Accepted Manuscript

Three-Dimensional Hygromechanical analysis of fibre polymer composites: Effect of Boundary Conditions

Deepak Jain, Abhijit Mukherjee

PII: S1359-8368(15)00743-X

DOI: 10.1016/j.compositesb.2015.12.011

Reference: JCOMB 3930

To appear in: Composites Part B

- Received Date: 18 December 2014
- Revised Date: 4 October 2015
- Accepted Date: 26 December 2015

Please cite this article as: Jain D, Mukherjee A, Three-Dimensional Hygromechanical analysis of fibre polymer composites: Effect of Boundary Conditions, *Composites Part B* (2016), doi: 10.1016/j.compositesb.2015.12.011.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



1 **Three-Dimensional Hygromechanical analysis of fibre polymer composites:** 2 **Effect of Boundary Conditions** 3 Deepak Jain^a, Abhijit Mukherjee^{b,*} 4 5 6 7 ^a Department of Mechanical Engineering, Lovely Professional University, Phagwara 144402, India ^b Department of Civil Engineering, Curtin University, Bentley, WA 6102, Australia * Corresponding author. Tel.: +61 8 9266 7609; E-mail address: abhijit.mukherjee@curtin.edu.au 8 9 Abstract 10 Moisture diffusion through a unidirectional fibre reinforced polymer matrix composite is studied. The stresses 11 due to the expansion of the matrix caused by moisture diffusion are evaluated. A three-dimensional (3D) 12 micromechanical model is developed to study diffusion both across and along the fibre. The well-known 2D 13 plane strain condition is modelled and validated as a special case of the 3D model. The utility of 3D modelling is 14 further demonstrated to analyse the stress along the fibre length. It is demonstrated that the variation of boundary 15 conditions along the fibre length has a dramatic effect on the stresses. The stresses along fibre length computed 16 through finite element analysis (FEA) are compared against an analytical solution obtained from axi-symmetric 17 composite cylinder assemblage (CCA) model. This paper demonstrates the importance of 3D diffusion kinetics 18 in unidirectional reinforced polymer composites. 19 20 Keywords: A. Polymer-matrix composites (PMCs); B. Environmental degradation; C. Computational 21 modelling; C. Micro-mechanics 22 **1. Introduction** 23 Fibre reinforced polymer composites are susceptible to moist environments that can cause premature failure [1]. 24 25 26 27 28

The difference in moisture diffusion coefficients, moisture expansion and elastic properties in the fibre and the matrix results in high interfacial stresses that often results in failure at the fibre-matrix interface [2, 3]. Finite element based micromechanical analysis is usually conducted considering different arrays of fibre matrix arrangements. The response of FRP composites subjected to elastic [4-8], thermal [7, 8] and hygral [9-12] environments is usually predicted by using 2D cross-sectional models plain stress/strain boundary conditions. As 29 the fibre length is much higher as compared to its diameter, the 2D plane strain assumption is reasonable in 30 assessment of responses in the interior regions [13-18]. In that paradigm, our previous work reports the 31 importance of fibre topology in the moisture diffusion [11, 12] and stresses thereof [19]. The progression of 32 moisture across the fibre is investigated and the importance of topological distribution of the moisture 33 progression is demonstrated. A number of fibre-matrix architectures were created by varying topological 34 parameters viz. inter-fibre distance, orientation and fibre density. It was concluded that by carefully designing

Download English Version:

https://daneshyari.com/en/article/7212884

Download Persian Version:

https://daneshyari.com/article/7212884

Daneshyari.com