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EDITORIAL

Special Issue on Resilience in Steel Structures

This special issue of Frontiers of Structural and Civil Engineering features nine technical papers focusing on resilience in steel structures with authors from Canada, China, Italy, Portugal, Singapore and the United States. Through their contributions, they have shared their technical expertise in innovative solution towards resilience in steel structures by conducting experimental investigation, formulating analytical modelling and developing finite-element simulation. Papers also addressed the topical issue on life-cycle costing, constructability and reparability. Current design provisions were also assessed and new design concepts and solutions were proposed. The following are the highlights of each of the technical contributions.

The first paper by Leon and Gao pinpoints the relationship between resiliency, sustainability and risk management. It describes the current sustainability agenda of steel and composite construction and highlights the key features of steel and composite construction towards resiliency agenda. Five systems aiming to improve resiliency on existing structures were summarized while six state-of-art solutions to safeguard resiliency for new structures were also outlined. It serves as an introduction to the following papers: Ricles et al., Maurya and Eatherton, Clayton et al., Yang and Li , Chou et al. and Silva et al. in this special issue. This paper is concluded with one of the pioneering works by the authors on the hybrid use of steel and SMA rods in a re-centering connection to circular concrete-filled tubes.

The second paper by Ricles et al. presents an experimental investigation on the seismic performance of a 0.6-scale three-story steel frame building structure with nonlinear viscous dampers. They adopted real-time hybrid simulations under the design basis earthquake (DBE) and maximum considered earthquake (MCE) in their investigations. The test structures consisted of a single-bay moment resisting frame (MRF) and an associated single-bay frame with a nonlinear viscous damper/associated bracings (DBF) in each story. Results indicated that a MRF building structure with nonlinear viscous dampers can be designed with a reduced MRF strength level but can still achieve (i) high level performance between the “Immediate Occupancy” and the “Life Safety” under DBE ground motions and (2) high performance under MCE ground motions with a low probability of collapse and a high probability of good post-earthquake functional performance.

The third paper by Maurya and Eatherton proposes a new self-centering beam (SCB) moment frame to address the current challenges in adopting self-centering (SC) seismic force resisting systems which includes complex field construction, deformation incompatibility between the SC system and gravity load system of the structure. The proposed SCB system can also be shop-fabricated and also be tuned specifically for particular design requirements on strength and stiffness to achieve the optimum use of steel materials. Prototype specimens were examined experimentally and all three SCBs were successfully tested up to a story drift of 6% without damages. Their proposed equations on moment capacity, beam moment at gap opening and post-gap opening stiffness found to be in good agreement with the experimental observations.

The fourth paper by Clayton et al. presents an overview of the numerical and experimental research program on a recently proposed self-centering steel plate shear wall (SC-SPSW) lateral force-resisting system. Focus is also made at the innovative post-tensioned beam-column connection and web plate designs. The proposed SC-SPSW have shown promising performance on constructability, resilience and seismic performance.

The fifth by Yang and Li examines an innovative buckling restrained knee braced truss moment frame (BRKBTMF) system through a prototype 4-story office building. The modelling methodology using robust buckling restrained brace model and element removal technique in OpenSees was developed and implemented. Results indicated that BRKBTMF demonstrated excellent seismic performance on inter-story drift, floor acceleration and resistance against collapse. Authors also adopted the next-generation performance-based earthquake engineering framework to assess the life cycle repair cost of BRKBTMF. Results also confirmed that BRKBTMF can effectively control the structural and non-structural damage and repair costs.

The sixth paper by Chou et al. experimentally examines an innovative steel dual-core self-centering brace (DC-SCB) by testing a DC-SCB sub-assemblage and a full-scale one-story one-bay DC-SCB frame. The key objective was to validate the seismic behavior of a steel frame with the DC-SCB as an earthquake-resisting mechanism. Authors have clearly described the behavior of an individual brace as well as the mechanism on how the force redistributed as damages progressed in the key dissipative elements – DC-SCBs, beams or columns. Accounts on reparability and replaceability on the braced frame were also discussed.

The seventh paper by Silva et al. presents the results of an experimental campaign to evaluate the bending behavior of a new concrete-filled steel tubular (CFST) column with the use of rubberized concrete (RuC). Numerical assessment was also carried out, using OpenSees to assess the seismic performance and resilience of moment-resisting frames with CFST columns. Experimental results indicated that RuC-CFST columns displayed ductile behavior while the effect of concrete type was negligible in the member’s bending behavior. Seismic performance assessment of the case studies indicated that the seismic design of composite moment-resisting frames using CFST columns in accordance with Eurocode 8 led to lighter solution and also improved the seismic and resilience performance as compared with equivalent steel options.

This Special Issue is concluded by two further contributions from Quan et al. and Gu et al. The paper, by Quan et al. describes an investigation on the use of narrow outer diaphragm and partial joint penetration welds between concrete-filled steel tubular column and steel beam under cyclic loads. Results from experimental, analytical and numerical campaigns confirmed the suitability of this type of joint configuration for seismic applications given appropriate control of the axial load level. The paper, by Gu et al. presents a numerical investigation to develop critical deformation limits for K- and X-joints under brace axial tension. The numerical methodology was validated and results were calibrated against existing experimental results. The proposed deformation limit provided an explicit measure to quantify the ductile fracture failure in engineering designs for a wide range of geometric parameters and material toughness levels.

We sincerely hope you will enjoy reading this special issue and join us in congratulating the authors for their immense achievements and contributions to this special field "*Resilience in Steel Structures*".

Guest Editors

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