

I. IDENTIFICATION DATA

Thesis name:	Thermomechanical Analysis of Ancient Roman Seawater Concrete
Author's name:	Torin Nicolas McCue
Type of thesis :	master
Faculty/Institute:	Faculty of Civil Engineering (FCE)
Department:	Department of Mechanics
Thesis reviewer:	Václav Kočí
Reviewer's department:	Department of Materials Engineering and Chemistry

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	challenging
<i>Evaluation of thesis difficulty of assignment.</i>	
<p>The main objective of the thesis specified by the assignment was to investigate thermal and mechanical processes in Roman concrete during a course of its hardening. In my opinion, the scope of the thesis is very specific as it combines several approaches to describe a thermomechanical performance of a selected historical building material. The assignment difficulty can be considered is more challenging than general demands placed on master theses. Therefore I can conclude fulfillment of the assignment qualifies the student to obtain the master degree.</p>	

Satisfaction of assignment	fulfilled
<i>Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.</i>	
<p>The assignment was completely met, as the student showed an excellent overview by analyzing mechanisms and principles that had led to specific properties of Roman concrete such as high strength or durability that are highly valued and required. The thermal processes were studied using a differential scanning calorimetry technique and validated by means of numerical modelling of heat transfer using a finite element analysis. The thermal analysis was then followed by a numerical analysis of stress development to understand deleterious effects that can be caused by effects of high temperature evolved during the process of hardening.</p> <p>All the analyses were performed thoroughly with a high level of student's contribution which means, the assignment was met satisfactorily..</p>	

Method of conception	correct
<i>Assess that student has chosen correct approach or solution methods.</i>	
<p>After summarizing general information about ancient Roman concrete and results of research findings, demonstrating a good overview on the problem studied, the main parts of the thesis follow: experimental testing (1) and numerical modelling (2).</p> <p>In the experimental testing part, the student described the mix design procedure including a specification and procedure of specimen preparation for particular tests (flexural strength, compressive strength and calorimetry). Test results were then summarized and discussed.</p> <p>In the modelling part, the parameters of thermal and mechanical models were described (model geometry, material properties (estimated), initial and boundary conditions) and several analyses were performed in order to:</p> <ol style="list-style-type: none"> 1. Understand the effect that mixing the concrete with seawater has on the time-dependent profile of the concrete pier. 2. Compare differences between an instantaneous casting scenario and 13-day casting scenario from the thermal point of view. 3. Investigate effects of the partial use of quicklime (10 %) instead of slaked lime only. 4. Monitor the development of stresses over time throughout the concrete block. <p>In my opinion, the solution methods could be chosen better, as the hydration process involves also transport of moisture with its indisputable influence on temperature distribution. This was completely neglected. I understand the reasons why was so (computationally expensive, demanding on input parameters, comprehensive model implementation etc.), however readers would appreciate at least a discussion about this shortage and its effects on the results obtained.</p>	

--

Technical level	A - excellent.
<i>Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.</i>	
The thesis is logically structured and well organized, so it is very comprehensible. The thesis is of a high quality and deals with the topic that is not typical for common civil engineering problems. Therefore I can assume knowledge gained by study of expert literature must have been used as well as data gained by own experience.	

Formal and language level, scope of thesis	A - excellent.
<i>Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.</i>	
The thesis is written in English. All the notations and terminology used in the thesis are correct and well explained.	

Selection of sources, citation correctness	B - very good.
<i>Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.</i>	
The thesis refers to 50 references, mostly books or journal papers. The student showed a good overview and an ability to find and process information from external sources. As far as I have noticed the citation ethics has not been breached and all bibliographic citations seem to be complete and in accordance with citation convention and standards.	

Additional commentary and evaluation
<i>Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.</i>
I have no additional comments.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.

The thesis deals with a thermomechanical analysis of ancient Roman concrete. Being written in English, it is well written and structured and fully meets the assignment. The student proved a good overview on the problem studied, i.e. thermomechanical performance of building materials which was treated experimentally and numerically as well. What I miss is in the work is a deeper comparison of particular results obtained (especially the experimental ones) with findings of other researchers, being supported also using references to other research papers. Furthermore, as mentioned in the section "Method of conception" of this review, proper solution methods should have been chosen or at least discussion about shortages of the approach chosen should have been added. Here are my comments and questions that should be answered during the defense:

1. In section 4.1.3, the homogenized value of thermal conductivity is estimated and used in the modelling as a constant, i.e. independent on temperature and other parameters. Could you describe which factors and how can affect the value of thermal conductivity of ancient Roman concrete (or building materials in general)? Could you also estimate how the temperature distribution in the concrete pier would be changed if these factors were considered?



REVIEWER'S OPINION OF FINAL THESIS

2. During the calorimetric measurement it is mentioned that initial offset time of 1.28 h is assumed representing the lag between initial mixing and the start of the test. To what extent can it affect the results? Can we expect some exothermal reactions within this period?

I evaluate handed thesis with classification grade **B - very good**.

Date: **17.7.2019**

Signature: