Near-Fault effects on the low-frequency nonstructural components and systems in high-rise buildings

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Near-fault ground motions are characterized by the high peak ground velocity and long period pulse. Therefore, long-period high-rise buildings under near-fault ground motions exhibit excessive drift ratios and acceleration responses, which are crucial seismic demands for displacement-controlled or/and force-controlled low-frequency nonstructural components and systems (NSCS) in high-rise buildings. Based on the recent earthquake experiences in Taiwan, the losses did not necessarily result from damages of building structures but non-structural components. For instance, the leakage of fire protection sprinkler systems in high-rise buildings after earthquakes could result in the shortage of building function and fire protection, and cause the malfunction and repairs of building contents. The fallen pieces of nonstructural components during strong earthquakes could obstruct the egress system, which is critical to ensure the life safety of high-rise buildings.

The objective of the proposed experiment facilities at NCREE Tainan Laboratory is to simulate the seismic demands for NSCS in high-rise buildings subjected to near-fault ground motions. In addition to the new shaking table system in Tainan branch, NCREE will establish the associated testing facilities to study the effects of high velocities and large displacements due to real floor responses on NSCS:

1. For acceleration-controlled NSCS:
   (1) A rigid framework for suspended NSCS will be established in 2018 to provide a large space to suspend critical NSCS on the shaking table, such as ceiling systems and fire suppression piping systems.

(2) According to the preliminary studies of the floor response of high-rise buildings, the acceleration and/or displacement capacity of the shaking table in NCREE Tainan branch may be not enough to reproduce the seismic demands for NSCS at higher floor levels. Referring to the study for NSCS in high-rise buildings in E-defense, a passive-controlled transform system will be proposed to amplify the input motion of the shaking table in about 2018 to 2019.

2. For both displacement and acceleration controlled NSCS:

   In order to provide proper simulation of story drift ratio and floor acceleration simultaneously for the components which are sensitive to both displacement and acceleration demands (such as exterior veneers and vertical piping components), a double-layered framework collocated with high-performance dynamic actuators will be established in about 2019.