On the identification of material parameters based on full-field measurements using the constitutive compatibility method: concept and challenges.

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Abstract :

The robust and low-cost identification of local material parameters in heterogeneous continua is a key step for accurately feeding advanced simulations of complex microstructures. Classical testing procedures that rely as much as possible on homogeneous mechanical fields only give access to averaged quantities at the scale of the specimen.

A way to experimentally obtain more local information is to capture the heterogeneous kinematics (typically the heterogeneous displacement field). This makes Image-based techniques the perfect tool for studying heterogeneous structures. The challenge is then to design a relevant inversion technique to recover the local material parameters from this enriched information.

We focus here on the CEGM, which, unlike other methods, considers the constitutive equation in a weak manner as a guiding norm for the identification.

First, we will discuss about the local identification of linear elastic behaviors. We propose a technique to uncouple the solution process into a global optimization over a specific stress space so called the ``solution stress space", followed by a local estimation of the material parameters in a strong manner at any point of interest in the domain. The proposed '``constitutive compatibility technique", leads to two major advantages: (1) a drastic reduction in the computation cost (2) an ability to easily determine points where the identified parameters are non-unique.

Second, we introduce a domain decomposition technique in the CCM framework. While plenty of work has been carried out on domain decomposition for forward problems, there is at our best knowledge no literature related to the development of domain decomposition technique specifically designed for DIC-based inverse problems. To address this, this talk describes the development of the domain decomposition CCM for more computationally efficient identification in the case of larger problems.

Short bio :

Prof Gilles Lubineau is the principal investigator for COHMAS (COmposite and Heterogeneous Materials Analysis and Simulation), an integrated environment for composite engineering that he created in 2009 when joining KAUST as an Associate Professor. Current research interests include: integrity at short and/or long-term of composite materials and structures, inverse problems for the identification of constitutive parameters, multi-scale coupling technique, multifunctional materials and modeling.

Before joining KAUST, Pr. Lubineau was a faculty member at the École Normale Supérieure of Cachan, and a non-resident faculty member at the École Polytechnique, France. He also served as a visiting researcher at UC-Berkeley.

He served as program chair of the Mechanical Engineering program at Kaust from 2009 to 2012 and as chair of the Master of Mechanical Enginnering at ENS Cachan from 2005 to 2007.

Pr. Lubineau earned a PhD degree in Mechanical Engineering from École Normale Supérieure de Cachan (ENS-Cachan), France. He was ranked 1st at the agrégation in theoretical mechanics and was granted his research habilitation in Mechanics in 2008. He received the Daniel Valentin Award for best innovative works related to the field of composite materials in 2004.