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Abstract. This paper presents a new system identification method called Damage Identification based on Total Energy Rate (DITER) to detect defects in structures. The proposed method employs an element-wise, time domain-based approach. Identification of elemental structural properties is performed through least squares optimization of an objective function created from the rate of total energy of the targeted elements. Using the total energy rate allows for a significant simplification in creating the objective function as compared to previous approaches that rely on equations of motion. Moreover, introduction of boundary elements' contribution in the derived objective functions makes the method flexible. As a result, it can be applied either to the whole structure or to any specific portion of the structure. In this novel approach, DITER converts displacement data into total displacement, measured from the undeformed configuration of the structure, by introducing static deflection correction terms. Thus, the proposed method is robust against static deflection variation and eliminates uncertainties in the initial displacement values. Numerical verification of the DITER method was performed on a two-span beam sample. Based on the results, DITER can be used as an efficient tool for nondestructive damage detection in existing structures.

Keywords: System identification; structural damage detection; nondestructive evaluation; energy rate, static deflection variation

1. Introduction

Structural integrity assurance is a vital concern for situations in which there is a significant possibility of structural damage or weakening over time. Over the last decades, many damage detection methods have been proposed. Extensive research has been dedicated to vibration-based damage detection methods. In these approaches, physical properties of the structure are detected by analyzing changes in its dynamic responses. In these studies, damage is usually defined as a reduction in stiffness or, occasionally, a variation in the damping properties of the structure, either in a wide or a localized area. Literature surveys in this area can be found in [1-6]. Vibration-based element-wise system identification (SI) methods have been broadly used for the purpose of non-

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