11th International Conference
on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Stability Loss in Nanotube Reinforced Composites

A.N.Guz (1), V.A.Dekret (1)*

(1) S. P. Timoshenko Institute of Mechanics, National Academy of Sciences of Ukraine, Kyiv, Ukraine, Nesterov str., 3, 03057, Kiev, Ukraine, Tel: (38044) 4569351, E-mail: dekret@ukr.net
* Corresponding author.

Abstract – The two models in the three-dimensional theory of stability of the nanotube reinforced composite materials are discussed. The model of "infinite fibers" and the model of "short fibers" are considered. The primary objective is attended to "short fibers" model. All results were obtained in the framework of the three-dimensional linearized theory of stability of deformable bodies.

The one of the main failure mechanisms under compression of unidirectional fibrous composites, including nanotube reinforced composite materials, is loss of stability in the structure of filler material. Approaches to building a theory of nanocomposites and a number of new series of results in the mechanics of nanocomposites are presented in publication [1]. The overwhelming number of results in this direction obtained in the model of infinite fibers, when analyzed periodic (along the fiber length) form of stability loss, the results presented in numerous publications in periodicals and in some generalizing publications. With further research, the results are presented in [2], it was found that for relatively short fiber critical strain values obtained using a model of infinite fibers, significantly different from results obtained using model of short fibers, when the matrix is considered to be endless, and the filler modeled as cylindrical fiber of finite size (Fig.1a).

In this paper we will restrict the study of stability of composite materials weakly reinforced by nanotubes in a plane strain. Composite material is modeled as piecewise-homogeneous medium when the material in the component composites is considered uniform and performed the contact conditions at the edge of components. The components of composite are considered as linearly elastic and isotropic. Thus, in plane x_1Ox_2, using model of short fibers with conditions of plane deformation under unidirectional compression along the ax Ox_1, we get the situation presented in Fig.1b. Let us the stability analysis is performed using a static method linearized three-dimensional theory of stability, when the initial state is determined from the equations of linear elasticity [1]. The stability problem is formulated with application of the three-dimensional linearized theory of stability of deformable bodies and the model of piecewise-homogeneous medium, such approach is most strict and physically correct.

The results of research allow us to conclude that under compression directed along the nanotube may result the failure of the composite due to stability loss of its structure. The results of study with the model of short fibers and the model of infinite fibers are consistent, because results for the model of short fibers asymptotically tend to the results of the model of infinite fibers with the increase of the length of fiber (Fig.2). However, the values of critical strain obtained in the framework of the model of short fibers with the values of geometrical parameters $LD^{-1} < 2000$ are differed significantly.

Therefore, when studying the stability of composite materials reinforced with nanotubes, which are the geometrical parameters in these ranges, the involvement of model of short fibers is preferred.

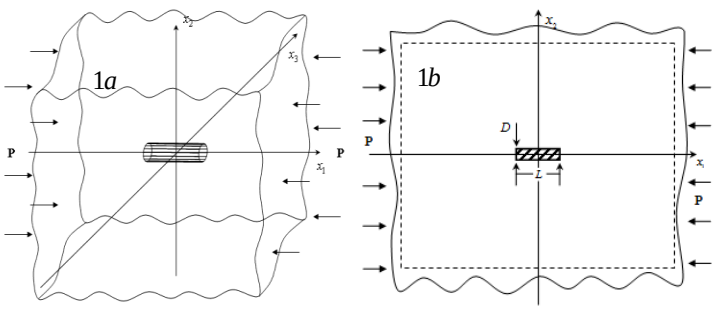

Figure 1: Short fibers model of nanocomposite, **a)** 3D-model **b)** Plane model.

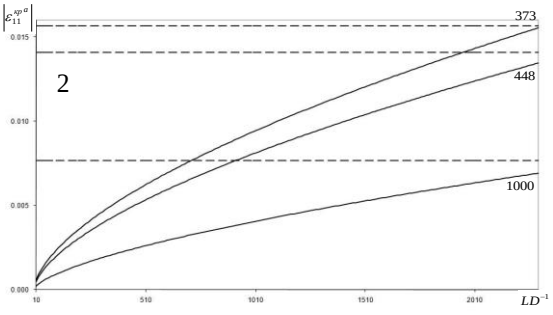

Figure 2: Dependence of the value of critical strain for a fiber on the geometrical parameters of fibers.

References

[1] Guz A.N. (2006): Three-dimensional theory of stability of a carbon nanotube in a matrix. International Applied Mechanics, Vol.42, No.1, pp.19-31.
[2] Guz A.N., Dekret V.A. (2008): On Two Models in the Three-Dimensional Theory of Stability of Composite Materials. International Applied Mechanics, Vol.44, No.8, pp.839-854.