MEASUREMENT OF THE FATIGUE CRACK DEPTHS IN ALUMINIUM PLATES

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ABSTRACT

This work estimates the depth of cracks using the eddy current method. After detection of one crack the material surface is scanned. The eddy currents are excited in the material using a special planar coil to produce a spatially invariant primary field. The secondary field, due to the eddy currents is measured using a high sensitivity giant magneto-resistor sensor. It is experimentally demonstrated that the maximum amplitude of the field perturbation due to the presence of a defect correlates with the depth of the crack.

Keywords: Eddy current evaluation, fatigue cracks, non-destructive quantitative evaluation.

INTRODUCTION

In this paper we use the eddy current method [1] to characterize cracks that have been machined on aluminium plates of the kind usually found in aerospace vehicles. The eddy current method has been widely used for a long time. Nowadays, with a large number of aged aircrafts in use, the non-destructive methods related to airplane maintenance continue being one of the most important ways to detect and characterize flaws in metallic non-ferromagnetic materials. Other methods are used to detect open aging fatigue cracks such as dye penetrants, thermography, radiographic methods, ultrasonic testing, acoustic emission or magnetic flux leakage.

Our probe [2] is depicted in Fig.1. With sinusoidal excitation it produces a spatially uniform magnetic field. Thus, the primary excitation field is invariant [3] under small translations.

![Fig. 1 - The planar probe induces parallel eddy currents in the central zone. The giant magneto-resistor (GMR) sensor is seen on the upper surface.](image)

The probe is mounted on a xy-positioning system which permits to scan the area over one crack. The giant magneto-resistor (GMR) signal is amplified, filtered and measured in amplitude and phase in relation to the excitation. The data obtained when seven cracks with different depths, made in aluminium were scanned is represented in Fig.2. It is assumed that
the crack’s orientations are known. Thus, the probe is mounted in order to induce eddy currents that are directed perpendicularly to the cracks’ lines. The better results were obtained when the field component under measurement was in the same direction of the primary magnetic excitation. The problem of separating a small perturbation from the primary excitation was solved.

RESULTS AND CONCLUSIONS

![Output of the GMR sensor when the plate was scanned.](image1)

Fig. 2 - Output of the GMR sensor when the plate was scanned. In this case, the measured component of the magnetic field is parallel to the primary excitation field

![GMR output peak voltage for the seven cracks, with the measured field parallel to the crack.](image2)

Fig. 3 - GMR output peak voltage for the seven cracks, with the measured field parallel to the crack.

The amplitude of the peak voltage measured by the magnetic sensor is correlated to the depth of the defect as depicted in Fig. 3 for the seven cracks used for measurement. Note that in a real case one standard specimen should be machined with the material thickness, electric conductivity and type of crack matching the situation under measurement.

ACKNOWLEDGMENTS

This work was developed under the Instituto de Telecomunicações project EvalTubes and supported by the Portuguese Science and Technology Foundation (FCT) projects: PEst-OE/EEI/LA0008/2013, SFRH/BD/81856/2011 and SFRH/BD/81857/2011.

REFERENCES

