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SHEAR AND TORSION TESTS OF VISCOELASTIC MATERIALS

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Abstract: The main scope of the paper are shear and torsion tests of cork-composite Amorim ACM87. The material is a particle composite with viscoelastic properties. In order to investigate the behaviour of viscoelastic materials, performance of specific mechanical experiments is important. Some materials, as for example ACM87, show different mechanical behaviour during uniaxial tests (tension, compression) and shear (torsion) tests. Three types of shear (torsion) experiments are presented.

Keywords: cork composite; viscoelastic; shear; torsion; experiments

1. Introduction

Particle composite Amorim ACM87 consisting of cork particles bonded together using rubber matrix [1] is investigated. Material properties of the particle composite are similar to properties of rubbers. The mechanical response of viscoelastic materials is strongly dependent on the type of loading. It is very important to perform experiments for different strains and for different strain rates [2]. This contribution describes three variants of shear and torsion experiments, which can be used for the mechanical response measurement. These variants are suitable for viscoelastic materials with the nonlinear stress-strain dependence and high strain rate dependence [2,3]. Presented experiments can be also used for a material parameters identification. Results of performed experiments will be used for the parameter calibration in further work.

2. Experiments

Three types of tests were performed. Geometry of experimental samples (a – simple shear sample, b – shear of Arcan [3] sample, c – torsion sample) is shown in the Figure 1. The simple shear test shown in the Figure 2a was the first experiment. The simple shear sample was glued between two steel plates, which were mounted into clamps of Zwick Roell Z050 testing machine. Translational displacement of the upper clamp led to the shear deformation of the sample. The Arcan sample shown in Figure 2b was used in the second experiment. The Arcan sample was set into a special holder and mounted between clamps of the Instron 8850 testing device. Also in this case, translational displacement of the upper clamp led the shear deformation of the sample. The torsion test shown in the Figure 2c was the third type of the experiment. The torsion sample was glued between two metal rods and mounted into the Instron 8850 testing device. Rotation of the upper rod led the torsional deformation of the sample.

Dimensions of samples was limited by the thickness of the material, produced in 2, 6 and 9 mm thick plates. Samples for simple shear and torsion tests were glued to the metal parts. Mechanical response of thin composite samples can be influenced by the glue.

2.1 Load

The investigated material was tested for combination of 3 levels of shear strains 0,2; 0,4; 0,6 and 3 levels of shear strain rates 2 s^{-1}; 0,2 s^{-1}; 0,02 s^{-1} [4, 5]. Prescribed load included relaxation time of 60 s

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on every level of the strain. Loading of samples was controlled by displacement, the reaction force was measured. Loading history (a – simple shear, b – Arcan sample shear, c – torsion sample) is shown in the Figure 3.

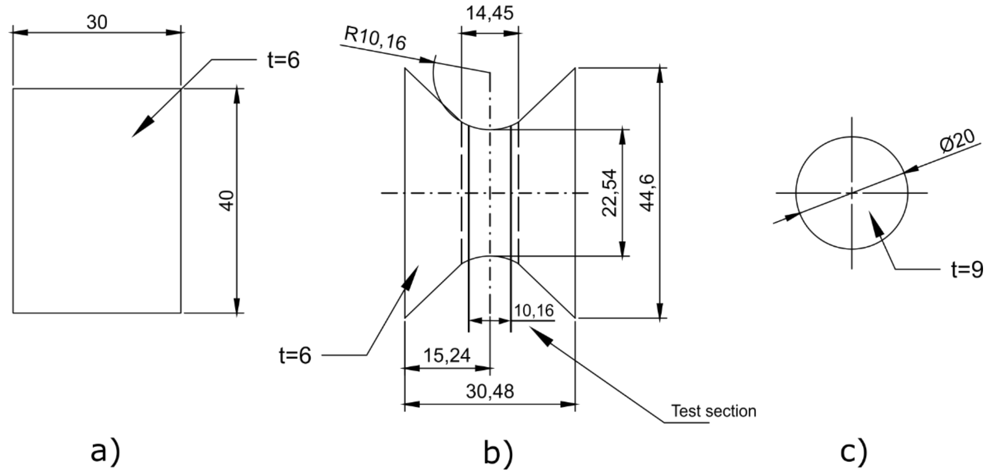

Figure 1 –Dimensions of samples

Figure 2 – Shear and torsion tests

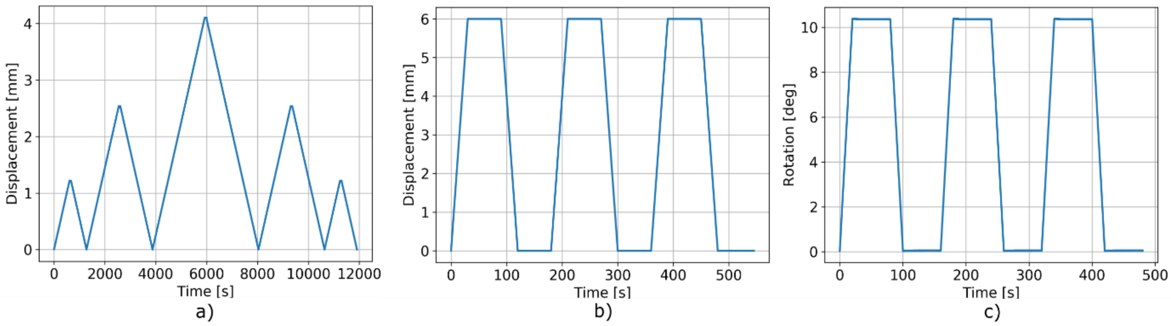

Figure 3 - Load history

3. Results

Following figures show the results of representative experiments. Time – Force (Moment) and Force (Moment) - Displacement diagrams are shown in Figures 4, 5 and 6. From the diagrams, relaxation of the material and significant loss of stiffness during cyclic loading can be observed.

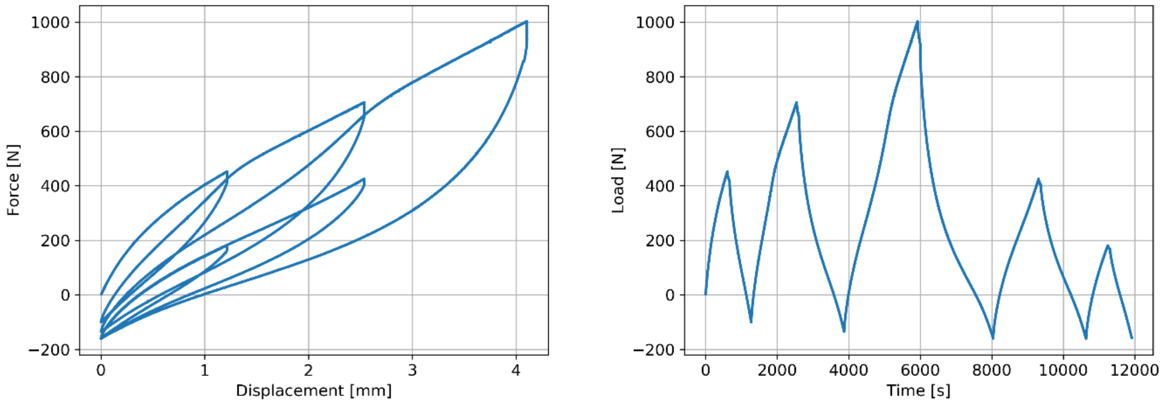

Figure 4 – Simple shear diagrams (0,6 maximum shear strain and 0,02 s^{-1} shear strain rate)

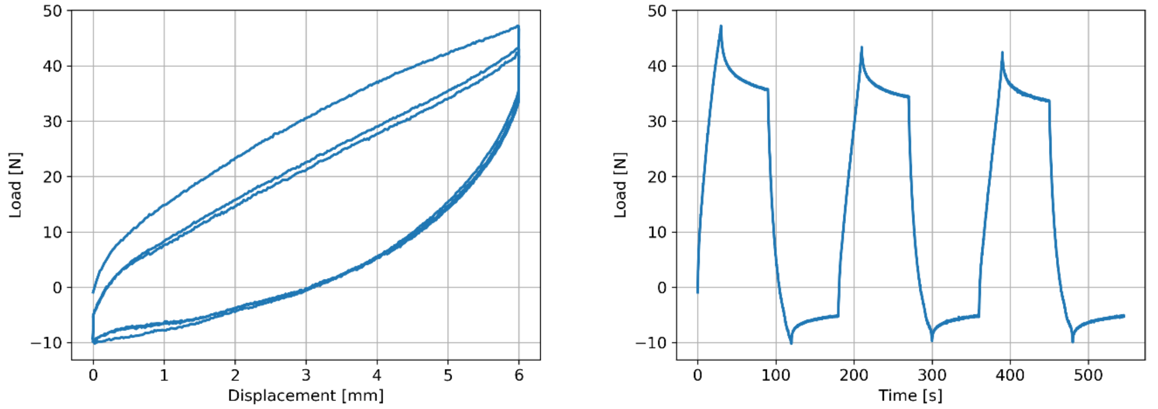

Figure 5 – Arcan sample shear diagrams (0,6 shear strain and 0,02 s^{-1} shear strain rate)

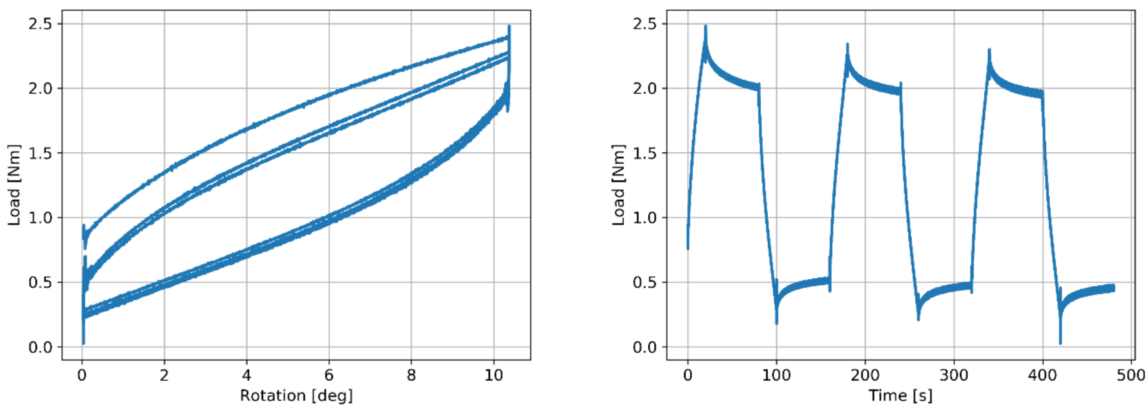

Figure 6 – Torsion diagrams **(**0,4 shear strain and 0,02 s^{-1} shear strain rate**)**

4. Conclusion

The mechanical response of the material (relaxation and stiffness loss) was similar for all of the performed tests. The response of simple shear and torsional samples could be influenced by a glue, which could change the properties of the material. Thicker plate of tested material can eliminate the influence of the glue. Unfortunately, maximal fabricated thickness of the investigated cork-composite is 9 mm. Results of the experiments will be used for the material parameters calibration of the Parallel network model and others.

Acknowledgement

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