4. Passive Variable Orifice Damper to Control Excessive Displacement of Seismically Isolated Buildings

- Performance of Damper with 500 kN Class Maximum Damping Force -

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Horizontal displacements that exceed the horizontal clearance of isolation layers can lead to collisions between superstructures and retaining walls. Typical countermeasures, including boosting horizontal stiffness or the damping of the isolation layer have the disadvantage of increasing the seismic force borne by the superstructure.

Our study sought to develop an energy dissipating device that passively adjusts the damping force to suppress the excessive horizontal displacement of the isolation layer that occurs during a large earthquake and to reduce the response acceleration during a moderate earthquake equal to that found in typical seismically isolated buildings. The developed damping device is a uniflow type oil damper that automatically and steplessly increases the damping force in accordance with the level of displacement in the velocity range of about 40 cm/s or less. A prototype damper with a maximum force of about 500 kN was manufactured and tested using sinusoidal excitation, which confirmed that the damping force varied as expected in accordance with the damper displacement. Numerical analysis showed that installing dampers incorporating characteristics obtained from the experiment in existing isolated buildings reduces the maximum displacement of the isolation layer by 15% during long-period earthquakes and is effective as a measure to avoid retaining wall collisions.

Key words: isolated building, passive variable orifice damper, displacement control design, long-period ground motions