Karlsruher Institut für Technologie

Institut für Baustatik
Leiter: Prof. Dr.-Ing.
habil. W. Wagner

Development and Validation of Modelling Methods to Predict TCW Joint Strength

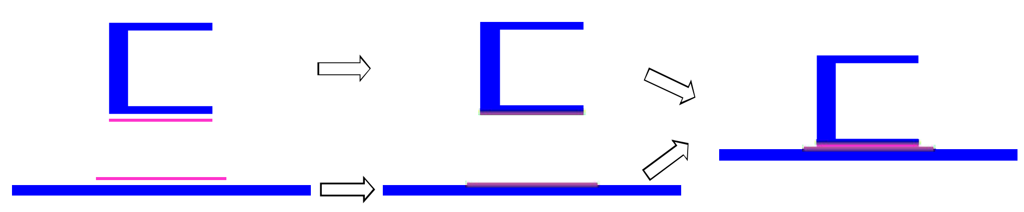
Franziska Wöhler BSc.

1. Introduction

Due to their superior strength- and stiffness-to-weight ratios in comparison to metals, composite material have a wide range of application. However, one of the main aspects currently limiting the applications of composites on large scales is their relatively high cost in relation to the raw materials, manufacturing and assembling. The objective herein is to predict values for TCW joint tests with simulations in MSC.Patran/MSC.Marc. Experimental testing is however still required, at least to verify model simulations, but is kept to a minimum.

2. Thermoset Composite Welding

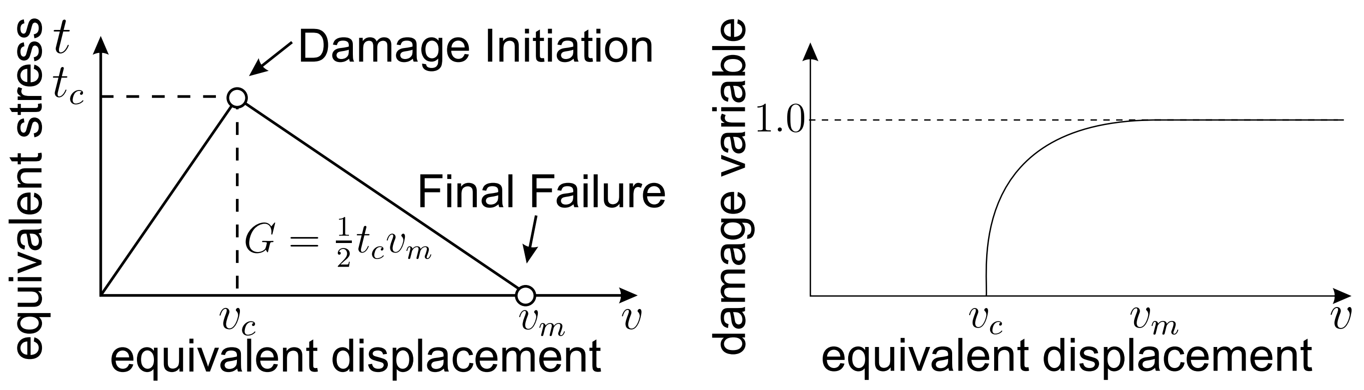
TCW is a welding process that is divided into a co-curing and welding stage. Hereby, a polymer layer gets integrated between composite prepregs and under moderate heat and pressure results in high-strength joints. For this joining technique, no extensive surface preparations are necessary.



Possible failure modes are adhesive or cohesive ones depending on the position the failure appears. Advantages are the robustness, excellent chemical resistance and low water uptake, all without cleanroom conditions required.

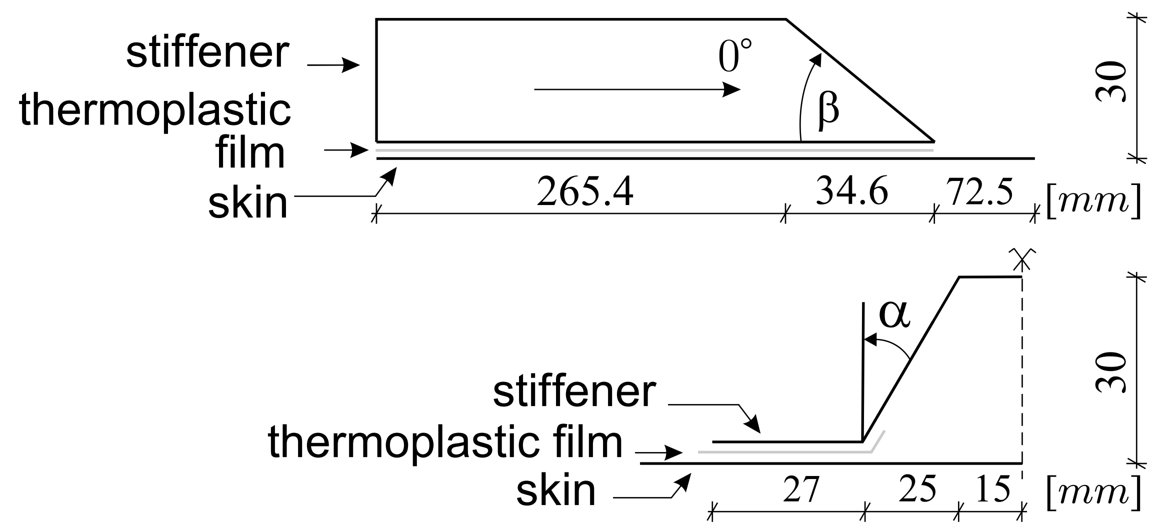
3. Cohesive Zone Modeling

Damage processes, crack propagation and delamination in composite materials are often described with Cohesive Zone Models. Hereby, the damage process is replaced by a local stress-displacement relationship prescribed as a material property set implemented to discrete interface elements. Important parameters are the traction t and cohesive energy G. The damage variable evolves when damage initiates and reaches from 0 to 1 when the discrete interface element is fully damaged.

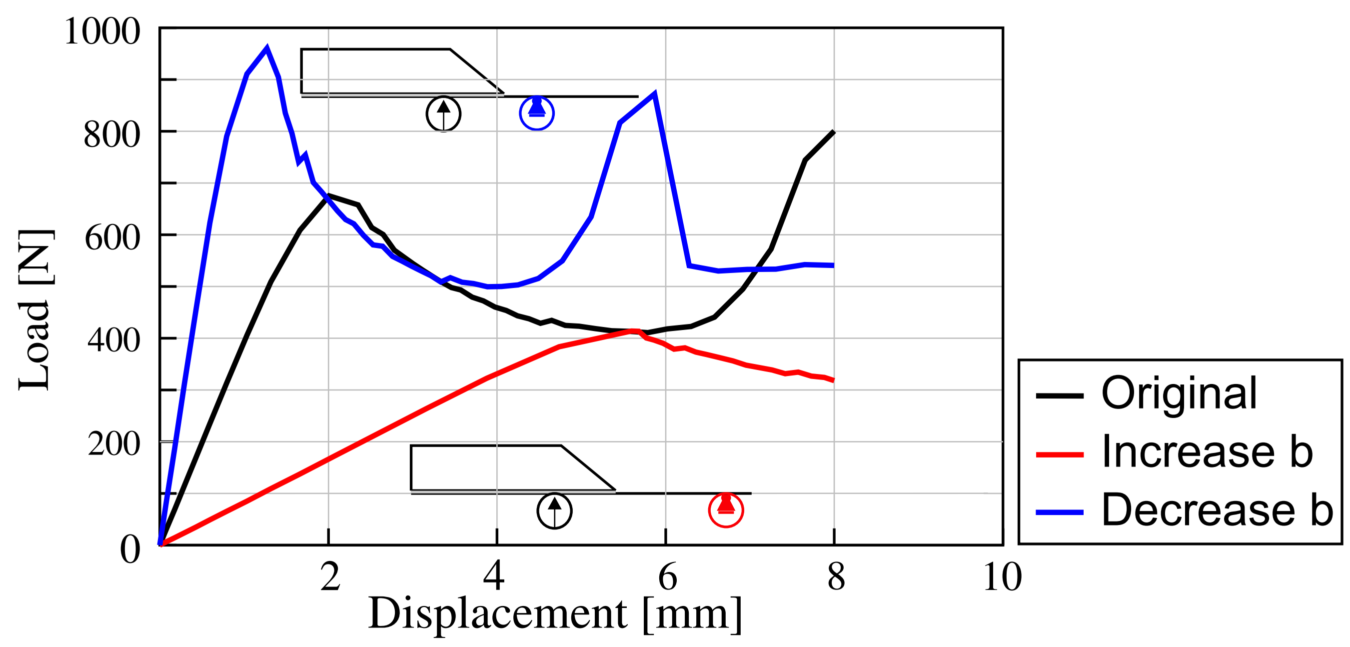


4. Simulation results

Simulations were considered to predict delamination failure for the opening mode under normal loading (Mode I) and sliding shear (Mode II) with presumed CZM and maximum strain failure criterion for composite laminates. Mode I simulations were set up as a four-point-bending test and Mode II was loaded under pure tension.



Investigations for Mode I sub-elements included damage propagation and failure prediction. Mode II investigations concerned failure and damage prediction and laminate thickness variations. Following, Mode I load-displacement results are presented respectively.



Normal loarding was highly influenced by the roller position, sliding delamination was affected by the laminate thickness. Both simulations reacted similar to changes in CZMs and a noticeable feature is that as soon the load drops, the delamination area increases massively.

5. Conclusion

TCW joints can be successfully predicted taking a calibrated CZM into account and considering variations of parameters for the implemented cohesive material and failure criteria of laminates. Parameter studies gave an improved understanding on material and geometry parameter influence on TCW joint strengths. Further investigations shall consider geometry and CZM paramter aspects.