Comparison Among Different Structural System Identification Methods

Maria NOGAL
Researcher
Trinity College, Ireland
NOGALM@tcd.ie

Jose Antonio LOZANO
Assistant Professor
University of Castilla-La Mancha, Spain
joseantonio.lozano@uclm.es

Jose TURMO
Professor
Universitat Politècnica de Catalunya, Spain
Jose.turmo@upc.edu

Summary

The observability techniques have been proposed to deal with structural system identification under static loading tests. Up to now, this method has only been analyzed from a symbolical point of view. Despite the elegance of this approach, this mathematic analysis is far from being applicable in actual structures. To fill this gap, this paper presents a new observability procedure that combines both a symbolical and a numerical approach. To illustrate the potential of the proposed method, the observability technique is compared with two alternative methods presented in the literature. This comparison shows that, unlike to other analyzed methods, no information from the undamaged structure is required. Furthermore, the number of measurements required to be measured for damage detection is significantly reduced.

Keywords: Structural System Identification, Observability Analysis, Static test

1. Introduction

With the advent of personal computers, structural modelling has developed vastly in the last decades. Presently, the most complex phenomena can be integrated in the analysis, such as complex dynamic behavior of long bridges [1], staggered erection of superstructure [2, 3], or time-dependent phenomena [4, 5]. However, no matter how complex those models are, the accuracy of them is very dependent on the values of the physical parameters used.

Structural-System Identification (*SSI*) can be used to improve model accuracy and to define damages [6]. An adequate damage detection method must be able to locate and quantify damage in actual structures. Once identified, damage can be modeled utilizing a Finite Element Model (*FEM*), increasing its accuracy and helping maintenance [7].

According to the loading test, *SSI* methods can be classified as dynamic [8, 9] or static [10, 11]. The static loading test *SSI* methods have attracted much attention from the 90s [12]. According to Adeli [13], *SSI* methods can be also classified as parametric and non-parametric. Due to the complexity of the mathematical relations among the variables, parametric methods have mainly been applied to very simple models. On the other hand, computer development has enabled increasing popularity in non-parametric methods, such as Neural Networks or Genetic Algorithms. Nevertheless, the main drawback of non-parametric methods is that the input–output relation is characterized and determined by a set of equations that may not have any explicit physical meaning.

Lozano-Galant et al. [14, 15]proposed a parametric *SSI* method based on static measurements based on observability techniques. The advantage of this method is that the mathematical foundation of the method can be completely understood and checked. Nevertheless, for the method to be implemented practically, a numerical analysis is required. To fill this gap, this paper presents the numerical application of the observability technique. This application includes the development of an algorithm that reduces the unavoidable numerical errors produced by the lack of precision of computers. To validate the proposed technique, the obtained results are compared with two alternative methods presented in the literature.

This paper is based on the numerical development of the observability techniques. The main assumptions of the symbolic application of this technique are first described in Section 2. In Section 3, an algorithm is presented for numerical identification. Furthermore, the analysis of two structures

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