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Opponent's review of the Doctoral Thesis

Candidate Ing. 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.
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Topicality of the doctoral thesis theme

Commentary: The issue addressed in this thesis is worthy of investigation because there is still gap in konwledge regarding heat and moisture conditions in unconditioned attic spaces. Therefore, subject of the thesis is topical and relevant to the field of study. Author defined scientific problem based on his own deep literature review. This review has shown that there are uncertainties in prediction associated with risk of moisture condensation, frost formation and growth of mold on the bottom surface of a roof above cold attics. A lot of existing attics are affected by wrong design of building enveope and kind of ventilation which results in shorter than expected service life. This is a good opportunity for young researchers to contribute to contemporary knowledge and give recommendations to designers.

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

Fulfilment of the doctoral thesis objectives

Commentary: Author defined two research objectives in the thesis. First was focused on finding one or more unconditioned attic designs suitable for the whole or prevailing part of considered climate zone (humid, cold and temperate climate). The second objective was to create hygro-thermal nad airflow model (HAM) in Matlab software for numerical analysis and optimisation of unconditioned attics. The objectives of the thesis were met because of deep review of relevant studies was presented and HAM model was developed, verified and validated.

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

Research methods and procedures

Commentary: Author applied theoretical methods (analysis, synthesis and modelling) and empiric methods (observation and measurement). The review of existing literature was carried out to meet first objective of the thesis. Chapter 2 presents work methodology, results, discussion and conslusions. Main findings that fulfill first objective of the thesis are presented in chapter 2.4. Development of the HAM model is described in detail in chapter 3. The report regarding verification of the model is presented in Appendix B.Thermal model validation was based on the measurement results using special box placed in a climate chamber. Moisture model was validated using data from the report of the IEA ECBCS Annex 41. Data from experimental roof were used for validation of cavity-airflow model. Generally, the selected methods are suitable for fulfilling the objectives of the thesis.

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

Results of the doctoral thesis – dissertant's concrete achievements

Commentary: The results of literature review are presented in Table 3. The summary contains numbers of selected desings, source of data, study type (computational, experimental, laboratory experiments and in-situ measurement), climate classification, indoor conditions, selected design paramtres and moisture-related consequences. It is followed by discussion and conclusions with 8 main findings of the review. HAM model was developed, verified and validated. Detailed geometrical scheme of the model is presented in Figure 18. The thermal model is describe in chapter 3.1.1, the airflow model is presented ib chapter 3.1.2 and chapter 3.1.3 describes the moisture model.

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

Importance for practice and for development within a branch of science

Commentary: Conslusions based on the literature review can serve as a rules for correct design of attics in our climatic zone. Developed HAM model is suitable for next used in detailed simulations of environment in attics.

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

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

Commentary: Submitted thesis is written in English and 150 pages long. Thesis contains 4 main chapters, list of references and two appendices and nomenclature. First chapter is focused on background, definition of goals, target climate zone, causes of problems and results from measurements of environment and boundary conditions of selected attics. Chapter 2 contains description of methods used in literature review, results, discussion with main findings and conclusions. Chapter 3 is focused on the development of HAM model with description, verification, validation of the model. Conslusions are sumarized in chapter 4. Nomenclature contains description of all symbols. Reviewed thesis is well organised and fulfills requirements on the level of the doctoral thesis. From my point of view the quality of English is very good.

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

Remarks

1. Charts and pictures are printed in black and white. I recommend printing of charts in color for better readability of curves and associtated text as well.

2. Fig. 1 and Fig.2 show consequences of incorrect design of attics with very poor visibility because of low quality of black and white print. I recommend increasing the size of the descriptions of all pictures and charts.

3. Fig. 12 - first chart shows peaks of indoor temperature up to 34 °C. What is the reason of these high temperature peaks?

4. Subchapter 3.1 - there is no easy way to recognize which equations are addopted from literature and which equations are derivated by the author. There is only general information regarding liteture sources on the page 63.

5. There are a lot of assumptions, e.g. values of convective heat transfer coefficients, which are not supporeted by any literature source. The reasons for these assumptions are not justified.

6. Appendix B - please describe choice of geometry and envelope of the attic space, e.g. 50 mm thick gypsum board. Dimensions are missing. Why is thermal insulation of the ceiling missing? Values used in process of verification of the model could be describe here for better

understanding of presented charts.

7. Main findings show that use of ventailated and non-ventilated attics is possible when double-skin roof deck is designed. Which one (ventilated/non-ventilated) do you prefer?

8. Is it possible to say that empirical rules for design of ventilated cavities, sizes of inlets and outlets defined in ČSN 73 1901 are correct and can be safely used in practice?

9. For which cases (attic designs) is developed HAM model suitable? Can you sumarize limitations of the model? Subchapter 3.1 states that HAM model is quite versatile. But each model has some limitations.

10. Does the model take into acount heat transmission by the longwave thermal radiation to the atmosphere? If yes, how?

11. I recommend to describe all values (symbols) with units directy on the same page as equations although nomenclature contains all values.

13. What will be the focus of next candidate´s scientific work?

Final assessment of the doctoral thesis

Ph.D. candidate Ing. Jan Richter meets the objectives that were set for his doctoral thesis. The thesis demonstrates candidates deep theoretical knowledge and experience in the field of numerical modelling and developing of hygro-thermal and airflow model suitable for different attic designs. Ph.D. candidate demonstrated his ability to verify and validate developed model with the use of suitable experiments. Despite of the above written remarks I recommend this thesis for defence.

Following a successful defence of the doctoral thesis I recommend the granting of the Ph.D. degree

yes ☒	***no*** ☐

Date: 18th of September, 2020

Opponent's signature:.....