



Inverse Identification of Asymmetric Creep Parameters Using the I-DIC Technique

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Inverse Identification of Asymmetric Creep Parameters Using the I-DIC Technique

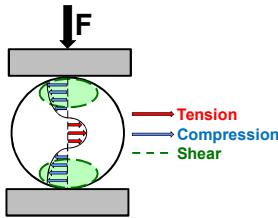
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1 – Introduction:

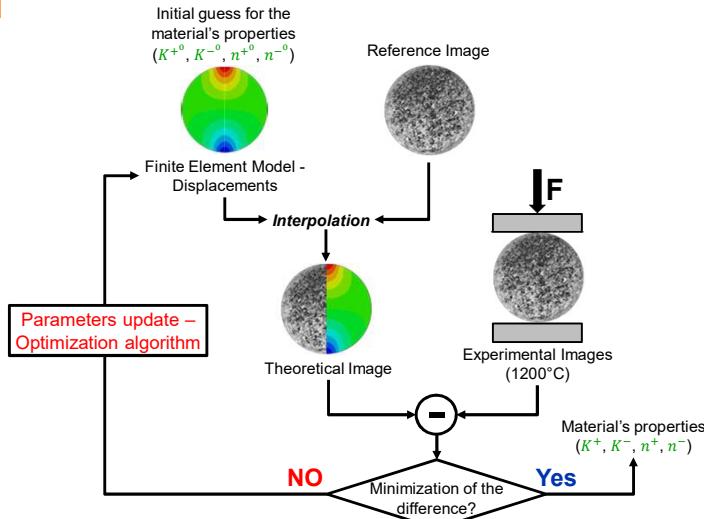
- The creep characterization of refractory materials at high temperatures requires complex tests
- This work intends to apply the Integrated Digital Image Correlation technique to the determination of the secondary creep properties of refractories at high temperatures
- It's expected to fully characterize the materials (tension, compression and shear) using a reduced number of tests, making use of the Brazilian test
- Images taken at 1200°C were virtually deformed using an asymmetric creep law (different behavior under tension and compression) with known materials' parameters. Later, starting from an initial guess for the parameters, an inverse identification was run to check the I-DIC software robustness

2 – Brazilian test:



The Brazilian test presents a complex stress distribution, with tension, compression and shear observed in the sample at the same time. This allows the identification of the asymmetric behavior using a reduce number of tests

3 – I-DIC algorithm:



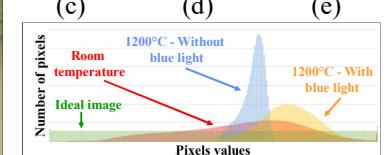
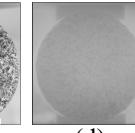
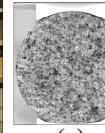
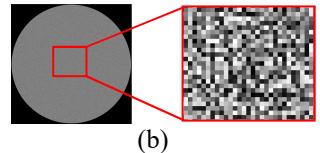
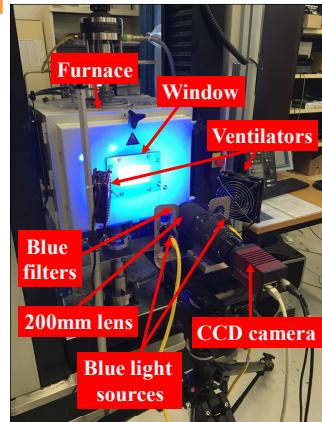
4 – Mathematical model:

$$\dot{\varepsilon}^p = \frac{3}{2} \frac{s^+}{\sigma_{eq}^+} \left(\frac{(\sigma_{eq}^+ - \sigma_y^+)}{K^+} \right)^{n^+} - \frac{3}{2} \frac{s^-}{\sigma_{eq}^-} \left(\frac{(\sigma_{eq}^- - \sigma_y^-)}{K^-} \right)^{n^-}$$

where σ_y is the yield stress, s is the deviatoric stress and σ_{eq} is the von Mises stress.

E. Blond, N. Schmitt, F. Hild, P. Blumenfeld, J. Poirier, Journal of the European Ceramic Society, 25[11] 1819-1827 (2005).

5 – Experimental setup:



(a)

(f)

(a) High temperature test setup and Brazilian test samples used with I-DIC. (b) Virtual image. (c) Room temperature. (d) 1200°C without using the blue lights. (e) 1200°C using the blue lights. (f) Images' histograms.

6 – Results:

A Genetic Algorithm was used to perform the inverse identification of the parameters. Tables 1 and 2 show the reference values used to create the deformed images, the range of variation used in the optimization and the identification results.

Table 1 – Reference values for the creep properties

	Reference values	Range of variation
Tension	$K^+ = 5773.5$	$K_{min}^+ = 5000$
		$K_{max}^+ = 6000$
	$n^+ = 2$	$n_{max}^+ = 2.2$
		$n_{min}^+ = 1.8$
Compression	$K^- = 1.0 \times 10^6$	$K_{min}^- = 5.0 \times 10^5$
		$K_{max}^- = 5.0 \times 10^6$
	$n^- = 1.5$	$n_{max}^- = 1.8$
		$n_{min}^- = 1.2$

Table 2 – Three best solutions given by the Genetic Algorithm

	Solution 1		Solution 2		Solution 3	
	Value	Error	Value	Error	Value	Error
K^+	5127.6	-11.19%	5543.3	-3.99%	5264.70	-8.81%
n^+	2.01	0.27%	1.99	-0.46%	1.99	-0.58%
K^-	9.71E+05	-2.91%	1.25E+06	24.97%	1.08E+06	8.14%
n^-	1.51	0.71%	1.48	-1.10%	1.51	0.35%

7 – Conclusions:

- The I-DIC technique is a convenient option to perform inverse identification of mechanical parameters at high temperatures
- For future works, the creep parameters of refractory materials will be identified using experimental images

ESR Position 09



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