Research on advanced 3D hybrid composite construction materials with the utilization of agro-waste fibers and biomass for thermal and acoustic insulation

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Abstract
The production, storage, efficient use, and prevention of waste related to energy are of great significance in today's world, considerably impacting the economies of countries and their relationships and even causing wars. Conservation of energy in general and preventing heat loss is a major concern. At the same time, noise pollution is one of the largest environmental problems in the modern industrial world. The use of novel composite materials showing advanced thermal and acoustic insulation for architectural and human design has become crucial, with the consumption of these materials serving as an indicator of progress in society. As composite materials are composed of a mixture of materials, their recyclability is also a key concern. Current research focuses on studying the thermal, acoustic, and mechanical properties of polymer-based composites reinforced with three-dimensional structures (spacer). The use of natural polymers, biomass, and agro-waste fibers in these structures can enhance the recyclability of the composites. The trapped air between the top and bottom layers in the composites leads to excellent heat insulation properties, and the sound transmission difference can turn them into powerful sound insulators. The deviation of fibrous structure from the center in the composites provides good cohesion properties. The hybridization of natural and synthetic fibers like glass in the fabric of three-dimensional structures can significantly improve their mechanical properties. We hypothesize that tests would indicate how it is possible to achieve desirable thermal, acoustic, and mechanical properties simultaneously by controlling the composition, thickness, and density, as well as the mixing ratio of the composites.