MICRO-MODELING OF THE MECHANICS OF THE FIBER-MATRIX INTERFACE

T. Bogetti (ARL), B. Powers (ARL), M. H. Santare, T. Cender (BME)

University of Delaware . Center for Composite Materials . Department of Mechanical Engineering
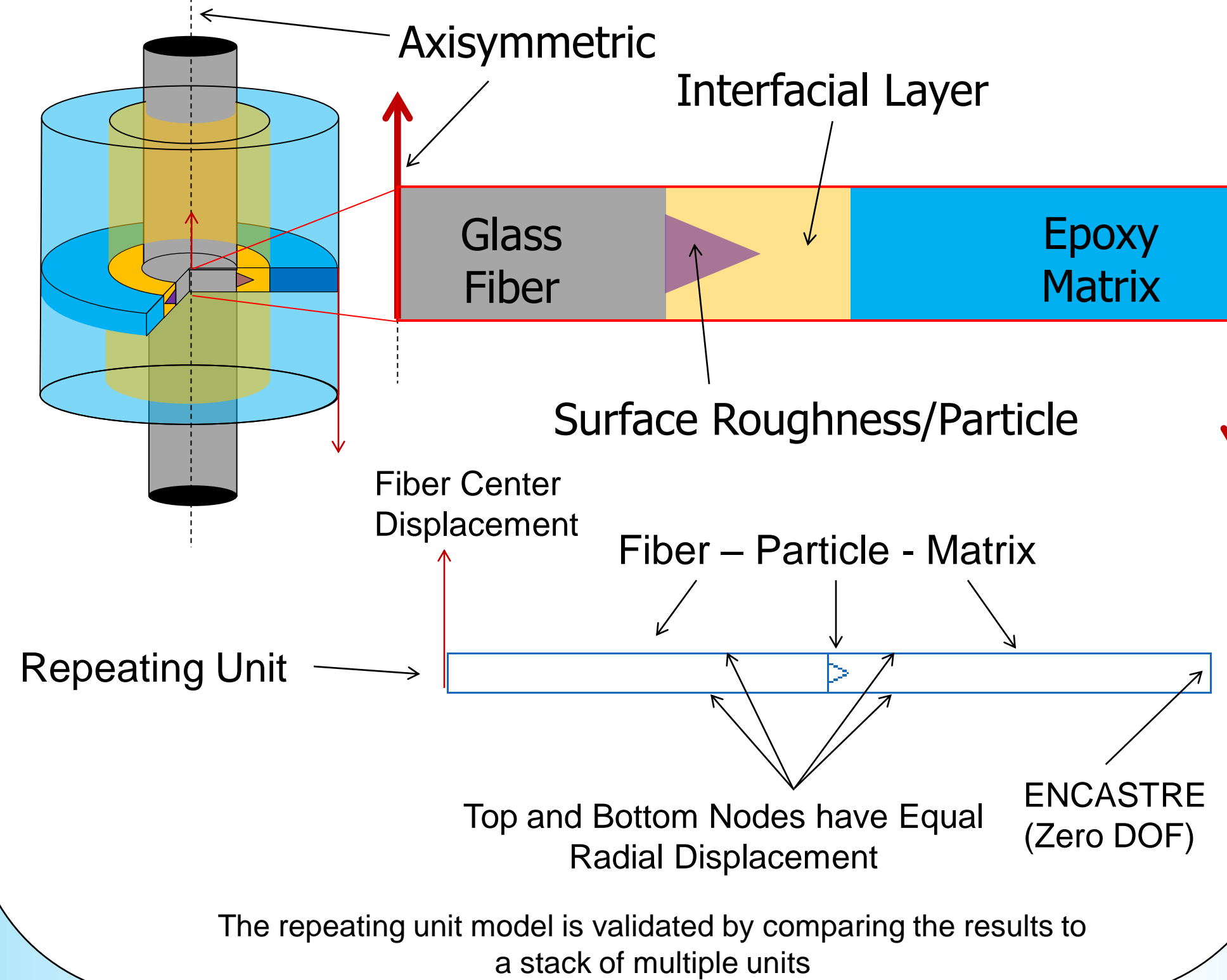
PROBLEM

The purpose of this research is to study the effects of different fiber coatings on the interfacial shear strength between a glass fiber and epoxy matrix
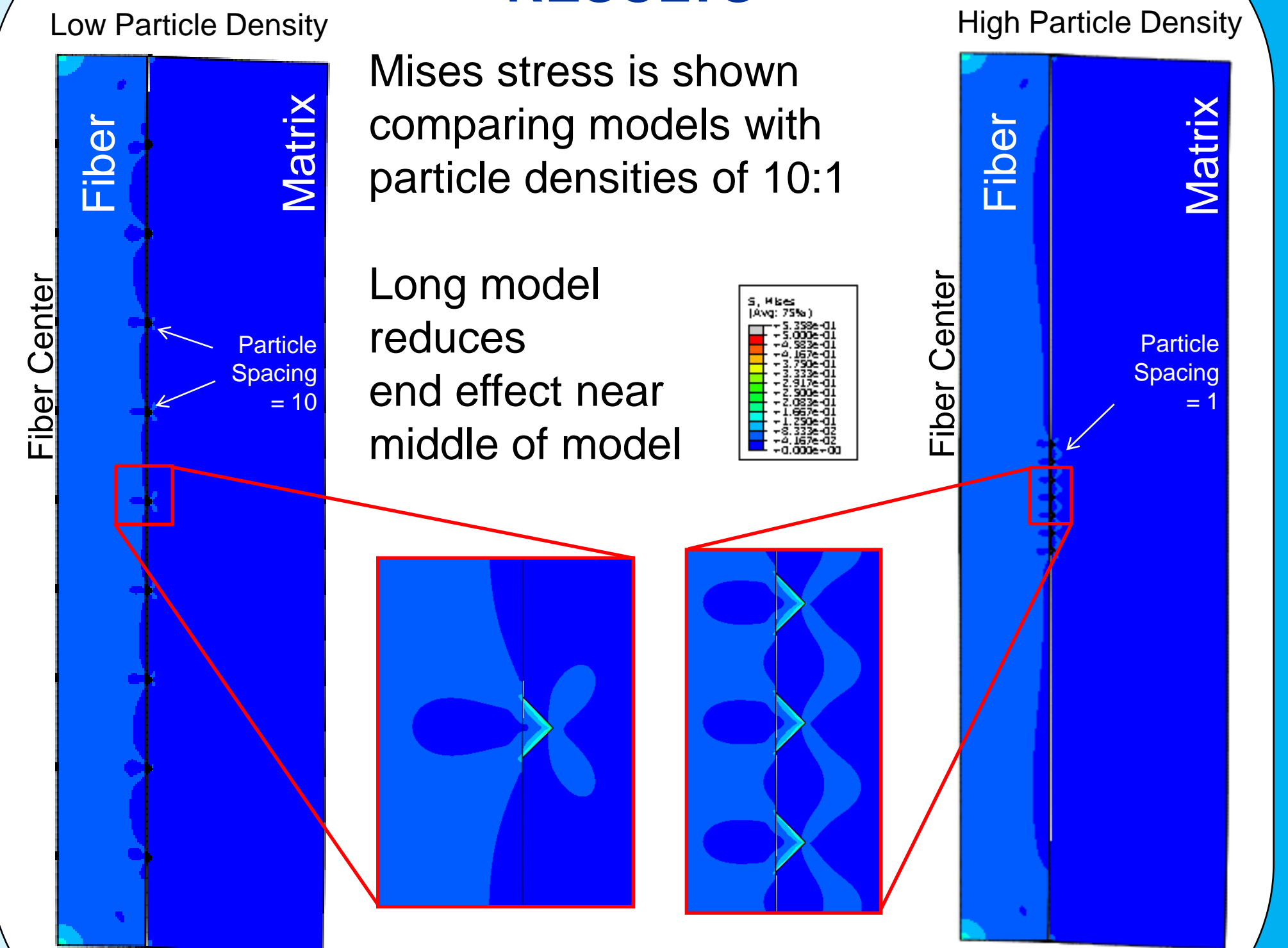
A finite element model has been developed to understand how stress transfers in response to surface roughness or the presence of nano-particles

The goal is to provide the tools to optimize the strength of the composite by varying particle density and shape along the surface of the fiber

MODEL APPROACH

Axisymmetric
Interfacial Layer
Glass Fiber
Epoxy Matrix
Surface Roughness/Particle
Fiber Center Displacement
Fiber – Particle - Matrix
Repeating Unit
Top and Bottom Nodes have Equal Radial Displacement
ENCASTRE (Zero DOF)

The repeating unit model is validated by comparing the results to a stack of multiple units

RESULTS

Low Particle Density
High Particle Density

Mises stress is shown comparing models with particle densities of 10:1

Long model reduces end effect near middle of model

Fiber
Matrix
Fiber Center
Particle Spacing = 10
Particle Spacing = 1

PARAMETRIC STUDY

A code has been written to create the model and mesh geometries in a parametric manner

This will be used to generate several models with varying surface roughness in order to study the effects of the coating parameters on material strength

DISCUSSION

The results show that a higher density of particles seeding the surface of the fiber causes a more uniform stress due to the interaction between particles

Investigations with the repeating unit model show the proposed boundary conditions satisfy the requirements of a unit cell, allowing models to be run more efficiently

FUTURE WORK

Generate 2D and 3D finite element models to simulate the micro-droplet test to compare results from actual tests

Continue to develop the current micro-scale model to include parametric geometries for optimization of mechanical properties

ACKNOWLEDGEMENTS

References

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