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Z. K. Kuralbayev

Almaty University of Power Engineering and Telecommunication, Almaty, Kazakhstan
zaufan@mail.ru

SOLUTION OF THE PROBLEM OF LOWERING OF MATERIALS OF VISCOUS LAYER DOWN THE HILLSLOPE

Abstract. The article deals with the problem of a modeling investigation of the mechanism of the landslides origin of sedimentary rocks. It is assumed that a viscous layer of rock, located on the surface of a stable elevation, with a decrease in the coefficient of viscosity, material flows down the slope under the influence of gravity. To study this process, a mathematical model method was used, as a result of which a mathematical model of the given process was obtained and a mathematical problem on the solution of a quasilinear equation of parabolic type was formulated. To solve the mathematical problem, a finite-difference method was used; a nonlinear implicit calculation scheme was chosen on the basis of which an algorithm for solving the problem was formulated and a computer program was developed. A numerical experiment was performed for various possible variants; the results are presented in the form of graphs and tables.

Keywords: sedimentary rocks, rheological properties, creep, mechanism of landslides origin, mathematical model, solution algorithm, numerical experiment.

The setting of the problem. One of the causes of catastrophic phenomena occurring in foothill areas or on hillslopes of elevations is the lowering of ground materials down their slope. As a rule, with the preservation of certain conditions, a stable position of ground materials remains. However, under the influence of natural phenomena, for example, prolonged heavy rains that lead to a change in the viscosity properties of the materials composing the upper layers of the ground, creep motions may occur under the influence of gravity. Research in this direction is relevant since the study of the mechanism of origin of one of such phenomena frequently occurring on the Earth is considered important for the prevention of catastrophes associated with them [1,2].

It is known [3,4,5] that sedimentary rocks, which cover more than 75% of the surface of the terrestrial land, have the property of creep. "Creep is a phenomenon of gradual growth of strain in time with constant stress and a decrease in strength under long-term loading" [5, p. 36]. Therefore, creep is the cause of such phenomena as landslides, mudflows, glacier flow and others.

The proposed article is devoted to a model investigation of one version of the mechanism of landslides origin when the ground lowering occurs under the influence of its own weight with a change in their rheological properties. In this case, a physical model of "creeping" flows in the viscous layer is used [3,4,7,8], and for the study of the process under consideration - the mathematical model method [6].

Mathematical model and setting of the mathematical problem. Let us consider a certain viscous layer of a certain thickness (power) lying on the surface of a stable hill. It is assumed that at the initial time the viscous layer is in a stable position, i.e. there is no movement in it. Then, because of the decrease in the coefficient of viscosity of the layer, it moves down the hillslope under the influence of its own weight. It is required to compile a mathematical model of this problem and set its mathematical formulation.

To solve the problem, it is necessary to introduce the notations for the main parameters describing the process under consideration.

Let it be assumed that there is a rectangular coordinate system, in which x and y - horizontal coordinates, and z – vertical coordinate; z axis is directed upwards, backwards to the direction of the gravitational vector $\vec{g}$ (Figure 1).