ABSTRACT

Steel jacket-type platforms are the common kind of the offshore structures. Structural health monitoring and global damage detection techniques have received a great deal of attention in the literature. There is less report about applying of Artificial Immune System (AIS) methods for structural damage detection purposes. In this study, the incorporation of modified AIS method into finite element model updating (FEMU) are adapted for structural damage diagnosis in the jacket type structure and inspected experimentally using a laboratory model for developing the robust technique which is less sensitive to both measurement and analytical model uncertainties. The approach that is based upon mimicking immune recognition method offers important advantages.

KEY WORDS:  SHM; Jacket-Type Platforms; Artificial Immune System; FEM; Modal Test.

INTRODUCTION

The offshore structures industry has been growing at a fast rate during recent six decades. Steel jacket-type platforms are by far the most common kind of offshore structures and they have been widely utilized for various purposes including offshore drilling, processing and support of offshore operations (Elshafy-Haddara and Marzouk, 2010). Monitoring of the structures is essential for ensuring their safety during their service. The process assumes greater significance in the case of offshore structures, since major parts of them are under water which makes the visual inspection process much more difficult and, they are highly vulnerable to damage due to the harsh marine environment (Nichols, 2003). The recent disaster of oil spill in Gulf of Mexico emphasizes the importance of attention to health monitoring problem for the offshore industry.

The dynamical behavior of the offshore structures is directly correlated with their dynamic characteristics. This unknown dynamic behavior is a combination of many aspects including assumptions in the design criteria, uncertainties in geometrical and material properties and some modeling uncertainties. Understanding the changes in the dynamic characteristics often requires a baseline of long-term structural health monitoring (SHM) which points out a base case scenario based on which SHM can be performed for structures. Such a baseline can be achieved from a FEM for simulating of structural behavior (Liu-Wolfa and Kim, 2009). Various methods are currently available to inspect the occurring damages in structures (Doherty and Kobayashi, 1987). Some of them are based on examination of changes in modal characteristics such as natural frequencies, mode shapes or mode shape curvatures. Doebbling-Frrar-Prime and Shevitz (1996) published a comprehensive literature review for the state of the art on vibration based damage detection methods. Over the last decade, the main parts of the research field on SHM have been implemented on data acquisition, feature extraction and data reduction techniques. Reynders et al. used an operational modal analysis with exogenous forces (OMAX) approach and conducting a case study on three real span bridges. They showed that updating the FEM using only the experimental output data yields the good results. They concluded that an OMAX approach allows detecting potential inaccuracies in the FEM (Reyners-Teughels and DeRoeck, 2010). Taha and Lucero (2005) and Taha-Noureldin and Osman, (2004) proposed integrating artificial neural networks (ANN) and wavelet multi-resolution analysis for intelligent SHM. Pawar and Ganguli, (2003) and Pawar and Ganguli (2007) generated fuzzy logic rule-based system (FLS) for a cantilever beam liked structure. It was concluded that the FLS performs very accurately even in the presence of noisy data. Chandrashekhar and Ganguli (2009) used probabilistic results from Monte Carlo simulation (MCS) in a FE analysis of a cantilever beam liked structure to create a FLS for damage classification in this sort of structures. Furthermore, a novel parametric model-based decomposition for SHM of time-varying systems was proposed by Eftefagh and Sadeghi (2009) which used the Fuzzy Expert System as a classification tool to reveal that the proposed method successfully identifies distinctive structural conditions when compared with those based on non-reduced and ordinary feature extraction.

There are no much reports about applying the AIS methods for structural damage detection purposes. Chen and Zang (2009) presented an Artificial Immune Pattern Recognition (AIPR) approach for the damage classification. They developed an AIPR-based structure damage classifier which incorporates several characteristics of the natural immune system. They investigated the validity of the method using a benchmark structure proposed by the IASC–ASCE and showed that the AIPR based pattern recognition is suitable for structure damage classification.

In the framework of this study, an initial FEM of the physical model is developed to determining the dynamic characteristics. The experimental vibration tests are conducted based on data obtained via...