Experimental Investigation of Reinforcement Fabric Cohesion in order to Prevent the Tow Sliding Defect

M. M. Salem[1,a)] E. De Luycker[1, b)] M. Fazzini[1,c)] P. Ouagne[1, d)]

[1] ***University of Toulouse, INP-ENIT, LGP, 47, avenue d'Azereix, F-65016 Tarbes, France***

[a)] *Corresponding author: mohamed-medhat.salem@enit.fr*
[b)] *emmanuel.de-luycker@enit.fr*
[c)] *marina.fazzini@enit.fr*
[d)] *pierre.ouagne@enit.fr*

Abstract. During complex shape forming process of textile woven reinforcement, tow sliding may happen. This defect was observed in the work of Ouagne et al. [1] during the forming of single layered flax plainweaves. The importance of applying a relatively low blank-holder pressure was highlighted to prevent the appearance of the defect as shown in Figure 1. Allaoui et al. [2] came to similar conclusions for the forming of an interlock reinforcements on a highly curved geometry. Nezami et al. [3] experienced similartow sliding on a boomerang shaped tool while forming single layer reinforcement under homogenous blank holders' pressure.

Figure 1: Tow sliding defect during complex shape forming of a flax plain weave fabric

Labanieh et al. [4] noted the effect of tow's tension, shear angle, relative orientation of the reinforcement to the tool, fiber/fiber and fiber/tool friction on the tow sliding and proposed an analytical framework to determine the friction force imposed by the blank holders causing tow sliding. To this day the tow sliding defect has yet to be fully understood and accurately simulated [5] eventhough this was already performed by Gatouillat et al [6] aiming towards an individual geometrical modeling of tows in a woven structure to reproduce the sliding defect.

As noted in [3,4] the fiber/fiber and fiber/tool frictions are heavily influenced by the reinforcement's relative orientation, tension and thickness which in turn is dependent of the shear angle. A simple friction test (slide test) is therefore inadequate to describe the actual friction mechanics taking place during the shaping process. Thus a fabric cohesion test has been developed. The test device consists of a picture frame developed in the "Laboratoire Génie de Production de Tarbes" that enables applying tension individually to each tow while shearing the whole reinforcement. The frame is then placed within the column of a mechanical testing machine so that to perform pull out tests on unrestrained tows.The pull-out test force can be related to the cohesion of the fabric and then to the appearance of tow sliding defects. The link cohesion of the fabric and tow sliding appearance will be presented for different woven fabric architectures and natures of the tows.

References

[1] P. Ouagne, D. Soulat, J. Moothoo, E. Capelle, S. Gueret, and S. G. P. Ouagne, D. Soulat, J. Moothoo, E. Capelle, "Complex shape forming of a flax woven fabric; analysis of the tow buckling and misalignment defect.," Compos. Part A, vol. 51, no. 1, pp. 1–10, Aug. 2013.

[2] S. Allaoui, G. Hivet, D. Soulat, A. Wendling, P. Ouagne, and S. Chatel, "Experimental preforming of highly double curved shapes with a case corner using an interlock reinforcement," Int. J. Mater. Form., vol. 7, no. 2, pp. 155–165, Jun. 2014.

[3] F. NosratNezami, T. Gereke, and C. Cherif, "Analyses of interaction mechanisms during forming of multilayer carbon woven fabrics for composite applications," Compos. Part A Appl. Sci. Manuf., vol. 84, pp. 406–416, May 2016.

[4]A. R. Labanieh, C. Garnier, P. Ouagne, O. Dalverny, and D. Soulat, "Intra-ply yarn sliding defect in hemisphere preforming of a woven preform," Compos. Part A Appl. Sci. Manuf., vol. 107, pp. 432–446, Apr. 2018.

[5] P. Boisse, N. Hamila and A. Madeo, "Analysis of Defect Developments in Composite Forming," In P.W.R. Beaumont, C. Soutis, and A. Hodzic: The Structural Integrity of Carbon Fiber Composites. Springer International Publishing. 2017.

[6] S. Gatouillat, A. Bareggi, E. Vidal-Sallé, and P. Boisse, "Meso modelling for composite preform shaping - Simulation of the loss of cohesion of the woven fibre network," Compos. Part A Appl. Sci. Manuf., vol. 54, pp. 135–144, 2013.