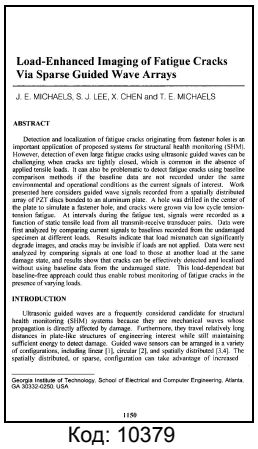

Load-Enhanced Imaging of Fatigue Cracks Via Sparse Guided Wave Arrays

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ABSTRACT

Detection and localization of fatigue cracks originating from fastener holes is an important application of proposed systems for structural health monitoring (SHM). However, detection of even large fatigue cracks using ultrasonic guided waves can be challenging when cracks are tightly closed, which is common in the absence of applied tensile loads. It can also be problematic to detect fatigue cracks using baseline comparison methods if the baseline data are not recorded under the same environmental and operational conditions as the current signals of interest. Work presented here considers guided wave signals recorded from a spatially distributed array of PZT discs bonded to an aluminum plate. A hole was drilled in the center of the plate to simulate a fastener hole, and cracks were grown via low cycle tension-tension fatigue. At intervals during the fatigue test, signals were recorded as a function of static tensile load from all transmit-receive transducer pairs. Data were first analyzed by comparing current signals to baselines recorded from the undamaged specimen at different loads. Results indicate that load mismatch can significantly degrade images, and cracks may be invisible if loads are not applied. Data were next analyzed by comparing signals at one load to those at another load at the same damage state, and results show that cracks can be effectively detected and localized without using baseline data from the undamaged state. This load-dependent but baseline-free approach could thus enable robust monitoring of fatigue cracks in the presence of varying loads.

INTRODUCTION

Ultrasonic guided waves are a frequently considered candidate for structural health monitoring (SHM) systems because they are mechanical waves whose propagation is directly affected by damage. Furthermore, they travel relatively long distances in plate-like structures of engineering interest while still maintaining sufficient energy to detect damage. Guided wave sensors can be arranged in a variety of configurations, including linear [1], circular [2], and spatially distributed [3,4]. The spatially distributed, or sparse, configuration can take advantage of increased

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Ключевые слова:

Содержание.