

**RANDOM DISTURBANCE PROCESSES IN THE DYNAMICS OF  
RAIL VEHICLES**

**Savoskin, Anatoly N., Romen, Yuri S., Akishin, Alexander A.**

**pp. 6 – 15**

Previous works contained correlation and spectral analysis of the four-dimensional disturbance process in the form of vertical and horizontal irregularities of left and right rails, causing oscillations in rail vehicles. But when speed increases, the disturbance frequency range shifts to high frequencies and can go beyond natural frequencies of the system. Then disturbance almost ceases to excite a part of vibration frequencies and obtained results will be incorrect.

The article considers requirements to the procedure of computer generating a multidimensional stationary random disturbance process, causing vibrations of rail vehicles. Using modeling, computer simulation, and mathematical analysis it is shown that when the speed alters it is necessary to change terms of the composition of the random process of geometrical irregularities of the track. The requirements for parameters of the probabilistic analysis are determined, examples of generating and the results of spectral analysis of irregularities generated for different speeds are shown.

The article is based on the papers, presented by the authors at the International scientific and practical conference «Rolling stock's Design, Dynamics and Strength», dedicated to the 75<sup>th</sup> anniversary of V. D. Husidov, held in MIIT University (March, 20-21, 2014).

**Keywords:** rail vehicle, random processes of geometric irregularities of the track, terms of an analytical expression, impact of speed, spectral analysis.

**INTERATOMIC INTERACTIONS ON THE SURFACES OF METAL  
POLYMER TRIBOCOUPPLING**

**Kolesnikov, Igor V.**

**pp. 16 – 27**

Tribology, which originated as the science of processes in macroscopic objects, thanks to advances in quantum chemistry and the development of experimental physics of X-ray photoelectron and Auger electron spectroscopy (XPS and AES), should now extend studies to micro- and nanolevels. It is necessary to examine in more detail interatomic interactions on the friction surfaces of both antifriction and friction couplings. The objective of the article is to present the results of studies of

segregation phenomena of alloying and impurity elements in the tribosystem «wheel-brake shoes», based on finite-element method, X-ray photoelectron and Auger spectroscopy, modelling, mathematical computations and simulation.

Considering regularities of the impact of temperature and thermal gradient on tribomechanical, triboelectric and tribochemical processes within the contact area of «polymer - metal», generalized recommendations on the selection of filling and strengthening elements became available.

For anti-friction composite polymeric materials the main criterion of minimizing the coefficient of friction and high wear resistance is the ability to spontaneously form on the friction surface a bilayer film that combines lubricating properties and high adhesion due to bipolar tribocharging of its composites.

For friction materials the main criterion to avoid increased wear and transfer of metal on the conjugate plastic surface is the reduction of the degree of hydrogenation of the metal counterface by establishing the optimum temperature gradient and positive tribocharging.

The solution of related non-stationary thermoelastic problem of brake disc-pad showed that the maximum temperature within all the thickness of the disk is located not on the surface but at depth. It was established experimentally that the maximum concentration of hydrogen in the disc coincides with the maximum temperature.

The binding energy of atoms of different elements to the surface of the grain is a periodic function of the atomic numbers of the elements. This may serve as a theoretical basis for predicting the strength properties of steel with a different composition of alloying and impurity elements.

The obtained results indicate the promising application of XPS, AES and quantum chemistry in solving tribological tasks.

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**Keywords:** railway, system wheel-brake shoe, tribological coupling, metal-polymers, interatomic interaction, film, diffusion, contact thermoelastic problem, temperature, segregation, electrification.

## **ON THE MODERNIZATION OF THE BRAKE SYSTEM OF FREIGHT CARS**

**Martynov, Igor E. (Kharkov, Ukraine), Nechvoloda, Constantine S. (Kharkov, Ukraine)**

**pp. 28 – 33**

The intensification of works to improve the running parts of freight cars in recent years is associated with significant deficiencies in the design of bogies. Extensive research is conducted, entirely new designs are created, existing systems are upgraded, and performance tests are conducted in the Russian Federation, the United States, China, the Ukraine and other countries. Components and spare parts, affecting driving performance of cars, are mainly exposed to changes and much less

attention is paid to a brake system of bogies, which is very important in terms of train safety. In some innovative types of bogies attempts are made to improve the brake system with a variety of additional devices. However, during field tests this modernization shows often unsatisfactory results and its implementation is rejected due to lack of efficiency and reliability. The main problem is the inability to achieve complete return motion of the brake shoes from wheels during brake release. Three-piece bogie brake system, which is currently in use (including for innovative options) was developed in the 30s of the last century [4] so that the amendment of the design changes entails a violation of dimensional chains, to which the main parameters of brakes performance are related. Because of this, researchers and designers are still unable to find an effective solution for increasing the reliability of brake systems of bogies.

The objective of the authors is to investigate some theoretical and practical issues of modernization of brake systems of freight cars, using mathematical and engineering methods.

The article results in a theoretical justification of negative properties associated with uneven return motion of brake shoes from wheels in the brake system of three-piece bogies. Besides kinematic analysis reveals the conditions under which innovative solutions are possible. The guarantee of high efficiency of theoretically grounded modernization of the brake system of bogies is that by changing the nature of gravitational forces the latter do not incline the brake shoes to mounting in wheels, and developed design of the guide device provides a strictly uniform keeping of brake shoes relative to the forming wheel tread. Improved reliability is achieved by simplicity of design and the neutralization of destructive force moment.

The article is based on the papers, presented by the authors at the International scientific and practical conference «Rolling stock's Design, Dynamics and Strength», dedicated to the 75<sup>th</sup> anniversary of V. D. Husidov, held in MIIT University (March, 20-21, 2014).

**Keywords:** railway, freight car, brake system, kinematics, negative properties, uneven return motion of brake shoes, modernization, efficiency.

## **SIMULATION OF IRREGULARITIES OF SUBWAY TUNNEL TRACK**

**Serdobintsev, Evgeny V., Ye Win Han (Yangon, Republic of the Union of Myanmar)**

**pp. 34 – 37**

Track in subway tunnel has some differences from the design of ground railway track. Therefore, to proceed with a study using the method of mathematical modeling of linear and nonlinear oscillations of subway cars for solving a system of differential equations, it is necessary to have a «generated» random disturbance process. The objective of the authors was to present methodology and results of simulation of equivalent geometrical irregularities of subway track tunnel to solve the

problem of research of random fluctuations of passenger cars. The authors used simulation method, mathematical calculations and analysis.

Perturbation process, generated for these purposes, is provided by the approximate method of moving summation. Two possible approaches are shown, each of which includes a range of research and computation. Irregularities obtained by those methods can be used to study oscillations of dynamic models of subway cars with a similar load from a wheel set on a rail.

The article is based on the papers, presented by the authors at the International scientific and practical conference «Rolling stock's Design, Dynamics and Strength», dedicated to the 75<sup>th</sup> anniversary of V. D. Husidov, held in MIIT University (March, 20-21, 2014).

**Keywords:** subway, track, rolling stock, tunnel, geometrical irregularity, mathematical model, spectral density.

## ON INCREASE OF AXIAL LOAD

**Korolkov, Evgeny P., Koturanov, Vladimir N., Korzhin, Sergey N.**

**pp. 38 – 44**

Studies show that the stress state in the contact area is achieved by pressure in the contact area, which influences the stress. Thus, considering the Hertz contact of a spherical indenter with elastic halfspace, Huber [1] determined stresses in the cartesian reference system by a set of expressions [2]. It is easy to see that the state of stress for each point is determined by the average pressure and physical characteristics of contacting materials and coordinates of the point in question. The objective of the authors was to investigate influence of increasing axial load on the wheel-rail interaction, stress state in the area of contact and wear rate of contacting surfaces, using mathematical tools and engineering methods.

As the result of detailed calculations the authors note that there is an increase of principal stresses and pure shear stress is outside the contact area. As wear is proportional to the applied force, the wear rate of wheel and rail surfaces increases. The authors emphasize the need to study the effect of increasing the load on other elements of the rolling stock, tracksuperstructure, roadbed. It is known that productivity of railways can be improved by increasing crossing capacity and carrying capacity. In turn, carrying capacity at constant geometrical parameters of rolling stock units can be increased with increasing axial load. And that again entails changing the state of stress in the contact area of wheel and rail. The article deals with some of the problems arising in the elements of the rolling stock and track superstructure, but does not consider the effect of increasing the load on the roadbed, artificial structures, longitudinal forces in the train, its stability, etc. Hence the authors declare a need for a thorough and comprehensive study to present all the inevitable interdependences in the complex.

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dedicated to the 75<sup>th</sup> anniversary of V. D. Husidov, held in MIIT University (March, 20-21, 2014).

**Keywords:** axial load, railway, productivity, stress state, contact patch, area and rate of wear, cracks, fatigue, loading and unloading cycles, shear area.

## **STRESS-STRAIN STATE OF CARGO FRAME OF A TRANSPORTER**

**Anisimov, Petr S.**

**pp. 46 – 55**

Standard eight-axle transporters of pit type with typical cargo frame, which are in operation now, are not suitable for transportation of large unique products because of the inability to fix them firmly. A special cargo frame has been created, which is mounted on a standard eight-axle transporter of pit type instead of a standard frame. In laden position it is placed horizontally and has 4 degree bulkiness, and in unladen position it is placed vertically and is located in the clearance of the rolling stock. Stability coefficient of unloaded structure from cross-tipping in curves is 1,96 and it is higher than the maximum permissible value of 1,8. The project was implemented by the department of railway cars and cars facilities of MIIT jointly with Kaluga Turbine Plant.

The objective of the author is to investigate stress-strain state of a cargo frame of a transporter, produced at Kaluga Turbine Plant, using finite element method, comparative and mathematical methods. For that purpose rectangular plates were taken with different geometrical characteristics, perceiving deformations of tension, compression, shear and bending in two planes. Basing on the analysis of the stress-strain state of originally designed cargo frame Kaluga Turbine plant-manufacturer got recommendations for more rational distribution of the metal mass in length and cross-section, as well as a decrease in metal intensity of the spaces of the cargo frame where calculations defined very low stresses. In general, studies of stress-strain state of the cargo frame showed that it is workable, strength reliable, easy for fastening of transported products and can be safely used for regular transportation of special products on railways of Russia on the same basis in accordance with the requirements for the mass rolling stock of the car fleet.

**Keywords:** railway transporter, special cargo frame, stress-strain state, finite element method, stability coefficient.

# **IMPACT OF HIGH SPEED FREIGHT TRAFFIC ON THERMAL LOADING OF WROUGHT WHEELS AT BRAKING**

**Savrukhin, Andrey V., Neklyudov, Aleksei N.**

**pp. 56 – 62**

Braking systems on modern freight cars act in a kind of tribological triangle: brake shoe - wheel - rail. Kinetic energy stored by the car during movement at braking due to friction is converted into heat, which is distributed between a brake shoe and a wheel. Numerous studies in recent years have proved that up to 60% heat is generated in the wheel when using iron shoes and up to 95% using composite shoes. During operation the material of the wheel is subjected to thermal impact, the intensity of which depends directly on braking modes and motion parameters of the rolling stock. Repetitive heating and cooling of wrought wheels have a significant effect on the kinetics of their stress-strain state.

The kinetics of the stress-strain state in operation is determined by the scheme and the level of residual stresses, formed during heat treatment in the manufacture of wheels, as well as stresses and strains associated with mechanical and thermal loading. The level of residual technological stresses in the wheel with which it comes into operation, in some cases, is one of the main indicators of quality, reliability and durability. The combination of stress-strain state with residual technological stresses under adverse conditions, such as low temperature, presence of microdefect or local deviations in the formation of the microstructure can lead to formation of cracks in disc or brittle fracture of wheel that has been repeatedly confirmed by experts.

The objective of the authors is to investigate impact of high speeds on wrought wheels, in particular in case of thermal loading: both heating and cooling. Methods and software developed in MIIT allow computer simulation of the kinetics of thermal, thermal deformation and deformation processes in nonlinear unsteady statement with account of kinetics of the structural state at each step of the solution, which allows to analyze the current state of the structural element using a wide range of technological and operational loadings throughout the life cycle.

Continuing the theme of modeling of wrought wheels thermal loading, described in previous publications, the authors on the basis of the calculation and simulation methodology, developed with their participation in order to determine heat intensity in the system «wheel-brake shoe», clarify the features of influence of high speed of car's movement along the rails on the values of maximum temperatures on the wheel surface during braking. The study confirmed theoretically grounded assumptions that increasing speeds significantly affect the value of the maximum temperature on the surface of wrought wheel at the time of the end of braking, as well as the complex of mechanical properties, kinetics of structures, conditions causing formation of cracks, metal chipping and other defects that endanger the operation of the rolling stock.

The article is based on the papers, presented by the authors at the International scientific and practical conference «Rolling stock's Design, Dynamics and Strength», dedicated to the 75<sup>th</sup> anniversary of V. D. Husidov, held in MIIT University (March, 20-21, 2014).

**Keywords:** railway, roadbed, rolling stock, wrought wheel, brake shoe, high speed, braking, kinetics, thermal loading.

## **A RAILWAY CAR ON A FERRY: IMPACT OF SEA WAVE**

**Lovskaya, Alyona A.**

**pp. 64 – 69**

The development of foreign economic relations between Europe and Asia promotes the establishment and operation of combined transport systems. The most promising among them are considered piggyback and container transportation. In countries with access to the sea area, ferry transportation has found a successful application. The process of loading of bearing structures of car bodies when they move on rail ferries by sea requires special attention, as the dynamic characteristics, which are typical of this type of combined transportation, significantly differ from the normal operating characteristics on main lines.

The statistics of damage of cars during ferry transportation in the Black Sea area show that each year about 10% of the units of rolling stock used in international rail and water transportation require repair with uncoupling. This is primarily due to the lack of structural adaptation of car bodies to their fastening on the decks of car ferries and increased loads influencing them during transportation in terms of sea waves.

The disadvantage of usually applied techniques of research on the conditions of freight transportation using car ferries is inability to account for wave angle with its disturbing influence relative to bodies of car ferries as well as for wind load on surface projection of a ferry with cars placed on its upper deck. The likelihood of moving of a car body during a sea wave is also disregarded.

The objective of the author is to present results of research on dynamics of bodies of freight cars during transportation on car ferries in confused sea with account of different wave angles in relation to the body of the car, using mathematical modeling, analysis, comparative method. The author presents the results of studies taking into consideration main types of vibration motion of a railway car at confused sea, which influence strength and stability of the body structure, located on the upper deck of the ferry. Since the revealed values of inertial loads that act on the bodies of cars for transportation of rolling stock on car ferries exceed operating loads on main routes, it is necessary to improve bearing car structures to ensure their secure fixing to the ferry decks.

The article is based on the papers, presented by the authors at the International scientific and practical conference «Rolling stock's Design, Dynamics and Strength», dedicated to the 75<sup>th</sup> anniversary of V. D. Husidov, held in MIIT University (March, 20-21, 2014).

**Keywords:** railway-sea transportation, ferry transportation, sea waves, freight car, impact dynamics, loading of the structure, mathematical model.

## **ENHANCEMENT OF WEAR RESISTANCE OF CUTTING TOOLS DURING RAILWAY CAR'S WHEEL TURNING**

**Kulikov, Mikhail Yu., Popov, Alexey Yu., Maung, Sann (Thazi, Republic  
of the Union of Myanmar)**

**pp. 70 – 76**

Accuracy and quality of manufacture and repair of critical parts of the rolling stock running gear are directly related to manufacturing quality, accuracy and durability of the used cutting tool. One way to improve its wear resistance in material processing is reduction of the thermal stress of the contact layers of the tool and the component part by the intensification of heat removal in the cutting zone [1].

The most effective way to improve heat removal is to use coolant-cutting fluids and media (CCF and CCTM). However, there are cases where their application is impossible due to technical or technological requirements.. The objective of the authors is to analyze a problem of wear resistance increase of the cutting tool at railway car-wheel processing, using engineering analysis, modeling, statistical method, evaluation method. One of the important results of this work was to identify rational areas for the use of heatconducting interfaces for different types of mechanical processing of the wheel tread profile. A method to increase the resistance of carbide cutting tools with the use of special silicone elastic compositions of high thermal conductivity, offered by the department «Technology of transport engineering and repair of rolling stock» of MIIT, was tested. Such compositions, applied to the reference plane of the tool holder socket plate, provide elimination of air pockets in the place of contact with the carbide plate which in turn improves heat removal from the cutting plate and thereby increases its wear resistance. The use of carbide tool with flexible thermally conductive gaskets of sheet reinforced material allowed increasing resistance of the cutting tool by almost 17% according to performed tests.

The article is based on the papers, presented by the authors at the International scientific and practical conference «Rolling stock's Design, Dynamics and Strength», dedicated to the 75<sup>th</sup> anniversary of V. D. Husidov, held in MIIT University (March, 20 -21, 2014).

**Keywords:** rolling stock, wheel set, wheel tread processing, carbide cutting tool, heat removal, thermal interface, thermal compound, tool life.

## **HIGH-SPEED DEFORMATION OF COHESIVE SOILS**

**Telykh, Alexander N.**

**pp. 78 – 82**

During design and research stages of various structures of actuating elements of track and roadbuilding machines (hereinafter-TRBM) a multi-step gradual study of



the process of interaction of actuating elements with environment for further improvement served as a generally accepted technique without considering changes in the characteristics of the soil. But the change in the properties of the material imposes certain restrictions on working equipment of TRBM, affects its effectiveness. The objective of the author was to present results of theoretical and experimental research related to obtaining rheological characteristics of soils on the basis of device created with participation of the author, using engineering analysis, comparative and mathematical methods. The dynamic deformation device allows simulating an interaction of actuating elements of track and roadbuilding machines with soil ground, while using a method for determining rheological properties of dispersed materials. Finally it was confirmed that machine-soil interaction speed in the range of 3 -4 m / s should be considered optimum in terms of impact on the soil.

**Keywords:** track and road-building machines, soil, dynamic deformation, rheology, viscosity coefficient, speed of impact.

## **OPPORTUNITIES TO ENHANCE EFFECTS OF REGENERATIVE BRAKING OF DC ELECTRIC LOCOMOTIVES**

**Feoktistov, Valery P., Tretinnikov, Oleg V., Borisenkov, Sergey S.**

**pp. 86 – 92**

Regeneration system is mounted on all electric locomotives designed for driving freight trains. There has been a tendency of its use in combination with dynamic brake on passenger locomotives and electric trains.

The objective of the authors is to analyze regulatory and protection functions of electrical equipment and its operation in regenerative mode, using analytical method, mathematical calculations, simulation and comparative method.

Regenerative braking should be considered as the most effective means of reducing energy consumption in electric traction. Therefore, its scope should be expanded, including its use for returning of kinetic energy of the train to electric traction network. The authors present a methodology for calculating the energy when an electric locomotive moves downhill, analyze individual components of the energy balance, indicate possibility of increasing the efficiency of the locomotive in regenerative behavior. An analytical review of regulatory and protection functions of electrical equipment was carried out and has shown that in regenerative behavior a set of these functions is much broader than in traction. Electric equipment, implementing regeneration, should be improved using new technologies (static converters, onboard microprocessors, high-speed protection). It is necessary to keep the achieved level of functional reliability and maintain proven schematics, including cross-cyclic excitation of traction electric motors.

**Keywords:** railway, electric locomotive, direct current electric braking, recovery, traction electric motors, short circuit.

## **FORMALIZATION OF SELECTIVE TECHNOLOGY OF INFRASTRUCTURE MAINTENANCE AND SAFETY FUND**

**Krakovsky, Yuri M., Nachigin, Vladimir A.**

**pp. 94 – 99**

Any failure of technical means or abnormal operation situation reduces the intensity of rail traffic, significantly affects economic and operational performance of the transport market actors. In recent years, these complex processes have additionally been affected by threats caused by adverse changes in the economy and irregularities in the organization of transportation [1, 2]. So it is necessary to move from a traditional (situational) technology to a new one, «preventive», which is determined by means of monitoring and diagnostics based on a missed freight turnover and structural features of the track superstructure. The objective of the authors is to investigate a selective technology of repair and maintenance of the track superstructure.

The proposed technology is called selective because it is focused on repair of infrastructure on the fact (optionally, selectively). Selection implies the existence of an insurance or safety fund, which performs two functions: it collects payments with varying frequency to perform various types of repair work, and then as needed pays for these works. Cash flows related to the insurance fund, are structured and designed for a specific frequency of use, and the state of the fund itself is described by a random process of risk. Assessment of technological risk indicators and measures of reliability is given by simulation.

**Keywords:** railway, insurance fund, payments, selective technology, repairs, track superstructure, simulation, risks, costs, cash flows.

## **ALLIANCES IN THE SEA SHIPPING MARKET: BENEFITS AND RISKS FOR WORLD ECONOMICS**

**Kotlyarov, Ivan D.**

**pp. 100 – 107**

Various forms of partnership of business entities are widespread in the economy. One variety of this partnership is competitive cooperation or cooptation (from the words «cooperation» and «competition»), where competitors without stopping real competition for the consumer, are joining forces in the industrial, scientific, technical, financial and other sectors to reduce costs and improve customer service. The most striking result of this collaboration for all its members is the emergence of a unique competitive advantage over other market players outside the partnership (alliance). The objective of the author is to investigate competitive cooperation at the cargo shipping market as a certain form of partnership, using

analysis, evaluation method and economic approach. The author analyzes the differences of competitive cooperation from other forms of business organization. The risks are shown, which are associated with development of alliances at the container shipping market as well as with dual role of such economic unions, when at the same time with maximization of benefits partners have undue pressure on consumers and limit the competitive industry environment. The story of the project of alliance P3 et al., followed by 2M and O3, leads to the conclusion that at international container shipping market there is an objective need for consolidation of operators. However, carriers, cooperating on one or a limited number of routes, don't interact on other key routes, where new alternative alliances emerge. Consolidation of carriers should not be too comprehensive (to prevent emergence of a dominant player, able to impose its will on a global scale). The presence of national regulatory authorities, linked to certain centers of the world economy, protect the interests of these centers, and thereby contribute to the preservation of competition in global markets.

**Keywords:** maritime transport, economy, container traffic, competitive cooperation, market cooperation, cartel, alliance.

## **QUALITY OF TRANSPORT INTERCHANGE HUBS: INTEREST AND DEMAND**

**Evreenova, Nadezhda Yu.**

**pp. 108 – 114**

The efficiency of the transport interchange hubs (hereinafter -TIH) functioning is closely related to the quality of service provided to its passengers and visitors. Like any other products and services, transport services provided to customers have a qualitative component. Requests of passengers are satisfied not only in course of transportation, but also by a set of additional services in TIH, increasing the quality of the entire trip, making it less burdensome and more attractive. Quality of service of TIH users is a combination of economic, technological, technical, aesthetic, environmental indicators, enabling their needs for transport (mobility) and service (additional services) sectors of the passenger complex [see 1-6]. Along with the price and reliability of transportation, quality of services is increasingly becoming a determining factor attracting passengers, and hence cumulating revenues of transport companies.

The objective of the author is to present a sequence of developing of a system of indicators and of evaluation of the quality of service of passengers and visitors of the transport interchange hub.

The article suggests three groups of indicators or indices (simple, complex, integral). Furthermore a coefficient of the significance of an individual quality indicator is proposed to be determined by the survey, expert assessments or statistical methods, and the values of generated indicators - through the differential estimate, characterizing the level of the actual value of private quality indicator as compared to the standard (normative) value. Development and implementation of measures to

improve the quality of service in TIH is associated with significant costs, so some preliminary marketing research of demand and transport service market conjuncture, thorough economic calculations of efficiency are required.

**Keywords:** transportation, transport interchange hubs, interaction of transport modes, competition, demand, quality of service, economy, management, complex indicator of quality.

## **MULTIMODAL CONTAINER TRANSPORTATION OF GRAIN**

**Kirichenko, Sergey A., Lahmetkina, Natalia Yu.**

**pp. 116 – 125**

Record grain harvests in 2009 and 2011 in Russia showed that the country's export capacity is limited by transport complex, carrying capacity of specialized grain terminals of ports, as well as fleet of specialized rolling stock of grain cars [1].

Transport infrastructure lags behind the needs of the agricultural industry. Part of the grain is loaded through the ports of other countries. On the other hand Russian transport industry is focused on forecasted average annual value of the export of grain, as downtime of special equipment in the lean years, caused by narrow profiling of equipment, results in complexes. In this connection, containerization of export grain cargo flow is becoming increasingly of interest for researchers. The objective of the authors is to investigate multimodal container transportation of grain in railway-sea and automobile-sea traffic, using analytic, statistic and comparative methods. The article analyzes benefits, technical conditions and risks of container transportation of grain as well as highlights features of bulk cargo transportation with pre-tilting of the container during loading. Two main types of tilters - mobile and stationary are investigated. The practices developed for international shipments can be used for domestic transportation a drop of economic performance of transshipment as well.

**Keywords:** marine, railway, car, elevator, grain, container transportation, technology, tilter, bulk cargo.

## **MAPPING OF PROCESSES AS A TOOL OF INDUSTRIAL ENGINEERING**

**Kalinina, Daria V., Budchenko, Lyudmila V.**

**pp. 126 – 137**

In terms of companies with complex organizational structure focused on the functioning of various business verticals and interaction of multiple crosscutting processes, a correct approach to the organization of production is particularly

important. Every company that cares about the future of its activities and attraction of revenues, provides continuous control of overhead costs and looks for ways to eliminate them. Among many approaches to improve the production organization the theory of lean production has taken its place in recent years. The concept of lean production requires the involvement of all employees to search for and eliminate losses. In Russia, the concept of lean production is used by such large companies as JSC «KAMAZ», holding company «GAZ», JSC «Sberbank», JSC «Mosenergo» and others. But the tools were developed primarily for typical industrial processes, so they need to be adapted to the implementation at the enterprises where main activities focus on services, e. g. regarding transportation system. The project of lean production in JSC «Russian Railways» is deemed to identify and reduce losses in the implementation of cooperation within the holding company between various departments, as well as external customers. One of the most important instruments of lean production is mapping of production and technological processes. The objective of the authors is to investigate mapping of the processes particularly with regard to JSC «Russian railways», using special mapping technique, comparative method, and general scientific methods. The article describes stages of planning and implementation of mapping and its special transport-related features. The main conclusion is that while implementing mapping to transportation company it ultimately should not be seen as a way to reflect the technological sequence of operations, but as a look at the technology of manufacturing processes from the perspective of the customer, that is, from the point of view of the consumer (internal or external).

**Keywords:** transport, lean production, loss reduction, value for a customer, business value, technology of processes' mapping, map of value stream, operations evaluation parameters.

## **LEVELS OF ORGANIZATIONAL RELIABILITY OF SYSTEMS**

**Klyuka, Vladislav P., Leksutov, Ilya S., Lutoshkina, Tatiana A.**

**pp. 138 – 144**

The reliability of the transportation process, as well as the railway infrastructure capacity are provided by the organizational and technical complex. The objective of the authors is to review levels of organizational reliability of the transportation process in Russia regarding railways, to study different dependences, management levels and algorithms of the work of employees as a result of the deep reforming of the sector, using economic evaluation, general scientific methods, comparison. Reliability of transportation depends on a set of technical requirements, inherent to railways, but also on other parameters, which ensure satisfaction of customers.

Customers are regarded as passengers, consignors, freight forwarders, and the owners of rolling stock. Actions of such contractors must comply with the rules established and adopted by market participants, which focus primarily on

maintenance of the transportation process. Reliability is also provided by manufacturing plants that manufacture rolling stock. The article contains examples of new forms of interaction at macro- and micro- (local) of the actors of the rail industry. The authors state that as a result of structural changes rail transport has become a highly competitive environment that links together the various institutions of society and simultaneously adjusts the contradictions between the major sectors of the economy. Given the increasing role of rail traffic in the global economy increase in the reliability of organizational and technical systems at all levels will strengthen the competitive advantages of the national transport system.

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**Keywords:** railway, organizational and technical system, interaction of objects, reliable operation, infrastructure, transportation process, algorithm.

## **SIDING SHEATHING SHAPE AND CYCLES OF VIBRATION LOADING OF GONDOLA CARS**

**Lapshin, Vasily F., Kolyasov, Constantine M., Dolgikh, Constantine O.**

**pp. 148 – 153**

The design of the side walls of freight gondola cars, designed for the use of vibration loading technology assume their sheathing with sheet profiles. Earlier held survey of technical state of gondola cars with a body height of 2365 mm, delivered for unloading and cleaning of cargo residues using vibration equipment [3] revealed an increased damageability of elements of the side walls. About 90% of gondola cars had separations of siding sheets from the side wall pillars and cracks of up to 200 mm in the corners of middle and upper corrugations of the first and second panels. This led to the fact that a new edition of GOST 22235, in force since 2010, prohibits the delivery of cars with body height of 2365 mm for unloading using vibration technology. To increase the operational reliability of such complexes, different designs, models are offered, new calculations and experiments are conducted. The article presents the results of authors' research, conducted primarily with simulation and hybrid modeling methods, its conclusions and options of alternative sheathing profiles, tested in Yekaterinburg, showing the possibility of using overhead vibration machines for unloading gondola-cars with a height of the body of 2365 mm and with account of permissible time of operation of the rolling stock.

The article is based on the papers, presented by the authors at the International scientific and practical conference «Rolling stock's Design, Dynamics and Strength», dedicated to the 75th anniversary of V. D. Husidov, held in MIIT University (March, 20-21, 2014).

**Keywords:** railway, gondola-car, sheathing profile, loading cycles, overhead vibration machine, allowable loading time, stress concentration, cargo hovering, damageability of elements, turnaround time.

## **INTERVAL REGULATION WITH TEMPORARY CHANNEL DIVISION**

**Bestemyanov, Petr F., Zakharov, Denis P.**

**pp. 154 – 160**

Known automatic cab signaling (continuous automatic cab signaling (CACS), integrated continuous cab signaling (ICCS)) involves integration of a separate signaling channel in the rail line, which is a disadvantage in terms of material and energy costs. Except for the coverage of the numerical code automatic locking cab signaling maintains its inherent weaknesses, in particular the problem of electromagnetic compatibility of transmission / reception path of track circuits in parallel operation of automatic blocking and automatic cab signaling. The objective of this article is to consider options for organization of polling / transmission based on requirements for the response time of the system for interval regulation with time division. With account for requirements for reducing energy consumption in the traffic control it is proposed to use a signal of the rail line control as a signal for automatic cab signaling using temporal division of channel for polling of track circuits and information transmission to the locomotive. Useful signal parameters are determined depending on the polling time of the area (response time of the system). It is shown that during temporary control of the rail line it is necessary to strive to have a selection of chains with approximately equal length, and to comply with a number of conditions.

Acknowledgments. The research was held and article was written with the support of Russian Foundation for Basic Research, grant № 13-08-13138.

**Keywords:** railway, control system, interval traffic control, automatic locking, automatic cab signaling, time division.

## **DIMENSIONING OF ZONES OF LASER THREATENING TO AIRCRAFTS**

**Rahmanov, Boris N., Kibovsky, Vladimir T.**

**pp. 162 – 181**

Issues of blinding of pilots of aircrafts with laser items have been discussed for some years. In many countries legal regulations stipulate arraignment for offenses of that kind. And the article put forward a problem: what are the geometric parameters (dimensions) of the region of space surrounding the aircraft in which laser products

can actually pose a real threat to flight safety? The article assesses methods of determining a size of areas of possible blinding and possible eye damage of a pilot, as well as minimal risk height of the aircraft, where temporary blinding of a pilot or damage to the retina of his eyes become possible. The results of the analysis suggest conducting organizational and technical measures, enabling to reduce the laser threat to flight safety. The authors considered examples of expert assessment of «laser hooliganism» cases, recorded in the first half of 2014. A methodology to estimate a degree of a real laser hazard to flight safety described in this paper can serve as an effective tool in determining legal liability for laser hooliganism.

**Keywords:** aviation, aircraft, flight safety, «laser hooliganism», zone of probable blindness of a pilot, zone of probable damage to eyes, minimum dangerous flight altitude, expert evaluation, laser dosimetry.

## **GEOMETRIC CONTROL MODELS OF CARS' EXHAUST GAS RECIRCULATION**

**Abbasov, Alexander E.**

**pp. 182 – 191**

Ensuring compliance with requirements for the emission of harmful substances in accordance with the standard Euro-4 is one of the priorities in the design of devices associated with a reduction in toxicity of motors [1, 2]. Up to 60% of harmful emissions into the atmosphere accounts for road transport.

The use of modern information technologies of visualization and three-dimensional computer modeling of devices of systems intended for toxicity decrease of cars allows for a systematic analysis at any level of difficulty. The technical result of creation of three-dimensional computer geometric models (hereinafter - TDCGM) means reduction in time and computing resources spent on the design. The objective of the author is to investigate a new technique for creation of geometric control models of EGR system.

The data for visual analysis with the help of 3D images of the EGR control system components are analyzed, the choice of software is justified and 3D modeling of recirculation valve for the car «Kalina-2» is conducted. In particular, there are improvements in layout scheme of recirculation valve, control parameters of its materials and weight and size characteristics. A method is proposed to simplify design and calculation of transient electromagnetic processes of synchronous stepper motor with permanent magnets, ensuring the operation of the valve.

The practical application of the method enables to reduce the timing of preliminary design stage, to improve the weight and size parameters, to calculate the transient electromagnetic processes for subsequent optimization of parameters of EGR system by criterion of reduced power losses of an automobile engine.

**Keywords:** environmental safety, car, exhaust gas recirculation, system analysis, virtual space, simulation.



## **MOBILE ACOUSTIC CONTROL SYSTEM OF WHEEL SETS**

**Bondarenko, Vyacheslav V. (Kharkov, Ukraine), Skurihin, Dmitry I.  
(Kharkov, Ukraine)**

**pp. 192 – 197**

Defective wheels and axle boxes of cars still remain among main reasons that lead to disasters, accidents and significant material costs for rail transport. In this regard, an extremely important problem is reliable and accurate detection of defaults at the early stage of emergence. It is difficult to completely eliminate the occurrence of failures in the form of local irregularities on the wheel tread taking structural, technological and operational measures, because their causes can be within a range of unpredictable random factors: short-term dynamic unloading of wheel sets when passing over irregularities of rail tracks, the volatility of the coefficient of friction of the wheels and rails, etc. In this case, the actual task is a rapid identification of a wheel defect arose in transit and timely notification of the train crew and rail services to prevent threats to safety, minimize the likelihood of damage and reduce maintenance time trains. A new wireless onboard diagnostic system of passenger cars is proposed, which is designed to detect defects of wheel sets. This system is based on the method of acoustic control. Under the body of the passenger car microphones are mounted through which in the automatic mode recording and the analysis of frequency range of an acoustic signal from wheels and axle bearings, allowing detecting timely deviations from the set standards. This onboard diagnostic acoustic system has obvious advantages over its ground acoustic analogs, since the latter, as known, have problems with the reliability of the diagnosis because of the negative impact on the accuracy of the Doppler effect, especially when trains run past the stationary located microphones at high speeds.

The article is based on the papers, presented by the authors at the International scientific and practical conference «Rolling stock's Design, Dynamics and Strength», dedicated to the 75<sup>th</sup> anniversary of V. D. Husidov, held in MIIT University (March, 20-21, 2014).

**Keywords:** car, wheel set, damaged wheels, defect diagnostics, acoustic method, onboard control system

## **THE IMPACT OF PROFESSIONAL WORK EXPERIENCE ON INDUSTRIAL INJURIES RATE**

**Dementieva, Yulia V.**

**pp. 198 – 204**

There is a hypothesis that professional experience has a significant impact on the safety and with its increase professional competence and mastery of employees

grow, and hence the risk of an accident reduces. The objective of the author is to investigate the impact of professional work experience on the industrial injuries on the example of the track maintenance section of Kuibyshev Railway. The findings, presented in the paper, are based on statistical analysis and calculation of the degree of correlation between the average length of service and the number of victims of accidents. Variables, measured in the interval scale, and Pearson correlation coefficients were taken into account.

The author drew an unpredictable conclusion that the number of victims of accidents at work in no way depends on their professional work experience. To support her statement, the author provided certain explanations. Editorial note: the authors' technique could be applied to larger sample to verify the correctness of those conclusions.

**Keywords:** work safety, industrial injuries, track facilities, maintenance section, professional work experience, correlation.

## **LEARNING OF LEAN PRODUCTION**

**Steblyansky, Nikolai V., Gaidukov, Alexander M.**

**pp. 206 – 221**

The world has changed rapidly, today those companies benefit more that keep pace with the changes taking place, that increase their efficiency. Now there is a change in economic structures [1], the traditional mass production is giving way to a lean, more efficient, active and flexible in terms of consumer demand.

When creating the concept of practical training for production system of JSC «Russian Railways» a question arose what could be its foundation. Attempts to subordinate task of staff training in large companies to the interests of lean production (flexible in responding to market demand) do not always lead to success. This is confirmed, in particular, by data, cited in the article, collected from surveys of executives of the holding structures, which are held at the Corporate University of JSC «Russian Railways», as well as by the analysis of the experience of foreign companies and enterprises.

The general opinion of experts, the adopted approaches of the classical corporate training does not always meet the conditions of the time, it is necessary to look for new ways of knowledge transfer. The dynamics of the globalizing market is so high that the classical training system is not keeping pace with ongoing reforms, as traditional training is focused mainly on the transfer of knowledge, rather than on the audience involvement. They can hardly serve as an ideological influence on the audience, change their mindsets, train leaders. This contradicts the very idea of improving the production system.

The article the way how a new system of corporate training adapted to the interests and ideology of lean production was implemented. The article contains detailed review of approaches of lean production itself as well as authors' conceptual approaches to the creation of a «system of lean learning», serving the needs of the

lean production. The objective of the authors was to analyze advantages and disadvantages of lean learning system, using experience of the large foreign and Russian companies. Adaptation and debugging of learning processes, perhaps, are the most difficult issues in the practical application of the concept of lean production, and it is understandable. The development is impossible without a change of thinking, and it is also to be done, if the educational goals become such a comprehensive and responsible vector.

**Keywords:** corporate university, lean production, lean learning, systematic approach, management personnel, business result.

## **TRANSPORT INDUSTRIAL-ACADEMIC PARTNERSHIP AS A KEY SUCCESS FACTOR OF INNOVATION**

**Jan C. Harder (Constants, Germany)**

**pp. 226 - 242**

The author examines cooperation of large companies of the railway industry and universities in R&D, its contribution to innovative development of railway industry within a wider context of the increasing role of transport technologies in meeting challenges of globalization. Forms of corporate innovation process, participation in international research programs, including EU funded projects, interaction with universities, particularly with MIIT are analyzed at the example of the Alstom Group. The article in view of innovative achievements, which are key for rail transport, gives examples of technical results of the implementation of environmentally friendly and high-tech developments in the field of energy efficiency, ergonomics and qualitative improvement of the high-speed rolling stock.

**Keywords:** university, transport, partnership, innovation, research, intellectual property, human capital, energy efficiency, rolling stock, high speed rail.

## **SIMPLICITY WILL SAVE THE WORLD**

**Grigoriev, Nikolai D.**

**pp. 244 – 253**

The article is a historical review of the biography of Fedor Pirotsky. The rational ideas of this man not only anticipated the development of rail and electric transport in XIX century, but also played a great role in the fate of electric traction on railways, underground metro lines, the birth of the prototype of the modern tram, as well as those systems of electricity production, which on the basis of the principle «generator-motor» helped solve the problem of its transmission to the consumer over long distances without large losses. The figure of Fedor Pirotsky is also interesting

because a general reader knows very little about him. The life of the inventor was full of ups and downs. Some of his ideas were accepted enthusiastically, but many of his proposals were ahead of his time and were duly appreciated only after the death of this outstanding inventor.

**Keywords:** rail transport, rail conductor, electric train, electric tram, underground, track circuits, electrified line.

## **WORKING LIFE OF DIESEL ENGINES: A RETROSPECTIVE ANALYSIS (PART 2)**

**Sirotenko, Igor V., Gogrichiani, Georgy V.**

**pp. 258 – 268**

This is the final part of the review article (for the first part see *World of Transport and Transportation*, 2014, Vol.12, Iss. 6, pp.212-221) showing that diesel engines of the first post-war II generation were characterized by inherent structural deficiencies of new developments, unfinished ideas. The results of studies carried out in that period are considered, technical solutions taken at that time are critically analyzed, including those that aimed at addressing identified problems. The analysis allowed the authors, in particular, to draw conclusions that for this generation of diesel engines brands of used metals, wear resistance and fatigue strength of cast iron, features of bearing fillets, cylinder block group, the quality of welded joints had the fundamental importance. As follows from the obtained data, engine components are not equal in their impact on engine reliability and working life, form their levels of importance, have their own «place» in the design of the engine structure as a system.

**Keywords:** railway, history, diesel locomotive manufacturing, diesel locomotive, working life, failures, retrospective analysis, regularities of the postwar generation.

## **TRANSPORT IN THE SYSTEM OF INTERSECTORAL INTERACTION**

**Macheret, Dmitry A.**

**pp. 270 – 274**

**THE REVIEW OF THE BOOK:** Pozamantir, Elmar I. *Computable general equilibrium balance of economy and transport. Transport in a dynamic intersectoral balance.* Moscow, Poly Print Service publ., 2014, 280 p. ISBN 978-5-904466-07-7.

**Keywords:** transport, economy, interindustry interaction, development dynamics, mathematical model, computable general equilibrium, infrastructure, investment, fixed assets.