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Modelling specimens testing for 3D fiber composites tensile strength characterization

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The subject to present research is composites with spatial 3-dimensional reinforcing fiber frame (3d). Today, 3d-compositesare used in various areas of engineering and in medicine. In these composites are used both orthogonal Cartesian and cylindrical reinforcing systems. Experimental mesuring of mechanical properties of composite materials is still difficult task. The main reason is that stress state of the specimen in working area is highly inhomogeneous. Besides, the machine cutting of the specimen from the bulk material breaks the integrity of the reinforcing fiber frame. So the fibers can decrease their loading capacity significantly, and defects of specimen structure can appear. All these factors have results that mechanical properties measured on specimens are understated.

This paper presents computer models of the specimens of 3d material, which takes into account the structural features of the material. These models consider material consisted of frame of reinforcing rods embedded into matrix. The number of rods of every direction has to be equal to the number of yarns of appropriate direction. Reinforcing rods, as well, consist of fiber and matrix. The properties of the rods can be determined upon fiber and matrix properties on the basis of structural phenomenological models of lower level.

The developed models take into account in explicit way geometrical features of the frame, curvature and possible defects of fibers in working area of the specimen. Far off working area the composite behavior is described with the model of homogeneous anisotropic body with effective properties. Such model allows to describe more accurately the contact of the specimen with loading device.

On the basis of the developed models we made calculations of stress-strain state of several specimens which used for 3d composites mechanical properties evaluation. An analysis of the influences of structural features of the specimens, loading devices and loading conditions such as misalignment of applied load and specimen axis, friction in loading devices and so on, on homogeneity of stress-strain state. The influence of the deviation of the frame parameters, defects and structure damages on the composite properties is evaluated.

It is shown that mathematical modeling allows to interpret correctly the results of material specimens testing and to determine the "true" mechanical properties of the 3d composites.

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