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) 2 2435 8735

Review of Thesis

submitted in partial fulfilment of requirements for promotion to associate professorship

Specialization: Theory of Building Structures and Materials

Applicant: Tomas Krejci

Reviewer: Gabriele Milani

Thesis title: Numerical analysis of coupled problems in selected engineering applications

Importance of topic of thesis
Comments: Coupled problems in mechanics are common in engineering applications and may be found, among the other cases, in the study of reinforced concrete, masonry and rock mechanics/geotechnics. Despite such matter is of crucial importance, the difficulties in solving a coupled problem are intutitively many, and this is the reason why the research in this specific field is still rather geopardized and very active. Major challenges when multi-field problems are tackled are many, but the most important is certainly the required computational burden, which may need the implementation of parallelization strategies. The practical importance is crucial and -to be successful- a coupled approach requires deep knowledlge in multi-physics problems (e.g. continuum mechanics, thermodynamics, transportation processes, moisture influence, etc.), in applied mathematics, which particular regard on numerical methods for partial differential equations, and informatics (knowledge and training of effective programming languages and parallelization).

Superior	☒	Good	☐	Average	☐	Poor	☐	Not applicable ☐

Method of solution
Comments: The method of solution adopted by the candidate is robust and convincing, classically based on Finite Elements. It relies into the further development and utilization of the open source SIFEL Finite Element Computer Code, with particular regard to three different plugins (MEFEL for Mechanics, TRFEL for heat and moisture transfer and METR for the coupled problem). Particular care is posed in improving the data accessability, data transfer and extensibility.
Three main case studies are investigated in three different fields of resarch exhbiting major importance in mechanics: a thermo-mechanical analysis of a nuclear reactor container (concrete structure), the thermo-hygro-mechanical analysis of a historical masonry arch bridge (Charles bridge in Prague) and the thermo-hygro-mechanical analysis of a bentonite barrier (tunnelling problem).
The method of solution is rigorous and based on classic concepts of discretization of the coupled thermo-hygro-mechanical problems. The numerical efficience is optimized thanks to parallelization and the utilization of a code framework conceived from the beginning for large scale, multi-physics problems. The most relevant advantage when comparing with existing commerical codes (e.g. Comsol) is the possibility to implement new models in an open source environment. Parallelization is another major advantage.

Superior	☒	Good	☐	Average	☐	Poor	☐	Not applicable ☐

Quality and correctness of results achieved
Comments: The correctness of the results achieved is always checked with either experimental

measures or already existing numerical models. The quality is directly understandable by the very good fitting obtained and the consequent predictivity of the models proposed.

| Superior | ☒ | Good | ☐ | Average | ☐ | Poor | ☐ | Not applicable | ☐ |

Originality of results achieved

Comments: The field of investigation is complex and the available literarure in the field still quite limited. For these reasons, the originality of the results achieved is rated as extremely high.

| Superior | ☒ | Good | ☐ | Average | ☐ | Poor | ☐ | Not applicable | ☐ |

Publication rate of results achieved

Comments: The publication rate of the results achieved is relatively limited but of very high quality; according to the references reported in the thesis, it may worth noting the following scores: 5 publication in high impact journals (e.g. Computers & Structures, RILEM Materials and Structures) and 11 contributions including international congresses and internal reports.

| Superior | ☐ | Good | ☐ | Average | ☒ | Poor | ☐ | Not applicable | ☐ |

Response to results and citation rate

Comments: According to a Scopus Research, taking into account the overall productivity (i.e. not limiting the response of the scientific community soley to those papers cited in the References, which represent a small part of the scientific activity of the candidate, which is actually mainly focused on coupled problems), the candidate has in his portfolio 55 records (16 journal papers) and an h index equal to 10 (accession date 20/07/2022). Such numbers are in line with the international stardards for a position as Associate Professor. The citation rate is therefore adequate and the response to results pretty evident.

| Superior | ☒ | Good | ☐ | Average | ☐ | Poor | ☐ | Not applicable | ☐ |

Applicability of results to development in the field and for further research

Comments: The applicability of the results in real engineering problems seems very straightforward. The utilization of an open source code gives potentially the possibility to put at disposal codes, procedures and results directly to other research groups and practitioners for an independent development of the approaches and the models proposed.

| Superior | ☒ | Good | ☐ | Average | ☐ | Poor | ☐ | Not applicable | ☐ |

Applicability of results to technical practice

Comments: As mentioned in the previous points, the applicability (and actually the applications shown in the thesis) of the results to technical practice by other research groups and private societies is one of the major strengths of the thesis. The evaluation is extremely high.

| Superior | ☒ | Good | ☐ | Average | ☐ | Poor | ☐ | Not applicable | ☐ |

Compliance with requirements on thesis – quality of thesis

Comments: The compliance with requirements on the thesis is complete. The quality of the thesis

is evident, high, within the international stardards for the position of Associate Professor and it is much appreciated the ability to contemporarily deal with very complex theoretical coupled problems and present interesting results with immediate applicability in engineering practice.

| Superior | ☒ | Good | ☐ | Average | ☐ | Poor | ☐ | Not applicable | ☐ |

Comments

Overall evaluation of thesis

The overall evaluation of the thesis is extremely positive. The common thread of the thesis is extremely clear and the application to three different resarch topics in mechanics appears fascinating, rigorous and especially extremely useful from a technical point of view.

Additional comments on the thesis and the author:
No additional comments

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

Date: .20/07/2022............................

Reviewer's signature: ███████████