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Opponent's review of the Doctoral Thesis

Candidate Jan Richter

Title of the doctoral thesis Cold Attics in Humid Cold and Temperate Climate

Branch of study Building Engineering

Tutor Prof. Ing. Jan Tywoniak, Csc. Ing. Kamil Stanek

Opponent Prof. Dr.-Ing. John Grunewald

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Topicality of the doctoral thesis theme				
Commentary: The building physical problems - such as condensation, frost damage or mold growth - of unheated attics in humid cold and temperate climate are a challenging and relevant research topic. The available knowledge in this area is incomplete and sometimes contradicting itself.				
☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Fulfilment of the doctoral thesis objectives				
Commentary: The first aim of the thesis was to find one or more moisture-save cold attic designs. This was fully completed be an extensive literature research and own measurements. The conclusions are logical and concise. The second goal was to develop a suitable HAM model. It is not common and quite challenging for writers to develop their own model from scratch. This has been achieved with many simplifications. Therefore, the model does not reflect the state of the art in the field. There is no comparison between model simulations and our own measurements, which would have been necessary for validation of the model.				
☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Research methods and procedures				
Commentary: The research methods successfully applied in the thesis include monitoring of existing buildings, lab experiments, model simulations and evaluation of cases from literature. While existing buildings represent complex cases with many uncertainties, lab experiments should be designed such that specific relevant effects captured by the model could be seperately tested and validated. This was only partially implemented.The chosen experimental set-up does not fully reflect the building physical situation of cold attics, e.g. it remains unclear how the air flow model could be validated. A better description of the lab experiments and their evaluation by the model would be benficial.				
☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Results of the doctoral thesis – dissertant's concrete achievements
Commentary: The work provided a complete overview of the research in the field of experimental study of cold attics. The extensive literature research and the method for evaluating the results

are innovative and unique. The conclusions are drawn very precisely. Developing a complete HAM model from scratch typically takes up to 10 years. This task cannot be completed in the time of a single doctoral thesis. Therefore, the implementation, verification, calibration, validation, and application of the model remains incomplete to some extent.

☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Importance for practice and for development within a branch of science

Commentary: The conclusions from the literature review and own measurements can be directly implemented in practice. There are rules of good practice which could be confirmed and refined throughout the work of the thesis.

The HAM model still has limitations to overcome before it can be used in science or practice. From science point of view, targeted calibration experiments and validation with building monitoring projects would be required. On the other hand, engineers need simulation tools with professional support, graphical user interfaces, complete databases and streamlined workflows in order to work cost efficiently.

☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Formal layout of the doctoral thesis and the level of language used

Commentary: The layout and language of the doctoral thesis are good and meet the standards. The structure of the work is clear and logical. The topics are well explained and formulated. Finally, some minor corrections should be made: e.g. reformatting of some formulas and some grammar fixes (e.g. changing some words from singular to plural).

☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Remarks

The development of this topic is to be regarded as not completed. For further work, it is recommended, in the course of national or international cooperation, to address the problem on a platform where different partners can contribute their skills.
In addition, the work in the field of cold attics should be embedded in a larger framework of building performance simulation, because many partial models can be reused. This makes particular sense because the development and experimental validation of building performance tools is extremely complex and normally overwhelms the resources of a single research institution.
With regard to the development of the model, there are a few critical points to be noted that should be pursued further. First, the model for the radiation balance has to be validated against internationally established models. Diffuse and direct solar radiation as well as long-wave radiation and atmospheric counter-radiation must be considered separately.
Second, a moisture model that aims to explain moisture-related damage must take into account the liquid water transport together with the convective and diffusive vapor transport. The coupling between heat, air and moisture (e.g. phase change processes) must be fully captured. Completely measured moisture storage functions of building materials should be used in the hygroscopic and over-hygroscopic ranges.
Third, the air transport model should be made applicable to air-permeable building materials, air gaps and interior spaces. A 1D-approach is not sufficient. Different models for these problems may be necessary.
Finally, a meaningful encapsulation in sub-models and their runtime coupling via an FMI interface must be examined. The tools-set must allow investigation of diffent coupling strategies since this considerably affects the overall accuracy and performance.

Final assessment of the doctoral thesis
Jan Richter has presented a convincing thesis, which in all respects meets the quality criteria that must be placed on a doctoral thesis.

Following a successful defence of the doctoral thesis I recommend the granting of the Ph.D. degree		
	yes ☒	***no*** ☐

Date: 01.12.2020

John Grunewald

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