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IMPROVEMENTS IN DAMAGE DETECTION USING MODAL STRAIN FIELDS MESURED BY DIGITAL SHEAROGRAPHY

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Summary. *In this paper we present a novel approach for damage detection based on discontinuities analysis of experimental modal strain fields. These fields are extracted from the combination of two rotation fields and they are measured using digital shearography with stroboscopic double illumination. The rotation fields of a damaged laminated plate are frozen by the synchronization between the LASER illumination and the modal vibration of the object. The quantitative evaluation is performed for each digital shearogram using a time modulation technique. The evaluation of a delamination damage on composite plates is performed by using dedicate image processing techniques. Finally, a comparative analysis of damage detections using the experimental measurement of rotation and deformation fields and their spatial derivatives is presented.*

1 INTRODUCTION

The strain field or modal curvature has been pointed out by several authors as one of the best methods for detecting damage in structures [1-5]. The proposed methods are based on the difference between the modal field curvature before and after damage. These fields are determined by numerical differentiation of the displacement field and/or experimental rotations. A major limitation of these methods, which leads to unsuccessful results, is that the full strain field is not directly accessible by available experimental techniques. The effectiveness of damage characterization is strongly dependent on the quality of the strain field, but this quality depends on the numerical differentiation technique used, the spacing of experimental data and the measurements noise level.

This paper proposes a new technique for the direct full-field measurement of modal strain fields using digital shearography, thus avoiding the problems associated with numerical differentiation process.

The Michelson shearography interferometer is a full-field technique for the measurement of slope or spatial displacement gradients [5-6]. The stroboscopic illumination, with the same excitation frequency as the one of the object, is introduced by an acousto-optic modulator for

the modal slope measurement on a laminated plate. The proposed method combines the information from two slopes with opposite sensitivity vectors, $\Delta_{+\theta}$ and $\Delta_{-\theta}$, to obtain in-plane modal strain fields. The sensitivity vector is adjusted during the measurements using two different illumination angles (see Fig. 1). The plate is excited at their natural frequencies by a loud speaker.

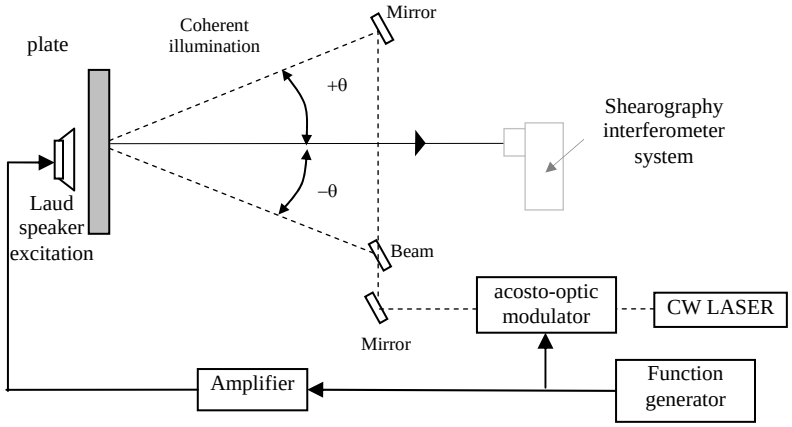

Fig. 1. Schematic diagram of experimental set-up.

9 CONCLUSIONS

The proposed experimental method showed to be effective in modal slope and strain fields measurements. The strain field has a low spatial resolution compared with the resolution of the rotations fields. This requires using higher vibration amplitudes, producing experimental measurements with higher noise levels. The damage was located successfully using both experimental fields, but the higher noise level in the strain field has led to worse result.

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