10th International Congress on Civil Engineering, 5-7 May 2015
University of Tabriz, Tabriz, Iran

Structural Health Monitoring Technologies for Civil Engineering Structures

Ahmet Turer
Middle East Technical University, Civil Engr. Dept., 06800 Ankara, Turkey.

aturer@metu.edu.tr

Abstract

This paper discusses basic principles of Structural Health Monitoring (SHM), how it has evolved and current state-of-the-art. The need for monitoring is categorized under main titles of necessity for SHM. The toolbox of monitoring projects share similar sensors. Most commonly used sensors and their working principles are briefly discussed. The duration of measurement and outcomes obtained from short and long term monitoring are elaborated. Dynamic and static measurements sometimes need to be combined for the maximum gain from monitoring studies. Advanced tools like modal analysis, acoustic emission, ultrasonic pulse velocity, eddy current, NDT techniques are covered in principle. The variety of structure types that are suitable for monitoring are listed and discussed. The conclusions summarizes the past, present, and future of SHM and its applications.

Keywords: structural health monitoring, structures, sensors.

1. INTRODUCTION

Construction of buildings, bridges, tunnels, and all similar infrastructure has been one of the primary needs of civilized world starting from the early ages. The basic objective is to build strong and long lasting structures to perform their intended purpose while making them as economic as possible. With the recent developments in technology and improvements in the engineering body of knowledge, structures are now far better built than before. One of the reasons for the achievements is measurement and monitoring technologies in addition to development of computational power with the use of computers. Engineers now can measure the response of structures to various types of loadings and are capable of extrapolating performance using the available data gathered through sensors. The commonly used name for monitoring structures is Structural Health Monitoring (SHM) and main purpose is to detect damage or characterization of existing properties of a structure.

This paper covers basic issues in structural health monitoring, since the subject is quite broad and too many sub branches exist. The earliest studies on SHM is considered to be started at the medical sector to monitor health of patients. Most commonly known technologies can be listed as x-ray, MRI, holter heart monitor, ultrasound imaginary are among others (Fig. 1). The pioneers in the engineering area for SHM are aerospace engineers. Aviation and space ships being much more complicated than those on the ground, required additional sensors and monitoring to maintain a controlled flight. Even today, those structures defy dynamic structural engineering frontiers. Monitored parameters such as cabin pressure, altitude, tilt, remaining and consumption rate of fuel, etc are some basic and sometimes vital parameters to be monitored. The next generation of engineering that uses SHM commonly is mechanical engineering. Complex motors and dynamic parts that should work in harmony and performance relying on various parameters that should be controlled most of the time requires monitoring such as temperature of the engine, oil pressure, rotation per minute, speed of the car, even recently tire pressure can be monitored. The next discipline of engineering following the SHM technologies is civil engineering. In the last two decades, the construction industries have started picking up the advantageous use of monitoring in structural, geotechnical, surveying, material, transportation, hydrology, water resources, harbor, and ocean engineering areas. Generally observed necessities for monitoring, the types and techniques, as well as most commonly used sensors are described in the following sections.