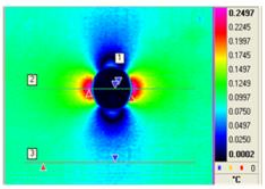
RESIST - Residual stress and structural integrity studies using thermography

Residual Stress (RS) attracts considerable attention in engineering because of its impact on part distortion, service performance and the costs associated with failures resulting from RS. Currently RS measurement can be expensive, time consuming, destructive and may provide only single point data. In this project a new means of evaluating RS is proposed based on material and system models combined with data from a full-field, non-contact, non-destructive measurement technique. This approach will be particularly suited to large or expensive components, where material removal is undesirable and/or where contact is impossible.

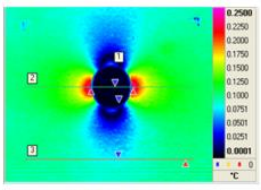
Project Objectives

The objectives of the project are to develop:

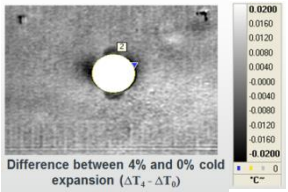
- A physical understanding of, and a theoretical framework for, RS evaluation using thermography and thermoelastic stress analysis (TSA);
- Material models for calibration of data and system models for the determination of RS;
- Demonstrators for RS evaluation, including its industrial application and validation.



ΔT - 0% Cold Expanded Hole



ΔT - 4% Cold Expanded Hole



Difference between 4% and 0% cold expansion ($\Delta T_4 - \Delta T_0$)

Thermal images of cold expanded holes of different expansion levels and the difference between the two due to residual stress

Residual stresses are self-balancing, internal stresses that are usually developed during manufacturing. If RS is not considered, then the addition of RSs to service loads can cause unexpected failure. The purpose of the research is to identify the residual stresses at welds in service components. Most portable residual stress measurement techniques are destructive. Other non-destructive residual stress measurement techniques are not portable. The thermography approach is non-destructive and portable, therefore offering a means to investigate components in service without costly down time. The proposed technique has been validated in a laboratory environment. However, there are still significant challenges to be addressed to bring the system to market, which will be dealt with in the planned research work by an expert consortium.

The consortium is made up of Enabling Process Technologies, The University of Southampton, The National Physical Laboratory, TWI and EDF Energy. The University of Southampton is a world-leader in thermography in experimental mechanics, the industrial support from EDF Energy brings the background to assessing residual stresses directly on nuclear plant, the support from TWI and NPL bring in the benefit of a wealth of experience in residual stress assessments across sectors and EPT have the experience of implementing new systems into a variety of industrial environments.

To determine the RS a novel hybrid technique based on extensive material and system modelling is required. The major technological challenge will be bringing together the experimental data with material or system models in a way that is computationally efficient and straightforward to apply to meet industrial needs, providing a unique and world leading approach.

This project is funded by the Technology Strategy Board.

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