Three-dimensional Woven Auxetic Material as a Fibrous Reinforcement for Composites

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Abstract: Efforts have been undertaken in recent years to develop and produce materials with auxetic behavior, characterized by a negative Poisson's ratio. These materials exhibit distinct properties compared to conventional materials, particularly in terms of stiffness, impact resistance, shear strength and fracture resistance. Additionally, the Poisson's ratio appears to significantly influence the natural vibration frequencies of these materials due to variations in the local density of the material [1].

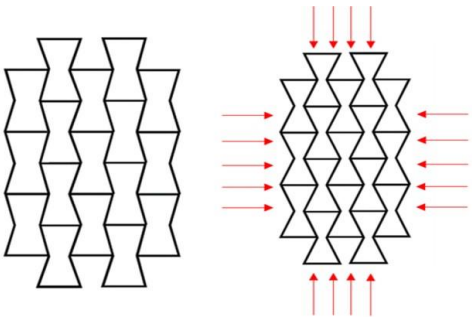

Figure 1 Auxetic behavior under compression loading

In literature, several architectured materials known as auxetics have been identified and studied [2]. Among these, the hexagonal auxetic honeycomb demonstrates notable potential concerning mechanical performance, Poisson's ratio, and textile feasibility [3]. However, fewer studies have been conducted on fibre-reinforced auxetic composite materials.

In general, fibre-reinforced composite materials represent promising candidates for achieving satisfactory mechanical properties with reduced mass. The incorporation of auxetic reinforcements in these materials offers a compelling prospect for achieving a balance between improved mechanical properties and enhanced damping. Specifically, this work proposes investigating the substitution of elastomeric silent blocks in the automotive domain with auxetic composite materials such as the reentrant hexagonal structure.

The production of the three-dimensional hollow woven reinforcement is carried out using a manual weaving loom. To achieve this, multiple layers of fabric are superimposed and bonded to create a honeycomb structure. The thread employed is a bi-component wrapped thread comprising a thermoplastic resin and aramid multifilaments, which was developed in laboratory to reach the requirements of the project specifications. A 15° angle was chosen following a parametric study. After shaping to obtain an auxetic geometry, the final composite is obtained by thermoforming and will then be subjected to mechanical tests.

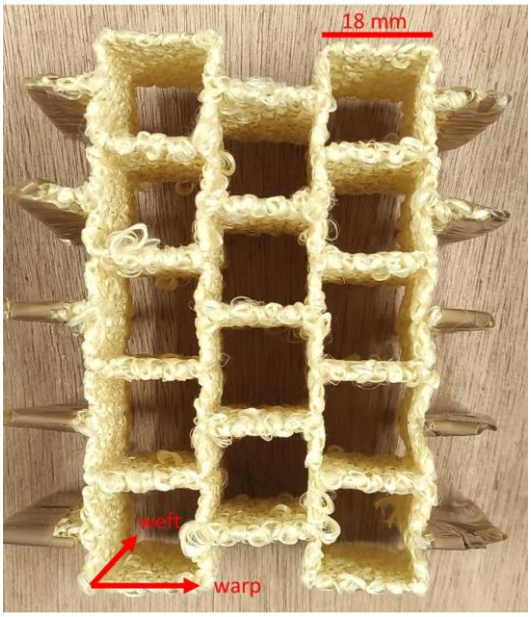

Figure 2 Auxetic composite after thermoforming

Keywords: *auxetic, woven reinforcement, hollow fabric, composite*

ACKNOWLEDGEMENT*: This project is funded by the french Ministery of Defense under the RAPID framework CORPLAUX 2021 – 29 0959.*

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