Structural Mechanics for Real Geometry of Basalt Woven Composites

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Abstract

In this paper, woven composites with basalt reinforcement plain 1x1 are examined to define their structural mechanics. Woven composites were created by the prepreg technology, 8 layers of plain-weave basalt fabrics were saturated by the precursor, polysiloxane matrix Lukosil®, and joint pressed during temperatures of 200°C and 600°C. The yarns are identical in the warp and weft directions and they consist of 8000 fibres assembled without twisting. Voids complete the entire structure. Therefore, the main components of the internal structure consist of longitudinal yarns, cross-section yarns and voids.

Defining the structural mechanics originates from geometrical parameters. These were obtained from microphotographs of cross sections of the real internal structure. The microphotographs were scanned by the method of composed images, taken by the metallurgical microscope Nikon Eclipse ME 600 D, which was connected to CCD camera DS-5M. These were further processed to binary images using the tools of image processing toolbox in MATLAB®. Elementary woven cell was defined from binary images using flim2curve and contour functions of COMSOL Multiphysics®. This is a very complicated and time consuming process, during which it is necessary to pay attention to the accuracy of the transfer of the bitmap image to the vector structure. It is also necessary to define the individual points, graphs and subdomain, see Fig. 1. However, it is worth the effort, because the method of experimental observation, based on the geometrical approach, seems to have more advantages, and to be more realistic than other methods. It is possible to define the textile geometry of meso-mechanical models, see Fig. 2.

The conclusion is that the observation of real composite structure is not easy, but it is a very important point of view. Reorganization of the yarns and fabrics during composite manufacturing seems to be a very important phenomenon for mechanical behaviour. All this information can be used for more specification of meso-mechanical and micromechanical models and for proposing of optimization algorithm.

Acknowledgement
The author acknowledges the support provided by the Czech Science Foundation No. P105/11/0224

Reference

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ISSN: 0196-6219

Figures used in the abstract

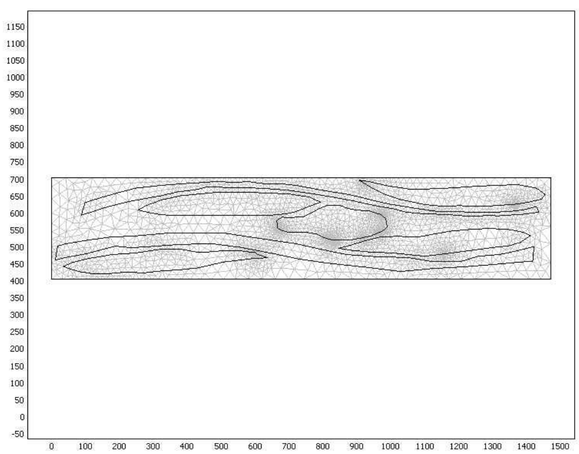

Figure 1: Basic unit cell – matrix, longitudinal yarns, cross yarns, voids

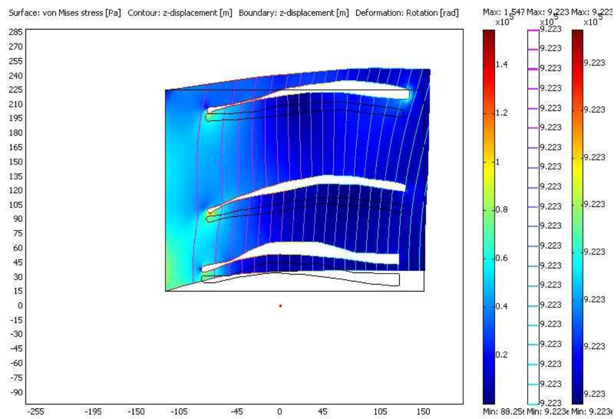

Figure 2: Von Mises stress – basic unit cell, longitudinal yarns