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Opponent's review of the Doctoral Thesis

Candidate Ing. Luboš Řehounek

Title of the doctoral thesis Design of a porous metal structure for use in intraosseous parts of dental and orthopedic implants

Study Programme Civil Engineering - Physical and Materials Engineering

Tutor doc. Ing. Jan Vorel, Ph.D.

Opponent Prof. dr.ir. Roman Wan-Wendner

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Topicality of the doctoral thesis theme				
Commentary: The topic of the doctoral thesis is of high relevance and current interest. Additively manufactured components (here biocompatible implants) represent an interesting alternative to the current practice with the potential to revolutionize the field.				
☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Fulfilment of the doctoral thesis objectives				
Commentary: The doctoral thesis summarizes nicely the challenges related to dental implants from which the potential use of 3D infill patterns are derived. After preliminary studies on infill patterns a numerical study comparing established implant types to the proposed alternatives nicely demonstrate the potential.				
☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Research methods and procedures				
Commentary: The candidate employs a mix of experimental and numerical work. While the experimental results suffered some set backs (tensile testing) and sometimes lack a clear explanation of how the quantitative results were obtained the demanding numerical simulations are clearly explained and convincing. Further work on experimental verification should of course follow.				
☐ excellent	☐ above average	☒ average	☐ below average	☐ poor

Results of the doctoral thesis – dissertant's concrete achievements				
Commentary: In this reviewer's opinion the main achievement is the comparative numerical analysis of dental implants (individual, group) comparing the current practice with the proposed alternative considering also the heterogenous nature of bone and the complex jaw geometry through CT scans.				
☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

Importance for practice and for development within a branch of science

Commentary: The present thesis pushes the boundary of current practice and convincingly puts forward a new type of implants that promises improved biocompatibility and reduced stress shielding. Pending further experimental validation and in depth studies this thesis sets the basis for the next generation of implants. Outside the field of dental implants relevant contributions to the use of gyroid infill patterns are made that will further the wider state of knowledge from which also e.g. structural engineering applications will profit.

☐ excellent	☒ above average	☐ average	☐ below average	☐ poor

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

Commentary: The thesis is well-structured and written and clearly guides the reader (even one not familiar with dental implants and bone mechanics) from objectives, over challenges, printing technologies, infill patterns, their global characterization to proof of concept simulations showing the value of the proposed solution.

☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Statement on compliance with citation ethics

Both scientific literature and own work are properly cited.

Remarks

An overview of published work with sub-division in conference papers and international peer-reviewed journal papers would have been interesting to see.

The demonstration of experimental results remain rather qualitative. More information on data analysis and post-processing would have been instructive to the reader.

While the objective of running simulations in "real time" on a consumer PC is understandable, this reviewer is not convinced that this is the future. The availability of modern cloud based HPC infrastructure no longer necessitates purchasing expensive workstations or limiting oneselves to low computational resources.

Final assessment of the doctoral thesis

Overall, the candidate submitted a solid thesis that is well-written and clearly leads the reader from problem statements over objectives to the numerical proof of novel solutions for dental implants based on additive manufacturing of gyproid infill patterns. The work is supported by experimental investigations and to a larger extent well executed nummerical 3D analyses exploring a trade-off between computational cost and accuracy.

Following a successful defence of the doctoral thesis I recommend the granting of the Ph.D. degree		
	yes ☒	***no*** ☐

Date: 18/12/2023

Opponent's signature: .....