Department of Automotive, Combustion Engine and Railway Engineering
Czech Technical University in Prague
Faculty of Mechanical Engineering

Review of Dissertation Thesis

Author: **Ing. Bekir Tuna Kayaalp**
Title: **ACCURACY IMPROVEMENT OF MEASUREMENTS BY ANALYZING DYNAMIC RESPONSE OF A TRAM WHEEL ROLLER-RIG**
Reviewer: **Ing. Jan Kalivoda, Ph.D.**

1. General description

The thesis consists of eight chapters, two appendixes, bibliography and list of author's publications. The thesis is written on 129 pages all together.

The first chapter is an introduction to the topic and summarisation of benefits of roller rig testing. The second chapter contains a comprehensive and up-to-date literature review focused on the history of roller rig testing, concepts and functionalities of roller rigs, fundamentals of wheel rail interaction and differences between wheel-rail and wheel roller contact. In chapter three, the dissertation objectives are explicitly defined. The fourth chapter contains overview of applied methods, performed experiments and simulations and their results. The results are summarized in chapter five, followed by conclusions in chapter six, proposals for future work in chapter seven and summary of dissertation contributions in chapter eight.

The structure of thesis conforms to principles and requests to the structure of scientific thesis. The formal processing of the thesis good, pictures and diagrams are well arranged and clearly legible.

The thesis fulfils the formal requests.

2. The topicality of the thesis

The overall objective of the thesis is to improve the performance of the plane type roller-rig placed in Educational Centre in Transport in Doubravice, Pardubice and thus increase the quality and accuracy of measured data. The topic is very specific and results are important primarily for the owner and operator of the experimental device. However, the problem of reliability and accuracy of an experimental test device is general and very frequent. Approaches and methods described in the thesis are generally applicable.

The topic of thesis is actual and relevant in the context of up-to-date research.

3. Aims and methods of the thesis

The subject of this work is the test bench capable to measure adhesion conditions in a contact of two rollers. Two types of undesirable behaviour of the test bench are identified:

- Poor dynamic performance that causes oscillations and delays in the measured signal,
- uncertainty of measured coefficient of adhesion with respect to the procedure of loading torque.

Possible reasons for such behaviour are identified and investigated. The test bench is divided to mechanical part including stationary and moving parts and electrical part including electric drives, control system and data acquisition system. Stationary mechanical part is investigated by finite element calculation that is partially verified by stain gauge measurement. Moving mechanical parts and electrical system are investigated by a simulation model. The out of roundness of the rollers and the deformation of the roller shafts and bearings are measured using both mechanical contact sensors and laser sensors. Considerable part of the thesis is devoted to the design of a filter for the processing of measured signal.

Selected methods and developed models are fully consistent with the objectives of the dissertation.

Aims and methods are clearly described; methods of research work are up-to-date and appropriate to the aims.

4. Results of the thesis and their benefit

FE analysis of stationary parts is significantly simplified; only the stresses are assessed. Given the objectives of the work, it would be beneficial to evaluate also the deformations and in particular to perform a modal analysis. Verification of the FE model using a strain gauge measurement in a single location, where the stress distribution is obvious, is questionable.

The main contribution of the thesis is the dynamic model that includes mechanical rotating masses, electric drives of, elastic couplings and adhesion contact between rollers. The mathematical model was successfully verified by experiments on a test rig. Subsequently, the effects of individual model parameters on the dynamic behaviour of the rig were investigated. Asynchronous motor and its dynamic characteristics are identified as the main cause of undesirable dynamic behaviour of the test rig.

Nevertheless, the model and the methods used to create it have more general contribution. It can be utilised to investigate a torsional dynamics of mechanical systems in which electrical drives and adhesion contact between two bodies are present. Typically models of traction drives of rail vehicles.

Author has sufficiently presented his work related to the dissertation. The list of author's publications contains 5 papers presented at conferences or published in scientific journals and one paper under publication process.

The dissertation fulfils its objectives, brings new findings and is applicable for future research.

5. Questions

1. FE analysis of stationary parts of the test rig was verified by strain gauge measurement. The results of FE analysis and strain gauge measurement are compared on Fig. 30. At this comparison, was the rig structure loaded in vertical direction only or was it loaded both in vertical and horizontal direction? If vertical only, why? What direction is important with respect to the objectives of the thesis?
2. Besides of the poor dynamic performance, two more undesired phenomena were identified at the test rig. See chapters 4.2.2 CoA-Creep Inconsistency and 4.2.3 Waving Torque Output Under Free Rolling. Apart from short statements on page 94, solution of these issues is not addressed in the thesis: "*For the CoA-Creep inconsistency, it has been concluded that no need to find a solution…*", *"…Also, the decreasing rounded oscillation around zero Creep-CoA plot has been solved by the torsional stiffness and AM delay*". Could you be more specific on that?
3. What was the criteria for the filter selection? Why was the Savitzky-Golay filter selected as the most suitable? What method was applied for comparison of filtering methods?

6. Conclusion

In my opinion, **Bekir Tuna Kayaalp** proved his ability to do creative scientific work and his dissertation „**Accuracy improvement of measurements by analyzing dynamic response of a tram wheel roller-rig**" meets the requirements for awarding the title Ph.D.

Praha, January 17th, 2020

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