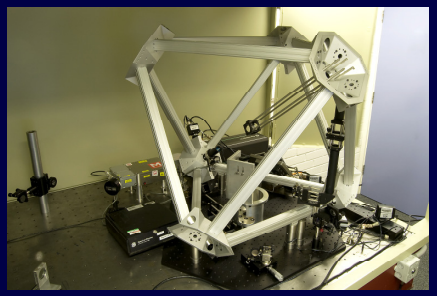
Estimation of damage location in advanced composite materials

Introduction

Damage, normally difficult to assess, causes unpredictable behaviours in structural components. To take a decision of whether to repair or retire the part, inspection for damage is important. In engineering, damage modelling is assumed to be driven by a number of unknown parameters, which reduces the inspection to one of parameter estimation, sometimes known as inverse problems. A novel optical topographic system able to measure internal strain fields is being developed within the Wolfson School, and the current project deals with the process of determining damage distributions from the output of this interferometer by using two numerical methods. The Virtual Fields Method is one such technique that allows the distribution of mechanical properties to be determined from measured full-field displacements and applied loads. Finite Element Model Updating is a second technique to identify structural damage and perform the assessment of the structure.



Optical topographic system in development

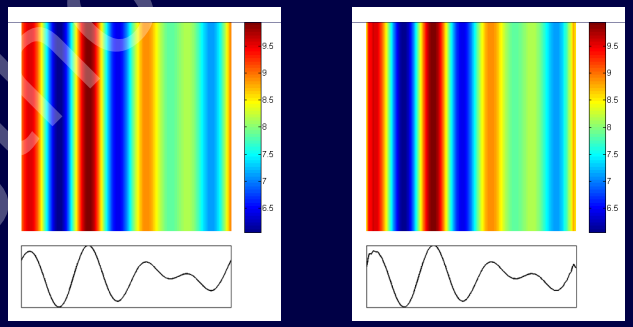
Methodology

- The Virtual Fields Method (VFM) relies on the Principle of Virtual Work in which the unknown properties, the measured strain fields and the applied forces are in connection with the virtual strain and displacement fields.
- The purpose of Finite Element Model Updating (FEMU) is to modify the parameters governing damage of a numerical model to obtain better agreement between numerical results and experimental data.

Aims and Objectives

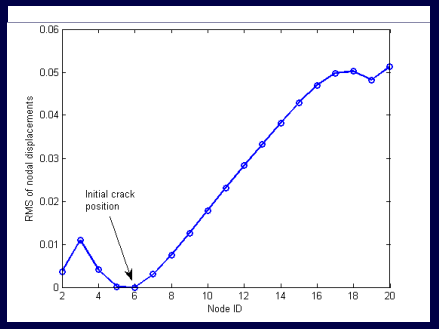
- Direct estimation of 3-D elastic modulus distributions from experimentally-determined displacement fields and applied loads.
- Optimization of parameterized damage models in 3-D finite element models.

Recovering modulus



A square plate of varying modulus is subjected to tensile loads horizontally directed towards left and right. The left figure shows the original modulus field of the plate and its profile while the figure on the right represents the modulus field and profile recovered by applying a novel Fourier-based implementation of the Virtual Fields Method.

Locating crack



A finite element model of a single matrix crack is initially located at node ID #6. Random search is carried out at all possible locations where the crack can appear. Nodal displacements are recorded to estimate the actual crack location.

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