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IDENTIFICATION OF THE MESOSCALE MODEL OF A MICROSTRUCTURE IN USING EXPERIMENTAL MEASUREMENTS WITH AN IMAGE FIELD METHOD AND ONE SPECIMEN

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Biomechanical materials, as cortical bones, are complex materials to be modeled with respect to the complexity level of their constitutive materials at the micro-scale. At a macro-scale, such a medium is often modeled as a homogeneous material for which the effective mechanical properties can be identified using experimental tests. At micro-scale, this material is not only non homogenous and random but it also cannot be described in terms of mechanical constituents. It is the reason why a meso-scale is considered and for which the medium is modeled with apparent properties represented by an elasticity-tensor random field. A complete methodology is proposed for the experimental identification of the random field at meso-scale (1) using image field measurements at macro- and meso-scales, (2) introducing three numerical indicator quantifying distances between the experimental measurements and a probabilistic computational model for simulating the experimental measurements. An application will be presented for cortical bone with experimental measurements performed on only one specimen at macro and meso-scale simultaneously for a given specimen submitted to a given load. The experimental displacement (strain) field is measured on the whole domain (1x1 cm) at the macro-scale while, at the meso-scale, the displacement (strain) field is measured only on a representative elementary volume (1x1 mm). The identification of the parameters of the stochastic model of the elasticity-tensor field at meso-scale is carried out by (1) introducing a first mesoscale indicator based on the likelihood of random displacement (strain) field computed by the stochastic boundary value problem with the experimental displacement (strain) field at meso-scale and by (2) a second multiscale indicator based on the distance between the experimental macroscale elasticity tensor and the effective elasticity tensor of the material at macro-scale. The identification is carried out by seeking for the point minimizing the distance between the origin and the Pareto front associated with those two indicators. This methodology has been validated numerically and an application with experimental measurements is given. A CCD camera with a DIC method has been used for obtaining the experimental measurements.

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