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MATHEMATICAL MODEL OF ELASTIC CLOSED FLEXIBLE SHELLS WITH NONLOCAL SHAPE DEVIATIONS

VIKTOR OLEVSKYI AND YULIIA OLEVSKA

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Abstract. A model of deformation and mechanical stability of a thin-walled shell with geometric deviations, which is close to a circular cylindrical shell, under the action of axial compression and normal pressure is developed. The model uses the scheme of a flexible shell of zero Gaussian curvature with a perturbed edge, which makes it possible to apply the methods of the geometrically nonlinear theory of torso shells.

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1. Introduction

It is well known that thin-walled shells are very sensitive to the presence of local initial geometrical deviations of the middle surface and ends [24]. The presence of even small deviations within the limits of the wall thickness of cylindrical shells leads to a significant decrease in the carrying capacity of the shell by a factor of 2–3, especially when axial compression is applied.

At the same time, multifactor experimental studies show that nonlocal deviations such as ovality and taper are also significant [11, 21]. Moreover, holographic interferometry of shells with both ovality and conicity (Fig.1) shows surprising proximity of their radial displacements field to the displacements of cylindrical shells with deviation in the form of two waves along the edge. This similarity requires an explanation.

Shells with nonlocal deviations, which are made of sheet material by joining it without stretching the middle surface, are shells with an unfolding principal surface, or, equivalently, with zero Gaussian curvature. The essential complexity of describing the behavior of such shells arises already at the stage of describing the geometry of their principal surface. If the ovality of the opposite ends is not the same, then the principal surface differs from the cylinder and cone. In this case, there is no single point of intersection of the generators and the axis of the shell,