Bridge Health Monitoring: A Proposal to Preserve Egyptian Bridge Network

Ebtisam YEHIA
Civil Engineer
Design Engineer
Cairo, Egypt
Eyehia16@yahoo.com

Ayman KHALIL
Professor
Ain Shamsc University
Cairo, Egypt
Adec_2005@yahoo.com

Hatem ELBEHAIRY
Assistant Professor
Al Azhar, University
Cairo ,Egypt
h.elbehairy@yahoo.com

Amr ABDELRAHMAN
Professor
Ain Shamsc University
Cairo, Egypt
Amr@ace.com

Ahmed ESSAWY
Professor
Ain Shamsc University
Cairo, Egypt
asessawy@tebrconsulting.com

Summary

In the last few decades, Bridge Health Monitoring (BHM) has become a major demand to preserve the bridge wealth worldwide. BHM is a process aiming at providing accurate and in-time information concerning structural condition and performance. In order to establish BHM system in Egypt, accurate definition and classification of bridges, common defects, and available resources are required. The bridge network in Egypt consists of more than fifty thousand bridges and about 50% of these bridges were built before 1970. These bridges need to be evaluated to ensure their safety and serviceability to maintain their function and efficiency. In this paper, an investigation was carried out on a sample of Egyptian bridges in the ownership of the General Authority of Roads and Bridges (GARBLT) included 1249 bridges. The bridge sample under concern is classified according to their construction date, construction material, statical system, span length, bridge location and deck type. In addition, finite element (FE) models were generated for a selected number of bridges to extract its dynamic properties (frequencies, modal shapes). Changes in dynamic properties for several defect scenarios were estimated. More detailed FE models for common bridge types through group of shell element models expressing damage propagation at high flexural zones were developed. Modal properties corresponding to each damage step were extracted. Different damage indicators were adopted and calculated at each damage step providing tables indicating deterioration propagation. Deterioration tables for each bridge were considered a database to establish bridge management system (BMS) to prioritize maintenance, repair and rehabilitation (MR&R) activities. Prioritization of bridges was performed through proposed model solved by genetic algorithm (GA) software. Results proposed by GA solver were compared to traditional prioritization methods in order to indicate prioritization efficiency and will be discussed in another paper.

Keywords: Bridge health monitoring; Egyptian bridge inventory; Modal analysis; Dynamic properties.

1. Introduction

Bridge health monitoring (BHM) has become an important requirement to preserve existing bridge network and predict life performance of newly constructed bridges. Malfunction or failure of bridges can result in great loss in human life, environmental pollution, and the whole country economy. Losses in time and traffic delay affect the productivity of the people using the failed bridge. In addition, BHM is considered the main element in establishing bridge management system (BMS) [1].In order to establish a BMS, an investigation of common deck type, span lengths, and construction material should take place. This investigation will help in determining common types of bridges and expected damage scenarios and its effect on bridge behaviour. General Authority of Roads, Bridges and land transport GARBLT has started a recording program of bridges in its ownership. Bridge record included 1249 bridges of different bridge types, locations, and span length. In this part, classification of bridges in adopted bridge sample was performed. Although some missing data is noticed in this list, however, available data was a good start to initiate a database for BHM program. In the second part of this paper finite element models FEM of major