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Identification of Material's Parameters at High Temperature Using the I-DIC Technique

Introduction

Numerical simulations are often used to study the structural behaviour of a given practical application, such as the resistance of refractory linings against thermomechanical loads. To be able to do this kind of analysis, the parameters of the material's constitutive law need to be identified. The Integrated Digital Image Correlation (I-DIC) technique can be associated to a mechanical test in order to provide this information.

Mechanical tests at high temperature

A picture of the sample is taken at the beginning of the test (called "reference image"). Later, during the load application, pictures are taken at defined time intervals (called "deformed images"). These images are used in the I-DIC algorithm to calculate the sample's deformation and to identify the material's properties.

Figure 1 shows the experimental setup used to take pictures of a sample at 1200°C. At such a high temperature, the pictures present almost no contrast, what makes it impossible to use the I-DIC technique. To solve this problem, blue light sources can be used in association with blue bandpass filters, and pictures with higher contrast can be obtained [1].

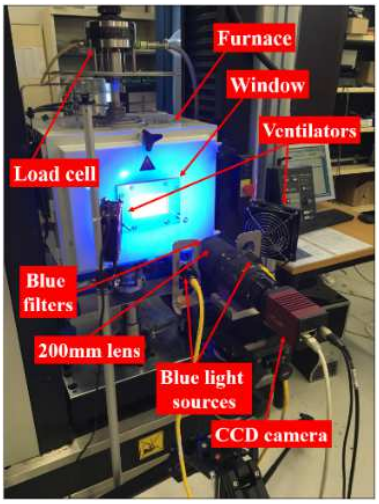

Figure 1 – Experimental setup.

I-DIC technique

In the I-DIC technique, the images obtained in the mechanical test are treated and analysed. A numerical model of the mechanical test is created, and the displacements' field is computed considering an initial value for the material's parameters, defined by the analyst. Using this displacements' field, the pixels' grey levels of the reference image are interpolated to create the so called "virtually deformed images". The virtually deformed images are compared with the deformed images (obtained during the mechanical test), and the difference in their pixels' grey levels generates a residual, i.e., a measure of the error. Later, a new value for the mechanical parameters is defined using an optimization algorithm, and the loop continues until the residual is below a given tolerance. Figure 2 illustrates the I-DIC algorithm [2].

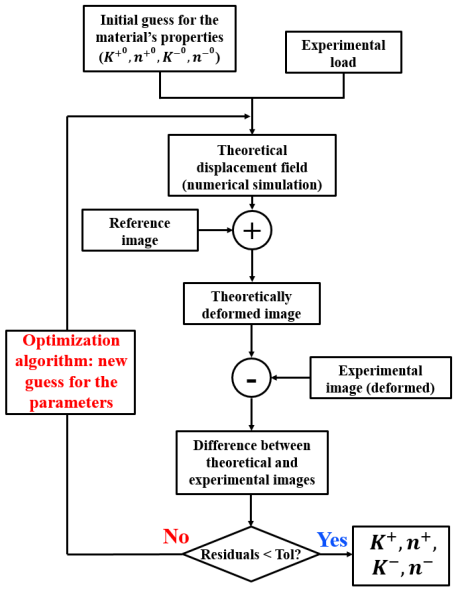

Figure 2 - I-DIC algorithm

Expected Result

The output of the I-DIC technique associated with mechanical tests is the identification of the parameters of the constitutive law that describes the material behaviour.

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References

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