

# LASER INDUCED PLATE WAVES USING WAVEFORMSHAPING OPTICS AND STRAIN SENSING BY FIBER OPTICS CROSS-SENSITIVITY EFFECT

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## INTRODUCTION

Aircraft are being used in service significantly longer than their original design life. This cost driven measure, is subjecting aircraft structures to conditions that are increasing the probability of failure, particularly as a result of aging. Aircraft that already endured a long service life of more than 35 years are now being considered for an additional service of 45 more years. This issue is long term usage is relevant to both military and commercial aircraft and it is a well - recognized fact. The 1988 failure of the Boeing aircraft that was operated by Aloha Airlines heightened the level of attention of aircraft manufacturers, users and the Federal Aviation Administration (FAA) to the issue of aging commercial aircraft. The increased usage of old aircraft has added a great degree of urgency to the ongoing need for reliable and efficient NDE methods for detection and characterization of flaws in aircraft structures. Particularly, corrosion detection with current technology is time consuming, demands great attention to details by the inspectors and, in many cases, requires a costly disassembly of the structure. The reliability of the test results depends heavily on the type of instrumentation that is used, the condition of the instruments, the methods and environment under which they are used and above all, the interpretation of the inspectors. While a large variety of NDE methods are available for inspection of aircraft structures, the speed of inspection, the need for coupling, and other constraints are imposing limitations on the field use of such methods.

Recent studies with plate waves [1] and particularly leaky Lamb waves have shown effective capabilities of quantitative evaluation of plate structures such as bonded joints and composite materials. The use of plate wave NDE methods allow the determination of the elastic properties of the adhesive and the composite laminates as well as to detect and characterize flaws. Models were developed assuming in the case of composite materials that they consist of transverse isotropic layers [e. g., 1-3]. Dispersion curves (phase velocity as a function of the thickness x frequency) are measured and are used to determine the properties by an inversion algorithm. Generally, a homogeneous composite laminate with the symmetric axis parallel to the surfaces supports the formation of two modes of propagation: symmetric and antisymmetric. The lowest symmetric (extensional) and antisymmetric (flexural) modes are the easiest to measure in an ultrasonic experiment and their velocity value are used to determine certain material constants. Unfortunately, the transmission of the ultrasonic signals for the leaky Lamb wave experiments require the use of water immersion or water injection through squirters. This water-coupling requirement restricts the field applicability of the method and limits the number of constants that can be measured. Particularly, the constant  $c_{11}$  is difficult to determine due to need for a