Summary of doctoral thesis

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Dynamic analysis of rectangular plates with dense system of the ribs in two directions

The main subject of the thesis are thin rectangular plates with microstructural building. The fundamental feature of the considered plates is presence of two homogenous materials. One of them represents repeatable system of beams in two directions and another fills the plate. In the thesis, the beams are denoted as ribs and the latter material as matrix. This work focuses on microheterogeneous materials in which the microstructure is periodic or slowly varying in the midplane. Considered models are characterized by a certain element which is called a cell. In case of repeatable structure of the cell, we deal with periodic structure. A cell has a specific size which is sufficiently small comparing to the minimum length of the plate and, what is a fundamental feature, is comparable with the thickness of the plate. In the model, in which the width of the ribs varies slightly in comparison to the neighboring ribs, we deal with the change of microstructure that takes place on the micro level. Those kind of materials are denoted as functionally graded materials, FGM.

In the thesis the dynamics of the periodic and FGM plate, that were subjected to the normal forces acting in the midplane of the plate as well as without initial load, was analyzed. Kirchhoff theory of the thin plates is a basis to derive equations for the above mentioned micro-heterogeneous bodies. Considering homogenous bodies, this theory is described by the equations containing constant coefficients. However, in case of micro-heterogeneous bodies, those equations have highly oscillating and discontinuous coefficients and are too complicated to be used in the engineering analysis and numerical calculations. Hence, there is need for using models which are characterized by two main properties. Firstly, coefficients in the above equations should be smooth or constant in order to solve them by well known methods of calculations. Moreover, the solution obtained from those equations should resemble the behavior of considered bodies on the micro level.

The aim of this paper is to propose and apply averaged mathematical model that describes dynamic behavior of the thin micro-heterogeneous plates. Mathematical models presented in the paper are obtained by using tolerance averaging technique. The fundamental definitions and assumptions of that method are described in the second Section.

In the third Section, equations that describe dynamic behavior of thin plates with dense system of the ribs in two directions are derived using tolerance averaging approach. Using above equations, natural frequencies of defined plates were investigated. In the first approach, periodic thin plates were analyzed. In the second part of the section, thin FGM plates were examined. In order to

validate the accuracy of obtained averaged model, natural frequencies received from finite element method (Abaqus program) and averaged mathematical model were compared.

In the fourth section, the dynamics of thin rectangular plate subjected to normal forces acting in the midplane was analyzed in the analogous way to calculations presented in the previous section. The last part of the thesis presents the conclusions and the literature.