COMPARISON OF EXPERIMENTAL TESTING PROTOCOLS FOR THE EXTRACTION OF RELIABLE MECHANICAL PROPERTIES USED TO MODEL ANEURYSM FORMATION

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Introduction

Aneurysm is a localized dilatation of arteries, commonly observed in the intracranial or abdominal area. As aneurysm is also observed in rubber tubes under particular pressure conditions [Bucchi, 2013], they can be considered reliable models for arteries due to their typical hyperelastic behaviour [Doyle, 2009]. Experimental testing of rubber materials did not see consistent improvements since 1980s. [Mohan, 1982]. As a consequence, most of the recent numerical predictions still rely on experimental data obtained using obsolete techniques [Volokh, 2008].

With the aim of predicting the formation and development of the aneurysm a new protocol for experimental determination of material properties is proposed, using rubber models first. The method will be then implemented for the experimental investigation of both healthy and damaged aortic tissue.

Methods

In order to compare directly the rubber and aorta's testing methodology, the same standard dimensions for both materials were used. The smallest dumb–bell specimen available is the type 4 of the ISO standard [ISO, 2005]. Specimens were cut out from rubber by means of a custom made die. Samples (n=10) were tested (MTS Landmark, 2.5 kN load cell) to failure. The speed rate (0.1 mm/s) was determined as an average of typical speed rates reported in literature [Cox, 2008; Jerabek, 2010].

Strain was determined using video-extensometer (Messphysik) and the results compared with those obtained from the machine cross-head.

Results

Experimental results of the uniaxial tensile test showed a remarkable scatter in the strain (Highest=3.6, Lowest=2.34) between data recorded by the MTS Landmark and video-extensometer for the same specimen (*Figure 1).*

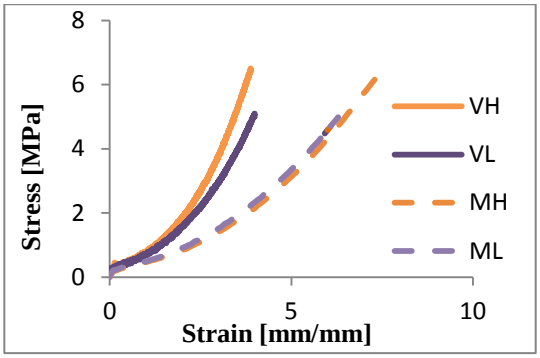

Figure 1: Highest (MH-VH) and lowest (ML-VL) scatter for the stress-strain recorded by the MTS cross-head (dashed lines M) and video-extensometer (continuous line V).

Discussion

Further comparison between a well-established technique (video-extensometer), will be carried out against an advanced 2D digital image correlation (DIC) based on Aramis®. This investigation appears to be quite new and limited to rigid polymeric specimens [Sutton, 2009]. We expect to show a substantial difference in strain recorded by the two approaches, especially at large strains.

References

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