

**REVIEWER'S FORM
for thesis evaluation**



1. Identification of the student

Student:	Jacopo Scacco
Thesis:	Nonlinear numerical evaluation of the bearing capacity and the structure stability of the St. Jacob Church from the Group of Churches
1 st Institution:	University of Minho
2 nd Institution:	Czech Technical University in Prague
Academic year:	2017/2018

2. Identification of the reviewer

Name:	Drahomír Novák
Institution:	Brno University of Technology, Faculty of Civil Engineering, Institute of Structural Mechanics
Position:	BUT

3. Fulfillment of thesis goals

excellent <input type="checkbox"/>	above aver. <input checked="" type="checkbox"/>	average <input type="checkbox"/>	below aver. <input type="checkbox"/>	weak <input type="checkbox"/>
Comments: Based on the thesis proposal it is clear that all goals proposed were successfully fulfilled. Some of the achievements, see Chapter 5, go even beyond the original goals set. What I miss is the stability analysis mentioned in the thesis title. This subject, however, does not appear in the list of thesis goals.				

4. Academic/scientific/technical quality

excellent <input type="checkbox"/>	above aver. <input checked="" type="checkbox"/>	average <input type="checkbox"/>	below aver. <input type="checkbox"/>	weak <input type="checkbox"/>
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Comments:

The final report clearly proves a good theoretical background of the candidate in the field of mechanics. The candidate successfully addressed several topics, mostly computational, within the framework of uncoupled multi-scale analysis moving from a detailed mesoscopic study of actual arrangement of stones within a wall over to the full three-dimensional analysis of the entire church. The candidate managed to master several computational programs based on the Finite Element Method, which required a reasonable knowledge in the field of nonlinear numerical modeling, the theory of plasticity and damage of quasi-brittle materials. This certainly goes beyond usual requirements set on a typical Master thesis. Nevertheless, the connection between individual computational parts of the thesis would deserve more attention. In this context, I have a few questions the candidate might wish to clarify during the thesis defense. In particular:

1. Why the ATENA program has not been used in the full-scale 3D analysis? This would make the connection to the mesoscale analysis more straightforward.
2. A reference to equation on page 27 is missing. Where does this equation come from? Has the comparison between the measured compressive strength and the mentioned reference in the paragraph following the mentioned equation been made? Also, the formula for the calculation of elastic modulus based on the compressive strength mentioned in the 1st paragraph on page 28 is missing. This should be explained. It is also not clear, how the values of compressive strength posted in Table 4.1 were adopted in obtaining the data in Table 4.2 finally used in numerical analyses. A comment on that is welcome.
3. Please explain how the data in Table 5.1 were determined. Given these data, has the nonlinear response of soil been of any concern in the calculation of settlements using the GEO5 program? Within the scope of this analysis, why the wall was introduced in the analysis. I suppose applying the load only would be sufficient. Please comment on that.
4. Section 5.5 mentions the need for obtaining a homogenized Young modulus in case of layered subsoil. Although partially explained in the 3rd paragraph on page 46, this step, in connection to program Depth, is not clear to me. Can you please explain this in more details? The last paragraph on this page mentions a foundation depth of 7,55 m. How was this depth determined? Is there any connection to the FEM analysis carried out in the previous section?
5. Please be more specific on how the results derived in Chapter 4 (mesoscale analysis) were essentially utilized in obtaining the material data needed in full scale analysis in Section 6.2, Table 6.1.
6. The author suggests the cause of damage due to horizontal settlement dated back 80 years. The cracks should therefore appear long time ago. Are there any sources reporting them?

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5. Formal arrangement of the thesis and level of language

excellent ☐ above aver. ☒ average ☐ below aver. ☐ weak ☐

Comments:

The submitted thesis are organized in 7 Chapters, generally well written and in most parts easy to follow. Starting with a broad discussion about the history of architecture with emphases on churches in Broumov the thesis develop in a systematic way from the lower scale analysis acquiring effective properties of stone masonry all the way to full-scale 3D analysis of bearing capacity of the church. The analysis has shown a potential threat to the structure linked to a differential settlement. Potential rehabilitation measures to improve the current church conditions have also been proposed. The submitted thesis are therefore comprehensive.

Nevertheless, if considering publishing the achieved results, the level of English should be considerably improved. Also, the introductory part would deserve more attention by clearly stating the work, which has been done on this topic by other students.

6. Further comments

Apart from improving English I pose some particular comments to be taken into account if submitting the current research to journal publication:

1. Equation should be numbered.
2. Figs. 4.10, 4.11 – the vertical axis should be labeled σ_z instead of f_c .
3. Notation should be unified. I suppose G_t in table 4.2 stands for a fracture energy in tension denoted in previous equations as G_f . Please check. The units of stress should be consistently written as MPa (kPa, GPa), not Mpa.

7. Grade: A (excellent)

Use the following scale

A (excellent)	B (very good)	C (good)	D (satisfactory)	E (sufficient)	F (fail)
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BUT, Brno

July 13, 2018

The Reviewer: Drahomír Novák