INTERNATIONAL SUMMER SCHOOL CONFERENCE ADVANCED PROBLEMS IN MECHANICS

APM ONLINE 2020

ABSTRACTS

St. Petersburg 2020

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Institute of Problems in Mechanicle Engineering

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costly computational fluid dynamics (CFD) models based on solving Navier-Stokes equations for two-phase flow [3,4]. The use of these models has been mainly restricted to qualitative studies of droplet detachment in gas channels (GC), while simulating water transport in gas diffusion layer (GDL) was practically unfeasible. The goal of the present work is to address the WM issue in both GDL and GC developing a robust and efficient CFD solver to model microscopic two-phase flow in a complex media.

The present work builds on the level-set method [5] for representing the interface in the two-phase system. Surface tension is computed in the present work only at the interface alleviating the need for a high resolution mesh in the vicinity, faced in the commonly used “continuum force approaches”[6]. In order to effectively resolve spurious oscillating currents issue, in this work additionally to performing the re-initialization of the distance function, special enriched shape functions are introduced in a manner that the jump in the pressure and discontinuity of its gradient at the interface can be efficiently handled. Solid-liquid contact is included by implementing the forces acting at the contact line. A Navier-type slip boundary condition is applied to avoid a contact line force singularity [7]. The overall model is stablized within the framework of algebraic sub-grid scale (ASGS) approach.

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MODELING OF DYNAMICS OF A DRILL STRING WITH VARIABLE STRUCTURE BY THE LUMPED PARAMETERS METHOD

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Modeling of dynamic systems evolving over time, in particular the motion of drill strings applied in the oil and gas extraction industry, can be complicated by various factors such as the effect of local and pointwise loads, variable material structure, the use of constructive elements (dampers, stabilizers) in the system, which allow obtaining more accurate and realistic results. Moreover, taking into account the mentioned factors results in the need for search and application of the methods most convenient and effective for solving such problems.

The purpose of this work is modeling of the drill string dynamics with the application of the lumped parameters method. This approach has been successfully used to study dynamics of elastic planar linked bar mechanisms [1] and allows accounting for variable structure of the object.

In the framework of the study, the model of longitudinal vibrations of the horizontal drill string subjected to static compressive loading is considered. In contrast to T.G. Ritto's work [2], where the finite element method was applied, here the model is discretized by the lumped parameters method. According to this method, the drill string represented as an elastic rod is divided into the finite number of spans, and the equation of motion is replaced by the system of second-order ordinary differential equations. The numerical solution of the system is found by the fourth order Runge-Kutta method using C++ programming language. The results are then visualized in the Tecplot graphical environment and verified with previously published data [2, 3].

The conducted research confirms the effectiveness of application of the lumped parameters method for studying the dynamics of drill strings with variable structure. At the next stage of the work, lateral vibrations of a vertical drill string with the use of the lumped parameter method will be investigated.

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DETERMINATION OF DAMAGE PARAMETER OF METALLIC MATERIALS FROM EXPERIMENTAL CREEP CURVES

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The problem of creep and long-term strength of metallic materials and alloys is considered. Under the long action of relatively small stresses and high temperatures many metallic materials lose plasticity and fractured as brittle with a small value of residual deformation. This problem is known as the problem of thermal brittleness of metals. Because these effects are observed in elements of many important engineering objects, in particular, in power and nuclear, the problem of brittle fractures became a subject of numerous theoretical and experimental researches. The damage conception was introduced in the mechanics of materials to solve this problem. A system of simple kinetic equations for the damage parameter and creep deformation was proposed to describe the brittle region of the experimental long-term strength curve, and a long-term strength criterion was formulated. To solve this problem a system of kinetic equations for the damage parameter and creep deformation was considered in the works of L.M. Kachanov [1], Yu.N. Rabotnov [2] and R.A. Arutyunyan [3]. In this work we propose to determine the damage parameter changes according to the experimental high-temperature creep curves. Only one kinetic equation for creep rate for compressible medium recorded using the damage parameter is formulated. The damage parameter is determined from this kinetic equation and depends from the creep rate and creep deformation. Similarly, the value of the damage parameter is determined according to the Rabotnov solution. To describe the experimental creep curves various empirical dependencies in the form of power, exponential and mixed functions are used. The long-term strength criterion was obtained under the condition, when damage parameter is reached the critical value. It was shown, that for the compressible medium the damage accumulation and, accordingly, the fracture processes are passed more intensive, compared with Rabotnov solution.

Financial support of the Russian Foundation for Basic Research is gratefully acknowledged (Grant N 18-01-00146).

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STABILITY OF THE MICROPOLAR THIN ROUND PLATE

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In this paper the micropolar thin round plate of isotropic micropolar elastic material is considered. Applied two-dimensional geometrically nonlinear model of micropolar elastic thin plates in curvilinear coordinates is constructed. The micropolar thin plates are considered in which the elastic deflections are comparable with their thickness, at the same time are small in relation to the basic size, also both the angles of rotation of the normal elements to the middle plane before deformation and their free rotations are small. Thus, in the strain tensor and tensor of bending-torsion takes into account not only linear but also the nonlinear terms in the gradients of displacement and rotation.

Then the basic equations in polar coordinates for round plates are obtained. Supposed that the plate is loaded with uniformly distributed forces applied on the contour of the middle surface of the plate. First, the solution of the system of linear equations of the plane stress state of micropolar elastic round plate was obtained in case of the specified external influence. Further, to this initial stress state the small perturbation is given. After linearization, the obtained nonlinear problem is reduced to the homogeneous system of equations of the stability problem with homogeneous boundary conditions. After the solving of the obtained boundary value problem, the critical value of the external force is determined. The critical force of the micropolar problem is compared with the value of the classical solution. The important properties of micropolar material are established.

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