Modal Properties of a Scaled Model of Floating Structure

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ABSTRACT

The problem of identification of the modal properties of a structural system has received much attention over the years because of its importance in structural model updating, structural health monitoring and structural control. This paper presents dynamic properties such as natural frequencies and mode shapes of a scaled model of floating structure. A modal testing is performed on the structure and modal parameters for the structure are extracted from the measured data. The results are compared to a finite element model of the floating structure and the correlation between the measured and analytical modal parameters is investigated.

KEY WORDS: Floating structure; modal test; frequency; mode shape.

INTRODUCTION

Dynamic characteristics of a structural system, such as natural frequency, damping, and mode shape have been widely used for structural model updating, structural health monitoring, and structural control by many researchers. In the early period of structural health monitoring, studies have focused on the possibility of using modal properties such as shifts in resonant frequencies as indicators of structural damage. Many researchers have investigated and applied vibration monitoring to offshore structures (Vandiver, 1977; Kenley and Dodds, 1980; Osegueda et al., 1992).

The consequence of seismic events and failure of bridge have resulted in attempts to monitor the integrity of bridges (Biswas et al., 1990; Choi et al., 2004). The use of sensitivity approaches based on the relationship between the eigenfrequencies, modal stiffness, modal mass, and modal damping have focused on the development of methods that predict the location and magnitude of any damage in the structure (Stubbs and Osegueda, 1990). In addition, Park et al. (2006) presented blind test results of damage detection by using the simulated time domain data from a four-story steel frame. They reported the results of modal analysis and also reported damage locations and estimation of damage severities for two damage cases using only mode shapes of undamaged and damaged structures.

Recently, the possibility of monitoring the structural integrity of a containment structure in the nuclear power plant was explored by utilizing modal properties from an ambient vibration measurement (Choi et al., 2010). In this study, the modal parameters, i.e., resonant frequencies and corresponding mode shapes, were extracted using the peak picking and the frequency domain decomposition methods. A sensitivity-based structural identification technique with the finite element model was used to identify the elastic modulus of the concrete. Usually the structural model updating, structural health monitoring, and the structural control methods comprise the measurement technique for recording dynamic responses, the data processing technique for extracting dynamic characteristics, e.g., resonant frequencies, damping, and mode shapes, and the system identification technique for relating the extracted dynamic characteristics to physical properties of the structural system. (Doebling et al., 1996).

To ensure the various methods mentioned above successful, the exact modal properties are essential. There are two methods available in measuring the dynamic responses of a structure: the forced vibration test and the ambient vibration test. The forced vibration test is the most popular method because of its accuracy and convenience. Since in the forced vibration method the input force is known, transfer function can be obtained directly from the measurements of input force and output response. However, in the ambient vibration test, output responses are only measurable. So the process to get the transfer function and modal parameters is more complicated than the forced vibration test. Although many vibration tests have been applied to various types of structures, the study on application to the floating structure is almost non-existent in the literature. The objective of this paper is to present the modal properties, e.g., resonant frequencies and the corresponding mode shapes of a scaled model of steel box structure which is floating on the water. In order to achieve the stated goal, the following tasks are performed. First, an impact modal testing is performed on the scaled model of selected structure. Second, the modal parameters including resonant frequencies and corresponding mode shaped are extracted from the measured data by utilizing the peak picking method in the frequency domain. Third, a finite element model is constructed and the analytical modal parameters are computed. Finally the correlation between the experimental and analytical modal parameters is investigated.

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