Title: Experimental evaluation of Stress Intensity Factors from strain fields using Digital Image Correlation

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Extended abstract.

Optical techniques offer many benefits to experimentalist compared with gauge methods. Optical techniques such as holographic interferometry, electronic speckle pattern interferometry, photo- and thermoelasticity, and various grid methods are non-contact, full-field and can have high resolution.
However, they are expensive or require special surface preparation or provide reliable measurements only in certain locations (fringes). Moreover, these techniques are hard to apply in field conditions. In contrast, the image correlation technique is cheap, easy, versatile and requires minimal surface preparation. It is ideally suited for field application. In this work a two-dimensional image correlation method was used to measure in-plane displacement fields near crack tip. Linear elasticity was assumed outside the crack tip plasticity zone. In the elastic region Muskhelishvili's complex functions approach was used to calculate the stress intensity factors from the measured displacements.
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Computationally the problem is that of solving an overdetermined system of non-linear equations. In this work genetic algorithm was used to find the solution.
The method was applied to fatigue cracks in 2 and 3 mm thick Al 7010 alloy plates loaded under mixed mode (I+II). The stress intensity factors were calculated to within 10-20% of the nominal applied values. In addition the crack tip location was calculated. The sensitivity of the technique to the experimental noise and the issues of the location and the number of the experimental data points will be discussed. Finally the extention of the method to a real time monitoring will be analysed.

Keywords: stress intensity factors, aluminium alloy, digital image correlation