Simulation of Movement of Drill Rods at Large Deformations

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Abstract. The purpose of the paper is modeling of nonlinear vibrations and stability of movement of boring columns at finite deformations. Movement of boring columns for shallow drilling (up to 500 m) applied in oil-gas extractive industry is considered.

Nonlinear models of movement of acompressed-torsioned drill rod within the nonlinear theory of finite deformations of V.V. Novozhilov are constructed. A method for its analysis and criterion of dynamic stability are offered. The numerical analysis of its elastic dislocations and instability zones of the basic resonance is carried out, which confirm the efficiency of the offered nonlinear dynamic model of rod elements and techniques for their calculation.

Introduction

The paper is dedicated to applied problems of dynamic stability of frameworks. We consider stability of movement of drill rods, which are used in petroleum industry. We know from drilling practice that up to 30 % of boreholes are rejected. Major factors for a borehole rejection are its curvature and drill rods breakage. Curvature intensity is determined by the action of many factors, which can be divided into three groups: geological, technological and technical.

Some researchers believe that geological conditions of rock bedding and distinction in their hardness and drilling area principal cause of borehole curvature.

Under another concept, a principal cause of borehole curvature is instability of the rod rectilinear form. This can be caused by various factors, such as dynamic cross influences; large inertial forces that arise at drilling; initial curvature of the rod; stress concentrators and other factors. Absence of a uniform model for a drill rod movement, which would describe a borehole curvature in view of all factors, draws attention of many researchers to the present problem.

The basic purpose of the present paper is simulation of stability of drill rods movement at various complicating factors, in view of finite strains in particular. They can arise under the action of large variable axial forces and twisting moments.

Stable movement of a drill rod will be understood as its movement in the absence of movement resonant modes, which are most dangerous for normal work of the drilling rig.

The solution for the present problem assumes definition of an optimum operating mode of a drill rod with maintenance of trouble-free operation of boring machines.

In connection with an object in view the following problems are solved in the paper:

1) Development of a nonlinear model of a drill rod movement in view of finite deformations.

2) Development of a technique for definition of instability zones of resonant vibrations of a drill rod with Floquet theory application.

3) Development of a design procedure for instability of resonant vibrations of a drill rod with a method of partial discretization.

4) The numerical analysis of stability of drill rod movement with the specified techniques application.

Nonlinear Model of Movement of a Drill Rod for Shallow Drilling

Movement of a drill rod for shallow drilling (up to 500 m), which is used in oil and gas industry (Fig. 1), is considered.