Simulation of Frictional Contact Interactions Between Heddles and Yarns Withing Jacquard Harness of Weaving Looms for 3D Interlock Fabrics

S-E. Mermouli[1,2], P. Del-Sorbo[2], D. Durville[1], B. Tranquart[2] and D. Coupé[2]

[1] Université Paris-Saclay, CentraleSupélec, ENS Paris-Saclay, CNRS, Laboratoire de Mécanique Paris-Saclay, 91190 Gif-sur-Yvette, France
Email : salah-eddine.mermouli@centralesupelec.fr
[2] SAFRAN TECH / SAFRAN COMPOSITES, 91760 Itteville, France

Key Words: *Jacquard harness, Frictional contact interactions, Finite element simulation*

The use of 3D interlock fabrics for manufacturing composite parts enables to make stronger and lighter parts. These fabrics are produced using Jacquard weaving looms, in which a large number of heddles are gathered within the so-called Jacquard harness, and are operated to move the warp threads up and down to allow the insertion of weft threads. The relative motions between the warp threads and the heddles induce frictional interactions. Under confining effects due to the high density of heddles and threads within the harness, these interactions can generate congestion mechanisms that can damage the threads or block the motion of threads and cause weaving errors.

A finite element approach with an implicit solution scheme [1] is used to simulate the interaction phenomena that occur in such harnesses. As all the elements involved in the harness can be considered as slender structures, the problem is set as a frictional contact interactions problem between moving components modelled as beams. A specific constitutive model is considered for the warp threads to account for their multifilament structure. Special attention is paid to the detection and the following of interactions between beam elements undergoing large displacements.

Warps tensile load, heddles and warps positioning are all implemented according to the actual operating conditions. The motions defined by the loom card for shedding are prescribed as displacements to the upper ends of the heddles.

The resulting forces required to move the heddles are obtained as simulation results. The influence of the reed in lateral confinement is underlined. Furthermore, using moving rigid planes driven by force, it is possible to prescribe a lateral force to account for the pressure exerted by the rest of the harness on a set of few ten heddles and threads. Simulations results in terms of forces are compared to experimental data [2].

Simulation results for a 5-layer interlock fabric with 20 warp threads will be presented, taking into account the taking-up phase and showing the evolution of the forces applied to the heddles over a few dozen shed openings.

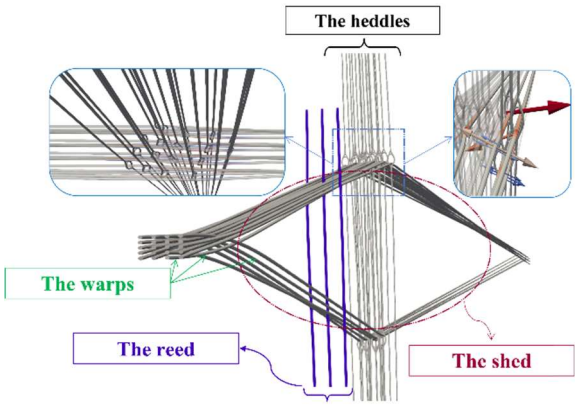

Figure 1 : Simulation model at shedding phase showing frictional contact interactions

REFERENCES

[1] D. Durville, *Contact-friction modeling within elastic beam assemblies: an application to knot tightening* Computational Mechanics, vol. 49, no. 6, pp. 687–707, 2012.
[2] J. Walther, and al. *Yarn Damage Conditions Due to Interactions During Interlock Weaving Process: In-situ and In-lab Experiments*. Applied Composite Materials, 1-18, 2021.