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STUDY ON PERFORMANCE OF SEMI-ACTIVE BASE-ISOLATION SYSTEM USING EARTHQUAKE OBSERVATION RECORDS

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SUMMARY

To improve the performance of the ordinary base-isolation systems, we have developed a semi-active base-isolation system using semi-active hydraulic dampers that can be switched between two primary damping coefficients. The piston velocity-damping force relationship of the semi-active hydraulic damper is shown in Figure 1. An 11-storey university building and a 26-storey super high-rise building equipped with this system were completed in April 2005 and February 2008, respectively. A sliding mode control has been used to reduce the acceleration response of the buildings, while keeping the deformation of the isolation story relatively small. Sliding mode control considering the time lag of the damper force was developed based on a bilinear optimal control theory and a control law for simultaneous bidirectional control was proposed. A monitoring system is also developed to detect the malfunctions of the whole system, including the computer, the sensors, the electromagnetic valves of the dampers etc. The monitoring system helps the semi-active base-isolation system to be certified as highly reliable system that offers continued control even in the event of a major earthquake.
This paper discusses the basic performance of the semi-active hydraulic damper and the performance verification through shaking table tests as well as the damping effectiveness as determined based on earthquake observation records. As for the 11-storey building, seismic response analysis using a pseudo three-dimensional model of the building was also conducted to simulate the building response observed in the 2011 off the Pacific coast of Tohoku Earthquake. The effectiveness of the semi-active control was thereby confirmed.

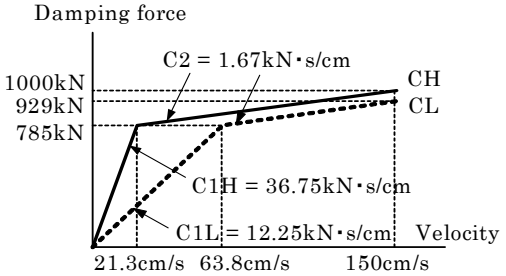

Figure 1. Piston velocity-damping force relationship of semi-active hydraulic damper