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Abstract: Frequently, the process of liquid flow, named ex-poro-hydrodynamic (XPHD), takes place inside a highly compressible porous layer (HCPL), where the elastic forces of the solid phase are negligible, compared to the hydrodynamic forces. The squeeze process of different configurations on a HCPL imbibed with Newtonian liquid, in XPHD conditions, was modeled. The damping capacity of a HCPL is considerably greater than that of the Newtonian liquid layer. The theoretical models were validated by experiments, using wash-cloth as HCPL imbibed with water, impacted by falling ball. The permeability of the wash-cloth was measured using various techniques, in static and dynamic conditions.

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Cover Letter

This work analyzes theoretically and experimentally the squeeze process in highly compressible porous layer imbibed with liquid for different contacts. The work was carried in the Machine Elements and Tribology Department at the Polytechnic University of Bucharest.

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SQUEEZE PROCESS IN HIGHLY COMPRESSIBLE POROUS LAYER IMBIBED WITH LIQUID

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Abstract

Frequently, the process of liquid flow, named ex-poro-hydrodynamic (XPHD), takes place inside a highly compressible porous layer (HCPL), where the elastic forces of the solid phase are negligible, compared to the hydrodynamic forces. The squeeze process of different configurations on a HCPL imbibed with Newtonian liquid, in XPHD conditions, was modeled. The damping capacity of a HCPL is considerably greater than that of the Newtonian liquid layer. The theoretical models were validated by experiments, using wash-cloth as HCPL imbibed with water, impacted by falling ball. The permeability of the wash-cloth was measured using various techniques, in static and dynamic conditions.

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1. INTRODUCTION

During the last 10-15 years a new lubrication mechanism applicable to highly compressible porous layers acting as self-sustained films has been developed [1-4]. The existing papers or conferences published in this area belong to professors Weinbaum and Pascovici who worked independently. This new type of lubrication implies „*that the normal forces generated by elastic compression of the fibers comprising the solid phase are negligible compared to the pressure forces generated within the porous layer*” [2]. This structure could be represented by:

- the unwoven and woven textile materials, as felt, or similar materials used as wash-cloth [5];
- the endothelial surface glycocalyx that uniformly coats the mammals microvessels [6],[7];
- the articular cartilage [8],[9];
- the fresh powder snow [2].

This paper analyzes the load capacity of this new type of lubrication for different configurations, with sliding motion (wedge effect) or normal motion (squeeze effect).

This type of lubrication is strongly dependent on porosity variation and consequently on permeability hence, the name **ex-poro-hydrodynamic-XPHD lubrication** was proposed.

1.1 GENERAL ANALYTICAL MODEL FOR SELF-SUSTAINED XPHD LAYERS

The momentum equation of a fluid in such a structure/medium is described by the Brinkman equation [10].

$$\nabla p = \eta\left(\nabla^2 - \frac{1}{\phi}\right)u_m \qquad (1)$$

where u_m is the mean fluid velocity through „the channels in porous media”.

For low permeability, ϕ, this equation becomes an alternative of Darcy law [10]:

$$\nabla p = -\frac{\eta q_p}{\phi h} \qquad (2)$$