MatchID
Metrology beyond colors

Application Note

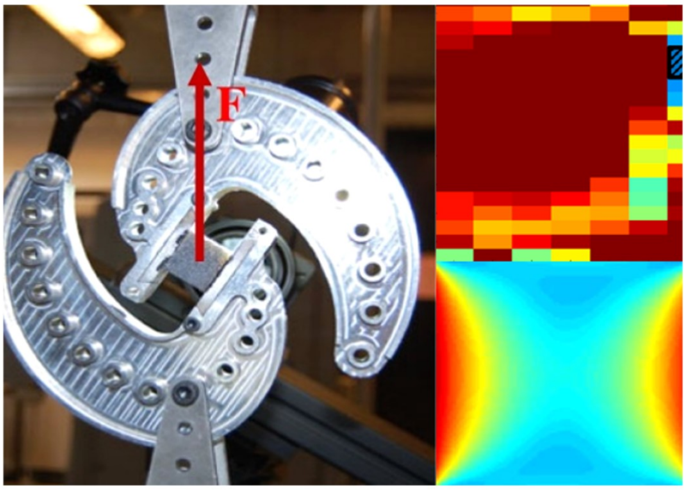
Optimized Experimental Characterisation of Polymeric Foam Material Using DIC and VFM

Case Description

In collaboration with the Aalborg University and the University of Southampton, a methodology has been developed to characterize the elastic stiffness parameters of an orthotropic PVC foam material in one single test, hereby combining DIC and the Virtual Fields Method.

An optimum test configuration was first determined by simulating the entire identification process via deformed synthetic images. Then, an experimental campaign was conducted using these derived conditions.

The identified values match well with data from traditional tests that require more (difficult) test procedures.



Experimental Setup

- ✓ **Cameras:** 2x 8 bits CCD cameras (2048 × 2048) with 50mm lenses in a back-to-back configuration
- ✓ **Loading:** Modified Arcan fixture
- ✓ **Field of View:** ~20mm x 20mm
- ✓ **Foam thickness**: 5mm

Analysis

- ✓ **FEDEF**: Virtual test conditions according to a 2D plane stress model
- ✓ **2D**: Real test on an optimized configuration accounting for uneven thickness strain
- ✓ **VFM**: identification of elastic stiffnesses in one test

Results

- ✓ **Optimum test configuration** w.r.t. minimization of identified uncertainties and precision
- ✓ **Four stiffness components in one test** compliant with traditional coupon testing.

Why MatchID

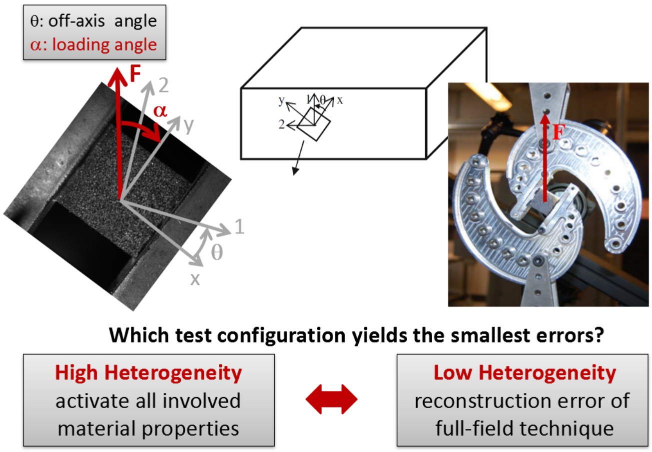
- ✓ Identify the optimum test configuration via **virtual testing.**
- ✓ **Seamless coupling** between DIC and material identification solutions.
- ✓ **Uncertainty quantification** on the identified properties.
- ✓ **Reduced testing time** and less material used with **full-field stress information.**

Virtual Testing

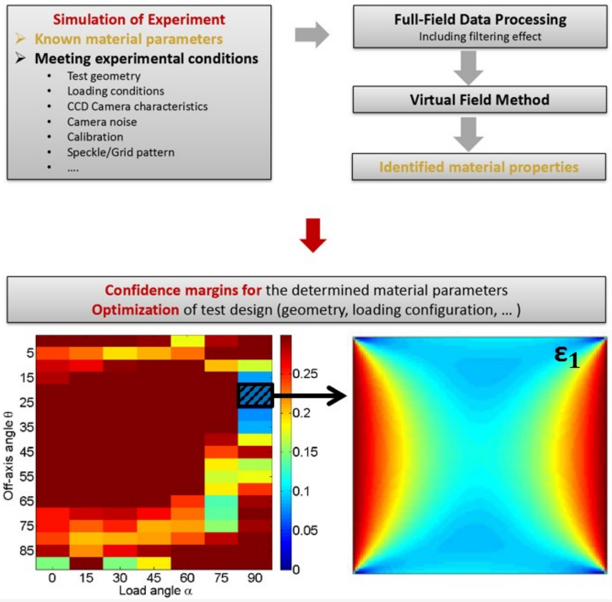
The aim of this study is to identify all the material properties in one single test. As such, the experiments should be designed to induce balanced heterogeneous strain maps for all the components to be identified. Indeed, DIC acts as a low-pass filter and as such a reconstruction error can be induced when the test invokes too high strain gradients. On the other hand, a too homogeneous and uniform strain field might not activate all the stiffnesses involved.

Via a modified Arcan fixture, both the loading as the off-axis angle w.r.t. the material orthotropy directions act as design variables in the determination of this optimum balance.

Instead of performing many physical tests to identify both design variables, a virtual test campaign is initiated.



Optimized Configuration



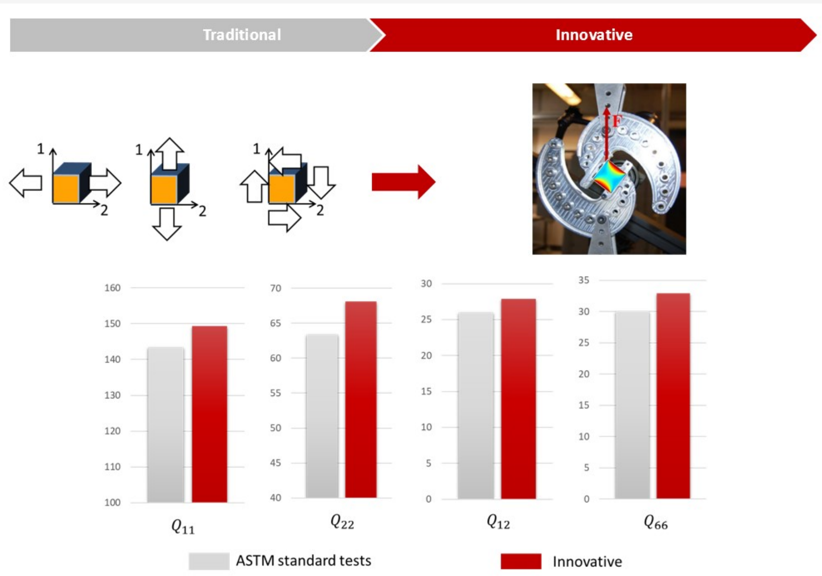
This virtual test campaign is based on simulating the entire identification chain via numerical deformed images based on benchmark FEA displacement data and known experimental conditions. A DIC analysis followed by a VFM identification on these virtual images allows a benchmarking of the derived properties to the known FEA ones. This process is repeated for multiple combinations of both design variables (loading and off-axis angle) in the simulation process, as such identifying the optimum combination that generates the smallest error on the involved stiffness components.

The strain field of the identified test configuration indeed shows a heterogeneous character, but avoids high strain gradients.

Material Identification

Finally, 20 repetitions of a real physical test are performed for the identified optimum test configuration. Two back-to-back cameras allow to average displacement results in order to remove effects of out-of-plane motion and uneven strain through the thickness.

The identified stiffness values match well with data from the traditional testing techniques. The number of tests to be performed, however, is reduced by a factor of three.



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