CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Numerical Analysis of Concrete Biological Shield**
Author's name:	**Bc. Jiří Kovář**
Type of thesis :	master
Faculty/Institute:	Faculty of Civil Engineering (FCE)
Department:	Department of Concrete and Masonry Structures
Thesis reviewer:	Ing. Jiří Rymeš, Dr. Eng.
Reviewer's department:	Červenka Consulting s.r.o.

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **challenging**

How demanding was the assigned project?

The thesis assignment is rather complex as it spans from the understanding of the underlying theory of the non-linear finite element analysis through its numerical implementation to a specific application in the field of the nuclear industry.

Fulfilment of assignment **fulfilled**

How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.

The tasks mentioned in the thesis assignment were fulfilled. The theoretical part of the thesis covers several aspects for the formulation of the non-linear finite element method. The developed code is then used for two specific problems – material model calibration and analysis of a biological shielding wall. The obtained results are discussed and compared with state-of-the-art literature data.

Methodology **correct**

Comment on the correctness of the approach and/or the solution methods.

The applied approach is correct in the scope of a master thesis; however, as admitted by the author, several important aspects that are needed for reliable analysis of a concrete biological shield are neglected.

Technical level **A - excellent.**

Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?

The technical scope of the thesis is well covered.

Formal and language level, scope of thesis **A - excellent.**

Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?

The text is well-structured and logically organized. The matter is clearly explained and the text is written in a form that is pleasant to read. The English seems great.

Selection of sources, citation correctness **A - excellent.**

Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?

Yes.

Additional commentary and evaluation (optional)

Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.

See the summary at the end.

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III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.

The author presents a well-structured thesis and clearly demonstrates that he gain a good understanding of the topic. This knowledge was used for developing a tool for non-linear finite element analysis and further applied to an analysis of a component of a nuclear power plant subjected to RIVE. Such a complex approach seems to exceed the common scope of a master's thesis.

The presented results, however, seem to overestimate the damage in a real concrete biological shield. This is due to the complex action of several mechanisms that come into account and were neglected in the analysis, mainly due to the application of an isotropic damage model, neglecting the creep effect and the fact that the damage localizes in the real concrete material. Due to this, the obtained results are questionable. This should not be viewed as major criticism but as an acknowledgment of the complexity of the problem. The outcomes developed and presented in the thesis can be a solid background for further study of the topic.

I suggest some of the following topics to be discussed during the thesis defense:

1) In chapter 3.5.1., it is mentioned that the solution at each step ends either when the convergence criterion is met or when the maximum number of iterations is exceeded; however, when presenting the results, the author does not mention how the solution converged. Can you elaborate on that? Was convergence always found during the iterative solution?
2) The damage in the structure origins from differential volumetric expansion prescribed to the model. Such a problem might be sensitive to the choice of boundary conditions. Can you explain in more detail the boundary conditions applied in the model?
3) The implemented material model neglects the effect of RIVE on the material level. Why this was neglected and do you plan to add this mechanism in future work?
4) What is the main difference between the axisymmetric and full 3D formulation of the model?
5) Can you elaborate on the boundary conditions used during the simulation of the compression test? Was the deformation/slip allowed in the radial direction on the top and bottom of the cylinder? How it can affect the material model?

The grade that I award for the thesis is **A - excellent.**

Date: **31.1.2023**

Signature: