DS '11 KOBE
International Symposium on
Disaster Simulation & Structural Safety in the Next Generation (DS'11)
September 17-18, 2011, JAPAN

Analyses and E-Defense Tests on a Full-Scale Building with/without Dampers

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***Keywords*:** *Passive control, Steel building,viscoelastic damper, Numerical simulation, Slab-girder interaction*

SUMMARY

Japan has constructed the largest number of passively-controlled buildings, and is believed to have conducted the most extensive research to realize various control schemes. A variety of dampers are being produced by more than twenty manufacturers and more than ten general construction companies in Japan. Numerous technical papers on the schemes are also published.

Passive control is now considered to be a reliable scheme better protecting the building and its contents. However, because of its short history, the scheme has never been attested under the major and catastrophic quakes, while increasingly used in Japan. Thus, it is extremely important to validate the advanced scheme by realistic experiments, before occurrence of such earthquakes.

The full-scale shake table test made possible by the E-Defense would be the best option for such validation. Realistic three-dimensional shake table tests using E-Defense were conducted for full-scale 5-story building specimens with/without dampers to evaluate seismic performance, under ground motions of a variety of scales ranging from minor to catastrophic levels. The building was tested repeatedly, inserting and replacing each of 4 damper types, i.e., steel, viscous, oil, and viscoelastic dampers.

In addition, because of lack of test result of full-scale building with dampers, the accuracy of the analytical method for passive control systems has not been verified. This test will be one of the best opportunities to understand the passive control effect and calibrate the analytical method for better accuracy.

Based on these, the present paper focuses on the correlative analysis of tests conducted to the building without dampers and the building with viscoelastic dampers. The frame is modeled by simple line elements, whose properties are carefully tuned. The damper is modeled by the viscoelastic constitutive model based on fractional derivative of stress and strain, by simulating the frequency and temperature dependencies of the material.