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STSM REPORT

COST Action: FP1006
STSM title: Internal vapour pressure of plywood during hot pressing process
Applicant: Mr Jussi Ruponen, M.Sc. (tech.)
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Location: Thünen-Institut für Holzforschung / Thünen Institute of Wood Research, Hamburg, Germany
Host: Dr Martin Ohlmeyer, Thünen-Institut für Holzforschung / Thünen Institute of Wood Research, martin.ohlmeyer@ti.bund.de

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STSM Scientific Report Contents:

1. Purpose of the STSM

The objectives for this STSM were (1) to learn to use the two available pieces of measuring equipment that are designed to observe the development of internal vapour pressure and temperature within wood based panels and (2) to record data using instruments not available at Aalto University. Additionally, (3) such a collaborative visit would enable experiencing and learning some of the best practices applied in a colleague organisation.

The topic of my doctoral studies is "Self-bonding of wood" which includes, for instance, welding of wood as well as binderless bonded plywood, i.e. self-bonded plywood. The idea for this STSM originates from the challenges to understand and control the internal vapour (or gas) pressure during the hot pressing process. The same applies partially to ordinary plywood as even though the process is controlled the knowledge about how the internal vapour pressure develops during hot pressing is very vague. The special challenges of self-bonded plywood originate from the veneers that are moister than the veneers for ordinary plywood.

2. Description of the work carried out during the STSM

The measurement instruments are designed for especially MDF and particleboard but they have been successfully applied also with OSB. Previously, one of the pieces of measurement equipment was once successfully applied with veneer based products (LVL) but the other trials were unsuccessful so far. Therefore, a big share of the STSM was needed for testing various ways to arrange the measurements to ensure reliable results.

In the Thünen Institute of Wood Research there were two types of instruments available. A system with sensors outside the lay-up (called Pressman) is depicted in Figure 1. The first sealing application was with MDF fibres, shown on left, and on the right the last sealing application with silicone. One experiment was completed also without any sealing and this was unsuccessful as expected. Also the fibre filling was unsuccessful as it could not stand the pressure but leaked.

Figure 1. Pressman with a 300 mm steel tube and sealing with both MDF fibres (left) and silicone (right).

The other piece of measurement equipment was borrowed from GreCon and it was based on wireless chips that were placed within the lay-up and activated and read with a special reader device. The whole system is designed and manufactured by GreCon and it is called Easylog. The parts of this system are shown in Figure 2.

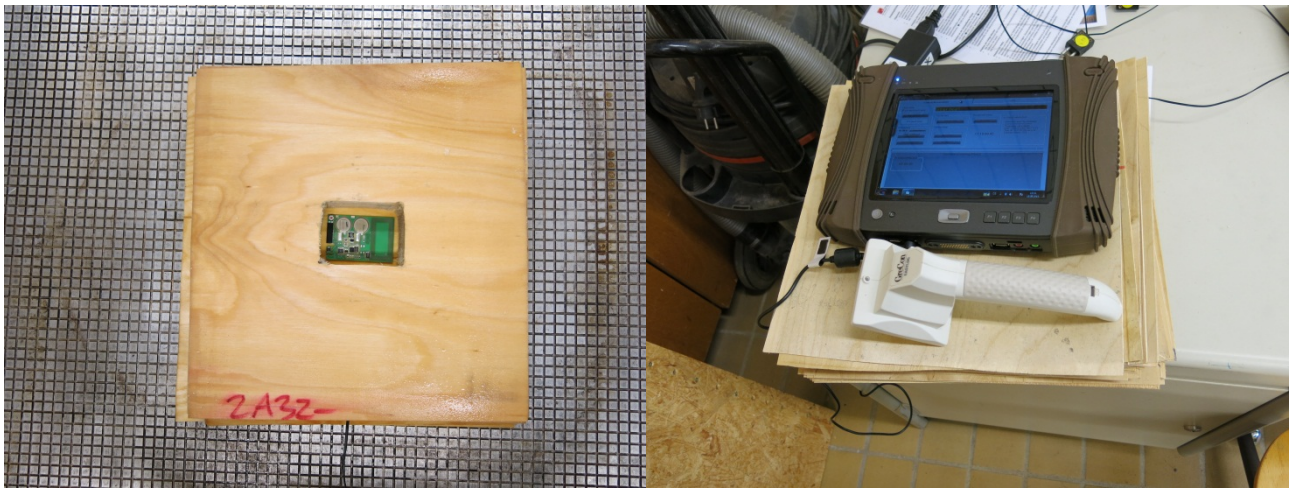

Figure 2. On the left an Easylog chip placed into a hole cut to a lay-up. Before putting the lay-up into the press several surface veneers were placed above the lay-up shown. On the right the reader and a tablet for controlling the measurement and collecting the data after reading it from the chip.

Most of the experiments were completed with veneers conditioned at a RH 65 % and a temperature of 20 °C. In this case the veneers reached a MC of about 10 % and the results are somewhat comparable to ordinary plywood production as when certain parameters rule the proportional amount of water in lay-up is in the same range, 11–13 %. The parameters affecting the total water content are the moisture content of the veneers (e.g. 4 % on average), water content of the adhesive (e.g. 50 %) and the adhesive spreading (e.g. 150 g/m^2). The total water content of 12-13 % is reached with the aforementioned values and a veneer thickness of 1.5 mm. Due to the comparability also ordinary plywood production may benefit from some of the results. However, as water is distributed differently (in adhesive vs. in wood) the comparability is limited.

As self-bonding phenomenon has shown to be very effective with soaked and green veneers some experiments were also completed with soaked veneers.

3. Description of the main results obtained

Both pieces of measurement equipment were finally through trial and error successfully applied even though the results are partly speculative. Moreover, the results from both devices were in line even though it was finally impossible to apply them simultaneously and therefore in secured identical circumstances.

An example data set is illustrated in Figure 3. This data is collected with Easylog system and it shows that the internal gas pressure reaches its maximum value 250 kPa after approximately 1550

seconds of hot pressing (counting from timestamp 1). This is about 50 seconds after the first decrease of mechanical compression (the pressure was dropped stepwise as in ordinary plywood production). Figure 3 shows also that the internal gas pressure does not begin to increase before the temperature reaches 100 °C also in the core part of the lay-up. Therefore, we may assume that even though one of the factors influencing internal gas pressure is mentioned to be gaseous compounds in the void spaces of wood and lay-up, their effect is very minor. Another factor, volatile organic compounds from thermal degradation of hemicelluloses cannot be distinguished from vapour. Even though the VOCs neither affect greatly the internal gas pressure compared to vapour we should not say that the graph illustrates the internal vapour pressure.

Probably the most increasing pieces of information are the range of internal gas pressure which is much more higher compared to MDF (e.g. 100 kPa) and PB (e.g. 70 kPa) production as well as the very moderate rate of degasing, i.e. the decrease of internal gas pressure beyond the peak value. So even though mechanical compression was dropped in six steps it did not have a big influence to the internal gas pressure until opening the hot press.

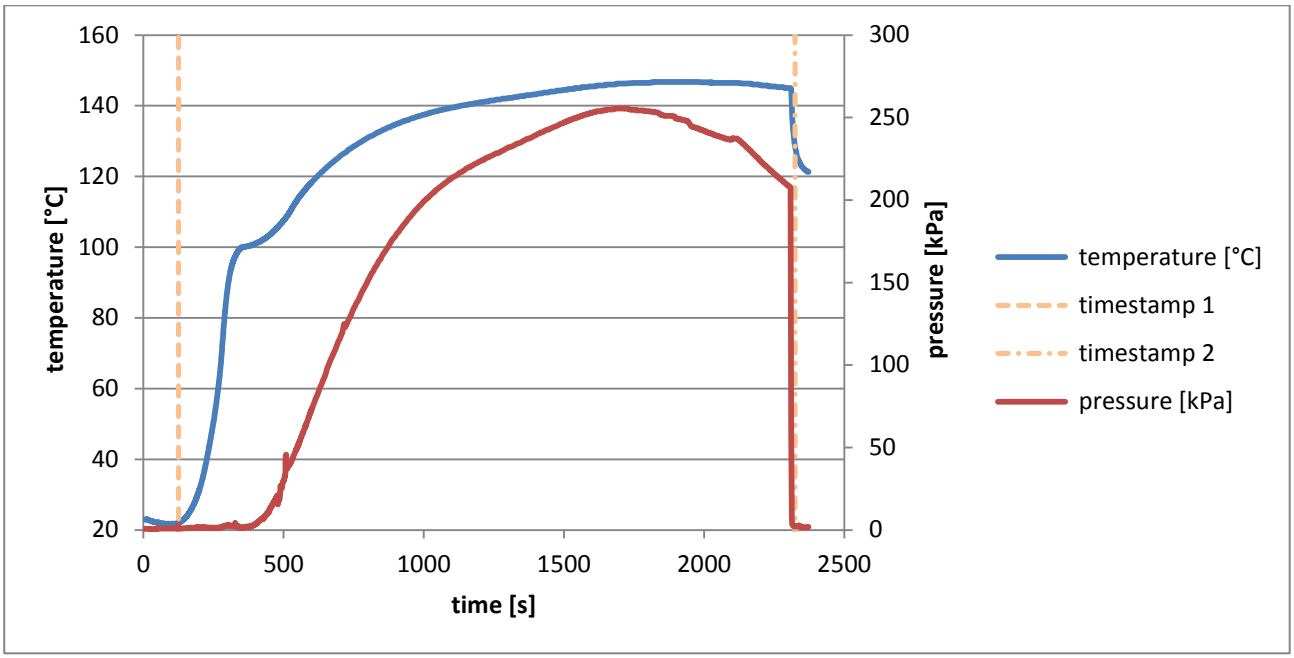

Figure 3. Red line shows the internal gas pressure and the blue line the temperature, both in the core part of the lay-up.

4. Future collaboration with host institution

Me and doctor Ohlmeyer had preliminary discussions considering launching a project that aims to determine how internal gas pressure develops during hot pressing process for certain standard plywood products, including the differences between surface, intermediate and core parts. The project that possibly could be a master's thesis project would be completed at either Thünen insititute or Aalto University. In the latter case, one of the pieces of measuring equipment (Pressman) could be borrowed to Finland now that I am able to use it and teach others to use it.

Additionally, as the results so far regarding self-bonded plywood provide interesting results, the tests for deeper analysis may continue at the facilities of Aalto University as it is possible to borrow the Pressman measuring equipment.

5. Foreseen publications/articles to result from the STSM

The results obtained during this STSM are reported selectively next March at ECWM7 in Lisbon if my abstract is accepted as an oral or poster presentation. Moreover, some of the results support next year one of my peer-reviewed publications related to self-bonded plywood.

6. Confirmation by the host institution of the successful execution of the STSM

The confirmation letter is in a separate file. However, as the host Dr. Martin Ohlmeyer was prevented from signing it he was substituted by Dr. Othar Kordsachia.

7. Other comments

This was my first STSM and I am happy to say that my experiences were very positive. This kind of funding system enables and encourages young researchers to visit colleague organisations to learn to use new devices and collect data not measurable at the home institute. Naturally the co-operation and encounters with colleagues both widened my scientific network as well as built up the professional skills.

These measurements helped me to understand and study self-bonding phenomenon further and thereby this STSM strongly supported my doctoral studies.

I acknowledge the COST Action FP1006 for supporting this STSM as well as Thünen Institute, GreCon and especially my host Martin Ohlmeyer for collaboration, support and the possibility to use all the devices.