
ASYMPTOTICALLY CONFIRMED HYPOTHESES METHOD FOR THE CONSTRUCTION OF MICROPOLAR AND CLASSICAL THEORIES OF ELASTIC THIN SHELLS

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Introduction. Current methods of reducing three-dimensional problem of theory of elasticity to two-dimensional problem of theory of plates and shells are the followings: a) hypotheses method, b) method of expansion by thickness, c) asymptotic method [1, 2]. Review of researches in direction of theories of micropolar elastic thin plates and shells is done in papers [3, 4].

The main problem of the general theory of micropolar and classical elastic thin plates and shells is in approximate, but adequate reduction of three-dimensional boundary-value problem of the theory of micropolar elasticity to two-dimensional problem. From our point of view, for achievement of this aim [5–8] during the construction of applied general theory of micropolar or classical plates and shells main results of the asymptotic solution of boundary-value or initial boundary-value problem of three-dimensional micropolar theory of elasticity in thin domain of the shell or
plate can be used used, which are formulated as hypotheses [9,10]. Micropolar and classical theories of plates and shells, constructed on the basis of such approach, are asymptotically correct theories. This problem is also essential in classical theory of elasticity during the construction of mathematical models of thin plates and shells with the account of transverse shear deformations: in paper [11] it is shown, that one of the main theories of plates and shells of Timoshenko’s type, where transverse shear deformations are taken into account, is not asymptotically consistent.

**Problem statement.** It is assumed that in the frame of micropolar or classical theory of elasticity problem of studying stress state of thin shell can be introduced as three-dimensional boundary-value problem

\[
M(\Phi) = 0, M^f(\Phi) = M_0^f, M^b(\Phi) = M_0^b,
\]

where written equations symbolize three-dimensional system of equations for micropolar or classical theory of elasticity and, analogically, conditions on surfaces of the shell; \( \Phi \) is the complex of unknown quantities of micropolar or classical theory of elasticity.

As boundary-value problem (1) is singularly perturbed with small geometric parameter \( \delta = h/R \) in shell’s three-dimensional domain ( \( h \) is the half of the thickness of the shell, \( R \) is characteristic radius of curvature of the shell middle surface), applying corresponding asymptotic method, internal iteration process and boundary-layer will be constructed and problem of their jointing will be studied. On the basis of initial approximation of internal iteration process, problem of the construction of general applied theory of micropolar or classical theories of shells can be formulated. The mentioned problem can be formulated in the following way: to determine qualitative aspects of the asymptotic solution of boundary-value problem (1) and mathematically formulate them as hypotheses. On the basis of such hypotheses, general applied theory of micropolar or classical elastic thin shells is constructed:

\[
L(\Psi) = L_0(\Psi), L^b(\Psi) = L_0^b(\Psi),
\]

where the first equation symbolizes two-dimensional system of equations of micropolar or classical theory of elastic thin shells; the second one-boundary conditions; \( \Psi \) is complex of unknown two-dimensional quantities of corresponding theory.

It is obvious that micropolar or classical theory of elastic thin shells, constructed in such way, will be asymptotically consistent theory [5–8, 12].

As the consideration of shear deformations is important in micropolar theory, the developed asymptotic method and formulated hypotheses reduce to refined theory of elastic thin shells in classical case (with the account of transverse shear deformations) [12].

**References**

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THE APPLICATION OF SHELL MODEL TO BIOLOGICAL MEMBRANES

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Introduction. Cells are the basic unit of life. Our bodies are composed of many cells that are specialized for different functions; for example nerve cells for the neural system, sensory cells for senses such as vision and hearing, and muscle cells for force production. One of the most basic constituents of the cell is the plasma membrane, which separates the interior of the cell from its outside environment. It is composed of a lipid bilayer, into which proteins and other molecules are embedded. The membrane is a viscoelastic or fluid-like structure that allows the membrane to move and change the shape of the cell. The cytoskeleton, which maintains cell shape and organizes its movement, is usually found just beneath the plasma membrane. Actin filaments are one of the components of the cytoskeleton [1].

Cell movement / migration / motility plays a key role in our bodies. Cell movements have an important role in the function of outer hair cells (OHCs) in the inner ear. In the following section, we explain OHC motility based on the conformational change of the motor protein prestin. In addition, we discuss modeling and analysis of their deformation and movements.

OHC motility. OHCs are one of the two types of sensory cells found in the inner ear and they show voltage-dependent length changes, which underlie the am-