



## Opponent's review of the Doctoral Thesis

Candidate Mgr. Yuliia Khmurovska

Title of the doctoral thesis Influence of Neutron and Gamma Irradiation on Concrete Properties and Structural Performance

Branch of study Civil Engineering / Structural and Transportation Engineering

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

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### Topicality of the doctoral thesis theme

Commentary: The understanding of Neutron and Gamma irradiations on concrete properties and behaviour is important and timely topic regarding the aging nuclear infrastructure. The new insights in fundamental mechanisms involved are needed.

excellent  above average  average  below average  poor

### Fulfilment of the doctoral thesis objectives

Commentary: The objectives, as stated in Section 1.2, are fulfilled.

excellent  above average  average  below average  poor

### Research methods and procedures

Commentary: The main part, focused on experimental investigation is well designed, documented and based on state of the art techniques. The numerical part (model of biological shield) is based on FEM model using nonlinear damage based constitutive model. In this part, some of the methods could be improved to gain more insight, but keeping in mind that the focus was on experimental part the methods were adequate.

excellent  above average  average  below average  poor

### Results of the doctoral thesis – dissertant's concrete achievements

Commentary: The thesis contains detailed overview of the state of the art in the field. It critically reviews available results and identifies the open problems, while trying to address some of them. The experimental sections are particularly interesting and contain new results. The numerical model in Chapter 3 combines available knowledge and is used to predict damage of biological shield.

excellent  above average  average  below average  poor

**Importance for practice and for development within a branch of science**

Commentary: There are many nuclear power plants worldwide that must be operated under safe conditions. The concrete is used in these facilities as core construction material to build pressure vessels and biological shields. The understanding of fundamental mechanisms taking place during Neutron and Gamma irradiations on concrete is necessary. The presented thesis summarizes the achievements made up to date and fills some gaps in understanding the effect of early-age gamma-ray irradiation on properties of cement mortar and concrete creep.

excellent     above average     average     below average     poor

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

Commentary: The thesis is logically structured, and well written. Reviewer find difficult to follow some results presented in Figures (Figs. 4.4 and 4.5, for example). The colors should be used to differentiate individual results.

excellent     above average     average     below average     poor

**Remarks**

I have following remarks:

Section 3.2.7: The components of concrete have different thermal expansion characteristics, as mentioned by the author. Has this been taken into account in numerical simulations? The differences can contribute to development of cracks.

Section 3.3: Model of Mazar: The original formulation of the model is not objective regarding the mesh size. How was the mesh objectivity ensured?

Section 3.3, page 58: Is assumption of constant relative humidity valid when water radiolysis takes place?

Section 3.3: Force controlled Newton-Raphson solver has been used. What force loading was applied/controlled? As there was no force loading present, the solution was controlled rather by time.

Section 3.4: Solver was unable to find equilibrium. What was the cause of the problem? What could be used to overcome convergence problem?

Section 4.4.1: Equation 4.1: what was the error of the fitted relation?

A1.1: Author wrote: Newton Raphson method was employed for convergence algorithm. I don't agree with this statement. The Newton-Raphson method was used to solve nonlinear algebraic equations. On what depend the convergence of the method?

**Final assessment of the doctoral thesis**

The thesis contains detailed overview of the state of the art in the field. It critically reviews available results and identifies the open problems, while trying to address some of them. The experimental sections are particularly interesting and contain new results.

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

yes     no

Date: 13.8.2019.....

Opponent's signature:.....