MULTI-SCALE HYBRID STRATEGY FOR MATERIAL PROPERTIES CHARACTERISATION OF COMPOSITE STRUCTURES WITH NON-DESTRUCTIVE TESTS

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One of the main issues of composite materials is related to the difficulty of characterising the full set of material properties at both mesoscopic and microscopic scales. Usually, classical mechanical tests (traction/compression, 3 and 4 points bending tests, etc.) are used to obtain material properties: it is well known that these tests are not able to provide the full set of 3D material properties of composites. Furthermore, these tests can provide only the in-plane elastic properties of the constitutive ply. Micro-scale experimental tests are not trivial to be realised, due to the presence of a large dispersion of obtained experimental data (serious difficulties to manage the constituent phases of composite materials). Therefore, to go beyond the main restrictions imposed by standard destructive tests, this work at proposing a general methodology to characterise the material properties of a composite plate, at each relevant scale, by means of a single non-destructive dynamic test performed at the macroscopic scale, i.e. that of the specimen. To face such a problem a general multi-scale identification strategy (MSIS) is proposed. This procedure has already successfully utilised, e.g. to find meso-scale electromechanical properties of piezoelectric structures [1]. This strategy aims at identifying the constitutive properties at both micro and meso-scales by exploiting the information restrained in the macroscopic dynamical response. In this context it is possible to characterise both elastic and viscoelastic micro-scale properties. The MSIS is organised in two steps and it relies firstly on the strain energy homogenisation technique of periodic media (to get the effective material properties of the ply) and, secondly, on a specific hybrid algorithm (genetic + gradient-based algorithm [2]) to perform the solution search for the problem. The identification problem is stated as a constrained inverse problem (a least-square constrained problem), where the objective function depends upon both the measured (from experiments) and numerical dynamic response of the plate. The effectiveness of the MSIS is then validated through a campaign of experimental/numerical tests conducted on composite plates.

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