



Review of the Doctoral Dissertation
by Ms. Agata Jasiołek with the title

„Paper-based building envelopes – design proposals and environmental assessment“

Background of the work

In her dissertation, Ms. Jasiołek is concerned with systematically expanding the design fundamentals for the use of paper as a material in construction and making concrete design proposals, which are then also evaluated using the LCA method. She is particularly concerned with the challenges of making paper water-resistant and fire-resistant, which are major barriers to the use of paper today. Ms. Jasiołek thus raises important issues for making materials for construction more sustainable and their reuse or disposal more environmentally friendly.

Work content

The submitted dissertation consists of 209 pages in total. In the introduction (chapter 1; 6 pages) the background of the thesis, the motivation and 8 research hypotheses are presented and the structure of the thesis is explained.

Chapter 2 (42 pages) describes the state of knowledge of paper as building material for the following areas:

- Paper in architectural application
- Mechanical properties of paper-based products
- Thermal properties of paper-based products
- Acoustic properties of paper-based products
- Protection against water and humidity
- Protection against fire
- Connections and lamination of paper-based components
- Environmental impact of paper-based components



- Paper-based building envelopes.

Chapter 3 under the heading "Microscale - techniques" deals with Ms. Jasiołek's own experimental work. She presents her experiments and test results on application tests of nine commercially available impregnations to improve water resistance, the tests with nine also commercially available impregnations to improve fire protection and the tests with six commercially available adhesive applications for the production of laminates.

In chapter 4 (32 pages), six new paper-based envelopes are presented as well as 14 outer layer concepts for indoor and outdoor application. The technical details are discussed including results for thermal analysis and life cycle assessment.

Chapter 5 "macroscale – building envelope" (18 pages) two full-performance paper-based building envelopes developed on the basis of the knowledge derived from previous chapters are investigated and compared with more conventional designs. The comparison is desktop work based on the dimension of the elements, calculated thermal properties and estimated fire and water resistance performance. In addition a comparative LCXA-study for these designs has been carried out.

The last stage of the work is presented in chapter 6 "Implementation – building" (8 pages). Full scale demonstrators for both paper-based concepts of chapter 5 were built with dimensions of 2 m x 2 m.

Chapter 7 presents the conclusions (7 pages)

The thesis closes with curriculum vitae, references and list of figures and list of tables.

Appreciation of the work

The dissertation submitted by Ms. Agata Jasiołek is very readable, well structured in a comprehensible manner and meets the requirements of a scientific paper in terms of form and design. Figures and tables are easy to understand.

Ms. Jasiołek addresses a current and innovative topic and her work makes a significant contribution to further establishing paper as a material for construction applications.



The statements on the state of knowledge cover all relevant areas, but are not complete in all fields. In parts, the explanations do not go beyond previous work (e.g. dissertation R. Bach, RWTH Aachen) and current publications from 2023 are not included.

The author's own experimental work is described in a sensible and comprehensible manner. However, explanations and criteria for the specific selection of the materials investigated are missing. In this respect, an evaluation is also open as to whether better materials could not have been used to increase water resistance and flame retardancy and for bonding.

The work on using life-cycle-assessment as an evaluation method for comparing different design concepts is a very interesting approach and provides valuable results. Somewhat restrictively, it must be noted that the exact parameterizations and boundary conditions for the LCA calculations are not directly specified. For example, it remains unclear with which model the multiple recycling of paper is taken into account. Thus, the results are consistent, but can only be compared with other calculations with additional effort.

The development of own design concepts is really worth highlighting. The systematic comparison of two new paper-based solutions with conventional approaches provides very exciting and valuable results, which are also very interesting for the development of application solutions in the construction industry.

The dissertation ends with a description of the process for building 2 m x 2 m demonstrator. It's a great approach to finally reflect the desktop findings with real size demonstrators. Unfortunately this chapter ends very abruptly. There are not even pictures of the finished demonstrators and unfortunately no validation of the thermoetic results.

Conclusion

In her dissertation, Ms. Jasiołek presents new design concepts for building with paper. In addition, she has developed and tested a method to systematically compare different design concepts and thereby also show the weaknesses and strengths of the variants. In this way, she provides new and valuable data and has also tested her design proposals on a technical scale.

The work shows that Ms. Jasiołek has appropriate expertise for a dissertation in the field of building with paper and can also apply it appropriately.

The quality of the work is somewhat limited by the fact that the literature search regarding current work is not entirely complete and that the selection of the investigated materials for moisture protection and fire protection is not systematically explained. Also missing is a validation of the calculated key figures, which should have been possible on the demonstrators. In chapter 2.1, individual formulations should be corrected or clarified (see appendix).

The work fulfills the requirements for a dissertation and Ms. Jasiołek thereby demonstrates her ability for independent scientific work.

I recommend the faculty of architecture of Wrocław University to accept the thesis and continue the dissertation process of Ms. Agata Jasiołek.



Prof. Dr.-Ing. Samuel Schabel

Darmstadt, den 10.09.2023



Appendix: Corrections recommended:

Page 15

- 1) „Most of the fibres are aligned in the direction of the screen’s movement”: this is not correct – even if the literature reference may state this
- 2) “chemical sulphate method results in ... pulp consisting of approx. 95 % cellulose”: this is not correct. The content of hemicelluloses and other substances is more than 5 % - even if the literature reference may state this
- 3) “Pulp can be obtained from any plant cell” this is not correct

Page 16

- 4) “Paper can be recycled up to seven times, ..., mechanical processes which result in the decreasing of the mechanical properties”: this is not correct. It has been published many times but has never been proofed. On the contrary authors like Höke and Schabel in “Recycled Fibre and Deinking”, Chapter 8 show that pulp fibers can be recycled much more often and the reduction of mechanical properties is minimal.