INSTITUTE OF MACHINE AND INDUSTRIAL DESIGN

FME

Faculty of Mechanical Engineering
Brno University of Technology

Principal supervisor's final report on the PhD study

1. PhD candidate
Ondřej Červinek / ondrej.cervinek@vut.cz
2. Name of PhD programme
Machines and Equipment
3. Title of PhD thesis
Computational models for non-linear mechanical loading analyses of lattice structures made by laser powder bed fusion

4. Principal supervisor
Assoc. prof. Ing. Daniel Koutný, Ph.D. / Daniel.Koutny@vut.cz
5. Co-supervisor
Assoc. prof. Ing. David Paloušek, Ph.D. / palousek@fme.vutbr.cz

6. Stays at other institutions (min. 7 days)
Institute of Lightweight Design and Structural Biomechanics TU Wien / Austria / **01/08/2019 / 09/08/2019** Institute of Lightweight Design and Structural Biomechanics TU Wien / Austria **/ 01/06/2021 / 31/08/2021** Institute of Virtual Manufacturing ETH Zürich / Switzerland / **04/02/2022 / 31/07/2022**

7. Teaching activities
Machine design fundamentals / 182 hrs Machine Design / 78 hrs CAD / 26 hrs Design and CAD / 78 hrs 3D Digital Technology and CAD / 8 hrs Finite Element Method – Structural Analyses / 12 hrs Team Project / 26 hrs Finite Element Method – Advanced Analyses / 8 hrs Analytical Project / 26 hrs Additive Technologies / 100 hrs

8. List of main publications
Papers published in journals with impact factor: VRÁNA, R.; ČERVINEK, O.; MAŇAS, P.; KOUTNÝ, D.; PALOUŠEK, D. Dynamic Loading of Lattice Structure Made by Selective Laser Melting-Numerical Model with Substitution of Geometrical Imperfections, 2018, vol. 11, no. 11, p. 1-22. ISSN 1996-1944 *Journal impact factor = 3.748, Quartile Q2, Citations = 18*

ČERVINEK, O.; WERNER, B.; KOUTNÝ, D.; VAVERKA, O.; PANTĚLEJEV, L.; PALOUŠEK, D. Computational Approaches of Quasi-Static Compression Loading of SS316L Lattice Structures Made by Selective Laser Melting. Materials, 2021, vol. 14, no. 9, p. 1-24. ISSN: 1996-1944.
Journal impact factor = 3.748, Quartile Q2, Citations = 9

WERNER, B.; ČERVINEK, O.; KOUTNÝ, D.; REISINGER, A.; PETTERMANN, H.E.; TODT, M. Numerical and experimental study on the collapse of a triangular cell under. International Journal of Solids and Structures, 2021, vol. 236, no. 76, p. 1-12. ISSN: 0020-7683.
Journal impact factor = 3.9, Quartile Q1, Citations = 1

ČERVINEK, O.; PETTERMANN, H.; TODT, M.; KOUTNÝ, D.; VAVERKA, O. Nonlinear dynamic finite element analysis of micro-strut lattice structures made by laser powder bed fusion. Journal of Materials Research and Technology, 2022, vol. 18, no. 1-16, p. 3684-3699. ISSN: 2238-7854.
Journal impact factor = 6.267, Quartile Q1, Citations = 1

VRÁNA, R.; KOUTECKÝ, T.; ČERVINEK, O.; ZIKMUND, T.; PANTĚLEJEV, L.; KAISER, J.; KOUTNÝ, D. Deviations of the SLM produced Lattice Structures and Their Influence on Mechanical properties. Materials, 2022, vol. 15, no. 9, p. 1-20. ISSN: 1996-1944.
Journal impact factor = 3.748, Quartile Q2, Citations = 2

Papers in conference proceedings:

ČERVINEK, O, R VRÁNA, D KOUTNÝ a D PALOUŠEK. Static and dynamic compression performance of lattice structures made by selective laser melting. In: *European Powder Metallurgy Congress and Exhibition, Euro PM 2019*. EPMA, 2019. ISBN 9781899072514.

VRÁNA, R, O VAVERKA, O ČERVINEK, L PANTĚLEJEV, J HURNÍK, D KOUTNÝ and D PALOUŠEK. Heat treatment of the SLM processed lattice structure made of AlSi10Mg and its effect on the impact energy absorption. In: *European Powder Metallurgy Congress and Exhibition, Euro PM 2019*. EPMA, 2019. ISBN 9781899072514.

9. Assessment of the supervision process

Very good

Justification for evaluation: The main communication with the doctoral student regarding the topic of his thesis was carried out in the form of regular meetings on weekly bases. For each meeting, the student prepared summarization of his progress. After his presentation, the choking nodes and the most important point were discussed in detail. Based on the discussion, possible solutions to particular issues were concluded. It is necessary to mention that the student usually reflected the recommendations of his supervisor and was able to proceed to further steps of thesis solution. On the other hand, the student came up with his own innovative ways of solutions which offered new unexplored possibilities. The supervision of the student was without any issues, as he was well organized, punctual, and fulfilled his tasks reliably.

10. Assessment of the candidate's ability to work independently

Excellent

Justification for evaluation: The doctoral student proved his ability to work independently. From the beginning of the studies, he participated on several research projects and contracts with industrial partners. The tasks he received were done on time and in a good quality. He fulfilled his teaching duties with passion, showing a positive feedback from teaching coordinators and students. He proved to be capable to guide student projects, bachelor and diploma thesis. His students passed very well. The student also demonstrated the ability to formulate hypotheses on his own research and test them with experiments he

designed. On the basis of the experiments, he formulated conclusions with suggestions of possible explanations. During his studies, he applied several times for an internship abroad. On the basis of the results achieved on workplaces abroad, he prepared manuscripts of studies which were later published. At the ILSB TU Wien he started long-term cooperation, which led to successful project application focused on international mobility.

11. Assessment of the contribution that the research makes to knowledge in the field
Very good
Justification for evaluation: The doctoral student focused on development and investigation of a nonlinear numerical model of lattice structure loading. The research involved computational models that included unique combination of the most significant geometrical imperfections, specific properties of multi-strut samples, and dynamic effects. These effects have already investigated before, but always separately without consideration of their mutual effects. The combination of effects in computations allowed to achieve an accurate estimation of deformation properties of lattice structures and explore their potential in practical applications. Verified computational models can be used to find efficient structure configurations determined for a specific amount of energy absorbed without prior manufacturing and testing. Using this approach, a variety of energy absorbers with desired deformation characteristics can be designed in the future for the transport industry. Simulations will help to reduce development expenses, shorten development time, and increase efficiency particular designs.

12. Other comments
Conferences and seminars 11/2020 ANSYS Workbench Mechanical – Nonlinear course 7/2020 An ECCOMAS Advanced Course on Computational Structural Dynamics 2020 9/2018 Course of the scientific work basics (AV ČR) 11/2018 ANSYS Workbench Explicit STR course Honours and awards 01/07/2018 2nd place in Student competition SVS FEM of the best ANSYS project (Prof. Jaroslav Buchar Award) – SVS FEM s.r.o. 01/06/2018 Winner of Diploma theses conference – BUT FME 24/11/2020 Rector's Commemorative Medal of Merit – BUT

13. Conclusion
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.
YES

14. Date and signature	
27/02/2023	

Please note

A. *Evaluate categories 9 to 11 using the following scale: unacceptable, acceptable, satisfactory, good, very good, excellent.*
B. *In each category 9 to 11 explain reasons for evaluation using between 100–200 words.*
C. *E-mail the completed form to: Klara.Javorcekova@vut.cz*