6th International Conference on Advances in Experimental Structural Engineering
11th International Workshop on Advanced Smart Materials and Smart Structures Technology
August 1-2, 2015, University of Illinois, Urbana-Champaign, United States

Structural Stiffness Identification based on Incomplete Modal Data with Uncertainties

Wenai Shen*, Ying Lei, Hongping Zhu, Zhouquan Feng

* *Presenting Author*

Corresponding Author: ***Wenai Shen***
Contact Email: ***wshen@hust.edu.cn***

ABSTRACT
Structural stiffness identification has been extensively investigated for structural damage detection and condition assessment in the last three decades. However, most of methods are not of high efficiency or even ineffective when applied to large-scale structures. This paper presents a simple method to identify the structural stiffness at element level using incomplete modal measurement with uncertainties. The major advantage of the proposed method is free from the requirement of matrix inverse operation, which provides an efficient way to estimate the stiffness of large-scale structures. The statistical distribution, including mean and standard deviation, of stiffness for each element can be obtained using a set of modal measurement with noise contamination. The proposed structural stiffness identification method can be extended to damage detection based on identified statistical distributions of 'undamaged' and 'damaged' cases based on statistical inference theory. Two numerical examples are presented to verify the proposed method. In the first example, the stiffness of a twenty degree-of-freedom shear building model is estimated using the modal data of the first several modes, and the noise effect is investigated in the simple case. Then, a large-scale truss model is employed to demonstrate its effectiveness for large-scale structures. Some challenges are also discussed based on the numerical results.

KEYWORDS: *Structural health monitoring; stiffness identification; damage detection; large-scale structures; proportional flexibility matrix*