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Opponent's review of the Doctoral Thesis

Candidate Ing. Michaela Herzfeldt

Title of the doctoral thesis Mechanical response of concrete structures to effects of ionizing radiation

Study Programme Structural and Transportation Engineering

Tutor prof. Ing. Petr Štemberk, Ph.D., D.Eng

Opponent Ing. Jan Červenka, Ph.D.

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Topicality of the doctoral thesis theme				
Commentary: The thesis topic is very important for the assessment of the safety and reliability of the biological shielding of nuclear power plants and especially in the view of their planned service life extension.				
☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Fulfilment of the doctoral thesis objectives				
Commentary: The aim of the thesis was the development of models that could be used for large scale analysis and modelling of biological sheilding concrete structures. This objective has been fully achieved.				
☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Research methods and procedures				
Commentary: The candidate provides and extensive overview of the available research data on the subject, which is used for the development of a model for the expansion of concrete aggregates utilizing the fuzzy logic. The model is validated and verified on experimental data. Its applicability for large scale modelling was demonstrated on the analysis of VVER 1000 biological shielding element.				
☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Results of the doctoral thesis – dissertant's concrete achievements				
Commentary: The candidate main achievement consist of the development of a model for the material expansion of irradiated concrete using the fuzzy logic. The model was validated using meso-scale experiments and then the model application to macro-scale analysis of NPP shielding structures was demonstrated.				
☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Importance for practice and for development within a branch of science				
Commentary: The main impact for practice is that the presented work provides methodology and models for the verification of safety and reliability of biological shielding structures in NPPs affected by radiation, which should be an important part of the structural assessment during the life time extension process of NPPs.				
☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Formal layout of the doctoral thesis and the level of language used				
Commentary: The presented thesis is well organized and all conclusion and results are supported by the presented data. The thesis is written in English language with only minor mistakes mainly in the usage of definite and indefinite articles.				
☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Statement on compliance with citation ethics
The oponent has not detected any violation of citation ethics.

Remarks
The main achievement of the thesis is the development of fuzzy logic based model for concrete swelling due to irradiation.I have two questions that the candidate should address during her thesis defense: (1) This is more a comment for an interesting further extension of the work. Would it be possible to apply the presented fuzzy logic model also to the reduction of mechanical properties of concrete such as elastic moduls, compressive and tensile strength? (2) Second question is whether any reduction of mechanical properties due to irradiation was considered in the macro-scopic analysis of the biological shielding in the Section 8. If not, what kind of effect would you expect on the results if such a reduction would had been considered?

Final assessment of the doctoral thesis
The thesis deals with an important topic of concrete swelling due to irradiation in nuclear power plants, which may potentially impact the safety and reliability of the structural elements of the biological shielding around the nuclear reactor. The these provides a comprehensive overview of the existing knowledge. The models are developed using fuzzy logic and applied to the analysis of the material behavior on the meso- and macro-scale. The thesis develops a methodology that can be used in practice for the verification and assessment of biological shielding structures in NPPs.

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

Jan Červenka

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Date: 10.4.2024

Opponent's signature: .....