Damage detection using generic elements:  
Part I. Model updating

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Abstract

The authors propose the use of generic elements as a viable tool for parametric model based damage detection. The subject is divided into two related papers, and this paper is concerned with the requirements of the baseline model for damage detection, and the use of model updating to produce a validated finite element model of the undamaged structure. Two parameterisations are considered, based on the need to use the same parameterisation for subsequent damage detection. The novel aspect of this approach is the use of generic elements in damage detection where a preliminary updating exercise is required. The result is an updated model with physical meaning that may be used to detect and locate damage in a symmetric structure.

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1. Introduction

Damage detection methods that use mathematical models can be divided into non-parametric and parametric approaches. Doebling et al. [1] gave an extensive review of these methods. Friswell and Mottershead [2] provided a review of parametric identification techniques in the context of model updating. Farrar and Duffey [3] reviewed the subject of damage detection in rotating machinery. Non-parametric methods detect damage via the direct use of such quantities as natural frequencies and modes, stiffness and flexibility matrices. Parametric methods use a pre-selected set of parameters to define the model of the structure in question and the assumed damage mechanisms and their potential location. These methods determine the damage state of the structure by means of changes in the values of the parameters. The choice of parameterisation and the type of damage can considerably influence the performance of these methods. A number of parameterisation techniques may be employed, among them are substructure, physical and geometric parameters, generic elements and equivalent models of inadequately idealised structural parts of the finite element models. The following presents a brief review of the recent use of different parameter types in damage detection.

Abdalla et al. [4] used substructure parameters along with the theory of linear matrix inequalities to formulate a convex optimisation problem for damage detection. The authors applied the same approach to a real cantilevered beam [5] and evaluated the approach for incomplete measurements [6]. Contursi et al. [7] proposed a procedure optimising the correlation between vectors of differences in the natural frequencies due to damage in the experiment and analytical model. Hassiotis [8] formulated damage detection as a quadratic programming