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An improved mixed numerical-experimental method for stress field calculation

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Abstract

In this work a numerical-experimental method is used to study the dynamic behavior of an aluminum plate subjected to a small mass impact. The out-of-plane displacements, due to transient bending wave propagation, were assessed for successive time instants, using double pulse TV-holography, also known as pulsed ESPI. The experimental setup and the image processing methods were improved to allow the calculation of the plate transient stress field. Integral transforms are used to obtain the strain fields from spatial derivatives of displacements noisy data. A numerical simulation of the plate transient response was carried out with FEM Ansys®. For this purpose a PZT transducer was used to record the impact force history, which was inputted in the numerical model. Finally, the comparisons between numerical and experimental results are presented in order to validate the present methodology.

Keywords: Interferometry; TV-holography; ESPI

1. Introduction

Nowadays composite materials have a wide use in structural applications. Despite of these advantages, comparing to metallic materials, they present a high vulnerability to internal defects resulting from the manufacture process or service loadings. These defects can severely reduce the structural performance lowering its load capability.

The impact response in plates is mainly determined by the impactor/plate mass ratio. Small mass ratio creates very short time impact, for the order of wave propagation time through thickness, resulting in dilatation waves in the plate mass. Longer time impact, higher mass ratio, will create a transient response with flexure wave's propagation. For much higher mass ratio, a longer time impact will be obtained, enough for the wave to reach the boundary. This way, bending and shear waves are generated and the response will be identical to a "quasi-static" loading case [1,2].

The main objective of this work is the development of a numerical-experimental methodology that can be used to characterize the dynamic behavior of polymeric matrix composite materials and also to evaluate the effect of damages in its structural behavior. The complexity of the composite materials response, due to his orthogonal and non-homogenous properties, leads to difficulties in experimental data interpretation. So, before this objective can be achieved, the methodology development was started with isotropic materials and this work presents the first approach based on the study of an isotropic and homogeneous aluminum plate.

Using holographic interferometry techniques non-contact field measurements can be performed to assess the displacement/vibration amplitude of an object surface with very high resolution [3]. Its sensitivity depends on the laser wavelength and is of the order of a few 10th of micrometer. This way; they can be applied over diffuse and complex geometry surfaces without interfering with its structural behavior. With these techniques quasi-static, periodic or

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