SPECIFIC PROPERTIES OF 3D WARP INTERLOCK CARBON FABRICS FOR COMPOSITE MATERIAL

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ABSTRACT

3D warp interlock fabrics have been used in different industrial fields due to their distinct mechanical properties, mainly thanks to the binding yarns that are in their thickness direction. According to the different types of 3D warp interlock fabrics (Hu, 2008) given by the type and position of the binding warp yarn into the woven structure, several architectures can be obtained with different mechanical performances while produce on the same weaving loom and process parameters (Corbin et al., 2018). Based on the latest complete definition of 3D warp interlock fabrics provided by Boussu et al. (2015), several types of 3D warp interlock fabrics as: Orthogonal/Through-the-thickness, Orthogonal/Layer-to-layer, Angle/Through-the-thickness, Angle/Layer-to-layer, have been produced on the same dobby loom with the same 6K carbon yarns both in the warp and weft directions. Special attention have been paid during the warping and weaving of the carbon yarns to avoid any fibre damages as already measured by Rudov- Clark et al. (2003) while producing 3D warp interlock fabrics with continuous multi-filaments yarns as E-glass, or which can lead to severe loss of strength as demonstrated by Archer et al. (2010) during the 3D weaving of carbon yarns. Thanks to the prototype weaving loom, based in the GEMTEX laboratory, dedicated for 3D warp interlock carbon fabrics, high quality production in terms of defects rate and general uniformity has been reached without any serious yarn damage, keeping the same mechanical strength from the bobbin to the fabric. Thanks to our mechanical characterization of fabrics, product parameters as the weave diagram pattern of binding warp yarns or the presence of stuffer warp yarns have led to reveal some significant and distinct breaking mechanisms. While 3D warp interlock carbon fabrics without stuffer yarn have higher breaking force in warp direction than in weft direction, fabrics with stuffer yarns shown opposite behaviour. Also, it was determined the fabrics that are differentiated by weave diagram pattern have quasi- linear increase at first then follow force decreasing as sharp, gradually or two peaks for tensile force versus strain behaviour because of different warp shrinkage values into the fabric. The specific behaviour of this different type of 3D warp interlock carbon fabrics can help the designer/mechanical engineer to easily choose the suited architecture to be used and formed to the final 3D shape of its composite material.