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Refined Models of Contact Interaction of a Thin Plate with Positioned on Both Sides Deformable Foundations

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Abstract—We consider a rectangular plate connected along the outer contour with an absolutely rigid and fixed support through a low tough elastic support elements included in the class of transversely soft foundations. It is assumed that the contact interaction of plate at its points of faces of the connection to the support elements there is no relative slip and separation, and the opposite boundary surfaces of the support elements are fixed. Deformation of plate's mid-surface is described by geometrically nonlinear relationships of the classical plate theory based on the hypothesis of the Kirchhoff–Love (the first option), and refined Timoshenko model taking into account the transverse shear compression (second version). The mechanics of support elements is described by the linearized equations of three-dimensional theory of elasticity, which have been simplified in the framework of transversely soft layer model. By integrating the latter equations along the transverse coordinate and satisfying to the conditions of the kinematic coupling of plate to the support elements at their initial compression in the thickness direction, two-dimensional geometrical nonlinear equations and their corresponding boundary conditions have been introduced, which describe the contact interaction of elements of the concerned deformable system. Simplification of derived relationships for the case when foundations have a symmetrical layer structure is carried out.

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INTRODUCTION

At manufacturing of structures or that their purpose if necessary tightness is ensured by using special types of connection elements via adhesive layers, buffer layers of polymeric materials such as mylar, rubber, sealant, etc. In such designs products of constructional optics elements (illuminators, radomes, aircraft glass lamps, etc.) constitute a separate group due to both the characteristics of their functional purpose, and physical and mechanical properties of the materials from which they are made. In particular, most of them are used for the manufacture of structural materials (organic, silicate and quartz glass) are very sensitive to contact stress [1–3], etc., which leads to the need to develop special components for their connection to other structural elements. Presented in Fig. 1, a typical compound of the structural element in the form of plate number 1 with the element of the power set of number 2

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