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FBG SENSORS APLICATION FOR RESIDUAL STRESS MEASUREMENT USING THE HOLE DRILLING METHOD

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ABSTRACT

This work focus on the development of a new sensor for residual stress measurement using fiber optic Bragg sensors. A known stress field was induced on a specimen and results obtained from both the fiber optic Bragg sensors rosette and traditional electrical strain rosette were compared. Also a FEM model was used to confirm the obtained results.

Keywords: residual stress, hole drilling, FBG sensor.

INTRODUCTION

Weight and cost reduction policies have increased the pressure to better understand the effect of residual stresses on the mechanical properties of components/structures. Several failure mechanisms can be exacerbated by the presence of locked-in residual stresses. In most cases, residual stresses are created due to mechanically induced plasticity or by thermal effects (Withers & Bhadeshia, 2001) Quantitative estimation of residual stresses is important for a safe performance of structural components (Venkitakrishnana, et al., 2007).

Hole drilling is a widely accepted technique for residual stress measurement, existing already an ASTM standard regarding the technique (ASTM, 2008). This method, involves drilling a small hole into the surface of a component at the centre of a special strain gage rosette and measuring the relieved strains. This type of sensor can be problematic when used on industrial environments, mainly due to electrical noise and magnetic fields. In order to eliminate this drawback, this study is focused on the development of a new methodology to replace the electrical sensors with fiber optic sensors, fiber Bragg grating (FBG) sensors. After installation and residual stress measurements, this new type of sensors can also be used to monitor the strain loading of the component during service.

RESULTS AND CONCLUSIONS

A four point bending system (see Figure 1) was specially made in order to induce a consistent stress field in AA7075-T73 aluminium alloy specimens. Electrical strain gauge rosettes and fiber optic rosette measurements were compared. Figure 2 shows an example of principal stresses for the electrical strain gauge rosette.

A finite element method (FEM) model (see Figure 3) containing 547840 C3D8R elements was analyzed using Abaqus, and the obtained stresses were then compared to the experimental results.

Fig. 1 - Four point bending system

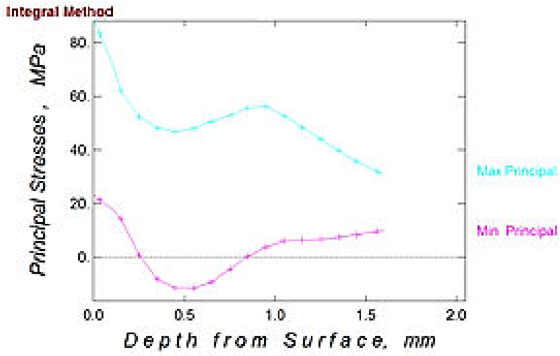

Fig. 2 - Example of results for principal stresses distribution measured using an electrical strain gauge rosette

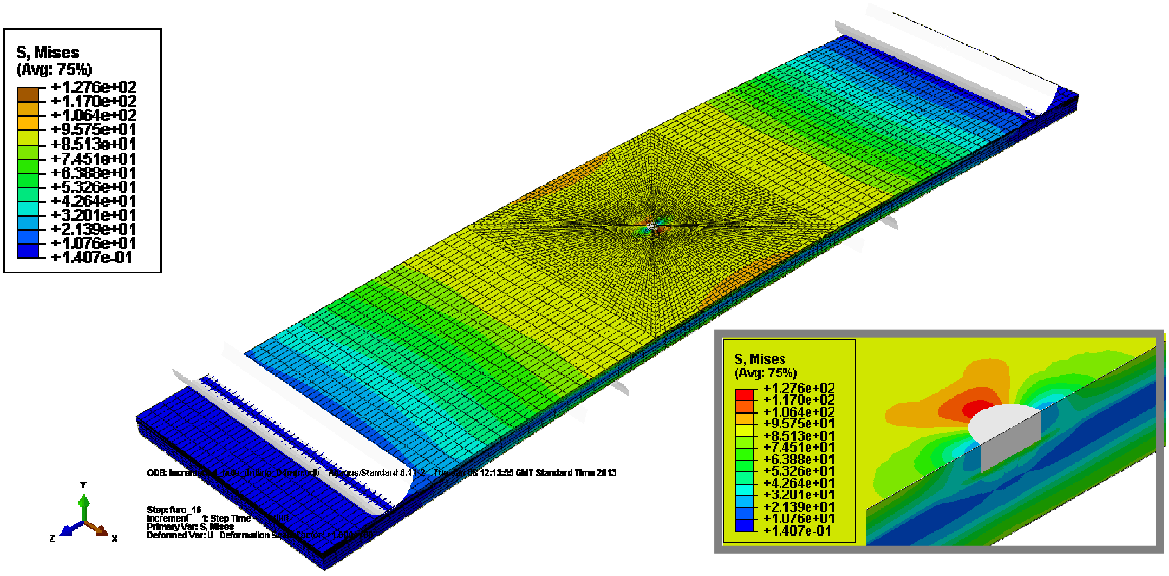

Fig. 3 - FEM model

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