

REVIEWER - doc. Ing. Jan KRMELA, Ph.D.
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Opponent Assessment Report on Doctoral Thesis

Title of Thesis: **Design and Validation of the Methods for Comprehensive Characterization of the Hyperplastic Properties of Elastomers**

Author of Thesis: **Eng. Rohitha KEERTHIWANSA**

The submitted doctoral thesis, which is written in English language, is connected with the current topic, involving the design of method for determination and fitting of parameters of constitutive hyperelastic material models as well as their prediction based on data, namely from uniaxial tensile tests. The given doctoral examination summary consists of 95 pages that are divided into 7 numbered and 1 unnumbered (very important chapter: *Contribution to science and practice*) main chapters, which are followed by a list of used references, lists of figures, tables and symbols and a list of own publishing activities along with Curriculum Vitae

The doctoral thesis has an intelligible and logical concept. The definition of the aim of work is presented in a separated No. 2 chapter: *The Objective* after *Introduction*. Finally, there is the separated chapter *Contribution to science and practice* after chapter *Conclusion*.

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 can be used as input data for computational modeling of tires, rubber conveyor belts, elastomer springs etc. The approach is selected and used appropriately, and they are adequate to the topic of the work. The most important part of the thesis for practical usage is connected with subchapters 4.3 and 4.4, including data fitting and their prediction with their statistical evaluation. There are new equations for obtaining biaxial tensile data standing for validity for different strain range.

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

the submitted work represents a new different approach to the determination and prediction of hyperelastic behaviour, and therefore the obtained results are original, applicable in practice. The achieved so far results can be considered as a beneficial for the Production Engineering and other scientific fields, such as conveyor belts and tire industry.

- **from the aspect of the problem-solving process, the method used and the fulfilment of the objective**

the author used Mooney-Rivlin two and three parametric models as the final model for data fitting. In addition, the author deals with Yeoh and Ogden models. The author should have tried to use also any other models, such as models at <http://www.hyperfit.wz.cz/models.php> (you could have included the knowledge from e.g. webpages and manuals of the HYPERFIT software and PolyUMod MCalibration software by Verist Engineering, LLC and other similar programs which are used for data fitting in the research study of dissertation thesis as I have written in the review of doctoral examination summary). The methods are clearly defined – for the prediction of the biaxial experimental data, based on uniaxial experimental data, the predicted data has to be as accurate as possible. The objective “find a method of obtaining realistic and accurate material constants whenever only uniaxial data is available” has been achieved.

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

the all own publishing activities (10 references) are at SCOPUS, 7 of which are in the journal *Materials science forum*. It has to be pointed out that 11 records are listed in the SCOPUS database and the author forgot to mention: Javořík, J., Nekoksa, P., Kledrowetz, J. and Keerthiwansa, R.: Applicable FEM models for layered beams, *Manufacturing Technology*, 2017, 17(4), pp. 474–479. Moreover, the own reference No. 1 is from 2018. It is a pity that the continuous results were not published in some major magazine with higher impact factor because I think that the results can be very interesting for practical use.

- **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. Data fitting in graphs is 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.

From the above-mentioned facts, I state that the submitted doctoral thesis of author, Eng. Rohitha KEERTHIWANSA meets the requirements given to doctoral thesis.

I would like to ask PhD-candidate to answer the following questions briefly (mainly questions no. 1, 2 and 4):

1. **Did you try to put so-called "weighting coefficients" into the calculations (for low or high values of elongation)?** Perhaps the curves would be better described such as curve at Figure 5.6 (page 50).
2. **Did you try to regain the reconstruction of the dependences of force and deformation (based on the knowledge of the Mooney-Rivlin parameters) for comparison with experimental raw data? Do you know why it would be good to do reconstruction?**
3. Did you try to use shear experimental data together with uniaxial tensile test data to predict biaxial data? How could it affect the results and accuracy of the prediction?
4. At Discussion – part 6.4 (page 73) – there is text “*objective of the work is rather less focused on a particular model, but on data*” – It is always necessary to create a model in accordance with the data, so the data can be verified by experimental data. **Can you clarify what you mean by that** (maybe it was an inaccurate statement)?
5. Did you try to use neural networks via e.g. Matlab for prediction of biaxial experimental data and final material parameters of elastomers?

I evaluate the submitted doctoral thesis in a positive way and

I propose to accept this thesis by Eng. Rohitha KEERTHIWANSA for dissertation defense

and after successful defense of the dissertation thesis

I propose to award title Ph.D. (“doctor”) to Eng. Rohitha KEERTHIWANSA
in the P3909 Production Engineering study programme.

In Tuchyňa, November 1, 2020


doc. Ing. Jan KRMELA, Ph.D.