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Direct-Displacement Based Design for Buildings with Non-Linear Viscous Dampers

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Abstract : An approach is proposed for the design of regular buildings equipped with non-linear viscous dissipating devices. The approach is based on a direct-displacement seismic design method which satisfies seismic performance objectives. The global system involved is formed by structural regular moment frames capable of supporting gravity and lateral loads with elastic response behavior plus a set of non-linear viscous dissipating devices which reduce the structural seismic response. The dampers are characterized by two design parameters: (1) a positive real exponent α which represents the non-linearity of the damper, and (2) the damping coefficient C of the device, whose constitutive force-velocity law is given by $F=Cv^{a}$, where v is the velocity between the ends of the damper. The procedure is carried out using a substitute structure. Two limits states are verified: serviceability and near collapse. The reduction of the spectral ordinates by the additional damping assumed in the design process and introduced to the structure by the viscous non-linear dampers is performed according to a damping reduction factor. For the design of the non-linear damper system, the real velocity is considered instead of the pseudo-velocity. The proposed design methodology is applied to an 8-story steel moment frame building equipped with non-linear viscous dampers, located in intermediate soil zone of Mexico City, with a dominant period T_s = 1s. In order to validate the approach, nonlinear static analyses and nonlinear time history analyses are performed.

Keywords : based design, direct-displacement based design, non-linear viscous dampers, performance design
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