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An Advanced Exponential Model for Seismic Isolators Having Hardening or Softening Behavior at Large Displacements

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Abstract : In this paper, an advanced Nonlinear Exponential Model (NEM), able to simulate the uniaxial dynamic behavior of seismic isolators having a continuously decreasing tangent stiffness with increasing displacement in the relatively large displacements range and a hardening or softening behavior at large displacements, is presented. The mathematical model is validated by comparing the experimental force-displacement hysteresis loops obtained during cyclic tests, conducted on a helical wire rope isolator and a recycled rubber-fiber reinforced bearing, with those predicted analytically. Good agreement between the experimental and simulated results shows that the proposed model can be an effective numerical tool to predict the force-displacement relationship of seismic isolation devices within the large displacements range. Compared to the widely used Bouc-Wen model, unable to simulate the response of seismic isolators at large displacements, the proposed one allows to avoid the numerical solution of a first order nonlinear ordinary differential equation for each time step of a nonlinear time history analysis, thus reducing the computation effort. Furthermore, the proposed model can simulate the smooth transition of the hysteresis loops from small to large displacements by adopting only one set of five parameters determined from the experimental hysteresis loops having the largest amplitude.

Keywords : base isolation, hardening behavior, nonlinear exponential model, seismic isolators, softening behavior
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