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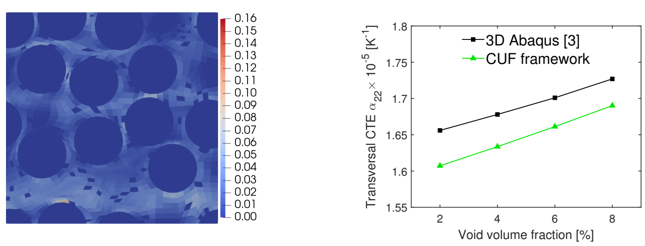
ABSTRACT

Manufacturing of carbon fiber reinforced polymers (CFRPs) can generate defects, e.g., dispersed air gaps - voids - in the matrix that can alter the microstructure of the materials and affect thermoelastic properties [1]. The present work investigates the effect of voids on the local stress and strain fields, including plasticity over the matrix. The micromechanics framework is based on the use of 1D higher-order structural theories obtained via the Carrera Unified Formulation (CUF) and periodic boundary conditions (PBC) [2]. Voids in the matrix are randomly generated, and several distributions for each void volume fraction are chosen to carry out a statistical analysis. Figure 1a illustrates the equivalent plastic strain (PEEQ) over the matrix of an RVE with a random distribution of fibers and 3% of voids. Moreover, the micromechanical approach retrieves the homogenized coefficients of thermal expansion (CTEs) of CFRP with defects. Figure 1b shows the variation of mean transversal CTE for each void volume fraction by comparing CUF results and the work of [3].



(a) (b)

Figure 1: Distribution of PEEQ over the cross-section of random RVE with 3% of voids applying ε_{xz} (a), and variation of the transversal thermal expansion coefficient according to the void volume fraction (b).

Numerical results have shown that increments of void fractions lead to higher stress and strain values. Regarding the CTEs, the results have shown a good agreement with the benchmarks references, thus confirming that voids have a remarkable effect on thermoelastic properties.

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