

Development of the Failure Criteria for Composites

Software Lab Project 2019

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Introduction and Objective

Composite materials have proven their potential for use in high performance engineering applications over the last fifty years. Due to their high strength, low weight and design flexibility, composites offer product manufacturers several advantages in terms of weight and performance. However, composite materials also come with several challenges during product design related to their complex microstructure and failure mechanisms which require very extensive testing schemes.

In this project, User-defined material models are developed to establish a progressive damage analysis framework within ABAQUS FEA package, the material models coded using FORTRAN support 3D orthotropic laminates and the user has the flexibility to select between different implemented failure theories and damage models as required.

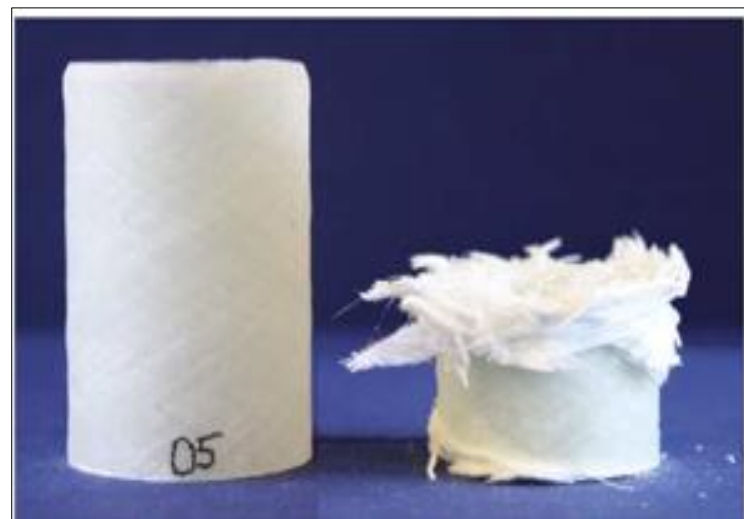


Fig. 1 Filament wound tube before and after impact (A. Berger, 2014)

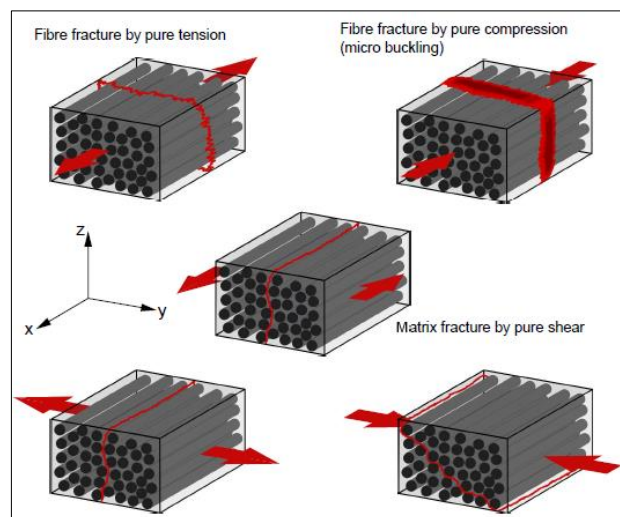


Fig. 2 Fracture Modes for UD composites (A. Berger, 2014)

Prograssive Damage Analysis Framework

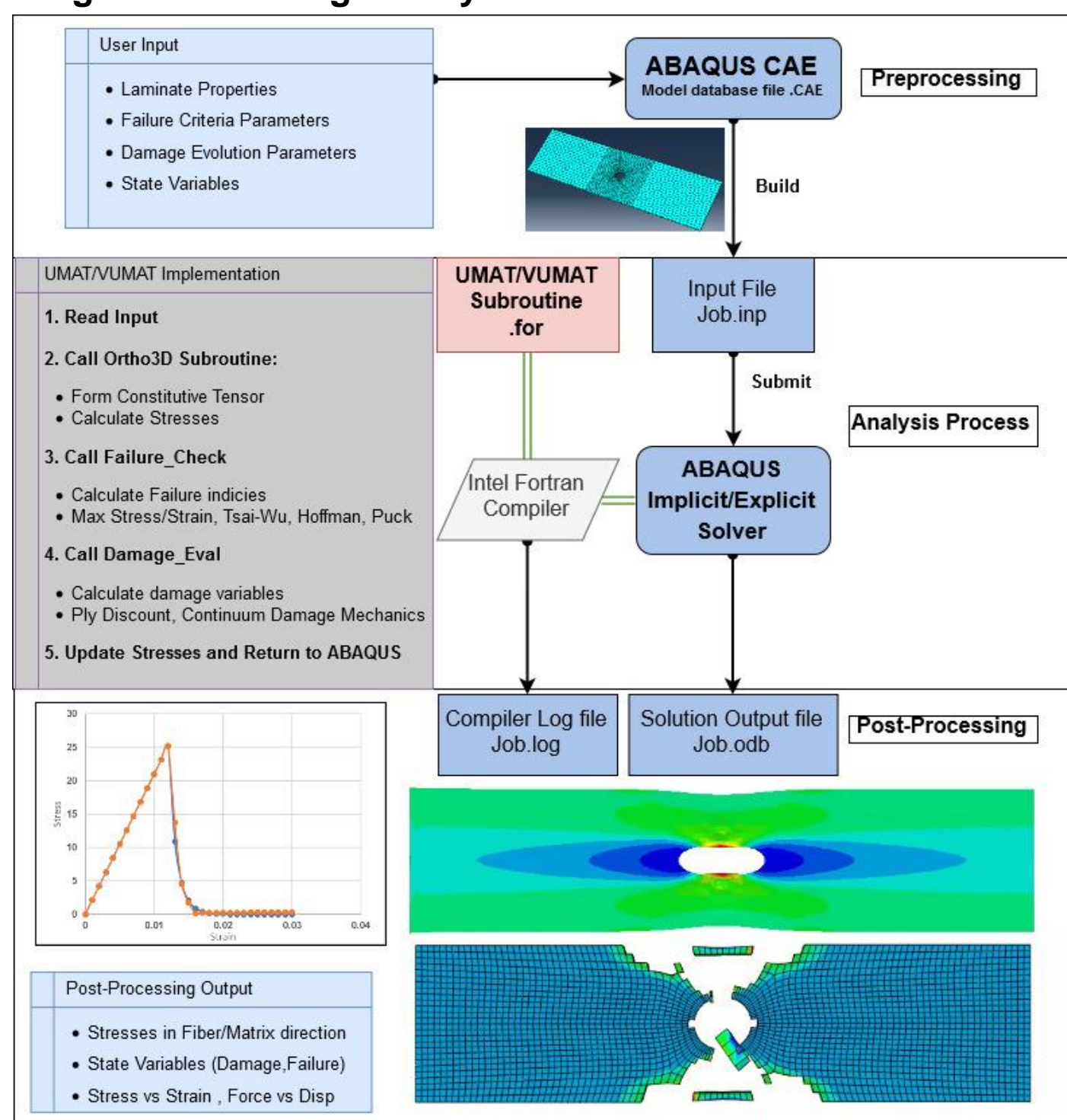


Fig. 3 Data flow for Progressive damage analysis using UMAT (Khallouf,2019)

Testing and Results

In order to verify the numerical implementation of the developed subroutines, several benchmark problems are modelled and analyzed in ABAQUS, typical results include force-displacement curves which help to distinguish between first ply failure and ultimate failure point of the lamina as shown in Fig.5

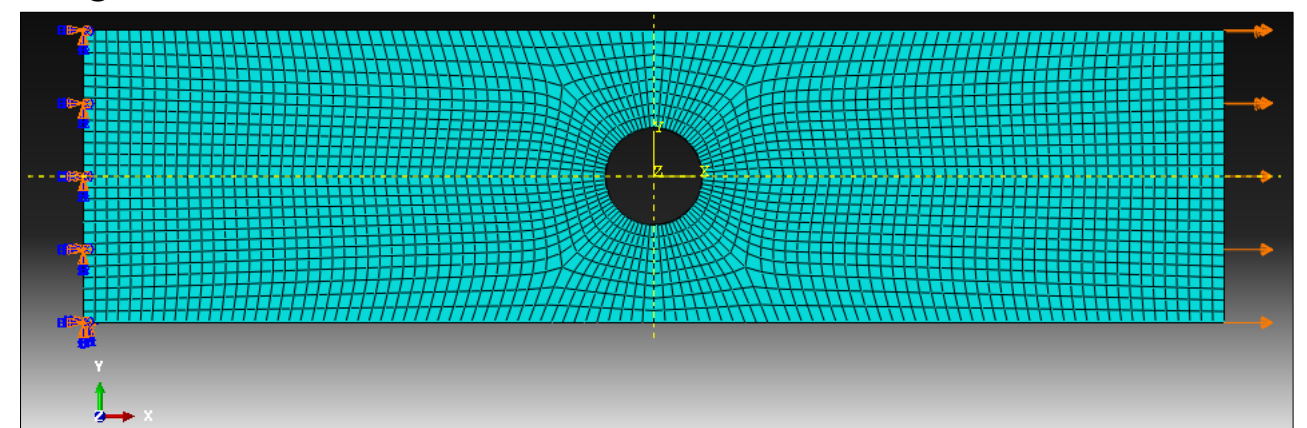


Fig. 4 T300/5208 Tensile Specimen FE Model in ABAQUS (Khallouf,2019)

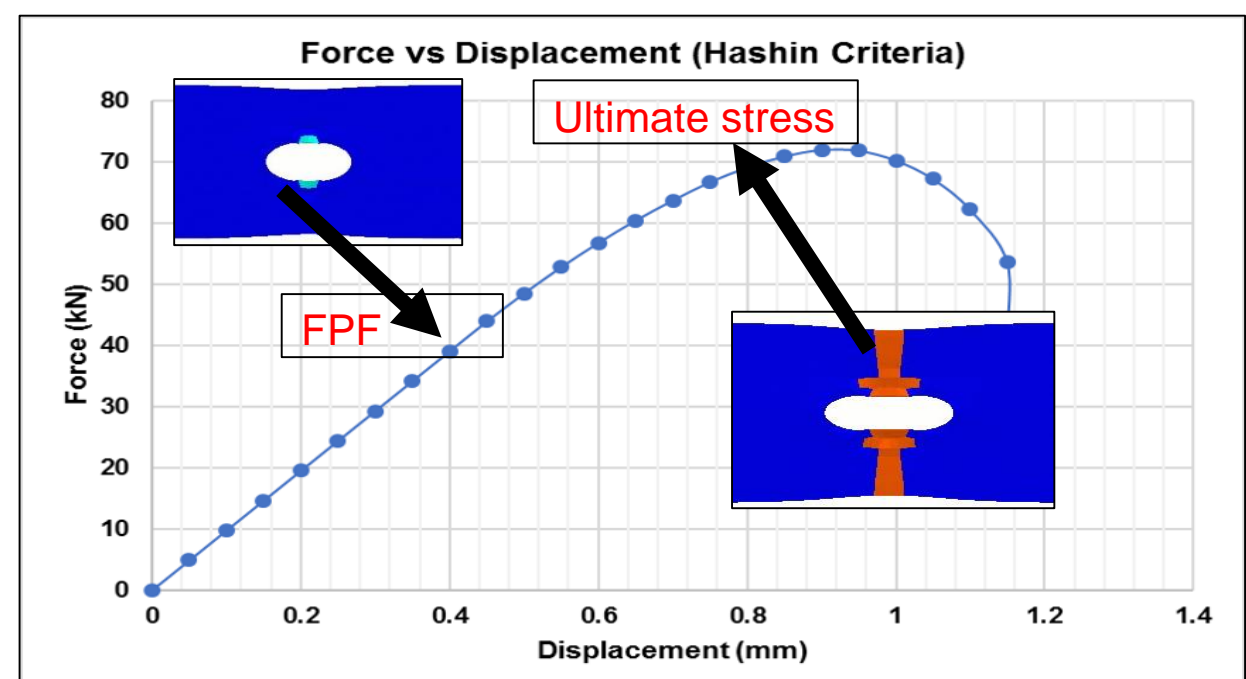


Fig. 5 Force vs Displacement graph for Tensile Specimen Graphite/epoxy laminate (Khallouf,2019)

Conclusions and outlook

In Conclusion, the aim of this project was to develop user defined material models within ABAQUS that can capture the failure characteristics of laminated composites. This has been achieved by implementing various number of failure and damage theories that are well established in research and industry. The results of the FE simulations are found to be in good correlation with the tested benchmark problems results.

References

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