V ECCOMAS Thematic Conference on the Mechanical Response of Composites COMPOSITES 2015
S.R. Hallett and J.J.C. Remmers (Editors)

EMBEDDED ELEMENTS METHOD IN MESO- FINITE ELEMENT MODELLING OF DAMAGE IN TEXTILE COMPSOITES

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Continuous damage mechanics (CDM) has been widely used in meso-scale damage modeling of textile composites that describes progressive stiffness degradation of a rate-independent material. In this research, the unit cell modeling and damage initiation and propagation in multilayer 2D plain weave composite[1] using the embedded element (EE) concept are investigated. The EE method is based on the "mesh superpositioning" proposed by Ortiz et. al [2] and Fish et al.[3]. The validity of the strain/stress field calculations in the textile composites using the mesh superpositioning technique had been investigated by [4-5]. However, the application of the mesh superpositioning method in the damage modelling of textile composites is investigated in the current research for the first time. The unit cell of 2D plain weave composite is initially modeled in WiseTex based on the geometrical information. The modeled yarns in the WiseTex are imported to the Abaqus using the Python code. The matrix box is modeled and meshed separately. Then the "embedded element (EE)" technique is used to define the spatial relation between the yarns and matrix. The volume redundancy in the EE technique is resolved by stiffness matrix correction in the embedded region. Moreover, the interpenetration of the yarns is corrected using the contact algorithm. Here, for damage modeling, the yarn is supposed as a unidirectional flat ply laminate. The Puck criterion [6] is employed to predict the damage initiation and orientation as part of Zinoviev's type damage development algorithm, proposed by Ivanov[7]. To model the damage propagation, the damage evolution approach of Ladeveze is implemented based on the energy release rate[8]. The damage model is implemented in a UMAT subroutine which updates the material properties of the yarns according to the amount of damage accumulated during the FE analysis in ABAQUS.
The feasibility of usage of EE method in meso-FE damage modeling of textile composites is confirmed after comparison with the continuous mesh solution and experimental data for the glass/epoxy woven composite.

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