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MECHANICAL RESPONSE OF NBR (70): EXPERIMENTAL CHARACTERIZATION AND FEM SIMULATIONS

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ABSTRACT

The objective of this work is to develop an overall experimental characterization programme and a FEM modelling routine that will allow for the accurate prediction of NBR (70) response under stress-strain conditions. Tensile (uniaxial) tests and Blow-Up tests were carried out together with optical 3D strain measurements and digital correlation image (DIC) processing. The experimental data was used for the calibration on an advanced 3D constitutive model using an inverse method calibration technique. The model prediction capability was then validated performing biaxial "Blow-Up" tests and contrasting the experimental results with finite element simulation predictions.

Keywords: tensile test, blow-up test, computational simulation, finite element modelling.

INTRODUCTION

The ability to predict mechanical behavior of elastomeric materials is a technological problem still being solved (Hamdi 2006). In many applications, elastomeric components are subject to cyclic deformation and multiaxial stress state. Typical examples of these applications are car's tires and engine supporter. In this type of applications mechanical properties are highly dependent on stress conditions such as temperature, frequency, strain rate and environment (Jerrams 2012). For these reasons, to develop new elastomeric components properly, it´s essential to model mechanical response of elastomeric materials under different stress states (Feng 2003). In the present work, both mechanical testing and computational modeling are used in order to obtain necessary information that clarifies phenomena observed (Balakhovsky 2012).

RESULTS AND CONCLUSIONS

The results from the tensile tests are shown in Fig. 1. Three different strain rates were implemented (Fig. 1a) and one loading-unloading cycle as well (Fig. 1b). The most significant difference in the mechanical behaviour of the elastomeric material is observed for a strain rate of $4\ s^{-1}$.

From the experimental curves the parameters of the constitutive model were fitted using the MCalibration software. Table 1 shows the results of the parameters corresponding to the Bergström-Boyce model (J. Bergström 2001).

a) b)

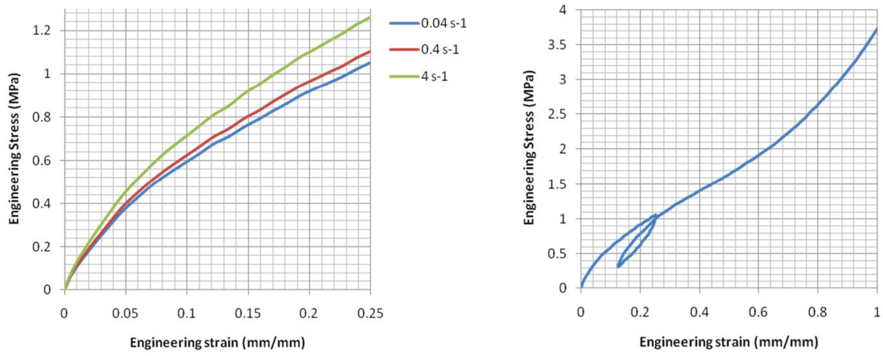

Fig. 1 - Tensile test results, a) three different strain rates 0.04 s^{-1}, 0.4 s^{-1}, 4 s^{-1}; b) Cyclic loading

Table 1 - Constitutive model parameters

Parameter	Value
μ	0.99 MPa
λ_L	1.47
κ	500 MPa
ξ	0.0034
C	-0.98
τ_{base}	23.9 MPa
m	1.3
$\hat{\tau}_{cut}$	0.01 MPa

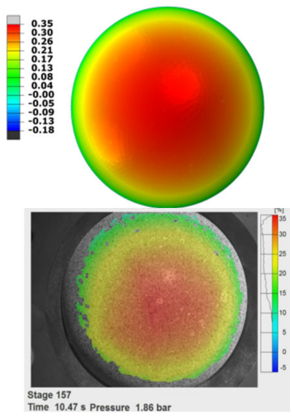

Fig. 2 - FEM Model vs. experimental results

This study shows that NBR 70 mechanical behavior is dependent on the strain rate and shows hysteresis when cyclic loading is applied. Further FEM analysis is being carried out in order to validate the results, Fig. 2.

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