The 2025 World Congress on
Advances in Structural Engineering and Mechanics (ASEM25)
BEXCO, Busan, Korea, August 11-14, 2025

Study on the Elastic-Plastic Response Spectra of Vertical Seismic Motion Based on an Asymmetric Bilinear Hysteresis Model

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ABSTRACT

Different from horizontal isolation, a current research challenge lies in how to account for the gravity loading effect in vertical isolation, which results in the isolation system being in a preloaded state. Studying the dynamic effect of the structure under vertical seismic action is of great value for the development and improvement of vertical isolation design theory. In this paper, the asymmetric bilinear hysteresis model under the consideration of gravity preloading is discussed, and the corresponding elastic-plastic response spectrum analysis program for the single-degree-of-freedom (SDOF) system is developed. The effects of structural self-oscillation period (T), ductility coefficient (μ) and stiffness ratio (α) on the single-degree-of-freedom elasto-plastic response spectra of vertical earthquakes are investigated by inputting 100 vertical ground shocks. The results show that an appropriate extension of the structural self-oscillation period and the ability of energy dissipation can significantly reduce the acceleration response by up to 70% compared with the elastic system, while the vertical dynamic and residual displacements are kept within acceptable limits. For example, when T=0.1s, α=0.1, μ≥15, the average maximum dynamic displacement corresponding to the peak ground acceleration of 1m/s² is only 1.7mm.

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