Nonlinear dynamic deformation of a rod in the presence of nonstationary extreme external action

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Abstract

In this paper, we study a nonlinear model that describes the longitudinal deformation of an elastic rod with a power-law nonlinearity in the presence of non-stationary extreme external action that is very strong at the initial time. For this model, all invariant submodels given by invariant solutions of the equation of this model are obtained. These submodels have not been previously noted in the literature. Invariant solutions of equation which describes this model are found either in explicit form, or their search is reduced to solving systems of differential equations of the first order. For the submodels given by the explicitly found solutions, we found out whether or not the destruction of the rod over time will occur within this submodel. For specific parameter values included in these solutions the distribution longitudinal displacement in the rod are shown in the graphs. In some cases, it was possible to find the place and time of the destruction of the rod. For other submodels, we study physically meaningful boundary value problems that describe non-linear longitudinal deformations of an elastic rod, for which at the initial moment of time at a fixed point either a longitudinal displacement and its gradient, or a longitudinal displacement and a rate of its change are given. The existence and uniqueness of solutions to these boundary value problems are established. under some additional conditions. This allows us to solve these problems numerically correctly.Boundary value problems for some specific values of the parameters included in them are solved numerically. The results of solving these boundary value problems are shown in the graphs.

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