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Modern Seismic Design Approach for Buildings with Hysteretic Dampers

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Abstract : The use of energy dissipation systems for seismic applications has increased worldwide, thus it is necessary to develop practical and modern criteria for their optimal design. Here, a direct displacement-based seismic design approach for frame buildings with hysteretic energy dissipation systems (HEDS) is applied. The building is constituted by two individual structural systems consisting of: 1) A main elastic structural frame designed for service loads and 2) A secondary system, corresponding to the HEDS, that controls the effects of lateral loads. The procedure implies to control two design parameters: A) The stiffness ratio (α=K_frame/K_(total system)), and B) The strength ratio (γ= V_damper / V_(total system)). The proposed damage-controlled approach contributes to the design of a more sustainable and resilient building because the structural damage is concentrated on the HEDS. The reduction of the design displacement spectrum is done by means of a damping factor (recently published) for elastic structural systems with HEDS, located in Mexico City. Two limit states are verified: Serviceability and near collapse. Instead of the traditional trial-error approach, a procedure that allows the designer to establish the preliminary sizes of the structural elements of both systems is proposed. The design methodology is applied to an 8-story steel building with buckling restrained braces, located in soft soil of Mexico City. With the aim of choosing the optimal design parameters, a parametric study is developed considering different values of α and γ. The simplified methodology is for preliminary sizing, design, and evaluation of the effectiveness of HEDS, and it constitutes a modern and practical tool that enables the structural designer to select the best design parameters.

Keywords : damage-controlled buildings, direct displacement-based seismic design, optimal hysteretic energy dissipation systems, hysteretic dampers
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