SHAPING THE BENDING STIFFNESS OF DISTANCE KNITTED FABRICS THROUGH AUXETIC CUTS USING LASER PLOTTER

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ABSTRACT

Warp knitted distance fabrics are spatial structures with a thickness of several to dozens millimeters. Their properties, such as: high air permeability enabling passive ventilation of the product, moisture transport ability, or high elastic recovery after removing compressive forces cause that these structures find new application areas, thus replacing commonly used foamed materials.

Difficulty of using spacer fabrics in 3D constructions with a curved surface is caused by their drapability. An example of such a construction with a spherical surface may be shock absorbing elements used in protectors, helmets, etc.. The impact barrier elements have a large radius of curvature and are usually made of plastic, in a layered or foamed form. The authors of the paper decided to replace these materials with 3D fabrics. In order to improve the multi-directional deformation of these knitted fabrics, the authors were inspired by auxetic materials. The spatial architecture of these materials was used to design geometrical systems along which cuts were made on distance knitted fabrics using a laser plotter. These cuts significantly increase the rate matching knitted materials into curved planes by reducing surface bending stresses without changing the compression stiffness.

In the first stage of the research, the parameters of the laser plotter cutting process of distance warp knitted fabrics, made of synthetic yarns, were optimized. Then, for selected structures of distance knitted fabrics, directions of auxetic cuts on the surface as well as through the entire thickness of the spatial textile material were modeled. For the obtained variants, the bending stiffness was determined and the impact of the cutting process on the change in multidirectional drapability of the analyzed materials was described.

As a result of the research, optimal parameters of the knitted structure were determined and it was found that the parameter of spatial drapability of 3D knitted fabrics on spherical surfaces depends among other things on: the shape and curvature radius of the impact damping element on which the knitted fabrics are placed; the structural parameters of the knitted fabric, including its thickness; as well as on the geometry of the cuts made using a laser plotter.