



Ústav výrobního inženýrství

---

## DOCTORAL THESIS EVALUATION REPORT

**Author:** Ing. Tomáš Doktor

**Doctoral Thesis:** Strain-rate sensitive cellular materials for energy absorption

**Supervisor:** prof. Ing. Ondřej Jiroušek, Ph.D.

**Supervisor–specialist:** doc. Ing. Daniel Kytýř, Ph.D.

**Reviewer:** doc. Ing. Soňa Rusnáková, Ph.D.

The aim of submitted doctoral thesis, which is written in English language, is to better understand the mechanical behaviour of cellular materials at high strain rates and the possibility of increasing the ability to absorb impact energy using polymeric fillers (polyurethane puty, polyurethane foam and ordnance gelatin). I fully understand and support the approach of multi-level experimental testing to assess the mechanical properties of both the base material and cellular structure.

The given doctoral examination summary consists of 88 pages that are divided into 7 numbered and main chapters, which are followed by a list of used references. The lists of figures and tables is followed after abstract. The doctoral thesis has an intelligible and logical concept. The definition of the aim of work is presented in a separated No. 1.2 chapter: Aims and objectives. Chapter No.1.3 clearly describes of thesis structures. I miss at thesis a chapter Contribution to science and practice which is usually as the standard part according by the requirements and conditions of Czech universities.

### Assessment or Evaluation of the Doctoral Thesis

- from the aspect of the topicality of the problem

---

the submitted work is up-to-date because obtained results offered original results of impact energy absorption. This energy is connected with the safety application and therefore the thesis brings new combination of interpenetrating-phase composites,

The approach is selected and used appropriately, and they are adequate to the topic of the work.

**- from the aspect of work for the scientific field**

the submitted work represents a complex approach for determination of mechanical response under impact investigated by drop test and Split Hopkinson pressure bar. The SHPB showed a strain-rate sensitivity in the impact energy absorption characteristic.

The achieved so far results can be considered as a beneficial for the Technology and Technics of Transport and Communications and other scientific fields, such as impact energy absorbers. The results are multidisciplinary on the border with material engineering. Porous materials represent a promising group of impact energy absorbers. The inspiration come out from the nature and belong to the novel trend of bioinspired techniques.

**-from the aspect of the problem-solving process**

the methods used and the fulfilment of the objective the author used:

time-lapse computed tomography for detailed description of cellular structures of the metal foam, micro-scale mechanical tests for investigation of mechanical properties,

the experimental testing on cellular metals and IPCs under moderate strain conditions by a drop tower,

mechanical response of filling materials and IPCs at higher strain-rates by Hopkinson bar,

the investigation of the influence of the controlled stiffness of the struts' joints in an auxetic lattice on the strain energy density and Poissions' functions and investigation on the influence of the filling material on the impact energy absorption.

**-the evaluation of author's publications in relation to the topic of work**

the all own publishing activities (10 references) are at SCOPUS or WoS, 4 papers of which are published in journal with impact factor.

Regarding the numbers of published papers with peer-reviewed process the doctoral thesis of Tomáš Doktor far exceeds obviously the requirements and conditions of Czech universities. I miss

information about pedagogical activity of candidate. I appreciate engagement in research projects with total budget €321 000 and €213 000, which were evaluated as successfully solved.

**- from the aspect of the formal arrangement of the thesis**

the graphic processing of the doctoral thesis has a very high level and the same can be said about the formal and grammatical editing of the text. Tables and graphs are appropriately presented with good orientation for readers.

**- from the aspect of the overall level of the doctoral thesis**

from a technical and scientific aspect, the doctoral thesis is processed at a high-quality level. Based on this fact, I can state that the PhD-candidate has the ability of a scientific approach in relation to solving challenging technical problem. Experimental work shows that the candidate is capable of scientific work, can process the obtained data, draw conclusion from them and on the basis of them plan the progress of further experiments.

I would like to ask PhD-candidate to answer the following questions briefly:

1. Which challenges could offer predictive numerical models to obtain response of cellular materials and lattices in term of high manufacturing cost and reliability of the fabrication process? Which approach for modelling auxetic unit cell can be apply?
2. On page 62 you mentioned engineering strain and stress, which you converted into the true strain and true stress. How they differ and how many repeated compression test did you realised? According to which methodology did you set the testing conditions?
3. Can you describe more detail applications where such materials could be used based on the current knowledge achieved in your dissertation?
4. How we can minimize the effect of imperfection on the local buckling of auxetic structures?
5. What did you inspire at designing specimens and manufacturing?
6. How large sample file did you use for example high strain-rate impact testing?

**I evaluate the submitted doctoral thesis in a positive way and I propose to accept this thesis by Ing. Tomáš DOKTOR for dissertation defense**

**and after successful defense of the dissertation thesis**

**I propose to award title Ph.D. ("doctor") to Ing. Tomáš DOKTOR in the Technology and Technics of Transport and Communications study programme.**

in Zlín, 27<sup>th</sup> November, 2020

doc. Ing. Soňa Rusnáková, Ph.D.

