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REVIEW OF THE DOCTORAL THESIS

of M.Sc. Michał Maslej,

title: PROPERTIES OF FURNITURE LIGHTWEIGHT PANELS WITH A PYRAMIDAL CORES

Supervisor: Prof. Dr. Jerzy Smardzewski,
Poznan University of Life Sciences, Faculty of Wood Technology, Department of Furniture Design

Based on the request for the opponent's review, dated July 14, 2023, from the Scientific Council of the Forest Sciences Discipline, Poznan University of Life Sciences, I submit the following review.

Doctoral thesis of M.Sc. Michał Maslej has the character of a set of seven published original scientific papers, which are supplemented by current commentary and discussion. These papers are published in important scientific journals or proceedings of scientific papers from international conferences.

The topic of developing and producing lightweight materials is highly relevant to the furniture industry. In the literature, more research still needs to result in modelling the mechanical properties of light wood-based boards with auxetic cores. Regarding load-bearing capacity, the 3D auxetic lattice structures provide excellent performance and have obvious negative Poisson's ratio effects when loaded uniaxially. 3D cellular structures have unique advantages in terms of absorption at low densities. Therefore, they are promising for applications that require low weight.

The research and the resulting series of scientific papers are aimed at designing the geometry of pyramidal cells and the lattice structure of the core cells of furniture panels and the description of their elastic properties depending on the geometry of single core cells to achieve the required mechanical properties at the lowest relative density of the material. The content and conclusions of the scientific papers, which are arranged in a logical sequence, fulfil the primary goals stated in the doctoral thesis.

The series of papers begins with research that focuses on the effect of temperature and air humidity changes on the stiffness and strength of L-type eccentric joints made of honeycomb panels. As a result of the increasing temperature and air humidity, a significant decrease in the stiffness and strength of the corner joints was confirmed. A new numerical simulation method of stiffness and strength of joints exposed to changes in relative humidity and air temperature was developed. Concerning maintaining quality, this result has practical significance for furniture manufacturers and exporters.

Subsequently, the author focuses on the design of cells with auxetic properties of different geometry to achieve the lowest relative density of the material. The results are mathematical models that describe the relationship between the density of the elementary cell and its geometric shapes and dimensions.

The author uses the latest and most affordable 3D printing technologies in his research to create a pyramid core using various filaments, some with the addition of wood dust. Although the idealized analytical models showed significant differences compared to experimental tests and numerical simulations, it is possible to estimate the dependencies between cell parameters. The research further showed that sandwich panels with an auxetic lattice core, produced by 3D printing from the bio-composite fiber LayWood, are interesting in their ability to absorb impact and low-velocity energy. If there is space in the discussion, please give your opinion on using other suitable filaments, considering their mechanical properties. The author showed that the investigated sandwich panels with an auxetic grid core are characterized by low density and are competitive with paper honeycomb panels. Their bending strength is comparable to reference chipboards of similar thickness.

I positively assess that to achieve the set main goals. A comprehensive approach was taken. The results of the experiments are confronted by numerical modelling. They are processed by statistical methods to achieve the most suitable geometry of the cell cores of the structural panels. At the same time, experiments also verified the validity of the accepted assumptions and the correctness of the used numerical models.

The results and conclusions presented in the doctoral thesis can be a prerequisite for developing new joining methods or design principles influenced by the studied types of lightweight materials. The setting of process parameters when processing lightweight materials is also worth mentioning. These assumptions positively influence the development and innovation of the furniture industry.

Results of the doctoral thesis of M.Sc. Michał Maslej, his publishing activity and previous work experience in furniture manufacturing demonstrate high work commitment, enthusiasm, and a mature scientific personality. He is well-versed in the production and innovation of construction materials used in furniture manufacturing, and future research will be carried out independently by him to meet the standards of his scientific community.

I do state that the reviewed Ph.D. thesis by Michał Maslej meets the requirements determined by Article 13 Section 1 of the Act from March 14, 2003, on academic degrees and academic title and degrees and title in art. Therefore, I do put forward a motion to the Scientific Council of the Discipline of Forestry Sciences of Poznań University of Life Sciences for admitting Michał Maslej to the next stages of the registration and conferment procedure for a doctoral degree.

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Zvolen, 31th July 2023

Assoc. Prof. Nadežda Langová, PhD.