Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **28 (2021)** 197-213

ASYMPTOTIC ANALYSIS OF A DYNAMIC FLOW OF THE BINGHAM FLUID

Abdelkader Saadallah[1,*] and Hamid Benseridi[1]

[1]Applied Math Lab, Department of Mathematics, Faculty of Sciences, University of Ferhat Abbas-Sétif 1, SETIF, 19000, Algeria

Abstract. The aim of this paper is to study the asymptotic behavior of an incompressible Bingham fluid in a dynamic regime occupying a bounded domain of $\mathbb{R}^3$ with nonlinear friction of Tresca type. Firstly, the existence and uniqueness of weak solution is proved. Then we show the estimates for the velocity field and the pressure independently of the parameter ε. Finally, we give a specific Reynolds equation associated with variational inequalities and prove the uniqueness. The proof uses the asymptotic behavior when the dimension of the domain tends to zero.

Keywords. A priori inequalities; Asymptotic approach; Bingham fluid; Reynolds equation; Tresca law; Weak solution.

AMS (MOS) subject classification: 35R35, 76F10, 78M35.

1 Introduction

In this work we analyses the asymptotic behavior of an incompressible Bingham fluid in a dynamic regime occupying a bounded homogeneous domain $\Omega^\varepsilon \subset \mathbb{R}^3$ with boundary $\Gamma^\varepsilon = \overline{\Gamma}_1^\varepsilon \cup \overline{\Gamma}_L^\varepsilon \cup \overline{\omega}$, where ω is the bottom of the domain, $\overline{\Gamma}_1^\varepsilon$ is the upper surface and $\overline{\Gamma}_L^\varepsilon$ the lateral surface. We assume that Γ^ε is Lipschitz continuous. We also suppose that the Dirichlet boundary conditions is satisfied on $\overline{\Gamma}_1^\varepsilon \cup \overline{\Gamma}_L^\varepsilon$, for the velocity. On the bottom surface, the normal velocity is null. However the tangential velocity is unknown and satisfies the Tresca boundary condition.

The model of Bingham fluid is a non-Newtonian fluid, whose flow properties differ in any way from those of any Newtonian fluids. There are many phenomena in nature and industry exhibiting the behavior of the Bingham fluid medium. For instance, the flow of metals, plastic solids and some polymers. Let us mention the work which is realized by the authors in [5], in which they mainly consider a problem describing the motion of an incompressible, isothermal and non-Newtonian fluid in a three-dimensional thin domain with Tresca law. The existence and uniqueness solutions a two dimensional Navier–Stokes shear flow with time dependent boundary driving