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Adaptive and Off-Line Techniques for Non-Linear Multiscale Analysis

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Abstract

This paper presents two procedures, based on the numerical multiscale theory, developed to predict the mechanical non-linear response of composite materials under monotonically increasing loads. Such procedures are designed with the objective of reducing the computational cost required in these types of analysis. Starting from virtual tests of the microscale, the solution of the macroscale structure via Classical First-Order Multiscale Method will be replaced by an interpolation of a discrete number of homogenized surfaces previously calculated. These surfaces describe the stress evolution of the microscale at fixed levels of an equivalent damage parameter (d_{eq}). The information required for these surfaces to conduct the analysis is stored in a Data Base using a json format. Of the two methods developed, the first one uses the pre-computed homogenized surface just to obtain the material non-linear threshold, and generates a Representative Volume Element (RVE) once the material point goes into the nonlinear range; the second method is completely off-line and is capable of describing the material linear and non-linear behavior just by using the discrete homogenized surfaces stored in the Data Base. After describing the two procedures developed, this manuscript provides two examples to validate the capabilities of the proposed methods.

Keywords: Multiscale, Multiphysics, Optimization

Introduction

A composite material is defined as a complex structure characterized by two or more components with different mechanical, thermal and/or chemical properties. The combinations of multiple constituents leads to a new material that usually improves significantly

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