Geophysical Research Abstracts
Vol. 19, EGU2017-14313, 2017
EGU General Assembly 2017

Comparison of damage localization in mechanical systems based on Stochastic Subspace Identification method.

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Damage identification in mechanical systems under vibration excitation relates to the monitoring of the changes in the dynamical properties of the corresponding linear system, and thus reflects changes in modal parameters (frequencies, damping, mode shapes) and finally in the finite element model of the structure [1]. Damage localization can be performed using ambient vibration data collected from sensors in the reference and possibly damaged state and information from a finite element model (FEM). Two approaches are considered in this framework, the Stochastic Dynamic Damage Location Vector (SDDLV) approach [2, 3] and the Subspace Fitting (SF) approach [4, 5].

The SDDLV is based on finite element (FE) model of the structure and modal parameters estimated from measurements in both reference and damaged states. From the measurements, a load vector is computed in the kernel of the transfer matrix difference between both states and then applied to the FE model of the structure. This load vector leads to zero (or close to zero) stress over the damaged elements. A joint statistical evaluation has been proposed, where several stress estimates and their uncertainties are computed from multiple mode sets and different Laplace variables for robustness of the approach.

SF approach is a finite element model updating. The approach makes use of subspace-based system identification, where an observability matrix is estimated from vibration measurements. Finite element model updating is performed by correlating a finite element model observability matrix with the estimated one. SF is applied to damage localization where damages are assumed to be modeled in terms of mean variations of element stiffness matrices. Localization algorithm is improved by taking into account the estimation uncertainties of the underlying finite element model parameters.

Both localization algorithms are presented and their performance is illustrated and compared on simulated and experimental vibration data.

References

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