

## Habilitation Thesis Review

Author of the habilitation thesis: **PhD, Eng. Tomasz Figlus**

Title of the habilitation thesis: **The study of noise and vibration of means of transport in the aspect of reducing their level and usefulness in monitoring the condition of vehicles**

Discipline:

**5.2.59. Doprava**

At the request of the Dean of Fakulta Prevádzky a Ekonomiky Dopravy a Spojov Žilinská Univerzita v Žiline, Prof. Ing. Anna Križanová, CSc, the habilitation thesis by PhD, Eng. Tomasz Figlus entitled „The study of noise and vibration of means of transport in the aspect of reducing their level and usefulness in monitoring the condition of vehicles” was sent to me for review in a letter of 25.11.2014, no. C.j.:1107/2014/PEDAS/Sem. I have prepared the review in accordance with §1, item 8 of Ordinance MŠ SR 6/2005 Z.z.

The habilitation thesis submitted for review consists of 154 pages. It is divided into 7 main chapters, which contain information concerning: an introduction to the subject of the undertaken research, a description of the purpose, scope and theses of the habilitation thesis (in view of the analysis of the relevant publications), as well as a review of the results of the author's own research, illustrating his investigations and the conclusions drawn from them. The habilitation thesis also includes abstracts in English and Slovak, the author's declaration that he has prepared the habilitation thesis independently, as well as lists of figures, tables and references. The habilitation thesis contains 107 figures and 11 tables, the majority of which have been prepared by the author.

### ***Relevance of the subject***

The intensive development of means of transport and road infrastructure has led to an increase in vibration and noise hazards for the environment. In view of this, it is appropriate and desirable to undertake research aimed at identifying these detrimental effects on the environment, and to search for various design solutions which decrease the related vibration and noise levels. An important part of these studies is original research into the use of vibration and noise generated by means of transport as carriers of information concerning their technical condition. In this scope, the methods of measuring and processing vibroacoustic signals in order to detect damage to the subassemblies of means of transport which have been prepared by the author should be considered promising and worth continuing. These are original investigations which are important for the development of the science of the diagnostics of means of transport.

*In view of this, the research into the reduction in the vibration and noise generated by means of transport, and into the use of measurements and processing of vibroacoustic signals in the diagnostics of the technical condition of vehicles, as presented in the habilitation thesis, can be considered very promising and relevant. They fit in well with the current needs of practical diagnostics, which arise from research and practical goals related to the functioning of transport.*

### ***Objectives of the habilitation thesis and their execution***

The author of the habilitation thesis has assumed that vibration and noise generated by means of transport can be reduced through a multi-faceted approach which includes the creation of new solutions in the scope of the design of means of transport, and activities aimed at reducing traffic noise. He also assumed that noise and vibration are valuable carriers of information on the technical condition of means of transport, and the related vibroacoustic influence. Based on these assumptions, in the second chapter of the habilitation thesis the author presented the aims and scope of the conducted research, and formulated 3 theses.

*Based on the results and analyses of the author's own research shown in chapters 4, 5 and 6 of the habilitation thesis, it can be concluded that the adopted assumptions and aims have been achieved, which indicates that the theses of the habilitation thesis can be accepted.*

### ***Research methods used***

The results of the habilitation thesis have been derived from the author's own extensive research: operational and laboratory tests, as well as numerical simulation calculations. The author used suitable equipment, including digital sound analysers, piezoelectric transducers, and laser vibrometers, to measure noise and vibration. The measurement data have been acquired and processed using various data acquisition cards and signal processing software (LabView or Matlab). Programs for numerical calculations using FEM and the Matlab-Simulink software were used for simulations. When processing the recorded signals the author used known algorithms and built his own software signal processing solutions in the Matlab software base.

*The research methods based on measurements, simulations and signal processing which had been adopted in the habilitation thesis were used correctly, making it possible to achieve the aims of the habilitation thesis and to prove the adopted theses.*

### ***Test results and their usefulness***

The habilitation thesis submitted for review presents a wide range of results of tests and analyses aimed at proving the possibility of reducing the adverse effect of noise and vibration in means of transport on the environment, and of applying these signals to diagnose vehicle subassemblies.

The author demonstrated in the habilitation thesis that the use of additional sound barrier diffractors allows reduction in traffic noise near the road by several decibels (depending on the measurement point). The results of the examination of the influence of surface type on traffic noise level showed that surfaces made of cement concrete, in spite of their greater durability and important properties affecting traffic safety, generate greater noise than surfaces made traditionally from asphalt mixtures. The results of this examination may provide important information for institutions in charge of building and maintaining roads.

As far as research into the possibility of reducing the vibroactivity of subassemblies in means of transport is concerned, the candidate has demonstrated that it is possible to decrease noise and vibration by several decibels by choosing suitable ribbing of the gear transmission, and by using gears with a high total tooth contact ratio. The results of this research can be considered a recommendation for design agencies and designers of drives of this type.

The results of research presented by the author into the possibility of adapting the recorded vibroacoustic signals to diagnose the technical condition of vehicles confirmed a thesis concerning the possibility of using vibration signals to detect excessive engine valve clearances while using signal processing methods proposed in the habilitation thesis in the time domain, frequency domain as well as the time and frequency domain. Their algorithms proved to be useful tools for checking the technical condition of combustion engines and for detecting excessive clearances.

*In summary, I wish to state that the author has solved an important scientific and practical problem, dedicated to the analysis of noise and vibration accompanying means of transport, related to the use of methods prepared by the author, in order to achieve the specified diagnostic aims. The theoretical and experimental layers are clearly visible in its execution. Their results show an original approach to an important scientific and practical problem, which holds promise for its further exploration and a search for its broader applications in practical diagnostics.*

*I wish to state that the proposed research approach is promising and has a significant research and utilitarian value, and the obtained results of the habilitation thesis constitute a valuable source of new information concerning the diagnostic examination of phenomena accompanying the functioning of means of transport which may be of use during their operation.*

*Therefore, it can be concluded that the treatise meets the requirements to be met by habilitation thesis, both in terms of originality and the quality of the performed analyses. The results shown are useful both in their direct practical application and for creating new measuring and analysing tools.*

#### ***Questions for the author***

1. Please address the problem of the uncertainty analysis of the conducted studies.
2. Please characterise the range of solutions leading to the reduction in the vibroactivity of means of transport at the design stage.
3. Please characterise how autonomous tools for diagnosing local damage to combustion engines should work.
4. Can the measuring and signal processing methods described in the habilitation thesis be used for diagnosing other subassemblies in means of transport?

### **Conclusions**

*The habilitation thesis by PhD, Eng. Tomasz Figlus, which has been submitted for review, meets all the requirements for granting the title of „docent” in accordance with §1, item 8 of ordinance MŠ SR 6/2005 Z.z. The prepared habilitation thesis shows the extensive knowledge of the author in the field of scientific research into means of transport, and can be admitted for public defence in discipline 5.2.59. Doprava.*

*Based on the conducted review, I propose that the Academic Council of Fakulta Prevádzky a Ekonomiky Dopravy a Spojov Žilinská Univerzita grant PhD, Eng. Tomasz Figlus the title of*

***Docent in discipline 5.2.59. Doprava***

Kraków, 16.12.2014

Professor Włodzisław Batko D.Sc., Ph.D.