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Iterative damage index method for structural health monitoring

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Abstract. Structural Health Monitoring (SHM) is an effective alternative to conventional inspections which are time-consuming and subjective. SHM can detect damage early and reduce maintenance cost and thereby help reduce the likelihood of catastrophic structural events to infrastructure such as bridges. After reviewing the Damage Index Method (DIM), an Iterative Damage Index Method (IDIM) is proposed to improve the accuracy of damage detection. These two damage detection techniques are compared based on damage on two structures, a simply supported beam and a pedestrian bridge. Compared to the traditional damage detection algorithm, the proposed IDIM is shown to be less arbitrary and more accurate.

Keywords: vibration-based damage identification method; damage index method; damage detection algorithm; structural health monitoring

1. Introduction

Recently, effective inspection and maintenance for infrastructure are placing great importance because infrastructures are deteriorating after construction due to fatigue and corrosion. The Bureau of Transportation Statistics (2008) reported that nearly 26 percent of the bridges in the U.S. are substandard. Traditional inspection procedures for bridges generally rely on subjective and irregular visual examination. As such, there are variations in the inspection results even for the same structure because of the differences in inspectors' experience and judgment. Visual checking is also apt to be a schedule-based inspection process. Discrete inspection processes can fail to detect hidden effects of poor design or maintenance that can be the source of sudden and dangerous events such as a bridge collapse. Between 1989 and 2000, out of 65 bridge failures (caused by design, detailing, construction, maintenance, or material problems), 43 failures were attributed to poor maintenance (Wardhana and Hadipriono 2003). As an alternative to periodic inspections, structural health monitoring (SHM) is a continuous process (Hurlebaus and Gaul 2006) that can detect damage early, reduce the cost of repair and rehabilitation, and help reduce the chance of catastrophic events with the structures.

A number of studies have sought to improve the accuracy of damage detection using SHM. Several researchers (Lenzen 2005, Kim and Kawatani 2007, Kim *et al*. 2008, Mizuno *et al.* 2008,

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