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Modelling and Numerical Analysis of Thermal Non-Destructive Testing on Complex Structure

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Abstract : Composite material is widely used to replace conventional material, especially in the aerospace industry to reduce the weight of the devices. It is formed by combining reinforced materials together via adhesive bonding to produce a bulk material with alternated macroscopic properties. In bulk composites, degradation may occur in microscopic scale, which is in each individual reinforced fiber layer or especially in its matrix layer such as delamination, inclusion, disbond, void, cracks, and porosity. In this paper, we focus on the detection of defect in matrix layer which the adhesion between the composite plies is in contact but coupled through a weak bond. In fact, the adhesive defects are tested through various nondestructive methods. Among them, pulsed phase thermography (PPT) has shown some advantages providing improved sensitivity, large-area coverage, and high-speed testing. The aim of this work is to develop an efficient numerical model to study the application of PPT to the nondestructive inspection of weak bonding in composite material. The resulting thermal evolution field is comprised of internal reflections between the interfaces of defects and the specimen, and the important key-features of the defects presented in the material can be obtained from the investigation of the thermal evolution of the field distribution. Computational simulation of such inspections has allowed the improvement of the techniques to apply in various inspections, such as materials with high thermal conductivity and more complex structures.

Keywords : pulsed phase thermography, weak bond, composite, CFRP, computational modelling, optimization
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