INFLUENCE OF VOIDS ON THICK DCB JOINT BEHAVIOR

Jialiang Fan[1], Anastasios P. Vassilopoulos[2], Véronique Michaud[1]

1. Laboratory for Processing of Advanced Composites (LPAC), Institute of Materials (IMX), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland – jialiang.fan@epfl.ch.

2. Composite Construction Laboratory (CCLab), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland .

Introduction

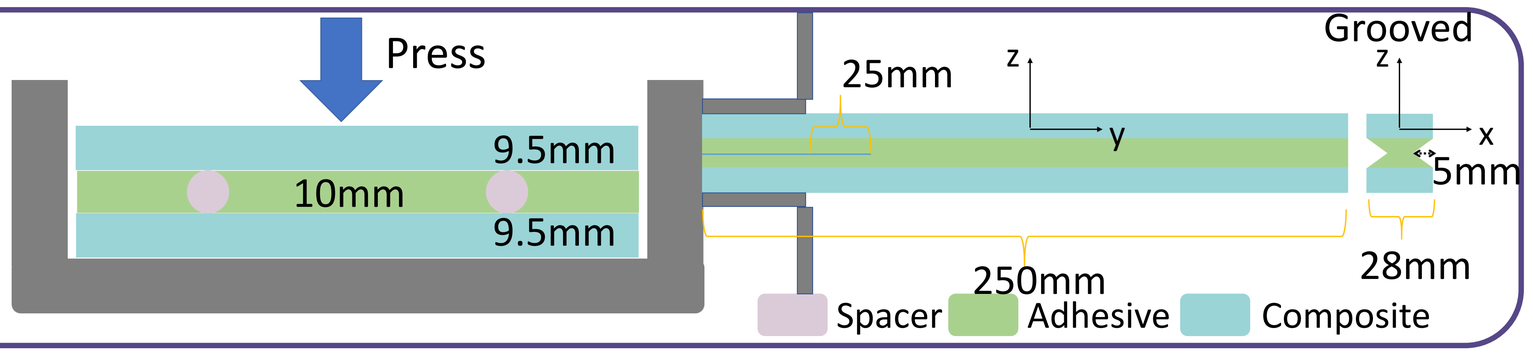
- The increasing length of wind turbine blades leads to the increase of adhesive use in bonded connections
- Adhesive joints in wind blades are much thicker than joints in other fields, reaching several cm, containing voids
- The shape and distribution of the voids influence the fracture behavior of the thick adhesive joints

Objectives

- Manufacturing thick DCB joints with different void contents and achieve cohesive failure
- Study the void content influence on the quasi-static Mode I fracture behavior

Materials and manufacturing

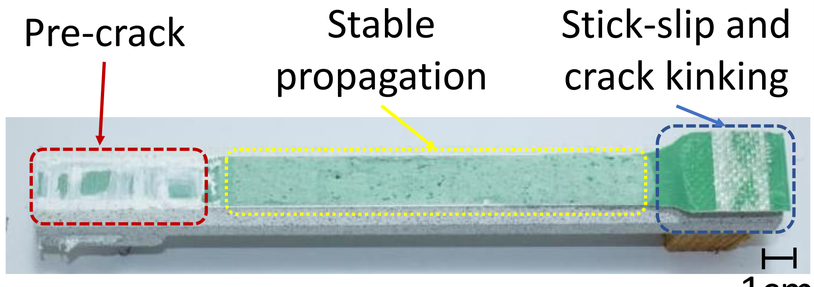
- Adherend: $[90/0]_{7s}$ cross-ply composite
- Adhesive: High viscous SikaPower®-830
- Thickness control by spacers and pressing
- Grooved geometry



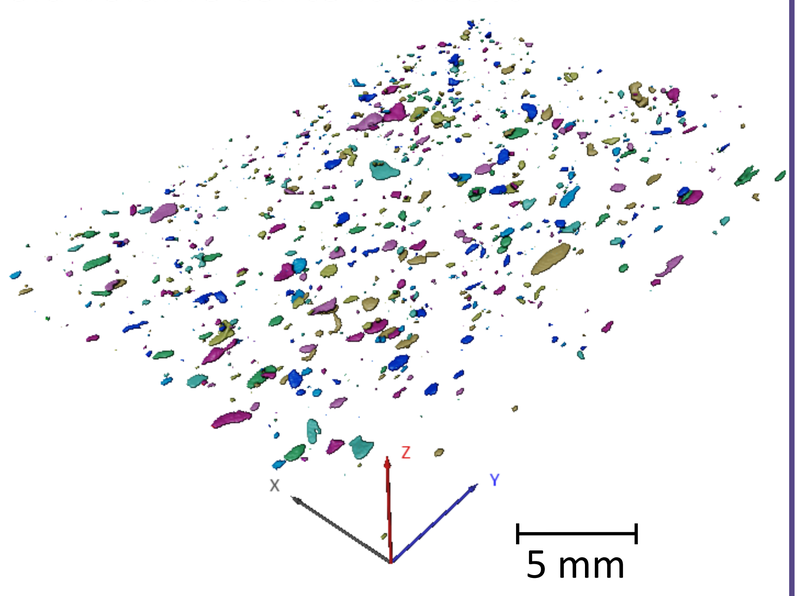
Tests and Results

- Results shows below with fracture surface, X-ray scanning void distribution picture and ERR curves
- Stick-slip propagation: unstable propagation with fracture surface color change
- Crack kinking: crack propagation direction changes

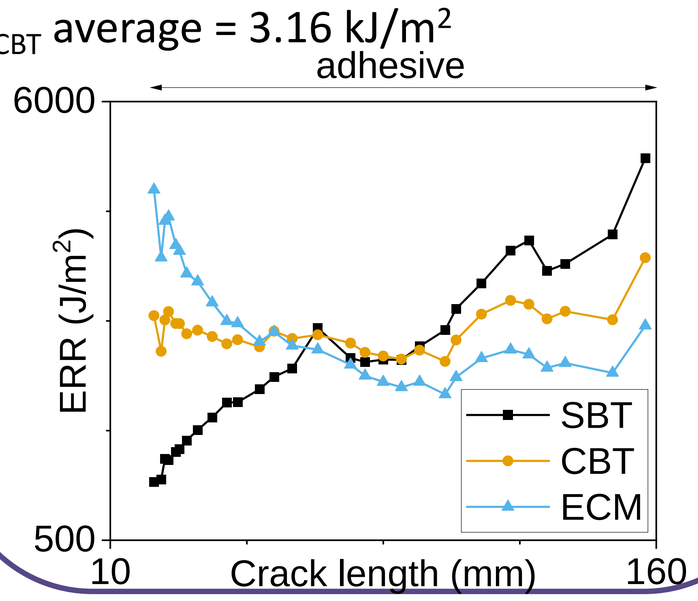
Low void content



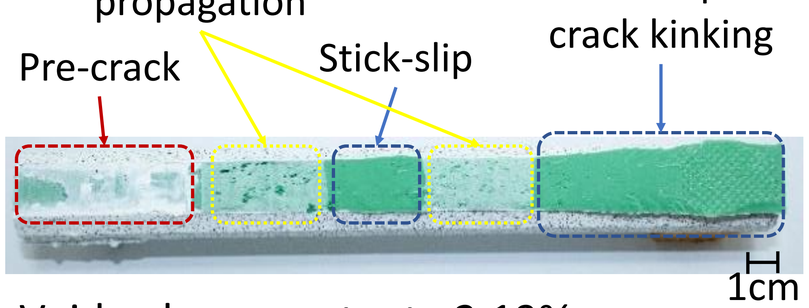
Void volume content: 0.39%



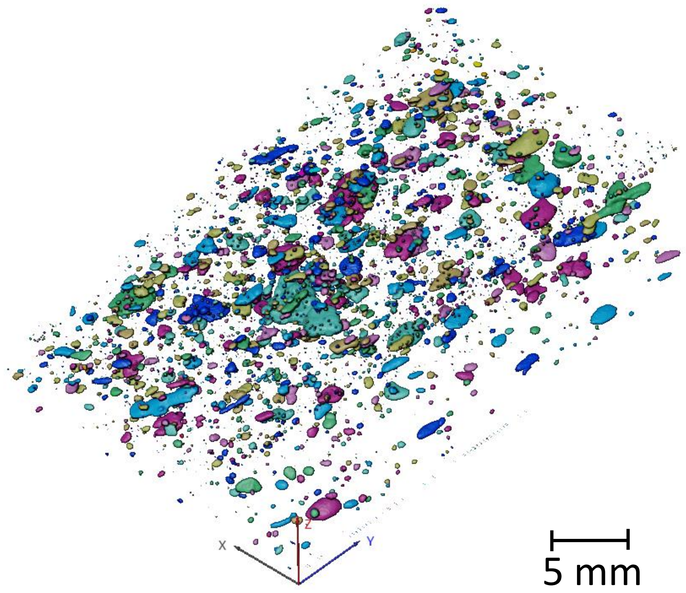
G_{CBT} average = 3.16 kJ/m²

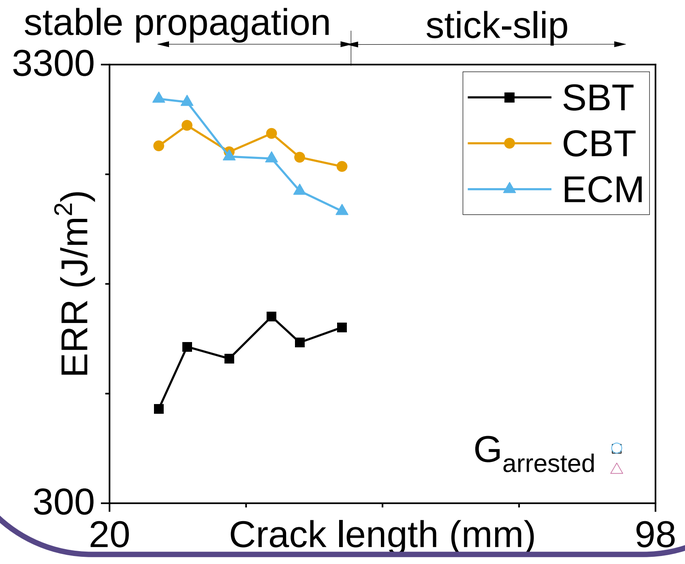


Medium void content

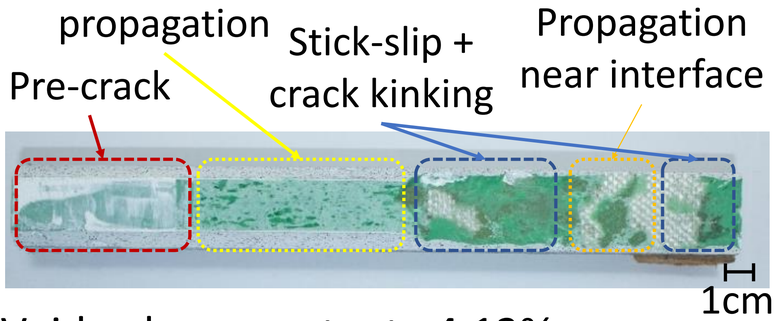


Void volume content : 2.19%

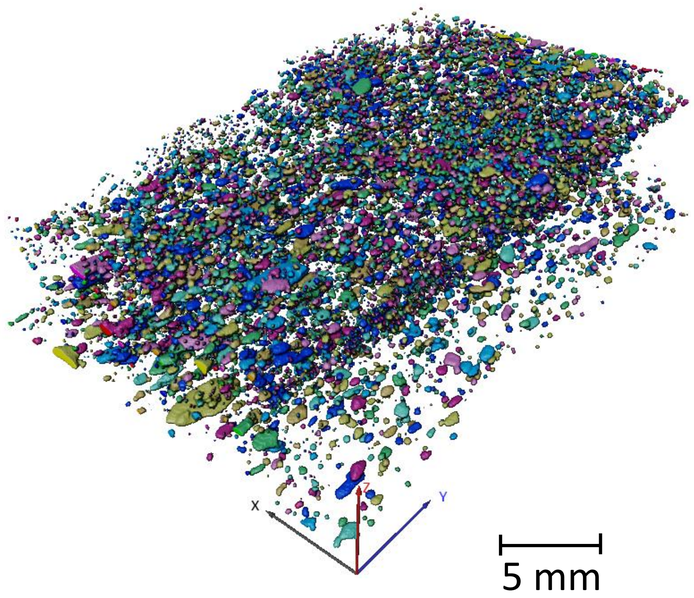




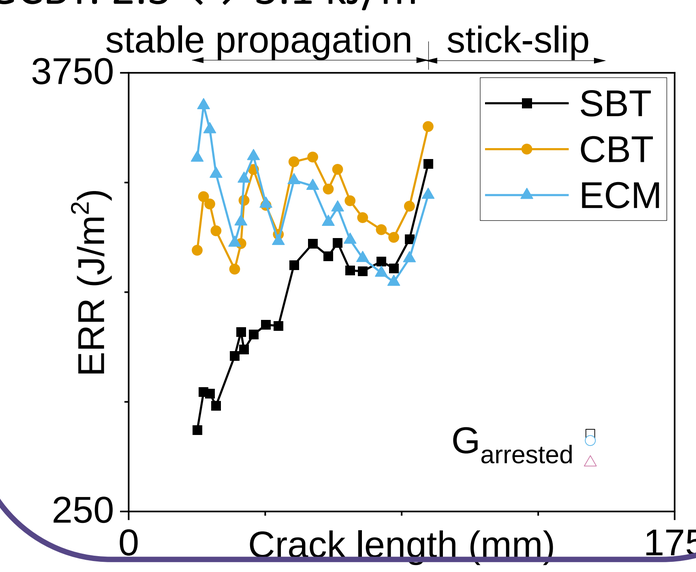
Large void content



Void volume content : 4.13%



GCBT: 2.3 ↔ 3.1 kJ/m²



Conclusion

- Voids always exist within thick adhesive layers and large voids ahead of the crack tip can lead to unstable crack propagation
- Small void content is beneficial for stable crack propagation without crack kinking
- Large void content can result in fluctuating ERR curve or more complicated behavior
- Fracture will prefer to choose the path with voids, which consumes less energy