Accepted Manuscript

Fully coupled thermomechanical analysis of laminated composites by using ordinary state based peridynamic theory

Yan Gao, Selda Oterkus

PII: S0263-8223(18)31634-9
DOI: https://doi.org/10.1016/j.compstruct.2018.09.034
Reference: COST 10180

To appear in: *Composite Structures*

Received Date: 5 May 2018
Revised Date: 29 July 2018
Accepted Date: 17 September 2018

Fully Coupled Thermomechanical Analysis of Laminated Composites by Using Ordinary State Based Peridynamic Theory

Yan Gao and Selda Oterkus*

Department of Naval Architecture, Ocean and Marine Engineering, University of Strathclyde, Glasgow, G4 0LZ, United Kingdom

Abstract:
This study presents fully coupled ordinary state based peridynamic (PD) model for of laminated composites. The formulation includes coupling of both thermal and mechanical fields. In order to verify the proposed model, numerical simulations for benchmark problems are carried out and their results are compared with the ones from ANSYS solutions. First, the thermomechanical behaviour of the laminated composites subjected to both uniform and linear temperature changes are tested for single and multi-layer composites. Then, fully coupled thermo-mechanical formulations are validated for laminated composites subjected to pressure shock. Finally, the crack propagation paths and temperature distributions are predicted for shock loading conditions. In conclusion, the present PD model is well suited for solving fully coupled thermomechanical problems for laminated composites including crack initiations and propagations.

Keywords: Ordinary state based peridynamics, composites, fully coupled, thermomechanics, crack propagation

1 Introduction

In recent years, high performance composite materials like fibre-reinforced composites (FRCs) and carbon-carbon composites (CCCs) are increasingly used in aerospace and mechanical industries, especially for the working environments with mechanical shocks and large temperature variations [1]. The analyses of this type of problems have been carried out in the past using the uncoupled or semi-coupled thermoelasticity theory. It is assumed that the deformation induces relatively small temperature changes, and hence can be conveniently neglected. Only the effect of the temperature on the deformation field is considered. However, the coupling coefficient of composites is much larger than the metal materials. Furthermore, the coupling effect on temperature is significant under the loading conditions like a sudden change of temperature or a mechanical shock. Therefore, the deformation effect on temperature field is crucial in these cases. The uncoupled or semi-coupled analysis may not be accurate enough, and the employment of the fully coupled thermoelasticity theory is necessary in these cases [2].

*Corresponding Author: Selda Oterkus, Department of Naval Architecture, Ocean and Marine Engineering, University of Strathclyde. Email: selda.oterkus@strath.ac.uk