dieng	539
Strength of Masonry Walls Retrofitted with Epoxy Resin Injection	
H. Araki, A. Yasojima and J. Kagawa	545
Securing Bridge Girder-End Gap during Earthquake Using Large-Deformation Blocks	
H. Hatano, M. Yamakami, Y. Sakaguchi, K. Kobayashi and K. Rokugo	551

Strengthening of a Multistory R/C Building under Lateral Loading by Utilizing Ties O. Markogiannaki and I. Tegos	559
Enhancing the Impact Resistance of Historical Stone Masonry Units with Fibre-Reinforced Hydraulic Lime Mortars V. Bindiganavile, M.T. Islam and R. Chan	565
Shear Behavior of Rectangular Beams Strengthened with either Carbon or Steel Fiber Reinforced Polymers G.C. Manos, K. Katakalos and C.G. Papakonstantinou	571
Beam-Column Joint Retrofitting with High Performance Fiber Reinforced Concrete Jacketing C. Beschi, A. Meda and P. Riva	577
Numerical Simulations on Impact Resistant Behavior of Rahmen-Slab Type RC Structures H. Kon-No, H. Nishi, S. Yamaguchi, T. Sawamatsu and N. Kishi	583
Experimental Study on Shock Absorption Effect of Mechanical Device Utilizing Wedge and Rubber K. Ishibashi, S. Katsuki, A. Hirose and K. Tanaka	589
Experimental Investigations of RC Frames Retrofitted by Steel Braced Frames Using a New Hybrid Connection M. Nishiyama, P. Javadi, K. Maeda and T. Yamakawa	594
The Influence of Concrete Surface Preparation when Fiber Reinforced Polymers with Different Anchoring Devices are Being Applied for Strengthening R/C Structural Members G.C. Manos, K. Katakalos and V. Kourtides	600
Bridge Girder Heavily Damaged by Impact Vehicle Load: A Case Strategy for Structure Assessment and FRP Strengthening C. Beltrami	606
Experimental Investigation on Soft-Story RC Frames Retrofitted by Hybrid Wall Technique T. Sunagawa, P. Javadi, K. Maeda and T. Yamakawa	612
Axial Performance of Various Strengthening Methods Applied on Full-Scale Rectangular RC Columns P.C. Chen, M.L. Lin and Y.H. Wu	618
Paraseismic Strengthening of Masonry Walls by FRP Composites R. Suter and O. Francey	624
A Study of FRP-Concrete Bond under Impact Y. Khalighi and N. Banthia	630

Chapter 4: Structural Management, Protection and other Related Topics

A Quick Level Methodology for the Volcanic Vulnerability Assessment of Buildings B. Faggiano, A. Formisano, D. De Gregorio, T. De Lucia and F.M. Mazzolani	639
Development of Negative Stiffness Dampers for Seismic Protection H. Iemura, A. Toyooka, M. Higuchi and O. Kouchiyama	645
A New Passive Seismic Control Device for Protection of Structures under Anomalous Seismic Events D. Cancellara and M. Pasquino	651
Two-Scale Risk Management in Case of Post-Earthquake Fire B. Faggiano and F.M. Mazzolani	657
Blast Wave Effects from Internal Explosion of Subsurface Explosive Storage Facility Y. Nakayama, K. Wakabayashi, T. Matsumura and M. Iida	663
Clearing of Blast Waves on Finite-Sized Targets – an Overlooked Approach A. Tyas, T. Bennett, J.A. Warren, S.D. Fay and S.E. Rigby	669
Blast Testing and Analysis of Composite Cable Shields Z.I. Smith, E.R. Fyfe and S.P. Wisotzkey	675
Research of Elastomeric Protective Layers Subjected to Blast Wave J. Malachowski and T. Niezgoda	680

Computer-Aided Design of Protective Structures: Numerical Simulations and Experimental Validation	
S. Dey, T. Børvik and O.S. Hopperstad	686
Designing a High Energy Rockfall Kit	
B. Boutillier, A. Clarke and D. Huber	692
Progressive Collapse Mitigation in Multistory Tilt-up Structural Systems	
S. Quiel and S. Marjanishvili	698
Use of External Testing Methods to Assess Damage on Rockfall Protection Structures	
A. Heymann, M. Collombet, S. Lambert and P. Gotteland	704
Protection Effect on a Ballistic Impact of NATO 7.62 Ball Bullet into Helicopter Drive Shaft: Numerical Simulation	
D. Lumassi, A. Manes and M. Giglio	710
Numerical Simulations of Rockfall Protection Retaining Wall Joined to Steel-Pile Foundation	
S. Yamaguchi, H. Nishi, H. Kon-No, S.Y. Omote, N. Kishi and Y. Ushiwatari	716
Analytical Model for Rockfall Protection Galleries - a Blind Prediction of Test Results and Conclusion	
K. Schellenberg, N. Kishi and H. Kon-No	722
Numerical Analysis of Vehicle Suspension System Response Subjected to Blast Wave	
P. Baranowski, J. Malachowski and T. Niezgoda	728
Real Scale Experiments on Rockfall Protection Barriers	
A. Trad, A. Limam and P. Robit	734
Mitigation of Ground Shock Effects on Buried Structures—Advantages of Unsaturated Ground	
E.C. Leong, S. Anand and C.H. Lim	740
Fire Safety Engineering for Open and Closed Car Parks: C.A.S.E. Project for L'Aquila	
E. Nigro, G. Cefarelli, A. Ferraro, G. Manfredi and E. Cosenza	746
An Experimental Study on Fire Resistance of Slim Floor Beam	
H.J. Kim, H.Y. Kim and S.Y. Park	752
Fire Protection of High-Performance Concrete Using Protective Lining	
E.W. Klingsch, A. Frangi and M. Fontana	758
On the Fire Scenario in Road Tunnels: A Comparison between Zone and Field Models	
P. Bamonte, R. Felicetti, P.G. Gambarova and A. Nafarieh	764
Robustness Based Structural Design: An Integrated Approach for Multi-Hazard Risk Mitigation	
D. Dubina and F. Dinu	770
Multi-Hazard Assessment of Steel Hangar Structures Subjected to Seismic and Wind Loads	
R. Chiodi, D. Asprone, F. Maimone, A. Prota and F. Ricciardelli	778
Assessment Spectra for Structures Subject to Passing Underground Trains	
F. Behnamfar and R. Nikbakht	784
Spatial Geotechnical Information-Based Assessment of Seismic Structural Vulnerability Related to Site Effects at Daegu Metropolitan City	
C.G. Sun	790
Structural Health Monitoring of Bridges Using Wireless Sensor Network	
A.A. Islam, F. Li and P.K. Kolli	796
Dynamic Monitoring Systems for Structures under Extreme Loads	
D. Inaudi, P. Favez, R. Belli and D. Posenato	804
Performance of a Covering Pipe for the Protection of Underwater Cable Subjected to on-Site Impact Loadings	
H.H. Lee	810
Structural Individuation of Damages Occurred on St. Gemma Church in Goriano Sicoli during the 2009 L'Aquila Earthquake	
E. Ciber, G. Brando and G. De Matteis	816