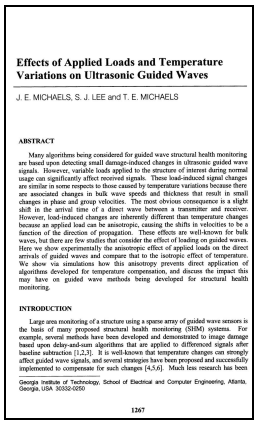

Effects of Applied Loads and Temperature Variations on Ultrasonic Guided Waves

J. E. MICHAELS, S. J. LEE and T. E. MICHAELS

ABSTRACT

Many algorithms being considered for guided wave structural health monitoring are based upon detecting small damage-induced changes in ultrasonic guided wave signals. However, variable loads applied to the structure of interest during normal usage can significantly affect received signals. These load-induced signal changes are similar in some respects to those caused by temperature variations because there are associated changes in bulk wave speeds and thickness that result in small changes in phase and group velocities. The most obvious consequence is a slight shift in the arrival time of a direct wave between a transmitter and receiver. However, load-induced changes are inherently different than temperature changes because an applied load can be anisotropic, causing the shifts in velocities to be a function of the direction of propagation. These effects are well-known for bulk waves, but there are few studies that consider the effect of loading on guided waves. Here we show experimentally the anisotropic effect of applied loads on the direct arrivals of guided waves and compare that to the isotropic effect of temperature. We show via simulations how this anisotropy prevents direct application of algorithms developed for temperature compensation, and discuss the impact this may have on guided wave methods being developed for structural health monitoring.

INTRODUCTION

Large area monitoring of a structure using a sparse array of guided wave sensors is the basis of many proposed structural health monitoring (SHM) systems. For example, several methods have been developed and demonstrated to image damage based upon delay-and-sum algorithms that are applied to differenced signals after baseline subtraction [1,2,3]. It is well-known that temperature changes can strongly affect guided wave signals, and several strategies have been proposed and successfully implemented to compensate for such changes [4,5,6]. Much less research has been

Georgia Institute of Technology, School of Electrical and Computer Engineering, Atlanta, Georgia, USA 30332-0250

1267

Код: 10734

J.E. Michaels, S.J. Lee, T.E. Michaels

Effects of Applied Loads and Temperature Variations on Ultrasonic Guided Waves

Издательство DEStech Publications, Lancaster, 2010 год

6 стр; формат: 23,5 x 16 см; библиографический список: 8 единиц
ISBN: 978-1-60595-024-2

Many algorithms being considered for guided wave structural health monitoring are based upon detecting small damage-induced changes in ultrasonic guided wave signals. However, variable loads applied to the structure of interest during normal usage can significantly affect received signals. These load-induced signal changes are similar in some respects to those caused by temperature variations because there are associated changes in bulk wave speeds and thickness that result in small changes in phase and group velocities. The most obvious consequence is a slight shift in the arrival time of a direct wave between a transmitter and receiver. However, load-induced changes are inherently different than temperature changes because an applied load can be anisotropic, causing the shifts in velocities to be a function of the direction of propagation. These effects are well-known for bulk waves, but there are few studies that consider the effect of loading on guided waves. Here we show experimentally the anisotropic effect of applied loads on the direct arrivals of guided waves and compare that to the isotropic effect of temperature. We show via simulations how this anisotropy prevents direct application of algorithms developed for temperature compensation, and discuss the impact this may have on guided wave methods being developed for structural health monitoring.

Ключевые слова:

Содержание.