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Auxetic lightweight composite panels – enhanced mechanical properties and vibration damping in transportation structures

Auxetic materials and structures are characterized by possessing an overall negative Poisson's ratio and, thus, are able to expand/contract in tension/compression.

This behaviour does not contradict the imposed thermodynamic limits on isotropic solid bodies by the classical theory of elasticity that defines the allowable values of Poisson's ratio as being confined between -1 and 0.5. In practical terms, due to this counterintuitive deformation behaviour, these materials are expected to possess high relative shear and fracture resistance, elevated relative hardness and superior vibration damping.

The referred characteristics may be extremely advantageous in transportation structures, given that they may allow the design of components with reduced mass, enhanced riding comfort by mitigation of on-board vibrations and the increased lifespan of mechanical components by the mitigation of vibration induced mechanical fatigue.

Due to the apparent lack of isotropic auxetics in natural states, many researchers have devoted their efforts to the design and manufacture of artificial structures that mimic such behaviour, such as chiral, rotating geometry and reentrant models.

In this study, a novel class of Reinforced Honeycomb and Auxetic Reentrant Auxetic Lattices are presented, being used to show the advantages of negative Poisson's ratio materials in the form of lightweight composite panels. It is shown that the presence of negative Poisson's ratio enhances the static, impact and dynamic mechanical behaviour and, therefore, may be an interesting evolution on new materials for the transposition industry •