

REVIEW

**by Dr. Eng. Slavi Yassenov Lyubomirov, professor at Plovdiv University
"Paisiy of Hilendarski"**

Of a dissertation for the award of an educational and scientific doctorate degree
in the field of higher education 5. Technical sciences,
professional field 5.1. "Mechanical Engineering",
doctoral program "Methods for controlling and testing materials, products and equipment".

Author: Mag. Eng. Nikolay Asenov Toshev

Topic: "Research on active safety systems in cars"

Scientific supervisors:

1. Prof. DSc. Georgi Atanasov Mishev - Plovdiv University "Paisiy Hilendarski".
2. Assoc. Prof. Dr. Kaneta Ilieva Paskaleva - Plovdiv University "Paisiy Hilendarski".

1. General description of the materials presented

By order No. PD-22-1060 of 09.05.2025 of the Rector of Plovdiv University "Paisiy Hilendarski" (PU), I am appointed as a member of the scientific jury for ensuring a procedure for the defense of a dissertation on the topic "Research on active safety systems in cars" for the acquisition of the educational and scientific degree "doctor" in the field of higher education 5. Technical sciences, professional field 5.1. "Mechanical Engineering", doctoral program "Methods for controlling and testing materials, products and equipment". The author of the dissertation is M.Eng. Nikolay Asenov Toshev, a full-time doctoral student at the Department of Mechanical Engineering and Transport, with scientific supervisors Assoc. Prof. Dr. Kaneta Ilieva Paskaleva and Prof. DSc. Georgi Atanasov Mishev from Plovdiv University "Paisiy Hilendarski".

The set of materials presented on paper by Nikolay Asenov Toshev is in accordance with Art. 36 (1) of the Regulations for the Development of the Academic Staff of the University of Plovdiv, includes the following documents: a request to the Rector of the University of Plovdiv for the opening of the procedure for the defense of a dissertation; a curriculum vitae in European format; a protocol from the departmental council related to reporting the readiness to open the procedure and to a preliminary discussion of the dissertation; dissertation; abstract; a list of scientific publications on the topic of the dissertation; copies of the scientific publications; a declaration of originality and authenticity of the attached documents; a certificate of compliance with the minimum national requirements.

The doctoral student has applied for four publications, based on which, a total of 60 points is achieved, covering the minimum national requirements for awarding an educational and scientific degree "doctor" in the relevant field.

2. Brief biographical data about the doctoral student

Nikolay Asenov Toshev completed his secondary education at the Technical School of Non-Ferrous Metallurgy "Dimitar Blagoev" in Asenovgrad, majoring in "Machine Fitter for Assembly, Maintenance and Repair". In 1998, he graduated from Plovdiv University "Paisiy Hilendarski" - Plovdiv, Technical College - Smolyan, majoring in "Technology and Organization of Road Transport", after which he completed a master's degree at Burgas Free University, majoring in: Technology and Management of Transport. He works as the head of the ROPSANDV group in the traffic police sector at the ODMVR in Smolyan. From November 1, 2020, to the present, he has been working as an assistant at the PU "Paisiy Hilendarski" - Faculty of Physics and Technology.

Mag. Eng. Nikolay Asenov Toshev is a graduate engineer in transport engineering. He works actively in the field of automotive engineering and technical safety. He is the author of several scientific publications at conferences and journals. His professional orientation and academic training are in full accordance with the topic of the dissertation.

3. Relevance of the topic and appropriateness of the set goals and objectives

The topic of the dissertation is of particular relevance and importance for modern society, given the continually increasing demands for road safety and the need to implement intelligent, active safety systems in cars. The research focuses on key technologies, such as anti-lock braking systems (ABS) and automatic emergency braking (AEB), the improvement of which directly contributes to the reduction of road accidents. The objectives of the work are formulated and purposefully aimed at experimental research and optimisation of the functioning of these systems.

The study of active safety in cars affects critical aspects of modern automotive engineering—the dissertation work of Mag. Eng. Nikolay Toshev lays the foundation for a deeper understanding of the processes that occur within the framework of road safety, focusing not only on the technical dimensions but also on risk management strategies.

4. Knowing the problem

In developing his dissertation, Mag. Eng. Nikolay Toshev has referred to 135 literary sources. Of these, only two sources by Bulgarian scientists are presented. It is striking that a large part of the scholarly sources are from recent years. This shows good literary awareness by correctly citing the sources. The publications and scientific achievements of current authors, on which the claim for novelty and originality in the dissertation work is based, have been critically analysed. The large

number of literary sources suggests a good knowledge of the problem by the doctoral student and their ability to cope with the tasks set. The reference to these sources and the achieved results speak of a good knowledge of the problem and its creative solution.

5. Research methodology

The author has employed a thorough and systematic approach to the study's methodology, combining theoretical analysis with experimental studies of real cars in a controlled environment. The methodology utilises modern measuring systems (EnergoSM 4.0) to precisely determine braking delay, braking distance, and stopping time under various road conditions and speeds. The author demonstrates good preparation and an appropriate choice of experimental setup, which enables the obtaining of reliable and reproducible results. Of great importance is the fact that the author does not limit himself to laboratory conditions but applies his methods in real-world scenarios, which significantly increases the study's applicability.

Chapter One provides a comprehensive overview of existing active safety systems in automobiles. Key technologies are analysed, including:

- Anti-lock braking system (ABS) – working principle, efficiency and historical development;
- Autonomous emergency braking systems (AEB and AEBS) – algorithms for obstacle recognition and activation conditions;
- Traction and stability systems (ESP, TCS) – their functions are to prevent skidding and loss of traction;
- Driver assistance systems (FCW, LDWS, APS) – collision warnings, lane departure warnings, parking assistance;
- Intelligent control systems (ACC, AFS) – automatic speed control and adaptive lighting;
- Methods for estimating stopping distance and delay, with a focus on their role in increasing safety.

A special place is given to braking control systems. This review provides an in-depth examination of the principles of operation for ABS, AEB, and AEBS. An analysis is conducted to examine how these systems respond at various speeds and under different road conditions, as well as how they assist the driver through automated braking. The work of ESP and TCS, which monitor and regulate the traction and lateral stability of the vehicle in risky situations, such as skidding or loss of control, is presented. An overview of the approaches to assessing braking delay, time and distance, as well as their impact on integral active safety, is presented. The aim of the dissertation is formulated. Four tasks are set to achieve this goal.

The second chapter is devoted to the research methodology. This chapter describes the scientific basis and instruments used to conduct the experiments. The selection of the research object includes three different passenger cars. The EnergoSM 4.0 measuring system is used for non-contact measurement of speed, braking time and braking delay.

Discussed:

- Research object – selected types of cars and conditions;
- Measuring equipment – the EnergoSM 4.0 system for contactless measurement;
- Testing site – description of locations and surfaces;
- Planning and conducting experiments – selection of speeds, conditions and emergency braking scenarios;
- Calculation methodology – formulas for braking distance and braking delay under different conditions.

The aim is to conduct an objective and quantitative assessment of the effectiveness of ABS on dry, wet, and sandy surfaces. The planning of the experiments on test sites with different surfaces – dry, damp and sandy – is described. A methodology for evaluating and comparing the results using mathematical formulas and tables with absolute values is included.

Chapter III of the dissertation presents specific results from the experimental studies:

- Influence of pavement and speed – analysis of their effect on braking distance, stopping time and delay;
- Comparison between summer and winter tires – vehicle behaviour with different types of tires;
- Studies with deactivated ABS system – differences in behavior and results;
- Mathematical modelling – using formulas and simulations to confirm empirical data. Real data and graphs from measurements were used, which substantiates the role of tires and ABS in braking efficiency.

Measurements were conducted on dry, wet, and sandy surfaces. The effect of speed on braking distance, braking time and delay was studied. These studies include graphs and tables confirming the essential role of the road surface. Experiments were conducted with winter and summer tires, measuring the effect of the tires on braking behaviour with and without ABS. Mathematical modelling of the experimental results, including error analysis and validation against theoretical expectations, is presented. Numerous empirical data and their analysis are presented.

The fourth chapter aims to study the effectiveness of the automatic emergency braking (AEB) system. The experimental setup, scenarios used, method for simulating real-world situations, and the

process for recording results are described in detail. Results for the probability of AEB activation are presented, along with an analysis of the braking characteristics obtained. Dependencies between speed and braking behaviour are derived.

Data from a series of tests with varying speeds and distances are included.

Conceptually, it is specified on:

- Testing methodology – scenarios, staging and preparation of experiments.
- Probability of triggering – depending on speed, distance and other parameters.
- Analysis of braking performance with AEB – comparison between different conditions, results and graphical analyses.
- Effectiveness assessment – summary of results and conclusions about the applicability of AEB in various real-world situations.

Chapter IV provides key practical value and highlights the importance of automation in road safety.

The final analysis compares the results with those from cases without AEB and provides guidelines for improving the system.

6. Characteristics and evaluation of the dissertation work

The dissertation work of Mag. Eng. Nikolay Toshev is a comprehensive, in-depth, and balanced study that demonstrates excellent scientific preparation, logical research, and practical experience. The work is structured into logical sections, beginning with an introduction, proceeding through a theoretical review and analysis of existing systems, and concluding with a detailed methodology and an analysis and interpretation of the results. It consists of four main chapters, which examine in detail the active safety systems, their testing methods and experimental results. The research is accompanied by an extensive theoretical analysis, illustrated with tables, graphs and mathematical models, which significantly facilitates the perception and analysis of the obtained data.

The dissertation submitted for review has a total volume of 181 pages. The dissertation comprises an introduction, four chapters, a summary of the results, a discussion of the dissertation's contributions, a list of relevant scientific works, citations, and a bibliography of the literature consulted. The dissertation is formatted according to the requirements, the figures are clear and understandable, and of an appropriate size. The content and text are well structured. The experimental part is rich in empirical data, which are methodologically correctly collected, processed and analysed. The analytical tools and visualisation methods used (tables, diagrams, and graphs) are appropriate and contribute to a comprehensive understanding of the results.

The author constructs a research logic that is grounded in theoretical justification and supported by concrete empirical results, ultimately leading to practical conclusions and recommendations. This approach is highly recommended in engineering sciences and proves the maturity of scientific research.

The focus on specific components such as ABS and AEB systems allows for a detailed understanding of their functionality and significance in real-world conditions. Through mathematical models and experimental simulations, the author presents a realistic portrayal of vehicle behaviour under various conditions.

The use of modern measuring tools, combined with precise processing of the results, reveals a high level of professionalism and attention to detail. The experimental data are subjected to detailed analysis, with each element interpreted in the context of its applicability.

7. Contributions and significance of the development for science and practice

As a reviewer, I have no objections to the claims formulated by the doctoral student for the contributions. I support the contributions of the dissertation. I accept that they are scientifically sound and applicable. Systematically, the contributions presented by the doctoral student, Mag. Eng. Nikolay Asenov Toshev, united with me, are the following:

Applied contributions of the dissertation work

1. It has been proven that a functioning ABS contributes significantly to improving the vehicle's braking performance, regardless of the type of road surface and driving speed.
2. A statistically significant influence of the tread height of car tires on braking efficiency has been established, with decreasing height resulting in reduced braking acceleration and increased braking time and distance.
3. It has been confirmed that selecting the correct tires, tailored to the season and specific road conditions, has a direct impact on road safety.

Scientific and applied contributions of the dissertation work

1. A methodology has been developed for experimental research into the braking characteristics of cars, ensuring high accuracy and reliability of the data obtained.
2. The significant influence of the type of road surface on the braking properties of the vehicle has been proven by taking into account the coefficient of friction between the tires and the surface.
3. A relationship has been established between vehicle speed and braking efficiency, considering the decreasing friction force with increasing speed.

4. A methodology has been developed for the experimental evaluation of the automatic emergency braking (AEB) system's effectiveness, enabling the determination of its activation probability and analysis of its behaviour under various conditions.
5. A theoretical model of braking characteristics has been validated using experimental data, enabling the reliable prediction of the braking process under various driving modes and road surface conditions.

The contribution of the dissertation is not only scientific, but also educational. The developed methodology and its results can be used as a basis for building curricula related to automotive safety and engineering disciplines.

8. Assessment of dissertation publications

I have familiarised myself with the publications presented in the dissertation, which are sufficient in number. The results have been published in specialised scientific publications. In connection with the dissertation work, mag. Nikolay Asenov Toshev has presented four publications, one of which has been published in a scientific journal and is referenced and indexed in the world-renowned Scopus database. Additionally, one article has been published in a collection of reports from the Scientific Papers of the Union of Scientists in Bulgaria-Smolyan, and two in international conferences. This suggests that the research results presented in the dissertation are already known to the scientific community. In the presented publications, mag. Nikolay Asenov Toshev is in first place, and in two of the publications, he is an independent author.

The publications presented reflect the essence of the dissertation topic. No information on the citation of the articles is provided.

9. Personal participation of the doctoral student

From the dissertation submitted for review and the related publications, it is evident that the doctoral student conducted the experimental study independently, focusing on key technologies such as anti-lock braking systems (ABS) and automatic emergency braking (AEB), which directly contribute to reducing road accidents. Four publications on the dissertation are presented, one of which is indexed in Scopus, essentially reflecting the results obtained from the development. In all the articles submitted, the doctoral student is listed first, and in two cases, he is an independent author. This testifies to the doctoral student's significant contribution to the results obtained. I have no common publications with the doctoral student, and I am not a related person, as defined by the law.

10. Author's abstract

The submitted abstract is 32 pages long and faithfully reflects the content of the dissertation in a summarised form. The review of the dissertation abstract demonstrates full compliance with the

requirements for its preparation, as well as the adequacy of its reflection of the main results and contributions of the dissertation.

11. Critical remarks and recommendations

The notes on the dissertation are editorial in nature and in no way diminish the significance of the research and its contributions. Despite the high quality of the work, it would be helpful for the author to make a broader comparative analysis between different types of cars and international standards. It is also recommended to consider the factors related to human behaviour in the use of active safety systems in more depth, which would enrich the research and make it even more applicable in practice.

I have the following questions for the doctoral student:

1. Based on the experimental studies conducted on ABS and AEB systems under various road conditions, how do you analyse the impact of drivers' increasing trust in these technologies on their behavioural responses, as well as the potential road safety risks that may arise from it?
2. Given that ABS and AEB have been considered separately, discuss the possible synergistic effects of their simultaneous operation and propose strategies for optimising their interaction to increase the overall effectiveness of active safety systems.

12. Personal impressions

I have known M.Eng. Nikolay Asenov Toshev since he began working as an assistant professor in the Department of Mechanical Engineering at the Faculty of Physics and Technology, Paisii Hilendarski University. He approaches his teaching activities responsibly, constantly updating the content of the teaching material in the disciplines he teaches.

13. Recommendations for future use of the dissertation contributions and results

My recommendation to the doctoral student is that, in their subsequent research and development, they should justify their choice by considering all the technical and economic parameters of the given problem.

CONCLUSION

The dissertation work contains applied and applied scientific results that represent an original contribution to science and meet all requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADSRB), the Regulations for the Implementation of the ADSRB and the relevant Regulations of the PAISY HILENDARSKY PU.

The dissertation shows that the doctoral student, Mag. Eng. Nikolay Asenov Toshev possesses in-depth theoretical knowledge and professional skills in scientific speciality 5.1. "Mechanical Engineering" by demonstrating qualities and skills for independent scientific research. In conclusion, the presented dissertation is a serious scientific research with high practical value.

Due to the above, I confidently give my positive *assessment for the research conducted, presented by the above-reviewed dissertation, abstract, achieved results and contributions, and I propose to the esteemed scientific jury to award the educational and scientific degree "doctor"* of Mag. Eng. Nikolay Asenov Toshev in the field of higher education: 5. Technical Sciences, professional field 5.1 Mechanical Engineering, doctoral program "Methods for controlling and testing materials, products and equipment".

10.06.2025

Reviewer:

(Prof. Slavi Lyubomirov, Eng., PhD)