ABSTRACT AND REFERENCES

ENGINEERING TECHNOLOGICAL SYSTEMS

IMPROVING THE DESIGN OF CAGES FOR BEARINGS OF HIGH TECHNICAL LEVEL (p. 4–8)

Anatoly Gaydamaka

The structure of roller bearings of axle boxes of freight and passenger cars was analyzed. The type of bearings depends on the operating conditions in a particular country. In the UK, the US, Japan, Poland, railcars are equipped with wheelsets with double-row cylindrical roller bearings. In Austria, bearing assemblies with two cylindrical roller bearings are used, and in Sweden – axle unit with two spherical roller bearings. Conventional, most massive cylindrical roller bearings (almost 99 % of all bearings) of axle boxes of Ukrainian freight and passenger cars were chosen as the basic design taking into account the technical and economic aspects of operation. Structural decomposition of basic bearings according to functions was performed. Structural and functional relationships of the bearing parts and elements of parts were revealed, the structural-functional model was constructed, making it possible to improve the functions of cages of basic bearings. Several new functions of cages appeared – the function of elimination of misalignment of its design, the function of reduction of forces of interaction with rollers and locator ring, the function of slippage reduction of rollers. The design changes in the cage components by increasing the number of windows, the convex shape of side surfaces of jumpers, profile section of the cage rings, which contribute to raising the technological level of bearings within the specified dimensions were grounded.

Keywords: roller bearings, bearing structural-functional model, bearing cage functions, cage design.

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RESEARCH INTO PARAMETERS OF ENERGY LOSS WHEN TRAINS INFLUENCE THE TRACK WITH WOODEN SLEEPERS (p. 9–13)

Yusef Tuley, Natalia Bugaets, Alina Malishevskaya

The magnitude that quantitatively characterizes the process of interaction between the track and the rolling stock was determined as equivalent coefficient of dissipation (ECD). This coefficient, as an estimated magnitude, takes into account all kinds of friction forces in the process of dissipation – the forces of dry friction that depend on the deformation of the track structure, as well as viscous friction forces that depend on deformation velocity, and, possibly, other types of friction forces. These forces exert considerable effect on the characteristics of strength of a railway track and, therefore, on the safety of motion, which is why the research in this paper is quite relevant.

Theoretical positions are presented that allow us to determine a mathematical formula for the calculation of ECD for rail supports of railway track.

We detected the values of vertical and horizontal transverse ECD for the wooden sleepers, for which we used data of experimental studies carried out at 12 sections of Ukrainian railways with different operational conditions. Based on these data, dependence was established of ECD of rail supports in the vertical and horizontal plane on the magnitude of tonnage that passed the track. Results of the experiments indicate that with an increase in tonnage from 0 to 300 million tons, values of coefficients of dissipation in the vertical plane increase by 1.5–1.9 times, and in the horizontal plane – by about 1.3 times.

Based on the aforementioned, there is a possibility of practical use of ECD to determine the current state of the track and a need for repair work.

Keywords: dissipative forces, equivalent coefficient of dissipation, empirical dependences of changes, rail supports.

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RESEARCH INTO DEFECTIVENESS OF WELDED JOINTS OF STEAM PIPES OPERATED OVER A LONG TIME (p. 14–20)

Alyona Glushko

The welded joints of steam pipelines of the power units of thermal power plants, which are operated for long periods under conditions of creep and low-cycle fatigue, are the most damaged elements of power units. By the attributes of cohesion, we presented the classification of the types in the defectiveness of the welded joints of steam pipelines, which is appropriate to use for refining the special features of physical-chemical processes and structural changes that occur in metal of the welded joints of steam pipelines. The represented types of damages are characteristic for the welded joints, which exhausted their base resource, including the prolonged one. We revealed the most characteristic places of defectiveness in metal of the welded joints and orienting of cracks towards the weld metal, as well as the metallographic attribute of defectiveness. The physical-chemical processes are examined, which specify structural changes in the long-operated welded joints of steam pipelines. We examined the process of slowing down the dislocations by the carbide precipitates, which coagulate lengthwise and, in the form of intermittent chains, are concentrated along the boundaries of grains of the α-phase. We established that the creep pores to the largest degree are formed in the places of contact between coagulating carbides and grains of the α-phase. It was revealed that the creep cracks are formed at the sections of incomplete recrystallization of the heat-affected zone of welded joints (about 75 %), the fusion (approximately 15 %), while the rest is at other sections of HAZ, as well as in the weld metal and in the base metal.

It is demonstrated that the creep cracks developed by the brittle mechanism, which is contributed by the presence of segregations in the near-boundary zones of grains of the α-phase. We established that the fatigue cracks predominantly develop at the section of fusion, overheating and incomplete recrystallization of HAZ, as well as near the backing rings in the places of contact of the pipe elements with different thickness. Dependence is detected of the reduction in metal resistance of the long operated welded joints of steam pipelines to the formation of fatigue cracks on the level of degradation of their structure. Data of present study are necessary for obtaining welded joints with decreased defectiveness in the process of prolonged operation under conditions of creep and low-cycle fatigue.

Keywords: defectiveness of welded joints, welded joints of steam pipelines, heat-affected zone, heat-resistant pearlitic steels

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RESEARCH INTO THE FACTORS WHICH INFLUENCE EFFICIENCY OF THE WATER SUPPLY NETWORKS RECONSTRUCTION BY THE «BERSTLINING» TECHNOLOGY (p. 21–28)

Dmitriy Goncharenko, Alevtina Aleinikova, Vladlen Volkov, Sergey Zabelin

The experience of operating enterprises over recent years has attested to the fact that in Ukraine an increasing attention is paid to the questions of using trenchless technologies, known in the world as NO-DIG or TRENCHLESS TECHNOLOGIES. In this connection, it is necessary to highlight the restoration of the water utilities networks by the «Berstlining» method, which provides carrying out earthworks with a minimum volume and impact on the surrounding massif. On the basis of field research at the objects of restorations of water utilities networks, we generalized technical and organizational-technological peculiarities of conducting the work by the «Berstlining» method.

With the aid of the method of expert estimations, we defined the factors that influence the effectiveness of conducting repair work. Using the method of ranking of the revealed factors, the most significant of them are determined, such as: physical-mechanical conditions of the soil, technical condition of the existing pipeline, the longitudinal profile of the section for restoration. Results of the studies attest to the fact that the detailed research into these factors will make it possible to improve the technical and economic indices of reconstruction works, which is a key aspect under conditions of limited financing of the enterprises of water utilities in Ukraine.

Keywords: water supply, pipeline, water utilities networks, trenchless technologies, the «Berstlining» method.

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STUDY OF THE PROCESS OF SOIL STRIP TILLAGE BY VERTICAL MILLING ADAPTER (p. 28–36)

Eugen Prasolov, Yuriy Bielovol, Svetlana Bielovol

The substantiation of expediency of developing and determining optimal parameters of the implement for pre-sowing soil tillage by the Strip-till technology, was presented. The technical solution of the vertical milling adapter for strip tillage of soil, which is protected by an invention patent, was developed. The analytical study of the influence of vertical milling adapter on working medium indicates the achievement of high-quality soil crushing and stirring with the adjustable parameters of cultivation depending on the conditions of its performance and the assigned quality indicators. On the basis of regulative documents, the procedure of conducting laboratory and field studies was substantiated and the experimental plant with vertical milling adapters was developed. The factors, influencing the work of the experimental plant and the optimal indicators of quality of the technological process, were defined. We established the dependence of the parameters of tillage quality on the adapter parameters, according to which the maximum content 77.5 % of fractions with optimal diameter from 0.001 to 0.005 m and from 0.005 to 0.01 m in the cultivated layer is achieved at angular rotation velocity of the adapter disks 26.5 s^{-1} and velocity of translational motion 2.2 m/s; the optimal value of density 1.2 ... 1.25 g/cm^3 is achieved at angular velocity of rotation of adapter disks 14...16 s^{-1} at different values of velocity of translational motion; the maximum content of plant residues 79 % of optimum size from 0.005 to 0.03 m is achieved at angular velocity of rotation of adapter disks 26.5 s^{-1} and velocity of translational motion 1.2 m/s.

Keywords: strip tillage, vertical milling adapter, working medium, kinematical parameters.

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MATHEMATICAL MODELING OF STRENGTH OF HONEYCOMB PANEL FOR PACKING CONTAINERS AND PACKAGING WITH REGARD TO DEVIATIONS IN THE FILLER PARAMETERS (p. 37–43)

Vitaly Gaydachuk, Ganna Koloskova

A mathematical modeling of strength of the honeycomb panels for packing containers and packaging is presented. A panel works under combined loading by the forces of compression and shear. The Bubnov-Galerkin method is used for the solution of the problem on stability. The solution of the problem on stability of a three-layered panel includes the physical-mechanical characteristics of honeycomb filler, which depend on the geometric dimensions of honeycomb filler. Locations of origin of imperfections in the parameters of honeycomb filler are analyzed. Special features of the influence of deviations in filler on its physical-mechanical characteristics are examined. An analysis of the effect of deviations in the parameters of honeycomb filler on the bearing capacity of a three-layered panel is carried out. It is demonstrated that for the provision of value of critical shear in the range of permissible values, it is necessary that the deviations in the parameters of honeycomb filler are within certain interconnected ranges. A basic result of the represented study is the improvement of the model of strength of a three-layered panel taking into account the influence of deviations in honeycomb filler for the case of complex loading by the forces of compression and shear of the elements of packing containers and packaging. Results of the study might be used for the solution of the problem on determining the quantitative characteristics of quality and working ability of a three-layered honeycomb panel.

Keywords: packaging materials, three-layered panel, honeycomb filler, imperfections in filler, model of strength.

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PREDICTION OF THE PROPAGATION OF CRACK-LIKE DEFECTS IN PROFILE ELEMENTS OF THE BOOM OF STACK DISCHARGE CONVEYOR (p. 44–52)

Leonid Polishchuk, Orest Bilyy, Yevhen Kharchenko

The criteria of evaluation of technical condition of structures with crack-like defects on the basis of the concept of «resistance of structural element to crack propagation» were proposed. This indicator is a characteristic of the rate of change in stress intensity factor at the top of the crack in the structure element in the course of its development.

For six model cases of crack-like defects, taking into account the theoretical principles of mechanics of destruction of materials and structures, we established analytical dependences of SIF K_I and derivative dK_I /da with respect to dimensionless parameter a/t, where a and t are characteristic dimensions of a crack and a slab. We substantiated the characteristic values of ratios (a/t)*, as well as the depth of potential crack-like defects, in case of exceeding of which there is an abrupt increase in the rate of change in stress intensity factor K_I. Values (a/t)* will be used for assessing the strength and reliability of elements of constructions with crack-like defects.

At the same time, using the created experimental database and analytical relationship in the form of the Paris power law, the criterial values of SIF in the studied elements of structures for different systems «material-environment» were defined. These values are put into the basis of calculating critical lengths of crack-like defects in profile elements of the structure by the model scheme, considered above.

The examples of assessing technical condition of damaged elements of a structure according to the cracks depth with regard to operational factors (load nature, influence of working media, condition of material etc.) were considered. Engineering recommendations for the prediction of crack-like defects were formulated.

As an analysis of the outcomes of conducted studies demonstrated, monitoring of defect detection of profile elements of the boom of stack discharge conveyor is necessary to carry out, guided by the calculations of resistance of material to crack propagation. Each system «material – environment» requires an individual approach to diagnosis and monitoring of technical condition.

The research outcomes might be used for engineering evaluations of the results of monitoring of profile elements of the boom of stack discharge conveyor.

Keywords: boom of stack discharge conveyor, profile element, crack-like defect, resistance to crack propagation.

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THE USE OF CONTACT HEAT GENERATORS OF THE NEW GENERATION FOR HEAT PRODUCTION (p. 52–58)

Gennadii Varlamov, Kateryna Romanova, Olga Daschenko, Mykola Ocheretyanko, Stanyslav Kasyanchuk

We substantiated the need for searching for, and realization of, fundamentally new approaches, using more efficient physical, heat-mass-exchanging and aerodynamic processes, which will make it possible to improve energy effectiveness and ecological cleanliness of heat generation in the systems for individual and decentralized heat supply.

For the heat supply to large cities and industrial regions, we examined the advantages of using highly efficient contact heat-generators of different types, which include compactness due to low metal consumption and, as a result, attractive price.

It is proposed to use a heat-generator of contact type of the new generation, with the aid of which it was possible to solve a set of problems on the qualitative combustion of fuel and effective heat exchange of gases with the heated water. The use of tubular technology for the combustion of gas is its special feature. Due to it, quality heat exchanging characteristics are provided.

In view of further studies, we presented the relevance of creating heat-generators with the use of highly effective hydrogen technologies, which will make it possible to devise the new energy paradigm of heat supply for residential areas and industrial zones through the possibility of accumulation of electrical energy and accumulation of hydrogen.

Keywords: contact heat-generator, thermal energy and heat supply to large cities and industrial regions, heat generation.

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