CZECH TECHNICAL UNIVERSITY IN PRAGUE
Faculty of Civil Engineering
Department of Science and Research
Thákurova 7, 166 29 Prague 6, Czech Republic
e-mail: hamarova@fsv.cvut.cz tel.: (+420) 224 358 735

Review of Thesis

submitted in partial fulfilment of requirements for promotion to associate professorship

Specialization: Theory of Building Structures and Materials

Applicant: Ing. Jan Sýkora, Ph.D.

Reviewer: Dr. Peter Grassl

Thesis title: Transport Processes and Related Inverse Problems

Importance of topic of thesis

Comments: i) Mass transport processes in building materials are directly linked to their durability. Therefore, the better these processes are understood, the more durable and safer we can design structures and decide when structures should be repaired and strengthened. This should lead to a more efficient use of resources, which will become more limited in the future. ii) Inverse analyses techniques have become more important because of the increase of the amount of data that is collected/measured.

Superior	Good	Average	Poor	Not applicable
☐	☒	☐	☐	☐

Method of solution

Comments:
Overall, advanced techniques are used to obtain the solutions. However, it is questionable if the methods used have been always appropriate for the type of results obtained. For instance, in chapter 2, very complex multiscale modelling techniques are applied. Still, it is questionable if the input required for these models is more straight forward to select or the results are more insightful than they would be for simpler techniques.

Superior	Good	Average	Poor	Not applicable
☐	☒	☐	☐	☐

Quality and correctness of results achieved

Comments: Overall, the results appear to be of good quality. Nothing appears to stand out to be controversial. However, more effort should have been made to check the results against bounds obtained from analytical methods or simplified techniques. This also refers to the techniques to present results. For instance in chapter 2, showing water ingress on a linear scale makes it difficult to check the quality of the results. A better check would provide the reader with more confidence in the results.

Superior	Good	Average	Poor	Not applicable
☐	☒	☐	☐	☐

Originality of results achieved

Comments: There is nothing that stands out as particular original. The results are interesting and reasonable. However, they did not provide any substantial new insight into the response of building materials.

Superior	Good	Average	Poor	Not applicable
☐	☐	☒	☐	☐

Publication rate of results achieved								
Comments: Good publication rate. 85 publications are listed on Scopus. Good number of these publications are in international journal with high impact factors.								
Superior	☐	Good	☒	Average	☐	Poor	☐	Not applicable ☐

Response to results and citation rate								
Comments: It is not clear what is meant with "Response to results". It is assumed that this is refering to the impact that the papers had. The impact outside academia cannot be judged as there is no information available to assess it. The citation record can be straight-forwardly extracted from Scopus, which was done here by removing self citations of all co-authors. The resulting number of citations to the publications is very low. However, number of citations is a poor indicator of the quality of scientific work.								
Superior	☐	Good	☐	Average	☐	Poor	☒	Not applicable ☐

See also next page.

Applicability of results to development in the field and for further research									
Comments: There is a lot of potential to continue and further improve the modelling techniques. Inverse analysis is a topic which will only increase importance because of the availabity of data which can be collected with inexpensive sensors. Durability will become even more important in the future when availablity of resources will reduce.									
Superior	☐	Good	☒	Average	☐	Poor	☐	Not applicable	☐

Applicability of results to technical practice									
Comments: The topics discussed in this thesis are of practical interest. It is not clear how the results obtained in the studies will directly apply to technical practice.									
Superior	☐	Good	☐	Average	☒	Poor	☐	Not applicable	☐

Compliance with requirements on thesis – quality of thesis									
Comments: The thesis is of good qualities. There are a few comments and questions that I have which are listed in the attached document.									
Superior	☐	Good	☒	Average	☐	Poor	☐	Not applicable	☐

Comments
Please see my comments and questions in the attached document.

Overall evaluation of thesis
Overall, this is an interesting habilitation thesis on a range of important topics. The contents of the thesis is certainly of good enough quality to qualify for promotion to associate professorship.
Additional comments on the thesis and the author:

Promotion to associate professorship recommended	*yes* ☒	*no* ☐

Date: 05.03.2020

Reviewer's signature: [redacted]

See Comments on next pages.

Review of “Transport Processes and Related Inverse Problems”

Ing. Jan Sykora

The present habilitation thesis contains a summary and 4 papers on the topic of transport processes in building materials and inverse problems. In the summary part, the models used in the papers are categorised by introducing groups of convection, diffusion and advanced models linked to the specific applications discussed in the papers, such as modelling mass transport in wood, assessing fire risk and damage in mortar due to ice formation. In addition, inverse problems are discussed. Then, in the papers, the topics of water ingress in wood, fire risk assessment, degradation processes in mortars and probabilistic identification methods are presented. Overall, this is an interesting habilitation thesis with an impressive range of applications. The papers are very detailed and are published in well-respected journals. There is no doubt that the quality of the work is appropriate for promotion to associate professor subject to a successful defence based on the questions and comments listed below.

Comments:

Chapter 1

1.1) You show the main equations of convection models.
i) Please explain the meaning and units of the symbols used in these equations in eq. (1.2).
ii) What are units of the individual components (q_w, D_w,w, D_theta,w, K)?
iii) K is a scalar and q is a vector. What is missing there?

1.2) For the diffusion models:
i) Please define diffusion and explain how it differs from advection.
ii) How is term diffusion used in Section 1.2? Explain the practical importance to distinguish between diffusion and advection.

1.3) On page 9 Figure 1.4, you show curves of the moisture uptake versus time.
i) Please explain what the driving physical process of the moisture uptake is.

Chapter 2

2.1) i) Explain the aim of this paper.

ii) You talk about the need for reliable analysis at the top of page 28. Later on, accuracy is mentioned as well. What do you mean with terms “accuracy” and “reliability” in the context of computational modelling. Please explain. How do you check accuracy and reliability?

2.2) On page 28, you mention that eigenstrain can result in damage if restrained. Later on, the model seems to be entirely elastic. Explain at which scale the eigenstrain coud be restrained. Is this due to boundary conditions at the macro-scale or is it due to the heterogeneity of the micro-structure which undergoes swelling at different rates?

2.3) Above Figure 2, the setup of the experiment is described. It is stated that “The resulting pressure gradient caused a one-dimensional vapor flow through the specimen. It is not easy to understand the initial and boundary conditions of this experiments. It is then later described in more detail in the modelling part. However, even then not everything is clear. Please explain the initial conditions of the specimen (degree of saturation). Then please state the values of relative humidity on both sides of the cup. What is moisture content distribution across the specimen? How do you determine/check the initial condition of your specimen?

Chapter 3

You focus in this study on the risk of fire induced spalling of concrete layer. State how risk associated with other effects of tunnel fires compare to the selected one. Please explain your justification to limit yourself to spalling.

Chapter 4

i) You state that “understanding is … the first step toward avoiding deterioration.” Could you please give an example how this understanding could help to protect historical mortars from frost damage? Is this mainly related to repair materials or are there techniques that could be used to treat existing mortar to make them more resistant?

ii) On page 98, you use Biot’s coefficient. Please explain what the physical meaning of it is? For which cases (materials) would Biot’s coefficient approach 1?

iii) On page 98, you introduce an isotropic damage model, which uses a single scalar to reduce the stiffness. How does the reduction of the stiffness links to the answer given for ii)? How should Biot’s coefficient vary with damage?

iv) Explain how you consider the influence of damage on the build up of ice? Should porosity depend on damage? How is this taken into account? How important is this dependence?

v) In Eq. (34), you introduce a nonlocal extension for your damage model. Why do you do this? Are you able to reproduce localised crack patterns in your analyses which would require this regularisation to obtain mesh-independent results? Please explain your motivation behind this. Did you check if your results are mesh-independent?

vi) You state in your conclusion, that you find a “high importance of porosity on the evolution of damage”. Is the value of porosity important or is it the size and their connectivity that are the important parameters? Please explain by means of thought experiments how pore size and connectivity influence the results.