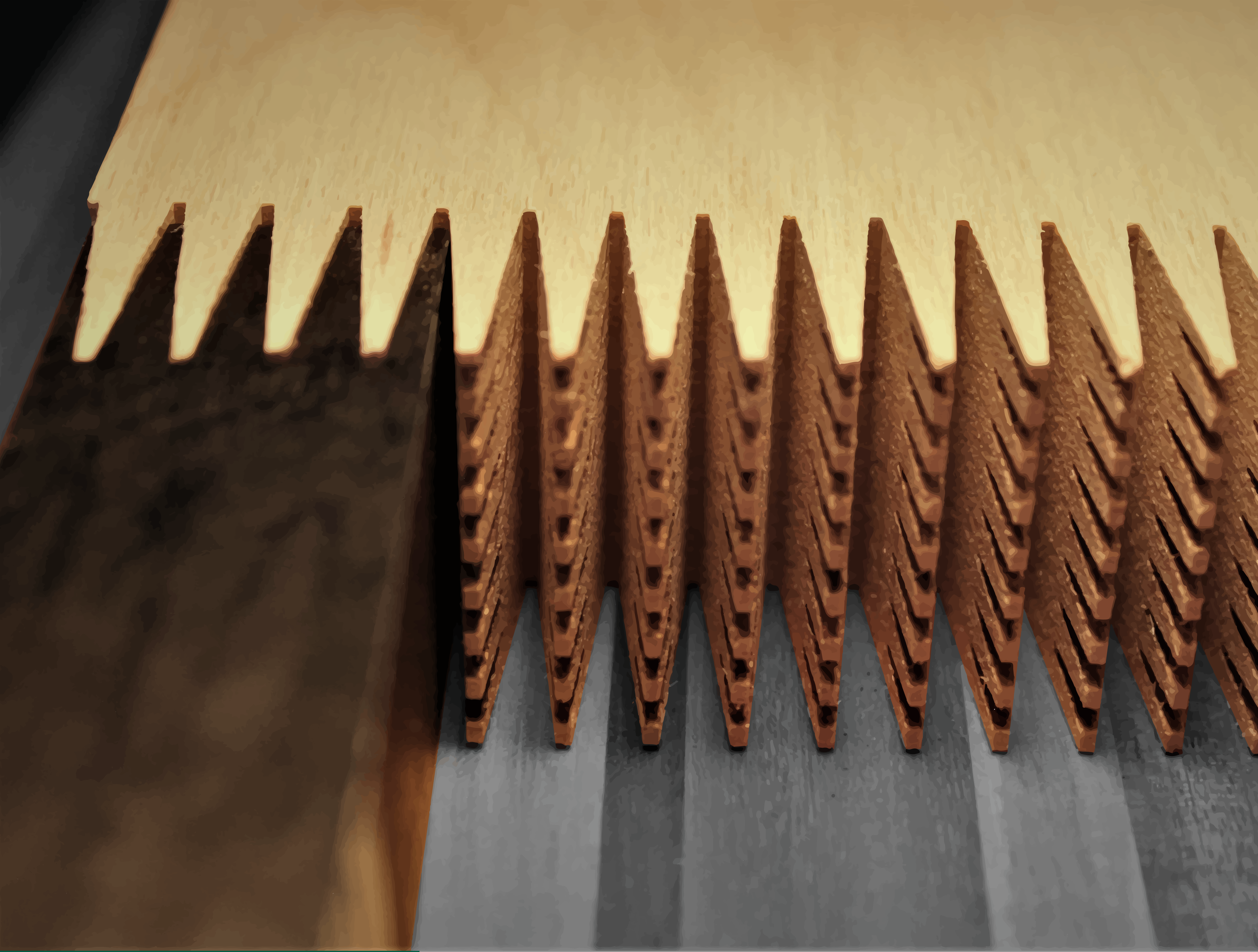

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Accelerating wood densification – Are we going too fast?

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Background

Through transverse compression of wood, the density of the material is increased, improving some mechanical properties, such as hardness and abrasion resistance. This work presents the first results of a large-scale study on the continuous thermo-mechanical densification of wood in a belt press-type machine. A continuous process allows for a higher throughput and less constraints on the length of the input material compared to a batch-type process. Additionally, an integration into the continuous wood processing chain may be facilitated (Neyses 2019).
The press used in this study is a prototype acting as a research and development platform and its working principle is presented in Neyses et al. (2022). The objective was to study the influence of the process parameters and input material properties on the performance of the belt press and the properties of the densified wood to obtain further insights into the possibilities and constraints of the continuous densification of wood.

Keywords: modification, process development, wood compression

Experimental

120 Scots pine (*Pinus sylvestris* L.) boards with dimensions of 39 (T) x 126 (W) x 830 (L) mm were surface-densified to a target thickness of either 32.0 mm or 28.5 mm. The boards contained sapwood and heartwood as well as sound and dead knots of varying size. The press parameters were varied as following: 12.5% or 25% compression ratio, 1-8 m min^{-1} belt speed, and 140-180 °C hot belt temperature. During densification the torque of the three belt-driving motors and the vertical forces was recorded at four positions along the feed direction.

Spring back, i.e., the difference between target thickness and thickness after densification was calculated. After densification, the Brinell hardness was tested according to EN 1534, but measuring the indentation depth instead of the indentation diameter. Knots and their surrounding volume were visually examined before and after densification to determine the challenge these features impose on the densification process.

Results and Discussion

Figure 1 shows the pressing forces during the densification process and the measured properties of the densified boards. A faster belt speed increased the required force and the spring back – most likely due to the reduced contact time between the boards and the heating belt. All tested parameter combinations resulted in the expected increase in Brinell hardness based on experience from static batch-wise densification.

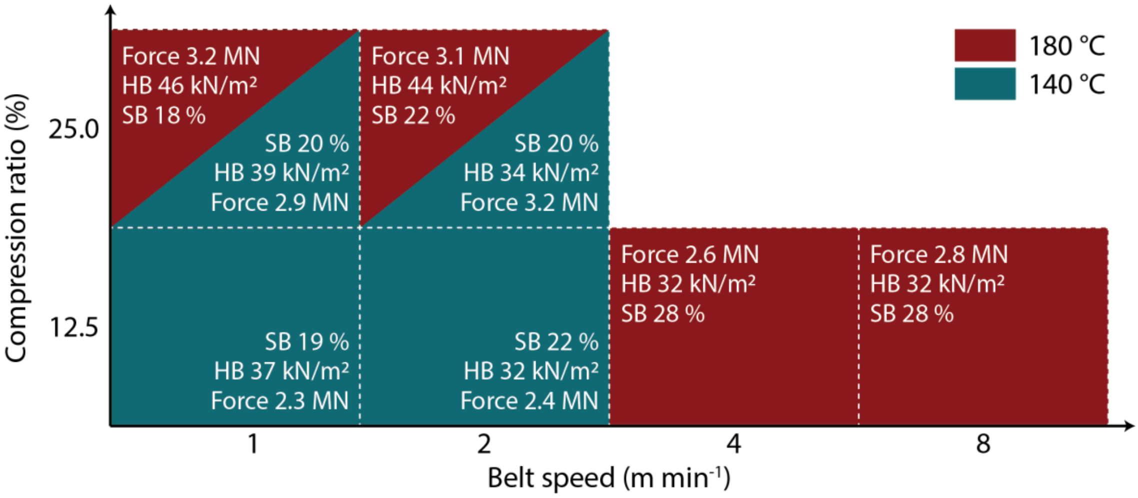

Figure 1. Maximum force measured during densification, Brinell hardness (HB) and spring back (SB) based on the process parameters compression ratio, belt speed and hot belt temperature.

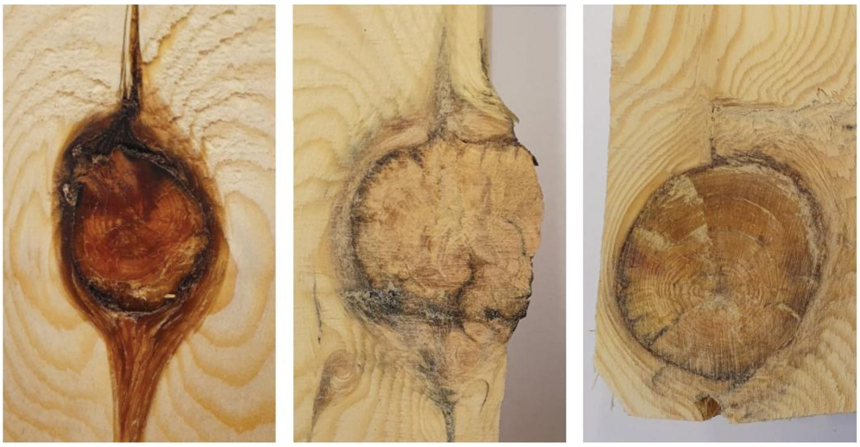

Figure 2. Appearance of different defects occurring around knots with diameters ≳ 30 mm.

Defects around knots such as cracking or bulging occurred depending on the position and size of the knot (Figure 2). This may be reduced by specific selection of the input material. Large sound knots with diameters > 60 mm led to a fivefold increase of the torque (7500 Nm) required from the belt-driving motors to feed the board through the press compared to knot-free sections. Besides compression ratio and process speed, knots could be one of the limiting factors for the process.

Conclusions

The tested parameters were all within the capabilities of the press and the densified boards exhibited the expected increase in Brinell hardness. Higher process speeds can hence be tested, the stresses large knots impose on the belt press construction have to be taken into account.

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