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# MODELLING AND SIMULATING THE FORMING OF FLAT STACKS OF UNIDIRECTIONAL DRY REINFORCEMENT

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As a response to the weight to cost trade-off for next-generation aircrafts, Hexcel has developed HiTape®: a unidirectional dry carbon reinforcement with a thermoplastic (TP) veil on each side designed for aircraft primary structures. One privileged high volume automated production route consists in Dry Fibre Placing flat reinforcement stacks with an Automated Fibre Placement machine, forming them through specific processes, and inject or infuse the resin to yield the final composite part. The aim of this work is to develop a model that can simulate the forming step in order to predict the geometry and distribution of properties of the formed stack for process optimisation and reverse engineering. Extensive work has been carried out on prepreg and dry woven fabrics forming behaviour and simulation, but the interest for dry non-woven reinforcements has emerged more recently.

Tension in the fibre direction, out-of-plane bending, along with inter-ply friction are identified as the main mechanisms controlling the HiTape® response during forming. Bending is characterised using a modified Peirce's flexometer. Inter-ply friction is studied using a "pull-through"-type equipement.

A large deformation continuous approach at ply-scale is selected. The reinforcement is modelled in the Zset framework [1] with 3D quadratic elements representing the fibrous layer and governed by a hyperelastic behaviour; together with cohesive zone elements [2] describing the specific inter-ply behaviour due to the presence of the TP veil, and associated with a pure sliding behaviour (no opening allowed). Experimental tests are first simulated both to verify the robustness of the models and to identify the constitutive laws.

## REFERENCES

[1] http://www.zset-software.com

[2] E. Lorentz, A mixed finite element for cohesive zone models. *Computer Methods in Appl. Mech. and Engng*, Vol. **198**, pp. 302–317, 2008.