

International Research (Project No.: 30W-04)

Project name: Tuned Hybrid Systems for Resilient Seismic Building Performance
同調ハイブリッド構造システムによるレジリエントな耐震性能の実現

Principal Investigator: Larry Fahnestock

Affiliation: University of Illinois at Urbana-Champaign

Name of DPRI collaborative researcher: Masahiro Kurata

Research period: June 1, 2018 ~ May 31, 2020

Research location: Kyoto University, Hokkaido University, University of Illinois at Urbana-Champaign, Lehigh University, Oregon State University

Number of participants in the collaborative research: (DPRI staff: 1, non-DPRI staff: 5)

- Collaborators: Masahiro Kurata, Taichiro Okazaki, Larry Fahnestock, James Ricles, Richard Sause, Barbara Simpson
- Number of graduate students: 2 (Master students: 0, Doctor students: 2)
- Participation role of graduate students: preliminary structural analysis, design and experimental planning

Implementation status in FY2018

During FY2018, the research team collaborated on development of schematic system design concepts and preliminary experimental planning. The initial broad concept of a tuned hybrid system for seismic resilience was refined and focused to a frame-spine system with force-limiting connections for seismic resilience. This novel steel frame-spine lateral-force-resisting system with force-limiting connections is intended to control multi-modal seismic response and protect a building from damaging lateral drift and accelerations, providing resilient structural and non-structural building performance. This economical seismic-resilient system will be particularly valuable for essential facilities, such as hospitals, where damage to buildings and contents, and occupant injuries, must be prevented. The system concept is a unique opportunity for bilateral U.S.-Japan research collaboration that enhances seismic resilience in both nations. The research team developed and submitted a major proposal to the U.S. National Science Foundation for funding to conduct full-scale 3D shake-table testing at E-Defense in partnership with the Japanese project, Enhancement of Resilience for Tokyo Metropolitan Area, funded by NIED and the Ministry of Education, Culture, Sports, Science and Technology (MEXT). A steel and protective systems team (led by Kurata) is focusing on Holistic Assessment of Seismic Damage in Medical Facilities, including shake table tests of two (linked) full-scale steel special moment-resisting frame buildings (one base isolated) at E-Defense. Investigation of the new frame-spine system is directly integrated with this steel and protective systems team. The objective for study of the new frame-spine system is to provide fundamental system-level response data and support advancements in computational modeling.

During FY2018, the research team participated in joint discussions on two occasions:

- Collaboration meetings November 27-28, 2018 at E-Defense and DPRI (travel funded by this DPRI grant).
- Collaboration meetings February 7-8, 2019 at E-Defense as part of the NHERI/E-Defense 2nd Joint Research Planning Meeting (travel of U.S. participants funded by the U.S. National Science Foundation).

In addition, an industry partnership was established with Nippon Steel & Summikin Engineering (NSSE) to provide support for developing, testing and supplying force-limiting connections for large-scale frame tests.

Implementation plan in FY2019

During FY2019, the research team will continue development of the frame-spine system. The schematic design concepts that have been established will be refined and used to proportion realistic buildings. These building systems will be evaluated using nonlinear static and dynamic simulations. These simulations will inform decisions about full-scale testing, which is contingent upon funding from the U.S. National Science Foundation. The decision on this submitted proposal is expected within the next couple months. The research team will continue to interact with industry partner NSSE to develop force-limiting connection concepts and plan for pilot testing.

During FY2019, a research team collaboration meeting will be held, with location and dates still to be determined.