ROTATION AND TWIST MEASUREMENTS ON LAMINATES WITH EXTENSION/TWIST COUPLING IN ROTATIVE FIELD

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1 Introduction

The purpose of this study is the understanding and quantification of the plate behavior with extension/twist coupling when they are loaded in axial strength, which can be a constant axial force or centrifugal force. Some authors already have published on rotative bench and meanings to measure twist deflection [1-3].

This submission is based on the whole experimental apparatus used to retrieve data from the rotating tests of laminates. In this article, some ways to measure twist or rotation at the end section of a plate are explored, beginning with a brief explanations of such methods. Next, the accuracy of these measurements is quantify and allow to conclude about the reliability of these measures.

2. Bench presentation

The experimental apparatus in snapshot in Fig.1. represents the entire system of extension/twist coupling laminate testing in rotation. These laminates are rotated in order to create a centrifugal load. A polystyrene sandwich disk prevents aerodynamical forces and insures a great stability of the whole system. This test bench reaches a rotational speed of 35 rd.s^{-1}, which is enough to expose large twist deflection.

3. Experimental measurement

Twist can be seen with the rotation at the end of a plate in an average way (see Eq.1) or directly measured on the plate with strain measures.

$$\Theta(x) = \frac{d\theta(x)}{dx} \approx \frac{\theta(L)}{L} \qquad (1)$$

So, an innovative wireless SAW (surface acoustic waves) technology [4] and regular strain gages stick at the middle of one of the plates joined with a telemetry transmission system has been used to collect strain data during the rotation of samples.

Two optical systems are also used to record rotations at the end section of plates. One of them is based on the reflection of a laser beam on a grating (see Fig. 2). On the other plate, the mass is covered with a printed pattern. A snapshot of this pattern during the trial is converted in rotation with the radon transform.

An usual capacity sensor with a PC timer allow to estimate the speed rotation and to precisely trigger cameras.

4 Results

Fig. 3 shows in-plane strains during a trial, where, as expected, shear in middle plane is negligible and strains in other directions are proportional with the centrifugal force created by the acceleration of the mass at the end of the plate. Fig. 4 represents the same trial with out-plane strains, k_{xy} curvature post-treatment is done in order to examine the twist of the plate at the location of the gages. The twist exposed by the plate over 25 rd.s^{-1} (mass take-off) is quite important, 20°.m^{-1} and can be accurately estimated with simulation.

References

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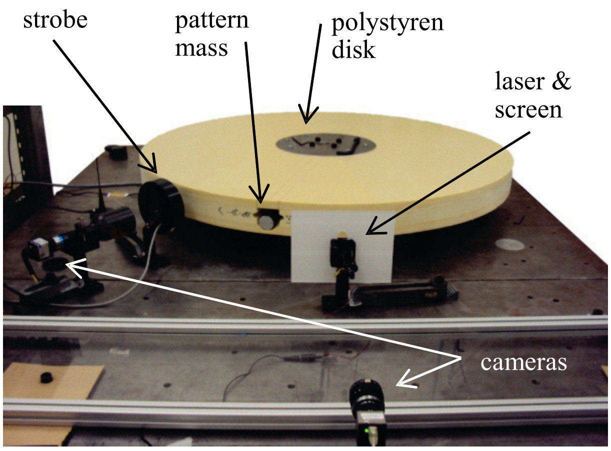

Fig. 1. Rotative test bench

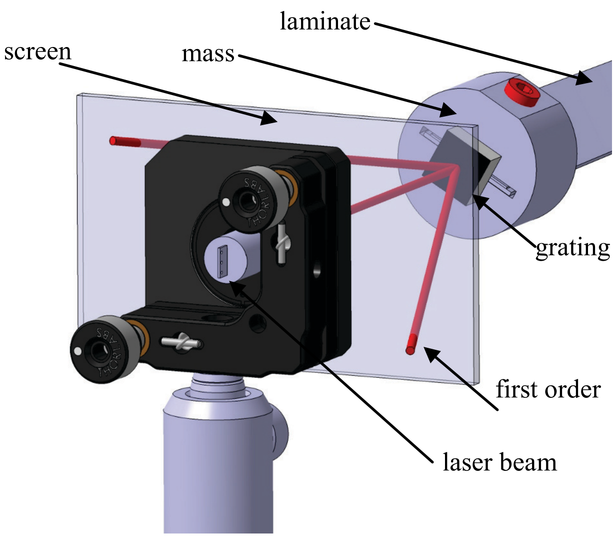

Fig. 2. Twist measured with laser diffraction

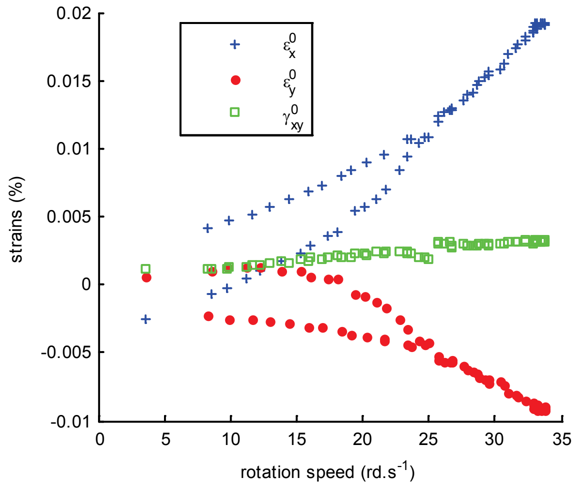

Fig. 3. Strains versus rotation speed

laser beam

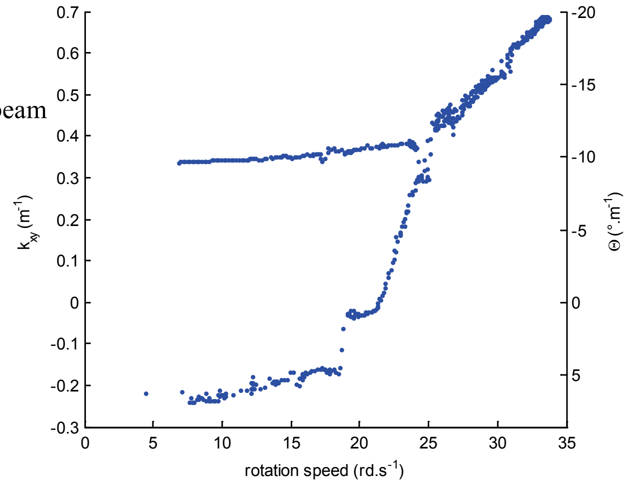

Fig. 4. Twist versus rotation speed