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Simulation of Dynamic Behavior of Seismic Isolators Using a Parallel Elasto-Plastic Model

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Abstract : In this paper, a one-dimensional (1d) Parallel Elasto- Plastic Model (PEPM), able to simulate the uniaxial dynamic behavior of seismic isolators having a continuously decreasing tangent stiffness with increasing displacement, is presented. The parallel modeling concept is applied to discretize the continuously decreasing tangent stiffness function, thus allowing to simulate the dynamic behavior of seismic isolation bearings by putting linear elastic and nonlinear elastic-perfectly plastic elements in parallel. The mathematical model has been validated by comparing the experimental force-displacement hysteresis loops, obtained testing a helical wire rope isolator and a recycled rubber-fiber reinforced bearing, with those predicted numerically. Good agreement between the simulated and experimental results shows that the proposed model can be an effective numerical tool to predict the forcedisplacement relationship of seismic isolators within relatively large displacements. Compared to the widely used Bouc-Wen model, the proposed one allows to avoid the numerical solution of a first order ordinary nonlinear differential equation for each time step of a nonlinear time history analysis, thus reducing the computation effort, and requires the evaluation of only three model parameters from experimental tests, namely the initial tangent stiffness, the asymptotic tangent stiffness, and a parameter defining the transition from the initial to the asymptotic tangent stiffness.

Keywords : base isolation, earthquake engineering, parallel elasto-plastic model, seismic isolators, softening hysteresis loops
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