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Comparisons of mode shapes based damage detection methods for bending- and shear-type buildings

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ABSTRACT

Damage detection methods in the field of structural health monitoring can be relied on identified modal properties, in particular of mode shapes. In these identified modal properties, the first mode is mostly available for building structures. Moreover, the first mode shape is relatively insensitive to the environmental effects (e.g., temperature) as compared to the first-mode natural frequency and damping ratio. Therefore, this study explores the mode shape related damage detection methods for building structures. Buildings in this study are categorized into bending and shear types, while the obtained (or identified) mode shapes are separated into these two types. Thus, the rotational mode shapes must be included in the mode shape information and can be approximated by cubic spline functions from the translational mode shapes. The separated first bending-type mode shape is integrated into curvature-based damage detection methods, i.e., the mode shape curvature method, curvature-based strain energy damage index method, and curvature-based wavelet transform method, for damage diagnosis of bending-type buildings. Meanwhile, the separated first shear-type mode shape is combined with slope-based damage detection methods, i.e., the mode shape slope method, slope-based strain energy damage index method, and slope-based wavelet transform method, for damage diagnosis of shear-type buildings. As seen in the numerical results, the separation of first mode shape for different types of buildings can correctly and accurately locate and quantify damage of buildings.

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