Mixed Mode Fracture Mechanics of Wood Welded Joints:
Two Dimensional Fracture Criterion for Beech Welded Joints

Motivation & Objectives
Recently, linear friction welding has been applied to wood to make wood welded joints at BFH. The behavior of this type of joints for beech (Fagus Sylvatica) was studied previously for mode I and II; however, the behavior of this joint for mixed mode was unknown.

The aim of this project is to compute the energy release rate of beech welded joints and establish a fracture criterion trough experimental Arcan tests, Mixed Mode Bending tests and finite elements simulations.

Welding of Beech Joints
The welding process of the specimens required for the welding tests were done using a linear friction welding machine Branson M-DT24L. The parameters used for the welding process were a welding time of 9.4 [s], an amplitude of 3 [mm] and a pressure of 1.5 [MPa].

Specimens Preparation
Machining, Welding, Gluing

Arcan Specimens
Experimental test Outputs: Load, Displacement

Finite Element VCCT Model Outputs: Energy Release Rate for mode I and II

Compliance and Reduced methods to find ERR
Outputs: Energy Release Rate for mixed mode GII/GT = 0.3

Comparison and Validation 2D Fracture Criterion

Arcan Test

Arcan Specimens
Experimental test Outputs: Load, Displacement, Crack Length

Arcan Device
Loading angles: 0° / 45° / 60° / 75° / 90°

Mixed Mode Bending Test

The MMB test is made in order to validate the Arcan results. It is considered as a more precise test; however, this test is more laborious and it demands longer time. The MMB was realized for a mixed mode ratio of GII/GT = 0.3. The results are the load, displacement and crack length that was captured with a camera. The compliance method and other reduced methods were used to compute the ERR of the samples. The figure of the right shows the load displacement curves for the specimens and the result of a FE model created using cohesive elements. The input of the model was the average initiation energy release rate calculated.

Results and Conclusion
In summary, the 2D fracture criterion established for beech wood joints enables to calculate correctly the fracture initiation values for different mode mixtures. The criterion has good agreement with the values for mixed mode GII/GT = 0.3 with the MMB and the modes I and II are from literature. In short, the area over the curve is defined as the safe zone to work in.