

# **Structures Congress 2013**

## **Bridging Your Passion with Your Profession**

**Pittsburgh, Pennsylvania, USA  
2-4 May 2013**

**Volume 1 of 4**

**Editors:**

**Brian J. Leshko  
Jonathan McHugh**

**ISBN: 978-1-62748-406-0**

**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© (2013) by the American Society of Civil Engineers  
All rights reserved.

Printed by Curran Associates, Inc. (2013)

For permission requests, please contact the American Society of Civil Engineers  
at the address below.

American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, VA 20191

Phone: (800) 548-2723  
Fax: (703) 295-6333

[www.asce.org](http://www.asce.org)

**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)

# TABLE OF CONTENTS

Volume 1

## BLAST

### MULTI-HAZARD ROBUSTNESS ASSESSMENT OF BUILDING STRUCTURAL SYSTEMS 1

Collapse Resistance Mechanisms in Steel Frame Buildings .....	1
<i>Honghao Li, Sherif El-Tawil</i>	
Collapse Test of a 3-Story Half-Scale RC Frame Structure .....	11
<i>Y. Xiao, Y. B. Zhao, F. W. Li, S. Kunnath, H. S. Lew</i>	
Probabilistic Analysis of Vulnerability of Reinforced Concrete Buildings Against Progressive Collapse .....	20
<i>Jia-Liang Le, Bing Xue</i>	
Large-Scale Experimental Evaluation of Steel Gravity Framing Structural Integrity .....	32
<i>J. M. Weigand, T. Francisco, E. S. Johnson, L. A. Fahnestock, J. Liu, J. W. Berman</i>	

### MULTI-HAZARD ROBUSTNESS ASSESSMENT OF BUILDING STRUCTURAL SYSTEMS 2

Robustness of Prototype Steel Frame Buildings Against Column Loss: Assessment and Comparisons .....	43
<i>J. A. Main, J. Liu</i>	

## RECENT RESEARCH ADVANCES IN DISPROPORTIONATE COLLAPSE

Structural Integrity of Composite Steel Gravity Frame Systems .....	55
<i>A. Jamshidi, R. G. Driver</i>	
Static and Dynamic Disproportionate Collapse Testing of a Reinforced Concrete Frame .....	67
<i>Sarah Orton, Stephen Stinger, Joseph Kirby</i>	

## ANALYSIS METHODS FOR BLAST LOADS

Numerical Simulation of Blast Wave Mitigations on RC Buildings via Improved Structural Configuration and Column Cross-Section Properties .....	78
<i>Oruba Rabie, Yahia M. Al-Smadi</i>	

## PREDICTION OF BLAST LOADS 1

Effect of Inertia Forces on Support Reactions of Beams Subjected to Uniform Blast Loads .....	93
<i>Macarena Schachter Adaros, Scott Wood, Peggy Van Eepoel</i>	
Are You Positive About Negative Phase? .....	103
<i>Larry M. Bryant, J. Mikhael Erikson, Kenneth W. Herrle</i>	

## PREDICTION OF BLAST LOADS 2

Breach Evaluation of Structures Using the Applied Element Method .....	115
<i>Arturo Montalva, Hollice Stone, Ayman El-Fouly, Michael Hahn</i>	

## TESTING METHODS FOR BLAST RESPONSE

Effect of Window Sizes and Glazing Panel Aspect Ratios on Mitigating the Injuries from Flying Glass due to Air Blast .....	125
<i>Hossein Ataei, James C. Anderson</i>	

<b>Experimental Evaluation of Static Resistance Function Using a Vacuum Chamber.....</b>	137
<i>H. Salim, S. Roberts, A. Saucier</i>	
<b>Behavior of Spliced Steel Girders under Impact.....</b>	148
<i>Musab Aied Qissab Al-Janabi, Thamir K. Mahmoud</i>	

## **BLAST RESISTANT GLAZING AND CURTAINWALL**

<b>Innovative Blast Resistant Glazing System.....</b>	161
<i>Yousef Alostaz, Robert Pyles, Jim Lorenzo, Ashish Bhargava</i>	
<b>Modeling and Testing of Laminated Curtain Wall Systems under Blast Loading.....</b>	170
<i>M. Nawar, H. Salim, B. Lusk, K. Perry, S. Kiger, G. Miller</i>	
<b>Blast Design Considerations for Double-Façade Curtain Walls .....</b>	181
<i>A. M. Coughlin, C. J. Field</i>	
<b>Quantification of Aluminum Increase Factors for Curtain Wall Design Using Finite Element Methods.....</b>	191
<i>Lara D. Leininger, Sharon M. Gallant</i>	
<b>High Strength Glass Testing and Model Validation for Static and Dynamic Loading .....</b>	203
<i>Ryan M. Alberson, Carrie E. Davis, Kirk A. Marchand</i>	

## **EVALUATING NEW MATERIALS AND METHODS FOR BLAST PROTECTION**

<b>Blast and Earthquake Resistant Bridge Pier Concept: Retrofit and Alternative Design Options .....</b>	216
<i>Pierre Fouché, Michel Bruneau, Vincent Chiarito, Jared Minor</i>	
<b>Design and Detailing of Metal Stud Wall Systems in Response to Air-Blast Loading Effects.....</b>	226
<i>Jessica Godinho, Sharon Gallant, Leslie Quiter, Ady Aviram, Ronald L. Mayes, Ronald O. Hamburger</i>	
<b>Evaluation of Mechanical Anchoring System to Improve Performance of CFRP Mitigated Concrete Slabs under Close-In Blasts .....</b>	239
<i>Sarah Orton, Matthew Wheeler, Vincent Chiarito</i>	

## **PROGRESSIVE COLLAPSE AND STRUCTURAL ROBUSTNESS: AN INTERNATIONAL PERSPECTIVE**

<b>Robustness Assessment of a Steel Truss Bridge .....</b>	250
<i>P. Olmati, F. Brando, K. Gkoumas</i>	
<b>Design for Disproportionate Collapse Prevention of Precast and Prestressed Structures .....</b>	262
<i>C. Naito, N. Cleland, J. Brewe</i>	
<b>Progressive Collapse Susceptibility of a Long Span Suspension Bridge .....</b>	272
<i>Pierluigi Olmati, Luisa Giuliani</i>	
<b>Pancake-Type Collapse—Energy Absorption Mechanisms and their Influence on the Final Outcome .....</b>	284
<i>Nikolay Lalkovski, Uwe Starossek</i>	
<b>Collapse Analysis of a Metal Structure .....</b>	296
<i>C. Crosti, F. Bontempi</i>	

## **BRIDGE PRACTICE**

### **STRUCTURAL HEALTH MONITORING OF FULL-SCALE BRIDGES 1**

<b>Critical Issues, Condition Assessment and Monitoring of Movable Bridges: Image Processing for Open Gear Monitoring.....</b>	308
<i>M. Gul, F. N. Catbas</i>	
<b>Structural Identification Methods for Full-Scale Bridges .....</b>	319
<i>Ian F. C. Smith, James-A. Goulet, Irwanda Laory</i>	
<b>Uncertainties in Identification of a Steel Bridge Dynamic Characteristic .....</b>	328
<i>Siavash Dorvash, Shamim Pakzad</i>	
<b>Development of Carbon Nanofiber Aggregate .....</b>	340
<i>Rachel Howser, Y. L. Mo</i>	

## **STRUCTURAL HEALTH MONITORING OF FULL SCALE BRIDGES 2**

<b>Identification of Physically Simulated Damage on a Footbridge Based on Ambient Vibration Data.....</b>	352
<i>A. Kody, X. Li, B. Moaveni</i>	
<b>Identification of Truck Types using Strain Sensors include Co-located Strain Gauges.....</b>	363
<i>Navid Zolghadri, Marvin Halling, Paul Barr, Steven Petroff</i>	

## **BRIDGE MONITORING AND ASSESSMENTS**

<b>PARAMeter Identification System (PARIS) for Automated Finite Element Model Updating of Full-Scale Structures .....</b>	376
<i>Masoud Sanayei, Peeyush Rohela</i>	
<b>Seismic Vulnerability of Select Critical Bridges in North Mississippi.....</b>	388
<i>M. Miah, K. Bethay, C. Mullen</i>	
<b>Health Monitoring and Bayesian Updating of Deteriorating Bridge Infrastructures.....</b>	398
<i>A. A. Taflanidis, I. Gidaris</i>	

## **STRUCTURAL HEALTH MONITORING**

<b>A Prototype Imaging and Visualization System for Robotic Infrastructure Inspection.....</b>	410
<i>David A. Lattanzi, Greg Miller</i>	
<b>Evaluation of Low Cost Dynamic Exciters for Controlled Dynamic Testing of Bridges .....</b>	422
<i>J. L. Carreiro, E. V. Fernstrom, K. A. Grimmelsman</i>	
<b>Comparison of Sparse Representation and Fourier Discriminant Methods: Damage Location Classification in Indirect Lab-Scale Bridge Structural Health Monitoring.....</b>	436
<i>Z. Wang, S. Chen, G. Lederman, F. Cerda, J. Bielak, J. H. Garrett, P. Rizzo, J. Kovacevic</i>	

## **BRIDGE SUBSTRUCTURE ANALYSIS**

<b>C-STM Modeling of Bridge Piers without and with ASR/DEF Deterioration.....</b>	447
<i>Madhu M. Karthik, John B. Mander, Stefan Hurlebaus</i>	
<b>Performance Assessment of Pile-Supported Bridges in Extreme Flood Conditions .....</b>	457
<i>J. V. Klinga, A. Alipour</i>	

## **BRIDGE ANALYSIS**

<b>Multi-Scale Analysis of the Steel Cable Anchorage System of Self-Anchored Suspension Bridges.....</b>	467
<i>Meng Zhou, Jian-Guo Nie, Jian-Sheng Fan</i>	
<b>Thermal Effects on Load Rating of Reinforced Concrete Arch Bridges.....</b>	479
<i>Lung-Yang Lai</i>	
<b>Cross-Frame Forces in Skewed Steel I-Girder Bridges: Field Testing and Analytical Results.....</b>	491
<i>Jennifer McConnell, Kelly Ambrose, Matija Radovic</i>	
<b>Non-Linear Time History Analysis of A Highly Horizontally Curved Bridge on Yerba Buena Island (YBI) WB On-Ramps, Bay Bridge, San Francisco, CA .....</b>	502
<i>Yong Deng</i>	

## **BRIDGE SEISMIC AND DYNAMIC BEHAVIOR**

<b>Dynamic Response of a Floating Bridge to a Moving Light Rail Train .....</b>	514
<i>Hassan Sedarat, Iman Talebinejad, Alexander Kozak, Alex Krimotat, Tom Cooper, John A. Harrison, John Sleavin, Paul Cornish</i>	
<b>Effects of Different Support Modeling Assumptions on the Seismic Response of Ordinary Bridges .....</b>	531
<i>A. Hajishemini, S. Pezeshk, E. G. Burdette</i>	

## **STRUCTURAL BEHAVIOR**

<b>Experimental Characterization of Aging Effects on Steel Bridge Bearings under Cyclic Loads.....</b>	541
<i>Xiaohu Fan, Jason McCormick</i>	
<b>Structural Behavior of HFRP-UHPFRC Composite Girders .....</b>	553
<i>H. Nguyen, H. Mutsuyoshi, W. Zatar</i>	
<b>Behavior of FRP Composite Wrapped Concrete Cylinders with Embedded Debonds .....</b>	566
<i>Udaya B. Halabe, Shasanka S. Dutta, Hota V. S. Gangarao</i>	

## **BRIDGE RESEARCH AND IMPLEMENTATION**

### **AESTHETICS OF AMERICAN SIGNATURE BRIDGES**

<b>The Golden Gate Bridge Art Deco Suspension Bridge Masterpiece .....</b>	576
<i>Reinhard Ludke</i>	
<b>The New San Francisco-Oakland Bay Bridge .....</b>	588
<i>Marwan Nader, Brian Maroney</i>	

### **BRIDGE PRACTICE AND CASE STUDIES**

<b>Main Street Bridge Project, Danville, VA—Open Spandrel Concrete Arch Bridges: New and Old.....</b>	599
<i>W. M. Davidge, James M. Fariss Jr.</i>	
<b>Rehabilitation of TDOT'S SR56 Deck Truss Bridge Crossing Center Hill Lake .....</b>	611
<i>Todd J. Stephens, Michael C. Irwin, Edward P. Wasserman, John M. Kulicki, Adnan Kurtovic, Wayne J. Seger</i>	
<b>Assessment of Extent of Capacity Loss in Deteriorated Highway Bridges .....</b>	622
<i>B. Shafei, A. Alipour</i>	

## **THE BRIDGES OF PITTSBURGH**

<b>Rankin Bridge Rehabilitation.....</b>	632
<i>Glenn D. Stickel</i>	

## **BRIDGING THE PITTSBURGH AREA WITH STEEL**

<b>Homestead Grays Bridge Rehabilitation and Widening .....</b>	644
<i>Daniel W. Wills</i>	

## **UNIQUE BRIDGE ENGINEERING**

<b>A Rapidly Deployable Bridge System .....</b>	656
<i>Gareth R. Thomas, Bernard J. Sia</i>	
<b>Bridge Load Rating of a Super Load using AASHTO LRFR.....</b>	668
<i>David J. Lawson, Cheng Lok Hing, Jason A. Carota</i>	
<b>Fundamentals of Highway Bridge Demolition .....</b>	680
<i>Matthew Barsottelli, Onur Avci</i>	

## **BRIDGE SIMULATIONS AND FATIGUE STUDY**

<b>Impact Behavior of Concrete Bridge Deck on Girders Due to Moving Vehicles.....</b>	689
<i>Dongzhou Huang</i>	
<b>Fatigue Reliability of Stiffened Panels using Finite Element Monte Carlo Simulations.....</b>	699
<i>H. N. Mahmoud, G. A. Riveros</i>	
<b>Reliability and Remaining Life Assessment of Fatigue Critical Steel Structures: Integration of Inspection and Monitoring Information .....</b>	709
<i>Mohamed Soliman, Dan M. Frangopol</i>	

## **BRIDGE DESIGN**

<b>Hybrid Simulation of Curved Four-Span Bridge: Comparison of Numerical and Hybrid Experimental/Analytical Results and Methods of Numerical Model Calibration.....</b>	721
<i>Thomas Frankie, Adel Abdelnaby, Pedro Silva, David Sanders, Amr Elnashai, Billie Spencer, Daniel Kuchma, Chai-Ming Chang</i>	
<b>Use of Aggressivity Functions in the Dimensioning of Simple-Span HSR Bridges .....</b>	733
<i>Chiara Rosignoli, Raja Tenneti, Marco Rosignoli</i>	

## **FIRE RISKS AND IMPACTS TO BRIDGES**

<b>Fire Risks for Highway Bridges: A Statistical Investigation.....</b>	744
<i>Michael Woodworth, William Wright, Brian Lattimer, Elisa Sotelino</i>	

### Volume 2

<b>Evaluating Fire-Damaged Components of Timber Bridges and Structures.....</b>	758
<i>Brian Kukay, Robert H. White, Charles S. Todd, Tyler Jahn</i>	
<b>Parameter Study of Highway Bridge Fires via Combined Fire Dynamics and Finite Element Modeling .....</b>	768
<i>Michael Woodworth, Mohamed Nahid, William Wright, Brian Lattimer, Elisa Sotelino</i>	

## **PERFORMANCE BASED DESIGN OF BRIDGES: PRACTICAL APPLICATIONS**

<b>The Gerald Desmond Cable-Stayed Bridge—A Case Study in Performance-Based Seismic Design .....</b>	781
<i>Michael H. Jones, Semyon Treyger, Patrick W. Pence, Ayman Shama</i>	
<b>Performance-Based Seismic Evaluation and Retrofit of Suspension Bridges.....</b>	793
<i>Qi Ye, Quan Nguyen, Guang-Nan Fanjiang</i>	
<b>The New Performance Based Seismic Design Criteria for New York City.....</b>	807
<i>Jagtar S. Khinda</i>	

## **ASSESSMENT OF THE SEISMIC RESPONSE OF STRUCTURES CROSSING FAULT-RUPTURE ZONES**

<b>The Response of the Seismically Isolated Bolu Viaduct Subjected to Fault Crossing.....</b>	817
<i>Alper Ucak, George P. Mavroeidis, Panos Tsopelas</i>	
<b>Seismic Performance of Highway Bridges with Seat-Type Abutments Subjected to Near-Fault Ground Motions.....</b>	827
<i>J. Wieser, M. Maragakis</i>	
<b>Validation and Implementation of a Simplified Analysis Procedure for Bridges Crossing Earthquake Fault Ruptures .....</b>	839
<i>Jennifer Tures, Rakesh K. Goel, Bing Qu</i>	

## **BUSINESS**

### **CHALLENGES FOR THE PRACTICE OF STRUCTURAL ENGINEERING**

<b>Current Status of BIM Benefits, Challenges, and the Future Potential for the Structural Discipline.....</b>	849
<i>Ryan Solnosky</i>	
<b>Vegas High Roller 3D Modeling and Integration.....</b>	860
<i>Matthew Reid, Stephen Corney, Jason Krolicki</i>	
<b>Monitoring Procedures for the Application of the Concept of Pre-Allocation of Total Float .....</b>	873
<i>Aslam Amirahmad, A. Rahman Al-Sinaidi</i>	

## **BUSINESS AND PROFESSIONAL PRACTICE**

### **THE STRUCTURAL ENGINEERING PROFESSION FROM A YOUNG PROFESSIONAL'S PERSPECTIVE: DIVERSITY, CHALLENGES AND RETENTION**

- Gender and Racial Diversity in the Structural Engineering Profession.....885**  
*E. N. Leong, A. B. Liel, J. Mitrani-Reiser, E. Guglielmo, D. Friis, D. Lumbard, R. Oliveira, R. Pekelnicky*

## **WHAT'S THE MATTER WITH ENGINEERING**

- Engineers Don't Think Enough About Engineering .....897**  
*Jon A. Schmidt*
- Engineers Shouldn't Think Too Fast .....908**  
*William M. Buleit*
- Engineers Need to Get Real, But Can't: The Role of Models.....916**  
*Irfan A. Alvi*

## **BIM BEYOND DESIGN**

- SmartCodes and BIM.....928**  
*Nawari O. Nawari*
- Defragmenting the AEC Industry through a Single, Component-Based Building Information Model .....938**  
*Anton C. Harfmann, Jennifer Bray, Christine Carlo, Samuel Carl, Tyler Gentry, Joseph Russell*

## **EXTREME LOADING**

### **EXTREME LOADS ON COLD-FORMED STEEL FRAMING—ANALYSIS AND DESIGN FOR EARTHQUAKE, BLAST AND FIRE**

- Axial Hysteretic Modeling of Cold-Formed Steel Members for Computationally Efficient Seismic Simulation .....948**  
*D. A. Padilla-Llano, M. R. Eatherton, C. D. Moen*
- Investigation of Cold-Formed Steel Wall Reinforcement Systems to Resist Progressive Collapse.....960**  
*Ismail Mohamed, Nabil A. Rahman, R. Seracino*

## **NATURAL DISASTERS AND EXTREME LOADING**

- Structural Hardening of Critical Facilities for FEMA and ICC Compliance .....970**  
*Joel Figueroa-Vallines*
- Accuracy of EF Ratings Following a Tornado Event: An Engineer's Perspective.....980**  
*Vincent F. Fratinardo, Scott A. Schroeder*

## **INNOVATIVE ENGINEERING**

### **INNOVATIVE ENGINEERING 1: CASE STUDIES OF SUCCESSFUL PROJECTS**

- Design and Fabrication of Precast Segmental Concrete Foundations in the U.S. and Erection in the Remote Arctic .....991**  
*Cory R. Brett, Scott J. Difiore, Dominic J. Kelly, Paul J. Cheever*
- Waste Not Thy Hour: The Innovative, Fast-Tracked Reconstruction and Seismic Rehabilitation of Whatcom Middle School .....1002**  
*Erik S. Bishop, David B. Swanson, Paul N. Crocker, Suzie R. Brendle*
- Removal of Steel Tie Rods in a Segmental Tied Arch Floor System .....1014**  
*J. Lan, R. Gilsanz, M. Lo*
- King Abdullah Financial District Conference Center .....1025**  
*Charles Besjak, Preetam Biswas, Georgi I. Petrov, Blake Altshuler*

## **INNOVATIVE ENGINEERING II: CASE STUDIES OF SUCCESSFUL PROJECTS**

<b>Center for Character and Leadership Development at the United States Air Force Academy .....</b>	1036
<i>Charles Besjak, Preetam Biswas, Raymond Sweeney</i>	
<b>Seismic Retrofit of a 1960's Steel-Frame Industrial Building in Washington State Using Viscous Dampers .....</b>	1046
<i>D. Gonzalez, C. Ash, W. Brown, J. Ahlport, M. Abdi</i>	
<b>Dr. Phillips Center for the Performing Arts, Orlando, Florida.....</b>	1058
<i>Michael C. Head, Laura A. Lewis</i>	

## **HIGH-RISE/TALL BUILDINGS TOPICS**

<b>Design of Diagrid Structural System for High Rise Steel Buildings as per Indian Standards .....</b>	1070
<i>Khushbu D. Jani, Paresh V. Patel</i>	
<b>Tuning Structural Properties of High-Rise Buildings to Control Wind Response.....</b>	1082
<i>Rafik Gerges, Kal Benuska</i>	
<b>Performance-Based Engineering of Core Wall Tall Buildings .....</b>	1094
<i>M. Sarkisian, E. Long, W. Hassan</i>	

## **RESPONSE OF TALL BUILDINGS TO FIRE**

<b>Out-of-Plane Full-Field Strain and Curvature Behavior of Two RC Bearing Walls under Fire.....</b>	1109
<i>M. J. McGinnis, K. A. Mueller, M. W. Lisk, Y. C. Kurama</i>	
<b>Guidelines for Achieving Optimum Fire Resistance in FRP-Strengthened Reinforced Concrete Beams.....</b>	1120
<i>V. K. R. Kodur, A. Ahmed</i>	
<b>Structural Design for Fire Conditions: Reliability-Based Resistance Criteria.....</b>	1131
<i>Therese P. McAllister, Bruce R. Ellingwood</i>	
<b>Observations from the Fire and Collapse of the Faculty of Architecture Building, Delft University of Technology .....</b>	1138
<i>Michael D. Engelhardt, Brian Meacham, Venkatesh Kodur, Adam Kirk, Haejun Park, Ijsbrand Van Straalen, Johan Maljaars, Kees Van Weeren, Rene De Feijter, Kees Both</i>	

## **MASONRY AND WOOD**

### **USING HYBRID MASONRY TO BRACE STEEL-FRAMED BUILDINGS**

<b>Design of Hybrid Masonry Systems .....</b>	1150
<i>Robert Asselin, Larry Fahnestock, David Biggs</i>	
<b>Ductile Fuse Connectors for Hybrid Masonry Systems.....</b>	1159
<i>Ian Robertson, Gaur Johnson, Steven Mitsuyuki, James Aoki</i>	

### **ADVANCES IN MASONRY TESTING AND DESIGN**

<b>A Combined Experimental and Numerical Study: Linking Vibration Response to Load Carrying Capacity of a Masonry Dome.....</b>	1169
<i>Sez Atamturktur, Ismail Farajpour</i>	
<b>Investigation of the Post-Cracking Dynamic Behavior of Masonry Structures Retrofitted with CFRP .....</b>	1181
<i>N. Goudarzi, H. Vafakhah, Y. Korany</i>	
<b>Rapid and Affordable Seismic Retrofit of Substandard Confined Masonry .....</b>	1193
<i>R. Ghorbani, F. Matta, E. Garbin</i>	

### **ADVANCES IN THE DESIGN AND ANALYSIS OF WOOD BUILDING SYSTEMS**

<b>Low-Cost Shape Memory Alloy Devices for Seismic Response Modification of Light-Frame Wood Buildings.....</b>	1205
<i>Elaina N. Jennings, John W. Van De Lindt</i>	

<b>Direct Displacement Design of Vertically and Horizontally Irregular Woodframe Buildings.....</b>	1217
<i>Pouria Bahmani, John W. Van De Lindt</i>	

## **ADVANCES IN WOOD TESTING AND DESIGN**

<b>Seismic Performance of Mid-Rise Hybrid Light Wood Frame Buildings and Influence of Diaphragm Flexibility.....</b>	1229
<i>Zhiyong Chen, Ying H. Chui, Chun Ni</i>	
<b>Modelling the Roof-to-Wall Connections and Roof Failures in Residential, Wood-Frame Buildings under Realistic Wind Loads.....</b>	1242
<i>T. K. Guha, G. A. Kopp</i>	
<b>Wood Truss Installation Loads Due to OSHA Fall Protection .....</b>	1255
<i>D. P. Hindman, L. M. Koch, J. Morris, T. Smith-Jackson</i>	
<b>Raising the Height Limit of Wood-Framed Apartment Buildings .....</b>	1265
<i>Rahim Abbasi</i>	

## **NON BUILDING STRUCTURES**

### **DESIGN AND ANALYSIS OF POWER PLANTS**

<b>Revisiting the Design, Construction and Damage Assessment of Large Hyperbolic Cooling Towers.....</b>	1277
<i>Phillip L. Gould</i>	
<b>Checking the Flexural-Torsional Stresses in Power Plants Pipe Supports Steel Frames .....</b>	1289
<i>Hazim Sharhan</i>	
<b>A Discussion of Power Plant Loads and Load Combinations .....</b>	1301
<i>David F. Six</i>	

## **ART AND CREATIVITY OF STRUCTURAL ENGINEERING**

<b>Wind Comfort Studies for the Vegas High Roller Observation Wheel.....</b>	1313
<i>Ibrahim Almufti, Michael Willford, Mary Ferguson, Andrew Allsop, Jason Krolicki</i>	
<b>The Structure of Art.....</b>	1323
<i>S. A. Jorgensen</i>	
<b>Vegas High Roller: Giant Observation Wheel Design .....</b>	1338
<i>Jason Krolicki, Brandon Sullivan, Michael Willford</i>	

## **ANALYSIS AND MODELING OF NONBUILDING STRUCTURES**

<b>Wind Effects on Four Steel Stacks in Square Arrangement .....</b>	1350
<i>T. G. Mara, B. J. Vickery</i>	
<b>Calculation of Response Modification Factor for an Existing All-Concrete Elevated Tank Pedestal .....</b>	1362
<i>C. T. Kevit, A. A. Liepins</i>	
<b>Limitations of Equivalent Lateral Force Procedure for Nonbuilding Petrochemical Structure Configurations .....</b>	1373
<i>Eric Wey, Dawar Naqvi, Ankur Sepaha</i>	
<b>Shaking Response of Tall High-Voltage Equipment Retrofitted with Friction Dampers.....</b>	1381
<i>P. Dusicka, M. J. Riley, K. Kraxberger, S. Knowles</i>	

## **FOUNDATIONS AND OTHER DESIGN ISSUES FOR WIND AND SOLAR TOWERS**

<b>Response of Wind Turbine Towers to Seismic Loading at Different Damping Ratios .....</b>	1391
<i>S. Jerath, S. Austin</i>	

## **EQUIPMENT CONTAINMENT STRUCTURE AND FOUNDATION DESIGN**

<b>Design of Foundations for Large Dynamic Equipment in a High Seismic Region .....</b>	1403
<i>Zhong Liu</i>	

<b>Innovative Design of High Speed Balancing Bunkers.....</b>	1415
<i>Yousef Alosta, Erlend Scott</i>	
<b>Mass Concrete Foundation Design for Precision Manufacturing of Large-Scale Equipment .....</b>	1425
<i>Marco T. Lo Ricco, Robert J. Schumacher</i>	
<b>Vibratory Machine Foundation Design: When to Perform a Dynamic Analysis .....</b>	1437
<i>Eric Wey, Silky Wong, William Bounds</i>	

## **NON STRUCTURAL COMPONENTS**

### **FULL-SCALE BUILDING-NCS EARTHQUAKE AND FIRE TEST PROGRAM: A NEES-LANDMARK PROJECT**

<b>Shake Table Testing of a Full-Scale Five-Story Building: Performance of the Major Nonstructural Components—Egress and Façades.....</b>	1447
<i>E. Pantoli, X. Wang, M. Chen, T. Hutchinson, B. Meacham, H. J. Park</i>	
<b>Shake Table Testing of a Full-Scale Five-Story Building: Pre-test Simulation of the Test Building and Development of an NCS Design Criteria .....</b>	1460
<i>Xiang Wang, Hamed Ebrahimian, Rodrigo Astroza, Joel P. Conte, Jose I. Restrepo, Tara C. Hutchinson</i>	
<b>Shake Table Testing of a Full-Scale Five-Story Building: System Identification of the Five-Story Test Structure.....</b>	1472
<i>R. Astroza, J. P. Conte, J. I. Restrepo, H. Ebrahimian, T. C. Hutchinson</i>	
<b>Overview of the Building Nonstructural Components and Systems (BNCS) Project .....</b>	1485
<i>Tara Hutchinson, José I. Restrepo, Joel Conte, Brian Meacham</i>	
<b>Shake Table Testing of a Full-Scale Five-Story Building: Post-Earthquake Fire Performance .....</b>	1499
<i>B. J. Meacham, J. K. Kim, H. Park</i>	

Volume 3

## **ESTABLISHMENT OF SEISMIC DEMAND ON NONSTRUCTURAL COMPONENTS**

<b>Simulation and Control of Floor Motions in Structures.....</b>	1511
<i>K. P. Ryu, A. M. Reinhorn, G. Maddaloni</i>	
<b>Seismic Evaluation of Suspended Ceiling Systems using Static and Dynamic Procedures .....</b>	1523
<i>Amir S. J. Gilani, Shakhzod Takhirov, Lee Tedesco</i>	

### **RESPONSE OF CEILING SYSTEMS, SPRINKLER PIPING, AND NONSTRUCTURAL PARTITIONS TO EARTHQUAKE LOADING**

<b>Seismic Fragility Study of Fire Sprinkler Piping Systems.....</b>	1533
<i>Siavash Soroushian, Arash E. Zaghi, Manos Maragakis, Alicia Echevarria, Yuan Tian, Andre Filiautault</i>	

## **WIND LOADING ON ROOF MOUNTED SOLAR SYSTEMS**

<b>Wind Loads on Solar Collectors and PV Panels on Roofs.....</b>	1545
<i>Ted Stathopoulos, Eleni Xypnou, Ioannis Zisis</i>	
<b>Aerodynamic Loads on Solar Panels.....</b>	1555
<i>Aly Mousaad Aly, Girma Bitsuamlak</i>	

## **PITTSBURGH UNIQUE STRUCTURES**

### **PITTSBURGH'S PROFESSIONAL SPORTS FACILITIES**

<b>Heinz Field: A Showcase in Steel.....</b>	1565
<i>William B. Wallis</i>	
<b>Consol Energy Center Design and Construction .....</b>	1599
<i>W. Steven Hofmeister</i>	

## **REINFORCED CONCRETE**

### **NEW DEVELOPMENTS FOR ANALYSIS AND DESIGN OF STRUCTURAL CONCRETE BEAM-COLUMN CONNECTIONS**

<b>High-Strength Concrete and Reinforcing Steel in Beam-Column Connections .....</b>	1606
<i>H.-J. Lee, S.-J. Hwang</i>	
<b>Development of a Parametric Equation to Predict the Joint Shear Strength .....</b>	1616
<i>Burcu Burak</i>	
<b>Seismic Vulnerability of Gravity-Load-Designed Beam-Column Connections .....</b>	1629
<i>Bing Li</i>	

### **TWO-WAY SLABS—CURRENT DESIGN AND CONSTRUCTION ISSUES**

<b>Voided "Two-Way" Flat Slabs .....</b>	1640
<i>Mike Mota</i>	
<b>Finite Element Modeling of Punching Shear in Two-Way Slabs Reinforced with High-Strength Steel .....</b>	1650
<i>R. Hawileh, M. Naser, F. Malhas</i>	
<b>Behavior of Concrete Columns Confined with Cross Spirals under Different Loads.....</b>	1662
<i>Riyadh Hindi</i>	
<b>Experimental Study on the Seismic Response of L-Shaped Reinforced Concrete Columns .....</b>	1673
<i>Bing Li, Thanh Phuong Pham</i>	

## **RESEARCH**

### **EMERGING STEEL FRAMING SYSTEMS TOWARDS DAMAGE RESISTANT SEISMIC DESIGN AND REHABILITATION**

<b>Research Needs for Seismic Rehabilitation of Sub-Standard Buildings using Stiff Rocking Cores .....</b>	1683
<i>M. Pollino, S. Sabzezbar, B. Qu, G. Mosqueda</i>	
<b>Full-Scale Testing of Self-Centering Steel Plate Shear Walls.....</b>	1694
<i>Patricia M. Clayton, Daniel M. Dowden, Chao-Hsien Li, Jeffrey W. Berman, Michel Bruneau, Laura N. Lowes, Keh-Chuan Tsai</i>	
<b>Self-Centering Beams for Seismically Resilient Moment Frames.....</b>	1701
<i>S. C. Darling, M. R. Eatherton, A. Maurya</i>	
<b>Seismic Design Parameters for the Link Column Frame System .....</b>	1713
<i>M. Malakoutian, J. W. Berman, P. Dusicka, A. Lopes</i>	

### **STRUCTURAL CONTROL AND VIBRATION MITIGATION**

<b>Modeling and Optimal Semi Active Control Strategies for Adaptive MR-TMD .....</b>	1722
<i>Alessia Ussia, Alessio Bonelli, Oreste S. Bursi</i>	
<b>Performance Assessment of a Highway Bridge Structure Employing Adaptive Negative Stiffness for Seismic Protection.....</b>	1736
<i>N. Attary, M. Symans, S. Nagarajaiah, A. M. Reinhorn, M. C. Constantinou, D. Taylor, A. A. Sarlis, D. T. R. Pasala</i>	
<b>From Old to New: Vibration Issues with Old Buildings and Their New Office Spaces.....</b>	1747
<i>Richard E. Lindenberg, John Fraczek</i>	
<b>Solving Floor Vibration Problems Using Dynamic Analysis and Testing.....</b>	1759
<i>Brad Davis, Di Liu, Thomas M. Murray</i>	

### **SEISMIC INPUT AND STRUCTURAL MODELING**

<b>Producing Broadband Synthetic Time Histories for Central and Eastern North America.....</b>	1767
<i>Alireza Shahjouei, Shahram Pezeshk</i>	
<b>Life-Cycle Cost Based Optimal Retrofitting of Structures by Fluid Dampers .....</b>	1777
<i>A. A. Taflanidis, I. Gidaris</i>	

## **INFRASTRUCTURE RESILIENCE TO NATURAL DISASTERS**

<b>Community Resilience Index Integrating Network Interdependencies .....</b>	1789
<i>G. P. Cimellaro, D. Solari, Chris S. Renschler, A. M. Reinhorn, Michel Bruneau</i>	
<b>Regional Hazard Damage Estimation Using System Reliability.....</b>	1800
<i>H. L. Bonstrom, R. B. Corotis</i>	
<b>Improving Resilience of Infrastructure: The Case of Bridges .....</b>	1812
<i>James Brownjohn, Emin Aktan</i>	

## **RISK-BASED DECISION MAKING FOR INFRASTRUCTURE SYSTEMS**

<b>Risk Communication for Critical Civil Infrastructure Systems .....</b>	1822
<i>Jack Baker, Jason Coray, Paul Destefano, Leonardo Dueñas-Osorio, Stephanie King, Lance Manuel</i>	
<b>Reliability-Based Performance Indicators for Buildings, Bridges and Other Civil Infrastructure.....</b>	1833
<i>M. Ghosn, D. Frangopol</i>	
<b>Risk-Based Decision Making for Sustainable and Resilient Infrastructure .....</b>	1845
<i>Zoubir Lounis</i>	

## **STRENGTHENING AND RESTORATION USING COMPOSITE MATERIALS**

<b>Long-term Durability Design of GFRP Reinforced Concrete Structures in U.S.: Code Assessment and Evaluation .....</b>	1857
<i>J. Huang</i>	
<b>Manufacturing and Modeling of SMA Composite Reinforcement for Enhanced Performance of Concrete Structures under Sequential Ground Motion Records .....</b>	1867
<i>Adeel Zafar, Bassem Andrawes</i>	
<b>Behavior of FRP-Reinforced Concrete Element under Shear: Experimental and Analytical Investigations .....</b>	1879
<i>Guang Yang, Mehdi Zomorodian, Abdeldjelil Belarbi, Ashraf S. Ayoub</i>	

## **PITTSBURGH RESEARCH-IN-PROGRESS**

<b>A Multi-Scale Material Model for Predicting the Multi-Decade Behavior of Concrete Structures.....</b>	1891
<i>Qiang Yu, Chunlin Pan, Teng Tong</i>	
<b>Ultrasonic Monitoring of a Pressurized Pipe in Operation.....</b>	1903
<i>Chang Liu, Joel B. Harley, Yujie Ying, Martin H. Altschul, Mario Bergés, James H. Garrett Jr., David W. Greve, José M. F. Moura, Irving J. Oppenheim, Lucio Soibelman</i>	
<b>Methods in Computational Inverse Mechanics for the Advancement of Smart Structure Technologies.....</b>	1914
<i>J. C. Brigham, B. Notghi, S. Wang</i>	

## **TESTING OF NOVEL STRUCTURAL CONCEPTS**

<b>Displacement Monitoring of Marble Panels under the Application of Gravity, In-Plane Lateral and Out-of-Plane Lateral Loads .....</b>	1926
<i>Christopher Kercsmar, Christina O'Neill</i>	
<b>A Practical Approach to the Phase and Amplitude Error Estimation for Pseudodynamic (PSD) Testing .....</b>	1938
<i>R. Mirza Hessabi, O. Mercan</i>	
<b>Experimental Evaluation of a Multi-Story Post-Tensioned Coupled Shear Wall Structure .....</b>	1950
<i>Michael J. McGinnis, Steven Barbachyn, Michelle R. Holloman, Yahya C. Kurama</i>	
<b>A New Approach for Acceleration Tracking of Shake Tables Using Combined Acceleration and Force Feedback Control .....</b>	1962
<i>Matthew Stehman, Narutoshi Nakata</i>	

## **COMPUTATIONAL MODELING OF NONLINEAR STRUCTURAL PERFORMANCE**

<b>Analysis of Connections in Composite Construction Under Cyclic Loading.....</b>	1975
<i>M. A. Reza, N. E. Shanmugam, W. H. Wan Badaruzzaman, Rajesh P. Dhakal</i>	

<b>A Practical Method for Critical Load Determination and Stability Evaluation of Structures .....</b>	1987
<i>Pedro Fernandez, Frederick R. Rutz</i>	
<b>Quantification of Modeling Uncertainties Based on the Blind Prediction Contest Submissions .....</b>	1997
<i>Siamak Sattar, Abbie B. Liel, Paolo Martinelli</i>	
<b>Efficient Nonlinear Finite Element Modeling of High Strength Pre-Tensioned Concrete Girders .....</b>	2009
<i>Kibraeb Gebreselassie, Ashraf Ayoub</i>	

## **RESILIENCE**

### **STRUCTURAL SYSTEM RESILIENCE AND RISK MITIGATION UNDER MULTIPLE HAZARDS**

<b>Combined Loss Due to Hurricanes and Storm Surge.....</b>	2020
<i>Thang Dao, Yue Li, John W. Van De Lindt, Sigridur Bjarnadottir</i>	
<b>An All-Hazards Approach for Quantifying Loss of Function for Critical Healthcare Infrastructure.....</b>	2032
<i>C. Jacques, J. Mitrani-Reiser, T. D. Kirsch</i>	

## **SEISMIC**

### **SEISMIC RETROFIT AND ENHANCEMENT 1**

<b>Structural Performance Assessment and Retrofit of Reinforced Concrete Buildings Under Seismic Loads.....</b>	2044
<i>J. P. Palacio, A. J. A. Pablo, E. A. J. Tingatinga, W. L. Mata</i>	
<b>ASCE 31/41 Evaluation of Damaged Chilean Walled Buildings .....</b>	2056
<i>Anna C. Birely, Laura N. Lowes, Dawn E. Lehman, Ady Aviram, Dominic J. Kelly</i>	

### **SEISMIC RETROFIT AND ENHANCEMENT 2**

<b>Seismic FRP Bond Strengthening of the Critical Splice Region in Wide Reinforced Concrete Columns .....</b>	2068
<i>Elie G. Hantouche, Mohamed H. Harajli</i>	
<b>Seismic Performance and Global Ductility of Reinforced Concrete Frames with CFRP Laminates Retrofitted Joints .....</b>	2080
<i>Mostafa Fakharifar, Mohammad Kazem Sharbatdar, Zhibin Lin</i>	
<b>Comparison of Modeling Strategies to Capture Component Level Damage in Non-Ductile Reinforced Concrete Buildings .....</b>	2094
<i>Blaine Fuselier, Jamie E. Padgett</i>	

### **CASE STUDIES USING NONLINEAR DYNAMIC ANALYSIS**

<b>Evaluation of Computational Tools for Performing Nonlinear Seismic Analyses of Structural Collapse .....</b>	2106
<i>K. K. F. Wong</i>	
<b>Response of Structures with Viscous Dampers Subjected to Large Earthquakes.....</b>	2118
<i>H. Kit Miyamoto, Amir S. J. Gilani</i>	
<b>Nonlinear Seismic Analysis of a Round Concrete Tower with a Post-Tensioned Self-Centering System .....</b>	2128
<i>Susendar Muthukumar, Rafael Sabelli</i>	

### **COLLAPSE ASSESSMENT OF CONVENTIONAL AND HIGH-PERFORMANCE STRUCTURES DESIGNED IN SEISMIC REGIONS**

<b>Dynamic Stability Testing of Isolation Systems Composed of Elastomeric Bearings and Implications for Design .....</b>	2140
<i>Xing Han, Gordon P. Warn, Amarnath Kasalanati</i>	
<b>Effect of Composite Action on the Dynamic Stability of Special Steel Moment Resisting Frames Designed in Seismic Regions .....</b>	2151
<i>Ahmed Elkady, Dimitrios G. Lignos</i>	

## **SEISMIC ANALYSIS AND PERFORMANCE BASED DESIGN**

<b>Consideration of Mainshock-Aftershock Sequences into Performance-Based Seismic Engineering.....</b>	2161
<i>Ruiqiang Song, Yue Li, John W. Van De Lindt</i>	
<b>Modal Displacement Based Seismic Design of Multi-Story One Way Asymmetric Plan Building Structures.....</b>	2168
<i>P. Wilkinson, O. Lavan</i>	
<b>Experimental Evaluation of Ground Motion Scaling Methods for Nonlinear Analysis of Structural Systems .....</b>	2180
<i>A. P. O'Donnell, Y. C. Kurama, E. Kalkan, A. A. Taflanidis</i>	
<b>Two Stage Analysis: Implementation Challenges .....</b>	2192
<i>Michael Allen, Ngai-Chi Chung, Alfred Tran, Daniel Zepeda</i>	
<b>Practical Application of Experimental Subassembly Data to Nonlinear Analysis .....</b>	2203
<i>A. M. Shuck, T. J. Graf, M. M. Hachem, G. G. Wray</i>	

## **PROPOSED SEISMIC PERFORMANCE FRAMEWORK FOR DESIGN OF NEW BUILDINGS**

<b>ATC-84 Project: Improved Seismic Performance Factors for Design of New Buildings.....</b>	2215
<i>Charles A. Kircher, John L. Harris, Jon A. Heintz, Ayse Hortacsu</i>	

## **SUPPLEMENTAL DAMPING SYSTEMS**

<b>Comparison of Dynamic Characteristics and Response Analysis of Building Structures Incorporating Viscous Fluid Dampers and Buckling Restrained Braces .....</b>	2229
<i>Bulent N. Alemdar, Yili Huo, Rakesh Pathak</i>	
<b>Experimental Testing of a Large 9-Story Structure Equipped with Multiple Nonlinear Energy Sinks Subjected to an Impulsive Loading .....</b>	2241
<i>N. E. Wierschem, J. Luo, S. Hubbard, L. A. Fahnestock, B. F. Spencer Jr., A. F. Vakakis, L. A. Bergman</i>	

Volume 4

<b>Linear or Nonlinear Fluid Viscous Dampers? A Seismic Point of View .....</b>	2253
<i>A. Bahnsy, O. Lavan</i>	

## **FLOOR DIAPHRAGMS: BEHAVIOR AND DESIGN**

<b>Inelastic Seismic Response of Hysteretic-Parametric In-Plane Analysis of Concrete Floor Diaphragms.....</b>	2265
<i>M. T. Al Harash, N. Panahshahi</i>	
<b>Collective Chord Behavior in Large Flexible Diaphragms .....</b>	2274
<i>J. W. Lawson, C. N. Yarber</i>	
<b>Effect of Diaphragm Flexibility on Tall Building Responses .....</b>	2286
<i>Mohammad T. Bhuiyan, Roberto T. Leon</i>	

## **SEISMIC INNOVATION**

### **INNOVATIONS IN SEISMIC BRACED FRAMES**

<b>Incremental Dynamic Analysis of Existing Steel Braced Frame Buildings in Moderate Seismic Zones.....</b>	2298
<i>Lucia Tirca, Ovidiu Serban, Ming Zheng Wang, Domenic Di Modica</i>	

### **INNOVATIONS IN SEISMIC STEEL MOMENT FRAMES**

<b>Evaluation of the Response of Partially Restrained Bolted Beam-to-Column Connection Subjected to Cyclic Pseudo-Static Loads .....</b>	2310
<i>E. Brunesi, R. Nascimbene, G. A. Rassati</i>	

<b>Effect of Powder Actuated Fasteners on the Seismic Performance of Steel Moment Frame Connections .....</b>	2322
<i>C. E. Watkins, B. W. Toellner, K. Laknejadi, E. Abbas, M. R. Eatherton</i>	
<b>Evaluation of HSS-to-HSS Moment Connections for Seismic Applications .....</b>	2334
<i>Matthew Fadden, Jason McCormick</i>	

## **SEISMIC TESTING AND EVALUATION**

### **ADVANCED TESTING METHODS IN EARTHQUAKE ENGINEERING RESEARCH**

<b>Reliability Assessment of Real-Time Hybrid Simulation Results for Seismic Hazard Mitigation.....</b>	2346
<i>Cheng Chen, Jose Valdovinos, Hector Santiallno</i>	
<b>Nonlinear Effective Force Testing Using Loop Shaping Controller .....</b>	2358
<i>Narutoshi Nakata, Erin Krug</i>	
<b>A Benchmark Testing System for Real-Time Hybrid Simulation Development .....</b>	2370
<i>Adam Mueller, Chelsea Griffith, Xiaoyun Shao, Griffin Enyart</i>	
<b>An Enhanced Hydraulic Actuator Control Method for Large-Scale Real-Time Hybrid Simulations .....</b>	2382
<i>Yunbyeong Chae, Brian Phillips, James M. Ricles, Billie F. Spencer Jr.</i>	

### **APPLICATION OF EXPERIMENTAL TECHNIQUES FOR SYSTEM-LEVEL SEISMIC EVALUATION OF STRUCTURES**

<b>1-g Scale Hydraulic Flume-Based Soil-Fluid-Structure Model Testing and Evaluation of Surging and Scouring Effects .....</b>	2394
<i>Ryan Homles, Zhiqiang Chen, Rahul Tripathi, Jianfei Chen</i>	
<b>Hybrid Simulation of Semi-Rigid Partial-Strength Steel Frames.....</b>	2410
<i>Hussam Mahmoud, Amr Elnashai</i>	
<b>Hybrid Simulation of a Wood Shear Wall Frame.....</b>	2421
<i>C. Griffith, X. Shao, J. Van De Lindt, P. Bahmani, W. Pang, E. Ziae, T. Dao</i>	

## **SPECIAL BUILDING TOPICS**

### **FLOOR VIBRATIONS SERVICEABILITY**

<b>Vibrations Assessment of a Hospital Floor for a Magnetic Resonance Imaging Unit (MRI) Replacement .....</b>	2433
<i>Ashish Bhargava, Jeremy Isenberg, Peter H. Feenstra, Yahia Al-Smadi, Onur Avci</i>	
<b>A Review of Structural Health Monitoring of a Football Stadium for Human Comfort and Structural Performance .....</b>	2445
<i>M. Gul, F. N. Catbas</i>	
<b>Surface Train and Subway-Induced Ground Vibration Characteristics for Full-Scale Buildings .....</b>	2455
<i>Pradeep Maurya, Masoud Sanaye, James A. Moore, Anish Kayiparambil P.</i>	
<b>Factors to Consider in Design for Rhythmic Crowd Loading for Vibration Serviceability .....</b>	2466
<i>K. A. Salyards</i>	
<b>Investigation of Floor Vibration Evaluation Criteria Using an Extensive Database of Floors .....</b>	2478
<i>Scott Pabian, Aaron Thomas, Brad Davis, Thomas M. Murray</i>	

### **STRUCTURAL OPTIMIZATION IN FRAMED BUILDINGS—SPANNING FROM THEORY TO PRACTICE**

<b>Shape Optimization of Energy Dissipation Devices for Passive Seismic Control of Building Frames .....</b>	2487
<i>Hidekazu Watanabe, Makoto Ohsaki, Junki Nozoe</i>	
<b>Applications of Structural Optimization in Architectural Design .....</b>	2499
<i>Alessandro Beghini, Lauren L. Beghini, William F. Baker</i>	
<b>Optimization of Large Steel Frames Using a Design-Driven Harmony Search.....</b>	2508
<i>Patrick Murren, Kapil Khandelwal</i>	
<b>Mixed Variable Plate Girder Cost Optimization Using Mesh Adaptive Direct Search.....</b>	2520
<i>S. M. Wilkerson</i>	

## **FIRE LOADING: MODELING TECHNIQUES AND BUILDING RESPONSE**

Bridging Disparities in Scale across the Fire and Structural Domains .....	2534
<i>Xiaojun Yu, Ann E. Jeffers</i>	
Symmetric and Asymmetric Collapse Mechanisms of a Multi-Story Steel Structure Subjected to Gravity and Fire .....	2545
<i>Sami Kilic, Serdar Selamet</i>	
Effects of Fire Following Earthquakes on Steel Frames with Reduced Beam Sections .....	2555
<i>Mehrdad Memari, Collin Turbert, Hussam Mahmoud</i>	
Probability-Based Structural Fire Load .....	2566
<i>Leo Razdolsky</i>	
Parameters Influencing Collapse Resistance of Building Structures Subjected to Fire Loading .....	2578
<i>Anil Agarwal, Amit H. Varma, Kristi L. Selden</i>	

## **ADVANCES IN REINFORCED CONCRETE TESTING AND DESIGN**

Non-Linear Behavior of Multi-Story Walls Using Unbonded Post-Tensioned Concrete Coupling Beams.....	2590
<i>Theresa C. Aragon, Brad D. Weldon</i>	
Strengthening Square Reinforced Concrete Columns by Shape Modification and CFRP.....	2602
<i>Thong M. Pham, Le V. Doan, Muhammad N. S. Hadi</i>	
Seismic Testing of the Slotted Beam Detail for Reinforced Concrete Structures.....	2614
<i>C. A. Muir, D. K. Bull, S. Pampanin</i>	
Seismic Displacement Demands for Hybrid Precast Concrete Shear Walls .....	2626
<i>B. J. Smith, Y. C. Kurama</i>	
Aftershock Probabilistic Seismic Demand Model of Damaged Non-Ductile Reinforced Concrete Frames in California.....	2638
<i>J. S. Jeon, R. Desroches, I. Brilakis, L. N. Lowes</i>	

## **STEEL TOPICS**

### **STABILITY ANALYSIS AND DESIGN: THEORY IS PRACTICAL**

Seismic Stability Response of Columns in Multi-Tiered Braced Steel Frames for Industrial Applications.....	2650
<i>Ali Imanpour, Christopher Stoakes, Robert Tremblay, Larry Fahnestock, Ali Davaran</i>	
Stability of X-Bracing Systems with Traditional Bolted Connections.....	2662
<i>R. Tremblay, A. Davaran, A. Gélinas</i>	

## **DESIGN INNOVATIONS FOR STEEL BRACED FRAMES AND STEEL PLATE SHEAR WALLS**

Evaluation of Collapse Potential and the Response Modification Coefficient of SCBFs .....	2675
<i>P. C. Hsiao, D. E. Lehman, C. W. Roeder</i>	

## **SUSTAINABILITY IN STRUCTURES**

### **SUSTAINABLE SYSTEMS AND MATERIALS**

Sustainable Concrete: The Role of Performance-Based Specifications.....	2693
<i>Lionel Lemay, Colin Lobo, Karthik Obla</i>	
Service-Load Deflection Behavior of Reinforced Concrete Beams with Recycled Concrete Aggregate .....	2705
<i>Adam M. Knaack, Yahya C. Kurama</i>	
Disaster Resilience and Sustainable Design: Quantifying the Benefits of a Holistic Design Approach .....	2717
<i>Matthew V. Comber, Chris D. Poland</i>	

## **SUSTAINABLE BUILDING SYSTEMS**

### **GREEN GIANTS: TALL AND SUSTAINABLE**

Achieving Enhanced Seismic Design Using Viscous Damping Device Technologies.....	2729
<i>M. Sarkisian, P. Lee, L. Hu, R. Garai, A. Tsui, E. Reis</i>	
Innovation in Sustainable Engineering Design: Sustainable Form-Inclusion System (SFIS) .....	2745
<i>M. Sarkisian, E. Long, D. Shook, L. Hu</i>	

### **AESTHETICS OF SUSTAINABLE STRUCTURES**

Sustainable Structures through Morphogenetic Design.....	2755
<i>M. Sarkisian, D. Shook</i>	
Comparing Adaptability—A Case Study of Three Historic Buildings.....	2767
<i>L. Maclise, T. Nelson, M. Kyler, G. Kang, S. Hohener, P. Littler, A. Nudel</i>	
Structure as Aesthetic in Sustainable Design Case Study .....	2779
<i>S. J. Means, D. W. Cocke</i>	
In the Looking Glass of Sustainable Architecture .....	2789
<i>Russ Miller-Johnson</i>	

## **POSTER**

### **POSTER SESSION 1**

Test on Torsion Behavior of CFST Columns Subjected to Complex Load.....	2795
<i>Yu-Hang Wang, Jian-Guo Nie, Jian-Sheng Fan</i>	
Experimental Research on Seismic Performance of K-Style Steel Outrigger Truss to Concrete Core Tube Wall Joints.....	2802
<i>Jianguo Nie, Ran Ding</i>	
Vulnerability of Disproportionate Collapse in Older Flat Plate Buildings Subjected to Sudden Removal of a Bearing Column.....	2814
<i>Jinrong Liu, Ying Tian, Sarah L. Orton</i>	
Disaster Resilience of Hospitals Considering Emergency Ambulance Services .....	2824
<i>G. P. Cimellaro, V. Arcidiacono, A. M. Reinhard, Michel Bruneau</i>	
Polyester Rope, an Alternative to Steel Cable for Pedestrian Suspended Bridges.....	2837
<i>E. M. Segal, S. Adriaenssens, T. P. Zoli, J. F. Flory</i>	
Collapse Behavior of Steel Columns under Lateral Loading .....	2848
<i>J. Fogarty, S. El-Tawil</i>	
Response Analysis of a Long-Span Arch Bridge under the Seismic Traveling Excitation .....	2860
<i>Menglin Lou, Qiang Li, Shan Gao</i>	
Shear Buckling Behavior of Steel Plate Girders at Elevated Temperatures.....	2872
<i>Jonathan D. Glassman, Maria E. Moreyra Garlock</i>	
Perforated Steel Plate Shear Walls for Tunable Seismic Resistance .....	2884
<i>M. Koppal, M. R. Eatherton</i>	
Seismic Analysis of Integral Abutment Bridges Considering Soil-Structure Interaction.....	2895
<i>Yasser Khodair, Ahmed Ibrahim</i>	

### **POSTER SESSION 2**

Prediction of Bridge Behavior Through Failure: A Case Study of the Minnesota I-35W Bridge Collapse .....	2904
<i>Hamed Salem, Huda Helmy, Ayman El Fouly</i>	
Constitutive Model for Compressive Strength and Elastic Modulus for Concrete under Elevated Temperature .....	2916
<i>Samson Ezekiel, Robert. Y. Xiao, Chee Seong Chin</i>	
Investigation Correlations between Strong-Motion Duration and Structural Damage .....	2926
<i>M. Sarieddine, L. Lin</i>	
Predictive Seismic Load History Comparison of AEM Model Prediction vs. Empirical Results .....	2937
<i>Ahmed Khalil, Hamed Salem, Huda Helmy, Michael Hahn</i>	

<b>Failure of Unreinforced Masonry Under Compression.....</b>	2949
<i>Kaspar Willam, Amir Mohammadipour, Reza Mousavi, Ashraf S. Ayoub</i>	
<b>Modeling of Nonlinear Soil-Foundation-Structure Interaction in Response History Analysis—An Existing-Building Evaluation Case Study .....</b>	2962
<i>Silvia Mazzoni, Mark Sinclair</i>	
<b>Development of Ring-Shaped Steel Plate Shear Walls .....</b>	2971
<i>A. Maurya, N. Egorova, M. R. Eatherton</i>	
<b>Evaluation of Liquefaction Screening Criterion Based on Standard Penetration Test Values .....</b>	2983
<i>Ravi Kant Mittal, N. Mahalakshmi, S. Singh</i>	
<b>Geometric Optimization of Kuwait University Stadium and Tennis Centre.....</b>	2989
<i>Charles Besjak, Preetam Biswas, Georgi I. Petrov</i>	
<b>Real-Time TDR Field Bridge Scour Monitoring System.....</b>	2996
<i>Junliang Tao, Xinbao Yu, Xiong Yu</i>	
<b>Author Index</b>	