INSTITUTE OF MACHINE AND INDUSTRIAL DESIGN

Faculty of Mechanical Engineering
Brno University of Technology

Review of Doctoral Thesis

1. PhD candidate
Ing. Martin Valena/ Martin.Valena@vut.cz
2. Name of PhD programme
Design and Process Engineering (Mechanical Engineering Design)
3. Title of PhD thesis
Performance Evaluation of Products for Rail Head

4. Principal supervisor
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7. Overview of the scope of PhD thesis[1]
Very good
Justification for evaluation: 100 – 200 words. The title, “performance evaluation of products for railhead” is covered by multi-phase laboratory to field methodologies using top-of-rail (water based) friction modifiers and top-of-rail (oil based) lubricants. Problems with previous test methods have been highlighted and a new test rig has been designed to aid evaluation of these TOR products, using methods that are more representative of the real wheel/rail contact. Improvements in some aspects upon previous friction measuring devices have been made. This work, as well as the two new devices that have been developed (contact simulator and tribometer) will be valuable for both academia and the rail industry. The aims of this thesis have been met and the novel work carried out here provides an excellent platform for further testing, using the described methodology in field environments to optimise TOR product usage and improve operational wheel/rail performance.

8. Significance of the topic and clarity of problem statement
Excellent
Justification for evaluation: 100 – 200 words. The topic, evaluation top-of-rail friction management products, is valuable for the current rail industry. Evaluation and therefore optimisation of these products

[1] Overview of the scope of PhD thesis is a short description of objectives of PhD thesis’s research and summary of main findings and scientific achievements.

has been difficult. This is due to a number of reasons, such as the small amounts of TOR product applied, the variability of wheel/rail contact and environmental conditions in the field and also due to the lack of friction measuring technology that closely simulated the wheel/rail contact. Improvements to the evaluation and optimisation of these products could lead to performance benefits such as reduced noise, energy consumption, extension of wheel/rail lifespan and reduction in carbon. TOR product suppliers can improve their formulations and application methods can be improved.

9. Knowledge of existing literature

Very good

Justification for evaluation: 100 – 200 words. A “state of the art” analysis has been carried out, covering the benefits of using TOR products and the problems with current methods to evaluate them. This includes information about the difficulties comparing between the laboratory and the field. TOR product effects that are frequently observed on MTM/twin disc small scale contacts may not be as prevalent/applicable in operational situations, such as over-lubrication. Different types of friction measurement methods are compared and the importance of a test rig that can be used in the laboratory and the field, a robust methodology to use this rig to evaluate different TOR products was described.

10. Choice of methods and technical soundness

Very good

Justification for evaluation: 100 – 200 words. Small scale laboratory test rigs such as MTM are well established methods to determine product properties, but have limitations of a very small and cyclic contacts, as well as TOR product applications and third body effects. The author acknowledges this and develops a portable tribometer to provide more representative data to the real wheel/rail contact. The design of tribometer and a comparison of operation in comparison to other tribometers available at the time of writing has been carried out. The methodologies required to collect and interpret friction data from the laboratory and field (where possible) have been thoroughly assessed.

11. Quality, originality and significance of the results

Excellent

Justification for evaluation: 100 – 200 words. This work provides a significant increase in the knowledge of top-of-rail friction management products. The author highlighted the lack of suitable portable tribometers and designed a novel measurement method. This has improvements on previous devices and will be of significant benefit to both academia and the rail industry. The originality of the contact simulator is also relevant, which provides a mechanism to simulate wheel passes without requiring expensive and complex full scale test facilities or wheel passes. This provides a a novel approach to the problem of run-in procedures and TOR product dispersal in the laboratory. The results are clearly displayed in high quality, peer reviewed journals.

12. Quality of attached papers

Excellent

Justification for evaluation: 100 – 200 words Together, the set of four paper provide a useful guide to evaluating TOR product properties the laboratory, including a field case study. The carry down and retentivity of products is of particular interest to friction management suppliers and infrastructure operators

at the moment. The authors comparison of the tribometer results compared to small scale mini-traction machine and twin disc highlights that the risk of friction being too low due to product over-application is less severe in the field than may have been previously expected from small scale laboratory results. This is important information for TOR product suppliers and users in the rail industry. In future, field trials using real vehicle passes (rather than the contact simulator) and realistic TOR product applications (either on-board or wayside) would provide valuable information for optimising TOR product application.

13. Overall assessment, strengths and weaknesses (based upon the above evaluation categories 8–12)

Excellent

Justification for evaluation: 100 – 200 words. A thoroughly researched thesis containing excellent and novel contributions to the field of wheel/rail friction management. The steps required to assess the performance of TOR products, including scaling results between the lab and the field have been clearly described. Novel features include both the design and use of a new tribometer as well as the contact simulator the simulate wheel passes, essential for run-in procedures and TOR product dispersal. An improvement could be a more detailed discussion on the field application of these top-of-rail products in real application situations and the benefits of this. Further field trials would be useful with these wayside or on-board applications, but I acknowledge that getting track access can be very complex or expensive. This is noted in “next steps” at the end of the thesis but an approach/framework could be described, even if the field investigation could not be carried out. Further discussion could be made on how the results of this work can be used to improve operational wheel/rail performance. For instance a further understanding of carry down, retentivity and noise suppression could influence both TOR product application and the resultant effects on the wheel/rail contact.

14. Questions and comments

1) Bearing steel has been chosen for the tribometer measuring wheel. Is this due to availability or to improve durability of the wheel? What is the surface finish/roughness of the wheel and is does it change throughout usage? Have you thought about the effects of this on the resultant friction coefficient? 2) the run-in wheel/rail friction increased by a large amount compared to the “clean” rail. Why do you think this is? 3) How do you think this TOR evaluation approach can be used to improve friction management in the wheel/rail interface? 4) The tribometer wheel is cleaned between measurements. How do you think the results for the field approach would differ if the tribometer wheel was not cleaned. Would this be more representative of the real wheel/rail contact? 5) In my experience the application of TOR product can vary laterally as well as longitudinally across the rail surface. Have you thought of any procedures that could be carried out to “map” out this product coverage? 6) In the paper titled “A benchmarking methodology for top-of-rail products: Carry distance and retentivity”, the same amount (80 ul) was used for both the TOR-L and TOR-FM. Operational application amounts from each manufacture differ in the field, could the testing be adapted to include this?

15. 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

16. Date and signature

24/11/2024	

Please note

A. *Evaluate categories 7 to 13 using the following scale: unacceptable, acceptable, satisfactory, good, very good, excellent. The qualification of 'excellent' should only be given for a PhD Thesis in the top 3% of the research in your field of expertise.*
B. *E-mail the completed form to: Klara.Javorcekova@vut.cz*