Damage Detection in Structures – Examples

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Abstract

Damage assessment of structures includes estimation of location and severity of damage. Quite often it is done by using changes of dynamic properties, such as natural frequencies, mode shapes and damping ratios, determined on undamaged and damaged structures. The basic principle is to use dynamic properties of a structure as indicators of any change of its stiffness and/or mass. In this paper, two new methods for damage detection are presented and compared. The first method is based on comparison of normalised modal shape vectors determined before and after damage. The second method uses so-called l_1-norm regularized finite element model updating. Some important properties of these methods are demonstrated using simulations on a Kirchhoff plate. The pros and cons of the two methods are discussed. Unique aspects of the methods are highlighted.

Keywords: mode shape damage detection, finite element model updating, l_1-norm regularization.

1. Introduction

Structural damage can cause loss of load bearing capacity with far-reaching consequences. To prevent that risk, early identification of damage, preferably by non-destructive testing, is of great importance. Non-destructive techniques such as ultrasonic methods, radiography, magnetic particles, eddy currents and acoustics emissions are capable to detect and locate damages even if they are not visible on the surface of the structure. The main disadvantages of these methods are that they require inspection of very small areas and that they therefore need a prediction of the damage location in advance as well as that they need to have access to that part of the structure [1, 2].

Nowadays, structural health monitoring (SHM) systems, especially for large structures, e.g. bridges, high rise buildings, cultural heritage structures, can be based on another non-destructive testing technique, namely vibration-based monitoring. Here the global behaviour of a structure is described by its dynamic properties, such as natural frequencies, mode shapes and damping ratios and measured by accelerometers.

A basic assumption of the vibration-based damage detection is that the structural damage causes changes in the physical properties of the structure such as stiffness and/or mass properties which in turn cause changes in its dynamic properties.

There is a variety of vibration-based damage detection methods that are being widely investigated by many researchers because of their global sensitivity to damage. In general, all these methods can be divided into two groups: model-based and model-free. Model-based methods

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