
Table of Contents

Preface.....	iii
List of Figures.....	xiii
1. Introduction.....	1-1
1.1 About SPONSE	1-1
1.2 Past International SPONSE Workshops.....	1-2
1.3 Fifth International SPONSE Workshop	1-2
1.4 Technical Themes.....	1-11
1.5 Sponsors	1-11
2. Technical Papers	2-1
KEYNOTE 1 – Seismic Performance of Non-Structural Elements in New Zealand – What Have We Learnt? J. Stanway	2-3
KEYNOTE 2 – Floor Acceleration Spectra: from Research to Seismic Code Provisions, P. Fajfar.....	2-14
KEYNOTE 3 – Development of the New Nonstructural Seismic Design Provisions in ASCE/SEI 7-22 and Enhanced Seismic Resilience for Nonstructural Components, B. Lizundia	2-27
KEYNOTE 4 – Influence of Vertical Floor Accelerations on the Seismic Performance of Building Non-Structural Elements, K. Ryan	2-46
SESSION 1A – PERFORMANCE BASED-SEISMIC DESIGN OF NON-STRUCTURAL ELEMENTS:	
1. Component-Based Simplified Framework to Assess Integrated Structural and Non-Structural Seismic Upgrade Strategies, A. Miliziano, L. Wiebe, S. Pampanin, D. Perrone, A. Filiatrault	2-57
2. The Impact of Nonstructural Damage on Building Function, D. Cook, S. Sattar.....	2-68
3. Seismic Evaluation of Existing Unreinforced-Masonry Partition Walls to Achieve Project Goals, A. Kurt, A. Rush	2-79
4. Seismic Performance of Pre-Fabricated Façade Panels, A. Itsekson, E. Guetter	2-91
SESSION 1B – PERFORMANCE BASED-SEISMIC DESIGN OF NON-STRUCTURAL ELEMENTS:	
1. Case Study of a Rapid Assessment of Seismic Upgrade Viability using Performance Based Earthquake Engineering, P. Stenecker, L. Wiebe, A. Filiatrault, D. Konstantinidis	2-102

2.	Review of Current Design Standards for Acceleration Sensitive Nonstructural Components, P. Steneker, D. Arnold, D. Carson	2-113
3.	Design for Enhanced Nonstructural Performance – Case Studies and Recommended Practices, M. Phipps, S. Jumakuliyeva	2-123
4.	A Snapshot of Societal Expectations for the Seismic Performance of Buildings in New Zealand – What This Reveals about Future Design Considerations for Non-Structural Elements, H. Ferner, C. Brown, S. Horsfall, S. Abeling, H. Cowan	2-136

SESSION 2A – EXPERIMENTAL STUDY RELATED TO THE SEISMIC PERFORMANCE OF NON-STRUCTURAL ELEMENTS:

1.	New Testing Protocol for Acceleration-and-Drift-Sensitive Non-Structural Elements through the Innovative 9-DOFs Multi-Story Dynamic Testing Facility, I. Lanese, D. Bolognini, E. Brunesi, F. Dacarro, P. Dubini, L. Grottoli, S. Peloso, E. Rizzo Parisi, M. Rota.....	2-148
2.	Experimental Facility for the Seismic Testing of Non-Structural Elements and Systems under Full-Scale Floor Motion, F. Dacarro, D. Bolognini, G.M. Calvi.....	2-160
3.	Seismic Performance of Suspended Ceilings and Development of Floor Motion Responses for Experimental Testing, C.C.W. Flude, G.A. Davidson, D.T. Lau, J. Erochko, K. Kasai.....	2-171
4.	Numerical Simulation of Prefabricated Steel Stairs to be Implemented in the NHERI TallWood Building, S. Sorosh, T.C. Hutchinson, K.L. Ryan, S. Wichman, K. Smith, R. Belvin, J.W. Berman.....	2-182
5.	Numerical Simulation to Predict the Seismic Behavior of Continuous Plasterboard Suspended Ceiling Systems, V. Patnana, D.C. Rai.....	2-193
6.	Experimental Study to Validate an Improved Approach to Design Acceleration-Sensitive Nonstructural Components, A. Elkady, D. Vamvatsikos, D. Lignos, A.K. Kazantzi, E. Miranda.....	2-205

SESSION 2B – EXPERIMENTAL STUDY RELATED TO THE SEISMIC PERFORMANCE OF NON-STRUCTURAL ELEMENTS:

1.	Component-Test-Informed Seismic Design Methodology for Façade Systems, S. Peloso, E. Brunesi, E. Rizzo Parisi	2-214
2.	Ongoing Extension of Systems for Seismic Securing of Masonry Facades through Refurbishment, Strengthening and Retrofitting, S. Hine, M. Roik	2-225
3.	In-plane Quasi-Static Reversed Cyclic Tests on Infilled Façades made of Lightweight Steel Drywall Systems, S. Shakeel, L. Fiorino, R. Landolfo	2-235
4.	Seismic Testing and Multi-Performance Evaluation of Full-Scaled Unitized Curtain Walls: Research Overview and	

Preliminary Results, S. Bianchi, G. Lori, V. Hayez, R. Schipper,
S. Pampanin, M. Overend, G. Manara, T. Klein 2-245

SESSION 2C – EXPERIMENTAL STUDY RELATED TO THE
SEISMIC PERFORMANCE OF NON-STRUCTURAL
ELEMENTS:

1. Shaking Table Tests of a Braced Outdoor Aircon Unit, B.
Huang, M. Cheng, W. Lu 2-256
2. Seismic Fragility Testing of Electrical Equipment for the Safe
Operation of Hydroelectric Facilities, A.M. Coughlin, K.M.
Braman, B. Bergman 2-266
3. Seismic Isolation of an Industrial Steel Rack using Innovative
Modular Devices: Shake-Table Tests, G. Guerrini, F. Graziotti,
A. Penna 2-282
4. Quasi-Static Cyclic Testing of a Drift-Sensitive Sub-Assembly
of Non-Structural Elements with Low-Damage Characteristics,
R. Clement, R.P. Dhakal, M. Tripathi, G. De Francesco, M.
Rashid, T.J. Sullivan..... 2-293

SESSION 2D – EXPERIMENTAL STUDY RELATED TO THE
PERFORMANCE OF NON-STRUCTURAL ELEMENTS:

1. Seismic Cable Bracing of Sprinkler Piping, J. Carl, H.
Mostafaei 2-304
2. Numerical Analysis of Gypsum Board Subjected to Bending
Moment using Fiber Model, F. Sakyraba, A. Shegay, Y. Sato, S.
Motoyui 2-315
3. A Zinc Sheeting such as a Shear Wall in a Mixed CFS Frame
with Non-Structural Masonry, X. Nieto-Cárdenas, C. Takeuchi,
J. Tamasco 2-325
4. Dynamic Properties and Seismic Performance of an Innovative
Cleanroom, M. Zito, D. D'Angela, G. Magliulo..... 2-337
5. Shaking Table Experimental Campaign on Pre-Code Masonry
Infills Subjected to In-Plane and Out-Of-Plane Loading, M.
Kurukulasuriya, R.R. Milanesi, D. Bolognini, I. Lanese, L.
Grottoli, G. Magenes, F. Dacarro, P. Morandi 2-347
6. Evaluation of Nonstructural Walls with Drift-Compatible Details
in a 10 Story Mass Timber Building Shake Table Test, W. Roser,
S. Wichman, Y. Ji, Sir L. Wynn, K.L. Ryan, J.W. Berman, T.C.
Hutchinson, S. Pei 2-360

SESSION 2E – EXPERIMENTAL STUDY RELATED TO THE
SEISMIC PERFORMANCE OF NON-STRUCTURAL
ELEMENTS:

1. Seismic Demand on Power Actuated Fasteners (PAF) under In-
Plane Loading of Drywall Partitions: An Approach, L. Fiorino,
A. Campiche, P. Grzeisk, R. Lanfoldo 2-371
2. Failure Mode and Hysteretic Behavior of Steel Angles used for
Floor-Mounting of Non-Structural Elements, C-J. Bae, C-H. Lee,
S-C. Jun, S. Lee 2-382
3. Crack Widths in Concrete Floor Diaphragms, in Relation to
Selected Power Actuated Fasteners used to Attach Interior

- Partition Walls, M.R. Eatherton, R. Avellaneda-Ramirez, P. Grzesik, C. Gill.....2-393
4. Performance of Power Actuated Fastener Connections for Cold-Formed Steel Framing, A.E. Schultz, S.D. Overacker, D. Amori, P. Grzesik. C. Gill.....2-404

SESSION 3A – MODELING/NUMERICAL SIMULATION TO PREDICT THE SEISMIC BEHAVIOR OF NON-STRUCTURAL ELEMENTS:

1. Parametric Seismic In-Plane Fragility Models for Clay Masonry Infills in Low-to-Medium-Rise Reinforced Concrete Frames, S. Peloso, E. Brunesi, D. Perrone, B. Chichino, G. Sinopoli, C. Moroni2-414
2. Numerical Study on the Seismic Interaction between Innovative Ductile Masonry Infills and RC Elements, S. Pelucco, R. Milanese, P. Morandi, V. Bolis, A. Stavridis, G. Magenes, M. Preti.....2-425
3. Development of a Simplified Modeling Technique for Seismic Performance Assessment of Gypsum Partition Walls, I. Lotfy, M. Salkhordeh, S. Soroushian, E. Rahmanishamsi, M. Maragakis2-436
4. Numerical Investigation of the Displacement Incompatibility between Masonry Infill Walls and Surrounding Reinforced Concrete Frames, L. Pedone, S. Pampanin.....2-447
5. Seismic Performance of Point Fixed Glass Facade Systems through Finite Element Modelling and Proposal of a Low-Damage Connection System, S. D'Amore, S. Bianchi, J. Ciurlanti, S. Pampanin.....2-458

SESSION 3B – MODELING/NUMERICAL SIMULATION TO PREDICT THE SEISMIC BEHAVIOR OF NON-STRUCTURAL ELEMENTS:

1. Effect of Floor Slab Vibration on Seismic Performance of Suspended Ceiling Systems, S. Gopagani, A. Filiatrault, A.J. Aref.....2-469
2. Study the Effect of Aspect Ratio of Unbraced Suspended Ceiling Systems on their Dynamic Responses and Damage Failure Mechanisms, R. Rezvani, S. Soroushian, A.E. Zaghi, M. Maragakis2-480
3. On In-Plane Shear Stiffness of Ceiling Surface in JPN-US Suspended Ceiling, R. Morohoshi, S. Motoyui2-491
4. Numerical Analysis of Suspended Ceiling Considering Pounding Behavior between Ceiling Surface and Walls, M. Li, S. Motoyui, Y. Wang, H. Jiang, K. Kasai.....2-500

SESSION 3C – MODELING/NUMERICAL SIMULATION TO PREDICT THE SEISMIC BEHAVIOR OF NON-STRUCTURAL ELEMENTS:

1. Numerical Simulation of Piping Systems Connected by Grooved Fit Joints, T. Wang, L. Qiu, Q. Shang2-510

2. Seismic Response Analysis of Irregular Piping Networks Accounting for Vertical Acceleration, G. Blasi, D. Perrone, M.A. Aiello 2-521
3. Modelling One-Dimensional Rolling Response of Rigid Bodies on Casters using Physics Engine Simulation, C. Xu, Q. Ma, M. Kurata 2-532
4. Seismic Response Analysis of Freestanding Building Contents Exhibiting Rocking, Sliding, and Wall Pounding, Y. Bao, D. Konstantinidis..... 2-545

SESSION 3D – MODELING/NUMERICAL SIMULATION TO PREDICT THE SEISMIC BEHAVIOR OF NON-STRUCTURAL ELEMENTS:

1. Evaluation of Seismic Demand on Bridge Nonstructural Components using ASCE 7, N. Girmay, M. Tumbeva, T. Do, D. Ojala 2-557
2. Computational Modelling and Seismic Performance of Non-Traditional Automated Warehouse Storage System, L. Mello, A. Coughlin 2-571
3. Case Study to Evaluate the Key Parameters of the Dynamic Response of Floor-Anchored Nonstructural Components, T. Feinstein, J.P. Moehle 2-583
4. Effect of Spectral Shape on the Amplification of Peak Floor Acceleration Demands in Buildings, G. Scagliotti, E. Miranda 2-595
5. Nonlinear Approach on Seismic Design Force of Non-Structural Components for Isolated and Fixed Base Buildings Comparison, S. Shakeri, J. Wong, T. Hart, M. Halligan 2-606

SESSION 4A – EVALUATION OF THE SEISMIC DEMAND ON NON-STRUCTURAL ELEMENTS:

1. Absolute Acceleration Floor Response Spectra for Inelastic Buildings: Quantification of Amplitude Capping and Period Lengthening, D. Rodriguez, D. Perrone, A. Filiatrault, E. Brunesi 2-617
2. Estimating Floor Acceleration Response Spectra for Self-Centering Structural Systems with Flag-Shaped Hysteretic Behavior, B.K. Shrestha, A.C. Wijeyewickrema, H. Miyashita, N. Malla..... 2-628
3. A Practice-Oriented Floor Response Spectrum Prediction Method for Seismic Design of Non-Structural Elements, K. Haymes, T.J. Sullivan, R. Chandramohan, L. Wiebe..... 2-640
4. Free-Field Earthquake Hazard Spectra to Establish Nonstructural Test Requirements for Global Code Compliances, J.A. Gatscher, S.R. Littler 2-651

SESSION 4B – EVALUATION OF THE SEISMIC DEMAND ON NON-STRUCTURAL ELEMENTS:

1. Equipment Seismic Performance in the General Docente Ambato Hospital, Ecuador, O.S. Saravia, A.G. Haro 2-664

2. Effect of Unequal Slab Levels in Adjacent Buildings on the Seismic Demand of Non-Structural Building Components, P. Verma, Y. Aggarwal, S. Kumar Saha.....2-676
3. Seismic Assessment of Acceleration-Sensitive Nonstructural Elements: Reliability of Existing Shake Table Protocols and Novel Perspectives, D. D'Angela, M. Zito, C. Salvatore, G. Toscano, G. Magliulo2-687
4. Development of a Code-Compliant Seismic Input for Shake Table Testing of Acceleration-Sensitive Nonstructural Elements, M. Zito, D. D'Angela, G. Maddaloni, G. Magliulo2-697

SESSION 4C – EVALUATION OF THE SEISMIC DEMAND ON NON-STRUCTURAL ELEMENTS:

1. Mitigate Seismic Rocking Responses and Deformations on the Isolated Equipment-Platforms Sets by Wire Rope Isolators Mounted in Low-Rise Buildings, A. Al Jawhar2-707
2. Seismic Demand on Sprinkler Piping Systems: Findings from a Shake Table Testing Program & Relevance to NZ Standards, M. Rashid, R.P. Dhakal, T.J. Sullivan, T.Z. Yeow2-718
3. Analytical Studies in Support of an Improved Approach to the Design of Acceleration-Sensitive Nonstructural Elements, A.K. Kazantzi, E. Miranda, D. Vamvatsikos, A. Elkady, D. Lignos2-728
4. Simple and Economical Details to Improve the Seismic Resiliency of Large Power Transformers, N.G. Moore.....2-738

SESSION 5 – INNOVATIVE TECHNIQUES TO MITIGATE DAMAGE TO NON-STRUCTURAL ELEMENTS:

1. Seismic Performance Evaluation of Braced and Friction-Added Suspended Ceilings Based on Shake Table Testing, S-C. Jun, C-H.Lee, C-J. Bae, D-S. Lee2-751
2. Seismic Response of a Braceless Seismic Restraint System for Suspended Nonstructural Elements, B. Chalarca, A. Filiatrault, D. Perrone, R. Nascimbene.....2-763
3. Non-Structural Contents Mitigation: Design, Implementation, and Community Outreach Structures, G. Granholm, S. Austin, K. Briggs, M. Benthien.....2-774

SESSION 6 - STANDARDIZATION OF QUALIFICATION AND FRAGILITY TESTING AND DESIGN PROCEDURES:

1. Seismic Performance of Electrical Cabinets during Shake Table Testing, R. Merino, D. Perrone, A. Filiatrault, R. Nascimbene.....2-781
2. A New Testing and Evaluation Method for Seismic Rating of Non-Structural Elements, N. Zamani, C. Beiter, D. Perrone, A. Filiatrault, D. Rodriguez, C. Tokas.....2-792
3. Performance Assessment of Seismically Damaged Firestopping Systems: A Preliminary Framework, Z. Ye, A.K. Abu, C.M. Fleischmann, R.P. Dhakal2-803

4. Seismic Qualification of Square D Relays Type KPD13 at Laguna Verde Nuclear Power Plant, G. Jarvio, J. Guadarrama, V.A. Jarvio 2-817
5. Recent Developments in the Field of Anchoring Heavy Facades in Seismic Areas, M. Roik, C. Piesker 2-827

SESSION 7 - LOSS ESTIMATION WITH SPECIAL FOCUS ON BUILDING REOCCUPANCY AND FUNCTIONAL RECOVERY:

1. The Influence of High-Dispersion Nonstructural Component Fragility Curves in Damage and Loss Uncertainty, J.V. Manousakis, D. Konstantinidis..... 2-838
2. Seismic Performance of Acceleration Sensitive Non-Structural Elements in Stiff Self-Centering Structural Systems, W.W. Carofilis, E. Kim, D. Jung 2-848
3. Impact of Masonry Infill Variability on the Seismic Demand of Non-Structural Elements, G. Mucedero, D. Perrone, R. Monteiro 2-859

SESSION 8 - PRACTICAL IMPLEMENTATION/INSTALLATION OF NON-STRUCTURAL ELEMENTS IN BUILDINGS:

1. Overlooked Nonstructural Component Flexibility Design Issues, B.E. Kehoe 2-871
2. Seismic Design Optimization of Sprinkler Piping Restraint Installations with Dynamo, M. Casto, D. Perrone, R. Nascimbene, A. Filiatrault, M.A. Aiello 2-882
3. Improving Seismic Restraint Design Implementation, A. Baird, C. A. Muir, A. Pourali, W.Y. Kam..... 2-893
4. Practical Considerations for Non-Structural Bracing Design of Multiple Suspended Utilities in Congested Areas of Facilities, J. Masek, P. McMullin, B. Larsen..... 2-904

SESSION 9A - IMPACT OF NON-STRUCTURAL ELEMENTS ON THE SEISMIC PERFORMANCE OF BUILDINGS:

1. Seismic Response Analysis of Precast Structures with Closure External Panels, D. Bellotti, F. Cavalieri, R. Nascimbene... 2-915
2. Assessment of the Effect of Non-Structural Walls (NSWs) on the Dynamic Properties and Inter-Story Drifts of a Case Study Building, A. Ramadan, R. Assi 2-926
3. Probabilistic Evaluation of Post-Earthquake Functional Recovery of a Seismically Isolated RC Building, J. Chavez, J. Murcia-Delso, F. Lopez-Almansa 2-937

SESSION 9B - IMPACT OF NON-STRUCTURAL ELEMENTS ON THE SEISMIC PERFORMANCE OF BUILDINGS:

1. Comparison of Seismic Loss and Floor Response Spectra of Low-Rise Buildings with Various Types of Braced Frames, A. Banihashemi, L. Wiebe, A. Filiatrault..... 2-948
2. Wooden Infills Influence on the Seismic Performance of Steel Structures, M. Calò, G. Mucedero, V. Nicoletti, G. Gabbianelli 2-959

3.	Customized Tools for Assessing Nonstructural Element Vulnerabilities in Hospitals in Nepal and Myanmar, J. Rodgers, H. Kumar, W. Holmes, Y. Lotay, D. Joshi, U. Ojha	2-969
4.	Managing Seismic Risk in the San Francisco Legal Arena: Performance Gap Claims based on Curtain Walls and other Non-Structural Elements, M. White	2-979
	Applied Technology Council Directors	A-1