Structural Monitoring and Maintenance, *Vol. 1, No. 3 (2014) 339-356*
DOI: http://dx.doi.org/10.12989/smm.2014.1.3.339

Impedance-based damage monitoring of steel column connection: numerical simulation

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(Received May 20, 2014, Revised August 16, 2014, Accepted September 4, 2014)

Abstract. This study has been motivated to evaluate the practicality of numerical simulation of impedance monitoring for damage detection in steel column connection. In order to achieve the objective, the following approaches are implemented. Firstly, the theory of electro-mechanical (E/M) impedance responses and impedance-based damage monitoring method are outlined. Secondly, the feasibility of numerical simulation of impedance monitoring is verified for several pre-published experimental examples on steel beams, cracked aluminum beams, and aluminum round plates. Undamaged and damaged steel and aluminum beams are simulated to compare to experimental impedance responses. An aluminum round plate with PZT patch in center is simulated to investigate sensitive range of impedance responses. Finally, numerical simulation of the impedance-based damage monitoring is performed for a steel column connection in which connection bolts are damaged. From the numerical simulation test, the applicability of the impedance-based monitoring to the target steel column connection can be evaluated.

Keywords: electro-mechanical impedance; PZT sensor; damage monitoring; numerical simulation; steel column connection; bolted connection

1. Introduction

During service life of civil structures, the occurrence of damages is inevitable. If the damages are not detected timely, they will cause catastrophic incidents for the safety of not only self-structures but also the humans. Therefore, structural health monitoring (SHM) becomes an important technology and plays a significant role in the safety and service life of civil structures. One of the promising ways to guarantee the structural safety and integrity is to enact SHM in a regular periodic manner and to detect critical damage in its early stage (Doebling *et al*. 1998, Farrar 2001, Kim *et al*. 2014, Li *et al*. 2014). As the concern is limited to the SHM in civil infrastructures, there have been many research attempts on structural response analysis, development of new sensing mechanism, adaptation of SHM method suitable to the structure, and field evaluation and application. Along with the research track, this study focuses on impedance-based SHM technique.

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http://www.techno-press.org/?journal=smm&subpage=7 ISSN: 2288-6605 (Print), 2288-6613 (Online)

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