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MULTI-OBJECTIVE OPTIMIZATION OF VISCOUS DAMPER FOR ENHANCED SEISMIC RESILIENCE OF BUILDINGS

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Abstract

The implementation of seismic protection devices in buildings often involves a trade-off between global and local structural responses. While global demands such as interstory drift and floor acceleration can be effectively reduced, local effects in structural members may increase. This behavior is particularly evident in structures equipped with viscous dampers, devices that dissipate seismic energy by reducing drift and acceleration while amplifying axial forces in the supporting columns.

Higher damping capacities generally improve global seismic performance while intensifying local force demands. In addition, drift and acceleration are not reduced proportionally. Peak floor accelerations are more critical in upper stories, whereas interstory drift governs the response at lower levels. Consequently, designs optimized for acceleration control require larger damping capacities at upper stories, while drift-oriented designs favor stronger damping at lower stories. As a result, configurations that minimize acceleration differ from those that minimize drift.

This conflict motivates the formulation of the damper design problem as a multi-objective optimization problem involving three competing objectives: minimization of interstory drift, floor acceleration, and axial forces in the supporting columns. Analyses of objective pairs (drift versus axial forces and acceleration versus axial forces) reveal distinct optimal solutions, which also depend on the seismic source characteristics, including far-field, near-fault, and subduction earthquakes.

When all three objectives are minimized simultaneously, consistent solution patterns emerge across seismic sources. These optimal configurations are characterized by an increasing damping capacity with height and by diamond and zig-zag device orientations. The results identify a compact set of robust solutions that balance global performance improvements with controlled local demands, providing practical guidance for preliminary design and retrofit applications without significantly altering the original structural system.