Inverse analysis of nonlinear dynamic systems is an important area of research in the field of structural health monitoring for civil engineering structures. Structural damage usually involves localized nonlinear behaviors of dynamic systems that evolve into different classes of nonlinearity as well as change system parameter values. Numerous parametric modal analysis techniques (e.g., eigensystem realization algorithm and subspace identification method) have been developed for system identification of multi-degree-of-freedom dynamic systems. However, those methods are usually limited to linear systems and known for poor sensitivity to localized damage. On the other hand, non-parametric identification methods (e.g., artificial neural networks) are advantageous to identify time-varying nonlinear systems due to unpredictable damage. However, physical interpretation of non-parametric identification results is not as straightforward as those of the parametric methods. In this study, the Multidegree-of-Freedom Restoring Force Method (MRFM) is employed as a semi-parametric nonlinear identification method to take the advantages of both the parametric and non-parametric identification methods.

The MRFM is validated using two realistic experimental nonlinear dynamic tests: (i) large-scale shake table tests using building models with different foundation types, and (ii) impact test using wind blades. The large-scale shake table test was conducted at Tongji University using 1:10 scale 12-story reinforced concrete building models tested on three different foundations, including pile, box and fixed foundation. The nonlinear dynamic signatures of the building models collected from the shake table tests were processed using MRFM (i) to investigate the effects of foundation types on nonlinear behavior of the superstructure and (ii) to detect localized damage during the shake table tests. Secondly, the MRFM was applied to investigate the applicability of this method to wind turbine blades. Results are promising, showing a high level of nonlinearity of the system and how the MRFM can be applied to wind-turbine blades. Future studies were planned for the comparison of physical characteristic of this blade with blades created made of other material.

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The public is welcome to attend.