Development of an advanced mathematical model describing the

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In 2022, 216 million m3 of particleboards and high/medium density fibreboard were produced globally [1]. These are produced via the hot pressing of adhesive-treated wood particles or fibres and adhesive. The press is the costliest part of the production process [2] and often determines the plant's production rate. Furthermore, the hot pressing process plays a crucial role in determining the final properties of the wood-based panels.

Due to the importance of the hot pressing process, the wood-based panel industry and associated academia have invested significant time and resources to understand the relationship between the underlying mechanisms to improve final panel properties, such as the vertical density profile (figure right) and process productivity. Among these, there have been a few different attempts to generate a physical computational model of the process. Currently, the only one on the market is VHP 2.0 by Wood Composite Simulations, also known as Prod-IQ. This software adequately models the hot pressing process but still has some limitations when it comes to accurately computing the material densification and stress behaviour, including relaxation.

This thesis focuses on improving the current modelling of these features. To this end, various experimental and theoretical approaches are tested and applied. This includes developing and validating a new mini-press system for the Zwick test machine and developing a simplified density and pressure development model during pressing.

Furthermore, the different mechanical properties of the Burger-Humphrey model (figure left) are evaluated for two different fibre sources. Also, the behaviours of wood fibre mats under differing press schedules and conditions (static and dynamic) are evaluated. This leads to the development of a new theory regarding vertical density profile development and addendums to the current hot pressing model to better simulate the features mentioned above. The impact of natural fibre variation and adhesive content was also investigated.

References

1. – Food and Agriculture Organization of the United Nations, "FAOSTAT," FAO, [Online]. Available: https://www.fao.org/faostat/en/#data.
2. – M. I. M. S. Heiko Thoemen, Wood-Based Panels: An Introduction for Specialists, London, UB8 3PH. England: Brunel University Press, 2010.
3. – H. T. ·. C. R. H. ·. P. E. Humphrey, "Modeling the physical processes relevant during hot pressing of wood-based composites. Part II. Rheology," Holz als Roh- und Werkstoff, vol. 64, pp. 125-133, 2006.

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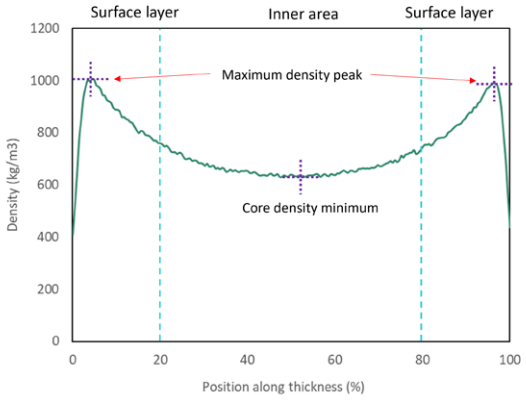
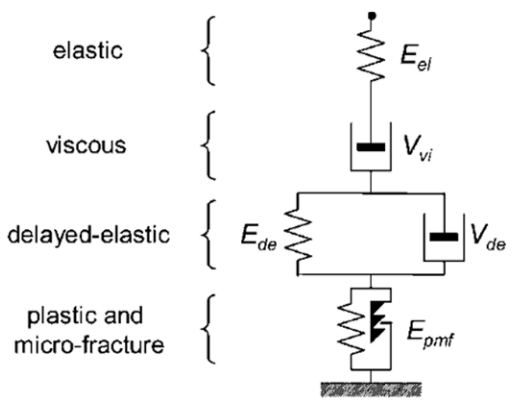


Idealised vertical density profile with relevant performance features highlighted



Representation of the Burgers-Humphrey model from [3], with the different forms of deformation highlighted