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IDENTIFICATION OF THE ELASTICITY TENSOR OF AN UNCERTAIN BIOMECHANICAL COMPUTATIONAL MODEL USING AXIAL TRANSMISSION

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ABSTRACT

Biomechanical systems are often very complex to be modeled in regard to the complexity level of their constitutive material at the microscopic scale. Very often, these biomechanical systems are modeled using a mechanical model which can be more or less sophisticated using or not a multiscale approach. Nevertheless, assumptions yielding modeling simplifications and approximations are introduced and therefore the complexity level of these biomechanical systems is almost always greater than the complexity level of the mechanical model. Since the model developed is always a rough approximation of the real biomechanical system, it is interesting to model uncertainties in order to extend the domain of validy of the simplified model. Nevertheless, it is important to give an experimental validation of such simplified models. The purpose of this paper is the identification of the mechanical properties of the cortical bone using the ultrasonic axial transmission technique [1]. The main objective is firstly to propose a simplified model adapted to this technique in order to perform such an identification and secondly to present an experimental validation of this simplified model. In this paper, the simplified mechanical model is constructed as a fluid-solid semi-infinite multilayer system in which the solid layer (the cortical bone) is a nonhomogeneous anisotropic elastic material and the two others semi-infinite layers are fluids. Thus, the mechanical properties of the solid elastic layer is not constant along the finite

dimension but it is constant along the infinite dimension. The solver used for this problem is presented in [2]. The uncertainties introduced in the construction of this simplified model are taken into account by a parametric probabilistic approach for the elasticity tensor. A first application to the cortical bone has been presented in [3] for a homogeneous isotropic material. Presently, we propose a nonhomogeneous anisotropic modeling for which the probabilistic model of the elasticity tensor is constructed using [4]. The identification of the mechanical properties of the solid layer is carried out by solving an inverse stochastic problem related to the simplified model and using an experimental database obtained by ultrasonic axial transmission for a cortical bone. The complete stochastic model is presented with its experimental validation.

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