Edited by
Aleksander SŁADKOWSKI

SOME ACTUAL ISSUES OF TRAFFIC AND VEHICLE SAFETY

MONOGRAPH

GLIWICE 2013

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Monograph

FACULTY OF TRANSPORT
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CONTENTS

FOREWORD REVIEWS

Review 1

Presented by the authors monograph is devoted to the important topic, safety means of transport and transport systems. Said subject is very actual due to fact that in most European countries there is a significant increase in both the number of means of transport and traffic intensity. The latter applies to road transport that is most noticeable, well as other modes of transport. Hence the relevance of the set of subjects can't be doubted.

Editor of the monograph (Prof. A. Sładkowski) in the introduction said that it is the main goal - to compare the methods used to ensure the safety of different types of transport. Indeed, despite the differences and peculiarities of transport in different countries and regions of the world, there are common approaches to assessing its safety. In the considered book studied the safety of air, road, sea, rail, urban and industrial transport. Obviously, it was difficult to consider all aspects of safety. Nevertheless, it is also clear unity of approaches to achieve security. For example, on the current level, the most commonly used numerical methods (FEM), as evidenced by chapter devoted to road and rail transport. Operational problems can often be overcome by studying the oscillatory processes. At the same time it can be as electric oscillations (chapter on urban transport) and mechanical vibrations (road transport). Critical issues in the management of vehicles can be solved with the use of GPS, which is proved in the chapters devoted to the sea and air transport. Thus, we can confirm what the editor posed, the goal was achieved.

Obviously, besides the above-mentioned aspects of the monograph contains a lot of other very valuable facts for practice of authors achievements. It is also noted the importance of collaboration among scientists from different countries to solve such problems. The book in question is a good example of such an interaction, as it has united the efforts of specialists from Poland, Slovakia, Czech Republic and Ukraine.

I would also like to emphasize the importance of scientific achievements as well as its practical value. We should also note that each chapter of the monograph contains enough information and a detailed analysis of the literature devoted to ascertaining the current state of security issues for each of the transport modes considered. The authors also provide data about their own research in this area, which is very valuable. Should emphasize the development of new tram by experts from the Czech Republic (Chapter 6), the development of methods for assessing the fatigue strength of frame structures of railway rolling stock (Ukrainian scientists, Chapter 7) or complex investigations tanks for gaseous fuel vehicles (scientists from Poland, Chapter 5). Obviously, the monograph under holds some promise for further researches

I believe that the publication of the monograph will stimulate further research. Also important is the fact that it is written in English, which has now become the international language of scientific communication, which means that the achievements described in the book,

will be available for experts from different countries. Also note the cognitive aspect of the monograph, which would be a definite help for students, PhD students and young scientists in preparing their own works. It is also obvious that the book in question can help designers or operators in their daily practice. Thus, as a reviewer strongly recommend publication of this monograph and its widest possible dissemination of the scientific community.

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Review 2

This considered monograph is devoted to the problems of transport safety. It's not news that transport in general, and separate means of transport, in particular, are a source of danger. This danger connected with the fact that the movement is carried out usually at great speed, vehicles are sufficiently complex equipment, under various failure. This aspect can be called internal safety. In addition it should be noted the danger of accidents caused by failures in the traffic management. Moreover, such an aspect can be internal, i.e. all sorts of accidents and external, for example, the impact of the environment (storm, fog, etc.), or from entering birds in aircraft engines, animals on the road and many other aspects. Finally, it is essential to the human factor, i.e. various errors in management vehicle or transport system. All this can be termed «safety», various aspects of which are given by the authors in the title of the book. There is another area, which, unfortunately, is also relevant. This is an unacceptable negative effect on a targeted transport system. This is also the human factor, defines by the word «security». It is no secret that the ensuring security of the transport of terrorism is no less urgent problem compared with the «safety». In general monograph answers the aims posed in the title by the authors and examines some aspects of the problem of the safety of a movement as a whole, and individual vehicles.

This monograph discusses safety problems various types of transport. In particular, Chapters 1 and 2 are devoted to the safety of air transport, in Chapters 3 - 5 discusses the safety of road transport, Chapter 6 considers the security problems of urban transport by the trams example, in Chapter 7, studied the safety of railway transport, Chapter 8 is devoted to maritime transport, and finally in Chapters 9, 10 is considered by the example of industrial transport lifting and transport equipment and conveyors. We note that while the diversity of the considered types of transport and the difference of scientific schools the authors of the individual chapters belong to, there are common approaches to solving problems. For example, the finite element method is used for calculating of the vehicle for both parts and assemblies of road transport (Chapter 5), and of rail transport (Chapter 7); spectral analysis for mechanical vibrations (Chapter 4) and for electrical oscillations (Chapter 6); management of vehicles on the basis of GPS signal for air transport (Chapter 1) and maritime (Chapter 8). In this case it is necessary to acknowledge the editor of the monograph prof. A. Sładkowski, who managed to connect on the pages of a book achievements of scientists from different countries and different sectors of transport science.

Assessing the overall highly monograph «Some actual issues of traffic and vehicle safety» I want to note its practical orientation. All the above aspects are used in modern transport technology and serve as a basis for the development of new models of vehicles or transport systems in general. It is also clear that the proposed monograph authors will be useful for scientists involved in the design means of transport or the development of new transport systems, as well as for undergraduate and graduate students as a supplement to traditional textbooks. I

believe that the above monograph is substantial collective scientific work, containing new materials research, and I highly recommend the publication of this book.

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INTRODUCTION

The problems of safety in transport are on the one hand an inexhaustible theme, on the other hand the actual question. Different modes of transport are as common safety problems and their specific, unique for this type of transport. The idea of this book was to compare these problems, emphasize their importance and relevance, and maybe find some common aspects that could be useful for professionals involved in safety issues in each of the transport modes considered. In accordance with this idea this book deals with air, road, rail, marine, industrial and urban transport. Even this enumeration can't take into account the diversity of transport, but allows you to make some small step for understanding of the importance of these issues and joining efforts of specialists from different countries.

According to EUROCONTROL forecasts, in the coming years we will see a significant increase in air traffic, which - under favorable economic situation in the world - by 2035 will double from 9,5 million air operations in 2012 to 17,3 million and in 2050 will reach 26,1 million operations. It is necessary to increase an efficiency of air traffic management systems, ensure maximum level of safety and take transnational efforts to reduce continuously number of deaths caused by air accident also caused by bird strikes. The first chapter focus in-depths analysis of two related methods of making air traffic management safer: implementation of Global Satellite Navigation Systems and bird hazard management. The dynamic development of aviation caused also huge development of techniques and technologies in navigation. One of them – satellite technologies are becoming involved in every sphere of activity of man. GNSS like GPS, Galileo or EGNOS improves air management and enable perform precision approach at airports. That is why, implementation of ABAS, SBAS, GBAS (also in Poland) are so important. The aim of bird hazard management is to ensure maximum level of safety during these approaches, unattractiveness of airport environment for birds (using GNSS devices), as well as apply techniques includes scaring, using of pyrotechnical means and gas guns or method of natural enemy. Bird control is a crucial element of airport safety system, because bird strike can cause serious damage to a starting and landing aircrafts and even lead to a crash.

In the second chapter the problems associated both with the definition of aviation safety and with the present state of the safety problem of air transportation; components and factors affecting the safety of flight. The role of avionics in flight safety was mention. Problems and principles of design avionics systems corresponding to the desired level of safety are reviewed in this section. Proposed approach to the design of avionics systems based on the principles of rational control. The tendency of the autonomous objects operationability control under the influence of the destabilizing actions is considered. The peculiarities of the autonomous objects operationability rational control by means of the new control principle by diagnosis are described. The models and methods of the autonomous objects operationability diagnosing and recovery under the influence of the destabilizing actions are expounded. The results of the experimental researches on the rational control of the aerospace autonomous objects operationability are given. The perspective directions of further researches are represented.

The safety of vehicles in road traffic is very important because of potential hazards of people's lives and health, damage and loss of freight and high costs of crash effects. The technical state of all vehicles has been examined during required periodical inspections, but in spite of this, the technical conditions of large number of vehicles have been poor. The range of inspec-

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tions and their frequency have been determined according to the law of each country. The methodology and frequency has been determined in accordance with domestic legislation. The methodology of technical inspections concerns only some important systems of vehicles but not all. For example, anti-lock systems, retarders, adaptive cruise control systems, speed limitation devices etc. have not been examined. The results of examinations of 4745 vehicles have been presented in the third part of this book. Tests were carried out in scope of securing safety in road traffic. The methodology of compulsory periodical inspections was applied during initial tests. Vehicles were examined on typical control stands and in road tests. A special methodology for road tests for coaches with anti-lock systems was elaborated. Additional checks were carried out in cases when the results of basic tests were unsatisfactory.

Technical condition of systems and elements of car vehicle are extremely important for driving safety. There are systems in which influence on passive and active safety is indisputable. One of those is suspension system. It has to be considered not just in term of vibration isolation but also in terms of ensuring proper contact between wheels and road surface. This contact determines the possibilities of steering, braking and stability of the car. Although the vibration isolation, which determine the shock, transferred to car body and vehicle's occupants can be issue of driving safety. The human exposure to whole-body vibration can affects in many ways, since the discomfort feeling through short term sickness to lose control on driving. Thus the vibration isolation can be considered as driving safety aspect as well. The fourth chapter discusses the disadvantages of commonly used methods for suspension diagnostics. Instead the novel methods for identification of technical condition of vehicle suspension in terms of driving safety have been presented. Proposed methods based on acceleration of vibration measurements in non-invasive techniques. The algorithms of vibration signal processing have been depicted. The discussion on results sensivity on chosen defects or operation and exploitation parameters show large implementation possibilities of this method.

Alternative fuels are increasingly being used to provide power of vehicles. Nowadays liquefied petroleum gas (LPG) is very popular. There are two main reasons. Firstly, availability of LPG at petrol stations - a well-developed infrastructure. Secondly, the possibilities to simply adapt the factory engines to power LPG. The most popular are oval-cross section toroidal tanks for LPG, which are mounted in place of the spare wheel. These special tanks are the low-pressure, thin-walled vessels. Safety in operation of the LPG tank depends on properly carried out procedures of the vessel shells construction. Equally important are numerical and experimental verification processes of the strength properties of the tank along with additional equipment (pressure relief valve). All operations must be carried out in accordance with the law. This is governed by the relevant regulations and standards. Continuous reduction in production costs makes that contemporary designs for LPG tanks are made on the border of the minimum strength requirements. An increasingly thin metal sheets and lower-strength steels are used in manufacture. In this situation, the safety in operation of the tank can ensure only scrupulous verification of its structure. The fifth chapter discusses the structure verification process of the toroidal LPG tanks. A range of issues have been addressed: starting from the pre-analytical calculations, through the selection and preparation of FEM numerical model, FEM numerical simulations, pressure tests, comparison of numerical and experimental results, fire tests and fatigue tests. The whole process is illustrated with an example of the calculations and experimental tests on the selected design toroidal tank. The authors have practical experience because they had the opportunity to examine many of the structures during the works of approval of the tanks, carried out at the Faculty of Transport (Silesian University of Technology).

The sixth chapter presents long-term research at JPTF. The control structures and the algorithms for PMSM including flux weakening mode were researched first and then followed the

design of the PMSM drive including EMC problems with respect to the reliability and safety of this drive for light traction vehicles. The experimental rail vehicle with independent rotating wheels driven by PMSM was constructed on the basis of this extensive research. Currently the problem of superset control systems of this vehicle is being solve. The new solution of this control will bring increasing safety of vehicle against derailment, increasing characteristics of electrodynamic brakes and also enable to utilize adhesive properties of this vehicle, which have effect on energy efficiency. The partial results of this research are given in the chapters of this article.

Areas of application of technical safety and risk models are described, the reasons of their occurrence are considered in the seventh chapter. Evolution of the term "safety" understanding and differences of its methods from reliability methods is displayed. The concept of admissible risk and a principle of its optimum value definition by criterion of specific expenditures for maintenance and minimum service of mechanical system is shown. This criterion is more objective, than practised assignment of risk limiting value by developed frequency and intensity of emergencies for the given branch. As a security measure its index representing the logarithm of the guaranteed margin of longevity is offered for the first time, defining it by means of comparison of an operating time and longevity distribution functions. The solving of the equation for an index of safety equal to zero states a conservative estimation for probability of no-failure. The safety index is convenient as a complex diagnostic parameter at control of availability index of mechanical systems state for refusals of gradual type. Due to the offered resource treatment of a safety index its estimation is harmonized at gradual and sudden refusals. The model of safety on the basis of its index is realized at prolongation of a railway specialized rolling stock resource. The many-stage methodology is developed for this purpose completed by prediction of guaranteed life expectancy. Examples of execution of the given stages are shortly shown. Studies of fatigue of carriages fragments after 30 years of maintenance are described in more details. The original model of a fatigue resistance in the form of the general equation of longevity, and also its parameters for steels, which have completed a standard resource, is offered. Lowering of cyclic strength for welding zones is examined. In the foundation of definition of a safety index the algorithm of searching of a longevity distribution function is laid which is shown for many-mode processes of railway cars stressing. For sudden refusals the limiting size of a crack in a longitudinal cradle girder is fixed, and under the theory of ejections the period of occurrence of dangerous loads is evaluated and the longevity curve is received for sudden refusals. The offered algorithms allow to raise essentially degree of a resource usage, saving demanded safety of mechanical system.

The eighth chapter presents problem of safety of sea transport, which can be divided on following three branches international law regulations (convention), seafarers education and training and technical development. Maritime transport of fluids, gases, materials and other goods for trade between countries creating economic development and played important role on the process of globalization. In the shipping, including maritime transport, there are number of players that have influence and responsibility on safety on the sea. The most important position have shipbuilder, which has responsibility for construction and technical standard of vessel, ship-owner, which decides level of technical standards of project above minimum requirements, employ crew and organize safety policy of vessel operation, cargo-owner, which pays and presses for the transport service regarding quality, time of transport, management company, which has responsibility for technical state of vessel and quality of crewing, insurer, which takes the risk of crew, cargo, vessel and results of potential accidents, classification society, which undertakes independent control on technical state of vessel on behalf of shipowner and insurer, local maritime administration, which controls safety standards in the harbour, port and navigation infrastructure and confirms quality of local educated crew, flag

state, which controls all standards connected with maritime transport, local ministry of sea affairs and defense, which are responsible for military safety (e.q. maritime piracy, fishing area, etc) and cooperation between vessels, warships and maritime authority. There are some conclusions connected with the marine environment, which are exposed on ships and vessels. All vessels were classified according to the major types. Moreover there were presented some information according to vessel problems of flotation and stability. Important role play problems of navigation for safety of sea transportation. Chapter consists of information about a new marine technology like the E-Navigation, which would help reduce navigational accidents, errors and failures by developing standards for an accurate and cost effective system. The safety of sea transport consists of problems of sea and air pollution and finally the marine piracy, which was mentioned in the chapter as well.

The ninth chapter shows security issues in the design and use of cranes and also recent accidents involving cranes in Poland and their reasons are presented. The security of transport equipment, outlined normative acts require manufacturers specific requirements for design, construction and operation. These guidelines also apply to cranes, which are the subject of this publication. In general, cranes are some of the basic equipment that can be applied in the handling and transportation of cargo. Damage of cranes, manifested by abnormal operation may lead to the emergence life-threatening conditions of people that support them. Therefore, the chapter also presents the safety design principles of cranes using the standards specifying the general principles of forces determination, its combination and load calculation. Safe operation of cranes and other handling equipment significantly depends on the technical condition and proper use as intended. Article extensively describes the equipment, that is installed in cranes, which is to increase the level of safety in the usage phase, and gives issues related to technical supervision and mandatory inspections.

The belt conveyer is one of the most basic and effective bulk material transportation devices. It is from a group of devices with the best output in terms of bulk materials. The basic components of a belt conveyer design are: drive system, carrying structure, and belt. The whole is built as an open construction with possibility of direct access to the working parts and assemblies. Such a construction should meet stringent safety requirements, particularly in the mining industry. Many questions associated with the construction operational are not solved. To them belong such as dusting on the unloading, poor output a conveyor belt cleaning equipment with residual material on the belt and under conveyor, brake safety enabling stop of the conveyor at any time and maintenance work without moving gravity. Machines are subject to continuous transport of the CE marking and the submission by the manufacturer's declaration of compliance with the applicable requirements of the law. With the number of accidents, shows that the user is also responsible for the safety of the operation, because it is required to use the machine properly, in accordance with the instructions provided by the manufacturer. Producer (designer) in order to meet the essential requirements for the product must follow a specific procedure. And wanting to meet the requirements for new machines, can use the system of technical standards harmonized to the Machinery Directive. Among the many safety aspects of working machines a continuous motion is part of the design of safety-related system, which is described in the standards. Taking into consideration that the machines running a continuous motion are the source of many hazards, discussed the issue seems to be extremely important in theory and practice.

Thus, the monograph offered here for the wide range of readers is the result of the core team, which unites the efforts of scientists from Poland, Czech Republic, Slovakia and Ukraine. The authors hope that scientists and specialists, students and teachers will find some valuable and useful aspects that will be used later in their professional practice.