Parametric Identification of Complex Bridge Structure using Substructure Approach

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Summary

Parametric identification of structures is one of the important aspects of structural health monitoring. Most of the techniques available in the literature have been proved to be effective for structures with small degree of freedoms. However, the problem becomes challenging when the structure system is large, such as bridge structures. Therefore, it is highly desirable to develop parametric identification methods that are applicable to complex structures. In this paper, the LSE based techniques will be combined with the substructure approach for identifying the parameters of a cable-stay bridge with large degree of freedoms. Numerical analysis has been carried out and the results demonstrate that the proposed approach is capable of identifying the structural parameters with reasonable accuracy.

Keywords: structural health monitoring, LSE, parametric identification of structure, substructure approach.

1. Introduction

Parametric identification based on vibration characteristics provides useful information for both real-time online monitoring and overall offline evaluation of structures. The modal parameters (such as damping and frequency) of structure vibrations are dependent variables that relate to physical parameters (such as mass and stiffness). Therefore, the accurate identification of structure parameters is the premise of a reasonable structure health monitoring system. However, the problem becomes challenging when the structure system is large and complex, for example, bridge structures where the number of degree of freedom (DOF) is huge, because most of the identification methods available in the literature have better accuracy and adaptability for relatively small DOF structural systems. Therefore, in order to ensure accurate identification of structural parameters, it is desired to decompose the complex structure having multiple DOFs into smaller parts such that the number of unknowns is limited within a certain range, which is known as the substructure approach.

Since 1960s, many scholars have proposed various substructure theories constantly for the dynamic analyses of structural responses. In particular, Koh et al [1] conducted systematic studies on the parametric identification of structures with different scales and conditions using genetic algorithm and found that the accuracy of substructure identification approach is higher than full structure identification method and requires much less computation time.

In this paper, the substructure approach proposed in Koh et al [1] will be combined with the least square estimation (LSE) method given in Yang and Lin [2] for identifying the parameters of a cable-stay bridge with large DOFs. Numerical analysis will be carried out for the structure with different sampling frequencies and various measurement noise levels to verify the capability and accuracy of the proposed parametric identification approach for complex structures.

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