Sensitivity of an hysteretic material model for random vibration analysis of base-isolated rigid-block historical artifacts

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Abstract

Nonlinear response of rigid bodies standing on seismic base isolation systems has received a significant attention during the last decade due to the need of assessing the seismic risk of museum artifacts (Roussis et al. (2008)). Such a response depends on a complex interaction between the isolation devices, often presenting nonlinear behavior, and the dynamics of a rigid block.

Within a seismic context, it is essential to determine the first excursion probability and to assess the properties of the bearing devices in order to maintain it within a safety interval. To this purpose, one of the most effective strategies available in the literature is the Tail-Equivalent Linearization Method Fujimura and Der Kiureghian (2007) although such strategy requires the computation of response sensitivity in closed form.

We present the computation and the implementation of the sensitivity relevant to a recently formulated phenomenological nonlinear material Vaiana et al. (2018) which is capable of reproducing several typologies of hysteretic loops without requiring iterative algorithms to determine its response. Moreover, it is based on a set of parameters having a peculiar physical meaning and provides responses characterized by smooth derivative. Hence, the model is particularly feasible to be implemented within a finite-element based reliability code aiming to perform tail-equivalent linearization and random vibration analysis.

Within this context, the implemented model has been tested by analyzing a base-isolated structural system inspired at the Riace Bronze A. Numerical tests confirm the effectiveness of the sensitivity formulation and of its capabilities for tail-equivalent linearization purposes.

References

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