DEVELOPMENT OF HEXAGONAL MESH FOR FINITE ELEMENT ANALYSIS OF UHMWPE FIBERS

UNIVERSITY OF DELAWARE | CENTER FOR COMPOSITE MATERIALS

Malika Iyer (BME)[2], Eli Bogetti (MME) [2], Abdelrahman Abounabet, Bazle Z. (Gama) Haque, Ph.D.[1,2]
University of Delaware | Center for Composite Materials[1] | Department of Mechanical Engineering[2]

Introduction

- Understanding the effects of fibrillated microstructure of UHMWPE fibers on perforation performance is critical for advancing ballistic protection systems
- Effects of cross-linked molecules are on the microscale and not accessible with a continuum FE model
- Rate dependent progressive composite damage model MAT162 in LS-Dyna is the state-of-the-art for ballistic penetration and perforation modeling
- Meshing fibers with hexagons will yield better simulation result compared to LS-Dyna's default 4-noded elements (rectangles)

Objective

- Develop a computational framework to hexagonally mesh a 2D surface
- Visualize mesh for easy selection
- Once hex mesh is applied, disturb vertices to generate realistic model
- Write positions of nodes to LS-PrePost

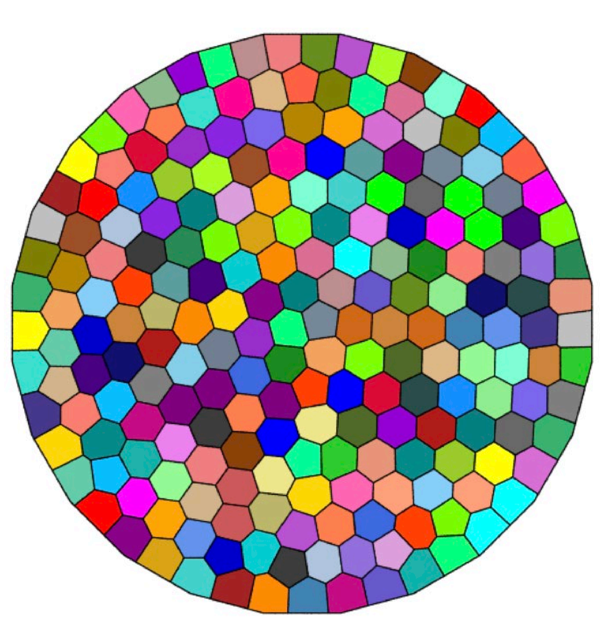

Figure 1: HexMesh achieved using NEPER for a uniform cross section

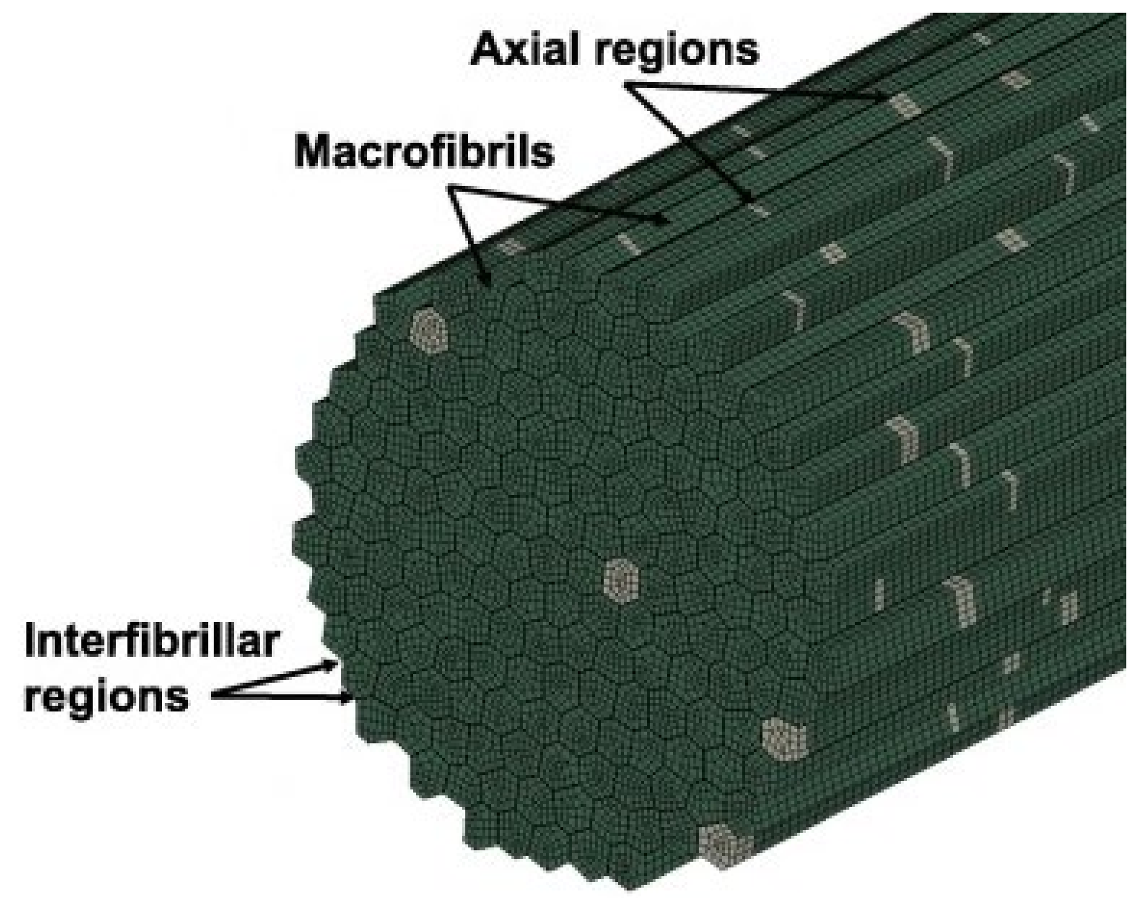

Figure 2: A Finite Element model of a fiber generated using Abaqus and MATLAB [1]

Problem Specification

- Continuum FE models do not account for effects of important micromechanics of UHMWPE fibers
- Existing lattice generation software are not specific for LS-Dyna

Modeling Methodology

- Creating a user interface to upload 2D geometry and tile hexagons of a specified radius
- Detect which hexagons to use to model the geometry
- Write the selected hexagons to a LS-PrePost model.
- Extrude 2D cross-section to 3D fiber in LS-PrePost

Results and Discussion

- Graphical User Interface offers visual output for reviewing the mesh before applying nodes
- 2D geometry can be uploaded and tiled with hexagons of desired radius

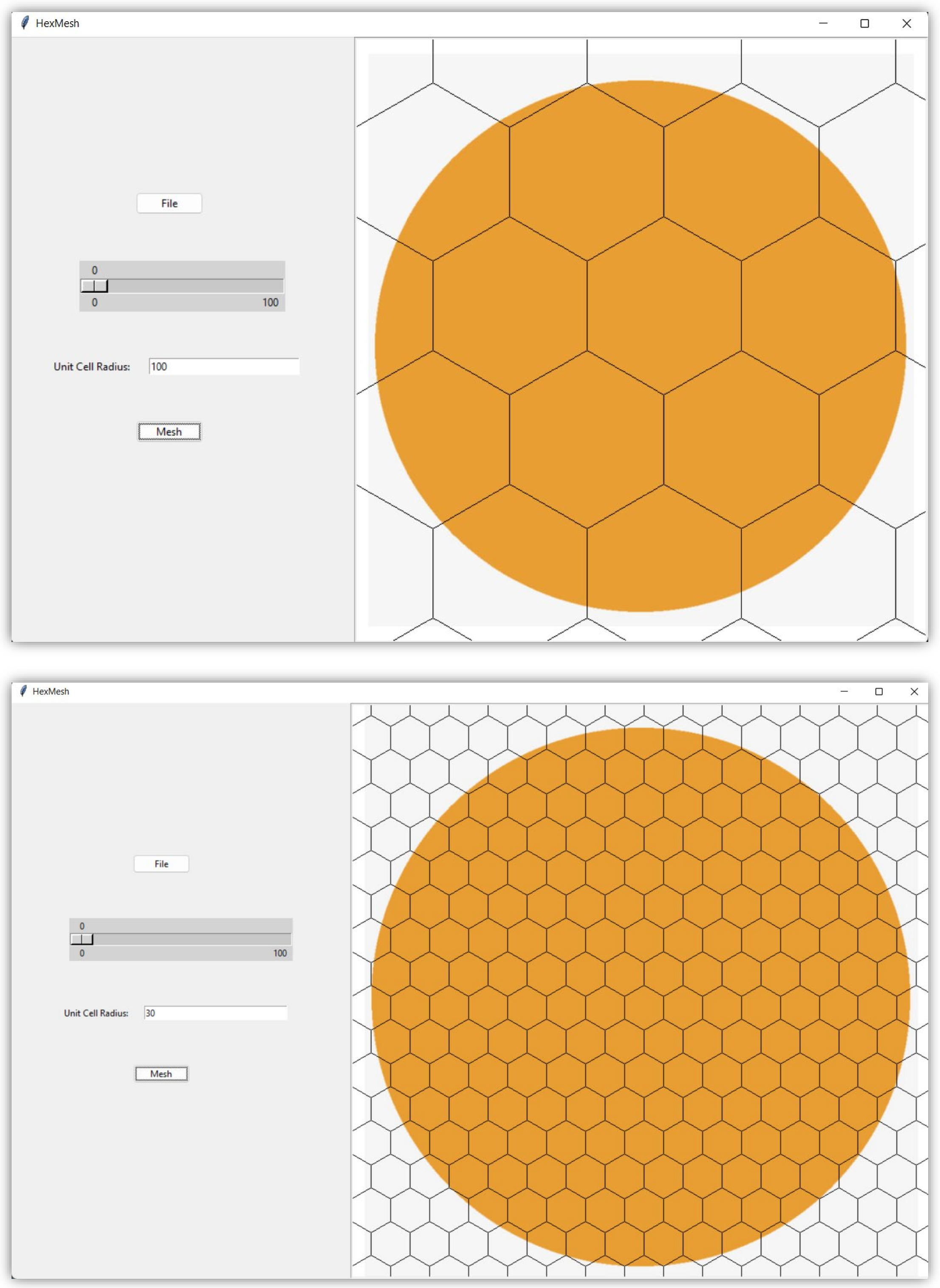

Figure 3: GUI with different sized meshed hexagons over uploaded circle

Summary and Conclusion

- Graphical User Interface has been developed
- Ability to tile any 2D geometry with an explicit boundary with regular hexagons of desired radius has been achieved

Future Work

- Edit element geometry at edges to match supplied cross-section boundary
- Disrupt vertices stochastically to make model more realistic (Figs. 1 and 2)
- Clear previous canvas to be left with hexagons within the boundary
- Run ballistic simulations on unidirectional composites with microscale fibers

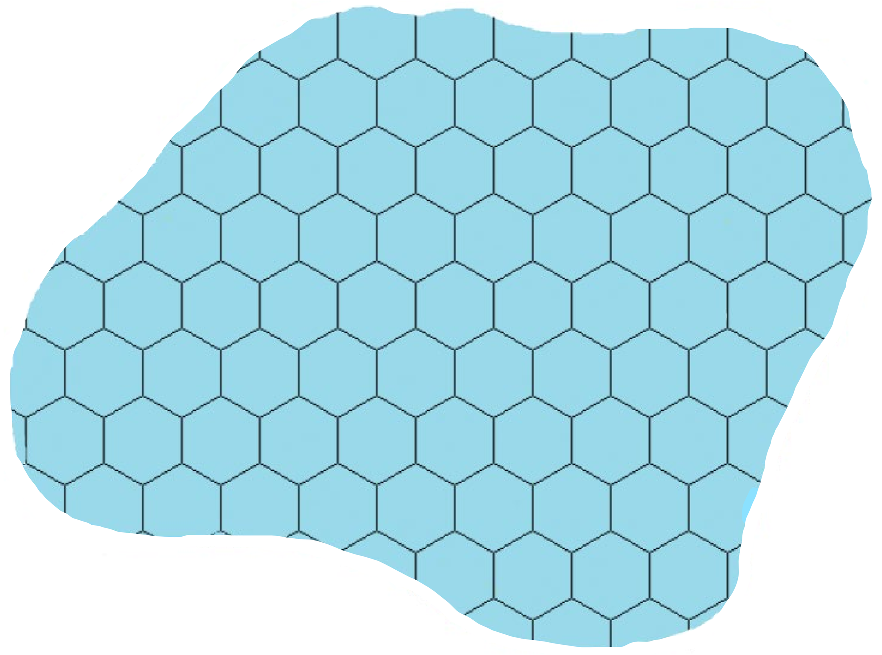

Figure 4: Expected final output for modifications accounted by the Future Work section

Acknowledgements

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References

1. Staniszewski, J. M., Bogetti, T. A., Wu, V., & Moy, P. (2020). Interfibrillar behavior in ultra-high molecular weight polyethylene (UHMWPE) single fibers subjected to tension. *International Journal of Solids and Structures*, *206*, 354–369.

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