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ACTIVE AND HYBRID STRUCTURAL CONTROL RESEARCH IN JAPAN

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ABSTRACT

Recently, several effective research and development programs on structural control have been promoted towards the mitigation of the urban earthquake disasters. From the author's view-point, the structural response control can theoretically be classified into the following two general categories: (I) installation of a damping mechanism to absorb vibration energy input to the building, and (II) achievement of a non-resonant structural vibration state to reduce the seismic input motion. The category (I) includes the passive-type control devices such as steel elasto-plastic dampers, oil dampers, viscous dampers and sloshing dampers, as well as the active-type control devices including auxiliary-mass-type dampers such as the Active Mass Driver (AMD), the Hybrid Mass Damper (HMD), and the Active Passive Composite Tuned Mass Damper (APTMD). The typical example of the category (II) is the Active Variable Stiffness (AVS) System developed recently by the authors, and the so-called base isolation system, which means a passive system designed to evade resonance with the dominant high-frequency earthquake ground motion.

The Great Hanshin Earthquake struck when of these systems were being developed. However, only two base-isolated buildings in the Kobe area have been incorporated, and none yet had any full-scale active or hybrid structural control system. Furthermore, the auxiliary-mass-type active control devices in several buildings located at Osaka area have been designed to control the strong wind-induced vibrations. Consequently, the control action of all of them stopped during the earthquake, with the exception only one case in which was able to control vibration due to the tail of earthquake ground motion. Therefore, here the effectiveness could scarcely be assessed.

This paper discusses the development status in Japan of active and hybrid structural control systems that have been promoted for practical application since 1986, keeping in mind the classification the above structural control types and their behaviors in the Great Hanshin Earthquake. It also discusses the appropriate level for external earthquake or strong wind excitations that can be controlled and furthermore pays attention to the future direction of research and development.

KEYWORDS

Structural response control, Active control, Hybrid control, Damping mechanism, Non-resonant system, Auxiliary-mass-type damper, Practical application, Future direction