CZECH TECHNICAL UNIVERSITY IN PRAGUE
Faculty of Transportation Sciences
Dean's Office - Department of Science and Research
Konviktská 20, 110 00 Prague 1

Opponent review of the doctoral thesis

I. Identification data

Title of dissertation:	**Experimental investigation into dynamic properties of additively manufactured materials and structu.**
Author's name:	**Ing. Jan Falta**
Training centre:	**Department of Mechanics and Materials**
Opponent of the thesis:	**Dipl.Ing. Dr.techn. Georg Baumann BSc**
Opponent's workplace:	**Graz University of Technology, Vehicle Safety Institute**

II. Evaluation based on individual criteria

Actuality of the dissertation topic	
The present dissertation topic is of a highly novel nature, dealing with an Open Hopkinson Pressure Bar (OHPB) paired with a contactless instrumentation method in the form of a high-speed linear magnetic encoder. Additionally, it delineates the implementation of flash X-ray radiography (FXR), a technique that facilitates high-speed in-situ observation of the penetration process and internal deformation of a specimen. Innovative auxetic lattice structures manufactured using additive processes as well as shear thickening fluids (STF) within the core of sandwich panels, have been subjected to rigorous testing, yielding encouraging results.	
evaluation	**Excellent**

Fulfillment of the goals of the doctoral thesis
All six research objectives were fully covered and discussed in the submitted doctoral thesis. The research focused on the development of advanced instrumentation methods and their application to characterise dynamic material responses. In particular, the following research goals were addressed: **- Development and validation of an alternative, contactless sensor technology, that is both cost-effective and compact** **- Design and implementation of an Open Hopkinson Pressure Bar (OHPB) configuration with an instrumentation on both bars, which allows for deformations up to high strain levels** **- Integration of flash X-ray (FXR) and high-speed X-ray systems for real-time observation of internal deformations** **- Application of experimental setups for the investigation of novel structured and additively manufactured materials, including auxetic lattice structures and STF-filled sandwich panels**

- Evaluation of the reliability and precision of the newly developed instrumentation method, by comparing the results with strain-gauge measurements and digital image correlation (DIC), as well as with numerical simulations. **- Creation of reference data sets and methodological guidelines for the evaluation of the wave separation method and the dynamic characterisation of structured and unconventional materials.**

evaluation	**Excellent**

Methods and procedures of solution
The methods and procedures described in the sources for obtaining the results can be considered highly advanced, comprehensive and methodologically transparent. The studies are characterised by the combination of novel instrumentation techniques with thorough validation procedures in order to overcome the challenges of dynamic testing of complex materials. **The research is based on the application and further development of the Open Hopkinson Pressure Bar (OHPB) and Direct Impact Hopkinson Bar (DIHB) configurations, which were specially developed for the dynamic compression of cellular materials.** **A key feature of the process is the application and validation of a novel contactless method for measuring velocities using high-speed wireless linear magnetic encoders.** **The combination of dynamic mechanical testing with flash X-ray radiography (FXR) and high-speed X-ray radiography is a crucial procedural detail and an important step in obtaining real-time information about internal deformation mechanisms.** **In summary, it can be said that the methods and procedures described, demonstrate a high degree of precision, redundancy and scientific depth, particularly through the successful integration of contactless speed sensors and in-situ X-ray imaging into the Hopkinson bar technique.**

evaluation	**Excellent**

Výsledky disertace – konkrétní přínosy disertanta
The most significant expansion of knowledge is to be found in the further development and validation of novel, integrated experimental techniques for the characterisation of materials with low impedance and complex geometry at high strain rates. **Experimental configurations allowed the test specimen to be compressed to high strains (up to densification) in a single, uninterrupted impact event, which is especially advantageous for the characterisation of cellular materials.** **In-situ radiography provides fundamental information about deformation processes in the microstructure of samples, which is crucial for the development of highly accurate numerical simulations.** **Some of the samples tested, exhibited high rate sensitivity, which was reflected in the dynamic increase factor (DIF). In the case of the STF samples, values of 50 and above were reached.** **Despite the supposedly auxetic cell design, the auxetic character (negative Poisson's ratio) was not confirmed; the area difference was positive for all configurations examined.**

This was attributed to the geometry of the spatial arrangement, the limited precision of the manufacturing process and the small size of the re-entrant areas, demonstrating the complexity of such structures.

evaluation	**Excellent**

Significance for practice and for the development of the scientific field
The thesis is of considerable importance both for the development of the scientific field of experimental impact dynamics and for practical applications in the area of high-performance materials and impact protection. **The main contributions to scientific advancement lie in the establishment and validation of novel, integrated experimental methods that overcome the limitations of conventional dynamic testing methods.** **Furthermore, the work provides detailed quantitative reference data sets on the dynamic deformation behaviour of additively manufactured architectural materials (auxetics, lattice structures, sandwich panels) and unconventional materials such as STF-filled panels.** **The practical significance stems from the novel application possibilities and the direct contribution to the optimisation of impact and protective structures.** **An improved basis for numerical simulations has been created, such as the ability to measure reliable force, velocity and deformation profiles while simultaneously visualising internal phenomena in situ using FXR.** **This overcomes a significant limitation in the formulation of functional material models and significantly improves inputs for finite element simulations.**

evaluation	**Excellent**

Formal arrangement of the doctoral thesis and its language level
The present doctoral thesis is clearly and logically structured and follows the typical arrangement of a scientific work. The language used is highly scientific and precise and technical terms were used correctly and were also summarised in the abbreviations. **In addition, the work is very striking due to its extensive use of visual elements. Numerous diagrams, charts and images are used to illustrate the complex experimental setups and results.** **Moreover, the mathematical principles such as for wave propagation, wave separation and strain and force evaluation are clearly presented through numbered equations.** **Certain sections on validation or wave analysis require a high degree of concentration, as they present complex relationships in nested sentences.** **Throughout the entirety of the thesis, only few and minor errors in grammar and spelling are to be found.**

evaluation	**Above average**

Reminders:

Questions from the opponent:

1) Page 4 "Gap of designed materials":
How would you assess the potential of lightweigth, high-performing materials designed not by humans, but by nature? e.g. of wood, plant fibres, mollusk shells, etc.

2) Page 18 "Rods out of viscoelatic materials":
What are the main benefits and drawbacks of using rods made from viscoelastic materials?

3) Page 35 "Equilibrium condition":
Which criteria has to be fulfilled to achieve a state of stress equilibrium between both sample sides (incident and transmission side)?

4) Page 38 "Choice of pulse shaping technique":
What criteria are used to select pulse shapers and how are they chosen?

5) Page 42 "Limitations regarding achieveable impact velocities":
What are key factors that determine the maximum possible impact speeds in a (Split) Hopkinson test bench?

6) Page 43 and 84 "Influence of cross-sectional changes on the transmission bar":
As the specimen is much larger in diameter than the transmission bar, a disc is attached to support it (see Fig. 4.11 and 5.12). However, the increased diameter and mass of the disc may affect the shape of the measured pulse in the transmission bar. How is this considered in the evaluation?

7) Page 47 "Strain gauge positioning in an OHPB setup":
Which factors are crucial for effectively positioning strain gauges in an OHPB setup?

8) Page 72 "Strain-rate effect on the stress-strain response":
Why is the stress-strain curve of the lower dynamic strain-rate sequentially higher than the curves of the high dynamic strain-rate (see Fig. 5.5)?

9) Page 77 "Choice of strain gauges":
Why were strain gauges designed for use on steel surfaces (LY61) used on aluminium bars?

10) Page 112 and 113 "Clearly visible overshoots in the force signal":
What causes the extreme overshoots in the force signal measured in the outputbar (see Fig. 5.34 and 5.35), meaning that the force value temporarly turning negative?

III. Final evaluation

Final evaluation of the doctoral thesis:

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This work represents an outstanding achievement in experimental impact dynamics and is considered groundbreaking in terms of both methodology and application. The overall assessment is based on the exceptional methodological innovation, the scientific rigour of the validation and the specific, quantitative results that advance our understanding of complex materials under dynamic loading.

Ph.D. title award: **I recommend.**

In **Graz,** day **25.11.2025**

Signiert von: Georg Baumann
Datum: 25.11.2025 13:09:37
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Signature of the opponent