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Comparison of two output-only modal identification methods used for high-rise building: Enhanced Frequency Domain Decomposition and Stochastic Subspace Identification

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Abstract

Vibration-based system identification methods provide new insights in the Civil Engineering by providing powerful tools for determining dynamic characteristics of buildings including natural frequency, mode shapes, and damping. Additionally, due to complex behavior of High-rise building and significant importance of these structures, a powerful and reliable system identification method is needed to be introduced. In this study, two system identification methods Enhanced frequency Domain decomposition (EFDD) and Stochastic Subspace Identification (SSI), are compared based on ambient vibration data in order to evaluate their accuracy for the system identification method of tall buildings.

Keywords: High-rise building, System Identification, Ambient Vibration, Comparative Study

1. INTRODUCTION

The identification of the dynamic characteristics of a building including natural frequency, mode shapes, and damping plays a vital role in many engineering problems. Structural health monitoring and damage detection [1], vibration control of the buildings particularly high-rise buildings or very-important structures [2], and finite element model updating of the existing structures for model calibration or other purposes [3] are some clear examples which demonstrate the importance of system identification issue in civil engineering.

Output-only methods present an important advantage compared to input-output methods which is the eliminating of the measured input excitation for system identification purpose. Moreover, the existing sensors can reliably and efficiently measure the low-amplitude response of the structures induced by human activities, vehicle transportations, wind or seismic forces, etc.

High-rise buildings are much more important structures compared to common structures like residential buildings, pedestrian or small bridges, due to the vast financial costs of construction, a large number of occupants and, more important, unpleasant consequence of their collapse. Consequently, a huge amount of attention must be spent in the process of design, construction, and maintenance of this kind of structures. Modal identification plays an essential role in the two latter processes [4, 5].

In this study, based on the ambient vibration data of a tall building located at MIT university campus, the modal characteristics of the structure were obtained using two common and well-known modal identification methods and then, the results were compared with their real ones in order to introduce more efficient and reliable method for system identification of high-rise buildings.

2. STRUCTURAL DETAILS AND FIELD MEASUREMENTS

The MIT green building is a tall building located at MIT University Campus and is designed and constructed more than 55 years ago [6]. The building contains 21 stories above the ground with various usages like classrooms, labs and offices and one floor below the ground level. Moreover, the overall height of the building is 83.7 and its footprint is 16.5 m by 34 m. The main material used for constructing the building was cast-in-place reinforced concrete. The eastern-western lateral force resisting system of the building is moment resisting frame while the northern-southern direction of the building benefits from shear walls with a thickness of 0.228 m. It is worth noting here that the height of floors are non-consistent and the top floors