Multiple damage detection in structure by FE model updating using coordinate strain modal assurance criterion

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Abstract

Structural health monitoring (SHM) is a ubiquitous demand in modern industry and life. Structural damage detection and localization technology is the basis of SHM. This paper investigates the feasibility of a damage detection method for structure with multiple damage sites based on finite element updating using the measured strain modes both numerically and experimentally.

The advantages of strain mode as a model updating metric were explained in our previous paper. In the current work, a surrogate model of strain modal shape is constructed for damage detection to save the computational cost in FE model updating. The coordinate strain modal assurance criterion is developed to build the objective function. Then, the hybrid pattern search technique is introduced to minimize the objective function and damage detection procedures are explained.

A clamped-clamped Euler-Bernoulli beam is adopted to verify the ability of the proposed procedure in localizing and quantifying multiple damages and its robustness against measurement noise. Experimental strain modal shapes of a laboratory aluminum beam with various level of distributed damage is used to validate the method in practical conditions. The results show that the present FE model updating using coordinate strain modal assurance criterion residual is promise for detecting multiple damages of the structure.

Keywords: Damage detection, model updating, strain mode, coordinate strain modal assurance criterion, Kriging model