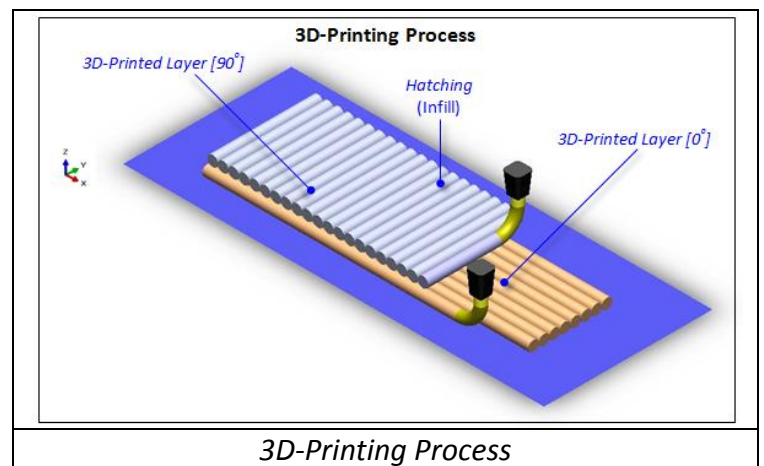


## 3D-Printed Chopped Composite

### Challenge

A major challenge in a 3D-printing process employing short graphite fiber composites is to accurately analyze the constituent properties which would play a vital role in enhancing the efficiency of the manufacturing process and the performance of the final product.

The key objective of this case study is to (1) provide a comprehensive guide on how to model short-fiber composites containing manufacturing defects (particularly, in this exercise, void, interface reduction, and waviness); (2) predict the material mechanical properties; and (3) predict the most effective fiber orientation for any given manufacturing methodology.



### Solution

Given a 3D-printed UD lamina (thickness  $t = 0.0055$  in) properties, obtained from two ASTM static tests, do the following:

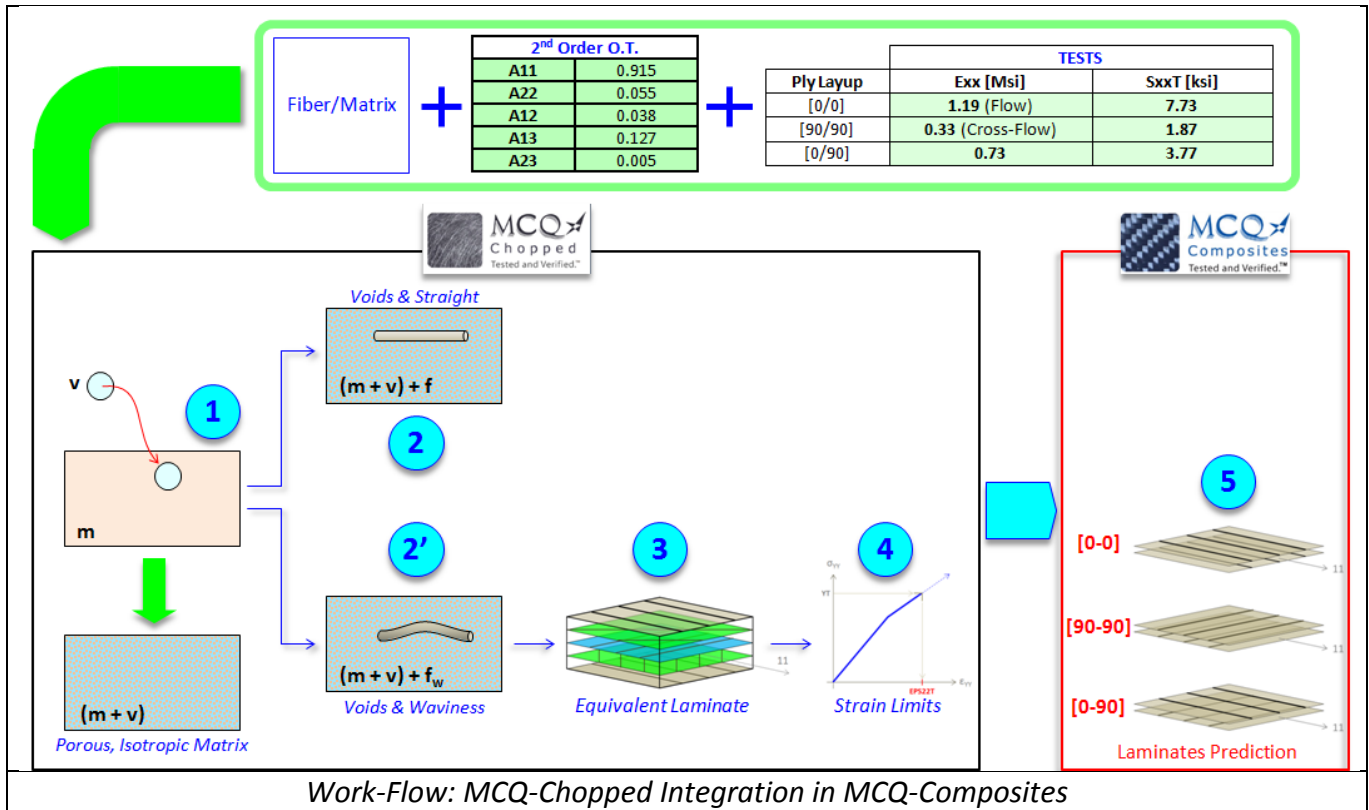
Reverse engineer the fiber and matrix effective (in-situ) properties of the UD lamina.

Fully analyze a 3D-printed, symmetric [0/90]<sub>s</sub> laminate.

Methodology involved in the case study includes Mori-Tanaka, Equivalent Laminate Analogy, Classical Laminate Theory (Analytical)

The step by step process involved in this case study as well as a work-flow chart which provides the virtual description is shown next:

- **Step-1:** Porous Isotropic ABS-matrix Determination
- **Step-2:** Porous Straight AS4-ABS Composite Parameters Calibration
- **Step-2':** Porous Wavy AS4-ABS Composite Parameters Calibration
- **Step-3:** Equivalent Laminate Stiffness Determination
- **Step-4:** Equivalent Laminate Strength Determination
- **Step-5:** 3D-Printed Layers Performance Prediction



## Results & Conclusion

- Fiber and matrix effective (in-situ) material properties for a chopped fiber coupon while considering the effect of defects.
- Prediction of the elastic and strength performance of a 3D-printed chopped composite build, having the 4 printed layers oriented as [0/90]s (each layer being manufactured with a 3D-printing process).
- The laminate Progressive Failure Analysis (PFA) results ply damages, etc.; can easily be extracted from this study as well.
- The calibration process generates fiber and matrix in-situ properties, while the prediction process produces the elastic and mechanical properties of the given 3D-printed laminate.

## Key Highlights & Benefits

**Product:** MCQ-Chopped and MCQ-Composites

**Industry:** Aerospace and Automotive

**Application:** 3D Printing

**Benefits:** (1) De-Homogenization Approach: models composite constituents and chopped fiber orientation; (2) Considers effect of Defects; (3) Accurately predicts strength in addition to stiffness

## Related Publication

Numerical Simulation of Big Area Additive Manufacturing (3D Printing) of a Full Size Car. SAMPE Journal 2015.