MEASUREMENT OF THE RESIDUAL STRESS FIELD IN AN ALUMINIUM ALLOY 2014A COMPONENT OF COMPLEX GEOMETRY

S. Hossain[1], M. Fardi[1], U. Stuhr[2], D.J. Smith[1], C.E. Truman[1*]

[1] Department of Mechanical Engineering, University of Bristol, Queen's Building, University Walk, Bristol BS8 1TR, UK
[2] Laboratory for Neutron Scattering, ETH Zu¨rich and Paul Scherrer Institute, CH-5232 Villigen, Switzerland

Abstract

Accurate prediction of residual stress fields plays an important role in the structural integrity assessment of engineering components. With the advent of modern computers, solving complex non-linear finite element analyses has become a routine practice. The output of the results from such analyses however still remains dependent on accurate definition of material characteristics and process parameters. In order to achieve a reliable solution, the predictions therefore need to be verified with hard measurements. In safety-critical components it is vital to validate the initial finite element prediction with meticulous measurement before progressing into the subsequent steps within the structural integrity assessments.

In this paper, results are presented from a series of measurements using the neutron diffraction technique to measure the residual stress present in a complex geometry manufactured from an aluminium alloy 2014A followed by cold water quenching. The quenching process imparts good mechanical characteristics on the sample. The sample in the present study includes a pump casing with an aerospace application. The measured residual stress distribution along a selected number of lines through the thickness of the pump casing is compared with an earlier non-linear finite element simulation. The finite element prediction requires a good description of material physical and mechanical properties such as the heat transfer coefficient, temperature dependent and strain rate dependent yield stress, temperature dependent elastic constants, etc in order to accurately predict the residual stress field. An initial comparison illustrates a good correlation between the measurement and the prediction along a selected number of paths through the thickness of the pump casing sample. On a closer assessment, however, it is seen that more refinement of the finite element study is required, before a better correlation with the measurement along the remaining measured paths through the thickness of the sample, and hence an experimental verification of the finite element result, may be achieved.

[*] Corresponding author: Dr Christopher E Truman, Email: C.E.Truman@bristol.ac.uk