

Review of doctoral thesis

Title: Developing Trabecular Structures

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Reviewer: doc. Ing. David Paloušek, Ph.D.

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1. Achievement of the dissertation goal

The aim of this study is to test the hypothesis that the AM cellular structure mechanical properties are influenced by open-cell architecture, strut thickness, relative density, and choice of material. Formulation of objectives are not well thought out, because the answer is known in advance. On the other hand, sub-goals are clearly defined in line with the research findings. The delivered results are of good quality due to systematic preparation of each experiment and a statistical evaluation. The experimental part is complemented by finite element analysis and the explanation of each observed phenomenon supports the quality of the results.

2. Analysis of the current state of knowledge in the dissertation

The references are properly used, relatively well-structured and properly described. Cited documents refer to relevant articles, but I would expect a better focus on the aim of the thesis. More than 70% of used references are papers published after year 2010, but most actual papers are missing. It is not clear, why the comparison of SLM and EBM technologies is presented. In terms of solved problems, I miss the comparison of different types of 3D structures and a description of their mechanical behaviour.

3. Theoretical contribution of the dissertation

Static behaviour of the SLM printed lattice structures is already described and well known. This work, however, complements current state-of-art with an explanation of manufacturing limitations and specific behaviour after post-processing. I highly appreciate a testing of

dynamic properties and energy absorption of the structures. Especially, testing within the presence of liquid is interesting. Unfortunately, a closer description of the experiment is missing. The achieved results are of good quality and provide theoretical information useful in further research.

4. Practical contribution of the dissertation

Although the work does not contain specific recommendations for the use of 3D structures, it draws attention to particular problems in the production of implants for the human body and related limitations. I see the main benefit for practice in identifying effects of surface treatments which offers possibility to compensate them in technological data preparation stage. Also possibility to predict desired properties of lattice structures is a significant and important step towards an applicative outcome.

5. Suitability of used methods and their application

In general, the work lacks the basic framework of experiments and the reasons why they are done. Figure 4.1 is not sufficient and a description of the individual steps and their logical connections must be included. Moreover, the problem definition is missing. The choice of methods is appropriate. The candidate proved to be able to select the experimental methodology suitable to analyse most of the examined phenomena. Nevertheless, for a deeper understanding of the phenomena I would expect to use of an advanced method, such as a metallography or a computed tomography.

The thesis deals with the spatial structure analysis. In this context, the Chapter 4.2 seems redundant. It seems to me that the interconnection of 2D structure and 3D structure is not essential for the work. I appreciate the effort to simulate the human body environment when measuring the dynamic response of structures.

The work contains unreliable data that I did not understand. For example:

- *“The samples were fabricated from Concept Laser CP-Ti Grade 2 powder consisting of particles with size ranging from 45 to 100 μm [53]. The process parameters were in accordance with manufacturer’s recommendation: building chamber was not pre-heated, the laser beam power was 200 W, the scan speed was 7 m/s, the layer thickness was 20 μm , and the offset distance was 75 μm .”*

It looks like a nonsense, because a range of particles size is double against layer thickness.

- *Concept Laser’s ‘island’ scan strategy was applied.* I am not sure, if in a reality the strategy was used due to a tiny geometry and cross-sections.
- An internal porosity of tensile samples within a cross-section smaller than 1,5 mm² is not presented and analysed.
- It is also unclear what was the shape of tensile specimens.

6. Evaluate whether the doctoral student has demonstrated knowledge in the field.

PhD thesis is an independent scientific work that presents a novel solution to a significant problem in the research area and demonstrates the candidate’s ability to conduct independent research. The student showed good knowledge and orientation in the field.

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7. Formal requirements of work

In general, English is sometimes confusing, and the author does not use established terms for description. Also, several typing errors do not help in this work. Some images and paragraphs are duplicated and therefore redundant, also equations are not numbered. In some cases, the reader is not sure what the author wants to express. It would be preferable to express the technical information in a table rather than in the text. Despite my reservations, I consider the elaboration of the dissertation sufficient to describe and explain chosen problems.

8. Recommendation

Despite the above-mentioned shortcomings, **I recommend the work for defence.**

Date and signature: 8.1. 2020



David Paloušek