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Resilient Optimal Viscous Damper Design For Elastic-Plastic Moment Frames Using Normalized Critical Double Impulse

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An input velocity adjustment method of the critical double impulse (DI) is presented for resilient optimal design of viscous dampers for elastic-plastic moment frames. The input velocity is adjusted so that the input energy to the lowest eigenmode under the critical DI is equal to those under the selected recorded ground motions. This adjustment makes the critical DI work as the active earthquake, which bounds or maximizes the structural response under the selected motions. The response bounding property of the critical DI is supported by, 1) the multi-modal property of the critical DI, 2) the usual excitation of the lowest-mode response under recorded ground motions, 3) the large proportion of the instantaneous input energy to the total input energy in the critical DI. The proposed method can treat not only pulse-like near-fault ground motions but also ground motions of random nature. It is noted that the use of the critical DI as the active earthquake for optimal damper design efficiently provides the design with high reliability. This is because the only use of the active earthquake saves the use of multiple ground motions for optimal damper design. The local search-based optimization method proposed in the previous paper is applied to the search of the viscous damper placement. The method effectively uses the transformation of a moment frame into the 1st-mode equivalent shear mass system and the efficient inverse damper transformation to find the optimal damper placement for the moment frame. It is reminded that the critical DI with adjusted input velocity amplitude is used as the input ground motion. Numerical examples are presented for 10-stpry and 20-story elastic-plastic moment frames to demonstrate the effectiveness of the proposed design method.