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Stresses in an elastic plate lying over a base due to strip-loading

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Abstract. The closed-form analytic expressions for the stresses at any point of an elastic plate coupling in different ways to a base as a result of a two-dimensional shear strip-loading are obtained. The contact between the horizontal layer and the base is either smooth-rigid or rough-rigid or welded. The variations of the shear stresses with the horizontal distance have been studied numerically. It is found that the effect of different boundary conditions on the stress field is significant and the stresses for an elastic layer lying over an elastic half-space differ considerably from those of an entire homogeneous elastic half-space.

Keywords. Elastic plate; rigid base; smooth base; shear stresses; shear surface loads.

1. Introduction

The solution of the problem of the deformation of a horizontally layered elastic material under the action of surface loads is finding wide applications in engineering, geophysics and soil mechanics. The deformation of a multilayered elastic half-space due to two-dimensional and three-dimensional surface loadings has been studied by many researchers, (Kuo [6], Singh [9], Pan [7], Chaudhuri and Bhowal [1], Garg and Sharma [2, 3] and others). Recently, Garg and Sharma [4] discussed the deformation of an elastic layer coupling in different ways to a base due to a very long vertical strike-slip fault situated in the layer.

In the present paper, the closed-form expressions for the stresses in an horizontal plate of infinite lateral extent lying over a base due to strip-loading are obtained. In geophysics, the elastic plate represents the crust of the earth. The interface between the plate and the base may be either welded or rigid. The rigid interface is either smooth-rigid or rough-rigid. The deformation of the plate corresponding to each type of the interface is obtained. The deformation of an homogeneous entire half-space due to strip-loading can be obtained from our results as a particular case. Similarly, the deformation of an elastic layer lying over an elastic half-space can be recovered from our results. Finally, the variation of stresses is studied numerically.

2. Basic equations

Let (x, y, z) be the cartesian coordinate system with z-axis vertical. Let (u, v, w) be the displacement components. We consider the antiplane strain problem in which