Damage detection using generic elements: Part II. Damage detection

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Abstract

This paper proposes the use of generic elements in damage detection, based on the use of an updated baseline finite element model, modal sensitivities and changes in the measured modal quantities arising from structural damage. A companion paper presented the fundamental theory of model updating and generic element or substructure parameterisation. The experimental structure was chosen so that a considerable difference existed between the baseline finite element model and the undamaged (healthy) structure. However the structure was successfully updated so that the model can be used effectively for damage detection and location. The main aim of this paper is to propose a method for the estimation of damage location and apply it to an experimental case study. The novel aspects of this approach are the type of parameterisation employed for the model updating and damage detection studies and the use of measured mode shapes to handle geometrical symmetry of the structure.

Keywords: Generic elements; Parameterisation; Experimental modal analysis; Finite element method; Damage detection; Damage location

1. Introduction

Four distinctive features are addressed by the current pair of articles, namely the updating of imprecise models for subsequent use in damage detection/location, finite element model parameterisation by means of generic elements/substructures, damage location by means of parameter subset selection and the experimental demonstration of the approach. While the first paper [1] improved the baseline model using model updating so that it more accurately reflected the structure’s dynamics, this one applies that model and its parameterisations for the purposes of damage detection and location. Gladwell and Ahmadian [2] first proposed generic elements as a parameterisation in model updating, where the eigenvalues and/or eigenvectors of individual substructure stiffness matrices are modified. They also demonstrated that this parametrisation incorporates many standard parametrisations (for example, substructure parameters, physical parameters). Law et al. [3] applied generic elements in a simulated study of the Tsing Ma bridge in Hong Kong, by representing parts of the structure by super-elements. An eigensensitivity approach was used to update the model for the simulated case, and the influence of noise and modeshape incompleteness was investigated. However, improvements are needed because of the influence of model reduction for the super-elements. Wang et al. [4] gave probably the first application of generic elements to damage detection to date, and considered the simulated problem of damage detection in a frame structure with flexible L-shaped...