Секция II

ИННОВАЦИОННЫЕ ПОЛИМЕРНЫЕ И БИОПОЛИМЕРНЫЕ КОМПОЗИЦИОННЫЕ МАТЕРИАЛЫ. ПЕРСПЕКТИВНЫЕ ТЕХНОЛОГИИ И ОБОРУДОВАНИЕ ДЛЯ ПРОИЗВОДСТВА ИЗДЕЛИЙ НА ИХ ОСНОВЕ. КОМПОЗИЦИОННЫЕ МАТЕРИАЛЫ ДЛЯ ПРОИЗВОДСТВА БПЛА. ЭНЕРГОНАСЫЩЕННЫЕ МАТЕРИАЛЫ И СЫРЬЕВЫЕ ИСТОЧНИКИ ДЛЯ ИХ ПРОИЗВОДСТВА

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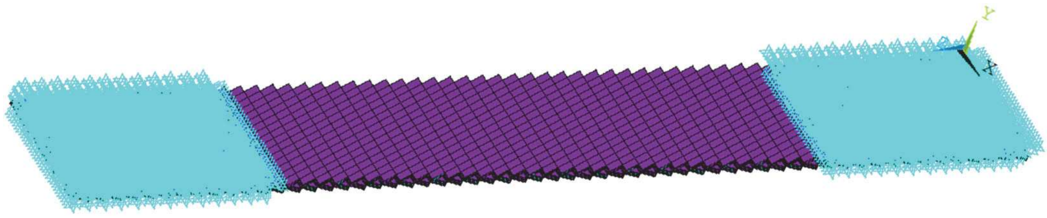
COMPUTATIONAL MODELING OF SPECIFIC TENSILE TEST OF COMPOSITE WITH RUBBER MATRIX

The paper deals with the computational modelling of specific tensile test of composite with rubber matrix [1]. AG-X test machine plus 5 kN Shimadzu with a video-extensometer as a noncontact optical system is used for the test. The change in length and the true longitudinal strain is measured by the video-extensometer at a distance of ±25 mm from the center of the test specimen (the initial distance of 50 mm between the measuring points). The change of width (contraction) is measured together. Therefore, this tensile test is a specific test because the video-extensometer is used for the measurement of the change of width and length in the work area.

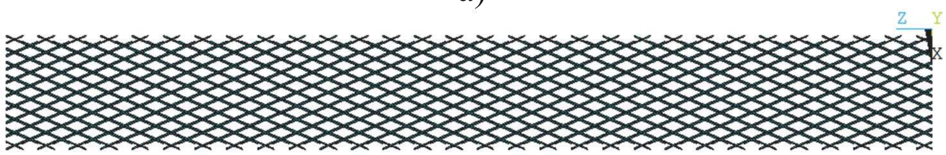
The real composite two-layer specimen consists of 2x0.32 steel cords as reinforcement with a diameter of 0.32 mm and an EPM of 560 m^{-1} (the EPM means that the distance between the cords is approximately 1.79 mm). The angle of the cord is ±23°, and the sample dimensions are a length of 135 mm, a width of 14.1 mm, and a thickness of 0.6 mm per layer.

The computational model is created based on the geometrical parameters of real composite specimens. The Ansys APDL (Ansys Parametric Design Language) procedure [2, 3] is used to create the computational model for computational modelling of the strain-stress state. The SOLID186 volume element is used. The parameters of the material, as modulus of elasticity and Poisson ratio describe the steel cords with modulus of elasticity of 210 GPa and Poisson ratio of 0.3. For the definition of the elastomeric matrix, the Mooney-Rivlin two-parametric hyperelastic material model is used with parameters 0.55 MPa and 0.11 MPa. The computational model consists of approximately 11,000 elements. Summary reaction forces on the *z*-axis are searched. The computational model with cords is shown in Fig. 1. The computational model is reverse loaded by a displacement of 12.5 mm.

The results are obtained from the experiment: force at break of 595.2 N for deformation of 12.5 mm, true strength of 56 MPa, strength of 40.5 MPa (based on engineering approach), ductility (value of the true strain in working area when the test specimen breaks) of 12.2 %, contraction of 27.6 %, Poisson ratio of 2.2, and tensile modulus of elasticity of 460.8 MPa (based on true stress). The width of the specimen at break was 10.1 mm.



a)



b)

Figure 1 – Two-layer computational model (a) and steel cords inside model (b)

The displacement of the matrix and steel cords from the simulation are shown in Figs. 2 and 3.

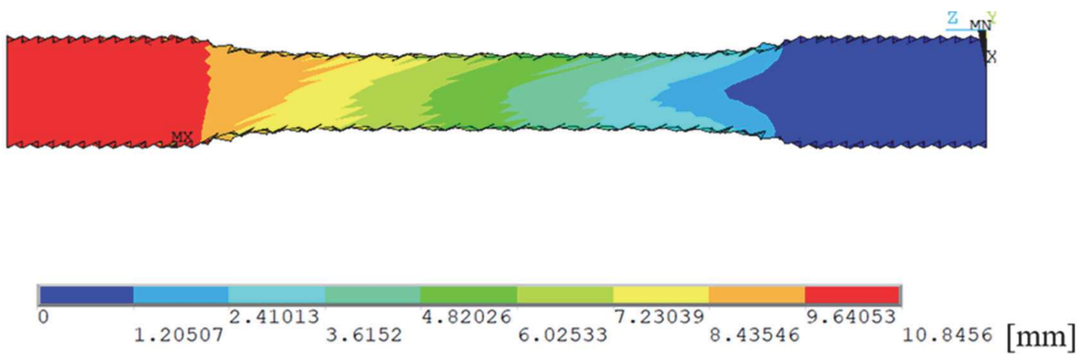


Figure 2 – Summary of the displacement of matrix

The results of computational simulations are verified with experimental data. The reaction tensile force based on simulation is 519.6 N for the deformation of 12.5 mm, see Fig. 4. The tensile force - true longitudinal strain / transverse strain dependences are shown in Fig. 5. The difference in tensile force at the same longitudinal deformation between the simulation and the experiment reached a difference of 9.2 %. The difference in tensile force at the same true longitudinal strain between the simulation and the experiment reached a difference of 12.7 %.

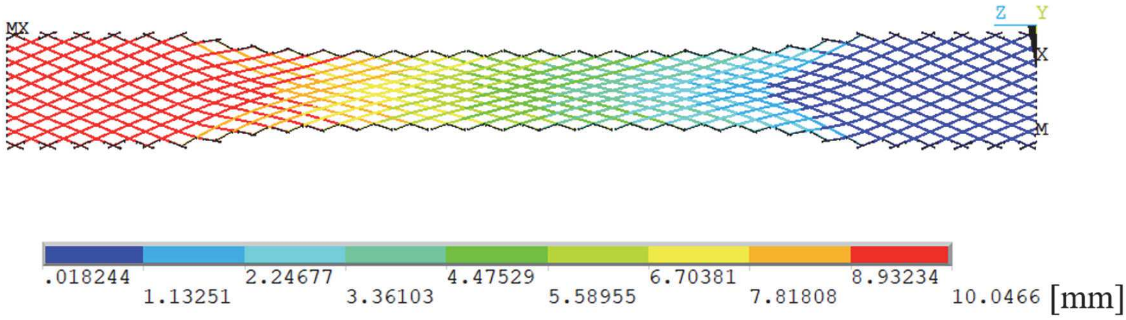


Figure 3 – Summary of the displacement of steel cords

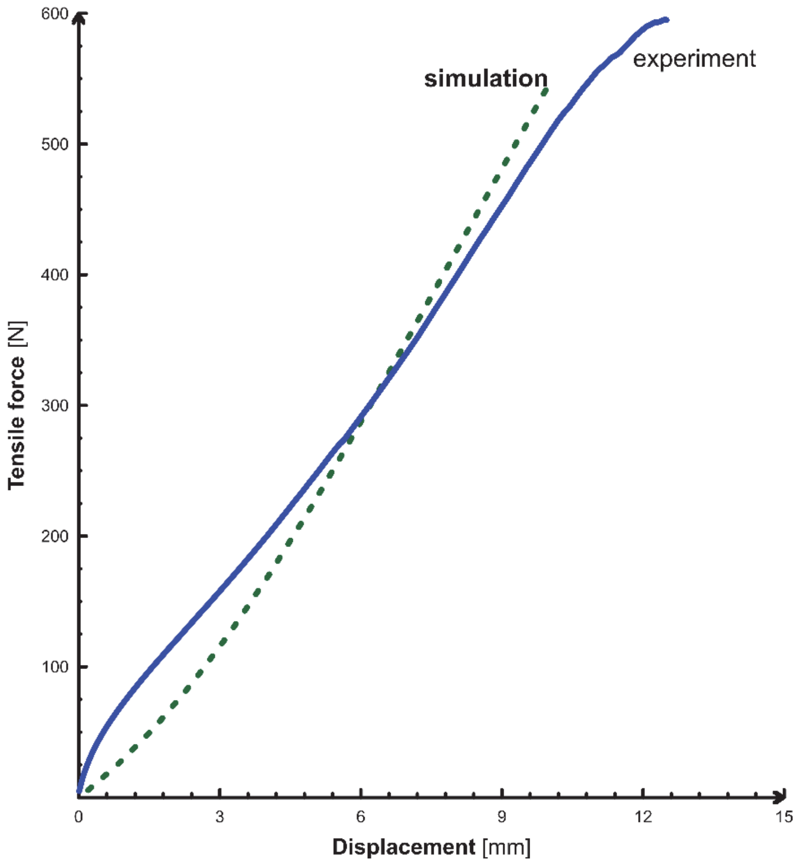


Figure 4 – Tensile force - displacement between jaws of tensile machine dependencies

Other results from computational simulations and experiments of composites are continuously published on the website www.laborator.sk.

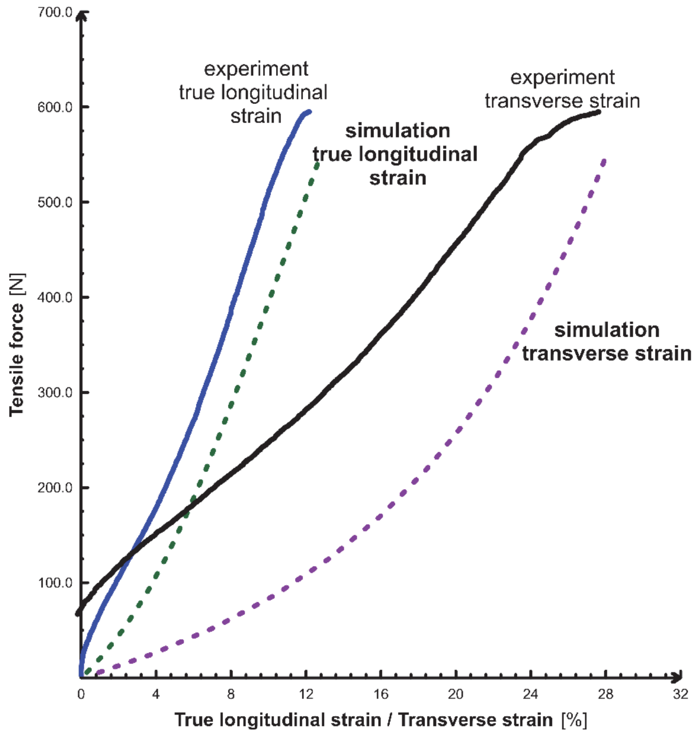


Figure 5 – Tensile force - true longitudinal strain / transverse strain dependencies

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